

PUBLIC



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Abstract

This document presents an outline of the partners exploitation plans starting from the business rationale and value proposition perspective, and provides a response to the 1st Annual Review recommendations. The exploitation of the outcome of SUIT assets on the level of SUIT consortium and on the level of individual SUIT partner is based on market analysis in the relevant market segments and Operators expectations. Information on commercial drivers and the potential for integration with partners existing portfolios of products and service are presented. SUIT technology implementation on the consortium level has resulted into a near commercial system made possible by a close involvement and integration effort of the Broadcaster (MCT/TVI), D7.4 presents operators expectations and likelihood of early adoption of SUIT concept.

Keyword list: Technology Implementation Plan (TIP); Exploitation

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Technology Implementation Plan (TIP)

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List of abbreviations & symbols

| | |
|------------|---|
| All-IP | = All-Internet Protocol |
| AVC | = Advanced Video Communication |
| ARPU | = Average Revenue Per User |
| BWA | = Broadband Wireless Access |
| CC/PP | = Composite Capabilities/Preferences Profile |
| COST | = European Co-operation in the Field of Scientific and Technical Research |
| CTC | = Convolutional Turbo Coding |
| DVB-T | = Digital Video Broadcasting-Terrestrial |
| DVB-T/H | = DVB-T/Handheld |
| DVB-RCT | = DVB- Return Channel Terrestrial |
| ENG | = Electronic News Gathering |
| ETSI | = European Telecommunications Standards Institute |
| FEC | = Forward Error Correction |
| FMO | = Flexible Macroblock Ordering |
| FPGA | = Field Programmable Gate Array |
| FTP | = File Transfer Protocol |
| FWA | = Fixed Wireless Access |
| HD | = High Definition |
| HDTV | = High Definition Television |
| HO | = Hand_Over |
| IBBT | = Interdisciplinair Instituut voor Breedband Technologie Vzw |
| IEEE | = Institute of Electrical and Electronics Engineers |
| IRT | = Institut für Rundfunktechnik GmbH |
| IPR | = Intellectual Propriety Right |
| ISP | = Internet Service Provider |
| IT | = Instituto de Telecomunicações |
| ITU | = International Telecommunications Union |
| ITU-R | = International Telecommunication Union Radiocommunication Sector |
| JVT | = Joint Video Team |
| LDPC | = Low Density Parity Check |
| MCT/TVIF | = Motion-Compensated Temporal Filtering |
| MD | = Multiple Description |
| MDC | = Multiple Description Coding |
| MD-SVC | = Multiple Description-Scalable Video Coding |
| MHP/IPTV | = Multimedia Home Platform/ Internet Protocol Television |
| MMR | = Monthly Management Reports |
| MPEG21-DIA | = Moving Picture Experts Group 21 Digital Item Adaptation |
| MPEG AVC | = MPEG Advanced Video Coding |
| OFDM | = Orthogonal Frequency Division Multiplexing |
| OFDMA | = OFDM Access |
| PB | = Project Board |
| QAM | = Quadrature Amplitude Modulation |
| RF | = Radio Frequency |
| QoS | = Quality of Service |
| R&S | = Rohde & Schwarz |
| RTP/RTCP | = Real-time Transport Protocol/ RTP Control Protocol |
| RTSP | = Real Time Streaming Protocol |
| RUNCOM | = Runcom Technologies Ltd |
| SDC | = Single Description Coding |
| SDP | = Session Description Protocol |
| SDPng | = Session Description Protocol (New Generation) |
| SDR | = Software Defined Radio |
| SIP | = Session Initiation Protocol |

| | |
|-----------------|---|
| MPEG-21 DIA-UED | = Moving Picture Experts Group 21 Digital Item Adaptation – Usage Environment Description |
| SoC | = System on Chip |
| SVC | = Scalable Video Coding |
| TIP | = Technology Implementation Plan |
| UHF | = Ultra High Frequency |
| UPA | = Unequal Power Allocation |
| UPM | = Universidad Politécnica de Madrid |
| UniS | = The University of Surrey |
| URL | = Universitat Ramon Llull Fundacio Privada |
| VITEC | = SA VITEC |
| WAVECOM | = WAVECOM - Soluções Rádio, Lda |
| WiFi | = Wireless Fidelity |
| WiMAX | = Worldwide Interoperability for Microwave Access |
| WISP | = Wireless Internet Service Providers |
| WLAN | = Wireless Local Area Network |
| WP | = Workpackage |

1 Introduction

1.1 Implementation of Corrective Measures

Since last annual review, SUIT Consortium has undertaken major efforts on various fronts:

- As an immediate response to reviewers' criticism of technology exploitation plans, SUIT members have taken the initiative to identify and admit into the consortium a capable operator (MCT/TVI). MCT/TVI experience in developing operator profitable business models could help SUIT partners, on one hand, to meet SUIT reviewers' expectations, and on the other hand, encourage Operators and Service Provider community to adopt SUIT concept.
- MCT/TVI, since its acceptance to SUIT consortium, is leading the integration of all assets developed within SUIT into a viable system which is designed to demonstrate a near commercial deployment meeting various scenarios and applications.
- SUIT partners have undertaken market analysis and thorough understanding of the dynamic business environment and market drivers, in areas relevant to SUIT, through purchase and analysis of important market surveys. Five major market surveys were studied and the findings of market analysis are presented in this deliverable.
- In order to assess probability of early adoption of SUIT concept, SUIT partners have approached Telecom Operators, Service Providers, Broadcasters, Content Providers and Terminals Manufacturers, and SUIT concept was presented. Encouraging messages were received, some have expressed interest to follow project results, MCT/TVI has joined SUIT consortium. One Service Provider expressed interest in carrying out field tests with SUIT combined with REMON-4G demo based on OFDMA technology. It seems that the potential for deploying experimental system as a first step for SUIT exploitation will largely depend on availability of plurality of broadband Wireless access systems, such as Mobile WiMAX, DVB-H, LTE and other broadband wireless access systems. Most of the companies we approached are experimenting with Mobile WiMAX. Detailed responses are covered in D7.1.4.

1.2 Market drivers for SUIT potential adoption

- SUIT solution presents a new paradigm in promoting cooperative diversity concept which can offer a good answer for the market mobility demands, which, by using a robust receiver system, allows reliable mobility reception even at high speed. With a DVB-T and a WiMAX network, the broadcasters are able to offer mobile services to their customers. It could be a very interesting solution for receiving HD video in cars, trains and bus, as well.
- Convergence between Mobile-WiMAX and HSPA-Evolved, Mobile WiMAX and LTE in next decade and plurality of deployed WBA systems at the premises of the Service Provider will pave the way for the implementation of SUIT concept.
- The advent of Mobile WiMAX and the emerging 3GPP/LTE will have a major role in advancing the implementation and affordability of broadband innovative services where efficient use of the spectrum and enhanced QoS in delivering rich multimedia content are of prime importance. Several technological trends and industry drivers are favourable towards endorsement and implementation of SUIT concept by Service Providers and ISPs.

SUIT business opportunities are not limited by time and “window of opportunity” exists and wide enough as long as the march for the Mobile WiMAX deployment and LTE later on is proceeding in vigorous steps.

Some of these trends are the following:

- a. Convergence of broadband communication networks and the on-going development of multi-mode user terminals such as WiMAX-WiFi, WiMAX-EV-DO and in the future

WiMAX/LTE. The advent of certified WiMAX wave 2 systems with integrated MIMO and beamforming capabilities.

- b. Of particular importance to SUIT is the implementation of MIMO Matrix B aiming at increasing link throughput by a factor of two where two different data streams, each is transmitted from a different antenna of the Base Station antenna matrix. This will be fundamental for SUIT since only one delivery system will be required to transmit the scalable multiple descriptive visual contents from the Base Station to the mobile or fixed users.
- c. Availability of spectrum for WMAX deployment. The ITU Radiocommunication Assembly (RA-07) meeting in Geneva agreed in October 2007 to include WiMAX in the IMT-2000 family, which is a major victory for the WiMAX camp, which has spent the past few years fighting to get access to spectrum, most notably in Europe the 2.5-2.69GHz band. Spectrum availability will be fundamental for roll out of Mobile WiMAX and creating of effective and expanded ecosystem.

2 Project Summary

SUIT is well positioned to take advantage of the new era of convergence between Broadcast and Telecommunication ushering new generation of Broadband Wireless Systems and DTV delivery systems, utilizing innovative broadband OFDM/OFDMA access technologies. The most profound revolution is the transition from Fixed Internet to Mobile Internet and enormous number of Mobile subscribers which has exceeded, by now, the number of the fixed subscribers. The huge demand for Multimedia, video streaming and interactive applications, on the move, and the need for reliable, efficient use of the spectrum and just the required bandwidth for each specific application will offer to SUIT partners excellent business opportunities. It is expected that Internet and interactivity will be integrated into television. A good example of network convergence is UMTS/xDSL and DVB-T/H. Nevertheless, SUIT proposes a wireless broadband convergence in order to deliver scalable TV from hand-held resolution to high definition resolution.

The main idea is to combine in a fruitful manner DVB-T with the broadband wireless access network IEEE802.16e providing a low round-trip delay and robust communications at high mobile speed, above 150 km/h. In this context of network convergence, broadband networks like DVB-T/H and Mobile WiMAX will certainly play an important role, delivering multimedia data namely compressed video to fixed and mobile subscribers. There is a strong movement towards convergence at multiple levels and particularly in view of potential efficiency gains obtained from integration. Therefore, convergence goes through integration of services, networks, systems, platforms and terminals. However, an efficient end-to-end content delivery through heterogeneous networks and terminals requires a serious and deep research in order to guarantee an acceptable QoS.

The other main idea in SUIT is to broadcast and stream scalable and, if necessary, multiple descriptive visual contents in an optimal way through DVB-T/H along with IEEE802.16 (WiMAX) networks to homes and to extended home environments.

The QoS (delay and bandwidth) will also be guaranteed by the intelligent multiplexer at the playout site and by requesting appropriate bit rate and spatio-temporal layers from the scalable servers and live encoders. The proposed novel system will deliver multimedia data to users, including broadcasting, multicasting and unicasting under the big umbrella well known as all-IP.

2.1 Reference model

SUIT reference architecture is shown in Fig. 1, below. The radio interfaces are fed by live scalable contents, pre-recorded scalable contents and Internet data. The playout will dynamically and optimally manage all those resources and adapt them to the network conditions. Once the SUIT terminal interfaces to the WLAN, it will deal locally with instantaneous variations of QoS and thus minimizing the effects by reacting as swift as possible. The connection between the playout and the transmitters will be ensured by the core network, possibly radio links which allow us to implement different field trials easily.

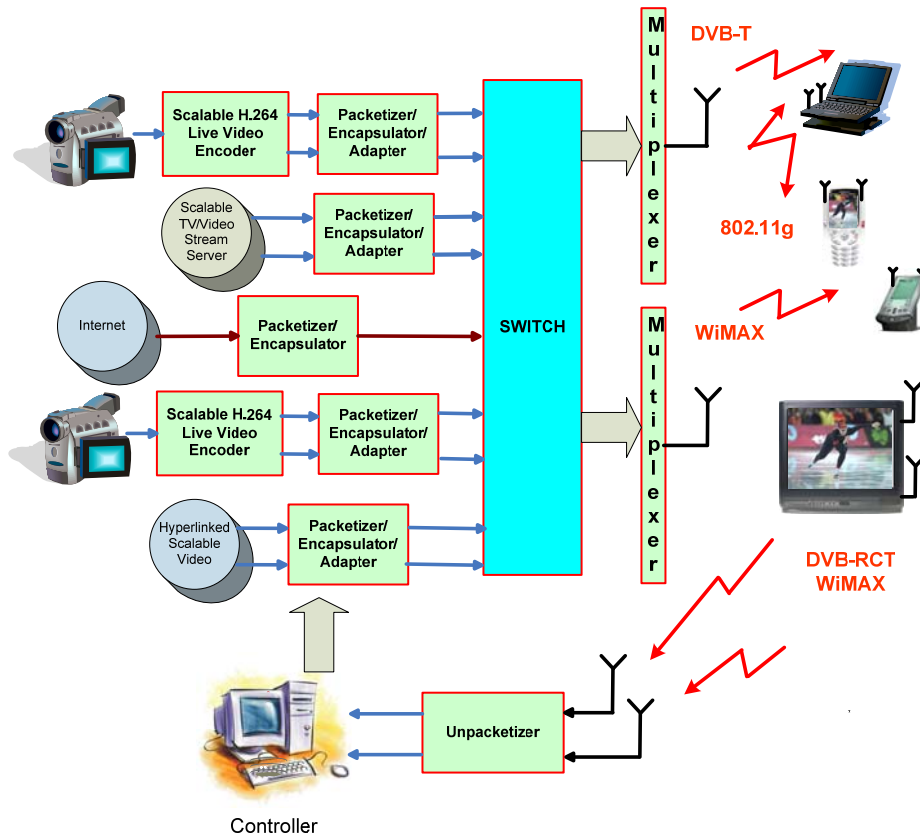


Fig. 1- Overall SUIT Architecture.

Figure 2 shows the gateway/terminal architecture where four RF signals will be tuned and combined through some decoders by making use of the video descriptions. In the case of a gateway, it follows a transcoder to accommodate LAN characteristics fluctuations and a LAN interface.

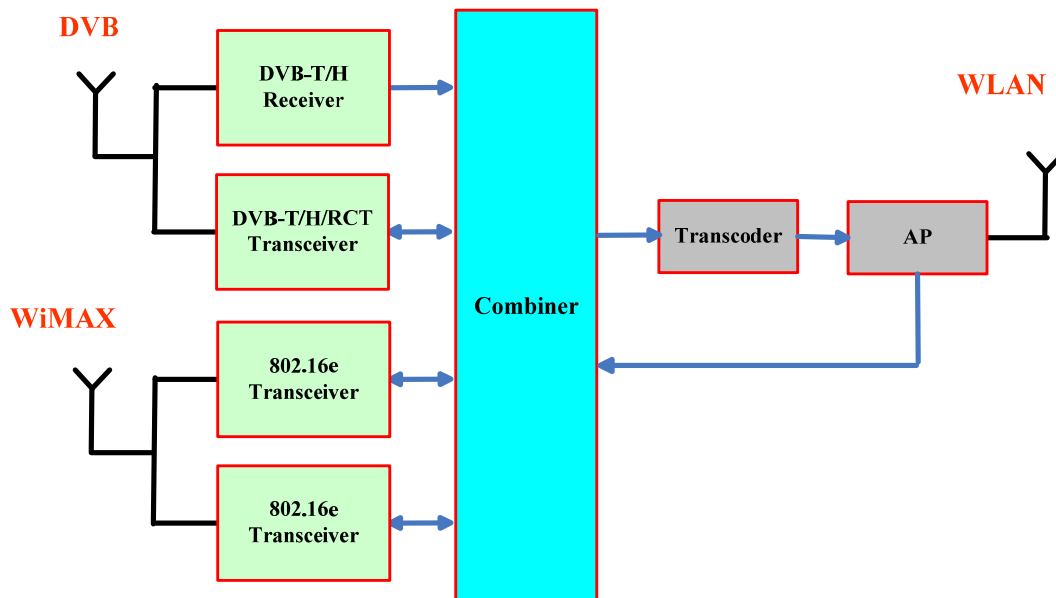


Fig. 2- Gateway.

The advantages of a convergent solution (DVB-T/H + WiMAX) proposed by SUIT in comparison to any divergent solution are:

- Supporting for return channels for interactive services as well as for conversational services like VoIP
- More robust reception for broadcasting signals in urban areas
- Supporting for broadcasting and unicasting services
- Mobility support at high speed above 150 km/h
- Supporting Quad-play (fixed and mobile)
- Intelligent routing of data (like hyperlinked video) using both networks.

Other singular features are:

- For rural areas, SUIT provides Internet services over UHF bands using DVB-T/RCT technology
- Support wide range from HD to Mobile devices

The above advantages along with SUIT scalability functionalities and compatibility with legacy broadcasting networks turn SUIT into an unbeaten solution targeting the next generation broadcasting networks.

2.2 Specific system architecture

Following analysis of market needs, SUIT tailors the system in order to accommodate these needs. Accordingly, SUIT proposes, beyond scalability and multiple description solutions, several reception solutions are described. This section presents the particularities of SUIT in comparison to legacy systems. SUIT follows an IPTV structure in spite of not using a pure IP-oriented network (DVB-T). However, WiMAX forced SUIT to make both networks to be IP compatible. The advantages are enormous under the point of view of interoperability at the media contents and networking.

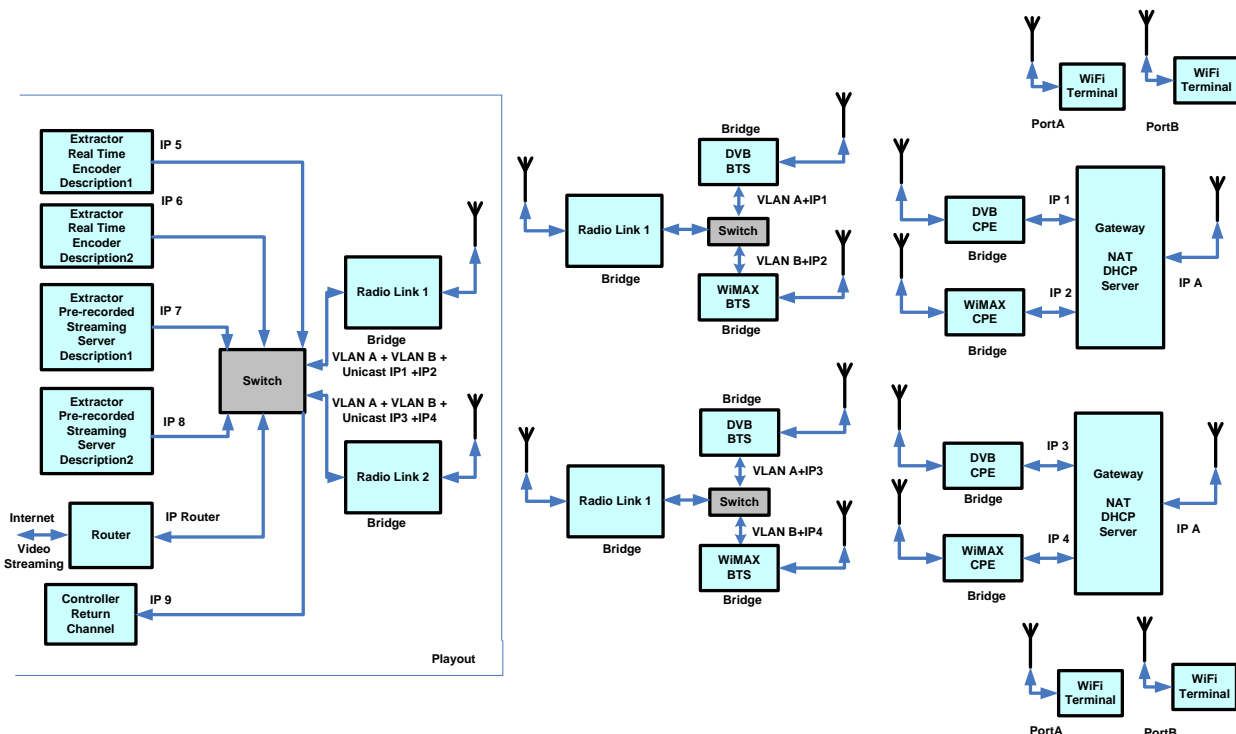


Fig. 3- Field trial architecture.

In Fig. 3, it is shown the field trial architecture which is very close to an operator practical network scenario. Two base stations, one WiMAX and other DVB-T are co-sited in order to assess horizontal and vertical handover. The selection of a specific base station is accomplished by a Switch. There is a terminal designed in SUIT with the capability of decoding SVC. However, there is no SVC STB available in market at the time of writing this deliverable.

3 The Partners

3.1 *IT*

IT is a private, not-for-profit organization, declared to be of public interest. IT is an association of three Universities, a manufacture, Siemens, and an operator, Portugal Telecom, each one with experience and traditions in research and development in the field of Telecommunications. IT mission is to create and disseminate scientific knowledge in the field of telecommunications and thus it undertakes fundamental and applied research in telecommunications in an international context in order to improve higher education and training, both at graduate and postgraduate levels. According to its statutory Advisory Committee, formed by three independent internationally recognized experts in the field of telecommunications, acting in a personal capacity, IT has established itself as a centre of excellence of international reputation. IT scientific output is of about 90 and 300 published papers per year in international journals and conferences, respectively. Some international journals where IT regularly publishes are IEEE Trans on Circuits and Systems for Video Technology, IEEE Trans on Microwave Theory and Techniques, IEEE Trans on Instrumentation and Measurement, IEEE Trans on Circuits and Systems and IEEE Trans on Vehicular Technologies. Besides, IT holds several patents on Telecommunications Systems.

IT has been from several years technically active, having designed, from scratch, several complete communication systems in the IT Laboratories. The knowledge gathered in those projects, allows a deep understanding and more efficient resolution of communication systems problems. IT has scientific knowledge in Wireless Communications, namely systems design, antenna design and testing, millimetre-wave systems, microwave and RF circuit and system design, and circuit and system analysis for studies of non-linear impairments on telecommunication systems as well as in video coding and resilient radio transmission of digital video/TV signals. In this project, IT is prepared to cope with its main objective which is to research and develop fast solutions from the physical to the application layers.

IT activity is mostly organised around projects that vary in size from a couple of person months, such as final year undergraduate students, to hundreds of person months in large projects. The scope may range from national (involving more than one research centre or more than one institution), to European or international with tens of partners. Typical examples drawn from the 3rd, 4th, and 5th European Framework Programmes include SAINT, MBS, SAMBA, FRAMES, ASILUM, FLOWS and MATRICE in mobile radio, AMFIS and ALDC in integrated systems and circuits, MOMUSYS, TALISMAN, DICEMAN, GMF4ITV in image/TV, BLISS, SPEED, UPGRADE, and ATLAS in optical communications, OPTIMUM, BROADBANDLOOP, VITAL and MOMENTUM in networks. Examples from FP6 are, VISNET, Euro-NGI, ACE, B-Bone, NEWCOM and E-Photon I and from FP7 are, Codiv and Futon amongst other.

3.2 *IBBT*

IBBT, the Interdisciplinary institute for BroadBand Technology, is a research institute founded by the Flemish Government, focusing on information & communication technology (ICT) in general, and applications of broadband technology in particular. IBBT's primary mission is to gather highly competent human capital, and to perform multidisciplinary research at the disposal of the Flemish business community and the Flemish government. In this research all aspects necessary for enabling the development and exploitation of broadband services are attended to on the technical and legal as well as the social level. Through investment in multidisciplinary research, the Flemish government wants to empower Flanders as an authoritative and international player in the future information society.

The research institute IBBT (Interdisciplinary institute for Broadband Technology) was founded as a virtual research centre, based on research teams from existing knowledge centres. These teams proceed from their own institutions, completed by a few (limited) central functions. IBBT groups 500 researchers in the aforementioned technological area.

As for the research activities, the institute provides a mix of interdisciplinary strategic basic research of its own with joint research as well as bilateral research contracts with companies and the services sector, with or without R&D support by the IWT, European commission, ... In this research project two IBBT research departments are represented: ETRO and MML.

3.3 URL

The Digital Television Centre (CeTVD) is a research and development centre within the Audiovisual Technologies Department of La Salle School of Engineering and Architecture in the Ramon Llull University (URL) in Barcelona, Spain. URL is one of the largest private universities in Spain and La Salle School of Engineering and Architecture provides degrees of Electronics, Computer Science, Telecommunication, Image & audio, Multimedia and Architecture (3+2 years curriculum and PhDs). Since its creation in 1999, the CeTVD has been actively working in the Digital Television and Video domain especially through industrial and research projects. The mission of the CeTVD is to become a technological reference in the Spanish area and as an element of support to television and video industry towards the digitalisation process. The center not only directly collaborates with the companies of the sector for the transference of technology, but also considers as fundamental tasks the specialized training and the research in digital television and video. Some of the fields of expertise of CeTVD related to project proposal are:

video indexing, MPEG-7/TV Anytime metadata generation and synchronization, digital television, interactive television, MHP application transmission, MHP application development, Personal Video Recorders, TVAnytime, MPEG-21, Digital Video Broadcasting, DVB-T or DVB-H among others. For the development of its activities the CeTVD counts with a complete digital TVlaboratory with encoders, multiplexers, modulators, analyzers and receivers.

Previous projects of the centre are: Wing-TV : (Celtic project) for the implementation and evaluation of Digital Video Broadcasting Handheld (DVB-H) in experimental platforms. META-TV: National project (FIT-330300-2004-44) devoted to the development of a complete metadata TV Anytime playlist for digital television. I2CAT Integrated project: Project promoted by the Catalan Internet 2 Foundation aims to explore the possibilities of multimedia peer-to-peer broadband networks. CeTVD is responsible for implementing the MPEG-21 module that will provide content identification, description, rights management and terminal adaptation. SWING-TV: National project developed in collaboration with industrial partners has as main goal to set up a field test of the emerging DVB-H standards for digital TV over handheld devices. CA-MHP: This national project (FIT-330300-2004-45) in collaboration with industrial partners has as main goal to study and implement the possibilities of combining conditional access systems with DVB-MHP applications. DTT Micromarkets in Catalonia: This national project consists on a set of pilot tests with real end users that made possible to acquire knowledge of the market, technology and communication before the commercial launching of DVB-T with MHP. AdStudio: This industrial project allows the easy cre This national project (FIT-070000-2003-418) aims to develop an end-to-end system of generation, broadcasting and reception of multimedia content enriched with MPEG7/TV Anytime descriptions.

Cataloguing and indexing of audiovisual broadband contents: This national project, (FIT-150500-2002-224), consists of the development of an MPEG-7 compliant cataloguing tool for indexing audiovisual broadband contents. GMF for iTV (Generic Media Framework for Interactive TV, www.gmf4itv.org): European project of the IST program (ref IST-2001-34861). The project enables the content and service provider to create, manage and, distribute linearly composed, pre-recorded video streams in conjunction with non-linear data and allow interactivity at the end device on object or key-frame level of the content. FlowServer: FlowServer is a complete DVB play-out and management system for data content broadcasting (i.e. MHP applications) in digital television.

3.4 R&S

The Rohde & Schwarz group of companies with headquarters in Munich develops, produces and markets communications and T&M instruments and systems with the emphasis on mobile radio, broadcasting, EMC measurements, general-purpose and RF test equipment, radio-monitoring and radiolocation, radio-communications as well as IT security. The group with its 5000 employees achieves a turnover of about one billion Euro world-wide.

The Broadcasting Division has long term experience in DVB broadcasting and measurement equipment.

The company spends a comparably high percentage of its turnover on research and development, and in doing so provides the means to employ specialists for each particular field of activity, such as measurement instruments, codecs, modulators and demodulators, receivers and transmitters. R&S Broadcasting Division has extended experience in the fields of DVB-compliant signal generation and analysis, as well as DVB-compliant modulation and demodulation. This is reflected in a product range that covers many applications in these areas.

3.5 UniS

The Centre for Communication Systems Research (CCSR) is a part of a 5**A rated Electrical Engineering department at the University of Surrey, UK. CCSR has been internationally recognized for its high quality research in Multimedia Communications, Mobile Communications and Communication Networks. Researchers in CCSR have been working in several mobile and fixed communications systems. Recently, CCSR has embarked on two new large-scale initiatives: the Wireless Network Test-Bed and the Media Lab (I-Lab), which will lay out the path for research in the coming years. The first is a state-of-the art Wireless Test-Bed, which consists of a campus-wide wireless network and is being used to carry out research into mobility management, network reconfigurability and multimedia communications. The second is a high-tech Media Lab, whose main purpose is to enable research into virtual and augmented reality technologies, multimedia communications and their resulting effects on end-users. The I-Lab is equipped with a variety of source capture devices, high-power real-time media processing engines and simulation servers, wireless access facilities and appliances, an immersive visualisation facility, head-mounted displays, graphics workstations, 2D/3D modelling and prototyping facilities and a usability testing laboratory. More detailed information on both the Wireless Network Test-Bed and I-Lab is available from the following links:

<http://www.ee.surrey.ac.uk/CCSR/Mobile/Projects/Testbed/>

<http://www.ee.surrey.ac.uk/CCSR/multimedia/llab>

3.6 Vitec

VITEC Multimedia is a leader in digital video technology and is developing and manufacturing original multimedia products at the point where micro-computing and video technology meet. VITEC is very well experienced in MPEG-digital video technology. The whole VITEC's business has been MPEG and only MPEG for more than 15 years. VITEC has a full range of MPEG products (see <http://www.vitecmm.com>). VITEC's innovative and competitive products are sold worldwide through computer distributors, multimedia VAR's, system integrators and OEM's. VITEC has built an existing distribution network and direct sales in 24 countries and is exporting over 80% of its turnover. In 1997, VITEC established a commercial subsidiary in the US. VITEC develops algorithms for image coding, electronic boards for PC's or for embedded systems, ASIC's for low cost products and application software under Windows. VITEC received the IST 2001 Prize for its most recent MPEG-2 compression hybrid technology (VM2000 Asic).

Moreover, VITEC already has experience of the management of European research projects (Viper and NetCam). VITEC was also involved as a contractor in the TRANSIT and CAR projects (RACE), in ISIS (ACTS), and finally in INK, HIPER-KIDS and D-ARTS projects (ESPRIT). VITEC is also participating to ITEA programme with the AMBIENCE and MAGELLAN projects. VITEC is interested in improving the quality of compression algorithms that are used for encoding video streams. VITEC is also willing to enrich video streams with complementary information dealing with video content, especially concerning audio-visual object extraction and description that can be compliant with MPEG-4/-7/-21 standards.

3.7 Runcom

Runcom is the leading pioneer of Orthogonal Frequency Division Multiple Access (OFDMA) technology – an advanced development of OFDM. Runcom's multi-carrier OFDMA technology has been endorsed in leading European and international standards, DVB-RCT ETSI standard and IEEE802.16d for fixed BWA and 16e for mobility.

Launched in 1997, Runcom Technologies' main focus is on the development of superior technological standards and product offerings for the emerging Broadband Wireless Access and Digital Interactive TV markets. Runcom is the recognized pioneer of Orthogonal Frequency Division Multiple Access (OFDMA) technology, accepted in 2001 by ETSI as the core component of the DVB-RCT standard, a wireless-enabled platform that facilitates content-rich interactivity between TV broadcasters and subscribers over traditional terrestrial infrastructure. OFDMA has also been incorporated as the preferred solution for the IEEE 802.16.a BWA standard, enabling Telecom companies to provide customers with enhanced voice and data services. OFDMA is considered as the preferred technology driving the BWA service provision market and is considered the leading technology for the upcoming 4G cellular infrastructure.

Runcom's OFDMA based products address a wide range of players in the wireless arena, including Set Top Box (STB) and Customer Premises Equipment (CPE) manufacturers, system integrators, broadcasters, content and service providers, and Telecom operators. Based in Israel, Runcom plays a key role in leading, global standardization bodies, including DVB, ETSI-BRAN and IEEE 802.16. The Company's proprietary technology is protected by over six patents OFDMA was developed by Runcom as an enhancement technology to the existing Orthogonal Frequency Division Multiplexing (OFDM) standard used by major wireless markets. A comprehensive wireless access solution, OFDMA technology enables "outdoor to indoor" operation without the need of outdoor antennas in the subscriber side and is faster and far more effective and reliable than its OFDM predecessor. The technology provides bi-directional, interference-free broadcast capabilities for Interactive TV providers and enables the delivery of converged, content-rich media for wireless Telecoms. In both environments (DVB and BWA) OFDMA facilitates the high-speed flow of data – downstream and upstream – to multiple subscribers, while allocating bandwidth and QoS according to real-time needs.

Runcom will maintain its active participation and contribution to the preparation of IEEE802.16e and IEEE802.16m addressing the Mobile BWA.

3.8 IRT

In the project SUIT, the Institut für Rundfunktechnik GmbH (IRT) will represent the technical and operational interests from the broadcasting, especially the public service broadcasting, point of view. IRT will participate in Workpackages WP1, 2, 4, 6 and 7 of the SUIT work package structure as indicated in Section 7. IRT will also act as the leader of WP 6 (Integration and testing). IRT is the research and development centre of the public service broadcasters in Germany (ARD, ZDF, DLR), in Austria (ORF) and in Switzerland (SRG/SSR). The IRT is a non-profit making company working in the interest of the general public. It was founded in 1957 and employs almost 200 highly skilled engineers, researchers and support personnel. A full description of IRT's mission is available under http://www.irt.de/IRT/home/indexIRTinfo_e.htm .

The R&D work is managed within five business areas: Online and Audio Television; Programme Distribution; Collaborative Research; R&D Services.

The IRT sees its role as that of a technical advisor to broadcasters as well as a body for industry to contact with technical questions related to broadcasting. IRT's work encompasses both operation-related and new systems development including spectrum management. IRT also supports its associates during trial phases and in the introduction of new services and techniques. The IRT regularly co-operates with industry, universities and broadcasters in national and international R&D projects. Co-operating is becoming more and more close with the manufacturing industry so that requirements can be implemented quickly. R&D at IRT is organised in knowledge-based units (ref.diagram in http://www.irt.de/IRT/orga_e.htm).

The main activities are: Digital television - Digital Video Broadcasting (DVB); Digital radio – Digital Audio Broadcasting (DAB); Multimedia (media convergence); Studio and production techniques (sound, TV, data, archives); Digital broadcasting (coverage); Digital networks and network management; Frequency management; Collaborative projects; National and international representations. The work is carried out on the basis of annual work plans. It is generally based on dedicated development projects (either internal or collaborative ones). All necessary supportive functions such as a powerful central computer system, drawing, printing and craftsmen workshops are available in-house. The results are reported in an annual review report as well as in numerous technical publications (national and international) and at various scientific symposia such as IBC or NAB. .

In the past years IRT has worked on true service convergence, e. g. in the framework of the IST project SAMBITS, of which IRT was the project co-ordinator. SAMBITS demonstrated, at IBC'01, the convergence of interactive TV, multimedia and on-line services using remote interactivity in combination with a powerful and controlled data carousel contained in the EPG (see <http://www.irt.de/SAMBITS/>). For mobile usage, IRT has continued this work in the IST projects CISMUNDUS (terminal and network aspects for the convergence of UMTS and DVB-T), CONFLUENT (special aspects of mobile media convergence) and, most recently, in INSTINCT. In SAVANT we demonstrated the joint delivery of synchronized content via (stationary) broadcast and internet connections. In PRETIO we worked on market validation for intelligent transport system services using a combination of digital radio and cellular networks.

The IRT is known for its engagement in DVB-MHP. IRT has developed and programmed its own reference implementation (MHP-RI) of the MHP specification (currently version 1.0.3). More details are available by clicking on the MHP logo at IRT's website: <http://www.irt.de>. Regularly, IRT organises so-called MHP interoperability workshops where companies that develop MHP products or applications can test their implementations. These workshops are attended by up to 70 professionals from over 30 companies.

The IRT is heavily involved in the technical work of the EBU (the European Broadcasting Union) and is a contributor to all major professional associations and international standardisation bodies or initiatives in the broadcasting/multimedia sector. Examples are ITU-R, ITU-T, ISO/IEC, ETSI, CENELEC, EICTA, SMPTE, WorldDAB, DRM, DVB, MPEG or TVAnytime.

The IRT operates experimental playout-centres for both DAB-T and DVB-T, and maintains experimental internet pages for broadcast services, e.g. <http://radio.irt.de>.

3.9 UPM

Imp The GTI (*Grupo de Tratamiento de Imágenes*: Image Processing Group) of the UPM (*Universidad Politécnica de Madrid*) of Spain is a research group working on theory, methods and applications of digital image processing, for its compression, analysis and synthesis. Its areas of expertise include:

- Theory and methods of digital image processing.
- 3D model coding and image synthesis.
- Image and video compression (low bit-rate, TV and HDTV).

- Multimedia information coding and processing.
- Computer vision and image analysis.
- Parallel implementation of image analysis/synthesis systems.

The research activity of the GTI is supported by the Spanish National Research Programme, the European Framework Programme, and by direct contracts with Spanish and European companies. Regarding recent European projects related to this proposal, the GTI:

- worked in the ESPRIT projects LOCOMOTIVE (LOW-COST MOVING symbols recognition Through Intelligent Vision Engineering) and VICTORIA (VISION Computing for Tracking and Object Recognition In open Areas), where parallel, real-time systems were developed;
- worked in the successful ACTS projects MOMUSYS (MOBILE MULTIMEDIA SYSTEMS, which was the European platform for MPEG-4) and HYPERMEDIA (Continuous audiovisual digital market in Europe, which gave support to the development of the MPEG-7 standard);
- worked in the IST projects ORION (Object Rich Information Network) and VISIRE (Virtual Image processing System for Intelligent Reconstruction of 3D Environments).
- is currently working in the IST projects OLGA (A Unified Scalable Framework for On-line Gaming) and SLIM-VRT (Self Learning Integrated Methodology - Virtual Reality Tool).

The GTI has collaborated as well in the development of international standards: it was a main contributor to ITU-T J.81 and MPEG-2; and, more recently, to MPEG-4 and MPEG-7.

3.10 Wavecom

Wavecom is a leading broadband wireless transmission solutions provider in Portugal. Created in 2000 by a nucleus of Senior RF and Microwave Engineers coming from different segments of the Wireless market, namely operators, system integrators and manufacturers, but that prior to those activities had been working together on R&D of adaptive antennae, mobile broadband systems, satellite TV and RF circuit design.

Wavecom was setup as a company providing wireless solutions, taking advantage of its staff know-how, and has been dedicated to wireless networks deployment with existing technology from different manufacturers, having installed both licensed and unlicensed band networks with point-to-point and point-to-multipoint topologies.

As a project oriented company Wavecom has been innovating in telecommunications solutions such as:

- Use of radiating cable instead of regular antennas for Wi-Fi networks on hotels, that typically have long halls with rooms on one or both sides
- Use of powerline communications as backhaul to WLANs overcoming the need for new network cabling to reach the Wi-Fi access points
- Use of 5GHz unlicensed bands (Short Range Devices 5.8GHz band and Hiperlan 5.6GHz band)
- Use of VOIP solutions over wireless bridges

Wavecom's development plan points R&D a medium to accomplish Wavecom competitiveness in its two main areas: Broadband Wireless Networks and Radiolocation.

3.11 MCT/TVI

Med Cap Technologies is an IT development company of the Media Capital Group which is currently the main and the most complete media player in Portugal, with leading or reference

brands in most of the market segments such as television broadcasting, radio broadcasting, outdoor advertising, internet and press.

Media Capital is also present in other businesses that are related or have strong synergies with the media such as television contents production, music edition musical and cultural events and movie rights distribution.

The Media Capital Group aims to lead the media sector in Portugal, not only in profitability and audience shares but also in its impact in the Portuguese society. Its leadership strategy is grounded in a commitment to develop information, culture and entertainment in Portugal, having as a solid reference the interests and preferences of viewers, listeners, readers and advertisers.

Med Cap Technologies was founded in 2001, and provides a broad range of innovative telecommunication and information technologies solutions. It has worked closely with all of the Media Capital Group companies in plural multidisciplinary research projects.

From its founding, it was build with a proactive mindset that has provided Med Cap Technologies with a significant deep knowledge in IT technical area.

By emphasizing its strengths in highly flexible operations, seamless excellent development team skills, it helps Media Capital achieve the best custom-built technical solutions for improving operational processes and supporting new business projects.

4 Drivers for near term commercial exploitation of SUIT concept

4.1 Plurality of Wireless Broadband Access Systems is a must

Prospect for near term commercial exploitation of SUIT concept will, largely, depend on plurality of deployed Wireless Broadband Access systems. Market news and recent market analysis show that Mobile WiMAX and LTE systems are likely to co-exist and each will have its share in the market, where LTE may have the biggest share.

Moreover, Dual mode WiMAX/LTE is taking shape and being addressed by ASIC and system manufacturers.

Availability of Broadband delivery systems coupled with the need for HDTV delivery will motivate Service Providers to utilize these systems with other Wireless Broadband Access systems, at their disposal, to offer HDTV and interactive services based on SUIT concept.

4.2 SUIT can gain from MIMO & AAS Technology

Advanced Antenna technologies are the key to improving WiMAX link budgets and enable a profitable WiMAX business model with greater user coverage and satisfaction. This takes into special consideration the characteristics of PDA type devices which are low power and restricted in antenna gain.

- MIMO A/B &STC: The impact of MIMO A/B lies in its ability to switch between MIMO A and MIMO B. MIMO B operates in “spatial multiplexing factor 2” which effectively doubles the bandwidth of the transmission link- but only if there is low correlation in the 2 antenna signals and if CINR is high. Once those conditions are not met Mobile WiMAX systems switch to MIMO A “spatial diversity”, which provides single bandwidth, but adds much robustness to the link and increases the range of the cell. MIMO A is especially valuable for coverage in NLOS conditions. MIMO A with single receive antenna is also known as STC (Space Time Coding) mode.
- AAS: Adaptive Antenna Systems make use of multiple antennas to dynamically form a directional beam. This beam is controlled by the BS to point at the User Terminal which it communicates with. AAS can provide major gains in LOS environment and is well suited in interference limited scenarios.
- MIMO B +AAS: The best of both worlds scenario, it employs a minimum configuration of MIMO 2x2 + AAS (2 segments).

MIMO B can implement SUIT concept in the delivery of multiple descriptive streams using one delivery system instead of two.

4.3 Creation of Ecosystem and the drive for low cost infrastructure and equipment

Key mobile WiMAX proponents, including Intel, Samsung, Nokia, Motorola, Alvarion, BT, KT, Sprint Nextel, and Google, have all lined up to support creation of broad and strong ecosystem. Equipment manufacturers are becoming increasingly active in Mobile WiMAX. Vendors such as Samsung, Nortel Networks, Alcatel and Nokia-Siemens Networks are all involved in 802.16e projects globally. Motorola have just announced a major deal in Pakistan. Companies that have been heavily involved in operator proprietary broadband wireless implementations such as Alvarion and Proxim are also developing 802.16e compliant platforms. Various chipset providers such as Wavesat, Runcom Technologies and Beceem Communications are developing OFDMA chips and are testing their products for interoperability with solutions from other vendors. Dual mode handsets will be very popular with Mobile WiMAX deployments with GSM/OFDMA and CDMA/OFDMA handsets dominating the market.

4.4 Availability of spectrum is crucial for the adoption of SUIT

The biggest boost, in recent months, was the announcement by ITU last October that IEEE 802.16 (WiMAX) is now an official 3G standard and part of the IMT-2000 family. This opens the door for many operators to use mobile WiMAX (802.16e) within their IMT-2000 spectrum allocation (the most promising being 2.5 GHz to 2.69 GHz band.

4.5 Dual mode systems is essential for SUIT adoption

Convergence among different networks is already taking place, Mobile WiMAX and WiFi, CDMA and WiFi,. Development is going on for the development of SDR based combined platforms for the Base Station and User terminals bringing together Mobile WiMAX and LTE. In the near future we can expect dual mode Mobile WiMAX and LTE and multi mode platforms at a later stage, where the platform could be configurable into Mobile WiMAX, LTE, WCDMA, HSPA or WiFi. The rational behind this drive is ease of platform configuration and modification as the standard evolve along the time life of the equipment. Motorola has announced dual mode user terminal combining Mobile WiMAX and LTE, Lucent Alcatel together with LG are demonstrating dual mode platform.

The availability of dual mode Mobile WiMAX and LTE in the near future will encourage and promote use of both platforms for the delivery of HD scalable video to the user terminal and take advantage of the diversity gain in beaming two streams from different sites to the same user. SUIT concept will be eventually exploited in commercial deployments.

5 Potential for SUIT Exploitation

SUIT presents a new paradigm in the realm of advanced wireless communication, promoting utilization of advanced cooperative diversity schemes and fusion of diversified and multi-disciplinary technological areas-scalable video processing, delivery of reliable HD video and multimedia content over multiple broadband wireless heterogeneous communication systems in a high mobility environment.

Results achieved by SUIT partners during the last two years as described in Partners Exploitation Plans indicate successful implementation achievements on a wide front. Partners have provided a near commercial assets that their integration in one system can validate SUIT concept in real environment. Field tests conducted so far confirm meeting SUIT objectives and SUIT partners have intent for exploitation of results and some have definite commercialization plans for new products.

Figure 1 describes, on the right hand, the development steps followed throughout the project, starting with assets development, going on with the integration of assets developed in order to validate SUIT concept in real field test in order to assess system performance. SUIT partners followed SUIT auditors recommendation to recruit and admit a broadcaster as a partner to SUIT who can take the lead for system integration and testing according to a deliberate test plan prepared by MCT. Based on results achieved in field tests we are confident that SUIT will emerge as an attractive and a highly valuable solution for reliable HD content and data delivery utilizing diversity concept. SUIT partners, each in his country, approached Operators, Broadcasters and telecom Service Provider to present SUIT concept and have a direct feedback on likelihood of exploiting and deploying such systems. feedback is encouraging and SUIT consortium is planning to demonstrate SUIT system in real environment to stakeholders. A successful demonstration is deemed as an important step to advance the dialog with Broadcasters and Teleco Service Providers for eventual deployment of SUIT system in some point in time when multiple broadband wireless access system will be available and affordable, such as Mobile WiMAX, LTE, DVB-RCT and DVB-T/H.

SUIT partners are willing as a group to commercialize SUIT , each bringing in his device. IT will apply for patent on behalf of SUIT partners.

The right side of Figure 1, describes chain of drivers which are essential for the commercial realization of SUIT solution which depends on availability of multiple broadband wireless access system at the disposal of Service Providers. The second driver is the advent of dual or multi mode systems. As indicated, use of MIMO B combined with Mobile WiMAX or LTE will have the potential to fully satisfy SUIT solution using only one delivery system instead of two BWA systems. Another important factor is affordability of SUIT solution. A large number of companies are involved in both Mobile WiMAX and LTE and thus strengthening the buildup of strong ecosystem. The market anticipates a low cost infrastructure deployment and low cost user terminals, which is the case now.

These indicators are promising and all contribute to the possible adoption of SIUIT solution. We are in the opinion, that a larger share of BWA system capacity will be consumed by multimedia and HD delivery of content which is at the basis of SUIT concept.

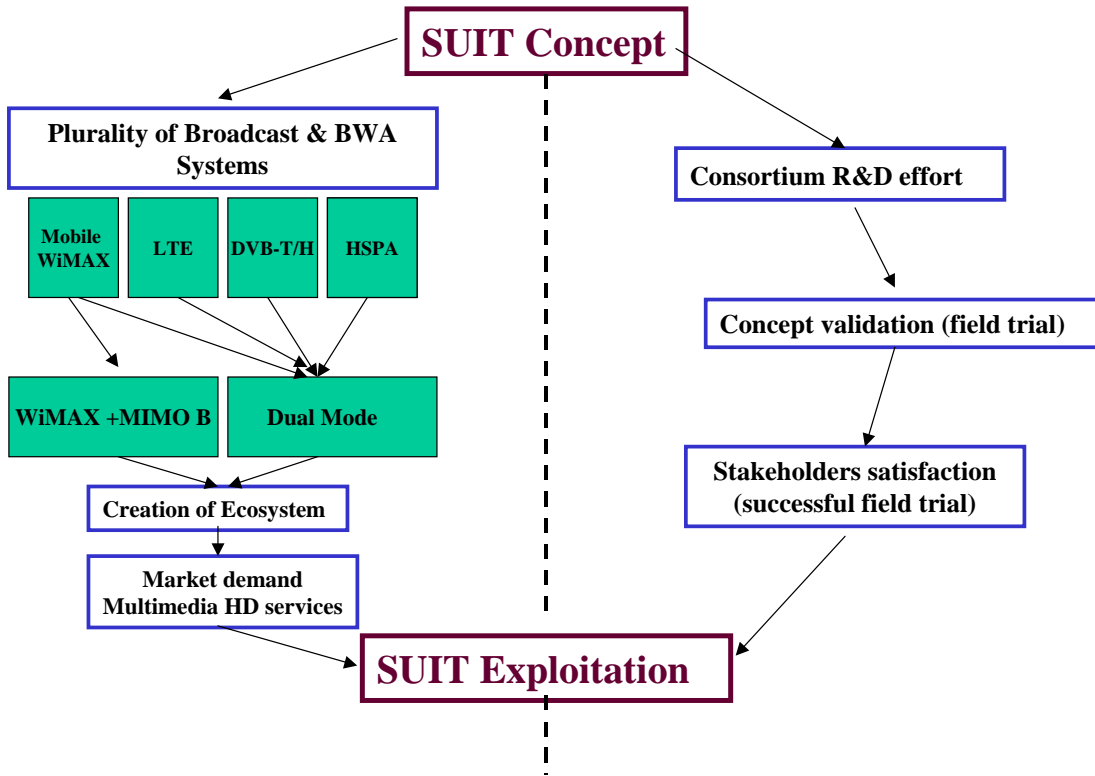


Figure 1- SUIT from concept validation to full exploitation

6 Essential Technologies developed by SUIT partners

6.1 Vitec

6.1.1 Synthesis about technological results that could lead to further implementation:

- Deployment of a distributed but not centralized broadcasting infrastructure enabling to master the quality of transmission at the level of each base station and to dynamically share the bandwidth among all the users connected to a same base station;
- Improvement of the quality of transmissions inside an existing architecture by proposing to use multi-band receivers enabling to spread transmitted information over a wider spectrum of frequencies or to duplicate sensible data over different communication channels;
- If inter-layer prediction mechanisms are not used between spatial layers, then scalable video coding intrinsically provides a multiple description scheme enabling to deal with packet losses;
- If inter-layer prediction mechanisms are used between quality layers, then scalable video coding enables to stream audiovisual content which bit-rate can be tuned on the fly at the level of each base station.
-

6.1.2 Short summary of the technology developed within SUIT

- R-T technology for H.264/MPEG-4 AVC dedicated to HDTV;
- R-T technology for MPEG-4 SVC dedicated to personal IPTV applications;
- SVC technology used for statistical multiplexing;
- MD-SVC technology used for robust delivery in wireless environment;
- SVC-to-AVC trans-coding for promoting SVC technology by reusing existing display terminals.

6.1.3 Synthesis about the positions of major actors in Western Europe :

- Concerning the telecommunication operators, there is no given transmission technique to favor, all is depending of the situation present in a given location: the kind of geographical relief, the population density, and the technologies that have been already or not deployed. According to the existing, it will be tried to deploy such-or-such a technology in order to improve the situation at the optimal difference between costs and revenues;
- Concerning the broadcasters, interactivity and mobility allow to create new services that can increase the sources of revenues, especially from wealthy populations that are often nomadic;
- Concerning service providers, it is expected to create new services to enrich existing bunches gathered into a single subscription contract that can take in account the constraints associated to the transport over heterogeneous communication networks.

6.1.4 Pointing out essential technological results that could lead to further development and its commercial applications.

Possible products built from SUIT results may be:

- R-T HD H.264/MPEG-4 AVC Encoder;
- R-T H.264/MPEG-4 SVC Encoder;
- H.264/MPEG-4 SVC Statistical-Multiplexer;
- H.264/MPEG-4 MD-SVC Post-Processor;
- H.264/MPEG-4 MD-SVC Combiner;

- SVC-to-AVC Transcoder.

Possible markets might be for each potential product:

- Broadcast live television, as DVB is promoting MPEG-4 AVC for HDTV ;
- Telecommunication operators for the deployment of personal television (IPTV);
- Improvement of audiovisual programmes multiplexing in broadcast delivery;
- Robust consumer videophone communications;
- Robust professional videophone communications;

Consumer premises electronics.

6.2 Runcom

6.2.1 Summary of essential technologies developed within SUIT.

1. Design and implementation of the converged SOC`s using special platforms designed specifically to SUIT. The platform based on Runcom`s design blocks were integrated with video combiner (designed by UPM). The converged WiMAX & DVB-RCT SoC`s platform was completed with the addition of Ethernet interface which has been defined from the transceivers to the video combiner. The Design of the converged SOC`s platform has been extended, implemented and tested via **urban** and **vehicular** profiles.

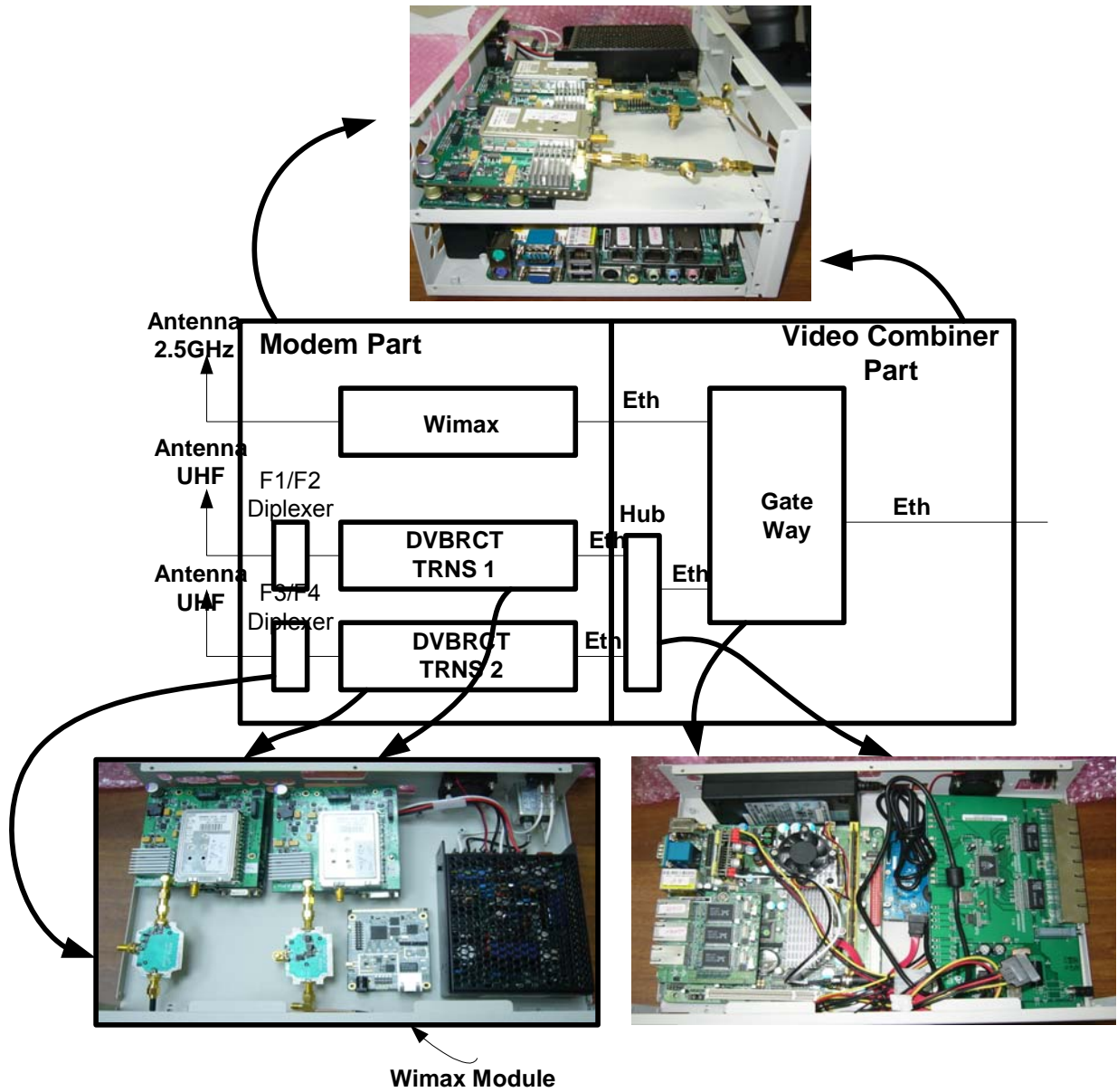
On validation of SUIT concept in a series of Field Tests, the design of the converged WiMAX & DVB-RCT SoC`s platform can be converted into one ASIC package on implementation of the exploitation plans following termination of SUIT project.

2. Implementation of robust mobile profiles for both WiMAX and DVB-RCT focusing on modifications and enhancements of the following parameters:

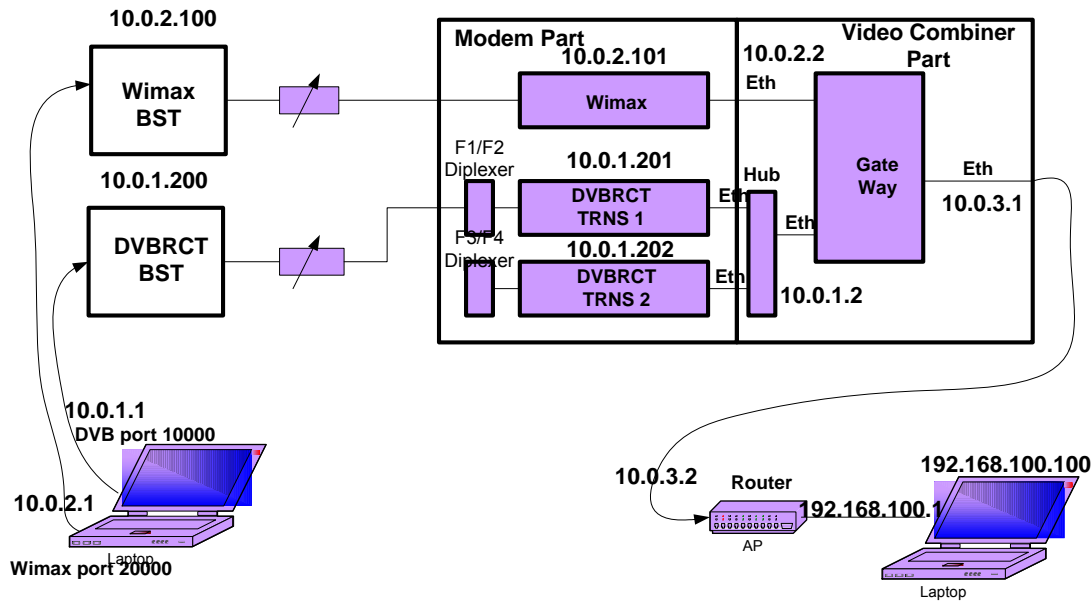
- All modem loops (Automatic Power Control (APC), Automatic Frequency Control (AFC) and Automatic Gain Control (AGC)) optimised for operation in a high mobility environment (150km/h, NLOS). Satisfactory operation was demonstrated in several field test in speed of 150km/h on A25 highway transferring video with good quality at this speed.
- Interfaces design for the scalable video (called IPC). Implementation of all MAC amendments for the scalable video.
- Adaptivity (Adaptive modulations, QPSK, 16QAM,64QAM, FEC, power) Runcom has modified the adaptivity modes to comply with SUIT requirements.
- Flexible and dynamic BW allocation complying with SUIT requirements. Implementation of Hand – off for both WiMAX and DVB-RCT. Emphasis on DVBRCT, since this standard was prepared for fixed environment and an enormous amendments efforts were needed in order to establish Hand - off.
- Robust Bi directional IP applications. It was checked and found operating properly in Wimax and DVBRCT. IP of 14Mbit/sec in DVBRCT and 8Mbit/sec were achieved in mobile tests.

6.2.2 Converged SOC`s platform for User Terminal Fixed and mobile design.

Runcom has designed and implemented a Converged Wimax 16e and DVBRCT platform for fixed and Mobile environment and with all capabilities as it is defined in SUIT requirements. It consists of Wimax SOC, DVBRCT SOC. The gateway is connected via Ethernet cable in an additional box. Figure 2 below presents the mobile terminal.



Converged DUAL Mode SoC, Wimax and DVBRCT - Mobile Terminal



All Chain integration Set UP

The Figure above presents the set up of the SUIT chain held at Runcom . The integration has included the Payout, RF (Wimax and DVB-RCT) including the CPE’s and SUIT user terminal.

6.3 MCT

MCT is a branch of a Portuguese media and broadcaster Group. MCT involvement in SUIT project brings to the company deep knowledge in many important technological areas. RF coverage projects, network implementation, wireless IP networks, WiMAX technology, mobile TV have strengthened MCT staff in such core and relevant matters.

As SUIT WP6 leader, MCT gain big expertise in integration of complex broadcast systems, which is very useful once the company intend to explore, in a near future, multi-platform broadcasting services.

Further development

MCT is very interested in this SUIT type of service concept. Certainly, it will help Media Capital to explore new services and new business models on video content and interactivity.

Media Capital has attended to the tender for a DTT Portuguese operations license. The DTT tender regulations imposed DVB-T technological platform, without RCT. However, it seems that, it will be possible implement a SUIT based solution, if of course, Media Capital win the license. In second semester of this year, a public tender for WiMAX licenses will be opened by the Portuguese communications regulator ANACOM. The company will attend this tender as well. If the company succeeds in these two tenders, it will be in good conditions to explore the SUIT concept solution in the Portuguese market.

6.4 UNIS

During the SUIT project, the University of Surrey has worked on three main technology areas. While Surrey will consider possible commercial exploitation, the most likely forms of exploitation are research publications, and new bids for research grants. The technology developed will also be used for training of PhD students. The three technology areas are summarised below, along with their exploitation plans:

6.4.1 WiMAX, WLAN simulations and emulators.

The results of the simulations have already been made freely available to the research community via the SUIT webpage. Therefore, commercial exploitation of the simulation code is not expected.

Instead the simulations will be used in future research work at Surrey. It is important that the research work simulates relevant and state-of-the-art networks. Therefore, the WiMAX simulations are particularly valuable for future research work. The real-time emulator will be exploited by using it as a demonstrator for visitors to Surrey, but it also intended to integrate it into a test bed that already features a number of other emulators.

6.4.2 Unequal Power Allocation.

The UPA work involves cross layer optimization of the energy used to transmit the video. It can either provide better video quality, or enable transmission of the video at lower overall power (energy efficient video transmission). The kind of cross layer optimization required for UPA is not currently possible in existing networks. Therefore, the work on UPA is more likely to be exploited in the long term. Particularly as energy efficiency becomes more of an important issue. More research will be conducted in this area, resulting in further research publications.

6.4.3 Multiple Description Audio Coding.

When MDC video is deployed, it would seem logical to also deploy a form of MDC audio. The MDC implemented in SUIT is a simple repetition of the audio in each channel (analogous to the redundant picture coding used in one version of the MDC video). The performance results of this simple scheme, in the overall SUIT system, will be exploited in the design of a new, more advanced MDC algorithm for audio. Much of the previous work, at Surrey, on audio has been theoretical. Therefore, the experience of testing an MDC audio scheme in the SUIT scenario is extremely valuable. The new knowledge gained will lead to further publications on MDC audio.

6.5 URL

URL has developed several applications in SUIT project, using some well known technologies but also new emerging technologies that will facilitate URL further research and new projects. The applications developed by URL are the following:

6.5.1 Video Server

The application is developed using C++ programming technology and it has the following implemented features:

- Offline and real-time video sources support
- Delivery of several types of MDC/SVC services:
 - Quality on demand
 - Video on demand
 - Broadcast/multicast/unicast.
- RTP encapsulation and synchronization of SVC/MDC streams
- SDP signaling of audio and video streams
- RTSP server for VoD sessions
- RTSP authentication
- The Video Server can work as standalone application using a configuration file or can be configured and controlled by the playout manager software
- UDP interfaces to receive playout control messages
- SOAP support to make the communication with the Intelligent Unit WS easier

6.5.2 Web Playout Manager

The Playout Manager is a web application developed using Microsoft Visual Studio 2005 c# and asp.net programming technology. The application is a web interface used to configure the playout modules and to control them in a friendly manner.

The web application has the following implemented features:

- SUIT services configuration
- Configuration and control of several video servers
- Bit rate monitoring
- Configuration of WiMAX and DVB-T multiplex
- User accounting configuration
- Monitoring of user terminal capabilities and channel information from the base station (BST)
- SD&S (service discovery and selection) server configuration and control
- Configuration and management of system backups

6.5.3 Intelligent Unit Web Service

The Intelligent Unit is a web service application developed using Microsoft Visual Studio 2005 c# and asp.net programming technology.

The WS application has the following implemented features:

- Allows the communication between the Playout Manager and the different playout modules
 - Video Server control
 - SD&S control
- Bit rate algorithms taking into account available bit rates, services, user requests, service priority policy, terminal capabilities, network characteristics, etc.
- User authentication control

6.5.4 Playout Database

The playout system is supported by a MySQL database used to store playout configuration.

6.5.5 Internet Proxy

A SUIT Proxy was developed to detect and control internet access. Thanks to the Proxy the playout can know the number of connected users, to control the used bit rate.

Pointing out essential technological results that could lead to further development and its commercial applications.

URL as academic partner is interested in project dissemination, but we can provide the knowledge of new technologies to develop commercial applications.

The following points can be taken into account in new research projects and developments:

- Development of a complete playout system for statistical multiplexing of SVC services.
- Enhancement of Video Server to satisfy market needs.
- Personalization of web playout manager to satisfy market needs of the operators interested in SUIT project.
- URL will study the IP distribution of SVC and MDC services over P2P (peer to peer) networks.

6.6 UPM

UPM's core work on SUIT project has been focused on the technology applied to optimize video transmission over wireless networks, particularly over Wi-Fi networks. In this sense, UPM has been a main actor in designing and developing the SUIT Gateway. The SUIT Gateway (see Figure 1) is in charge of: (i) interfacing both broadband networks (DVB-T/H and WiMAX), and the WLAN (Wi-Fi); (ii) processing Multiple Description SVC streams (combination and rate-control) to generate a standard SVC stream.

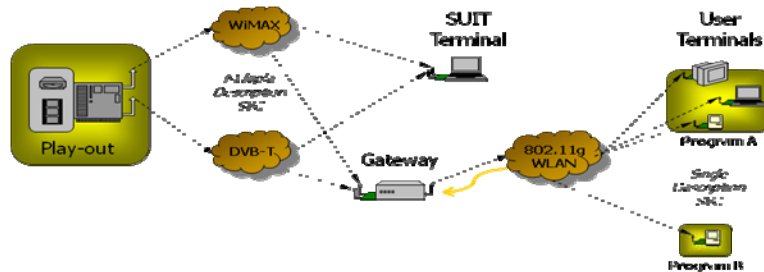


Figure 1 Gateway into the general view of SUIT architecture.

More specifically, the main UPM's contributions in terms of developed technology can be summarized in:

- **Stream management and synchronization.** Video contents are delivered by the play-out using both last mile networks. Contents are encoded using a Scalable Multiple Description coding approach resulting in two different scalable descriptions (MD-SVC). Each incoming MD-SVC coded stream is transmitted through a different last mile wireless network and, as a result, may suffer losses, or arrive to the Gateway disordered or delayed. To cope with this behaviour, UPM has developed a Synchronization module that works at two different levels:
 1. *RTP level.* Based on RTP data, this module ensures that NAL units from both descriptions belonging to the same frame are processed at the same time.
 2. *NAL Unit level.* For both descriptions, NAL units (NALUs) that belong to the same frame are synchronized based on an analysis of the NALU-header data.
- **Optimized WLAN transmission.** SUIT has adopted 802.11g for the wireless local network due to its bandwidth capacity to deliver video based contents. However, the local network characteristics may vary dynamically (local devices move far away from each other, interferences, etc.). SUIT Gateway tackles this issue through the introduction of transmission control technology: *rate control module*. The module works based on both:
 1. A novel *discrete Wi-Fi model* that captures the stochastic behaviour of the channel.
 2. A *distortion model* customized for SVC streams.

The developed technology is in charge of optimizing the quality of the decoded sequence by intelligently retransmitting the most significant NALUs of the stream. This optimization is performed under certain maximum rate constraints in a low delay transmission scenario.

In this sense, relevant technological outcomes are:

- The **Gateway software** as a complete set. This SW (developed in collaboration with other partners - Wavecom, URL, IBBT-) represents a good basis that can be extended and customized to provide SUIT services in additional profiles, or new SUIT-alike services where stream management capabilities and Wi-Fi transmission optimization were required.
- As individual components of the Gateway:
 - **Synchronization module.** This module can be used as a component for new types of terminals which has to deal with Multiple Description schemes.
 - **WLAN optimized transmission module.** This module can be customized for other wireless channels, as well as for other encoding schemes such as AVC or MVC including the appropriate models for those elements. In addition, it can be extended for medium delay scenarios.
- As related outcomes of the transmission control technology

- **Tools** for analyzing channel behavior and computing discrete models. These tools allow the generation of new channel models that can be used to develop customized transmission strategies.

6.7 ETRO-VUB

6.7.1 Short summary of the technology developed in WP3 within SUIT

The technological achievements in WP3 consist of the design of *scalable multiple-description video coding* approaches adaptable to the dynamic network characteristics and the multitude of types of user terminals. In this context, we carried-out research on multiple description coding based on scalar quantization, and focused on their application in scalable coding of multimedia. With this respect, we designed an architecture for scalable multiple description video coding system (MDSVC), which incorporates the MDC principle for the encoding of both texture and motion vector data. For such system, we derive the principles of *channel-aware MDC rate-allocation*, which enables adjusting both the bit-rate and the resilience to errors of the output stream. Such adaptation is performed on-the-fly, depending on the channel condition. Results prove the advantages of MDC and the effectiveness of MDC system when transmitting video streams over unreliable networks.

The developed system architecture (MDSVC) is capable of providing layered descriptions allowing for rate adaptation among each of the targeted networks, namely WiMAX, DVB-T/H and WLAN. This is feasible, since the coder inherits its scalable features from the H.264 SVC coder. In order to provide error resilience, an MD module is employed, allowing the exploitation of *three different approaches*: (1) Unbalanced MD; (2) MD based on redundant slices and (3) MD based on EMDSQ. All employed MD methods provide several descriptions of the scalable video stream in order to overcome the error proneness of the transmission channels. The architecture was defined for a specific network and codec setting, the general principles can be ported to any transmission systems that allows for the exploitation of path or time diversity.

The technological achievements in WP3 include also the design of *adaptive joint source and channel coding techniques* for optimal network resource allocation, taking advantage of the source scalability and channel conditions. For this we have developed a novel design for scalable erasure-resilient video coding that couples the compression efficiency of scalable video coding (SVC) with the robustness provided by multiple description coding. In our approach, scalability and packet-erasure resilience are jointly provided via embedded multiple description scalar quantization. In general, EMDSQ allows for steering the number of descriptions and the redundancy between them. In the context of packet-switched networks, we derive a novel framework that performs optimized rate-allocation and controls the amount of redundancy by selecting the subset of coded descriptions minimizing the expected distortion at the decoding site. The proposed framework adapts the level of robustness to the network conditions, without resorting to channel coding. The proposed scalable MDC video coding approach seamlessly adapts the data rate to the available channel bandwidth, just the same as in SVC. Similarly, having retained a number of descriptions suitable for a certain packet-loss rate, the system can adapt to a lower loss-rate by removing the unnecessary redundancy. Hence, the system is scalable in error-resilience terms. We conclude that the proposed scalable MDC architecture is suitable for multicast scenarios, as it allows for performing a single coding step followed by a rate-redundancy allocation procedure which transmits to each client the appropriate data according to the user's requirements, available bit-rate and expected packet-loss rate.

6.7.2 Pointing out essential technological results that could lead to further development and its commercial applications.

In WP3, a novel design for scalable erasure-resilient video coding that couples the compression efficiency of scalable video coding with the robustness provided by multiple description coding has

been developed. In the context of packet-switched networks, our novel framework performs optimized rate-allocation and controls the amount of redundancy. Scalability and packet-erasure resilience are jointly provided via embedded multiple description scalar quantization (EMDSQ). EMDSQ allow for producing an arbitrary number of descriptions that are scalable and independently decodable. The ability of EMDSQ is to control the redundancy within the transmitted data. The EMDSQ technology is applicable to any particular MDC system that requires scalability and resilience against transmission errors.

In summary, the SUIT project demonstrated (1) how scalability and error-resilience can be simultaneously provided, (2) how rate and redundancy need to be optimally allocated for given channel conditions, (3) how MDC coding principles can be applied in a specific standardized video coding technology, which is the scalable video coding extension of H.264, and (4) how different channels with different characteristics (WiMAX, DVB-T/H,...) need to be handled in such scalable MDC transmission scenarios.

We conclude that this technology finds its application in any video transmission scenario that simultaneously addresses users and transmission mediums with various and dynamically changing characteristics.

7 Partners Exploitation Plans

7.1 IT

7.1.1 Project Results (Value Propositions)

| No | Title of Exploitable result | Category | Exploitation intention |
|----|---|----------|---|
| 1 | SUIT Terminal in collaboration with other partners (Vitec, UPM, IBBT, MCT) | A | As a research institute our first objective is to publish our results. Knowledge gained by this result can be used as a basis for future projects. |
| 2 | Some reception profiles (Building, Rural, STB) with Wavecom and Transcoder profile with Vitec. | B | As a research institute our first objective is to publish our results. Knowledge gained by this result can be used as a basis for future projects. |
| 3 | The DVB-T+WiMAX emulator in collaboration with UniS. | B | As a research institute, our first objective is to publish our results. Knowledge gained by this result can be used as a basis for future projects. |
| 4 | One MDC (encoding) solution, i.e. MDC-3. | B | IT intends to commercially exploit the encoding solution as an integral part of the whole SUIT system |
| 5 | A VoIP solution | A | The objective is to publish the results and further exploit it in future projects |
| 6 | Several publications (conference proceedings and journal publications) disseminating our results have been delivered (cf. D.7.1.4). | A | As a research institute our first objective is to publish our results. Knowledge gained by this result can be used as a basis for future projects. |

- Type A: results usable outside the consortium If a result could be made available for exploitation by others then it should be classed as type A, even if project partners are going to exploit it.
- Type B: results usable exclusively within the consortium If you are only going to allow the project partners to exploit it.
- Type C: non usable results If for some reason your results are not exploitable at all.

7.2 IBBT

7.2.1 Results (Value propositions)

| No | Title of Exploitable result | Category | Exploitation intention |
|----|--|----------|--|
| 1 | Development of a prototype for scalable multiple description coding and transmission based on redundant slices. | B | As a research institute our first objective is to publish our results. Knowledge gained by this result can be used as a basis for future projects. |
| 2 | Development of a prototype for scalable multiple description coding and transmission based on embedded multiple description scalar quantizers (EMDSQ). | B | As a research institute our first objective is to publish our results. Knowledge gained by this result can be used as a basis for future projects. |
| 3 | MPEG-21 communication module for terminal descriptions. | B | As a research institute our first objective is to publish our results. Knowledge gained by this result can be used as a basis for future projects. |
| 4 | Several publications (conference proceedings, journal publications and book chapters) disseminating our results have been delivered (cf. D.7.1.4). | A | As a research institute our first objective is to publish our results. Knowledge gained by this result can be used as a basis for future projects. |

- Type A: results usable outside the consortium If a result could be made available for exploitation by others then it should be classed as type A, even if project partners are going to exploit it.
- Type B: results usable exclusively within the consortium If you are only going to allow the project partners to exploit it.
- Type C: non usable results If for some reason your results are not exploitable at all.

Within SUIT, IBBT developed :

- Two MDC solutions (MDC-1 and MDC-2).
- Two bitstream extractors.
- An MPEG-21 communication module to signal terminal properties to the playout.

The knowledge acquired by the project will be used in several ways:

- Know-how of practical video streaming architectures will allow IBBT to be involved in new projects, both academic and industrial ones.
- Practical MPEG-21 knowledge offers IBBT the advantage of being able to more easily set up communication structures between existing components.

We must observe that part of the technology used in the SUIT project by IBBT, and that is, the Embedded Multiple Description Scalar Quantizers (EMDSQ) has been covered by two patents - see [1], [2]. The proven benefits of EMDSQ in the context of the SUIT project do serve as an incentive for future projects and valorization tracks for this technology.

Additionally, EMDSQ can complement FEC-based approaches for error-resilience, and together can be used in hybrid systems enabling delivery of scalable error-resilient video over heterogeneous un-balanced channels.

[1] A. Gavrilescu and A. Munteanu, "Embedded Multiple Description Scalar Quantizers for Progressive Image Transmission," US Patent 2005/0027521 A1, IMEC, February 3, 2005.

- [2] A. Gavrilesco and A. Munteanu, "Embedded Multiple Description Scalar Quantizers for Progressive Image Transmission," EU Patent: 1465350, IMEC, October 6, 2004.

7.2.2 Market forecast for mobile television

Considerable interest in mobile television using DVB-H has been seen in various European countries. Therefore, IBBT launched the Maduf (Maximizing DVB Usage in Flanders) project. Its objective was to generate an optimum model for providing mobile television services in Flanders via DVB-H and developing a proof of concept. Next to the technical aspects, the project also focused on legal and economic aspects. The economic portion of the research focused on models for cooperation between the various players in the media and communications markets. The project united several major players, both network and content providers.

The results of the project showed a clear interest of consumers in mobile television. Content especially of interest to them was (personalized) news, sports, films and series. A surprising result was that they would not only want to have access to mobile television while being on the move (e.g. while waiting in line, riding the bus, ...) but also at home. Peek moments for watching mobile television, by a 30 person test audience, was in the evening.

As a whole, consumers do not care how they receive the content (DVB-H, WiMAX, UMTS) as long as it is at a reasonable price (up to €11 per month in Flanders) and they do not have to buy a separate device for it.

A survey showed that 17% of the population would be among the early adopters while another 43.7% of the population would use it later on.

7.2.3 Sales forecast in targeted markets

As a research institute we do not target directly specific markets or customers. However, the valorization trajectories for IBBT include patents, research projects and direct technology transfers with industry. From a research perspective, investigating error-resilience mechanisms for scalable coding and transmission of video leaves still several open issues, and creates the opportunity for future projects.

7.3 R&S

7.3.1 Project Results (Value propositions)

- **Control software for test set-up**

- It is planned to validate the control software modules that control the test signal generators with potential costumers from the receiver industry. In such a case, the receiver that initiates the handover in a DVB-T/H system is the DUT. Therefore, a receiver manufacturer needs to access QoS relevant information at an internal receiver interface, and integrate the respective control software modules into their testbed control software.

- **Test streams**

Test streams are required to provide input signals for the test signal generators of the testbed. These test streams are generated in pairs. They contain at least one service which is identical in both streams but the signalling (PSI/ SI in the respective tables) is different in both streams.

Such pairs of test streams will be generated for various bit rates in such a way that they can be used with different modulation schemes and different code rates.

- **Wireless Network Emulator**

A wireless network emulator is required to evaluate video performance over WiMAX and DVB-T/H under multipath channels. The network operators can decide parameters and configurations.

- **To summarise**

- Control SW for controlling test signal generators in a HO testbed;
Decision on product development after validation with potential customers;
Availability planned for early 2008.
- Test streams for test signal generators as part of a stream library;
Availability planned for early 2008.
- Emulator as part of our equipment portfolio. It can be an option of a test equipment
Availability planned for 2008.

7.3.2 Sales Forecast in Target markets

First tentative discussions with manufacturers of mobile terminals indicate a time frame between 2010 and 2012 for the development and implementation of handover mechanisms from DVB-T/H and WiMax and vice versa. R&S plans to be able to offer a test environment for such scenarios for this time window.

At this point in time it is not clear which percentage of mobile phones will have such handover mechanisms implemented in the long run. First estimations point at a rather low percentage. This is the reason why R&S plans to develop a set of adaptable building blocks which can be combined to serve customers' needs and requests.

7.4 VITEC

7.4.1 Project Results (Value propositions)

| No | Title of Exploitable result | Category | Exploitation intention |
|----|--|----------|---|
| 1 | R-T technology for H.264/MPEG-4 AVC to HDTV | B | RT_AVC is exploited commercially- AVC Encoder, CGS release |
| 2 | R-T technology (SVC Encoder) for MPEG-4 SVC dedicated to personal IPTV applications | C | It is exploited commerciall –SVC Encoder, FGS release |
| 3 | SVC technology used for statistical multiplexing. technology | | Intent for exploitation as SVC statistical-Multiplexer. Ownership is shared with URL |
| 4 | MD-SVC technology post processor and combiner used for robust delivery in wireless environment | B | Intent for exploitation as MD-SVC Post-Processor Intent for exploitation as MD-SVC Combiner Ownership is shared with IBBT |
| 5 | SVC-to--AVC trans-coding for promoting SVC technology by reusing existing display terminals. | B | Intent for exploitation as SVC-toAVC Transcoder |

VITEC Multimedia is developing and manufacturing original multimedia products in MPEG-digital video technology. VITEC's innovative and competitive products are sold worldwide through computer distributors, multimedia VAR's, system integrators and OEM's. VITEC has built an existing distribution network and direct sales in 24 countries and is exporting over 80% of its turnover.

VITEC has a full range of MPEG products. VITEC Multimedia has started the development of a DSP-based family of video multiprocessor platforms. They are designed to afford OEM customers with advanced means for developing real-time video applications based on MPEG technology (MPEG-1/2/4 up to SD/HD levels). VITEC provides the following services to OEM customers:

- SDK and source code for building OS drivers and DSP sample codes;
- Technical support with purchase of development kit;
- Production facilities to deliver boards in volume at reasonable cost;
- Board customization and FPGA implementation.

In its own field of expertise, VITEC is expecting to see the emerging of the following exploitable results from SUIT project:

- R-T HD H.264/MPEG-4 AVC Encoder;
- R-T H.264/MPEG-4 SVC Encoder;
- H.264/MPEG-4 SVC Stat-Mux;
- H.264/MPEG-4 MD-SVC Post-Processor;
- MD-SVC Combiner;
- SVC-AVC Transcoder.

In conjunction with a French RIAM research project named ArchiPEG, VITEC is expecting to soon provide the market with a real-time H.264/MPEG-4 AVC dedicated to HDTV. It will allow to encode and broadcast live feeds in 720p and 1080i formats. Experiments will be done to evaluate how

1080p live feeds could be encoded in real-time. DVB is promoting the use of MPEG-4 AVC for HDTV broadcasting because of the bandwidth savings that are provided by this technology in place of MPEG-2 currently used for DTV.

In parallel, relying on the same technology an SVC release of the same encoder should be available for testing the first live television broadcasts using scalable video formats. It will mainly interest telecommunication operators that will have soon to deal with huge uncontrolled video streams launched by the deployment of personal or community IPTV applications.

The playout proposed in SUIT project leads to develop a multiplexer that can usefully rely on the scalable structure of video streams and their related quality information. These efforts can be generalized to propose a convenient statistical multiplexer which performances can be compared to transraters arrays used concurrently to achieve the task of multiplexing several video programs into a single channel of a given bandwidth.

For wireless applications, redundancy can afford the necessary robustness enabling to stream video over wireless networks. So, a second release of the SVC statistical multiplexer could be derived to satisfy wireless delivery of video content. But multiple descriptions should be multiplexed into a single stream to be proposed as a product itself. Among the three different schemes, the second based on redundant slices should be shipped as it for consumer applications.

The third scheme based on scalar quantization provides a finer control of redundancy and should satisfy high quality demanding applications for the professional market. It might then be proposed with an appropriate combiner that can retrieve information from lost packets in the remaining content.

Finally, in order to set up field tests without waiting the development of SVC-compliant terminals, it will be derived from the project bitstream extractor an SVC-to-AVC transcoder. It will enable to reuse the existing range of MPEG-4 AVC set-top boxes.

7.4.2 Market forecast

Quad-play

With the digitalization of all different means of communication and the progressive adoption of a single protocol of communication, fixed and mobile services can get independency of transport media. It is now possible to phone over an Internet network (VoIP), to receive TV channels over a wired phone line (TVoADSL) and to exchange data over a broadcast network (Internet over cable or satellite).

As a result, competition set up between Internet Service Providers, Telecommunication Operators and Television Broadcasters. For many of them, revenues dropped down.

Profit margins can then be expected if popular and innovative services are proposed gathered in bundles needing only a single subscription.

Presently main attractive offers refer to triple-play services. They consist in bundles proposed on broadband networks and are commonly composed of the following basic services:

- local and international phone calls;
- broadband Internet access;
- a given bunch of digital TV and radio channels.

Compared to previous passive ways of audiovisual content consumption, innovation in triple-play services stands in proposing interactive services like:

- presence services (push-to-talk and instant messaging);
- unified messaging (text, voice and video);
- service on demand (gaming and video on demand).

There are gathered in the term of IPTV in which interactivity is provided by a simultaneous use of Internet and TV.

Interactive services enabled by broadband access have allowed network providers to slow down the falling of their revenues. But it is focused on a consumer market where margins are remaining low.

Mobility appears then as a new major source of profits. The market is of course presently restricted to a nomadic or a professional part of the population, but that can spend more expenses to keep a continuity of service all along moving.

Dual-band handsets have been recently launched to provide a continuity of service between inside and outside of home environment. Despite WiFi/cellular phones are available, it requires a hotspot for accessing to broadband (WiFi). WiMAX should soon afford a true broadband access that should be widely deployed and that could be efficiently used in conjunction with a DVB-T/H receiver for providing a full bundle of interactive multimedia services, continuously accessible on the move. It would provide a truly usable quadruple-play offer.

Visiongain reports in a recent market analysis and forecast about Quad-Play Fixed Mobile Convergence in 2006-2011 states that if cable and satellite subscribers would remain in the same range between 443.6 million in 2005 and 498.7 million in 2011, broadband (Quad-Play) access connections should raise during the same period from 88.1 million up to 438.2 million, offering in this way a real market for the deployment of IPTV services. Even if Asia-Pacific would represent at the end the wider market for IPTV prospects, Europe would have a pioneering position in the world by showing the fastest growth in the meanwhile. In the most prosperous area, North America, it is expected that 35% of households will get finely a triple-play package and that for 12,5% of households it will include a quadruple-play offer by 2011.

DRM technology overview

This following is a short presentation of the current standardised technologies that are currently or soon available for protecting content and services that are delivered over the air.

The main objective of any DRM solution is to ensure that usage permissions and consumption rights associated with a protected content are enforced. The main threats are coming from unauthorized access to protected content, creation of illegal copies and redistribution of valuable content.

Two main actions are then performed to protect efficiently the access to valuable content by the means of services bundled in commercial offers:

- Package content in a secure way;
- Authenticate and authorize a user to perform a service relying on protected content.

Concerning broadcast and multicast services, three main standardization bodies are actives:

- DVB Forum, which is proposing to different models for DRM, the Open Security Framework, where keys are stored in a smartcard, and the 18Crypt profile, where keys are stored in the terminal;
- OMA BCAST and 3GPP MBMS, which are closely related and which also share two different profiles depending on the way used to manage keys at the user side.

7.5 RUNCOM

7.5.1 Project results (Value propositions)

| No | Title of Exploitable result | Category | Exploitation intention |
|----|---|----------|---|
| 1 | Mobile DVBRCT/WiMAX for Unicast, Multicast and broadcast application. The mobile feature includes Handover which has been developed within SUIT project specifically (for DVBRCT) | B | <p>Mobile applications providing high throughput is going to be one of the highest demands in the future market. The spectrum efficiency in DVB/WiMAX is very high – talking about future systems it might reach 4bit/sec/Hz.</p> <p>In DVBRCT throughput might be up to 25Mbit/sec in DL and 10Mbit/sec in UL.</p> <p>In WiMAX this throughput might be achieved in the future MIMO systems</p> <p><u>Background:</u> Runcom has the technology flexibility to develop the systems for the above-mentioned throughput.</p> |
| 2 | Fixed and Mobile ENG applications. Surveillance application as well. | B | <p>ENG application or Surveillance application is one of the market demands. Runcom has validated DVB-RCT mobile capability and high throughput in UL)</p> <p><u>Background:</u> Runcom has been approached by few customers in the last two years to demonstrate Surveillance application in high mobility. The demand is to transmit 2-4Mbit/sec of high quality video that can be achieved with Runcom's technology capabilities.</p> |
| 3 | Mobile terminal for urban and rural environment. | B | <p>Runcom has developed for SUIT consortium a special terminal that includes transceivers of WiMAX and DVBRCT technologies. This kind of diversity system can provide a good reception in high data rate, high speed in urban areas by using WiMAX transceiver and the same features in Rural environment by using DVBRCT transceiver. The results could be exploited in the development of Dual mode modem</p> |
| 4 | HD video provided by SUIT Encoders/decoders | B | <p>Runcom, together with the other partners in SUIT have demonstrated in trials the ability to transfer HD video using two descriptions. One description is delivered by WiMAX pipe and the other is delivered by DVBRCT pipe. By combing these two descriptions high quality HD video can be provided in fixed and mobile applications.</p> <p>This type of cooperative diversity will be the target for exploitation in Runcom</p> |

RUNCOM regards collaboration in SUIT project with other partners as a unique opportunity for future commercial exploitation of OFDMA technology, which is poised as a promising candidate for nextG cellular mobile systems. The implications of the adaptive multi access OFDM (OFDMA) are profound which signifies a paradigm shift opening new business opportunities for operators, service providers, system-on-chip and equipment manufacturers. Runcom will exploit the tangible

results of SUIT project together with other industrial and academic partners to commercialize technology assets developed within the project and reach mature products in the following areas:

- 1. Dual mode User Terminal-** Runcom intends to exploit results and develop a converged dual mode system-on-chip combining 16e chip (WiMAX Chip) and DVB-T chip thus extending reach of the two converged networks.
- 2. Upgrade to Mobile WiMAX Wave 2 requirements-** Runcom plans to develop a second generation SoC as an upgrade for its OFDMA based SoC for the User Terminal to comply with Mobile WiMAX Wave2 requirements. Wave 2 will support operation with variety of Base Stations equipped with MIMO capabilities (MIMO matrix A, MIMO matrix B and Beam-forming). Such product could take the form of a module sold to OEM's and ODM manufacturers (Figure 6.7.1 Runcom roadmap for User Terminals)
- 3. Pico Base Station-** Runcom has completed the design stage and will initiate a plan for the development of SoC for Pico Base Station complying with Wave 2 requirements which is viewed as a further step in the implementation of its roadmap). The rationale behind this development is the identified market need to introduce a low cost solution for the base stations and thus to contribute to the uptake of Mobile WiMAX mass market.

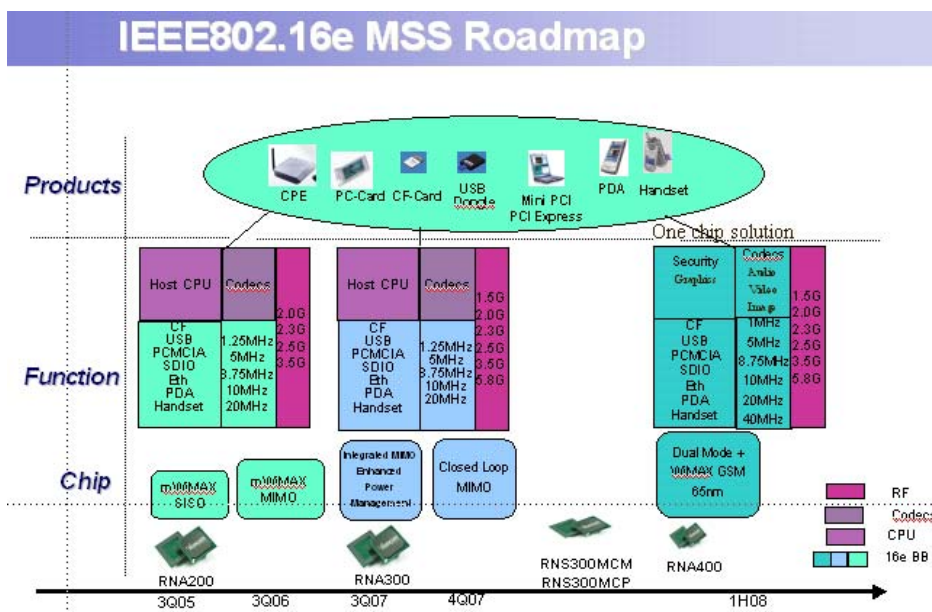


Fig. 4- Runcom Mobile Subscriber Station (MSS) roadmap

- 4. Mobile Video Surveillance Systems-** Runcom intends to exploit its system capabilities and availability of SoC's solutions on both the base station and user side to introduce to the market a WiMAX based Mobile Video Surveillance system in addition to the existing DVB-RCT solution.
- 5. SUIT concept validation with Cellcom-** Use of Mobile WiMAX Wave2 equipped with Matrix B, where two different data streams can be transmitted, simultaneously, from the Base Station to the user will offer the opportunity to validate SUIT concept of streaming scalable multiple descriptive visual contents. The plan is being negotiated with Cellcom and the test will be performed in Cellcom premises within the framework of Israel 4G consortium led by Runcom.

Runcom intends to introduce more enhancements on the second generation of "modem on chip" where OFDMA will be employed as the access scheme, enabling additional level of adaptivity through the dynamic allocation of sub-carriers within the same OFDM symbol to different users. This level of adaptivity can be equally applied to broadband wireless access systems operating in TDD or FDD modes.

7.5.2 Market forecast

Mobile WiMAX was selected by SUIT project together with DVB-T/RCT as the preferred platforms for the implementation and demonstration of SUIT concept of streaming scalable multiple descriptive visual contents over heterogeneous networks. The advent of Mobile WiMAX and the emerging 3GPP/LTE will have a major role in advancing the implementation and affordability of broadband innovative services where efficient use of the spectrum and enhanced QoS in delivering rich multimedia content are of prime importance. Several technological trends and industry drivers are favourable towards endorsement and implementation of SUIT concept by Service Providers and ISPs. SUIT business opportunities are not limited by time and window of opportunity exists and wide enough as long as the march for the Mobile WiMAX deployment and LTE later on is proceeding in vigorous steps. Some of these trends are the following- Convergence of broadband communication networks and the on-going development of multi-mode user terminals such as WiMAX-WiFi, WiMAX-EV-DO and in the future WiMAX/LTE. The advent of certified WiMAX wave 2 systems with integrated MIMO and beamforming capabilities. Of particular importance to SUIT is the implementation of MIMO Matrix B aiming at increasing link throughput by a factor of two where two different data streams, each is transmitted from a different antenna of the Base Station antenna matrix. This will be fundamental for SUIT since only one delivery system will be required to transmit the scalable multiple descriptive visual contents from the Base Station to the mobile or fixed users.

The market

Today there are over 250 million broadband users: by 2012 this figure is forecast to grow to over 1.8 billion. Most people today experience broadband via a PC connected over a fixed line (usually DSL or cable). However, for many of the broadband users expected to get online over the next few years, a fixed line is simply not an option and wireless networks will be their primary broadband access method.

Over the last 15 years, mobile communications have revolutionized how we stay in touch with each other and broadband has connected the world in an unprecedented way. The market looks set to continue its expansion by enabling a richer lifestyle with communication for all enabled by broadband everywhere connectivity for individuals, enterprises and the society as a whole. Broadband access is a natural part of our daily lives and an integral part of business, thanks to the convenience and benefits of 'always on' high-speed Internet access.

In an increasingly global economy, businesses are under intense pressure to perform. The need to control costs, boost productivity and enhance customer satisfaction has never been greater. New technologies are providing the solutions to meet these challenges. Telecoms are reshaping business models and the boundaries between enterprise and carrier, wireline and wireless, voice and data are increasingly blurred. Mobilizing the enterprise improves efficiency, creates more flexible working conditions and provides a competitive edge.

As the distribution of content on physical media (CDs, DVDs, etc.) continues to decline, content distribution over networks is growing fast, which is having a profound effect on the market. Broadband connections are becoming the key interface for delivering and managing media, as well as for enjoying entertainment services such as TV, music and gaming. Like many other new services that started in the fixed networks, broadband is migrating into the mobile world. Mobile broadband will be a larger part of this future broadband growth – helping to deliver the 'broadband everywhere' vision.

Mobile WiMAX- The global technology of choice

Meeting these challenges and the expectations of consumers requires cost-effective, proven and reliable solutions. Mobile WiMAX and the emerging 3GPP/LTE have the potential to meet the needs for economies of scale, global reach and innovation ecosystem.

Multi-Mode radio devices (Converged radio)

The integration of multiple radios into single device means that users will have access to broadband everywhere. Users will be able to access the same services using the same device whether at home, in the office or on the move. Convergence between Mobile-WiMAX and HSPA-Evolved, Mobile WiMAX and LTE in next decade and plurality of deployed WBA systems at the premises of the Service Provider will pave the way for the implementing SUIT concept.

The need for Added Value services coupled with a higher QoS requirement, the efficient use of the spectrum and the plurality of BB delivery system operated by same SP/ISPs will make SUIT a highly attractive business proposition.

Capacity Enhancement

Use of MIMO Matrix B (Spatial Multiplexing) to increase throughput by a factor of 2 will offer an excellent opportunity for the implementation of SUIT utilizing only one delivery system instead of two.

7.6 MCT/TVI

7.6.1 Project results (Value propositions)

As a member of a media and broadcast Portuguese group, MCT/TVI is very interested in this SUIT type of service concept. Certainly, it will help Media Capital to explore new services and new business models on video content and interactivity. His collaboration is also a big and unique opportunity for gain expertise and knowledge on how to deploy a combined DVB-T/H and WiMAX coverage project. MCT/TVI is interested to acquire SUIT solutions in case all SUIT concept is technologically well designed and proven. Besides, MCT/TVI, in the framework of SUIT, would like to collaborate in elaborating business solution for operators as well as in demonstrating SUIT via real field trials.

7.6.2 Market forecast

Mobile TV (DVB-T/H)

As the industry matures the dash for diversification begins. The mobile industry generates more than a trillion dollars and has well over 2 billion customers. It has for several years been seeking for a new killer application. Mobile internet, machine-to-machine communications, MMS are just new services that mobile operators have tried to popularized. One of the latest, greatest hopes of this industry is mobile television.

The industry players believe that customers will be able to watch a news channel on their phones before they get into the office, or an entertainment channel to amuse them and kill the time. Broadcasters, telecom operators and handsets manufactures are strongly engaged in opening new market opportunities. Broadcasters want new way for selling contents and increase their revenue, telecom operators are looking for new added services in order to boost their ARPU and manufactures want to sell new products with new features that granted them differentiation from competitors.

Companies have invested large sums in developing mobile television solutions so far, and has been much debate over the best approach. What should be done? Should they stream to individual devices or broadcast? And about contents? Should be created new contents specifically for mobile devices? Should the operator charge a fee for the service or rely on advertising? So many questions, so little answers.

Television is an inherently passive medium, best consumed when the viewer is sitting back and comfortable immersed. Mobile, by contrast, is an active medium, used in dynamic circumstances and for purposes that demands interaction. Another issue is the screen size of a high end mobile phone that is limited to about two inches if measured diagonally. We know video needs size and the bigger, the better.

Trials of the mobile TV service is taking place in several countries in an attempt to ensure high quality upon launch and discover correct pricing models with which to attract subscribers. Parallel to these trials, many consumer surveys have been conducted and have shown widely varying results. Some of that surveys reveal consumers interest on service and others show public apathy. For example, in a mobile TV trial in UK 76% of those trialists stated that would pay for this service and 83% went further stating that they were very happy with the service. However, a survey in US revealed that 75% of the respondents had no interest in viewing TV on mobile phones.

A new Datamonitor report, "Opportunities in the mobile broadcast TV market, 2006-2012," finds that mobile broadcast television has the opportunity to combine two popular consumer technologies — namely TV and mobile telephone, but a number of competing bearer technologies, including MediaFLO, DMB, DAB-IP and DVB-H, have made the direction of the market unclear. Datamonitor is forecasting that Europe will have 42.7 million mobile broadcast TV subscribers in 2012, making it the second largest subscriber base in the world after Asia.

Commercial experiences have been launched in some countries around the world, namely, Japan, Korea, Vietnam, Italy and Finland since May 2007. Vietnam, Italy and Finland have adopted DVB-H as technological platform.

Italy is the most advanced Mobile TV market in Europe and possibly the most advanced market outside of Japan and Korea. Three of the four major operators have Mobile TV services, with 3 being the first to launch. The company saw significant growth with Mobile TV during the World Cup. Now, additional subscriber growth has been harder to attain. It seems to be the most popular mobile tv services outside of Japan and Korea.

The increasing number of deployments, is an indication that market players believe that the service has potential and there will be notable opportunities in the sector. However, there are still significant barriers for mass adoption for mobile broadcast TV including spectrum availability, device functionality, lack of a standard certification process for DVB-H chipsets and business model.

7.7 WAVECOM**7.7.1 Projects results (Value propositions)**

| No | Title of Exploitable result | Category | Exploitation intention |
|-----------|---|-----------------|---|
| 1 | Within SUIT, WaveCom was able to develop stand alone integrated version of the WiMAX/DVB-T/H) access gateway. | B | Wavecom intends to exploit the result and further develop the dual mode access gateway towards commercial exploitation |
| 2 | The TDD power amplifier, designed in collaboration with IT and MCT | B | Wavecom intends to exploit the 2.5 GHz PA. This product triggers the development of higher power TDD amplifiers even at 3.5 GHz. Therefore, wavecom intends to research a new integrated TDD PA to be more competitive in the market. |
| 3 | Fixed reception profiles | B | Wavecom is now prepared to install fixed reception systems namely the building profile developed in SUIT |
| 4 | Wavecom gained a huge experience in the process of SUIT system integration and testing. | B | Wavecom considers integrating SUIT and sell it to the operators |

7.8 IRT

7.8.1 Project results (Value propositions)

| No | Title of Exploitable result | Category | Exploitation intention |
|----|----------------------------------|----------|--|
| 1 | IPTV Metadata server | B | <p>IRT markets its SD&S Metadata server. Within the work in SUIT, the SD&S Metadata server could be improved in terms of stability and flexibility (enable support for scalable content)</p> <p><u>Background:</u> IRT's IPTV Metadata Server provides all necessary metadata information to run IPTV services compatible to the DVB IPI standard (ETSI-TS 102034 v. 1.2.1). It delivers all required Service Discovery and Selection (SD&S) records and EPG data for Broadcast Content Guides (BCG) via both delivery mechanisms, http and multicast. For integration into the SUIT playout, adaptation of the SD&S server was required.</p> |
| 2 | FRANSY (Frequency planning tool) | B | <p>Fransy is already a commercial product of IRT and optimized/verified for DVB-T.</p> <p>There are considerations to extend FRANSY in respect to WiMAX coverage calculation. Verification of the simulations by measurements in the field is just one important step into further commercialisation of FRANSY. Additional steps (outside the scope of SUIT) would be the incorporation of (unwanted) reflections and distortions, going beyond of S/N ratio calculations.</p> <p><u>Background:</u> WiMAX coverage calculations for the field trial area of Munich have been performed with the IRT owned frequency planning tools "Fransy" supporting ray-tracing capabilities. In contrast to DVB-T, where Fransy algorithms have been refined also by field measurements, algorithms have not been verified in the frequency bands foreseen for WiMAX.</p> |
| 3 | WiMAX testbed, ENG-application | B | <p>As a research and development institute of the public broadcasters of Germany, Austria and Switzerland, IRTs main intention is to acquire well founded knowledge and experience in new technologies, amongst them WiMAX. This know-how is essential for consulting our owners. In particular the possible application of an ENG-system via WiMAX is highly of interest.</p> <p>Practical demonstrations to decision makers help to prove IRTs competence which is of relevance to attract further potential partners for cooperation.</p> |

- Type A: results usable outside the consortium If a result could be made available for exploitation by others then it should be classed as type A, even if project partners are going to exploit it.
- Type B: results usable exclusively within the consortium If you are only going to allow the project partners to exploit it.
- Type C: non usable results If for some reason your results are not exploitable at all.

7.9 UPM

7.9.1 Project results (Value propositions)

| No | Title of Exploitable result | Category | Exploitation intention |
|----|-----------------------------|----------|---|
| 1 | Tools for channel modelling | B | The results obtained by the UPM will be used as background knowledge for other R&D projects, copyright and patent issues being properly handled through the Technology Transfer Offices of the UPM. |
| 2 | Gateway Sw | A | The results obtained by the UPM will be used as background knowledge for other R&D projects, copyright and patent issues being properly handled through the Technology Transfer Offices of the UPM. |
| 3 | Synchronization module | B | The results obtained by the UPM will be used as background knowledge for other R&D projects, copyright and patent issues being properly handled through the Technology Transfer Offices of the UPM. |
| 4 | WLAN transmission module | B | The results obtained by the UPM will be used as background knowledge for other R&D projects, copyright and patent issues being properly handled through the Technology Transfer Offices of the UPM. |
| 5 | SUIT terminal | A | The results obtained by the UPM will be used as background knowledge for other R&D projects, copyright and patent issues being properly handled through the Technology Transfer Offices of the UPM. |

The contribution of UPM (Universidad Politécnica de Madrid) to the SUIT project has enlarged its knowledge and experience in the areas of scalable and multiple description video coding, packet transmission over wireless networks under the all-IP paradigm, and rate control applied to scalable video coding over WLANs. The results are expected to cross-fertilise with current activities and to support future initiatives in these areas. It is an intrinsic role of any University to contribute to the dissemination of the results in any possible media.

The UPM will, thanks to the SUIT project, continue building its long and rich tradition in this field, focusing mainly on technical and research publications, and contributions to international standards. But besides its teaching, research and development activities, the UPM is highly interested to participate in the exploitation of the outcomes of the projects in which it is involved. This participation will depend on the type of result and each partner's contribution. The results obtained by the UPM will be used as background knowledge for other R&D projects, copyright and patent issues being properly handled through the Technology Transfer Offices of the UPM.

Particularly, UPM's main expectative is focused on the technology applied to optimize video transmission over wireless networks. In this sense, exploitable results in the terms described above are:

- Tools for obtaining channel models. These models provide insights about the behavior of the channels, allowing developing customized transmission strategies.
- The Terminal in collaboration with other partners (Vitec, IT, IBBT)
- The gateway software in collaboration with other partners (Wavecom, URL, IBBT):
 - Synchronization module. This module is in charge of synchronizing to incoming video descriptions, and can be used as a component for other types of terminals.
 - WLAN optimized transmission module (rate-control).

7.10 URL

7.10.1 Project results (Value propositions)

| No | Title of Exploitable result | Category | Exploitation intention |
|----|---|----------|--|
| 1 | Playout managing software | A | The know-how acquired with the implementation of a web based manager developed using C# and ASP .NET technologies supported by a MySQL Database, will allow URL to face new projects. |
| 2 | Intelligent Unit Web Service | A | The know-how acquired with the implementation of a intelligent playout capable of serving broadcast / unicast / multicast services over DVB-T and WiMAX networks, and knowledge of IPTV, will allow URL to face new projects |
| 3 | Video Server | A | Knowledge about RTP encapsulation and signalling of H264 SVC will allow URL to acquire experience in networking, and to offer a wider technological perspective when collaborating with external companies. |
| 4 | RTP encapsulation modules to deliver MDC H264/SVC: 1. based in LiveMedia 555 2. based in jrtp lib 3.6.0 | B | Knowledge about RTP encapsulation and signalling of H264 SVC will allow URL to acquire experience in networking, and to offer a wider technological perspective when collaborating with external companies. |
| 5 | SUIT Internet Web Proxy | B | The know-how acquired with the implementation of an Internet Web Proxy will allow URL to face new projects. |

As a research and development centre located at the Universitat Ramon Llull, the Digital TV Centre is strongly involved in the deployment of the broadcasting and audiovisual technologies in Spain. URL is currently involved in projects related to technologies covered by SUIT such as SVC, RTP, DVB-H, DVB-T, MHP, MPEG-21, MPEG-7 and many others always related to the broadcasting, consumption and management of A/V content and data.

The results from SUIT will allow URL to perform exploitation in several ways:

- Knowledge about RTP encapsulation and signalling of H264 SVC will allow URL to acquire experience in networking, and to offer a wider technological perspective when collaborating with external companies.
- The know-how acquired with the implementation of a intelligent playout capable of serving broadcast/unicast/multicast services over DVB-T and WiMAX networks, and knowledge of IPTV, will allow URL to face new projects.

To summarize, URL will have the following exploitable software implementations:

- Playout managing software.

- Intelligent Unit Web Service
- Video Server (RTP encapsulator+Extractor) in collaboration with IBBT.
- RTP encapsulation modules for MDC H264/SVC:
 1. based in LiveMedia 555
 2. based in jrtplib 3.6.0
- SUIT Internet Web Proxy

7.11 UNIS

7.11.1 Project results (Value propositions)

| Result | Exploitation Plan |
|--|--|
| DVB-T+WiMAX emulator in collaboration with IT. | <ul style="list-style-type: none"> ▪ Will be used in future research at UniS to validate the performance of multimedia transmission schemes; ▪ Will be integrated with other emulators at UniS to investigate heterogeneous network scenarios. The emulators include UMTS, EDGE, and WLAN. The emulator will also be tested with an IEEE802.11e test-bed; ▪ Will be demonstrated to visitors from industry and government organizations |
| WiMAX models constructed using open source software, and a modified JVT loss simulator that makes use of the WiMAX error traces. | <ul style="list-style-type: none"> ▪ Will be used in academic research on multimedia transmission; ▪ Will be made publicly available to the research community and to partners on other research projects ▪ Will be updated to include MIMO |
| WLAN models constructed using open source software | <ul style="list-style-type: none"> ▪ Will be used in academic research on multimedia transmission; ▪ Will be made publicly available to the research community and to partners on other research projects; ▪ Will be updated to support 802.11n to ensure that the multimedia algorithms are tested on up to date network simulations |
| Multiple Description Scalable Audio | <ul style="list-style-type: none"> ▪ Results will be presented at international conferences; ▪ The performance results of audio in the SUIT system will be fed back into the MDC audio research to ensure that new MDC schemes meet the needs of real network scenarios |
| LATM encapsulation of AAC | <ul style="list-style-type: none"> ▪ Very little effective open source code exists to perform this. Therefore, we will consider making it available to the open source community. |
| Unequal Power Allocation algorithm | <ul style="list-style-type: none"> ▪ UPA will be further investigated as part of a cross layer research programme; ▪ Work will be carried out to prove its effectiveness to academia and industry; ▪ Further papers will be submitted to conferences and journals |
| Generally improved know-how about components in an interactive TV system | <ul style="list-style-type: none"> ▪ Will be used to get future research funding at EU and UK national level; ▪ <i>Educational courses.</i> UniS has already held discussions with a UK operator about running a short course on DVB and related technologies to ensure that their employees knowledge is kept up to date. The knowledge gained in SUIT can be used to enhance such a short course. Results knowledge from SUIT will also be integrated into final year and masters courses on video communication. ▪ <i>Research student training.</i> ▪ <i>Future research projects.</i> Results and knowledge |

| | |
|-------------------|--|
| | <p>gained from SUIT will be used in the preparation of new research proposals, both at the EU level, and at UK level.</p> <ul style="list-style-type: none">▪ <i>Collaboration with industry.</i> The expertise gained from SUIT will allow UniS to approach operators to discuss future collaboration in the areas covered by SUIT. |
| Conference papers | <ul style="list-style-type: none">▪ Each university in the UK is given a rating according to the quality of their research. This helps determine the level of funding that they get. One factor used to measure research funding is publication output. Therefore, the publications gained so far from SUIT, and that will be published in the future, are very valuable |

1. Annex A- Opportunities in global markets

1.1. Europe

The European market is crucial to the success of SUIT. If we can sell it in Europe, we will be able to sell it around the world. To sell SUIT as a transport and transmission technological solution, the consortium should take into account some important issues, namely, backward compatibility, high definition and quad services. The compatibility between SUIT and the existing DVB-T infrastructure is one of the most important aspect.

Legacy compatibility

As we know, the migration to digital terrestrial television is taking place across the Europe. Since 1998 a significant number of European countries has launched commercial DTT services. Three business models have emerged in meantime. Pay-TV platform was the original business model in UK, Spain and Sweden. This solution has not succeeded and DTT did not take-up. After those unsuccessful experiences, a new business model has appeared. The FTA (free-to-air) business model, offering a variety of free channels, financed either by public funds or advertising revenues, has been adopted in Italy, Finland, Germany and in UK since May 2002. The FTA offering has been the key to the take-up of the DTT platform. For instance, in UK, digital terrestrial television has shown very healthy growth in recent years, with 6.4 million homes switch from analog reception. In most of these countries, it is now taking place a migration to an hybrid business model combining FTA with some form of pay-TV.

DVB-T with MPEG-2 is the standard behind DTT platform across Europe. If SUIT development process takes into account this legacy, it will be successful in Europe. In fact, finding a viable business model with SUIT technology should be carefully addressed. In most European countries, operators have made large investments in DVB-T technology and are focusing on achieving the return on these. Certainly, they are unwilling to invest in another technology before the potential of their investment is realized, despite SUIT providing unique technical advantages.

High Definition

According ScreenDigest report "European TV Homes get HD-Ready", at end 2006, 12.8m households were equipped with HD-ready televisions-an average eight per cent penetration of TV homes. They expect the number of HD-ready households to grow to 94m at end 2011 (56 per cent of TV households). Of the current 12.8m HD-ready homes, they estimate that only 520,000 were already viewing HD-quality broadcasts at the end of 2006, mostly from pay TV (390,000). So about 12m households have an HD-ready set, but are not viewing HD pictures.

Major broadcasters are now attracted by the prospect of extra revenues from premium HDTV services and the contribution can make towards retaining existing subscribers in face of increased multi-platform competition. Developments that are likely to drive HDTV services across Europe include:

Rapid sales growth of wide screen televisions;

High penetration of multi-channel television leading to the search of next innovation in broadcasting;

Consumers are, increasingly, accustomed to pay for innovations, like high definition such as, home cinema and widescreen television.

Europe took its first steps to introducing HD broadcast services. BBC and other public UK broadcasters has conducted a temporary HD trial on DTT platform in a small region of London, limited to a 450 trialist households since early June 2006. The free-to-air HD service has showcased a wide range of HD content from each of the public service broadcasters, from a range of key genres. The HD content shown has exceeded the already high expectations of the majority of the consumers involved in trial, and their reactions have been very positive. Genres like News,

Sports and films were seen to benefit from being in HD satisfying trialists expectations of quality viewing experience.

With the adoption of the SUIT technology, the broadcast operators can delivery HDTV services with low investments.

Mobility

It is expected that there will be a strong demand for TV services on handled terminals, though a variety of other terminal may also be used.

DVB-H is a technology developed by the European DVB project that enables mobility reception of TV and multimedia contents. Some key challenges lie ahead on DVB-H developments, including, spectrum allocation and the significant network investments required to rollout the DVB-H service. In addition, incorporating receivers into handsets implies an incremental cost that manufactures

may need to support. The lack of a standard certification process for DVB-H chipsets is another challenge. All these issues may put the outcome of DVB-H projects at risk.

SUIT solution is a good answer for the market mobility demands, which, by using a robust receiver system, allows reliable mobility reception even at high speed. With a DVB-T and a WiMAX network, the broadcasters are able to offer mobile services to their customers. It could be a very interesting solution for receiving television in cars, trains and bus, as well.

SWOT Analysis

| | | | |
|---|---|---|--|
| 1 | Strengths | 2 | Weakness |
| | <ul style="list-style-type: none"> • State of art technology; • Innovative TV solutions; • Legacy compatibility; • Affordable Price; • Excellent technical staff; | | <ul style="list-style-type: none"> • Informal organization; • No sales force; • No market presence or reputation; • Development process focused on technology instead of market product/solution; |
| 3 | Opportunities | 4 | Threats |
| | <ul style="list-style-type: none"> • Market demand for HD services; • Market demand for mobility; • Quad services market growth; • Manufactures are incorporating WiMAX receivers on laptops and handled terminals; • Growing development of DTT; • Regulatory environment; | | <ul style="list-style-type: none"> • Operator switching costs; • Infra-structure investment (WiMAX); • Reactions of the other platforms operators and 3G mobile operators; • Adoption of the other wireless broadband (like 3G LTE) by the local body regulator; |

1.2. America

Overview

In the next five years, WiMAX will become a mature technology for mobile broadband access and will be ready to take one the challenge from LTE. Initially, the largest opportunity for WiMAX lies in

the fixed-access and nomadic market in emerging countries and in a few developed countries like the US. This will give WiMAX the opportunity to gain a strong foothold in the market, as mobile devices become commercially available and affordable to the mass market.

Legacy compatibility

With time, mobile access will gain more traction, as mobile operators commit to deploying high-capacity, low-latency, all-IP mobile broadband networks.

By the end of the forecast period, most subscribers will use WiMAX as a mobile technology. In developed countries, WiMAX is a natural evolution beyond 3G; in emerging markets, it may represent the first mobile broadband data network for subscribers. In all cases, WiMAX subscribers will increasingly use multiple devices linked to a single account, depending on where they are and which applications they are using.

It is not yet clear which technology, WiMAX or LTE, will win the battle to conquer the mobile broadband mass market. The stakes are high, as mobile broadband has the potential to become as pervasive as cellular voice. Both WiMAX and LTE use a similar set of technologies at their core so the performance will be comparable. However, unlike LTE, WiMAX is ready now.

High Definition

In the United States, all U.S. television broadcasts will be exclusively digital as of February 17, 2009, by order of the Federal Communications Commission. This deadline was signed into law in early 2006. Furthermore, as of March 1, 2007, all new television sets that can receive signals over-the-air, including pocket-sized portable televisions, must include digital or HDTV tuners so they can receive digital broadcasts. Currently, most U.S. broadcasters are beaming their signals in both analog and digital formats; a few are digital-only. Citing the bandwidth efficiency of digital TV, after the analog switch-off, the FCC will auction off channels 52–59 (the lower half of the 700 MHz band) for other communications traffic, completing the reallocation of broadcast channels 52–69 that began in the late 1990s. The analog switch-off ruling, which so far has met with little opposition from consumers or manufacturers, would render all non-digital televisions dark and obsolete on the switch-off date, unless connected to an external off the air tuner, analog or digital cable, or a satellite system. The FCC has determined that an external tuning device can simply be added to non-digital televisions to lengthen their useful lifespan. However, as of May 2007, external tuning devices are not widely available, are relatively expensive, and require bulky AC power supplies. Starting in 2008, the government will take requests from households for up to two coupons to reduce the price of some converter boxes by \$40. Currently, even the earliest televisions continue to work with present broadcast standards. This mandate was designed to help provide a painless transition to the new standard.

The Canadian Radio-television and Telecommunications Commission (CRTC) has adopted the same digital television standard for Canadian stations as the United States. The CRTC initially decided not to enforce a single date for transitioning to digital broadcasts, opting to let the economy decide when the switchover will occur. However, a later decision settled on the date of August 31, 2011.

CITY-TV Toronto was the first Canadian station to provide digital terrestrial service. As of 2005, other digital stations on-air included the CBC and Radio-Canada stations in Toronto and Montreal, as well as CTV's CFTO Toronto and CIVT Vancouver, and CKXT (*SUN TV*). This list is not necessarily exhaustive and other station launches are pending, although all are in the major markets of Toronto, Vancouver and Montreal. Also, this does not include digital or high definition versions of specialty services.

Mexican television company Televisa made experimental HDTV broadcasts in the early-1990s, in collaboration with Japan's NHK. Some events now broadcast in high definition.

During the first half of 2005, at least one cable provider in Mexico City (Cablevision) has begun to offer 5 HDTV channels to subscribers purchasing a digital video recorder (DVR).

In 2005, TV Azteca signed a deal with Harris Corporation's broadcast communications division for digital TV transmitters and HDTV encoding equipment to bring high-definition TV to nine Mexican cities.

The launch will be carried out in two phases. By the third quarter of 2006, HDTV transmissions will be available in Mexico's largest markets: Mexico City, Guadalajara and Monterrey. Phase Two of the national rollout will bring HDTV services to six cities along the Mexico-U.S. border (Matamoros, Reynosa, Nuevo Laredo, Ciudad Juarez, Mexicali and Tijuana) through the first half of 2006. This rollout takes advantage of HDTV receivers already in place thanks to an earlier HDTV rollout by stations on the American side of the border.

Argentina selected the ATSC standard back in 1998 (Res.2387/98) and has been conducting experimental broadcasts since 1999 but the government later overruled the decision. The current government in Argentina appears to be reconsidering its earlier decision. ATSC and DVB-T are apparently both being considered, but there appears to be no interest in ISDB-T. The governments of Argentina and Brazil had decided independently which digital TV standard each nation would deploy, but have recently agreed to work together to implement a single standard for the Mercosur customs union. While HDTV-ready TVs sales are increasing in this country, no single HD feed is currently available. Local cable company "Cablevision" will start HDTV transmission on January 20, 2007. Major TV broadcasters, namely Canal 13 and Telefe, started to show some HDTV samples in electronic shows. Canal 13 has invested in ATSC equipment, and the recent decision by the government to review this in favour of DVB added some turmoil in an already clogged scenario for such decision. Due to lack of clear directives, consumer electronic market offers LCD and Plasma equipment without digital tuners, only NTSC/PAL analog ones are included at the moment (may 2007). At the same time, some equipment were marketed as "HD-ready" when, in fact, they offered only a 852x480 pixel resolution, clearly insufficient to fulfill that claim.

The SBTVD standard was proposed by government in the end of 2005 - being able to be compatible with either ISDB, ATSC or DVB. The Brazilian government took a while to decide which standard to choose, but on June 29th 2006, President Luis Inácio Lula da Silva signed a decree choosing ISDB-T as the national standard. Various criteria were taken into account, including better technical quality, robustness, and a US\$2 billion investment on construction of a semiconductor factory in the country financed by NEC, Sony, Panasonic and Toshiba (which would allow for the TV sets and decoders to be built in the country). The terrestrial standard, which will be free and accessible "country-wide", is slated for commercial launch December 2007. The transition to ISDB is expected to take at least 9 years. The analog system will be shutdown in 2016. Manufacturers will adopt the new standard for new TV sets and will also make converters (set top boxes) available for older analogue PAL-M TV's.

In the Uruguay, on August 27, 2007, the government issued a decree stating that the DVB-T and DVB-H standards will be adopted.

Chile has recently announced that the Standard will not be decided because the cabinet changes in April 2007. HDTV-ready TVs are available quite long. TVN has made HDTV tests in 1999, Canal 13 is now broadcasting only in Santiago a test transmission in the three HDTV formats (ATSC, DVB and ISDB), in Valparaiso UCV in making only ATSC broadcastings tests only for the Valparaiso area and Canal 13 also has made tests in DVB format in April 2007 exclusive for the Valparaiso area.

Mobility

The nature of wireless communications dictates that the antenna design will have a substantial impact on what is achievable. Typically, Fixed WiMAX networks have a higher-gain directional antenna installed externally at the customer's premises which results in greatly increased range and throughput. Mobile WiMAX networks comprise mostly of indoor CPEs such as desktop modems, laptops with integrated Mobile WiMAX or other Mobile WiMAX devices. Mobile WiMAX devices typically have an antenna design which is of lower-gain by nature due to their inherent omni-directional (and portable) design. In practice this means that in a line-of-sight environment with a portable Mobile WiMAX CPE, symmetrical speeds of 10 Mbit/s at 10 km could be delivered,

but in urban environments it is more likely that these devices will not have line-of-sight and therefore users may only receive 10 Mbit/s over 2 km. Higher-gain directional antennas can be used with a Mobile WiMAX network with range and throughput benefits but the obvious loss of practical mobility.

Like most wireless systems, available bandwidth is shared between users in a given radio sector, so performance could deteriorate in the case of many active users in a single sector, especially if proper capacity planning has not been undertaken. In practice, many users will have a range of 2-, 4-, 6-, 8-, 10- or 12 Mbit/s services and additional radio cards will be added to the base station to increase the capacity as required.

Because of this, various granular and distributed network architectures are being incorporated into WiMAX through independent development and within the 802.16j, mobile multi-hop relay (MMR) task group. This includes wireless mesh, grids, network remote station repeaters which can extend networks and connect to backhaul.

Some cellular companies are evaluating WiMAX as a means of increasing bandwidth for a variety of data-intensive applications; Sprint Nextel announced in mid-2006 that it would invest about US\$ 5 billion in a WiMAX technology buildout over the next few years.

In line with these possible applications is the technology's ability to serve as a high bandwidth "backhaul" for Internet or cellular phone traffic from remote areas back to an Internet backbone. Although the cost per user/point of WiMAX in a remote application will be higher, it is not limited to such applications, and may be an answer to reducing the cost of T1/E1 backhaul as well. Given the limited wired infrastructure in some developing countries, the costs to install a WiMAX station in conjunction with an existing cellular tower or even as a solitary hub are likely to be small in comparison to developing a wired solution. Areas of low population density and flat terrain are particularly suited to WiMAX and its range. For countries that have skipped wired infrastructure as a result of prohibitive costs and unsympathetic geography, WiMAX can enhance wireless infrastructure in an inexpensive, decentralized, deployment-friendly and effective manner.

1.3. Africa

Overview

Africa remains the least connected continent in the world both from the view of the total bandwidth feeding the entire continent and from an Internet penetration perspective. Restrictive regulatory policies, state monopolies, high costs and a shortage of local skills in information and communication technologies have been responsible for the slow development of African telecoms.

Legacy compatibility

For the past years, a wave of deregulations and the prioritization of the telecoms sector through pan-African initiatives such as the NEPAD have boosted the creation of independent regulators and the entry into the market of competing services providers.

Initially, those operators were dominated by either small and local ISPs (Internet Service Providers) or new mobile operators attracted by a huge demand for voice services not met by the state monopoly. By 2010 most of the countries will be open to competition. All these facts make the African continent one of the most viable for telecom application using BWA especially for WiMAX which will bring the standardization's low cost advantages and allow new entrants and ILECs to compete and construct viable business cases when addressing residential and business customers.

African operators who have deployed DECT or Wireless Local Loop will use existing networks to the limits before investing in any new fancy wireless technology. Money or the lack of it is an issue in Africa. Other challenges include entities that have won licenses and either do not know what to do with them or lack the cash to invest in the required network.

High Definition

In Namibia's, public broadcasters still rely on analogue transmission and have not announced a transition date to digital television. Actually, the operator Multichoice already operates a digital television service using the DVB-T standard. Reaching approximately 3000 subscribers, the transition occurred on 18 February 2005 without the use of a dual-illumination period due to the lack of spare frequencies.

The first digital television implementation in South Africa was a satellite-based system launched by pay-TV operator Multichoice in 1995. On 22 February 2007 the South African government announced that the country's public TV operators would be broadcasting in digital by 1 November 2008, followed by a three year dual-illumination period which would end on 1 November 2011.

Mobility

IP Wireless, although not a WiMAX player, has been very active in Africa through its partner Axcera with substantial deployments reported. The largest of those deployments is in South Africa with operator Sentech. Sentech is a state owned enterprise that provides broadcast signal distribution, international telephony and broadband services. The network is composed of about 50 base stations (or 130 sectors) and serves about 5,000 users in the 2.5GHz band. The service named "MyWireless" targets both residential and business users with fixed and portable data services.

Sentech also deployed VectaStar fixed wireless access equipment at 3.5GHz from UK-based Cambridge Broadband's. Sentech is the only operator in South Africa other than the incumbent telecom operator to have a 3.5GHz fixed wireless license. The company plans to use the spectrum to provide Broadband Wireless services to business and residential customers, as well as for backhauling traffic from other network components.

In Nigeria, IP Wireless/Axcera deployed a network with Netcom Africa in the 2.5GHz band. The service name "MyNetcom" is initially offered in the largest cities including Lagos and Abuja. In Tanzania, Axcera reports that CatsNet, a local ISP has deployed a commercial network in the 1.9GHz. Other actives in the continent include trials in Douala (Cameroon) and with EmiNet in Mozambique.

In April 2005, Wireless Business Solutions (WBS) officially launched its iBurst mobile broadband service in South Africa, after six months of pre-commercial operation. WBS' network using Arraycomm iBurst equipment is now operating in Johannesburg, Cape Town, Pretoria, Durban, and Robin Island. WBS will continue to intensify its base station roll-out in metropolitan areas and is currently looking at beginning roll-out to rural areas.

Connections to the iBurst network can be made through a desktop modem or PCMCIA card, providing full subscriber mobility.

Alvarion is the largest pure BWA/WiMAX system vendor so far with activities in all continents. Its presence in Africa is strong. According to company sources, there are 50 Alvarion BWA/WiMAX networks in Africa. Alvarion claims a presence in the following countries: South Africa, Ivory Coast, Congo, Burkina, Faso, Kenya, Namibia, Nigeria, Botswana, Swaziland, Madagascar, Eritrea, Benin, Tanzania, Uganda, Angola, Zimbabwe, Uganda, Angola, Ghana, Guinea, Liberia Mauritania. Networks have been deployed using a variety of licensed and unlicensed spectrums to provide voice and data services to residential and business users.

1.4. Asia

Initial certified mobile WiMAX deployments will begin towards the end of 2007 as this is when certification from the WiMAX Forum will happen. Currently there are nearly 200 operators trialing both mobile and WiMAX technology globally.

Countries which show a high market demand for portable and mobile services such as South Korea and Japan will initially drive the markets throughout the developed world.

Both India and China are viewed as large market opportunities for WiMAX technology as they have relatively poor telecommunications infrastructure and booming markets.

Many parts of India are still without access to a standard telephone service. The Indians view the 700MHz frequency band as suitable to deliver both mobility and broadband services such as rich multimedia content, Video and VoIP telephony over WiMAX throughout the country. This frequency has not been certified by the WiMAX Forum and even if it is, this will not happen for another two years. It is expected that by the year 2010 there will be 70-100 million broadband subscribers in India. This is a huge increase from the current 1.7 million.

Aircell Business Solutions, which is a subsidiary of the Aircell cellular provider in India, has recently agreed to deploy a WiMAX network to serve small and medium enterprises in fifty Indian cities throughout the Northern and Eastern regions of the country using equipment from Alvarion. The platform will operate in the 3.3GHz band as this frequency band is currently allocated for WiMAX use in India.

China also has issues with spectrum surrounding the 2.5GHz band because of the launching a C-band satellite transmission system by the end of H1 2007. However Samsung has announced that it is in an agreement with Beijing Airway Communications to deploy WiBro. It is believed that Samsung is also in negotiations with other Chinese telecom operators for the same service. The deployment of WiBro throughout several provinces is a clear indication that the Chinese government is becoming more flexible on spectrum issues.

The Korean and Japanese markets are well known for their high demand for portable and mobile services. Korea Telecom was the first global operator to deploy mobile WiMAX (WiBro) in June 2006, however, the service has not been very successful to date. It is expected that this will change once deployments become more extensive, more handsets are available and the technology is more mature. In Japan mobile WiMAX has been trialled by four operators. Australia, New Zealand, Malaysia, Singapore and Taiwan are also rolling-out WiMAX networks. The Asia-Pacific region therefore seems to be enthusiastic on the technology. The chart below shows the forecasted number of subscribers between 2007-2012 for this region.

During the years 2007 and 2008 the vast majority of these users will be fixed WiMAX subscribers. However, after the year 2009 the number of mobile WiMAX subscribers will rise and be equal to the number of fixed WiMAX subscribers throughout this region of the world. After the year 2010 the number of mobile WiMAX subscribers will increase as the technology will have matured, wider coverage and more roaming agreements will have been realised and more, user terminal devices will be commercially available.

Nortel Networks and Alcatel are also collaborating with Runcorn and are integrating their 802.16e compliant chipsets for their MIMO enabled WiMAX network infrastructure and terminals.

2. Annex B- Comparative analysis of WiMAX and LTE

1. Ecosystem Support (Advantage: WiMAX)

To succeed in today's marketplace, an emerging technology must be supported by a complex web of component suppliers, equipment manufacturers, systems integrators, software developers, service providers, and media companies. The importance of such a nurturing ecosystem has been demonstrated more than a decade ago by the success of the USB Implementers Forum. Founded by seven major technology companies that came together to create a new ecosystem, the group defined the need for USB and drove the development and adoption of the nascent technology.

Similarly, key mobile WiMAX proponents, including Intel, Samsung, Nokia, Motorola, Alvarion, BT, KT, Sprint Nextel, and Google, have all lined up to support the standard. Recent announcements at the 2008 Mobile World Congress, as well as product information leaks, such as the mention of an enhanced Nokia N830 Internet Tablet in Best Buy's February Mobile Buyer's Guide, demonstrate significant, growing support for WiMAX in consumer devices. This support provides critical mass for a rapid launch and creates a shared incentive for these key players to make WiMAX a success.

2. Consumer Positioning (Advantage: WiMAX)

While in the past marketing was irrelevant to choosing a new technology standard, today it can greatly influence how the consumer "feels" about making the purchase and signing up for service. Consider the success of Intel's "Intel Inside" campaign—the consumer-oriented branding of a complex technology architecture standard. Who would have thought that consumers would really care about the brand of the processor in their computers?

In the case of WiMAX, its key proponents have made the wise move of attaching the standard to the ubiquity of Wi-Fi—a user-friendly technology that has fended off other wireless and wireline home networking standards to become part of the consumer lexicon. While this move was somewhat inappropriate from a technical point of view, given the higher complexity and infrastructure-based network architecture of WiMAX, it appears likely to have the intended impact on consumers' perception. Will WiMAX really be as ubiquitous and easy to use as Wi-Fi? Surely not in the near term, but such a positioning with consumers gives WiMAX a leg up on LTE, which is virtually meaningless to most people as a brand.

3. Delivery Timing (Advantage: Undecided)

Another important determinant of adoption success today is aligning the launch of an emerging technology with other key events in its supporting ecosystem—as part of a comprehensive and coordinated market-entry strategy. Such a strategy may require preemptive cannibalization of existing technologies, products, and services. And it may require a wave of innovation across different disciplines to develop and support the new paradigm.

For example, the rise of digital imaging during the early 2000s relied on developments in several areas simultaneously: computing capabilities (memory, processing power, storage), imaging technologies (CMOS sensors, batteries, flash memory), printing technologies (inkjet heads, ink, paper), and user behavior (expectations for instant viewing, acceptance of digital quality, online printing, and photo sharing). This lucky confluence of events enabled the triumph of digital photography—all but replacing traditional film, processing, and printing in less than a decade!

What will WiMAX proponents have to do to achieve a similar paradigm shift in the wireless services business model? For one, they will have to persuade high-ARPU customers to “upgrade” from their existing broadband technologies, such as EVDO and HSPA. This may be a tall order, given that EVDO and HSPA already offer proven performance and widespread coverage, while the initial coverage of WiMAX will be (at best) uneven. The challenge for WiMAX is to find and piggyback on synergetic events in the ecosystem: perhaps a new release of Microsoft Windows that encourages PC upgrades, or a new Intel chipset that disrupts costs, or even a change in YouTube that radically improves the mobile creation and distribution of video content. It seems that leading WiMAX adopters such as Sprint Nextel will have to nail this one if they hope to add a substantial number of new customers.

4. **Technology Capability and Cost** (Advantage: LTE)

While historically the sheer technical capability of a new standard was an important determinant of success, this factor seems to be less relevant in the adoption of new technologies. For example, compare Betamax with VHS recording. Beta was clearly far superior, but it lacked the consumer positioning and strong coalition of support that VHS had. The same argument could be made for Apple versus Intel, or even HD-DVD versus Blu-Ray. Perhaps this consideration gives WiMAX a leg up, as LTE is arguably superior in many ways, including baseline speed and the road map for future capabilities, speed, and capacity. While the expected cost advantage of WiMAX may bring some initial advantage, the long-term road map is unclear and may well drive convergence with LTE.

5. **Standards Bodies Approval** (Advantage: WiMAX)

The technology world is a funny place: On one hand, it has a proliferation of standards bodies, some of them self-declared. On the other hand, it lacks truly global standards for key attributes, such as spectrum and safety. As a result, the approval of standards bodies is nearly meaningless in the big picture of adoption success. Most new technologies, such as solid-state storage, LED lighting, HDTV, and even smart phones didn't get the approval of standards bodies before making a big impact on the marketplace. In the case of WiMAX, does anyone really care that the ITU classified it as a 3G (rather than 4G) technology? Surely not—except perhaps for a regulator who naively allocated spectrum to 3G technologies only.

6. **Regulatory Buy-in** (Advantage: Even)

Regulatory buy-in to the launch of a new technology shouldn't be assumed. For example, the adoption of GSM technologies in the U.S. was slowed down by at least five years by the regulators who were reluctant to disenfranchise existing providers and customers of analog networks. The WiMAX community needs to avoid the same pitfalls in other geographies. While WiMAX already has received the go ahead for deployment across wide swaths of spectrum in many countries, the jury appears to be out with other local regulators in key emerging economies, such as Brazil. The WiMAX community and its representative bodies (e.g., WiMAX Forum) should be on the lookout for potential regulatory roadblocks and act quickly to prevent them from impeding a rapid rollout of the technology.