Towards an ANWIRE B3G Wireless System Integration Architecture

ANWIRE Task Force 1.5: System Integration

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***Abstract*—This paper is part of a contribution to the ANWIRE 1st International Workshop on "WIRELESS, MOBILE & ALWAYS BEST CONNECTED". It reflects the objectives of work programme for the ANWIRE [1] System Integration task force, and the results as achieved to date. The overall aim of the task force is to generate proposals for integrated system service architecture. For this, a detailed structured review of current system integration R&D efforts was created and is presented here in summary form. Based on the review, requirements for a targeted architecture will be extracted and crystallised as part of the future activities of the task force.**

Keywords: ANWIRE Task Force1.5, system integration

I. Introduction

The emerging of different wireless technologies and the development of the mobile terminals industry accommodate people's basic needs for communication and mobility. After the landline telephony service, the second generation of mobile networks (2G) provides wireless mobile telephony service to the users. The third generation of mobile networks (3G) promises to support mobile telephony service as well as data services. However, driven by the enormous success of the Internet within the last ten years with steady increasing data rates made available to the (wired) subscriber and the inherent deployment of new services, certain expectations emerged. Not only businessmen who used to be the first customers in the beginning of mobile communication but all communication services users demand for a wired-service like connection while on the move; a challenge that obviously will not be satisfied solely by 3G deployments.

An auspicious solution to this problem is seen in Wireless Local Area Networks (WLANs) and other wireless technologies arriving in the market and featuring data rates outperforming the ones of 3G mobile networks. Due to the high bit rates and the free frequency licensing WLAN technology is partly seen as a competitive technology to the 3G mobile network technology. However, due to the rather small cell area, it seems utopian to realize a nationwide coverage based on sole WLAN deployment. This is why currently WLAN and 3G mobile networks are seen as complementary technologies. The aspired integration is a key element for systems 'beyond 3G' or '4G'[1]. In fact, WLAN is a type of 'volunteer' to be used in indoor environments or hotspots while 3G systems show advantages in broad outdoor environments. Integration between the two technologies is necessary to ensure the continuity of the service to the mobile users following the 'anywhere', 'anytime' dogma. In the projected 4G environment interconnection and interoperability between different technologies is foreseen as the norm in order to ensure (seamless) handovers from one technology to another, thus to provide a continuous and hopefully always best connected (ABC) service to the users [2].

1 Within this paper both notations are used equally.

II. Overall Objectives of the ANWIRE Task Force "System Integration"

Within the thematic network ANWIRE two main overlapping research tracks are discussed: 1) Wireless Internet and 2) Reconfigurability. The aim is to organise and coordinate parallel actions in these key research areas, as an effort towards the design of a fully integrated system or systems. ANWIRE aims to promote and disseminate relevant proposals, solutions and ideas among the research and industrial community.

The 'System Integration' task of ANWIRE has the goal to organise and coordinate activities on evaluation of mechanisms that allow the integration of different systems and technologies to form a heterogeneous network. Thus, attention is focused on incorporating and integrating results of closely related fields like 'Efficient and always on connectivity', 'Application architectures for the support of Reconfigurability and Adaptability' or 'Adaptable Service Architectures' in order to evolve solutions for systems which offer efficient connectivity and a flexibility in the service provision infrastructure.

The task force aims maybe briefly stated: To organize and coordinate activities on:

- integrating specific solutions to create a 4G environment which is able to handle generic requirements efficiently;
- defining generic design rules for the envisioned integrated system architectures that will support reconfigurability, adaptability and always-on connectivity features;
- generating and issuing a chart of recommendations for the technological development required to achieve the envisioned systems;
- proposing a migration roadmap towards a fully integrated system (systems) and
- providing input to dissemination/promotion activities.

The task force begun work in this ANWIRE strand by assessing the state of the art in system integration efforts of other research groups and projects like ETSI BRAN, 3GPP, WINE GLASS, MOBY DICK, SUITED, BRAIN/MIND, DRIVE, TRUST/SCOUT, FLOWS, MOBIVAS and others.

The aim was to give an enclosing overview of current efforts in system integration and to reflect the major trends. Each project thereby was reviewed following the same scheme:

- Project overview: Includes a brief introduction about the specific project/standardisation body, describing the overall aims, constitution, run-time and participating members.
- System integration efforts: Presents related topics addressed in the respective project followed by an evaluation of the approach answering questions like:
  - Which topics have been addressed in detail?
  - Which tasks have not been touched?
  - Which points have been addressed but still require further study?
  - Does the project cover a comprehensive solution or only specific parts?
- Conclusion for ANWIRE: Deals with the question of how the goals and achievements of the projects correspond with ANWIRE aims.
- Commonalities and differences of approaches: Analyses the projects reviewed and their approaches to establish their commonalities and differences. Key issues include:
  - diversity of systems researched (cordless, WLAN, cellular, (digital) broadcast, satellite)
  - integration level sought and achieved (tight, loose, non-existent)
  - applied business models and scenarios

III. State of the Art in System Integration Efforts and Achievements for ANWIRE

Within the following section, an overview of ongoing or already completed work related to R&D in the field of system integration will be given.

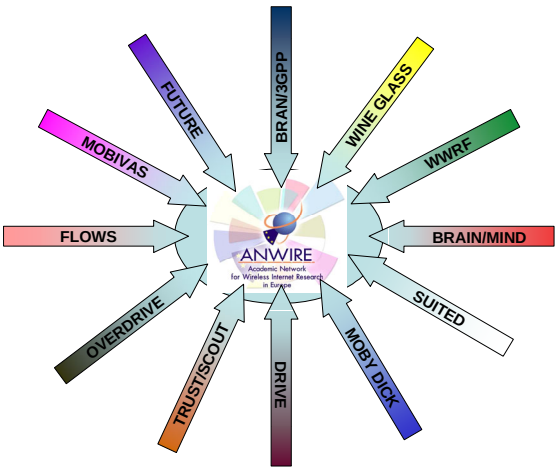

Figure 1. Consideration of system integration approaches

The presentation does not attempt to mirror exhaustively the specific project descriptions and achievements. Rather, the focus is to address special issues of system interworking and integration in order to determine the skeleton of a dedicated ANWIRE system integration architecture see .

A. *ETSI BRAN/3GPP*

1) *Project overview*

The two approaches taken in ETSI BRAN provide the network operators with the option of high and low level of system integration depending on the requirements and the feasibility of deployment in a specific area or conditions.

In the loose approach the main advantage for the operators is that being simple to implement, the approach is ready for rapid market entry without major modification. The approach allows centralised authentication and signalling information related to a user in single core network equipment, independent of the radio access network the user is attached to at the time. A single operator can therefore offer an integrated service to the user. However the loose coupling approach does not allow for seamless handover between HIPERLAN/2 and UMTS since the local IP address needs to be changed and information need to be exchanged at higher level (IP or application). Furthermore, the QoS for each connection has to be renegotiated. More information can be found at [3]

2) *Strengths and weaknesses of the proposed architecture*

The ETSI BRAN tight approach on the other hand allows for seamless interworking between UMTS and HIPERLAN/2, reusing the mechanisms for mobility, QoS and security of the UMTS core network for HIPERLAN/2. Furthermore certain addresses and identifiers of UMTS are used by the HIPLERLAN/2 via the new Iuhl2 interface. However, this approach entails both, increase of complexity as well as increased level of signalling. This approach is only feasible if a single operator is running both networks.

3) *Conclusion for ANWIRE*

The standardization work carried out in ETSI BRAN /3GPP provides a good overview of the variety of approaches that can be adopted, depending on the level of integration that is required or deemed necessary. The loose interworking ETSI/BRAN approach for example has the advantage of being simple which enables it for rapid market entry. The approach allows centralised authentication and signalling information related to a user in a single core network equipment, independent of the radio access network to which the user is attached. A single operator can therefore offer an integrated service to the user. The loose coupling approach however does not allow for seamless handover between HIPERLAN/2 and UMTS since the local IP address needs to be changed and information need to be exchanged at higher level (IP or application). Furthermore, the QoS for each connection has to be renegotiated.

Several aspects in mobility and handover are still open items in ETSI BRAN including knowledge of terminal location accuracy, the state of the terminal, usage of the Iurhl2, Iurhl2/utr interfaces, handover time and use of radio resources, handover trigger and controlling, further study of mapping of different QoS classes in UMTS to WLAN. These aspects may be considered as focus points in ANWIRE.

B. *WINE GLASS*

1) *Project overview*

All IP was the main objective of the Wine Glass [4] project in order to support mobility and soft-guaranteed QoS in a wireless Internet architecture using UMTS and WLAN, and to

investigate their potential in enabling location- and QoS-aware application services for wireless mobile users. The Project has developed a wireless Internet testbed incorporating an IP back-bone, UTRAN access to IP-based core network, and WLAN access to intranets, as means to investigate, develop, test, integrate, validate and evaluate such innovative techniques and applications. Two main issues have been explored; the integration of the wireless access networks and the IP-based backbone in a convergent scenario involving a variety of service contexts; and the definition of service schemes suited for location-aware applications in an integrated system environment.

2) Strengths and weaknesses of the proposed architecture

The project covers all the initial objectives as it provided effectively an implemented wireless IP architecture incorporating UMTS and WLAN, supporting IPv6 based mobility, soft-guaranteed QoS and location- and QoS-aware application services for wireless mobile users.

The WINE GLASS QoS architecture considers DiffServ architecture in the IP backbone, and Connection Admission Control is performed in the UTRAN access and Packet marking is done in the Mobile Terminal. However, the project doesn't provide any QoS architecture In the WLAN access network. In addition, it doesn't consider service adaptability and network reconfigurability, which are two important aspects in the 4G mobile and wireless networks.

3) Conclusion for ANWIRE

Some results of WINE GLASS project such as the all IP in the UMTS core network and the vertical handover solution are good starting points for 4G and ANWIRE. However, some of ANWIRE interests do not appear in the WINE GLASS project. In fact, Wine Glass doesn't deal with adaptability or re-configuration issues as it does not focus on the application level, these two points should be of important interest and the added value of the ANWIRE Project.

C. MOBY DICK

1) Project overview

The general purpose of the IST MOBY DICK [5] project is to establish quantitatively and qualitatively if the Internet is able to replace the existing connection-oriented infrastructure.

They target a QoS-enabled and AAA2 supported mobility on a heterogeneous network infrastructure. So Moby Dick merges mechanisms of three different research areas namely QoS, AAA, and Mobility management (based on Ipv6).

a) Strengths and weaknesses of the proposed architecture

The Moby Dick project will develop prototype architecture for tests and evaluation that will be carried out at a trans-European scale.

b) Conclusion for ANWIRE

In its attempt to design an architecture for mobility and "always on connectivity", Moby Dick is very close to ANWIRE; ANWIRE should have a close look at the architecture to propose when defining design rules for the ANWIRE envisioned architecture. However, Moby Dick puts a very strong emphasis on QoS support, security and accounting (AAA) which do not appear as central (although important) in ANWIRE.

Last, but not least, Moby Dick does not address the reconfigurability and adaptability issues that are key to ANWIRE (recall that one of the core activities of the integration work package being the study of overlapping or conflicting issues between Wireless Internet and Reconfigurability).

D. SUITED

1) Project overview

The main objectives of SUITED [6] – Multi-Segment System for Broadband Ubiquitous Access to Internet Services and Demonstrator–were to contribute towards the understanding of IP based mobile networks consisting of both satellite and terrestrial (UMTS, GPRS, W-LAN) components through the development of an integrated system – the Global Mobile Broadband System (GMBS). Issues were addressed through theoretical analysis (e.g., network architecture, QoS and mobility management) and experimental work. A series of trials, using an integrated testbed comprising of a prototype multi-segment infrastructure and a prototype multi-mode mobile terminal, capable of operating seamlessly with both satellite and terrestrial networks, were executed. The trials included navigation capabilities integrated into the user terminal in order to enhance the performance of personal communication services and physical layer functions.

2) Strengths and weaknesses of the proposed architecture

The architecture was effective for investigating seamless integration of satellite-terrestrial systems and establishing the major research and developments, and standardisation work for this kind of integration of multiple mobile networks for the benefit of the user. Business models still however require a much greater development.

3) Conclusion for ANWIRE

As part of the new generation broadband mobile Internet, the R&D effort invested into integrating system and service requirements for the GMBS demonstrates the possibility of effective interworking of different wireless network infrastructures, and suggests standardisation activities to support this. The definition of the GMBS network architecture and performance evaluation from a service and network perspective is a useful case study, as is the validation campaign to qualify the GMBS performance in providing Internet QoS for R&D activities expected in evolution of 4G networks. The prototyping of the satellite/terrestrial multi-mode terminals may also be viewed as clear activities on the road map of reconfigurable 4G terminals' R&D.

E. BRAIN/MIND

1) Project overview

"Broadband Radio Access for IP based Networks" (BRAIN) research project [7] - and its continuation in the "Mobile IP based Network Developments" (MIND) project [8] - had the overall aim of provide broadband multimedia services (up to 20 Mbps) fully supported and customised when accessed by future mobile users from a wide range of wireless access technologies such as GPRS/UMTS, WLANs (mainly based on Hyperlan/2), PANs and also ad hoc networks.

a) Strengths and weaknesses of the proposed architecture

BRAIN and MIND projects introduce a "flexible" and "open" framework. It allows the use of any kind of Mobility Management protocol, QoS, AAA and Security solutions

2 Authentication, Authorization, and Accounting

inside each access network based on ongoing efforts at the IP level in the IETF; even though, the projects had developed their own "scalable" and "robust" micro-mobility protocol, recommendations/mechanisms for End-to-End QoS support over heterogeneous networks, seamless horizontal/vertical handovers procedures, systems integration solutions and "adaptation" of multimedia services to the terminal and also to network conditions. At the contrary, the device re-configurability function (at lowest and also highest layers) was not considered an essential requirement. The framework was focused only in communication-centric services. Other services considered important in 4G systems like context-aware, location-aware and personalisation services were not included.

2) Conclusion for ANWIRE

The BRAIN/MIND architecture for the provision of broadband wireless Internet may be considered a good candidate as a reference model to ANWIRE aims. It achieves with almost all the needs for system integration presented in this documents and other more generic with respect to 4G mobile and wireless communication systems. Not much effort should be necessary to adapt this framework to cope with other unfulfilled requirements.

F. TRUST/SCOUT

1) Project overview

As the TRUST/SCOUT [9] projects are based on the inclusion of reconfigurability in wireless networks, the approach taken provides the high level of integration (by very tight coupling) to enable support for fast decision for reconfiguration. The approach provides seamless interworking and combination with reconfiguration provides better radio network planning and design, improved QoS and mobility support. The Major drawbacks in this approach are higher levels of signalling between the entities as well as requirement of the definitions suitable interfaces and other mechanisms currently under consideration.

2) Strengths and weaknesses of the proposed architecture

Within the project, major requirements for a possible intersystem handover algorithm have been derived and formulated. Those requirements should be taken into consideration when defining future integrated systems. In particular, SCOUT focuses on a very tight coupling approach because it aims on a very fast handover execution and fast decision finding processes before and during the reconfiguration mode.

However, the "open coupling" and "loose coupling" themselves are not applicable for SCOUT.

3) Conclusion for ANWIRE

The projects under investigations tackled a number of open issues left in ETSI BRAN such is handover triggering and control, handover time and use of radio resources. Those items should also be incorporated in designing a targeted ANWIRE system integration architecture. Regarding a suitable approach for system integration issues as to be brought up by ANWIRE, the tight coupling seems to be the favourable one due to its inherent high level of integration.

G. FLOWS

1) Project overview

The FLOWS project is motivated by a vision of future communications in which IP plays an increasing role and there is a convergence of wireless systems such as 3G and WLANs. An important concept adopted by this project is to use a common access network based on IP. Onto this common network a variety of wireless access points will be connected, for example using GSM, UMTS or HIPERLAN/2. For the FLOWS project a key issue is defining what is meant by "convergence" in future wireless systems and in particular the simultaneous use of standards. Also the implications for the radio access networks and service provision will be analysed. The project has to ensure that the impact of using multiple standards takes into account the business needs of users. Additionally, key issues are the exploitation of the flexibility offered by MIMO techniques to achieve convergence of wireless standards, and the demonstration of key techniques and systems performance by using appropriate models, simulations and designs. Further information can be found at [10].

2) Strengths and weaknesses of the proposed architecture

The proposed architecture is more focused on terminal and radio access system issues, thus it cannot be seen as a global architecture for a "convergent" system. Despite this, the proposed architecture emphasises the need for a convergence manager entity to cope with reconfigurability. Model assessment, field measurements, specially using MIMO techniques and all the simulation work are also object of detailed work. Other good aspects are the outputs from the definition of scenarios and social impacts of these wireless convergent systems.

3) Conclusion for ANWIRE

The highlights can be put in the following areas:

- Scenarios and Services - definition of scenarios where the various standards will work, which can be an input for an Always Best Connected usage of advanced mobile services;
- Managing convergence – a reference model of common access networks based on IP is proposed;
- Commercial and Social impacts of wireless systems using simultaneous standards are also addressed, giving the possibility of assessing and ensuring that the business needs of potential users are fulfilled.

H. Chinese 863 Program Project in Wireless Communication –FuTURE

1) Project overview

FuTURE is a key project in the wireless communication branch of the National High Technology Research and Development Program of China (863 Program) [11]. The technology objective of FuTURE is to carry out investigations on key technologies for air interface of Beyond 3G/4G mobile communication system, set up demo systems to verify the key technologies that can support future wireless services, promote international cooperation, contribute to laying out standardization and intellectual property for Beyond 3G systems. There are 7 key topics to implement the objective. They are: B3G Radio Access Techniques; Wireless LAN and Ad hoc; Multiple Antenna Environment (MIMO) and RF; 3G-Based Ad hoc; IPv6-Based Mobile Core Network; Generic Techniques for Mobile Communications; System Structure, Requirement and High Layer Applications.

2) Strengths and weaknesses of the proposed architecture

The FuTURE project focuses on the physical layer architecture of future wireless system. A new multiple access scheme - LAS-CDMA (Large Area Synchronized CDMA) scheme has been accepted by 3GPP2 as one candidate for 3G Beyond standard. It is compatible with future all IP networks and current wireless communication standard, thereby giving a great fillip to the upgrading of telecommunication products as well as the sustaining enlargement of telecom service.

However, the FuTURE seems have not formed a unified frame and less concern with the SDR (Soft Defined Radio), so is not clear how it connected with ANWIRE, especially with the reconfigurability and Adaptability.

3) Conclusion for ANWIRE

The FuTURE project focuses on technologies such as air interface and spectrum distribution for universal radio environment and attempts to establish an integrated architecture of a future wireless system. Some new network concepts, sub-system structures, handover methods and access schemes have been proposed.

IV. Requirements of an Integrated System's Architecture

A typical integration scenario of 2G and 3G cellular radio systems via their Internet Protocol (IP) based core network with WLANs is shown in Fig. 2. It is assumed here that the mobile terminals are supporting at least one mobile radio and one WLAN air interface.

The integration might be:

- tight, if the Intranet of the WLAN is part of the core network of the mobile radio network.
- loose, if both fixed IP networks are connected to exchange control and signalling information.
- not existent, i.e. if both systems are operated completely separated from each other. For example a mobile terminal then might contain two subscriber identification modules (SIM) according to the two different contracts signed with the operators of the mobile radio network and WLAN, respectively.

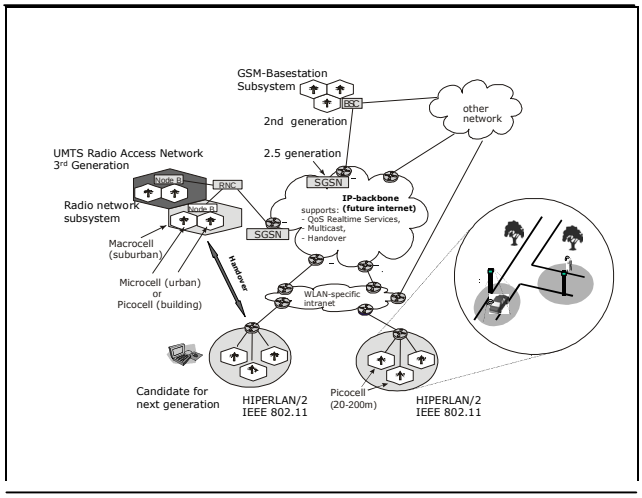

Figure 2. 2G and 3G system integration with WLAN[12]

To attain integrated systems various issues need to be better conceptualised in order to progress the R&D effort in evolving solutions. This will be an ongoing process for the Task Force

These issues are related to the *network*, the *terminal*, the *services* and the *user*.

From the network point of view, the integration system level depends on the network layers' integration. The loose integration is achieved with the integration at the high layer. The tight integration can be achieved at the link and the physical layer.

The integration process at the high layer may be achieved by the integration of the system management of the different networks, and the AAA system. In this integration we need to consider these requirements:

- *System management integration requirements*: The management system of each network can exchange management information with each other. The management information can be related to QoS, mobility and security. In the integrated system, the system management has to consider the personal and service mobility management. Here, session continuation issues, service portability issues, roaming users' issues, and security issues need to be considered.
- *AAA integration requirements*: Depending on the level of integration, the system integration can have a unique AAA system (tight integration) or just exchange AAA information between the integrated networks.

The integration process at the network layer needs to consider these requirements:

- *AAA integration requirements*: Depending on the level of integration, the system integration can have a unique AAA.
- *Seamless Mobility management issues*: Mobility management in homogenous networks intends to define seamless mobility which is a challenging issue actually. In addition to the issues in the mobility management in homogenous networks, the integration of different networks needs to consider vertical handover issues.
- *Routing issues*: Depending on the network type, the routing issues are different; wired, Ad Hoc and Multi Hop networks routing issues need to be considered.

The integration process at the link and physical layer should provide the tight integration between the network technologies; it's probably the most difficult area of integration. Here the wide range of air interfaces (modulation formats, bandwidths, operating frequencies) together with the many physical layer signal interference problems will be a source of significant interoperability challenges to be resolved in the drive for a seamless integration.

From the terminal point of view, the integration system process needs to consider requirements such as:

- *Multimode terminal*: The terminal needs to support different interfaces from each network technology serially, but in due course also in parallel when multiple connections in multiple wireless networks simultaneously will need to be supported..
- *Adaptive and reconfigurable terminal*: Re-configurability (software radio), adaptability, multiple SIM support, wide band receivers.

From the user and service point of view, the integration system process needs to consider requirements such as:

- *User identification*: Should the user have a unique identifier in the network, where to store this identifier (may be a smart card)?
- *User contract*: Should the user negotiate a service contract with one administrative operator or several operators. This depends on the level of the system integration. In case of integrated AAA system, the user will have only one contract, in case of separate AAA systems, the user could have several contracts.
- *User services, adaptive services, always best connected user*: In the integrated system, the user needs to be always best connected having continuous service when changing network technology or changing terminal (adaptive and reconfigurable actions and issues).

These requirements, besides having important technical implications, are essential to addressing potential business models. Further related work in the context of user requirements may be found in [13].

Finally, security issues need to be considered in each integration system level.

V. Future Activities of the Task Force

Based on the perceptions gained from the investigations of state of the efforts in the field of system integration, the Task Force in this strand of ANWIRE will investigate which possible structures/ideas may be adopted, perhaps with enhancement suggestions and proposals, and identify which parts are still missing to achieve a proper interworking. Then necessary structures on system and service level will be more particularly identified in order to develop the corresponding architectures. This will lead to the definition of a set of functional entities, protocols and interfaces that will form a reference model of a future wireless system, which integrates multiple platforms and provides the means for the support of reconfigurability and adaptability.

Finally, the Task Force aims at proposing a migration map for the evolution of today's wireless networks to the proposed integrated architecture. The overall roadmap and dependencies for an ANWIRE system integration reference model finally are summarized by Fig. 3.

Acknowledgment

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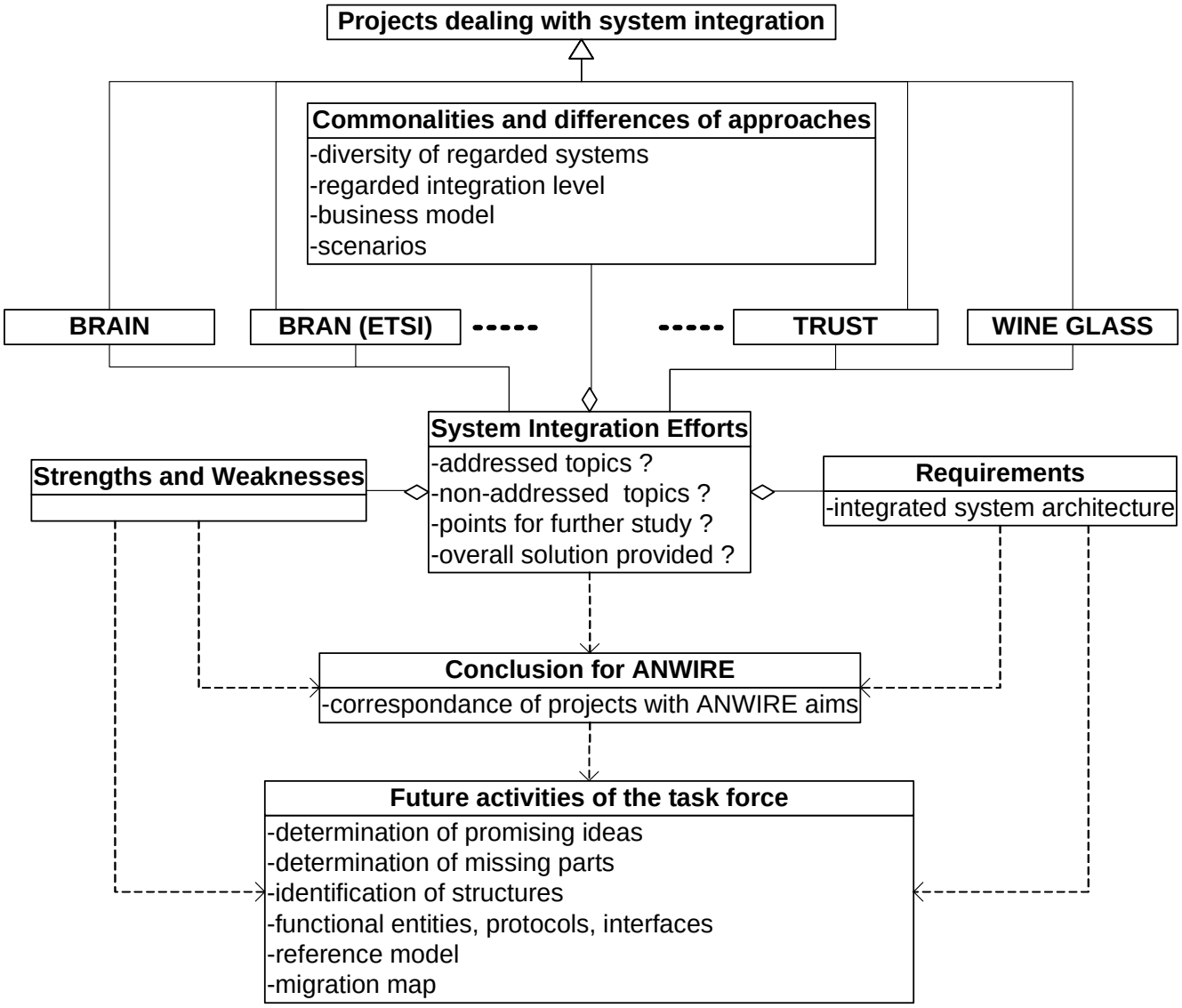

Figure 3. Roadmap and dependencies for an ANWIRE system integration reference model

	Key topics	Strengths	Weaknesses	Conclusion for ANWIRE
ETSI BRAN/3GPP	▪ HIPERLAN/2 and UMTS interworking ▪ high and low level of system integration	▪ loose approach simple to implement for the operators ▪ tight approach allows seamless handover	▪ loose approach no seamless handover ▪ tight approach only feasible for operators providing both infrastructures	▪ standardization work carried out in ETSI BRAN /3GPP provides a good overview of the variety of approaches that can be adopted, depending on the level of integration ▪ open items in ETSI BRAN as focus points in ANWIRE: o knowledge of terminal location accuracy, o the state of the terminal, o usage of the Iurhl2, Iurhl2/utr interfaces, o handover time and use of radio resources, o handover trigger and controlling, o further study of mapping of different QoS classes in UMTS to WLAN
WINE GLASS	▪ Convergence in networking technology ▪ Wireless Internet testbed ▪ Support of mobility and soft-guaranteed QoS ▪ Inter-working in the wireless Internet architecture ▪ Location-aware application services	▪ All IP in the UMTS core network ▪ Support micro, macro and inter-technology mobility using Mobile IPv6 ▪ Support location aware services	▪ No adaptability ▪ No reconfigurability ▪ Soft-QoS guarantee ▪ No ad hoc networks	▪ All IP and vertical handover are good starting points for 4G ▪ Adaptability ▪ Reconfigurability ▪ QoS in wireless access networks ▪ Complete QoS aware mobility architecture ▪ Fully integrated system
MOBY DICK	▪ establish quantitatively and qualitatively if the Internet is able to replace the existing connection-oriented infrastructure ▪ QoS-enabled and AAA supported mobility on a heterogeneous network infrastructure ▪ Project will develop a prototype architecture for tests and evaluation		▪ Moby Dick does not address the reconfigurability and adaptability issues that are key to ANWIRE	▪ Moby Dick is very close to ANWIRE ▪ ANWIRE should have a close look on the architecture Moby Dick proposes when defining design rules for the ANWIRE envisioned architecture
SUITED	▪ Development of an integrated system consisting of both satellite and terrestrial (UMTS, GPRS, W-LAN) ▪ theoretical analysis (e.g., network architecture, QoS and mobility management) and experimental work ▪ navigation capabilities integrated into the user terminal in order to enhance the performance	▪ effective for investigating seamless integration of satellite-terrestrial systems ▪ established the major research and developments, and standardisation work for this kind of integration of multiple mobile networks	▪ Business models still however require a much greater development. ▪ Many integration issues raised which require further study and development.	▪ demonstrates the possibility of effective interworking of different wireless network infrastructures ▪ definition of the GMBS network architecture ▪ performance evaluation from a service and network perspective ▪ validation campaign to qualify the GMBS performance in providing Internet QoS
BRAIN/MIND	▪ broadband wireless multimedia services for IP over heterogeneous access networks	▪ all-IP architecture, open, flexible, robust, scalable, adaptable at different layers; end-to-end QoS, localized mobility	▪ Lack of mechanisms for device re-configuration; it only considers	▪ Good candidate as a reference model of systems integration. It could be extended to be in line with ANWIRE

	Key topics	Strengths	Weaknesses	Conclusion for ANWIRE
		management, seamless horizontal and vertical handover; different systems integration approaches, enhanced IP to wireless interface, up to 20Mbps	multimedia communication services, it only includes terrestrial networks	requirements
WWRF	▪ service architecture based on an I-centric approach ▪ Services provided will have three main different features: ambient awareness, personalization, and adaptation			
DRIVE	▪ the DRIVE project addresses the convergence of cellular and broadcast networks to lay the foundation for innovative IP-based multimedia services ▪ Inter-working of different radio systems (GSM, GPRS, UMTS, DAB, DVB-T) ▪ Co-operation between network elements and applications in an adaptive manner ▪ the convergence between radio access networks made possible by the application of an intelligent backbone network, a novel dynamic spectrum allocation mechanism and flexible and adaptive applications	▪ dynamic spectrum allocation mechanism	▪ not fully support IPv4 based access systems ▪ lack of supporting mobile multimedia and traffic distribution	▪ For the academic wireless integrated network, W-LAN should be the majority. In this case, there is less benefit from dynamic spectrum allocation mechanism
OVERDRIVE	▪ project builds on the findings of the successful DRiVE project ▪ efficient mobile multicast techniques ▪ spectrum sharing between systems using Dynamic Spectrum Allocation (DSA) according to the actual load ▪ Investigation of system coexistence in one frequency band ▪ vehicular router, providing multi-radio access to a moving intra-vehicular area network (IVAN)	▪ resource efficiency with improved methods for sharing network and spectrum resources ▪ efficient mobile multicast techniques (MMC)		▪ project is still under development ▪ co-ordination of existing radio networks, which should not be mainly used in ANWIRE ▪ The purposed mobile multicast architecture can be *corresponded to ANWIRE regarding the multimedia services*
TRUST/SCOUT	▪ reconfigurability in radio systems and networks, with particular attention on the terminal ▪ mapping reconfiguration concepts to an IP based radio access and core network ▪ Research on QoS or GoS requirements and their implications on the network architecture for software download and reconfiguration concepts in IP-based environment ▪ the SCOUT approach regarding the interworking between different RATs is a mixture of, tight and very tight coupling, namely hybrid	▪ major requirement for a possible intersystem handover algorithm were identified ▪ Scout focuses on very tight coupling approach because it allows for very fast handover, fast decision before and during the reconfiguration mode	▪ "Open Coupling" and "Loose coupling" are not applicable for SCOUT	▪ tight coupling (high level of integration) seems to be the suitable approach to system integration issues brought up in ANWIRE ▪ many open issues left in ETSI BRAN have been tackled, including handover triggering and control, handover time and use of radio resources

	Key topics	Strengths	Weaknesses	Conclusion for ANWIRE
	coupled heterogeneous network			
FLOWS	▪ Use of a common access network based on IP where a variety of wireless access points (GSM, UMTS, HIPERLAN/2) will be connected. ▪ Definition of "convergence" in future wireless systems and in particular the use of simultaneous standards. ▪ Ensure that the impact of using multiple standards takes into account the business needs of users. ▪ Exploitation of the flexibility offered by MIMO techniques to achieve convergence of wireless standards. ▪ Demonstration of key techniques and systems performance by using appropriate models, simulations and designs.	▪ Approach of using a convergence manager entity to take adaptability and reconfigurability in consideration. ▪ Model assessment and field measurements using MIMO techniques to evaluate radio conditions. ▪ Definition of wireless convergent scenarios focused on users. ▪ Social and economical impacts of these systems.	▪ The proposed architecture is not that global. ▪ Focus mainly on terminal radio access systems.	Several commonalities with ANWIRE are: i) *Definition of scenarios* where the considered standards take part could be an input for an Always Best Connected usage of advanced mobile services. ii) *Managing convergence* – a reference model of common access networks based on IP is proposed. iii) *Commercial and Social* impacts of wireless systems using simultaneous standards are also addressed, giving the possibility of assessing and ensuring that the business needs of potential users are fulfilled. All this outputs can be of great interest to ANWIRE.
MOBIVAS	▪ develop a middleware architecture that should enable the creation of an open, dynamic market environment for mobile services, provided over reconfigurable networks and systems	▪ Automated deployment and management of 3rd party value-added services ▪ service discovery, downloading and execution by end-users ▪ Flexible charging, billing and accounting for mobile services	▪ Certain security aspects have not been addressed ▪ Modelling and representation of network profile data has not been addressed	The following aspects may apply to ANWIRE: ▪ Design and architecture of the service provision platform ▪ Generic, dynamically extensible adaptation and context management mechanisms. ▪ Network reconfigurability management. ▪ Charging, accounting and billing schemes. ▪ Definition of open APIs. ▪ Software downloading management. ▪ Security architectures and mechanisms
Chinese 863 Program Project in Wireless Communication – FUTURE	▪ key project in wireless communication branch of the National High Technology Research and Development Program of China (863 Program). ▪ technology objective is to – carry out investigations on key technologies for air interface of Beyond 3G/4G mobile communication system, – set up demo systems to verify the key technologies that can support future wireless services, – promote international cooperation, – contribute to laying out standardization and intellectual property for Beyond 3G systems.	▪ focuses on the physical layer architecture of future wireless system. ▪ A new multiple access scheme - LAS-CDMA (Large Area Synchronized CDMA) scheme has been accepted by 3GPP2 as one candidate for 3G Beyond standard. ▪ Compatible with future all IP networks and current wireless communication standard, thereby giving a great fillip to the upgrading of telecommunication products as well as the sustaining enlargement of telecom service.	▪ FuTURE seems have not formed a unified frame and less concern with SDR (Soft Defined Radio), so is not clear how it is connected with ANWIRE, especially with Reconfigurability and Adaptability.	▪ The FuTURE project focuses on the technologies such as air interface and spectrum distribution for universal radio environment and attempts to establish integration architecture of future wireless system. Some new network concepts, subsystem structures, handover methods and access schemes have been proposed.

	Key topics	Strengths	Weaknesses	Conclusion for ANWIRE
	▪ 7 key topics to implement – B3G Radio Access Techniques; – Wireless LAN and Ad hoc; – Multiple Antenna Environment (MIMO) and RF; – 3G-Based Ad hoc; – IPv6-Based Mobile Core Network; – Generic Techniques for Mobile Communications; – System Structure, Requirement and High Layer Applications.			