New Infrastructure Elements in the Access Network

Beijing, 16 May 2007

Jan Erreygers
R&D Manager
Tyco Electronics
Jan.Erreygers@tycoelectronics.com

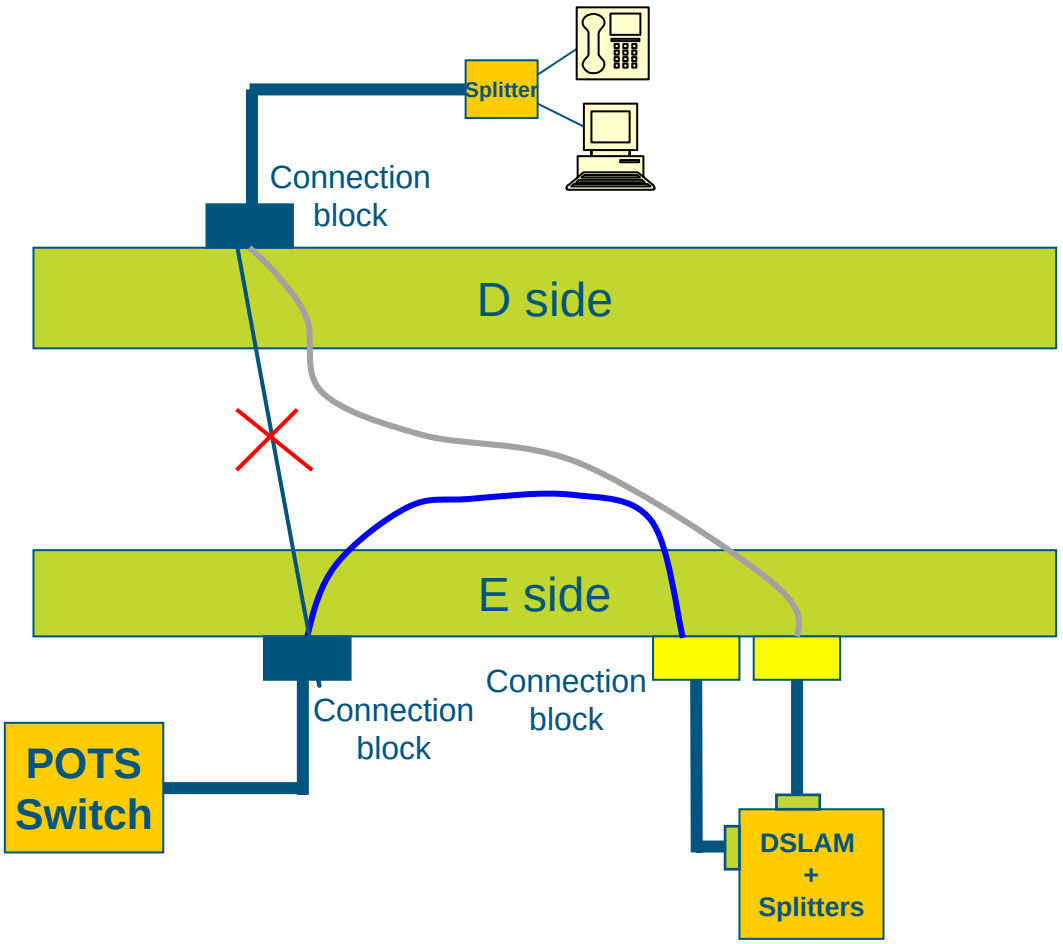
Overview

- Introduction
- xDSL Splitters
- Metallic Test Access Solutions
- Outside Plant Cabinets for Active Equipment
- Underground Enclosures for Active Equipment
- Automated Main Distribution Frame/Crossconnect
- Broadband Injection Infrastructure
- Conclusion

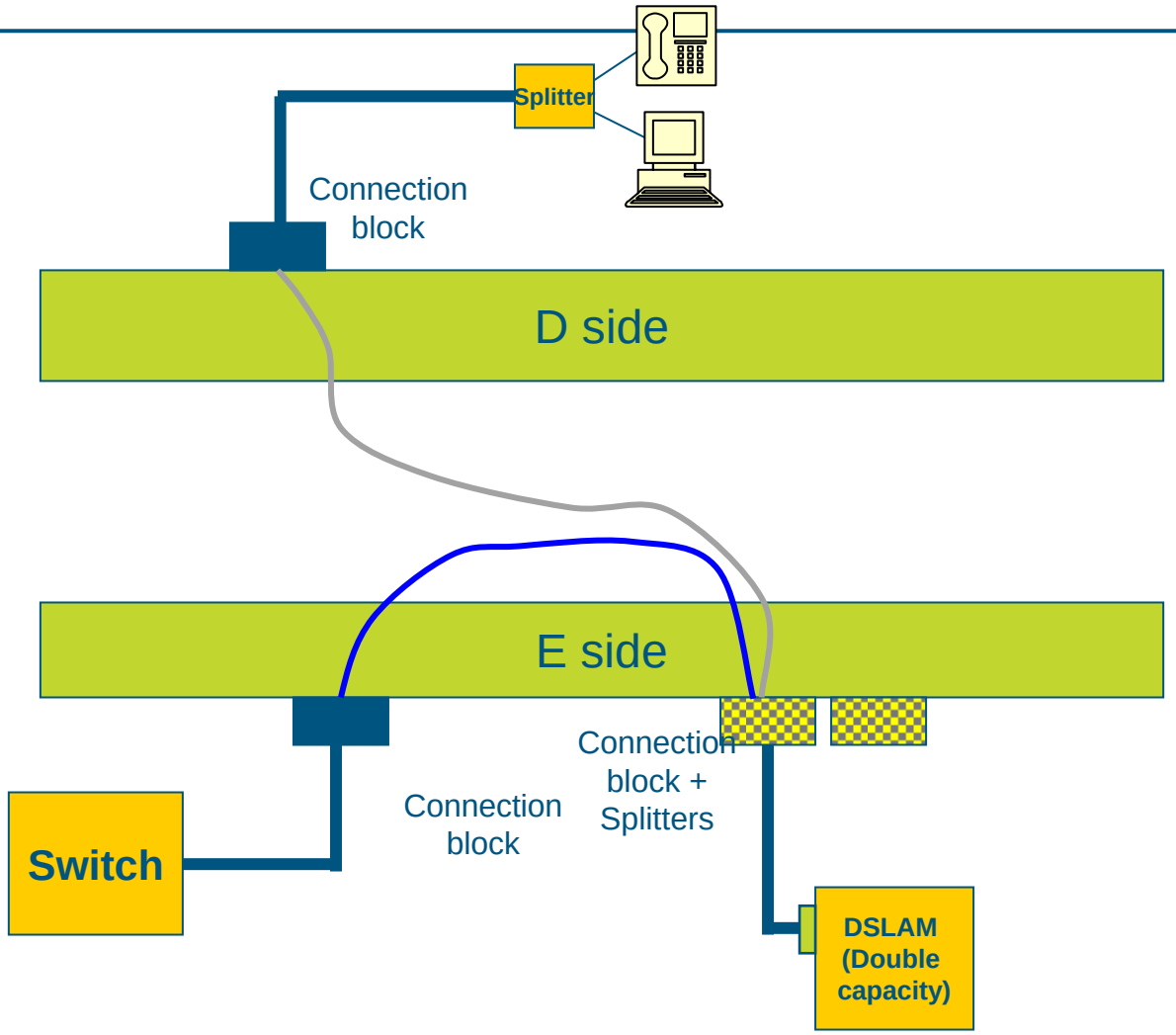
Introduction

- Why so many new types of equipment in the Access Network?
  - Introduction of ADSL (late 1990s)
  - Unbundling of the access network
  - Evolution of xDSL technology: ADSL, ADSL2, ADSL2+, VDSL1, VDSL2
  - Trade-off between bandwidth and loop length
  - Need for more sophisticated test access
  - Streaming video applications over DSL
  - Migration to new technology platforms (VoIP)
  - Move towards an all-IP network

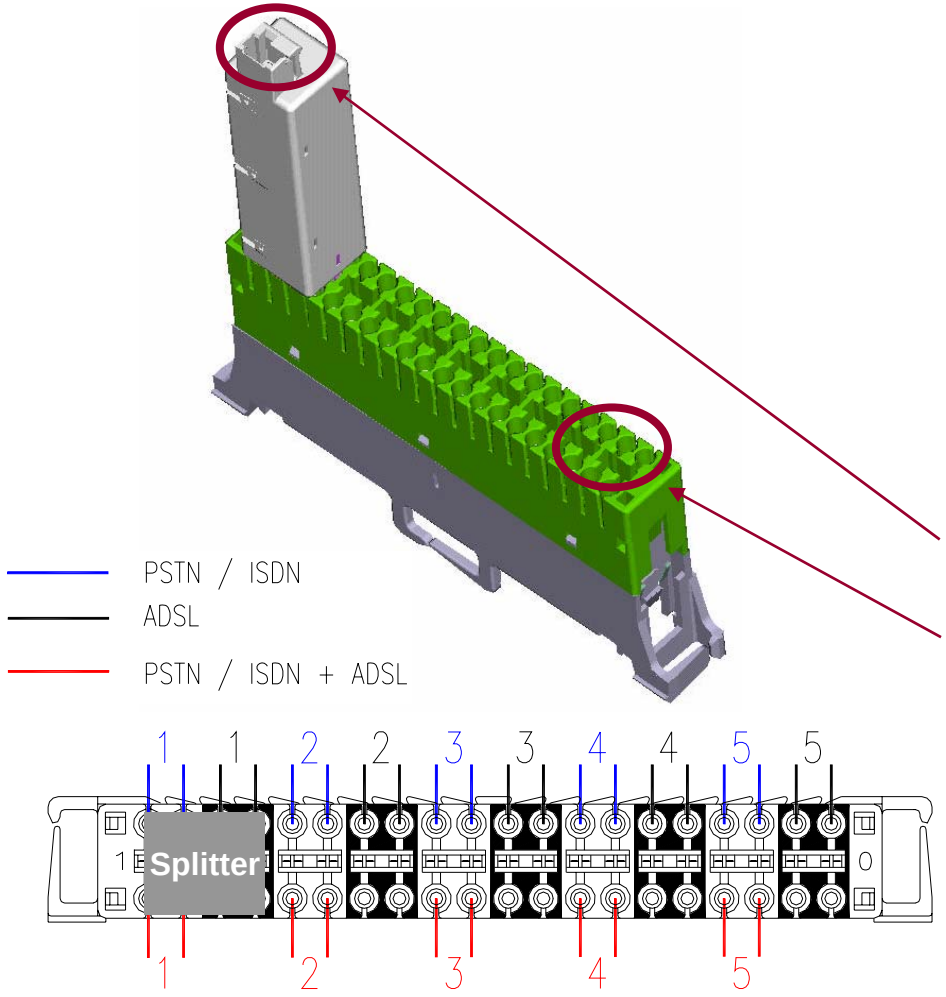
xDSL Splitters: First generation cabling



xDSL Splitters: Reducing CO Cabling

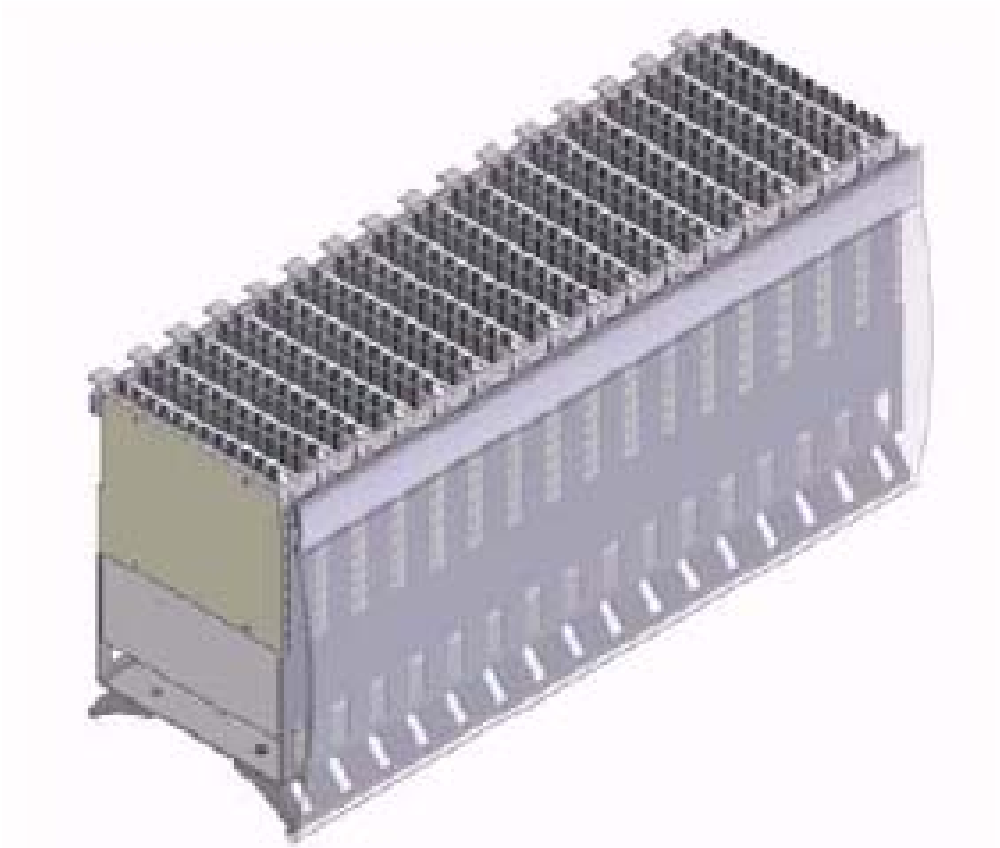


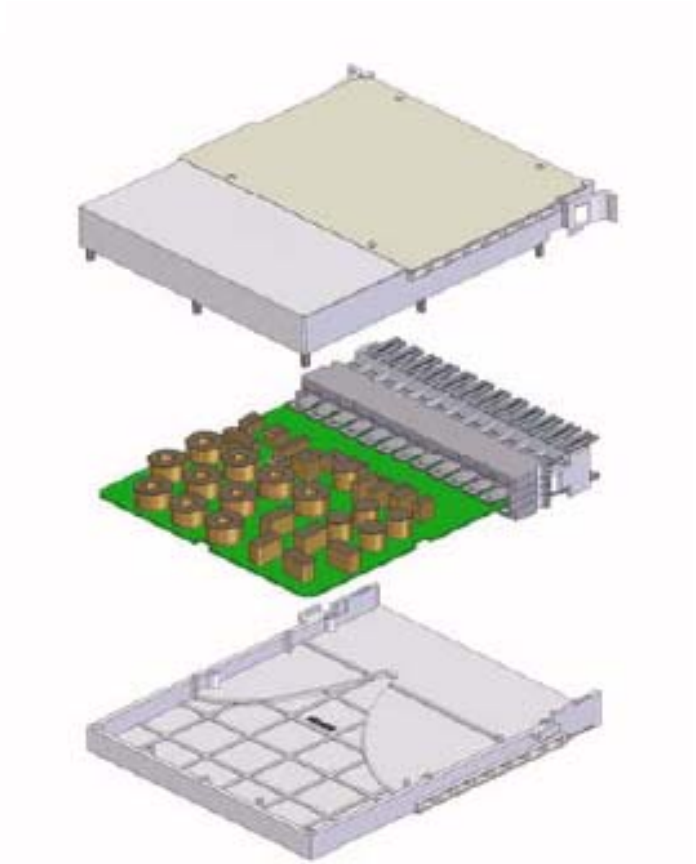
Individual Plug-in Splitters



- Individual splitter
- One plug in, one unplug
- Incremental investment
- Easy and low cost maintenance
- Less connection points: save cable, cabling, connectors and failure points
- Non intrusive test point
- Intrusive test point

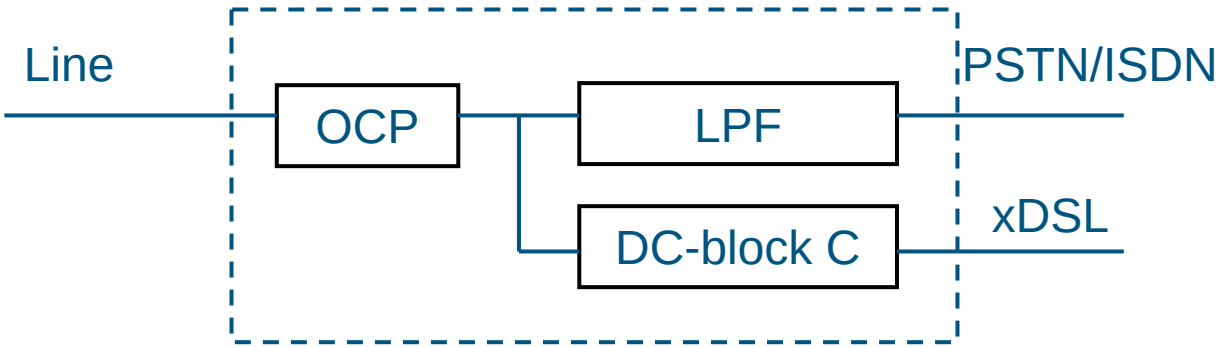
Modular splitter blocks





xDSL Splitters: SG5 aspects

- First component connected to the copper pair (except for primary protection)
- Termination impedance for coordination tests (DC-blocking capacitor is not always present)
- Power contact tests



Metallic Test Access Solutions

- Why?
- Different flavors
  - I-TAM
  - E-TAM
  - F-TAM
  - Combined Splitter-TAM solutions

Facts and Figures on Broadband Service Assurance

- Massive DSL penetration leads to exponential growth of OPEX (mainly driven by customer service calls & truck rolls).

- In more than 50% of customer service calls:
  - There is no fault
  - Or, the fault can be solved by the customer (PC configuration, ...)
  - A truck roll could have been avoided

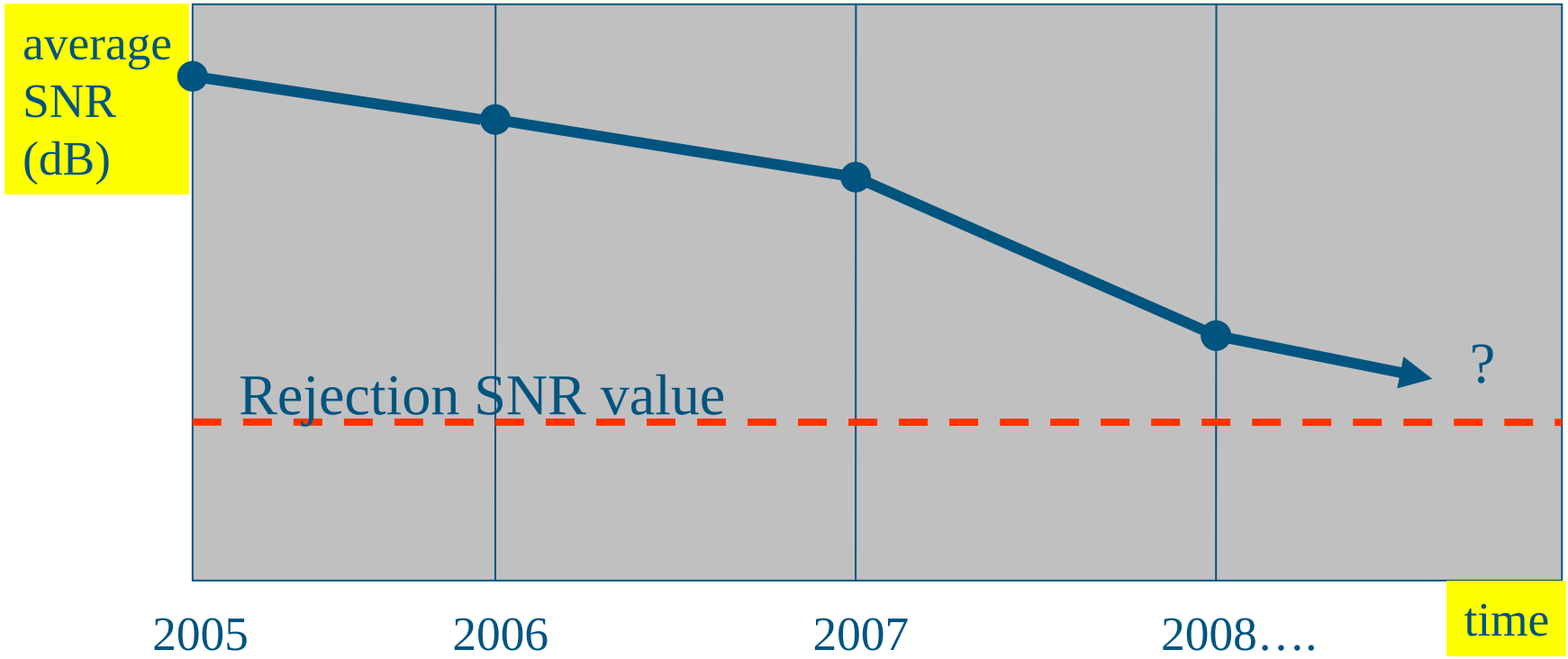
- More than 30% of truck rolls need a second truck roll because:
  - Engineer went to wrong location
  - Engineer with different skills is required to solve the problem

Broadband Service Assurance Testing

- Reduce operating expenses for massive ADSL deployment
  - ↳ Reduce # truck rolls
- Monitor lines to understand trends in copper loop performance
  - ↳ Monitor SNR
- Qualify lines for higher speed, more revenue services
- Plan in advance for New Construction vs Maintenance
- Improve customer satisfaction, and avoid customer churn to competitors….
- Demarcate responsibilities with OLO's

Why broadband line monitoring?

Copper Loop degradation is a reality
Higher DSL penetration leads to more crosstalk



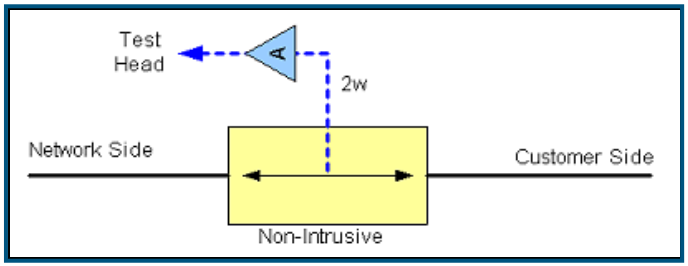
Broadband Test Heads

- Will determine:
  - If there is a fault on the broadband connection
    - Across all the layers of the OSI model
    - Towards subscriber side and towards backbone network
  - Who's responsibility is the fault (customer, ILEC, DATA-CLEC,ISP)
  - Which corrective action is required to solve the fault
- In the future the POTS switch will be phased out. Narrowband test access is thereby eliminated.

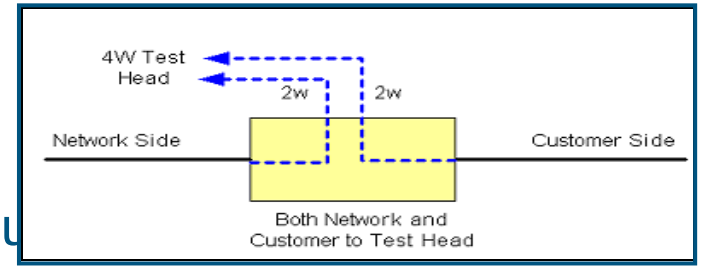
- **Need a metallic test access point that allows testing towards the customer and towards the network**

Metallic Test functionalities

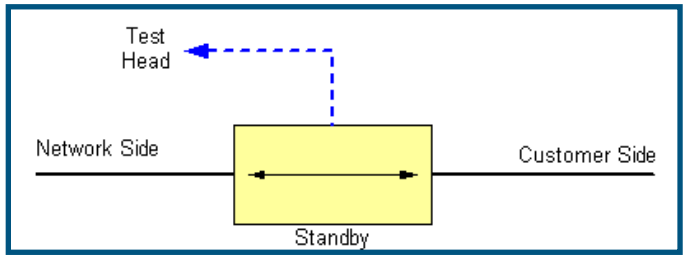
- Non-intrusive test



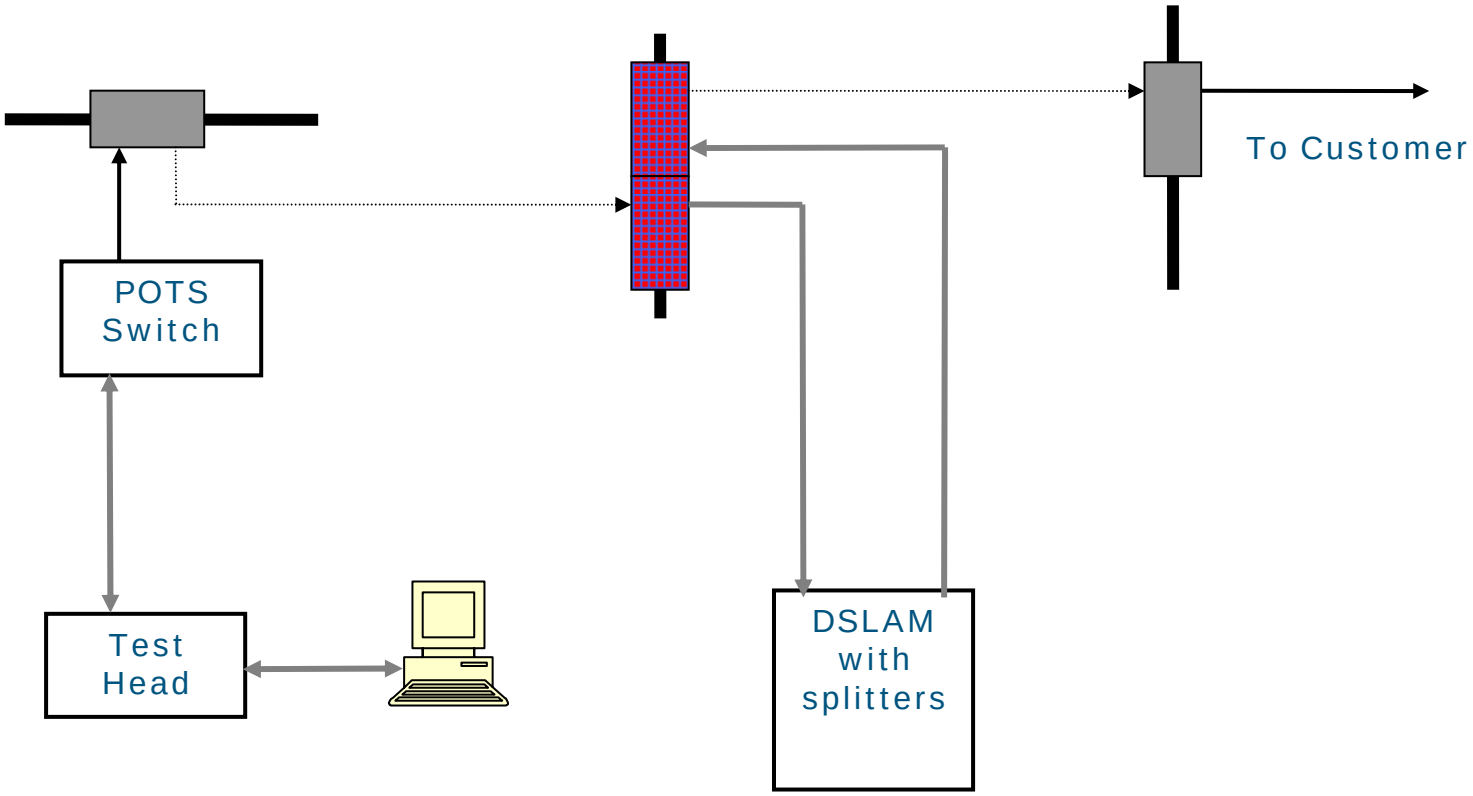
- Intrusive test
  - Look-in test (DSLAM side)
  - Look-out test (customer side)
  - Simultaneous look-in and look-ou



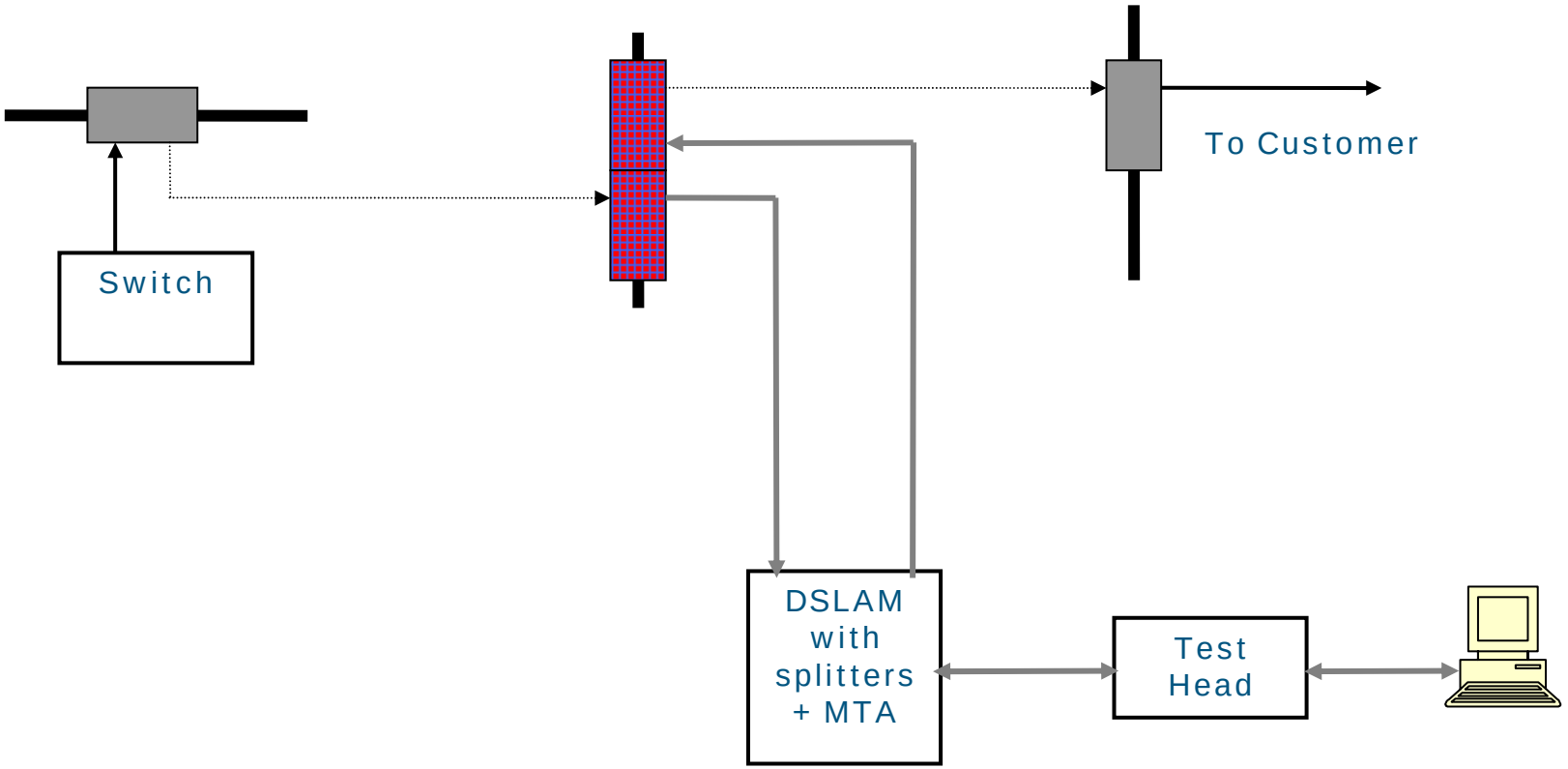
- Circuit standby
  - For calibration of test bus



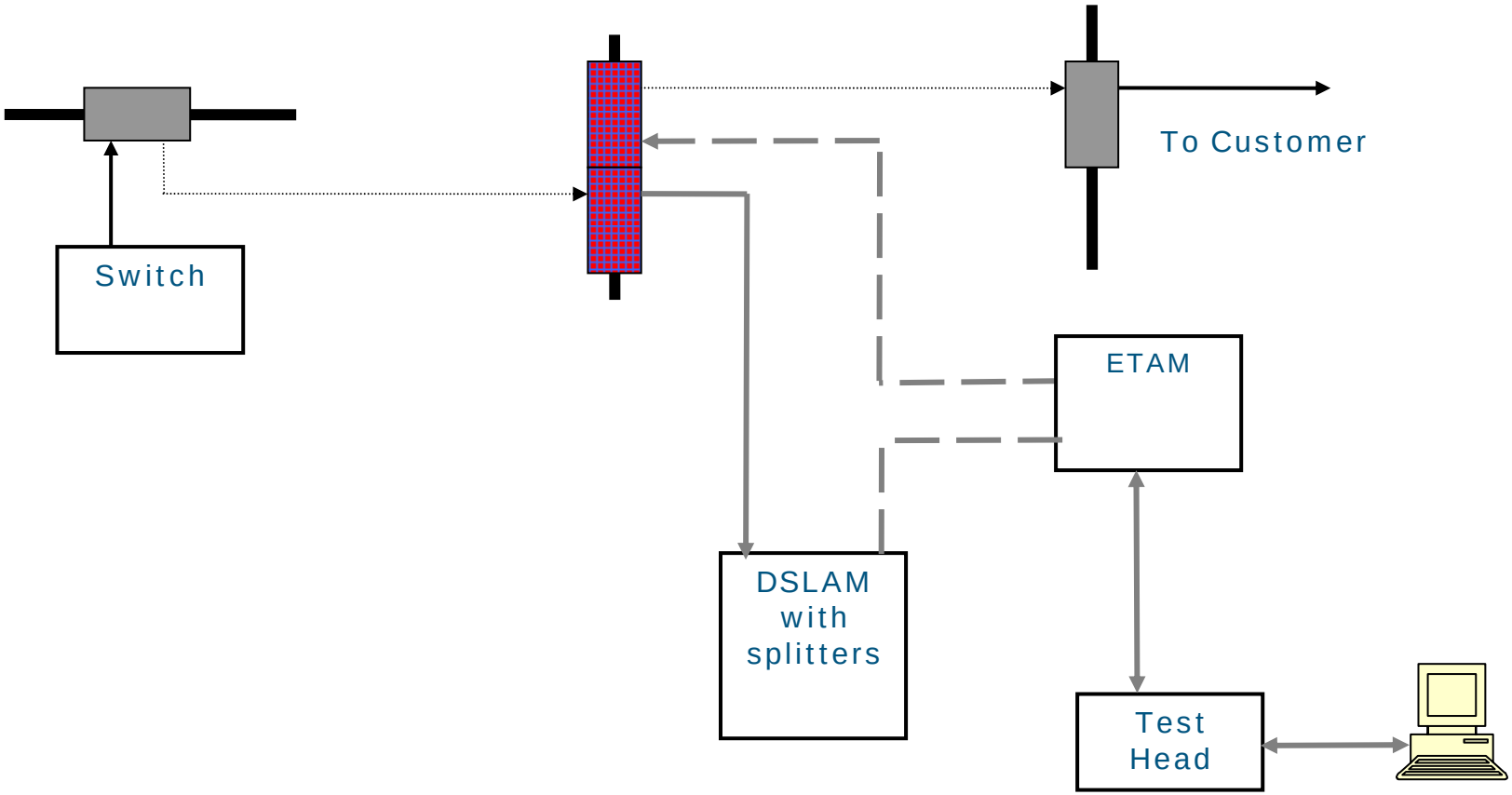
Current Central Office Architecture
No access to higher frequencies



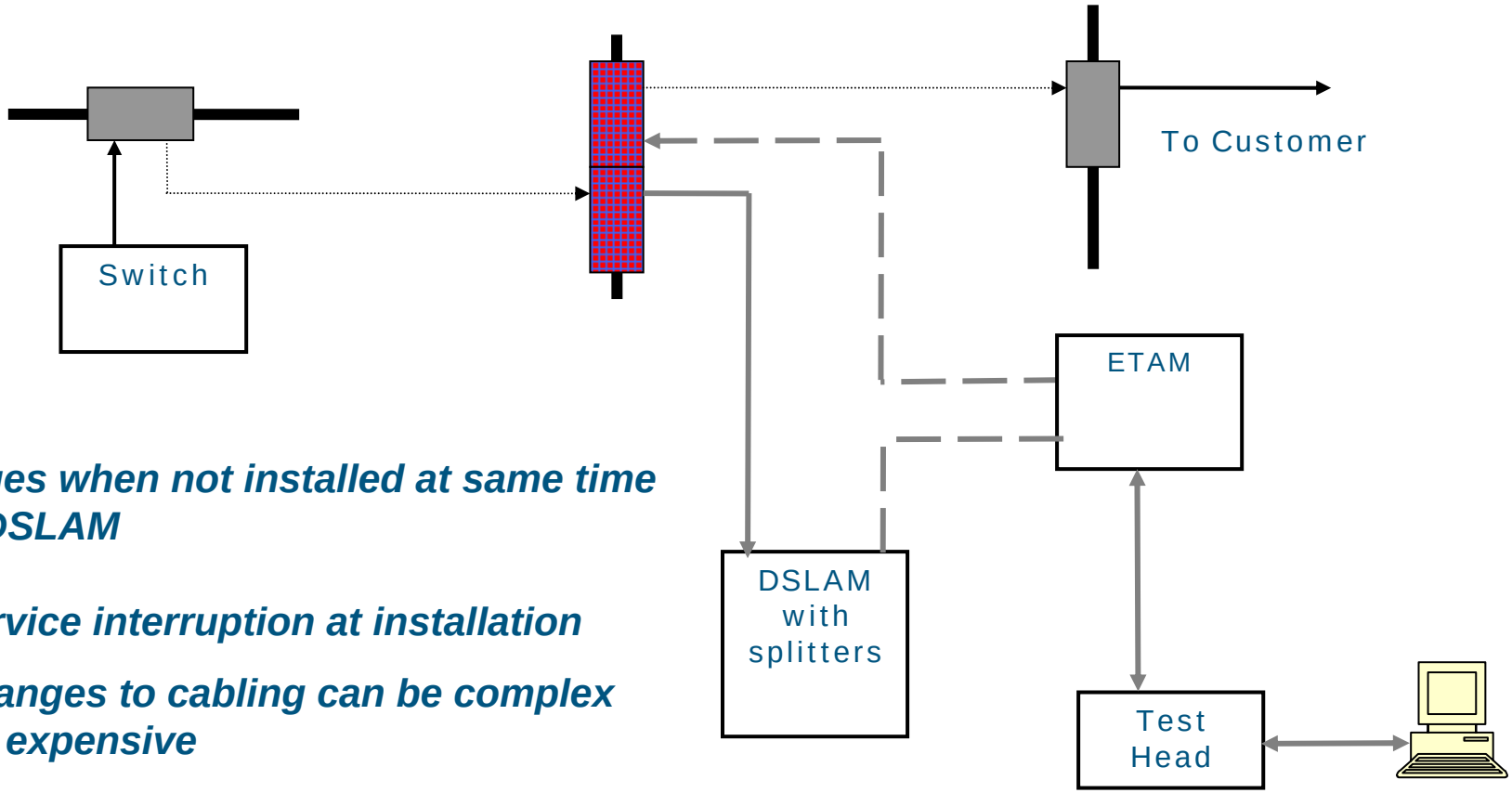
Test Access integrated in DSLAM (ITAM) Concept



Rack based Test Access Matrix (ETAM) Concept



Rack based Test Access Matrix (ETAM) Concept

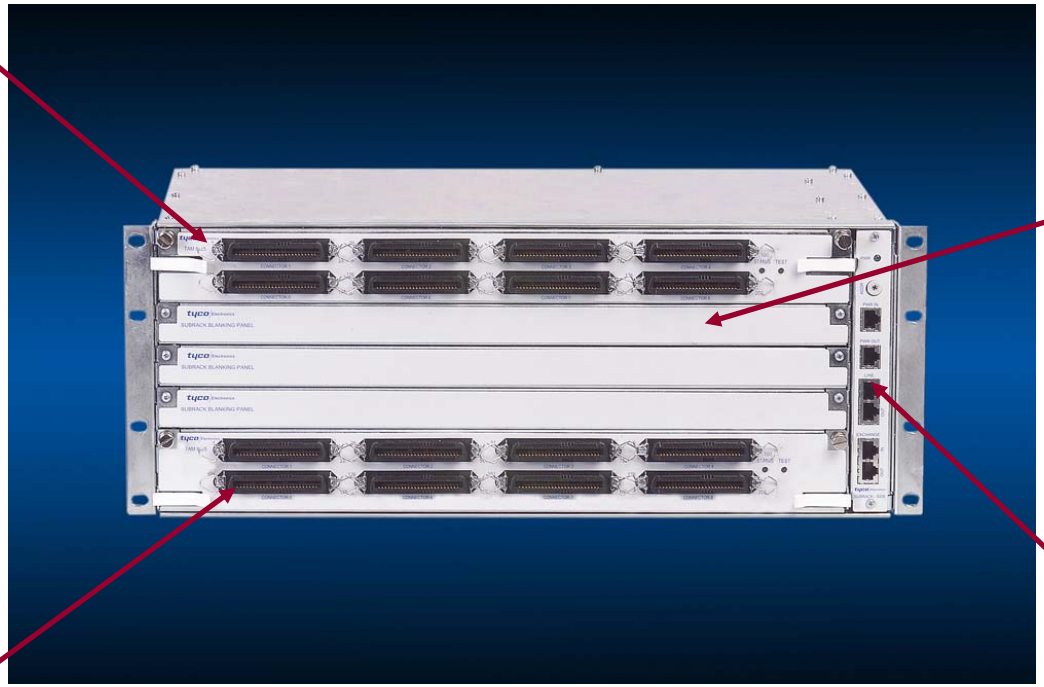


Issues when not installed at same time as DSLAM

- ***Service interruption at installation***
- ***Changes to cabling can be complex and expensive***
- ***Requires additional space***

Rack based MTA System

Subscriber connection
+ TAM (200 lines)



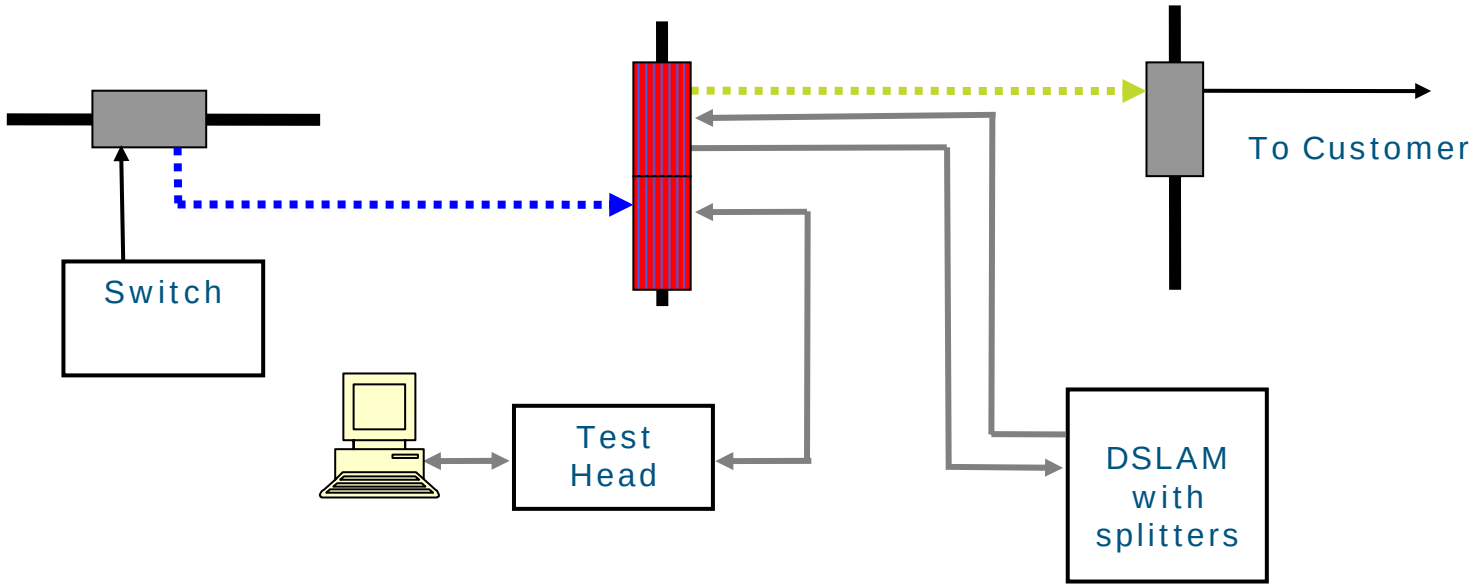
Optional switch cards for
special services or OLO's

DSLAM connection
(200 lines)

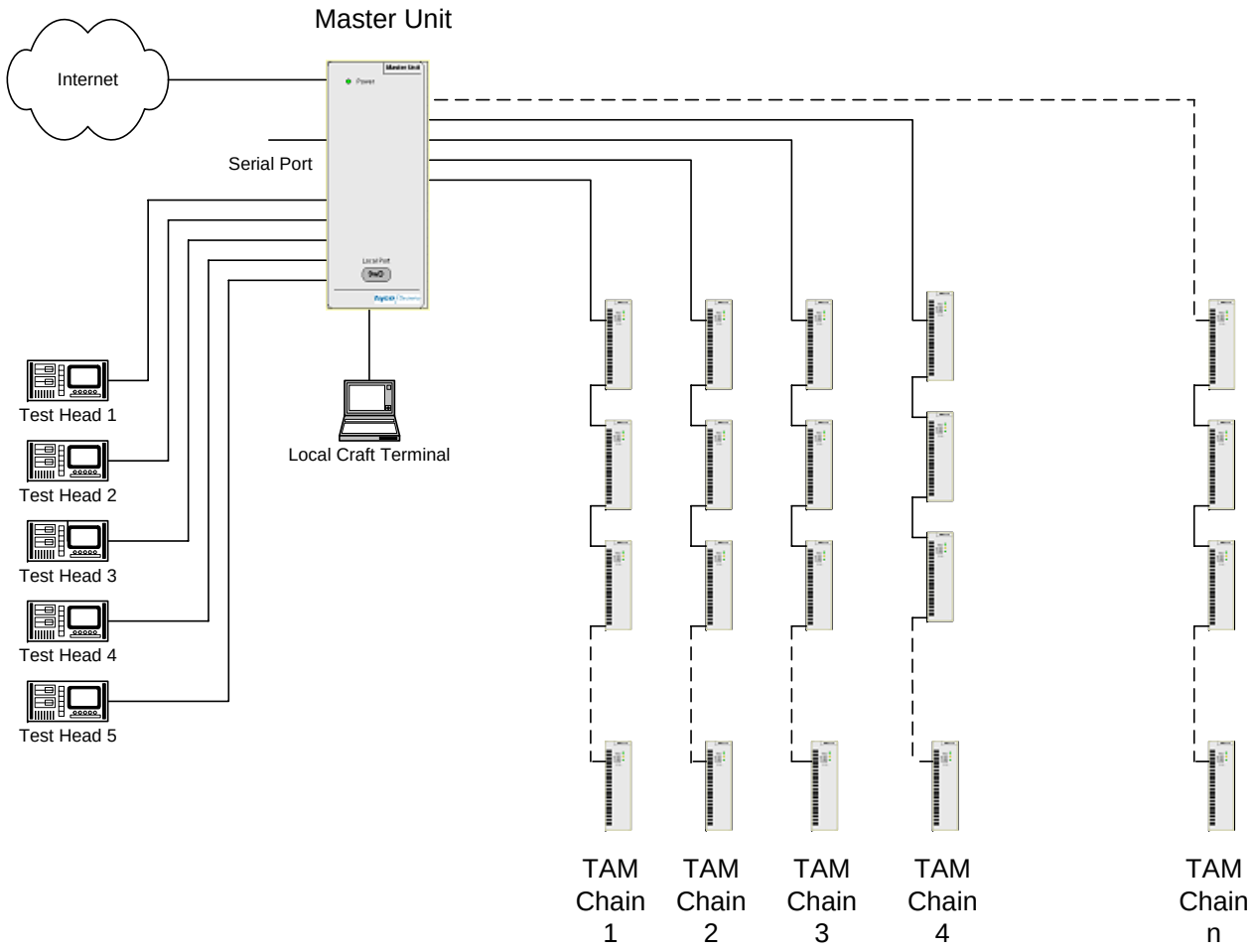
Test Bus connection
towards
Controller / Test Head

Distribution Frame based Test Access: F-TAM concept

Integrates MTA in the MDF



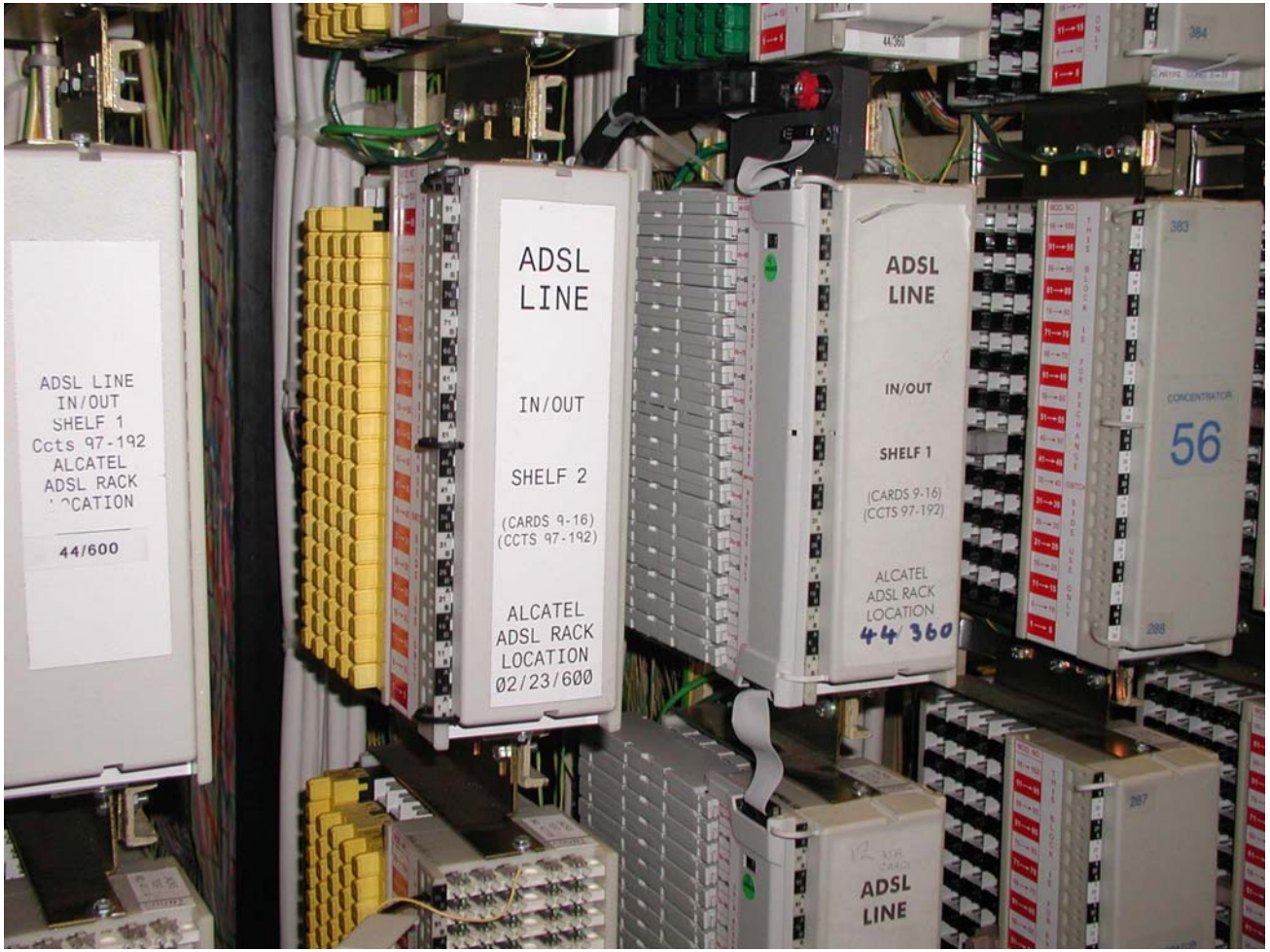
Generic Architecture of a TAM System



Frame-based TAM example

- TAM Card
  - Consists of a control board and compact connectors to install the TAM Cartridges
  - Contains remote upgradable software
  - Interfaces to Master Unit through a bus architecture
- TAM Cartridges
  - Install in the disconnection slots of the MDF connector block
  - Make the galvanic contact with each of the copper pairs

Real Life Installation of a TAM System



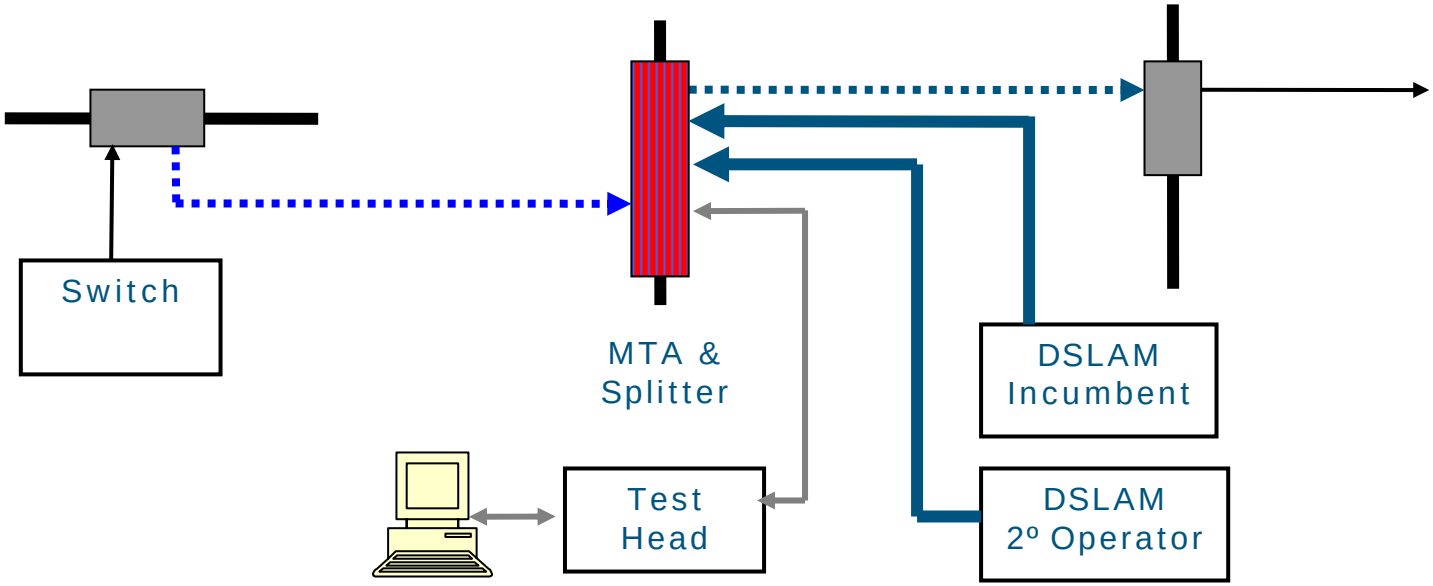
Real Life Installation of a TAM System (Cont'd)

Frame Base TAM integrated with the Distribution Block

- 96 DSL subscribers/box
- MDF installed
- Pre-terminated ADSL cabling in the back
- Jumpers towards OSP are accessible at front face
- 6 TAM Cartridges per box, each providing automated MTA for 16 subscribers

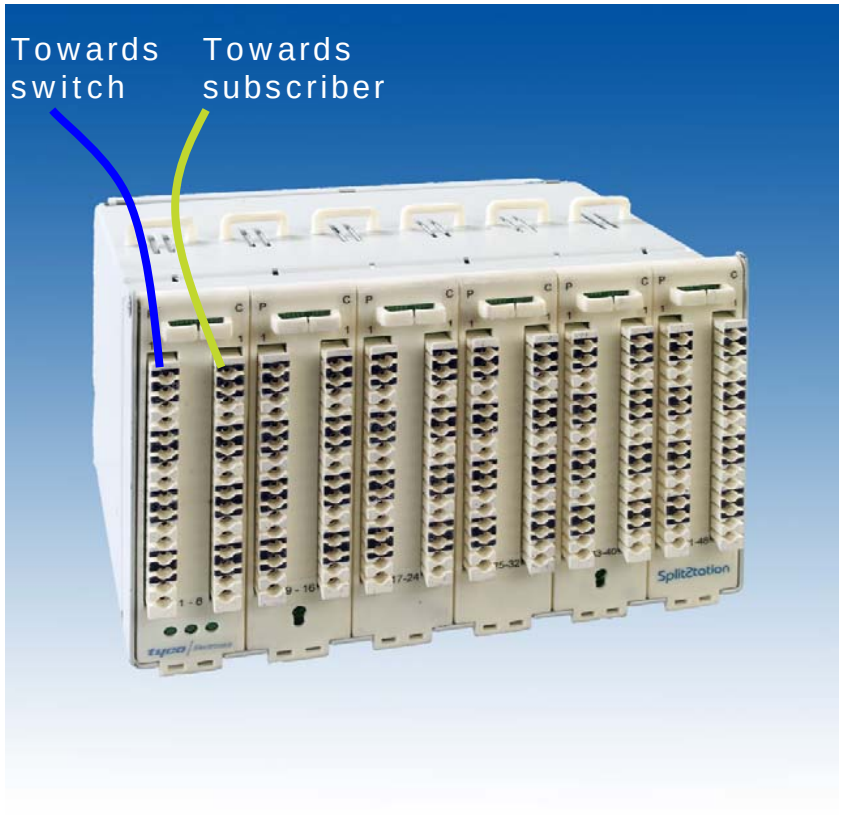
Combined Test Access & Splitter Solutions

Metallic Test Access + Splitters in the MDF



Example of combined TAM & Splitter

POTS
COMBI (POTS+ADSL)



- 48 ADSL splitters/box
- MDF installed
- Pre-terminated ADSL cabling in the back
- Only jumpers to Switch and OSP are terminated on demand
- Jumpers are easily accessible at front face

Example of combined TAM & Splitter

- Make-before-brake connectors secure life-line for POTS
- 6 cards with 8 splitters each, are interchangeable (ILEC or CLEC)
- 8 POTS or ISDN splitters per card, with automated TAM, 48 splitters/box
- Space savings by installing at MDF

Metallic Test Access Summary

- Greater need for testing due to broadband roll-out
- Traditional test access through the POTS switch is not sufficient
- Customers with all-IP access do not have a connection to the POTS switch
- Operators are installing broadband test access solutions
- Variety of architectures are possible:
  - I-TAM
  - E-TAM
  - F-TAM
  - Combined F-TAM & Splitter solutions

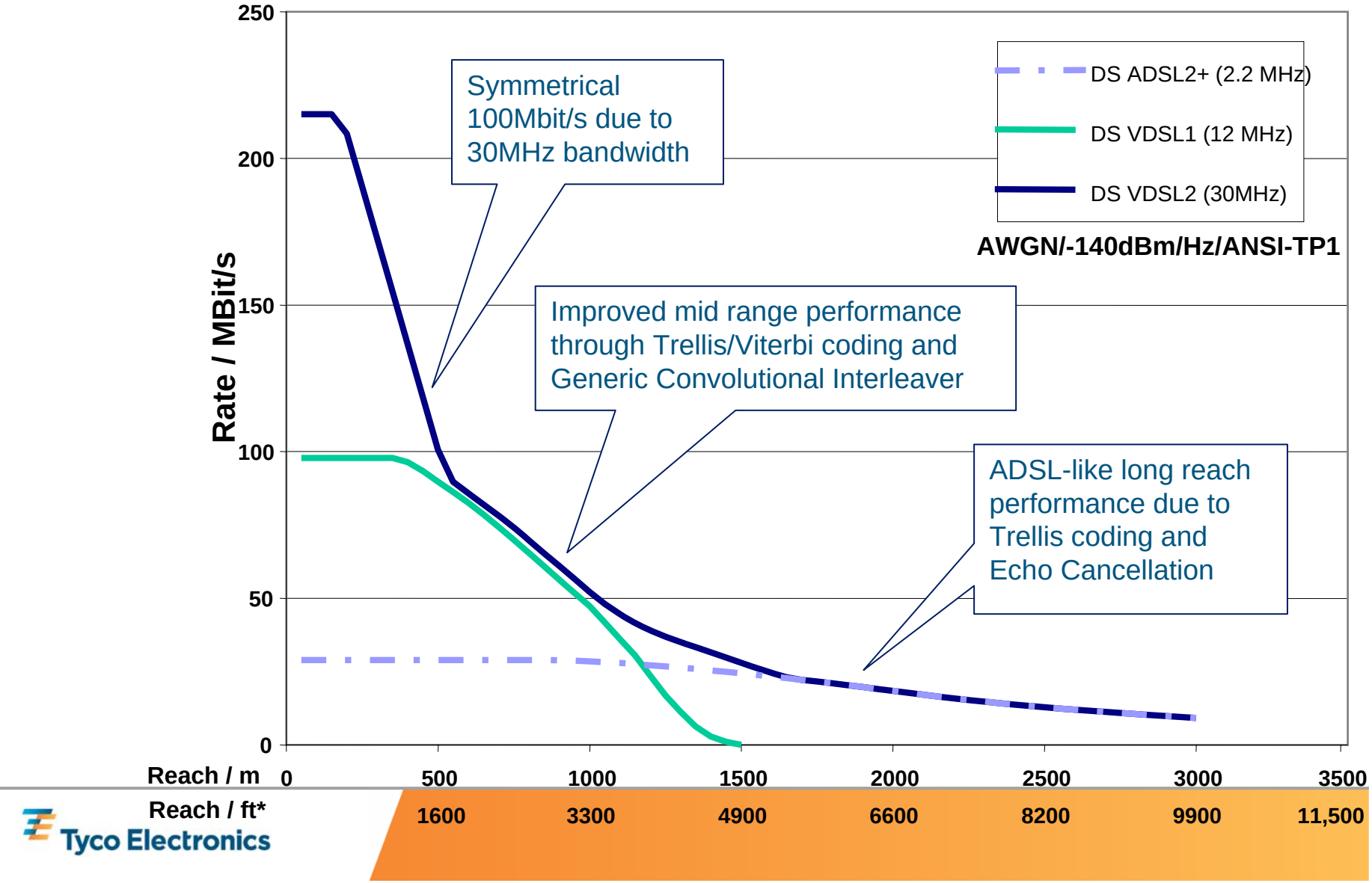
Metallic Test Access: SG5 aspects

- First component connected to the copper pair
- Protection coordination tests
  - Operator wants very low series resistance
- Power contact test: we can get a cascade of overcurrent protectors
- Impact on xDSL transmission

Outside Plant Cabinets for Remote Active Electronics

- More bandwidth is required for new services
  - Streaming video, multiple channels
  - HDTV, multiple channels
- Trade-off between bandwidth and loop length (next slide)
- Need to install DSLAMs closer to the subscriber
- Concept of small buildings is difficult for planning reasons
- Need to install DSLAMs near to existing flexibility points (cabinets)
- New type of cabinet for remote electronics

ADSL2+ & VDSL2 DS Performance



Tyco Electronics

Active Cabinets: General Requirements

- IP55 sealing (EPDM), IK10
- ETSI 300 019-1-4 in general
  - **Earthquake protection acc. ETSI 300 019-1-4 seismic zone 4**
  - **Climate class 4.1.E requirements**
- Bonding and earthing according ITU-T recommendation K35
- Vandalism protection acc. EN 61969-3:2001 and EN 50102:1995 (special kit that can be added to the design of the cabinet)
- Integrated EMC shielding

Thermal management

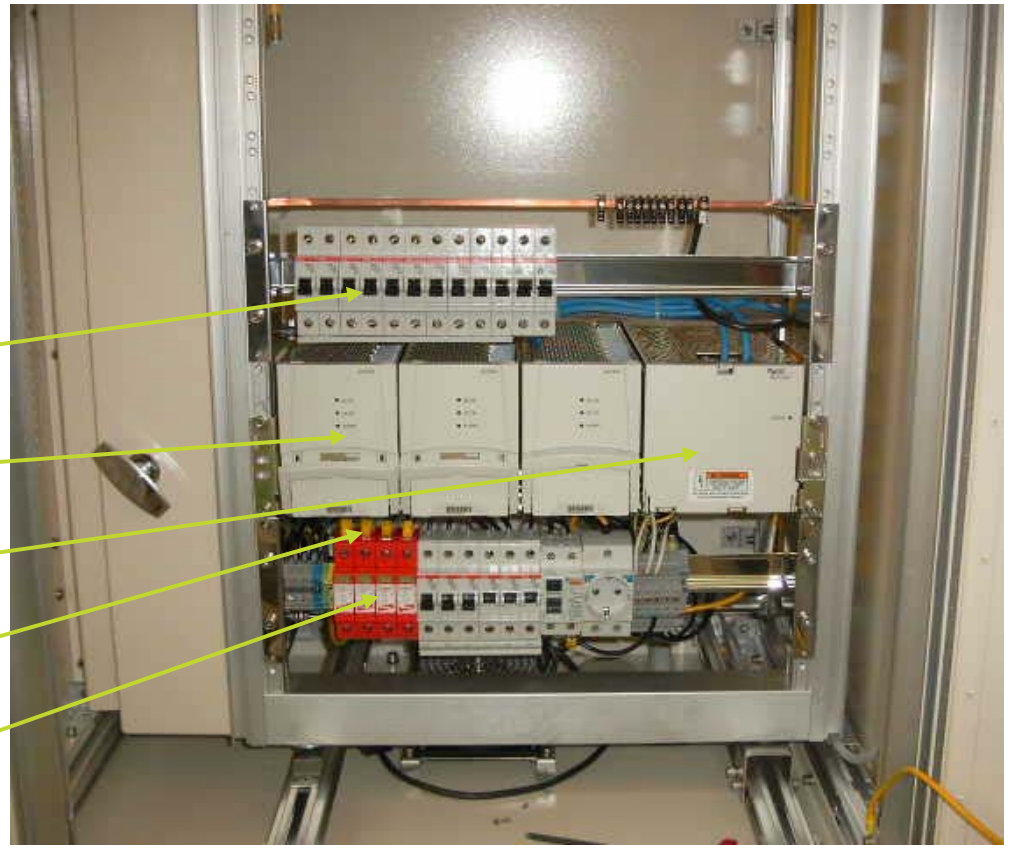
- 5 levels of thermal management
  - Passive thermal management
  - Enforced air flow thermal management
  - Heat exchanger thermal management
  - Membrame filter thermal management
  - Air conditioning thermal mangement
- Choice depends on the internal thermal load, the sunload, the max/min temp specified inside/outside and the cabinet surface area
- The engineered cabinet configuration requires a final thermal management testing to confirm the calculation and to verify for potential hot spots; 19” or ETSI 1U fan trays with alarm and speed control
- Wide range of heaters from 10 to 1200W to fullfil cold start, prevent condensation and guarantee battery lifetime

Detectors / switches

- Temperature monitor
- Humidity control
- Smoke Detector
- Flood Level Switch
- Door Switch
- Locks

Powering (example)

- Power for 650W up to 1950 W 48V DC
- AC distribution for 1or 3 Phase input 110/230V
- DC distribution with DIN style breaker or customised available



- DC Distribution
- Rectifier
- Controller/ LVD
- AC distribution
- Surge arrestors

Powering (example)

Rear side

- **Load return (Positive)**
- **DC Distribution**
- **Battery Switch (negative)**
- **Battery and Load Return (Positive)**
- **AC wiring**

Example cabinet

Sample Cabinets

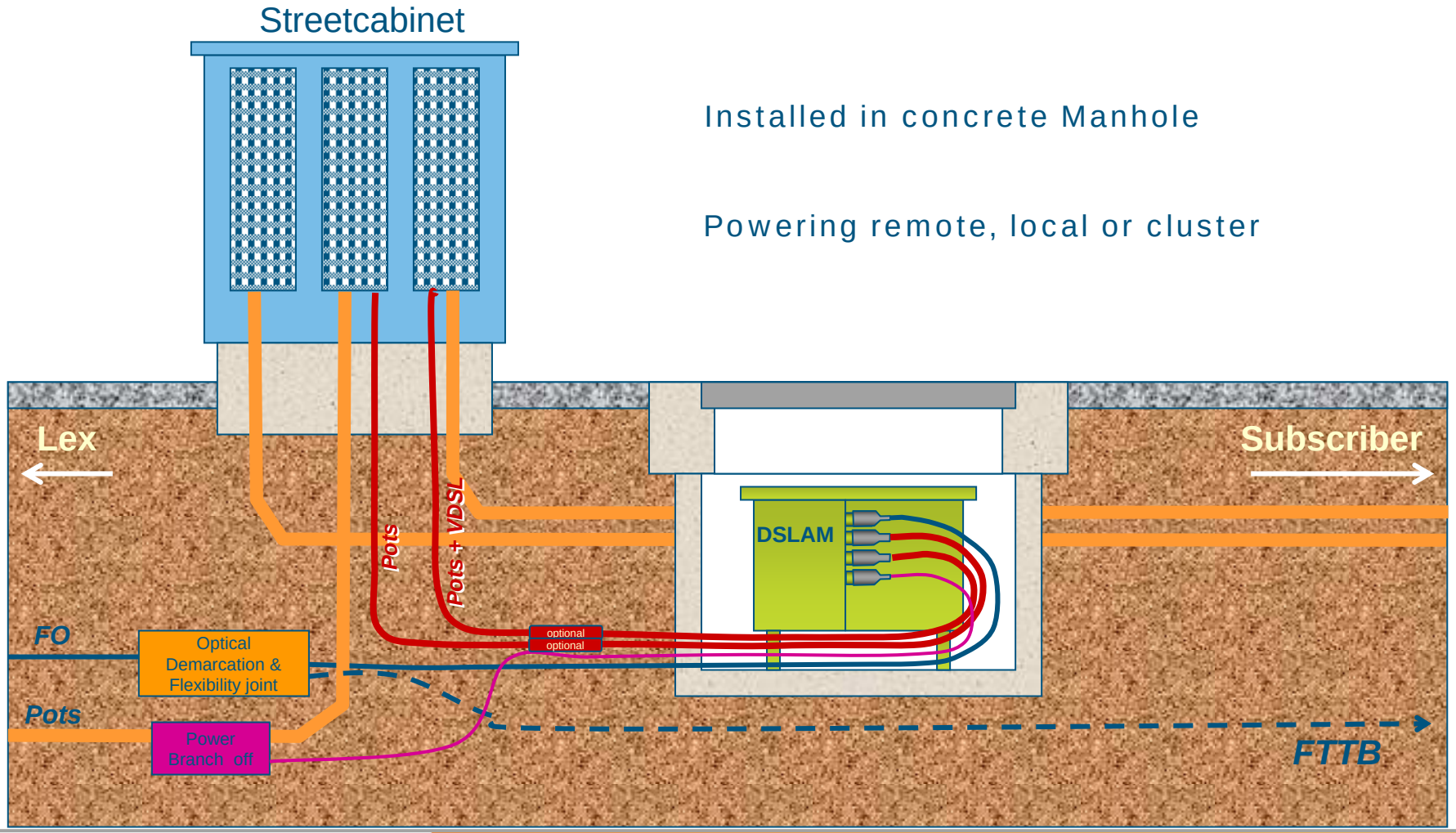
Active Equipment Cabinets: SG5 Aspects

- Earthing & Bonding
- Overvoltage protection: lines & mains (K.45)
- Consider environmental performance of protections
- Remote power feeding
- EMC: interference between
  - Power equipment
  - Fans for cooling
  - DSLAM
  - All kind of sensors

Underground Enclosures for Active Equipment

- Why?
  - Vandalism protected
  - Protected against traffic accidents
  - Local government regulations

Typical application

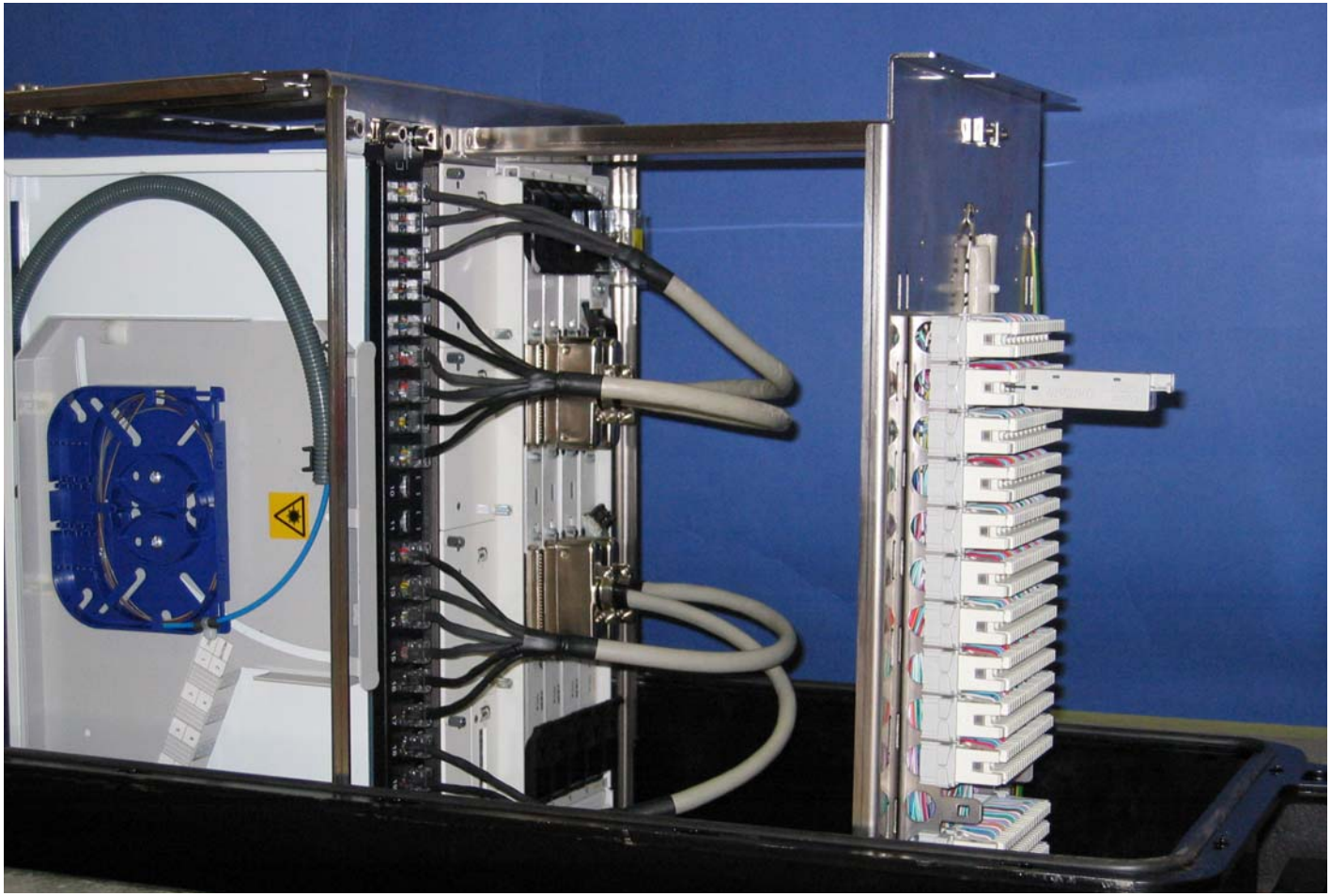


Installed in concrete Manhole

Powering remote, local or cluster

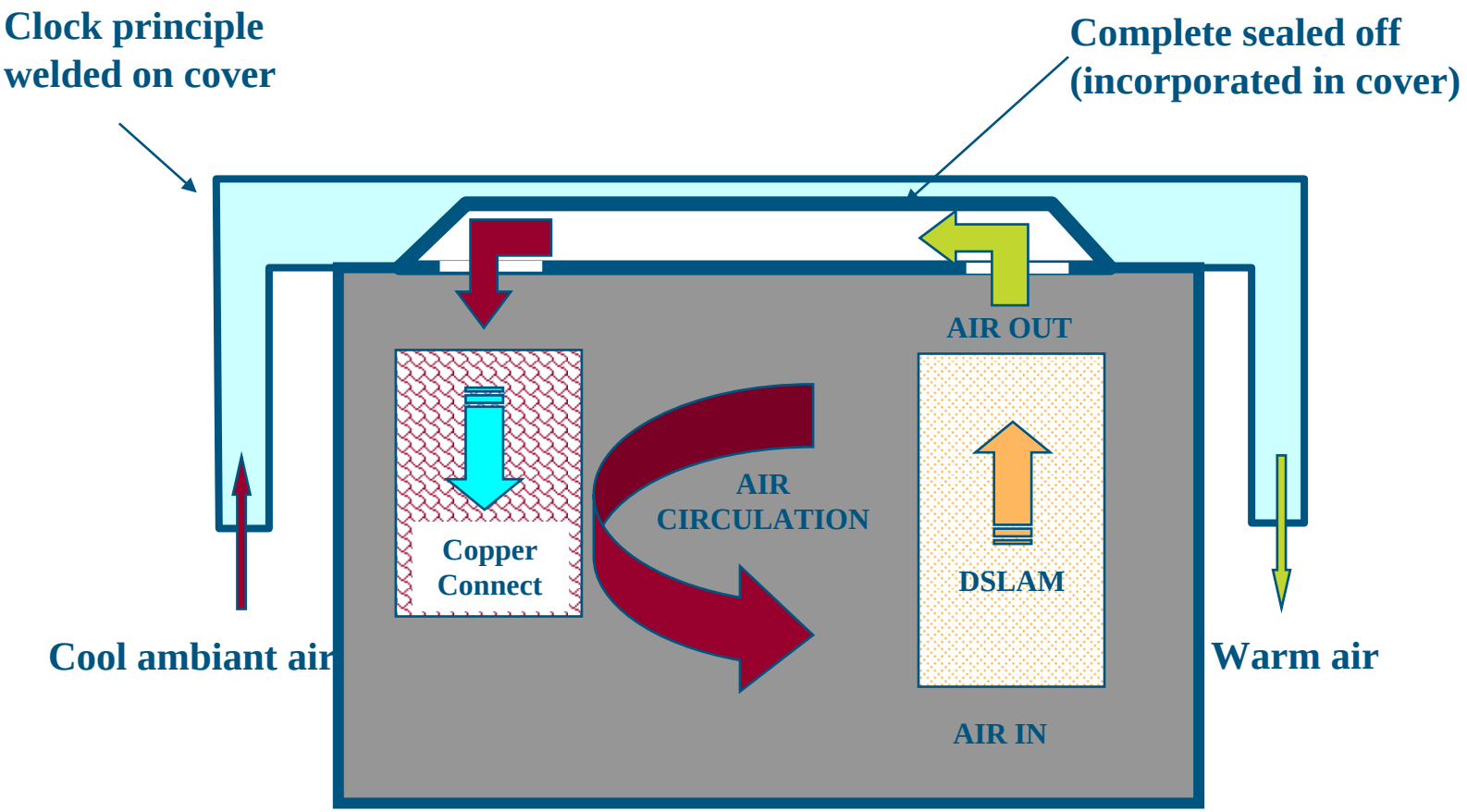
Typical application in the field

Equipment/CDF frame



Air to air heat exchanger

- **Air flow through heat exchanger**



Cover with heat exchanger (Hinged)

Underground Enclosures for Active Equipment: SG5 Aspects

- Earthing & Bonding
- Overvoltage protection: lines & mains (K.45)
- Consider environmental performance of protections
- Remote power feeding
- EMC: interference between
  - Power equipment
  - Fans for cooling
  - DSLAM
  - All kind of sensors

Automated Main Distribution Frame & Crossconnect

- Applications – Business Case Aspects
  - Active Cabinets
  - Central Office
- Architectural Considerations: A2A vs. A2M
- Technologies
- Conclusion

Active Cabinets – The Need

- Deployment of active cabinets is growing fast
  - Need for higher speed needs shorter loops (e.g. VDSL2, ADSL2+)
  - Need for universal coverage
  - Reduce real estate assets
  - Migration path to FTTC, FTTH
- Connections of new Broadband subscribers requires jumpering to connect POTS customers to the DSLAM
- Every new connection requires a truck roll which is expensive and slow
- Assuming a truck roll cost of 80€, and 25% pick up/churn rate per year, the current cost is 20€ per line, per year

→ Business case for ADF in active cabinets shows acceptable pay back in many cases

Active Cabinets – Other Considerations

- Manual service provisioning in remote cabinets will:
  - require many installers
  - be difficult to plan and manage
  - create many network faults
    - *“Every fourth manual intervention in the network creates a fault.”*
- “On line” provisioning of new services might be a valuable marketing tool to increase market share
  - *“Buy your (VDSL) set top box today and watch AC Milan – AS Roma tomorrow”*
- Equivalence considerations might force incumbents to provide “on line” access to OLO’s

Central Office

- Business case is much more complex, because:
  - CAPEX is higher because larger systems are required
  - OPEX savings are smaller because most central offices are manned
  - Implementation is much more complex because size & history

Central office business case for ADF is not easy, but can be attractive in certain situations

Central Office – The Need

- Operators consider to replace their legacy telephony platform by new multi service platforms to:
  - Reduce OPEX of supporting multiple, old platforms today
  - Become Broadband centric, rather than Telephony centric
  - Realize CAPEX and OPEX benefits of an end-to-end IP network
  - Reduce real estate assets, move to smaller, lower cost buildings
  - ➢ Significant MDF activity is required to install, test and commission the new platform
- Increased competiton leads to increased churn between incumbent operators and new operators (OLO's)
  - ➢ Jumper activity and related OPEX costs increase rapidly
- Fast or on line provisioning of new services can increase market share
  - ➢ On line provisioning requires automated jumpering to limit OPEX

Central Office – Benefits of Automated Distribution Frames

- Avoid manual jumpering / reduce OPEX for
  - New (broadband) service provisioning
  - Churn to and from OLO's
- Facilitate the transfer engineering to a new NGN platform:
  - Automated testing prior to cut over
  - Automated cut over
  - Roll back to the old platform if required
- Provide on line provisioning of new services to increase market share
- Allow prequalification for higher speed, higher revenue services
- Support service assurance testing through build in metallic test access
- Avoid human errors due to manual interventions
- Provide accurate records

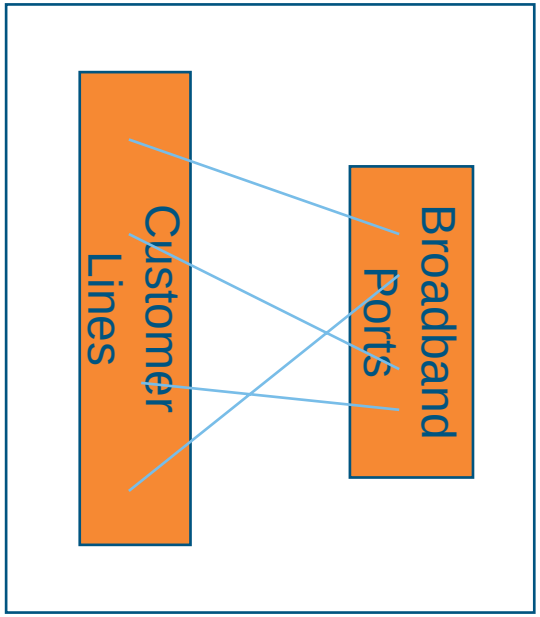
Outline

- Applications – Business Case Aspects
  - Active Cabinets
  - Central Office
- Architectural Considerations: A2A vs. A2M
- Technologies
- Conclusion

Any-to-Any Concept

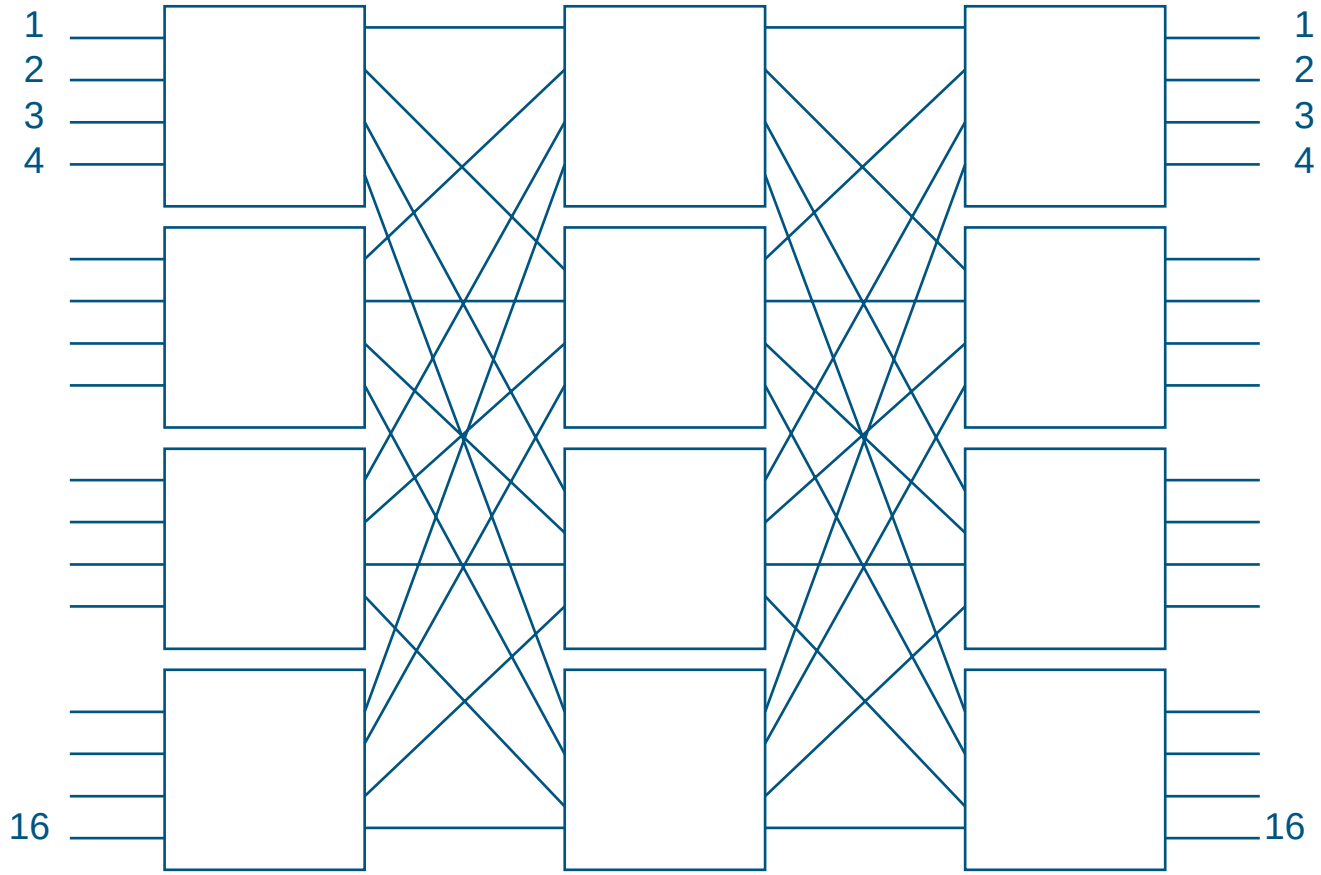
- Allows to connect any subscriber line to any equipment port.
- The most flexible solution, with the same functionality as a manual MDF
- However:
  - Also the most expensive and largest solution
  - Maximum expansion size needs to be determined on Day 1, further increasing the upfront investment

But, is this functionality allways required ?



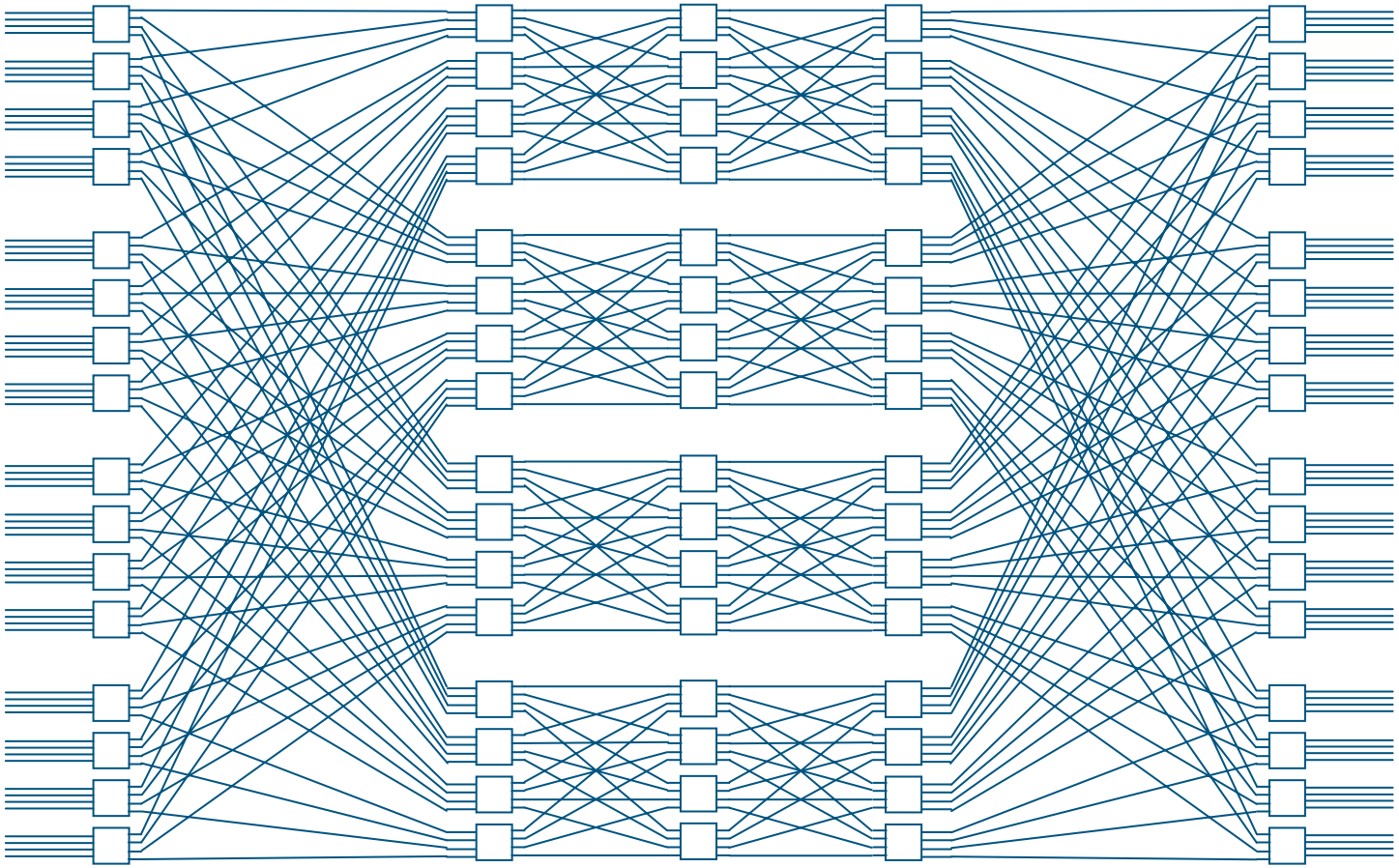
A2A Switch Basics:

16x16 Any-to-Any with 4x4 switch elements



A2A Switch Basics:

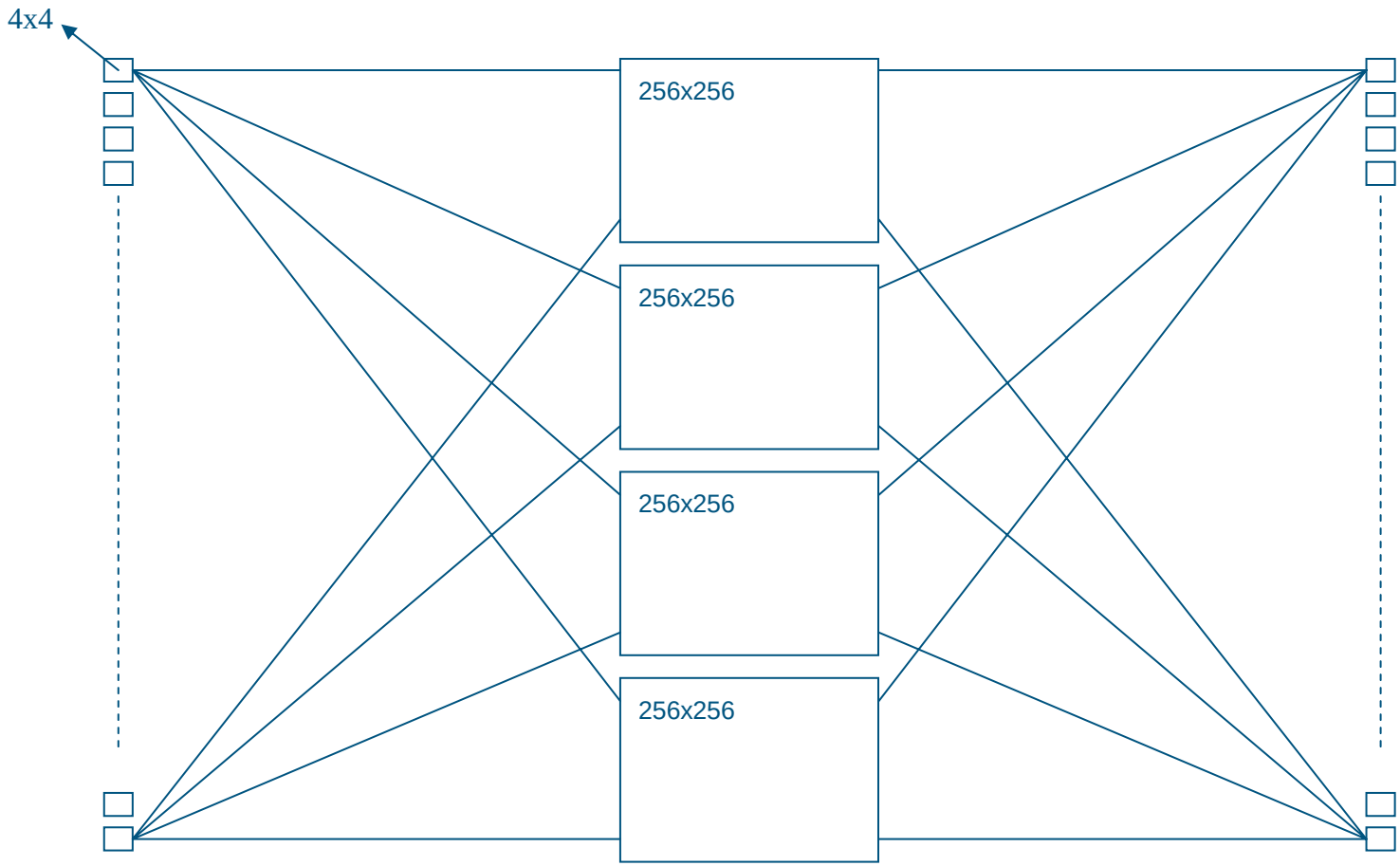
64x64 Any-to-Any with 4x4 switch elements



1-to-4 expansion | 16x16 Any-to-Any | 1-to-4 expansion

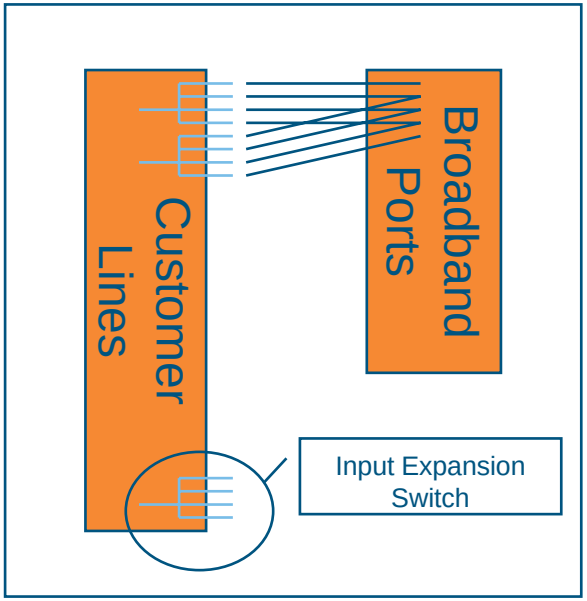
A2A Switch Basics:

1024x1024 Any-to-Any with 4x4 switch elements



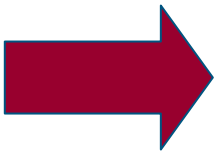
An Alternative:
The Any-to-Many or Service Switch Concept

- Allows to connect any subscriber to an available service port for every service
- Significant cost reduction compared to any-to-any, particularly for:
  - Few service types
  - Larger systems
  - Low to medium penetrations
- No need to define maximum expansion size on Day 1
- Switches can be virtually non blocking (< 0,0001%)



Any-to-Many: Other considerations

- System integration is somewhat more complex because provisioning scheme might be affected
- Reduced number of switches and rearrangements will also improve QoS
- Hybrid A2M – A2A ADF solutions can combine the best of both worlds
- Other concepts can be combined in overall system architecture:
  - splitter bypass
  - transfer engineering
  - test access



In many applications, a creative approach on system architecture combining A2A, A2M and other elements might represent a much more efficient solution than just automating the manual MDF

Outline

- Applications – Business Case Aspects
  - Active Cabinets
  - Central Office
- Architectural Considerations: A2A vs. A2M
- Technologies
- Conclusion

ADF Technologies

	Relays	Mechatronics	MEMS
Tech. Maturity	Proven	Medium	New
Speed	High	Medium	High
Cost	Medium – High	Low	Medium => Low

- Technology choice is important,
  but other considerations as system architecture, transfer engineering, test access, OSS integration and connectivity are that too.

Automated MDF & Crossconnect: SG5 Aspects

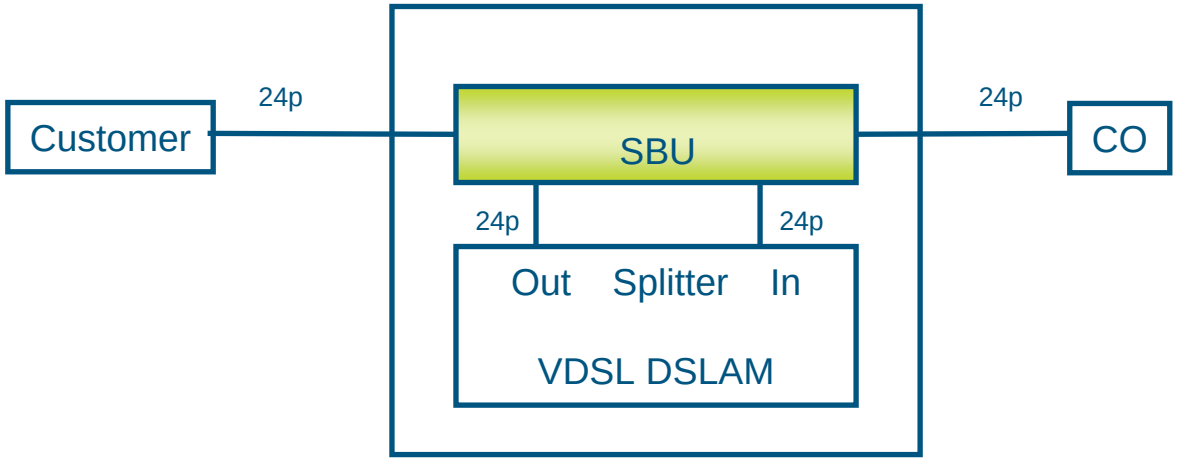
- Directly connected to outside plant
- Overvoltage & overcurrent protection:
  - Especially for MEMS technology
- Coordination with primary protection:
  - Operators insist on very low series resistance

Broadband Injection Infrastructure

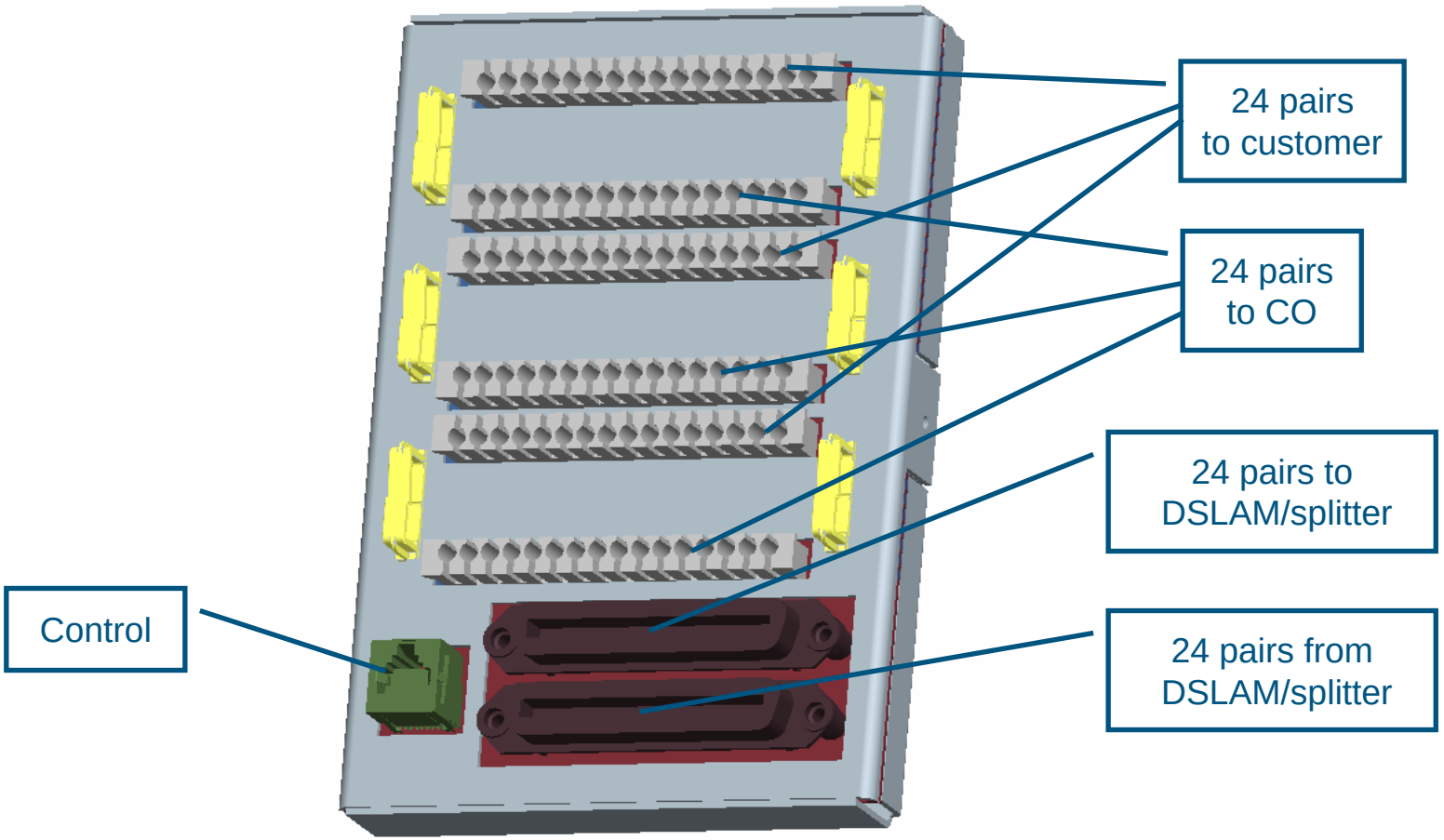
- Fiber is being is installed closer and closer to the end customer
- DSLAMs are becoming smaller at reasonable cost
- Where space is at premium, cabinets may be too large
- Tendency to plan for full VDSL2 provisioning
- For MDUs (Multi Dwelling Units) installation in the basement is an easy solution
- Infrastructure needed for gradual transfer to an all-DSL/IP network

Splitter Bypass Unit

- Switch straight trough for POTS or ADSL customers
- Switch a line to the VDSL DSLAM when a customer wants VDSL service
- Re-switch straight for change of service



Splitter Bypass Unit Example



New Infrastructure Elements Conclusion

- Migration from legacy POTS network towards Broadband and NGN networks has created needs for new infrastructure elements in the access network.
- A large variety of equipment has been introduced since the advent of DSL technologies.
- Nearly all the new devices are directly connected to the copper network and are exposed to overvoltages and overcurrents.
- It has to be made sure that the new equipment adequately withstands the electromagnetic environment in the access network.

Thank you!

Questions?

Tyco Electronics