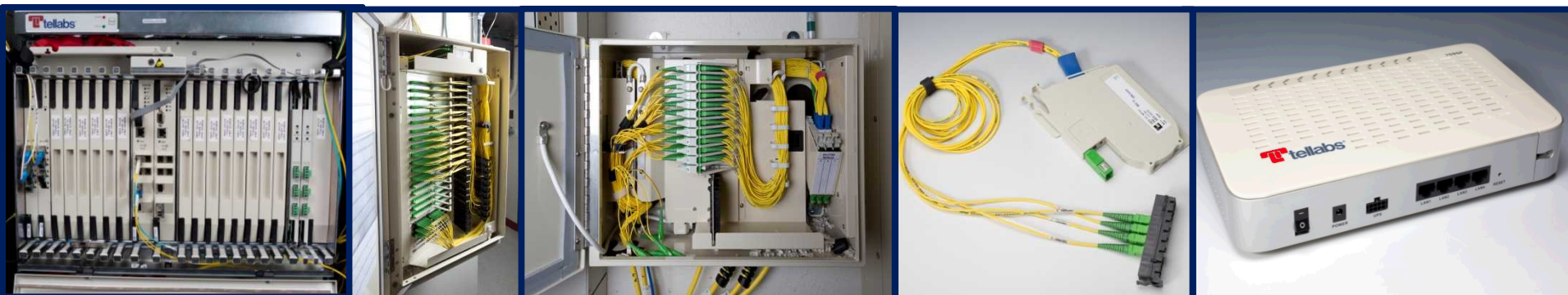


*Exceptional service in the national interest*



# Deploying GPON Tutorial

Joseph P. Brenkosh

Jimmie V. Wolf

# Topics To Be Covered

---

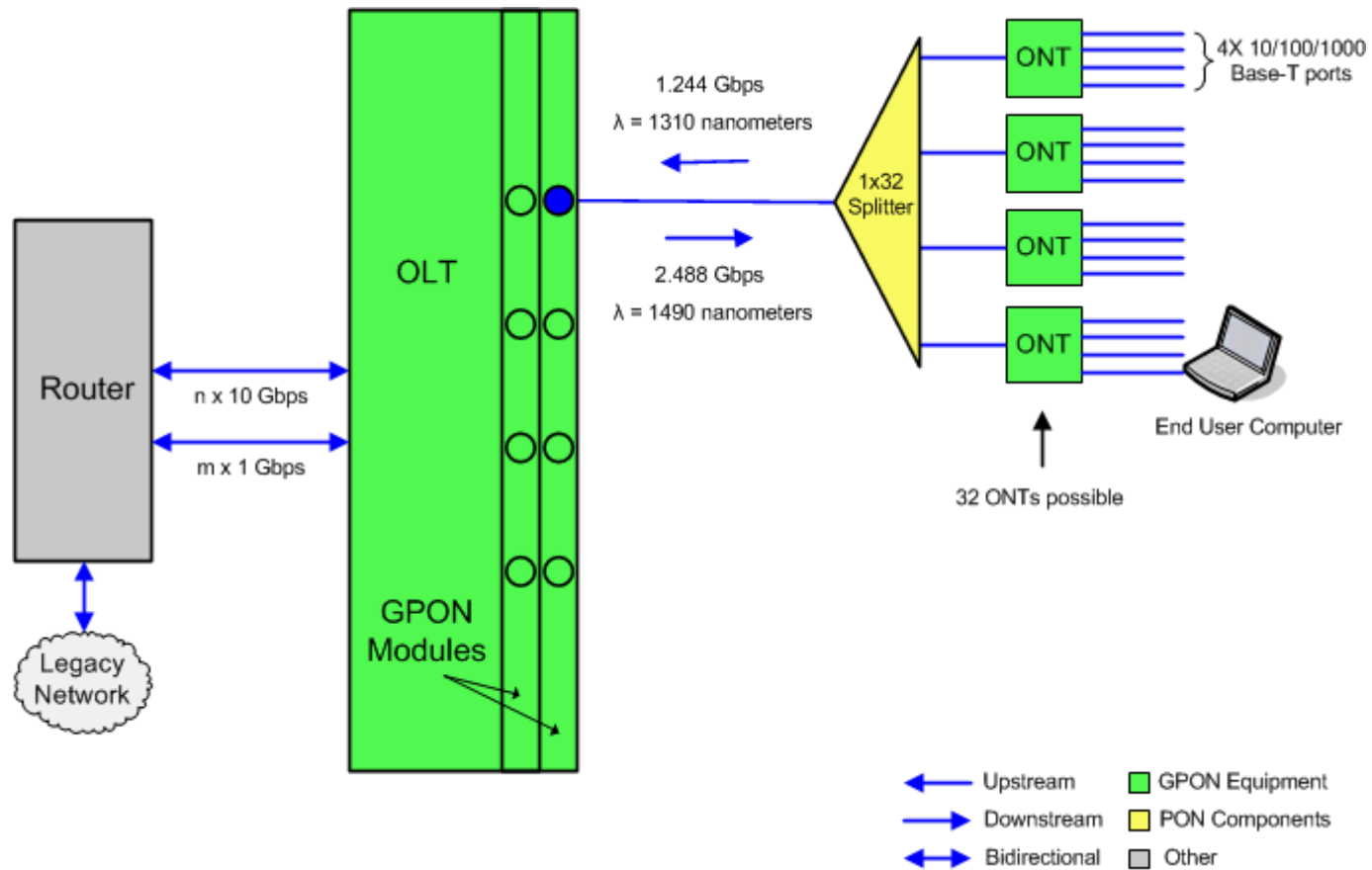
- Introduction to GPON
- Selecting GPON Equipment
- Building the Fiber Optic Infrastructure
- Installing and Managing GPON
- GPON Troubleshooting
- GPON Power Consumption
- Lessons Learned
- Future GPON Technologies at SNL

# Introduction to GPON

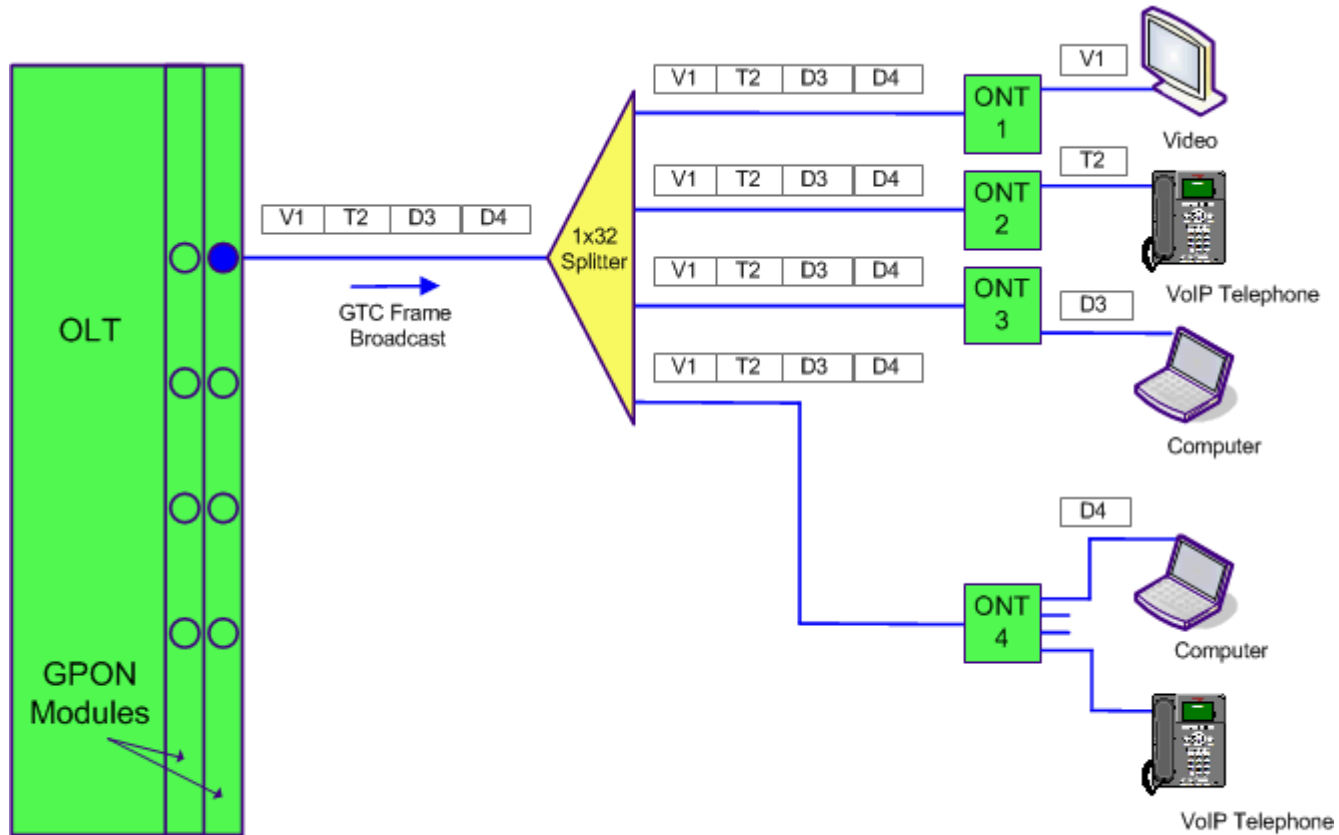
---

- Gigabit Passive Optical Network (GPON)
- Access layer technology
- Based on ITU-T G.984 standards
- Uses active and passive components
- Supports triple play services (voice, video, and data)
- VLAN based
- Downstream encrypted with AES-128

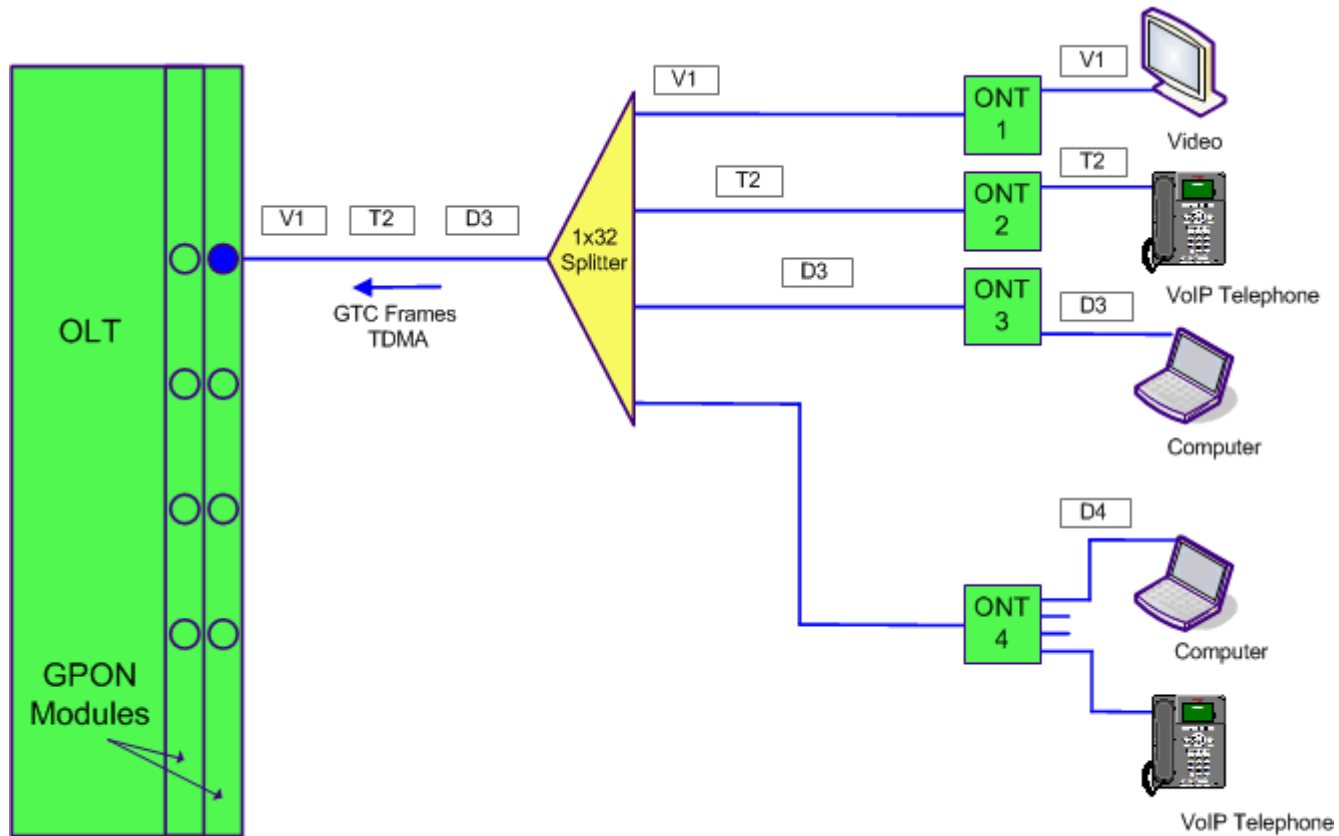
# GPON Topology



# GPON Downstream Operation



# GPON Upstream Operation



# Selecting GPON Equipment I

- Optical Line Terminal (OLT)
  - Number of GPON modules per shelf (2 – 16)
  - Number of GPON ports per module (4)
  - Number of controller modules for redundancy (1-2)
  - Number and bandwidth of uplinks (8 X 1 Gbps, 4 X 10 Gbps)
  - Switching capacity (200 Gbps – 2.56 Tbps)
  - Split Ratio 1:32
  - Optical Budget 28 dB
  - ONTs supported (128 – 2048)
  - Power: AC and DC options



# Selecting GPON Equipment II

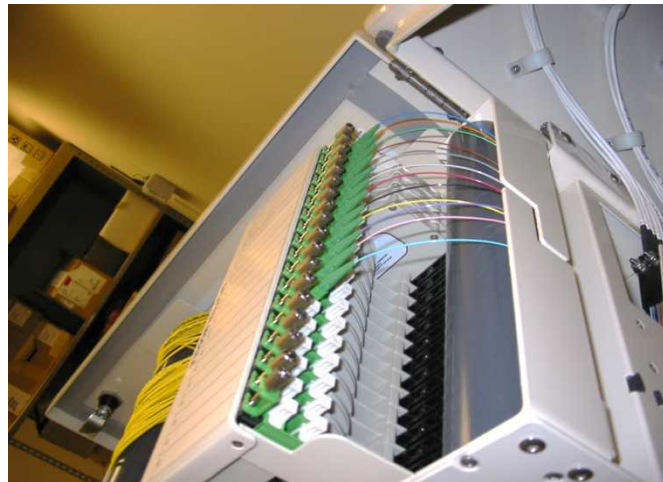
- Optical Network Terminal (ONT)
  - Number and bandwidth of ports (1 – 24 10/100/1000 Mbps)
  - Power: AC, DC, and battery backup
  - Wall mounting or desk mounting



- Needed wherever GPON is to be deployed
- Uses single-mode fiber
- New advances make the installation easier
  - Better fiber
    - Pre-terminated fiber is preferred
    - Bend-insensitive fiber eases deployment
    - Angled Polished Connectors have lower loss
  - PON devices (Specifically designed for PON)
    - Passive Optical Splitter
    - Fiber Distribution Hub (FDH)
    - Remote Distribution Terminal (RDT)
    - Fiber Splitter Box (FSB)
- Should be tested before GPON deployment

# Passive Optical Splitter

- Distributes the GPON transmission to ONTs
- No power or cooling required
- Virtually unlimited MTBF
- Common sizes: 1X8, 1X16, 1X32, 2X32
- Higher split ratios allow for more ONTs per GPON port
- Higher split ratios decrease the available bandwidth per ONT and distance



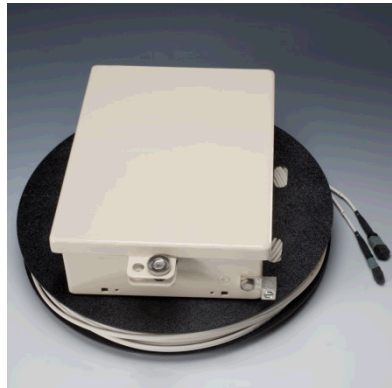
# Fiber Distribution Hub (FDH)

- All passive
- Houses passive optical splitters
- Connects to Rapid Fiber Distribution Terminals
- Factory terminated connections
- Placed indoors or outdoors
- Lockable cabinet
- 72 to 864 fiber capacity



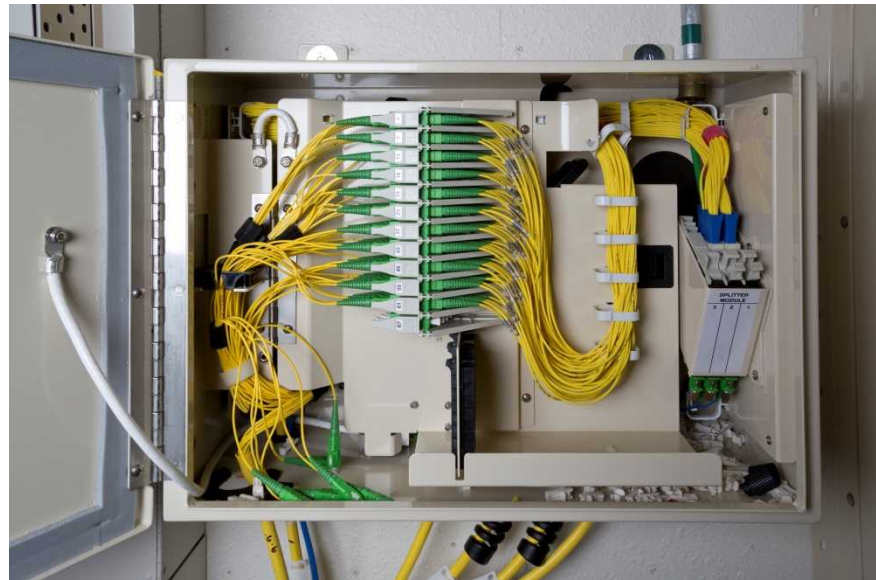
# Rapid Fiber Distribution Terminal (RDT)

- Used to connect FDH to ONT drop cables
- Placed in the plenum
- Built-in spool with 2 MTP® or MPO terminated 12 count fiber cables
- SC/APC connectors are used on ONT drop cables

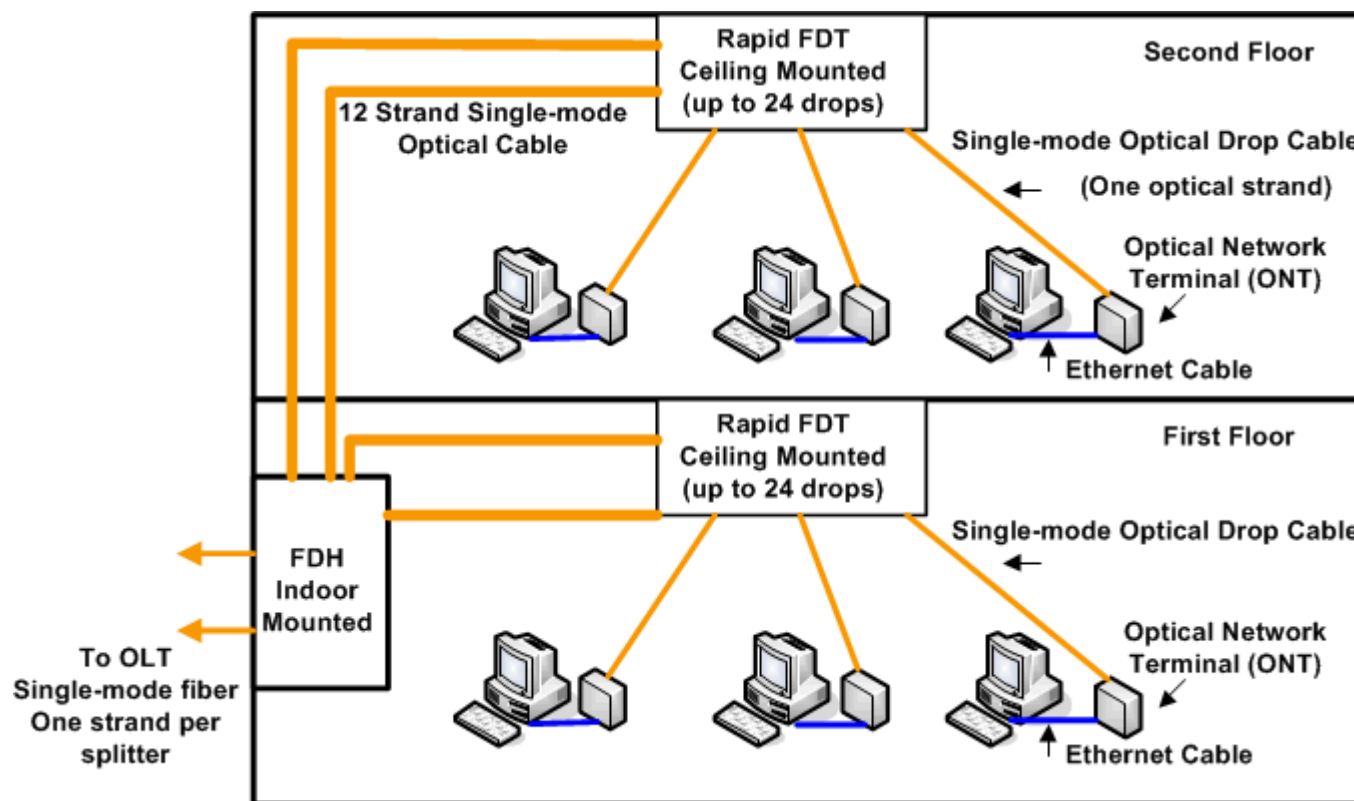


# Fiber Splitter Box (FSB)

- A mini Fiber Distribution Hub
- Useful for lower count locations
- Wall mounted



# GPON Building Deployment

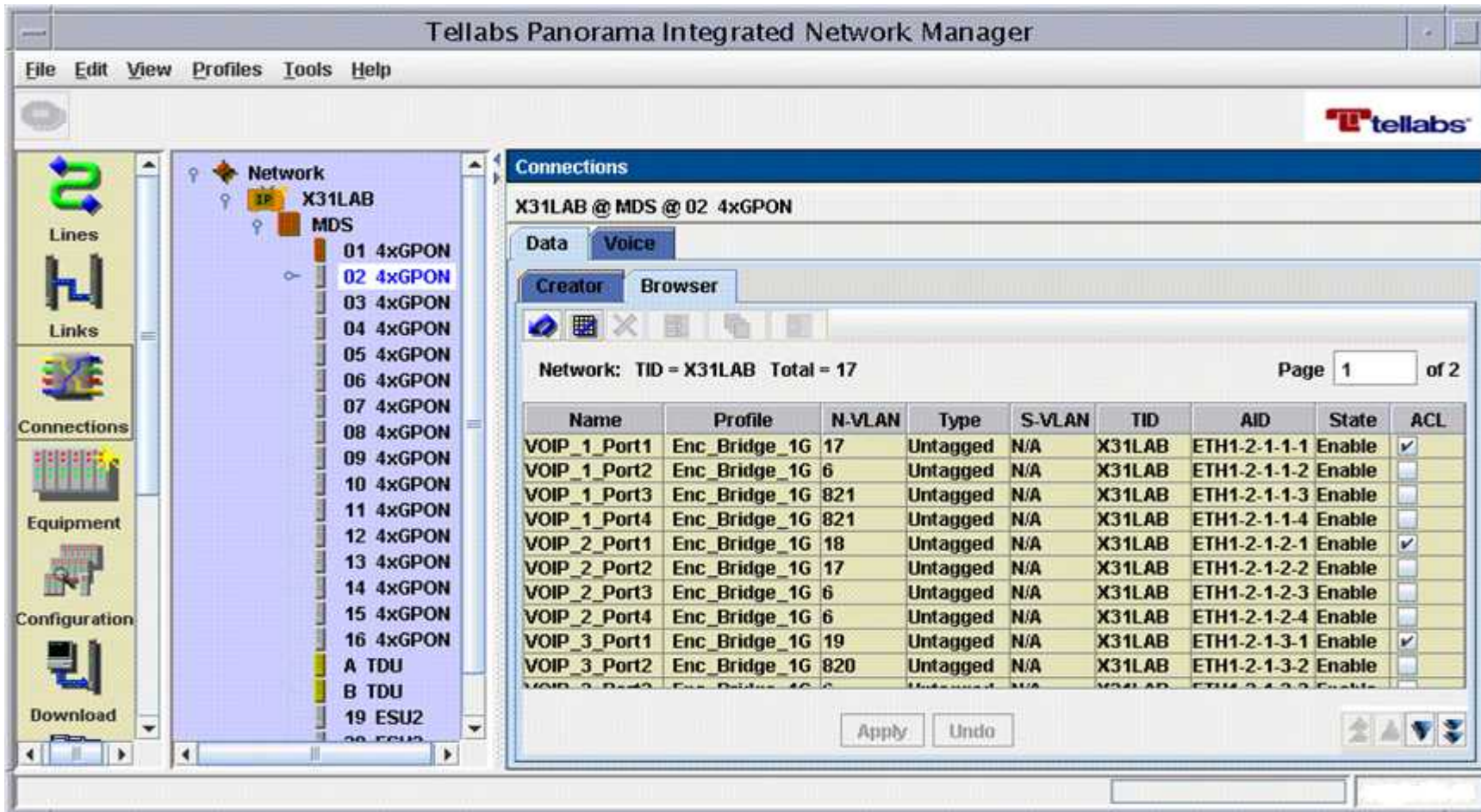


# Installing and Managing GPON

---

- Preliminary setup
  - Carefully plan locations of the OLTs, FDHs, RDTs, FSBs, and ONTs
  - Physically deploy and test the fiber optic infrastructure
  - Install the OLTs and ONTs
  - Provision VLANs and route points on routers and or switches
  - Install GPON management software on management platform
- OLT Provisioning
  - Perform initial turn up
  - Add the OLT to the GPON management application
  - Provision other information such as DHCP, Radius, SNMP, NTP, and Protection Group
  - Provision Uplinks
- ONT Provisioning
  - Discover and register the ONT
  - Assign the ONT Port to a VLAN
  - Assign profiles for various parameters (QoS, security, LLDP, etc.)
- Connect computers to the ONTs and test

# Panorama ONT Connections Screenshot

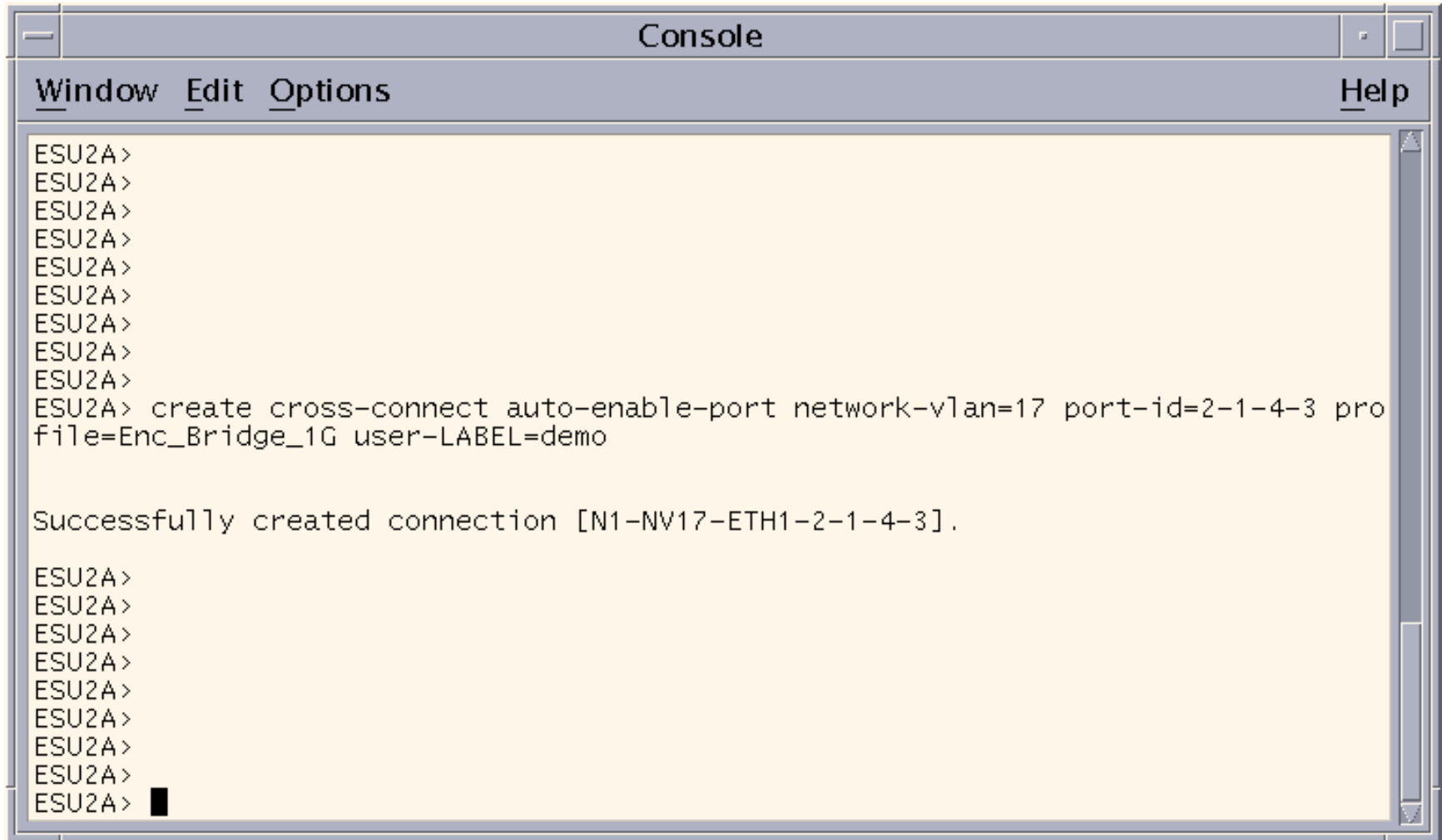


The screenshot displays the Tellabs Panorama Integrated Network Manager interface. The main window is titled "Tellabs Panorama Integrated Network Manager" and features a menu bar with "File", "Edit", "View", "Profiles", "Tools", and "Help". On the left, a navigation pane includes icons for "Lines", "Links", "Connections", "Equipment", "Configuration", and "Download". The central pane shows a tree view of the network structure, including "Network", "X31LAB", and "MDS". A list of 20 4xGPON ports is displayed, with port 02 selected. The right pane, titled "Connections", shows the configuration for "X31LAB @ MDS @ 02 4xGPON". It includes tabs for "Data" and "Voice", and sub-tabs for "Creator" and "Browser". A table lists the connections, with columns for Name, Profile, N-VLAN, Type, S-VLAN, TID, AID, State, and ACL. The table shows 17 connections, all of which are "Untagged" and "Enable".

Network: TID = X31LAB Total = 17 Page 1 of 2

Name	Profile	N-VLAN	Type	S-VLAN	TID	AID	State	ACL
VOIP_1_Port1	Enc_Bridge_1G	17	Untagged	N/A	X31LAB	ETH1-2-1-1-1	Enable	<input checked="" type="checkbox"/>
VOIP_1_Port2	Enc_Bridge_1G	6	Untagged	N/A	X31LAB	ETH1-2-1-1-2	Enable	<input type="checkbox"/>
VOIP_1_Port3	Enc_Bridge_1G	821	Untagged	N/A	X31LAB	ETH1-2-1-1-3	Enable	<input type="checkbox"/>
VOIP_1_Port4	Enc_Bridge_1G	821	Untagged	N/A	X31LAB	ETH1-2-1-1-4	Enable	<input type="checkbox"/>
VOIP_2_Port1	Enc_Bridge_1G	18	Untagged	N/A	X31LAB	ETH1-2-1-2-1	Enable	<input checked="" type="checkbox"/>
VOIP_2_Port2	Enc_Bridge_1G	17	Untagged	N/A	X31LAB	ETH1-2-1-2-2	Enable	<input type="checkbox"/>
VOIP_2_Port3	Enc_Bridge_1G	6	Untagged	N/A	X31LAB	ETH1-2-1-2-3	Enable	<input type="checkbox"/>
VOIP_2_Port4	Enc_Bridge_1G	6	Untagged	N/A	X31LAB	ETH1-2-1-2-4	Enable	<input type="checkbox"/>
VOIP_3_Port1	Enc_Bridge_1G	19	Untagged	N/A	X31LAB	ETH1-2-1-3-1	Enable	<input checked="" type="checkbox"/>
VOIP_3_Port2	Enc_Bridge_1G	820	Untagged	N/A	X31LAB	ETH1-2-1-3-2	Enable	<input type="checkbox"/>
VOIP_3_Port3	Enc_Bridge_1G	6	Untagged	N/A	X31LAB	ETH1-2-1-3-3	Enable	<input type="checkbox"/>

# OLT Command Line Provisioning Screenshot



```
ESU2A>
ESU2A>
ESU2A>
ESU2A>
ESU2A>
ESU2A>
ESU2A>
ESU2A>
ESU2A>
ESU2A>
ESU2A>
ESU2A> create cross-connect auto-enable-port network-vlan=17 port-id=2-1-4-3 profile=Enc_Bridge_1G user-LABEL=demo

Successfully created connection [N1-NV17-ETH1-2-1-4-3].

ESU2A>
ESU2A>
ESU2A>
ESU2A>
ESU2A>
ESU2A>
ESU2A>
ESU2A>
ESU2A>
```

# Protecting GPON

---

- Important to have control of fiber optic infrastructure and all devices
- Access control lists on ONTs
- MAC address limiting to prevent flooding overflow
- 802.1X
- Unexpected ONT detection
- Upstream broadcast rate limiting and filtering

# QoS for GPON

---

- Uses 802.1P for QoS
- Based on VLAN-ID, 802.1p bit, or ToS/DSCP
- Can mark 802.1p
- Has ToS/DSCP to 802.1p mapping

# GPON Troubleshooting

---

- Conventional light meters will not work because OLT will not transmit unless it receives grant from OLT
- Need inline GPON light meters
- Panorama or other GPON manager Alarm reporting
- Tcpdump on GPON port
- GPON Analyzer
- Sniff uplink

# GPON Power Consumption

---

- Tellabs OLT fully populated at peak load: 1200 Watts
- Tellabs ONT:
  - 4.1 Watts idle
  - 6.7 Watts peak load
- When fully realized, SNL New Mexico will reduce power consumption by 1 Million KWh annually
- Will save \$87K in annual power costs

# Lessons Learned I

---

- Over 14,000 ONTs installed in 270 buildings
- 17 OLTs installed
- GPON implementation provides a total cost savings of \$20M over 5 years in CapEx and OpEx
- Keep installation crew ahead of provisioning crew
- Don't assume office access, space, or power
- Wall mounting is preferred in unclassified areas
- Upgrading the core network at the same time can cause difficulties
- A network upgrade will be blamed for almost all IT problems

# Lessons Learned II

---

- Be sure you can replace the legacy network, otherwise you will now be supporting and providing power for two networks
- Retain smaller decommissioned switches to replace larger switches supporting a limited number of legacy ports that can not be migrated such as server rooms and labs
- Firmware upgrades should be tested thoroughly prior to implementation on production networks
- Scripting or bulk provisioning is important for large deployments

# Future GPON Technologies at SNL

---

- XG-PON2 (10 Gbps GPON)
- NG-PON2 (40 Gbps TWDM-PON)