Basic MoCA

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Cable TV Pioneers
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Square Pegs in Round Holes

When you need to make a data connection…

…but you are only wired for coax.
Using Mocha in the home

MoCA, not Mocha!
What is MoCA?

MoCA (Multimedia over Coax Alliance) is a collection of hardware and content providers, working in conjunction to promote and specify the delivery of video and information over in-home coaxial cable.

Specifically, the MoCA protocol is an Ethernet over coaxial cable technology that is used to “network” audio/video devices in the home, using primarily existing in-home coaxial TV cabling.
Why use MoCA?

90% of homes in North America already have coax installed to at least some of the TV sets in the home

The use of coaxial cable ensures a high level of shielding, providing immunity to interference and noise (especially when compared to Wi-Fi)

MoCA is compatible with cable modem networks as it occupies bandwidth above the standard HFC frequency range

MoCA provides the necessary throughput for transporting multiple data streams carrying multimedia content
MoCA in the home

- Ethernet
- Video
- Coax with RF & Data

Wi-Fi Repeater → MoCA Adaptor → MoCA client STB → TV
- or -
MoCA Adaptor → Smart TV

- or -
MoCA enabled DVR → PC
- or -
MoCA enabled Modem/Router
- or -
MoCA Adaptor

MoCA capable splitter or amplifier

Tap
RFoG
MoCA enabled IP ONT
Whole Home DVR

- Ethernet
- Video
- Coax with RF & Data

- Tap
- RFoG
- MoCA enabled IP ONT

- MoCA Enabled DVR
- MoCA enabled Modem/Router
- MoCA Adaptor

- Wi-Fi Repeater
- MoCA Adaptor
- MoCA client STB

- TV
- Smart TV

- PC
- Modem / Router

- ground block
- MoCA capable splitter or amplifier
Wi-Fi Extension

- Ethernet
- Video
- Coax with RF & Data

- Wi-Fi Repeater
- MoCA Adaptor
- MoCA client STB
- TV
- MoCA Adaptor
- Smart TV

- MoCA enabled DVR
- MoCA enabled Splitter or Amplifier
- MoCA enabled Modem/Router
- MoCA Adaptor

- Tap
- RFoG
- MoCA enabled IP ONT

- ground block
DLNA Media Player

- Wi-Fi Repeater
- MoCA Adaptor
- MoCA client
- STB
- Modem / Router
- MoCA Adaptor
- Smart TV
- MoCA enabled DVR
- MoCA capable splitter or amplifier
- MoCA enabled Modem/Router
- Modem / Router
- MoCA Adaptor

Network Connections:
- Ethernet
- Video
- Coax with RF & Data
- Tap
- RFoG
- ground block
- MoCA enabled IP ONT
MoCA Basics

MoCA 1.1
- MoCA 1.1 provides 175 Mbit/s net throughputs (275 Mbit/s PHY rate) and operates in the 500 to 1500 MHz frequency range.
- The Alliance publishes a list of certified products on their home page.

MoCA 2.0
- MoCA 2.0 supports two performance modes, Basic and Enhanced, with 400 Mbit/s and 800 Mbit/s net throughputs (MAC), using 700 Mbit/s and 1.4 Gbit/s PHY rates, respectively.
- Turbo Mode yields 1Gbit/s net throughput.
- Operating frequency range is 500 to 1675 MHz.
- Packet error rate is 1 packet error in 100 million.
- MoCA 2.0 also offers lower power modes of sleep and standby and is backward interoperable with MoCA 1.1
MoCA 1.1 Attributes

Eight 50 MHz RF channels, 1125 to 1525 MHz

Each channel has;

• 256 sub-bands, 224 occupied OFDM (orthogonal frequency-division multiplexing) plus guard bands
• Each sub-band goes from BPSK (binary phase-shift keying) to 256 QAM in near real time
• Channel 1 (1125-1175) is most likely choice, can be made a requirement via addressable set top controls
MoCA 1.1 Attributes

System operation

• 175 Mbps throughput (target PHY rate of 270 Mbps)
• Demonstrated operation to 57 dB dynamic range
• Transmitter lowers power when link exceeds target rate
• Beacon always at maximum output power (56 dBmV)
  (The beacon contains basic information that is necessary for new devices to join the network.)
  • Some MSOs are considering lowering the beacon to 40 dBmV, which also reduces the link budget to 41 dB, due to concerns with overdriving the input to non-MoCA enabled devices with the high beacon carrier level
• Up to 16 devices on the in-home network
## MoCA 2.0 Changes

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<th>Details</th>
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<td>400+ Mbps MAC throughput (500+ Mbps in turbo mode)</td>
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<td>700 Mbps PHY rate</td>
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<td>Single 100 MHz channel</td>
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<td>800+ Mbps MAC throughput (1+ Gbps in turbo mode)</td>
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<td>Energy saving modes</td>
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<td></td>
<td>Reliability improvements (latency, improved Packet Error Rate, re-transmission)</td>
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<td>Backward Interoperability with MoCA 1.1</td>
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</table>
MoCA Operating Characteristics

- MoCA Co-exists with CATV and DOCSIS
- Coexistence with other services is required
  - Typical cable modem upstream 5-42 MHz
  - Typical cable operator downstream 55-850 MHz with expansion up to 1 GHz
- OFDM with Reed Solomon Forward Error Correction
- CATV Frequency Plans
  - E-band for DirecTV use 400 MHz – 700 MHz
  - DECA (DirecTV Ethernet-to-Coaxial Adapter)
    - A1 800 – 950 Mhz
    - B1 850 – 950 MHz
    - C1 800 – 1050 MHz
    - C2 850 – 1075 MHz
    - C3 850 – 1100 MHz
    - C4 875 – 1125 MHz
  - D 1125 – 1675 MHz (default frequencies and most commonly used)

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<th>Frequency Range (MHz)</th>
<th>Description</th>
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<td>54 – 860 MHz (up to 1 GHz)</td>
<td>CATV</td>
</tr>
<tr>
<td>800 – 1675 MHz MoCA</td>
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</table>

5 - 42 Upstream
MoCA Physical Topology

Normal 2-Way CATV path

Splitter Jumping

Splitter Jumping

Ground Block

MoCA Filter

MoCA Device

MoCA Device

MoCA Device

MoCA Device
MoCA operates as a fully meshed point-to-point network, where each node is interconnected bi-directionally to every other node in the MoCA network.

The speed of each link is determined by the quality of the communications path between those two nodes.

The data rates for each link are scalable, up to the aggregate network throughput (400 Mbps for 2.0).

Multi-Room DVR Data Rate Usage Example:

- Assuming 1 DVR connected to 3 MoCA enabled STBs
- Each link is bi-directional and contains both control information and the video information
  - Example video is MPEG2 HD @ 20 Mbps per stream
  - Control is < 1 Mbps
  - Each link is 21 Mbps
- Total bandwidth consumed is 3 x 21, or 63 Mbps
- Data rate remaining for other MoCA services is 400 Mbps minus 63 Mbps, or 337 Mbps
Installation Considerations

- Tap to TV
- Loss Calculations
- Connectors
- Signal Level Requirements
- Cabling
- Splitters

Standard CATV Install and Service Practices remain in place when MoCA enabled Whole Home DVRs are deployed.
### Installation Considerations

- **Low-pass filter (5 to 1002 MHz)** must be installed at each residence to protect against adjacent home interference.
  - Ideal location is at the first splitter or in the drop amp to maximize benefit.

- **57 dB maximum loss between MoCA nodes**

- **Low splitter insertion loss at MoCA frequencies**
  - Too high splitter insertion loss may limit the number of MoCA devices that can be on the same network.

- **Low port to port isolation at MoCA frequencies**
  - Port to port isolation is the loss between output ports on a splitter.
  - For operation in the return path (5 to 42 MHz), this needs to be \( \geq 35 \text{ dB} \).
  - For MoCA frequencies, it should be lower (\( \leq 20 \text{ dB} \) is targeted, but will work with current products with higher port to port isolation).
Installation Considerations

The MoCA transmitter adjusts its bit rate automatically, depending on channel quality, to maintain a low bit error rate (BER) at the MoCA receiver.

As a result, the PHY rate is a measure of link quality.
Example Loss Budgets

- **Loss Calculations @ 1125 MHz**
  - Total cable length 50 ft
  - Cable loss (RG-6) 3.48 dB
  - Port-to-Port isolation 25 dB for a typical 2-way splitter
  - Total loss @ 1125 MHz 28.48 dB

- **Loss Calculations @ 1525 MHz**
  - Total cable length 50 ft
  - Cable loss (RG-6) 4.05 dB
  - Port-to-Port isolation 21 dB for a typical 2-way splitter
  - Total loss @ 1525 MHz 25.05 dB
Example Loss Budgets

- **Loss Calculations @ 1125 MHz**
  - Total cable length 100 ft
  - Cable loss (RG-6) 6.95 dB
  - Port-to-Port isolation 25 dB for a typical 4-way splitter
  - Insertion loss 4.1 dB for a typical 2-way
  - Total loss @ 1125 MHz 44.05 dB

- **Loss Calculations @ 1525 MHz**
  - Total cable length 100 ft
  - Cable loss (RG-6) 8.09 dB
  - Port-to-Port isolation 21 dB for a typical 4-way splitter
  - Insertion loss 4.1 dB for a typical 2-way
  - Total loss @ 1525 MHz 48.19 dB
Point of Entry (POE) Filtering

MoCA Point of Entry (POE) Filter should be placed as close as possible to premise entrance location to avoid potential for Home to Home interference and to improve in-home receive levels.
MoCA Point of Entry (POE) Filter recommended as close as possible to premise entrance location to avoid potential for Home to Home interference and to improve in-home receive levels

- Prevents interference between MoCA homes on the same tap or Point of Entry
- Minimizes MoCA energy on CATV feeder
- Generally located at Residence Point of Entry (gnd. block) or at the TAP
- Not recommended for self-install – installed by cable tech

Key Operating Characteristics

- Passband 5 – 1002 MHz,
- Stopband -35 dB at 1125 – 1525 MHz
Point of Entry (POE) Filtering

- CATV Tap
- Ground Block
- MoCA Filter
- MoCA enabled Modem
- MoCA Device
- MoCA Device

- CATV Tap
- Ground Block
- DC-6 TAP
- MoCA Filter
- Non-MoCA Modem
- MoCA Adaptor
- MoCA Device
- MoCA Device
- MoCA Device
- Cat5
MoCA Ready

Home Amps must be capable of passing MoCA to keep MoCA functioning properly.

If the Amp is not certified to pass MoCA frequencies, link budgets cannot be maintained, and devices will not connect properly.
MoCA Ready
Benefits of Reflective MoCA Filters

MoCA works in this example, but does not benefit from the reflective energy of a filter, and has a higher loss calculation.

MoCA filters have high reflectivity in the MoCA frequencies and improve loss budgets of the MoCA network, along with preventing upstream migration.

Port-to-Port Isolation = 25 dB Loss @ 1125 MHz

Insertion Loss x 2 + Reflective Return Loss = 4.1 dB + 4.1 dB + 1.5 dB = 9.7 dB total Loss @ 1125 MHz
Troubleshooting MoCA

- Standard signal level meters don’t cover MoCA frequencies above 1 GHz
- Drop qualification for MoCA requires a different process than qualification for other services
- Node to Node testing for link budget and throughput are both required
- Based on cable age, loss at MoCA frequencies may be a concern
- Drop passives will vary in performance at MoCA frequencies
- Signal leakage and signal ingress are both concerns in MoCA
- Drop passive placement in the design is critical to maintaining the 57 dB MoCA Link Budget
## Troubleshooting MoCA

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<th>Coaxial Cable Plant Quality</th>
<th>Connectors, splitters, filters and amplifiers affecting MoCA carriers?</th>
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<td>Spectrum</td>
<td>Noise and interference impacting MoCA carriers?</td>
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<td>Network Capacity</td>
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<td>Customer Equipment Diagnostics</td>
<td>Customer equipment or coaxial cable plant?</td>
</tr>
<tr>
<td>Quality of Experience</td>
<td>Verify the customer’s quality of experience?</td>
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</tbody>
</table>
Viavi (formerly JDSU) offers testing equipment specific to testing of MoCA networks in the home.

Using multiple probes, one placed at each location in the home, the meter can make accurate maps of the entire network at once and determine loss calculations to find potential issues.
Troubleshooting MoCA

- **Does the equipment’s MoCA interface function properly?**
  - Validate the equipment’s MoCA interfaces
    - Connect directly to the equipment and determine data rates

- **Does a bi-directional data rate issue exist between nodes?**
  - Measure the data rates between MoCA nodes
    - Use test set to measure the data rates between MoCA nodes

- **Does the coaxial plant between nodes have a problem?**
  - Confirm the integrity of the coaxial cable plant
    - Assess the coax segment-by-segment

- **Does noise or interference affect the MoCA carriers?**
  - Identify noise/interference using bit loading analysis
    - Examine the bit loading analysis
Examples of MoCA Enabled Ethernet Bridges & Gateways

- D-Link DXN-221 Coax Ethernet Adapter Kit
- Actiontec ECB2200 MoCA Network Adapter
- NetGear MCAB1001 Ethernet to Coax Bridge
- Actiontec MI424WR Broadband Home Router
- Westell UltraLine Series3 MoCA Gateway
Examples of MoCA Enabled Set Top Boxes

- ADB ADB-6880CX
- Motorola DCX-3200M
- Motorola QIP6416
- Motorola DCX-3400M
- Pace DC900X
  HD DVR Network Attached Storage Device
- Cisco Explorer 8652HDC
  DVR with M-Card Interface
We Are Video!

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