Action Plan for the development of Internet protocol version 6 (IPv6) in Luxembourg

LUXEMBOURG IPv6 DEPLOYMENT ROADMAP

IPv6 Luxembourg Council

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Content

1 OBJECTIVE

The objective of this Action Plan is to propose practical recommendations to support the widespread introduction of the next version of the Internet Protocol (IPv6) in line with the European Commission Communication published on May 2008:

- timely implementation of IPv6 as the pool of IP addresses provided by the current protocol version 4 is being depleted down to just 13% by 2010.

- IPv6 with its huge address space provides a platform for innovation in IP based services and applications,

- maintain and improve Luxembourg´s leadership position in the New Internet Economy sustaining its competitiveness in the global economy,

- set the stage for viral innovations and future Internet content and services based on two-way and interactive Internet paradigm,

- stimulate end-user interest in view of a new Internet experience,

- prepare the Internet of end users, peer to peer in an independent setting,

- get the ecological effect by controlling home appliances, heating and air-conditioning in an intelligent and ubiquitous framework.

2 RATIONALE FOR ACTION

2.1 Preparing for the growth in Internet usage and for future innovation

One specific element of the Internet architecture is the "Internet Protocol" (IP) which in essence assigns any router, server, hosts or simple Internet devices (such as mobile Internet phone or sensors and RFID devices) connecting to the Internet a number, an address (162.168.1.1), so that it can communicate with other similar devices.

This address should be unique, to ensure global connectivity. The current version, IPv4, provides for just 4.3 billion such addresses. However the remaining address space is down to just 560 M IP addresses or 13% as of January 2009. The address space has become a scarce resource and will not be enough to sustain with the continuing growth of the Internet. Being aware of this long-term problem the Internet community developed an upgraded protocol, IPv6, which has been gradually deployed since the late 90s.

In a previous Communication on IPv6, the European Commission made the case for the early adoption of this protocol. This Communication has been successful in establishing IPv6 Task Forces4, enabling IPv6 on research networks, supporting standards, and setting-up training actions. Following the Communication more than 30 European R&D projects related to IPv6 were financed. Europe has now a large pool of experts with experience in IPv6 deployment. Yet despite the progress made, adoption of the new protocol has remained slow while the issue of future IP address scarcity is becoming more urgent.

Luxembourg enjoys one the highest Internet penetrations in Europe with a high growth rate from 2000 to 2007. The Internet population is about 345 K with 71 % penetration way over the European average of 43% (http://www.internetworldstats.com/stats4.htm#europe).

It is therefore well placed to become also in the coming years one of the leaders in the IPv6-area. The time has come to take concrete steps in that direction. In doing so, it can rely on practical experiences that date back as far as 2004. At the time, LtCol Carlo Simon had indeed a real vision and technical case in designing a national resilient and redundant Alert and Warning system to prevent large-scale catastrophes. This project, known as u2010, is designed to research and bring new technologies into play to design a redundant, low cost, scalable system to survive and cater for small and major disasters. The u2010 project had a very beneficial impact in terms of introduction of IPv6 in Luxembourg with some real viral applications, especially in starting a network on the fly and using any technology that survived a major disaster or where mobility and redundancy are the essence with Satellite as the prime candidate.

Two strategic Internet services providers are partners of the u2010 project: EPT and SES-ASTRA. EPT has recently tested IPv6 in the project with great success for very good use for the Luxembourg Internet community and EPT has plans to announce IPv6 service in the foreseeable future. SES ASTRA has participated in the same IPv6 tests in u2010 and the use of IPv6 in the satellite service has been demonstrated quite successfully during the ING Marathon together with HITEC. HITEC introduced a mobile SAT station called NoSaCo using ASTRA2Connect and IPv6 and the test were conclusive that IPv6 brings something that IPv4 cannot resolve.

It is also good to note that EuroDNS based in Luxembourg has already implemented IPv6 for a couple of years now, which is excellent especially it offers .eu using IPv6. LIX has not yet implemented IPv6. The LuxConnect is a good opportunity to offer IPv6 service as a competitive advantage.

The other organisations that have IPv6 prefixes and have not yet activated it are DCLux, Visual Online, Netline, Root eSolutions, Broadcasting Center Europe, CEGECOM and Vicus. The last 3 however have applied for IPv6 in 2008 which is promising.

All this indicates that Luxembourg has a very good IPv6 engineering community testing IPv6. If the various organisations mentioned above could turn on IPv6 by the end of 2009, then Luxembourg would be in very good shape.

Recommendation: Creation of the Luxembourg IPv6 Council

It is recommended that these organisations (as well as Comité National des Télécommunications (CONATEL) members) should be asked to become members of the Luxembourg IPv6 Council to come to a consensus and adopt this draft Luxembourg IPv6 roadmap with immediate milestone by beginning of 2009 and then build the momentum to get to the 25% penetration in using IPv6 by 2010.

It goes without saying that other relevant actors will be in position to join the Council at later stage.

2.2 Maintaining and improving Luxembourg's competitiveness

It is now time to take further actions. Otherwise there is a risk that many actors will not be prepared in time to keep pace with an accelerating deployment of IPv6. Taking no action could also lead to a further delay of IPv6 adoption with disadvantages for all users and a weaker competitive position of Luxembourg's industry.

This roadmap paper analyses the present-day situation and sets out a number of actions to achieve widespread IPv6 implementation in Luxembourg by 2010.

2.3 Contributing to the Lisbon Strategy

This Action Plan is part of the Lisbon Strategy as implemented in the i2010 initiative. It will contribute to the assessment of the performance of the EU in the Internet economy and its readiness to face future challenges foreseen for the Spring Council in 2009.

3 THE CURRENT SITUATION

3.1 Increasing scarcity of IPv4 addresses: a difficulty for users, an obstacle to Innovation

Initially all Internet addresses are effectively held by the "Internet Assigned Numbers Authority" (IANA) and then large blocks of addresses are allocated to the five Regional Internet Registries (RIRs), which in turn allocate them in smaller blocks to those who need them, including Internet Service Providers (ISPs). The allocation, from IANA to RIR to ISP, is carried out on the basis of demonstrated need: there is no pre-allocation.

The address space of IPv4 has been used up to a considerable extent. At the end of June 2008 about 15% was left in the IANA pool, i.e. approximately 600 million IPv4 addresses. There are widely quoted and regularly updated estimates which forecast the exhaustion of the unallocated IANA pool somewhere between 2010 and 2011. New end-users will still be able to get addresses from their ISP for some time after these dates but with increasing difficulty.

Even when IPv4 addresses can no longer be allocated by IANA or the RIRs the Internet will not stop working: the addresses already assigned can and will be used for a significant time to come. Yet the growth and also the capacity for innovation in IP-based networks would be hindered without an appropriate solution.

Luxembourg has 377 K IPv4 addresses, with less than one IP address (0.8) per Luxembourg citizen while the US has received over 1.4 B IPv4 addresses extending 5 IP address per US citizen. China has been given recently a larger chunk of IPv4 addresses of 155 M over the past couple of years though it is still 0.1% or 0,001 per capita. http://www.bgpexpert.com/addressespercountry.php

A limited number of new IPv4 addresses can be obtained until the RIPE pool dries out by 2010.

How to deal with this transition is currently the subject of discussion in the Internet community in general, and within and amongst the RIR communities in particular. All RIRs have recently issued public statements and have urged the adoption of IPv6.

3.2 IPv4 is only a short term solution leading to more complexity

Concerns about the future scarcity of IP addresses are not a recent phenomenon. In the early days of the Internet, before the establishment of the RIRs and before the take-off of the World-Wide Web, addresses were assigned rather generously. By 1990, almost 50% were handed out. There was a danger of running out of addresses very quickly. Therefore changes in allocation policy and in technology were introduced which allowed allocation to be more aligned to actual need.

One key IPv4 technology has been "Network Address Translation" (NAT). NATs connect a private (home or corporate) network which uses private addresses to the public Internet where a single public IP address is required. Private addresses are blocks of addresses (3 blocks of addresses: 10, 172, 192) reserved for that purpose. The NAT router acts as a gateway between the private network and the public Internet by translating the private addresses into a single public address. This method therefore reduces consumption of IPv4 addresses.

However the usage of NATs has two main drawbacks, namely:

- It hinders direct end-device-to-end-device communication: intermediate NAT routers are required to all hosts or devices with private addresses to communicate across the public Internet. This also stops incoming devices calls disallowing two-way communication.
- It adds a layer of complexity in that there are effectively two distinct classes of computers: those with a public address and those with a private address. This often increases costs for the design and maintenance of networks as well as for the development of applications.

Some other measures could extend the availability of IPv4 addresses. A market to trade IPv4 addresses might emerge which would offer incentives to organisations to sell addresses they are not using. However IP addresses are not strictly property.

They need to be globally acceptable to be globally routable which a seller cannot always guarantee. In addition they could become a highly priced resource. So far RIRs have been skeptical about the emergence of such a secondary market.

Another option consists of trying to actively reclaim those already-allocated address blocks that are under-utilised. However, there is no apparent mechanism for enforcing the return of such addresses. The possible cost of it has to be balanced against the additional lifetime this would bring to the IANA pool. There is a clear indication that no new address blocks could be claimed back.

Though such measures may provide some interim respite, sooner or later the demand for IP addresses will be too large to be satisfied by the global IPv4 space. Efforts to stay with IPv4 too long risk increasing unnecessary complexity and fragmentation of the global Internet. A timely introduction of IPv6 is thus the better strategy.

3.3 IPv6: the best way forward

IPv6 provides a straightforward and long term solution to the address space problem.

The number of addresses defined by the IPv6 protocol is huge. IPv6 allows every citizen, every network operator (including those moving to all IP-"Next Generation Networks"), and every organisation in the world to have as many IP addresses as they need to connect every conceivable router, host, network and devices directly to the global Internet.

IPv6 was also designed to facilitate features which were not tightly designed in IPv4. Those features included enhanced quality of service, auto-configuration, end-to-end security, built-in multicast and mobility and another two dozens of features too technical to list in this paper. Redundancy regarding network access: As end user I may connect my appliances on any internet enabled network and being back in the game on the fly.

In the meantime, however, some of those features have been re-engineered in and around the original v4 protocol. Indeed, the perception that it's the large address space is the only issue that makes IPv6 attractive for future applications as this will simplify their design compared to IPv4. This perception has been cultivated by IPv4 and NAT sustaining engineers.

The benefits of IPv6 are, therefore, most obviously apparent whenever a large number of devices need to be easily networked, and made potentially visible and directly reachable over the Internet. A study funded by the Commission shows this potential for a number of market sectors such as home networks, building management, mobile communication, defence and security sector, and car industry.

Prompt and efficient adoption of IPv6 offers Luxembourg potential for innovation and leadership in advancing the Internet. Other regions, in particular the Asian region, have already taken a strong interest in IPv6. For instance the Japanese consumer electronics industry increasingly develops IP enabled products and exclusively for IPv6. The Luxembourg industry should therefore be ready to meet future demand for IPv6-based services, applications, and devices and so secure a competitive advantage in world markets.

To conclude, the key advantage of IPv6 over IPv4 is the huge, more easily managed address space. This solves the future problem of address availability now and for a long time to come. It provides a basis for innovation - developing and deploying services and applications which may be too complicated, too unreliable or too costly in an IPv4 environment. It also empowers users, allowing them to have their own network connected to the Internet.

3.4 What needs to be done?

IPv6 is not directly interoperable with IPv4. IPv6 and IPv4 devices can only communicate with each other using translation gateways. They do not provide a general future-proof solution for transparent interoperability. However IPv6 can be enabled in parallel with IPv4 on the same device and on the same physical network. There will be a transition phase expected to last for 10, 20 or even more years) when IPv4 and IPv6 will co-exist on the same machines (technically often referred to as "dual stack") and be transmitted over the same network links. In addition other standards and technologies (technically referred to as "tunnelling") allow IPv6 packets to be transmitted using IPv4 addressing and routing mechanisms and ultimately vice versa. This provides the technical basis for the step-by-step introduction of IPv6.

Because of the universal character of the Internet Protocol, deployment of IPv6 requires the attention of many actors worldwide. The relevant stakeholders in this process are:

- Internet organisations (such as ICANN, RIRs, and IETF), which need to manage common IPv6 resources and services (allocate IPv6 addresses, operate domain name system (DNS) servers, etc), and continue to develop needed standards and specifications.

As of May 2008 the regional distribution of allocated IPv6 addresses is concentrated in Europe (RIPE: 49 %) with Luxembourg leading, and Asia and North-America growing fast (APNIC: 24 %, ARIN: 20%). Less than half of those addresses are currently being announced on the public Internet (i.e. visible in the default-free routing table).

In the DNS the root and top-level name servers are increasingly becoming IPv6 enabled. For instance, the gradual introduction of IPv6 connectivity to .eu name servers has begun in 2008.

- ISPs, which need over time to offer IPv6 connectivity and IPv6 based services to customers.

There is evidence that less than half of the ISPs offer some kind of IPv6 interconnectivity. Only a few ISPs have a standard offer for IPv6 customer access service (mainly for business users) and provide IPv6 addresses. The percentage of "Autonomous Systems" (typically ISPs and large end-users) that operate IPv6 is estimated at 2.5%.

Accordingly, IPv6 traffic seems to be relatively low. Typically the IPv6/v4 ratio is less than 0.1% at Internet Exchange Points (of which about one in five supports IPv6). However, this omits direct ISP to ISP traffic and IPv6 which is "tunnelled" and so appears at first glance to be still IPv4. Recent measurements suggest that this kind of traffic IPv6 which is "tunnelled" is growing.

- Infrastructure vendors (such as network equipment, operating systems, network application software), which need to integrate IPv6 capability into their products.

Many equipment and software vendors have upgraded their products to include IPv6. However there are still issues with certain functions and performance, and vendor support equivalent to IPv4. The installed equipment base of consumers, such as small routers and home modems to access the Internet, still by and large do not yet support IPv6.

- Content and service providers (such as websites, instant messaging, e-mail, file sharing, voice over IP), which need to be reachable by IPv6 on their servers.

Worldwide there are only very few IPv6 websites. Almost none of the global top sites offer an IPv6 version. The de-facto non-existence of IPv6 reachable content and services on the Internet is a major obstacle in the take-up of the new protocol.

- Business and consumer application vendors (such as business software, smart cards, peer-to-peer software, transport systems, sensor networks), which need to ensure that their solutions are IPv6 compatible and increasingly need to develop products and offer services that take advantage of IPv6 features.

Today there are few if any current applications that are exclusively built on IPv6.

One expectation has been that proliferation of IP as the dominant network protocol would drive IPv6 into new areas such as logistics and traffic management, mobile communication, and environment monitoring which has not taken place to any significant degree yet.

Many home end-users, without being aware of it, operate IPv6 capable equipment and yet as a result of missing applications without necessarily making use of it. Companies and public administrations are cautious to make changes to a functioning network without a clear need. Therefore there is not much user deployment in private networks visible. Among the early adopters have been universities and research institutions.

All EU national research and education networks also operate on IPv6. The European Géant network and the Luxembourg RESTENA are IPv6 enabled, whereby approximately 1% of its traffic is native IPv6.

How much and which efforts are required to adopt IPv6 differ amongst actors and depend on each individual case. Therefore it is practically impossible to reliably estimate the aggregated costs to introduce IPv6 globally. Experience and learning from projects have shown that costs can be kept under control when deployment is gradual and planned ahead. It is recommended introducing IPv6 step-by-step, possibly in connection with hardware and software upgrades, organisational changes, and training measures (at first glance unrelated to IPv6). This requires a general awareness within the organisation in order not to miss those synergies. The costs will be significantly higher when IPv6 is introduced as a separate project and under time constraints.

Introduction of IPv6 will take place alongside the existing IPv4 networks. Standards and technology allow for a steady incremental adoption of IPv6 by the various stakeholders which will help to keep costs under control. Users can use IPv6 applications and generate IPv6 traffic without waiting for their ISP to offer IPv6 connectivity. ISPs can increase their IPv6 capability and offer this in line with perceived demand.

3.5 The need for policy driving at Luxembourg level

Today, for a number of stakeholders the advantages of adopting IPv6 are not immediately visible. The benefits are long-term and also depend on other stakeholder's decisions on when and how to implement IPv6.

The more users work with IPv6 the more attractive it becomes for others to do the same. As the number of users increases more products and services will be offered at lower prices and better quality. The collective knowledge about IPv6 operation and management will also increase. The result will be an eco-system of suppliers and service providers re-enforcing each other, boosting confidence, and accelerating deployment. However similar market forces apply to IPv4 where this eco-system has been in place for many years resulting in a large legacy of appliances and applications.

A collective movement to implement IPv6 is difficult to trigger as stakeholders cannot easily take into account others' decisions. There is no single authority to steer IPv6 introduction or to establish a co-ordinated master plan. Thus roll-out of IPv6 is largely a decentralised and market driven process on a global scale. In this situation many stakeholders have taken a "wait and see" position on IPv6 or opted for a "safe and known" IPv4 solution. The cumulative result has been the described delay in the widespread adoption of IPv6. This is a situation where appropriate policy measures could give a market stimulus by encouraging people and organisations to consider moving ahead positively. Those measures will be more effective when taken collectively at Luxembourg level.

4 ACTIONS: IPV6 TO BECOME WIDELY IMPLEMENTED IN LUXEMBOURG BY 2010

Luxembourg should set itself the objective that at least 25% of users should be able to connect to the IPv6 Internet and to access their most important content and service providers without noticing a major difference compared to IPv4.

4.1 Actions to stimulate IPv6 accessibility to content, services, and applications

- The Luxembourg IPv6 Council calls upon content and service providers to make their offer IPv6 accessible by 2010, amongst them the top 100 Luxembourg web sites. It intends to facilitate this co-operation through "Thematic Networks" involving vendors, ISPs, and content and service providers, as part of the Competitiveness and Innovation Programme (CIP).
- The Luxembourg IPv6 Council calls upon industrial stakeholders that are now embracing IP technology in their core business,
- to consider IPv6 as their primary platform for developing applications or appliances (such as sensors, cameras etc).
- The Luxembourg IPv6 Council calls upon the Luxembourg Government to enable IPv6 on public sector websites.
- The Luxembourg IPv6 Council calls for further standardization efforts.
- The Luxembourg IPv6 Council will encourage research projects funded by Framework Programme 7and facing a choice of computer network protocol, to utilise IPv6 whenever possible.

4.2 Actions to generate demand for IPv6 connectivity and products through public Procurement

In a public consultation the use of public procurement was identified as an efficient way to speed up the transition to IPv6. For example in 2005, the US Government directed all federal government agencies to migrate their core backbone networks to IPv6 by mid 2008.

- The Luxembourg Government should specify IPv6 capabilities as a core requirement for the continuous renewal cycle of its own network equipment and services. It will carry out timely and appropriate internal trials and projects to prepare for IPv6.
- The Luxembourg Government should apply for its own IPv6 prefix.

4.3 Actions to ensure timely preparation for IPv6 deployment

The transition to IPv6 will take some time and will require operating a dual IPv4/IPv6 network, bringing up specific issues to be resolved. All actors will need to prepare themselves for developing and deploying IPv6 compliant solutions; the sooner the better. Organisations should not wait for their ISPs to provide native IPv6 connectivity but should begin to enable the protocol on their own network.

- The Luxembourg IPv6 Council will undertake targeted awareness campaigns to various user groups.
- The Luxembourg IPv6 Council encourages ISPs to provide full IPv6 connectivity to their customers by 2010 and where applicable to upgrade the equipment they supply to consumers.
- The Luxembourg IPv6 Council supports the inclusion of IPv6 technology knowledge in relevant retraining curricula and in computer and network engineering courses of universities etc.

4.4 Actions to tackle security and privacy issues

Security issues in IPv6 are not better or worse than in IPv4, they are just different. In a dual IPv4/v6 environment security issues could become complex to deal with in terms of implementation and configuration.

The Court of Justice has recognised that an IP address may be considered as personal data falling within the scope of the Data Protection directives. Some concerns have been expressed about IPv6 and privacy, in particular by the Article 29 Data Protection Working Party.

- The Luxembourg IPv6 Council will disseminate best practices and will work with vendors to provide full IPv6 functionality.
- The Luxembourg IPv6 Council will monitor the privacy and security implications of widespread IPv6 deployment, in particular through consultation with stackholders such as data protection authorities or law enforcement.

5 EXECUTION OF THE ACTION PLAN

This Action Plan is scheduled to be executed over the next 3 years. The Luxembourg IPv6 Council will monitor the adoption of Pv6; in particular it will carry out an implementation test to measure the degree of IPv6 availability and functionality for users in Luxembourg.

- The Luxembourg IPv6 Council will continue to follow the activities of the Internet organisations, such as the ongoing debate about IPv4 distribution policies with in the registries communities, and where necessary make contributions.
- The Luxembourg IPv6 Council will regularly make available progress reports on its website and by other appropriate means.

IPv6 Council Luxembourg