DIGITAL TELEVISION: THE PRINCIPLES FOR SPECTRUM PLANNING
Response by the Digital TV Group

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While this DTG response reflects discussions that have taken place within the Group, it cannot fully represent the varied views of all our members, many of whom are submitting their own individual responses. In particular, BSkyB has indicated that it will respond separately to the consultation.

Summary

- The DTG is fully supportive of the Government's Action Plan for Digital Television and of its objective of analogue switchover at the earliest possible date. To that end, we believe it is essential to extract as soon as possible the maximum improvements in DTT coverage that can be obtained from the uhf spectrum before analogue switch-off. We urge the Government to give its full backing to this, including reasonable tenure of the frequencies employed.
- Furthermore, we urge Government to allow frequency channels released by cessation of the analogue networks to be re-used to improve digital coverage to serve between 90 and 95% of UK households.
- The government's stated ambition to reclaim uhf spectrum runs the risk of stalling the take-up of Digital Terrestrial, because existing terrestrial multiplex operators are having difficulty justifying capital expenditure to improve coverage until definitive statements are made by Government on the future of the uhf bands. We believe the immediate resumption of transmitter coverage improvements is vital to the future of platform and that the Government has an overarching duty and imperative to create an atmosphere in which this can happen.
- By taking over analogue networks, coverage could be extended to fully equate with analogue, albeit at considerable expense. However, this would require the whole of bands (iv) and (v). Some of our members believe this is the right course of action but we are inclined to the view that increasing coverage to 90 – 95% of the population, which would give some capacity for new services, would be a better solution for the platform as a whole.

  Satellite could be an acceptable alternative for unserved viewers and progress has been made in making receivers available in an open market without subscription

(for free-to-view services) at a comparable price to DTT receivers. A low cost solution to encryption requirements remains an outstanding issue.

- Spectrum liberated by analogue switch-off should be allocated to:

  (a) increasing FTV DTT coverage up to 90 – 95% whilst, as far as practical, minimising the number of households requiring new aerial installations.

  (a) maximising coverage to portable television sets.

  (c) developing new services based on the platform, particularly in terms of enhanced multimedia services, local services and new types of mobile services.

- We counsel that it is unwise to assume that increases in coding efficiency will offer a significant increase in the number of services transmitted. Evidence points to greater bandwidth being required for each channel as large widescreen displays become more common and as DVDs set a new norm for technical quality in the home.

- We remain convinced that there are greater gains in spectrum efficiency to be made by re-using spectrum for new types of services using the existing pattern of 8MHz allocations and the DVB(T) standard. The best way to discover the demand for uhf spectrum is to 'test the water' by releasing a small amount of spectrum, say 3 – 4 channels for expressions of interest and trials, before international agreement on its future use. Such trials would inform international standardisation and ensure that the UK stays in the forefront of developments.

- We are concerned that the UK should remain in step with international spectrum policy and allocation. In Europe, the emphasis is on so-called '4G' hybrid services using a combination of DVB-T to broadcast high speed data and umts to provide one-to-one communication. We recommend that an independent study be commissioned to compare all possible approaches to gaining greater use from the uhf spectrum. This study should take in the possible commercial advantage of developing radical new types of consumer products, based on the emergent 4G Hybrid concepts.

- Little or no mention has been made in the consultation of other users of uhf spectrum. Yet radio microphones and some point-to-point radio links are wholly dependent on unused analogue channels at particular locations for ancillary support for broadcasting. Already the threat to this spectrum has undermined the sales of such equipment. Unless provision is made for such users within bands (iv) and (v) or a planned and managed migration to alternative frequencies over a period, allowing for the proper depreciation of existing equipment, users' livelihoods will be threatened.

- In considering the possible uses to which released spectrum could be put, the government should balance both broadcasting and telecommunications potential uses and find the optimum answer in terms of consumer and social (and not simply financial) outcomes.

Section 1

1.1 General Comments about the Consultation

The Principles for Spectrum Planning consultation is built on the findings of the Genesis Study and, before that, the NERA report of 1998. From the beginning, these studies were channelled by artificially constrained terms of reference and much evidence, submitted by correspondents including the DTG, were ignored in the reports.

It is vital that recommendations arising from the consultation take full account of all the responses and that they have a broad consensus of Industry support. Without that, analogue switchover may be a long time coming.

1.2 Taking stock

At this time when the future of ITV Digital hangs in the balance, it is appropriate to take stock of Digital Terrestrial and its progress over the last 3½ years.

In the first implementation of DVB-T in the world, the UK faced many unknowns and planning had to be carried out without the advantage of previous experience. If we were starting again, with the advantage of hindsight, the terms of reference used in planning would have been different in a number of respects.

(i) The first concerns digital reception. Before the launch of digital services it was assumed that DTT reception in marginal conditions would either work or it wouldn't. The point of failure was, within a few dB, a "cliff edge." We failed to understand that marginal reception would in many cases suffer from intermittent failure – blocking and freezes.

(ii) We failed, too, to take account of actual aerial installations rather than theoretical ones, although evidence of the poor state of actual aerials was known. (Viewers' aerials are, in the main, installed to give just adequate analogue reception; many have degraded seriously over the years and most have serious deficiencies in terms of immunity to impulse noise.)

(iii) Thirdly, we failed to understand the importance of reception of <u>all</u> of the multiplexes, in providing a proposition to the viewer to switch to digital. In the preparation for Digital Terrestrial, additional capacity was sought to provide greater competition to other platforms and two additional multiplex networks added having lower coverage than the initial four. Digital Terrestrial has proved to have little appeal to viewers in areas where only some of the multiplexes could be received.

Fundamentally, we planned a system that is, in coverage and reliability terms, less good than the analogue that it is intended to replace. We always knew that the full benefits of DTT would not be available until we could begin to replace analogue terrestrial on a significant scale. The challenge was always to make the interim version, planned so as to coexist with analogue for about a decade, robust and reliable enough to build consumer demand and public acceptance.

Now that we have diagnosed the shortcomings of this interim version on the basis of hard experience, we urgently need to address the coverage/reception issues as vigorously as possible, if we are to achieve our goal of early analogue switchover.

1.3 The Domestic Aerial Problem

1.3.1 It is clear that we need to mobilise a range of actions and improvements if we are to overcome the dire situation that we are facing today. The Government Action Plan

for Digital Television is the best hope we have for getting our "ducks in a row" and has the full support of the DTG and of the TV Industry. It is not appropriate in this consultation to in general comment on the Action Plan, except where it impinges on spectrum usage.

1.3.2 There is a fundamental problem in persuading viewers to upgrade their aerials for digital. ONdigital / ITV Digital realised this at an early stage and offered subscribers a low fixed price deal for resolving reception problems. Approximately one third of new subscribers took advantage of this deal but it is clear than many more should have done. ITV digital state that churn in subscribers amounts to as much as 25% and that a high proportion of these, perhaps as many as 50%, cite technical problems as the reason for ending their contract, though not all of these are necessarily poor reception.

We must recognise that a significant proportion of remaining analogue viewers will need new aerials for reliable reception of DTT and that there is considerable consumer resistance to upgrading aerial installations, even at a significantly subsidised price.

1.3.3. It is clear that the ONdigital "plug and play" campaign did both the company and the platform a significant disservice in this respect. But altering consumer expectations is only part of the problem. As the cost of digital set-top boxes falls, the need to replace domestic aerial installations will become for many the major part of the cost of acquiring digital and is likely to become a critical barrier to uptake.

1.3.4 Even if consumers can be persuaded to pay for a new aerial, the CAI has highlighted the lack of trained aerial installers to carry out the work required if switchover targets are to be achieved.

1.3.5 We therefore conclude that the only solution to achieving switchover in the short timescales wanted by both Government and Industry lies in reducing the number of aerial improvements required. This means:

- Increasing transmission powers to nearer that of analogue
- Seeking to reduce the use of out of band transmissions wherever possible
- Eliminating nulls in radiation patterns necessitated by the use of unsuitable uhf channels

Clearly, any power increases that can be effected now, whilst analogue simulcasts continue, should be carried out immediately. But recent evidence from power trials taking place at Lark Stoke and Heathfield suggests that a general increase of between 3 and 6dB is the best that can be hoped for. Whilst valuable, this will not provide a solution to achieving the 90 – 95% coverage we believe is necessary.

Taking over existing analogue networks for DTT use offers the best and probably only prospect for overcoming this situation.

1.4 Choice of DVB-T Parameters

1.4.1 DVB-T has a number of parameter variables that allow robustness of the signal to be traded against the possible datarate. Changing the mode of transmissions would not fundamentally alter the arguments described in 1.3 (above) but it may contribute to the long-term solution

1.4.2 UK planning was initially carried out assuming use of the 16QAM modulation, with a datarate of approx 18Mbit/s per multiplex; it was later changed to 64QAM because it was recognised that greater capacity was needed in order that the platform could better compete with satellite and cable. The consequence of this decision is that some dBs greater signal strength is needed at the receiver for reliable reception.

Whilst any change to the existing mode of transmissions needs to take account of a consequent reduction in datarate, we recommend that the future use of spectrum considered in this consultation, should include consideration of the use of other DVB-T modes.

1.4.3 Another decision was to adopt the so-called 2K mode, for which silicon was available at an earlier date, rather than the 8K mode adopted in the rest of Europe. 8K conveys a number of important advantages, the most important of which is a theoretical 6dB greater immunity to impulse noise. As the limits of coverage are reached, this improvement, if substantiated in practice, could have a significant effect on overall population coverage figures. More importantly, it could reduce the level of blocking artefacts observed by viewers and give rise to greater customer satisfaction.

1.4.4 Transmission could be switched to 8K without any loss of datarate. However, a significant proportion of existing set-top boxes and receivers are not capable of 8K operation, so any proposal to switch to 8K would have to take account of this legacy. However, these first-generation receivers have other deficiencies (processor power, memory, etc) and will, in due course, have to be replaced. It is therefore argued that a possible change to 8K should be properly researched, such that it could be adopted in the future if the advantages are proven.

1.4.5 8K operation would also allow filler relay stations on the same channel to be built if required.

1.5 The Place of Satellite in Achieving Switchover

1.5 1 It is a commonly expressed opinion within the Radiocommunications Agency and other government departments that satellite provides a better alternative for many of today's broadcast services and this deserves careful scrutiny in any debate on the use of spectrum.

1.5.2 It is undoubtedly true, from a technical point of view, that digital satellite transmission offers a cheap and highly satisfactory way of transmitting national television services. It can be used to offer regional variations and, importantly, a choice of regional variations, at additional cost.

1.5.3 However, for satellite to be a satisfactory alternative, the Government would have to face a number of political and regulatory issues concerning the licence arrangements of the public service broadcasters with the satellite provider, coupled with national security issues associated with the use of satellite for primary communication.

1.5.4 There is a public perception that terrestrial broadcasting is available as of right, which does not apply to satellite. Any change that challenged that perception would require careful management.

1.5.5 Satellite could be an acceptable alternative for some viewers and progress has been made in making receivers available in an open market without subscription (for free-to-view services) at a comparable price to DTT receivers. A low cost solution to encryption requirements remains an outstanding issue. We recommend that the Government investigates barriers to wider satellite usage through the Action Plan.

1.5.6 However, we believe there is an overarching need and an obligation on Government to ensure that Digital Terrestrial is developed to provide a primary home for public service broadcasting and competition for other platforms.

1.6 Capacity for Future Growth

The technical picture quality of digital services is determined by the 'norms' of the period. At the start of digital broadcasting, these norms were set by existing PAL services and, to an extent, by the quality of VCR recordings. Also, payTV providers often pushed down datarates to the point where encoding artefacts became common in order to provide a larger number of services.

That situation is changing. New norms are being established by the rapid take-up of DVD. Also, large widescreen TVs are becoming common, which show up artefacts much more than the 4x3 screens they replace. New 40" and 50" plasma displays will in the next few years become affordable as consumer items. These trends will more than balance improvements in encoding efficiency likely and the number of TV services per multiplex is unlikely to increase over the next decade.

A recent report by RAI Research and the EBU[1] concludes: "If the widespread use of large screen displays materialises as manufacturers predict, then the current working assumptions about the bit rate needed to provide SDTV may no longer be valid. PDP displays act as an impairment annoyance magnifier, and broadcast bit rates considerably higher than are used today will be needed to systematically provide broadcast services which do justice to the displays."

In terms of the number of services, satellite sets the standard that other platforms aspire to. Certainly, ITV Digital is quite clear that the proposition for the platform would be improved if there were greater capacity for additional services, not necessarily pay TV.

Data services on DTT were deliberately limited in the Broadcasting Act 1996 to use no more than 10% of the available capacity, a rule that now seems increasingly obsolete. The UK Government has indicated it is contemplating introducing new capacity to carry government information services and we are very aware of numbers of new companies with ideas for new data services, which are defeated by the lack of capacity to carry them.

The DTG argues that Digital Terrestrial should have sufficient spectrum allocated to provide roughly equivalent coverage to analogue for all existing services, including portable TVs. Additional capacity is needed to allow expansion of broadcast multimedia content and information services and for transmission of new types of services to 'people on the move.'

1.7 Using Digital Terrestrial for its Inherent Strengths

The DTG fully supports the concept that each platform should be developed to maximise its unique capabilities. Thus, satellite would be the platform of choice for high definition services, which are likely to become viable in the next ten years, whereas DTT, with its limited bandwidth capability, would not provide a realistic alternative.

It makes sense, then, to develop DTT to provide for portable and mobile use, which cannot be satisfied by other means of broadcasting. However, it does not seem likely that portable and mobile uses in the foreseeable future would, on their own, make a viable proposition. Therefore, we argue that DTT should be developed specifically to

[1] *Will the coming of flat panel displays change DVB broadcasting?* Mario Stroppiana RAI-CRIT and David Wood EBU presented at DVB 2002, Dublin, March 2002.

provide service to portable and mobile devices, whilst, at the same time, providing healthy competition and choice for fixed living-room installations.

Thus, one might argue, over a period of time, living room viewing will migrate to high definition services delivered over satellite, whilst Digital Terrestrial evolves to service mainly local metropolitan, portable and mobile users. But this is speculation. The point is to provide the framework where such evolution can take place naturally.

1.8 The Prospects for 're-farming' the uhf spectrum

In the boom times of mobile phone take-up, the view was expressed that the exponential growth being experienced at the time, projected forward, would lead to a shortage of capacity within a few years. However, we have not seen justification for this assertion, nor do we believe it is likely in the more sober climate of today.

Mobile communication has substantial, as-yet unused, capacity in the 3G allocations, which will be sufficient to cope with significant take-up of new IP based services. What in theory could lead to a huge growth in traffic is the transmission of moving images over the 3G network. However, the DTG believes that the business model for such services is not sustainable.

The only way that advanced broadband services could be viable is to split content into separate one-to-many broadcast and one-to-one communications components. By transmitting high bandwidth video and data over a broadcast network to many recipients simultaneously, bandwidth demands are reduced dramatically. (Many people advocate the most popular internet content should be transmitted this way to reduce access times for fixed line internet access.)

These hybrid broadcast / 3G systems, christened 4G, are being investigated by a number of interested organisations, some with the support of European Commission funding. To limit broadcast capacity such that these services could not develop could cut the UK off from developments in Europe. 4G services are further considered in Section 3 of this response.

1.9 Summary

We have argued that the current planning standards for Digital Terrestrial are insufficient to provide an acceptable replacement for analogue. Short term improvements need to be carried out as a matter of urgency and Government needs to provide reassurance on the future of the uhf spectrum in order to give confidence on the necessary investments.

Spectrum planning investigations show that it will not be possible to provide equivalent coverage to analogue whilst simulcasting continues. We urge the Government to make an early commitment to raising coverage to at least 90% of all UK households using spectrum released by analogue switch-off, with particular emphasis on service to secondary and portable TVs, and to provide capacity for the expansion of Digital Terrestrial to include more capacity for local, regional and national data services.

Capacity should be earmarked for possible mobile TV 4G information services and, if possible, for early trials of such developments. However, the Government needs to reconcile itself to the thought that it cannot satisfy the full scope of Treasury ambitions for the release of spectrum without sacrificing DTT on the altar of expediency.

Section 2

Response to Questions Asked in the Consultation

Q1. Our working assumption is that planning will continue for six multiplexes, as today. However we would also be interested in views on the costs and benefits of a more radical re-planning. This could be either reducing or increasing the number of multiplexes by one. Do you have views on this?

While other technical possibilities need to be kept in mind, weight needs to be given to the need to reassure existing multiplex licensees of the future security of their investments, especially as further investment in coverage is an urgent requirement.

Q2. What do you see as the costs and the benefits of maintaining the current basis for network configuration compared with those for adopting a configuration using fewer frequency channels?

There is a consensus amongst European planners that a minimum of six channels per network is necessary to achieve a network with worthwhile coverage and a number of networks planned to access portable TVs are being planned with 8 channels per network.

Clearly, it depends what DVB-T parameters are used. It would be possible to reduce the number of channels per network if more robust parameters are used (eg 16QAM) then fewer channels per network are appropriate. But the available datarate is reduced with stronger coding parameters such that fewer services can be carried. There are many variables currently to consider how to achieve maximum spectrum efficiency. They are:

- number of channels available
- core coverage required
- DVB-T coding parameters
- Possible use of hierachical modulation and single frequency networks
- Number of transmitting stations (power / cost)

Fundamentally, the question is flawed. In planning it might be possible to plan some networks with 5 channels if optimum channels are available but planning gets more difficult as the number of networks is increased and more channels are needed.

In summary, we believe that attempts to reclaim spectrum by adopting a simplistic figure of the number of channels per network could leave DTT emaciated with inadequate coverage. We recommend the alternative of setting coverage targets of, say, 95% and creating a business environment which encourages spectrum users to develop their businesses through spectrum efficiency increases.

Q3. Do you agree that we should continue to plan on an interleaved basis to support regional services?

Q4: To what extent should the future planning of this spectrum take account of the provision of local services?

Absolutely and unequivocally yes. There is of course a place for both national and regional single frequency networks but regional and local services should be

accommodated, including digital replacement of the current RSL licences and provision for radically new data services with fine granularity.

Local television has had a chequered history in the UK. It has generally had the support of the public, who value local programmes but its high cost compared to local radio services has meant that it often has quasi-amateur status. A recent attempt to link stations together into a network has gone into voluntary receivership.

Actually, local television needs to go digital. The ability to carry a flexible blend of audio, data, still and moving pictures as an application makes it possible to assemble meaningful programming very cheaply, and in very narrow bandwidth. A series of applications running in narrow band channels could build into a comprehensive suite of community news and information services, providing an ideal framework into which local government and public service information could slot.

Unfortunately, no digital bandwidth has been made available so far, to test the interest in such services. We strongly believe that additional spectrum should be sought for trials of local programmes. Note that it should be comparatively easy to find suitable channels since there is no requirement to provide universal (overlapping) coverage.

It should also be noted that, whilst interleaving is a very powerful tool in maximising spectrum usage, it does rely on co-operation between operators to deal with inevitable interference problems that occur as network configurations change.

Q5. What factors would have to be taken into account in order to plan to support mobile broadcasting services?

There is widespread interest in mobile broadcast services using DVB-T around the world. The only service currently operating in Singapore is proving instructive in terms of understanding special services for commuters but is not yet profitable.[2]

DVB-T services to city buses have been the subject of many experiments and demonstrations across Europe. However, Germany has taken a different approach by building an experimental network of 40 low power transmitters along North German autobanns for use by luxury cars. With the same broadcasts, service is provided to portable TVs in homes within the service areas of the transmitters. Plans to extend from the trial to full commercial service are awaiting approval by German regional government.

The consensus of commercial and technical expertise is that the requirements of portable reception and mobile reception are similar; that portable reception offers the most obvious target in the short term but that mobile services are almost certainly going to be important in the future, as our understanding of needs increases and as the technology matures.

We strongly recommend that the result of this consultation should not close off the possibility of mobile services in the UK in the future.

[2] *TV Mobile; The World's First Commercial Digital Television Mobile Network*. Paper presented at Broadcast Asia 2001.

Q6. Does this analysis of coverage potential and associated costs adequately inform those taking decisions about the level of coverage by terrestrial means that should be required for public service broadcasters?

It is clear from the discussion in the consultation paper (Sections 3.1 – 3.6) that the government appreciates that there is insufficient data from which to say with any certainty what the coverage and corresponding costs are for increasing the number of transmitters in each network.

It is our assertion, in any case, that such a study should include alternatives by varying DVB-T transmission parameters and by radical alternatives such as converting networks, by degrees into cellular networks of low power transmitters.

However, taking the question at face value, we would offer the following contributions to the debate:

(i) We believe it is for the Government to decide what level of coverage the BBC, as the primary public service broadcaster, should have. It involves questions that are largely political, for example, about becoming reliant on international commercial operators for carriage of public service broadcasts.

(ii) It is understood that the regulation of Independent Broadcasters with public service obligations trades privileges against those obligations. An important obligation is, to our mind, to extend coverage to localities for which service would not be justifiable on purely commercial terms.

The DTG would not wish to comment further on matters affecting the commercial livelihood of individual members.

Q7. Our working assumption is that the public service broadcasters should be required to reach a certain minimum percentage of households by the terrestrial platform. However, we would like your views on whether it is right to require a minimum, what that might be and the associated costs and benefits?

The fundamental fact on which to base this debate is that anything less than existing analogue coverage, to both rooftop antennas and portables, will be understandably be seen as a backward step by members of the public.

There is already plenty enough evidence that the public will understand and accept lower coverage for a period of time, if they can see an ongoing programme of building and be given estimates of when coverage will be extended to them. However, to close off completely any hope of terrestrial coverage will undoubtedly generate an adverse reaction amongst consumers and amongst the press and needs to be taken very carefully indeed.

Nevertheless, there is a general view amongst our members that universal terrestrial coverage is an unaffordable luxury and that satellite could provide an acceptable alternative for the last 5 – 10% of the population. Satellite would be an acceptable alternative if receivers were available in an open market without subscription (for free-to-view services) at a comparable price to DTT receivers.

There is a trade-off between coverage and spectrum efficiency. The consensus amongst DTG members is that the compromise is coverage of around 94% of UK households.

Q8. Do you agree that the level of coverage provided by the networks supporting the four multiplexes carrying predominantly pay-tv services should be left to the commercial judgement of the operators?

Any change in the terms of the current licence would have to be negotiated with the licensee. However, as argued above, it is clear that the platform is significantly less appealing if only some services are available to a consumer.

It is in the interests of the multiplex operators collectively and in the interests of the public, that subscription and pay-per-view services match the coverage of public service broadcasters and that pay TV operators are not precluded from doing so by a shortage of spectrum if they see commercial reasons for it.

Q9. Which channels are cleared will depend on the costs and benefits of different replanning options. For example clearing 5 channels at the top and bottom of the frequency range is less disruptive to consumers and has lower switching costs than clearing ten at the top end. The benefits, though, will depend on the use to which such freed up spectrum can be put. We would like your views on the costs and benefits of different options.

Q10. Which frequency channels should we clear?

The DTG believes the costs of clearing spectrum has been understated and would ask for reference to studies from which this figure is drawn. We remain sceptical that spectrum could be re-allocated if it required consumers to fit new domestic aerials (again). We have not seen cogent arguments to support the case for additional blocks of spectrum for mobile communications in the UK, when it is obvious that it will be next to impossible to clear the same spectrum across Europe as a whole.

The development of mobile phones has undoubtedly been a great success to the nation. However, it would be a mistake to think that growth will continue to the point where existing spectrum (including 3G) is saturated. To our mind, this will only happen if it is used in an inappropriate way ie by using a one-to-one mechanism for broadcast purposes.

Studies by the broadcasters suggest that it may be possible to clear a small number of channels at the top of band V without massive disruption. Also, it may be possible to clear a few channels around channel 35 but we would recommend that very great care is taken in assessing cost benefits before irrevocable decisions are made.

Section 3

The Role of Broadcasting in Future Communications Infrastructure

3.1 Foundation to the Technical Argument

Communications network providers have painted a picture of people on the move watching live transmission of football matches over communications networks. But the reality is, that delivered on a one-to-one basis, the network will be come saturated with only a handful of users and that a realistic price for such a service could never be achieved.

Both communications and broadcast communities understand this privately and there is serious work being carried out between the UMTS Forum and the DVB, for example, to develop combination systems offering the best of both worlds[3]. Data broadcasting using DVB-T can be very efficient in two ways:

(i) The use of COFDM and DVB-T modulation schemes are amongst the most technically efficient ways of transmitting data of any.

(ii) The use of multiple transmitters with local injection gives the potential for highly targeted data paths to the user.

Thus, we would argue that the current uhf band should remain reserved for broadcasting, using the definition above, and that future government policy should be directed towards maximising spectrum efficiency and liberating capacity for radically new high bandwidth data services based on the existing 8MHz channel structure.

3.2 Introduction to 4G

The term '3G' (3rd Generation) has been used to describe the next generation of mobile communication technology. Intended to build on the overwhelming success of gsm (2 G) technology, telecoms operators allowed themselves to dream of a future where almost anything was possible. To that extent, it was technology driven and not market driven.

A number of learned authorities believe that 3G represents flawed thinking and have urged the telecoms community to look again at market needs. They have coined the phrase 4G to represent a step beyond 3G where different (existing) technologies are employed in a unified system to provide a flexible and scalable system based on perceived market requirements for a wide range of mobile communications.

3.3 4G Market Needs

Existing 2G services were designed for two-way voice communication and is thus built on frequency division duplex (FDD) channels. Such communications are, by definition, symmetric. Clearly, it is inefficient for multimedia traffic such as multimedia communications or multicasting.

Likewise, inefficiencies (and ultimately unnecessary cost) can arise through inappropriate rf channels for the required use. A layered approach to personnal communications suggest the following different situations exist:

- Personal layer, in room (2.4GHz)

[3] *The Convergence of Broadcast & Telecommunications Platforms*, DVB TM 2466 (Aug 2001)

- Local layer, in building (eg DECT, 802.11)
- Mobile personal (2G, 3G)
- Regional assymetric (DAB, DVB-T)
- National, Global (2G/3G[roaming], Satellite)

3.4 Examples of Convergence

It is suggested that a design for 4G should allow the user the freedom to select seamlessly the service most appropriate to his/her need with commensurate cost, quality of service, user preference, etc. A range of such systems should form part of a unified whole, such that handover between systems is possible as the user moves across operational boundaries as well as physical ones.

As an example, let us look at how DAB / DVB-T might be used in conjunction with GPRS / 3G. It seems likely that a future PDA will be equipped with both and studies are under way on how these two technologies may be used together in an optimised way.[4]

From a broadcast point of view, mobile telephony has the assets of convenient back-channel and proven mechanisms for charging, including micro-payment. From, the telco's viewpoint, a combined equipment could open the door to the possibility of new broadband information services.

3.5 Integration of technologies: hybrid systems

From a spectrum point of view multicasting to *n* users is *n* times more spectrum efficient by using an access network based upon broadcast technology, like DVB-T. The reason is simple, broadcast systems only need to transmit one time the multicast connection to *n* users whereas telecom systems have to transmit *n* parallel point-to-point connections to *n* users.

For unicast communications broadcast networks, especially DVB-T/S/C, could offer great capacity and efficiency compared to telecom systems because of the large bit rate offering large trunking gains. Furthermore DVB-T provides the largest bandwidth to individual mobile receivers at high speeds than any other radio interface as shown in the ACTS MOTIVATE.

Future 4G wireless networks will combine several access technologies in order to reach a higher number of users and maximise the capacity delivered to them, resulting in an optimisation of the wireless resources. Some of the technologies that are expected to participate in this network integration are the broadcast family (DVB-T, DVB-S, T-DAB), the cellular family (GSM, GPRS, UMTS), and the WLAN family (IEEE802, Hiperlan2, Bluetooth).

[4] MCP. Hybrid Broadcast-Telecom Systems For Spectrum Efficient Mobile Broadband Internet Access (Framework 5 funded project)

3.6 Reconfigurable Technology

It has been suggested that the only long term solution is to implement reconfigurable technology, such that compatibility between layers is achieved by a continuous process of software changes. [5] There are a number of challenges to this approach:

- Standards and regulation
- Business models
- Intersystem handover mechanisms
- Flexible spectrum allocation
- Security, privacy
- Software download mechanisms, security (virus)
- Enabling technologies

3.7 Dynamic Capacity Allocation between TV and Mobile Internet

The broadcast of TV content could be deliberately *tailor-made* to fit the variations of DVB-T-based mobile Internet traffic during the day. The mobile Internet traffic is a function of user behaviour, and can be assumed known statistically. In this way a dynamic capacity allocation TV/mobile Internet could be achieved *within DVB-T*, so that 100% of the spectrum is utilised 100% of the time.

3.8 Conclusions

Broadcasting and mobile telecom are both optimised for certain kinds of services but are clearly sub-optimum for others. Only by combining broadcast and mobile telecom functionality can a future 4G system provide full cost/spectrum efficiency for widest possible range of services. In the EU funded MCP project an open hybrid system based on any combination of broadcast network(s) and mobile telecom network(s) is being developed and specified.

With an MCP system an increase in spectrum efficiency can be achieved for content that is relevant for many users, such as a large part of the www traffic, by using the broadcast functionality. Thanks to the emerging existence of hard disks in set-top-boxes and to the forecast continuous exponential increase in storage capacity, consumption of TV will be more and more time shifted in the future. This could open the door for dynamic capacity allocation between digital terrestrial TV and mobile Internet *within* a DVB-T signal. This would further increase the spectrum efficiency of DVB-T.

[5] Prof Aghvani, Centre for Telecoms Research, Kings College, London. IEE Colloquium, Dec 2001