Fibre-Optic Network Testing:
Avoid clogs and pains in Smart City & IoT projects

Jean-Baptiste Letang, Application Engineer @ EXFO

BICSI Middle East Conference, Dubai, April 18-20, 2017

EXFO & ALT booth **#314**

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Agenda

- Understanding the Smart Cities needs
- Infrastructure changes and challenges
- Benefits of testing
- Summary and Q&A

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The ongoing bandwidth explosion…

EVERYONE...

Image: Sonymobile.com

...WANTS HIGH-QUALITY

Image: U.S. Department of Transportation/ Wired.com

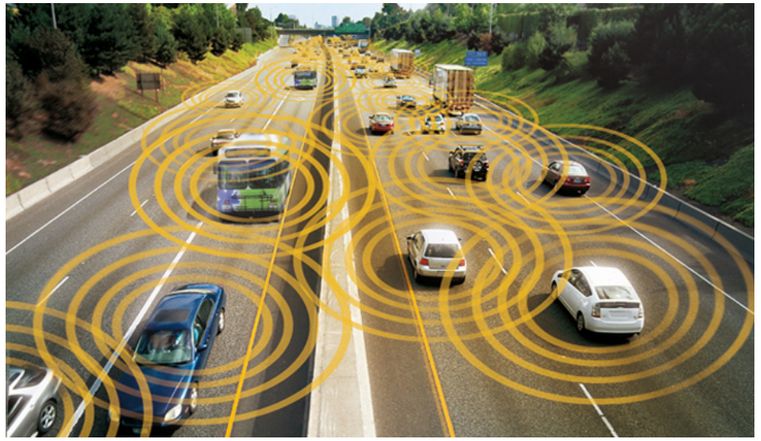

Image: Amanda Kooser/CNET

EVERYWHERE, ANYTIME…

AND ON MULTIPLE DEVICES!

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…powered by Smart Cities

"Develop systems merging IT, Geographic information, databases and sensors (

) for the benefits of both ***Citizens*** *and* ***Municipalities*** *to aim a* ***better quality of life****"*

Key elements required for a successful Smart City project :

- Connected populations
- **Fibre Network & immersive connectivity**
- Basket full or Apps & IoT services
- Monetisation of municipal investments

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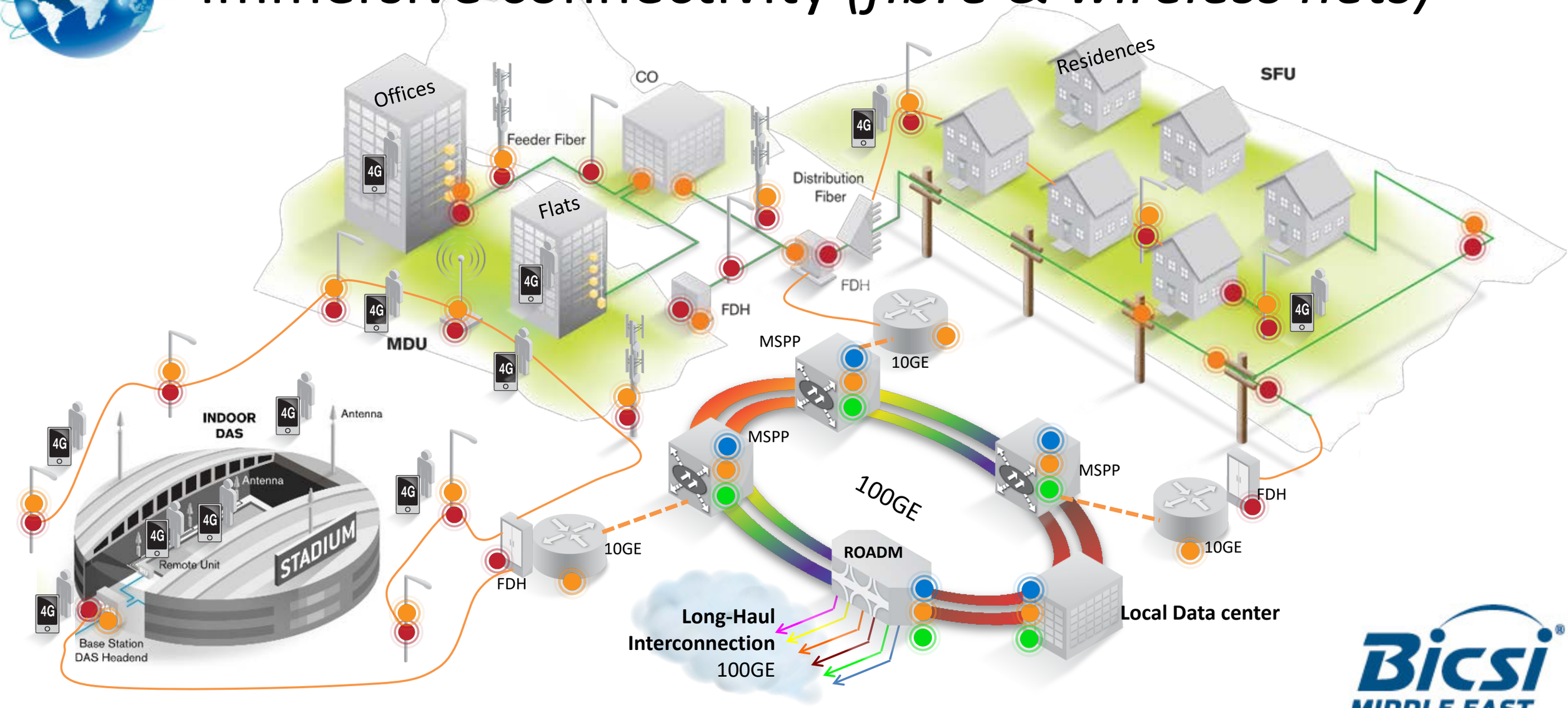
Immersive connectivity *(fibre & wireless nets)*



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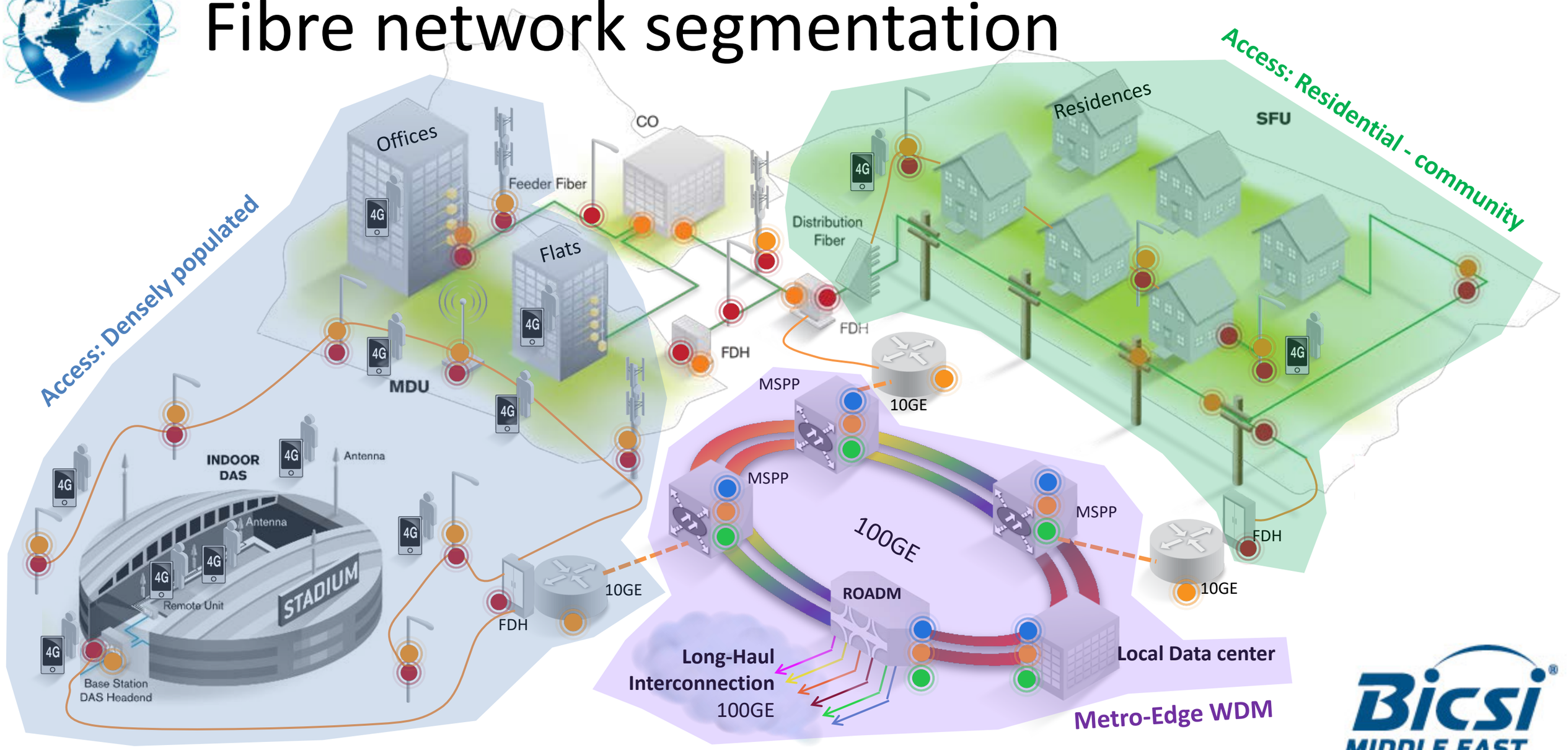
Fibre network segmentation



Infrastructure Solutions for Immersive Connectivity

Metro-Edge WDM

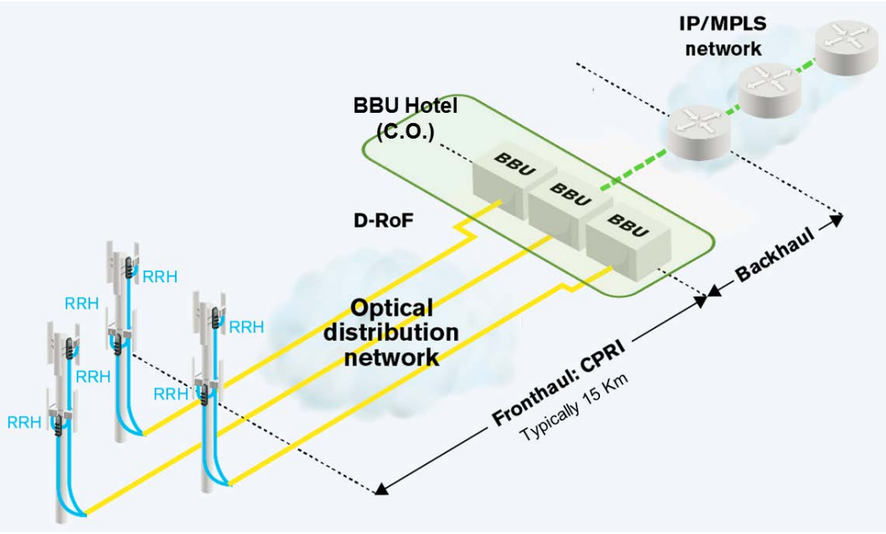
WDM rings

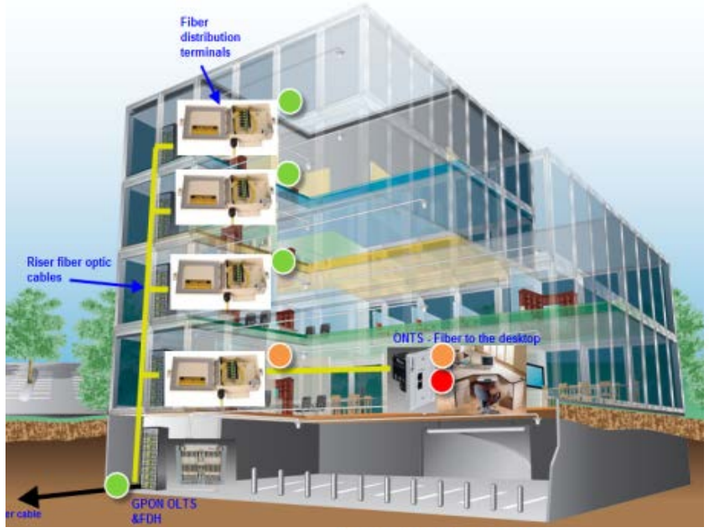
Active/Passive C-RAN deployment

Residential – community & Densely populated area

More small cells to be deployed outdoor (PON + DAS)

Passive Optical LAN **(POL)** & DAS inside large buildings and stadium





To support the associated challenges:

Trouble free & futureproof network

- FO infrastructure reliability
- xWDM
- *etc…*

Bandwidth scaling

- 10G to the cell site
- 100G to the metro
- Landing 400G
- *etc…*

(ultra) low latency and high QoS

- 5G
- DCI
- Ethernet Services
- *etc…*

Setting up a Fibre Optic Network Testing Strategy is key to avoid clogs and pains in Smart Cities & IoT projects

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Delivering the quality demanded by Next-Gen networks and services

Introduction to Fibre Optic Testing Strategies

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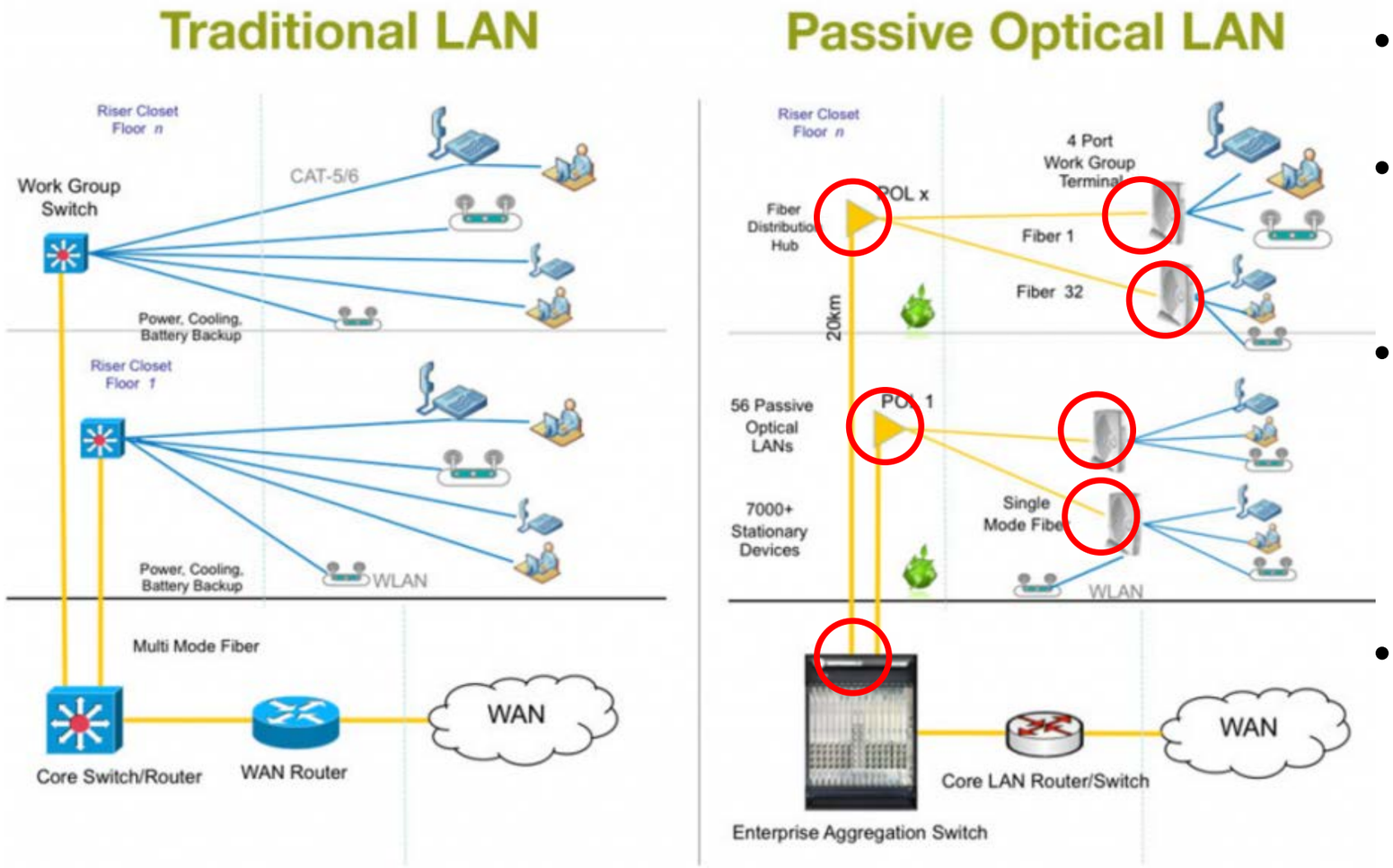
Access: from TLAN to POL



- Indoor POL works on the same principle than outdoor PON.
- POL & PON architecture is future proof, OLT & ONTs can be replaced to migrate to higher speed.
- Traditional LAN (TLAN) uses fiber trunk to feed active switches and copper cables limited in rate and reach; maintenance cost of TLAN is significantly higher.
- Main elements:
  - OLTs and ONTs
  - FO connectors
  - Singlemode fibre
  - Optical splitter

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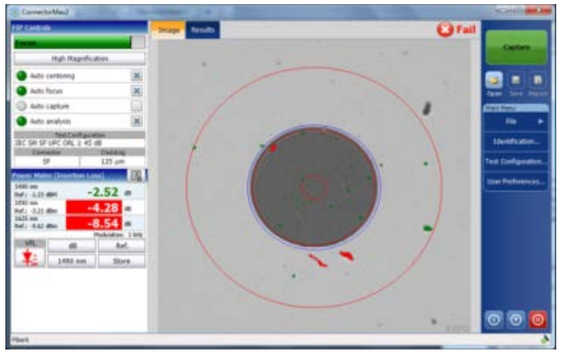
Testing strategy for a quality POL deployment:

POL deployments

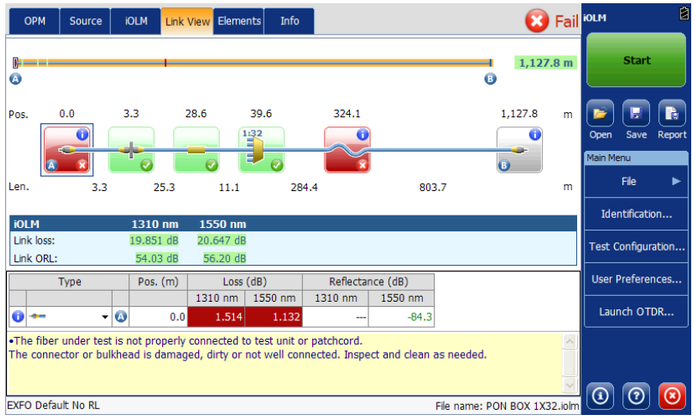
1

Connector Inspection



2

Fibre characterisation OTDR/iOLM/OLTS



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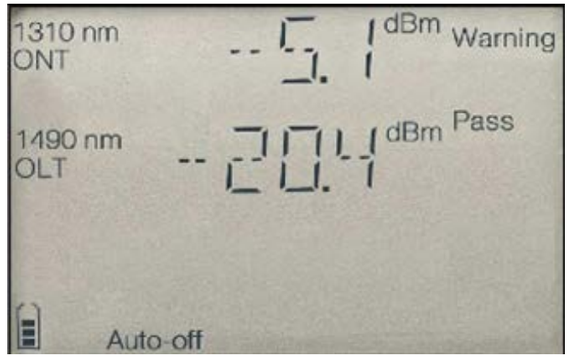
Service Activation PPM



4

Reporting

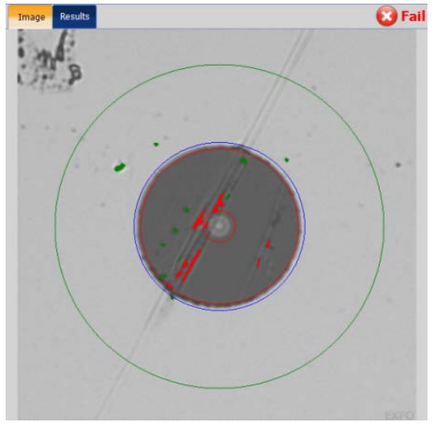
1. FO Singlefibre Connector Inspection

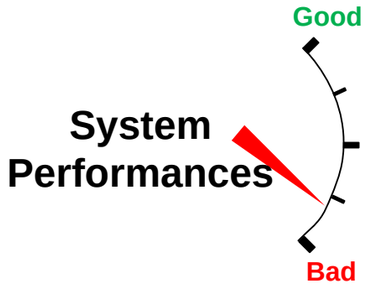
Contaminated connectors is #1 cause of network failures

Connector Inspection is the first step in any FO handling procedure:

DAMAGED = REPLACE

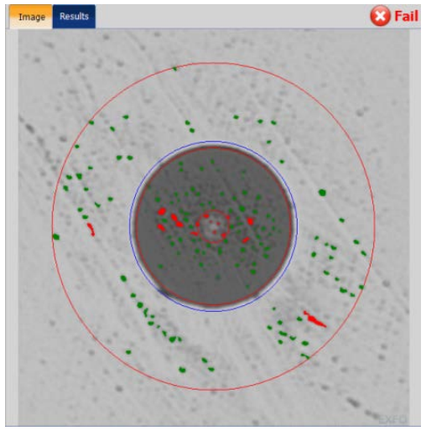
You CANNOT clean a damaged connector

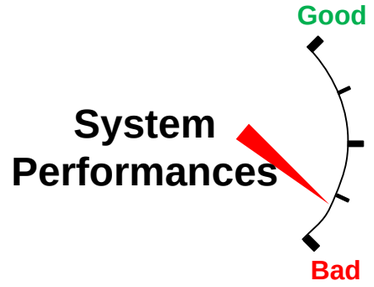




DIRTY = CLEAN

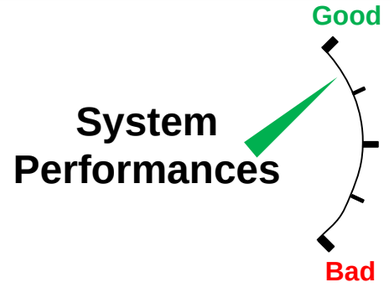
Clean ONLY if needed





CLEAN = CONNECT

NO cleaning required



Only cleaning is not enough…
Or unnecessary!

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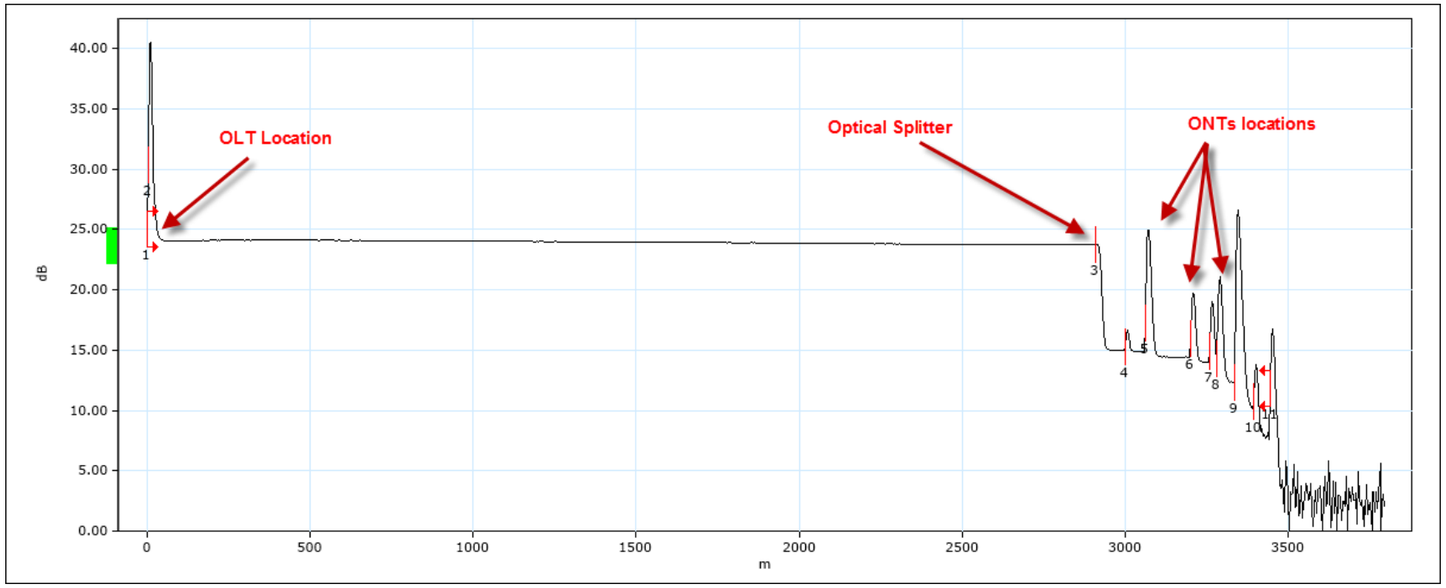
2. Elements Characterisation

- By design, splitters show high loss depending of the ratio (will vary with manufacturers):
- Testing from the OLT cannot provide accurate elements characterisation due to RBS from all legs:

Splitting Ratio	IL (dB)	Uniformity (dB)
1x2	3.6	0.5 - 0.9
1x4	7.7	0.5 - 0.9
1x8	10.8	0.8 - 1.2
1x16	14.5	1 - 1.7
1x32	18	1.3 - 2
1x64	20	1.3 - 2



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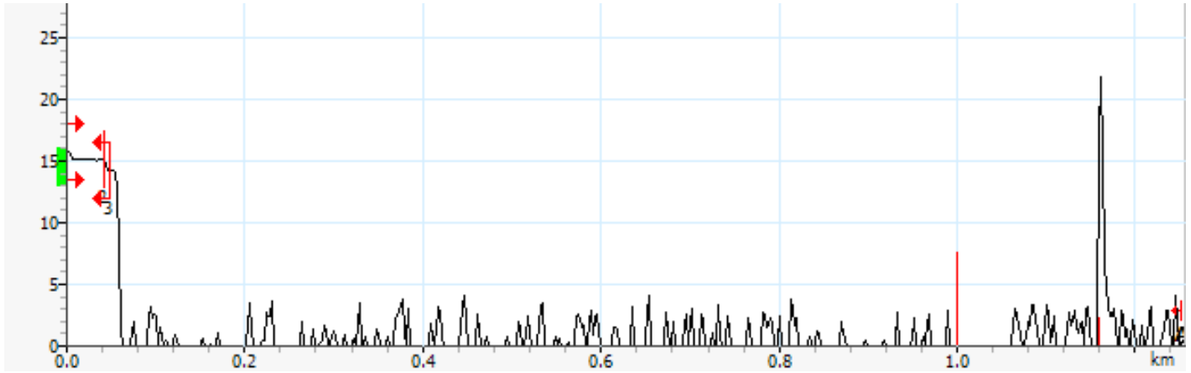
2. Elements Characterisation

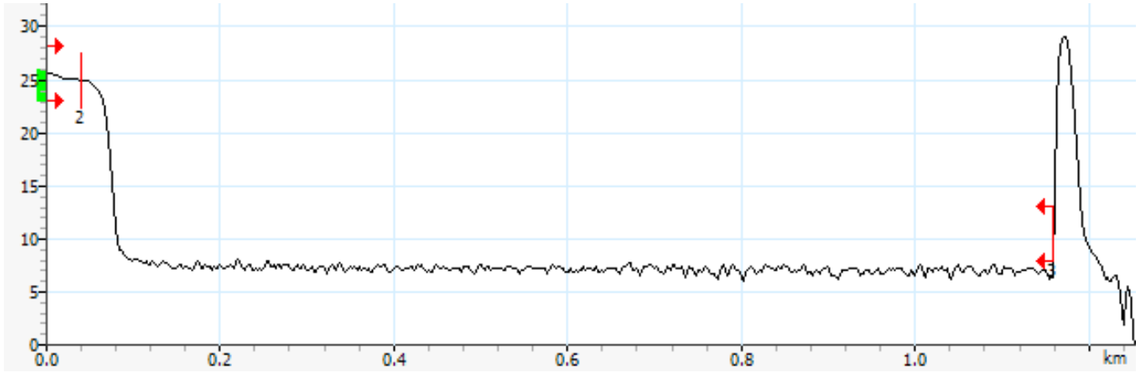
Classic OTDR is a trade-off between Power and Resolution. It becomes even more challenging when measuring through Splitter:

Short PW will give resolution up to the splitter



Splice is characterised but not splitter -> fibre break?

Large PW will give enough power to see full span



What about the splice?

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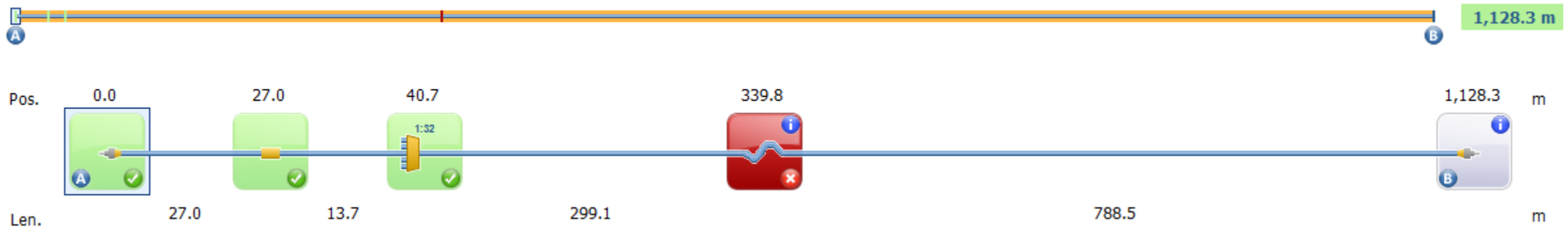
2. Elements Characterisation

A multipulse OTDR testing approach is mandatory for a right first time test through Optical splitter from the ONTs location and easy understanding:

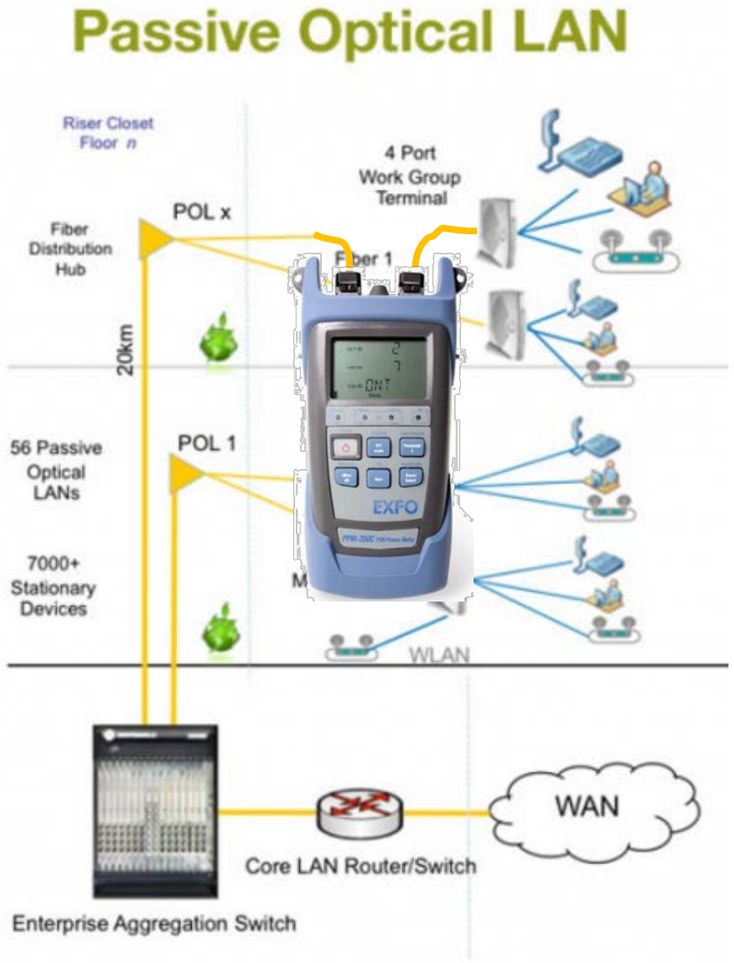


Small pulsewidths to characterise what is before the splitter

Medium to large pulsewidths to characterise the splitter itself and elements around

Large pulsewidths to characterise total loss, total length and end of fiber elements

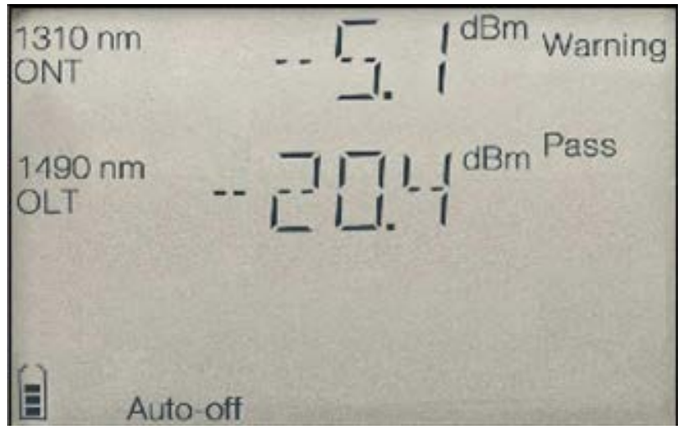
3. Service Activation



Standard PM will not work as “hand-shake” is required between OLT and ONT

Birth certificate of each “leg”: power level from both OLT and ONT at the same time.

A pass-through Power Meter will enable the sync between OLT and ONT and will measure the Optical levels:



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POL Testing summary

- POL networks are very similar to FTTH in terms of testing
- Proper testing tools and MOPs help deploying POL networks with a trouble-free 25-year warranty
- Documenting physical layer tests before activating the service gives a birth certificate of the link

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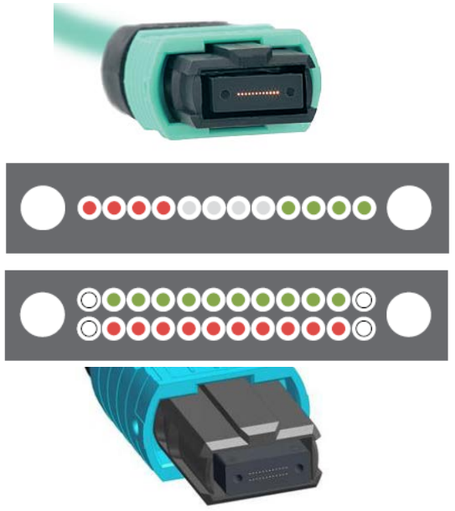
Metro-Edge: Meeting the network KPIs

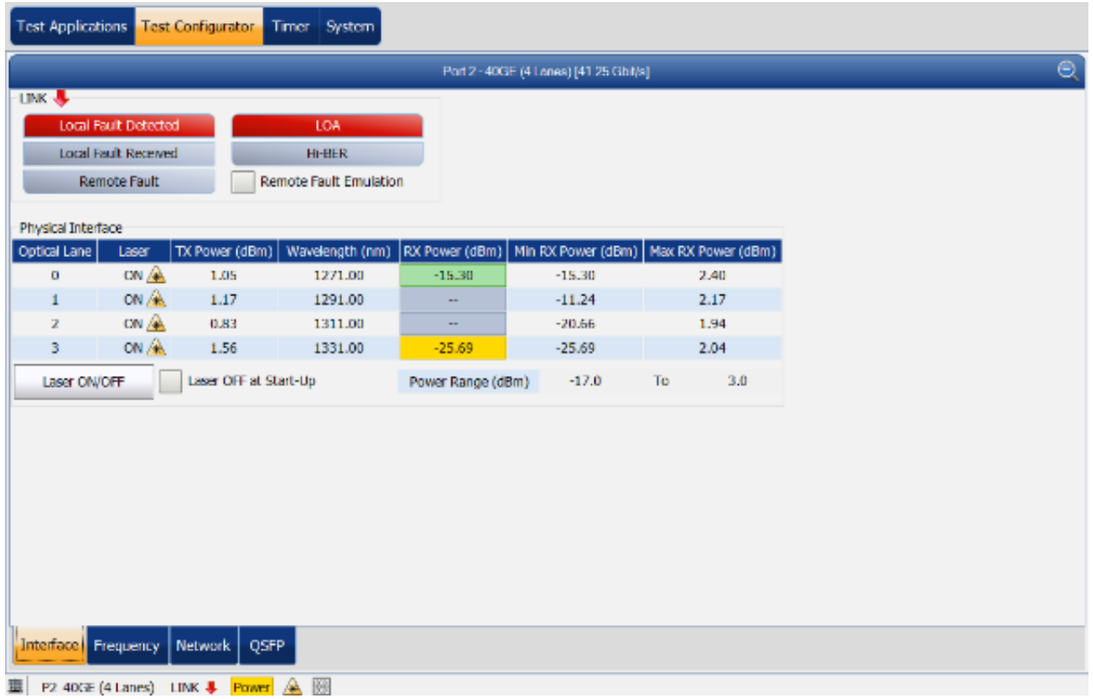
- High Speed Ethernet as Services is the trend
  - DataCenter, smaller carriers, etc…
- Driven by 40G and above, new pluggables & connectors :

CFP CFP2 CFP4 QSFP28

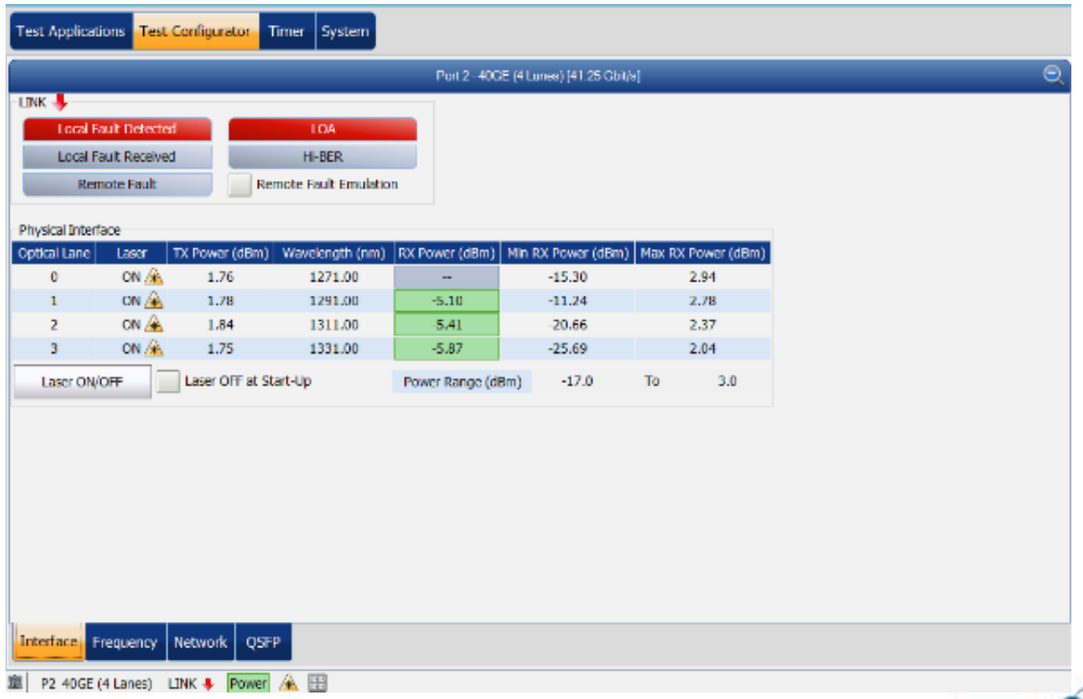


Typical Transceiver Problems

Invalid/Imbalanced Power Measurement



Missing Optical Channel Detection



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Testing transceivers in all scenarios

- New deployment and avoid truck rolls
- Troubleshooting before changing the card!

CFP
4 ports/chassis
24W

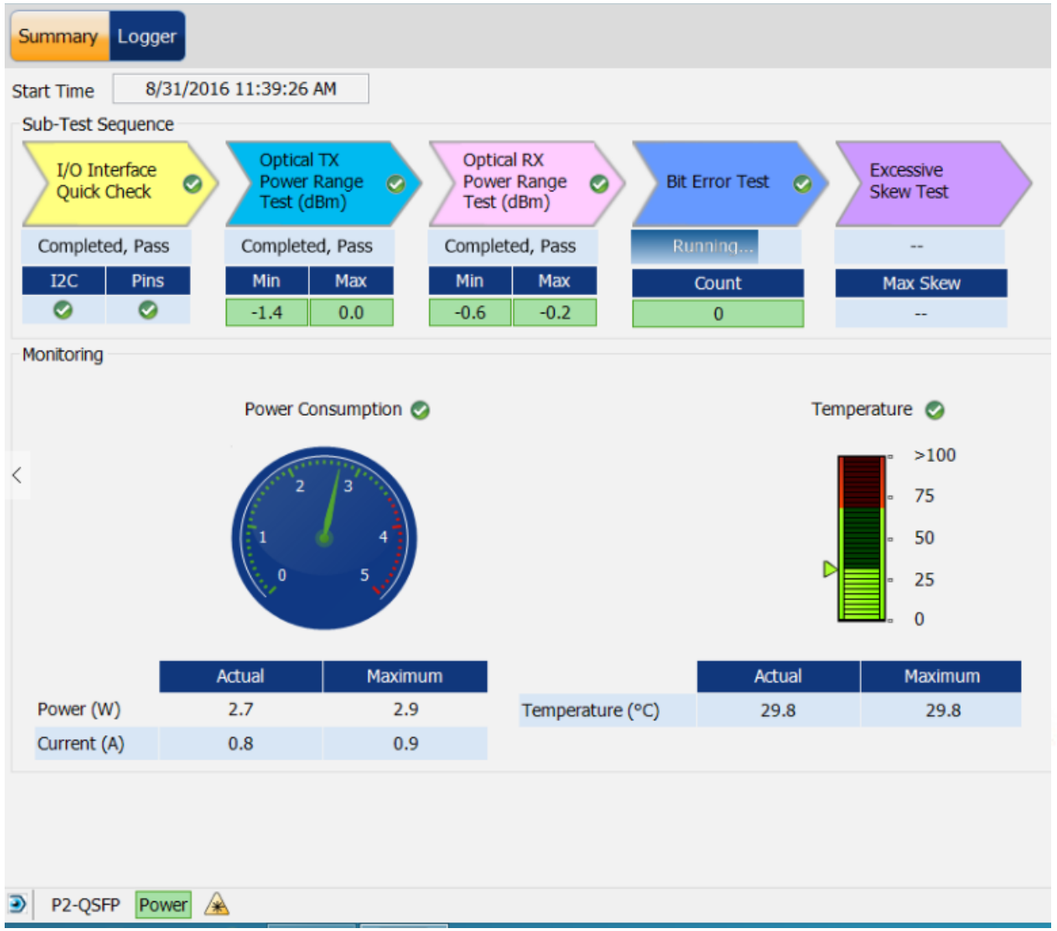
CFP2
8-10 ports/chassis
8W

CFP4
16-18 ports/chassis
5W

QSFP28
18-20 ports/chassis
3.5W

MPO loopback and w/ Attenuation

Smart applications can perform **a series of test** (I/O Interface check, Optical Tx/Rx test, BERT, skew, etc…) While **monitoring Temperature and Power consumption**.

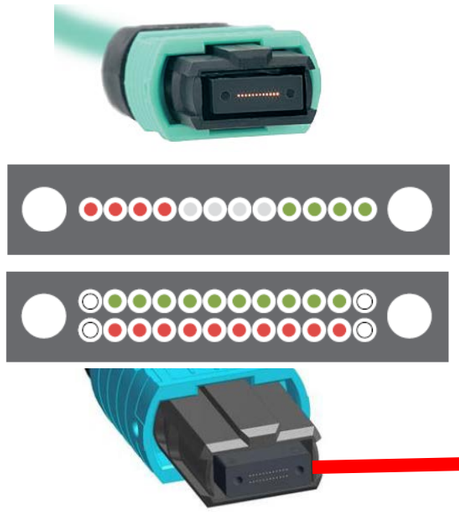


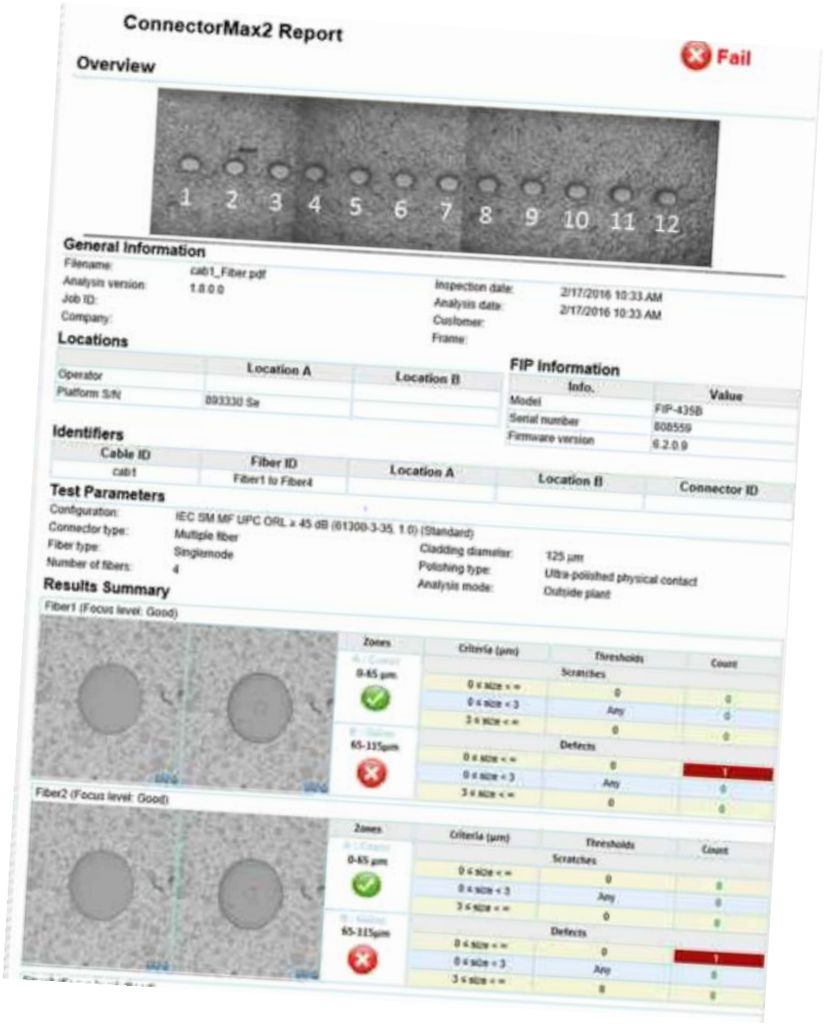
Multifibre Optical Connectors

Provides high density capability and easy bandwidth scaling.

Single row (12/16) or Dual row (24/32)

Only the use of an automated Inspection Probe allow to accurately inspect each fibre:





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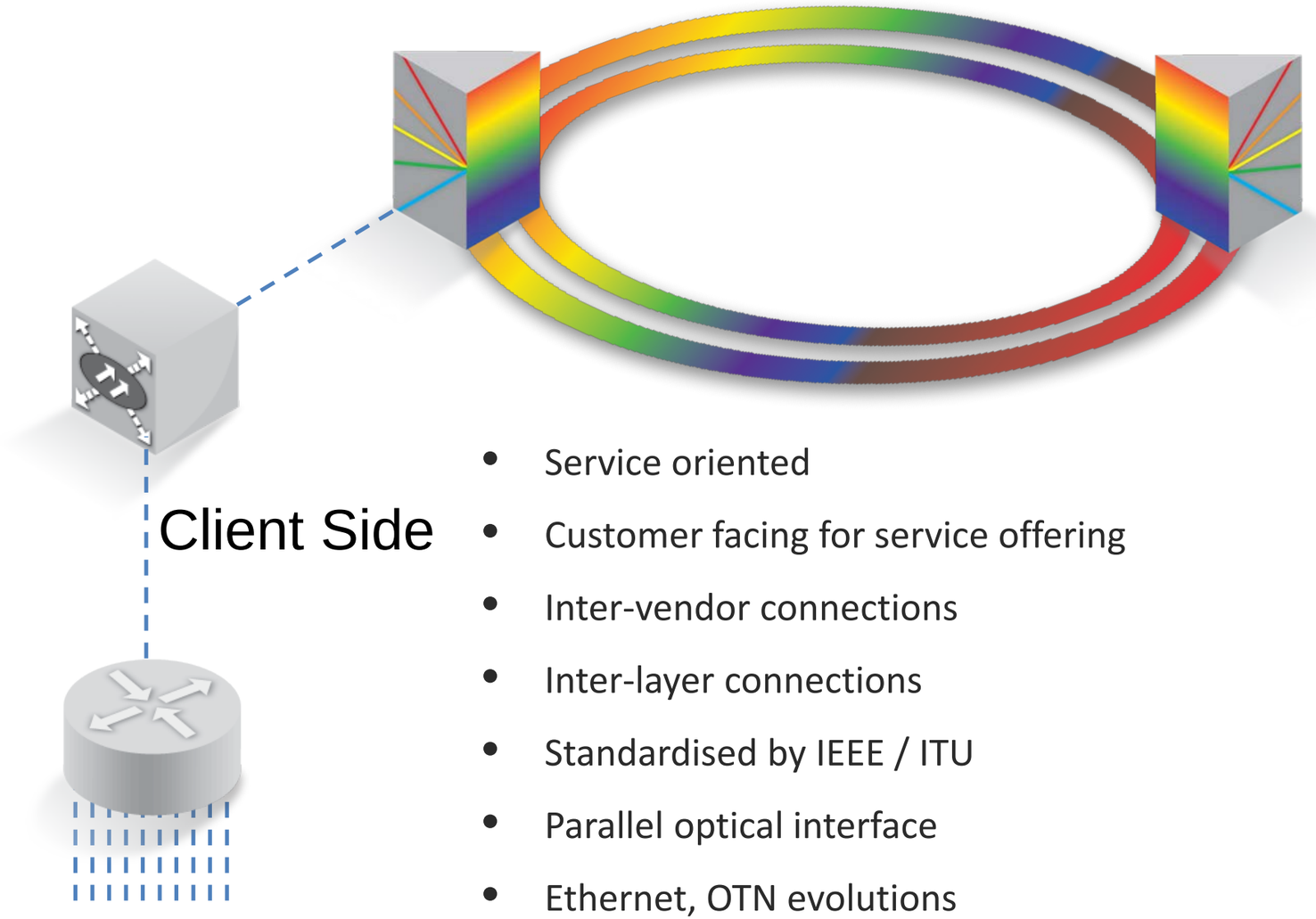
100GE Within The Network



- DWDM core network
- Transport oriented
- Serial optics
- Phase modulated
- OTN

- Service oriented
- Customer facing for service offering
- Inter-vendor connections
- Inter-layer connections
- Standardised by IEEE / ITU
- Parallel optical interface
- Ethernet, OTN evolutions

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Which KPIs for switched circuit? QoE engaged…

Throughput

Amount of data traversing the circuit

Latency

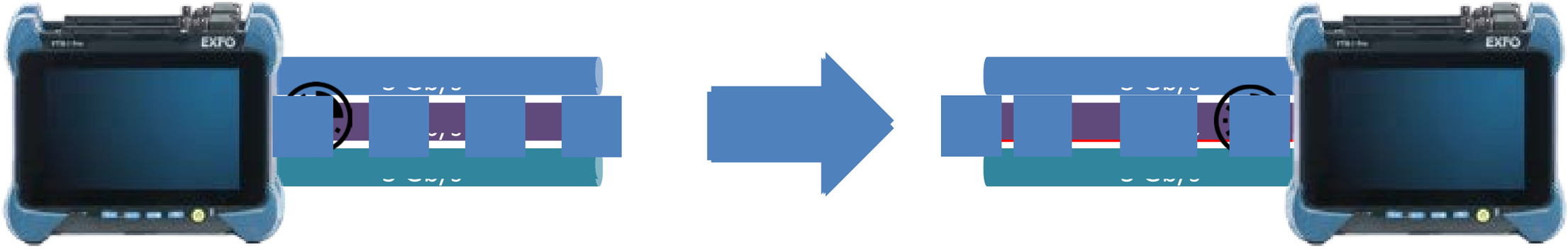
Time it takes data to traverse the circuit

Jitter

Delay between data frames being received

Lost Frames

Data frames being dropped from the network



Application sessions may fail

Applications that require a specific bandwidth may have degraded performance

Data may become corrupted

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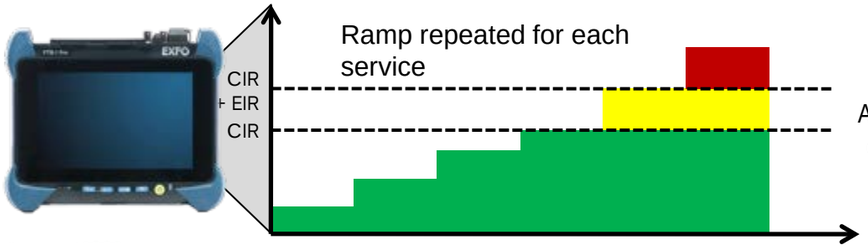
Ethernet Service Activation

ITU-T Y.1564 defines a methodology to successfully validate Ethernet Services versus KPIs in Next-Gen networks:

Phase 1: Service Configuration Test (Ramp & Burst Test)

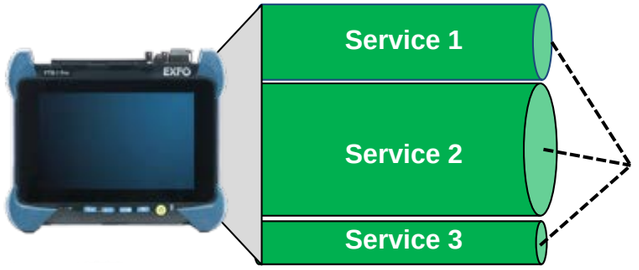
Objective: Validate the network configuration of each defined services (rate limiting, traffic shaping and QoS)	**Methodology:** For each service, a ramp test is used to gradually reach and exceed the CIR. All KPIs are measured against a threshold



All SLA parameters measured at each step (FD, FDV, frame loss (OOS)), with pass/fail result

Phase 2: Service Performance Test

Objective: Validate the QoS of each defined service and the conformity of the SLA	**Methodology:** All services are generated at once to their CIR, and all KPIs are measured for all services



All pass/fail results of the SLA parameters measured throughout the test (i.e., throughput, frame delay, frame loss, frame delay variation and OOS)

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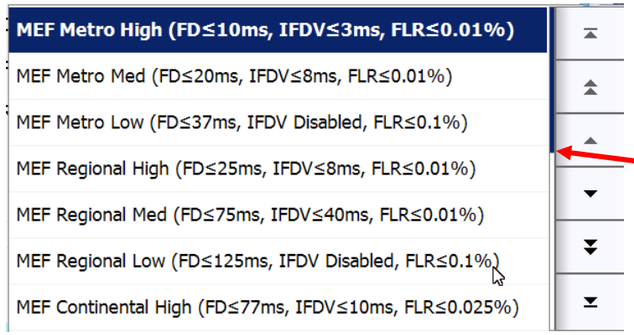
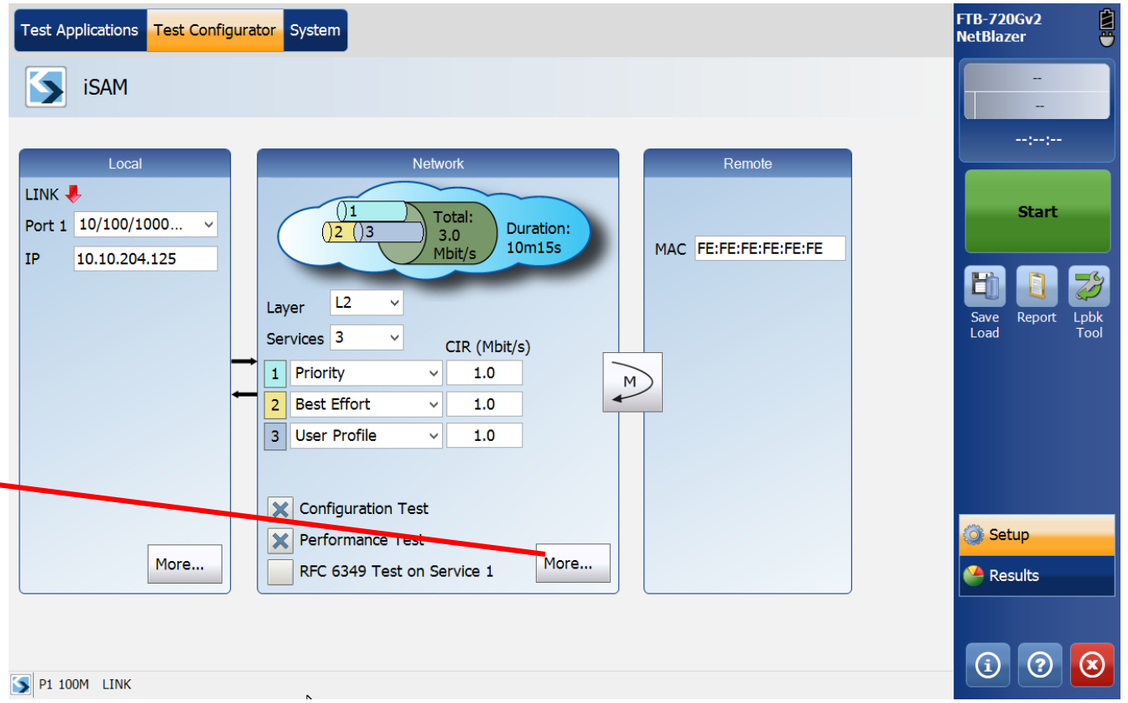
Ethernet Service Activation Summary

Testing in compliancy to ITU-T Y.1564 is recommended to support Next-Gen Networks:

- Validate SLAs between SP and customers





- Non harmful test through the network
- Validate SP's network configurations

How to maintain QoS?

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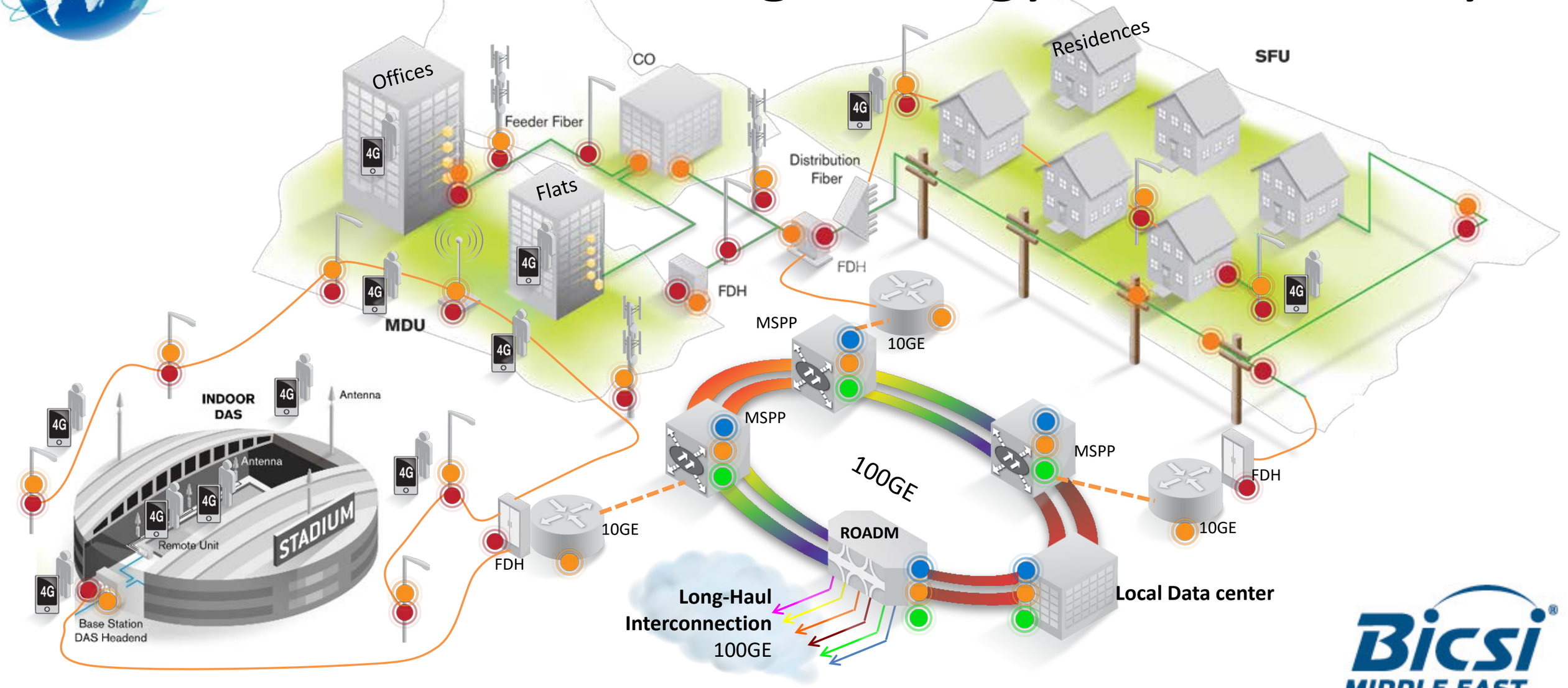
FO Network Testing strategy for Smart City



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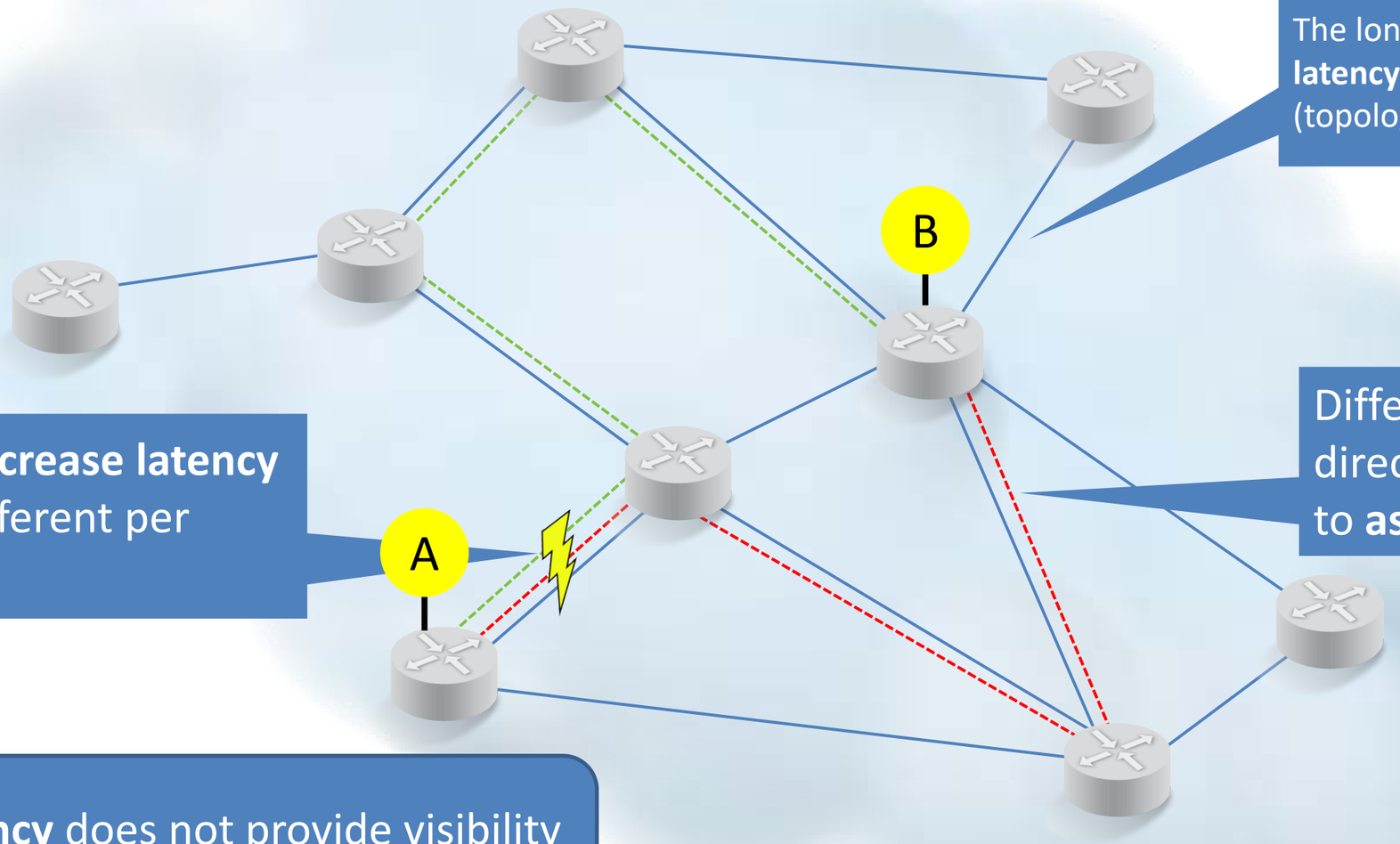
Latency is not fixed and varies over time



The longer the links the more **latency** the traffic will experience (topology or operations)

Congestion will **increase latency** and is typically different per direction.

Different route per direction leads to **asymmetrical latency**.

Round Trip Latency does not provide visibility in what path delay degradation occurs

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Impacts of latency on QoE

Data Transfer

Latency impacts applications using TCP (http, ftp, email, etc…)

Real-time service (VoIP, Video)

Latency variation directly impacts QoE

VoIP services very sensitive to **one-way latency**, impacting conversational speech (OTT)

Streaming and interactive applications

Tight **latency** control important for QoE

Latency directy impacts interactivity and responsiveness of application

High latency levels mean frustrating user experience

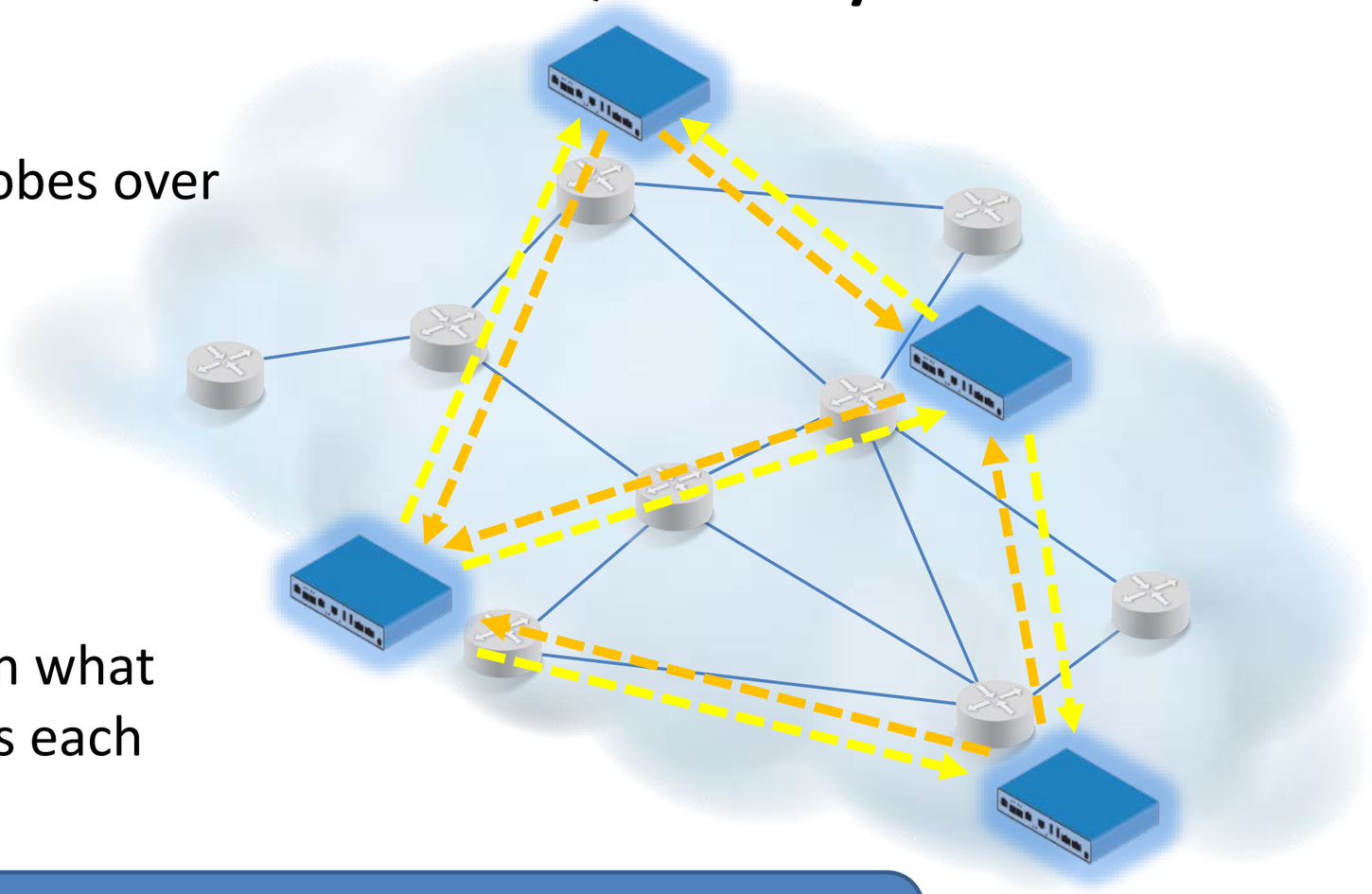
Maintaining Smart Cities QoS 24/7

Strategically deploying Smart/Virtual probes over the network allows to:

- Actively monitor and test KPIs 24/7
- Check real time QoE

Round Trip Latency is not enough:

- Only **One-Way Latency** determines in what direction delay degradation occurs as each path is independently measured.



Not only monitoring the KPIs & QoS 24/7 but proactively maintaining the network **before Services are impacted**

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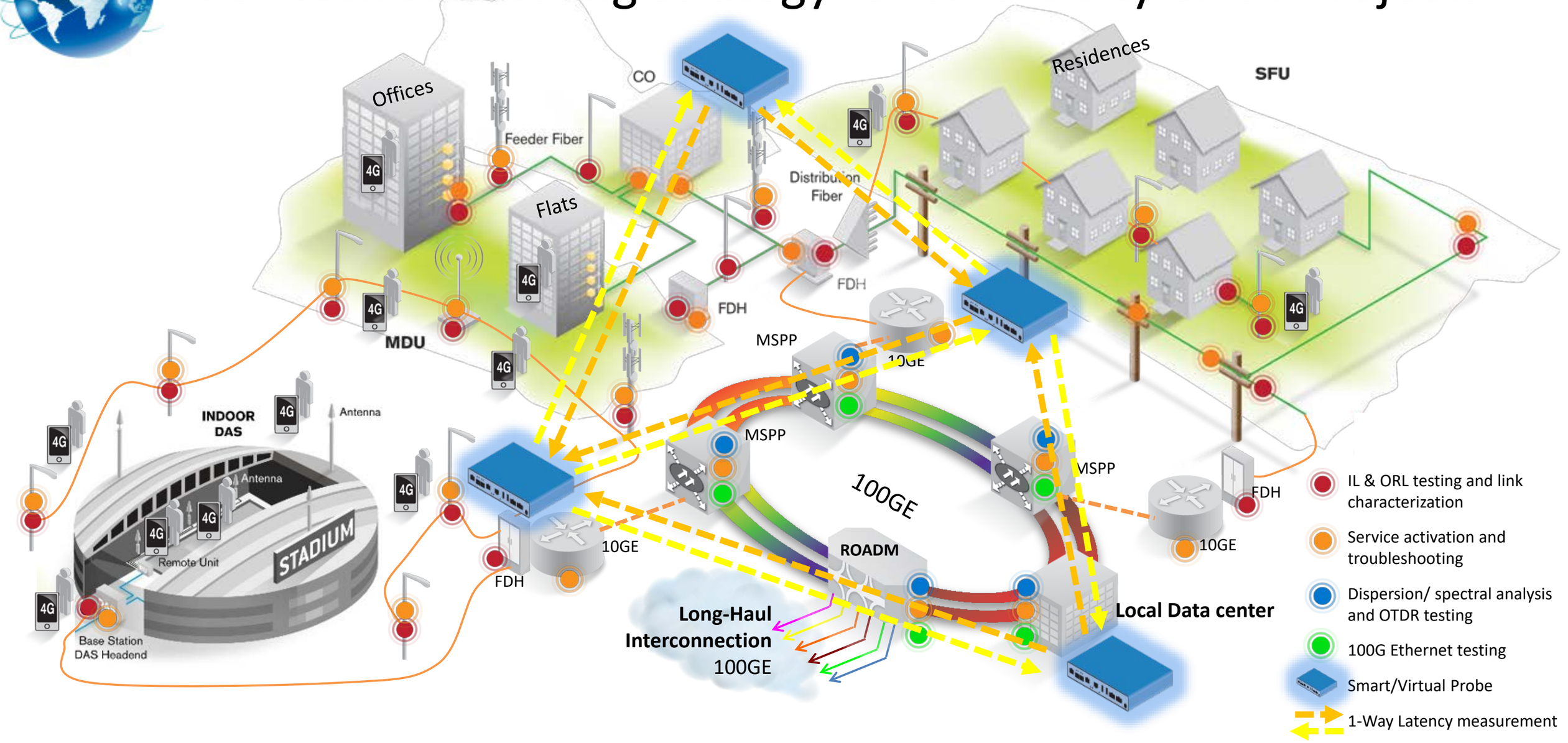
FO Network Testing strategy for Smart City & IoT Projects



Conclusion & Remarks 1/2

- **Immersive Connectivity** is the heart of **Smart Cities** and implies changes in:
  - Bandwidth requirement
  - Infrastructure

Conclusion & Remarks 2/2

- Adopting an adequate **FO Testing Strategy** starting **from L1** ensures to meet the associated challenges:
  - Trouble-free FO network
  - Reliable and high QoS over time
  - Citizens satisfaction using App and IoT services

- Latency is a rising challenge and is becoming more important in the transition to 5G, IoT and NFV

Thank you for your attention, Questions?

Jean-Baptiste Letang, Application Engineer @ EXFO

BICSI Middle East Conference, Dubai, April 18-20, 2017

See you at EXFO & ALT booth **#314**