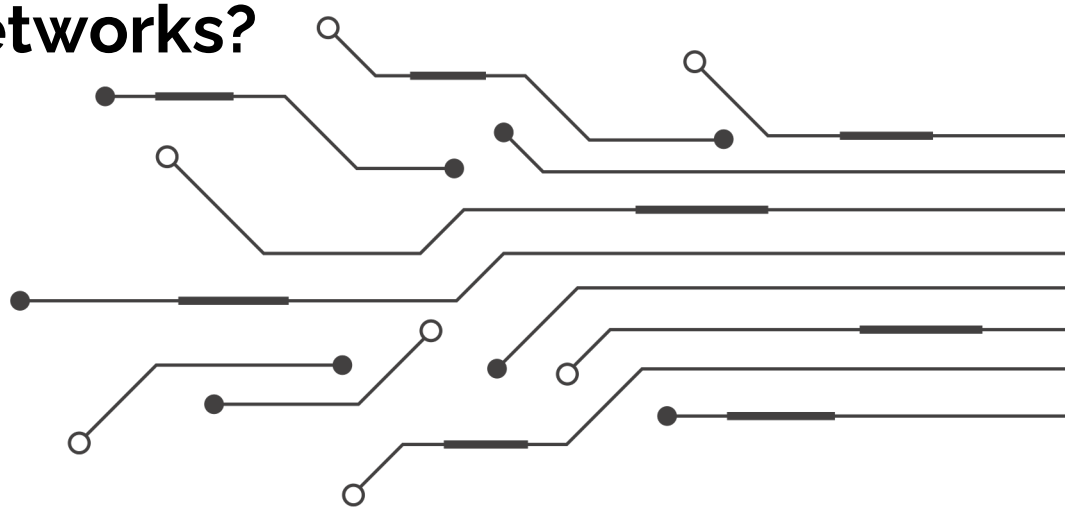
PICadvanced

Is integrated optics a perfect fit for next generation of Access Networks?

teixeira@picadvanced.com



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COMPETE 2020 PORTUGAL 2020 UNIÃO EUROPEIA Fundo Europeu de Desenvolvimento Regional PRR Plano de Recuperação e Resiliência REPÚBLICA PORTUGUESA Financiado pela União Europeia NextGenerationEU fct Fundação para a Ciência e a Tecnologia Co-funded by the European Union

About us

2014

Privately held company

2020

Series A
Verizon Ventures
200M fund

1st

In the market with NG-PON2 ONU fully compliant solution

PICs4PON

From foundation pushing PICs for PON applications and markets

34M€

Revenue in 2023

>35%

Year over year growth

Investors

Verizon Ventures · 200M · HFA

Partners

altice · Fraunhofer · INESC MN Microsystems and Nanotechnologies · UPV fAB

Members of

European-American Chamber of Commerce Cincinnati - Chapter · broadband forum · Câmara de Comércio · INOVARIA · EPIC European Photonics Industry Consortium · OPTICA Formerly OSA · tice.pt

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Market in PON?

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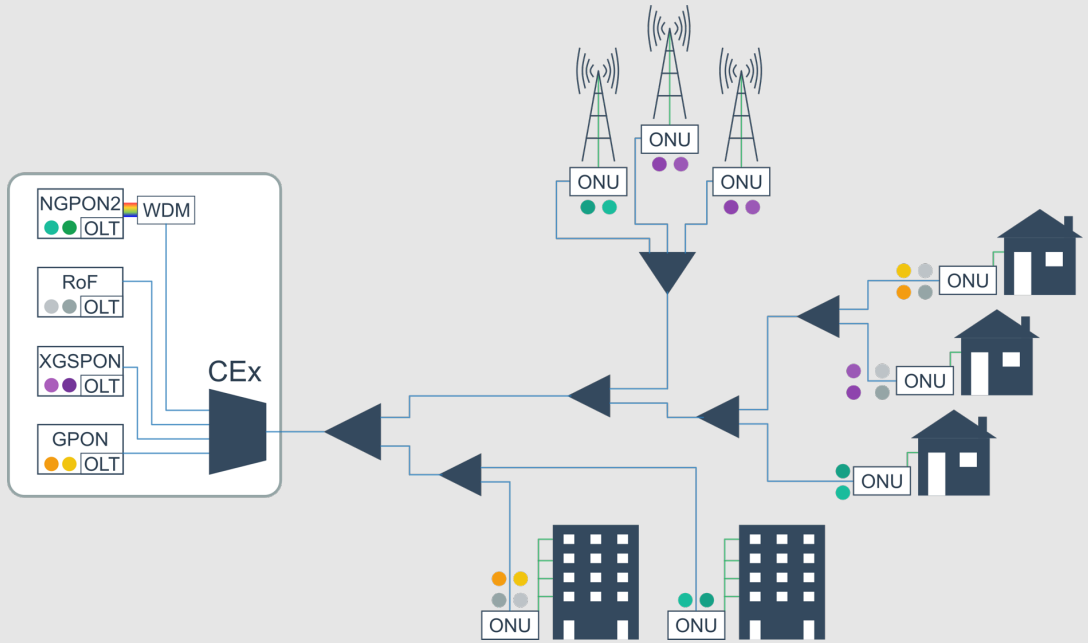
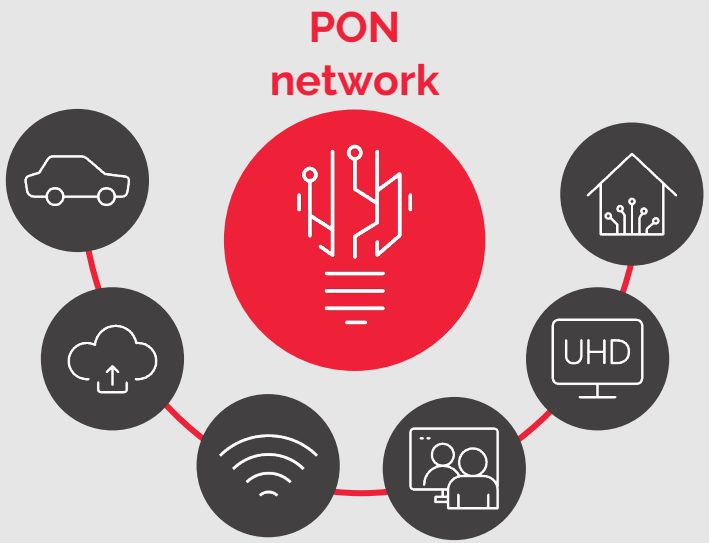
Next Generation Access Networks: Enhanced Broadband





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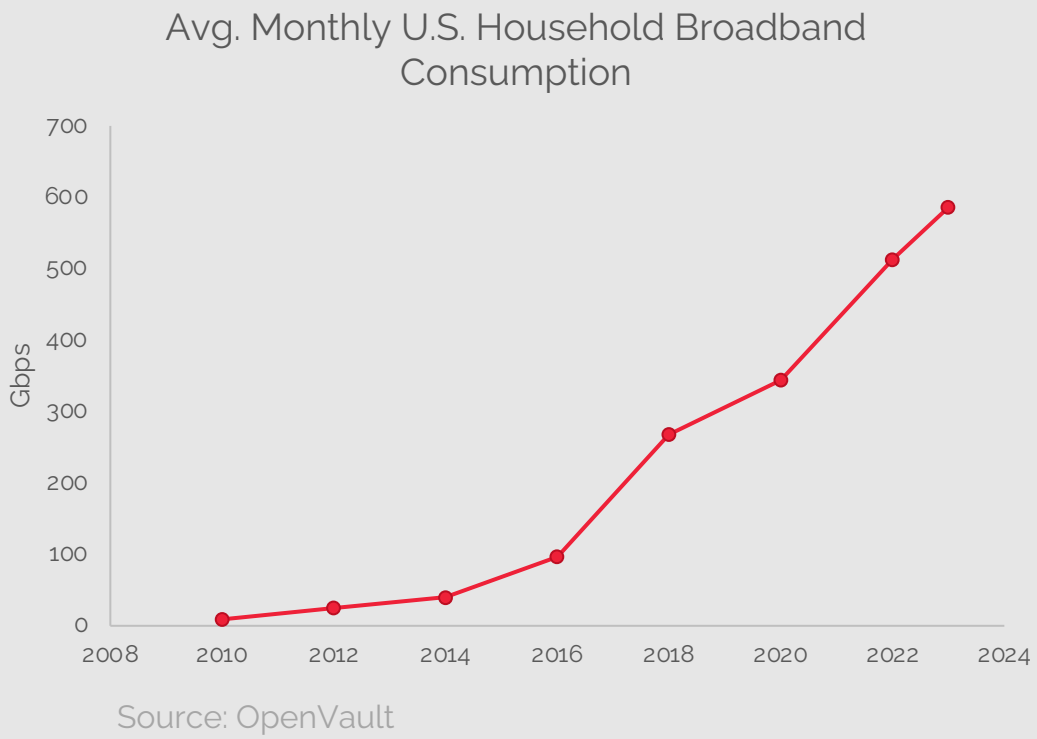
PONs: driving today's communication at exponential growth



Source: OpenVault

110Mbps

Global Average fixed broadband speed

Source: Cisco

17.4%

Projected CAGR PON Market (2028)

Source: MarketWatch

$35.59 bn

PON Market size by 2030

Source: Fortune Business Insight

50.3%

Projected CAGR NG-PON2 Market (2026)

Source: OMDIA

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Requirements for next PON ?

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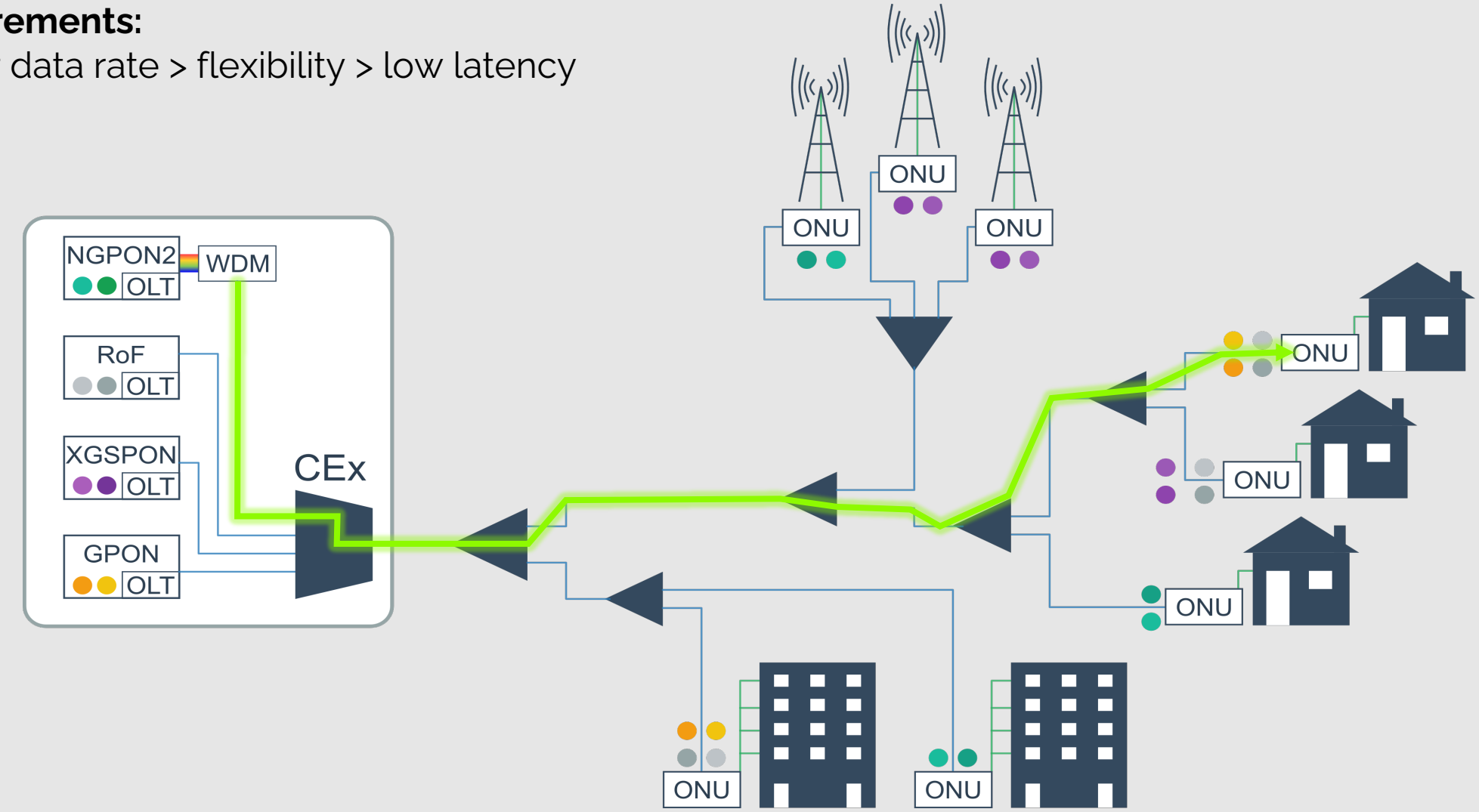
Scenarios of present and next gens

Data service

Requirements:

Higher data rate > flexibility > low latency



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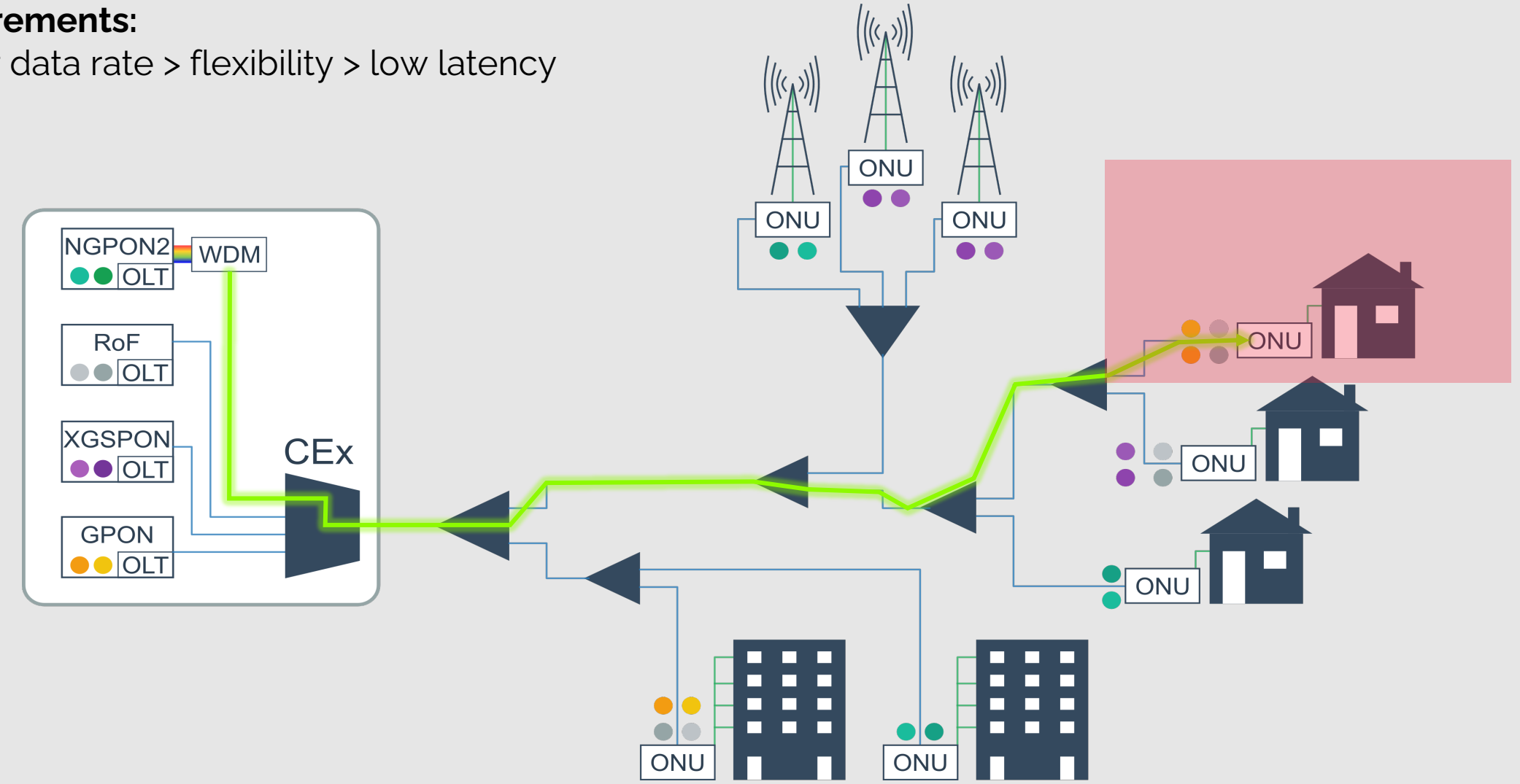
Scenarios of present and next gens

Data service + distributed computing (e.g. AI)

Requirements:

Higher data rate > flexibility > low latency



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Scenarios of present and next gens - sectioned

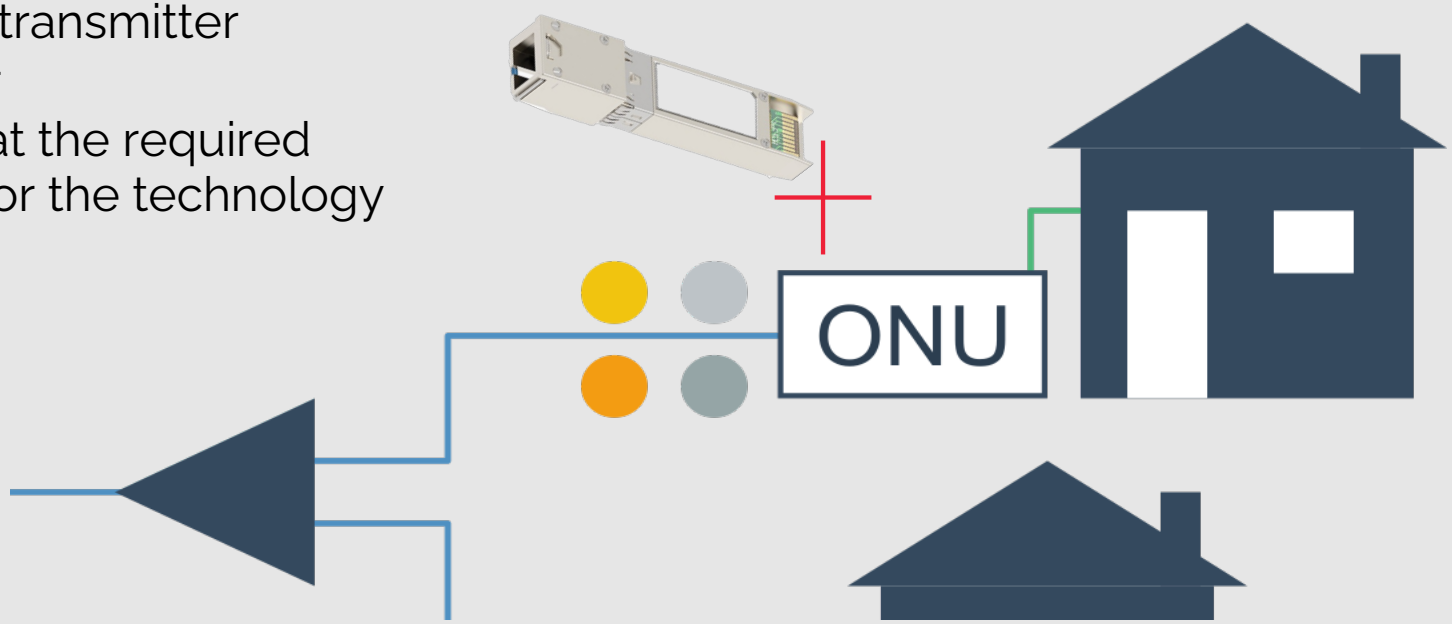
SFP+/XFP ONU

Requirements:

- Optical technology filter
- Burst mode transmitter
- CW receiver
- Electronics at the required bandwidth for the technology

O/E conversion
PHY optical signals converted into electrical and back in burst mode US

Ethernet interface
OMCI, L2 capabilities /MAC ITU Gxxx, Synchronization IEEE 1588



	CW	High Speed	Fixed	Tunable	Multiband
LD	✓	✓	✓	✓	
Rx		✓			
Filter			✓	✓	
Electronics		✓			
Proc/ Memo					

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Scenarios of present and next gens - stick

SFP+/XFP ONU stick

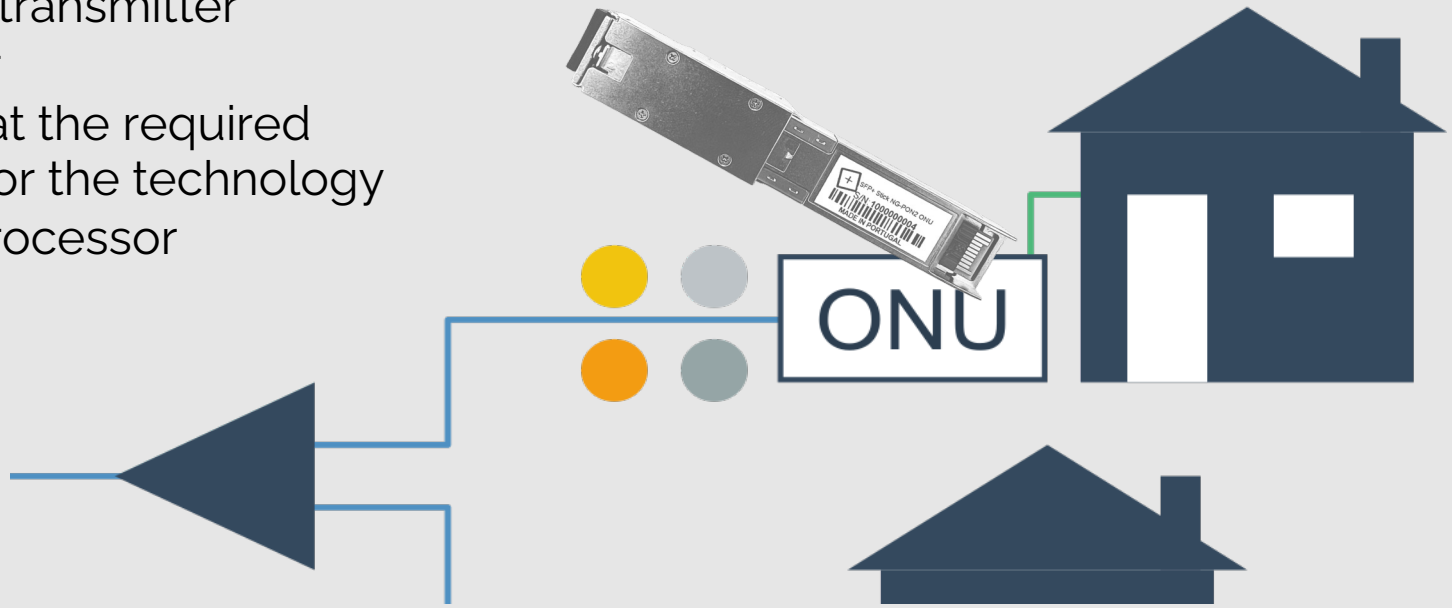
O/E conversion
PHY optical signals converted into electrical and back in burst mode US

+

Ethernet interface
OMCI, L2 capabilities /MAC ITU Gxxx, Synchronization IEEE 1588

Requirements:

- Optical technology filter
- Burst mode transmitter
- CW receiver
- Electronics at the required bandwidth for the technology
- Memory + Processor



	CW	High Speed	Fixed	Tunable	Multiband
LD	✓	✓	✓	✓	
Rx		✓			
Filter			✓	✓	
Electronics		✓			
Proc/ Memo		✓			

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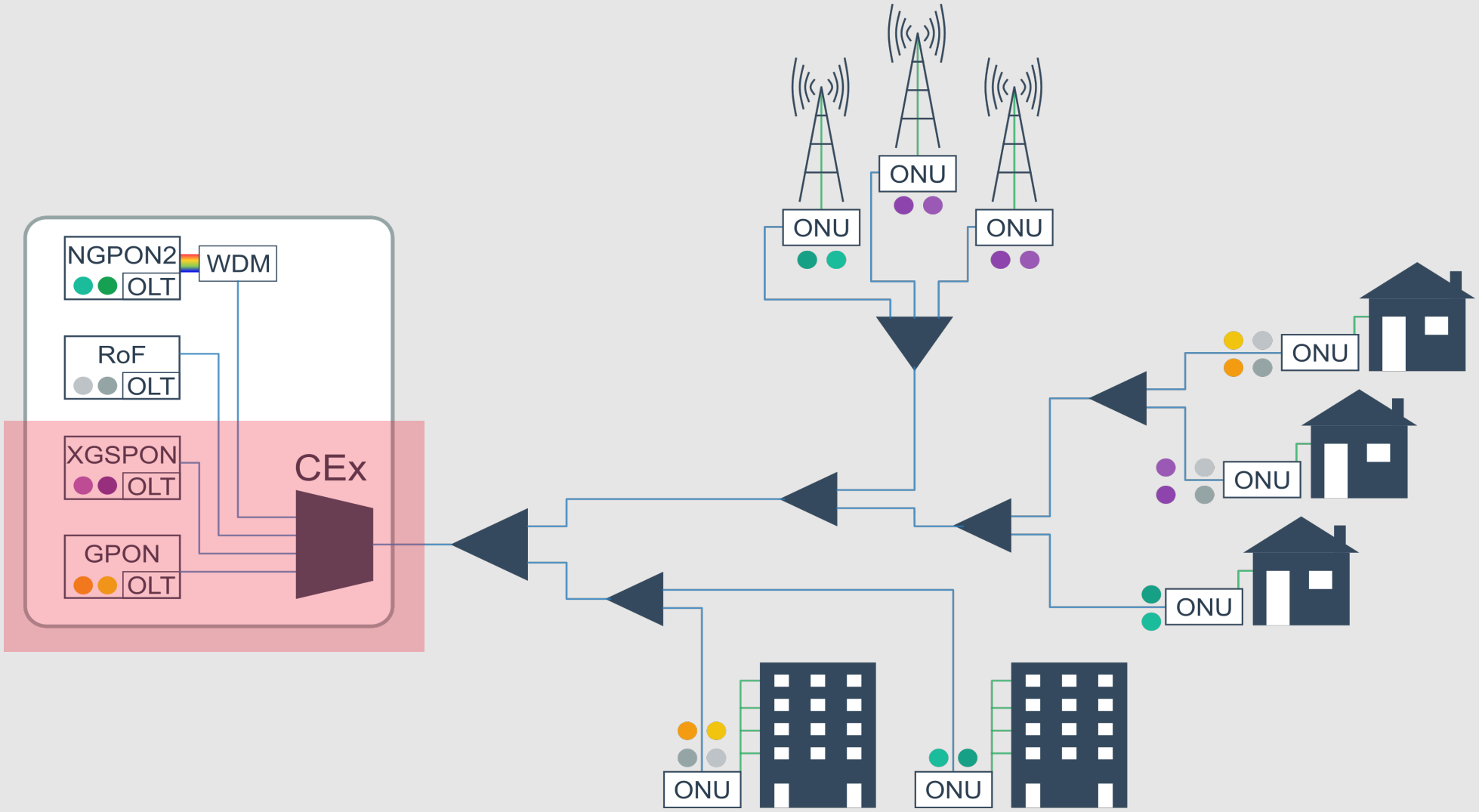
Scenarios of present and next gens



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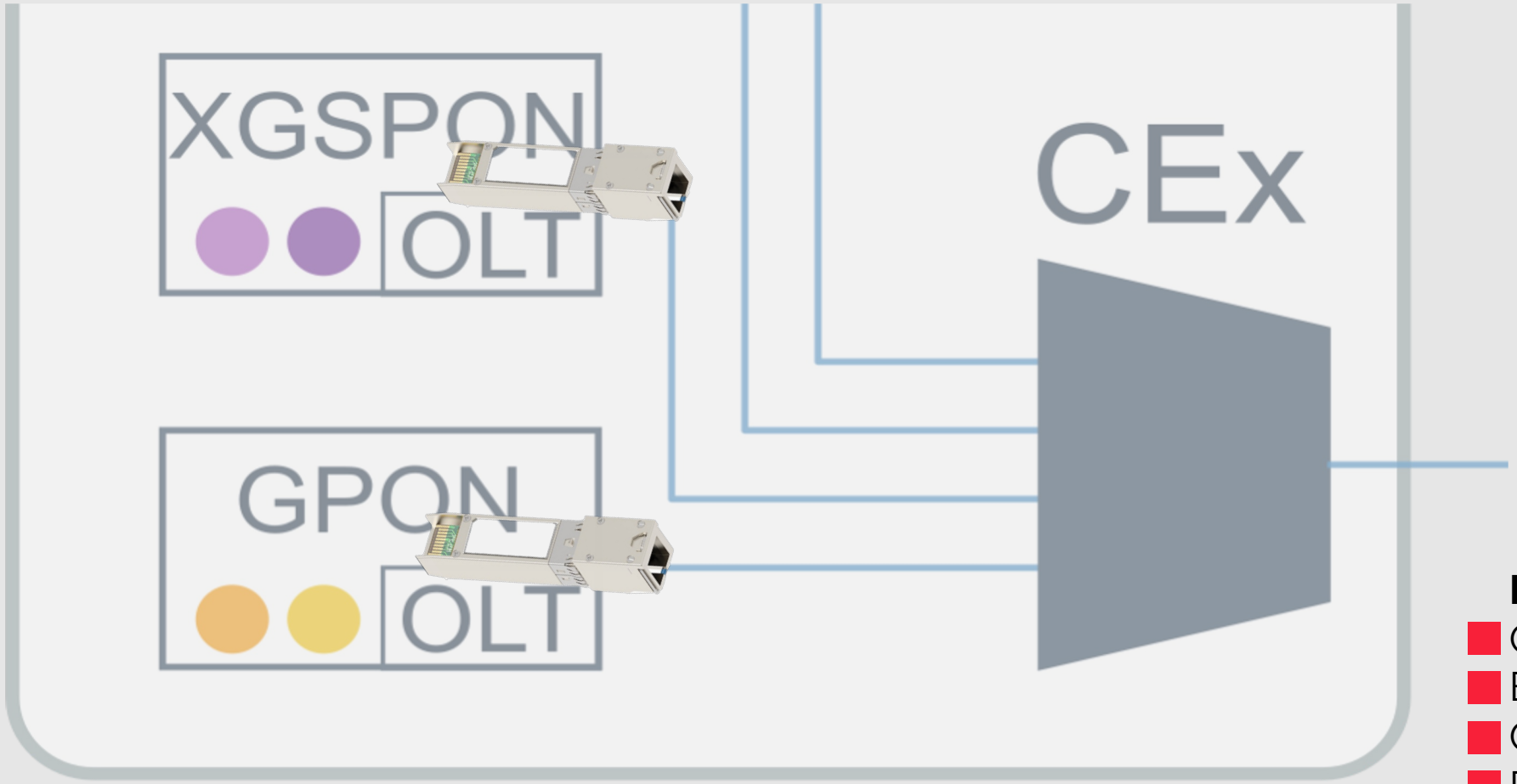
Scenarios of present and next gens – single technology



	CW	High Speed	Fixed	Tunable	Multiband
LD	✓	✓	✓		
Rx		✓			
Filter			✓		
Electronics		✓			
Proc/ Memo					

Requirements:

- Optical technology filter
- Burst mode transmitter
- CW transmitter
- Electronics at the required bandwidth for the technology

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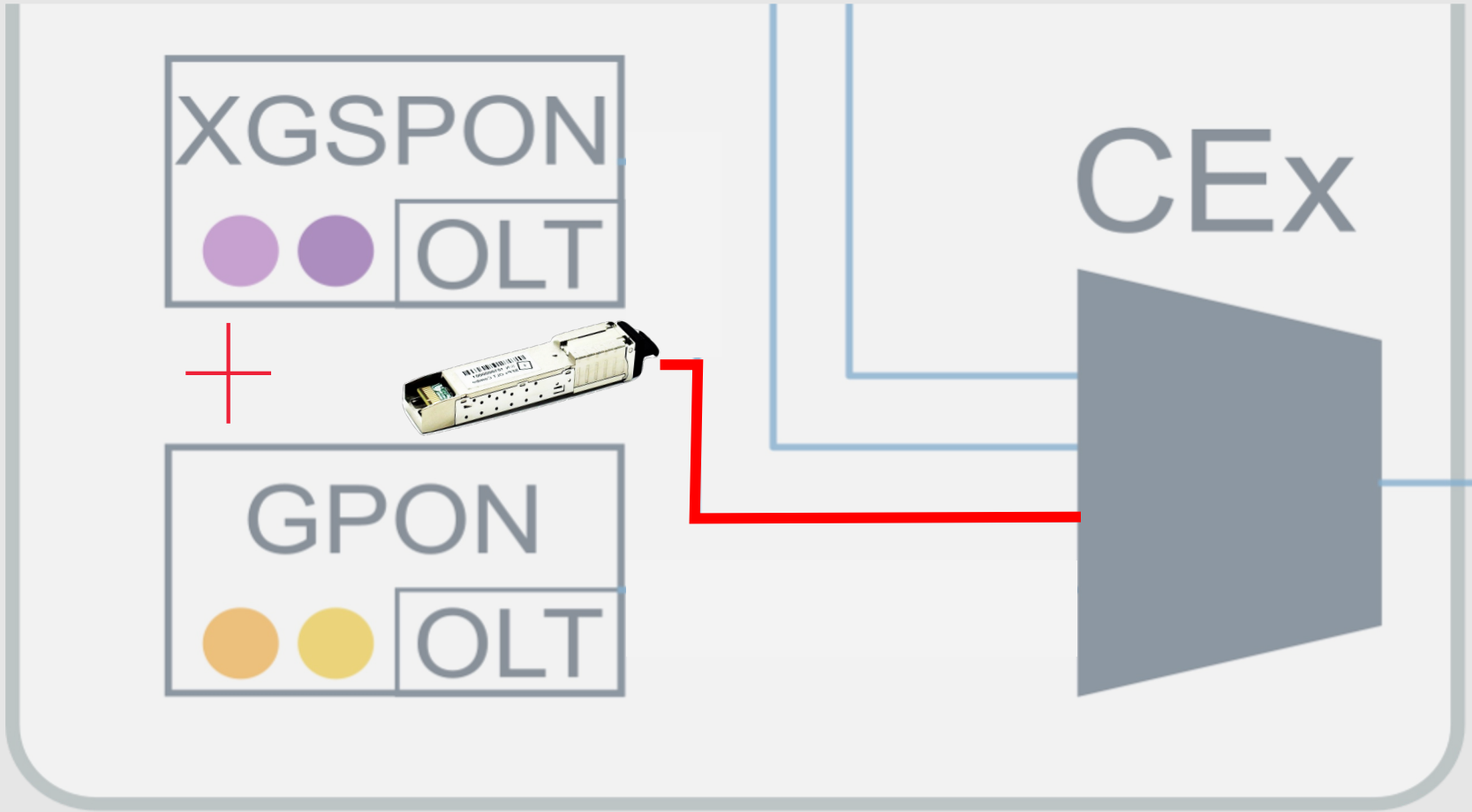
Scenarios of present and next gens – Multi-technology



	CW	High Speed	Fixed	Tunable	Multiband
LD	✓	✓	✓		✓
Rx		✓			
Filter			✓		✓
Electronics		✓			
Proc/ Memo					

Requirements:

- Multi technology optical filter
- Burst mode transmitter
- CW transmitter
- Electronics at the required bandwidth for the technology

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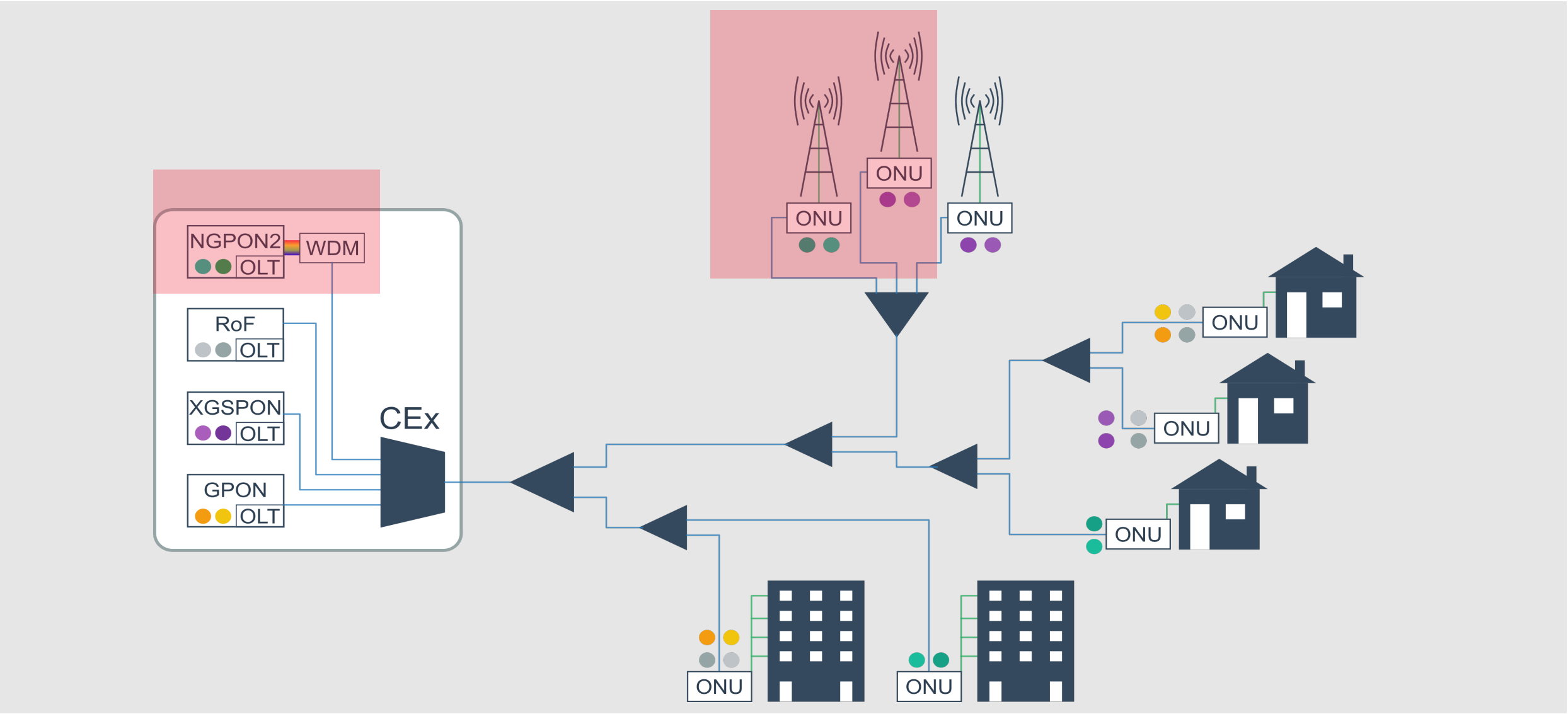
Scenarios of present and next gens



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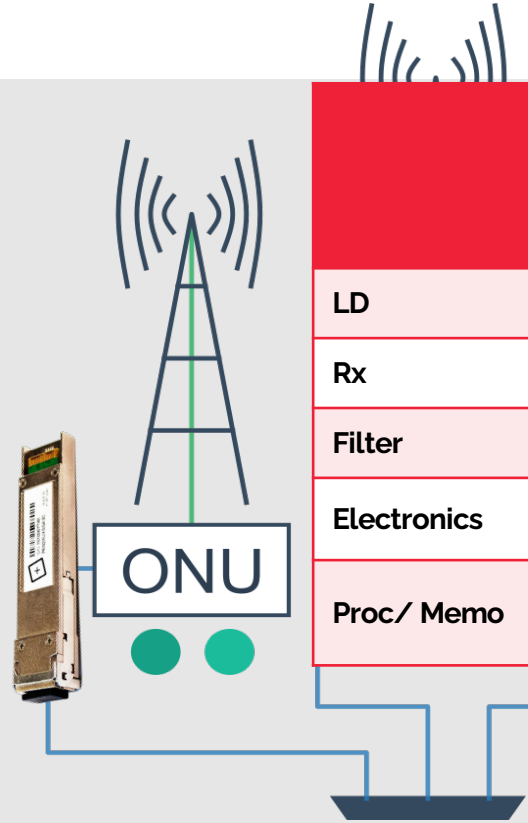
Scenarios of present and next gens

	CW	High Speed	Fixed	Tunable	Multiband
LD	✓	✓	✓		✓
Rx		✓			
Filter			✓		✓
Electronics		✓			
Proc/ Memo					

Requirements:

- Multiple Single wavelength transmitters or Multi-wavelength transmitter, with single or multi-wavelength with burst mode receivers



	CW	High Speed	Fixed	Tunable	Multiband
LD	✓	✓	✓	✓	✓
Rx		✓			
Filter			✓	✓	
Electronics		✓			
Proc/ Memo					

Requirements:

- Tunable optical TX/RX or
- Bonded Multiple channels
- Allowing new PHY functionalities as load balancing and power management.

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Optics/electronics requirements

	CW	High Speed	Fixed	Tunable	Multiband
LD/ mod	✓	✓	✓	✓	✓
Rx		✓			
Filter			✓	✓	✓
Electronics		✓			
Proc/ Memo		✓			

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Direct implications of complexity and rate?

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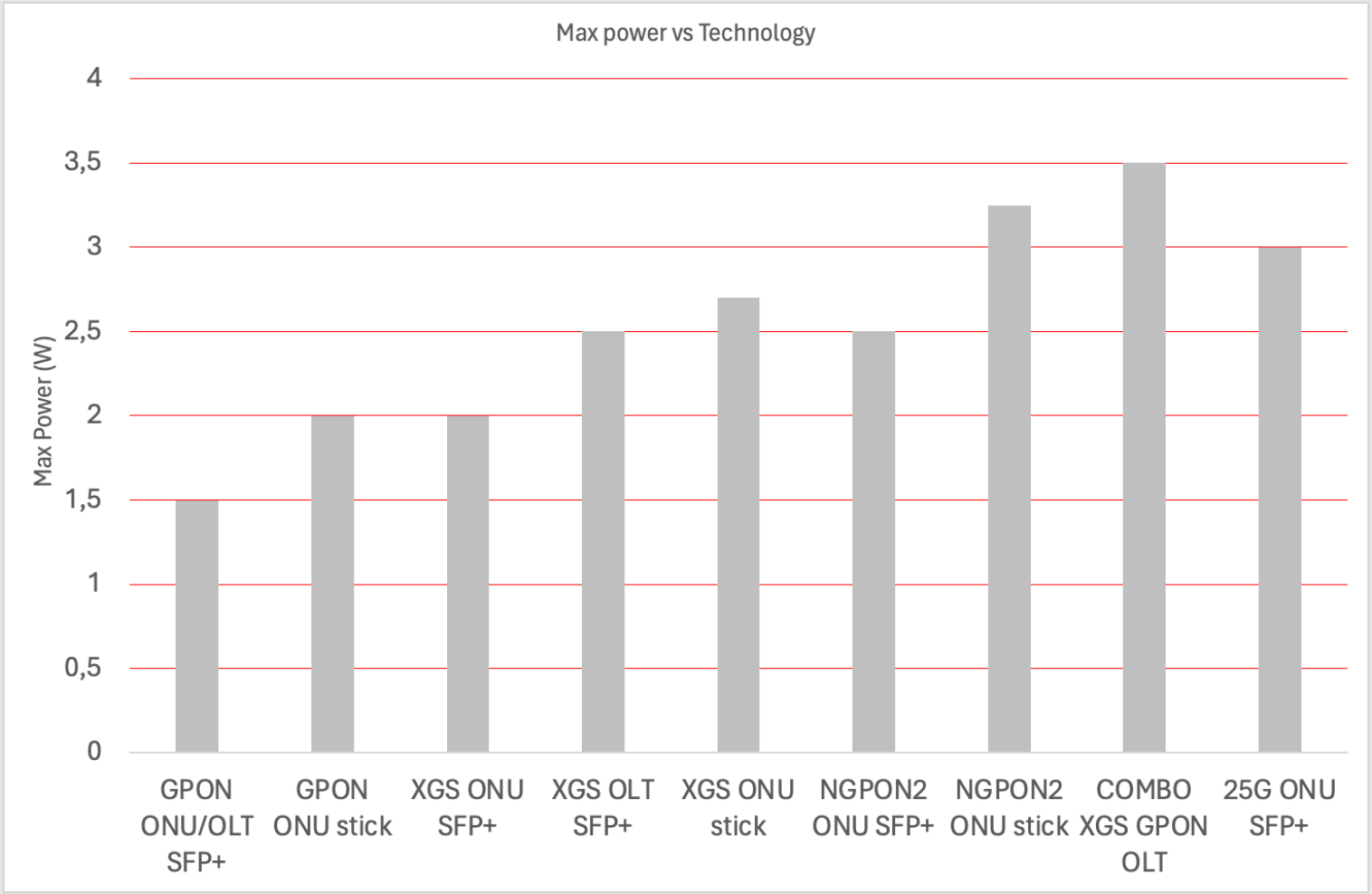
Impacts of data rate and complexity



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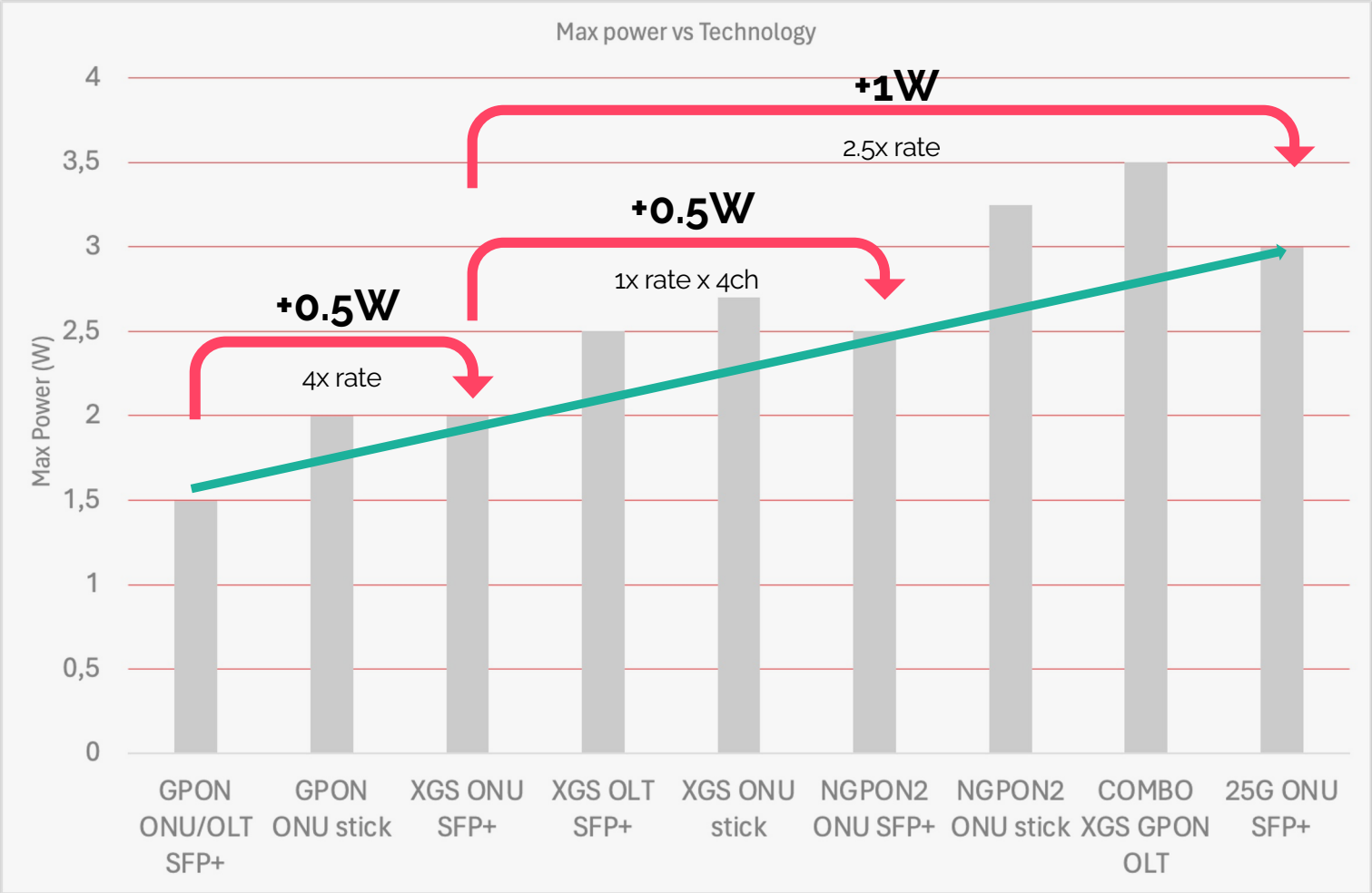
Impacts of data rate and complexity



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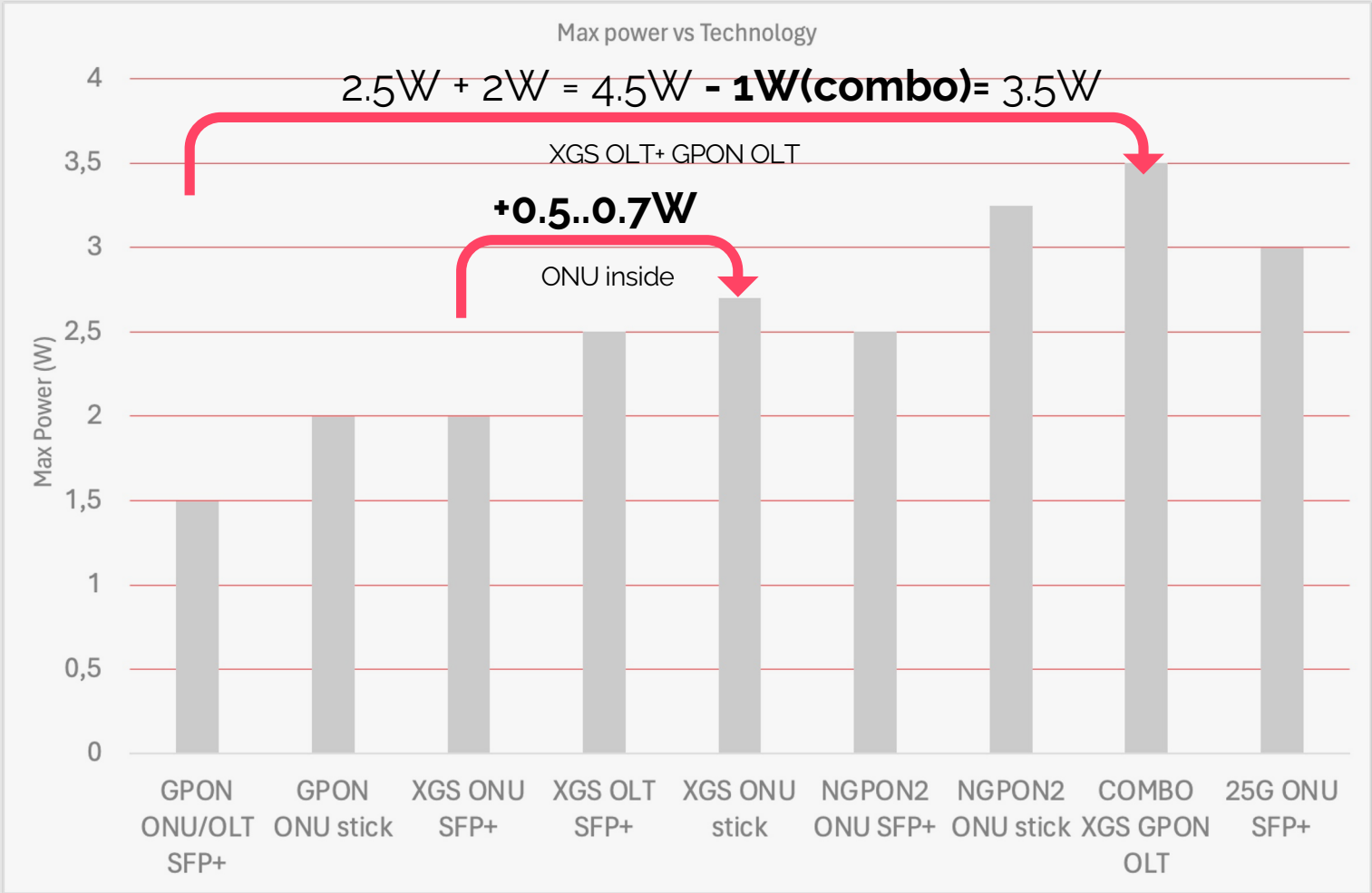
Impacts of data rate and complexity



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Pricing in PON?

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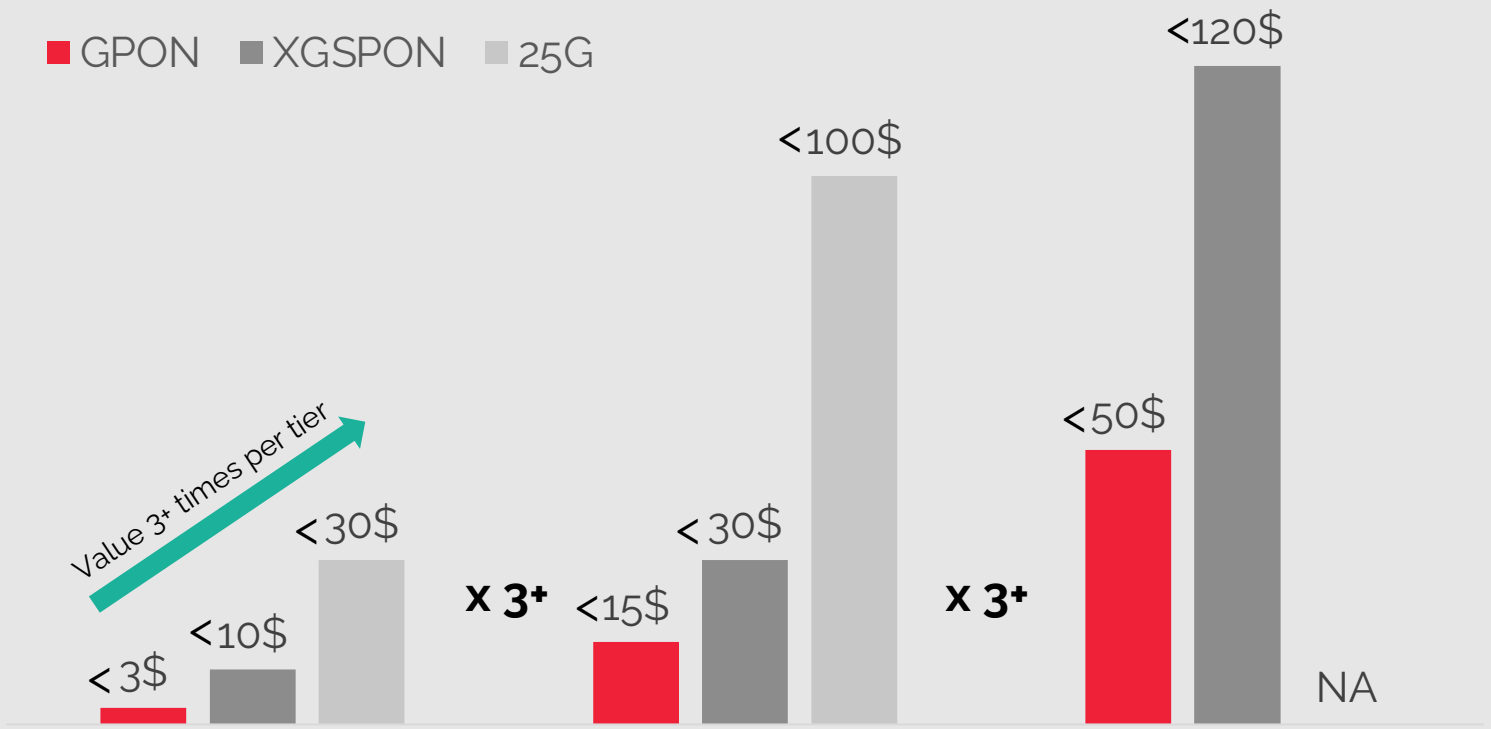
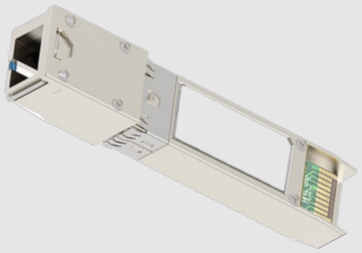
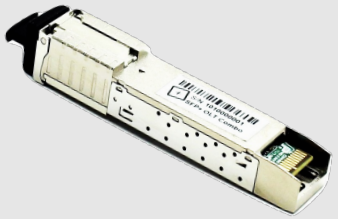
Pricing in PON



technology	OLT
GPON+XGSPON	<200$

SFP+ Combo





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is there an opportunity for PICs in these PON scenarios?

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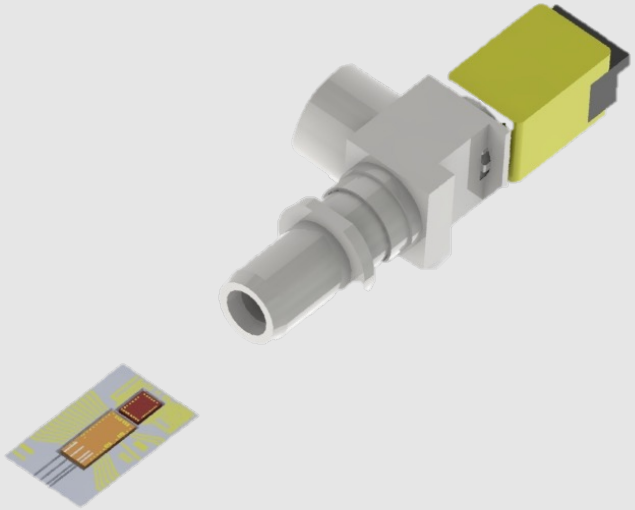
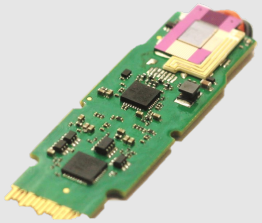
Do PICs compare to typical BOSA?



- >5 x less volumetric
- Single cooling[1]
- Few step packaging
- Higher component count
- lower O-E-O count, …
- High speed, smaller electric paths, …

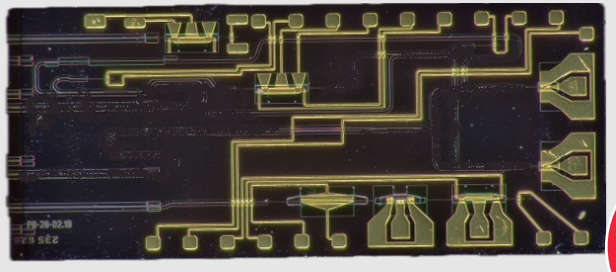


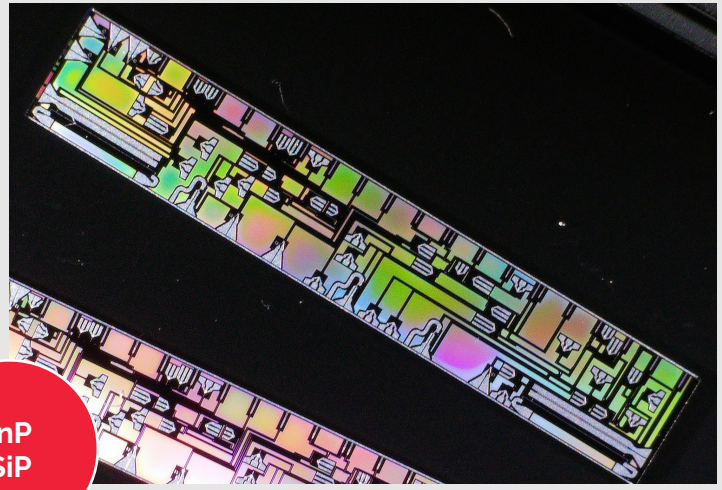
- **Mass production enabled**
- **Cost advantage**
- **Towards 25/50G seamless transition**

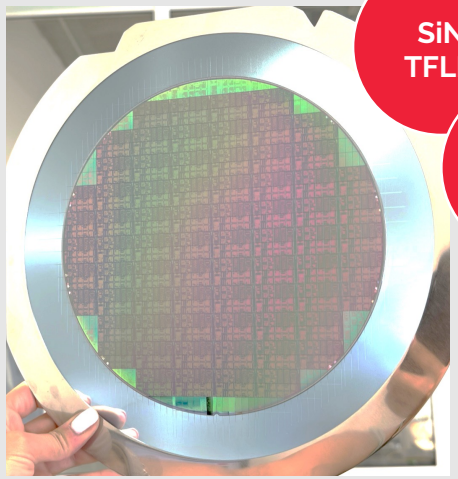
Confinanciado por:

Do PICs fulfill the requirements?

	CW	High Speed	Fixed	Tunable	Multiband
LD/ mod	✓	✓	✓	✓	✓
Rx		✓			
Filter			✓	✓	✓
Electronics		✓			
Proc/ Memo		✓			





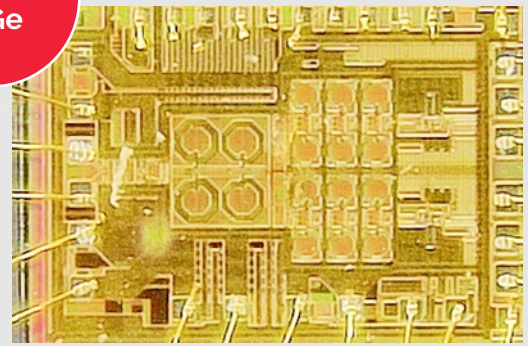


InP SiP

SiN TFLN

CMOS SiGe

others



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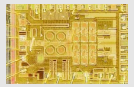
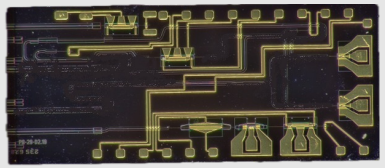
How PICs comply with increased functionalities?

HS Electronics



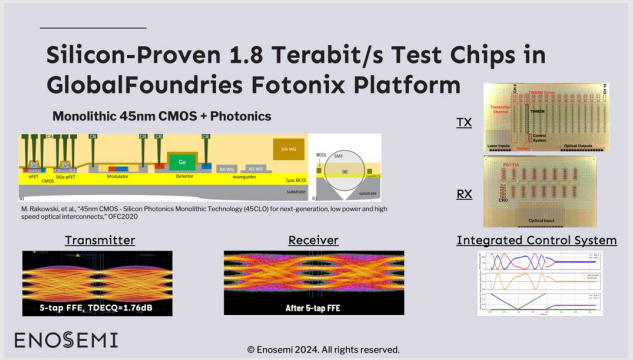


HS photonics

combine

hybridize

Hybrid (optics + electronics)



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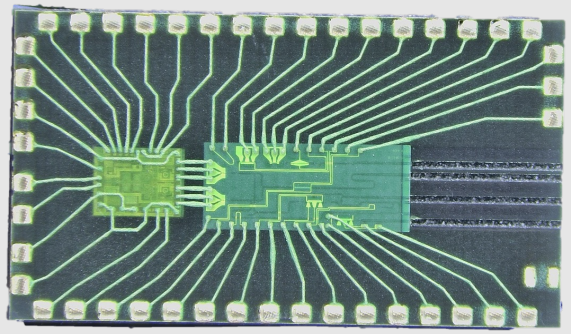

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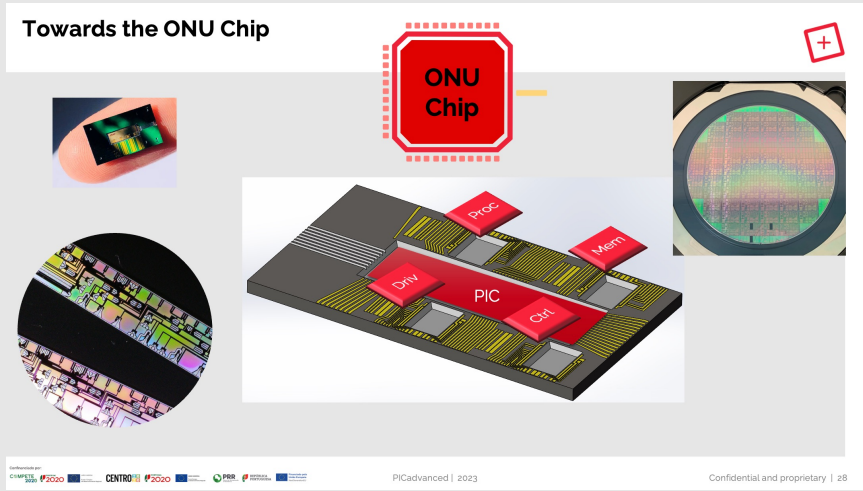
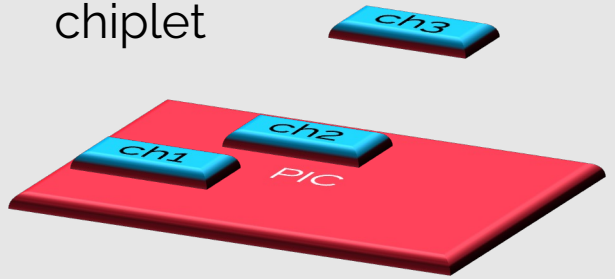


OR

chiplet



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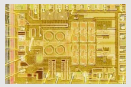
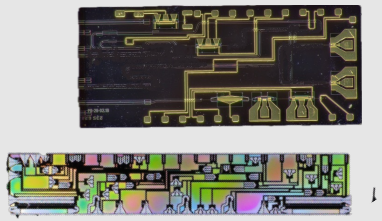
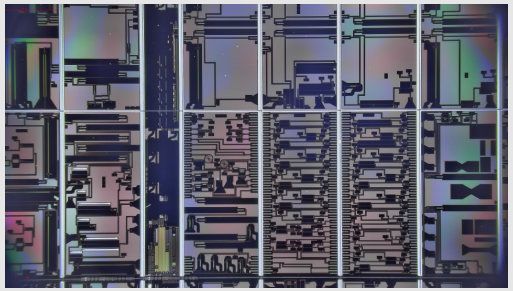
How is PICadvanced approaching the challenge?

CORE

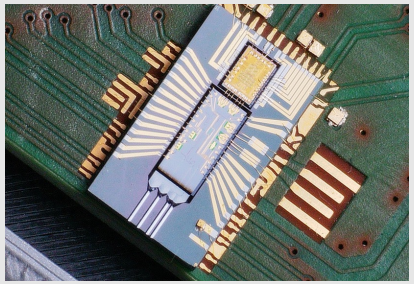
PIC and ASIC co-design



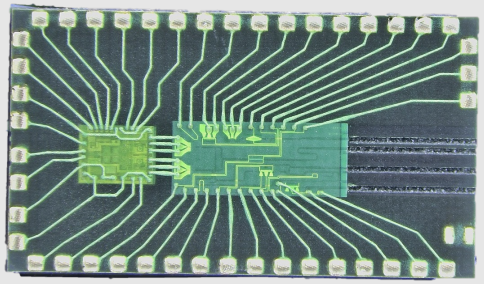




Advanced packaging platforms



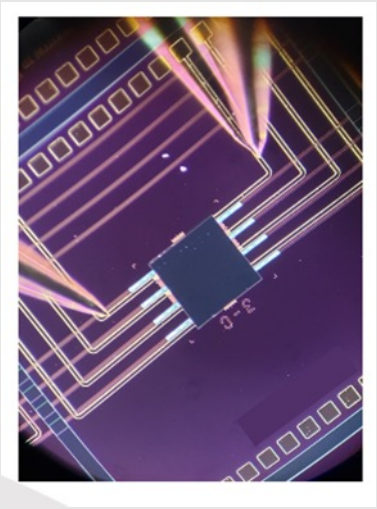
Flexible



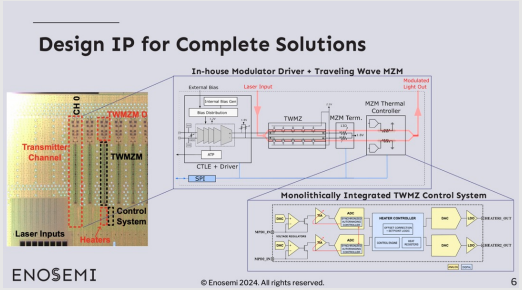
Wire bond free
+ Vias

On the way

Chip to chip bonding



Electronics and photonics in a Chip



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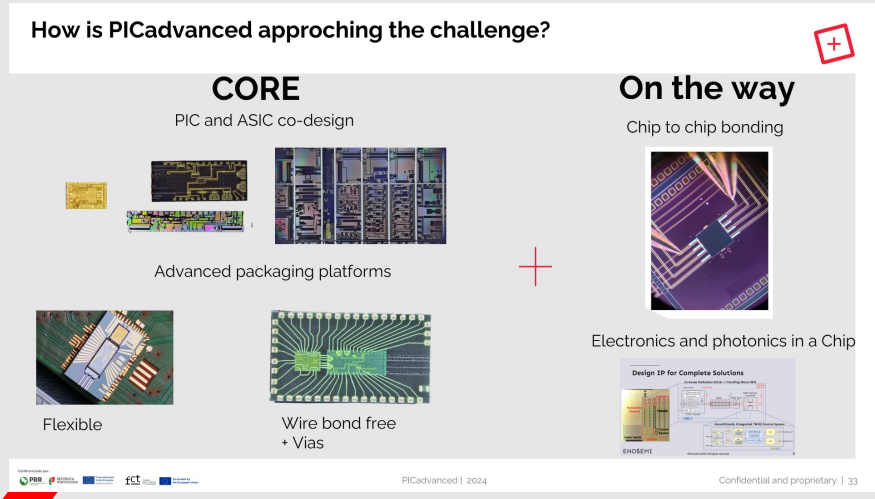
How is PICadvanced approching the challenge?



In-force standards

GPON,
XGSPON
NGPON2
Combo

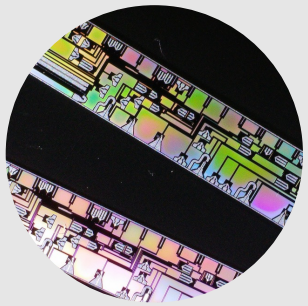
Innovative solutions

Coherent
Quasi-coherent

High speed next gens
(50G, 100G, 200G and beyond)

Co-design of high speed electronics blended with photonics
Chip to chip bonding for optimization of technologies and materials

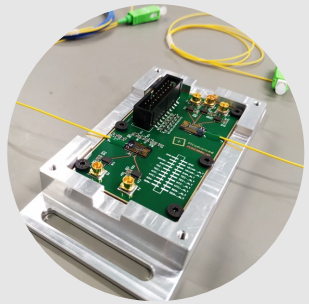
PICadvanced Full flow: design -> productization turn-key solutions



Photonic Integrated Circuits

Simulation and design capabilities for different platforms

High sensitivity provided by quasi-coherent receiver



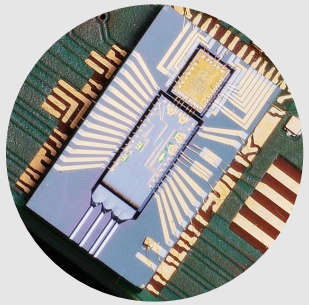
Electronics, SW and FW

Design and layout of customized electronic PCBs

Customized Software, Firmware & control algorithms

Digital Signal Processing (DSP) for real-time applications

Production Line automation



PIC Packaging

Precision epoxy die bonding and Au wirebonding

Automated fiber alignment (<1 dB coupling losses)

Si Host design including up to 8 optical I/O & up to 60 DC and 8 RF tracks (>30GHz)

Thermal management control with high linearity Au sensors and TEC sub mount

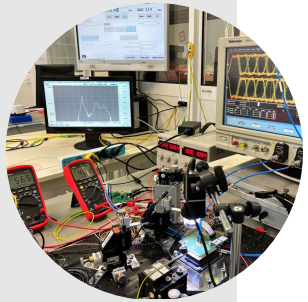
Standard and customized housing

PIC testing and characterization

High frequency optical modulators and receivers

From diode to system automated test capabilities

In-house fast prototyping CNC PCB fabrication and 3D printing



Productization and production management

From designs and prototypes to automated production lines

Testing and certification for telecom

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“

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