



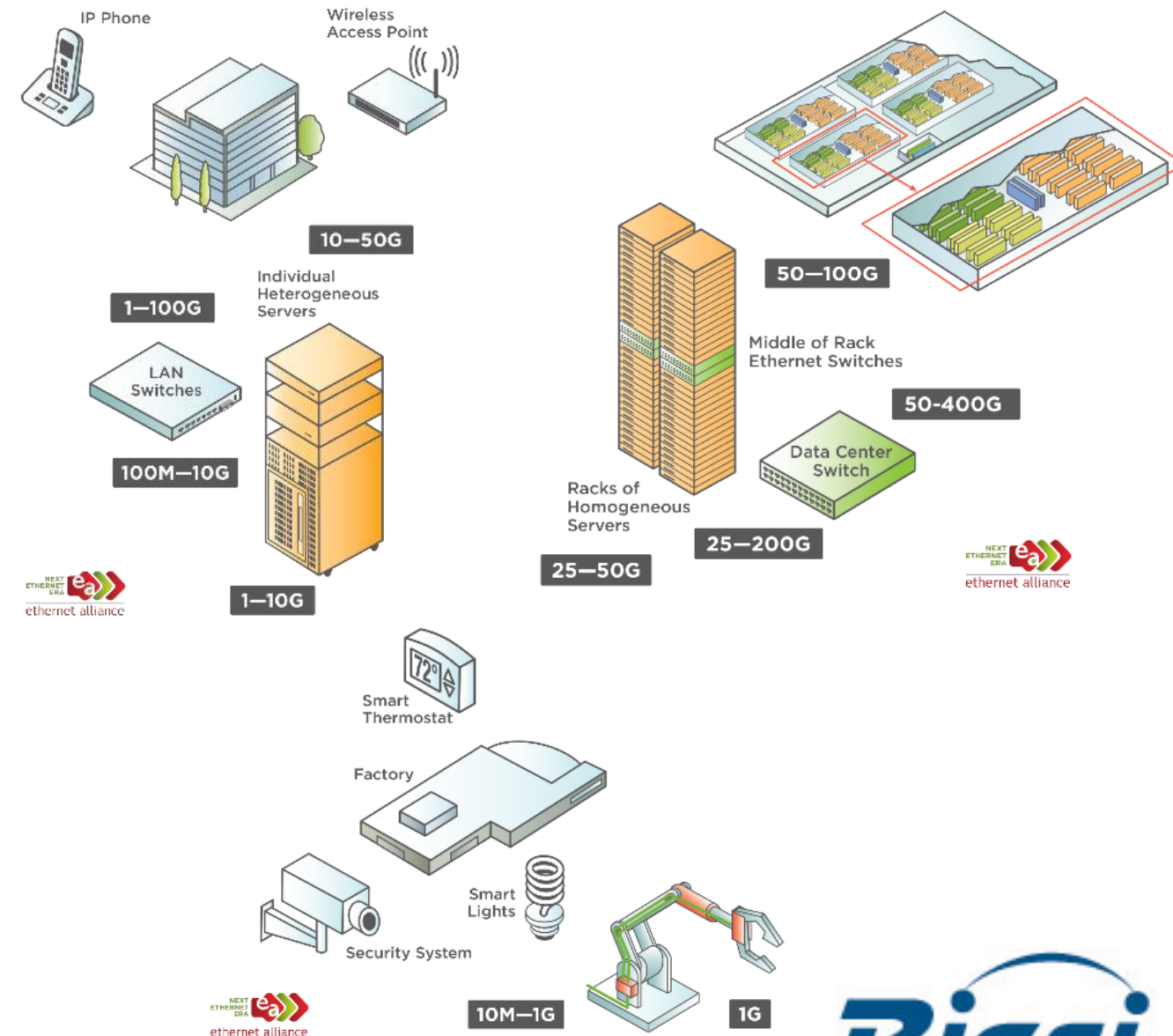
# How future-proofing a legacy multimode fiber cabling infrastructure?

*Is transforming multimode fibers into singlemode fibers possible?*



# Bandwidth consuming apps in the LAN

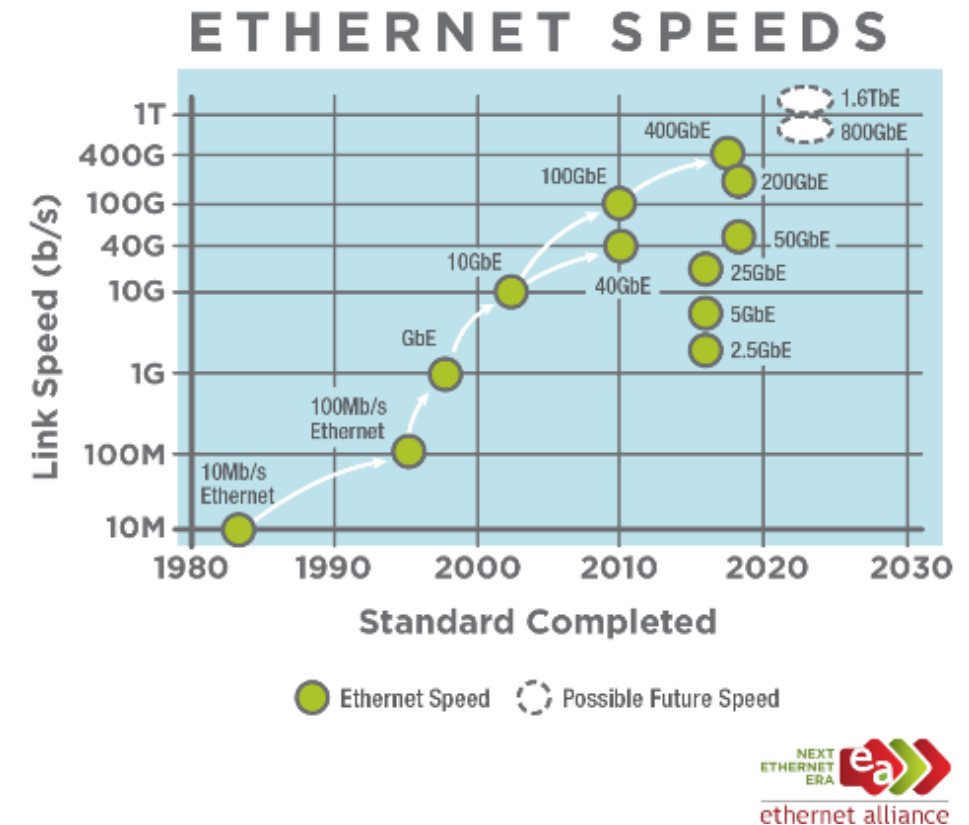
- WiFi (802.11ac up to 7Gb/s)
- VoIP, video-conference
- CCTV
- Virtualization, cloud computing
- Connected objects, BYOD
- Consumer/industrial IoT up to 20Gb/s
- Smart building, smart factory, etc.
- ...





# Increased bandwidth capacity needs

- New standards mean more bandwidth and versatility for tomorrow's Ethernet networks



**Bandwidth-intensive applications + latency-aware traffic types**

- LAN cabling infrastructures need to support ever-growing bit rates



# Multimode fibre

=



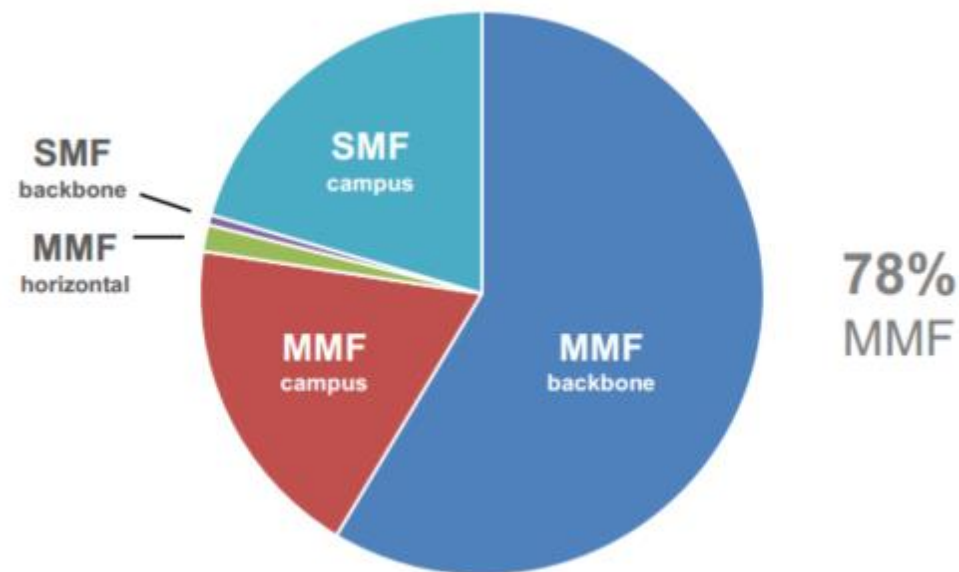




# MMF everywhere in LANs

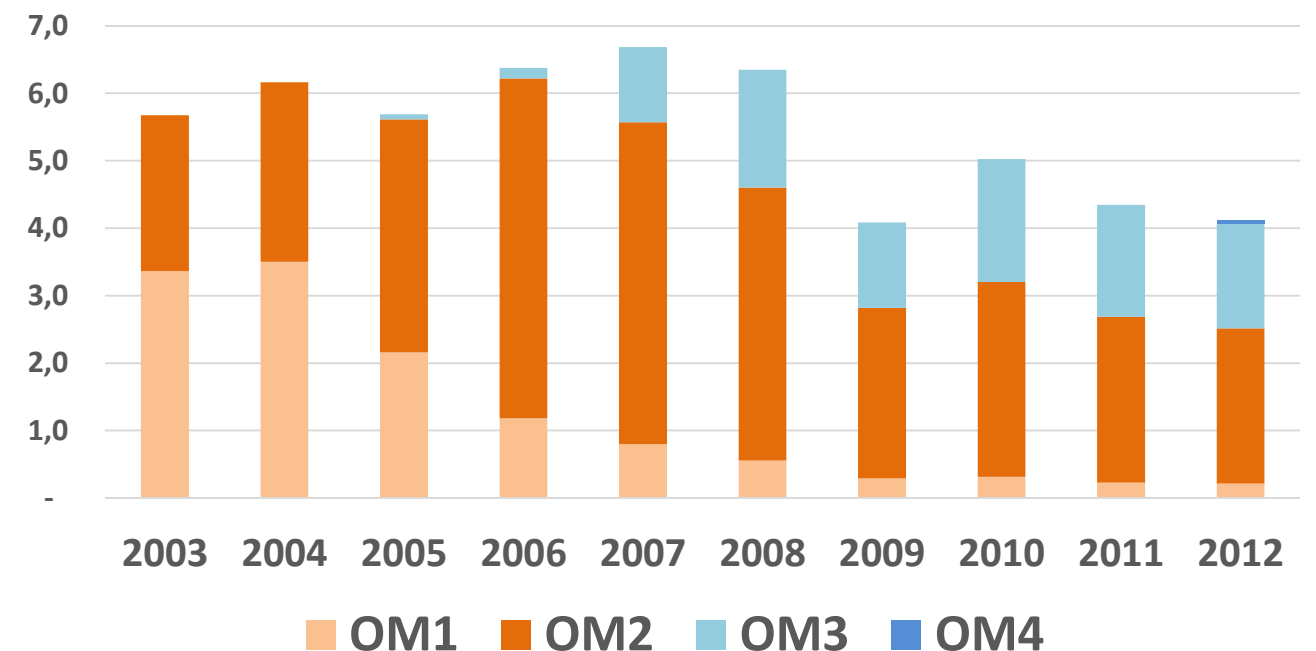
Almost 80% of fibres in LAN are **MMFs**

Big part of existing MMFs are **limited to 1 Gb/s (or 100 Mb/s max)** [mainly OM1-OM2]



Source: BSRIA worldwide sales fiber cable for LAN applications in 2018  
<https://www.bsria.co.uk/market-intelligence/market-reports/>

*Total LAN MMF cable deployed in Italy, by type (millions cable meters)*



Source: BSRIA - No data before 2003  
(12 MMFs strands per cable on average)



# But MMF is bandwidth limited

Limited bandwidth = Maximum reach decreases when bit rate increases

Maximum reach over MMF (850nm) (IEEE)	1 Gb/s (IEEE 802.3Z 1998)	10 Gb/s (IEEE 802.3ae 2002)	40 Gb/s (IEEE 802.3ba 2010)
OM1	400 m	33 m	N.A
OM2	550 m	82 m	N.A
OM3	575 m	300 m	100 m
OM4	600 m	450 m	150 m

➤ The cause of this limitation: **modal dispersion**

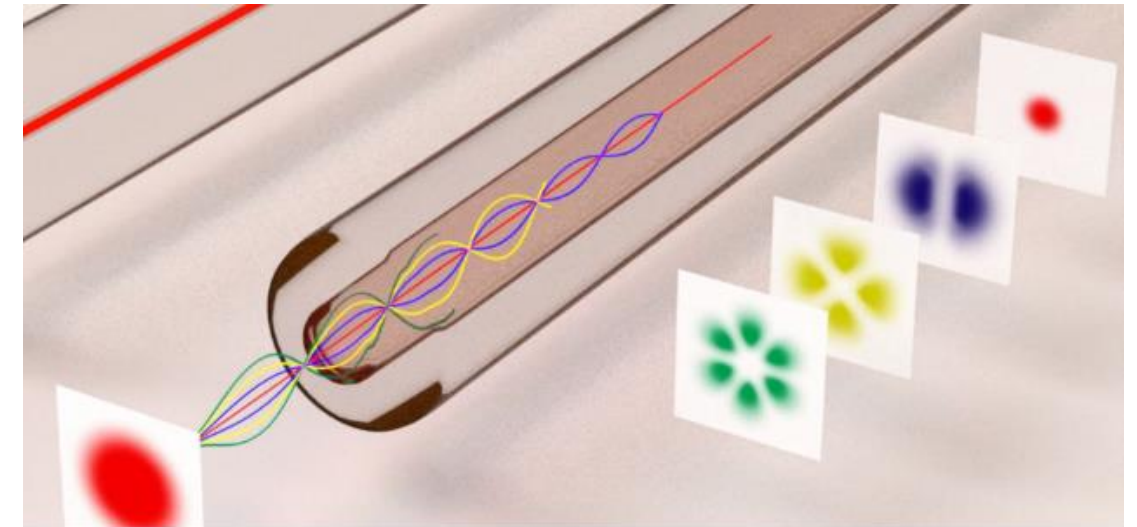
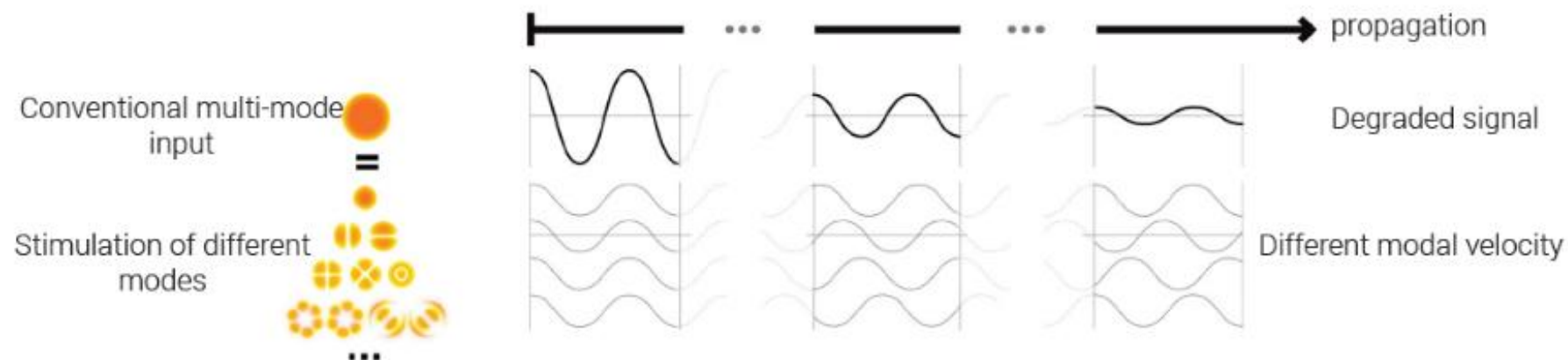


# Modal dispersion

**Distorsion mechanism of optical pulse** occurring in multimode fibres during propagation

**Different modal speeds**

**Leads to poor transmissison quality for high bit rates** (degraded bit error rate)





# **UPGRADING NETWORKS BY OVERCOMING THE MMF LIMITATION ISSUE**





# Overcoming MMF limitations

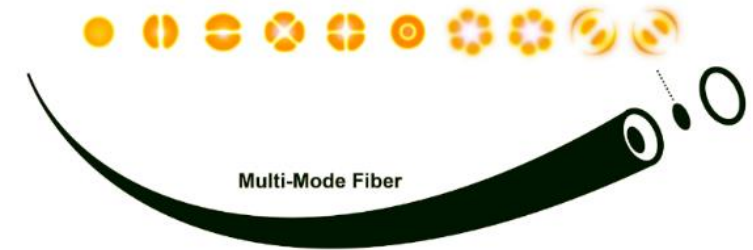
Pros & Cons of existing alternatives:

<i>Alternative</i>	<b>Modulation</b>	<b>Parallelization</b>	<b>Multiplexing</b>	<b>Deploying fibers</b>	<b>Light launching conditions</b>
<i>Objective</i>	Increased spectral efficiency (PAMx, QPSK,...)	BW limitation bypassed with MPO	BW limitation bypassed with several WDM channels	Latest generation fibres (OM5/SMF)	Removed modal dispersion impact (MPLC)
<i>Capacitiy benefit</i>	+	-	+/-	++	++
<i>Cost</i>	--	+	-	- to --	+ to ++
<i>Ease of deployment</i>	+	+	+	- to --	+
<i>Ease of operation</i>	-	+	-	++	++
<i>Suitable to upgrade</i>	Yes	No	Yes	No	Yes



# A new dimension: the shape of the light

It is possible to **avoid modal dispersion by coupling and detecting precisely the modes within the MMF.**



**MPLC** : Multi-Plane Light Conversion technology

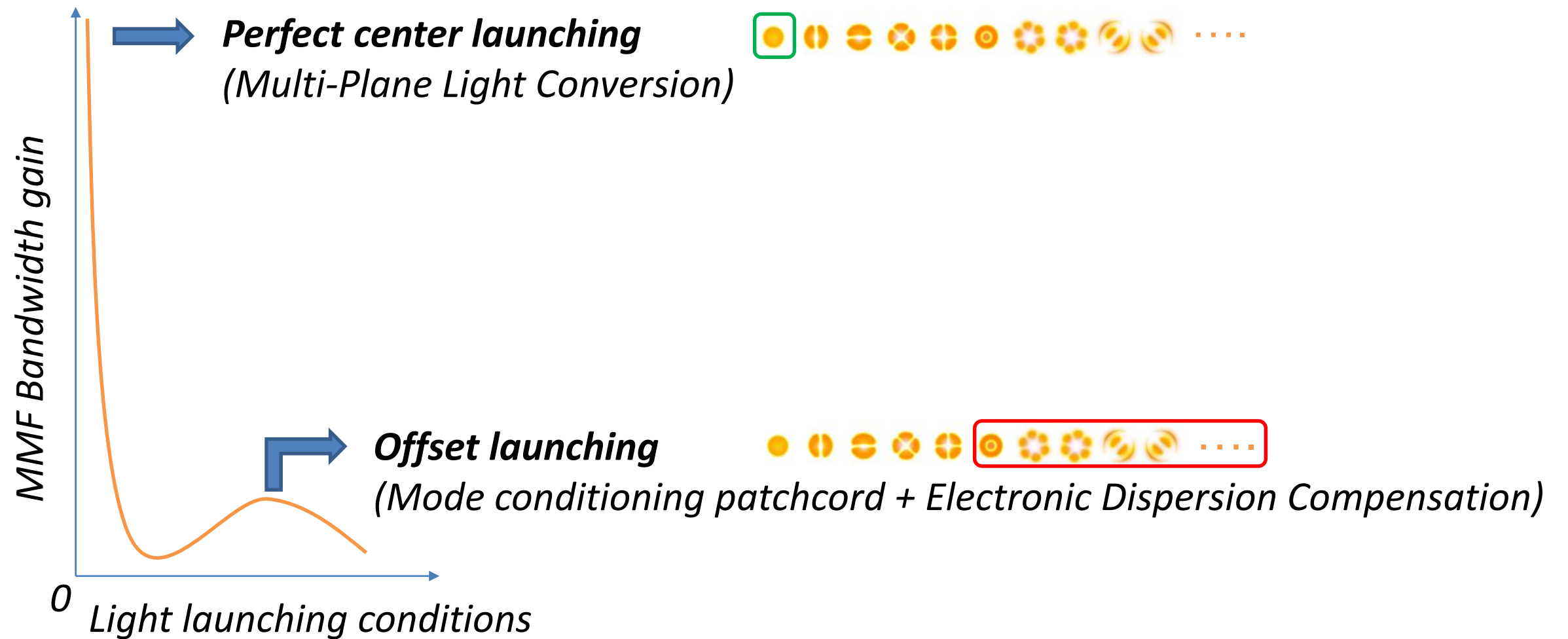
➤ **passive optical process** derived from quantum optics **to shape the light**

Solution to increase bit rates :

➤ **Excite only one mode** to have a **single-mode transmission over multimode fibres**



# Addressing modes inside MMF



Theoretical MMF bandwidth gain according to launching conditions (extract from IEEE 802.3aq study)



# Modal dimension tested and validated



100 Gb/s CWDM4 over 1km  
OM1 with modal adapter



160 Gb/s over 1km  
OM4 with SDM



14.5 Tb/s over  
2200 m OM2



100 Gb/s CWDM4 over 2km of OM1  
160 Gb/s over 2km OM3



GPON & XG-PON1  
transmission over MMF



GPON & XGS-PON  
transmission over MMF







# Remove MMF bandwidth limitation

## Increased capacity

**High capacity** channels (10+ Gb/s), **WDM compatible**

**Adaptable to the network topology** (point to point, star, Passive Optical LAN)

## Compatible with standard fibers and transceivers

Any type of **multimode fibre 62.5/125  $\mu\text{m}$  or 50/125  $\mu\text{m}$  (up to 10km)**

Any type of **single-mode transceiver; Transparent to communication protocol**

## Ease of installation - Reduced cost

**3 times less expensive** than a fibre roll-out; **up to 10 times** less expensive if complexities exist

Installation takes **only few hours**

**Passive system:** no additional cost of consumption, cooling, monitoring



# Why proposing this new technology?



Innovative  
solution

Gain a competitive edge by  
providing a cutting-edge technology



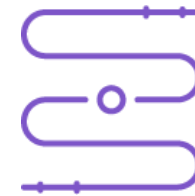
New clients

By differentiating your  
company from competition



Short sales  
cycle

Closing deals quickly due to  
less operationnal constraints



Alternative to  
recabling

Upgrade possible if certain links too  
expensive or technically constraining  
for installers



Ressources

Easy installation / fewer human  
ressources → increase margin



Tender

Secure the whole contract by adding  
this technology to tender response





# What does it look like ?

## 1U 19" rack



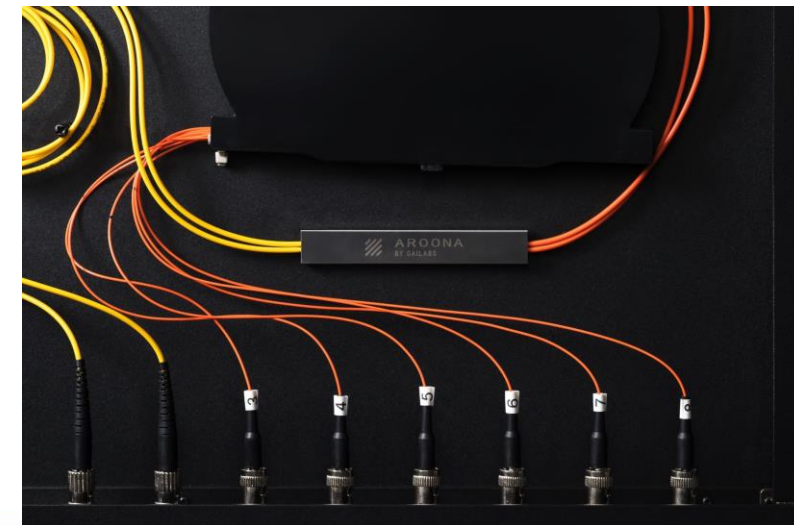
- 4 or 8 or 12 fibers version
- To be installed as new patch panel in network bay



## High density packaging



- 1 or 2 fibers version
- To be installed in existing MMF patch panel





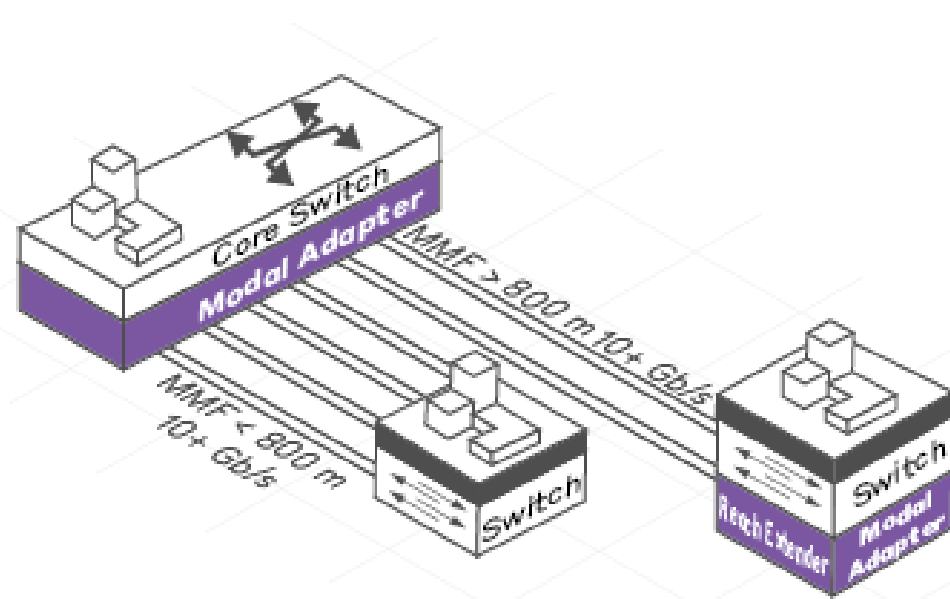


# How implement modal adapter? (for standard Ethernet LAN)

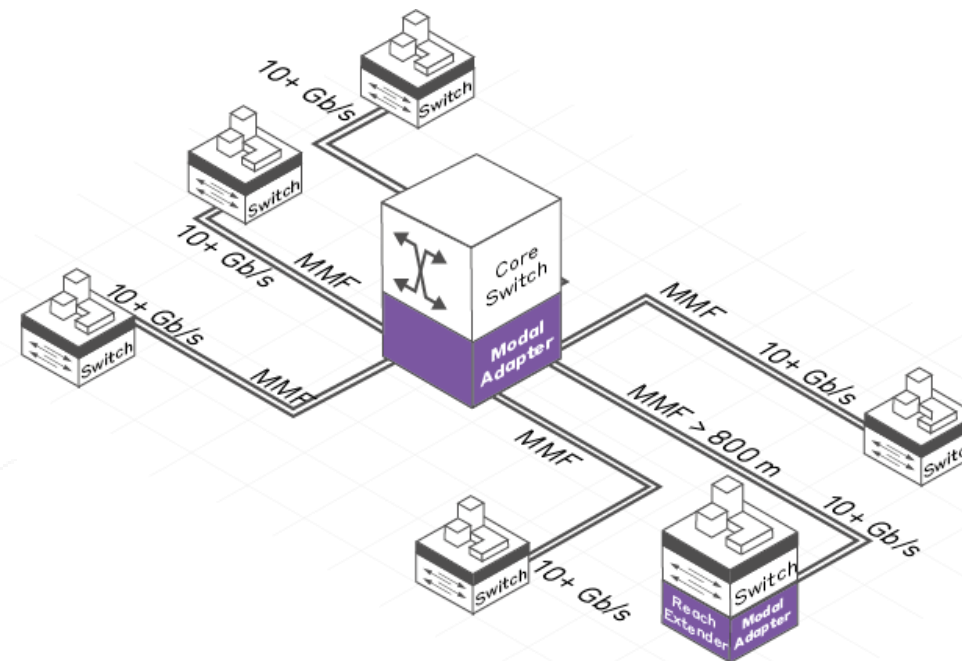
Upgrade several MMFs of the network with a single component

Only at the core of the network - No installation required at remote sites if links < 800m

Reach extender modal adapter to extend to **10km high bit rates MMF link**

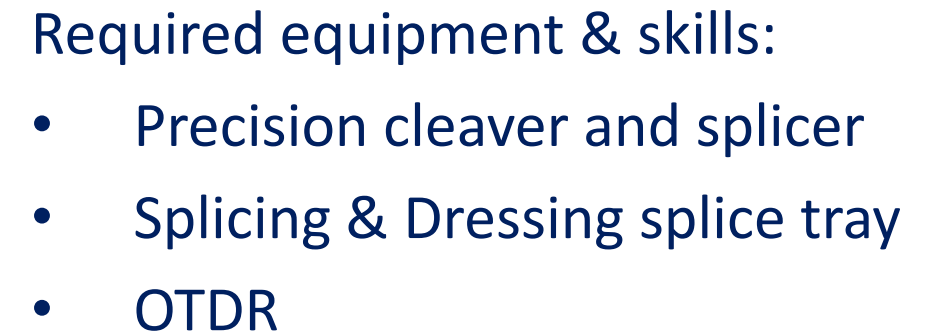


*Over Point-to-Point topology*



*Over Star topology*







# Futur proofing a factory network

MPLC enabled a steel industry to upgrade its CCTV system and to implement its smart factory program

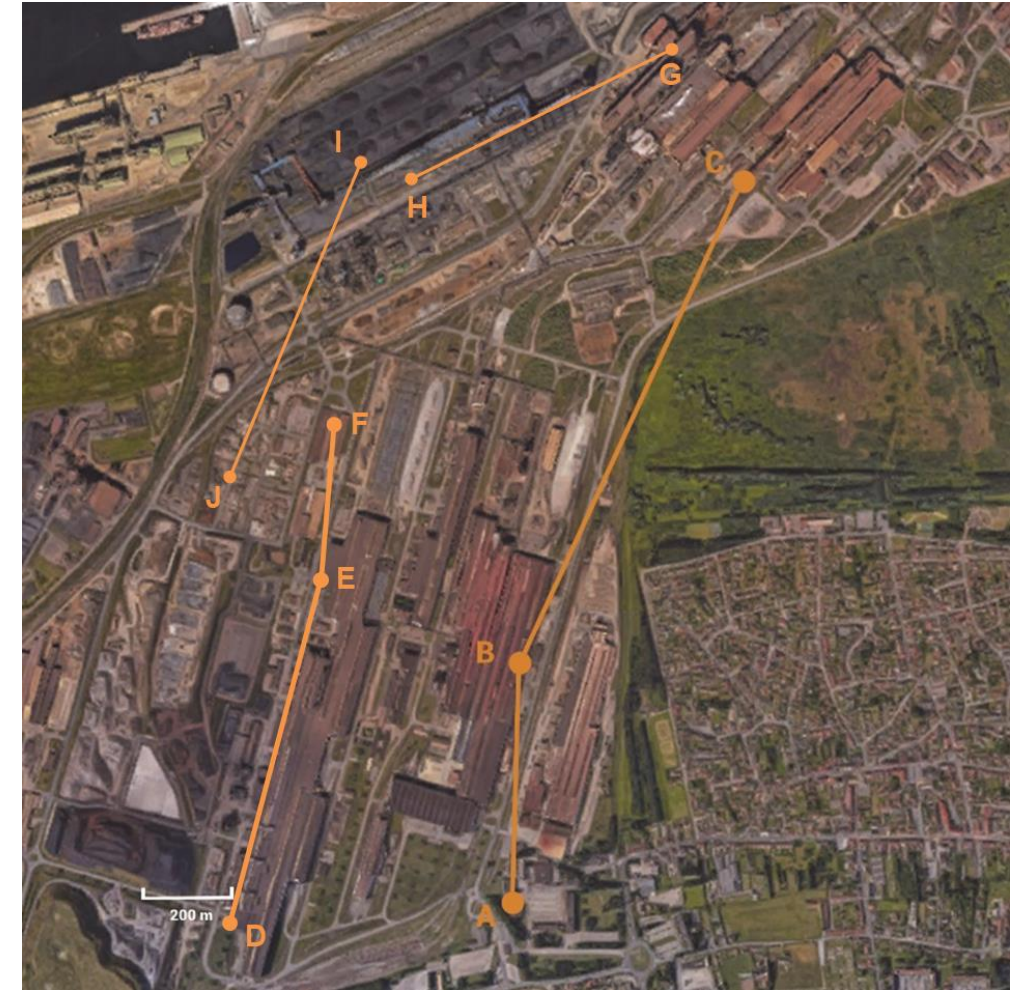
**OM1** fibre backbone

**Several links** between **900 to 2200m**

**No free cable conduit** under building and parking

**SEVESO** site = complexities for civil engineering

- **10 Gb/s** enabled + **CWDM** implemented
- Light project management & prevention plan
- **Neither construction work** nor production line on-site interrupted
- **New client** for the system integrator thanks to innovative solution







# Broadband for university campus

MPLC enabled Georgia Tech to implement high bit rate MMF network within campus and Student Accommodation Building

**Cabling not an option due to project cost**

**OM1 fibre backbone (star topology)**

**35 remote buildings between 400 and 1100m**

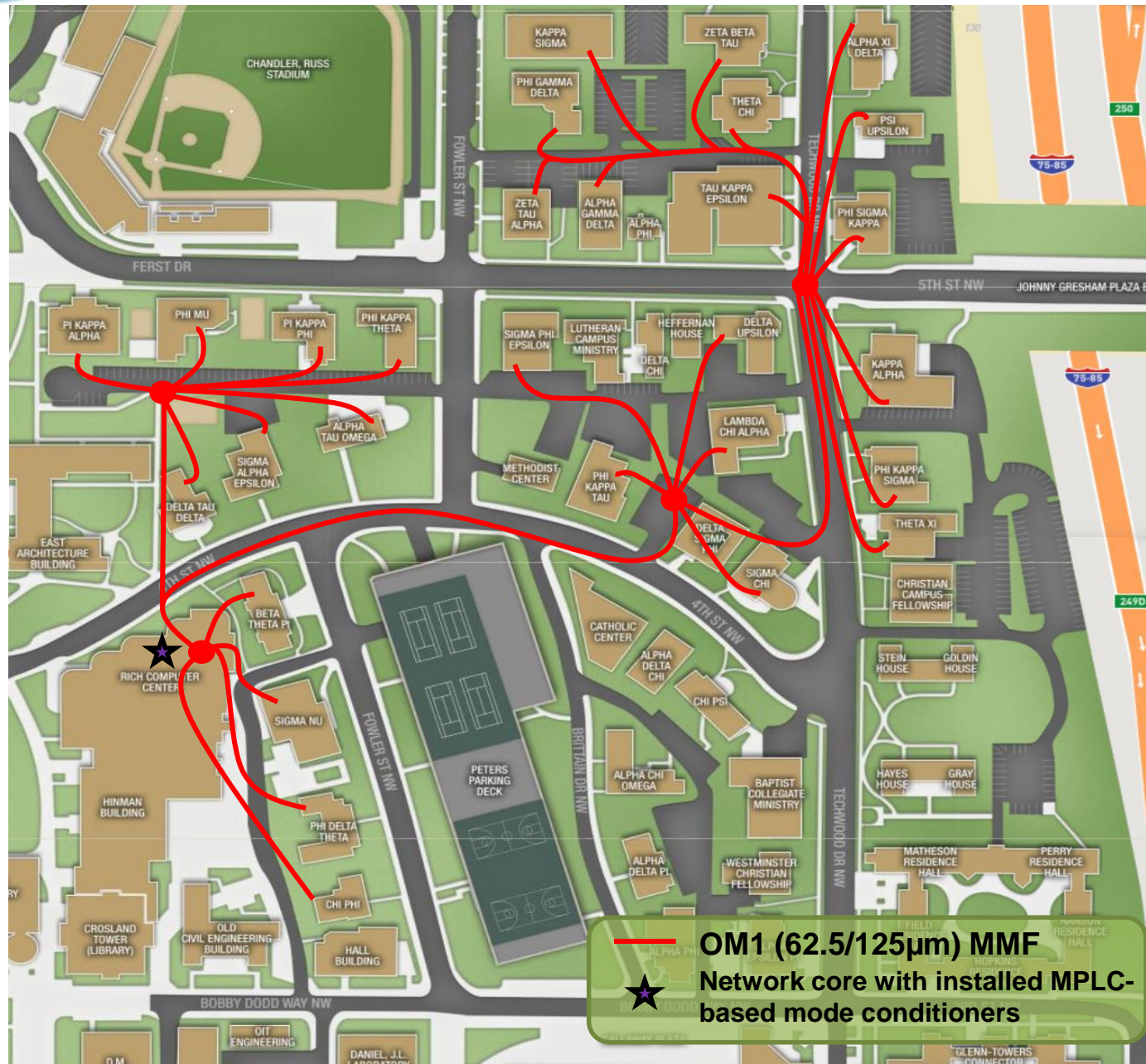
- **10 Gb/s** throughput available
- Project-enabler / Ease of installation
- 5x less expensive than new fiber deployment
- Big margin for installer







# Broadband for university campus



***“All buildings are up and running on 10Gb/s network speeds. It is pretty cool to have magical technology in use and functioning so well!”***

*Robert T., Network engineer, GIT*



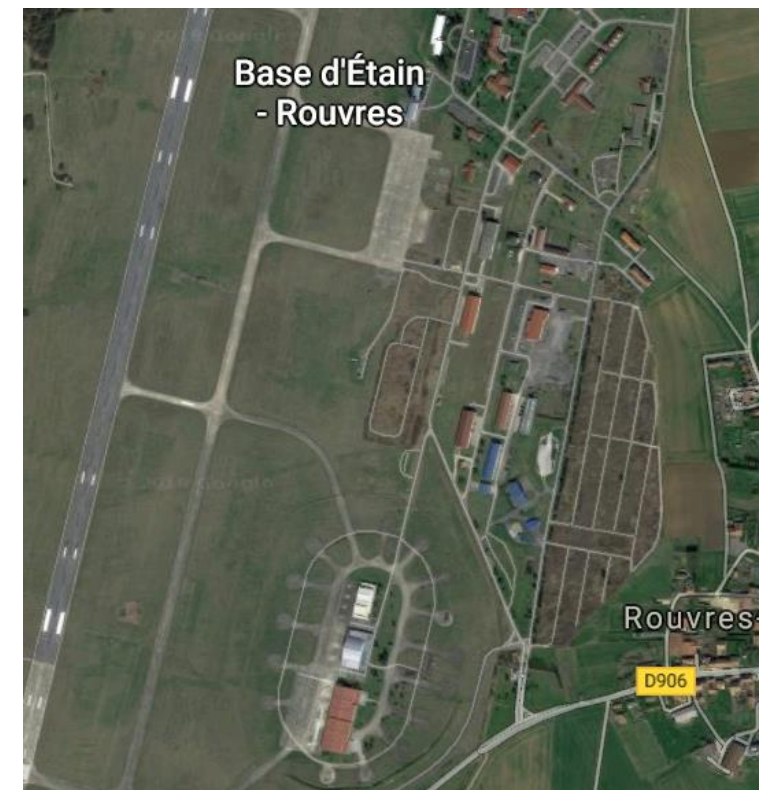


# Facilitate digital transition of military bases

MPLC enabled transition from 100 Mb/s to 10 Gb/s on a entire military base without fiber roll out.

Upgraded **OM1** MMF links lengths between **600 m and 1850 m**

- **Up to 40 links at 10 Gb/s** instead of a limit of 100 Mb/s
- **5x less expensive** than a new fiber deployment
- **Easy installation**
- No disruption and construction work. Reduced cut-off time





# Unique technology for a global problem

The problem of **MMF bandwidth limitation** is found on **various typologies and topologies of local area networks**

- University / School group
- Hospital
- Factory
- Military sites
- Shopping center
- Ski resort
- Urban community
- Amusement park
- Airport
- Sports complex
- Museum
- ...

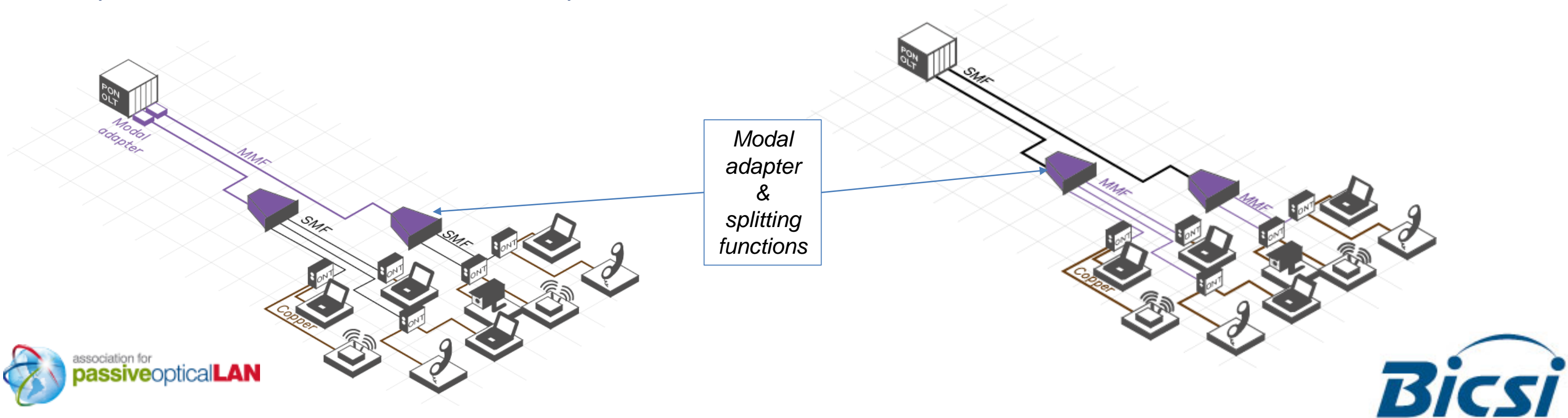


# How implement modal adapter? (for Passive Optical LAN)



Controls the **spatial modes coupling** and adapts MMFs to SMFs by simple replacement of an **optical splitter**

Facilitates the **transition to Passive Optical LAN** on existing cabling infrastructure (GPON and XGPON over MMF)

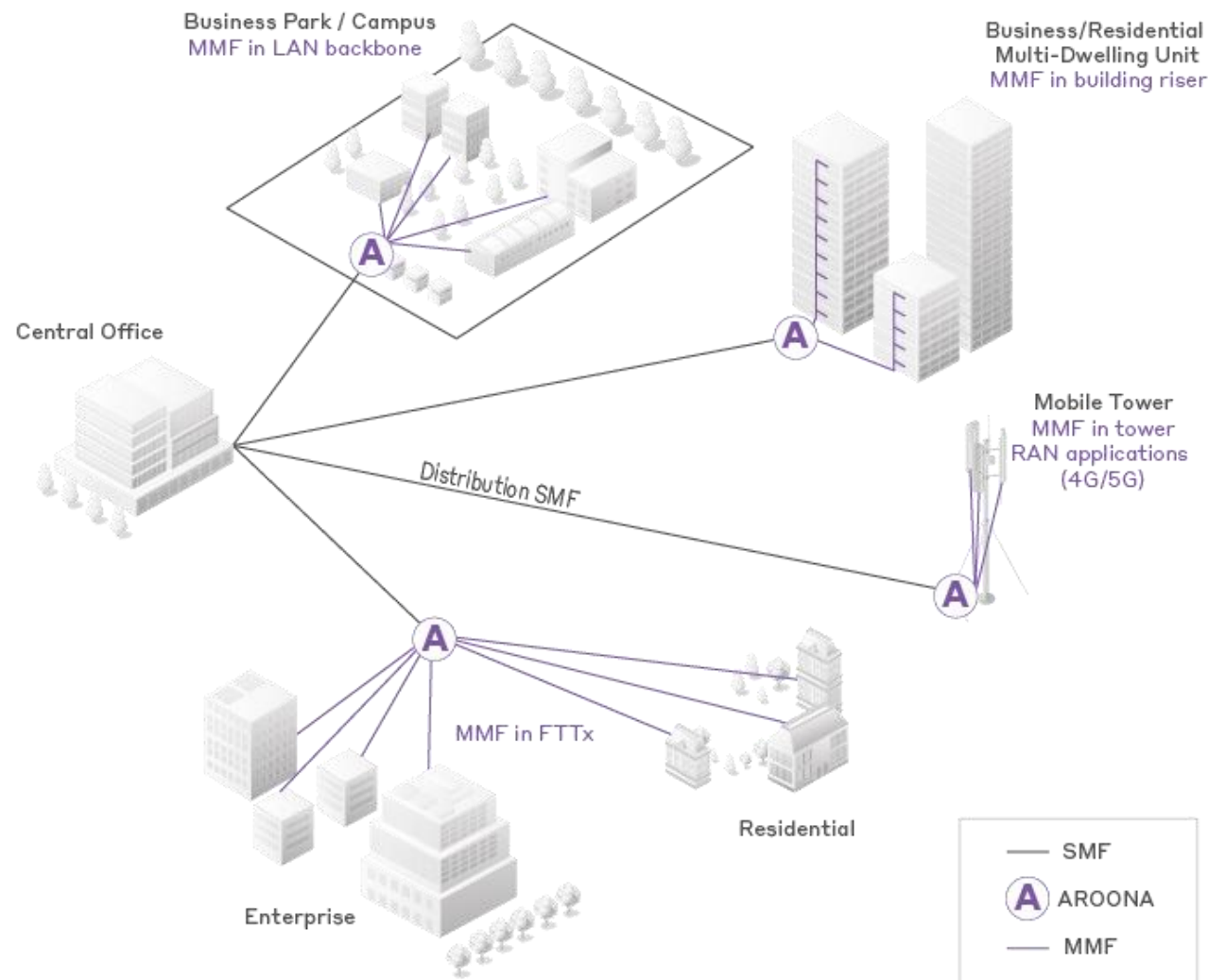






# How to expand last mile fiber?

## Leverage existing MMF?



Expanding telco's networks to the last mile enables better service

- Fixed wireless networks: WLAN, DAS, small cells, private LTE
- Fiber-To-The-Premise
- Risers in multi-dwelling units
- Wireless service in public venues
- Mobile towers of RAN (Radio Access Networks)

MPLC technology acts as a passive adapter or distribution splitter between distribution SMF and existing MMF drops

- Reduced CAPEX for last mile fiber
- Fiber available immediately, no need for roll-out on the client's property
- No disruption for tenants, No risks for other utilities



# Transforming MMF into SMF, it is possible !

Local Area Network fiber infrastructure **mainly composed of multimode fibre**

**MMF = bandwidth limitation** (due to modal dispersion)

Depending on the need, **on the shelf solutions to overcome MMF bandwidth limitation**  
(advanced modulation, parallelization, cabling, MPLC modal adapter)

**MPLC** (Multi-Plane Light Conversion)

**Alternative to complex fiber (re)cabling** with advantages for installers & end-users

Light shaping innovative passive technology **to harness the full potential of MMF**

**Overcome modal dispersion to increase MMF capacity**

# cailabs

SHAPING THE LIGHT

**Any question?**

*Distributed by*



**Grazie per l'attenzione. Non esitate a contattarmi  
se volete maggiori informazioni o demo!**

- [aroona@cailabs.com](mailto:aroona@cailabs.com)
- [www.cailabs.com](http://www.cailabs.com)

