

# Gigabit over Plastic Optical Fibre

## Call For Interest

IEEE 802.3 Ethernet Working Group

# CFI Panel Members

- Chair and Presenters:
  - Carlos Pardo (KDPOF)
  - Thomas Lichtenegger (Avago)
  - Antonio París (Telefonica)
  - Hiroki Hirayama (Furukawa Electric)
- Supporters and experts for the Question and Answer session:
  - Naoshi Serizawa (Yazaki)
  - Oscar Rechou (Casacom/DigitalStrom)

# Supporters I

## ***Automotive OEMs***

- Hideki Goto (Toyota)
- Takashi Yasuda (Toyota)
- Manabu Kagami (Toyota Central Lab)
- John Leslie (Jaguar Land Rover)
- Efsthathios Larios (Jaguar Land Rover)
- Philip Jackson (Jaguar Land Rover)
- Michael Kaindl (BMW)
- Stefan Buntz (Daimler)
- Samuel Sigfridsson (Volvocars)
- José Villanueva (Renault)
- Yasuhiro Okuno (Honda)

## ***Automotive TIER-1 / TIER-2***

- Takanori Watanabe (Yazaki)
- Naoshi Serizawa (Yazaki)
- Shigeru Kobayashi (TE)
- Markus Dittmann (TE)
- Andreas Engel (TE)
- Yoshifumi Kaku (Denso)
- Tomoyuki Koike (Denso)
- Hiroyuki Nakamura (Clarion)
- Tomoyoshi Terao (Murata)
- Nobuhiko Kusaba (Murata)
- Yoshihiro Imanishi (Murata)

# Supporters II

- Hayato Yuki (Sumitomo)
- Kiyoshi Kato (Sumitomo)
- Keisuke Kawahara (Furukawa Elec)
- Hiroki Hirayama (Furukawa Elec)
- Tetsuya Hiraiwa (Furukawa AS)
- Yukitoshi Inui (Toyoda Gosei)
- Naoyuki Okita (Toyoda Gosei)
- Richard Mellitz (Intel)
- Kouichi Tojo (Megachips)
- Ryouyuke Ohmura (NXP Electronics)
- Jeroen Gerlings (NXP Electronics)
- Nobukatsu Kitajima (Renesas)
- Carlos Pardo (KDPOF)
- Thomas Lichtenegger (Avago)

## ***Silicon suppliers***

- Sadafumi Arita (Micrel)
- Kentaro Imai ( Marvell)
- Robert Wang (Intel)
- Kent Lusted (Intel)
- Charles Moore (Avago)
- Henry Muyshondt (Microchip)
- TMarris, Arthur (Cadence)
- Hugh Hennessy (Firecomms)

# Supporters III

## ***Telecom operators***

- Javier Perez (Telefonica)
- Antonio París (Telefonica)
- Angelantonio Gnazzo (Telecom Italia)
- Andrea Bergaglio (Telecom Italia)
- Luca Giacomello (Telecom Italia)
- Mario Zerson (Deutsche Telekom)
- Unai Labirua (Vodafone)

## ***Industrial / professional***

- Eric Y Chan (Boeing)
- Tuong K Truong (Boeing)
- Jaume Altesa (Alstom)
- Jean-Paul Matkovic-Ramirez (Alstom)

- Alan Lobban (HP)
- Jordi Hernandez Creus (HP)
- Josep M. Rio (HP)
- Roger Forrester (Axman)
- Marco Rizzetti (Luceat)

## ***Home networking product/component manufacturers***

- Carmelo Gago (Comtrend)
- César de la Serna (Bluecastle)
- Óscar Rechou (Casacom/DigitalStrom)
- Jose Faller (HomeFibre)
- Philippe Bolle (Skylane)
- Sandro Basso (Feller by Schneider)

# Supporters IV

- Raul Bonade (Feller by Schneider)
- Bryan Sparrowhawk (Leviton)
- H.C. Shyu (Radiantech)
- Bas Huiszoon (Genexis)
- Farid Hamidy (Pulse)
- Yutaka Tanida (Mitsubishi Corporation)
- Yoshihiro Tsukamoto (Mitsubishi Rayon)
- Mr. Ken Eben (Mitsubishi International Corporation)
- Frank Aldinger (Mitsubishi International GmbH)
- Eden Tsai 蔡易達 (Comoss)
- Mike Cao 曹质文 (IPT-Industrial)
- Ulrich Pint (Rutenbek)
- Frank Bünger (Rutenbeck)
- Jan Streibel (Fränkische Rohrwerke)

## ***Others***

- Thompson, Geoffrey (GraCaSI S.A.)
- Bob Grow (RMG Consulting)
- David Estes (UNH-IOL)
- Olaf Ziemann (POF-AC)

# Supporter statistics

- Automotive OEMs
  - Individuals 11
  - Organizations 7
- Automotive suppliers
  - Individuals 18
  - Organizations 8
- Silicon suppliers
  - Individuals 15
  - Organizations 11
- Telecom operators
  - Individuals 7
  - Organizations 4
- Industrial / professional corporations
  - Individuals 9
  - Organizations 5
- Home networking product and component manufacturers
  - Individuals 20
  - Organizations 17
- Others (Academia, consulting ...)
  - Individuals 4
  - Organizations 4
- **Total**
  - **Individuals 82**
  - **Organizations 56**

# CFI Objective

- To gauge the interest in starting a study group developing a Plastic Optical Fiber Gigabit PHY
- This meeting will NOT:
  - Fully explore the problem
  - Debate strengths and weaknesses of solutions
  - Choose a solution
  - Create a PAR or 5 Criteria
  - Create a standard or specification

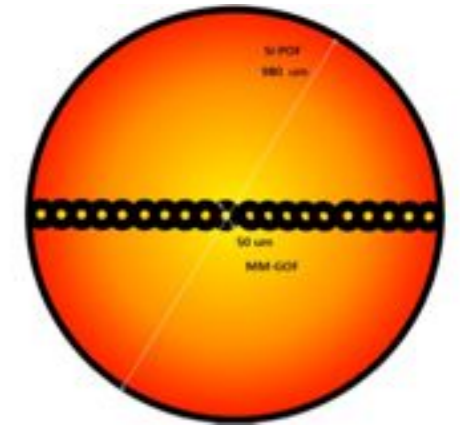


# Agenda

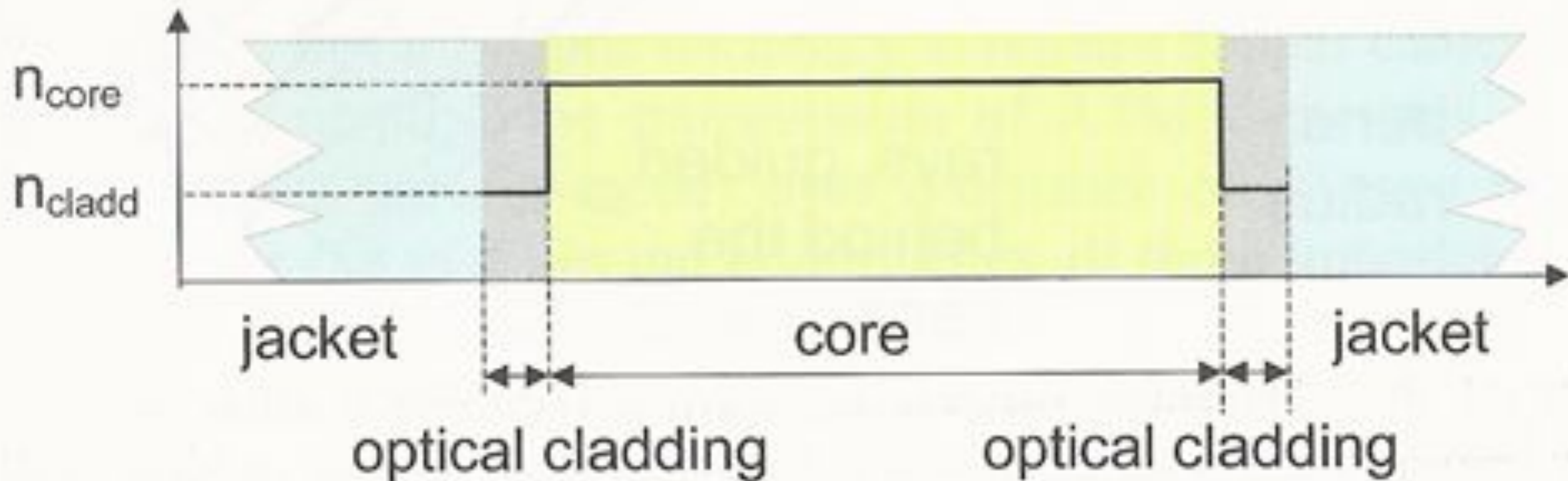
- What is POF ? How does POF work?
- POF assemblies
- POF light sources / detectors
- History of POF networking
- Target markets
  - Home networking potential
  - Automotive market potential
  - Professional networking potential
- Why now ? Why IEEE 802.3 ?
- High level summary
- Q&A
- Straw Polls



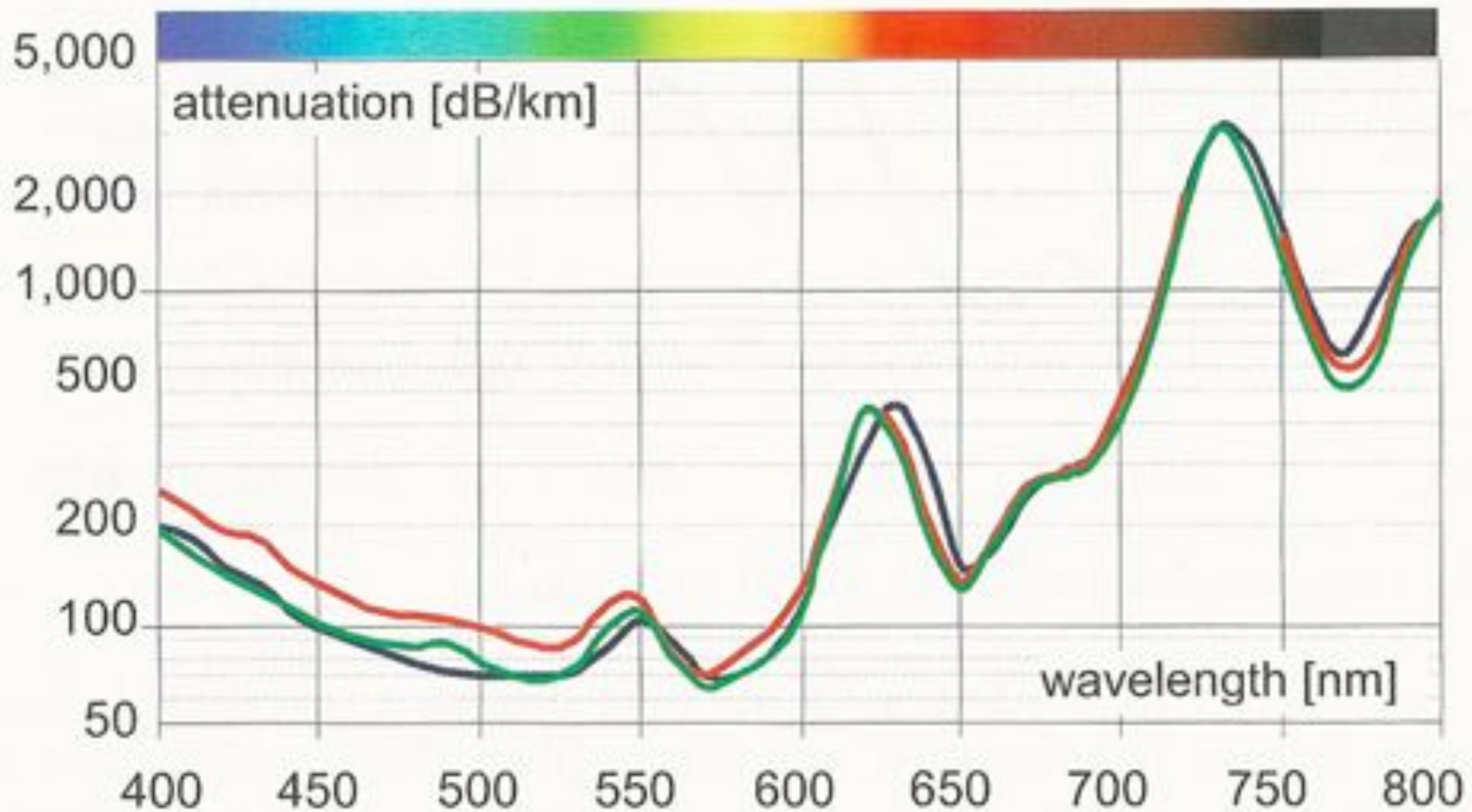
# What is POF ?



- Full Duplex 1mm core plastic optical fiber. Standardized in ISO/IEC (IEC 60793-2-40 A4a.2).
- Step Index with 980um core and NA = 0.5
- Very easy to install. No special tool or training for cutting and plugging.

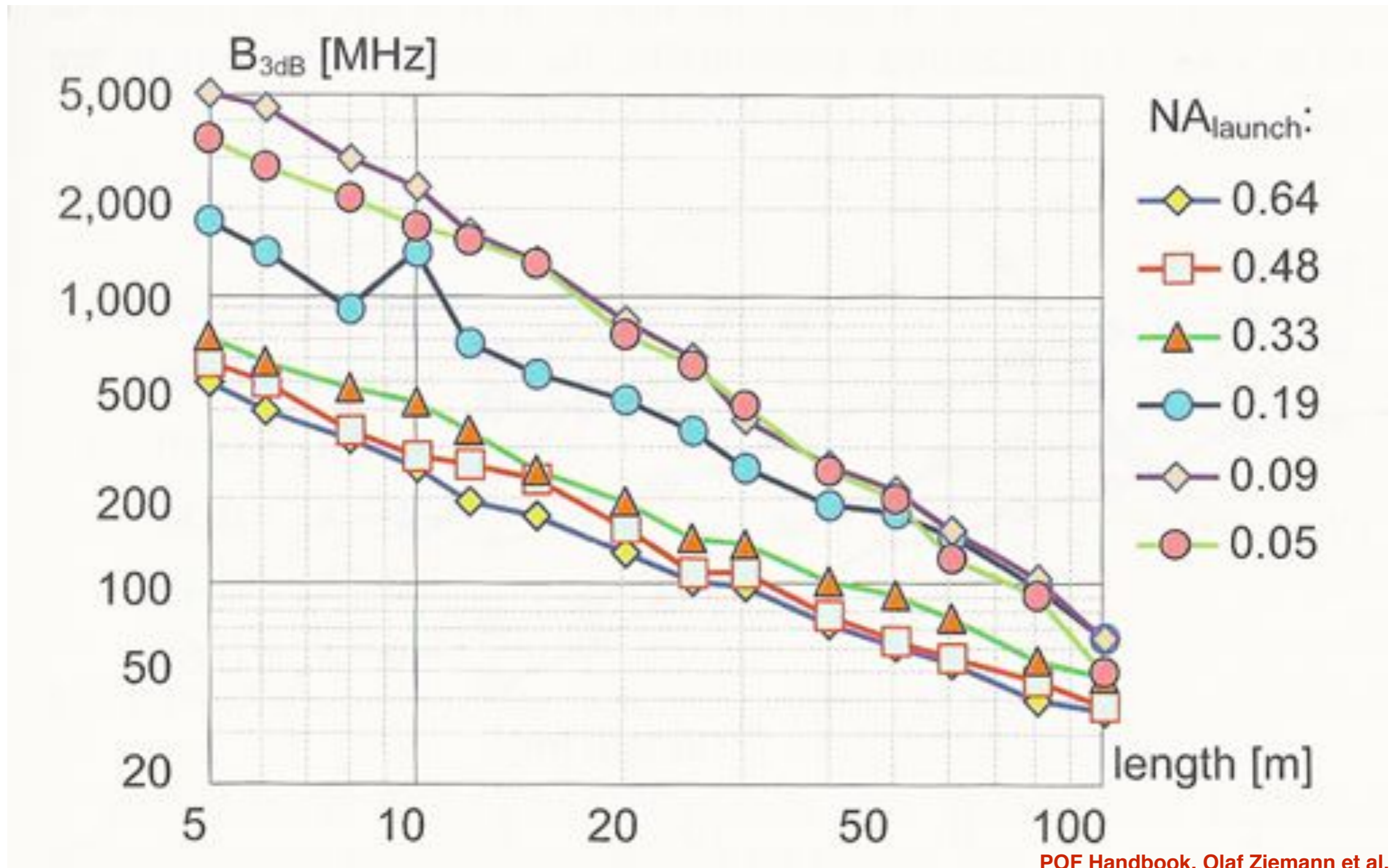


# How does POF work?



POF Handbook. Olaf Ziemann et al.

# How does POF work?



POF Handbook. Olaf Ziemann et al.

# POF Assemblies in different markets

- Home networking
  - Bare fibre connector
- Automotive
  - MOST type connectors
- Professional
  - Many different connectors



# POF light sources/detectors

- Red LED (650 nm) with -3dBm nominal optical output power is the primarily used light source
  - This light source is already qualified for automotive operation.
  - LED bandwidth around 70 MHz (-3dB electrical)
  - Launching NA ~ 0.3
  - Attenuation ~18 dB/100m
- Low power (3 to 6dBm) green laser (520 nm) might be used for long fibre distances.
  - Laser bandwidth around 400 MHz (-3dB electrical)
  - Launching NA ~0.15
  - Attenuation ~9dB/100m
- Large diameter Si-PIN photodiodes
  - Large photodiode capacitance
  - Very wide dynamic range and low noise Trans-Impedance Amplifiers
  - Integrated CMOS technology --> very strong EMI/ESD protection

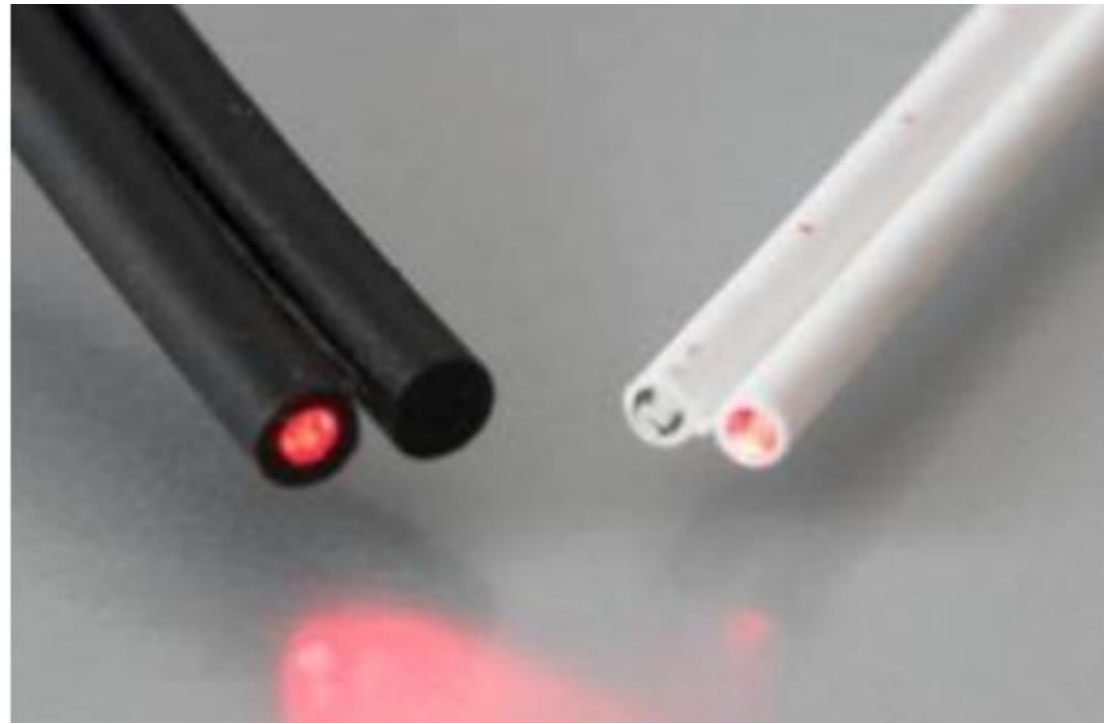
# History of POF networking

- Currently, the biggest market is automotive, driven by MOST multimedia networking (25/150 Mbps)
  - More than 100 million nodes sold
  - Many OEMs worldwide have POF experience and use it in volume production
  - POF is very reliable physical layer with negligible failure rate
- Several trials during the last 10 years in the home network market reusing the 100BASE-FX PHY
  - Small volumes because “no-new-wires” (Power Line Communications & WiFi) technologies provided enough speed and coverage
- Professional 100 Mbps networking market in environments with high electrical noise
  - Medical, power generation, industrial automation & connectivity, etc
  - Overall volume for Ethernet about 1 Million ports per year

# Target markets

- Consumer networking
- Automotive networking
- Professional networking





# Consumer networking

## Home networks

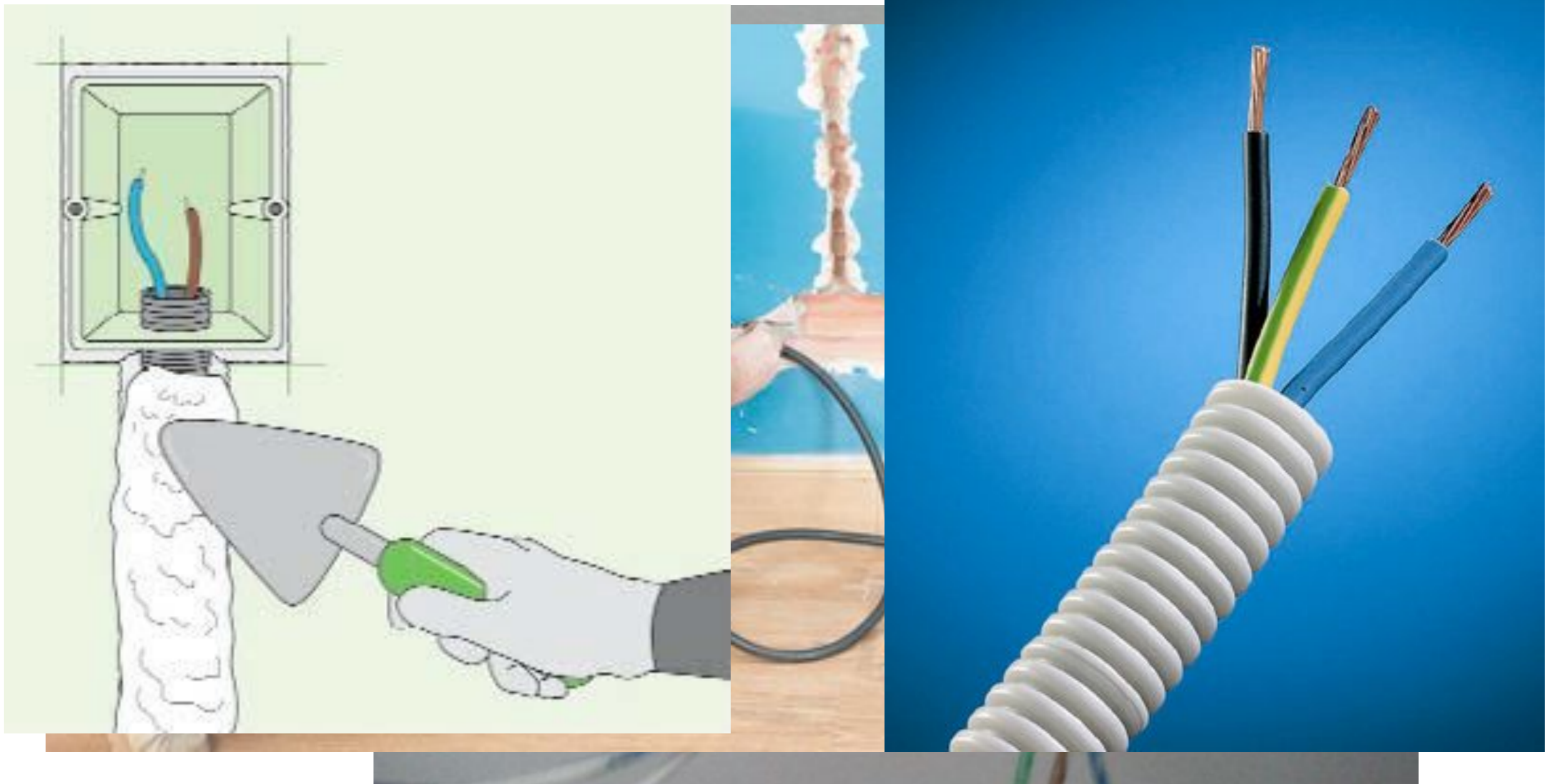
# Home networking market

- Today Fiber To The Home (FTTH) provides from 100 Mbps to 1 Gbps
- Inside the homes, Network Attached Storage (NAS) and other home servers are standard equipment requiring high bit-rates
- In many households (E.g., Europe, Latam, etc), neither Wi-Fi nor Power Line Communications (PLC) are able to provide these speeds with full house coverage
  - Noisy PLC and saturated Wi-Fi limits speed and robustness
  - Many ISPs stopped offering PLC due to unpredictability quality
  - Additional attenuation in brick houses over wooden ones is around 3.5dB per wall and 12 dB per floor. (ITU-R M.1225 Appendix 1 to annex 2)
- As an example, current IPTV services are offered via 1000BASE-T and not via Wi-Fi or PLC
- Installation of 1000BASE-T in brown field houses is an expensive task, or visually ugly

**In summary: New cables are needed.**

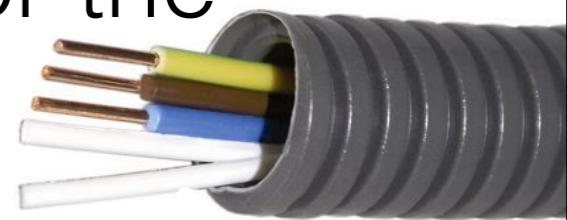
# Home networking market

- Power supply cables in many European houses are installed using plastic conduit-like pipes, embedded in brick, cement and plaster.



# Home networking market

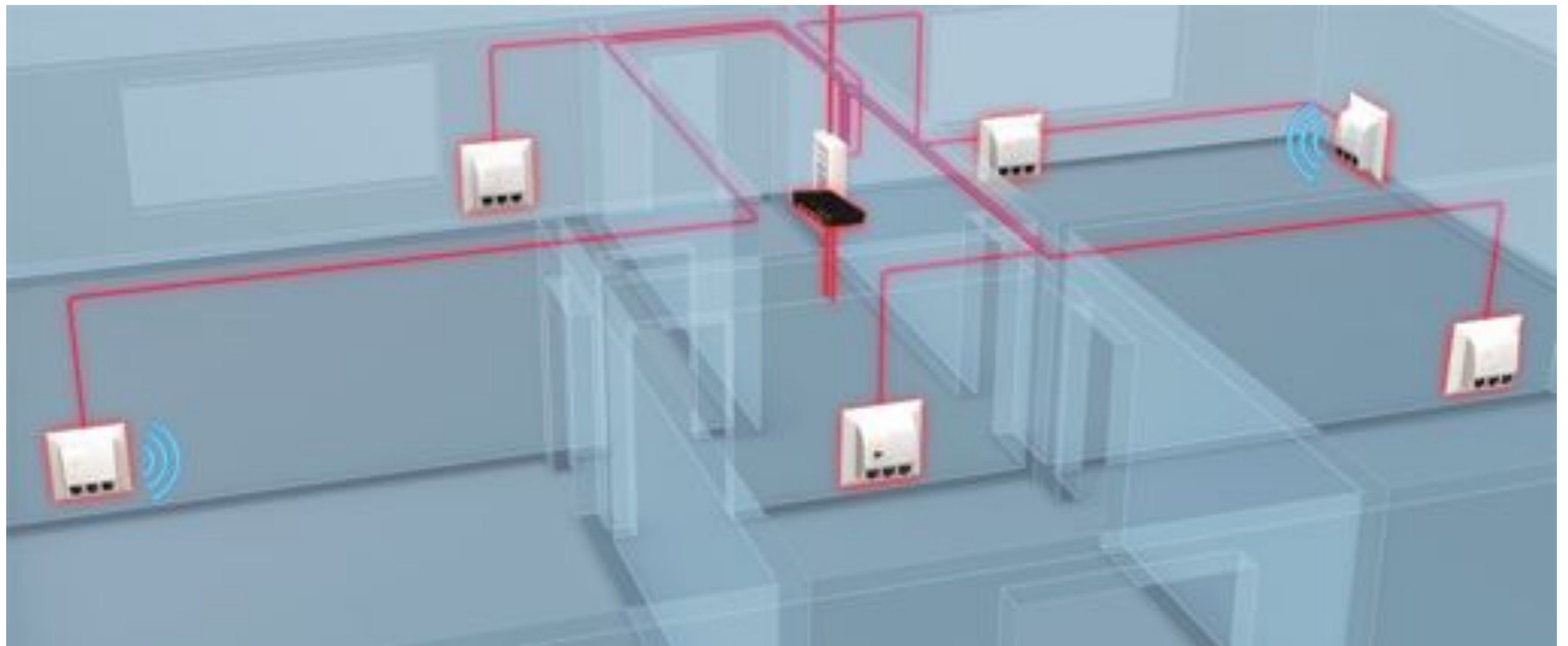
- A 1 Gbps POF-based home backbone solution:
  - Codes allow use of power conduits for the installation of fibre
  - Star, tree, daisy chain and mixed topologies are possible
    - ▶ Supports typical link lengths of 15-50m
  - Per room, integrated wall-plugs with Wi-Fi access point and RJ-45 Ethernet socket(s) ensures comfortable user access.



# Home networking solution

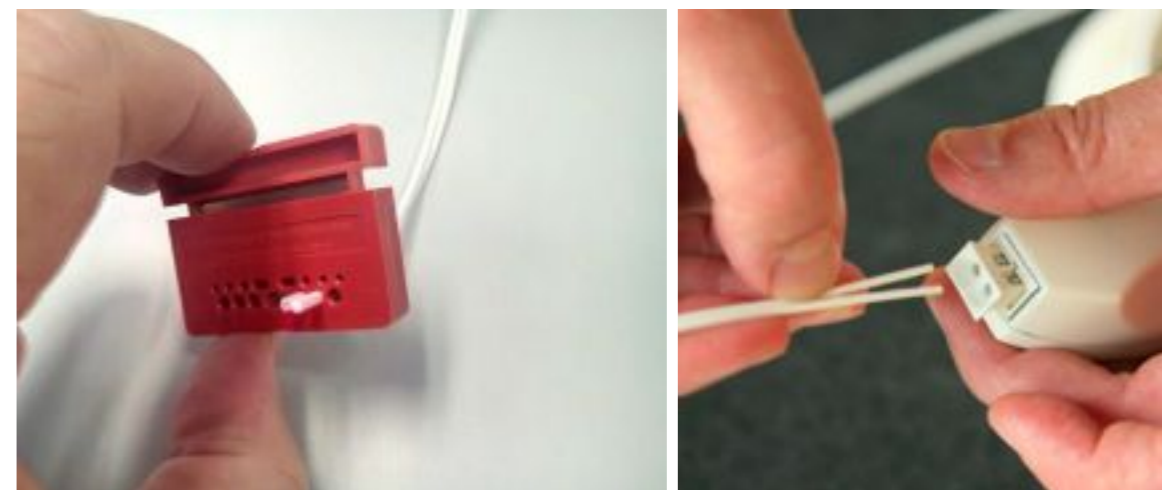
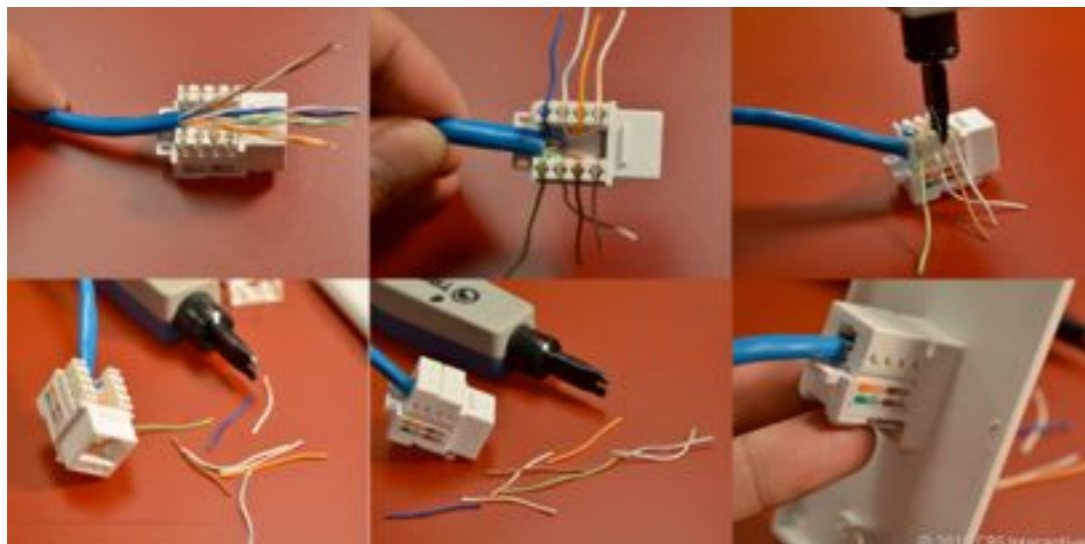


# Home networking solution



# Home networking market

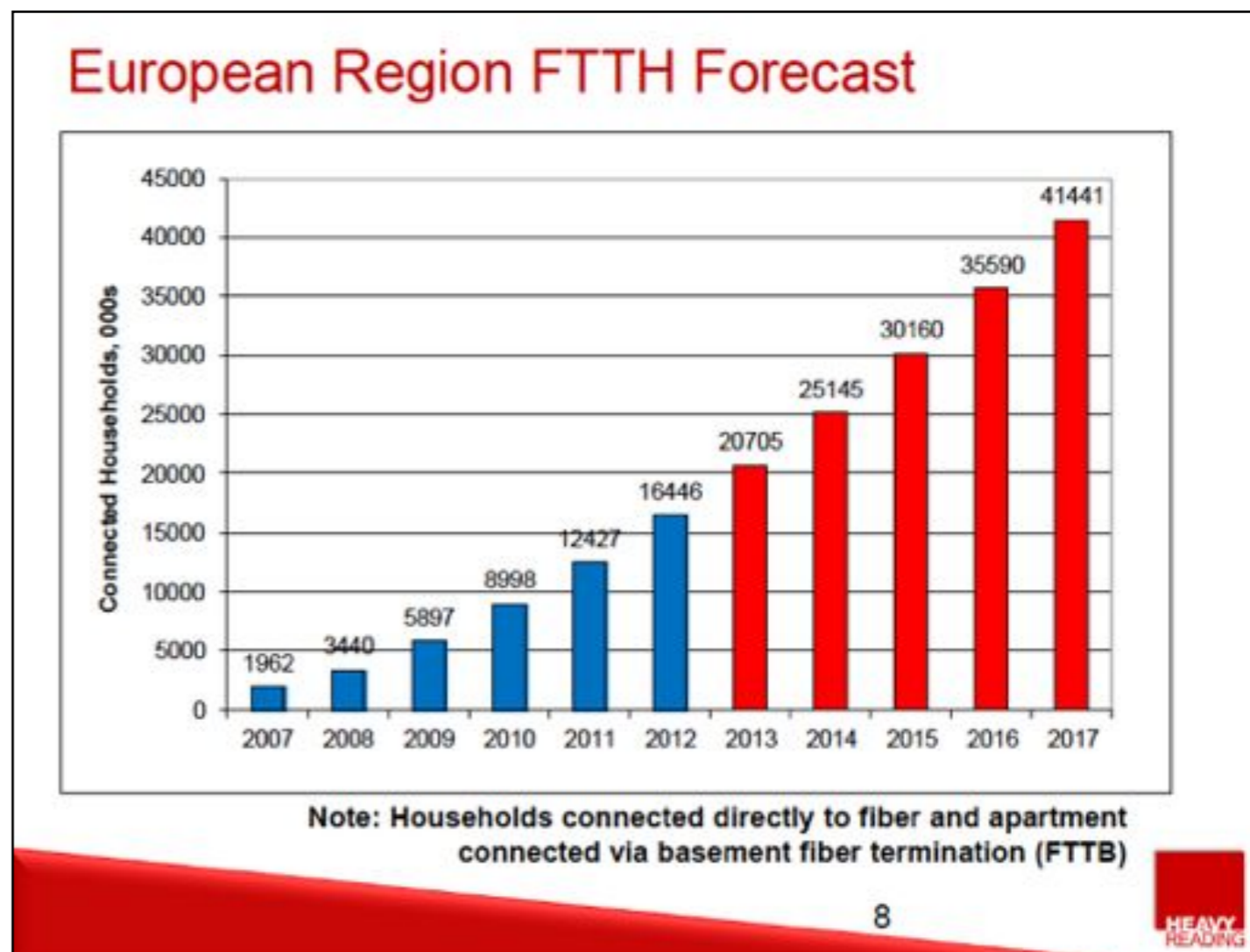
- Why POF and not CAT5e cables ?
  - POF does not need connectors, and installation time is much shorter
  - Codes do not allow CAT5e/6 cables to be placed together with power in the conduits
    - ▶ Security reasons
    - ▶ EMI / EMC reasons
    - ▶ Size issues



# Market potential

- Who needs 1 Gbps POF Home Network ?
  - In principle, all households with Internet access of 100Mbps or more
- The world wide FTTH deployment gives a good approximation of the market potential for the Gigabit Home Networking
  - 5M households per year in Europe
  - 15M households per year Worldwide with new FTTH
  - 12M households suitable to POF solution
  - Average 6 ports per household
  - Professional installers, high end house builders, etc may also be considered

- **Potential market of >72M ports per year.**





*Telefonica*

## POF in Home Networking

Telefonica Spain  
18.03.2014

*BE MORE\_*





## Telefonica Group

- 1st European integrated operator
- 7<sup>th</sup> Telco worldwide by market capitalization
- 320M Customers, 40M fixed Broad Band accesses, 240 MM mobile customers, 3.4 M TV customers
- 24 countries
- 130K Employees



## Telefonica Spain

- 6M Broad Band fixed customers, 800K IPTV subscribers
- Moving to ultra high-speed accesses
  - FTTH
  - LTE



Solutions to distribute HDTV and Ultra Broad Band services at customer premises.

# Searching for Home Networking solutions supporting the present & future requirements, we did a field trial with real customers, 30 houses on May 2012

## External Media converter



- Self install POF/ Ethernet adapters
- USB power supply
- Focus on point-to-point connectivity

## Wall-plug



Wall-plug media converters with two user interfaces:

- Media converter to Ethernet switch
- Media converter to Ethernet switch+802.11n access point

## Trial conclusions

- POF is thinner than CAT5e/6 and easier to install
- The connectors provided with the devices allowed a simple way to install the devices
- The use of LED instead of laser makes an eye safety solution
- Compatible with electrical conduits installation
- Good support of the portfolio of services at that moment (50 +10 Mbps Data access and 2 HD streams IPTV)
- Flexibility provided by having multiple 802.11n access point in the house

## But still something to improve...

### Things to improve

- The trial was done with 100 Mbps POF PHY, which was suitable at that moment, but the services are moving ...
  - The conventional FTTH profile is now 100/10 Mbps and growing ...
  - IPTV is evolving with more HD streams and with UHD TV-4K at the horizon
- If the customer invests in POF based home network, it must be future proven with new coming services
- 100 Mbps is not enough
- For Telefonica, solutions based on a standard is a must to guarantee the provisioning and low cost
- Daisy chain support is a must to simplify the installation of the POF network

### Next steps

- New field trial with real customers with Gigabit POF
- Evaluate the trial results and deliver the information to all of Telefonica Spain and Operational Businesses of Telefonica group

*Telefonica*

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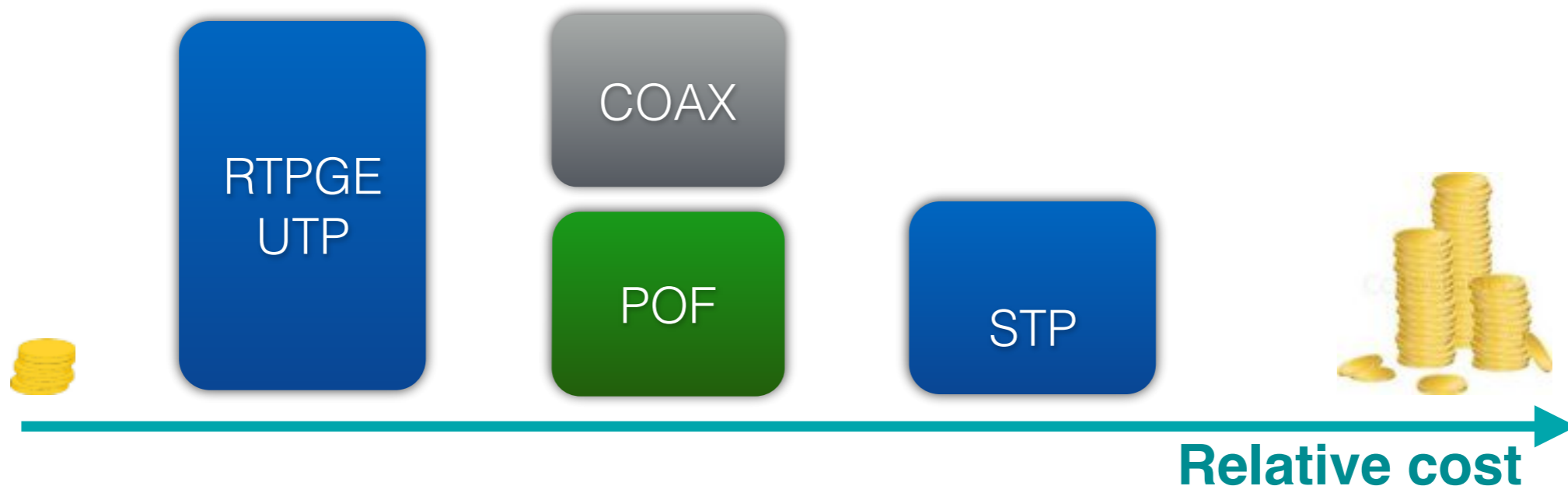
BE MORE\_



# Automotive networking

# Automotive networking

- Complements RTPGE/1000BASE-T1
  - Addresses those applications that can't be serviced with 1000BASE-T1 UTP cabling
  - E.g., high electromagnetic noisy areas, galvanic isolation, long distances
- POF is already used in automotive for information and entertainment with the MOST technology
  - Re-use of current MOST LED will guarantee automotive qualification
  - Leverages on already qualified connectors and cables



# Market potential

- As stated in RTPGE CFI (March 2012)
  - Overall automotive Ethernet market up to 270 Million ports in 2019
- Brings current automotive POF users to a fully seamless Ethernet solution
  - Stronger Ethernet automotive market potential growth
- Complementarity use of RTPGE and Gigabit POF solutions

	RTPGE	GIG-POF
Weight	✓	✓✓
EMI/EMC	✓	✓✓✓
Galvanic Isolation	✓	✓✓✓
Temperature	✓✓	✓
Length	✓	✓✓
Cost	✓✓	✓



*One voice of JAPAN - JASPAR was established, in 2004, in order to pursue increasing development efficiency and ensuring reliability, by standardization and common use of electronic control system software and in-vehicle network which are advancing and complexing.*

**Board:** TOYOTA, Nissan, Honda, DENSO, Toyota Tsusho Electronics

**Members:** Regular: 75 / Associate: 56 (as of Jan. '14)

**WGs:**

- **Next Generation High-Speed Network WG**
- Functional Safety WG
- AUTOSAR/FlexRay Standardization WG
- Multimedia Architecture WG
- Bluetooth Conformance WG
- Mobile Device Interface WG

**Next Generation High-Speed Network WG**

Chair: **TOYOTA**

Nissan, Honda, Denso, Renesas Electronics, Sumitomo Electric, Murata Manufacture, Toyoda Gosei, Clarion, Bosch Japan, NXP Japan, Micrel Japan, Yazaki, Furukawa Electric, Toyota Central R&D Labs, Marvell Japan, TE Connectivity, Nippon Seiki, Fujitsu TEN, Nippon Seiki, Isuzu Motor, Clarion, Mitsubishi Electric, Fujitsu Semiconductor, Toshiba Information Systems, Hitachi Automotive Systems, Calsonic Kansei, Micware, OTSL, Analog Devices, Vector Japan, ETAS, Marvell Japan, Sunny Giken, Telemotive AG, Ricoh, MegaGhips, Tokai Rika

**Requirements Definitions of the WG**

- Recommendation's application
- Network
- Function profiles
- Physical layer and wiring design
- Data description format

# Optical Network Systems for Automotive

## Optical communication in cars

1980      1990      2000      2010      2020

Peer to peer



More than **100,000,000** nodes  
 More than **150** car models  
 Over **10** years

## Features of POF and components

- High speed
- Scalability/Expandability
- EMC/EMI
- Dimensions
- Weight
- Small cable diameter
- Small bending radius

## In-vehicle optical components



Header



Connector



POF

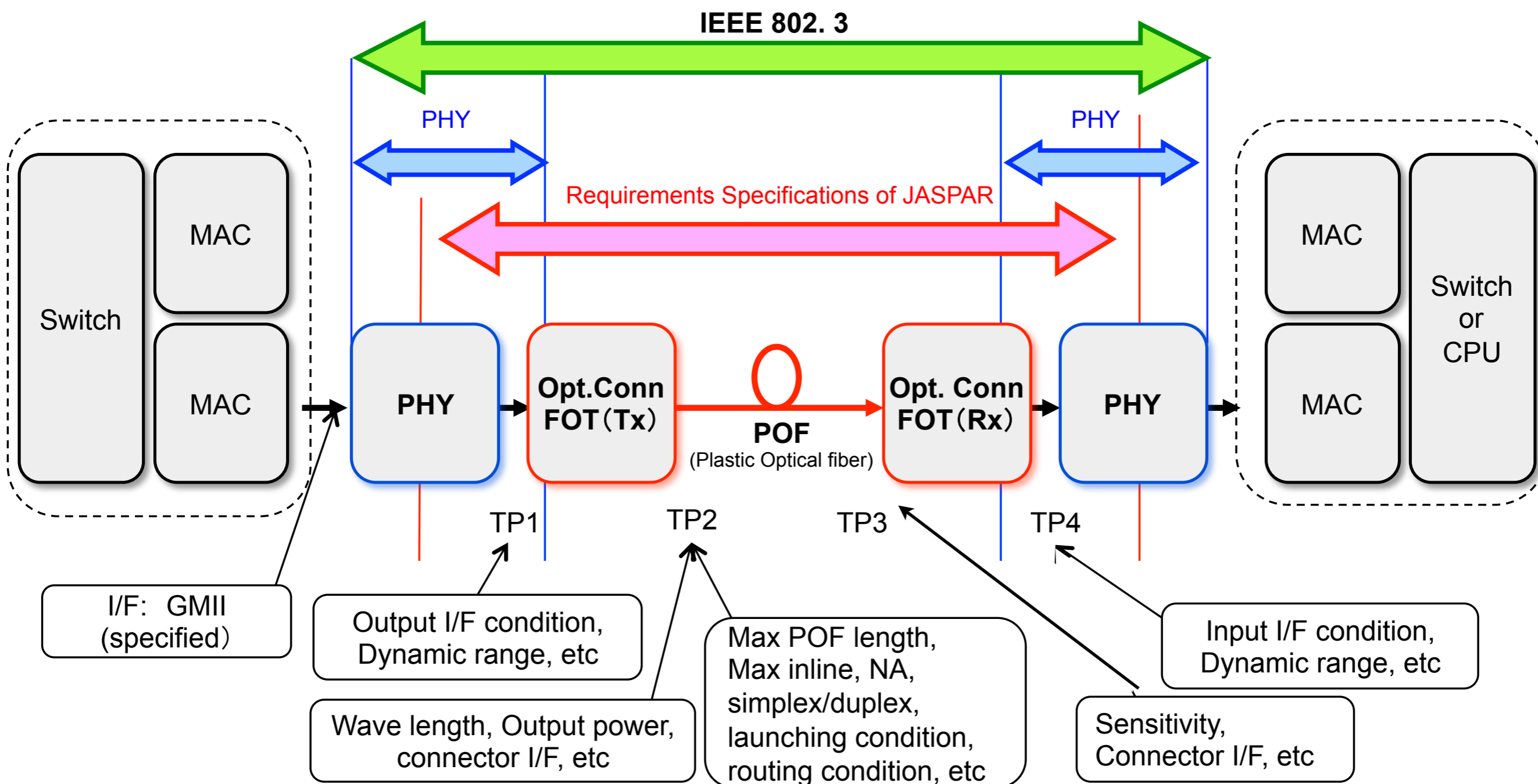


Model link

## Cost competition strategy

- No more measures against noise
- Standardized test methods and components
- Full automation manufacturing
- Use proven technologies from other industries
- Demonstration project

# Wiring Requirement Specifications of JASPAR

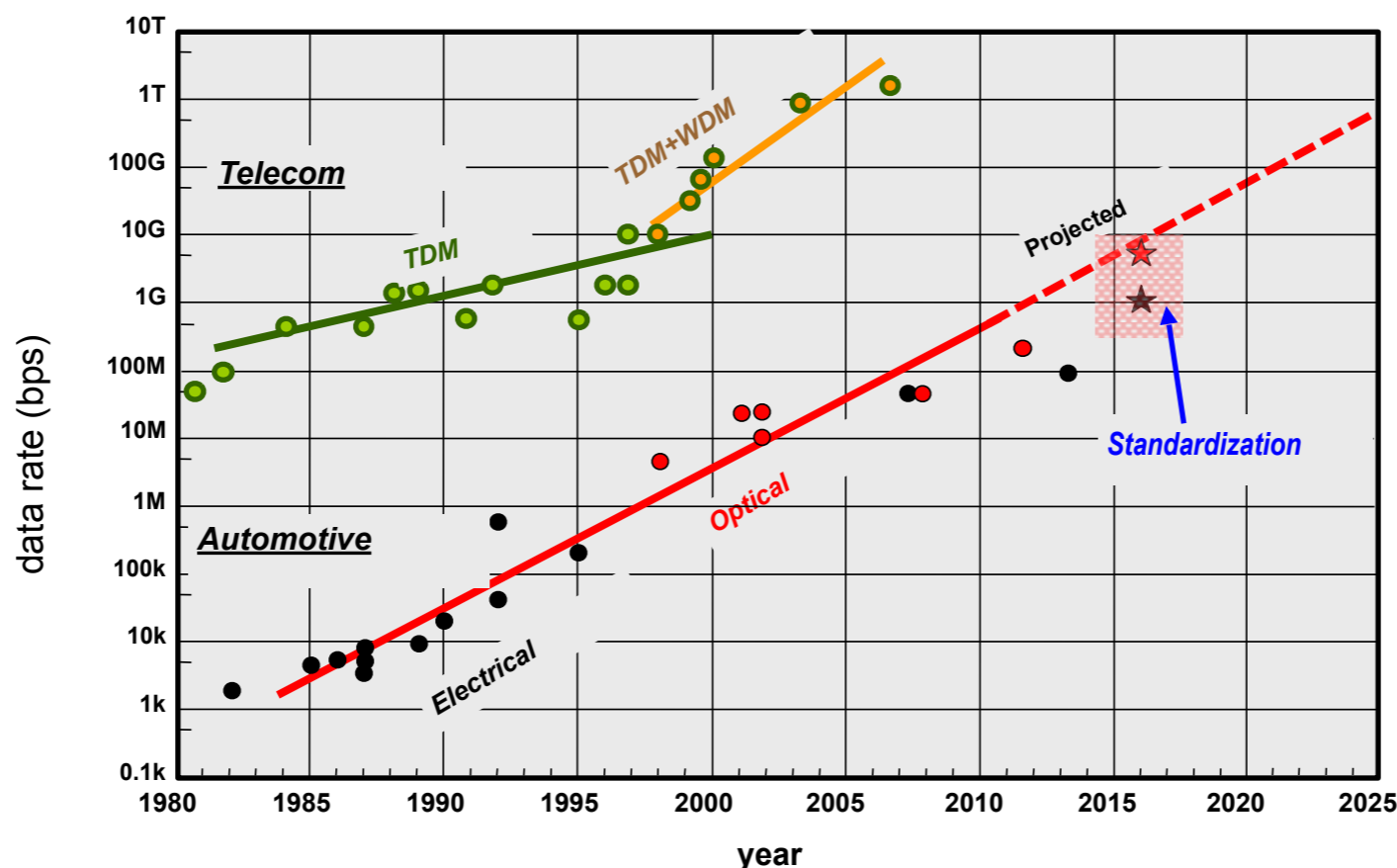


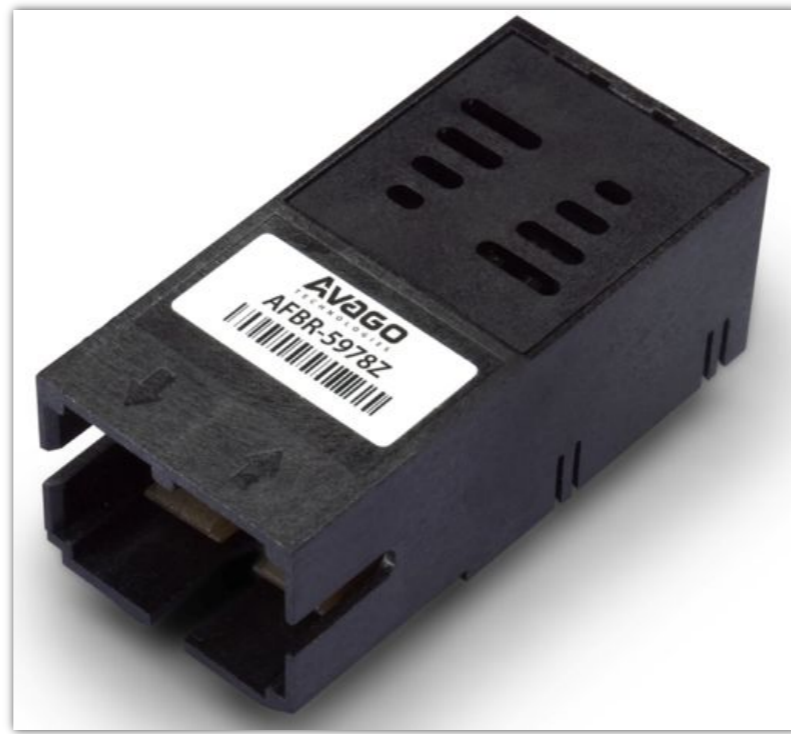
FOT: Fiber Optic Transceiver

# Summary for Automotive Applications

- Complementary technologies, electrical and optical, bring **benefits** for customers
- Optical fiber is a **proven technology** in automotive
- Beyond Gigabit Ethernet enhances **future applications**
- **JASPAR** companies members will contribute to the IEEE standardization works

## Never Shrink Network Traffic





# Professional networking

# Professional market

- Applications with 1 Gbps requirements and harsh environments
  - Automation technology
  - Medical devices (CT, PET, MRI, etc)
  - Power generation and distribution
  - Transportation: Aviation, Trains
  - Factory network back-bone
  - Security and surveillance cameras
  - Very large format printing
- Many fiber network standards available for lower speeds:
  - Profibus, SERCOS, PROFINET, many proprietary real time Ethernet standards (e.g. EtherCAT, HCS1, ODVA) and many proprietary network standards
- Next speed grade of 1Gbps needed
- POF is needed because of EMC robustness, galvanic isolation

# Professional market

## Automation applications

Value proposition

- EMI/EMC
- Galvanic isolation
- Bending durability of POF fibre
- Monitoring of link quality



## Power applications

Value proposition

- EMI/EMC
- Galvanic isolation



## Medical applications

Value proposition

- EMI/EMC
- High reliability of POF fibre
- Monitoring of link quality



# Why now ? Why IEEE 802.3 ?

- A POF media option allows Ethernet to better serve other markets where Ethernet is already used
- A POF option for the automotive environment allows Ethernet to complement automotive network media options being standardized in IEEE today
- IEEE 802.3 WG is the right place to standardize Ethernet PHYs
- Technical feasibility is demonstrated with already available products



# High level summary

- POF can be described as rugged and easy to use optical fibre
- Gigabit POF will cover business opportunities in different markets
  - Consumer networking, automotive networking and profesional networking
  - Gigabit POF addresses a share in each
- Different light sources and fiber distances may be considered for the different markets

# Gigabit over Plastic Optical Fibre PHY Q&A (15 min)

# Straw Polls

# Straw Poll

- 84 Number of people in the room
- 17 Individuals who would attend and contribute to a Gigabit over Plastic Optical Fibre Study Group
- 19 Companies represented by individuals that support formation of a Gigabit over Plastic Optical Fibre Study Group

# Straw Poll

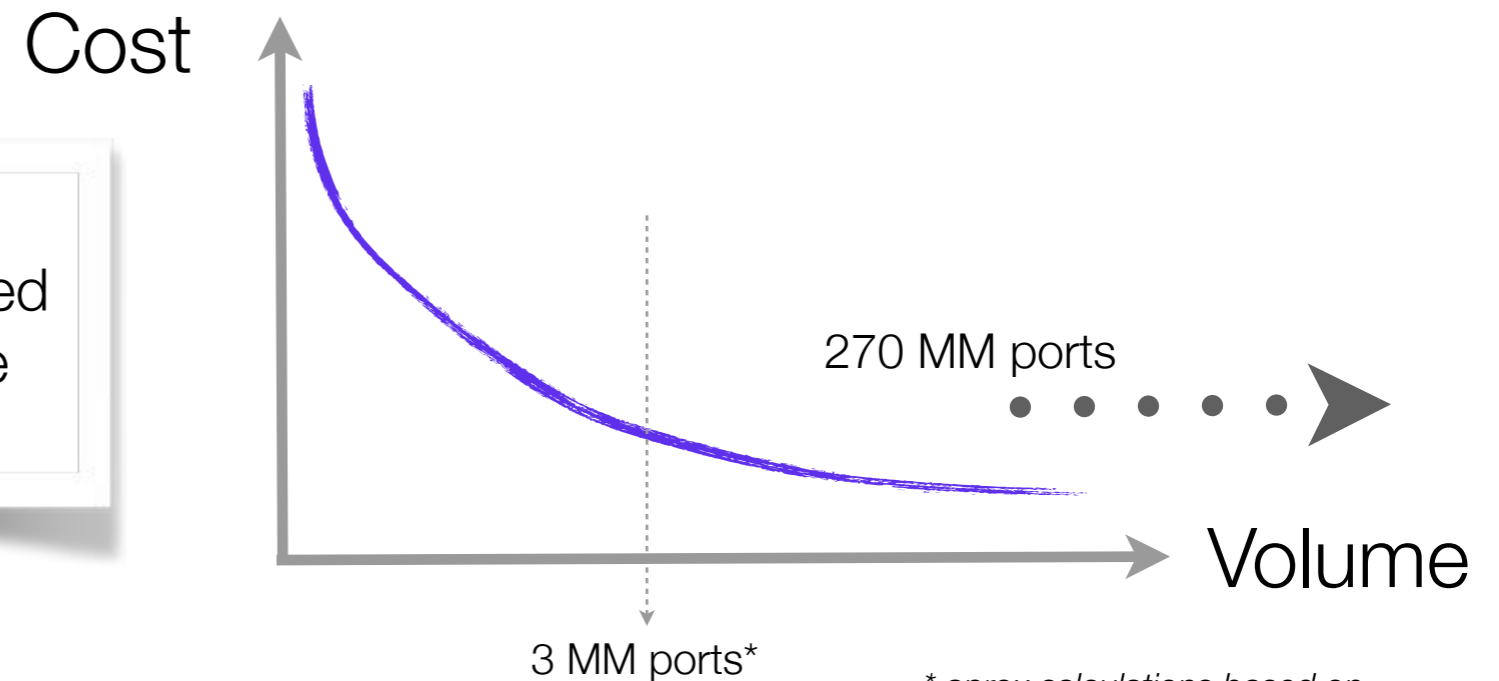
- Request that IEEE 802.3 WG form a study group to develop a PAR and CSD (Managed Objects and 5C) for a Gigabit over Plastic Optical Fibre

	All attendees	802.3 voters only
Yes	34	13
No	9	10
Abs	38	28

# Backup slides

# Market Growth vs. Split

With a Potential market of 270 MM ports in 2019 cost has already reached the “High Volume market” level where cost is not sensitive to volume.



*\* aprox calculations based on 1 \$/port ASP, 1 M\$ NRE, 1M\$ Tooling & 1M\$ Qualification.*

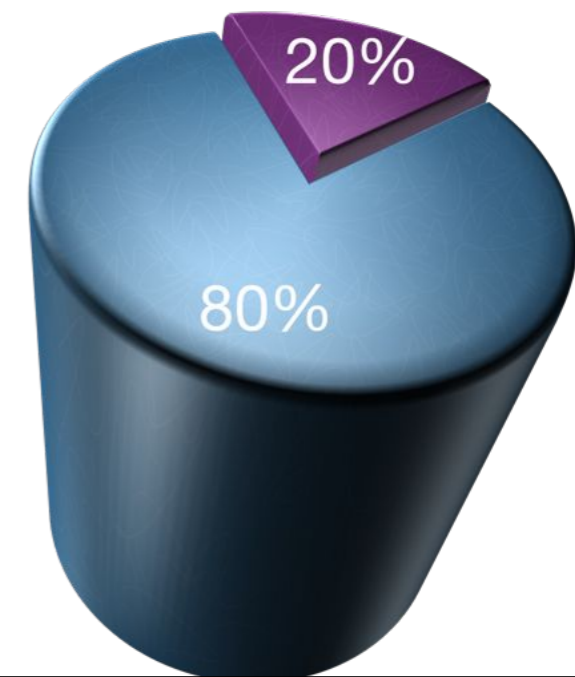
The current-to-future volume gap is so high that market development focus should be on growth not on market split concerns.

Growth is fostered offering a set of alternatives for Ethernet adoption.

## Focus on Share



## Focus on Growth



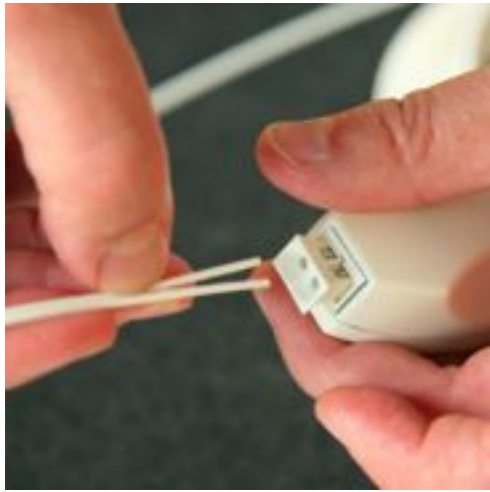
# Gigabit over POF CFI

Carlos Pardo  
KDPOF



# Gigabit POF CFI

- Deployment of Ethernet continues to stimulate the need for PHY technologies that address particular market needs
- Plastic Optical Fibre provides distinct advantages for deployment of Gigabit Ethernet in diverse environments
- POF provides significant installation advantages for home networking
- It is also an attractive and complementary medium for automotive application environments
- This Call for Interest will request the formation of a study group to explore the available technologies, market need and market application requirements for a POF 1 Gbps Physical Layer specification



## Plastic Optical Fibre (POF)

- A proven and mature medium applicable to Ethernet
- A medium that will answer application requirements in multiple markets
- A simple, easy to install medium
- A media option with broad industry support

# Simplified agenda

- Gigabit POF CFI consensus meeting
  - Tuesday 18th
  - 19:30 - 21:00
  - Room: Grand Ballroom CD, CW-L1
- Overview of POF technology
- Look at selected market applications
- Ample time for Q&A

# Motion slide

# Motion

- Authorize formation of a Study Group to develop a Project Authorization Request (PAR) and Criteria for Standards Development (CSD) document for Gigabit Ethernet over Plastic Optical Fibre
- By: Carlos Pardo
- Seconder:
- Y: \_\_\_\_\_ N: \_\_\_\_\_ A: \_\_\_\_\_