Ethernet for Residential Access Applications

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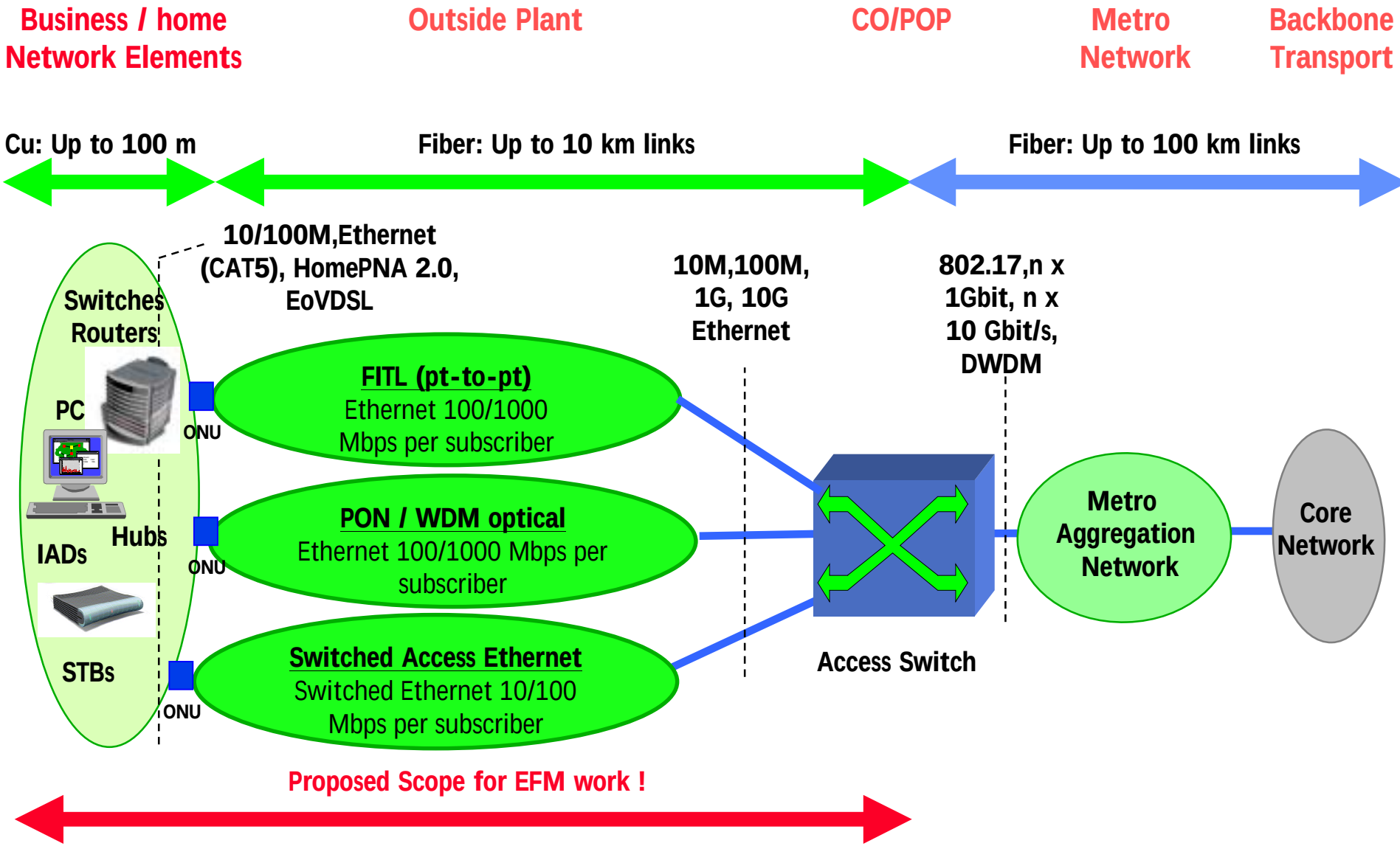
Agenda

- Access network requirements of multi-service operators
- Ethernet in the access network
- New standardization work needed in IEEE 802
- Recommendations

Multi-Service Operator Requirements

- Services in typical multi-service operator network are:
  - Packetized Voice
  - Switched digital video: broadcast, pay per view, video on demand, video telephony, HDTV
  - Data: Internet access, VPNs, …
- Residential access network requirements
  - Bandwidth 100Mbit or Gbit per household – 10M or less is NOT enough to support video services with quality comparable to CATV, considering the need to support multiple STBs
  - All services over IP (over Ethernet…), control plane IP based
  - Enough QoS to support services, low delay, low loss classes, priority or IP DiffServ with admission controls likely to be enough
  - Passive outside plant preferred (pt-pt fiber or “EPON”)
  - Should be able to re-use existing residential copper: phone lines and CATV coax
  - May need to be able to support “open access” in some manner

Ethernet Access Network



In-house copper networks

- In-house copper is typically owned by the house owner
- New construction residential houses increasingly install structured cabling systems, typically CAT-5 copper
- Existing (older) houses typically have phone network and CATV coaxial cable network for analog video distribution
  - Phone lines can be used for carrying data, using HomePNA 2.0
  - Problem with HomePNA is low data rate, typically 10Mbits shared between attached devices, typically ok for Internet access and other residential data services
  - 10Mbits is ok for single video channel
  - Other option for phone wiring is to use VDSL as drop technology to single device, such as bridge or home gateway
  - ➢ Best option for the switched video distribution / high-speed data access seems to be to standardize method for transmitting Ethernet over the in-house coaxial plant

Ethernet over In-house CATV coax

- Need to specify physical layer to do this
- Requirements
  - Should be able to support at least 100Mbits data rates
  - Should support transmission distances of at least 100 m
  - Should support bi-directional transmission
  - Should support multiple attached devices (min 4, up to 8)
  - Should support multiple service classes (min 4, up to 8)
  - Should support bandwidth allocation per device and per class basis
  - Does NOT need to support simultaneous transmission of analog video signals
- Baseline CDMA MAC protocol can't meet the above QoS requirements, some work needed here

Point-to-point Ethernet access issues

- Gigabit standards for dual fiber are ok, but 100Mbits is enough for the required services and has some cost and power advantages over 1G Ethernet
- No standard for the 100Mbit Ethernet transmission over 10km single mode fiber
  - But number of peoples do this using ITU G.957 optics for OC3 rate
  - IEEE should specify this for dual-fiber transmission using 1310 nm optics
- No standard for transmission over single fiber
  - IEEE should also specify the dual wavelength interface for both 100Mbit and for 1Gbit rates
  - Suggest using 1310/1550 as in APON

PONs in Ethernet access (1)

- APON issues
  - Unnecessary need to shred and reconstruct your packets
  - Adds 20+% percent overhead to IP packet transport
  - Ok for low to medium speed applications, such as Internet access
- General PON issues
  - Non scalable architecture with respect to bandwidth
  - 100Mbit per user (1Gbit for 32 users split gives just ~30M per residence)
  - Does not scale up to gigabit per user rates without significant modifications on the deployed network topology
  - Fiber is not the major cost component on optical access deployment - construction cost is, depends heavily on duct space availability, pole installations in US help to reduce cost
  - If you deploy brand new fiber access network, would you do so knowing that you might need significant modifications to support “Next Big Thing” (100M access speed will not be the end of it) ?

PONs in Ethernet access (2)

- Good things with PONs
  - Reduces the required number of fibers in trunks, but not in drops
  - No active components in the plant (vs. VDSL), no powering needs, no need for CEVs
  - Flexible architecture with respect to capacity
  - Can support data rates needed NOW with smaller split ratios (100Mbits can be achieved with split ratio on 1:10
  - Standard (G.983) available for APONs
  - APON is usable for Ethernet access, might want to specify the protocol profile (less ATM, more frames) to do this, alternative is to come up with new PON MAC for frames
- PONs and CATV access compatibility
  - The home coaxial access requirements are subset of the access PON requirements
  - If there will be new specification for the MAC layer for PONs, it should also be usable for the coaxial CATV cable MAC as described before
  - To happen, this would likely need bi-directional 100Mbit transmission support over same coax plant

PONs in Ethernet access (3)

- WDM PON access
  - Wavelength per residence ?
- PROs
  - Ideal architecture from the capacity scalability standpoint
  - Keep the fiber saving advantages of broadcast and select architecture
  - Better security than broadcast and select PONs, all endpoints do not (necessarily) receive all wavelengths
  - Can add bandwidth per wavelength by replacing system endpoints on subscriber basis
- CONs
  - NTs in customer premises must be identical, would need to have either wideband sources or tunable sources & wavelength allocation protocol and passive filters in outside plant → expensive at a moment
  - Passive components have troubles with operating up to spec over the wide temperature ranges required in outside plant

PONs in Ethernet access (4)

- What to do with Ethernet PON standardization ?
- Evaluate options:
  - Option 1: just use simplified APON, possibly specify the standard profile to use as an Ethernet access method
  - Option 2: study the feasibility of the Ethernet WDM PON implementation
  - Option 3: specify new MAC protocol for Ethernet PON access, use same for the home CATV coax access
- Should this be owned by IEEE or some other standardization body (which one) ?

Market Potential

- The operator network situation determines which of the proposed interfaces are used in any particular case
- Number of different type network operators are interested on deploying standards based solutions (US and European telcos and CLECs, cable operators)
- Total market potential estimate for the US and Europe is estimated to exceed 200 Million households for residential market only
- Number of the compliant interfaces is much higher
- This also has secondary effect on promoting the use of the switched Ethernet as a first technology of choice in the new construction home networking environments

Recommendations

1. Standardize 100Mbit transmission and MAC extensions as required to enable the in-house CATV coax cable re-use
2. Standardize 100Mbit dual-fiber transmission using 1310 nm optics, minimum reach 10 km
3. Standardize dual wavelength interface for 100Mbit rate using 1310/1550 nm, minimum reach 10 km
4. Standardize dual wavelength interface for 1Gbit rate using 1310/1550 nm, minimum reach 10 km
5. Study the feasibility & cost of Ethernet / frame based PON, also if the same protocol could be used to support in house Coax access
6. Study feasibility of high speed PON / WDM system specification, that supports 100Mbits per subscriber, standardize if doable at feasible cost point (must have total installed cost price advantage over point to point system)