Title:	**IPv6 Task Force** **Trials Framework Working Group Report**
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Date:	**04.02.2002**
Version:	**1.2**
Distribution:	**Participants list**
Document number:	**72**

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1. Introduction

It is recognised that the Internet has become an essential element of our business and social lives and that its continuing development is essential for economic as well as social development – the future eEurope. The current Internet, that uses Version 4 of the Internet Protocol (IPv4), has certain limitations. The next generation (Version 6) of the Internet Protocol (IPv6) overcomes these limitations and will enable the Internet to grow and reach its full potential to serve the needs of industry and society.

The standardisation, implementation, trialling and deployment of IPv6 will however take a number of years. This report is from the Trials Working Group of the IPv6 Task Force and sets out a framework for IPv6 trials in Europe and recommends actions that should be taken to accelerate the introduction of IPv6 in Europe. This report in particular deals with IPv6 trials, other reports from the IPv6 Task Force deal with Mobile Services, Infrastructure (Internet) and Applications.

2. General IPv6 Trials Framework

This section introduces the concept of a general IPv6 trials framework. A framework for IPv6 trials is important to ensure that the work done in the various trial initiatives is maximised by eliminating duplication and enabling maximum sharing of relevant knowledge. Also the framework will facilitate co-ordination of trial activities. This will enable trial areas that are being overlooked to be identified as early as possible; hence mechanisms can be put in place to ensure all aspects of IPv6 trials are adequately being addressed. It is believed that an IPv6 trials framework will help to ensure that IPv6 is ready for commercialisation when market forces dictate.

Figure 1 depicts the generic IPv6 trials framework, it is based on there being a number of activities in the standalone testbed area that will feed into a number of IPv6 trials activities. The testbed and trials will enable a number of roadmaps to be produced:

- IPv6 equipment roadmap
- IPv6 networks roadmap
- IPv6 services roadmap

All the various initiatives in both the testbed and trials areas will produce results but it is the roadmaps that will capture and combine the knowledge from all the initiatives. These will be an invaluable resource for companies and people working outside the trials framework. It is the availability of this high quality information that will enable these people to develop their networks, products and services more efficiently and effectively to meet the emerging IPv6 marketplace.

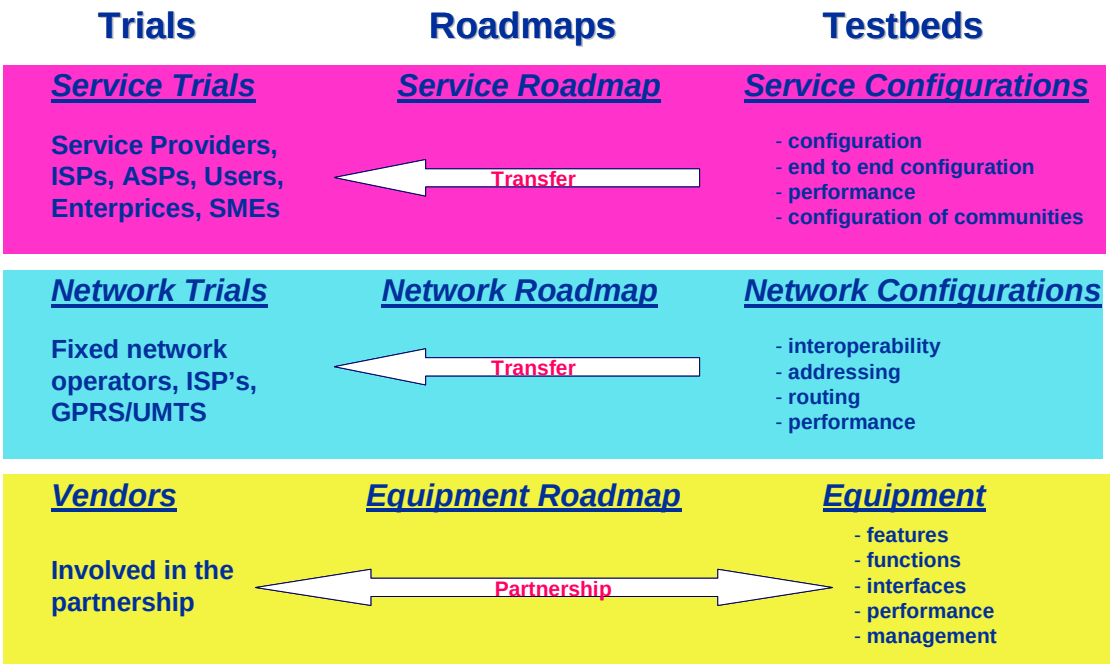

Figure 1 – Generic IPv6 Trials Framework

In slightly more detail the types of people and organisations involved in the testbeds will predominately be R&D establishments, academia and professional conformance testing houses. Three types of testbeds have been identified:

- **IPv6 Equipment Testbeds**

  These are predominately to test individual pieces of equipment e.g. routers. In many cases this will be done in partnership with equipment vendors. The early model is that vendors get R&D and academic establishments to evaluate their early prototype equipment. This is already happening with many vendors collaborating with R&D and academic establishments to evaluate their pre-production products. The next stage is for independent conformance testing to be undertaken by independent professional conformance test houses. There is some evidence that this is just starting to happen as network IPv6 equipment in certain areas starts to reach maturity. Of course this cycle of evaluation and conformance testing will be ongoing as new devices with increased performance and functionality are developed.

- **IPv6 Network Configuration Testbeds**

  This is where complete networks are built and are proven, in particular it is the interaction of various technologies and features that are being checked. In the core network area the interaction of routers supporting technologies such as MPLS, SDH, ATM, SONET and WDM that need to be checked. In the ISP area interactions such as DNS, Interworking, AAA, dial-up and xDSL need to be checked and proven to work between different vendor equipment. The major players in this area are, when the technology is being proven, R&D

and academic establishments but as commercial products become available professional consultancy is being used increasingly. Work has already started in this area but many facilities that are required for large-scale ubiquitous IPv6 deployment have yet to be proven. Knowledge gained from proving a technology in a constrained testbed, i.e. from the R&D and academic establishments, is invaluable to the IPv6 network trials area where technologies are being proven on more costly geographically disperse networks.

- **IPv6 Service Testbeds**

  It is here that the service differentiators of IPv6 are proven, namely that the features of IPv6 allow new innovative services to be developed. The IPv6 service testbeds will also check that IPv6 will still support the base services that we currently enjoy on IPv4, but, more importantly, it is new revenue-earning services that will be tested. At the moment this is probably the least developed of the three testbed areas. Once again the results and knowledge gained here needs to be transferred to the trials area dealing with services.

On the left hand side in the figure of the generic IPv6 trials framework is the trials area. The trials area is where networks and services are deployed and trialled in a pre-commercial environment to ensure that everything is technically and commercially (peering, billing etc agreements) in place for large scale deployment of IPv6 networks and services. It is therefore essential that these trials are driven by the final IPv6 commercial players i.e. IPv6 vendors, IPv6 network operators, IPv6 ISPs, Virtual ISPs, Service Providers, ASPs, Enterprises and end users. This should not preclude academic organisations, with their wealth of IPv6 experience, being involved. Three trial areas have been identified:

- **IPv6 Vendor Trials**

  Some vendors do trials, in private, with a particular network operator to trial their equipment in a particular configuration. More often vendors are interested in providing equipment and taking part in network trials with a group of network operators. In this way they get experience of their equipment being used in a multi vendors, heterogeneous network under realistic conditions.

- **IPv6 Network Trials**

  This is the area where large scale networks are deployed to test all aspects of the technology. It is essential that these trials are led and conducted by industrial players because they will be responsible for the IPv6 commercial networks of tomorrow. It is however essential that academic organisations, with their wealth of IPv6 experience, are also fully involved. IPv6 will touch every aspect of the Internet and the emerging Mobile Internet. In fact IPv6 needs to be flexible enough to meet all the diverse deployment situations that IPv4 currently fulfils as well as the emerging home and mobile environments. It can therefore be seen that many different network trials are required to prove that IPv6 is robust, flexible and scaleable enough to meet all deployment scenarios.

- **IPv6 Service Trials**

One of the major stumbling blocks for IPv6 is the current lack of services. This area is therefore essential for the early successful deployment of IPv6. Services, both existing and novel new services, are required for all the areas where IPv6 will be deployed, i.e. fixed, home, mobile, etc. This service trials area will utilise the network trials as a platform to test, evaluate and prove the complete spectrum of services.

The centre of the generic IPv6 trials framework is a set of roadmaps. These roadmaps, in the three areas of equipment, networks and services, will provide an invaluable source of information that will enable everyone to evaluate the implications that IPv6 will have on their company.

Recommendation - Develop roadmaps for the introduction and deployment of IPv6 services, equipment and networks. A systematic approach should be taken to analyse and identify areas that need special attention for an efficient introduction of IPv6, particularly with the help of trials. These roadmaps will help to identify missing areas for trial activities that could be catalysed by the EU, national governments and industry fora. The production of these roadmaps is essential for the timely deployment of IPv6 in Europe and beyond.

	Fixed Network	Mobile Network	Enterprise Services	Public Services
IPv6 Services Roadmap	IPv6 Connectivity IPv4/v6 Tunnels IPv6 VPN Addressing Native IPv6/PPP xDSL	• IPv6 Mobile Portals • IPv6 Web • Mobile access services • VoIPv6 IPv6 DNS • IPv6 DHCP • IPv6 Multimedia • Games On Line • Mobility services • Security	• IPv6 VPN's • IPv6 QoS • IPv6 Connectivity • Addressing • Security	• IPv6 Connectivity • IPv4/v6 Tunnels • IPv6 VPN's • Addressing • Native IPv6/PPP • xDSL • IPv6 Web • IPv6 Servers • IPv6 DNS • IPv6 DHCP • Games On Line • IPv6 portals
IPv6 Equipment Roadmap	• Core Routers (P) • Edge Routers (PE) • BAS (xDSL) • IPv6 DNS • Firewall • Interworking	• SSGN • GGSN • IPv6 DNS • Firewall • Terminals	• IPv6 DNS • Firewall • Client Routers (CE)	• Terminals • IPv6 Appliances (cars, fridges,PDA's) • Personal Routers
IPv6 Network Roadmap	• Backbones • ISP Networks • xDSL access • Dial access	• GPRS core • UMTS core • UMTS Reel.5 network	• IPv6 LAN • IPv6 WLAN • Intranet	• Home Networking

Figure 2 – Examples of what the IPv6 Roadmaps could contain

Figure 2 gives some suggestion as to the areas that the three roadmaps could cover.

3. Generic IPv6 Trial Framework Discussions/Recommendations

In this section each element of the generic IPv6 trials framework is discussed in detail and recommendations made.

3.1. Testbeds

There is currently considerable activity in the testbed area and a well established collaborative research environment within the EU and elsewhere that supports this type of activity. It is felt that enough facilities are in places but people need to be encouraged to take advantage of the existing facilities in the IPv6 area.

Recommendation – Publicise existing collaborative funding opportunities and projects with the aim of encouraging more IPv6 activities. The EU, European Governments and Industry fora should raise awareness in their area of influence for the upcoming infrastructure improvements towards IPv6 and the benefits to participate in trial activities from a very earl point in time, to gain a competitive position in the Next Generation Internet.

3.2. Vendor Trials

Vendor trials and network trials very closely related, this section discussed the requirements that various vendor sectors have for network trials. Without large scale network trials the vendors and equipment manufactures have no “proving ground” for their equipment.

3.2.1. Network equipment

From network equipment manufacturers’ point of view, the existence of advanced trials is essential to validate and evolve any new technology, this is especially true for IPv6 which is one of the fundamental technologies of the Internet.

In most IPv6 products the introduction of IPv6 is being done in four distinct phases:

- **Software based support**

  Initially all new features, functions and protocols defined by the standardisation bodies are implemented by manufactures in software. This allows for a fast and cost effective development cycle.

- **Hardware accelerated support**

  When a degree of stability and acceptance is achieved, the features implemented in software are then transferred to platform-specific hardware components so that the range

of interfaces supported is broader and the performance higher. It is important to notice that the development time of hardware-specific components is significantly higher.

- **Management support**

  In parallel to the previous areas, another development area focuses on the management of the new technology, product, service or solution that is introduced. Initially, a simple MIB-based approach will allow for individual network element management. In a later stage, more complex management architectures based upon sophisticated applications with IPv6 support will be introduced. Today this is one of the areas where there is still a significant amount of work to be done by the standardisation bodies.

- **Interoperability**

  Finally, the interoperability of the equipment of different manufactures needs to be tested and assured. Procedures for equipment certification should take this into account. It is worth nothing that as part of a certification scheme or outside it, attendance at interoperability events (sometimes called bake-offs or plugfests) is seen as a simple, efficient and cost effective way of helping companies iron out potential problems and avoid the creation of products that are not interoperable. ETSI operates such tests already for IPv6.

Every new technology must evolve from development to deployment through a trial-and-acceptance stage. The supporters of this trial stage are usually the developers of the new technology (manufacturers), researchers, large corporations interested in the early adoption, or institutions on behalf of the benefiting communities. Technology manufacturers rely upon this stage to move from simulation to final product, from laboratory to the market.

However, the evolution of current Internet infrastructures to the new IPv6 protocol prompts operators to embark on projects with profound implications and transformations on the existing network architectures. Adding these implications to the demand for specialised resources, costly early-adopter risk factors, and a long investment-to-return cycle, makes this migration a very high investment for an operator and/or manufacturer to incur alone.

The combination of the above constraints generates, at the current stage, a cyclic impasse, whereby the developer cannot deploy without a field trial, and the recipient cannot support the field trial alone.

These constraints are understandable in the light of the evolution in large common infrastructures, used by the public community today. As with the railways, bridges, or telephone systems, these infrastructural progresses are very broad in scope, and therefore not wholly containable in the laboratory. Also, having wide communities as potential recipients, these projects need to be born out of partnerships between the scientific community, the manufacturers, the operators, and the governments, on behalf of the common welfare.

Recommendation – As one efficient way to pool expertise and benefit from collective test beds, it is encouraged to support the setting up of interoperability events in particular organized by a neutral organization such as those organized by ETSI and supported by the eEurope initiative. These events are an opportunity for engineers from competing organizations to meet together in a commercially secure environment, to share experiences and improve interoperability between their implementations.

3.2.2. Home environments (including white goods, etc.)

Home and industry automation (including white goods, security devices, alarm/surveillance systems, entertainment devices), should be able to take advantage of features such as the massive address space, ease of plug and play, and the end-to-end connectivity offered by IPv6 to offer new services and applications. ADSL and wireless networks are examples of technologies that will enable advanced home networking, which in turn will increase the need for IPv6. At present most homes have at most one IP-enabled device (a PC), and that does not always need to be globally addressable. As users begin to demand access to devices in their homes (e.g. webcams, document and image/video servers, programmable white goods, etc), global, static IP addresses (and associated names) will be required. Equipment manufactures in this area need large scale trial networks to test their emerging devices.

3.2.3. Security Products

Security related applications, like basic transactions, as well as complex E-commerce applications will greatly benefit from the IP6 security mechanisms. These procedures and devices once again need trial networks to prove, in practice, they work, interoperate etc.

Recommendation – It is recommended to perform trials that show the benefits of IP security in IPv6. One of the main hurdles of widely used IP security is the lack of a functional Public Key Infrastructure (PKI). It is therefore recommended to the EU, European Governments and Industry to start trials with IP security in IPv6 and the parallel implementation of a PKI.

3.2.4. Automotive Platforms

The car is an area where IPv6 could bring a revolution. It is however a technically very challenging environment, being very cost sensitive, hostile in terms of temperature, vibration etc and, of course, mobile. Trial networks are essential for long term tests to be performed on automotive platforms.

3.2.5. Aviation Equipment

The EU has made a statement and produced a paper about the idea of a single European sky. But in Europe there are many different players in the aviation business operating different systems and procedures, change is slow because of safety and security concerns when updating equipment.

This is set against a background of ever increasing air travel and the inherent delays that this is causing. The following are some of the issues facing the single European sky idea:

- For the concept of a Single European Sky to be implemented the air frame manufactures and air lines need to update their equipment.

- Networking and communications will play a vital role in this. In fact airlines are independently looking at some of this for maintenance reasons. However for Air Traffic Management to improve, communications needs to be enhanced. This will also facilitate new ideas and methods for managing the air space, distributing work load etc.

- The main issue is safety and security. Secure transmission of data will always be an issue and guaranteed delivery of data - no denial of service - is another security point. QoS will play a role in it, too.

- Mobile ad-hoc networks using group communication (multicast). This is important because the idea is that aircraft could communicate within a cell area for certain navigation information. These networks being created as aircraft join and leave the area.

- Security in group communication in a mobile environment. The ATC centre will need to perform group communication and be sure of a secure delivery and not tampered with. Also Airlines may wish to send eminence information to their fleet and vice versa which must not be tampered with as it will have safety issues. e.g. engine data, aircraft performance in certain weather conditions

- Quality of Service: What is QoS and can QoS be changed depending on the changing networking environments, e.g from high bandwidth networks to low bandwidth ones. Applications being notified of these changes instead of just hanging.

- Share communication form passenger, air line operational data and ATC data will all have different levels of priority. But could, in certain circumstances, the maintenance information - if related to safety - take precedence over ATC data.

- Reliable Multicasting with security in a mobile environment with a changing sub network. Guaranteeing group communication if an aircraft moves to a low bandwidth environment.

- Peer to peer communication in a mobile environment. Not having to use a ground station. Aircraft communicating with each other in a less dense environment with poor connection to the ground e.g over the Pacific or Atlantic. Messages could be routed to aircraft where there is no coverage via an aircraft that has coverage.

There is a large number of issues here that although mentioned in relationship to the aviation manufactures have a lot in common with other areas, all these features need to be tried and proven on large scale trial networks.

3.3. Network Trials

In the previous sections dealing with vendor trials several different equipment manufacturing segments have been discussed and many requirements for large scale network trials identified. Without these network trials the equipment manufactures have nowhere to prove practically their equipment - this is the first requirement for network trials. The other is for the commercial organisations that will deploy IPv6 in all areas (core, access, home, mobile, enterprise etc) to gain experience of the technology in terms of deployment, technical and architectural issues, management, interoperability, peering and billing. The ISP and UMTS areas are discussed in slightly more detail below but the other areas of Internet Exchanges, Corporate networks, backbone providers, home networks etc are equally important.

3.3.1. Internet Service Providers

For IPv6 to be ubiquitously available Internet Service Providers will have to embrace the technology and invest heavily in their infrastructures to provide IPv6 support and interworking between IPv6 and IPv4. The large scale deployment of IPv6 is not a simple task and covers many areas:

- Access – dial, xDSL, AAA, DNS
- Core – tunneling, MPLS, dual stack, routing protocols
- Features – Security, QoS, Multicast
- Operational support systems (OSS) – massive area
- Interworking of devices, applications and services with IPv6 and between IPv6/IPv4
- Address allocation and its potential architectural implications
- Mobility – Mobile IPv6

The telecommunications industry globally is currently in a depressed state and hence commercial organisations are finding it difficult in invest in technologies and trials where the “pay back” is several years. For IPv6 to be successfully deployed it is essential that these commercial organisation are involved in the network trials. Currently the existing EU sponsorship favours academic organisation with 100% funding whereas commercial organisation get 50% and are often asked/obliged to provide interconnection bandwidth either free or below cost. Increasing the level of funding to 100% for commercial organisation would encourage them to actively take part in network trials and hence speed the deployment of IPv6 in Europe. Of course 100% funding is only cost recovery and hence may still not attract overwhelming participation.

Recommendation - To stimulate the involvement of commercial organisations in the network trials area the EU, the national governments and industrial institutions should investigate and support new ways to facilitate network trials, like increasing funding levels in projects with high network requirements, and support for smooth transitions from successful pre-commercial trials to full commercial operations. Particularly Small and Medium Enterprises (SME) should be encouraged to step in the IPv6 area by actively participating in trials to support their transition towards IPv6.

3.3.2. UMTS Mobile Operators

UMTS (3G) is an area where IPv6 has been specified as a requirement (3GPP Rel. 5 for the IM Domain). Many of the issues that will face the mobile operators when they introduce IPv6 are the same as those facing the fixed operator except that mobility brings in the extra constraint of limited bandwidth that is expensive and error prone. Some of the issues are:

- Mobile IP advantages/disadvantages of the use of mobile IPv6 within the Network
- Interworking between IPv6 and IPv4 parts of the network and to other networks. How to deal with IPv4 only terminals, i.e. with IPv4 addresses, in an IPv6 network.
- QoS issues - general and e.g. when tunnelling IPv6 over IPv4
- Issues related to IPv6 minimum header size and air interface.
- Interoperability within 3G Network – ISP – Fixed Network (IPv4/IPv6).
- Mobile Services: IPv6 Server (Mobile portals, Web, DNS, DHCP), Multimedia services (focusing on Streaming and Conversational QoS on IPv6), etc.
- Application: Portability from IPv4 to IPv6.

Once again commercial organisations and operators need to be actively involved as proposed above.

3.3.3. Transition Strategies

The transition between, and integration of, IPv4 and IPv6 will be a special challenge for network operators and service providers, as well as for corporate networks and private users. Ideally the non-technical Internet user should not recognise the transition as such, but this will not happen by itself. Several transition mechanisms and tools are developed by the IETF, but the appropriate usage of these tools will be of high importance for the transition period. Some strategies, for example in ISP environments have been investigated but it is proposed to investigate other areas, like Intranets, Internet dialup users and the whole application and services are.

Recommendation – A special effort should be taken by the EU, national governments and industry to simplify the transition from IPv4 to IPv6 as much as possible, so transition cost, time and know-how should be minimal for regular users, which will, in turn, accelerate the transition from IPv4 to IPv6. Trial activities should be started with a special focus to ease the transition from IPv4 to IPv6.

3.4. Service Trials

Services generate the revenue that will drive further investment and hence this is a critical area. Currently activity in this area is light, the companion applications report from the IPv6 task force is providing further information on IPv6 application development.

The raw development of applications are very important in the IPv6 area but the combination and interaction of the applications with each other and with the features and functionality of the network provide the user with added value services. It is this service trials area that will investigate and prove via large scale deployment on top of the network trials these complete services.

A couple of service trial areas are outlined below.

3.4.1. Pan European University Wireless Trials

Services driven by IPv6 mobility in the wireless environment are an important market that needs to be tested and evaluated. One area where these services could be tested is via trials on the Campus of different universities. University students (young people) and their teachers are early adopters of innovative technologies and would provide an idea environment to fully test and evaluate any services. The trial could be across many universities in Europe and could have a considerable user base (potentially millions of students in Europe).

The topics and issues that this large scale service trial could address are:

- IPv6 applications
- Mobile IPv6
- Security
- Wireless (WLAN)
- QoS
- Authentication, Authorization and Accounting
- Ad-hoc connectivity in hot spot networks
- Terminals (PDA's, PC's etc)

This would be a major initiative using a community of people that are willing to use the latest technology, it would involve applications, services as well as mobile and fixed network trials.

Recommendation – Instigate an initiative to trial wireless IPv6 applications and services in a Pan European University Wireless Trial.

3.4.2. IP-Telephony

Currently the majority of voice traffic is circuit switched, predictions are that this will move to the IP domain within the next few years. Within the UMTS environment, as well as in the circuit switched

environment, voice traffic in the IP domain will be carried via IPv6 and use the SIP protocol. People's expectations of a "voice telephone call" and the characteristics of voice traffic are demanding for IP, i.e. people expect a black and white quality of service i.e. you get busy tone or you get good speech quality (though it is interesting to note that cellular quality is seen by many as a trade-off for convenience, if the price is right). Technical parameters (objective parameters) that are necessary to meet those expectations include:

- delay
- jitter (variation in delay)
- lost/misordered packets.

The above list includes only some of the issues that need to be investigated, for example the interworking IPv4/IPv6, IPv6/PSTN and SIP/H323 also need investigation.

Voice is such a fundamental part of any future network that special facilities should be put in place to encourage investigation and trialling. VoIP is projected to reach a high penetration by 2010 and a different naming scheme (e.g. ENUM) could be used to replace or complement traditional phone numbers especially as large countries may be running out of phone numbers by that time by that time. It is not recommended that users get an "IPv6 address for life"; rather they should have expectation of the use of *a* global IPv6 address.

Recommendation – Investigate the adoption of facilities to encourage the research, development and trialling of VoIPv6. In view of wider deployment of VoIP by 2005, European telecom vendors are encouraged to develop dual stack SIP phones by 2003 and perform related trials.

3.4.3. Entertainment

Within the home there is a proliferations of intelligent entertainment devices, e.g. set top boxes, games consoles, etc. The significant benefits of IPv6 networking to these devices and the services they offer should be investigated and trialled. It is felt that the entertainment market could be a significant driver for the introduction of IPv6 into the home; in addition to peer-to-peer gaming (which can reduce server overhead costs for game companies) console devices could be used for messaging. This is just one example of (end-to-end) service convergence that is enabled by IPv6.

3.5. Framework Co-ordination

If the benefits of the IPv6 trial framework are to be realised it needs a body/organisation to support it. This body would be responsible for the co-ordination of all the activities that fall within the framework, in particular:

- **Research Gaps**

  One of the great benefits of having a co-ordinated approach to the IPv6 trials area is that duplication and gaps can be identified and recommendations made to enable IPv6 to reach a stage for commercial deployment earlier than would otherwise be the case.

- **Standards**

  The various trials activities will almost certainly identify areas where the current standards are either inappropriate or missing a "piece" for large scale deployment. The framework co-ordination body can bring together all these standards related issues and suggest how, at a European level, they can be tackled in an appropriate and timely manner. It is felt that this may involve a change to the current EU project structure because projects between interested parties need to be established very quickly in some cases to address these standards related issues promptly.

- **Roadmaps**

  It is felt that the production of the roadmaps in the areas of equipment, networks and services will be a very significant source of information that will enable IPv6 to be ready for commercialisation early than otherwise. It will be the responsibility of the framework co-ordination body to co-ordinate the production of these roadmaps.

Recommendation – Establish a co-ordination body to oversee the IPv6 trials framework.

Recommendation – Investigate ways to establish rapidly projects to address standards related issues.

4. Summary and List of Recommendations

This document outlines an IPv6 trials framework and discusses the various testbeds, trials and roadmaps that makeup the framework. The advantages of the framework are highlighted in terms of making IPv6 ready for commercialisation earlier. This is achieved by a combination of encouraging trials in a number of areas, being able to identify early trial gaps and providing a comprehensive set of roadmaps that will stimulate industry. Specific recommendations are made to enable this to happen:

Recommendation - Develop roadmaps for the introduction and deployment of IPv6 services, equipment and networks. A systematic approach should be taken to analyse and identify areas that need special attention for an efficient introduction of IPv6, particularly with the help of trials. These roadmaps will help to identify missing areas for trial activities that could be catalysed by the EU, national governments and industry fora. The production of these roadmaps is essential for the timely deployment of IPv6 in Europe and beyond.

Recommendation – Publicise existing collaborative funding opportunities and projects with the aim of encouraging more IPv6 activities. The EU, European Governments and Industry fora should raise awareness in their area of influence for the upcoming infrastructure improvements towards IPv6 and the benefits to participate in trial activities from a very earl point in time, to gain a competitive position in the Next Generation Internet.

Recommendation – As one efficient way to pool expertise and benefit from collective test beds, it is encouraged to support the setting up of interoperability events in particular organized by a neutral organization such as those organized by ETSI and supported by the eEurope initiative. These events are an opportunity for engineers from competing organizations to meet together in a commercially secure environment, to share experiences and improve interoperability between their implementations.

Recommendation – It is recommended to perform trials that show the benefits of IP security in IPv6. One of the main hurdles of widely used IP security is the lack of a functional Public Key Infrastructure (PKI). It is therefore recommended to the EU, European Governments and Industry to start trials with IP security in IPv6 and the parallel implementation of a PKI.

Recommendation - To stimulate the involvement of commercial organisations in the network trials area the EU, the national governments and industrial institutions should investigate and support new ways to facilitate network trials, like increasing funding levels in projects with high network requirements, and support for smooth transitions from successful pre-commercial trials to full commercial operations. Particularly Small and Medium Enterprises (SME) should be encouraged to step in the IPv6 area by actively participating in trials to support their transition towards IPv6.

Recommendation – A special effort should be taken by the EU, national governments and industry to simplify the transition from IPv4 to IPv6 as much as possible, so transition cost, time and know-how should be minimal for regular users, which will, in turn, accelerate the transition from IPv4 to IPv6.

Recommendation – Instigate an initiative to trial wireless IPv6 applications and services in a Pan European University Wireless Trial.

Recommendation – Investigate the adoption of facilities to encourage the research, development and trialling of VoIPv6. In view of wider deployment of VoIP by 2005, European telecom vendors are encouraged to develop dual stack SIP phones by 2003 and perform related trials.

Recommendation – Establish a co-ordination body to oversee the IPv6 trials framework.

Recommendation – Investigate ways to establish rapidly projects to address standards related issues.

Recommendation – IPv6 is a worldwide protocol and hence the early introduction of IPv6 in Europe needs to co-ordination and take account of similar initiative around the world. European trials need to link and be co-ordinated with other initiatives around the world.

5. Annex A: Selected IPv6 Projects in the European Commission IST programme

6INIT (http://www.6init.org)

6NET (http://www.6net.org)

6WINIT (http://www.6winit.org)

6LINK (http://www.6link.org/)

Euro6IX (http://www.euro6ix.org)

GTPv6 (http://www.ipv6.ac.uk/gtpv6)

NGNI (http://www.ngni.org)

6. Annex B: Selection of other IPv6 projects in Europe

Eurescom Armstrong (http://www.eurescom.de)

Eurescom Tsunami (http://www.eurescom.de)

@IRS (http://www-rp.lip6.fr/airs)

List of UK IPv6-powered sites (http://www.ipv6.org.uk)

JOIN (http://www.join.uni-muenster.de/welcome-e.html)

Bermuda 2 (http://www.ipv6.ac.uk/bermuda2/)