Home Networking On Coax for Video and Multimedia

Overview for IEEE 802.1AVB

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Outline:

- What is MoCA?
- MoCA home usage model
- MoCA MAC/PHY features
- Field test results
- Summary
About MoCA

MoCA’s Mission

To develop and promote specifications and certify interoperable products that enable distribution of entertainment within the home using the existing in-home coaxial cabling.

Board of Directors

- Comcast, Cox, Echostar, Entropic, Linksys, Motorola, Panasonic, RadioShack, Toshiba, Verizon

MoCA Activities

- Develop technical specifications, validate through field tests, certify MoCA enabled products as interoperable, and ensure access to necessary intellectual property for all members on reasonable and non-discriminatory terms

Drivers for Home Multimedia Networks

- Cable operator whole-home DVR and triple play
- DBS whole-home DVR
- Telco “triple-play”: video, voice, data
- Retail
  - Home server & client for multimedia
  - DVD-DVR combo
  - Media Center PC to Media Center Extender/TV
  - Backbone for Wi-Fi
Multimedia Throughput Needs

- **Data rate**
  - Simultaneous multiple HDTV, SDTV, data, voice, gaming, ...

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<th>Ave Mbps</th>
<th>Peak Mbps</th>
<th>Trick mode Mbps</th>
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<td>SDTV</td>
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<td>ATSC</td>
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<td>20 – 40+</td>
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- Customers ask MoCA for 60 to 100+ Mbps net throughput

- **Quality & reliability**
  - Does not degrade when other services are added
  - Does not degrade when neighbor or housemate runs services
  - Does not degrade when home appliances are turned on
The Home Usage Model And Connectivity

- Each room can be a source and sink of multi-media content
- Consumers may
  - Move equipment to other rooms
  - Add a cable or splitter
- Mandatory connectivity model
  - Room-to-room, peer-to-peer, full mesh, all outlets source and sink
  - Backwards through splitters
- MoCA is the only technology that provides no-excuses networking room-to-room over in-home coax as is

MoCA
MULTIMEDIA over COAX ALLIANCE
MoCA Channel Characteristics

Room-to-room characteristics dictate and require a custom PHY/MAC solution for ubiquitous coverage.

Frequency Response
- Long Path: F → B
- Short Path: F → E
Coexistence with Other Services

- Coexistence with other services is required
- Cable modem upstream (5-42 MHz)
- Cable operator downstream (50-860 MHz)
- Coax and splitters support reliable communications above 860 MHz
MoCA PHY Layer Features

- 50 MHz MoCA channel bandwidth
- 224 OFDM subcarriers signal where each subcarrier can be modulated from BPSK to 256-QAM
- Adaptive bitloading OFDM at the transmitter
- PHY layer packet are R-S encoded for error recovery
- Three different probes are used to characterize the MoCA channel condition
- Four types of preambles are used for different PHY data packets to optimize throughput
- MoCA channels are located at different frequency bands between 875 MHz to 1500 MHz
- Robust PHY layer transmissions (PER $\leq 10^{-5}$) over coax using Time-Division Duplexing (TDD)
- PHY data rate in a two-node MoCA network $> 250$ Mb/s
MoCA MAC Layer Features

- Distributed mesh network architecture with TDMA based scheduled access
- MoCA network support communications from 2 to 8 nodes
- Any MoCA node can become a Network Coordinator (NC) node – automatically selected
- NC node broadcasts beacons every 10 ms
- Network access is coordinated using MAPs and reservations
- MAPs are transmitted by the NC node ≈ 1 ms
- Every node must go through an admission process before becoming part of the MoCA network
- Every node gets a reservation opportunity to send packets per MAP
- Robust network operation – every node periodically updates its transmit power levels and PHY profiles using link maintenance operation (LMO)
- Seamless recovery of network – backup NC node takes over when NC fails
- Secured network - all packets in the MoCA network are encrypted except for beacons
MoCA Specification Development

- Initial MoCA MACPHY Specification v1.0 was released on 2/26/06.
- Latest MoCA MACPHY Specification v1.0 was released on 4/5/07.
- Extensions to MoCA specification are being discussed in SWG include:
  - L2ME Messaging protocols
  - Full-Mesh Rate Transaction
  - Parameterized QoS Transactions
  - 16 nodes
  - Packet aggregation
Field Testing of MoCA

- Goal - validate performance and coverage in real world conditions
- Field Test conducted in ≈ 250 homes, 15 cities
  - Multiple operators and service providers
  - All MoCA Members participated in tests
- Tests conducted under normal living conditions
  - No modifications to cable plant
  - Existing devices connected to cable
  - Existing services connected to cable
- Tests systems designed for use by non-technical persons
  - MoCA nodes deployed at each home cable outlet
  - Test coordinated by laptop PC
  - Collected multiple statistics on coverage, performance, and link
Field Test Results

- Packet Error Rate less than $10^{-6}$
- Average one-way latency less than 3.5 ms
- Net usable (MAC) data rates, with no changes to the home coax system:
  - 97% of all paths in all homes achieved $\geq 100$ Mbps
- Net usable (MAC) data rates, with simple remediation to the installed coax cable system:
  - 100% of homes achieved $\geq 95$ Mbps on every path in the home
MoCA Performance/Coverage

Performance: Percent of Paths vs. Bit Rate

- % Paths vs. Mbps
- PHY Rate and Throughput (MAC) Rate

MoCA: MULTIMEDIA over COAX ALLIANCE
Summary

- Home usage model
  - room-to-room, peer-to-peer, full mesh connectivity
  - 100 Mbps net throughput
  - No-excuses, glitch-free video
  - Consumer or Service provider enabled

- Coexistence with other services

- A reliable home mesh networking of digital content among MoCA devices using existing coaxial cables

- Proven real-world validation
  - Large scale deployment of MoCA (> 5M installed MoCA nodes)
  - >100Mbps in 97% of all connections
    - Reasonable remediation for other connections

- Secured network with seamless network recovery when NC fails