ADDRESSING FUTURE GROWTH IN BROADCAST TV AND VIDEO CONSUMPTION ON MOBILE DEVICES

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ABSTRACT

Much greater cooperation between broadcasters, Internet content aggregators and mobile operators would enable the industry to address the business challenges and opportunities arising from current trends in TV and video consumption on personal devices. Forecast growth in demand over the next 10-15 years could be met in a more affordable way by using new strategies to increase network capacity. This paper outlines alternative technical solutions and revised business models to meet demand to the end of the next decade at lower cost, that's both profitable for operators, sustainable for broadcasters and affordable to consumers.

1. INTRODUCTION

In the future of media (TV, radio, online content, games etc.), two trends seem inescapable - a sustained increase in data usage and much greater consumption of video on mobile and portable devices. Both trends represent major challenges for many parts of the broadcast, mobile and broadband ecosystems. Consumers will expect to access both free-to-view and purchased content on any of their devices wherever they are; the delivery mechanism won't matter to them provided the quality is good, access is easy-to-use and the service is affordable.

2. DEMAND FORECASTS AND SPECTRUM PRESSURE

The latest forecasts from respected organisations, such as Cisco VNI, continue to show annual growth rates on mobile data of around 60% per annum, equating to a 10-fold increase in demand every 5 years[1]. Although it's highly unlikely that growth at this level will continue into the very long term, we can foresee it continuing well into the next decade, possibly easing off in 10-15 years as demand reaches 1,000-times current levels by 2030.

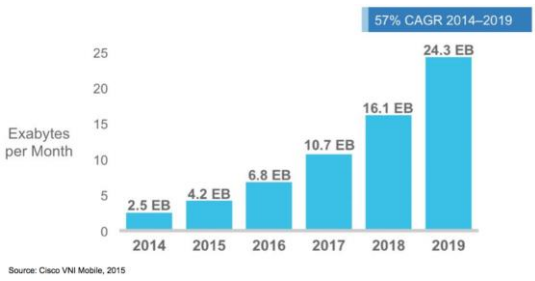

Figure 1 – 10-fold growth in mobile data traffic over 5 years to 2019

Daily TV and video consumption has been steady in many developed markets at around 4 hours per person for some years. Recent data in the UK and US markets has shown a gentle decline of around 10% in total viewing on large screen TVs, with growth in viewing on tablets and smartphones

[1] Cisco VNI Global Mobile Data Forecast 2014-2019

largely offsetting that decline. It could be argued that we're seeing a rebalancing of viewing from large to smaller screens within a broadly steady overall level of daily usage. Unconstrained access to TV services on small screen personal devices could lead to much more viewing over mobile networks, rising to as much as 25% (i.e. one hour per day or more), with the remaining 75% delivered over traditional broadcast and fixed broadband networks to small or large screens in the home. By 2025, we could therefore see average mobile users consuming between 1GB and 4GB per day in total for all services over mobile networks, assuming the trend in video codec efficiency improvement continues at a similar rate to that experienced over the past 10 years. Moreover, broadcasters will want their content to be available for viewing on these smaller-screen devices, both at home and out and about.

3. IMPLICATIONS OF CONTINUING WITH CURRENT MOBILE DATA TECHNIQUES

Mobile operators, broadcasters and other content distributors will all find that their existing business models and cash flows are under pressure from the pace of change in consumers' behaviour and the trend towards a significant proportion of viewing moving to handheld devices.

3.1 Opportunities for Mobile Operators

The market for mobile network services has reached maturity in many nations and the opportunity for network operators to increase total network services revenue is heavily constrained. Independent forecasts suggest annual growth of around 3% can be expected. Consumers are looking for their increasing consumption of mobile data to be delivered at little or no extra cost in an increasingly competitive market. Currently, following the roll out of 4G networks, many operators may have under-utilised capacity. Current technologies and planned improvements can probably meet the forecast 10-fold growth in demand over the next 5 years. However, to meet the 100-fold growth by 2025 there would need to be higher capital investment by operators. With constrained revenues, operators' profit margins and cash flow could be better sustained using radical, new solutions. Operators can take the lead in reshaping their cost base using these alternative technologies and effective new business models to secure a profitable future.

3.2 Opportunities for Broadcasters and Content Distributors

For broadcasters the implications of consumers' preference for multi-device viewing will be equally challenging. To remain relevant to their viewers, especially the young and the digitally fluent consumer, broadcasters will firstly need to secure access to their viewers on smartphones and tablets. Secondly, they will need to do so in a way that is financially sustainable as the proportion of viewing over non-traditional networks grows rapidly. The BBC in the UK and SVT in Sweden are reporting that unit distribution costs are five-times higher to broadband-connected customers than using traditional broadcast networks. Through the adoption of new technology and new business models, broadcasters could meet their goals, by (a) securing capacity to reach consumers on the move and (b) adopting affordable ways to deliver their services over mobile and broadband networks.

4. TECHNICAL SOLUTIONS TO CONSIDER

For reasons of infrastructure cost and available spectrum, using existing technologies to deliver live and on-demand media content over mobile networks to personal devices will become commercially challenging during the 2020's. Recent analysis of several potential

solutions has enabled us to select a short-list of alternative technologies that could, in combination, make a substantial contribution to meeting consumers' demand at an acceptable cost – allowing mobile operators to sustain their profitability and to meet broadcasters' requirements for their content to be readily viewable on personal devices, while still offering tariffs that are acceptable to most consumers.

4.1 Multicast Delivery and Improved Global Standards

The first step to take, as a foundation to a range of further technical solutions, is to implement effective methods of multicasting. These would be used over both the core (backbone) network and the final (access) network link to the consumer. Some fixed broadband networks are already using IP multicast to deliver real-time TV services to broadband customers. Several mobile network operators are trialling multicast / broadcast technology within individual cells using the LTE Broadcast (eMBMS) standard when there are two or more users accessing the same content. Others are using DVB-T2 broadcast standards to mobile devices. Both of these approaches have specific limitations and the preferred solution would be to define a much-improved, integrated multicast solution that can be incorporated as a standard feature in the next generation of mobile chip-sets. There are some enabling commercial steps that regulators and operators would also need to adopt so that the full potential of multicasting can be realised – see section 5.1 below for details of the spectrum allocation and capacity sharing techniques that would also be required. Multicast delivery can be used in three different ways to replace unicast techniques to provide better service quality and to reduce costs per user. There are trials of the first two, and the third (yet to be trialled) offers the greatest potential: -

- To deliver real-time TV, video and radio services including live broadcasts
- To deliver on-demand content (TV catch-up and Internet video) where more than one user is watching the same item at the approximately the same time in a network cell
- To deliver on-demand content in advance of actual user consumption based on algorithms that predict each user's likely behaviour – see Local Caching, below.

4.2 Local Caching in the Mobile Device

Recent economic modelling and further analysis of time-of-day demand patterns has identified the highly predictable pattern of total demand for mobile data during the day. Mobile network costs are primarily driven by the capital investment required to satisfy peak-hour demand, resulting in substantial amounts of under-utilised off-peak capacity. The cost of device storage is falling rapidly. Moore's Law and the growth in demand for ever-larger capacity in semiconductor memory chips points towards a Terabyte of flash memory costing less than €50 in 2020 and €5 in 2025. Using device-based or cloud-based software, in conjunction with network-based monitoring of overall on-demand content consumption, the device cache will be pre-loaded on a daily basis from a multicast carousel using off-peak network capacity, updated more frequently with recent on-demand content that each user is predicted to want to view. Off-peak unicast delivery can also pre-load the cache with selected 'long tail' content likely to be viewed by specific users.

The device application that manages the local cache could be invisible to the user, simply tracking each request for on-demand content and substituting the locally-cached version in

place of unicast delivery whenever possible. The user benefits from reliable picture quality without any of the delays or 'blocking' experienced on congested mobile networks.

Although it's not economic to include a Terabyte of local caching in mobile handsets today, by the early 2020's the cost will have fallen far enough to make device-level caching a much cheaper solution, offering the potential to meet demand growth at significantly lower overall cost than by additional investment in network capacity.

4.3 Edge-of-Network Local Caching

As a stepping-stone towards device caching, and as a technical solution to moderate the demand peaks on fixed broadband networks too, local caching could take place in a home hub (i.e. a broadband router with additional functionality) or at the local mobile base station. The mobile device could use Wi-Fi capacity to view on-demand content cached in the home hub, reducing demand at the time of viewing on the fixed or mobile network. See Figure 2. The home hub would be used as a staging server to hold content known to be of interest to one or more users in that home. The local base station could have content storage, to reduce demand peaks on the back-haul network or to store-and-forward to mobile devices when there's spare capacity in the cell. In either case, the content could remain on the home hub or base station cache until it's viewed over the local network or it could be downloaded to the handset or tablet cache for later consumption.

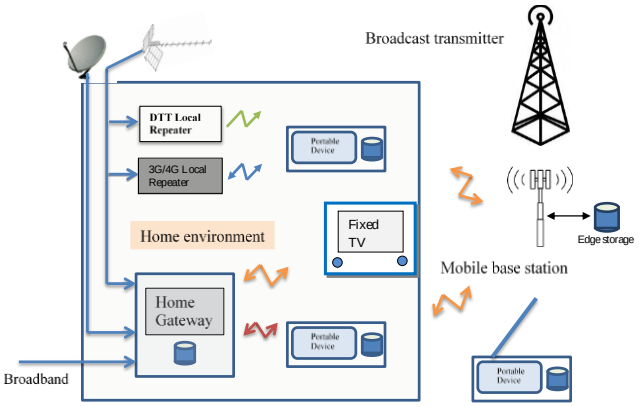

Figure 2 – Future Home Architecture

4.4 Multicast Delivery to the Local Cache

Each local cache, whether in a mobile device or a home hub, could be updated outside peak hours using under-utilised fixed or mobile network capacity at close to zero marginal cost for network transport. Unicast delivery may well remain appropriate for delivery of some content that's of interest to specific users that are limited in number within a specific geography e.g. an expatriate community's on-demand content in their native language.

However, the majority of on-demand viewing is concentrated on a small proportion of total available content. The selection of items held in many people's local cache will have considerable overlap with other people's selections too. Therefore it would be much more efficient in terms of delivery bandwidth and cost to use multicast techniques to update the majority of content in local caches. A combination of multicast and unicast updates can be used to optimise delivery costs. It is noted that a very efficient form of wide-area multicast already exists in the existing terrestrial and satellite broadcast networks.

4.5 On-Channel / In-Home Repeaters

In-building reception of mobile data services can often pose difficulties, especially in rural locations or at the edge of the local base-station's coverage area. Some mobile operators

are offering rooftop antennas and in-home repeaters to their users to boost the signal strength for in-building reception. The wider adoption of this approach would enable more efficient use of the mobile spectrum as the transmitted power or the allocated bandwidth in a specific area could be reduced whilst ensuring acceptable levels of in-building reception.

Where mobile devices or portable TV sets are used to directly receive UHF terrestrial TV services, an on-channel repeater in the home connected to the existing rooftop aerial would ensure good-quality reception without the need for additional cabling or conversion to Wi-Fi. A sophisticated home hub could be used to convert satellite, cable or broadband-delivered services into a white-spaces UHF channel, received using the existing TV tuner.

4.6 Intelligent Software

Broadcasters and Internet content aggregators have a deep understanding of the viewing patterns of their consumers, at an individual level and collectively. This insight into consumers' behaviour patterns is essential to the effective use of multicast delivery and device caching. Understanding and predicting the content consumption patterns of each user can be achieved at a personal level within an app that captures the viewing history and patterns of each user's content consumption. The app would then decide which items of multicast content should be stored locally, and which items ignored because there's a low probability of them being viewed on that device. Knowledge of the size of local cache available and the amount of cache already used to store high-probability items would also need to be known. Like a 'virtual butler' the app, or the service provider themselves may recommend specific items already in the cache at relevant times of day to the user. This extends the concept already used by online retailers to recommend new items to purchasers who have similar behaviour patterns to others.

The intelligent software could equally be based in the cloud. Although there may be data protection issues in some countries, it opens up the opportunity to assign each individual a profile, clustering people with similar interests and behaviour patterns into groups.

5. COMMERCIAL AND REGULATORY SOLUTIONS TO CONSIDER

5.1 Content sharing for multicast content delivery

When operating a network configured for calls, texts and unicast data services, there is limited benefit in aggregating traffic from multiple service providers onto a single physical network. The benefits of competition between two or more physical network operators are likely to outweigh the limited advantages of a single shared network. However, when multicast delivery of content becomes a substantial part of the overall payload over mobile networks, a compelling case can be made for multicast services to be accessible to all users in that geography. Otherwise, there's likely to be a very high level of duplication in the content distributed over each operator's multicast network. For example, if there are four competing operators in a locality and, taking a mid 2020's scenario, multicast delivery accounted for half of the total traffic then a saving of up to 37% of all traffic could be realised by removing the duplicated multicast content between operators.

Implementing this change is likely to require some regulatory changes and adjustments to the way mobile networks are configured to relax the existing constraints between users' SIM cards and the networks they can access. For the avoidance of doubt, these changes would not require a general change to allow users to roam between networks in their home market. The strongest economic case is confined to allowing access to all users for any

multicast delivery of live or on-demand content for immediate or future consumption. Of course, network operator and programme provider branding together with effective control of access to content will need to be carefully considered, from the consumer's and regulator's perspective as well as from a commercial point of view.

5.2 Sustaining Public Service Broadcasting

An increasing proportion of total TV consumption – already over 10% in some markets and growing rapidly – is consumed on tablets and smartphones. Whilst broadcasters are more than happy to ensure viewers can access their services wherever they are and on the device of their choice, there are two major commercial issues to address. Firstly, some broadcasters[2] are reporting that the unit cost of non-traditional delivery via Content Distribution Networks (CDNs) is 5 to 6 times higher than traditional distribution networks and these 'per viewer' costs are, in total, rising broadly in proportion to the hours of viewing over CDNs. Secondly, there are questions of strategic importance to Public Service Broadcasters (PSBs) as broadcasting/multicasting over mobile networks becomes more popular. Will viewers be able to access PSB services freely over mobile networks, subject to paying any PSB-related annual licence fee?

If, in the future, broadcasting to large TV sets shifts towards broadband Internet distribution, then traditional broadcasting spectrum might be used more for multicast delivery to mobile devices. By combining broadcast/multicast delivery models, the delivery costs could be changed from a high per user/hour model to a fixed cost delivering to all mobile users that better fits broadcasters' business models. This should not prevent the appropriate use of targeted advertising, inserted seamlessly into broadcast or on-demand service streams where there's a commercial case to do so.

5.3 Use Broadcast Infrastructure to Deliver Mobile TV

Recent trials in France[3] and Italy have shown that existing broadcast infrastructure can be used to deliver TV, video and other data services to mobile users. There's a range of technical options being used, including eMBMS-delivered content transmitted within a DVB multiplex. This shows how capacity within the UHF band can be flexibly allocated between services configured for fixed TV reception and more robust mobile reception within a single multiplex. Other trials have shown how mobile devices with built-in DVB-T2 receivers can be used to deliver robust video services to users on the move. A strong case is emerging for DTT infrastructure to play a central part supporting integrated AV content distribution.

6. ASSESSMENT OF THE IMPACT OF USING A COMBINATION OF THESE TECHNIQUES

No single technology on its own will be sufficient to meet the 1000-fold growth in demand (by 2030) for mobile data and meet the broadcasters' requirements to make their content easily available on personal devices.

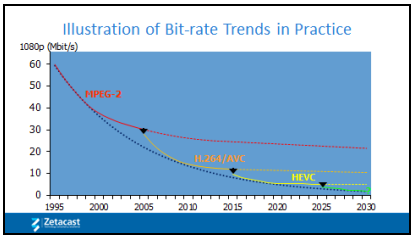

Figure 3 – Codec Efficiency: 50% reduction every 7 years

[2] SVT presentation to ETSI / EBU workshop on 6th May 2015. Mediatique presented to the BBC Trust Finance Committee Nov 2013.

[3] TDF and others: trial of eMBMS services from Eiffel Tower DTT transmitter – press release April 2015

However, an appropriate combination of new technologies and new business models together can provide the necessary increase in capacity and enhanced quality of service needed to satisfy consumers' reasonable expectations. Figure 3 above illustrates past and expected future trends in video codec efficiency[4]. The table below estimates the increase in the amount of content that could be delivered over a given amount of spectrum from a range of technical solutions and business model enhancements. By selecting an optimal combination, based on the cost/benefit of implementation, the required increase in overall capacity can be provided at the lowest overall cost.

Illustration of Relative Costs and Benefits				
Technical Solutions	Incremental Cost	Estimated Capacity Benefit over 10 years	Cost / Benefit Assessment	Comment
Improved Video Coding (HEVC and future standards)	€	2.7 x (50% lower bit-rate every 7 years)	✓✓✓✓	High level of confidence. Low incremental cost.
Enhancements to standards (best of DVB and 3GPP)	€	2.2 x (approx. 8% annually[5])	✓✓✓	Requires cooperation on next generation global standards, using DVB and 3GPP resources
Device caching, via off-peak multicast or unicast delivery	€€	6 x	✓✓✓✓✓	Becomes viable around 2020, as 1TB memory cost falls below €50
Exiting operator plans to improve network efficiency	€€	10x	✓✓✓✓✓	Convert 2G/3G to 4G/5G, efficient new network kit, improved network mgmt.
In-home repeaters (4G / 5G / DTT)	€	1.5 x	✓✓✓	Lower transmit power / less bandwidth needed for in-building coverage
Reduce cell size across network to increase capacity	€€€€	3 x	✓	Highly capital intensive. Requires many additional base station sites.
Acquire additional spectrum and equip existing sites	€€€€	1.5 x	✓	Highly capital intensive. Costly rearrangement of existing services e.g. DTT
Business Model Enhancements	Incremental Cost	Estimated Capacity Benefit over 10 years	Cost / Benefit Assessment	Comment
Operators share multicast capacity	€	1.5 x	✓✓✓	Requires regulatory change. Assumes 4 networks share.
Use DTT broadcast infrastructure to deliver mobile services	€	1.5x	✓✓✓	Optimise DTT spectrum plan for fixed reception. Allocate multiplex capacity for mobile TV.

[4] "HEVC in DVB"; Ken McCann; DVB World 2014, Prague , March 2014

[5] 3GPP is addressing constraints in current eMBMS specifications. DVB has proposed several new ways to further increase the spectral efficiency over terrestrial broadcasting and mobile networks. These could potentially be combined into new 5G specifications.

Although many of these solutions and enhancements are based on existing technology, the use of the technology in novel ways would need to be piloted and refined before the costs and benefits from a commercial rollout can be confirmed. By adopting a selection of the most promising of these solutions (shaded in green), capacity could be increased in the order of 500x by 2025 at a reasonable overall cost to operators and broadcasters, without needing further additional spectrum or many more base stations. Assuming that there is under-used capacity within existing 4G networks and that the 700MHz band is used to increase mobile capacity, this approach should comfortably meet forecast demand through to 2030. In comparison, the existing approach comprising enhanced codecs, network efficiency gains, smaller cell sizes and additional spectrum together would deliver a capacity increase in the order of 120x by 2025 at considerably greater capital cost, with demand still exceeding capacity during the 2020's.

7. CONCLUSIONS / CALL TO ACTION

The sustained, rapid growth in consumption of video content on personal devices from broadcasters and Internet aggregators could be met in a cost-effective way through the adoption of new technical solutions and revised business models. The alternative strategy, based on smaller cells and more spectrum would require very large capital investments in mobile infrastructure, is unlikely to satisfy demand throughout the 2020's. Without these new solutions, it would be commercially challenging to sustain margins at current levels of revenue per consumer, which are forecast to grow only modestly in future. Mobile network operators and broadcasters will therefore be at the forefront of these cost pressures and together they can drive the piloting, followed by the commercial rollout of these new solutions. However, to enable their full potential to be realised, much greater levels of cooperation and coordination will be required. The areas where activity should be focused over the next 3 years are: -

- Piloting of large-scale local caching via off-peak unicast and multicast delivery solutions that are easy for consumers to use.
- Well-targeted research into key technologies, such as demand prediction algorithms and cache management apps
- Product roadmap planning with smartphone and tablet manufacturers and their semiconductor suppliers to address the technical challenges of device caching
- Global standards initiatives to bring together new technologies from the broadcast and the mobile sectors into next generation standards – potentially there could be a unified set of standards for broadcast and mobile under the 5G umbrella.
- Engagement with regulators to enable, and possibly require, mobile operators and broadcasters to develop an integrated approach to AV content delivery, avoiding the duplicated use of spectrum for delivering such content.