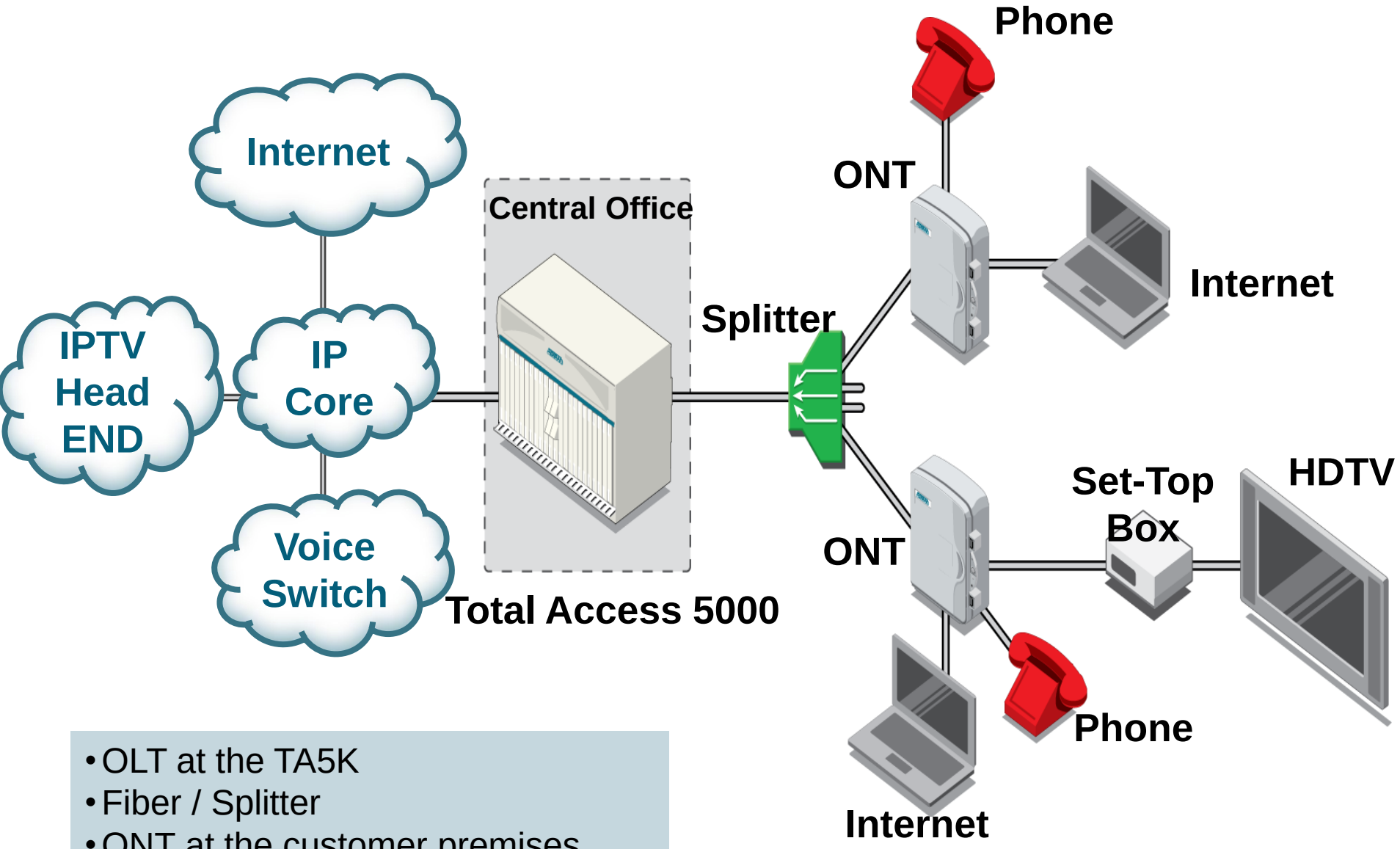
Total Access 5000
Gigabit Passive Optical Network (GPON)

Technology Overview

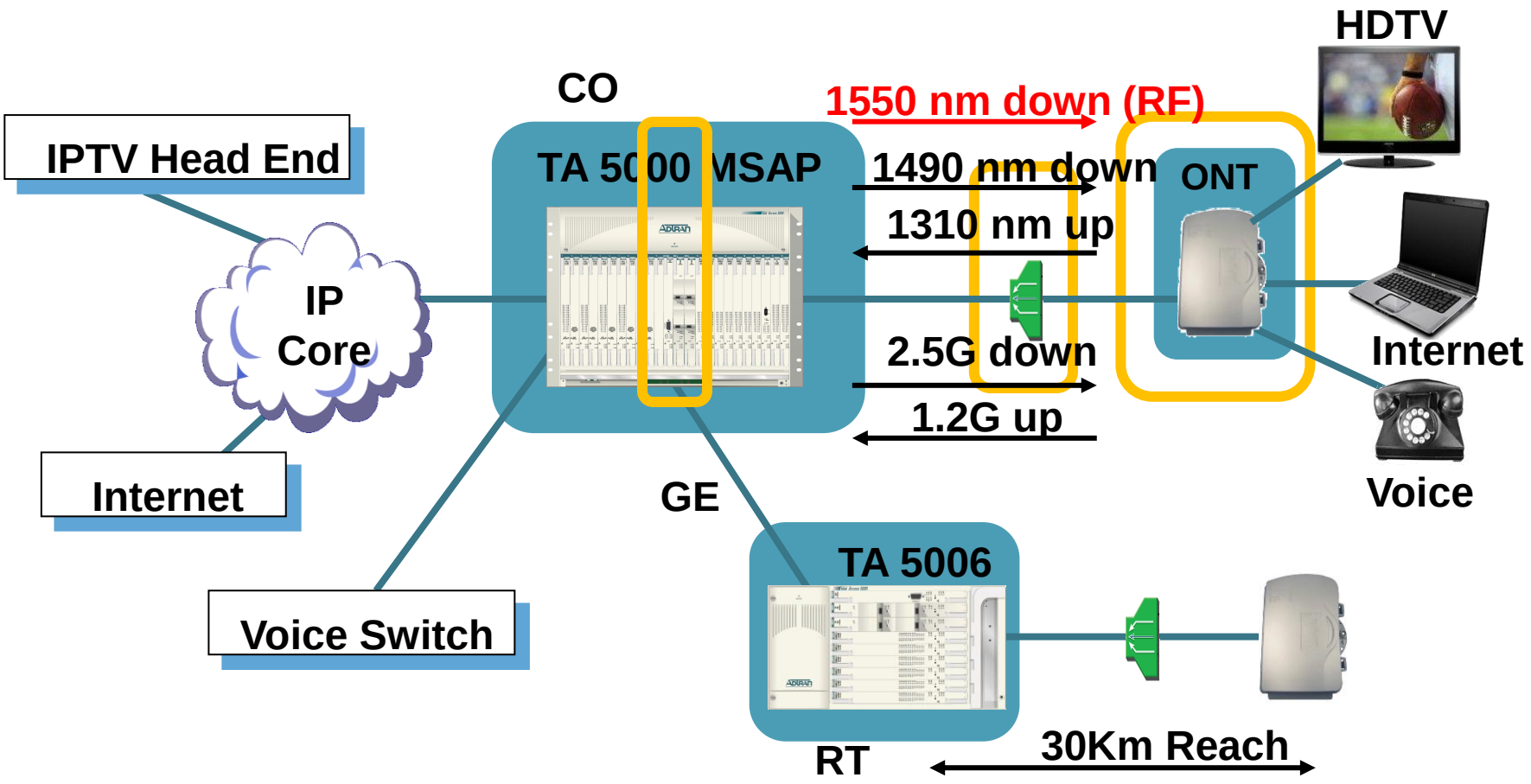
SR 5.5

GPON Reference Architecture



- OLT at the TA5K
- Fiber / Splitter
- ONT at the customer premises

Typical GPON Network



- 2.5 G downstream, 1.25 G upstream traffic
- Downstream wavelength is 1490 nm, upstream is 1310 nm

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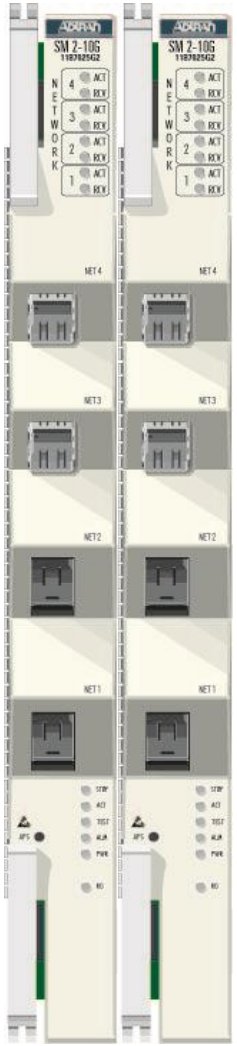
Components

Meeting Bandwidth Demands

- SM2 10GE
  - Two 10Gb faceplate XFP cages
  - Two 1 / 2.5Gb faceplate SFP cages
  - ERPS
  - LAG
  - 32k MACs
    - Scales for IPTV deployments
- Ethernet Switch Fabric
  - Fully featured
  - Latest technology available
  - Supports advanced service delivery
    - Without Resource modules
  - Designed for system deployments
- Scalable / Flexible design
  - Scale to meet bandwidth needs without swap-out
  - 10, 20, 40Gb LAG capable
    - Just add XFPs
    - Direct “pipes” to fabric

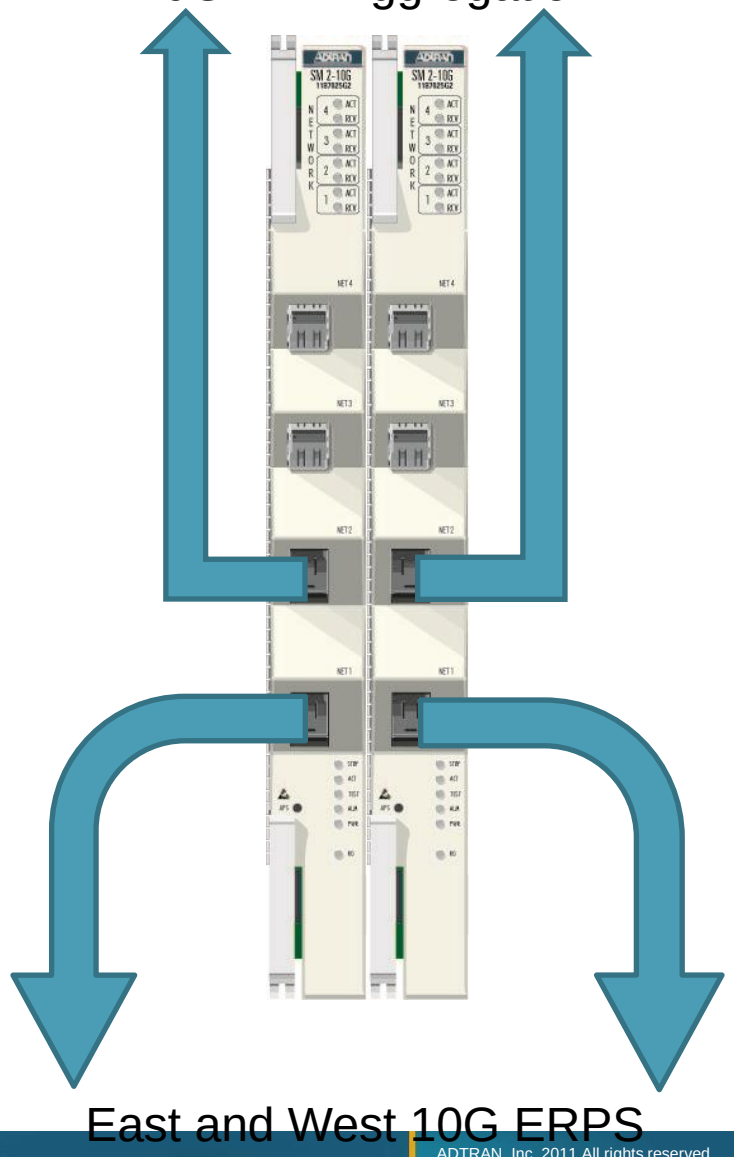


Switch Module Features

- Switch Module (SM)
  - Optionally redundant
  - Optical and electrical SFPs supported
  - Multiple XFP Options
  - 802.1Q VLAN tagging
  - Q-in-Q support
  - 802.1p Prioritization
  - 802.3ad Link Aggregation
  - IGMP and multicast
  - DHCP relay
    - Option 82 support
  - PPPoE relay
    - PPPoA to PPPoE conversion

ERPS Access Ring

- Ethernet Ring Protection Switching
  - ITU-T G.8032 standards based
  - Fully redundant
  - 10 Gbps line rate with 10 Gbps throughput on the ring
  - 10 Gbps add/drop from each span
  - Interface via XFP cages on faceplate of SM
  - 1 and 2.5Gbps ring support – cost effective growth
  - All Ethernet solution
- Integrated transport
  - Transport and uplink on SMs
  - Redundant hardware and path
    - Same UI, point-to-point buses
  - East and West
- Advanced capabilities
  - Topology Aware
    - Easy adds and deletes
    - No single point of failure
  - Misconfiguration Detection
  - Wait to Restore (WTR)



GPON OLT

- 502 OLT
  - 4 port GPON OLT
    - Doubles density to 2,688 ONTs per TA5000
  - Same faceplate as Quad GE
  - All features of 2 port OLT
  - SFP:
    - B++
    - 30 KM Reach 32 Way Split No Differential Delay
    - 37 KM Reach 16 Way Split (17-37KM)

Current Portfolio GPON

IPTV, POTS, Data
Total Access 351
Total Access 352
Total Access 324

324 2 Pots 4 Ethernet Indoor
351 and 352 1 or 2 Ethernet 2 Pots
372 8 Pots 2 Ethernet 4 DS1

IPTV, POTS, Data, RF
Total Access 361
Total Access 362
Total Access 362S
Total Access 362R
Total Access 334

IPTV, POTS, Data, DS1
Total Access 372

361/362 2 Pots 1 or 2 Ethernet RF Overlay
334 2 Pots 4 Ethernet RF Overlay Indoor

362R RFOG RF Overlay / Return
362S Special RF Overlay Return for SA

Total Access 300 Series

- Corning Housing for GPON and AE ONTs
  - Best in class product
  - Gasket-less design
- Hardened outdoor enclosure
  - Fiber slack storage
  - Corning OptiTap support
  - Power and phone terminations
  - Grounding
- Snap in cartridge
  - Install in logical steps
  - Add electronics upon turn-up
  - Secure access
  - Status LEDs
  - POTS test jacks

Total Access 324 Indoor ONT

- Indoor Single Family Unit (SFU)
  - Total Access 324
    - 2 POTS
    - 4 - 10/100/1000Bt
  - Total Access 334
    - Adds RF overlay support
  - New hardware design
    - Common code with TA35x
      - Minimize time to market
      - Guarantee functionality and feature-set
    - Hardened option for garage deployments

3rd Party ONT – CIG G-93E3

- Features:
  - Port
    - 2 POTS
    - 4 - 10/100Bt
  - MDI / MDI-x autosense
  - Support 802.1Q Vlan
  - IP ToS/DSCP to 802.1p mapping
  - Support VLAN Stacking (Q-in-Q)
  - Support Jumbo Frame 2000 bytes
  - IGMP Snooping

3rd Party ONT – CIG G-93T1

- Features:
  - Port
    - 2 POTS
    - 4 - 10/100/1000Bt
  - MDI / MDI-x autosense
  - Support 802.1Q Vlan
  - IP ToS/DSCP to 802.1p mapping
  - Support VLAN Stacking (Q-in-Q)
  - Support Jumbo Frame 2000 bytes
  - IGMP Snooping

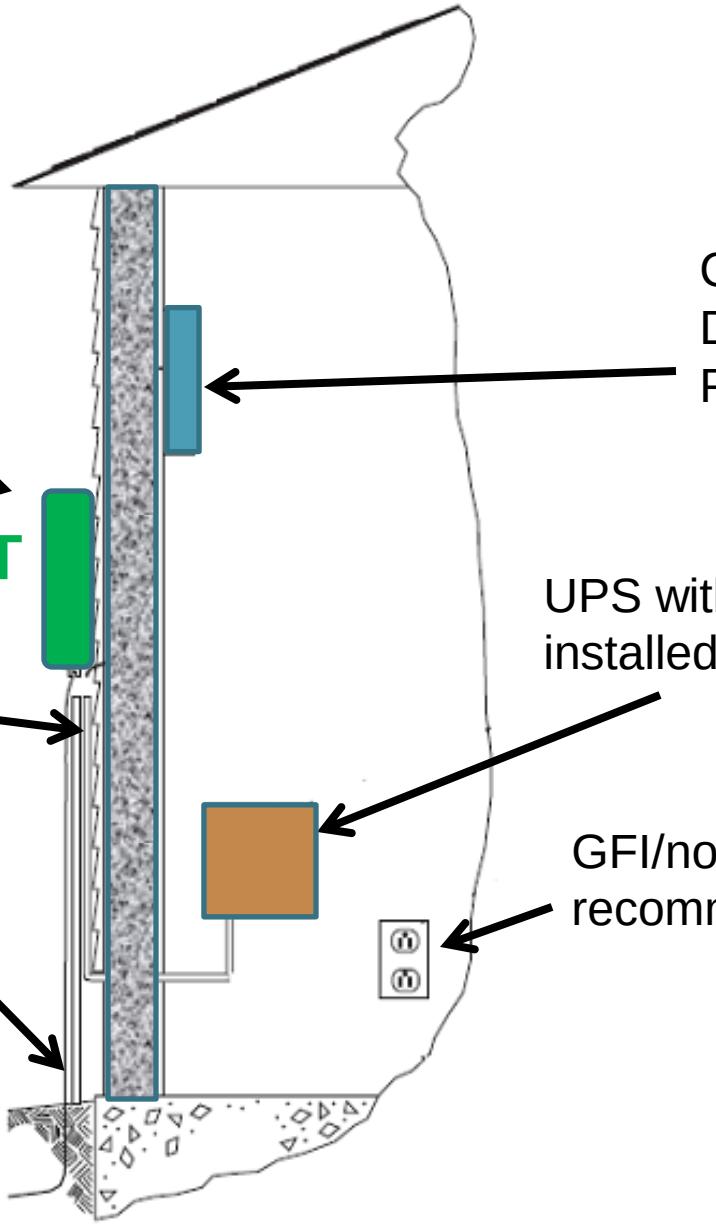
Total Access 5000
GPON

Hardware, Installation, and Turn-Up

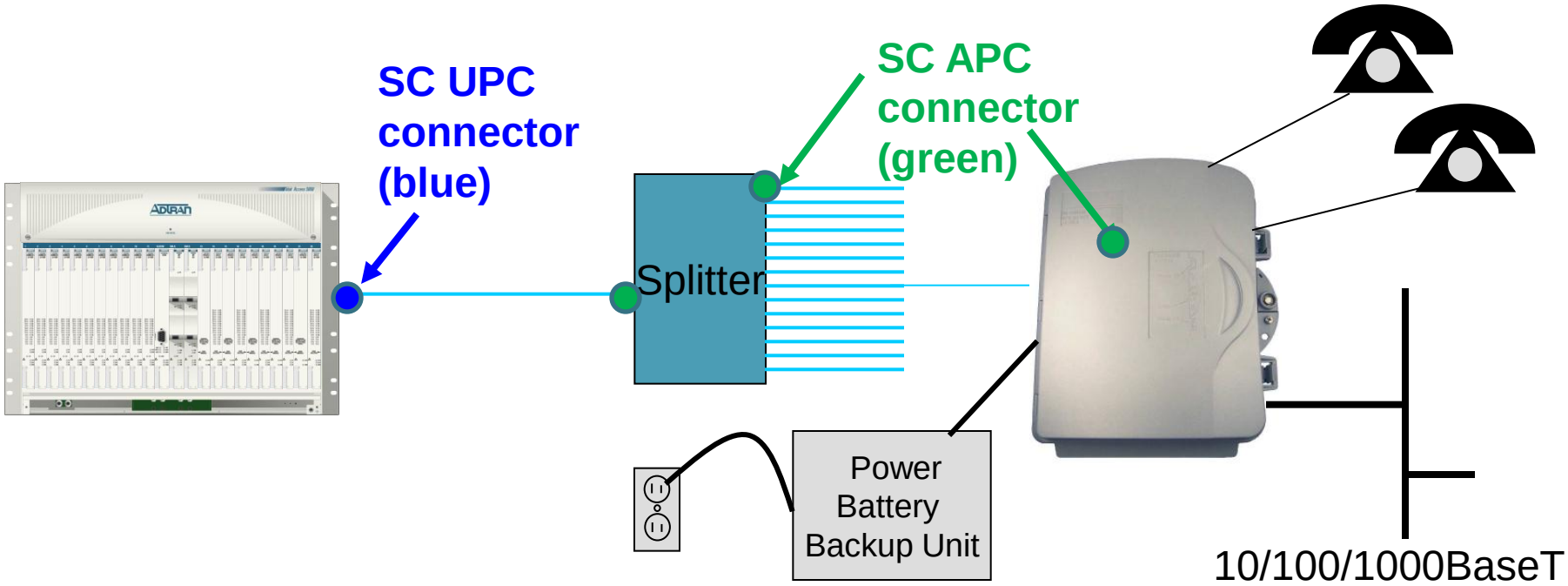
Typical ONT Installation

Subscriber provided premises wiring:

- CAT5 or higher Ethernet cable
- POTS twisted pair
- Terminated in the ONT by technician

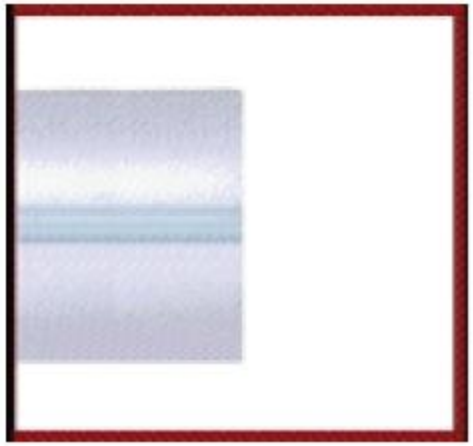


OLT to ONT Connections



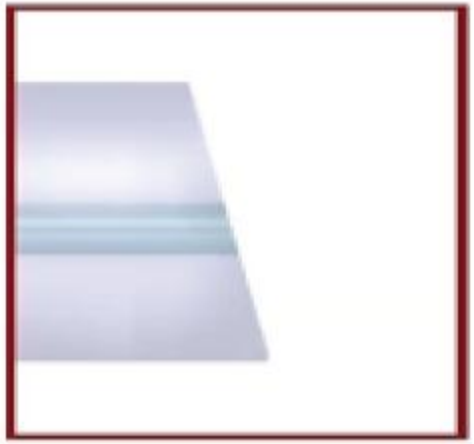
- SC APC connector (green) for network connection on ONT.
- Always use matching jumper.
- SC UPC (blue) jumper can damage interface and will at least introduce extra loss.

Connectors in the Fiber Network



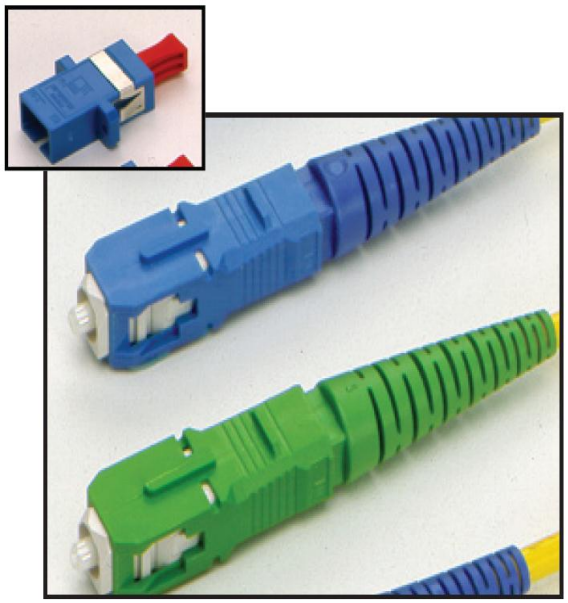
UPC Ultra Polish Connector

- Light is reflected back down to the core.
- Return Loss = 57 dB
- Adequate for most applications



APC Angle Polish Connector

- Light is reflected into the cladding.
- Return Loss = 60 dB (0.0001% of power reflected back)
- Ideal for video applications



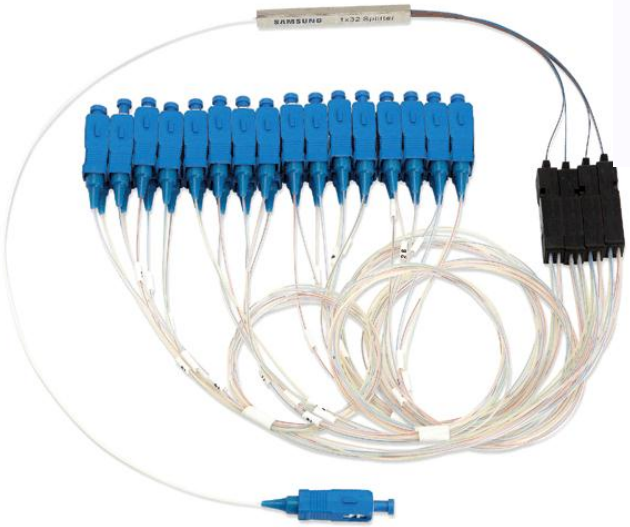
Color Code:

UPC– blue

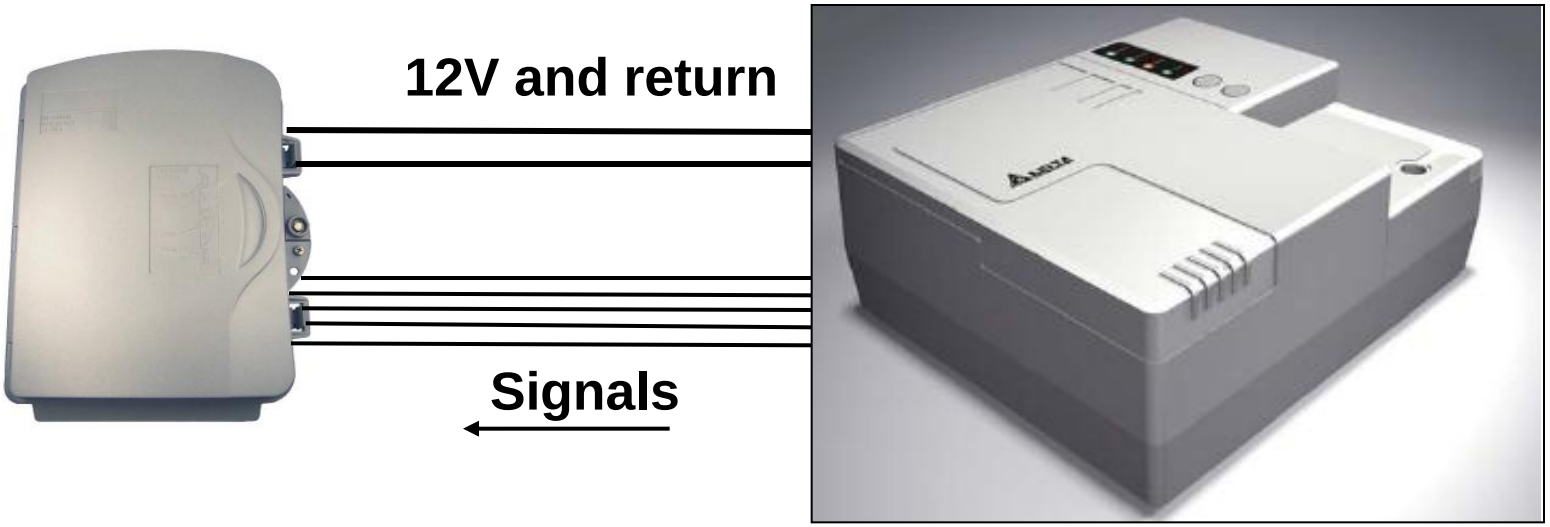
APC – green

Splitter

- Up to 1:32
- Operating band 1260 ~ 1600nm



Battery Backup Unit/Power Supply



- 7 conductors: 2 for power and 5 for signals
- Signals: Low battery, battery missing, replace battery, on battery, and a signal return wire
- Approx. 50 feet between with 18 AWG power conductors

Total Access 5000

Chassis Description

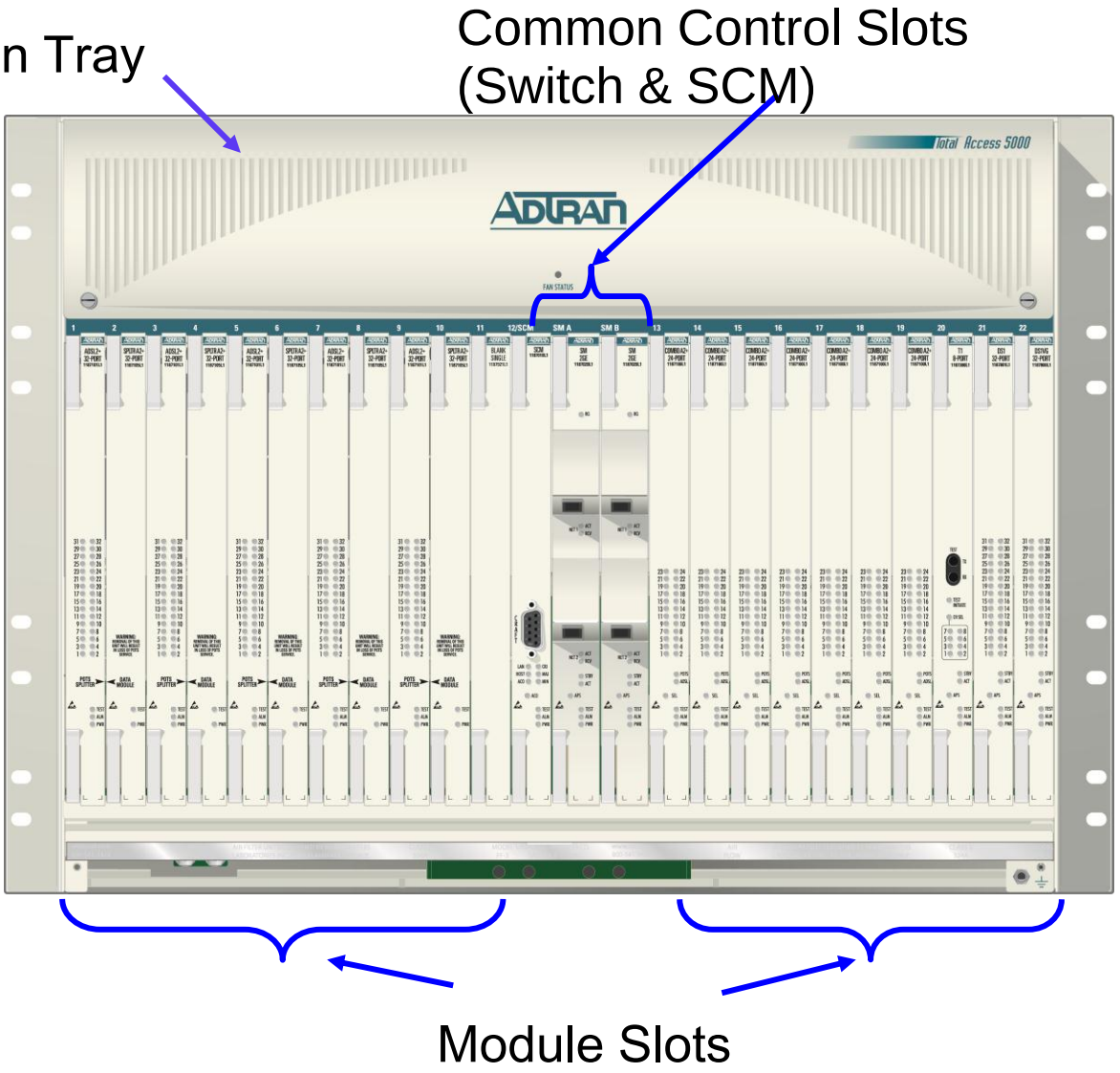
System Architecture

Fully redundant dual star bus backplane

- Native **IP/Ethernet** architecture
- Up to 20 Gbps per slot bi-directional
- Three (3) common control slots with carrier class redundancy
- Twenty-One (17) configurable access slots

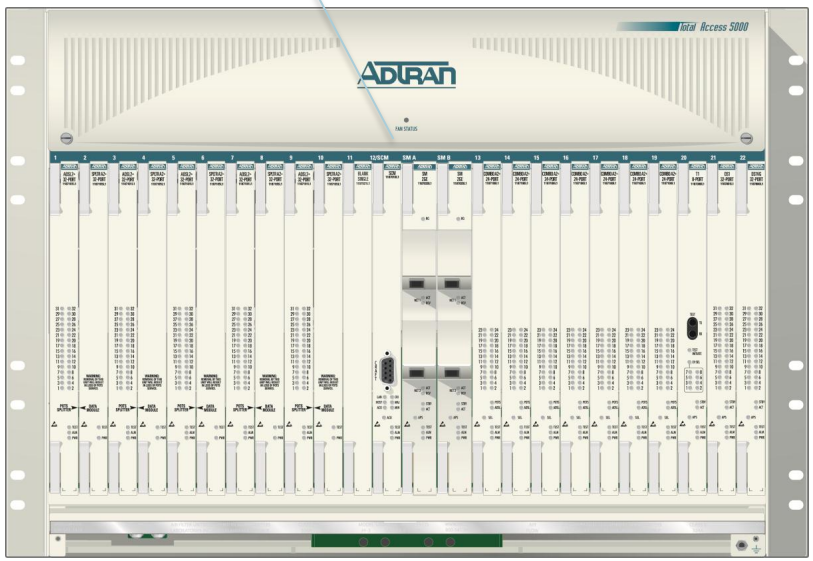
Physical

- 19” rack mount
- 15.75” height (9RU)



Modules

COMMON MODULES
(provide management, control, switching, and expansion – SCM and SM)



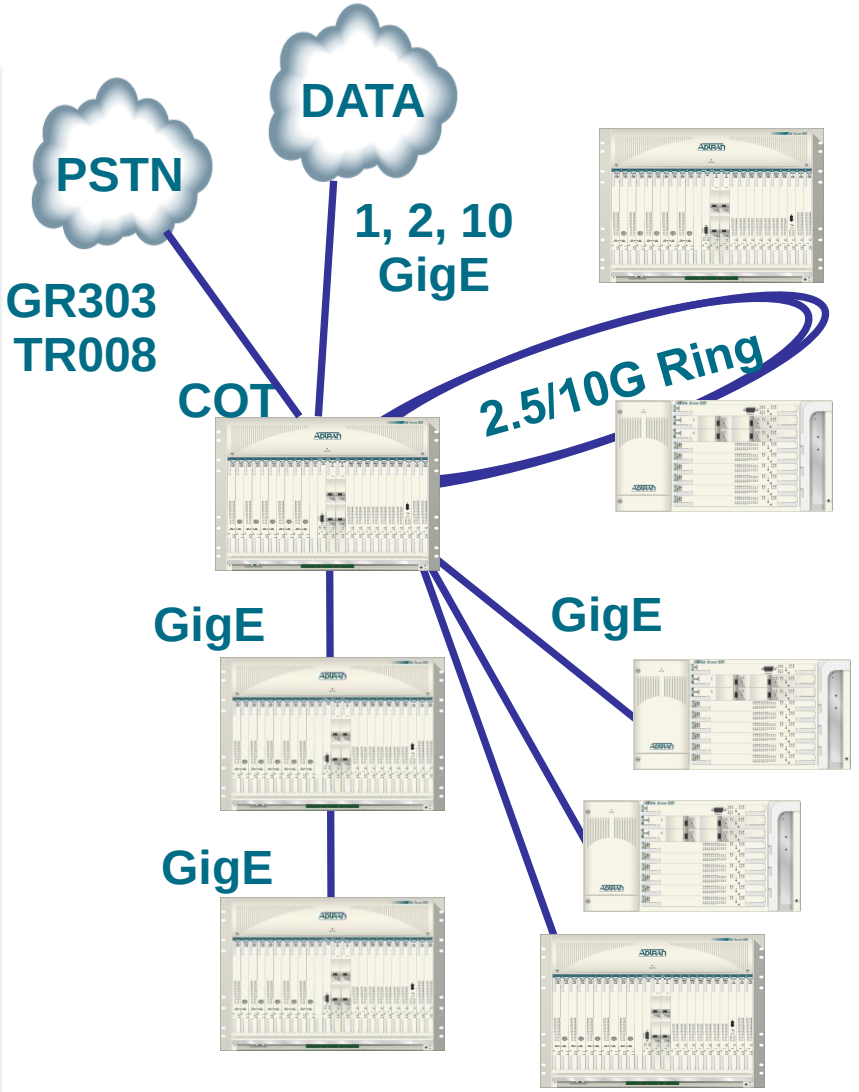
LINE MODULES
Provide transport and expansion - Quad GigE, etc.

ACCESS MODULES
Provide services – ADSL2+, VDSL, GPON, AE, SHDSL

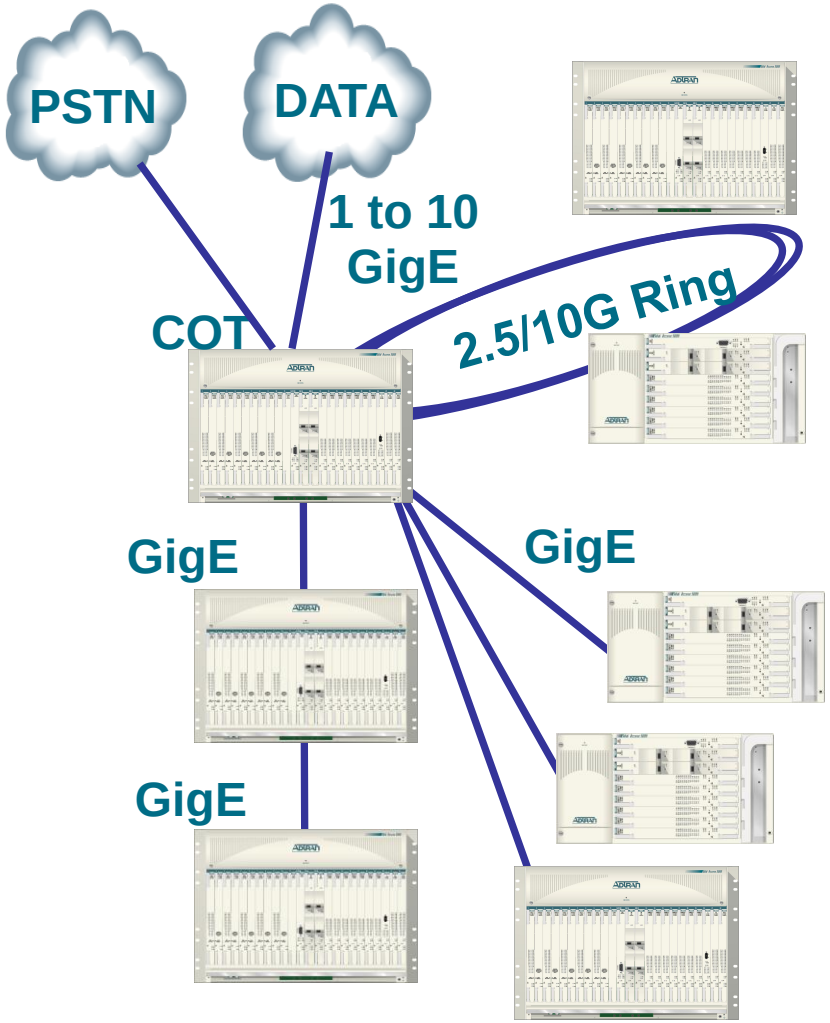
Topologies
And Node Expansion

Flexible Transport Topologies

- **Linear Chain**
  - Fiber starved environments
  - Redundancy support
- **Star**
  - Scale with Quad GE card
  - Redundancy support
- **Ring**
  - 10Gb ERPS
  - 2.5Gb RPR
  - Main ring with support for sub-rings



Node Expansion Guidelines



1. Node 1 Uplink is the sole Ethernet uplink to the network
2. Each RT node must have a unique node number (2-63)
3. The “uplink” setting for each node is its “default network”
4. S-tags must be unique

Node Expansion Guidelines

Node Expansion

- Lower Range: 1-63 nodes total for TA5K and 1124P
- Upper Range: 101-1024 for TA 1108VP
- 4-deep from Switch Module (total of 5 in chain)
- 3-deep from Quad GigE (total of 4 in chain)

Ring

- 2 RPR rings per COT (7 nodes each,15 nodes total)
- 1 ERPS ring (10G) with possible RPR sub-ring

Unique S-tags required throughout

- TA 5000 alerts user of duplicate VLAN in the node, not the network

Node Expansion Module Options

Switch Modules – Chaining

- Net 2 of Node 1 to Net 1 of Node 2, and so on
- Max number in chaining is 4

Quad GigE - Star

- Connect directly to another TA 5K Switch Module Net 1
- Max number of nodes deep is 3
- Used where fiber is available

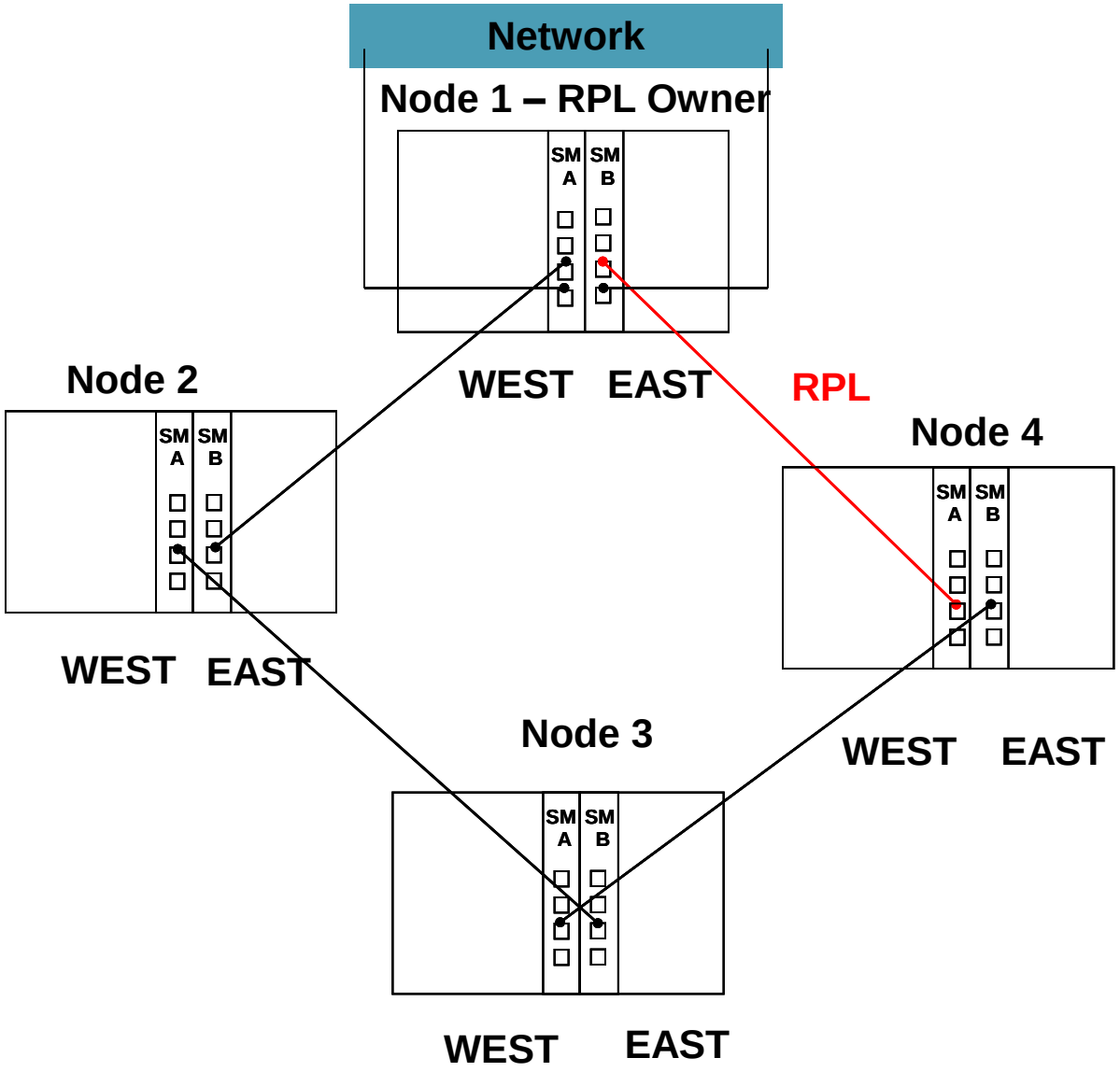
Octal GigE

- Node to Node connectivity (Network Mode) or
- Ethernet aggregation of 3rd party devices (Edge Mode).

DS3 EFM (unchannelized)

- Bonding up to 4 ports for 180 Mbps
- EFM connection between systems.

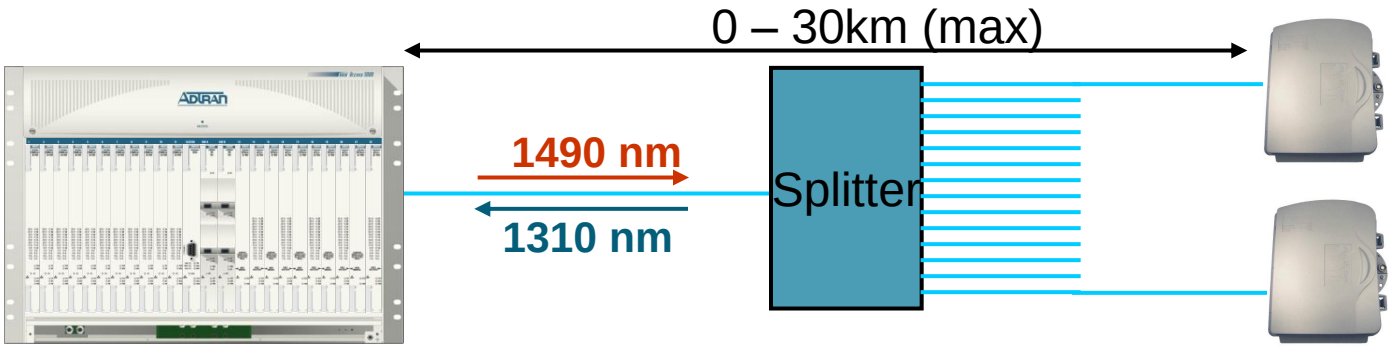
ERPS - Ethernet Ring Protection Switching



- Two physical ports (spans) per node
- One span each on SM A and SM B
- SM A contains West spans, SM B contains East spans
- Connect East port to West port
- East link from Node 1 is Ring Protection Link (RPL)
- RPL blocked in "Ring Idle State"

GPON Network Details

GPON Network Details



Receiver Sensitivity

- SFP B++ : -30 dBm minimum

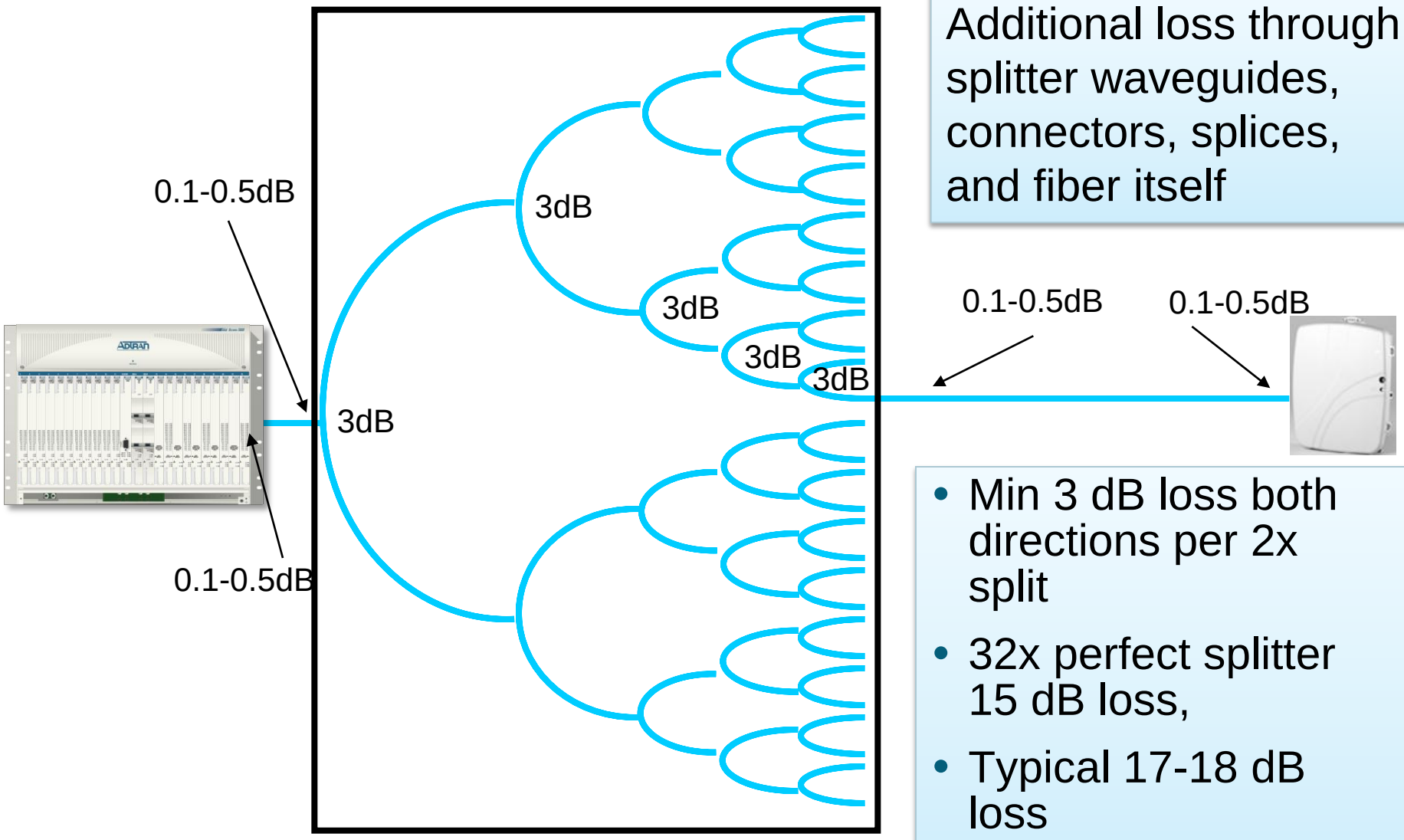
Fiber Loss Characteristics

- Minimum 10 dB loss between OLT and ONT: use attenuator or splitter
- SMF-28e fiber: ~0.25db/km 1490nm, ~0.35db/km 1310nm

Transmit Power

- Measured launch power at OLT SFP +1.5 to +5 dBm
- Depending on actual ones' density of payload
- Launch power cannot easily be measured at ONT -- only transmits when connected to OLT

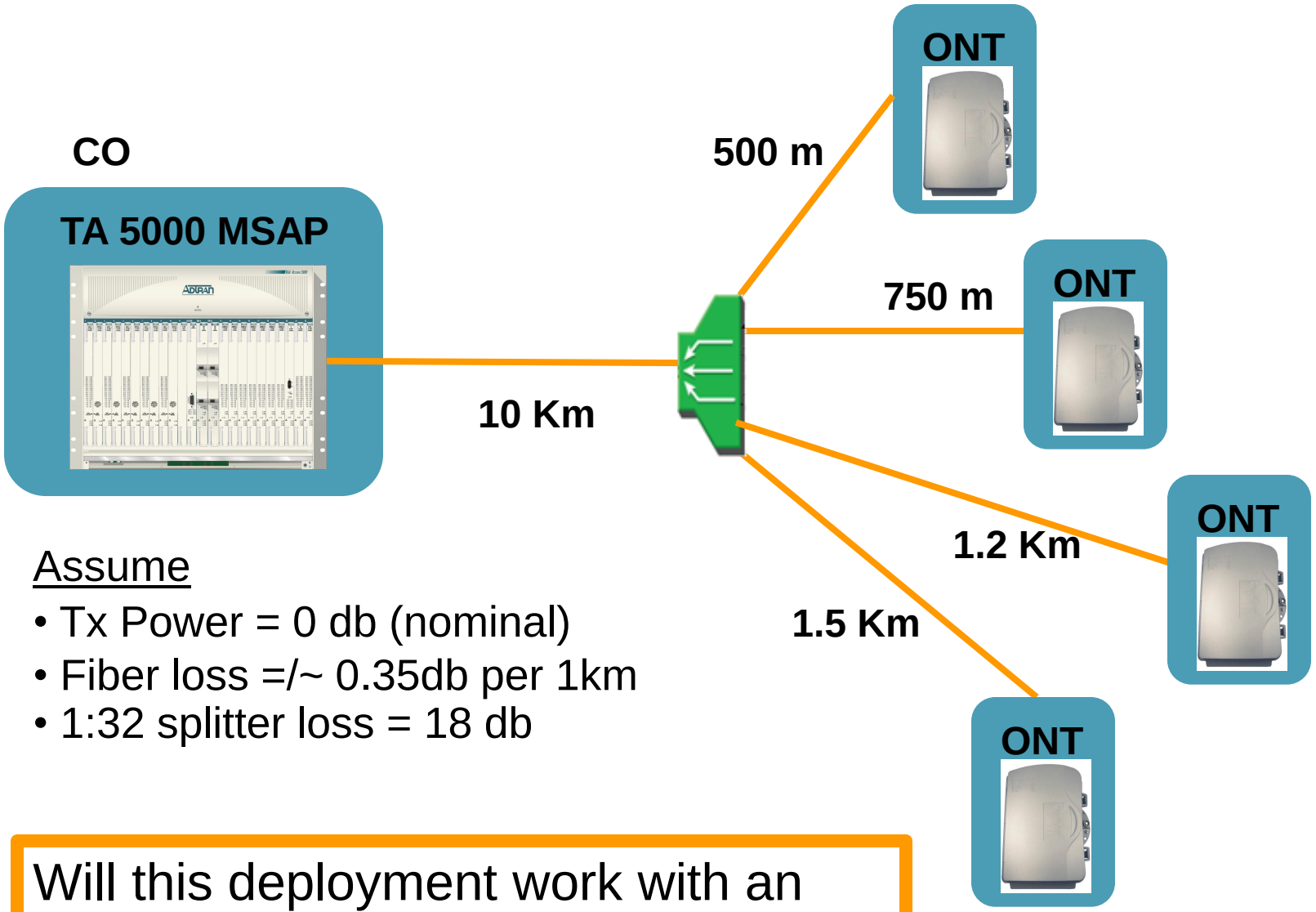
Splitter and Optical Power Loss



Additional loss through splitter waveguides, connectors, splices, and fiber itself

- Min 3 dB loss both directions per 2x split
- 32x perfect splitter 15 dB loss,
- Typical 17-18 dB loss

EXERCISE – Optical Budget

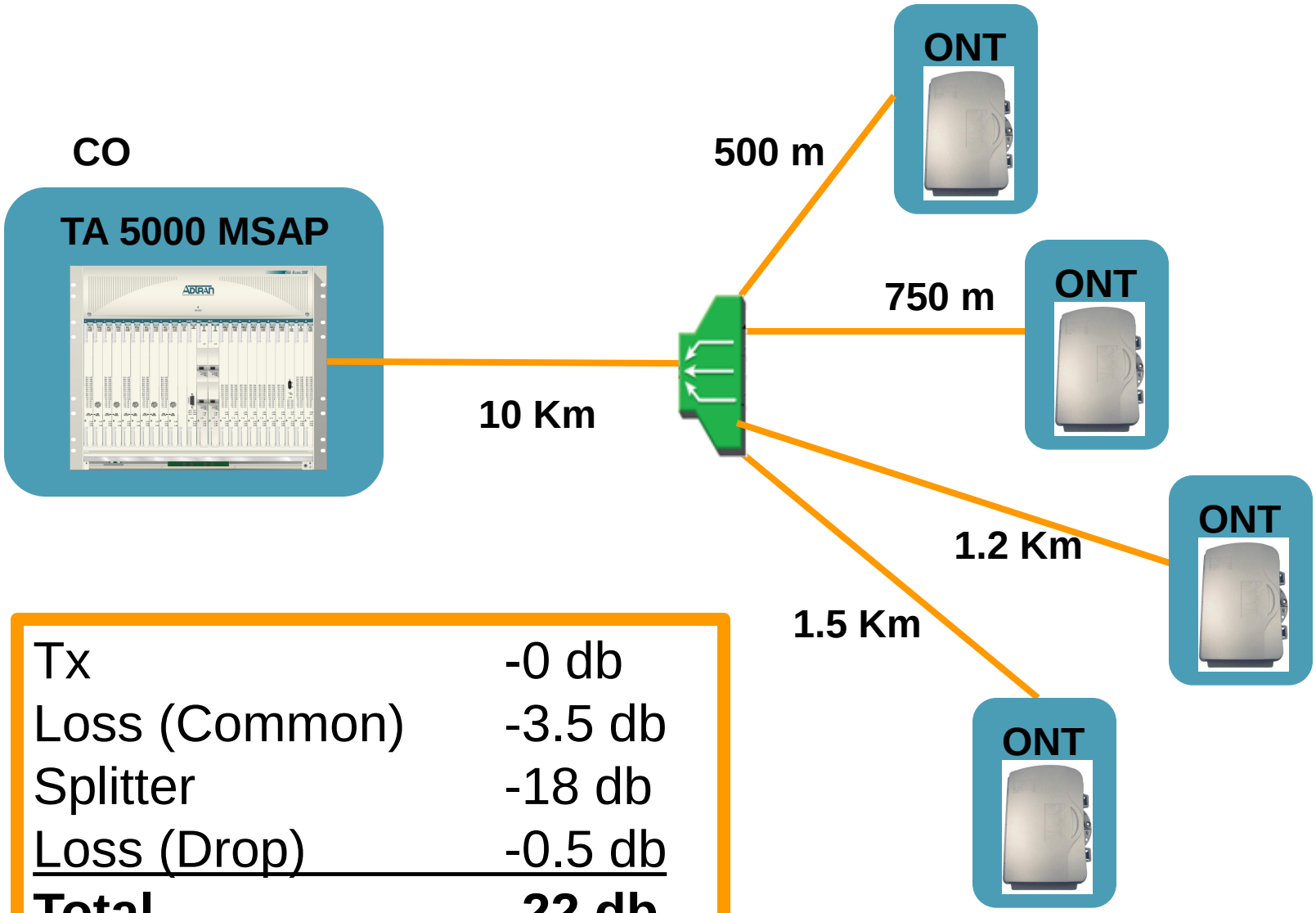


Assume

- Tx Power = 0 db (nominal)
- Fiber loss =/~ 0.35db per 1km
- 1:32 splitter loss = 18 db

Will this deployment work with an **optical budget of 26db loss?**

EXERCISE – Optical Budget



Tx	-0 db
Loss (Common)	-3.5 db
Splitter	-18 db
Loss (Drop)	-0.5 db
Total	**-22 db**