Benefits of Fiber

August 2017

FUTURE-READY

Telecast FIBER SYSTEMS
A BELDEN BRAND

grass valley
A BELDEN BRAND

Telecast Fiber Systems

2018

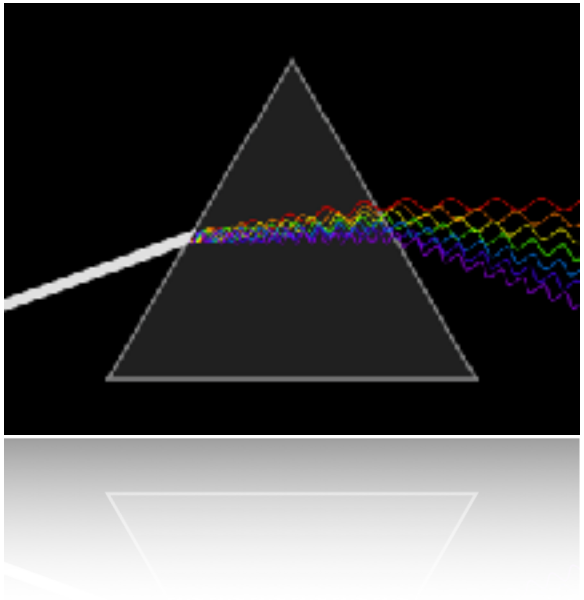
FUTURE-READY

Telecast FIBER SYSTEMS
A BELDEN BRAND

grass valley
A BELDEN BRAND

Agenda

Fiber 101 Overview
Fiber in Broadcast
Multiplexing Signals
Fiber types
Connectivity Options
Maintenance /
Troubleshooting



Typical Live Broadcast Scenario

With and Without Fiber

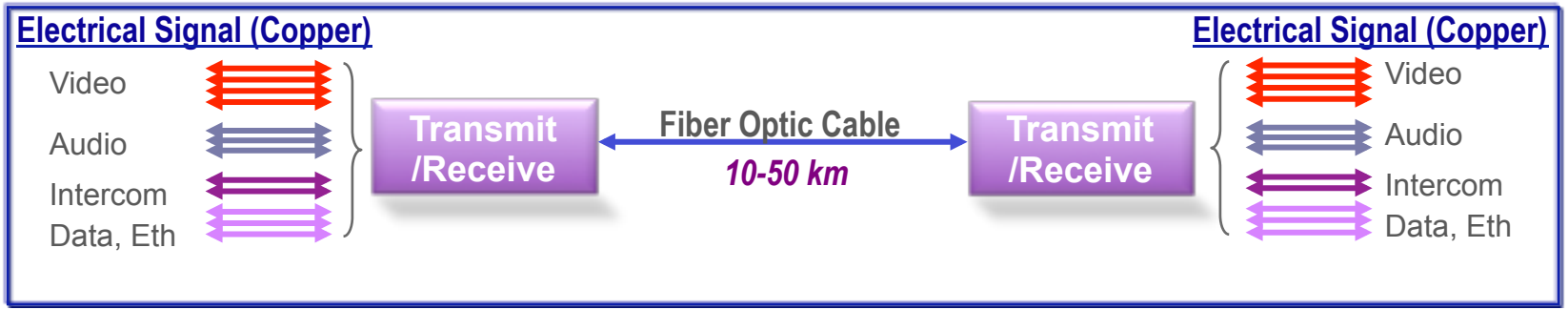
FUTURE-READY

grass valley

A BELDEN BRAND

What is the Fiber Solution series?

- Fiber-based signal multiplexers and transport solutions for sending source-quality signals over long distances
- Primarily for acquisition and production: news, sports and entertainment
- Known as Telecast Fiber Systems founded in 1991, Acquired by Belden in 2009, integrated into Grass Valley production line in 2014
- First product: A portable fiber system for remote TV production
- Allowed long distance camera signal transmission over a single tactical fiber cable



Telecast Product Markets & Applications

Outside Broadcast (OB Trucks)

- Live production of entertainment & sports events
- Contracted to mobile production companies

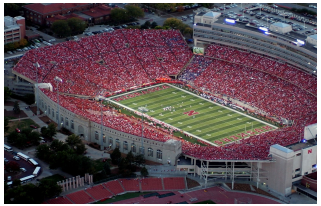
bexel

nep

ESPN

CBS SPORTS

grass valley
A BELDEN BRAND



Large Venues

- Professional & university sports venues
- Venue broadcast infrastructure
- In-house production of events

MASTERS

BOSTON RED SOX

Yankees

COWBOYS

Electronic News Gathering (ENG)

- Live news field coverage
- Multi-camera field production

NBC

abc NEWS

FOX NEWS Channel

KTLA

Government

- Federal, state, and local government executive and legislative branches
- Court houses
- Law enforcement

THE WHITE HOUSE COMMUNICATIONS AGENCY

THE DEPARTMENT OF THE TREASURY 1789

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

Digital Teleproduction

- Digital cinema production (2D, 3D & 4K)
- Non-drama and reality TV production
- Live TV production

3ALITY DIGITAL

WEXLER

PACE
Revolutionize the Experience

PANAVISION

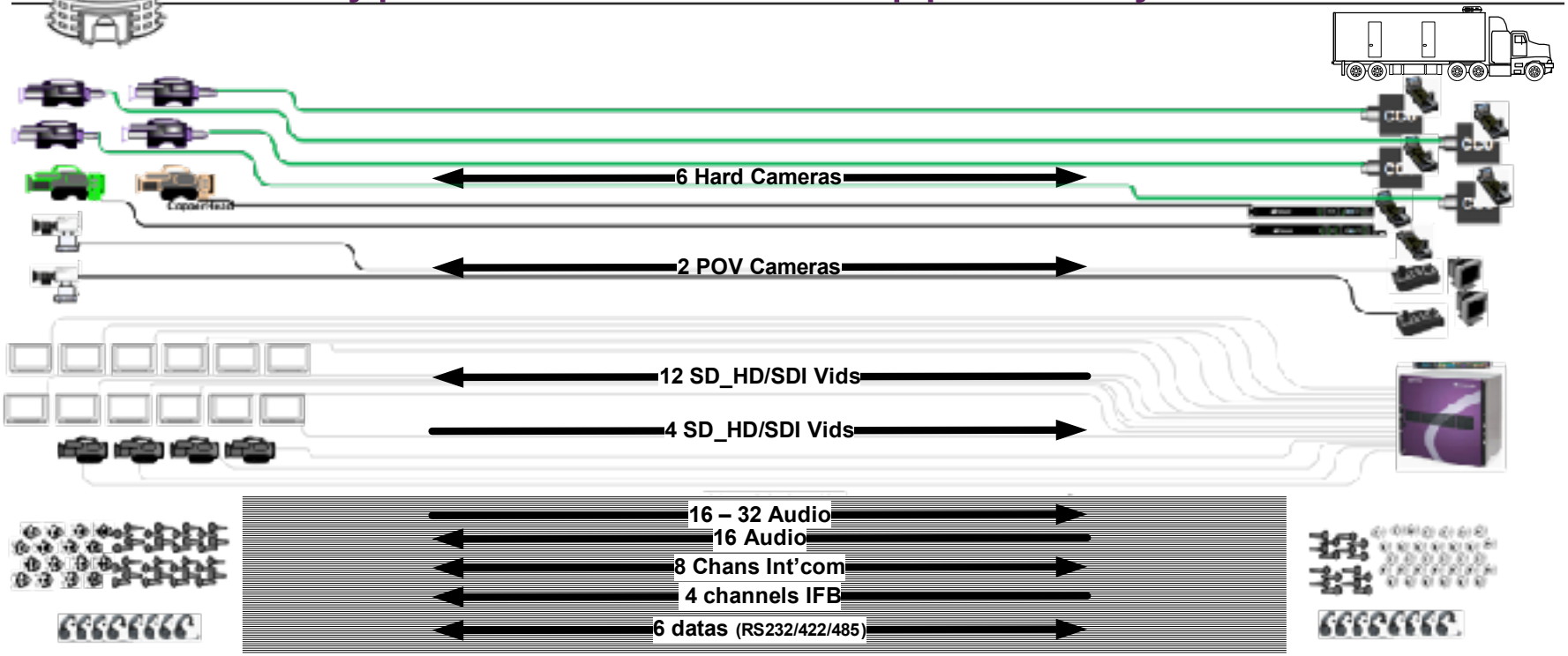
The Solution – Fiber Optics

- Multiple signals can be carried on a single, lightweight fiber optic strand
- Labor savings & utilization – faster set-up and strike
- Transportation costs (shipping & trucking penalties)
- Distance a signal can be carried (no repeaters)

The most comprehensive camera fiber systems

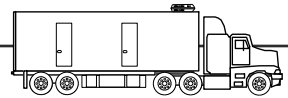
grass valley
A BELDEN BRAND

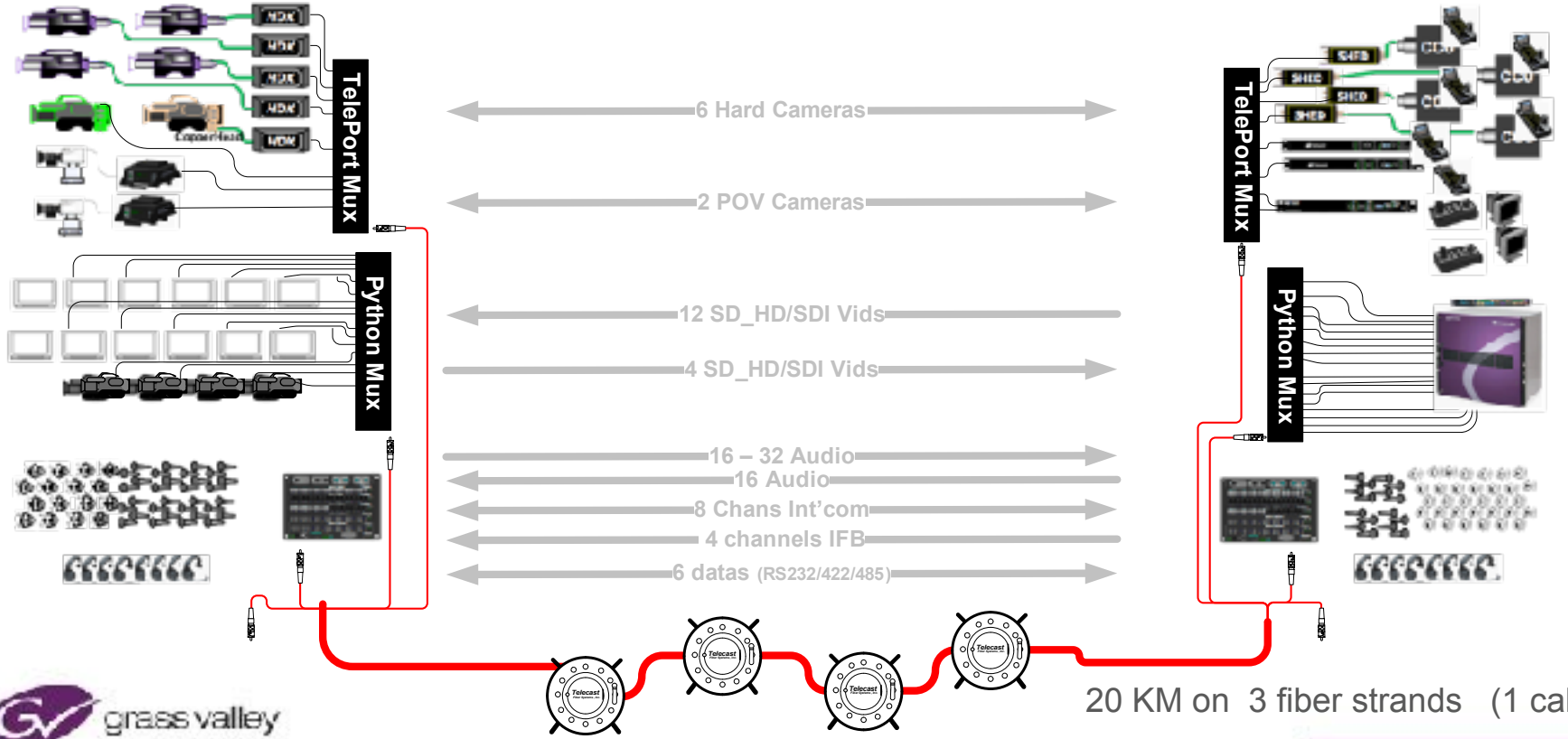
Typical OB Show: Copper & Hybrid



6 Hybrid Fiber cables
2 Tactical Fiber cables
18+ Coax cables
8+ Data cables
56 Audio cables
1 Ethernet cable

Typical OB Show: Muxed Fiber





grass valley
A BELDEN BRAND

Fiber 101

How it works / Review

FUTURE-READY

grass valley

A BELDEN BRAND

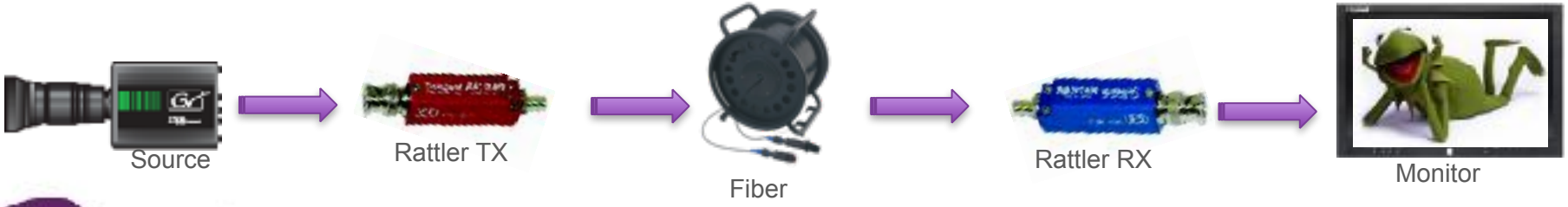
Fiber Optics – Primary Components

Transmitter: converts virtually ANY electrical analog or digital signal into an optical signal.

- If analog, the light source modulates.
- If digital, it flashes really fast!
  More robust transmission in digital

Fiber cable: consists of one or more glass fibers, which act as waveguides for the optical signal.

Receiver: The converts the optical signal back into a replica of the original electrical signal



Why Fiber Optics

JP's Top 10 Reasons Fiber Popularity has grown in Broadcast / Motion Picture Industries

1. Bandwidth
2. Distance
3. Speed of Deployment / Strike
4. Immune to EMI, RFI, Crosstalk & Hum
5. Universal Carrier
6. Limited Space in Conduit
7. Weight – Truck Belly Bay / Shipping
8. Cost of fiber optic electronics declining
9. Robust / Tactical Fiber
10. Future Proofing

Broader Understanding of Fiber Technology

Types of Signals on Fiber

Common broadcast signals can be converted to light and transmitted of fiber

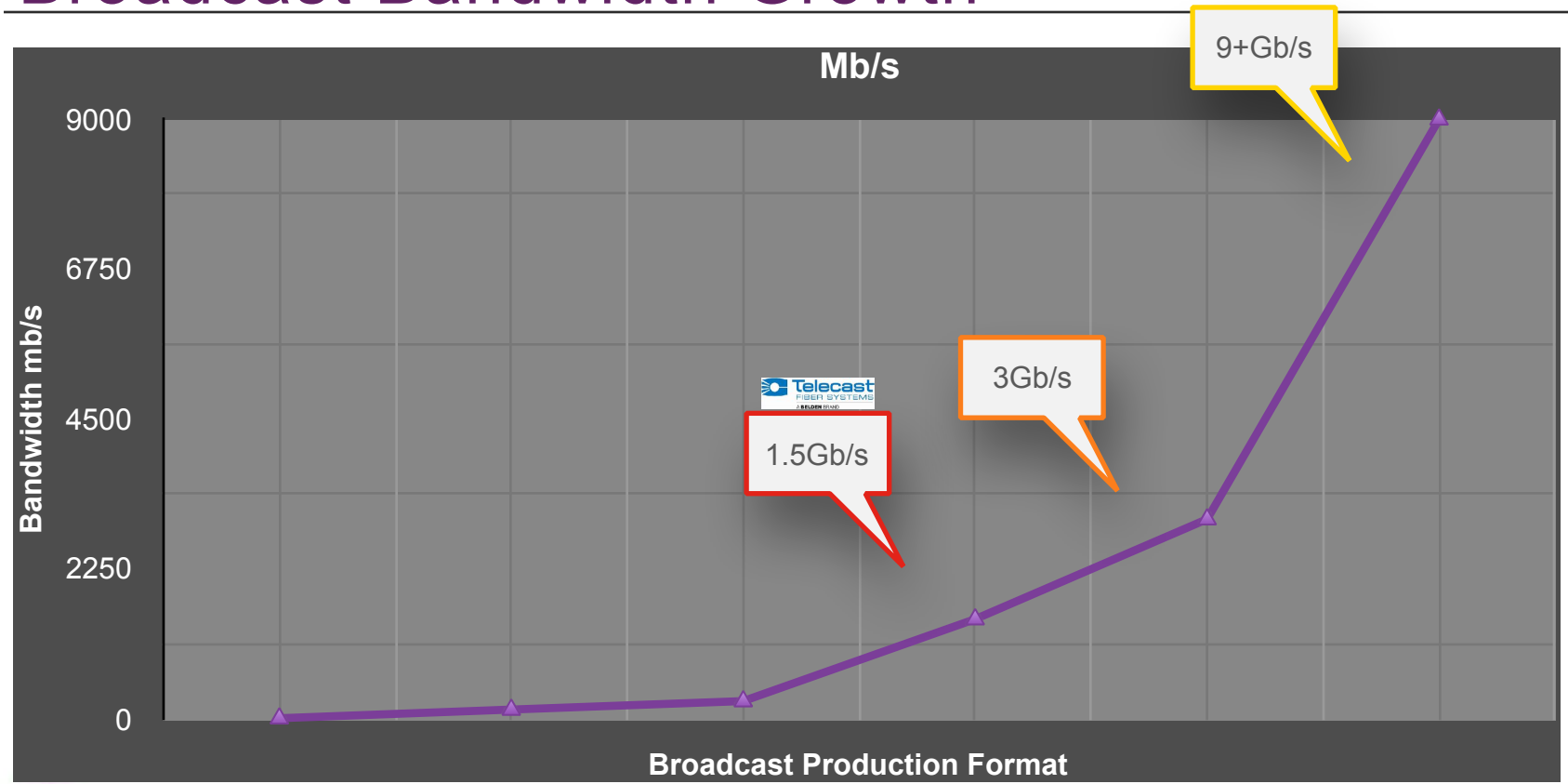
Video

1. Composite video
2. HD/SDI
3. 3G
4. 4K / Ultra HD

Audio

1. Analog Audio (mic/line)
2. AES
3. Intercom

Broadcast Bandwidth Growth



Data Rate:	143 Mb/s		177 Mb/s		270 Mb/s		360 Mb/s		1.5 Gb/s		3.0 Gb/s	
Spec:	SMPTE 259M		ITU R BT. 601		SMPTE 259M		SMPTE 259M		SMPTE 292M		SMPTE 424M	
Application:	Composite NTSC		Composite PAL		Component Serial Video		Component Serial Widescreen		HD-SDI		1080p/50 1080p/60	
	ft.	m	ft.	m	ft.	m	ft.	m	ft.	m	ft.	m
1694DT	500	152	450	137	300	91	340	104	110	34	60	18
1855A	1100	340	700	220	980	300	1120	340	120	37	N/A	N/A
8279	910	277	810	247	640	195	N/A	N/A	N/A	N/A	N/A	N/A
1855A-7737A	800	250	650	200	790	240	930	287	250	78	150	46
1855P	980	301	897	274	742	226	843	196	105	32	100	30
9259	1035	314	980	299	750	229	N/A	N/A	N/A	N/A	N/A	N/A
9259A	1010	308	960	293	690	209	N/A	N/A	N/A	N/A	N/A	N/A
1505A, 7744A	1140	4498	1980	415	1110	338	970	296	310	94	220	67
1505F	1300	304	1040	317	830	253	710	216	215	66	145	44
1506A	1300	497	1300	396	940	286	810	247	254	77	168	52
9231	1482	436	1270	387	1000	305	N/A	N/A	N/A	N/A	N/A	N/A
9141	1482	420	1270	387	1000	305	N/A	N/A	N/A	N/A	N/A	N/A
8281	1482	436	1280	390	1000	305	N/A	N/A	N/A	N/A	N/A	N/A
8281D	1482	436	1270	387	1000	305	N/A	N/A	N/A	N/A	N/A	N/A
8281F	1350	381	1160	353	891	272	N/A	N/A	N/A	N/A	N/A	N/A
1694A-7710A	1640	500	1410	431	1430	436	1240	378	400	122	270	82
1694T	1500	457	1960	415	1270	328	970	277	255	57	190	58
1695A	1700	518	1350	412	1270	387	1560	337	310	94	220	67
7731A	2700	820	2460	750	2040	622	1990	530	350	106	360	110
7732A	2625	800	2960	710	1800	686	1540	500	440	134	270	82

The serial digital interconnect standards are designed to operate where the signal loss at 1/2 the clock frequency does not exceed the approximate loss value listed below.

Maximum length = 35 dB loss at 1/2 the clock frequency: SMPTE 259M, PAL, Widescreen
Maximum length = 20 dB loss at 1/2 the clock frequency: SMPTE 292M

Fiber Optic Design

Basic Principles / What Signals / How Many Strands

FUTURE-READY

grass valley

A BELDEN BRAND

Fiber Optic Design for Broadcast

Fiber Design Considerations & Questions

- What types of signals do you need to move?
- What direction? (one way or bidirectional)
- How far? (across campus, small studio)
- What fiber do you have currently in your facility?
- How many strands?
- Power? (SMPTE 311)
- Fiber Connectors (existing vs. new)
- Application? (live sports, news, fly pack, installed)
- Budget?

3ality Technica 3D Live Broadcast

From Point A to Point B….What do I Need?

One size fits all solution?

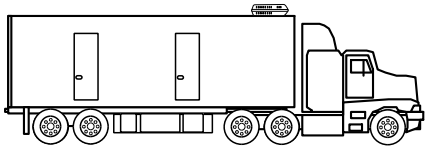
- Is there one product to satisfy my needs
- Is the solution made up out of multiple products
- Scalable
- Variations (product or fiber dependent)

Project Scope?

- Simple
  - Single signal over one strand
  - One type of signal (HD, Audio)
- Complex
  - Single control room/multiple venue
  - CWDM

Determining a Fiber Solution

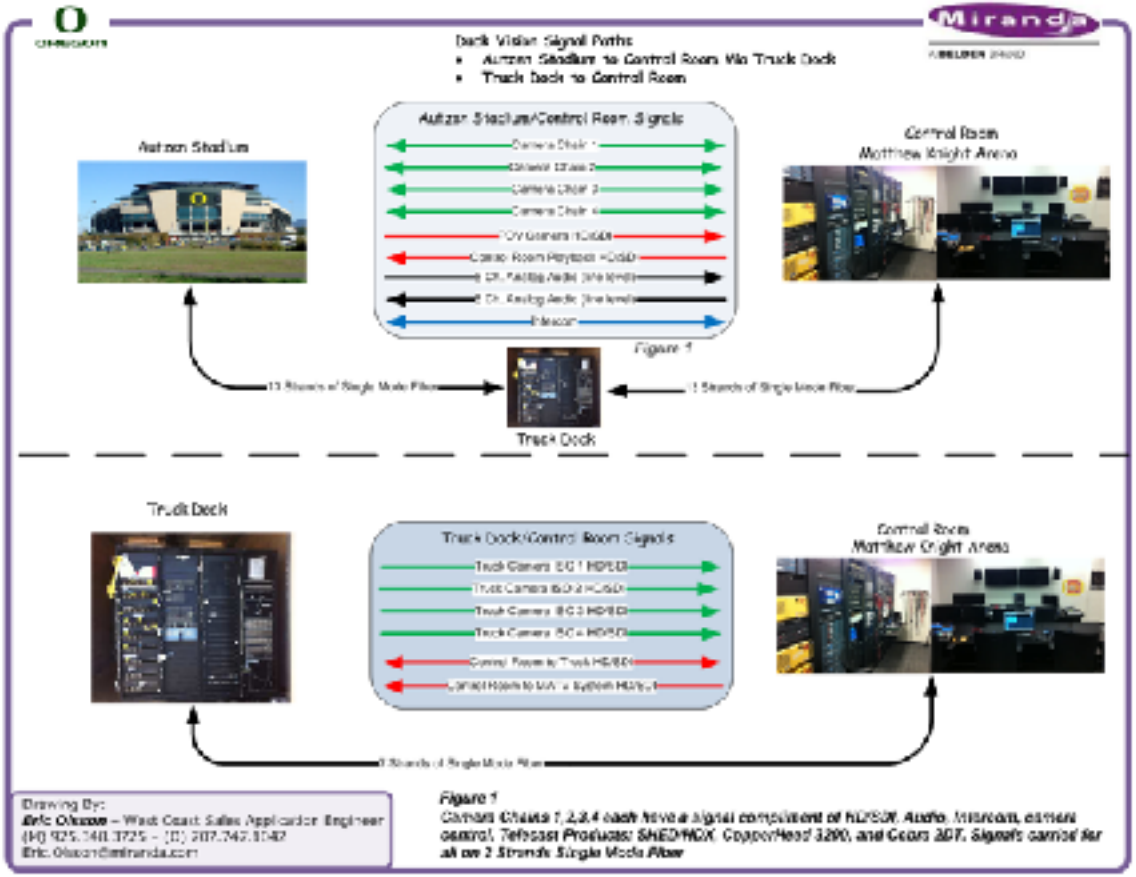
HD/SDI
HD/SDI
HD/SDI
HD/SDI
Analog Audio (x6)
Analog Audio (x2)
Intercom
DATA- RS232,422, Ethernet



How Many Strands?

Budget Restrictions?

Sample Configuration Drawing



Fiber Science

Under the Hood

FUTURE-READY

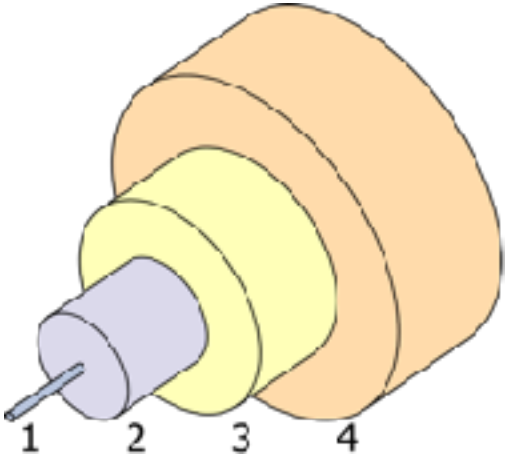
grass valley

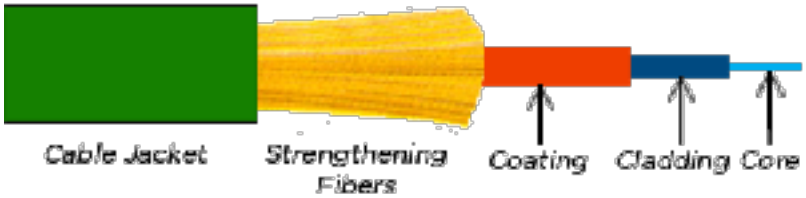
A BELDEN BRAND

Fiber Properties

The structure of a typical single-mode fiber.

1. Core 8 µm diameter
2. Cladding 125 µm dia.
3. Buffer 250 µm dia.
4. Jacket 400 µm dia.

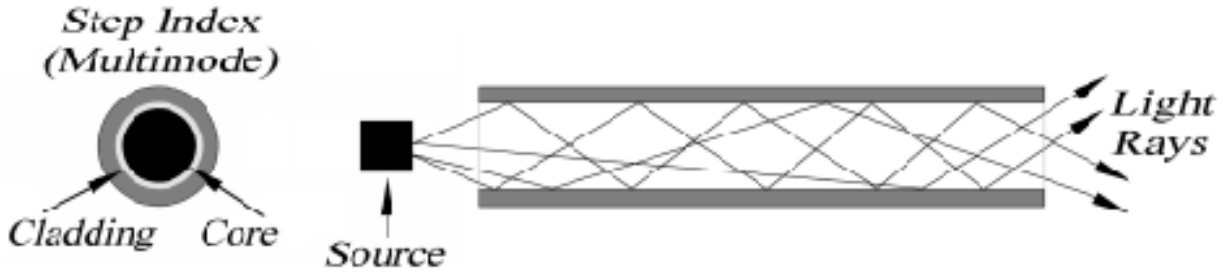




Multi-Mode Vs. Single Mode Fiber

Multi-Mode Fiber

62.5 Micron
or 50 Micron

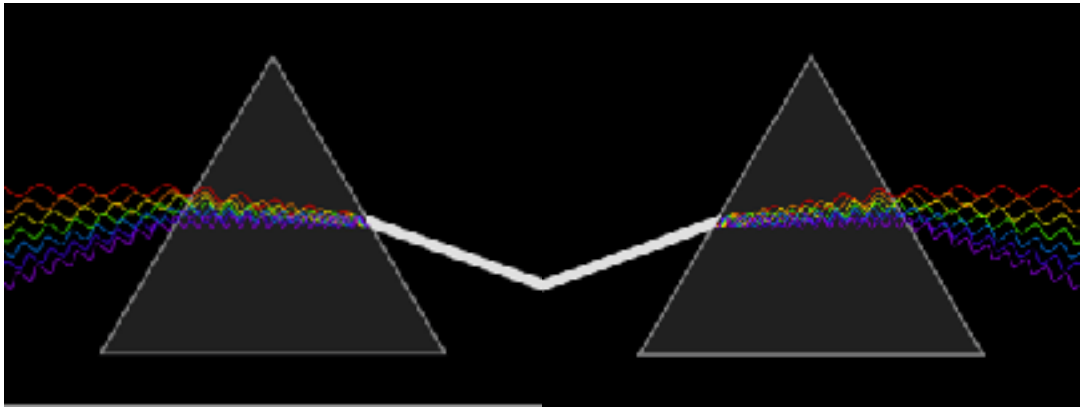


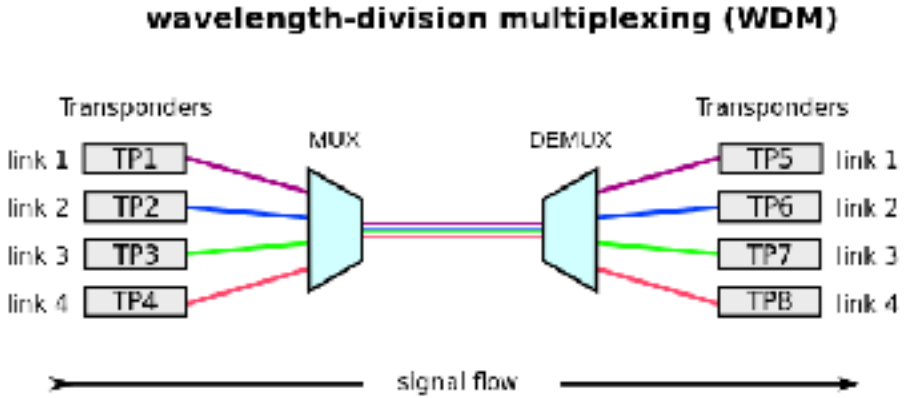
Single Mode Fiber

8 Micron
The thickness of a human hair

Fiber Drivers SFP

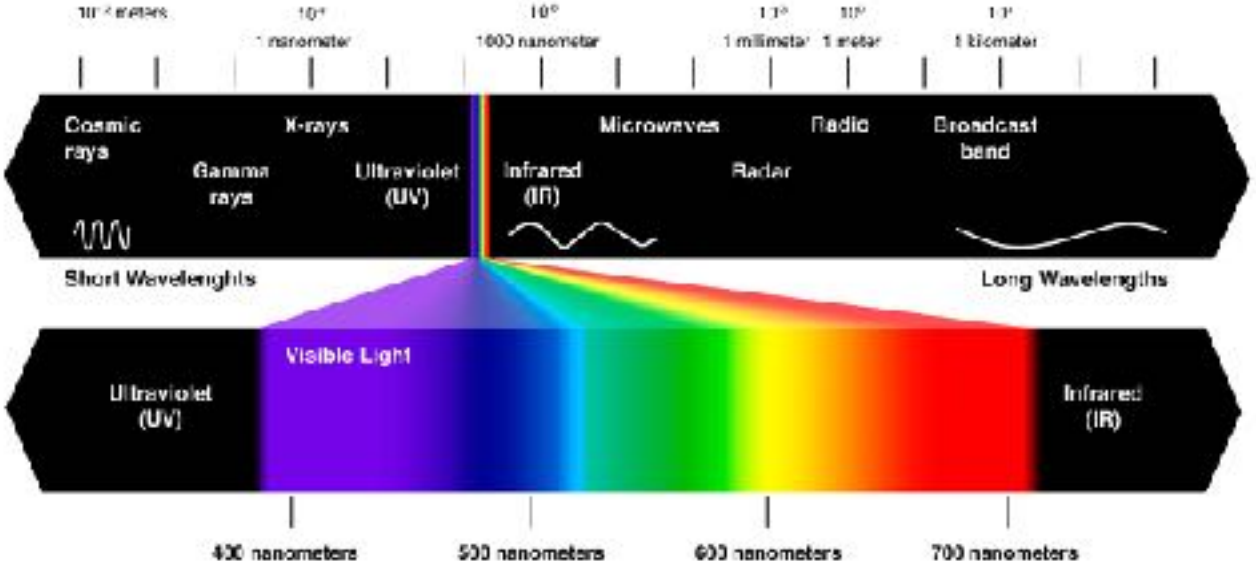
Multiplexing / Muxing





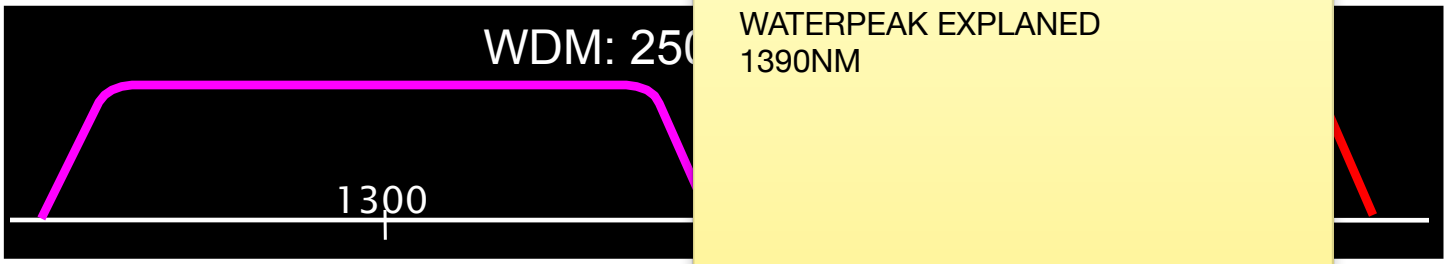
Typical Broadcast Wavelenths

- Infrared Light 850nm / 1300nm / 1550nm
- Wide Band, CWDM Wavelengths
- -10db to +0 to 3db optical power



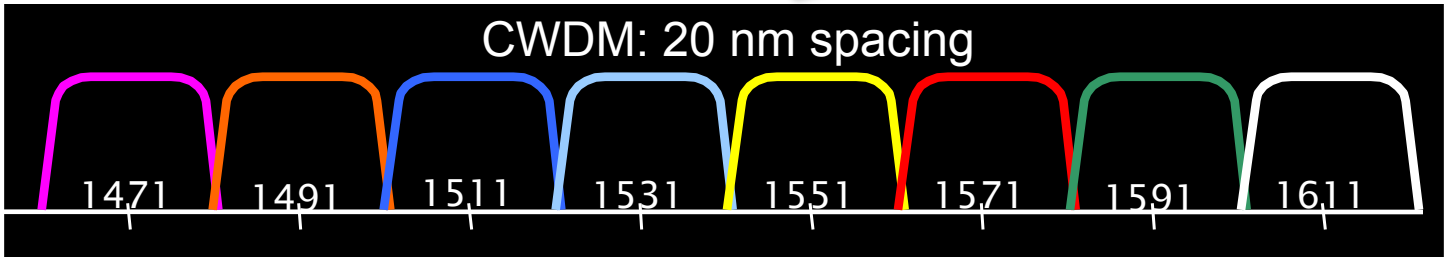
WDM /CWDM

Wave **D**ivision **M**ultiplexing

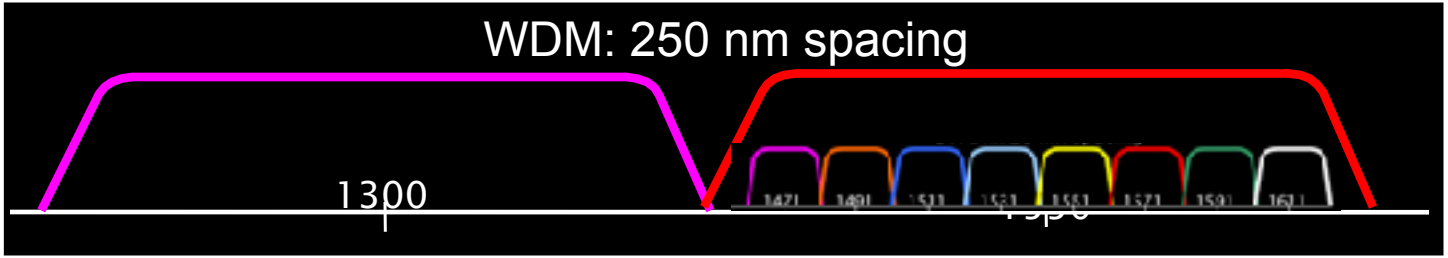


WATERPEAK EXPLANED
1390NM

Course **W**ave **D**ivision **M**ultiplexing



CWDM



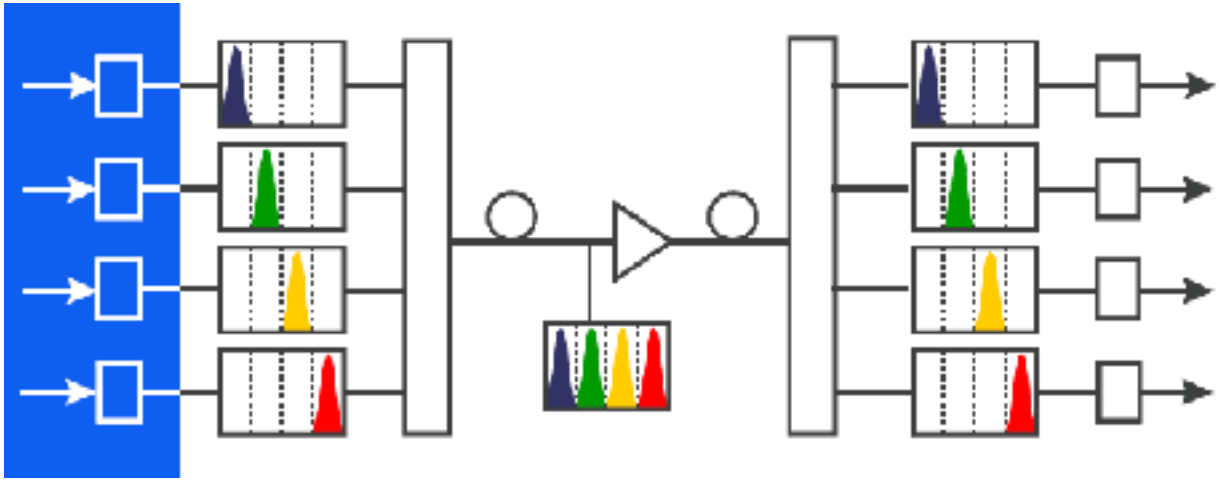
250nm spacing is cut up into 20nm increments

Band 1 (red band) 1471 / 1491 / 1511 / 1531 / 1551 / 1571 / 1591 / 1611

Band 2 (blue band) 1271 / 1291 / 1311 / 1331 / 1351 / 1371 / 1391 / 1411 / 1431 / 1451

Combines / separates 8 channels with a 20 nm spacing

CWDM



Combines / separates 8 channels with a 20 nm spacing

Multiplexing over Fiber

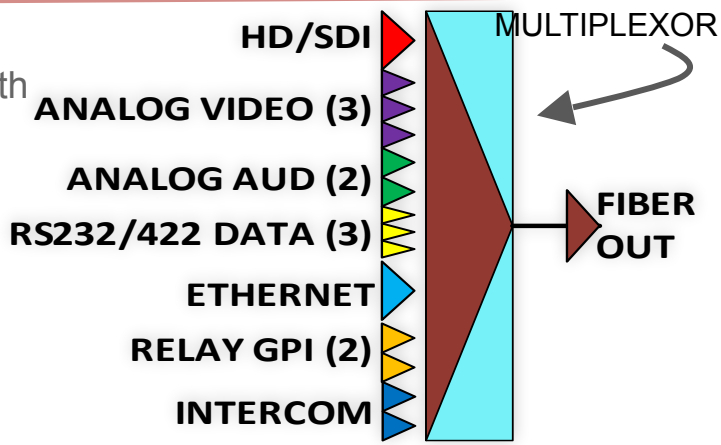
- **Electronic Multiplexing**

Combines multiple signals digitally, converts to a single wavelength

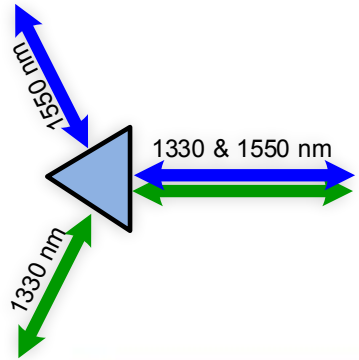
- Time Division Multiplexing (TDM)
- Frequency Division Multiplexing (FDM)

Example: Telecast's CopperHead

- **Combines many signals <u>electronically.</u>**

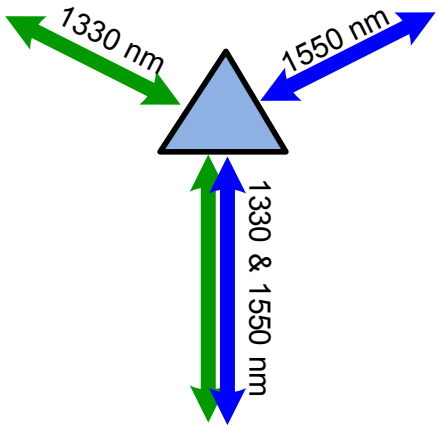


- **Wave Division Multiplexing**
  - WDM, CWDM
  - Optically combining several wavelengths of light
  - Passive process - combines and decombines light (Passive Prism)

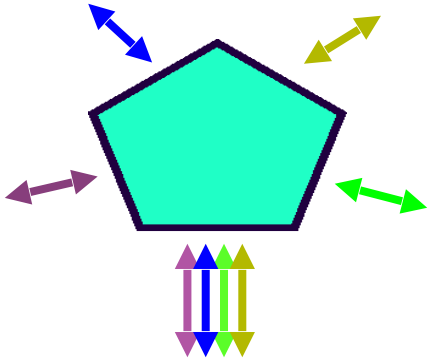


Wave Division Multiplexing

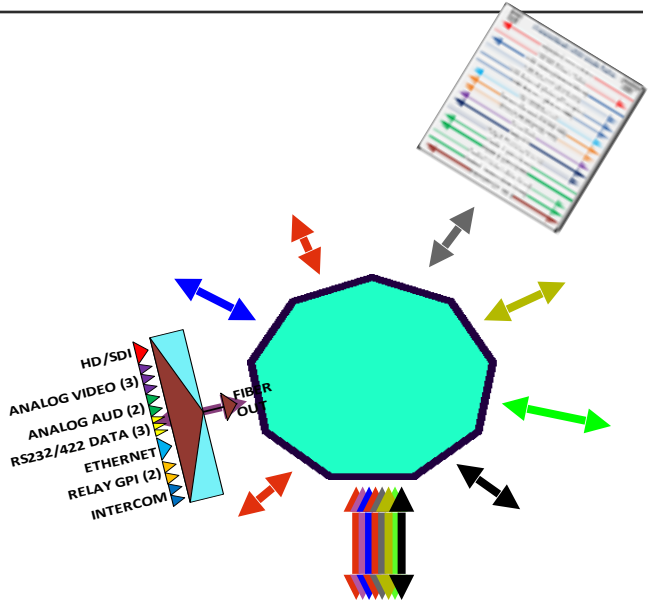
- WDM - 2 channels
- Coarse WDM (CWDM) – 4, 8,16, 18 channels



2 Channel WDM
1300 nm, 1550 nm



4-Channel CWDM
ex: 1511, 1531, 1551 & 1571 nm



8-to 18 Channel CWDM
ex: 1471, 1491, 1511, 1531, 1551, 1571, 1591 & 1611 nm

Calculate the Link Budget

- **Calculation: Output of the transmitter minus maximum receiver sensitivity**

Example:

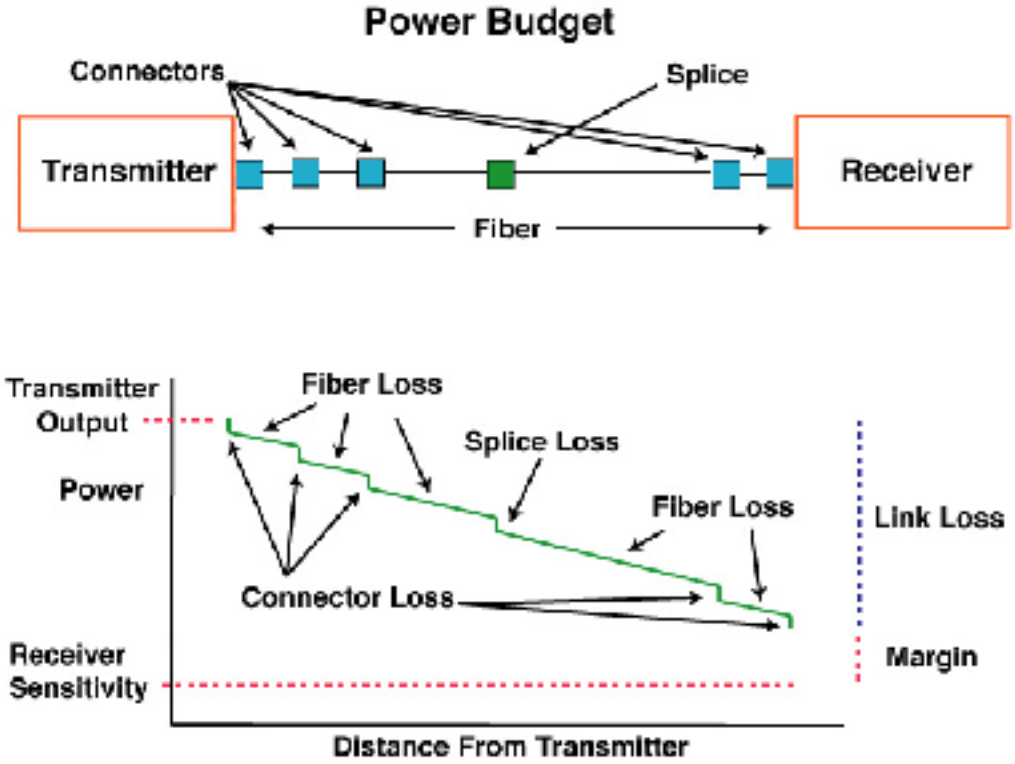
Transmitter:
Output power = -7 dB

Receiver:
Sensitivity = 0 to -22 dB

Calculation: -7 - -22 =
-7 + 22 =
22 – 7 = 15dB

Base Link Budget is 15dB

Calculating Optical Budget



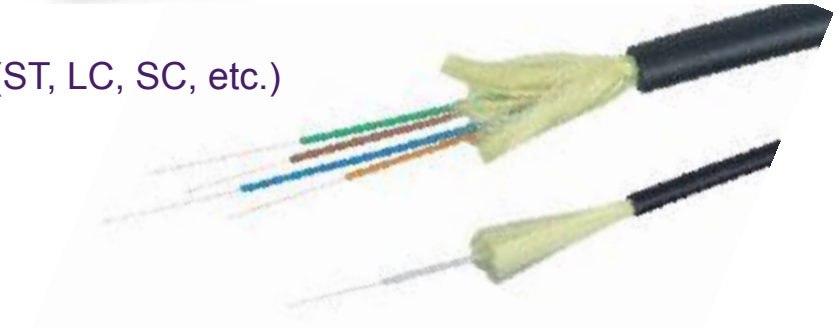
Connectivity

FUTURE-READY

grass valley

A BELDEN BRAND

- Military Spec: tougher than triax, coax or wire cables
- Kevlar Reinforced
- TAC1, TAC2, TAC4, TAC6, TAC12
- OX™ Reel, comes in 3 sizes SM, MD and XL
- Various connector options: MX, OpticalCON, Breakouts (ST, LC, SC, etc.)
- For field deployment, not infrastructure use



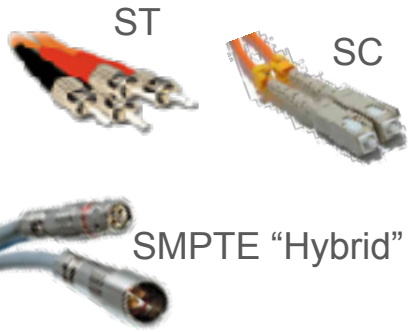
MX Expanded Beam

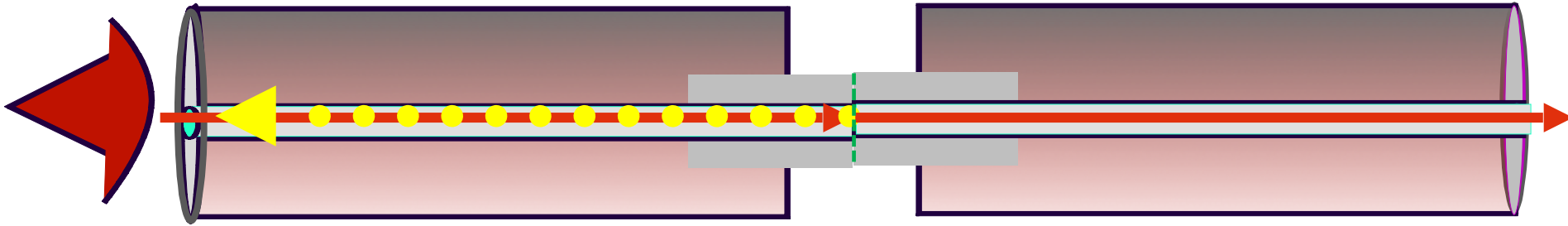
Neutrik OpticalCON

grass valley
A BELDEN BRAND

Connections: Flat Polish

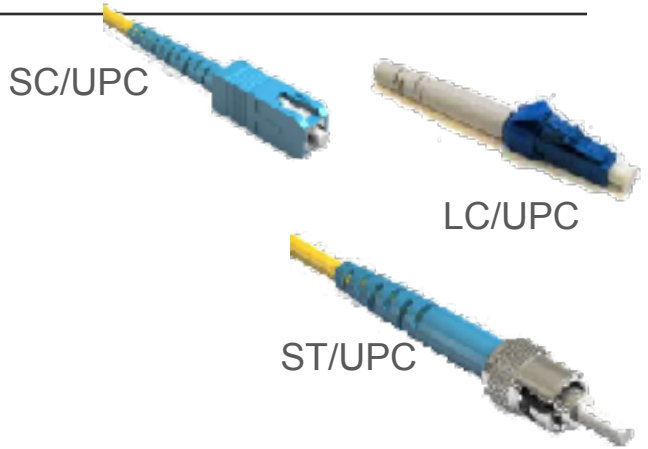
- ST, SC, LC, SMPTE Hybrid
- Critical Alignment – butted together at 8 Microns!
- Back Reflections: up to 4% of the light reflected back to the source
- Average return loss: -40dB

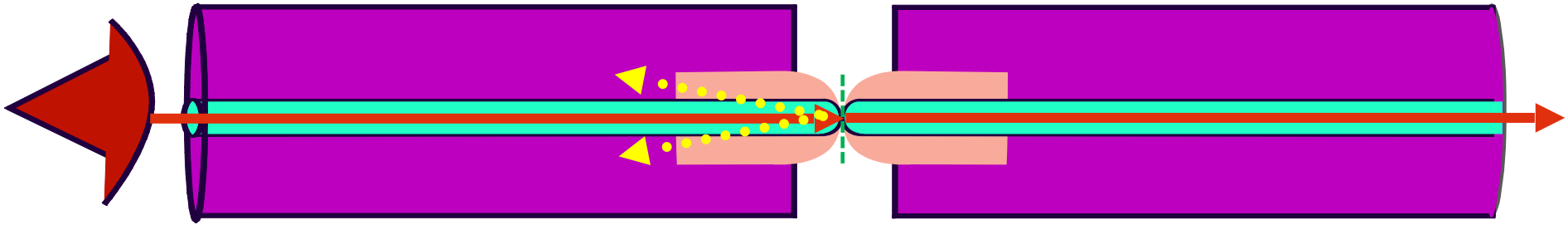




Connections: Ultra Polish

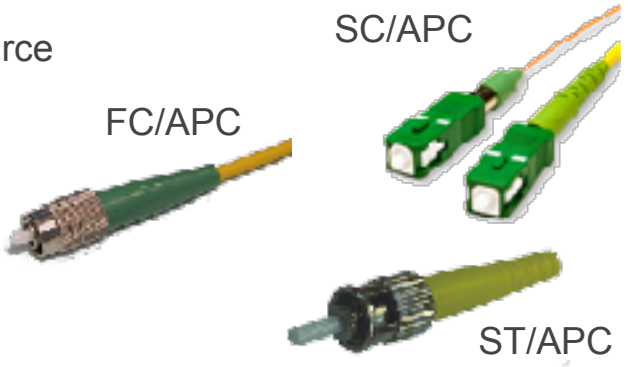
- ST, SC, LC, FC
- Back Reflections: up to .001% of the light reflected back to the source
- Average return loss: -55dB
- Blue denotes “UPC” for “Ultra-Polished Connector”

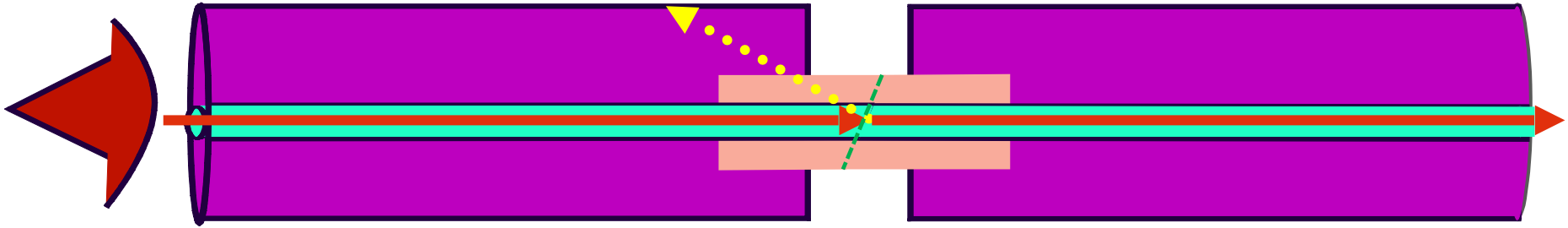




Connections: Angle Polish

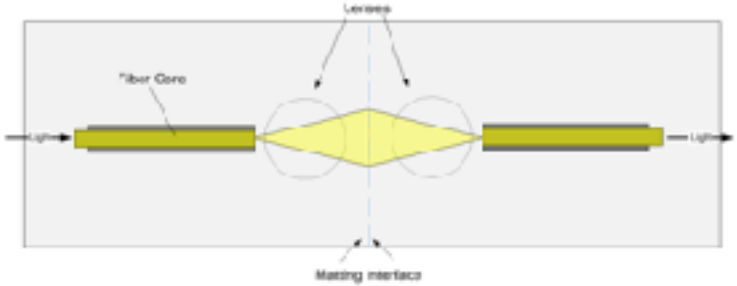
- Ferrule cut at 8-degree angle
- Back Reflections: up to .00032% of the light reflected back to the source
- Average return loss: -65dB
- Green denotes “APC” for “Angle-polished Physical Contact”





Harsh Environment Connectors

MX Expanded Beam Connector

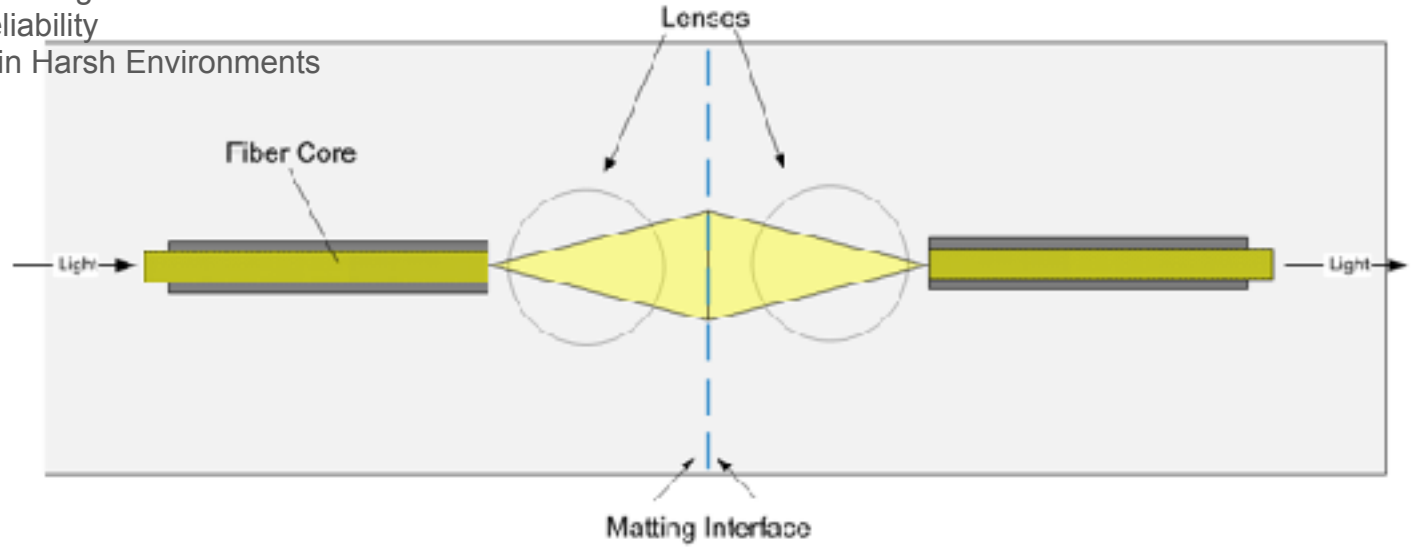


Neutrik OpticalCON Duo/Quad

MX Mini-Expanded Beam Connector

TAC Fiber Only

- TAC 2 (2 Lens)
- TAC 4 (4 Lens)
- Expanded Beam Technology
- Multimode or Singlemode
- Hermaphroditic Operation
- Plug, Jam-Nut, Flange Mount
- Easy Cleaning
- High Reliability
- Proven in Harsh Environments



Neutrik OpticalCON Connector

- OpticalCON system is based on LC-Duplex connectors
- Duo – TAC 2
- Quad TAC 4
- Duo with Copper (powered) SMPTE Hybrid Fiber
- Eliminates LC weakness by Harsh Environment Housing
- Dust protected and rugged connection
- User Flexibility LC Design
- In use since 2005

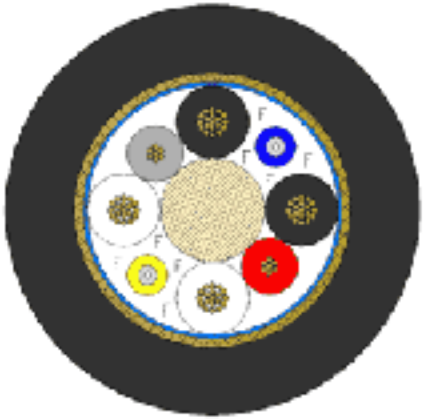
opticalCON DUO

opticalCON QUAD

Hybrid Fiber Cable: SMPTE 311M

Single Mode Fiber + Power

- Two Single Mode fibers for HD plus all other signals
- Four Large Copper Conductors for High-Voltage power
- Two Smaller Copper Conductors for Low-Voltage “signal” (safety interlock)
- 16 gage steel strength member
- One SMPTE Standard Connector: SMPTE 304M
- One other common connector: OpticalCON



COMPONENT DESCRIPTION	QTY
[illegible]	1
AUXILIARY COND. (BLACK)	2
AUXILIARY COND. (WHITE)	2
[illegible]	1
SIGNAL COND. (RED)	1
[illegible]	1
SINGLEMODE FIBER (YELLOW)	1
FILLER (F)	AS NEEDED
[illegible]	1
COPPER BRAID	1
JACKET (BLACK)	1

OpticalCON

SMPTE 304M

grass valley
A BELDEN BRAND

Keep it Clean!

Particle Migration:

- Repeated matings cause large particles break apart and migrate
- Dirt can spread from the cladding to the core after successive matings
- Dirt mated between connectors can be permanently embedded in the glass, making cleaning impossible
- Major loss of optical budget

Fiber Maintenance

#1 Field Issue with Fiber = DIRT

- Clean all connectors and connection points
- Many cleaning tools and fiber cleaning products
- Wet / Dry Cleaning
- Wet Cleaning
- Dry Cleaning

Wet / Dry Solution Cleaning Kit

ElectrO-Wash Wipes

IBC Click Cleaning Tool

1. Simplex or Duplex
2. ST, SC
3. LC
4. SMPTE 304M

Fiber Troubleshooting Tools

Tools for troubleshooting on set fiber issues

- An **optical power meter** (**OPM**) is a device used to measure the power in an optical signal. Many cleaning tools and fiber cleaning products
- **Visual Fault Locator** works as an end-to-end cable continuity tester that helps you diagnose and repair fiber link problems
- An **optical time-domain reflectometer** (**OTDR**) is an instrument used to characterize an optical fiber.

Optical Power Meter

Optical Fault Locator

OTDR- optical time-domain reflectometer