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Final Report for the 6WINIT Project

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Abstract: This is the final Report for the 6WINIT project, which has been investigating a range of IPv6-enabled applications over an IPv6-enabled wireless Internet. It summarises the work done in the project, which covers the areas of end-stations, routers, gateways, generic technologies and applications – with specific emphasis on following the IPv6-related standards emerging in the IETF. Thus clearly Mobile IP, Road Warrior technology, Quality of Service, agent technology and security are of particular concern. Generic applications investigated included conferencing, voice/IP, video streaming and home environments. There was specific emphasis on clinical applications, where secure mobile access to clinical data and radiographic images, and emergency treatment from ambulances for A & E. Most of the work was in the context of Wireless LANs, since the access to and functionality of GPRS were very limited and the access to UMTS test facilities was provided only at the project end.

Since there was an earlier Deliverable D20, which summarised and evaluated the workpackages, this report is more administrative in nature. It provides detail on the organisation and accomplishments of the project, and describes how the project was carried out – and what resources were expended with which exploitable results.

Keywords: IPv6, wireless Internet, clinical applications, conferencing, VoIP, agents, active networks, routers, gateways, A&E, radiographic images, Road Warrior, Mobile IP, security, IPv6-IPv4 transition, WLAN, GPRS, UMTS

Executive Summary

This project was set up to investigate the problems arising in running IPv6-based applications over the emerging wireless Internet. The wireless Internet was considered as the backbone network we all know, with access networks consisting of Wireless LANs (WLANs), third Generation Cellular Wireless (UMTS), and the intermediate extension to GSM called GPRS. When the project was proposed, in early 2000, GPRS was considered only as a stepping-stone to UMTS, but was expected to be exploitable immediately, while UMTS was not expected to be deployed before mid- 2001. The financial climate of the industrial partners, and the expectations of the Communications Industry were quite different from the climate a year later, when the project started. This impacted many parts of the project. The most important of these were: the availability of 3G network facilities (even for test beds), the speed at which UMTS or GPRS moved to IPv6, and the readiness of industry to develop IPv6-based components and applications for UMTS. While this led to a dearth of GPRS and UMTS equipment, the WLAN use grew rapidly; its equipment became widely available on both laptops and PDAs. At the same time, the IPv6-based products from the main hardware providers matured, and the availability of a complete range of such equipment became a reality.

The project has required the utilisation, and often the development, of a number of different types of component: end stations, routers and relays, generic technologies, different network technologies, applications. Almost all the components have been used as part of applications and/or demonstrations. Many of the applications are generic, and can be used in their own right. They run on both PDAs and laptops, using WLANs and where possible GPRS with reduced functionality Examples are: conferencing, Voice/IP, video streaming, home environments, a weather station and location-awareness. However a major emphasis in the project has been on clinical applications; these have been found to be a fertile, but demanding, user of the developments from outside the clinical area. The applications pursued include: include mobile, secure access to clinical data, accident and emergency work with ambulances and access to radiographic images. The clinical partners have found it turn that it has been very instructive and useful to work with their technical partners. Because of the intentions to investigate major real-life applications, it has been very important also to consider the transition from the IPv4 wired world to the IPv6-enabled, all-IP, wireless world.

The work done in the project was largely practical, and there was little interest in defining or using proprietary solutions. For this reason, there was a major activity in following, influencing, and implementing the rapidly changing IPv6 standards. There was little similar activity in the GPRS and UMTS standards, because the project was not setting up such networks. It was essential that we had access to real networks for our work; this was the case for IPv6-enabled wired and WLAN networks. There was limited access to the IPv4-enabled GPRS, which could be used for IPv6 by encapsulation; there was no access to even UMTS test bed equipment until the last two weeks of the project. Thus most of the practical work involved WLANs and some GPRS. UMTS was used only in the final demonstration.

It was a fundamental tenet of the project that we would demonstrate our results publicly; mention is made of these public demonstrations. The principal results of the project, the roles of the partners and their exploitation intentions are all described.

Since there has been another evaluation Deliverable, this document is more administrative in nature, and details also the resource utilised in the project.

Table Of Contents

1 INTRODUCTION

1.1 Project Objectives

This project was conceived in the beginning of 2000. The financial climate of the industrial partners, and the expectations of the Communications Industry were quite different from the climate a year later, when the project started. This impacted many parts of the project. The most important of these were in the availability of 3G network facilities, the probability that there would be a rapid financial return from its introduction, and hence the availability of both the network itself and the readiness to develop new components for it.

The principal objectives of the 6WINIT project were the following:

- To validate the introduction of the NEW MOBILE WIRELESS INTERNET in Europe - based on a combination of the new Internet Protocol version 6 (IPv6) and the new wireless protocols (GPRS and UMTS/3GPP);
- To validate the integration of the protocol suites in (1) into real applications by running complete application test beds;
- To ensure that the implementations of (1) were generic, and not specific to a particular supplier or operator;
- To ensure that the validation applications of (2) were not too tied to specific choice of applications;
- To ensure that the international perspective was maintained.

We chose as applications some generic, but important ones. In addition we wished to consider a specific domain in depth for some applications test beds, and settled on the clinical domain. We intended to avoid being tied to specific operators or suppliers, by ensuring that our applications worked with different networks. Moreover, by including international partners from Eastern Asia and North America, we hoped to avoid being too insular in our approach, and to be considering the international dimension.

1.2 History and Partners

The project was relatively stable, considering the size of the project, the number of partners and the turmoil in the industry. There were no changes in the nature of the original partners, and the changes in most of their roles were minimal. With the delays in the provision of UMTS system, the Carrier partners (BT and T-Nova) were unable to provide UMTS tested systems; a contributing cause was the loosening of the ties between these research organisations and their cellular operators.

There were a few changes in emphasis. BT provided GPRS instead of UMTS to the UK partners, and did more work than planned on IPv6 applications. T-NOVA was unable to provide UMTS, but played a leading role in organising the INET 2002 and IST 2002 demonstrations. Ericsson reduced effort on its router, but stepped in to provide the UMTS Pilot. VTT were unable to provide a commercial application, but provided a home networks pilot instead. ETRI joined the project as a full partner. Telscom were unable to provide a Basel clinical trial, but provided a VoIP application instead. Finally, as the only dropouts, the international partners from North America, CRC (Canada) and WorldCom (USA) were forced to drop out through lack of resources.

1.3 The Structure of the Project

The project was divided into 10 workpackages. These are listed below:

WP1: Administration and Management

WP2: Dissemination and Liaison Activity

WP3: Specification and Architecture of the Network

WP4: Specification, Architecture and Implementation of Generic Applications

WP5: Specification and Architecture of the Clinical Applications

WP6: Provision of Gateways and Relays

WP7: Provision of Applications and Network Components

WP8: Design, Implementation and Operation of the 6WINIT Network Infrastructure

WP9: Set-up, Use and Description of the Clinical Applications

WP10: Evaluation of the Components, Infrastructure and Applications

1.4 The Deliverables

There were 20 Technical Deliverables. These are listed below. In addition, there were the usual Quarterly Management Reports – of which a total of eight were, of course, provided.

Del. No	Del. Title	WP No	Lead Participant
1	Available IPv6 Communications, Gateways and Components	3	Ericsson
2	Status of Basic Relays and Gateways	6	TED
3	Specification and needs of the Clinical Test beds	5	UCL
4	Reviews of status of early relevant standards	2	Telscom
5	Review of collaborations with other projects.	2	Telscom
6	Design of the Communications Infrastructure	3	Ericsson
7	Description of Implementations of the Clinical Test bed Applications	5	UCL
8	Description of Basic Network Components	6	TED
9	Early Aids to deployment	6, 7	UoS
10	Status of Basic Components	7	UCL
11	Early Network Infrastructure	3, 7, 8	T-Nova
12	Early non-clinical Applications	4	VTT
13	Description of Server Components	7	UCL
14	Description and Experience of the Clinical Test beds	5, 9	UCL
15	Update Reviews of status of relevant standards	2	Telscom
16	Advanced Non- Clinical Applications	4	VTT
17	Advanced Aids to Deployment	6, 7, 8	UoS
18	Advanced Network Infrastructure	3, 6, 7, 8	T-Nova
19	Description and achievements of Clinical Test beds	9	UMM
20	Evaluation of the Components, Networks and Services	10	UCL

1.5 Role of Key Partners

Each of the partners below had a significant role. This is shown by the fact that each, except Telscom, has provided at least one Result in Section 2. Nevertheless the important results were often in areas where no

Result is claimed. In the discussion below, Rx denotes Result x in the Technology Implementation Plan (TIP), Dx denotes responsibility for Deliverable x, and WPv denotes Work Package v.

1.5.1 UCL

UCL had the key role of managing and coordinating the project. In this context, they led WP1, wrote the eight Quarterly Reports, and edited the TIP and this Final Report. They also provided a conferencing application, an Active Server with a special server. This server did bandwidth adaptation and Unicast-multicast conversion (the TAG, R6). It played a key coordinating role, obtaining an IPv6-enabled Public Key infrastructure from the Euro6IX project. UCL-CHIME provided one of the main clinical applications, contributing heavily to R11 on a clinical application. UCL also led four Workpackages: WP1, WP5, WP7 and WP10. It was also responsible for six Deliverables: D3, D7, D10, D13, D14 and D20.

1.5.2 UoS

UoS provided a number of transition aids (R7) and its agent framework (R12). It was also responsible for D9 and D17.

1.5.3 BT

BT provided GPRS connectivity for the UK partners. It developed and provided the UK IPv6 Exchange (R8). and a number of applications – including the VideoLan streaming one. It hosted the first Review of the project.

1.5.4 Ericsson-Telebit.

Ericsson-Telebit developed components of its router, and provided it free of charge for the applications, which required it. As part of this effort, it produced two results (R2 and R4). It led D6, and was responsible for D2 and D8. It played a key part in three demonstrations – IST2001, INET2002 and the Final Review.

1.5.5 Ericsson Systems

Ericsson systems developed its multi-access mechanisms, which are reflected in R14. It led WP3, and was responsible for D1 and D6. It hosted the final Review, and made available its UMTS test bed for the final demonstrations – several of which used the Ericsson multi-access. Its Finnish branch organised the major demonstrations at INET2002.

1.5.6 T-Nova

T-Nova provided GPRS facilities to the German partners. It led WP8, and was responsible for D11 and D18; this is reflected by its result R13. It organised the major demonstrations at IST2002.

1.5.7 IABG

IABG provided its Road Warrior (R3), which was a fundamental component in all the demonstrations. They provided much of the input on Mobile IP. They contributed to many Deliverables e.g. D4, D12, D15 and D18.

1.5.8 TZI

TZI provided its SIP Gateway (R5), which was also used in both IST2002 and the Final Review. They contributed to many Deliverables e.g. D6,D8,D10 and D17.

1.5.9 RUS

RUS was the main technical partner supporting the clinical application GANS (R1). They played a prominent part in the demonstrations at IST2001, INET 2002 and IST2002. They contributed to several Deliverables e.g. D18 and D19.

1.5.10 UKT

UKT provided a major clinical application GANS (R1). They played a prominent part in the demonstrations at IST2001, INET 2002 and IST2002. They contributed to several Deliverables e.g. D3, D7, D16 and D19.

1.5.11 6WIND

6WIND provided many advanced features in its routers for transition, security and mobility. This is reflected in R2 and R4. It provided 8 of its routers to different sites. They were heavily used in INET 2002 and IST2002. They contributed to D2, D5, D6, D8, D9, D11, D15, D17, D18.

1.5.12 VTT

VTT provided its weather station, location-aware and home environment applications (R8 and R9). It led WP4, and was responsible for D12 and D16. It demonstrated at each of the major demonstrations.

1.5.13 UMM

UMM acted as the technical support for the John Paul Hospital activities (R11). It led WP9, and was responsible for D19. It contributed also to D3, D7 and D14. It demonstrated at INET2002 and IST2002.

1.5.14 Telscom

Telscom’s main activities were in Standards and in liaison with other projects. It also contributed its VoIP application. It led WP2, and was responsible for D4, D5 and D15. It demonstrated at IST2002 and the Final Review.

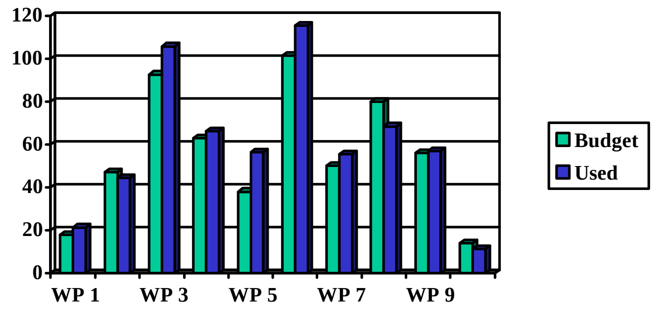
1.5.15 ETRI

ETRI officially joined the project only in September 2002, but participated actively from the start of the project. They provided their high performance conferencing tools (R15) and their streaming server (R16). They also provided an early IPv6 stack and various transition tools. They demonstrated at IST2002, and contributed to many Deliverables, e.g. D6, D8, D9, D10, D11, D16, D17, D18.

1.6 Use of Resources

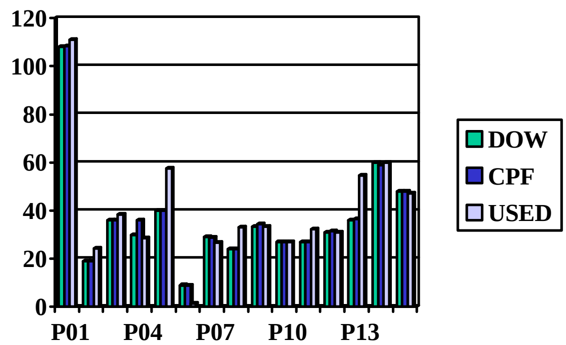
Movement of resources between partners is always difficult in IST projects, and was hardly attempted here. There was a small transfer between two different parts of Ericsson – who count as independent organisations in the 6WINIT project. The transfer was needed because of the project’s need to have access to the Ericsson Systems UMTS test bed.

Figure 1 Effort Used Per Work Package in pm



The actual effort budgeted and used per workpackage is shown in Figure 1. On the whole the effort used was very close to that budgeted. The differences are due mainly to interpretations on which WP to assign to a particular activity.

Figure 2 Total Effort by Partner in pm



Similarly Fig, 2 shows the distribution of effort by partner in person-months. The discrepancy between the figures in the Description of Work (DoW) and the Contract Preparation Form (CPF) is usually greater than that between either and the effort actually expended. This discrepancy is due mainly to the way in which the CPF form in any amendment does not allow for the actual expenditures in previous periods, but has to be completed as a single form with constant labour rates subject only to a single inflation figure. In any case, the figures in Fig. 2 are derived from the management reports; the final figures in the claim forms are somewhat difference – particularly, for example, for P06, who did not always submit claims before the Final Cost Claim.

2 THE APPROACH AND EXECUTION

2.1 Background Environment

While the mobile community retains a strong interest in IPv6, its move to introduce it in commercial networks has moved several years beyond the horizon of the 6WINIT project; this has strongly impacted the range of networks available for the project. It has also impacted severely the rate of development of IPv6-enabled telephones and PDAs.

The progress by the main hardware providers has remained strong in IPv6 – but more in an R & D aspect than large-scale commercial deployment. There has been steady progress in the availability of IPv6 stacks in all components – even though this has been a little slower than expected in 2000. An important aspect has been that there have been such frequent updates in software, that it has been hard to track the upgrades.

2.2 Approach

The basic network components used in the project were a combination of new Internet Protocol version 6 (IPv6) and wireless networks (GPRS, UMTS and WLAN). The project provided an insight into the problems in deploying real applications in the emerging IPv6-enabled wireless-enabled Internet; WLAN, GPRS and a UMTS test cell were used as wireless networks. We carried through complete systems pilots, and identified what components are inadequate in the applications, network facilities, major components and middleware. The project concentrated on mobile and wireless aspects of the system, but it also linked into the existing IPv6 wired infrastructures provided under the 6NET and Euro6IX projects. The technical approach was to take applications from other activities, which were expected to gain from the mobile IPv6 environment. These applications, which were mainly selected from the clinical health care, multimedia conferencing and streaming, in- and outdoors navigation and home control domains, were ported to work over IPv6. This way we ensured that all the requisite technology was available to allow them to work in a wireless-enabled IPv6 environment. Consequently we were also working on IPv6-enabled components: routers, relays, hand-helds, IPv4 to IPv6 transition mechanisms and other software components required by the applications. Because of the limited capability of the GPRS network, some of the traffic had to be run, in that case, in IPv6/IPv4 encapsulation

It is convenient to divide the project into five sections: Period 1 (P1) is approximately the first half of 2001. Period 2 (P2) is the second half of 2002. Period 3 (P3) is the first half of 2002. Period 4 (P4) is July – October 2002. Period 5 (P5) is November 2002 – January 2003. During P1, the partners took stock of the current state of the applications, tools and networks at their disposal; Deliverables D1-D3 were the result of this phase. During P2, the partners developed the relevant architecture, the various components and applications, and put in network facilities – largely on their own sites. This phase ensured that all the components were solidly based on IPv6. This phase ended with a strong demonstration at IST2001 in Düsseldorf – but the real integration of the components was still minimal. It did lead, however, to a very strong set of Deliverables – D4 – D11. During P3, the partners were working together very intensively, leading up to a strong showing at INET2002 in Washington – where the partners had had to integrate their components. During this period the integrated Deliverables D12 – D14 were produced – but still the main networks used were WLANs and IPv6 wired networks. As a result, it became clear what integrations between the partners were still necessary. During P4 These integrations were made, and a fully integrated set of demonstrations were carried out as part of the IST2002 in Copenhagen. During this period, the first intensive use of GPRS was achieved – and it was discovered that it was not very useful for our applications. The final period P5 was spent in producing the definitive deliverables – D15-D19, which described all the work we had done. It also was the period in which we considered which demonstrations to mount over the UMTS test bed, and preparing for the Final Review and UMTS demonstrations in Stockholm. The whole project was also reviewed and evaluated in D20. After P5, until the end of March 2003, all the effort was devoted to producing this Final Report and the TIP.

2.3 Accomplishments

The Evaluation Deliverables D19 and D20 have evaluated the whole project from the clinical and general viewpoints. It is clearly not sensible to repeat their considerations here. The Reviewers accepted these reports without change, so they may be taken as conclusive evaluations of the whole project. The results themselves are presented in Section 3.1, and the exploitation intentions are considered in considerable detail in Section 3.2. Further elaboration of both sections is given in the Technical Exploitation Plan (TIP), which is appended to this report.

The Reviewers did make some comments on some other aspects of the project in each of the two reviews. The comments of the reviewers after the first review were taken into account in revisions of one Deliverable (D6) and the whole work of the second year. We only received the results of the final review at the end of February, our resulting actions are considered in the next section.

2.4 The Final Review and its Recommendations

The Final Review was held in the Ericsson premises, and included a number of demonstrations over the UMTS test bed that they operate. The Final Review report makes a number of recommendations. These are listed below and the actions that have been taken are appended.

R1: The project should complete its work by delivering the final project report and TIP to schedule.

This is being done in this report and its accompanying TIP

R2: The TIP should include details of specific conference and journal papers to be submitted by the partners from the results of the project.

Some papers are included in the TIP. However additional papers will be submitted later. There is a problem here, however. Since there is no further funding for travel from this project, some such papers will acknowledge work done under this project, but be submitted under another project.

R3: Deliverable 6 2.1.3.3 is still inaccurate in its description of 802.11 functionality in paragraph 1 & 2. See 802.11 (1999) standard, Section 3. – “Definitions”, 3.7 and Section 5. – “General Description” for the correct material. This deliverable cannot be accepted with an inaccurate description of 802.11 functionality.

Deliverable 6 has been updated

R4: Deliverables 17 & 18 need to be updated to document the experience gained in porting applications to IPv6 including mapping QoS requirements onto IPv6 DiffServ classes, and issues in Multicast and Security, as requested in R3 from the 1st review.

Deliverable 17 has been revised. Extra comments have been made in D18 to show where these issues are being addressed.

R5: The final report and TIP should be delivered on schedule to complete the project.

This is identical to R1. This is being done in this report and its accompanying TIP

R6: Deliverables containing valuable tutorial materials should be made available through the 6LINK project as input for chapters in an IPv6 book.

One such chapter has been submitted to 6LINK. The complete deliverables have been made available on the Web, since a few items of a proprietary nature have been removed. References to such planned publications are mentioned in this report.

3 RESULTS AND ACHIEVEMENTS

3.1 Results

The most significant outcome of the 6WINIT Project was the global insight gained by the 6WINIT partners of what was needed to provide applications in the Mobile IPv6 world. This is a holistic result; the components that contribute towards it are discussed very fully in Deliverables 19 and 20, which evaluate the project as a whole, and the Clinical applications in particular. These findings will not be repeated here. Instead we will concentrate on the specific results which the Partners feel have come out as tangible entities, and which the plan to develop further either as R & D activities or as commercial products.

3.1.1 Guardian Angel System accident and emergency consultation system

The GANS system, Result 1 in the TUP, is a real-time tele-medical system for acute consultancy in medical emergencies. The concept was conceived by RUS and 6 UKT and technically designed and implemented by RUS. While the system is applicable also in a WAN context, in 6WINIT the GANS concept was applied to an ambulance-to-hospital consultancy scenario – an accordance with the specific 6WINIT technical goals of capitalising on Mobile IPv6 (MIPv6). Using results from other 6WINIT partners, the Linux-based MIPv6 component is provided by Ericsson, the audio system was delivered by TZI, Tests and demonstration were successfully carried out between Tübingen and Düsseldorf during IST2001, Tübingen and Washington during INET2002. During the Final Review, it was shown functioning over the Ericsson UMTS test bed in Stockholm.

A study performed in the realistic patient simulator environment of UKT showed from a medical point of view an increase of patient outcome by 50 %!

GANS is a fairly generic application of the type “real-time communication and data acquisition between a vehicle and its base station” in 3G and B3G networks.

3.1.2 Router Transition Mechanism

Ericsson-Telebit and 6WIND implemented Transition mechanisms in their routers as Result 2. The transition mechanisms implemented include IPv6 to IPv4 translation mechanisms such as NAT-PT and advanced IPv6/IPv4 tunnelling mechanisms such as ISATAP, and DSTM. The mechanisms have been developed during 6WINIT. The result has a direct commercial impact. Many of the mechanisms have been made commercially available and some will be used as base for future commercial products.

The IETF has defined a wide range of IPv6 transition tools. Some are aimed at ISP providers, while others are aimed at site networks, and even to individual IPv6-enabled hosts “trapped” in an IPv4-only routed network. Inevitably transition tools will make use of the existing IPv4 infrastructure, for example by transporting (tunnelling) IPv6 packets as data in IPv4 packets, by translating IPv6 headers into IPv4 headers, or by having hosts enabled for both protocols (dual stack).

The objective of these tools and methods is to allow IPv4 and IPv6 hosts to communicate, and to communicate in a way that is as transparent as possible to the end user. Therefore, mechanisms provided by Ericsson-Telebit and 6WIND may contribute to the IPv6 deployment while preserving existing IPv4 infrastructures.

3.1.3 Road Warrior

As Result 3, IABG has developed an implementation of the Road Warrior, which offers an IPSec-based secure connection for nomadic users connecting to the network on different points of attachments with different IP addresses.

While the majority of IPSec implementations provide security between two IPSec gateways (tunnel mode) or two IPSec clients (transport or tunnel mode), the Road Warrior is an extension for the provision of security between a client and a gateway, using the IPSec tunnel mode. The term Road Warrior more specifically identifies the IPSec client itself, but specific functionality is needed for the Road Warrior on both sides of the security association, on the client as well as on the gateway side.

The Road Warrior developed within 6WINIT is an IPv6 based extension to the IPSec implementation from FreeS/WAN and consists of both, client and gateway code for Linux systems. In 6WINIT the Road Warrior has been used for securing nomadic clinical and home environment applications, in principle it would be adequate for securing any nomadic application running over IPv6 on Linux systems.

3.1.4 Mobile IP mechanism in Gateways

As Result 4. 6WIND and Ericsson-Telebit have implemented the Mobile IPv6 “Home Agent” feature in their routers. Such a function is typically useful in a wireless context and could be offered as a new service by WLAN operators, Hot-spots operators.

The implementation of this innovative feature has a direct commercial impact; The Mobile IPv6 Home Agent functionality will be available commercially in 6WIND routers. Ericsson-Telebit’s implementation will be the base for future Mobile IPv6 Home Agent implementations in Ericsson router products

The main objective of Mobile IPv6 is to avoid communications being broken even when people are moving to different IP networks. While IP networks are including more and more mobile and wireless applications, MobileIPv6 represents a great opportunity for IPv6 to cope with the new behaviour of users that are now utilizing Internet from handheld devices. Another benefit is that users remain accessible with the same IP address (“Home Address”) what greatly simplifies management.

This feature is specified by an Internet draft. The current IETF specification is mature since very few topics are remaining open. 6WIND and Ericsson-TED current implementations are compliant with draft 13. A new implementation conforming to draft 20 is being developed by 6WIND.

3.1.5 SIP Gateways

As Result 5, TZI has developed the TZI-Gateway, which is a signalling and media gateway for both SIP and H.323 with support for IPv4 and IPv6. It enables implementations of SIP and H.323 based conferencing systems in different network layer domains (IPv4 and IPv6) to interoperate. The gateway also provides content adaptation features and media transport enhancements such as adding error resilience to media streams. These features allow for different interesting application scenarios such as multimedia communication between IPv4 and IPv6 endpoints, transparent transcoding to accommodate otherwise incompatible system capabilities and conferencing services such as media mixing. The media adaptation services are especially useful for wireless environments where individual participants of a conferencing session that reside on potentially low-bandwidth wireless links with higher bit-error-rates, require an adaptation of the media stream in order to participate in a conference.

The SIP-proxy is compliant to RFC 3261 and provides SIP-proxy and SIP-registrar functions. The SIP-proxy is interoperable with a broad range of IPv4 and IPv6 based SIP implementations and can be configured as a standalone proxy/registrar for a domain and as an IPv4/IPv6 translation gateway.

The integrated media processor can process the RTP streams of multimedia conferences and can apply media transcoding and other adaptations, e.g., in order to provide more robust audio transmission or to mediate between incompatible end-systems. As an example for a media transport enhancement, the gateway supports audio redundancy coding (RFC 2198) in the media processor. Since most (commercial) endpoints do not support this mechanism, it can be provided by two gateway systems that are configured accordingly. For example, two gateways, each of which is responsible for a certain SIP domain, could be configured to use audio-redundancy coding for all calls between these domains, e.g., in order to bridge an unreliable wide-area network.

3.1.6 Transcoding Active Gateway

As Result 6, UCL has developed a gateway based on policy-controlled Active Software components, referred to as Proxylets; these are used to distribute, manipulate, and/or record group sessions. The two primary proxylets developed under this effort are an IPv6-enabled Transcoding Active Gateway (TAG). TAG is a software gateway used to bridge or transcode multicast flows through unicast-only networks. Functionality can be added based on policy defined for its operation. One such function involves performing media adaptation at boundaries. The current implementation only does rate limiting, though this can be policy controlled. This feature represents a rudimentary form of back off in when a flow is experiencing loss (presumably due to congestion).

Control and management of TAG is accomplished through a policy-based management system. The proxylets were developed in the ANDROID project, but extended under this project for use in a wireless environment – complete with a dynamic form of loading near access points of a wireless environment. It also includes a resource discovery functionality.

The TAG needs considerable more sophisticated policies and functions. It also needs to be deployed further to get experience on what further functionality is required before it can be used in earnest.

3.1.7 IPv6 Tunnel Broker: enabling access for IPv6 services over IPv4 networks

As Result 7, UoS has implemented a tunnel broker based upon the IETF RFC 3053. A tunnel broker is a mechanism to aid deployment of interconnected IPv6 devices and networks in a predominantly IPv4 world.

The key elements of a tunnel broker are the tunnel broker web server, which receives web requests from users who require a tunnel service (passing back a script to set up one end of the tunnel) and the tunnel server, which creates the remote endpoint for the tunnel from the user.

This tunnel broker is implemented on FreeBSD, based on open-source components. The web server is Apache2, which is by default IPv6-enabled; the IPv6 tunnel server communication uses OpenSSH, while the tunnel parameters and data are held in an IPv6-enabled OpenLDAP database.

The implementation is one of only a handful of tunnel broker implementations available.

The current most popular application of the result is to provide tunnelled IPv6 services from the university IPv6 network to staff or students in their homes, when mobile, or in their (student) halls of residence. The broker is being made available in other projects, including 6NET (www.6net.org).

3.1.8 UK6X Exchange

As Result 8, BTexact has implemented UK6X - an IPv6 Exchange. Its main purpose is to facilitate and assist with the interconnection of IPv6 networks. The actual exchange of data between the various interconnecting organisations is done via a switch. Routing could follow the data but to achieve complete interconnectivity this would require a complete mesh of BGP peerings. This is not a scalable solution and so a route server has been introduced. A route server is a device that all interconnecting parties peer with. The route server combines all the routes and advertises them to everyone. Upon receiving the complete combined routes they are filtered to delete routes where commercial agreements to exchange traffic are not in place. A route server therefore has numerous advantages:

- makes the exchange scalable;
- reduces the complexity of BGP peerings;
- largely separates the commercial peering arrangements with the technical interconnection. The exchange of data between two parties now relates to altering filter lists rather than establishing BGP peerings.

It should be noted that a route server does not add to the BGP hop count between two parties i.e. it is a zero hop element.

3.1.9 Secure IPv6 Home Environment

As Result 9, VTT has implemented a Secure IPv6 home environment that is designed for controlling home appliances such as TV, video, lighting, heating etc. The system allows accessing and controlling all devices using a single control device and user interface. The devices can be controlled via PDAs, laptops, PCs, speech or gestures. The original application was made in Interactive Intelligent Electronics (IIE) strategic research project and in VHE ITEA-project. In 6WINIT, the application was ported to IPv6 and enhanced with remote access.

The application was designed for homes but it can be used elsewhere too (e.g. in offices). It can also ease the life of special groups such as elderly people or disabled.

3.1.10 Indoor navigation based on WLAN (802-11b) positioning

As Result 10, VTT has developed a WLAN (802.11b)-based positioning technique able to locate objects carrying WLAN equipment to an average accuracy of 2 meters. The method is most appropriate for indoor use where GPS satellite positioning is not available. Compared to other indoor positioning methods WLAN positioning has the benefit of not requiring any specific infrastructure or hardware – a normal well-designed wireless network is enough.

The accuracy is not sufficient to function as the only navigation method for an autonomic robot, but is adequate for many location-dependent services indoors e.g. in offices, industrial plants or public buildings. In some cases its usage area can be expanded also to outdoor use, e.g. to city centres. So far WLAN positioning has been used as part of a navigation tool (i.e. a map service), to facilitate location enhanced communication between people (i.e. Presence and Location Instant Messaging platform developed by Telematica Instituut) and as part of a location aware service (i.e. home environment).

3.1.11 Consultation on and Development of clinical applications

As Result 11, UCL and UMM have developed two clinical applications: an electronic health record server and a DICOM image viewer for portable hand-held devices.

The electronic health record server developed by University College London comprises a set of Java middleware components interacting with an Oracle database, for storing, retrieving and interrogating any arbitrary clinical information. It conforms to published clinical and medico-legal requirements, and its internal reference model conforms to the CEN standard for EHR Communications. Its design team have contributed to a decade of EHR research, through several EU Health Telematics projects. The record server is operational at the Whittington Hospital in London, supporting anticoagulation, chest-pain and heart-failure outpatient services. Through the 6WINIT project its architecture now supports access via wireless IPv6.

The DICOM image viewer can allow doctors to access medical images on their handheld equipment. The Java language has been chosen for the implementation. Its portability between multiple PDA platforms and ease of integration with Jini/Jiro technology were the most important advantages. It allows users to display and zoom DICOM examinations, view DICOM textual tags and mark annotations. The communication with the server is realized using HTTPS protocol running over IPv6 giving secure data transfer and authentication of both participating sides. The application has been integrated with existing NetRAAD system running in the John Paul II Hospital in Kraków and has been tested intensively

3.1.12 Java-based Agent Framework supporting IPv6 Communications

Result 12 is a UoS application, based on the Southampton Framework for Agent Research (SoFAR), which has been developed in the IAM Research Group at the University of Southampton. The Slite framework is a lightweight distributed-agent architecture adaptation of the Southampton Framework for Agent Research. The framework is based on Speech Act theory, using a set of performative-based communication primitives to support auction based and argumentative agent negotiation strategies for Distributed Information Management tasks.

The Slite framework consists of a number of agent platforms. A platform is an instance of the Java Virtual Machine (JVM), and hosts a number of agents. Each platform has a special agent, an *agent launcher*, which oversees the launching of agents and registration into their capabilities to the platform.

SoFAR is described in “SoFAR with DIM Agents: An Agent Framework for Distributed Information Management”, L. Moreau et al,. In *Proceedings The Fifth International Conference and Exhibition on The Practical Application of Intelligent Agents and Multi-Agents (2000)*, pages 369—388.

With release 1.4.1 of the Sun Java Development Kit (JDK), the JDK has included IPv6 support for basic connectivity (unicast and multicast). The full agent framework (SoFAR) has been tested to operate with IPv6, and the lightweight agent framework (SoFAR Lite, or Slite) was developed with IPv6 multicast as a key feature for local communication and service advertisement and discovery.

There are currently very few people using IPv6 for agent-based computing. This number is expected to rise, especially when devices (in addition to people) begin to use agent technology. More importantly, the Grid community, now using Java in the OGSA-based Globus Toolkit 3, should embrace IPv6 for inter-device communication. The 6WINIT demonstrators showed the feasibility.

The applications are currently running on Sun JDK1.4.1 on the RedHat Linux (7.1) platform. The code is being used for experimentation within the local Department’s agent-based computing group.

3.1.13 IPv6 Backbone Network and MPLS Showcase

As Result 13 T-Systems, together with other partners in the 6WINIT project, has worked to provide the necessary IPv6 backbone connectivity to the project partner networks. Connectivity has been provided by different means such as tunnelling or dedicated access.

In order to emulate further native IPv6 offerings, T-Systems has build a near production-level IPv6 trial network in Germany, connecting three POPs in Münster, Darmstadt and Berlin. Native IPv6 has been provided over 2.4 Gbit MPLS links based on Cisco 6PE implementation. This network runs in a quasi-production environment, providing the necessary interconnections to other IPv6 related activities inside and outside Germany. Exemplar interconnected networks are 6bone, 6net and Euro6IX.

The German network has been offered to 6WINIT participants to be used as part of their Pan-European backbone.

Certain IPv6 services were offered in conjunction with the possibility to obtain IPv6 address space. For people without direct access to the POP locations a Tunnel Broker offers the possibility to gain tunnelled access.

In order to stress test the network several trials were conducted such as an IPSec trial. Directly using the developed results from other partners of the project.

Experience has been gained into IPv6 operational issues such as address and user management.

Further work is necessary in order to match IPv6 services with the quality and reliability currently deployed in the IPv4 environment and expected from the Network Operators.

3.1.14 Functionality integrated into Mobile IPv6 that allows mobile nodes to use several network interfaces simultaneously

As Result 14, Ericsson has developed techniques that allow devices to move seamlessly between different types of access networks – as required in the Mobile Internet. The devices might be attached to personal, local or wide-area networks, and use different link-layer technologies. Ericsson Research has implemented this functionality at the IP/network layer within a Multiaccess Mobile IPv6 stack. The implementation fully conforms to the Mobility Support in IPv6 Internet-Draft; therefore it is compatible with any existing Mobile IPv6 nodes.

The implementation is based on standard Mobile IPv6 and is integrated into a Linux Mobile IPv6 stack (MIPL) provided by the Helsinki University of Technology. In Multiaccess Mobile IPv6, in addition to Mobile IPv6 handovers, IP traffic can be transferred between different network interfaces connected in a Mobile Node

(MN). These may be called as *vertical handovers*. Available interfaces are found by using the standard IPv6 address autoconfiguration. In addition, several interfaces may be in use simultaneously in one MN. This may be called as *simultaneous multiaccess*.

Multiaccess Mobile IPv6 solution does not require any modification to applications using IPv6 access networks or any additional nodes to the access network. The solution is also independent of access technology.

To be able to use effectively the multiaccess capability, it must be possible to configure and control this functionality according to the needs of applications and users. The implementation includes interface selection mechanisms on account of the remote IP addresses (or domains) and port numbers of the connections. A user interface is also provided for defining the connection management policies. Using this the mobile users can dynamically define local policies where the preferred interfaces are listed on account of a connection association and possibly QoS-related information. Several possible interfaces can be listed in a priority order – the system automatically selects the best possible based on availability

3.1.15 High-quality Video Conferencing Tool (HVCT)

As Result 15, ETRI implemented an IPv6 multicast based video/audio conferencing tool, HVCT (High-quality Video Conferencing tool) which is based on the MPEG video and audio codec. HVCT uses an MPEG-4 codec for video encoding and decoding and an MP3 (MPEG-1 audio layer 3) codec for voice data encoding/decoding. Also, HVCT supports an IPv6 multicast as well as unicast communications for the conferencing work.

HVCT uses the Real-time Transport Protocol (RTP) [RFC1889] and MPEG-4 video on the Windows 2000 operating system with SP1 (Service Pack 1). It also allows users to monitor the traffic per participant basis and has an adaptive bandwidth control (Frame Rate control) according to the network status.

The HVCT software has been release by ETRI in 2002 and is available at http://www.6neat.net/hvct/.

3.1.16 IPv6 Video Streaming Client and Server

As Result 16 ETRI has developed a Video Streaming client and Server – which are increasingly popular technologies with which to view and listen to multimedia contents. This technology is seen as one of the new value-adding Internet services and competition in this area and continues to be intense. Especially, also the streaming services will be more useful for various application areas, for example entertainment, education and so on.

ETRI implemented the IPv6 video streaming server and its client under 6WINIT. Basically the platform for the streaming server is Linux, and the clients support Linux and Windows 2000/XP operating system. The supporting media types for clients are MPEG-1, 2 (PS only) and MPEG-4 videos (Divx). It supports a streaming over both IPv4 and IPv6 protocol and also supports the RTP and HTTP based streaming.

3.2 Exploitation

While the detailed exploitation plans are either described in the TIP or in confidential reports to the Commission, we provide below an overview of the exploitation plans of the partners.

3.2.1 UCL

UCL has the two distinct groups the Department of Computer Science (UCL-CS) and the Centre for Health Informatics and Multi-professional Education (CHIME).

UCL-CS plans to bring its TAG gateway (R6) to a deployable level, and then to deploy it in the 6NET testbed. In fact a generalisation of the ideas behind the TAG will lead to further activities in Overlay networks, of which Virtual Private Networks are one example, and Content Distribution Networks are another. We expect to investigate how these concepts can be broadened to provide the resilience and deployability of more conventional Internet components in future projects – often involving the IPv6 and mobility of 6WINIT.

CHIME expects to complete any necessary software engineering to produce an easily installable set of software components suitable for uptake and deployment by third parties. It then intends to form a not-for-profit company that can hold copyright and licence the use of the components, raising any funds necessary to meet the costs of the endeavour.

3.2.2 UoS

UoS expects to do further research & development on its tunnel broker (R7) and its Slite (R12) in existing FP5 and new FP6 programme projects (e.g. 6NET, Euro6IX); in these it will incorporate new features, and may contribute t further standardisation.

3.2.3 BT

BT intends to develop the facilities on its UK6X exchange (R8) by increasing its capacity, adding more access networks, and improving the service facilities. It also intends to market the existence of the exchange aggressively.

3.2.4 Ericsson-Telebit

Ericsson-Telebit plans to complete its NAT-PT implementations (R2), and to use its mechanism for the IMS services in the 3G core network that has been provided to the company's 3G core product division The NAT-PT prototype will provide the basis for a full-fledged implementation of NAT-PT that will be developed and tested in the Euro6IX project. The implementation will be based on Ericsson's new real-time router for the Mobile Internet, RXI820.

It will enhance its Mobile IPv6 implementation (R4) from its current version 13 of the IETF draft specification to be compliant with future versions; they also expect to continue to continue to contribute to the IETF draft specification within the areas of Mobile IPv6 and IPSEC interworking and of authentication of Mobile IPv6 control messages. The Mobile IPv6 Home Agent prototype will provide the basis for enhanced home agent functionality that will be implemented and tested in the Euro6IX project. The implementation will be based on Ericsson's new real-time router for the Mobile Internet, RXI820.

3.2.5 Ericsson Systems

Ericsson intends that its Multiaccess prototype (R14) will provide the basis for enhanced Mobile IPv6 functionality that will be implemented and tested in future research projects. The implementation will be based on Ericsson's commercial IPv6 stacks.

3.2.6 T-Nova

T-Nova expects to extend the IPv6 network (R13) offered in 6WINIT to match IPv6 services with the quality and reliability currently deployed in the IPv4 environment and expected from the Network Operators. It will continue research inside DTAG T-System to improve its IPv6 Show Case which is seen as an initial starting point for an future IPv6 based service of DTAG.

It expects to develop translating units for roaming in 3G networks, which allow communication between the new IPv6 supporting systems and legacy IPv4-only servers in the Internet without any service disruption – and which will work in a carrier-scale environment.

3.2.7 IABG

IABG's exploitation intentions with the Road Warrior (R3) are not public, but it is no secret that they plan to develop it further and make it the basis of further exploitation..

3.2.8 TZI

TZI intends to extend it SIP gateway (R5) by providing support for conferencing (audio mixing, SIP conferencing). It will also provide a SIP-based endpoint for mobile systems (PDAs, wearable computers) and a SIP-presence server with support for IPv4 and IPv6.

3.2.9 RUS

RUS plans to play its part in getting GANS (R1) to be commercially viable. In this it will assist UKT.

3.2.10 UKT

UKT is preparing, with some of the 6WINIT partners and new ones, a FP6 eHealth proposal to complete the GANS application with the development of the GANS centre including intelligent decision support tools and aspects of the decision-making process. UKT is working also at getting acceptance of GANS from medical organisations and bodies, to ensure that it can become a viable commercial product. It will also attempt to find partners for a GANS company

3.2.11 6WIND

6WIND detailed exploitation plans are not public. However it intends to build on its experience with its router (R2) and (R4) to improve its functionality and increase its competitiveness.

3.2.12 VTT

VTT expects to continue its work in the secure home environment (R9) and location-aware services (R10) in ongoing FP6 projects. It will market its activities aggressively, to open new markets for IPv6 related R&D services. It will also provide a permanent Home environment demonstration at the Eurov6 showroom in Basel.

3.2.13 UMM

UMM plans to develop its clinical activities further both in ongoing FP6 and National projects, and in real patient situations.

3.2.14 Telscom

Telscom intends to exploit the result of its work in future IPv6 projects.

3.2.15 ETRI

ETRI expects to collaborate in further research & development activities to extend its integrated collaboration service platform (R13) using the conferencing tools. It expects to extend its streaming service (R14) to support mobility on WLANs using Mobile IPv6.

3.3 Publicity and Dissemination

The partners were very active in the dissemination of their results. Whilst they attended many meetings and conferences, we will not mention those here. We will state here, however, those activities where there was a visible dissemination output: the conferences we organised and the papers we presented and wrote.

3.3.1 Conferences Organised

The conferences /workshops organised are shown below:

Date	Location	Topic	Participants	Outcome
2001-09-12	Sitges, Spain	IPv6 cluster workshop	Telscom, UCL, BT, T-NOVA, TED	The workshop covered the issues to be addressed for IPv6 development and liaison with other projects.
2001-09-17	Krakow, PL	DAIS'2001: 3rd IFIP International Conference on Distributed Applications and Interoperable Systems	All 6WINIT staff at UMM; over 100 participants from Europe and all over the world.	The conference covered some European state-of-the-art wireless research topics. There was an invited talk by Prof. A. Wolisz from TU Berlin and many papers on wireless internet, charging and QoS issues.
2001-11-27	Bremen, Germany	Security in Enterprise Communication Infrastructures	TZI and others	Gave presentations on "Security for IP Telephony" and on "WLAN Security in heterogeneous Enterprise Networks"
2002-04-22	Southampton, UK	GEANT TF-NGN	UoS	Included IPv6 WG discussion. Meeting used 6WINIT IPv6 WLAN infrastructure.
2002-05-10/11	Santander, Spain	EoI Network of Excellence	UKT	Submission of an EoI
2002-06-06	Limerick	IPv6 workshop	Telscom	Presentation of users views of IPv6
2002-07-02	JP2 Hospital, Krakow, PL	1st Festival of Advanced Telemedicine	Media (local press, TV, radio)	Presentation of UMM medical applications developed within WP5 and WP9

3.3.2 Papers presented

In Annex B we list all the papers presented in journals or conferences. In Annex C we list the IETF drafts and RFCs that have been submitted. Finally, In Annex C we list papers we will certainly write – but there will be others. We would not normally mention future papers, but we have been requested to list them by the Reviewers

3.4 Conclusions and the Future

The more we participate in two-year projects, the more we realise that they are too short-lived. This is partly because of the time it takes for partners to work well together. It is also because only after they have worked together for some time, is one able to profit from the total activity being greater than its parts. In this project great progress was made in the provision of the basic components: routers, network provision, middleware, end-stations and applications. Few were ready for use by other partners by the end of the first year, most only by the middle of the second. Thus the last nine months were a hectic and rewarding activity in integration. The necessary concentration on the last three major demonstrations were immensely useful as forcing functions – but left us all sad that we did not have time to really profit from the individual achievements.

By the end of the project, we had excellent connectivity with each other. Certain of the non-clinical applications – like conferencing, agent technology and streaming were ready for large-scale deployment. The gateways and routers which would allow such deployment in a mixed IPv4/IPv6, wired and wireless, world were also finally ready – but there was no time for the operational use, which would uncover those extra adjustments which would be needed for excellent services. The clinical applications had reached a surprising maturity, but again each had had to gloss over certain necessary components – security in one case, proper only an *ad hoc* transition mechanism in another, applying the lessons learnt from interference measurements in Poland to the British scene in a third.

There was clearly one vital place where we had failed. The use of UMTS was only a last-minute activity - far too little to draw real conclusions or to understand the impact of that technology on the wealth of components that have been developed. This was not due to any failure by the project partners; it was due to the delay in the availability of any UMTS facilities, because of the financial and technical problems with the whole industry.

We were able to make limited use of GPRS. That technology clearly has its place, but at the present juncture, its place has little to do with 6WINIT. The speed that it offers is too low, and the round-trip times too long, for the applications we wished to address in any case; the constraints in the way that it has been implemented made it almost useless to the project. Delays of months to get at servers, the need to tunnel IPv6/IPv4 and the lack of fixed IP addresses, reduced its usefulness yet further. Finally the costs of its usage, while bearable in a research project, made it clearly unsuitable for the applications in 6WINIT to be deployable.

The project has made a considerable impact on what can be done over the IPv6-enabled wireless Internet. We expect that many of the partners will develop further the activities they have brought to such an interesting stage in existing projects like Moby Dick, 6NET and Euro6IX. Beyond that, it is clear that Framework-6 offers immense potential to finish the job, which we were unable to complete in 6WINIT. Provided only that UMTS really does take off, and that its integration with WLANs is not blocked by deliberate sabotage, 6WINIT has laid an excellent basis for the future.

There is one area where the lack of UMTS has not been a vital factor, and that is the clinical domain. Here it is extremely gratifying how much progress has been made. Some of the components do need UMTS, for instance audio/video in GANS and radiographic images at a distance. In fact institutional and organisational constraints will probably need more time for real clinical deployment than it will take to deploy UMTS widely. However, the collaboration between the clinical and the technical sides has been immensely fruitful; it has galvanised the 6WINIT clinical partners to allow the technology developed to be deployed for real in healthcare.

All in all, a huge amount has been achieved. All of us are looking forward to using and commercialising our results over the next few years.

Annex A Conferences/workshops organised

Date	Location	Topic	Participants	Outcome
2001-09-12	Sitges, Spain	IPv6 cluster workshop	Telscom, UCL, BT, T-NOVA, TED	The workshop covered the issues to be addressed for IPv6 development and liaison with other projects.
2001-09-17	Krakow, PL	DAIS'2001: 3rd IFIP International Conference on Distributed Applications and Interoperable Systems	All 6WINIT staff at UMM; over 100 participants from Europe and all over the world.	The conference covered some European state-of-the-art wireless research topics. There was an invited talk by Prof. A. Wolisz from TU Berlin and many papers on wireless internet, charging and QoS issues.
2001-11-27	Bremen, Germany	Security in Enterprise Communication Infrastructures	TZI and others	Gave presentations on "Security for IP Telephony" and on "WLAN Security in heterogeneous Enterprise Networks"
2002-04-22	Southampton, UK	GEANT TF-NGN	UoS	Included IPv6 WG discussion. Meeting used 6WINIT IPv6 WLAN infrastructure.
2002-06-06	Limerick	IPv6 workshop	Telscom	Presentation of users views of IPv6
2002-07-02	JP2 Hospital, Krakow, PL	1st Festival of Advanced Telemedicine	Media (local press, TV, radio)	Presentation of UMM medical applications developed within WP5 and WP9

Annex B Conferences and Journal and Papers

1. Cocquet, Patrick, *"IPv6 Deployment Vision"*, http://www.6wind.com/pdf/events/6WIND_Deployment vision.pdf, 2002-05-09/11
2. Cocquet, Patrick, *"IPv6 and Security"*, IST 2002 Conference, 2002-11-04/06
3. Lukasz Czekierda, Dominik Radziszowski, Krzysztof Zielinski, Sawomir Zielinski, *"IPv6 in Mobile Access Applications"*, Proceedings of Polish National Optical Internet Conference PIONIER 2002, April 2002
4. Czekierda, L, S. Zielinski and K. Zielinski, *"Access to Radiology Data from PDA Devices"*, Conference of American Telemedicine Association, April 27-30, 2003 in Orlando, Florida, USA, June 2002
5. Czekierda, L, S. Zielinski and K. Zielinski, *"IPv6 Research in Europe"*, IEEE SAINT 2003 (International Symposium on Applications and the Internet), Orlando, Florida, Jan 27-30, USA, June 2002
6. Fritsche, Wolfgang *"Mobile IPv6"*, DFN Congress, June 2001
7. Kalra D, Austin A, O'Connor A, Patterson D, Lloyd D, Ingram D., *"Design and Implementation of a Federated Health Record Server"*, Towards an Electronic Health Record Europe 2001, Paper 001: 1-13. Medical Records , Institute for the Centre for Advancement
8. Kalra D, Austin A, O'Connor A, Patterson D, Lloyd D, Ingram D., *"Information Architecture for a Federated Health Record Server"*, In: Mennerat F. (ed) Electronic Health Records and Communication for Better Health care; 47-71. IOS Press, Amsterdam, 2002.
9. Kirstein, P., Carlsberg, K., Hasler, K. and O'Hanlon, P, *"Media transmission over coupled wired/wireless networks using application level active IPv6 networks"*, Proceedings of Interworking 2002, Perth, 2002-10-13/16
10. Kirstein, P., "Internet Extension to S. Caucuses and Central Asia: the SILK project", Proc. Interworking 2002, October 2002
11. Kirstein, P., Carlsberg, K., Hasler K. and O'Hanlon, P., *"Media Transmission Over Coupled Wired/Wireless Networks Using Application Level Active IPv6 Networks"*, Proc. 6th Int. Symp. Comm. Networking, Perth, 13-16 October, pp 195-207, 2002, July 2002
12. Kosiski, Janek (in Polish), *"Models and aspects of IPv4 to IPv6 Migration"*, Proceedings of Polish Annual Networking Conference, Zakopane, June 2002
13. Kosinska, Joanna, *"Implementation of Tele-conferencing System using Jini and Jiro"*, Proceedings of III International Conference "Multimedia in Business", March 2003
14. Pagtzis, T and Kirstein, P., "On the Performance of Contention-free-period Repetition Interval in Mobility-enabled Wireless LANs", LCN 2002, November 2002
15. Pagtzis, T and Kirstein, P., "A Model for Proactive Seamless IP Mobility and Mobility-Hop Routing", ICON 2002, August 2002
16. Pagtzis, T and Kirstein, P., *"Proactive Mobility for future IP Wireless Access Networks"*, Wireless and Optical Computing 2000, July 2002
17. Rao, Sathya *"The IPv6 impact on 3G deployment"*, IIR 3G Conference, May 2001
18. Rao, Sathya, "Mobile network architecture and applications support", Netties Conference,
19. Rao, Sathya, *"QoS in wireless network architecture"*, Wireless networks conference 2001,
20. Radoslaw RUCHALA and Krzysztof ZIELINSKI, *"IPv6 in the context of mobile applications"*, 8th Polish Networking Conference, June 2001
21. Radziszowski, Dominik, *"Linux and iPaq (a paper in Polish)"*, LinuxPlus, No 11/2001 (55), pp 54-58

22. Dominik Radziszowski, *"Linux for Mobile"*, Telenetforum magazine (http://www.telenetforum.pl/index200202.html), Feb 2002
23. *"Electronic Health Records"*, Toward an Electronic Health Record Europe 2001
24. "Electronic Health Records", EuroRec01
25. *"GANS education"*, Telemedizinfuehrer Deutschland 2002,
26. *"GANS education"*, Proceedings of the MDS Meeting
27. *"IPv6 based Mobile Routing"*, Interworking 2002, June 2002
28. *"'Konversion, nicht Konvergenz: Warum, Voice over IP' erst der Anfang ist."*, Deutsches Forschungsnetz (German Research Network) General Meeting,
29. *"Mobiler Campus Bremen"*, Final workshop of the BMBF (German Ministry of Education and Research) sponsored WLAN project,
30. *"Network Services in Context of Pervasive Mobile Internet"*, Proceedings of the Second International Workshop of Central and Eastern Europe on Multi-Agent Systems, October 2001, Krakow, Poland,
31. *"Robust Header Compression (ROHC) - The last mile in all-IP wireless"*, IP in Cellular Networks 2001, Paris,
32. *"State of VoIP at the University of Bremen"*, VoIP-meeting of the German Research Network organization, April 2001,
33. *"SIP Conferencing"*, IIR SIP Congress 2001, Stockholm
34. *"A Short History of SIP"*, Marcus Evans SIP Conference 2001, Geneva, May 2001
35. *"SIP WG Status"*, Voice on the Net (VON) Europe 2001, Stockholm, June 2001
36. *"SIP Location Servers"*, Voice on the Net (VON) Europe 2001, Stockholm, June 2001
37. *"SIP/VoIP"*, ComVerse User Forum
38. *"SIP/VoIP"*, IIR IP-PSTN Service Integration

Annex C Internet Requests for Comment (RFCs)

1. "RObust Header Compression (ROHC): Framework and four profiles: RTP, UDP, ESP, and uncompressed", RFC 3095
2. "RTP Payload Format for DV (IEC 61834) Video", RFC 3189
3. "RTP Payload Format for 12-bit DAT Audio and 20- and 24-bit Linear Sampled Audio", RFC 3190
4. "Robust Header Compression (ROHC) over PPP", RFC 3241
5. "A Message Bus for Local Coordination", RFC 3259

Annex D Internet Drafts

1. Dirk Kutscher, *"The Message Bus: Guidelines for Application Profile Writers"*, draft-ietf-mmusic-mbus-guidelines-00.txt, 2001-02-23
2. Jörg Ott, Dirk Kutscher, Dirk Meyer, *"An Mbus Profile for Call Control"*, draft-ietf-mmusic-mbus-call-control-00.txt, 2001-02-23
3. Carsten Bormann et al., *"RObust Header Compression (ROHC)"*, draft-ietf-rohc-rtp-09.txt, 2001-02-28
4. Dirk Kutscher, Jörg Ott, *"An Mbus Profile for Internet Appliance Control"*, draft-kutscher-mbus-ipac-00.txt, 2001-02-28
5. Jörg Ott, Colin Perkins, Dirk Kutscher, *"A Message Bus for Local Coordination"*, draft-ietf-mmusic-mbus-transport-04.txt, 2001-02-28
6. Carsten Bormann, Dirk Kutscher, Jörg Ott, Dirk Trossen, *"Simple Conference Control Protocol"*, draft-ietf-mmusic-sccp-01.txt, 2001-03-05
7. Carsten Bormann et al., *"ROHC over PPP"*, draft-ietf-rohc-over-ppp-01.txt, 2001-03-05
8. Stephan Wenger, Jörg Ott, *"RTCP-based Feedback: Concepts and Message Timing Rules"*, draft-wenger-avt-rtcp-feedback-02.txt, 2001-03-08
9. Ksinant, Vladimir, *"DNS extensions for IPv6 records"*, rfc1886 extensions: http://www.ietf.org/internet-drafts/draft-ietf-dnsext-rfc1886bis-02.txt, 2002-07
10. *"Requirements for Session Description and Capability Negotiation"*, draft-ietf-mmusic-sdpng-req-01.txt,
11. *"Session Description and Capability Negotiation"*, draft-ietf-mmusic-sdpng-00.txt
12. *"A Message Bus for Local Coordination"*, draft-ietf-mmusic-mbus-transport-06.txt
13. *"Advice for Internet Subnetwork Designers"*, draft-ietf-pilc-link-design-06.txt
14. *"RTP Payload Format for 12-bit DAT, 20- and 24-bit Linear Sampled Audio"*, draft-ietf-avt-dv-audio-04.txt
15. *"NACK-Oriented Reliable Multicast Protocol (NORM)"*, draft-ietf-rmt-pi-norm-02.txt
16. *"RTP Payload Format for DV Format Video"*, draft-ietf-avt-dv-video-04.txt
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