Optical Access

Free-Space Ethernet-Based Optical Mesh Networks for First Mile Connectivity

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The Problem

- Enterprise and Small Businesses are the initial Target customers for service providers: T1, Ethernet, DS3, Fast Ethernet, OC3 …
- For Multi-tenant Buildings and single home, the need to support voice, data and video especially real-time interactive video for distance learning (considered the killer application of the Internet)
- Absence of fiber in the last mile: In San Diego, only 3% of business buildings are on fiber and 75% of the rest are within one mile.
- Barriers to fiber deployment:
  - Economics: Requirement for end user long-term commitment.
  - Time to service: Competing wireless technologies.
  - Right of way and permit obstacles (worst internationally)

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Technology

- **The Network: Ethernet based IP Mesh**
  - Seamless integration into corporate networks and the Internet
  - Carrier class resiliency
  - Easy to build flexible topologies
  - Simple to install, provision and manage
  - Low cost and easy to support growth (pay as you grow ..)
  - Redundancy and restoration at all levels for Network survivability
  - QoS: DiffServ, ToS, MPLS
  - Security and Management

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Technology

- **The Transport: Free space optical communication systems**
  - No dependency on any cable plant
  - Line of sight
  - Unlimited Bandwidth
  - No FCC licensing required (space is FREE when it comes to light)
  - Same day installation
  - You own the system: Transportable upon service termination (No need to long-term commitment)
  - Limitation: affected by weather condition, especially FOG
  - Microwave Backup for 99.999% link availability
  - Immunity from interference
  - Low maintenance cost

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Technology

- **The Transport: Free space optical communication systems**
  - Easily upgraded
  - Low Bit Error Rates
  - Low latency (propagation delay)
  - Easy to use
  - Highly Secure (wide military applications)
  - Compatible with WDM technology
  - Low power consumption
  - Multi-protocol Support

Piece of History: In 1881, Graham Bell introduced the first wireless phone *PhotoPhone*, which modulated sunlight to transmit voice.

Microwave Backup

- Microwave backup support to guarantee carrier-class link availability of 99.999% and better.
- Modular architecture that supports any standard physical interface microwave product (Unlicensed, LMDS, MMDS..)
- **Backup link supports lower data rates than the optical link (1000/100 and 100/10 as examples) → need to define rate adaptation while maintaining QoS for real-time and critical network data.**

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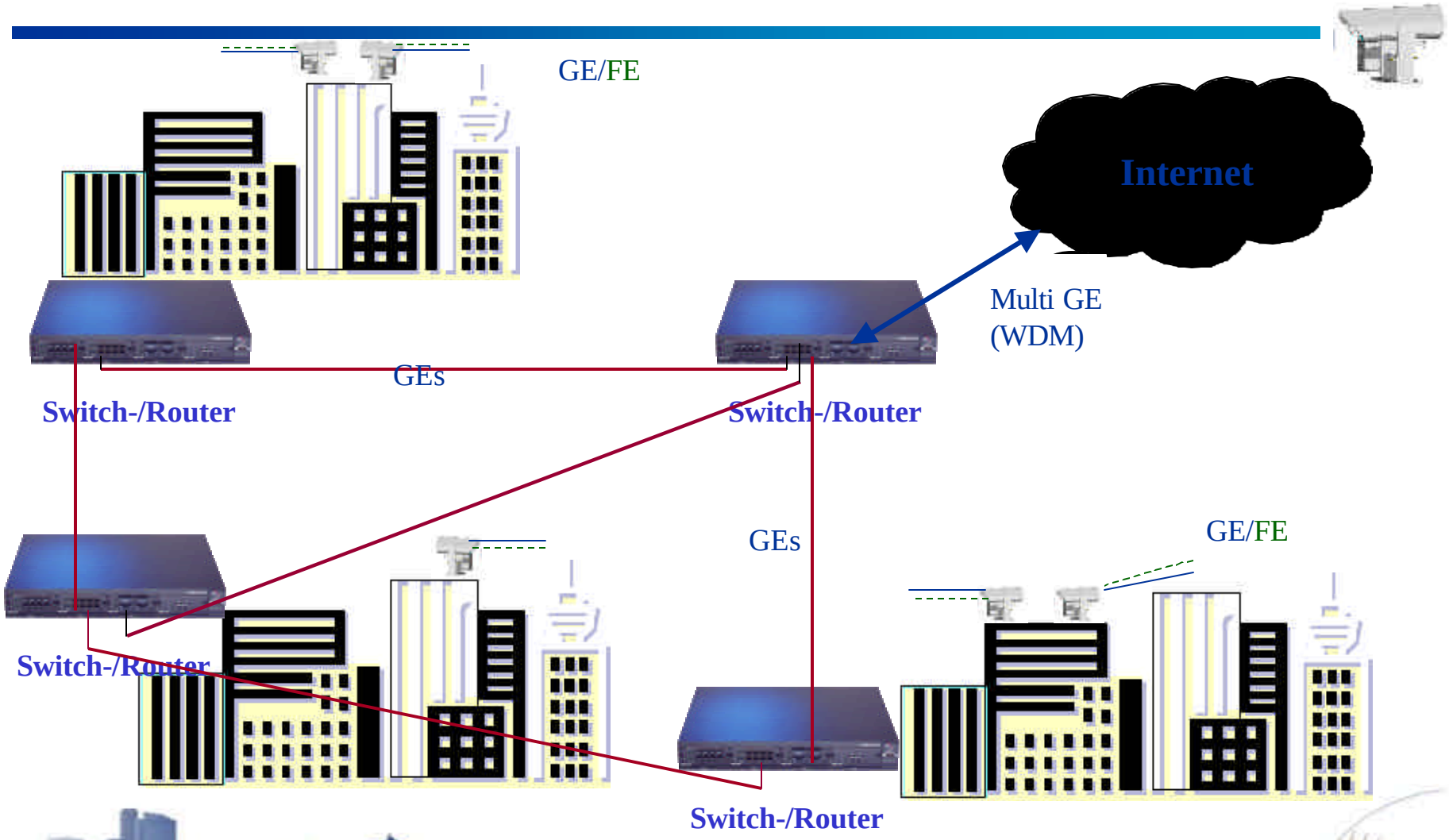
Inter-LANs Connectivity



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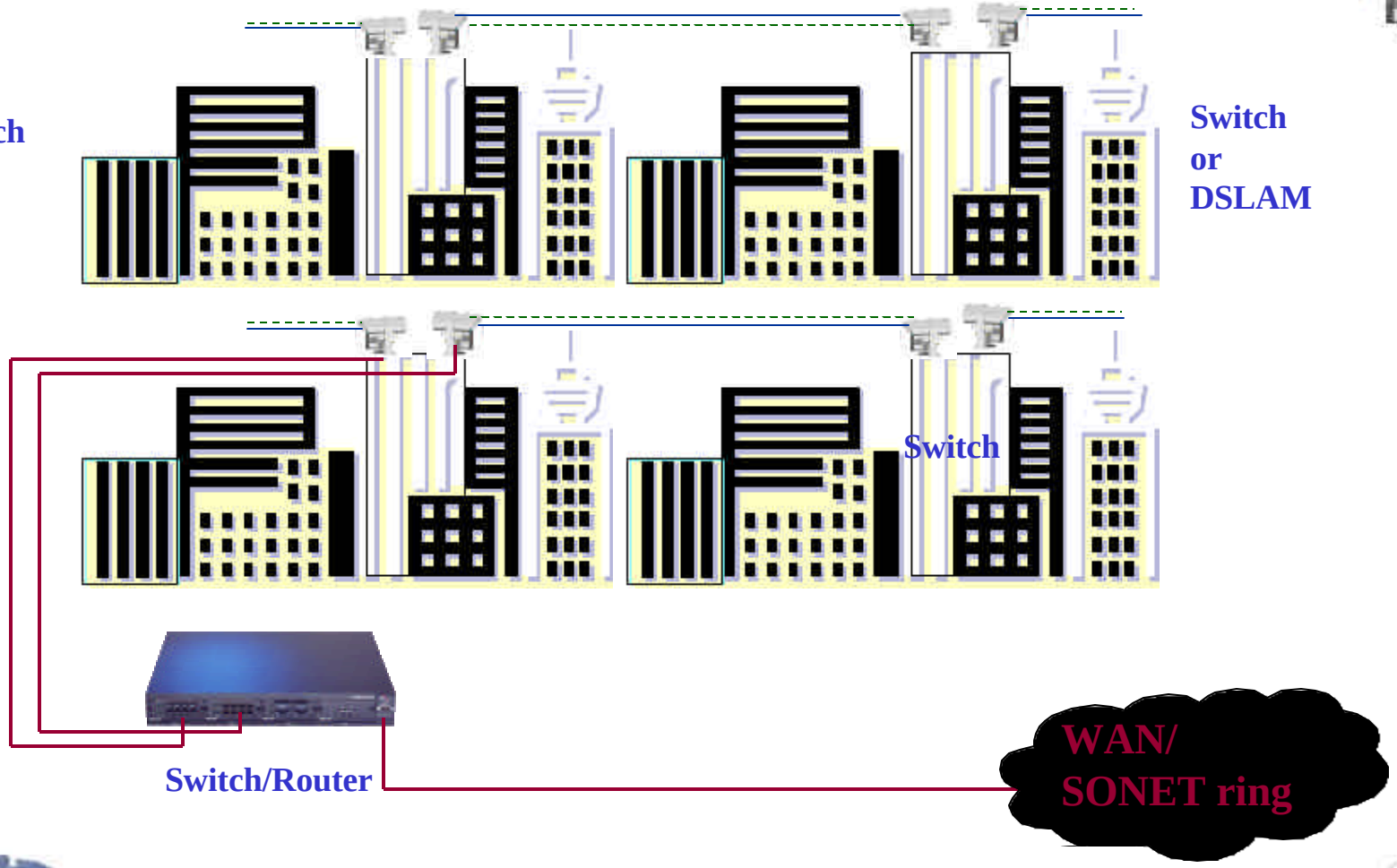
GEs Wireless LAN



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Five Criteria

- QoS
- Scalability $\rightarrow$ Low Cost
- Support of different transport media: rate adaptability
- Symmetrical High Data Rates
- Survivability: Faster Network recovery time

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PIECE OF HISTORY

- As a Harvard student, Metcalfe was searching for a thesis idea. He believed that by using advanced mathematics, called queuing theory, Network performance can be improved without damaging its essential elegance and simplicity. Metcalfe's discovery is known as Ethernet. His thesis was initially rejected.
- Metcalfe then writes "And of all variations of multimedia, the one that will drive ATM is personal computers videoconferencing – interactive, two-way, real-time, integrated digital voice, video and data. Ethernet will remain as a legacy LAN".
- Kleinrock, the father of queuing theory, declared that collision-detection of Ethernet will drown with large bandwidth, short packets and long distances.
- Ethernet is a simple system that is stabilized by its own failures. As Metcalf explains: "Ethernet works in practice but not in theory"
- Metcalfe's law and legacy will win again, in spite of his own suspicions.