ACORN-NL

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Introduction

In December of 2010 Acorn-NL received $42K from CANARIE to undertake work relating to IPv6 deployment among the ORANs. With CANARIE funding, ACORN-NL was given the opportunity to work with standard IPv4 applications in an IPv6 environment. Applications such as DNS, FTP/file transfer, and videoconferencing, were well understood from the perspective of IPv4, but the group wanted more experience with these applications in an environment using IPv6 addressing. With this in mind, ACORN-NL developed a five month project that allowed the group the chance to further develop expertise in these areas (applications) in advance of a more comprehensive IPv6 transition.

Project Deliverables

The project identified five objectives. Each of these is outlined below with their respective performance measures.

1. **Establish a IPv6 DNS and configure peering with ACORN-NS**.
   A production Domain Name Server with IPv4/IPv6 support will be added to the ACORN-NL network which will be authoritative for the acorn-nl.ca domain. The server will provide mutual back-up with the DNS in the ACORN-NS network.

   Performance measures: Deployment of IPv4/IPv6 DNS Service, successful testing, and successful DNS zone transfers with ACORN-NS.

2. **ACEnet/Access Grid Videoconferencing using an IPv6 environment.**
   Prototype and test IOCOM VC using IPv6. These tests will be performed locally at two sites. Testing will then proceed at other ACEnet sites.

   Performance measures: Prototype and design documentation, successful local videoconference testing, and successful regional testing.

3. **File transfer speed testing:IPv6 vs. IPv4**
   ACEnet currently has three separate protocols which transfer data between sites: SCP (file transfer), NFS mounts, and LDAP multi-master transfer. IPv6 will be enabled for these ACEnet protocols. Data transfers would be performed under both IPv4 and IPv6 and results compared.

   Performance measures: Transfer times, file sizes, number of files.

4. **IPv6 Advanced networking day.**
   A half day IPv6 advanced network event will be scheduled in March 2011. All ACORN-NL member institutions, and CANARIE will be contacted and encouraged to have management and technical representatives attend a seminar and Q&A session. The seminar will cover the current state of IPv6 in Canadian R&E networks, and IPv6 readiness and awareness.

   Performance measures: Attendee survey and ACORN-NL membership representation.

5. **Staff training and knowledge transfer.**
   Train local technical staff and management on IPv6, leveraging offerings from CANARIE. Procure additional reference materials for continued future work with IPv6 protocols.

   Performance measures: Post project knowledge, familiarity with IPv6.

Project Outcome

With funding secured, the next goal of this initiative was to establish a team of specialists to perform the work. ACORN-NL drew on individuals with expertise in networking, security, DNS and server configuration and application management. Using these resources a plan was developed and the work undertaken.

While most of the outcomes were achieved as anticipated and planned, the group encountered a number of difficulties and surprises along the way, resulting in significant knowledge gain. Details on each deliverable are provided below:

1. Establish a IPv6 DNS and Configure Peering With ACORN-NS

An IBM xSeries server was purchased to be used as the DNS server home. The OS used for work was Red Hat Enterprise Linux Server image 5.6, running under a VMware ESXi platform. The DNS server is BIND 9.7.0-P2 running as 'named'. The DNS system is configured to be authoritative for the domain ipv6.Acorn-nl.ca provides a mutual backup support with the ACORN-NS system in Nova Scotia using a zone transfer.

Some installation issues that arose along the way included the need to allow the MUN name servers to handle general requests from the IP subnet used by ACORN-NL, and familiarization with some of the differences in the IPv6 configuration vs. the IPv4 standard configuration. There were some minor delays as members of the team worked out the details of routing IPv6 to CANARIE and worked out whether the group would use static IPv6 address assignments or stateless auto configuration.

The DNS servers on the MUNet domain are linked to the ipv6.acorn-nl.ca sub-domain and will now also be able to provide DNS support to the servers and routers on the ACORN-NL network which will simplify

future configuration of the operational ACORN-NL network. The DNS support is successful and has been instrumental (when combined with Wireshark packet tracing) in determining the success of some other products using IPv6 protocols.

The team was able to establish an IPv6 DNS server and peer it with a similar device at another ORAN's location. Staff at this location gained valuable experience in working with and troubleshooting a DNS environment using IPv6 addresses and databases. These skills will be leveraged going forward as ACORN-NL continues to maintain and improve the current IPv6 DNS services.

2. ACEnet/Access Grid Videoconferencing Using an IPv6 Environment

The videoconferencing portion of the project was the most difficult. At the time of writing of this report the group has not been able to achieve a complete video and audio connection over IPv6 between the two ACORN networks. ACORN-NL will continue to trouble-shoot and look for a working solution. Windows-based systems have been temporarily excluded from the testing for the time being.

The existing conferencing system at Memorial (IOCOM Grid) does not natively support IPv6 at this time so alternatives were explored. These alternatives included: Access Grid 3.2, Microsoft Live Messenger and the Linphone open-source program. All of these are described as IPv6 ready yet each of them presented challenges in at least one area.

The Access Grid 3 system is widely deployed in academia and is used in at several Research and Education networks as a primary teleconferencing vehicle. The group tested the current release of Access Grid and was unable to achieve a video conference link under IPv6. On browsing some of the code in AG3, it appears that the largest difficulty in the Windows world is the varying level of support for IPv6 found between different major releases of Windows.

The Linphone system is an open source video conferencing system that was written for use in Linux and Windows. When this system was tested under Windows using an IPv4 network, communications were excellent. However, when the team attempted a similar test under IPv6 it was unable to repeat those successes. The calling station was able to make the phone ring on the called station but no sound or video was transferred in either direction after the call was answered. Further tests were inconclusive as the video driver issues caused repeated crashes of the Windows XP workstation. Linphone appeared to work in a virtual environment in which two virtual Linux machines did connect and pass real-time data representing audio and video streams. These tests did not use actual video and sound from a real webcam, microphone and headset.

Linphone was tested using an up-to-date version of Linux, Ubuntu Desktop Edition 10.10 on a Dell Latitude that has recently been installed in St. John's and an Ubuntu system that is available in the Nova Scotia ACORN site.

One further attempt to use IPv6 for video conferencing was explored at the very end of the project. The Microsoft products known as “Windows Live Messenger” are stated to be IPv6-ready and they do appear to be ready to operate in the IPv6 world. Wireshark traces of the traffic generated when a user logs in to the “Windows Live Network” show all of the right DNS queries for ‘AAAA’ records ahead of queries for ‘A’ records. Unfortunately, the responses to the IPv6 queries were all negative, as Microsoft does not provide any of the necessary IPv6 servers.

Future developments with all of these technologies should be followed and the tests can be repeated as new versions of Access Grid and Linphone are released. The Windows Live Messenger system should be reviewed on World IPv6 Day on June 8th 2011 to see if Microsoft provides any suitable servers.

3. File Transfer Speed Testing: IPv6 vs. IPv4

For the file transfer tests ACORN-NL used OpenSSH as modified by the Pittsburgh Supercomputing Center.

For the tests, the OpenSSH server was started on a pair of non-standard ports on ‘blue.acorn-nl.ca’, one port to serve IPv4 tests and one to serve IPv6 tests. The ports were 2004 and 2006 respectively. The client executables built on the server at MUN were copied to the shell account at ACORN-NS so that the tests could be executed without requiring privileged access on the ACORN-NS system.

Two different test cases were designed for this deliverable. The first test would transfer a large file from one system to the other and the second test would transfer an entire directory containing thousands of small files, from one system to the other. The file for the first test was generated using the Unix “dd” command to generate a file of 20 Gigabytes of zeroes. The directory for the second test employed the compiled source tree for the OpenSSH client system as copied to the ACORN-NS server account.

The file transfer tests were repeated until a pattern was observed in the results. The IPv6 version of the code emerged as a faster technology. In the case of bulk file transfers, the IPv6 version required about three quarters of the time that the IPv4 version used. In the directory transfer, the IPv6 system was consistent with all times, being within about five seconds of the mean of seventy-five seconds. The IPv4 version of this test had widely varying results ranging from 162 to 435 seconds (after excluding even more extreme outliers). There was a mean of 337 seconds.

Table 1a -IPv4 Bulk (20GB) Data Transfer Test

All Rates in MBps (MegaBytes per Second). All times in hh:mm:ss or seconds.

No	Elapsed Time	Computed Rate
1	0:23:26	14.57
2	0:23:30	14.52
3	0:23:08	14.76
4	0:25:00	13.65
5	0:23:36	14.46

Minimum time	0:23:08	Seconds		
Average time	0:23:44	Seconds		
Average rate	14.39	MBps	115.14	Mbps

Table 1b -IPv6 Bulk (20GB) Data Transfer Test

No	Elapsed Time	Computed Rate
1	0:17:38	19.36
2	0:18:01	18.95
3	0:17:00	20.08
4	0:18:08	18.82
5	0:17:45	19.23

Minimum time	0:17:00	Seconds		
Average time	0:17:42	Seconds		
Average rate	19.29	MBps	154.3	Mbps

Table 2a -IPv4 Subdirectory with 103 MB and 1,976 files transferred

No	Elapsed Time (s)	Computed Rate
1	105	0.98
2	295	0.35
3	386	0.27
4	162	0.64
5	220	0.47
6	206	0.50
7	256	0.40
8	344	0.30
9	182	0.57
10	269	0.38
11	1283	0.08
12	237	0.43
13	435	0.24

Minimum time	337	seconds		
Average time	336.92	seconds		
Average rate	.43	MBps	3.45	Mbps

Table 2b -IPv6 Subdirectory with 103 MB and 1,976 files transferred

No	Elapsed Time (s)	Computed Rate
1	78	1.32

2	73	1.41		
3	77	1.34		
4	75	1.37		
5	73	1.41		
6	76	1.36		
7	74	1.39		
8	75	1.37		
9	75	1.37		
10	76	1.36		
11	74	1.39		
12	76	1.36		
13	77	1.34		
Minimum time	73			
Average time	75.31			
Average rate	1.37MBps		10.95	Mbps

4. IPv6 Advanced Networking Day

An Advanced Networking Day was held on March 22nd, 2011. Invited speakers from Cisco Systems and Bell Aliant presented the Business Case and a technical outline of the current state of IPv6 in the industry. Approximately 30 individuals attended and included ACORN-NL users, academics from Memorial University and representatives of the Government of Newfoundland and Labrador and the K-12 school system. Invited Guest speakers were Mr. Jim Bailey of Cisco Systems and Mr. Gerard White of Bell Aliant.

Bailey addressed both the Business Case for IPv6 which emphasized the growth of the internet and the impending exhaustion of the IPv4 address space. Further, the need for enterprises to support IPv6 will come from both inside and from outside, when employees, customers, suppliers and distributors will need to access the enterprise over IPv6. Enterprises hope to realize advantages when they offer access to their services on IPv6 and offer products that support IPv6 in response to market demands. Bailey emphasized the need for a senior management driven planned approach to making the business IPv6-ready.

Finally, Bailey identified the Cisco Advanced Services that are available now (and in the future) and the fact all major Operation Systems provide functioning IPv6 stacks. Bailey reviewed several scenarios for integration and coexistence, discussing the technical nuances of each. He recommended the use of the Dual Stack, widely accepted now, and provided more details about mechanisms designed to provide solutions to specific problems in different situations one may encounter in practice.

White covered a number of issues that supported much of what Bailey expressed and gave a number of real-world examples of differences in the IPv6 implementations of several different versions of

Microsoft Windows. White noted that there are new security concerns for IPv6 networks, including the argument that the multiple header structure in IPv6 introduces the possibility that more than one destination port may receive payload from a single IP datagram. This may have implications for institutional firewalls.
White indicated that Bell has deployed a national backbone network that has twinned routers at every major node. Each pair of twinned routers is made up of one Cisco and one Juniper router. The company is interested in providing IPv6 transit services to its institutional customers but they respect the fact that users will require some time before this becomes widely deployed.

5. Staff Training and Knowledge Transfer

Staff training included a video- based training course provided by CANARIE and presented over the Cisco "WebEx" service. The course comprised ten sessions, each lasting about ninety minutes. A recording of each session was posted to the CANARIE IPv6 'Twiki' web site. The subject matter included the configurations of routers, switches and important services provided on servers. The sessions are currently available for review and may be used by any member of the IPv6 Readiness project team.

Training materials in the form of up-to-date textbooks were obtained and are being reviewed by members of the project team. These include books on the subject of IPv6 and the VMware ESXi system used to support the ACORN-NL server hardware. Other reading materials are available through the Memorial University Library system which includes access to a number of subscription services that offer online access to relevant textbooks, including a Safari Books subscription, a books24x7.com subscription, the Academic Complete feature of ebrary.com and the Springer E-book Collection from Springer Science+Business Media.

Conclusion

As a result of the IPv6 project work funded by CANARIE, ACORN-NL and its technical staff now have a much improved technical foundation upon which to build. This project has allowed our staff to gain experience working with IPv6 applications, understanding the pitfalls encountered, and highlighting the differences between IPv4 and IPv6.

Work was carried out on each of the planned deliverables as described in our original proposal. While not all the plans were completed as hoped, the process itself was a learning experience. The lessons learned within each objective's activities provided important IPv6 knowledge that ACORN-NL technical staff now have and will use as we continue to work with the hardware services now in place.

In addition the hosting of the Advanced Network day on IPv6 provided us with the opportunity to raise the awareness level among staff at Memorial University, government and K-12 educational staff that were in attendance. The feedback received from this event has been extremely positive and similar future events would almost certainly be well attended.

Going forward the team intends to maintain the environment it created, will continue to carry out trials and application testing under IPv6, leveraging the work completed under this project.

Appendix A: CANARIE Defined PMIs for ORAN IPv6 Program (O-IPv6)

The following PMIs are extracted from CANARIE's Annual Report Guidelines.

PMI-1: Network Operations (Connectivity)

Indicators	Answers
1. Please indicate if there was a successful installation of the equipment required to transition to IPv6.	We were able to successfully install an IPv6 DNS service, and currently ACORN –NL equipment has both IPv4 and IPv6 addressing configured.

PMI-2: Technology Innovation

Indicators	Answers
1. Please indicate if IPv6 was successfully deployed and available to the ORAN stakeholders?	As a part of our project we were able to successfully peer our IPv6 DNS services with a similar service located at AVORN-NS.
2. Please provide the number of Institutions that have transitioned to IPv6 and are benefitting from the implementation of the service.	There have been no institutions that will have converted to IPv6 as a result of this project. The work in this project will serve as a springboard from which we can launch other IPv6 initiatives in the future
3. Please provide examples of where unnecessary bottlenecks were removed by implementing proper IPv6 routing.	No bottlenecks were removed as a result of this work thus far. We will continue to work with IPv6 inside of ACORN-NL and grow our understanding of the protocol.
4. Please provide examples of how performance issues caused by network partial routing were reduced.	NA

Appendix B: Further Video Conferencing Testing.

Following the official conclusion of the IPv6 project ACORN-NL staff continued to work with peers at other ORAN institutions to test video conferencing under IPv6. We are happy to report that earlier issues with the connectivity have been resolved and we were able to successfully connect and communicate via a video conference using IPv6 protocols.