



MoCA® Technology Installation Best Practices for a Home Network



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1 Introduction

1.1 Overview

This document describes the best practices for installation of a Home Network using MoCA® technology. The intended audience is home networking and service provider installers as well as anyone developing methods and procedures for installation of MoCA technology.

The following is a summary of MoCA technology used for installation. Please refer to the MoCA specifications for more detail about design, implementation, testing, and certification.

MoCA® technology is the fastest and most reliable in-home backbone for Wi-Fi® and has been adopted by cable, telco/IPTV and satellite operators worldwide. MoCA 2.0 offers actual throughputs (MAC rate) up to 1 Gbps and MoCA 2.5 is capable of up to 2.5 Gbps actual throughput. MoCA 2.1 and MoCA 2.5 also offer an additional set of network management and security features.

The Alliance has recently entered into the broadband access market targeting MDUs with MoCA Access™. It is based on MoCA 2.0/2.5 and uses the existing coaxial cabling.

The Alliance has 225 certified products and 45 members worldwide.

1.2 MoCA technology, a review

MoCA technology leverages existing coax inside of a home or building. The advantages of using existing coaxial wiring is its prevalence in both homes and offices as well as MDU infrastructures with limited requirements for additional installation of multiple wire types.

MoCA technology also allows for installations with less impact to the homeowner.

MoCA technology occupies unused frequency spectrums.

Finally, MoCA technology offers reliable quality performance suited for transporting high quality, consistent signals and bandwidth. Devices enabled with MoCA technology form a full mesh, peer-to-peer network as shown in Figure 1.

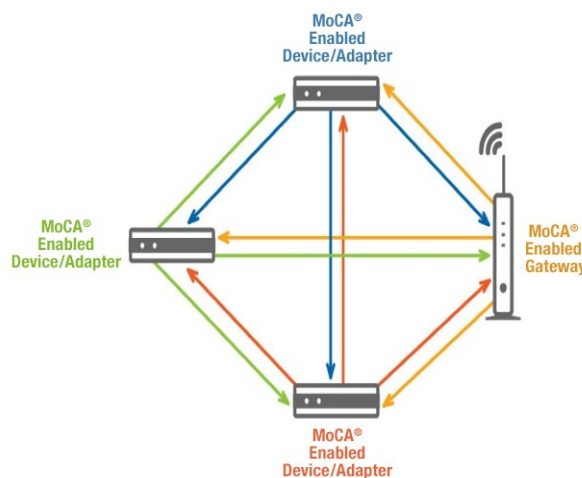


Figure 1 Example MoCA Logical Connection

1.3 MoCA Versions and Profiles

There are three different versions of MoCA technology: MoCA 1.0/1.1, MoCA 2.0, and MoCA 2.5.

Starting with MoCA 2.0 and continuing thru MoCA 2.5, bonded channel options can be utilized for enhanced network bit rates. Table 1 and Figure 2 outline the major differences between different MoCA technologies.

Table 1 Summary of MoCA Versions

Version	Number of Channels Transmitted	Channel Bandwidth (MHz)	Maximum MAC Rate	Maximum Nodes	Bands Supported
1.0	1	50	175 Mbps	8	D, E, F
1.1	1	50	175 Mbps	16	D, E, F
2.0	1	100	500 Mbps	16	D, E, F, Extended D
	2	100	1000 Mbps	16	D, E, F, Extended D
2.5	3	100	1500 Mbps	16	D, E, F, Extended D
	4	100	2000 Mbps	16	D, E, F, Extended D
	5	100	2500 Mbps	16	D, E, F, Extended D

	MoCA 1.0	MoCA 1.1	MoCA 2.0	MoCA 2.0 Bonded	MoCA 2.1	MoCA 2.1 Bonded	MoCA 2.5
Mb/s Actual Throughput	100	175	500	1000	500	1000	2500
Number of Channels Bonded				2		2	3~5
Power Save (Standby and Sleep)							
MoCA Protected Setup (MPS)							
Management Proxy							
Enhanced Privacy							
Network Wide Beacon Power							
Bridge Detection							

Figure 2 MoCA Technology Comparison

1.4 Terms and Definitions

Term	Definition
Amplifier	Any device which increases the amplitude of electrical signals. For MoCA, this generally means an RF amplifier. A UGA is one such amplifier.
AP	Generally a Wi-Fi Access Point. A device which bridges Wi-Fi with either MoCA (WECB) or Ethernet.
Attenuation	How much a signal's amplitude (strength) decreases.
Band D	MoCA frequency range from 1125 MHz to 1525 MHz. Band D is generally used by cable operators to deploy MoCA.
Band D Extended (Extended D)	An extension to Band D added in MoCA 2.0. The frequency range is from 1125 MHz to 1625 MHz.
Band E	MoCA frequency range from 400 MHz to 700 MHz. Band E is generally used by satellite operators to deploy MoCA.
Band F	MoCA frequency range from 650 MHz to 875 MHz. Band F is generally used by satellite operators to deploy MoCA.
Bandwidth	The range of frequencies within a given band, in particular for a transmitted signal.
Bonded Channels	When more than one MoCA channels are utilized together to pass data.
CATV	Community Antenna Television a.k.a. Cable Service Provider
CPE	Customer Premise Equipment – Any device that resides within a customer's home but generally refers to modems and equivalent devices such as gateways.
Coax	Coaxial cable. A type of electrical cable which has an inner conductor surrounded by an insulator and then a shield conductor and an insulating outer sheath. The common coax cable types used with MoCA are RG6 and RG59. RG11 can be utilized but in practice is not used for internal home runs due to its size and lack of flexibility.
dB	Decibel – A method of measuring signals that uses a logarithmic scale. It is a ratio between two signals. The number of decibels is ten times the common logarithm (base 10) of the ratio of two power quantities. A change in power by a factor of 10 corresponds to a 10 dB change in level ($P = 10 \log P_1/P_2$). For electrical voltage or current measurements with a constant impedance, the number of decibels is twenty times the common logarithm (base 10) of the ratio of two voltage or current quantities ($V = 20 \log V_1/V_2$, $I = 20 \log I_1/I_2$).
dBm	Power in decibel relative to 1 mW – Measurement of power. 0 dBm = 1 mW, 10 dBm = 10 mW, 30 dBm = 1W or 1000 mW.
dBmV	Voltage in decibel relative to 1 mV – Measurement of voltage. 0 dBmV = 1 mV, 20 dBmV = 10 mV, 60 dBmV = 1 V or 1000 mV.
Demarcation	The point at which an outside network connects to the home.
Directional Coupler	Similar to a splitter but with different attenuation between the output ports. Generally there is one main output that has little attenuation and a second output that has more attenuation.
DOCSIS	Data Over Cable System Interface Specification – Cable TV's data protocol.
ECB	Ethernet Coax Bridge – a device which bridges between MoCA and Ethernet.
eMTA	embedded Multimedia Terminal Adapter – Device used in CATV for telephone service with in embedded DOCSIS cable modem.
Gateway	Generally, a modem embedded in a home router usually with a Wi-Fi access point.
GCD Bit Rate	Greatest Common Density Bit Rate – A measured bit rate that reflects the actual throughput experienced by that node. It is often available as an SNMP MIB or from a node's status screen.
Home Run	The method of wiring a home so that all cables come to a single location. Also called star wiring.
Impedance	The effective resistance of an electric circuit or component taking into account both the DC resistance and AC resistance (called reactance).
IP	Internet Protocol
Isolation Loss	The signal attenuation between two output ports.

Term	Definition
MAC	Media Access Control. Multiple meanings. • A MAC address is a unique ID assigned to a given device which consists of a vendor ID and a unique number assigned by the vendor. • The MAC layer is responsible for moving data packets to and from devices (nodes in MoCA terminology).
MAC Rate	The MAC rate is the rate of data transfer (as opposed to PHY rate which is the raw bit rate).
MoCA®	Multimedia over Coax Alliance – The technology developed to carry data signals over coaxial cable and the Alliance which develops the specifications and certifies products using MoCA technology. More about the Alliance at www.mocalliance.org . For purposes of this document, MoCA shall be defined as the technology.
MoCA Compatible	Any RF device that can operate with the MoCA network RF signals present but not necessarily be capable of joining the MoCA network.
MoCA Device	Any RF device that is capable of joining a MoCA network. This can include STBs, gateways, ECBs, WECBs, and other devices.
MoCA Privacy	Method of encrypting the data over MoCA between nodes. A common password has to be shared between the connecting nodes.
Modem	Any device which converts data signals to modulated signals.
Node	Any device which connects to a MoCA Network.
Node Controller	Part of MoCA protocols, a controlling node is selected based on several different items including which device has the best connection to all nodes. This node is responsible for control of the MoCA network.
PHY Rate	The raw bit rate utilized on the wire.
POE or PoE Filter	Point Of Entry, aka POE Filter, PoE Filter –A filter which does not allow passage of a selected MoCA band. Usually to isolate the home network from the outside plant network. A POE filter also reflects the selected MoCA signal back into the home network and minimizes port-to-port isolation loss.
Port Isolation	How well ports are isolated from each other. Generally used for splitters and measured as the attenuation (dB) between output ports.
Power	The strength of a signal. This is measured in either dBm (Power) or dBmV (Voltage). Since the coax impedance is 75 ohms, there is a direct relationship between dBm and dBmV in the MoCA world.
RF	Radio Frequency – All electromagnetic frequencies which fall between 3 KHz and 300 GHz.
RG	Radio Grade – Used to categorize different types of coaxial cable (e.g. RG-6).
Service Provider	Any entity that provides video, telephony, and/or Internet data services. Examples are Cable, Satellite, and Telco companies but can also include universities, municipalities, schools, government, utilities, and others.
SNR	Signal to Noise Ratio – Measure in dB, this is ratio of the signal level to the noise level. This is a critical measurement for determining signal quality.
Splitter	A device which is used to split an RF signal to two or more devices.
STB	Set-Top Box – Any device which supplies video and audio signals to a television. These generally are cable, satellite, or IP inputs.
Telco	Telephone Company Service Provider
UGA	Unity Gain Amplifier – an amplifier which incorporates a splitter so that the signal outputs of the splitter ports are the same signal level as the input.
UI	User Interface – Main types are a Command Line Interface (CLI) and a Graphical User Interface (GUI). A browser based GUI is sometimes called a WUI (Web User Interface).
WECB	Wi-Fi Ethernet Coax Bridge – a bridge which converts between Wi-Fi, Ethernet, and/or MoCA, in any combination.

2 Key MoCA Parameters

The following is a description of the key MoCA parameters with respect to installation.

2.1 Frequency

2.1.1 Frequency Bands

There are three frequency bands selected by the service provider: D, E, and F. MoCA 2.0 introduced an extension to Band D called Extended D.

Table 2 MoCA Frequency Bands

Band	Lower Frequency	Upper Frequency	General Use
D (MoCA 1.0/1.1)	1125 MHz	1525 MHz	Cable
Extended D (MoCA 2.0/2.5)	1125 MHz	1675 MHz	Cable
E	400 MHz	700 MHz	Satellite
F	650 MHz	875 MHz	Satellite

2.1.2 MoCA Channels

MoCA defines certain frequencies as being assigned to MoCA channels. Any bonded channels are required to be adjacent to each other. There are additional restrictions for certain channels regarding bonded channels. Please refer to:

http://www.mocalliance.org/MoCA2/specification/MoCA_2.0_and_2.5_Device_RF_Characteristics-160808d.pdf

Table 3 Band D Channel Frequency Assignment

Band	Channel Number	Frequency	MoCA Version
Band D	D1	1150 MHz	1.1
	D1a	1175 MHz	2.0,2.5
	D2	1200 MHz	All
	D2a	1235 MHz	2.0,2.5
	D3	1250 MHz	All
	D3a	1275 MHz	2.0,2.5
	D4	1300 MHz	All
	D4a	1335 MHz	2.0,2.5
	D5	1350 MHz	All
	D5a	1375 MHz	2.0,2.5
	D6	1400 MHz	All
	D6a	1435 MHz	2.0,2.5
	D7	1450 MHz	All
	D7a	1475 MHz	2.0,2.5
	D8	1500 MHz	All
	D8a	1535 MHz	2.0,2.5
	D9	1550 MHz	All
	D9a	1575 MHz	2.0,2.5
	D10	1600 MHz	All
	D10a	1635 MHz	2.0,2.5

Table 4 Band E Channel Frequency Assignment

Band	Channel Number	Frequency	MoCA Version
Band E	EE1	450 MHz	2.0/2.5
	EE2	475 MHz	2.0/2.5
	E1	500 MHz	All
	E2	525 MHz	All
	E3	550 MHz	All
	E4	575 MHz	All
	E5	600 MHz	All
	EE3	625 MHz	2.0/2.5
	EE4	650 MHz	2.0/2.5

Table 5 Band F Channel Frequency Assignment

Band	Channel Number	Frequency	MoCA Version
Band F	F1	675 MHz	1.1
	F2	700 MHz	All
	F3	725 MHz	All
	F4	750 MHz	All
	F5	775 MHz	All
	F6	800 MHz	All
	F7	825 MHz	All
	F8	850 MHz	1.1

2.2 PHY Rate

The PHY (or Physical) rate is the raw bit rate. It is the single most important parameter for determining if there is a good MoCA connection between two devices. The PHY rate is dependent on the power level and signal to noise ratio (SNR) across the channels.

It is important to note that each possible connection between MoCA devices may have a different PHY rate. For example, Figure 3 shows a MoCA node with four MoCA devices (W, X, Y, and Z), with the six PHY rates calculated by the nodes:

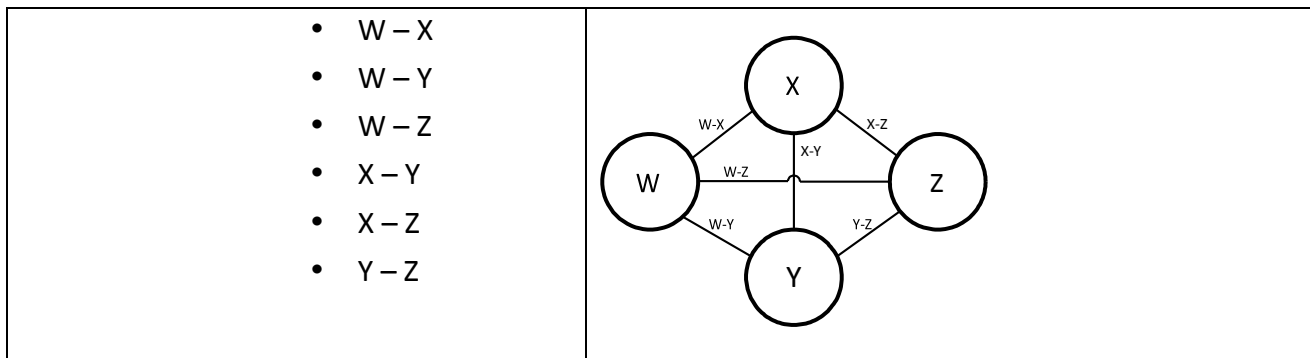


Figure 3 MoCA 4-Node PHY Rate Example

The service provider should designate a minimum acceptable PHY rate for their system based on the application. For example, if only STBs are utilized, then the minimum PHY rate could be the maximum streaming video bitrate times the maximum number of streaming video plus some additional overhead. If Internet Data is utilized, then the minimum PHY rate could be the

expected maximum PHY rate. Please check with your service provider for the lowest acceptable PHY rate.

Table 6 shows the maximum PHY rates for the different MoCA versions and profiles.

Table 6 Expected Maximum PHY Rates

Version	Band	Channels	ExpectedMaximum PHY Rate ¹¹ (Mesh)
1.0/1.1	D	1	225 Mbps
	E, F	1	240 Mbps
2.0	D, ExtD, E, F	1	600 Mbps
		2	1200 Mbps
2.5	D, ExtD, E, F	1	600 Mbps
	D, ExtD, E, F	2	1200 Mbps
	D, ExtD	3	1800 Mbps
	D, ExtD	4	2400 Mbps
	D, ExtD	5	3000 Mbps

NOTE: There is a mode in MoCA 2.0 called Turbo mode, which exists when there are only two MoCA devices present. When this is recognized, some of the overhead transactions are removed thereby giving a 12% increase in PHY rate.

2.3 Power

This is the strength of the MoCA signal, both transmitted and received. The received power is dependent on the attenuation between the transmit device and the receive device.

The power values give a good indication of the quality of the signal between different MoCA devices which relates directly to the PHY rate.

2.3.1 Transmit Power

MoCA performs a ranging function such that the power level transmitted from one node to another node is dependent on the attenuation. The highest level is the Maximum Output value which has a wide range due to manufacturing issues. Table 7 outlines the different power levels for the different versions and profiles of MoCA.

Table 7 Summary of MoCA Transmit Power

Version	Number of Channels Transmitted	Channel Bandwidth (MHz)	Maximum Output Power per Channel	Maximum Output Power Total for all Transmitted Channels
1.0/1.1	1	50	-1 dBm to +7 dBm	-1 dBm to +7 dBm
2.0	1	100	-3 dBm to +5 dBm	0 dBm to +8 dBm
	2	100	-4.5 dBm to +3.5 dBm	+0.3 dBm to +8.3 dBm
2.5	3	100	-5.3 dBm to +2.7 dBm	+0.7 dBm to +8.7 dBm
	4	100	-6 dBm to +2 dBm	+1 dBm to +9 dBm
	5	100	-1 dBm to +7 dBm	-1 dBm to +7 dBm

2.3.2 Receive Power

¹¹ Actual value may be higher depending on vendor implementation. These values are the minimums required by the MoCA specifications.

The minimum PHY rate for a MoCA device is dependent on a minimum signal level at the channel frequency as well as the SNR. Signal levels below this rate will still communicate but at a lower PHY rate. For an explanation of dBmV and dBm, please refer to section 5.1

The minimum signal level to meet the minimum PHY rate is dependent on the frequency band as shown in Table 8.

Table 8 Minimum Receive Power

Version	Band	Minimum Receive Power	PHY Rate
1.0/1.1	D	-51 dBm (-2.25 dBmV)	225 Mbps
	E, F	-49 dBm (-0.25 dBmV)	240 Mbps
2.0	D	-44 dBm	600Mbps/Channel
	E, F	-43 dBm	600Mbps/Channel
2.5	D, E, F	-42 dBm	650Mbps/Channel

2.4 Physical Medium & Devices

2.4.1 Coax

Coaxial cable, also called coax, is any cable that consists of an inner conductor surrounded by insulation, a shield conductor, and an insulating jacket.



Each type of coax cable is designed to provide a characteristic impedance. For the purposes of MoCA discussion, only 75 ohm cable is utilized.

There are three main types of 75 ohm coax typically utilized in MoCA deployments:

- RG-6 – Most common used today for in-home wiring, very flexible with relatively low attenuation.
- RG-11 – Larger and less flexible than RG-6, primarily used for outside wiring, lowest attenuation.
- RG-59 – Smallest of the common 75-ohm coax cables, rarely used for new installations, highest attenuation.

The most important consideration for a good MoCA connection is attenuation, especially in the coax cable. The attenuation is dependent on the type of cable, the MoCA channel frequency, and the length of cable. Table 9 can be used to calculate the attenuation.

Table 9 Typical Coax Cable Attenuation at 1 GHz per 100 ft.²

MoCA Frequency Band	RG-6	RG-11	RG-59
D	6.6 dB	4.3 dB	8.1 dB
Ext D	8.3 dB	5.1 dB	10.5 dB
E	4.7 dB	3.0 dB	5.9 dB
F	5.6 dB	3.4 dB	7.0 dB

For example, MoCA 1.1 specification design parameters were designed to support a maximum length of 300 feet of cable. However, silicon vendors have stated that a longer length can be supported with their products. Please discuss with the device's vendor to determine if a length greater than 300 feet can be supported.

2.4.2 F- Connectors

F-Connectors provide either the mechanical and electrical coupling between the coax cable and the MoCA Device, or the connector and an adaptor. A common adaptor is female to female (commonly called a bullet) that is used in wall plates within homes.



Example of bullet F-Connector



Example of RG-6 F-pin Connector

It is important that the F-connector be installed correctly on the coax cable (installation is outside the scope of this document). In addition, the bullet adaptors need to be of a good quality as poor quality adaptors have caused installation issues, especially with vibration such as the customer walking in the area causing momentary loss of signal.

2.4.3 Splitters

A splitter is a device which splits the RF signal into two or more outputs. One of the key functions is that the impedance is kept the same for the input and outputs, which necessitates circuitry which has a frequency range. It is important for good MoCA connectivity that a splitter with adequate frequency range be utilized.

The splitter installation has an input port and multiple output ports as shown in Figure 4.

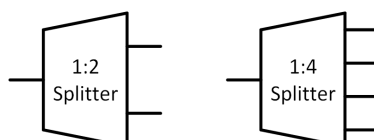


Figure 4 Example of 1:2 and 1:4 Splitters

The attenuation between the input and the output ports for a 2-port splitter is ~3.5 dB within the frequency range of the splitter as shown in Table 10. NOTE: Each splitter vendor and model has different attenuation. The numbers here represent a typical value.

² Actual attenuation is dependent on the cable manufacturer. Please check with the cable manufacturer for their values.

Table 10 Typical Splitter Attenuation³

	Input to Output Attenuation	Output to Output Attenuation (Port Isolation)
1:2	3.5-4.5 dB	20-40 dB
1:3	5.6-7.2 dB	20-40 dB
1:4	7.0-9.0 dB	20-40 dB
1:8	10.5-13.5 dB	20-40 dB

Note that some 3-way splitters are made up of two 2-way splitters so one output will have 3.5-4.5 dB attenuation and the other two outputs will have 7-9 dB attenuation. Other 3-way splitters will have the same attenuation of 5.7 dB across all outputs. Not all splitters are the same so care must be taken when calculating the attenuation. This is true for any odd number of outputs splitter.

Since MoCA signals will have to traverse between the different output ports on a splitter, port isolation needs to be known when calculating the attenuation between two MoCA devices. Port isolation is the attenuation between the output ports and typically is 20 dB or more. The port isolation loss can be offset by use of a POE filter (see section 2.4.5).

2.4.4 Directional Coupler

A directional coupler (also called line tap or tap) is similar in function to a splitter except that the outputs are not equal. It is generally used if one device cannot tolerate a lower signal while another device can tolerate more attenuation. For example, a directional coupler might have one output which has 2.2 dB attenuation and the other output has 12 dB attenuation (the tap).

2.4.5 POE Filter

A POE filter for MoCA Band D is a low pass filter which passes signals below 1 GHz and filters out signals above 1 GHz. They are specified with an attenuation for signals > 1 GHz. For MoCA, the range is usually between 30 and 50 dB for signals above 1 GHz.

A POE filter performs two functions:

1. It blocks the MoCA signal from output connections, i.e. it isolates the home network to the home.
2. It reflects RF signals above 1 GHz back into the home network. This helps to increase the MoCA signal level available within the home network.

A POE filter can be thought of as a mirror to any frequencies above 1 GHz where it blocks them from going past it and reflects them back into the home network.

The advantage is that a MoCA signal going from an output port to another output port on a 2-port splitter without a POE filter will have the port isolation loss of typically 20 dB. But if a POE filter is installed on the input port of the splitter, the reflected signal would only have a 7 dB loss (3.5 dB from output port to input, then 3.5 dB from input port to output port after being reflected by the POE filter)

Some older cable modems and STBs may have performance issues when in the presence of a MoCA signal. A POE filter installed in front of these devices will prevent these issues.

³ Values used are typical. Please refer to the splitter vendor for exact values.

2.4.6 Amplifiers

There are amplifiers made specifically for MoCA compatibility. These amplifiers are typically UGA (Unity Gain Amplifiers) which generally contain an input port, a splitter port from the input port intended for a eMTA in that requires connectivity even if power is removed, an amplifier to boost the signal⁴, and an the 8-way splitter. All output ports have the same signal level as the input port, and an in-line POE filter on the amplifier output. The upstream is generally passively passed to the input port.

A MoCA signal will typically see between 7 dB to 21 dB attenuation between output ports, depending on the amplifier design.

CATV amplifiers that are not designed for MoCA generally create excessive attenuation for the MoCA signals. These are not recommended to be in-line with a MoCA network.

NOTE: Not all UGAs are designed with MoCA in mind. Please consult with the device specifications to ensure they are MoCA compatible.

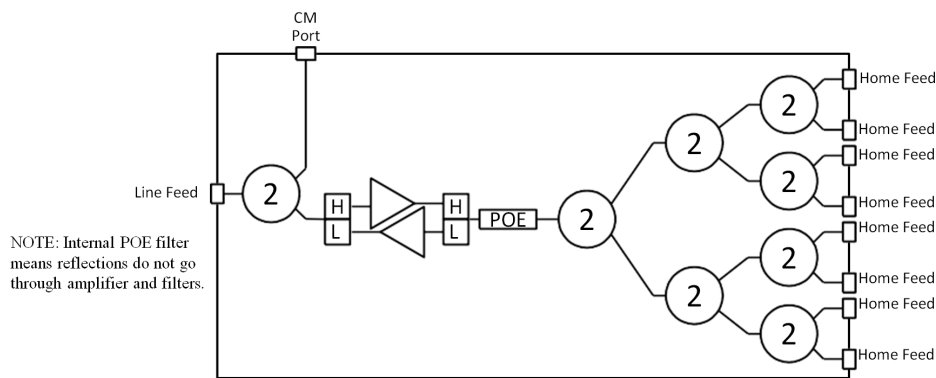


Figure 5 Unity Gain Amplifier (UGA)

3 Installation Practice

The following are suggested best practices for MoCA installation. Each service provider is expected to develop their own methodology based on their provisioning and diagnostic systems as well as internal processes.

3.1 Installation Summary

Installation consists of 4 items:

- Location and Wiring
- POE Filter Installation
- MoCA Node Installation
- Verification

⁴ Telephone equipment, such as an eMTA, is required to be operational during power outages for a certain period of time, generally 8 hours. During the power outage, the equipment is either powered by a battery or is network powered. For CATV systems, the eMTA is powered by a battery.

3.1.1 Location and Wiring

3.1.1.1 Location Analysis

Make a determination on where the MoCA devices need to reside. For example, if the MoCA device is a STB, then it will be located by the television. If it is a Wi-Fi access point (AP), and if wiring already exists in the general area of the desired location of the AP, it is suggested that it be placed there.

3.1.1.2 Wiring Determination

It is strongly suggested that a “Home Run” method be utilized for wiring multiple MoCA devices. This consists of bringing all the MoCA devices wiring to a single point in the house, usually near the demarcation point. This minimizes the attenuation differences between MoCA devices and is easier to diagnose if there is a problem.

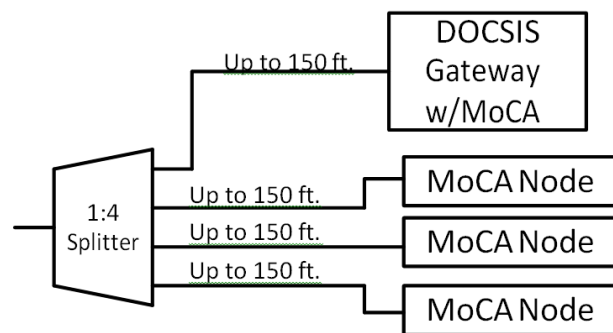


Figure 6 Example of Home Run Wiring

It is acceptable to have two MoCA devices at the end of a run if the RF levels are adequate for both devices (this includes both MoCA and any other RF requirements such as DOCSIS or satellite levels). This might be the case where a directional coupler is desired over a splitter. For example, if a STB utilizes DOCSIS signal levels, a splitter might reduce the DOCSIS signal level to below usable values whereas a directional coupler will allow for acceptable DOCSIS signal levels and a good MoCA connection to both devices.

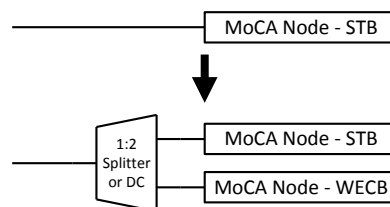


Figure 7 Example of Adding a 2nd Device

3.1.1.3 RF Amplifiers

RF amplifiers which are not MoCA compatible need to be outside the MoCA network, isolated by the POE filter. RF amplifiers, usually UGAs, which are MoCA compatible generally include their own POE filter. Please verify with the RF amplifier vendor prior to installation. Please refer to section 2.4.6 for more information on RF amplifiers.

3.1.1.4 Wiring Installation

The following are suggested for installation:

1. Utilize a Home Run wiring method
2. Allow for two MoCA devices to be on the same wiring run
 - a. Utilize a splitter if non-MoCA signal levels allow
 - b. Utilize a directional coupler if non-MoCA signal levels do not allow a splitter
3. Minimize the cable length. If the cable length between any two nodes is >300 feet, connect with RG-6 or RG-11 cable and verify correct PHY rates. Recommend calculating the attenuation prior to wiring to determine which cable to utilize, or if a separate MoCA network needs to be created (see section 3.7).

Select the appropriate coax cable type (see section 3.2).

3.1.2 POE Filter Installation

The POE filter is required to prevent MoCA signals from leaving the house as well as act as a reflector back into the house to give better connectivity. The following rules are suggested for POE filter installation:

1. Place the POE filter at the demarcation point, after any RF amplifier output
 - a. Ensure that any non-MoCA compatible RF amplifier is outside of the MoCA network (see Figure 10)
2. If an older cable modem, gateway, or STB exists, a POE filter might be required in front of the device to prevent issues with the MoCA signals. Please check with the vendors.
 - a. Note that newer gateways support MoCA and should never have POE filter installed in front of them. Please check with the vendor if there are any questions.

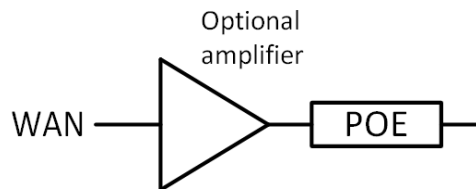


Figure 8 Typical POE Filter Installation

3.1.3 MoCA Node Installation and Verification

Connect the MoCA node devices, then verify that the PHY rates are acceptable. This can be done either on a diagnostic screen on the device or utilize the service provider tool which reads the values using either SNMP or TR-069/TR-181.

3.2 Coax Cable Selection

When possible, RG-59 coax cable should not be used due to the higher attenuation. RG-11 can be difficult to utilize within a home due to its inflexibility even though it has the lowest attenuation. Therefore, RG-6 is recommended for in-home wiring as the best compromise between attenuation and ease of installation. (See section 2.4.1)

3.3 Frequency Selection

The frequency used by a service provider might be fixed and not agile. In general, the lower the frequency selected then the less attenuation through the coax cable. Splitter and directional coupler frequency ranges should be selected to pass the selected frequency with minimal attenuation.

3.4 POE Filter Selection

The primary purpose of the POE filter is to keep the MoCA signal within the home and most importantly, not to establish a connection with an adjacent home. Since both homes will have a POE filter, the POE filter attenuation will double. For example, if a 30 dB POE filter is selected, there will be a 60 dB attenuation between two homes just from the POE filters and ignoring the tap and coax cable attenuation.

The service provider will need to determine if greater attenuation is required to prevent MoCA signals from accessing the outside plant or an adjacent home.

3.5 Splitter Selection

The primary factor to consider is the frequency bandwidth of the splitter. If band E or F is utilized, then to pass MoCA, a 1 GHz splitter is sufficient (NOTE: There can be other requirements, such as in a Satellite system, which require a higher bandwidth such as 2 GHz). If band D is utilized, then a 2 GHz splitter is suggested, especially as MoCA is expected to use even higher frequencies in the future.

3.6 MoCA Compatible Amplifiers

Any non-MoCA amplifier needs to be outside the MoCA network. Only MoCA compatible amplifiers should be installed within the MoCA home network.

3.7 Corner Cases

While there are a number of different corner cases, the most common ones are premises which require a long cable run and those that have many nodes.

3.7.1 Long Cable Run

If there is a need to have a node at the end of a long cable run, such as to connect up a guest house, barn or a very large house, and it is connected to the local MoCA network there can be a problem with RF signal levels. The proposed solution is to create a separate MoCA network just for the cable run by utilizing two ECBs (Ethernet Coax Bridge) as outlined in Figure 9. Note that because no STBs exist which require other RF signals, the extension design is fairly simple.

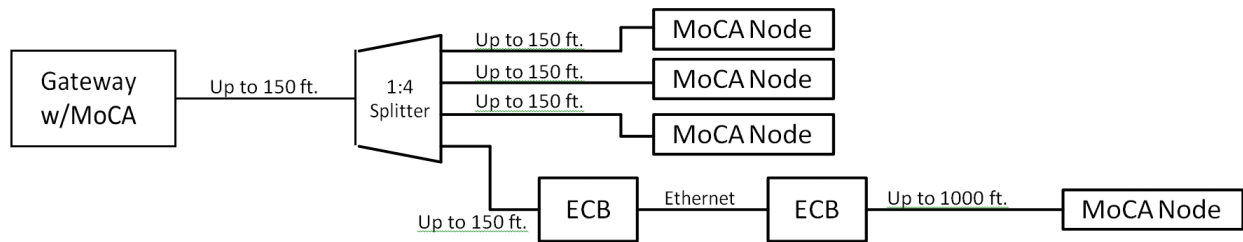


Figure 9 Long Cable Run without STBs

In the event that RF signals are required for STBs, then the diagram in Figure 10 shows the connection. This assumes that the MoCA Node does require non-MoCA RF signals, such as a STB that includes MoCA technology.

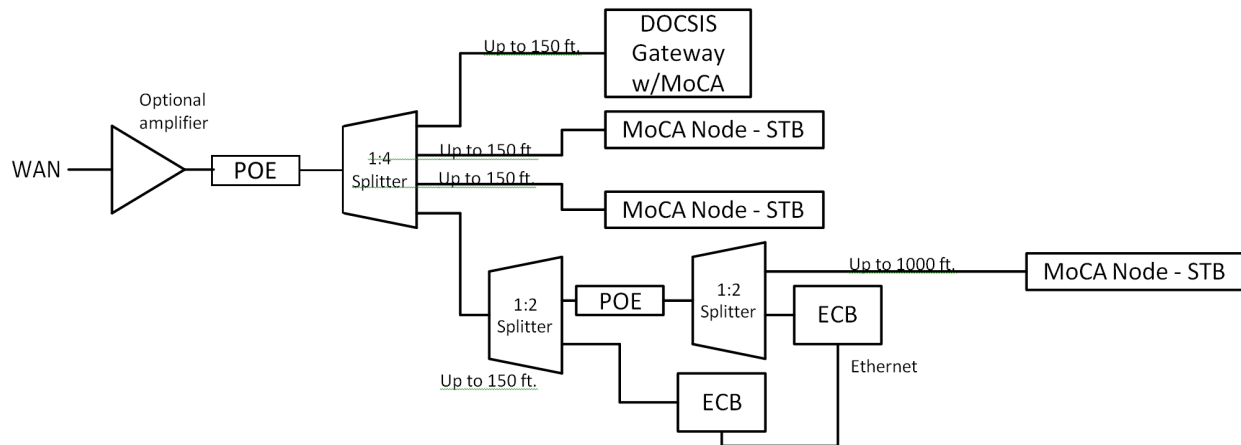


Figure 10 Long Cable Run with STB

3.7.2 Multiple MoCA Networks

There are cases where multiple MoCA networks should be installed:

1. When there is insufficient RF signal level given the length and type of coax cable as well as the number of splitters for all MoCA devices
2. The MoCA technology has a limit of 16 nodes and there is a need for more MoCA devices

The best solution is to set up multiple MoCA networks within the home utilizing ECBs. If there are other RF signals, such as in a satellite or cable system, care must be taken to be sure that the MoCA networks are sufficiently isolated which might require having a high attenuation POE filter or two POE filters in series to ensure the networks are isolated.

Figure 11 shows an example of wiring up 28 MoCA nodes in four different MoCA networks within a premise. This diagram assumes that the MoCA nodes require non-MoCA RF signals, such as STBs with MoCA.

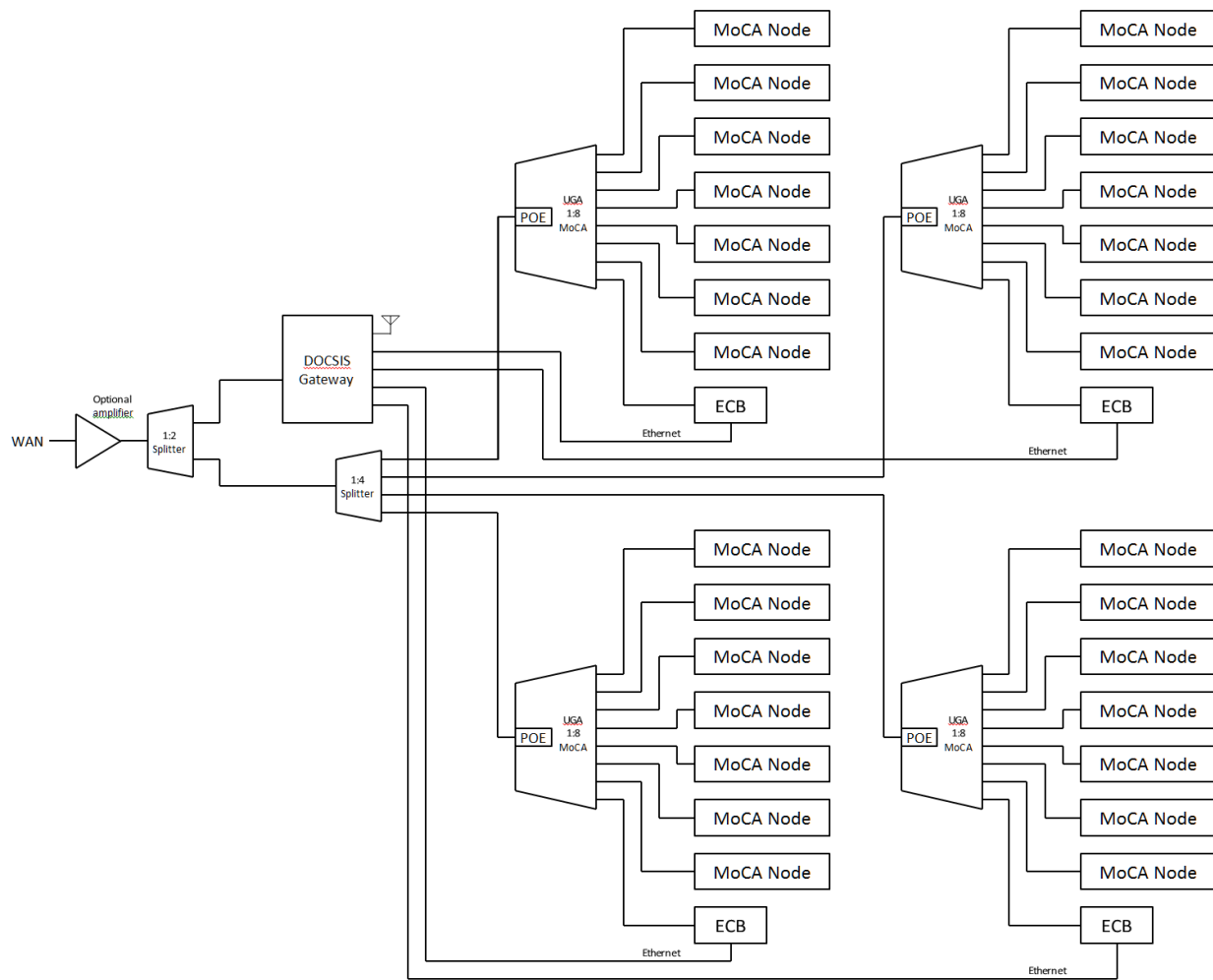


Figure 11 Many Nodes

Figure 12 is an example of wiring multiple nodes if there are no other RF signals, such as when there are no STBs.

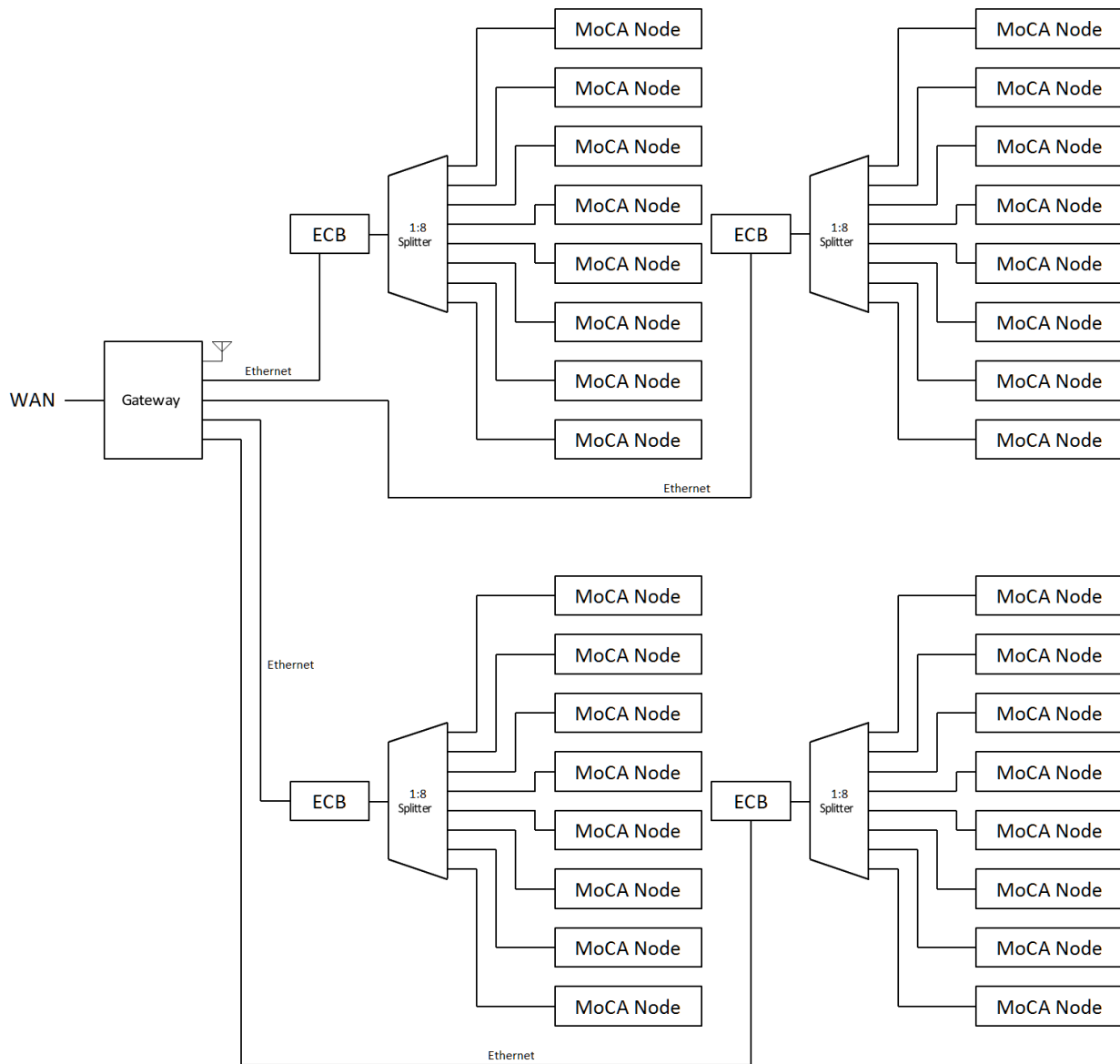


Figure 12 Many Nodes without STBs

4 Troubleshooting

Most MoCA installs have no issues that can be tied directly back to MoCA technology. If there is an issue, it's likely to be found in the home wiring or some other piece of equipment such as a hidden amplifier. This section provides you with tips for troubleshooting those situations.

MoCA technology relies on the impedance quality of the coaxial home drop system and the host or terminal devices. Improper home network configurations can negatively impact a MoCA network. Resolving impairments is easy so long as you know what to look for in a MoCA network.

The best method of troubleshooting a MoCA network is to first use the MoCA device diagnostics and read the PHY rate of the MoCA devices.

If the PHY rate is not present (i.e. device is not connecting to the MoCA network), then either the connection is open or there is too much attenuation. Severe impedance and mismatches in the coaxial drop system can negatively impact a MoCA network.

Steps to follow:

1. Verify the continuity of the coax cable
2. Ensure that the F connectors are properly installed (e.g. center conductor is of sufficient length)
3. Ensure that splitters are correctly installed
4. Ensure that POE filters are correctly installed

After verifying the home is configured correctly, start by looking for cable and connector deficiencies in the network. Remember, once two MoCA technology enabled devices are connected together, a MoCA network in the home is formed.

If the PHY rate is present but low then there is most likely too much attenuation in the network. Any extreme breaks, bends, or gaps in the network will cause impedance changes. A low PHY rate can occur because of a splitter being incorrectly installed, bad connection, or that the network needs to be segmented (see section 3.7.2). Impedance mismatch could be in-between any of the MoCA enabled devices

Interference problems can also occur if the wrong band is used. Check with the service provider to determine which band should be used. (see section 2.1).

The key is to review those connected MoCA technology enabled devices with the lowest PHY Rate signal path. The devices with the lowest PHY Rate paths can be located using the MoCA enabled device's diagnostic tools.

Steps to follow:

1. Ensure that splitters are correctly installed
2. Ensure that F connectors are properly installed and tight
3. Ensure that POE filters are properly installed
4. If RG-59 coax cable is utilized, upgrade to RG-6

Calculate the attenuation to determine whether the network needs to be segmented

Troubleshooting Tips

1. A POE Filter must be present and installed before any Splitter or Unity Gain Amplifier (UGA) set-ups; as close as possible to the centrally located Splitter, UGA, or Ground Block.
2. Configure coaxial network (Splitters and UGAs) in a centrally located network. Always, minimize daisy chained and loop-system splitter configurations when at all possible.
3. Begin troubleshooting at Devices with the poorest PHY Rate signal paths. Note that devices have In/Out paths.

5 Appendix

5.1 Power – dBm to dBmV Conversion

Power is measured in dBm. Since the coax cable, splitters, amplifiers, and devices utilize a fixed impedance (75 ohms), for MoCA circuits there is a direct relationship between dBm and dBmV. Either might appear on device diagnostic readouts.

The conversion between the two is:

$$\text{dBmV} = 48.7506 + \text{dBm}_{75\Omega}$$

$$\text{dBm}_{75\Omega} = \text{dBmV} - 48.7506$$



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