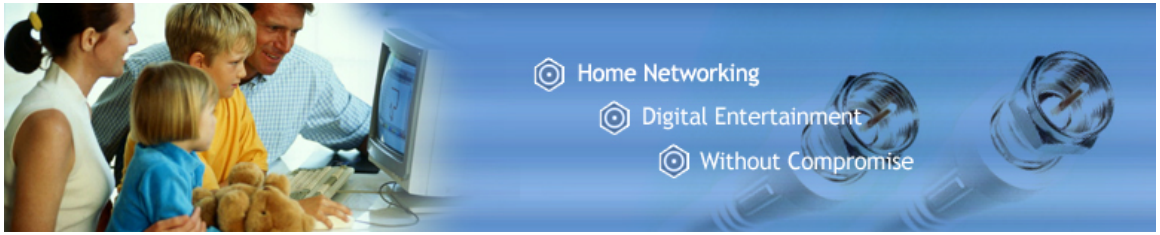


MoCA
MULTIMEDIA over COAX ALLIANCE

Home Networking On Coax for Video and Multimedia

Overview for IEEE 802.1AVB

Shlomo Ovadia

www.MoCAlliance.org

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
- Join MoCA: http://www.mocalliance.org/en/join/index.asp

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, ...**

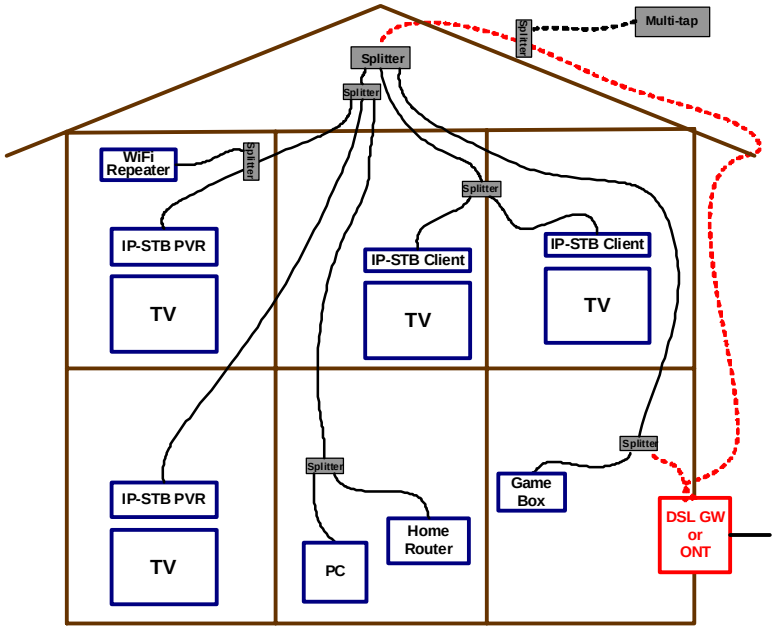
	Ave Mbps	Peak Mbps	Trick mode Mbps
SDTV	1-2.5	2 - 9	4 – 20
HDTV	8 - 20	8 - 25	8 – 40+
ATSC	20	20	20 – 40+

  - **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**

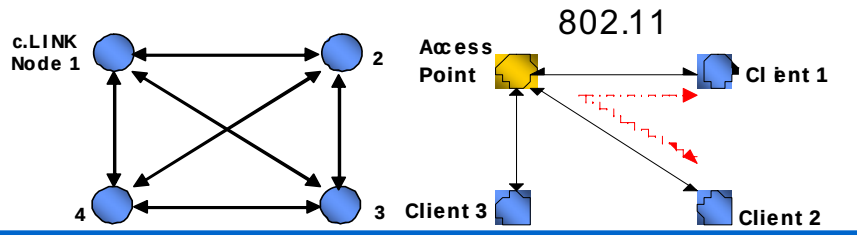
The Home Usage Model And Connectivity

- 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

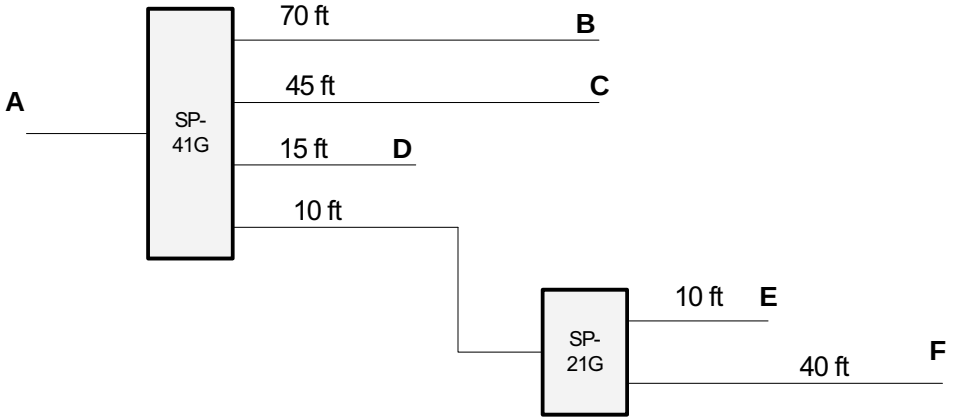


Connectivity Model

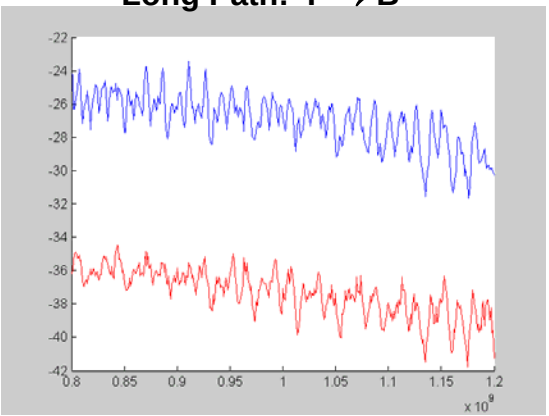
Desirable **Not Desirable**



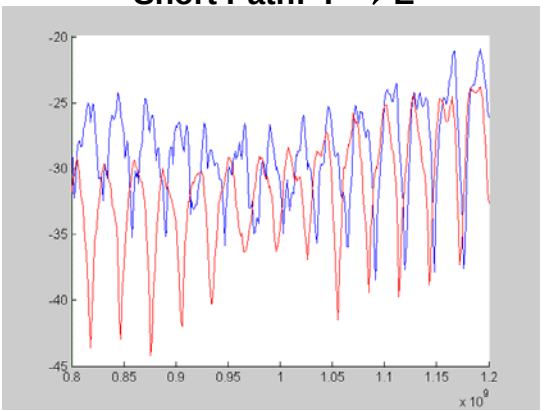
MoCA Channel Characteristics



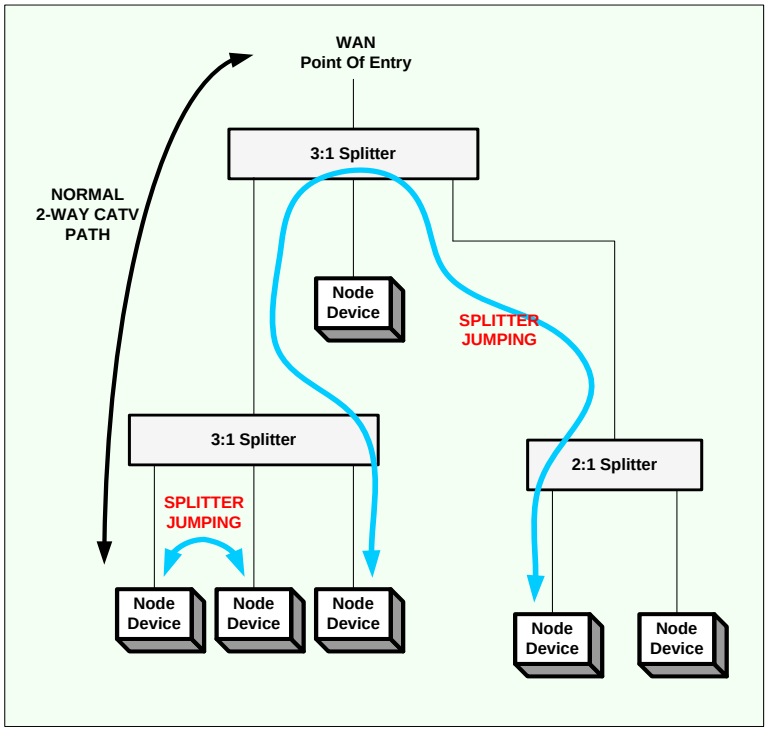
Frequency Response Long Path: F → B



Frequency Response Short Path: F → E

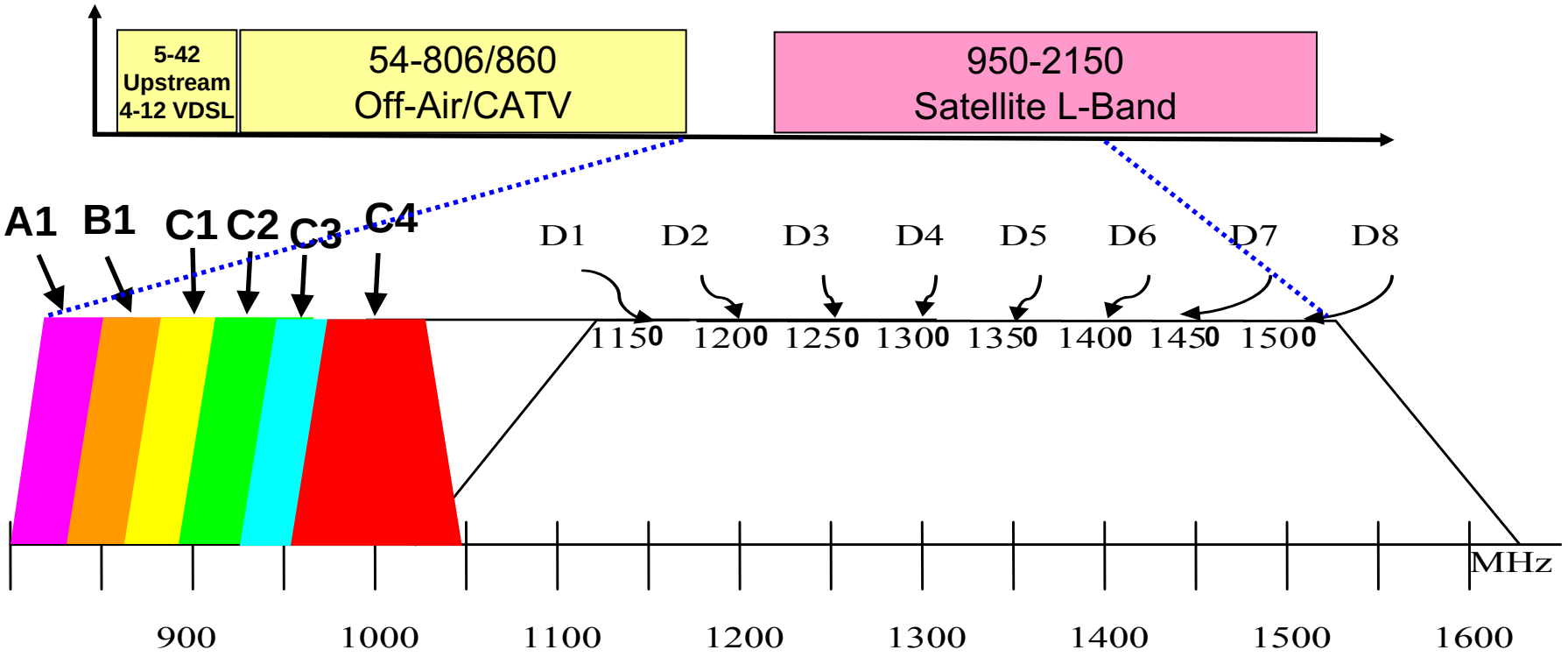


Room-to-room characteristics dictate and require a custom PHY/MAC solution for ubiquitous coverage



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 MAC/PHY Specification v1.0 was released on 2/26/06.
- Latest MoCA MAC/PHY 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

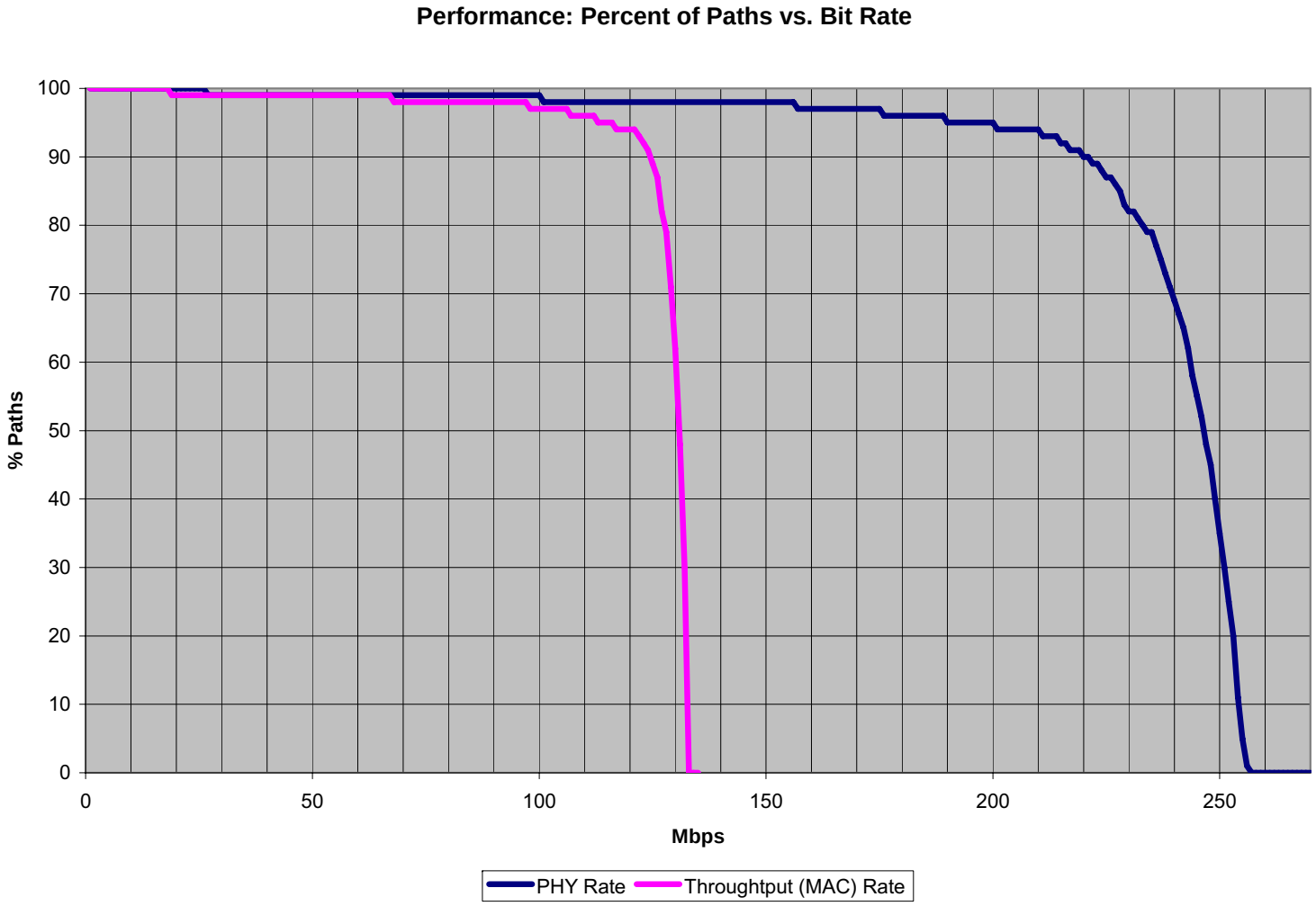
Field Testing of MoCA

- 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



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