
HFC For Small and Medium Business Services

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Needs of Small and Medium Businesses

- Multiline Telephone Service.
- High-Speed Data.
 - Up to 100 Mbps.
 - Guaranteed minimum bandwidth.
- Video.
 - Although not consider a core business service the ability to deliver television service to small businesses is a unique advantage for the Cable MSO and can be bundled in as the final selling feature.

Delivery Methods (HFC)

- Adding Businesses to the Existing HFC Nodes.
 - Easy addition to existing infrastructure if the HFC network is present in the business parks.
 - Can be difficult to deliver guaranteed minimum bandwidth.
- Dedicated HFC Nodes.
 - Business parks and complexes can use a dedicated HFC node that feeds only the area businesses.
- RFoG
 - Fibre to the business using HFC.

HFC Advantages (for the Cable MSO)

- The advantages come from the back office, billing, OSS and operational integration, not necessarily from the service delivery technology.
 - Uses the same customer equipment we use today:
 - Cable modems and eMTAs.
 - Set-top boxes.
 - The existing billing, provisioning and support systems are utilized therefore time to market is reduced and there are no added costs for a new support systems.
 - The cable technical staff are already competent in dealing with the technology.

Adding Businesses to the Existing HFC Infrastructure

- Businesses can be added to the existing HFC/DOCSIS infrastructure via a HFC leg/drop to the businesses.
- Multiline eMTAs can be used to provide multiline telephone service.
- DOCSIS 3.0 can provide the speeds businesses desire/require, but as many as eight bonded channels may be required to offer 100M speeds to multiple businesses.
- Video is provided in the same manner as the residential service today.
- Low cost.

Adding Businesses to the Existing Infrastructure – Disadvantages

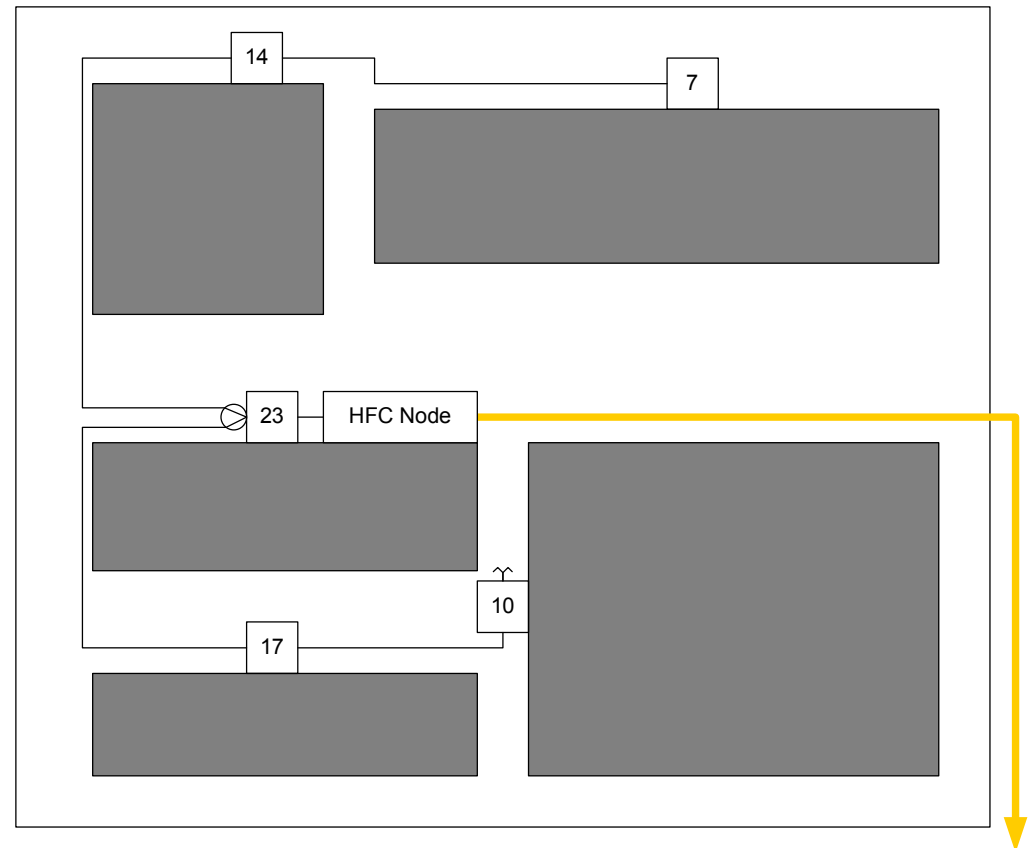
- Although the ability to offer television service is an advantage a significant portion of the spectrum is tied up offering analogue video to the residential subscribers.
- DOCSIS 3.0 deployments will likely be limited to four channels due to the real-estate taken up by the analogue TV stations.
 - May not be able to offer 100 Mbps downstream service.
- The current nodes have limited return capacity (likely a total of 40 to 60 Mbps per node due to the 5 to 42 MHz limitation).
- Minimum guaranteed bandwidth will likely interfere with the service provided to residential subscribers in the same node. The business customers will also be competing for bandwidth with the residential subscribers.
- Cable TV plant tends not to go into businesses parks.
 - There can be significant cost to extend the nearest HFC node to the business park.

Dedicated Business Nodes – Advantages

- An HFC node can be installed in a business park or strip mall to service only the businesses.
 - The Cable MSO may need to build plant into the non-residential area, it might as well be fibre.
- Analogue TV is not required. We can use a business only channel line-up.
 - Drop the analogue channels from the node line-up. The “legality” will depend on the details of the Cable BDU.
 - Keep the DTV channels to offer digital TV to business customers.
 - This will free up spectrum (more DOCSIS 3.0 channels) and the return can be extended to beyond 42 MHz.

Example Business Complex

- Customers in the businesses park can be fed via individual drops in the same manner as residential customers.
- Each building may include a single customer (example big box retail) or multiple businesses.
- DTV, Business Data, and Voice can be provided to each business.

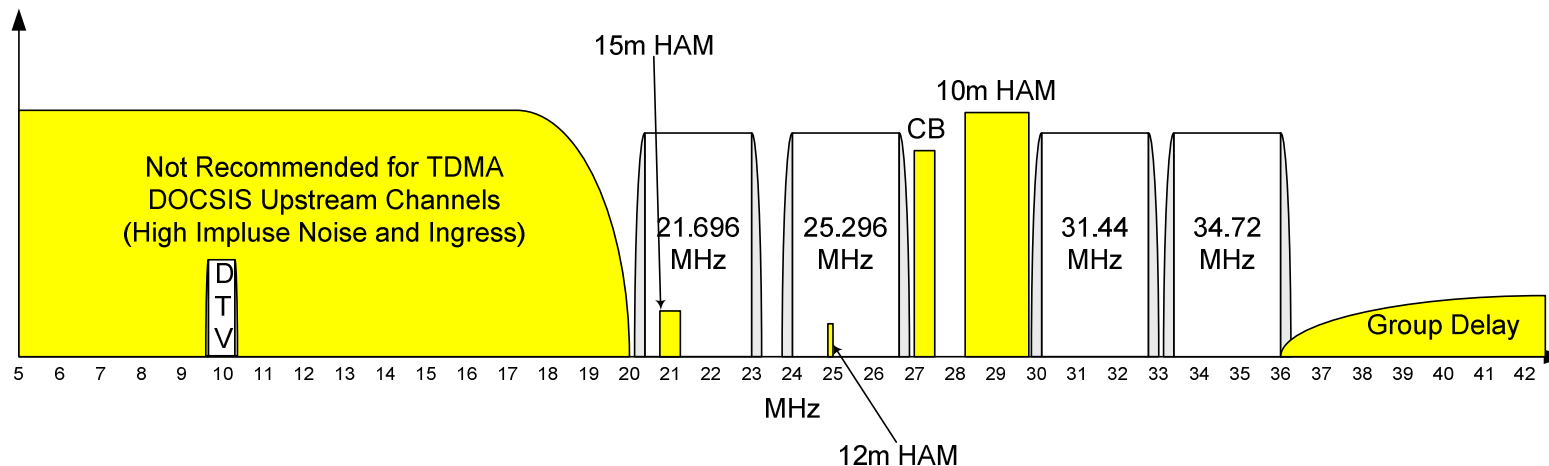


Unique Downstream Channel Line-Up

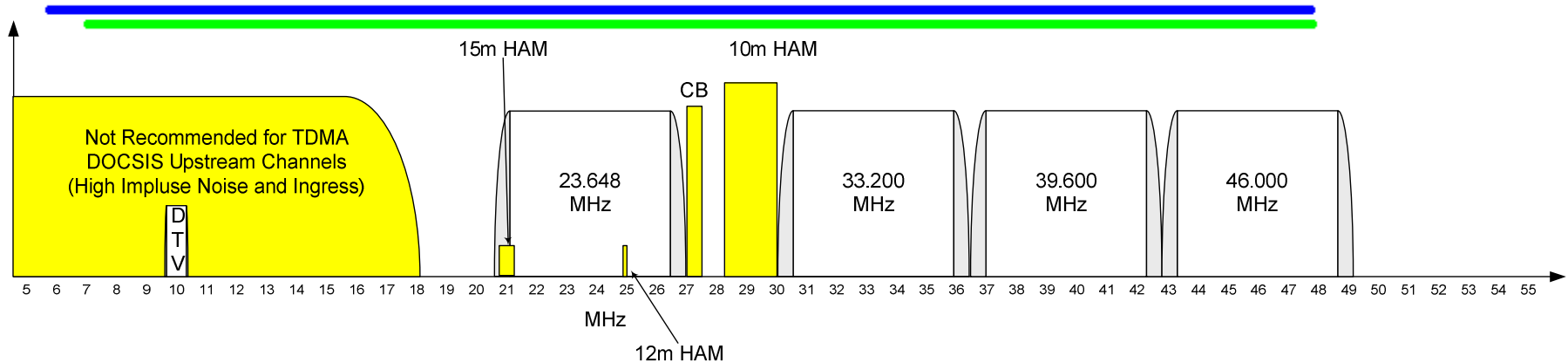
- Since the analogue channels will not be required DOCSIS 3.0 can use the spectrum currently occupied by the high analogue channels.
 - This will allow for eight DOCSIS 3.0 channels and a total downstream pipe of ≈ 300 Mbps.
- The unique channel line-up will require a dedicated CMTS interface.
 - The business only CMTS interfaces will mean that business customers are not competing with the residential subscribers for bandwidth.
 - Guaranteed minimum bandwidth is easier to deploy and scale.
- The downstream line-up will also free up the spectrum below 88 MHz for an expanded return band.

Conventional Upstream Channel Line-Up

- Conventional return channel alignments are typically limited to four 3.2 MHz carriers.
- With each carrier running at 64 QAM the maximum return bandwidth is 60 Mbps.



Unique Upstream Channel Line-up



- DOCSIS 3.0 opens up the return to beyond 42 MHz. There is no need for Legacy DOCSIS modem support and the removal of the analogue channels will allow the return spectrum to be opened up.
- Using four return channels—6.4 MHz at 64 QAM—will provide an upstream bonded pipe size of 120 Mbps.
- Special duplex filters will be required in all actives. Return NPR will need to be carefully considered to avoid laser clipping.
- Watch out for ingress from the off air TV stations! Triple shielded drop cable is recommended.

RFoG

- RFoG (RF over Glass) extends the fibre portion of the HFC node to the customer. RFoG can be considered a PON like technology while still HFC.
- Coax is still used to feed the cable modems, eMTAs and set-top boxes. The same CPE devices can be used (same as conventional HFC).
- RFoG offers a fibre to the customer option to G-PON that does not require any special provisioning beyond the current cable back-office.
- Each RFoG segment can feed up to 64 businesses.
- There are pitfalls with RFoG that must be considered.

RFoG – Advantages

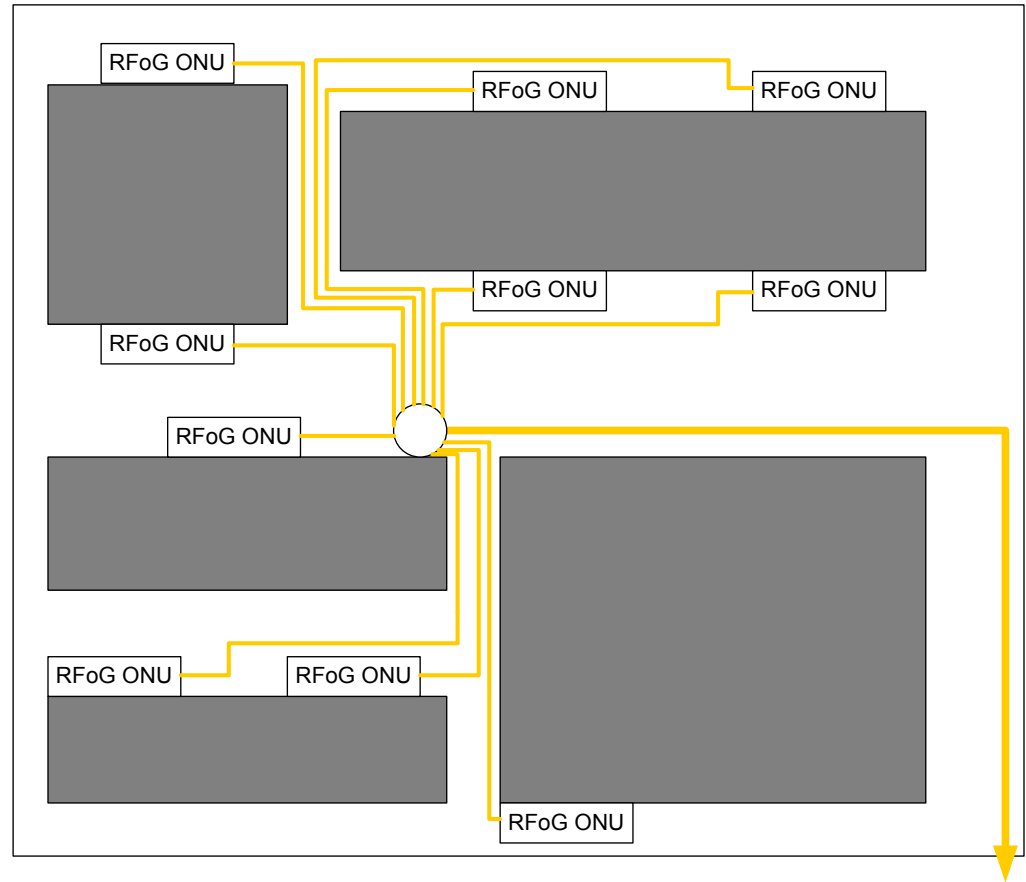
- RFoG can be installed in a business park or strip mall to service the businesses.
 - As with a dedicated fibre node the Cable MSO may need to build plant into the non-residential area, it might as well be fibre.
- A business only channel line-up can be used with RFoG just like the dedicated HFC node solution.
 - Drop the analogue channels from the node line-up. The “legality” will depend on the details of the Cable BDU.
 - Keep the DTV channels to offer digital TV to business customers.
 - Unlike the dedicated node solution the return spectrum should stay at 5 to 42 MHz.

RFoG – Advantages Continued

- RFoG can be easily migrated in the future to G-PON.
 - RFoG can be considered the end solution or a time to market step towards G-PON.
- Lower operational costs (compared to conventional HFC).
 - The fibre portion of the plant is ingress free.
 - The passive nature of the technology reduces electronic equipment failures.
 - Lower power requirements when compared to conventional HFC.

Example Business Complex

- Customers in the businesses park are fed with fibre via a local optical splitter.
- Each building may include a single customer (example big box retail) or multiple businesses. Each business will receive a RFoG ONU/ONT and coax to feed the business.
- DTV, Business Data, and Voice can be provided to each business via conventional cable boxes/modems.



Unique Downstream Channel Line-Up (RFoG)

- Since the analogue channels will not be required DOCSIS 3.0 can use the spectrum currently occupied by the high analogue channels.
 - This will allow for eight DOCSIS 3.0 channels and a total downstream pipe of ≈ 300 Mbps.
- The unique channel line-up will require a dedicated CMTS interface.
 - The business only CMTS interfaces will mean that business customers are not competing with the residential subscribers for bandwidth.
 - Guaranteed minimum bandwidth is easy to deploy and scale.

RFoG Upstream Considerations

- RFoG “uses the DOCSIS protocol” to turn lasers off and on. The lasers turn on when the modem behind the laser is transmitting, the laser is off when the modem is idle.
- If too many modems are active at once the return system will not function correctly. Too many lasers will be active at once.
- Ideally we want only one or two modems active at a time.
 - This poses a problem when using S-CDMA, TDMA/A-TDMA is the best solution for RFoG.
 - The number of upstream channels should be limited to two. This is why we do not recommend the expanded return spectrum for RFoG.

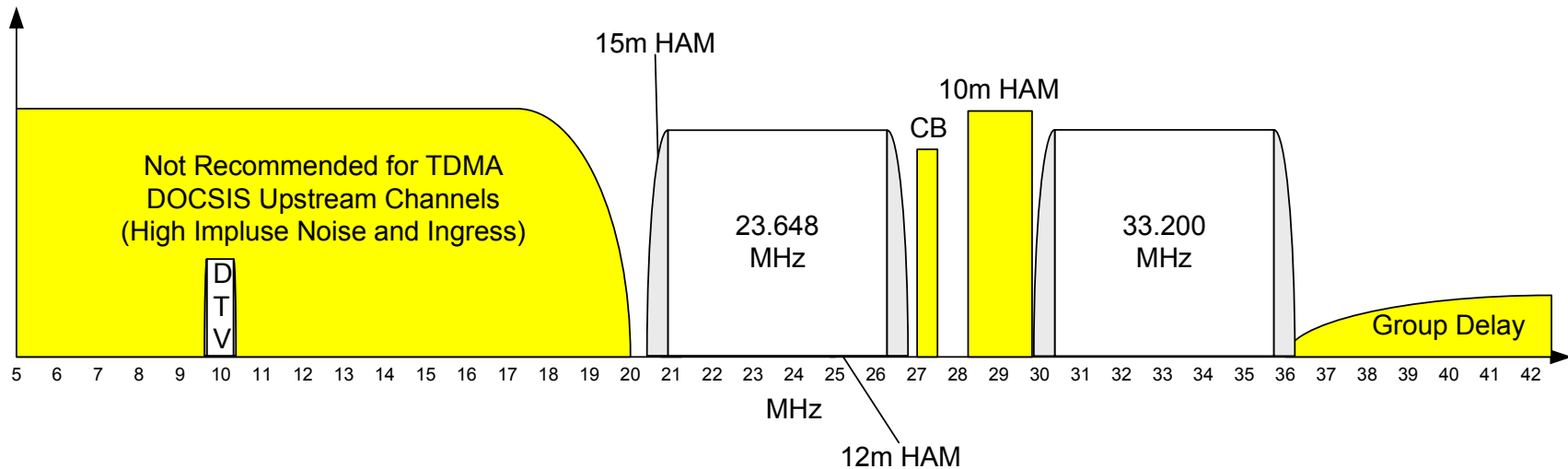
RFoG Upstream Considerations Continued

- It is important that the upstream channels be time synchronized.
 - Multiple primary channels can be a problem if they are not time synchronized.
- Modem maintenance IUCs should be left at QPSK since these IUC are collision domains and therefore multiple modems can be active at the same time.
- The upstream modulation scheme may need to be tuned to improve operation (e.g. preamble).
- There is a significant advantage to using DOCSIS imbedded set-top boxes since a conventional DTV return will not be time synchronized and will overlap DOCSIS payload.

RFoG Upstream Considerations Continued

- Due to the dependency on the DOCSIS protocol for the proper operation of RFoG it is important that the DOCSIS Engineer and the HFC Engineer have a good understanding of the cross functional dependencies/interaction.

Unique Upstream Channel Line-up (RFoG)



- By using two time synchronized return channels only two modems will be active (payload) at any given point in time.
- The two channels will provide up to 60 Mbps of return (bonded) bandwidth (64 QAM).
- The DTV channel will not be time synchronized so it can interfere with voice traffic but the overall impact should be small.
 - A DOCSIS set-top box deployment would correct this.

RFoG Migration to G-PON

- The RFoG business solution can be migrated to G-PON in the future. RFoG gets you to market fast while still providing a fibre to the customer product. In the future you can stay with RFoG or switch to G-PON.
- This can be accomplished by a future fork-lift replacement of the electronics or a G-PON overlay.
 - G-PON can use the same fibres on separate wavelengths and run in parallel to the RFoG solution.
- Some RFoG vendors have migration paths already available that contain RFoG and G-PON in the same ONU/ONT.

Summary

- Using HFC to support business customers will allow the cable MSO to get to market quickly since the existing billing, back-office and OSS support infrastructures are already in place.
- The existing cable modems and eMTAs (multiline) will be used to support business customers, no special CPE equipment is required.
- In the case of RFoG there is a future migration path to other PON technologies.