Options of wholesale access to Cable-TV networks with focus on VULA

Workshop for ACM, den Haag

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Agenda

- Market definitions and VULA
- Characteristics of CA-TV networks
  - DOCSIS 3.0
  - DOCSIS 3.1 and future developments
- Evaluation regarding VULA
- ACM Questions
- Summary

The market definitions of the EC requires ex ante defined markets to be analyzed for significant market power; they are undergoing changes

Today:

- Market 4: Wholesale (physical) network infrastructure access (including shared or fully unbundled access) at a fixed location

- Market 5: Wholesale broadband access

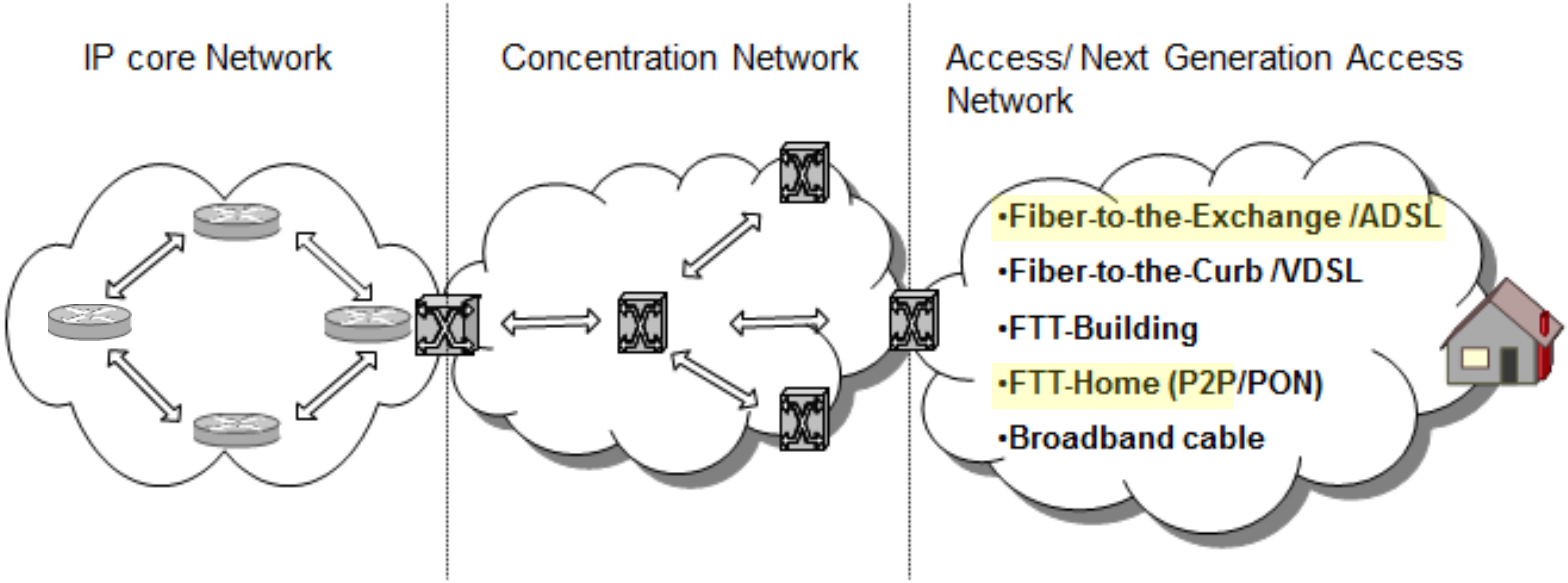
  (comprises non-physical or virtual network access including „bit-stream“ access at a fixed location. This market is situated downstream from the physical access covered by market 4 listed above, in that wholesale broadband access can be constructed using this input combined with other elements.) (Source: EC recommendation 2007/879/EC, Annex)

Tomorrow:

- Market 3: a) Wholesale local access provided at a fixed location
  b) Wholesale central access provided at a fixed location for mass market products

  (Source: Draft EC recommendation on relevant product and services markets …, Brussels 10. October 2013, Annex)

Next Generation Access Networks (NGA) allows to give access for all communication (voice, data, video/ TV) to one IP Network



Label
Edge Router

xx Locations

Metropolitan Point of Presence (MPoP)

1400? Locations

~800? are unbundled

FTTE and FTTH P2P are the only access topologies allowing for physical unbundling of copper or fibre lines at MDF location – physical unbundling in case of FTTC, FTTB and FTTH (PON) technically and/ or economically not feasible

Physical Unbundling may be replaced by a Virtual Unbundling Local Access (VULA) under specific cirumstances

- **If:**
  - Physical unbundling is ***not economically feasible***
  - Due to network ***technology*** (e.g. Vectoring, G.fast, CA-TV)
  - Network ***topology*** (Point-to-Multipoint GPON (economic reason also))
- Many cases notified at EC: They admitted a VULA (L2 bitstream) with features close to the physical unbundling:
  - "*should be made available at a location close to the end customer premises, similar to LLU,“*
  - "*should allow product differentiation and innovation similar to LLU and thus give access seekers a sufficient degree of control including the quality of service, over the local connection to the end-user"*
  - Source: EC to UK VULA decision, UK/2010/1065, EC C(2010)3615, 01.06.2010, p.7

Recent EC decisions: overview

Country	NRA	Year	Virtual unbundling obligation in case of …	Local bitstream obligation in the case of …	Consequences for the physical unbundling obligation
UK	Ofcom	2010	FTTC/B/H	-	Non imposition of (physical) unbundling in case of FTTH-GPON
AT	RTR	2010	FTTC/B	-	Release of SLU in case of overlapping coverage
BE	BIPT	2011	-	FTTC	Release of SLU in case of FTTC and VDSL Vectoring
IT	AGCOM	2011	FTTC/B/H	-	Non imposition of (physical) unbundling in case of FTTH-GPON
SK	TÚSR	2012	FTTH	-	Non imposition of (physical) unbundling in case of FTTH-GPON
DK	DBA	2012	FTTC/B	-	no
MA	MCA	2012	FTTC (during migration to FTTC only) FTTH (after ongoing Roll-out)	-	 Non imposition of (physical) unbundling in case of FTTH-GPON
IE	ComReg	2012	-	FTTC/B	Release of SLU in case of FTTC and VDSL Vectoring
AT	RTR	2013	FTTH/B/C; Copper network with Vectoring at MDF	-	Non imposition of (physical) unbundling in case of FTTH-GPON Release of SLU in case of FTTC without (s. 2010) and with VDSL Vectoring Release of SLU in case of FTTC and VDSL Vectoring at MDF without LLU demand
DE	BNetzA	2013	-	FTTC	Release of SLU for frequencies above 2,2 MHz in case of FTTC and VDSL Vectoring

Market 4 or 5?

Characteristics of VULA (bitstream) demanded by EC so far:

- Local
- Service agnostic
- Uncontended product
- Sufficient control of the access connection
- Control of customer premise equipment

Austria: Layer 2 VULA shall be close to SLU/ LLU characteristics

- Layer 2 product with Ethernet interface
- Handover at MDF location, offer for all access lines of the MDF, higher level handover as volunteer option
- Harmonized characteristics, covering all NGA variants (FTTx)
- Multicast enabling
- CPE is provided by wholesale seeker
- Contention rate is determined by wholesale seeker
- Last Mile status analysis enabled for wholesale seeker
- Traffic handover on behalf of third parties is admitted
- Detailed protocol specifications, i.a. for VLAN handling
- Process quality surveillance by KPI-Definition/ -Monitoring

Withdrawing existing SLU/ LLU due to NGA roll out requires migration of competitors‘ end customers

Example Austria

- If migration is enforced at some cabinets within an MDF area, the complete MDF area may be migrated on demand of the competitor in order to prevent the operation of two parallel access infrastructures within one area.
- The cost of the migration is borne by the incumbent operator.
- The price of the access product remains unchanged if the access line speed is not upgraded.
- The competitor’s frustrated investment (bookvalue of the no longer usable access equipment) has to be refunded by the incumbent.
- The steps of the migration process have to be mutually agreed upon in lines and dates.
- LLU charge remains unchanged except the access line speed is upgraded
- KPI-Monitoring of the migration process

Wholesale access on CA-TV networks: Cases in Denmark, Belgium and Germany

- Denmark: ***Bitstream*** obligation to the national incumbent fixed network operator TDC, who controls appr. 33% fixed access lines on CA-TV network infrastructure,
  - national IP-layer handover points,
  - no VULA
- Belgium: ***Resale*** obligation for analogue TV and Broadband Internet and access to the digital TV platform on 5 CA-TV network operators,
  - no VULA
- Germany: ***Layer 2 access framework rules on volunteer base***, agreed upon in the German NRA's industry round table „NGA Forum" working groups,
  - local, regional and national Ethernet layer handover points
  - No VULA, but rather close

New EU-VULA (L2 bitstream) proposed by EC in draft Single Market/ Connected Continent regulation[1]

EU-wide harmonized

- Closer to the end customer premises than the national or regional level
- Flexible allocation of VLANs
- Service agnostic connectivity, control of download and upload speed
- Security enabling
- Flexible choice of customer premise equipment (CPE) (as long as technically possible)
- Remote access to the CPE
- Multicast functionality (where demanded)

Also: Features of business processes, ancillary services, IT-Systems.
In future more detailed characteristics expected

Substituting SLU/ LLU on equal level or subordinated compromise?

Regulation: immediately binding national law

[1] EC proposal for a Regulation "Single Market/ Connected Continent", COM(2013) 627 final, 11.09.2013 , already changed significantly

Draft new EC market definition expands access market to CA-TV networks and includes VULA

- EC recognizes that VULA is replacing ULL where technically and/ or economically required. VULA is an active remedy like Bitstream. Borders between the markets (4, 5) disappear to some extent.
- Both markets deal with access to end customers, thus now one market 3 (Wholesale Access) with two distinct sub-markets 3 a) and b)

  a) Wholesale local access (WLA) provided at a fixed location
  includes LLU, SLU of copper and fibre, VULA

  b) Wholesale central access (WCA) provided at a fixed location for mass market products
  includes classical bitstream at a national level

- CA-TV (and LTE) shall be included in the markets if appropriate

(Source: Draft EC recommendation on relevant product and services markets …, Brussels, 10. October 2013, Explanatory Note)

Wholesale Local Access (WLA) includes ULL, SLU and VULA

Conditions to be cumulatively fullfilled:

- Access occurs locally (MDF, Cabinet, …)
- Service agnostic transmission capacity uncontended in practice, dedicated logical connection, LLU-like services (e.g. multicast where appropriate)
- Sufficient control over the transmission network to be a functional substitute to LLU, allow for *product differentiation and innovation* similar to LLU; access seekers control of core network elements, network functionalities, operational and business processes, ancillary services and systems (e.g. *CPE*) should allow for a sufficient control over the end user product specification and the quality of service provided (e.g. varying *QoS parameters*).
- *No protocol layer mentioned for VULA (Layer 2/ Ethernet) here*

Wholesale Central Access (WCA) is dedicated for mass market products and neither WLA nor a High Quality Access (another new market 4)

Characteristics inter alia:

- i) best effort QoS,
  no availability guarantees,
  higher contention rate,
  no symmetrical speeds and resilience,
  enable access seekers to produce only standardized retail services or services with limited features

- ii) reduced possibilities for access seekers to differentiate their access offers, due to limited control over the network (and the ancillary services and systems)

- *No protocol layer mentioned for VULA (Layer 3/ IP) here*

Evolving technologies like CA-TV and LTE shall be investigated in order to decide if to include them in the markets

- LTE (release 10 – LTE advanced – release 15 – 1.000 Mbit/s per cell??)
- Can LTE be part of WLA (VULA) or WCA (Bitstream), substituting other offers? -> EC: so far not yet
- CA-TV (competition of DOCSIS 3.0 roll out, availability of DOCSIS 3.1)
- Can CA-TV be part of WCA market (Bitstream)?
  High probability from technical characteristics point of view,
  regional vs. national market definition?
- Can CA-TV be part of WLA market (VULA)?
  To be investigated in depth

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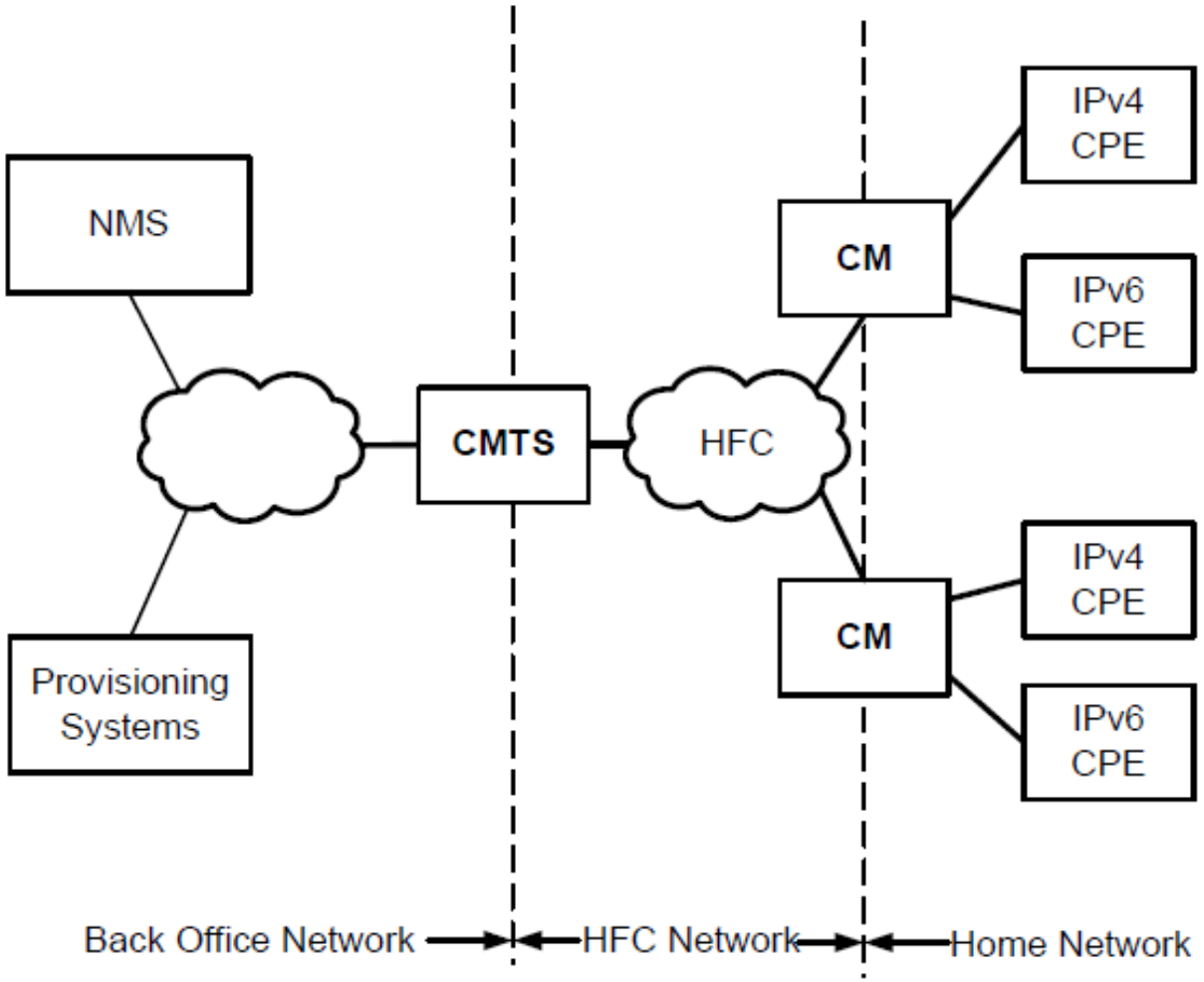
DOCSIS HFC networks

Key characteristics

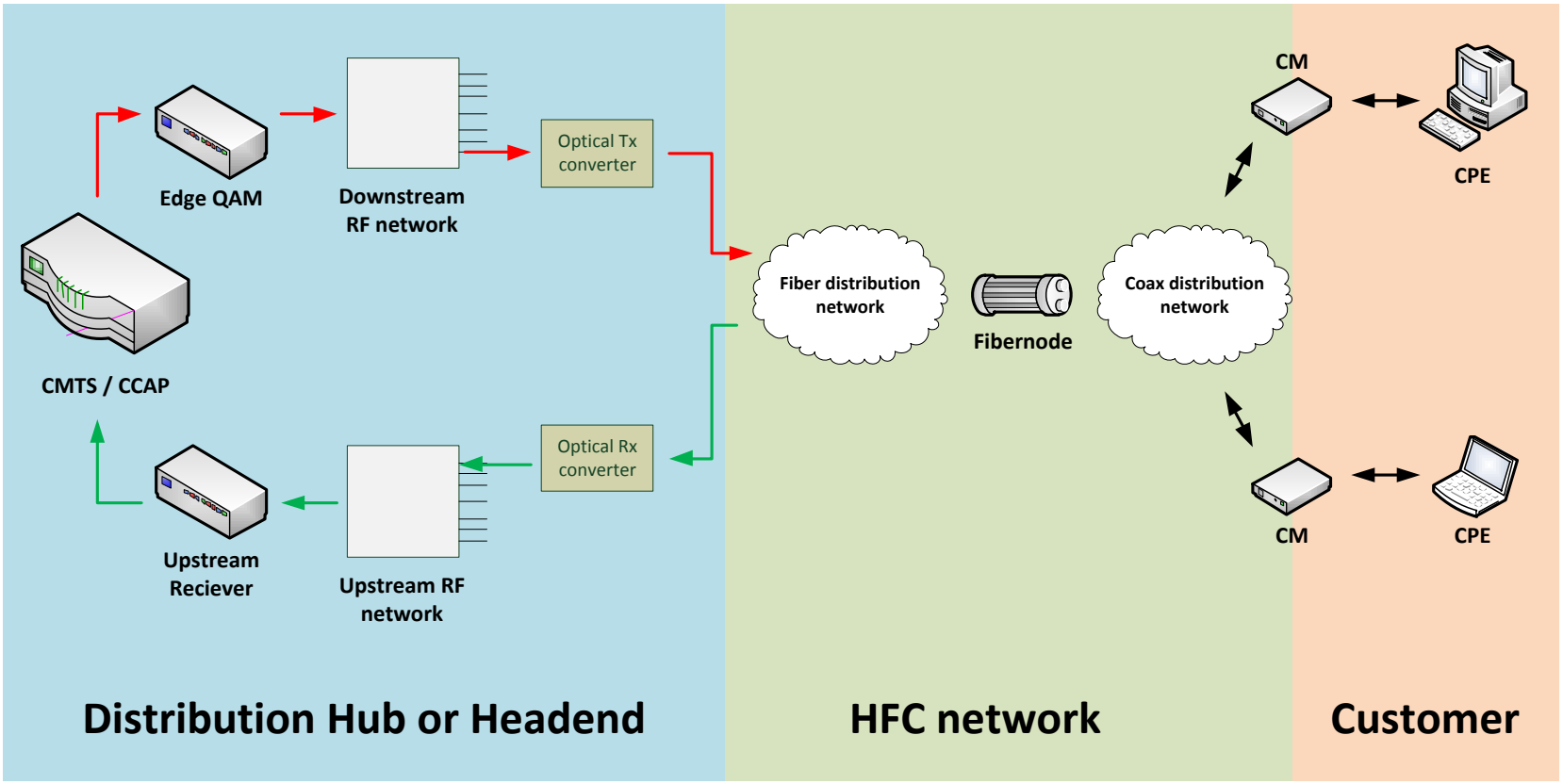
- Tree-and-branch architecture (star-bus topology)
  - Mixture of optical and electrical components
  - Last mile is a shared medium (electrical / coax)
- **Layer 3 based architecture**
- A maximum distance of 160km between CMTS and CM
- Real multimedia network (converged network)
  - TV / Radio
  - Video
  - Voice
  - Internet

DOCSIS reference model (1)



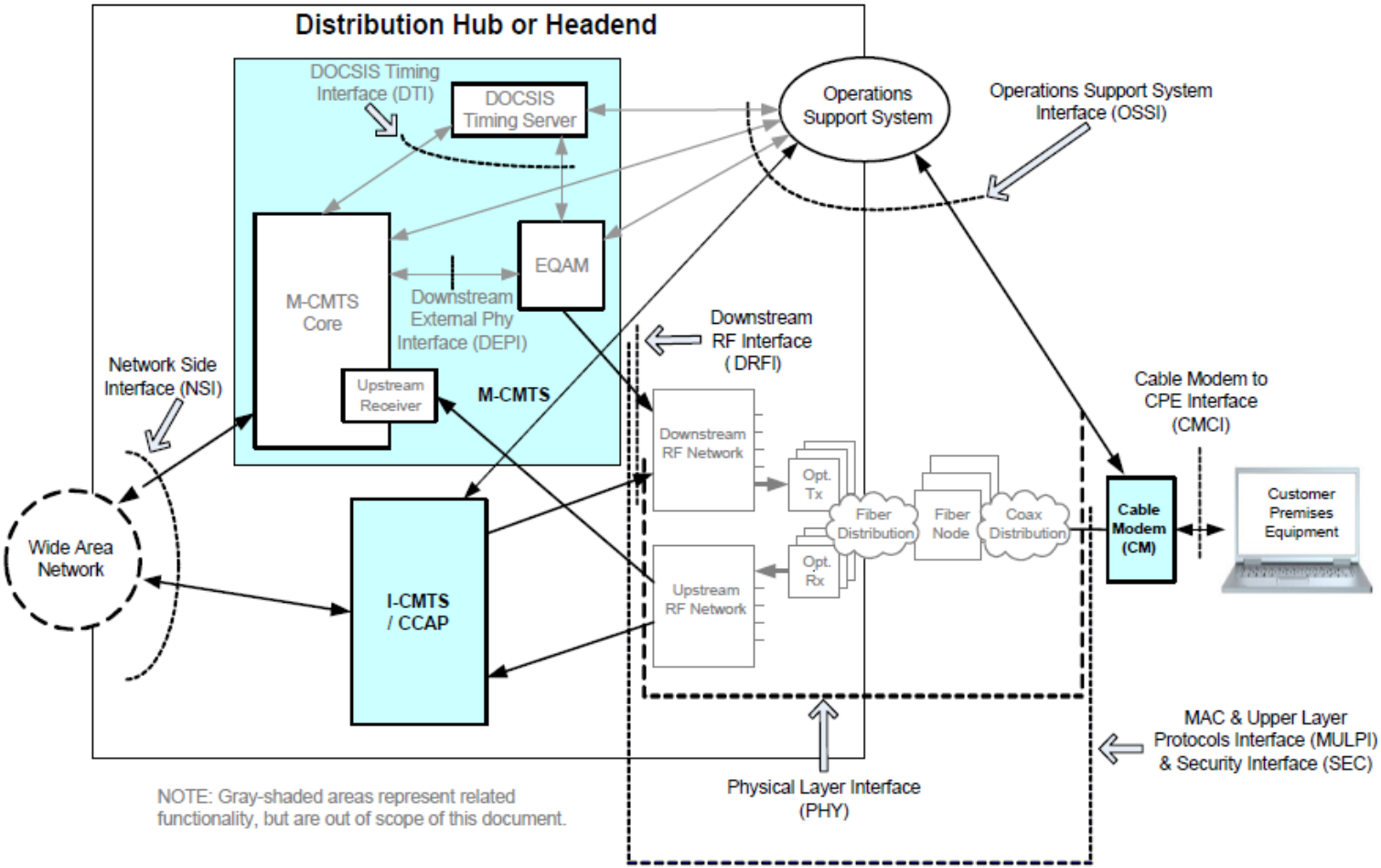
DOCSIS reference model (2)

- Schematical DOCSIS 3.0 / 3.1 architecture



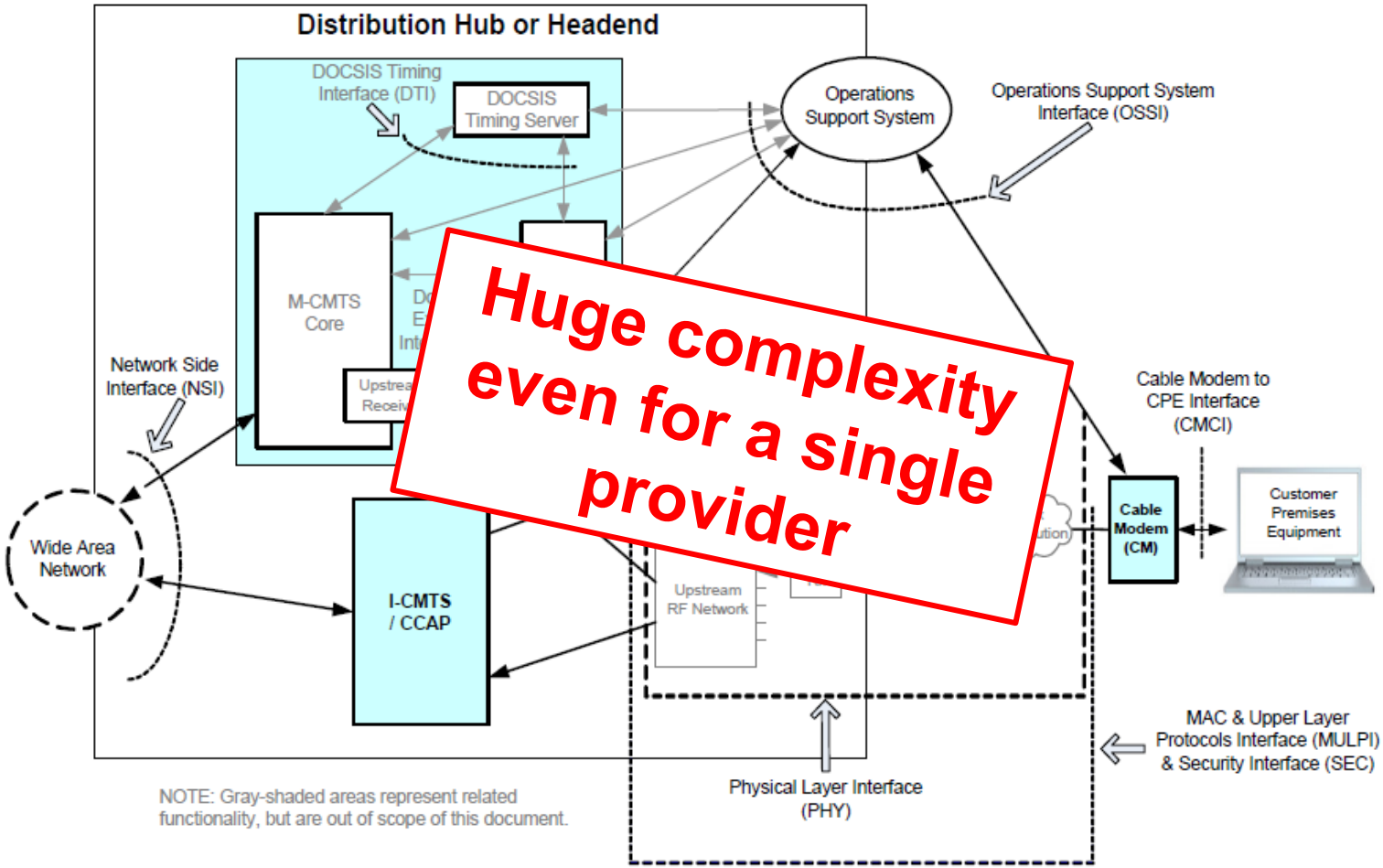
DOCSIS reference model (3)

- DOCSIS 3.0 / 3.1 architecture in detail

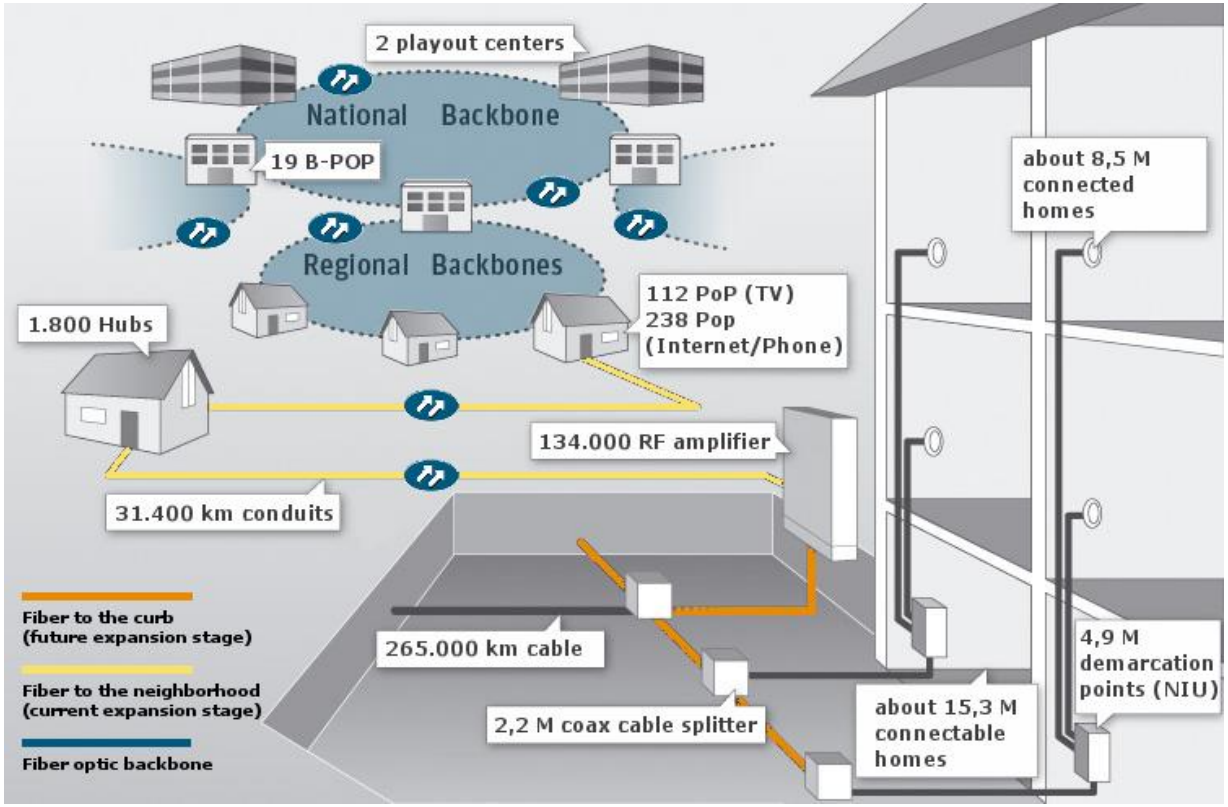


DOCSIS HFC networks

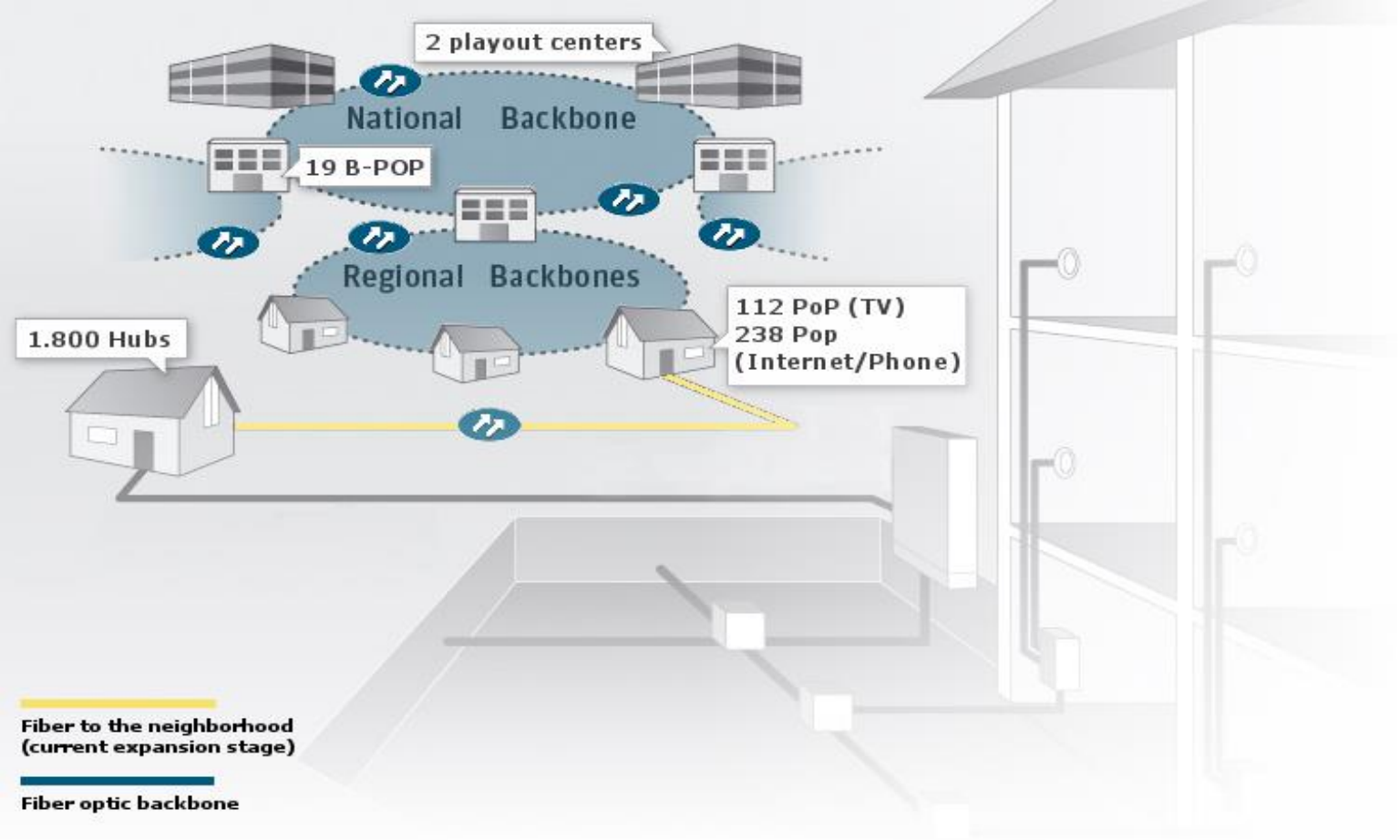
- DOCSIS 3.0 / 3.1 architecture in detail



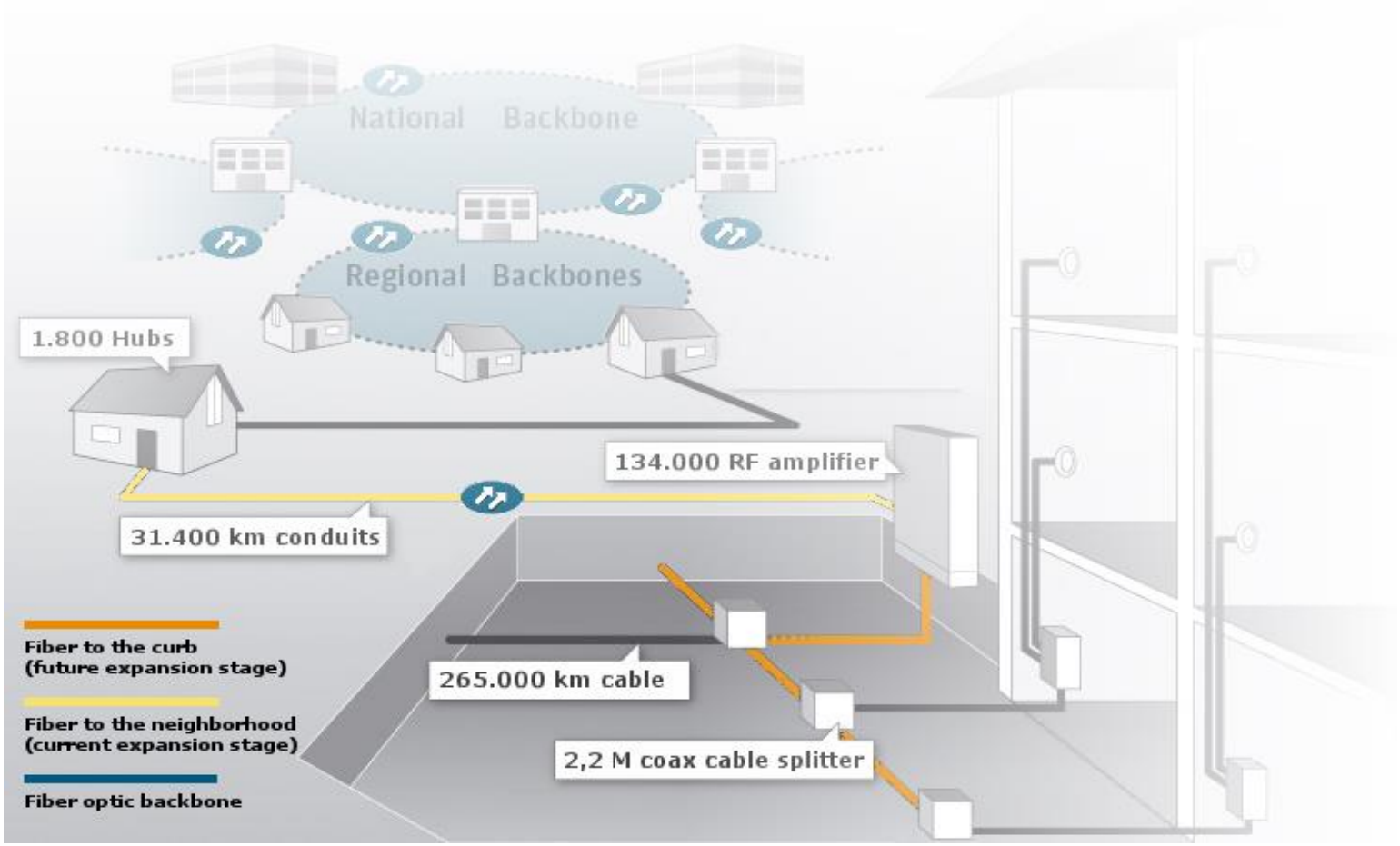
Typical HFC network infrastructure (1)



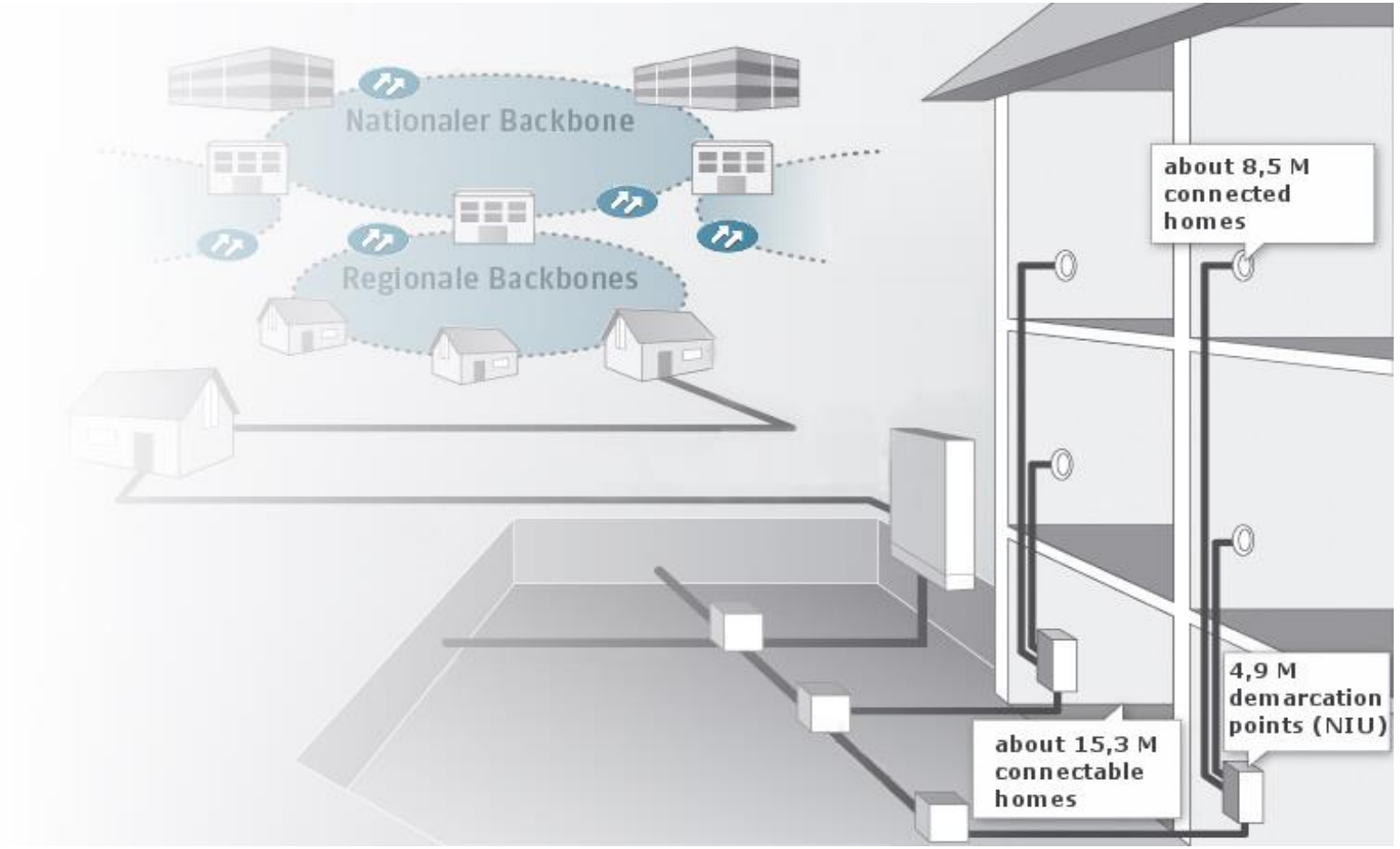
Typical HFC network infrastructure (2)



Typical HFC network infrastructure (3)

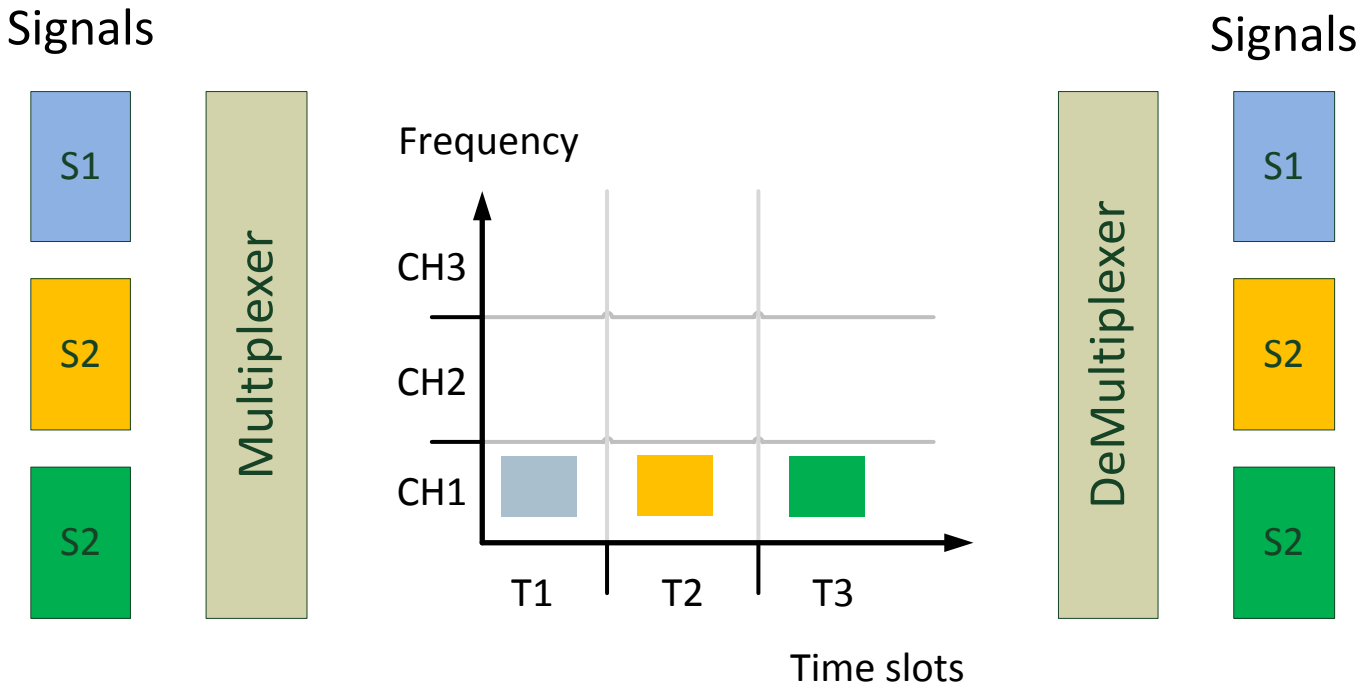


Typical HFC network infrastructure (4)



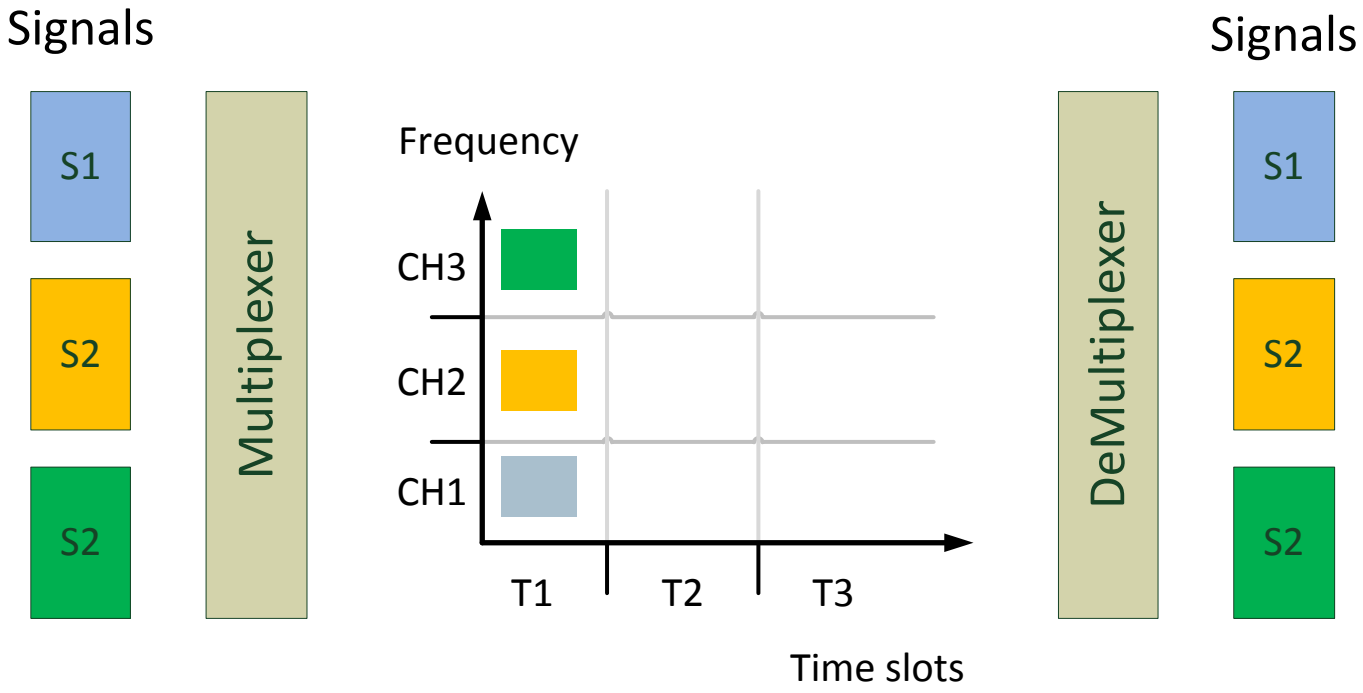
Multiplexing (1)

- Time devision multiplexing



Multiplexing (2)

- Frequency devision multiplexing



EuroDOCSIS (1)

Short overview

- DOCSIS 2.0
  - Downstream: max. 50 Mbps **per User (FDM)**
  - Upstream: max. 32 Mbps **for all Users (TDM)**
- DOCSIS 3.0
  - Downstream: max. n * 50 Mbps **per User (FDM / channel bonding)**
  - Upstream: max. n * 32 Mbps **for all Users (TDM / channel bonding)**
- DOCSIS 3.1
  - No channels any longer (DS: 6 – 10 Gbps, US: 200 Mbps – 1 Gbps)
  - **FDM** on Downstream and **Upstream**

EuroDOCSIS in detail

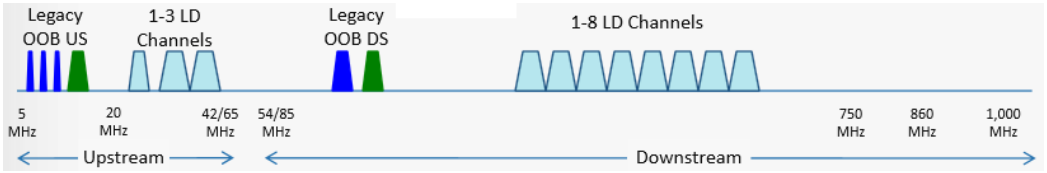
			TODAY	
Category	**Property**	**EuroDOCSIS 2.0**	**EuroDOCSIS 3.0**	**EuroDOCSIS 3.1**
Common	Launch date	2001	2006	2013 - 2016
Downstream	**typical offer per customer**	**2 Mbps**	**16 – 100 Mbps**	**1 – 6 Gbps (up to 10+ Gbps)**
	Bandwidth	112 – 858 MHz	112 – 858 MHz (must) 85 – 999 MHz (may be)	1st Step: 112 – 1002 MHz (6 Gbps) 2nd Step: 112 – 1200 MHz (7+ Gbps, amp upgrade) 3rd Step: 200 – 1700 MHz (10+ Gbps, tap upgrade)
	Bandwidth per channel	8 MHz	8 MHz	200 MHz OFDM block spectrum 20 – 50 KHz subchannels
	Max. nominal data rate (per channel)	~37 Mbps (64 QAM) ~50 Mbps (256 QAM)	m * 37 Mbps (64 QAM) m * 50 Mbps (256 QAM)	no channels anymore
Upstream	**typical offer per customer**	**128kbps**	**1 – 6 Mbps**	**100 Mbps (up to 1 Gbps)**
	Bandwidth	5 – 65 MHz	5 – 65 MHz	1st Step: 42/65 MHz (200 Mbps) 2nd Step: 85 MHz (400 Mbps) 3rd Step: ~230 MHz (1 Gbps)
	Bandwidth per channel	0.2 – 6.4 MHz	0.2 – 6.4 MHz	OFDM block spectrum
	Max. nominal data rate (per channel)	~32 Mbps (128 QAM)	m * 32 Mbps (128 QAM)	no channels anymore

DOCSIS Migration path (1)

- EuroDOCSIS 3.1 migration path

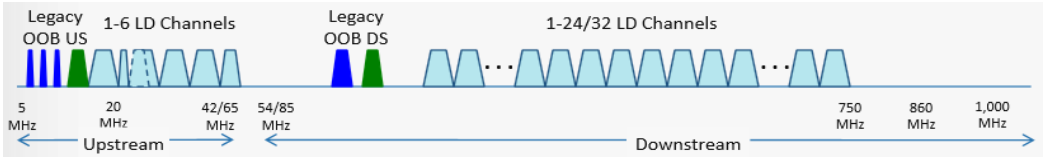
Today

- M-CMTS
- DOCSIS 1.x,2.0,3.0 mix



2015+

- M-CMTS or CCAP
- DOCSIS 2.0,3.x mix
- Deploying 3.1 CMs in LD mode

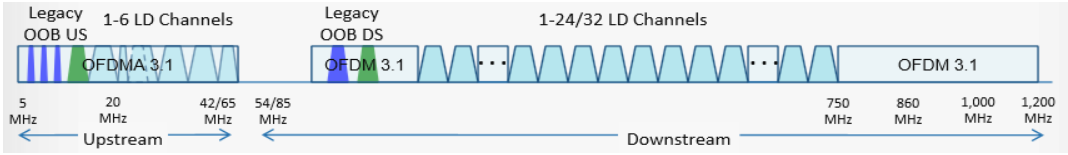


DOCSIS Migration path (2)

- EuroDOCSIS 3.1 migration path

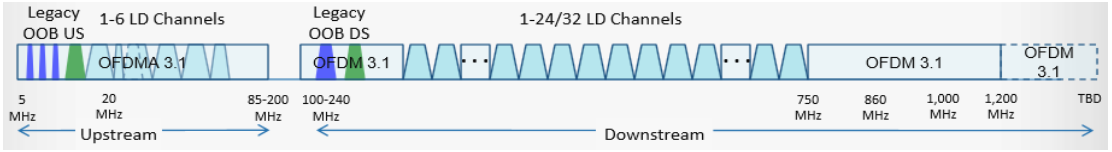
Future

- M-CMTS and CCAP coexist
- DOCSIS 2.0,3.x mix
- Beginning of OFDM

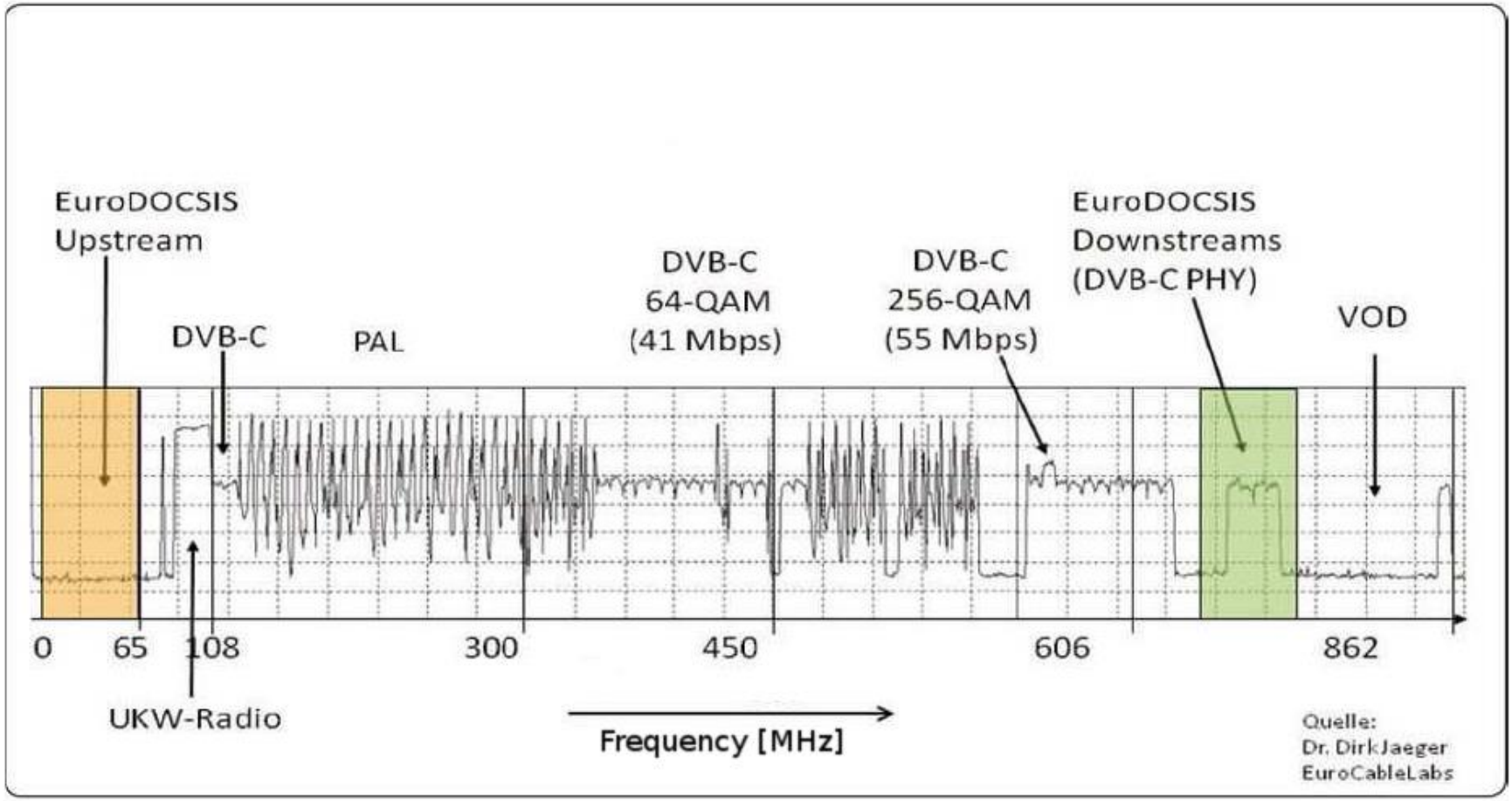


Long Term

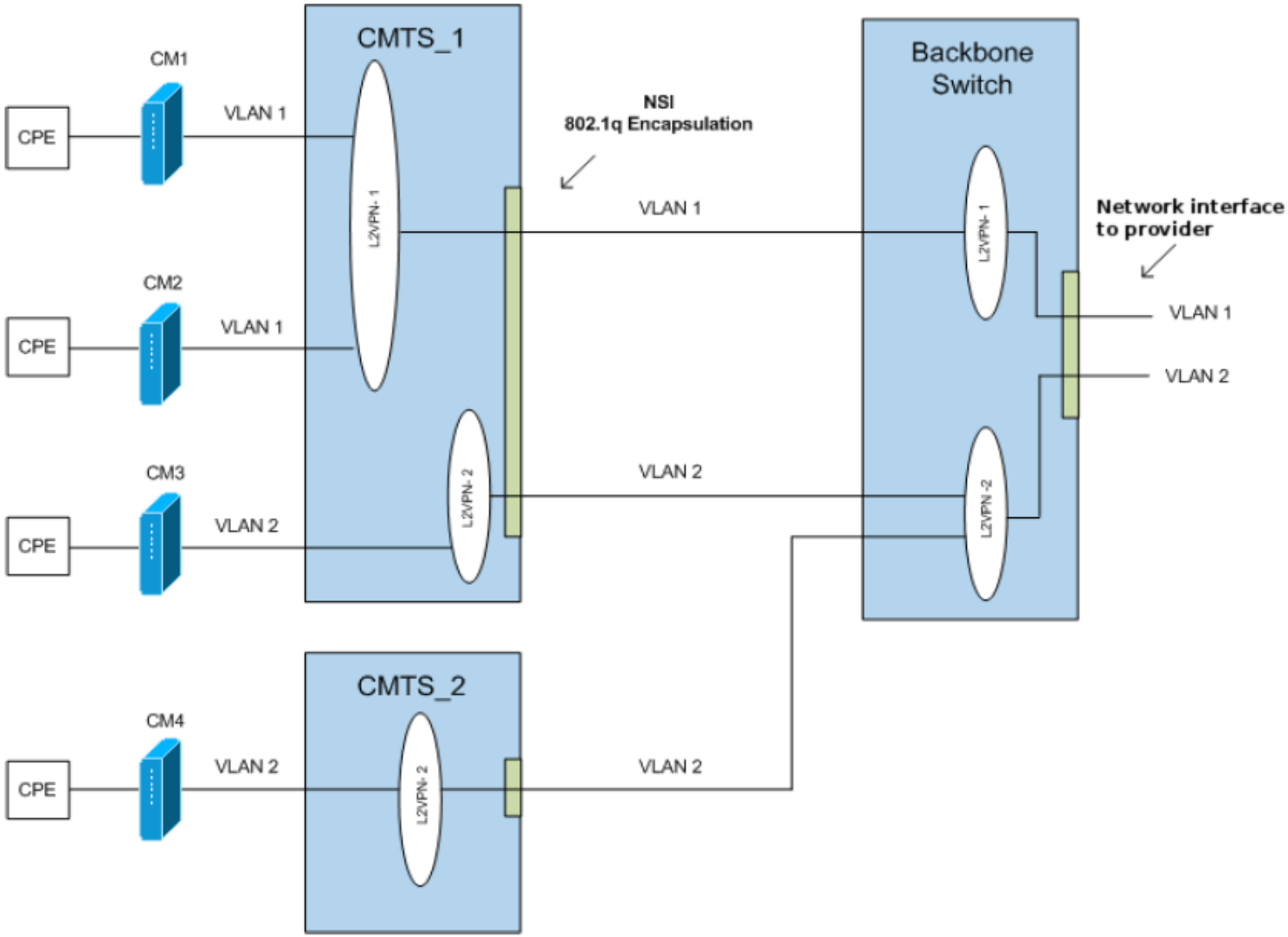
- 3.x CCAP only
- Up to 1700 MHz bandwidth
- Reducing 2.0 equipment



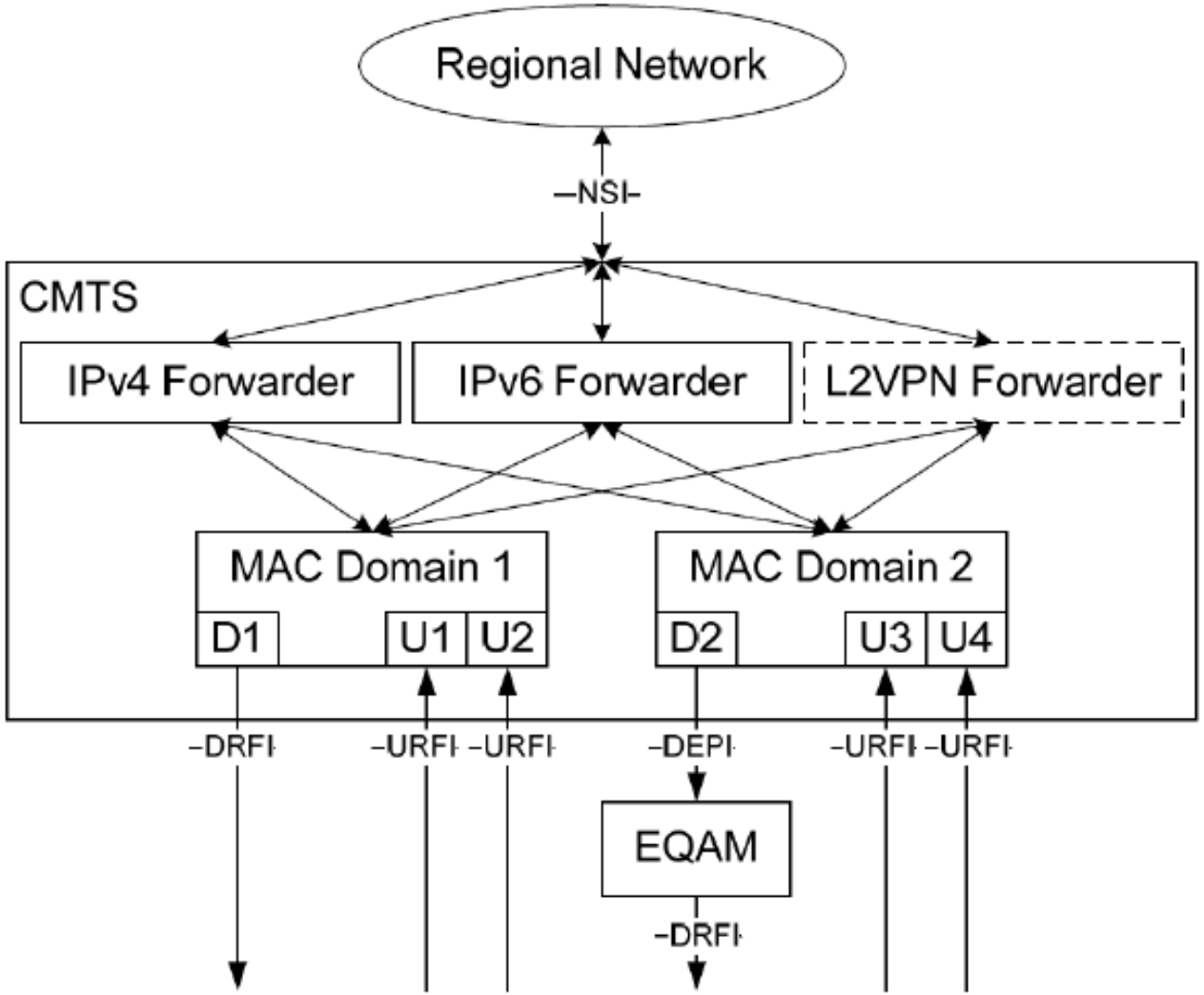
Cable network frequency spectrum by example



L2VPN BSoD


CMTS_1
CM1
CPE
VLAN 1
L2VPN- 1
NSI
802.1q Encapsulation
VLAN 1
Backbone
Switch
L2VPN- 1
Network interface
to provider
VLAN 1
VLAN 2
CM2
CPE
VLAN 1
CM3
CPE
VLAN 2
L2VPN- 2
VLAN 2
L2VPN -2
CMTS_2
CM4
CPE
VLAN 2
L2VPN- 2
VLAN 2

L2VPN forwarding inside a CMTS



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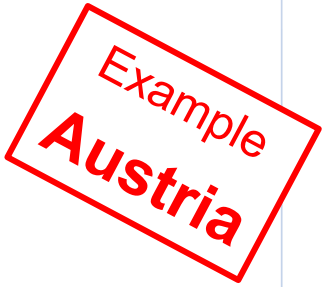
Evaluation criteria for being VULA capable are todays best pratice approaches accepted by EC

- Local
- Service agnostic
- Uncontended product
- Sufficient control of the access connection
- Control of customer premise equipment

- Access to features of business processes, ancillary services, IT-Systems

So far VULA definitions had been a compromise of technical capabilities and obligations in order to enable faster broadband roll out and coverage compared to FTTH P2P, meeting DAE targets

Taking the Austrian VULA definition as EU‘s best practice check list



- Layer 2 product with Ethernet interface
- Handover at MDF location, offer for all access lines of the MDF, higher level handover as volunteer option
- Harmonized characteristics, covering all NGA variants (FTTx)
- Multicast enabling
- CPE is provided by wholesale seeker
- Contention rate is determined by wholesale seeker
- Last Mile status analysis enabled for wholesale seeker
- Traffic handover on behalf of third parties is admitted
- Detailed protocol specifications, i.a. for VLAN handling (e.g. VLAN tagging for S and C-VLAN, Ethernet Frame size > 1560 bytes, …)
- Process quality surveillance by KPI-Definition/ -Monitoring

The Explanatory Note WLA conditions are weaker

Check DOCSIS 3.0/ 3.1 against Checklist (Austria)

Layer 2 product with Ethernet interface	L2 BSoD optional, IP always
Handover at MDF location, offer for all access lines of the MDF, higher level handover as volunteer option	CMTS location coverage
Harmonized characteristics, covering all NGA variants (FTTx)	no, see 1
Multicast enabling	only when no L2VPN
CPE is provided by wholesale seeker	√
Contention rate is determined by wholesale seeker	determined within given budget
Last Mile status analysis enabled for wholesale seeker	√, in principle
Traffic handover on behalf of third parties is admitted	√
Detailed protocol specifications, i.a. for VLAN handling (e.g. VLAN tagging for S and C-VLAN, Ethernet Frame size > 1560 bytes, …)	limited, systemdepend.
Process quality surveillance by KPI-Definition/ -Monitoring	√

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Original questions 26.5.2014 (Q 1)

Which other other (compared to Belgiums resale and Denmarks IP bitstream with central handover), maybe more advanced, forms of cable access are technically feasible within the next 4 years (on docsis 3.0 as well as on docsis 3.1)

- The Dutch HFC-network consists out of Regional Centres (RC's) and Local Centres (LC's). According to Dutch cable companies it is impossible to offer access on these locations to alternative operators.
  - The Cable Modem Termination System (CMTS) is placed on RC's or sometimes on LC's. The CMTS would make it impossible to have more operators active on the same access network.
  - The expectation is that it is impossible to relate incoming traffic to the origin of the traffic, which makes it impossible to distinguish between the originating operators and separate the traffic to different ports. According to cable operators these ports are connected via an optical network to IP Core P routers on RC's. These routers can forward these pseudowire signals only on a MPLS basis. A MPLS P router cannot end the pseudowire.
  - In addition it seems impossible to use a multi-CMTS solution within one network. Docsis and the characteristics of the broadcast network make it impossible to distinguish the traffic per connection en send it to the right CMTS.
  - A solution lower in the network, on the level of the final amplifier (eindversterker), would practically not be implementable.
  - Does WIK recognize this reasoning?

WIK view on Dutch cable company statements (Q 1)

Statement 1:

The Cable Modem Termination System (CMTS) is placed on RC's or sometimes on LC's. The CMTS would make it impossible to have more operators active on the same access network.

Explanation:

Like in most connection technologies the connection between a CMTS and a CM is a master-slave communication where the CMTS represents the master side. Having two master devices on the same network segment implies a synchronysation between them, which is not defined in the DOCSIS standard. Especially in the case of upstream management where both devices would have to work whithin the same bandwidth segment (5-65/85 MHz, edge to edge) this feature would be really required.

WIK view on Dutch cable company statements (Q 1)

Statement 2 + 3:

The expectation is that it is impossible to relate incoming traffic to the origin of the traffic, which makes it impossible to distinguish between the originating operators and separate the traffic to different ports. According to cable operators these ports are connected via an optical network to IP Core P routers on RC's. These routers can forward these pseudowire signals only on a MPLS basis. A MPLS P router cannot end the pseudowire.

In addition it seems impossible to use a multi-CMTS solution within one network. Docsis and the characteristics of the broadcast network make it impossible to distinguish the traffic per connection send it to the right CMTS.

Explanation:

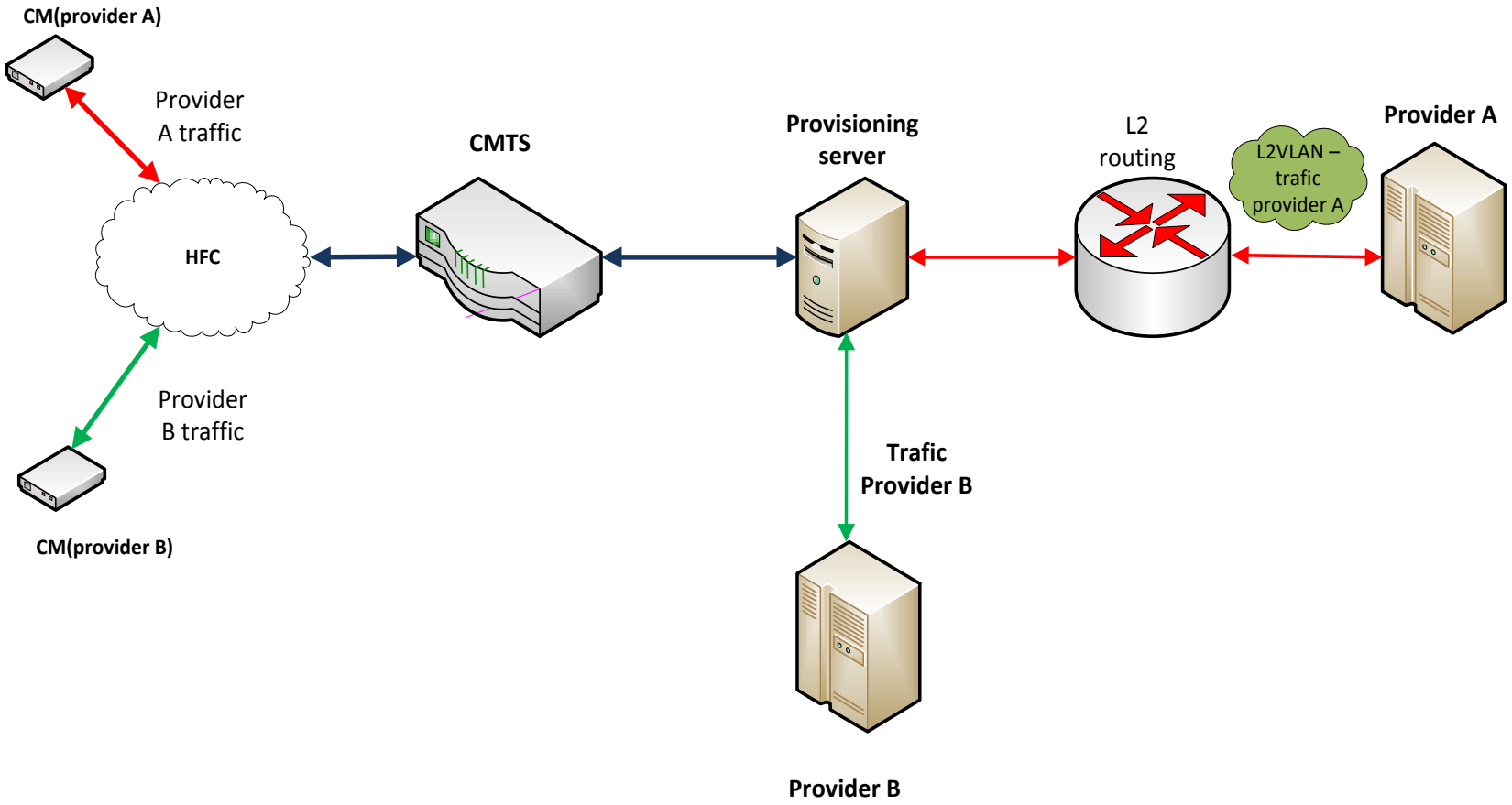
A solution based on frequency separation between the different providers CMTSs might be technical possible, but is not defined or even mentioned in the DOCSIS standard. Providers trying to do this will face different problems like a shared upstream bandwidth segment or CMs scanning the same bandwidth segment for downstream channels. Conflicts in frequency space for future DOCSIS 3.1 upgrades.

A separation of the traffic can be done at the level of provisioning server that provides authentication at the MAC layer addresses, and direct the traffic at L2VLAN (MPLS) level to the provider which manages the specific devices (CM`s).

WIK view on Dutch cable company statements (Q 1)

Drawing for explanation (statement 2 + 3)

Simple block diagram how to organize multiple access to 1 HFC network from different providers:



WIK view on Dutch cable company statements (Q 1)

Statement 4:

A solution lower in the network, on the level of the final amplifier (eindversterker), would practically not be implementable.

Explanation:

Amplifiers in the coaxial distribution network may affect the stability of the network as a whole (at network level L1) and are unrelated to the logical organization of network access of multiple providers (levels L2-L3).

A solution on this level would also require either a newly developed CMTS based solution at this network level or bandwidth filters and the exchange of the existing amplifiers.

Network interconnection at amplifier level would require access to each of the amplifiers, which would in fact result in infrastructure duplication down to the amplifiers and poor economies of scale.

Original questions 26.5.2014 (Q 2 + 3)

- Q2: Would it be possible to offer a layer 2 ethernet service on the Regional Centres and/or Local Centres within the cable network?

Answer: L2 Ethernet level access to regional and local CMTS is not difficult today. This is organized by VLAN access, which is supported by an overwhelming majority of CMTS.

All cable modems operating at standards DOCSIS 3.0/3/1 support VLAN technology as well.

- Q3: Are there forms of non-overbooked (1:1) cable access possible?

Answer: Technically this is possible due to QoS mechanisms in CMTS (like statically assigned bandwidth in the upstream, UGS). But often current cable network segments have up to 800 CMs and more sharing the same coax cable segment using up to 12 bonded channels for downstream traffic transport.

In such a case 800 CMs share a bandwidth of 12 * 50 Mbps = 600 Mbps.

Original questions 26.5.2014 (Q 4)

- Q4: Are alternative operators able to implement their own multicast streams in the cable network? If so, what does this mean for the division of spectrum between telecom operators?

Answer: A broadcast organization via multicast can be implemented as described above to access via the VLAN (multicast streams encapsulation in DOCSIS) or using Edge-QAM technologies. VLAN will share the same spectrum by all operators. In that case multicast streams will be transformed to unicast streams.

Using Edge-QAM method will require additional capacity (use of additional frequencies/ spectrum, additional equipment) in the network, which is not always easily realizable in individual cases, and require additional financial investment of the owners of the network (e.g. amplifiers).

Original questions 26.5.2014 (Q 5)

- Q5: Are alternative operators able to use their own type of customer modems when they use this kind of access to the cable network?

Answer: With CMTS operating DOCSIS 3.0/3.1 technology operators can use any cable modem that supports this technology, regardless of the supplier/ manufacturer. There may be restrictions regarding additional operator specific network management features implemented in the cable modems.

There is only a difference in the versions of the implementation - Eurodocsis / Docsis.

DOCSIS standard developed under the standard TV NTSC operates with 6 MHz channel bandwidth, while Eurodocsis operates 8 MHz channel bandwidth. These are not compatible to each other.

Original questions 26.5.2014 (Q 6)

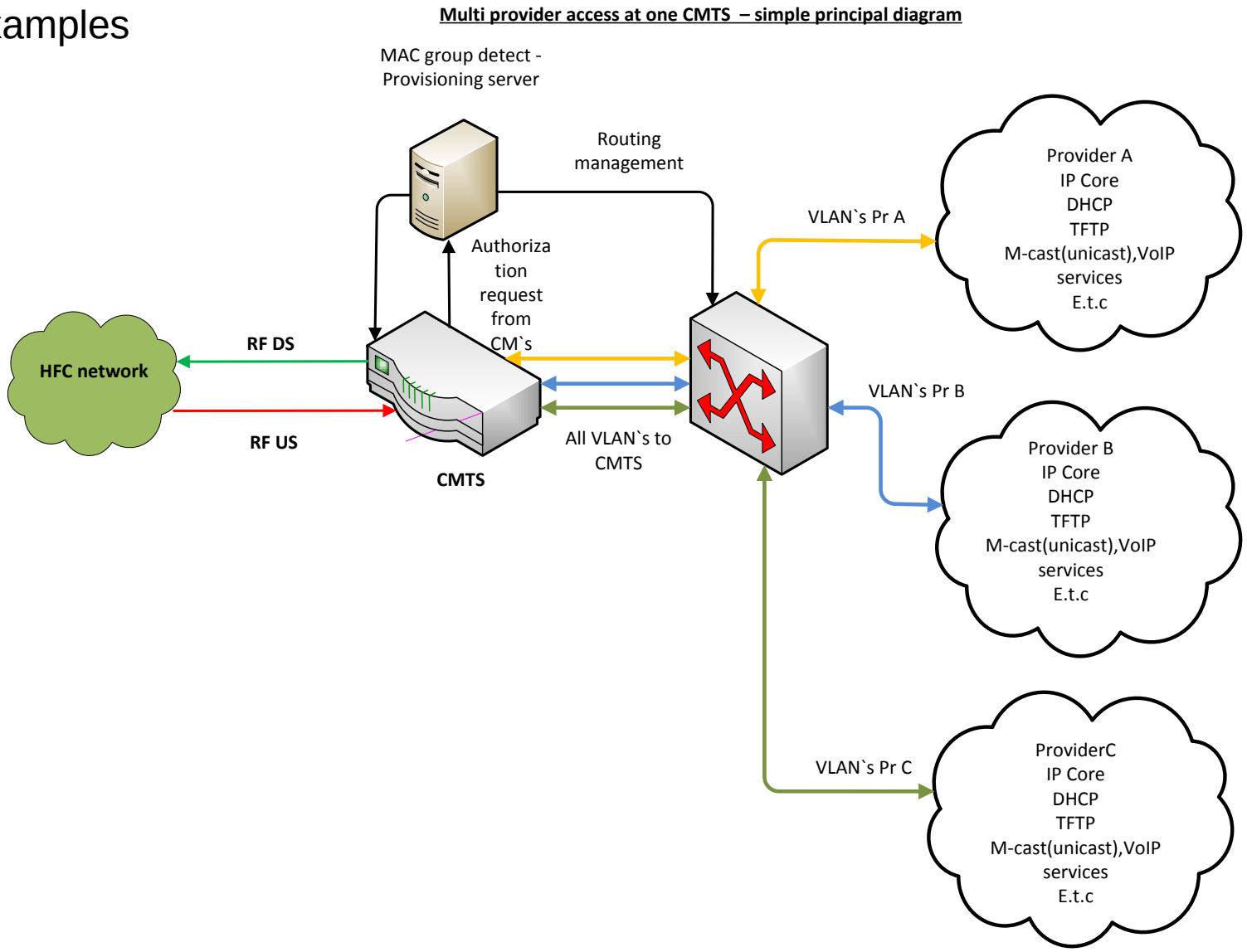
- Q6: If this form of cable access leads to necessary adjustments (network locations, equipment, IT-systems), what costs and effort do these adjustments require?

Answer: When implementing various access providers to the same network segment will require high-speed connections between the operators themselves involved in the process (to ensure traffic from own services, billing data, QoS, etc.). Ensure filtering MAC addresses and redirect traffic to the correct provider, calculating peak loads of the network, adjust the overall quality of service policy. This question is quite capacious and largely depends on the hardware organization infrastructures of providers, hardware and logical organization of the entire IT networks.

This requires a detailed project design and in this part of the cover is not possible.

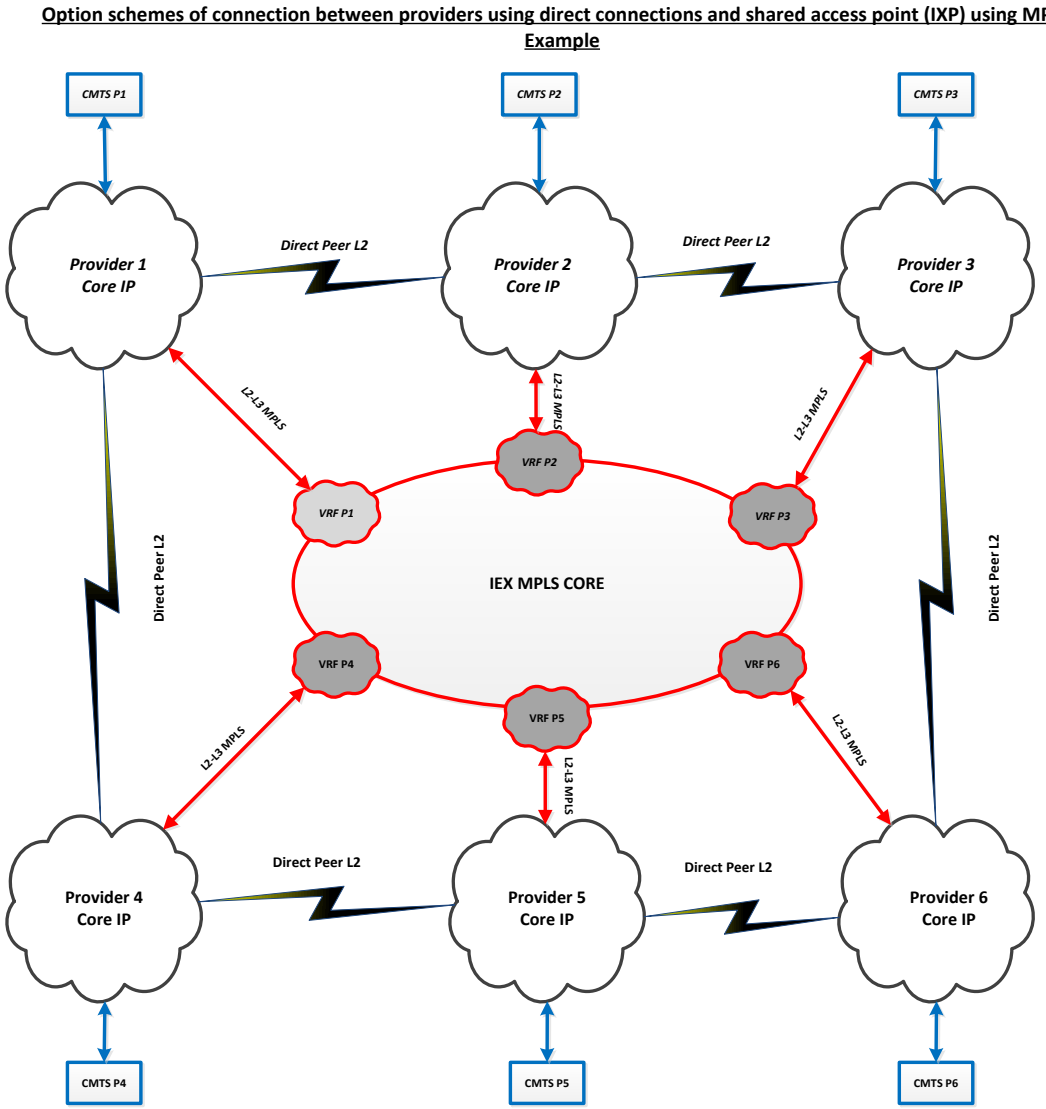
Original questions 26.5.2014 (Q 6)

Examples



Original questions 26.5.2014 (Q 6)

Examples



Original questions 26.5.2014 (Q 6)

- Q6: …, what costs and effort do these adjustments require?

Answer: IP or VLAN interconnection require additional interfaces towards the operators CMTS, e.g. an additional router / switch. The wholesale seeker has to physically collocate at the regional/ local CMTS centers and terminate their network there or the network interconnection will be provided by a backhaul line provided by the network operator at a wholesale customer site (customer sited collocation).

Original questions 26.5.2014 (Q 7)

- Q7: To what extent are the forms of access mentioned before possible on (V)DSL-networks?

Answer: IP-based and Layer 2 VLAN (tagging) based access are both possible on (V)DSL-networks. Both are standard in today‘s VULA definitions. Frequency division based access is not possible with (V)DSL technologies.

Additional questions 13.6.2014
Q1: Unicast and multicast streaming (1)

- Q: What are the possibilities for i. Class of Service and/or ii. Quality of Service for both unicast and multicast tv streams on cable networks?
- A: In earlier versions of the DOCSIS standard (1.1 and 2.0) QoS was introduced using the concept of service flows. Service Flows can been seen as „tubes“ between a CM and a CMTS (a bigger tube transports more data at a time).
- SF types
  - Best-efford
  - UGS (offers CBR by using fixed packet sizes / rates)
  - RTPS (using unicast polls to query modems for bandwidth needs)
- Multicast is managed via IGMP
  - No specific DOCSIS 1.x / 2.0 support

Q1: Unicast and multicast streaming (2)

- Q: What are the possibilities for i. Class of Service and/or ii. Quality of Service for both unicast and multicast tv streams on cable networks?
- A: DOCSIS 3.0 adds several multicast features
  - Source specific multicast (SSM)
  - Enhanced Multicast Authorization
  - Multicast QoS
    - Downstream Service IDs for multicast packets
    - Group Service Flows
    - Group Classifier Rules
  - IPv6 multicast support
  - Multicast PHS (ability to suppress multicast packet headers)

Q2: Guaranteed bandwidth

- Q: In case a guaranteed bandwidth is possible on cable networks: which part of the traffic can be transmitted on this guaranteed bandwidth without negatively affecting the other traffic?

- A: In current DOCSIS networks a guaranteed bandwidth could be realized with an UGS-type service flow. Any traffic assigned to this service flow is transported at a constant bit rate (CBR).
  Due to this solution is a static bandwidth reservation within the shared bandwidth for all CMs other traffic is always being negatively affected.

Q3: Layer 3 multicast product

- Q: Is it possible for access seekers to realize a layer 3 multicast product on the basis of a layer 2 wholesale product?

- A: Considering that multiple service providers share the same network segment on a layer 2 tunneling base (BSoD L2VPN) the DOCSIS multicast mechanisms do not work, due to the fact that the CMTS is not aware of the transported / tunneled traffic. As a result multicast signals will be transformed to unicast signals on that cable segment.

  On the other hand per user bandwidth is heavily increasing on cable networks. Considering this a layer 3 multicast product like tv streaming might be possible in the future based on statically assigned per-user-bandwidth.

  As an alternative solution tv multicast streams might be provided by incumbent cable operator on subcontract basis (Resale).

Q4: Shared CPE-specifications

- Q: Which (Docsis) CPE-specifications should (at least) be shared with access seekers by a wholesale cable access supplier to enable the access seeker to use its own CPE?

- A: From the DOCSIS standard view, there is no need for sharing CPE-specifications. The access seeker is able to use any CPE he/she needs.

  Sharing specifications might only be needed for services on a reselling base (like IPTV or VoD services that are technically provided by the wholesale cable access supplier).

Q5: MPLS and 802.1q

- Q: Besides MPLS which other options are there to split wholesale traffic to different interfaces/interconnection points of different wholesale providers on the CMTS?
- A: Regarding current CMTS equipment not all hardware manufactors support MPLS (not mandatory). Alternatively IEEE 802.1q encapsulation is supported by all hardware manufactors that support BSoD.

Q6: Development of cable networks

- Q: What are the main (technical) developments with respect to BSOD (business services over Docsis)? If there is currently no guaranteed non-overbooked cable access possible, will developments by CableLabs with respect to BSOD realize this form of access? Do you expect that this will be realized any time soon?

- A: The current focus at CableLabs is on the DOCSIS 3.1 rollout, not on BSoD. The DOCSIS 3.1 standard itself is mainly focused on hardware (and bandwidth management).
  A development of non-overbooked cable access depends on a huge amount of fibre node splits and a rollout of DOCSIS 3.1 equipment on the one hand and on a reorganization of the cable channel matrix (e.g. analog TV channel meltdown, bandwidth extension) on the other hand. These steps are cost-intensive long term tasks towards a NGA.

- CableLabs and the DOCSIS standard will address the cable network operators needs on their way towards that NGA. So the focus is on the cable network operators (cable access suppliers).

Q7: S- and C-VLAN tagging

- Q: To what extent is S- and C-VLAN tagging possible on a cable wholesale product ?
- A: The only mandatory transport mode mentioned in the DOCSIS BSoD standard is using IEEE 802.1q encapsulation with P2P forwarding. In this mode the S-VLAN ID is used by the cable network operator to route the VPN traffic through the network. Only the C-VLAN can be used by ISPs and other access seekers. It has to be taken care of the maximum Ethernet packet size allowed with BSoD if C-VLAN tags are used.

Q8: Interconnection at CMTS-locations (1)

- Q: Do you expect that it will be feasible to realize wholesale access on cable networks by implementing interconnection for alternative operators on CMTS-locations? What are your initial views on this matter with respect to the necessary investments by cable operators and access seekers?

- A: IP or VLAN interconnection requires additional interfaces towards the operators CMTS, e.g. an additional router/ switch. The wholesale seeker has to physically collocate at the regional/ local CMTS centers and terminate their network there or the network interconnection will be provided by a backhaul line provided by the network operator at a wholesale customer site (customer sited collocation).

Q8: Interconnection at CMTS-locations (2)

- Q: Do you expect that it will be feasible to realize wholesale access on cable networks by implementing interconnection for alternative operators on CMTS-locations? Shared coax-cable access: What are your initial views on this matter with respect to the necessary investments by cable operators and access seekers?

- A: Using a shared connection on a cable is similar to using the air as medium. Disregarding that this solution is not covered by the DOCSIS standards and might be technically impossible with the current hardware equipment, such a solution needs a lot of trial and error investigation in each CMTS-location for both, the cable operator and the access seeker. Both parties have to syncronize their services at least on the OSI layers 1-2/3 for CMTS and cable modems.

- **E.g. especially in the upstream bandwidth both CMTS have to work in the range from 5 – 65 MHz (edge to edge), which is impossible.**

Additional Question (17.06.2014): Number of IP voice channels (1)

- Q: We would like to discuss briefly whether the shared nature of cable access networks and requirements regarding quality of service limit the number of IP voice channels a cable operator can simultaneously offer. Cable operators sometimes state that they cannot serve business clients with a demand for more than 2 voice channels on their cable networks, only on their fiber networks. This does not seem logical, as a voice channel does not require much bandwidth.
  How does WIK view these and what factors would limit cable companies to increase the number of voice channels on their cable networks?

- A: Regarding voice services the bandwidth is only one of the limiting factors. Voice data have to be delivered „in time“, so that additionally delay and jitter (clock fluctuation) have to be regarded.
  Having in mind that voice services are synchronous services these limiting factors apply on upstream and downstream. Whereas this is often not a big problem in the downstream the upstream lags of both, huge bandwidth and low delay/jitter due to its TDM based nature.

Number of IP voice channels (2)

- **A simple example calculation**
  - 1 upstream channel (= 30,72 Mbps)
  - 50 % reserved for voice data (typical) (= 15,36 Mbps)
  - 2 telephone lines per user (100kbps per line)
  - **=> ca. 78 end users (non-overbooked)**
  - Typically a coax network segment is shared between 500 – 2500 users

Agenda

- Market definitions and VULA
- Characteristics of CA-TV networks
  - DOCSIS 3.0
  - DOCSIS 3.1 and future developments
- Evaluation regarding VULA
- ACM Questions
- Summary

Summary

- DOCSIS is a very powerfull technology enabling high bandwidth, also enabling layer 2 services for business customers (BSoD)
- There is a wide spectrum of technological options, which are not in the focus of the suppliers and standards so far
- DOCSIS (3.0/ 3.1) so far is not intended to support wholesale services in a VULA manner, but may be developed towards such features, if there is demand for it
- Demand may be caused by cable-TV network operators who want to offer wholesale access services in a VULA quality; unsure, if the operators develop into that direction.
- Demand will not be stimulated by the regulatory objective to regulate SMP.

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