Securing Europe's Cable Future

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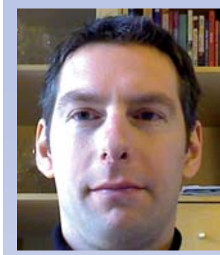
Immediate development of a next generation HFC solution is needed to secure the future of European cable networks.

Jan de Nijs

Jan de Nijs is currently working in the area of cable and WiMAX networks and infrastructures. He has a Masters degree in Theoretical Physics and a Ph.D. in Applied Physics. After a professional career of a decade in semiconductor technology, he joined the Wireless Communications Group of the Technical University of Delft in 1998.

In 2001, he started working at TNO Information and Communication Technologies as a senior consultant in access networks with a focus on cable and fixed wireless (WiMAX) networks. He is charged with the development of innovation projects in these areas. Besides these activities, Jan acts as a senior consultant on cable networks, migration strategies and radio spectrum management issues.



Tim Gyselings

Tim Gyselings received a Masters of Science degree in Electrical Engineering from Ghent University in 1995, and obtained a PhD at the same university in 2000 for his work on optical crosstalk in all optical cross-connects.

In 2000, he joined the Research & Innovation department of Alcatel in Antwerp. From 2007 onwards, he has been a member of Bell Labs in Antwerp. His research work focused on different aspects of fixed access technology, including research on different kinds of Passive Optical Networks (PON), access nodes, service enablers in access, packet processing and Hybrid Fiber Coax networks (HFC).

Carsten Engelke

While studying Telecommunications at Gerhard Mercator University (graduating with a diploma in electrical engineering) Carsten Engelke worked not only with Ericsson in the GSM Systems' department but also at Fraunhofer Institute (FhG), Duisburg on micro-electronic circuits and systems where he developed, designed and tested hardware circuits based on CMOS technologies with the Cadence Design Framework.

In 1996 Engelke joined URBANA Telecommunication, a cable operator in Hamburg. Here, he developed interactive services based on CATV networks and took part in different international standardisation bodies for strategic product development. His core skills were the Internet, DVB and telecommunication services. After the merger of URBANA Telecommunication and Tele Columbus and the transfer to Deutsche Bank Investor in 1999, Engelke worked with Tele Columbus Holding in Hannover. He was assigned the position of Project Director to develop Triple Play services based on CATV Networks and reported directly to the Board of Managing Directors. From 1999 to 2002, he was one of ten industrial representatives in G8 meetings dealing with security in cyberspace based as part of the Lyon Group. Nowadays, he still takes part in European expert meetings of the European Commission.

Since 2003, Engelke has served as Technology Director for the ANGA Association of German Cable Operators.

Since the very first network roll-outs, cable operators have proved their capability to closely follow market developments: every time that the network capabilities started falling back on consumer requirements, the networks were successfully upgraded. As such, operators are familiar with upgrades, considering network upgrades as part of the business.

Currently, a large palette of evolutionary solutions for capacity expansion and capacity saving is being developed and introduced, such as Universal EdgeQAMs, Switched Digital TV, H.264 coding and DOCSIS 3.0 whereas new solutions like DVB-C2 are progressing well. As in the past, operators will implement these technologies to prepare their networks for continued competition from DSL networks.

Nevertheless, despite this rather comfortable position, operators should be alert; they should regularly evaluate their (future) network capabilities against market expectations in a timely fashion to identify risks and develop appropriate counter solutions. Such alertness appears even more crucial given the large variation amongst European networks and regional market conditions. These network and market variations, in combination with the palette of evolutionary upgrade and capacity saving solutions, could easily mask the need for a new and future proof next generation HFC network solution.

In this article, we will investigate the issue in more detail. We will argue that the need for a next generation HFC solution is not acute; however, immediate development of such a next generation HFC solution is needed to secure the future of European cable networks.

Assessing operator requirements

In the FP7 ReDeSign project, we are addressing the evolution of HFC networks. To provide a firm basis, we started the study with an assessment of the future business requirements of operators together with an inventory of European cable networks. An extended questionnaire was sent to 62 operators, of whom 21 returned the completed document. This response provides a detailed and representative overview of:

i) the current status of the networks

ii) the preferences and limitations regarding technical upgrades

iii) the expected development of the services portfolio and capacity requirements.

This data allows an evaluation of the network capabilities against market expectations, as already mentioned. In this contribution, we will share the high-level results of these studies thus providing an up-to-date picture of the positioning of HFC networks and their expected evolution to serve the future market.

Upgrade option	Rating
Network segmentation	8.1
Statistical multiplexing	5.6
Analogue switch off	5.3
Better modulation codes	5.0
QAM sharing	4.,9
Switched digital TV	4.5
Extension up to 1 GHz	3.2
Extension beyond 1 GHz	2.9

Table 1: Average rating (Scale 1-10) evolutionary upgrades technologies

In the survey operators were asked to indicate their preferences on the options to create more network capacity for digital services and to use the network more efficiently. The average rating of the possible upgrades as provided by the operators is shown in Table 1. H.264 coding was not included in the questionnaire because its deployment appears inevitable.

Clearly, splitting of the optical nodes is by far the most preferred option to expand the network capacity. Next follows a number of options with an approximately comparable rating. The table shows furthermore that extension of the frequency spectrum is considered least attractive.

Next, the operators provided data on services that they foresee and the market penetration of such services for the near term (1-2 years) and more distant future (2-5 years and 5-10 years). Data such as the numbers of analogue channels, of broadcast SD TV and HD TV channels, switched SD TV and HD TV channels as well as the channels allocated for VoD services were given in combination with the expected subscription figures.

Although the data was not fully complete, it allowed the formulation of a good estimate of the future network capacity needs.

To determine whether the evolutionary network upgrade and capacity-saving solutions will suffice we have to match, on the one hand, the required capacity to deliver the services (assuming that solutions to save capacity are implemented in a timely fashion) and, on the other hand, the potential capacity of the network when implementing the various network upgrades. The result of such an exercise is shown in Figure 1.

Since operators have a clear preference for further segmentation of the optical nodes, this figure shows the capacity required per fiber node to offer the (average of the) foreseen services in case of a maximum splitting of the existing nodes.

To account for the large spread of the current node size among European cable networks, and the future node sizes after a complete segmentation, we calculated the required capacity per node for nodes of 600 HP (Homes Passed) and 200 HP.

The 600 HP case refers to those networks with large nodes of 2000 HP or more, which are most representative for the European case. For the minority of the European HFC networks with small nodes of less than 1000 HP, the 200 HP scenario is applicable.

To properly account for the migration from MPEG-2 to H.264 encoding we have assumed that standard TV broadcast is MPEG-2 encoded whereas HDTV, VoD and Switched Digital TV (the new services) will be H.264 encoded. Other capacity saving options, such as the deployment of switched TV, are also taken into account from the data supplied by the operators.

Apart from the ultimate node size, the downstream high-frequency edge is an equally important network parameter that limits the network capacity. For direct comparison with the existing downstream frequency spectrum, we have indicated the capacity per fibre node for a frequency edge of 550MHz and 862MHz respectively. In addition, we have calculated the network capacity assuming that the existing DVB-C channels are gradually replaced by DVB-C2 QAM 1024 modulation while analogue channels that are shut down are replaced by DVB-C2 QAM 4096 modulation. Thus, the RF power budget of the HFC network is not violated.

The data in Figure 1 shows that the capacity of the HFC networks is sufficient to meet the currently foreseen market demand, as indicated by the operators, provided that the network upgrades and capacity-saving solutions are appropriately implemented in a timely fashion. For networks with a frequency edge of 550MHz or less, the upgrades should include an extension of the frequency range toward 862MHz.

Although the above analysis indicates that the HFC networks potentially can provide the capacity to serve the markets for another ten years, one has to be aware that these results reflect the averaged business and network environment of all operators that responded to the questionnaire. When applying the results to one's specific situation, one should take notice of the following possible complications:

- The above data reflects the average capacity demand. The response of the operators showed a large variation regarding the future capacity demands associated with the different market situations; some markets prove more demanding whereas others are less demanding.

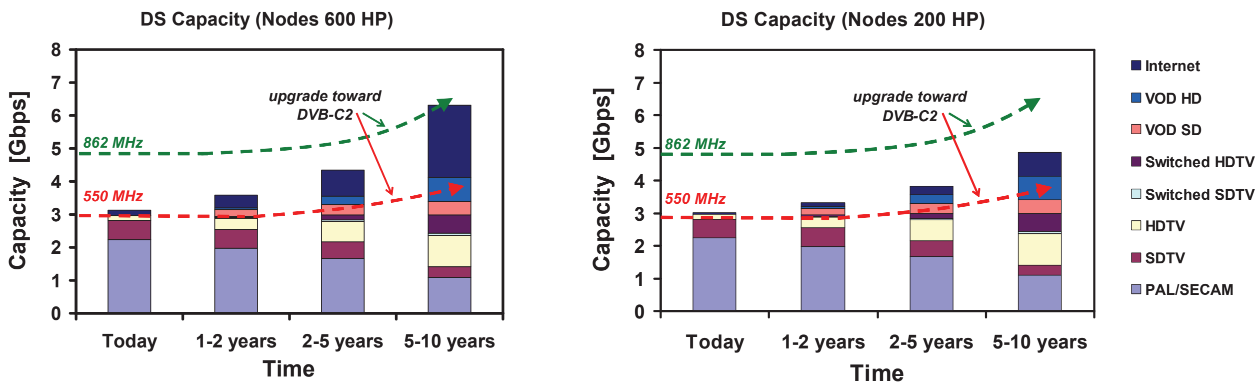


Figure 1: Potential network capacity per fibre node (nodes of 600 HP and of 200 HP) for a network with 550MHz and 862MHz downstream band edge versus future (average) capacity needs, assuming capacity-saving solutions are implemented in a timely fashion. The data is based on the input of European MSOs.

- For most migrations, the network will have to support both the legacy and the new technology for a transition period. These transitions are accompanied by inefficiencies that are not included in our analysis. For example, migration to H.264 video coding requires simulcast of TV channels.
- To supply the large digital capacity foreseen, vast numbers of CMTSs and EdgeQAM are needed. In our analysis, we have not taken the space and power requirements into account. Conceivably, space and power requirements might not be achievable in practice.
- The costs and investments are not considered. So, although technically feasible, we abstain from arguing that, from an economic viewpoint, upgrading is the most attractive option.

Apart from the downstream capacity, upstream capacity limitations could also become a business constraint. In Table 2, we summarize the relevant upstream network data obtained from the questionnaire. The information reveals that not all operators have yet completed the upstream channel upgrades.

For half the networks, the full frequency range up to 65MHz is not available and only in a small proportion of the networks can 64 QAM and/or a 6.4MHz channel width be deployed. The data clearly confirms the ingress noise limitation of the return path. In the best networks, typically 4 channels of 6.4MHz and 16QAM modulation can be used at most, corresponding to a capacity of about 80Mbps per segment.

In the future, when downsizing the upstream segments, 6 channels of 6.4 MHz and 64QAM modulation (equivalent to a capacity of 180Mbps per segment) can be created. The use of more than 6 channels will be difficult since it would require spectrum below 25MHz.

Upstream band feature		Occurrence
Modulation	QPSK	38%
	16 QAM	75%
	64 QAM	25%
Channel Width (MHz)	1.6	13%
	3.2	81%
	6.4	31%
Band Edge (MHz)	42	33%
	52	13%
	65	53%

Table 2: The current use of the upstream band

	Today	1-2 years	2-5 years	5-10 years
Asymmetric				
Peak bitrate (Mbps)	1.7	3.6	4	6
Overbooking	125	100	75	50
Symmetric (Mbps)				
Peak bitrate (Mbps)	20	34	42	65
Overbooking	125	100	75	50

Table 4: Evolution of the upstream capacity demand (peak bit rate) assuming asymmetrical and symmetrical (internet) services

Next, in Table 4, we list the peak bit rate of the expected upstream internet services and the overbooking factor obtained from the information provided by the operators. The overbooking factor is derived from the current upstream service demand, but reduced for the periods “1 – 2 years”, “2 – 5 years” and “5 – 10 years”.

Using this data, in combination with the subscription figures, we have calculated the future gross upstream capacity requirement per upstream segment, again assuming nodes of 600 HP and 200 HP associated with the full segmentation of the fibre nodes.

In Figure 2 and Figure 3, we map the expected market demand of the upstream capacity and the current and potential upstream network capacity. The data is rather intriguing.

If the market does not develop towards symmetrical services, the analysis shows that the networks can support future upstream service demand. However, in case of a development towards symmetrical services, a capacity shortage will develop for networks with large nodes that cannot be split into nodes of say 300 HP or less.

Summarizing the results for the downstream and upstream network capacity, we can conclude that HFC networks that can be segmented into networks with small fibre nodes of, say, 200 HP are properly positioned to fulfil in a timely manner all market demands for the next decade. Networks with large nodes are positioned to serve the market for the next few years.

However, after 10 years, the capacity limits of the networks will be exceeded, even though all evolutionary network upgrades and capacity saving measures are implemented,

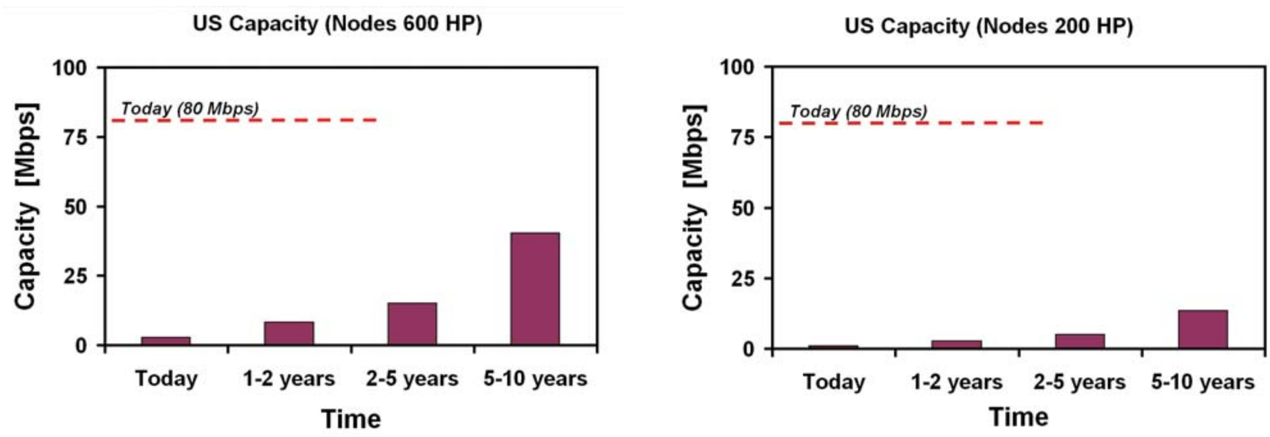


Figure 2: Future upstream capacity demand for segments of 600 HP and 300 HP, in case of an asymmetrical service demand.

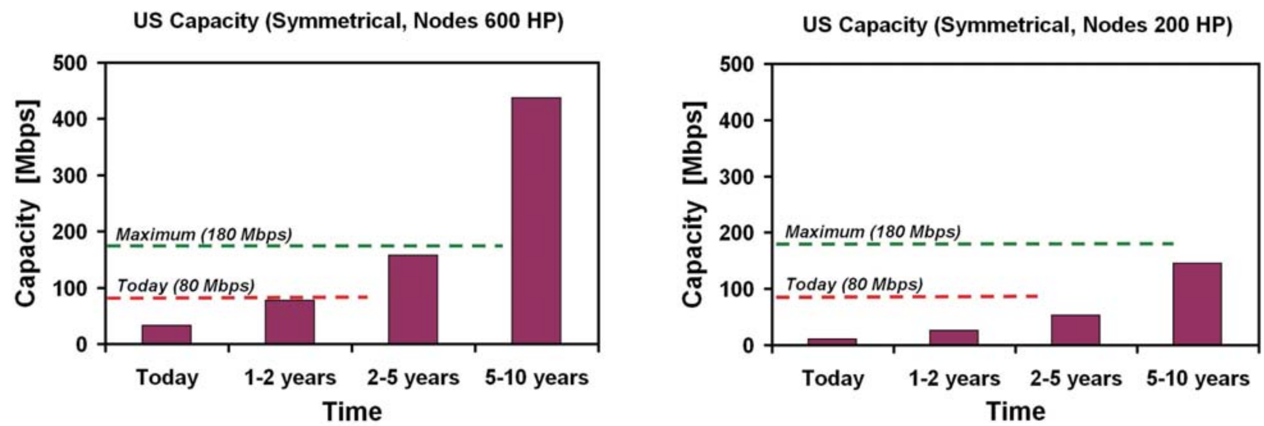


Figure 3: Future upstream capacity demand for segments of 600 HP and 200 HP, in case of a symmetrical service demand

including the extension of the downstream frequency edge up to 862MHz. Moreover, these operators also face the risk of a market development towards symmetrical services; an increased usage of P2P services and new services like video-telephony (using the HD TV set) and camera surveillance of private homes could possibly boost upstream capacity demands.

Every MSO addresses its own network migration strategy based on its current assets and the local market conditions. The analysis shows that most HFC networks may remain competitive for at least for another decade. However, networks with large nodes, representing the majority of the European market, face large and complex upgrades and it appears questionable whether these upgrades will sufficiently secure the competitiveness beyond the next decade.

In particular, splitting the fibre nodes and extending the downstream frequency edge up to 862MHz will require vast investments; investments that consequently have to be earned back in a short period, making them unattractive from a business viewpoint. For these cases, a MSO must consider the choice of a disruptive network upgrade towards a next generation HFC solution. Although such an upgrade will require a larger investment, these investments can be depreciated over a much longer period.

Unfortunately, today, there is no widely accepted next generation HFC solution or a roadmap towards this solution, and, consequently, a MSO does not have the choice between implementing all evolutionary upgrades or early migration to a next generation HFC network. Currently, an operator is forced to continue the path of evolutionary upgrades; there is no alternative.

Therefore, whilst work on next generation HFC solutions should not be postponed, immediate action is needed to secure the future of the European cable networks and business.

Acknowledgement

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