



HIGHSPEED RUGGED NETWORKS WITH WAVE DIVISION MULTIPLEXING

PRESENTED BY MOOG RUGGED OPTICAL SOLUTIONS

MOOG

COTSWORKS, INC. is an innovative manufacturer of rugged optical components and subsystems for harsh environment networking and sensing applications.



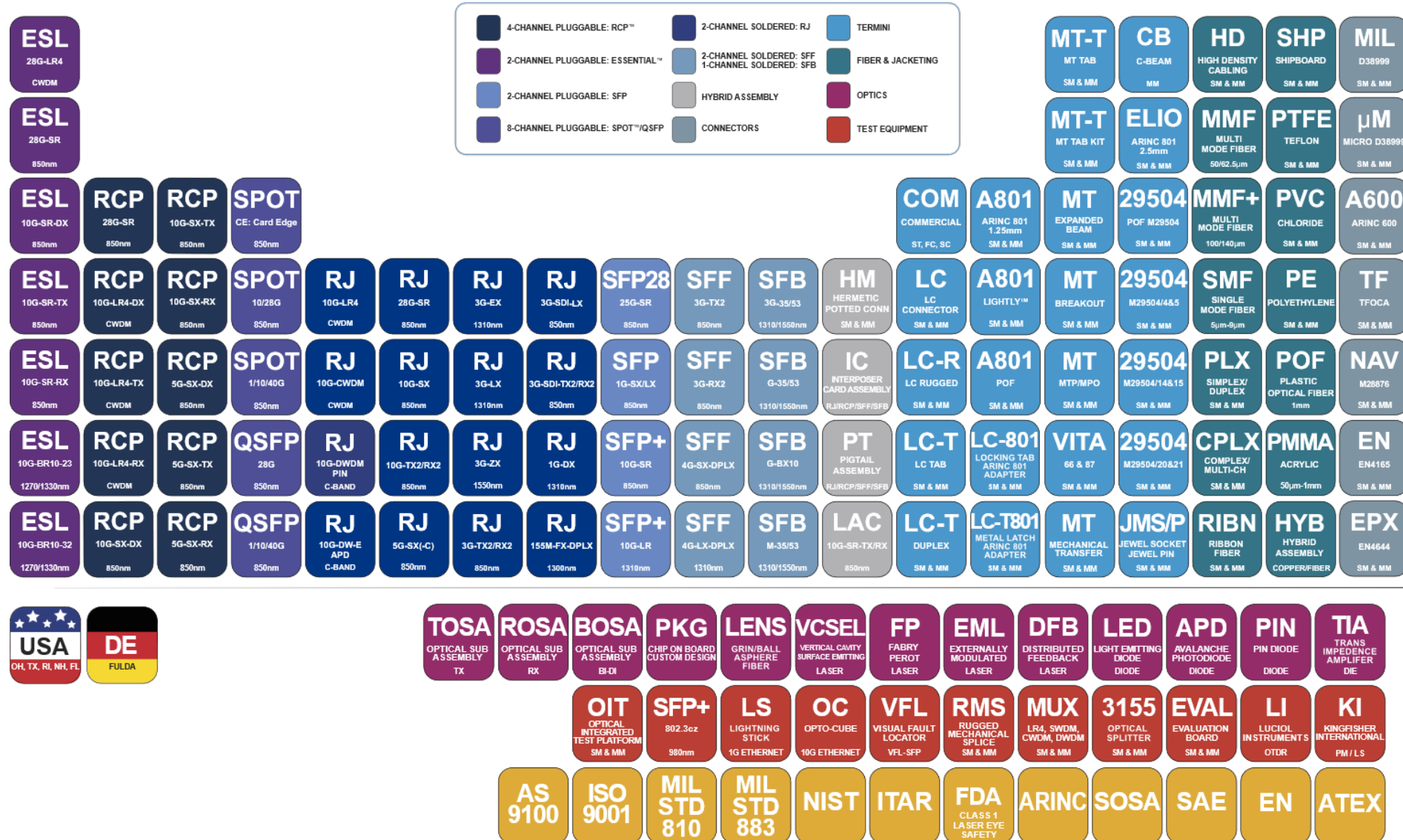
Commercial OR Custom-Off-The-Shelf components are integrated across multiple engineering disciplines to WORK in the most consistent, highest quality, performance, and cost-effective process and configurations.

Optical Transceivers, Simplex and Complex Cables, and Test Equipment are designed for Commercial and Military Aerospace, Military Tactical, Industrial & Energy, Rugged Networking and Sensor markets.



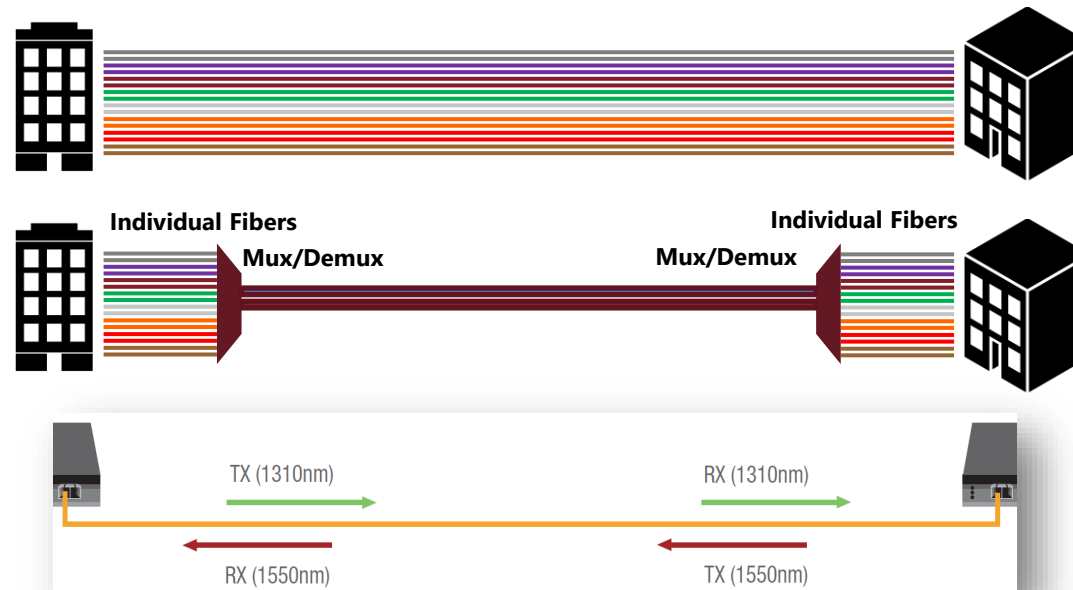
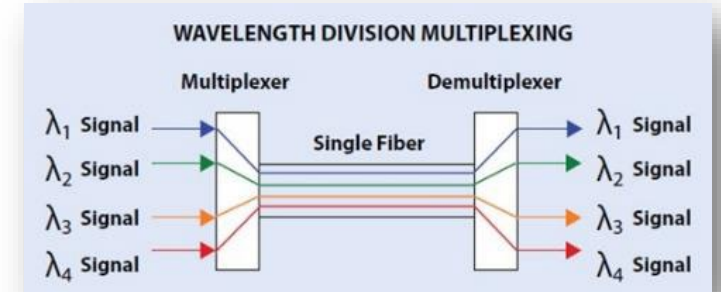
AS9100, ISO 9001, and ATEX certified, founded in 2006, with 100+ employees in North America, Europe, and representatives in Asia and Middle East. Privately funded with investment from Industry leaders.

Elemental Product Platforms

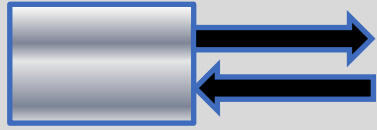


What Is WDM?

- **Wavelength Division Multiplexing** is a commonly used technology in digital communications where multiple wavelengths are multiplexed onto the same fiber
- Each wavelength is an independent lane, driven separately electrically
- Enables single fiber duplex communication (two wavelengths on one fiber) or capacity expansion (start with one, add many), or aggregate bandwidth (big pipe)



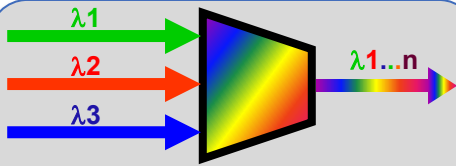
Rugged WDM Network Components



Optical Transceiver

Transceiver

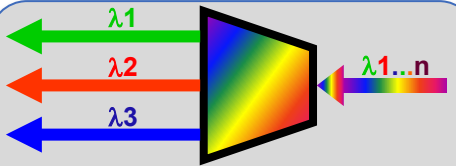
- Uses WDM-specific transmitter wavelengths, wideband receivers.



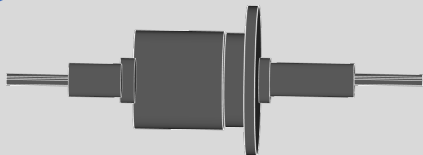
Optical Multiplexer

Multiplexer/Demultiplexer (same component, different optical path taken)

- Combines (or splits) multiple channels into (out of) fiber.
- Filters allow for connectivity to correct receivers in multi-channel systems.
- Thin-Film Filters (TFF) have greater stability over wider temperature range, and do not require heaters.



Optical De-multiplexer



Fiber Optic Rotary Joint (FORJ)

Fiber Optic Rotary Joint (FORJ)

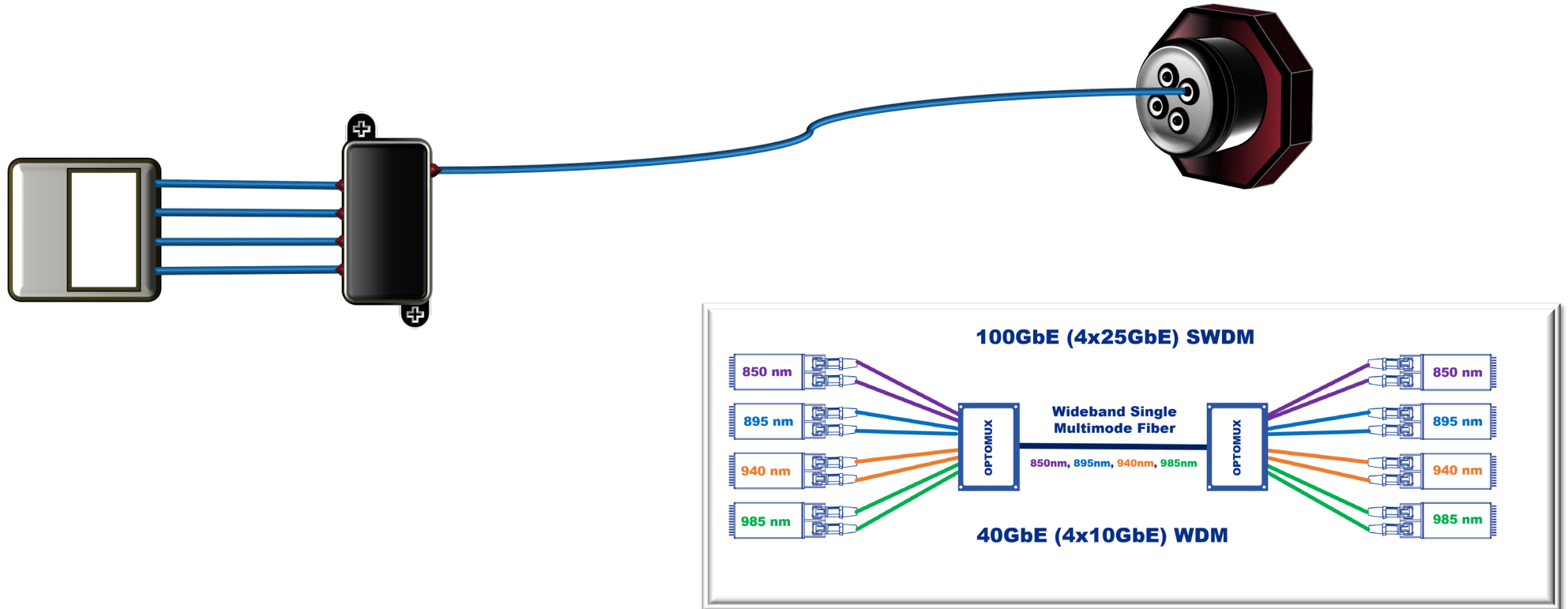
- Allows for connections for fiber optic links through rotating components. WDM + FORJ allows for multiple channels over minimal fiber count which reduces cost and complexity

SWDM vs CWDM vs DWDM

Comparison	SWDM	CWDM (LR4)	DWDM
Description	Shortwave WDM	Coarse WDM	Dense WDM
Fiber Type	MMF	MMF* and SMF**	SMF
Wavelength	850nm,880nm,910nm,940nm	1270/90/1310/3nm 1470-1610nm	1550nm center
Channel	4 Channels	4 plus 8 Channels	192 Channels
Max Link Budget	11 dB	13-15 dB	22 dB
Cost (xcvr, mux, cable, termini)	\$800/25Gbps	\$1200/25gbps	\$2000/25Gbps

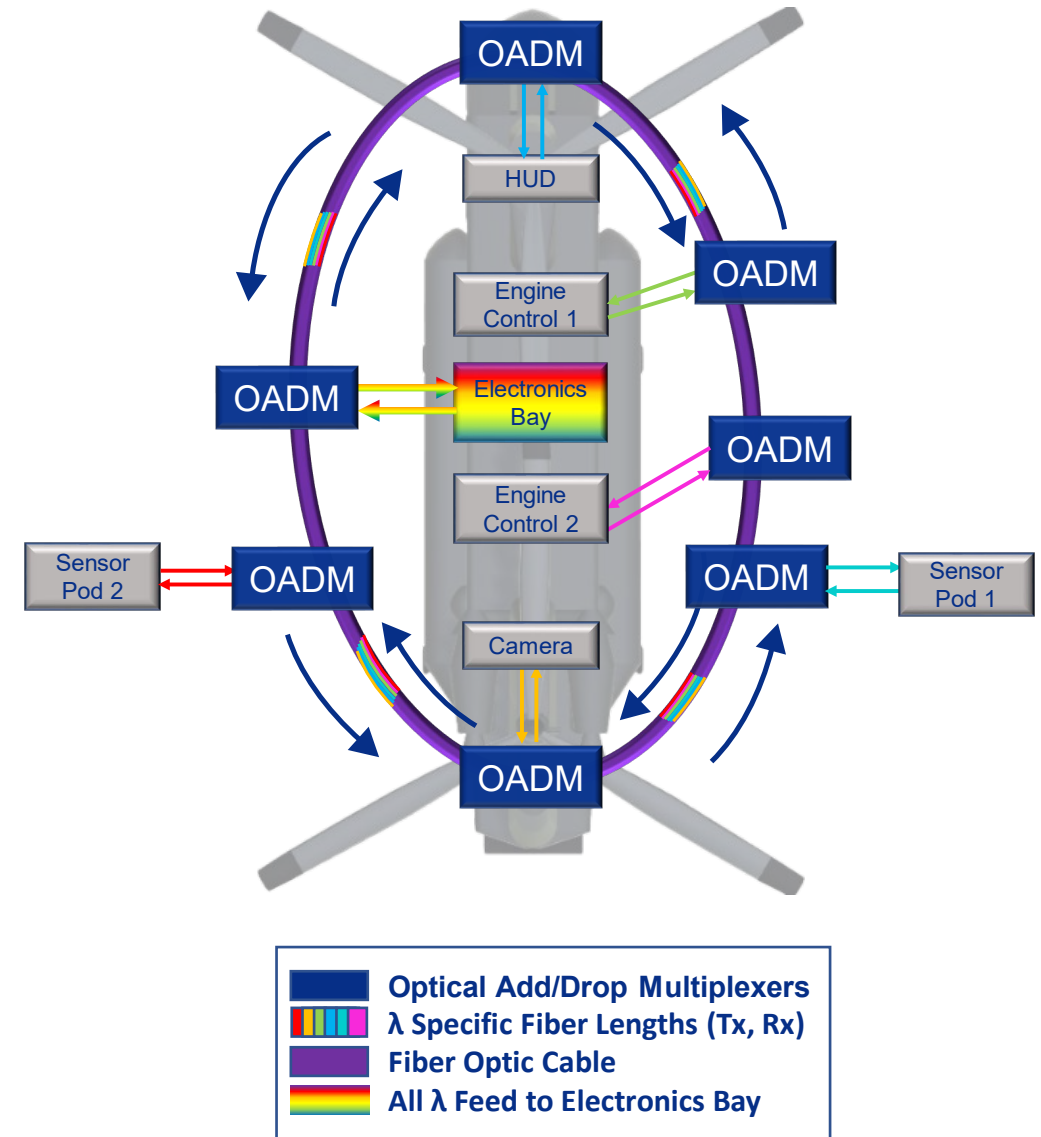
Point to Point Application of SWDM

- An optical transceiver's multiple signals are multiplexed onto one fiber enabling the use of low-cost commodity Mil/Aero connectors
- This also enables upgrades on the existing fiber runs in the future
- An existing fiber cable run today with 1Gbps could become the drawing and diagram below at 10, 40, or even 100Gbps by adding channels



Ring Network Using WDM

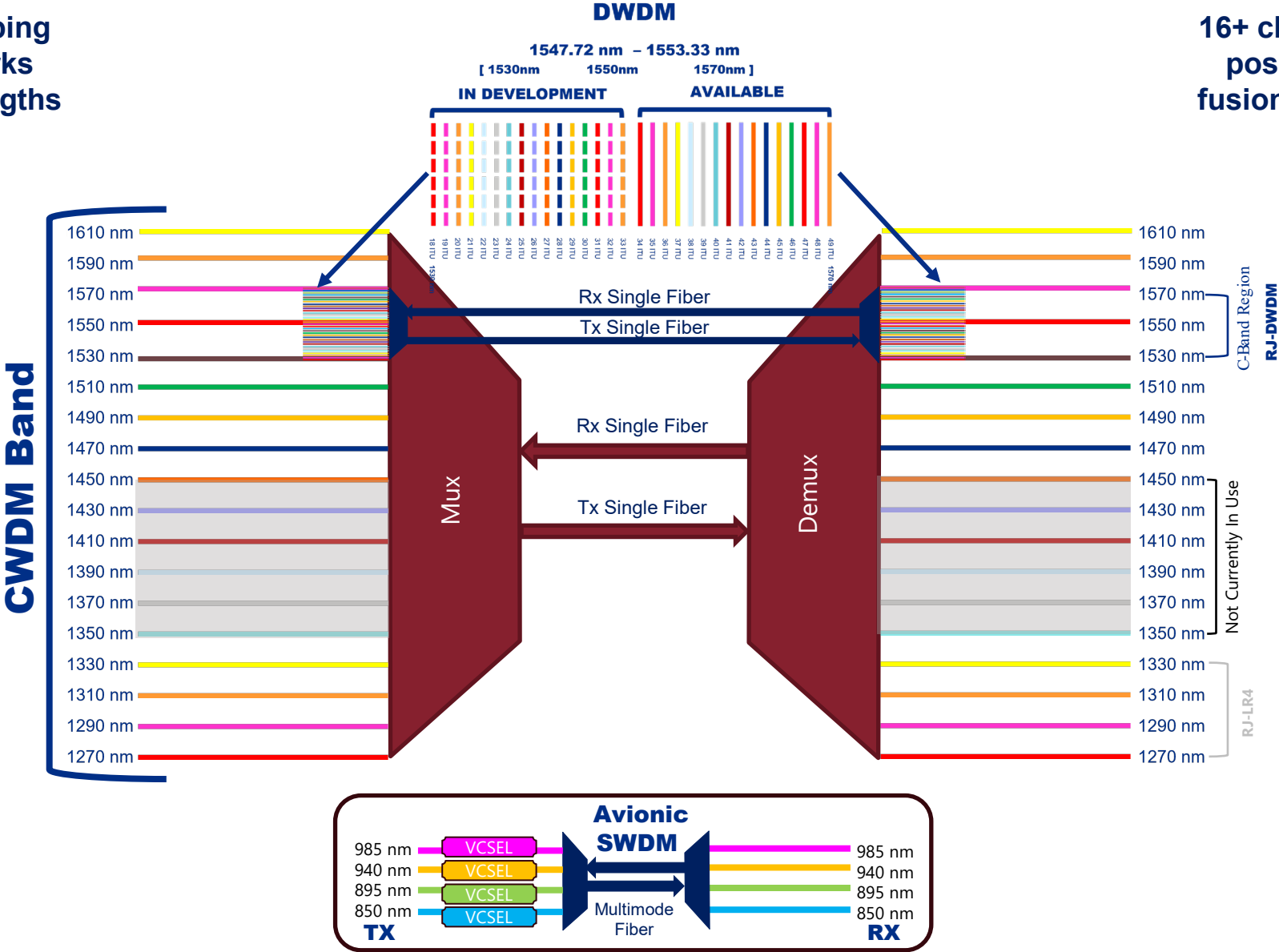
- Wavelengths added or dropped to/from network through Optical Add/Drop Mux
- WDM systems can be used to connect multiple systems in various topologies
 - Sensors
 - Processors
 - Displays
 - Cameras
- Multiple sensors can be connected on a simplex cable run with data independent channels added as needed/approved
- 10Gbps, 16 channels, in Mil/Aero
- RFOverFiber coming at WDM channels



WDM Channels Block Diagram

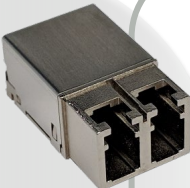
COTSWORKS is shipping up to 100Gbps networks with different wavelengths

16+ channels at 25Gbps are possible, enabling sensor fusion, AI for video analysis



SWDM enables 100x upgrade on existing fiber runs

RJ Transceiver: RJ-25G-SR-xx
xx=85/88/91/94



RJ TX Pair: RJ-25G-SR-TX2-y
*y=A(850,880)
=B(910,940)
=C(850,910)
=D(880,940)*



RJ Dual Receiver: RJ-25G-SR-RX2

25G Transceiver	850	880	910	940
	830-960	830-960	830-960	830-960
25G Dual Transmitter	850	910	850	880
	880	940	910	940
25G Dual Receiver (wideband)			830-960	
			830-960	

RCP 4λ Transmitter: RCP-25G-SR-TX-4W
RCP Quad Receiver: RCP-25G-SR-RX



RCP 2λ Transceiver: RCP-25G-SR-2TRy
*y=A(850,880)
=B(910,940)
=C(850,910)
=D(880,940)*

25G Quad Transmitter 25G Quad Receiver		850		830-960
		880		830-960
		910		830-960
		940		830-960
25G Dual Transceiver	850	910	850	880
	850	910	850	880
	880	940	910	940
	880	940	910	940

CWDM(LR4) on MM fiber with SWDM = 200Gbps

RJ Transceiver: RJ-25G-LR-xx
xx=27/29/31/33

RJ TX Pair: RJ-25G-LR-TX2-y
y=A(1270,1290)
=B(1310,1330)
=C(1270,1310)
=D(1290,1330)



RJ Dual Receiver: RJ-25G-LR-RX2

25G Transceiver	1270	1290	1310	1330
	1260-1620	1260-1620	1260-1620	1260-1620
25G Dual Transmitter	1270	1310	1270	1290
	1290	1330	1310	1330
25G Dual Receiver (wideband)			1260-1620	
			1260-1620	

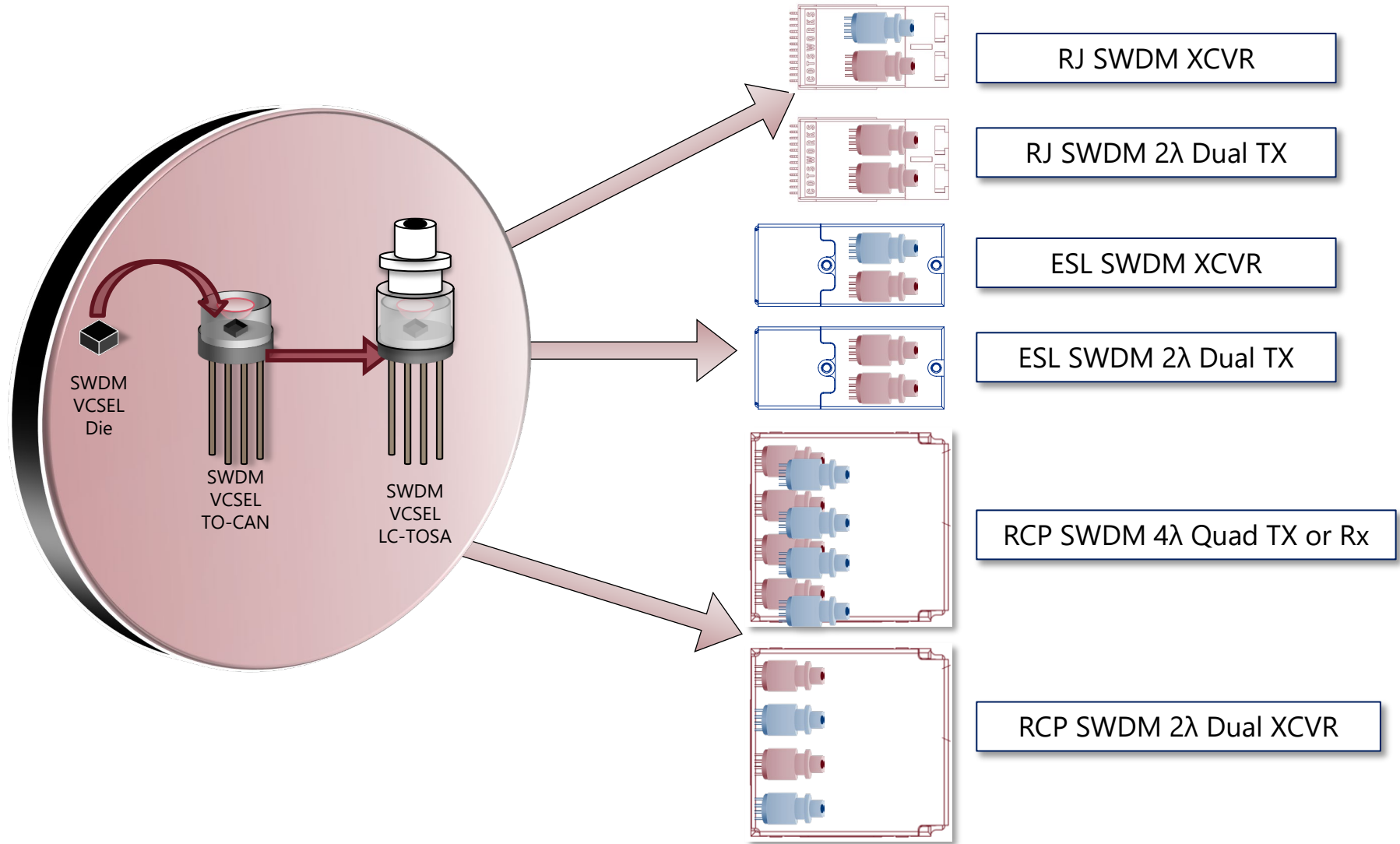
RCP 4λ Transmitter: RCP-25G-LR-TX-4W
RCP Quad Receiver: RCP-25G-LR-RX

RCP 2λ Transceiver: RCP-25G-LR-2TRy
y=A(1270,1290)
=B(1310,1330)
=C(1270,1310)
=D(1290,1330)



25G Quad Transmitter 25G Quad Receiver		1270		1260-1620
		1290		1260-1620
		1310		1260-1620
		1330		1260-1620
25G Dual Transceiver	1270	1310	1270	1290
	1270	1310	1270	1290
	1290	1330	1310	1330
	1290	1330	1310	1330

Wavelength based optical ICs in sealed package (OSAs)



WDM Technology

- Scalable bandwidth growth on existing fiber plant
- MM or SM cable solutions
- Simplex cable & legacy supt.
- Utilizes LC, 29504, A801
- Works with optical slip rings
- 11+ dB link budgets
- Each channel is secure and can be monitored

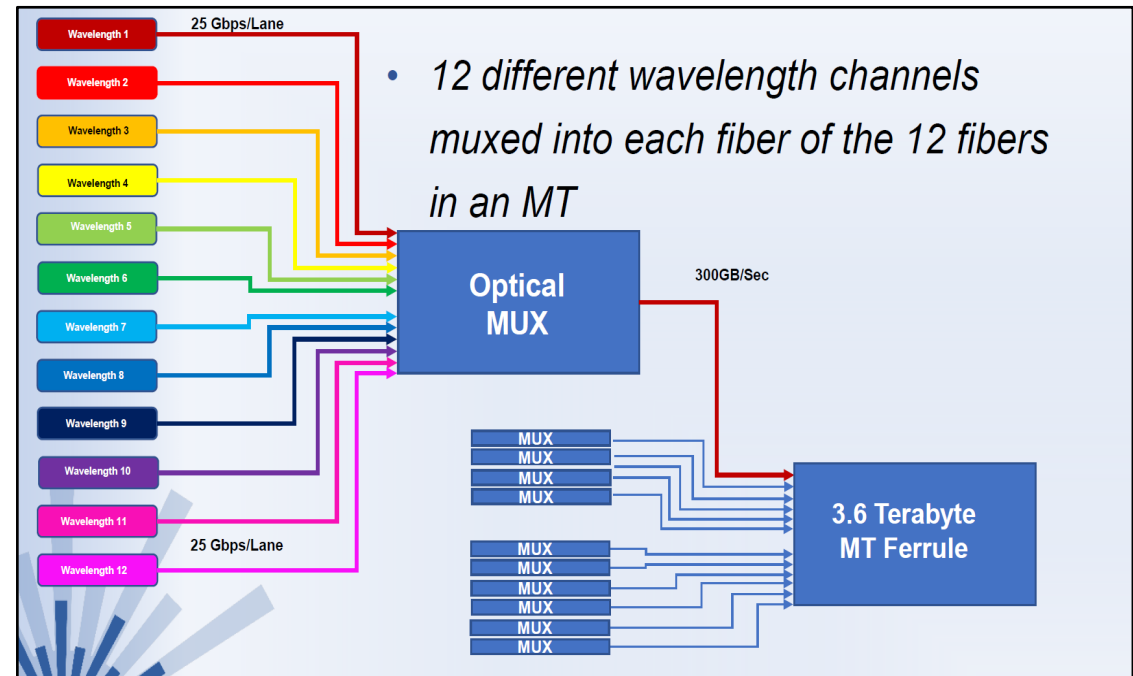
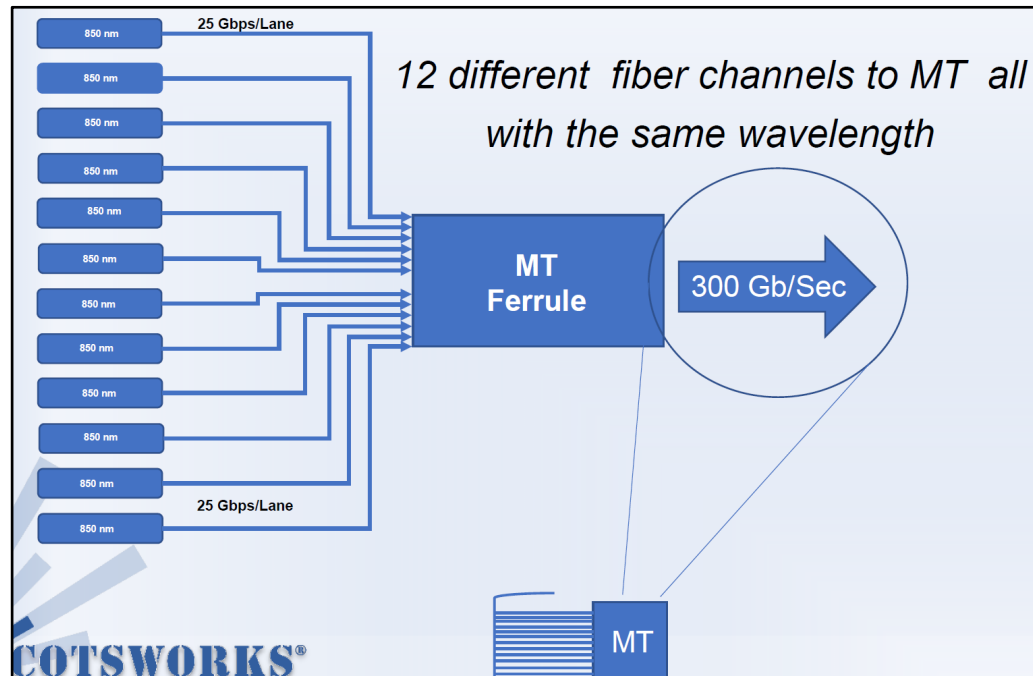
Parallel Optical Technology

- Densely packed optical lanes
- Smallest form factor available
- Low power
- Low heat dissipation
- Dense electrical socket
- Custom electrical interface
- Pigtailed or delicate clip
- 6-7 dB link budget

WDM can upgrade existing simplex fiber runs or support "nose to tail" networks while parallel excels at card to card or LRU to LRU for high density comms.

300Gbps to 3.6 Terabytes

- Using 850nm Parallel technology only yields a maximum of 300Gbps on a ribbon fiber cable run
- Using WDM, this can increase to 3.6 Terabytes



							
RJ 1-10G (2 Channel, Dual TX/RX or Duplex, SX, SR, LX, LR, LR4)	RJ-28G (2 Channel, Duplex, possible Dual TX/Rx), SR, SWDM	RJ-10G-CWDM/DWDM (2 Channel Duplex External Modulation), CWDM, DWDM	RCP™ 1-10G (4 Channel, Quad TX/RX or Dual Duplex) MM or SM, SWDM or LR4	Essential™ 1-28G (2 Channel, Duplex, TX or RX, LR4, Bi-Di, SWDM)	QSFP 1,10, 40 or 100G (8 Channel TX or RX, Quad Duplex)	SFF 100M-4G 2 channel Dual TX/RX or Duplex SFB 1-3G 1 channel, Bi-Di TX and RX)	SPOT-MB™ SPOT-CE™ 1,10,40G (8 Channel TX or RX Quad Duplex)
<i>Ethernet, Fibre Channel, SDI, HDMI, A818, SFPDP protocol support</i>							

COTSWORKS ships 100,000 channels/year into Boeing and Airbus commercial aircraft and many USA and EMEA warfighters, transports, rotorcraft, and radar/sonar systems worldwide.

Company Information

Quality System:

ISO 9001:2015 + AS9100:D CERT-0136100

ATEX Compliant, OP IS

S20.20 ESD program

J Standard electronic parts work

Compliant to FAR 52.204-2, DFARS 252:204-7012

NIST 800-171 Compliance in process



Aerospace and Electronics
Industry Quality Standards



FDA/CDRH Laser Safety Test
and Manufacturing Support



International Traffic in
Arms Regulations



ESD handling and Facility Testing,
Operation, and Certification



Harsh environments including
Oil and Gas compliance



Foreign Object Debris Procedures,
Auditing, and Training

Company Information:

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ECCN: EAR99

ITAR: M37737

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