

# Advancing Fiber Optic Connectivity

## Fusion Spice-On Connectors

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# Presentation Overview

- Advancements in Fiber Optic Connectivity
  - Shift toward Fusion Splice-On Connectivity (FSOC)
  - Specification in Installation
- Distinguishable Benefits of FSOC
  - Performance
  - Quality
  - Efficiency
  - Case Study
- Market Factors Affecting Migration
  - Product Life Cycle
  - Associated Technology



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# Presentation Overview

- Tooling Requirements and Associated Factors
  - Alignment Technology
  - Splicer Designs and Product Advancements
- Break
- Panel Discussion



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# Shift Toward Fusion Splice on Connectivity



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## Shift Toward **F**usion **S**plice-**O**n **C**onnectivity

- FSOC is a fully standards compliant Connector Solution
  - Fully Interoperable...not proprietary
    - TIA, IEEE, IEC and Telcordia Standards compliant
    - Division 27 Specifications Available
    - With FTTH Beginnings, gaining widespread adoption in Enterprise and Data Center Markets



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## Shift Toward **F**usion **S**plice-**O**n **C**onnectivity

- FSOC is a fully standards compliant Connector Solution
  - Designed using the best of previous generation connectivity solutions
    - Factory Polished Connectors from Legacy Mechanical Designs
    - Performance and Quality from Pigtail Splicing in the field
    - Accommodates weaknesses in previous generation designs and implementation



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## Shift Toward **F**usion **S**plice-**O**n **C**onnectivity

- FSOC is a fully standards compliant Connector Solution
  - SC/LC/ST/FC...and **MPO** Connector Availability
    - Can be spliced to 250&900um buffers and up to 3mm jackets
    - MPO can be spliced directly to ribbon fiber
    - MPO can also be spliced directly to loose tube fibers
      - Ribbonization of loose fibers required
      - ...or **NOT?! More on that later.**



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# Specification and Installation



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## Specification and Installation

- FSOC can be offered as a technical equivalent in design specifications
- Fully Interoperable with legacy passive panels and active equipment
  - Specific termination procedures are required (like any other)
  - Specific termination equipment is required (like any other)
  - ***Visit the relevant booths here at BICSI***



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# Specification and Installation

- Quantifiable Benefits are realized by both the User and the Installer
  - Performance
  - Quality/Durability
  - Efficiency/Economics



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# Distinguishable Benefits of FSOC



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# Distinguishable Benefits of FSOC

- Performance
  - Factory Polish similar to Mechanical and Pigtail Solutions
  - Fusion Splice provides better fiber alignment
    - Improved performance vs. Mechanical Connectors
    - Similar performance to Pigtail Splicing
    - Varying levels of improvement based on alignment method



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## Distinguishable Benefits of FSOC

- Quality/Durability
  - No Index Matching Gel
  - Direct splice provides better fiber retention
  - Shrink sleeve with splice support provides better fiber retention



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## Distinguishable Benefits of FSOC

- Efficiency/Economics
  - Better quality and durability results in less maintenance and less downtime
  - Splicing directly at the connector (under the boot) results in removal of splice trays. This results in more efficient installation, more economical installation and less congestion in racks and cabinets.



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# Case Study

*Data Collected and summarized by Ilsintech using original report from  
Japan NTT*



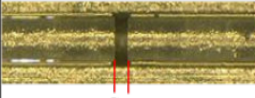
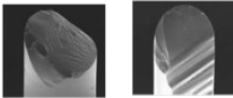
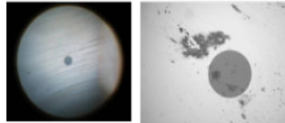
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# Causes of Faults and Failures

## 1. Fiber Gap & Incorrectly cleaved fiber ends

Type [Typical examples]	Fiber connection using refractive index matching material [FA and FAS connectors, mechanical splice, etc]		Fiber connection using physical contact [FC, SC, ST, MU, and LC connectors, etc]	
Cause of fault	<p><b>(3-1) Wide gap between fiber ends</b></p>  <p>Gap</p>	<p><b>(3-1) Incorrectly cleaved fiber ends</b></p> 	<p><b>(3-2) Contaminated connector endface</b></p> 	

We collected actual defective field assembly connectors from an area of Japan and checked their optical characteristics and dismantled them to identify the cause of the fault. 12% of the faults were caused by increased optical loss due to incorrect cleaving of the optical fiber. An incorrectly cleaved fiber end is shown in above.



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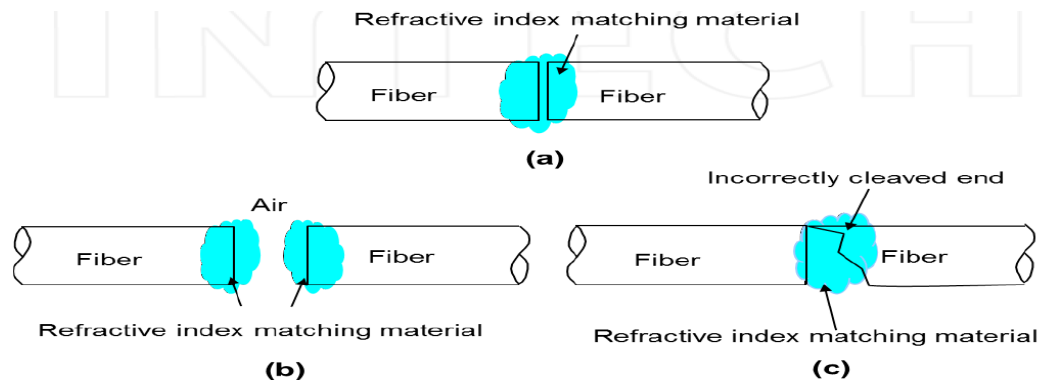
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# Causes of Faults and Failures

## 2. Fiber connection with refractive index matching material



(a) shows the normal connection state with a narrow gap between flat fiber ends,

(b) shows an abnormal connection state with a wide gap between flat fiber ends

(c) shows an abnormal state with an incorrectly cleaved (uneven) fiber end.



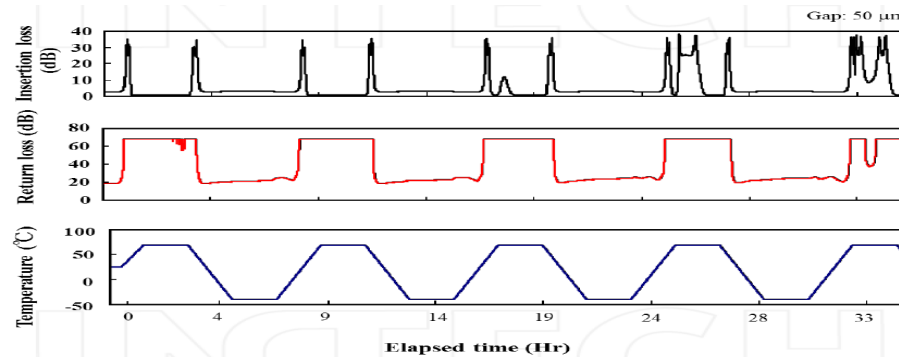
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# Causes of Faults and Failures

## 3. Heat-cycle test results for fiber connection with wide gap between flat fiber ends



The insertion loss increased to more than 30 dB. Consequently, the optical performance of fiber connections with a wide gap between flat fiber ends might be extremely unstable and vary widely. Therefore, it is important to prevent the gap from becoming wider and avoid mixing air with the refractive index matching material in the gap between fiber ends for these fiber connections.



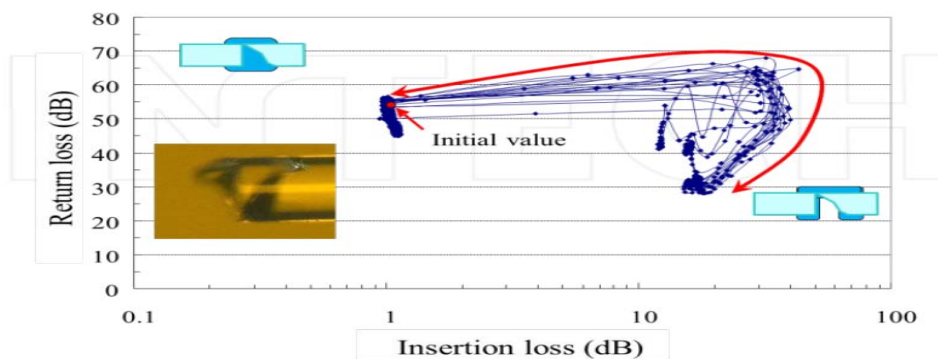
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# Causes of Faults and Failures

4. Scatter diagrams of results from heat cycle test for fiber connection with an incorrectly cleaved (uneven)



The initial insertion loss was low at about 1 dB and the initial return loss was high at more than 40 dB. The insertion loss increased greatly and then the return loss decreased as the temperature changed. At worst, the insertion loss changed to 43 dB and the return loss changed to 28 dB.



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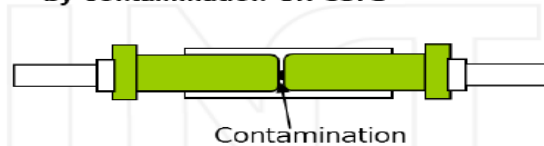
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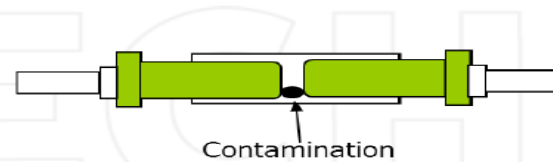
# Causes of Faults and Failures

## 5. Abnormal connection states for PC type connector with contamination

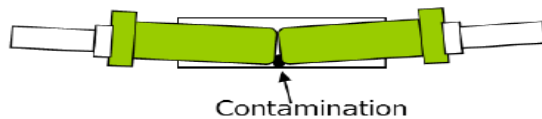
**(A) Light-blocking caused by contamination on core**



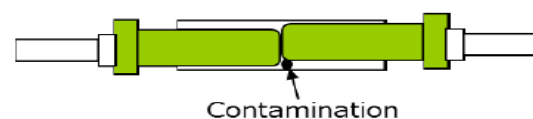
**(B) Gap caused by contamination**



**(C) Tilt misalignment caused by contamination**



**(D) Offset misalignment caused by contamination**



Conditions (A) to (D), which are caused by contamination on the fiber and ferrule endfaces, are thought to mainly affect the optical performance of connectors and make huge losses.



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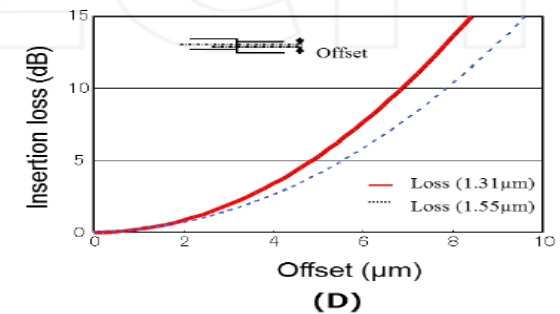
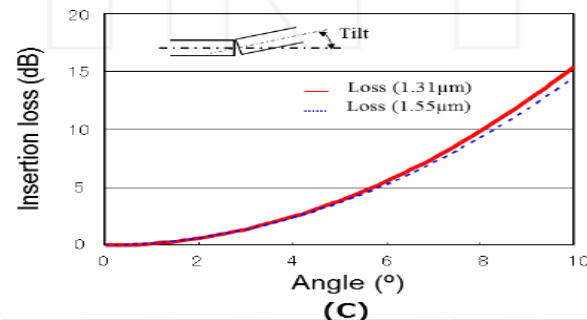
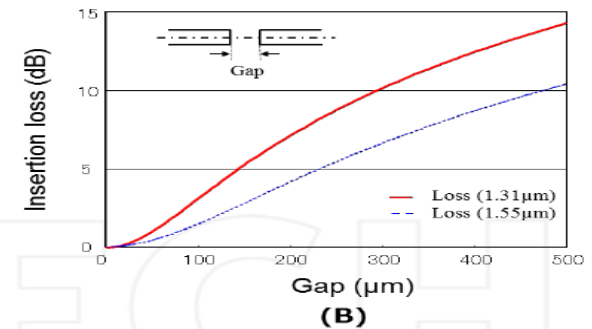
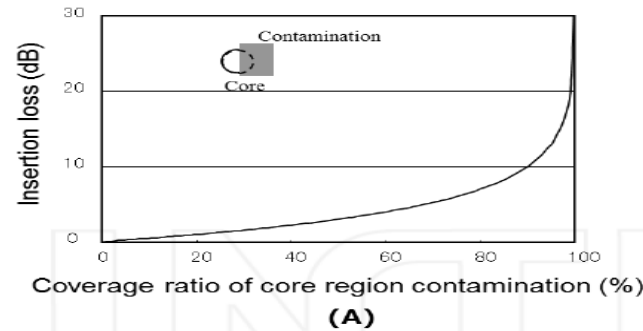
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# Causes of Faults and Failures

## 6. Calculated insertion loss

- (A) cover ratio of contamination to fiber core
- (B) caused by air-filled gap
- (C) caused by tilt
- (D) caused by offset



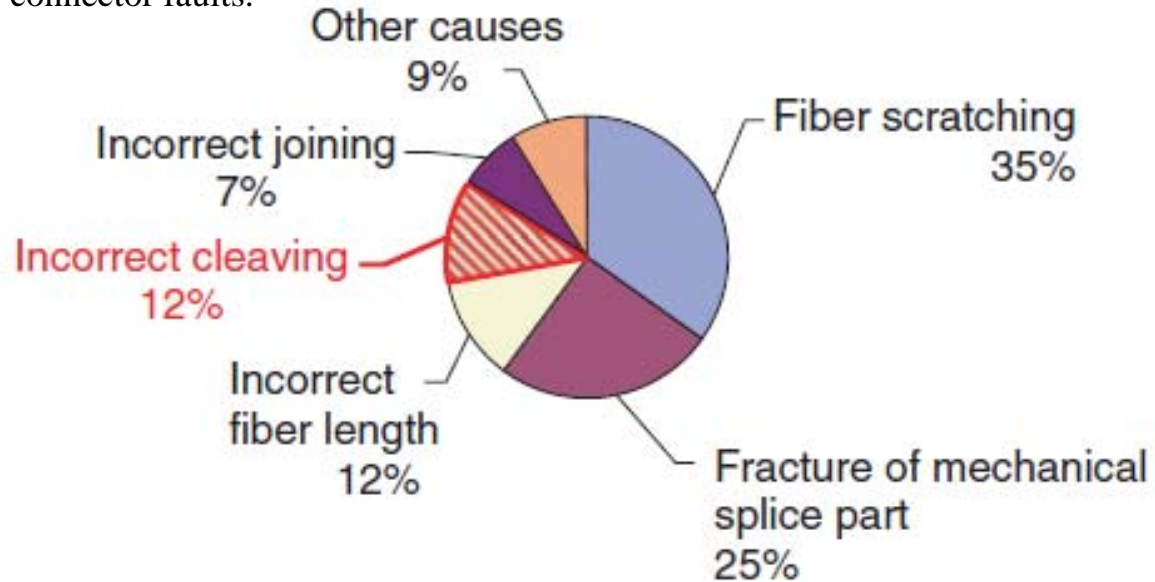
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# Causes of Faults and Failures

7. Causes of field assembly connector faults.



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# Causes of Faults and Failures

8. Examples of scratched optical fibers.



(a) Scratching caused by nipper blades



(b) Scratching caused by coating debris



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# Causes of Faults and Failures

- FSOC Termination Method with Quality Connectors and Quality Tools corrects these issues resulting in higher adoption in the market.
  - Quality Connectors
    - Field Strip and Cleave provide cleanest solution.
  - Quality Splicers
  - Quality Cleavers



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# Causes of Faults and Failures



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# Market Factors Affecting Migration



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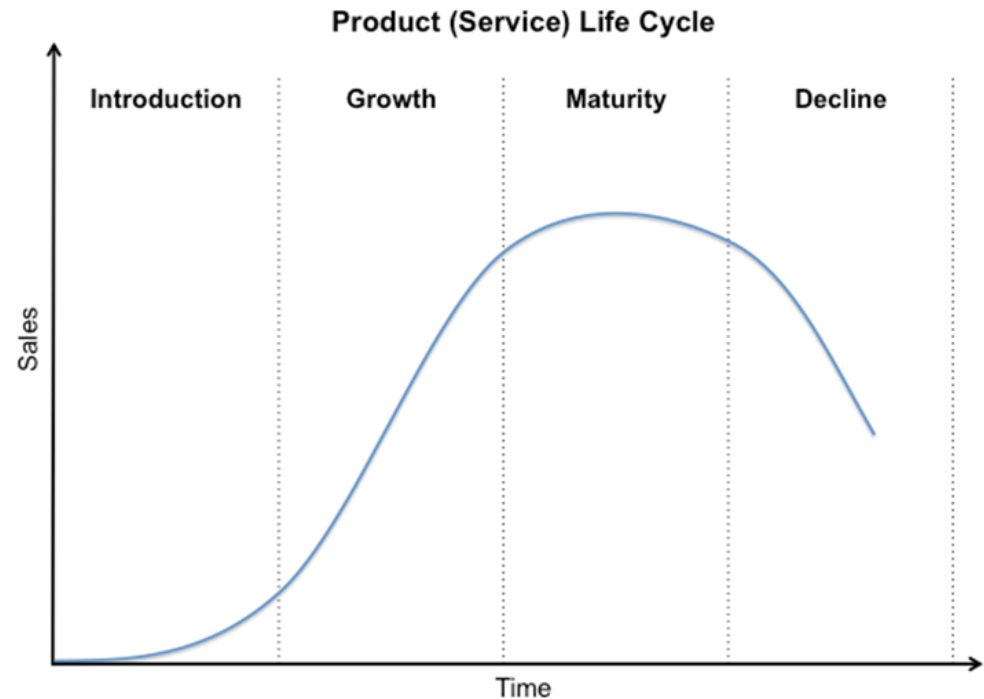
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# Life Cycle of Products

- **Product Life Cycle Model**

- Introduction...New Products still with a few bugs
- Growth...Bugs worked out, costs go down, followed by rapid adoption
- Maturity...Widely accepted products with few new features/benefits. Shortcomings are known and people are looking for a new alternative.
- Decline...obsolete technology, but still used by a few in legacy networks.



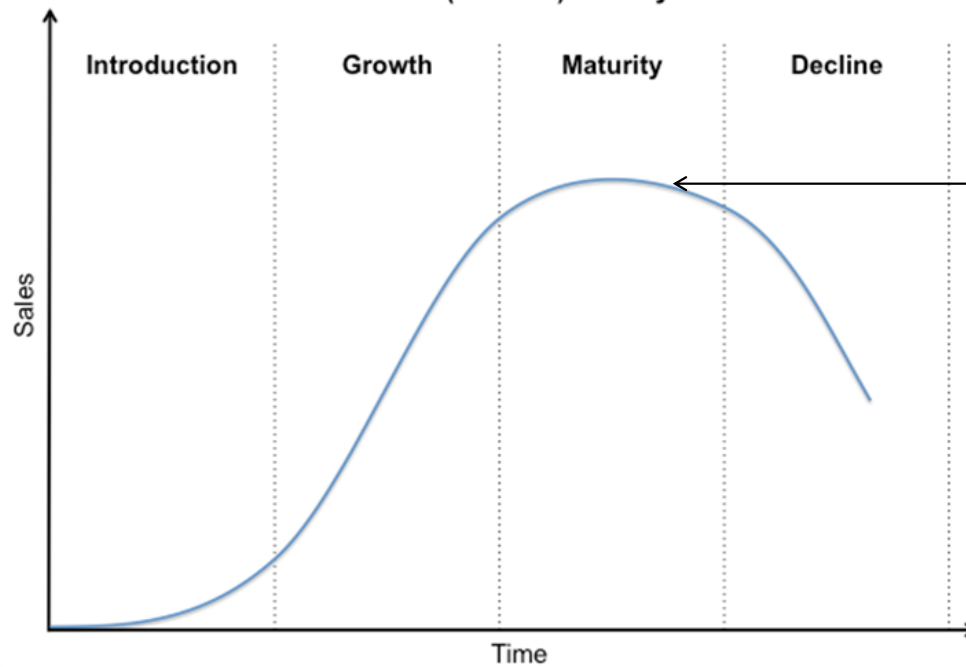
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# Life Cycle of Products

Product (Service) Life Cycle



Mechanical Connectors are late in the Maturity Stage

- Few New Products
- Few New Features/Benefits
- Flaws are known and accepted
- Market looking for a new solution



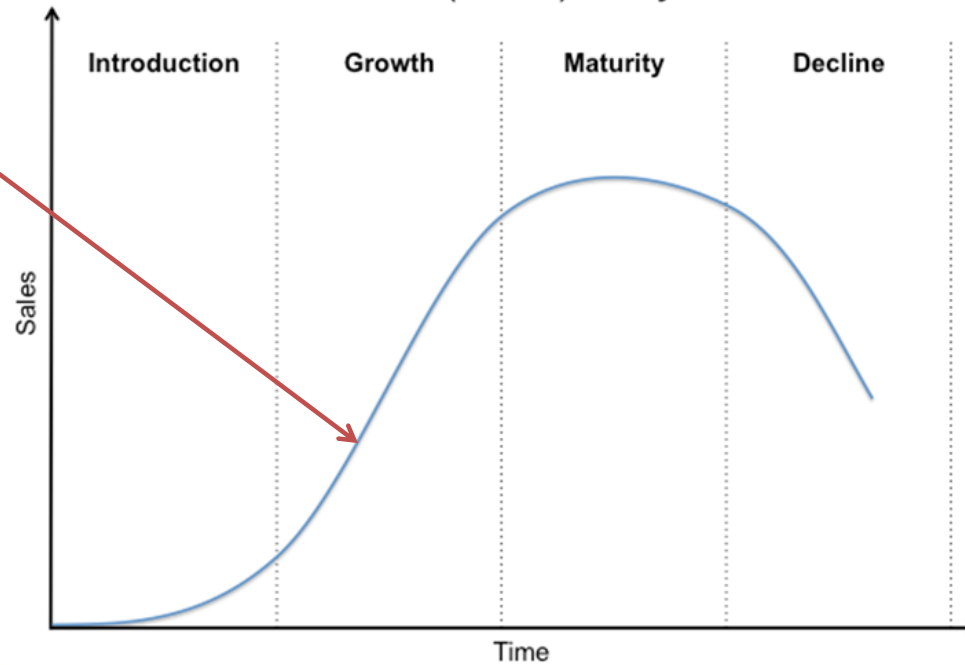
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# Life Cycle of Products

Product (Service) Life Cycle



FSOC is in the Growth Stage

- Fully developed technology
- Rapid Adoption
- Solves previous generation problems
- Support from related technology



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# Associated Technology

- Thermal Strippers
- Cleaning Products
- Precision Cleavers
- Faster Splice Times
- Fusion Splicer Sizes
- Fusion Splicer Costs



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# Associated Technology

- Splicer Alignment Methods
  - V-Groove
  - Active Clad
  - IPAAS Core
  - Ribbon Fibers

# Need Images!



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# Associated Technology

Or...All In One Splicer Designs



- Thermal Stripper
- Cleaner
- Cleaver
- Splicer
- Sleeve Heater



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## Associated Technology

- MPO Connector Termination
  - Splice to Ribbon Fiber
  - Splice to Loose Tube Fiber
  - Loose Tube MultiFiber Holder

# Need Images!



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