Wi-MAX extension to isolated research data networks

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Abstract—**WiMAX, the new standard for wireless communications, is one of the main promising technologies for broadband access in a fixed and mobile environment. This paper describes the objectives and main challenges of the WEIRD project (WiMAX Extension to Isolated Research Data networks) , which aims at designing, prototyping and validating a next generation network and control infrastructure in order to allow, through WiMAX radio links, wireless access to scientific research communities and equipment in remote or impervious areas.**

I. INTRODUCTION

In the last few years wireless Metropolitan Area Networks (MANs) increased momentum, due to the need to reach more and more user communities – in case isolated – by overcoming the cost barriers of wired technologies. This trend paved the way to the use of mainly proprietary solutions, some of them based on updated and empowered WiFi systems, others focused on point-to-point wireless connections based on RF or optical technologies. This somewhat sub-optimal progression stimulated the relevant standardization bodies to work on the introduction of new open standards, facilitating large scale economies and wide market acceptance: in this context the IEEE 802.16 (also known as WirelessMAN, [8]) and the ETSI HiperMAN [9] started to be defined and the Worldwide Interoperability for Microwave Access (WiMAX) consortium was established, among others, to address interoperability challenges and to support certifications of the IEEE 802.16-2004 standard [10]. Since December 2005, the IEEE working group added also mobility support to the standard, with the "amendment e", that was standardized under the name IEEE802.16-2005.

In the meanwhile, most of the worldwide research initiatives started to focus on IP network architectures able to decouple the Application, Service and Control Planes from the underlying Transport Plane. The main objective of these studies and developments is the seamless end-to-end integration of the various network technologies, and this is commonly achieved through special "convergence layers" in the most advanced network architectures. With respect to the Transport Plane, these convergence layers are able to cope with the different underlying technologies by means of special technology-dependent drivers; towards the Control Plane, they provide special functionalities for Quality of Service (QoS), resource management, access authentication, *layer 3* and *layer 2* mobility, security, etc. The control mechanisms enabled by the entities in the "convergence layers" have the aim to enhance the network performance, both in terms of resource utilization/consumption and of end-users' satisfaction, because they simplify the provisioning of the best network configuration for each incoming service request.

This paper describes the WEIRD European Integrated Project [1] that will contribute to the integration of WiMAX into next generation networks trough the design development and validation of advanced transport and control planes.

The paper is organized as follow: Section II describes the WEIRD project objectives and challenges, Section III describes the scenarios driven by the research communities, Section IV gives an overview of the functional architecture of the WEIRD platform, and finally Section V draws the conclusions.

II PROJECT OBJECTIVES

The WEIRD project aims to exploit and enhance the WiMAX technology in a convergence layer heterogeneous network architecture, in order to cope with future needs of research user communities and to build test-beds allowing the European research backbone networks like GÈANT, GÈANT2 [2] and relevant National Research and Education Networks (NRENs), to be reachable from isolated or remote areas.

To build such a broadband access network infrastructure, and to improve the QoS and quality of experience (QoE) for end-users, WEIRD project must cope with the following technical challenges:

- Enhancements to the WiMAX technology, which will mainly consist of:
  - Extensions of the convergence layer for the WiMAX support (WiMAX driver);
  - Enhancements of Data Link and PHY layers;
  - QoS support both in license and license-exempt bands;
  - Enhancements of handover and access control mechanics at convergence layer for WiMAX;
  - Interoperability with mobility management;
  - Radio-over-fiber (RoF) techniques for massive and cost-effective WiMAX network deployment.

- Enhancements to the IP network Control Plane, which will mainly consist of:
  - Advanced Authorization, Authentication and Accounting framework, in order to prevent unauthorized accesses and provide an effective charging for the use of the network resources;
  - QoS support for real time and mission critical applications;
  - IP multicast management framework;
  - A resource management framework to control bandwidth allocation, in order to achieve the maximum bandwidth exploitation;
  - A roaming framework to provide easy to use connections for nomadic researcher stations to GÈANT, by means of a WiMAX channel;

- Supporting studies and deployment recommendations, which will mainly consist of:
  - Study and simulations on optimum network planning, device configurations and distributed Medium Access Control procedures, which can guarantee QoS in a scenario with competing and non cooperative networks transmitting into license exempt bands, both in LOS (Line of Sight) and Non LOS (NLOS) environments;
  - Definition of a set of guidelines and best-practices for the permanent deployment of the WEIRD architecture in GÈANT/GÈANT2 and NRENs.
  - Liaisons and project feedback with all research organisations [GARR, ROEDUNET,RED.ES,FUNET-CSC] and networks following guidelines stated in the sponsoring letters signed during proposal preparation.
  - Liaisons with all projects relevant to WEIRD and progressing in FP6 and EUREKA programs.

III SCENARIOS AND APPLICATIONS

The scientific user communities partners of the project includes Fire Prevention Laboratory of University of Coimbra, Portugal, Association OASI Maria SS., Italy, Vesuvio Volcano monitoring scientific site, Italy, Icelandic Meteorological office, Iceland. These communities will describe their user scenarios that will drive system requirements and specifications. The main scenarios in which the WEIRD system shall be able to operate are:

- WiMAX as a backhaul solution for research networks in remote areas;
- Broadband access for fixed remote research sites where wired solutions are not cost-effective;
- Broadband mobile access for nomadic personnel and aggregation systems collecting data from sensor equipments in impervious areas (e.g., volcanos);
- Broadband mobile access for extended research campus;
- Broadband mobile access for fire monitoring and prevention;
- Broadband mobile access for medical personnel requiring high resolution medical information in nomadic emergency camps;
- Broadband mobile access for high resolution tele-hospitalization.
- Other broadband mobile access scenarios where advanced broadband applications will be used.

Applications that the WEIRD WiMAX convergent solution may offer, includes:

- Environmental Monitoring: Fire prevention and volcano monitoring, including data and video streaming from sensor networks and remote cameras;
- Telemedicine: High resolution video streaming from medical instruments and access to patients data.
- Mobile Broadband Access: VoIP, data, video conferencing and video streaming for the research communities..

IV SYSTEM FUNCTIONAL ARCHITECTURE

As stated in the introduction, the WEIRD platform, in order to be integrated in a heterogeneous network infrastructure, aims at having all the characteristic of a convergent network. Hence, the applications adopted are those that use the IETF (Internet Engineering Task Force) protocols and the IP Multimedia Subsystem (IMS) model for service provisioning being developed by 3GPP (3^{rd} Generation Partnership Project).

The WEIRD control and service plane will be able to enrich the service offer with many important characteristics such as security, privacy, QoS and the possibility to access the system while in roaming. The transport plane, with a convergence layering architecture, will enrich the IP layer with more functionalities regarding mobility, QoS and Access Control. Finally, improvement in the WiMAX Data Link and Physical layers, regarding Medium Access Control and adaptive antennas, will boost the performance of the system. The functional architecture is sketched in Figure 1.

A. Control Plane

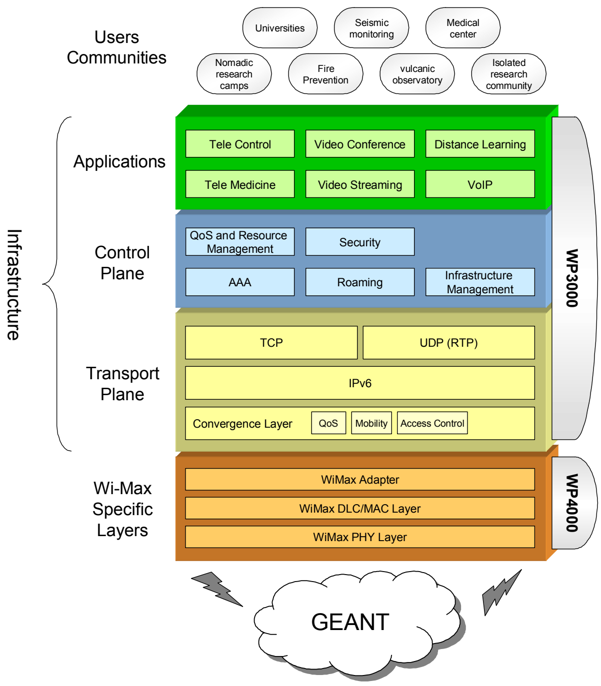

Figure 1. WEIRD functional architecture

The WEIRD Control Plane encompasses all the advanced network functionalities required to support the applications of the user communities. The main objectives and functionalities are:

- Coherent end-to-end *QoS and Resource Control & Management*. This functional module is specified in such a way to satisfy the QoS requirements of the user communities; the protocols and the interfaces are compliant with those specified by the 3GPP, ETSI (European Telecommunications Standards Institute) and IETF standards. One of the objectives of the resource and QoS controller is to give the maximum satisfaction to the users, in terms of experienced quality, but at the same time trying to exploit network capacity in the most efficient way. In order to cope with this problem, particular emphasis will be given to the application of control theoretic approaches to develop resource management algorithms (e.g., admission control, and congestion control), following the principle of autonomic communications (some of the partners are member of the Autonomic Communication Forum [3], sponsored by European Future Emerging Technologies program);

- Integrated *End-to-End Control Plane* for connection-oriented transport services; it's based on an hybrid MPLS (Multiprotocol Label Switching) and DiffServ (Differentiated Services) technologies (a blend of DiffServ connectionless QoS specification, centralized resource control and distributed and connection-oriented MPLS resource control). This work will integrate the recent developments of the NSIS (Next Steps In Signalling) IETF Working Group and the DiffServ Control Plane interest group;

- *Authentication, Authorization, Accounting* (AAA), basically in the perspective of a multi-technology and multi-region network. The WEIRD solution for AAA shall match the needed dynamism of the network transport services exploiting different technologies across a multi-operator network as well as with mobile users. WEIRD AAA shall support seamless subscriber mobility, roaming and vertical handover in a IPv4/6 based network environment and to accomplish these objectives will be integrated with the Mobile IP protocol [11],[12];

- *Security*, both hop-by-hop and end-to-end, by hiding the internal structure of the network, by protecting against malicious activities (e.g., Denial of Service, theft of service attacks or hacking sessions), by providing the confidentiality of messages exchanged in control plane. This will include the IEEE802.1x framework, IPSec protocol, application level security and NAT (Network Address Translation) / Firewall transversal mechanisms [4] being studied in the IETF NSIS framework;

- Network planning and *Traffic Engineering* for advanced packet services in a non-disruptive interoperation of different technologies. The expected outcomes from this task include network dimensioning compliant with traffic engineering heuristics; network configuration by means of automated management tools; and periodical network re-optimization, triggered by the feedbacks from a network measurement system.

- *Network Management* via SNMP and Web management tools, including a user interface to control and configure all the control entities, to provide automatic service discovery and composition.

Some of the most relevant aspects in the WEIRD Control Plane specifications are related to the inter-working of MPLS and DiffServ, the AAA and the security in wireless mobile contexts.

Concerning the inter-working of MPLS and DiffServ, specified within IETF [5], it is a basic functionality needed for the deployment of a complete and seamless integration between the heterogeneous network technologies that are crossed by the end-to-end service. Network Operators recognize DiffServ as a flexible and scalable solution and different combined solutions (e.g., IntServ/DiffServ) have been proposed and tested, aimed at building end-to-end dynamic services which adapt the coarse-grained QoS configurable in the core to the finer-grained user QoS requests.

On the other hand, in the perspective of a more controllable and manageable network architecture, the MPLS standardization has resulted in a set of tools (e.g., for traffic engineering and its survivability) and protocols aimed at enabling the paradigm of a intelligent circuit-oriented network in the context of connectionless packet networks.

The integration of the two architectures results in an optimal merging of their respective advantages. In the WEIRD view, the integration of the two architectures rely not only on a Data Plane level as mainly addressed by the state-of-the-art implementations; but, this integration is founded especially on the definition of a common Control Plane framework in which the DiffServ and MPLS can complete each other and/or can be managed easily and alternatively according to the Network Operator requirements. In this new perspective pure MPLS, pure DiffServ and merged domains can interwork by means of the same Control Plane, which has in charge the semantic joint between the MPLS signalling (pure Control Plane) and the DiffServ policy mechanisms/protocols (shared between Control and Management Plane), in a configurable combination of distributed and centralized approaches.

With respect to the AAA system, the WEIRD approach will rely on DIAMETER protocol [6], which will be extended in order to add handover mechanisms to the standard registered information and to insert new functions that manage the added data.

DIAMETER is an innovative AAA protocol for the next generation IP network, which goes ahead the protocols commonly used for AAA in terms of flexibility, extensibility, security, roaming support, failover recovery and accounting. DIAMETER is flexible and extensible because is composed by a base protocol and extensions that are named applications in DIAMETER standards. One of these extensions is dedicated to Mobile-IP protocol [7]. DIAMETER supports natively subscriber roaming across different networks and vertical handover.

With respect to security, WEIRD environment will follow the port based access control approach depicted by IEEE 802.1x standard using EAP (Extensible Authentication Protocol). Multiple EAP implementations (EAP-TLS, EAP-TTLS, EAP-MD5, EAP-SIM, EAP-AKA) will be investigated. In addition to 802.1x, 802.11i WPA (WiFi Protected Access) will be addressed too. These security mechanisms will be integrated with IP level security provided by IPSec and application level security.

B.. Transport Plane

The WEIRD Transport plane provides the data path for the project testbed infrastructure. This plane will provide a technology independent interface with upper-layers and technology dependent MAC and PHY layer solutions for WiMAX subsystems in order to integrate it seamlessly to high speed GEANT backbone network. The Transport plane will be implemented as a Convergence Layer solution including native IPv6 / IPv4 support, TCP and UDP transport protocols (and maybe SCTP and DCCP) and providing Application Programming Interface (API) modules for:

- QoS management;
- Mobility management control;
- Multi-access control.

The Convergence Layer mechanism includes the API modules and interfaces for IPv6/v4 network and hardware device drivers in WEIRD system base stations (BS) and mobile subscriber stations (SS). The convergence layer is a middleware solution providing interfaces for underlying hardware solutions and upper-layer protocols. This layer will be designed in a technology-independent fashion; it consists of a set of modules aiming at enhancing and making uniform Access Network (AN) performance. All the functions of the Convergence Layer are performed in a technology independent fashion; the interworking with the underlying network technology is provided by the Adaptation Layer via a vertical signalling channel. Moreover, Convergence Layers of different entities avail of a horizontal signalling channel. Some of the most relevant aspects in the Transport Plane activity are briefly described in the following.

- *IPv6* - the WEIRD Transport plane will include IPv6. IPv6 ongoing efforts are helping to achieve a faster deployment, even if there are still some issues, both architectural and also implementation related, which require to be worked. Mobility is one of these issues. While IPv4 did not consider mobility (partly because at the time there was no need for such requirements), IPv6 was designed to support native mobility. However IPv6 mobility mechanisms still need to be optimized in order to provide seamless mobility. WiMAX will bring new mobility requirements to IPv6 that need to be addressed in a consistent way. This will be one of the contributions of WEIRD. In addition, WEIRD will help to understand how IPv6 specific headers/fields might be useful for current QoS models, and what are the features required for the supported signalling solutions, to become IPv6-compliant. WEIRD will also help to identify how current technologies (such as IPv6 enabled MPLS implementations) support and perform when IPv6-enabled, in particular in a mobility framework.

- *QoS support* - in order to guarantee the best possible quality for service and to utilise the high speed connection efficiently, it is required for SSs and base BSs to adapt themselves to the changing environment of WiMAX system. The Convergence Layer QoS module utilises the vertical and horizontal signalling channels to gather the network and channel state information and application requirements.
  The QoS sub-module performs QoS differentiation mechanism at Convergence Layer, providing the traffic control components such as classifiers, schedulers, active queue management for WEIRD architecture. The QoS subtask provides also tools for traffic characterization for tuning the traffic control components and upper-layer end-to-end QoS support.
  The proposed architecture allows the QoS module to implement some QoS procedures; the effectiveness and the complexity of these procedures depend on the BS capabilities. For the base station functionalities, two BS models can be defined. In case of a standard BS, the QoS module allows performing differentiation and regulation of the traffic directed towards the BS via scheduling and policing algorithms; the packet snooping is allowed by the Adapter.
  In case of an Enhanced BS, also more complex resource management procedures can be performed, such as congestion control, admission control. These QoS procedures will exploit information on the status of the Access Network (WiMAX).

- *Mobility management* **-** The IEEE 802.16e standard, which was frozen at the end of year 2005, specifies mobility support for the WiMAX system. The mobility support is carried out with both physical and medium access control layer enhancements for the IEEE 802.16-2004 standard. The proposed solutions will provide efficient mobility support only for handovers between base stations within the single subnet. This means that, when the subscriber station is changing the network, the WiMAX mobility control is not sufficient and upper layer mobility control is required. Especially for the Voice and Video over IP scenarios, the IEEE 802.16e mobility may not be sufficient and upper layer mobility management functionalities will be needed. Mobility management mechanisms such as Mobile IP (MIP) and Host Identity Protocol (HIP) for IPv6 are considered. MIP and MIPv6 especially are widely supported in today's backbone networks and

in majority of router solutions. The HIP is a novel mobility management protocol, which benefits from security and session mobility support compared to mobile IP.
The session mobility is required e.g., in video over IP and streaming scenarios, in which the user session is seamlessly transferred to the different subscriber station of other user terminals on either wireless or wired network domain.
In order to enhance the mobility management functionalities, the convergence layer mobility for WiMAX introduces policy based triggering engine for seamless session handovers and across subnet handovers in WiMAX system. The task aims to specify and implement the triggering engine for the WiMAX handover mechanism.

- *Multi-Access and multi-homing* - The purpose for the access control is to enhance the network access of the system by supporting multiple network input/output interfaces in WiMAX system. The task aims to specify and implement a policy based triggering mechanism for interface selection utilizing the cross-layer information form the lower layer system entities. The cross-layer information required for the access control mechanism including e.g., signal-to-noise (SNR) ratio from the wireless channel and other channel statistic, is gathered from the system with WiMAX adapter entity. In co-operation with WEIRD convergence layer QoS module and application layer rate control functionalities the purpose of access control mechanism is to enhance the system and especially the Video and Voice over IP application performance.
The WEIRD Access Control mechanism provides the multi-access control and load balancing mechanisms for multiple of interfaces of same or different type (e.g., WiMAX, WLAN, RoF). The multi-access module in Convergence Layer utilizes the traffic monitoring mechanism and channel state information (CSI) in order select the best possible interface and connection for required service. In order to provide high speed connection to fast backbone, the binding capabilities of multiple interfaces can be also considered in order to provide optimal data throughput. The Access Control module requires also API for lower-layer adapter entity in order to utilize the channel state information. The access control components, such as resource and admission control are taken into consideration, in order to let them operate in compliance with the AAA and Security modules at the WEIRD Control plane.

B. *WiMAX Layers*

The specifications of the technology dependent layers includes: WiMAX PHY and WiMAX DLC/MAC layers and the WiMAX adapter to interface with the convergence layer. In details, the WiMAX dependent layers will include the enhancements described below.

- *The adapter* – The adapter has a role of interfacing the WEIRD Convergence Layer with the technology-dependant layers of the WiMAX Access Networks (DLC/MAC and physical layers), namely with the WiMAX service specific converge sublayer (SSCS). In practice the WiMAX adapter works as an operating system dependent driver, providing the interface between the WiMAX hardware and operating system kernel entities and protocol stack. The adapter provides the required signalling mechanisms for Convergence Layer and data transmission from and to WiMAX hardware and upper layer protocols.
First the enhancements of the WiMAX for the adaptation to the planned functionalities of the WEIRD Convergence Layer will be specified. Then, adapter will be designed. The focus of work will be on the CSI information delivery and API for convergence layer mobility, traffic monitoring and access control mechanisms.

- *PHY layer enhancements* - In PHY layer multiple antennas can be exploited to improve, among others, spectral efficiency and link reliability. Typically, multi-antenna systems exploit space diversity, beamforming, and spatial multiplexing techniques. Multiple antennas have traditionally been used at the receiver end to combat channel impairments caused by multipath fading, a technique known as space diversity. Increased link reliability can be attributed to the resulting reduced amount of fading compared to a single-input single-output (SISO) system. If a feedback channel is available, additional use of adaptive coded modulation can be used to improve spectral efficiency. However, information-theoretic results on multiple-input multiple-output (MIMO) systems in wireless communications have shown that huge capacity gains can be achieved if multiple antennas are utilized at both the transmitter and the receiver. A dominant feature of the MIMO systems is that they thrive in rich scattering environments. Spatial multiplexing of the data can then be exploited, a technique where independent streams of data are transmitted from each transmit antenna. Since the channel associated with the transmit antennas induce different spatial signatures at the receiver in a rich scattering environment, the receiver can separate the individual data streams. In such a system, the channel capacity scales linearly rather than logarithmically, with increasing signal-to-noise ratio (SNR). Another important benefit is that this increase in capacity comes at no extra bandwidth or increased power expenditure.
The objective of PHY layer research is to develop methods and algorithms enhancing the performance of WiMAX physical layer. Our approach is to use the optional MIMO features provided for OFDM and OFDMA in IEEE 802.16e standard, namely space-time coding (STC) that exploits space diversity and adaptive antenna systems (AAS) that use beamforming, to increase the system performance. STC techniques exploit the space diversity and in some cases offer also coding gain.

AAS systems enhance the performance by reducing multiple access interference (MAI) and inter-symbol interference (ISI), and the use of beamforming also increases the power of the received signal. The trade-offs between STC and AAS schemes, as well as the possibilities for combining the techniques will be analyzed. Also the requirements set by the algorithms, such as the use of MIMO channel state information at the transmitter, will be considered as well as the possible changes to MAC/DLC layer required by the MIMO algorithms. Physical implementation of the enhanced system will be supported by estimating the complexity of the PHY layer functionalities. Finally, the simulation results will be compared to the performance results achieved from the real testbeds. A study for STC/AAS for IEEE 802.16e will be done including:

- A state-of-the art literature review
- Simulation models with floating point simulations and comparison to the testbed results
- Complexity estimation.

- *Radio over Fibre* - the application of radio-over-fibre (*RoF*) techniques for WiMAX signal distribution within the access segment of the communications network will be deeply studied, considering the two main applications of WiMAX:
  - As a backhaul network for other access protocols (PtP links), such as WiFi or cellular telephony, and fixed wireless access (FWA).
  - Mobile applications (PtMP environments with IEEE 802.16e) enabling broadband access directly to WiMAX-enabled portable devices ranging from smartphones and PDAs to notebook and laptop computers.

By using optical fibre for WiMAX signal distribution, the network operator may extend the coverage of its network by separating the costly control equipment at the central station (CS) / Point of Presence (PoP) from the TX/RX equipment, i.e., the antenna, so called base station..

In this way, the CS includes the intelligence of the access network: switching and routing functions, handover management, signalling logic, RF circuitry and other costly network components. Then, WiMAX signals are transmitted/received to/from the BS at their correspondent RF frequency bands, as they “fly” through the wireless link, and radiated by the antenna at the BS. The equipment in the BS is kept as simple as possible, just filtering, amplifying and radiating the RF signals, and therefore its CAPEX and OPEX costs are very low. In this way, the coverage of the WiMAX network can be extended to reach the desired target area at a moderate cost from a reduced set of PoP’s/CS’s through a number of low-cost BS’s.

The main benefits resulting from the use of RoF WiMAX signal distribution are the following:

- Low cost, through extremely simple base stations where only the laser and photodetector and electrical filters, amplifiers and the antenna are needed.
- Low attenuation through optical fibre transmission.
- Huge bandwidth, with compensation of chromatic dispersion.
- Low weight.
- Immunity to EMI.
- Multi-service and multi-operator capability (infrastructure coexistence), especially when considering WDM technology for optical transmission.
- Flexibility and capability for dynamic configuration of the network capacity. Thanks to the centralization of the intelligence of the network in the CS, the operator can distribute the traffic capacity of their network on a time basis depending on the specific requirements of their customers (sport events, fairs, day/night demand, etc.)

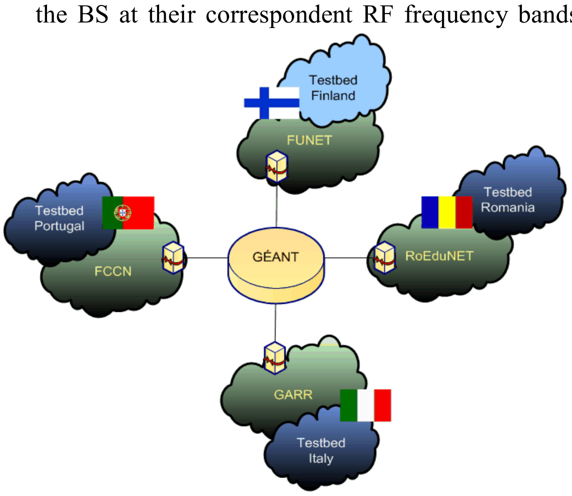

Figure 2 WEIRD European interconnection

V. EUROPEAN TEST-BEDS

The technical solutions developed within the WEIRD project will be implemented, tested and validated in four test-beds to be deployed. The test-beds will be located in Finland, Italy, Portugal and Romania, and the interconnection between test-beds will be arranged via the pan-European GEANT2 research network (Figure 2).

The test-beds will have different profiles according to the aforementioned scenarios. Moreover, every test-bed will be specialized in order to highlight certain technical solutions. Thus, the WEIRD Project will move in a considerably large and rich domain for validating the developed solutions. This is considered as one of the most valuable and unique assets of the project.

Even though not all of the application scenarios and technical enhancements are developed in every test bed, the project aims to provide the developed solutions for each test bed at the end of the project and to demonstrate some of the selected applications in larger scale e.g. the Video over IP and VoIP transmission through the pan-European research network

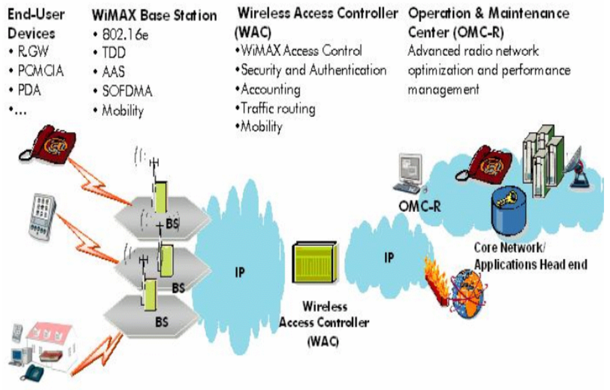

Figure 3 WEIRD test-plant

Figure 3 describes an emblematic deployment of one out of the four WEIRD testbeds. It is structured with the objective of creating a basic architecture of the real field infrastructure, complete with traffic carrying systems related to different services, especially oriented to the scope of testing and integrating the new solutions output of the WEIRD project. The environments in which this testbed should work, are those described in the four main user scenarios considered, such as the volcano monitoring, impervious areas monitoring, fire prevention and telemedicine. This allows simulating actual network critical scenarios and eventual network malfunctions in order to analyse them and find reliable solutions that run smoothly when applied to the actual network.

The test plant will be structured so as to provide quick and efficient implementation of the described scenarios to reduce to a minimum the time needed for testing before application to the traffic network. It will also take into account existing experiments and trials carried out on WiMax in various European countries whose results, architectures and frequency allocation issues will serve as guidelines for the project.

Among the various aspects the following issues will be taken into account for compared evaluation:

- Data Rate, Coverage, QoS, Standardization..
- Compatibility (with existing WiMAX equipment, WiFi, Backbone like FIBER, DSL technologies), VAS and Perspectives.

The aim will be to design the best experimental environment, starting from the gained experience using different access technologies.

To increase the validation pertinence, the user communities of the project will be targeted according to the commercial offerings opportunities and metrics as have been considered in the following aspects:

- Perceived quality of the global solution
- Security for the integrated environment
- Reliability of the system
- Provisioning of the complete service platform

VI. Conclusions

Using the WiMAX technology as a next generation access network, both for fixed and mobile reception, is one of the most promising business activities being carried out by stakeholders of the BWA (Broadband Wireless Access) market. This paper described how the WEIRD project is facing this challenging problem when the technology has to be used for scientific and research domain customers. The analysis of the open issues highlighted the necessity to smoothly integrate, from the beginning, the WiMAX technology into the Next Generation Network architecture, by using a convergence layering approach, and build on top of it the necessary control and management elements that allow the maximum QoS to be delivered to the user, by giving to this term a wide significance, from good perceived audio and video quality, to security and privacy.

The first prototype of the WEIRD system will be released for evaluation in the testbeds in June 2007, while the final results of the tests and trials will be ready for the end of the project, expected in June 2008.

Acknowledgment

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