



# Home Networking bandwidth growth needs and POF



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# OUTLINE

- Home networking requirements
- GEPOF use cases
  - FTTH home networking applications
  - FTTH MDU applications
  - DOCSIS HFC home networking

# Home, Smart Home, Gigabit home...

- Advance of FTTH technology enables gigabit services to the home
  - 10G EPON can provide 10 Gbps symmetric shared bandwidth
  - NG-PON2 can provide 40 Gbps aggregated capacities
- Several service providers have announced providing Gigabit services to residential and business customers
- Smart Home requires high bandwidth (data rate) connectivity in home
  - Cloud, 4K video, multi-room DVR, high speed Internet, Internet of things...
- The current home network physical medium may become the bottlenecks

# Home networking mediums today...

Twisted pair (Since 1880's)



G.HN

Power line



Homeplug av

What are in common?

- Limited spectrum bandwidth
- Limited data rate
- Vulnerable to RF interference
- Vulnerable to EMI
- Complexity at PHY & MAC layers

Coax cable (Since 1940)



MOCA

Air or vacuum (better be air)



... Tomorrow, SMART HOME needs networking medium that can meet the bandwidth growth in the coming decades and centuries ...

# PHY overheads do matter

**Low overhead is essential for mediums that have limited spectral resources...**

medium	Standard	PHY rate	MAC rate
Twisted pair	G.HN	900 Mbps	500 Mbps
Coax	MOCA 2.0 base	700 Mbps	400 Mbps
	MOCA 2.0 Extended	1.4 Gbps	800 Mbps
Power line	HomePlugAV	200 Mbps	80 Mbps
	HomePlug AV2 (SISO)	750 Mbps	300 Mbps

**POF may provide the spectral resource needed, and GEPOF may provide the required bandwidth and efficiency**

# Fiber or Copper for Home Networking?

## Fiber

### Advantages

- Optical medium
  - Immune to EMI
  - Immune to RF noises
- Non conductive cables
  - Immune to lightning strike
  - Eliminating Spark Hazards
- Higher bandwidth growth potential

### Disadvantages

- Small or no installed base
- GOF is hard to handle

## Copper

### Advantages

- Well Established foot print in home
  - Twist pair phone line
  - Coax
- New copper based home networking standards
  - G.hn, MoCA2, homeplug AV2

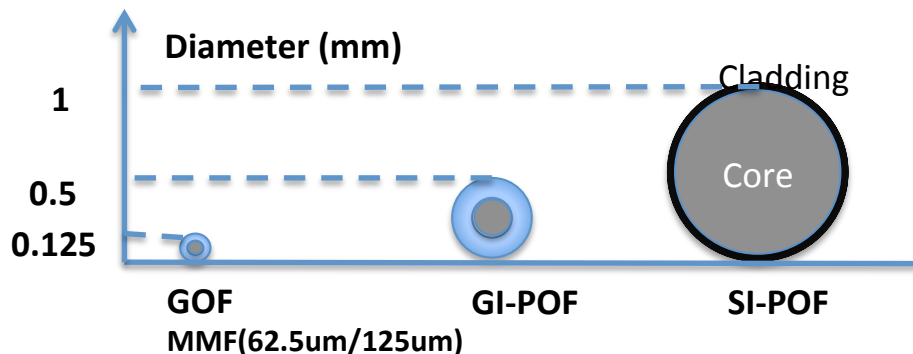
### Disadvantages

- Very limited bandwidth grow potential

**When bandwidth growth potential is the key weight, fiber is the choice for home networking**

# GOF or POF for Home Networking?

## Comparison POF with GOF



### GOF advantages

- Infinite amount of bandwidth for home networking

### GOF disadvantages

- Need professional person and equipment for installation

### POF advantages

- Large core diameter ~ 1mm
  - Low cost connectors
  - Easy installation and termination
- Low cost light sources for POF
  - High speed LED
  - VCSEL

### POF disadvantages

- Limited to short reach networking applications

**When easy installation, termination of fiber is the key weight, POF is the choice for home networking**

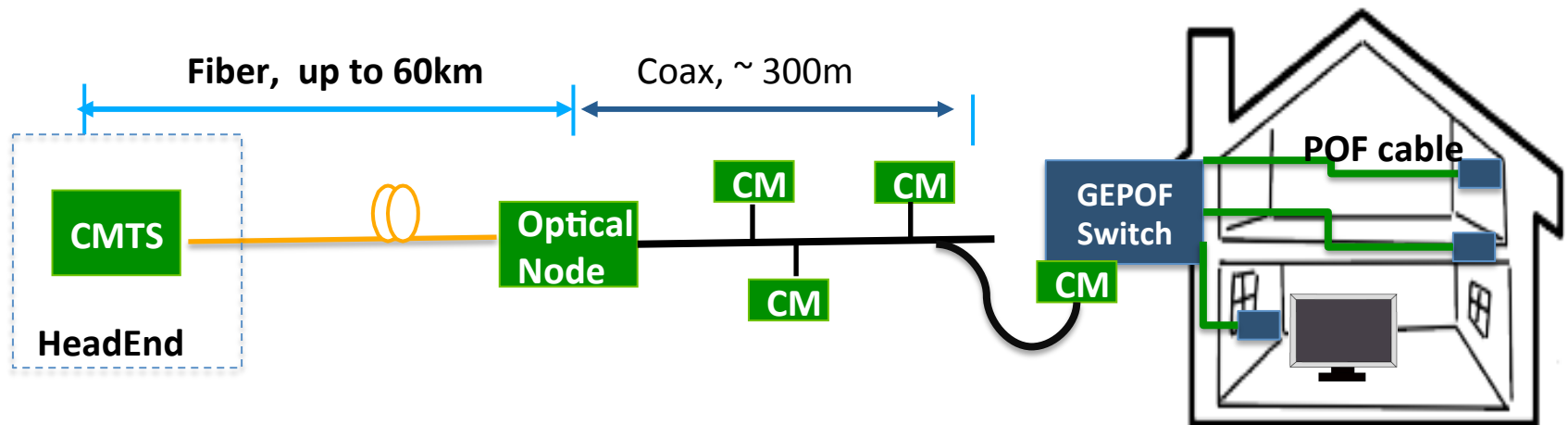
# GEPOF use case 1: DOCSIS home networking

## Problem

- Even though Coax cable has a shield, it can still be subject to EMI and RF interferences
- Some customer sites experience persistent EMI and/or RF interferences

## Solution

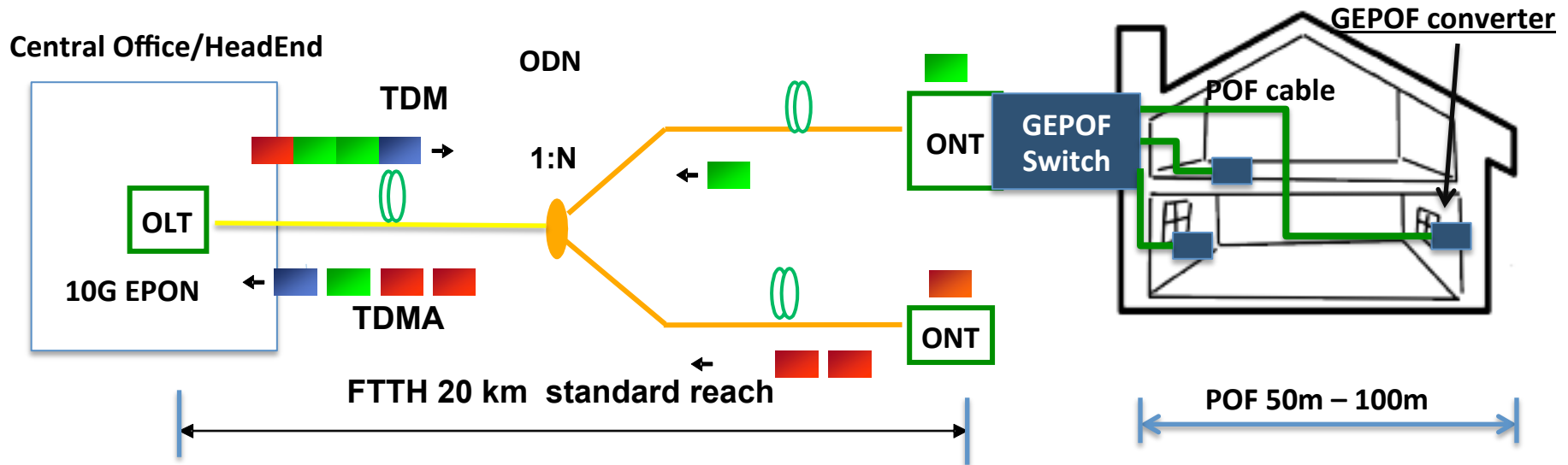
- Replace in home Coax cable with POF
- A cable operator in US reported very positive results



A cable operator in US already use POF for DOCSIS HFC home networking

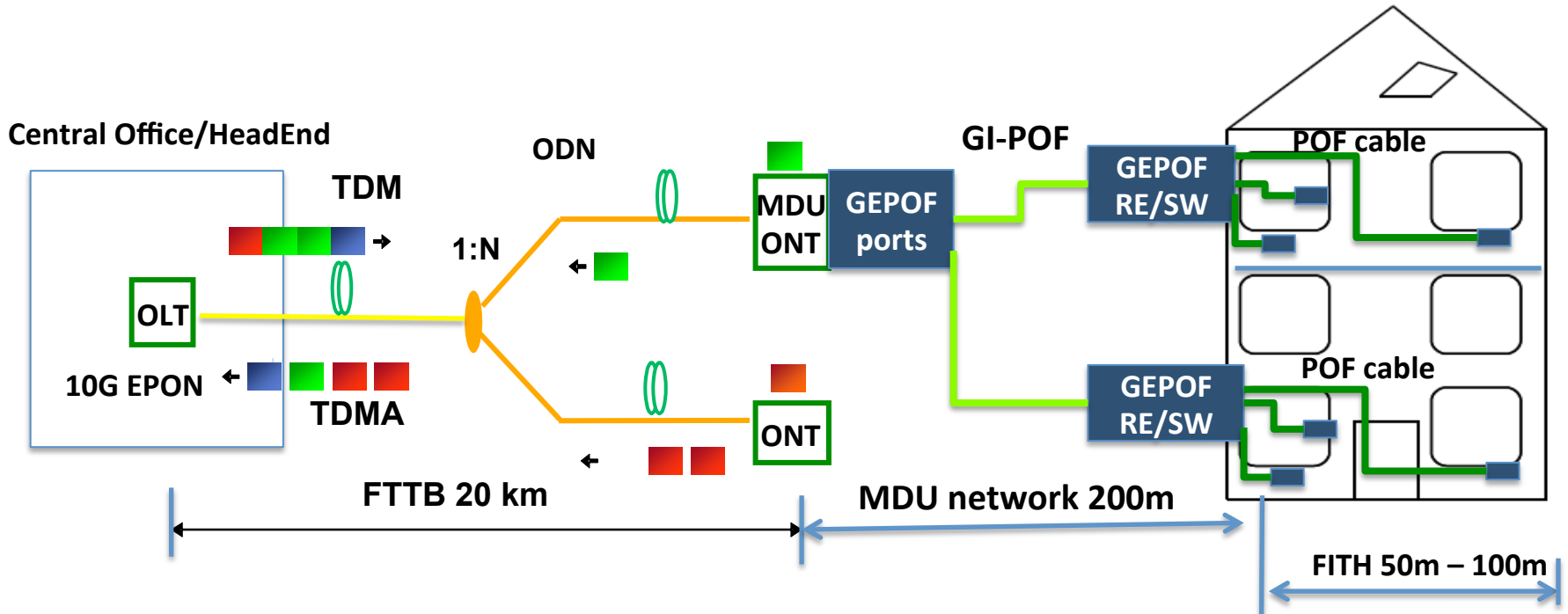


# GEPOF use case 2: FTTH + POF home networking



- 10G EPON provides Gigabit service to the home
- GEPOF switch provides P2P Gigabit Ethernet in home POF network
- Active GEPOF converters provide Gigabit Ethernet connectivity in home
  - To active GEPOF wall jack today
    - Connect to wireless routers and/or consumer devices
  - To passive POF wall jack in the future

# GEPOF use case 3: MDU applications



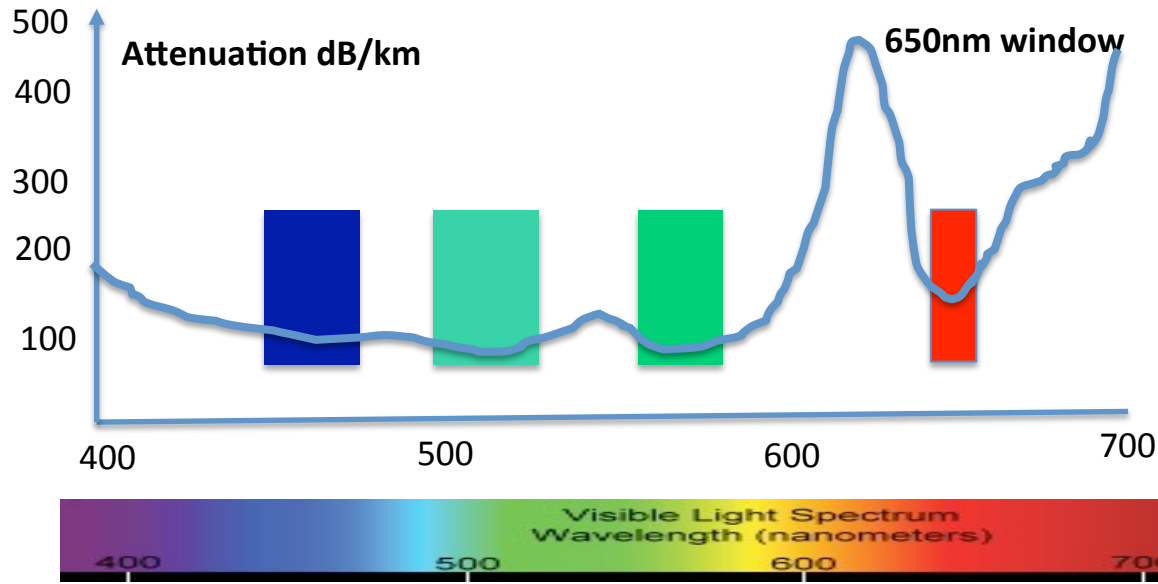
- MUD ONT with GEPOF ports provide GE to multiple homes and/or apartment units over POF cable
- GI-POF may be needed for MDU POF networks in order to achieve Gigabit rates with extended reach (further study)
- GEPOF repeater/switch provide GE to in home SI-POF network

# POF transmission rate today

- GEPOF technology is proven, Gigabit rate transmission on 50m SI-POF demo product is available
- Experiment of 5.6 Gbps transmission on 50m GI-POF is reported\*

\*]Visani et. al., Photon. Technol. Lett., 23, 768 (2011)

# POF for bandwidth growth



- The 650nm red window can be used for GEPOF today
- More low attenuation windows can be used in the future
- GI-POF for multi-Gigabit home networking

# Summary

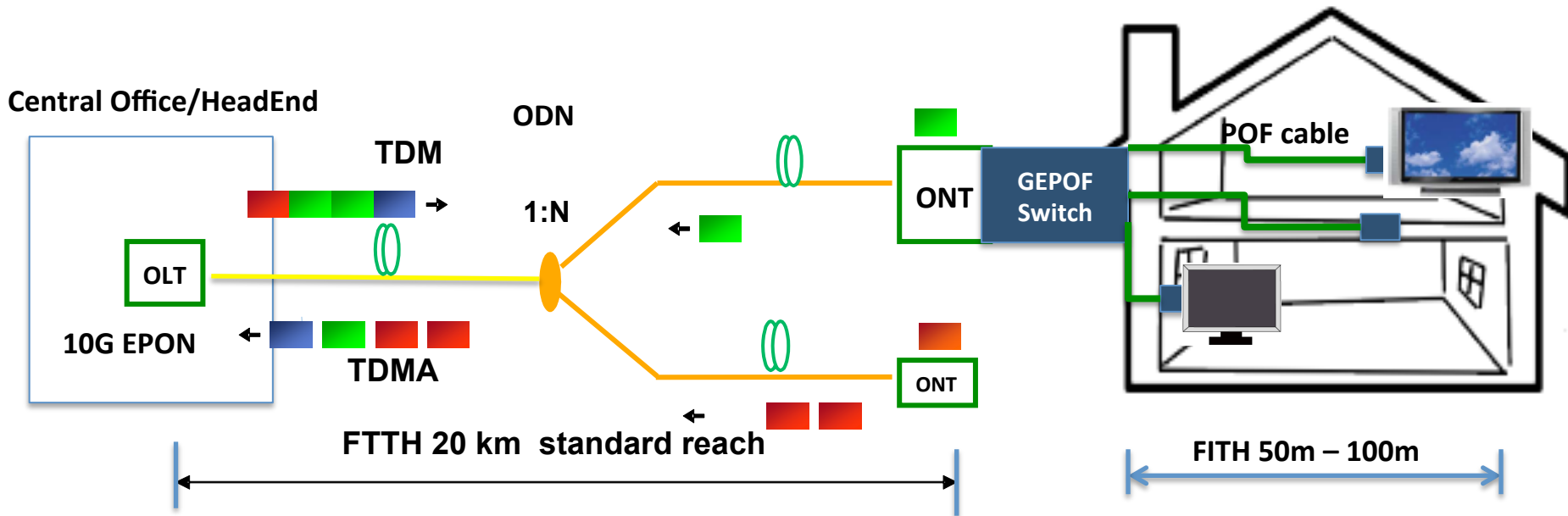
- The advances of PON provide Gigabit and above services to the home
- Home networking needs to keep up with the bandwidth for the next decades
- POF is a promising physical medium to meet the home networking bandwidth growth today and in the future
- POF also have advantages in the situation that EMI and RF interferences hard to correct
- We have discussed 4 GEPOF use cases
  - FTTH + FITH
  - FTTH + FTTD
  - FTTH MDU
  - DOCSIS HFC home networking



# Thanks

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# GEPOF use case 3: FTTH + FTTD



- 10G EPON provides Gigabit service to the home
- GEPOF switch provides P2P Gigabit Ethernet over in home POF network
- Passive POF wall jack
- GEPOF converters are integrated with consumer devices

TV with GEPOF interface

