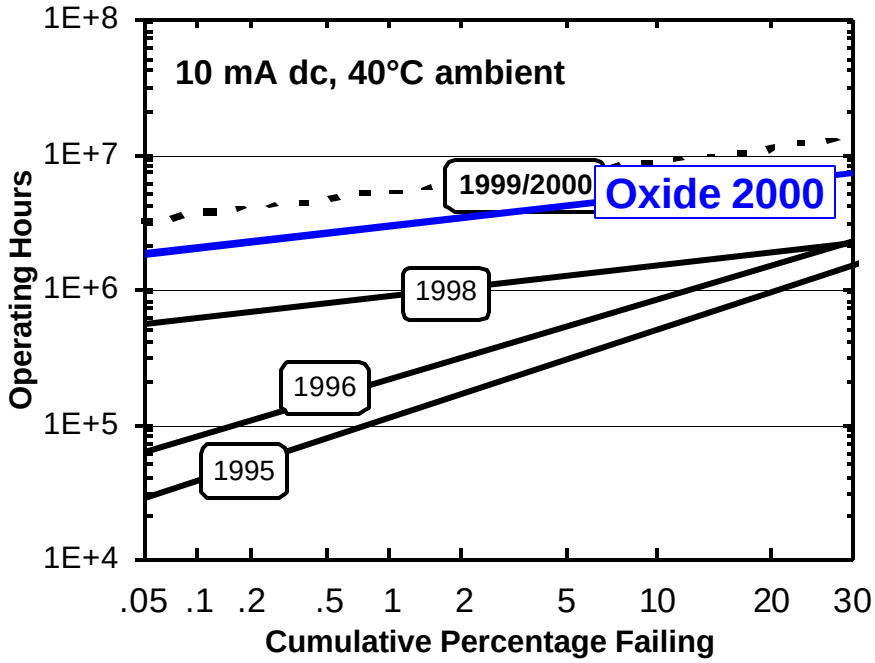
VCSEL Based Bi-directional (1310nm up, 1610nm down) links for IEEE802.3ah Applications

Dr. Jim Tatum
Honeywell VCSEL Products
830 E. Arapaho Road
Richardson, TX 75081
(972) 470-4572
jim.tatum@honeywell.com

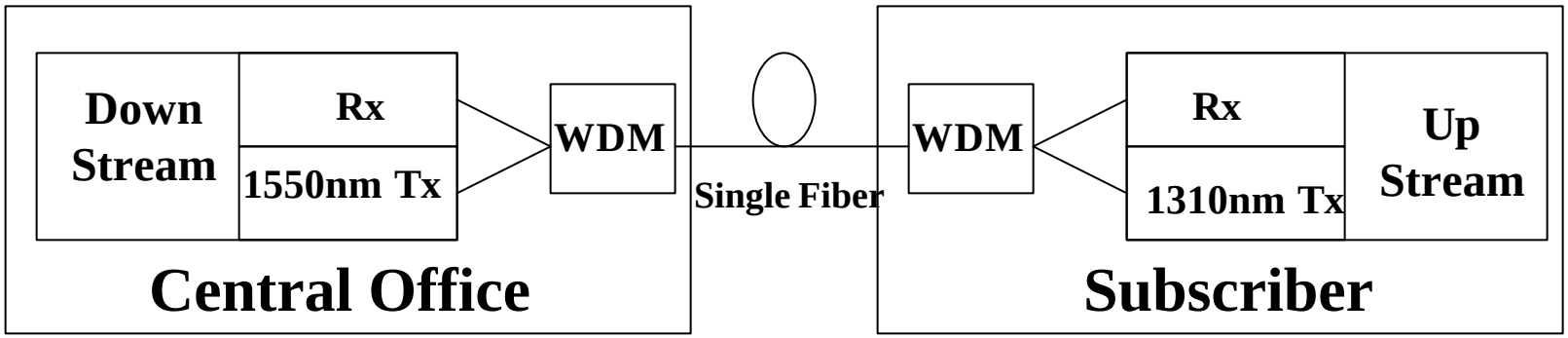
VCSEL History (850nm)

- Commercialized in 1996 by Honeywell
- Many millions of VCSELs in the datacom space today
  - Extremely high reliability
  - Excellent performance at speeds up to 10GB/s
  - Proven volume manufacturing
- Cost effective solution



FTTX Architectures

- Bidirectional (point to point)
  - Single fiber
  - Nearly unlimited bandwidth
  - Lowest cost optical components



- EPON (point to multipoint)
  - Broadcast dependencies
  - Costly optical components (both active and passive)

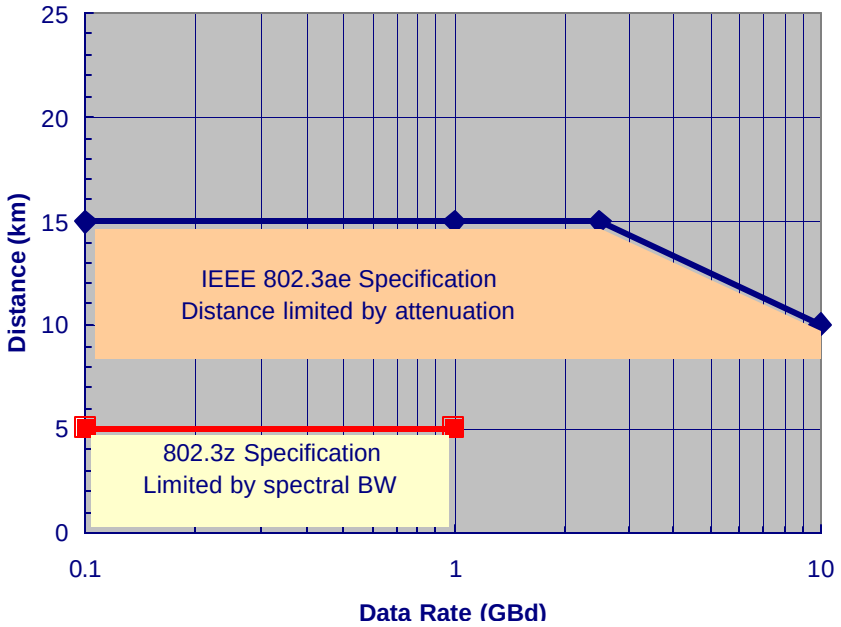
1310nm VCSELs

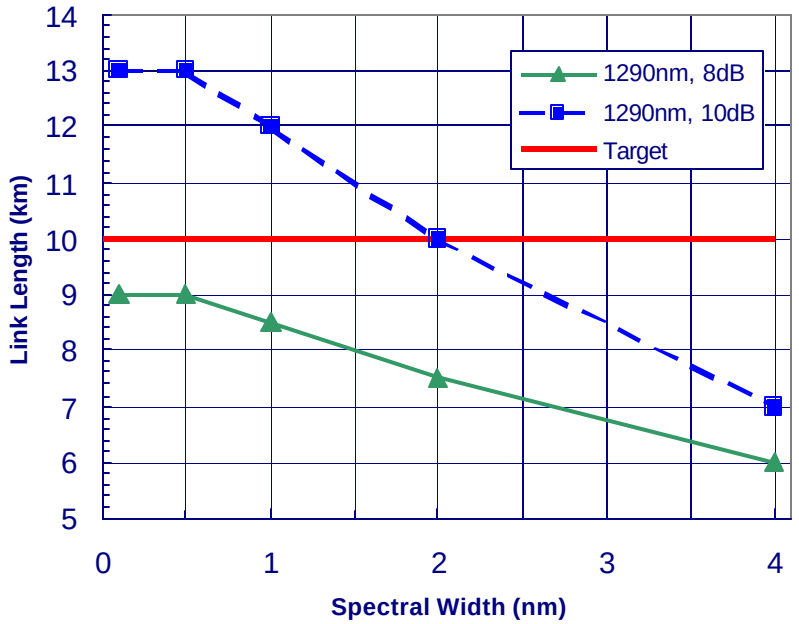
- Under development by several companies
  - Honeywell
  - Cielo
  - Infineon
  - Picolight
  - Emcore
  - Others
- Material challenges are being overcome
- Commercialization is anticipated in 2002, some issues are:
  - Power
  - Single spatial mode
  - Temperature
  - Reliability

1300nm VCSEL State of the Art

- Operation to 125ºC
- Maximum single mode power at room temperature ~1mW
- Reliability - No published long term data
- Materials
  - InGaAsN/GaAs
  - InGaAsNP/GaAs
  - InGaAsNSb/GaAs
  - Highly strained InGaAs/GaAs

1300nm VCSEL Link Simulations (1GBd)





- Ways to increase the link distance
  - Increase power budget (Min Tx power launch, Rx sensitivity)
  - Reduce spectral bandwidth
- VCSELs can meet both of these
  - Min Power launched -8dBm
  - RMS spectral BW < 0.5nm
  - Links exceed 10km with lowest cost

Longer lengths achieved with increased power budget (12dB to get 20km)

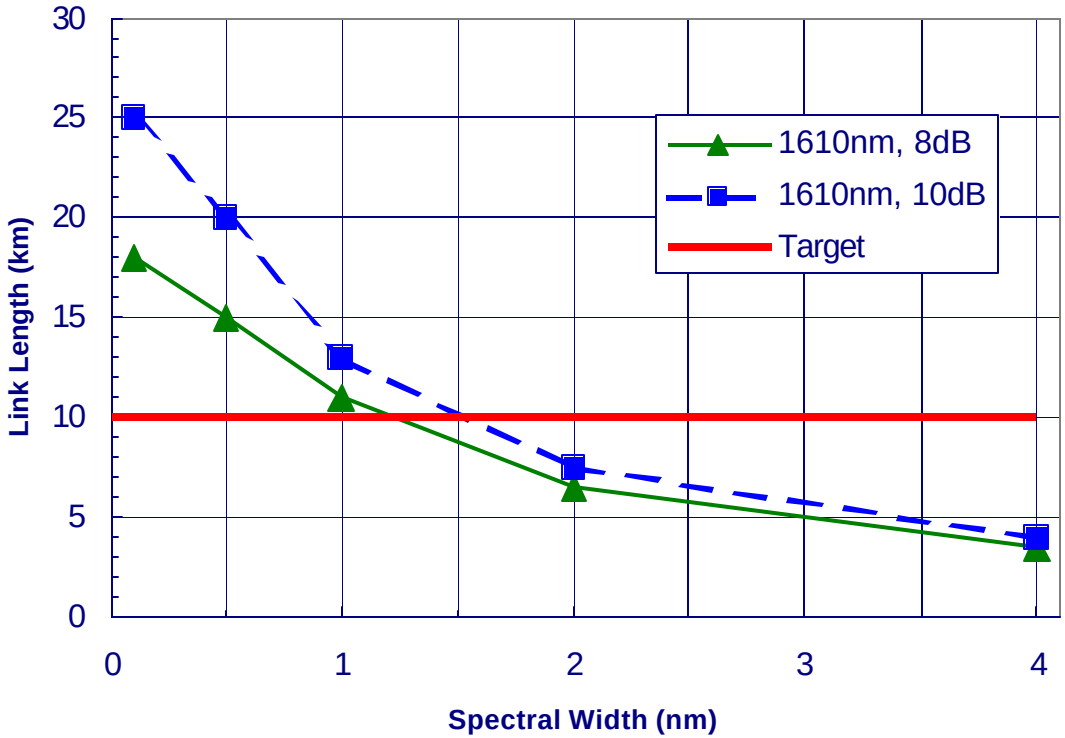
1550nm VCSELs

- Under development by several companies
  - Honeywell
  - Bandwidth 9
  - Agility
  - Others
- Material challenges are being overcome
- Commercialization is anticipated in 2002, some issues are:
  - Power
  - Single spatial mode
  - Temperature
  - Reliability

1550nm VCSEL State of the Art

- Operation to 88 ºC
- Maximum single mode power at room temperature ~1mW
- No published long term reliability
- Materials
  - InGaAlAs/InP
  - GaAsSb/GaAs
  - GaAsSb/GaSb
  - InGaAsP/InP
- VCSELs can be made across the wavelength span of 1490 to 1610
  - Link budget is nearly agnostic
  - To leave the C band open for future access, specifications could be written for either the L or S band

1550nm VCSEL Link Simulations (1GBd)



- Current IEEE 802.3ae specifications are overkill with regard to power budget (launch power) and requiring single mode sources
- 1550nm VCSELs can meet requirements for 20km links
- Wavelength range is from 1490-1610 (1610nm used as worst case

VCSELs…. Good to the Last Mile!

- Adopt flexible VCSEL friendly specifications for IEEE 802.2ah
  - Allows direct upgrade path from 100MB to 10GB
  - Multiple vendor support
- Key specifications for achieving 20km links (1300nm)
  - 1290-1350nm
  - 12dB power budget
    - Min power launched -7dBm
    - Min receive sensitivity -19dBm
  - 1nm spectral width
- Key specifications for achieving 20km links (1550nm)
  - 1490-1610nm
  - 10dB power budget
    - Min power launched -9dBm
    - Min receive sensitivity -19dBm
  - 1nm spectral width