DELIVERABLE TR7.1

INTERIM REPORT ON USE-CASES AND SCENARIOS ASSOCIATED TO COMMON BROADCASTING SPECIFICATIONS

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Version 1.0 (2012 - Jan. 31th)

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1 INTRODUCTION & CONTEXT

The introduction on the mobile market of Smartphones, and more recently of Tablets, has massively contributed to the dramatic increase of mobile data traffic, generated by the recent evolution of usages (see below, CISCO and Ericsson forecasts).

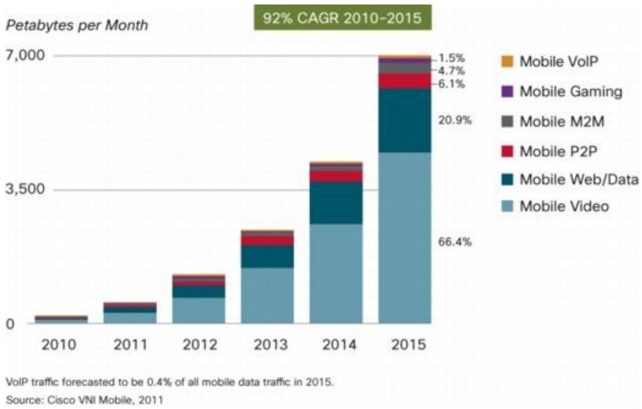


Figure 1 - *"Mobile Video Will Generate 66 Percent of Mobile Data Traffic by 2015"* (see [1])

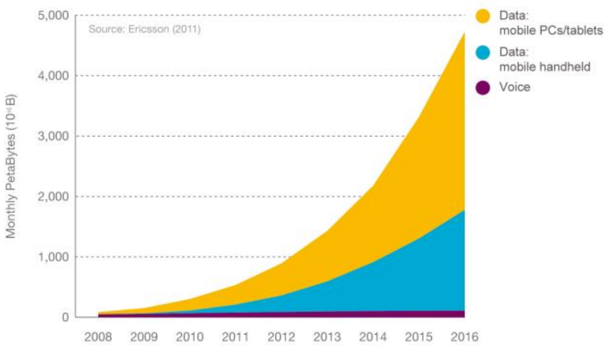


Figure 2 - *"Mobile traffic: voice and data, 2008-2016"* (see [2])

The main part of this huge traffic will be video (66% by 2015), coming for instance from websites like YouTube or Dailymotion (can be user generated contents), but also from live TV channels... Such contents are carried today on 3G mobile networks in a "unicast" (point-to-point) fashion, meaning that two (or more) users requesting the same content at the same time will use two (or more) distinct spectrum/radio resources carrying the same data.

A first solution to relieve 3G networks consists in offloading traffic, for instance, on a WiFi connexion (when user is at home or at work and under WiFi coverage). In Cisco Visual Networking Index (VNI), it is forecasted that "the total offload for smartphones and tablets will be 39% in 2015, up from 31% in 2010" (see figure below).

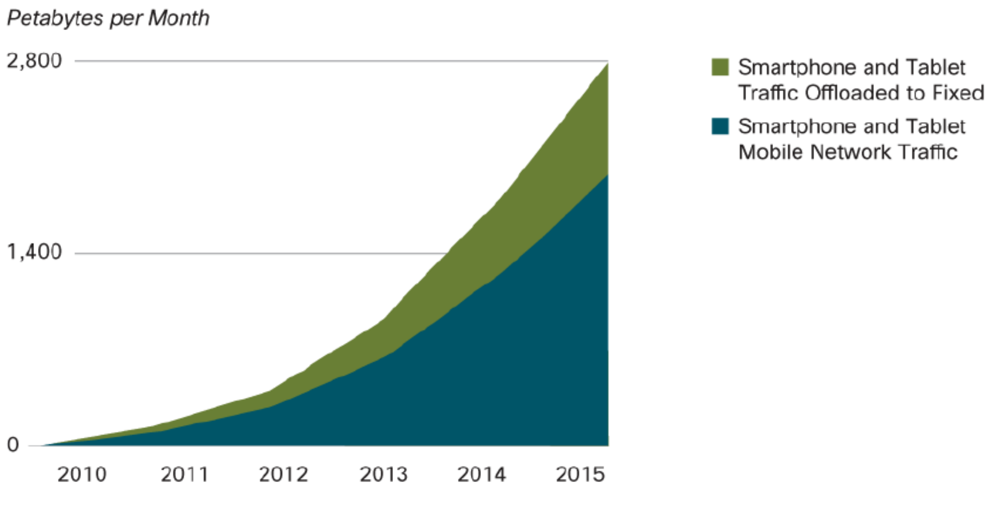


Figure 3 – *"39% of Smartphone and Tablet traffic will be offloaded by 2015"* (see [1])

As explained in the same white paper, approximately 35% of the mobile data use happens on the move for which WiFi is not the appropriate solution.

In such a case, and when applicable (some services can be transmitted via broadcast while others, requiring interactivity, must use point-to-point transmission), a broadcast technology could be used in order to optimize spectrum resources and decrease network costs (not only at roll-out stage – CAPEX – but probably also while in operation – OPEX –).

Devices, such as smartphones and tablets, usually provided and sometimes subsidized by mobile operators, will be used more and more in the coming years to watch videos and TV; so having a broadcasting chipset, implementing a solution based on a broadband (3GPP) existing standard and improved with latest broadcast technologies, embedded in such mobile devices, will be a real enabler for the success of traffic offload on broadcasting. An initiative from DVB towards 3GPP encouraging the joint definition of Common Broadcasting Specifications – CBS – (see 3.1) has been proposed in 2010-2011. The creation of a study item in a 3GPP subgroup dealing with services has been discussed in May 2011; the objective was ”*to study the feasibility of, and creating common service requirements and use cases for, a* ***common broadcast specification*** *which can be used in a 3GPP mobile communications network and a broadcasting network that is based on DVB or other similar standards.*”

This study item was after all not created but ENGINES project believes that this converging approach is of interest for both broadcasters and mobile network operators and then decided to support it at an early stage. So this document will propose scenario(s) and use cases requirements associated with CBS; a reference business chain is proposed and added value for each player involved is detailed.

2 A LOOK BACK IN MOBILE BROADCASTING MIRROR

	ISDB-T 1-seg	CMMB	MediaFLO	DVB-H	ATSC-MH	DVB-SH
Frequency range	VHF, UHF	VHF, UHF, L & S bands Satellite : S band	VHF, UHF	VHF, UHF, L band	VHF, UHF	VHF, UHF, L & S bands Satellite : S band
Channel bandwidth	6; 8 MHz	2 (L) ; 8 MHz (UHF, S)	5 ; 6 ; 7 ; 8 MHz	5 ; 6 ; 7 ; 8 MHz	6 MHz	1,75 (L) ; 5 (S); 6; 7; 8 MHz
Modulation scheme	Multi-carrier OFDM	Multi-carrier OFDM	Multi-carrier OFDM	Multi-carrier OFDM	Single carrier	Multi-carrier OFDM
Number of sub-carriers	2k / 4k / 8k	1k / 4k	4k	2k / 4k / 8k	1	1k /2k / 4 k / 8k
Sub-carrier modulation	DQPSK, QPSK, 16QAM, 64QAM	BPSK, QPSK, 16QAM	QPSK, 16QAM (+ hiérar.)	QPSK, 16QAM	8-VSB	QPSK, 16QAM
Guard Interval	1/32, 1/16, 1/8, ¼	1/8	1/8	1/16, 1/8, ¼	NA	1/32, 1/16, 1/8, ¼
Non uniforme Modulation	Possible	Possible	Possible	Not possible	Not possible	Not possible
Channel coding	RS (Outer) + Viterbi (Inner) per segment	RS (Outer) + LDPC (Inner) per service	RS (Outer) + Turbo-code (Inner) per service	RS (Outer) + Viterbi (Inner) (+ MPE-FEC per service)	SCBC + RS (Outer) + TCM (Inner) (+AL-FEC for mobile service capacity)	Turbo-Code (Inner) (+ MPE-iFEC per service)
Inner code rate	½, 2/3, ¾, 5/6, 7/8	½, ¾	1/3, ½, 2/3 (2)	½, 2/3	2/3	1/5, 2/9, ¼, 2/7, 1/3, 2/5, ½, 2/3
Outer code rate	(204,188)	(240,176), (240,192), (240,224), (240,240)	(16,8), (16,12), (16,14), (16,16)	(204,188)	(207,187)	NA
Time interleaving	No	25 ms per seconde	~250 ms	No	1 s + transmitter diversity (8s-10s)	~300 ms to 10 s
Source coding	H.264, MPEG HE-AAC	H.264	MPEG-4, H.264	MPEG-4, H.264	H.264, MPEG HE-AAC	H.264
Max. bit rate (1)	NA, typically 416 kbit/s (QPSK, 2/3, 1/8)	16 Mbit/s	14,9 Mbit/s	12,9 Mbit/s	NA, typically 150 to 2500 kbit/s (3)	15,8 Mbit/s
Max. spectrum eff. (1)	-	2,0 bit/s/Hz	1,87 bit/s/Hz	1,53 bit/s/Hz	-	1,97 bit/s/Hz

(1) : indicative values for a common set of parameters except ATSC-MH : Channel Bandwidth = 8 MHz, 16QAM, CR=2/3, GI=1/8, MPE-FEC=7/8 for DVB-H, RS(16,16) for MediaFLO, RS(240,240) for CMMB

(2) :TC value of 2/3 for MediaFLO can't apply to QPSK modulation (except hierarchical broadcast mode)

(3) : at the expense of a main data loss of 900 to 7300 kbit/s refered to a full capacity of 19,4 Mbit/s and for different levels of robustness (AL-FEC)

Figure 4 - Main technical features of mobile broadcasting standards at a glance.

2.1 ISDB-T 1-seg

2.1.1 Main Features

ISDB-T 1-seg relies on ISDB-T technology, which is the DTT Japanese standard, and designed in the same time as DVB-T. One specific feature is the organisation of the RF channel (bearer) with a total of 13 frequency segments. Each of them carries OFDM symbols with a modulation and FEC code value suited to targeted services (fixed or mobile). By this way ISDB-T standard provides native in-band facilities, allowing different levels of robustness per segment.

For ISDB-T 1-seg, the central segment of the RF channel (bandwidth = 6 MHz) is dedicated to the broadcast of mobile multimedia services (throughput of 416 Kbit/s for QPSK 2/3). The 12 other segments are used for the broadcast of fixed HDTV services (throughput of 16.9 Mbit/s for 64QAM ¾).

In 2008, Japan decided to design the ISDB-T version dedicated to mobile TV (namely ISDB-Tmm), including advanced features compared to the original standard. The main difference compared to ISDB-T 1-seg is the possibility to combine any of the 13 segments for carrying mobile multimedia services (better spectrum efficiency and flexibility). This standard remains backward compatible with the existing ISDB-T 1-seg version.

ISDB-Tmm highlights better RF performances than DVB-H, but comparison to systems of the same generation (DVB-SH, FLO EV) is not easy to establish.

2.1.2 Devices

Current shipment of ISDB-T compatible devices is the following:

- More than 98 million 13-seg television sets,
- More than 94 million 1-seg mobile phones.

1-seg receivers are also widely available for non connected devices: pocket TV, AV players, PC cards, USB dongles, PND (Portable Navigation Device), handheld game console, and dictionary. Many of these devices use a small whip antenna for reception.

2.1.3 Coverage

In Japan the broadcast network topology is designed for reaching fixed users (antenna rooftop reception). Even with a better robustness, it means that the 1-seg reception is offered on a best effort basis, with a reduced coverage footprint. Fortunately many TV transmitters with high ERP (Effective Radiated Power) are located in the cities or neighbouring suburbs, which is a helper for the reception of 1-seg services in dense population areas. In some places of interest or hot-spots, gap-fillers have been installed.

Tmm will rely on a dedicated SFN broadcast network, and the use of VHF band.

2.1.4 Services

1-seg services are FTA (Free To Air: no subscription fee). Various types of services can be achieved using functionalities combining 1-segment service reception and mobile communications:

- Broadcasting program view: to receive and view broadcasting program with mobile terminal.
- Data broadcasting view: to receive data broadcasting on the air (due to low bit rate content is limited).
- Mobile data online: TV program is on the air, and data is received via the Internet (without limitation of bandwidth).
- Link to web sites: full screen display of Internet content (TV program does not appear on the screen).

Example of known commercial applications:

- TV shopping: the service enables viewers to purchase commercial goods shown on shopping program.
- Local service: the service can provide local information such as emergency alerts, local events, and notice from local government or hospital.
- Coupon ticket: service enables to get coupon tickets such as grommet, movie, book...

- Additional information service: the additional information linked to on-air programs is supplement service such as information on athletes and celebrities, recipes, questionnaire and answer to a quiz.

On the other side, Tmm plans to introduce storage type services, and high-quality real time services.

2.1.5 Market

ISDB-T 1-seg has been commercially deployed in Japan since April 2006. It is also available in a few South American countries which have adopted ISDB-T (Argentina, Brazil, Chile and Peru). As mentioned above one key success of 1-seg is that there is no subscription fee.

In Japan the ecosystem is favourable for the launching of ISDB-Tmm services (subscription fee) on a nationwide basis. Launch is expected in April 2012. Mobile handsets and smartphones are the primary targeted devices for Tmm. It would be followed in a second step by dedicated receivers, such as tablet devices or PNDs.

2.2 CMMB

2.2.1 Main Features

CMMB was developed based on China's own mobile television receiver standard, STiMi, which is its first domestic system. CMMB provides the transmission signal frame structure, channel coding and modulation standards for broadcasting channels in the mobile multimedia broadcasting system, in the frequency range of the broadcasting business, from 30 MHz to 3000 MHz.

Based on a combined satellite (S-band at 2600 MHz) and/or terrestrial broadcasting network (UHF band), nationwide roaming for broadcast television, radio, data and other multimedia signals can be achieved. The system is somewhat comparable to DVB-SH, but technically DVB-SH outperforms CMMB in mobile environments. The CMMB satellite component is not deployed and there is no sign of a future implementation.

2.2.2 Devices

CMMB implementation requires a dedicated receiver unit. It is already integrated with GSM, 3G and 4G in most flavours. Several types of mobile terminals such as mobile phones, PDAs, MP3, MP4, PNDs, notebook computers (USB dongles) are supported. Most of them use a small whip antenna for reception. Normal terminals implement a very basic handover (simple scan mechanism). Car devices can include an UHF bi-tuner to implement “smooth” handover (e.g. between two cities / SFN areas of different frequencies).

2.2.3 Coverage

Coverage relies only on the terrestrial broadcasting network (tall towers and high ERP). All UHF channels can be used. At the end of 2010, 340 cities (500 millions inhabitants) were covered. Quality of coverage reaches 95% for outdoor reception, decreasing at 40% to 50% for indoor reception.

2.2.4 Services

CMMB supports various services:

- Live TV-Radio services (national + local)
- Government information publishing (e.g. emergency messages), mainly HTTP/WAP messages.
- Pushed internet-style content (HTML pages, videos, music), both from the telecom operator portal (e.g. pushed juke-box sound samples) and the ISP internet portal (popular web content). This service may induce two way communications, depending on what users do.
- Customized information broadcasting: localised information (e.g. traffic status, “TPEG” oriented), electronic newspapers.

- Navigation services or profile based advertising, e.g. smart location of neighbouring shops, restaurants, facilities. The location information is obtained through 3G (for connected devices) or through GPS (for non connected devices).

2.2.5 Market

China Mobile network cover more than 1 billion inhabitants in China. China mobile's TD SCDMA and CMMB are used in a complementary way. The telco offers are:

- Voice
- Full internet
- Rich VoD package (subscribed by 22 to 30 millions people)

CMMB is sold separately and dedicated to broadcast (currently mostly TV), but it is possible to switch from broadcast mode to unicast and vice-versa. Each service is used to stimulate the usage of the other (e.g. unicast on-demand music service is advertised by pushing sound samples on CMMB).

Commercial launch is effective since March 2010. At the end of 2010, CMMB service has reached between 10 and 15 million subscribers. Due to a market fragmentation related to several 3G systems (WCDMA, CDMA 2000, TD-SCDMA), CMMB extension can be slowed.

Since the shut-down of FLO TV services (see below), CMMB tries to enter the American market, see the following URL: http://cmmbamerica.com/

2.3 Media-Flo

2.3.1 Main Features

MediaFLO is an end-to-end system which covers the head-end, the distribution and broadcast networks. MediaFLO was developed based on Qualcomm's own mobile television standard, and is branded in USA as "FLO TV". Like most of the known digital broadcast technologies, FLO (Forward Link Only) relies on OFDM transmission (4K), and supports bandwidths of 5, 6, 7 and 8 MHz. FLO is intended to be used on terrestrial broadcasting network. Initial standard was FLO Rev 0 (USA market), followed by FLO Rev A (worlwide market). Only FLO Rev 0 has been widely deployed in USA. RF performances are better than DVB-H thanks to the use of turbo-codes, but remain lower than DVB-SH. However FLO upper layers are efficient compared to other systems (not based on IP, reduced overhead), and AV coding relies on advanced features derived from MPEG-4.

The last known version of the standard was FLO-EV. Main improvement was a better RF sensitivity, close to what is provided by DVB-SH at same capacity. However due to commercial failure of FLO TV, no chipset and devices have been designed following this last version of the standard.

2.3.2 Devices

MediaFLO devices were designed under the control / requirements of Qualcomm. The range included mobile phones and a personal TV receiver. A technical advantage in USA is that services were broadcast on one of two adjacent RF blocks (2x5 MHz in the 700 MHz band). The bandwidth to receive remains narrow, and allows RF optimization of the reception antenna (integrated type). Thanks to optimized upper layers, zapping time was fast compared to other systems.

2.3.3 Coverage

The FLO TV USA network was built on an opportunistic basis and is moderately dense. It means the use of high ERP powers (range between 4 kW and 50 kW) and transmitters are located on tall buildings, hills and medium mountains. Only one RF block was used on a nationwide basis (see above), meaning frequent SFN issues to solve. At the end of 2009, 105 markets (203 million inhabitants) were covered. After opening new markets, the network planning philosophy was to proceed to highway corridor coverage expansion, and deepening coverage of existing markets.

2.3.4 Services

MediaFLO services were exclusively TV centric (a common trunk of 14 TV services + 2 additional TV services per MNO). However MediaFLO was capable to convey other types of services, and Qualcomm had planned to extend them, but decision came probably too late.

2.3.5 Market

Commercial launch started in 2007, but unfortunately FLO TV services have been shut down since March 2011. Since then, Qualcomm has sold their FCC licences to AT&T, and has stopped FLO technology developments.

2.4 DVB-H

2.4.1 Main Features

DVB-H has been developed around 2000-2003, and is built on the fundamentals of DVB-T (designed in 1994). It means that RF performances are lower than any advanced system such as DVB-SH, MediaFLO or CMMB. An important part of the capacity is also lost through upper layers (overheads coming from MPE-FEC, IPDC). At encoding level DVB-H use the so-called MPEG-4 "baseline profile", which remains less effective compared to last systems derived from MPEG-4.

Nevertheless DVB-H remained at one time the most widespread mobile TV system throughout the world (trials, commercial services). Compared to current mobile broadcast technologies, DVB-H is definitively obsolete.

2.4.2 Devices

Several DVB-H devices were designed such as mobile phones and personal TV receivers. But as the market remained narrow on the long-term, wireless dongles and headsets have been also introduced as alternative devices. Theoretically they allow to be used with a wide range of standard devices, but they are not very convenient for the consumer, or show limited compatibility. Nowadays it is not possible to find new mobile phones supporting natively DVB-H.

2.4.3 Coverage

Depending on the local context, all scenarios about broadcast network topology can be found. The network can be built on an opportunistic basis, mapped on an existing television network, or tailored to specific requirements. Hybrid broadcast (DVB-T + DVB-H) is also possible, but has never been introduced whatever is the technical scenario: mixed services at transport stream level, or use of hierarchical modulations.

Quality of coverage experienced by the consumer is different from one country to another. This is the result of the chosen network broadcast topology. Quality of coverage on a targeted area can go from outdoor reception (e.g. Morocco) up to good indoor reception (e.g. Switzerland), with all intermediate levels.

2.4.4 Services

In practice DVB-H services were exclusively TV and radio centric. However thanks to DVB-IPDC, any IP content could be theoretically delivered.

2.4.5 Market

The market is in sharp decline. One reason is the lack of a relevant ecosystem and a limited attractiveness for the consumer (services and devices). Here it is not related to the DVB-H technology, and the story is the same as for FLO TV services. In Europe, All DVB-H markets are shut down one after the other. A few DVB-H markets remain still active in Africa and Far East, but probably not for a long time.

2.5 ATSC-M/H

2.5.1 Main Features

Traditional ATSC based on 8-VSB modulation (ATSC standard A/53) won't suffice for mobile or pedestrian based receivers. In order for ATSC Mobile DTV to be successful, the signal needs to have enhancements that will provide higher immunity to signal fades caused by multipath, Doppler, etc. In October 2009, after significant industry collaboration ATSC published the A/153 standard that enables broadcasters to provide new services to mobile and handheld devices using the digital television transmissions.

So what is the difference between ATSC (A/53) and ATSC Mobile DTV (A/153)? In a nutshell the A/153 provides:

• Enhanced upper layers reducing threshold C/N requirement (~11dB) compared to standard 8-VSB for SD/HDTV. However the resulting capacity for mobile services dramatically increases the main data rate loss (efficiency is about 17% to 35%, depending on payload data rate and robustness).

• Advanced video coding (H.264 / AVC) for the best compression efficiency with scale video coding capabilities

• Lower video resolution compatible with limited size screens

• Time slicing (sending video in bursts) to minimize battery drain on the receivers

• An Internet Protocol (IP) based delivery system (RTP/RTCP over UDP over IP)

• Native 16:9 aspect ratio

• Interactive application stack compatible with Telco mobile standards

2.5.2 Devices

All existing ATSC receivers are able to receive ATSC legacy part of the ATSC MH broadcast.
Specific devices are used to receive mobile part. LG proposed a receiving device chipset. At both the CTIA and the NAB shows, manufacturers such as Dell, Kenwood, LG Electronics, Samsung, Zenith, Valups, and others unveiled products for the ATSC Mobile DTV marketplace.

2.5.3 Coverage

ATSC MH coverage is directly linked to the existing infrastructure of ATSC legacy transmitters. The coverage gain is given by the gain of robustness given by the new coding scheme. The main target coverage is for vehicular reception as the main service is the re-transmission of existing TV broadcast to mobile receivers.

2.5.4 Market

ATSC MH is attractive where ATSC standard is deployed and it provides the traditional TV broadcaster a cost efficient mean to attract larger audience for mobile TV transmission. However, ATSC suffers from a poor spectral efficiency compared to latest deployed standard (max. 19/4Mb/s).

2.6 DVB-SH

2.6.1 Main features

DVB-SH is the first generation of standard delivering video, audio and data broadcast services to mobile phones and to vehicle-mounted devices with hybrid terrestrial-satellite network.

Hybrid satellite/terrestrial system allows, thanks to satellite component, to achieve a huge coverage (large regions or even a whole country) and to improve service availability in urban environments thanks to terrestrial repeaters.

Built on DVB-T and DVB-H specifications, the main innovations introduced in DVB-SH standard are the error correction coding solution and the definition of a long time interleaver.

Based on a hybrid terrestrial-satellite network, DVB-SH standard defines synchronisation mechanism solution between satellite and terrestrial components, enabling continuous coverage.

The DVB-SH standard implements the turbo codes introduced in the CDMA2000 and 3GPP2 systems. These codes improve the robustness of the transmission and expand the coverage of DVB-SH networks compared to DVB-T/H systems.

DVB-SH has extended the frequency range from VHF, UHF and L-bands to S-band (2170-2200 MHz), where two sub-bands are identified. With the adding of S-band, DVB-SH allows the use of satellite and the co-location with 3G/4G terrestrial frequency bands.

2.6.2 Devices

DVB-SH chips are available on the market. They were developed through the TVMSL project (financed by France institutions) and their performances were analyzed through a European collaborative project B21C.

These chips could be implanted into vehicles in order to receive DVB-SH Digital radio service from W2A satellite over extended French coverage.

2.6.3 Services

DVB-SH services are targeted at a single user (owner of a personal terminal) or a restricted set of users sharing the same terminal. The user can access the services while on the move, e.g. walking or while travelling in a car or on a train. The main interest is in broadcast services.

2.7 3GPP initiatives

Even if working on the specifications of mobile communications standards, 3GPP standardization body has also worked on the definition of broadcasting modes for the delivery of multimedia contents starting from Release 6, with introduction of MBMS (Multimedia Broadcast Multicast Service). Release 7 has introduced Single Frequency Network capability. The very first effective 3GPP broadcasting system is IMB (Integrated Mobile Broadcast) specified in Release 8.

2.7.1 IMB

IMB, based on 3G standard (CDMA), is an MBMS SFN (= MBSFN) TDD technology:

- The objective is to carry a Multimedia Broadcast Multicast Service,
- In a Single Frequency Network,
- On Time Division Duplex spectrum, owned by mobile operators, but still not used. So there is no impact on the FDD spectrum resources dedicated to unicast.

Another interest of IMB is that it re-uses 3G unicast technologies; then this is not big effort to upgrade a “basic” base station with IMB feature (a dedicated overlay network is not required – CAPEX savings).

IMB offers a useful robust 5 Mbps broadcast capacity into a TDD 5 MHz bandwidth.

Given that 1900-1920 MHz TDD band is very close to 3G FDD uplink frequency at 1920-1925 MHz, filtering and protection must be carefully achieved to ensure interference free operation between IMB and 3G.

IMB GSMA white paper (see [3]) gives a couple of examples of services that could be offered with IMB: live TV is considered but not exclusively; non-linear services are also detailed (pre-download of the content before viewing – contents could be all kind of news, e.g. stock market updates, weather or traffic information... but also music, games, e-books...).

IMB is currently trialled in UK by O2, Vodafone and Orange operators, with the support of IP Wireless, Ericsson and Streamezzo.

IMB accessories are available for IPhones and IPads.
(http://www.ipwireless.com/files/pictures/iPhone_iPad_accessory%20copy.pdf)

2.7.2 E-MBMS

E-MBMS (Evolved Multimedia Broadcast Multicast Services) is the broadcast mode of 3GPP LTE (Long Term Evolution) and has been specified starting from Release 9.
In its current version, it can be transmitted in a TDM (Time Division Multiplex) fashion with unicast (LTE) – known as shared carrier in 3GPP terminology –, which however decreases available unicast throughput. Broadcast resources can be (semi-)dynamically transmitted in time and location, what is very interesting to absorb occasional traffic peak (e.g. popular live TV event), while avoiding roll-out of a dedicated broadcast network.
E-MBMS re-uses LTE physical layer (based on OFDM); a specific guard interval value has been added for SFN purpose when E-MBMS is used in standalone way.
Thanks to this “in-band” definition of a broadcast mode on top of LTE, a “single” hardware can be used for both unicast and broadcast, not only in base stations (network upgrade cost significantly reduced) but also in devices.

2.8 Analysis and enabling/disabling factors

A first point to underline here is that dedicated mobile broadcasting networks – T-DMB, ISDB-T – have been nationally rolled out in countries where it has been clearly encouraged by local authorities (Korea, Japan). A wide coverage has now been reached in these countries (maybe at the exception of deep indoor); many different types of devices are available; ecosystem is mature. However, in both cases, only free-to-air transmission has met the success; business models based on pay-TV service are tricky (users disagree to give money to what they can get for free on internet ... and money usually comes from end-users!). It is quite clear now that "Live-TV-only" service will not lead to the commercial success of mobile broadcasting networks.

In order to optimize network roll-out costs (CAPEX), up-to-date mobile broadcasting standards are "in-band" solutions, meaning that "mobile broadcasting" is a "by-product" of a mother system: E-MBMS & LTE, 1seg & ISDB-T, DVB-T2 Lite & DVB-T2... The same hardware can be re-used for two distinct (complementary) systems: mobile broadcast upgrade of base stations/transmitters is far less expensive than the roll-out of a dedicated network.

Another decisive element is the availability and renewal of devices (see DVB-SH and DVB-H cases for which either no devices were available or no renewal of handhelds was possible after a couple of years). As it can be observed today with smartphones and tablets, devices are key in the business chain and such terminals will have to embed a broadcast chipset for the success of mobile broadcasting. It must be noted here that such devices are often provided (and sometimes subsidized) by mobile operators.

The availability of common (mobile) broadcasting specifications between mobile and broadcast worlds would have probably many positive aspects:

- Past attempts to propose "on-shelves" mobile broadcast solutions to telcos remained vain (see DVB-H for instance). In order to be able to access smartphones and tablets, it is quite obvious that starting from existing 3GPP technologies would greatly help for future integration in equipments and devices.
- 3GPP is already a worldwide organisation and specify standards widely deployed around the world. A 3GPP-based unified broadcast standard would also avoid market fragmentation and fierce battle between multiple standards (it used to be the case between MediaFLO, DVB-H, 1-seg, DVB-SH and is still currently the case between DVB-T2, ISDB-T, etc...). A single standard would also lead to economies of scale.
- A clever unified system would allow each operator (mobile or broadcast) to optimize its own roll out with specific parameters; then a complementary or collaborative coverage could be considered; handover, when required (either between unicast and broadcast, or between telco-operated and broadcaster-operated networks), could be made far more easier as based on a same physical layer.
- ...

3 BROADCAST-BROADBAND CONVERGENCE INITIATIVES

3.1 DVB/3GPP standardization bodies and CBS

In the framework of DVB-NGH (Next Generation Handheld) standardization, Orange proposed in March 2010 to define a standard based on 3GPP LTE (Long Term Evolution) broadcast mode, known as E-MBMS (Evolved Multimedia Broadcast Multicast Services). Although this proposal has not been, in a first time, welcome with much enthusiasm, DVB Forum decided to contact 3GPP in November 2010 to discuss about collaboration opportunities.
A joint session then took place in March 2011 in Kansas City in the course of which presentations of 3GPP E-MBMS and DVB standards have been done (http://www.3gpp.org/SA-51-Highlights).

In May 2011 a study item proposal was presented to sub-group 3GPP SA1 (dealing with services). The objective of this study was to " study the feasibility of, and creating common service requirements and use cases for, a common broadcast specification which can be used in a 3GPP mobile communications network and a broadcasting network that is based on DVB or other similar standards." In this document the acronym CBS (Common Broadcasting Specifications) has been used for the first time. This proposal was discussed but not accepted, due to lack of mobile network operators' support.

These events are summarized in the figure below.

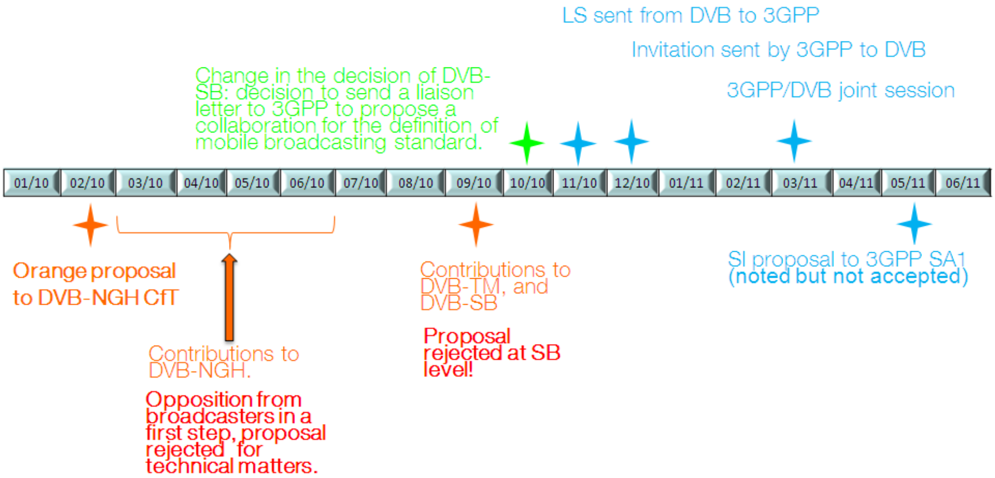


Figure 5 – DVB/3GPP mobile broadcasting standards convergence initiatives: timeline.

3.2 Worldwide initiatives

3.2.1 ATSC 3.0

On US side, ATSC (Advanced Television Systems Committee) has initiated technical discussions between industrials in order to identify candidate technologies for the definition of next generation broadcasting standards. In the final report summarizing the contributions, "universal broadband broadcasting" concept is proposed:"*The proposal suggested working towards convergence with IMT-Advanced (LTE, IEEE 802.16M) systems, if possible, by operating collaboratively within portions of the broadcast television spectrum.*"

During SMPTE Conference (Oct. 2011), the concept was detailed and broadcast overlay was presented as a solution "to provide complimentary 'shared' services and infrastructure to more efficiently use the UHF spectrum" with wireless operators (offload from mobile operators network to broadcast network is suggested). An example of extended OFDM parameters based on existing 3GPP E-MBMS standard are also proposed and impacts on architecture are discussed.

Main ideas of the proposal are summarized in the figure below.

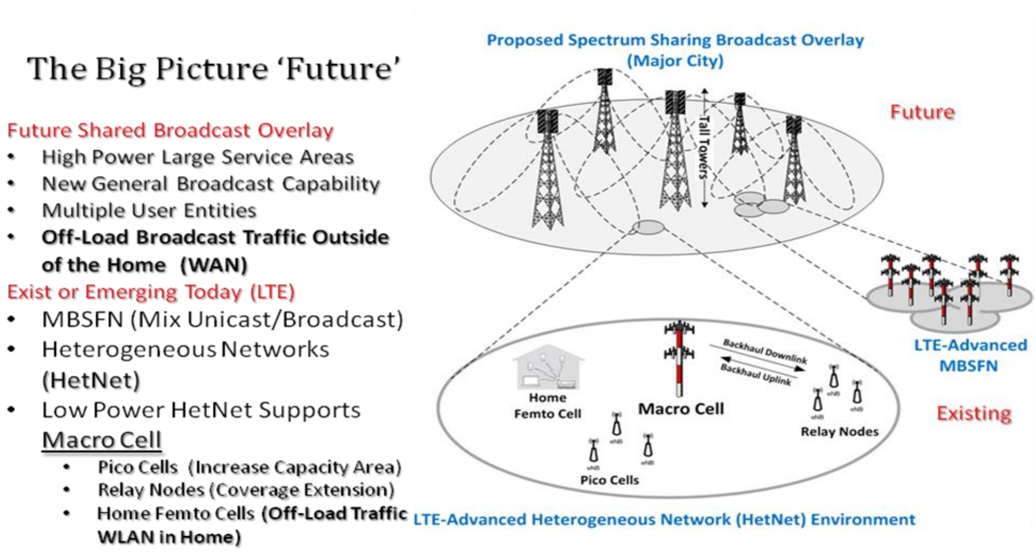


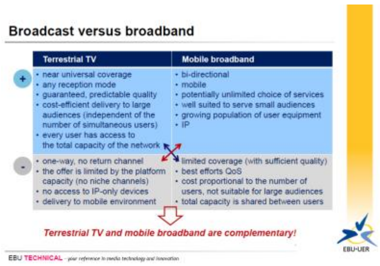
Figure 6 – ATSC 3.0 broadband/broadcast cooperation overview

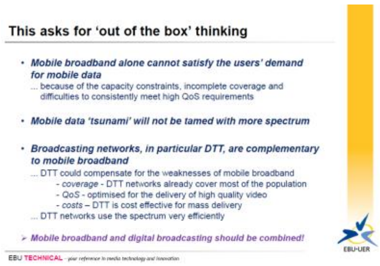
3.2.2 FoBTV Summit

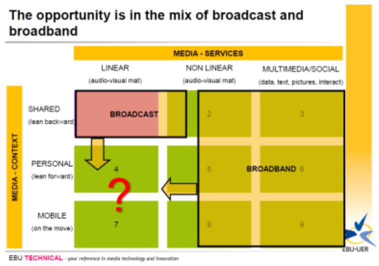
The objective of FoBTV (Future of Broadcast TV) Summit in November in Shanghai was to gather together all the worldwide broadcasting organizations, and to exchange about the opportunities for the definition of common worldwide broadcasting specifications, as it is done today for mobile standards inside 3GPP.
The outcome of this summit is the signature of a joint declaration that includes the following objectives:

- To define the requirements of future terrestrial broadcast systems
- To explore unified terrestrial broadcast standards
- To promote global technology sharing.

The two first points include collaboration/cooperation with communication systems. The following slides from the EBU presentation explains why and how this collaboration could happen.







3.3 Need for feasibility study

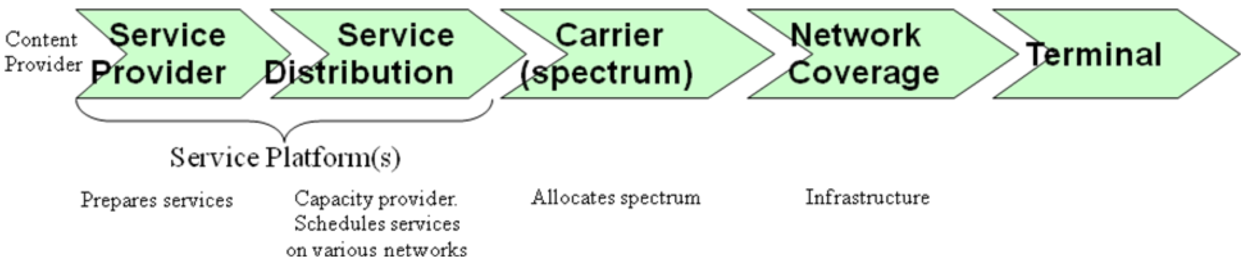
These initiatives described above mainly come from the broadcasting side of the world. In order to convince mobile operators of the interest of such an overlay broadcast, the need for more detailed explanation on the definition of scenario(s), use cases and service requirements is established; it is a pre-requisite before any standardization work can start.
The object of this document is to propose first use cases of collaboration between mobile and broadcast operators, based on a common broadcasting specification, and to derive added value for each player involved in the business chain.

4 USE CASES AND SCENARIOS FOR CBS

4.1 Reference Business Chain, Definitions and Roles of Actors.

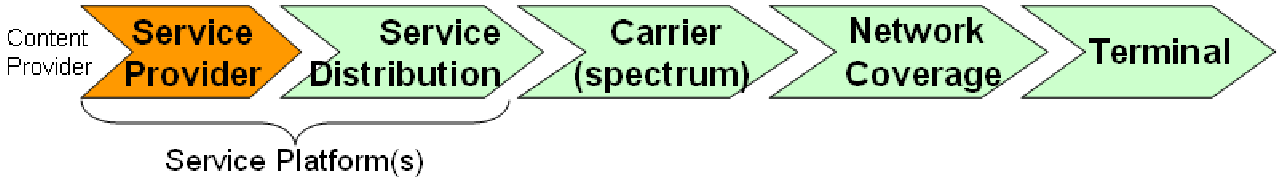
As mentioned above, CBS is defined as a broadcasting system which can be used in 3GPP mobile telecommunications and/or broadcasting networks. It means that several use cases can be encountered, resulting in different situations for each actor. For a better understanding it is proposed to introduce a reference business chain, where respective entities and roles are defined. Then, impact of the different use cases are considered on each entity of the business chain.

The proposed reference business chain is shown below:



Each component of the reference business chain is described and studied in the following sub-chapters.

4.1.1 Service Provider



Positioning

Service Provider is one of the two components belonging to a Service Platform. Service Provider is fed by the Content Provider who delivers elementary content. Contents are original streams, such as live TV stream provided by a broadcaster, or non formatted files such as a video file of a movie.

The role of the Service Provider is focused on the content aggregation. It includes two main steps:

- The gathering of the elementary contents, and their local storage.
- The aggregation and formatting of the original contents, according to commercial and technical requirements.

Content supplied from the service provider can be sets of formatted video streams or files, with additional third party audio track, logo or data (text or multimedia). Formatting includes also audio/video encoding or trans-coding, with suited resolution, aspect ratio, data rate. A close link exists also with the Service Distribution (see next chapter) with a possible loopback coming from it.

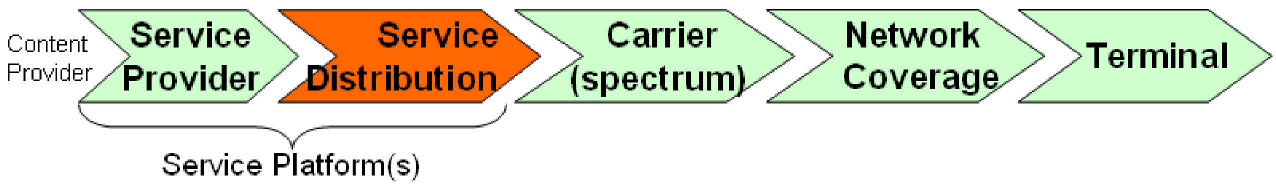
Network sharing impact

If no network sharing is considered, it means that there will be two independent Service Providers (a telco one and a broadcast one). Each of them will tailor the provided content (which can also differ from one to another) to their own technical and commercial requirements.

If network sharing is considered, a single set of services is possible. It can be provided by a single Service Provider if actors agree on this point.

Between these two scenarios, there can have intermediate ones. As an example the network sharing can be not systematic. Depending on targeted areas or local networks topology, services can be delivered to the consumer through only one medium, which is the most relevant at a given place.

4.1.2 Service Distribution



Positioning

Service Distribution is the second component belonging to the Service Platform. Service Distribution is fed by the formatted content coming from the Service Provider. Role of the Service Distribution can be understood as a Capacity Provider, with several objectives:

- It manages in real time the available capacity in the most efficient way, suited to the different distribution modes, e.g. content on demand, stated from a portal, or delivered in push mode.
- It schedules the delivery of push content, and builds the appropriate signalling to enable the terminal to find the services (e.g. program guide).

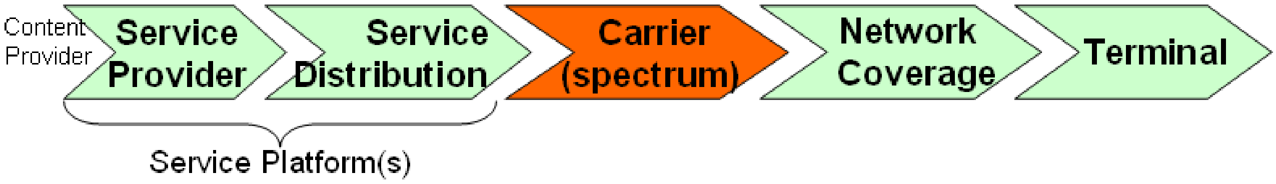
- It determines the routing of the different services to one or several networks, till at service level and location of transmitter or base station

Network sharing impact

If no network sharing is considered, it means that a Service Distribution is dedicated to each network. For example in a TV broadcast context, the Service Distribution is identified as the broadcast multiplex operator.

If network sharing is considered, the Service Distribution is necessarily shared. This scenario implies consolidation on routing and cross-signalling. The Capacity Provider must be able to manage both broadcast and unicast distribution capabilities.

4.1.3 Carrier

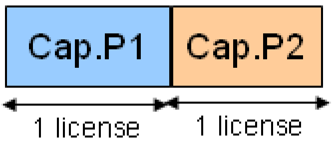


Positioning

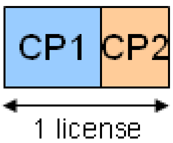
Carrier refers to the Spectrum License Owner. It is not necessarily the owner of the distribution network, especially in the world of broadcasting. It allocates spectrum granted by its license to Capacity Providers. In many cases allocated spectrum may be physically not contiguous (frequency blocks or channels).

Network sharing impact

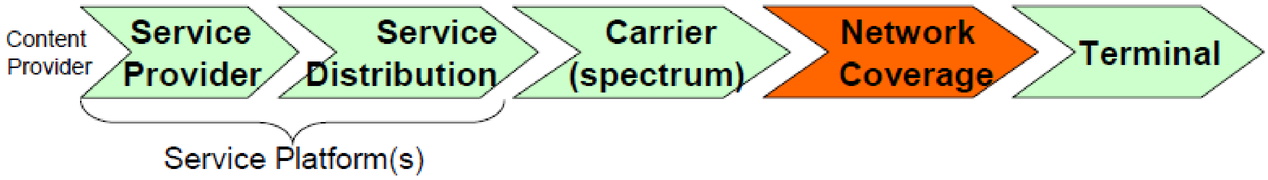
If there is no network sharing, it means that there is no spectrum sharing at Capacity Providers level. In this situation the Service Provider, Service Distribution and Carrier are often a single entity, which owns an exclusive operating license. However this situation does not exclude cooperation with two actors owning distinct licenses. See drawing below.



Conversely spectrum sharing implies network sharing. Spectrum sharing can be done following FDM and/or TDM techniques. For an efficient delivery of services, spectrum sharing requires a smart management at Capacity Provider level (broadcast and unicast distribution capabilities). For this reason there is only one Service Distribution entity, whatever is the number of involved Capacity Providers. The Spectrum License Owner through the Service distribution is alone to manage the overall resources for all kind of networks. See the simplified drawing below.



4.1.4 Network Coverage



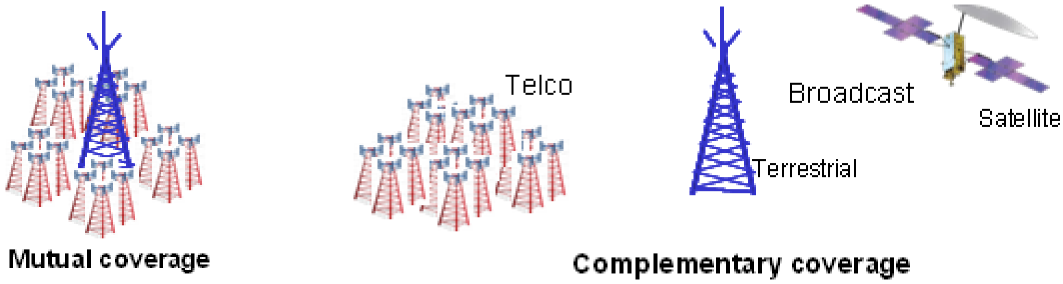
Positioning

The Network Coverage results from the infrastructure (ensemble of transmit sites or base stations and associated backhaul / transport networks) implemented by one or several Network Operators. Telco networks generally belong to the Spectrum License Owner, but for broadcast networks the situation is variable from one country to another, according to regulatory aspects.

Main objective is to provide required capacity over a given area. Satellite delivery can be also relevant, depending on commercial requirements. However if satellite delivery is taken into account, the impact on CBS specifications could be strong, due to specific requirements for satellite transmission and reception.

Network sharing impact

For any scenario of cooperation involving or not spectrum sharing, the pooling of network infrastructures follows two types of scenario: mutual coverage or complementary coverage.



Mutual coverage: a single targeted area, complementary uses:

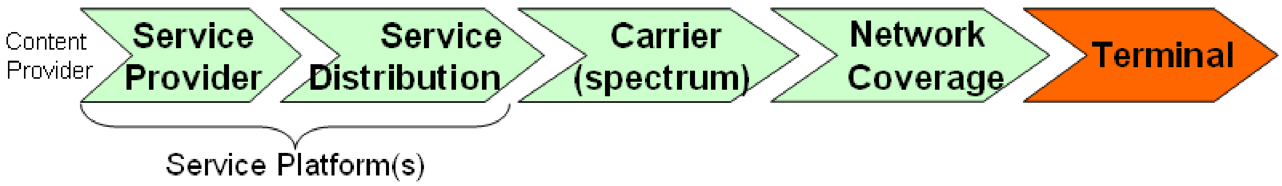
- Many implementation variants: MFN or SFN,
- Same content broadcast on all sites or not,

A possible strategy can be the optimisation of the coverage cost, according to indoor and outdoor coverage requirements. The existing telco network remains the main driver for building an efficient combined network.

Complementary coverage: targeted areas are different.

- Different operators for city versus rural areas
- Possibly use of a satellite component, part of an hybrid network

4.1.5 Terminal



Positioning

This refers to the personal device used by the customer. Suited software provided by the Service Provider is loaded into the terminal, allowing the access to the different services. The objective is to render a service from the data received from one or several networks, according to rights subscribed by the user to a service provider (eventually no subscription in the case of free-to-air).

Network sharing impact

Any scenario involving cooperation at network level requires a CBS compliant receiver (downlink only in broadcast mode) and another unicast system (the current telco path).

As several frequency bands can be used, all relevant frequency ranges and required spectrum schemes, such as adjacent or spread frequency blocks must be supported. Carrier aggregation which allows expansion of effective bandwidth delivered to a user terminal through concurrent utilization of radio resources across multiple carriers, can be also of interest here. If CBS bearer is broadcasted in a wideband of spectrum, the manufacturer will have to pay attention to RF performances, such as sensitivity and immunity to other embedded RF systems.

4.1.6 A few scenarios in a nutshell

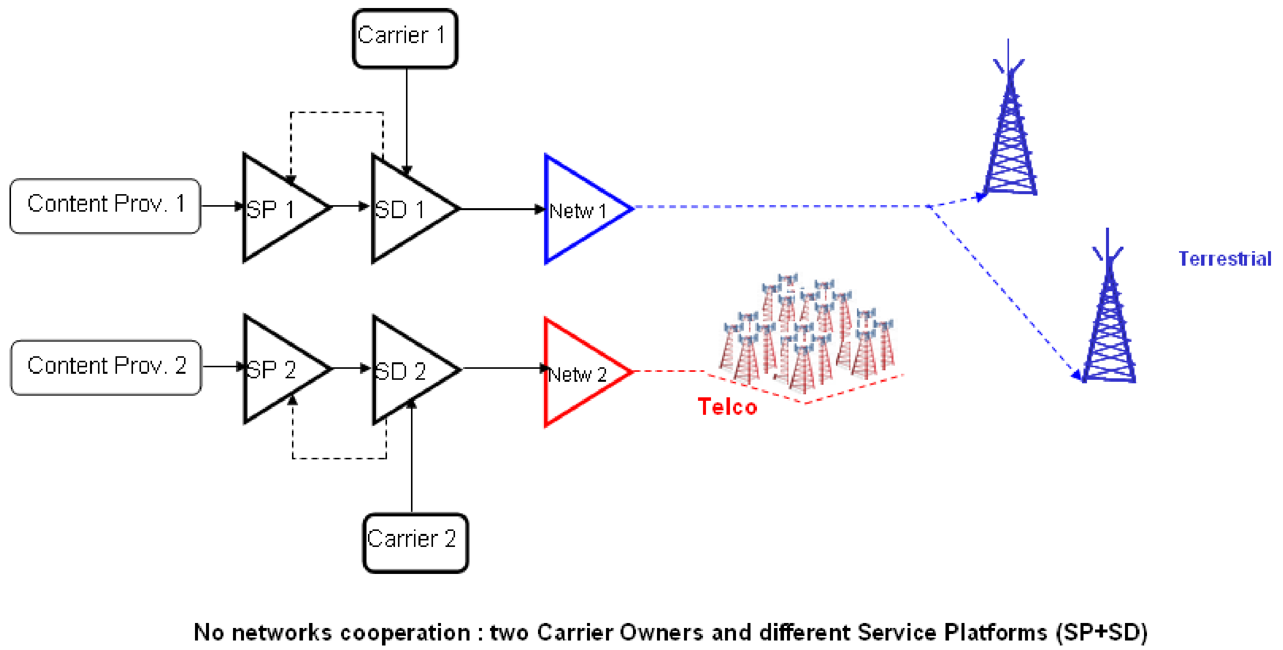
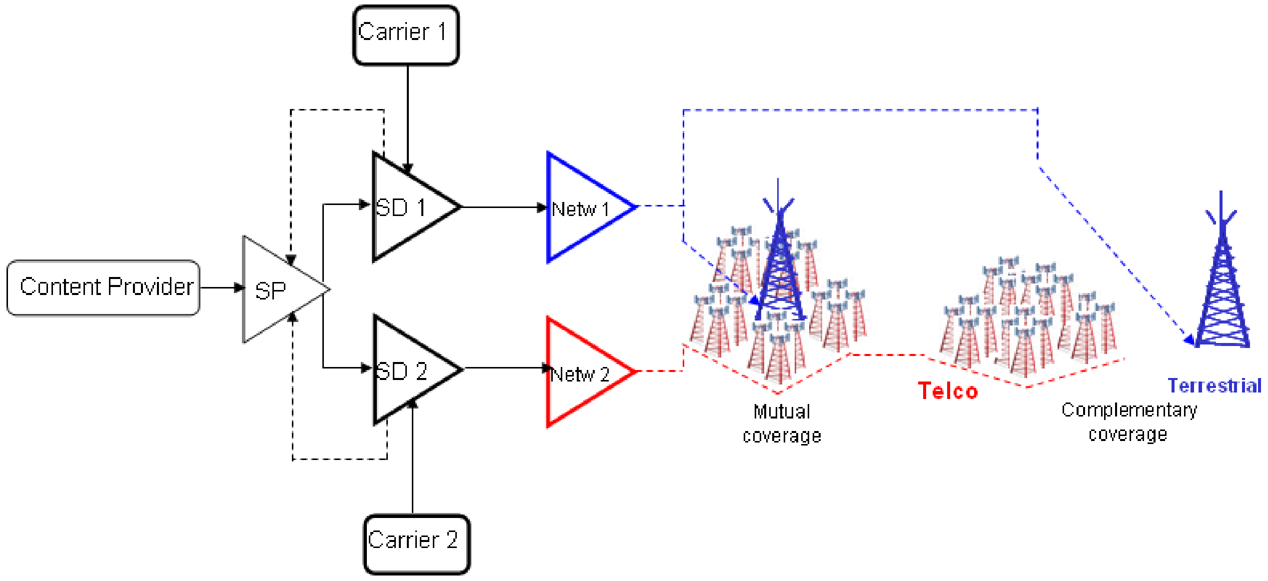
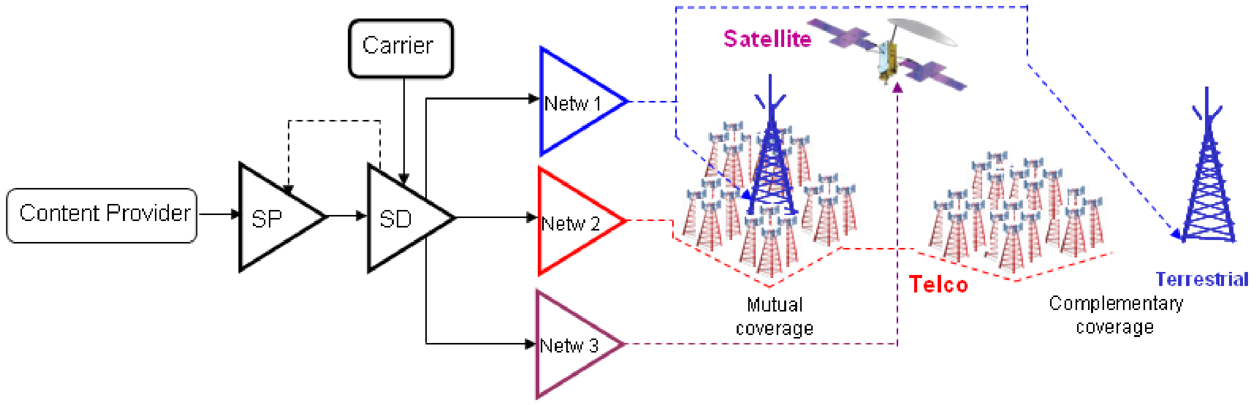


Figure 7 – Scenario without no broadcast/broadband cooperation.



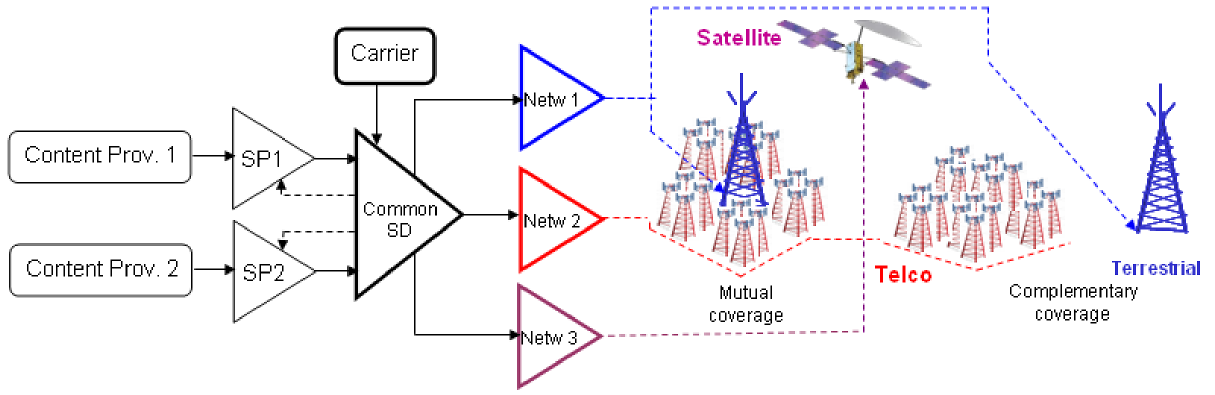
Networks cooperation without spectrum sharing : two Carrier Owners and common Service Provider

Figure 8 – Scenario with common service provider.



Networks cooperation with spectrum sharing : one Carrier Owner , one Service Provider and Capacity Provider

Figure 9 – Scenario with spectrum sharing, common service provider and capacity provider.



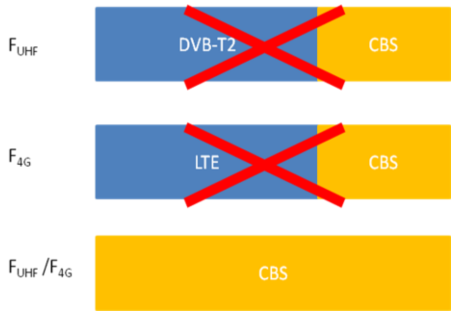
Networks cooperation with spectrum sharing : one Carrier owner, two Service Providers and common Capacity Provider

Figure 10 – Scenario with spectrum sharing and common capacity provider.

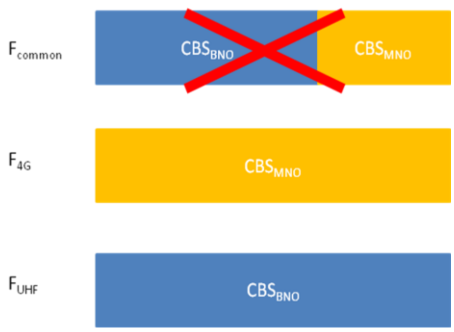
4.2 Dedicated Carrier Downlink Only use case

This first use case is the most straightforward one. Let's assume that a mobile broadcasting standard has been defined jointly by DVB and 3GPP. Different set of parameters can be selected either by broadcast operators to cover large areas thanks to high powered elevated towers, or by mobile network operators to cover smaller cells from low powered base stations.

Spectrum, in which the system can be transmitted, is 100% dedicated to broadcasting (and then downlink only). No sharing, in time or frequency, between fixed and mobile broadcasting (case of DVB-T2 and DVB-T2 Lite for instance), or between broadcast and unicast (case of LTE and E-MBMS for instance) is allowed.



Moreover, parts of spectrum allocated to mobile operators and broadcast operators remain distinct, e.g. 4G bands for mobile operators and UHF spectrum for broadcast operators. No time sharing between MNO broadcasting and BNO broadcasting in a single band is then considered here.



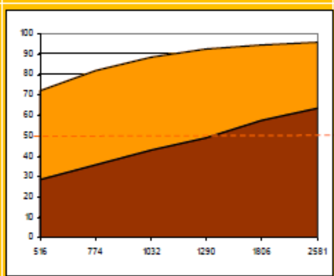
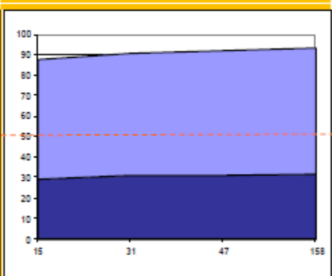
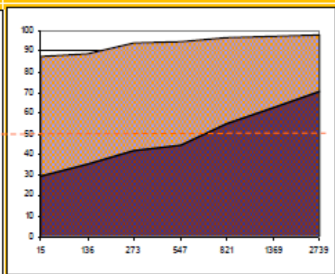
This use case is 100% in line with what had been proposed to 3GPP in May 2011. Here follows an extract of the SID (Study Item Description) companion slide set, explaining the targeted scenario.

CP:	Content provider (e.g. Disney)
SP:	Service Provider (e.g. BBC)
MNO:	Mobile Network Operator (e.g. Orange)
BNO:	Broadcast Network Operator (e.g. TDF)
CBS:	Common Broadcast (= downlink only) Specification
B. spectrum:	Broadcast spectrum
MC spectrum:	Mobile Communication spectrum

In this proposed scenario, “Service Providers” can be different (on telco and broadcast sides) or a single actor; the same rule applies for “Service Distribution”.
In a basic analysis, in the proposed scenario, “Carriers” are different: one actor has been granted the broadcast licence and another actor owns the telco licence. However, according to regulation, it could be considered that a single actor owns both licenses. Such an integrated operator (if the “Carrier” is an operator) could maybe choose the “best” spectrum/access mode (unicast versus broadcast) to deliver contents.
In terms of coverage, either mutual or complementary coverage could be considered:

- Mutual coverage:
  - In this case CAPEX could be saved: broadcasters would not have to deploy a dense network in order to reach indoor users; they could rely on dense mobile operators’ networks. Conversely a mobile operator could rely on already existing broadcasters’ infrastructure to deliver cost efficient video services for instance.
- Complementary coverage
  - In some cases a given area will not be covered by both types of operators; in this case each operator will manage his own network and will select delivered contents. At the borders, seamless handovers strategies have to be defined in order to offer service continuity. Based on a similar standard, handovers could be made easier.

Former studies, led by Orange in 2006 and related to DVB-H network planning over Paris area, concluded that a mix between mobile sites and broadcast sites was optimal for outdoor up to deep indoor coverage (see [5] for more details on parameters settings).

	Mobile Sites	Broadcast Sites	Mix Scenario
Served population (in %) according to # of activated sites			
Power	100W	h<50m: 100W 50m<h<100m: 1kW h>100m: 2.5kW	Mobile: 100W Broadcast: 100W to 2.5kW

- Indoor coverage based on broadcast sites is limited whatever the amount of activated sites but effective with the highest 15 sites (>100m). The emitted power for these sites is a key point as it might dramatically increase indoor coverage rate.
- Rollout based on mobile sites allows achieving stronger indoor coverage rate but requires a large part of mobile sites to be equipped.
- Outdoor coverage is not a challenge as good rate can be fulfilled with only a few sites whatever the type of sites used

5 Conclusion and Perspectives

In this document, an overview of past experiments in mobile broadcasting is presented; enabling and disabling factors of success are also analysed. Starting from this, initiatives of broadband-broadcast cooperation are summarized, assuming that a key element for success of broadcast is that broadcast-capable-chipsets must be integrated in smartphones and tablets. Specific emphasis is put on 3GPP-DVB discussions aiming at defining common broadcasting specifications.
In order to assess the interest of such a unification of standards, a reference business chain, for the delivery of mobile multimedia services, is proposed and added value of CBS for each player is discussed. The focus is put on dedicated carrier downlink only use cases.
This preliminary version of the document does not include potential consequences on networks architecture, services platforms and so on. This will be studied in 2012 in the context of ENGINES project and detailed in release 2 of this document, planned for December.
Other use cases, not considered here but that could be relevant too, are based on shared carrier scenarios:

- Unicast and CBS broadcast (scenario similar to LTE and E-MBMS) transmitted on a single frequency;
- Fixed and CBS mobile broadcast (taking part of DVB-T2 Future Extension Frame for instance) transmitted on a single frequency;
- CBS mobile broadcast transmission from mobile operators and from broadcast operators transmitted on a single frequency.

6 References

[1] "Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2010-2015", CISCO, Feb. 2011.
[2] "Traffic And Market data report", Ericsson, Nov. 2011
[3] "Integrated Mobile Broadcast (IMB) Service Scenarios and System Requirements", GSMA, Sep. 2009
[4] "Broadcasting - The Technology and the Medium. 'Bringing Efficiency to Platforms and Services'", Mark Aitken / Sinclair Broadcast Group, October 21, 2011
[5] "DVB-H network planning and cooperative coverage", Orange, Nov. 2011