



**NUI TEC**  
CONSULTORIA EM TELECOMUNICAÇÕES

# 400G ZR - O Santo Graal da comunicação óptica

**IX Fórum 13**

**11 de Dezembro 2019**

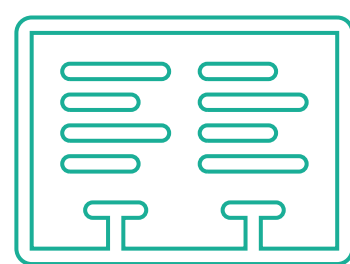
**Tiago C. Setti**

- Consultor NuiTec
- Membro BPF

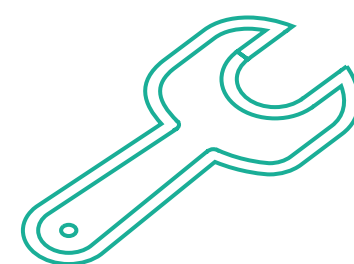
# Sobre Nós

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*A NuiTec fornece serviços e consultoria altamente especializada para ajudar a resolver necessidades de rede e infraestrutura desafiadoras.*



Consultoria



Serviços Profissionais



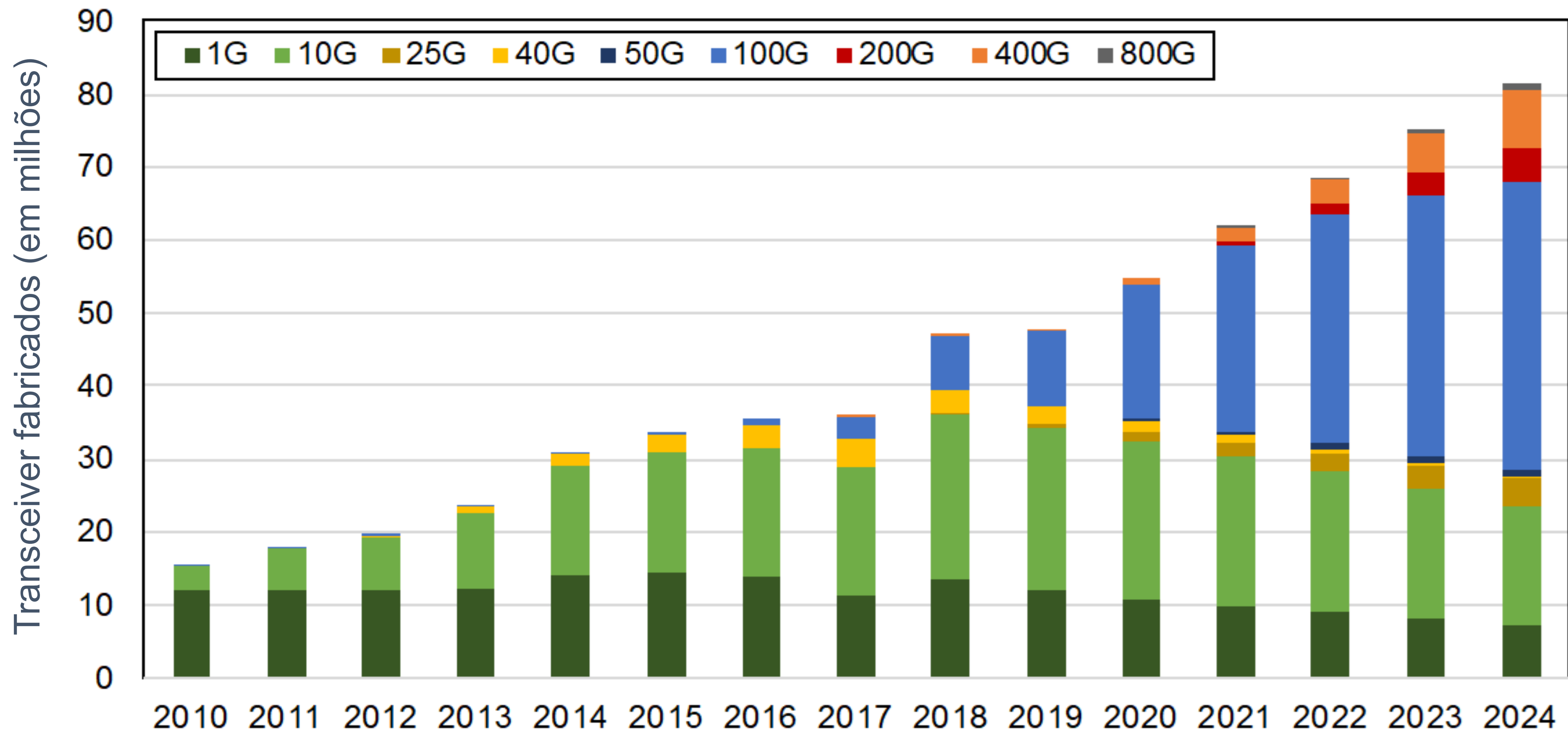
Treinamentos

A photograph featuring a silver chalice and a loaf of bread. The chalice is on the right, with a faceted stem and a wide, flared base. The bread is on the left, partially obscured by a dark blue semi-transparent rectangle. The background is a soft, out-of-focus light brown.

O Santo Graal

# Transição para novas

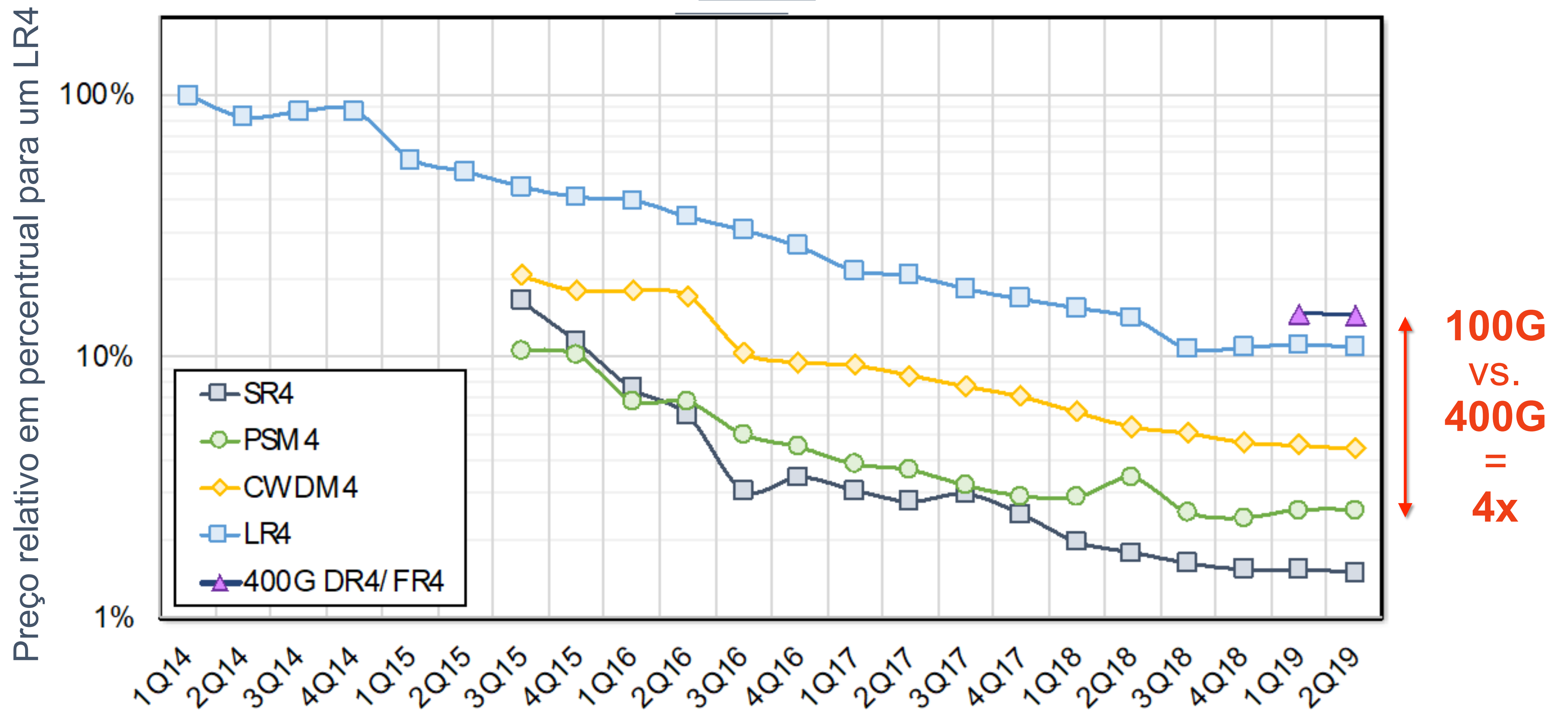
Adoção pelo mercado  
velocidades



Fonte: Lightcounting, Mar/2019 High Speed Ethernet Optics Report

# 400G ainda é algo novo

Mercado em fase de "descoberta"



Fonte: Lightcounting, Mar/2019 High Speed Ethernet Optics Report

# Formato Físico

Opções Atuais para 400G



CFP8

24W

OSFP

20W

QSFP-DD

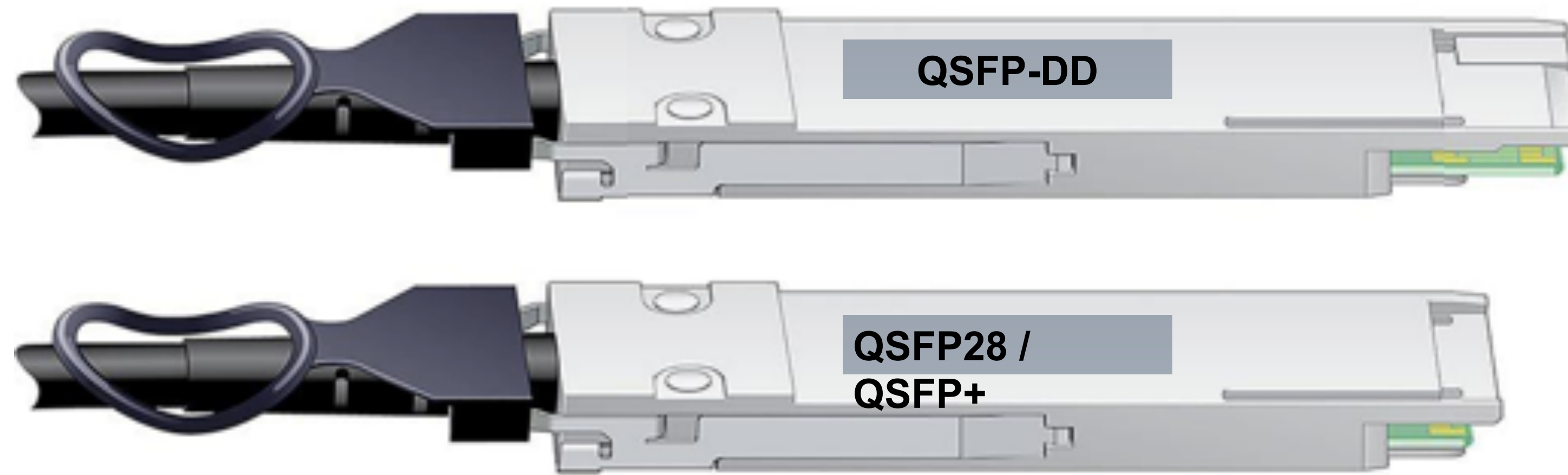
15-18W

QSFP28

5W

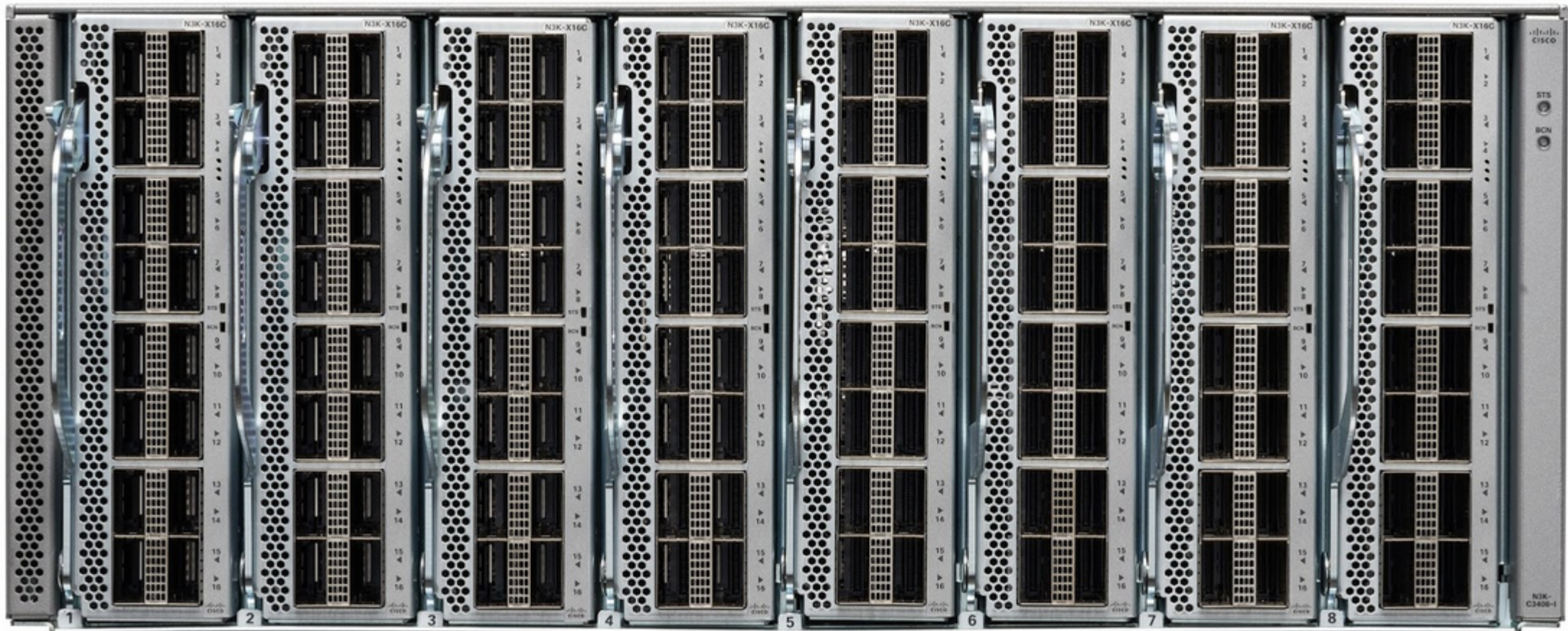
# QSFP-DD vs QSFP28

Evolução



# Equipamentos 400G

Roteadores e Switches





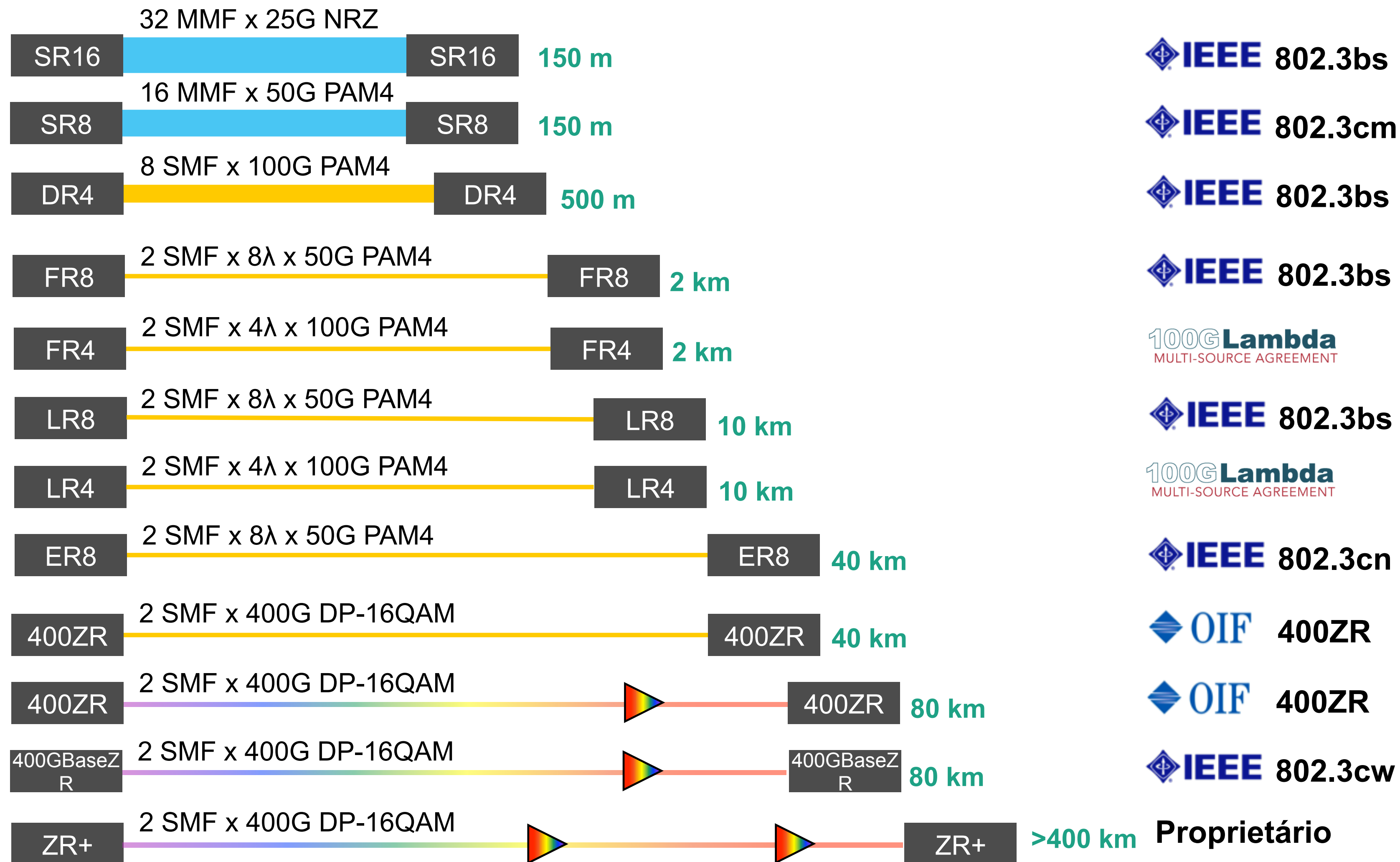


**400G**

**Padronização**

# Padronização 400G

Diversos padrões IEEE/OIF/Proprietários





# 400G DWDM

# Coerente vs Detecção

Transporte de 400GBASE Ethernet

## Direta

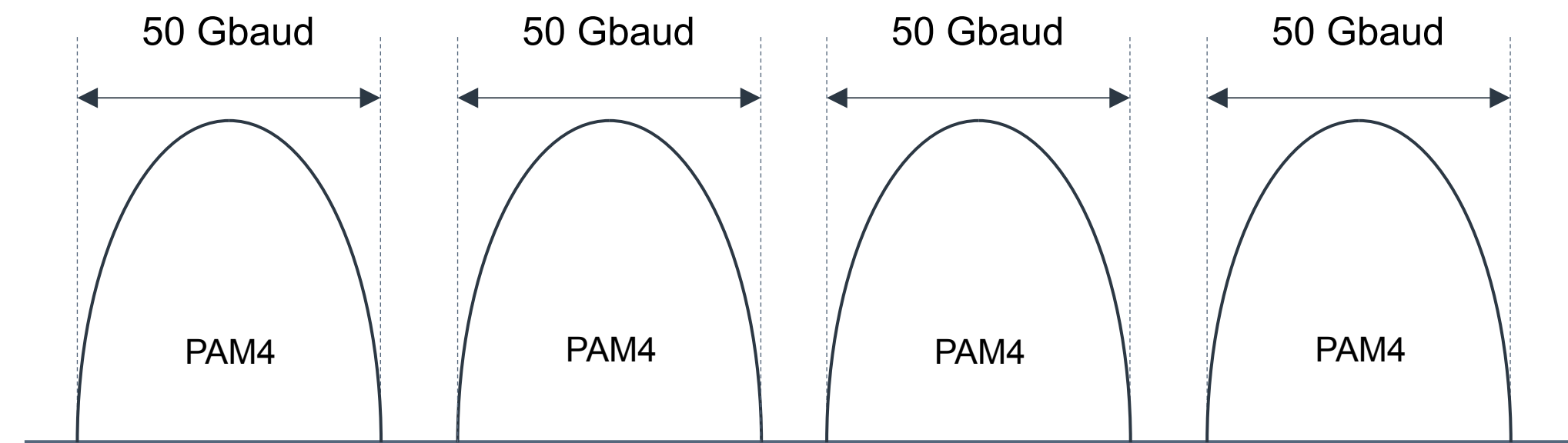
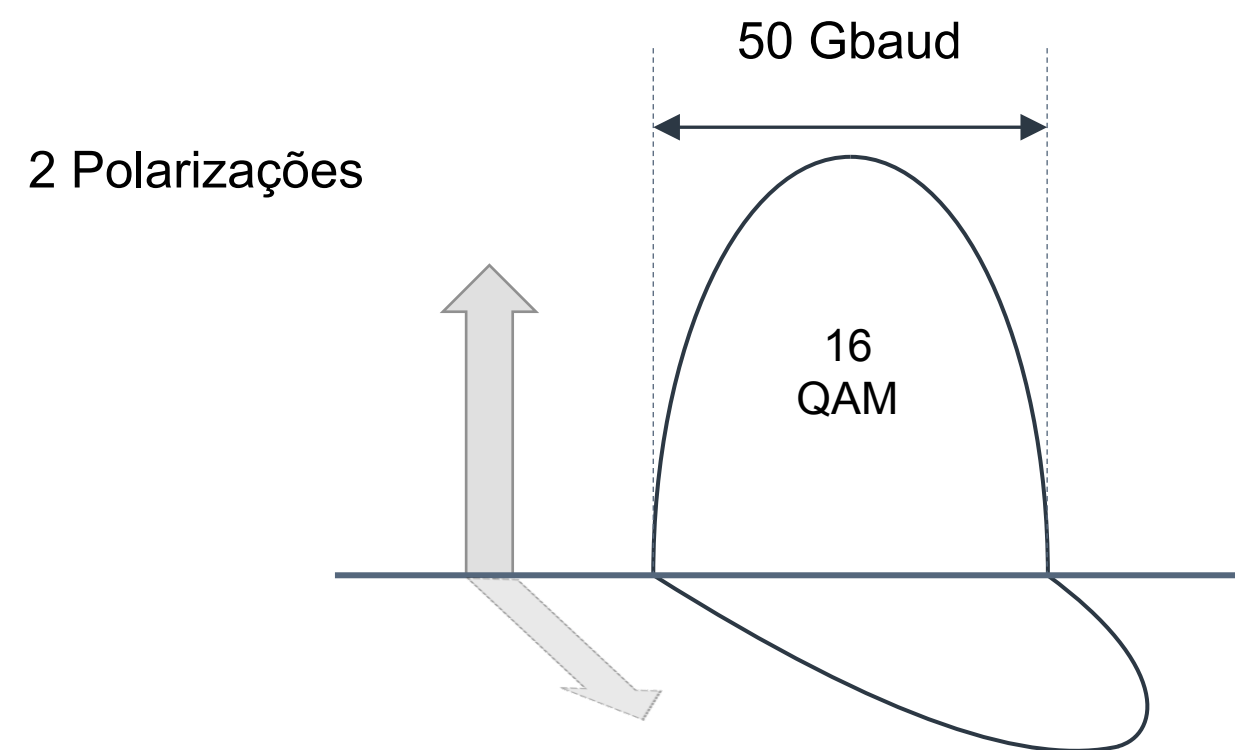
### DWDM Coerente

400G DP-16QAM (Único Laser)

### Detecção Direta

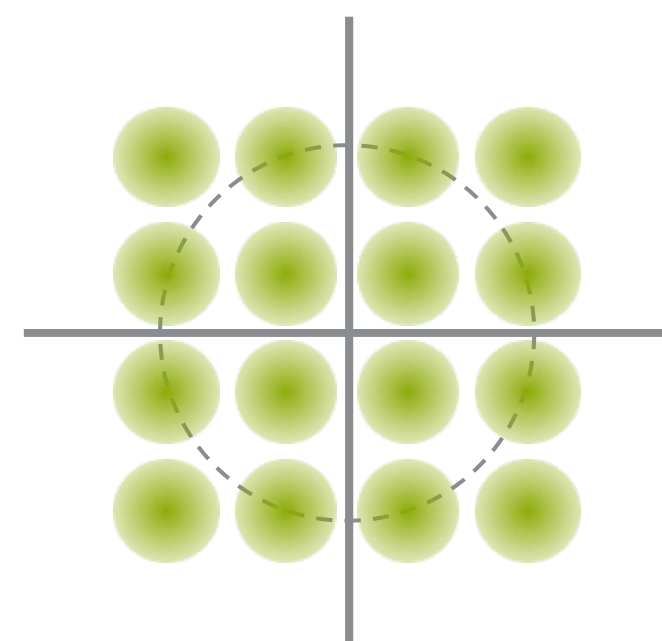
400G FR4 (4 Lasers)

Espectro Óptico

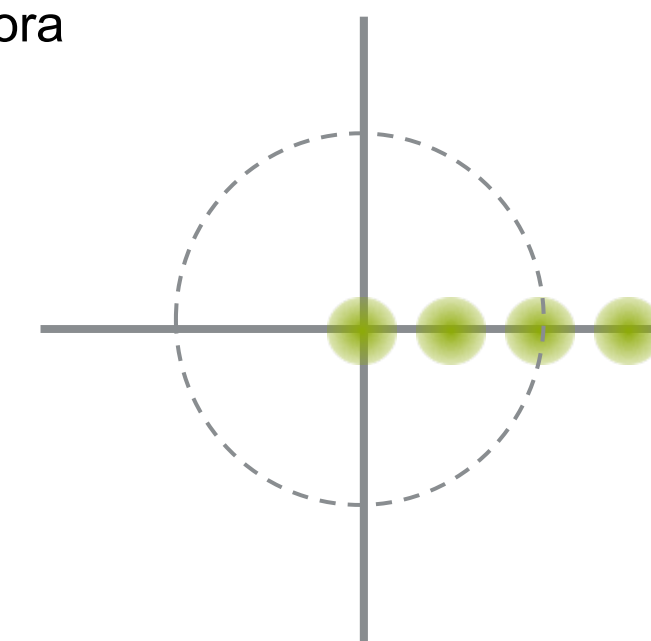


Modulação

4 bit/símbolo/polarização



2 bit/símbolo/portadora

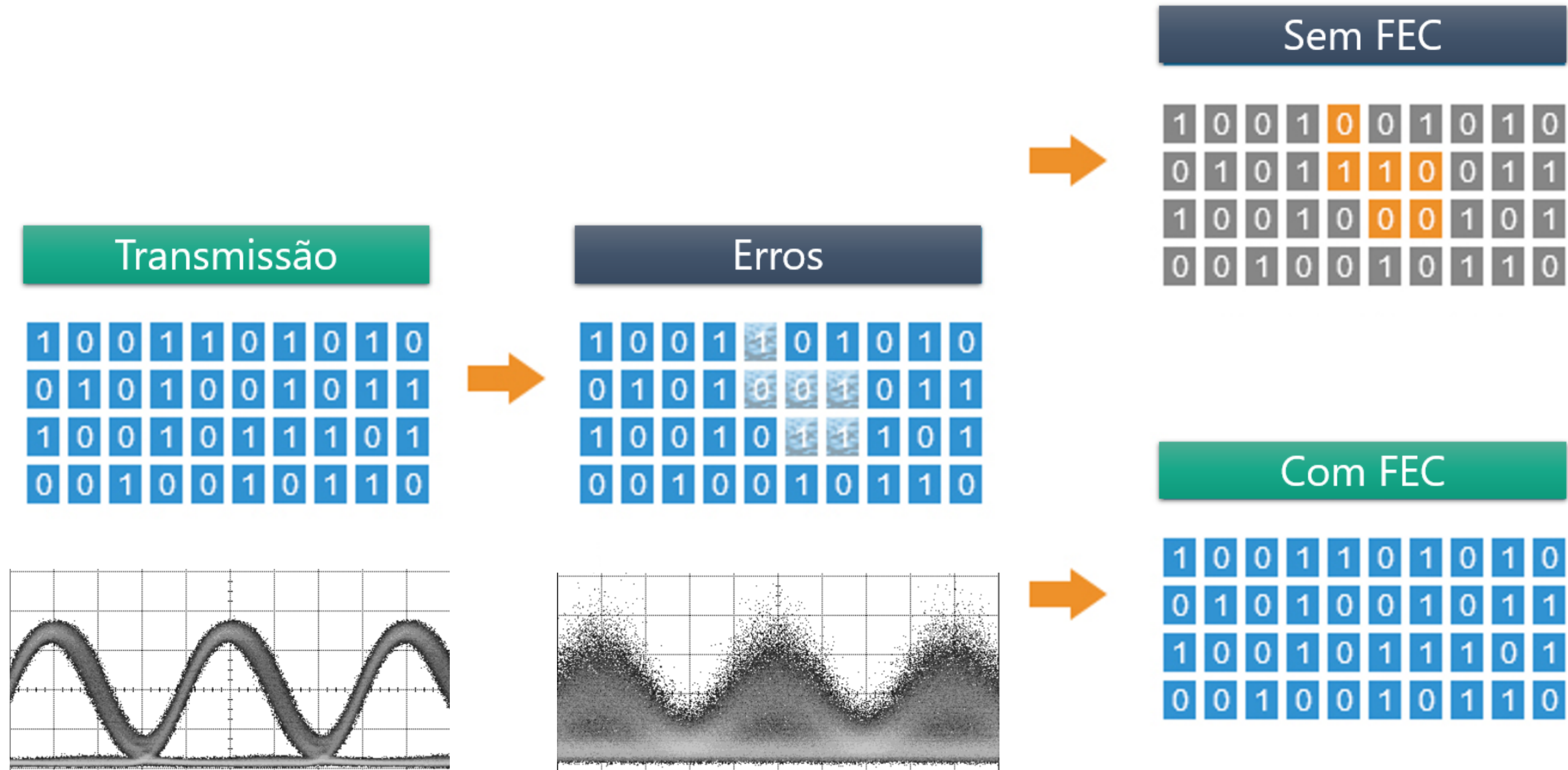


$$50 \text{ Gbaud} * 2 \text{ pol} * 4 \text{ bit/símbolo} = 400 \text{ Gb/s}$$

$$50 \text{ Gbaud} * 4 \text{ portadoras} * 2 \text{ bit/símbolo} = 400 \text{ Gb/s}$$

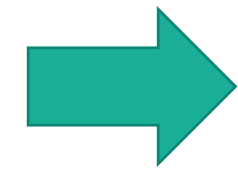
# Forward Error Correction

Correção de Erros Posterior

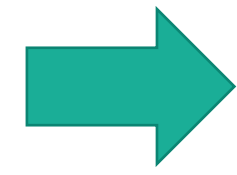


# Evolução

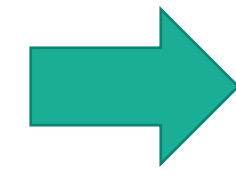
Módulos e Transponders para 400G



CHASSI



DCI



CFP2  
DCO



QSFP-DD  
DCO

# Principal Desafio

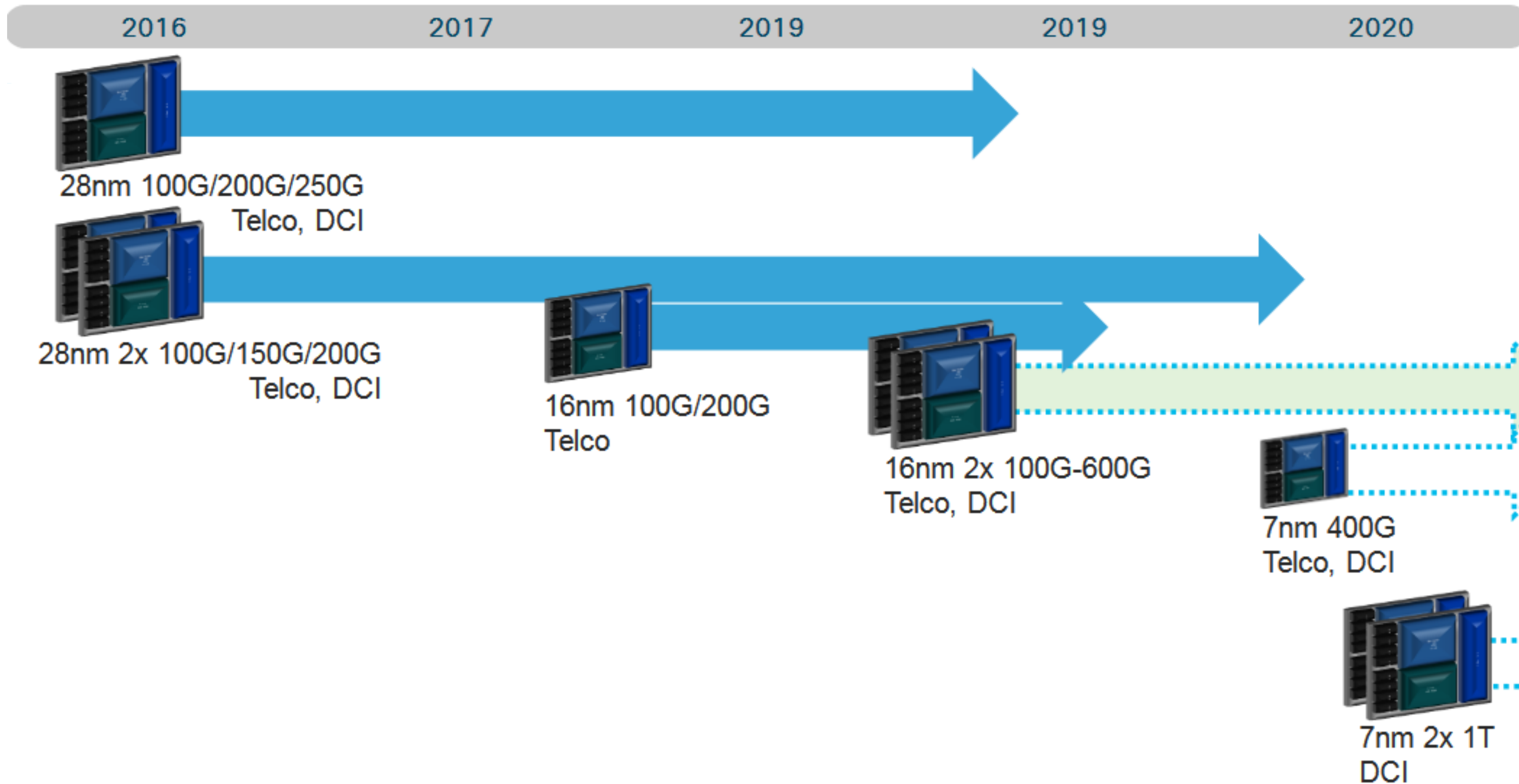
Consumo e Dissipação

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# DSP

Tecnologia 7nm





# DSP

Tecnologia 7nm



- Primeiro DSP 7nm do mercado
- 100/200/300/400Gbps
- Disponível. Produção em escala a partir de 2H/2020



- DSP 7nm em desenvolvimento
- Integração com Silicon Photonics
- Em fusão com a Cisco



- DSP 7nm anunciado
- Disponível a partir de 2020

A night sky with a bright orange arc and a dark grey diagonal overlay. The arc starts from the bottom right and curves towards the top left. The background is a gradient of dark blue and purple. A dark grey diagonal shape covers the bottom right portion of the image.

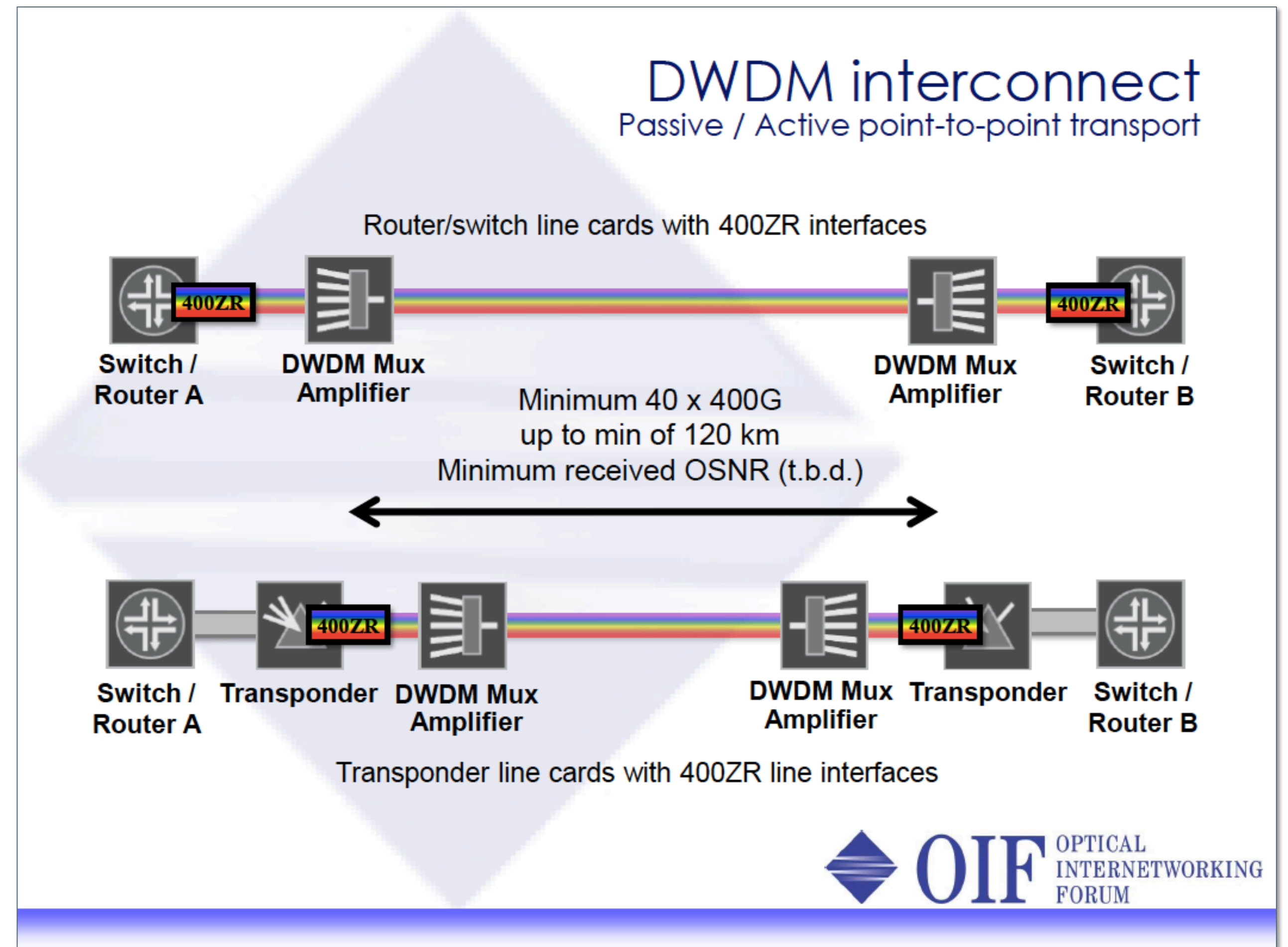
**400ZR**

# OIF 400ZR

400G Coerente DWDM até 80km

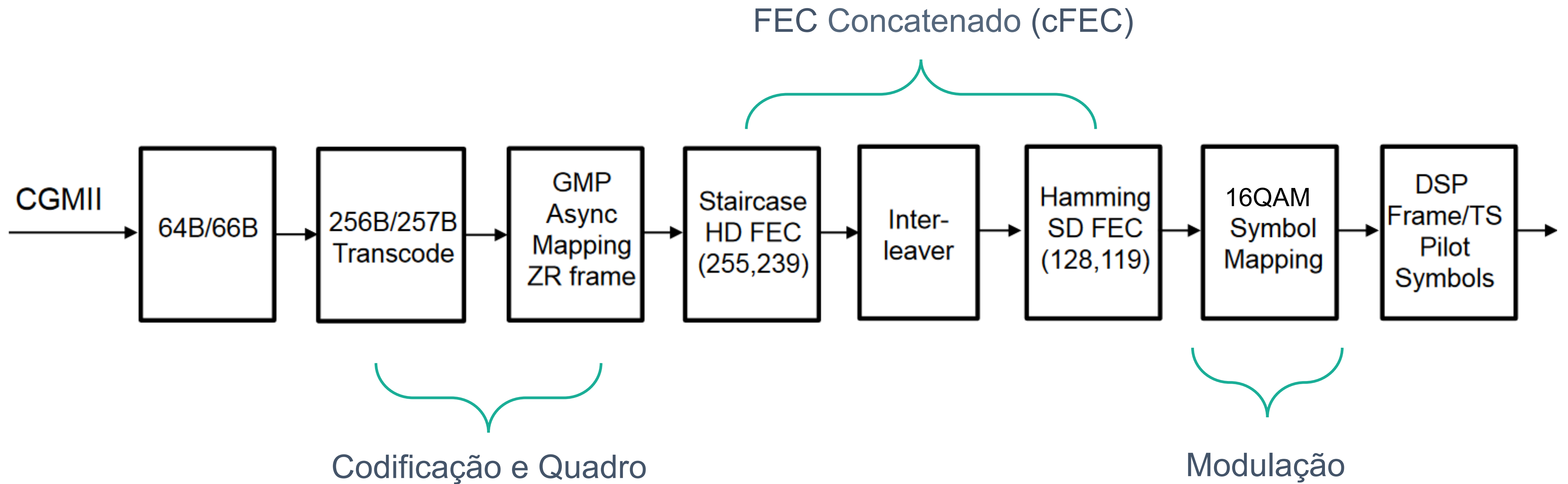
## Padrão OIF 400ZR

- Padrão proposto por Microsoft, Google, Acacia e Juniper.
- Projeto padroniza na indústria os principais atributos:
  - FEC (cFEC)
  - Modulação (DP-16QAM)
  - Quadro (257B/GMP)
- Até 40 km sem amplificação
- Até 120 km com amplificação
- No máximo 64 canais por fibra (75Ghz)
- Formato físico de modulo DCO < 15W.



# Quadro OIF 400ZR

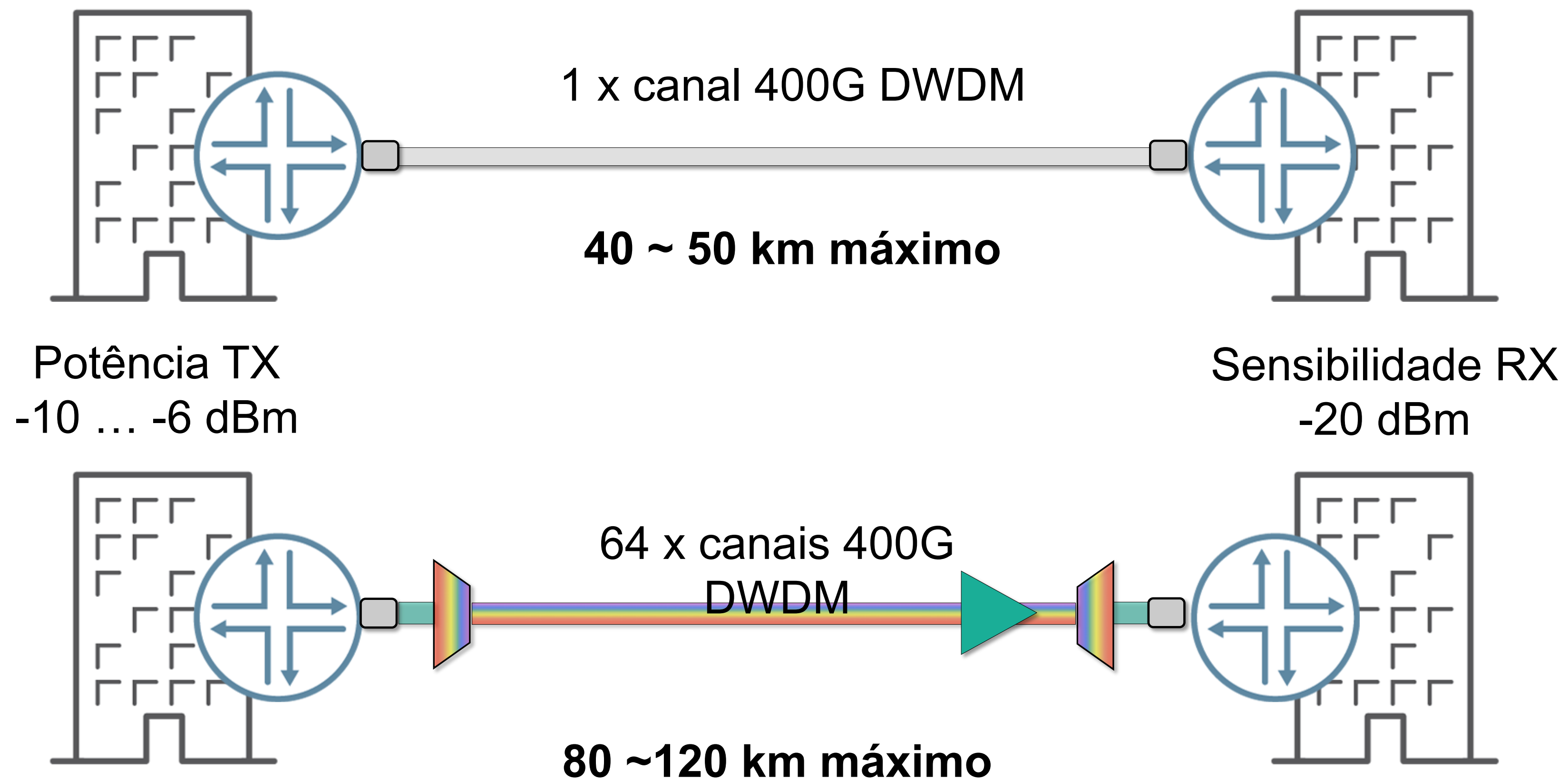
Formato adotado com ~15% de Overhead



Incompatível com OTN

# 400ZR

Exemplos de uso

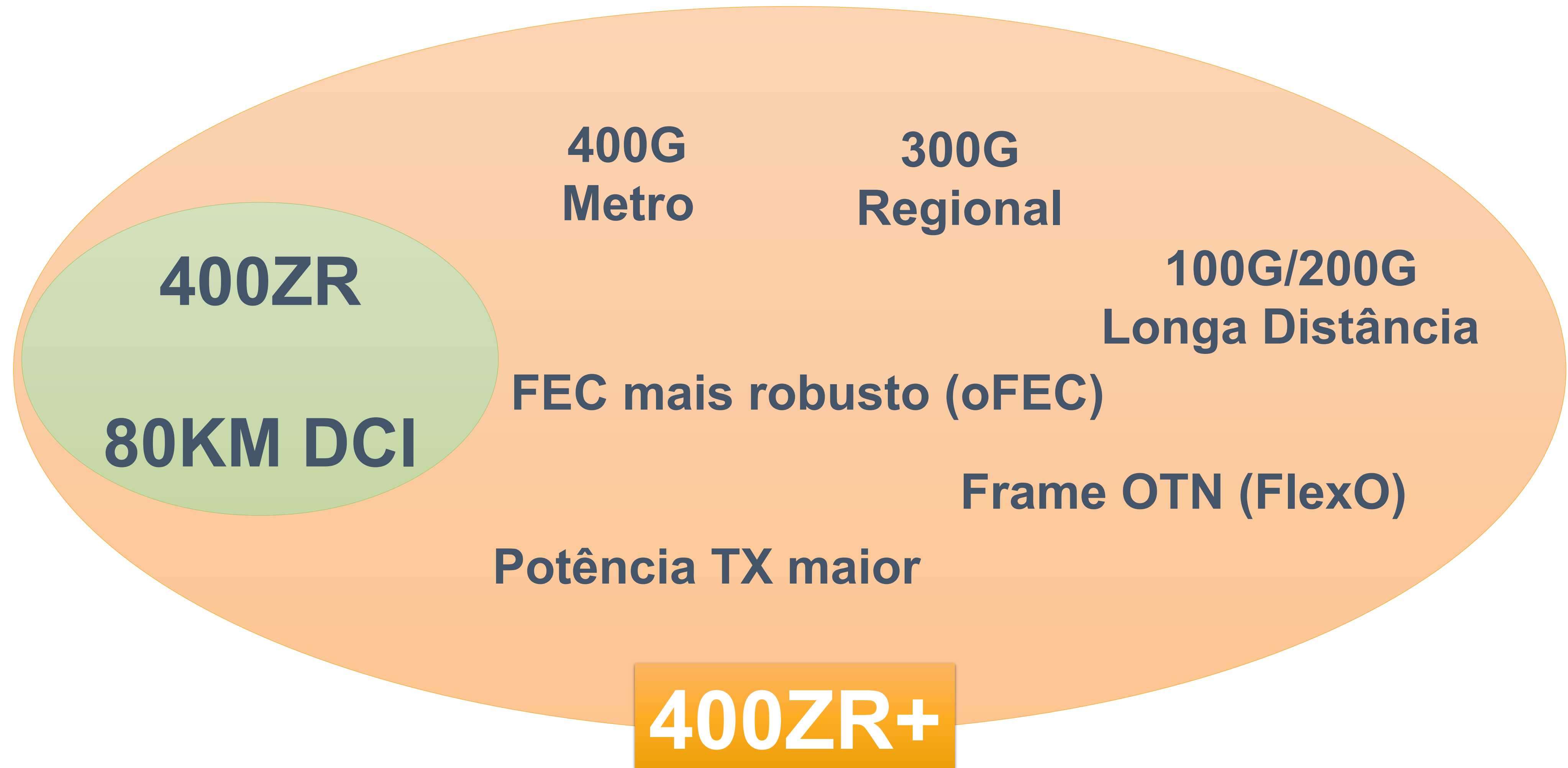


The background is split diagonally from the bottom-left to the top-right. The upper-left portion is black with several large, semi-transparent teal circles of varying sizes, creating a bokeh effect. The lower-right portion is a solid, muted blue-grey color. In the center of this lower-right section, the text "400ZR+ e outros" is written in a clean, white, sans-serif font. The overall aesthetic is modern and tech-oriented.

**400ZR+ e outros**

# 400ZR+

Padrão proprietário para ampliação do uso



# 400ZR+

## Comparativo de modos de funcionamento

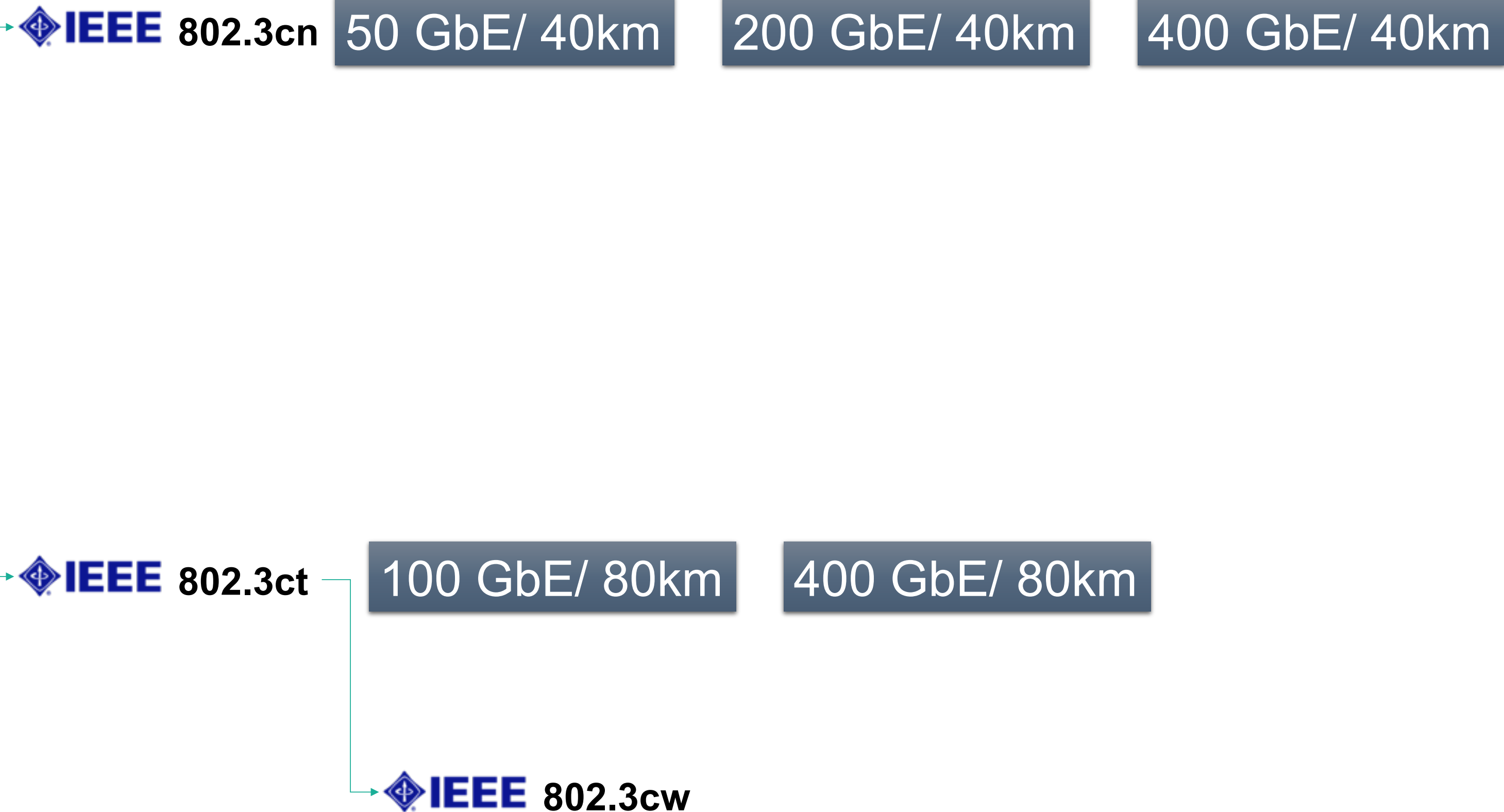
Taxa (Gb/s)	Modulação	Aplicação/Padrão	Baud Rate (Gbaud/s)	FEC	Distância máxima (km)	OSNR mínimo (dB)	Consumo Energia (W)
400	DP-16QAM	OIF 400ZR	60	C-FEC	120	23	$\leq 15$
400	DP-16QAM	Metro	62	O-FEC	500	21.5	$\leq 18$
300	DP-8QAM	Regional	62	O-FEC	1000	18	$\leq 17$
200	DP-QPSK	Longa Distância	62	O-FEC	$>2000$	14	$\leq 16$
200	DP-8QAM	Regional	42	SD-FEC	1500	16.5	$\leq 15$
200	DP-16QAM	Metro	31	SD-FEC	1000	18.5	$\leq 14$
100	DP-QPSK	Submarino	31	SD-FEC	$>7000$	11	$\leq 13$
100	DP-QPSK	Longa Distância	28	HG-FEC	$>2000$	13.5	$\leq 12$



# IEEE

Iniciativas para padronizar ER 40km / ZR 80km

50 Gb/s, 100 Gb/s,  
200 Gb/s, and 400  
Gb/s over Single-  
Mode Fiber and  
DWDM



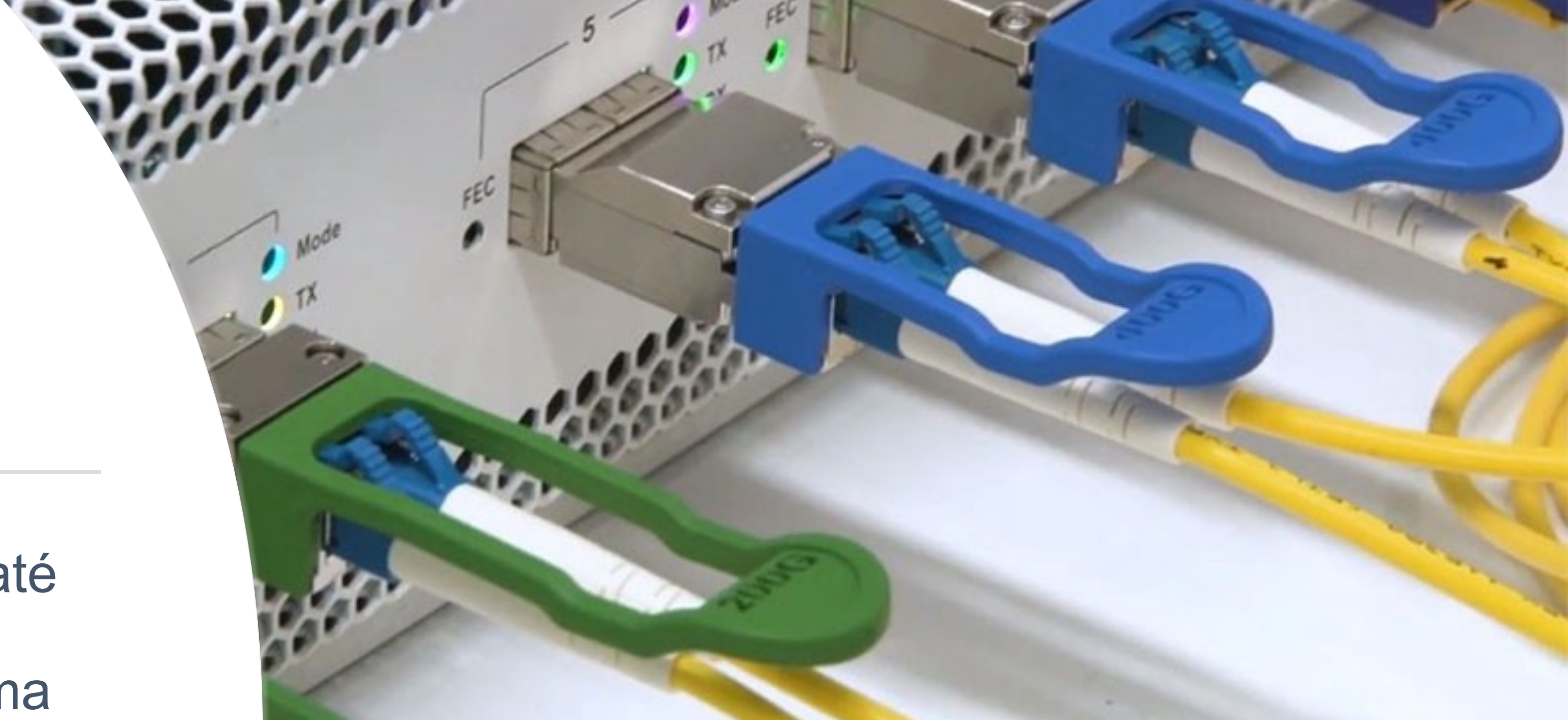
# Beneficios



# Densidade

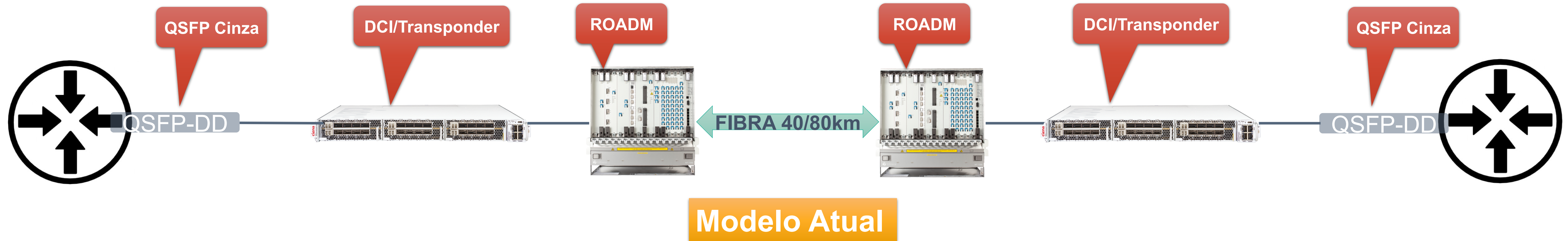
As portas QSFP-DD com potência de até 18 W permitirão a combinação de interfaces de cliente e DWDM na mesma placa de linha ou no mesmo RU

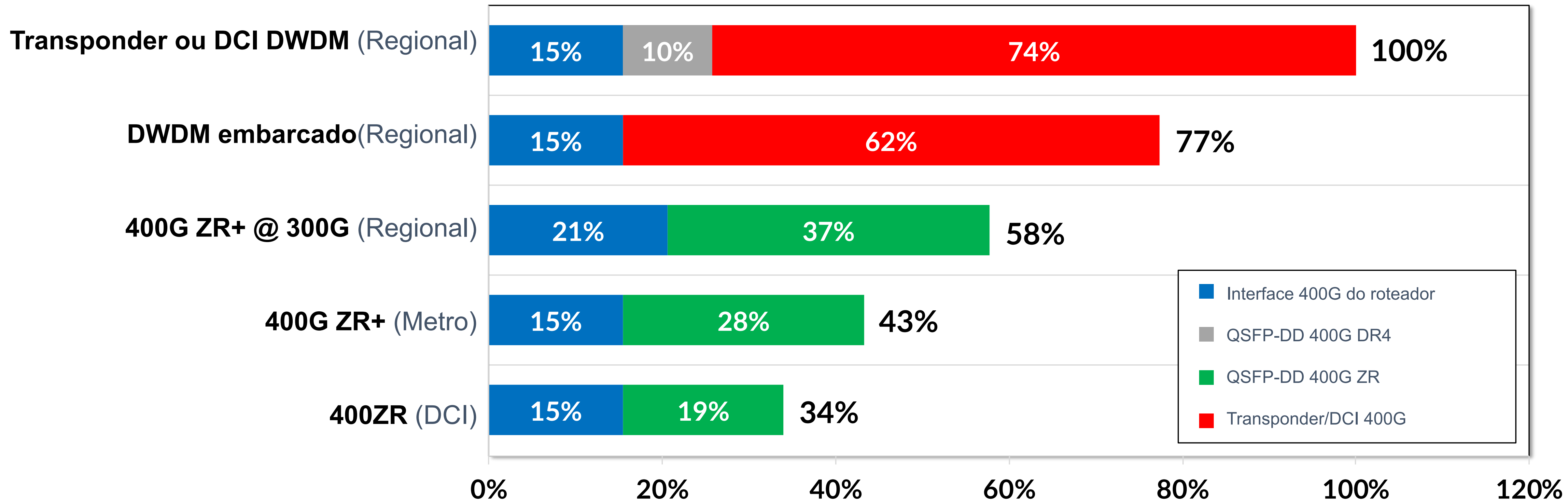
**sem perder densidade!!**



# Topologia

ROADM-Less





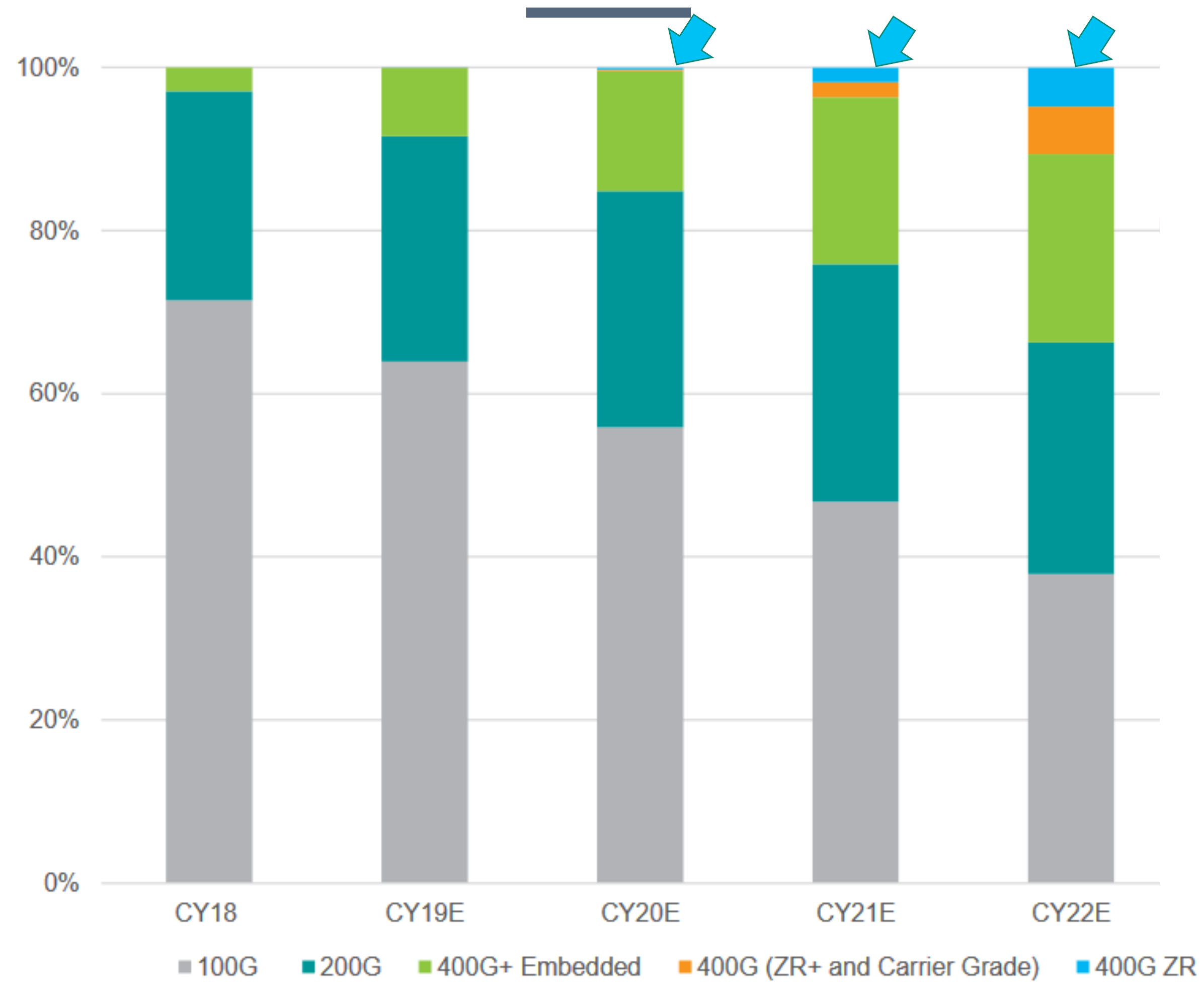
## Custo

• Interfaces coerentes plugáveis tornam o custo de uma solução DWDM muito mais atrativo.

# Disponibilidade 400ZR

A partir do final de 2020

Segmentação mercado DWDM coerente



Fonte: IHS Markit, Nov/2019



OBRIGADO

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