IMAGINE THE POSSIBILITIES...
DOCSIS® 4.0 Network Migration Made Easy

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Outline

• Confusing Times …
• Network Migration Tools
• Network Migration Decision Tree
• Time-Aware Decision Making
• Example Network Migration Strategy
• Conclusions
Confusing Times: Possible Evolutions for Typical ‘Node +X’ MSO

- PON FTTH is the ultimate end goal... But who knows when?
- In the meantime... the existing HFC Plant has a lot of un-tapped BW Capacity left-over to carry MSOs deep into the future (if they choose to use that BW)...
- HFC can be used with cost-effective, evolutionary changes between now and the PON FTTH end goal...
- HFC may live for 10-20 years or more
Network Migration Tools

- **Selective Subscriber Migration**
  - Move low-penetration super users to another platform. Reduces the pressure on HFC networks!

- **Node Splits & Segmentations**
  - Reduces the SG size. Reduces congestions and enables offering higher peak rates

- **Video Spectrum Reclamation (Digital Video, SDV, IPTV)**
  - Yields additional spectrum usable by the more efficient DOCSIS3.1 OFDM technology

- **Split Upgrade**
  - Enables offering higher US peak rates
Network Migration Tools

- **FDX**
  - Enables simultaneous use of US & DS spectra for N+0 networks

- **Dynamic Soft -FDD**
  - Sliding Split. FDX flavor for N+x networks!

- **Extended Spectrum DOCSIS**
  - FDD-based. Allows higher US splits, DS up to 1.8 GHz in 3 GHz housing

- **Active Taps**
  - Enables extended use of hardlines for higher frequencies (up to 6 -10 GHz depending on the cable type)
Network Migration Tools

- **FTTT**
  - Avoids replacing drop cables
  - Point-to-point network that enables simple FDX operation
  - Enables ESD operation up to 25 GHz
  - Enables combined simple FDX & ESD operation

- **FTTH**
  - Ultimate goal!
Migration Decision Tree

Today
42 MHz US, 750/870 MHz DS

Is next desired/ planned US Tmax > 400 Mbps?
Yes
No

Is desired/ planned US Tmax > 400 Mbps?
Yes
No

400 Mbps US Tmax
85 MHz US

Does OOB issue?
Yes
Reclaim DS Spectrum
No

End

UHS US

42 MHz & 750/870 MHz: 65 Mbps US Tmax & 1.6/2.5 Gbps DS Tmax
65 MHz & 750/870 MHz: 250 Mbps US Tmax & 1.3/2 Gbps DS Tmax
DS Tmax values assume video channels

85 MHz US

Today
424 MHz US, 1 GHz DS

Is next desired/ planned US Tmax > 1.3 Gbps?
Yes
No

1.3 Gbps US Tmax

Is desired/ planned DS Tmax > 1.3 Gbps?
Yes
No

1.3 Gbps US Tmax

Is desired/ planned DS Tmax > 1.3 Gbps?
Yes
No

1.2 GHz DS

Decision Point 3

Dynamic Soft-FDD?
Yes
No

Use Dynamic Soft FDD
1.2 GHz Nodes/Amps

Reclaim more DS Spectrum Applicable & go 65 MHz

End

Branch 1

Branch 2

Branch 3

Branch 4

Branch 5
SG = 250, Digital Video
The diagram illustrates the changes in Digital Video (DS & US Tmax) over time, with various splits and bandwidths. The key points are:

- **DS Tmax**: 85 MHz Split with 1.2 GHz DS
- **US Tmax**: 85 MHz US Split
- **DS Tmax**: 204 MHz Split with 1.2 GHz DS
- **US Tmax**: 204 MHz US Split
- **DS Tmax**: 300 MHz Split with 1.2 GHz DS
- **US Tmax**: 300 MHz US Split
- **DS Tmax**: 204 MHz Split with 1.65 GHz DS
- **US Tmax**: 396 MHz US Split
- **DS Tmax**: 300 MHz Split with 1.65 GHz DS
- **US Tmax**: GPON (1x2.5 Gbps)
- **DS Tmax**: 396 MHz Split with 1.8 GHz DS
- **US Tmax**: GPON (1x2.5 Gbps)

The graph shows how these values evolve from 2020 to 2036, reflecting the trend and capacity increase in Digital Video services over this period.
SG = 64, Digital Video

DS & US Tmax (Digital Video)

- DS Tmax: 85 MHz Split with 1.2 GHz DS
- US Tmax: 85 MHz US Split
- DS Tmax: 204 MHz Split with 1.2 GHz DS
- US Tmax: 204 MHz US Split
- DS Tmax: 300 MHz Split with 1.2 GHz DS
- US Tmax: 300 MHz US Split
- DS Tmax: 204 MHz Split with 1.65 GHz DS
- US Tmax: 396 MHz US Split
- DS Tmax: 300 MHz Split with 1.65 GHz DS
- US Tmax: GPON (1x2.5 Gbps)
- DS Tmax: 396 MHz Split with 1.8 GHz DS
- US Tmax: GPON (1x2.5 Gbps)
SG = 250, IPTV
SG = 125, IPTV
SG = 64, IPTV
Near Term Tools

- Enable more DOCSIS 3.1 OFDMA for the US
- Enable more DOCSIS 3.1 OFDM for the DS
- Node split/segmentation
- Enabling Switched Digital Video
- Increasing Video Compression
- Video BW reclamation by moving to IPTV
- Increasing the US split
- Increasing the DS spectral range
- Selective subscriber migration
Mid/Long Term Migration Plan

- Apply some of the near-term tools
- Reframe goal as constrained NT migration by applying Selective Subscriber Migration
- Continue reducing SG size using node splits and segmentations
- Move to 204 MHz High Split US with 1.2 GHz DS
- Continue reclaiming video BW. Digital video to SDV and then IPTV
- Increase the US & DS rates by moving to ESD
- Active Taps
- FTTT
- FTTH
Conclusions

- There are many network migration tools available to extend the life of HFC networks

- Light/Medium touch options can extend the life of the HFC network to 2030 when T_{max} is 2 Gbps or less
  - DOCSIS 3.1 OFDM/OFDMA
  - High-Split with 1.2 GHz DS
  - Nodes splits and segmentations

- Other tools like IPTV and ESD can extend the life of HFC networks well into the 2030 decade

- Going with US splits higher than 396 MHz when the DS is limited to 1.8 GHz may not be optimal
Thank You!

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