TrellisWare Technologies

TW-875 TSM Ghost Radio User Guide

Version 6.1.7

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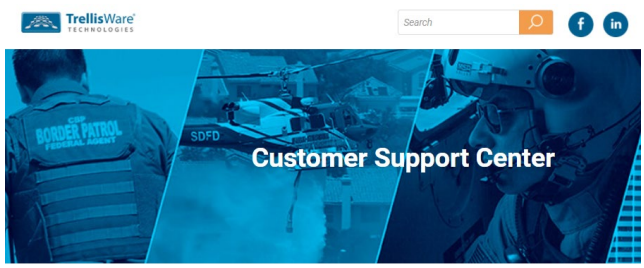
Support Center

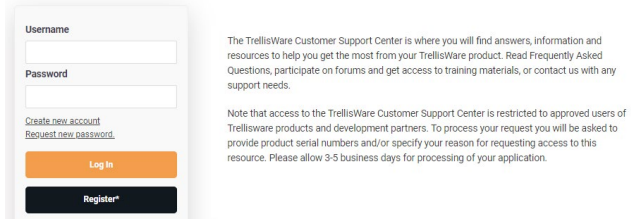
Answers to commonly asked questions can be found at TrellisWare's Support Center:

https://support.trellisware.com

Access technical notes, documentation, and information about training and software updates.

Contact support@trellisware.com or visit us on the web.





Throughout this document, references to Technical Notes (TN) look like:

Please refer to **TN-0000 – Example** for more information.

And special notes look like:

NOTE: These are important notes about the product and software.

CHAPTER 1

Introduction

TSM™ Networking

TrellisWare's TSM waveform enables a self-forming, self-healing, infrastructure-less Mobile Ad-hoc Network (MANET) that provides wireless coverage in challenging environments or during critical situations. It is designed with advanced signal processing and cooperative communication techniques for long distance connectivity, and it supports a variety of services. Your Software Defined Radio (SDR) product is powered with TrellisWare's unique TSM waveform for superior mobile ad-hoc networking.

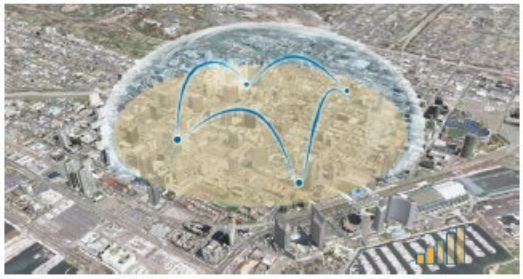
This chapter discusses the following:

TSM Waveform Characteristics

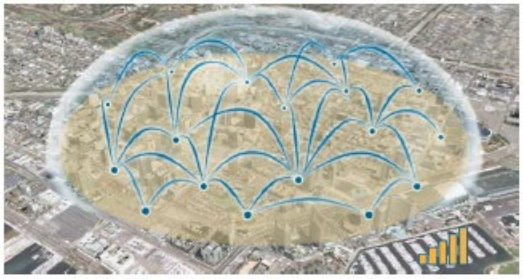
Common features for your tactical mobile ad-hoc network:

- No towers needed; it is not dependent on a fixed infrastructure
- No central control points, programmed routes or tables, access points, or directional antennas (needed for Wi-Fi or cellular networks)
- No restrictions on topology
- No restrictions on the number of radios to host in a single network
- No special setup required to connect to a computer or existing network
- Every radio is a receiver, transmitter, and relay – all in one
- Each radio directly communicates with other radios for all network traffic
- Reliable communications with low latency and low overhead

The entire MANET increases in robustness, area of coverage, and path diversity as more radios are deployed.



Radios form a network in an urban area



Network strength improves with more radios

TSM Waveform Benefits

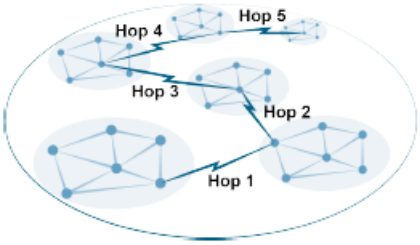
Network Benefits

- **Self-forming, Self-healing** - Infrastructure-less mobile ad-hoc networking
- **Scalable** - Large and small network capability, 500+ nodes in a single RF channel
- **Fast re-entry** - Less than one second
- **Non-routing** - IP devices are plug and play
- **Secure** - AES-256, remote disable, RSA-2048, SHA-256

Services of Network

- **Voice, Data, PLI** - Simultaneous voice, data, PLI (GPS), gateway
- **Cellular quality voice** - 12+ Up to 16 channels, AMR 5.9, or MELPe
- **Video** - Capable of streaming multiple simultaneous videos H.264, MJPEG
- **Data rate** - Up to 33 Mbps IP throughput per channel
- **Talk groups** - Up to 32 voice talk groups

Wide Network Coverage



- **Range** - 26 mile Line of Sight (LOS) per network hop, 150 mile LOS per network hop in Long Range Mode
- **Multi-hop** - Up to 8 hops
- **Mobility** - Instantaneous network anywhere at any time (vehicle to ground to air)
- **Harsh RF Environments** - Urban, ships, buildings, tunnels, etc.

Network Capabilities

TSM gives you tactical mobile networking when it matters most. Many radios can be deployed quickly by being able to auto-configure into a wide area network (WAN) without relying on a fixed infrastructure.

Whoever you are, TSM is ideal for you!

- First responder (Fire fighter, disaster relief, paramedic)
- Warfighter (Tactical communications)
- Miner
- Mariner/sailor
- Security
- ISR
- Unmanned (Aircraft, robot)

Wherever you are, TSM is perfect for any environment.

- Dense urban
- Heavy foliage
- Hilly or rugged terrain
- In high multipath
- Onboard ships
- Mines/caves/ tunnels
- Desert
- Coastal

CHAPTER 2

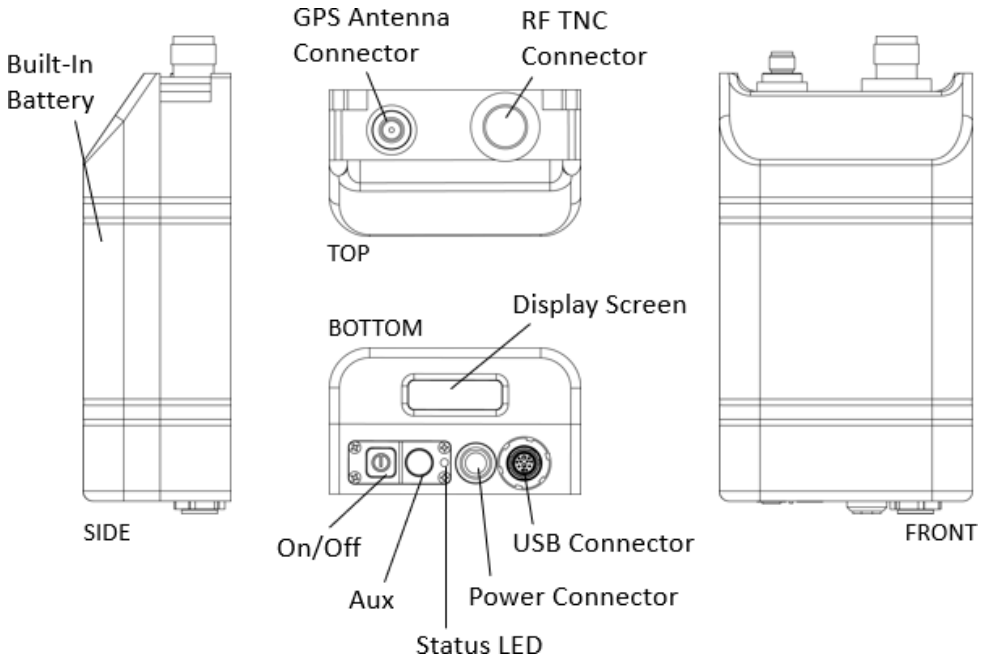
Radio Basics

The TW-875 TSM Ghost™ radio is highly portable with a built-in battery that provides flexibility in deploying TSM networks. The radio supports PLI of assets and coalition partners without requiring a larger, full-featured TSM radio. The low-profile design of the radio is perfect as a leave behind networking relay to enhance and extend network range. The TW-875 is equipped with GPS and RF antenna connectors, USB data connector, external power, and a small LCD display.

- Relay device/leave behind
- Internal battery, and external supply/charge
- Supports missions: Intelligence, Surveillance, and Reconnaissance (ISR), Tactical Video Surveillance (TVS), Tagging Tracking & Locating (TTL) and data ex-filtration

This chapter discusses the following:

TSM Ghost Diagram



GPS Antenna Connector	SMA connector on top of the radio that supports external GPS.
RF TNC Connector	TNC for RF antenna connection on top of the radio.
Built-in Battery	The TW-875 radio includes an internal battery. Recharging time via an external power cable takes approximately 3 hours or less when the radio is turned off.
Display Screen	Small LCD display screen for quick status on features such as mode, battery life, link quality, and temperature.
On/Off Button	Pressing the On/Off button serves to activate or de-activate the device.
Aux Button	Button for cycling through radio modes and secondary UI functions.
Status LED	LED flashes colors to indicate the On/Off cycle, battery life, signal strength, or radio modes.
Power Connector	External power supply connector for charging built-in battery.
USB Connector	External connection for USB capability.

TSM Ghost Specifications

Physical	
Overall Size	4.06 L x 2.50 W x 1.46 H in (103.12 x 63.50 x 37.08 mm)
Weight	16 oz (0.45 kg)
Frequency Range	• L-UHF: 225–450 MHz • U-UHF: 698–970 MHz • L/S Bands: 1250–2600 MHz
Configurable Bandwidth	1.2, 3.6, 10, 20, 40 MHz
Transmit Power	100 mW, 250 mW, 500 mW, 1 W, 2 W
Input Power	5 V to 20 V
Connectors	• USB On-the-Go • RF TNC • GPS SMA
Data Rate	Pt. to Pt., up to 33 Mbps (1-hop)
Security	• Built-in AES-256 COMSEC • TRANSEC
Waveform	TSM 6
Environmental	MIL-STD-810G
Water Resistant	IP68
Operating Temperature Range	-20°C to +55°C (-4°F to +131°F)

Radio Accessories

The radios include internal web applications, default factory settings, and are compatible with hardware accessories such as RF and GPS antennas, USB Type-A adapters, and power cables. Since the radio can be used in vehicles, body worn, or left behind, you can interchange accessories to meet the needs of your network and mission.

TW-875 Basic Actions

The TW-875 TSM Ghost is a powerful but streamlined device. This radio does not have a side interface for dongles, but it does include RF, GPS, power, and data connectors. TSM Ghost is unique in that it can relay audio and video data, but it cannot generate it.

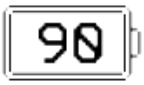
The On/Off, Aux, and Status LED controls on the bottom of the radio offer ways to interact with your radio and network. In general:

- A button is "pressed" when it is activated for less than 3 seconds
- A button is "held" when it is activated for 3 seconds or more

TW-875 Display Screen Icon Descriptions

The display screen shows a series of radio status icons within 4 columns. From left to right the columns are:

On/Off	Pressing the on/off button serves to activate or de-active the device
Aux	Button for cycling through radio modes and secondary UI functions
Status LED	LED flashes colors to indicate and on/off cycle, battery life, signal strength or radio modes
Power Connector	External power supply connector for charging built-in battery
USB Connector	External connection for USB capability
Display Screen	Small LCD display screen for quick status such as mode, battery life, link quality, and temperature.
	The signal strength of network connectivity is represented in bars. The more bars displayed in black, the stronger the signal. The signal strength bars display when the radio is in a regular operating mode.
	If a letter displays above-left of the signal bars, this indicates the radio's network status. C = Command node in the command network, A = Command node in the alternate network, Z = The radio is zeroized, X = No signal
	The lock icon indicates the radio is in Tamper mode, and protection features have been activated. To recover, you must reload certificates and software in Programming mode.
	If the radio is not in regular operating mode, the display screen shows the mode it is in. These modes are: PGM= Programming mode (to configure and customize the network), RCOV= Recovery mode (to re-initiate radio hardware and software from failures, "bootstrap" to recover the unit). OFF means the radio is off and regular operating mode displays with the signal bars.
	The water drop icon displays when the Dive mode is activated. When Dive mode is enabled, it disables power to peripheral functions (in preparation for getting the radio wet). With the radio on, hold the On/Off and Aux buttons to enable or disable Dive mode. The Status LED flashes blue when enabling and yellow when disabling this mode.
	• If a power cable is connected and the battery is charging, the lightning bolt icon appears solid. • If the power source is < 8V, the battery will slow charge, indefinite operation is not guaranteed, and the bolt icon flashes.

	• If the internal battery temperature > 45C, the temperature icon will blink, indicating that the battery will not charge. Even though the battery isn't charging, the radio will continue to operate normally from the remaining battery power or external power (if available). • If the battery temperature > 65C, the temperature icon will be solid. This is a warning that the battery's temperature is approaching thermal shutdown. • If the battery temperature > 70C, the radio will shut down.
	The battery icon graphically displays the battery charge percent.

Power On

To turn on in a normal operating mode:

Press and hold the On/Off button for 3 seconds until the TrellisWare logo appears on the display screen, and the Status LED starts to emit a series of colors: white, red, yellow, light blue, blue, and LED off. When the LED goes off, the display screen shows relevant icons and the radio is ready to be used.

Boot Menu

Boot mode for the TSM Ghost radio is any mode other than the regular operating mode. The modes available from the dis- play screen are Programming mode and Recovery mode. Regular operating mode is indicated by the signal strength bars.

1. To enter the Boot menu, with the radio Off, press and hold both the On/Off button and the Aux button.
2. To select a radio mode, continue to hold the On/Off button, and then press the Aux button to cycle through avail- able modes. Cycling through the Boot menu displays the mode on screen and the Status LED flashes corresponding colors to the mode. (Green= Programming mode, Red= Recovery mode, Blue= Regular operating mode.)
3. To select the desired mode, release the On/Off button hold as it displays in the menu cycle.

View Screen with Radio Off

The display and status LED are inactive by default while the radio is Off. However, you can quickly view radio status even with the radio remaining off. In this state, the display shows an OFF icon, battery icon with charge percent, and a charging icon if the battery is charging.

To activate the display and LED for 5 seconds, quickly press the On/Off power button.

Note: The display screen has no back light and the brightness cannot be adjusted.

Connect Antenna

Attach an antenna to the radio to transmit and receive signals. You'll need one each of the following:
RF antenna (TNC connector) GPS antenna (SMA connector)

To connect:

1. Attach the TNC connector on the antenna to the RF antenna connector, and then connect the GPS antenna to the GPS connector.
2. Turn the connectors clockwise until firmly seated.

Tips:

- The GPS antenna can be set to "on" or "On with Antenna Powered" via TMT or TNC Remote Control.
- Do not use antennas as handles when connected to the radio.
- When deployed, always try to elevate the antenna or bend it upwards if the radio is lying flat.
- If multiple radios are deployed in the same frequency, antennas should be at least 15 feet apart.

Connect USB data

EUD: TW -875 TSM Ghost includes a rugged USB data connector at the bottom of the radio to support USB On-the-Go (OTG) with 1A power capability.
To connect USB to end user device (EUD):

Insert the standard end of the USB cable into the EUD USB A port, and then insert the ODU end into the USB Data connector on the TSM Ghost device.
The USB data connection allows for use with an ATAK or smart phone EUD via the USB connector (or secure Wi-Fi adapter). When connected the radio is then controlled through the EUD

Note: Hold the Aux button to enable or disable USB OTG power output override for Nett Warrior EUDs. The Status LED flashes green when enabling, and red when disabling.

Programming: It is recommended to use the TW-1670 USB Type-A Adapter to connect to a PC for radio programming and setup:

1. To connect cable to radio, align the red dots on the 12-Pin connector on the radio and cable.
2. Push the data cable downward until the data connector clicks into place.
3. Connect USB-A to standard USB-A jack.
4. To disconnect cable from radio, slide the data locking mechanism upward and remove.

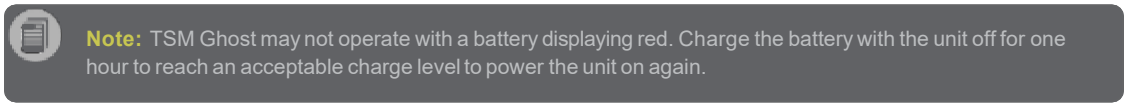
Connect Power Source

TW-875 provides power either through its 3 internal 18650 lithium-ion batteries, or through an external source. The radio provides full functionality indefinitely when the input supply is at least 8 V.

Battery Charge
Depending on the network type, demands on relay traffic, and the configured operational mode of the radio, a fully charged battery may last anywhere from 1.5 hours up to 12 hours.
The Status LED on the bottom of the device, provides an indication of the charge level of the battery. The Battery LED blinks if a charger is attached and the battery is charging up.

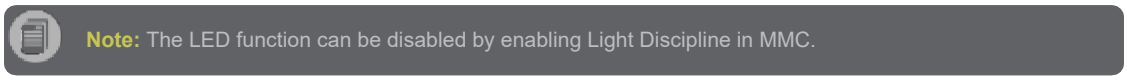
To check battery status:
View the display screen to read the current battery charge from the icon, or
Press the On/Off button to activate the Status LED for 5 seconds. The LED color indicates battery level, and the LED flashes if the battery is charging. LED color and approximate charge level:

Blue = 95% – 100%
Green = 50% – 95%
Yellow = 10% – 50%
Magenta = 2% – 10%
Red = 0% – 2%



Read the LED Light

The radio indicates signal and battery status by emitting light through the status LED on the unit.



Network Status
The network automatically assigns a reference point. You have the option to select a radio as a command node where that assigned radio then acts as a reference point for the network. If no radios have been tagged as a command node, then the network would appear as a non-command network (or alternate network).

Note: There is no difference in performance between a command or alternate network.

View the display screen to identify the radio's role in the network. If a letter "C" displays above-left of the signal bars, this indicates the radio is the command node in a command network. If the letter "A" displays, then the radio is the command node in an alternate network.

Signal Quality

To see the link quality or signal strength of network connectivity from your radio to the command radio (or other designated node), do one of the following:

- From the display screen, view the bars. Like the bars represented on a cell phone, the more bars displayed in solid black, the stronger the signal.
- The signal strength can be indicated by pressing the Aux button to activate the Status LED for 5 seconds. The LED emits colors ranging from blue, green, yellow, to red. The signal quality ranges from better to worse, where blue is the best.

Note: Data bandwidth increases as signal strength improves.

Note: If the radio is in Programming Mode, the signal quality function will not work because the network is not running (and the signal strength icon is replaced with the PGM icon.

Power Off

To turn TW-875 TSM Ghost off:

- Hold the On/Off button for 3 seconds. The display menu shows the TrellisWare logo and the Status LED flashes red until the radio is off.

CHAPTER 3

Quick Start

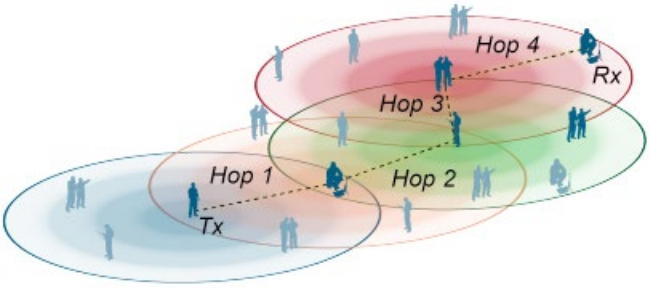
After getting familiar with the radio, you'll need to know how to set up your network. We'll go over what you need to get started, step through basic concepts of the MANET, and perform simple tasks for configuring radios and monitoring a network.

Every radio includes a series of software applications that you'll use to interact with the radios from initial configuration through deployment. In addition, you'll use the TSM Management Tool to create preset files that customize and optimize the performance of your network.

This chapter discusses the following:

Network Basics for Hop Count

Hop Count



Networked radios communicate by broadcasting messages to one another. Each radio is a peer, and receives, transmits, and relays its transmission to all radios within its coverage area. A hop is created when it reaches its maximum distance. Another radio within the network relays that same transmission to radios within its coverage area. This process continues until it reaches the destination radio. A hop always takes the shortest path, and each relay in that path is a hop count. The network can extend 8 hops from its reference point and each hop can reach up to 26 miles.

Command and Alternate Networks

The network designates a reference point on its own for network timing, but you can also assign a radio as a command node. The reference point also serves as a starting point for the hop count. Once deployed, any radio that comes within range of the command radio or the command network will automatically join the command network. If no command radio is designated prior to deployment, the network selects a command node. If one or a group of radios goes out of range of any radio in the command network, then they form an alternate network.

A command radio only indicates that a priority level has been set and therefore, it acts as a reference point for the network. If no radios have been tagged as a command node, then the network would appear as a non-command network (or alternate network). See "Read the LED Light" for more information.

NOTE: Alternate network command radios cannot be designated.

Please refer to **TN-0023 – Command Radio** for more information.

Tips:

- If no command radio is present, the network automatically forms an alternate network.
- For increased range, a good GPS signal for known satellite time synchronization may be required.
- Avoid placing the command radio in an Unmanned Air Vehicle (UAV) since it is better in a fixed location.

For highly mobile networks it is better not to assign a command radio, but rather to let the network select a reference point dynamically as the network changes.

Planning for a Strong Network

- Network robustness and coverage improves as more radios are deployed.
- Strengthen the network by placing radios as relays or in strategic positions to increase RF multipath. Do not spread your network too thin.
- Establish a LOS vantage point without obstructions to increase transmission distances. Higher ground is better than lower ground.
- Avoid placing radios in depressions or valleys.
- Point antenna up and elevate it - on body, in vehicles, and in the field.

See "Build a Strong Network" for additional information.

Programming Mode

Programming mode is used if you want to configure and customize your own TSM network. When configuring a radio, installing new certificates, and loading new software to the device, the radio must be in Programming mode.

In addition to Programming mode, the radios have other operational roles that can be assigned to them through TNC. The modes offer levels of security and functionality during deployment.

NOTE: The "agent radio" is the unit that serves the browser-based web applications. The agent radio cannot update itself, but it is necessary to access other radios while in Programming mode or Operator mode.

To power on in Programming mode:

1. Connect a dongle with an Ethernet port.
2. Press and hold the **Volume Up/Zeroize** button and pull-to-turn the **Power/Channel/Zeroize** control clockwise. The LED will flash white.

NOTE: When a radio is in Programming mode, all RF communications are disabled.

Pre-Mission Configuration

Before configuring your network, some basic computer pre-configuration is necessary in order to communicate with radios and to access the radio hosted web applications.

To do this, you'll need:

- Recommended System Requirements with administrator privileges on your computer
- TrellisWare's default certificate
- Radio, dongle, and Ethernet cable
- USB cable (for radios that connect via USB, make sure you have the RNDIS driver installed - see below)

The pre-configuration steps are:

1. Load certificates.
2. Set the computer IP address.
3. Connect to your radio.

Install RNDIS Driver

A Remote Network Driver Interface specification (RNDIS) driver is needed for a PC and a device to communicate with each other via USB. The driver is available for download on the TrellisWare Customer Support site via My Products/Your Registered Product/Software/Drivers.

To install:

1. Connect the radio and PC by inserting one end of the USB cable into the computer and the other end into the USB connector on the dongle.
2. Power on the radio.
3. When the PC prompts for unknown hardware, point it to the downloaded USB driver folder to update the driver software. Follow the sequence of windows to install.

Please refer to **TN-0020 – Installing USB drivers Win7, TN-0085 – Installing USB Drivers Win10, TN-0040 – Computer Pre-Configuration** for more information.

Load Certificates

The certificate adds a layer of physical security to your network.
Chrome

1. Launch the Chrome web browser to load the certificate to your personal Windows store.
2. At the top right, click the three dots, then click **Settings**.
3. Click the search icon (magnifying glass) and type **Cert**.
4. Click **Security**.
5. Click **Manage Certificates**.
6. From the Certificates window > Personal tab, click the **Import** button.
7. Follow the Certificate Import Wizard and click **Browse**.
8. Navigate to the location of the certificate on your local machine. (Make sure the bottom right dropdown says **All Files**) This will import into the Windows Current User certificate store.
9. When asked for a password, leave it blank.
10. Click **Next**>**Next**>**Finish** to import the new certificate.

Firefox

1. Launch the Firefox web browser.
2. From the Firefox main menu bar, click the three bars in the top right corner and select **Options**.
3. In the left panel, select **Privacy & Security**.
4. Under Privacy & Security, scroll to the bottom to find **Certificates**, then click the **View Certificates** button.
5. On the Certificate Manager, select the **Your Certificates** tab.
6. Click the **Import** button and navigate to the Certificates folder in the software release bundle.

7. Select your generated certificate or the **oem-default.p12**, and click **Open**.
8. At the Password Entry Dialog, click **OK** as no password is required.
9. The Certificate Manager now displays the TrellisWare certificate.

Please refer to **TN-0115 – Certificates** for additional certificate information.

Set the Computer IP Address

Access TrellisWare software web applications for configuration and network management through the radio's IP address.

If you have a DHCP server on your LAN, skip to "Connect to your Radio."

If you do not have a DHCP server on your LAN, do the following to configure your PC:

1. Open the Network Connection window for your computer (the location varies depending on OS used).
2. Click the **Local Area Connection**.
3. In the Local Area Connection Status window > **General** tab, click **Properties**.
4. In the Local Area Connection Properties window > **Networking** tab, select Internet Protocol (TCP/IP v4), and click **Properties**.
5. In the IP Properties window > **General** tab, click **Use the following IP address**, and enter the IP address for the computer. It is recommended to enter the IP address of 10.x.x.x, and a subnet mask of 255.0.0.0.
6. Click **OK** and close out of the other windows.

IP Addressing

When connecting a radio to an end user device (EUD), such as a laptop, you must be aware of 1) the radio's serial number, and 2) the default subnet mask of 255.0.0.0. The PC should be set 10.x.x.x, to connect to the radio using the mDNS name as the radio will auto-assign an IPv4 address in the 10.x.x.x IP range by default.

TrellisWare radios use the multicast Domain Name System (mDNS) protocol, which is implemented by Bonjour. This makes it easy to access a radio because the mDNS is the radio's serial number, or sn-xxxx.local name. When using the mDNS name, the EUD must be in the subnet of the radio. Which by default is 10.x.x.x.

As an advanced feature, the radio allows you to set a static address on the radio, configuring all octets of the IPv4 address. This offers more flexibility when you know a specific IP address; with very little chance of experiencing an address conflict.

If a radio is in Programming mode in a local area network (LAN), the DHCP networking protocol always takes precedence over an auto-static IP address. But if there is no DHCP service, then it defaults to auto-static or the user set static address. See "Programming Mode."

In some modes of operation, a secondary common (or maintenance) IP address is available: 10.1.0.2. This address is provided for flexibility in those operational modes, but it is recommended that the mDNS name be used in all circumstances.

Connect to your Radio

1. Attach a dongle to your radio
2. Connect the radio and computer via Ethernet cable. (You can also connect multiple radio's via switch or router.)
3. Turn the radio on (in Programming mode for configuration).
4. Access the web apps to configure, view, and manage the network by typing the following in the Firefox web browser's address bar:
    - The radio's serial number. Enter sn-xxxx.local wc-xxxxa.local or wc-xxxxb.local where xxxx is the SN.

Please refer to TN-0001 – Avoiding Network Loops

Configure Radio

Out of the box, the radio includes a default IP address (IPv4 = 10.x.x.x, subnet = 255.0.0.0), loaded software applications, and a factory Preset configuration. The radio's default common IP address is set to 10.1.0.2. The common IP is disabled in Programming mode, but functions in Operator mode.

Once the certificate is loaded, and the network connection is made, radios can then be setup for customization.

TMT recognizes all radios connected to the IP network, so you can configure one radio via USB/ Ethernet or multiple radios via an Ethernet switch at the same time.

To configure your radio, you'll need:

- Radio(s) for configuration
- Dongle(s) with Ethernet or USB port
- Ethernet cable
- USB cable
- Ethernet switch or router (if connecting multiple radios)
- The TSM Management Tool
- Computer with web browser to access TNC

Configuration steps include:

1. Open the TSM Management Tool. First-time users will have to click the Add Preset button available on the **Preset Manager** tab.
    a. Create a network preset file.
    b. Change configuration parameters to mission needs and generate security keys.
    c. Save the preset.
2. Turn on the radio(s).
    a. Ensure radios are on the same network as the PC.
        i. To load multiple radios on a switch, they all must be in **Programming** mode.
        ii. To load an individual radio, it can be in **Operational** or **Programming** mode.
    b. On the **Device Configuration** tab, select the radio(s) to configure and the preset for the selected radio(s).

c. Apply the configuration to the radio.

3. (optional) Start TNC to further define network characteristics.

For more information about connecting the radios to a network, see **TN-0040–Computer Pre-Configuration** and **TN-0113 – TSM Management Tool**.

Monitor Network

With the preset loaded and radio configurations applied, your network is ready for deployment. You can launch the TrellisWare Network Controller (TNC) web application from any radio within the network to monitor and manage your operating network.

To monitor the network, you'll need:

- Radio to access TNC
- Attached dongle with an Ethernet port
- Ethernet cable
- Computer with web browser to access TNC

Basic TNC operations are:

1. Start the TNC web app.
2. Map radio locations and view connectivity.
3. View video activities.
4. Remotely change radio settings and set audio thresholds.

Start TNC

1. Access TNC by typing in the radio's IP or hostname into the browser.
2. A security prompt appears. Accept the risk and select continue.

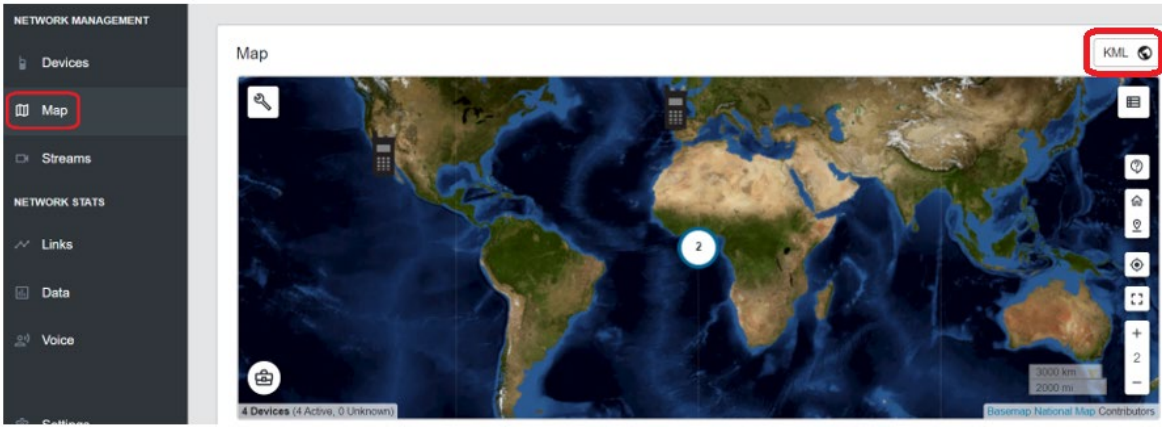
Map Radio Locations

The purpose of the Maps application in TNC is to show the location of the devices in your network. You can also view information about the radios in your network devices, such as links between nodes, RF noise floor, NTR connectivity, etc. You also have the ability to manage your TSM network in the **Map** tab by remote-controlling into individual radios and changing settings.

There are several ways to visualize radio locations on a map:

1. You can use the built in TNC map tiles.
2. You can download the KML file generated by TNC to view the radio topology outside of TNC in Google Earth Pro. Be aware that Google Earth would first have to be installed on your computer. Additionally, only certain versions of Google Earth are compatible with the KML file in TNC.
3. The user may specify a Custom Tile Server URL for TNC to use. Note that the tile server must be accessible from your network.

4. The user may specify a Custom WMS Server for TNC to use.



Devices - show as a thumbnail on the map. To see more information about a particular device, click on it and a pop-up will appear. The pop-up displays basic information and controls specific to that node.
Map Details Button – Clicking this button displays a list which shows all devices on the map and allows the user to enable link lines for each respective one by clicking the **Show Links** button next to it.
Links – Each device has two link readings – the receive SNR as measured by the radio on both ends of the link. This means two lines are drawn next to each other for each link.

Please refer to **TN-0114 – Trellisware Network Controller** for more information.

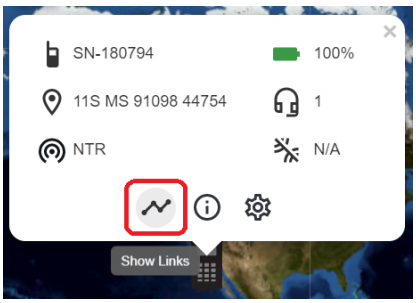
Network Connectivity

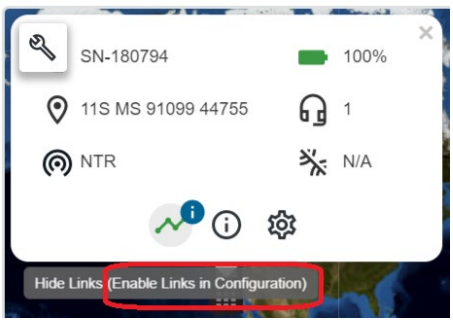
Each device has two link readings – the receive SNR as measured by the radio on both ends of the link. This means two lines are drawn next to each other for each link.

- The color ranges from Red>Yellow>Green>Blue, depending on signal strength (bad to good).
- If you hover over a link line, it tells you the SNR readings and the alias names of the devices it belongs to.

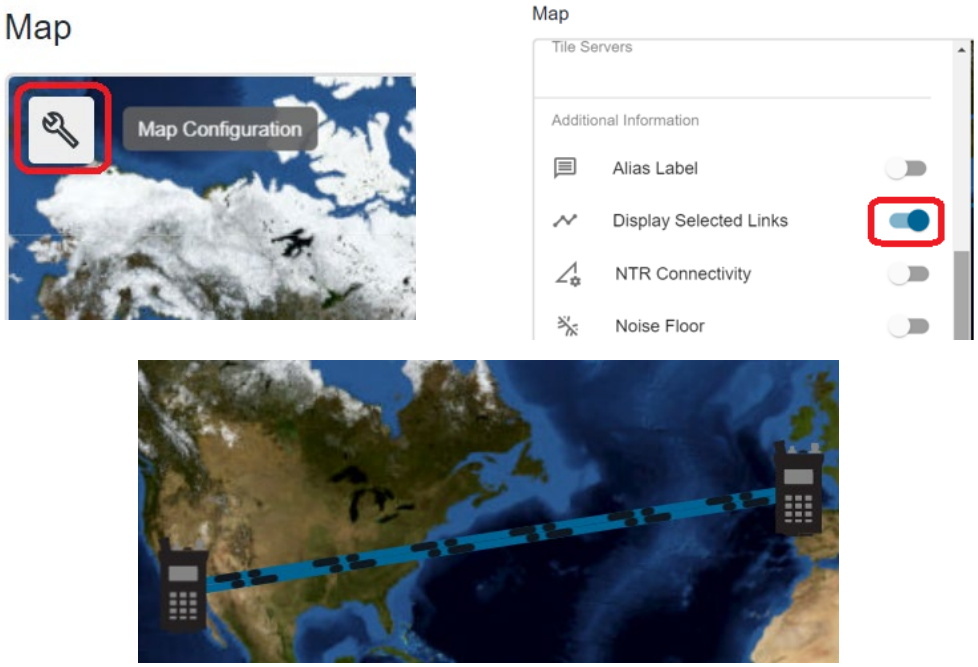
To display the links for a node observed on the map, follow these steps:

1. Click the radio on the map and then click the **Show Links** button. You may receive a message prompting you to enable the links from the **Map Configuration** menu. Note that enabling links for a radio can also be done within the **Map Details** pane.





2. To ensure that links are enabled in the **Map Configuration** menu, click the **Map Configuration** icon in the top, left corner of the map. Scroll down within the pop-up window and click the **Display Selected Links**. The footprint pattern shows the direction. A footstep has the longer part first and the shorter part after, so if the link line is going from left to right and a short dash is followed by a long dash, the link is going right.



View Live Video

Network activities happen through the Streams tab in TNC. There are several methods on how to view videos, but the easiest way is using a VLC player.

NOTE: The advantage to streaming through a VLC player is that you can record video. Also, using VLC offers less latency than some other video source applications.

View in a VLC player

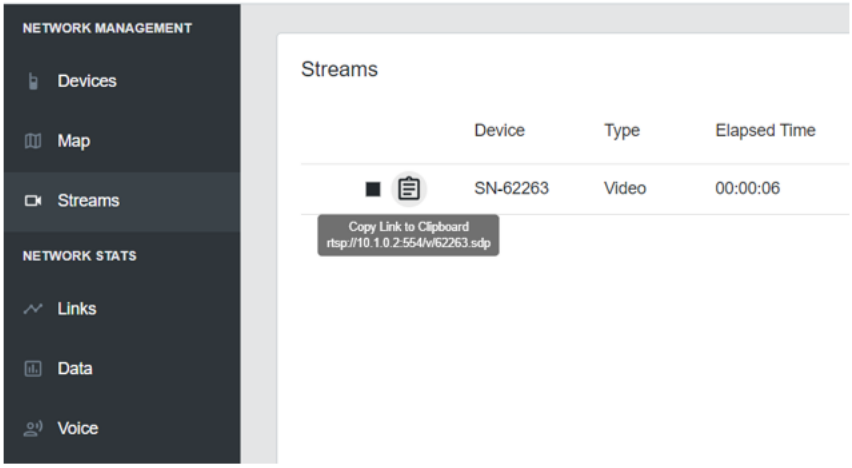
You'll need:

- The latest version of VLC: 3.0.8 or higher. Download it from http://videolan.org/vlc.
- The PC running VLC must be connected to a radio in the TSM network.

1. Optimize the VLC player. From the VLC's **Tools** drop-down, select **Preferences**.
2. Select the **Input and Codecs** option from the top panel.
3. Select the **RTP over RTSP (TCP) located in the Network** section.
4. From the Streams tab (under Network Management) in TNC, you will see all available/active streams in the network.
5. You will see either a **Play** symbol or a **Stop** symbol.
   a. If you see the **Play** symbol, the stream is not active. Press **Play** to start the stream.
   b. If you see a **Stop** symbol, that stream is active and will offer you a “Copy Link to Clipboard” symbol.

NOTE: If the stream is actively streaming, it consumes network IP bandwidth. If you set up a stream to Auto Start, the stream will activate upon the radio powering up and power is applied to your camera source.

1. Click on the **Copy Link to Clipboard** icon. This will allow you to paste the RTSP link in VLC.

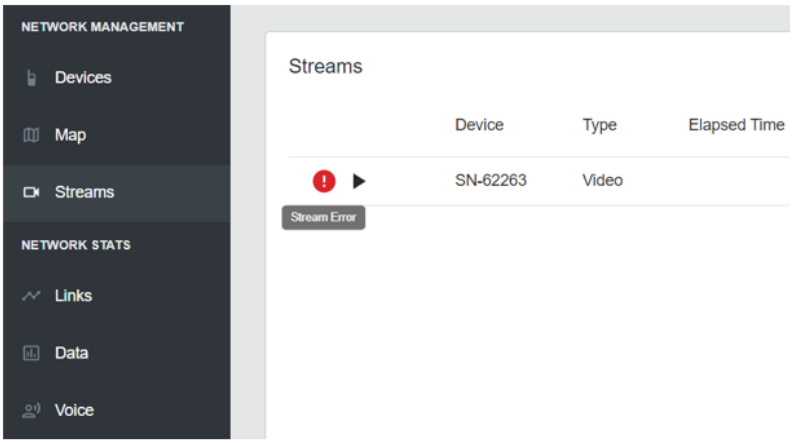


2. From the VLC player's **Media** menu, select **Open Network Stream**.
3. In the Open Media window, paste the link in the **Network URL** text box, then click **Play**.

Please refer to **TN-0035 – Viewing Media Streams in VLC**, **TN-0041 – IP Cameras and Video Encoders** for more information.

Tips:

- If the sensor stream does not play and you get a Stream Error (see screenshot below), check the signal strength. If the stream source or viewer has weak signal strength, the stream does not play. This can also happen if you do not have power to the camera or the sensor dongle has a hardware issue (i.e. damaged pins)
- If the video stops after a minute, make sure the RTP over RTSP option in VLC's Preferences is selected. If not, a sensor video stream starts but will stop after 1 – 2 minutes.



Change Radio Settings Remotely

Using the Remote Control functionality, you can change basic parameters over the network.

1. From TNC's Devices list, click the **Remote Control** icon for the radio you'd like to change settings for.
2. The Remote Control panel appears on the right side. Remote Control provides a means for remotely changing features on the radio that would otherwise be performed locally.
3. Make the desired changes.
    - To make audio changes, adjust the **Volume** and **Headset** settings under the Voice tab.
4. Changes are automatically saved.
5. Close the Remote Control panel once you have completed making changes.

NOTE: Changes to settings in Remote Control are immediate and do NOT force a radio reboot.

Please refer to **TN 0114 – TrellisWare Network Controller** for details.

CHAPTER 4

Get the Most from your Product

Now that you have the basics down, let's explore what your product is really capable of doing. We'll cover a wide range of topics, from how to build successful networks, TSM networking basics, to over the air functionality, and maintenance.

This chapter describes how to approach your product as a whole and the processes involved for getting the most out of your tactical mobile ad-hoc network.

This chapter discusses the following:

Build a Strong Network

There are many factors to consider when creating a network, such as the deployment environment, where a radio is located, RF obstructions, or the number of radios, which all contribute to connectivity, signal strength, and network robustness. This section goes over:

- Radio placement and network planning
- Command radio
- Monitoring links
- Reviewing data during and post-mission

To do this, you'll need:

- Radios configured with the same preset file

Key Factors

Creating a strong and successful MANET can require some network planning. Planning is not essential, but it helps to ensure a robust network. Keep in mind the following best practices for optimizing your MANET with radio placement:

Pay attention to your antenna

- Keep the antenna pointed up
- Avoid touching the antenna with your hands, body, or other objects
- Avoid local obstructions, such as placing the radio behind a body or vehicle. Man-made or natural objects degrade performance

Pay attention to your environment

- When possible, strive for Line of Sight between radios
- Avoid large transmitters such as cell towers
- Use height to your advantage (better LOS and fewer obstructions)

Pay attention to your signal strength

- Better signal strength leads to better network performance
- When signal strength is low, consider leaving a radio as a relay to extend network
- Adding more radios to the network will increase coverage and performance

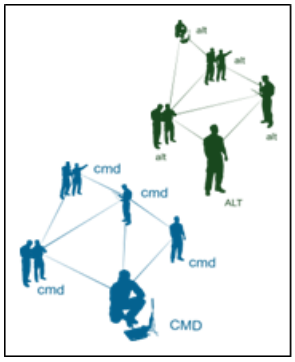
Asymmetric Links

Symmetric links between radios on the network is recommended for ideal connectivity. This is when one radio can reach another, and vice versa with the same link quality. For example Radio (or alias) A can reach Radio B, and Radio B can reach Radio A (with the same link quality). An asymmetric link happens when radios can only communicate in one direction (Radio A can reach Radio B, but Radio B cannot reach back to Radio A). Asymmetric links are caused by local interference near one of the radios or by having different transmit power levels between two radios.

TSM relies on bidirectional communication between each radio in the network for relaying voice, IP data, and PLI. When planning your network, consider radio placement and power settings to avoid asymmetric links.

NOTE: Asymmetric links may reduce network robustness in the local area, but the network is designed to work around local interference.

Command Radio



By default, the TSM network automatically elects a network reference and forms a network. The network can change the alternate network reference as network conditions change to select the best available node. The command radio property allows this default behavior to be overridden and forms the network around a user-specified reference radio. All other radios in the network adjust their timing to match the network reference, so if a command radio is selected, it is recommended to place it in a known good location with good GPS reception.

If a command radio is present in the network, network join audibles can be enabled to announce entering and exiting the command network. Since every radio is treated equally in an alternate network, there are no hierarchical audibles in alternate networks.

To assign a command radio over the air:

1. From the TNC Devices list, select a radio and click on the **Remote Control** icon.
2. From the **Remote Control** side panel that appears, scroll down to the **Advanced** category and enable **Command Node**.

Please refer to **TN-0023 – Command Radio** for more information.

Monitor Network Connectivity

You can monitor the quality of your network, network activity, and view radio locations using GPS in TNC maps (or Android, or other mapping app). Please refer to **Chapter 3>Map Radio Locations** and **Network Connectivity** for more information.

Since standard links update rather slowly and do not provide a real-time report of information, you also have the option to implement Rapid PLI at any time.

Rapid PLI

Rapid PLI supports faster position information updates on a network encompassing geolocation, network status, links, configuration, etc. Rapid PLI is beneficial over standard PLI, reduces latency, and shows information in real-time. Its drawback from standard PLI is it uses the data channel and thus reduces the available bandwidth for user data.

Rapid PLI is enabled per node and can be viewed from all other radios in the network.

NOTE: If using Rapid PLI, data throughout will be reduced.

To enable Rapid PLI:

1. From the TNC Devices list, select a radio and click on the **Remote Control** icon.
2. From the **Remote Control** side panel that appears, scroll down to the **Advanced** category and enable **Rapid PLI**.

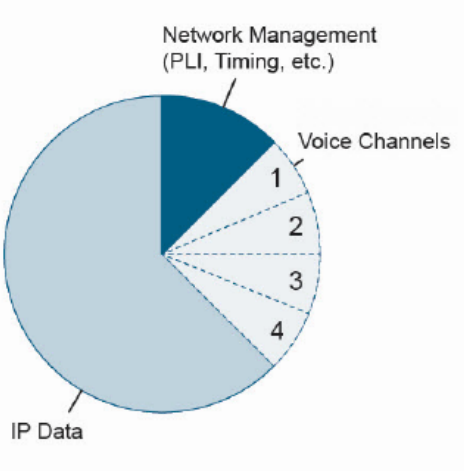
Voice and PLI Services

In real-world deployments, talking to people and knowing where others are in your network is imperative for a successful MANET. When other devices may lose RF connectivity in harsh environments, TSM products deliver robust voice transmissions and position location information (PLI).

Network Resources

Voice and PLI services (as well as data services) take up bandwidth on the network. With TSM, there are set network resources for each of these services. The resources are not shared, but they work simultaneously with each other.

- PLI is part of dedicated resources for network management. This also includes bandwidth for network timing and other services that keep the network running.
- Voice channels always have a certain amount of bandwidth allocated to them. Voice channels are never shared with data or network management resources.
- IP data also has dedicated resources and can never override allocated voice channel or network management resources.



Example: Overview of TSM's Dedicated Network Resources

TSM Ghost supports up to 32 logical talk groups that can be trunked onto up to 16 voice channels. (The number of talk groups do not change the data throughput from the normal data throughput of the network voice channels configuration.)

Talk groups support "private conversations" to other radios in the network. Voice channels dictate "simultaneous conversations" that you can have in the network. Using the TSM Management Tool you can input custom names for each talk group.

Voice Connectivity

Voice parameters for the network get set while making a preset file in the TSM Management Tool. Voice components are important because it contributes to how your network resources are divvied up; which network the radios are on and how radios talk to one another (so long as they are within range of each other and able to transmit and receive radio frequencies).

Please refer to **TN-0113 – TSM Management Tool** for more information.

PLI

All TrellisWare radios are capable of GPS (when equipped with an antenna). Position Location Information (PLI) is a feature that extracts GPS data so you can track where radios are and how well they are connected on the network. Since all radios share PLI data within the MANET, this is an excellent resource for situational awareness monitoring.

There are three ways to view PLI:

PLI in TNC

View PLI in the Map tab. TNC displays PLI as it is available from the radio.

- Steps on how to view radios in the network are in **Chapter 3** > **Map Radio Locations**.
- When viewing PLI in TNC, you can quickly see signal strength and the status of connectivity for all the nodes in your network.

PLI with KML

Serves data in the Keyhole Markup Language (KML) format. Google Earth can be used to read and visualize this information. A Google Earth PLI client periodically requests PLI updates from the server radio.

PLI with Cursor on Target (CoT)

A radio can be configured to send network PLI data in a CoT format as it becomes available. There are many applications that read CoT, but some are FalconView, Android Precision Assault Strike Suite (APASS), and Android Tactical Assault Kit (ATAK).

NOTE: When using ATAK or WinTAK, the following versions have been tested and verified ATAK 4.3.0.2, WinTAK 4.2.1.143

Please refer to **TN-0013 – Cursor on Target, TN-0008 – Connect Radio and Android** for more information.

IP Data Services

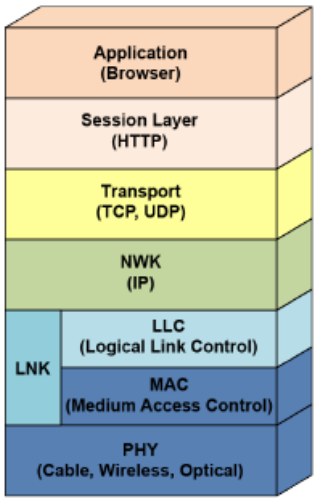
TSM products support IP data services where information can transmit over your network. In this section, we'll take a closer look at TSM's network:

- Understand IP networking
- Network layers that TSM operates in
- Data channels and data rates
- Test the network

You'll need access to a computer on a configured network.

Understand IP Networking

Functionality of a network can be very complex. To visualize and organize this complexity, network functions are described and viewed in layers. Each layer of a network provides a set of capabilities. Interfaced together, different layers provide full network functions. The classic layered model is defined by the OSI (Open Systems Interconnection) model, as shown here.



A typical network such as the IP network, consists of a Physical layer (PHY), Link layer (LNK), Network layer (NWK) and Transport layer. The Link layer (LNK) is further divided into Logic Link Control (LLC) and Medium Access Control (MAC) sub layers. Different protocols are used at each layer. A network node can contain all or part of those layers, depending on their role in the network. It is customary to call the Physical layer as Layer 1, Link layer as Layer 2 and Network layer as Layer 3. Note that many networking protocols, including TCP/IP networking, do not follow the strict layering model depicted in the OSI model.

Relationship of various network layers in a typical IP network

Layer	TCP/IP Network	Functionality
Application layer	Web browser	User applications
Session layer	HTTP, FTP	Establish connection sessions between applications
Transport layer	TCP, UDP	Provide end-to-end routing of data
Network layer	IP	Route IP packets between network nodes
Link layer	Ethernet	Direct data connectivity between nodes
Physical layer	Ethernet cable, Fiber, radio/wireless modem	Transmit and receive bits between nodes

TSM Network Layers

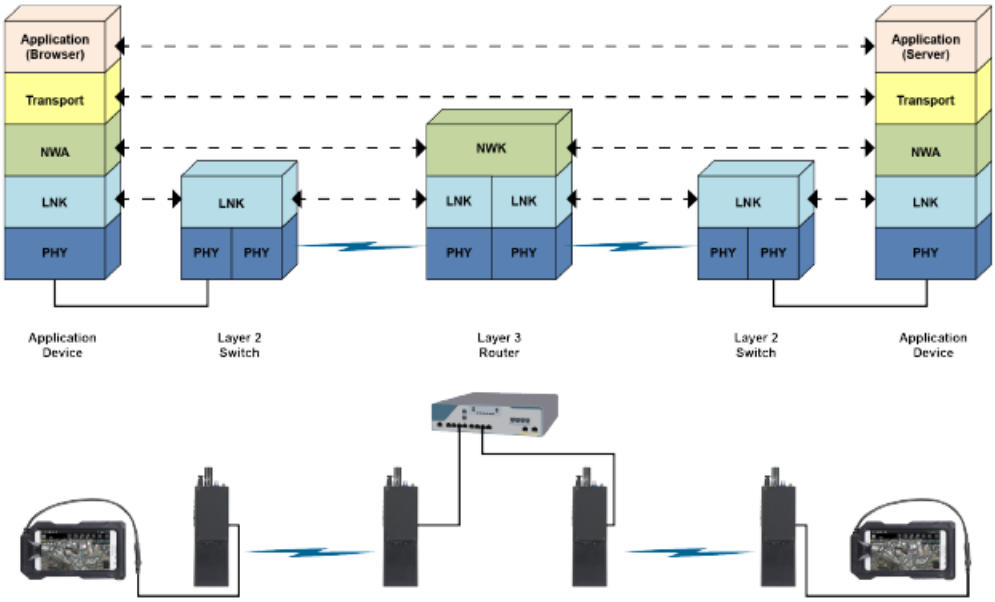
TSM supports IP networking traffic at Layer 2 (Link layer), similar to the Ethernet. In fact, TSM radios present themselves to IP capable devices as an Ethernet Interface or Ethernet over USB interface. One way is to view the whole TSM network as an Ethernet hub that spans over a multi-hop wireless medium.

Because TSM is a Layer 2 network, it shares common characteristics with other Layer 2 networks, such as the Ethernet:

- TSM does not care about the IP address of devices (computer or mobile devices)
- All Ethernet traffic, even non-IP traffic, is transported transparently over the TSM network like an Ethernet hub

TSM radios do have IP addresses for configuration and network monitoring. The web applications reside with an IP address so they can be accessed by a web browser. However, the IP addresses have no impact to the traffic transported on the TSM network. The following illustrates the TSM networking functions in relationship to the network layers.

NOTE: TSM radios do not need matching IP addresses to forward traffic, but the matching addresses are needed to access web applications, APIs, or streaming servers.



TSM and IP Devices

A computer and a radio communicate if they are in the same IP subnet. By default your radio acts as a DHCP server for any connected devices ensuring that the radio and device are in the same subnet.

Access to Data Channels

As discussed in "Voice and PLI Services," voice, PLI, and IP data take up network resources, but these resources are not shared and they work simultaneously with each other. IP data has dedicated resources, so the allocation of IP data cannot override other network resources and other resources cannot reduce the available IP data bandwidth.

Dedicated resources protect allotted data schedules and time slots, but there are limitations because data and access to data channels all consume bandwidth. All data transmissions are

scheduled by the network. A network can be considered full if all bandwidth is being used or if all the channel access bandwidth is being used. It is important to keep in mind the overall “size,” data rates, and usage of network services in your network.

Use the TMT and TNC web applications to monitor general network resources, and data utilization for reducing data collisions and avoiding IP network congestion specifically.

NOTE: The TSM network uses the TDMA (Time Division Multiple Access) channel access method, which divides shared channels into different time slots.

TCP and UDP

As the network processes and then forwards data packets at the Link layer, any Transport layer can be used to transmit data across the network. The most common ones are: User Datagram Protocol (UDP) and Transmission Control Protocol (TCP).

UDP is recommended for use on the TSM network due to its low overhead and ability to communicate to multiple receivers efficiently. The main drawback when using TCP is that each TCP segment has to be acknowledged, which consumes additional bandwidth and channel access bandwidth.

Data Rates

Network resources are dynamically divided and allocated a number of time slots to transmit data from one radio to another when sharing a frequency (using TDMA). These time slots are used whenever data is transmitted from one device to another, or if data is transmitted from a device with the intention of being received by many other devices in the network (multicast or broadcast).

The data rate for IP resources is based on the number of users on a channel and the number of slots allocated for voice. The maximum number of time slots depends on the voice channel map used, and how many hops (1, 2, or multi-hop) the data must travel before reaching the destination address.

NOTE: The TSM Management Tool configures data rates for you based on parameters selected. The TSM Management Tool also shows the maximum achievable data rates based on the configuration.

Please refer to **TN-0113 – TSM Management Tool** for more information.

Latency

Data latency varies slightly based on the selected number of voice channels, but on average you should expect the following IP data latencies in an idle network: 1 hop – 200 ms, 2 hop – 300 ms, Multi-hop – 600 ms.

Multicast vs. Unicast

Two main ways the network supports data transport are by unicast or multicast broadcasting. Depending on the data you are sending one method makes sense over the other.

Unicast is for sending information from one entity to another. It is optimal if one destination needs to receive the data, and the recipient is within 1-2 hops of the source where higher data throughputs can be used.

Multicast is for sending information from one entity to everyone else. It is optimal if the transport needs to be received by multiple destinations and any recipients are 3 hops or more away from the source. With multicast, additional receivers do not consume network bandwidth —this point is unique to TSM networking.

Please refer to **TN-0006 – Understanding Unicast vs. Multicast** for more information.

1 hop and 2 hops vs. Multi-Hop

TSM has the advantage of automatically increasing the usable throughput of the network by a factor of 2 (in a 2 hops case) or 4 (in a 1 hop case) when data only needs to travel 1 or 2 hops from the data source to the intended receiver of the data. If a destination is farther than two hops from the data source the default multi-hop data rates are used.

When designing networks, placing radios that exchange large amounts of data within 1 or 2 hops from one another can have substantial data throughput gains. The 1 and 2 hop adaptation factors in answers to these questions:

- Is the data unicast?
- Is the destination for the data <= 2 hops away?
- Is there good link quality to the destination?

If so, the 1 and 2 hop adaptation is engaged and higher data rates can be achieved between two nodes.

Tips

Data rates are determined by IP data type, priority, and the topology of the network.

- Configure the network to use 20 MHz of frequency allocation. Selecting a smaller bandwidth allocation reduces the maximum data rate across the network.
- Unicast one hop and two hop transmissions provide the maximum data rate.
- Maximize connectivity whenever possible. Weaker signal strength between nodes can lead to poor data performance.

Test the Network

Once you have your network set up for IP data and are comfortable with the data rates, it is a good idea to test the network. There are a few things you can do to make sure all the connections work:

- Ping device
- Measure bandwidth using Iperf

Ping

Use the ping network utility to test between the host and destination device. It indicates whether or not the devices can “talk” to each other, and it measures the speed of the connection (round-trip time, latency, and completion rate). This is an easy way to validate hardware and network configurations. For example, test a connection between laptop to laptop, or laptop to radio. There are several ways to ping an IP address, but here is a common way:

1. Open a command prompt (cmd) on your computer.
2. Enter a ping command. Type `ping <IP Address>` (or you can type `ping <hostname>`). For example, `ping 10.1.5.5`.
3. Press the ENTER key. The results display in the window.

Tips

- No response can mean there is no connection. Check for typos or check the IP address in network settings.
- Lost packets can mean an unreliable connection and that data is lost in the transfer.

Iperf

The Iperf program is a reliable way to test IP data by measuring the amount of IP throughput that is sent over the network. Iperf for Windows is run through the Windows command prompt and can be downloaded from the following site: **http://www.softpedia.com/get/Network-Tools/Misc-Networking-Tools/Iperf.shtml**

To measure bandwidth the Iperf program needs to be run from two PCs, one set as the server and the other as the client. The client side generates data and sends it over the network to the server, who measures the amount of data received.

To run Iperf:

1. Set up the server. In this example the server (`-s`) is configured to listen for UDP traffic (`-u`). At the Windows command prompt, type: `iperf -s –u`
2. With the Iperf server set up, the Iperf client can send data to the server. Consider the following options: `-c` sets the Iperf application as the client, `-b` sets data rate that the client is to send data over the network (setting a bandwidth implies UDP), `-t` sets the total length of time in seconds that the test is to run.
3. To start the client, type: `iperf -c <IP address of server> -b <bandwidth> -t <time>`. For example: `iperf -c 172.16.10.75 -b 200k -t 120`
4. Press the ENTER key, and the client starts to send data to the server.
5. The test results show the length of testing, the amount of data transferred, and the bandwidth, or rate at which the data was sent.

NOTE: To get an accurate measurement of the bandwidth, it is recommended to run Iperf for a minimum of 5 minutes (a -t setting of 300 seconds).

Please refer to **TN-0032 – Measuring IP Throughput with Iperf, TN-0034 – Optimizing a PC for a TSM Network** for more information.

Over the Air Capabilities

Over the Air (OTA) controls allow you to interact with all the radios on a network from a central location. This alleviates the need for physical access to a radio to change its settings, which ultimately saves time and effort.

One of the capabilities is Remote Control, where a unit is controlled remotely by performing OTA functions. This is useful when your network is deployed in a remote location and you need to change settings on a specific radio from its current configuration. Remote Control works well when a person is not nearby to directly make changes to it. Refer to Chapter 5 - TNC for details on the Remote Control panel and functionality.

NOTE: Remote Control does not require a radio reboot for changes to take place.

To do OTA functions, you'll need:

- A configured network
- Access to the web applications

OTA functions covered are:

- Change device settings OTA - Make basic radio configuration changes OTA
- Change and start stream settings - Using Remote Control change sensor settings OTA
- Change audio thresholds - Using Remote Control adjust audio decibels OTA
- Rekey - Provide new security keys OTA
- Zeroize - Make radio act as a relay only OTA
- Shutdown - Remotely turn off a radio
- Clean - Remove configurations and wireless capabilities off a radio

Change Device Settings OTA

It is sometimes necessary and useful to make changes to the radio configuration settings when your network has already been deployed and the radios are not centrally located.

1. From the TNC Devices List, select a radio and click on the **Remote Control** icon. The Remote Control side panel opens, displaying information for the selected radio.
2. Under the Remote Control section, change a setting. For example:
    - Type a new alias.
    - Click the various drop-downs such as **Voice, GPS, or CoT** and make a change. The changes take place over the air.

Change and Start Stream Settings OTA

1. From the TNC Devices List, select a radio and click on the **Remote Control** icon. The Remote Control side panel opens, displaying information for the selected radio.

2. Under the Streams section, add new or change existing sensor parameters during deployment. For example:
    a. Select the **Video** tab.
    b. Select the appropriate video compressor parameters.
    c. Under the **Video** tab > **Advanced**, set a multicast IP address, port, time-to-live, and priority in order for the video stream to broadcast over the network. This is necessary for others on the network to see the stream.
3. Click the **Save** button to push the changed settings to the unit.
   Under the Stream window, click the **Play** button to broadcast the stream OTA.

NOTE: This same process applies to other stream types.

Perform Rekey

Use this function to rekey a zeroized radio. Rekey distributes new secure COMSEC keys to one radio at a time.

1. From the TNC Devices list, select a radio to zeroize and click the **Remote Control** icon.
2. From the **Remote Control** side panel that appears, select the **OTA** category in the top toolbar.
3. Scroll down to the **COMSEC Rekey** category and click the **Rekey** button.
4. A dialog box appears asking you to browse for the key file. Select the correct key file to continue.

Perform Zeroize

A zeroized radio only functions as a relay for network data, voice, and PLI, but decrypt it. To zeroize a node over the air:

1. From the TNC Devices list, select a radio to zeroize and click on the **Remote Control** icon.
2. From the **Remote Control** side panel that appears, select the **OTA** category in the top toolbar.
3. Scroll down to the **Zeroize COMSEC Keys** category and click the **Zeroize** button.

Perform EMCON

Emissions Control (EMCON) is a status in which radios in an area are asked to stop transmitting for safety or security reasons. This mode is controlled by an API call, which can be invoked locally on the front panel of the radio or remotely via the web interface. EMCON can be configured and functions in all operational modes (except Programming mode).

In EMCON mode:

- RF transmission is inhibited, which will be transparent to all higher-level components attempting to transmit.
- Any communication requiring transmit will not work on an EMCON enabled-radio.
- For a radio to be the active NTR of a network, it can't be in EMCON mode since a radio that is not transmitting cannot serve as the NTR.
- ARP (and by extension, unicast data) will not work with EMCON enabled-radios.

- EMCON mode will persist (even after radio reboot) until another API call is received to change the setting.

1. Access EMCON Mode on the front panel of the radio under **Menu -> Advanced**.
2. Select **Enabled**. A confirmation dialog appears, confirming your EMCON selection. The bottom left corner of the front panel will read EMCON instead of TSM when the radio is running in normal operation, and once EMCON is disabled, the display returns to TSM.

NOTE: Anytime the radio restarts or the active preset is changed while EMCON is enabled, an informational dialog appears, indicating that EMCON is enabled and the radio transmitter is DISABLED.

Please refer to **TN-0109 – EMCON Mode** for details.

Perform Shutdown

To remotely shut off one or multiple radios at once, perform a shutdown. This is useful for emergency power off situations.

1. From the TNC Devices list, select a radio and click on the **Remote Control** icon.
2. From the Remote Control side panel that appears, select the **Maintenance** category.
3. Click the **SHUTDOWN** button in the **Remote Shutdown** section.
4. Confirm the decision in the prompt that follows.

NOTE: After a remote shutdown, the radio must be retrieved and physically be turned off (by turning the Power/Volume/Zeroize knob off), before it can be turned on again.

Perform Clean

Perform a clean operation over the air to a unit that may have been compromised, where sensitive information and the radio need to be removed from the network. Remote clean wipes all configurations and wireless capabilities from a radio. The unit becomes non-operational and left in a tamper mode. To recover, re-load certificates and software to the radio. Please be aware that there is no fast way to get that radio working again on the field.

1. From the TNC Devices list, select a radio and click on the **Remote Control** icon.
2. From the Remote Control side panel that appears, select the **OTA** category.
3. Scroll down to **Clean Keys and Certificate**, and click the **CLEAN** button.
4. Confirm the decision in the prompt that follows.

Please refer to **TN-0057 – Identify and Recover from a Tamper** for details.

Software Maintenance

To keep your product working with optimal performance, it is sometimes necessary to know and be able to perform basic maintenance tasks.

Routine maintenance includes:

- **Software Updates** - Keep the latest and greatest software version loaded.

- **Certificates** - Your radios and web browser must have certificates installed for operation and security.

Software Updates

TrellisWare is always improving its software components. The software loading process is quick and robust, as it offers benefits such as load status indicators, reconfiguring to the factory defaults, displaying error messages, and storing older software versions. It is important to upgrade the software promptly upon release. This keeps your network and radios working at top performance.

Before updating the software:

- Get the software update files from the Support Center (https://support.trellisware.com).
- Review the **upgrade-paths** file in the **/Updates/** folder from the software download.
- Review the latest software Release Notes.

Use the TSM Software Download Tool to load software updates and certificates to one or more radios at the same time.

Please refer to **TN-0059 - TSM Software Download Tool, TN-0060 – TSM Software Load Tool-Bootstrap.**

Restore Default Settings

Restore Default Settings is a feature that allows users to restore radio settings to the last software update. The Restore Default Settings feature is supported on TW-135, TW-900, TW-950, TW-650, TW-600, TW-660, TW-870, TW-875.

- Restore Default Settings will **NOT** restore radio software (hard reset).
    - A user should reload software if radio-level software changes are made (ex: loading a patch).
- ONLY the TW-135 and TW-950 support an HMI menu option to restore the radio to default settings.
    - Location of feature: Advanced->Restore Defaults
- Restore default settings for all devices using the TSM Management Tool (TMT).

On completion of restore default settings, the radio will reboot and the operational mode will automatically be set to `Operator mode`.

Please refer to **TN-0112 – Restore Default Settings** for details.

Error Codes

If any software loading error occurs, the radio alerts you:

- For radios with an LED status indicator: the LED light flashes red and green.
- For radios with a display panel: the screen displays “Loading Error. Error code: XXX”

NOTE: If you receive an alert to an error, you can press any button on the radio to resume using it with the previously loaded software; and the radio remains fully functional.

If problems occur when uploading software, error codes could appear. In general, error codes in the 100 range are user fixable, and error codes in the 200 to 300 range may require assistance from customer support.

Certificates

TrellisWare radios are protected by certificates that add a level of data security and ensure user authorization when accessing the radio. Even though each TrellisWare radio is loaded with default certificates (OEM-Default) before it is shipped, the best security option is to create your own and change periodically as needed. In order to access a radio with a PC and make changes to the radio, the radio and the PC must have the same certificate loaded.

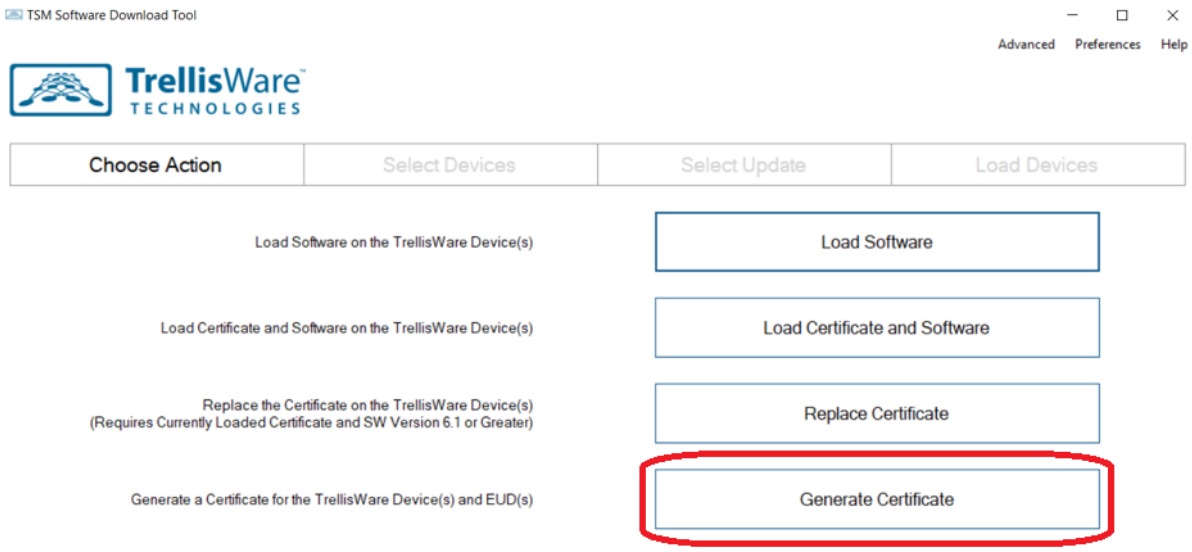
Generate a Custom Certificate

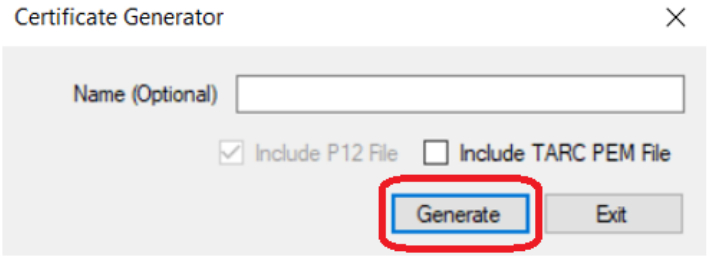
Requirements:

- TSM™ Software Download Tool

Steps:

1. Launch the **TSM Software Download Tool**. (Screenshot below)
2. From the Home screen, select **Generate Certificate**. (Screenshot below)
3. The Certificate Generator displays. Enter a **name** for your custom certificate (limited to 16 characters) and select either the **.p12** and/or **.pem file format**.
4. Select the **Generate** button.
5. From the Save Certificate window, navigate to a directory and folder, and select the **Save** button. Note that the .p12 and .pem file formats are saved via separate save dialog boxes.
6. From the TSM Software Download Tool Home screen, select either **Load Certificates and Software** or the **Replace Certificate** option to load the new certificate to the networked radio.





NOTE: The P12 file is what you will load in your Windows store on the PC and your radio, whereas the PEM file loads onto your Android device (shown in later sections below).

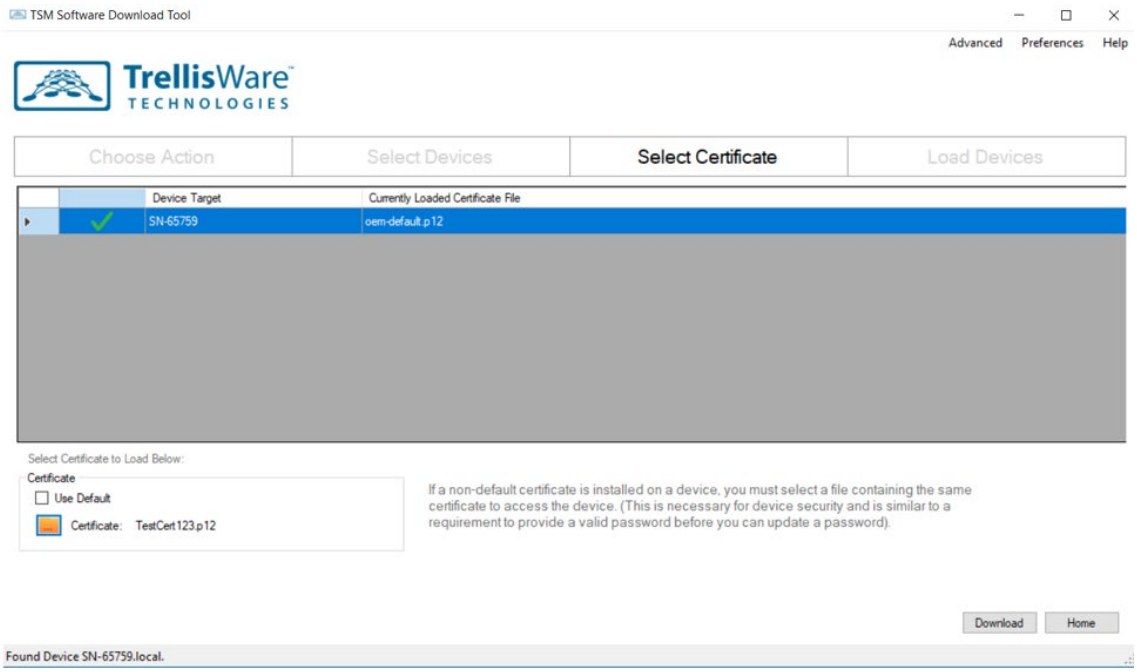
Load a Certificate onto a Radio

Requirements:

- TSM™ Software Download Tool
- Radio booted in **Programming Mode** and connected to a PC
- Two certificates:
  - Existing certificate on the radio
  - New certificate
- Radio must be on 6.1 software (SW) or higher; if the radio is on 6.0 or older SW, update your radio to 6.1 or higher SW

Steps:

1. Launch the **TSM Software Download Tool**.
2. From the Home screen, select **Replace Certificate**.
3. From the main window, select one or more radios to change the certificate on.
4. Click **Next**. The tool automatically bundles selected radios into product types.
5. Select **Currently Loaded Certificate**. The old factory default certificate, TWT-default.p12, auto-fills into the TSM Software Download Tool automatically. If TWT-default is not your currently loaded certificate, right-click in the target product table and click **Select Certificate File** to select the custom certificate currently loaded on the radio.
6. The example below is a radio with oem-default.p12 as the active certificate on the radio. The desired certificate to be loaded is TestCert123.p12.



7. Select a certificate to load:
   a. Select **Use Default**. This loads the oem-default.p12 certificate.
   b. Deselect **Use Default** and click the **Certificate** folder to select a custom certificate to load. This opens a type to use.
   c. Use **Default** or use a custom certificate.
8. Click the **Download** button.
9. The certificate in the radio has been replaced upon completion and reboots automatically.

Load a .p12 Certificate into Chrome/Firefox

Chrome

1. Launch the Chrome web browser to load the certificate to your personal Windows store.
2. At the top right, click the three dots, then click **Settings**.
3. Click the search icon (magnifying glass) and type **Cert**.
4. Click **Security**.
5. Click **Manage Certificates**.
6. From the Certificates window > Personal tab, click the **Import** button.
7. Follow the Certificate Import Wizard and click **Browse**.

8. Navigate to the location of the certificate on your local machine. (Make sure the bottom right dropdown says **All Files**) This will import into the Windows Current User certificate store.
9. When asked for a password, leave it blank.
10. Click **Next**>**Next**>**Finish** to import the new certificate.

Firefox

1. Launch the Firefox web browser.
2. From the Firefox main menu bar, click the three bars in the top right corner and select **Options**.
3. In the left panel, select **Privacy & Security**.
4. Under Privacy & Security, scroll to the bottom to find **Certificates**, then click the **View Certificates** button.
5. On the Certificate Manager, select the **Your Certificates** tab.
6. Click the **Import** button and navigate to the Certificates folder in the software release bundle.
7. Select your generated certificate or the **oem-default.p12**, and click **Open**.
8. At the Password Entry Dialog, click **OK** as no password is required.
9. The Certificate Manager now displays the TrellisWare certificate.

For more information, including how to load a custom certificate on an Android for TARC and how to change an expired TWT-Default Certificate, please refer to **TN-0115 – Certificates.**

CHAPTER 5

Web Applications

If you are in the position to configure the radios, control the network during deployment, or make remote changes, you'll need to interact with the web applications. Every TrellisWare radio hosts a variety of software web applications.

To become familiar with tasks, workflow, and scenarios where you would use the web applications, see chapters: Quick Start and Get the Most from your Product.

Use the following sections to learn about the web applications and how to access them.

This chapter briefly discusses the following:

TSM Management Tool

The TSM Management Tool (TMT) streamlines creating presets and configuring radios operating in a network together. This PC-based application includes features for defining network and radio characteristics for quick and easy deployment. Use TMT for creating network preset files, modifying existing presets, uploading presets, and radio configuration.

The advantage of using TMT is having the ability to build preset and radio configuration without the need for pre-configuration steps or security certification.

Below is a quick overview of TMT. For detailed information, please refer to **TN-0113 – TSM Management Tool**.

Requirements

- Windows 10
- Installation of the TSM Management Tool_<version>.exe which installs .net (4.7.2)
- Factory default certificate oem-default.p12 or custom certificate loaded to your PC's Windows store
- The PC needs to be on the same network as the radios
- Bonjour Print Services

Quick Start Steps

TMT recognizes all radios connected to the IP network. You can configure one radio via USB/Ethernet or multiple radios via an Ethernet switch.

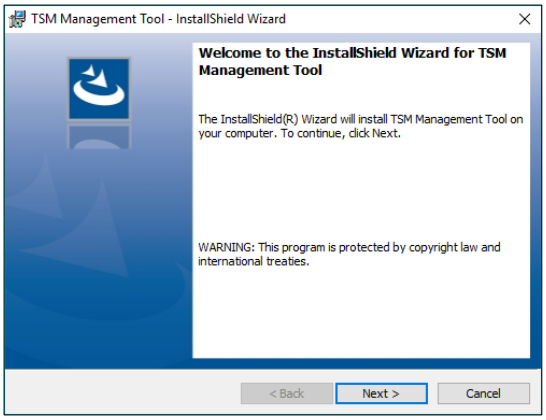
1. Open the TSM Management Tool. First-time users will have to click the Add Preset button available on the **Preset Manager** tab.
    a. Create a network preset file.
    b. Change configuration parameters to mission needs and generate security keys.
    c. Save the preset.
2. Turn on the radio(s).
    a. Ensure radios are on the same network as the PC.
        i. To load multiple radios on a switch, they all must be in **Programming** mode.
        ii. To load an individual radio, it can be in **Operational** or **Programming** mode.
    b. On the **Device Configuration** tab, select the radio(s) to configure and the preset for the selected radio(s).
    c. Apply the configuration to the radio.

For more information about connecting the radios to a network, see **TN-0040–Computer Pre-Configuration**, and the radio user guide **Chapter 3, Pre-Mission Configuration > Set the Computer IP Address, IP Addressing, and Connect to your Radio** sections.

How to Install the TSM Management Tool

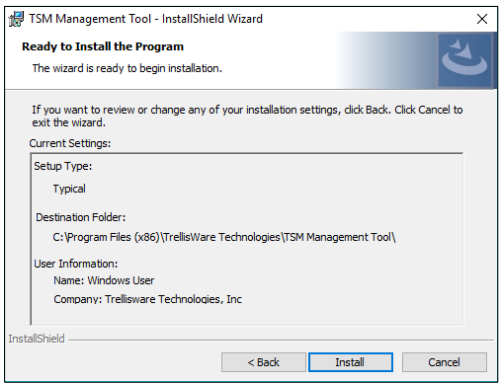
1. Double-click the **TSM Management Tool <version>exe** file. If this is not the first time installing TMT, you will be required to uninstall the program first.

2. Select **Yes** to allow this application to make changes to your PC.



3. At the TSM Management Tool InstallShield Wizard, select **Next**.

4. Click **Install**.



TrellisWare Network Controller

Feature Overview
TrellisWare Network Controller (TNC) is TrellisWare's next generation web application, enabling users to remote control the radios, monitor network performance, make run time configurations, view GPS locations and maps, access other networks through TSM bridges, stream live videos, and perform over-the-air functions.

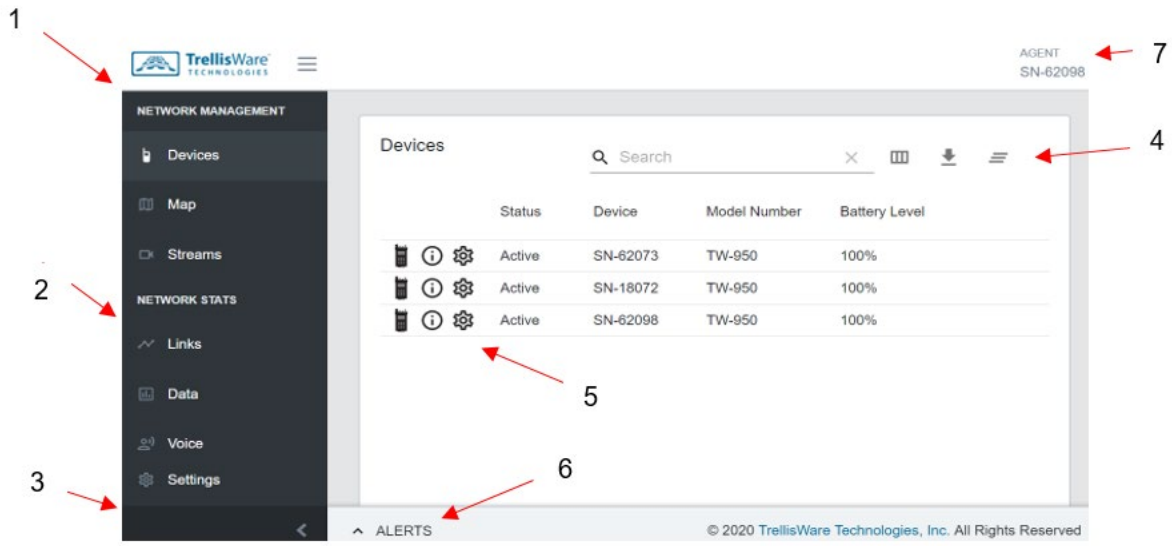
Below is a quick overview of TNC. For detailed information, please refer to **TN-0114 – Trellisware Network Controller**.

Access

1. Access TNC by typing in the radio's IP or hostname.
2. A security prompt appears in the browser. Accept the risk and select continue.

Home Screen
Once you access TNC, you will be directed to the homepage, which is made up of:

1. Network Management
2. Network Stats
3. Settings
4. Toolbar
5. Devices Action Icons
6. Alerts
7. The Agent radio you are using to view TNC is also listed in the top right corner.

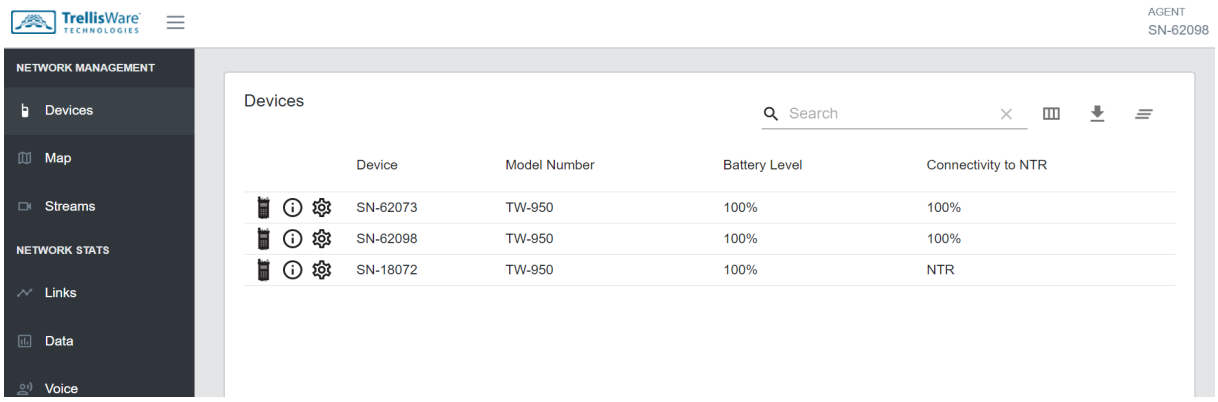


Network Management

On the left side of the screen is the Network Management and Network Stats tab selection area, which contains several tab options to view specific network details. A user can select a tab to view different network details such as link quality, data utilization, or maps.

Devices Tab

The Devices tab lets you view all devices in the network. This is the primary screen you will use to view your network. All active radios in your network are listed here, and include stats and important information. The Devices tab also allows you to make configuration changes to radios in your network.



CHAPTER 6

Troubleshooting

If you are having issues with your radio, its configuration or deployment, review this chapter for quick solutions to common problems involving:

- Hardware
- Configuration
- Deployment

For further support, visit our Support Center at: https://support.trellisware.com

Configuration Solutions

Problems	Solutions
"Secure Connection Failed" when opening web apps	**Load certificates** - Check to make sure the PC has web certificates installed. **Latest browser** - Check the recommended web browser and version. **Correct time** - The time on your computer must be set for approximately the right time (within valid times of the certificate). If using Firefox v30 and above, see TN-0015 – Installing Certificates in Firefox.
HTTP 0 Error when load- ing software	**Install Bonjour** - Bonjour Print Services is required to use MMC. Bonjour is on Macs by default but Windows needs it installed. **Power off and on in Programming mode** - Cycle the power on the radio and load the software again. **Turn Wi-Fi off** - If Wi-Fi is enabled on the computer, turn it off. **Check the power** - Make sure the radio has a good power source or full battery. **Restart computer** - Restart the computer and reload the software again. **Check connections** - Try checking all connections on the radio and PC. **Use a different computer** - If experiencing the error with above checks, try switching computers.
Radios do not show in MMC	**IP network settings** - The PC and the radios must be in the same IP network. Check the computer's network settings to make sure they match the radio. » **Check for a DHCP server on the network** » If there is a DHCP server the radio gets its IP address from the DHCP server when in Programming mode. If in Gateway mode, this happens when DHCP is selected through MMC. If there is no DHCP server, the radio defaults to the last configured IP scheme. Out of box, this scheme is 10.1.0.0 with a subnet of 255.0.0.0. **Install Bonjour** - Bonjour Print Services is required to use MMC. Bonjour is on Macs by default but Windows needs it installed. Bonjour can be downloaded here: http://support.apple.com/kb/dl999 **Ping radio** - Open a command prompt and attempt to ping the radio. Try to ping the IP address of the radio and then try to ping the host name. (The host name for each radio is sn-xxxx.local, where xxxx is the serial number.)

Deployment Solutions

Problems	Solutions
IP Data does not work	**Check signal strength** - A yellow signal or better is needed for IP data, but blue is preferred. Because this is a function of the overall network signal strength, the best way to check is in TTV-C maps. **Check network connectivity** - Try to conduct a ping or Iperf test.
Growing age in TTV-C with radio in network	**Check signal strength** - When a radio is on the edge of a network, the signal strength may not be strong enough to update in TTV-C. The age continues to grow, and GPS position is not reported.
Active video streams not playing	**Install VLC for Firefox** - When a video displays as the TrellisWare logo, this is indicating that a video codec is required to view sensor video streams. Download VLC from http://videolan.org/vlc **Play the video in VLC** » When a video displays as the VLC logo or as a black screen, copy the video link in the Remote Media Stream Manager and play the video in VLC. » Activate RTP/RTSP under Settings/Input codecs in VLC.

GLOSSARY

A

Agent

Radio used to access other radios while in Programming mode or Operator mode.

B

Bandwidth

Refers to frequency band, or data capacity.

D

Decibel

Measure of signal strength.

DHCP

Dynamic Host Configuration Protocol for automatically assigning IP addresses.

H

Hop

A hop is created when a trans- mission reaches its maximum distance.

L

Latency

Any delay between the time data is requested to the time it arrives.

M

Multipath

Receiving the same signal at different times and power levels.

P

Preset

A preset file optimizes net- work performance for specific mission profiles. The file is

generated using the Preset Tool.

Programming Mode

Radio mode for configuration and customization.

Propagation

The environment that the RF energy travels through a medium.

S

Slots

Time is divided into small slots, where each user or application is dynamically allocated some number of these slots to transmit data.

T

TDMA

(Time Division Multiple Access) - Allows multiple users or applications to share a single frequency.

Throughput

Measure of how much data flows over a channel in a given period of time.

INDEX