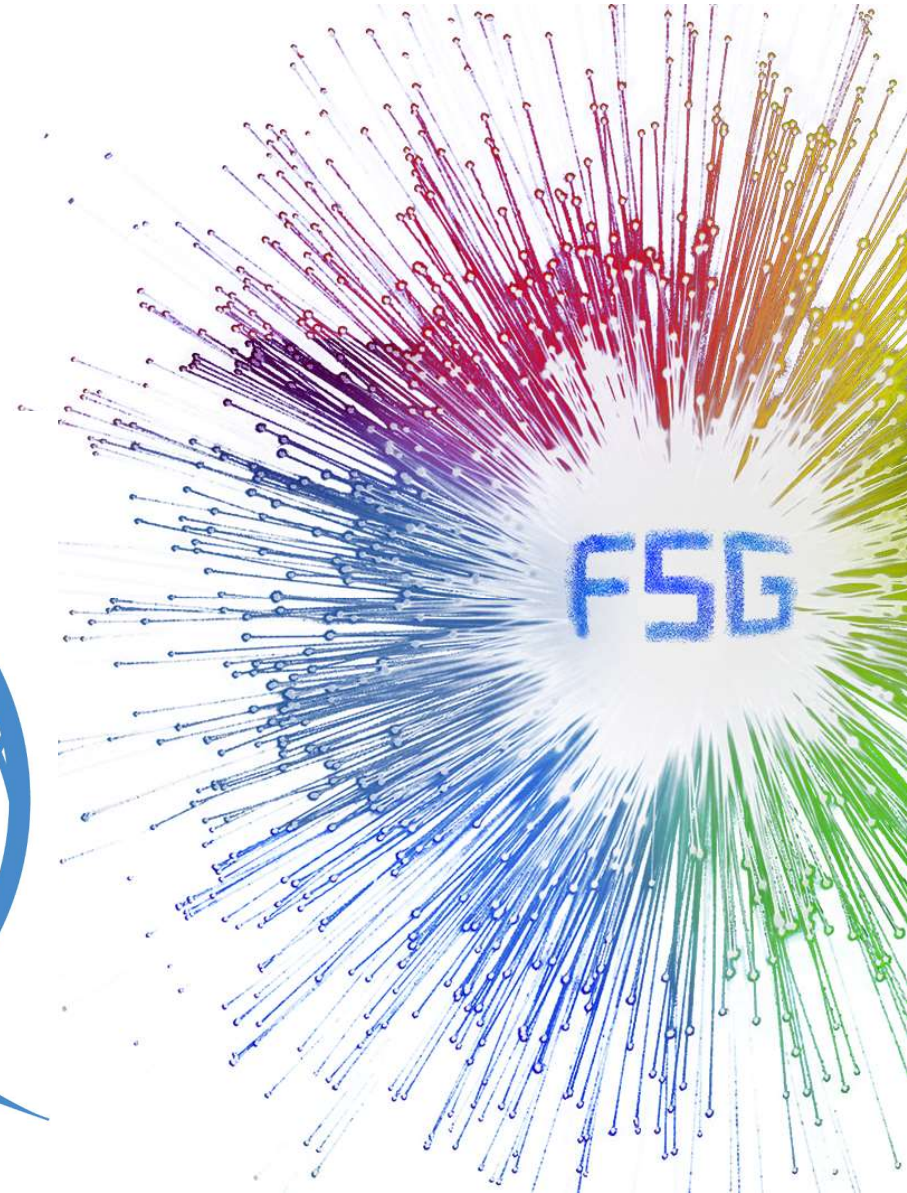




# Fixed 5<sup>th</sup> Generation Advanced, 50G-PON, and Very-High-Speed PON

**Frank Effenberger**  
**March 2023**



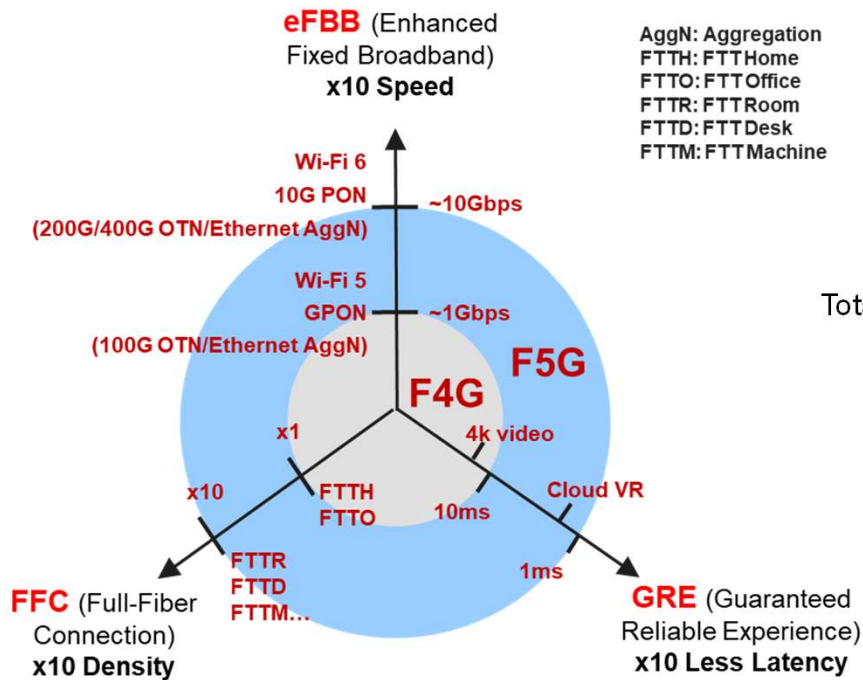
## The pacing of generations



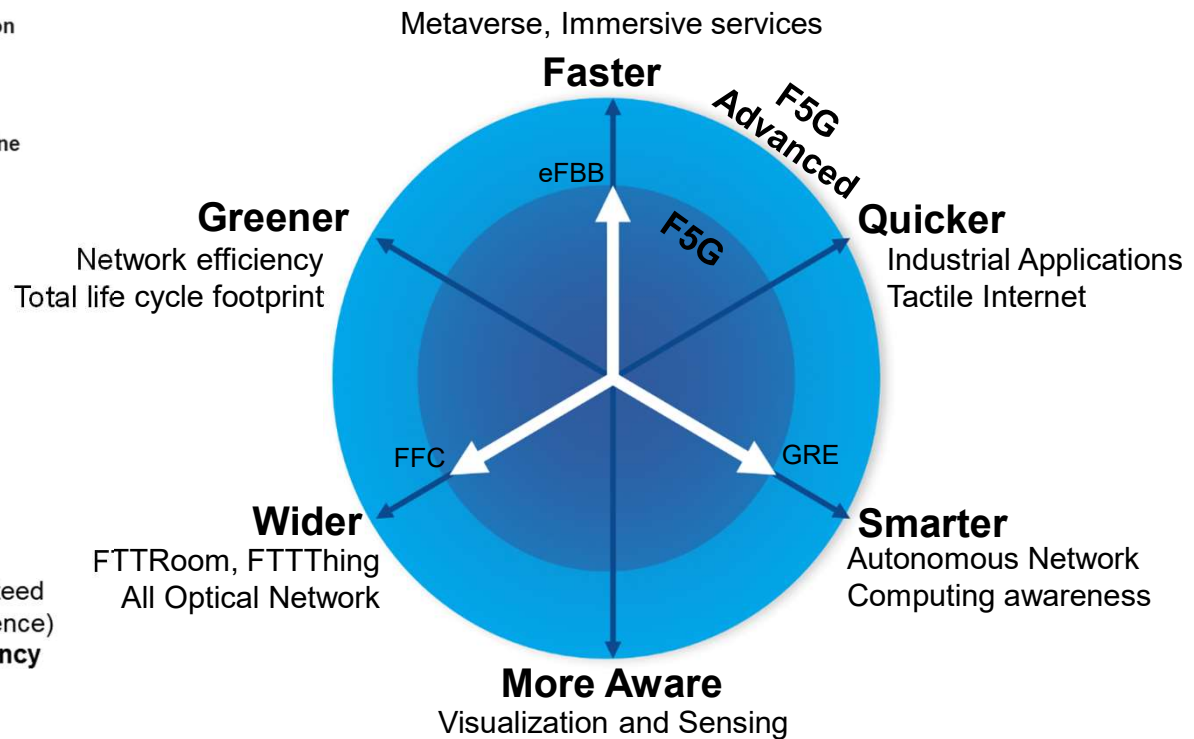
- Historically, major deployment generations happen every 10 years
  - F5G expects to follow this rhythm, meaning F6G will happen in 2030
- The fixed network contains many different technologies
  - It is unrealistic to expect all these things to synchronize their development
  - For example, PON generations happen 2005, 2015, and 2025
- The F5G Advanced work can be thought of as a “F5.5G”, an interim step forward in capabilities, that allows all the technologies to happen in their natural time

# Performance dimensions

## The three dimensions of F5G



## F5G Advanced: Extend and Expand



# Key Technologies

## Fiber to the terminal (FttT)

- FttRoom (residential)
- FttMachine (industrial)
- FttCampus/Office (business)

## Network technologies

- 800G+ OTN and related systems
- Sub-1G OSU-OTN
- OXC for agile green networking
- 50G-PON
- Novel PON functional split
- Wi-Fi 7

## Network-based sensing

- Fiber cable digitization
- Distributed optical fiber sensing
- Wi-Fi sensing

## Latency control technologies

- Deterministic Networking
- End to end slicing

## Energy efficiency technologies

- Network Level Energy efficient technologies
- Equipment Level Energy efficient technologies
- High level design for energy efficiency

## High Quality Distributed Computing Networks

- Security guarantee of computing power
- Computing Network Information gathering
- Elastic resource scaling
- Latency aware process dispatching
- Joint optimization of network and computing
- Ensuring computing service experience

## Autonomous Network Management

- Intent-based management
- Knowledge graph for fault management
- Improved network information gathering

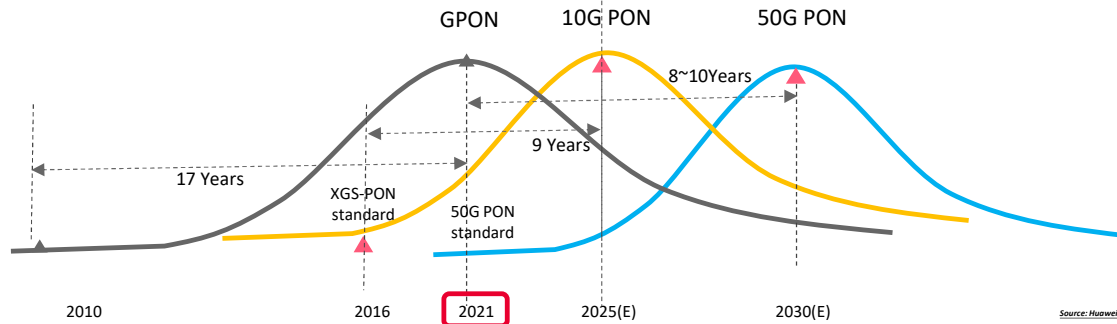


Technologies for enhancing trustworthiness



# 50G PON is the Best Choice after 10G PON

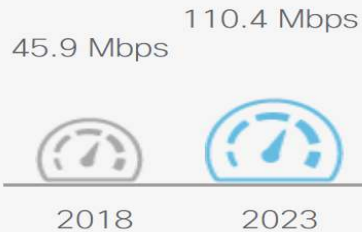
## PON Technology evolution : 8 ~ 10 years for one generation



## Bandwidth upgrade : doubles every 4 years, 4 ~5times in 8~10 years.

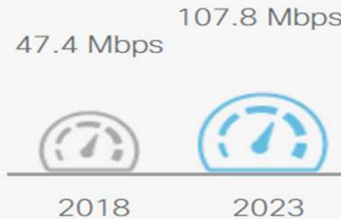
### Global : 20% CAGR(2018-2023)

Average Broadband Speeds



### Germany: 18% CAGR(2018-2023)

Average Broadband Speeds



<https://www.cisco.com/c/en/us/solutions/executive-perspectives/annual-internet-report/air-highlights.html#>

## Access Upgrade Pace

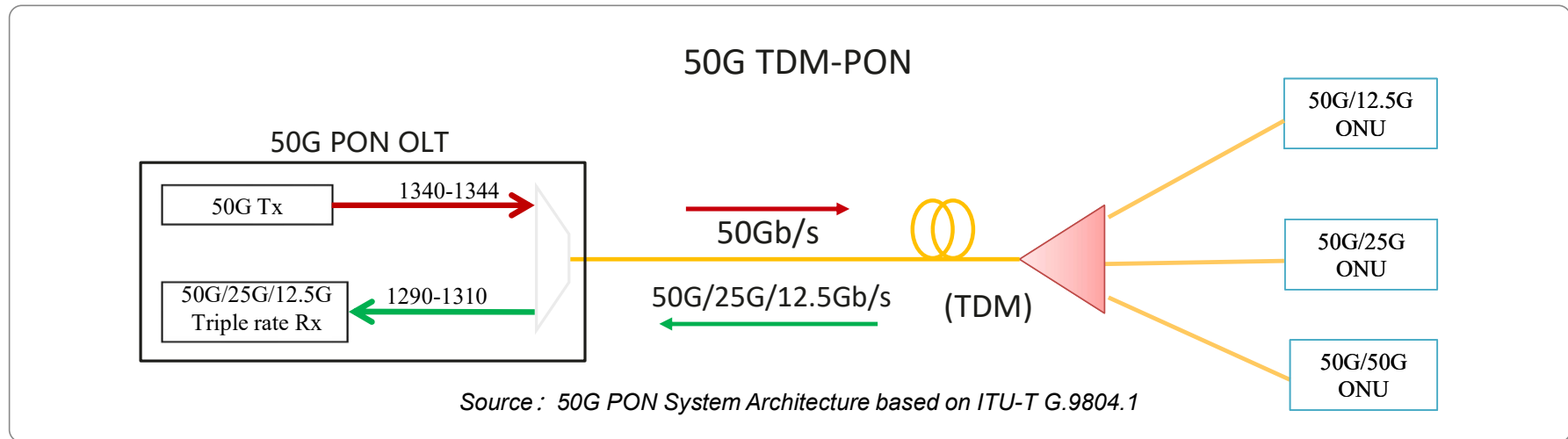
Per PON Generation

8 ~ 10 Years

4+ Times Bandwidth

- Access network deployment **pace is 8 to 10 years**. Going any faster cannot be supported economically or operationally
- **4 times** bandwidth growth is the sensible choice of PON technology evolution.

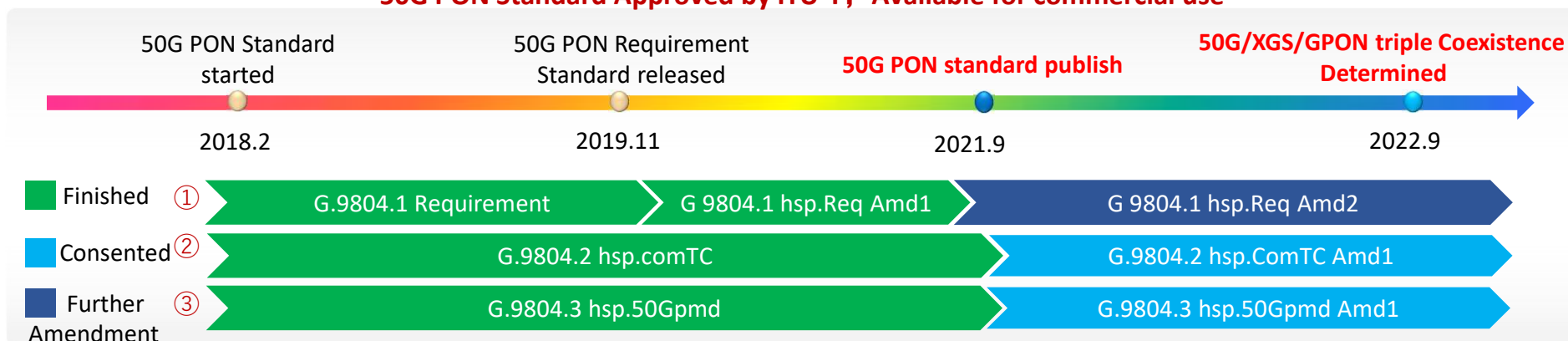
# 50G PON System Architecture



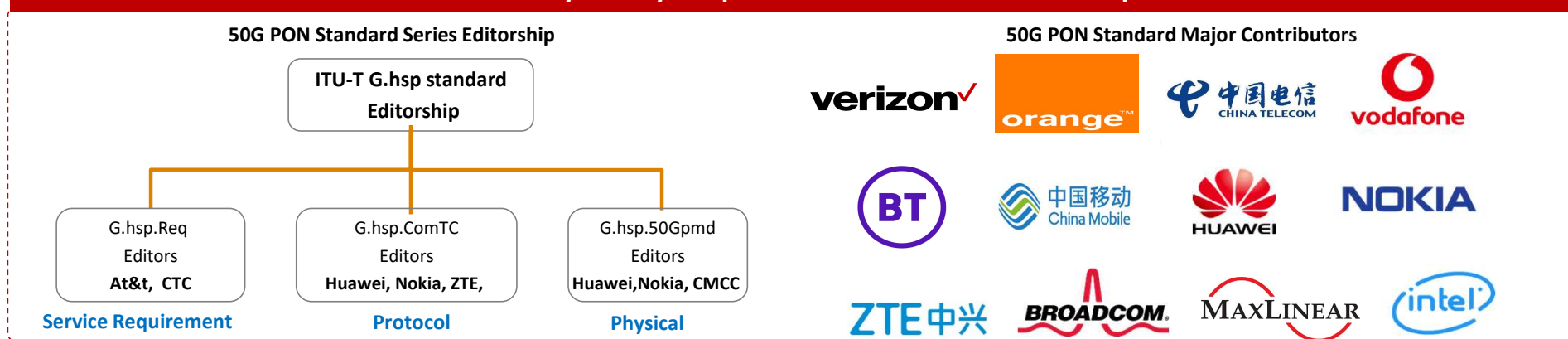
- 50G PON downlink support 50Gb/s, uplink support 12.5G,25G,50G
- ONUs with different rates can coexist under the same OLT PON port in time division mode.
- Similar to 10G PON, 50G PON has a simple architecture. It has single upstream and downstream wavelengths. The ONU upstream is in the zero-dispersion band and has a 20 nm spectrum width.

# 50G-PON standard published and support triple coexistence

50G PON Standard Approved by ITU-T, Available for commercial use

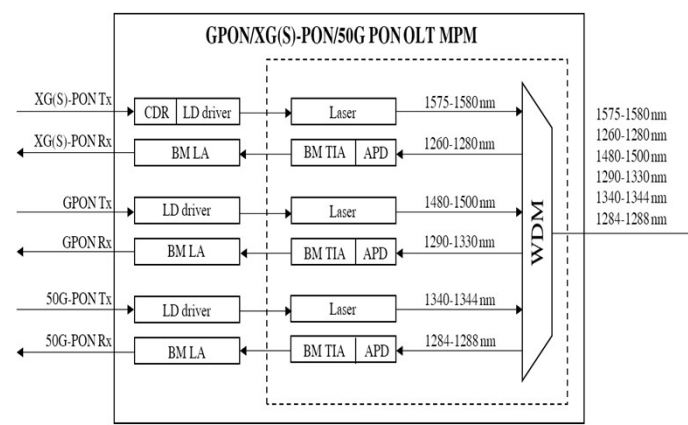
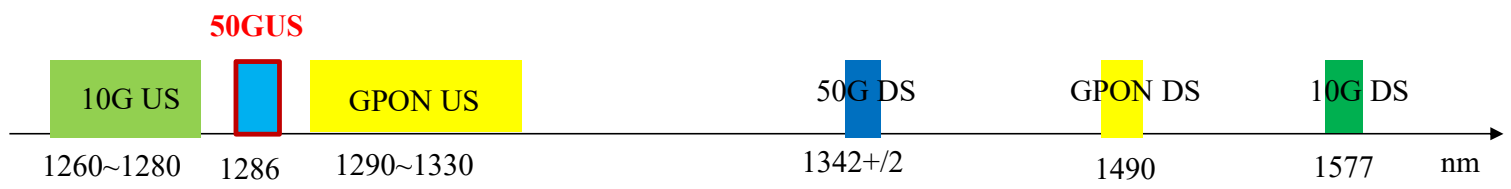


## 50G PON Industry Widely Cooperation between Vendors and Operators.

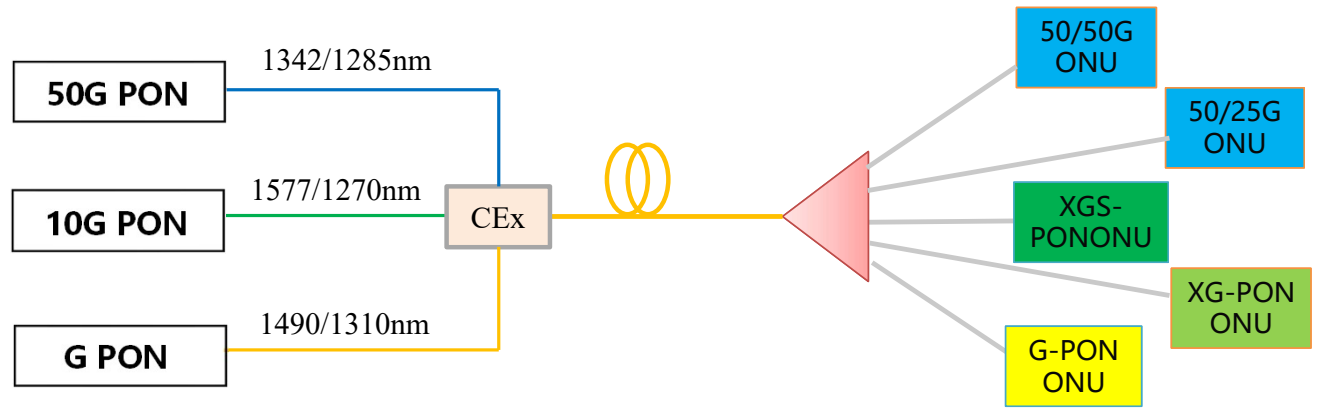


# Three generation coexistence (GPON + 10G + 50G PON)

Three Generation coexistence wavelength plan



ITU-T G.9805 Figure III.7 – Reference diagram of GPON/XG(S)-PON/50G PON OLT MPM

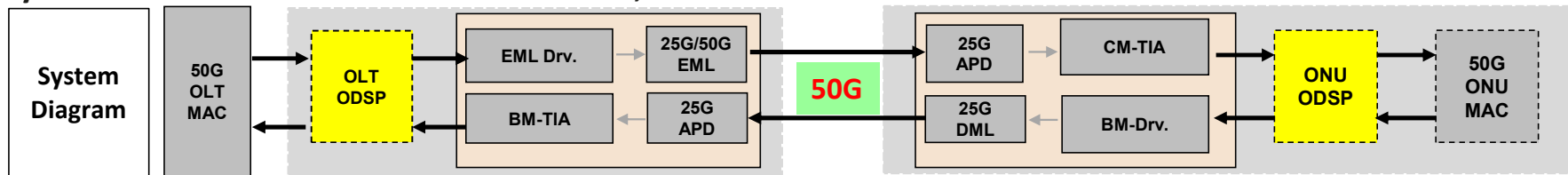


Allow operators deploy 50G-PON without disturbing current GPON and 10G-PON users



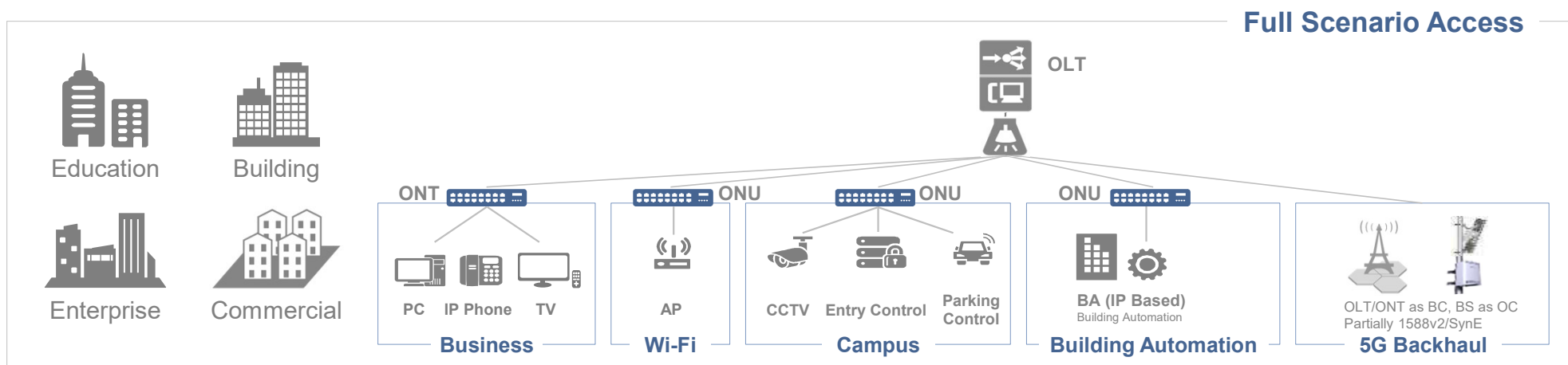
# 50G PON Industry Makes Progress towards commercialization in 2024

● System Architecture : similar with 10G PON, extra with DSP



Industry have made good progress to enable 50G PON commercialization in near term			
OLT Devices		ONU Devices	
	Industry progress		Industry progress
25G/50G EML + SOA	Sampling	25G DML	Shipping
EML Driver	Shipping	Burst-mode DML Driver	Shipping
25 Gbps APD	Shipping	25 Gbps APD	Shipping
25 Gbps Burst Mode TIA	Shipping	25G/50 Gbps Continuous Mode TIA	Shipping
DSP Equalizer	Developing	DSP Equalizer	Developing
25G Burst Mode CDR	Shipping	Continuous CDR	Shipping
Optical Module	Sampling	Optical Module	Sampling

# 50G PON: One Fiber, Full Services, All Scenarios



## Huawei 50G PON prototype plan

- 2018.1 Off-line prototype 1.0
- 2019.1 Real time prototype 2.0
- 2020H2 Real time prototype 3.0 based on 5800 Single slot line card with 50G down/25G up line rate (technology trial)
- 2022 50G PON pre-production prototype

## Field trial of 50G PON

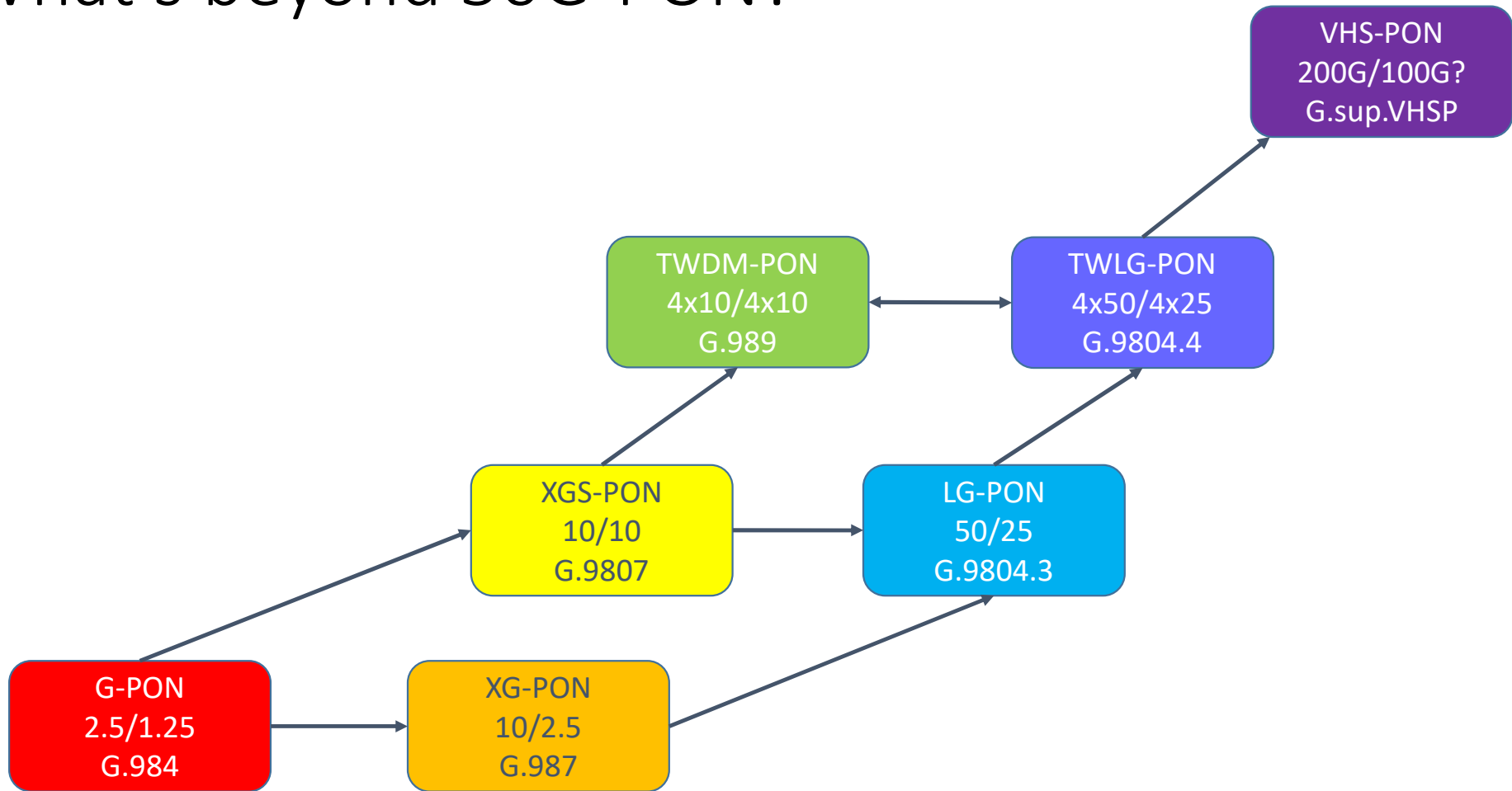


 **swisscom** 2022 July @

1:64 splitter **Downstream:** 50 Gbps (42 Gbps)  
**Upstream:** 25 Gbps (16 Gbps)

\*Image Source: <https://www.swisscom.ch/en/about/news/2022/07/11-neuster-glasfasertechnologie.html>

# What's beyond 50G-PON?



## G.sup.VHSP scope

- This supplement is intended to serve as a clearing house for any and all technical proposals for PON systems >50 Gb/s
- This may include
  - IM-DD feasibility, including exploring new line codes
  - Multiple (bonded) channel designs, a la 50G EPON
  - Simplified coherent approaches: fancy OLT, simple ONU
  - Flexible rate concepts for link adaptability
  - Various multiplexing modes, include TDMA, OFDMA, and hybrid
- All of these raw ideas need to be “cooked”
  - Running these ideas up against the many requirements for access, and evaluating how practical they really are

## Agreed format for each technology evaluation

It was recently agreed that each technology “proposal” should consider at least the following topics

- Overview and Base physical architecture/configuration
- PMD capabilities
- Loss budget, Optical split, Fibre Distance, Differential Reach
- Upstream and Downstream architecture
- Multiplexing and multiple access techniques
- Wavelength plan, Coexistence with legacy PON systems, Migration scenarios
- Transmission convergence layer aspects
- Power Saving Opportunities
- Technology Status/Maturity Summary

## How will this play out?

- Technologies will be evaluated and compared
  - Against each other, on multiple bases (complexity, readiness)
  - Against the various network requirements (which are not homogeneous)
- Multiple outputs might happen
  - There might be a nearer-term incremental technology
    - An improvement of the current PON system
  - And a longer-term revolutionary technology
    - The next generation of PON system, that would coexist with prior systems
- Then it is up to building consensus on how to proceed
  - Strong engagement from major operators and vendors is essential
  - Need to pace the development of standards to match deployment





**Thank you.**

