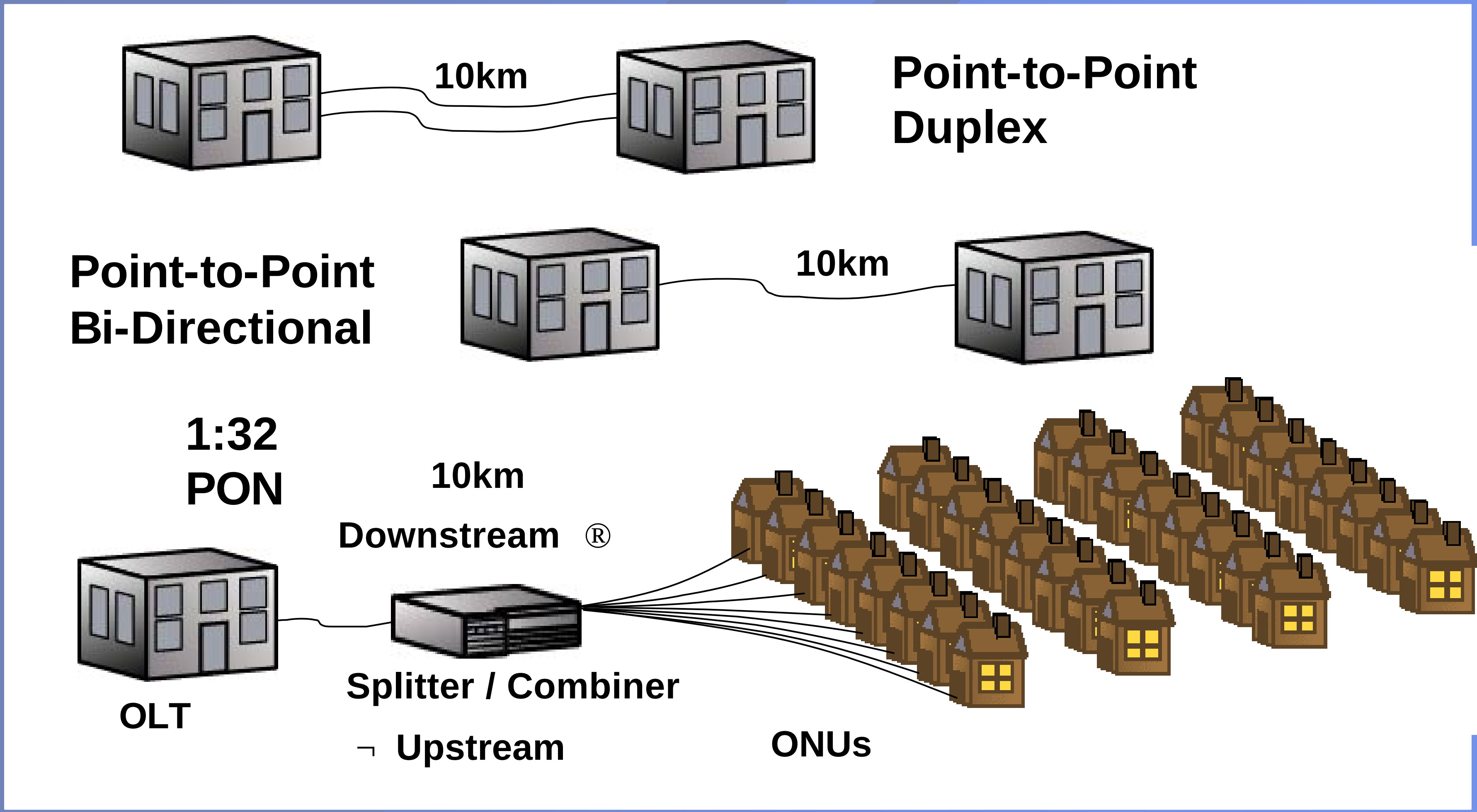
EFM PMDs

Jack Jewell, David Kabal, Chris Simoneaux

March 13, 2001

Access distributions



1000BASE-LXE: Point-to-point; duplex; GigE

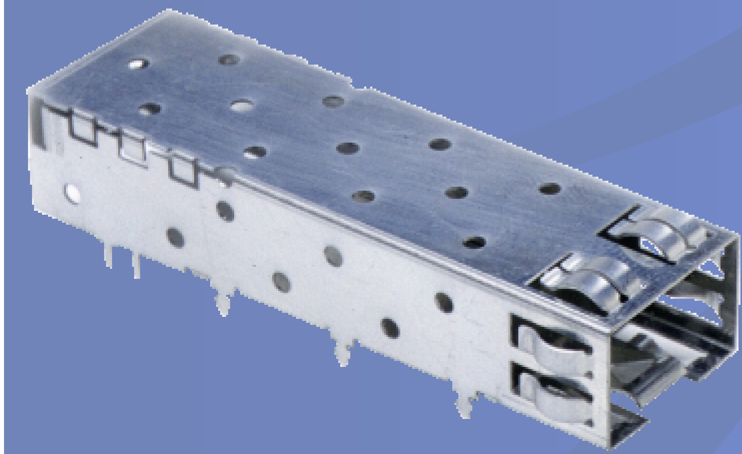
- SFP form factor
- Duplex LC (separate Tx & Rx)
- Like 1000BASE-LX
  - 10km reach

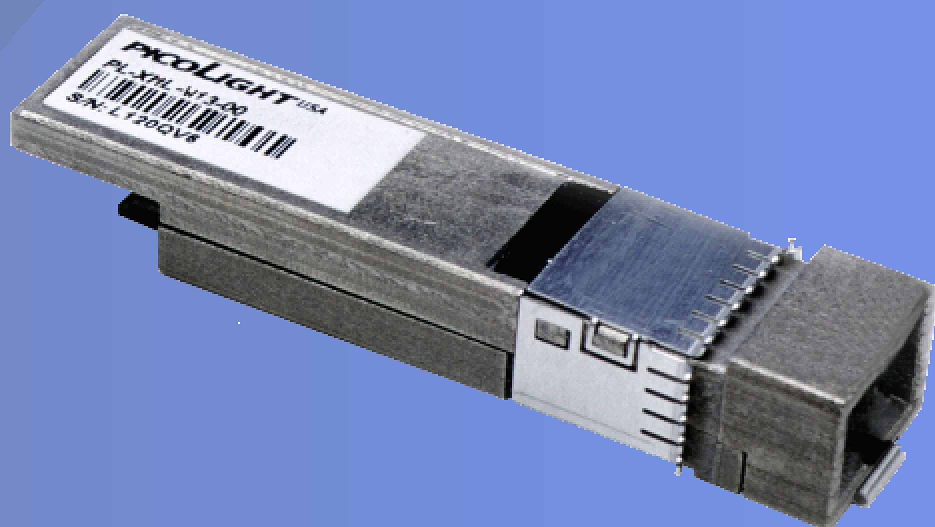
2001

PICOLIGHT

1000Base-BX : Point-to-Point; bi-directional; GigE

- Two SMF transceiver parts
- Single SC Connector
- “Downstream” 1260-1275 nm
- “Upstream” 1285-1310 nm
- ~Equivalent transceivers

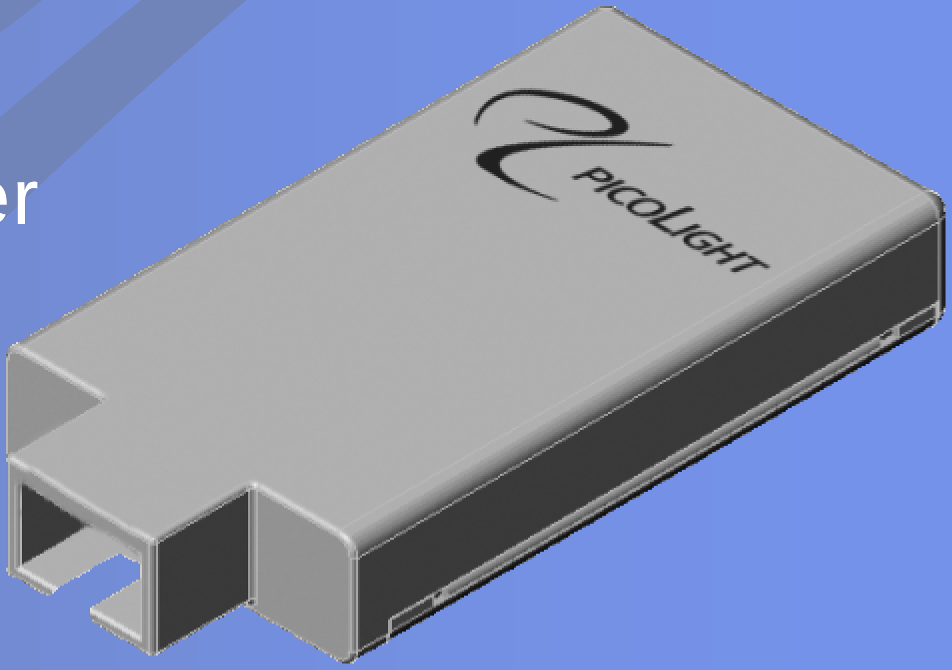




Late 2001

1000BASE-PX:
PON distributed; bi-directional; GigE?

- Dual 1310 nm or 1310/1550 nm bidirectional transceiver module
- High-loss link budget
- Burst-mode operation
- Module size depends on IC size
- Upstream + downstream modules differ greatly



2002

PICOLIGHT

Why Gb/s E-PONs?

- PONs form a naturally efficient architecture for neighborhood distribution – minimizes total length of fiber and number of transceivers
- PONs are already being deployed using OC-3 (upstream) and OC-12 (downstream)
- Industry at large would benefit from the increased bandwidth and from the format being Ethernet (or at least close to it)

1000BASE-PX Link Budget Summary

Link Power Budget and Penalties

Description	PX-U-S	PX-U-L	PX-D-L	PX-D-S
Operating Distance (km)	10	10	10	10
Fiber Modal Bandwidth (MHz-km)	1000000	1000000	1000000	1000000
Wavelength (nm)	1260	1310	1310	1260
Link Power Budget (dB)	26.0	26.0	26.0	26.0
Channel Insertion Loss (dB)	23.16	22.96	22.96	23.16
Link Power Penalties (dB)	0.69	0.55	0.55	0.56
Unallocated Margin (dB)	2.15	2.49	2.49	2.29
Pisi (dB)	0.30	0.19	0.19	0.20
Splitter Loss (dB)	17.0	17.0	17.0	17.0
Connections Loss (dB)	2.0	2.0	2.0	2.0

Transmit Characteristics

Description	PX-U-S	PX-U-L	PX-D-L	PX-D-S
Signal Speed (Gbaud)	1.250	1.250	1.250	1.250
Wavelength (nm)	1260	1310	1310	1260
Trise / Tfall (20%-80%) (ps)	150	150	150	150
Max RMS Spectral Width (nm)	1.00	1.00	0.50	0.50
Max Avg Launch Power (dB)	2.0	2.0	5.0	5.0
Min Avg Launch Power (dBm)	-2.0	-2.0	0.0	0.0
Avg Launch Power of OFF Transmitter (max) (dB)	-30	-30	-30	-30
Extinction Ratio (min) (dB)	9	9	9	9
Max RIN (dB/Hz)	-120	-120	-120	-120

Receive Characteristics

Description	PX-U-S	PX-U-L	PX-D-L	PX-D-S
Signal Speed	1.250	1.250	1.250	1.250
Wavelength (nm)	1260	1310	1310	1260
Max Avg Receive Power (dBm)	-15.0	-15.0	-12.0	-12.0
Receive Sensitivity (dBm)	-28.0	-28.0	-26.0	-26.0
Min Return Loss (dB)	12.00	12.00	12.00	12.00
Stressed Rx Sensitivity (dBm)	-15.46	-15.23	-13.73	-13.93
Vertical Eye Closure Penalty (dB)	2.60	2.60	2.60	2.60
Receive electrical 3dB Upper Cutoff Frequency (max,MHz)	1500	1500	1500	1500

KEY	
PX-U-S	10km; PON; Upstream; Shorter wavelength
PX-D-L	10km; PON; Downstream; Longer wavelength
PX-U-L	10km; PON; Upstream; Longer wavelength
PX-D-S	10km; PON; Downstream; Shorter wavelength

Yellow	Characteristics of OLT transceiver
Light blue	Characteristics of ONU transceiver

PICOLIGHT

PON issues

- 32:1 splitter/combiner means 15dB loss
- Higher Rx sensitivity required, but dynamic range not greatly affected

- Upstream traffic not always present and needs coordination
- ONU transmitters must “warm up” before sending data – more sophisticated drive circuitry
- OLT receiver must rapidly respond to rapid changes in incoming signal strength

PICOLIGHT

EFM and Gigabit Ethernet

- Logical next steps
  - Build on GigE success and adoption
  - NEW PHYs or PMDs for GigE
- EFM opportunities (NEW PHYs for GigE)
  - Point to point access links (2001: 1x 1000BASE-LXE)
    - Higher link budget
  - Bidirectional access links (late 2001: 1.5x-2.0x 1000BASE-BX)
    - Single fiber; simple, reliable connector
    - 10 km, dual wavelength 1310 nm using high-volume, cost-effective VCSELs, DFBs, FPs
  - Passive optical networks [PONs] (2002: 3x-4x 1000BASE-PX)
    - Single fiber; simple, reliable connector; high-loss splitter/combiner; burst-mode ICs; Ethernet compatible?
    - Provides transceiver and cable plant density

PICOLIGHT

Summary

- EFM PMDs outlined
- Draft specifications for Gb/s PON links
  - 1310 / 1550 nm wavelengths (upstream / downstream)
  - Specs designed to reduce cost of ONU transceivers which outnumber OLT transceivers by 32:1
- PONs hurdles include IC availability

PICOLIGHT