Video delivery over the FTTH network

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Video is the high bandwidth FTTH application

Application		bandwidth (Mb/s)
2 x HDTV	2 x 20 Mb/s	40.0
2 x standard digital video TV	2 x 2 Mb/s	4.0
CD quality sound	200 kb/s	0.2
telephony	<100 kb/s	0.1
web surfing	10 Mb/s (max)	10.0
	total bandwidth	**54.3**

"Video delivery over the FTTH network," Broadband Access Industry Watch, ICBN-04, 9 April 2004, Kobe, Japan

Video delivery can be in-band or out-of-band

- Out-of-band – **Video over RF**
  - Dedicates a wavelength to downstream *overlay* video services using *radio frequency* (RF) technology
  - Closely resembles traditional cable delivery method
  - Fundamentally a one-way system
  - Targeted services (VoD) implemented via *narrowcasting*
  - The RBOCs have chosen this approach for FTTP
- In-band – **Video over IP**
  - Packetized video content
  - Bandwidth intensive; easily *breaks* as it scales
  - Regarded as more highly interactive
  - A *converged* network
- Hybrid RF-IP is also possible

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$\text{Applications}_{(\text{Present + Future})} + \text{Technology}_{(\text{Present})} \Rightarrow$ delivery method

- Present and future applications
  - HDTV is a present and competitive offering in US
  - >1 HDTV per home may become reality
- Present technology
  - B-PON

$$\frac{622\ \text{Mb/s}}{32\ \text{users}} \times \frac{1\ \text{user}}{3\ \text{TV}} \sim 6.5\ \text{Mb/s / TV}$$

  - No mass market IP TV or IP set top boxes

The emergence of HDTV, as well as RF-based digital products and standards makes the RF overlay a practical choice.

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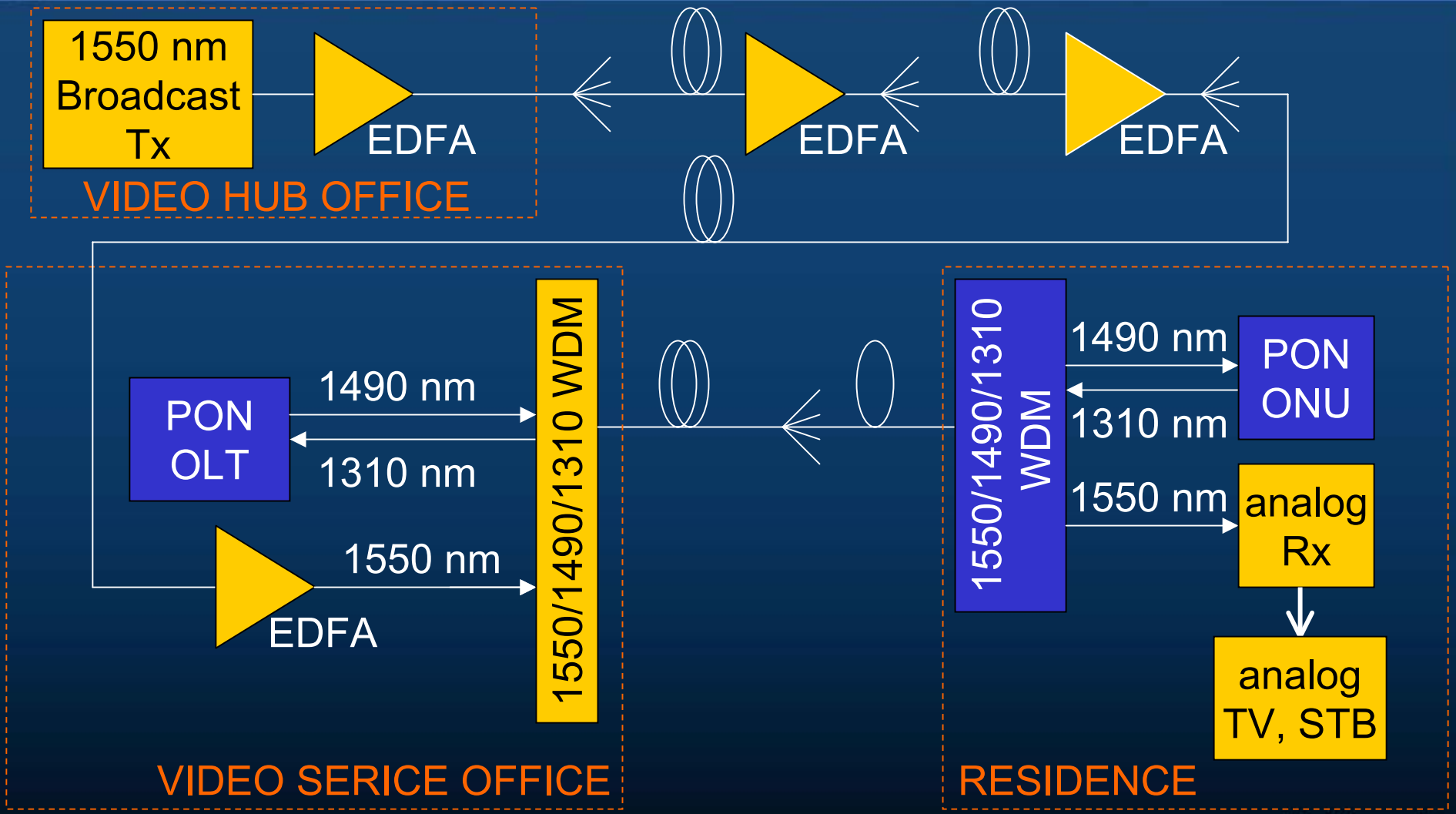
EPON and ATM-PON specifications accommodate the RF video overlay



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The RF video overlay is highly developed and low risk

- In the home
  - The “analog” TV is the most common residential gateway in the world.
  - Analog video serves multiple TVs without extra set top boxes
  - Digital set top box volume driven by CATV applications - digital video and video on demand
  - Most homes are already “wired” with coax.
- At the Headend / Central Office
  - Broadcast video scales with demand better than IP video
  - Headend infrastructure equipment for video overlay is proven and mature
    - for analog video
    - digital broadcast video
    - for video on demand
    - **for HDTV**

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The RF video overlay is bandwidth efficient

modulation format	data rate in 6 MHz RF channel
	Mb/s
256-QAM	38
64-QAM	28
QPSK	10

MPEG encoding + statistical multiplexing + 256-QAM modulation

up to 18 broadcast quality video streams within a 6-MHz bandwidth

110 RF channels with 256-QAM modulation

> 2000 SD broadcast quality video streams or
> 4 Gb/s of data

(compare to 100, 155, 622, 1000,1250 , 2500 Mb/s TDMA-PON)

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RF video overlay enables both broadcast and targeted content

- Not all video content is broadcast
- *Video on Demand* content is unique to the subscriber
- *Optical Narrowcasting* uses DWDM to assign bandwidth segments to targeted service groups of multiple 32-user PONs
  - Broadcast and Narrowcast content are optically MUXed using DWDM
  - Content is deMUXed at the ONT via RF Sub-Carrier Multiplexing (SCM)
    - Both wavelengths shine on the same photodiode. No DWDM deMUX required at the ONT

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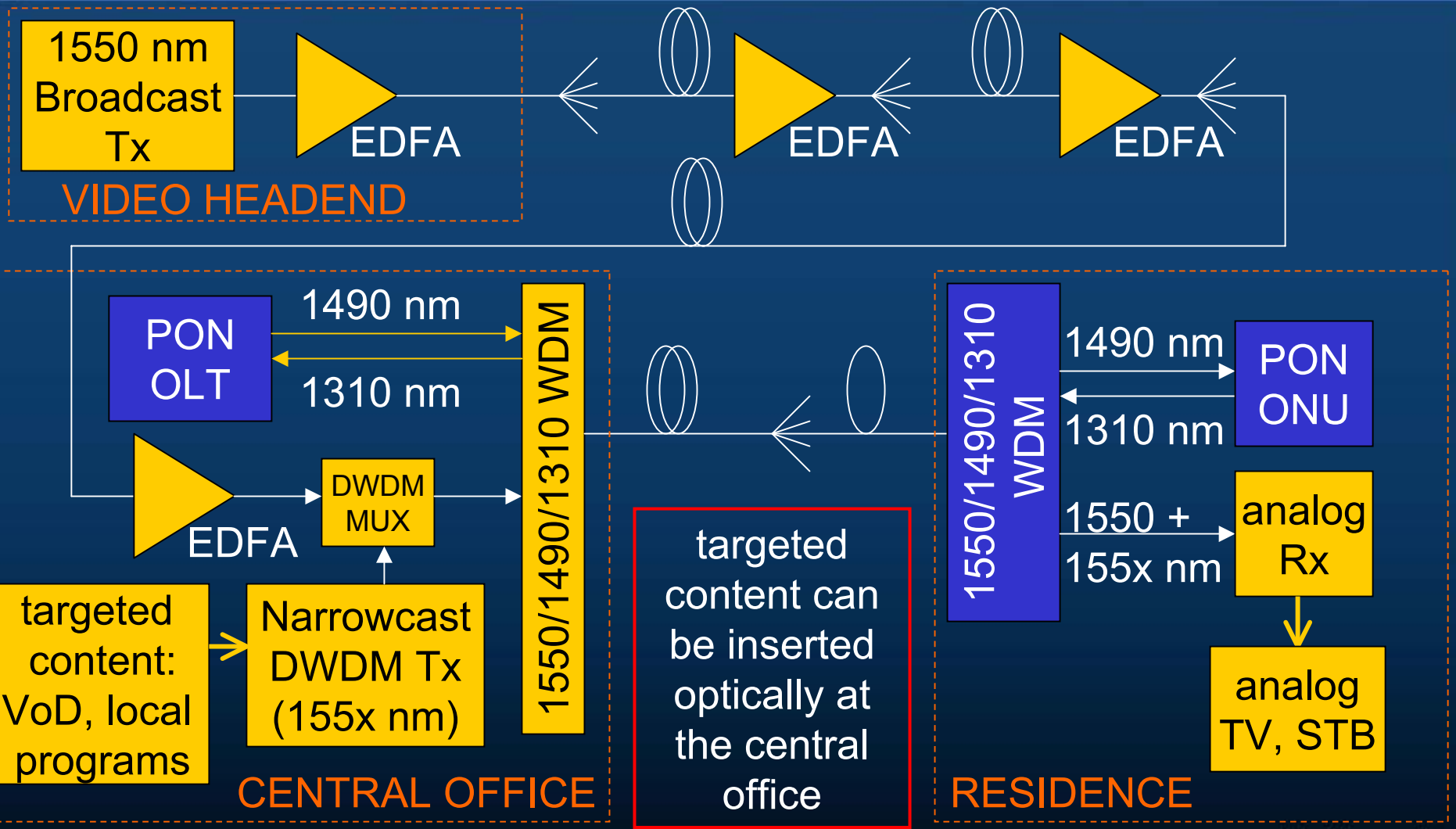
RF video overlay uses DWDM for *narrowcasting*



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The *Return Path* is the RF video overlay's weakness

- The RF video overlay does not naturally accommodate the cable return path
  - Limits use commodity two-way cable set-top-boxes
- Solution: *The RF adaptor*
  - Co-located at the ONT
  - Enables interactive video services over RF overlay architecture
  - Demodulates upstream RF (5-42 MHz) QPSK set top box communications and translates into IP packets

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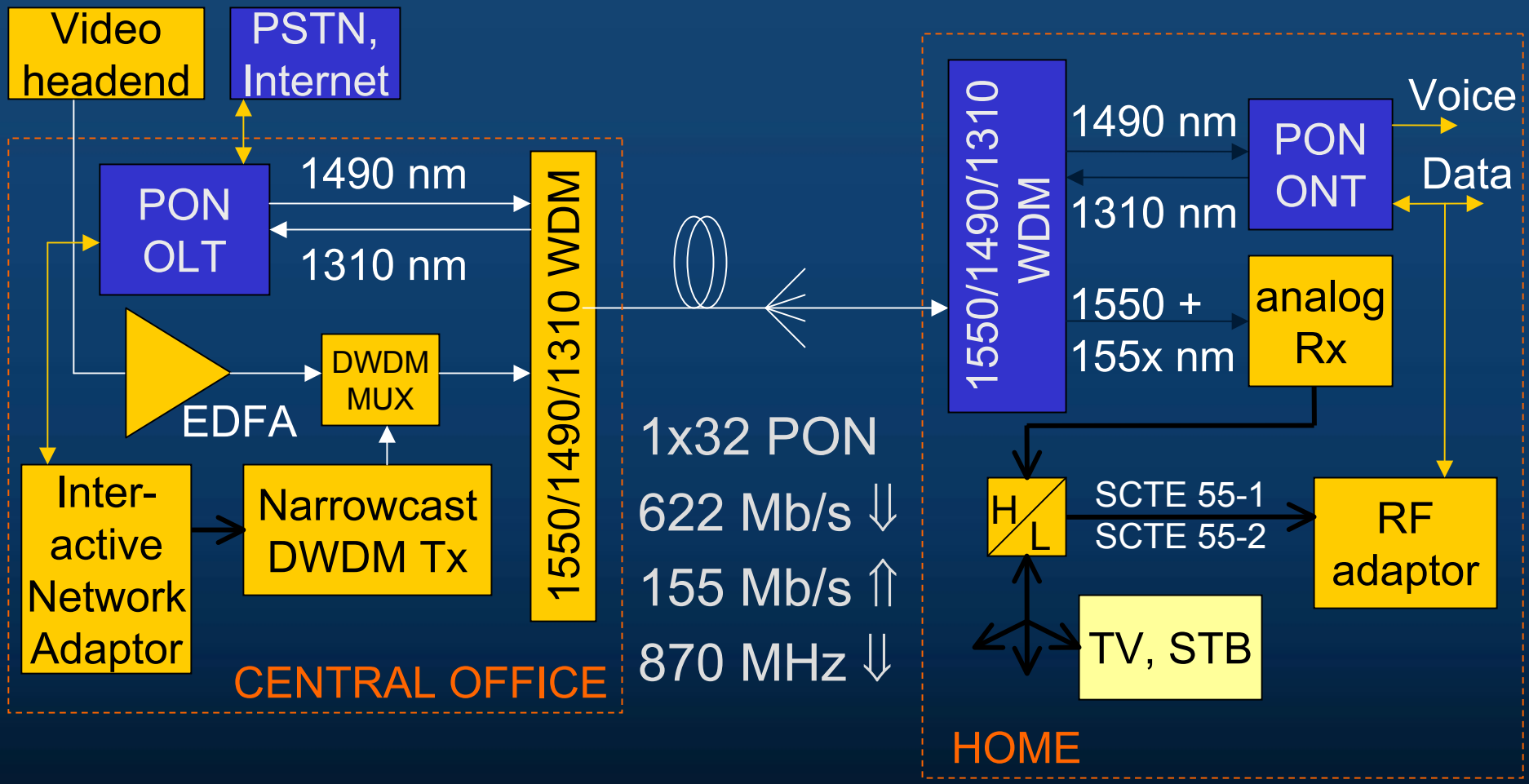
Fiber to the Premises

-Video overlay with RF adaptor for STB return over IP



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Summary

- Present HDTV bandwidth requirements are ~10 times greater than SDTV
  - Video over switched infrastructures (xDSL, ATM-PON, IP) is challenging
- RF video is very bandwidth efficient.
- RF video accommodates a flexible mix of broadcast and narrowcast content
- The *RF adaptor* allows use of standard two-way set top boxes
- RF video leverages mature technology
- RF video is the selection of record for the US RBOCs FTTP plans

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