

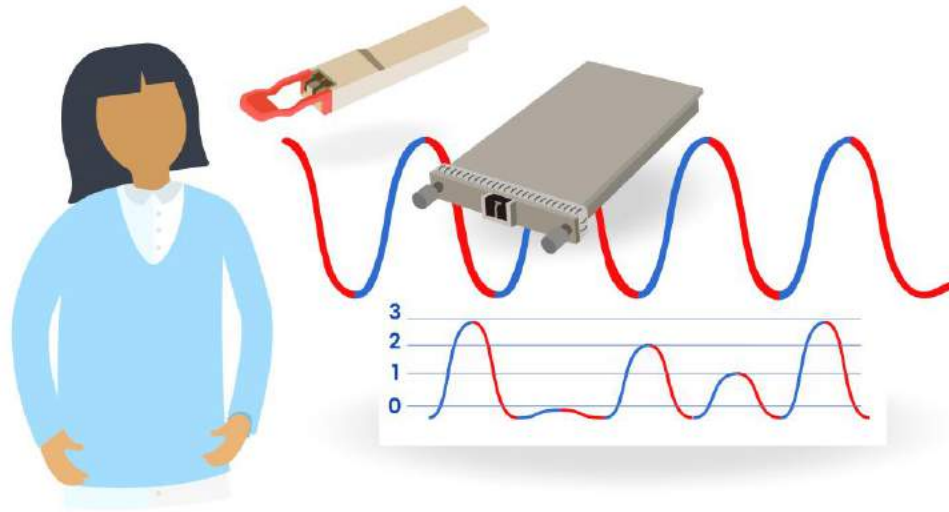
# **SOLID OPTICS**

THE PRESENT AND FUTURE OF DATA CENTER INTERCONNECT



# WHAT ARE THE OPTIONS BEYOND 10G?

## Single & Multiple Links



### Single 100G Link – Gray

- QSFP28 100G ER4
- QSFP28 100G ER4+
- QSFP28 100G ZR4
- Converter CFP or CFP2 to QSFP28

### Single 400G Link – Gray

- QSFP28-DD 400G ER8

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### Multiple 100G Links – Color

- CFP ACO/DCO (Coherent)
- CFP2 ACO/DCO (Coherent)
- QSFP28 100G LR1 CWDM (Single Lambda)
- QSFP28 100G DWDM ZR (PAM4)

### Multiple 400G Links – Color

- QSFP28-DD 400G ZR (Coherent)



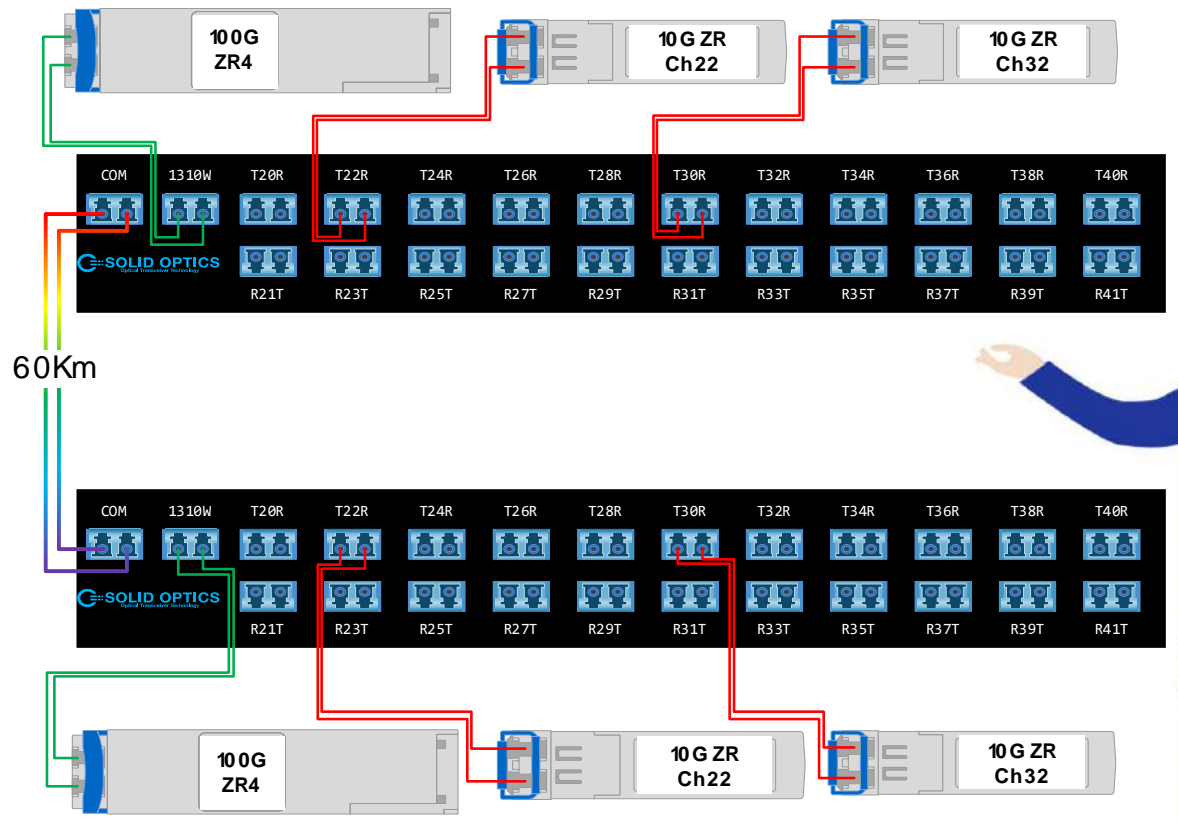
# SINGLE LINKS

GREY



# Single 100G Link

- Seamless upgrade in P2P links
- Can be used in combination with 10G DWDM if MUX has 1310W port or by adding an EOADM1-1310W





## Single 100G or 400G Links

### 100G ER4/ER4+

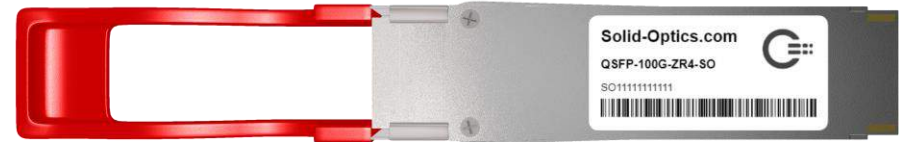
- ER4 reach 30Km without FEC/40Km with FEC
  - ER4+ reach 40Km without FEC
  - Lane wavelengths 1295.56/1300.01/1304.58/1309.14nm
  - 18dB power budget
  - Maximum power consumption 4.5W(ER4)/5W(ER4+)
- 

### 100G ZR4

- ZR4 reach 80kmn with FEC
  - Lane wavelengths 1295.56/1300.01/1304.58/1309.14nm
  - 30dB power budget
  - Maximum power consumption 6.5W
- 

### 400G ER8

- ER8 reach 40Km with FEC
- Lane wavelengths  
1273.54/1277.89/1282.26/1286.66/1295.56/1300.05/1304.58/1309.14nm
- 15.5dB power budget per lane
- Maximum power consumption 15.4W





# MULTIPLE LINKS

## COLOR

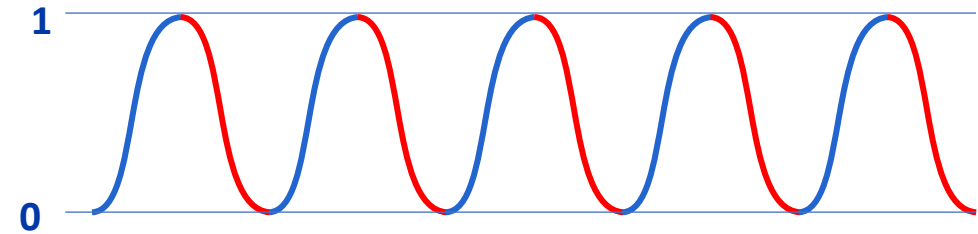


# WHAT ARE THE TECHNOLOGIES & METHODS USED TO ACHIEVE (MULTIPLE) 100G/400G LINKS?

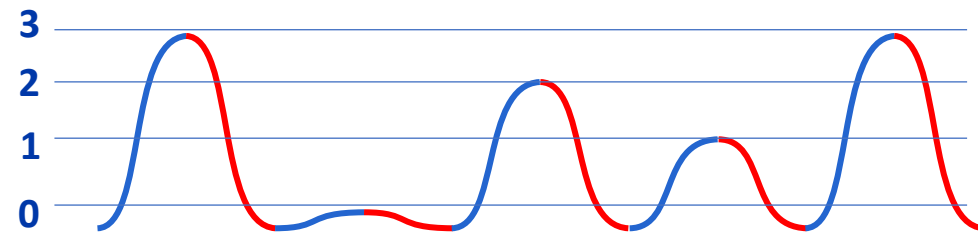
## Modulation Methods

- 100G signals are composed of multiple 25G or 50G signals
- Modulation is used to achieve 100G
- Modulation can occur in amplitude where the signal has more positions per bit or phase where the signal is rotated

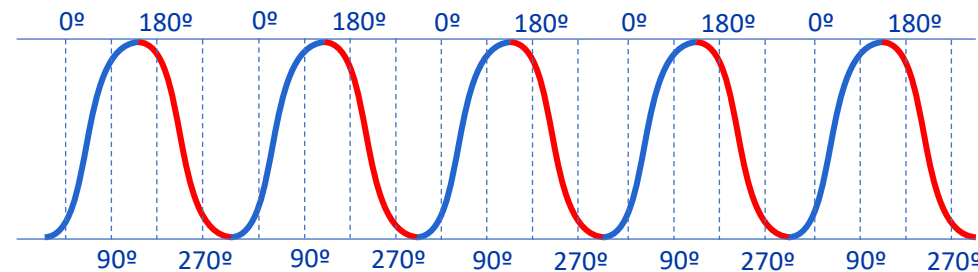
25G SINGLE SIGNAL



AMPLITUDE



PHASE





MULTIPLE 100G LINKS

-

CWDM Single  
Lambda Technique

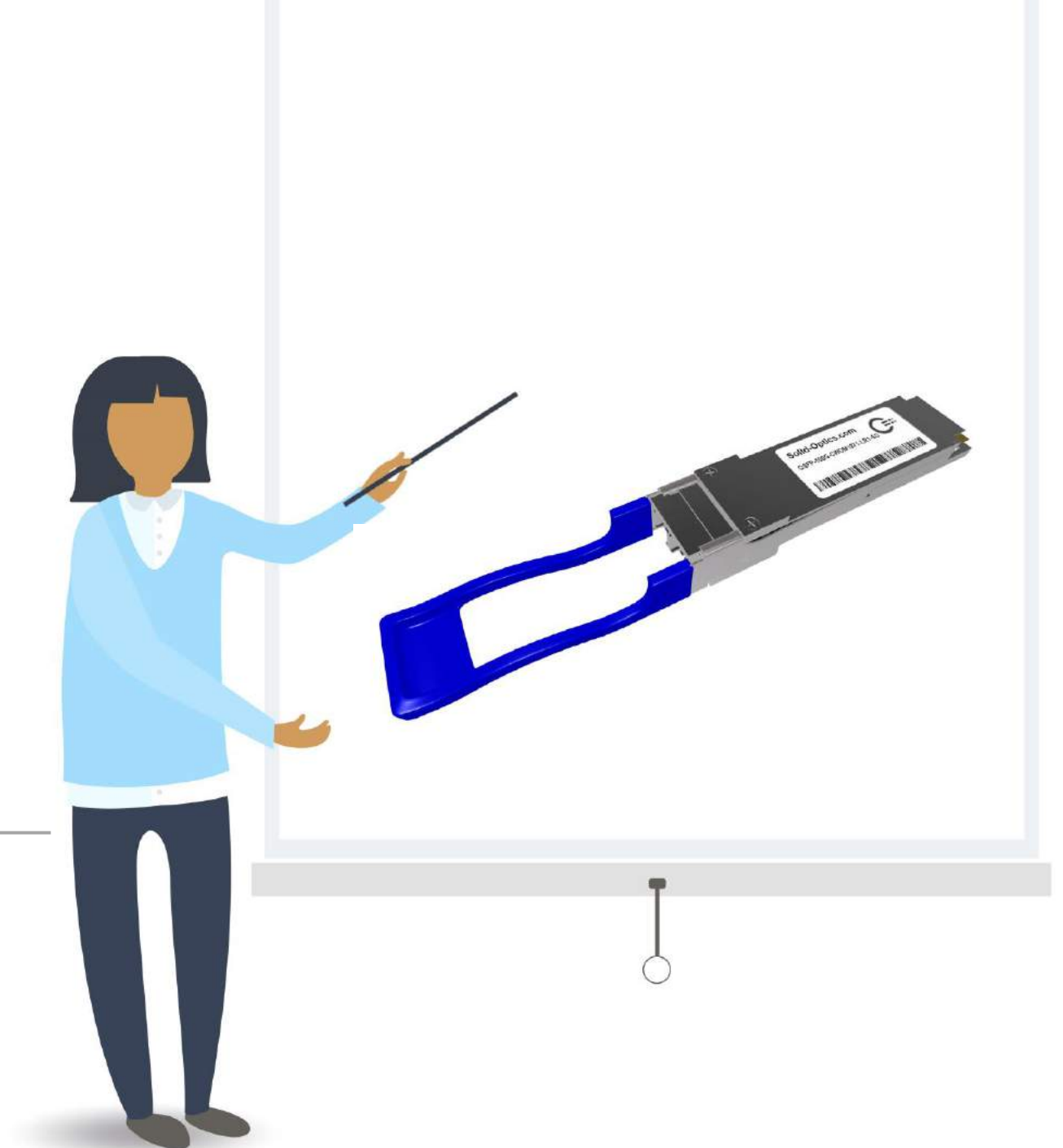




## Single Lambda LR1 Transceivers

### QSFP 100G CWDM1xxx LR1

- Available in fixed CWDM channels 1271 to 1331nm
- Reach 10Km with FEC
- 6.3dB power budget
- Passive solution
- Normal power consumption (Max. 4.5W) supported in standard equipment
- Best when implemented together with our SO-CWDM-ULTRAMUX-4CH-1270-1330 (0,8dB Max. loss) to maximize the reach





# COHERENT TECHNIQUE



# Coherent Transceivers

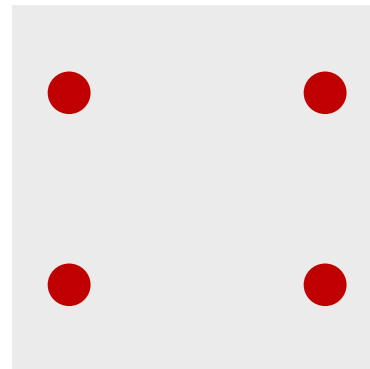
## CFP/CFP2 ACO/DCO

- Tunable to any DWDM channel
- Uses QPSK modulation to achieve 100G or 8QAM/16QAM to achieve 200G
- No amplification required for up to 120KM
- Amplification required from 120KM up to 2000KM
- No dispersion compensation is needed
- High power consumption (16W to 20W), requires a special linecard to be supported



## QPSK

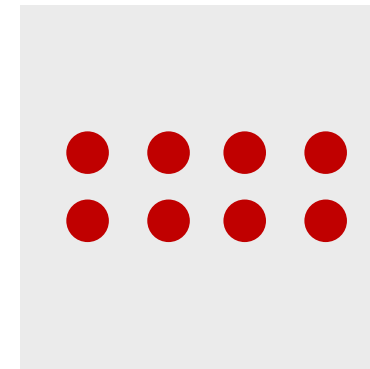
- Quadrature Phase-Shift-Keying
- Able to push 100G over 2000Km (with inline amplification)
- Lower power consumption compared to QAM modulation types



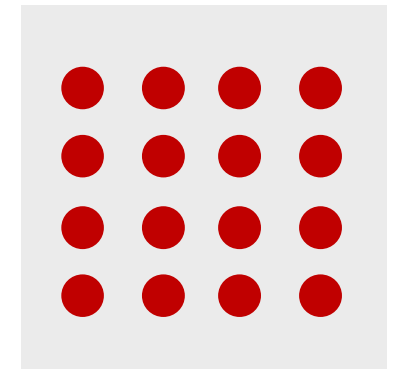
QPSK CONSTELLATION

## 8/16QAM

- Quadrature Amplitude Modulation
- Able to push 200G over 1000Km (with inline amplification)
- Higher power consumption compared to QPSK modulation



8QAM CONSTELLATION



16QAM CONSTELLATION



# COHERENT PLATFORM SOLUTIONS



# MULTIPLE 100G LINKS COHERENT CISCO

## Cisco DCO Solutions

### ASR 9000 (RSP880 OR HIGHER)



A9K-MOD-400



A9K-MOD-200

- 2 ports of 100GE CFP2
- 1 port of 100GE CFP2
- 1 port 200GE CFP2



A9K-MPA-2X100GE



A9K-MPA-1X100GE



A9K-400G-DWDM-TR

- 2 ports of CFP2 DCO + 20 SFP+

### NCS 5500



NCS 55-MOD-A-BM



NCS-55A2-MOD

- 2 ports of CFP2
- 1 port of CFP2 + 2 ports of QSFP28 (4x10G/40G/100G)



NC55-MPA-2TH-S



NC55-MPA-1TH2H-S



# MULTIPLE 100G LINKS COHERENT JUNIPER

## Juniper DCO Solutions



ACX 6360

- 8 x CFP2-DCO
- 20 QSFP28



ACX 5448

- 32 x SFP+
- 2 x QSFP28
- 2 x CFP2-DCO



MX 960  
MPC5E-100G10G

- 2 x CFP2-DCO
- 4 SFP+



PTX 5000  
P2-100G-OTN

- 4 x CFP2-DCO



# MULTIPLE 100G LINKS COHERENT OTHER MANUFACTURER SOLUTIONS

## Other Solutions



CIENA 5171 DCO



INFINERA XTM SERIES



PacketLight PL-1000GT



Coriant Groove G30



# PAM4 TECHNIQUE





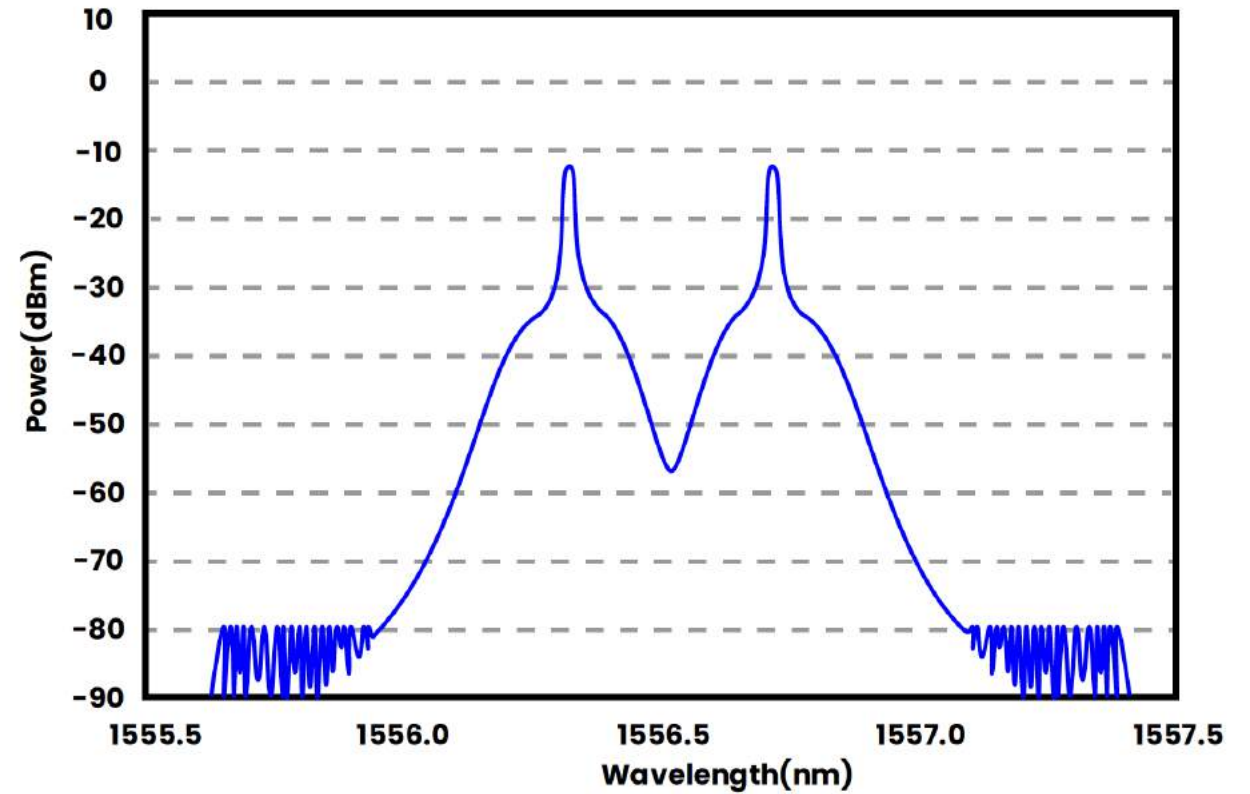
## Multiple 100G Links

### PAM4 Transceivers

- Available in fixed DWDM channels 17 to 61
- Uses PAM4 modulation to achieve 100G
- Amplification needed from the first centimeter, dispersion compensation needed from 5Km
- Normal power consumption (Max. 5W), is supported in standard equipment



- Pulse Amplitude Modulation
- Signal composed of 2 x 56Gb/s 50GHz DWDM wavelengths modulated with PAM4
- FEC integrated in the optic DSP
- -9dB Power output per lane
- -2dB to 6dB receiver sensitivity per lane



QSFP28 100G DWDM MODULATED WITH PAM4



# PAM4 PLATFORM SOLUTIONS



# WHICH COMPONENTS DO YOU NEED TO GET PAM4 UP AND RUNNING?



EDFA



EDFA



DISPERSION COMPENSATOR



MUX



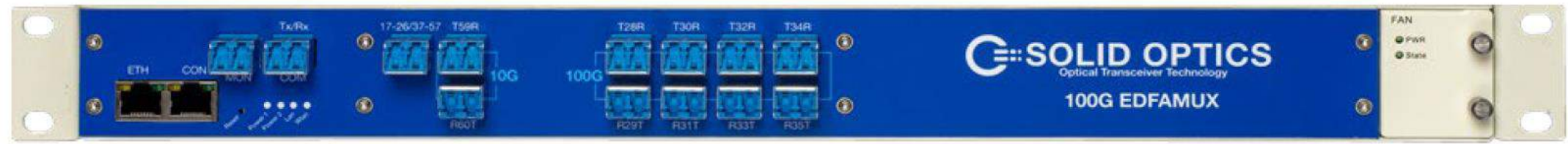
# OR OUR ALL-IN-ONE SOLUTION EDFAMUX

## Multiple 100G Links

- All-In-One solution in 1RU size
- MUX, Pre/Post EDFAs, and Dispersion Compensator built-In
- Network agnostic (operate at physical level)
- Web and console configuration
- Low power consumption

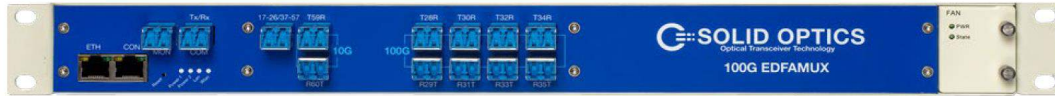
### STANDARD FEATURES

- ✓ 1% Monitor port
- ✓ Console port
- ✓ Default LC/UPC with auto dust shutters
- ✓ Redundant AC power supplies (DC optional)
- ✓ Syslog Monitoring
- ✓ HTTP API access
- ✓ SNMP Monitoring





# MULTIPLE 100G LINKS EDFAMUX



## 8x100G 80km

SO-DWDM-8X100G-EDFAMUX-80KM

- Up to 8 x 100G lines from 5km up to 80km and to 18dB aggregated power budget
- Upgrade port
- 2 x 1G/10G (Ch59-60) except in the Ch52-59 version
- Available in the following channel blocks:

- Ch20-27
- Ch28-35
- Ch36-43
- Ch44-51
- Ch52-59

## 8x100G 120km

SO-DWDM-8X100G-EDFAMUX-120KM

- Up to 8 x 100G lines from 60km up to 120km and to 30dB aggregated power budget
- Available in the following channel blocks:

- Ch20-27
- Ch28-35
- Ch36-43
- Ch44-51
- Ch52-59

## 16x100G 40km

SO-DWDM-16X100G-EDFAMUX-40KM

- Up to 16 x 100G lines from 5km up to 40km and to 18dB aggregated power budget
- Available in the following channel blocks:

- Ch20-35
- Ch43-58

## 16x100G 80km

SO-DWDM-16X100G-EDFAMUX-80KM

- Up to 16 x 100G lines from 40km up to 80km and to 30dB aggregated power budget
- Available in the following channel blocks:

- Ch20-35
- Ch43-58





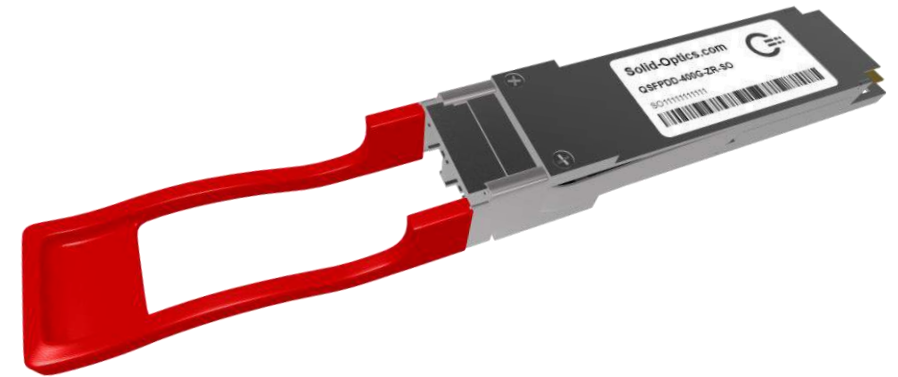
# 400G COHERENT TECHNIQUE



# Multiple 400G links

## QSFP-DD 400G ZR

- Full C-Band channel tunable
- Requires amplification
- Maximum power consumption 16.5W



MODULATION	SPEED	CHANNEL SPACING
		100/75GHz
16QAM	400G	50GHz
16QAM	200G	100/75GHz
QPSK/DQPSK	200G	50GHz
QPSK/DQPSK	100G	



## THANK YOU

We hope that you have enjoyed and will benefit from this presentation. If you require more information or would like to speak to the team, please get in touch by email: [infous@solid-optics.com](mailto:infous@solid-optics.com) or call:

