OPTICONN
TECHNOLOGIES THAT CONNECT

User Manual

Fi-Speed Micronode

Deliver up to 2.5 Gbps symmetrical over coax cable

Fi-Speed 2.5G Micronode

TABLE OF CONTENTS

TABLE OF CONTENTS

Introduction

1. Safety instructions

When using these products, always follow basic safety precautions to reduce risk of fire, electric shock and injury to persons, including the following:

- Do not look directly into light source from cables or optical ports.
- Do not bend optical cables.
- Do not force insertion or extraction of optical modules.
- Make connections in a clean, dust-free environment.

2. Directive

Unless express written consent and prior approval is given by Opticonn Inc., you may not disassemble, de-compile, reverse engineer, trace or otherwise analyze equipment, its content, operation, or functionality or otherwise attempt to derive source code (or the underling ideas, algorithms, structures or organization) from the equipment or from other information provided by Opticonn Inc., except to extent that this restriction is expressly prohibited by local law; copy, rent, loan, re-sell, sub-license or otherwise transfer or distribute of equipment to others, modify, adapt or create a derivative of equipment, remove from any copies of equipment any product identification, copyright or other notices, disseminate performance information or analysis (including, without limitation, benchmarks) from any sources relating to the equipment.

Such acts not expressly approved by Opticonn Inc. will result in loss of product warranty and may invalidate user's authority to operate this equipment in accordance with CE/FCC rules.

Disclaimer- Opticonn Inc. releases all responsibilities in events of use that does not comply with instructions in this document.

3. Disclaimer

All information in this document relates to given hardware and software versions of Opticonn Inc. products. This document as well as hardware and software versions of Opticonn Inc. products are subject to change without notice.

4. Setup

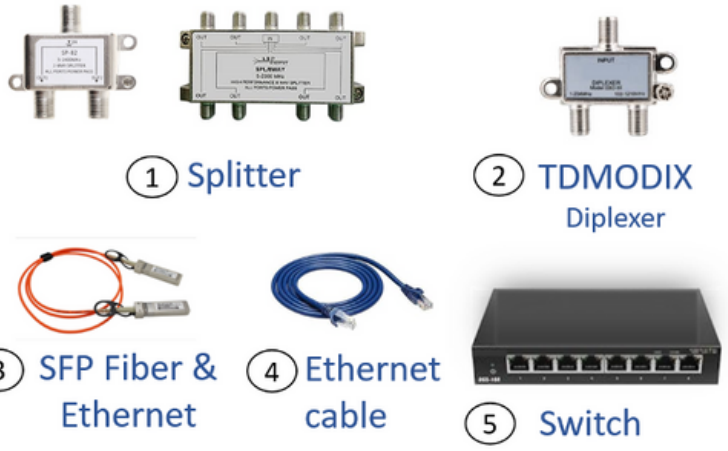
4.1 Content

Fi-Speed main components:

1	Fi-Speed Micronode with indoor PSU (12V/3A)	Ports P1/P2/P4/P5 are for coaxial connection to the CNUs. Port AC is to input fiber. Front port is for input of Ethernet and DC power (12V/3.A)
2	Fi-Speed-CNU-2.5G-RP with PSU (12V/Amp depends on RPF option), accessories and dedicated user manual	Ethernet cable is for 2.5Gb/s transmission.

The following content is referenced in this manual and not provided:

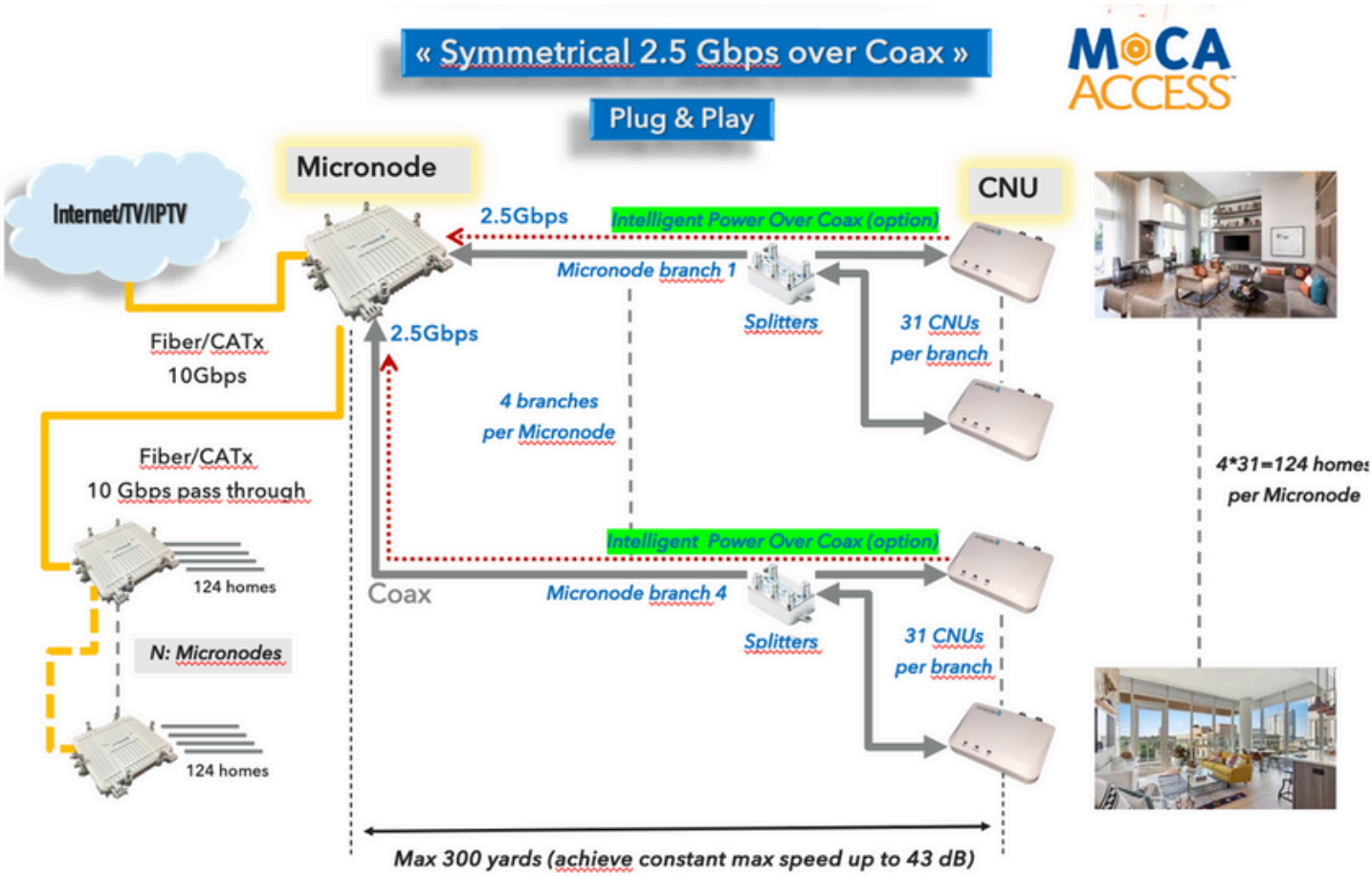
1	Splitter	RF Splitters referenced in this documentation must have frequency range [5-1800] MHz
2	Diplexer	A diplexer can be used to merge typical CATV signal with frequency below 1000MHz together with MoCA signal [1125-1675] MHz onto a single coaxial that can then be split to reach all CNUs.
3	SFP/SFP+	Micronode supports SFP and SFP+ up to 10Gb/s. **A SFP/SFP+ to be inserted in the Micronode must be qualified by Opticonn. SFP compatibility test is provided in troubleshooting section.**
4	/Ethernet cables	Fiber and Ethernet CAT-7 cables must be selected for being compatible with 10Gb/s speeds.
5	Switch	Switch to isolate networks using VLAN and to isolate traffic between ports, i.e. to ensure traffic direction is constant either upstream or downstream between devices deployed and infrastructure.



System Overview

4.2 Generic installation and Networks

Typical network installation is depicted below:



Note: If no Cable/SAT/Off-Air TV Low and High Band can be combined to deliver up to 6 Gbps

Micronode is connected through 10Gb/s fiber to the internet backbone on one side and up to 124 CNUs via coaxial cables on other side. End user connects its devices through Ethernet to Ethernet plug of CNU and can access internet. Micronode provides up to 4 MoCA connection ports. Each Micronode connection port allows connecting 31 CNUs. The distance between a CNU and the Micronode can be up to ~ 300 yards. Each CNU provides a 2.5Gb/s symmetric ethernet connection point to end users.

Fi-Speed installation is split into 2 parts:

- Micronodes and CNUs providing network access to end-users through coax connections,
- Fi-Speed Network Management System (FISPEED-NMS) for provisioning, configuring, and monitoring deployed devices.

The network link between micronodes/CNUs and FISPEED-NMS is called Out Of Band network (OOB network) in the following pictures and chapters. micronodes use OOB network to connect to FISPEED-NMS via REST API in order to report status and events as well as to get configurations for each micronode/CNU. FISPEED-NMS also provides a web based front end for monitoring and configuring linked micronodes and CNUs.

Default Micronode configuration to setup OOB network is to use untagged packets and to get an IPV4 address via DHCP. Once it gets an IP address on OOB network, micronode reports itself to FISPEED-NMS using a default URL https://tdfmc00-nms.td-tcl-nms.com. All technical parameters, including FISPEED-NMS URL, are stored into a default configuration file in the micronodes at production time. Default configuration file of a micronode can be updated via FISPEED-NMS. The full micronode provisioning sequence is provided in the following chapters.

Interface for management and monitoring of production default FISPEED-NMS is at https://tdfmc00-fre.td-tcl-nms.com/. FISPEED-NMS front-end allows modifying micronodes configuration, including FISPEED-NMS URL to which micronode reports as well as all OOB network parameters (VLAN, IP, …).

Additionally, other than OOB network, we also refer to In Band network (IB network) which is network used to link the end-users with Internet via their CNU. All parameters regarding IB network are configurable via FISPEED-NMS per end-user, i.e. per CNU.

Below table summarizes the split between the 2 networks:

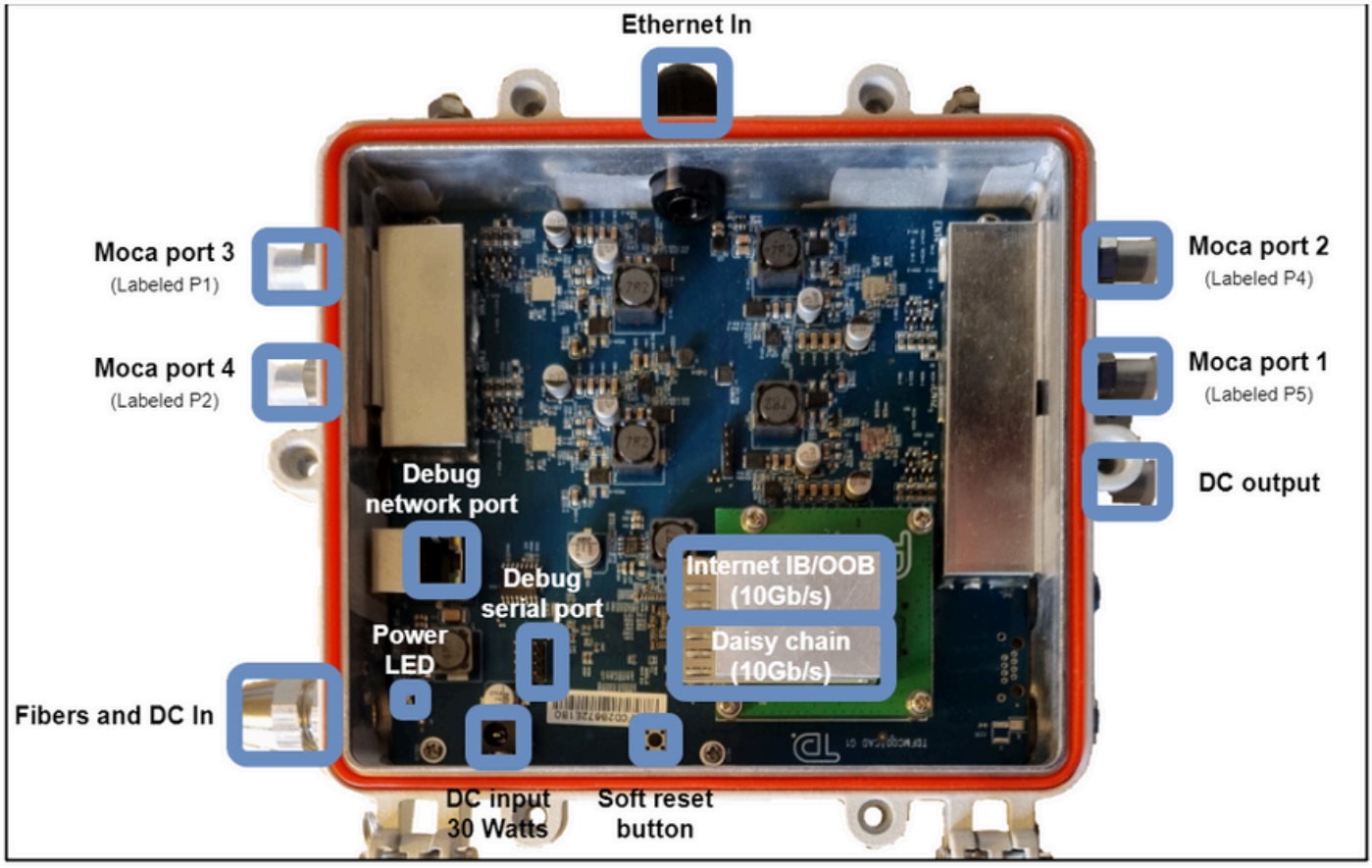
Name	Source and destination	Isolation by default
Out Of Band network (OOB)	Between Micronodes and FISPEED-NMS	Not isolated
In Band network (IB)	Between devices behind CNUs and infrastructure/internet	Not isolated

Finally, a Support and Maintenance network (SAM network) is also brought up by micronode on top of OOB network in order to provide access to the micronode by Opticonn. SAM network is used by each micronode to open a point-to-point tunnel with Opticonn support team using a Wireguard (https://www.wireguard.com/) encrypted connection. All parameters of SAM network are stored in configuration file in micronode and can be updated via FISPEED-NMS.

4.3 Setup connection

4.3.1 Micronode connection ports

Below figure depicts micronode connection ports:


Ethernet In
Moca port 3
(Labeled P1)
Moca port 4
(Labeled P2)
Moca port 2
(Labeled P4)
Moca port 1
(Labeled P5)
DC output
Debug
network port
Debug
serial port
Power
LED
Internet IB/OOB
(10Gb/s)
Daisy chain
(10Gb/s)
Fibers and DC In
DC input
30 Watts
Soft reset
button

Connection ports:

- **Network:**

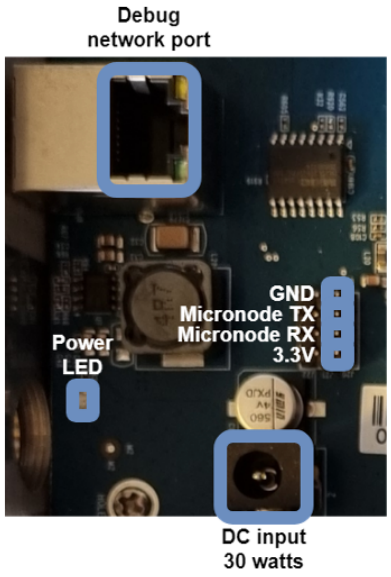
- 'Ethernet In' and 'Fiber and DC In' ports are used to let corresponding cables enter micronode housing. Care should be taken when wiring these ports to remain sealed and maintain proper level IP code as ensured by micronode housing (IP 65).
- Internet IB and OOB SFP+ port is used to connect to Internet backbone up to 10Gb/s. SFP+ can be fiber or copper SFP+. SFP+ should be validated by Opticonn Inc. before being inserted into micronode, please contact Opticonn Inc. for a list of certified SFPs.
- Daisy chain SFP+ port is used to propagate Internet backbone link received on Internet IB/OOB SFP+ port to additional micronodes.
- MoCA ports 1 to 4 are F-type, 75 Ohm female connectors. MoCA ports are used to connect CNUs at 2.5Gb/s. Up to 31 CNUs are connected to a single MoCA port using MoCA Access protocols. Each port connects up to 15 CNUs when using Moca Mesh protocol. MoCA protocol, Access or Mesh, can be configured per port via FISPEED-NMS. CNU's connected to a MoCA port in a given protocol must be compatible with that protocol. Protocol for all MoCA ports in default configuration is MoCA Access.
- MoCA ports frequency range MoCA frequency is 400MHz-1675MHz.
- MoCA ports 1 to 4 on micronode can receive power injected by CNUs with reverse power option.

- **Power**

- DC input receives 12V/3A AC/DC power converter output. This 12V DC input is optional and can be replaced by injecting power to micronode via MoCA ports 1 to 4 from connected CNU's power source.
- Power LED shows green as soon as micronode is powered on.
- DC output port is a F-type female connector. DC output port is linked to 12V main power bus of the micronode. Caution must be taken on micronode power source (either DC port or RPF) when using this DC output to power an external device. Total system peak power usage (micronode + external system powered through DC output port) must be at most 85% of full power capability of the micronode power source.

- **Debug**

- Debug serial port is used to connect to micronode system via serial link using 115200 bauds, 8 bits, no parity and 1 stop bit parameters (115200/8/N/1). This link is used to debug and provides access to micronode console. Mapping of signals to connectors are as below.

Micronode RX/TX serial signals require usage of a signal level adapter to switch signals level to RS-232 expected level. The adapter can be powered by the 3.3V pin. **Contact Opticonn Inc. for information on how to get a signal level adapter.**	

o Debug ethernet port is used to connect to micronode system via IP. IP parameters used for connection depend on micronode software:

- When micronode bootloader is running, network parameters are fixed at:
  VLAN: untagged
  IP: 192.168.144.1/24

Micronode bootloader network link can be used to modify micronode running configuration and to factory reset device.

- When micronode system is running, network parameters in default configuration file are:
  VLAN: 2
  IP: 192.168.144.1/24

Micronode system network link can be used to fully configure the micronode either through micronode Web interface or by console access.

- Soft reset button allows to force a soft reset of the micronode system.

4.3.2 CNU Connection ports

4.3.2.1 Fi-Speed CNU, High-Band RPF 2.5Gb/s CNU with CATV passthrough

Next figure depicts FISPEED-CNU-2.5G-CATV-RP connection ports. Connection ports are:

· **Network:**

o Common CATV/MoCA port is a F-type Female connector. This port must be connected to a coaxial cable linked to a Micronode. This port will split and route the signal it receives according to frequency ranges:

- 54MHz-1002MHz is routed to CATV passthrough port.
- 1100MHz-1675MHz is routed to MoCA chipset.

Common CATV/Moca port also provides a 48V DC signal to power up the Micronode. 48V DC signal is provided only in specific cases explained in the LED description below.

o Ethernet 2.5Gb/s port must be connected to end-user network equipment.

· **RF:**

o CATV pass through is a F-type female connector. It provides all signal received on Common CATV/Moca in the frequency range from 54MHz to 1002MHz.

· **Power:**

o DC in port must be connected to the AC/DC adapter DC output providing 12V/3A.

· **Informational:**

o Power LED is a mono-color green LED:

- Power LED is off when CNU is powered off.
- Power LED is green when CNU is powered on.

o Ethernet LED is a bicolor green/red LED. Ethernet LED color depends on ethernet link rate negotiated between CNU and end-user equipment:

- Ethernet LED is green when negotiation leads to 2.5Gb/s ethernet link.
- Ethernet LED is orange when negotiation leads to 1GB/s ethernet link.
- Ethernet LED is red when negotiation leads to 10Mbits/s or 100Mbits/s ethernet link.

Ethernet LED blinks when there is RX/TX traffic on Ethernet.

- Moca LED is a bicolor green/red LED. Green LED is used to report Moca link status:
- Moca LED green is ON when Moca link is up.
- Moca LED green is OFF when Moca link is down.

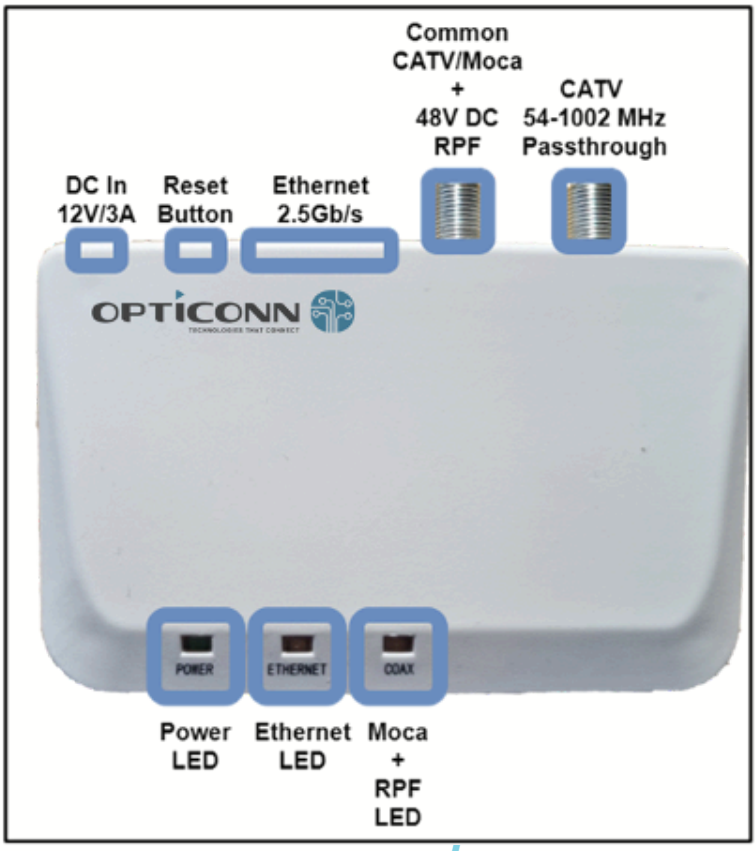
Red LED is used to report RPF injection status. Moca red LED must never remain still in red. If Moca red LED remains still ON, please power off CNU and contact Teamly Digital to report the malfunction. Proper red LED behavior is detailed in the RPF dedicated paragraph below. Moca LED red should be constantly OFF when RPF system is working properly. Moca LED red will blink to either signal it restarts a RPF identification sequence or to report an error code.

· **Reset**

o Reset button is used in two ways:

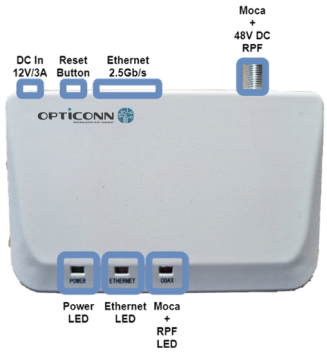
- Short press will reset the device,

- Long press (> 15sec) will force a factory reset of the CNU.



4.3.2.2 Fi-Speed, Full-Band RPF 2.5Gb/s CNU

Next figure depicts FISPEED-CNU-2.5G-RP connection ports. Connection ports have same functions as FISPEED-2.5G-CATV-RP except for CATV RF path. Please refer to above for dedicated connection port explanation.

Regarding RF path: · MoCA port is a F-type Female connector. This port must be connected to a coaxial cable linked to a Fi-Speed micronode. This port will route received signal to internal MoCA chipset. MoCA port also provides 48V DC signal output power to power attached micronode. 48V DC signal is provided only in specific cases explained in the information description of FISPEED-CNU-2.5G-CATV-RP above.	

4.3.2.3 Fi-Speed, Full-Band RPF 2.5Gb/s CNU

Next FISPEED-CNU-2.5G-4 connection ports are as follows:

· Network

o Common CATV/MoCA port is a F-type Female connector. This port must be connected to a coaxial cable linked to a Fi-Speed micronode. This port will split and route signals it receives according to frequency ranges:

- 54MHz-1002MHz is routed to CATV passthrough port.
- 1100MHz-1675MHz is routed to MoCA chipset.

o Ethernet 4*1Gb/s ports must be connected to end-user Ethernet network

- **RF:**

o CATV pass through is F-type female connector. It provides signal received on Common CATV/MoCA in frequency range from 54MHz to 1002MHz.

- **Power:**

o DC in port must be connected to AC/DC adapter DC output providing 12V/1.5A.

o Power switch is a toggle switch to power CNU ON or OFF

- **Informational:**

o Power LED is a mono-color green LED:

- Power LED is off when CNU is powered off.
- Power LED is green when CNU is powered on.

o MoCA LED is green. MoCA LED reports MoCA link status:

- MoCA LED is ON when MoCA link is up.
- MoCA LED is OFF when MoCA link is down.

When MoCA link is up, MoCA LED will blink with data traffic.

o Switch ports LEDs are 4 green LEDs, 1 LED per Ethernet port on back panel. Ethernet LED is green when a peer is connected to corresponding Ethernet port. Ethernet LED blinks with data traffic.

o WiFi 5G LED is green LED. WiFi 5G LED is ON when WiFi 11ac access point is enabled and running. WiFi 5G LED blinks with 11ac wireless traffic.

WiFi 2.4G LED is green LED. WiFi 2.4G LED is ON when WiFi 11n access point is enabled and running. WiFi 2.4G LED blinks with 11n wireless traffic.

- Reset

o MoCA Reset Button (labelled 'Reset') is used in two ways:

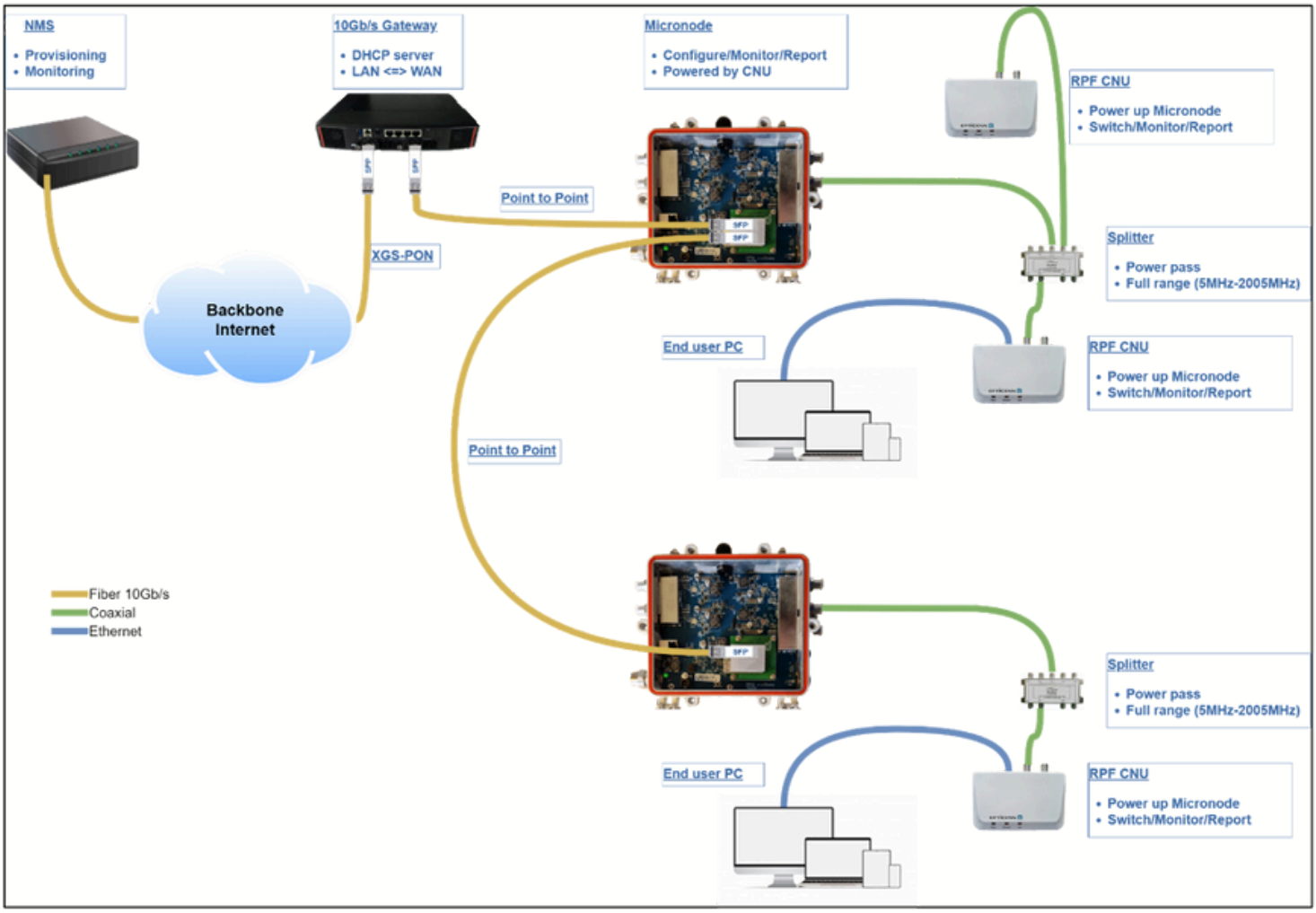
- Short press will reset the MoCA link,
- Long press (> 15sec) will force a factory reset of the MoCA link.

o Switch Reset Button (labelled 'WPS') is used in two ways:

- Short press will reset the CNU OpenWRT system,
- Long press (> 15sec) will force a factory reset of the CNU OpenWRT system

4.4 Plug and Play Connection Setup

Below image represents plug and play physical connections when using Fi-Speed devices out of the box with their default configuration.

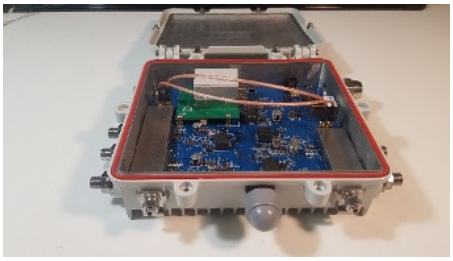
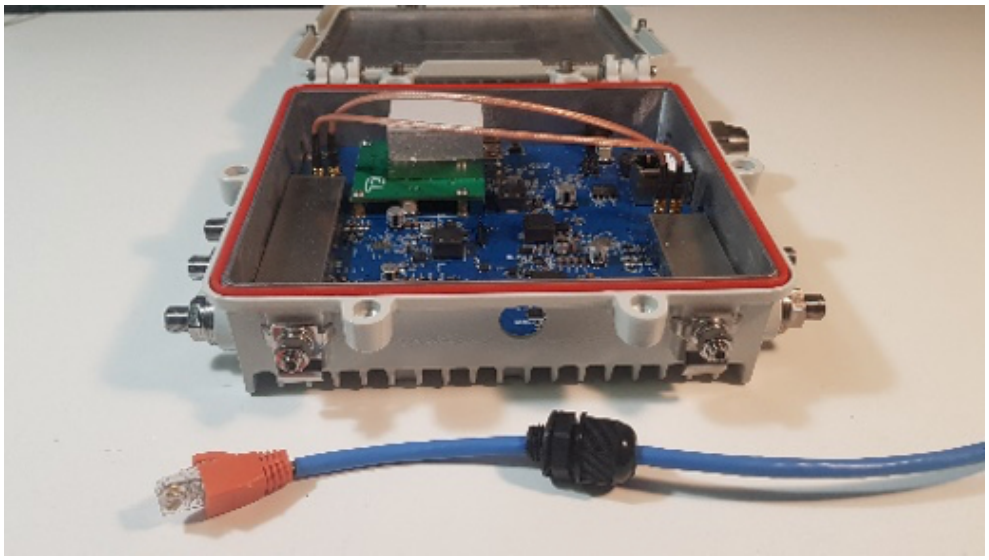
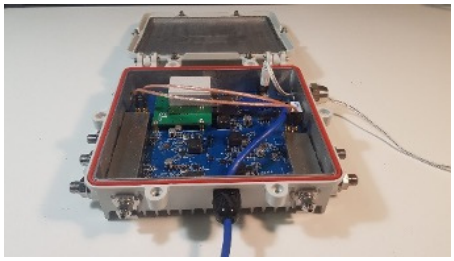
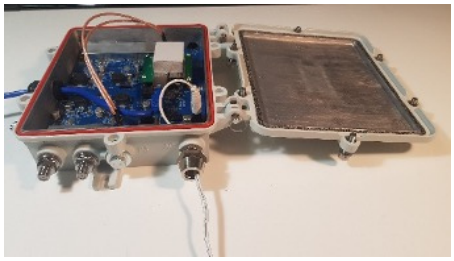
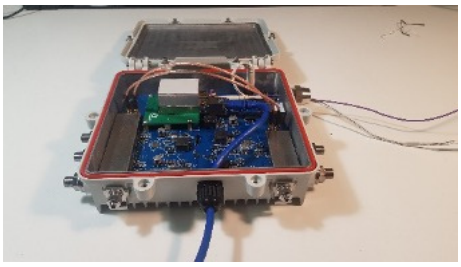
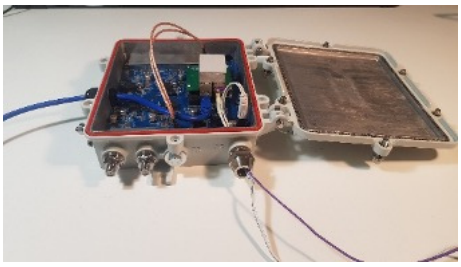
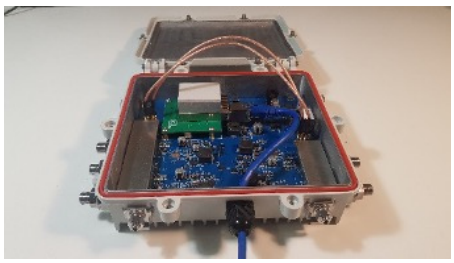
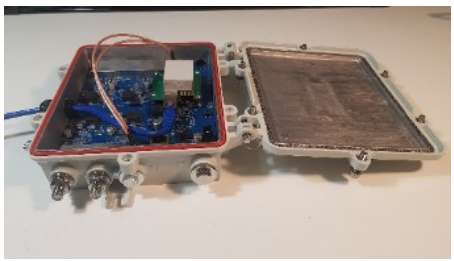


Starting from top left, point to point fiber SFPs are inserted into micronode and Gateway to connect micronode to 10Gb/s gateway from operator. XGS-PON link provided by operator is simple example. Micronode is connected to in building coax network (i.e. coax splitters, coaxial cable) to CNU's. 2nd micronode is connected using point to point fiber SFPs, which demonstrates daisy chain capabilities of Fi-Speed network. At the residence coax splitter is shown to provide MoCA signal to CNUs with reverse power feed. CNUs receive MoCA signal and provide corresponding data on their Ethernet ports. End user PC is connected to Ethernet port of CNU's. Reverse power feed of CNU's inject power on coaxial cable for powering up micronode remotely.

This is simple plug and play deployment, there is no configuration needed. Each CNU is isolated from other CNUs on the network by default settings in micronode. This due to default MoCA Access security protocols. Full isolation of network depends on operators and how 10Gb/s gateway settings are configured.

4.5 Plug and Play Connection Setup

Micronode housing allows IP66 isolation ensuring use in external conditions (dust and significant water projection), with temperature in range of 41°F to 113°F. Below images show typical connections to be used in order to ensure dust and water isolation in outdoor conditions. The images are FISPEED-2.5G-MN-4-RP, same constraints are valid for each Fi-Speed micronode model.

Isolating bottom hole when not using Ethernet input to the micronode. A cover must be placed on top of cable gland placed in bottom connector to ensure correct isolation.		
When using Ethernet for connecting micronode, ethernet cable must be prepared and plastic cable gland need to be placed on Ethernet cable. Selected Ethernet connector and its protection must be able to feed through bottom hole.		
Connecting Ethernet port using bottom hole with isolation with DC in. DC in cable needs to be in a sheath.		
Connecting Ethernet port using bottom hole with isolation using DC in and optical daisy chain between micronodes. DC in cable and optical fiber must be placed in a single sheath to ensure isolation.		
Connecting Ethernet port using bottom hole with isolation in RPF case, i.e. DC hole is closed.		

4.6 RPF (Reverse Power Feed)

4.6.1 Power injector

4.6.1.1 Reverse Power Feed CNU, Rules For Providing Power to Fi-Speed micronode

RPF CNUs, models with -RP, inject up to 12W (48V/0.25A maximum) power to micronode through coaxial cable. This mechanism is implemented to provide power to micronode without power connections nearby its installation.

RPF implementation has following rules:

RPF Rule 1. A CNU will provide power only:

o if it recognizes electrical signature of a micronode, see ETSI TS 101 548 for the description of the signature principle and on safety checks,

OR

o if its MoCA connection is up, meaning it is connected to a micronode.

RPF Rule 2. Power provided by a CNU is sufficient to power the part of micronode which is needed for connecting its system (Micronode + CNU) to the network.

RPF Rule 3. A Micronode powered by RPF will open data connectivity only on ports providing power (continuity and current), i.e. only if a RPF CNU is connected to that port.

RPF Rule 4. Micronode controls power it uses from each branch providing power according to criteria:

o A branch must provide a minimum amount of power.

o In a fully loaded system, 4 CNUs provide power to micronode.

o Calculation of the part of power requested by micronode to a branch is based on criteria that can be adapted. 3 criteria are already implemented and can be selected:

- Power requested to a branch = Total energy / number of branches providing power
- Power requested to a branch = f(branch network bitrate)%
- Power requested to a branch = %_branch * total power

Other criteria can be implemented upon request and after feasibility study by Opticonn Inc., i.e. after confirmation that the criteria has a real impact on global power and can be easily evaluated for each branch.

Rule 3 is configurable, and a parameter allows removing link between Micronode providing data to a branch and CNU connected to that branch and providing RPF. This allows support for the DC injection case (see next chapter). When disabling that link and using RPF CNU, strong care should be taken to ensure energy requested to each RPF CNU remains in design limits, i.e. it is not possible for a single RPF CNU to provide energy required to run all 4 branches of a daisy chained Micronode (maximum Micronode power consumption).

4.6.1.2 DC injector

DC injector can be used to inject 48V into the coaxial cable to power the micronode remotely. Micronode maximum power consumption is 30W and DC injector must be able to provide 48V/0.7A to ensure proper powering of micronode.

When using an external DC injector, the branch connected to the injector will solely power micronode (no need for multiple DC injectors). In this case, configuration parameters linking data to power injection (RPF rule 3 defined above) should be removed to ensure all branches are connected to data source.

4.6.2 Installation

Remove power supply of micronode and of RPF CNUs. Connect coaxial on each side so micronode and RPF CNUs are linked. Connect power to RPF CNU's. It is essential to use provided DC power supply supplied with RPF CNUs.

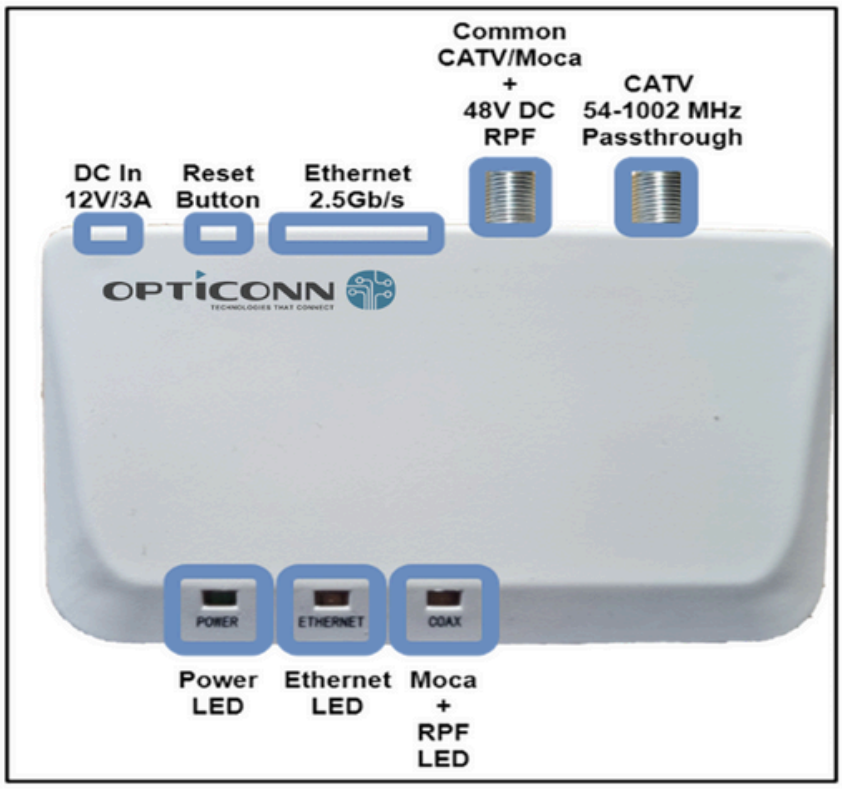
Above procedure is true even when using external DC injector. Caution should be taken to never connect a powered DC injector to coaxial cable connected to the micronode. There is potential to cause damage to micronode if center conductor is grounder when center pin is hot with power applied.

WARNING: Connecting a RPF CNU or external DC injector to micronode already powered by main power supply can result in damages to micronode and, when applicable, to CNU. This should be avoided.

4.6.3 Troubleshooting and Monitoring

4.6.3.1 RPF CNU LED behavior

When a RPF CNU is connected to a micronode, red color COAX LED provides information on use of reverse power feed and state of its physical connection, see below figure for the COAX LED position on the CNU:



Scenarios for RPF LED (Red LED labeled 'COAX'):

- **RPF LED is OFF:**

o RPF technology is working properly, i.e. RPF CNU is injecting power.

OR

o CNU is checking for micronode signature on coaxial and RPF is being initiated

- **RPF LED is ON:**

o This situation must NEVER happen, RPF LED should never remain constant ON. If this happens, unplug CNU immediately

- **RPF LED is blinking, RPF manager is reporting an issue. Number of blinks indicates the problem scenario:**

o one blink, initialization for reset or reinitialization.

o two blinks, presence of voltage during initialization, the connection should not be powered during initialization.

o three blinks, error on signature detection, no micronode detected.

o four blinking, error on classification detection, current to high (>500mA), likely due to a short circuit.

o five blinking, error on classification detection, voltage to high (>21V), probably due to a short circuit.

six blinking, error on classification detection, not enough current (<3mA), likely due to an open circuit

o seven blinking, error on DCDC ramp monitoring.

After encountering an error, CNU automatically returns to initialization phase, sometimes indicates return by blinking once.

After successfully powering micronode, red color of COAX LED is turned OFF and RPF CNU monitors power to detect open and short circuits and acts accordingly.

4.6.3.2 Voltage level to Power On Micronode

In order for micronode to power ON via RPF, DC voltage reaching micronode on at least one branch of coax cable must be in range [34V to 48V]. Specifically, if DC voltage falls below 34V then micronode will not have sufficient voltage to start its power up process and will remain OFF. On the other hand, if > 48 is supplied to micronode, then damage can occur and micronode may become inoperable

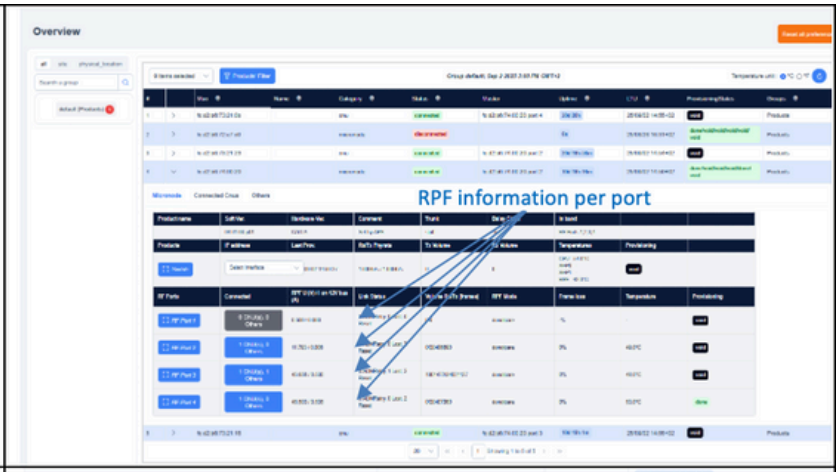
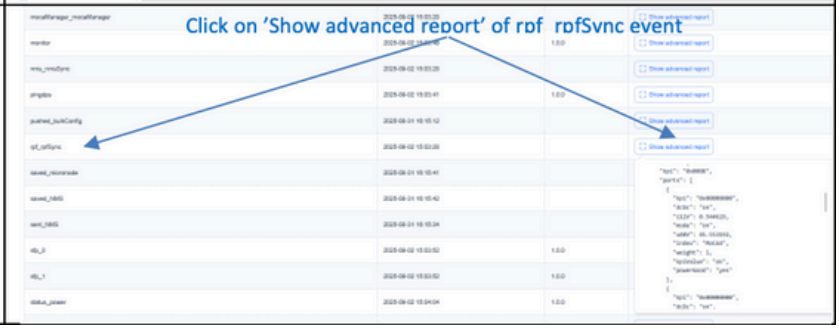
4.6.3.3 Using a RPF CNU as a constant DC injector

On demand, Teamly Digital can provide a RPF CNU transformed into a constant 48V DC injector. A RPF CNU transformed into a DC injector must NOT remain connected to the coaxial network as it does not ensure security for the people manipulating the coaxial network or all the equipment connected to it.

A RPF CNU constantly injecting 48V DC can be used to confirm power path between injection to the coaxial network and reception of the power by the Micronode and allow level measurements.

4.6.3.4 Using FISPEED-NMS to read RPF level

Each micronode periodically reports power status to FISPEED-NMS. Reverse power information is available in several pages FISPEED-NMS, as shown in below tables. To login into FISPEED-NMS and navigate pages is explained more in detail in next chapter.

Go to product overview page and select product. When opening product, RPF information is provided for each port (U for voltage received from CNU and I for current injected on main 12V power bus).	
Go to micronode Switch (port 0) inspect page and click on 'show advance report' button of rpf_rpfSync event. This displays full content of events provided for each branch: • Voltage level as input • Current level to main power source DC/DC activity Measurements are not calibrated and should be used as a guide. Actual measurements should be measured with proper power measurement equipment	

5 FISPEED-NMS, Monitoring and Provisioning

FISPEED-NMS provides following functionalities:

- Create and manage group of devices to ease configuration and report,
- Reset, configure and upgrade the micronodes connected to it,
- Reset, configure and toggle connectivity of the CNUs connected to it,
- Trigger alarms and send mails (and SMS) on:
- devices connections/disconnections,
- links bitrate threshold cross.

FISPEED-NMS also provides textual as well as graphical status and events reporting to keep track of all states and information reported by micronodes.

5.1 FISPEED-NMS, Monitoring and Provisioning

5.1 FISPEED-NMS, Monitoring and Provisioning

FISPEED-NMS has 2 software elements:

- a backend managing the system and its elements, private and interfaced through REST APIs
- a front-end using backend REST APIs to present system status and allow configuration through web pages and excel file

5.1.1 Backend

Backend maintains an event/status database and provides a set of REST APIs to be used by connected devices. Backend is scalable and instantiable to allow management of any number of connected devices. Backend is split into dockers each providing a part of service, communicating through TCP/IP. Dockers running on same machine are attached to same network bridge.

Backend at its minimal scale is included in a single virtual machine running a ubuntu LTS server (currently version 22.04).

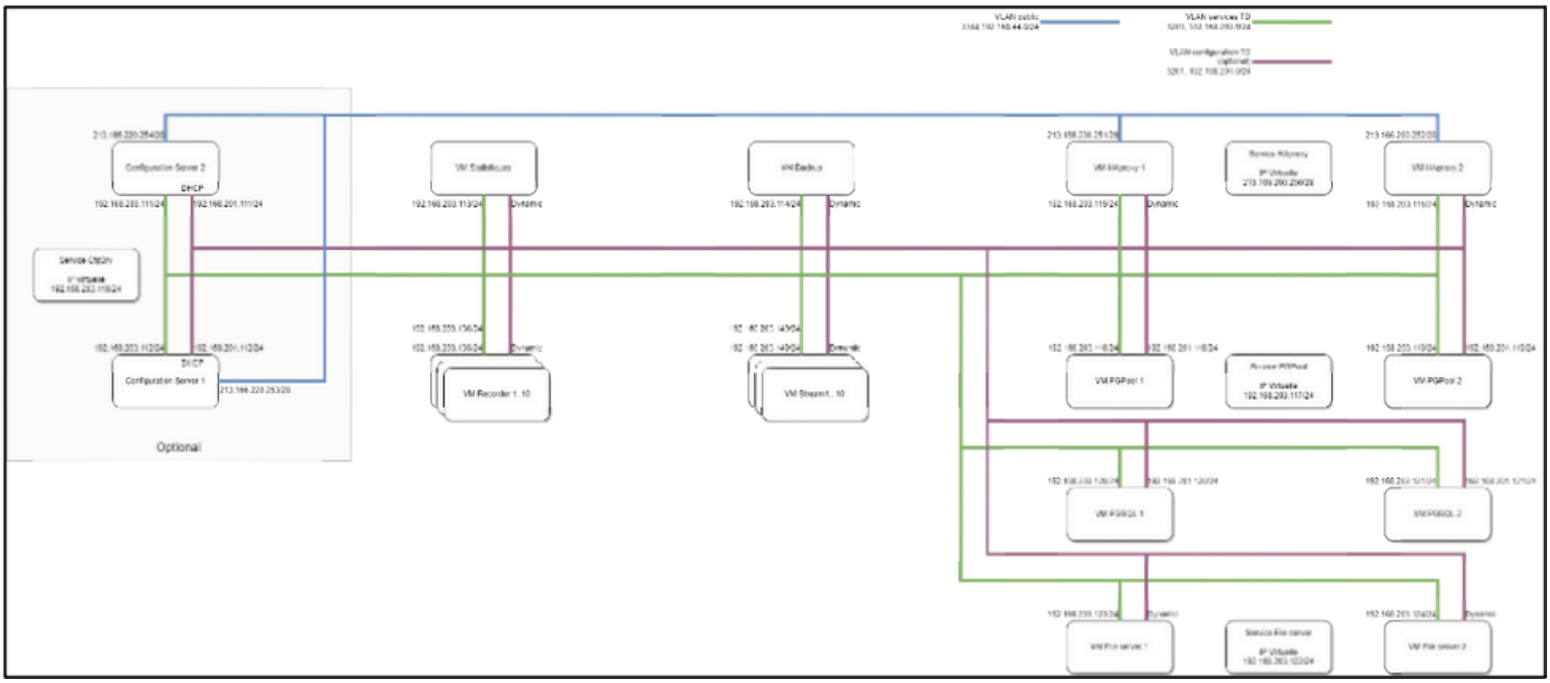
5.1.2 Front-End

FISPEED-NMS front-end is a VueJs application deployed by an Apache server. FISPEED-NMS front end uses its backend REST APIs to get all information it needs and push all configuration sets to FISPEED-NMS backend. FISPEED-NMS backend is responsible for properly reporting device events and configurations to devices.

Front-end at its minimal scale is included in the same virtual machine as FISPEED-NMS Backend.

5.1.3 Large scale deployment

When deploying FISPEED-NMS in a large scale environment, an example of recommended architecture is provided below. This architecture uses virtual IPs to avoid Single Point Of Failure(SPOF) and ensure proper reaction time via load balancing.



5.2 FISPEED-NMS and Micronode/CNUs Interactions

5.2.1 Path definition to FISPEED-NMS by configuration or by DHCP option 43

Micronode does not rely on FISPEED-NMS for executing its functionalities. FISPEED-NMS is optional for micronode to work properly:

· When a micronode is connected to FISPEED-NMS, it reports its events and allows configurations of the micronode(s).

· When a micronode is not connected to FISPEED-NMS, it does not report its events and it can be configured only via its console and local web interface.

Below image shows how micronode identifies to which NMS it will connect to. Identification can take 2 paths:

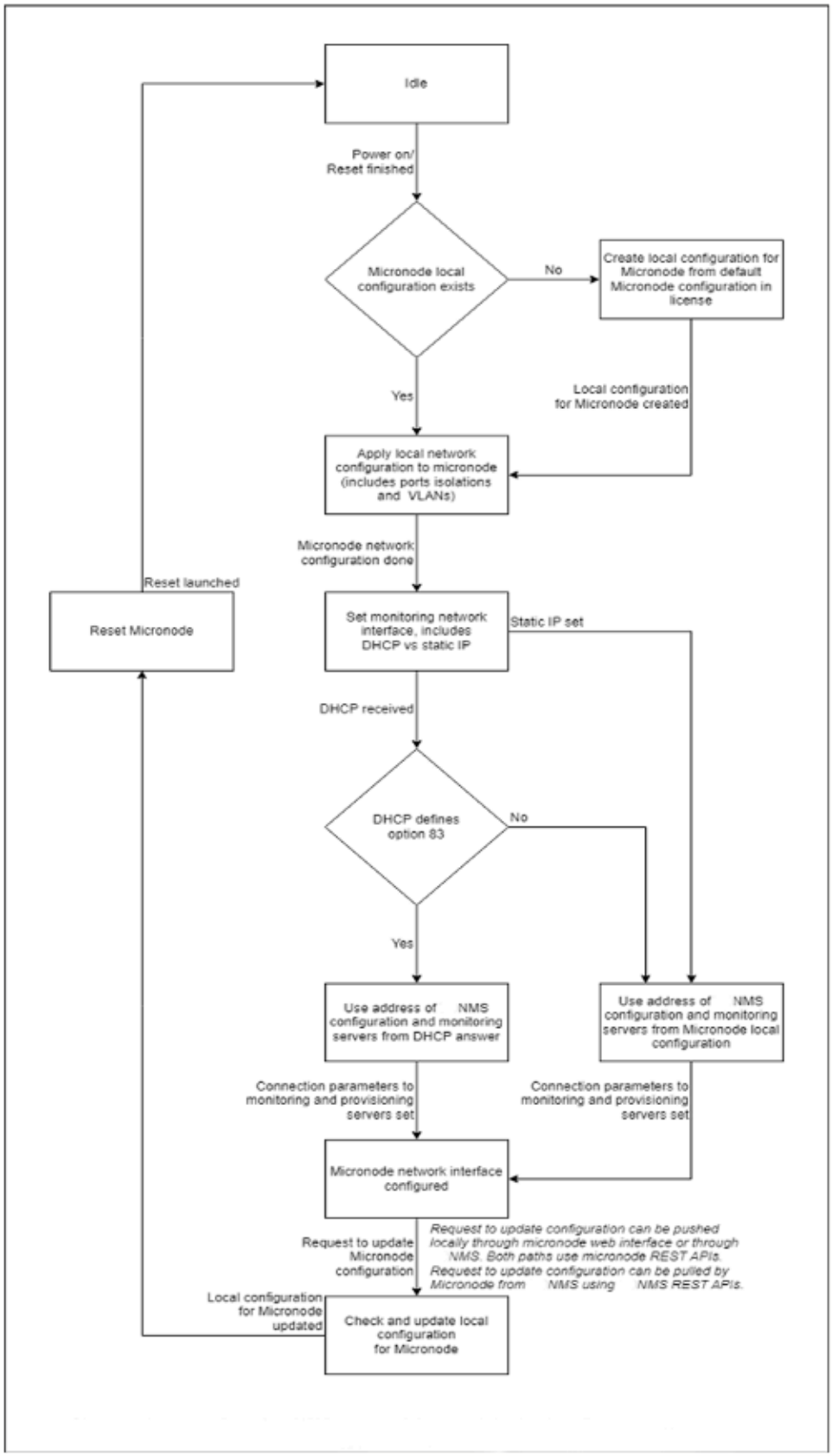
· Local configuration file defines FISPEED-NMS URL

· DHCP answer to its IPV4 request includes option 83 and defines FISPEED-NMS URL

Once FISPEED-NMS URL has been identified, micronode checks its local configuration with respect to FISPEED-NMS.

Reset path is currently not needed, it exists in case a criteria to launch is encountered.

Please note that DHCP option 43 can be used to provide FISPEED-NMS URL to deployed micronodes and that this setting overrides any configuration local to micronode. DHCP request of micronode includes option 43 to help DHCP server identify micronode and thus point to correct FISPEED-NMS URL. An example of isc dhcp server configuration file to provide NMS URL via DHCP option 43 is provided in annex.


Idle
Power on/
Reset finished
Micronode local configuration exists
No
Create local configuration for Micronode from default Micronode configuration in license
Yes
Local configuration for Micronode created
Apply local network configuration to micronode (includes ports isolations and VLANs)
Micronode network configuration done
Reset launched
Reset Micronode
Set monitoring network interface, includes DHCP vs static IP
Static IP set
DHCP received
DHCP defines option 83
No
Yes
Use address of NMS configuration and monitoring servers from DHCP answer
Use address of NMS configuration and monitoring servers from Micronode local configuration
Connection parameters to monitoring and provisioning servers set
Connection parameters to monitoring and provisioning servers set
Micronode network interface configured
Request to update Micronode configuration
Request to update configuration can be pushed locally through micronode web interface or through NMS. Both paths use micronode REST APIs.
Request to update configuration can be pulled by Micronode from NMS using NMS REST APIs.
Local configuration for Micronode updated
Check and update local configuration for Micronode

5.2.2 Micronode provisioning sequence

Once micronode has identified FISPEED-NMS it connects. Generic interactions between micronode and FISPEED-NMS is depicted in below image for reporting and provisioning.

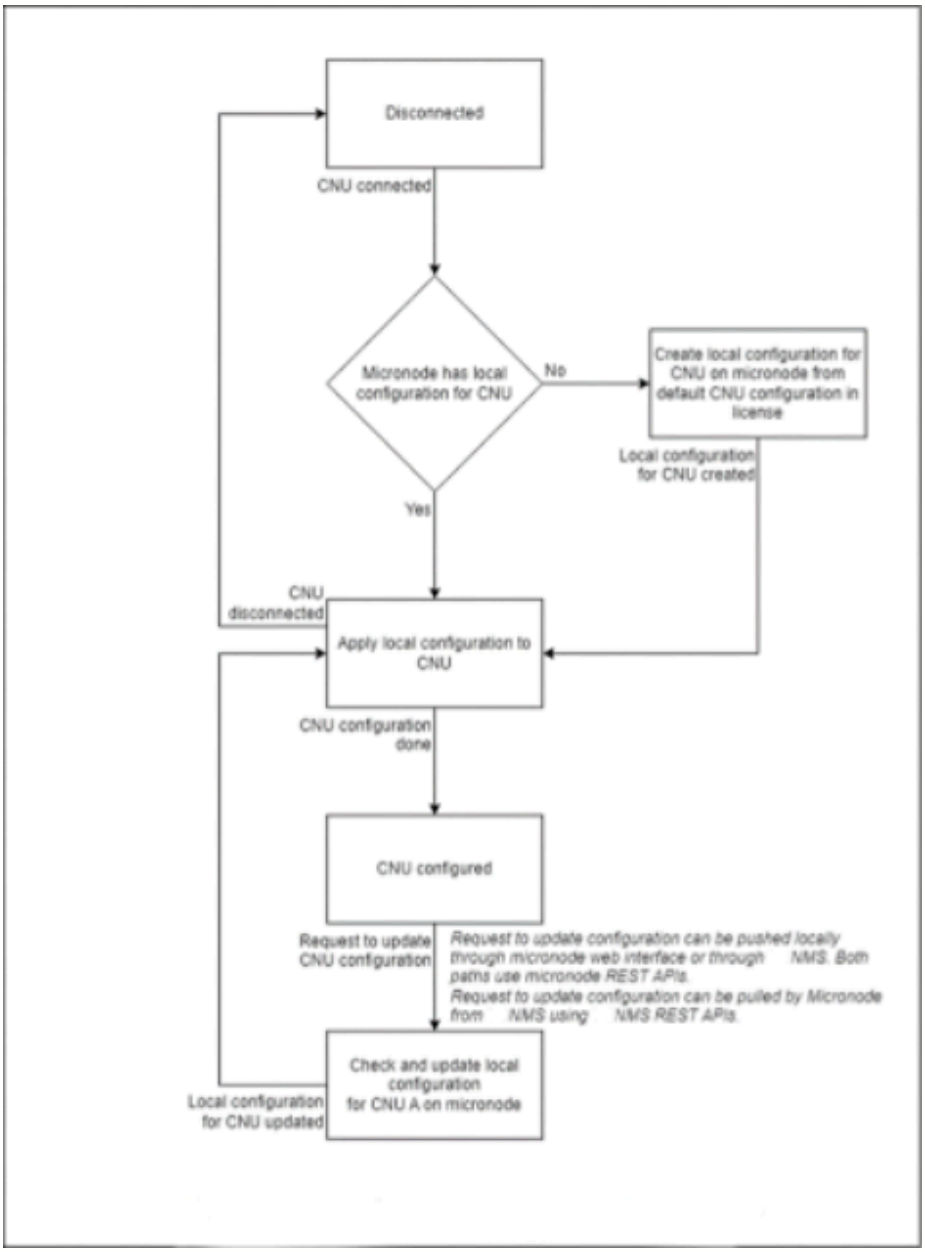
The figure allows understanding how micronode remains independent from FISPEED-NMS to provide its functionality. Connectivity with FISPEED-NMS is only used for reporting and configuration and is not preventing any functions to be executed properly by micronode according to its local configuration.

The sequence can be summarized as:

1. Micronode boots up,
2. Micronode sets its interfaces according to its local configuration,
3. Micronode connects to FISPEED-NMS. Micronode remains at that step as long as connection to FISPEED-NMS fails,
4. Micronode reads configuration from FISPEED-NMS
5. Micronode loops pooling commands to be executed from FISPEED-NMS and then executing commands as they are received (reset/upgrade/configure).

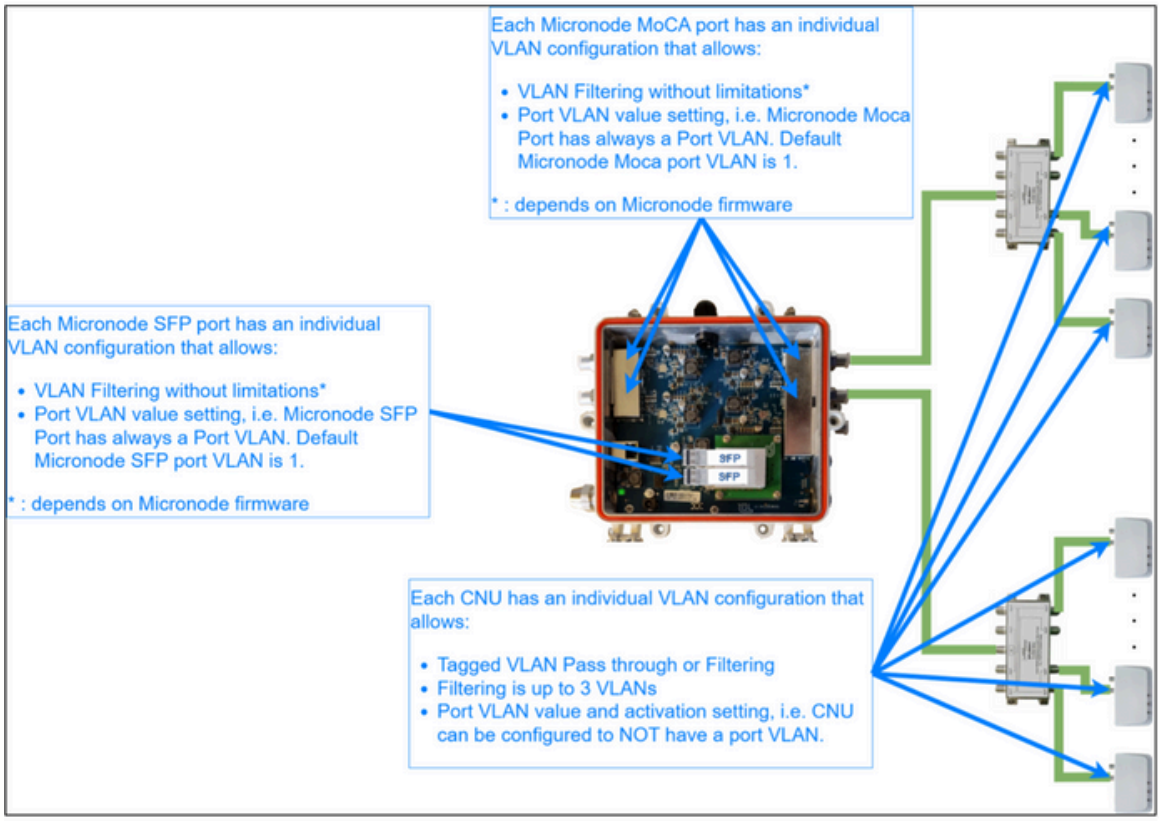
5.2.3 CNU provisioning sequence

CNU provisioning sequence is fully managed by micronode to which the CNU is connected. Image below depicts sequences executed by micronode to provision a CNU when it gets connected. Dynamic configuration is also possible when FISPEED-NMS sends specific configurations for a given CNU.



6 VLANs and Isolation

Fi-Speed solution allows full control of VLAN and port isolation. Below picture depicts where configuration of VLAN tagging/untagging/filtering can be configured.



Isolation is split into 2 domains:

- MoCA domain isolation depends on MoCA protocol :

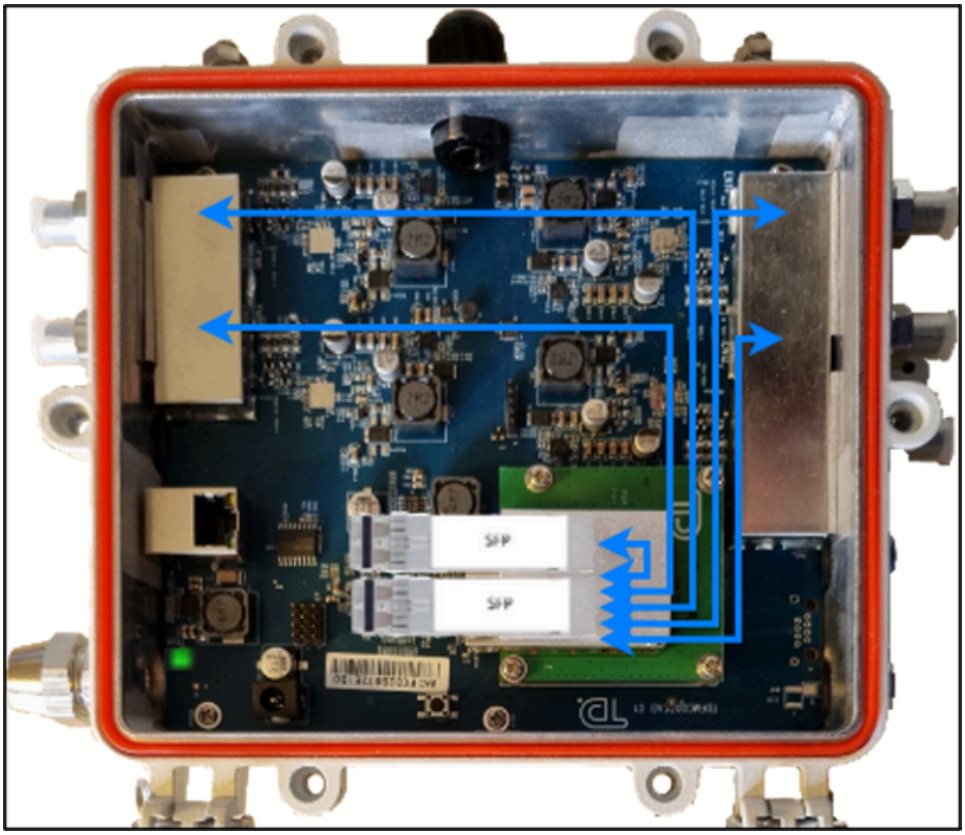
o MoCA Access ensures full isolation between CNUs connected to same MoCA port. It is not possible for a device behind a CNU connected to a micronode port to connect directly to another CNU connected to the same micronode port. MoCA Access master in micronode will forward packets to outside. This isolation is not configurable, it is part of MoCA Access protocol.

o MoCA Mesh does not isolate any devices connected to same coax port. Any CNU connected to same MoCA port of micronode will be able to communicate with any other CNU connected to that same port. This lack of isolation is not configurable, it is part of MoCA Mesh protocol.

- Micronode domain:

o Micronode domain allows full isolation of any port. In default settings, isolated paths are depicted in figure below. Default configuration links SFP internet port to all other ports and isolate all other ports one from the other, including the daisy chain port. All traffic goes through SFP internet port and it is up to connected peer to decide if packets should be transported back to micronode for to its target or not. These default parameters are fully configurable. Below picture shows network packets paths inside

micronode and that MoCA ports and daisy chain ports CANNOT communicate with one another.



7 Using FISPEED-NMS Front-end

7.1 Features per page

This chapter describes features of each NMS page.

7.1.1 Features per page

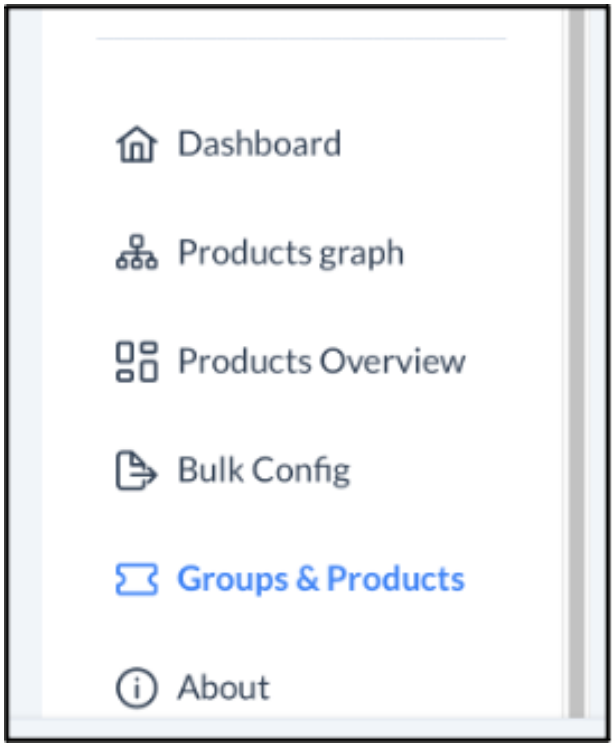
Login page is an interface requiring a username and password, as provided by Opticonn Inc to customer. It also displays backend to which front-end will send its requests.
If login fails, an error message is displayed. There is no limitation on number of times login fails and user can try as many times as needed.

When a user forgets their login or password, they must contact site administrator. Site administrator should be able to add/remove/modify user information, including password. If you are the site administrator, please refer to chapter on user configuration.

7.1.2 Navigation

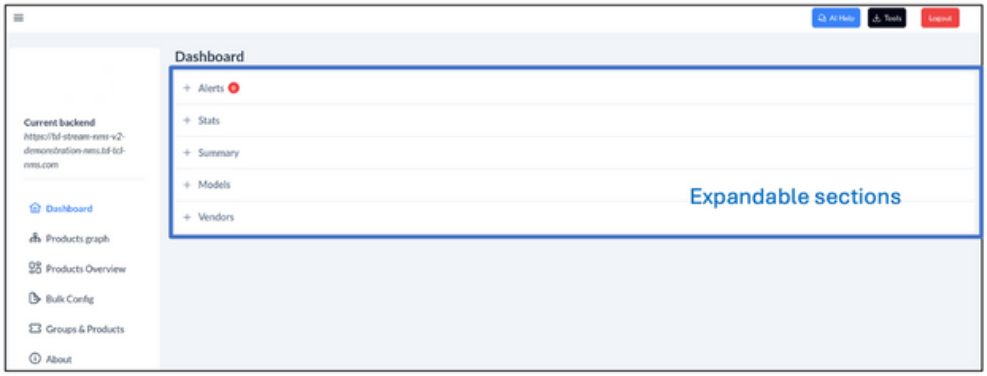
To navigate FISPEED-NMS front-end, a menu listing of global pages (image to the right) is always available at the left of NMS page, and it can be hidden or displayed using menu button at top-left of the page. The backend to which the front-end points to is also visible in menu.

Some pages are product- or device-related, as thus they are not accessible from menu but from specific buttons that will be presented in corresponding sections of this manual.



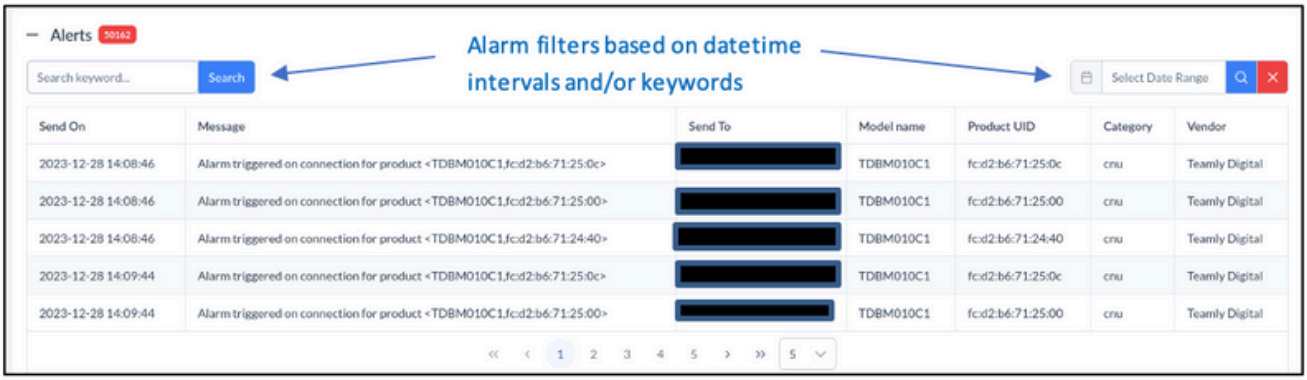
7.1.3 Dashboard

Once logged in, the user first lands on the Dashboard page, which contains 5 sections. Each section is meant to display general information, and overall health of the network.
By default, the Stats and Models sections are open.



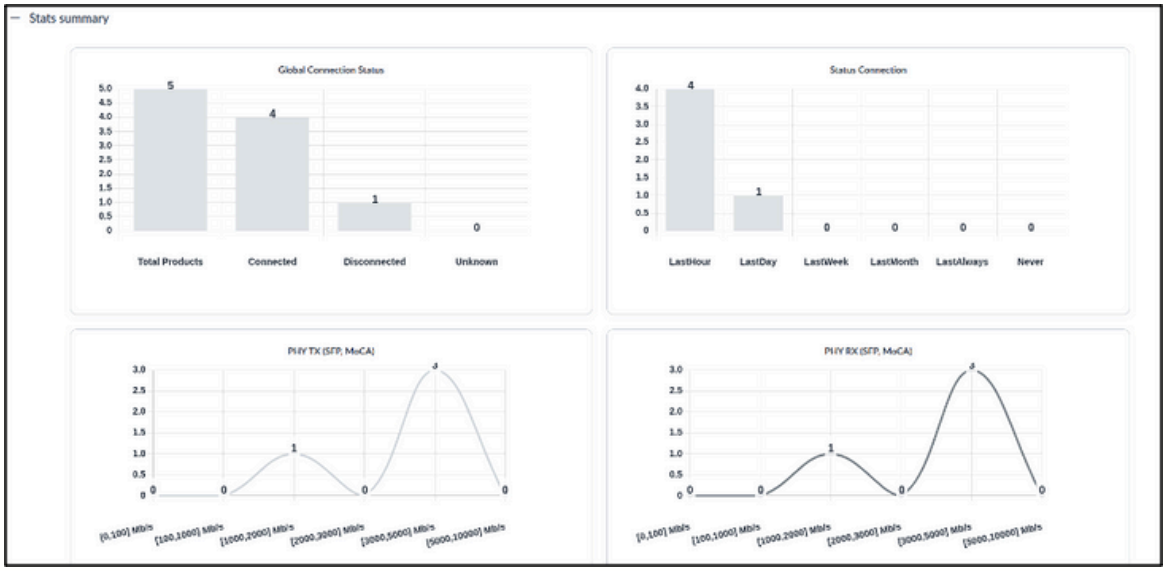
7.1.3.1 Alerts

Alerts are mails that were sent to some of FISPEED-NMS users at some point in time, to inform them of some event that occurred related to one of Fi-Speed products known by the NMS (i.e declared products). All of the information about the dispatched alerts (regardless of their target user(s) and the logged in user) are displayed in the table.



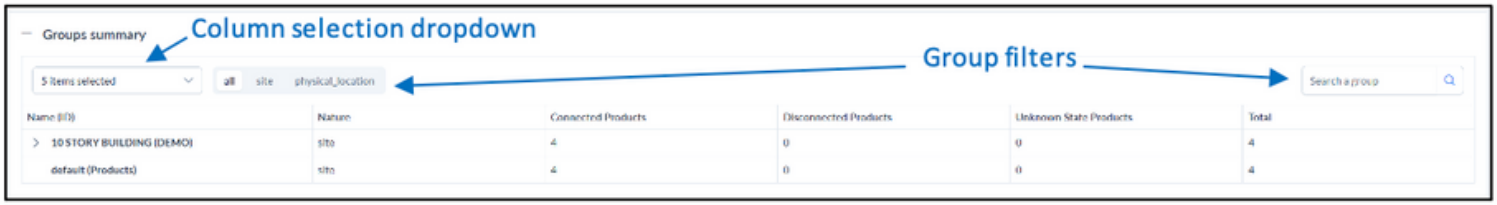
7.1.3.2 Stats

Statistics can be used to see the overall health of the network using different types of graphs. For all the declared Fi-Speed products, it summarizes: their current connection state, how many were connected in the last hour/day/week/month (or more), and their TX and RX phyrates.
It is not possible to see the details of each graph (e.g which products are currently disconnected), that is something for the Products overview page.



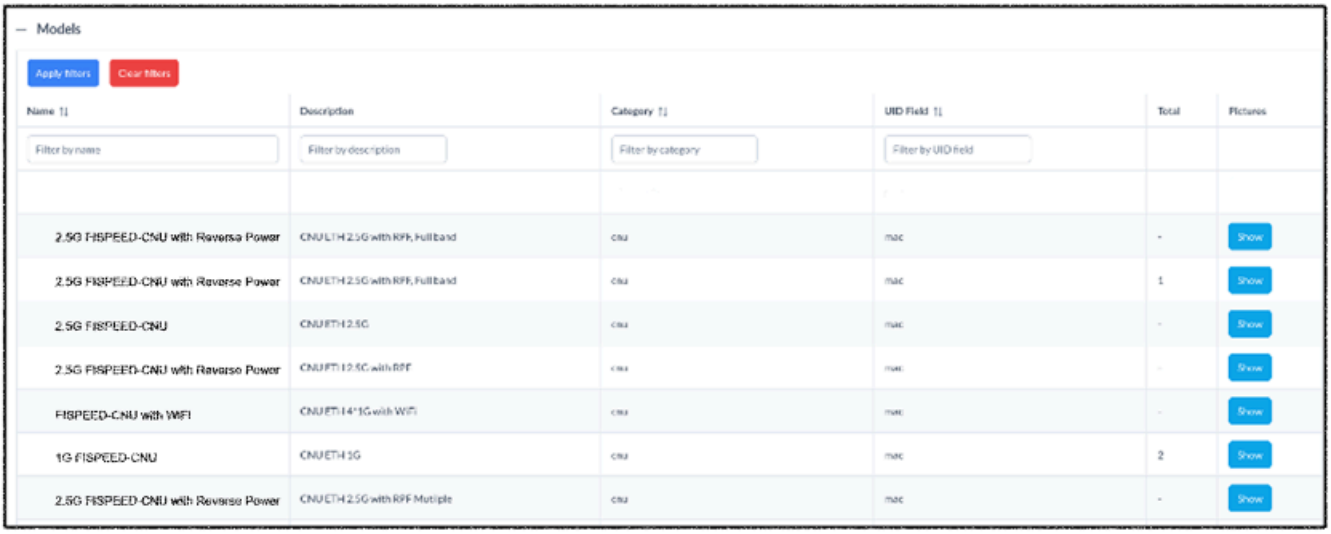
7.1.3.3 Groups summary

The table in this section details the global connection status graph with the products' connection state per group of products.
Groups are displayed in a tree structure, in accordance with their "hierarchy" (i.e. groups and their subgroups). More information about said hierarchy can be found in the Groups & Products page section.



7.1.3.4 Models

Table in this section details information about existing Fi-Speed product models (their names, attributes, category), and the number of products for each of them that are known to the backend.



7.1.3.5 Vendors

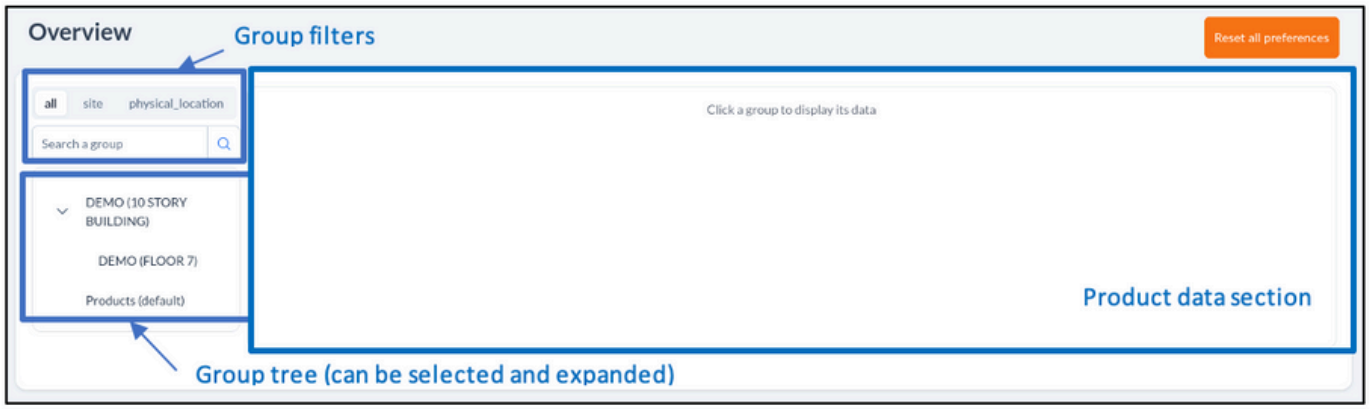
The table in this section details information about different vendors of Fi-Speed products.

7.1.4 Product Overview

The Products Overview page is where detailed status of all of Fi-Speed products can be found. The products themselves are not visible at first, instead all existing groups are displayed in a tree-like structure. Next to group identifiers, a little red icon with a number inside can be visible or not. When visible, it indicates how many products of that group are currently disconnected (i.e not reporting to the NMS).
That indicator can thus be used to detect anomalies quickly and direct user to potential malfunctioning products.

7.1.4.1 Navigation and filters

In this page, users can navigate through different groups which are displayed according to their "hierarchy". Resulting group tree can differ depending on selected group at the top of group navigation bar (see Groups & Products section for more information on the different group natures).
Groups can also be filtered by their names, using search bar above group list.
Only groups at the "base" (visually at the top) of the tree are affected by the name filter, but nature filter affects whole tree.



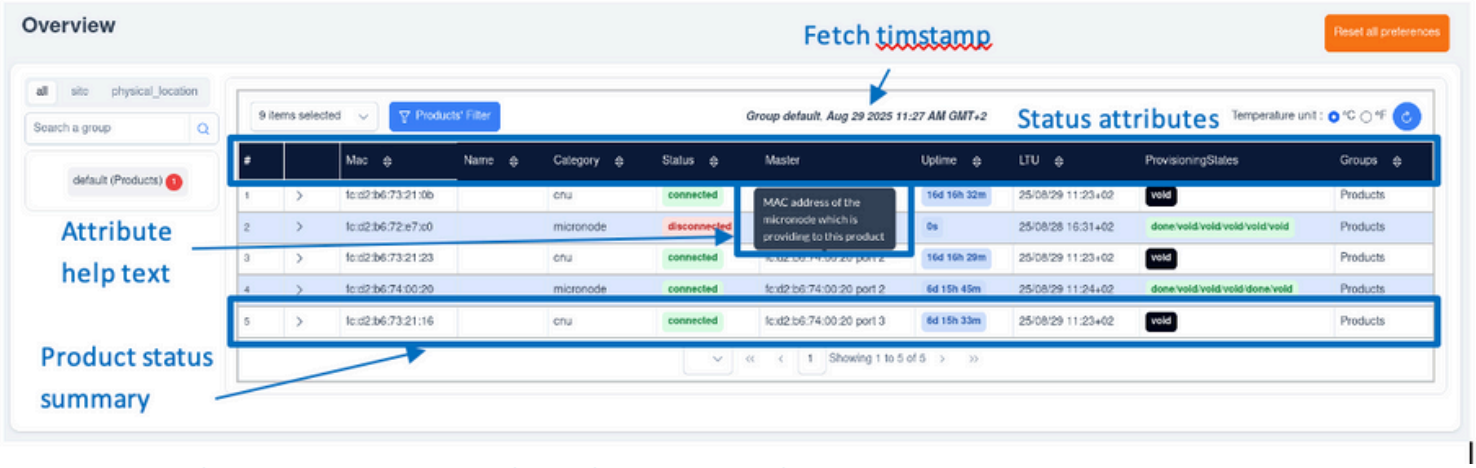
7.1.4.2 Products summary

7.1.4 .2.1 Overview

Once a group is selected, the list of products it contains is retrieved. That list also contains products which belong to subgroups of selected group, allowing user to see a detailed set of products.

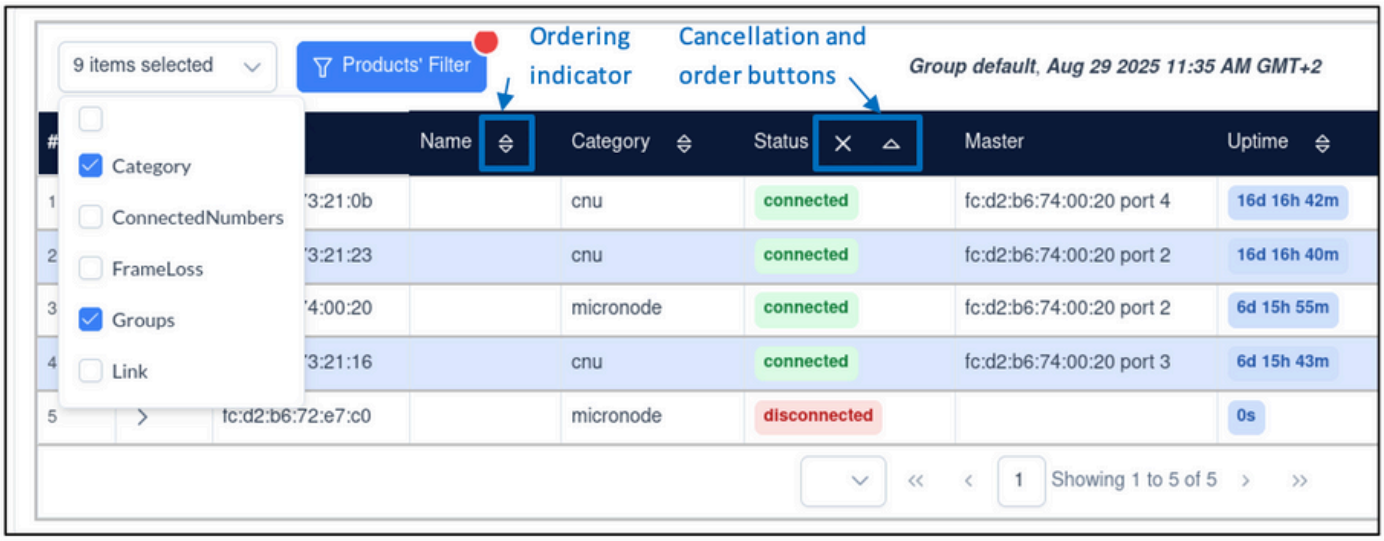
The list is displayed in tabular form: each row represents current "summarized" status of a product, and each column defines summarized attribute of that product's status. Above that list, there is timestamp at which the list was retrieved, used as a reference (e.g. if capturing the table for later analysis). At top right corner above the list, there is a refresh button along with currently selected group's name.

When hovering over a cell, a detailed description of that attribute is displayed, which is particularly useful when the attribute summary is an aggregation of multiple values: for example, summarization of temperatures of a micronode includes temperature for many of its components.

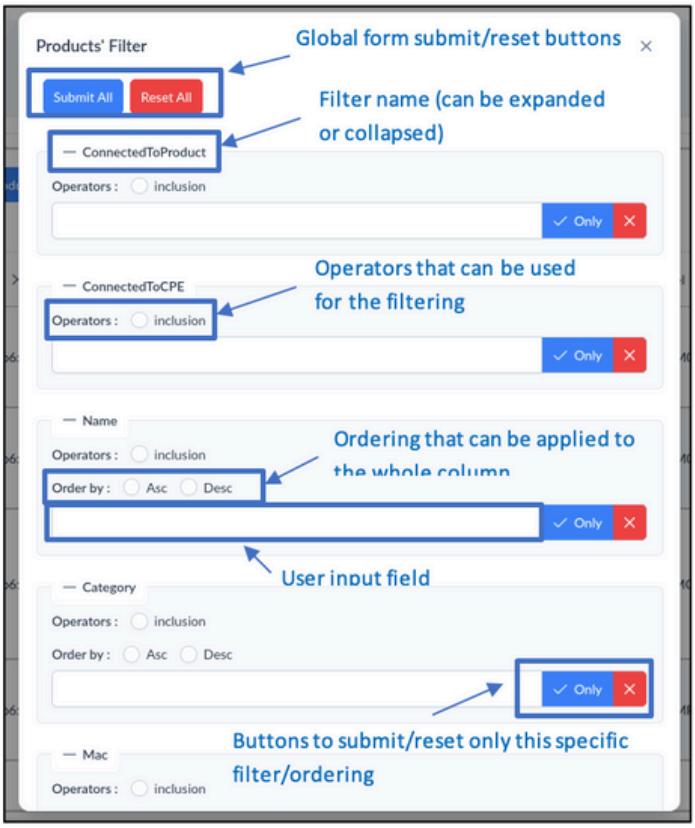


7.1.4.2.2 Display customization and filters

To focus on a few attributes at a time, there is a dropdown list at top left corner above the list, in which the attributes' names can be selected (or deselected), displaying (or hiding) the corresponding columns.
Some columns can be ordered, which is made visible by a small triangle icon next to attribute's name. When an order is active, the order (ascending or descending) is specified by corresponding triangle. It can be "reset" with cross button on the right of the attribute's name.



Next to the column dropdown list, there is a filter button which opens a form-like popup, allowing users to filter the list of products based on different values for different attributes. Although most of the filters correspond to one of the attributes displayed in the summary, some of them allow for more precision (e.g. filtering on CPU temperature among the micronode's temperatures). There are also filters that do not relate to summaries at all, but instead to current topology (e.g. to retrieve all of the products connected to a specific product).



Each filter has one or more available "operators". The selected operator defines how the actual values will be compared to the target value.
In this filter form, the orderable columns also appear as such, with explicit radio buttons to specify ascending or descending order.

To submit the whole form at once (with one or more filter/ordering values), the user should click on the "Submit All" button at the top left corner. To submit only one of the filter/ordering values, the user should click on the "Only" button next to the desired filter input field. This results in ignoring and resetting any of the other filled filters.

To reset the filters (i.e. cancel its effect), the user can do it one filter at a time with cross button next to the filter input field (which keeps the other active filters/orderings), or with the "Reset All" button next to the "Submit All" button (which resets all of the active filters/orderings).

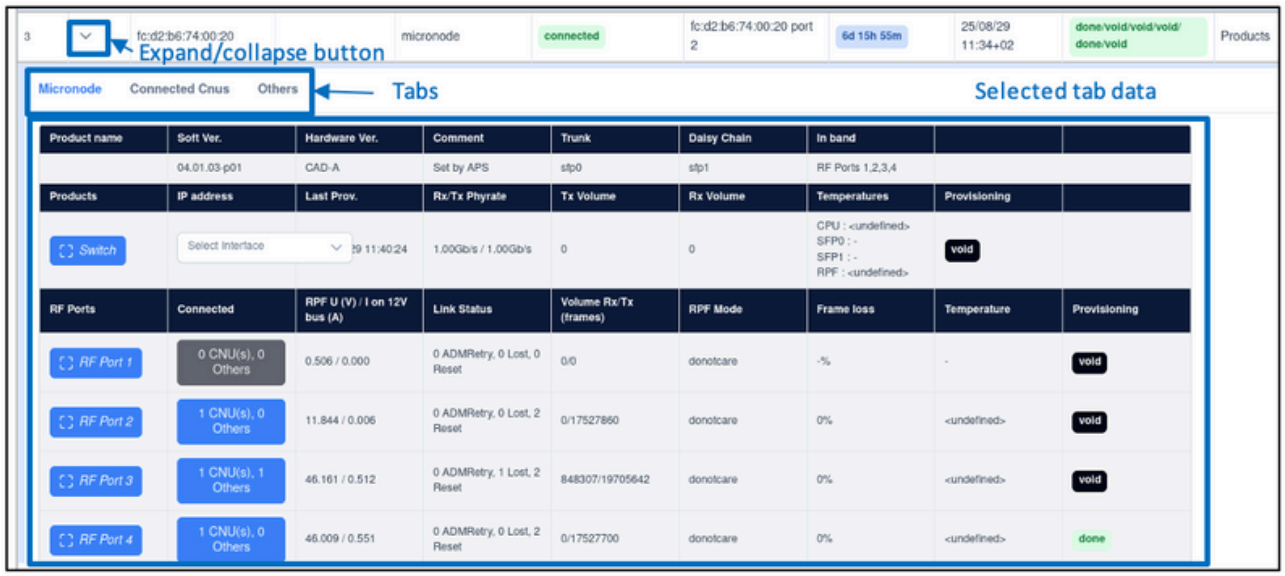
When the product list is filtered/ordered, a small red circle icon is displayed on the Products' filter button. A second "Reset all filters" button is available above the refresh button, and it has the same effect as the "Reset All" button in the filter form.

7.1.4.2.3 Detailed overview

Each row can be expanded to display the product's "detailed overview". Unlike the product summaries which are homogenized, its content depends on category of the product.

Micronode

A micronode's detailed overview contains 3 tabs. The first one describes both its status and some elements of its configuration. Each component (or "(sub)product") of the micronode is visible and has its own status/configuration. Some of the displayed information also appears in the product summary, but in the detailed overview, each information is labelled and distinct.



Some cells' content can be interacted with: