Technology Myth-Busting

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A few myths I have encountered:

- Myths about wireless technology often occur on opposite ends of the “spectrum”:
  - Myth: *Soon wired network technologies will not be necessary; everyone and everything will be wireless!*
  - Myth: *Wireless, particularly unlicensed frequencies, cannot support critical communications and don’t have a place in a very high-bandwidth world*
- Most often, myths are formed because of hype based on some truth
  - Myth: *Current fiber-to-the-premises (FTTP) deployments are “light-years” ahead of more common hybrid fiber/coax (HFC) cable television systems*

Wireless vs. wired misconceptions

- Wireless spectrum is always a shared medium, even when it is licensed
  - Consider that 4 to 5 HD video streams each at 4 Mbps saturate even a perfect 54 Mbps WiFi connection
- Every device in a wired network can re-use the full bandwidth of the cable without interference
    - Twisted pair copper: megabits to a gigabit
    - Coaxial cable: several gigabits
    - Fiber: gigabits to terabits
- Mesh networks can expand the reach of wireless coverage, making each radio a repeater, but does not necessarily increase capacity
  - Every radio “hop” in a wireless mesh between two points reduces the effective throughput in half
  - For example, an 11 Mbps WiFi connection is reduced to 1.4 Mbps in just three hops, which would have a maximum actual throughput similar to 768 kbps DSL – and even slower if there is more than one user

Wireless vs. wired misconceptions

- What about direct broadcast satellite services that provide hundreds of channels?
  - They are a good alternative to traditional cable services, but it will never be able to support interactivity or on-demand services like its wired "competitors"…
    - Satellite services are primarily one-way broadcasts
    - A satellite in orbit would be needed for every few hundred subscribers (only about $1million per subscriber) to provide the effective interactive capacity of typical HFC cable systems
- Bottom Line: Wireless does not replace wired communications – they are, and will continue to be complimentary technologies
  - As backbone communications trend towards fiber, wireless will also continue to grow as an access technology with a focus on mobility
  - There will always be a need for wired access connectivity where higher levels of quality and interactivity (two-way and on-demand) is preferred over broadcast services
  - When weighing the importance of on-demand and interactivity, consider the trend in today's use of media among younger demographics: YouTube vs. MTV

WiFi Demystified

- WiFi is not the holy grail of communications technologies *(just ask EarthLink)*
  - Interference from existing WiFi networks and other unlicensed spectrum devices
    - WiFi has 11 channels in the U.S., but only three non-overlapping (non-interfering)
  - Signal unpredictable due to obstructions
  - Limited range due to FCC power restrictions
- Deployment details can drastically affect the cost and feasibility of WiFi deployments
  - Access to electrical power, building construction, WiFi placement and attachment, physical terrain, etc.
  - Your situation may vary greatly from the next town

WiFi Alphabet Soup

802.11a	802.11b	802.11g
5 GHz	2.4 GHz	2.4 GHz
54 Mbps	11 Mbps	54 Mbps
Less interference (for now), more bandwidth available	Most widely adopted	Faster than 802.11b and better range than both a/b
Not as widely implemented, shorter range	Slower and older version	Uses more congested 2.4 GHz frequency

Other 802.11 standards include 802.11e (QoS, completed fall ‘05), 802.11i (security, completed summer ‘04), 802.11n (MIMO, in draft form)

WiMAX Capabilities

- Provide point-to-multipoint (fixed) and mobile wireless access at high data rates (several Mbps per user)
  - Possible applications:
    - Cellular network backhaul
    - WiFi network backhaul
    - Fixed alternative to DSL/cable modem Internet access (last mile Internet access)
    - High speed mobile data access
  - Speed
    - 70 Mbps throughput (20 MHz channel)
    - Targeted to provide several Mbps per user for mobile systems
  - Range
    - 70 km maximum (LoS, point-to-point)
    - Likely mobile “cell” range 4 – 6 miles
- Open architecture designed to provide advanced IP capabilities
  - Supposed to be less expensive than proprietary competitors (e.g. QUALCOMM Flarion Flash-OFDM)
  - Designed to provide guaranteed Quality of Service (QoS)
  - Voice and video services

WiMAX Standards

- The recent standards:
  - 802.16d – Also known as 802.16-2004
    - Point-to-multipoint only implementation
    - Standard-based equipment for licensed and unlicensed spectrum available as of late 2005. More equipment and WiMax certification to occur in 2006.
  - 802.16e – Adds mobility
    - IEEE approved in Dec. 2005
    - Allows fixed wireless or mobile Non Line of Sight (NLOS) coverage
    - Equipment meeting the standard is now becoming available

WiMAX Limitations

- Not the answer to the lack of unlicensed spectrum for broadband access
  - Standards allow for a wide range of frequency band usage – not a new type of FCC license
- Still challenged by the laws of physics
  - High capacity, high frequency channels still need line of sight (LoS) for any real distance
  - Lower frequency bands typically offer narrower channel widths, which means slower speeds
  - Always a tradeoff between range and capacity, regardless of RF channel size and frequency
    - A wide channel in a lower frequency band could provide range and high capacity
- Not yet available on a widespread basis in customer or end-user devices
  - Intel planning to have WiFi/WiMAX chipset available by mid-'08

WiMAX Interoperability

- Unlike the basic WiFi flavors (802.11 a/b/g), standardization does not mean seamless interoperability of compliant hardware
- WiMAX standards specify a very wide range of frequency bands
  - No global licensed RF spectrum for WiMAX
  - Even within a specific spectrum regulatory domain, carriers likely to want to use WiMAX within a wide range of licensed and unlicensed bands
  - Frequencies discussed for WiMAX are merely current “areas of focus”

WiMAX Frequencies

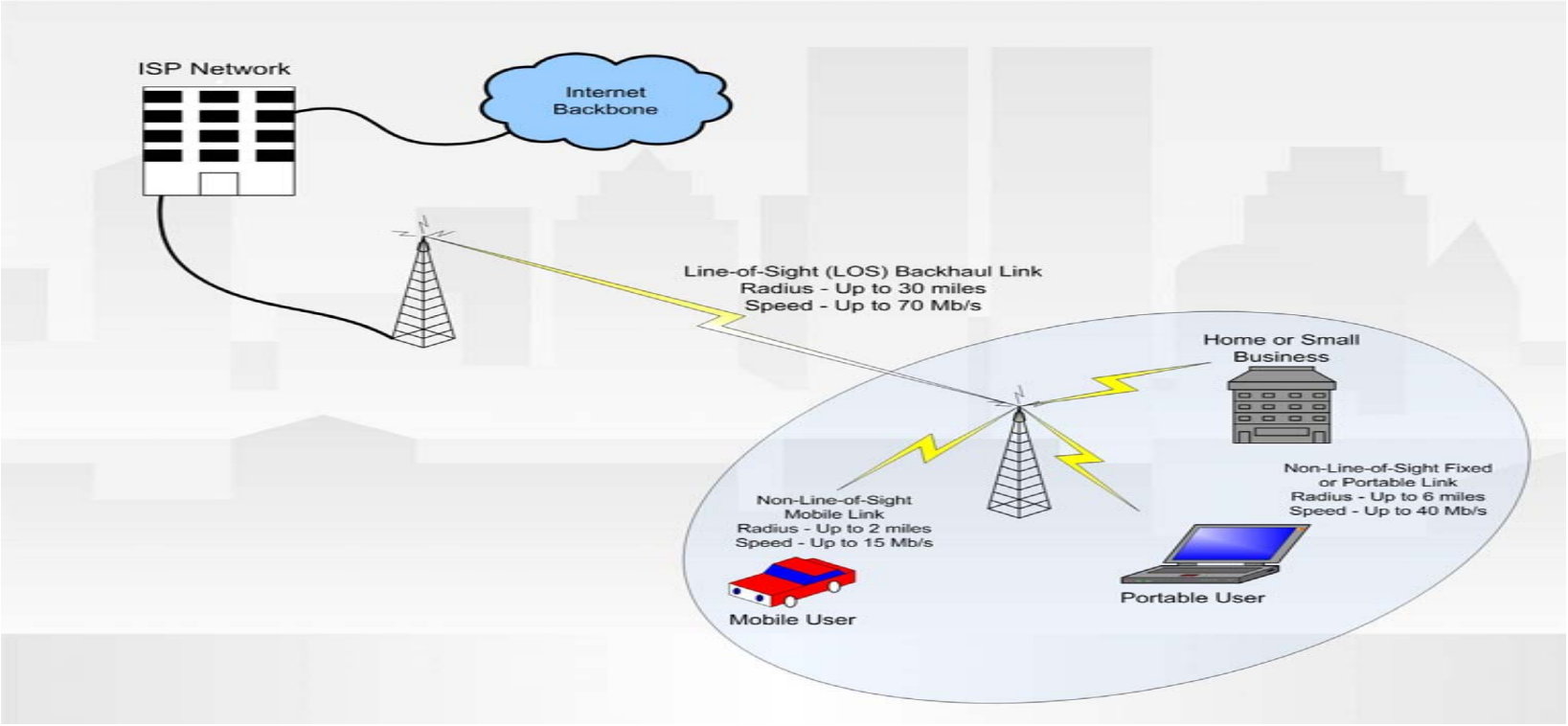
- Standards deal with two very broad ranges:
  - 2 – 11 GHz ("centimeter wave") and
  - 10 – 66 GHz ("millimeter wave")
- Bands used by initial systems
  - 2.4 GHz (same as WiFi)
  - 2.5 to 2.7 GHz (licensed MMDS)
  - 3.5 GHz (not in U.S.)
  - 5 GHz (same as WiFi)
- Flexible channel widths (unlike WiFi's fixed 20 MHz channels)
  - Typically 1.5 – 10 MHz for mobile
  - Typically 20 – 28 MHz for fixed

Using wireless where it fits…

- A few engineering ground rules – no wireless technology can escape physics, regardless of hype or industry adoption:
  - At a given power level, low frequencies travel farther than high frequencies
    - FCC limits power levels to ensure unlicensed devices can cohabitate
  - Antennas change the direction and pattern of energy sent or received; they do not amplify the signal
  - At a given bandwidth, higher data rate reduces range
  - Typically, only one transmission can occur at a given frequency in a given area (though channel hopping and other spread spectrum techniques can mitigate the effects of interference at reduced speed)

Using wireless where it fits… (cont.)

- Use a combination of wireless technologies where each offer particular benefits
  - Ex: WiMAX and other licensed or unlicensed as backhaul for WiFi



Using wireless where it fits…(cont.)

- Recognize the limitations of various technologies and align with your requirements
  - This means you need to first define requirements
  - If 99.999% reliability is necessary, very few approaches using unlicensed frequencies will work
    - Possibly in a fixed, point-to-point implementation with redundancy
  - Other design requirements might be:
    - Security
    - Mobility / rapid handoff between base stations at high speed
    - Converged voice/video traffic with guaranteed QoS
  - All of this is possible, but at a cost; very few municipal WiFi deployments have any real provision for these

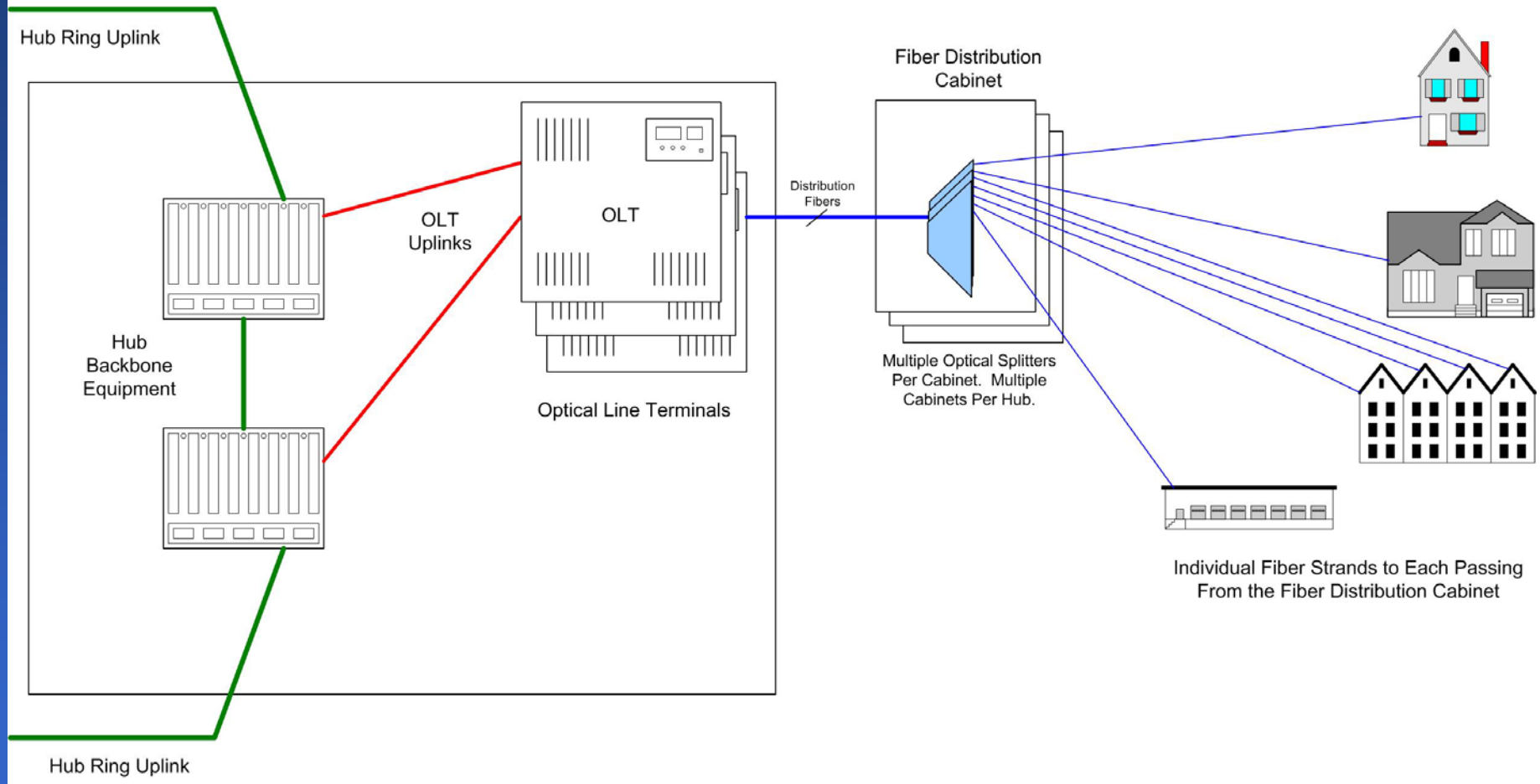
Fiber to the Premises

- What is it, and where can it go?
  - Broadband access network bringing fiber optics to homes and businesses
    - Providers offering voice, video, and data over a single network
    - Evolution of previous broadband access networks – twisted copper pair and coaxial cable
    - Potential of providing hundreds of megabits per second of Internet access to each subscriber
  - It does represent the future, for all providers (whether telco or cable operator)
    - Interactivity and on-demand media growth will continue to demand more capacity

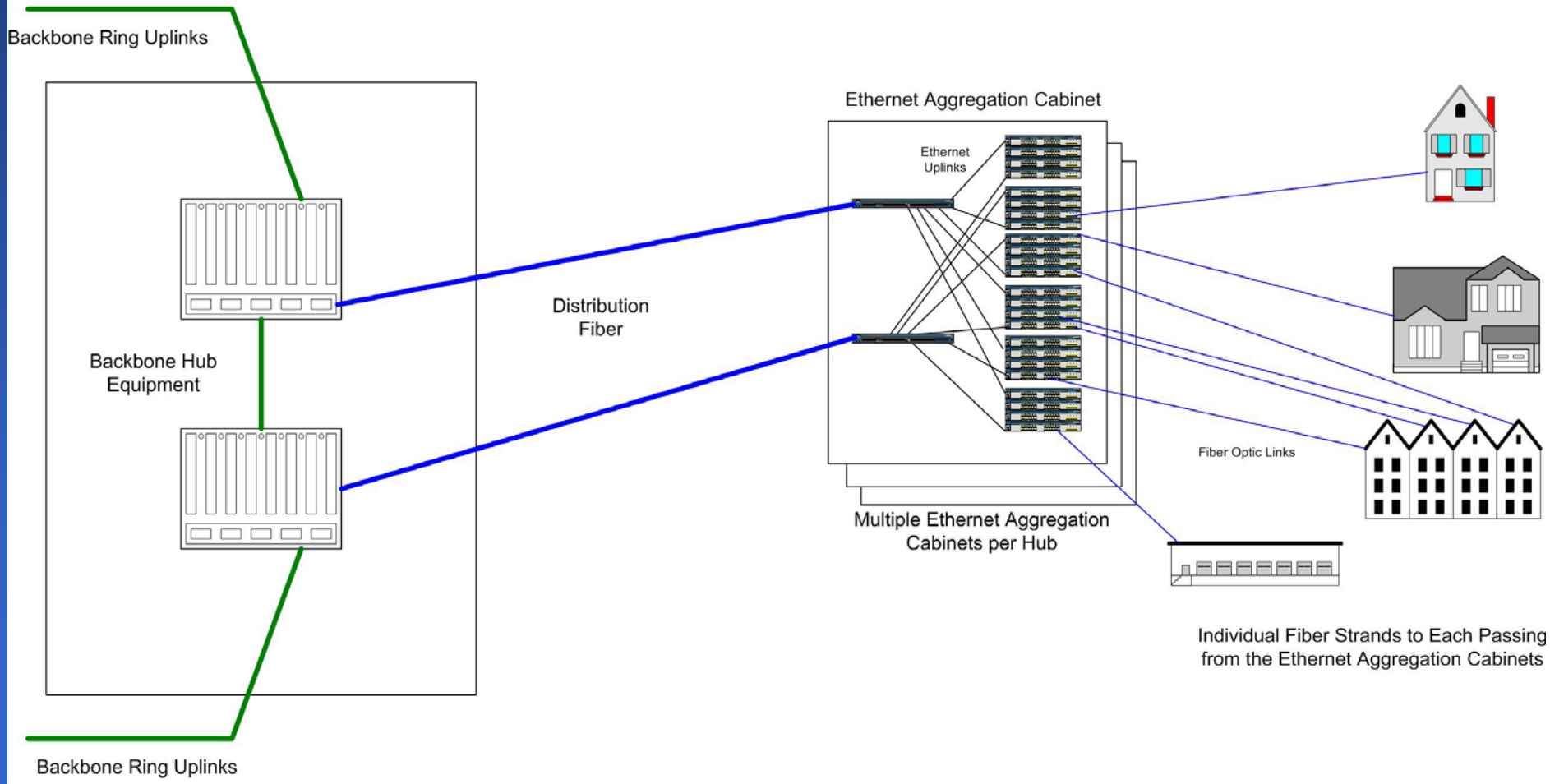
FTTP Architectures

- Passive Optical Network (PON)
  - Optical splitters used in the field
  - Verizon FiOS
- Active Ethernet
  - Powered networking equipment located in the field
  - UTOPIA
- Home Run
  - Individual fiber optic strands to from a network hub to each premises
  - Citynet (Amsterdam)

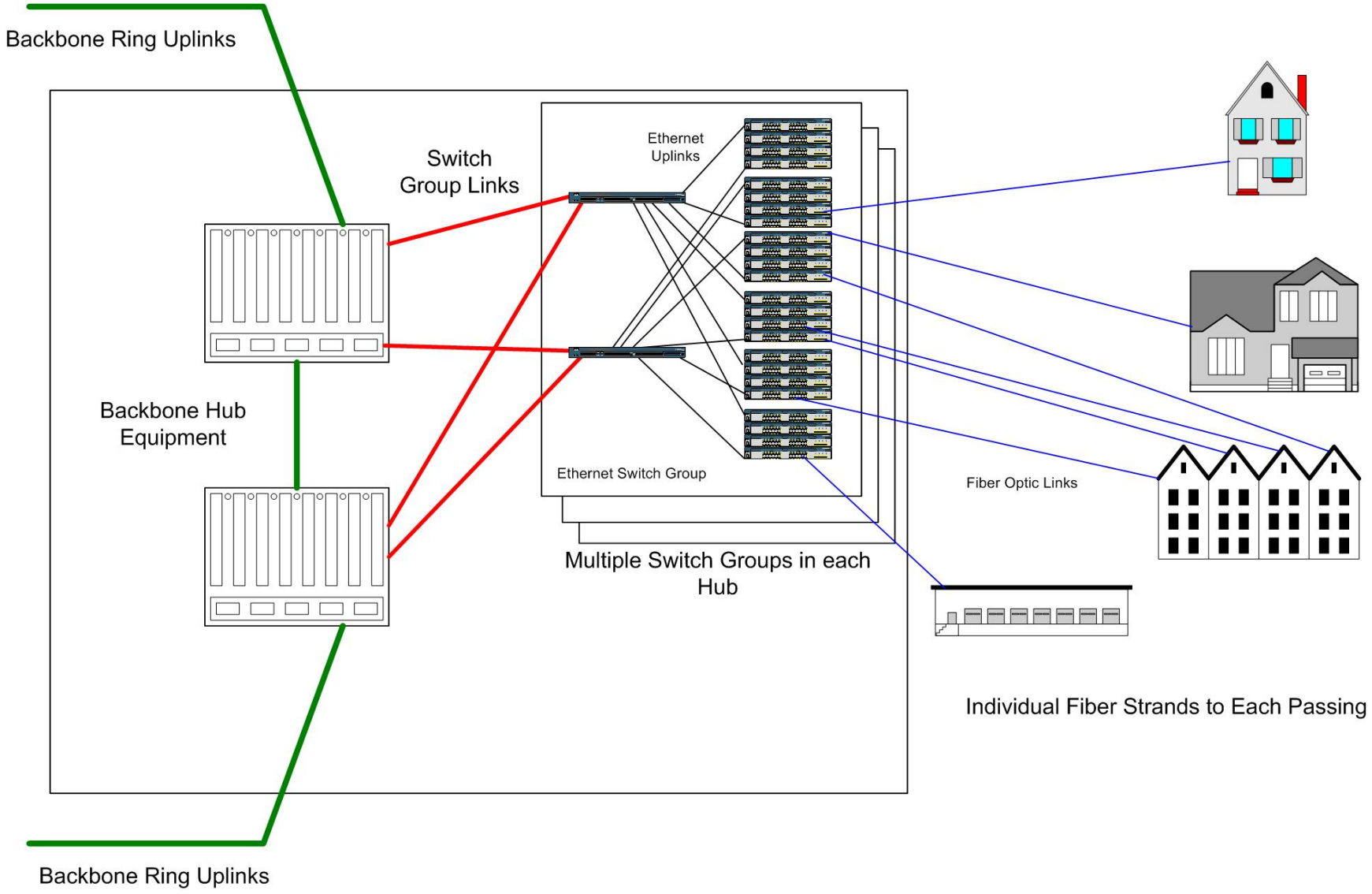
PON


Hub Ring Uplink
Hub
Backbone
Equipment
OLT
Uplinks
OLT
Optical Line Terminals
Distribution
Fibers
Fiber Distribution
Cabinet
Multiple Optical Splitters
Per Cabinet. Multiple
Cabinets Per Hub.
Individual Fiber Strands to Each Passing
From the Fiber Distribution Cabinet
Hub Ring Uplink

Active Ethernet



Home Run


Backbone Ring Uplinks
Switch
Group Links
Ethernet
Uplinks
Backbone Hub
Equipment
Ethernet Switch Group
Multiple Switch Groups in each
Hub
Fiber Optic Links
Individual Fiber Strands to Each Passing
Backbone Ring Uplinks

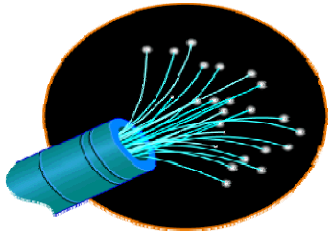
FTTP Today

- Major carriers, like Verizon, are leveraging the PON architectures primarily
  - It's fiber to your house, but it's shared by 32+ other homes
  - Current deployments carry a few hundred megabits per second to a couple gigabits per second
- It's still fiber, and each strand can carry terabits per second of traffic, so scalability exists even if the current deployments are already a bit outdated
- So is cable doomed?

Hybrid Fiber-Coax (HFC)

- Standard for Cable Television
  - Leverage existing infrastructure
- Standards based data transmission (DOCSIS)
- Replaced by FTTP in new housing developments
- Has evolved to support data
  - Channel bonding – 100+ Mbps

The cable that connects your TV to the cable outlet is a Coax cable.



Fiber Optic Cables are thin strands of glass that carry light instead of electricity. Fiber optics are lighter, immune to electrical interference, and carry information faster than standard network cables.

FTTP vs. Cable Today

- PON deployments, like Verizon's, use TDM technology similar to ATM (and DOCSIS cable modems)
- Most FTTP networks carry cable TV (video services) over a separate wavelength of light in nearly the same manner as traditional HFC cable operators
  - These networks will evolve to full IP-based transport before they are truly next generation
  - May need to augment backbone fiber for greater flexibility in hardware selection
- Meanwhile, DOCSIS 3.0 can enable equivalent or better data services over cable compared to most of today's FTTP
- Increased migration to digital channels on cable systems facilitates competitive signal quality with FTTP, HDTV channels, and on-demand access

FTTP vs. Cable Today (cont.)

- To compete, cable systems can be segmented (using more fiber to serve fewer homes) for some time to come
  - Coax cable can still carry several gigabits per second, and the user's applications don't yet demand this
  - Notice that the past trend, even in well served markets, is to provide cable modem capacity that is just good enough to compete with DSL, etc, despite the technology to offer substantially more today!
- Currently, FTTP is technically the better product from the end-user perspective
- Ultimately, cable operators are likely to naturally evolve into FTTP providers, but not until the applications and COMPETITION demand it

An final note about communications technology myths…

- Consider carefully the source of information
  - Hardware vendors obviously bought into the technology they sell (or are very hopeful), but the hype may be very speculative
  - Commercial carriers align their technology choices, network architectures, and lifecycle plans with their bottom line, not necessarily your business requirements
- Often times case studies chosen to demonstrate success have uniquely favorable conditions
  - “Results may vary…”
- Many myths and misconceptions are rooted in inconsistent terminology
  - “broadband”, “open-access”, “coverage”, etc.