Challenges and opportunities of broadcast-broadband convergence and its impact on spectrum and network use

EXECUTIVE SUMMARY

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DG Communications Networks, Content & Technology by:

plum

farncombe
Consult • Implement • Secure • Test

Digital Agenda for Europe

This study was carried out for the European Commission by

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S1 The purpose of the study

In January 2014 the European Commission initiated a study in which it asked a team from Plum and Farncombe to consider three main issues:

- To explore future developments in the delivery of audio-visual and Internet services over the next 15 years
- To explore how these developments will impact on evolution of terrestrial wireless access networks and especially digital terrestrial television (DTT) and mobile (broadband) networks
- To assess the social and economic merit in moving to a converged platform. A converged platform is defined as a common infrastructure (such as towers and backhaul) which delivers terrestrial broadcast services, mobile broadband services and converged broadcast-broadband services using UHF spectrum.

S2 Audio visual (AV) consumption now

Traditional linear TV, viewed over a mix of DTT, satellite, and cable networks, currently dominates AV consumption. The average EU citizen watches around four hours of content in this way each day and there is little sign of change. But there are trends which might alter the situation. For example we are seeing:

- Rapid take-up of portable devices with good video-viewing capability, such as smartphones and tablets
- Growing consumption of video content on these devices out of the home and on the move
- Significant growth, albeit from a small base, of non-linear viewing over these devices via over-the-top (OTT) and catch-up services
- Significant growth in take-up of IPTV services, both as a complement and an alternative to traditional TV broadcast networks
- A move towards higher resolution formats for AV content, such as high definition (HD) and ultra-high definition (UHD), for AV content.

AV consumption varies considerably between EU member states in terms of the mix of platforms used, the structure of the value chain which delivers content and the rate of change within the market. For example the proportion of households where DTT is a primary delivery platform varies from 4% in Belgium to 80% in Greece.

We have found it difficult to quantify the current level of non-linear AV consumption and the rate at which it is growing. The information available does not measure consumption in a consistent way across different devices and delivery networks, it is readily available in only a few member states, and it is sometimes contradictory. This lack of consistent data makes it difficult to monitor trends accurately and to support well-founded policy decisions on AV markets.

S3 Technology trends

The price/performance of the networks which deliver AV content to end-users - both broadcast and broadband - will change significantly over the next decade. We expect to see:

- Big improvements in the price/performance of **fixed** broadband networks when compared with the spectrum-based broadcast networks, given historic trends and anticipated future performance gains
- Continuing limitations on the role of unicast **mobile** services relative to fixed broadband. The incremental cost per gigabyte for mobile services is one to two orders of magnitude greater than for fixed broadband. There is clearly strong and growing demand for unicast, personalised video delivery to mobile devices. But that demand will be constrained by the higher unit costs of mobile broadband delivery
- Multicast mobile services (for example based on the eMBMS standard) may also become important as a way of meeting high demand for the same video content in an individual cell or cluster of cells
- A substantial growth in the capacity, speed and reach of Wi-Fi services - both in the home and via public hotspots - as new technology Wi-Fi routers replace legacy routers in the installed base.

S4 AV consumption in 2030

Given these technology trends we expect to see:

- Fixed broadband playing a central role in the delivery of TV content by 2030. Fixed broadband will both **complement** traditional TV broadcast networks[1] and **substitute** for traditional platforms
- Wi-Fi playing a growing role in AV distribution over the rapidly growing population of tablets and smart phones – both around and out of the home. For example Wi-Fi has the potential to act as a cheap substitute for unicast mobile video in many situations – both in and out of the home.

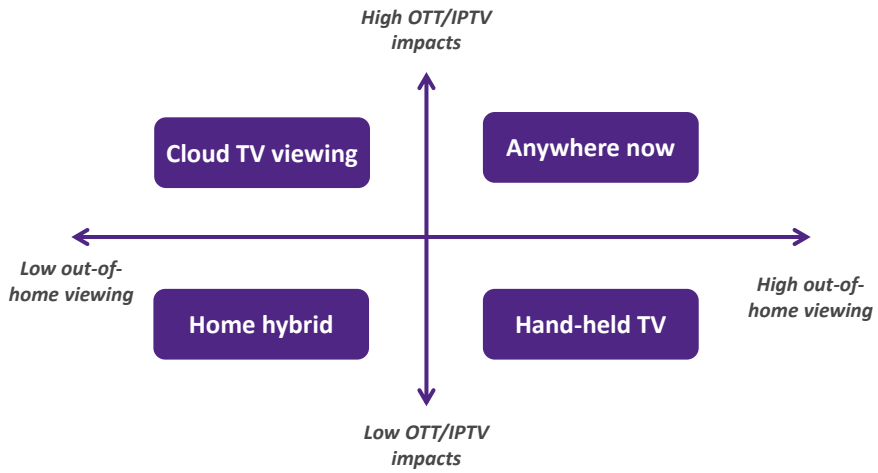
However there are big uncertainties over how AV consumption might change by 2030. For example, there are divergent views amongst stakeholders on:

- How quickly and to what extent will consumers switch from linear to on-demand viewing
- Whether DTT will retain its current position or be displaced to a substantial degree by pure OTT services or IPTV services in the average household
- The extent to which tablets will replace traditional TV sets for secondary viewing in the home
- How the balance between in-home and out-of-home viewing will change over the next 10 years.

To deal with these uncertainties we have constructed the four scenarios shown in Figure S1 for the possible states of AV consumption in 2030 in a typical member state. We consider the merits of a converged platform under each of these scenarios.

[1] To deliver hybrid services with mixed linear and non-linear TV consumption

Figure S1: Scenarios for AV consumption on 2030[2]



S5 The development of broadcast-broadband converged services

As well as substitution effects, the growing role of broadband in AV consumption is leading to convergence effects - in which complimentary combinations of broadcast and broadband services create new opportunities for value added services. We have identified four types of broadcast-broadband convergence:

- Content convergence at the device level which allows users to view broadcast and broadband AV content on the same device
- Application convergence at the device level which allows users to view broadcast and broadband AV content over the same user interface on the same device
- Service level convergence which allows end users to access the same linear and non-linear AV content seamlessly on multiple devices
- Infrastructure level convergence which uses the same infrastructure to deliver broadcast and broadband services to end users

Convergence activities are currently focused on combining broadcast and **fixed** broadband through the development of connected TVs and hybrid services like HbbTV-based services. But what is the potential to extend such convergence to combinations of mobile broadband and broadcast platforms as well?

At the content, application or service level such convergence will probably succeed or fail through normal market mechanisms. But infrastructure level convergence will need public policy interventions given current regulatory constraints[3]. So, before committing to any such initiatives, there is a need to consider the economic and social merits of a converged platform. In making that assessment we need to take account of the fact that convergence at the device and service levels is possible without a

[2] High OTT/IPTV impact – 70% reduction in DTT HH by 2030; Low OTT/IPTV impact – 10% reduction in DTT HH by 2030; High OOH viewing – 40 minutes/day/person OOH viewing on portable devices; Low OOH viewing – 20 minutes/day/person OOH viewing on portable devices

[3] For example on use of relevant spectrum and rules for DTT platforms

converged platform and that a significant proportion of the benefits of converged services can be captured without implementing a converged platform.

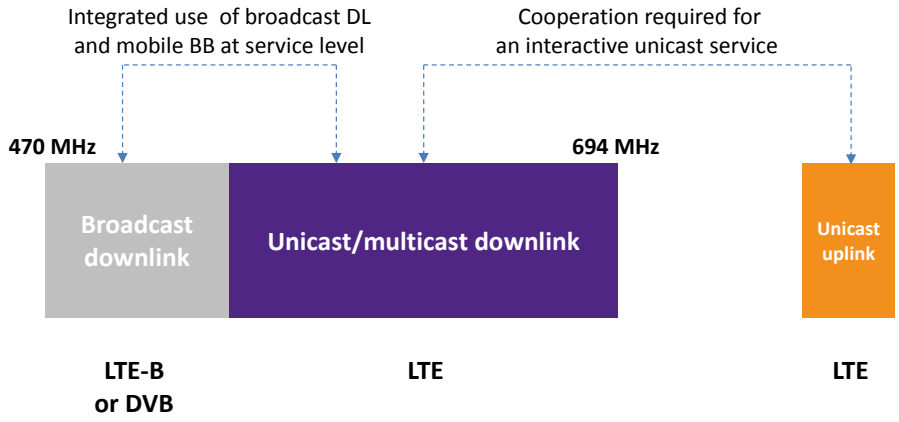
S6 Options for a converged platform

Any option for a converged platform will need to meet a number of requirements:

- To provide near universal free-to-air coverage so as to preserve the current European AV model
- To use sub-700 MHz UHF spectrum if it is to meet this requirement in a cost-effective way
- To deliver an adequate number of TV channels. The TV payload varies by member state. We have considered payloads from 60 to 180 Mbps
- To provide two-way mobile broadband services
- To free-up substantial amounts of sub-700 MHz spectrum so as to create incremental benefits which might justify the cost of transition.

After considering a number of options we selected two for detailed examination. Both involve moving from the existing high-power high tower (HPHT) DTT platform to the low-power low tower (LPLT) infrastructure of the mobile networks. Figure S2 shows how the spectrum might be used.

Figure S2: The LTE and DVB options for a LPLT converged platform



Both options involve dividing the spectrum between 470 and 694 MHz into two downlinks:

- A broadcast downlink. This might use existing DVB standards (the DVB option) or a new LTE broadcast standard (the LTE option)[4] for linear TV broadcasts
- A unicast downlink using LTE standards.

[4] 3GPP would need to develop existing the LTE standards to enable broadcast coverage in rural areas through longer cyclic prefixes, carrier frequencies to be used exclusively for a downlink, and free-to-air access for all

The unicast uplink which is needed to complement these downlinks might use spectrum at the top end of the sub-700 MHz band or higher frequencies (e.g. in the 900 MHz frequency range), depending on the business models which are developed for the licensing and use of the converged platform.

The DVB option has two main advantages over the LTE broadcast option:

- There are no upgrade costs for TV receivers
- DVB offers potentially higher spectrum efficiency (in excess of 3.5 bps/Hz compared to in excess of 2 bps/Hz for LTE). This makes migration easier and increases spectrum release

The LTE broadcast option has three main advantages over the DVB option:

- A single technology means lower cost networks and end user equipment
- A single technology means less processing required for broadcast-broadband integration of services
- It may be easier to reassign spectrum between broadcast and broadband use as market demand changes.

S7 Making the transition to an LPLT converged platform

There are a number of challenges in moving to an LPLT converged platform:

- Implementation of a converged platform is unlikely to be practicable before 2025 in many member states given:
  - The need to clear the 700 MHz band for mobile use
  - The need to migrate the HPHT network from DVB-T to DVB-T2 technology in a significant number of member states
  - The need to find a permanent spectrum home for PMSE audio use before implementing a converged platform
- There is a need to determine whether co-channel regional SFNs[5] will work satisfactorily on an LPLT network
- Simulcast spectrum will be required in the transition period so that the (old) HPHT DTT network and the new LPLT network can broadcast in parallel. It may be impossible to find the required simulcast spectrum for a member state with a high TV traffic load without a substantial temporary reduction in the TV payload
- Significant effort is also required to mitigate cross-border interference – especially in the member states which move first to a converged platform.

We have assumed in our cost benefit analysis that co-channel regional SFNs are viable with an LPLT network and that its spectral efficiency ranges from 2 bps/Hz (LTE option) to 3.5 bps/Hz (DVB option).

[5] In which adjacent regions use the same frequency to broadcast different content

With these assumptions the converged platform might free up between 110 and 170 MHz in the 470-694 MHz frequency range.

S8 The costs and benefits of a converged platform

To assess whether there is an economic case for an LPLT converged platform we have compared the net present value of the incremental costs and benefits of a converged platform relative to a counterfactual in which:

- Sub-700 MHz spectrum is exclusively used by HPHT DTT network for DVB TV broadcast
- There is commercial cooperation between TV broadcasters and mobile operators to develop broadcast-broadband converged services, with each type of supplier using its own existing network infrastructure.

Many of the benefits of a converged platform are also captured by the counterfactual (as discussed in Section S5). As such they are not incremental benefits. The main incremental benefit of an LPLT converged platform is that it frees up sub-700 MHz spectrum to use as a unicast mobile downlink. The value of this spectrum release is currently uncertain. We consider a range of values between €0.1 and €0.4 per MHz pop. In a hypothetical member state, with a population of 20 million and a population density of 250 per square kilometres, these assumptions lead to a net present value (NPV) of incremental benefits of between €265 million and €885 million. There may be additional incremental benefits from easier integration of broadband and broadcast functions on a converged platform. But there is as yet little evidence that these additional benefits would be substantial.

There are three main incremental costs for a converged platform:

- The cost of building and operating the LPLT network (less the cost of operating the HPHT network)
- The transition cost of ensuring end-users can use new platform - converting TV receivers (LTE option) and re-orienting TV aerials (both options)
- The transition costs of freeing simulcast spectrum and dealing with cross-border interference.

Figure S3 indicates under what circumstances the incremental benefits exceed the incremental costs.

Figure S3: Where do the benefits exceed the costs?

Benefits assumed at	Lower limit		Mid-point value		Upper limit	
OTT/IPTV impacts	Low	High	Low	High	Low	High
Central case (LTE option) [6]	No	No	No	Yes	Yes	Yes
DVB rather than LTE option	No	No	Yes	Yes	Yes	Yes
Low TV payload (60 Mbps)	No	No	Yes	Yes	Yes	Yes
High TV payload (180 Mbps)	No	No	No	Yes	Yes	Yes
10% DTT HH in 2014	No	No	Yes	Yes	Yes	Yes
70% DTT HH in 2014	No	No	No	Yes	Yes	Yes

Note: More heavily shaded cells indicate where benefits exceed costs

We can see that:

- There is no economic case for a converged platform if the incremental benefits are at the bottom end of our benefits range
- There is a good economic case for a converged platform if benefits are at the top end of the likely range
- If benefits are at the midpoint value then the case is ambiguous:
  - If OTT/IPTV reduces DTT demand by 70% by 2030 (high impact) then there are net incremental benefits in our hypothetical member state in all cases.
  - But if the impact of OTT/IPTV services on DTT is low, with only a 10% reduction in DTT demand, then there are net benefits only in member states where DTT currently has a low market share or where the DTT TV payload is small.

Of course not all member states are like our hypothetical member state. Our sensitivity analysis indicates that the case for a converged platform weakens considerably in small member states[7] but otherwise is similar to that for the hypothetical member state.

There are a number of qualitative issues which also need to be taken into account in considering the case for a converged platform:

- How easily could an LPLT converged platform meet the ICNIRP's RF emission limits? Adding substantial new carriers to a mast, especially at frequencies below 1 GHz, could significantly increase the size of the exclusion zone around the mast and so raise the costs of constructing an LPLT converged platform in urban areas
- Would network reliability (measured in terms of network uptime) be good enough? Our analysis of the limited information which is in the public domain is inconclusive, although there is anecdotal evidence to suggest that the LPLT network might be less reliable

[6] In which we assume LTE broadcast, support for primary TV sets only, 40% DTT households in 2014, 120 Mbps TV payload

[7] For example those with a population of less than 2 million

- Would a move to an LPLT converged platform lead to higher transmission charges for radio broadcasters using the HPHT network? This is possible but the effects are uncertain and would vary by member state

- Would a move to an LPLT network make the DTT network more flexible? Our analysis suggests that it would:

  – When compared with an HPHT network, an LPLT network could change at relatively low cost to meet evolving market requirements for delivery of TV content

  – A move to an LPLT network might make it easier to release UHF spectrum for mobile services in the middle of the day when TV payloads are (sometimes) significantly lower than in the evening.

S9 Conclusions from our economic assessment

The economic case for a converged platform is not yet made. As Figure S3 shows, net benefits might be positive or negative. Committing now to an LPLT converged platform would mean committing to substantial costs without any guarantee of net benefits in the long term. In any case it is unlikely to be feasible to implement a converged platform before 2025. This means that a decision by policy makers is not necessary now and there is value in preserving options by postponing a decision.

The fact that the economic case for a converged platform is ambiguous reflects two major market uncertainties:

- There is currently substantial uncertainty over the incremental value of releasing sub-700 MHz spectrum for mobile use. We would expect this uncertainty to reduce substantially over the next five years as the 700 MHz band is auctioned

- The extent to which take-up of IPTV and OTT services might reduce demand for HPHT DTT networks. Again the position here should be clearer by 2020.

There are also several other unresolved issues - on RF emissions, the viability of co-channel SFNs, network reliability, creating simulcast spectrum, and the costs of upgrading the macro-cells of a mobile network - which add to this market uncertainty.

This analysis points to the need for a further review of the merits of a converged platform (perhaps three to five years from now) when the market uncertainties listed above should be much reduced.

S10 Recommendations

Recommendation 1*: The Commission and industry should consider how best to develop and implement comprehensive measures of video consumption, which are consistent across EU member states over time.*

The lack of consistent measurement of traditional linear TV and non-linear AV consumption needs to be remedied if important policy (and commercial) decisions about the future of AV services in the EU are to be soundly based.

***Recommendation 2**: The broadcast community should provide relevant guidance to 5G research programmes.*

5G research programmes are starting now and there is as yet little focus on broadcasting capability. To fill this gap 5G research programmes might research the viability of a broadcast capability in 5G networks at low incremental costs and/or ways of integrating existing HPHT broadcast networks into 5G heterogeneous networks[8]

***Recommendation 3**: The relevant spectrum authorities should specify a long-term spectrum home for PMSE audio services, including whether to reserve part of the UHF band for PMSE.*

A move to a converged platform would lead to loss of access by PMSE audio services to most, or possibly all the entire sub-700 MHz spectrum. There are European Commission decisions which identify spectrum in the 800 MHz and 1800 MHz bands which might deal with loss of 800 MHz spectrum by PMSE audio. There are also initiatives in the 1 to 2 GHz range under consideration to compensate for loss of 700 MHz spectrum. But there is as yet no agreed way forward.

***Recommendation 4**: The broadcast and mobile communities should investigate further the feasibility and cost of implementing co-channel SFNs.*

The case for a converged platform is highly dependent on the viability of such SFNs. Yet studies by the BBC and ATDI (for Qualcomm) give very different results in terms of costs and coverage. These differences need to be resolved before the case for a converged platform is clear.

***Recommendation 5**: The European Commission should initiate another review of the case for a converged platform once the market uncertainties identified in Section S9 are substantially reduced.*

Market uncertainties mean that it is not yet possible to make a firm decision about a converged platform. We expect that these uncertainties will reduce substantially over the next 3 to 5 years. In particular 700 MHz auctions in next three to five years will give information about value of sub-700 MHz spectrum and the impacts of convergence in fixed environment should be much clearer.

Any future review should assess other options as well as a converged platform. This might include:

- The flexibility option proposed in the Lamy report. This would involve the implementation of unicast/multicast LTE downlinks in sub-700 MHz spectrum provided that they do not affect the existing HPHT DTT networks or their development
- A move to a single HPHT DTT network based on SFNs so as to release sub-700 MHz spectrum for mobile use
- Complete closure of the DTT network - which is replaced by a mix of free-to-air satellite DTH and IPTV broadcast.

In making Recommendation 5, we do not intend to inhibit market or technology developments in broadcast-broadband convergence services prior to the review. Specifically we propose that work on Recommendations 1 to 4 and Recommendation 7 takes place in advance of action related to Recommendation 5.

[8] Which may include LTE, WiFi and other networks

***Recommendation 6**: Those carrying out such a future review should resolve uncertainties in CBA parameters and technical assumptions.*

Such work might include assessment of the reliability of an LPLT network; safe emission limits; finding spectrum for simulcasting; and the costs of upgrading macro-sites to provide a LPLT converged network.

***Recommendation 7**: Between now and the next review, the broadcast and mobile communities should seek ways of working together to produce innovative broadcast-broadband converged services which are commercially viable and deliver added value to end users.*

Our research suggests that there is relatively little activity of this kind as yet but that there are opportunities for commercially viable broadcast–mobile broadband services which use the existing infrastructure of the broadcasters and the mobile operators. Any development of such services would change the counterfactual against which a converged platform is re-evaluated in future and might materially alter the findings of a future review.

If the review proposed in Recommendation 5 leads to a decision to implement a converged platform, then further work would be required. This includes:

- The development of the LTE broadcast standard
- A review of national regulations governing DTT platforms – for example those imposing technical, coverage and other restrictions on UHF spectrum use and requiring broadcasters to use the DTT platform
- The development of commercial and licensing models to consider who might run a converged network with what spectrum, and what role governments might play in enabling commercial models
- The development of the necessary spectrum management and frequency coordination arrangements such as a band plan, arrangements for incumbents, and bi-lateral/multi-lateral spectrum co-ordination arrangements.

S11 EU level commitment

Assuming the next review concludes that a converged platform is the best option for use of sub-700 MHz spectrum, then the Commission would need to consider what role it, and other EU level institutions and relevant bodies, should play in facilitating the transition to a converged platform. In defining this role there are a number of factors which need to be taken into account.

- There would be significant benefits from an EU-wide commitment to a move to a converged platform in terms of spectrum co-ordination and release, equipment production and EU-wide service provision
- There is currently a wide variety of audio-visual market conditions in different member states. Such variation would mean that an EU-wide move to a converged platform is likely to create winners and losers amongst member states, even if the move creates net benefits overall

- It is not clear to what extent a coordinated EU-wide move to a converged platform would help complete *the single market* in consumption of AV services. An EU-wide commitment would allow EU citizens to use portable devices across the EU to consume converged AV services. But the problem of national content rights would remain and citizens roaming in another member state may still be prohibited from viewing content originated in the home member states using (say) OTT catch-up services

There is, as yet, no evidence that an EU wide commitment to a converged platform would give the EU industrial policy leadership on a global basis. There is as yet little evidence that other world regions would be interested in implementing a converged platform.

European Commission

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