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Campus & Data Centers – Why Ribbon Technology Works for You

Characteristics and Benefits of Ribbon Fiber & Ribbon Cables

By

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Andrew Shire

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History of Fiber Cable

Long History of Successful Deployment

Over 35 years of successful deployment provides assurance that the technology is solid, reliable …

History of 30 years

1980

Ribbon Slotted Core Cable

Primarily 4, 8, 12 fiber ribbons

Smaller diameter
High fiber count

1990

Mass Ribbon Fusion Splicer

40mm

1000-Fiber Ribbon "Multi" Slotted Core Cable

1000-Fiber Ribbon "Single" Slotted Core Cable

28mm

Mid-span access

ROL stranded core

2000

Small diameter and Light weight 1000-Fiber Ribbon Slotted Core Cable

23mm

Single fiber operation

Enhanced Peelable Ribbon

Easy Accessibility Cable

Progress in Workability

2010

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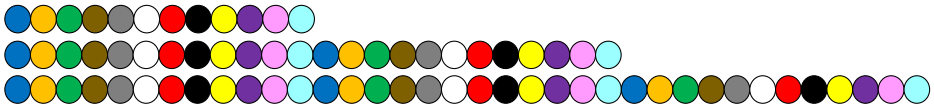
Ribbon Fiber & Identification

Easy Identification	Standard color codes and print string on ribbon make identification easy. Many more fibers installed in less time, terminated faster and proven reliability show why ribbon growth has been explosive.



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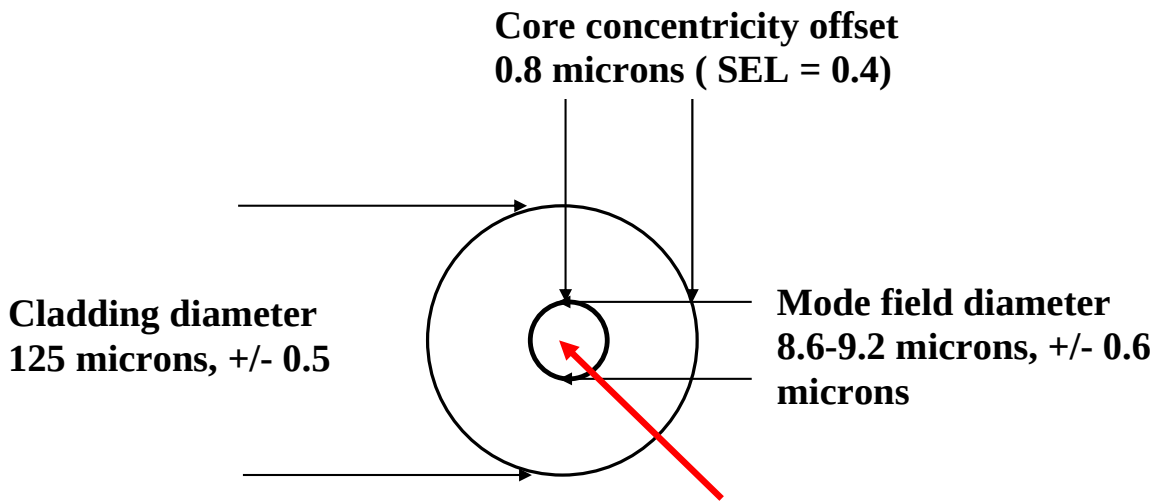
Optical Fiber Specifications & Guidelines

FIBER TYPE	ITU	TIA DETAIL	ISO/IEC
50um Multimode Fiber	G.651	492AAAB 492AAAC-A	11801
62.5um Multimode Fiber	G.651	492AAAA	11801
Non-Dispersion Shifted Single Mode Fiber	G.652B	492CAAA	60793-2-50 B1.1
Non-Dispersion Shifted Single Mode Fiber with "Zero Water Peak"	G.652D	492CAAB	60793-2-50 B1.3
Dispersion Shifted Single Mode Fiber	G.653B	492DAAA	60793-2-50 B2
Cut-Off Shifted Fiber	G.654C	see ITU	see ITU
Non-Zero Dispersion Shifted Single Mode Fiber (NZDSF)	G.655C	492EAAA	60793-2-50 B4
	G.655D	492EAAA	60793-2-50 B4
	G.655E	492EAAA	60793-2-50 B4
Non-Zero Dispersion Shifted Wideband Transport Fiber (NZWTF)	G.656	see ITU	60793-2-50 B5
Bend-Insensitive Single Mode Fiber	G.657A1	see ITU	60793-2-50 B6A
	G.657A2	see ITU	60793-2-50 B6A
	G.657B2	see ITU	60793-2-50 B6B
	G.657B3	see ITU	60793-2-50 B6B

ITU – T G.652D

Uniformity of Fiber in Ribbon	Ribbons manufactured with fiber which adhere to the standards provide compatibility… The core concentricity offset allows ribbon to be spliced uniformly

STANDARD SINGLE MODE FIBER



Bend Insensitive Fibers are typically at the low end of the mode field measurement, 8.6 microns, or better.

Evolution of Fiber Optic Ribbon Based Cable

	ITU-T G.652.D Max. / Typical	ITU-T G.657.A1 Max. / Typical	ITU-T G.657.A2 Max. / Typical
General			
Type	Single Mode	Single-Mode	Single-Mode
Refractive Index Profile	Matched Clad	Matched Clad	Matched Clad
Manufacturing Process	VAD	VAD	VAD
Dimensional			
Cladding Diameter	125.0 ± 0.5 um	125.0 ± 1.0 um	125.0 ± 1.0 um
Cladding Non-circularity	< 0.5 %	< 1.0 %	< 1.0 %
Core to Cladding Concentricity	≤ 0.4 um	≤ 0.4 um	≤ 0.4 um
Coating Diameter	245 ± 5 um	245 ± 10 um	245 ± 10 um
Transmission			
Typical Uncabled Attenuation (1310/1550 nm)	≤ 0.31 / 0.19 dB/km	0.40dB/km @ 1310 0.22 dB/km @ 1550 nm 0.25 dB/km @ 1625 nm	0.40 dB/km @ 1310nm 0.37 dB/km @ 1380 nm 0.22 dB/km @ 1550 nm 0.25 dB/km @ 1625 nm
Attenuation Point Discontinuities	≤ 0.10 dB	≤ 0.10 dB @ 1550 nm	≤ 0.10 dB @ 1550 nm
Cabled Cutoff Wavelength	≤ 1260 nm	≤ 1450 nm	≤ 1300 nm
Mode Field Diameter	9.2 ± 0.4 um @ 1310nm Typ. 10.4 ± 1.0 um @ 1550 nm	9.2 ± 0.50 um	8.3 ± 0.50 um
Zero Dispersion Wavelength	1302 - 1322 nm	≤ 1450 nm	≤ 1450 nm
Zero Dispersion Slope	≤ 0.090 ps/(nm^2 km)	< 0.060 ps/(nm^2 km)	< 0.05 ps/(nm^2 km)
Polarization Mode Dispersion	< 0.2 ps/ km$^{1/2}$	< 0.2 ps/ km$^{1/2}$	< 0.2 ps/ km$^{1/2}$
Mechanical			
Proof Test	120 kpsi	100 kpsi	125 kpsi
Environmental (as fiber)			
Temperature (-60 to 85°C)	≤ 0.05 dB/km @ 1310/1550 nm	≤ 0.05 dB/km @ 1550 nm	≤ 0.05 dB/km @ 1550 nm
Temp-Humidity	≤ 0.05 dB/km @ 1310/1550 nm (-10 ~ 85°C / 30 ~ 98% RH)	≤ 0.05 dB/km @ 1550 nm (-40 ~ 85°C / 30 ~ 98% RH)	≤ 0.05 dB/km @ 1550 nm (-40 ~ 85°C / 30 ~ 98% RH)

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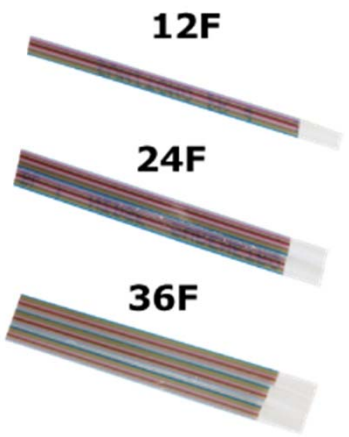
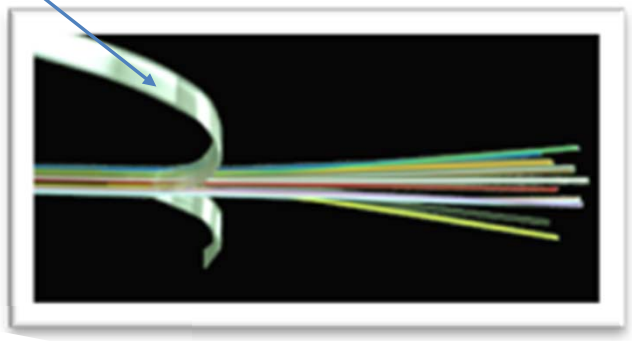
Ribbon Competitive Advantage

Easy Peel Technology

The most user friendly ribbon is craft friendly…. Strips faster and easier for speed of termination

- Fibers separate easily, cleanly - improves productivity, no additional cleaning of fibers necessary
- Provides for access to individual fibers easily
- Various fiber counts available – Flexibility
- Supports 1G/10G with 12F based ribbons, 40G/100G/400G with 8F based ribbons





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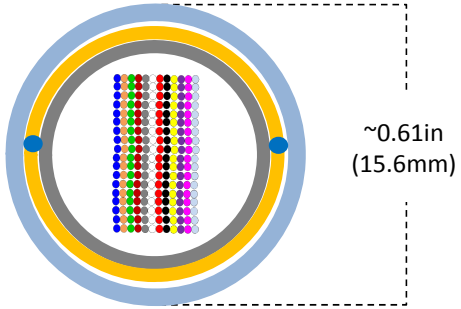
Advantages of Standard Fiber Optic Ribbon Cable

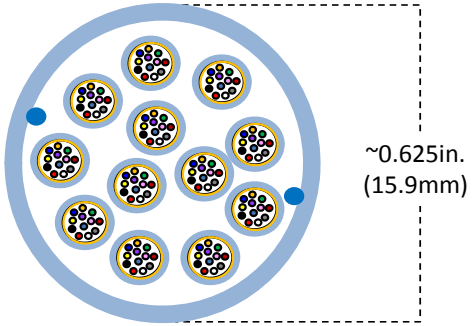
Greater Fiber Packing Density

For indoor rated cables with fiber counts of 144 or greater the fiber packing density with fiber optic ribbon based central tube cables exceeds that of typical loose tube construction…

216ct Ribbon Central Tube Cable



144ct 250um Loose Tube Cable



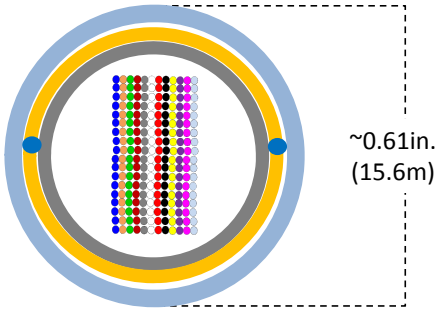
At these counts and higher the smaller OD ribbon based cable allows for better utilization of cable trays and cable management

Advantages of Standard Fiber Optic Ribbon Cable

Greater Fiber Packing Density Cable OD

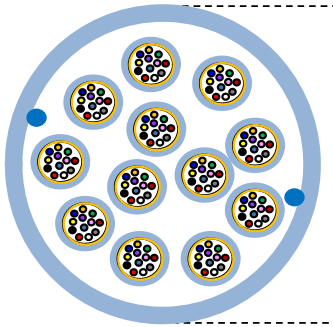
Comparing ribbon cables to loose tube or tight buffer cable constructions the fiber count per cable OD is significantly greater for the ribbon based central tube cable construction…

216ct Ribbon Central Tube Cable



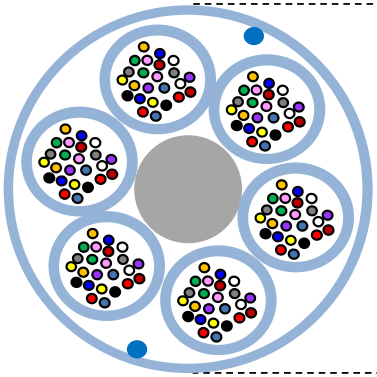
~0.61in. (15.6m)

144ct 250um Loose Tube Cable



~0.625 in. (15.9m)

144ct 900um Tight Buffer Cable



~0.93in. (23.6m)

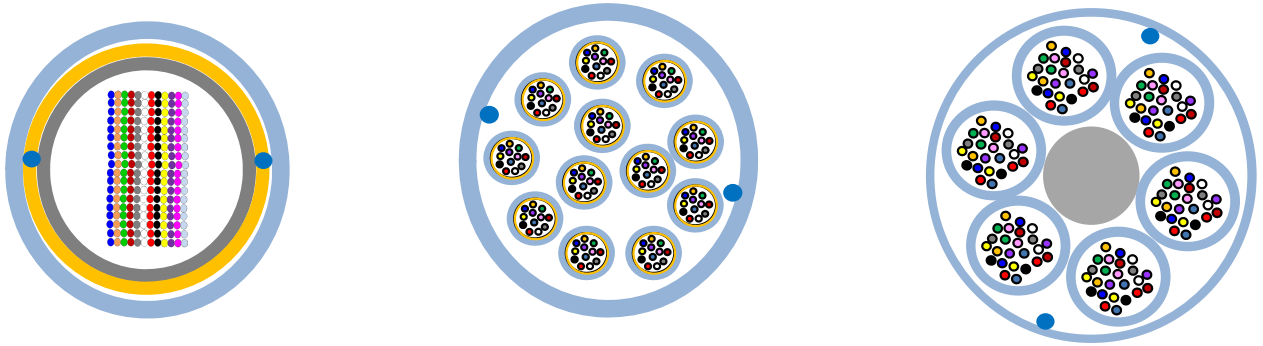
At these counts and higher the smaller OD ribbon based cable allows for better utilization of cable trays and cable management

Advantages of Standard Fiber Optic Ribbon Cable

Greater Fiber Packing Density Bend Radius

In this example, due to the greater fiber packing density the 216ct ribbon central tube cable has the smallest bend radius compared to the 144ct loose tube and tight buffer constructions.

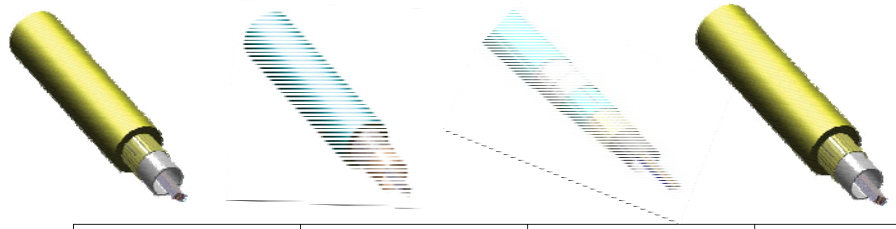
216ct Ribbon Central Tube Cable	144ct 250um Loose Tube Cable	144ct 900um Tight Buffer Cable
MBR-I = 9.0in. (234mm) MBR-O = 6.1in. (156mm)	MBR-I = 9.4in. (239mm) MBR-O = 6.3in. (159mm)	MBR-I = 13.9in. (354mm) MBR-O = 9.3in. (236mm)



MBR-I = Minimum Bend Radius during Installation / MBR-O = Operational/After Installation

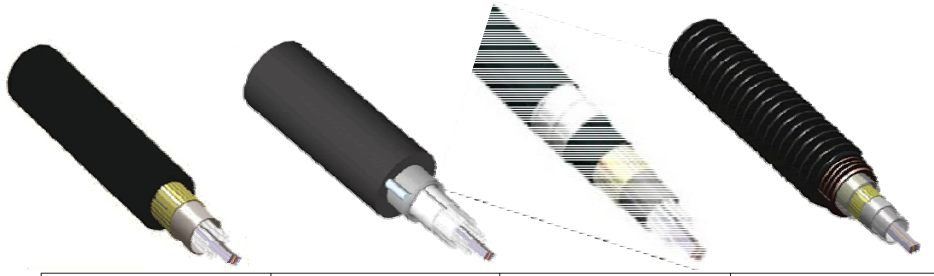
At these and higher fiber counts, the ribbon central tube construction installation and operation in terms of handling and routing is the same or better than that of the loose tube and tight buffer constructions

Fiber Optic Cable – Premise



	Riser Ribbon	Plenum Ribbon	Interlock Armor Riser Ribbon	Interlock Armor Plenum Ribbon
Fiber Count	**48 - 864**	**48 - 432**	**48 - 432**	**48 - 432**
SMF (652 / 657)	✓	✓	✓	✓
MM (OM2/3/4)	✓	✓	✓	✓
Tensile Load - I	**600**	**600**	**600**	**600**
Tensile Load - O	**200**	**200**	**200**	**200**
Operating Temperature Range	**-40 to 70°C (-40 to 158°F)**	**-40 to 70°C (-40 to 158°F)**	**-40 to 70°C (-40 to 158°F)**	**-40 to 70°C (-40 to 158°F)**
Outside Diameter	**48 to 96-0.52" 108 to 216 -0.62" 288 to 432 -0.81" 576 to 864- 1.01"**	48 to 96-0.55" 108 to 216 -0.65" 288 to 432 -0.85"	48 to 96 - 0.81" 108 to 216 - 0.91" 288 to 432 - 1.16"	48 to 96 - 0.83" 108 to 216 - 0.87" 288 to 432 - 1.15"

Fiber Optic Cable – Outside Plant



	Indoor/Outdoor Ribbon	Indoor/Outdoor Ribbon	Indoor/Outdoor Interlock Armor Ribbon	Hostile Environment Cable
Fiber Count	**48 - 144**	**576 - 864**	**48 - 864**	**48 - 216**
SMF (652 / 657)	✓	✓	✓	✓
MM (OM2/3/4)	✓		✓	
Tensile Load - I	**600**	**600**	**600**	**600**
Tensile Load - O	**200**	**200**	**200**	**200**
Outside Diameter	48 - 0.61" 60 to 144 - 0.67"	576 to 864 - 1.03"	48 to 96 - 0.89" 108 to 144 - 1.02" 576 to 864 - 1.51"	48 to 96 - 0.67" 108 to 216 - 0.77"
Operating Temperature Range	-40 to 70°C (-40 to 158°F)	-40 to 70°C (-40 to 158°F)	-40 to 70°C (-40 to 158°F)	-40 to 130°C (-40 to 266°F)

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Advantages of Splicing Fiber Optic Ribbon

Equipment for Single versus Mass Splicing

The difference in splicing ribbon fiber versus single fiber is the thermal jacket remover versus using the jacket stripping tool… AND you are doing 12 fibers at a time….

Single Fiber Core Alignment

Jacket Stripper

Multi-Fiber Mass Fusion

Can also splice single fibers

Thermal Jacket Remover

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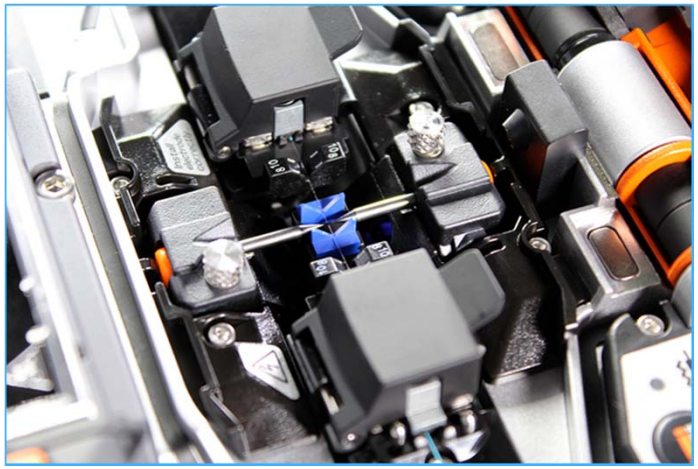
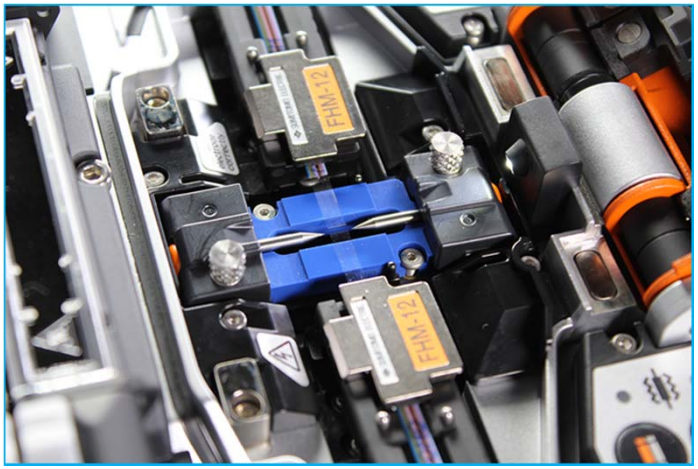
Termination Advantages

Ribbon based cable constructions offer multiple advantages over loose tube and tight buffer cable constructions in the area of terminations. Advantages exist in both time and costs…

Single Fiber Fusion Splice



12ct Ribbon Fusion Splice



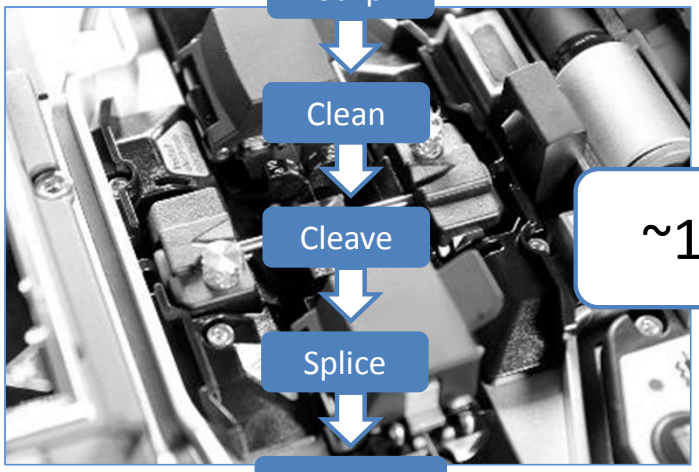
Advantages of Splicing Fiber Optic Ribbon

Termination Advantages

Typical splicing time for inline fusion splicing either two single 250um coated fibers or two 12ct ribbons is about the same, ~120sec

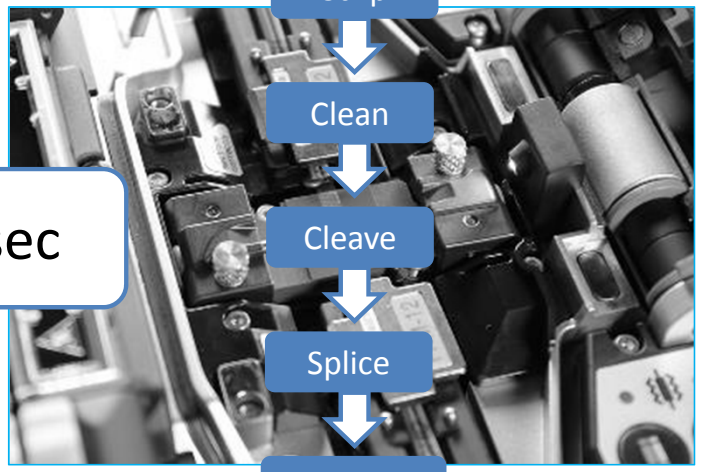
(This is an average time which may be less or more depending on technician experience and/or technicians per fusion splicing unit)

Single Fiber Fusion Splicing Process



~120sec

12ct Ribbon Fusion Splicing Process



*Advancements in heater technology & dual heater splicers equalize protection time for single and ribbon splicing

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Advantages of Splicing Fiber Optic Ribbon

Termination Advantages

How about quality of splice between core alignment and ribbon splicing?

Core Alignment Fiber Fusion Splicer

Typical Splice Loss,
Identical Fibers
for *CA fusion splicer
SMF: 0.02dB
MMF: 0.01dB

12ct Ribbon Fusion Splicer
(and/or V-Groove alignment fusion splicers)

Typical Splice Loss,
Identical Fibers
for *Ribbon fusion splicer
SMF: 0.05dB
MMF: 0.02dB

While the core alignment fusion splicer yields lower loss splices, the ribbon based splicer yields splice losses well inside the typical allowable loss per splice point. *Splice loss performance dependent on specific splicer manufacturers and models

Advantages of Splicing Fiber Optic Ribbon

Termination Advantages

…so, at ~120sec per splice for either a single fiber or 12ct ribbon splice the following comparison is true for in-line splicing a 144ct loose tube and 144ct ribbon based cable…

Single Fiber Fusion Splice	12ct Ribbon Fusion Splice
144 single splices @ 120 sec per splice =17,280 sec Or 288 minutes Or 4.8 hours	144 fibers = 12 ribbons @ 120 sec per splice =1,440 sec Or 24 minutes Or Half an Hour!
	

Splicing 12ct ribbon in this scenario is 92% more efficient than splicing single fiber

Advantages of Splicing Fiber Optic Ribbon

Termination Advantages

Not only is splicing 12ct ribbon significantly more efficient in regards to time, but the time savings is a DIRECT correlation to cost savings…

Single Fiber Fusion Splice

12ct Ribbon Fusion Splice

- Advantage of Ribbon Cable
  - More advantageous for network owner to deploy ribbon based cable and specify ribbon splicing, as ribbon splicing requires fewer splices
- Labor Saving Advantage of Ribbon
  - More advantageous for contractor to have ribbon based cable installed and utilize ribbon splicing to reduce the amount of time/labor to complete the splicing

Advantages of Splicing Fiber Optic Ribbon Cable

Termination Advantages

A few additional termination advantages when deploying ribbon based cable compared to loose tube or tight buffer cable constructions…

Single Fiber Fusion Splice Sleeve	Splice Tray	12ct Ribbon Fusion Splice Sleeve
		
Sing		0/ea.
Spl		ea.
12 S		Tray
144 Si		Tray
Total		Trays

90% Savings using Ribbon Based Cables!

*Not to even mention the space savings as well which correlates to a dollar savings too!!

*144ct fiber splicing scenario
Loose Tube or Tight Buffer

*144ct fiber splicing scenario
Ribbon Based Cable

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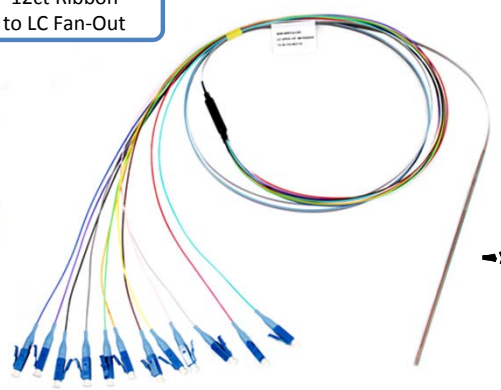
Advantages of Standard Fiber Optic Ribbon Cable

Termination Advantages

What if the application requires termination to single fiber based connectors, such as LC connectors? Isn't it better then to have loose tube or tight buffer cable construction?

12ct Ribbon to LC Fan-Out



12ct Ribbon

Fusion splice ribbon based cable to 12ct ribbon to LC fan-out

RU with LC adapters

Terminating to connector for further distribution/patching

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Yesterdays Connectivity Options

Connectivity of Yesterday	First there was the labor intensive Puck & Polish, then Pigtails which required splice trays and then Mechanical Connectors which had index matching gel issues…

Puck & Polish Connector

- Labor Intensive
- Blind Results
- Totally Technician Dependent
- Yield??

Mechanical Connectors

- Expensive
- Blind Results
- Index Matching Gel

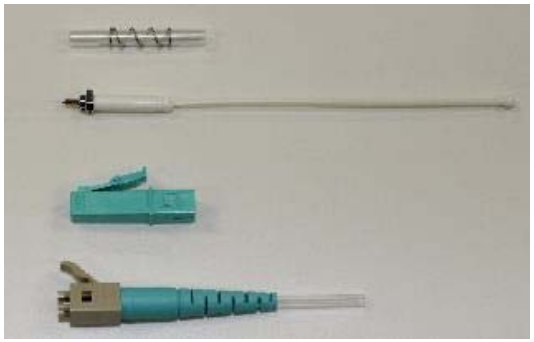
Pigtails (w/Splice trays)

- Expensive
- Additional space required
- Factory polished connector
- Requires Technician to pre-fit pigtail in splice tray

Todays Connectivity Options for Optical Fiber

Connectivity of Today

Fusion splicing of individual fibers is faster, easier, not dependent on technician, known results…
Splice-on Connectors provide the greatest in speed and accuracy, reliability for todays/future networks



Splice-on Connectors solves the problems of yesterdays connectors…

- No Blind Splicing
- Factory Polished End Face
- No Index Matching Gel Issues
- Technician Independent

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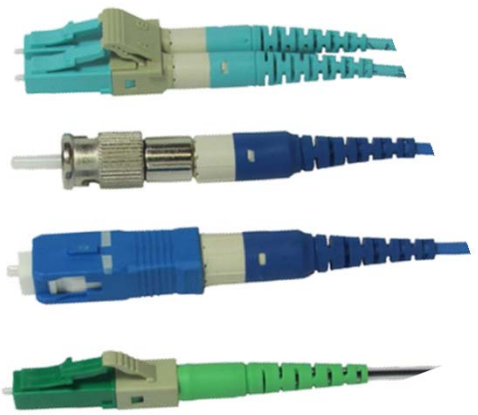
Lynx2 CustomFit® SOC's

Splice-On-Connectors	Fast, reliable, no index matching gel, fusion splicer provides much higher yields… for all connector types

- Kevlar strength members attached to the housing provide excellent pull out strength without pulling back on ferrule
- Fast and exact lengths achieved on-site without the problems of slack
- Instant splice loss feedback
- Factory ferrule and fiber bond
- Removes the technician judgment call inherent in mechanical splice technology



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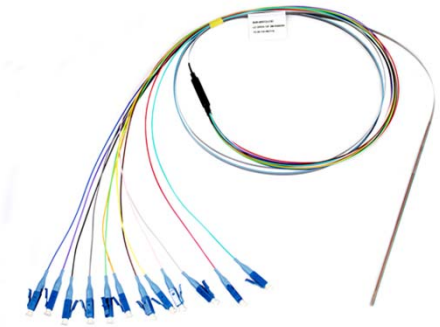
Connectivity Options for Fiber Optic Ribbon

Options for Ribbon Splicing

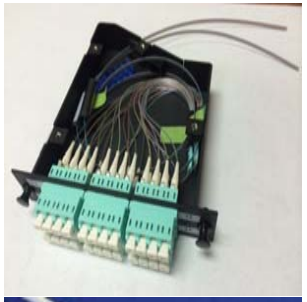
What if the application requires termination to single fiber based connectors, such as LC connectors? Isn't it better then to have loose tube or tight buffer cable construction?

Ribbon Break Out Kits



Splice On MPO

Ribbon Fiber Cassette



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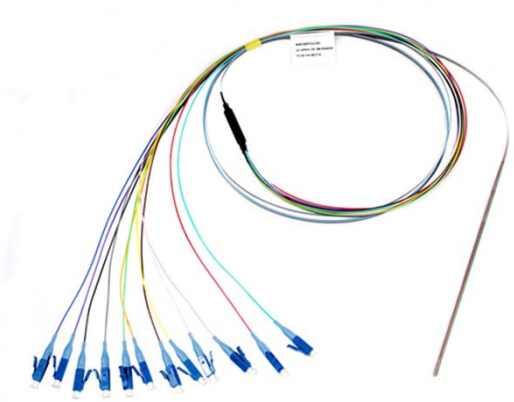
Connectivity Options for Fiber Optic Ribbon

1st Option
Breakout Kits

What if the application requires termination from ribbon to single fiber based connectors, such as LC connectors?

12 Fiber Ribbon Break Out Kit



Ribbon Interface

1. Most cost effective per connector

2. Available in all currently available connector types, fiber types, and lengths

3. Ribbon break-outs allow the fast, easy change of connector types with a single ribbon splice

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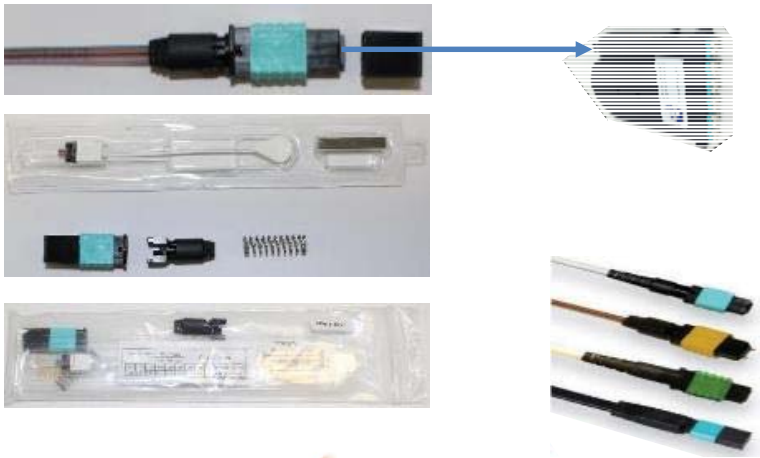
MPO Cassette Interface Options

2nd Option Splice-On MPO	MPO connectors plug into the cassette to allow quick, easy and technician independent change.

Splice-On MPO connector allows you to work with any ribbon cable and have the exact length you need without any pre-engineering design work.

Lynx2 MPO



MPO Interface

LGX-Conversion

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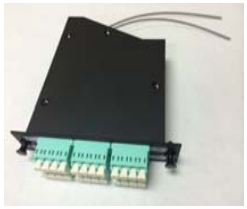
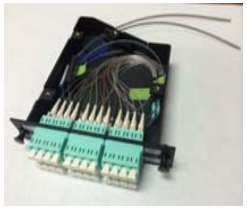
3rd Option
Ribbon Fiber Cassettes

What if the application requires termination from ribbon to single fiber based connectors, such as LC connectors?

HD

SEL





LGX

1. Cassettes with ribbon pigtails can provide any standard type connector
2. Cassettes with ribbon pigtails are terminated with a single mass splice
3. Cassettes with ribbon pigtails allow the fast, easy change of connector types with a single splice
4. Cost Effective because no pre-engineered cable length is required

Prestubbed Fiber Optic Patch Panel

4th Option
Pre-stubbed Ribbon Panels

What if the application requires termination from ribbon to single fiber based connectors, such as LC connectors?

- Cable comes pre-terminated with choice of connector/shelf
- The fastest installation method for high fiber count applications
- Exact length cable available to make installation even faster
- The lowest loss installation method- NO IN-PANEL SPLICES

Lynx2 CustomFit® SOC's

SOC's – Cover your every connector need

Comparing ribbon cables to loose tube or tight buffer cable constructions the fiber count per cable OD is significantly greater for the ribbon based central tube cable construction…

Panel with ribbon termination options.

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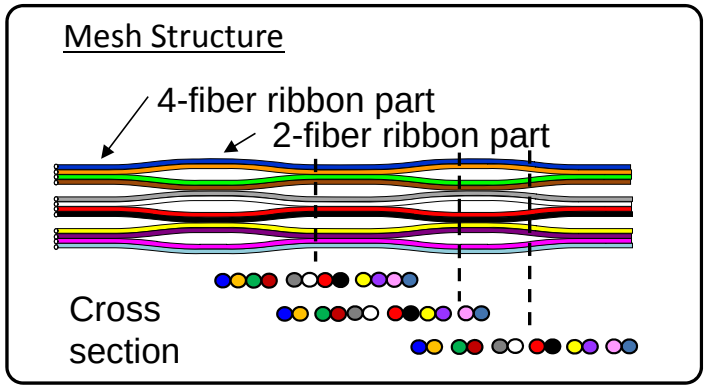
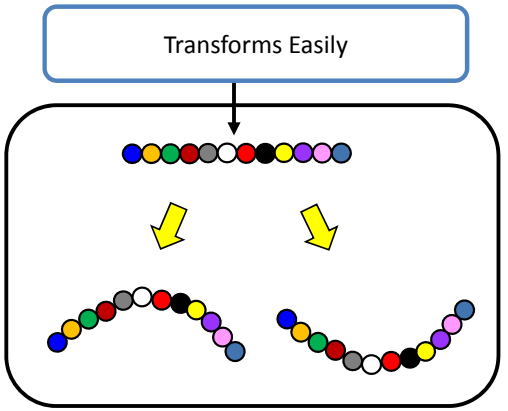
New Pliable Ribbon…Advantages & Benefits

Greater Fiber Packing Density

Comparing ribbon cables to loose tube or tight buffer cable constructions the fiber count per cable OD is significantly greater for the ribbon based central tube cable construction…





- Pliable ribbon is splice compatible with Conventional ribbon
- Pliable ribbon promotes smaller cable diameter
- Pliable ribbon is used for higher count slotted and central core cables

New Pliable Ribbon…Advantages & Benefits

Pliable Ribbon Structure	Pliable ribbon structure is similar to standard ribbon structure but with spaced separations of fiber groupings.

- ✓ Pliable ribbon creates a paradigm shift for cable design and construction
- ✓ Increases ribbon packing density
- ✓ Retains the termination advantages of standard ribbon

Pliable Ribbon shown fanned out

Pliable Ribbon Spliced to Standard Ribbon

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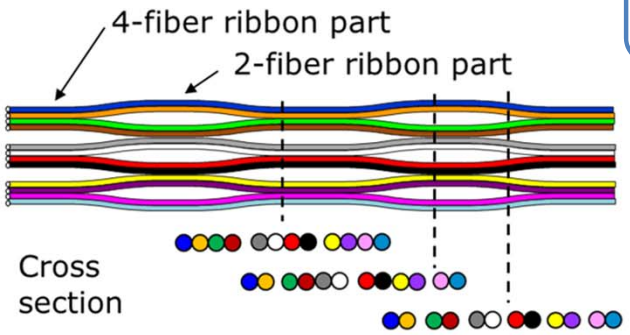
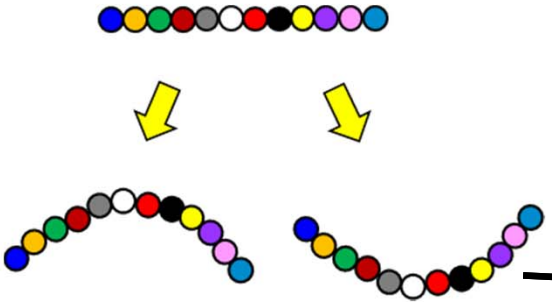
Ultra High Fiber Count Cable Overview

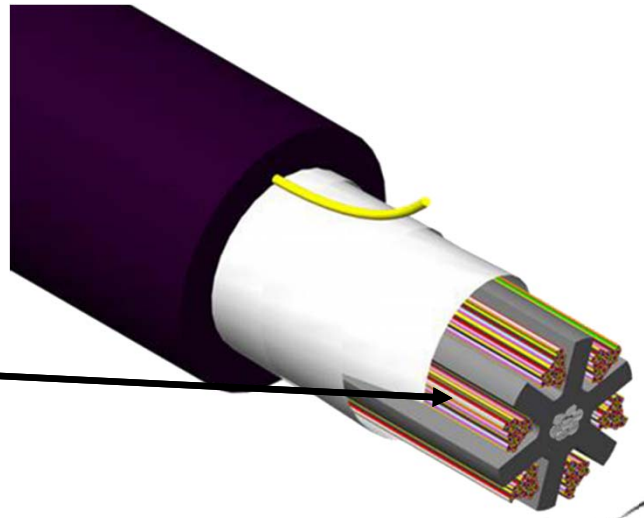
Ultra High Fiber Count Cable

It's not just about making a cable with more fiber, it's about making a cable with a lot more fiber that can still work in existing conduit pathways

By utilizing the combined technology of pliable ribbon and bend insensitive fiber (such as G657A1) high fiber count cables can be designed to improve utilization of existing cable pathways







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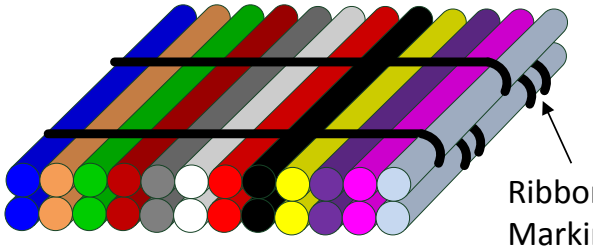
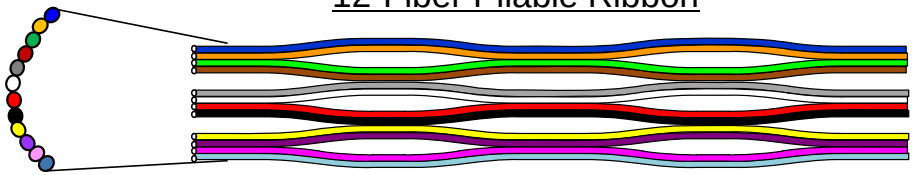
Ultra High Fiber Count Cable with Pliable ribbon

Greater Fiber Packing Density

Comparing ribbon cables to loose tube or tight buffer cable constructions the fiber count per cable OD is significantly greater for the ribbon based central tube cable construction…



12-Fiber Pliable Ribbon



Ribbon Marking Code

No.	Marking
1	▮
2	▮▮
…	…
5	■
6	■▮
…	…
10	■■
…	…
36	■■■■■

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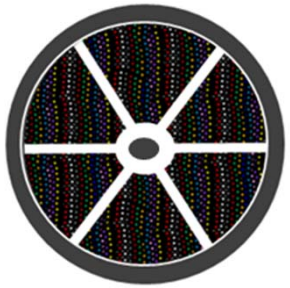
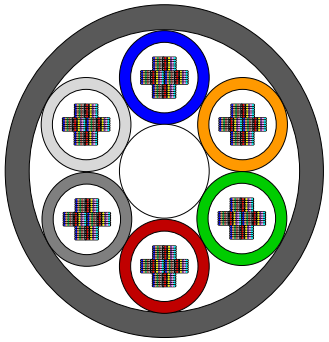
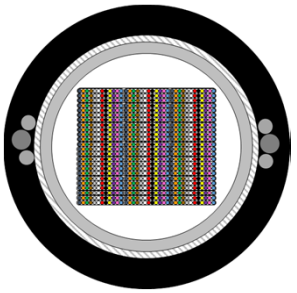
Ultra High Fiber Count Cable Advantages

Ultra High Fiber Count Cable

UHFC design utilizing the combination of pliable ribbon and bend insensitive fiber gives higher packing density to achieve cable with 2X+ fiber capacity within same duct space

Additionally, the UHFC/pliable ribbon based design allows for identical termination advantages as presented earlier with standard ribbon based cable constructions

1728ct UHFC OSP Rated Cable	1728ct LTR OSP Rated Cable	864ct OSP Rated Cable
		
OD ~1.0in. (25.6mm)	OD ~1.34in. (34mm)	OD ~1.0in. (25.6mm)
Allowable Duct = 1.5”	Allowable Duct = 2.0”	Allowable Duct = 1.5”

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Ultra High Fiber Count Cable Advantages

Greater Fiber Packing Density

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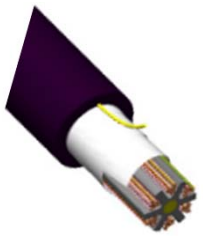

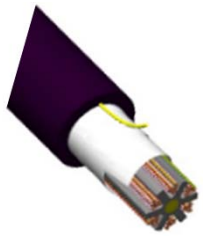

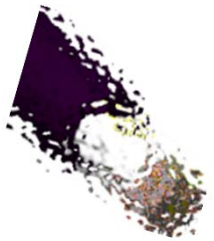

What's next?

Fiber Count	1152	1728
SMF (652 / 657)	✓	✓
Central Strength Member	✓	✓
Tensile Load - I	600	600
Tensile Load - O	200	200
Operating Temperature Range	-40 to 70°C (-40 to 158°F)	-40 to 70°C (-40 to 158°F)
OD	.98"	1.00"

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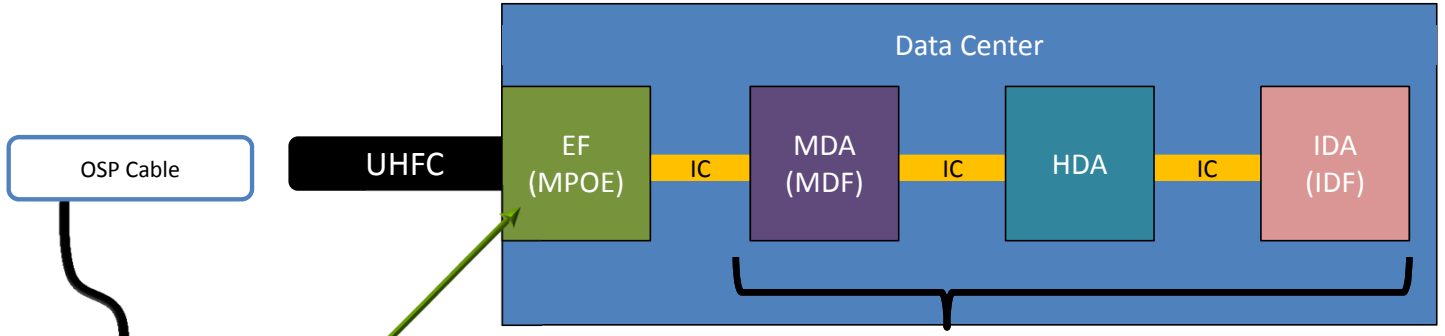
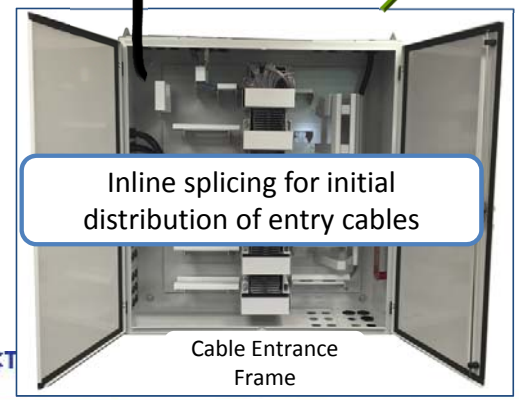
Ultra High Fiber Count Cable Overview

Termination Advantages

What are your options for terminating UHFC?





Inline splicing for initial distribution of entry cables

Cable Entrance Frame

Shelves with LC adapters

Terminating to connector for further distribution/patching

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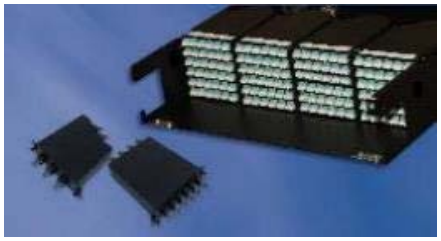
Ultra High Fiber Count Cable Overview

Termination Options

Comparing the density of the various options and ease of installation versus……

Pre-stubbed Shelves

Patch Panels



OSP HFC Closures

OSP Cable Entrance Facilities

Pre-terminated Shelves

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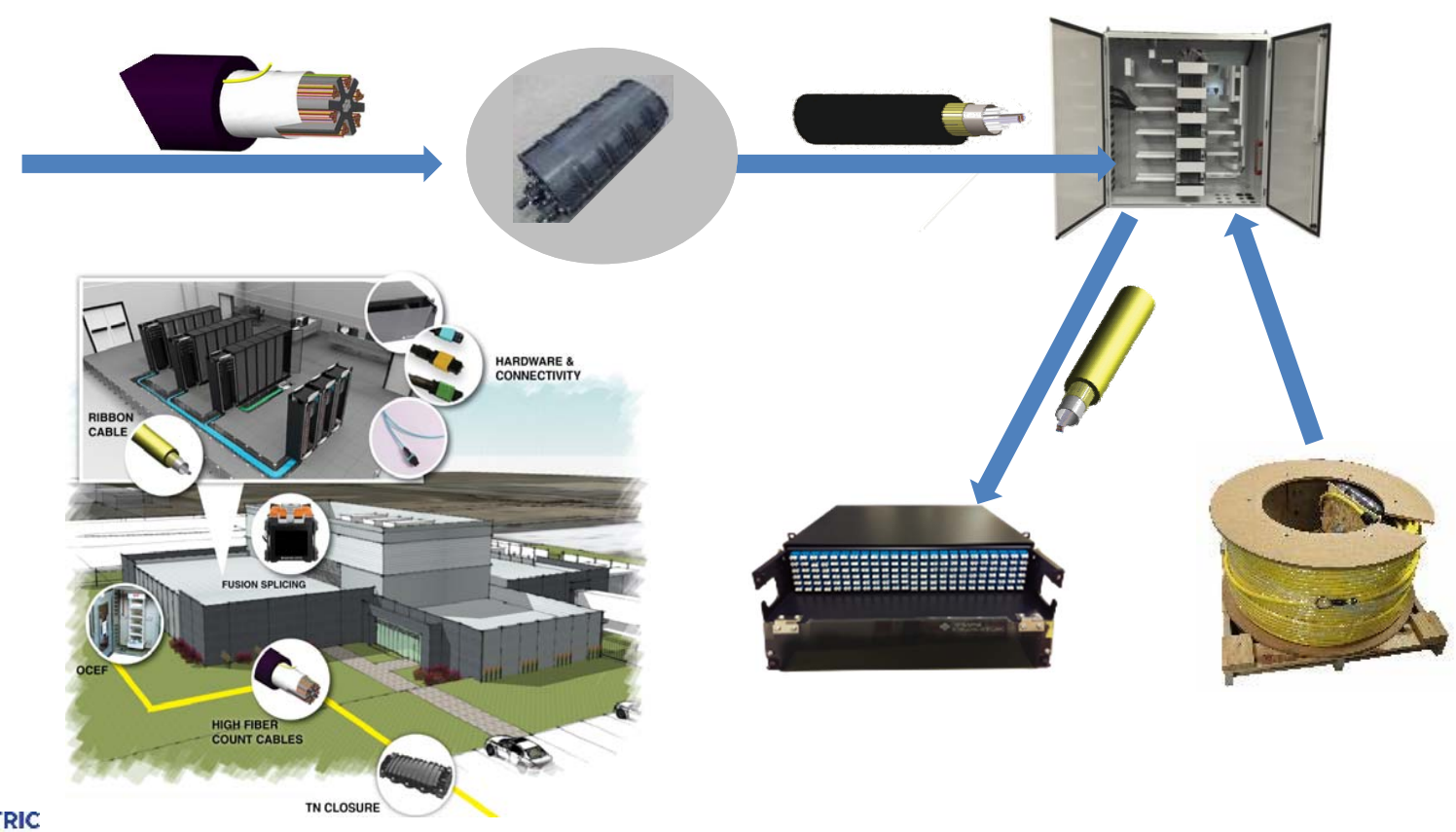

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Review of Benefits

- *Easily identifiable
- *Available in SMF & MMF
- *Easy Peel Ribbon Technology
- *Smaller Cable OD's per fiber
- *Save's space in cable trays
- *Fastest splicing per fiber
- *Multiple termination options
- *New Higher fiber count cables

Cost savings unmatched

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QUESTIONS?

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THANK YOU