



CORNING

Virgin Media Taster Training Day

Corning Incorporated

Founded:
1851

Headquarters:
Corning, New York

Employees:
~30,000 worldwide

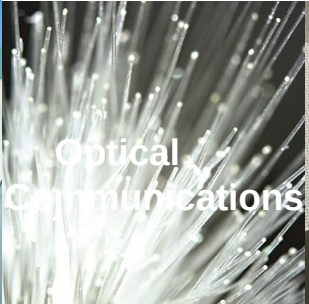
2013 Sales:
\$7.9B

Fortune 500 Rank (2013):
326

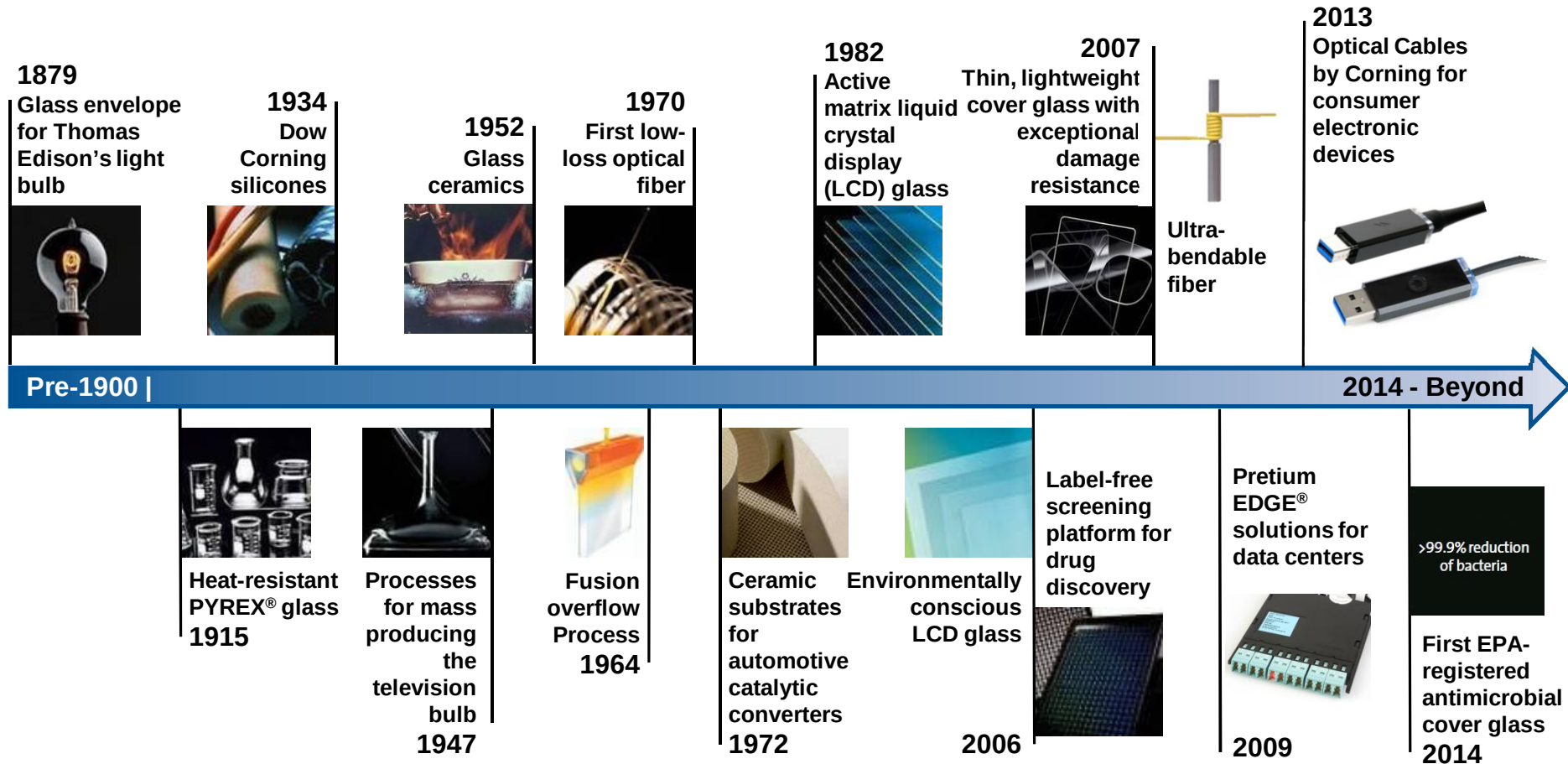
- Corning is the world leader in specialty glass and ceramics.
- We create and make keystone components that enable high-technology systems for consumer electronics, mobile emissions control, optical communications, and life sciences.
- We succeed through sustained investment in R&D, more than 160 years of materials science and process engineering knowledge, and a distinctive collaborative culture.



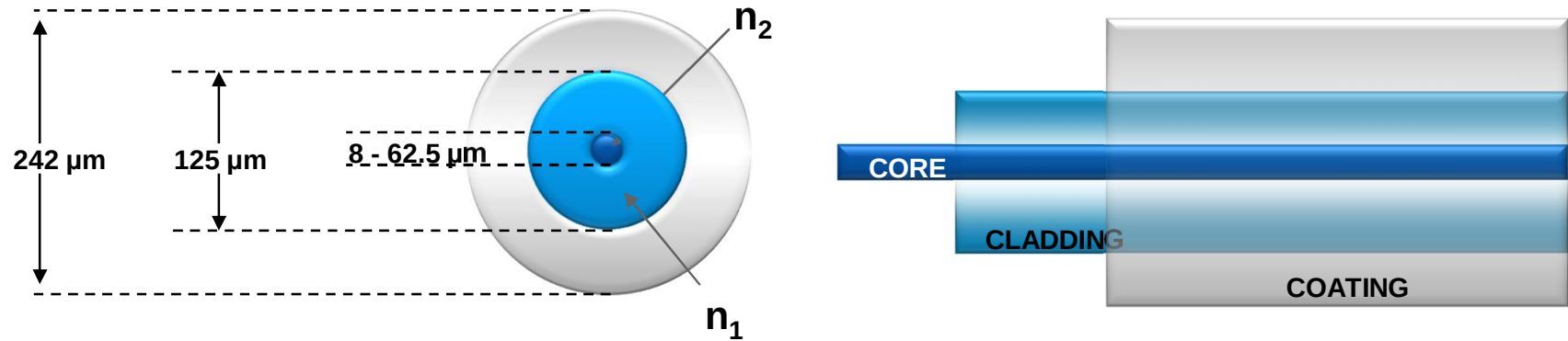
Corning Market Segments and Additional Operations

					
• LCD Glass Substrates • Glass Substrates for OLED and high-performance LCD platforms	• Optical Fiber and Cable • Optical Connectivity Solutions • Wireless Distributed Antenna Systems • Optical Cables for Consumer Networks • Copper Connectivity Components	• Emissions Control Products – Light-duty gasoline vehicles – Light-duty and heavy-duty on-road diesel vehicles – Heavy-duty non-road diesel vehicles – Stationary	• Cell Culture and Bioprocess • Drug Discovery • ADME/Tox • Genomics • Chemistry • Microbiology • General Laboratory Products	• Corning® Gorilla® Glass • Display Optics and Components • Optical Materials – Semiconductor materials – Specialty fiber – Polarcor™ • Optics • Aerospace and Defense • Corning Specialty Glass	• Emerging Innovations • Equity Companies – Cormetech, Inc. – Dow Corning Corp. – Eurokera, S.N.C. – Samsung Corning Advanced Glass, LLC (SCG)

A Culture of Innovation



Optical Fiber Construction



Core

- Carries the light signals
- Silica and a dopant to raise index of refraction

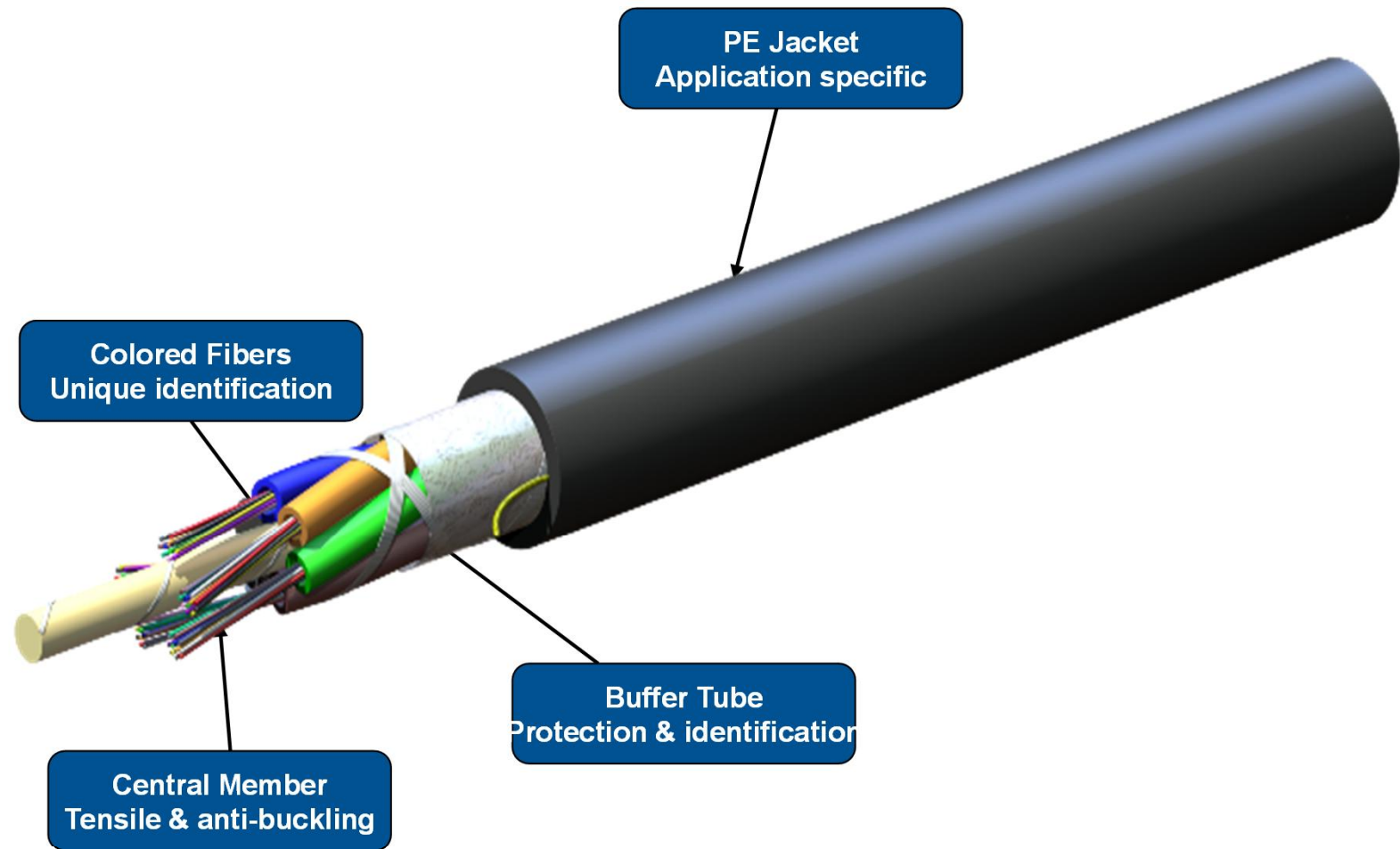
Cladding

- Keeps the light in the core
- Pure silica

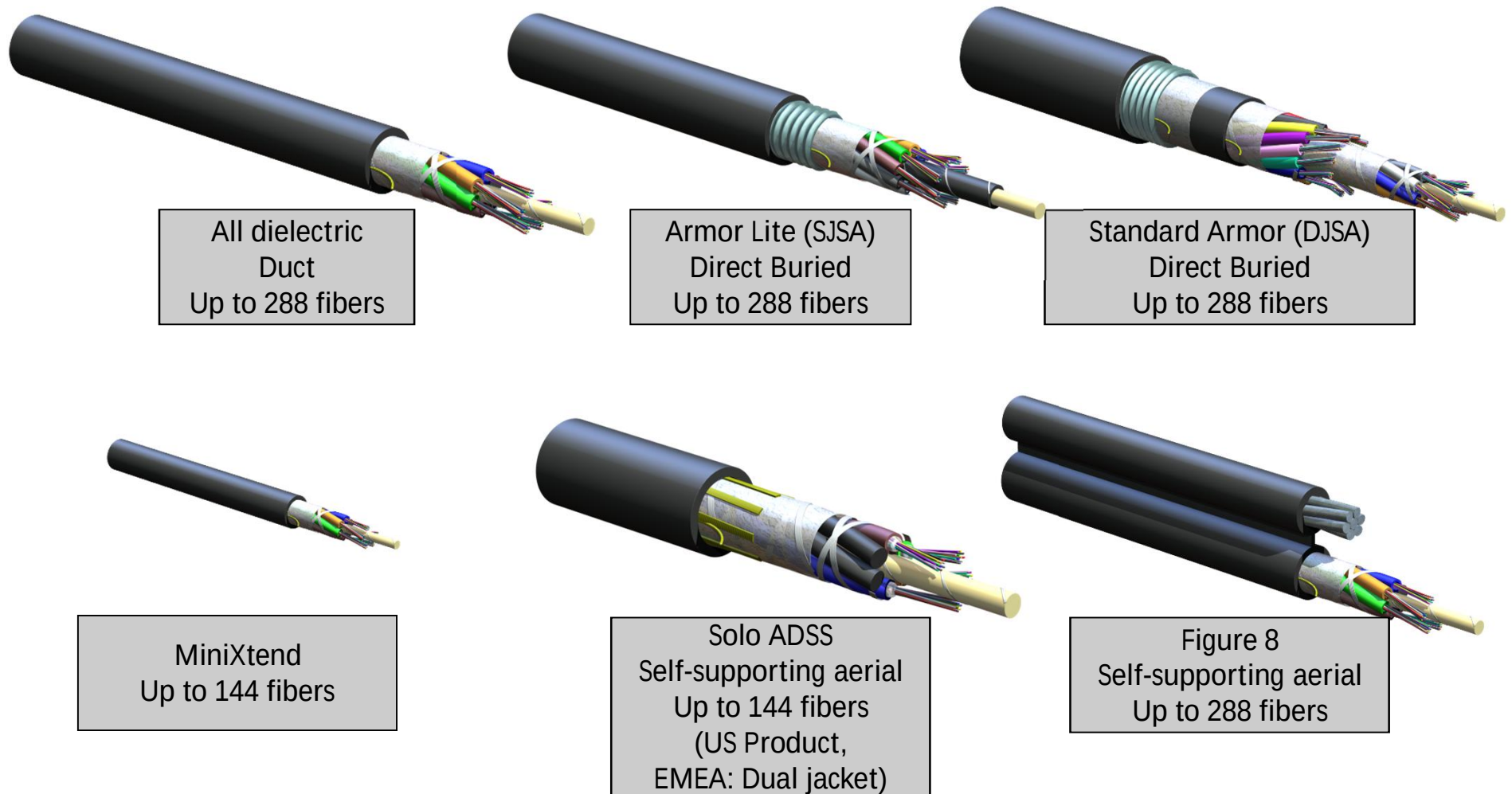
Coating

- Protects the glass
- Acrylate (plastic)

Cable Construction



Different Cable Solutions Depending on Application Spaces



What Can Be Done in 125 μ m of Good Glass!

Waveguide



Kerr Effect

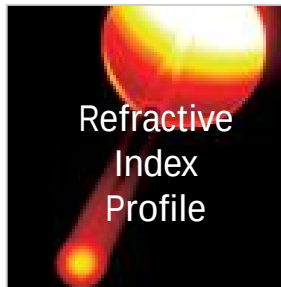
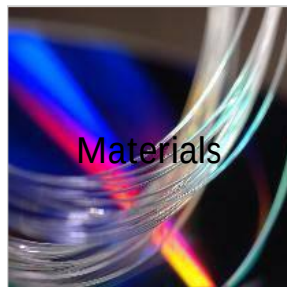
Attenuation

Effective
Area

Chromatic
Dispersion

Modal
Dispersion

Polarization
Mode
Dispersion



Environmental
Characteristics

Macrobend
Loss

Mechanical
Reliability

Aging

Amplification

Raman

Different fiber types
depending on the application

Different Standards Organizations All Around the World

- International Standards

- ITU-T



- IEC



- ISO



- US Standards

- ANSI



- TIA



- EIA



- ATIS



- Multi-national Standards

- IEEE



- Fibre Channel

- SCTE

International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.657
(11/2009)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA,
DIGITAL SYSTEMS AND NETWORKS

Transmission media and optical systems characteristics –
Optical fibre cables

Characteristics of a bending-loss insensitive
single-mode optical fibre and cable for the
access network

Recommendation ITU-T G.657



ITU-T G-SERIES RECOMMENDATIONS
TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

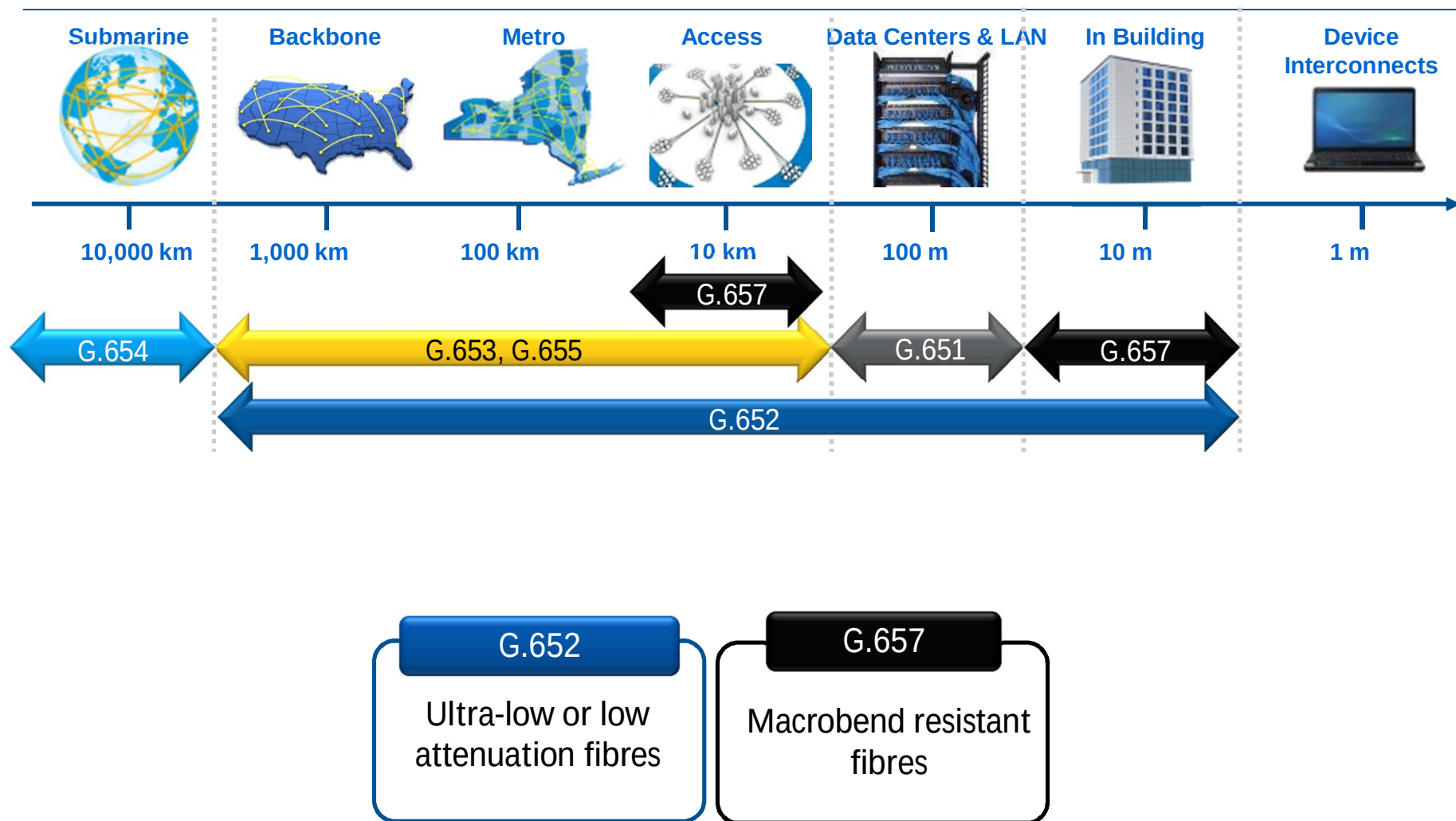
INTERNATIONAL TELEPHONE CONNECTIONS AND CIRCUITS	G 100–G 199
GENERAL CHARACTERISTICS COMMON TO ALL ANALOGUE CARRIER-TRANSMISSION SYSTEMS	G 200–G 299
INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES	G 300–G 399
GENERAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON RADIO-RELAY OR SATELLITE LINKS AND INTERCONNECTION WITH METALLIC LINES	G 400–G 449
COORDINATION OF RADIOTELEPHONY AND LINE TELEPHONY	G 450–G 499
TRANSMISSION MEDIA AND OPTICAL SYSTEMS CHARACTERISTICS	G 600–G 699
General	G 600–G 609
Symmetric cable pairs	G 610–G 619
Land coaxial cable pairs	G 620–G 629
Submarine cables	G 630–G 639
Free space optical systems	G 640–G 649
Optical fibre cables	G 650–G 659
Characteristics of optical components and subsystems	G 660–G 679
Characteristics of optical systems	G 680–G 699
DIGITAL TERMINAL EQUIPMENTS	G 700–G 799
DIGITAL NETWORKS	G 800–G 899
DIGITAL SECTIONS AND DIGITAL LINE SYSTEM	G 900–G 999
MULTIMEDIA QUALITY OF SERVICE AND PERFORMANCE – GENERIC AND USER-RELATED ASPECTS	G 1000–G 1999
TRANSMISSION MEDIA CHARACTERISTICS	G 6000–G 6999
DATA OVER TRANSPORT – GENERIC ASPECTS	G 7000–G 7999
PACKET OVER TRANSPORT ASPECTS	G 8000–G 8999
ACCESS NETWORKS	G 9000–G 9999

For further details, please refer to the list of ITU-T Recommendations.



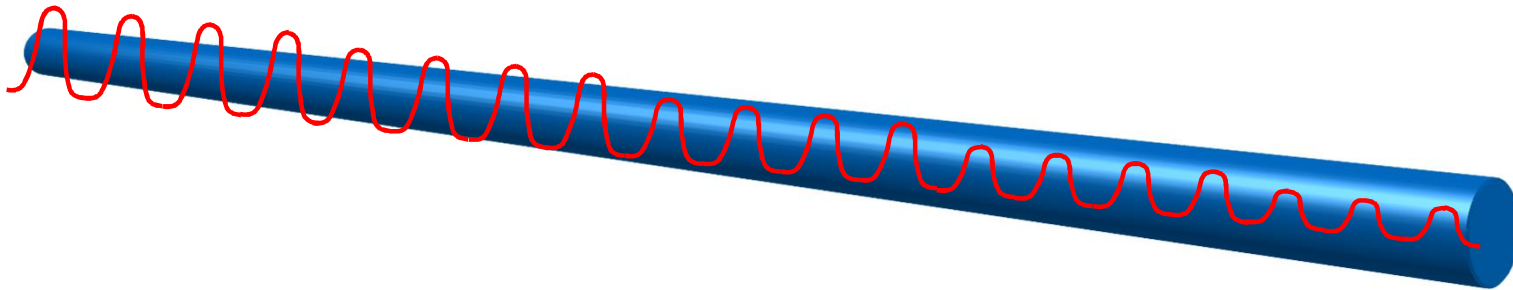
Different Optical Fibers for Different Scenarios

Application spaces of ITU-T standard optical fibers



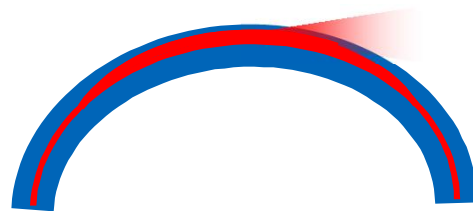
Key Parameters in Optical Fibers

The optical signal loses strength on transmission through the fibre...

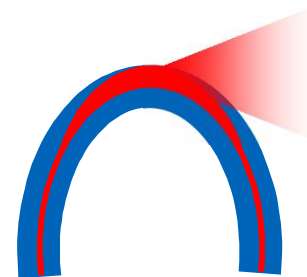


The optical signal leaks out the fibre at bends and loses signal strength

Moderate loss with moderate bends



Increased loss with tighter bends



Advanced Fibres for Next Generation Networks

Long-haul
networks



Loss Matters.

Access
Outside Plant



Access
In Building

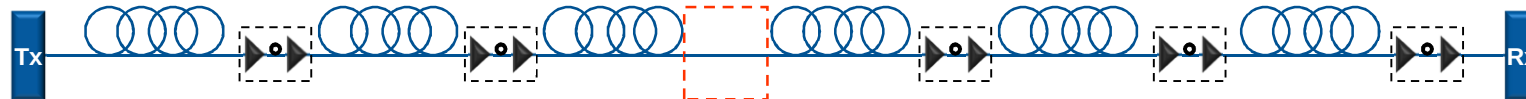
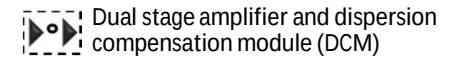


Loss Matters.

Network Performance Optimisation



Low attenuation fibre



Low attenuation fibre enable equipment simplification and higher data rates and optical switches with minimum compromise on reach.

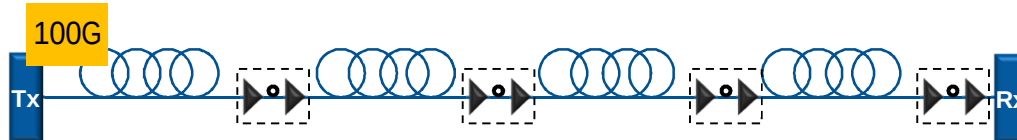
Loss Matters.

Network Longevity

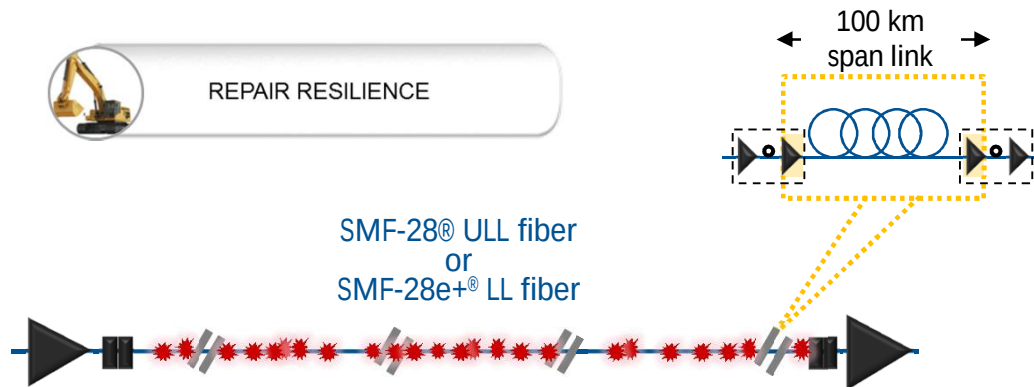


ULTIMATE CAPACITY
40G, 100G & Beyond

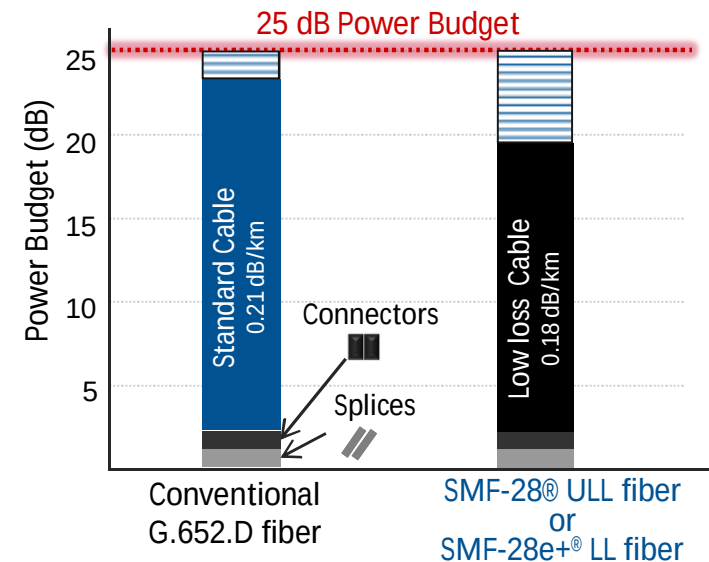
Low attenuation
G.652.D fiber



REPAIR RESILIENCE



- 1.75 dB margin available for repairs in standard cable
- 3 dB extra margin available for repairs in SMF-28e+® LL fiber cable = 15 extra repairs



A fiber with lower attenuation enables higher data rates and optical switches with minimum compromise on reach and greater repair resilience

Advanced Fibres for Next Generation Networks

Long-haul
networks



Access
Outside Plant



Access
In Building

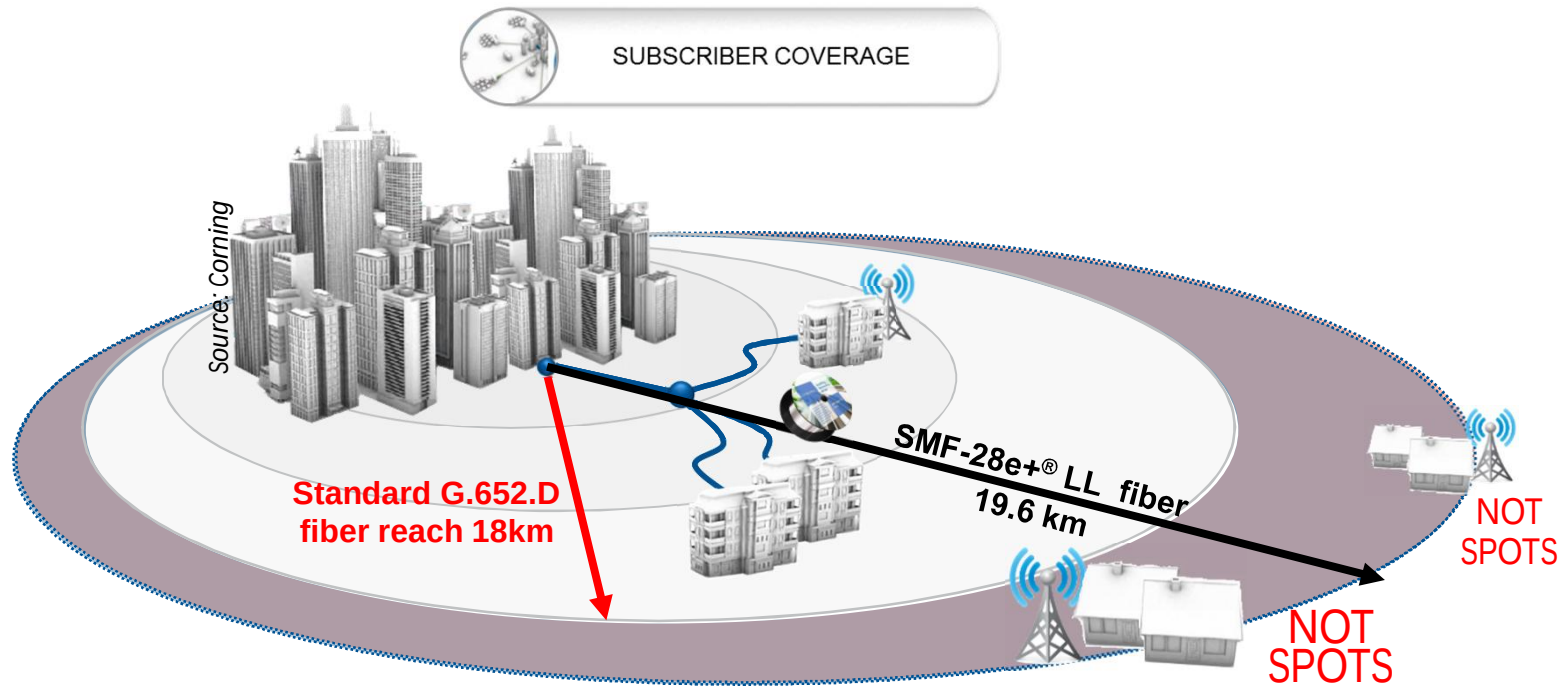


Loss Matters.

Bend Matters.

Loss Matters.

Lower Loss Extends Network Reach



- SMF-28e+® LL fiber extends reach by 10% to increase subscriber coverage area in 20 %

A low attenuation fiber naturally enables longer access network link lengths and so increases subscriber coverage

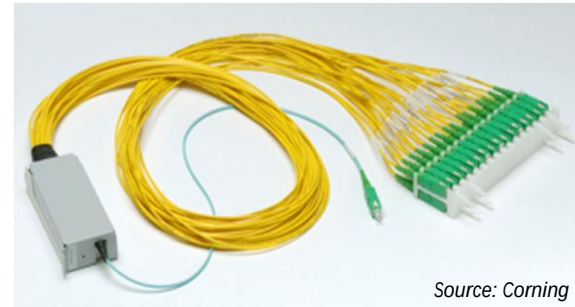
Better Macrobend Performance Enables Infrastructure Agility



SPACE OPTIMIZATION



Source: Corning



Source: Corning

- Aesthetic requirements and space restrictions drive the need for miniaturized cables, closures and cabinets
- Better macrobend fiber performance enables more flexible cables for smaller hardware and equipment in access networks
- ClearCurve® XB fiber enables 40% reduction in cabinets and 80% reduction in splitters
- What operators are saying:

“Our main design issue today is that our splicing cabinets are completely full. We used bend-insensitive fiber to deport some of the cable outside and coil it tightly to create some extra-space in there”

“We’re willing to explore all kinds of solutions that allow us to reuse existing space, everything is getting cramped”

Source: Diffraction Analysis & Corning market research, 2013

Macrobend improved fibers like SMF-28® Ultra fiber enable smaller, flexible cables and smaller, more aesthetic cabinets and closures

Advanced Fibres for Next Generation Networks

Long-haul
networks



Access
Outside Plant



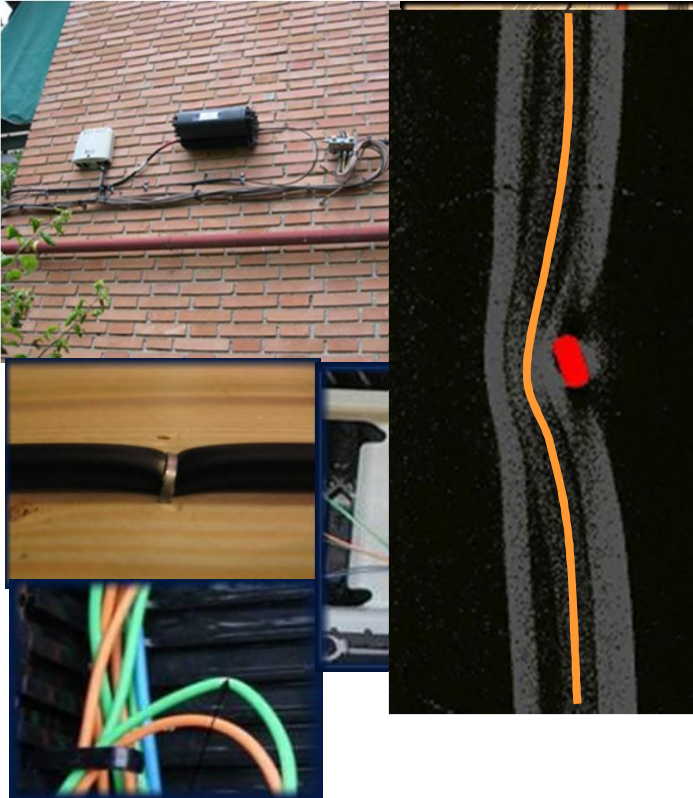
Access
Indoor



Bend Matters.



Indoor cabling and the bend challenge FTTH/B Networks



New Environment

- Space constraints
- Can experience tighter bends, staples

New Installation practices/requirements

- Higher installation speed requirements
- Must install 'like copper' to enable lower installation labour cost
- Meets more aggressive environment and handling
- Has an increased chance of inappropriate installation procedures

The Public

- More likely to experience unwanted/accidental public intervention
- Required to be more aesthetically pleasing

The fiber is challenged by BENDS



The ITU-T G.657 Standard

	G.657 Category B G.652-compatible (compliance not required)	G.657 Category A G.652-compliant		Corning ClearCurve G.657 optical fibers
Bend-insensitive	G.657.B3	G.657.B3	Compliant	Corning® ClearCurve® ZBL fiber
	7.5 mm radius = < 0.08 dB/turn		Better	7.5 mm radius = < 0.05 dB/turn
Bend-tolerant	G.657.B2	G.657.A2	Compliant	Corning® ClearCurve® LBL fiber
	7.5 mm radius = < 0.5 dB/turn		Better	7.5 mm radius = < 0.4 dB/turn
Bend-improved	---	G.657.A1	Compliant	Corning® ClearCurve® XB fiber
	10 mm radius = < 0.75 dB/turn		Better	10 mm radius = < 0.5 dB/turn

Advanced Fibres for Next Generation Networks

Long-haul networks



Loss Matters.

G.652



e.g. SMF-28® ULL
Fiber

Access Outside Plant



Loss Matters.

G.652

Bend Matters.

G.657



e.g. SMF-28® Ultra
Fiber

Access Indoor



Bend Matters.

G.657



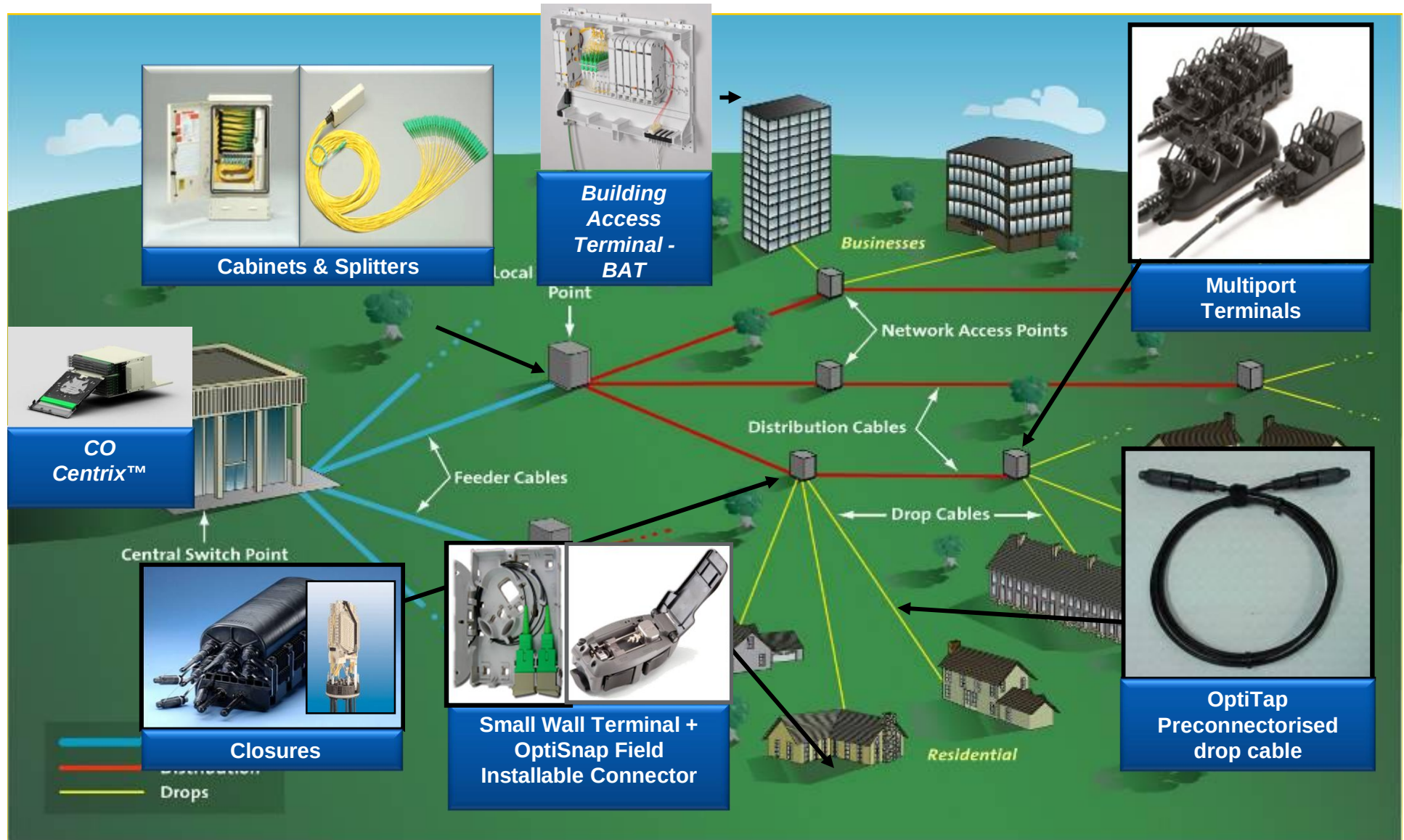
ClearCurve®
Single-mode
Fiber

The FTTH Outside Plant Lives In A World Which Has Changed Little In 100 years



- The practical challenge of installing fibre is just the same as installing electrical, gas and copper telecom utilities
- Civil costs can be up to 80% of the overall network build
- The key to a successful FTTH business case lies in exploiting the existing civil infrastructure

FTTX Architecture



CO Options

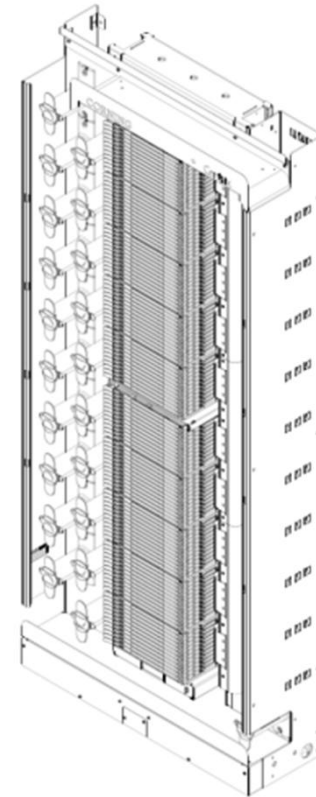
HDC Cabinets



EMF Frames



Centrix



Cabinet, Open Rack / Frame

Local Convergence

Spliced



19" Patched



Pre-Connectorised



**Street Furniture & Underground
Full Functionality**

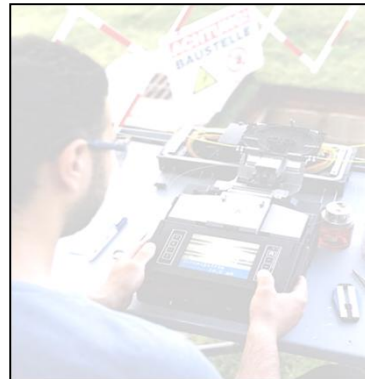
Splice v Connectors

Replace This



Splice v Connectors

Replace This



With This

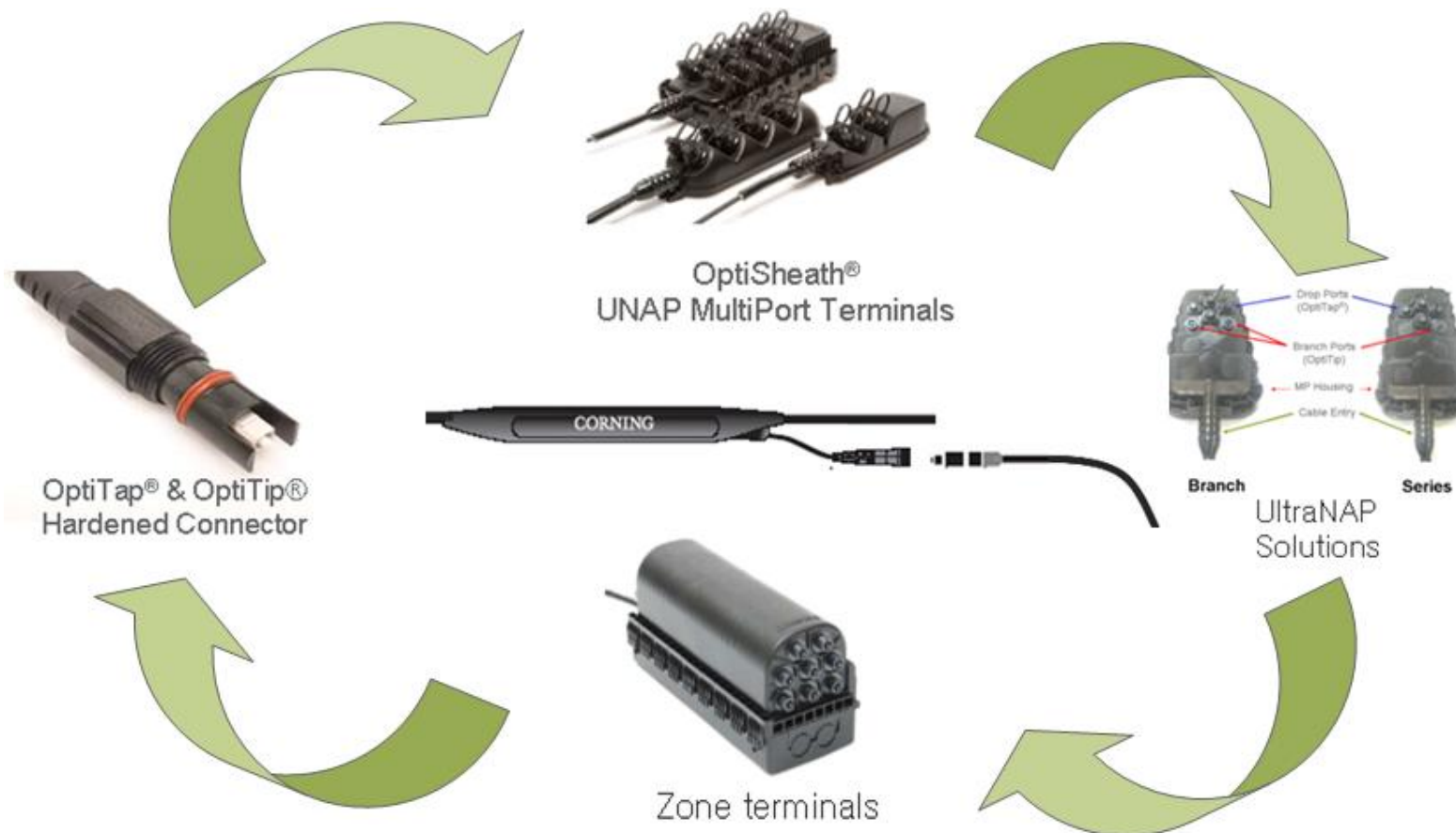


Pre-Connectorised Access Solutions

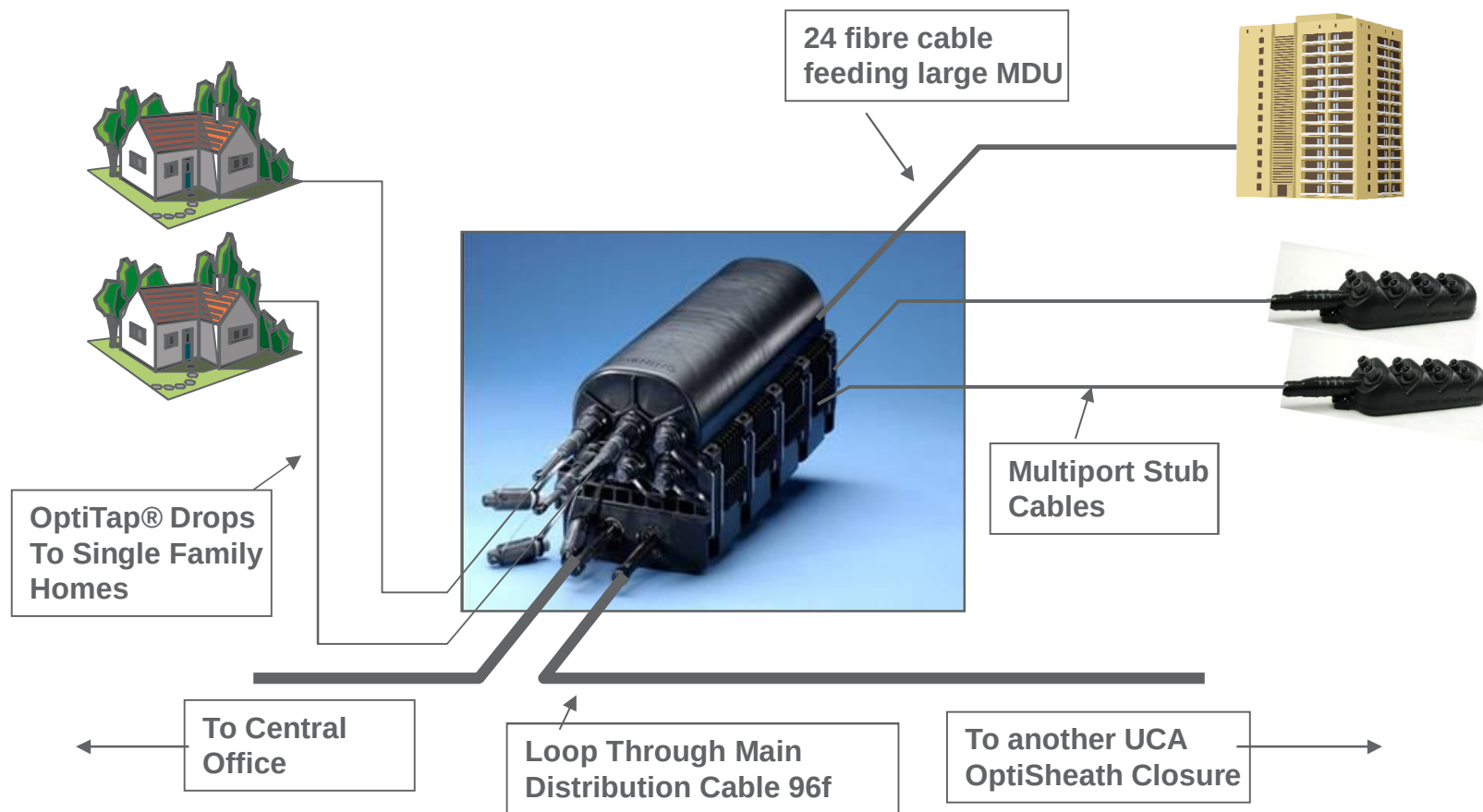


Coverage

Change the game of Fibre installation....



Typical Network Configuration For OptiSheath Closure



Example: Aerial installations



OptiSheath Closures + Multiports



OptiTap® Drop Cable Assemblies



**Multiport with loop of tether & stub
cable**

**No need for
complicated
aerial
splices**



**Connecting pre-connectorized drop-
cable**

Example: Duct installations



OptiSheath Closures + Multiports



OptiTap® Drop Cable Assemblies



Pre-connectorized Network Access Terminals deployed like standard closures

Example: Facade installations



OptiSheath Closures + Multiports



OptiTap® Drop Cable Assemblies



Multiport on facade

Minimal
visual
impact



FlexNAP tap hidden under balcony

Corning FTTP Experience

Preterminated Technology: A Proven Track Record

Fibre To The Premise

Innovating solutions that bring infinite bandwidth capabilities right to where you live, work and play

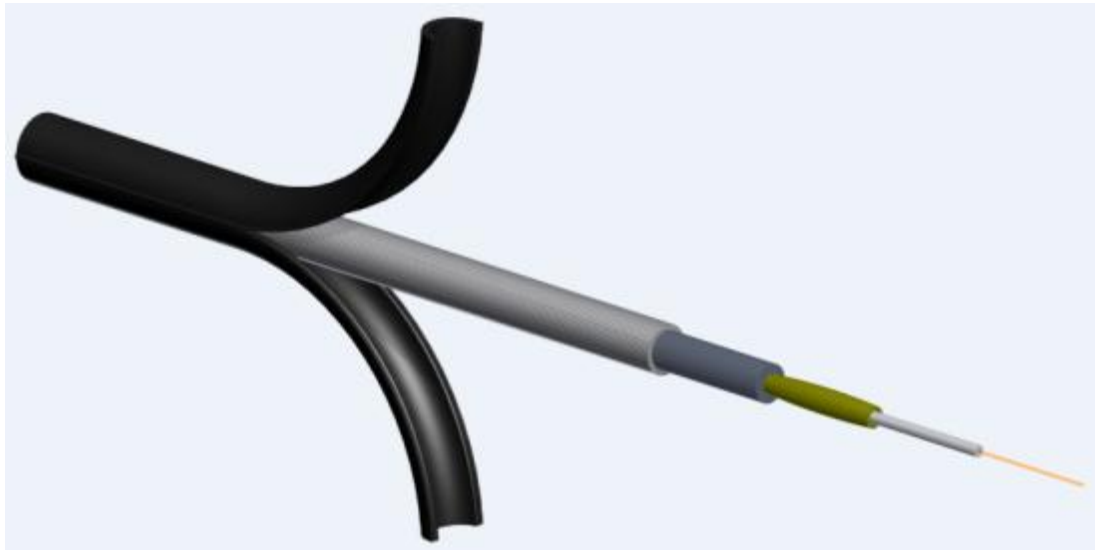


<u>Solution</u>	<u>Application</u>	<u>Number Shipped</u>
OptiTap® (Single-fibre) Connectors	Drops	> 8.0 million
OptiTap (Single-fibre) Adapters	Terminals, ONTs	> 17.4 million
OptiSheath® MultiPort Terminals (in ports)	Terminals	> 7.5 million
OptiSheath SCA/UCA Terminals (in ports)	Terminals	> 6.0 million
OptiTip™ MT (Multi-fibre) Connectors	FlexNAP Tethers	> 750,000
FlexNAP™ System access points (in ports)	Terminal Systems	> 3.0 million
FlexNAP Terminal Systems	Terminal Systems	> 125,000

More than 25 million homes passed and 4.5 million homes connected with  preterminated technology since 2004

Convertible Drop Cable With Fast Access Technology

- Outdoor rugged construction suitable for duct, Façade + Aerial
- Indoor small flexible construction with bend insensitive fibre
- Instant conversion from one state to the other
 - Fast Access Technology



Thank You

For More Technical Resources Visit Our Website

www.corning.com

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Optical Fiber

When fiber matters, education matters

Optical Fiber

In a breakthrough innovation that literally changed the world, Corning invented the first commercially viable low-loss optical fiber in 1970. Today Corning remains the global market leader in the industry.

Corning offers a full line of single-mode and multimode fibers for all network applications. Corning's optical fiber products are recognized for their excellence and innovation.

Products

- Corning® ClearCurve® multimode optical fiber
- Corning® ClearCurve® single-mode optical fiber
- Corning® ClearCurve® VSDN® optical fiber
- Corning® SMF-28e® optical fiber
- Corning® LEAF® optical fiber
- Corning® SMF-28® ULL optical fiber
- Corning® SMF-28e® LL optical fiber
- Corning® Vascade® optical fibers
- Corning® InfiniCor® fiber
- Specialty Fiber

Fiber Technology

- Fiber Facts Brochure
- Why Corning Fiber e-Brief?
- Fiber 101
- Fiber Manufacturing Advantage
- Corning® ClearCurve® ZBL Fiber Bending Demo
- At the Speed of Light
- SMF-28e® LL Optical Fiber Tutorial
- Corning Optical Fiber: At a Glance (Digital)

News

- NEC and Corning Achieve Record-breaking Results in Optical Transmission Capacity
- Corning, Condumex Renew Optical Fiber Supply Agreement
- ADVA Optical Networking and Corning Achieve 100G Direct Detection Across Record Distance
- T8 and Corning Demonstrated a 100G Unrepeated Transmission over 500 km Using Corning's Ultra-Low-Loss Optical Fiber (with ROPA)

Events

- OFC/NFOC March 19 - 21, 2013
- Africa Seminar- Algeria March 12, 2013
- SubOptic April 22 - 25, 2013

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Resource Center

In-depth white papers and technical information

Overview

- Article and News Reprints
 - General
 - Access and FTTX
 - Premises
 - Long-Haul and Submarine
- Technical Information
 - Application Notes
 - Conference Papers
 - Environmental and Safety
 - Fiber Mechanical Reliability
 - Measurement Methods
 - Product Information
- White Papers
- Tutorials and Videos
 - Fiber Matters
 - Bend Matters
 - Loss Matters

Corning Optical Fiber Resource Center

Welcome to the Corning Optical Fiber Resource Center where you will find a comprehensive library of resources and materials available on our Web site. Whether you are interested in understanding the basics about optical fiber, or if you need to know technical specifications for one of our products, you'll find it all here.

Our Resource Center is filled with a variety of materials that will demonstrate how our passion for innovation translates into new technologies for today and tomorrow. We think you'll find them to be a useful tool in your research and decision-making. Of course, if you have further questions about our optical fiber products and how they can meet your needs, please feel free to [contact us](#).

What's New

- > Wired or Wireless?**
Reprinted with permission from the Dec/Jan issue of South Asian Wireless Communications
- > Broadband Telecommunication Stimulates Economic Growth - Optical Fibre is a Key Enabler**
Reprinted with permission from the August Amcham newsletter
- > Fibre Innovation: Foundation of Next-Generation Networks**
Reprinted with permission from the December 2012 edition of tele.net
- > Advanced Optical Fibre for Next Generation Access Networks: Engineering the Future, Today**
Reprinted with permission from the November 2012 issue of Broadband Journal of the SCTE
- > Enabling an Efficient Cloud**
Reprinted with permission from Nov. 2012 edition of Voice and Data
- > Ready to Re-Build Backhaul?**
Reprinted with permission from the July/August edition of South African Wireless Communications



Thank you

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