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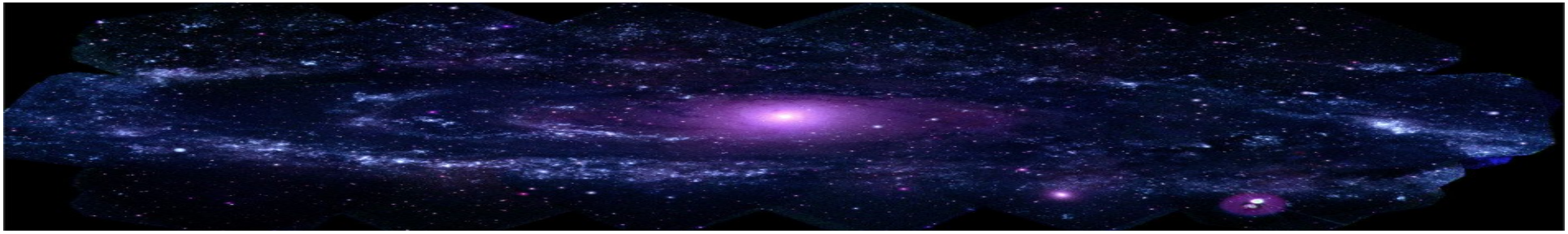
# Home Networking bandwidth growth needs and POF



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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 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

**Coax cable (Since 1940)**

MOCA

**What are in common?**

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

**Power line**

Homeplug av

**Air or vacuum (better be air)**


802.11x

**… 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 |

**The excessive PHY overhead limits copper based medium to meet the bandwidth growth**

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# Fiber or Copper for Home Networking?

## Fiber

Advantages

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

Disadvantages

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

## Cooper

Advantages

- Well Established foot print in home
  - Twist pair phone line
  - Coax
- New cooper 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**

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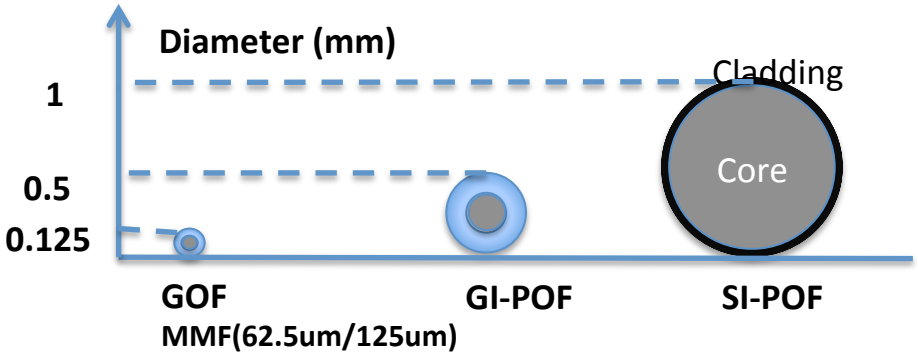
# GOF or POF for Home Networking?

## Comparison POF with GOF




**GOF advantages**
- Infinite amount of bandwidth for home networking

**GOF disadvantages**
- Very difficulty to use in the home

**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**
- Current consumer devices do not support GEPOF interface

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

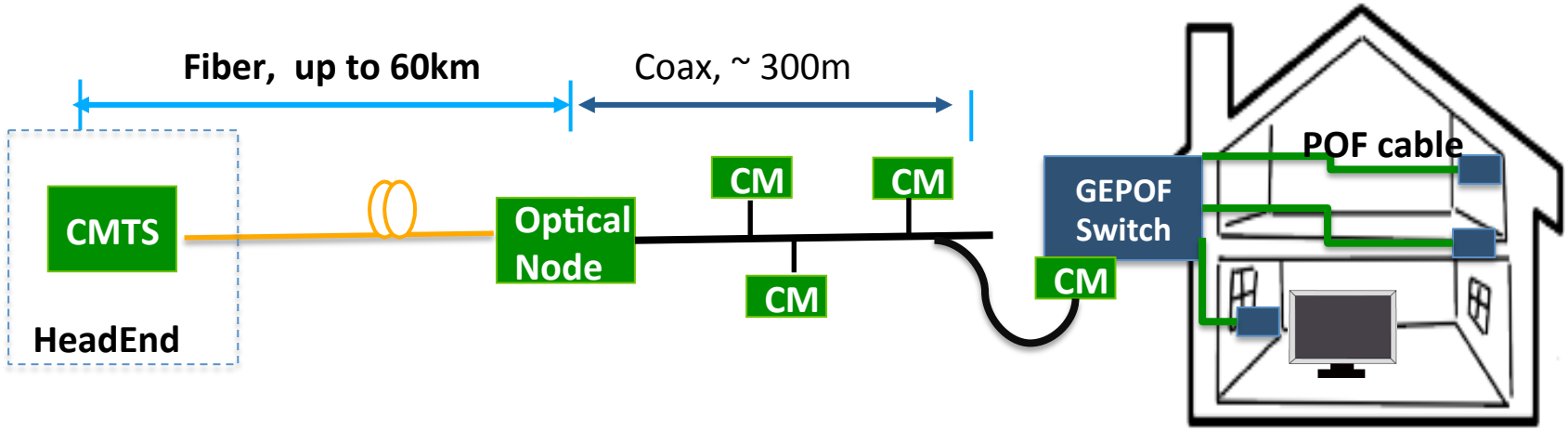
# GEPOF use case 1: DOCSIS home networking

**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

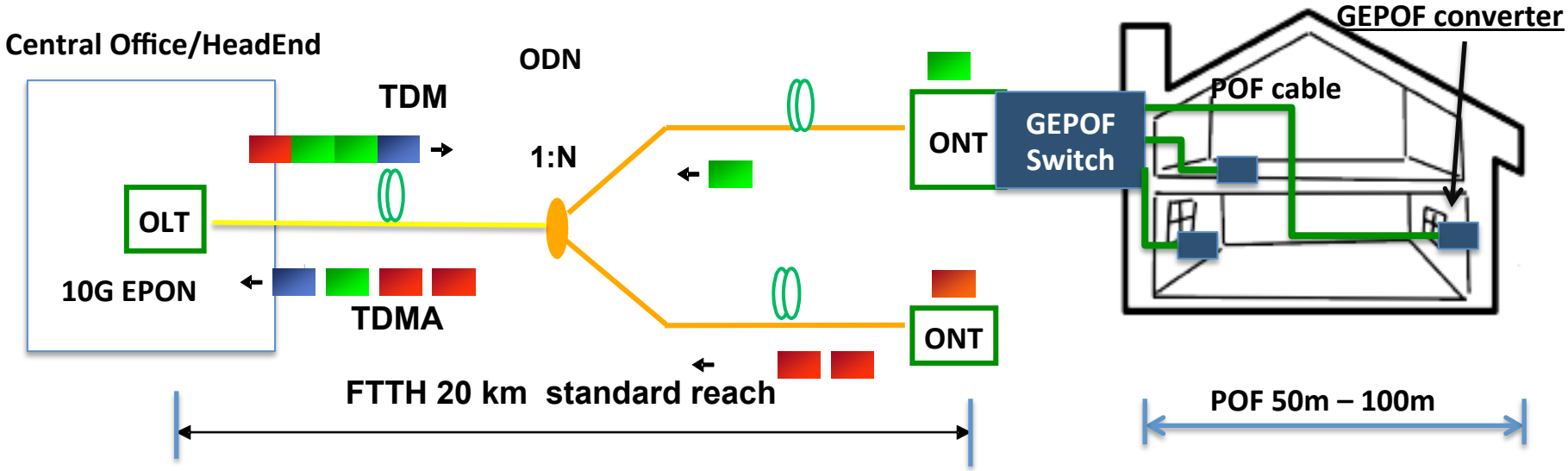
**Solution**

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



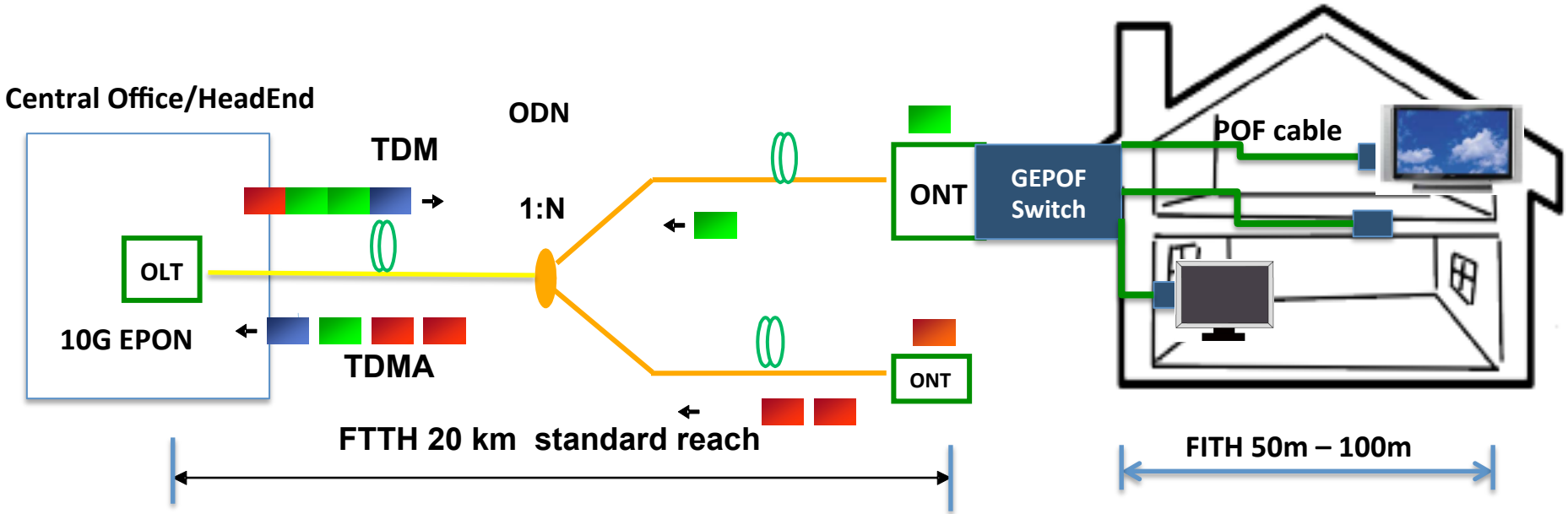

**MOS in US already use POF for DOCSIS HFC home networking**

# 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 devises
  - To passive POF wall jack in the future

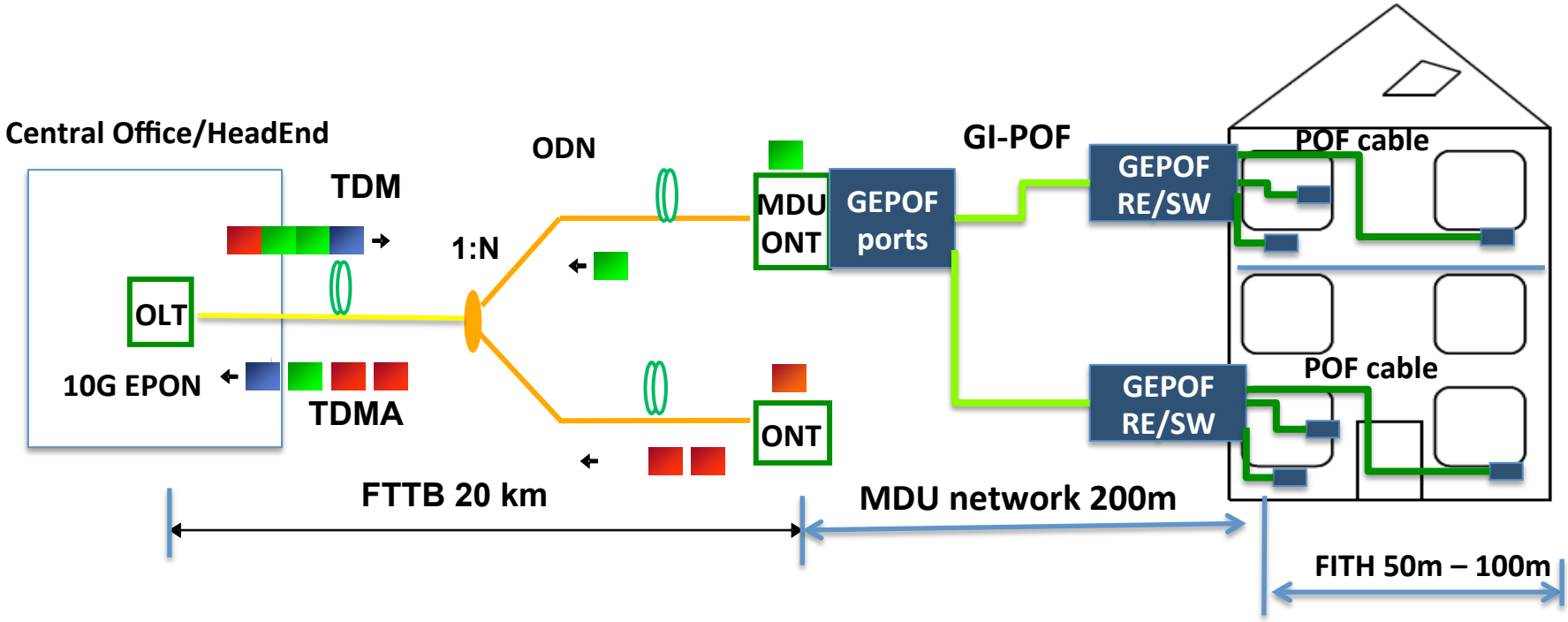
# GEPOF use case 3: FTTH + FTTD




- 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

# GEPOF use case 3: MDU applications



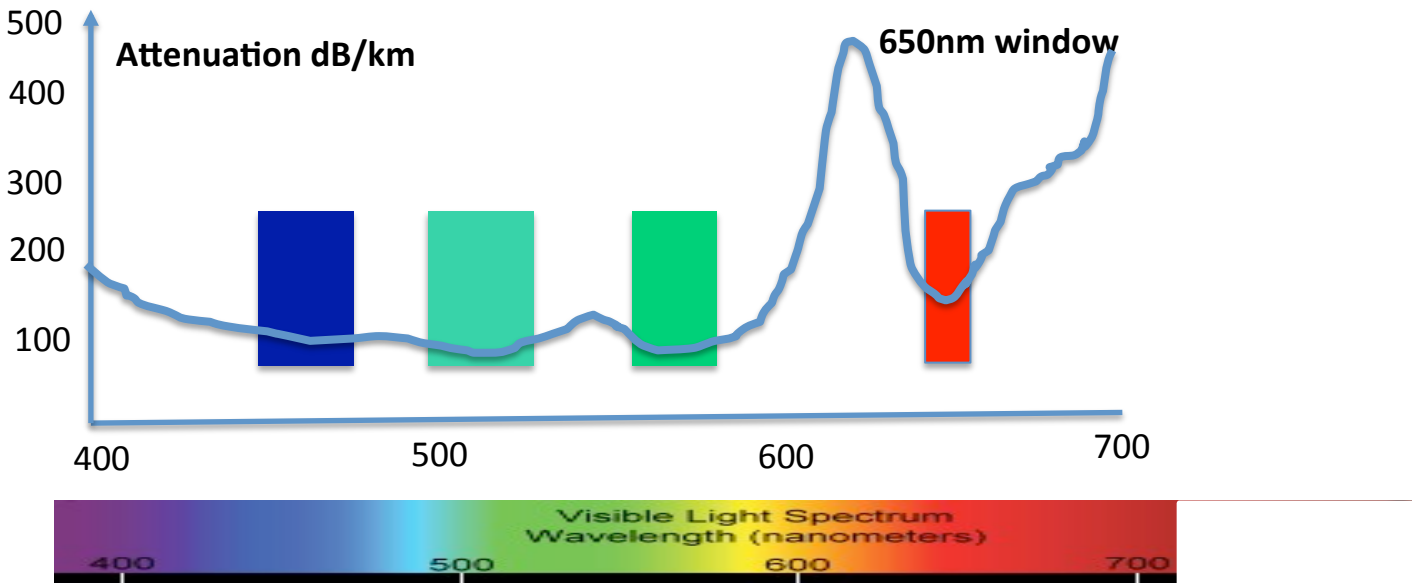

- MUD ONT with GEPOF ports provide GE to multiple homes and/or apartment units over POF cable
- GI-POF may be needed for MDU POF networks in order to achieve Gigabit rates with extended reach (further study)
- GEPOF repeater/switch provide GE to in home SI-POF network

# 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

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# Thanks

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