Distributed Fiber LAN Architectures in the Enterprise...Not So Weird Anymore

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90m was not a technology limitation, but many Telco “closets” were located within that distance.
When introducing the desktop computer and IP telephony to the workspace, the logical place for connectivity was in the same location as the telephone connection and thus led to standardization of horizontal cabling distances.
Traditional Ethernet

Main Telecom Room | Intermediate Telecom Room | Work Area

Fiber | Power | Cooling | Battery | Back Up

24 Fibers MPO LGX Cassette | 24 Fibers MPO LGX Cassette | Copper

Fiber | Copper | Copper
Today we have many other IP Devices that are located throughout our buildings in areas that are not desktops. In many cases we are forced with making the decision of how to adhere with the horizontal cabling distance limitations. Do we violate the limit? Do we build additional Telecom Rooms? Do we locate devices in less than ideal locations to adhere to the limit?
Evolution

- Ethernet Cable
- OM1/2

90m  |  500m  |  Beyond
A look back... Fiber LANs of the past

FDDI – 100Mb/s
Challenges

- Two Transceivers per device/location $$$
- Desk side transceiver/media converter reliability ↓
- Typically ST connectors (non Pull-Proof) ↓
- Costly multimode fiber $$$
- No management of remote devices ↓
- Limited physical flexibility ↓
Evolution

Category Xx

OM1/2
OM3
OM4

OS1/2

90m
500m
Beyond
**Distributed Fiber LANs**

**WHAT**
- All Fiber LAN Architectures
- Future proof cabling
- Distributed zone architecture
- Reduction in telecom rooms
- Smaller pathways
- Not distance limited
- Reduction/Elimination of HVAC
- Simplified management
- Flexible architecture

**WHERE**
- Hospitality
- Assisted Living
- Education (K-12 and Higher Ed.)
- Healthcare
- Military / Government
- Campuses
- Commercial Office
- Sporting Arenas / Stadiums
- Airports, Shopping Centers, Casinos
Passive Optical LAN

- Alternate structured cabling topology based on GPON FTTH architecture
- Based on ITU-T standards, but recognized for the Enterprise by ANSI/TIA and BICSI
- Point to multi-point, topology with committed information rates and bandwidth on demand
- **Passive Optical Network** over Singlemode fiber using passive optical splitters instead of active Ethernet switches
Passive Optical LAN

OLT

CORE

MDF

Splitter

IDF/Zone

ONT

WAO

ONT

WAO

ONT

WAO

ONT

WAO

Any IP Enabled Device

Category Cable

Singlemode Fiber

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Benefits

- **CapEx Savings (50-75% reduction)**
  - Significant Cu cable reduction
  - No cooling or battery backup

- **OpEx Savings (~50% reduction)**
  - No switches, UPS, and cooling

- **Space and Pathway Savings**
  - Reduction of Telecom Rooms
  - Significant cable mass reduction
  - Reduced fire load and fire stopping

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**Network Integration**
- Multiple 1G and 10G Ethernet Uplinks
- IEEE 802.3ad Link Aggregation Control Protocol (LACP)
- IEEE 802.1Q VLAN Encapsulation
- IEEE 802.1w Rapid Spanning Tree (RSTP)
- IEEE 802.1s Multiple Spanning Tree (MSTP)
- Virtual Router-to-Router Redundancy (VRRP)
- IPv4 / IPv6
- IGMPv2 / IGMPv3
- Network Access Control (NAC)
- IEEE 802.1x (Port-based Authentication)
- Dynamic Host Control Protocol (DHCP)
- DHCP Snooping and Option 82 insertion
- Port Security, Sticky MACs
- RFC-2267 (Denial of Service)
- Traffic Storm Control
- Bridge Protocol Data Unit (BFDU) Guard

**Service Delivery**
- 802.1p: Class of Service
- IP differentiated services code point (DSCP)
- Quality of Service: Per-VLAN, Per-Port, Per-Service queuing / scheduling *
- Sophisticated Qo5 and Traffic Management
- Eight Queues per VLAN
- Policing, Scheduling, Shaping per Queue
- Congestion and Flow Control
- Hardware Based ACLs: L2, L3, L4
- Hardware Based Multicast Management
- IEEE 802.3af, 802.3at (PoE)
- Link Layer Discovery Protocol (LLDP)

**Monitoring / Management**
- SNMP v1, v2, v3
- CLI Console Port
- Remote Monitoring (RMON) software agent
- RMON I & II
- Enhanced SNMP MIB support
- RFC 1213-MIB (MIB II)
- Extended MIB support
- Network Timing Protocol (NTP)
- RADIUS based authentication
- SSH v1, v2
- VMWare Support for EMS
- OLT SysLog support (2014)
- Y.1371 (2014)
- 802.1ag Fault Detection (2014)

*This represents a partial list of supported IEEE and IP/Ethernet protocols*
Challenges Compared

**FDDI - FTTD**

- Two Transceivers per device/location $$$
- Desk side transceiver/media converter reliability ↓
- Typically ST connectors (non-Pull-Proof) ↓
- Costly multimode fiber $$$
- No management of remote devices ↓
- Limited physical flexibility ↓

**Passive Optical LAN**

- One PON Port per 32 remote locations/One ONT per 4 or 8 devices* (*not including multiple VLAN ports)
- High availability, Telco grade ONT
- Single Fiber, Singlemode SC/APC Path
- Inexpensive singlemode fiber
- Full remote management of ONTs
- Highly flexible and reconfigurable

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Challenges

- Education/Familiarity on technology
- Electronics brands may not interoperate with each other
- Brand loyalty
- Resistance to change
- Separate budgets for cabling and electronics
Fiber to the Active Consolidation Point (FTTACP)

Innovative redundant Ethernet cabling concept with ACP:

- **No IDF/TR required** = Reclaimed space
- **Seamless retrofitting** - Does not interrupt operation
- **Accelerated project lead times and lower material costs**
  - Up to 50% in installation time savings
  - Up to 60% material costs savings for tertiary copper cabling
- **Reduced construction costs:**
  - Reduced cabling pathways and fire load
  - No IDF/TR, Reduced fire stopping, Reduced coring and drilling
  - Reduced material = Reduced Grey Energy (transport and disposal)
  - Reduced raw materials
Fiber to the Active Consolidation Point (FTTACP)

Simple, Flexible and Cost-effective

- Redundant Ring Backbone (SM or MM)
- ACPs within 20m of WAO
- Utilizes a fan-less switch
- < 75dBA
- Reduced Fire Load
- User performance is adjustable (e.g. smaller rings)
- Completely redundant network
Benefits

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Benefits and Challenges

**Benefits**

- Familiar equipment
- Similar management platform
- Migration path from traditional to POL
- Fan less industrial Ethernet switches
- Connectivity closer to the device
- Reduction or elimination of telecom rooms

**Challenges**

- No guaranteed bandwidth
- Decentralized switches
- Requires AC power in zone
- Extra zone enclosures
- May still require longer copper runs
- Potential need for parallel networks
Software Defined Distributed Fiber Networks

Traditional Network

Switch

Data Plane

Control Plane

Software Defined Network

SDN Controller Device

White Box Programmable Switch or OLT

Data Plane

Control Plane
Software Defined Distributed Fiber Networks

Software-Defined OLT (SDOLT)

Power Distribution Unit (PDU)

Software-Defined Data Plane (SDDP)

Discrete Cables
- x-2AWG
- SMF

Composite (SMF/x-2AWG)

Optical Network Terminal (ONT)
Self recognizing for Ethernet or POL

Category Cable

Devices

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Benefits and Challenges

Benefits

• Enables separate hardware and software layers

• Enables Ethernet and/or passive optical LAN using a common Software Defined Access Node (ONT)

• Technology Neutral - Supports audiovisual, building automation, cellular, Ethernet LAN, Passive Optical LAN, security, Wi-Fi, Zigbee, etc.

• Significant reduction of up-front and future upgrade costs due to reduced equipment and use of singlemode fiber to the edge

• Minimized overall network complexity and which helps improve network performance

Challenges

• Opposition to new equipment brands

• Opposition to different management

• Organizational challenges to converged networks

• Doesn’t “look” or “feel” traditional

• Potential single brand management

• May be perceived as more than needed
Summary

- Not intended to “kill” copper
- Category cabling can be used for the same 90m beyond the ONT, ACP, or SDAN
- Simply extends the “Backbone” cable (fiber) deeper into the zone
- SDN and POL management systems provide detailed insight and functional remote management to alleviate concerns over distributed equipment maintenance
- View and manage the entire network from a “single pane of glass”
Summary

• Locating switching nodes closer to the device allows for design flexibility, extended reach, and reduction or elimination of valuable floor space typically occupied by equipment

• Allow simple network extensions to provide connectivity to parking lots, remote buildings, or even across town provided that you own the fiber

• These “collapsed backbone” style topologies enable a grow as you go deployment model where you only deploy when and where needed

• Allows network design based on connected devices, not the other way around

• May allow for more finite management of bandwidth allocation, flow control, traffic prioritization, troubleshooting, visibility, and more
Summary

While they may appear visually different from what we are accustomed to, we shouldn’t let that, or what someone calls it, cloud the fact that network devices operate as if there were no difference as Core to NIC communication has not changed. Just like any other network topology, the task is to move Ethernet packets from point A to point B, on time and error free. They don’t seem so weird anymore.
Thank You!

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