OMRON

Fleet Operations Workspace Core

User's Manual

I635-E-06

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This manual was originally written in English. Created in the United States of America

Table Of Contents

Revision History

Revision code	Date	Revised Content
01	June, 2019	Original release
02	October, 2019	Corrected errors
03	March, 2020	Added information for Fleet Simulator.
04	June, 2020	Added HD-1500, EULA, and PrecisionDrive support.
05	May, 2021	Updates for FLOW 2.1
06	March, 2022	Updates for FLOW 2.2

Chapter 1: Introduction

The Fleet Operations Workspace Core (FLOW Core) is OMRON's solution for setting up, integrating and managing an autonomous mobile robot (AMR) fleet within a factory environment. FLOW Core provides the software tools to connect the autonomous mobile robot (AMR) fleet, the factory's manufacturing control solution, establish maps, define operational rules, and ensure safe, consistent operation on the factory floor.

This user's guide covers the basic procedures for installing and using the FLOW Core software to set up and manage your AMR fleet. Some advanced operating procedures are discussed in later chapters of the guide.

The following topics provide an introduction to the Fleet Operations Workspace Core.

1.1 Fleet Operations Workspace Core Overview

The Fleet Operations Workspace (FLOW) Core is a suite of mobile-robotics software applications for programming and operating a fleet of AMRs within a factory environment.

The FLOW Core software fully integrates OMRON’s AMRs and fleet management appliances (EM2100) to provide complete AMR fleet solutions. It incorporates specific tools to simplify integration with factory equipment and material-movement solutions (MES and ERP Solutions - refer to Related Manuals on page 19).

> **NOTE:** While this manual focuses primarily on fleet applications, the tools, capabilities, and techniques explained here can be used by customers deploying single AMRs as well.

FLOW Core software releases are coordinated to update both the AMR platforms and the fleet management systems for optimal performance with every new release.

FLOW Core software is installed at the OMRON factory on every AMR that OMRON produces. These AMRs can operate on their own, but are most effectively used in fleets. To support fleet operations, an additional Fleet Manager appliance is necessary.

OMRON provides two Fleet Manager configurations based on its standard EM2100 appliance, providing customers the option to purchase a Secondary unit as a backup, if desired. See Configure Paired Appliances on page 30 for setting up paired Fleet Managers.

> **NOTE:** The EM2100 is also the platform on which the Fleet Simulator runs. Refer to the *Fleet Simulator User's Manual (Cat. No. I649)* for information on the Fleet Simulator.

Table 1-1. OMRON Fleet Managers

Appearance	Product Type	Product Name	Model
	EM2100 Platform	Primary Fleet Manager	20271-900
	EM2100 Platform	Secondary Fleet Manager	20271-901
	EM2100 Platform	Fleet Simulator	20271-903

1.2 How the Fleet Operations Workspace Components Work Together

The figure below is a basic system architecture (for a fleet of AMRs) and illustrates the inter-relationship between Fleet Operations Workspace Core's various applications.

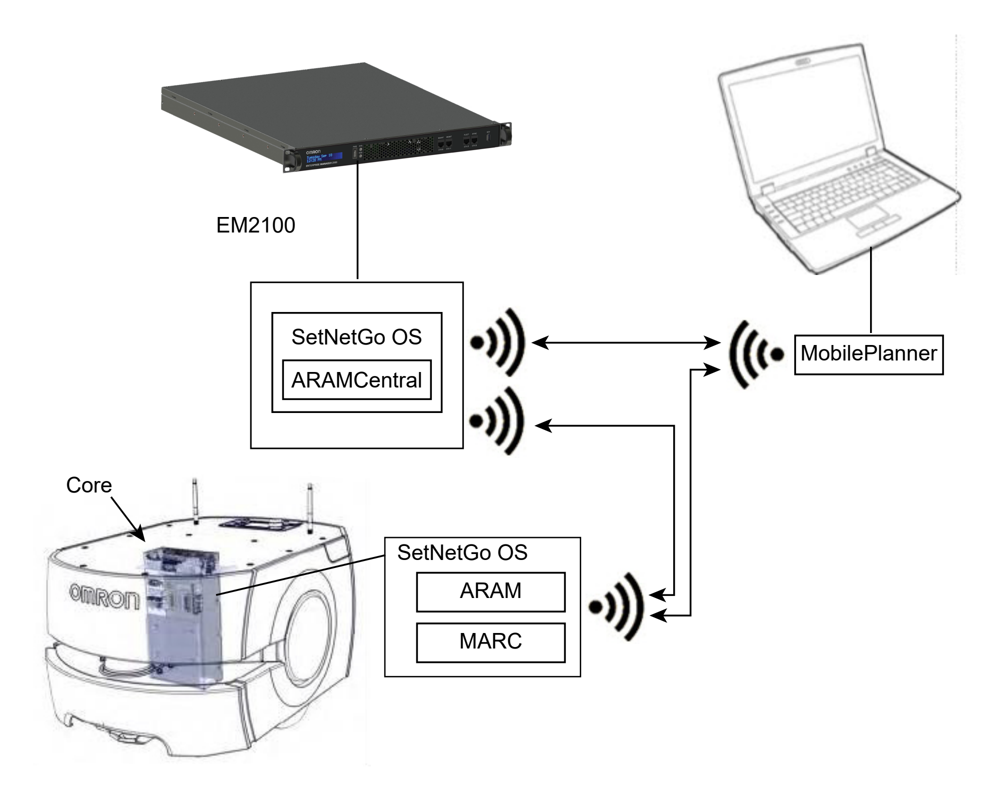


Figure 1-1. Components Working Together (LD-60 AMR Shown)

EM2100

The EM2100 is a network appliance, with built-in processor. It can be used to run the FLOW Core fleet management software or the Fleet Simulator software. As a Fleet Manager, the

EM2100 coordinates the movement of up to 100 AMRs. It manages maps, AMR configurations, traffic control, and job queuing. FLOW Core licenses are activated on the Fleet Manager.

> **Version Information:** Fleet Simulator support was added in FLOW Core version 1.1.

MobilePlanner

MobilePlanner is the graphical user interface (GUI) for communicating with and configuring the AMR, and displaying and editing AMR map files. It is the "control center" of the Fleet Operations Workspace Core. Its user interface has the tools for all major AMR activities, such as observing a fleet of AMRs, commanding individual AMRs to drive, creating and editing map files, goals, and tasks, modifying AMR configurations, and more.

The AMRs use map files to determine where they are, plan navigable paths to goals, execute tasks at programmed goals, and to control other AMR tasks.

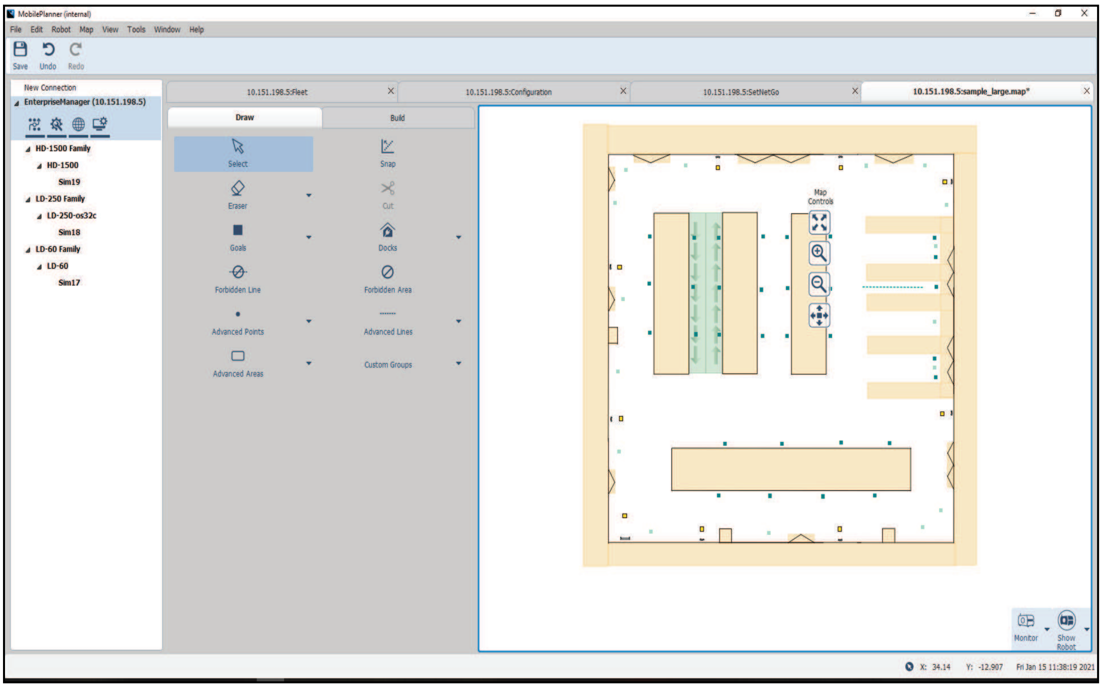


Figure 1-2. MobilePlanner Interface

From the MobilePlanner interface, you can:

- Connect to and drive the AMR.
- Create maps of the environment by importing and analyzing an AMR’s scan data.
- Edit maps by adding goals (and adding tasks to those goals), docks, forbidden areas, and more. You can also erase stray or unwanted artifacts, combine pieces of maps, and make other changes.
- Download and upload files, including maps and scan data, to and from an AMR.

- With the Fleet Manager, monitor the location and status of all AMRs in a fleet.
- View and interact with the job queuing manager.
- Manage the configuration parameters for the Fleet Manager, AMR groups, and individual AMRs.

For details, see MobilePlanner Interface on page 53.

MobilePlanner Accounts

User accounts with limited privileges provide the user with access to a limited set of tools for monitoring AMR and AMR job status, and allow for simple interventions in job execution sequences. For more information, refer to MobilePlanner Operator Account Overview on page 57.

SetNetGo

SetNetGo is the operating system that resides on AMRs and the EM2100 appliance. You can use the SetNetGo software to establish and configure your AMR's communication parameters, access diagnostic information (for example, download debug info file for service provider use, manage restore points, etc.), and perform software maintenance (upgrades). You most commonly access the SetNetGo interface through a tab in the MobilePlanner software, and then use that interface to enable the parameters needed.

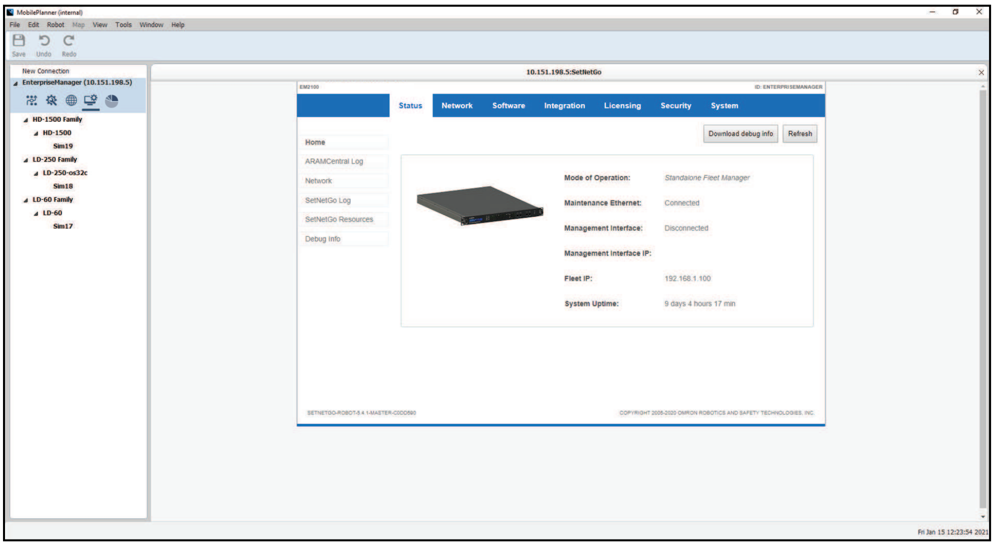


Figure 1-3. SetNetGo Interface

For details, refer to Overview of the SetNetGo OS on page 126.

> **NOTE:** Optionally, you can connect to SetNetGo through a web browser. Refer to Connecting to SetNetGo via web browser on page 127.

ARAMCentral

As the fleet management software running on the EM2100 appliance, Advanced Robotics Automation Management (ARAMCentral) provides:

- Centralized configuration and map management.
- Job queuing and dispatch.
- Traffic management.
- Single-point of integration and communication for software clients and other automation equipment.

ARAM

The Advanced Robotics Automation Management (ARAM) software runs on the AMR's core, and does the following:

- Performs all the high-level, autonomous robotics functions, including obstacle avoidance, path planning, localization, and navigation, culminating in the AMR’s motion.
- Manages wired and wireless Ethernet communications with off-board software, for external monitoring, development, and systems coordination, including coordination of a fleet of AMRs through the Fleet Manager.
- Enables external monitoring and control with the MobilePlanner application.

MARC/Polo

Mobile Autonomous Robot Controller (MARC), which resides on the LD-series AMR core, manages the AMR’s speed and heading, sensor readings, emergency stop systems, bumpers, and pendant. It also computes and reports the AMR’s odometry readings (X, Y, and heading) and other low-level operations which it reports to ARAM.

Polo performs the same functions for the HD-1500 AMRs.

1.3 Fleet Operations Workspace Licensing

There are licensing options for both FLOW Core and advanced features. These licenses help customers manage the costs of their AMR fleets through lower, annual subscription payments for FLOW Core and activation of advanced features only if they provide benefits to your specific applications. The licenses currently available are listed in the following table.

Table 1-2. Available Fleet Operations Workspace Licenses

Product	Product Description	Model
Primary Fleet Operations Workspace (FLOW) Core License	Entitlement for a 1 year renewable Primary FLOW Core license, runtime and development, per AMR connection.	20271-800
	Entitlement for a 5 year renewable Primary FLOW Core license, runtime and development, per AMR connection.	20271-806
Secondary Fleet Operations Workspace (FLOW) Core License	Entitlement for a 1 year renewable Secondary FLOW Core license per fleet, redundant runtime.	20271-802
	Entitlement for a 5 year renewable Secondary FLOW Core license per fleet, redundant runtime.	20271-807
Primary Fleet Manager (Temporary)	EM2100 appliance with Temporary 120 Day Fleet Operations Workspace license.	20271-900
Secondary Fleet Manager (Temporary)	EM2100 appliance with Temporary 120 Day Fleet Operations Workspace license.	20271-901
Bundle, Fleet Simulator	EM2100 appliance with entitlement for perpetual Fleet Simulator license.	20271-903
License, Fleet Simulator	Entitlement for perpetual Fleet Simulator license for use with existing EM2100 appliance, simulation runtime and development.	20271-804
Fleet Operations Workspace iQ, 1 Year License	Entitlement for a 1 year renewable FLOW iQ license.	20271-701
Fleet Operations Workspace iQ, 5 Year License	Entitlement for a 5 year renewable FLOW iQ license.	20271-705

To obtain the latest version of the Fleet Operations Workspace (FLOW) Core software, contact your local OMRON representative. An active subscription is required for access to software upgrades.

Additional Information:

- After four consecutive 1 year renewals (for a total of 5 years) or after purchase of a 5 year license, all fleet management functions will continue to operate without requiring subsequent subscription renewals. An active subscription will still be required to have access to subsequent software releases, including bug fixes, feature upgrades and performance improvements.
- Expiration of a 1 year subscription license without renewal will result in cessation of the fleet management functions of the OMRON AMR solution until the license is renewed.

1.4 How Can I Get Help?

For details on getting assistance with your OMRON software or hardware, you can access the corporate website:

http://www.ia.omron.com.

If you need help beyond what is covered in the manual, contact your local OMRON representative.

Related Manuals

Manual	Description
Mobile Robot LD Safety Guide (Cat. No. I616)	Describes safety information for OMRON LD-series AMRs.
Mobile Robot HD Safety Guide (Cat. No. I647)	Describes safety information for OMRON HD-1500 AMRs.
LD Platform OEM User's Guide (Cat. No. I611)	Describes the installation, start-up, operation, and maintenance of the LD-60 and LD-90 AMRs.
LD-250 Platform User's Guide (Cat. No. I642)	Describes the installation, start-up, operation, and maintenance of the LD-250 AMR.
HD-1500 Platform User's Manual (Cat. No. I645)	Describes the installation, start-up, operation, and maintenance of the HD-1500 AMR
LD Platform Peripherals Guide (Cat. No. I613)	Covers peripherals for LD AMRs, such as the Touchscreen, Call/Door box, and Acuity Localization options.
EM2100 Installation Guide (Cat. No. I634)	Describes the installation and initial configuration of an EM2100 appliance.
Fleet Operations Workspace Migration Guide (Cat. No. I636)	Describes the procedures for migrating your AMR from legacy to FLOW Core software, and from an EM1100 to an EM2100.
Fleet Operations Workspace Core Integration Toolkit User's Guide (Cat. No. I637)	Describes specific tools to simplify integration with factory equipment and material-movement solutions such as manufacturing execution systems (MES) and equipment resource planning (ERP) solutions.
Fleet Simulator User's Manual (Cat. No. I649)	Describes the operation of the Fleet Simulator.
Advanced Robotics Command Language Enterprise Manager Integration Guide (Cat. No. I618)	Describes the Advanced Robotics Command Language (ARCL) version for use with the EM2100 software. ARCL is a simple text-based command and response server used for integrating the Fleet Operations Workspace Core platform with an external automation system.
Fleet Operation Workspace Core Integration Toolkit User's Guide (Cat. No. I637)	Contains information that is necessary to use the Integration Toolkit facilitating integration between the Fleet Manager and the end user's client application.

Chapter 2: Safety and Regulatory Information

2.1 Safety and Regulatory

OMRON LD AMRs adhere to the following domestic and international safety regulations:

- EN 1525 “Safety of Industrial Trucks. Driverless Trucks and their Systems”
- ANSI 56.5:2012 “Safety Standard for Driverless, Automatic Guided Industrial Vehicles and Automated Functions of Manned Industrial Vehicles”
- JIS D 6802:1997 “Automated Guided Vehicle Systems - General Rules on the Safety”

OMRON's HD-1500 AMRs are evaluated to the following standards:

- EN ISO 10218-1
- UL 1740
- EN 60204-1
- EN ISO 13849-1

2.2 Warnings, Cautions, and Notes

Where needed, this manual calls out critical, important, or emphasized text via special alert notifications. Below are explanations of the special alert notifications used in this manual:

WARNING: This indicates a potentially hazardous situation which, if not avoided, will result in minor or moderate injury, or serious injury or death. Additionally, there may be significant property damage.

CAUTION: This indicates a situation which, if not avoided, could result in minor or moderate injury or in property damage.

IMPORTANT: Important indicates information that the reader needs to know to use the system correctly.

NOTE: Notes provide supplementary information, emphasize a point or procedure, or give a tip for easier operation.

Version Information: This indicates information that only applies to certain versions of software or hardware.

2.3 General Safety Precautions

Read the installation and operation instructions, as well as the appropriate robot user's guide and robot safety guide before using the equipment.

- Do not ride on the AMR.
- Do not exceed the AMR’s maximum weight limit.
- Limit operation to areas with no slope.
- Do not drop the AMR, run it off a ledge, or otherwise operate it in an irresponsible manner.
- Do not get the AMR wet, or expose the AMR to rain or moisture. The AMR has an IP rating of IP20.
- Do not use power extension cords with the docking station unless properly rated.
- Do not run the AMR if hair, yarn, string, or any other items are wound around the AMR’s axles or wheels.
- Never access the AMR’s interior with the charger attached. Immediately disconnect the battery after opening the battery compartment door.
- Never short the battery’s terminals together.
- Do not use parts (including charging docks, etc.) not authorized by OMRON

2.4 Safety Commissioning

Safety standards require testing of the AMR's safety systems by a trained and qualified person, both before leaving the factory and again at the customer's site.

Safety commissioning is executed from the MobilePlanner main menu. Access and execute the safety commissioning procedure from MobilePlanner by selecting **Robot** > **Safety Commissioning**.

The safety commissioning procedure is guided by on-screen prompts. The instructions that you see will be based on the type of robot that you have connected. The procedures will test each E-Stop and Safety Laser on the AMR, as well as the E-Stop on the pendant. Details for running these procedures are given in each AMR user manual.

2.5 What to Do in an Emergency

Press the **E-Stop** button (a red push-button on a yellow background/field) and then follow the internal procedures of your company or organization for an emergency situation. If a fire occurs, use either a type ABC or BC dry chemical extinguisher.

2.6 Additional Safety Information

We provide more safety information in the following manuals:

Mobile Robot LD Safety Guide (Cat. No. I616) and Mobile Robot HD Safety Guide (Cat. No. I647)

The *Mobile Robot LD Safety Guide (Cat. No. I616)* and *Mobile Robot HD Safety Guide (Cat. No. I647)* provide detailed information on safety for our AMRs. They also give resources for more information on relevant standards. A safety guide ships with each AMR.

Chapter 3: Fleet Manager Configuration and Operation

The Fleet Manager capabilities within FLOW Core provide tools for programming and configuring individual AMRs and fleets, and for centralized job dispatch and real-time AMR monitoring within your facility.

3.1 EM2100 Configuration Overview

This section provides instructions for setting up and connecting the AMRs and Fleet Manager to a network.

OMRON's EM2100 appliance provides the operating environment for the FLOW Core software. It will be the primary interface device to the network and any PC(s) running MobilePlanner. The EM2100 appliance comes pre-loaded with temporary, 120 day, FLOW Core and Flow iQ licenses, which allow initial set-up, testing, and validation to begin immediately, without a full subscription. FLOW Core and FLOW iQ licenses must be purchased after the 120 day set-up period.

> **NOTE:** The EM2100 can also run in the Fleet Simulator operating mode, with a Fleet Simulator license. Refer to the *Fleet Simulator User's Manual (Cat. No. I649).*

Configuration Tasks Overview

> **NOTE:** This section assumes that you have read and followed the instructions in the *EM2100 Installation Guide (Cat. No. I634).*

To configure the EM2100 appliance as a Fleet Manager, you must do the following tasks, which are described in detail later in this guide:

- Configure the network settings for the appliance Management Ethernet port.
- Configure the network settings for the FLEET ETH2 Ethernet port.
- Connect the Management and Fleet ports to the LAN.
- Define the login information.
- Configure each AMR to connect to the EM2100.
- Customize each AMR, if desired.

If you install a Secondary EM2100 appliance and configure Autosync, you must also:

- Install the same FLOW Core software version on the Secondary as is on the Primary appliance.
- Configure a unique IP address for the Management port.
- Connect the Management port to the LAN.

- Connect the FLEET ETH2 port to the LAN.
- Enter the Secondary Management IP address on the Primary appliance.
- Generate and download a key from the Primary appliance.
- Set the Secondary appliance Autosync role to Secondary.
- Upload the key to the Secondary appliance.
- Verify that the status of both appliances is active.
- Create a direct network connection between the Primary and Secondary appliances.

3.2 Power Interruptions

Use the front momentary power switch to turn the EM2100 on and off. The rear power switch should remain on unless you are uninstalling the appliance.

Power Interruptions on a Standalone EM2100

If there is an interruption to the power supply for any reason or duration, a standalone EM2100 automatically returns to its previous power state.

- A standalone appliance that was shut down and powered off when the interruption occurred remains shut down after you restore power.
- A standalone appliance that was powered on when the interruption occurred restarts automatically after you restore power.

After recovery from a power interruption, the EM2100 saves its job queue status and recovers the queue automatically after it restarts following a power failure. This does not apply to an operator-initiated emergency power off.

Power Interruptions on an Autosync Appliance

This section assumes that you configured Autosync on two EM2100 appliances and connected each appliance to separate power circuits for redundancy. Providing that only one circuit was affected, one appliance should remain operating normally during the power interruption. The sequence of events and method of recovery depends on which appliance is affected:

A power interruption on the Primary appliance results in a loss of connectivity with AMRs and MobilePlanner. You should:

- Determine whether the problem is a power outage or a loss of network connectivity.
- Manually reconfigure the Secondary appliance to become the Primary Appliance. Fleet Management functions are restored but Autosync status is now disabled.

  Autosync will need to be re-configured once the power issue with the original EM2100 appliance is resolved.
- Verify that MobilePlanner and AMRs reconnect to the Fleet IP address.
- Review the job queue status in MobilePlanner and verify the status of AMRs to make sure that no jobs are incomplete.

- Restore power to the former Primary appliance.
- Change the former Primary appliance to a role of Secondary appliance.

A power interruption on the Secondary appliance results in no loss of connectivity with AMRs and MobilePlanner. You should:

- Verify that MobilePlanner and AMRs are connected to the Fleet IP address.
- Review the job queue status in MobilePlanner and verify the status of AMRs to make sure that no jobs are incomplete.
- Restore power to the Secondary appliance. Autosync will be restarted if it was running when the power was interrupted. Fleet operations should be unaffected.

If both Autosync appliances are affected by a power interruption, they both behave as described in: Power Interruptions on a Standalone EM2100 on page 25:

- All fleet operations are terminated during the power interruption.
- Normal Active Autosync operation resumes automatically after you restore power to both appliances.
- The Primary EM2100 saves its job queue status and recovers the queue automatically after it restarts. Autosync will reconnect automatically when power is restored.

3.3 Set the IP Address on a Client PC's Network Adapter

Use the Maintenance Ethernet port to connect a client PC to the SetNetGo operating system.

IMPORTANT: You must assign a static IP address. Do not use a DHCP server.

Configure the network adapter IPv4 address on the Client PC as follows:

1. Connect an Ethernet cable from the client PC’s Ethernet port to the Maintenance Ethernet port on the EM2100 appliance.
2. In the command field on the Windows taskbar, enter the following command to open the Network Connections dialog: **ncpa.cpl**
3. Open the network properties of the PC ethernet network adapter used to connect to the Maintenance Ethernet port on the EM2100 appliance.
4. Double-click TCP/IPv4 to open the Internet Protocol properties dialog.
5. Enter as the IP address: 1. 2. 3. 5, or any IP address in the range 1. 2. 3. 0 to 1. 2. 3. 255, excluding 1. 2. 3. 4. (this is reserved for the Maintenance port).

   NOTE: For HD robot series the IP address is 169.254.10.15.

6. Enter as the subnet mask: 255. 255. 255. 0.
7. Click **OK** to close the Internet Protocol dialog, and then click **OK** to close the Ethernet Adapter dialog.

In future, you can use the Maintenance Ethernet port for emergency access to the Appliance at IP address 1.2.3.4. (For example, if you lose the password or if there is a network IP address conflict.)

3.4 Connect Your PC to SetNetGo on the EM2100

SetNetGo enables you to configure and manage EM2100 and AMR settings. This section describes how to access SetNetGo through the Maintenance port to perform initial configuration.

The user interface for SetNetGo on an EM2100 provides a different set of parameters and options compared to SetNetGo on an AMR. The upper left of the screen shows EM2100, LD, LD-250, or HD depending on your SetNetGo context (the device on which it runs, such as the OMRON LD-series AMRs).

Configure Access and Security

After you connect to the Maintenance Port as described in: Set the IP Address on a Client PC's Network Adapter on page 26 you can open the SetNetGo web interface.

Connect your browser to SetNetGo and configure SetNetGo access as follows:

1. In the SetNetGo web interface, click the Security Tab and then click SetNetGo Access and check **Enabled** next to the following:

   Maintenance Interface is automatically enabled.

   - Wireless Ethernet/User LAN Ethernet
   - (Optional) Remote Reboot.

2. Change the account password (default is no password) as required and click **Apply**.

   NOTE: Passwords are limited to a maximum of 20 alphanumeric characters.
   For increased security, specify a long (10+ characters) password string with both uppercase and lowercase letters. Include several digits.

3.5 Configure Management Interface Network Settings

To configure the Management Network, you require:

- A dedicated static IP address. (Do not use 1.2.3.4. That address is permanently assigned to the Maintenance Ethernet port.)
- The subnet mask for the Management network.
- The IP address of the network Gateway.
- The IP address of a Domain Name Server (DNS) (this is only required if any hostnames will be used in the Fleet Manager configuration), so that the Fleet Manager can resolve all IP addresses.

Configure the Management Interface network connections as follows:

1. In the SetNetGo web interface, click the **Network** tab.
2. Click **Management Interface** and enter the:

a. IP address.

b. Subnet mask.

c. Network Gateway IP address (typically a router).

3. Enter the IP address of your Domain Name Server (DNS), if required for devices other than the appliance and the fleet. Otherwise, leave it as 0.0.0.0.
4. Click **Apply**.

A message dialog informs you of the status of the change, and whether there is any affect on operations such as a restart or a time delay before the change takes effect.

3.6 Configure the Operating Mode

Configure the Operating Mode as follows:

1. In the SetNetGo web interface, click the **System** tab.
2. Click **Mode.**
3. Select the operating mode in which you will be using this EM2100.

   The choices will be:

   - Unconfigured (this is how the EM2100 ships)
   - Standalone Fleet Manager
   - Paired Fleet Manager
   - Fleet Simulator

   If a mode is grayed out, it means that you don't have the license to support that operating mode. Refer to Licensing Tab on page 138.
4. Click **Apply**.

   You will be shown several warning pop-ups. Respond **OK** to all.

   The EM2100 will reboot.

   At this time, **Status** > **Home** > **Mode of Operation** should show the operating mode that you selected.

A message dialog informs you of the status of the change, and whether there is any effect on operations such as a restart or a time delay before the change takes effect.

Additional Information: Licensing is activated when you initially configure the operating mode of the EM2100.

3.7 Configure the Fleet Interface Network Settings

To configure the Fleet Interface, you require:

- A dedicated static IP address to assign to the Fleet Interface port. This IP is allowed, but not required, to be on the same subnet as the Management IP. Do not use 1.2.3.4,

because that address is permanently assigned to the Maintenance Ethernet port.
- The subnet mask for the network that your Fleet will use.
- The IP address of the network Gateway.

Configure the Fleet Interface network connections as follows:

1. In the SetNetGo web interface, click the **Network** tab.
2. Click **Fleet Interface** and enter the:
   a. IP address.
   b. Subnet mask.
   c. Network Gateway IP address (typically a router).
3. Click **Apply**.

A message dialog informs you of the status of the change, and whether there is any affect on operations such as a restart or a time delay before the change takes effect.

3.8 Configure Paired Appliances

The default (when shipped) configuration for an EM2100 is Unconfigured. The configuration will need to be set as either a Standalone or Paired Fleet Manager.

To create an Autosync pair, refer to Configure the Primary Appliance on page 31 and Configure the Secondary Appliance on page 32. The paired appliances then function as follows:

- The Primary unit is a fully-functional EM2100, running the Fleet Operations Workspace Core and actively controlling the fleet.
- The Secondary unit is powered on, with its web interface accessible to the Primary unit. However, the fleet management functions are inactive on the Secondary unit, and it is inaccessible from MobilePlanner or AMRs.

The Primary Fleet Manager has two active IP addresses, while the Secondary has only one active IP address.

EM2100 Autosync — Ethernet Cabling

The following figure shows the physical connection of Ethernet cables to the appliances.

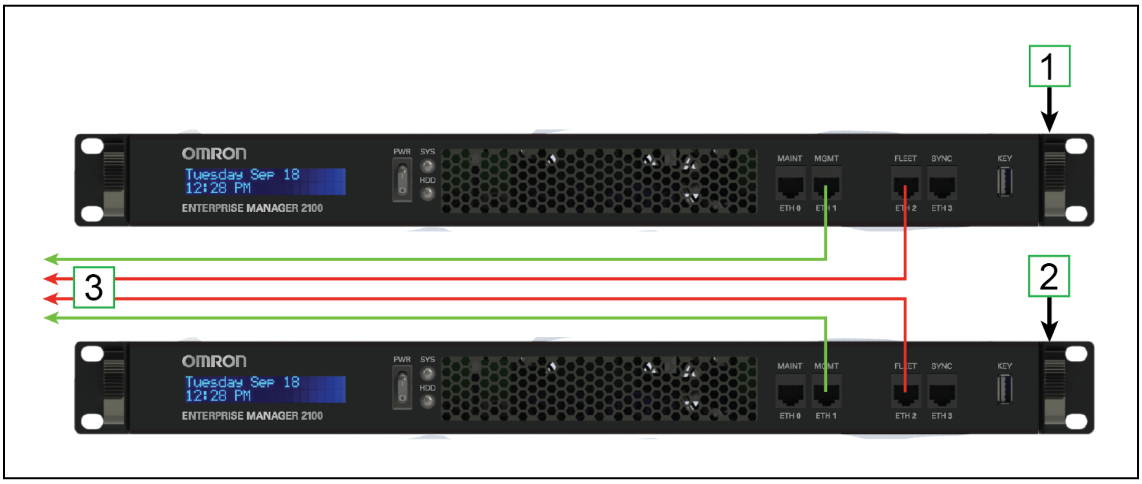


Figure 3-1. Cabling for an EM2100 Fleet Manager Pair

Callout	Description
1	EM2100 configured as a Primary appliance.
2	EM2100 configured as a Secondary appliance.
3	Ethernet cables to the LAN switch: • Primary and Secondary MGMT ETH1 • Primary and Secondary FLEET ETH2

Tasks in Autosync Setup

Before you set up Autosync, make sure that you have:

- Installed the Primary appliance and connected it to the network.
- Configured the Maintenance Ethernet interface on the Primary appliance.
- Physically installed the Secondary appliance hardware, as described in the *EM2100 Installation Guide*.

The tasks required to set up autosync between a Primary and Secondary appliance are:

- Configure the Primary appliance with a Fleet IP Address.
- Enter the Secondary appliance IP Address in the Primary appliance.
- Generate and Download the Primary key (to your PC).
- Set the Secondary appliance Autosync role to Secondary.
- Upload the Primary key to the Secondary appliance.

Configure the Primary Appliance

Do this only if you have two Fleet Manager appliances, and you want to configure one as a Primary Fleet Manager. You must first configure the Management and Fleet networks and cable the appliances.

1. In the SetNetGo web interface, click the **System** tab, then **Mode**.
2. Select **Paired Fleet Manager** from the drop-down menu. Click **Apply**.

   You will get a "Confirm Appliance Mode Change" pop-up message.

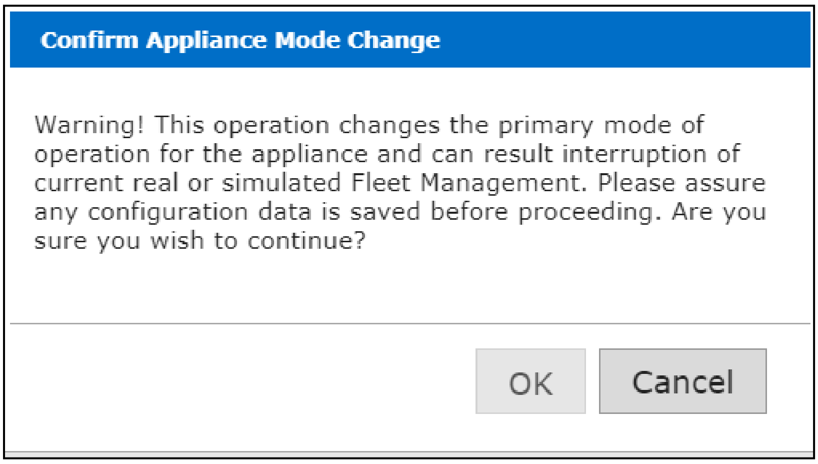


Figure 3-2. Confirm Appliance Mode Change Window

3. Click **OK**.

   You will get a second pop-up with a warning that this operation will interrupt the fleet management.
4. Click **OK**.
5. Click the **Pairing** Button that appears in the left margin of the screen.

6. From the drop-down menu next to the Pairing Role, select **Primary**, and click **Apply**.
7. Enter the IP Address of the Secondary appliance. Click **Apply**.
8. You will get a message to confirm changes, saying that ARAMCentral will restart, disconnecting AMRs and clients. Click **OK**.
9. You will get a confirmation message that the changes were successfully applied. Click **OK**.
10. Click **Generate New Key** to create an SSL key, or **Download Existing Key**, if you previously created an SSL key.

    Uploading the SSL key to the Secondary appliance grants permission for the Primary to perform RPC calls required for synchronization.
11. You are prompted for a location to save the key file. Enter a location (path) where you want to save the file on your PC, so you can later upload it to the Secondary appliance.
12. A warning message indicates the pending disconnection of AMRs and clients. Click **OK**.

Your Primary Fleet Manager is now configured to run as part of a pair.

Configure the Secondary Appliance

Do this only if you have two Fleet Manager appliances, and you want to configure one as a Secondary Autosync appliance. You must first:

1. In the SetNetGo web interface, click **System** tab, then **Mode**.
2. From the drop-down menu choose **Paired Fleet Manager** and click **Apply**.
3. You will get a "Confirm Appliance Mode Change" pop-up message. Click **OK**.
4. You will get a second pop-up with a warning message that this operation will interrupt the fleet management. Click **OK**.
5. A Pairing selection will appear in the left margin of the screen. Click on **Pairing**.

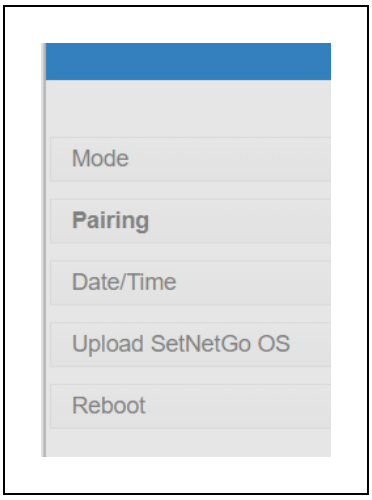


Figure 3-3. Pairing Selection, Left Bar

6. From the drop-down menu, next to the Pairing role, choose Secondary. Click **Apply**.

   You will get a Confirm changes message that ARAMCentral will halt, disconnecting AMRs and clients. Click **OK**.

7. You will get a confirmation message that the changes were successfully applied. Click **OK**.

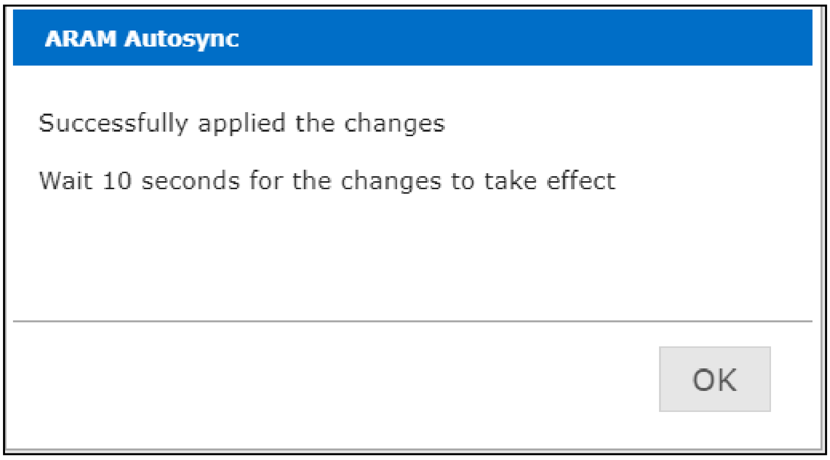


Figure 3-4. Changes Successfully Applied Window

8. Click **Choose File** to select the Primary SSL key from your PC to chose the proper file.

   Enter the name and path of the file to upload the key from the PC.

9. Click **Upload**.

   Your appliance is now configured as a Secondary appliance.

   NOTE: Although the Fleet Interface settings are saved for the Secondary appliance, the interface is inaccessible.

When the connection is complete, the Primary and Secondary appliances show a Current Status of *active*.

3.9 Configure Each AMR to Connect to the Fleet Manager

Before you can use the Fleet Manager appliance to manage AMRs, you must configure each AMR to connect to the appliance. To do so, you must connect to each AMR.

In most cases when an AMR connects to the appliance, the Fleet Operations Workspace Core overwrites the AMR's configuration parameters with Fleet parameters.

AMR Configuration Settings

To connect an AMR to the EM2100 appliance:

1. Launch MobilePlanner on your client PC and connect to the AMR's IP address.

   If this is a new AMR, its IP address will be the factory setting of 1.2.3.4 for LD-series AMRs, and 169.254.10.15 for the HD-1500 AMR. The connection must be hard-wired, because the AMR's wireless won't be configured yet.

2. Open the **Configuration** tab.

3. Check **Show Expert Parameters** to show the advanced configuration parameters.

4. From MobilePlanner, Config select **Fleet** and then **Fleet Manager Connection**.

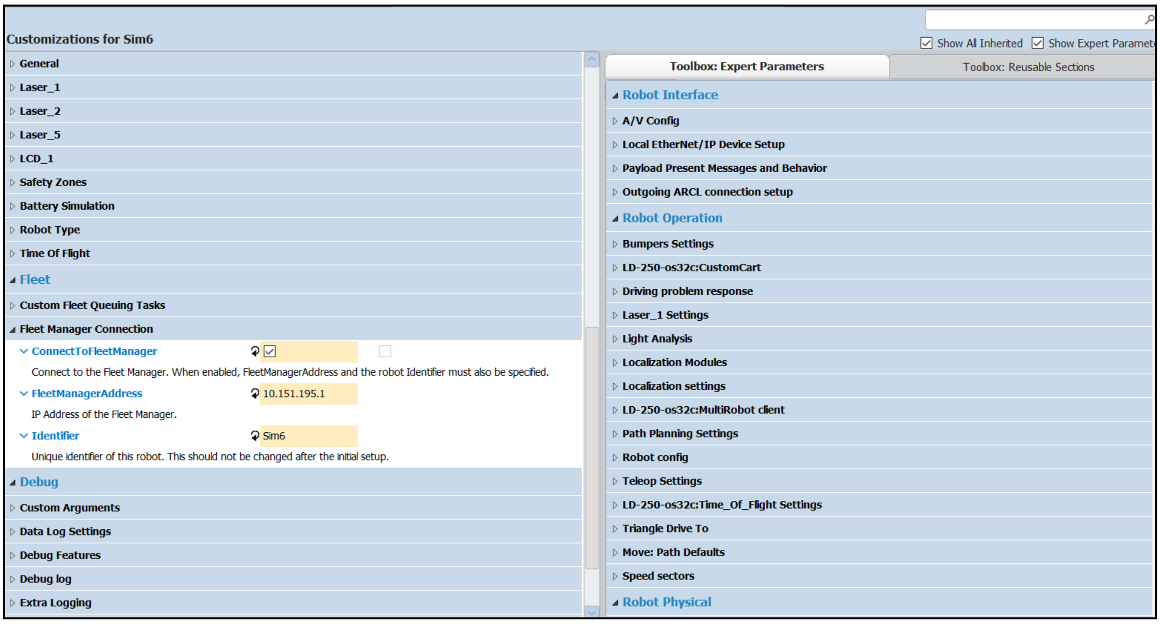


Figure 3-5. Fleet Manager Connection Screen

5. Check the **ConnectToFleetManager** checkbox.

6. Enter the IP address of the EM2100 appliance in the **FleetManagerAddress** field.

   > **NOTE:** This is the Fleet IP address, not the Management IP address of the EM2100.

7. Enter an identifier in the **Identifier** field. You must use unique identifiers for each AMR. Do not change this identifier after initial setup.

Repeat these steps for each AMR that you want to add to the fleet controlled by this EM2100 Fleet Manager.

Fleet-Level Settings

From MobilePlanner, Config, on the Fleet Manager:

1. Select **Fleet** and then **Fleet Features**.
2. Check the **FleetManagerGatherScans** box.

   This enables Fleet Operations Workspace Core to gather any scan files created by the AMRs.
3. Back up (copy) any required maps to a storage location.
4. [OPTIONAL] Check **DeleteUnusedMaps** to permanently delete unnecessary map files from each AMR.

3.10 What to do if a Primary Fleet Manager Fails

This section applies only if you installed a second EM2100, autosynchronized with the Primary Fleet Manager.

In the event of a failure:

1. Connect to SetNetGo on the Secondary EM2100.
2. Navigate to the Pairing section of the System area as shown below.

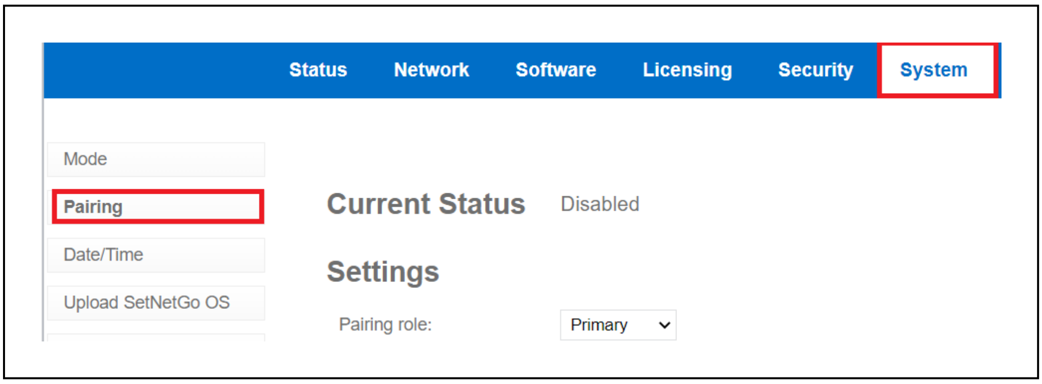


Figure 3-6. Pairing Section

3. Select the *Primary* option from the *Pairing role* selection and then click the **Apply** Button.

   Note each warning popup and select the **OK** Button.

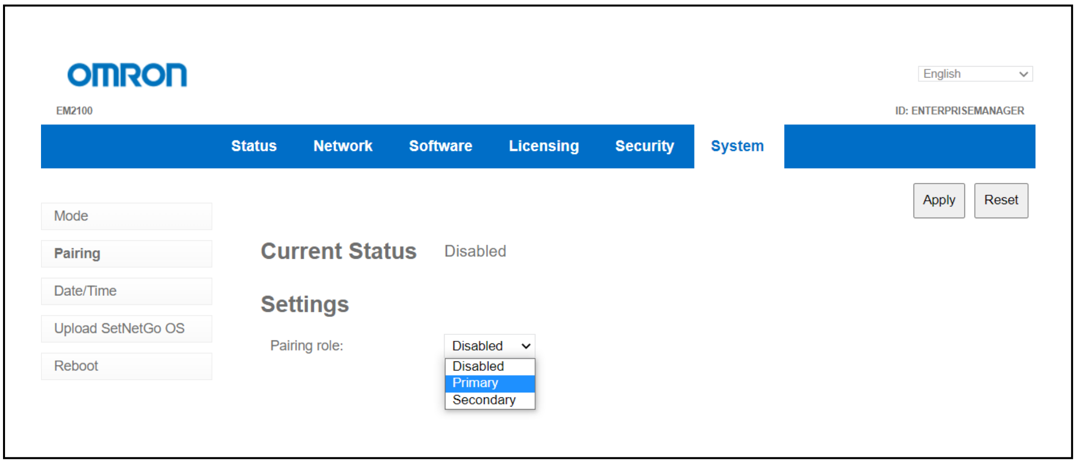


Figure 3-7. Changing the Pairing role to Primary

4. After 30 to 60 seconds, the ***Current Status*** should change to ***Starting***. After waiting and confirming the status change, the procedure is complete.

   IMPORTANT: The failed Primary appliance should not be returned to operation on the deployment network while the Secondary appliance is providing Fleet Management services

The AMRs automatically reconnect to the new Primary appliance.

The queue, configuration, and map data on the new Primary is identical to that of the old Primary, prior to failure. Depending on exact network configuration, it takes between 1-3 minutes for AMRs to reconnect and resume operation.

The original (failed) Primary appliance can now be safely removed from the rack without causing disruption to the fleet. The following considerations apply:

- The new Primary operates on the same Fleet IP as the old Primary appliance. Do not reconnect the old Primary to the network without first reconfiguring it. Doing so might cause a network IP conflict.
- The failed Primary has the queue file, which is no longer current. Before putting the failed Primary back into service, you should manually clear the queue. See Manually Clearing (Flushing) the Entire Queue on page 225.

3.11 Remove and Replace EM2100 Appliances from Autosync

This section describes how to remove an appliance from an Autosync configuration.

Remove a Primary Fleet Manager Appliance from Autosync

You might need to remove a Primary Fleet Manager appliance from an Autosync configuration while maintaining fleet operations. For example, if the Primary appliance is generating errors that indicate a potential failure or degraded performance. This procedure assumes that you do not make any changes to the software and data stored on the removed appliance.

To safely remove an EM2100 Primary Fleet Manager appliance from an Autosync configuration, you must promote the Secondary appliance to the Primary role as covered in the previous section. You can then safely remove the Primary as follows:

1. Verify that fleet operations are normal and job processing is on schedule.
2. Reconfigure the Primary appliance as a Secondary appliance. See: Configure the Secondary Appliance on page 32.
   MobilePlanner and fleet AMRs might lose their network connection to the appliance.
3. Reconfigure the Secondary appliance as the Primary appliance. See: EM2100 Configuration Overview on page 24.
4. Power off the Secondary appliance.
5. The Status tab in SetNetGo will now show that Autosync for the new Primary appliance is disabled (it is now a standalone appliance).
6. Verify that MobilePlanner can connect to the Fleet IP, that fleet AMR operations resume, and jobs are processed as scheduled.

To restore a removed EM2100 appliance or to replace it with a new appliance, it should be put into the role of Secondary Fleet Manager, not Master. This will cause less disruption to the fleet.

Remove a Secondary Fleet Manager from Autosync

You might need to remove a Secondary Fleet Manager appliance from an Autosync configuration while maintaining fleet operations. For example, if the Secondary Fleet Manager appliance is generating errors that indicate a potential failure or degraded performance. This operation is less disruptive than removing a Primary Fleet Manager.

> **IMPORTANT:** This procedure assumes that you do not make any changes to the Fleet Manager configuration or to the software and data stored on the appliance.

To remove a Secondary Fleet Manager appliance from an Autosync configuration:

1. Verify that fleet operations are normal and job processing is on schedule.
2. Power off the Secondary Fleet Manager appliance.

   If a soft shutdown doesn't work, use a hard shutdown. Refer to the *EM2100 Installation Guide* for details on hard- vs. soft-shutdowns.
3. Verify that MobilePlanner can connect to the Fleet IP, that fleet AMR operations continue, and that jobs are processed as scheduled.

To restore a removed Secondary Fleet Manager appliance:

1. Verify that fleet operations are normal and job processing is on schedule.
2. If you have removed any network cables, reinstall them. Configure Paired Appliances
3. Power on the Secondary Fleet Manager appliance. (This should not affect fleet operations or Ethernet connections to MobilePlanner and AMRs.)
   Both appliances now indicate that Autosync is **Active.**

If no changes have been made to the configuration, the Secondary appliance will come back up as a Secondary, but the Primary will be running as a Standalone.

4. Reconfigure the Primary appliance to be paired with the Secondary. See Configure the Primary Appliance on page 31.

Chapter 4: Fleet Operations Workspace Core Software

The Fleet Operations Workspace Core (FLOW Core) software has the tools and features to help you get your AMR up and running quickly. This chapter covers the initial steps needed to access your AMR with the PC and to begin using the Fleet Operations Workspace Core software.

4.1 How Do I Begin?

Before you can start using your AMR, there are a number of initial set-up and configuration steps you need to complete.

> **NOTE:** It is assumed that, prior to beginning fleet programming with FLOW Core, all AMRs and EM2100 appliances being used in the fleet have been unpacked, installed and set-up according to their respective user guides.

Procedure	Reference
Install the MobilePlanner software on your PC.	Install the MobilePlanner Software on page 43
Connect your PC to the AMR via Ethernet cable.	Connect Your PC to the AMR via Ethernet on page 45
Configure the AMR for wireless communication.	Configure Your AMR's Network and Security Settings on page 49
Establish a wireless connection to the AMR.	Connect to the AMR Wirelessly on page 50
Scan the AMR's environment.	Scanning the Operating Area on page 96
Convert the scan to a map.	Convert the Scan into a Map on page 97
Use MobilePlanner software to edit (erase stray and other dynamic features from) the map.	Editing a Map File on page 102
Add docks, forbidden zones, goals, and route(s) between goals, etc. to the map.	Working with Map Files on page 99
Save the edited map on the AMR.	Saving the Map on the AMR on page 118
Localize the AMR.	Set the AMR's Initial Location on page 121
Create some tasks, and have the AMR begin performing them.	AMR Tasks on page 172
Click the EULA to complete the process.	

4.2 End User License Agreement (EULA)

Users will be presented with and must agree to the End User License Agreement (EULA) in order to access and use any of the FLOW Core software content and functionality.

Definitions

- An **End User** is the person, company, or organization that actually uses the software and OMRON Mobile Robotics equipment.
- **System Integrators** are not End Users when they are installing OMRON Mobile Robotics solutions for another business.
- **System Integrators** are End Users when they own and install OMRON Mobile Robotics solutions for their own use (e.g. for test or demonstration fleets).

The Click-to-Accept (CTA) EULA will pop up:

- When the FLOW Core software is installed.
- Whenever the FLOW Core software is updated.
- Upon first launching SetNetGo software (Out Of the Box).
- Whenever the SetNetGo software is updated.
- Whenever a V2C (license) file is uploaded (first time, updates, and renewals).

  New entitlements are not required when existing dongles are transferred from a failed EM2100 or AMR to new EM2100 or AMR hardware. Therefore, no EULA is required in these cases.
- Whenever a new user-facing language is selected (in order to ensure delivery of the CTA EULA in the appropriate language).

Once the CTA EULA Prompt is Triggered

1. The CTA EULA pop-up will display in the language that matches the software installed.
2. The User must scroll through the entire End User License Agreement before the Accept Button is enabled (this button is grayed-out until then).
3. The User must check either "End User" or "Manufacturer or System Integrator" before the Accept Button is enabled.

   Accepting as "End User" will stop the CTA from re-triggering upon launching the software. All other triggers will still prompt the user with the CTA pop-up.

   Accepting as "Manufacturer or System Integrator" will not stop the CTA from re-triggering upon launching the software. This is to ensure that the End User gets prompted when first launching the software "out of the box".
4. The User can either click Accept, or abort the process.

   Aborting the CTA EULA process will cancel and close out of the process that triggered the CTA EULA pop-up (V2C Upload, Language Change, Software Update, Software Install, First-Time/Out Of the Box Software Start Up).

   In this case, the User can re-trigger the CTA EULA prompt by initiating one of the trigger processes listed above.
5. If the software license is activated at the factory, in the Fleet Simulator bundle for example, the CTA EULA pop-up will be displayed and a selection must be made prior to the Simulator performing its intended functions.

   The intent here is that the Fleet Simulator should be able to connect to SetNetGo and MobilePlanner but no configuration or simulations can be run until the user clicks the Accept Button.

Capturing CTA Interactions

1. Every time the CTA EULA process is initiated and completed, the following data shall be captured and logged:
   - What triggered the CTA EULA prompt (e.g "Software Update", "V2C Upload", etc.)
   - Date/Time CTA EULA process was triggered
   - Date/Time CTA EULA process was completed
   - Whether CTA EULA was Accepted, or the process was aborted (either of these will be considered as completed.
2. Users can access a reference log file, but will not have access to or the ability to make changes to the source data populating these logs.

NOTE: The Click-to-Accept EULA functions only apply to the FLOW Core software. There is no impact on the Legacy MSS 4.X software.

4.3 Install the MobilePlanner Software

Before setting up a wireless connection to your AMR, you will need to install MobilePlanner on your PC. This software is the primary interface to the Fleet Manager and AMRs, and allows programming of the AMR fleet.

System Requirements

Verify that your PC meets the following requirements before installing MobilePlanner:

- **OS**: Windows 7 (32-bit/64-bit), Windows 8 (32-bit/64-bit),or Windows 10 (32-bit/64-bit).
- **CPU**: 1.5 GHz Dual-core (min).
- **RAM**: 1.5 GB minimum, 4 GB recommended.
- **GPU**: 256 MB (min).
- **HDD/SSD**: At least 250 MB available space.
- **Monitor**: XGA 1024 x 768.

Installing MobilePlanner

Ensure that your PC meets the system requirements, then install (or download and install) MobilePlanner.

NOTE: The MobilePlanner software installs into a MobilePlanner6 directory. This different install directory allows you to use the relevant MobilePlanner version with your fleet.

Version Information: Only MobilePlanner software version 6 is compatible with FLOW Core 2.1 or higher. It is not compatible with OMRON fleets running on Mobile Software Suite version 4.X or earlier.
Refer to https://automation.omron.com for release notes or contact your local OMRON representative for more information.

1. Use one of the following methods to locate and/or install the MobilePlanner software:

   a. By **USB drive**: insert the software media (USB drive, includes your AMR’s software and documentation) into your PC, and browse to the USB drive to locate and install the software.

   From your EM2100: Open **SetNetGo** > **Software** > **Manage Installed Software** > **MobilePlanner** > **It can be downloaded here**. (Click on the "here" link in the EM2100 user interface, shown near the bottom of the following figure.)

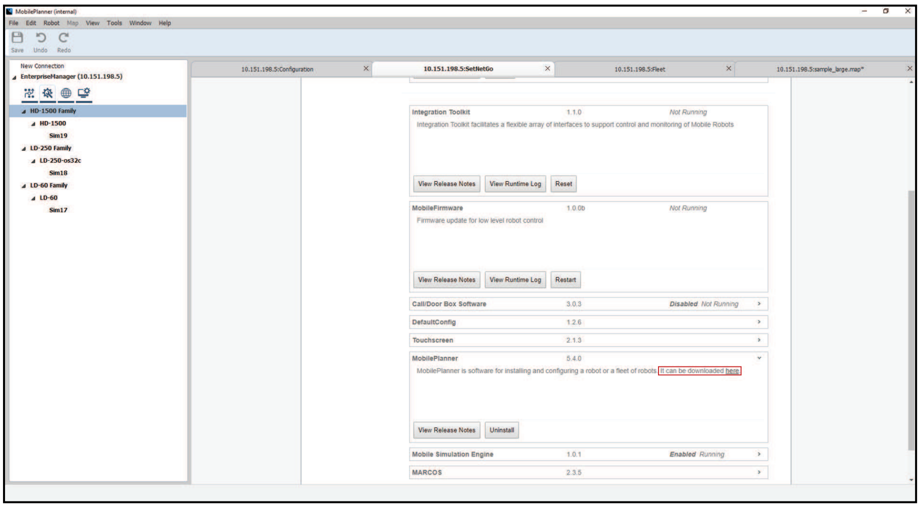


Figure 4-1. Manage Software Download

   b.

   c. By **download:** Contact your local OMRON representative for assistance with downloading MobilePlanner software.

   To download MobilePlanner from the internet, access www.robotics.omron.com or contact your local OMRON representative.

2. Launch the installer and, when the welcome screen appears, follow the prompts in each installation wizard window to complete the installation.

   If you used SetNetGo or downloaded the software, this will usually be in your Downloads folder. The actual location is determined by the settings in the browser that you use.

3. Click **Finish** when done.

4.4 Configure the AMR’s Wireless Communications

Before you can start working with your AMR, you have to configure it for wireless communication (via WiFi) using your PC. To do this, you will first have to connect your PC to the AMR via Ethernet cable to gain access to the AMR's wireless settings. In general, the set-up process is as follows:

- Connect Your PC to the AMR via Ethernet
- Set the IP Address on Your PC

- Access SetNetGo Software
- Configure Your AMR’s Network and Security Settings
- Connect to the AMR Wirelessly

  NOTE: The setup steps above assume that the AMR is fully-charged, powered up, and ready. If this is not the case, please refer to your AMR’s user manual for complete setup instructions.

Connect Your PC to the AMR via Ethernet

To connect your PC to the AMR:

1. Open the AMR's maintenance access panel (left side, upper right corner), by pressing the access panel’s upper left corner (see image below) into the side of the AMR.

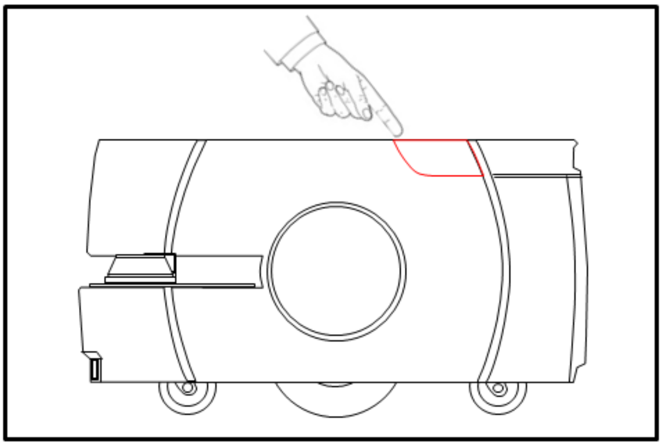


Figure 4-2. Maintenance Door Location

2. Using a standard (pass-through or cross-over) Ethernet cable, connect your PC directly to the AMR's maintenance Ethernet port. Refer to the following three figures. The AMR will auto-detect the cable type.

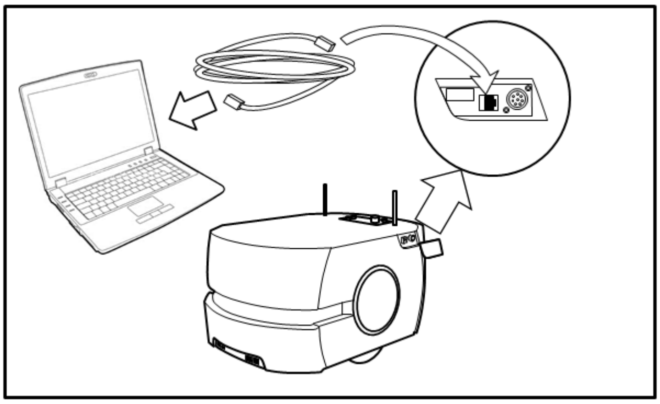


Figure 4-3. Maintenance Port Connection, LD-60 and LD-90

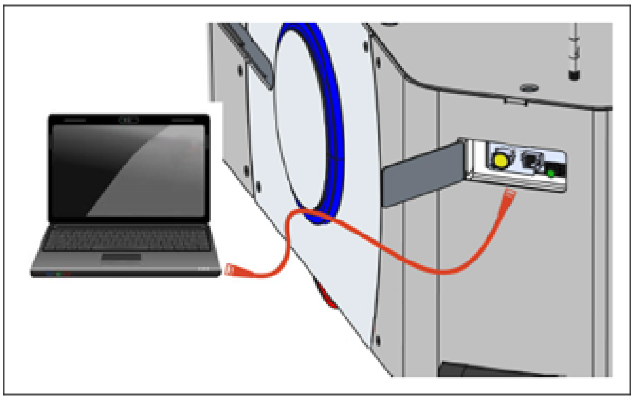


Figure 4-4. Maintenance Port Connection, LD-250

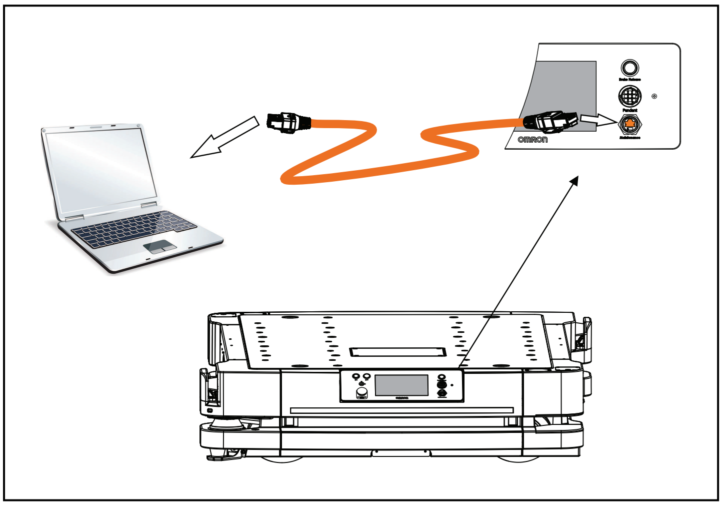


Figure 4-5. Maintenance Port Connection, HD-1500

Set the IP Address on Your PC

In order to configure WiFi on your AMRs, the LD-series AMRs and the HD-1500 AMRs are accessed differently. If you have a combination of the two, we suggest that you set up all of the LD-series AMRs and all of the HD-1500 AMRs as two separate procedures.

LD-Series AMR IP Address Setup

. The LD-series AMR's maintenance Ethernet port is always enabled and permanently set to IP address 1.2.3.4, with a Subnet mask of 255.255.255.0, for direct, wired access to the on-board systems. Refer to the following procedure for setting up your connection to the LD-series AMR.

1. Open the Local Area Connection settings on your PC.
2. Manually set your PC's Ethernet port IP address to 1.2.3.x, where x is any number 1 to 254, except 4 (which the AMR uses).
3. Set the Subnet mask to 255.255.255.0. No special DNS or gateway settings are needed.
4. Click the **OK** Button to confirm the configuration and complete this procedure. The AMR can be accessed for configuration.

HD-1500 AMR IP Address Setup

The HD-series AMR's maintenance Ethernet port is always enabled and permanently set to IP address 169.254.10.15, with a Subnet mask of 255.255.255.0, for direct, wired access to the on-board systems. Refer to the following procedure for setting up your connection to the HD AMR.

1. Open the Local Area Connection settings on your PC.
2. Manually set your PC's Ethernet port IP address to 169.254.10.x, where x is any number 100 to 149.
3. Set the Subnet mask to 255.255.255.0. No special DNS or gateway settings are needed.
4. Click the **OK** Button to confirm the configuration and complete this procedure. The AMR can be accessed for configuration.

Access SetNetGo Software

The SetNetGo software lets you manage a variety of settings related to the AMR's connectivity. You can access SetNetGo from MobilePlanner (most common), or a secure web browser (for example, Chrome, Firefox, or Internet Explorer).

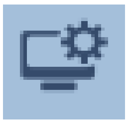
To Access SetNetGo from MobilePlanner

NOTE: Only start the following procedures if your computer is connected to the AMR via Ethernet cable.

1. Open the MobilePlanner software.
2. For an LD-series AMR, enter **1.2.3.4** into the AMR address field, then click **Connect**.

   For an HD-1500 AMR, enter **169.254.10.15** into the AMR address field, then click **Connect**.
3. Click the **SetNetGo** Button.

   Click the checkbox only if you want SetNetGo to open when you connect to an AMR or Fleet Manager. Otherwise, click anywhere in the rectangle shown in the following figure.

   
4. Click the **SetNetGo** tab.

To Access SetNetGo via Web Browser

1. Start a web browser on your computer.
2. Enter the URL **https://1.2.3.4** in the address bar of the web browser.

   For an HD-1500 AMR, enter **169.254.10.15** in the address bar of the web browser.

   This is the AMR’s maintenance Ethernet address. When accessing the software from a wired maintenance Ethernet port, you do not need a username or password.

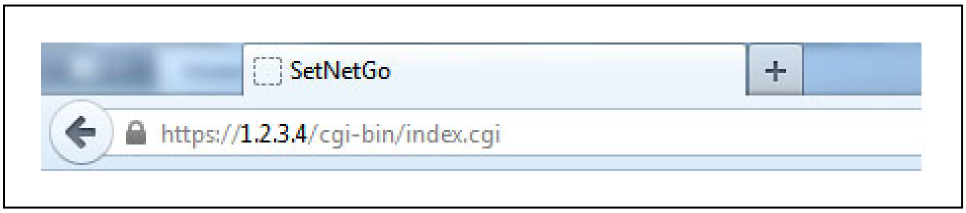


Figure 4-6. Browser Address Field

NOTE: You can ignore the certificate error that appears on the SetNetGo web-page; the error appears because the hardware is not attached to the Internet.

The SetNetGo startup screen is shown the following figure.

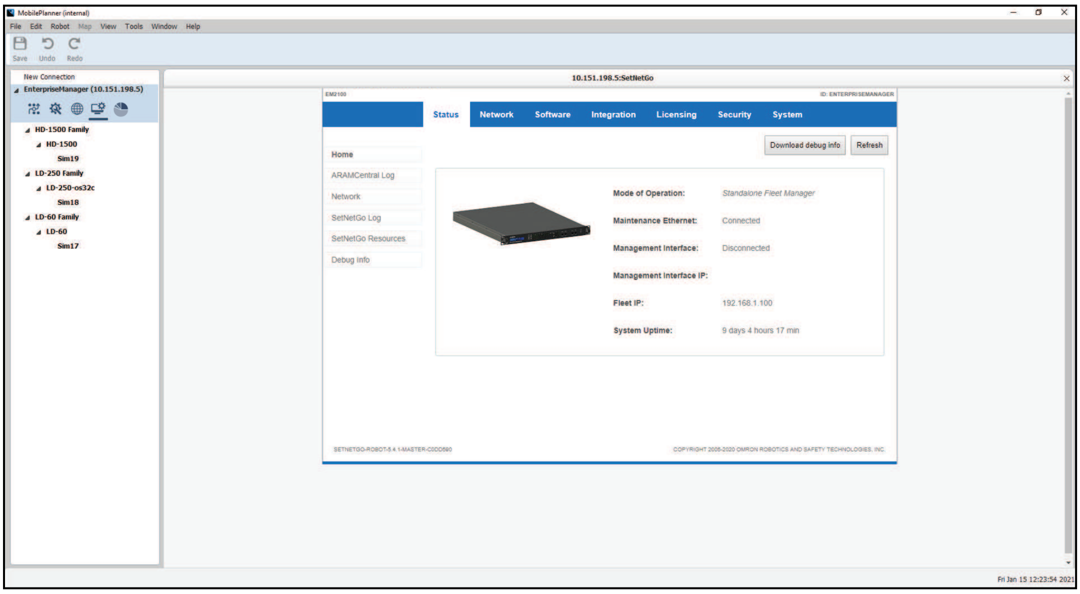


Figure 4-7. SetNetGo Interface

Configure Your AMR's Network and Security Settings

To access your AMR remotely, you should set up a static IP address for each AMR. The SetNetGo interface allows you to configure your hardware’s Ethernet settings, configure serial and TCP forwarding, and upgrade the on-board software. If you are not familiar with setting up a network or do not have an assigned IP address for the AMR, please see your system administrator.

> **IMPORTANT:** If you change any values in a SetNetGo screen, you must click **Apply** before switching to another sub-screen, or those values will not be saved. For example, when changing wireless Ethernet settings, be sure to click **Apply** before navigating back to the dashboard.

To configure network settings, click the **Network** tab at the top of the SetNetGo screen.

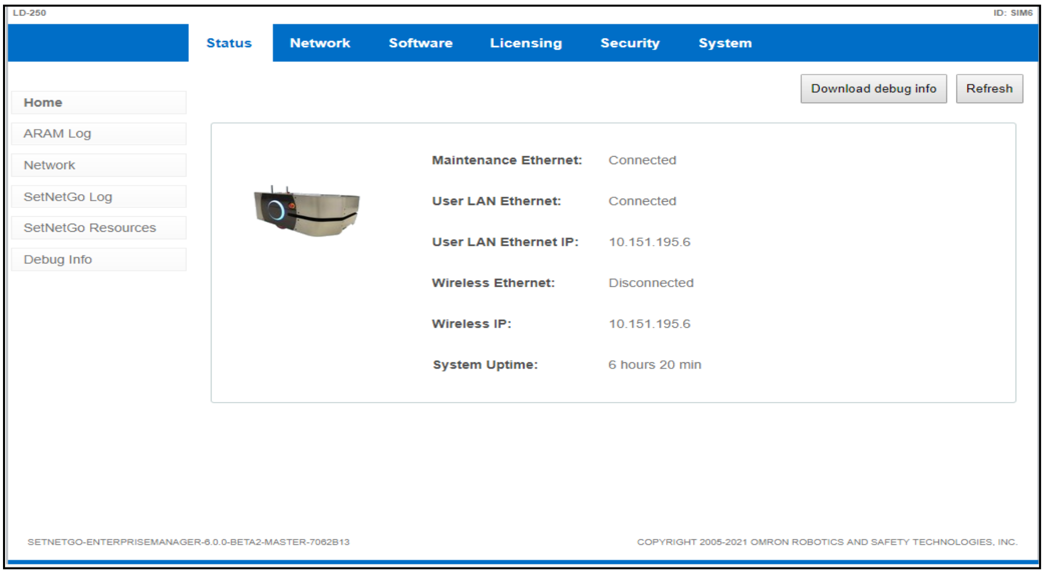


Figure 4-8. SetNetGo Interface

Table 4-1. Network Options

Network Menu	Description
Wireless Ethernet	Sets up your wireless Ethernet connection to your AMR, including IP settings, WiFi network settings, security settings, and radio settings.
User LAN Ethernet	This screen has user-configurable settings for interface mode, IP address, netmask, DHCP server for accessories, and DHCP IP range.
RS-232 Port Forwarding	Controls forwarding of serial data to a TCP port on the wireless and internal wired Ethernet networks, where the data is re-directed to a

Network Menu	Description
	TCP port on an IP address accessible via the Wired Ethernet interface (which must be set to accessory mode). There is also port-forwarding for the two extra on-board serial ports to a TCP port on the wireless Ethernet interface.
Ethernet Forwarding	Use the settings on this screen to control TCP port forwarding from your User LAN Ethernet interface to the wireless Ethernet interface.
Utilities	Use this screen to ping an IP address for testing and diagnostic purposes.

Set the Username and Password to Secure Access to the AMR

You must add one or more users, and assign usernames and passwords. Click the **Security** tab, then click the **Enabled** radio button and populate the username/password fields (see Setting Up User Accounts on page 147).

Connect to the AMR Wirelessly

Now that you have installed the Fleet Operations Workspace Core and configured the AMR for wireless communications, connect to your AMR.

1. (If not already running) double-click the MobilePlanner icon on your PC desktop.

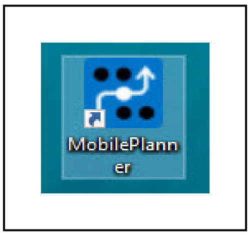


Figure 4-9. MobilePlanner Desktop Icon

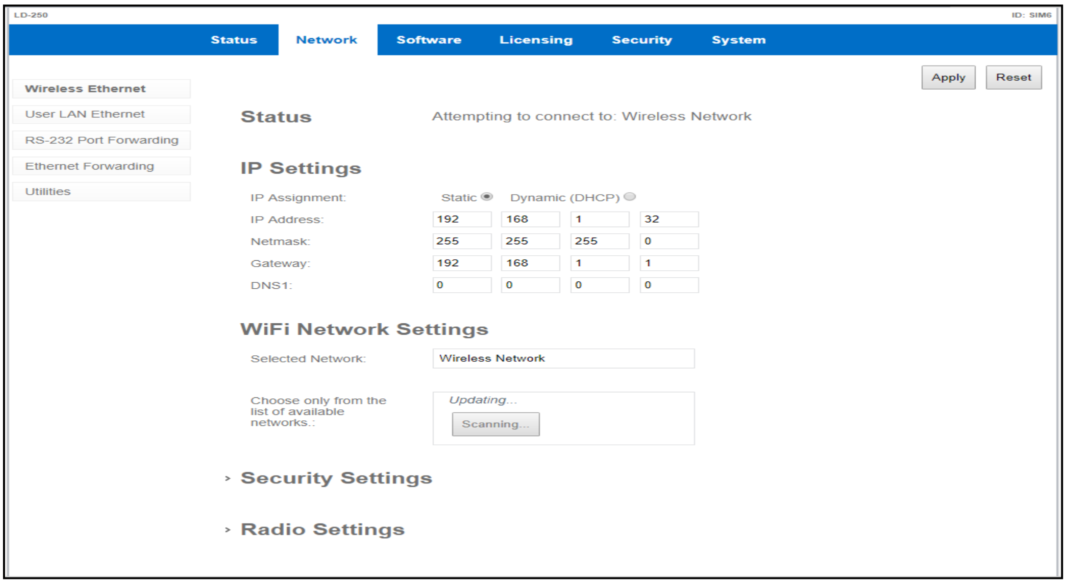


Figure 4-10. MobilePlanner Interface

> **NOTE:** If running MobilePlanner from an Operator account, the interface will look slightly different than above.

By default, the **Fleet**, **Config**, and **Map** Buttons have bars that become visible to indicate that those features will automatically load when you connect to the AMR.

2. In the **Connect** field, enter the IP address of the AMR, then click **Connect**.
3. Enter User Name and Password in the User Name and Password dialog box, then click **OK**.

> **NOTE:** If the **SetNetGo** Button's bar is visible, the User Name and Password dialog appears.

A login dialog appears in which you must enter a user name, password, and AMR server IP address.

> **NOTE:** After connecting to the AMR the first time, MobilePlanner remembers your user name. When connecting to the AMR again, you can select your user name from a combo box instead of having to re-enter, but you must still enter your password.

MobilePlanner completes its connection to the AMR. At this point, there is no map to load, so MobilePlanner opens with a blank map window.

Chapter 5: Using MobilePlanner Software

The MobilePlanner software is the "control center" of the Fleet Operations Workspace Core. Its user interface has the tools for all major AMR activities, such as observing a fleet of AMRs, commanding individual AMRs to drive, creating and editing map files, goals, and tasks, modifying AMR configurations, and more.

The following topics provide details on understanding and using the MobilePlanner features.

5.1 Overview of MobilePlanner

MobilePlanner has features you can use to scan the AMR environment, configure the AMR, create and edit maps, and more. The interface is designed to be user-friendly and efficient, which reduces the learning curve and the time needed for deployment.

The MobilePlanner interface supports the following languages:

- English
- French
- German
- Japanese
- Spanish
- Italian
- Korean
- Simplified Chinese
- Traditional Chinese
- Polish

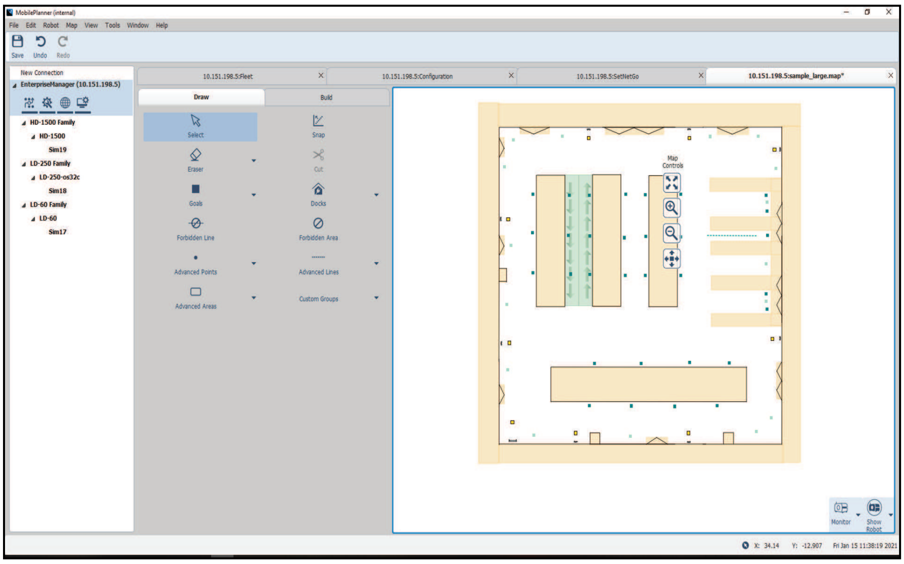


Figure 5-1. MobilePlanner User Interface (with Map)

NOTE: While MobilePlanner is not necessary for each AMR, you must have at least one copy of MobilePlanner to create a map.

From the MobilePlanner interface, you can:

- Connect to and drive the AMR.
- Create maps of the environment by importing and analyzing an AMR's scan data.
- Edit maps by adding goals (and adding tasks to those goals), docks, forbidden areas, and more. You can also erase stray or unwanted artifacts, combine pieces of maps, and make other changes.
- Download and upload files, including maps and scan data, to and from an AMR.
- With the Fleet Manager, monitor the location and status of all AMRs in a fleet.
- View and interact with the job queuing manager.
- Manage the configuration parameters for the Fleet Manager, AMR groups, and individual AMRs.

These features allow you to create a map with goals, docks, and advanced lines and areas, and to start the AMR working in its environment.

5.2 MobilePlanner Interface

The MobilePlanner interface consists of the Main Menu, Toolbar, and Fleet Explorer.

The Main Menu is located across the top of the application and contains tools for handling file management, driving the AMR, and initiating scans. The full list of options and functionality is documented in The MobilePlanner Menu .

Below the Main Menu is the Toolbar. The Toolbar contains buttons for Undo, Redo, and Save.

On the left of the application window is the Fleet Explorer. From this interface new fleets and robots can be connected to and managed. Robots and robot types in a fleet are visualized as a hierarchy for clarity, and can be further organized into sub-fleets for more granular configuration.

Additional interfaces can be opened using the Fleet, Map, Configuration, and SetNetGo buttons located in the Fleet Explorer menu shown in the image below. These menus are shown as Mode Tabs underneath the toolbar and can be rearranged and closed like tabs on a web browser. Within a given Mode Tab, there can also be Function Tabs.

Running along the bottom of the application is a bar referred to as the Tray, which displays information based on which Function Tab is currently selected.

The following figure is an example of the MobilePlanner interface showing goals and other map objects.

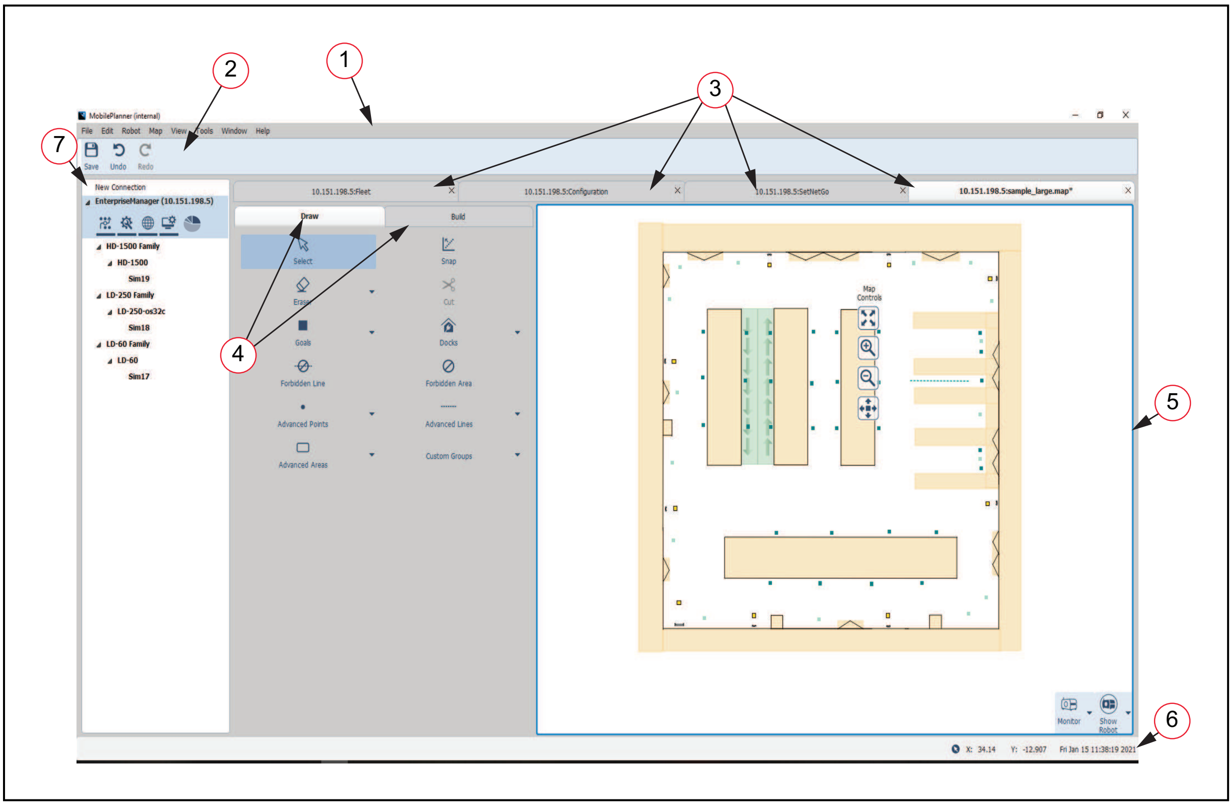


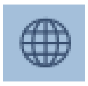
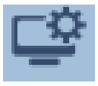
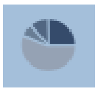
Figure 5-2. Sample MobilePlanner Interface

Table 5-1. MobilePlanner Interface Description

Item	Description
1	Main Menu
2	Toolbar
3	Mode Tabs
4	Function Tabs
5	Map Window
6	Tray
7	Fleet Explorer

Table 5-2. Fleet Explorer Button Icons and Their Functions

Icon	Description
	Opens the Fleet window, which shows status and job statistics for all AMRs in your fleet. It uses graphical icons to represent interrupted, canceled, in-progress, pending, and completed jobs. Click the checkbox to

	have the Fleet window open when you connect to an AMR or Fleet Manager.
	Displays the Configuration mode tab, which is used to set configuration parameters. For details, see Configuring the AMR on page 154. Click the checkbox to have the Configuration tab open when you connect to an AMR or Fleet Manager.
	Displays the Map mode tab, which is used to edit the map. For details, see Editing a Map File on page 102. Click the checkbox to have the map load when you connect to an AMR or Fleet Manager.
	Displays the SetNetGo mode tab, which is used to access the SetNetGo interface. For details, see Using the SetNetGo Software on page 126. Click the checkbox to have SetNetGo open when you connect to an AMR or Fleet Manager.
	Displays the FLOW IQ tab, which is used to view and FLOW IQ interface. FLOWIQ provides useful statistics about your AMR fleet. For more information on FLOW IQ and its features, contact your local Omron representative.

Configuration (Config) Tab

The Configuration tab works with the Fleet Explorer pane to allow easy management of the configuration parameters for the Fleet Manager, AMR groups and Individual AMRs. The configuration tab is divided into two main panes: the Customization pane and the Expert Parameters Toolbox. Configuration parameters can be moved from the Toolbox to the Customization pane to customize parameters for different robot groups in the Fleet Explorer. The configuration parameters are covered in Configuring the AMR on page 154.

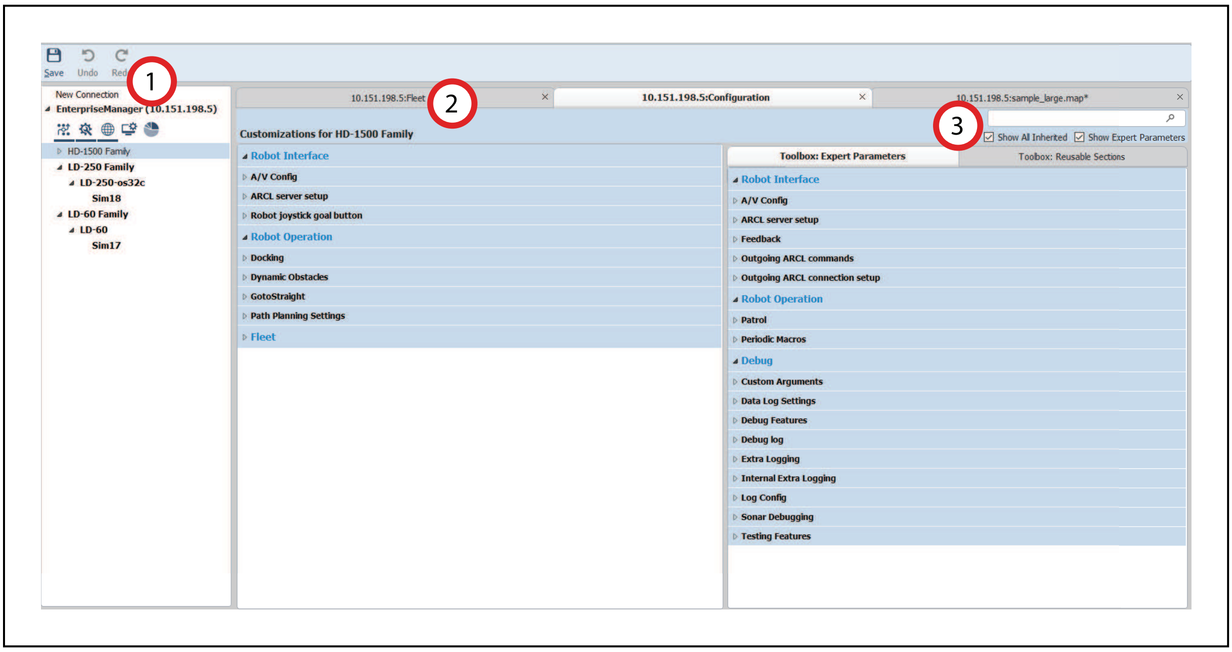


Figure 5-3. Configuration Window, (1) Fleet Explorer Pane, (2) Customizations Pane, and (3) Expert Parameter Toolbox Pane

Map Tab

- When the map tab is selected, the main window displays a map of the AMR's operating space. The map consists of points and lines representing the walls, doors and other stationary features within the environment. For more details, see The MobilePlanner Map Window on page 76.
- The Draw and Build Tabs, to the left of the map, provide map editing tools, and tools for setting the AMR up to do tasks at goals (route building).
- Robot tools are visible below the map when **Show Robot** is toggled on. You can use these tools to drive, dock, adjust speed, etc. These items are also available from the Robot menu.
- To the right of the Robot tools is the Monitor icon. For details, see Using Monitor on page 83.
- The Status area, located below the map, (shown with **Show Robot** Button toggled on) provides information on the AMR position, temperature, odometer, and battery charge. For details, see MobilePlanner Status and Tray Displays on page 85.

Map Features Legend

To view available map features in MobilePlanner, click **Map > Legend**. If **Show Robot** is on, the legend also shows map items associated with the AMR, like sensor readings, paths, etc.

SetNetGo Tab

The SetNetGo tab connects to the AMR’s SetNetGo interface, and displays the various configurations associated with the AMR.

SetNetGo is the operating system residing on the AMR and EM2100. You use SetNetGo to configure and establish network communication with the AMR, download debug information, and perform software maintenance (upgrades).

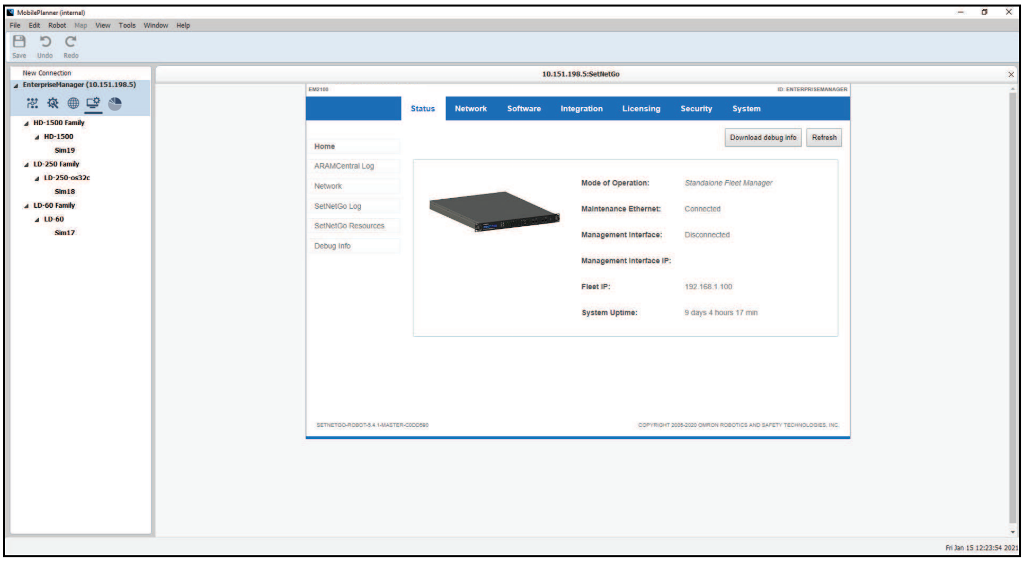


Figure 5-4. SetNetGo Interface

For details on the interface elements, see the remaining topics in this chapter.

5.3 MobilePlanner Operator Account Overview

Some sign-ins to MobilePlanner will be restricted to an Operator account (you can also select the MobilePlanner (Operator Mode) from the Windows Start menu).

An Operator account provides a limited set of tools for interfacing with AMRs or the Fleet Manager. Its main window, the Fleet window, shows the status of all AMRs in your fleet and their jobs, and allows for simple interventions in job execution sequences. Operator Mode does not support any setup operations, and the Map, Config, and SetNetGo windows are unavailable.

MobilePlanner Operator Account Interface

Operator Mode's simplified user interface focuses on monitoring fleet AMRs and jobs. It uses graphical elements to represent AMR statuses, and the status of all jobs (complete, in-progress, canceled, etc.).

To launch of MobilePlanner in Operator Mode, click the Windows Start menu, and select **Start > All Programs > Omron > MobilePlanner6 > MobilePlanner (Operator Mode)**. When MobilePlanner (Operator Mode) opens, enter the IP address of an AMR or Fleet Manager, and click **Connect**.

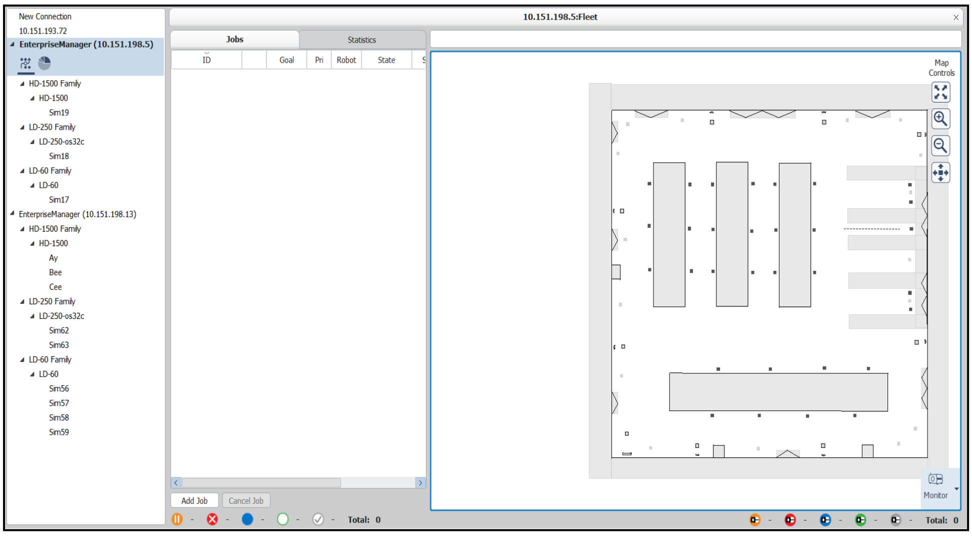


Figure 5-5. MobilePlanner Operator Mode UI

The MobilePlanner (Operator Mode) interface allows you to connect to and monitor multiple AMRs.

MobilePlanner Operator Mode Jobs Tab

The Jobs tab displays all jobs assigned to the AMRs (listed by job ID). For debugging purposes, you can also add a job to the currently monitored AMR by clicking the **Add Job** Button (lower right corner of the window), which displays the Add Job window.

> **NOTE:** The Add Job window is not the primary method for submitting jobs to the fleet.

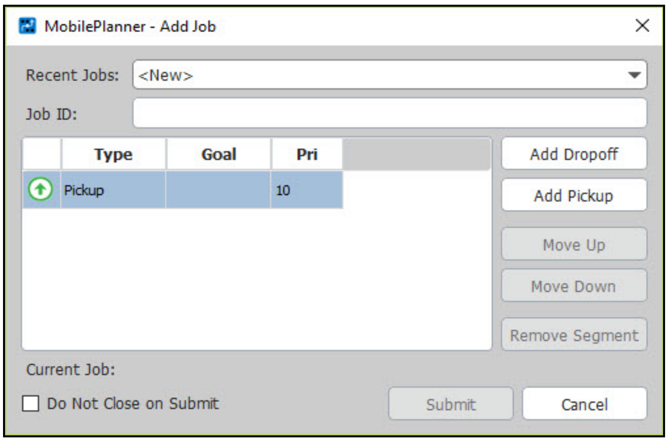


Figure 5-6. MobilePlanner Operator Mode Add Jobs window

Each job consists of multiple segments, and each segment has an associated goal. In this window, you can add or remove segments to or from a job, then submit the entire job to the queuing manager.

In this window, you can also add another job to the current job queue, assign a Job ID, set the job goal (double-click the field below Goal to display a drop-down list of goals), and set the job's priority.

Statistics Tab

The Statistics tab displays relevant statistics for your AMRs. Those statistics include:

- **FleetRobotInformation**: the number of AMRs currently connected to the Fleet Manager; their progress, and which are available and unavailable.
- **JobCounts:** the number of completed, canceled, and modified jobs and job segments.
- **LastTripReset:** the time (in sec), and human-readable date and time since last reset.
- **QueueInformation:** lists information about pending and in-progress jobs.
- **StateInformation:** information about the AMRs' states (driving time/distance, parking time, docking info, etc.).
- **TripJobCounts:** statistics related to the AMRs' job completion (number of completed, canceled, or modified jobs/segments).
- **TripStateInformation:** statistics about the AMRs' trips when completing jobs (distance driven or time spent at a particular job).

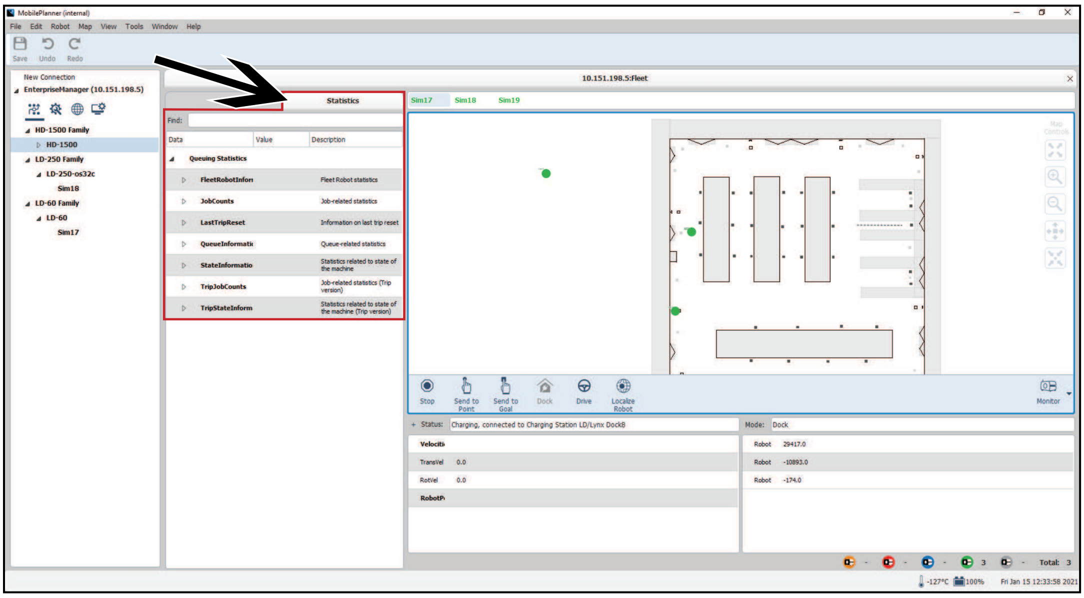


Figure 5-7. Statistics Tab

5.4 The MobilePlanner Menu

The MobilePlanner interface includes a menu bar to access the tools for editing the AMR's map file. It also applies to other non-map windows, provides tools for driving the AMR, initiating scans, route building, and searching the Config, and importing/exporting Config files.

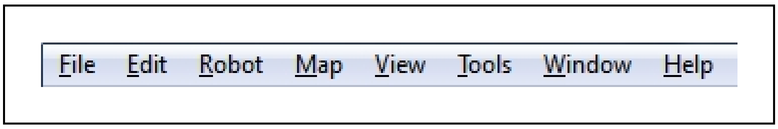


Figure 5-8. Menu Bar

The following table describes the menu bar selections.

Menu Option	Description
File	Allows you to open a local scan or map file, a map, scan, or configuration file on an AMR, save the map file, insert another map into the existing map file, and download or upload a files to/from an AMR. For more details, see Opens a submenu, which lets you select and open a file located on a particular AMR or the Fleet Manager. on page 62.
Edit	Allows you to undo or redo your last command. For more details, see Lets you undo the most recent action on the map file. on page 64.
Robot	Gives you control over various AMR activities (stop, drive, dock/undock), allows you to monitor the AMR dashboard and/or fleet details, create custom commands, create a fleet message of the day, and reload a configuration or stop the AMR. For more details, see Robot Menu on page 65.
Map	Allows you work with and edit the displayed map file. For more details, see Map Menu on page 66.
View	Allows you to change the units used in the map, and turn the toolbar labels on and off. For more details, see View Menu on page 67.
Tools	Allows you to update preferences. For more details, see Tools Menu on page 68
Window	Allows you to access the different files open in the workspace and change the way the windows in MobilePlanner are displayed. You can choose to tile them in the workspace or have them cascade. For more details, see Window Menu on page 68.
Help	Provides help on the MobilePlanner interface. For more details, see Help Menu on page 69.

File Menu	
Menu Option	**Description**
Open...	Opens a dialog, to search for and select a local map or a scan file to open.

File Menu	
Menu Option	**Description**
Open on Robot	Opens a submenu, which lets you select and open a file located on a particular AMR or the Fleet Manager. • **Robot Host Name or IP Address** opens the login page for that AMR. This submenu shows a list of the most recently used AMRs or Fleet Managers. • **Select Robot...** allows you to open the login dialog box and choose a file located on a different AMR. Displays the MobilePlannerRobot Login dialog box. Once you select an AMR, you can search for and select a map or scan file (if available) to open. You can also access the Configuration and SetNetGo software on the AMR.

File Menu

Menu Option	Description
Close	Closes the active file.
Import Config...	(Available when the Configuration Editor is selected.) Opens a dialog to import an AMR configuration file into MobilePlanner.
Insert Map...	(Available when the Map mode tab is selected.) Opens a dialog to search for and select a local map file to open and insert into the active map file. Used for small changes to the physical environment that affect the AMR's route, eliminates the need to rescan the entire workspace. See Inserting a Map File into an Existing Map File on page 114 for more information on this feature.
Save	Writes changes to the active file, and saves either onto an AMR (if opened from an AMR) or disk (if opened from a PC).
Save As...	Opens the Save As dialog. Used to save the active file under a different name and to a particular location on the local PC. Note that you can also save to different file formats (such as JPG or SVG). In those cases, the new file is not displayed in the editor.
Save on Robot	Opens a submenu for saving changes to a particular AMR's map file. • ***Robot Name or IP Address*** opens the login page for the AMR associated with that IP address. This submenu lists the five most recently used AMRs. • **Select Robot...** opens the login dialog box for choosing a different AMR on which to save the map file. If configured for the AMR, the MobilePlanner Robot Login dialog box displays. Once connected to the AMR, you can save the map file. This menu option is only available in Map mode.
Download/Upload	Opens a submenu to transfer a file to or from a particular AMR (most commonly, a sound file to use with 'play,' or playBackgroundSound'). • ***Robot Name or IP Address*** opens the login page for the AMR associated with that IP address. This submenu lists the five most recently used AMRs. • **Select Robot...** opens the login dialog box for choosing a different AMR on which to save the map file. The MobilePlanner Robot Login dialog box displays. Once connected to the AMR, you can upload the map file to the AMR or download a map file from the AMR.
Exit	Closes the application.

Edit Menu	
Menu Option	**Description**
Undo	Lets you undo the most recent action on the map file. This menu option is only available in Map and Config modes. **NOTE:** Undo is unavailable if you saved the map or configuration.
Redo	Lets you repeat the most recent action that you undid in the map file. This menu option is only available in Map and Config modes.

Robot Menu	
Menu Option	**Description**
Stop	Stops the AMR when it is in motion.
Drive	Activates the Drive pad for driving the AMR in its environment. **CAUTION:** Toggle the Manual Override to **OFF** to prevent the AMR from running into anything while you are driving it. If Manual Override mode is **ON**, the map background turns yellow, indicating "use caution" while driving. **NOTE:** Even in Manual Override mode, the AMR will avoid any obstacle detected by the navigation laser when traveling over 300 mm/s. **NOTE:** With **Show Robot** turned ON, you can access AMR drive icons from the Map view. **NOTE:** Driving remotely via MobilePlanner may not work with larger platforms such as HD robots, please reference the User's Manual for specific robots.
Dock	Sends the AMR to a dock.
Undock	Releases the AMR from the dock.
Monitor	(Same as the Monitor Button in the map and robot tools menu). Allows you to view and/or configure various AMR details - battery info, digital inputs and outputs, audio, add and execute tasks, macros, and routes.
Debug	Allows you to trace underway tasks for debugging. **NOTE:** This is an advanced feature, used for debugging advanced functionality.
Custom Commands	Allows you to create and send custom commands to the AMR. This is used mainly for debug log file starts and stops.
Map Creation	Allows you to start and/or stop the AMR's scanning process, from which you can build a map file.
Messages	Allows you to create custom Fleet Manager and/or Robot Messages of the Day.
Robot Tools	Provides access to advanced AMR tools, including localizing, reloading configurations, auto-docking, and issuing shutdown commands for a single AMR or all AMRs in the fleet.
Safety Commissioning	Allows testing and commissioning (verification of proper function) of an AMR's on-board safety systems. Uses a wizard to test E-Stop (tests brake activation) and Safety Laser (tests max speed limits and obstacle detection). Per EN-1525, commissioning must be done by specially trained people. See Safety and Regulatory Information on page 20 for details on Safety Commissioning.

Map Menu

Menu Option	Description
Fit in Window	Adjusts the map so it all fits within the map window.
Grid	Displays the grid in the map window. Grid line spacing is at 1 meter intervals. **NOTE:** The MobilePlanner grid is not the path planning grid or localization grid. It is simply for reference.
Origin	Displays the X/Y coordinates of the overall map. You must zoom the map view out to see the origin lines.
Robot Data	Allows you to control the display of various AMR-related map features such as sonar, laser, path, and localization.
Map Data	Opens a submenu, which lets you toggle the features to view on the active map file: • Points • Lines • Lights (if using Acuity)
Rotate	Opens a submenu, which lets you rotate the entire map in the map window. • Rotate Right • Rotate Left • Rotate Full 180° • Reset to None You can also save the rotated map as the default orientation.
Legend	Keeps track of all of the different features available in the map file. Each feature is identified on the map with a different color rectangle or line. For more details, see Map Legend on page 82.

View Menu	
Menu Option	**Description**
Units	Opens a submenu in which you can change map units. You can select: • Millimeters (default) • Meters • Feet/Inches • Inches The units apply to values displayed in the status bar, in map object edit boxes, and when using a measuring stick. See Advanced Lines and Areas on page 113 for details.
Show Main Toolbar Labels	Toggles toolbar labels ON or OFF. To hide the labels, uncheck this menu option.
Configuration	Submenu contains the option to toggle **Show Deprecated Parameters**.

Tools Menu

Menu Option	Description
Preferences...	Opens a dialog box with tabs for Comm and Computer ID parameters. • **Comm Tab:** Allows you to select Robot Server (from pick list), and set connection attributes for TCP/IP only, or reuse login information when reconnecting. • **Computer ID Tab:** Includes a field that displays the name of the computer on which the MobilePlanner installation exists (e.g., "John Doe's Laptop"), and allows you to select the goal nearest the AMR's current position. Click **OK** after making any configuration changes. Click **Reset...** reverts to initial installation-like state and resets all previous changes. Click **Cancel** to stop without making any changes.

Window Menu

Menu Option	Description
Tab	Arranges the open windows in tabs, just below the main toolbar. This is the default display mode.
Tile	Arranges the open windows as tiles, open next to each other.
Cascade	Arranges the open windows in a cascade, or waterfall, formation.
1:<*IPaddress*>:map	Contains a list of the open map and/or configuration files, or SetNetGo. Select from the list to make that the active window.
2:<*IPaddress*>:Configuration	
3:<*IPaddress*>:SetNetGo	

NOTE: Be aware that <IPaddress>: is only true for the Fleet Manager connection. It's <Identifier>: for robots.

Help Menu	
Menu Option	**Description**
Fleet Operations Workspace Core User's Guide	Allows you to open a Windows type help version of this guide while using MobilePlanner software.
Document Library (online)	Provides link to: http://www.ia.omron.com/products/category/robotics/mobile-robots/index.html
What's This?	Selecting this menu option, or using the shortcut Shift + F1, and then clicking on the MobilePlanner workspace displays a pop-up containing a brief description of some features.
Open Output Log Folder	Opens the folder containing saved MobilePlanner output logs.
About MobilePlanner...	Provides information on the current version of MobilePlanner and underlying applications/libraries.

5.5 Connecting to a Robot

Follow these steps to connect to a robot in MobilePlanner:

1. Double click on New Connection in the Fleet Explorer.

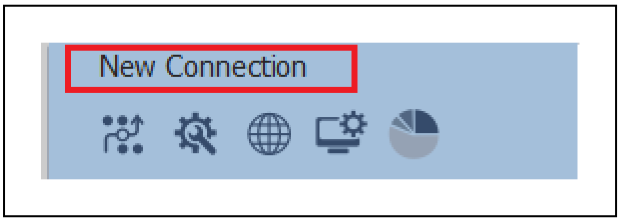


Figure 5-9. The New Connection Button

2. Add your username, password, and robot IP Address.
3. Click on the **Connect** Button.

After connecting to a robot, if you wish to disconnect you may do so by right clicking on the robot in the Fleet Explorer and selecting **Disconnect**.

5.6 Connecting to a Fleet Manager

The steps needed to connect to a Fleet manager (real or simulated) are the same as connecting to a robot. Use the Fleet manager IP address.

After connecting to a Fleet manager, you will see the name of the Fleet manager appear in the Fleet Explorer, along with the robots connected to that Fleet. See the following section for instructions on how to add a robot to a Fleet. The Fleet will be displayed as per the below hierarchy.

- Robot family
- Robot type
- Robot (name or Identifier)

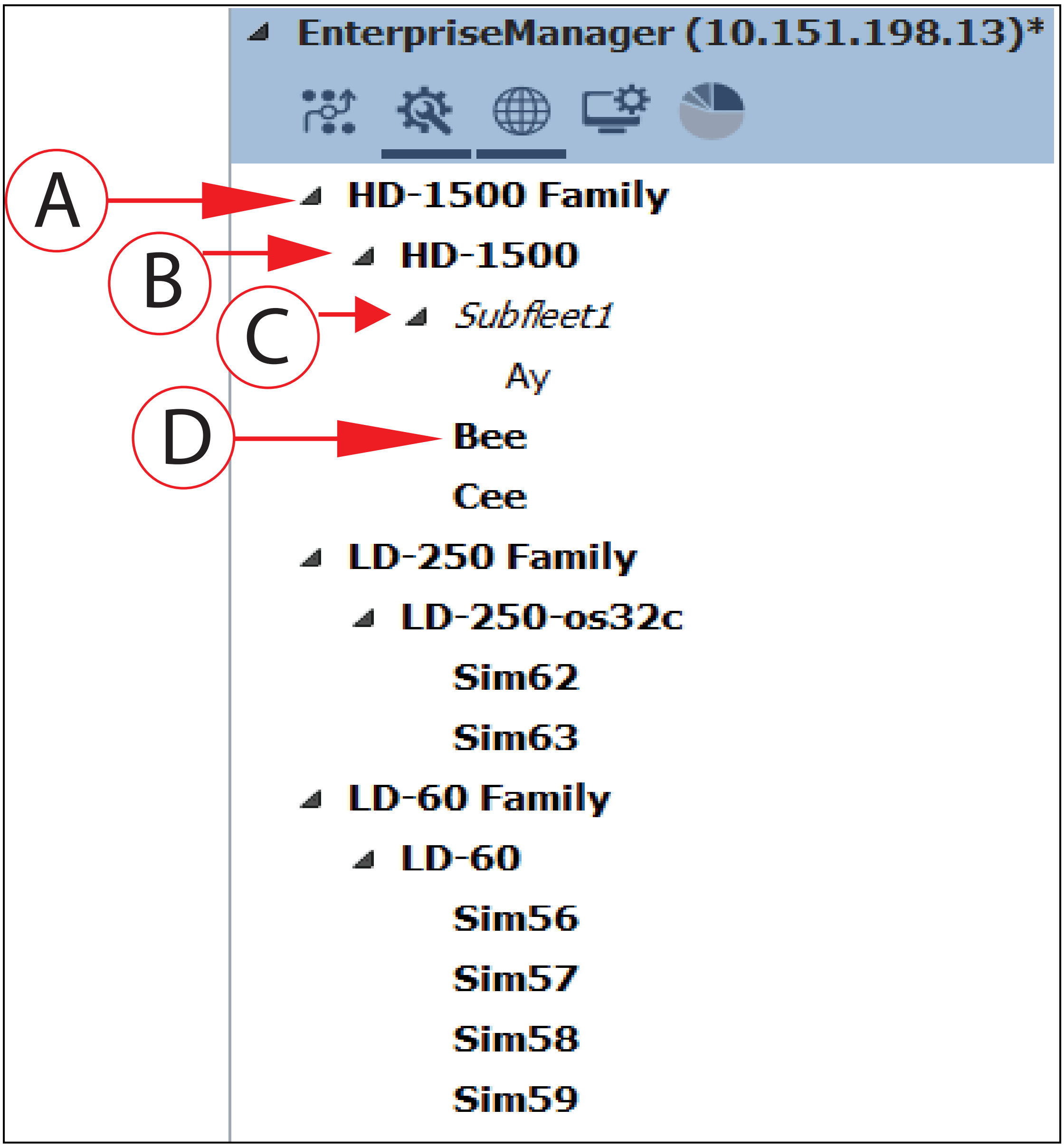


Figure 5-10. (A) Robot Family, (B) Robot Type, and (C) Subfleet (D) Robot Name/Identifier

The robot families, robot types and individual robots are sorted in alphabetic order. You may collapse the robot family hierarchy as well as the robot type hierarchy. You can do so by simply clicking on the expand/ contract widget ().

5.7 Connecting a Robot to a Fleet

Follow these steps to add a robot to a fleet in MobilePlanner:

1. Find the robot in the Fleet explorer and click on its **Config** Button.
2. Locate the *Connect to Fleet Manager* parameter in the Fleet Manager connection section under the Fleet category. Refer to the image below:

Figure 5-11. Fleet Manager Connection settings located in the Configuration pane

3. Enable the parameter by checking the box. The *FleetManagerAddress* parameter should appear.
4. Enter the Fleet manager's IP address as the parameter's value.
5. Save the configuration.

If the robot is on the same network as the Fleet Manager device, the robot's name should now appear in the Fleet Manager's hierarchy.

After connecting to a fleet, if you wish to disconnect you may do so by right clicking on the Fleet icon and selecting Disconnect.

5.8 Creating a Subfleet

A subfleet is a category inside the robot type hierarchy level that can be used to group robots for configuration management. For example, you may group a set of LD-250 robots based on their function (e.g. a "Conveyors" subfleet) or location in the map (e.g. a "Production Area C" subfleet) and then configure each subfleet separately.

Follow these steps to create a subfleet:

1. Open the configuration tab of the Fleet by clicking on the **Config** icon of the Fleet in the Fleet Explorer.
2. Right click on the robot type (For example LD-60, LD-90, LD-250).
3. Select **New Subfleet**.

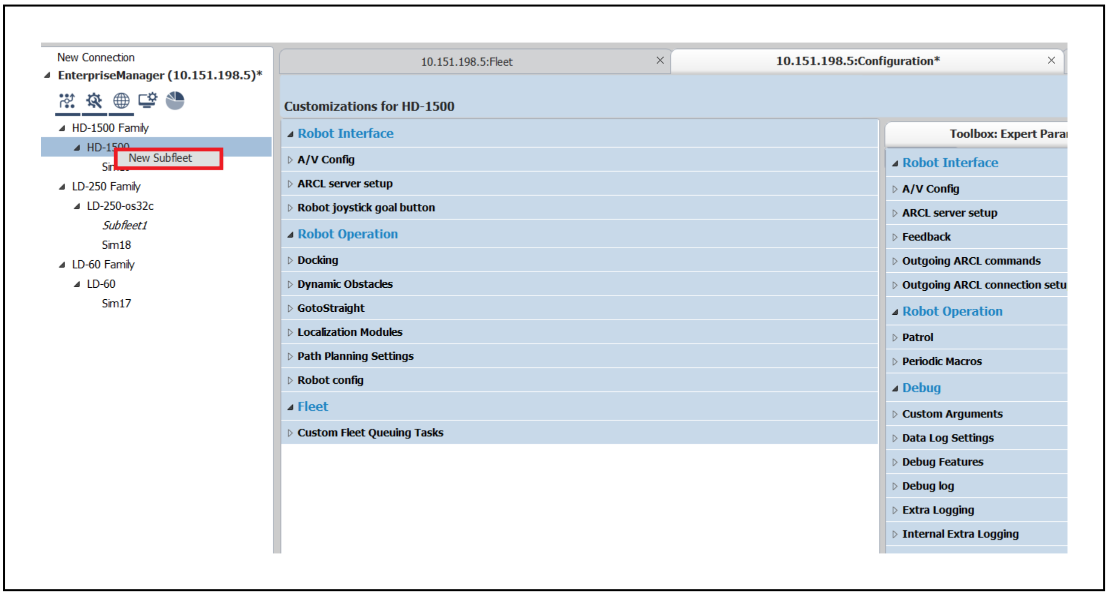


Figure 5-12. Creating a Subfleet

To delete a subfleet, right click on the subfleet, and the select **Remove**.

To add a robot to a subfleet, simply drag and drop the robot into the subfleet. To remove the robot from the subfleet right click on the robot, and then select **Remove**.

5.9 The MobilePlanner Toolbars

There are three toolbars possible in the MobilePlanner interface:

- The main toolbar, which is located at the top of the MobilePlanner interface.

In the Map tab only:

- The Map Controls toolbar is a floating toolbar, which you can move within the map area.
- The AMR toolbar, below the map.

The following sections describe each set of tools.

Main Toolbar

The MobilePlanner main toolbar is located at the top of the window, under the main menu.

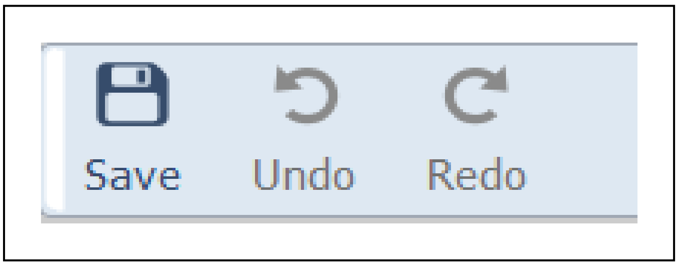


Figure 5-13. Example of jMain Toolbar

To view the main tool bar icons label you can hover over each icon, and view the label. You can also select **View > Show Main Toolbar Labels** to view the main toolbar top icons label.

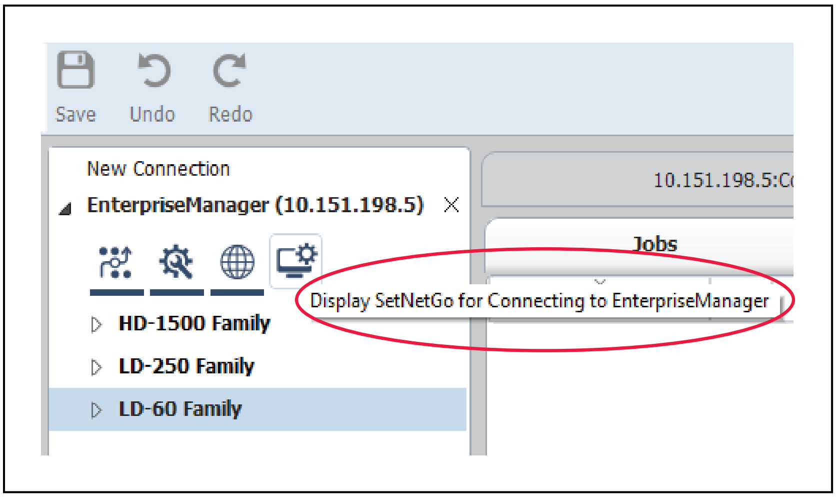


Figure 5-14. Example of hovering over an icon to view the label

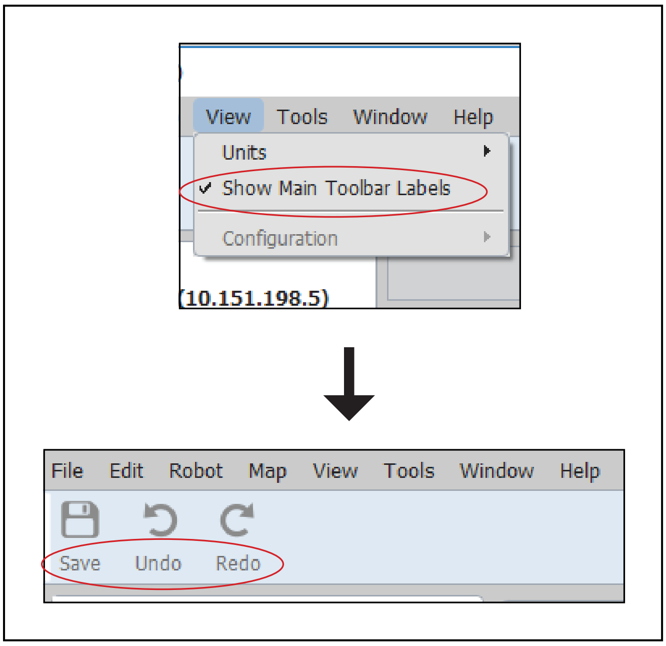
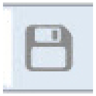
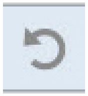


Figure 5-15. Displaying the Main Toolbar Top Icons Label

Table 5-3. Main Toolbar Icons and Their Functions

Toolbar Icon	Description

	Saves changes to the active map or configuration file on the AMR.
	Lets you undo the most recent action performed on the map or config file.
	Lets you restore the most recent item you undid in the map or config file.

Robot and Map Toolbars

The map toolbars control the view of the map, set a goal at the AMR position, and localize the AMR. (Localizing is telling the AMR where it is on the map of the work area.) There are two different map toolbars available: one when the **Show Robot** Button is toggled ON (the AMR is displayed on the map); the other with the **Show Robot** Button toggled OFF (the AMR is hidden from the map).

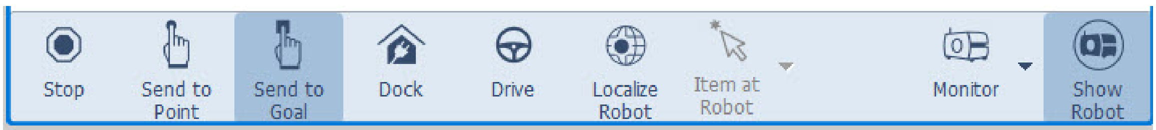


*Figure 5-16. Robot Toolbar (**Show Robot** ON)*

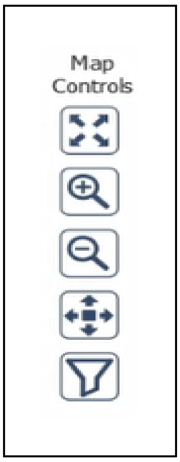
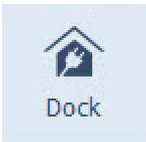
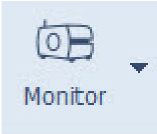
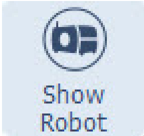
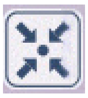


Figure 5-17. Floating Map Toolbar

Table 5-4. Robot and Map Toolbar Icons and Their Functions

Toolbar Icon	Description

Some of the following icons are available when the **Show Robot** Button is toggled ON, but are disabled if the AMR cannot service the request because of low state of charge, or if E-Stop is pressed.	
	Stops the AMR any time you click this icon, even when navigating in autonomous mode. **NOTE:** You can also use your keyboard's **Esc** key to stop the AMR.
	Sends the AMR to a point you select on the map.
	Sends the AMR to a goal you select on the map.
	OFF when the AMR is on a dock or heading to a dock. Also sends the AMR to a dock. When OFF, releases the AMR from the dock.
	Opens the Drive pad, which is used to move the AMR in its environment. Be sure that you have Manual Override toggled OFF, which prevents the AMR from running into anything while you are driving it. Even with Manual Override turned ON, the AMR will avoid any obstacles detected by its navigation laser when traveling over 300 mm/s. Highlight (click on) the pop-up window, and use the mouse or the arrow keys on the keyboard to move the AMR in the direction you want it to go. **CAUTION:** When Manual Override is ON, the background of the map turns yellow, indicating "use caution" while driving.
	Opens the Localize Robot dialog, which is used to localize the AMR to a point selected on the map.
	Allows you to create a goal and/or door with goals, or place a dock at the AMR's current location.

	The Monitor robot feature is available only when the **Show Robot** Button is toggled ON. It provides a convenient place to monitor important AMR details (battery info, state, job counts, sensors, and queuing stats), and the status of digital inputs/outputs. It also provides a place for sending an AMR on a route, adjusting audio input/output volumes, and inputting **Say** commands (phrases that the AMR speaks with its text-to-speech converter).
	Shows the location of the AMR on the map. Several toolbar features won't function unless this is toggled ON. Others won't function unless it is toggled OFF. The background color of the icon turns darker when it is ON.
	Centers the map on the current AMR. This is helpful when you have multiple AMRs in your workspace and you need to locate a specific AMR quickly. It also allows you to watch the AMR as it performs tasks.
	Adjusts the map view to fit in the map window.
	Zooms map out (reduced magnification, more map visible).
	Zooms map in (increased magnification, more details visible).
	Allows you to pan around the map. 1. Click on the **Pan** icon to display the Pan Map box. 2. Click on any of the four arrows of the Pan Map box to move that direction in the map. The keyboard arrow keys perform the same function as clicking on the Pan Map arrows. **NOTE:** • If Center on Robot is turned ON, you cannot pan the map window. • You can also pan the map by clicking and holding the right mouse button while moving the mouse around the workspace. The Pan Up, Pan Down, Pan Left and Pan Right icons are available when the Pan Button is turned ON.

5.10 The MobilePlanner Map Window

The MobilePlanner Map window displays the map file that you are editing. When you first start MobilePlanner, no map is displayed until you connect to an AMR or Fleet Manager. You can also open a map saved locally on your computer or network. For details on opening maps, see Loading an Existing Map File on page 100.

The following is an example of the MobilePlanner interface with a map file opened. Note that the **Show Robot** Button is toggled ON, which disables the tools on the Draw function tab.

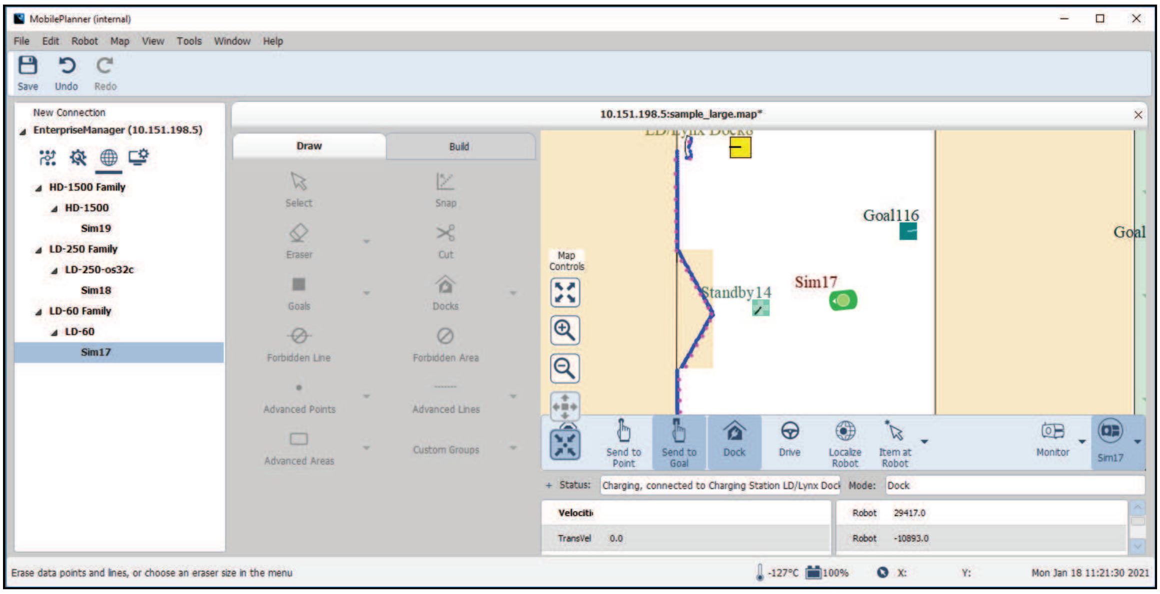


*Figure 5-18. The MobilePlanner Interface, Map Tab, **Show Robot** OFF*

NOTE: To create the initial map, you must first use MobilePlanner to scan the AMR's environment and then turn the scan into a map. For details, see Scanning the Operating Area on page 96.

Map Zoom

Maps initially open zoomed out to give you an overall view of the AMR’s environment. To quickly find the current AMR in the map, click the **Show Robot** Button, then click **Center on Robot**. The map zooms in, focused on the AMR.

NOTE: The **Show Robot** Button must be **ON** to display the **Center on Robot** icon.

Map Controls

You can use the mouse or the keyboard to adjust the map view. The following table describes the map controls.

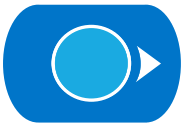
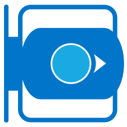
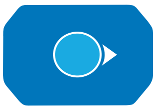
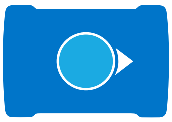
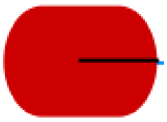
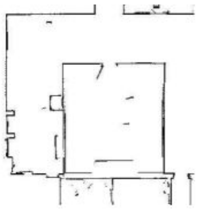
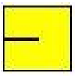
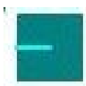
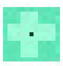
To...	Do this...
Pan	**Mouse:** press and hold the right mouse button (or use the scroll wheel), move the mouse around the workspace. **Keyboard:** use the arrow keys to move right, left, up and down. **NOTE:** You can’t pan the map when the **Center on Robot** toolbar icon is toggled ON.
Zoom in	**Mouse:** press the Shift key and click the right mouse button; or you can rotate the scroll wheel forward (without the Shift key). **Keyboard:** press the Shift key and the Up arrow.
Zoom out	**Mouse:** press the Shift key and click the left mouse button; or you can rotate the scroll wheel backward (without the Shift key). **Keyboard:** press the Shift key and the Down arrow.

Map Features

Map features can be as simple as the static features of the environment (walls, doors, etc.) or, depending on the features you add to the map, they can be quite intricate. In general, more map detail improves AMR navigation.

To create a detailed map of the environment, you need to scan the environment thoroughly and then edit the map. This is done in the MobilePlanner software. For more information on environment scanning and map editing, refer to Scanning the Operating Area on page 96 and Editing a Map File on page 102.

The following table describes the different features shown on the map.

Map Feature	Definition
	This represents the LD-60 and LD-90 AMRs. The white arrowhead indicates the direction that the AMR is currently facing.
	This represents the Cart Transporter AMR. The white arrowhead indicates the direction that the AMR is currently facing.
	This represents the LD-250 AMR. The white arrowhead indicates the direction that the AMR is currently facing.
	This represents the HD-1500 AMR. The white arrowhead indicates the direction that the AMR is currently facing.
	This is the Legacy representation of a robot. The black line indicates the direction that the AMR is currently facing. This may still appear in some system maps.
	The black dots and lines on the map are the walls, doors, and other static fixtures in the environment.
	The blue dots and lines are the features the AMR "sees" with its navigation laser. Some AMRs have additional lasers which produce different colored dots.
	The yellow squares represent the location where the AMR should go, and the black line is the direction it should face, when it starts to dock. The dock object should be approximately 1 to 1.5 meters in front of the dock.
	The green squares represent a goal. The line indicates the AMR’s desired heading when it reaches the goal. Goals are predefined locations where you can send the AMR.
	The light turquoise squares represent Standby Goals. These can be either buffering or parking.

Map Object Visibility Filtering

Using the **Filter** Button, visibility can be toggled between showing all map objects and showing only appropriate map objects for specific AMRs based on the Custom Tasks applied at the selected fleet hierarchy level. This is called Filter Mode. To determine which fleet hierarchy level is being shown, simply click on different levels in the Fleet Manager.

Figure 5-19. Filter Button in the Map Window

In the image below, **Filter** Mode is enabled, and the map is only displaying objects of relevance to the selected hierarchy group of AMRs. Any map objects with a Custom Task that is not configured for the selected AMR group will be hidden. Objects with no Custom Tasks will always be recognized by any AMR.

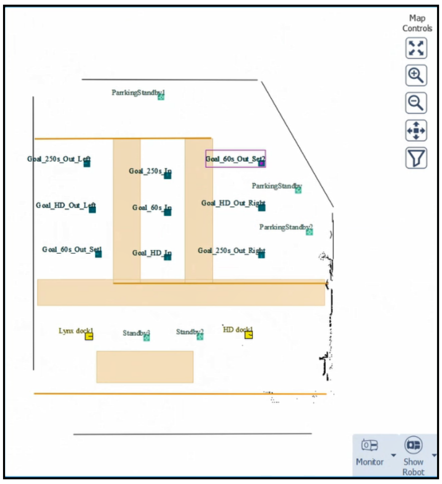


Figure 5-20. All map objects are currently visible

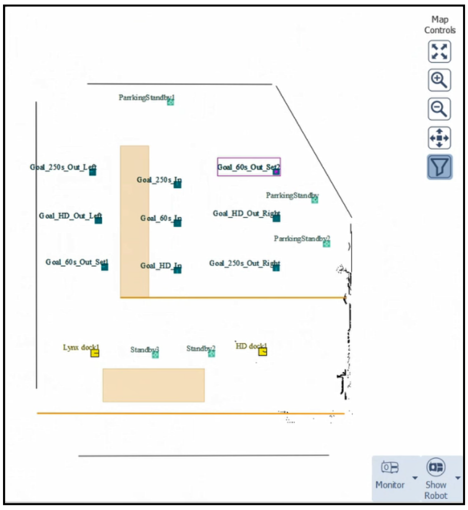


Figure 5-21. Filter Mode enabled

Regardless of whether Filter Mode is ON or OFF, clicking on map objects will highlight AMRs that can access it with a magenta line in the Fleet Manager. This is for quick reference on what AMRs in the fleet can recognize a map object.

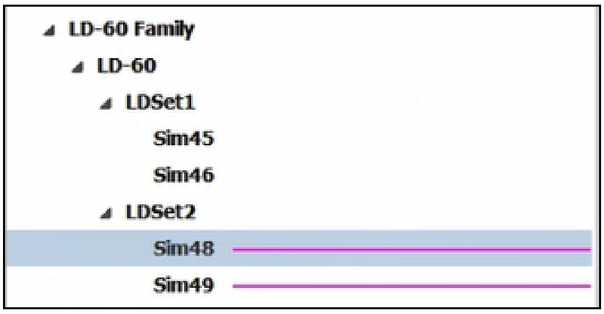
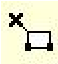
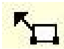
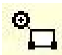


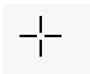
Figure 5-22. Magenta line indicating AMR compatibility with the selected map object

Map Modes

When **Show Robot** is ON, there are several map modes which provide a different AMR function, shown in the following table:

Icon	Map Mode	Definition
	Send Robot	Allows you to send the AMR to a certain spot on the map. When active, clicking on the map causes the AMR to move to that spot. To activate this mode, click **Send Robot** on the Toolbar, then click on the map with the left mouse button to send the AMR to that point. You can also send the AMR by holding down the Ctrl key and clicking on the map. To specify the AMR's desired heading when it arrives at the designated spot, press the mouse button and drag. To deactivate this mode, click the **Send Robot** icon to toggle it off. After you click a point on the map, the AMR autonomously drives to the point you selected.
	Robot Control	Allows you to drive or send the AMR using the keyboard. To activate this mode, hold down the Ctrl key and press the arrow keys.
	Localize to Point	Allows you to localize (mark the AMR's location) the AMR on the map. See AMR Localization on page 260 for details.

NOTE: When **Show Robot** is OFF, the cursor shape indicates what your mouse click or movement will do (see the following table). These cursors are visible after selecting an object.

Cursor	Function	Appears when you...
	Open the Edit window (double-click), or drag the object within the map.	Double-click or click-and-hold on an object, other than on a heading marker or endpoint.
	Change the heading of a goal or dock, or resize a line.	Click on the goal/dock heading marker or either end of a line.
	Resize a rectangular object (the cursor is rotated 90° depending on which corner you pick).	Click on a corner of an area or sector.
	Rotate the object.	Click on the heading arrowhead of an area.

Map Legend

As you edit the map file, you can create goals, lines, forbidden areas, docks and many other features in the environment. Use the Map Legend to keep track of all of the different features that can be added to your map file.

Select **Map > Legend...** from the main menu to open the Map Legend window.

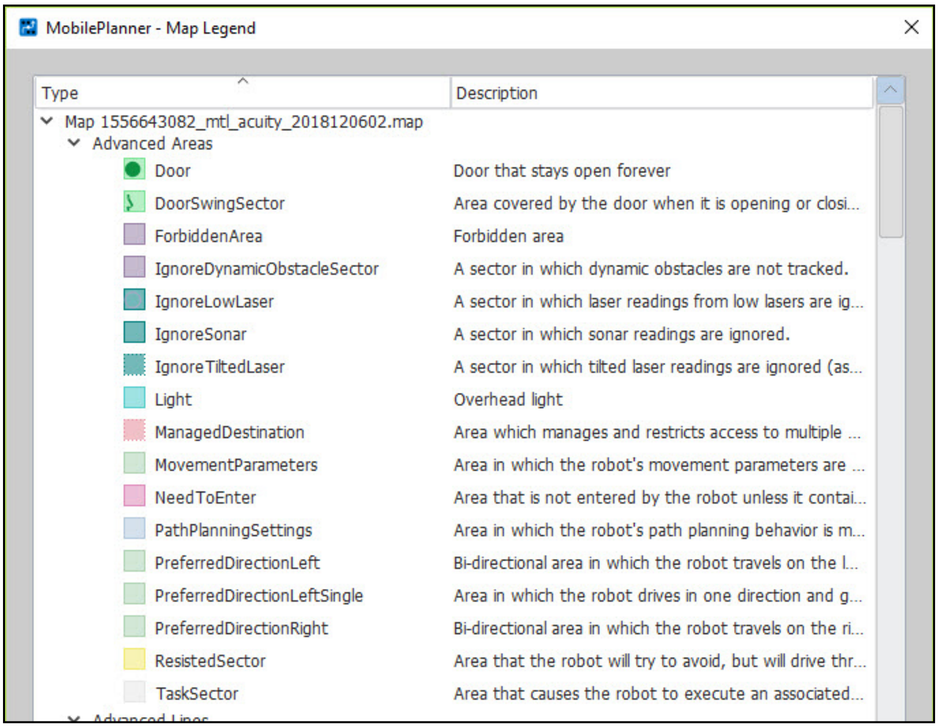


Figure 5-23. Map Legend (Partial)

5.11 Using Monitor

The Monitor feature provides a convenient place to monitor important AMR and Fleet Manager details (battery info, state, job counts, sensors, and queuing stats), and the status of digital inputs/outputs.

It also provides a place for sending an AMR on a route, adjusting audio input/output volumes, and inputting **Say** commands (phrases that the AMR speaks with its text-to-speech converter).

Monitor can be activated either in single AMR or Fleet mode, when you are attached to a Fleet Manager.

The displayed data and appearance will differ, depending on whether you are connected to a Fleet Manager or an AMR, and whether or not the **Show Robot** Button is ON.

To Access Monitor

1. Click **Monitor** on the Robot toolbar to display a sub-menu with various AMR attributes you can monitor.

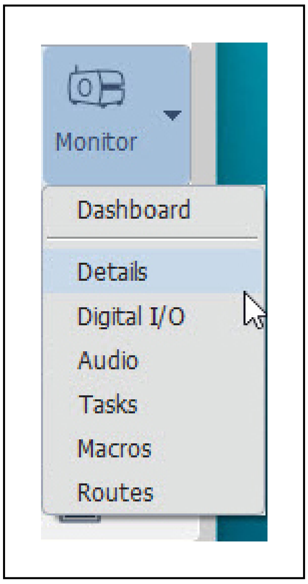


Figure 5-24. Monitor Drop-down Menu

The following table describes the various attributes you can monitor.

Item	Description
Dashboard	Displays an information window listing jobs (number of interrupted, canceled, in-progress, pending, and completed) and AMRs (that need assistance, have E-Stop pressed, busy, available, and unavailable).
Fleet Details	Lists information about AMRs in the fleet - availability, status of assigned jobs, queuing and state information, system status, and memory use.
Details	Lists specific details about the currently monitored AMR - battery/charge stats, path planning and following, AMR pose information, queuing statistics, system data, and wireless data.
Digital I/O	Allows you to monitor custom input/output states, and toggle output states ON (green) or OFF (black).
Audio	Controls incoming and outgoing audio volume. Audio Incoming: MobilePlanner Out: controls the level out (for example, 'sendSpeech'). Audio (Output): Robot Out controls the volume of speech audio files the AMR plays.
Tasks	Lists current tasks assigned to monitored AMR, and allows you to add them to the selected route builder list (normally a goal versus a route).
Macros	Lists and allows immediate execution of all existing macros.

Item	Description
Routes	Lists and allows immediate execution of all existing routes.

Adjusting Audio Levels

The robot monitor also allows you to adjust the incoming and outgoing audio levels. These controls are shown in the following figure.

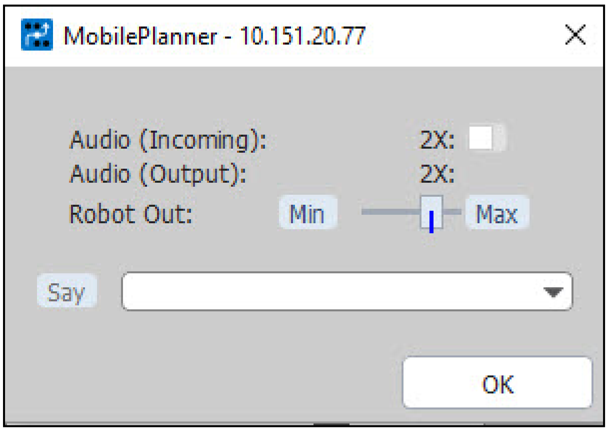


Figure 5-25. Audio Controls

You can adjust audio output level by moving the slide controls to the right (louder) or left (quieter). You can amplify the effect of the incoming audio control setting by selecting the 2X check box.

Making the Robot Talk

The **Monitor** > **Audio** window includes a text-to-speech feature. You can use the **Say** field to input a word or phrase that you want the AMR to speak.

When you click the **Say** icon, the text is converted to synthesized speech through the text-to-speech converter.

5.12 MobilePlanner Status and Tray Displays

The status and tray displays allow you to monitor the status of the AMR (or AMRs) directly from the software interface.

Status Information

The status of the selected AMR is displayed directly beneath the map, as shown in the following figure.

NOTE: In MobilePlanner, the Status area is only visible when the **Show Robot** Button is toggled ON.

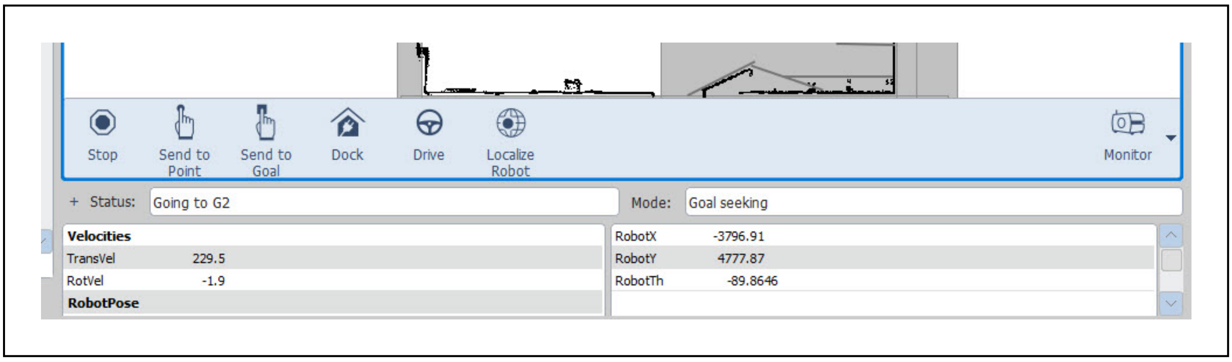


Figure 5-26. Status Information

The following table describes some of the available status information.

> **NOTE:** By default, the status area shows only a small sub-set of available AMR details. To view other data, see Displaying Other AMR-Specific Details (below).

Status Detail	Description
RobotX and RobotY	The current X and Y position of the AMR in the map.
RobotTh	Robot theta - the AMR's heading (which way it's facing), in °, measured counter-clockwise. 0 is the x axis.
TransVel	The velocity of the AMR.
RotVel	The AMR's rotational velocity (how fast it is turning).

Displaying Other AMR-Specific Details

There are many other AMR-specific parameters you can choose to display in the status area. To view and/or add other AMR details, in the MobilePlanner main menu, select **Robot > Monitor > Details**.

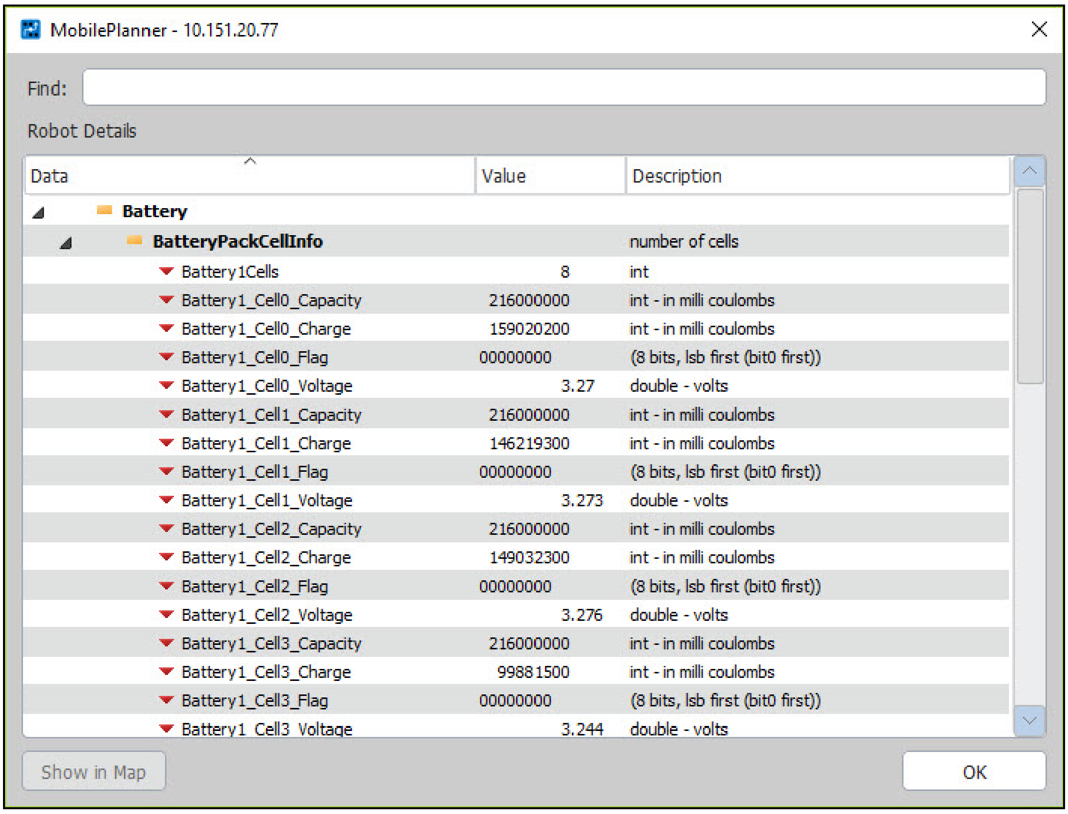


Figure 5-27. Robot Details Window

If you want to add a detail to the status area, click on the detail, then click the **Show in Map** Button (lower left corner). Or, you can right-click in the status area to Hide in Map.

Tray Information

Below the status area, there is a tray that contains information such as connection status and the pointer location.

NOTE: The tray information is always visible.

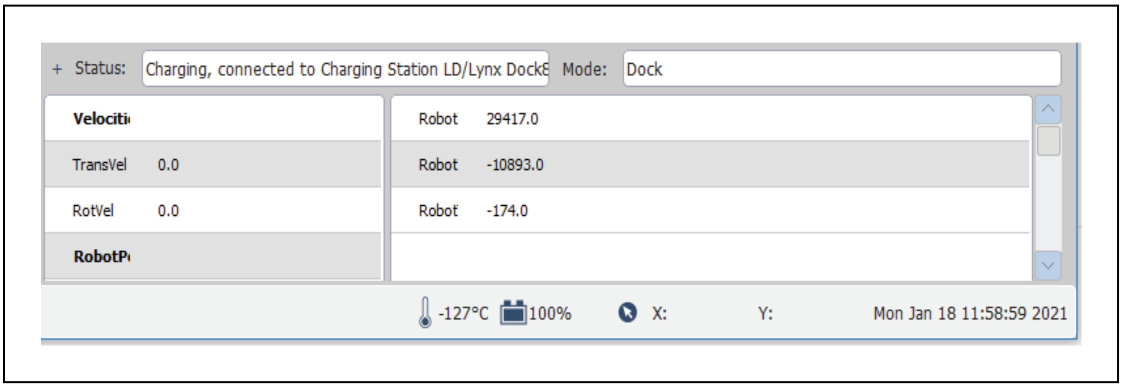


Figure 5-28. Tray Information

The following table describes the items available in the tray.

Table 5-5. Available Tray Icons

Tray Icons	Description
46°C	Displays the temperature reading of the current AMR.
50%	Indicates the state of charge (in %). The icon turns yellow when the charge begins to run low. It flashes red when the battery is low and the AMR needs to dock.
X:	Shows the X position of the pointer in map coordinates.
Y:	Shows the Y position of the pointer in map coordinates.
Mon Jan 18 12:04:49 2021	Displays the system clock.

Chapter 6: AMR Driving Overview

Now that you have installed the MobilePlanner and set up a wireless connection to your AMR, you are just about ready to drive the AMR around your workspace. You can drive the AMR using either the pendant and walking around your environment, or operating it from the MobilePlanner software. Using the keyboard in the MobilePlanner, you can dock and undock the AMR the from its docking station, drive the AMR forward, backward, turn the AMR, and control its speed. This capability is only available with the LDx systems, and can not be used with the HD robot series.

CAUTION: Before attempting to drive the AMR, be sure to read the appropriate AMR user's guide and Mobile Robot Safety Guide so you are familiar with the AMR's operation.

6.1 Before Driving the AMR

Both the HD, and LD robot series will automatically undock from the charging station before responding to the motion commands.

6.2 Manual Override

Autonomous Drive mode is the AMR’s default driving mode, and ensures the AMR does not run into anything in its environment. When driving the AMR using MobilePlanner, Autonomous Drive mode prevents the AMR from entering forbidden or restricted spaces. If driving the AMR using the pendant, you can make the AMR enter forbidden or restricted spaces, but the AMR always obeys the lasers for obstacle avoidance.

When Manual Override is ON, the map background turns yellow (see below).

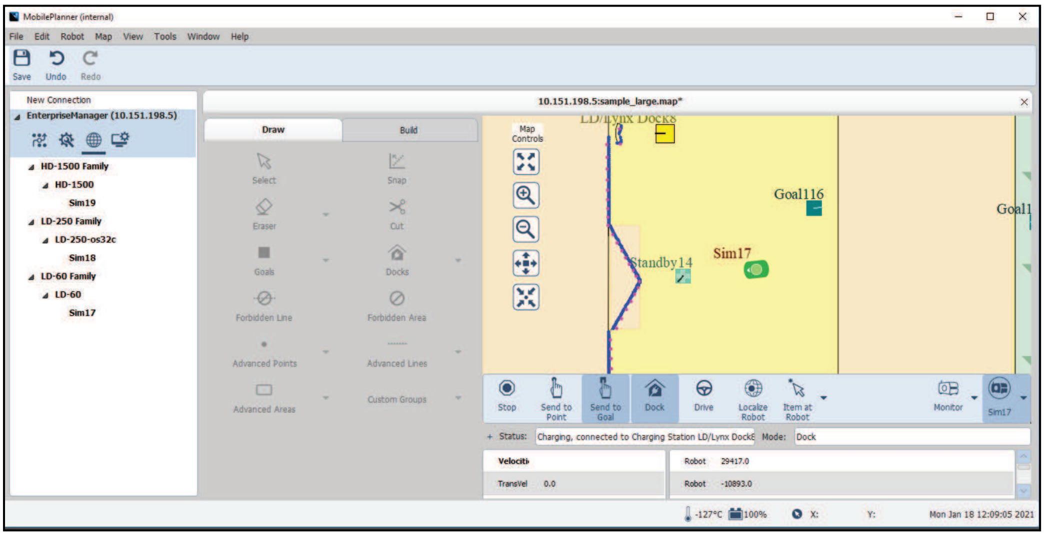


Figure 6-1. MobilePlanner, Manual Override ON

To Drive with Autonomous Drive mode OFF:

1. In the MobilePlanner main menu, click **Robot > Robot Tools > Manual Override**.
2. Click **Yes** to acknowledge the Manual Override dialog prompt.

NOTE: If you turn Autonomous Drive mode back ON when the AMR is in a restricted or forbidden area, it will not be able to drive itself out of the restricted area, and will require you driving it out using the pendant (which always ignores location-dependent areas). Also, while an AMR is in a forbidden area, even with Autonomous Drive mode still OFF, pressing the **Send Robot** Button will not cause the AMR to drive out of the forbidden area. You must drive the AMR out of a forbidden area using the pendant or your PC's arrow keys. See Driving Using the Software Interface (Drive Pad or Keyboard) on page 91.

6.3 Driving Using the Pendant

Refer to your AMR's user manual for details on the pendant and its use.

Preparation

1. If not already done, power up the AMR. The full power-up sequence can take several minutes.
2. Wait for MobilePlanner and/or the AMR to indicate it is ready (via wheel lights, LCD or touch screen).
3. Plug the pendant into the AMR's pendant connection port.
4. If driving with the pendant, proceed to Scanning the Operating Area on page 96.

6.4 Driving Using the Software Interface (Drive Pad or Keyboard)

NOTE: The Drive Pad functionality is not available for the HD-1500 AMR. The Drive Pad display will be grayed-out. Drive Pad operation is not changed for the LD-60, LD-90, and LD-250 AMRs.

Using MobilePlanner software and your PC's mouse and keyboard, you can:

- Dock and undock the AMR from a docking station
- Drive the AMR forwards, backwards, and turn
- Control the AMR's speed

To Drive the AMR Using the Software:

1. Ensure **Show Robot** is active, then click **Center on Robot** to locate the AMR (shown as a robot icon) in the map window (shown in the following figure).

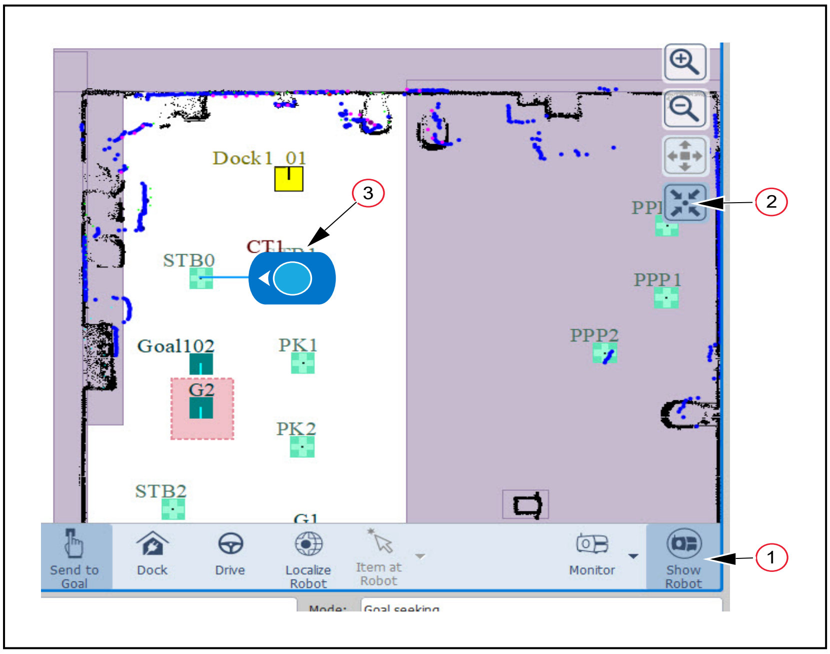


*Figure 6-2. AMR on Map (**Show Robot** ON)*

Table 6-1. AMR on Map Description

Item	Description
1	Show Robot
2	Center on Robot
3	Robot (LD-60 AMR shown)

2. Select **Robot > Undock** from the main menu, or click **Dock** (on the AMR tool bar) to turn docking off. In the map window, you should see the AMR move away from the docking station.
3. If the background in MobilePlanner is yellow (the AMR is not in Autonomous Drive mode), un-check **Robot > Robot Tools > Manual Override** from the MobilePlanner main menu.
4. Click **Drive** to display the MobilePlanner Drive Pad with Speed slider (figure below).

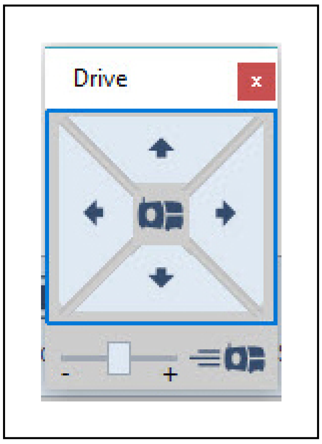


Figure 6-3. Drive Pad with Speed Slider

5. Highlight (click on) the map window, and use the mouse to click on the Drive Pad buttons, or use keyboard's arrow keys to control the AMR's direction. Use the speed slider (at the bottom of the Drive Pad) to control the AMR's speed.

   NOTE: If the speed slider is all the way to the left (-), the speed is set to zero and the AMR will not move.

Chapter 7: Scans and Maps

7.1 Map Overview

With Fleet Operations Workspace Core software, AMRs know where they are and drive from one place to another by themselves, without a human operator. To do this, the AMR must have a prepared map of the static features in its operating environment. MobilePlanner software makes creating maps for one AMR, or an entire fleet of AMRs fast and easy.

Maps are one of the most important features of MobilePlanner. In MobilePlanner, a map is a scanned representation of the floor plan in the AMR's operating space. Maps contain the static features in the AMR's environment, such as walls, doors, permanent shelving, etc. They also contain user-definable sectors, lines, and areas that help the AMR perform its job.

7.2 Scan Overview

The first step is to create a map of the AMR’s environment. In general, the process is as follows:

- Read the section on scanning (see Scanning Overview on page 94), and the section on scanning tips.
- Read the section on driving the AMR (see AMR Driving Overview on page 90).
- Scan the AMR’s operating space (see Scanning the Operating Area on page 96).
- Use MobilePlanner to generate a map from the scan.

7.3 Scanning Overview

Before the AMR can perform autonomous tasks, it needs to have an accurate map of its environment. It is best to create a scan that includes as many stationary features as possible in the workspace. After scanning, use MobilePlanner to turn the scan into a map, then begin assigning tasks to your AMR.

How Does the AMR Scan its Environment?

The AMR uses its forward laser, which scans in a 240° arc for the LD-series AMRs. The HD-1500 AMR uses only its front laser, scanning in a 270° arc. Note that the HD front (and rear) laser is not centered on the AMR.

7.4 What Gets Scanned?

Scans are on a thin horizontal plane. The scan is taken about 200 mm for the LD-series and 175 mm for the HD-1500 from the floor. So tables appear as four legs; a pedestal appears as a single pole, minus the feet.

Distance From Walls

While scanning, keep walls within that range as you drive throughout the workspace. For instance in a large warehouse, run the AMR along the outer walls as well as through the middle of the space.

Uni-directional Versus Bi-directional Scanning

Uni-directional scanning (scanning in a single direction) works very well for hallways and small rooms. Bi-directional scanning (scanning in two directions) will ensure complete scanning of all features (such as vending machines or bookshelves).

In either case it is still necessary to end the scan in roughly the same place that you started.

Doors and Windows

When scanning environments with doors, ensure that the doors are open in places where the AMR will drive. Some glass surfaces, particularly those with dark backgrounds, reflect the range finder signals; others don't or reflect weakly. Consider retrofitting particularly troublesome places with tape or other treatments to obtain proper scans. Additionally, you can designate these features as obstacles in the map using a forbidden zone sector.

Dynamic Features

During scanning, MobilePlanner sees people walking by, swinging doors and other things moving throughout the workspace. If a group forms during scanning, have them follow behind (not stand in front of) the AMR's scanner so they do not become permanent features of your map. For an HD-1500, have them stand behind and to the left, since the laser being used for scanning is on the front-right of the AMR. When editing the map, erase dynamic features (like the group) to improve the map's quality.

Docks

When scanning, scan and press the goal button to mark the AMR's dock so it can recharge when its battery runs low.

7.5 Scanning Tips

The following general tips will help increase the AMR's scanning accuracy, and reduce possible map errors:

- Remove any features like chairs, rolling cabinets, etc. that might not be present during normal operations.
- Walk behind the AMR while scanning (and ensure others walking with the AMR also walk behind the laser's sensing area). With an HD-1500, walk behind and to the left of the AMR, so that the laser (on the front right) doesn't see you.
- Drive the AMR into tight corners, down small corridors, and between stationary objects (with enough room).
- Scan in multiple directions - scan clockwise for one scan, counter-clockwise for another.
- If scanning rough terrain (like diamond plate flooring), drive slowly (to reduce the chances of wheel slip) and in multiple directions. This will help minimize introducing errors into the scan.

- Open doors that might be open during normal operations, and doors the AMR will have to drive through.
- Drive the AMR through previously scanned areas.

NOTE: Driving the AMR back through previously scanned areas, and returning to its starting position can help minimize errors.

Scanning the Operating Area

Be sure to drive the AMR to all of the places you would expect it to go on its own. Drive all the way around a room, not just in and out of the doorway. Turn the AMR to point into corners and move around stationary features. In other words, be thorough!

Also, while driving the AMR, orient and stop it along the way to mark important goals (especially a dock object). Later, you can edit these and add additional goals within MobilePlanner software.

When driving the AMR to create a map you can improve the process by returning to an area that the AMR has already been. This creates a "loop" which the MobilePlanner software can use to establish a more accurate map. It is important to end the mapping process with the AMR in close to the same location, with the same heading as the place where you began. This ensures that at least one loop is created. Including smaller loops while driving may result in a more accurate map. For example, drive the AMR in a loop around a room or open area instead of entering and exiting through different doors. Your map will benefit from sensor readings of this area taken from different angles, as well as from the creation of a loop. See the image below for an example of a thorough scanning path.

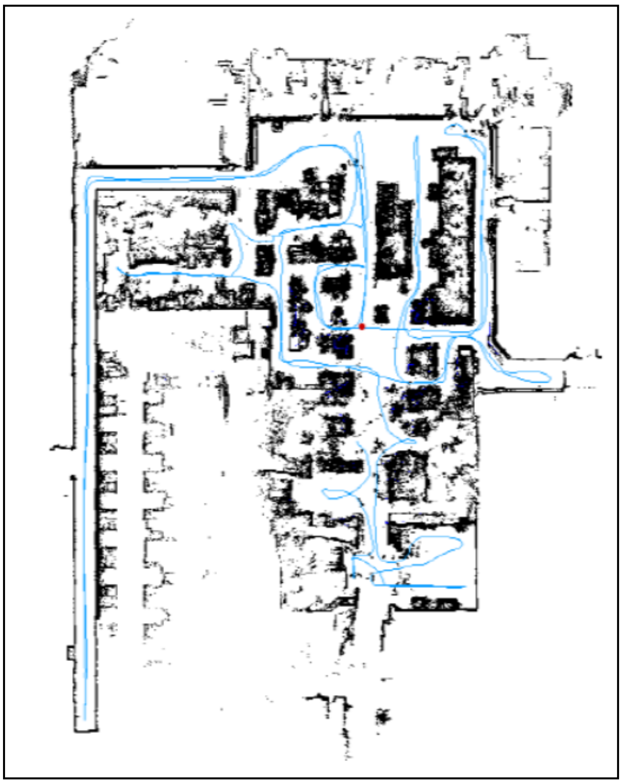


Figure 7-1. Example scanning path with ample looping around rooms

1. If not already done, launch MobilePlanner and connect to the AMR.

    NOTE: Before starting these steps, make sure the AMR is not charging. If the AMR is docked, undock it by clicking **Robot > Dock** (in the MobilePlanner main menu bar), or by clicking the Dock Button in the MobilePlanner toolbar (only visible if **Show Robot** is active).

2. From the MobilePlanner main menu, select: **Robot > Map Creation > Start Scan**.
3. Enter a name for your scan file in the **New Scan Name** field and click **OK**.

    This initiates the scanning process. Notice that the AMR's LCD changes to map scanning mode.

    NOTE: Before driving the AMR, make sure it is in Autonomous Drive mode (a yellow background in MobilePlanner indicates the AMR is not in Autonomous Drive mode). To enable Autonomous Drive mode, un-check **Robot > Robot Tools > Manual Override** in the MobilePlanner main menu bar.

4. Use the pendant to drive the AMR around its operating space.

    NOTE: Be sure to drive the AMR around the entire operating area to create an accurate scan of your environment.

5. If you want to create a goal at the point where the AMR is stopped, press the pendant's black GOAL button to mark a goal.
6. Continue driving the AMR around the operating space until you have a thorough scan of your environment.
7. Return the AMR to its starting position.
8. After you have finished the scan, select **Robot > Map Creation > Stop Scan** from the MobilePlanner menu.

The resulting scan file resides on your AMR, but not on the PC running MobilePlanner. The file name is the name you entered for the scan with the '.2d' extension. If scanning using Acuity, the file name has a '.z2d' extension, and includes additional data such as camera images used to scan overhead lights.

NOTE: Acuity localization is not yet supported for the HD-1500 AMR.

Convert the Scan into a Map

After the AMR scans the operating environment, you need to turn the scan file into a map file. To do this, open the scan file (.2d) in MobilePlanner.

NOTE: MobilePlanner can process only one scan file at a time. Opening a second scan file disables the toolbar Start Button until the first scan is finished.

1. Open the MobilePlanner software.
2. Select **File > Open on Robot,** then select the AMR, either from a list or by IP address.

   The **Open File on Robot** dialog box appears.

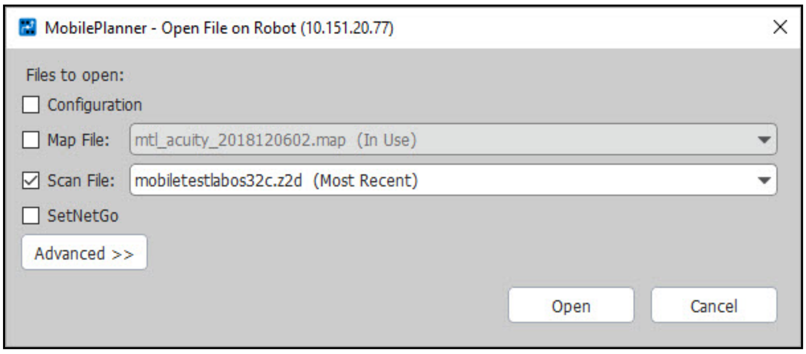


Figure 7-2. Open File on Robot Dialog

3. Check the **Scan File:** checkbox, select the scan file you just created from the pulldown list, and click **Open**.

   A new map window and the Scan Tools toolbar appear, and the conversion (registration) process begins automatically. Initially, the map shows an AMR icon in the map window. During file processing, the software adds scan points to the map window and updates the AMR's position showing a blue trail to trace the AMR's previous positions.

   NOTE: Be patient! Converting a large scan file can take considerable time (and memory), and is based on the size and layout of the area being scanned (for example, a small facility could take 20 seconds, a 20,000 square foot facility could take over an hour). If the small AMR icon in the lower right corner of the map window is still moving, the conversion process is still underway.

   NOTE: PC memory (RAM) is critical when processing a very large scan file. Processing large scan files with insufficient RAM can significantly degrade the performance of all applications. If this occurs, it might be necessary to create smaller scan files and use the Map Insert feature to combine the pieces (refer to Inserting a Map File into an Existing Map File on page 114 for details).

   When processing is complete, the AMR icon and its trail disappear from the map window, and the scan icon in the status bar stops animating. If the map has too many stray objects or otherwise does not appear as you need, you can adjust the scan settings and re-process the scan file (for details, refer to Changing the Scan Settings on page 119).

4. **Save** the cleaned map file locally on your PC.
5. In the Scan Tools toolbar, click **Finish** to complete the conversion process.

   NOTE: Unless working in batch mode, you must finish converting one scan before opening and converting another scan.

6. Edit the map file to erase (**Draw pane > Eraser**) stray, non-stationary objects (like chairs, people, etc.). Add forbidden areas and sectors. Create goals and macros, and assign tasks to your AMR. Refer to Editing a Map File on page 102.
7. Select **File > Save on Robot** to save the finished map file on the AMR, then select your AMR from the MobilePlanner menu. Optionally, you can enter a Fleet Manager address so it can be shared between multiple AMRs.

    NOTE: Select **Yes** when prompted to make the new map the AMR's current map so the AMR can localize, and appear on the map (when you click **Show Robot**).

Map Data

The finished map consists of points and lines (vectors derived from points) representing the walls and other real features detected by the scanning laser.

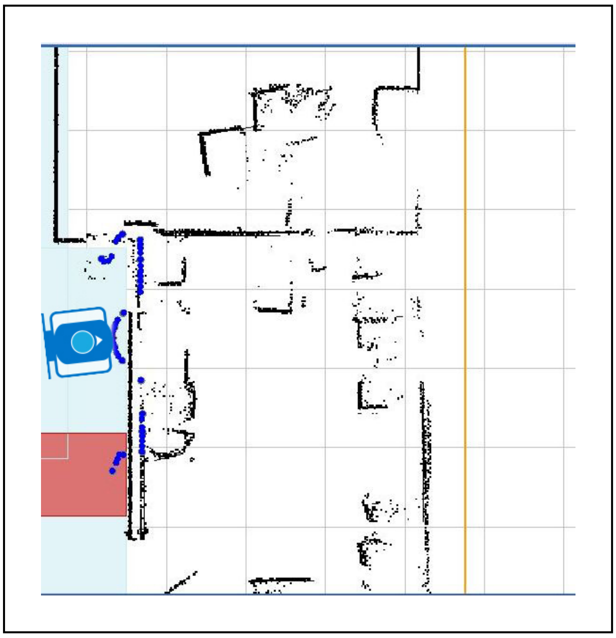


Figure 7-3. Scanned Environment

7.6 Working with Map Files

This section explains map files and how to work with them in the MobilePlanner software.

Making a Map

Before MobilePlanner can create a map of the mobile AMR's operating space, you have to drive the robot through the operating space as it scans the area with its laser and (if installed) Acuity. The resulting scan file contains all the raw data for features in the space. To be usable for mobile robot navigation, you have to use MobilePlanner to convert the scan file into a map file.

Generally, you only need to make a map when deploying your AMR for the first time in a new environment. Occasionally you might need to rescan if the workspace undergoes extensive structural modifications or lighting changes, cubicles added in what was open space, a new wing to the building, or remodel of an area. For more extensive map updates, MobilePlanner provides the tools to integrate a new map, partially or wholly, into your original application (refer to Inserting a Map File into an Existing Map File on page 114 for details).

The best time to create a map scan is when the environment is least busy, when you can minimize the amount of time spent avoiding people and other non-stationary obstacles, and when you can move about, opening and closing doors, without disrupting normal daily activities.

What Information is Stored in a Map File?

Map files contain four kinds of data about an operating environment that the AMR uses in planning navigation and executing tasks:

- Obstacles and features scanned by a laser, and/or overhead lights acquired by Acuity.
- Objects, such as goals, forbidden lines, and sectors that control AMR behavior.
- Macros and tasks associated with goals.
- Data that defines properties of special goal types and available tasks.

A map file name has an extension of .map. Scan file names have an extension of .2d.

Scan files for light localization have an extension of .z2d (scan file is a zip file referred to as the Scan Package) or .zmp (map file from scan - a zip file referred to as the Map Package).

- For information on creating a map using the scanning laser, refer to Scanning the Operating Area on page 96.
- For information on creating a map using Acuity for light localization, refer to Creating the Light Map on page 267.

Loading an Existing Map File

There is no map to display when you first start up the MobilePlanner software. You must use MobilePlanner, with ‘Map’ checked, and connect to an AMR or Fleet Manager to open a map file to edit. Or, you can open a map saved locally on your computer or (when the Map Button is checked) open a map that is currently in use on a specific AMR. You can also open maps on the AMRs that are currently not in use.

Opening a Map saved on your PC

When you use the Map Button to open and edit your map files, you can save them locally on your computer until you are ready to upload them to the AMR. Local map information is also written in the debug info files.

Selecting **File > Open** from the MobilePlanner main menu displays a dialog that lets you search for and select a local map file to open.

Opening a Map stored on an AMR

You can also click the Map Button to edit a map file that is already in use on an AMR, which is helpful for making quick changes to the map or the AMR's route.

1. In the MobilePlanner main menu, select **File > Open on Robot** to display a submenu that lets you select a particular AMR.
2. Either choose from the displayed AMR IP addresses, or enter a new AMR IP address to open a map on the specified AMR.

   A dialog box appears in which you can choose between Configuration, Map File, Scan File, and SetNetGo files.

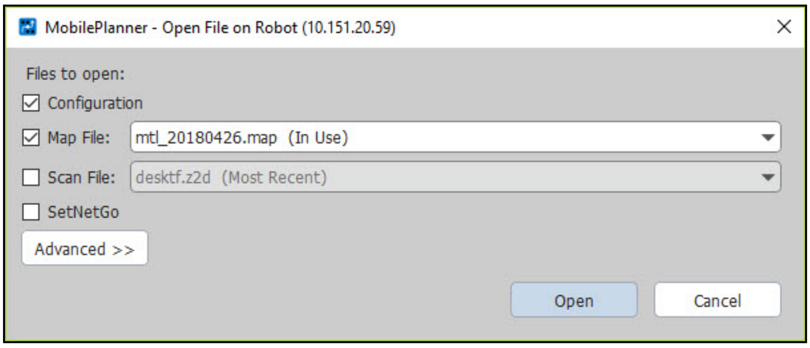


Figure 7-4. Open File on Robot dialog

3. Check **Map File** to choose a map file located on the AMR.

   You can use the Map File list and/or click the **Advanced** Button to search for and select a map file to open, as shown in the following figure:

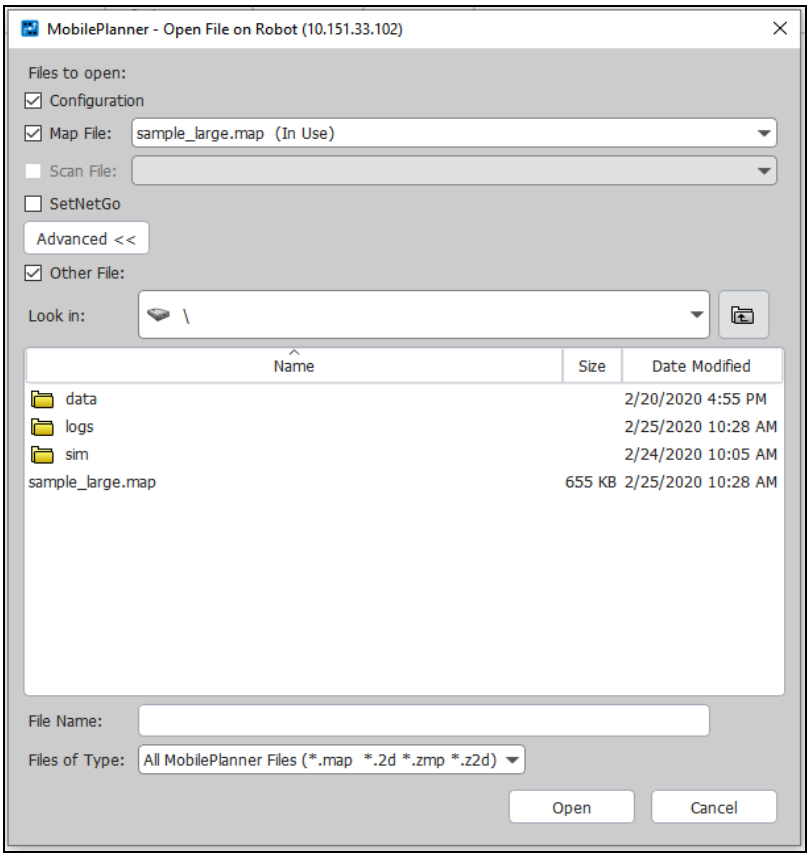


Figure 7-5. Open File on Robot, Advanced dialog

4. Select the map file you want to edit.
5. Click **Open** to load the map file into MobilePlanner.

Editing a Map File

After you create the initial map of your environment, you can use MobilePlanner to edit the map. First, use the Eraser tool (Draw pane) to remove map features that are temporary or moveable fixtures, such as chairs or forklifts.

Using the Drawing Tools

When editing your map file, you use the drawing tools to select and erase objects in the map, add goals, docks, forbidden lines and areas, as well as advanced lines and areas. The drawing tools are shown below.

> **NOTE:** These drawing tools are inactive (grayed-out) if **Show Robot** is active. The Cut icon is inactive until you select a map object.

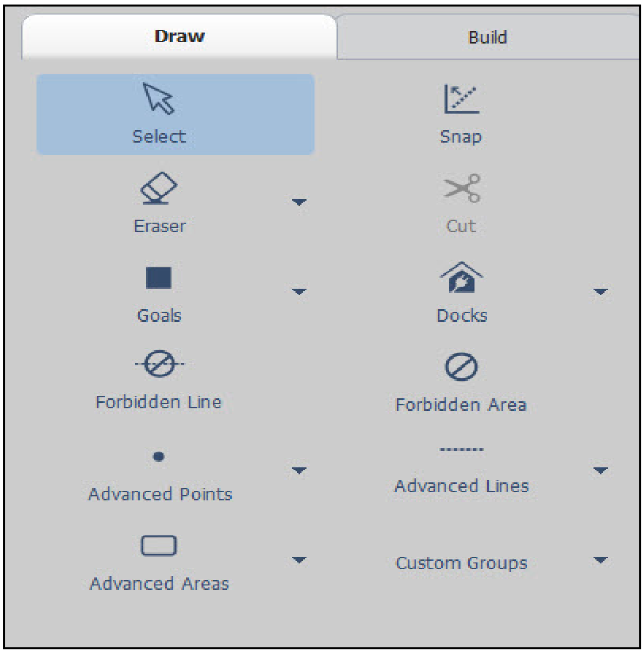


Figure 7-6. MobilePlanner Draw Tab

Selecting and Erasing Objects in the Map

Use the **Select** Button to select and highlight objects on the map. Press and hold the left mouse button to move the object around the map window. Click the right mouse button to display a pop-up menu that allows you to edit, duplicate, align, copy, or cut the object.

> **NOTE:** If there are overlapping objects on the screen, you can right-click on the overlapping map objects. A sub-menu lists all objects under the cursor so you can select the desired object.

Use the **Eraser** Button to remove data points and lines from the map. Press and hold the left mouse button to move the eraser over the data points or lines you want to remove. You can adjust the size of the eraser by selecting the pull-down menu from the **Eraser** Button. Choose an eraser size from 5 to 10,000 mm.

Cutting a Selection

Use the **Cut** icon (or **Delete** key) to remove any objects you have selected from the map.

Snapping Objects in Place

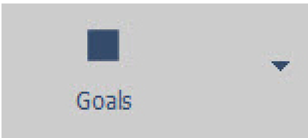
Use the **Snap** Button to force rotate objects (goals, docks, lines, and areas) at multiples of 45° angles. Deselect this button to draw or rotate at any angle.

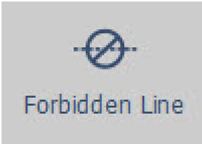
Draw Tab

You can use the Draw tab to add and edit map items (for details on map editing, refer to Editing a Map File on page 102).

NOTE: The Draw tab is only active when the **Show Robot** Button is toggled OFF.

The following table lists the toolbar icons and their functions.

Item	Description
	Select a feature (point, line, area, etc.) on the current map. The status bar on the bottom left side of the window displays information about the feature you selected, such as: FORBIDDEN LINE: Length = 98400 Angle = 0.0° Start = (-65041, 4478) End = (33359, 4478)
	Remove points or lines from the active map. Does not remove custom/landmark objects. 1. Click on the **Eraser** icon. 2. Use the pull down menu to select the eraser size from 5 mm to 10,000 mm. 3. Click and hold the left mouse button, while moving the mouse over the points and lines you want to erase.
	Click **Goal**, then click on a map location to add a goal. In the Edit Goal dialog box you can: • label the goal • provide a description • select the type of goal (if available) • adjust the X/Y position and heading. You can adjust the heading after placement by holding the left mouse button down, and dragging around the goal. The heading will follow the cursor.
	Click **Docks**, then click in the map at the new dock's location. In the Edit Dock dialog box you can: • label the dock • provide a description • select the type of dock • adjust the X/Y position and heading. You can adjust the heading after placement by holding the left mouse button down, and dragging around the dock. The heading will follow the cursor.

<table>
<tr>
<td>
</td>
<td rowspan="2">AMRs will not cross forbidden lines, or enter forbidden areas. To add a forbidden line or area:

Press and hold the left mouse button.
Drag the mouse to create the line or area and to adjust the size.
Release the mouse button (the line or area remains selected).
Press and hold the left mouse button.
Drag the selected line/area to move its location on the map.
For an area, click and hold on the heading arrowhead, then drag to rotate the area.
</td>
</tr>
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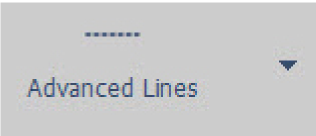
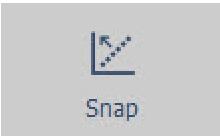
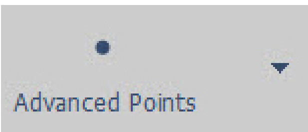
<tr>
<td>
</td>
<td>Allows you to measure distances, display a measuring stick, add Preferred or Resisted Lines, or a Map Data Line to your map.</td>
</tr>
<tr>
<td>
</td>
<td>Place lines and rectangles to the x/y axis (or 45° angles). Deselect this button to draw or rotate at any angle.

To temporarily toggle this button while drawing a line or rotating a rectangle, press and hold the Ctrl key. Release the Ctrl key after making the edit.</td>
</tr>
<tr>
<td>
</td>
<td>Places special areas on the map that the AMRs will avoid entering or crossing (e.g., door swing sectors, need to enter sectors, resisted sectors, etc. To add an advanced area to the map:

Press and hold the left mouse button.
Drag the mouse to create and size the line or area.
Release the mouse button (the line or area remains selected).
Press and hold the left mouse button.
Drag the selected line/area to move its location on the map.
For an area, click and hold on the heading arrowhead, then drag to rotate the area.
</td>
</tr>
<tr>
<td>
</td>
<td>Opens a submenu for adding a label to any advanced feature on the map.

Click on Advanced Points, then select Label from the submenu.
Click on a feature in the map you want to label, then use the Edit Label dialog box to enter a label, provide a description, and adjust the X/Y position and heading.

NOTE: The label box is a special text box that does not scale when zoomed.
</td>
</tr>
</table>

Using Advanced Lines and Areas

Advanced lines and areas (in **Config** > **Robot Operation** > **Map Features**) control the AMR's behavior. You can alter traffic flow, restrict the AMR from entering an area, and have the AMR use a preferred route. For more information on creating these features and more, refer to Traffic Management on page 228.

Advanced Lines

Advanced Line	Definition
Measuring Stick	Places a line on the map to measure distances in the map. You can change the measurement units by selecting **View > Units** from the main menu.
Preferred Line	Places a line on the map representing part of a path that you prefer the AMR use.
Resisted Boundary	Places a boundary line that the AMR resists crossing. If there is no other way around an obstacle, the AMR will cross a resisted boundary (though at a higher cost). For more information, refer to Cost-Based Path Planning on page 231. You can adjust the amount of line resistance. This is preferred, by an AMR, over a restricted boundary.
Restricted Boundary	Places a boundary line that the AMR will avoid if possible.
Switchable Forbidden Line	Places a boundary line that you can control with tasks or through ARCL.

Advanced Areas

Advanced Area	Definition
Door	Places an area on the map for a door.
DoorSwingSector	Places a sector on the map that corresponds to a door's swing arc.
Door Virtual	Places a goal on the map for the AMR to drive to before entering a door.
IgnoreLowLaser	Enables a sector in which the AMR ignores low laser readings (e.g., for driving up and down ramps, crossing the threshold gap in an elevator, etc.).
IgnoreSonar	Places an area on the map that will disable the sonar sensors. This can be useful for crossing known thresholds, so the sonar doesn't prevent the AMR from driving over the threshold. **NOTE:** If you have the low front laser, IgnoreSensor does not apply.

IgnoreTiltedLaser	Instructs the AMR to ignore inputs from side-mounted lasers.
ManagedDestination	Allows use of multiple goals as a single destination to determine AMR occupancy of the sector.
ManagedMotion	Limits the number of AMRs allowed to drive in an area (sector) at the same time.
ManagedMotionOverride	Makes contained AMRs appear to be driving. Used primarily in con-stricted areas.
Movement Parameters	Places an area on the map where you can change movement parameters, such as velocity, acceleration, and deceleration, in real time.
Need to Enter	Places an area on the map that the AMR can drive to only if it is already in the area or a goal that it needs to drive to is in the area.
PathPlanningSettings	Places a sector that changes path planning settings.
PreferredDirectionLeft, PreferredDirectionRight	Places an area on the map that directs the AMR to travel along the right or left side of the path, unless there is an obstacle in the way. The AMR chooses the preferred side regardless of which way the AMR is traveling. In other words, it follows the preferred side whether it is traveling up the hallway or down the hallway.
PreferredDirectionRight Single, PreferredDirectionLeft Single	Enable sectors that cause the AMR to prefer driving on the left or right, in one direction only. Generally, the bi-directional Pre-ferredDirectionRight/Left should be used instead. If two single dir-ection sectors are placed next to each other, they must be aligned with care so AMRs do not collide. Using a preferred direction single tells the AMR to travel along the right (or left) side of the path unless there is an obstacle in the way. The AMR chooses the preferred direction in one direction only. In other words, the AMR will prefer to travel on the right (or left) side only when it is traveling up the hallway.
SingleRobot	Places an area on the map that only a single AMR can be in at any one time.
SwitchableForbiddenArea	Places an area on the map that can be controlled with tasks or through ARCL.
TaskSector	Places an area on the map that has a task list of what the AMR will do immediately upon entering and exiting the sector.
VolumeAdjustment	Places an area on the map where the AMR's audio output can be changed.

Adding Forbidden Lines and Areas

You can place forbidden lines and areas on the map to prevent the AMR from crossing the line or entering a specified area.

> **NOTE:** Forcing the AMR to cross a forbidden line or enter a forbidden area is a special circumstance discussed in Restricting Traffic on page 247.

1. With the map active, click the **Draw** tab, then click **Forbidden Line** or **Forbidden Area**.
2. Click on the map where you want to place the forbidden line or area. Be sure to add forbidden lines or areas around the AMR's work space so it doesn't try to navigate outside of its space.
3. Hold the left mouse button, then drag the mouse to the location you want the line or area to end.
4. Click the right mouse button to display a pop-up menu that allows you to edit, copy or cut the forbidden line or area.

Creating and Adding Goals and Docks

Goals are virtual destinations that the AMR drives to in its environment. Docks are locations to which the AMR drives to prepare to recharge. You need to add both of these features to the map for the AMR to successfully navigate through the workspace.

You can quickly add a goal or dock to the map using the **Item at Robot** Button (robot tool bar), which allows you to add the object at the AMR's location. Once added, you can move goals and docks around by clicking on them with the left mouse button, holding the button, and dragging them to the desired location. You can also click on the heading line and drag it around, or put it in the middle to turn the heading off.

Types of Goals

You can choose from different types of goals:

- **Door Goal:** Doors and virtual doors are spots at which the AMR positions itself before entering or leaving a doorway (see Using a Door Goal on page 110). They appear green on the map, and are only available if the Doors parameter is enabled (click **Config > Robot Operation > Map Features**).
- **Goal:** This is the default goal. The X and Y positions are automatically entered based on the location you selected on the map. Click on the check box to enable a heading and enter a heading in degrees (you can also do this on the map by dragging the mouse cursor - see Creating and Adding Goals and Docks on page 108.). The goal heading specifies the orientation of the AMR when it arrives at the goal.
- **Standby:** Standby goals serve three purposes, each designed to help keep the AMRs out of the way of traffic and regions of interest (goals, tools, etc.):
  - **Buffering:** waiting at a standby goal for another AMR to clear an occupied goal or sector. Refer to Using Standby-Buffering Goals on page 112.
  - **Parking:** allows available AMRs to drive to a waiting area for assignment to another goal. Other parking goals include Preferred Parking goals (also known as

'park at pickup/dropoff' goals). Refer to Using Standby-Parking Goals on page 111.

- **Multi-Robot Standby (MRS):** (also referred to as Taxi Line) allows (and enforces) sequenced, orderly queuing of multiple AMRs from the same start (standby) position to the same goal. For more information, refer to Traffic Control Concepts on page 228.

To create a goal/dock:

1. With the map active, click on **Draw tab > Goal** or **Draw tab > Dock**.
2. Click the mouse on the map where you want to locate the goal/dock. Then, while holding the left mouse button, drag the mouse around the goal/dock to set its heading.

   NOTE: Place a dock object where the AMR should go to "look at" the dock, not where the dock actually is. The dock object should be 1 to 1.5 meters in front of the dock, pointed at the dock. See the following figure.

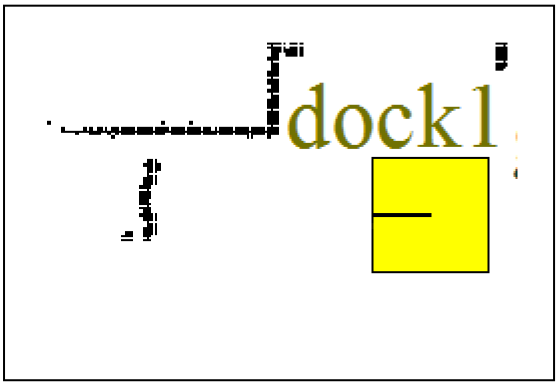


Figure 7-7. Dock as Imaged by AMR

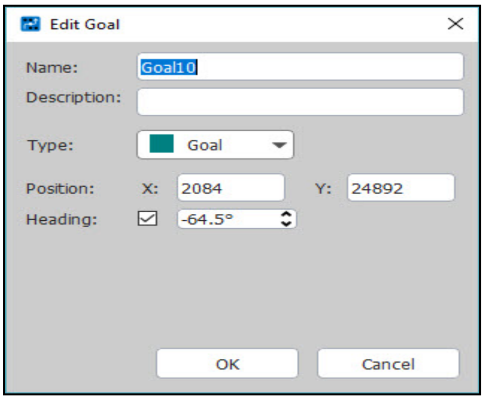


Figure 7-8. Edit Goal Dialog Box

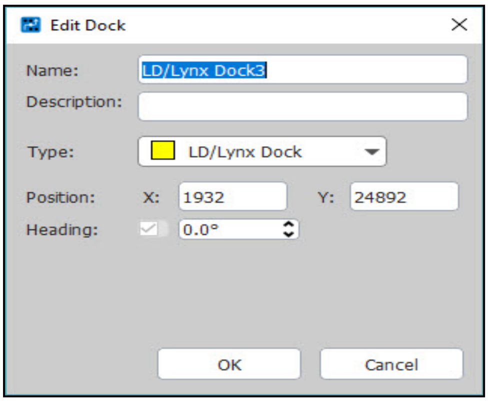


Figure 7-9. Edit Dock Dialog Box

3. In the appropriate dialog box (Edit Goal or Edit Dock), enter the name of the goal/dock you want to add to the map, for example "Receiving".
4. Enter a description of this goal or dock (optional).

5. Select the Type of goal or dock you are adding.
6. Enter the X and Y position to adjust the location.
7. Enter a heading value in degrees (required for docks, optional for goals).
8. Click **OK** to place the goal or dock on the map.

Using a Door Goal

The door goals appear as a green square on the map. They allow you to mark a spot for the AMR to position itself before entering or after leaving a doorway. The following dialog box appears when setting up a door goal.

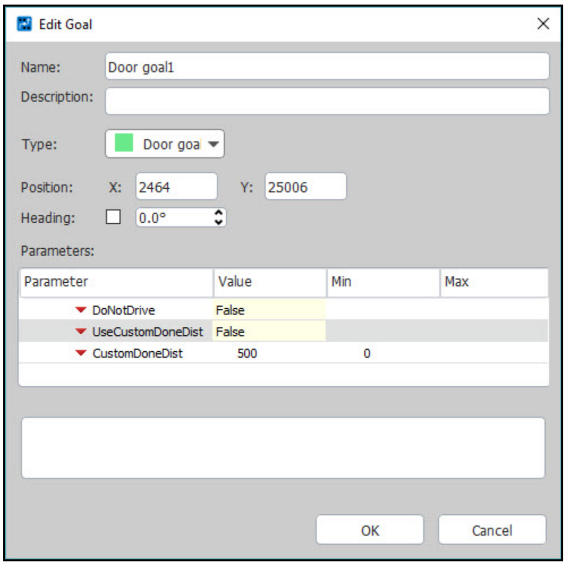


Figure 7-10. MobilePlanner Edit Goal dialog

NOTE: Click on a parameter to see its description near the bottom of the dialog box.

Door Groups

You can also add a door group, which creates the door items and their dependencies. Click on **Custom Groups** > **DefaultDoorWithGoals** to add a door group.

A door group is a Custom Group consisting of Entrance Goal, Exit Goal, and the Door itself.

When creating a door group, specify a door output in the Parameters list. This is necessary to ensure that the Door can properly receive the signal to open.

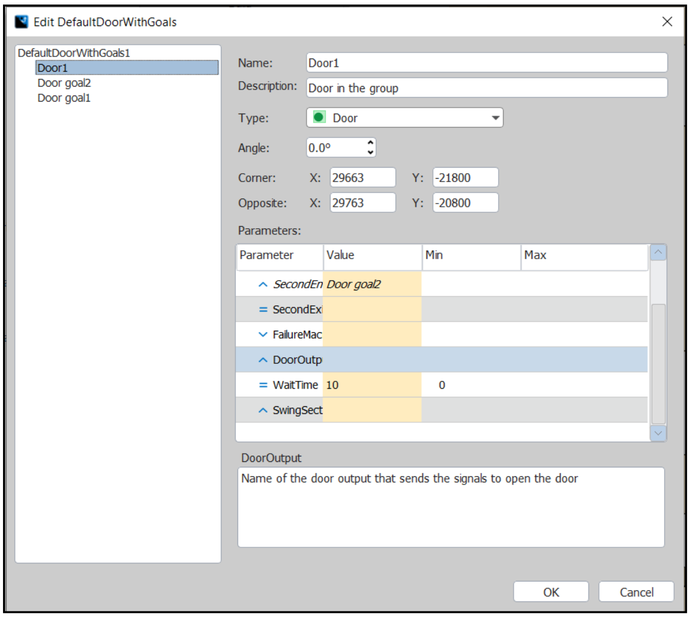


Figure 7-11. Configuring a new Door GroupReer to

Refer to Setting Up Special Tasks on page 197 for more information.

Goals Using High Accuracy Positioning System (HAPS)

If your AMR has one or more optional HAPS sensors installed, you can create goals that require the AMR to approach and position itself closely.

The most simple of these types of installations have a goal on the AMR's map, a length of magnetic tape on the floor (the track), and one marker. The AMR's objective is to approach and proceed down the track, and stop at the marker.

You can also install tracks with multiple locations at which the AMR stops. Each stop needs one track, one marker, one goal per marker, and an Engage task for each goal. Refer to Engage on page 179.

Standby Goals

Standby goals allow you to set up buffering when an AMR's destination is already occupied by another AMR. They also allow you to send AMRs to a parking area after completing a queuing job.

> **NOTE:** To use standby goals, you must enable them. Click the **Config** Button, then click the **Robot Operation** tab, then click **Map Features** (in the left pane), then click the checkbox for the **Standby** parameter.

Using Standby-Parking Goals

> **NOTE:** It's best to place standby-parking goals in areas out of the way of traffic and common AMR destinations.

To place a Standby-Parking goal on your map, do the following:

1. With the map active, click on the **Draw** tab, then click on the **Goals** drop-down list.
2. Select the **Standby** goal type.
3. Place the goal(s) on the map, then change the **PrimaryPurpose** parameter to **Parking**.
4. Use at least as many Parking goals as the anticipated number of waiting AMRs.

Using Standby-Buffering Goals

If an AMR is waiting for another AMR to clear a goal, it will use a Standby-buffer goal closest to its destination. Best practice, then, is to place Standby-buffer goals near tools and areas of interest, in locations that will not block AMRs leaving the goal.

To place a Standby-Buffering goal on your map, do the following:

1. With the map active, click on the **Draw** tab, then click on the **Goals** drop-down list.
2. Select the **Standby** goal type.
3. Place the goal(s) on the map, then change the **PrimaryPurpose** parameter to **Buffering**.
4. Use at least as many Buffering goals as the anticipated number of waiting AMRs.

Adding a Goal at the AMR's Current Position

You can add a goal (generic, door goal, cart goal, or docking station) at the AMR's current position as follows:

1. With **Show Robot** active, click the drop-down arrow on the **Item at Robot** Button (Robot Toolbar).
2. Select the type of goal you want to add.

   If you select one of the default goals (e.g., docking station), information about that goal is pre-populated in the dialog box.
3. If you selected a generic goal, fill in the name, description, and type, then click **OK**. For a default goal, click **OK**.

Accessing the Docking Parameters

Docking parameters define the AMR's actions during the docking process. To access the Docking parameters, click the **Config** Button, click the **Robot Operation** tab, then click **Docking**.

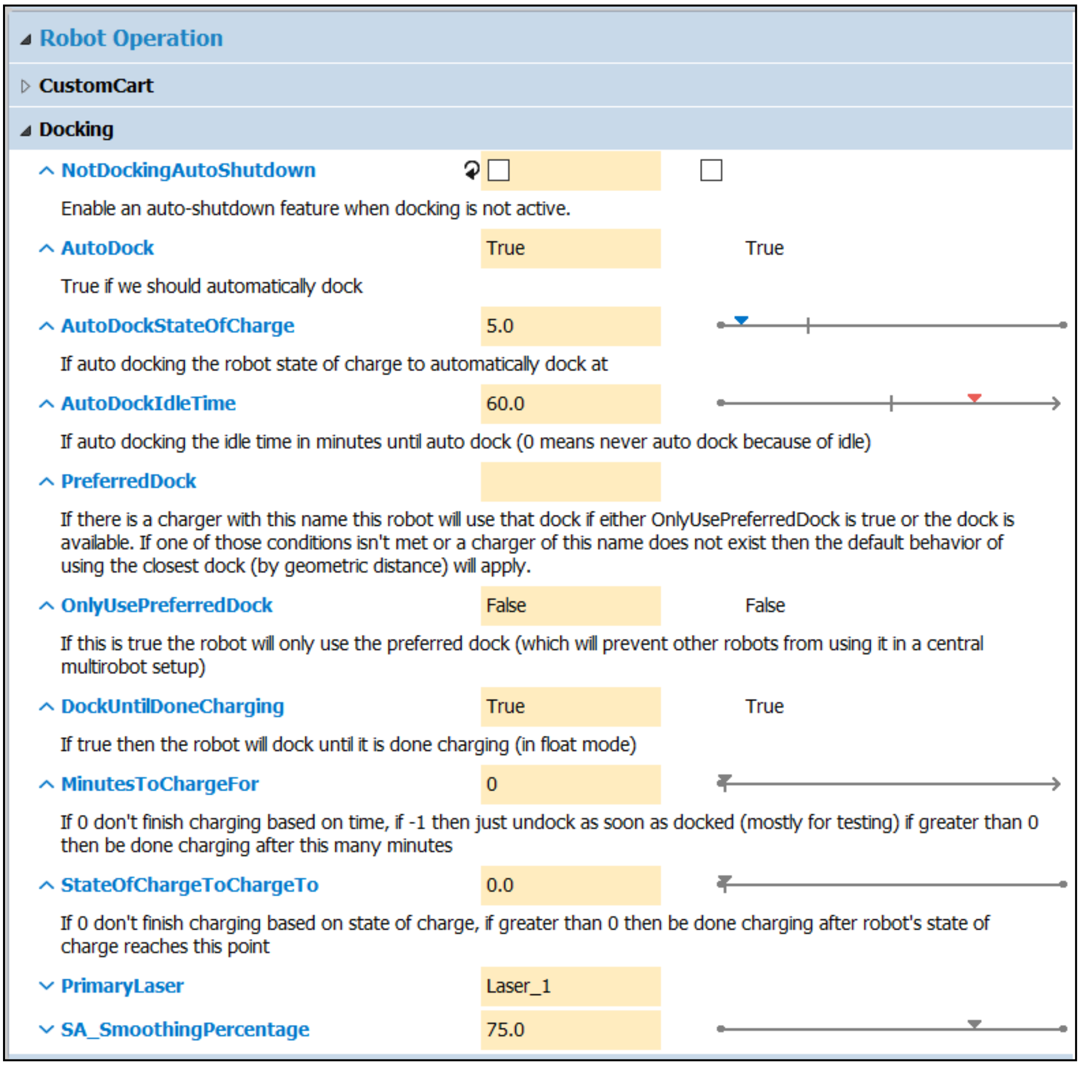


Figure 7-12. MobilePlanner Config - Robot Operations tab, Docking Parameters

NOTE: Docking parameters show in **Docking** and in **Fleet Docking**.

Advanced Lines and Areas

MobilePlanner has tools for adding special, or advanced, features to your map that perform the following functions:

- **Advanced Areas:** these are areas in which you can add doors (and their swing sector), control speed (Fast or Slow), direct the AMR to ignore laser or sonar inputs, limit the number of AMRs operating in the space at one time (ManagedMotion), set the AMRs' preferred travel direction, and direct the AMRs to enter (or resist entering).
- **Advanced Lines:** these include lines to measure distances on the map (measuring stick), lines representing the AMR's preferred path (preferred line), lines the AMR will resist crossing unless there is no other way around an obstacle (resisted boundary), lines the

(SwitchableForbiddenLine).

Adding an Advanced Area or Line

Advanced lines, points, and areas include features like closed doors, measuring sticks, switchable forbidden lines or areas, one-ways, and many more. You must enable some of these features under the **Config** Button, Robot Operations tab, Map features (likewise, you can also disable those that you do not want to use). See Restricting Traffic on page 247.

1. With the map active, click the **Draw** tab, click the drop-down menu triangle for either **Advanced Lines** or **Advanced Areas,** to display the available types, then select the type you want to add.
2. Click on the map where you want to start placing the line or area and, while holding the left mouse button down, drag the mouse to where you want the line or area to end.
3. If an Edit Advanced Line/Area dialog box appears, enter the needed information, then click **OK**.
4. Click the right mouse button to display a pop-up menu that allows you to edit, copy and cut the forbidden line or area.

Inserting a Map File into an Existing Map File

The Insert Map feature is helpful if there have been small or medium changes to the AMR's environment. You do not need to rescan the entire workspace and recreate the map file. To use the Insert Map feature, you can scan the area of the environment that has changed, turn that into a map, and insert it into an existing map.

In certain situations, you might want to insert only a subset of the region's data into the original map. For more information, refer to Using the Advanced Insert Option on page 117.

Select a Map File

In MobilePlanner, select a map to insert into an existing map.

- Select **File > Insert Map** from the main menu. A dialog box appears, which lets you search for and select a local map file to open.

The new map appears in the active map as a blue rectangle, and the Insert Map toolbar allows you to manipulate the inserted map.

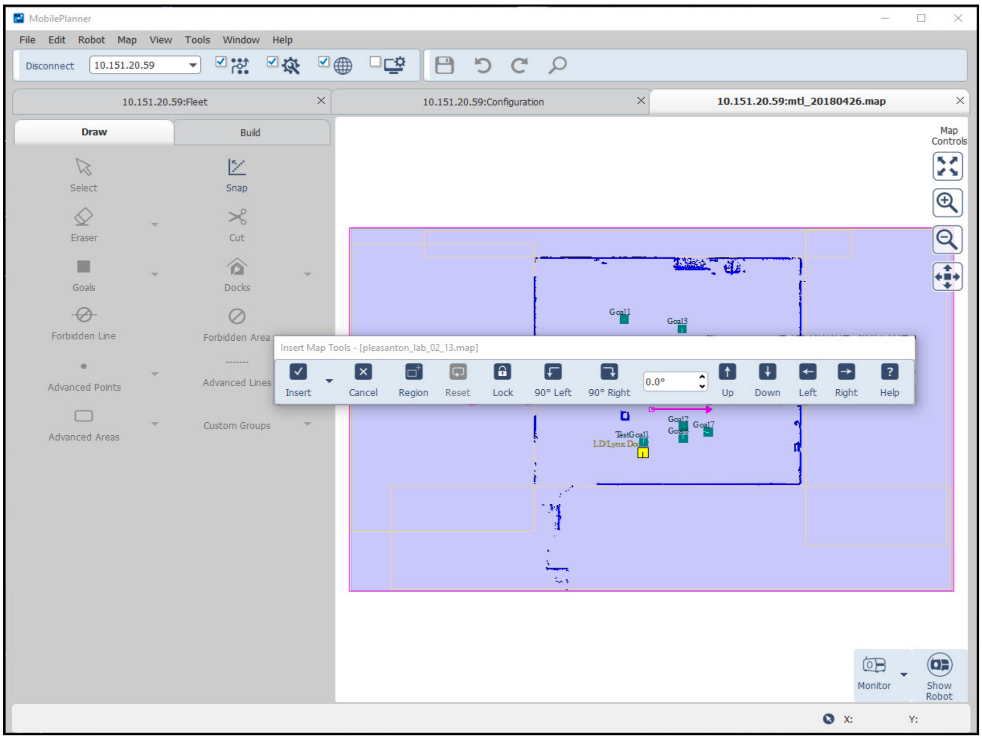


Figure 7-13. MobilePlanner, Insert Map Tools

Use the **Insert Map Tools** to position the inserted map into the existing map. After selecting a map section to insert, the **Insert Map Tools** toolbar automatically displays.

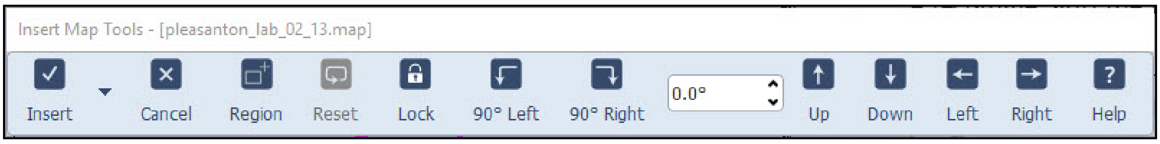


Figure 7-14. Insert Map Toolbar

The following table describes the buttons on the Insert Map Tools toolbar.

Insert Map Toolbar Button	Description
Insert	Works on intrinsic map data (points, lines, lights, etc.), and inserts the new map into the existing map at the blue rectangle. The Advanced insert lets you choose a subset of the new map's data, and make other adjustments like inserting user-created map items (e.g., goals, docks, sectors, etc.). Refer to Using the Advanced Insert Option on page 117 for details.
Cancel	Cancels the insertion.
Region	Defines the region to insert (useful if the default insert region is too big), or to have the newly inserted area properly overlap the old area. Refer to Define the Insert Region on page 116.
Reset	Erases all rectangles and restarts the region definition.
Lock	Locks the inserted map at its current position in the map. This can prevent accidental changes when panning and zooming the map. Turn off the button to enable more changes.
90° Left/90° Right	Rotates the inserted map 90° left or right. Use the Degrees field to set degrees of rotation (as measured from the x-axis in the counter-clockwise direction).
Up/Down/Left/Right	Moves the inserted map up, down, left or right. Allows small adjustments to the inserted map's position.
Help	Opens help information on the insertion process.

Position the Inserted Map

You can adjust the inserted map's location and orientation to position it correctly in the existing map as follows:

1. Hold down the left mouse button and drag the inserted map like any other object.
2. Use the Insert Map Tools' **Up**, **Down**, **Left**, and **Right** Buttons to make small adjustments to the insert's position.

Adjustment size depends on the map's zoom. To make a very small adjustment, zoom in; zoom out for a larger adjustment.

Define the Insert Region

The shaded blue rectangle is where the inserted map will replace a portion of the existing map. By default, all black data points on the blue background will be deleted (unless doing an Advanced Insert with ‘retain overlapping,’ in which they will remain).

If the default insert region is too big, click the Insert Map Tools' **Region** Button to define a new one. The default region clears (and becomes gray) and the insert locks at its current position. Use the mouse to draw a set of blue rectangles over the exact area to be replaced.

You should define the insert region after moving the map insert to the correct location.

You can use **Edit /Undo** and **Redo** from the MobilePlanner main toolbar while defining the insert region (Undo deletes the last added rectangle). To erase all rectangles and restart the whole process, press the Insert Map Tools' **Reset** Button.

Complete the Insertion

After correctly positioning the map insert and defining the insert region, click **Insert** to finish the insertion. It might take a few seconds for the original map to update. The process is complete when the shaded blue area disappears and the Map Insert toolbar closes.

If the resulting map is not correct, then press **Edit / Undo** from the MobilePlanner main toolbar to restore the map to its original state (which might take a few seconds).

> **NOTE:** The insertion process is not automatically resumed; you must restart it.

Using the Advanced Insert Option

Occasionally, you might want to insert only a subset of the region's data into the existing map.

To Use Advanced Options:

1. In the Insert Map toolbar, left-click on the **Insert** Button.
2. In the pulldown menu, select **Advanced**.

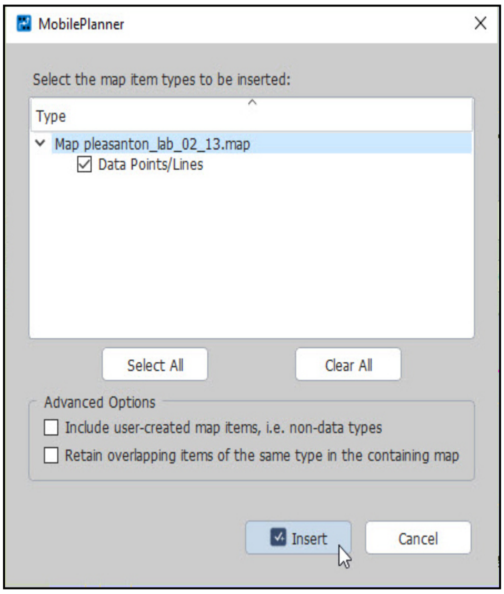


Figure 7-15. MobilePlanner, Advanced Insert Options Dialog

The dialog box has check boxes for each data type in the inserted map. To display non-data types, click the **Include user-created map items...** checkbox (shown un-checked in the image above).

3. Click the checkbox for each data type that you want to insert. Note that any corresponding map items are displayed in blue.
4. To retain the original map data as well as the inserted data, check the **Retain overlapping items . . .** checkbox.
5. Click the **Insert** Button to complete the insertion and close the dialog box.

Saving the Map on the AMR

The scan file that came from your AMR is saved on your local PC until you explicitly save it elsewhere.

To save the map on the AMR, from the MobilePlanner menu, select:

File > Save on Robot

Select the .map file that you just edited, and click **Save** to save the map onto your AMR.

7.7 After the Map

If you need to adjust the scan settings, see the next section. Otherwise, you need to localize the AMR. Refer to Set the AMR's Initial Location on page 121.

Changing the Scan Settings

To adjust the processing, scan, clean, and map settings, click **Settings** from the Scan Processing Tools toolbar.

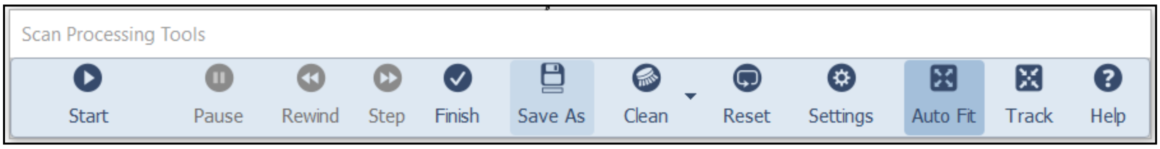


Figure 7-16. Scan Processing Tools Toolbar

Button	Description
Start	Initiates the scan session.
Pause	Temporarily pauses the scan session.
Rewind	Rewinds the AMR's path (blue trail) through the scanned area as shown on the MobilePlanner map.
Step	Allows you to step through the AMR's path, one segment at a time.
Finish	Completes the scan conversion process.
Save As	Allows you to save the newly created map with a specific name and location.
Clean	Allows you to manually remove unwanted scan points from the map.
Reset	Undoes any cleaning work you have done on the map.
Settings	Allows you to change scan tool configurations.
Auto Fit	Scales the scan file image to the MobilePlanner map window as you add more information.
Track	Centers the AMR in the scan image - works similarly to 'center on robot' in a normal map.
Help	Opens a help file to search for specific help topics.

The Scan Settings dialog box appears as shown below.

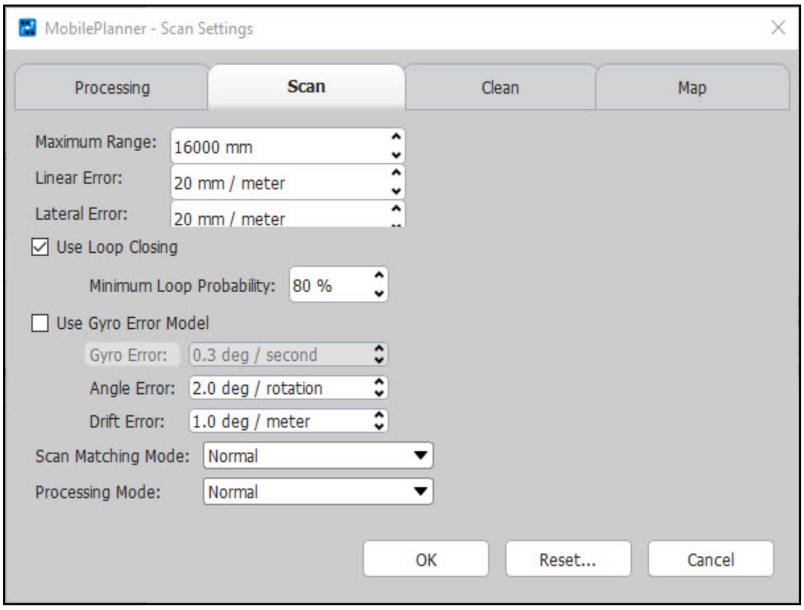


Figure 7-17. MobilePlanner Scan Settings Dialog

The following table describes the settings available from the Scan Settings dialog box.

Processing Settings	**Description**
Start scan when file opened	Disable this option to prevent the scan conversion process from automatically starting when you open the scan file in MobilePlanner. Allows you to adjust the scan settings before conversion. To start the process, click on the **Start** Button from the Scan Tools toolbar.
Clean after scans registered	Disable this option to leave all scan points in the map. Any cleaning must be done manually by pressing the Clean Button.
Prompt to save after scan complete	If this option is disabled, then the Save Map File As window is not automatically displayed.
Run in batch mode	Enable this option to process multiple scan files at the same time. **NOTE:** The files must all be of the same type. For example, they all must be basic scan files or all must be light localization scan files, they cannot be a combination of the two.
<filename>.map, overwriting any existing files	Select this option to overwrite the file name in batch mode.

<filename>_<currentDateTime>.map, less risk of overwrite	Select this option to have the current date and time added to the filename with each new scan conversion processed in batch mode.
Scan Settings	**Description**
Maximum Range	Specifies the maximum distance, in mm, used for the laser data.
Linear Error	The forward/reverse error, expressed as the average variation (in mm) per meter of travel.
Lateral Error	The left/right error, expressed as the average variation (in mm) per meter of travel.
Use Loop Closing	Used for open areas - indicates that the AMR has returned to a known location. Minimum Loop Probability allows you to set how closely the current position must match a previous scan. Default is 80%.
Use Gyro Error Model	Specifies allowable errors to correct for when registering laser scans collected during mapping.
Scan Matching Mode	Choose between Normal or Fast matching. If you select Fast, the scan match is performed only when MobilePlanner is in the registration phase.
Clean Settings	**Description**
Grid Size	Sets the size (in mm) of grid cells used to check whether the reading represents a real map point. A small value gives more cleaned readings; a large value includes more points in the map.
Max Range	Sets the maximum distance (in mm) from the AMR in which readings are considered for inclusion in the map. This value only affects the cleaning process; it does not affect the range used during the registration phase.
Map Settings	**Description**
Resolution	This adjusts the resolution of the map created from the scan file.

Set the AMR's Initial Location

It is important to establish the AMR’s starting location, which is also known as localizing your AMR. When you "localize to a point" on the map, you provide the AMR with location data. This data allows the AMR to match its current location with the same location on the map.

As the AMR attempts to find its location on the map, it provides a localization score, or confidence level. This confidence level should be 80% or better for the AMR to navigate properly.

For more detailed information on localization, refer to AMR Localization on page 260.

To Set the AMR's Starting Location:

1. Click the **Map** Button, then click **Show Robot**.

   The Map tool bar displays AMR control icons.

2. Click **Localize Robot**.

   This puts the map into localize-to-point mode (and changes the cursor to indicate the new mode). Refer to Robot and Map Toolbars on page 74.

3. Click and hold on a spot on the map where you want the AMR located. This is where you want the confidence threshold, or Localization Score, to be 80% or better as shown below.

   While still holding the mouse button down, drag the localization mark's direction indicator to the direction the AMR is facing. The AMR will choose the most likely pose near the clicked location. If the initial localization does not look correct, localize the AMR again until it appears in the correct location.

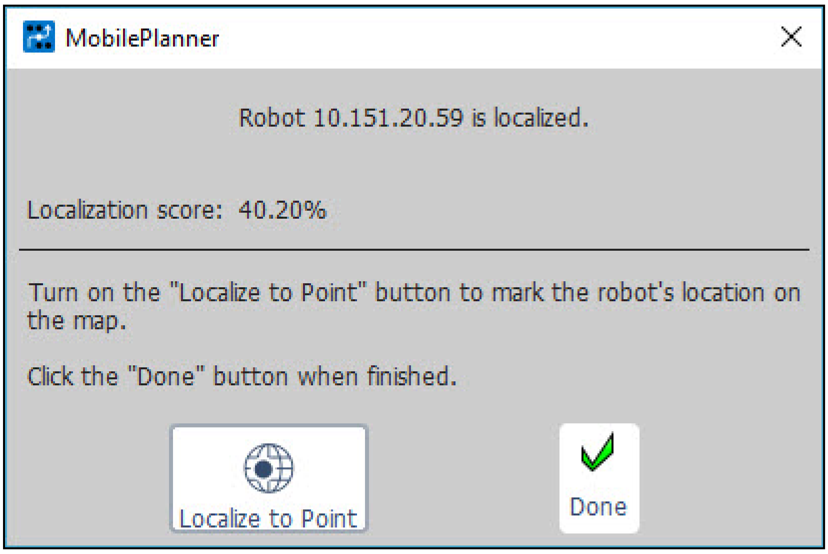


Figure 7-18. Localize to Point Dialog Box

4. Click **Done** when the AMR's localization score is where you want it to be.

   The AMR is now localized and you have successfully set the AMR's current position.

   > **NOTE:** You must set the AMR’s current position the first time you put the AMR in a different map.

What’s Next?

Now that your AMR is configured, you have scanned its operating space and created a detailed map, you can do any of the following:

- To edit your map further, refer to Working with Map Files on page 99.
- To learn about and start using MobilePlanner software, refer to Using MobilePlanner Software on page 52.

- To configure your AMR, refer to Configuring the AMR on page 154.
- If you are familiar with MobilePlanner and want to set up goals and tasks for your AMR to perform, refer to Working with Macros, Tasks, and the Route Builder on page 172

After Driving the AMR

After you're done driving the AMR, select **Robot > Dock** from the software main menu, or click **Dock**, to return the AMR to a dock.

Auto Dock

The **Config > Robot Operation > Docking > Autodock** parameter is the primary control for the AMR's automatic docking, and is normally set to True.

If the **Autodock** parameter is set to False, and you don't want to manually dock the AMR each time, using the **Auto Dock** menu item (**Main Menu > Robot > Robot Tools > Auto Dock**) will override the configuration parameter. The AMR will return to a dock when the charge is running low.

> **NOTE:** If the **Autodock** parameter is set to True, you can override that behavior by turning off automatic docking. If you do this, remember to turn it back on when you are done, or the AMR will not recharge and eventually stop running.

LD Docking

This section provides instruction on how to use the LD Dock Type. The LD DockType (compared to the current Lynx type) uses part of PrecisionDrive on the back end. As a result of this, many of the settings and parameters will feel the same. However, all specifications that apply to PrecisionDrive (as noted in the Application Notes and PrecisionGuide user's guide) also apply when using the LD Dock Type. All the existing dock pre-goals (the yellow docking goals) can be used as is from a regular map (see note about updating the offsets under step 3). If any problems occur, you can re-set the system to the legacy type by following these steps and switching it back to Lynx.

Follow these steps to set up docking for LD-series AMR series:

1. Switch the DockType to LD as shown in the following figure.

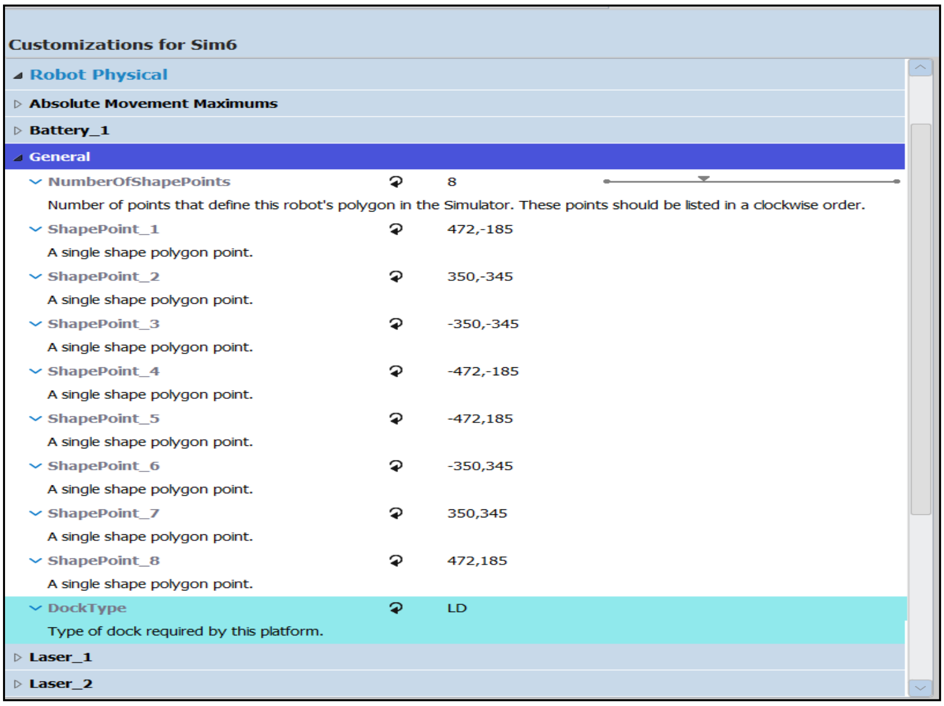


Figure 7-19. Switching to LD

2. Since the new docking parameters are not part of the defaultConfig, they must be entered exactly as displayed in the following figure. The only exception is the DockInitialX; -1500 is what OMRON has conducted all of its testing at, but making this slightly shorter (-1200) will not have significant impacts on the performance. In either case, the distance from the dock pregoal and the center of the dock triangle vertex needs to be within the tolerance.

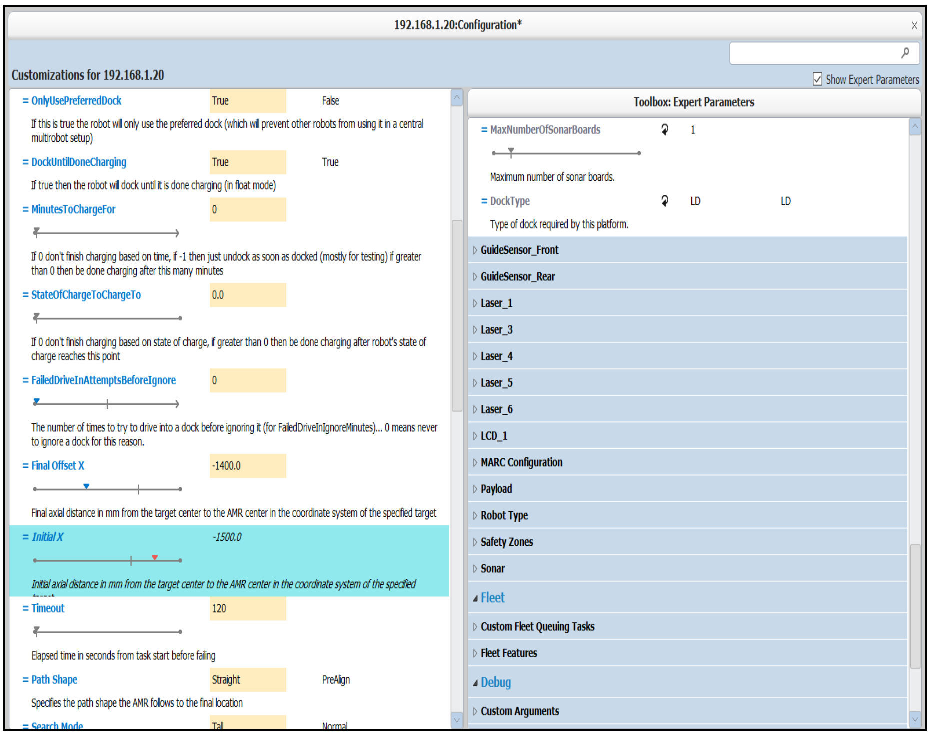


Figure 7-20. DockInitialX

Chapter 8: Using the SetNetGo Software

SetNetGo runs on both the AMRs and an EM2100 operating as a Fleet Manager. It sets the configurations for certain onboard systems, such as wireless communication settings.

You can access SetNetGo either from the MobilePlanner SetNetGo interface, or directly on the AMR using a secure web-based server. If needed, your organization's IT group can configure your wireless Ethernet for you.

8.1 Overview of the SetNetGo OS

The SetNetGo software allows you to configure certain on-board systems, such as the Ethernet interface settings, serial and TCP port-forwarding, and to perform systems diagnostics, such as examining and retrieving log files.

Connecting to SetNetGo

Access SetNetGo from MobilePlanner

The recommended way to connect to the SetNetGo OS is through the SetNetGo interface in the MobilePlanner software.

During normal operation, you access SetNetGo through the MobilePlanner software as follows:

1. Start the MobilePlanner software on your PC.
2. Enter the IP address for an AMR or your Fleet Manager, then click Connect.
3. Click anywhere in the SetNetGo selection box, to access the SetNetGo interface.

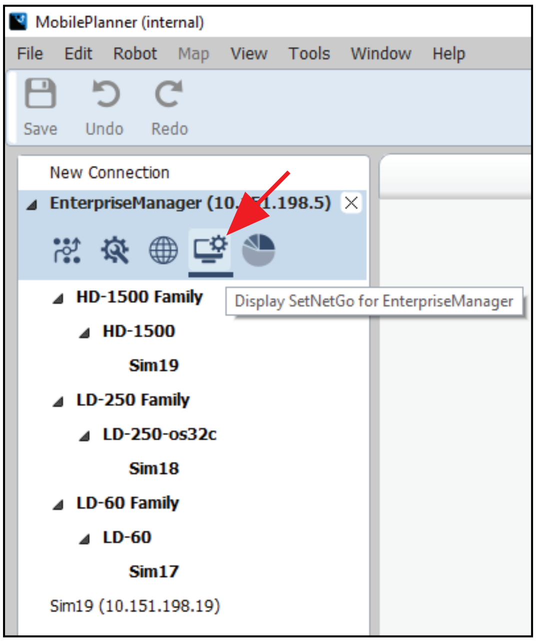


Figure 8-1. Hover Over the SetNetGo Selection Box

Hover over the selection box to reveal its boundaries. (See the the preceding figure.)

Additional Information: You can make changes to the SetNetGo parameters both at the robot level, and fleet level.

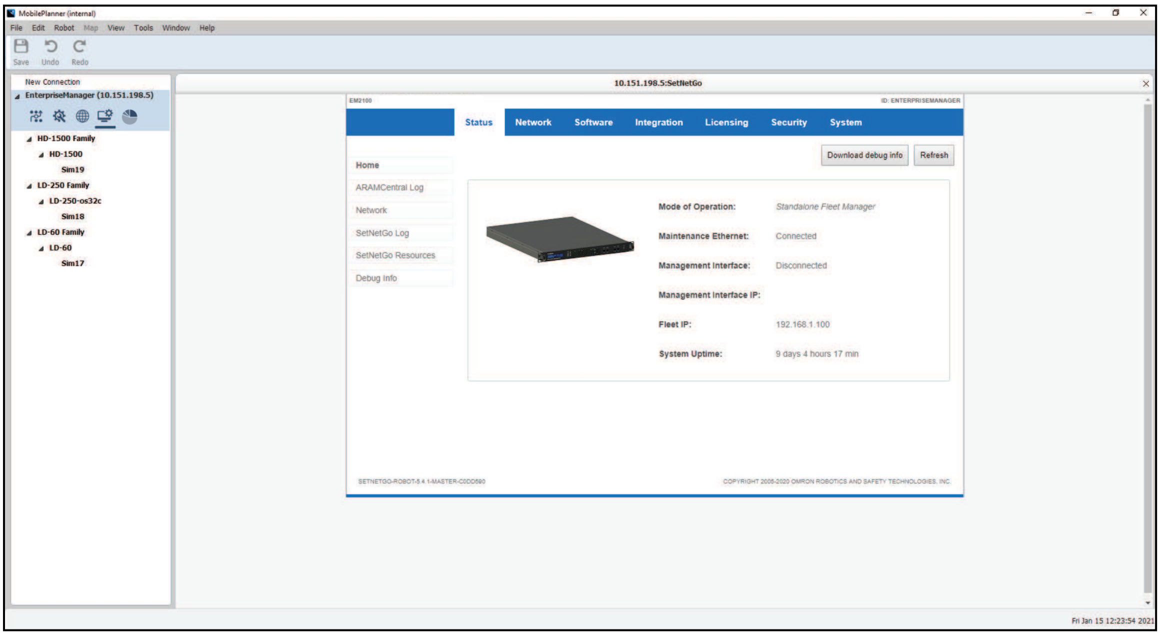


Figure 8-2. SetNetGo Interface—Status Tab, Home Screen

This is the SetNetGo home screen. It provides an overview of link status, IP addresses, and installed software versions.

Connecting to SetNetGo via web browser

You can also access the SetNetGo software via a web browser (such as Chrome, Firefox or Internet Explorer) if, for example, your IT department is helping with network configurations, or you don't have access to your laptop with MobilePlanner installed on it.

NOTE: Web browser access must be enabled in **SetNetGo > Security tab > SetNetGo Access**. To do this, connect one end of an Ethernet cable to your computer and the other end directly to the AMR's Ethernet Maintenance port.

If you have an LD-series AMR, set your IP address to 1.2.3.5 with a subnet mask of 255.255.255.0 and connect to SetNetGo Maintenance port at the URL: https://1.2.3.4.

If you have an HD-series AMR, set the adapter to automatically obtain an IP using DHCP and connect to SetNetGo Maintenance port at the URL: https://169.254.10.15.

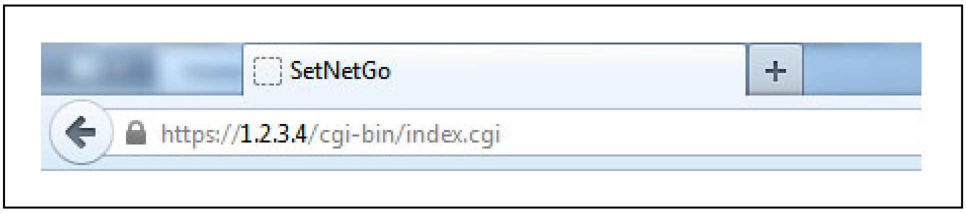


Figure 8-3. Browser URL Address

NOTE: You can ignore the SetNetGo certificate error. Click "**Continue to this website (not recommended).**" to display SetNetGo.

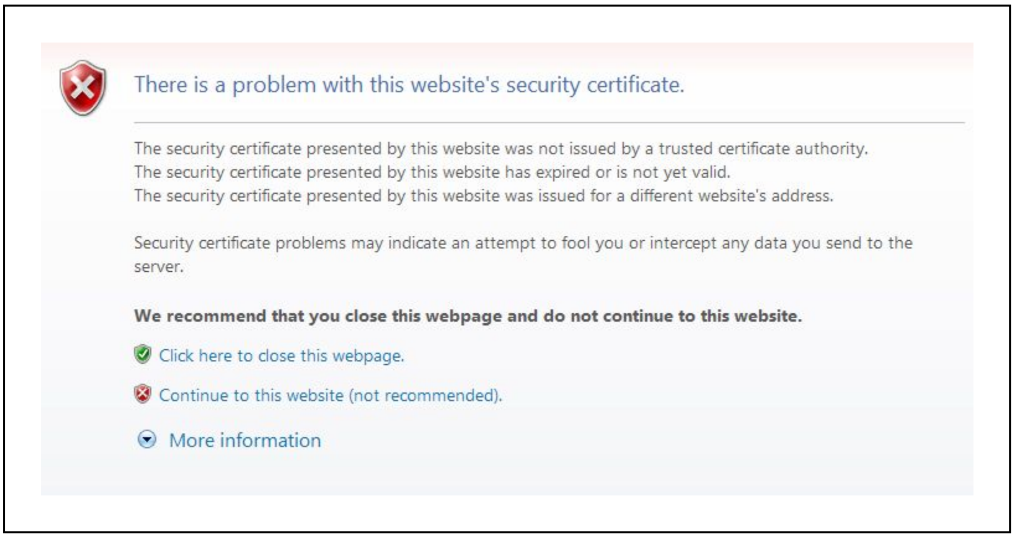


Figure 8-4. Browser Certificate Warning

IMPORTANT: SetNetGo versions prior to 5.x use TLS version 1.x security protocols. If using this SetNetGo version, browsers may encounter a security warning message. In this situation, either update SetNetGo or use a browser that supports TLS version 1 security protocols.

8.2 Using the SetNetGo Interface

SetNetGo resides on the AMR and any EM2100 operating as a Fleet Manager or Fleet Simulator, and is accessible through the SetNetGo interface in MobilePlanner.

The Fleet Simulator cannot be accessed through MobilePlanner - you have to access SetNetGo through a web interface instead.

The SetNetGo start-up screen, accessed from MobilePlanner, is shown below.

NOTE: The **Download debug info** Button provides a debug file that can be used for troubleshooting and other support requests.

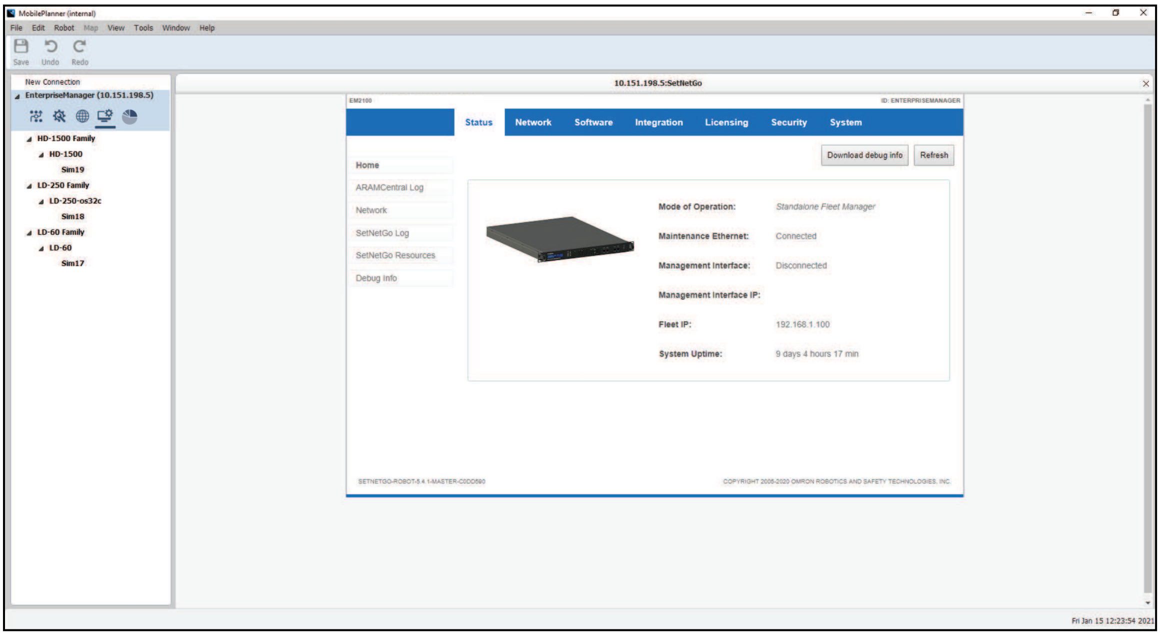


Figure 8-5. SetNetGo Interface

The SetNetGo menu, shown at the top of the screen, consists of the following tabs:

Menu Option	Sub-Menu Option	Description
Status	This menu option displays various logs and status updates. Refer to Viewing the Status Logs on page 133 for details.	
	Home	Returns you to the SetNetGo home screen.
	ARAM (AMR) or ARAMCentral (Fleet Manager) Log	Gives the option to display the entire ARAMCentral log, the last 200 lines, or continuous refresh displaying the last 200 lines of the ARAM log within SetNetGo. It also allows you to view the current log file or download of the last 7 log files.
	Network	Displays the current status of network interface, the wireless interfaces status and the routing table.
	SetNetGo Log	Displays the SetNetGo log file.
	SetNetGo Resources	Displays status of your resources, including processes currently running on the AMR or Fleet Manager, Kernel Log, Disk Usage, Memory Usage, the Interrupts table, IO Memory usage and IO Port usage tables, and USB Devices.
	Debug Info	Downloads a .zip file containing detailed information on system status for troubleshooting. **NOTE:** Download a debug file before requesting support.

Simulator	This option gives access to the Fleet Simulator option. This is covered in detail in the *Fleet Simulator User's Manual (Cat. No. I649).* This option will not be displayed if the Fleet Simulator license is not detected on the EM2100 or if SetNetGo was accessed from MobilePlanner. SetNetGo cannot be accessed through MobilePlanner in Fleet Simulator mode.	
Network	Configurations for setting up your network. See Network Tab on page 133 for details.	
	AMR Only	
	Wireless Ethernet	These parameters allow you to enter static or dynamic IP settings (IP Assignment and Address, Netmask, Gateway, and DNS1); select a WiFi network; configure security settings (i.e., encryption and authentication); and configure Radio settings, including Watchdog Timer.
	User LAN Ethernet	This screen has settings for interface mode, IP Address, Netmask, DHCP Server for Accessories, and DHCP IP Range. If you are using an EM2100 or a network-based hardware accessory for an AMR, you must set up a wired Ethernet port. Use Accessory mode (default) for individual AMRs, and server mode with an EM2100.
	RS-232 Port Forwarding	Forwards a custom TCP port on the wireless Ethernet interface to an RS-232 port on the AMR’s core. The TCP port and serial port settings are configurable.
	Ethernet Forwarding	Supports forwarding a custom TCP port on the wireless Ethernet interface to a custom TCP port on an IP address of a device connected to the User LAN interface. The TCP port numbers and IP address are user-configurable.
	Fleet Manager Only	
	Management Interface	This page allows configuration of the Management (MGMT) Ethernet interface with a static IP address. The network host configured as the "Management Interface" is the primary host for web configuration via a browser.
	Fleet Interface	This page allows configuration of the Fleet Ethernet interface with a static IP address. The network host configured as the "Fleet Interface" is the primary host for all Fleet Management connections, including use of MobilePlanner to connect with a Fleet.
	AMR and Fleet Manager	
	Utilities	On an AMR, use this tab to ping a specific IP address, initiate trace route (display packet path), and display

		the ARP table (correlate MAC address and corresponding IP address). On a Fleet Manager, this page permits running several network diagnostic tools on the AMR or appliance, including well known tools `ping`, `arp`, and `traceroute`.
Software	Configurations for ARAM/ARAMCentral settings (including install new software versions)	
	ARAM Settings or ARAMCentral Settings	Change advanced settings for recovery, such as reverting the configuration back to defaults.
	Manage Installed Software	This tab displays current versions of installed software, with options to view release notes, restart, uninstall, or disable application(s), and view runtime logs. Also allows you to download MobilePlanner, and update the mobile software.
Licensing	Configurations of existing licensing and upload/download of information for license activation and updates.	
	Information	This page displays license information, including name of the license, current status and expiration date, for any license relative to that specific device, either Fleet Manager or AMR.
	Upload	This page allows upload and provisioning of new licenses or license updates, which are provided by your local OMRON representative.
	Download	This page allows download of license information files for this device. This information must be downloaded and supplied to your local OMRON representative when inquiring about license updates.

Security	Manage Fleet user accounts and AMR access.	
	Fleet or ARAM Accounts	This page allows you to manage access controls that restrict who can access the AMRs and Fleet Manager with MobilePlanner. Allows you to specify specific access controls for admin, operator, and viewer access, and other users. You can also add new users to the access list. AMR only. This page allows configuration of Fleet Accounts, including usernames, passwords, and permissions. Fleet Accounts are primarily for user privilege separation and must be provided when connecting to a Fleet Manager or AMR through MobilePlanner. Fleet Manager only.
	SetNetGo Access	Allows you to enable or disable Web availability via Wireless/User LAN interface, and set access password.
	Integration Toolkit	This page allows generation and regeneration of the password required for all Integration Toolkit-provided services. This password must be configured in order to access fleet data through the Integration Toolkit-provided services, which include SQL via postgres, AMQP via rabbitmq, and a REST API via HTTPS.
System	Manage date/time, upload new SetNetGo OS, conduct backup and restore operations.	
	Date/Time	Set time, zone, and NTP Server. **NOTE:** The AMRs will automatically synchronize with a Fleet Manager. Use NTP on the Fleet Manager or for single AMR operations.
	Upload SetNetGo OS	Upload and install a new SetNetGo version. **NOTE:** The system can store two different OS images. You can select which version to load into each slot, and choose which is the bootable image.
	Backup/Restore Options (AMR only)	Allows you to configure restore settings (from the same, or a different AMR), set a new backup restore point, or revert to a different restore point.
	Reboot	Allows you to reboot the AMR's computer (core) or EM2100 appliance. Normally not a visible option unless enabled by checking the Remote Reboot radio button in **SetNetGo > Security > SetNetGo Access**.

		CAUTION: Rebooting the AMR's core interrupts all AMR operations, and could cause damage to the AMR. Rebooting the appliance will disrupt all jobs and AMRs.
	Mode (EM2100 only)	This page allows configuration of the appliance operating mode. The mode determines if the appliance will run as a Standalone Fleet Manager, a Paired Fleet Manager, or a Fleet Simulator.

8.3 Viewing the Status Logs

SetNetGo keeps track of various AMR activities, including ARAM, networking, and resource use. This information is stored in status logs that you can view through SetNetGo.

To view the status logs:

1. Connect to SetNetGo through the MobilePlanner SetNetGo interface.
2. Select the **Status** link at the top of the SetNetGo screen.

   The SetNetGo Status screen appears as shown in SetNetGo Interface on page 129.

   > **NOTE:** The **Download debug info** Button is critical for taking a backup of the current configuration, and providing this information when requesting support.

The status logs you can view depend on whether you are connected to SetNetGo through a Fleet Manager or a single AMR. Generally you can view the following type of status logs:

- ARAM (on the AMR), ARAMCentral (on the Fleet Manager)
- Network
- SetNetGo Log
- SetNetGo Resources
- Debug Info

8.4 Network Tab

Use SetNetGo to configure the AMR's network settings. For remote access to your AMR, you should set up a static IP address. If you are not familiar with setting up a network or do not have an assigned IP address for the AMR, please refer to your system administrator.

> **NOTE:** After changing a value in any SetNetGo screen, you must click **Apply** before switching to another sub-screen, or those values will not be saved.

To configure your AMR's network settings:

1. From the MobilePlanner SetNetGo interface, connect to SetNetGo.
2. Select the **Network** link from the top of the SetNetGo screen.

   The SetNetGo Network screen appears as shown in the following figure.

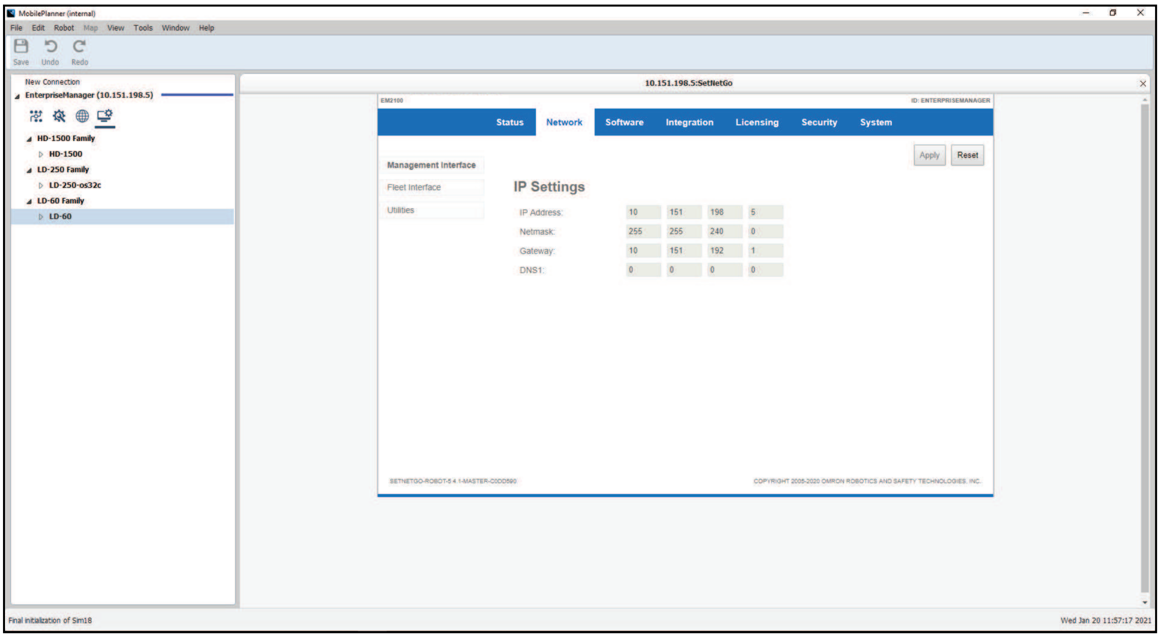


Figure 8-6. SetNetGo Interface - Network Tab

Wireless Ethernet Settings

Select **Network > Wireless Ethernet** to set up the wireless Ethernet interface. The table below describes the parameters that you can modify.

Wireless Ethernet Menu	
Parameter Setting	**Definition**
IP Assignment	Select the Static radio button to set a known IP address. You can also use DHCP, but a static IP address is recommended.
IP Address	Enter the IP address assigned to the AMR you want to access.
Netmask	Enter the Netmask.
Gateway	Enter the Gateway address.
DNS1	Enter the DNS1 address or leave it as 0.0.0.0 to disable.
WiFi Network Settings	
Selected Network	Displays the wireless network to which you are currently connected.

	NOTE: Clicking on a network name in the list will automatically populate the encryption and authentication fields.
Network list	Displays a list of available WiFi networks.
Security Settings **NOTE:** The fields listed below will change based on the security method you select, and could include username, password, private key (download or create new)/key length, hostname, and certificate (choose an existing or upload new). If unsure about settings, ask your IT department for assistance.	
Encryption	Set this to match the encryption method that is used on your network. Options are 64-bit or 128-bit WEP, TKIP/RC4, CCMP/AES, and TKIP/CCMP/AES.
Authentication	Set to match your authentication type. Use OPEN (default) when using no authentication or when using WEP. Select WPA-PSK for WPA Pre-shared key, PEAP-MSCHAPv2, or EAP-TLS.
Pre-Shared Key (PSK)	If using WPA/WPA2-PSK, enter the shared key in this field.
Key Type	Select from (click the radio button) Passphrase (8-63 ASCII only), or Raw Hex (64 Hex only).
Radio Settings	
Radio Mode	Select the mode that your network uses: 802.11a, 802.11b, 802.11g, 802.11n, or 802.11ac. Select Auto to allow the AMR to choose the most suitable channel from 802.11a/b/g (may lead to longer roam times).
Channel Set	Set to match the channels that are used at your site or leave them all selected (default) to allow the AMR to find the most suitable channel. Roam times will be faster if there are fewer channels selected.
802.11b/g Channels (2.4 GHz)	Use this list to select a specific WiFi channel (1 through 13) in the 2.4 GHz range
802.11a Channels (5 GHz)	Use this list to select a specific WiFi channel (36 through 165) in the 5 GHz range
Wireless Log Level	Determines the level of WiFi scanning detail in log files and debug info. Default is Normal. Set to **Verbose** for debugging efforts. If set to Verbose, log files cover a much shorter period of time. Recommend leaving at **Normal**.
RSSI Roam Threshold	Determines the frequency of background scanning. Default is 50. If signal strength is higher than the threshold, scanning happens at 10X the Background Scan Interval. If signal strength is below the threshold, scanning occurs every Back-

	ground Scan Interval seconds.
Background Scan Interval (sec)	Works with the RSSI Roam Threshold to determine how frequently the AMR performs background scanning. Default is 3 seconds (recommend leaving at default)
Watchdog	If enabled, automatically pings the Fleet Manager (if used) or the gateway IP address. If successive pings fail for Watchdog Timer seconds, the AMR automatically resets the wireless interface.
Watchdog Timer (sec)	If pings to the Fleet Manager fail consecutively for Watchdog Timer seconds, the wireless Ethernet interface automatically resets and attempts to reestablish communications.

User LAN Ethernet Settings

User LAN Ethernet Settings	
Parameter Setting	**Definition**
Interface Mode	Use to set up a wired accessory interface (e.g., Acuity or the touchscreen) for the AMR. This mode allows you to connect network-based, hardware accessories to the jack. Onboard accessories will be able to communicate with the software running on the AMR's core, and reach the rest of the network via the AMR's wireless interface.
IP Address	Set the IP address for this interface. Select a subnet that does not conflict with settings on the wireless Ethernet interface.
Netmask	Enter the Netmask.
DHCP Server for Accessories	Disable or enable (default) a DHCP server for an accessory on the AMR. **NOTE:** You must enable this parameter for both Acuity and the touchscreen (for more information on these options, see the *Mobile Robots - LD Platform Peripherals Guide (Cat. No. I613)*).
DHCP IP Range	Allows you to set the DHCP IP range for the address automatically assigned to the accessories.

Port Forwarding

If your AMR's payload has devices connected to the User LAN or Serial (RS-232) port, you can forward those ports and make the payload's device accessible via WiFi. Configure both RS-232 and Ethernet port forwarding in SetNetGo in the **Network** tab.

RS-232 Port Forwarding:

Controls forwarding serial data to a TCP port on the wireless and internal wired Ethernet networks. You can link an internal serial device and route it to an external port at a defined baud rate. This is useful for RS-232 devices connected to the AMR's core, and accessing them over WiFi.

Ethernet Forwarding:

These settings forward a TCP port on the User LAN Ethernet interface to a port on the Wireless Ethernet interface. The Internal IP Address is the IP address of the device connected to the AMR core's User LAN connection. Internal and External port setting route the Ethernet connection through WiFi.

Utilities

These tools allow you to view the ARP table, and ping or run a trace route to a specific IP address.

8.5 Software Tab

The SetNetGo software tab offers choices for ARAM Settings and Manage Installed Software.

ARAMCentral/ARAM

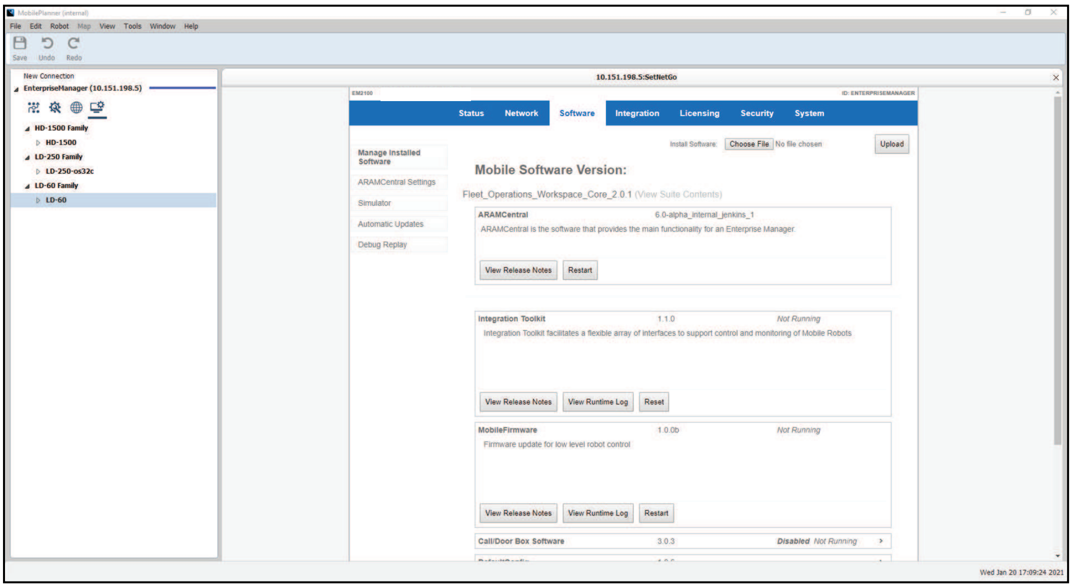


Figure 8-7. SetNetGo, Software Tab - ARAM Settings

- ARAMCentral Settings (main software on the EM2100) - configure ARAMCentral's features (disabling ASync logging, disabling ARCL, and disaster recovery settings.
- ARAM Settings (main software on the AMR) - configure ARAM's features (disaster recovery settings).

Manage Installed Software

The settings in this section allow you to view current versions and status (for example, Enabled Running, or Disabled Not Running) of software installed on the EM2100 appliance or AMR.

NOTE: The software version needs to match across the fleet. Also, make sure that you upload the SNG, and FLOW packages together when new versions released.

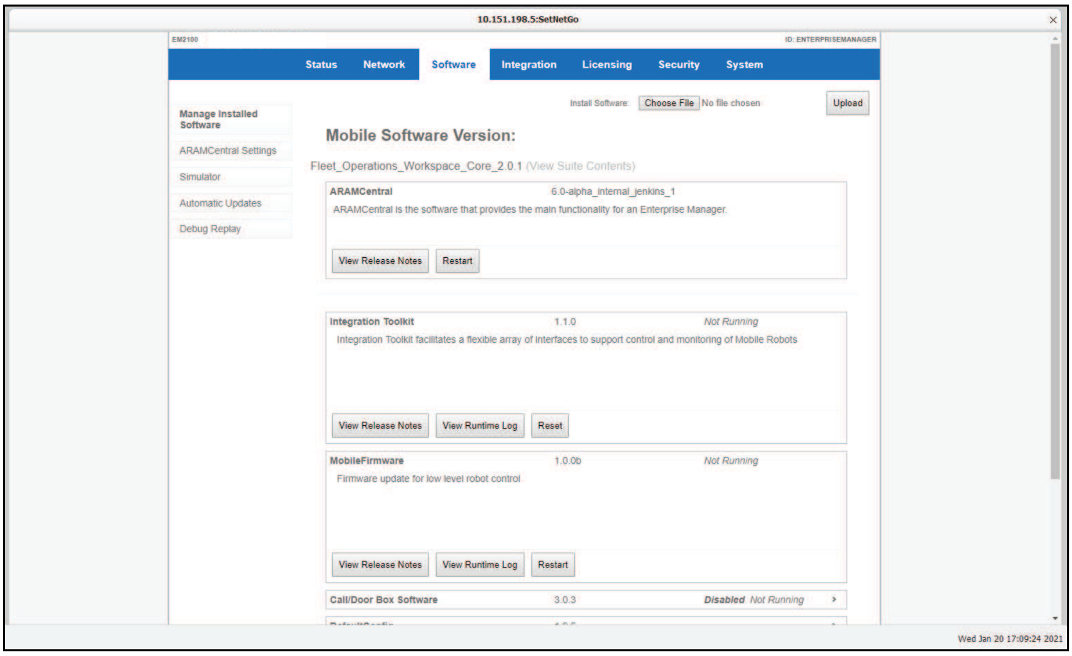


Figure 8-8. SetNetGo, Software Tab - Manage Installed Software

You can also use the functions on this tab to restart, disable, install and/or uninstall MobilePlanner software, or the MARC or Polo microcontroller firmware.

8.6 Licensing Tab

The SetNetGo licensing tab allows you to get information, including license name, status, and expiration date of any license that applies to the device you are currently connected to. It also allows you to acquire, renew or upgrade any licenses from the field on either a Fleet Manager or an AMR. Follow these steps in the given order to do so:

1. Go to the SetNetGo web interface of the Fleet Manager appliance or the AMR and open the Licensing tab. Click on the **Download** option in the left pane.
2. On the download page, click the **Download** Button.

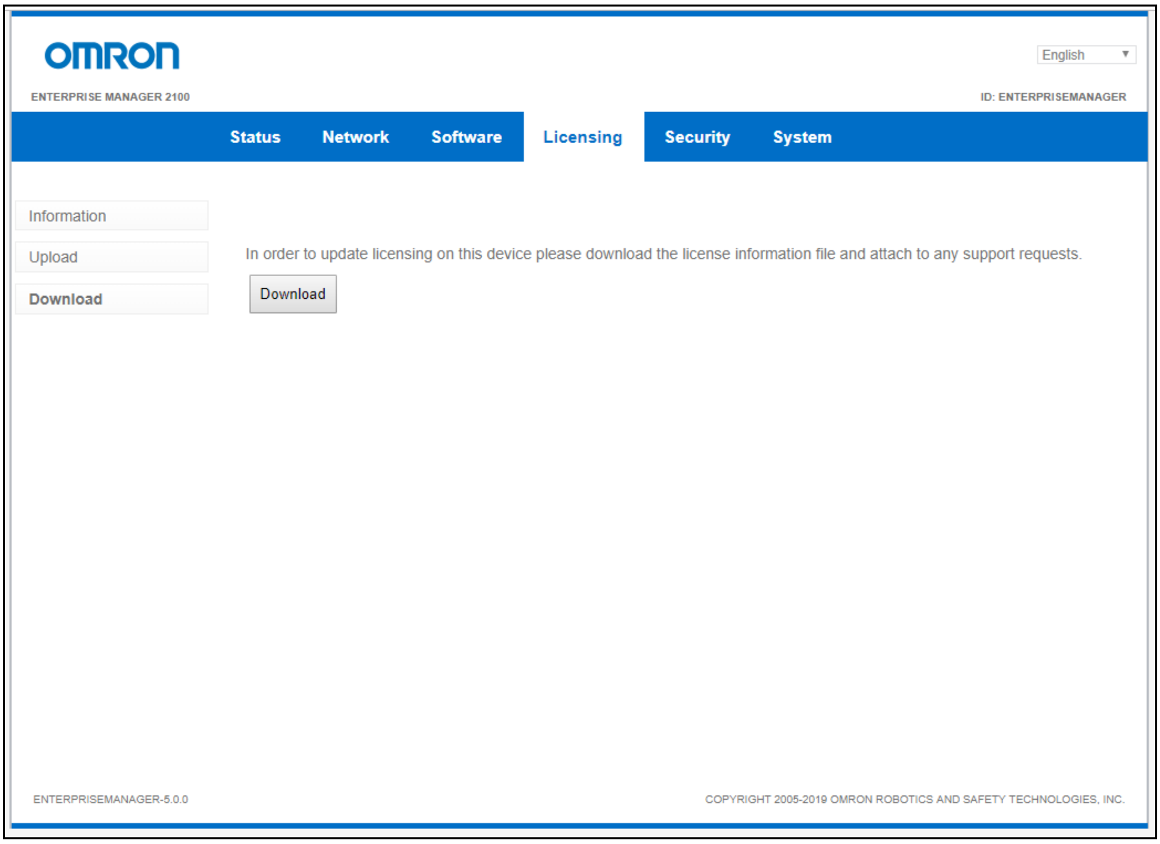


Figure 8-9. Licensing Download Screen

The downloaded C2V file will have the format:

1234567890-MMM-DD-YYYY.C2V

where MMM represents the first three letters of the current month, DD the day of the month, and YYYY the current year.

> **NOTE:** OMRON recommends that you establish a specific location and folder in which to store these license key files, in the event that they need to be accessed in the future. We also recommend that the C2V ID number (the first ten digits in the C2V file name) be referenced to its particular EM2100 or AMR to ensure that the matching license key file can be quickly identified and uploaded to that EM2100 or AMR.

3. Send the C2V file to your local OMRON representative or integration partner and request the appropriate license for the Fleet Manager mode or for the AMR Advanced Feature that you have selected. You will receive a V2C file with an ID and Date that matches the C2V file that you submitted.
4. Confirm the file names match before proceeding. If the filenames do not match, then contact your local OMRON representative or integration partner and report the issue.
5. Go to the SetNetGo web interface of the Fleet Manager or AMR. Select the Licensing tab and choose the **Upload** option from the left pane.

6. Click **Choose File** and select the appropriate V2C file.
7. Once the file is chosen, the SetNetGo Web UI shows the specific filename. Click **Upload File**.

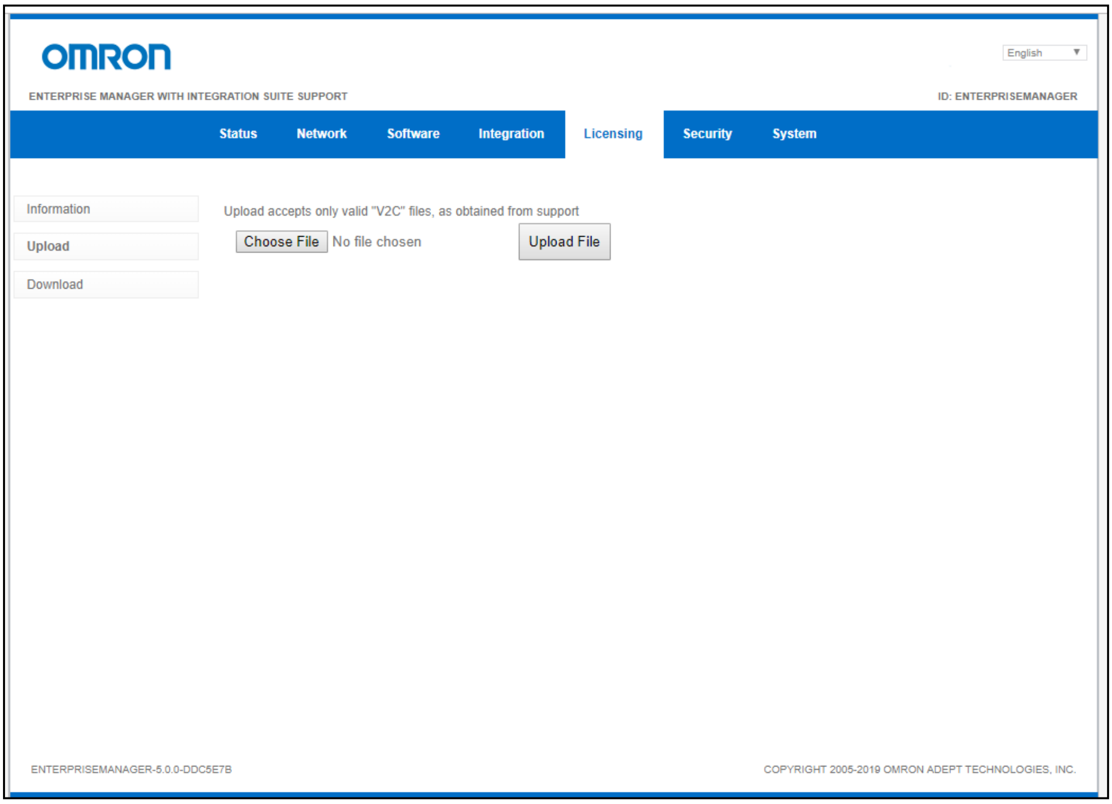


Figure 8-10. Licensing, Choosing a File to Upload

Now that a valid license is activated, SetNetGo will initiate the requested mode by starting the appropriate code on your Fleet Manager or AMR.

> **NOTE:** After a C2V file has been submitted to obtain a license, it cannot be reused. If you need another license you have to generate a new C2V file for the request. Likewise, a V2C file can not be reused with SetNetGo, either.

8.7 Uploading, Backing up, and Restoring SetNetGo

Through MobilePlanner, you can upload (upgrade to) a new version of SetNetGo by simply choosing the proper file.

Your upload options allow you to choose whether to upload a new version of SetNetGo into the Boot Image A slot (which is the default image slot), or the Boot Image B slot (which you then have to make bootable), or have versions in both slots.

In case of a software failure, you can also restore SetNetGo from a file maintained on the same (or a different) AMR. You can only restore to a specific restore point on an AMR (identified by its date/time), but only from the last restore point, and only on that AMR.

8.8 Uploading a New SetNetGo OS

1. In the MobilePlanner tool bar, click the **SetNetGo** Button, then click the **System** tab, then click the **Upload SetNetGo OS** menu item (left-side pane).

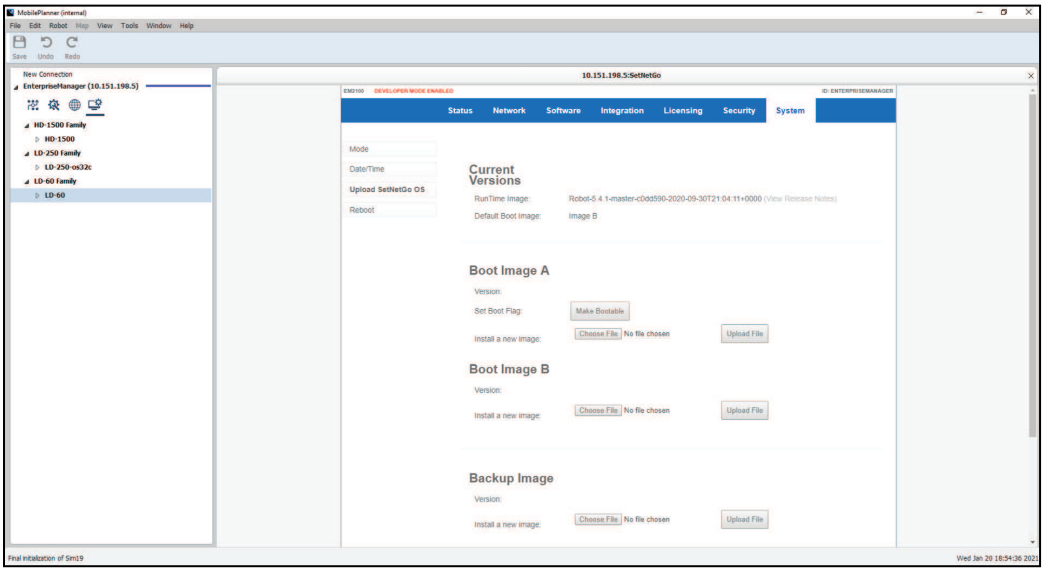


Figure 8-11. SetNetGo, System Tab

The Upload New SetNetGo OS page, Current Versions field, contains information about the current installed version (with option to view its release notes), and which image is the current bootable image (Image A in the example above).

2. To install a new SetNetGo version into the Boot Image A slot, click the **Choose File** Button, and browse to the location of the new image file. To upload a file, click the **Upload File** Button.

   NOTE: Clicking the **Upload File** Button will upload a new SetNetGo package, which will overwrite the existing image in the Boot Image A slot, and ask you to confirm before proceeding.

3. Click **Open** when done.

4. To install a new image file into the Boot Image B slot (and make it bootable), click the **Choose File** Button then, when you've chosen the file, click the **Make Bootable** Button.

8.9 Backing Up and Restoring SetNetGo

As with any system, it's a good idea to back up your system files frequently, especially after making configuration changes. After backing up, you then have a file from which you can restore your system back to working condition if a version becomes corrupted, if you swap AMR cores, or add a new AMR to your fleet that's identical to the others.

Creating a Restore Point

When you back up your system, the resulting file is date and time stamped with the current day and time of backup, and becomes a specific restore point (overwriting the your previously saved restore point).

1. In SetNetGo, click the **System** tab, then click the **Backup/Restore Options** item.
2. In the Restore-Point field, click the **Backup now** Button.

   The following advisory dialog appears.

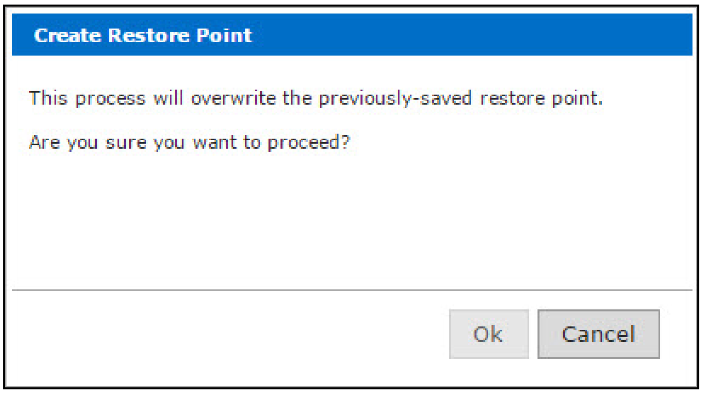


Figure 8-12. SetNetGo Create Restore Point Dialog

3. Read the confirmation then, if sure you want to proceed, click **OK**.

Reverting to a Restore Point

Reverting to a previously saved backup (restore point) takes your AMR's core back to its configuration as of the date and time of the restore point file you select. During the restore, you will lose your connection to MobilePlanner while the restore process resets your configurations.

> **Additional Information**: Files stored on the AMR (such as maps) are independent, and will not be affected by the revert process.

1. In SetNetGo, click the **System** tab, then click the **Backup/Restore Options** item then, under the Restore-Point heading, click the **Restore Now** Button.

The following advisory dialog appears:

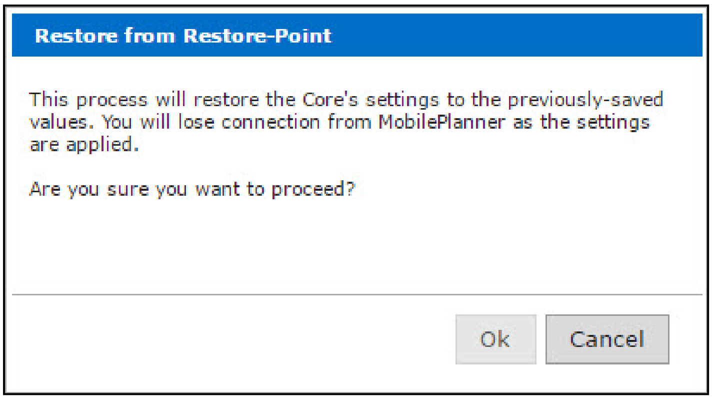


Figure 8-13. SetNetGo Confirm Restore Dialog

2. Read the confirmation then, if you are sure that you want to proceed, click **OK**.

   The selected file overwrites the previous settings in the AMR's core, and the AMR disconnects from MobilePlanner. After the restore is complete, you can reconnect to the AMR.

Restoring Settings from DebugInfo File

If you replace an AMR's core, and want to update the new core with all of the existing configuration information from that AMR onto the new core, use the **Restore from same robot** option. This process does not overwrite other software on the core. You should verify those software versions.

> **NOTE:** The Restore from same robot option does not include WiFi credentials (i.e., key, passphrase, certificates) or overwrite currently existing versions of other software (you should determine which versions to use).

If you have a fleet of one type of AMR and are adding another AMR of that type to your fleet, you would use the **Restore from different robot** option. This feature gives a quick method of configuring the new AMR so it performs identically to the others.

> **NOTE:** The **Restore from different robot** option does not change IP address or AMR calibration data (including AMR identifier). After using this option, you will need to re-set your AMR's WiFi, IP address, and identifier.

1. In SetNetGo, click the **System** tab, then click **Backup/Restore Options** from the list on the left.
2. Under the Restore Settings from DebugInfo File heading, click **Choose File** for either the **Restore from same robot** option or the **Restore from different robot** option (see explanations above for example use cases).
3. In the Open window, browse to and select the file you want to upload, then click **Open**.
4. Verify that the correct file name appears next to the **Choose File** Button, then click the **Upload** Button.

An advisory dialog will be displayed, asking for your confirmation.

5. Read the confirmation and, if you are sure that you want to proceed, click **OK**.

NOTE: Both of these processes creates a new restore point.

8.10 SetNetGo Recovery Mode

In the event that a specific AMR unit experiences a serious software malfunction that normal solutions do not resolve, Recovery Mode can be used to revert the system back to a stable and working state.

There are 5 Maintenance Options while in Recovery Mode.

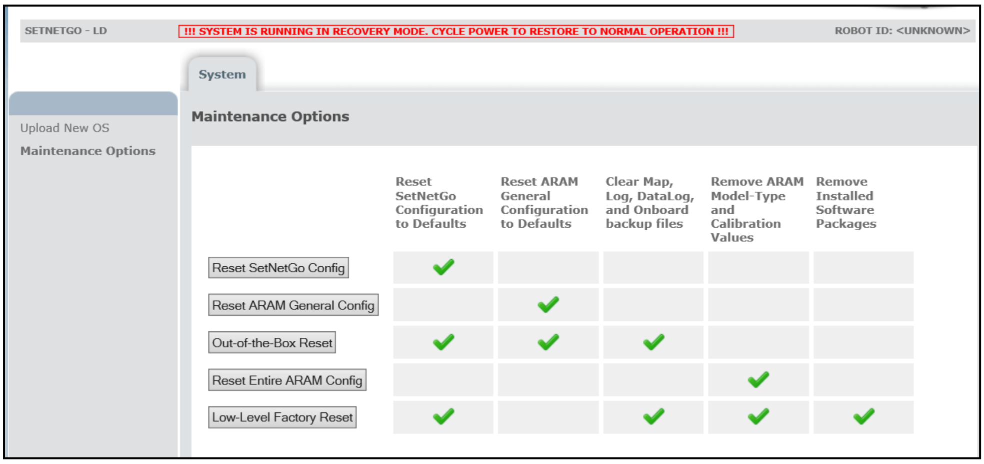


Figure 8-14. Maintenance Options

Each option will reset different combinations of configuration data, files, or software from the AMR. Exercise caution when selecting a recovery option. If you wish to cancel this procedure without making any changes, you can exit this mode by power cycling the AMR. This will revert the AMR back to normal mode in its current condition.

Maintenance Options

Refer to the following table below for more information on what data or settings each Maintenance Option will reset.

Table 8-1. Recovery Mode options

Recovery Option	Details
Reset SetNetGo Configurations to Default	Returns all SetNetGo configuration settings to their default values. The AMR will require re-connection to the network and Fleet.
Resets ARAM General Configurations to Default	Returns the AMR's configuration to the original default settings. Parameters will need to be re-input through MobilePlanner as necessary.
Clear Map, Log, DataLog, and onboard Backup Files	Deletes all on-board files such as audio files, log files, and map files. Files will need to be re-uploaded to the AMR in order to be used.
Reset Robot Model-Type and Calibration Values	Resets the Robot Model Type parameter, removing the default configurations until a new Robot Model Type is selected. Without a Robot Model Type, the AMR will not be able to fully power ON. If the "Reset Entire ARAM Config" option was selected, the AMR's model parameter value will need to be re-input before the AMR can be used. An AMR without a defined model parameter will continuously power cycle until the model value is set. To provide extra time to input a model value, a pop up window will appear in MobilePlanner with an option button to postpone the power cycle. You can set the model parameter in **Configuration** > **Robot Physical** > **Robot Type**.
Remove Installed Software Packages	Removes the software suite from the core, leaving only SetNetGo. The Mobile Software Suite will need to be re-installed before the core can be used again.

AMR Platform Recovery

Follow the procedure below to reset the AMR's settings using Recovery Mode.

Before beginning this procedure, ensure the following items are available:

- Computer
- Ethernet cable
- A web browser application
- MobilePlanner

> **IMPORTANT:** Many of these Maintenance Options will remove the configuration or data from the AMR. Exercise caution when selecting a recovery option. If you wish to cancel this procedure without resetting the AMR, you can exit this mode by power cycling the AMR. This will revert the AMR back to normal mode without any changes.

Additional Information: Refer to Connect Your PC to the AMR via Ethernet on page 45 and Set the IP Address on Your PC on page 46 for more information on connecting to the AMR's maintenance port.

1. Connect a PC to the AMR maintenance port with an Ethernet cable.
2. Open a browser and connect to robot's SNG by typing in the maintenance IP address.
3. Download a DebugInfo file from the AMR by selecting **Status** > **Download DebugInfo**, and save the file in a safe place. Refer to Connect Your PC to the AMR via Ethernet on page 45 and See "Set the IP Address on Your PC" for more information.
4. Access the Recovery Mode area by selecting **System** > **Upload SetNetGo OS** > **Recovery Mode** and click on the **Reboot and Enter Recovery Mode** Button. You will be prompted to confirm if you want to enter the recovery mode after the selection is made..

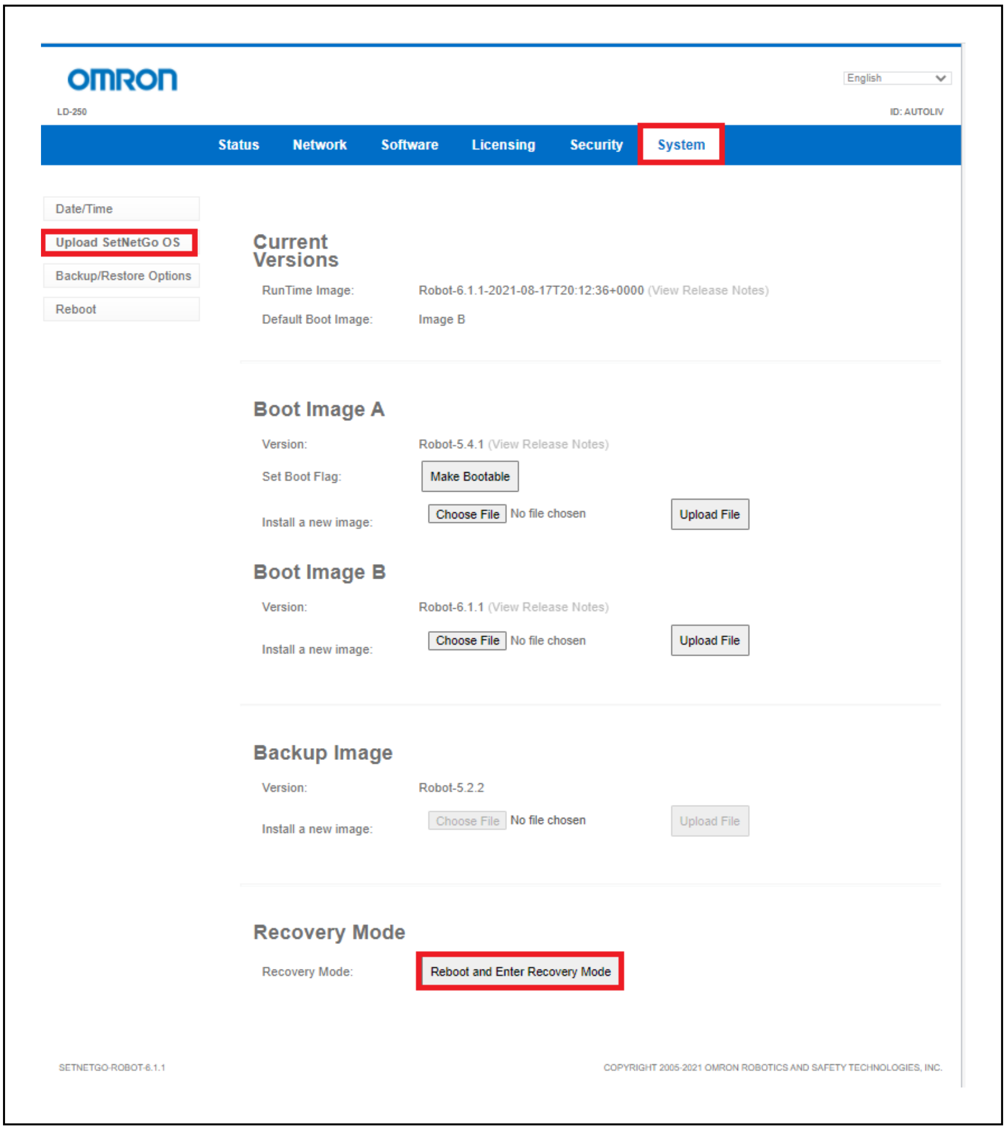


Figure 8-15. Reboot and Enter Recovery Mode Button

5. Wait approximately 30 seconds and then refresh the page after entering Recovery Mode.
6. In Recovery Mode, on the left tree go to *Maintenance Options*. You will see 5 options. Each option provides the functionality that have been checked for that option. Refer to the following table for additional detail on each option.
7. After making your selection, wait for a message to appear stating that the change was made successfully.
8. Power cycle the AMR (push the OFF button and then push the ON button).
9. Allow the power cycle to complete and confirm the AMR's status. Once the AMR's status is confirmed to be in the intended post-recovery state, the procedure is complete.

The changes that you requested in previous steps will have altered critical configurations, therefore you will need to make sure to properly configure the AMR to ensure normal and intended function.

8.11 Configuring ARAM

This section covers using the SetNetGo to set up and manage accounts, and to update the ARAM software.

Setting Up User Accounts

The SetNetGo Security tab allows you manage access control for accessing AMRs and the Fleet Manager via MobilePlanner. This allows you to restrict users from performing specific tasks.

> **NOTE:** At least one account must be enabled at all times. SetNetGo will enforce this.

1. From MobilePlanner, click the **SetNetGo** Button, then click the **Security** tab.

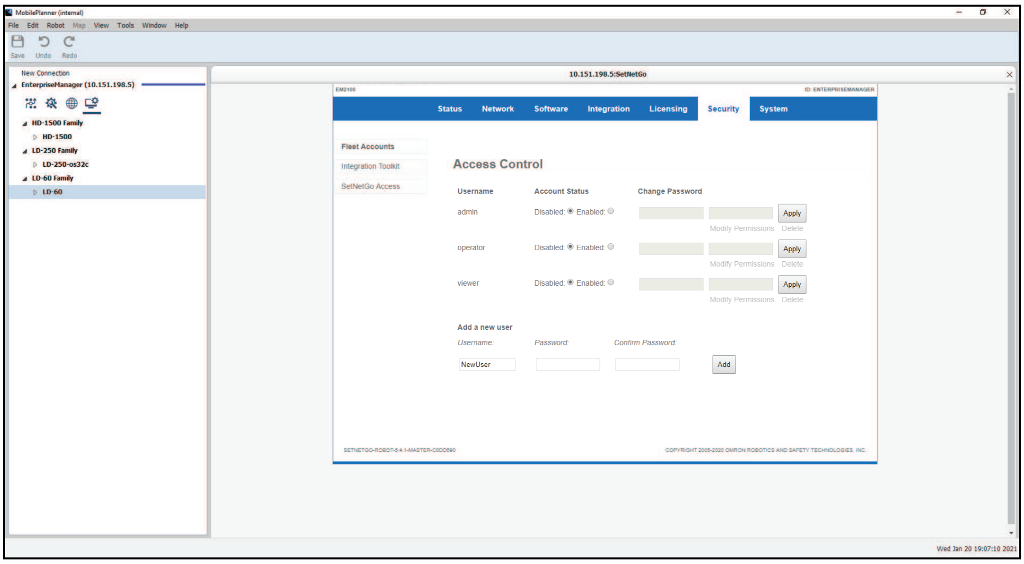


Figure 8-16. SetNetGo Interface - Security Tab

By default, access control for connecting to AMRs and/or Fleet Manager is enabled.

2. To change the access password for the admin, operator, or viewer accounts, click the associated **Enabled** radio button, then click **Apply** next to each modified username.

   Any change to account information will force a restart of ARAMCentral or ARAM.

3. Continue to the next section to set up user accounts.

To Set Up and Manage User Accounts

1. In MobilePlanner, open SetNetGo.
2. Click on the **Security** tab to display the page for Fleet Accounts (on the Fleet Manager) or ARAM Accounts (on the AMR).
3. Follow the instructions in the table below to add, delete, or edit a user account.

To...	Perform the following steps
Add a user account	1. Enter a Username in the **Add a new user** field. 2. Enter a password in the first Password field (on the same line as the Username). Passwords can have letters and numbers, and can be 1 to 20 characters long. . **NOTE:** Usernames and passwords are alphanumeric only, and do not accept spaces, special characters, uni-code marks, underscores, or periods (.) 3. Re-enter the same password in the Confirm Password field. 4. Click **Add**, and verify the new user account appears under the User-name column.
Delete a user account	1. Click Delete in the line of the Username you want to delete. 2. Click **Apply** to remove the user account from the list in the Username column.

Permission Groups

For each user account, you can enable and disable access to various features in MobilePlanner. For example, enabling FileUploading allows the user to upload and download files from MobilePlanner to the AMR.

1. To modify account permissions for each user (for example, admin user), click **Modify Permissions** (to the left, and below the **Apply** Button) to display the Change Account Permissions page.

   The following example shows account permissions page for the admin user who, by default, has all permissions assigned. Other users have different sets. Use the side scroll bar to see all permissions.

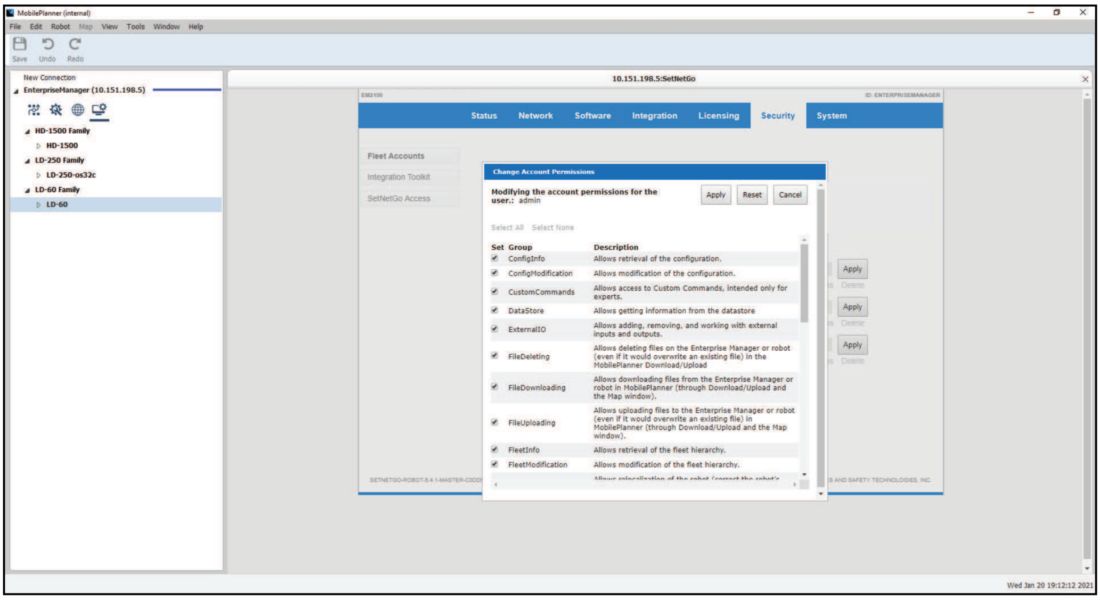


Figure 8-17. Change Account Permissions Page

2. Check the box(es) for the permission(s) you want to grant to the selected user account.

   You can quickly assign all permissions by clicking **Select All**, or click **Select None** to clear all assigned permissions.

3. Click **Apply** to set the selected account's permissions, and return to the ARAM Accounts page.

Operator Account

The Operator Account, by default, has the following privileges:

- CustomCommands
- Localize
- Map
- Movement
- Motors
- Navigation
- NavigationInfo
- RobotInfo
- SensorInfo
- Shutdown
- SoundFromRobot
- SoundOutRobot

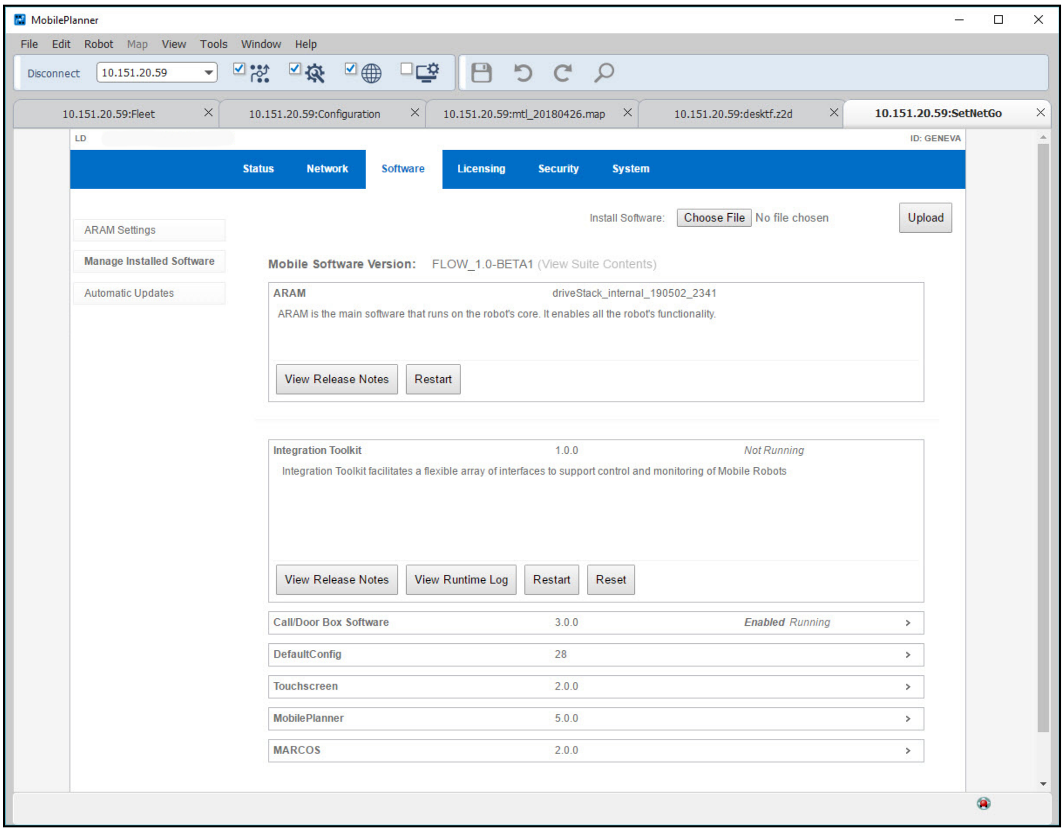
- Stop
- MovementUnprotected
- QueueInfo
- QueueModification
- FileDownloading

Updating Fleet Operations Workspace Core

For an updated Fleet Operations Workspace Core package, contact your local OMRON representative.

To Update the Fleet Operations Workspace Core

1. In MobilePlanner, click the **SetNetGo** Button, then click the **Software** tab, then click **Manage Installed Software** from the left side list.



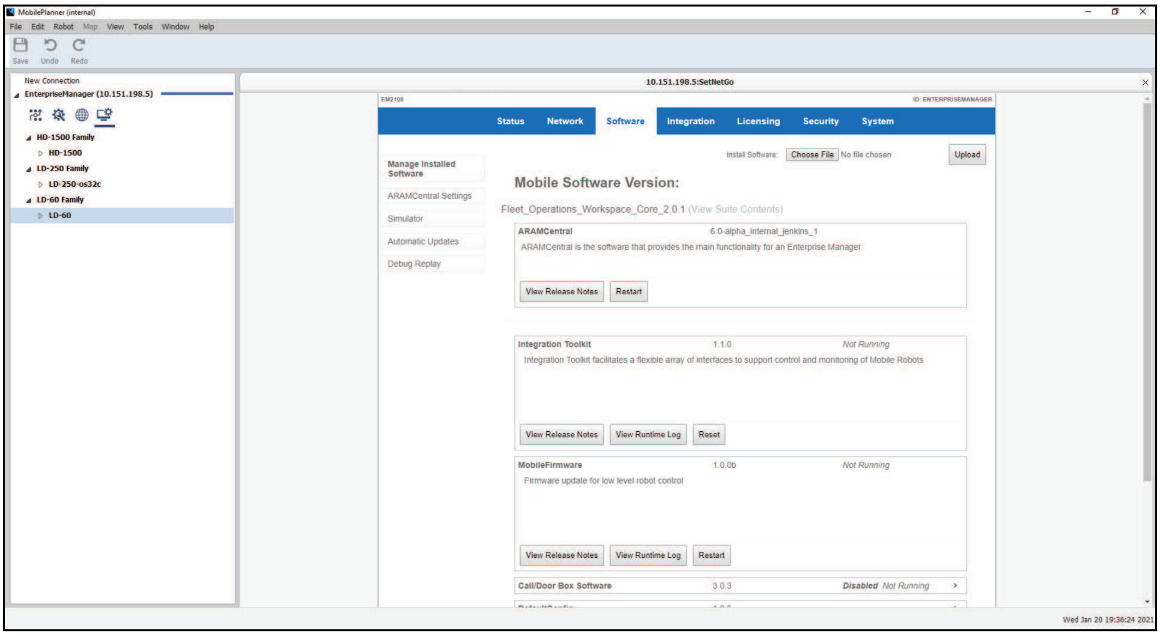


Figure 8-18. SetNetGo Interface - Software Tab

2. Click the **Choose File** Button to access the directory where the update file is located, and click **Open**.
3. Confirm that the correct file name is listed next to the **Choose File** Button, then click **Upload**.

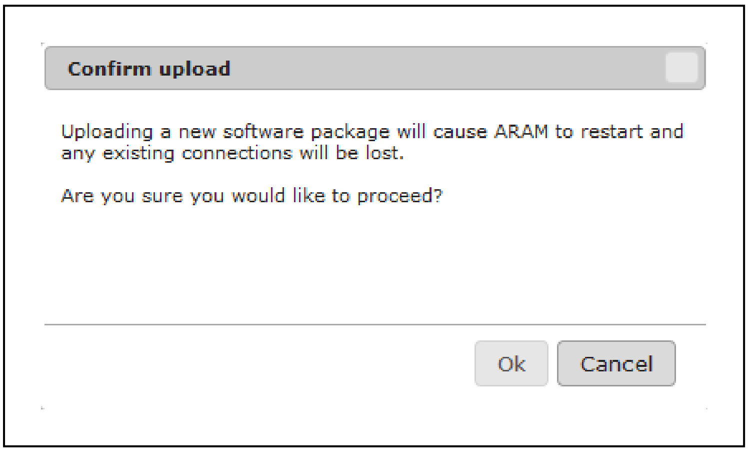


Figure 8-19. Confirm Upload Dialog

4. If you are certain you want to proceed, click **Ok**.

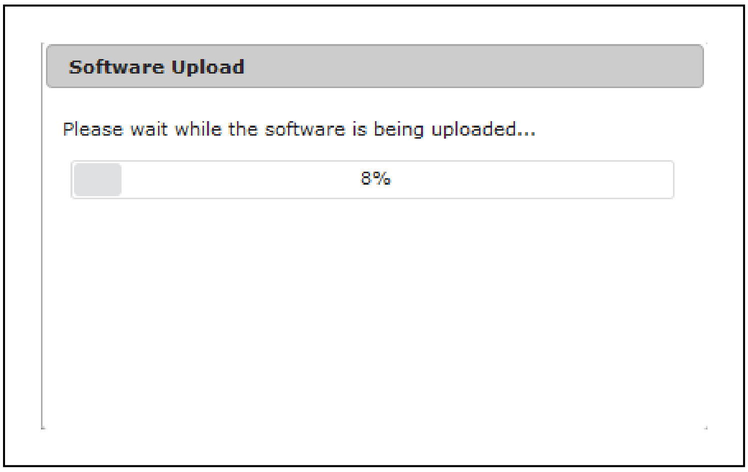


Figure 8-20. Software Upload Status

The AMR will be unavailable as it goes through its restart sequence (a status window shows the restart progress).

If the installation is successful, the new Mobile Software version appears in Manage Installed Software.

Viewing Software Packages

Clicking a package name expands the selection and shows the options for that package, which can include:

- Release notes
- The option to enable or disable the package (if the package is executable)
- Log files
- Uninstall (if available)

Restarting ARAM

ARAM automatically stops when any changes are made, but you can click the **Restart** Button to force ARAM to restart.

Chapter 9: Configuring the AMR

There are a large number of parameters that you can set in MobilePlanner to customize your AMR's operation in your environment. Other sections in this manual describe localization and mapping parameters. This section describes AMR operation parameters.

9.1 AMR WiFi Capabilities

OMRON's AMRs have multiple network interfaces, including a built-in wireless communications capability to enable their autonomous operation. The on-board wireless card can use 802.11a, 802.11b, 802.11g, 802.11n, or 802.11ac wireless standards on 2.4 GHz or 5 GHz channels, and the AMR will automatically switch between wireless access points as it moves through its environment.

> **NOTE:** If the AMR has difficulty connecting to a wireless access point, switches between 2.4 GHz and 5 GHz channels, frequently disconnects, or has weak signal strength, try disabling the 2.4 GHz channel. If the problem discontinues, inform your IT department of your finding.

The AMRs' wireless system can use the majority of the most common personal and enterprise-grade security methods and encryption, including:

- Open
- 64-bit or 128-bit wireless equivalent privacy (WEP)
- WiFi-protected access (WPA2)-pre-shared key (PSK) ASCII or HEX passphrase
- Extensible authentication protocol-tranport layer security (EAP-TLS)
- Protected EAP-Microsoft challenge handshake authentication protocol version 2 (PEAP-MSCHAPv2), or
- Advanced encryption standard/temporal key integrity protocol/counter mode with Cypher block chaining message authentication code protocol (AES/TKIP/CCMP) encryption.

The AMRs can also use certificates (small files containing identifying information that allows the AMR to connect to secure networks that require explicit identification and pre-authorization for access) with the following extensions:

- .pem - a privacy enhanced mail (PEM)-encoded X.509 certificate
- .pem/.cer/.crt - a PEM or distinguished encoding rules (DER) encoded X.509 certificate
- .p7b - a Public Key Cryptography standards (PKCS7) file containing one or more certificates (contains no private key)
- .p12 - a PKCS12 file containing one or more certificates (includes private key)

Your certificate authority (CA) server generates these certificates based on a certificate request (.csr) file. You manually install the certificates on the AMR. The AMRs can generate their own 1024-bit or 2048-bit RSA keys, or use keys generated by the CA.

9.2 Available Options and Peripherals

The following options and peripherals are available for your AMR. For more details, refer to the Peripherals Guide for your AMR:

Pendant

The pendant is an optional hand-held input device for driving the AMR. It attaches directly to the AMR's pendant port, and has controls to move the AMR forward and backward, turn left or right, and adjust its speed. It also has a configurable goal button for adding goals while mapping.

For the LD-series AMRs this is called a Joystick, and the port is the Joystick port. This is similar to, but not the same as the pendant used with the HD-1500 AMR.

Acuity

In addition to using a safety scanning laser (navigation laser) to create a map of its environment, the AMR can, with an upward-facing camera mounted on top of the platform or its payload, use overhead light localization for navigation (the laser then provides obstacle avoidance). Called Acuity, this peripheral add-on is ideal for dynamic environments, such as warehouses, in which objects on the floor undergo frequent location changes. For more information on localization, refer to What is Localization? on page 260.

> **NOTE:** If not installed by the factory, Acuity requires installation of the Acuity Support Package software via the MobilePlanner software. For information, see the *Mobile Robots - LD Platform Peripherals Guide (Cat. No. I613)*, found in the OMRON corporate website.

> **NOTE:** Acuity localization is not currently available with the HD-1500 AMR.

High Accuracy Positioning System (HAPS)

The HAPS peripheral uses a sensor (called GuideSensor_Front in the Robot Physical configuration) installed in the AMR to detect and follow magnetic tape applied to the floor. HAPS allows you to position the AMR at pick-up and drop-off locations with a high degree of accuracy. For more information, refer to the *Mobile Robots - LD Platform Peripherals Guide (Cat. No. I613)*..

Side Lasers

The LD Cart Transporter AMRs have side lasers to detect obstacles on either side (such as overhangs, tables, etc.) to help the AMR navigate through tight areas, such as office spaces.

All other LD-series and the HD-1500 AMR offer these as an option.

Touchscreen

The Touchscreen allows interaction with the AMR at any location. You can check the AMR’s status, send the AMR to goals, pause or release the AMR, or localize a lost AMR.

Call Buttons and **Door Boxes**

Call buttons issue a request for the AMR to go to the call button’s associated goal. Door Boxes act as remote I/O, and can issue requests to open closed doors equipped with a door activator so AMRs can pass through it. For additional information, see *Mobile Robots - LD Platform Peripherals Guide (Cat. No. I613)*

9.3 Types of Configurations

MobilePlanner allows you to view, modify, save, and import various AMR and fleet, and debug configurations. You can set AMR interface, operation, and physical configurations, Fleet Manager configurations (queuing tasks, fleet features, and connection), and debug configurations that control the output of debug log files.

General Configurations

General configurations include site-specific parameters for the AMR interface (A/V config, connection timeouts, language/location, speech synthesis, etc.), AMR operation (docking behavior, localization settings, path planning settings, task features, etc.), EM2100 features and connection, and debug information. General configurations are consistent across your site. If you have a fleet of AMRs, the general configurations reside on the EM2100. If you have a single AMR, the general configurations reside in the AMR's core.

The configuration interface for the fleet is similar to that of a robot. If you change the configuration of each level of the hierarchy, which includes robot family, robot type, and robot, it will change the levels below it. Refer to the following figure.

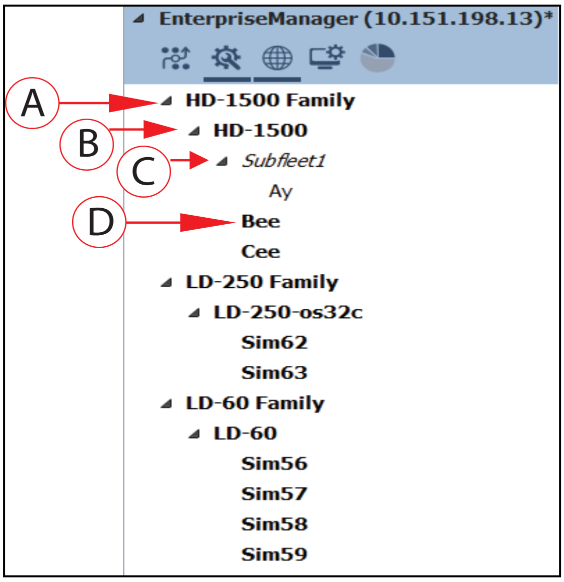


Figure 9-1. (A) Robot Family, (B) Robot Type, and (C) Subfleet Name (D) Robot Name/ID

Model and Calibration Configurations

These configurations relate to the AMR itself.

Model configurations include AMR model-specific parameters like movement maximums, battery information, Acuity camera configurations (LD-series option only), the MARC or Polo configuration, AMR type, sensor type(s) and location(s), fleet queuing tasks, etc.

Calibration configurations include general physical AMR information and parameters. Calibration configurations are specific to a single AMR and cannot be copied to other AMRs Model and calibration configurations always reside in the AMR's core.

IMPORTANT: Care should be taken when adjusting the parameters in the Absolute Movement Maximums section. These parameters can affect the safety of the platform. For example, if AbsoluteMaxTransDecel is too high, it could cause the platform to decelerate too quickly and tip over.

9.4 Using the Search bar

When MobilePlanner is in the Configuration tab, typing into the search bar allows you to filter all configurations for specific key words. This allows you to find parameters by name, or search for a specific word in a parameter's description (searching for 'Auto' in the example below). Terms you have searched for will appear highlighted in yellow in the interface.

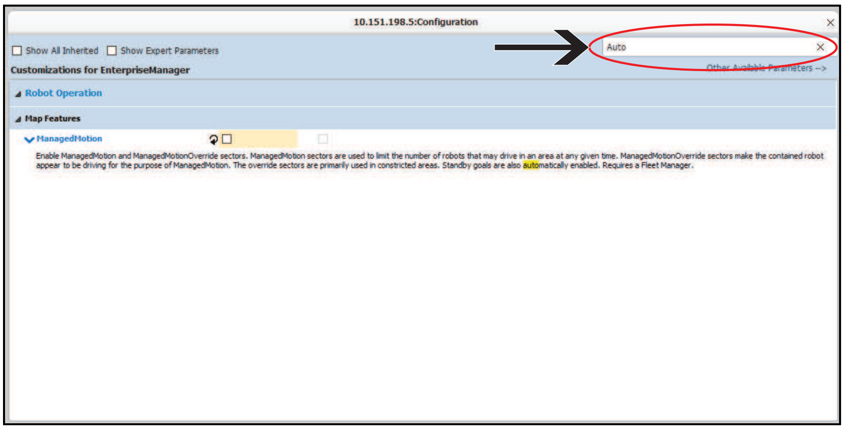


Figure 9-2. Search Window - Searching for 'Auto'

9.5 Setting the Configuration Parameters

Configuration parameters determine the available features on your AMR. You can enable or disable them, or assign them a value. You can set these parameters in MobilePlanner for a selected level (from single robot, Fleet manager, or at the Robot family level) in the Fleet Explorer.

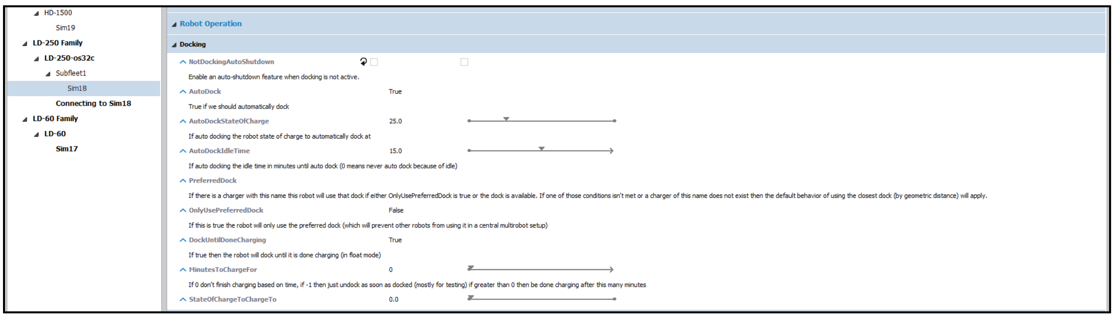


Figure 9-3. Configuration tab accessed from the Fleet Explorer

Using the categories listed here, you can set parameters for everything from audio feeds, to docking, mapping, localization, server setup, move settings, and many more.

There are five AMR parameter categories:

- Robot Interface
- Robot Operation
- Robot Physical
- Fleet
- Debug

The Configuration tab includes multiple categories which contain **sections**, and **parameters**. Click on a category, such as Robot Interface, to open and view its sections. You can click on the expand/ contract widgets next to each category to view its sections. To view individual parameters in each section, click on the expand/ contract widgets next to the section. You may click on the widgets again to collapse the category or the section. The following figures display categories, sections, and the parameters.

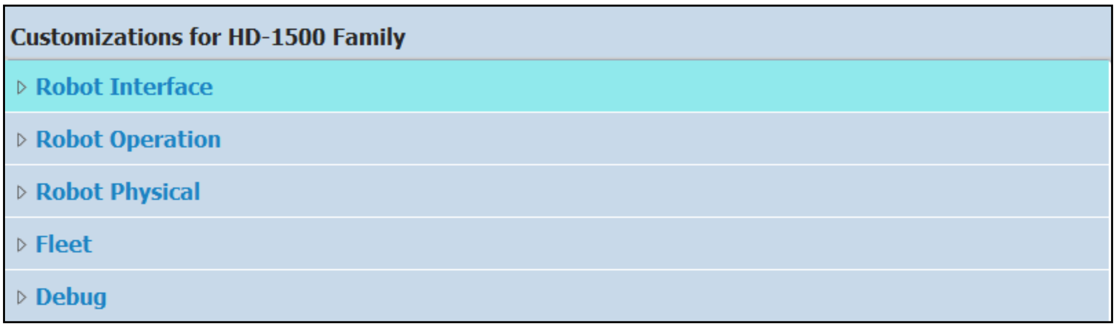


Figure 9-4. Configuration Categories Displayed (Categories Collapsed)

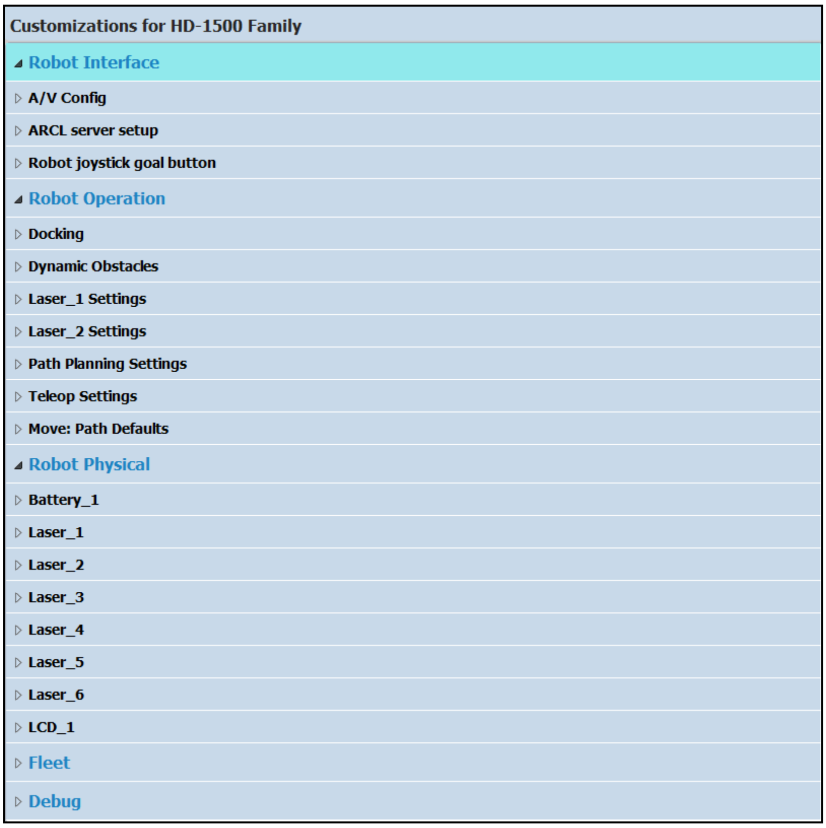


Figure 9-5. Configuration Categories Expanded

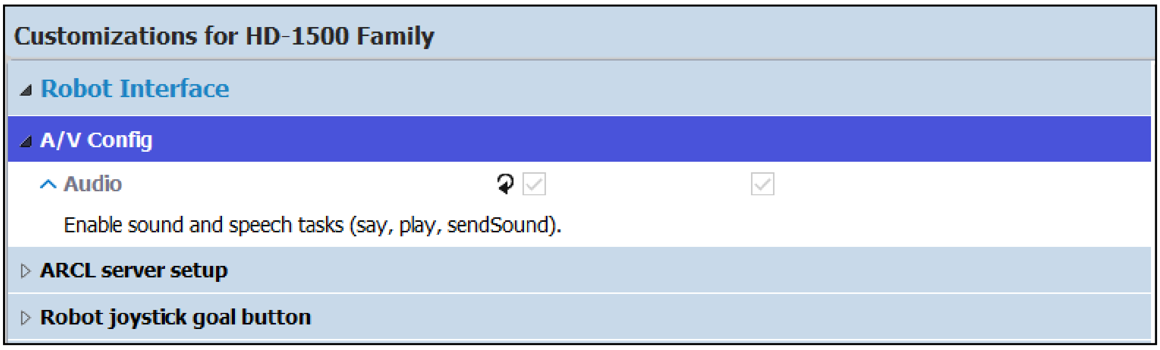


Figure 9-6. A/V Section Expanded (Displaying its Parameter)

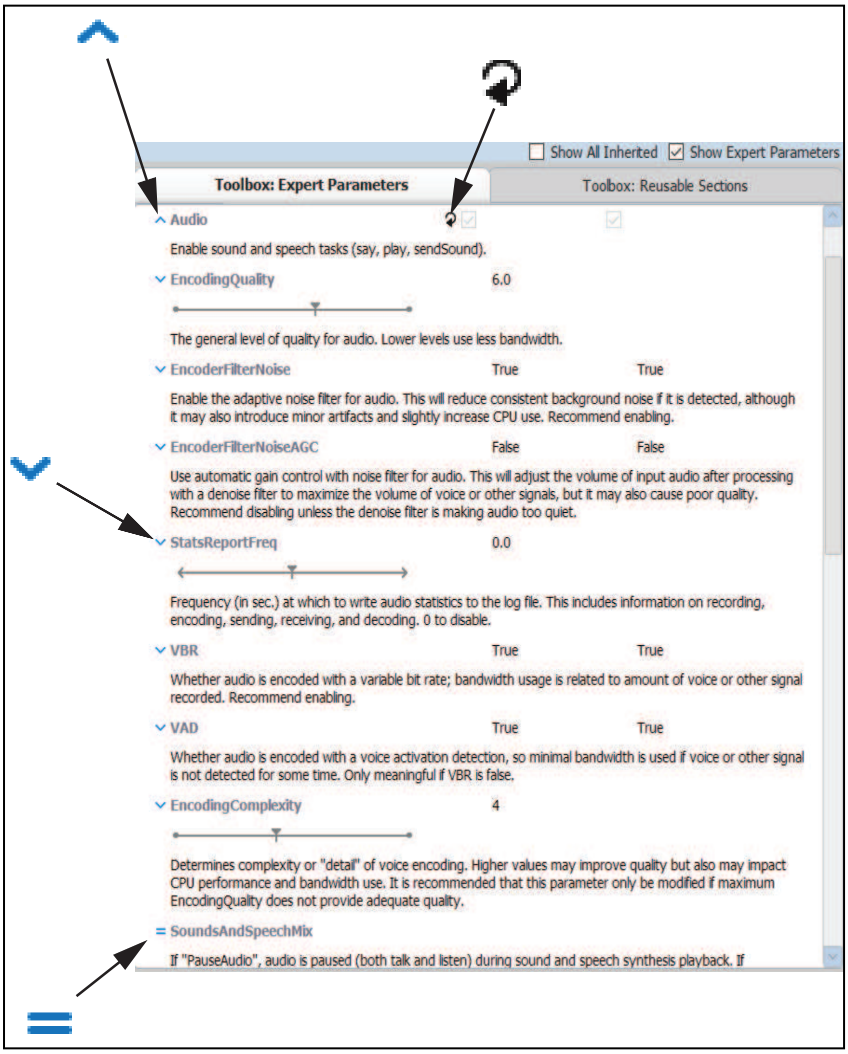


Figure 9-7. Robot Interface Tab, Parameter Info Icons

Table 9-1. Robot Interface Pane Description

Item	Description
	Automatic software restart if changed, and check mark removed. Also, this will delete the old interface.
^	Important parameters that generally must be changed or at least verified in an installation.
v	Advanced parameters that should only be adjusted by expert users.
=	Normal parameters that are likely to be modified.

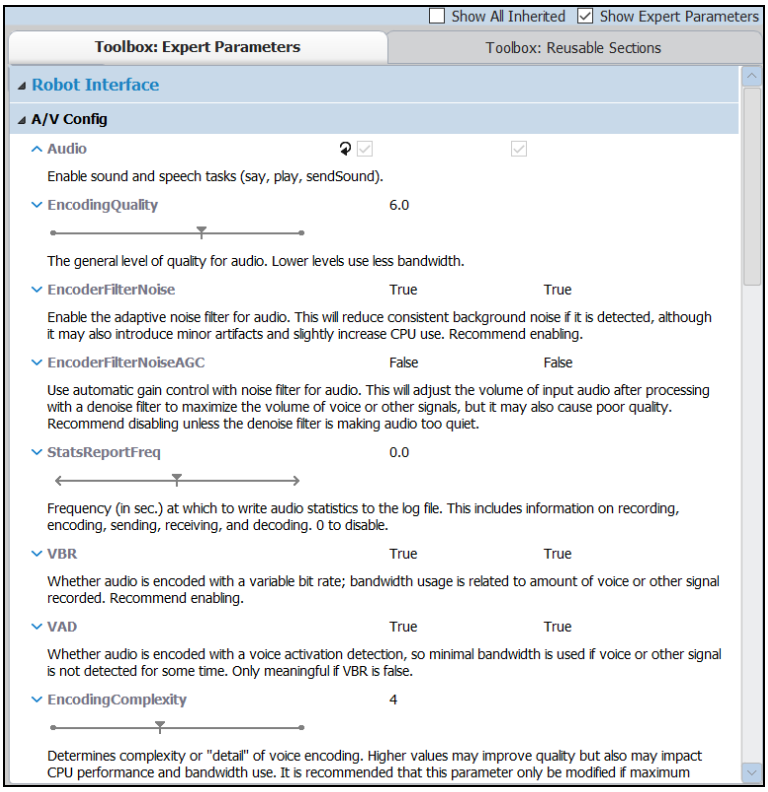


Figure 9-8. Robot Interface Category in the Available to Customize Pane

Most configuration windows in MobilePlanner software describe most of the parameters, and most are not repeated here. Where needed, this manual explains more complex parameters.

> **NOTE: The stylized 'i' icon to the right of** the description column of a parameter indicates that more information is available by clicking on that icon. The following figure is an example.

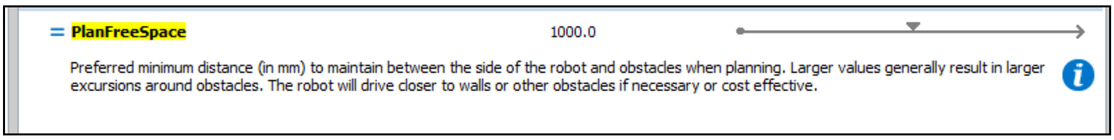


Figure 9-9. Configuration Parameter with stylized 'i' icon

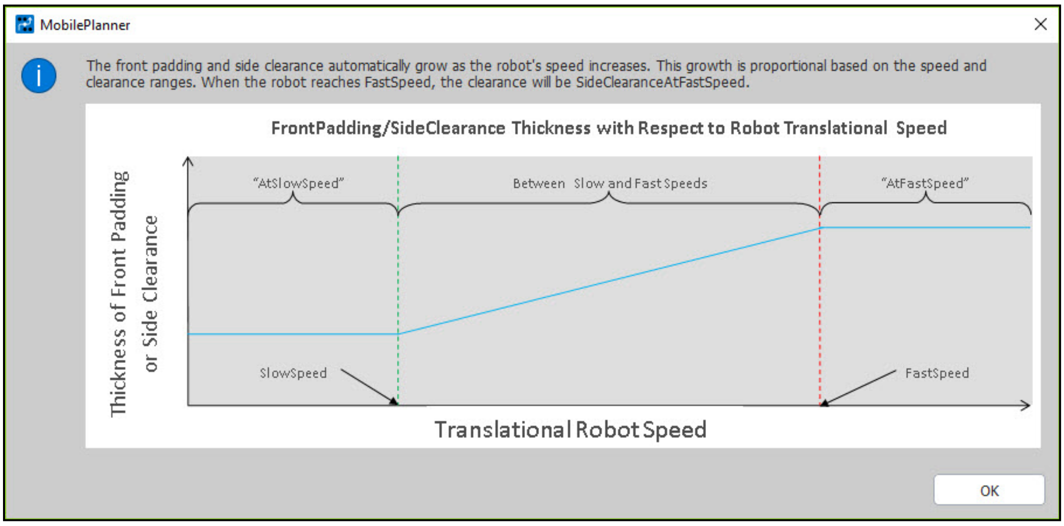


Figure 9-10. Pop-up Window for SideClearanceAtSlowSpeed when 'i' icon is Clicked

To set a parameter, open th configuration category in MobilePlanner, then select a Section to see the available parameters. You can then modify the specific parameter in the parameter table.

> **NOTE:** If a parameter is grayed out you can not change the value of that parameter directly. You can only change the parameters with names that are in blue color, and the values are highlighted in orange. The grayed out parameters indicate that the parameter has been set at a higher hierarchy level (indicated by the thick blue line used to highlight the relevent hierarchy level). Refer to the following figure for an example of grayed out parameters, as well as the parameters in blue.

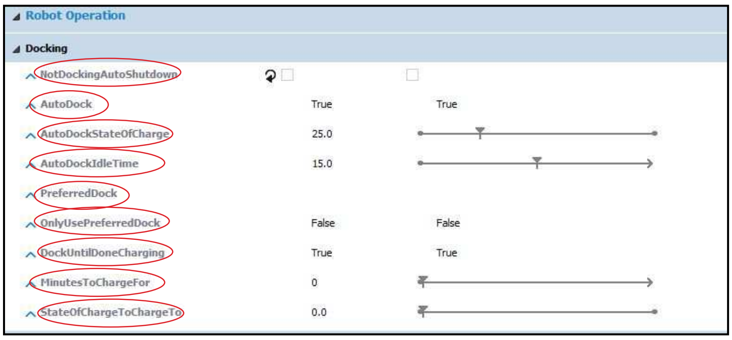


Figure 9-11. Grayed out Parameters

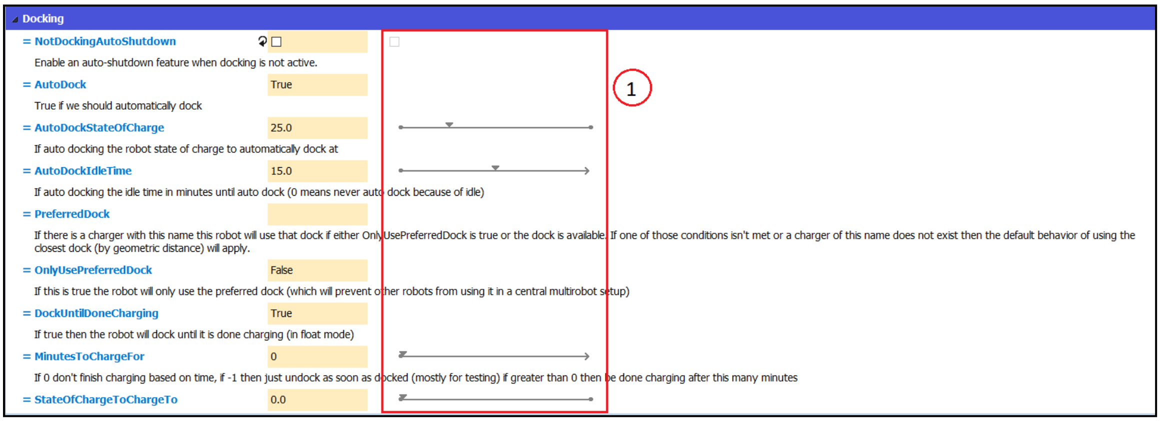


Figure 9-12. Blue Parameters, (1) Default Values

In this table's Value column, you can enter a value (numeric or text), choose a value from a drop-down selection, or click a checkbox. Most text fields have drop-down menus for selection.

For parameters which allow numerical input, there is an indicator bar. If you select a value that is above the default value, the indecator bar's arrow will change color to orange. If the selected value is below the default value, it will turn blue.

There are different types of parameters that accept different types of input. Some parameter can be checkboxes while others accept numbers or text. When looking at a parameter, the entry on the right side indicates the default value, and the entry on the left indicates the current value. If a parameter has its right entry set to a different value than the default, it means that the parameter has been altered.

Parameters with numeric values will be shown with an indicator bar. As the parameter's value is altered the arrow on the bar will move and change color to convey the change. When a parameter is changed, the indicator arrow will change color to show that the current value is either above (blue) or below (red) the default setting.

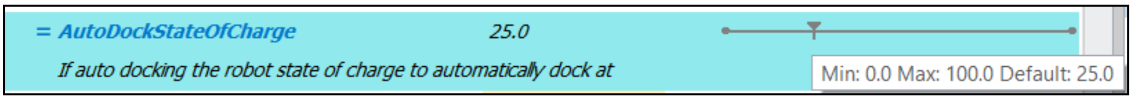


Figure 9-13. Indicator bar at default value

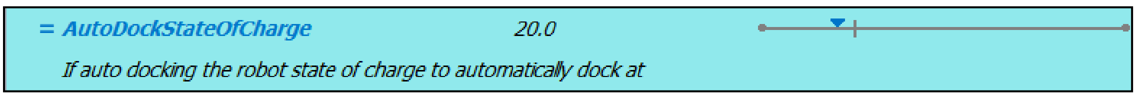


Figure 9-14. Indicator bar above default value

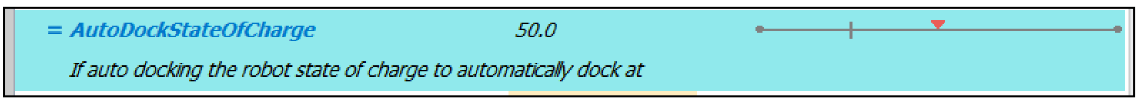


Figure 9-15. Indicator bar below default value

Most parameters are not stand-alone and interact with other parameters. This manual discusses various parameters. For example, if you are localizing the AMR, you will find the parameters related to localization in the Using Laser Localization on page 263 section of this manual.

If you change any parameter settings, you have to click **Save** (or use the keyboard shortcut Ctrl+S) for those changes to take effect. When MobilePlanner sends the update to the AMR, a small spinning icon and “Update Pending” message appear in the MobilePlanner status bar until the AMR applies the changes (at its next idle period). You can also stop the AMR if you want the changes to be applied more quickly.

> **NOTE:** ARAM automatically restarts automatically after some parameter changes.

If the parameter has a restart icon ( ) then, after ARAM writes the change, it displays the following dialog indicating the configuration change:

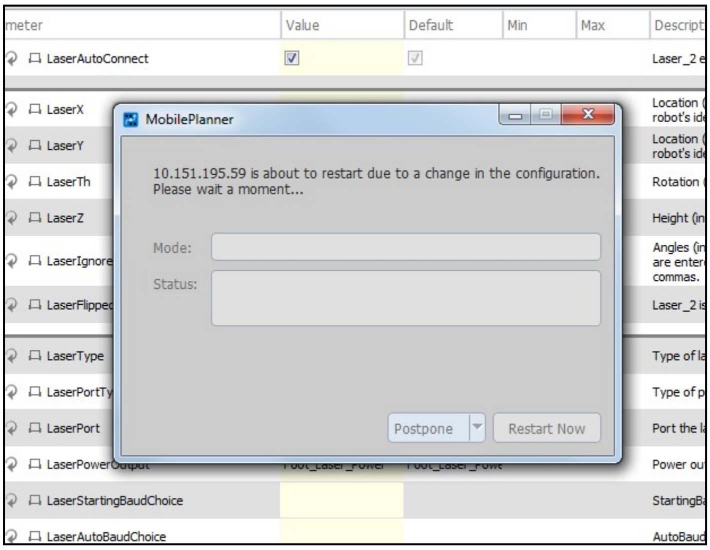


Figure 9-16. Robot Configuration Change

> **Additional Information**: An asterisk sign on the mode tabs indicate that the changes made to the parameters have not been saved.

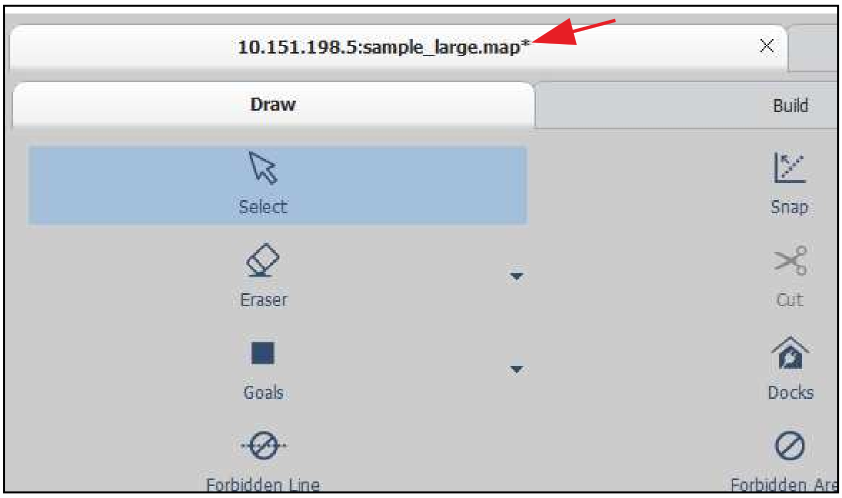


Figure 9-17. Asterisk Sign Indicating Unsaved Changes

Show Expert Parameters

The Show Expert Parameters check box is located on the top right of the Configuration window. When you check the Show Expert Parameters check box, two extra tabs open on the right side of the Configuration window, "Toolbox: Expert Parameters" tab and "Toolbox: Reusable Sections" tab.

The Toolbox: Expert Parameters tab displays the parameters which you most likely will not have to change as they are the non-essential parameters. However, if you decide to change one of the parameters in Toolbox: Expert Parameters tab you can do so by simply dragging the parameter and dropping it in the Customizations Pane. You can then change the parameter value similar to how you would do for the other parameters. Refer to the following figures for examples of how this is done.

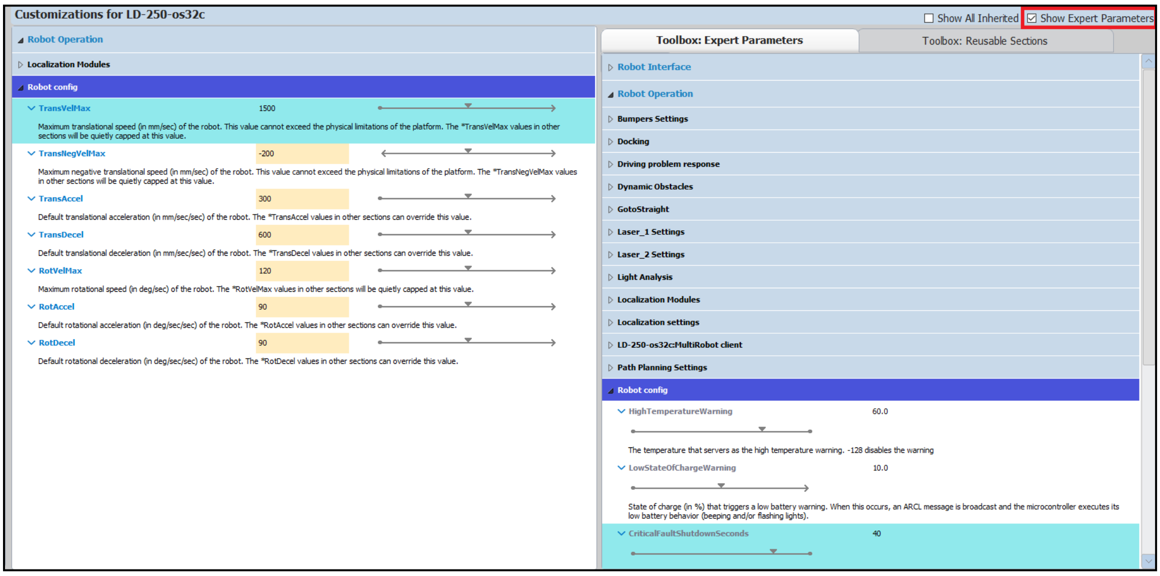


Figure 9-18. Enabling the option for viewing Expert Parameters

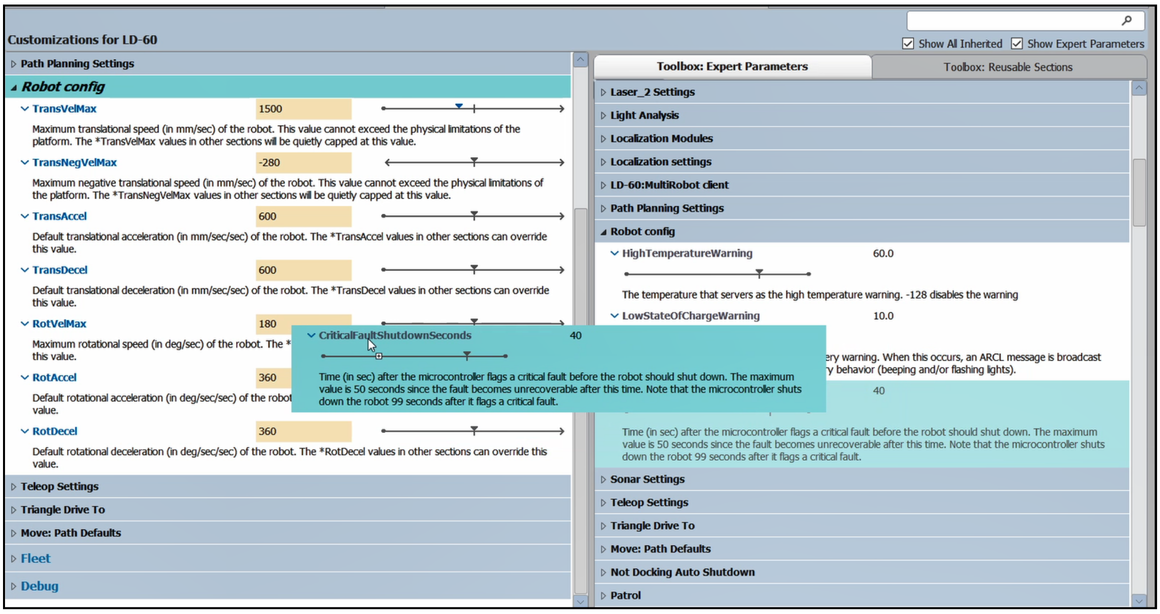


Figure 9-19. Clicking and dragging a specific parameter from the Expert Parameters section to the standard configuration section

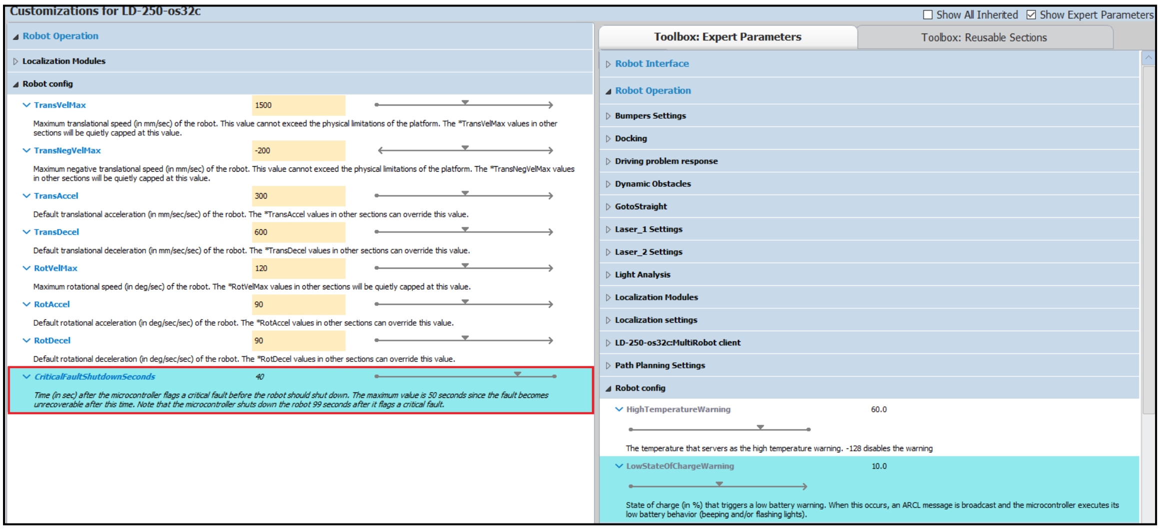


Figure 9-20. The chosen parameter successfully relocated

When a parameter is changed at a level with dependents (for example at the robot type level), the parameter at the lower level (robots in this case) is grayed out. This indicates that you can not undo the change at that lower level, and instead you must find out which level the change was originally made. You can do this by simply right clicking on the changed parameter, and selecting **Switch to edit** option (as displayed in the following figure). You will then be taken to the level where the change was inherited from. You can make the change there.

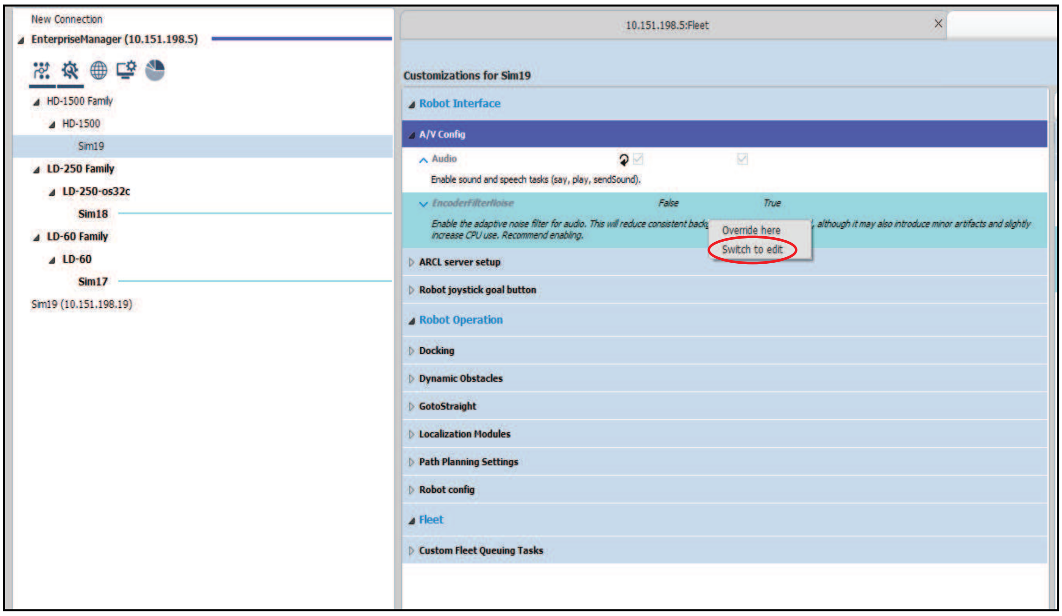


Figure 9-21. Switch to Edit Option

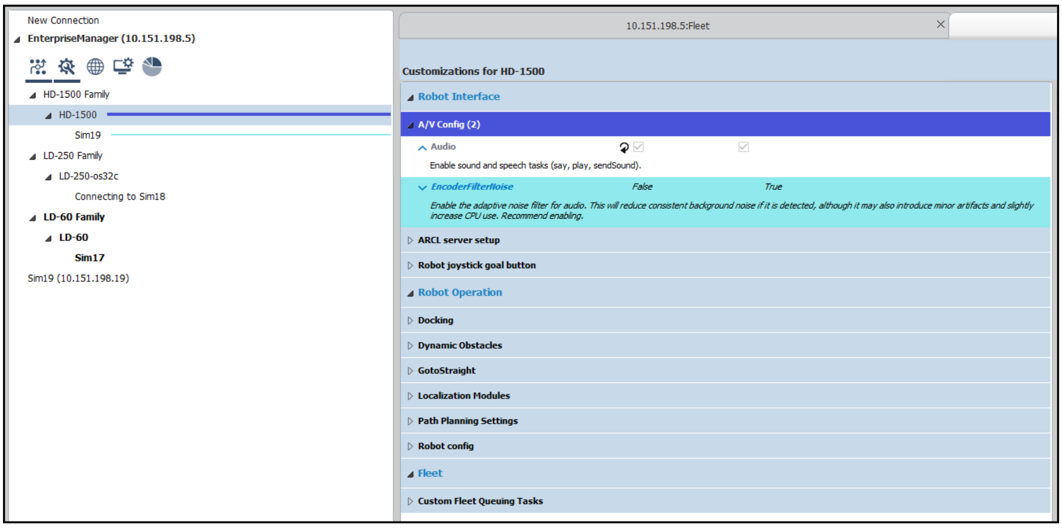


Figure 9-22. Original level where change was inherited from

Indicator Lines

Indicator lines appear in the Fleet Manager to tell you at which level the parameter was changed, and at which levels have taken effect. There is also an indicator line for searched items. You will see three types of lines as displayed in the following figure:

- The thick dark blue line indicates the original level the change was made.
- The thin light blue line indicates the robots that are affected by the changed parameters..
- The thick yellow line indicates where the searched items exist.

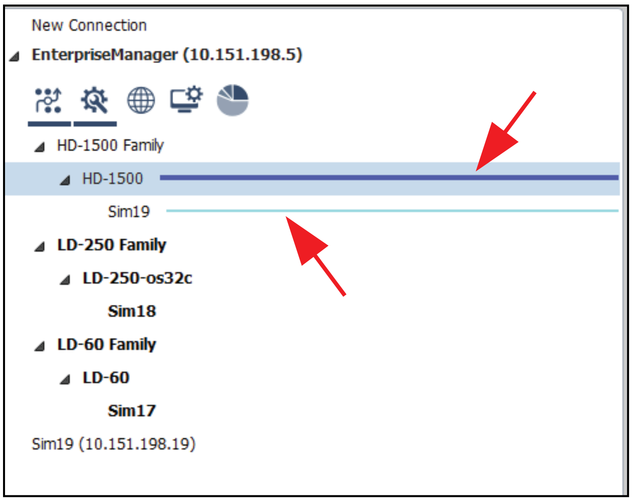


Figure 9-23. Blue Indicator Lines in MobilePlanner

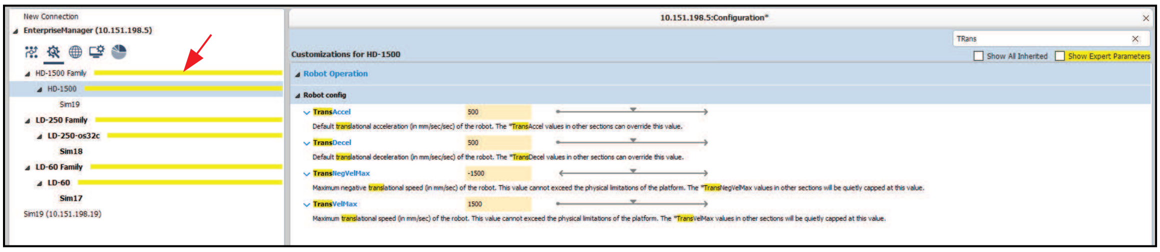


Figure 9-24. Yellow Indicator Lines in MobilePlanner

Show All Inherited

The Show All Inherited check box is located on the top right of the Configuration window. From Show All Inherited, you can see all paramters at a given level that have been inherited from a higher level in the hierarchy. When you check the Show All Inherited check box, a pop-up window is displayed which explains four options available to the users are:

- **Override here**

  Change the value of this parameter for the selected Fleet Explorer item, and its descendants. The change will not apply to descendants which have already overridden the parameter at their level. Other fleet items that use the parameter setting are not affected.

- **Switch to edit**

  Select the fleet item that defines this parameter setting so that its value can be changed for all of the fleet items that are using it.

- **Remove parameter**

  Stop customizing the parameter for the selected fleet item and its descendants. Instead, inherit the value from the parent.

- **Promote parameter**

Moves the parameter to the parent Fleet Explorer item. This enables it to affect a wider set of robots.

Toolbox: Reusable Sections

When a change is made to a parameter at a lower level in the hierarchy, the parameter will appear as a changed section in the Toolbox: Reusable Custom Sections tab located on the right side of the Other Parameters tab. When viewing a higher level of the hierarchy, you can see all sections that have been changed at lower levels. Clicking and dragging a changed section from the Reusable Custom Sections tab onto the main Configuration tab will overwrite the current values with what was set at the lower hierarchy level.

9.6 Saving and Importing the Configuration Parameters

You can save parameter settings on either an AMR or in the Fleet Manager:

1. In MobilePlanner, click the **Configuration** tab.
2. In MobilePlanner's main menu, select **File > Save As**, and give a file name and location for the file on your local PC.

   The Save <robot IP address> Configuration window opens.

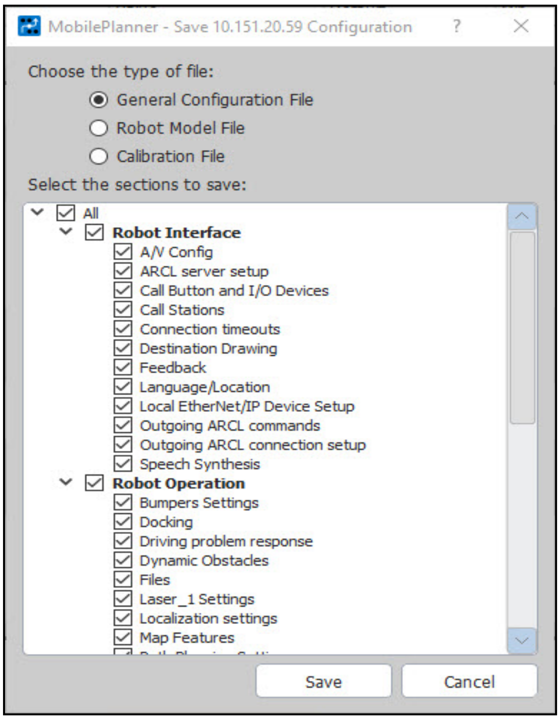


Figure 9-25. Save Robot Configuration Window

3. In the Save <robot IP address> window, select the type of file that you want to save (General, Robot Model, or Calibration), then either accept all checked configurations (default), or de-select the individual configurations that you do not want.
4. Click **Save** when done.

Importing

You can import parameter settings from your PC to either an AMR or the EM2100 appliance:

1. Select **MobilePlanner > Config.**
2. From the main menu, select **File > Import Config ...**, then select the file from your local PC.
3. Click **Save** from the main toolbar.

NOTE: If ARAM restarts after saving a configuration, you will need to repeat the above steps until the software no longer restarts.

9.7 Managing Files

MobilePlanner allows you to manage files associated with Fleet Operations Workspace Core, including:

- raw map-scans (.2d or .z2d) files
- maps (.map) files
- log files
- data files

Downloading, Uploading, and Saving Files

You can upload and download map, scan, log, and data files using **File > Download/Upload** from the top bar. Select the AMR you want to use, and then select the file or folder on the AMR and the file or folder on the PC that you want, and click either **Upload** or **Download**.

You can save map files using **File > Save As...** or, if the file already exists and you just want to save modifications, use **File > Save** (Save only affects the previously saved file). This is the same as clicking the **Save** icon in the Toolbar.

You can import a configuration file onto the current AMR using **File > Import Config...**

> **NOTE:** Import Config applies to the config copy on MobilePlanner, and must be Saved before it is on the current AMR.

9.8 Setting Up Data Logging

The ARAM software can log many kinds of data into one or more files. These data logs allow you to manipulate the data, using your own third-party data-processing software.

> **NOTE:** Log Config is a Section of parameters you can set in MobilePlanner. These logs are not the same as the files generated with data logging.

To set up data logging on an AMR, click the **Config** category, then click the **Debug** tab. When checked, the **Show Expert Parameters** checkbox displays advanced parameters that, by default, do not appear in the parameter list. Expand the Data Log Settings category and set the Log parameter to True.

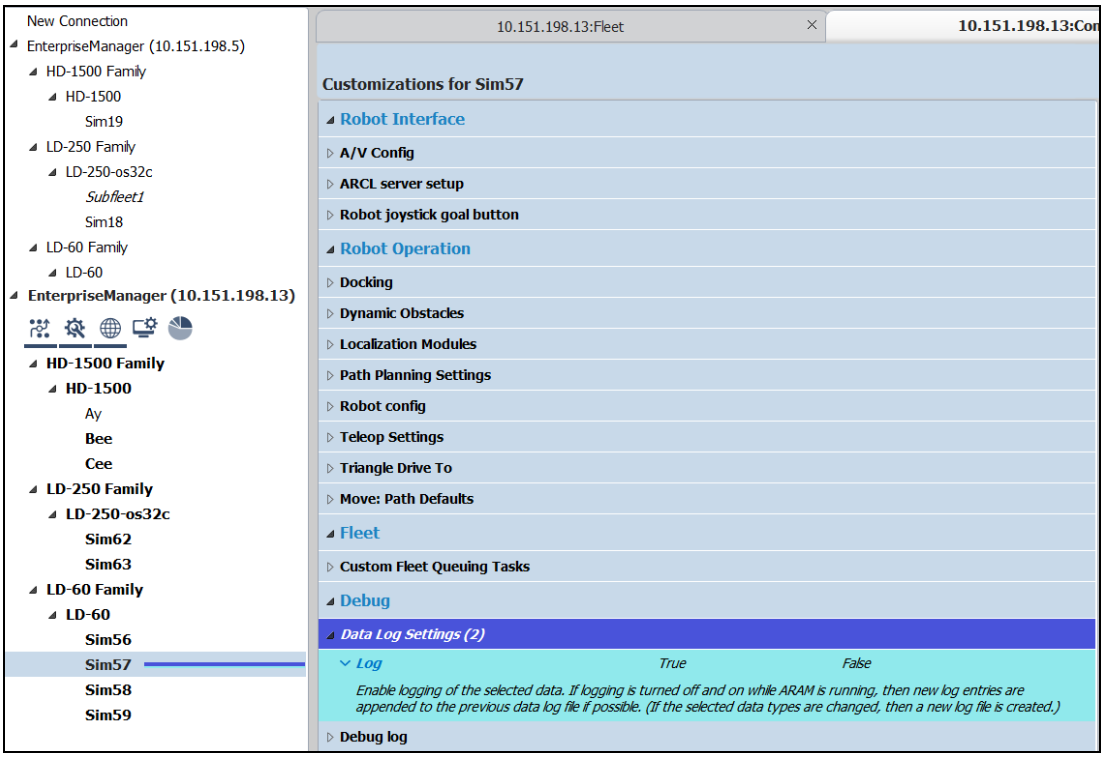


Figure 9-26. MobilePlanner Config, Debug Tab (Show Expert Parameters Checked)

Chapter 10: Working with Macros, Tasks, and the Route Builder

MobilePlanner gives you the flexibility to manually program a complex series of tasks for the AMR to perform at a goal before moving on to the next goal and performing additional tasks.

Instead, you could create macros that include all of the tasks the AMR is to perform at a given goal. You can add tasks and goals to macros, then use the macros within a route or several routes. In other words, macros are "reusable." You can also have individual tasks call a macro and execute the sub tasks within the macro.

For example, you could create a macro in which the AMR drives to Goal1, speaks a phrase and waits for a human action, after which it then drives to Goal2, where it waits for a specified time, then drives to Goal3.

You can use the MobilePlanner software to add tasks, goals, and macros into your facility’s map, associate tasks with routes and goals, and assemble series of goals, tasks, and macros into routes.

10.1 AMR Tasks

Tasks are activities that the AMR can perform, such as going to a goal or checking sensors. The AMR executes tasks at goals to accomplish useful work, such as enabling Digital IO and telling the AMR to move. These tasks are already available on the AMR but need to be defined and associated with the map that you are creating.

There are both instant and non-instant tasks available for the AMR to perform. Instant tasks allow other tasks to be started before the instant task finishes. Non-instant tasks force the next task to wait until they are completed.

You can add tasks to goals and routes. For details, refer to Using the Route Builder on page 205.

> **IMPORTANT:** Use of AMR tasks or ARCL commands to remotely or automatically re-enable motor power is not permitted. Doing so could result in unexpected AMR motion. Motor power may only be enabled by intentional, manual action at the AMR.

Assigning Tasks

You can assign tasks to a route or goal, or use them in macros. You can find available tasks under the Robot Tasks tab in the Source Lists pane. See Setting Up Special Tasks on page 197.

Many tasks need to have their corresponding ARAM parameters enabled to be available. For more information on enabling ARAM parameters, refer to Configuring ARAM on page 147. If you do not see a task displayed in the Source Lists pane, it might have previously been turned off. To display the task, enable (or re-enable) the appropriate ARAM parameter.

1. In MobilePlanner, click the **Map** Button, then click the **Build** tab.

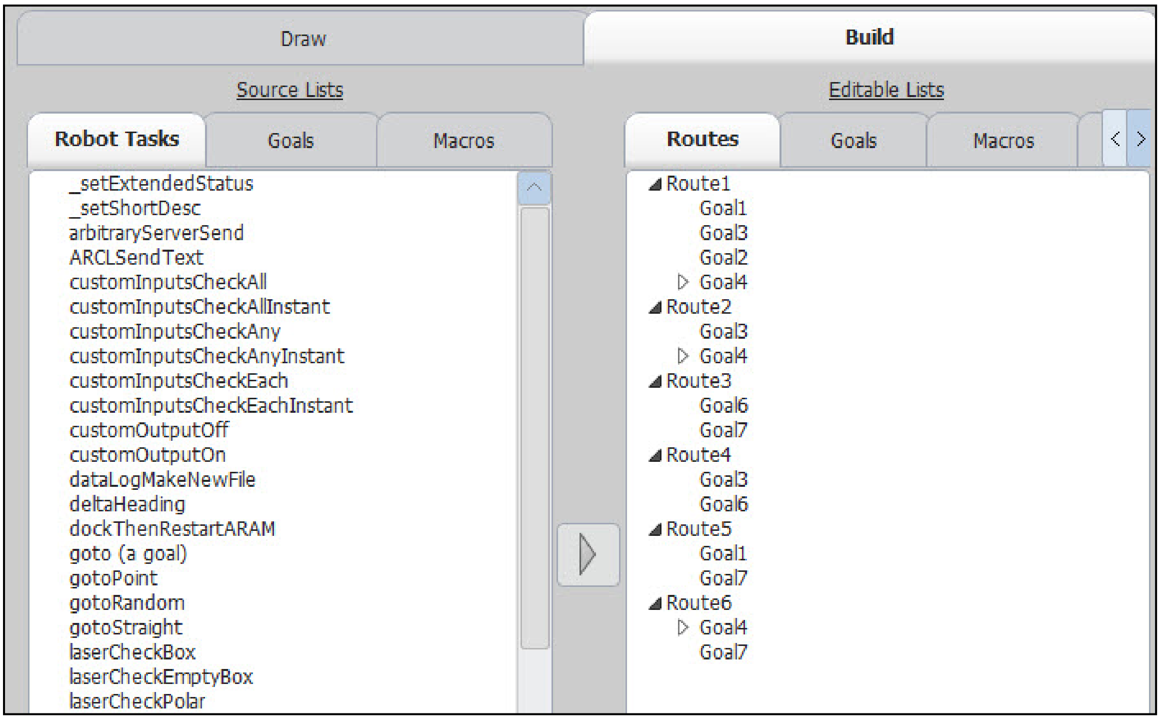


Figure 10-1. The Map Build Tab

2. In the Source Lists pane, click **Robot Tasks** tab to view tasks that are available on the AMR.
3. In the Editable Lists pane, click the **Routes**, **Goals**, **Macros**, or **Special** tab that corresponds to where you want to assign the task.
4. To assign a task to a route, goal, macro, or special item, in the Source Lists, **Robot Tasks** tab:
   a. Click on the task that you want to assign, and drag it over to the desired route, goal, macro, or special item, or
   b. Highlight the task, then highlight the desired goal, macro, special item or route, and click the **Add** Button (the arrow between the lists).

      NOTE: By default, tasks that are added to goals become part of the goal's "after" list (the AMR will perform the task after it arrives). The process also creates a "before" list for tasks that the AMR will execute before driving to the goal (you can also move tasks to the “before” list).

   If the task has associated parameters, a dialog box, shown below, opens ("sayInstant" task shown) :

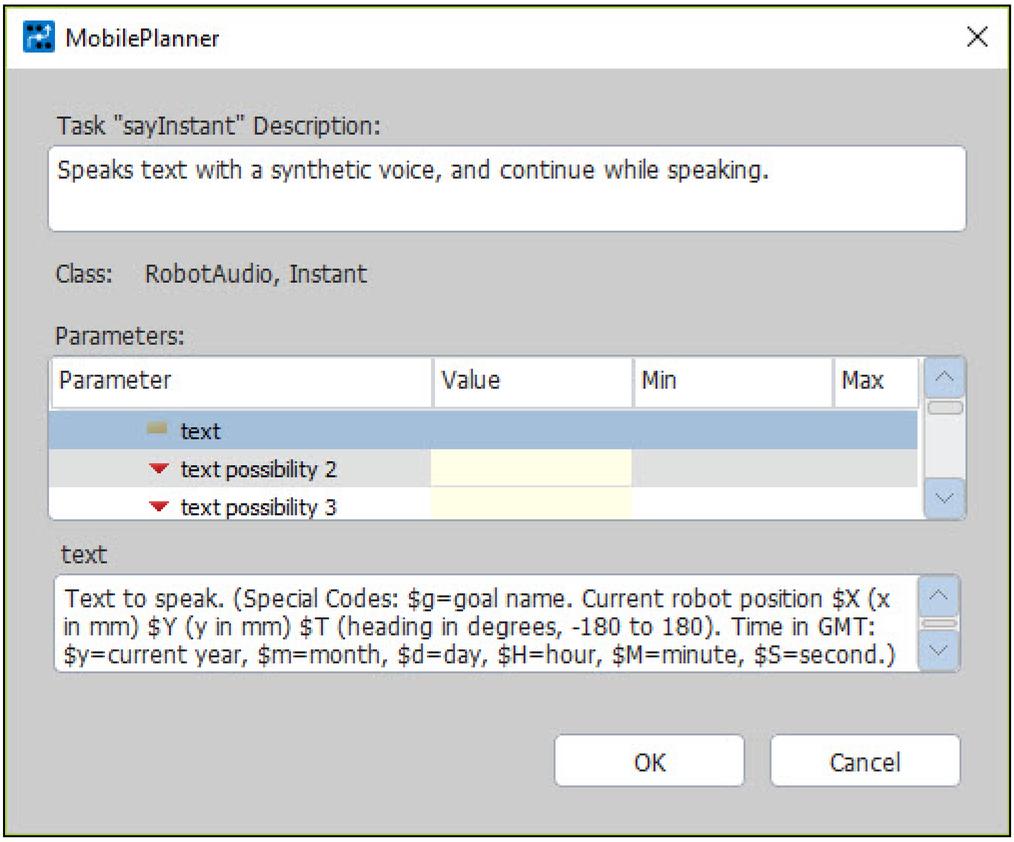


Figure 10-2. MobilePlanner Task Description Dialog

5. Click inside the **Value** field to add and edit each parameter's values.

   For more information on using individual tasks, refer to the task type (such as wait, driving, etc.) in the following section.

Using Instant and Non-Instant Tasks

In general, there can be only one sequence of non-instant tasks running at a time. AMRs can start an instant task without waiting for a previous instant task to finish. Non-instant tasks must finish before the AMR starts another task. In other words, both kinds of tasks are on the task list, but the non-instant tasks must finish before the AMR starts next task on the list. When an instant task runs, the task after it can start right away, without interrupting whatever else is happening.

Instant Tasks

Instant tasks allow the next task in the list to start while the instant task is still running, so the AMR can be running two tasks at once. The following are examples of instant tasks available in the software. The complete list of instant tasks and descriptions are available directly in the software.

Instant Task	Description
ARCLSendText	Sends a given string to the ARCL server.
customOutputOff	Turns a custom output OFF.
customOutputOn	Turns a custom output ON.
playBackgroundSound	Plays a random background sound (at 'Least Important') from a set of prefixes and suffixes (wild cards do NOT work), waiting a length of time between sounds, optionally resuming interrupted sounds, and with the ability to stop playing in some different circumstances. **NOTE:** To interrupt this sound, set the audio task **Cancel less important** to **True**.
playInstant	Plays a sound file and then continue while the sound plays.
popupSimple	Requests client applications to show a simple pop-up message (Client applications include MobilePlanner).
sayInstant	Speaks text with a synthetic voice.
sendSoundInstant	Sends sound from an AMR sound file to all clients and continue immediately.
sendSpeechInstant	Sends synthesized speech to all clients and continue immediately.

Non-Instant Tasks

Non-instant tasks run in their own time slot (the AMR must wait for them to complete before starting the next task in the list).

The following are examples of non-instant tasks. The complete list of non-instant tasks and descriptions are available directly in the software.

Non-Instant Task	Description
arbitraryServerSend	Sends the given text to a specified server and port.
cartCapture	Task to capture a cart.
cartRelease	Task to release a captured cart.
customInputsCheckAll/Any/Each	Checks whether all/any/each specified custom inputs properly triggered and executes a macro.
deltaHeading	Changes the heading by the specified relative amount.
followGuide	Used with HAPS - task to follow a magnetic guide strip on the floor.
gotoRandom	Drives to a random goal (could be optionally constrained by a matching name prefix).

Non-Instant Task	Description
laserCheckBox	Waits for something to enter the rectangular area surrounding the AMR. Macros may be triggered upon detection or timeout.
laserCheckEmptyBox	Waits for the rectangular area surrounding the AMR to be empty. Macros can trigger upon detection or timeout.
macroRepeat	Repeats the specified macro a given number of times or until it fails.
move	Moves forward by the specified distance, provided that no obstacles are encountered.
play	Plays a sound file and waits until it finishes playing.
say	Speaks text with a synthetic voice and waits until it is finished.
sendSound	Sends sound from an AMR sound file to all clients, continues when done.
sendSpeech	Sends synthesized speech to all clients.
setHeading	Turns to a specified global orientation/heading.
wait	Waits for the specified number of seconds. The wait may be interrupted by an explicit continue command.
waitActive	Calls a macro, and optionally waits a given number of seconds or until told to continue by command and control.
waitIndefinitely	Waits until commanded otherwise.

To verify if a task is instant or non-instant, right-click on the task and select **Description**. Or, go into ‘custom responses’ (**Build** tab **> Editable Lists > Special** tab) and click on one of them. The non-instant tasks are grayed out, instant tasks are active. Task classification appears in the "Class" category, as shown in the following figure.

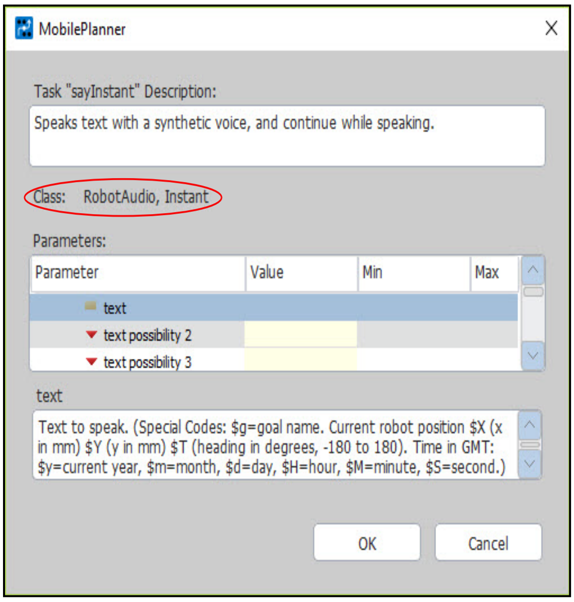


Figure 10-3. Task Class Category

Using a Wait Task

A wait task tells the AMR to wait a given number of seconds (or until told to continue by another command), before continuing. A wait task is not an instant task.

1. Open the map you want to edit. For details, refer to Using MobilePlanner Software on page 52.

   NOTE: Ensure that **Show Robot** is **OFF**, or you will not be able to proceed.

2. Click the **Build** tab.
3. Click the **Robot Tasks** tab in the Source Lists pane to view the tasks currently available on the AMR.
4. Add the Wait task to the route, goal, or macro where you want the AMR to pause before continuing its route. Refer to Assigning Tasks on page 172 for details.
5. Enter the number of seconds that you want the AMR to wait in the Value field of the seconds to wait parameter, as shown below.

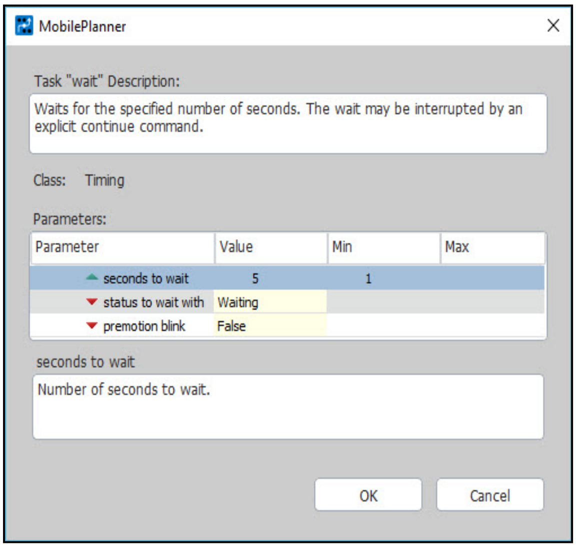


Figure 10-4. Parameters for Wait Task

6. Click **OK** to close the parameter dialog box and save your changes.

Using Driving Tasks

Driving tasks cause the AMR to move about its environment, carrying out various tasks at each goal. Driving tasks can include the following:

Task	Task Description
move	Tells the AMR to move the specified distance.
deltaHeading	Changes the AMR's heading.
setHeading	Turns the AMR toward a specified heading.

Step 1: Enable Movement Tasks

Not all available tasks are enabled by default. Before you can use those tasks, enable them in MobilePlanner by clicking the **Config** Button, then clicking the **Robot Operation** tab, then clicking **Task Features**. After clicking the checkboxes that you want to enable, click **Save** to save your changes.

The following table lists some examples of the driving and movement parameters that you can enable.

> **NOTE:** Some of the parameters in the following table require checking the **Show Expert Parameters** checkbox.

ARAM Parameter	Description
Engage	When used with HAPS, calls a macro when the AMR arrives at the goal, so that the AMR can be sent on a series of tasks, such as a followGuide task to go to a marker on the magnetic strip.
MovementParametersTempTasks	Enables tasks for temporarily changing movement parameters.

Step 2: Assign Movement Tasks

Driving tasks are non-instant, but the MovementParametersTempTasks are instant.

1. Open the map you want to edit.
2. Click the **Build** tab to display Source and Editable Lists panes.
3. In the Source Lists pane, click the **Robot Tasks** tab to view available tasks.
4. Add the driving task to the route or macro (for details, refer to Assigning Tasks on page 172.
5. Enter the parameter values for the assigned task.

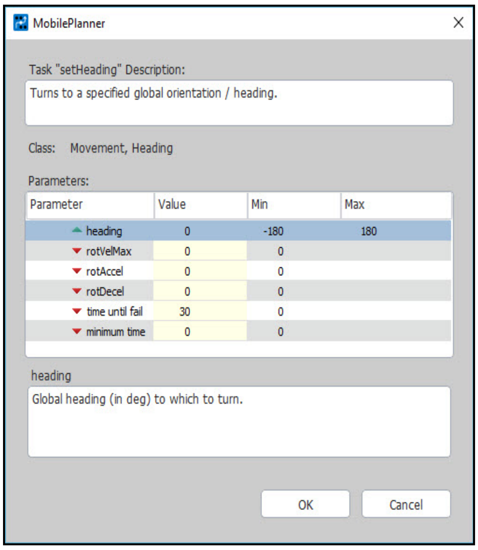


Figure 10-5. Parameters for setHeading Task

The following table shows examples of some of the task parameters and the tasks that use them.

Task Parameters	Parameter Definition	Associated Task(s)
heading	(Integer) The number of degrees to turn the AMR. Positive values turn the AMR left or counterclockwise. Negative values turn the AMR right or clockwise. For deltaHeading, if the absolute value exceeds 360, the AMR makes at least one full rotation.	deltaHeading, setHeading
distance	(Integer) The distance (in mm) the AMR should move from the current position.	move, move2, moveProx[1]
speed	(Integer) The speed (in mm/s) the AMR should move from the current position.	move, move2, moveProx[1]

[1] moveProx and other "Prox" tasks are not supported for the HD-1500 AMR.

6. Click **OK** to accept the parameter value and save any changes you made.

Cell Alignment Positioning System (CAPS)

The Cell Alignment Positioning System (CAPS) is a set of advanced features that provide improved destination alignment accuracy without requiring additional peripheral hardware on the AMR. These features are intended for use in applications that require better alignment accuracy than the standard solution.

CAPS now uses the PrecisionDrive task for improved alignment. Legacy versions of FLOW CAPS used the task TriangleTargetDrive and related tasks. These can still be used, but are not covered in this manual. Contact your local OMRON representative for information on legacy tasks.

PrecisionDrive

PrecisionDrive is a software task designed to increase the final position accuracy of the OMRON AMR platforms. It forms the basis of the Cell Alignment Positioning System (CAPS). PrecisionDrive uses the onboard OS32 scanning laser. It requires a reference target to be placed in the operating space. The AMR will locate and drive relative to this target.

The entire target must be visible by the selected or main laser for the duration of the task, as the laser does not capture and remember reference points while the AMR moves. Using a partial view of the target will cause repeatability to suffer. If the view of the target is completely lost while the task is in progress, the robot will continue using the last known position, and repeatability will suffer.

PrecisionDrive is configured using the MobilePlanner user interface. It is a robotic task that can be scheduled before or after a map goal.

The figure below lists the default parameter values for PrecisionDrive. These default values are the recommenced values for normal usage in mm, and are measured from the center of the robot.

Normal Setup

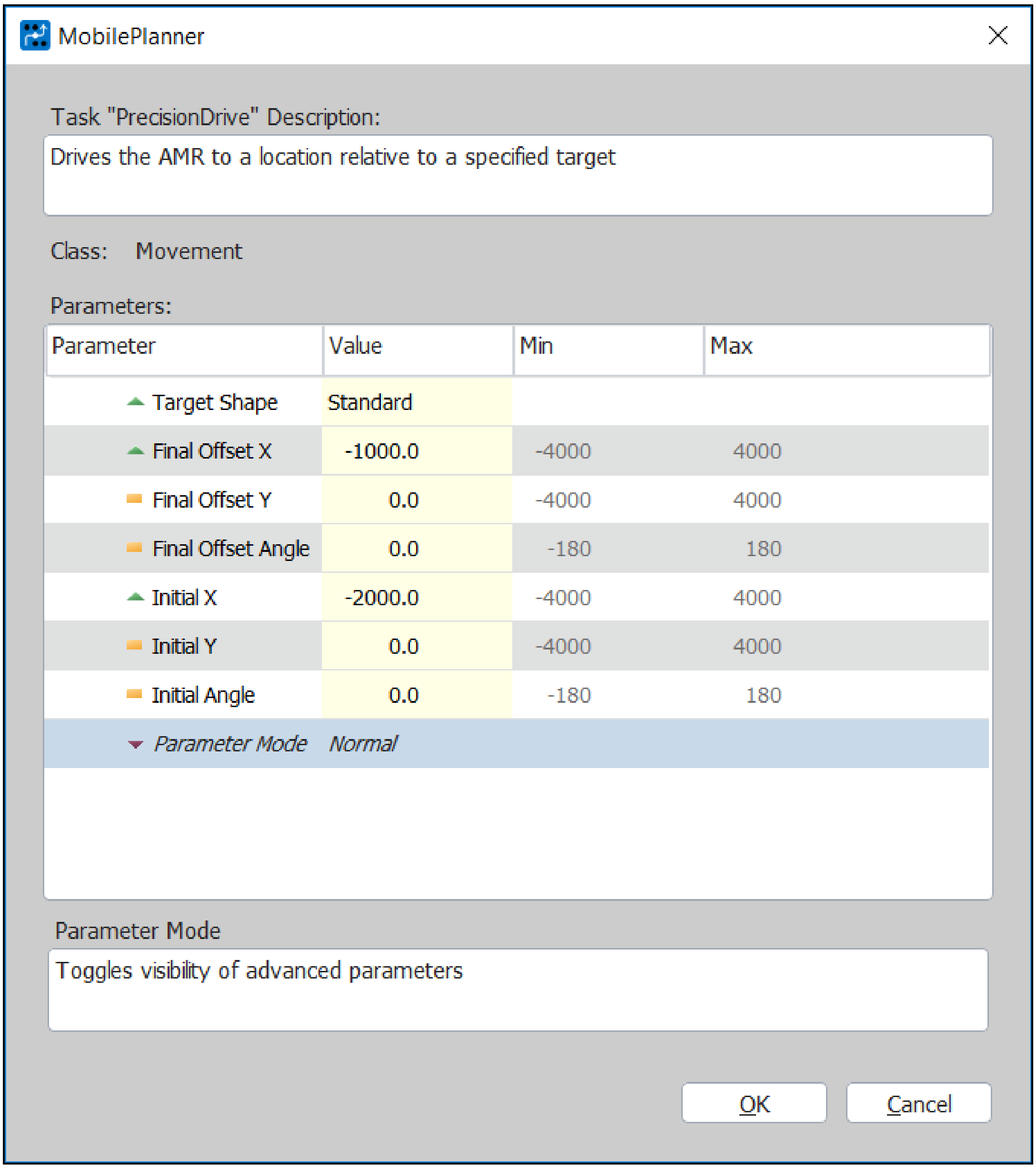


Figure 10-6. PrecisionDrive Normal Parameters

Target Shape

This dropdown controls which target the AMR will locate and move relative to in the operating space. The Standard shape is the default and is defined in Standard Target on page 190. Other shapes can be used based on need and space requirements. Users should give preference to the Standard shape when designing and setting up an application. Both legs of the target must be in the field-of-view of Laser_1 (the front navigation laser) at the beginning of the task – the AMR will not rotate to find the target.

> **NOTE:** The Standard target is the only target with listed accuracy specifications.

Final Offset X

Final Offset Y

Final Offset Angle

These three settings (X, Y, Angle) specify where the AMR will attempt to stop at the end of the task execution. They are 2D spatial coordinates and the diagrams for setup are provided in Standard Target on page 190.

> **NOTE:** These values are relative to the target, not the AMR. This is to simplify setting up tasks as they correlate directly to measurements taken from the target in geometric space.

Initial X

Initial Y

Initial Angle

These three settings (X, Y, Angle) specify the position for the AMR, from which it will attempt to locate the target when first starting the task. From the Initial position, the AMR should be able to see both legs of the target from the concave side. There is an associated search area to account for real world position uncertainty after arriving at the pre-goal. These are described in more detail under the Advanced Setup section. They are 2D spatial coordinates, and the diagrams for setup are provided in Target to Robot Coordinate Frame Transformations on page 190.

> **NOTE:** These values are relative to the target, not the AMR. This is to simplify setting up tasks as they correlate to measurements taken from the target in geometric space.

These three parameter sets are all that are needed to successfully set up and use the PrecisionDrive task in most applications. Users should use the Normal setup whenever possible. All other parameters (listed in the Advanced Setup section) are optimized for most use cases with the Normal setup setting.

Parameter Mode

This parameter toggles the Normal and Advanced setting menus. Normal only shows the parameters previously described in this section. Advanced shows the parameters listed in the Advanced Setup section that follows.

Advanced Setup

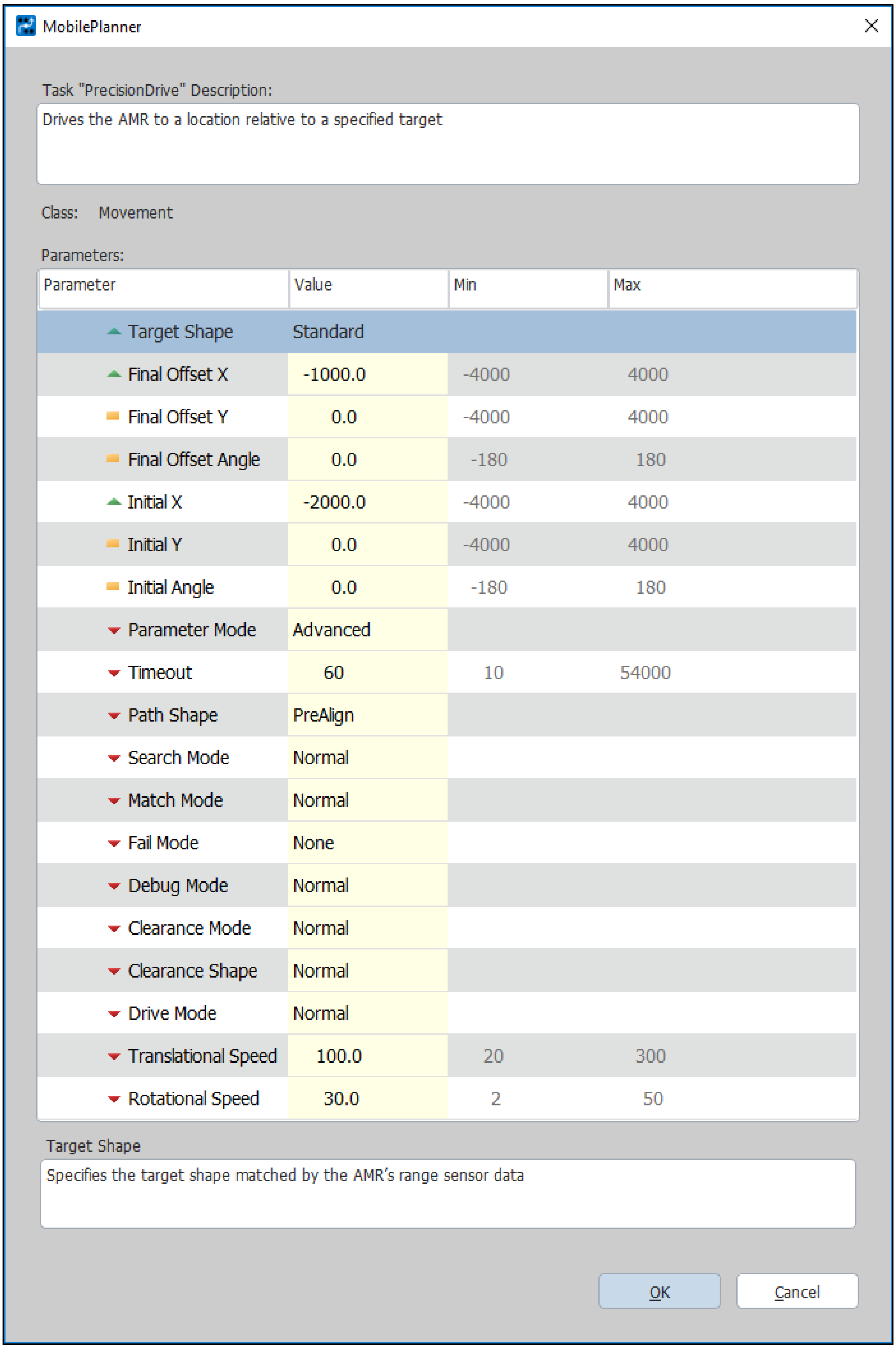


Figure 10-7. PrecisionDrive Advanced Parameters

Timeout

This sets the time before the AMR declares a timeout failure. The timer begins at the time the task first starts looking for the reference target. If the tasks has not reached the desired ending position before the specified time, the system will come to a stop, and signals failure of the goal task.

Path Shape

This parameter selected the desired path to the end position.

- PreAlign: This shape uses an arc-shaped path to first align with the vector path defined by the X,Y, and Angle Final position components, then follows the rest of the way moving straight with generally little or no final rotation required to achieve the desired final position. Some PreAlign moves may start and end with a straight path.
- Straight: This shape draws a straight line between the Initial position of the AMR and the desired Final location. In-place rotation at the beginning and end of the straight path is performed as necessary.

Search Mode

This parameter controls the amount of initial tolerance allowed. The general guideline is that larger tolerances are more likely to find a target, but more likely to choose the wrong item as the target. Smaller tolerances are more likely to fail to find a target, but less likely to choose the wrong target.

> **NOTE:** The Search coordinate frame is relative to the target, not AMR reference frames.

Mode	Tolerance		
	X	Y	Angle
Normal	500 mm	500 mm	15°
Wide	250 mm	750 mm	20°
Tall	750 mm	250 mm	20°
Minimum	200 mm	200 mm	8.5°
Max	750 mm	750 mm	30°
Rotation	350 mm	350 mm	45°

Match Mode

This parameter specifies how closely the laser data must match the selected TargetProfile.

- Normal: Balanced behavior between allowing for minor match errors with a reasonable guarantee that the target was correctly matched.
- Lenient: This behavior allows more error in the final line fit to decrease risk of failing the task due to sensor noise or poor geometry. This mode should only be used when the target is in open space to decrease the likelihood of an incorrect match.
- Strict: This behavior allows very little error in final data fit, but has a higher guarantee

that the target was correctly matched. This mode should only be used when incorrect target matches will have very detrimental effects on the application. Using this mode will result in more failed tasks, especially when operating large fleets as each scanning LIDAR has its own intrinsic errors and noise profiles that affect the final match quality.

Fail Mode

This parameter controls the different failure modes that would cause the task to immediately fail instead of attempting recovery to finish the task within the FailTime timeout.

FailOnSafetyStop: Any Safety stop (either from E-Stop buttons or Safety LIDAR) will cause the task to immediately fail.

Clearance Mode and **Clearance Shape**

These two parameters control how the AMR deals with obstacles (both real and virtual) that are detected in close proximity to the AMR.

Clearance Mode controls how the clearances behave.

- Normal: uses the default settings.

  Approach Distance = 400 mm away from sensed obstacles.

- Variable: allows two difference clearance sets to be used.

  Parameter **Clearance Switch Distance** controls when, during the task, the clearance switches from the initial clearance to the final clearance. This parameter is defined by the distance to the final location.

  This also allows control of the Approach Distance parameter.

- Custom: allows control of the Approach Distance parameter.

Clearance Shape is the clearance relative to the footprint of the AMR.

This parameter allows control over the size of the clearances around the AMR. All of the clearances are defined from the front, rear, and side edges of the AMR.

In general, clearances should be set to fairly low values (<100 mm). Clearances are a supplement to the Safety system but do not in any way replace the hardware Safety.

- Normal: Clearances sizes and definitions are set to give a good compromise between staying a safe distance away from the obstacle and still completing the required task.

Front Clearance	Side Clearances	Back Clearance
50 mm	75 mm	20 mm

- Tight: Clearances sizes and definitions are set to minimize likelihood of task failure. The AMR will be allowed to drive slowly past obstacles very close to the physical footprint of the AMR. Using this setting will result in fewer task failures, but an increased chance of failure upon leaving the area (AMR can get into a space that it may not be able to extract itself from).

Front Clearance	Side Clearances	Back Clearance
20 mm	20 mm	5 mm

- Expanded: Clearances sizes and definitions are set to maximize the likelihood of being able extract itself from the situation. The AMR will stop sooner due to the increased size of the clearances areas. Using this setting will result in more task failures, but an increased chance of success upon leaving the area (AMR will stay out of a space that it may not be able to extract itself from).

Front Clearance	Side Clearances	Back Clearance
100 mm	250 mm	20 mm

- Custom: You can specify the area around the AMR for obstacle protection while moving to the final location. These parameters are only visible when Clearance Shape is set to Custom. Refer to the following figure.

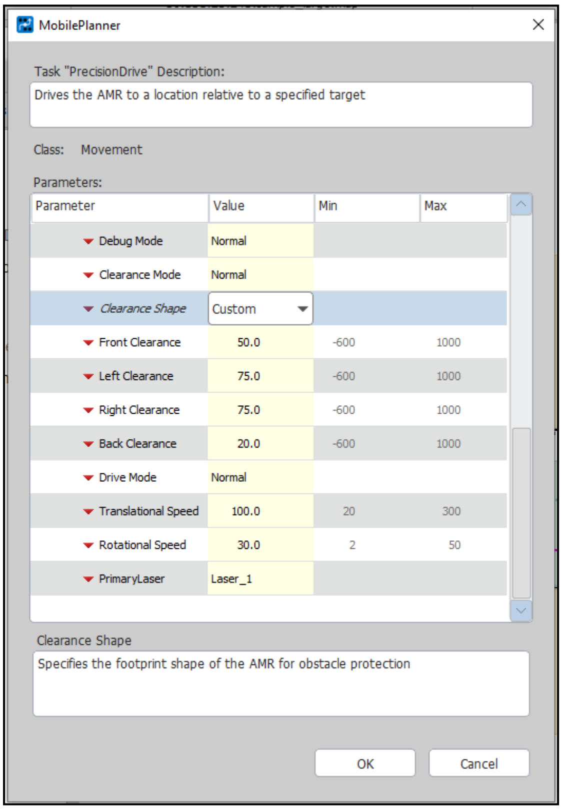


Figure 10-8. Clearance Shape Set to Custom

Allows control over Front, Left, Right, and Back Clearances.

Negative clearances (clearances that allow obstacles internal to the defined shape of the AMR) can also be programmatically set. Use with Caution!

PrecisionDrive Clearance Differences

NOTE: The clearances used in PrecisionDrive have a few key differences compared to other Clearance parameters within the FLOW Core software.

- The slowdown/stop behavior is different. The Approach Distance controls how far away the platform should stop instead of the Front Clearance (or Front Padding depending on the Task). This results in allowing smaller front clearances in most applications.

- Obstacles near the clearances but not within the clearances will cause the AMR platform to slow down.

Drive Mode

This parameter controls the driving behavior of the AMR.

- Normal: A balanced optimization giving the best all-around driving behavior.
- Precise: Minimizes Path and final error at the expense of being slower and with increased jitter in its motion.
- Fast: Minimizes time to goal at the expense of being less precise and increased jitter in its motion.
- Smooth: Minimizes motion jitter at the expense of being slower and less precise in its motion.

Table 10-1. Drive Mode Behaviors

	Precise	Fast	Smooth
Cycle Time	Increased	Decreased	Increased
Smoothness	Decreased	Decreased	Improved
Precision	Improved	Decreased	Decreased

Forward Speed

This parameter controls the maximum forward translation velocity that the AMR could achieve during the motion. This does NOT represent the speed at which it will complete the task - only the maximum. The Drive Mode will dictate the local speed based on the optimization chosen. Depending on the Drive Mode setting and the application, increasing this parameter may have no effect on the resulting motion.

Reverse Speed

This parameter controls the maximum reverse translation velocity that the AMR could achieve during the motion. This does NOT represent the speed at which it will complete the task - only the maximum. The Drive Mode will dictate the local speed based on the optimization chosen. Depending on the Drive Mode setting and the application, increasing this parameter may have no effect on the resulting motion.

Rotational Speed

This parameter controls the maximum rotational velocity that the AMR could achieve during the motion. This does NOT represent the speed at which it will complete the task - only the maximum. The Drive Mode will dictate the local speed based on the optimization chosen. Depending on the Drive Mode setting and the application, increasing this parameter will have no effect on the resulting motion.

OffsetCorrection

NOTE: This feature is only available to PrecisionDrive if there is a CAPS license activated.

MobilePlanner allows for the configuration of a custom offset for each AMR. The primary purpose is to compensate for minor mechanical tolerance differences between individual vehicles across a “uniform” fleet. Users should first verify that Laser_1 is well-aligned and in good condition before trying to use OffsetCorrection as a quick fix for a potentially larger problem.

> **NOTE:** This is a part of **MobilePlanner -> Robot Configuration -> Robot Physical**. It is not a part of the PrecisionDrive task.

Only one OffsetCorrection (X, Y, and Angle) is allowed for each AMR. This will be applied to all PrecisionDrive tasks for that AMR - it is not task- or target-specific. In most applications the overall approach and motion generally stay consistent and a single offset (if needed) is sufficient. The OffsetCorrection is added to the final position requested in the PrecisionDrive task (Final Offset X, Final Offset Y, and Final Offset Angle values). The OffsetCorrection values are relative to the target using the same coordinate reference frame for the Final Offset values as shown in Standard Target on page 190. For example, if the Final Offset X in the task is –1000, and the individual AMR needs to have a Final Offset X of –1005, Offset X for that AMR would be set to –5. The same approach is used for Offset Y and Offset Angle.

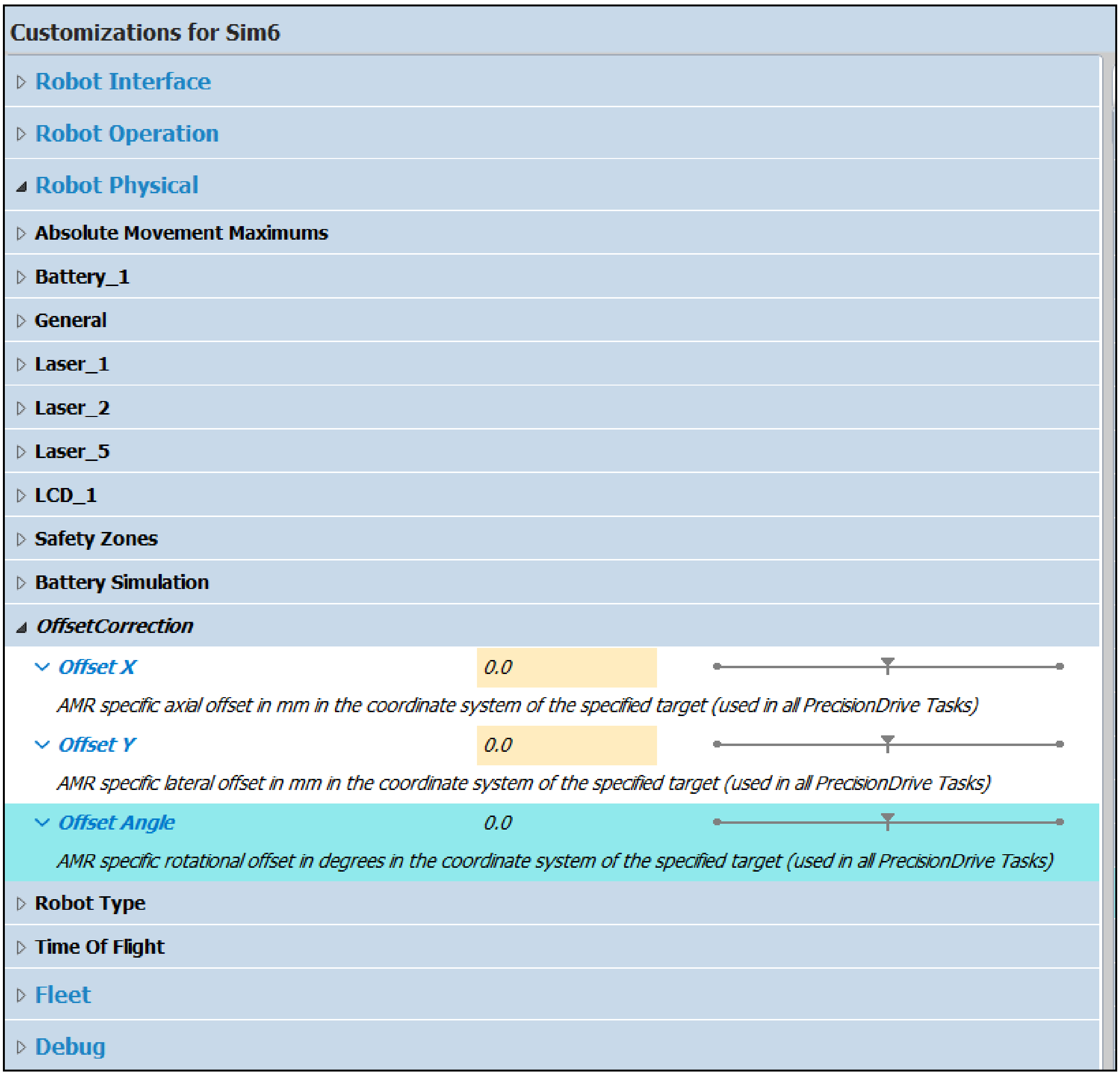


Figure 10-9. OffsetCorrection Parameters

The Descriptions of the Parameters shown in the preceding figure are in the following table:

Parameter	Description
Offset X	AMR specific axial offset in mm in the coordinate system of the specified target (used in all PrecisionDrive Tasks)
Offset Y	AMR specific lateral offset in mm in the coordinate system of the specified target (used in all PrecisionDrive Tasks)
Offset Angle	AMR specific rotational offset in degrees in the coordinate system of the specified target (used in all PrecisionDrive Tasks)

Standard Target

The target must be constructed to accurately reflect the dimensions shown below. The local flatness of the two segments and the 90° angle must be strictly observed for repeatable motion.

Notes for Drawing:

- All general tolerances ISO 2768 - Class M (Medium)
- Material: 5052-H32 Aluminum
- Finish: Paint matte gray. Option gray Cardinal X-Press polyester TGIC powder coat, P/N X041-GRW02871, 0.127- 0.254 mm thick (0.005 - 0.010 inches)
- debur and break all sharp edges between 0.10 mm - 0.25 mm max.
- Use minimum bend radius 1.5 max.

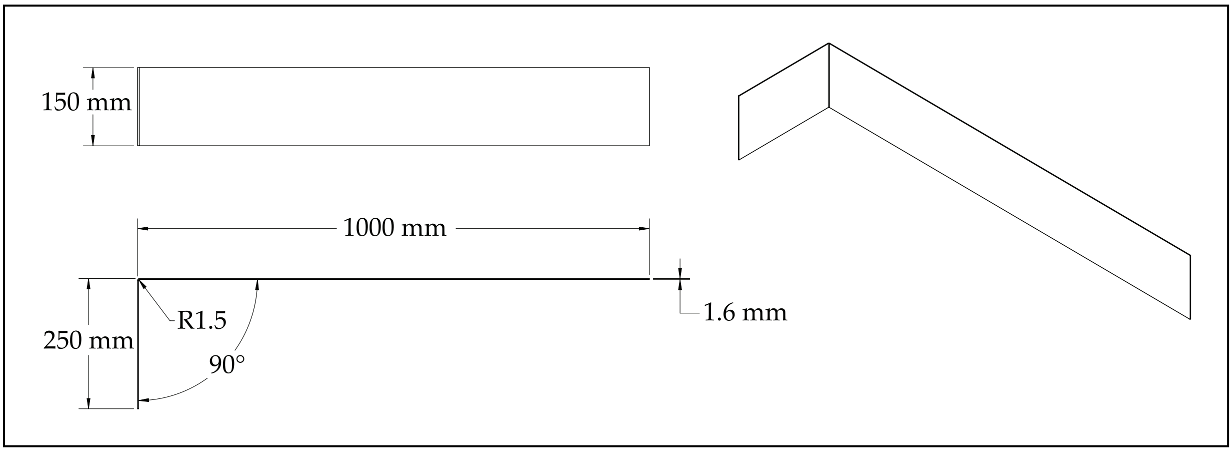


Figure 10-10. Standard Target

Target to Robot Coordinate Frame Transformations

These examples illustrate how to set the Initialn and FinalOffsetn parameters to achieve the desired behavior. The values shown by each AMR in the drawings represent the values that would be set in the PrecisionDrive task for each use case.

Example 1: The graphic below shows the results of a move with a MotionProfile of Straight, starting at (-2000, +250, Th 0) and moving to (-500, -500, Th 180). The AMR has to rotate in place at both the Initial and Final locations. The target is a Standard target. The AMR icons are for LD-250.

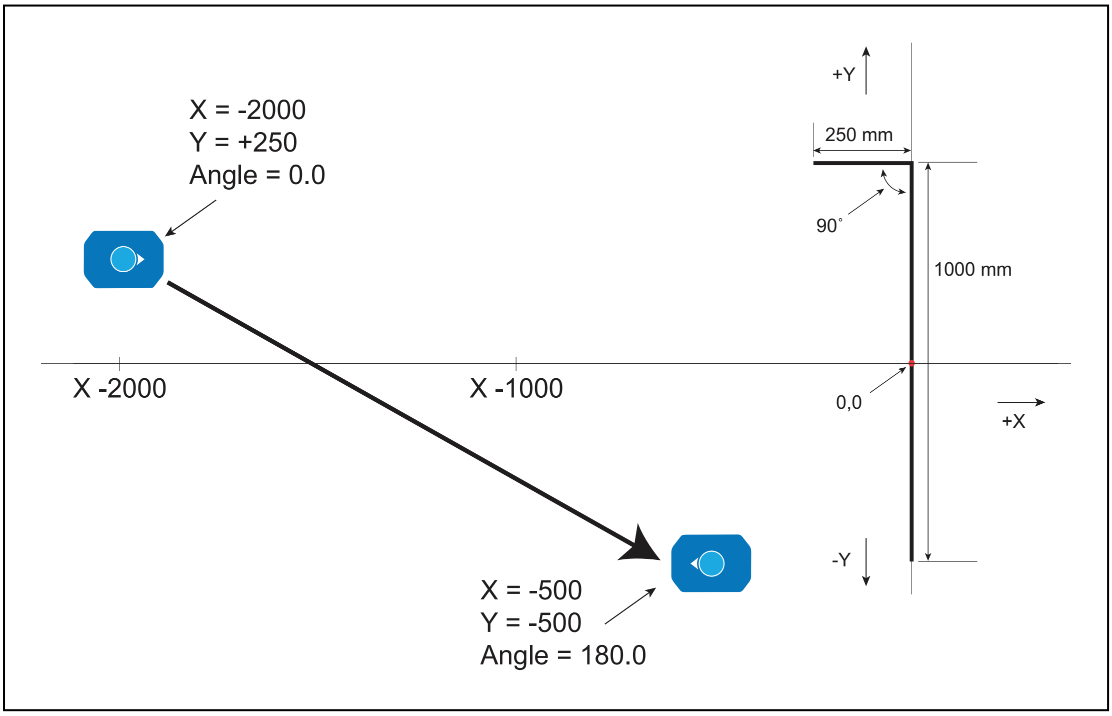


Figure 10-11. Straight Motion Profile

Example 2: The graphic below shows the results of a move with a MotionProfile of PreAlign, starting at (-2000, -500, Th 0) and moving to (-500, 0, Th 90). The AMR only turns for a part of the path. The target is a Standard target. The AMR icons are for LD-250.

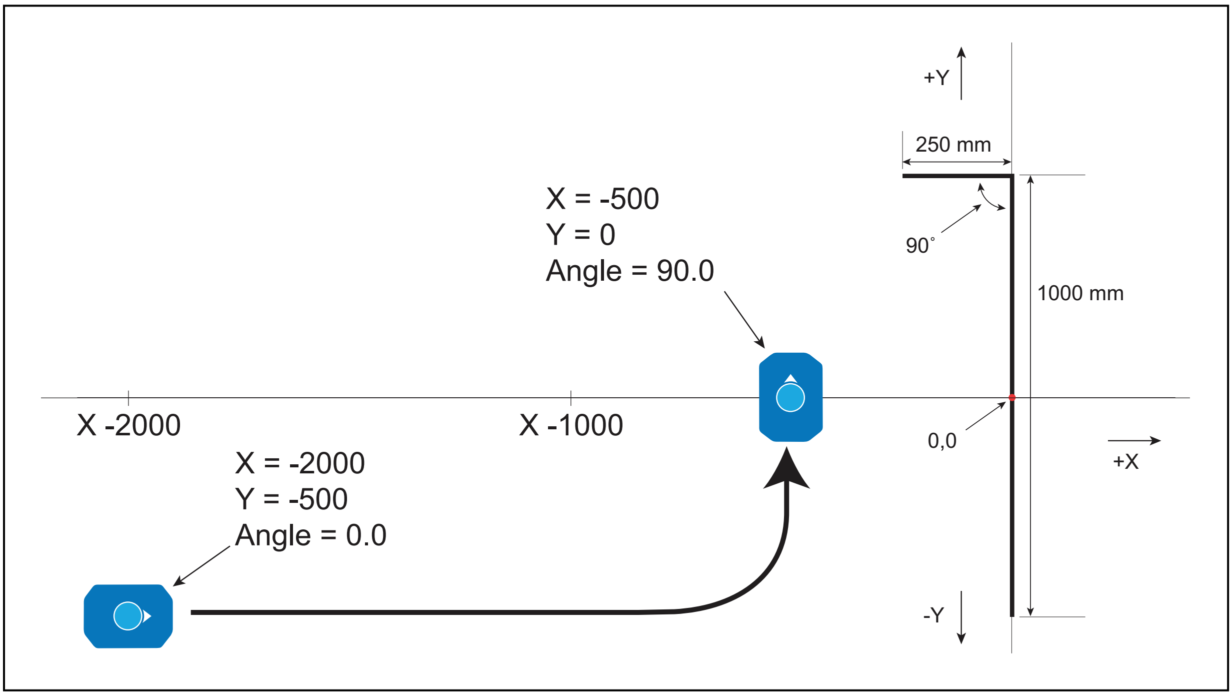


Figure 10-12. Prealign Motion Profile

CAPS License

CAPS is a licensed feature, and requires a license key file that must be loaded onto the AMR before CAPS takes effect. Licenses are granted to individual AMRs, minimizing cost by applying this feature only to those AMRs that require the higher accuracy it provides. Contact your local OMRON representative for instructions on ordering and obtaining the license key files for this feature.

The PrecisionDrive task can be used with or without a CAPS license. If PrecisionDrive detects a CAPS license, its alignment accuracy will improve significantly.

With or without the CAPS license, the setup, configuration, and use of PrecisionDrive does not change. With the license, the accuracy improves. The CAPS license is P/N 20271-805.

> **NOTE:** The TriangleDrive version of CAPS is legacy but can still be used if a CAPS license is detected. Contact your local OMRON representative.

The relative alignment accuracy of OMRON AMRs, with and without these features, is presented in the following table:

Table 10-2. FLOW Core Goal Alignment Features

Feature	Alignment Accuracy	Condition
Standard	± 100 mm	Standard FLOW Core Feature
PrecisionDrive without CAPS license	± 25 mm ± 2.0°	Standard FLOW Core Feature
PrecisionDrive with CAPS license	± 8 mm ± 1.0°	Licensed Feature (CAPS)
High Accuracy Position System (HAPS)	± 10 mm	Not licensed, requires optional hardware (sensors) to work

Using Speech and Sound Tasks

Speech and sound tasks control the AMR's audio. As the AMR navigates the operating space, it can (for example) play a sound file while driving, make a noise to alert anyone in the area that it is entering a room, or announce what task it intends to perform next.

The speech and sound tasks combine instant and non-instant tasks, as shown in the following table.

Instant Tasks	Non-instant Tasks
• playInstant • sayInstant • sendSoundInstant • sendSpeechInstant • playBackgroundSound	• play • say • sendSound • sendSpeech

Instant tasks send audio to the AMR as it continues on its path. Non-instant tasks cause the AMR to wait until the speech or sound is done playing. For example, if you want the AMR to announce that it is entering a room and then wait for a moment to allow people to get out of its way, use the **say** task rather than the **sayInstant** task.

The AMR speaks **say** tasks with a computerized voice. **Play** tasks play a sound file on the AMR. **Sound** tasks encode a file from the AMR and send it out to all MobilePlanner instances connected to that AMR.

To Use Speech and Sound Tasks

NOTE: Speech and sound tasks are normally enabled by default.

1. Click the **Config** Button, then click on the **Robot Interface** tab, then click on **A/V Config**, and enable the **Audio** parameter (click the checkbox). For more details, refer to Configuring the AMR on page 154.
2. For sound tasks, ensure that the sound file is stored on the AMR. You can use **File > Upload/Download**.
3. Click the **Map** Button, then click the **Build** tab.

   NOTE: Ensure that **Show Robot** is OFF, or you will not be able to draw or edit objects in the map pane.

4. In the Source Lists pane, click the Robot Tasks tab to view tasks currently available on the AMR.
5. Add the speech or sound task to the goal, route, or macro. For details, see Assigning Tasks on page 172.
6. Enter the parameter values for the assigned task. If using a **speech** task, enter the text for the AMR to speak in the **Value** field. If using a **sound** task, enter the name of the sound file in the **Value** field. If needed, click the **Browse** Button to search for the sound file.
7. Click **OK** to accept the parameter value and save any changes.

Using Sound Files with Tasks

Both the **play** and **sound** tasks use sound files. **Play** tasks play a file on a specified AMR. *Sound* tasks encode a file from the AMR and send it out to all the MobilePlanner instances connected to that AMR.

All sound files must be in AIFF WAVE (.wav files), .ogg files, or MP3 format.

Additional Information: Audio files with an encoded volume over 0.5 dB can cause playback issues when played at high volumes on the AMR. If playback issues occur, lower the AMR's playback volume or check the encoded volume level of the audio file and reduce if it is over 0.5 dB.

Adjusting the Audio

You can use the MobilePlanner software to adjust the audio input and output (if turned ON), and adjust both the software and AMR audio using the audio slide bars.

1. Click the **Map** Button from the main window to display the map window.
2. Click the **Monitor** icon to display the list of available items to monitor (see below).

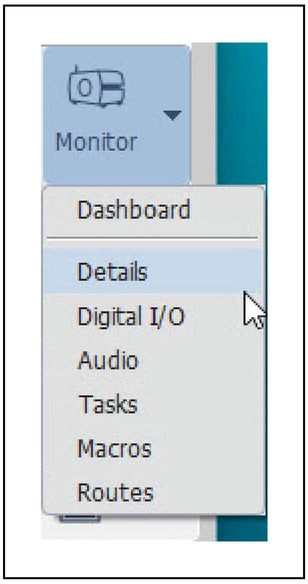


Figure 10-13. MobilePlanner Monitor Drop-down Menu

3. Click **Audio** to display the Audio dialog.

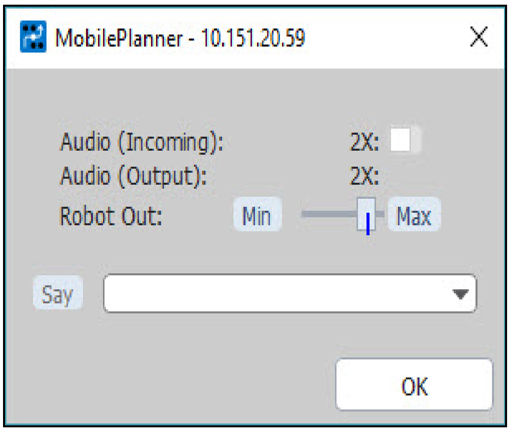


Figure 10-14. MobilePlanner Audio Dialog Box

4. Click on the slider bar and drag it left or right to adjust output volume.
5. If desired, you can enter a text string the AMR will speak (when configured to do so).
6. Click **OK** when done.

Accessing and Adjusting the Audio Parameters

Click **Config > Robot Interface > A/V Config** to display audio and video parameters.

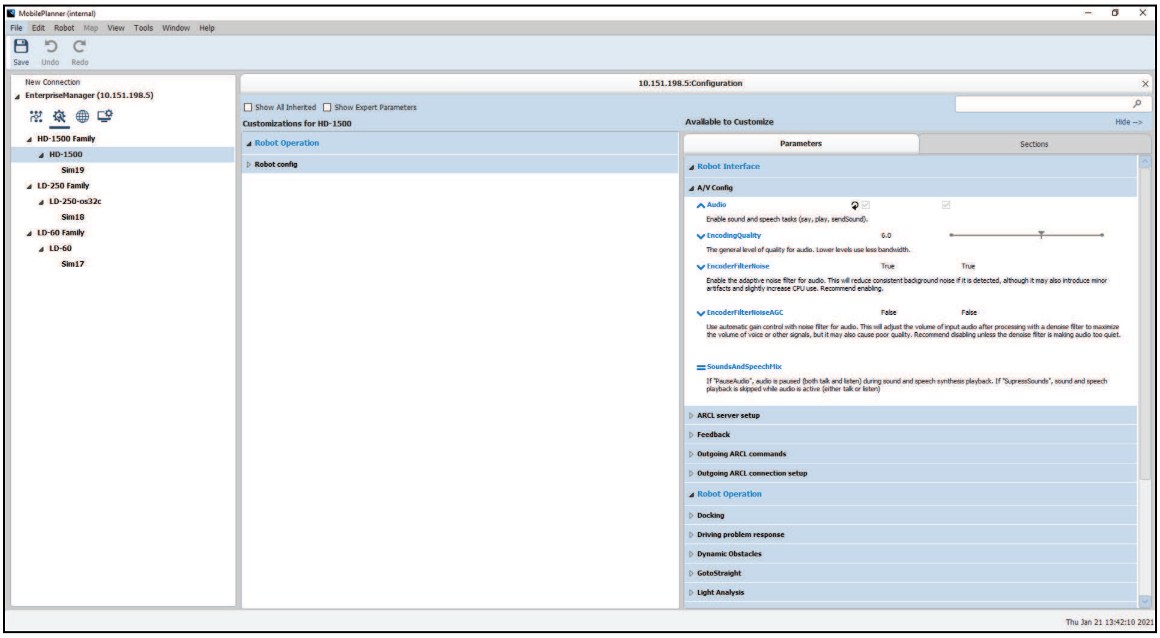


Figure 10-15. MobilePlanner A/V Configuration Page

I/O Tasks - LD-series AMRs

Digital Input/Output (I/O) provides an interface between the AMR’s equipment and sensors and the payload which often requires power (I/O inputs and outputs can, for example, control conveyor rollers). If you have an AMR with a conveyor payload aboard, you can use digital I/O to turn the rollers ON and OFF, check sensor inputs, and execute one or more macros based on a tote’s location (whether the tote is on the AMR’s conveyor or on the feed conveyor).

The LD-60, LD-90, and LD-250 AMR cores provide 16 digital inputs and 16 digital outputs, and have a User Interface connection for creating custom user interfaces with the AMR’s E-Stop, ON, OFF, keyswitch, and brake-release buttons.

With MobilePlanner, you can:

- Configure core digital inputs and outputs, and give these inputs and outputs aliases which make it easier to use them when needed.
- Create custom I/O tasks that turn payload power on or off to activate automatically-toggled proximity sensors.
- Detect single inputs and execute specific macros.

Using I/O Tasks

Custom inputs and outputs are digital inputs, outputs, and peripheral power outputs. You make them **custom** by setting their input type to custom and (optionally) giving them an alias.

> **NOTE:** Making theses tasks **custom** allows them to be shown in the MobilePlanner I/O window, as well as in the optional Touchscreen.

1. Click **Config > Robot Interface > Core Digital Inputs** (or **Core Digital Outputs**).
2. Configure the devices, then click **Save**.

3. In MobilePlanner's main menu, click **File > Open** to open the map you want to edit.

   NOTE: Ensure that **Show Robot** is **OFF**, or you will not be able to proceed.

4. Click the **Map** Button, then click the **Build** tab.
5. In the **Source Lists** pane, click the **Robot Tasks** tab to view the tasks currently available on the AMR.
6. Add the task to the route, goal, or macro. See Assigning Tasks on page 172 for details.

Digital Inputs

To configure the digital inputs, click **Config > Robot Interface**.

Tasks: customInputsCheckAll and customInputsCheckAllInstant

These tasks check whether all specified custom inputs trigger and properly execute a macro.

Parameters	Description
timeout	Duration (in seconds) to check the custom inputs.
timeoutMacro	Macro to invoke if no inputs are triggered before the timeout.
triggerMacro	Macro to invoke if all inputs are triggered before the timeout.
input<n> n = 1 to 8	Names of the custom inputs to check. Prefix the names with '!' to check the inverted value.

Tasks: customInputsCheckAny and customInputsCheckAnyInstant

These tasks check whether any of the specified custom inputs trigger and properly execute a macro.

Parameters	Description
timeout	Duration (in seconds) to check the custom inputs.
timeoutMacro	Macro to invoke if no inputs are triggered before the timeout.
triggerMacro	Macro to invoke if any of the inputs are triggered before the timeout.
input<n> n = 1 to 8	Names of the custom inputs to check. Prefix the names with '!' to check the inverted value.

Tasks: customInputsCheckEach and customInputsCheckEachInstant

These tasks check the custom inputs and executes a particular macro for each triggered input (on only if 'tasksForBetterCustomIO' is ON).

Parameters	Description
timeout	Duration (in seconds) to check the custom inputs.
timeoutMacro	Macro to invoke if no inputs are triggered before the timeout.
input <n> n = 1 to 8	Names of the custom inputs to check. Prefix the names with '!' to check the inverted value.
input <n> macro n = 1 to 8	Macro to invoke if input <n> is triggered before the timeout.

Digital Outputs

To configure digital outputs click **Config > Robot Interface**.

Task: customOutputOff

This task turns off the specified custom output.

Parameters	Description
output	Name of the custom output to turn OFF.

Task: customOutputOn

This task turns on the specified custom output.

Parameters	Description
output	Name of the custom output to turn ON.

I/O Tasks - HD-1500 AMRs

If I/O tasks need to be configured for the HD-1500 AMR, contact your local OMRON representative.

Setting Up Special Tasks

Special tasks allow you to define custom responses to events that the AMR might encounter. You can set up and use tasks for the AMR to perform in certain situations, such as when entering certain areas, before or after docking, or at every goal. Special Tasks can also be used as attributes for coordination between specific AMR sub-groups and map objects.

The Special Tasks below are detailed in the following sections:

- Custom Responses.
- Custom Tasks.
- Performing a task before or after every goal.
- Performing a task at a dock.
- Queuing Manager tasks.

NOTE: Special events don't have to be unusual. Going to a Goal or Point can be a special event.

To Customize AMR Operation:

1. In MobilePlanner, click the **Map** Button, then click the **Build** Tab.
2. In the Editable Lists pane, click on the **Special** tab.

   Since you cannot assign a goal to a Special task, the Goals tab is grayed out. Also, selecting one of the special events in the Special tab only enables instant tasks. All custom responses have to be instant, but other lists in this tab can allow non-instant tasks.

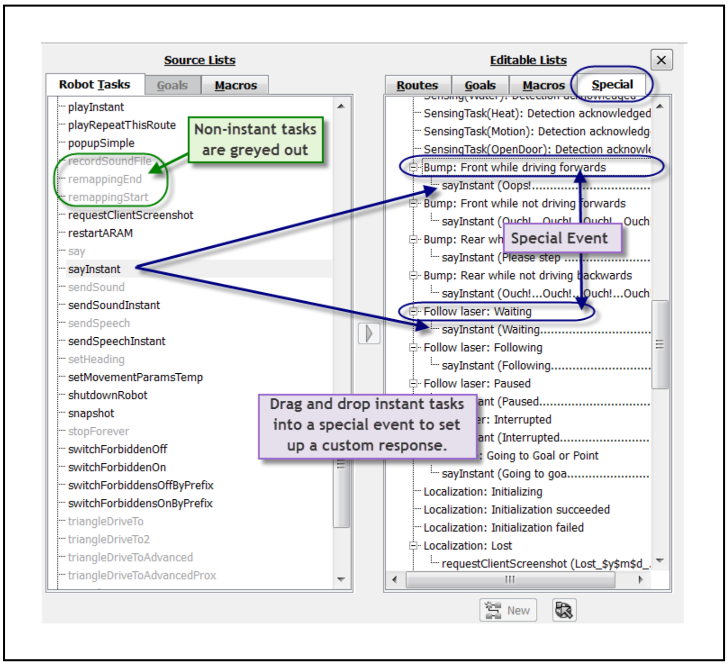


Figure 10-16. Build Tab Lists - Details

3. In the Source Lists pane, highlight a task from the **Robot Tasks** tab and drag it to the desired special event in the **Special** tab.

   NOTE: Most custom responses (e.g., Dock responses) have to be instant; all others can be non-instant.

Custom Responses

You can customize the AMR's operation using the Custom Responses found in the Special tab. The predefined conditions or events that trigger a custom response include:

NOTE: The following list is not an exhaustive list. The Custom Responses defined for a particular AMR depend on the parameters that you enabled or disabled. For configuration details, see Setting the Configuration Parameters on page 157.

- Fault responses.
- Localization.
- Path Planning (Failed, replanning).
- 'sayInstant' tasks (such as 'excuse me').

- Bumping into something (has four sub-events, based on what the AMR is doing when the bump occurs).
- Map Creation (has two sub-events, for starting and stopping a scan).
- Patrolling a route (has four sub-events).

Using custom responses, you can make the AMR talk when it encounters one of these events, and tell the people around the AMR what to expect.

All custom responses must contain instant tasks, such as *sayInstant*. Although the conditions that trigger a custom response are predefined for the AMR, you can customize the AMR's operation by adding one or more instant tasks to these events. For example, if the AMR bumps something in front of it, the AMR can respond appropriately (for example, the AMR could speak a phrase when it bumps into something).

Events automatically trigger the custom responses that make the AMR respond to its environment.

If there is no task associated with a specific Custom Response, the AMR will not do anything special when that condition occurs.

Custom Tasks

Custom Tasks allow AMRs to filter their recognition of objects on the map for more fine-tuned control of fleet movements. Custom Tasks are set for both the AMR and for goals on the map. Once a Custom Task has been applied to a goal, only AMRs that also have the Custom Task will accept pickup or dropoff jobs at the goal. In this way, Custom Tasks can be used and implemented like a label or tag that designates specific goals and AMRs on the fleet as compatible with each other. Goals with no Custom Task applied will still be compatible with all AMRs in the fleet.

Custom Tasks are assigned to an AMR in *Configuration*, and are a subset of Instant Tasks. When assigned to an AMR family, Custom Tasks are inherited to all AMRs lower in the fleet hierarchy level. Custom Tasks can only be added to AMR groups at lower fleet hierarchy levels, not removed.

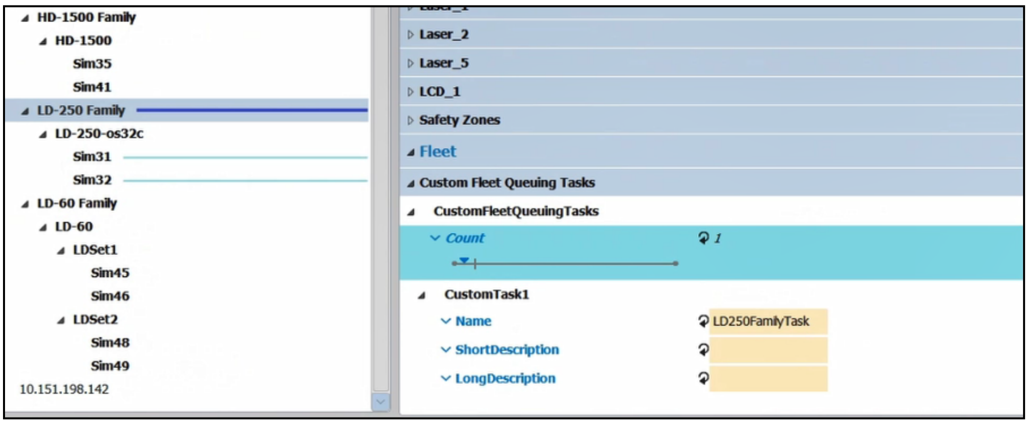


Figure 10-17. Custom Task applied to AMRs in the fleet hierarchy

Custom Tasks are assigned to goal objects on the map in the *Editable Lists* pane. Tasks can be applied to goals in either the Before Goal or After Goal lists. Once a Custom Task is applied, only AMRs in the fleet that share this Custom Task will recognize the goal.

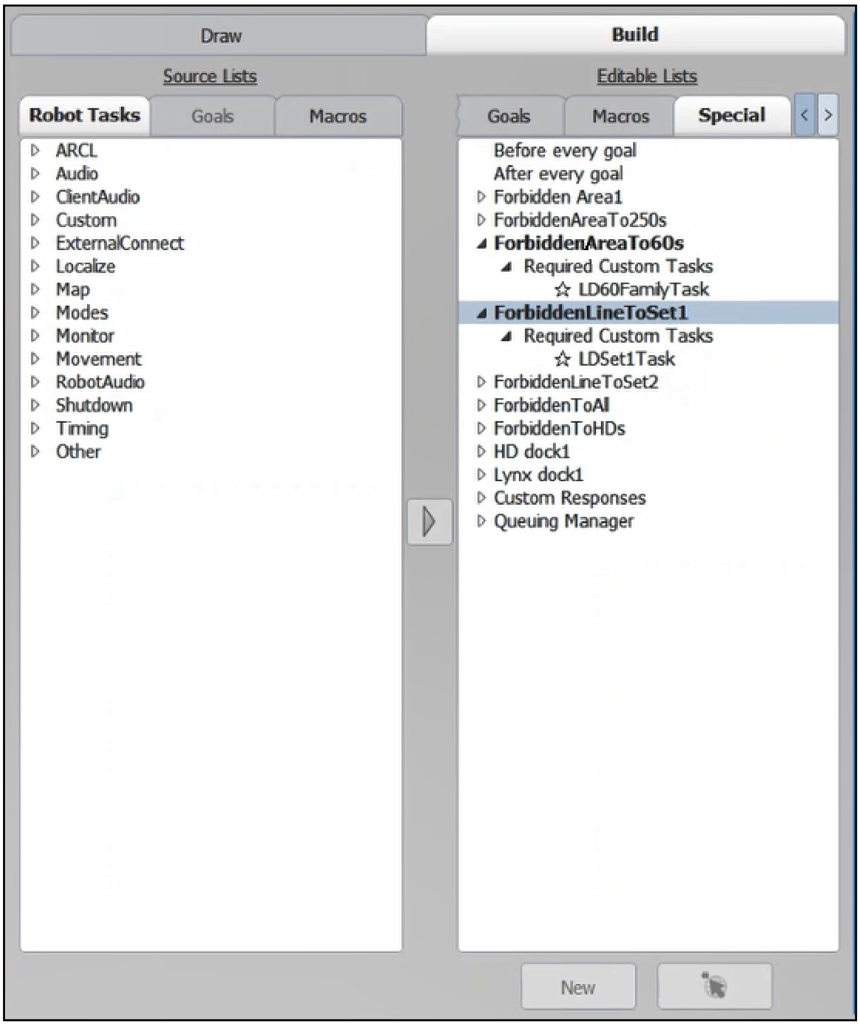


Figure 10-18. Custom Task applied to a map object in the Build Tab

Required Custom Tasks

Required Custom Tasks are an extension of Custom Tasks for other types of map objects, beyond goals. For example, specific AMRs can be configured to recognize and respect cetain forbidden zones that other AMRs would be able to move through unimpeded. Required Custom tasks can also be used with path planning to establish different behaviors between AMR groups, like setting different clearances for LD-60 and LD-90 AMRs.

Required Custom Tasks can be added to most map objects that apply to individual AMRs, including forbidden areas, path planning sectors, and movement parameter sectors. They are not supported by map objects that are used by the Fleet Manager to coordinate multiple AMRs, such as managed motion sectors and single robot sectors. If a map object has a non-empty name and supports Required Custom Tasks, then the map object is added to the Special tab.

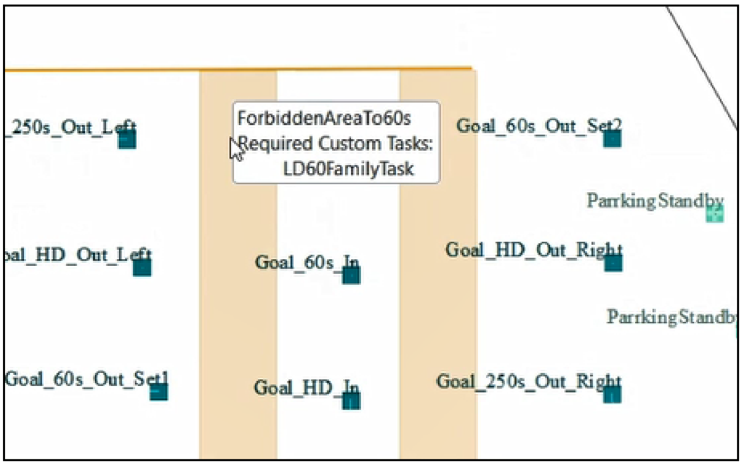


Figure 10-19. Tooltip display showing Required Custom Task on a map object

Performing a Task Before/After Every Goal

Special tasks can include instant and non-instant tasks the AMR performs before the AMR departs for a goal or after it reaches any goal.

Drag instant tasks from the Source Lists pane to either event in the Special tab in the Editable Lists pane.

> **NOTE:** You can override these tasks for specific goals within specific routes by un-checking the before/after this goal checkbox.

Performing a Task at a Dock

Special tasks can include instant tasks the AMR performs when docking. The AMR already has a set of defined docking events, including:

- Forced dock
- Idle dock
- Requested dock
- Driving to dock
- Driving into dock/docked
- Dock now unforced
- Dock now forced
- Undocking/undocked

You can add instant tasks to these docking events (e.g., have the AMR announce it is going to dock because it is 'idle.'). Drag instant tasks from the **Source Lists** pane to the appropriate event in the Special tab in the **Editable Lists** pane.

Queuing Manager List

AMRs can perform a variety of special tasks when they reach goals. For example, you can use the JobTypeCheck task to specify different macros depending on whether a goal is pickup, dropoff, or neither. Other examples of special tasks include:

- Before/After Pickup
- Before/After Dropoff

Drag instant tasks from Source Lists to a queue-related event in the Special (Editable Lists pane).

Editing a Special Task in the Editable Lists Pane

1. Right-click on the task you want to edit.
2. In the pop-up window, click **Edit**.

   If the task has associated parameters, the following dialog box opens:

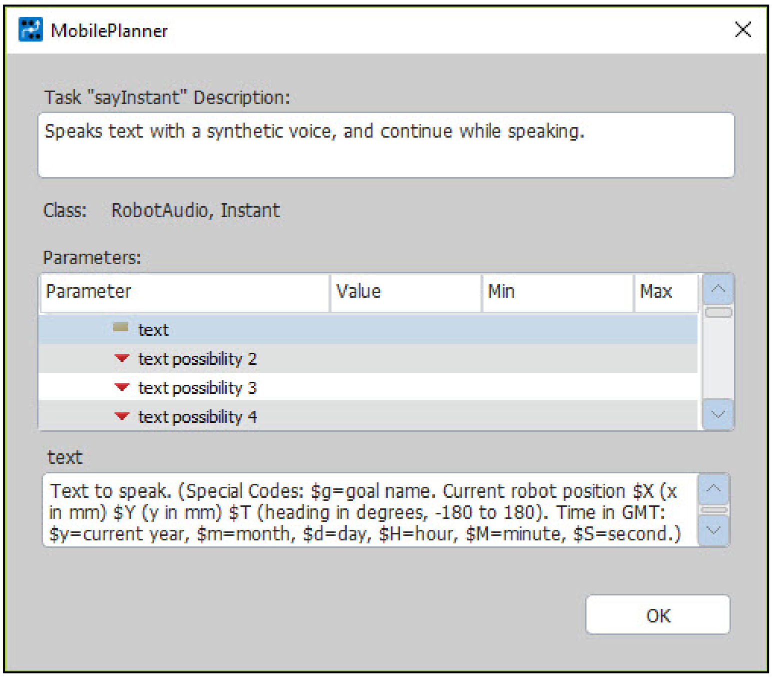


Figure 10-20. MobilePlanner Parameter Description Dialog

   Click in the **Value** field to add and edit the parameter's value . Click on a parameter to see its description.

3. Click **OK** when done.

Copying a Special Task from the Editable Lists Pane

1. Right-click on the task you want to copy.
2. In the pop-up window, clicking **Duplicate** creates a copy of the task.
3. Drag the copied task anywhere within the current tab.

Deleting a Special Task from the Editable Lists Pane

1. Right-click on the task you want to delete.
2. In the pop-up window, click **Cut** (or press the **Delete** key) to remove the selected task.

Editing a Task

To edit a task, from the Editable Lists pane:

1. Right-click on the task you want to edit.
2. In the pop-up window, click **Edit**.
3. Click inside the Value field to edit the value for each parameter.

NOTE: You can reorder or move tasks to another goal/macro/route by dragging them there.

Copying a Task

To copy a task, from the Editable Lists pane:

1. Right-click on the task you want to copy.
2. In the pop-up window, clicking **Duplicate** adds a copy of the task.
3. Drag the copied task to any position within the current tab.

Deleting a Task

To delete a task, from the Editable Lists pane:

1. Right-click on the task you want to delete (or click, the press the Delete key).
2. In the pop-up window, clicking **Cut** removes the selected task.

10.2 AMR Jobs Overview

Jobs are basic activities for the AMR(s) to execute. ARCL and protocols within the Integration Toolkit (ITK) can send job requests to the Fleet Manager for assignment to an AMR.

NOTE: Jobs are the recommended method for commanding the AMR or fleet of AMRs.

Jobs typically have one or two job segments (if queueMulti is enabled). All segments are classified either as PICKUP or DROPOFF.

- **PICKUP:** A PICKUP job request tells the Fleet Manager that any available, appropriate AMR can be assigned a PICKUP task.
- **DROPOFF:** A DROPOFF job request tells the Fleet Manager that only a specific AMR can be assigned a DROPOFF task.

Once the Fleet Manager receives the job request from ARCL or the ITK, it assigns a job ID and unique job segment ID (or, you can optionally assign a job ID).

Job Priorities

MobilePlanner prioritizes submitted job requests either by Non-First-In-First-Out (Non-FIFO) or First-In-First-Out (FIFO) priority. The requestor can specify the job priority, or jobs can use the default value for queuePickup, queuePickupDropoff, and queueDropoff commands. You can enable this in **Config > Fleet tab > Fleet Features**, *FleetQueuingConsumptionMethod.*

- **Non-FIFO:** Non-FIFO executes the highest priority jobs first, followed by lower priority jobs. Its goal is to minimize the AMRs' driving distance.
- **FIFO:** In FIFO, the system prioritizes jobs by which was submitted first, second, and so forth.

The default PICKUP priority is 10, and the default DROPOFF priority is 20. You can expedite a job by raising the pickup priority, while keeping the dropoff priority the same. For example,

- queuePickupDropoff goal1 goal2 10 20
- queuePickupDropoff goal3 goal 4 10 20
- queuePickupDropoff goal5 goal6 11 20

If you queued all of the above jobs at the same time, the third job's higher priority means the AMR will execute the third job before jobs 1 and 2. Otherwise, job1 or job2 will start.

Job vs. Job Segment

All submitted jobs carry a specific JobID (also referred to as the "job). Each part of a job is a 'job segment,' even if the job has multiple parts to it (for example, a Pickup-Dropoff sequence).

Custom Job ID

MobilePlanner uses the jobID to track the status of a request. A job ID must be unique among active jobs. Active jobs can share a jobID with previously completed or cancelled jobID still in the system. You can use a custom job ID that matches some other information in your automation system when submitting the pickup or pickupDropoff request.

Basic Job Commands

The following are some basic example job commands:

- "queuePickup goal1": submits a request to send any available AMR to "goal1."
- "queuePickupDropoff goal1 goal2": requests that any available AMR first drives to "goal1," then, once completed, drives to "goal2."
- "queueCancel jobid JOB7": immediately cancels job7, regardless of whether an AMR is performing that job.

Basic Job-Supporting ARCL Commands

The following ARCL commands support job queuing:

> **NOTE:** In ARCL command syntax, commands are not case sensitive, values in angle brackets < > are required, and values in braces [ ] are optional. Refer to the *Advanced Robotics Command Language Reference Guide (Cat. No. I617)* for more information.

- queuepickup <goal_name> [priority] [job_id]
- queuepickupdropoff <PICKUPgoal_name><DROPOFFgoal_name> [PICKUPpriority]

[job_id]

- queuecancel <canceltype> <cancelvalue> [echo_string] [reason]
- queuedropoff <goal_name> [priority] [job_id]
- queuequery <querytype> <queryvalue> [echo_string]
- queueshow [echo_string]

Refer to the Fleet Operations Workspace Core Integration Toolkit User's Guide (Cat. No. I637) for information about using RabbitMQ, REST, or SQL to submit jobs.

10.3 Using the Route Builder

With MobilePlanner Route Builder, you can set up tasks for the AMR to perform and goals for it to drive to. You can also customize AMR operation and build routes for the AMR to follow. All of this information is embedded into the map file. Once you download the map file to the AMR, you can use MobilePlanner to drive the AMR in its operating environment, and perform tasks.

NOTE: Jobs are preferred over routes in industrial environments.

Use the Route Builder to set up the following:

- **Tasks:** Activities that the AMR can perform, such as going to a goal or checking sensors. Tasks give the AMR useful work to perform. These tasks are already available on the AMR, but need to be defined and associated with the map that you are creating.
- **Goals:** Virtual destinations that the AMR drives to in its environment. These goals are defined in the map, and represent real-world places in the operating environment.
- **Macros:** Containers for sequences of tasks and goals. Once these macros are created, you can select the macro, rather than all of the individual tasks and goals, for the AMR to perform. You only have to define a macro once, but can use it as many times as necessary. You can also use macro templates, which are special macros that can accept simple parameters. You define parameter types when you create a new macro template, and specify the values when you use the template in another macro, route, etc.
- **Custom responses:** Actions such as making the AMR talk (e.g., when its path is blocked, fails the path, or does global replanning, etc.), performing a particular or sequence of tasks at all goals, when docking, or when a special event (such as a bump or E-Stop) occurs.
- **Routes:** A "to do" list or a series of tasks, goals, or macros for the AMR to follow. An AMR can execute a route continuously, unlike macros.

The Route Builder Interface

MobilePlanner’s Route Builder allows you to set up macros, tasks, goals, and routes for the AMR to follow.

Click the **Map** Button, then click the **Build** tab.

The Route Builder (Build tab) appears in the window, as shown in the following figure.

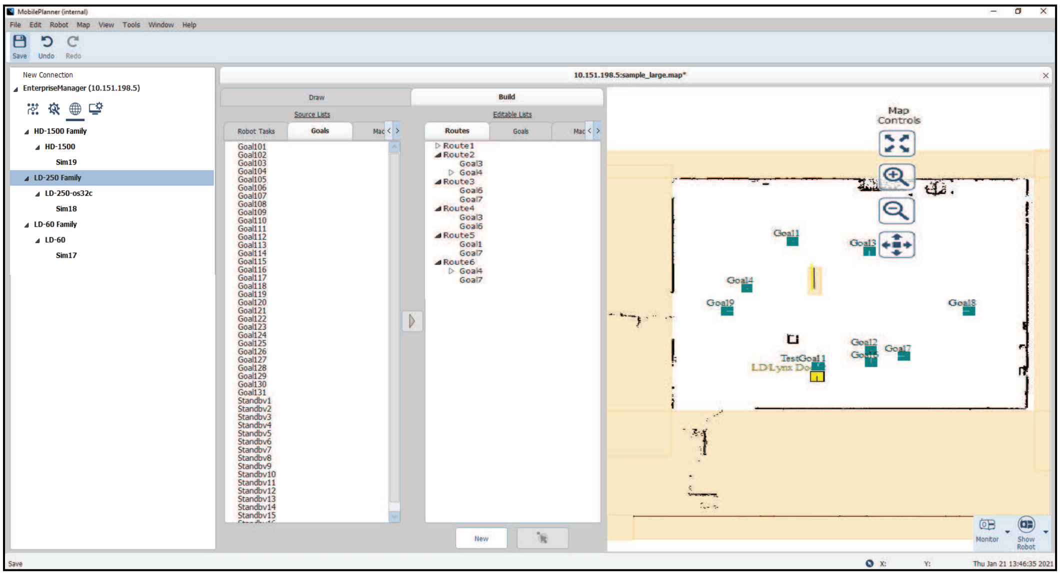


Figure 10-21. The MobilePlanner Map Workspace with the Route Builder Open

The Route Builder Elements

The Route Builder has two panes: Source Lists and Editable Lists. Each section uses tabs to switch between the different available options.

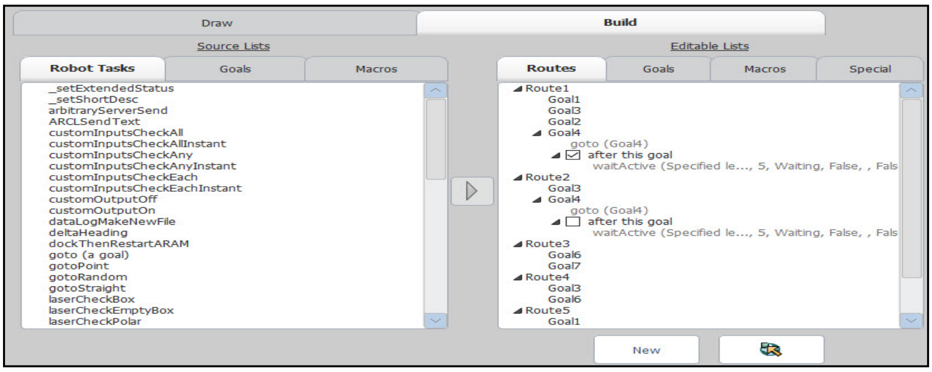


Figure 10-22. The Route Builder Elements

The Source Lists pane lists available AMR tasks, goals, and macros you can add to new routes, goals, macros, and special tasks.

The Editable Lists pane displays routes, goals, macros, or special tasks. The tabs allow you to switch between the different types of objects that you can build.

You can drag Source Lists objects into any of the Editable Lists routes (or macros) you are working on, or use the arrow icon between the lists.

Source Lists: Robot Tasks, Goals, and Macros Tabs

The tabs in the Source Lists pane display the tasks, goals, and macros you can use in building new routes, adding tasks to goals, and building macros and special tasks.

NOTE: Some of the Robot Tasks listed below need to be specifically enabled by clicking the **Config** Button, then clicking the **Robot Operation** tab, and the **Task Features** section.

- **Robot Tasks:** Lists the tasks available for creating new objects (routes, macros, etc.) on the map. Tasks are AMR and accessory-related operations, such as moving the AMR, talking, or playing a sound. These tasks are already available on the AMR, however you must include them in one of the Editable List items for the AMR to know when and where to perform them. For more information on using tasks refer to AMR Tasks on page 172.
- **Goals:** Lists the goals available for creating routes or macros. Goals are locations on the map that are destinations for the AMR. For more information on using goals, see Creating and Adding Goals and Docks on page 108.
- **Macros:** Lists available macros which you can add to tasks or goals. Macros are reusable containers for multiple tasks. For more information refer to Creating Macros on page 210.

For detailed information about a task, goal, or macro, right-click on the item and select **Description**.

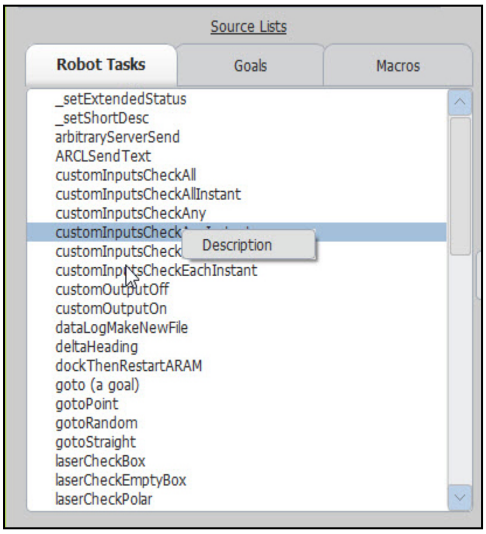


Figure 10-23. Accessing the Task Description

Click on the task parameter to read a brief description of the selected task. The figure below shows an arbitraryServerSend task. To set up different tasks and their parameters, refer to the specific task (Using Audio Tasks, for example).

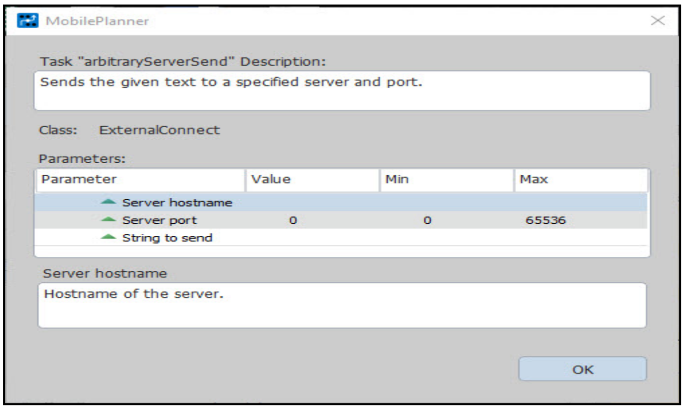


Figure 10-24. arbitraryServerSend Task Description

Editable Lists: Routes, Goals, Macros, and Special Tabs

- **Routes:** Lists created routes, and allows you to build new routes. For details, see Creating Routes on page 218.
- **Goals:** Lists created goals or destinations. You can add tasks for the AMR to perform at the specified goal. For more information on using goals, refer to Creating and Adding Goals and Docks on page 108.
- **Macros:** Lists created and defined macros, and allows you to create new macros. Refer to Creating Macros on page 210 for more information.
- **Special:** Used to customize AMR operation. Custom tasks allow you to have the AMR perform certain activities at every goal or at a dock. They also allow you to program the AMR to take special actions when specific events happen. For more information, refer to Setting Up Special Tasks on page 197.

Macros

Macros are reusable sequences of tasks that have their parameters set when you add them to the macro. So every time you use a macro, the tasks inside use the same settings. Macros are extremely effective if you have groups of tasks that you need to repeat in multiple places.

For example, you might have an AMR delivering parts to various places. At each of the multiple delivery locations, it needs to navigate to each, pause, announce its arrival, wait for the part recipient to retrieve the part, then move on to the next delivery site. Instead of manually programming each of these tasks at each goal, you can use macros to replicate this same functionality across multiple goals.

You can create macros in Editable Lists (in the Build pane) by clicking the **New** Button. Then, drag the appropriate tasks from the Robot Tasks list (under Source Lists) into the macro in the desired point. After adding the tasks to the macro, you can reorder and reconfigure them as needed.

Macro Templates

Macro templates are simple, text-only features for adding simple parameters to macros. Allowed parameters for macro templates are named $1 to $9. They do not allow variables or expressions.

To create a macro template, click the **Map** Button, **Build** tab, then use the **New** dropdown menu directly below the Editable Lists pane and select **Macro Template**.

For details, see Macro Templates on page 213.

The Build Tab

The Build tab allows you to create macros, and add tasks for the AMR to perform.

To display the route building tools, click the **Build** tab. The Build tools, shown in the following figure, are displayed on the left side of the map window. The Build tab displays two scrollable panes, each using tabs to organize the lists available for use.

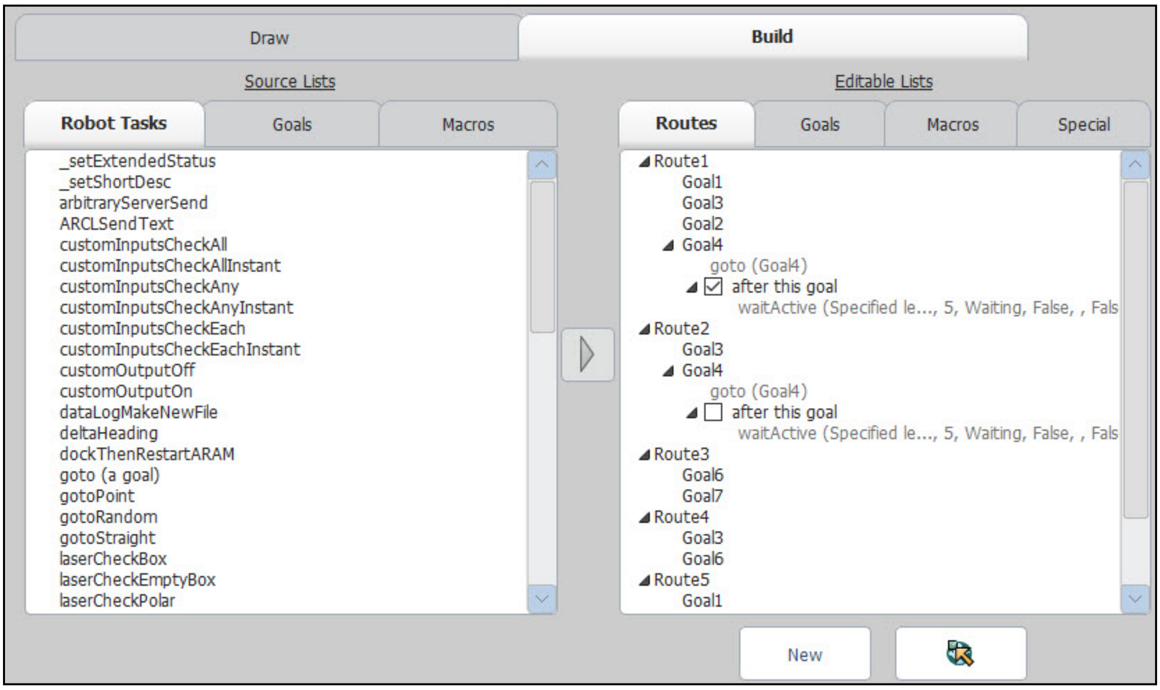
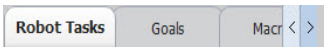
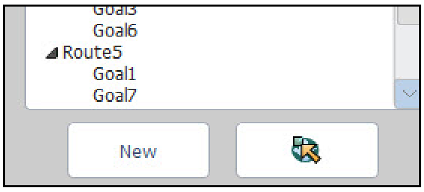
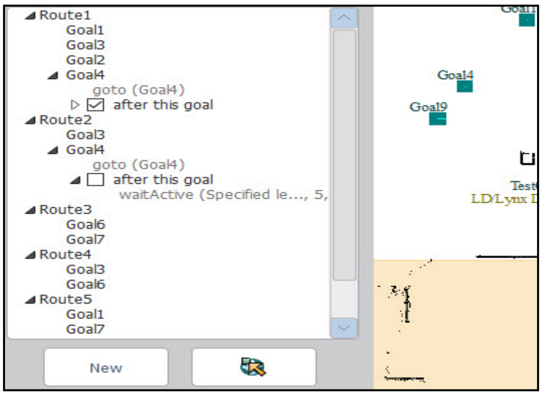


Figure 10-25. The Source Lists and Editable Lists Pane

The following table lists the toolbar icons and describes their functions.

Item	Description
Source Lists pane	Contains lists of AMR tasks and goals that you can use to create macros or routes for the AMR to navigate. You can also put macros in other macros as well. To view the different lists, select the appropriate tab.
Editable Lists pane	Contains lists of all current routes, goals, and macros. You can also add new tasks the existing lists that tell the AMR what to do in certain circumstances, such as after reaching a goal, when docking, and when specific event occur, such as bumping into something.

Item	Description
	If the MobilePlanner workspace is filled with multiple windows and some tabs are not visible, move between tabs using the arrows.
New Route/Macro Button 	Creates a new route and/or macro (depending on the window in which you are working), and adds it to the Routes tab. 
Pick Goal Button 	When ON and a route is selected, lets you click goals on the map, to add to the route. After adding the goals to the route, you can drag the goals up/down to set their order. 

For more information on creating tasks, goals, routes and macros, see Using the Route Builder on page 205.

Creating Macros

Macros are containers that hold a series of tasks, goals, and other macros. After you create a macro, you can reuse it as many times as needed. Macros can hold goals and use tasks with conditionals, and they can be embedded within macros and other tasks. As a result, macros are very versatile.

To Create a Macro:

1. Click the **Map** Button, then click on the **Build** tab.

   The Source and Editable Lists appear on the left side of the map.

2. Under Editable Lists, click the **Macros** tab.

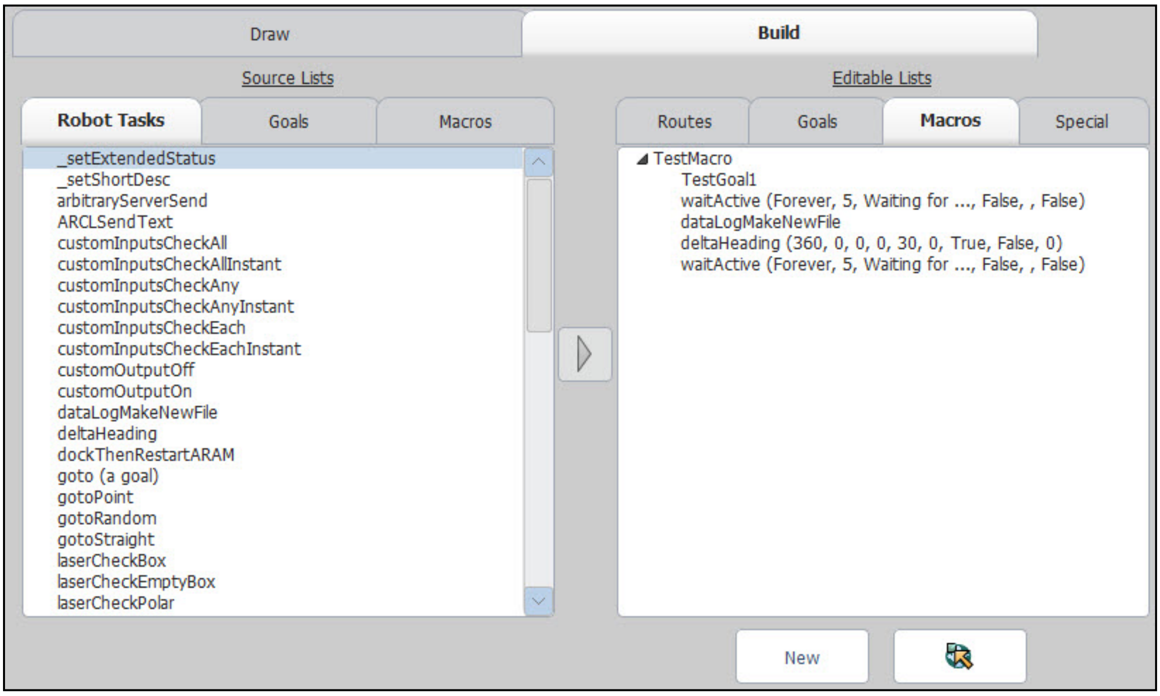


Figure 10-26. MobilePlanner Build Tools - Macros Tab

3. Click on the **New** Button an the bottom of the Editable Lists pane.

   This adds a new macro to the Macros tab which, by default, has the name "Macro1." This new macro name increments by 1 with each new added macro. See Renaming the Macro on page 213 for directions on changing the macro name.

4. Highlight a task from the Robot Tasks list and either drag it to the desired macro in the Macros tab or click the **Add** arrow (between the two panes).

   The new macro expands with each added task, as shown the following figure.

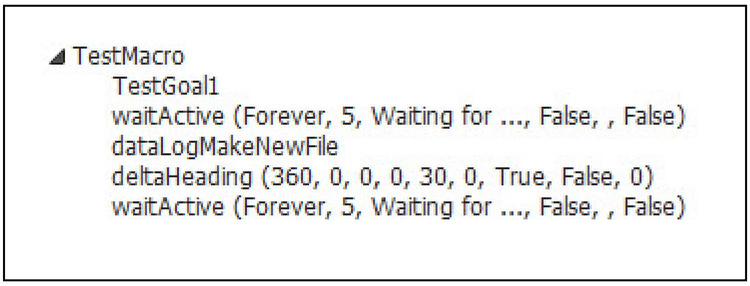


Figure 10-27. Macro Detail

5. Click the **Goals** tab to access the goals available to add to the macro, then drag the desired goal into the new macro you are creating. You can also pick a goal from the displayed map to add to the macro (see Picking a Goal from the Map on page 212 for details).

6. Click the **Macros** tab to access existing macros. You can then drag an existing macro into the new macro.

The macro below shows an example of tasks, a goal, and a macro named "Greeting" added to the new Macro1 macro.

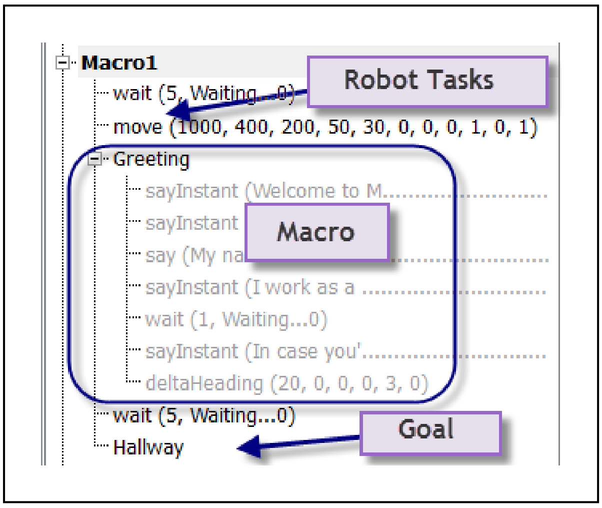


Figure 10-28. Macro Details

Using the Add Button

In addition to dragging a task, you can use the arrow (Add) Button to add a task to the macro.

1. Click on the **Macros** tab in the Editable Lists pane.
2. Highlight the macro to which you want to add a task, goal, or macro.
3. Click on the **Robot Tasks**, **Goals**, or **Macros** tab from the Source Lists pane.
4. Select the task, goal or macro you want to add to the new macro.
5. Click the **Add** Button to add the task, goal, or macro.

   If parameters are associated with the task, a dialog box appears that allows you to adjust parameters appropriately.

   For specific parameter information, refer to the task type (such as a wait task) for more information.

Picking a Goal from the Map

You can add goals to macros by clicking the goal on the map. This allows you to add multiple goals within the same vicinity.

1. Be sure that the goals you want to add to the macro are visible in the map window. For details, see Using MobilePlanner Software on page 52.
2. From the Editable Lists pane, select the **Macros** tab, then select the appropriate place in the desired macro to add the goal.
3. Click the **Pick Goal** Button at the bottom of the pane (next to the **New** Button).
4. In the map, click on the goal to add the goal to the macro (you can select multiple goals without having to click on the **Pick Goal** Button each time).

To Move the Goal within the Macro:

1. Click on the goal name in the macro list.
2. Drag it to the position you want the goal to be.

Renaming the Macro

1. Right-click on the macro you want to rename.
2. In the pop-up window, click **Rename** to change the macro name to editable text.
3. Type in the new name for the macro.

Copying a Macro

1. Right-click on the macro you want to copy.
2. In the pop-up, click **Duplicate** with the left mouse button.

   A copy of the macro appears in the Macros tab.

Deleting a Macro

1. Click the macro then hit the **Delete** key, or
2. Right-click on the macro you want to delete then, in the pop-up window, click **Cut** with the left mouse button to delete the selected macro.

Macro Templates

Using macro templates, you can easily add a variable to a set of tasks. This makes reusing macros or task sets with slight differences (depending on the goal or application) fast and easy. For example, you can create macro templates for changing wait times, status to wait with, line to log, activating a different IO, etc.

> **NOTE:** To use macro templates, you must have (at minimum) MobilePlanner 4.4.0 and ARAM 4.8. If you are using a map created under an older version of MobilePlanner, you will need to update it. After updating, it will not be backwards compatible with older MobilePlanner versions.

To update your map

1. In MobilePlanner's main menu, click on **Tools > Update Map Features**.

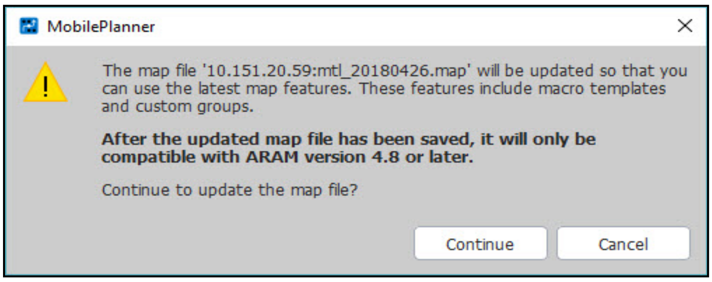


Figure 10-29. Update Map Dialog

2. Read the notes and information in the pop-up window, then click **Continue** to update the map.
3. After updating the map, you will need to save and reload the map.

   Macro Templates and Grouped Items will then be available for use, and there will also be default group items such as door goals, docks, and cart transporters.

Creating a New Macro Template

1. In the Build pane, Editable Lists, click on the **Macros** tab, then click the **New** Button drop-down arrow, and select **Macro Template**.

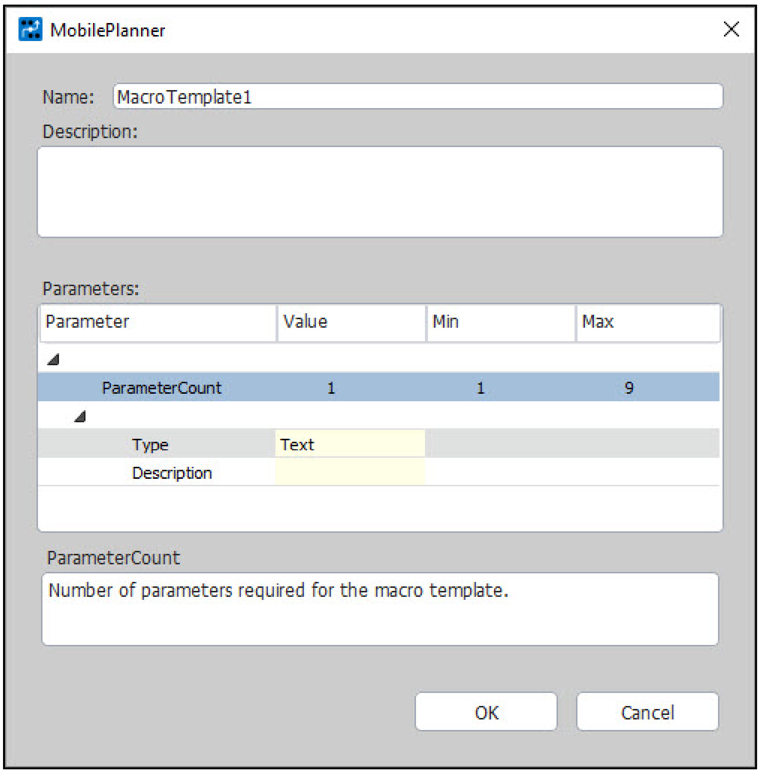


Figure 10-30. New Macro Template Dialog

2. Enter a name and description for the template, and set variable number(s), type(s), and descriptions.

   Types can be Text, Integer, Double, or Boolean.

Type	Allowed Value	Default
Text (or String)	Any letters or numbers	Zero
Integer	Number without decimal	Zero

Double	Number either with or without a decimal	Zero
Boolean	True or False	False

3. Enter up to nine parameters in the macro template.

   Parameter names use '$1' to '$9.' You can enter a text description of each '$#' variable in the Description field.

4. Add tasks to the template.

   Add '$#' to call a variable ('#' is limited to previously defined parameters).

5. To add the new macro template, drag and drop from the Source list into the Editable list.

Custom Groups

Using custom groups, you can define a reusable group of complex map objects, such as goals, sectors, etc. This allows you to place repeatable tasks (e.g., cart goals) on your map quickly and consistently, which helps to speed up application building time. Custom groups can interface with macro templates. Once created, you can add grouped items from the build tab as you would an advanced area.

Notes on using custom groups:

- You cannot edit or delete custom group definitions.
- You cannot modify originally selected map items, and they do not automatically become members of a new group instance.
- You cannot nest groups. The software ignores groups already in the original selection list.
- You cannot ungroup groups (i.e., you cannot convert them to top-level objects).

Custom groups also contain all tasks and macros (which you can individually edit) from every goal and sector that you included in the group.

Creating a New Custom Group

NOTE: Update the map format, then create a backup of your map before creating the custom group.

1. Ensure **Show Robot** is OFF.
2. Highlight all map objects (goals, sectors, etc.) you want to include in the group.
3. Right-click on the map location that is the group's anchor point (its origin), and select **Advanced > Create Custom Group**.

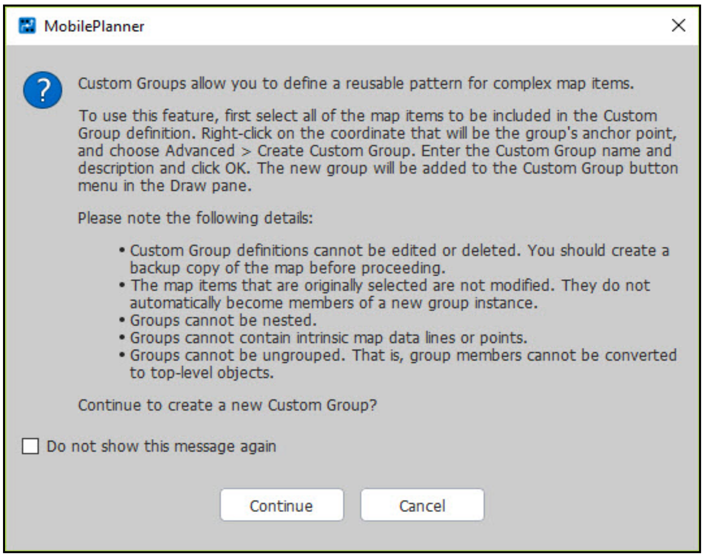


Figure 10-31. Create Custom Group Explanation Dialog

4. Read the information in the pop-up, then click **Continue** to create the custom group.

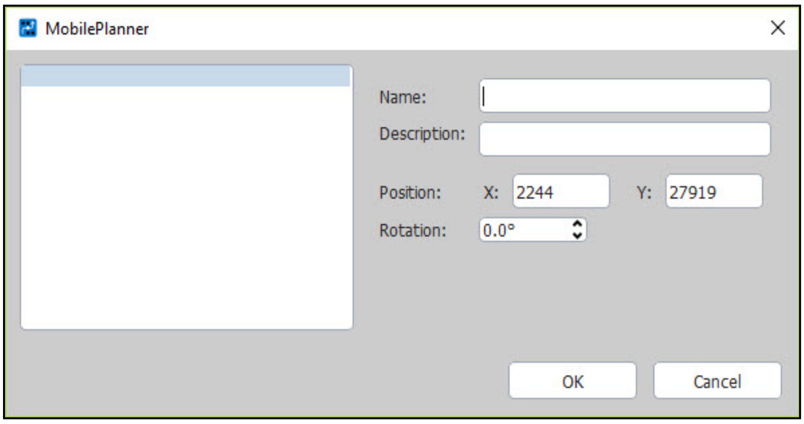


Figure 10-32. Create Custom Group Dialog

5. Enter the custom group’s name and description.
6. Click **OK**.

   The new group will appear under the **Custom Groups** Button drop-down menu in the **Draw** pane.

To edit a single item in the group, right-click and select the component you want to edit.

Adding a Grouped Item

After you create a grouped item, you can add it to the map as follows:

1. Verify that **Show Robot** is OFF.
2. In the Draw tab, click the **Custom Groups** drop-down arrow, and select a grouped item.

3. Move the cursor (appears as a ‘pencil’) to the grouped item’s intended location, and click to place the item on the map.

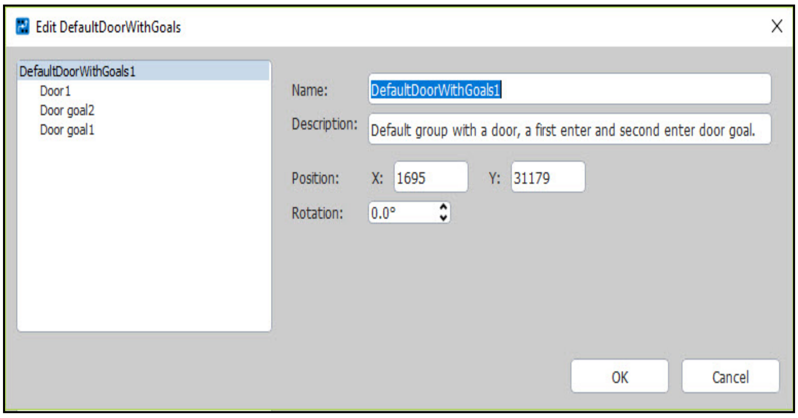


Figure 10-33. Add Grouped Item Dialog

4. Click **OK** to add the grouped item.

Adding New Goals to the AMR’s Current Location

MobilePlanner software's AMR monitor allows you to interact with the AMR (for example, you can move the AMR to a new location or goal, then add a new goal where the AMR is located).

1. Drive the AMR to the location where you want to add a goal or task (for details, see AMR Driving Overview on page 90).
2. When the AMR is at the desired position, click the **Item at Robot** Button (in the toolbar), and select **Create Goal**.

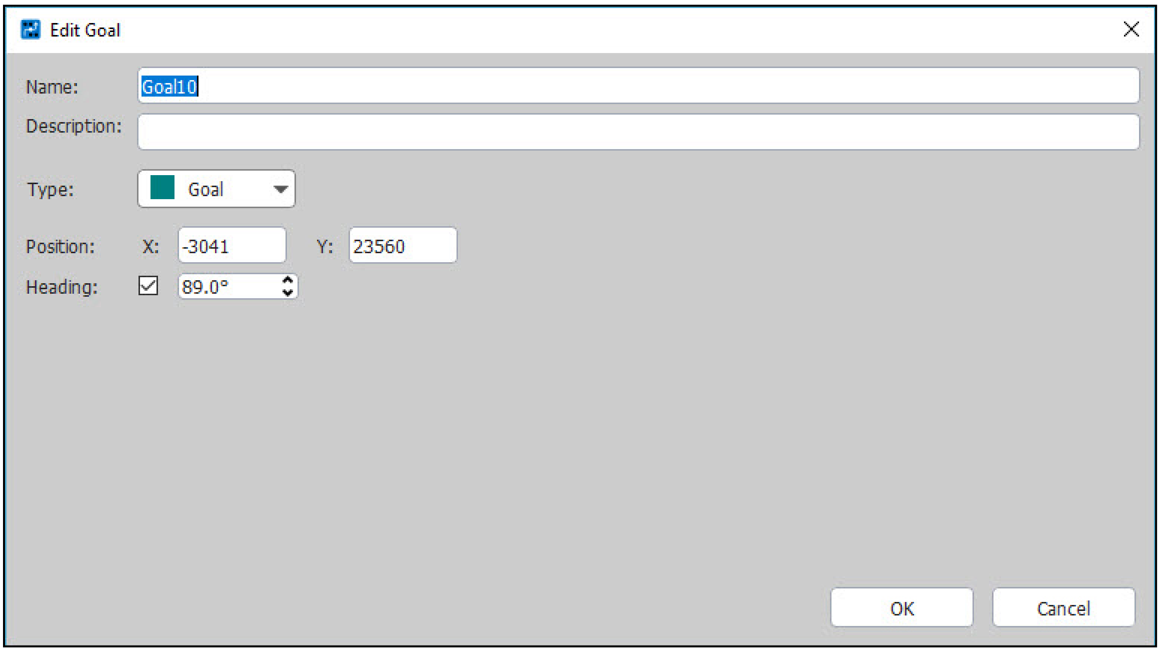


Figure 10-34. Edit Goal Dialog

3. In the Edit Goal dialog, enter the information, then click **OK**.

Creating Routes

A route is essentially a "to do" list for the AMR. It is a series of ordered tasks, goals, and macros for the AMR to complete. Tasks are AMR and accessory-related operations, such as talking or playing a sound, reading inputs, and triggering outputs.

Building Your Route

To build routes for the AMR, simply drag a task, goal, or macro from the Source Lists to the **Editable Lists > Routes** tab, as described in the following procedure.

To Build a New Route:

1. Click the **Build** tab to display the Route Builder.
2. Click on the **Routes** tab in the Editable Lists pane.
3. Click on the **New** Button on the bottom of the Editable Lists pane to add a new route to the Routes tab.

   The default name for this new route is "Route1," and each new route name increments by 1. See Renaming the Route on page 219 for details on renaming a route.
4. Highlight a task from the Robot Tasks tab (in the Source List pane) and drag it to the desired route in the Routes tab.

   The new route expands with each added task, as shown below.

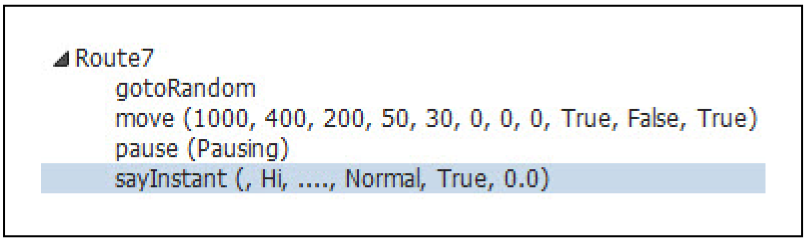


Figure 10-35. Route Detail

5. Click the **Goals** tab to access the goals available to add to the route, then drag the desired goal into the new route you are building. You can also pick a goal from the displayed map to add to the route, see Picking a Goal From the Map on page 219 for details.
6. Click the **Macros** tab to access the macros available to add to the route, then drag the desired macro into the new route you are building.

Using the Add Button

In addition to dragging a task, goal or macro into your route, you can use the arrow button to add the task to the route.

1. Click on the **Routes** tab in the Editable Lists pane.
2. Highlight the route to which you want to add a task, goal or macro.
3. Click on the **Robot Tasks**, **Goals** or **Macros** tab from the Source Lists pane.
4. Select the task, goal or macro you want to add to the route.
5. Click the **Add** Button to add the task, goal or macro to the route.

   If parameters are associated with the task, a dialog box appears in which you can adjust parameters appropriately. For specific parameter information, refer to the task type (such as a wait task) for more information.

Picking a Goal From the Map

You can add goals to routes simply by clicking the goal on the map. This allows you to easily add multiple goals to the route that are in the same vicinity on the map.

1. Be sure that the goals you want to add to the route are visible in the map window (see Using MobilePlanner Software on page 52 for details on using the workspace).
2. From the Editable Lists pane, select the Routes tab.
3. Click on the **Pick Goal** Button at the bottom of the pane.
4. Highlight the route in which you want to add the goal.
5. In the map, click on the goal you want to add to the route.

   This adds the goal to the route. You can select multiple goals without having to click on the **Pick Goal** Button each time.

To Move the Goal within the Route:

1. Click on the goal name in the route list.
2. Drag it to the desired position.

Renaming the Route

1. Right-click on the route you want to rename.
2. In the pop-up window, select **Rename** to change the highlighted route to editable text.
3. Type in the new name for the route.

Copying a Route

1. Right-click on the route you want to copy.
2. In the pop-up window, select **Duplicate** with the left mouse button.

   A copy of the route is displayed in the Routes tab.

Deleting a Route

1. Right-click on the route you want to delete.
2. In the pop-up window, select **Cut** (or use the Delete key) with the left mouse button to delete the selected route.

10.4 Managing Queuing

This section describes how to manage AMR job queues.

10.5 Queuing and Job Definitions

- **Job** - a single command issued to the Fleet Manager, consisting of one or more related, ordered moves (job segments). Each job has a unique job ID.
- **Job segment** - one discreet move assigned to an AMR. A segment consists of a single goal name, and you can define it as either a PICKUP or a DROPOFF job segment. The goals might have tasks that are assigned to the AMR, which count as part of the job segment. Each job segment has a unique ID.
- **Queue** - a collection of requested jobs and job segments, stored on the Fleet Manager, that are either assigned or waiting to be assigned to AMRs.
- **Assigned Job** - a job segment becomes assigned after the Fleet Manager has allocated an AMR to perform the job. A job segment transitions from Pending to InProgress after assignment.
- **Pickup** - a job segment that ends at a goal so that a payload is loaded onto the AMR. If the first segment of a job is a PICKUP, then the Fleet Manager assigns this job to whichever AMR it decides is most appropriate.
- **Dropoff** - a job segment that ends at a goal so that a payload is removed from the AMR. A DROPOFF segment is handled only by the required AMR.
- **Required Robot** - certain job segments are serviced only by a specific AMR. For example, the DROPOFF segment of a PICKUP-DROPOFF job must be handled by the same AMR that performed the pickup. Thus, whichever AMR handles the initial PICKUP job is the *required AMR* for the DROPOFF.

The Fleet Manager enables you to queue jobs. It can accept multiple requests for AMRs, and then select the best AMR for each job, based on the criteria you specify. It sends the selected AMR to the requested location. It tracks the status of jobs and AMRs as they perform their assigned jobs.

The requests that are queued include:

- a request for any AMR to be sent for a pickup (PICKUP) for which the delivery destination (DROPOFF) is not yet known (queuePickup ARCL command).

  It is assumed that the delivery destination is communicated directly to the AMR that responds, prior to completion of the pickup.
- a request that a specific AMR drive to a particular goal (DROPOFF) (queueDropoff ARCL command).

This is communicated directly to the AMR, but is queued and tracked by the Fleet Manager.

- a request that an AMR be sent for a job that has predetermined pickup and dropoff destinations (queuePickupDropoff ARCL command).

  To complete the job the AMR requires no further job commands.

The Fleet Manager manages jobs associated with either a PICKUP or a DROPOFF goal. Any AMR tasks that are associated with the goals are executed at the proper times, though they are not managed as separate jobs in the queue.

We recommend that you use the task *pause* when an AMR arrives at its destination, although this is not managed by queue. Use the associated *pauseTaskCancel* task to signal dismissal after the AMR is loaded or unloaded. You can trigger this task either by a manually-activated button, or by an automated system event.

When the Fleet Manager receives a request, it does the following:

1. Queuing
    - The request is assigned a default priority (unless another priority is specified) and put into the queue.

      Pickup/Dropoff requests are entered as two separate jobs - a pickup, and a dropoff.

      Each segment has a unique queue ID, as well as a job ID that tracks the entire pickup/dropoff sequence.
    - Queuing enables job cancellation.
2. Dispatching
    - An AMR is selected, based on the criteria you specified.
    - The AMR is sent to the goal.
3. Tracking
    - The queuing manager monitors the AMR and job status.
    - The job is deleted from the queue when the request is satisfied, or is requeued if the job fails.

   Jobs might be in one of six states:
    - Pending - new, unassigned jobs.
    - In Progress - jobs that are being actively processed.
    - Completed - jobs that were successfully processed.
    - Failed - jobs that failed, due to reasons such as a blocked path or E-Stop.
    - Canceled - jobs that were manually canceled with the queueCancel command.
    - Interrupted - jobs that have been interrupted by an Operator manually controlling the AMR. These jobs are reassigned after a brief pause.

10.6 Queuing Examples

The following flowcharts represent sample usage scenarios, and require some application-layer support to fully implement.

The following flowchart illustrates a simple pickup and delivery cycle. Other factors, such as state of charge, can alter this flow.

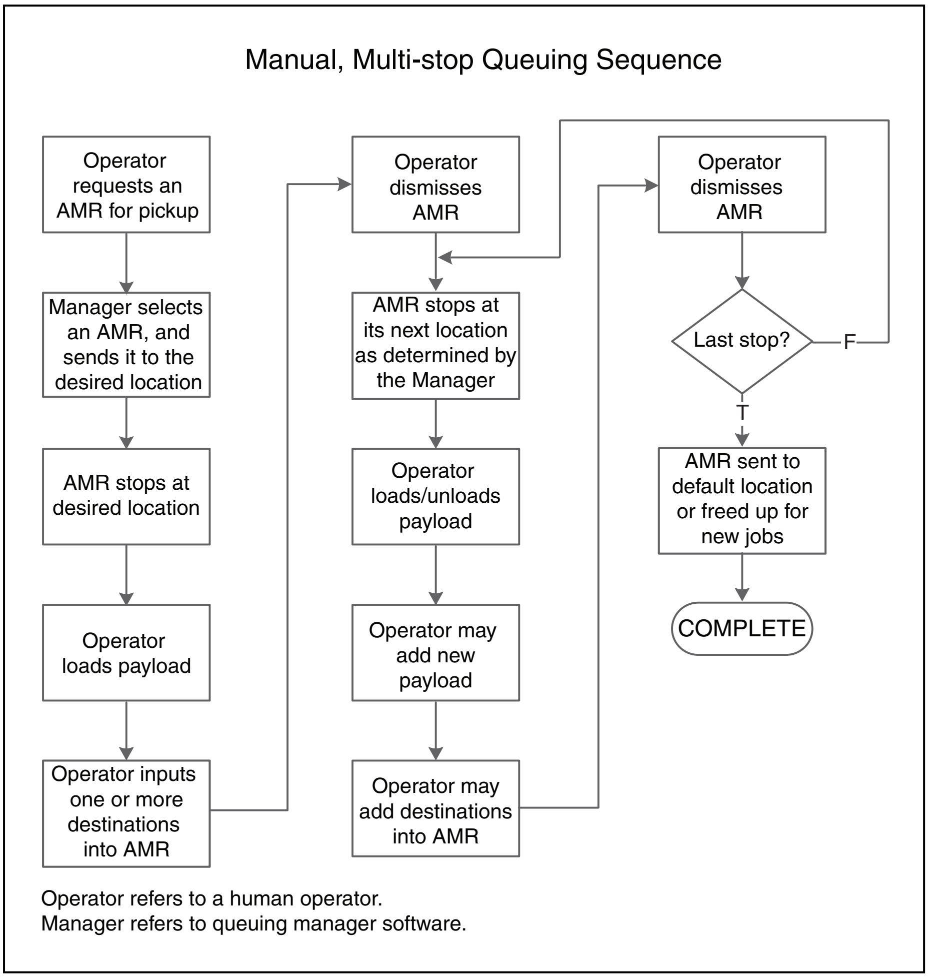


Figure 10-36. Manual Queuing Cycle

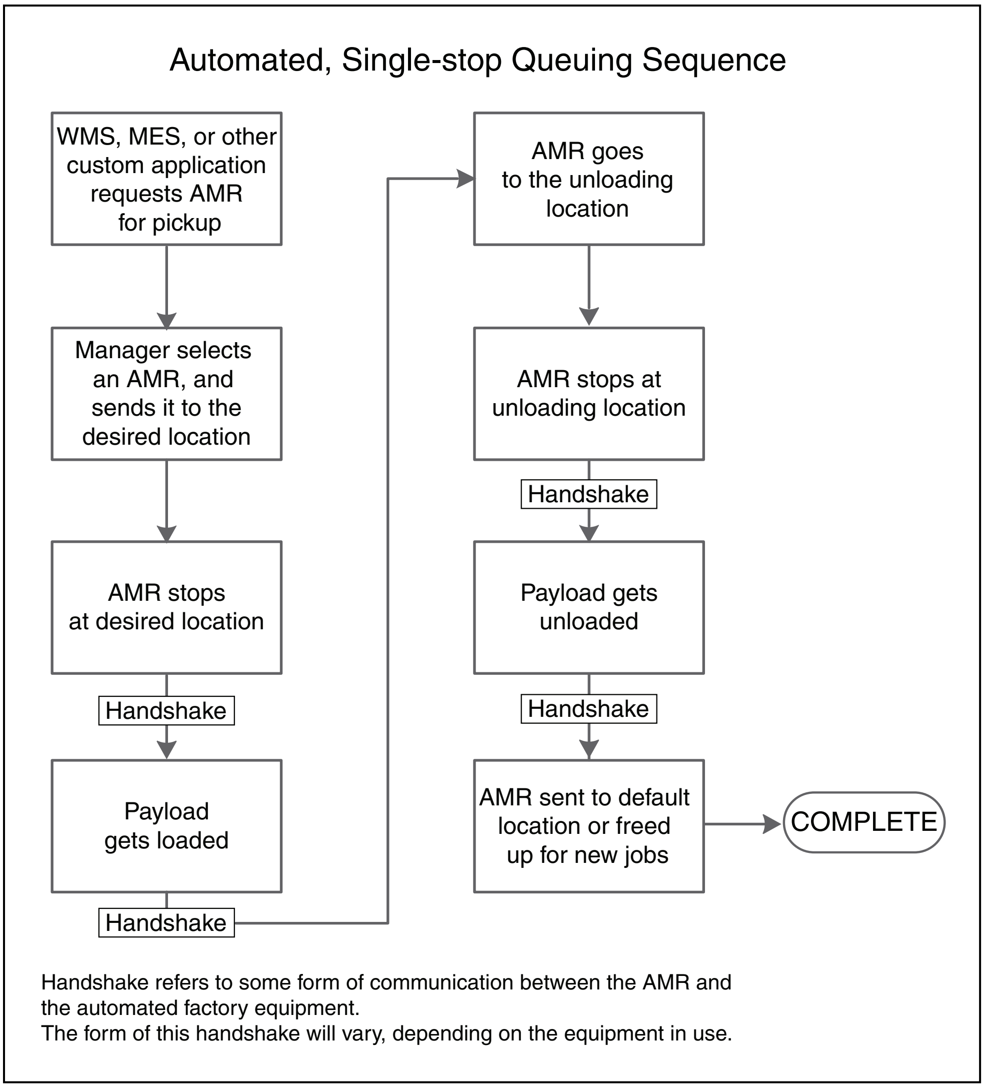


Figure 10-37. Fully-automated Queuing Cycle

10.7 Queuing Parameters

You configure various parameters to specify how the Fleet Manager processes queued requests. You set most of these parameters from within MobilePlanner. See Using MobilePlanner Software on page 52.

To access these parameters from the Fleet Manager:

In MobilePlanner click **Config** > **Robot Operation** > **Queuing Manager**.

The parameters that control the way that the Fleet Manager handles queuing are:

- **IdleTimeUntilResume** - Number of minutes to wait, after an AMR becomes available, before automatically resuming an interrupted job.

  If an AMR has recently booted, or recently operated manually, then this is the number of minutes that the queuing manager waits before assigning any new jobs to this AMR.

The parameter supports decimal numbers (such as 0.1 minutes for 6 seconds).

- **LowStateOfCharge** - This is the state-of-charge (SOC) below which the queuing manager no longer assigns new jobs to that AMR. If an AMR is below this state of charge when it completes a job, it is sent to dock.

  The AMR continues its assigned jobs until it reaches the SOC limit set by the value of the **AutoDockStateOfCharge** parameter. Consider the following constraints:

  - An AMR drives to a docking station any time that its state of charge falls below the limit set for **AutoDockStateOfCharge** even if it is performing a job. This is an AMR-level parameter, not visible or settable on the Fleet Manager.
  - We recommend that at least a 10% difference between LowStateOfCharge and AutoDockStateOfCharge, to make sure that the AMR does not drive to a docking station while performing a job.
  - An AMR docks only if you set AutoDock to True.
- **DefaultDropoffPriority** - The default priority to use in all dropoff requests to the queuing manager.
- **DefaultPickupPriority** - The default priority to use in all pickup requests to the queuing manager.
- **DeleteCompletedItemsMinutes** - Number of minutes to keep completed jobs.
- **MaxNumberOfCompletedItems** - Maximum number of completed jobs to keep.
- **EnableParking** - Sends the AMR to a standby goal after it completes its jobs.

The following screen shows configuration parameters for queuing:

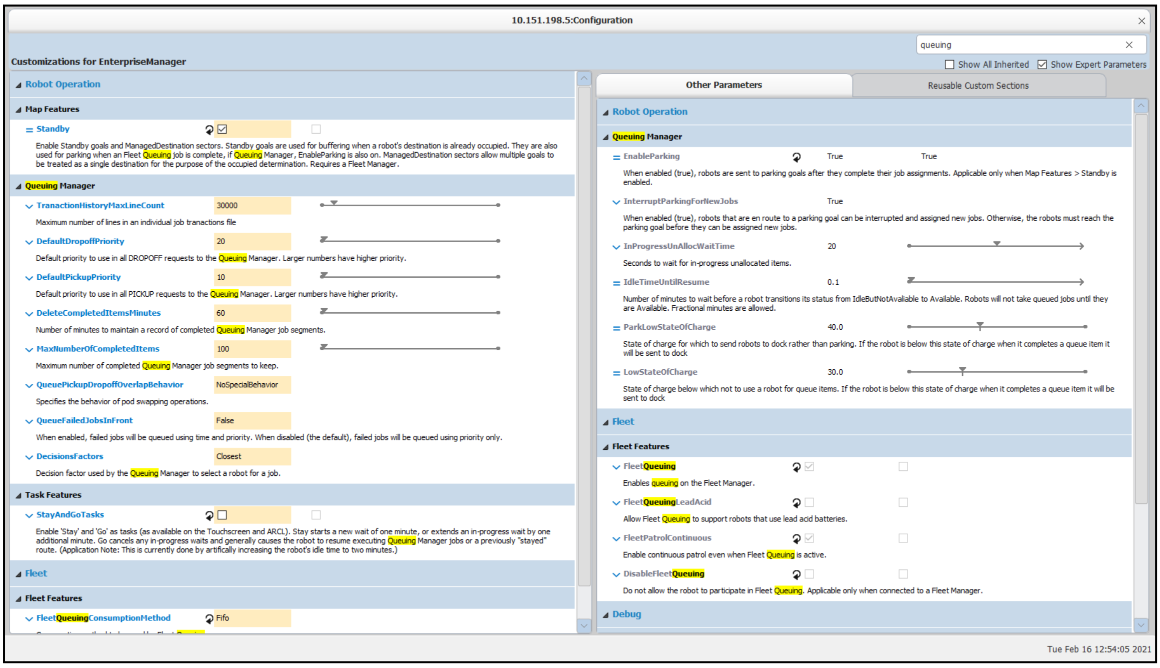


Figure 10-38. Queuing Manager Parameters

The following list shows the commands available for queuing.

- CancelQueueId
- CancelQueueJobId
- DisplayDeliveryQueue - Presents a pop-up window showing the delivery queue.
- DisplayShowRobot - Presents a pop-up window that shows the status of all AMRs in the fleet.
- QueuingLog
- QueuingStats

To find these parameters in MobilePlanner, click **Config > Robot Operation > Queuing Manager**.

10.8 Manually Clearing (Flushing) the Entire Queue

For a Fleet Manager, using SetNetGo, you can flush the queue via the Software page, and the ARAMCentral Settings tab. Check the box next to **recoveryEnterpriseQueuingFlush** and click apply. This will restart the Fleet Manager, and flush the queue. After the Fleet Manager is restarted, uncheck the checkbox.

Alternatively, for either a Fleet Manager or an AMR operating in single robot mode, you can open the configuration window using MobilePlanner, then select the Debug category and find the section called **Custom Arguments**. Add a custom argument **-**

recoveryEnterpriseQueuingFlush, and then save the configuration. This will restart the Fleet Manager or robot and flush the queue. After restarting, this parameter will be removed from the configuration.

Chapter 11: Traffic Management

This section describes managing traffic flow in your operating environment. Whether you are using a single AMR or a fleet of AMRs, defining how the AMR moves within the space allows you to better control the AMR's behavior. As a result, you can prevent the AMR from running into problems, allowing it to complete the tasks assigned to it more efficiently.

In MobilePlanner, you can add objects and areas to the map and manage how the AMR moves through its environment. You can add areas that direct or restrict traffic, and that control speed and docking behavior.

11.1 Understanding Traffic Control

MobilePlanner provides traffic control guidelines for the AMR to determine the best path through the operating space. You can control AMR traffic by adding areas to the map that tell the AMR which direction to go, how fast to drive, or how many AMRs you want to allow in an area at one time. With MobilePlanner, you can add these features and more to the map.

This section discusses the following traffic control features:

- Using Preferred Lines on page 241
- Using Preferred Directions on page 243
- Using Forbidden Lines and Areas on page 248
- Adding Switchable Forbidden Lines and Areas to the Map on page 249
- Using Resisted Lines and Sectors on page 252
- Using Need-to-Enter Sectors on page 255
- Using Single AMR Sectors on page 256
- Controlling AMR Speed on page 246

11.2 Traffic Control Concepts

In environments with more than one AMR, managing traffic becomes increasingly more critical. The main goals in managing traffic flow are safe and efficient operations, and minimizing traffic jams and collisions. The following sections describe some of the more important traffic control concepts.

Taxi Line (Multi-Robot Standby Goal)

Much like a row of taxis waiting outside the airport, the concept allows multiple AMRs to approach and arrive at the same Standby goal (called a ‘Multi-Robot Standby’ goal), in sequence, without bunching up and causing a traffic jam.

The Multi-Robot Standby (MRS) goal acts as a traffic control tool. The MRS goal extends the standard Standby map object to enforce sequenced queuing for multiple AMRs at a single starting point, each of which then moves linearly, in sequence to an end point. Along the way, the AMRs become available as they reach the end of their 'after' task.

The following figure shows the general design. The MRS start point is at the left, the MRS end point is on the right.

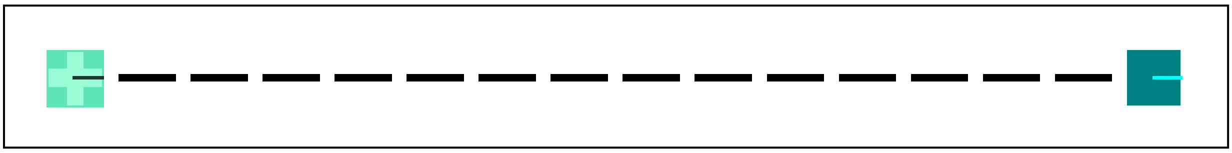


Figure 11-1. Taxi Stand (Multi-Robot Standby) Goal Design

An ideal implementation is at a map corridor that frequently becomes congested with multiple AMRs. By placing the start point some distance from the goal (for example, at the corridor entrance), the AMRs move through the corridor in sequence and reach the end point of the 'after' movement near the corridor's exit. Another ideal implementation is for high throughput sources of parts that need to go to many places (like a plant that has a few gantries serving a few hundred goals. The AMRs waiting in line near the source means a much higher throughput.

Implementing Taxi Line

Using this feature requires setting the Boolean 'AllowMultipleRobots' on standard standby objects (standbys with this Boolean flag active become Multi-Robot Standbys), and each goal using a nearby MRS must also have a Managed Destination sector placed over it, with the 'AlwaysBuffer' parameter enabled, and the sector's ReservedBuffer parameter set to the name of the MRS.

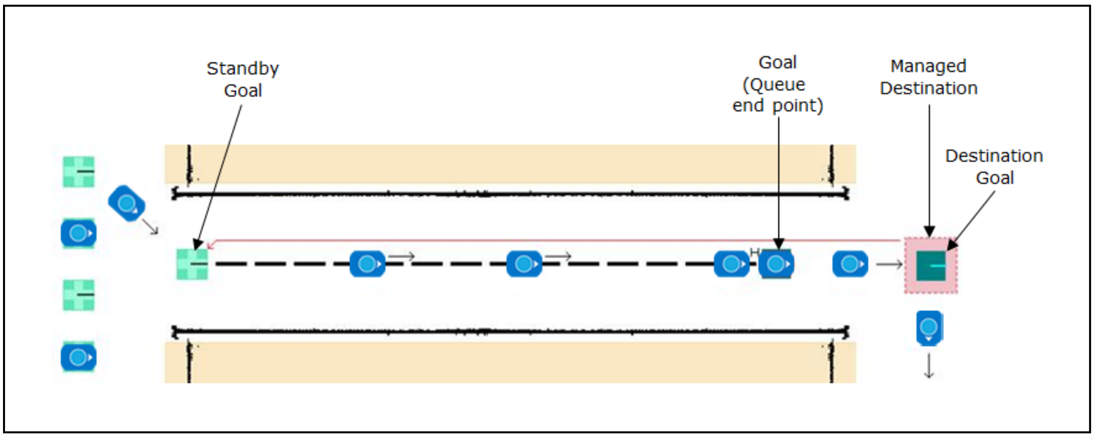


Figure 11-2. Taxi Stand Implementation Example

> **NOTE:** You can only use MRSs as ReservedBuffers. An MRS with no sector referencing it as a ReservedBuffer will display an error when saving the map, and will be ignored during normal operations. Each MRS can only be reserved by one map object.

A typical implementation is to place a standard goal on the map to use as the end point of the buffering line. The figure below shows how this would work with a single AMR (the dashed lines are for illustrative purposes only - they do not appear in the map).

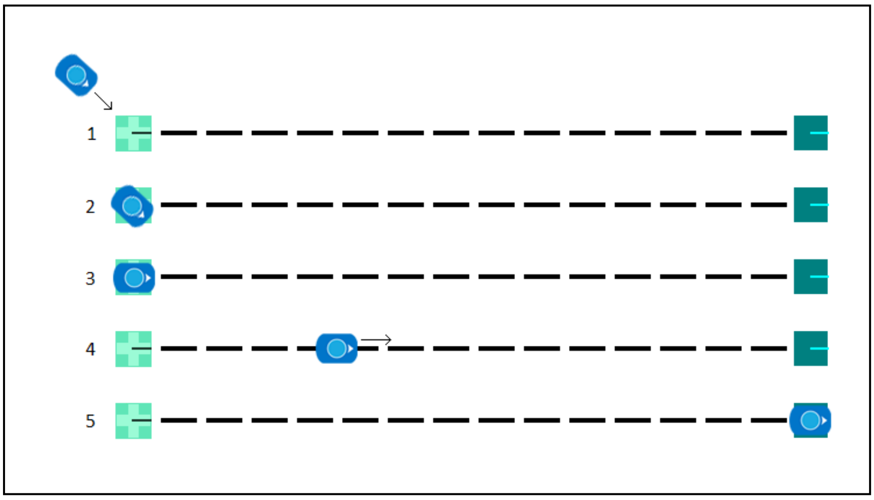


Figure 11-3. Taxi Stand (Multi-Robot Standby) Goal Design, Single AMR Use

As shown above, each AMR drives to the MRS start point (line 1), rotates to the correct pose (line 2), signals the Fleet Manager of its arrival, then executes an ‘after’ task (in this case, a ‘gotoStraight’) to the associated goal (lines 4 and 5).

With multiple AMRs, the sequence works as shown below. In line 1, a second AMR is moving towards the end goal, which is already occupied by another waiting AMR. It assumes a position behind the first AMR (line 2), and is then joined by two more AMRs (line 3).

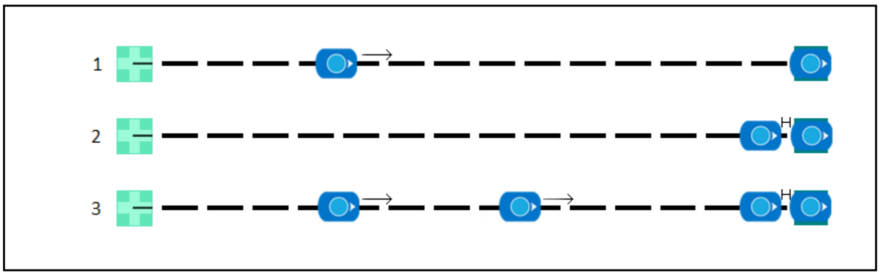


Figure 11-4. Taxi Stand (Multi-Robot Standby) Goal Design, Multiple AMR Use

Managed Motion Sectors

Certain situations might require that multiple AMRs drive in narrow spaces, like hallways and aisles. Without proper management, the AMRs could bunch up and cause traffic deadlocks. The Fleet Manager uses managed motion sectors to control AMR traffic flow in difficult areas, by directing the AMRs to wait at standby goals while awaiting permission to enter the sector. It allows only one AMR to drive autonomously through the sector at a time, while still performing tasks (such as pickup/dropoff) without requesting Fleet Manager permission. Managed Motion can use Taxi Line queuing, with each sector capable of having up to four reserved buffers.

Standby Buffering

Standby buffering is another type of ‘StandBy’ behavior in which an AMR must wait for another AMR to clear a sector or goal. The awaiting AMR can automatically select and move to a nearby ‘StandBy’ goal to wait.

Preferred Lines and Directions

You can specify preferred lines, and directions that govern how your AMRs move through their environment. Once placed on a map, the AMRs will, if possible, use the preferred areas. If something prevents an AMR from keeping to the preferred line or direction, it will seek out another path.

Resisted Areas and Lines

You can also place areas and lines on the map that you want your AMRs to avoid If the AMR is unable to complete a goal without moving into, or crossing over, one of these areas, it will do so, with a higher cost. Typically, resisted areas, lines, or directions are for special cases, such as setting up travel lanes in which moving is allowed but should be avoided. For an explanation of cost-based path planning, see Cost-Based Path Planning on page 231.

Forbidden Areas and Lines

As the name implies, these areas, lines, and directions are areas or lines the AMRs must never enter or cross over. These could be loading docks (or other areas that might lead outside), stairs, internal structures with walls, or other areas where the AMR could pose a hazard. Refer to Using Forbidden Lines and Areas on page 248.

DistanceUncrossable and DistanceAdjustment Lines

If the path between the AMR and its goal intersects a DistanceUncrossable line, the AMR will alter its path. You can use these lines to guide an AMR to the appropriate dock or standby goal. The DistanceAdjustment line artificially increases the distance calculation between two points. Queuing uses the distances to determine actions such as which dock to go to.

11.3 Path Planning and Collision Avoidance

MobilePlanner's tools allow you to plan the most expedient routes for your AMRs, while keeping them from running into objects in your facility and each other. There are may traffic control mechanisms associated with path planning.

This section discusses cost-based path planning, difficult spaces, and virtual doors.

Cost-Based Path Planning

ARAM uses a path planning scheme called Cost-Based Path Planning. In this scheme, an AMR instructed to proceed to a goal searches the map for the most efficient path from its current location to the goal, based on what it knows about the map. This path, called the global path, is the optimal path from point a to point b. The AMR then follows that path to the goal while avoiding unmapped obstacles. If the AMR detects unmapped obstacles, it alters its local path to avoid them. If unable to proceed along the global path, the AMR can re-plan a new global path.

The Path Planning Grid

The 'cost-based' aspect of this path planning scheme breaks a map into discrete 100 mm squares (typically sufficient), called the path planning grid (which is not the same as MobilePlanner's 1000 mm (1 meter) reference grid), and assigns a cost to each square. Free (empty) squares (those not close to any obstacles) have a cost of 0.1. The cost for squares containing walls and other fixed objects is infinite (meaning the AMR will never enter those squares because the cost is far too high).

> **NOTE:** Although you can improve path planning accuracy by decreasing the path planning grid squares (done in the PlanRes parameter), doing so increases AMR processing time. For example, changing the PlanRes parameter (**Config > Robot Operation > Path Planning Settings**) from 100 mm to 50 mm quadruples processing time.

Using cost-based path planning, the AMR plans a path with the lowest cost, and follows that path to its goal. If it detects any unmapped obstructions, it alters its path to avoid them. And while the resulting path deviation might be longer, the AMR will always choose the path of lowest cost.

Factors Affecting Cost

Generally, a grid's cost increases as its distance to an obstacle decreases, and occupied grid squares have infinite cost. Preferred lines and directions generally have the lowest cost, while resisted lines and areas have higher costs. Forbidden lines and areas (like those with walls or other fixed obstructions, loading docks, etc.) have an infinite cost, meaning the AMR will never cross or enter them.

For more information about preferred, resisted, restricted, and forbidden lines and areas, see Understanding Traffic Control on page 228.

Path Planning Parameters

MobilePlanner has dozens of path planning-specific parameters that control how the AMR moves through its environment, including (not an all-inclusive list):

- The AMR's maximum traveling and rotating speed
- Turning radius (radius needed to safely pivot in place, without forward or backward movement)
- Grid resolution
- Fast and slow speeds
- AMR padding and clearances (at fast and slow speeds)
- AMR rotational speeds at goals
- The amount of resistance for resisted sectors and lines
- Preferred and resisted lines, areas, and directions

To view and set these path planning parameters (when connected to an AMR), click **Config > Robot Operation > Path Planning Settings**.

> **NOTE:** MobilePlanner has the most complete and up-to-date descriptions of all path planning parameters, which will not be repeated here.

> **Version Information:** The default values of the two following Path Planning Parameters have changed from Mobile Software Suite 4.9.x to FLOW Core:
>
> - SmoothingWt
>   Default value for FLOW should be 1.0 (ARAM 4.9x was 0.0)

- ObsThreshold
  Default value for FLOW should be 0.3 (ARAM 4.9x was .33).

AMRs running FLOW Core will drive poorly if you copy your existing 4.9x path planning configuration values to a new FLOW Core robot, as the default values of the two parameters listed above have changed.

Dealing with Difficult Spaces

Clearance settings limit how close the AMR can move to detected obstacles. You can increase or decrease the required clearance based on the AMR's speed, and have the software stop the AMR if it will come too close to an obstacle in its path before it can stop by decelerating.

Changing clearance settings alters the AMR's behavior if it moves very slowly through doorways or other tight spaces, or stops too quickly when it senses an approaching obstacle. Conversely, if your AMR moves too close to obstacles or doesn't slow down rapidly enough, these settings can improve its behavior.

You can set the clearance and padding parameters in MobilePlanner by clicking **Config > Robot Operation > Path Planning Settings**.

- Front Clearance: a narrow (100 mm default), fixed buffer zone at the front of the AMR that does not change with AMR translational velocity.

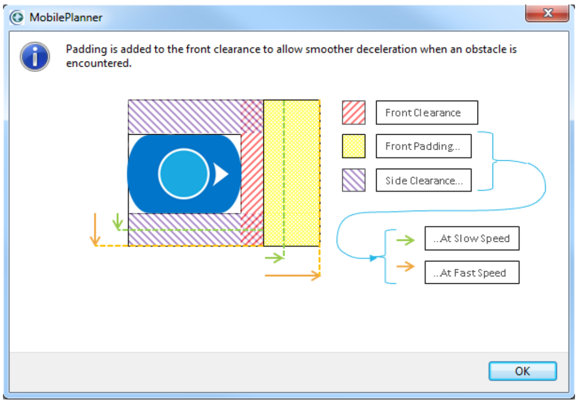


Figure 11-5. Front Clearances

- Side Clearance at Slow Speed (75 mm default) is the minimum side clearance applied at any translational velocity.

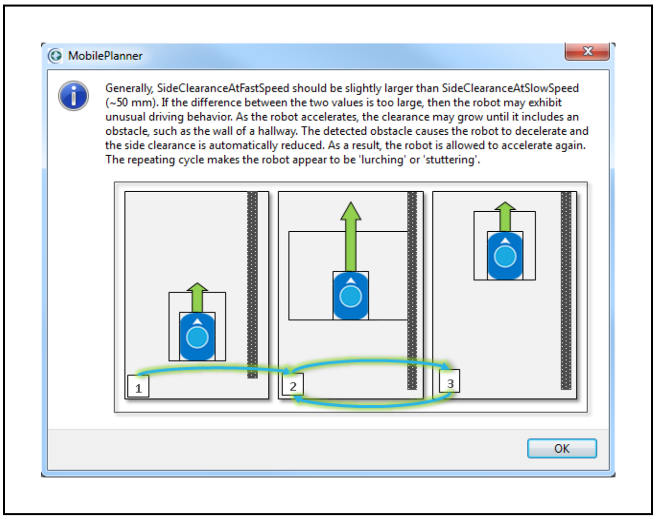


Figure 11-6. Side Clearances

- Front Padding and Side Clearance grow as AMR speed increases if you set these parameters. This is done as a safety precaution for faster-moving AMRs. The values for Front Padding at Slow and Fast Speeds, as well as Side Clearance at Slow and Fast Speeds can be set larger or smaller than the values shown in the figure above based on your facility, the expected level of traffic, and the general nature of the environment the AMR will be working in.

  As the AMR accelerates, Front Padding and Side Clearance increase from Slow Speed size towards Fast Speed size.

  > **NOTE:** If side clearance at high speed is set too large, the AMR will speed up and slow down in hallways and similar spaces. This is because the side clearance grows until it touches the wall, forcing the AMR to slow down until its side clearance shrinks. It is best to have a small gap between sideClearanceAtSlowSpeed and sideClearanceAtFastSpeed.

Dynamic Obstacle Tracking

This document introduces Dynamic Obstacle Tracking functionality. Dynamic Obstacle Tracking (DOT) allows AMRs to avoid moving objects by predicting the object’s path. Moving objects can include people, bikes, trucks, or other AMRs. Dynamic Obstacle Tracking is not a suitable replacement for an Fleet Manager with MultiRobot, but can enhance the performance of a fleet. DOT should be considered when moving vehicles such as bikes, trucks, and other AMRs are in the environment. People do not typically present a collision risk unless people are jogging or running, though DOT will make the AMR appear to be “friendlier” around moving people by moving around them at farther distances. Additionally, a customer may want to consider Dynamic Obstacle Tracking when non-employees will frequently be around the AMR, to prevent people unfamiliar with the AMRs from feeling uncomfortable.

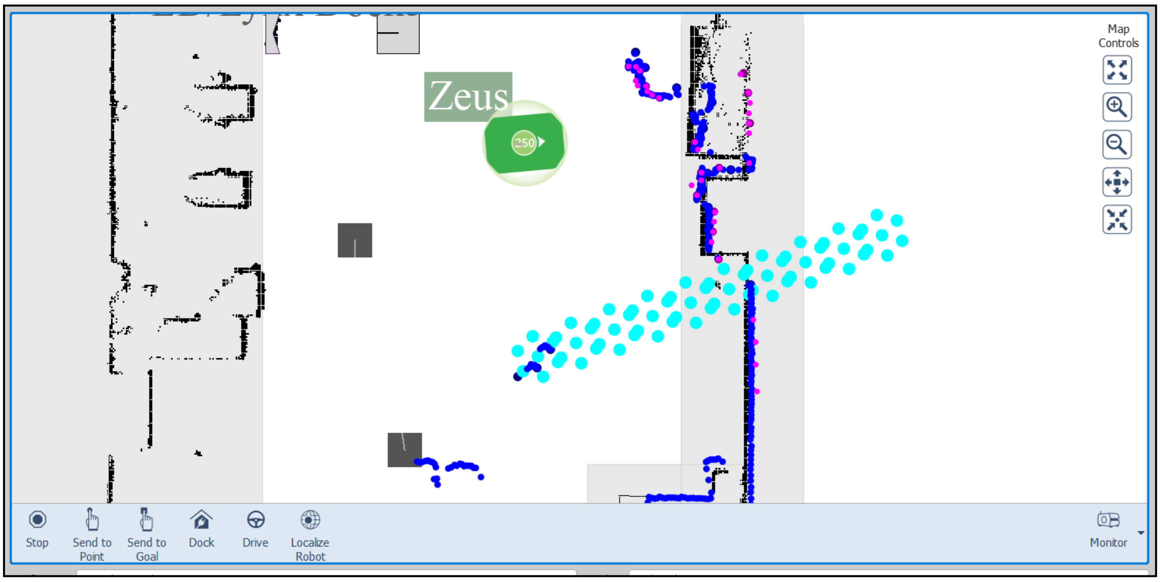


Figure 11-7. Path Projected by Two Moving Legs of a Walking Person (Shown in Cyan)

Configuration

Default settings for DOT are suitable for tracking people-sized obstacles in well-mapped and low-noise environments. Parameters can be adjusted to consider moving obstacles of other sizes and speeds, as well as environments with high noise.

Additionally, high-noise areas can be ignored using a new map area, by specifying those areas in the map editor. The map area, called IgnoreDynamicObstacleSector must be enabled as shown in the following figure.

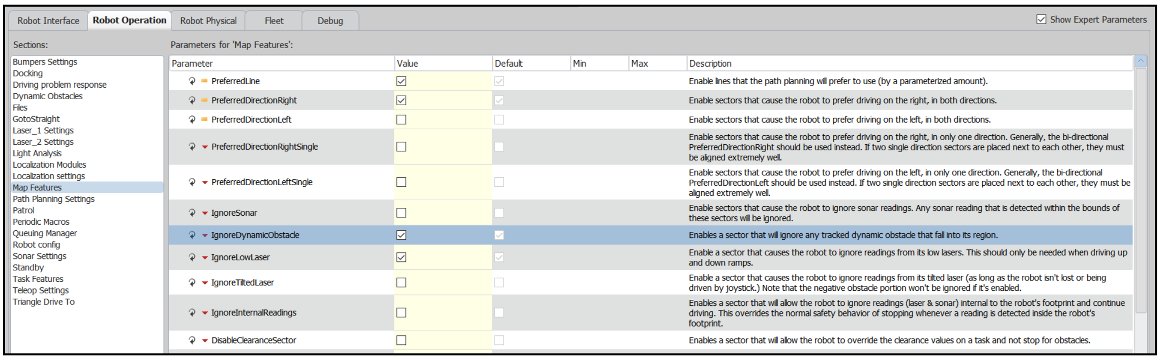


Figure 11-8. Enabling the IgnoreDynamicObstacle Sector

Description of Parameters

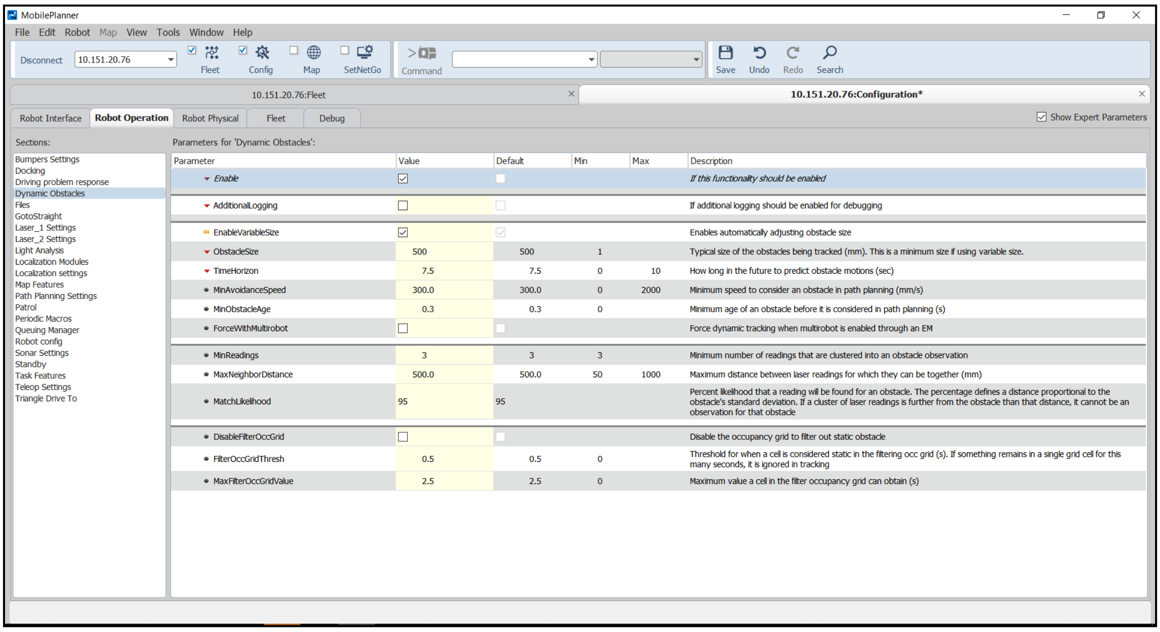


Figure 11-9. Configuration Parameters for Dynamic Obstacle Tracking

Parameters can be found in the Dynamic Obstacles configuration section of the Robot Operation tab of the configuration page, as shown in the figure above. Additional information is added here:

- Disable – Checking the box disables Dynamic Obstacle Tracking.
- AdditionalLogging – Adds highly verbose debugging info to the ARAM log, general not needed.
- EnableVariableSize – Scales the size of dynamic obstacles points (cyan colored) to match the objects they are tracking (see Figure 4 below).
- ObstacleSize – This is the size of the obstacles that DOT will create on the map if EnableVariableSize is turned off, otherwise it's the smallest obstacle size to track.
- DisableMaxObstacleSize – Checking the box disables the next parameter.
- MaxObstacleSize – DOT will not track obstacles large than the size defined here.
- TimeHorizon – DOT will predict obstacle trajectories this far into the future, for example: an object moving 1 m/s will project a 7.5 m path when TimeHorizon is set to 7.5 s.
- MinAvoidanceSpeed – Minimum speed of a tracked obstacle to have its path predicted, for example: if an AMR is moving less than 300 mm/s and the MinAvoidanceSpeed is 300, then that object will not have its path predicted.
- MinObstacleAge – The minimum amount of time in seconds for an obstacle to be tracked for its path to begin being projected.
- ForceWithMultirobot – Checking the box causes the Fleet Manager's multirobot to work with DOT, instead of overriding DOT when multirobot and DOT overlap. This should remain unchecked unless the environment has poor connectivity.
- MinReadings – The minimum number of primary laser readings necessary to project a predicted trajectory.

- MaxNeighborDistance – Maximum distance between laser groupings to be considered a as a single grouped obstacle.
- MatchLikelihood – Chooses a standard deviation percentage to scale with to determine if obstacle readings are outliers to be ignore, this should generally not be changed.
- DisableFilterOccGrid – Checking the box disables a grid which filters out unmapped static obstacles, this should generally remain unchecked.
- FilterOccGridThresh – Tenths of seconds required to determine if an unmapped obstacle is static, this should generally not be changed.
- MaxFilterOccGridValue – Tenths of a second to stop incrementing an unmapped obstacle as static, the difference between this parameter and FilterOccGridThresh is the time in tenths of a second required to forget a static area, this should generally not be changed.

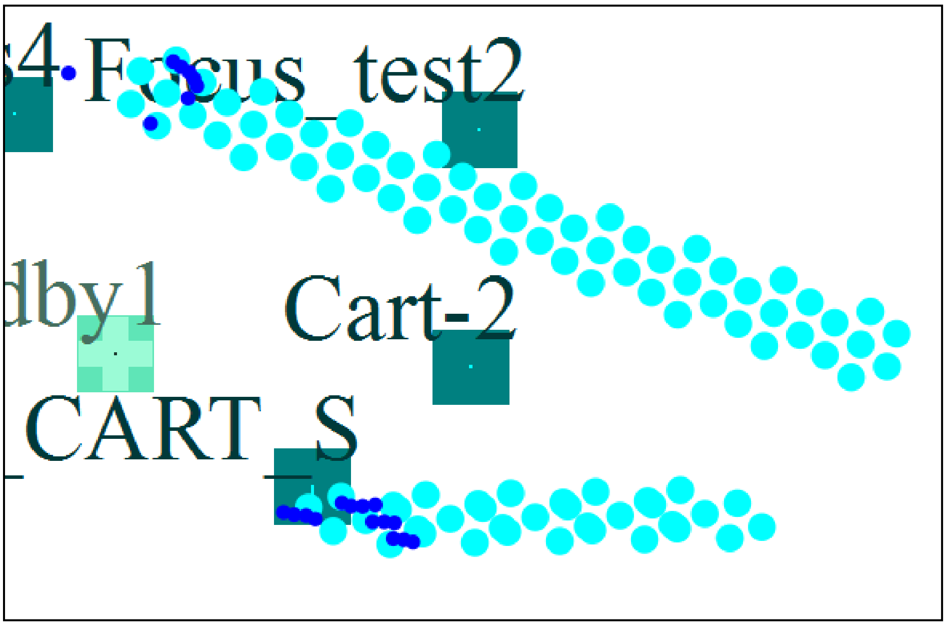


Figure 11-10. EnableVariableSize Parameter Causes the Cyan Obstacle Points to Match the Size of the Blue Obstacles They Track

Adjusting for Noise

Two parameters which are very easy to understand are also very easy to use for noise adjustment, MaxObstacleSize and MinAvoidanceSpeed. MaxObstacleSize should be set about 20% larger than the largest obstacle you expect to need to track, for humans this should be about 1000 mm or less, but forklifts and other objects may be larger.

MinAvoidanceSpeed should be set to at least 300 mm/s, as most objects travelling below this speed do not pose a collision risk. This parameter can be raised further if only slower AMRs (such as Cart Transporters) are being used, but should typically be left at or below 500 mm/s. The MinObstacleAge parameter can also be used to filter out static obstacles. Increasing this parameter increases the amount of time necessary for an object to have its path projected, which can cause lag in tracking. This lag could pose a risk if set too high when faster AMRs or obstacles (running persons, bikes) are present in the environment. This parameter should be left below 1.0 seconds, and 0.3 seconds is typically a good tradeoff between responsiveness and filtering. MinReadings can be used to tune to very specific obstacles and distances, more information is given in the section “Tuning”, below. MaxNeighborDistance prevents moving objects which appear to be multiple moving objects from being projected multiple times. For example, a walking person will appear to be two moving groups of laser readings, but by setting the MaxNeighborDistance greater than the distance between two legs the legs are treated as one dynamic obstacle. As such, both legs are given a single projection. FilterOccGridThresh and MaxFilterOccGridValue are more difficult to configure. Default values are set to handle most situations, and ignore areas will generally be a better fit for noise removal (see next section). These values should only be increased if unmapped static obstacles are taking too long to be filtered out as being static.

Zone Ignore Area

Dynamic obstacles can be ignored IgnoreDyanmicObstacleSector, just as sonar readings can be ignored with an IgnoreSonar sector. Dynamic obstacles from within an IgnoreDynamicObstacleSector will not create obstacle points which the AMR ignores, the AMR will not predict paths of obstacles located inside of the ignore sector. AMRs will not ignore the projected points of a dynamic obstacle inside the ignore sector if the obstacle is moving toward the sector. IgnoreDynamicObstacleSectors should be considered for use in areas where the AMR both will not enter and have workers or machines that commonly move around. This prevents the workers, whom are not likely to get in the AMR’s way, from being seen as dynamic obstacles to be avoided. Ignore sectors should also be used when a large amount of noise is present in an area, especially if most obstacles are static, as in the following figure.

Figure 11-11. An IgnoreDynamicObstacleSector (Purple) Used in a Noisy and Mostly Static Area

Turning

NOTE: Data from testing is provided in this section but any configuration setup should be tested in the application environment to ensure safe operation.

Tuning for People

In the following figure there are three data series. Each series represents the maximum distance that a person can be detected for any given MinReadings setting. Each series exists for a different type of relative motion. The “Perpendicular” series describes values for humans walking perpendicular to the AMR’s line of motion. “Straight to” series describes values for humans walking directly at the AMR. And the “Straight away” series is for humans walking away from AMRs. Dynamic Obstacle Tracking is best when tracking people walking perpendicular to the AMR’s line of motion, which would be crossing its path. Performance is similar for people walking away from the AMR, which can be useful for avoiding the area. The worst performance, by only a meter or two, is seen with humans walking straight towards the AMR. This is due to the time it takes to process a dynamic obstacle. To pick a MinReadings value, determine how far away you would like to detect people from. 15 meters is ideal, but not practical as a MinReadings of 3 or 4 will allow large amounts of noise through. If it was acceptable to start tracking people about 8 meters away, then a MinReadings value between 5 and 7 would be ideal. Determining the best distance to begin tracking people in the environment depends on how noticeable the AMR is. A very short AMR could be overlooked by a person, requiring a greater detection distance. Large, loud, and bright AMRs could be more noticeable and could only track people nearby. Additionally, members of the public or non-employee customers may not be comfortable around the AMRs and demand greater detection distances for their comfort and perception of safety.

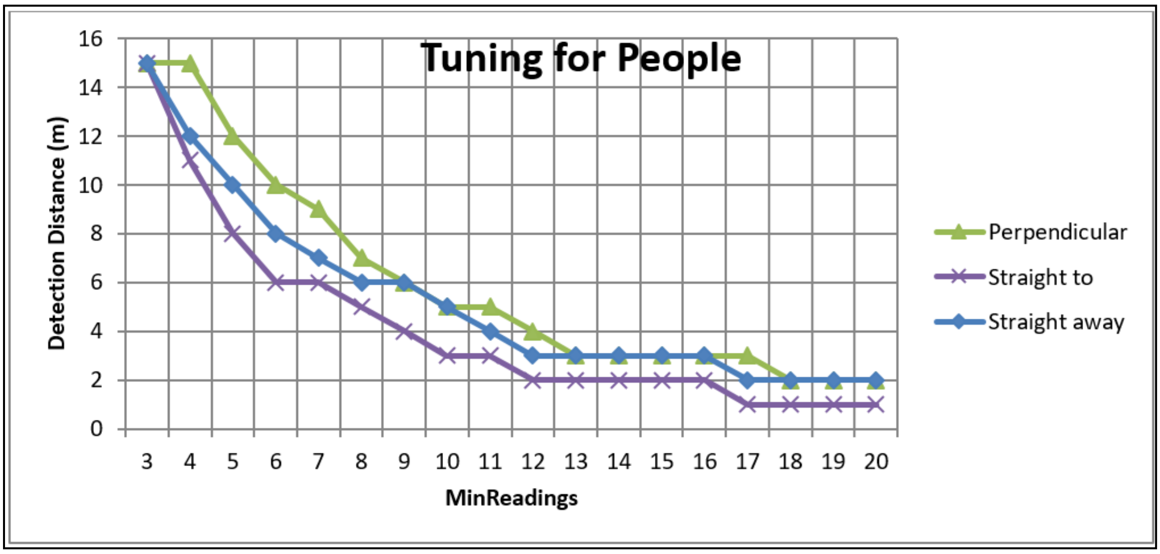


Figure 11-12. Turning for People

Tuning for Other LD AMRs

In an environments with poor Wi-Fi connectivity, DOT may be useful to prevent collisions if MultiRobot cannot broadcast correct positions of nearby AMRs in real time. The following chart can be used in the same manner as the chart in the previous section. For example, if detection to 8 meters was appropriate then a good value for MinReadings would be between 7 and 10.

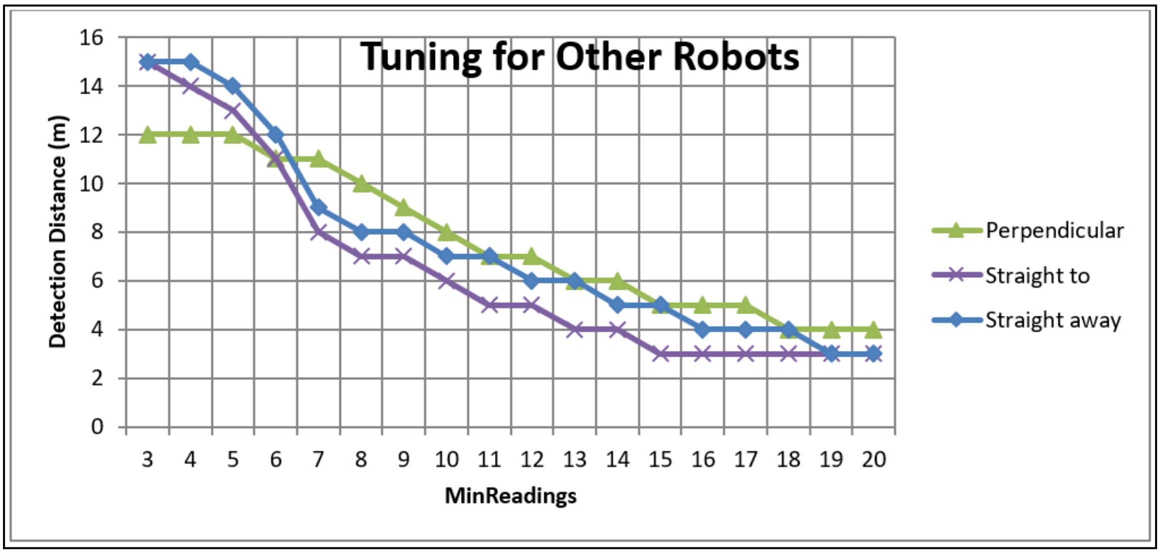


Figure 11-13. Turning for Other AMRs

Virtual Doors

Virtual doors (DefaultDoorWithGoals, for example) are areas on the map that allow the AMR to drive, automatically and seamlessly, through special areas. For instance, they allow an AMR to drive through plastic curtains that it would normally avoid.

When an AMR plans a path through a virtual door, it instead drives to a specified goal beforehand, and optionally to another specified goal afterward. As with normal goals, tasks can be done at the goals associated with virtual doors.

The following dialog opens when you insert a virtual door in a map:

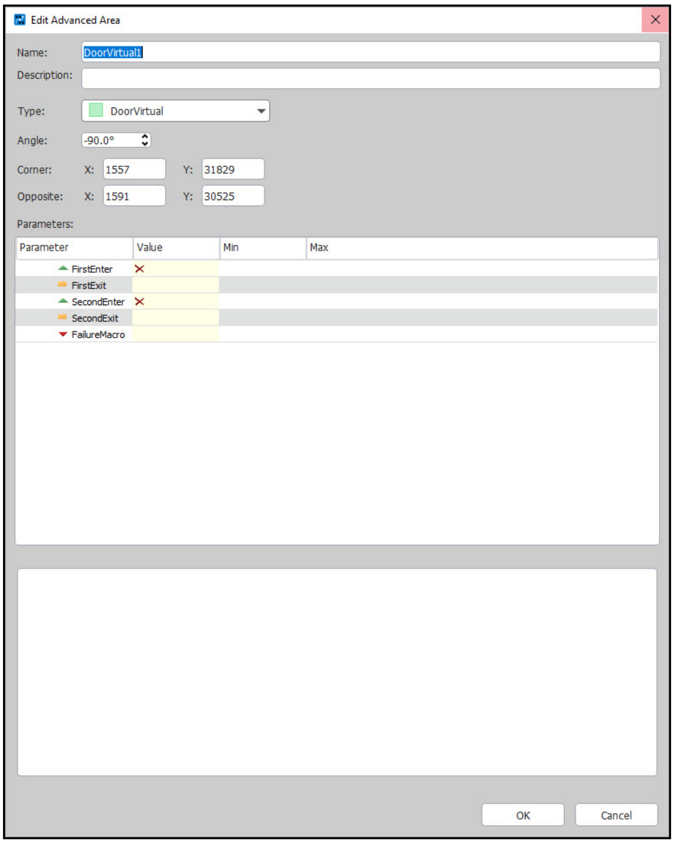


Figure 11-14. Edit Advanced Area, DoorVirtual

11.4 Directing Traffic

With MobilePlanner, you can direct AMR traffic by adding preferred lines and directions to your map.

Preferred lines make the AMR drive as though it's on a virtual rail, and reduce the 'cost' of grid squares it crosses. Though a preferred line might be longer than a straight path from Point A to Point B, the preferred line reduces the cost of each cell it crosses (the Preference parameter divides the cost of each cell the line crosses by 2, which means it costs half as much to drive close to the line), so it could be the least expensive in terms of the cost.

> **NOTE:** You can have MobilePlanner add grid lines to the map to help you place lines and areas more accurately. In MobilePlanner's main menu, click **Map > Grid**.

Using Preferred Lines

Before adding a preferred line to the map, enable (click the checkbox for) the PreferredLine parameter (in **Config > Robot Operations > Map Features > PreferredLine**) and **Save** the Config.

1. Click the **Map** Button to open the map you want to edit (see Using MobilePlanner Software on page 52 for details).
2. In the Draw pane, click **Advanced Lines,** then select **PreferredLine** from the list (the

cursor changes to indicate it is in drawing mode).

3. Place the mouse cursor on the map where you want the preferred line to start.

4. Click and hold the left mouse button, drag the mouse to where you want the preferred line to end, then release the mouse button.

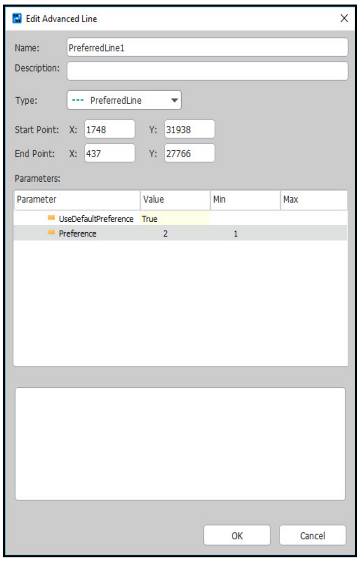


Figure 11-15. Edit Advanced Line, PreferredLine

The following table describes the parameters available on the Edit Advanced Line dialog box.

Parameter	Definition
Name	An optional name for the preferred line.
Description	An optional description for the preferred line.
Type	Set to PreferredLine. Selecting a different type from the pull-down menu changes the map's highlighted area to the selected type and updates the dialog box.
Start Point	X and Y coordinates of the PreferredLine starting point.
End Point	X and Y coordinates of the PreferredLine end point.
UseDefaultPreference	True or False (Boolean) value. If set to: • **True:** uses the default preference setting, ignores the Preference value. • **False:** the AMR overrides the path planning settings with the value of the Preference parameter. Use Path Planning Settings to specify default settings (see Path Planning and Collision Avoidance on page 231 for details).
Preference	Integer representing the line's preference. A normal line has a cost of '1', so a setting of '1' turns off the line's preferred behavior. A line with a preference of '2' means driving on the line costs half as much. Higher preferences yield a lower cost. Applies only when UseDefaultPreference is false. See Cost-Based Path Planning on page 231 for more information.

Using Preferred Directions

Preferred directions cause the AMR to attempt to drive on the specified side. In the image below, the AMR does not move directly down the center of the hall, but along the right wall (the preferred directions).

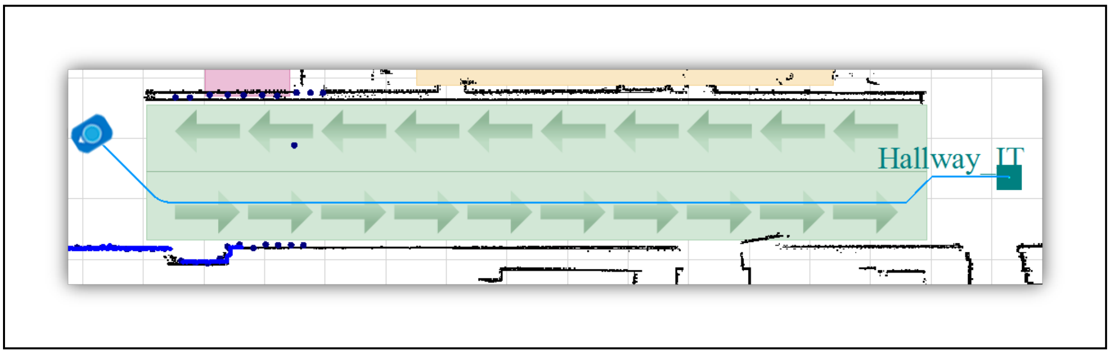


Figure 11-16. Preferred Direction

If the AMR cannot drive in the preferred direction for some reason, it will change its path to reach its goal, including driving against the preferred direction on the left side of the hallway (above). MobilePlanner allows you to add the following preferred directions to the map:

NOTE: You must enable each of the preferred directions listed below (**Config > Robot Operation > Map Features**) and **Save** before they will appear in the Advanced Areas pulldown menu (in the Draw tab).

- **PreferredDirectionLeft:** Places an area on the map that tells the AMR to drive on the left, in both directions.
- **PreferredDirectionLeftSingle:** Places an area on the map that tells the AMR to drive on the left, in one direction only. If you use this option and have two of these areas next to each other, align the two areas carefully. This is an advanced option. Use **PreferredDirectionLeft** for most applications.
- **PreferredDirectionRight:** Places an area on the map that tells the AMR to drive on the right, in both directions.
- **PreferredDirectionRightSingle:** Places an area on the map that tells the AMR to drive on the right, in one direction only. If you use this option and have two of these areas next to each other, align the two areas carefully. This is an advanced option. Use **PreferredDirectionRight** for most applications.

Adding a Preferred Direction to the Map

1. Click **Config > Robot Operations > Map Features**.
2. In the PreferredDirection (Right or Left) row, enable the PreferredDirection parameters you want to use, then **Save** the Config.
3. Click the **Map** Button to open the map you want to edit (see Using MobilePlanner Software on page 52 for details).
4. In the Draw pane, click **Advanced Areas**, then select the **PreferredDirection** from the list.
5. Place the mouse cursor on the map where you want the preferred direction to start.
6. Click and hold the left mouse button, drag the mouse to where you want the preferred area to end, then release the mouse button.

   The new area appears on the map, and the Edit Advanced Area dialog box appears.

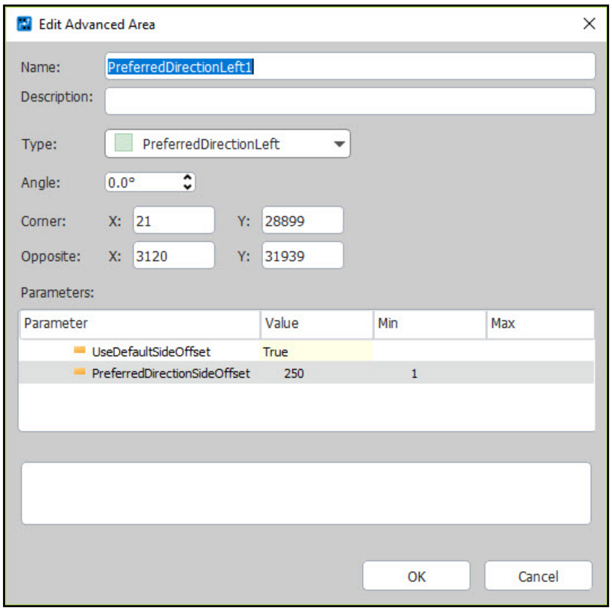


Figure 11-17. Edit Advanced Area, PreferredDirectionLeft

Edit Advanced Line Parameter	Definition
Name	Optional name for the preferred area.
Description	Optional description for the preferred area.
Type	Set to the type of preferred area you selected.
Angle	The preferred area's rotation angle.
Corner	The X and Y coordinates of the preferred area's starting corner.
Opposite	The X and Y coordinates of the preferred area's ending corner.
UseDefaultSideOffset	True or False (Boolean) value. If set to: • **True:** uses the default side offset. • **False:** the AMR overrides the path planning settings with the value of the PreferredDirectionSideOffset parameter. Use Path Planning Settings to specify default settings (see Path Planning and Collision Avoidance on page 231 for details).
PreferredDirectionSide Offset	(Integer) Represents how far away from the edge of the preferred direction area the AMR can drive.

Edit Advanced Line Parameter	Definition
	CAUTION: Setting this value too low can cause the AMR to drive out of the preferred area.

11.5 Controlling AMR Speed

You can control the AMR's speed in certain areas by adding Movement Parameter Areas to the map.

> **NOTE:** You can have MobilePlanner add grid lines to the map to help you place lines and areas more accurately. In MobilePlanner's main menu, click **Map > Grid**.

Adding Movement Parameter Areas to the Map

> **NOTE:** Movement parameters take effect after the AMR is in them.

1. In MobilePlanner, click **Config > Robot Operations > Map Features > MovementParameterSector** (checkbox).
2. Click the **Map** Button to open the map you want to edit (see Using MobilePlanner Software on page 52 for details).
3. In the MobilePlanner main menu bar, click **Map > Grid** to display the grid lines on the map.
4. In the Draw pane, click **Advanced Area**, then select **MovementParameters** from the pull-down menu.

   The cursor changes to indicate it is in drawing mode.
5. Place the mouse cursor on the map where you want the area to start.
6. Click and hold the left mouse button, drag the mouse to where you want the sector to end, then release the mouse button.

   The new area appears on the map.

Editing Movement Parameter Areas

1. In the Draw pane, click **Select**, then click on the area you want to edit to highlight it.
2. Right-click on the highlighted area, and select **Edit** from the pop-up menu.

   The Edit Advanced Area dialog box appears.

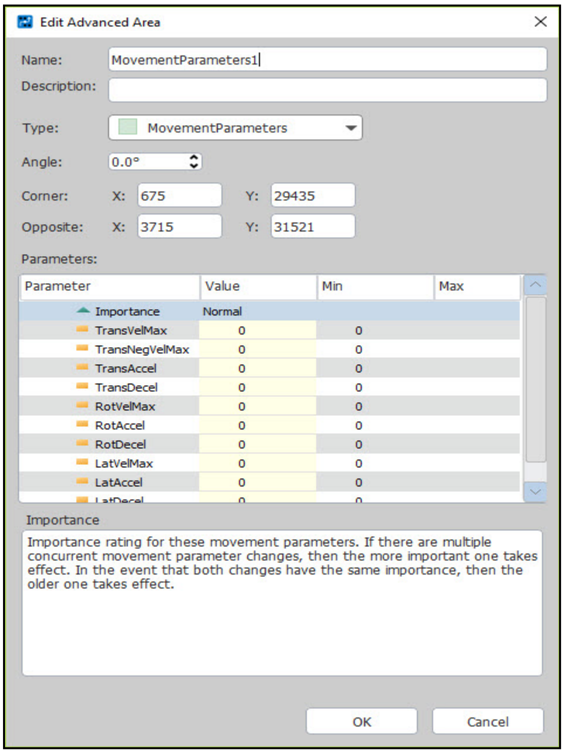


Figure 11-18. Edit Advance Areas, MovementParameters

The following table describes the parameters available in the Edit Advanced Area dialog box.

Parameter	Definition
Name	An optional name for the area.
Description	An optional description for the area.
Type	Set to **MovementParameters**. If you select a different type of advanced area, the highlighted area on the map changes to the selected type and the dialog box updates.
Angle	The angle the area is rotated within the map.
Corner	The X and Y coordinates of the starting corner of the area.
Opposite	The X and Y coordinates of the ending corner of the area.
Parameters	Parameters that affect the AMRs' behavior in the sector you drew on the map. A value of 0 means use defaults.

11.6 Restricting Traffic

You can restrict the AMR's movement by adding forbidden lines and areas to the map. These areas typically correspond to an area of the operating environment that you don't want the AMR to enter, or in which you want to restrict the number of AMRs operating at the same time (managed motion sectors). You can also add advanced features to the map that control traffic flow based on certain conditions. For example, you might want the AMR to avoid an area during monthly maintenance. You can set that up using switchable forbidden areas. You might also have an area in which you want only one AMR at a time.

You can set the parameters for these features in MobilePlanner by clicking **Config > Robot Operations > Map Features**.

The following features allow you to restrict AMR traffic in your operating space:

- Adding Switchable Forbidden Lines and Areas to the Map on page 249
- Using Resisted Lines and Sectors on page 252
- Using Need-to-Enter Sectors on page 255
- Using Single AMR Sectors on page 256 (helpful when you have multiple AMRs operating in the same environment)

  NOTE: You can have MobilePlanner add grid lines to the map to help you place lines and areas more accurately.

Using Forbidden Lines and Areas

You can place lines and areas on the map that correspond to places in your operating environment where you do not want the AMR to go. You can also add lines and areas that can be temporarily forbidden.

Forbidden lines are invisible barriers (virtual walls) in the operating space that the AMR will not cross when driving in Autonomous Drive mode (the default driving mode). The cost of map squares under a forbidden line is infinite. For more information see Manual Override on page 90.

Forbidden areas are places in the map that you do not want the AMR to enter. For example, if your operating environment has a loading dock that is open to the outside you might not want the AMR to accidentally drive outside, and off the loading dock. The area might be accessible on three sides, so you could place forbidden areas on the map corresponding to the loading dock.

You can also add forbidden lines and areas that you can turn on and off (switchable forbidden lines and areas).

Adding Forbidden Lines and Areas to the Map

NOTE: There are no required parameters for Forbidden Lines and Areas, which are always enabled.

1. Click the **Map** Button to open the map you want to edit. Refer to Using MobilePlanner Software on page 52 for details.
2. In the Draw pane, click on either **Forbidden Line** or **Forbidden Area**.

   The cursor changes to indicate it is in drawing mode, using a box around the icon to indicate an area.
3. Place the mouse cursor on the map where you want the forbidden line or area to start.
4. Click and hold the left mouse button.

5. Drag the mouse to where you want the line or area to end and release the button.

   The new forbidden line or area is selected and displayed in the map.

Adding Switchable Forbidden Lines and Areas to the Map

You can have certain tasks activate switchable forbidden lines and areas. These tasks can toggle individual lines and areas or they can toggle groups of switchable forbidden lines and areas.

1. To enable the **SwitchableForbiddenAreaAndLine** parameter, click **Config >Robot Operation >Map Features**, and click the checkbox to the right of the **SwitchableForbiddenAreaAndLine** parameter.

   NOTE: The server will automatically restart when you change the parameters.

2. Click the **Map** Button to open the map you want to edit. See Using MobilePlanner Software on page 52 for details.
3. In the Draw pane, click **Advanced Lines** or **Advanced Areas**, depending on what you want to add to the map.
4. Select **SwitchableForbiddenLine** or **SwitchableForbiddenArea** from the corresponding pull-down menu.

   The cursor changes to indicate it is in drawing mode, using a box around the icon to indicate an area.

5. Place the mouse cursor on the map where you want the line or area to start.
6. Click and hold the left mouse button, drag the cursor to where you want the line or area to end, then release the mouse button.

   The new switchable forbidden line or area appears on the map, and the Edit Advanced dialog box appears.

Editing Forbidden and Switchable Areas

NOTE: The following procedures only apply if you want to edit an existing advanced area.

1. Verify **Show Robot** is OFF then, in the Draw pane, click **Select**.
2. Either double-click on the area or line in the map, or right-click and select **Edit** from the pop-up menu.

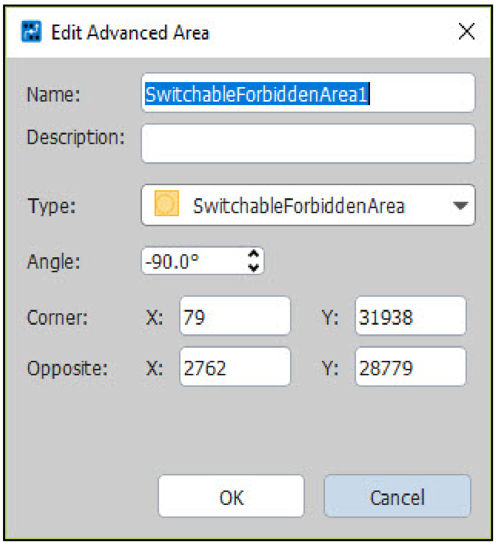


Figure 11-19. Edit Advanced Area, SwitchableForbiddenArea

The following table describes the options available in the dialog box.

Parameter	Definition
Name	A name for the forbidden area. **NOTE:** Since you switch forbidden areas by name, it's useful to use a common prefix when naming the ones you want to group together.
Description	An optional description for the forbidden area.
Type	Not displayed for ForbiddenLine. If you select a different type of advanced area in the drop-down list, the highlighted area on the map changes to the selected type and the dialog box updates accordingly.
Angle	The forbidden area's rotation angle (in degrees) in the map.
Corner	The X and Y coordinates of the forbidden area's starting corner.
Opposite	The X and Y coordinates of the forbidden area's ending corner.

Editing a Forbidden Line or a Switchable Forbidden Line

1. Verify **Show Robot** is OFF then, in the Draw tab, click **Select**.
2. Either double-click on the line in the map, or right-click and select **Edit** from the pop-up menu.

   If you selected a forbidden line, the Edi Forbidden Line dialog box appears. The Edit Advanced Line dialog box appears if you selected a switchable forbidden line.

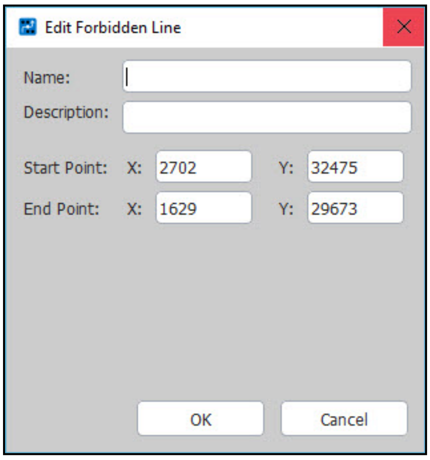


Figure 11-20. Edit Forbidden Line Dialog

Edit Forbidden Line Parameter	Definition
Name	An optional name for the forbidden line.
Description	An optional description for the forbidden line.
Type	Displayed for SwitchableForbiddenLine. If you select a different type of advanced line from the drop-down menu, the highlighted line changes to the selected type and the dialog box updates.
Start Point	The X and Y coordinates of the starting point of the forbidden line.
Opposite	The X and Y coordinates of the ending point of the forbidden line.

Switchable Forbidden Lines and Areas

There are two ways to turn on or off a Switchable Forbidden Line or Area:

- Tasks
- ARCL

  NOTE: ARCL is outside the scope of this manual. Refer to the corresponding reference guides for those products.

There are four tasks you can use to turn a Switchable Forbidden Line or Area ON or OFF:

- switchForbiddenOff
- switchForbiddenOn
- switchForbiddenOffByPrefix (you can specify a text prefix that turns all switchable areas with that prefix OFF)
- switchForbiddenOnByPrefix (you can specify a text prefix that turns all switchable areas with that prefix ON)

Driving into a Forbidden Area

Occasionally you might need the AMR to drive into a forbidden area. You can make the AMR do this by turning ON Manual Override mode, or using the pendant (even with Autonomous Drive mode ON).

1. Click the **Map** Button to open the map containing the forbidden area.
2. Attempt to drive the AMR into the forbidden area from multiple sides - the AMR should slow down and stop just before the forbidden area.
3. Click **Robot > Robot Tools > Manual Override** to turn Autonomous Drive mode OFF.

   WARNING: Turning Autonomous Drive mode OFF disables the AMR's obstacle-avoidance (of obstacles detected by the navigation laser) at speeds under 300 mm/second. Use extreme caution when driving the AMR under these circumstances.

4. Select **Yes** to turn Autonomous Drive mode OFF.
5. Drive the AMR into the forbidden area. This time the AMR should drive into the area.

   NOTE: Manual Override must remain ON to drive the AMR out of the forbidden area. Notice that the background color of the map changes to yellow when Manual Override is turned ON.

Using Resisted Lines and Sectors

You can add lines and areas to the map, called resisted lines and sectors, that the AMR will attempt to avoid because they cost more to drive through. The AMR's path planning system is similar to a GPS system that recalculates a route to avoid road construction. However, if another route is not available, the AMR follows the original. Similarly, the AMR will resist entering a sector or crossing a boundary if it is possible to avoid it; however, if it needs to drive through a resisted sector to reach its goal, it will.

Adding Resisted Boundaries and Sectors to the Map

1. In **MobilePlanner > Config > Robot Operation > Map Features**, enable ResistedSectorAndLine. See Setting the Configuration Parameters on page 157
2. **Save** your change to the AMR.
3. Click the **Map** Button to open the map you want to edit.
4. Ensure **Show Robot** is OFF, then click **Draw > Advanced Lines** or **Draw > Advanced Areas**, depending on what you want to add to the map.
5. In the pull-down menu, select **ResistedLine** or **ResistedSector**, and note that the cursor changes to indicate that it is in drawing mode (has a box around the icon to indicate an area).
6. Place the mouse cursor on the map where you want the resisted line or sector to start.
7. Click and hold the left mouse button.

8. Drag the mouse cursor to where you want the line or sector to end and release the button to display the new resisted line or sector in the map, and the Edit Advanced Area dialog box.

Editing Resisted Sectors

1. Verify that **Show Robot** is OFF and, in the Draw tab, click **Select**.

2. Either double-click or right-click on the sector in the map and select **Edit** from the pop-up menu.

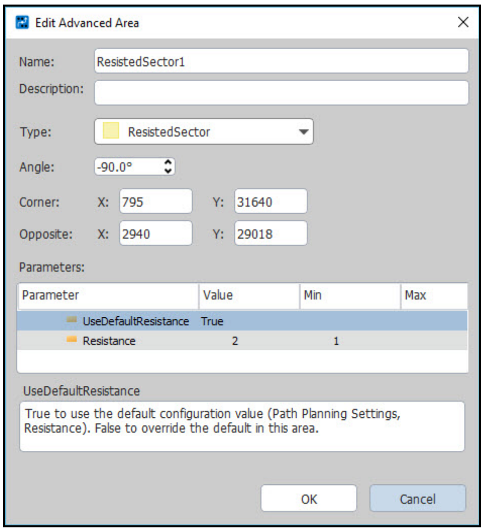


Figure 11-21. Edit Advanced Area, ResistedSector

Edit Advance Area Parameter	Definition
Name	A name for the resisted sector.
Description	An optional description for the resisted sector.
Type	Set to **ResistedSector**. If you select a different type of advanced area, the highlighted area changes to the new type and the dialog box updates.
Angle	The rotation angle of the resisted sector in the map.
Corner	The X and Y coordinates of the resisted sector's starting corner.
Opposite	The X and Y coordinates of the resisted sector's ending corner.
UseDefaultResistance	(Boolean) value. A True setting uses the default resistance setting , and ignores the Resistance value (default settings are set using the Path Planning Settings - see Path Planning and Collision Avoidance on page 231). If this is False, the AMR overrides the path planning settings with the value of the Resistance parameter.
Resistance	(Integer) Determines the cost of crossing the area. Defines how much the AMR will resist driving through a particular sector, and find an alternative path. The cost of driving through a resisted sector is multiplied by its resistance value. A normal area or sector has a cost value of 1. Set this value to 1 to turn off the resistance behavior.

Editing Restrictive Lines

1. Verify that **Show Robot** is OFF and, in the Draw tab, click **Select**.
2. Double-click (or right-click) on the boundary in the map, and select **Edit** from the pop-up menu.

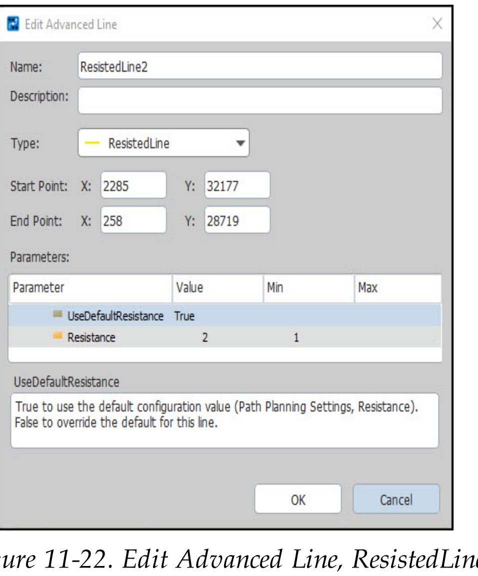


Figure 11-22. Edit Advanced Line, ResistedLine

Edit Advanced Line Parameter	Definition
Name	A name for the resisted boundary.
Description	An optional description for the resisted boundary.
Type	Set to **ResistedLine**. If you select a different type of advanced area, the highlighted area changes to the new type and the dialog box updates.
Start Point	The X and Y coordinates of the starting corner of the resisted boundary.
End Point	The X and Y coordinates of the ending corner of the resisted boundary.
UseDefaultResistance	(Boolean) A True setting uses the default resistance setting (set in the Path Planning Settings in the Advanced Areas pull-down menu). See Path Planning and Collision Avoidance on page 231 for details. If False, the AMR overrides path planning settings with the Resistance parameter value.
Resistance	(Integer) Determines the cost of crossing a boundary, how much the AMR resists driving across it, and finds an another path. The cost of driving across a boundary is multiplied by its resistance value. A normal area has a cost of 1, so set this value to 1 to turn off the resistance behavior.

Using Need-to-Enter Sectors

You can add areas to the map that only allow the AMR to enter if the goal the AMR is trying to reach is inside the sector. These are referred to as need-to-enter sectors. If the AMR is already in a need-to-enter sector, it can drive around in the sector or drive out of it.

Need-to-enter sectors are useful in (for example) cases in which there are loading or unloading areas where another AMR could cause congestion if it tries to pass through.

Adding Need to Enter Sectors to the Map

1. In **MobilePlanner > Config > Robot Operation > Map Features**, enable NeedToEnterSector. For details on how to do this, see Configuring the AMR on page 154.
2. **Save** your change to the AMR.
3. Click the **Map** Button to open the map you want to edit.
4. Click **Draw > Advanced Areas**.
5. Select **Need to Enter** from the pull-down menu, and note the cursor changes to indicate it is in drawing mode.
6. Place the mouse cursor on the map where you want the sector to start.
7. Click and hold the left mouse button.

8. Drag the mouse cursor to where you want the sector to end and release the button. The new need-to-enter sector highlights and appears in the map, and the Edit Advanced Area dialog box appears.

Editing Existing Need-to-Enter Sectors

1. Click **Select**.

2. Either double-click on the resisted sector in the map, or right-click on the sector and select **Edit** from the pop-up menu to display the Edit Advanced Area dialog box.

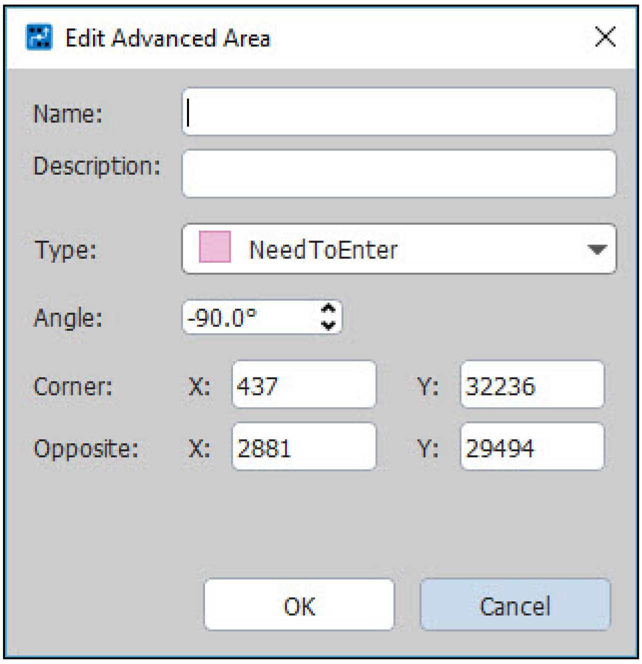


Figure 11-23. Edit Advanced Area, NeedToEnter

The following table describes the options available on the Edit Advanced Area dialog box.

Parameter	Definition
Name	A name for the need-to-enter sector.
Description	An optional description for the need-to-enter sector.
Type	Set to **NeedToEnter**. If you select a different type of advanced area, the highlighted area on the map changes to the selected type and the dialog box updates accordingly.
Angle	The angle the sector (rectangle) is rotated within the map.
Corner	The X and Y coordinates of the starting corner of the sector.
Opposite	The X and Y coordinates of the ending corner of the sector.

Using Single AMR Sectors

Single AMR sectors allow you to add areas to the map that only allow one AMR at a time to be in the specified area. This is useful for narrow hallways or narrow areas with only one entry/exit.

Adding Single AMR Sectors to the Map

1. In **MobilePlanner > Config > Robot Operation > Map Features**, enable **SingleRobotSector**. See Configuring the AMR on page 154 for details.
2. **Save** your change to the AMR.
3. Open the map you want to edit. See Using MobilePlanner Software on page 52 for details.
4. Ensure that **Show Robot** is **OFF**, then click on the **Grid** toolbar icon to display the grid lines on the map. This helps you to place the lines and areas more accurately.
5. Click **Draw > Advanced Areas**.
6. Select **SingleRobot** from the pull-down menu (the cursor changes to indicate that it is in drawing mode).
7. Place the mouse cursor on the map where you want the single AMR sector to start.
8. Click and hold the left mouse button.
9. Drag the mouse cursor to where you want the sector to end and release the button to highlight the new area in the map.

Editing Existing Single AMR Sectors

1. Click **Select**.
2. Either double-click on the sector in the map, or right-click on the sector, and select **Edit** from the pop-up menu to display the Edit Advanced Area dialog box.

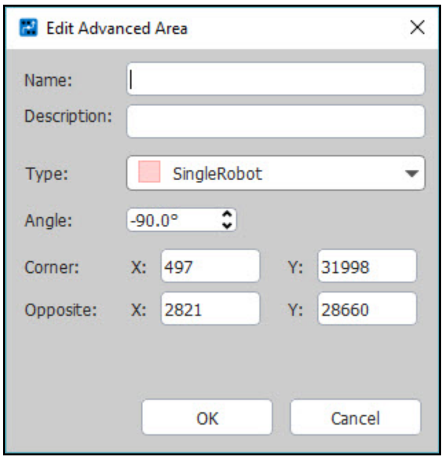


Figure 11-24. Edit Advanced Area, SingleRobot

The following table describes the options available on the Edit Advanced Area dialog box.

Parameter	Definition
Name	A name for the single AMR sector.
Description	An optional description for the single AMR sector.
Type	Set to **SingleRobot**. If you select a different type of advanced area from the pull-down menu, the highlighted area on the map changes to the selected type and the dialog box updates accordingly.
Angle	The angle the sector is rotated within the map.
Corner	The X and Y coordinates of the starting corner of the area.
Opposite	The X and Y coordinates of the ending corner of the area.

Chapter 12: AMR Localization

When a moving AMR is operating in an environment such as an office building or a warehouse, it must have some way of tracking its position and orientation on a map. This tracking is called localization. Accurate localization is a prerequisite for autonomous navigation.

This section discusses the types of localization your AMR uses. For more information, refer to the following:

12.1 What is Localization?

Localization is the way in which the AMR knows its location on the map. It is a process the AMR uses to estimate its position in its environment based on data collected during operation. Currently, the AMRs can use two types of localization:

- Laser localization uses data from the AMR's laser in conjunction with the map to calculate the AMR's position. This is the default way the AMR keeps track of its position in the operating space and is most useful in a static environment such as an office building or hospital.Using Laser Localization on page 263.
- Optionally, an AMR can use overhead lights to track its position in the environment. This localization process is often used in dynamic environments, such as a warehouse, where objects move too frequently for the AMR to localize based on their past positions. Using Acuity for Light Localization on page 267.

The key to localization is obtaining an accurate map of the environment (see Working with Map Files on page 99). The AMR compares the map to the data collected from its sensors to correct its position. With this information, the AMR knows its position on the map.

> **NOTE:** The AMR combines data collected with either of these methods with data from encoders on its wheels and the gyroscope in its core to determine its location.

Overview of Localization Process

Localization requires an iterative process of correcting for errors in the AMR odometry. When an AMR is powered up, it must determine its initial position (which could be its last position when it shut down). During operation, the AMR calculates the current position based on its last known position, along with the AMR's speed and direction. The AMR periodically recalculates its position to make sure it knows where it is. If the AMR cannot calculate a reliable pose, it is lost and must stop. After the AMR recalculates its position, the current location becomes the last known location.

12.2 Comparing Laser and Light Localization

The AMR can use data from its laser or from an upward-facing camera viewing the position of overhead lights (or a combination of the two), to accurately determine where it is in its physical space and in the map.

The following table highlights the differences between laser and light localization. For more information on each localization process, refer to the appropriate section.

	Laser Localization	Light Localization
Description	Uses a laser range finder located on the AMR to perform localization.	Uses a camera located on the AMR to monitor overhead lights in the environment as points of reference to perform localization.
Equipment	Laser range finder (standard)	Upward-facing camera option.
Accuracy vs. Reliability	Provides more accurate location data, but the AMR cannot deal with highly dynamic environments.	Provides more reliable localization in a dynamic environment, because there is less chance for the AMR to get lost, but the AMR positioning is less accurate.
Recommended Environment	Static (such as an office building)	Dynamic (such as a warehouse)

12.3 What Causes the AMR to be Lost?

When an AMR no longer has enough confidence in its position, it broadcasts that it is lost, and stops driving until a human intervenes. When an AMR is lost, it stops moving and broadcasts a notification (in the form of the dialog box below) that it needs attention.

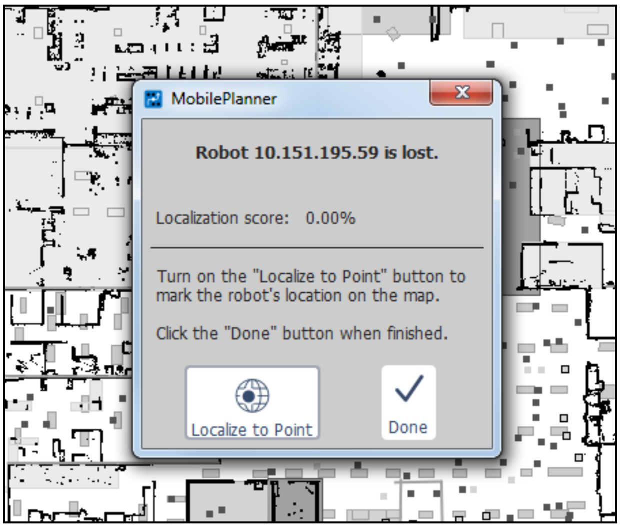


Figure 12-1. Localization Dialog - Lost Robot

Localizing a Lost AMR

1. Click **Localize to Point** in the lost AMR dialog box.
2. Click and hold the mouse on the map where you want to localize the AMR (at the

AMR’s current physical location) and, while holding the left mouse button, drag the mouse cursor to set the AMR's heading.

The Localization Score (or confidence threshold) should be 80% or better for optimum navigation.

3. Click **Done** when the AMR's localization score is where you want it to be.

Adjusting the Confidence Threshold

The PassThreshold and LostThresholdDistance parameters (**for laser localization**) and LockThreshold and LostLockUncertaintyThreshold parameters (**for light localization**) set the criteria for when an AMR is lost. With each localization, the AMR generates a localization score. The AMR is not considered lost until the localization score drops 20% below the PassThreshold parameter (**for laser localization**) or -100 on the LostLockUncertaintyThreshold (**for light localization**), and fails to recover. Once the localization score drops below PassThreshold/LockThreshold, the AMR will move up to LostThresholdDistance/LostLockUncertaintyThreshold, trying to raise its score. If it fails, it is considered lost. You can adjust the parameter values as needed.

LostThresholdDistance is the maximum distance (in mm) that the AMR will move from the last localized pose before the AMR will be considered lost. This parameter will only come into play if none of the samples during the sensor correction is higher than PassThreshold. As soon as this happens, the position uncertainty distance will grow based on the movement from the last localized pose.

1. In MobilePlanner, click **Config > Robot Operation > Localization settings** (or **Light Localization settings**).
2. Click on the **PassThreshold Value** (or **LockThreshold value** for light localization) field and enter a new threshold value (the minimum score to consider the AMR localized).
3. Click on the **LostThresholdDistance Value** (or **LostLockUncertaintyThreshold value** for light localization) field and enter a new distance value if desired.

12.4 Optimizing Localization

Localization accuracy depends on the accuracy of the map and sensor measurements. Typically, the AMR should be able to localize in most indoor environments. Occasionally, however, the AMR encounters situations in which it has trouble localizing, which can impact its ability to navigate.

The most common problem with localization is map accuracy. It might not have been accurate enough to begin with, or the environment might have changed enough (partitions moved, etc.), that the map no longer reflects the working environment.

You can improve localization accuracy, to some extent, by adjusting the localization parameters. However, changing one parameter generally affects other parameters. Therefore you will likely need to adjust several parameters to fine tune the localization score.

Laser and Light Localization use different parameters that you can adjust. Those parameters are discussed in Localization Parameters on page 264 and Light Localization Parameters on page 270 respectively. However, there are a few general guidelines to consider before you change parameter values.

Before Changing Parameter Values

Before changing any parameters (localization or other), make sure your map contains as much accurately scanned data as possible. The more static features the map has (walls, doors, shelves, etc.), the better the AMR is at navigating its way through the space.

- Don't erase any data from the map unless those points really do not correspond to any real, fixed object.
- Re-scan areas where features have been removed from or added to an area in the environment.
- If there were errors in the map-making process, and your map does not match the real space, re-scan the area again more carefully.

CAUTION: Before changing parameters, save a copy of your current config file. When experimenting with parameters, try one parameter or a small combination of parameter changes at a time. Revert to your saved config file if the AMR's performance does not improve. See Configuring the AMR on page 154.

12.5 Using Laser Localization

OMRON AMRs use one of two methods to locate their position in their environment: laser or light localization. For more information on using light localization, refer to Using Acuity for Light Localization on page 267.

Laser localization uses a laser range finder, located on the AMR, to detect walls and other objects in the environment. The data collected from the laser is combined with the AMR's odometry information and the map, which enables the AMR to determine its location.

Overview of Laser Localization

The most common way to localize an AMR in a given space is to use a laser range finder. The laser range finder takes a planar snapshot of the environment, then compares this with the map of the environment to determine the AMR's position. This is a relatively accurate method of localization for environments that tend to be static, such as an office space.

If the laser localization cannot match the laser readings to the map, it does have some logic that allows the AMR to drive for a while before reporting that it is lost. However, this is only useful in temporary situations, such as the AMR driving through a small area where a group of people have gathered.

In a dynamic space where unmapped cargo and equipment move in and out of the area (such as in a warehouse), data from the unmapped objects can easily overwhelm the mapped data, causing the laser localization to fail. In these situations, it is better to use light localization. See Using Acuity for Light Localization on page 267 for details.

Key Features

- Laser localization gives accurate positioning data for precise navigation, particularly in a relatively static environment.
- No potentially expensive retrofitting required to use laser localization.
- The map only needs to be updated if there is a change in the static environment.
- The AMR continues to operate even if some of the map features have changed, resulting in a flexible solution.

Limitations of Laser Localization

Laser localization is an accurate method of localization in a static environment such as an office, but has some limitations to consider:

- The laser cannot see glass, mirrors, or shiny objects. Environments with a lot of these objects make it difficult for the AMR to localize.
- In dynamic environments in which objects frequently change positions (such as a warehouse), laser data might not match mapped data closely enough for the AMR to localize. In these areas, the map won't contain objects added or moved after you created the map.
- In an environment with a lot of high racks for the AMR to navigate through, the confidence threshold could fall below 20% and cause the AMR to become lost.

Localization Parameters

In MobilePlanner, you can access the AMR's localization parameters and adjust them as needed.

To access the laser localization parameters, click **Config > Robot Operation > Localization settings**.

Improving Accuracy and CPU Usage

For laser localization, two settings directly affect the CPU usage for each localization:

- **GridRes** represents the size of the grid used for localization. The smaller the value is, the more accurate the localization score.
- **NumSamples** represents the number of poses sampled (or checked) each time the AMR moves; this number scales linearly, so adjusting a value of 2000 to 3000 takes up 1.5 times more processing power.

Other factors, such as TriggerDistance and TriggerAngle determine how often it attempts to re-calculate (or re-localize) its position. Recalculating uses a lot of CPU so, if the value of NumSamples is set too high, the AMR will localize less often. This can actually cause more problems than an AMR that localizes less accurately, but more often.

The K parameters (KMmPerMm, KDegPerDeg and KDepPerMm) are error parameters, and are explained below.

Using Laser Localization Parameters

With MobilePlanner, you can access the AMR's configuration parameters and adjust them as needed.

To access the laser localization parameters, click **Config > Robot Operation > Localization settings**.

In general, high CPU use for one laser scan might prevent the AMR from scanning as often as needed. Setting these parameters requires balance.

You can change parameters that affect the level of detail in an AMR's scan, how many possible locations (poses) the AMR will compare those results with, and how frequently, both in time and travel, it rechecks its location. There are also parameters to adjust the amount of expected error, both linear and rotational.

Additional Information:

- The robot configurations allows the end-user to adjust the Rotational Deceleration as well as the Rotational Acceleration. Make sure that the values of these two parameters are equal, and lower than the default values.
- The robot configurations allows the LD robot series to have a value of 360 deg/s^2. This large value, however, may not be an ideal value for smooth run when turning.
- The RotAccel and RotDecel parameters should be the same value. Setting differing values may result in sub-optimal driving smoothness.

Localization Parameters and Effects on CPU Use

Parameter	Description	Effect(s) on Localization
AdjustNumSamples Flag	Varies the number of samples based on the localization score.	When enabled, lowers the number of samples when the AMR is moving and the localization score is high. Reduces CPU demand.
AngleIncrement	Separation (in degrees) required between laser settings used for localization.	Discards readings too close together. Reduces CPU demand.
GridRes	Resolution (in mm) of map grids.	Scan resolution. Decreasing this value increases localization accuracy, but increases demand on RAM.
KMmPerMm	Millimeters of linear error per linear millimeter of travel.	Allowed percentage error (in mm) of the AMR's linear odometry readings. If set too high, sample poses are too spread out for the AMR to determine its location. If set too low, the AMR might not be able to localize.
KDegPerDeg	Degrees of error per degrees rotated.	Allowed percentage error (in deg) of the AMR's rotational odometry readings. If set too high, sample poses too spread out for the AMR to determine its location. If set too low, the AMR might not be able to localize.
KDegPerMm	Degrees of error per linear mm traveled.	Allowed error (in deg) of the AMR's rotation per one mm of linear travel. If set too high, sample poses too spread out for the AMR to determine its location. If set too low, the AMR might not be able to localize.
NumSamples	Number of pose samples AMR uses for localization.	Scan resolution. Increasing this value increases localization computations. If too low, the AMR fails to localize.
TriggerDistance	Distance AMR travels (in mm) before localizing.	How often to localize – helps reduce CPU demand. The AMR only localizes when it travels beyond listed value.
TriggerAngle	Angle (in deg) AMR turns before triggering localization.	How often to localize – helps reduce CPU demand. The AMR only localizes when it rotates beyond the listed value.

12.6 Using Acuity for Light Localization

Light Localization uses a wide-angle camera mounted on the AMR to detect the fixed overhead lights in the operating environment. After combining light position data with its odometry readings and map data, the AMR knows where it is in physical space on its map.

> **NOTE:** The navigation laser remains active for obstacle avoidance even when not being used to for navigation.

> **NOTE:** Acuity localization is not yet available for the HD-1500 AMR.

Overview of Light Localization

Using overhead lights as landmarks, the AMR is able to reliably calculate its position within its environment.

Light Localization allows the AMR to localize in a dynamic environment where change is frequent. A warehouse, for example, includes many boxes, pallets, vehicles and people that move frequently. In this situation, the AMR can use the overhead lights to determine its position in the environment. The AMR uses both camera and odometry data to calculate its current position.

Key Features

Key features of light localization include:

- No expensive retrofitting required to use light localization.
- The lights do not require special maintenance.
- Because the lights are overhead, they are not blocked by ground level obstructions that could prevent laser sensors from working.
- The map does not need to be updated because the light positions typically do not change.
- Even if some lights have failed, the AMR still has a reliable solution and continues to operate.

> **NOTE:** Using light localization in spaces with lights at different heights, or places with lights visually behind others, can require different scanning techniques not covered in this guide. For details, see the *Mobile Robots - LD Platform Peripherals Guide (Cat. No. I613).*

Creating the Light Map

Before creating a Light Localization map, be sure you are familiar with creating an initial map scan. Refer to Scanning the Operating Area on page 96 for more information.

> **NOTE:** When scanning the operating environment using Light Localization, be sure to drive under the lights or as close to the lights as possible. You need to do this in more than one direction, to make sure the camera sees the lights from all angles, collecting pan and tilt data along the way.

Compared with laser localization scan files, Light Localization scan files contain additional information about the AMR's operating environment and, therefore, require extra processing steps. The resulting map files also contain information about the location and height of overhead lights detected during the scanning process.

Light Localization is only available on AMRs equipped with the Acuity option, and you must enable the LightLocalization parameter in the MobilePlanner software to activate it. Refer to Configuring the AMR on page 154 for details.

Adjusting the Light Analysis Parameters

1. In MobilePlanner click **Config > Robot Configuration > Light Analysis**.

   This will display the parameters associated with light analysis.

2. Select **Show Expert Parameters** to access the main light analysis parameters.

The following table describes the most important parameters for light analysis:

Parameter Name	Description
3d:MinLightHeight	Minimum height (in mm) of the lights above the floor. This value is approximate and should be lower than the real value. It is used to establish a valid range and eliminate false positives (Double).
3d:MaxLightHeight	Maximum height (in mm) of the lights above the floor. This value is approximate and should be higher than the real value. It is used to establish a valid range and eliminate false positives (Double).
3d:MinLightLength	Minimum length (in mm) of the lights. This value is approximate and should be slightly lower than the real value. If -1, then this value is ignored (Double).
3d:MaxLightLength	Maximum length (in mm) of the lights. This value is approximate and should be slightly higher than the real value. If -1, then this value is ignored (Double).

Set the 3d:MinLightHeight and 3d:MaxLightHeight parameters to a range that encompasses the ceiling and light heights, but not too large.

If the lights are fluorescent tubes or the lights are partially hidden from the camera's view, you may also need to adjust the 3d:MinLightLength and 3d:MaxLightLength parameters.

After making these adjustments, reprocess the light scan in MobilePlanner. This does not require redoing the laser portion of the map creation, just reprocessing the light data.

Creating the Light Map

1. Turn all lights **ON** in the operating environment.
2. Open MobilePlanner and start the scan process. See Scanning the Operating Area on page 96 for details.
3. Drive the AMR around the environment, paying special attention to the overhead lights. Drive under the overhead lights in several directions.
4. Stop the scan.

5. Turn the scan into a map (see Convert the Scan into a Map on page 97 for details).
6. Verify the scanned map shows overhead lights in the correct position and with the correct height.

   You can view the height data by moving the mouse over the light icon on the map. The overhead lights appear as blue squares, rectangles or points (depending on the type of light), as shown below.

Figure 12-2. MobilePlanner Light Map - Detail

7. If the light map looks correct, click **Finish** on the Scan Tools toolbar.
8. If the light map does not look correct, you will need to adjust the light analysis parameters and reprocess the scan. See Adjusting the Light Analysis Parameters on page 268 for details.

By default, the overhead lights are hidden from the map after turning the light scan into a light map. You can view the lights by selecting **Map > Map Data > Light Items** from the MobilePlanner main screen.

The light map contains data (such as height) about the lights seen by the camera, but does not contain images of the lights themselves.

Limitations of Light Localization

Light Localization is a reliable method of localization, even in a dynamic, frequently changing environment such as a warehouse. The number of lights visible lights affects the accuracy of the AMR's estimated position and, if the AMR travels for a long time in a sparsely lighted area, it will end up with a low localization score. However, in general, the AMR tends not to get lost as often using light localization which is, therefore, more reliable in a dynamic environment.

Consider the following limitations:

- The lights must be on and visible for light localization to work.
- Skylights can be problematic.
- Currently, light localization works with LED lights, can lights (displayed as squares on the map) and fluorescent tube lights (displayed as rectangles).
- The more lights visible to the AMR, the better. Light localization does not work well with only one or two lights in an area.
- The lighting must be direct. The AMR must see a bulb or diffuser, not just a light reflection off of another surface.
- An environment that has lights of varying brightness might have problems.
- The tilt of the camera is assumed to be fixed. A change to this, such as when the AMR is on a tilted floor in the building, adversely affects the light localization.
- The accuracy of the localization depends on the accuracy of the light map. If the lights in the map are incorrect due to mapping errors, the localization will show a similar offset.
- The vertical distance from the camera to the lights should be at least a couple of meters for the light localization to work well. If the lights are too close to the camera, the error will be more than when the lights are farther away.

Light Localization Parameters

In MobilePlanner software, you can access the AMR's configuration parameters and adjust them as needed.

Accessing Light Localization Parameters

Click **Config > Robot Operation > Light Localization**.

This will display the parameters associated with light localization.

> **NOTE:** The parameters for light localization are described in the software, and are not repeated here.

Chapter 13: Glossary and Definitions

The following table lists acronyms and abbreviations, and defines key terms found in this user guide:

Term	Definition
802.11a, b, g, n, or ac	Standard for wireless local area networks (WLAN) in the 2.4GHZ and 5GHz frequency bands.
Acuity	AMR-mounted camera system for localizing the AMR using overhead lights versus its laser.
AES	Advanced encryption standard
AIFF	Audio interchange file format
AMR	Autonomous mobile robot
ARAM	Advanced robotics automation management
ARC4	Alleged Rivest Cipher 4 (RC4)
ARCL	Advanced Robotics Command Language. A simple, text-based, command-and-response operating language. Used with the Fleet Manager, ARCL can help manage a fleet of AMRs.
ARP	Address resolution protocol
A/V	Audio/Visual
Boolean	A type of data with two possible values, usually 'true,' or 'false.'
CA	Certificate Authority
CAPS	Cell Alignment Positioning System. A software option that uses a fixed-mount target in the workspace to provide more accurate AMR positioning when approaching a destination.
CCMP	Counter mode with Cipher block chaining message authentication code protocol.
Cost	An arbitrary numeric value assigned to map grids, lines, routes, etc. to determine the cumulative, net effect of an AMR's actions. Breaks maps into discrete squares called grids. Squares with walls, etc. have an infinite cost, and free squares, by default, have a value of 0.1. By design, AMRs always seek to execute their assigned tasks and goals at the lowest possible cost.
Cost-Based Path Planning	A method of planning optimal, 'least expensive' paths from "point a" to "point b" for the AMR to follow.

CPU	Central processing unit
DER	Distinguished encoding rules
DHCP	Dynamic host configuration protocol
DNS	Domain name service
Dock	Map location where the AMR "looks for" the charging station. Dock map icon should be 1 to 1.5 meters in front of the charging station, with the dock icon's black line pointing to the charging station.
DROPOFF	Job segment classification - tells the Fleet Manager that only a specific AMR can be assigned to the job segment.
EAP	Extensible authentication protocol
EAP-FAST	EAP flexible authentication via secure tunneling
EM2100	A network appliance that hosts the FLOW Core software. All fleet management capabilities of the FLOW Core software run on the EM2100 appliance.
Ethernet	A type of computer network used in local area networks. Typically uses a Category 5 (CAT5) or (CAT6) Ethernet cable; supports data speeds up to 100 MHz.
FIFO	First-In-First-Out - refers to the method used to prioritize jobs (higher number equals higher priority).
Fleet	A group of AMRs that operate in the same area, share the same map, and are controlled by one standalone Fleet Manager or a Paired Primary Fleet Manager, operating with a Paired Secondary Fleet Manager.
Fleet Manager	The set of capabilities within the FLOW Core software that executes all fleet management activities. These include the management of maps, AMR configuration, job queue management, and traffic coordination.
Forbidden (lines, areas)	Lines or areas onto or into which the AMR must not drive or enter on its own. In special cases, you can manually drive an AMR into a forbidden area.
Goal	Map-defined virtual destination(s) for AMRs (e.g., pickup or drop-off points).
GUI	Graphical User Interface
HAPS	High accuracy positioning system. Uses add-on sensors which detect and follow magnetic tape applied to the floor. Allows for very precise AMR positioning.
IP	Internet protocol. IP address is a computer's unique internet "address".
Job	An AMR activity, usually consisting of either one or two "job segments". (either PICKUP or DROPOFF). The Fleet Manager receives all job requests

	from ARCL.
LAN	Local Area Network
LEAP	Lightweight EAP
License Dongle	A USB device that contains the software (license key) required to run a licensed program.
Localization	The process by which AMRs determine their location in their operating environment. Laser localization uses the AMR's laser to scan its environment which it compares to its internal environment map. In light localization, the AMR uses overhead lights to determine its location.
Macro	A virtual "container" with a series or sequence of nested tasks and/or goals. Similar to routes. You can use macros as many times as needed to perform the same sequence of discrete functions in different tasks.
MARC	The Mobile Autonomous Robot Controller (MARC) firmware computes and reports the AMR's odometer (X. Y, and heading) readings and other low-level operating conditions to ARAM.
MobilePlanner	The primary software application for programming AMR actions.
MobilePlanner (Operator Mode)	A limited-functionality version of the MobilePlanner software. Has tools to monitor AMRs, AMR statistics, monitor and add jobs. Does not have tools to create or edit maps.
MSCHAPv2	Microsoft challenge handshake authentication protocol version 2
MP3	Moving picture experts group (MPEG) -2Audio Layer III
OS	Operating system (e.g., Mac OS, Windows OS, MARC, SetNetGo OS, etc.).
Path	The manner in which the AMRs drive from place to place in their environment.
PEAP	Protected extensible authentication protocol (EAP)
PEM	Privacy enhanced mail
Pendant	A handheld, external input device for manually driving an AMR. Connects to the AMR's pendant (or joystick) connection port. In this manual, pendant can mean either pendant (for HD AMRs) or joystick (for LD-series AMRs). The two devices are similar, but not interchangeable.
PICKUP	A job segment classification - tells the Fleet Manager that any available, appropriate AMR can be assigned to the job segment.
PKCS	Public key cryptography standards
Platform	The base AMR (with or without payload) – includes chassis, drive train, suspension, wheels, battery, safety scanning laser, sonar, on-board core with gyroscope and software to navigate, interface connections for pay-

	load, and covers.
Pose	An AMR’s position (location and heading).
PrecisionDrive	Using a target in the environment to aid in more accurate maneuvering. Targets can be placed on charging stations and other locations where you need accurate positioning. Associated with certain tasks.
Preferred (lines, directions)	Lines, directions you want the AMR to travel.
PSK	Pre-shared key
RC4	Rivest Cipher 4 (aka ARC4 – Alleged RC4)
Resisted (lines, areas)	Lines and/or areas the AMRs resist (attempt to avoid) crossing or entering, unless it must drive over/through resisted lines/areas to reach a goal.
Route	A “to do” list or series of tasks, goals, or macros for the AMR to follow.
Safety Commissioning	Allows testing and commissioning (verification of proper function) of an AMR's on-board safety systems. Uses a wizard to test E-Stop (tests brake activation) and Safety Laser (tests max speed limits and obstacle detection). Per EN-1525, Commissioning must be done by specially trained people.
Sector	Map areas that direct specific AMR actions, like ignoring sensor readings, driving on the right or left, limiting the number of AMRs in the area at one time, etc.
SetNetGo	Software OS, resides on AMRs and the Fleet Manager appliance. Used to configure AMRs’ communication parameters. Accessed via the SetNetGo tab in MobilePlanner.
SNG	SetNetGo.
Spline	Mathematical function for smoothing arcs and curves.
SSID	Service Set Identification – identifies a wireless LAN
Tasks	Instructions for the AMR to perform certain actions like reading inputs, setting outputs, movement commands, talking, waiting, etc. Tasks have adjustable parameters, which can be individually set for each copy of the task. There are two types of tasks; instant (allows concurrent processing of tasks while original task is executing), and non-instant (can interrupt a currently running task).
TCP	Transmission control protocol
TKIP	Temporal key integrity protocol
TLS	Transport layer security
Virtual Doors	Specially designated areas on the AMR’s map which the AMR performs cer-

	tain tasks (like 'move' or 'say' tasks, flashing lights, etc.) and/or allow the AMR to drive through special areas (e.g., plastic curtains).
WAVE	Waveform audio file format with an extension of .wav.
WEP	Wireless equivalent privacy
WPA	WiFi protected access

Appendix

A.1 Network Port Allocation

Network ports are assigned as described below.

Table 14-1. Logical Ports and Protocols

Protocol	Port(s)	Initiator to Recipient
Intra-fleet Communications Used to broadcast configuration updates to AMRs, to dispatch job commands, and to share position and trajectory updates throughout the fleet.		
TCP	37	AMR to Fleet Manager Maintenance, Management and Fleet ports use this.
TCP/UDP	5000	AMR Fleet Manager. Fleet port uses this.
UDP	Range 10000 and up	For UDP Range 10000 connections and up, such as an AMR connecting to an EM2100 appliance, this protocol grows with the number of robots. For best results, allocate at least twice as many UDP ports as there are AMRs in the fleet. For instance, a fleet of 20 AMRs should have an allocated range of 10000-10039.
TCP/UDP	7272	AMR to Fleet Manager Appliance
Integration Toolkit TCP Ports This list excludes dynamically allocated port numbers. All ports belong to TCP connections.		
TCP	5672	RabbitMQ AMQP
TCP	8443	ITK REST
TCP	5432	PostgreSQL
Configuration and Monitoring of Fleet Used for MobilePlanner connections to the Fleet Manager Appliance and AMRs for monitoring and configuration.		
TCP	443	Client PC to Fleet Manager Appliance Maintenance and Management ports use this.
TCP/UDP	Range 7272 and up	Client PC to Fleet Manager Appliance This protocol uses as many ports as there are AMRs. Each AMR that connects uses the next available port >= 7272.

Protocol	Port(s)	Initiator to Recipient
		For best results, allow a large number of ports, such as 7272-7999.
TCP/UDP	7272	Client PC to AMR
UDP	Range 10000 and up	Fleet Manager Appliance to Client PC This protocol uses as many ports as there are AMRs. Each AMR that connects uses the next available port >= 10000. For best results, allow a large number of ports such as 10000-10999.
UDP	10000	AMR to Client PC.
Job Monitoring and Submission (ARCL Interface) Used for managing jobs on the Fleet Manager Appliance. These are typically submitted from a Warehouse Management System (WMS) or Manufacturing Execution System (MES).		
TCP	7171	WMS/MES to Fleet Manager Appliance ARCL Server: if enabled in the configuration (*Robot Interface* and then *ARCL Server Setup*), this port is open on the Fleet Manager and accepts unlimited incoming connections. The port number is configurable. (This port might be available on the AMR, depending on the application.)
TCP	Configurable port #	Fleet Manager Appliance to WMS/MES Outgoing ARCL Connection: if enabled in the configuration (Robot Interface then Outgoing ARCL connection setup), then the Fleet Manager initiates an outgoing connection to the specified hostname and TCP port number.
Optional		
TCP	123	Fleet Manager Appliance to NTP server If you enable a Network Time Protocol (NTP) client Fleet Manager Appliance (*SetNetGo* then *System* and then *Date/Time*), the Fleet Manager Appliance attempts to set its clock from the network time server at the specified IP address. (This function is available on the AMR, if you do not use a client Fleet Manager Appliance.)
UDP/TCP	Range 1000-65535	Offboard devices to AMR If RS232 or Ethernet Port Forwarding is enabled on the AMR (*SetNetGo* then *Network*) then the configured TCP ports are open on the AMR for incoming connections.
Flow iQ EXTERNAL PORTS: None		

A.2 FLOW Migration: Upgrades and Downgrades

This section contains information that is necessary to either upgrade or downgrade the Fleet Operations Workspace (FLOW) Core Software or Legacy Mobile Software Suite (MSS) software for operating your existing fleet of AMRs.

If you prefer to use your existing MSS solution, this document provides instructions on how to downgrade any newly purchased AMRs or EM2100 appliances to be compatible with your existing fleet software solution.

Most installed AMRs can be upgraded via software without having to purchase new equipment. Some legacy AMRs may require a dongle change, and the steps to make these changes are included in this section. All Local Area Network, IP Addresses, wiring and power connections can remain the same.

Before either upgrading or downgrading your fleet operations you need to consider the existing fleet topology, hardware and any license requirements are needed. These topics are shown in the following sections.

OMRON recommends, that if you are operating a beta version of FLOW Core, that you contact your local OMRON representative for upgrade assistance.

Hardware

The only hardware change required to upgrade your fleet operations is that any existing EM1100 appliances must be upgraded to EM2100 appliances, refer to the *EM2100 Installation Guide (Cat. No. I634)* for more information.

> **NOTE:** OMRON does not provide a path for downgrading a physical appliance from an EM2100 to an EM1100. OMRON does provide an EM2100 to legacy downgrade path for your Fleet Manager.

Fleet Topology Overview

The legacy and (FLOW) Core fleet topologies are similar in that they both control OMRON AMRs, MobilePlanner and a Fleet Manager, which interfaces with the factory systems.

The legacy versions of MobilePlanner 4.7.9 and earlier require a licensing dongle but current releases of MobilePlanner are an integral part of the FLOW Core license. Legacy fleets may use the EM1100 or the initially released EM2100 appliance to perform the Fleet Manager role, as illustrated in the following diagram. Legacy applications running both a primary and secondary EM1100 for redundancy will have the same functionality within FLOW Core using the new EM2100s.

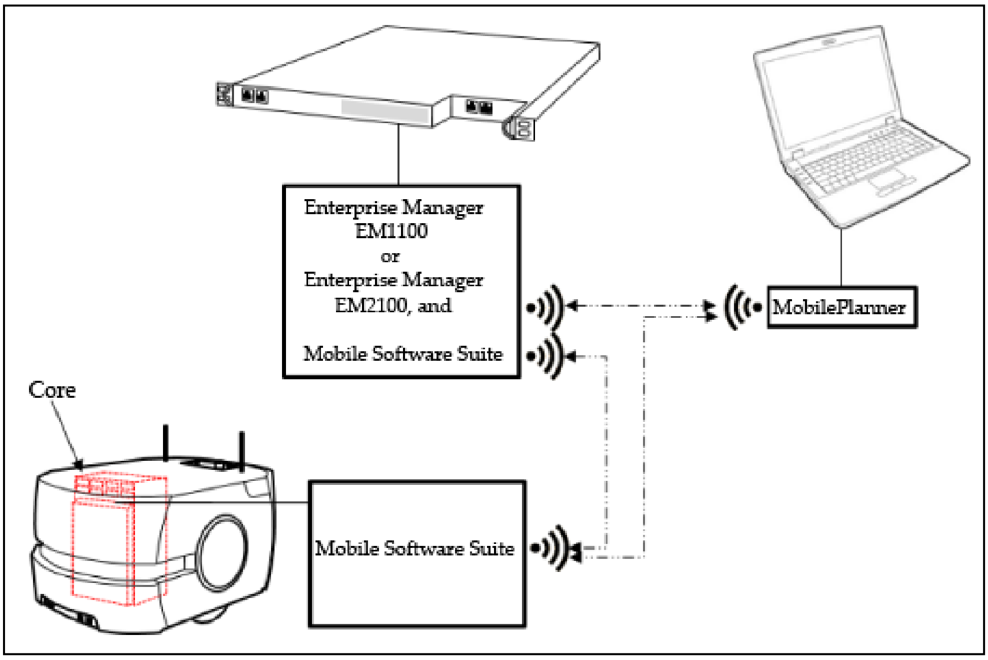


Figure 14-1. Legacy Mobile Software Suite Fleet Topology

FLOW Core fleets require that the EM2100 appliance running a licensed version of the FLOW Core software, as shown in the following figure, have the FLOW Core software replacing the Mobile Software Suite.

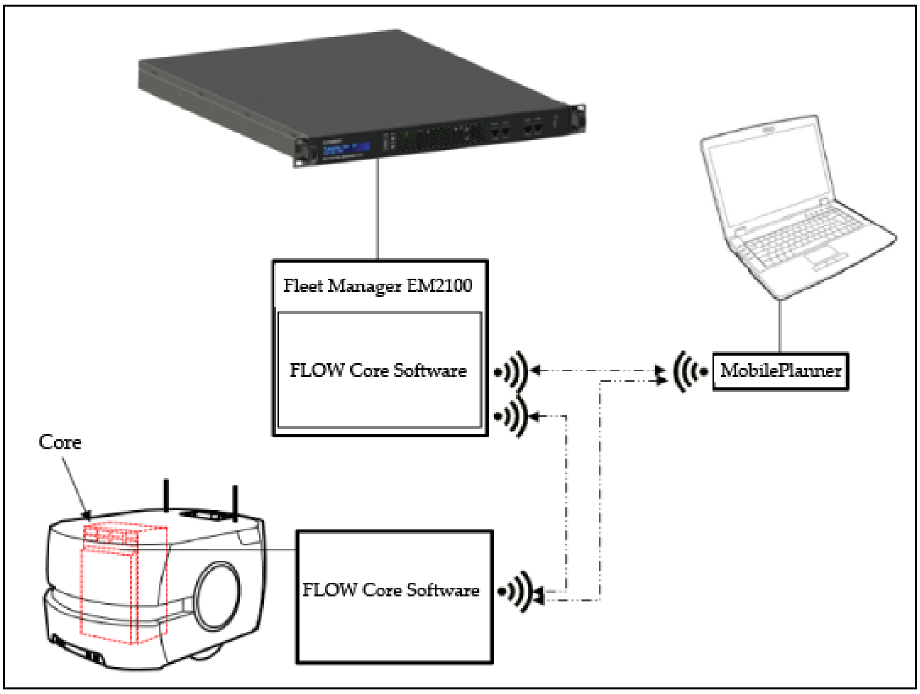


Figure 14-2. FLOW Core Fleet Topology with EM2100

OMRON Software, Licenses and Equipment

This section lists the necessary software and OMRON equipment needed to complete your migration to FLOW Core. Please consult with your local OMRON representative before performing any migration.

OMRON Software

The following table lists all software versions related to the migration.

Name	Location
Migrating from a Legacy to Fleet Operations Workspace (FLOW) Core Solution	
FLOW Core 1.0.1 Software	Obtain this software from your local OMRON representative **NOTE:** You can also download MobilePlanner 5.0 software directly from the SetNetGo Web interface of an EM2100 or AMR running FLOW Core 1.0.1.
SetNetGo EM 5.0.0 Software	
SetNetGo Robot 5.0.0 Software	
SetNetGo 4.10 Recovery Software	
MobilePlanner 5.0 Software	
Downgrading from Fleet Operations Workspace Core to a Legacy 4.x Solution	
Mobile Software Suite (MSS) 4.x	This is the version of MSS software that your fleet is running. You may already have this software. If not, obtain the desired version from your local OMRON representative.
SetNetGo 4.10 Software	Obtain this software from your local OMRON representative
MobilePlanner 4.X Software	This is the version of MSS software that your fleet is running. You may already have this software. If not, obtain the desired version from your local OMRON representative.

OMRON Licenses

When upgrading, you will need to have active FLOW Core and MobilePlanner licenses available to activate the software.

Part Number	Product Name	Purpose
20271-800	Primary FLOW Core License, 1Yr	Equal to the number of Primary

Part Number	Product Name	Purpose
		Fleet Managers being purchased.
20271-806	Primary FLOW Core License, 5 Yr	
20271-802	Secondary FLOW Core License, 1Yr	Equal to the number of Secondary Fleet Managers being purchased.
20271-807	Secondary FLOW Core License, 5 Yr	

OMRON Parts

If you are migrating your AMR fleet from a legacy fleet management system, such as an EM1100, to a FLOW Core solution, we recommend that you pre-order the following OMRON parts before starting the migration process.

Downgrading to a legacy solution does not require any hardware or software license purchases unless you desire additional MobilePlanner licenses.

> **NOTE:** Downgrading to a legacy solution does not require any additional hardware unless your robot has only one dongle that was converted to support FLOW Core.

Part Number	Product Name	Quantity
20271-900	Primary Fleet Manager	Equals the replaced number of EM1100s acting as a Primary Fleet Manager
20271-901	Secondary Fleet Manager	Equals the replaced number of EM1100s acting as a Secondary Fleet Manager

Migration Procedures

This section provides detailed instructions for migrating from a legacy MSS 4.X system to a FLOW Core 1.3 operating system. The migration instructions also include a visual representation of the migration process, with some important notes.

Please follow the basic steps for migration that are provided below and described in the following sections.

1. Replace an existing EM1100 with an EM2100
2. Remove the EM1100 from the rack and install the EM2100
3. If needed, migrate / upgrade the existing EM2100 from a legacy MSS 4.x To FLOW Core 2.2
4. License the Upgraded FLOW Core software

Migrate an EM1100

If the existing legacy system is using EM1100 appliances for fleet management, you must replace them with EM2100s. In that case, we recommend purchasing pre-configured EM2100 Fleet Manager units, which come with FLOW Core installed, and no appliance migration will be required. You will have to perform the upgrades to your operating fleet of AMRs.

Upgrade from an EM1100 to an EM2100

The EM2100 appliance can run either the legacy Mobile Robot Software Suite or the current FLOW Core software. Upgrading from an EM1100 to an EM2100 does not require a software change, although one may be desired.

1. Power OFF the EM1100 appliance.
2. Disconnect the AC power cable from the EM1100 appliance.
3. Disconnect all other cables, and remove the dongle(s) from the EM1100 appliance.
4. Remove the EM1100 appliance from the rack. Refer to the *Enterprise Manager 1100 User's Guide (Cat. No. I615)* for details.
5. Install the EM2100 appliance in the rack. Refer to the *EM2100 Installation Guide (Cat. No. I634)* for details.
6. Connect the cables and dongle(s) that you removed from the EM1100 to the EM2100.
7. Connect the AC power cable to the EM2100 appliance.
8. Power ON the EM2100 appliance to complete this procedure.

Migrate an EM2100 from Legacy MSS 4.X to FLOW Core 2.2

This section shows the steps to migrate an existing EM2100 which is being used as a Fleet Manager from the legacy software to FLOW Core 2.2.1.

You need to update your SetNetGo from existing 4.X to 4.10 to begin the migration path to FLOW Core 2.2.

CAUTION: It is critical that you not attempt to migrate from SetNetGo 4.10 directly to 5.1 or higher versions. You must migrate from SetNetGo 4.10 to SetNetGo 5.0.0, and then update SetNetGo 5.0.0 to SetNetGo 5.1 or higher versions.

The following graphic visually depicts the correct SetNetGo migration path for the EM2100 appliance.

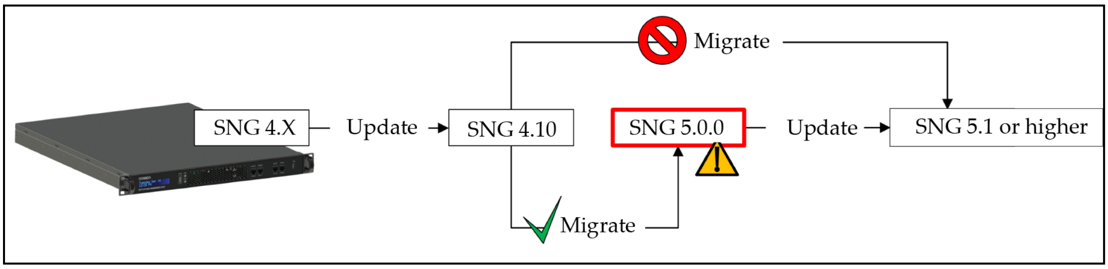


Figure 14-3. EM2100 SetNetGo Migration Path

CAUTION: POSSIBLE SYSTEM CORRUPTION.
Do not attempt to use SetNetGo 5.0.0 to operate your fleet or system. SetNetGo 5.0.0 is only a bridge between SetNetGo 4.10 and SetNetGo 5.1.

IMPORTANT: If you are using SetNetGo 4.9 or below, you must first update SetNetGo 4.9 to SetNetGo 4.10.

To upgrade an existing EM2100 appliance running Mobile Software Suite (MSS) 4.X to the FLOW Core solution, follow these steps.

NOTE: Do not reboot until after step 13 of the following series of steps.

Upgrade EM2100

Use the following steps to upgrade an existing EM2100 appliance running Mobile Software Suite (MSS) 4.X to the FLOW Core solution. The first series of steps upgrades SetNetGo, the second set is to upgrade FLOW Core. Once FLOW Core is upgraded, you then set the operating mode, and finally install the license for the FLOW Core upgrade.

SetNetGo Upgrade

The following steps are used to upgrade SetNetGo on the EM2100.

1. Download the SetNetGo containing SetNetGo 4.1.1 software onto a PC that you will use to access the FLOW Core EM2100 Primary Fleet Management appliance. Download the SetNetGo Robot 6.1.1, which is used with the AMR.
2. Using the PC, launch a browser, open the SetNetGo Web interface, and connect to the EM2100 appliance through the maintenance port, via its existing IP address.
3. Within SetNetGo, select the **System** Tab and select the **Upload SetNetGo OS** Page from the left hand list. Please refer to *Fleet Operations Workspace Core User's Manual (Cat. No. I635*) for further information.
4. Decide which Boot Image, A or B, you wish to replace with the new SetNetGo 4.1.0 software.
5. Select **Choose File** for that boot image.
6. Navigate to the SetNetGo 4.1.0 software file and select it for upload.
7. The file name should appear next to the *Choose File* button within the SetNetGo Web

interface.

8. Click on the **Upload File** Button and confirm the file is uploaded to the main partition, not the backup or recovery partitions..
9. Ensure that the boot image you have selected is now configured as the Bootable version.

   IMPORTANT: Do not reboot the system at this point, this is an upload process for the boot image.

10. In the Backup Image section, select **Choose File**.
11. Navigate to the *SetNetGo 4.10 Recovery* software file and select it for upload.
12. Click on the **Upload File** Button.
13. Once the upload is complete, reboot the EM2100 appliance by either clicking on the Reboot button in the SetNetGo **System** tab (if enabled), or by using the power switch on the front of the EM2100 appliance.
14. Close the browser with SetNetGo opened.
15. Download SetNetGo 5.0.0 onto the operating PC.
16. Using the PC, launch a browser, open the SetNetGo Web interface, and connect to the EM2100 appliance via its existing IP address.
17. Within SetNetGo, select the **System** Tab and select the **Upload SetNetGo OS** Page from the left hand list.
18. Decide which Boot Image, A or B, you wish to replace with the new SetNetGo 5.0.0 software.
19. Select **Choose File** for that boot image.
20. Navigate to the SetNetGo 5.0.0 software file and select it for upload.
21. The file name should appear next to the *Choose File* button within the SetNetGo Web interface.
22. Click on the **Upload File** Button.
23. Once the upload is complete, reboot the EM2100 appliance by either clicking the **Reboot** Button in the SetNetGo **System** tab. If the Reboot button is not enabled, use the power switch on the front of the EM2100 appliance.

Install FLOW Core onto the EM2100

Once SetNetGo is upgraded, use the following steps to install FLOW Core.

1. Within the SetNetGo Web interface, select the **Software** Tab and select the **Manage Installed Software** page from the left hand list.
2. Click on the **Choose File** Button at the top of the page.
3. Navigate to the FLOW Core software file. When you select it for upload, the file name should appear next to the *Choose File* button.

4. Click the **Choose File** Button.
5. Click on the **Upload File** Button to finish the installation procedure.

Configure EM2100 Operating Mode

The FLOW Core software is now installed. You need to configure the operating mode of the EM2100. If you experience a failure at this point, it is recommended that you contact your local OMRON representative.

1. Select the **System** Tab and select the **Mode** Page from the left hand column, as shown in the following figure.
2. Choose the EM2100 appliance operational mode using the drop-down menu.

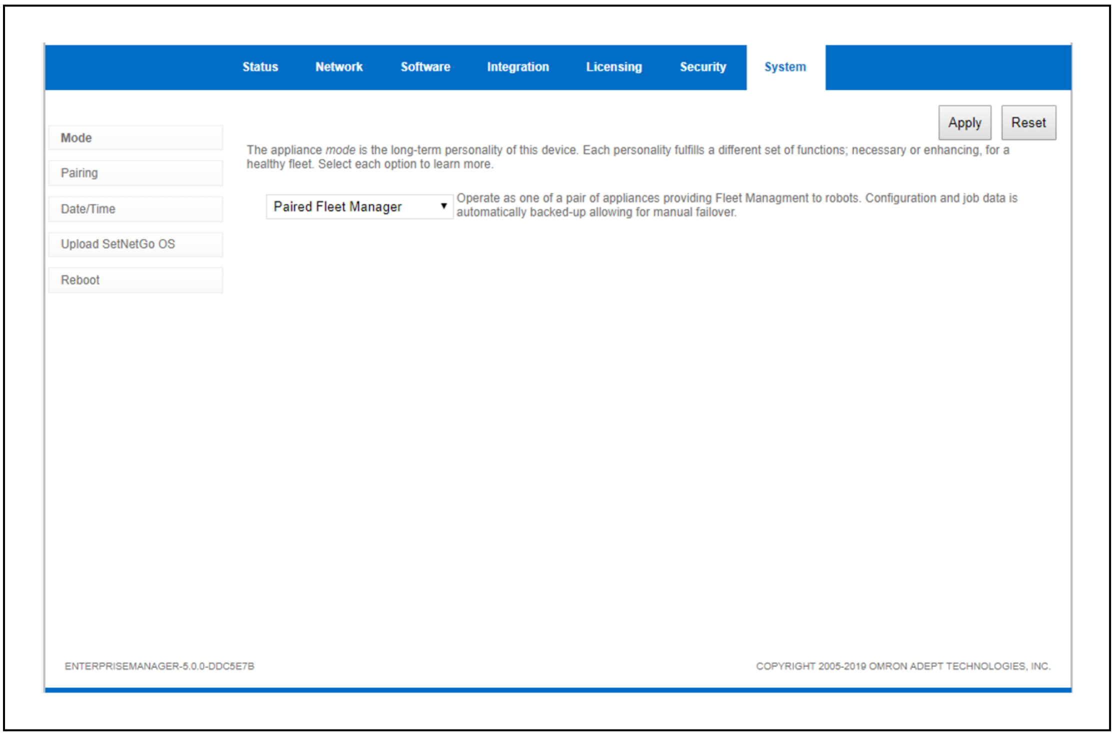


Figure 14-4. Operating Mode Screen

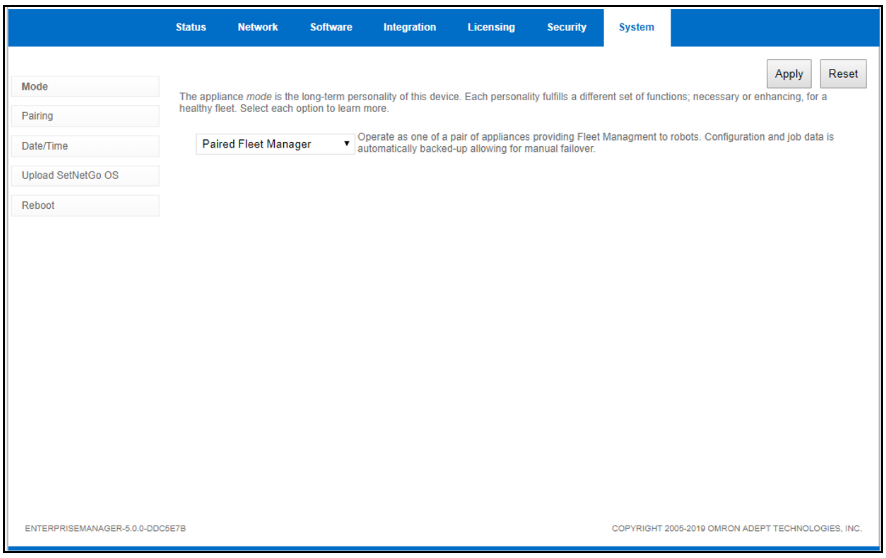


Figure 14-5. Operating Mode Screen

3. If your system is using only one EM2100 appliance, select the **Standalone Fleet Manager** option, click the **Apply** Button, then proceed to Install FLOW Core License on page 289.

4. If your system has a second EM2100 acting as a redundant unit, then make sure the secondary EM2100 is also migrated to FLOW Core software using the previous steps, and then select the **Paired Fleet Manager** Option, and click the **Apply** Button and proceed to the following steps.

   NOTE: If you select the Paired Fleet Manager option, you must designate one EM2100 as the Primary and the other as the Secondary (back-up) Fleet

Manager.

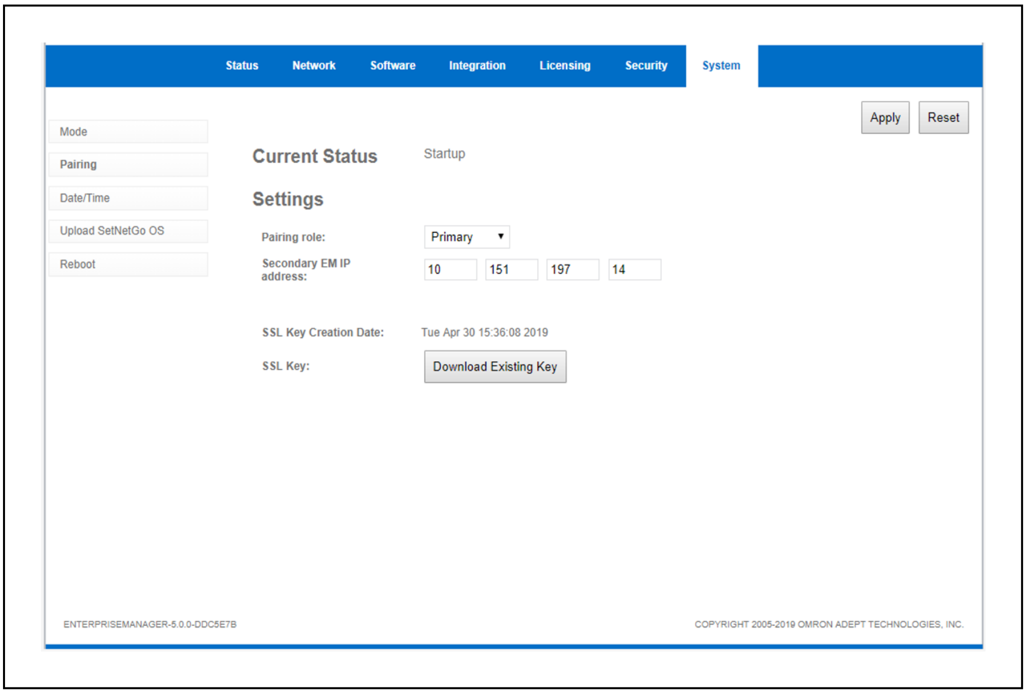


Figure 14-6. Pairing Settings

5. Click the **Pairing** Button (left margin) to designate the role of the EM2100 Appliance.
6. Select the pairing role for this using the drop down menu.

- If this was previously used in a paired system, then the Secondary IP address will already be entered.
- If this is a new installation, refer to the *EM2100Installation Guide(Cat. No. I634)* for details on setting up the Primary and Secondary appliances in your system.

7. This completes the procedure for configuring the operating mode of the EM2100. You must now request a FLOW Core license entitlement from OMRON.

Install FLOW Core License

Once FLOW Core is properly installed you need to obtain and install the operating license. Obtaining a license requires you to download and submit an identification file from the EM2100 Appliance to OMRON in order to receive a FLOW Core license.

1. Using SetNetGo web interface Licensing tab, choose the Download option, then click on the **Download** Button to download the .C2V file.

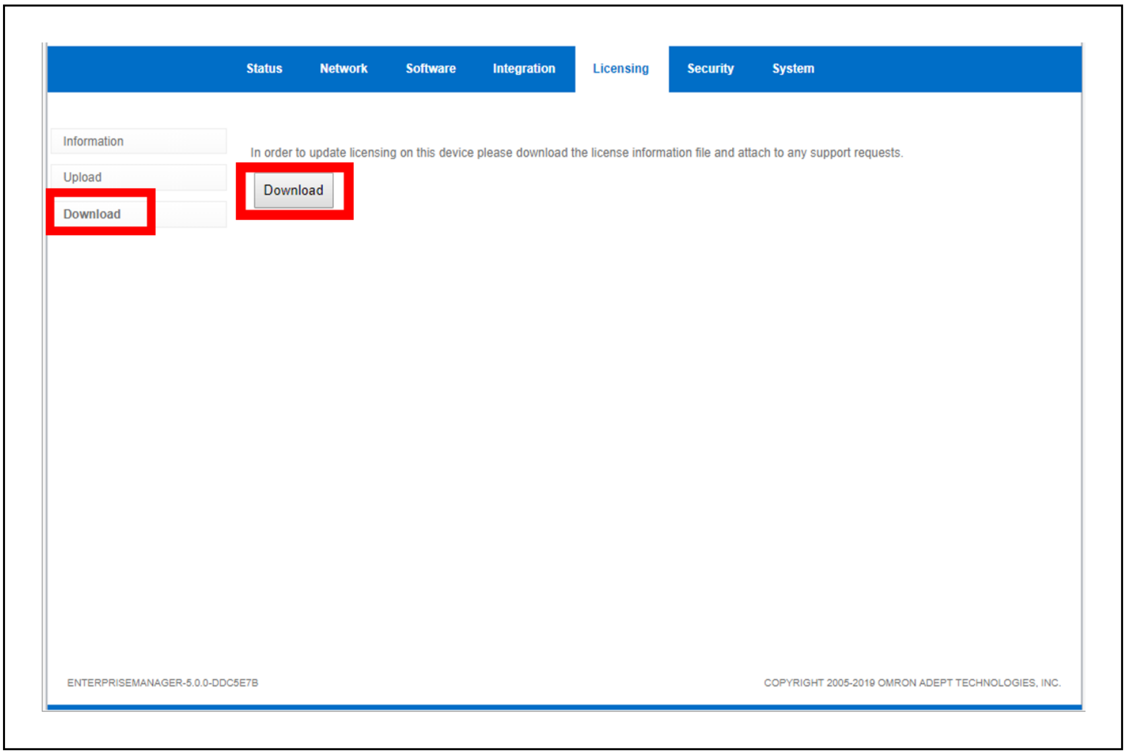


Figure 14-7. Download C2V

2. The downloaded .C2V file will have the format: 1234567890-MMM-DD-YYYY.C2V (Example. 7769436109-MAY-21-2019)

   NOTE: OMRON recommends that you establish a specific location and folder to store these license key files, so you can easily access them in the future.

CAUTION: Download only one file, any subsequent download invalidates the first download which may prevent you from submitting a valid .C2V file.

3. Send the .C2V file to your local OMRON support and request the appropriate license for the Fleet Management mode you have selected.
4. You will receive a .V2C file with a dongle ID and date that match the .C2V file which you submitted. Confirm the file names match before proceeding. If the file names do not match, then contact your local OMRON support to report and resolve the issue.
5. Reconnect your computer to the Fleet Management appliance using the SetNetGo Web interface. Select the **Licensing** Tab and choose the **Upload** Page from the left-hand banner. Select the appropriate .V2C file and click on the **Upload File** Button.

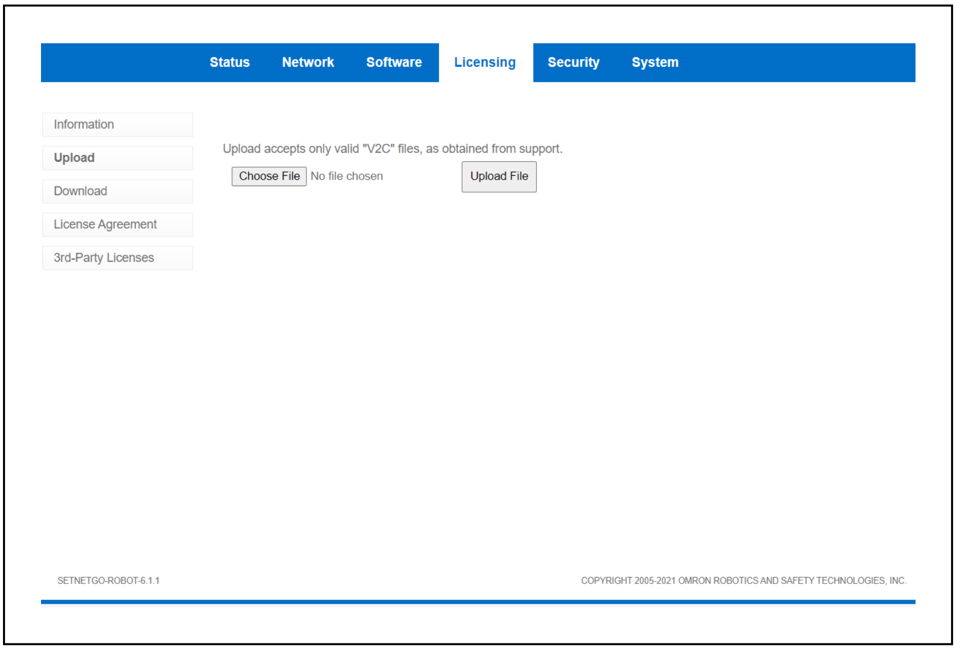


Figure 14-8. Licensing Upload

6. A confirmation pop-up will open once the process completes. Now that a valid license is activated, SetNetGo will initiate the requested mode by starting the appropriate software.

Your EM2100 appliance is now upgraded to the FLOW Core 2.2 solution and ready to be connected to your autonomous AMR Fleet.

The next migration step is to upgrade your AMR fleet to the same FLOW Core software version. The next section defines this process.

Migrate FLOW Core 1.0.1 or 2.0 to 2.1.X.

This section details the steps necessary to migrate an existing FLOW Core 1.0.1 or 2.0 installation which is being used as a Fleet Manager to FLOW Core 2.1.X.

Before upgrading your fleet you should plan for any possible downgrades by identifying fleet AMRs that are using separated configuration sections, since FLOW Core 2.1.X does not show these separations in the configuration. You can find the separated configuration sections by opening FLOW Core and navigating to *Fleet* > *Fleet Manager Connection* > *UseFleetManagerConfigSection*.

FLOW 2.1.X Added Functionality

FLOW 2.1.X represents a significant change from earlier FLOW 1.1 or 2.0 versions. As with all upgrades, we recommend saving Debug Info files before upgrading.

Configuration should be set from the highest functional level to the lowest, where the levels in descending order are Fleet Manager, robot family, robot variant, individual robot.

New FLOW 2.1.X parameters are correctly migrated when you first upgrade a fleet from FLOW 1.0.1 or 2.0 to 2.1.X. If you later downgrade the fleet, you must manually update the parameters in both the old and the new configuration sections.

FLOW 2.1.X introduces a new parameter; Fleet Features > Call Stations. This check box must be turned on if you want to configure MobilePlanner Tablet Edition as a call button.

> **IMPORTANT:** It is not possible to configure the MultiRobot path settings on a per-robot basis, in FLOW 2.1.X. This will be changed in a future version.

Migration Procedure

1. Download and install FLOW Core 2.1.X.
2. Using FLOW Core 2.1.X, select an AMR to use as your first migration for the fleet.
3. Download and save the Debug Info from the 1.0.1 or 2.1.X Fleet Manager and the selected AMR.
4. Select the AMR with the FLOW 2.1.X. You will see the unit will fail to connect at this point, indicating a configuration conflict between Fleet Manager and the AMR.
5. Confirm the migrated AMR's configuration and map are correct and error free.
6. Make a small, reversible change to the migrated AMR's configuration and save it.
7. Reconnect to the AMR and verify that the AMR is connected. When connected, change the configuration to the original values, changed in Step 6, and then save it.
8. Confirm there are no errors.
9. Confirm the AMR successfully connect to the Fleet Manager.
10. Verify the configuration of the Fleet Manager.

This is the first AMR to be upgraded and is the example unit for the process to migrate the other fleet AMRs. There should be minimal customizations at the AMR level for this unit.

- The *Fleet > Fleet Manager Connection* section is always expected to be set at the robot level.
- Other optional AMR-specific sections may be included, such as *Robot Physical > Offset Correction, Acuity Camera Calibration or Vehicle Calibration.*
- Any configuration sections that were added by an external program, such as ARCL, will appear at the robot level.

Proceed with the fleet upgrade by downloading debuginfo for any other AMRs with special settings such as different robot types and separated config sections.

Upgrade the remaining AMRs following the above steps 1 through 10 above.

> **IMPORTANT:** Verify the configuration of each upgraded AMR on the Fleet Manager.

- Remove any customizations at the robot level when each AMR is upgraded. Any parameter settings that differ between the initial AMR and the currently migrated AMR are automatically added at the lower levels.

Downgrade FLOW 2.1.X to FLOW 2.0 or 1.0.1

If downgrading from FLOW 2.1.X to FLOW 2.0 or lower, OMRON recommends to downgrade the AMRs before downgrading the Fleet Manager. Once the AMR is downgraded, navigate to Fleet and then Fleet Manager Connection. Confirm this section lists all of the correct SpecifiedSectionsToSeparate parameter settings if the UseFleetManagerConfigSettings is set to *All except specified*.

Migrate an AMR from Legacy MSS 4.X to the FLOW Core 1.0.1

This section defines the process for migrating your AMR fleet from a Legacy Mobile Software Suite (MSS) solution to the Fleet Operations Workspace (FLOW) Core solution. Nearly all OMRON AMRs may be upgraded using the software upgrade processes described in this section. Those AMRs that require more than a software upgrade use the dongle replacement procedure at the end of this section.

You need to update SetNetGo from 4.X to 4.10 to begin the migration path.

CAUTION: After updating to SetNetGo 4.10, it is of critical importance that you not attempt to migrate from 4.10 directly to 5.1. You must migrate from SetNetGo 4.10 to SetNetGo 5.0.0, and then update SetNetGo 5.0.0 to SetNetGo 5.1 or higher.

The following graphic visually depicts the correct SetNetGo migration path for the EM2100 appliance.

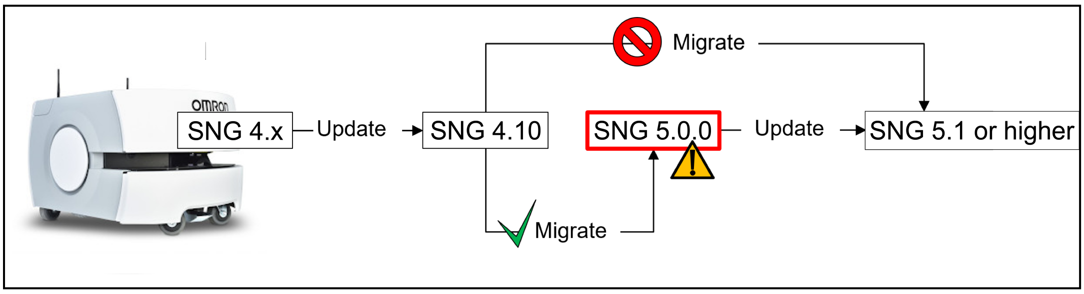


Figure 14-9. SetNetGo Migration Path

CAUTION: POSSIBLE SYSTEM CORRUPTION.
Do not attempt to use SetNetGo 5.0.0 to operate your system. SetNetGo 5.0.0 is only a bridge between SetNetGo 4.10 and SetNetGo 5.1.

Migration Procedure

IMPORTANT: If you are at SetNetGo 4.9 or below, you must first update SetNetGo 4.9 to SetNetGo 4.10.

To upgrade an existing EM2100 appliance running Mobile Software Suite (MSS) 4.X to the FLOW Core solution, please use the following steps.

CAUTION: Do not reboot until step 11 of this series of steps.

SetNetGo Upgrade

The following steps are used to upgrade SetNetGo.

1. Download the FLOW Core1.1 software and the SetNetGo (SNG) Robot 5.0.0 and 5.1 software onto the PC you will use to access the mobile robots.
2. On the PC, open the SetNetGo Web interface within a browser.
3. Select the **System** Tab and select the **Upload SetNetGo OS** page from the left hand list.
4. Decide which Boot Image, A or B, you wish to replace with the new SetNetGo 5.0.0 boot image.
5. Select **Choose File** for that boot image.
6. Navigate to the SetNetGo 5.0.0 software file and select it for upload.

   The file name should appear next to the **Choose File** Button.
7. Then click on the **Upload File** Button.

   NOTE: If you receive the error message, “The uploaded file appears to be invalid" follow the procedure in Upload File Invalid Errors on page 299 before proceeding.
8. Ensure that the Boot Image you have selected is now the Bootable version. It is identified next to the Default Boot Image line in *Systems* tab.

   CAUTION: Do not reboot at this point. Rebooting may cause the AMR to become non-operational.
9. In the Backup Image section, select **Choose File**.
10. Navigate to the *SetNetGo 4.10 Recovery* software file, select if for upload, then click on the **Upload File** Button
11. Once the upload is complete, reboot the AMR by cycling power on the robot.
12. Next, repeat steps 2 through 11, but use SetNetGo 5.1 in place of SetNetGo 5.0.0.

After SetNetGo 5.1 is installed, proceed with the following steps to install the FLOW Core 1.1 software onto the AMR.

Install FLOW Core 1.1 onto the AMR

1. Within the SetNetGo Web interface select the **Software** Tab and click on the **Manage Installed Software** Option from the left hand banner list.
2. Click on the **Choose File** Button at the top of the page.
3. Navigate to and select the Fleet Operations Workspace Core 1.0 software file.

The file name should appear next to the **Choose File** Button.

4. Then click on the **Upload File** Button.

   The FLOW Core software is now fully installed, and the AMR will now run as a FLOW Core unit.

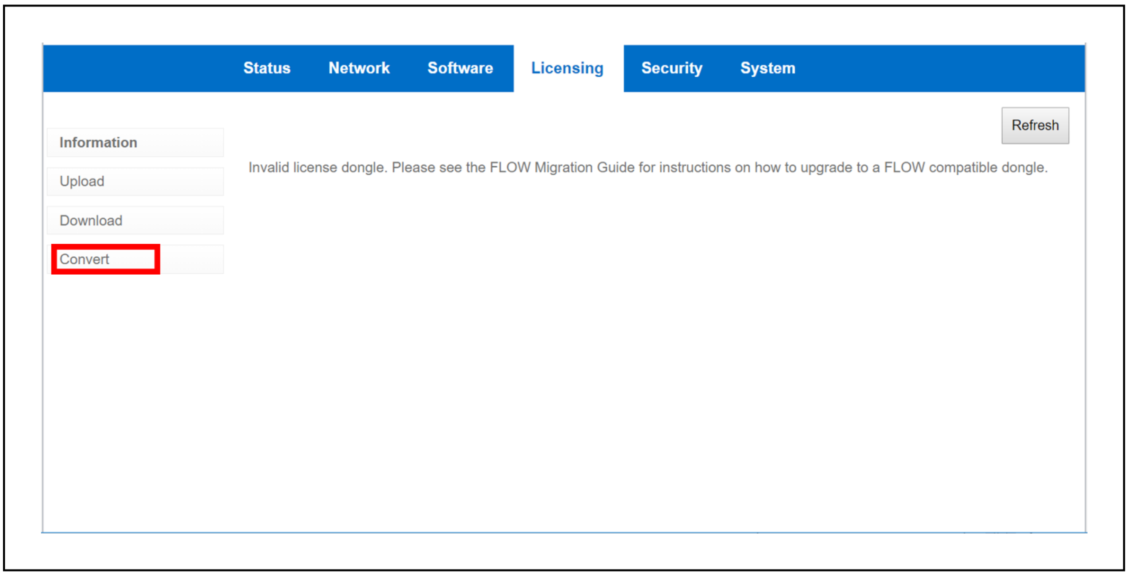
5. Reconnect to the AMR using the SetNetGo Web interface.

6. Within the SetNetGo web interface, click on the **Licensing** Tab.

   NOTE: If you receive the following error message when the AMR reboots; "Invalid License Dongle. The Dongle cannot be converted to a FLOW Core Compatible Dongle.", you cannot upgrade using this software process. These units require you to replace a dongle on the AMR core. If you have an OMRON AMR with one of these dongles, please refer to AMR Dongle Replacement. on page 1 for more information.

7. Check to see if the Convert sub-menu is displayed in the left hand banner. If it is, then continue.

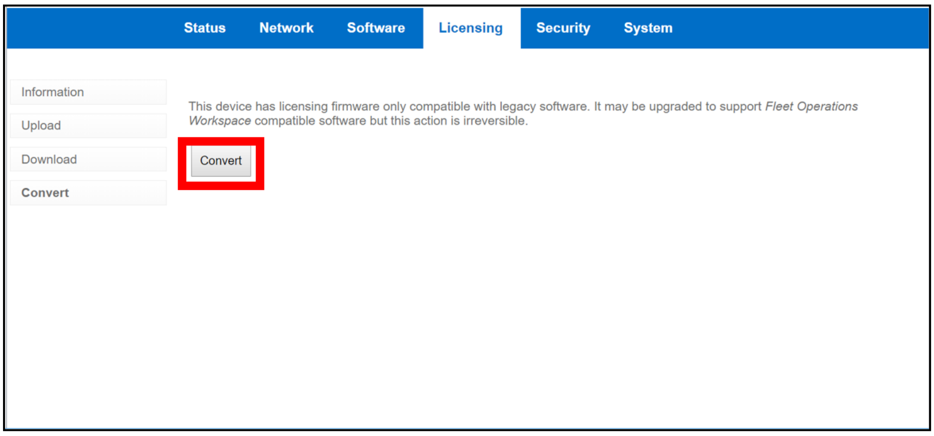
   If there is no Convert sub-menu in the left hand banner, then proceed to step 8.



8. Proceed with the following instructions to convert your legacy dongle to a blank FLOW Core compatible dongle.

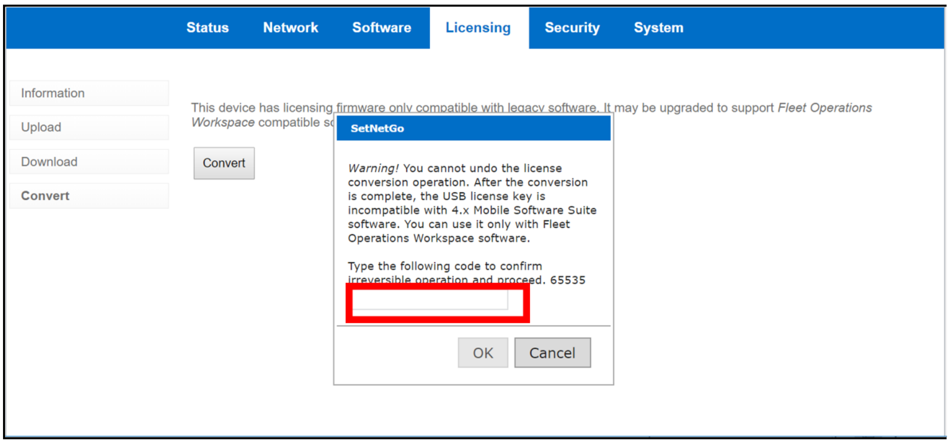
   a. Click on the **Convert** option in the left margin.

   b. Because the conversion process is irreversible, you will receive a first warning: "This device has licensing firmware only compatible with legacy software. It may be upgraded to support Fleet Operations Workspace compatible software, but this action is irreversible."



c. Click on the **Convert** Button.

A second warning message will appear.

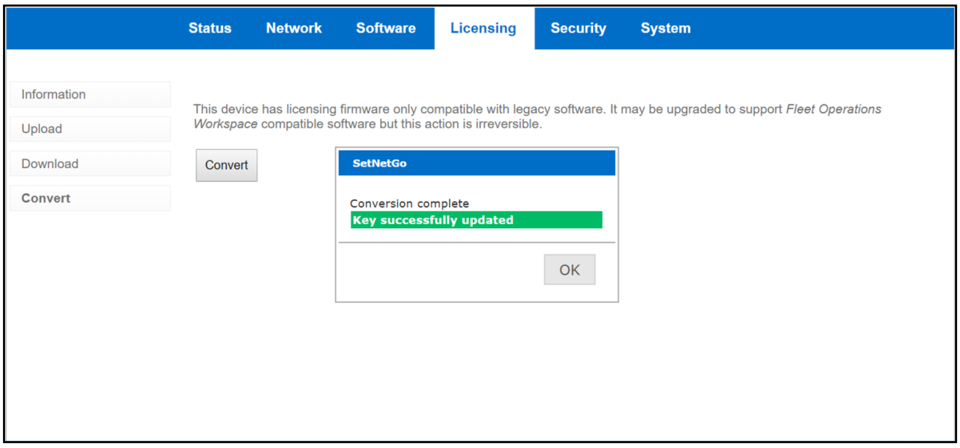


NOTE: This step requires you to enter a code before completing the upgrade process. After entering the code, click **OK**.

NOTE: Entering an incorrect code will give an error message, requiring you to restart the process from step a.

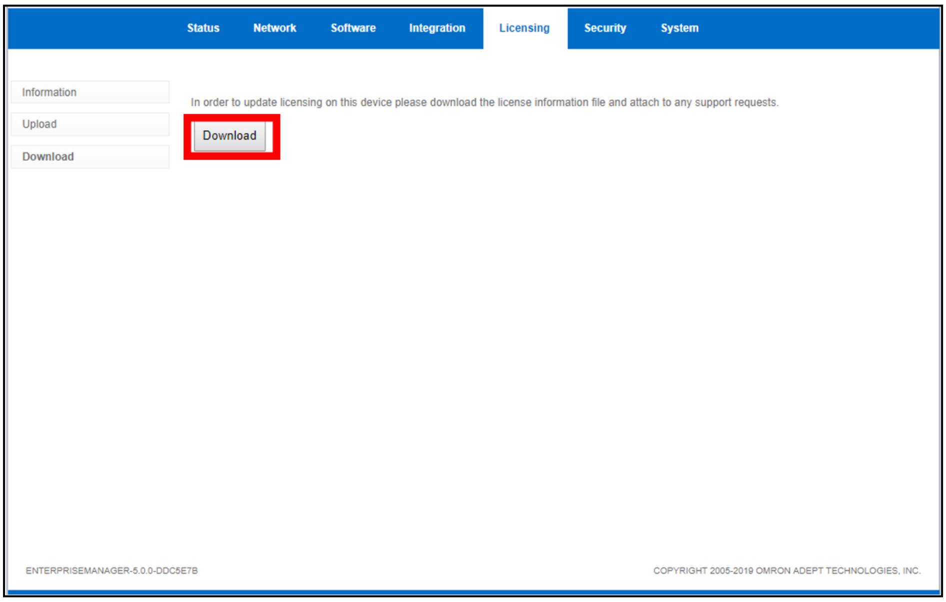
d. Enter the displayed number, and click **OK** to begin the conversion process.

When complete, a confirmation of success message displays.



The security dongle has now been upgraded for compatibility with the FLOW Core software. The next step is to obtain and apply a license for the AMR.

9. Within the **Licensing** tab, click on the **Download** option in the left-hand banner section.



10. On the download page, click the **Download** Button.

    The downloaded .C2V file will have the format:

    1234567890-MMM-DD-YYYY.C2V (example: 7765923100-JUN-21-2019.C2V)

    > **NOTE:** OMRON recommends that you establish a specific location and folder to store these license key files so you can easily access them in the future. We also recommend that you reference the .C2V ID number to the particular AMR where it is loaded, to ensure that you can quickly identify and upload the matching license activation file to that AMR.

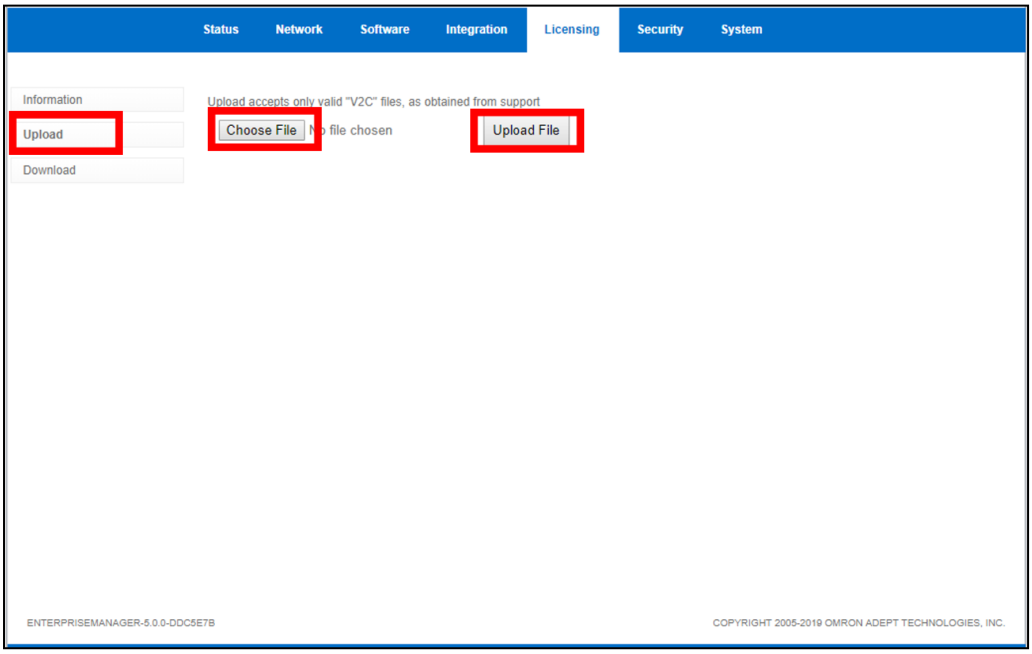
11. Send the .C2V file to your local OMRON support or integration partner and request a robot license.

You will receive a .V2C file with a dongle ID and Date that matches the .C2V file submitted by you.

12. Confirm the file names match before proceeding.

    If the file names do not match, then contact your OMRON support or integration partner and report the issue.

13. Reconnect your computer to the AMR using the SetNetGo web interface.
14. Select the **Licensing** Tab and choose the **Upload** Option.
15. Click the **Choose File** Button and select the appropriate .V2C file.



16. Once the file is chosen, the SetNetGo Web interface shows the specific file name next, click on **Upload File.**

    Now that a valid license is activated, SetNetGo will start the FLOW Core Software on your AMR.

17. Repeat this process for each AMR in the Fleet to complete the migration.

Once all the AMRs have been migrated to the solution, the Fleet Manager(s) and AMRs will communicate and are ready to be configured with any changes which might accompany the migration process.

Install MobilePlanner and Connect to Fleet Manager

Use the following steps to install MobilePlanner on the PC and connect to the Fleet Manager.

1. Open the current version of MobilePlanner 5.0.x, that was downloaded with FLOW Core on your PC.
2. Confirm the connection to the Fleet Manager IP address.

3. Once the connection is complete, you are directly connected to the Fleet Manager (EM2100 appliance) and able to operate the AMR fleet.

   Your AMR Fleet is now fully converted and is ready for operation.

Upload File Invalid Errors

The Upload File Invalid error indicates that this particular AMR requires an additional SetNetGo installation sequence, which involves installing an interim version of SetNetGo (version 4.10) and then installing SetNetGo 5.0.0.

To correctly install SetNetGo 5.0.0, follow the required process steps below.

1. Download the SetNetGo 4.10 software onto a PC which will be connecting to the AMRs.
2. Using the PC, open the SetNetGo Web interface within a browser.
3. Select the **System** Tab and click on the **Upload SetNetGo OS** page from the left hand list.
4. Decide which Boot Image, A or B, you wish to replace with the new SetNetGo 4.10 boot image.
5. Select **Choose File** for that boot image.
6. Navigate to the SetNetGo 4.10 software file and select it for upload.

   The file name should appear next to the Choose File Button.
7. Then click on the **Upload File** button.

If no error message appears the upload was successful. Cycle the AMR power. Then, in the SetNetGo Web interface, click the **System** Tab, at the top of the Upload SetNetGo OS page, and confirm that version 4.10 is listed as the SetNetGo version. After confirming this, re-install the SetNetGo 5.0.0 version using the following steps:

8. In the SetNetGo Web interface select the **System** Tab and click on the **Upload SetNetGo OS** page from the left hand list.
9. Decide which Boot Image, A or B, you wish to replace with the new SetNetGo 5.0.0 boot image.
10. Select **Choose File** for that boot image.
11. Navigate to the SetNetGo 5.0.0 software file and select it for upload.

    The file name should appear next to the *Choose File* button.
12. Then click on the **Upload File** Button.

    If no error message appears, the upload was successful. Cycle AMR power. Then, in the SetNetGo Web interface, open the **System** Tab and confirm that version 5.0.0 is listed as the SetNetGo version.

    Return to Step 8 in Migrate an EM2100 from Legacy MSS 4.X to FLOW Core 2.2 on page 284, and resume the migration process.

    If an error message persists, please contact your local OMRON representative for technical support.

AMR Dongle Replacement

There are AMRs which may have a security license dongle which cannot be upgraded using this software process. These units require you to replace a dongle on the AMR core. If you have an OMRON AMR with one of these older dongles, you will receive the following error message when the AMR reboots; "Invalid License Dongle. The Dongle cannot be converted to a FLOW Compatible Dongle." If this happens during your AMR upgrade, use the following instructions for removing the AMR core and replacing the dongle before proceeding.

The following instructions detail how to remove the AMR core, confirm the dongle color, and if necessary, replace it. Prior to opening the AMR and removing the core, please order blue replacement dongle, OMRON part number 13131-100F. This dongle is pre-programmed with a FLOW Core AMR license and it should replace the black dongle.

> **NOTE:** If the dongle in the AMR core is not black, there may be some other issue. Contact your local OMRON Representative for support in this case.

The LD Platform core is an enclosed unit, with internal fans as the only moving parts.

1. Power OFF the AMR in a secure location.
2. Move the payload structure , so you can access the payload bay.
3. Remove the battery door skin.
4. Unlatch and open the battery compartment door, at the rear of the AMR.

   The battery compartment door can be locked. You may need to unlock it.
5. Disconnect the battery power and data cables from the rear of the battery.
6. Disconnect all of the cables attached to the top portion of the core.
7. Remove the core mounting bracket from around the core.

   The bracket is two pieces; a front piece with two screws into the chassis, and a rear piece with two screws into the chassis, and four more going sideways into the core. Retain all of these screws for re-installing the core.

   See the following figure:

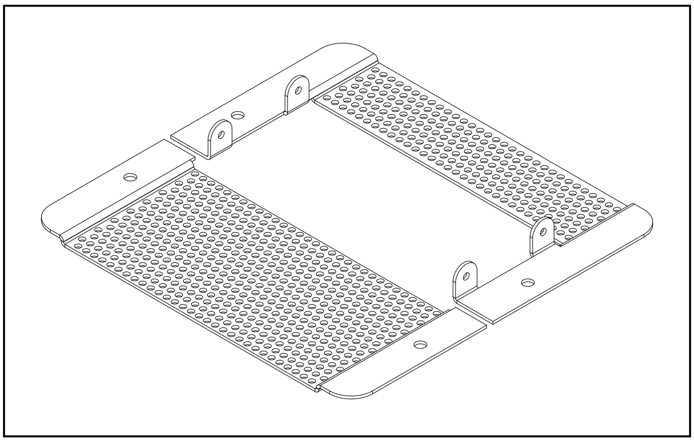


Figure 14-10. Core Mounting Bracket

NOTE: You might be able to reach the dongle(s) by only removing the front piece of the bracket. If not, continue with step 8.

8. Remove all cables connected to the otp portion of the core.

   Gently lift the core up, until you can access the dongle(s).

9. Remove the existing black dongle, and replace it with the blue dongle, P/N 13131-100F.
10. Install the core mounting brackets around the core.

    Using the screws and washers you removed from the old core, put four screws into the sides of the core, with four more going down into the platform chassis.

11. Reconnect all of the cables to the top portion of the core.
12. Reconnect the battery power and data cables to the battery.
13. Close and latch the battery compartment door.
14. Reinstall the inner rear skin.
15. Reinstall the payload structure.
16. Return to Migrate an EM2100 from Legacy MSS 4.X to FLOW Core 2.2 on page 284, Step 18.

Downgrade AMRs and EM2100s to run with Legacy Solution Software

All OMRON AMRs and EM2100 appliances ship with Fleet Operations Workspace (FLOW) Core software installed. In order to use newly purchased AMRs in fleets running Legacy Mobile Software Suite (MSS) 4.X software, the legacy software may need to be installed and enabled. New LD AMRs ship with legacy software preinstalled so that you need to change the Boot image and configure the robot through MobilePlanner. Additionally, compatible versions of SetNetGo (SNG) and MobilePlanner must be installed in your system to ensure the new and existing AMRs interact as designed.

This chapter provides detailed instructions which will guide you through the Legacy software installation process. Please follow these steps in the order provided in this chapter.

NOTE: No modification to any of the AMRs in the existing fleet is required. Even though the new AMRs will be running a newer version of SetNetGo, the existing AMRs can continue to run their installed versions of SetNetGo, MSS and MobilePlanner.

Downgrade a New EM2100 appliance from Fleet Operations Workspace 1.0 to Mobile Software Suite 4.9

This section defines the process for downgrading a newly purchased EM2100 appliance running the Fleet Operations Workspace Core software to the Legacy Mobile Software Suite (MSS) solution.

1. Install the EM2100 following the *EM2100 Installation Guide (Cat. No. I634)*, and *Fleet Operations Workspace Core Software Users Guide (Cat. No. I635)*. During installation, the system will assign a new network IP address, which will be used during the downgrade process.
2. Download the MSS 4.X software, which the mobile robot fleet is currently using, onto

the PC which will be used to downgrade the EM2100.

You can obtain this software from your local OMRON representative.

> **NOTE:** The SetNetGo 4.10 version which you will need is already installed on the AMR.

3. Using the PC, open the SetNetGo Web interface within a browser and connect to the EM2100 appliance via its existing IP address.
4. Within SetNetGo, select the **System** Tab and select the **Upload SetNetGo OS** page from the left-hand list.
5. Select **Boot Image B**, which should be labeled as SetNetGo 4.10 on the screen.
6. Reboot the EM2100 appliance by either clicking on the **Reboot** Button in the SetNetGo System tab, if enabled, or by using the power switch on the front of the EM2100 appliance.

   If the pre-installed version of MSS 4,x differs from the version presently operating the fleet, , install the MSS 4.X software onto the EM2100 appliance. Otherwise you can use the version that is operating the fleet.
7. Within the SetNetGo Web interface, select the **Software** Tab and select the **Manage Installed Software** page from the left-hand list.
8. Click the **Choose File** Button at the top of the page.
9. Navigate to the desired MSS 4.X software file and select it for upload.

   The file name should appear next to the *Choose File* button.
10. Now click on the **Upload File** Button.

    Once the upload is complete, the EM2100 appliance will be operating with the legacy MSS 4.X software solution.
11. Confirm that the desired version of the MSS 4.X software is installed on the EM2100 by selecting the **Software** Tab in the SetNetGo Web interface.
12. Choose whether EM2100 should run as **Primary** or as **Secondary Fleet Manager.**

- If the unit is configured as a Primary Fleet Manager, SetNetGo will automatically start ARAMCentral and autosync.
- If the unit is configured as a Secondary Fleet Manager, only autosync will run.

This completes the procedure and the EM2100 is now ready to connect to the existing AMR fleet for programming, using MobilePlanner.

Downgrade an AMR from Fleet Operations Workspace 1.0 to Mobile Software Suite 4.9

This section defines the process for downgrading a newly purchased AMR running the FLOW Core software to the Legacy MSS solution. If the AMR was shipped with FLOW Core pre-installed, you cannot downgrade the unit below SetNetGo 4.10. Additionally, if you have previously upgraded an AMR from MSS 4.x and are running SetNetGo 5.0.0 or higher and you want to downgrade to SetNetGo 4.1.0 you must first install SetNetGo 4.1.0 before performing the downgrade.

To downgrade your AMR, use the following steps.

1. Download the Mobile Software Suite (MSS) 4.X software, which is currently used by all other AMRs within the existing mobile robot fleet, onto the PC which will be used to downgrade the AMR.

   You can obtain this software from your local OMRON Representative.
2. Using the PC, open the SetNetGo Web interface within a browser.
3. Select the **System** Tab and select the **Upload SetNetGo OS** page from the left-hand list.
4. Select **Boot Image B**, which should be labeled as SetNetGo 4.10 on the screen.
5. Reboot the AMR by either clicking on the **Reboot** Button in the SetNetGo System tab, if enabled, or by using the power switch on the AMR HMI Panel.

   NOTE: A version of MSS 4.x is already installed. If this version doesn't match the one you are downgrading to, you will need to install the desired Legacy MSS 4.X onto the AMR.
6. Within the SetNetGo Web interface select the **Software** Tab and click on the **Manage Installed Software** page from the left hand banner list.
7. Click on the **Choose File** Button at the top of the page.
8. Navigate to the MSS 4.X software file and select it for upload.

   The file name should appear next to the *Choose File* button.
9. Then click the **Upload File** Button.

   Once the upload is complete, the AMR will run as an MSS 4.X unit.
10. Reconnect to the AMR using the *SetNetGoWeb* interface.
11. In the SetNetGo Software tab, confirm that the desired version of MSS software is installed.

If no configuration error is displayed, the AMR is now ready to connect to the Fleet Manager (EM2100 or EM1100), and for programming using MobilePlanner. If an error is displayed, perform the following steps.

1. Identify another existing fleet AMR in the fleet that is identical to the one you downgraded, such as an identical LD-60.
2. Download the debuginfo from this second AMR to your PC.
3. Upload the debuginfo to *System::Backup/Restore Options::Restore All Settings* in the AMR showing the configuration error.
4. Restart the AMR once the upload is complete and confirm the configuration error is gone.

If you do not have an identical AMR to the one showing the configuration error, or if the error persists after uploading the debuginfo file, please contact your local OMRON representative for further assistance.

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