

The background features a large, light blue watermark logo for the Somerset County Amateur Radio Club. The logo is circular with the text "Somerset County Amateur Radio Club" around the perimeter. In the center is a stylized antenna tower with a diamond-shaped lattice structure and a horizontal cross-arm with three rungs. Below the tower is a silhouette of the state of Virginia.

EXTENDING INTERNET

How to extend internet from home network to other buildings on your property

KR3L

K3SMT

SOLUTIONS

- The following are possible solutions. We will explore each during the presentation
- WiFi Extender
- Mesh Network
- Buried Cable
- Wireless Bridge

WI-FI EXTENDERS

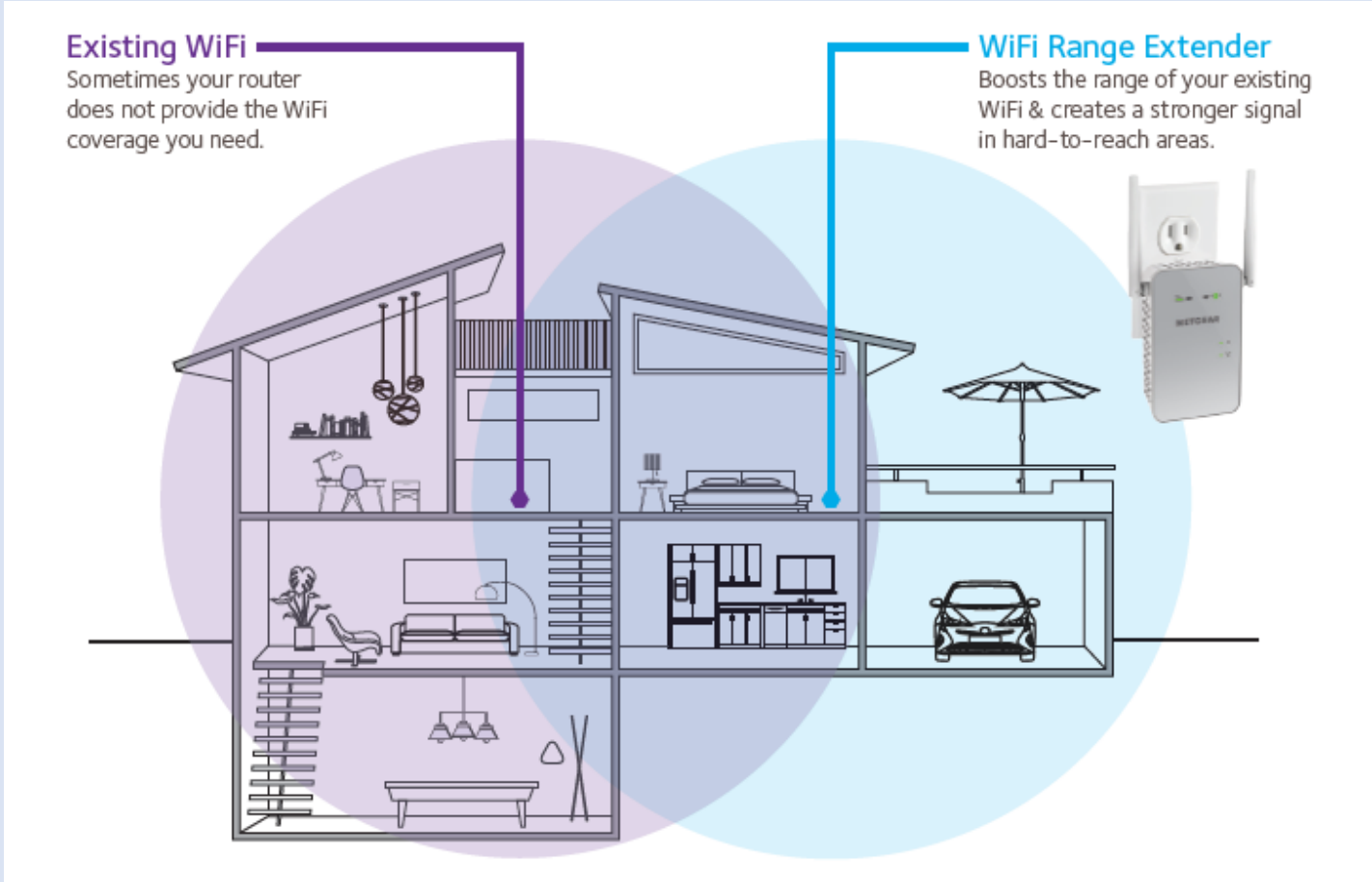
- There are two types of Wi-Fi range extenders: desktop and plug-in
- Most desktop extenders are typically equipped with external adjustable antennas and have multiple LAN ports for connecting to devices
- Plug-in extenders are much smaller and some models have external antennas, while others have internal antennas. Plug-in extenders usually have only a single LAN port



Pros and Cons

- While fairly easy to configure
- They often use a separate network SSID that requires users to log as they move within range
- Wi-Fi speeds are typically half of the main router
- Most dual-band extenders use both radio bands to transmit data to and from the router, which means devices connecting to the extender are competing for bandwidth with the router.
- These devices are omni directional
- Physical obstructions in homes, such as brick walls and metal frames or siding, can reduce the range of a Wi-Fi network by 25 percent or more.

Illustration of Wi-Fi Extender



Characteristics

- Typical range is 150 feet indoors, range is decreased by number walls the signal needs to penetrate.
- Price ranges from \$30 to \$180
- Support 2.4 and 5 GHz wireless network
- Will work if building is close and main WiFi is close to window or exterior wall
- The further away from the router the connectivity degrades and speed slow down.

MESH NETWORK

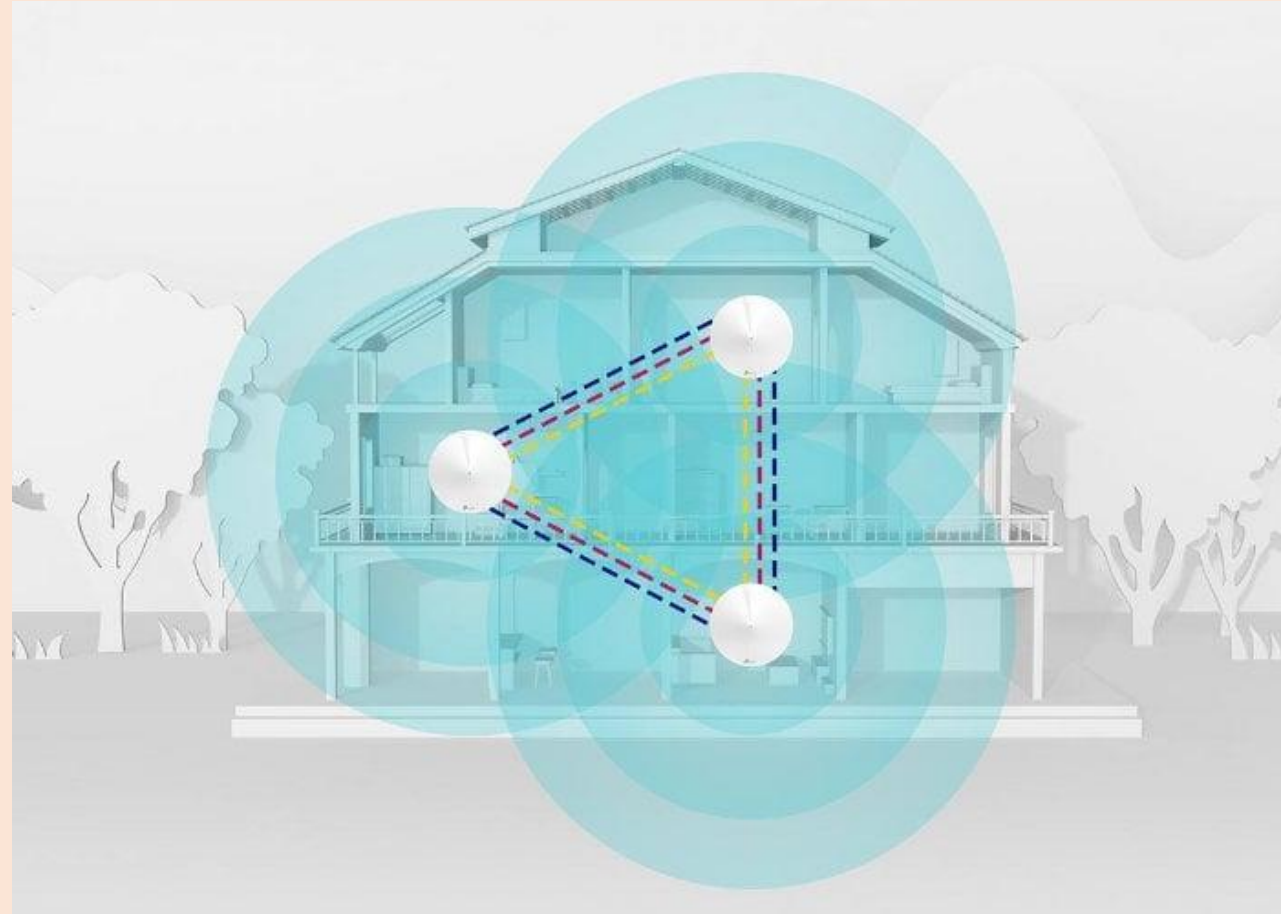
- Mesh WiFi network systems work by using multiple units to extend network.
- One is designated as the main router and connects to modem for internet.
- The other units are referred to as satellites and can be placed in areas the main unit cannot reach.



Characteristics

- “Mesh” network passes wireless traffic and keep signal strength smooth and strong across the network.
- The wireless network shares the same SSID and password.
- “Backhaul” refers to the process of transmitting data from satellite nodes back to the main router and the internet.
 - Mesh Wi-Fi systems are configured for wireless backhaul
 - Some systems use both the 2.4GHz and 5GHz radio bands for backhaul, while others use a dedicated 5GHz band.
 - Some systems use Ethernet cabling for wired backhaul, offering optimal performance and tighter security

Illustration of Mesh Network



Pros and Cons

- Single pane of glass configuration. Same network SSID and can easily add additional nodes
- Support 2.4 and 5 GHz wireless network
- Price ranges from \$1500 to \$200
- Range – Same as a Wi-Fi extender when using wireless
- Will work if building is close and main router is close to window or exterior wall
- The further away from the router the connectivity degrades and speed slow down.

DIRECT BURIED CABLE

- A wired network offers speed and security advantages over a wireless network, and it has a higher resistance to electromagnetic interference
- Cat 6, Cat 5, or Cat 5e Ethernet cables can be run outdoors to network computers with a local area network (LAN) between homes or other buildings



Characteristics

- Use exterior waterproof direct burial Cat 6 cables for outdoor runs rather than ordinary Cat 6.
- Direct burial Cat 6 cables cost more but are designed for outdoor use. The protective jacket is made of either PVC on the cheaper end or linear low-density polyethylene (LLDPE) on the more expensive and protective end.
- In addition to being sealed against moisture, they often have shielding against radio frequency (RF) interference.

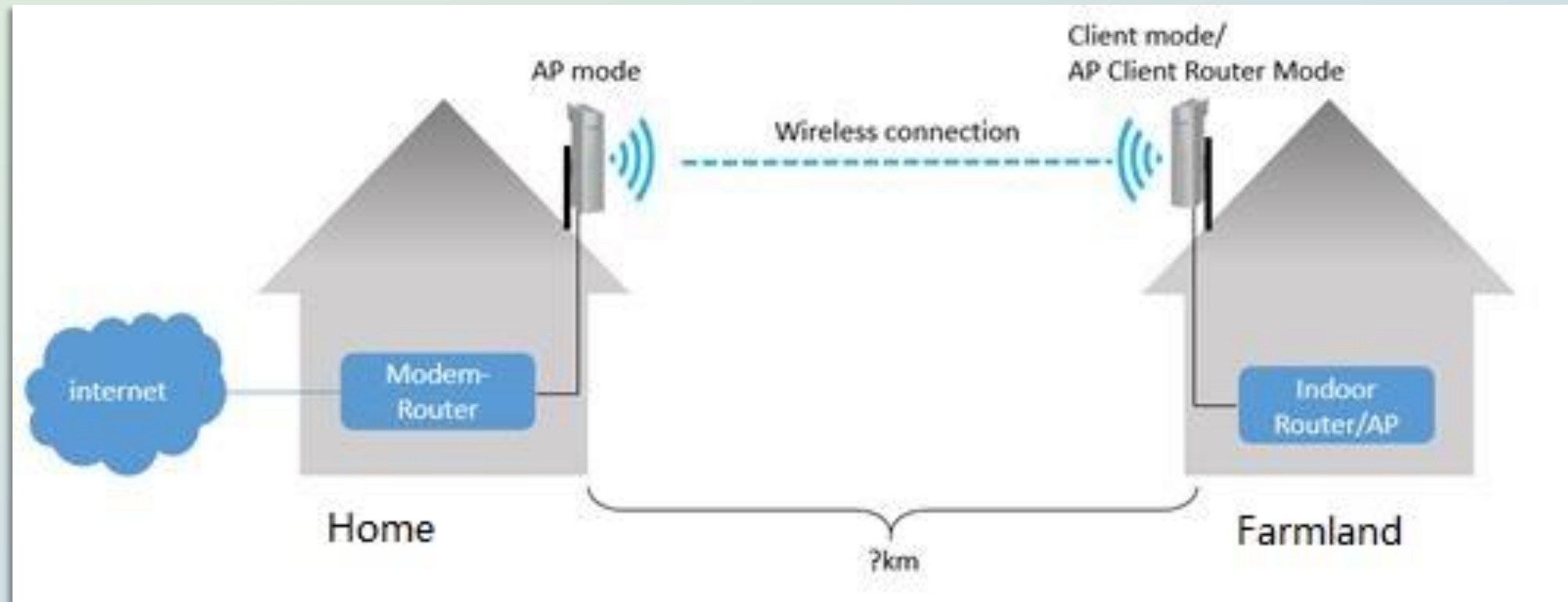
Pros and Cons

- Distance – up to 300 feet. Beyond this, the signal begins to attenuate and reduces the speed and reliability of the connections.
- Cost \$350 to \$400 dollars for 1000' cable
- Requires users to attach their own RJ45 connectors
- It can extend your network over two or more buildings. Initial installation is labor-intensive.
- Recommended that it be buried 6 to 8 inches below ground

WIRELESS P2P BRIDGE

- In computer networking, a bridge joins two networks so that the networks can communicate with each other and serve as a single network.
- Bridges make internetwork connections possible. This wireless bridging technology consists of hardware as well as network protocol support.
- The simplest form of bridging, Point-to-Point connections are pretty basic and do not require advanced hardware components.
- Connections are easy to configure and are meant for connecting networks that are remotely located.

Wireless P2P Bridge



Characteristics

- The first network usually feeds into an access point, which relays the same to another access point, thereby creating a bridge of sorts.
- These connections are meant for premises having two separate networks or can extend the home network.
- Ideal for remote radio shacks or outbuildings that needs to be connected to the original ISP via a bridge.
- This solution can provide highspeed connectivity (1.2 Gbps) to over 60 miles of separation

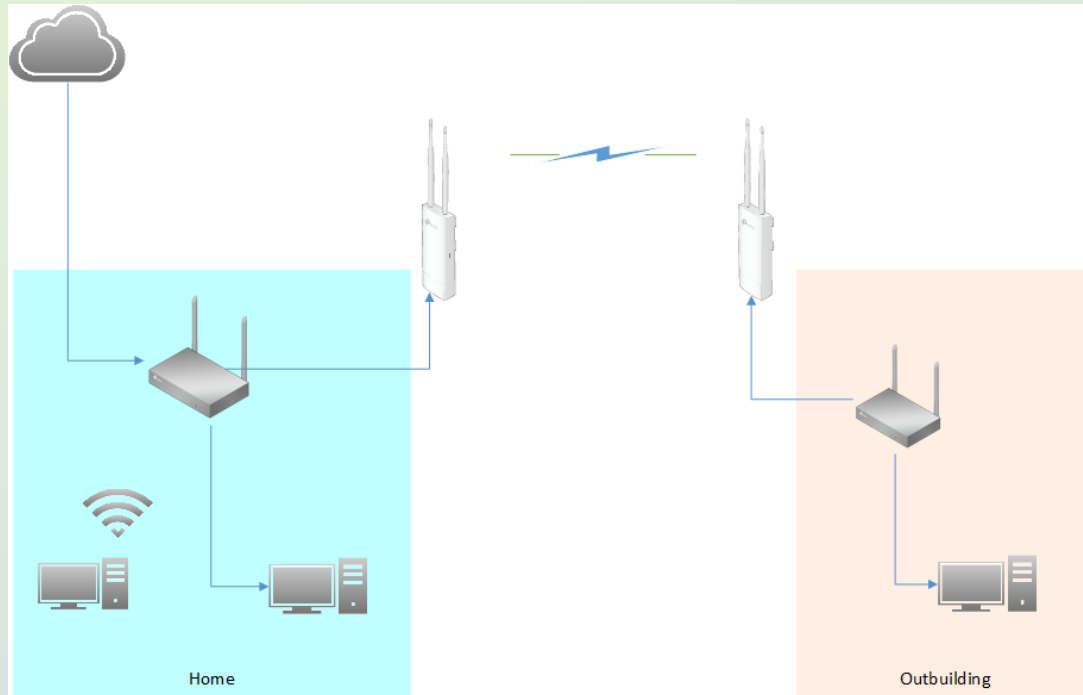
Pros and Cons

- Cost range from \$50 to \$3000
- Distance – Depending on hardware it can support remote locations up to 125 miles in distance
- Extends existing network greater distances without throughput loss
- Requires a router or switch on remote side if more than one device requires access
- Requires an understanding of networking to configure correctly, not for the faint of heart.
- May use a frequency outside 2.4 GHz and 5 GHz

Recommended Setup

- Creating a network for a remote site the following equipment is needed:
 - Ethernet Switch on primary network
 - Pair of wireless bridge devices (Master and Slave)
 - Router for remote site, if Wi-Fi is desired a wireless router may be preferred
 - If only connecting a computer with ethernet a router or switch is not required
 - If using a Wi-Fi mesh such as Eero in main house, bring one of your mesh kit's node out to remote site and plug in ethernet interface into wireless bridge, to extend home network.
- Recommend using the same hardware as existing network if possible

Site Selection



- It is recommended that the master and slave devices be located outside buildings.
 - Not required but will reduce interference
- There should be a clear line of site between both devices
 - Foliage and other obstructions can degenerate signal strength

Setup

- Route ethernet cable from home router to exterior
- Attach Access Point, to pole or building, facing outbuilding
- Connect one end of ethernet cable to access point and the other to network switch
 - Most of access point require power of ethernet (POE). If the switch does not have this capability you must use POE injector.
- Repeat the same process at the outbuilding
- Aim the devices towards each other
 - Most devices will have LED lights to aid in aligning both devices

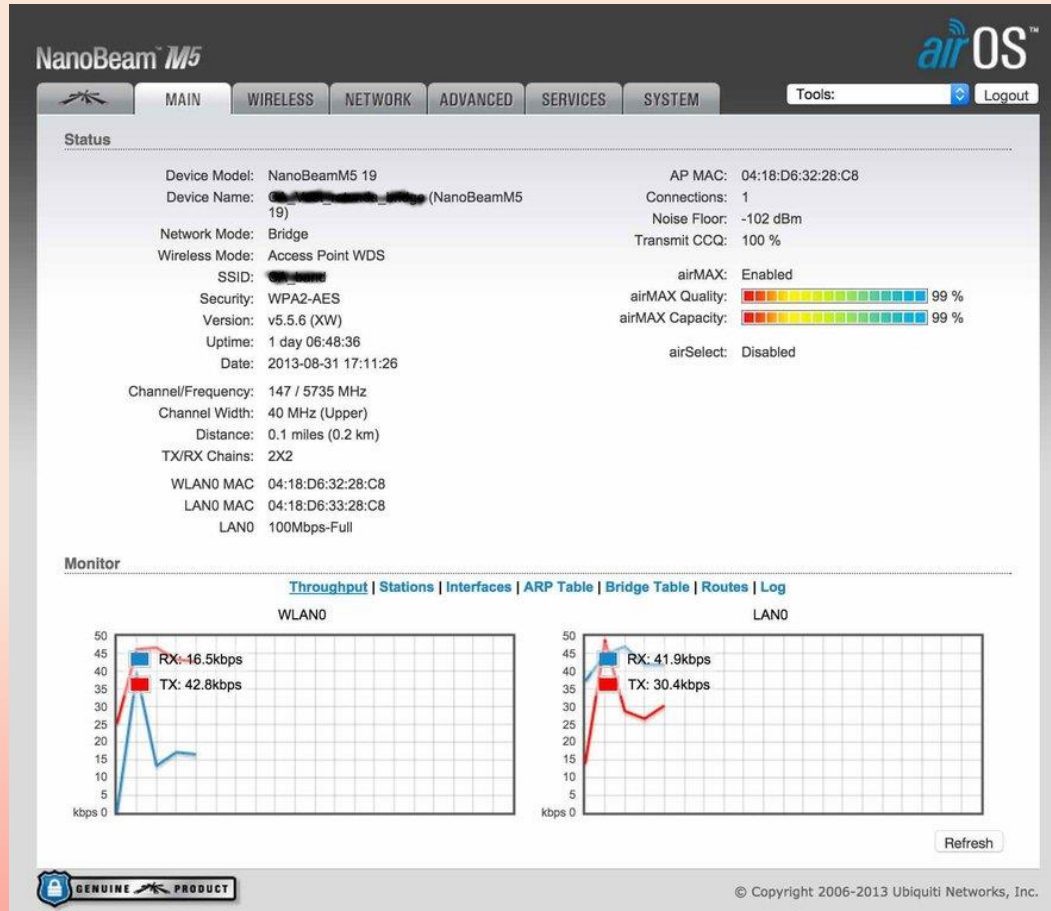
Configuration

- Most kits come with quick start guide. Follow the directions to get started.
- Ensure to set up the Access Point in full before beginning the Client setup.
 - The Client needs to connect to the already-configured Access Point during its initial setup.
- IP Settings – ensure access point and client have different IP addresses and they are not using the default.
- Wi-Fi Settings – It is recommended to use a different SSID name than the primary network.

EXAMPLE SETUP

- How-to on how to setup and configure a Point-to-Point wireless bridge with Ubiquiti devices.
- This is from [How to configure a Ubiquiti PTP wireless bridge in AirOS 5 : Go Wireless NZ Help Centre \(gowifi.co.nz\)](#) website

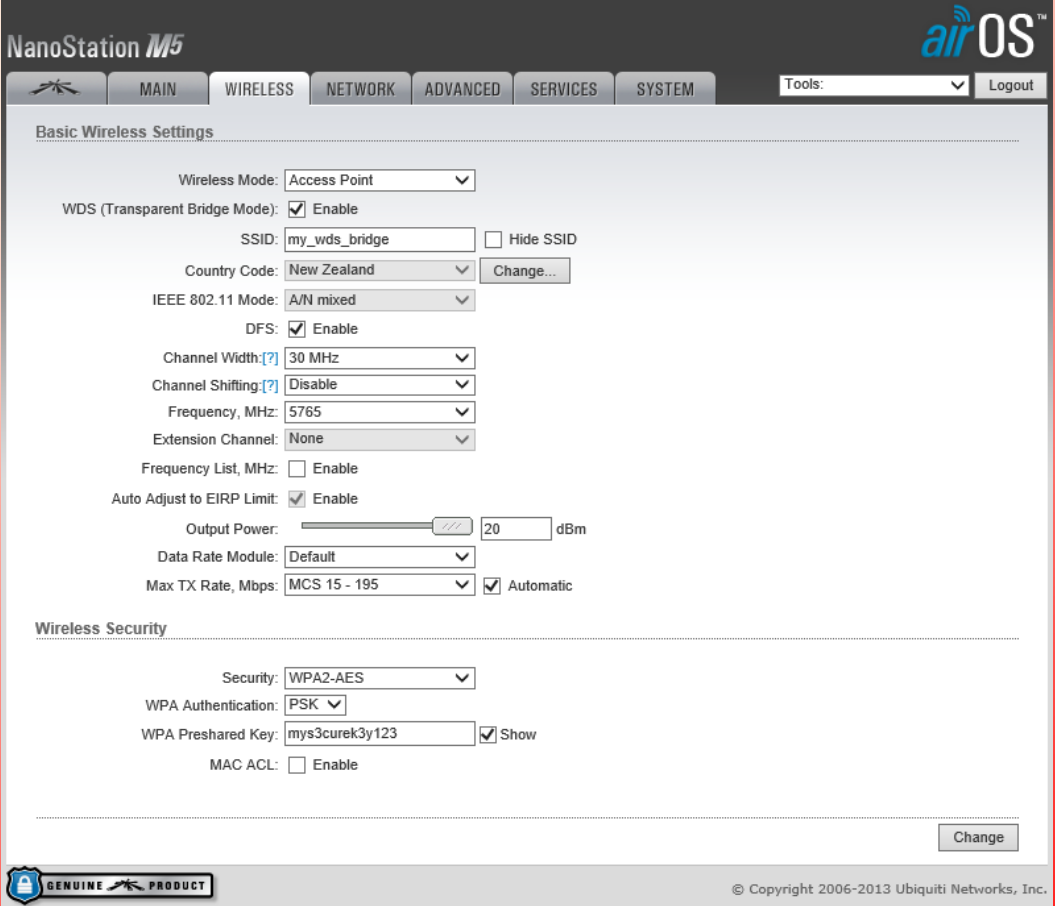
Configuration Page



- Connect your computer to the "root bridge" using a 192.168.1.x address – NOT 192.168.1.20.
 - Device interface for access is 192.168.1.20, this should be changed
 - Default username/password is ubnt/ubnt

Wireless Settings

- Make the following changes on the Wireless tab.
 - Wireless Mode: Access Point
 - WDS (Transparent Bridge Mode): Enable
 - SSID: my_wds_bridge
 - Channel Width: 30 MHz
 - Frequency, MHz: 5765
 - Output Power: 20dBm
 - Security: WPA2-AES
 - WPA Authentication: PSK
 - WPA Preshared Key: mys3curek3y123
 - Select Change but do not Apply settings yet.



The screenshot shows the NanoStation M5 airOS web interface. The top navigation bar includes tabs for MAIN, WIRELESS, NETWORK, ADVANCED, SERVICES, and SYSTEM. The WIRELESS tab is selected. The page title is "Basic Wireless Settings".

Basic Wireless Settings

- Wireless Mode: Access Point
- WDS (Transparent Bridge Mode): Enable
- SSID: my_wds_bridge Hide SSID
- Country Code: New Zealand
- IEEE 802.11 Mode: A/N mixed
- DFS: Enable
- Channel Width: 30 MHz
- Channel Shifting: Disable
- Frequency, MHz: 5765
- Extension Channel: None
- Frequency List, MHz: Enable
- Auto Adjust to EIRP Limit: Enable
- Output Power: 20 dBm
- Data Rate Module: Default
- Max TX Rate, Mbps: MCS 15 - 195 Automatic

Wireless Security

- Security: WPA2-AES
- WPA Authentication: PSK
- WPA Preshared Key: mys3curek3y123 Show
- MAC ACL: Enable

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Network Settings

- On the Network tab make the following changes.
 - Network Mode: Bridge
 - IP Address: 192.168.1.200
 - Netmask: 255.255.255.0
 - Gateway IP: 192.168.1.1
 - Primary DNS IP: 192.168.1.1
 - Select Change but do not Apply settings yet.

The screenshot displays the NanoStation M5 web interface. At the top, there is a navigation bar with tabs for MAIN, WIRELESS, NETWORK, ADVANCED, SERVICES, and SYSTEM. The NETWORK tab is selected. A notification banner at the top of the configuration area states "Configuration contains changes. Apply these changes?" with buttons for Test, Apply, and Discard. The configuration is organized into sections:

- Network Role:** Network Mode is set to Bridge; Disable Network is set to None.
- Configuration Mode:** Configuration Mode is set to Simple.
- Management Network Settings:** Management IP Address is set to Static. The IP Address is 192.168.1.200, Netmask is 255.255.255.0, Gateway IP is 192.168.1.1, and Primary DNS IP is 192.168.1.1. Other options like Management VLAN, Auto IP Aliasing, and STP are currently disabled.

A "Change" button is located at the bottom right of the configuration area. The footer includes a "GENUINE PRODUCT" logo and a copyright notice for Ubiquiti Networks, Inc. (© Copyright 2006-2013).

System Settings

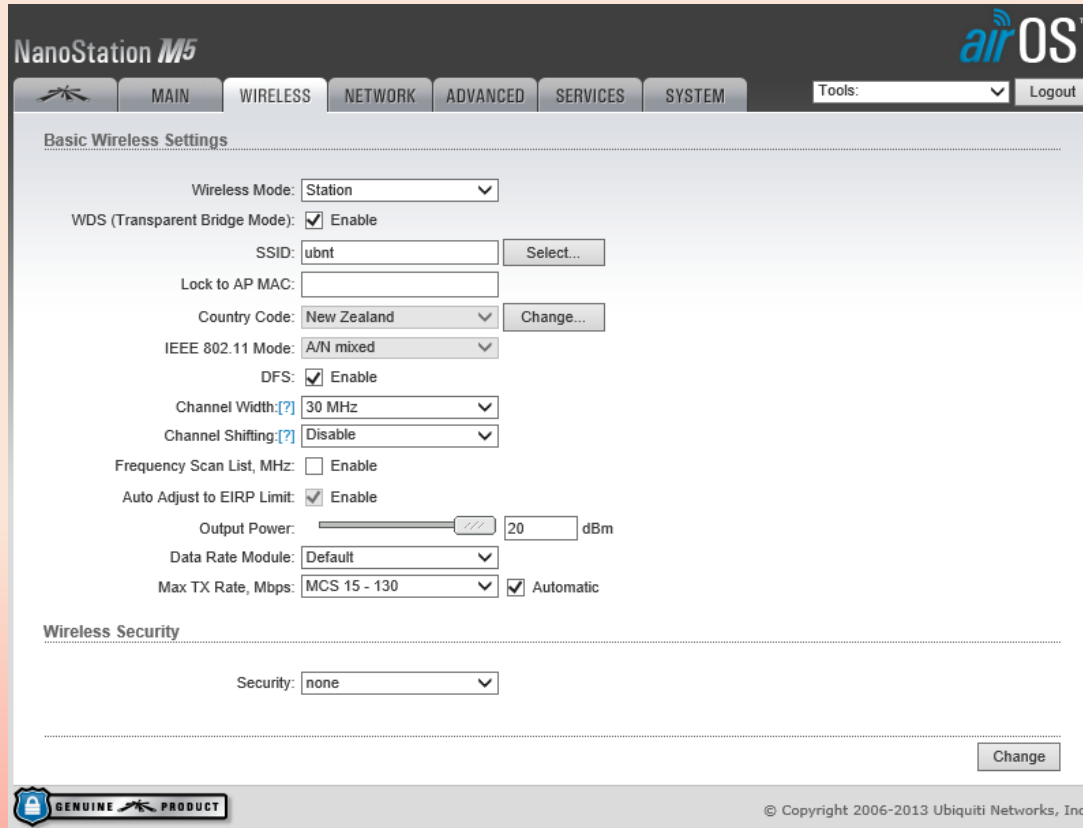
- On the System tab change the following.
 - Device Name: NSM5-AP (Optional)
 - Time Zone: (GMT+12:00) Auckland, Wellington, Fiji, Kamchatka (Optional)
 - Administrator Username: *admin*
 - Current Password: *ubnt*
 - New Password: *Create new password*
 - Select Change and Apply settings.

The screenshot shows the 'System' tab in the airOS web interface for a NanoStation M5. The page is divided into several sections:

- Firmware Update:** Shows the current firmware version (XM.v5 5.6) and build number (17762). There is a 'Check for Updates' section with a checked 'Enable' box and a 'Check Now' button. An 'Upload Firmware' section includes a file input field and a 'Browse...' button.
- Device:** The 'Device Name' is set to 'NSM5-AP' and the 'Interface Language' is set to 'English'.
- Date Settings:** The 'Time Zone' is set to '(GMT+12:00) Auckland'. There is a 'Startup Date' section with an 'Enable' checkbox and a date picker.
- System Accounts:** The 'Administrator Username' is 'admin'. There are fields for 'Current Password', 'New Password', and 'Verify New Password'. A 'Read-Only Account' checkbox is disabled.
- Miscellaneous:** The 'Reset Button' is enabled. There are 'Latitude' and 'Longitude' input fields.
- Device Maintenance:** Includes 'Reboot Device' (with a 'Reboot...' button) and 'Support Info' (with a 'Download...' button).
- Configuration Management:** Includes 'Back Up Configuration' (with a 'Download...' button), 'Upload Configuration' (with a file input and 'Browse...' button), and 'Reset to Factory Defaults' (with a 'Reset...' button).

At the bottom, there is a 'Change' button and a footer with the Ubiquiti logo and copyright information: '© Copyright 2006-2013 Ubiquiti Networks, Inc.'

2nd Bridge Wireless



The screenshot shows the NanoStation M5 airOS web interface. The top navigation bar includes tabs for MAIN, WIRELESS, NETWORK, ADVANCED, SERVICES, and SYSTEM. The WIRELESS tab is selected. The page title is "Basic Wireless Settings".

Wireless Mode: Station

WDS (Transparent Bridge Mode): Enable

SSID: ubnt [Select...]

Lock to AP MAC: []

Country Code: New Zealand [Change...]

IEEE 802.11 Mode: A/N mixed

DFS: Enable

Channel Width: 30 MHz

Channel Shifting: Disable

Frequency Scan List, MHz: Enable

Auto Adjust to EIRP Limit: Enable

Output Power: [Slider] 20 dBm

Data Rate Module: Default

Max TX Rate, Mbps: MCS 15 - 130 Automatic

Wireless Security

Security: none

[Change]

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- Connect the second Bridge laptop or network and navigate to the Wireless tab.
 - Wireless Mode: Station
 - WDS (Transparent Bridge Mode): Enable
 - Channel Width: 30 MHz
 - Select Change and Apply settings.

2nd Bridge Wireless

The image shows the NanoStation M5 airOS web interface. The top navigation bar includes tabs for MAIN, WIRELESS, NETWORK, ADVANCED, SERVICES, and SYSTEM. The 'WIRELESS' tab is active, displaying the 'Basic Wireless Settings' page. The settings include:

- Wireless Mode: Station
- WDS (Transparent Bridge Mode): Enable
- SSID: ubnt (with a 'Select...' button next to it)
- Lock to AP MAC: (empty field)
- Country Code: New Zealand (with a 'Change...' button)
- IEEE 802.11 Mode: A/N mixed
- DFS: Enable
- Channel Width: 30 MHz

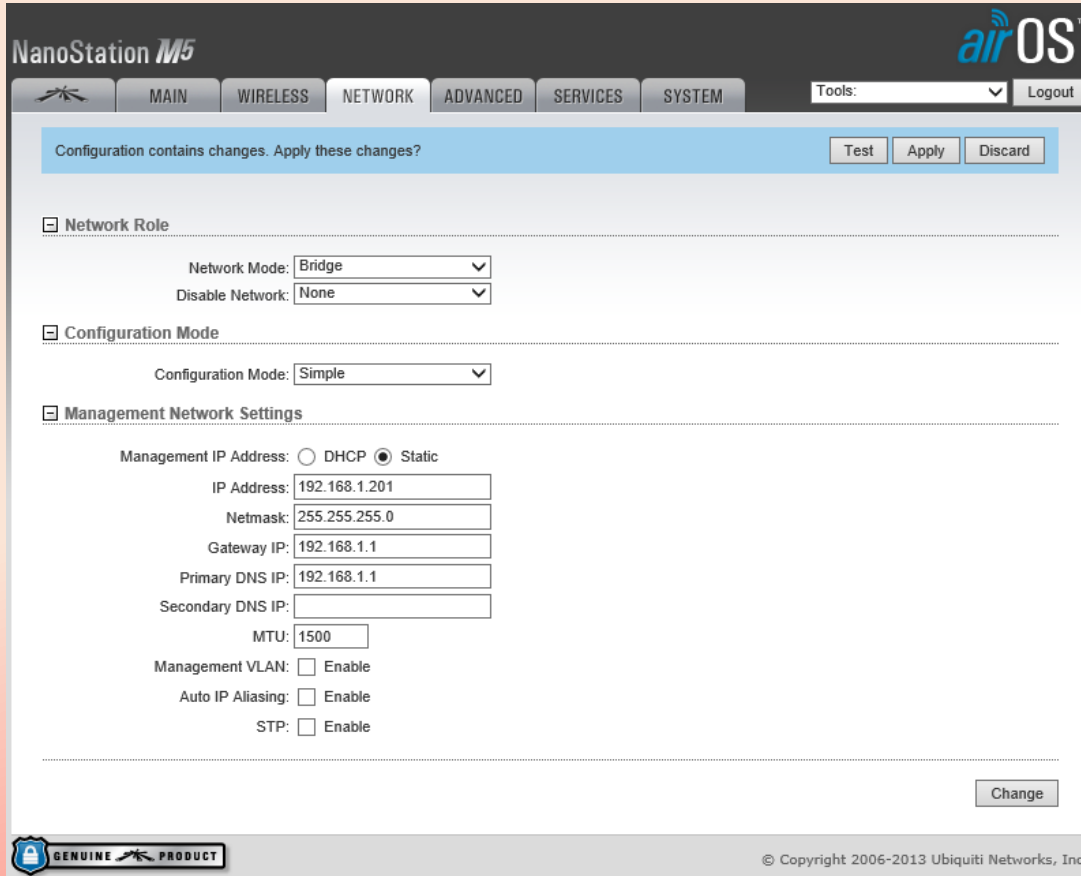
Overlaid on the bottom of the settings page is a 'Site Survey' window from Internet Explorer. The URL is https://192.168.1.202/survey.cgi?iface=ath0. The window displays 'Scanned Frequencies' and a table of detected wireless networks:

MAC Address	SSID	Device Name	Encryption	Signal / Noise, dBm	Frequency, GHz	Channel
<input type="radio"/> DC:9F:DB:6C:59:C0	my_wds_bridge	NSMS-AP	WPA2	-48 / -84	5.765	153

Below the table is a blue message box: 'Selectable SSID's must be visible and have compatible channel bandwidth and security settings'. At the bottom of the survey window are buttons for 'Lock to AP', 'Select', and 'Scan'.

- Click the Select button next to the SSID field.
- Click the radio button next to your SSID (my_wds_bridge) and then press Select.
- Enter WPA Preshared Key: mys3curek3y123
- Select Change but do not Apply settings yet.

2nd Bridge Network



The screenshot shows the NanoStation M5 web interface with the 'NETWORK' tab selected. A blue notification bar at the top states 'Configuration contains changes. Apply these changes?' with buttons for 'Test', 'Apply', and 'Discard'. The configuration is organized into sections:

- Network Role:** Network Mode is set to 'Bridge' and Disable Network is set to 'None'.
- Configuration Mode:** Configuration Mode is set to 'Simple'.
- Management Network Settings:** Management IP Address is set to 'Static'. The IP Address is 192.168.1.201, Netmask is 255.255.255.0, Gateway IP is 192.168.1.1, Primary DNS IP is 192.168.1.1, and Secondary DNS IP is empty. MTU is 1500. Management VLAN, Auto IP Aliasing, and STP are all disabled.

A 'Change' button is located at the bottom right of the configuration area. The footer includes a 'GENUINE PRODUCT' logo and the copyright notice '© Copyright 2006-2013 Ubiquiti Networks, Inc.'.

- On the Network tab make the following changes.
 - IP Address: 192.168.1.201
 - Netmask: 255.255.255.0
 - Gateway IP: 192.168.1.1
 - Primary DNS IP: 192.168.1.1
 - Select Change but do not Apply settings yet.

2nd Bridge System

The screenshot shows the 'SYSTEM' configuration page for a NanoStation M5. The page is divided into several sections:

- Firmware Update:** Shows Firmware Version: XM.v5.5.6, Build Number: 17762, and a 'Check for Updates' section with 'Enable' checked and a 'Check Now' button. There is also an 'Upload Firmware' section with a 'Browse...' button.
- Device:** Includes 'Device Name' (NSM5-ST), 'Interface Language' (English), and 'Date Settings' (Time Zone: (GMT+12:00) Auckland, Startup Date: [] Enable).
- System Accounts:** Includes 'Administrator Username' (admin), 'Current Password' (masked with dots), 'New Password' (masked with dots), 'Verify New Password' (masked with dots), and a 'Read-Only Account' checkbox (disabled).
- Miscellaneous:** Includes 'Reset Button' (checked 'Enable') and 'Location' (Latitude and Longitude fields).
- Device Maintenance:** Includes 'Reboot Device' (Reboot...), 'Support Info' (Download...), 'Back Up Configuration' (Download...), 'Upload Configuration' (Browse...), and 'Reset to Factory Defaults' (Reset...).

At the bottom, there is a 'Change' button and a footer with 'GENUINE PRODUCT' and '© Copyright 2006-2013 Ubiquiti Networks, Inc.'.

- On the System tab change the following.
 - Device Name: NSM5-ST (Optional)
 - Time Zone: (GMT+12:00) Auckland, Wellington, Fiji, Kamchatka (Optional)
 - Administrator Username: admin
 - Current Password: ubnt
 - New Password: Create new password
 - Select Change and Apply settings.

Primary Verification

- Verify the bridge has been configured successfully by logging into both Devices and checking the connection status on the Main tab.
- Note: If you cannot login to the Access Point that currently has PoE only i.e. No LAN connection you will need to troubleshoot why you do not have connectivity.

NanoStation M5

airOS™

MAIN WIRELESS NETWORK ADVANCED SERVICES SYSTEM Tools: Logout

Status

Device Name: NSM5-AP
Network Mode: Bridge
Wireless Mode: Access Point WDS
SSID: my_wds_bridge
Security: WPA2-AES
Version: v5.5.6
Uptime: 15:17:52
Date: 2013-05-29 21:12:46

Channel/Frequency: 153 / 5765 MHz
Channel Width: 30 MHz
Distance: 0.1 miles (0.2 km)
TX/RX Chains: 2X2

WLAN0 MAC: DC:9F:DB:6C:59:C0
LAN0 MAC: DC:9F:DB:6D:59:C0
LAN1 MAC: DE:9F:DB:6D:59:C0
LAN0 / LAN1: 100Mbps-Full / Unplugged

AP MAC: DC:9F:DB:6C:59:C0
Connections: 1
Noise Floor: -83 dBm
Transmit CCQ: 99.1 %

airMAX: Enabled
airMAX Quality: 98 %
airMAX Capacity: 96 %
airSelect: Disabled

Monitor

[Throughput](#) | [Stations](#) | [Interfaces](#) | [ARP Table](#) | [Bridge Table](#) | [Routes](#) | [Log](#)

Station MAC	Device Name	Signal / Noise, dBm	Distance	TX/RX, Mbps	CCQ, %	Connection Time	Last IP	Action
DC:9F:DB:6C:59:CA	NSM5-ST	-51 / -83	0.1 miles (0.2 km)	175.5 / 195	99	00:07:55	192.168.1.201	kick

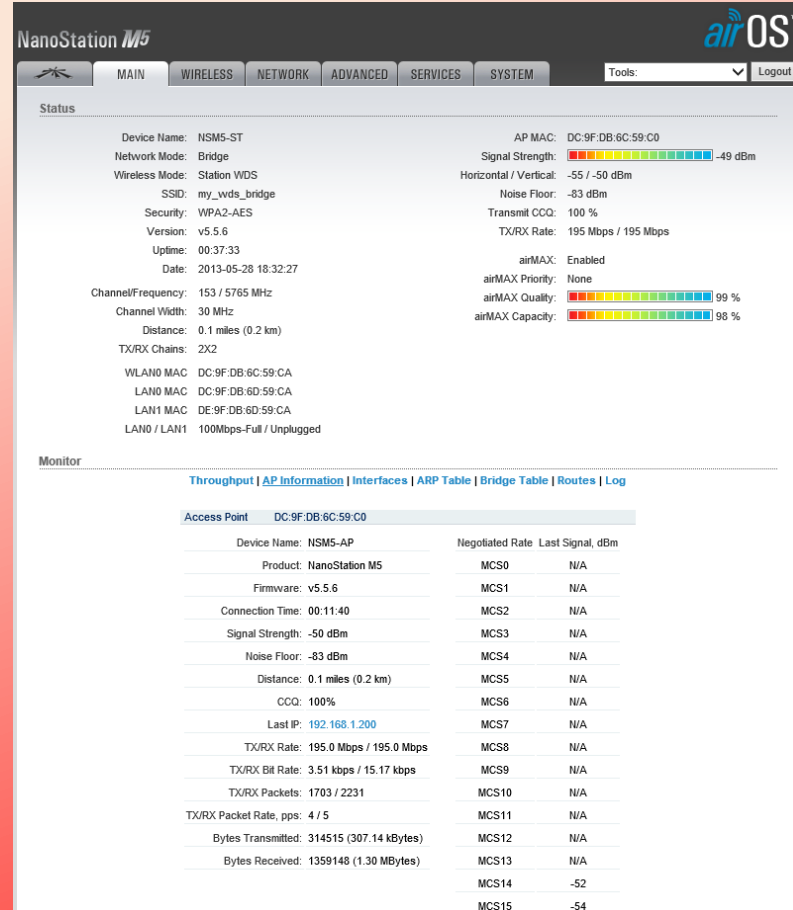
[Refresh](#)

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Secondary Verification

- Once verification is completed the outbuilding now has access to internet.
- Additional network configuration may be required on the outbuilding router or mesh node.



The screenshot displays the web interface for a NanoStation M5 device. The top navigation bar includes tabs for MAIN, WIRELESS, NETWORK, ADVANCED, SERVICES, and SYSTEM. The 'Status' tab is active, showing various system parameters. Below this, the 'Monitor' tab is selected, displaying a table of connection metrics for the access point DC:9F:DB:6C:59:C0.

Status

Device Name: NSM5-ST
Network Mode: Bridge
Wireless Mode: Station WDS
SSID: my_wds_bridge
Security: WPA2-AES
Version: v5.5.6
Uptime: 00:37:33
Date: 2013-05-28 18:32:27
Channel/Frequency: 153 / 5765 MHz
Channel Width: 30 MHz
Distance: 0.1 miles (0.2 km)
TX/RX Chains: 2X2
WLAN0 MAC: DC:9F:DB:6C:59:CA
LAN0 MAC: DC:9F:DB:6D:59:CA
LAN1 MAC: DE:9F:DB:6D:59:CA
LAN0 / LAN1: 100Mbps-Full / Unplugged

AP MAC: DC:9F:DB:6C:59:C0
Signal Strength: -49 dBm
Horizontal / Vertical: -55 / -50 dBm
Noise Floor: -83 dBm
Transmit CCG: 100 %
TX/RX Rate: 195 Mbps / 195 Mbps
airMAX: Enabled
airMAX Priority: None
airMAX Quality: 99 %
airMAX Capacity: 98 %

Monitor

[Throughput](#) | [AP Information](#) | [Interfaces](#) | [ARP Table](#) | [Bridge Table](#) | [Routes](#) | [Log](#)

Access Point	DC:9F:DB:6C:59:C0
Device Name: NSM5-AP	Negotiated Rate Last Signal, dBm
Product: NanoStation M5	MCS0 N/A
Firmware: v5.5.6	MCS1 N/A
Connection Time: 00:11:40	MCS2 N/A
Signal Strength: -50 dBm	MCS3 N/A
Noise Floor: -83 dBm	MCS4 N/A
Distance: 0.1 miles (0.2 km)	MCS5 N/A
CCQ: 100%	MCS6 N/A
Last IP: 192.168.1.200	MCS7 N/A
TX/RX Rate: 195.0 Mbps / 195.0 Mbps	MCS8 N/A
TX/RX Bit Rate: 3.51 kbps / 15.17 kbps	MCS9 N/A
TX/RX Packets: 1703 / 2231	MCS10 N/A
TX/RX Packet Rate, pps: 4 / 5	MCS11 N/A
Bytes Transmitted: 314515 (307.14 kBytes)	MCS12 N/A
Bytes Received: 1359148 (1.30 MBytes)	MCS13 N/A
	MCS14 -52
	MCS15 -54

QUESTIONS



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