
Long Reach WDM Access Networks and Other Access Researches in Taiwan

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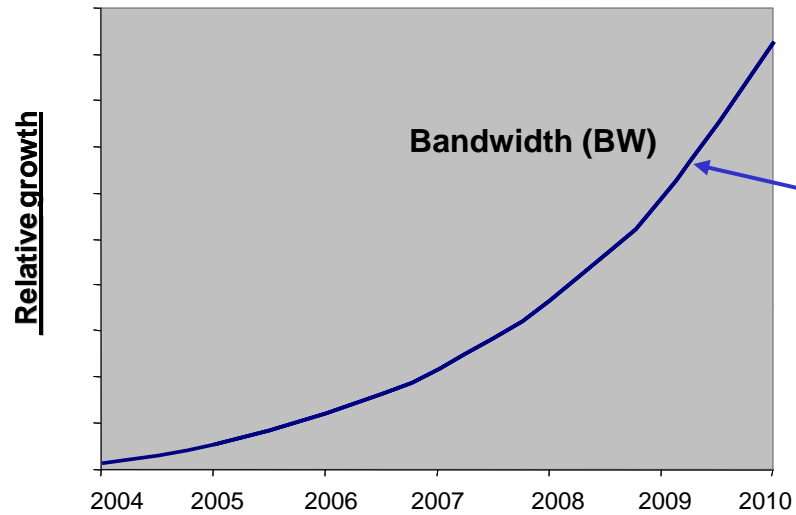
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Outline

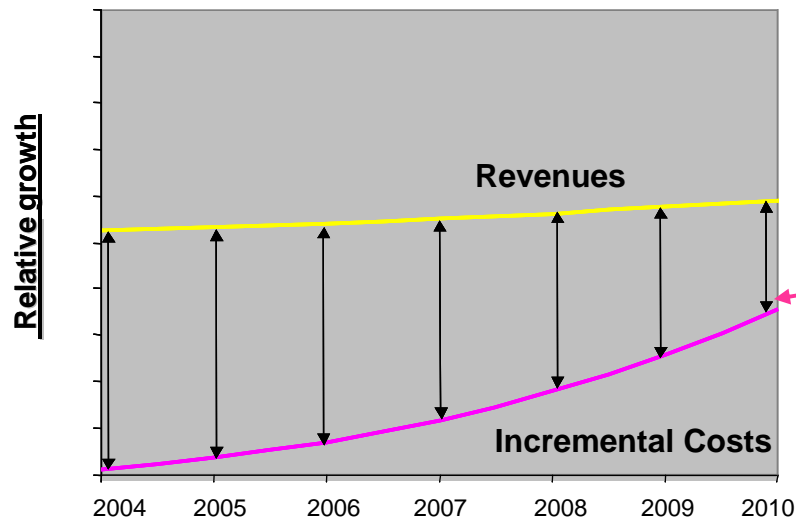
- Long reach WDM access networks
 - Challenges, architectures
- Fiber to the Antenna (FTTA) access networks
 - WiMAX FTTA system



Bandwidth Growth – The Profit Margin Challenge



Greater bandwidths
- New services
- Maintain/grow revenues

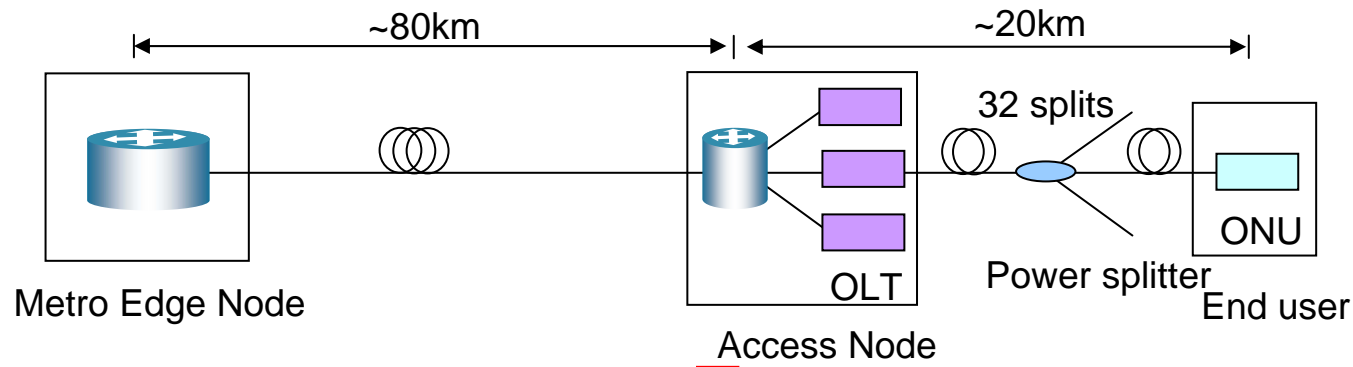


But costs rise faster

Each technology cycle, BW increases **X10**, but price of the service offering has only **X2** or less for each cycle

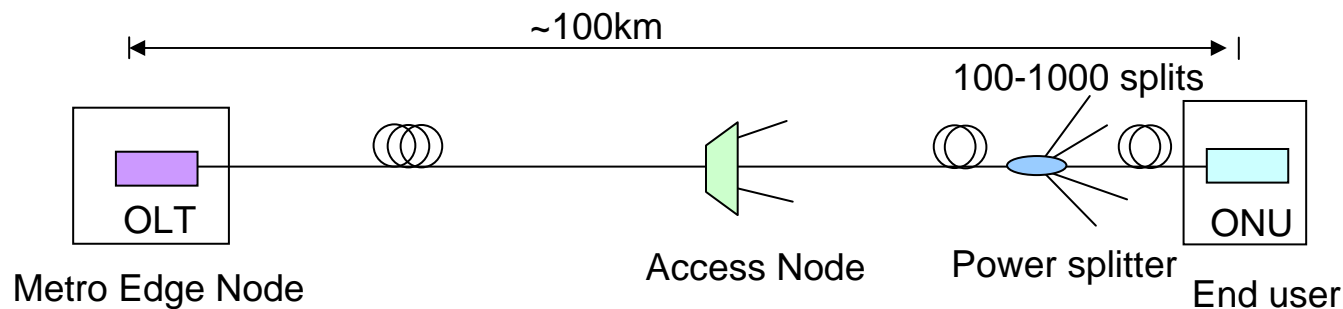
Long Reach Passive Optical Network (LR-PON)

Present PON



OLT: optical line terminal
ONU: optical network unit

LR PON



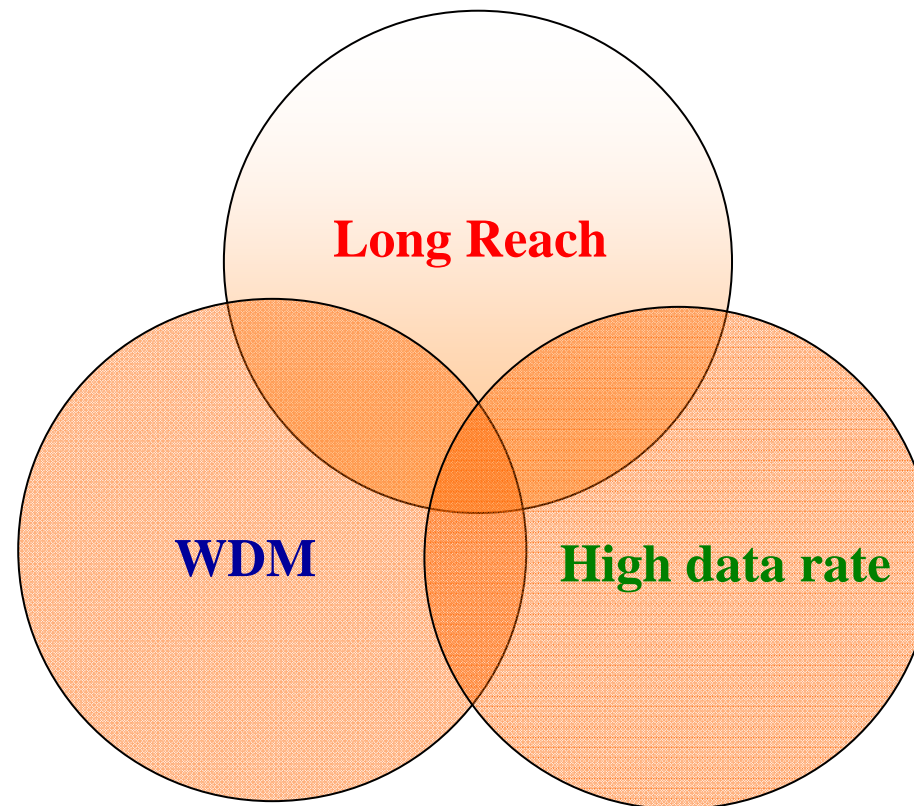
Since the underlying components (lasers, modulators, receivers etc.) cannot price decline a lot, only answer to reduce the cost is to reduce the number of interfaces, equipments and even network nodes

Long-reach (~100km) and high-split-ratio (100-1000) PON

- to integrate access and metro sections
- to reduce cost by simplifying network architecture
- wavelength division multiplexed (WDM) is usually considered



Features of LR Access



The LR access network will base on a new type of optically amplified, long reach (~100km) with high split-ratio (>100), high data rate, WDM PON



Challenges for LR PON

High power loss (e.g. 32 dB splitting loss for 1024 splits, ~30 dB fibre loss):

- Upstream, output power limited by ONU
- Stimulated Brillouin Scattering (SBS) limits launch optical power

Gain transient compensation for erbium-doped fiber amplifier (EDFA)

High speed Upstream Burst-mode Rx

Cost sensitive ONU (Tunable ONU/Reflective ONU):

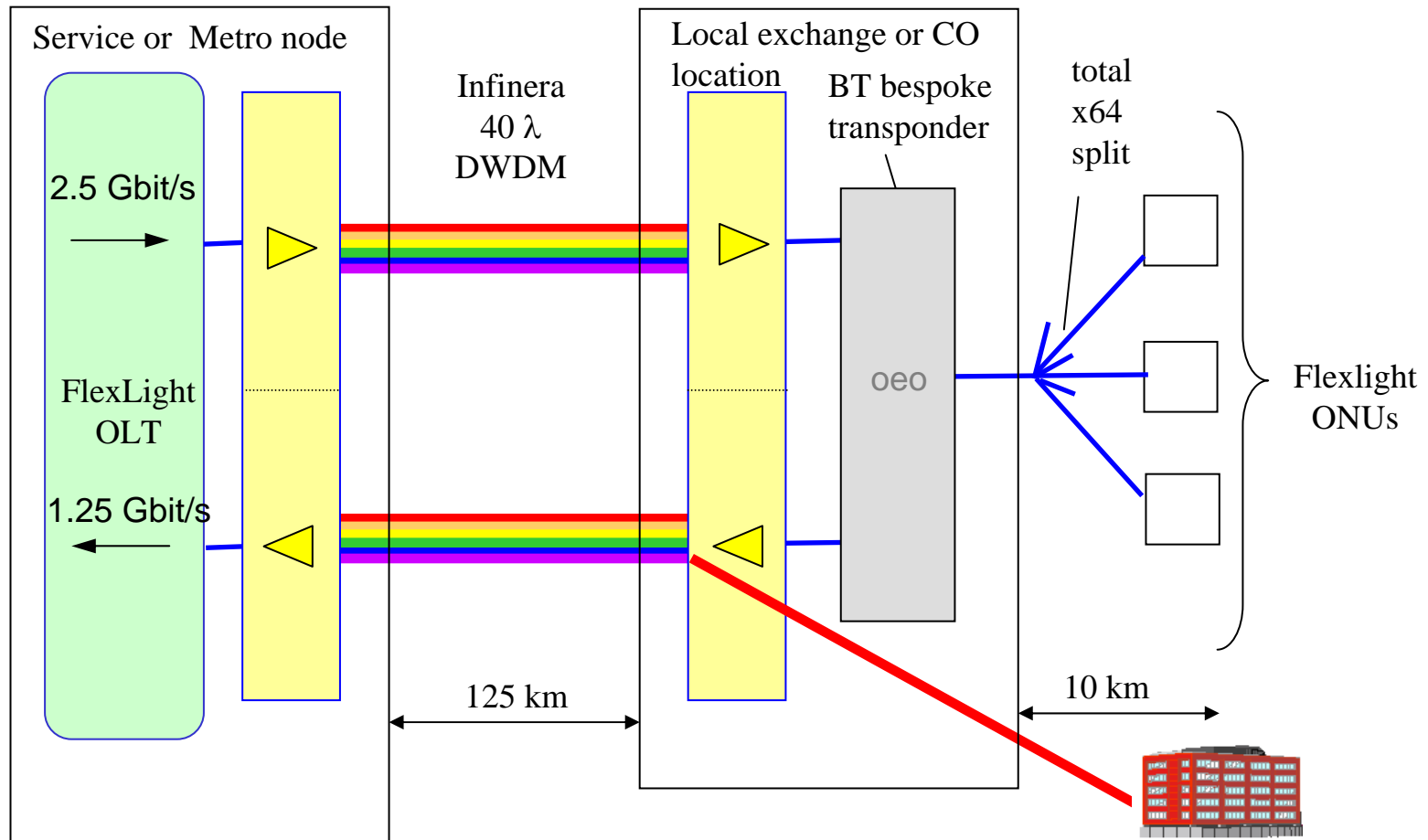
- Deployed at customer, should be low cost
- Wavelength stabilization (TEC, wavelength locker)

Long reach: fiber chromatic dispersion

10 Gb/s: External modulation or spectral efficient modulation formats

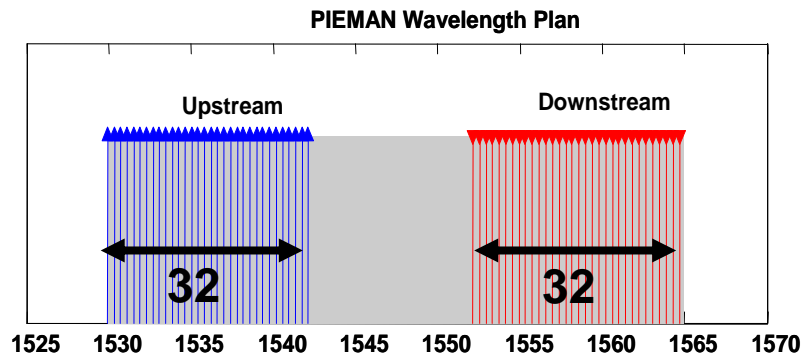
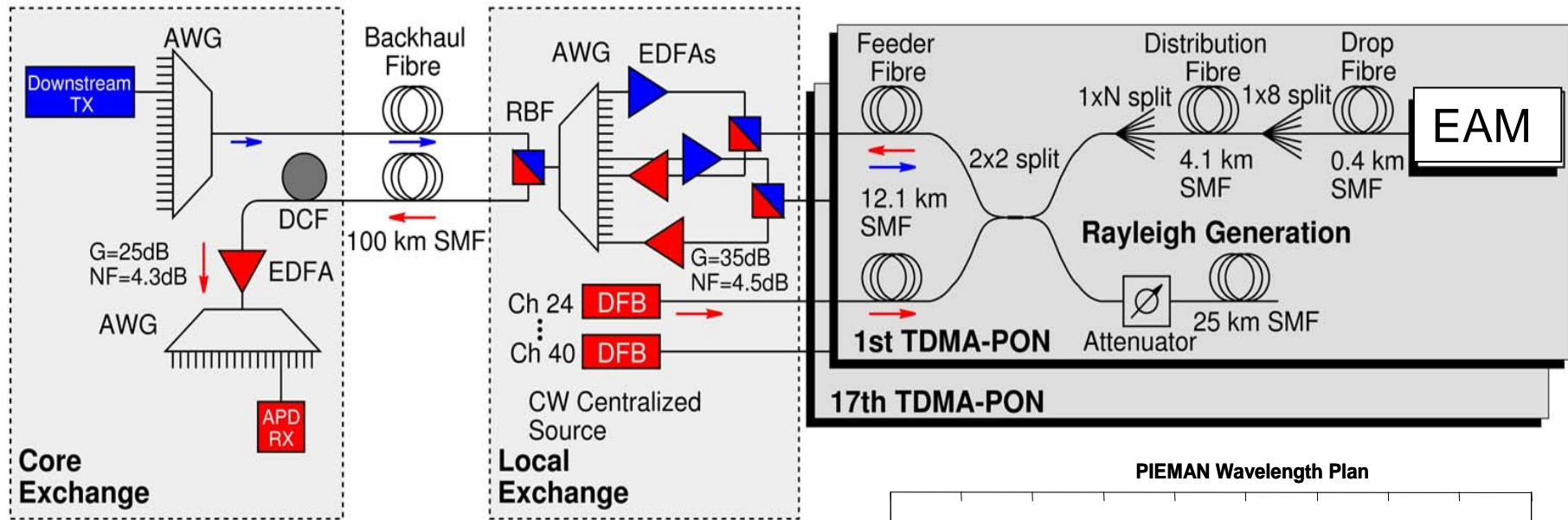


DWDM reach extension of GPON to 135 km



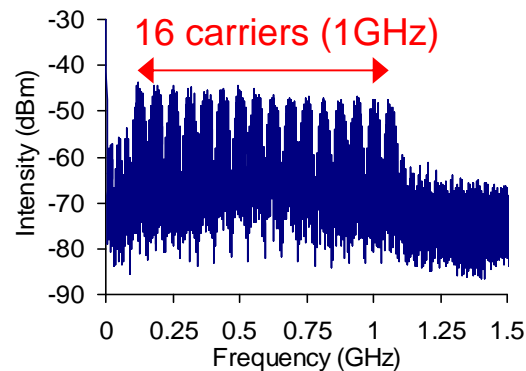
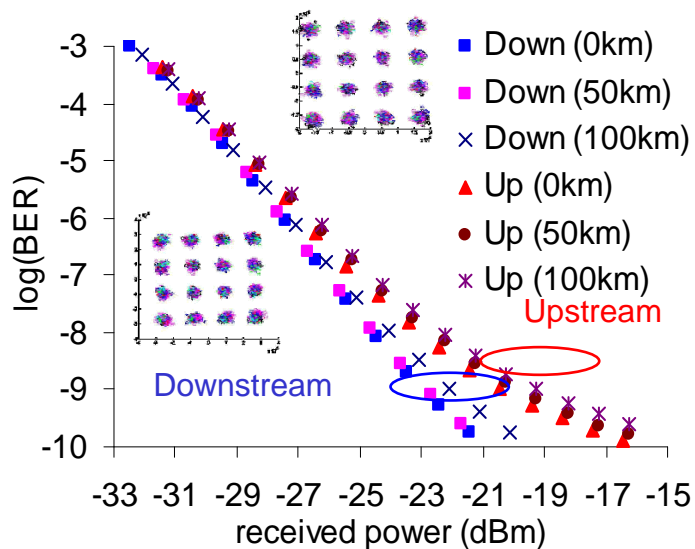
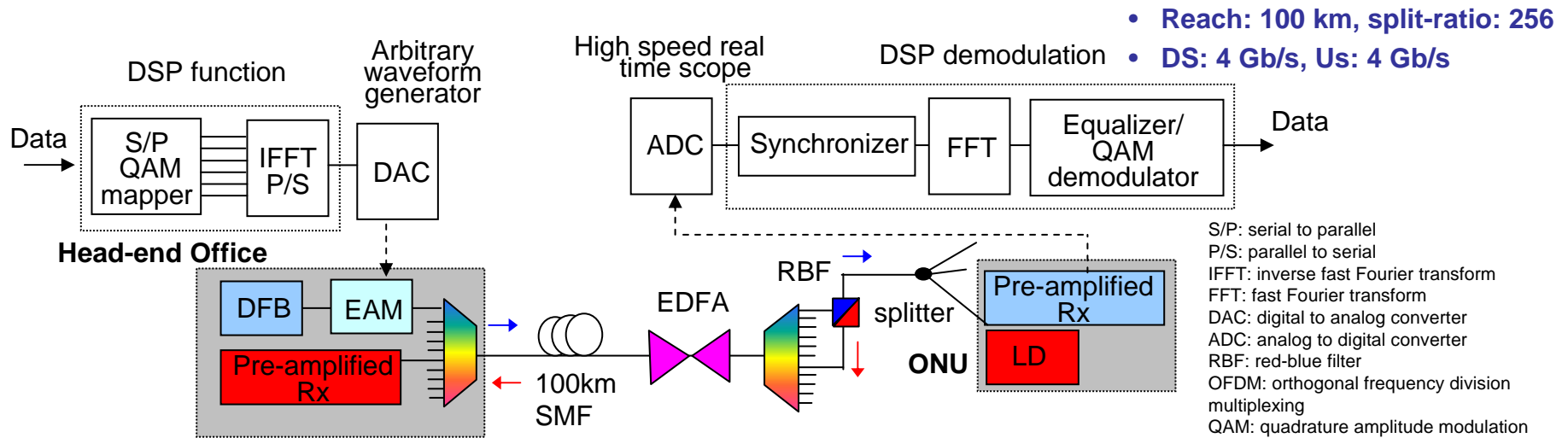
- Reach: 135 km, split-ratio: 64
- DS: 2.5 Gb/s, US: 1.25 Gb/s

10 Gb/s Carrier Distributed Long Reach PON with Colorless ONUs



- Reach: 116 km, split-ratio: 256
- DS: 10 Gb/s, US: 10 Gb/s

Experiment of LR-PON using OFDM-QAM

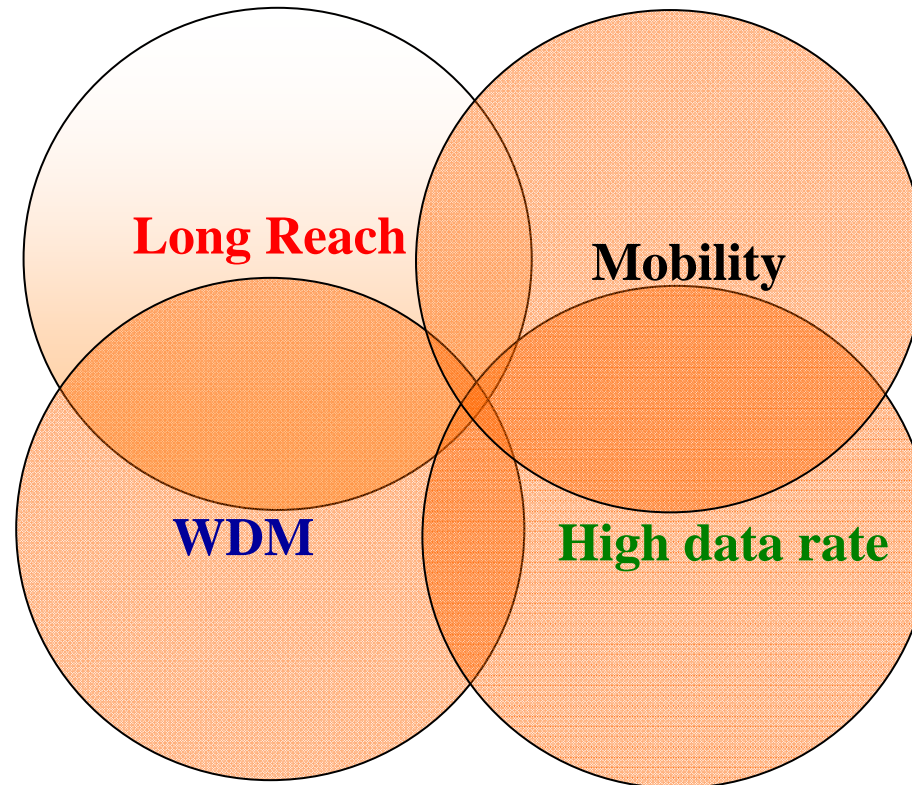


The 4Gb/s OFDM-QAM signal occupied the spectrum of ~1GHz

- Frequency diversity transmission of OFDM enables chromatic dispersion mitigation
- This also solves the frequency ripple problem caused by low cost components
- Due to high spectral efficiency of QAM, low-bandwidth optical components optimized for GPON (~1Gb/s) can be used

C. W. Chow, et al, CLEO'08, CPDB7, USA

Features of Future Access

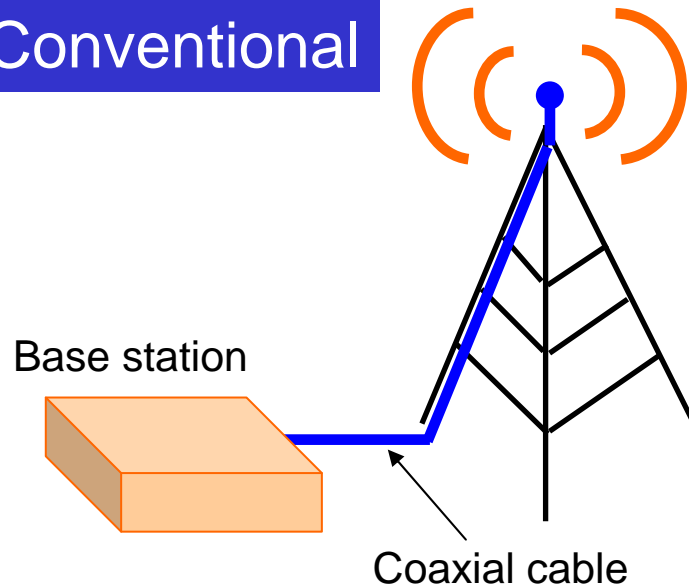


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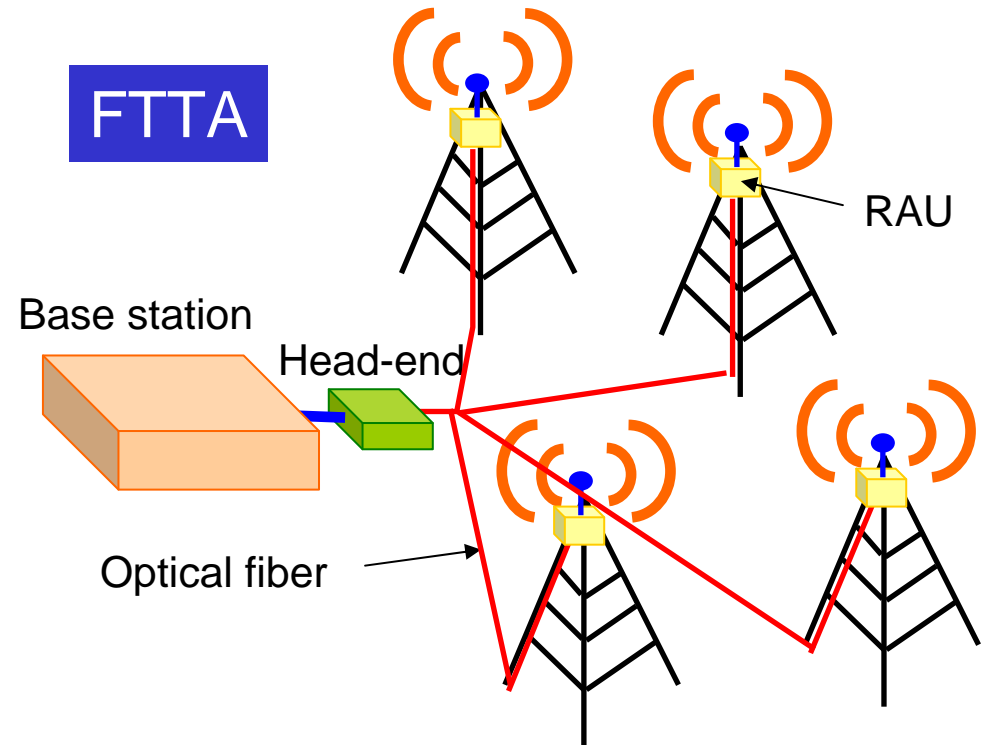


WiMAX FTTA Access Network

Conventional



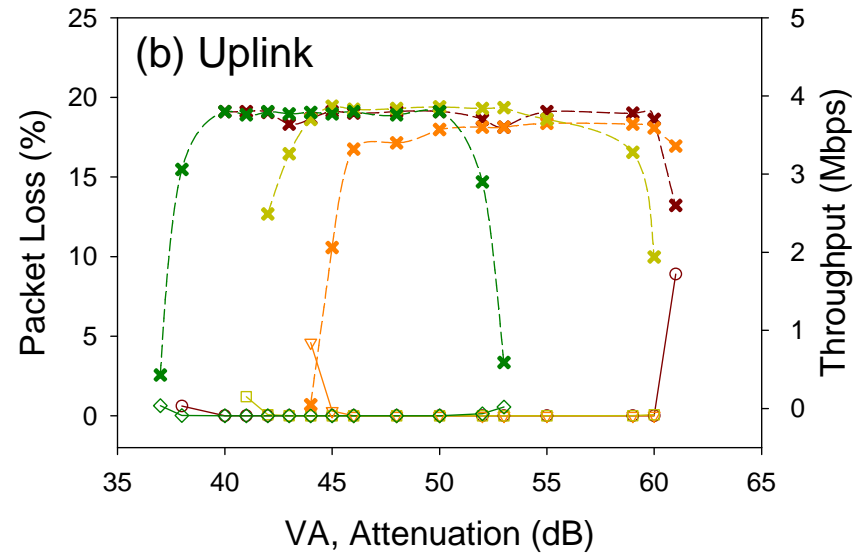
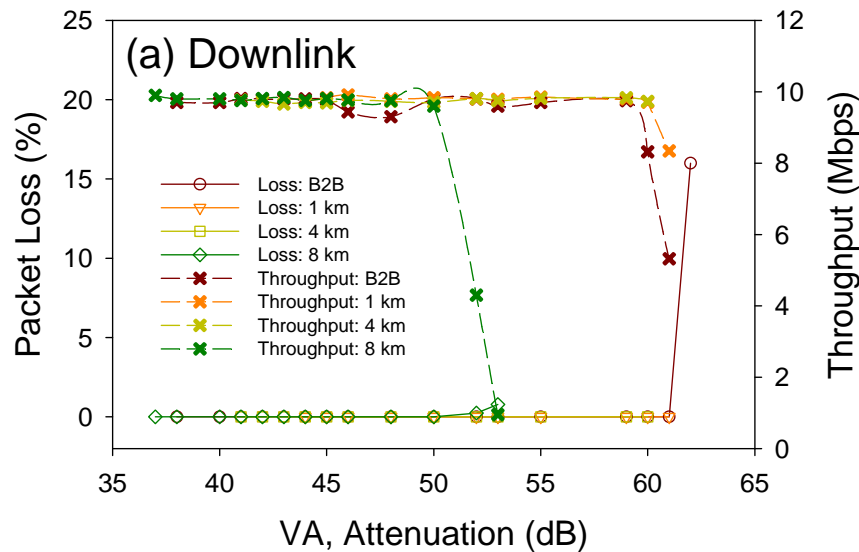
FTTA



- WiMAX (Worldwide Interoperability for Microwave Access) for the last mile connection to provide flexible access services to end users
- FTTA can extend the RF signal distribution by using loss cost and low loss optical fibers
- Reduce base stations (BSs) by using head-end (HE) and low cost remote antenna units (RAUs)
- It is particular suitable in tunnels where distribution of wireless signal is restricted

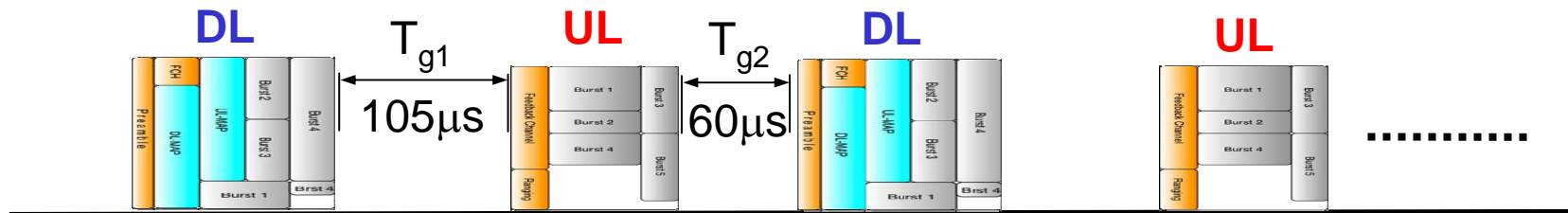


Preliminary Measurement Results



- The DL and UL throughputs are at ~10 Mb/s and ~4 Mb/s respectively
- **WiMAX-over-fiber** distance is limited to 8 km

Time Division Duplex (TDD) system limits the transmission distance



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Thank you
