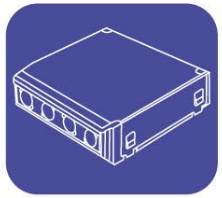
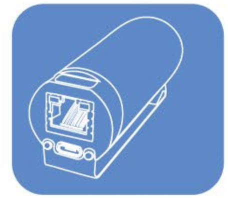
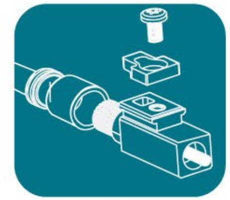
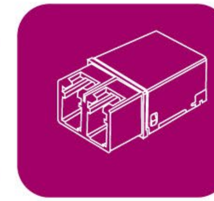
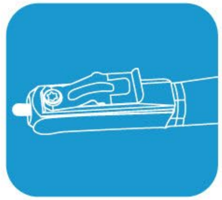
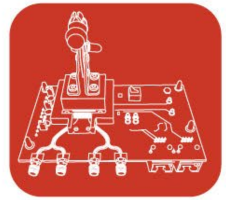
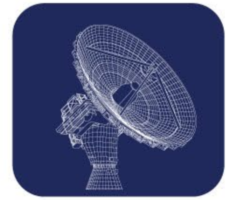
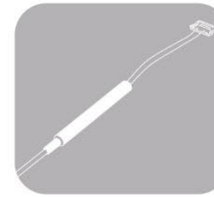
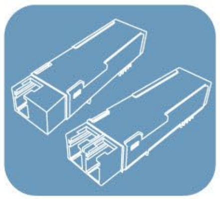
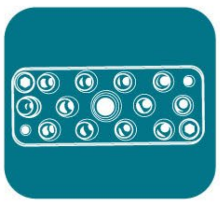




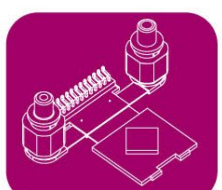




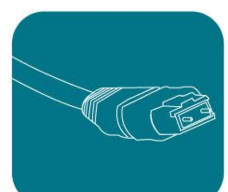
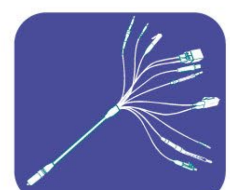
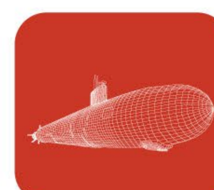

COTSWORKS®

Highspeed Rugged Networks with Wave Division Multiplexing

www.cotsworks.com

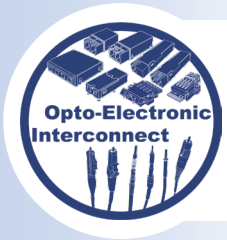




About COTSWORKS

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



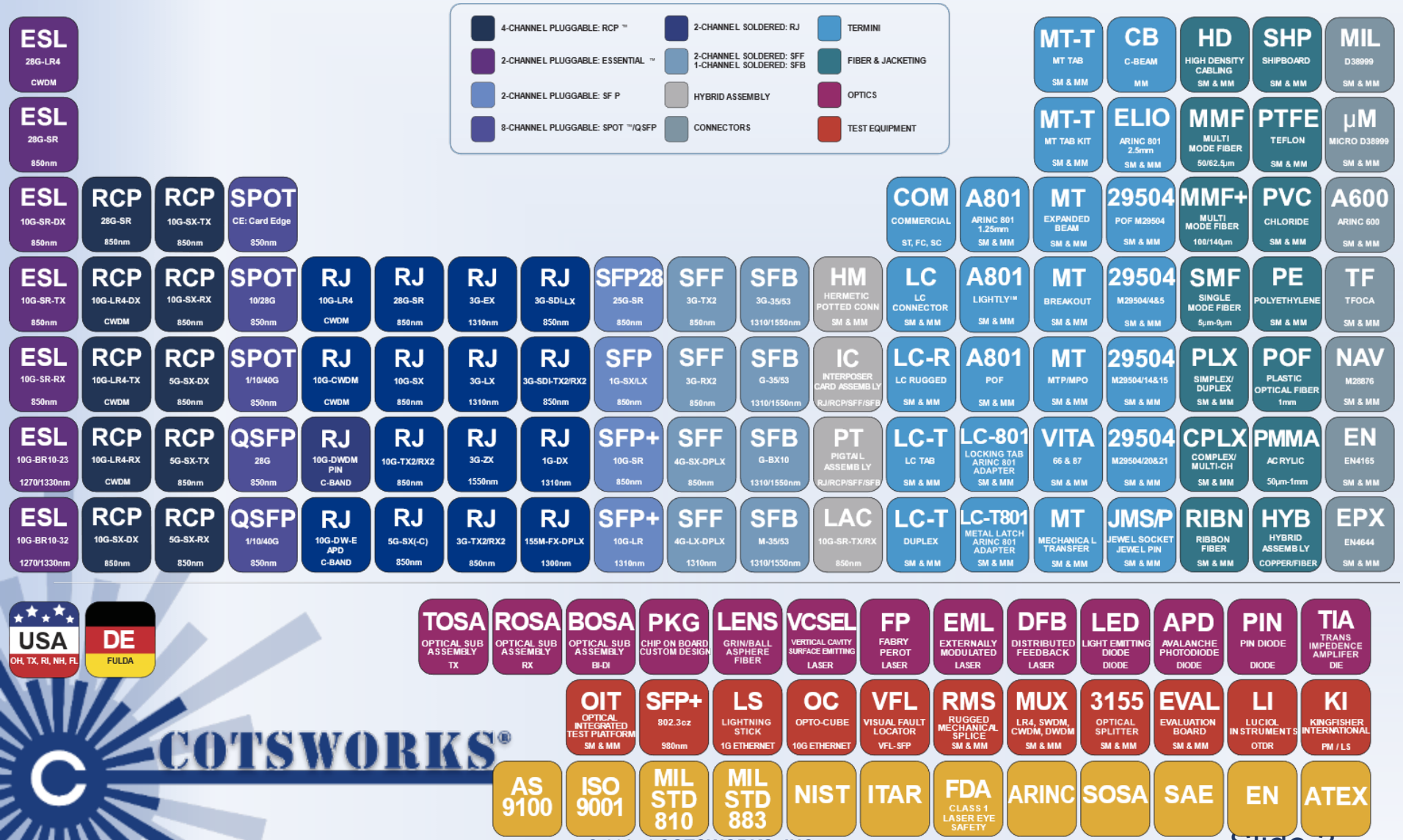
Commercial OR Custom-Off-The-Shelf components are integrated across multiple engineering disciplines to WORK in the most consistent, highest quality, performance, and cost-effective process and configurations.

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.

COTSWORKS®

Elemental Product Platforms



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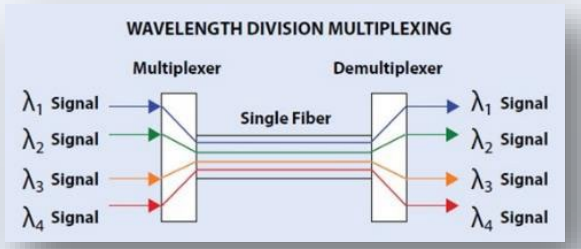
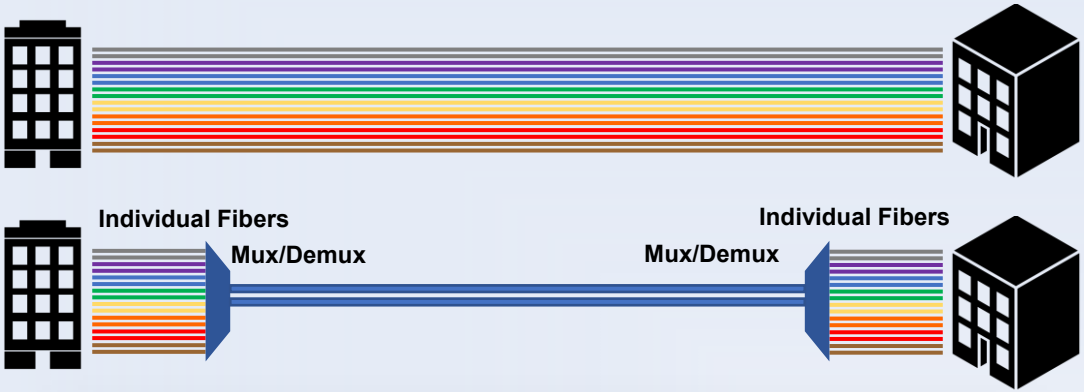
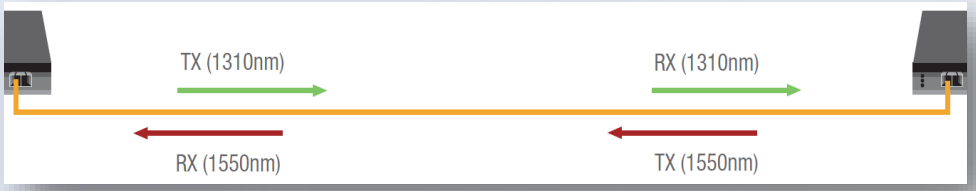
What Is WDM?

- **W**avelength **D**ivision **M**ultiplexing 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)







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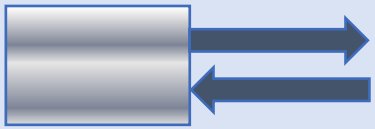
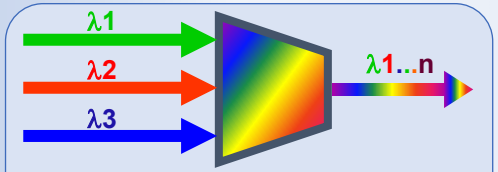
Rugged WDM Network Components



Optical Transceiver

Transceiver

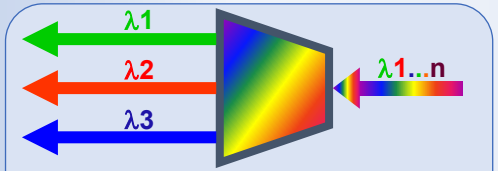
- Uses WDM-specific transmitter wavelengths, wideband receivers.



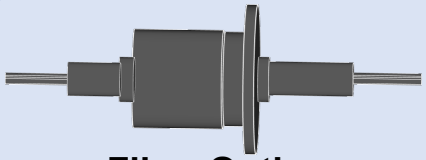
Optical Multiplexer

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

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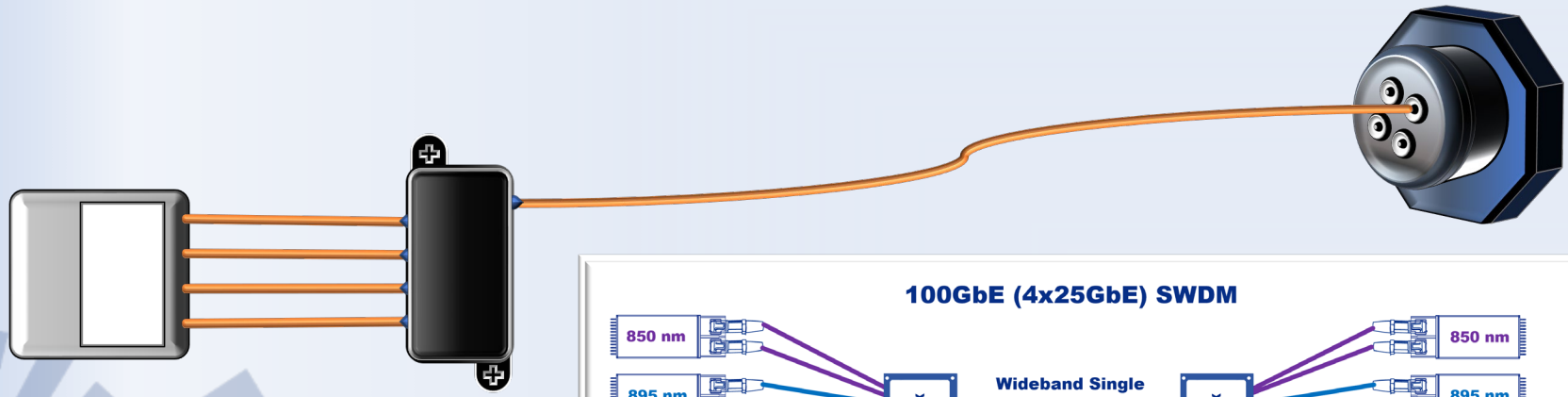
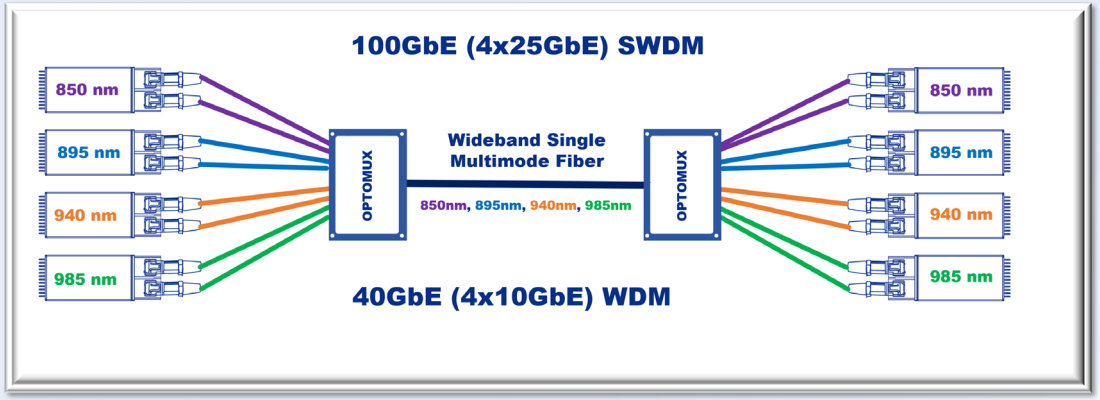
Point to Point Application of SWDM

- 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





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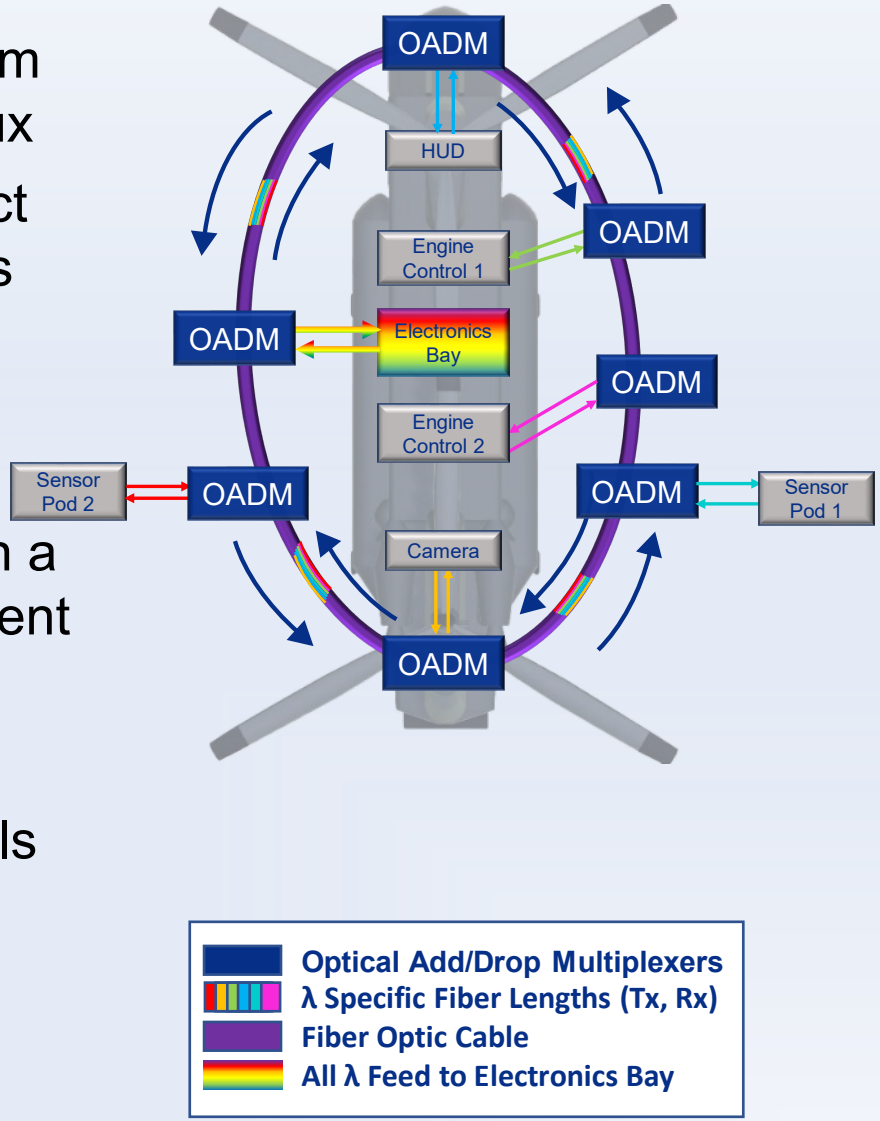
Ring Network Using WDM

- 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



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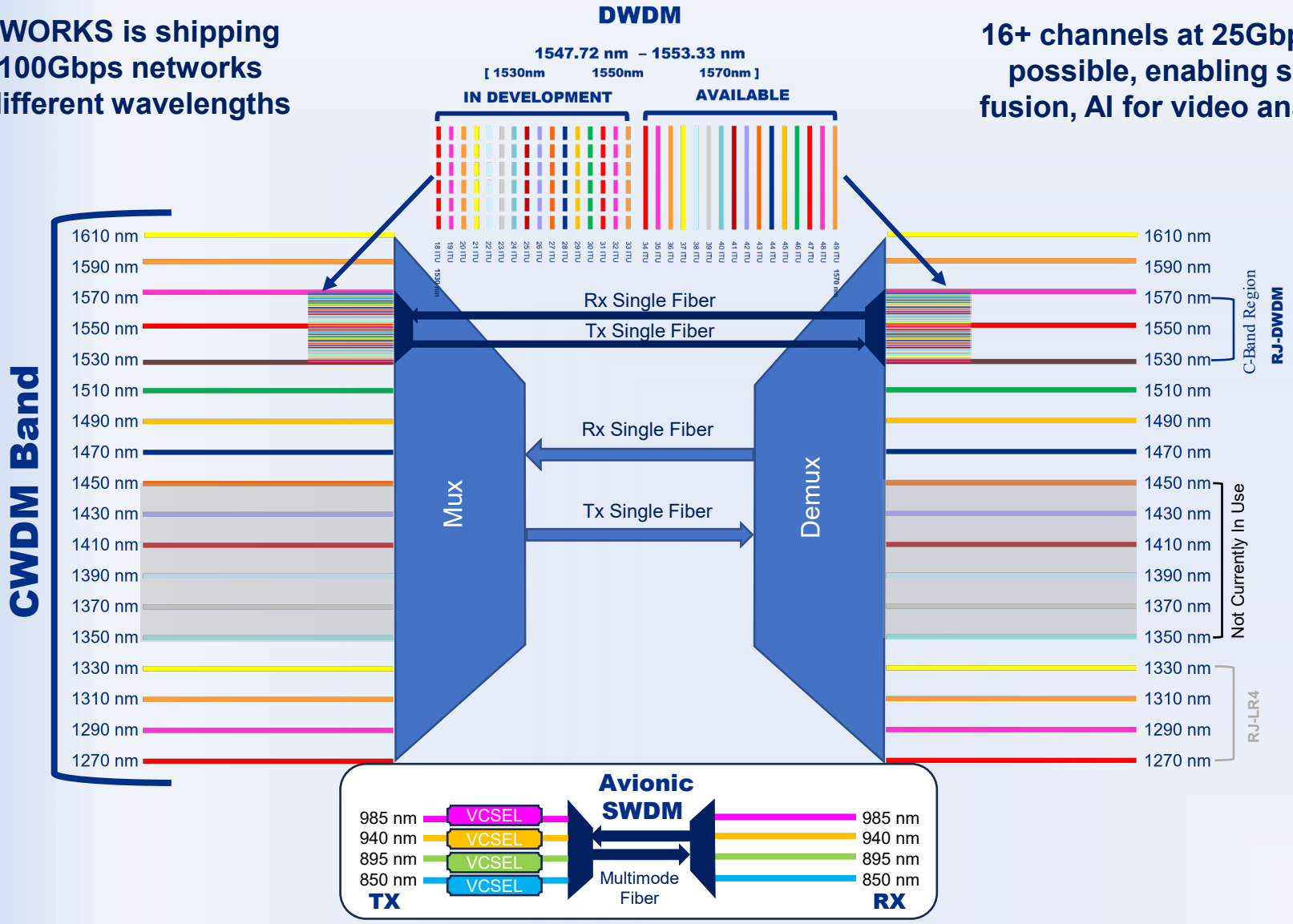
WDM Channels Block Diagram

COTSWORKS is shipping up to 100Gbps networks with different wavelengths

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



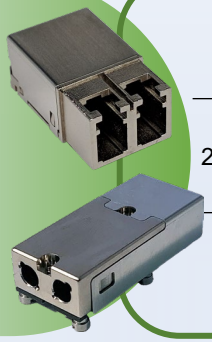
Upgrade from 1-10 to 100Gbps

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

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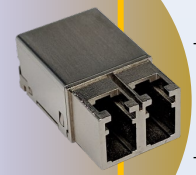
Then Upgrade to 200Gbps

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

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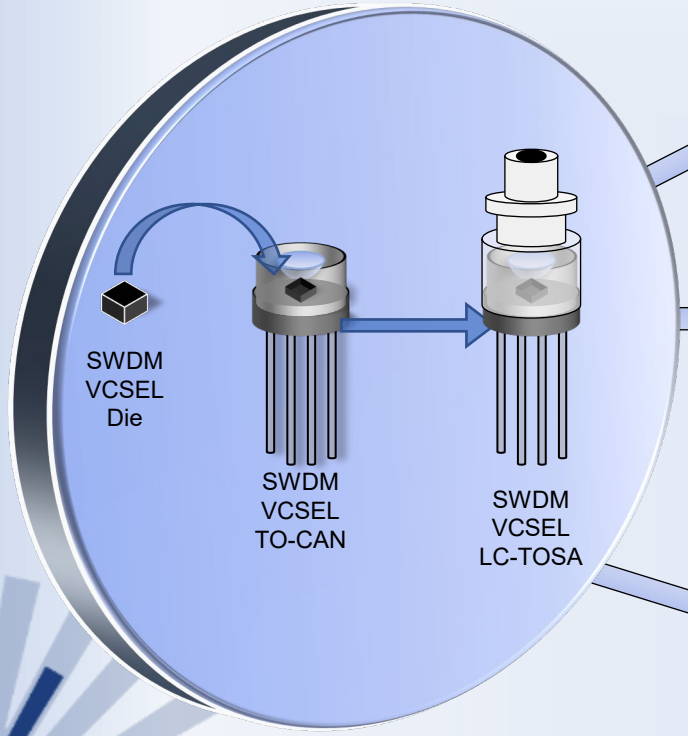
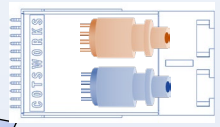
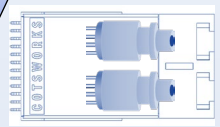
Inside the Transceiver

Wavelength based optical ICs in sealed package (OSAs)

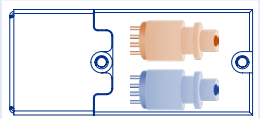




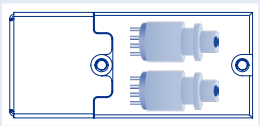
RJ SWDM XCVR



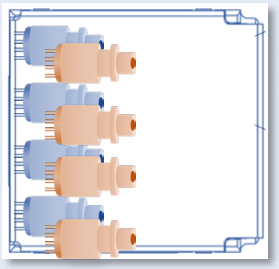
RJ SWDM 2λ Dual TX



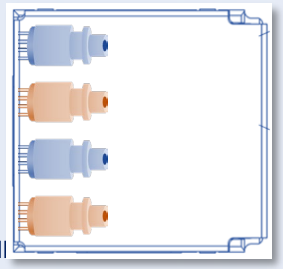
ESL SWDM XCVR



ESL SWDM 2λ Dual TX



RCP SWDM 4λ Quad TX or Rx



RCP SWDM 2λ Dual XCVR

COTSWORKS®

Serial MM/SM WDM Vs Parallel MM

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.

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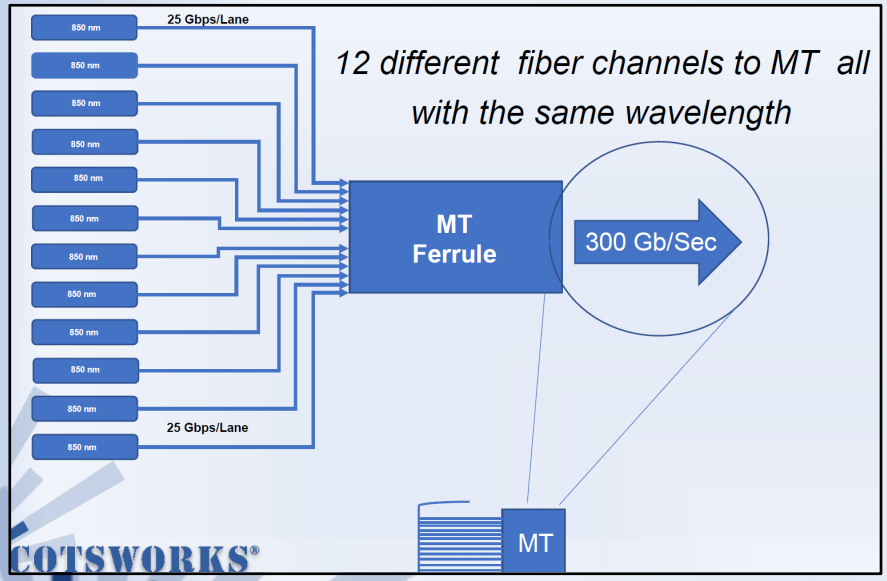
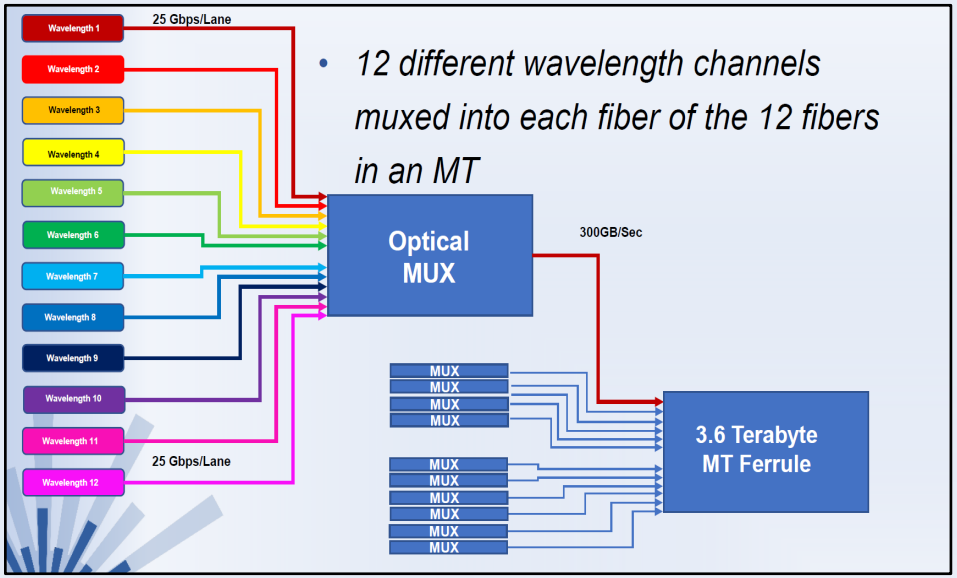
300Gbps to 3.6 Terabytes

- 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





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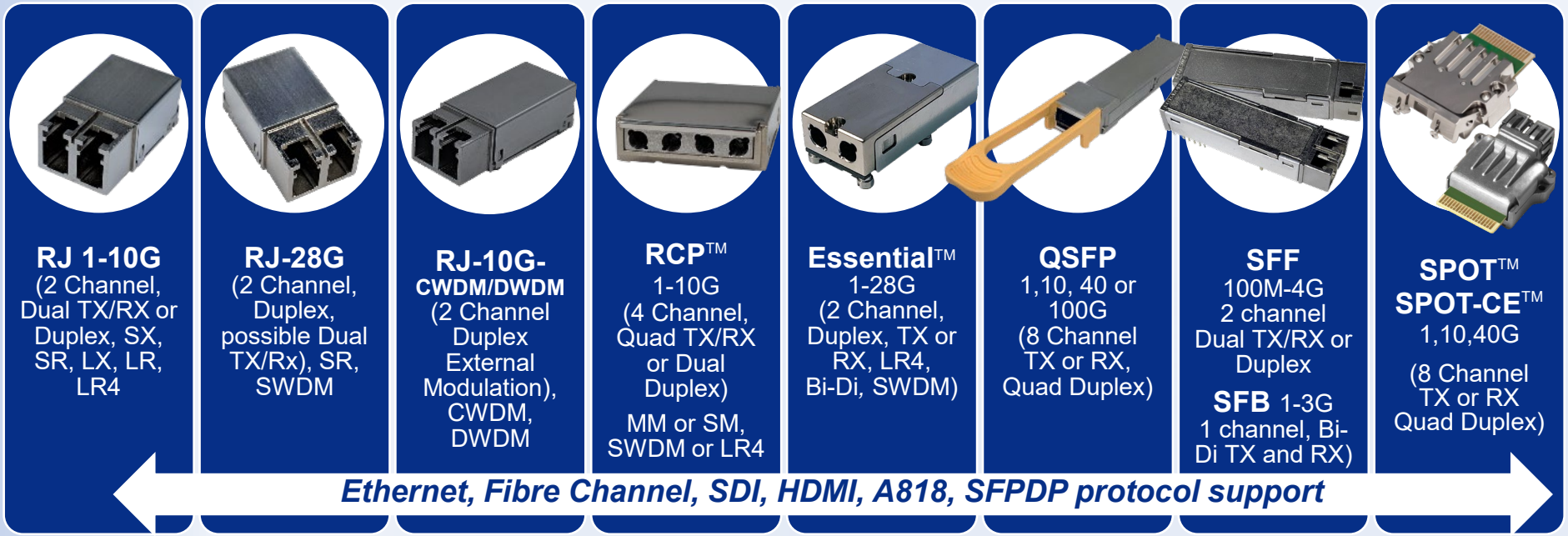
Opto-Electronic Platform



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™
SPOT-CE™
1,10,40G
(8 Channel TX or RX Quad Duplex)

Ethernet, Fibre Channel, SDI, HDMI, A818, SFPDP protocol support

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 + AS9100D CERT-0124317
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 International Standards for Quality Management Systems

FDA/CDRH Laser Safety, Test, and Manufacturing Support

ITAR International Trade and Arms Regulations

ESD Handling Procedures for Facility Testing, Operation, and Certification

Harsh Environment Operation Including Gas & Oil Certification

FOD Foreign Object Debris Procedures for Auditing and Training

Company Information:
EIN/Tax ID: 20-4055028
Vendor License: 18-90016
CAGE Code: 49T62
ECCN: EAR99
ITAR: M37737

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