ITU-T G.hn

CS 687
University of Kentucky
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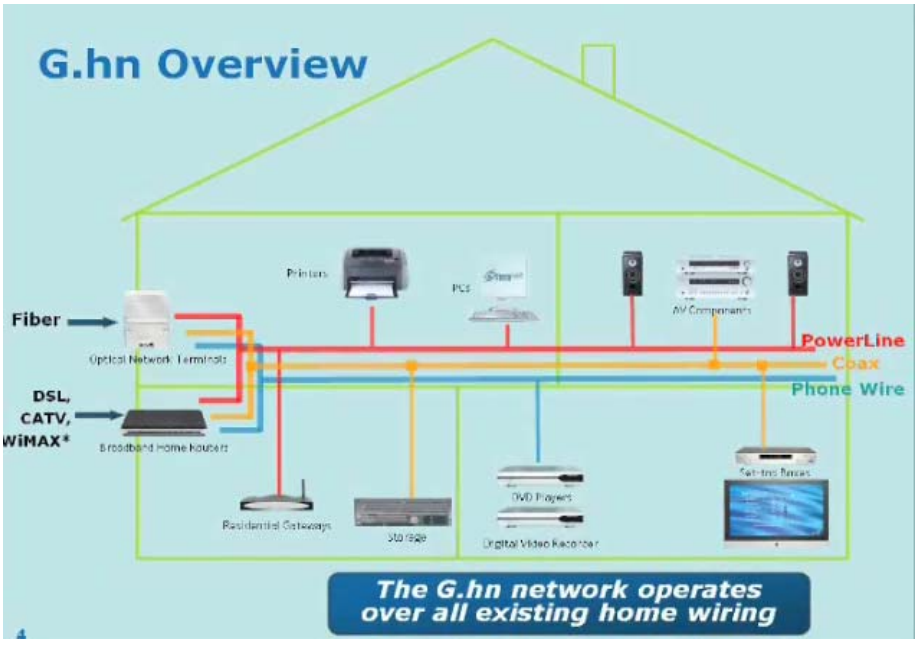
Acknowledgment: These slides are based on a presentation given by Barry O'Mahony from Intel labs (available at HomeGrid Forum.)

Outline

- Introduction
- Rationale for G.hn
- Architecture Overview
- PHY Layer
- Data Link Layer
- Publications

Introduction

- G.hn: An international standard for home networking on existing premises wiring
  - Power line
  - Coaxial cable
  - Telephone wiring
- Developed by the International Telecommunication Union – Telecommunication Standardization Sector (ITU-T)
- PHY/MAC standard with up to 1 Gbps performance
- Promoted by the HomeGrid forum



HomeGrid FORUM

For any wire, anywhere in your home.™

- Founded in 2008 as companion group to support and promote ITU-T G.hn in the industry
  - Maket G.hn technology to the industry
  - Ensure compliance and interoperability
- Worldwide industry representation
  - Service provider
  - Consumer electronics
  - Personal Computing
  - Silicon suppliers and IP licensing companies
  - Certification labs
  - Industry organizations
- Board of directors
  - Best Buy, British Telecom, Lantiq, Intel, Sigma Designs, Telefonica, Texas Instruments, Marvell (pending)

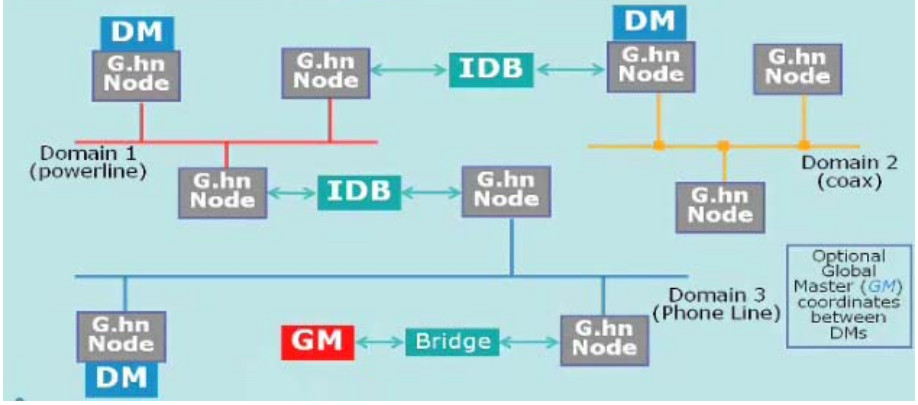
The Rationale for G.hn

- Home Networking on existing wiring plagued by fragmentation, lack of interoperable standard
  - Market fragmented into small segments per distinct wire type
  - Multiple technologies per wire type, each supported by 1-2 vendors
  - Volumes miniscule in comparison to home networks based on international SDO standards (e.g., Wi-Fi, Ethernet)
  - Uncertainty inhibiting Service Providers adoption and consumer adoption
- G.hn's goal – establish single standard for all media and all regions
  - Parameterized single PHY and MAC that may be optimized for operation on each media, regional regulatory requirements
  - Best-in-class performance with contributions from all current coax/phoneline/powerline technology providers

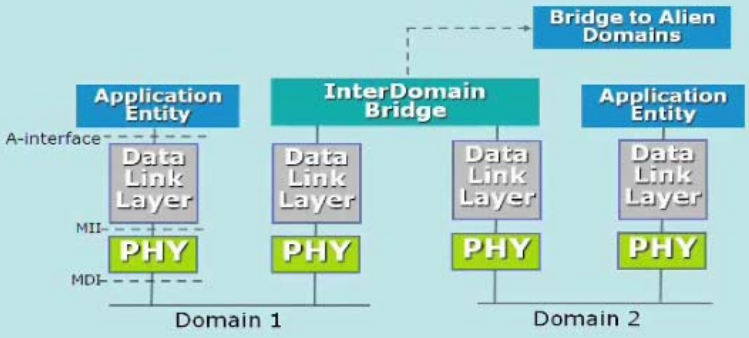
G.hn Network Architecture

- A G.hn network is made up of 1 or more *Domains*
- Each domain managed by a Domain Master (*DM*)
- InterDomain Bridge (*IDB*) interconnects domains

Domains support a minimum of 32 nodes; optionally up to 250.



G.hn Device Architecture



G.hn PHY

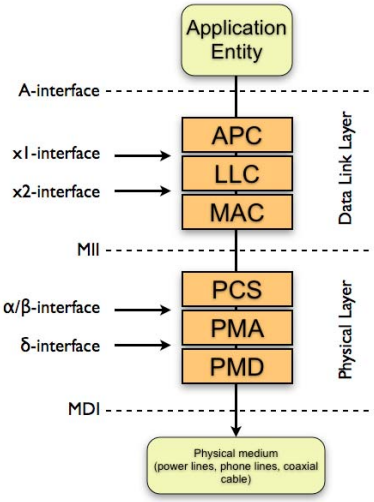
- Modulation: Windowed OFDM
  - Scalable power-of-2 FFT sizes
- Several bandplans: baseband (up to 100 MHz), passband, and RF bandplans (350 MHz to 2450MHz)
- Forward Error Control/Correction (FEC): Quasi-Cyclic Low Density Parity Check (QC-LDPC) code, similar to that used in WiMAX
  - Advantages over other advanced codes (e.g., Turbo codes)
    - LDPC better scalability at higher data rates
    - BLER operating point
  - Performance near Shannon theoretical limit
  - Two block sizes: 960 bits and 4320 bits (120 bytes and 540 bytes)
  - Five Code rates: ½, 2/3, 5/6, 16/18 and 20/21

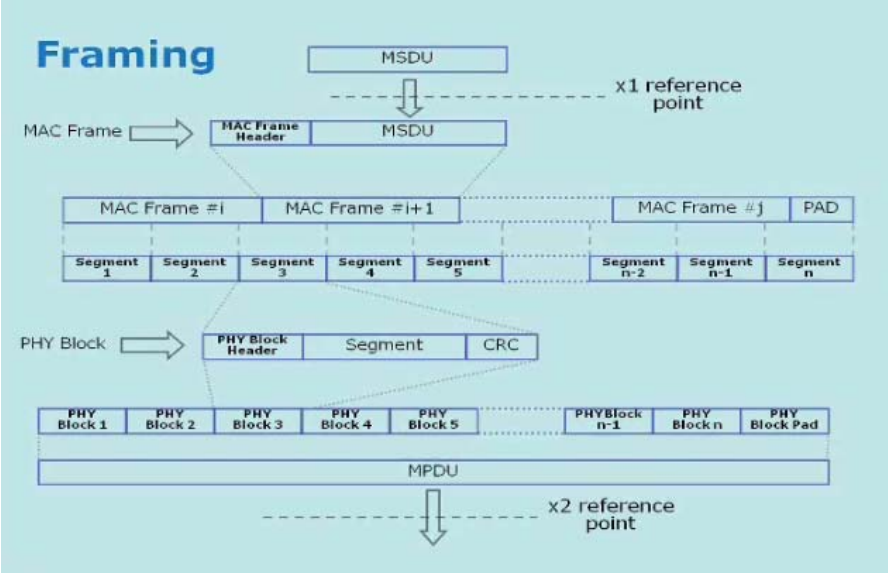
PHY Framing

- Preamble, PHY Frame Header, and Channel Estimation Symbol prepended to MPDU to make PHY Frame

Data Link Layer

- Application Protocol Convergence (APC)
  - Interface to client application
  - Bit rate adaptation between client and HN
- Logical Link Control (LLC)
  - Coordinates transmission as directed by the DM
  - Provides and enforces QoS
  - Provides Encryption
  - Provides retransmission when necessary
  - Control relaying
- Medium Access Control (MAC)
  - Controls access to the medium
  - Contention based and contention-free access





Medium Access

- DM assigns access according to MAC Cycles
  - Media Access Plan (MAP) message communicates access times to nodes
  - MAC cycles divided up to Transmission Opportunities (TXOP)
- Various TXOP types
  - Contention Free TXOP (CFTXOP)
    - Associated with a single node and a flow/priority
  - Shared TXOP (STXOP)
    - Shared among nodes; divided into Time Slots (TS)
    - If a node assigned to the TS has a frame of the assigned priority ready, it transmits it; otherwise, it skips the TS and passes the transmission opportunity to the node/priority assigned for the next TS
    - No collision occurs if carrier sensing is sufficiently reliable.
  - Contention-Based TXOP (CBTXOP) is
    - a shared TXOP, in which assigned nodes may contend for transmission based on frame priority
    - Arranged by contention period.

Security

- Design Goal
  - State of the art security
    - E.g., comparable to other modern LAN networks
    - Threat model similar to wireless
- AES128 Encryption
- X.1035 Authentication and Key Exchange
- Point-to-Point Encryption
  - Ensures that no device can decipher data transmitted between two other devices on the same network or no a neighboring network

Publications

- ITU-T G.9960, Unified high-speed wire-line based home networking transceivers – Foundation
- ITU-T G.9961, Data link layer (DLL) for unified high-speed wire-line based home networking transceivers
- ITU-T G.9972 Co-existence mechanism for wireline home networking transceivers
- ITU-T Technical Paper: Applications of ITU-T G.9960, ITU-T G.9961 transceivers for Smart Grid applications: Advanced metering infrastructure, energy management in the home and electric vehicles