



**FINAL REPORT OF  
“IPV6 APPLICATIONS AND SERVICES”**

**Advanced Network Applications Services and Technologies (ANAST)**

Presented to Canarie

by

Viagénie

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# 1. Description of Project and project results

IPv6 is the protocol that will replace IPv4 in the next few years. Our project has contributed to help Canadian industries and R&E community to access better IPv6 networks enhanced by many IPv6 services and applications.

- Strategic objectives of project.

This project contributed to Canarie mission by creating new network services of advanced Internet technology. The new services deployed are a major step for Canarie mission by providing on the edge infrastructure for R&E and industry.

Several partners worked with Viagénie and Canarie to develop these new IPv6 infrastructures and services. These organisations are ESnet (Energy and Science network in US), IPv6 Forum, CRC, 6INIT and Sun. The project wanted to place the Canada at the forefront of the Internet next generation and to keep Canarie's renown as one of the leading organisations on IPv6.

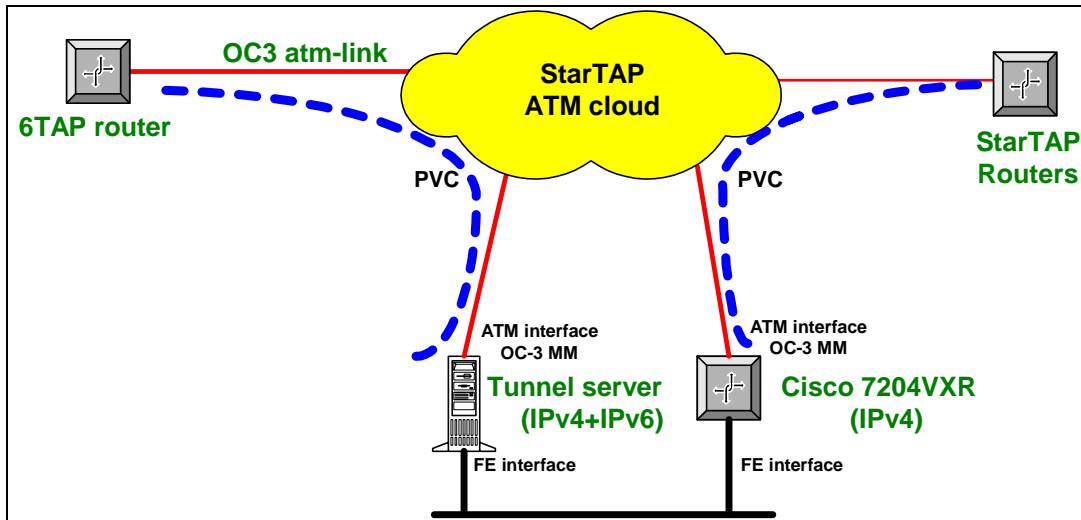
- Brief description of the project, outlining the development work undertaken and the innovative aspects of the deliverables.

In the long term, the main goal of IPv6 is to replace IPv4 because of some deficiency in the engineering of this protocol designed in the 70s. But replacing a world-wide protocol isn't an easy task because every IPv4 service must be moved on IPv6. To get IPv6 used by people, we worked on porting services and applications on IPv6, so the Internet community can use IPv6 in daily work and see that IPv6 will improve the use of the Internet.

During this transition time, IPv6 services must be deployed at large on the Internet to ensure organisations to slowly but steadily move their networks on the IPv6 protocol. It is why our project was based on giving services and applications usable on IPv6. The next part presents specific work done to accomplish these tasks.

## 1.1 IPv6 Exchange: 6TAP

With the coming of IPv6, providers and R&E networks need to exchange IPv6 traffic together, like in the IPv4 world where hundred of Internet exchanges are widely deployed. The first part of our IPv6 project consisted in designing and deploying an IPv6 exchange.

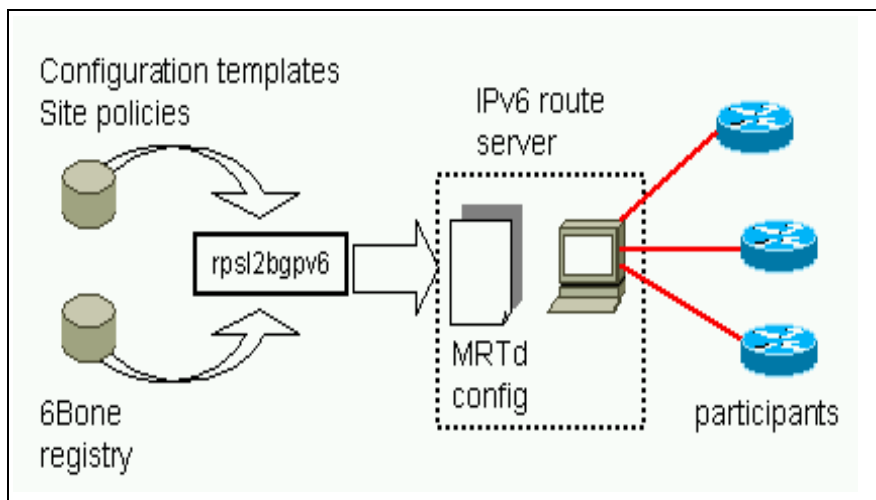


**Figure 1-1** The 6TAP made of routers, ATM links, IPv4 and IPv6 protocols

With our partner ESnet, we deployed an IPv6 exchange called the 6TAP at the StarTap (<http://www.startap.net/>), in Chicago, where numerous providers and R&E networks have presence. The 6TAP allows R&E networks with native IPv6 links to exchange IPv6 packets and routes between them. The 6TAP is made of IPv6 routers, servers, ATM links and IPv4 and IPv6 connectivity. In 2001, around 20 R&E networks are connected to the 6TAP. ESnet supports the 6TAP infrastructure on a 24/7 schedule.

## 1.2 IPv6 route server

An Internet exchange is a place where providers and R&E networks exchange their traffic using a routing protocol called BGP (Border Gateway Protocol). “Tier-1 providers” routers connected to those Internet Exchanges have to manage their own BGP routing policy and BGP peers with all other networks to be able to exchange traffic together. Therefore, on an Internet exchange where hundred of providers are present the number of BGP peers to manage equals  $n^{(n-1)}$  connections. Routing policies of the providers can be diversified; sometimes, this causes wrong routing policies that causes routing problem on routing table (“black hole”). To avoid these issues on IPv4, the route servers are deployed to extract and verify information from address registries. Then the route servers are able to build BGP peers and policies on behalf of all the providers of an Internet exchange. The number of BGP peers to manage with a routes server equals  $n-1$  instead of  $n^{(n-1)}$ . This also insures correct configuration of BGP routes by having a complete set of routes to be defined and configured.



**Figure 1-2** BGP peers between participants and an IPv6 route server

IPv6 is a new protocol: IPv6 exchanges are recent entities and route servers are not yet available on IPv6. We developed an experimental IPv6 route server compliant with RPSL standards (Routing Policy Specification Language) to enable scalable routing management for any IPv6 exchanges like the 6TAP. The route server was developed and integrated to the router software MRTd. The current RPSL language is defined for IPv4 and some basic extensions have been made for IPv6. However, RPSL for IPv6 is far from complete. During the course of this project, we proposed to the IETF and RIPE community a new version of the language, called RPSLng, which will also include provisions for Multicast routing and other novel use of BGP. Florent Parent is the chairperson of this working group and two drafts have been published to the IETF.

An Internet-draft has been proposed to IETF:

- *IPv6 Routing Policies using RPSL*, <http://www.normos.org/ietf/draft/draft-parent-rpsl-ipv6-00.txt>

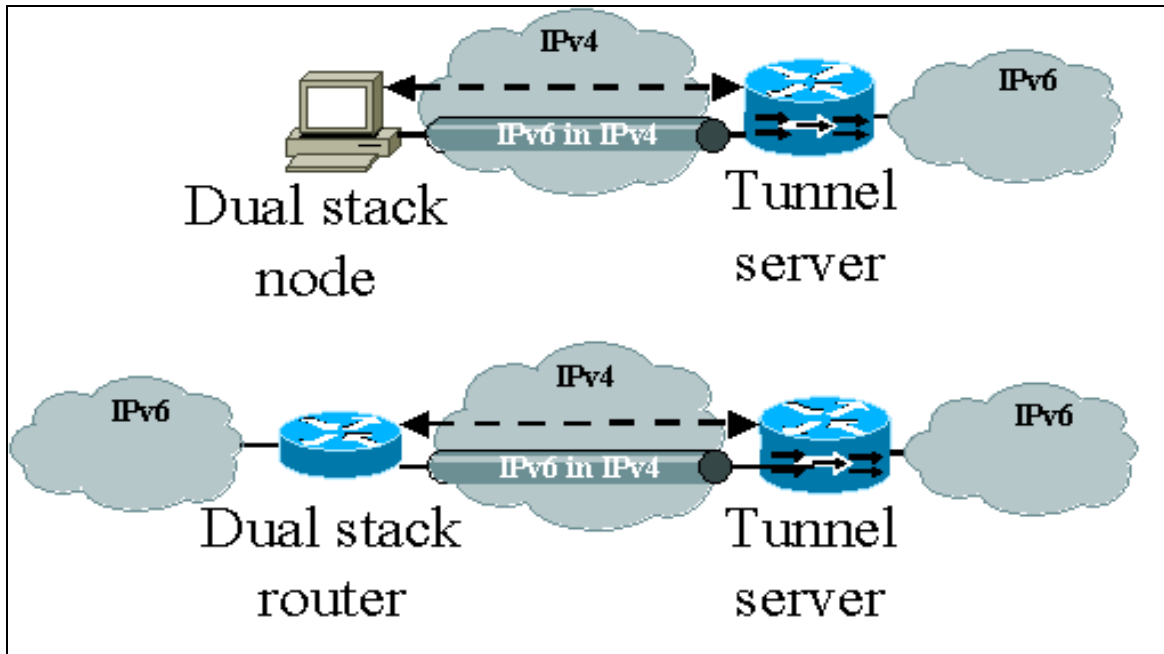
### 1.3 Tunnel Set-up Protocol for the Tunnel Server

The tunnel server and tunnel brokers are mechanisms of transition allowing IPv4 networks to move smoothly to IPv6. Tunnel servers and brokers are providing IPv6 connectivity over existing IPv4 networks to dual stack nodes (nodes that have both IPv6 and IPv4 stacks). However, these tunnel servers and tunnel broker technologies based on a Web interface do not scale and do not have interactivity with dual stack nodes. For example, if a node changes of IPv4 address or simply move to another network, its IPv6 connectivity is not listed: the tunnel server is not able to guess that the node has changed of IPv4 address.

The goal of this project was to design a signalling protocol between any dual stack nodes, dual stack routers and the tunnel server allowing a full interactivity between dual nodes and a tunnel server, so that the IPv6 tunnel could be established automatically without any user intervention and the tunnel would be kept running even if the IPv4 address change.

We developed the TSP (Tunnel Set-up Protocol). TSP adds a lot of new functionalities to the tunnel server technology. Dual stack nodes can be authenticated by the tunnel server, then a complete /48

prefix can be assigned instead of having only one IPv6 address. DNS delegation and broker mode with a Cisco router are also possible. This protocol brings also the scalability to the tunnel server mechanism.



**Figure 1-3** Dual stack nodes and routers get IPv6 connectivity from IPv6 networks using tunnel server

The tunnel server, the first in the world using a signalling protocol, can be used by anyone that has an IPv6 stack on the Internet at <http://www.freenet6.net/>. Client software (source and binary version) developed for Microsoft Windows NT, 2000 and XP, Solaris 8, Linux, FreeBSD, NetBSD, OpenBSD and Cisco can be downloaded from the site. The new service was put in production in June 2001. In December 2001, around 10 000 end-users used it. More than 1500 IPv6 prefixes (/48) have been delegated to end-users since June. This service is supported by Viagénie on a best effort basis.

Two Internet-drafts have been proposed to IETF about the TSP protocol:

- *IPv6 over IPv4 profile for Tunnel Setup Protocol*, <http://www.normos.org/ietf/draft/draft-vg-ngtrans-tsp-v6v4profile-00.txt>
- *Tunnel Setup protocol (TSP)*, <http://www.normos.org/ietf/draft/draft-vg-ngtrans-tsp-00.txt>

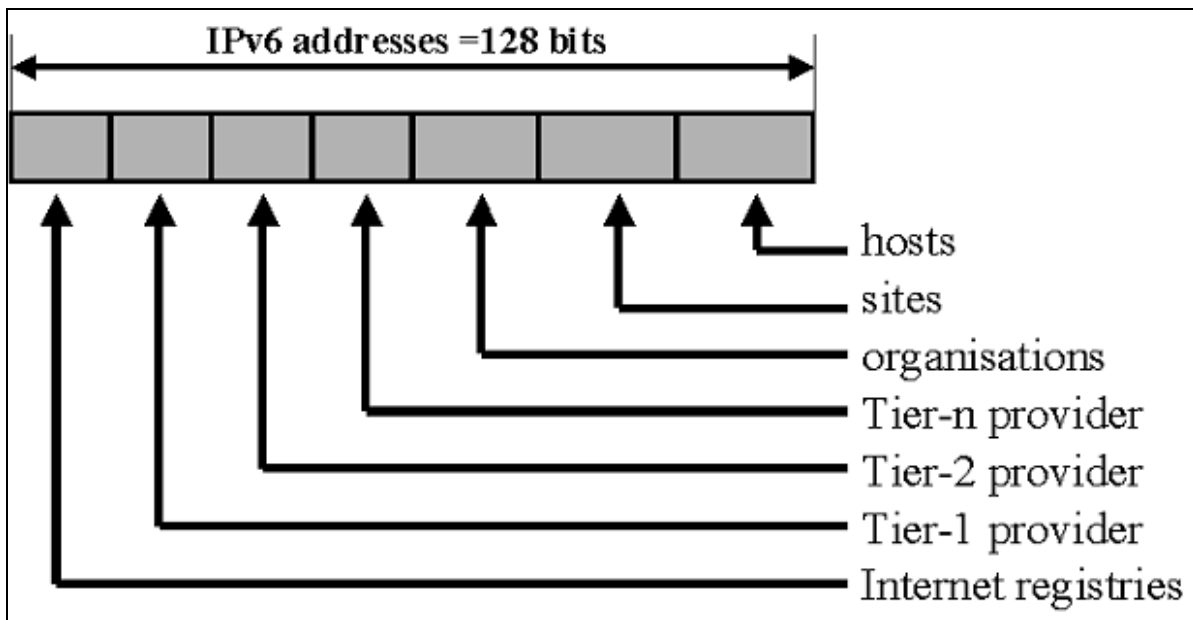
#### 1.4 IPv6 DNS root server

In the IPv4 world, there are only 13 DNS root servers serving all domains for the whole Internet. Prior to this IPv6 project, there was no DNS root server for IPv6. So, we deployed the first IPv6 DNS root server in the world for the 6bone and the IPv6 community. This experimental DNS root server runs in stealth mode to avoid any disruption of service in the IPv4 world.

This new service enables any name servers running over IPv6 to query DNS records using IPv6 protocol instead of IPv4 to reach the root zone. This server uses BIND software under Solaris 8 for Intel. Solaris 8 has an IPv6 implementation of IPv6. The service is supported by Viagenie on a best effort basis.

### 1.5 Sophisticated addressing method

In order to help providers and organizations to make their IPv6 addressing plan for their whole infrastructure, we designed a sophisticated addressing method. IPv6 has four times the number of bits than IPv4 has. This much larger address space allows multiple levels of addressing hierarchy. Any addressing plan must consider the hierarchy.



**Figure 1-4** Multiple levels of addressing hierarchy within an IPv6 address

We developed tools and applications to demonstrate the concept of this new method. The application is available at <http://www.viagenie.qc.ca/en/ipv6/allocation/index.shtml>

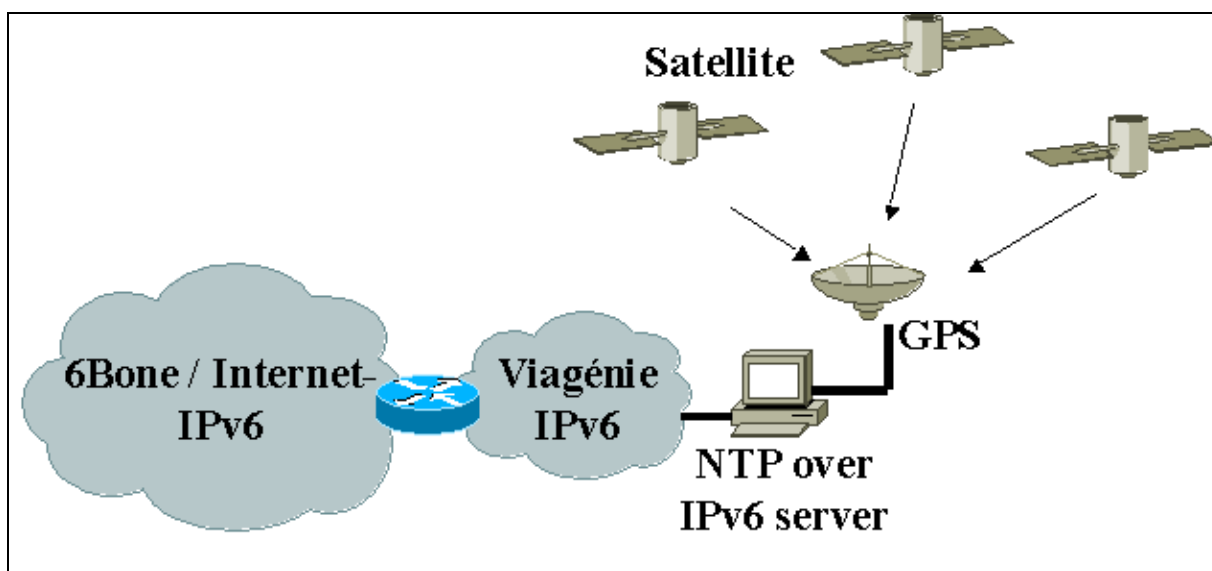
Several Internet-draft have been proposed to IETF regarding this method and other topics related to IPv6 addressing:

- *IPv6 Address Space Reserved for Documentation*, <http://www.normos.org/ietf/draft/draft-blanchet-ngtrans-exampleaddr-01.txt>
- *IPv6 Test Address Space Reserved for Documentation, Examples and Private Testing*, <http://www.normos.org/ietf/draft/draft-blanchet-ipngwg-testadd-00.txt>
- *Method for the assignment of bits of an IPv6 address block*, [http://www.viagenie.qc.ca/en/ipv6/ietf/draft\\_IPv6-address-block.txt](http://www.viagenie.qc.ca/en/ipv6/ietf/draft_IPv6-address-block.txt)
- *A flexible IPv6 addressing plan*, [http://www.viagenie.qc.ca/en/ipv6/ietf/draft\\_IPv6address.txt](http://www.viagenie.qc.ca/en/ipv6/ietf/draft_IPv6address.txt)
- *IPv6 address assignment*, <http://www.viagenie.qc.ca/en/ipv6/ietf/RFCIPv6address.txt>

- *Scheme of flexible allocation for IPv6 and IPv4 addressing,*  
<http://www.viagenie.qc.ca/en/ipv6/ietf/RFCflexibleallocation.txt>

## 1.6 Network Time Protocol over IPv6

The network time protocol (NTP) allows computers, servers and routers to synchronize their internal clock with timeservers over IP network. Prior to this project, the NTP protocol was only available over IPv4 networks. Many organizations tried to convert NTP to IPv6 before us but all failed; NTP was too complex. We worked hard on that project and finally converted NTP to IPv6. NTP server and clients implementations are converted to IPv6. IPv6 modifications of the code have been sent back to the developers of NTP and it is now integrated in the source code tree.



**Figure 1-5** NTP over IPv6 server is available to the IPv6 community

Viagenie also provides NTP over IPv6 service to the 6bone community using a GPS device that gets clock synchronization from satellites. NTP over IPv6 server acts as “stratum 1”, which is the higher level of precision for a timeserver. The server is supported by Viagenie on a best effort basis.

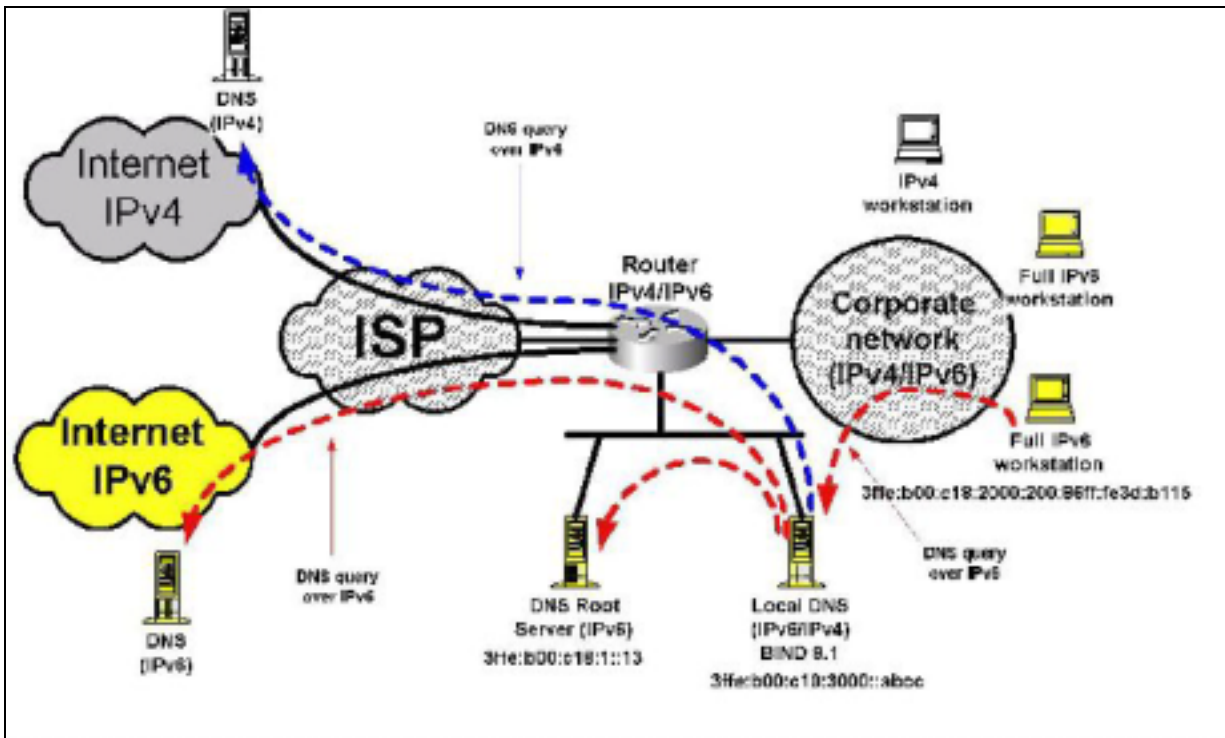
An Internet-draft has been proposed to IETF about NTP IPv6. This is related to a modification of the NTP protocol to support a special case related to the arbitration of multiple levels of synchronization. The draft was well received by the NTP community, however, there is still some discussions on how to implement it.

- *Reference ID for NTPv6,* <http://www.normos.org/ietf/draft/draft-boudreault-ipv6-ntp-refid-00.txt>

## 1.7 Full IPv6 workstation and Quake server over IPv6

In addition on developing services, we worked to port applications to IPv6. Thus, even if IPv6 is on a transitional period, a lot of computers have already been linked to the 6bone. However, any computer connected to the 6bone has to use both IPv4 and IPv6 stacks (dual stack). This is why we merged

with a complete package applications for a workstation that runs only on IPv6. We even ported a popular game! The Internet community required this type of proof to acquire faith in IPv6.



**Figure 1-6** Full IPv6 workstation are able to communicate with IPv6 and IPv4 nodes on the Internet-IPv4 and Internet IPv6

In this project, we ported Quake server and clients from IPv4 to IPv6. Quake was the first game program ever available on IPv6. Modifications of the code were sent back to the Quake developers and there are now integrated it in their code tree (sourceforge). Quake servers and client codes over IPv6 are freely available (<http://www.viagenie.qc.ca/en/ipv6/quake/ipv6-quake.shtml>).

## 2. Project Results

The overview of our project results is discussed in chapter 1.

### 2.1 General deliverables

We gave many presentations on IPv6 and our project as well as we wrote documents on these matters. The list of these is at the end of the report (Appendix A).

Viagénie has represented Canarie at the international IPv6 Forum as a founding member of this new organisation to promote IPv6.

#### 2.1.1 CA\*net3 and Program Criteria

- How the project made use of CA\*net3.

All the IPv6 servers, applications and services developed by Viagénie for this R&D project has made use of CA\*Net3.

- Degree of innovation – leadership, industry recognition.

The 6TAP was the first IPv6 exchange in the world in 1999. Freenet6 version 1 and version 2 were both the first tunnel server implementation ever available to any Internet end-users for the deployment of IPv6. We deployed the first DNS root server, NTP server and Quake server over IPv6. By realizing projects on the edge, we acquired a leadership on behalf of Canarie and the Canadian R&E community. We also published many IETF documents and are well recognized in the IPv6 worldwide community. However, IPv6 is a young protocol and the best is still to come. Much work remains to be done to move from the IPv4 world to the IPv6 one.

- How the project materially contributed to advancement of the state of the art in networking?

We proposed numerous Internet-drafts to IETF, some are currently under discussions while other are moving to RFC status. See the list in Annex A.

- Plan for ongoing service beyond Canarie funding.

All infrastructures, servers and IPv6 services deployed by us under this funding will continue to be supported by Viagénie on a best effort basis. Some prototypes developed during this project have potential to be commercialized and then to create jobs in Canada. However, we hope to get new funding from Canarie/CA\*net-4 to continue the work initiated.

- End user involvement.

During this project, we contributed to the advancement of networking by giving more services usable over IPv6. We have not stopped to give IPv6 services to the community since then. For example, the tunnel server developed and improved along Canarie's project is available to anyone who wants to use it. Moreover, we plan to improve it by adding some functionalities. The code of Quake over IPv6 is still available. We are also thinking about coding another game to demonstrate that the transition from IPv4 to IPv6 is feasible.

## 2.1.2 Technical Objectives

PROPOSED DELIVERABLES	DELIVERABLES ACHIEVED	VARIATION	JUSTIFY
<b>7. GENERIC PROJECT ACTIVITIES</b>	This milestone was devoted to on-line activities such as creating the present Web site and participating to various meeting and working groups.		
Building a Web site	Site available at <a href="http://www.viagenie.qc.ca/en/ipv6/canarie/index.shtml">http://www.viagenie.qc.ca/en/ipv6/canarie/index.shtml</a>		
Participating in various IPv6 tech groups	See Appendix A for the list of the presentations we gave at meetings.		
<b>7.1 6TAP PHASE 1</b>	6Tap has been a joint project of Canarie/Viagénie and ESnet to set the first IPv6 exchange for R&E networks in the world. (The 6TAP Web site is available at <a href="http://www.6tap.net">http://www.6tap.net</a> )		
Deploying an IPv6-routing infrastructure at 6TAP	<p>At the end of March 2000, a Cisco router was installed at the 6Tap. A Cisco 7204 has been used to make a link between R&amp;E networks connected to IPv6 over ATM.</p> <p>6Tap Web server at <a href="http://www.6tap.net">http://www.6tap.net</a></p> <p>A schema on “6Tap phase 1” is available at <a href="http://www.viagenie.qc.ca/images/projetsRetD/6tap-phase1.gif">http://www.viagenie.qc.ca/images/projetsRetD/6tap-phase1.gif</a></p>		
Developing and installing an IPv6/IPv4 tunnel server at 6Tap.	<p>A tunnel server was installed at the 6Tap. This is the link between IPv6 over ATM and IPv6 over IPv4. The equipment used creates tunnels that allow transportation of IPv6 for R&amp;E networks that use IPv4 only.</p> <p>A schema on “6Tap phase 2” is available at <a href="http://www.viagenie.qc.ca/images/projetsRetD/6tap-phase2.gif">http://www.viagenie.qc.ca/images/projetsRetD/6tap-phase2.gif</a></p> <p>Native IPv6 links was established between the tunnel server and the 6Tap IPv6 router. Since then, Viagénie has been using the IPv6 prefix 3ffe:3900:1000:/48 to delegate configured tunnels.</p> <p>A Web interface is available at <a href="http://206.220.240.242">http://206.220.240.242</a> to provide IPv6 connectivity. This is the official tunnel server Web site.</p>		
Replacing an IPv6 ACCORN's router located at RISQ by Viagénie router; international links for IPv6, at Viagénie	<p>The IPv6 traffic operation and management were on an ACCORN's Cisco 4500 router at Risk's office in Montréal. ACCORN shut down its equipment at the end of ANA project (in 1999).</p> <p>The traffic connectivity and management was then moved to Viagénie's office in February 2000. Viagénie used a Cisco 4700 router to do so. Viagénie is now one of the two places</p>		

	<p>in Canada that maintains and supports IPv6 connectivity for CA*net3 network.</p> <p>A schema on “IPv6 over CA*net3” is available at <a href="http://www.viagenie.qc.ca/images/projetsRetD/IPv6overCA.NET3.gif">http://www.viagenie.qc.ca/images/projetsRetD/IPv6overCA.NET3.gif</a></p> <p>Links and peers maintained by Viagénie at <a href="http://www.viagenie.qc.ca/cgi-bin/tunnel6bone.pl">http://www.viagenie.qc.ca/cgi-bin/tunnel6bone.pl</a></p>		
Establishing an IPv6 link with CRC and Berkcom (Gr)	Teleglobe is providing IPv6 connectivity between CRC and Berkcom. CRC network admin are managing the connectivity.		
Developing a basic system (tools) to collect IPv6 stats	<p>Under FreeBSD, ucd-snmp ported to IPv6 was installed. SNMP daemon supporting IPv6 MIB is running.</p> <p>Gif interfaces (IPv6) for configured tunnel (IPv6 over IPv4) and ATM interfaces are used to collect statistics about traffic.</p>		
Installing a statistic system at 6Tap; creating Web site	MRTG is used as a basic tool to collect statistics. Basic stats are available at <a href="http://206.220.240.242/mrtg/index.html">http://206.220.240.242/mrtg/index.html</a>		
<b>7.2 6TAP PHASE 2</b>	The phase 2 had for goal to enable routing management at the IPv6 exchange to replace the IPv4 route server devices that currently exist.		
Developing and code an experimental IPv6 route server	<p>The route server was developed and has used the 6bone registry for its source data. (See figure at <a href="http://www.viagenie.qc.ca/en/ipv6/phase2/route-server-architecture1.png">http://www.viagenie.qc.ca/en/ipv6/phase2/route-server-architecture1.png</a>)</p> <p>Also a router configuration tool was developed to do the same functionality as Rtconfig. The tools and functions modified were:</p> <ol style="list-style-type: none"> <li>1. IPv6 Solaris server with ATM OC-3 interface</li> <li>2. IPv6 BGP implementation with route server functions (BGP views, transparent peering)</li> <li>3. IPv6 RPSL classes</li> <li>4. IPv6 IRR supporting these classes</li> <li>5. Router configuration tool (RtConfig)</li> </ol> <p>The route server functionalities were integrated into MRTd. This software supports BGP IPv6 views and transparent peering functions.</p>		
Installing an IPv6 route server at 6TAP	The 6TAP, as part of the StarTAP project, is currently relocated from its location (Ameritech premises) to the Northwestern University. Our partner, ESnet, is taking care of moving the 6TAP infrastructure. After the move, the route server will be placed there.		
Modifying and code tools for IPv6 network Internet topology representation	The RPSL classes of the 6bone registry enable the view of the route peering and routes for the full IPv6 Internet.		

<b>7.3 NETWORK SERVICES IN IPv6</b>	To help organizations to move their network from IPv4 to IPv6, Viagénie's team developed various services on IPv6.		
Adding IPv6 support to the root domain name server so that the DNS root server will accept IPv6 DNS requests	We signed an agreement with Network Solution to get DNS root zone files for (.)COM, (.)NET, (.)ORG, (.) EDU. We installed a server (beta test) with 2 gigabytes of RAM to support DNS zones files. This server accepts DNS queries in IPv6. Every week, we replicate zone files.  We installed an experimental set-up (local DNS supporting DNS queries over IPv6 from hosts)		
Making available the IPv6 DNS root server so that the DNS root server in production	We developed the <a href="http://www.Viagénie.qc.ca/en/ipv6/dnsrs/utilisation.shtml">IPv6 DNS root server</a> which is now available. To know how to use it, go to: <a href="http://www.Viagénie.qc.ca/en/ipv6/dnsrs/utilisation.shtml">http://www.Viagénie.qc.ca/en/ipv6/dnsrs/utilisation.shtml</a>		
Developing a software for IPv6 addressing plan  Developing a software to make IPv6 delegation addresses plan	These two steps were done together, based on an Internet-draft written by Marc Blanchet <a href="http://www.viagenie.qc.ca/en/ipv6/ietf/draft_IPv6address.txt">http://www.viagenie.qc.ca/en/ipv6/ietf/draft_IPv6address.txt</a> . First, a routine had been coded then a tool was developed to help people making IPv6 addresses. You can use the tool at <a href="http://www.Viagénie.qc.ca/en/ipv6/allocation/index.shtml">www.Viagénie.qc.ca/en/ipv6/allocation/index.shtml</a>		
<b>7.4 IPv6 NETWORK TIME SERVER</b>			
Over the Internet, many timeservers synchronize their computer clock on the same time base. So, Viagénie deployed this service on IPv6.			
Developing a NTP IPv6 client and server	We ported the NTP client and server to IPv6, based on the NTP distribution code of Dave Mills. When announced, this generated a lot of interest in the NTP and IPv6 community, which spawned additional work, some coming from Dave Mills himself.  The IPv6 modifications of the code were sent back to the developers of NTP and it is now integrated in the source code tree.		
Making available an NTP IPv6 server on IPv6 Internet	NTP service over IPv6 is available at <a href="http://www.Viagénie.qc.ca/en/ipv6/ntp6/index.shtml">http://www.Viagénie.qc.ca/en/ipv6/ntp6/index.shtml</a> . The NTP server can be only accessed by IPv6 at ntp.ipv6.Viagénie.qc.ca		
<b>7.5 IPv6 IMPLEMENTATION PACKAGE</b>			
A lot of computers are already linked to the 6bone, even if no stack developer hasn't merged yet with an IPv6 application package that runs only on IPv6. IPv6 applications are primordial to gain the trust of end-user in IPv6.			
Building an IPv6 package to allow a full user implementation on IPv6 (IPv6 software for	Full IPv6 package were developed. It has allowed computers using FreeBSD 4.2 STABLE to run fundamental Internet services over IPv6 only. With a special combination of client and servers applications well-configured, it has been possible		

the day to day life)	<p>for end-users to browse Internet, send and receive messages.</p> <p>To understand how to run over IPv6 only, go to <a href="http://www.Viagénie.qc.ca/en/ipv6/fullipv6ws/index.shtml">http://www.Viagénie.qc.ca/en/ipv6/fullipv6ws/index.shtml</a></p> <p>Quake client and server have been ported to IPv6. Sources and binaries are available at <a href="http://www.Viagénie.qc.ca/en/ipv6/quake/index.shtml">http://www.Viagénie.qc.ca/en/ipv6/quake/index.shtml</a></p> <p>Work has been done to port Web and DNS software.</p>		
<b>7.6 IPv6 TUNNEL SERVER</b>	<p>Even if there are several hundred of IPv6 sites around the world, the main problem of early adopters in 2001 is to get IPv6 connectivity and prefix. Large R&amp;E networks such as CA*net-2 and I2 are connected to the 6bone with a huge IPv6 space addressing. However, end-users within universities/research centres are not able to get IPv6 addresses or IPv6 connectivity for their sites. Previous tunnel server initiatives used through a Web page were interesting but not enough to provide IPv6 connectivity and delegate IPv6 space addressing to sites at large scale. This situation hinders the deployment of IPv6.</p>		
Creating and developing a tunnel server	<p>Instead of a Web interface to request configured tunnels and IPv6 addresses, Freenet6's TSP is a new model based on a client/server approach. A protocol is used to request one single IPv6 address up to a full IPv6 prefix from a client to a tunnel server accordingly to the broker model. The protocol could be integrated directly into the operating system to give a service like DHCP but for requesting IPv6 addresses or prefixes over an IPv4 network (Internet). Viagénie has designed and developed a new IPv6 service to provide IPv6 connectivity at a larger scale. Dynamic IPv6, static IPv6 addresses and full IPv6 space could be requested through this new service.</p> <ul style="list-style-type: none"> <li>- New IPv6 service Web site: <a href="http://www.freenet6.net/">http://www.freenet6.net/</a></li> <li>- To understand the new protocol: <a href="http://www.freenet6.net/howtsp.shtml">http://www.freenet6.net/howtsp.shtml</a></li> <li>- Downloading clients developed: <a href="http://www.freenet6.net/download.shtml">http://www.freenet6.net/download.shtml</a></li> <li>- Getting IPv6 space (/48): <a href="http://www.freenet6.net/how48.shtml">http://www.freenet6.net/how48.shtml</a></li> <li>- Create your account: <a href="http://www.freenet6.net/cgi-bin/new_account.pl">http://www.freenet6.net/cgi-bin/new_account.pl</a></li> </ul>		

### 2.1.3 Schedule Objectives

Milestones	Planned completion date	Actual completion date	Justification
<b>7. GENERIC PROJECT ACTIVITIES</b>	2001-09-30	2001-09-30	
<b>7.1 6TAP PHASE 1</b>	2000-06-30	2000-05-15	
<b>7.2 6TAP PHASE 2</b>	2001-09-30	2001-09-30	
<b>7.3 NETWORK SERVICES IN IPv6</b>	2000-12-31	2000-12-31	
<b>7.4 NETWORK TIME SERVER IPv6</b>	2000-12-31	2001-08-31	<p>This work required much more work because of the complexity of the protocol: NTP needs to support different modes of operation.</p> <p>On a general way, we hired three employees who worked on the project and two of them quitted us along the course of this project. This gave us some important delays due to the initial learning curve of new employees that is completely lost when they leave early.</p>
<b>7.5 IPv6 IMPLEMENTATION PACKAGE</b>	2000-12-31	2000-12-31	
<b>7.6 IPv6 TUNNEL SERVER</b>	2001-05-31	2001-05-31	

## 3. Contributions of Partners and Participants

ESnet and StarTap contributed to our project by hosting our equipment to set the first IPv6 exchange for R&E networks in the world.

## **4. Benefits and Impacts**

The project has been essential in the development of the next generation of Internet protocols. Our work proved that IPv6 could be used by thousand of users without problems and that applications can be ported to IPv6 so a full-IPv6 workstation can be used. Thus any users can go to [www.freenet6.net](http://www.freenet6.net) to get an easy way to access IPv6 networks. Our work demonstrated the need and the usefulness of IPv6 and how it has been appreciated by the R&E community. For instance, we have received mails about how our tunnel server has been useful; in fact, our tunnel server is often considered as the easiest way to get to IPv6 networks. Currently, more than 10 000 users have used it since last June.

### **4.1 Direct Benefits.**

Many direct benefits occurred during this project. For example, we employed 2 students to help out with this project; one of these students still works with us as a part-time employee.

Also, this project allowed us to improve a tunnel server that was made previously in collaboration with Canarie. The Freenet6 tunnel server is widely used by the community. We are actually thinking about the goodness of commercializing one of the products developed during this project. On a general way, this project gave us renown as IPv6 experts in Canada, allowing us to obtain some contracts with private companies and to give tutorials on IPv6.

### **4.2 Indirect Benefits.**

We acquired an expertise on IPv6 that lead our company as one of the world leader. We keep giving conferences, seminars and tutorials on IPv6 to disseminate our knowledge. Thus, due to our expertise, Marc Blanchet has been asked to be part of the IPv6Forum while Florent Parent has been leading a working group on Routing Policy Specification Language (RPSL) modified for IPv6 routes and objects.

Moreover, during this project, Viagénie's employees wrote many Internet-Drafts on IPv6; these documents are contribution to advancement of the state of the art in networking.

### **4.3 Ultimate Impacts.**

All together, these benefits bring Canada at the forehead of the Internet technology. The R&E community can use much better network functionality.

## **5. Future**

We presently work on enhancing some functionalities on our tunnel server. Also, we want to port to IPv6 other applications such as bzflag and mysql. In addition, we are currently working on implementing shipworm based on an Internet-draft.

## **6. Program Administration**

This program allowed us to plan and do a huge project on IPv6 that we wouldn't be able to do alone. Canarie supported us through these last years; even if we are a small company, Canarie's people believed in our capabilities to conduct such a long-term project. Strength of this program was also that the criteria were wide enough so you can get enough freedom in your project: freedom is vital for creative R&E projects. However, the administrative requirements for the project are now heavier than when we started the project back in 1999. On global view, the ANAST program was very helpful to help us doing R&D projects and we want to thank Canarie's for its contribution and support throughout our project.

## APPENDIX A

### ***Presentations (<http://www.viagenie.qc.ca/en/ipv6/phase2/ipv6events.shtml>)***

Parent Florent, *IPv6 Tutorial*, Prague, RIPE, October 2001  
Parent Florent, *IPv6 routing policies using RPSL*, RIPE, Prague, October 2001  
Blanchet Marc & Desmeules Régis, *Deploying IPv6*. INTEROP, Atlanta, September 2001  
Viagénie, *Tunnel Set-up Protocol*, 51<sup>st</sup> IETF, London, August 2001  
Viagénie, *IPv6 Address Space Reserved for Documentation*, 51<sup>st</sup> IETF, London, August 2001  
Blanchet Marc, *Tutorial on IPv6*, INET 2001, Stockholm, June 2001  
Parent Florent, *IPv6 Overview*, NET2001, Calgary, June 2001  
Blanchet Marc, *Managing Tunnels for Networks*, IPv6 Forum, Ottawa, May 2001  
Blanchet Marc, *Update on IPv6 in Canada*, ISW, Tokyo, February 2001  
Blanchet Marc, *Deploying IPv6*, INTEROP, Las Vegas, February 2001  
Blanchet Marc, *IPv6 Update*, Canarie workshop, Montréal, November 2000  
Parent Florent, *IPv6 Overview*, MWIF, Toronto, July 2000  
Blanchet Marc, *Tutorial IPv6*, INET2000, Yokohama, July 2000  
Blanchet Marc, *Tutorial IPv6*, iBAND - Stardust, San Francisco, June 2000  
Parent Florent, *IPv6 Tutorial, v1.1*, IPv6: The new Internet, England, June 2000  
Blanchet Marc, *IPv6 Porting applications*, IPv6Forum, England, May 2000  
Blanchet Marc, *IPv6 Transition mechanisms*, IPv6Forum, England, May 2000  
Parent Florent, *6Tap update*, 47th IETF, Australia, March 2000,  
Desmeules Régis & Parent Florent, *IPv6 Tutorial*, IPv6Forum, Colorado, March 2000  
Desmeules Régis, *Canarie: Canada Internet development*, IPv6Forum, Colorado, March 2000  
Desmeules Régis, *Viagénie's presentation*, 6INIT, France, January 2000  
Desmeules Régis, *Canarie and CRC presentation*, 6INIT, France, January 2000  
Blanchet Marc, *Tunnel Set-up protocol*, 46th IETF, United-States, November 1999

### ***Press release (<http://www.viagenie.qc.ca/en/nouvelles/commdepresse/IPv6.shtml>)***

Viagénie, *Viagénie's Freenet6 Delivers Billions of Free IPv6 Addresses*, May 2000

**Internet-draft (<http://www.viagenie.qc.ca/en/ipv6/ietf/index.shtml>)**

Internet-draft, *Reference ID for NTPv6*, Marc Blanchet, Jean-Francois Boudreault, IETF, 2001-11-20, <http://www.normos.org/ietf/draft/draft-boudreault-ipv6-ntp-refid-00.txt>

Draft-IETF, *IPv6 Routing Policies using RPSL*, Florent Parent, IETF, 2001-10-18, <http://www.normos.org/ietf/draft/draft-parent-rpsl-ipv6-00.txt>

Internet-draft, *IPv6 over IPv4 profile for Tunnel Setup Protocol (TSP)*, Marc Blanchet, IETF, 2001-07-18, <http://www.normos.org/ietf/draft/draft-vg-ngtrans-tsp-v6v4profile-00.txt>

Internet-draft, *Tunnel Setup Protocol (TSP)*, Marc Blanchet, IETF, 2001-07-18, <http://www.normos.org/ietf/draft/draft-vg-ngtrans-tsp-00.txt>

Internet-draft, *IPv6 Address Space Reserved for Documentation*, Marc Blanchet, IETF, 2001-07-02, <http://www.normos.org/ietf/draft/draft-blanchet-ngtrans-exampleaddr-01.txt>

Internet-draft, *IPv6 Test Address Space Reserved for Documentation, Examples and Private Testing*, Marc Blanchet, IETF, 2001-05-07, <http://www.normos.org/ietf/draft/draft-blanchet-ipngwg-testadd-00.txt>

Internet-draft, *Method for the assignment of bits of an IPv6 address block*, Marc Blanchet, IETF, 2001-03-02, [http://www.viagenie.qc.ca/en/ipv6/ietf/draft\\_IPv6-address-block.txt](http://www.viagenie.qc.ca/en/ipv6/ietf/draft_IPv6-address-block.txt)

Internet-draft, *Optical BGP (OBGP): InterAS lightpath provisioning*, Marc Blanchet, Florent Parent, Bill St-Arnaud, IETF, March 2001, [http://www.viagenie.qc.ca/en/obgp\\_wdd/ietf/draft\\_obgp-v1.txt](http://www.viagenie.qc.ca/en/obgp_wdd/ietf/draft_obgp-v1.txt)

Internet-draft, *A flexible method for an IPv6 addressing plan*, Marc Blanchet, IETF, 2000-11-24, [http://www.viagenie.qc.ca/en/ipv6/ietf/draft\\_IPv6address.txt](http://www.viagenie.qc.ca/en/ipv6/ietf/draft_IPv6address.txt)

Internet-draft, *A method for flexible IPv6 address assignments*, Marc Blanchet, IETF, 1998-10-17, <http://www.viagenie.qc.ca/en/ipv6/ietf/RFCIPv6address.txt>

Internet-draft, *A flexible allocation scheme for IP addresses (IPv4 and IPv6)*, Marc Blanchet, IETF, 1998-07-02, <http://www.viagenie.qc.ca/en/ipv6/ietf/RFCflexibleallocation.txt>