MSO Use Case Topologies for EPOC

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5. EPOC signal through Active and Passive Coax with no other services present in HFC network

    All IP / Ethernet Network via EPOC transport only

EPOC Signal through entire HFC network

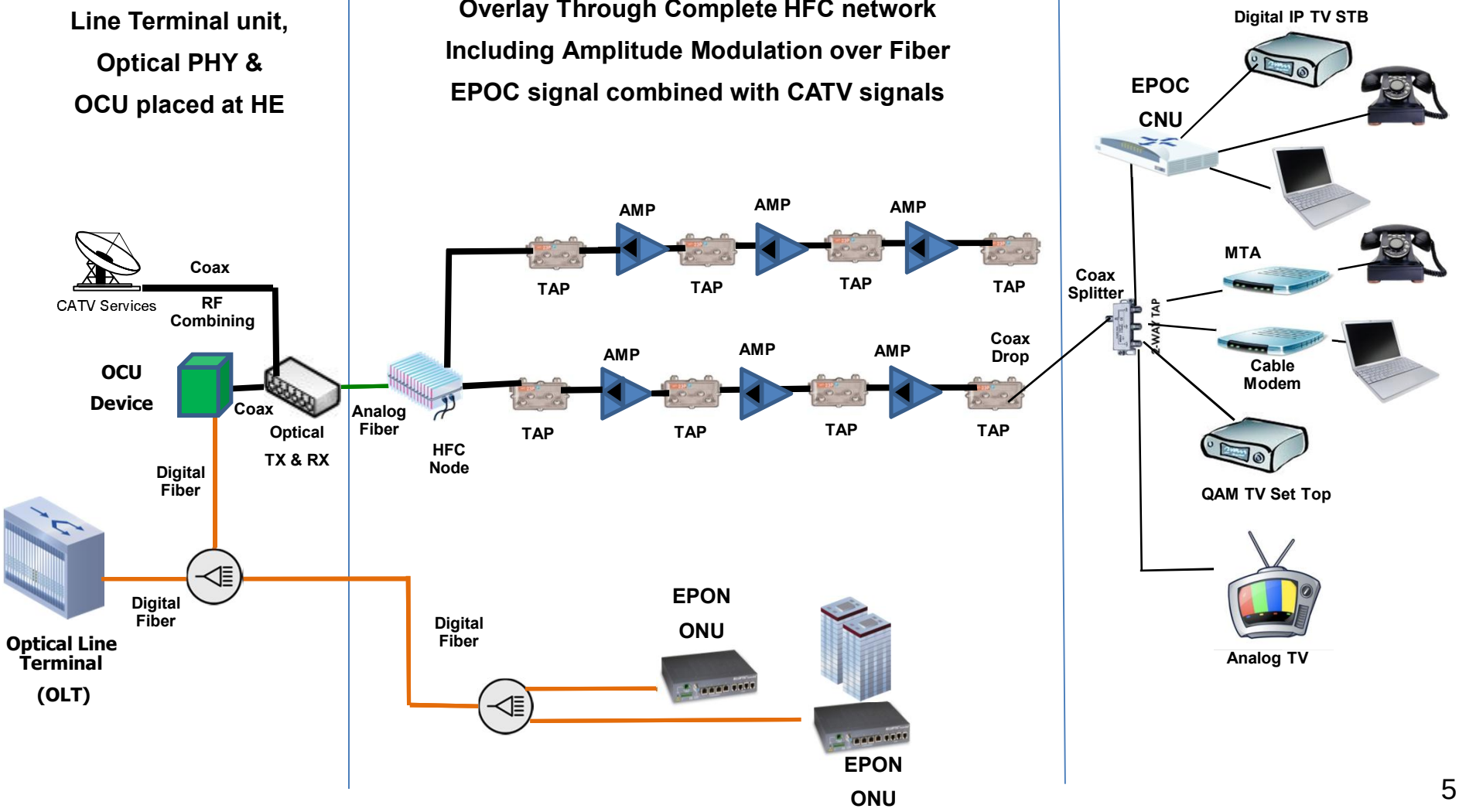
Hub / CO Facility

Line Terminal unit,
Optical PHY &
OCU placed at HE

Outside Plant

Overlay Through Complete HFC network
Including Amplitude Modulation over Fiber
EPOC signal combined with CATV signals

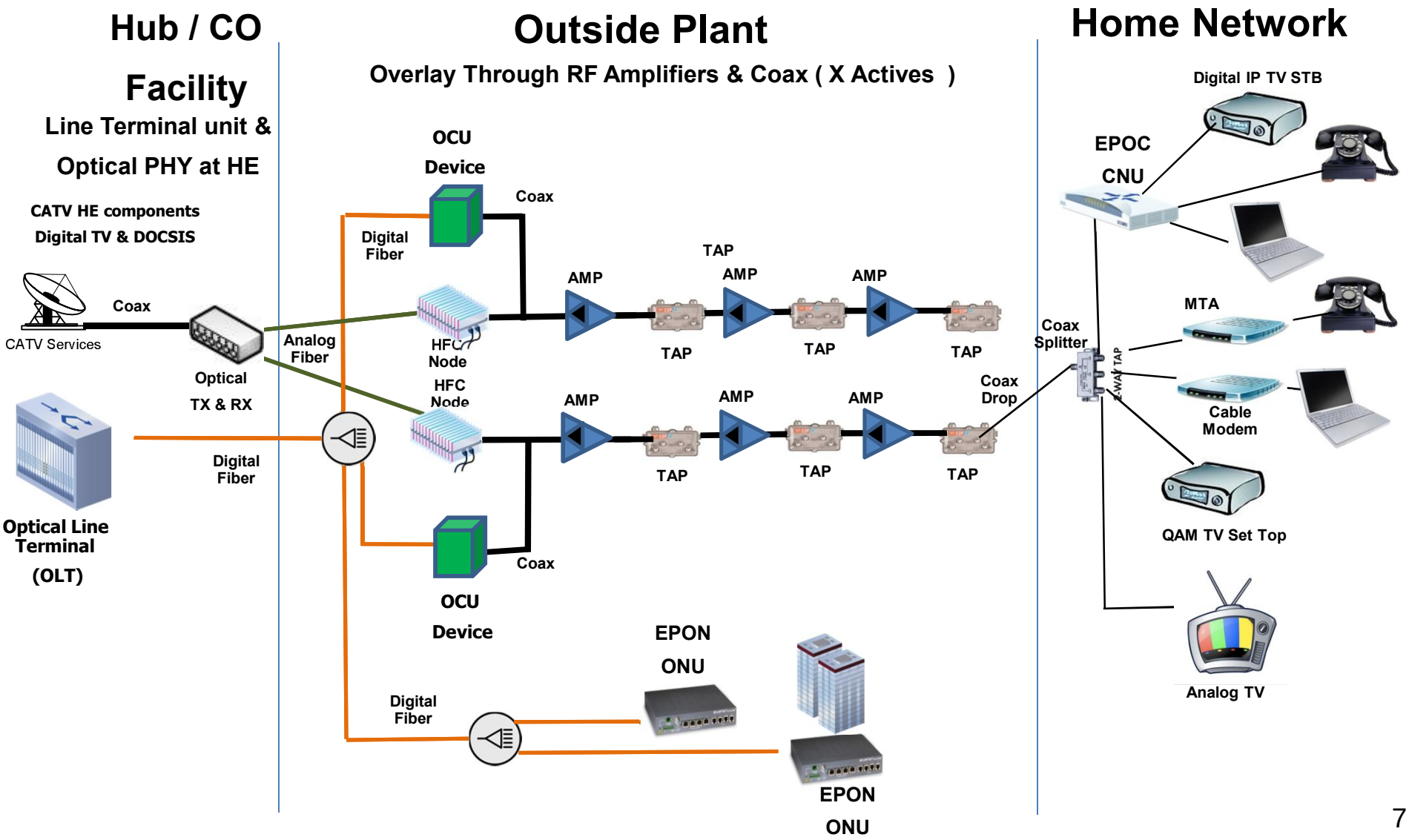
Home Network



EPOC Signal through entire HFC network

- EPOC signal through the existing HFC Topology including the AM Fiber optical transmission, HFC Node and Coax.
- EPOC signal must transmit through a number of RF amplifiers or be capable of amplification
- Flexible EPOC frequency assignment, to avoid impact to
  - EPOC Signal Must Coexist with existing CATV services existing services.
- Optical Line Terminal and OCU devices all located at the HE and combined with CATV services for distribution through the entire HFC network including AM fiber to Fiber HFC node.
- Assumes no changes to existing HFC topology
- EPON ONUs operate on separate fibers within the ODN

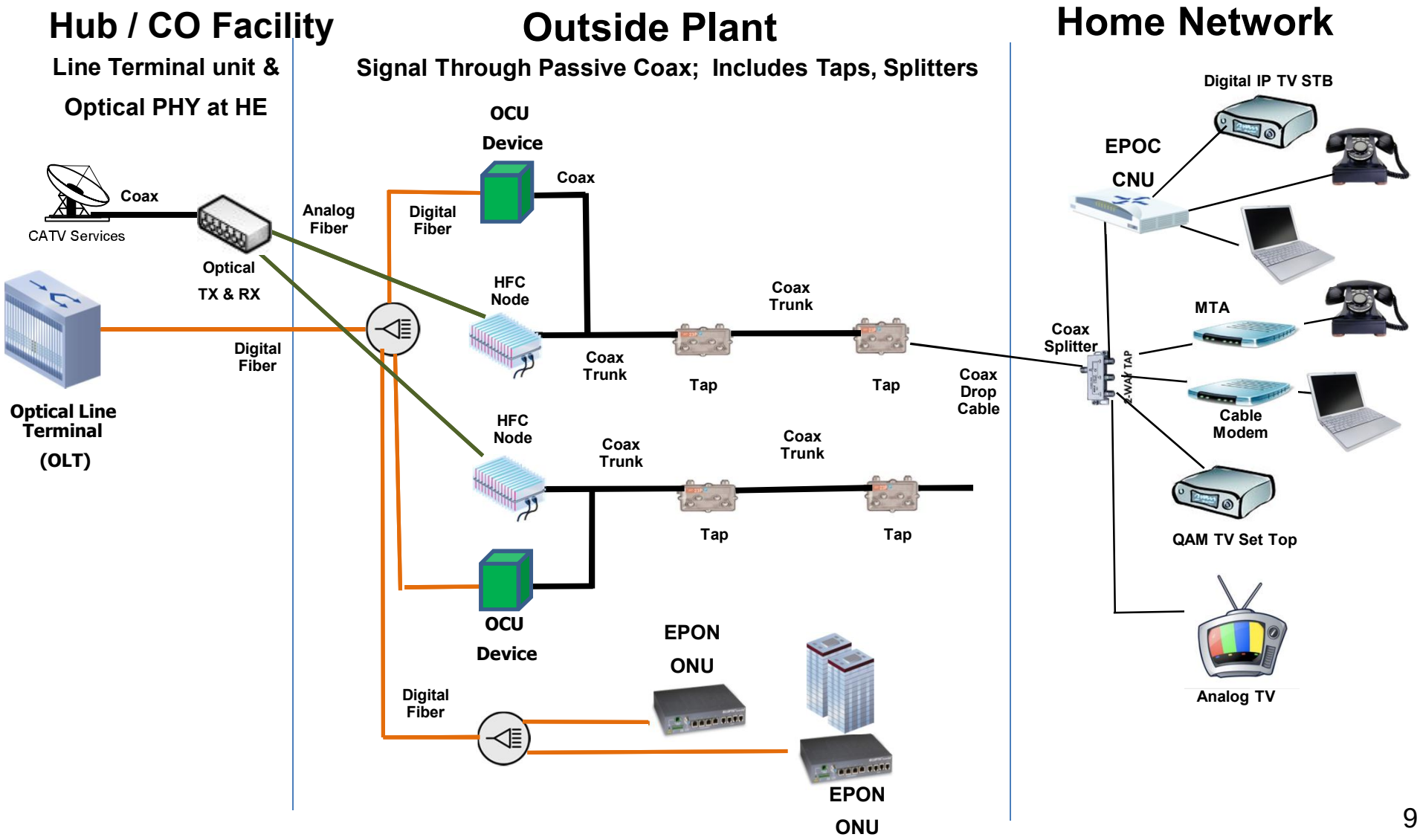
EPOC Signal through Actives in Coax



EPOC Signal through Actives in Coax

- Insertion of EPOC signal on the existing Coax HFC Topology
- EPOC signal must transmit through a number of RF amplifiers or capable of amplification in the Coax segments of the network
- Flexible EPOC frequency assignment, to avoid impact to existing services
  - EPOC Signal Must Coexist with existing CATV services
- OCU devices and EPON ONUs Coexist on the same fibers in the ODN
- HFC Node maybe on separate Fiber to avoid wavelength conflicts at 1310nm.
- Assumes Flexible placement of OCU devices in the HFC network

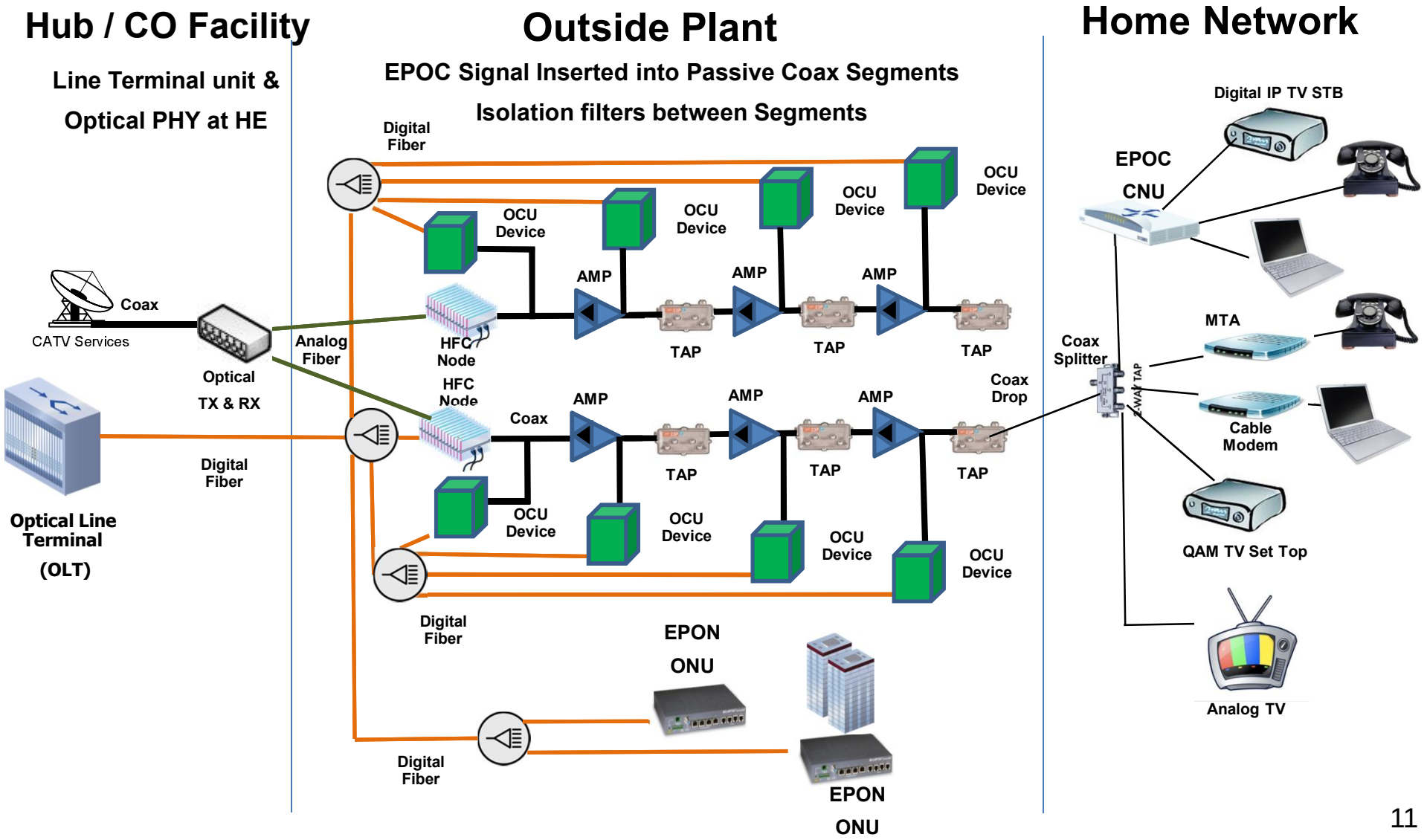
EPOC signal through Passive Coax & Coexistence with existing services



EPOC signal through Passive Coax segments Coexistence with existing services

- Insertion of the EPOC signal into the existing HFC Topology in passive segments of the Coax
  - EPOC signal inserted into only passive segments of Coax
  - EPOC signal does not transmit through RF Amplifiers in Coax
- OCU devices physically placed to insert EPOC signal into Passive Coax segment
- Flexible EPOC frequency assignment to avoid impact to existing services
  - EPOC Signal Must Coexist with existing CATV services
- HFC Node may need to be on separate Fiber to avoid wavelength conflicts at 1310nm
- OCU devices and EPON ONUs Coexist on the ODN

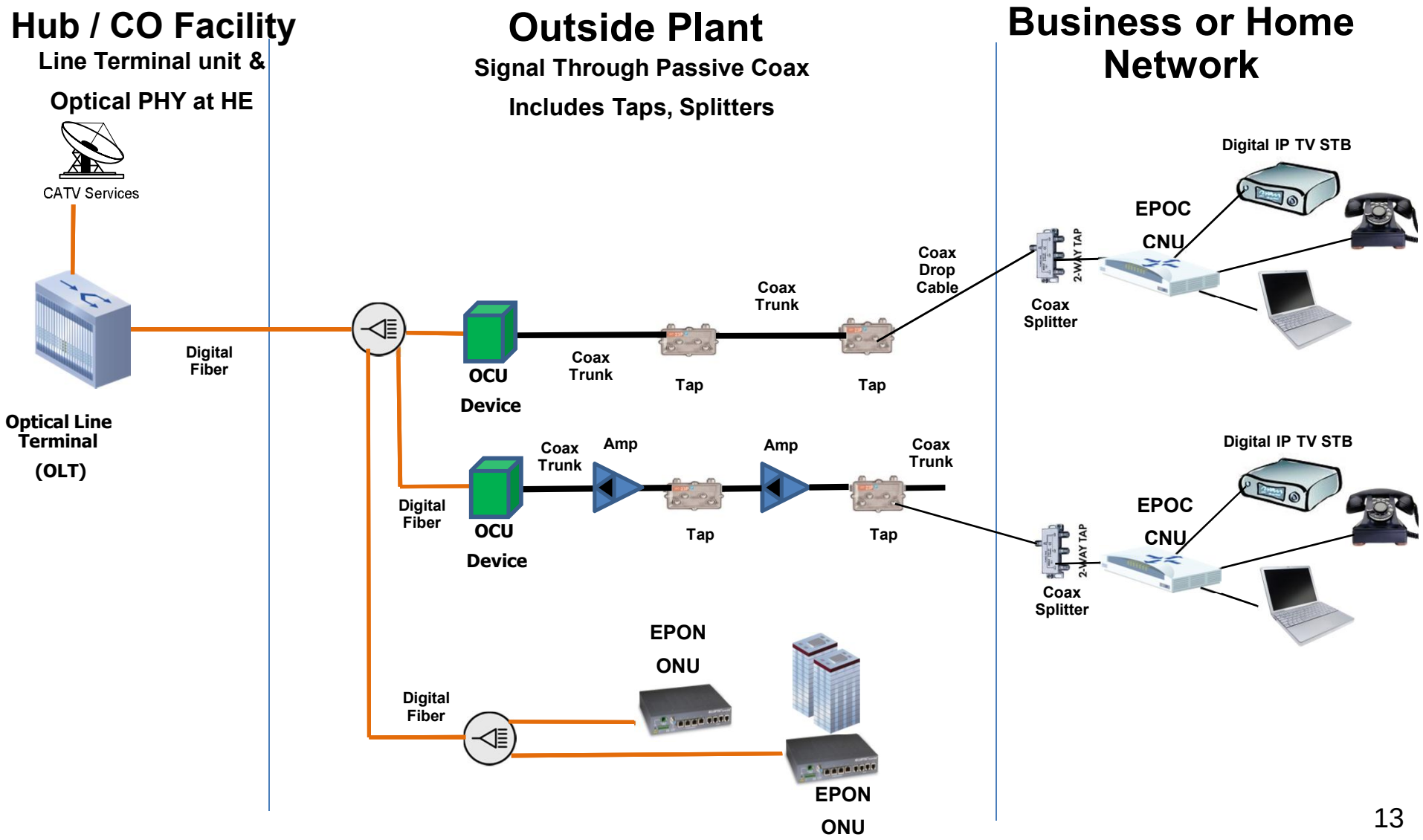
EPOC Signal in Passive Coax segments between Amplifiers in HFC network



EPOC signal through Passive Coax segments Coexistence with existing services

- Insertion of EPOC signal into the existing HFC Topology in passive segments of the Coax.
  - EPOC signal inserted into only passive segments of Coax
  - EPOC signal does not transmit through RF Amplifiers in Coax
  - Filters installed at each AMP location to block EPOC signal from traversing AMPs and into neighboring passive segments of Coax
- Flexible EPOC frequency assignment to avoid impact to existing services
  - EPOC Signal Must Coexist with existing CATV services
- HFC Node may need to be on separate Fiber to avoid wavelength conflicts at 1310nm
- OCU devices and EPON ONUs Coexist on the ODN

EPOC signal through Active and Passive Coax with no other services present in HFC network



EPOC Signal through Passive Coax no other services

- All IP services is Target Market
- No other services exist on HFC / Coax segments where EPOC signal is inserted
- Insertion of EPOC signal into the existing HFC Topology
  - EPOC signal inserted into passive segments of Coax
  - EPOC signal inserted into active segments Coax, transmitting bidirectional through the RF amplifiers
- OCU devices physically located to insert EPOC signal into either Active or Passive Coax segments
- OCU devices and EPON ONUs Coexist on the ODN

I. EPOC Use Case Network Topologies

II. Existing Services & Spectrum Utilization

III. Potential EPOC frequency assignment options

Existing Services & Spectrum Utilization

- Existing Services on the HFC Networks
  - In service & Operator variations
  - Available space for EPOC Signal

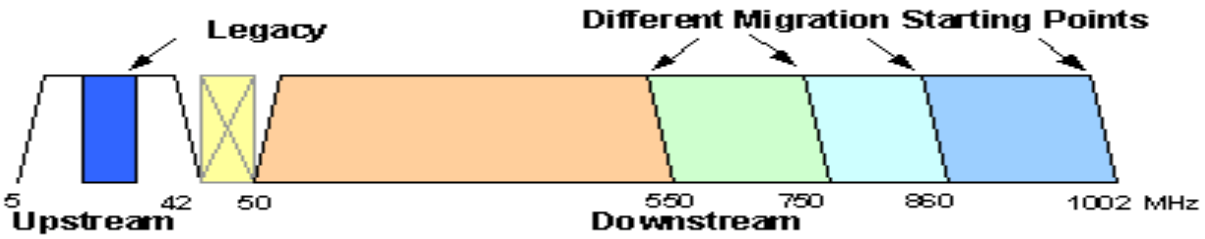
- Spectral range definitions
  - Low Band
  - High Band
  - Ultra High Band

Typical Existing N.A. CATV Services

- Analog TV Carriers
  - 200MHz to 550MHz - full channel line-up
  - 50MHz to X - based on Analog reclamation by MSO operator
- Digital TV Downstream Carriers
  - 550MHz to 750MHz or 860MHz * depending on HFC capacity
  - 50MHz to X MHz based on Analog channels recovered
- Digital STB Forward Carriers
  - Multiple 125KHz or single 1.0MHz / 2.0 MHz channel in the 70MHz to 130MHz range and varies by MSO operator and Digital STB platform
- Digital STB reverse Carriers
  - Multiple 125KHz or single 2 MHz channel in the 5MHz to 42MHz range and varies by MSO operator and Digital STB platform
- DOCSIS Downstream Carriers
  - 550MHz to 1Ghz depending on HFC capacity / MSO operator
- DOCSIS Upstream Carriers
  - 3.2MHz or 6.4MHz channels in the 5MHz to 42MHz range and varies by MSO operator
  - 1, 2, 3 or 4 carriers currently allocated for DOCSIS upstream capacity. Up to 6 carriers (full US spectrum) possible with CCAP

Existing Services
Spectrum Utilization

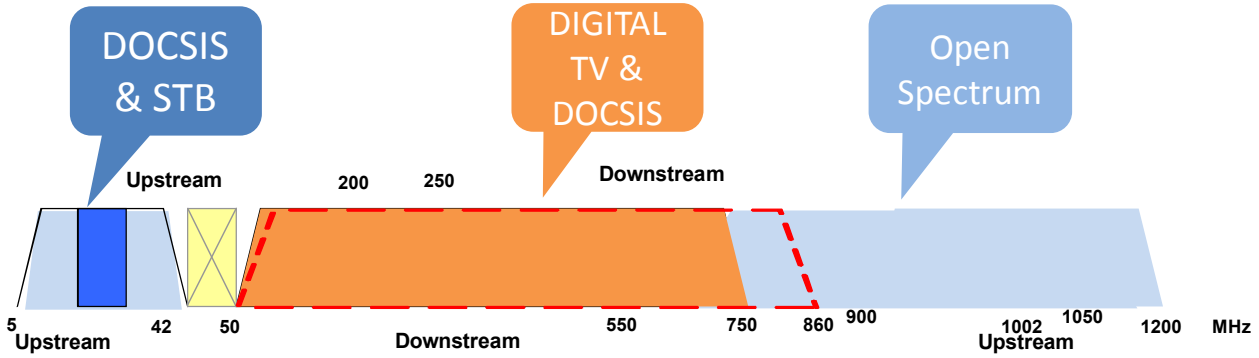
Operator HFC Networks have differing Capacities based on how upgrades performed over the years.



Therefore MSO Networks will have Differing Capacity / Spectrum availability

Existing Service Spectrum Allocations

Note: these vary by MSO Operator



Definition of Spectral Ranges for the Potential EPOC Frequency Profiles

- Low Band
  - Defined as a range between 5MHz & ~200MHz
  - 5MHz to 42MHz/65MHz
  - 5MHz to 85MHz (Requires mid split in existing HFC)
  - 5MHz to~200MHz (Requires high split in existing HFC)
- High Band
  - Defined as a range between 750MHz & ~1.1GHz
  - 750MHz to ~1.1GHz
  - 860MHz to ~1.1GHz
- Ultra High Band
  - Defined as a range between 1.2GHz & 2.0GHz
  - 1.2GHz to 1.6GHz (Requires upgrade of actives and passives in HFC)
  - 1.2GHz to 2.0GHz (Requires upgrade of actives and passives in HFC)

I. EPOC Use Case Network Topologies

II. Existing Services & Spectrum Utilization

III. Potential EPOC frequency assignment options

Potential Frequency Assignment of FDD Profiles

- FDD Profiles (4)
  - FDD Profile 1 US Low band & DS High band
  - FDD Profile 2 DS High Band & US High Band
  - FDD Profile 3 DS High Band & US Ultra High Band
  - FDD Profile 4 DS Ultra High Band & US Ultra High Band

  - Use of Ultra High Band spectrum, above 1.2GHz will require upgrade of all HFC components including new actives and passives to utilize, place EPOC signal in this spectrum range.

FDD Profile 1
EPOC US Low band & DS High band

FDD Upstream in the 5-42MHz Range

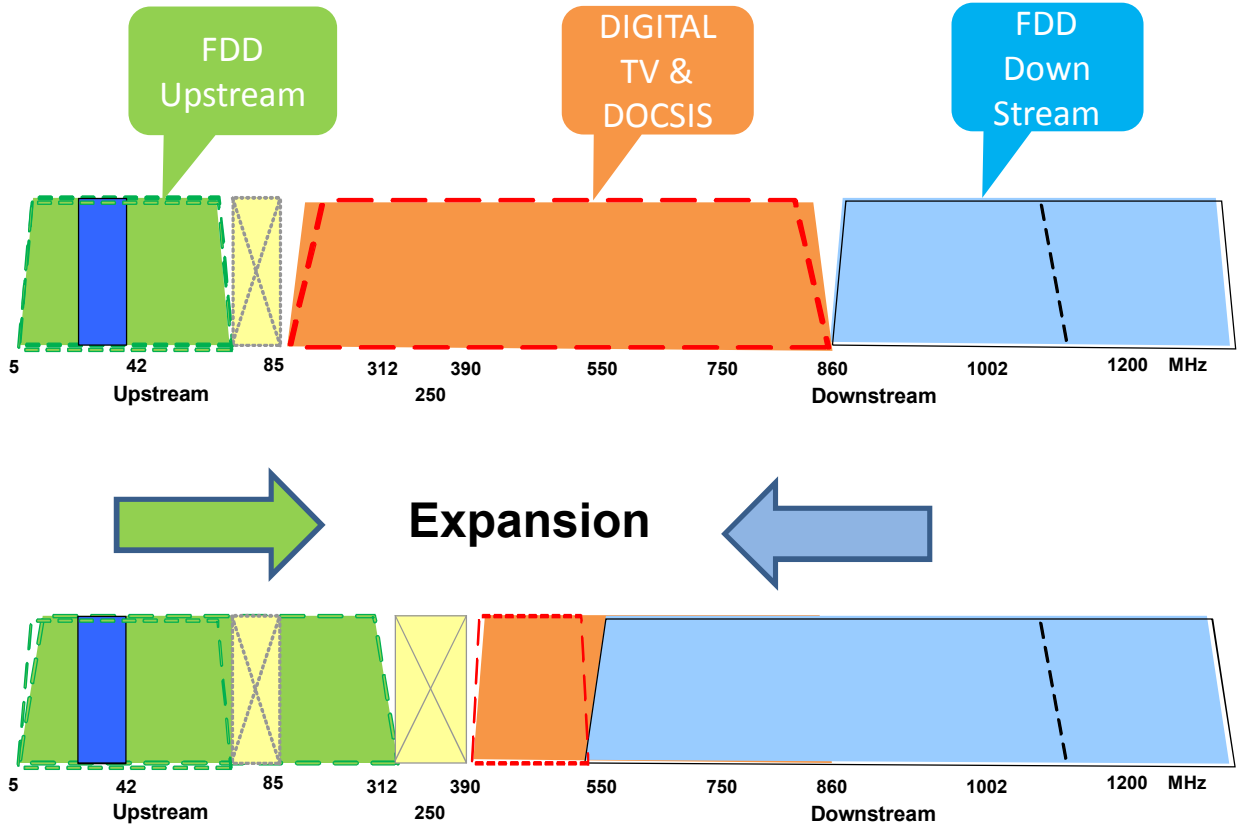
FDD Upstream grows into 65, 85 or 100 MHz

FDD Downstream 750MHz to ~1100MHz

FDD Upstream expands 5-200MHz

FDD Downstream 550MHz to1100MHz

FDD Downstream 400MHz to1100MHz



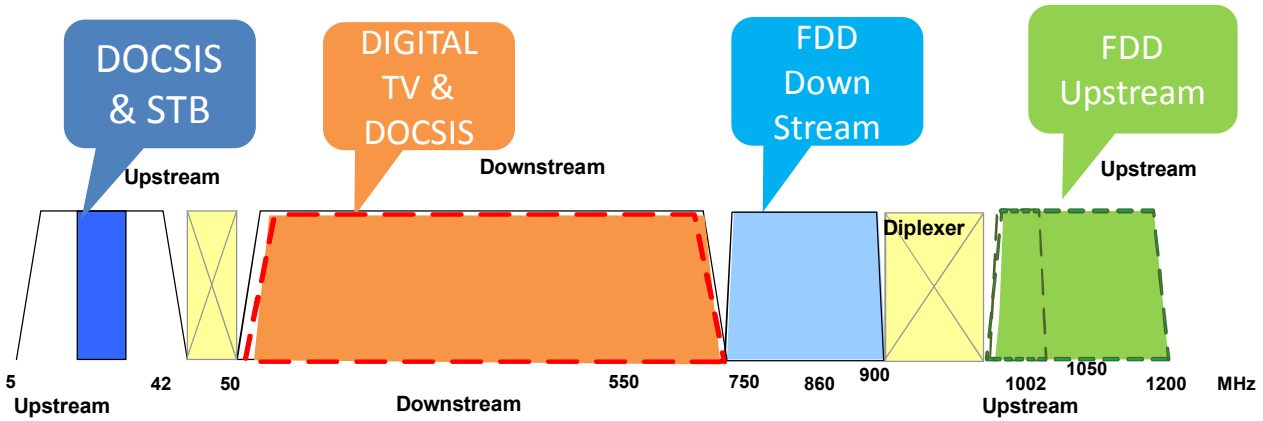
EPOC US Low band & DS High band

- EPOC FDD Upstream Carriers
  - Initial EPOC US signal in the 5MHz to 42MHz range
  - Expansion of EPOC US signal into the 5MHz to 85MHz range
  - Future Expansion of EPOC US signal into the 5MHz to 100MHz or 200MHz range
- EPOC FDD Downstream Carriers
  - Initial EPOC DS signal in the 750/860MHz to 1100MHz range
  - Expansion of EPOC DS signal into the 550/750MHz to 1100MHz range
  - Future Expansion of EPOC DS signal into the 300MHz to 1100MHz range
- FDD Downstream or Upstream EPOC carriers can operate as noncontiguous spectrum, i.e. “notch” around other existing carriers in the HFC network, to obtain a block of spectrum for the carrier.

FDD Profile 2
EPOC DS High Band and US High Band

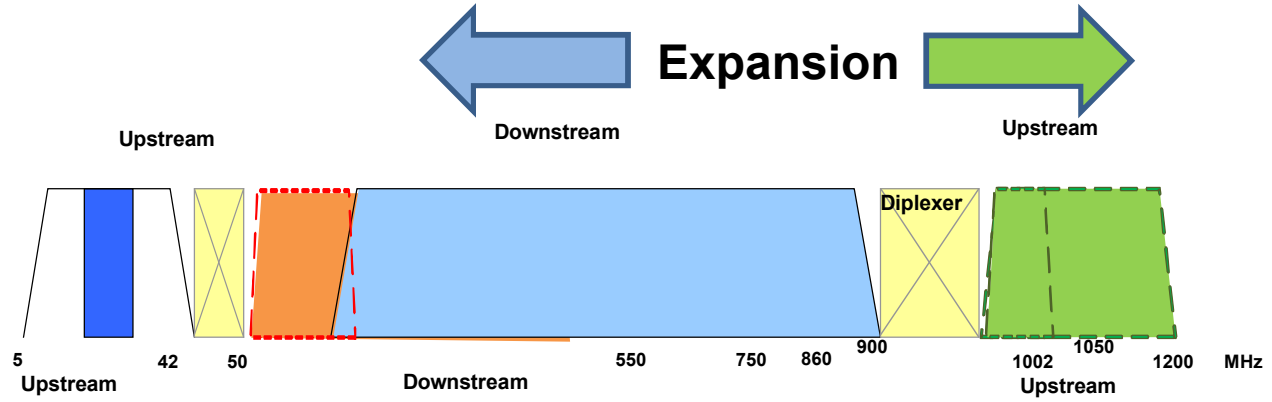
FDD Upstream in the > 1000MHz

FDD Downstream in 750 - 900MHz



FDD Upstream in the 1000 ï 1200MHz

FDD Downstream in 300 ï 900MHz



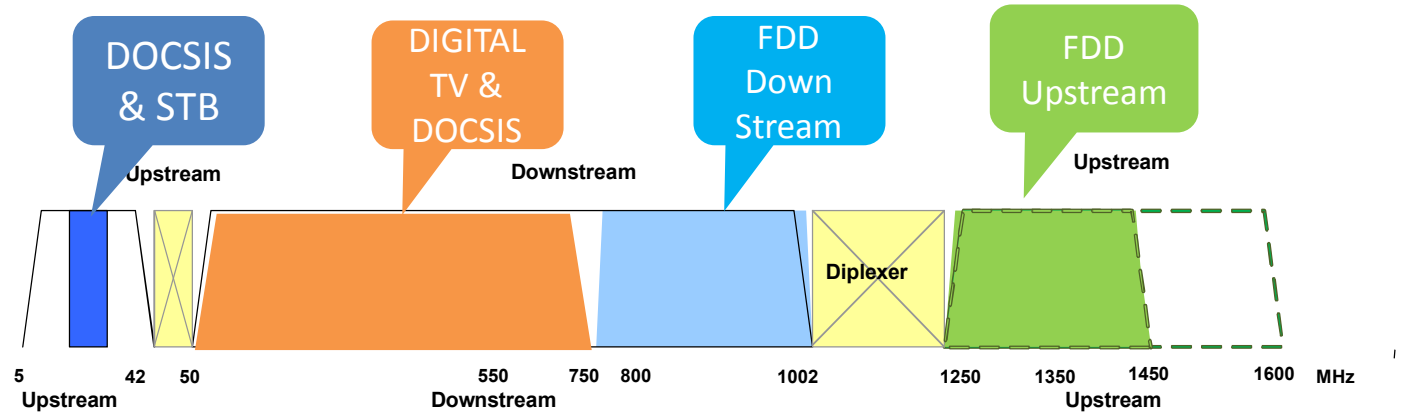
EPOC DS High Band and US High Band

- EPOC FDD Downstream Carriers
  - Initial EPOC DS signal in the 750/860MHz to 900MHz range
  - Expansion of EPOC DS signal into the 550/750MHz to 900MHz range
  - Future Expansion of EPOC DS signal into the 300MHz to 900MHz range
- EPOC FDD Upstream Carriers
  - Initial EPOC US signal in the 1000MHz to 11000MHz range
  - Expansion of EPOC US signal into the 1000MHz to 1200MHz range
- FDD Downstream or Upstream EPOC carriers can operate as noncontiguous spectrum, i.e. “notch” around other existing carriers in the HFC network, to obtain a block of spectrum for the carrier.

FDD Profile 3
DS High Band and US Ultra High Band

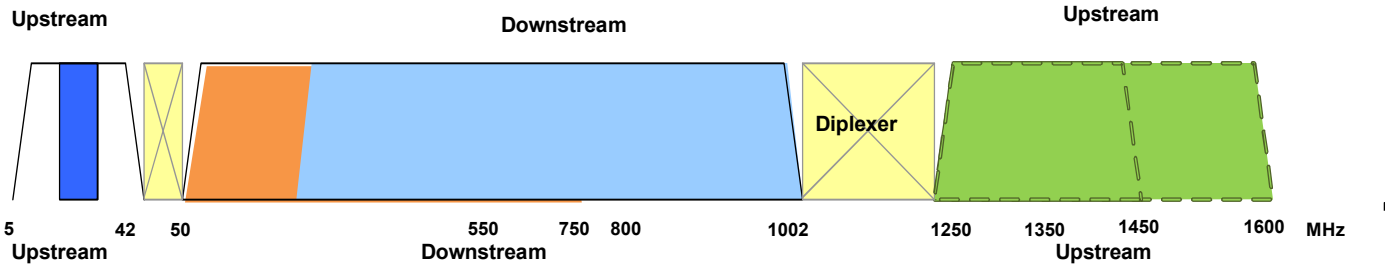
FDD Upstream in the 1250 ï 1450MHz

FDD Downstream in 750 ï 1000MHz



FDD Upstream in the 1250 ï 1800MHz

FDD Downstream in 300 ï 1000MHz



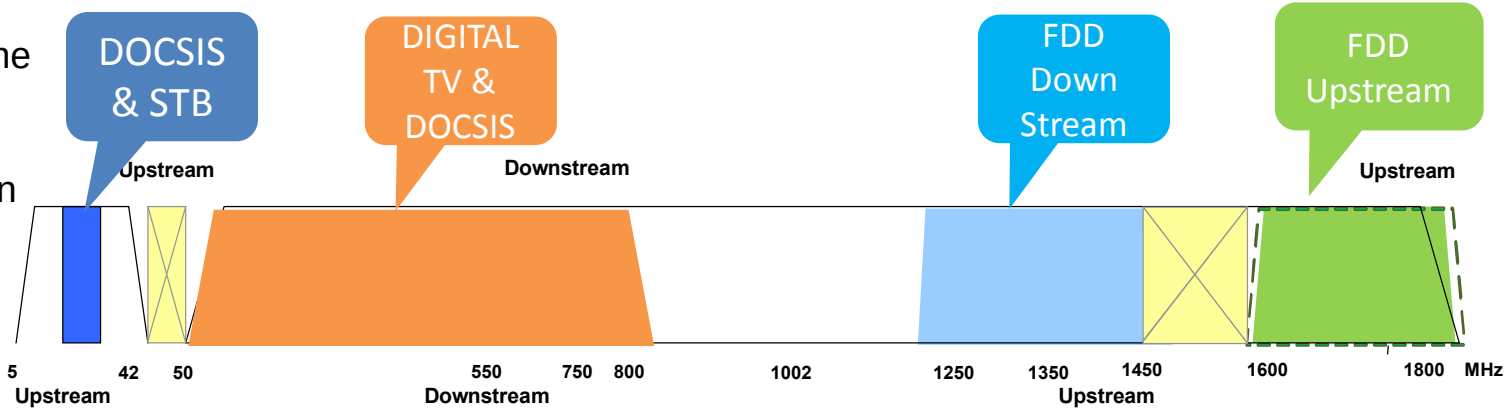
EPOC DS High Band and US Ultra High Band

- EPOC FDD Downstream Carriers
  - Initial EPOC DS signal in the 750/860MHz to 1100MHz range
  - Expansion of EPOC DS signal into the 550/750MHz to 1100MHz range
  - Future Expansion of EPOC DS signal into the 300MHz to 1100MHz range
- EPOC FDD Upstream Carriers
  - Initial EPOC US signal in the 12500MHz to 1450MHz range
  - Expansion of EPOC US signal into the 1250MHz to 1800MHz range
- FDD Downstream or Upstream EPOC carriers can operate as noncontiguous spectrum, i.e. “notch” around other existing carriers in the HFC network, to obtain a block of spectrum for the carrier.

FDD Profile 4
DS Ultra High Band and US Ultra High Band

FDD Upstream in the 1600 ï 1850MHz

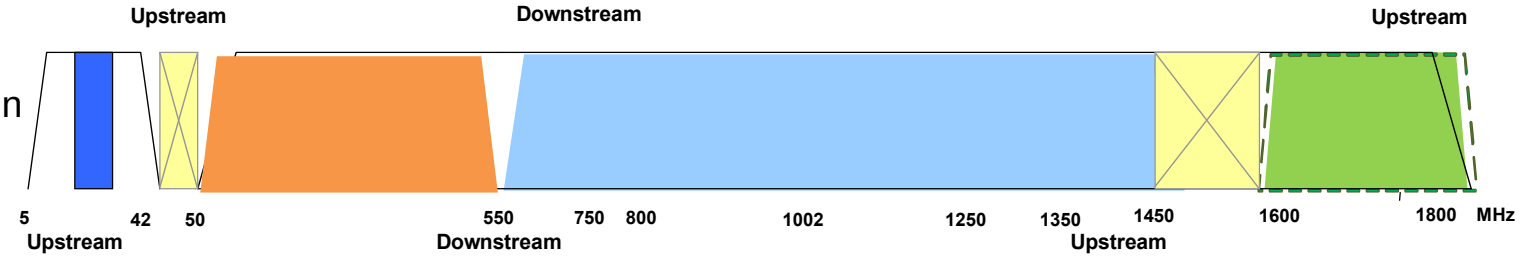
FDD Downstream in 1250 ï 1450MHz



Expansion

FDD Upstream in the 1600 ï 1850MHz

FDD Downstream in 300 ï 1450MHz



EPOC DS Ultra High Band and US Ultra High Band

- EPOC FDD Downstream Carriers
  - Initial EPOC DS signal in the 1250MHz to 1450MHz range
  - Expansion of EPOC DS signal into the 550/750MHz to 14500MHz range
  - Future Expansion of EPOC DS signal into the 300MHz to 1450MHz range
- EPOC FDD Upstream Carriers
  - Initial EPOC US signal in the 16000MHz to 1850MHz range
  - Expansion of EPOC US signal into the 1600MHz to 2000MHz range
- FDD Downstream or Upstream EPOC carriers can operate as noncontiguous spectrum, i.e. “notch” around other existing carriers in the HFC network, to obtain a block of spectrum for the carrier.

Potential Frequency Assignment of TDD Profiles

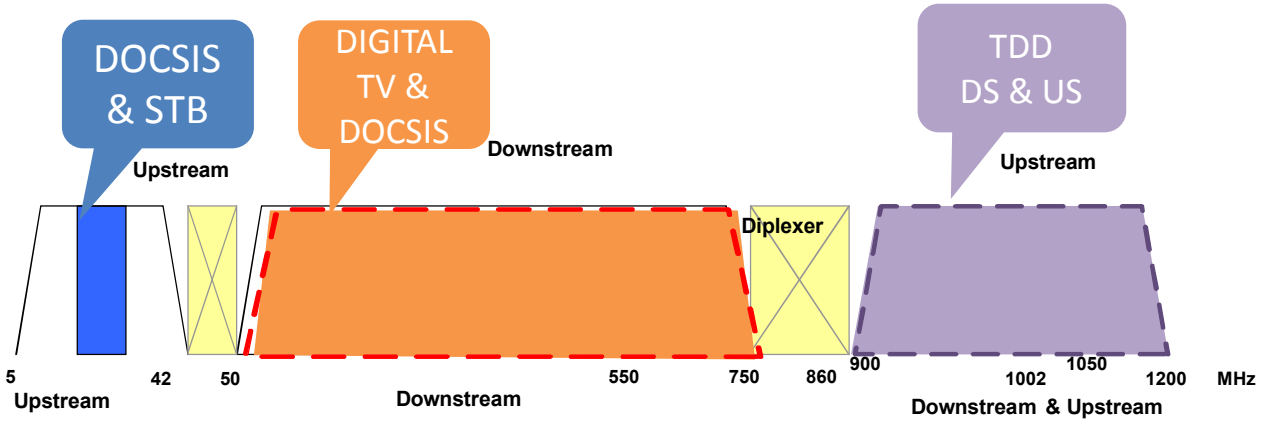
- TDD Profiles (3)
  - TDD Profile 1 Signal High Band expanding to Low Bands
  - TDD Profile 2 Signal High Band expanding to Ultra high Band
  - TDD Profile 3 Signal Ultra High Band

  - TDD Modulated signals will require passive coax segments and will require changes in the HFC network to support this, i.e. Fiber to the amplifier.

  - Use of Ultra High Band spectrum, above 1.2GHz will require upgrade of all HFC components including new actives and passives to utilize, place EPOC signal in this spectrum range.

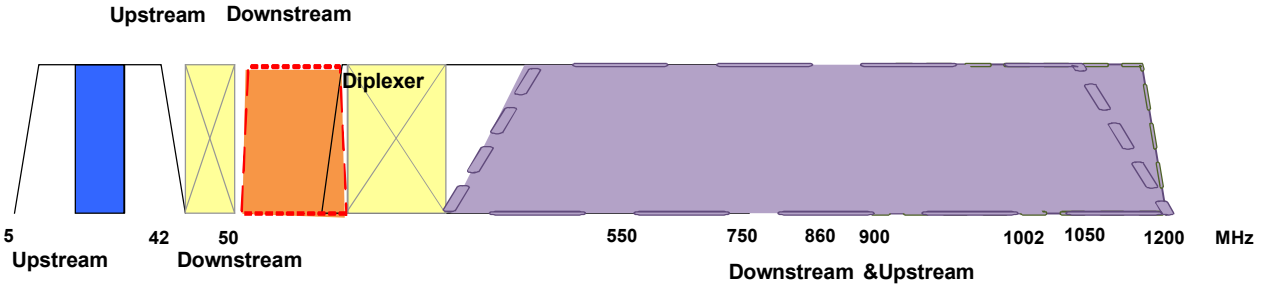
TDD Profile 1
High band Expanding Low

TDD Signal
900 ï 1100MHz



Expansion

TDD Signal
300 ï 1100MHz

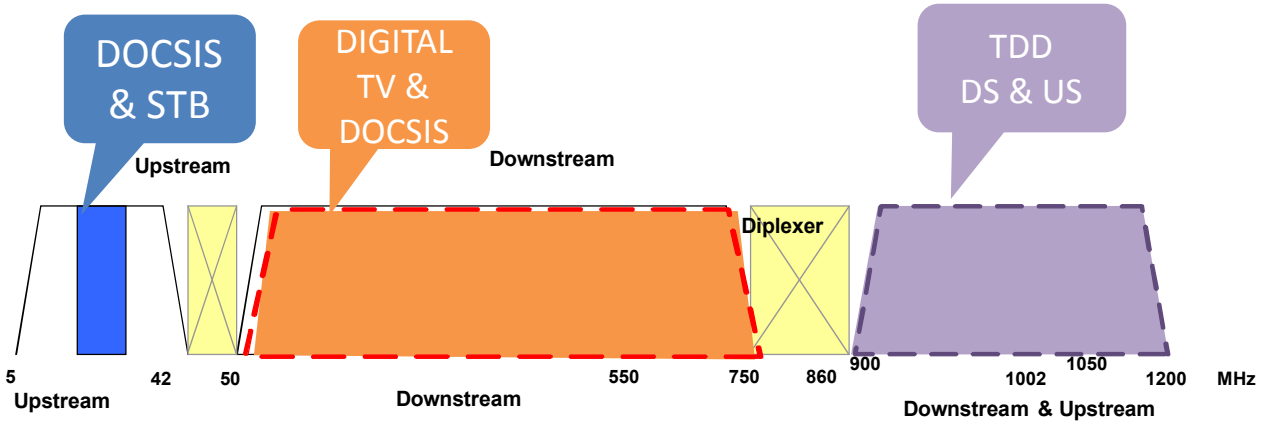


EPOC TDD in High Band
Expanding into Lower Bands

- EPOC TDD Signal
  - Initial EPOC TDD signal in the 900MHz to 1100MHz range
  - Expansion of EPOC DS signal into the 300MHz to 1100MHz range

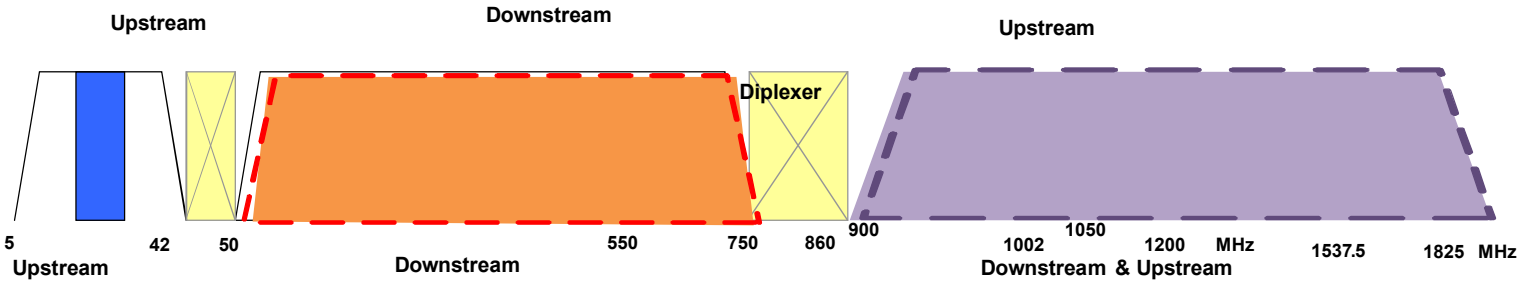
TDD Profile 2
High Band Expanding Ultra High Band

TDD Signal
900 ï 1100MHz



TDD Signal
900 ï 1825MHz

Expansion

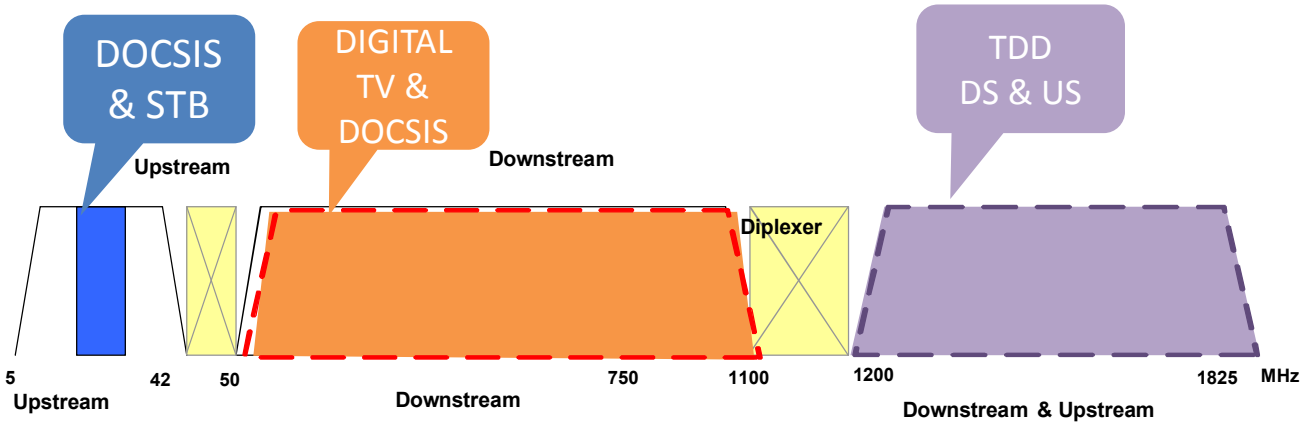


EPOC TDD High Band
Expanding into Ultra High Band

- EPOC TDD Signal
  - Initial EPOC TDD signal in the 900MHz to 1100MHz range
  - Expansion of EPOC DS signal into the 900MHz to 18500MHz range

TDD Profile 3
Ultra High Band

TDD Signal
1200 ï 1825MHz



EPOC Signal in the Ultra High Band

- EPOC TDD Signal
  - Initial EPOC signal in the 1250MHz to 1450MHz range
  - Expansion of EPOC signal in the 1250MHz – 1850MHz range

Thank You

Questions