

Project factsheet information

Project title	VIPNet: A Virtual IPv6 Application Testbed
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Partner organizations	None
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Project summary	<p>Due to the rapid development of the Internet and use of Information Technology to cope educational, research, business, and many other fields, IPv4 has become a circumscribed resource. Even if IPv6 solution is available, it is still not being widely used or popular. We believed that deploying IPv6 is delayed mainly due to the lack of supportive application, security issues and the hardware cost. In order to develop IPv6 applications, we must have a cost effective test bed. Building such test bed by using real hardware is very expensive for a developing country. On the other hand IPv6 simulators and emulators available in the market are also expensive and they focus on the IP network layer.</p> <p>By considering these problems and requirements, we have designed a viable solution called A Virtual IPv6 Application Testbed (VIPNet) using virtualization technologies. VIPNet can create a virtual IPv4 or IPv6 network with only using a single personal computer. This approach could be used to create necessary application environment for deploying and testing applications, which requires an IPv4 or IPv6 network.</p> <p>The final progress report summarizes our activities during the reporting period. In general, the vision of our research team is to develop low cost IPv6 application test bed with necessary tools.</p>

Table of contents

Project factsheet information.....	1
Justification	3
Project objectives	3
Project implementation	4
Project outputs and dissemination.....	7
Lessons learned from project implementation	8
Project management and sustainability	8
Impact.....	8
Overall Assessment.....	8
Recommendations.....	8

Project Summary

We built a low cost IPv6 test bed, which can be used to test IPv6 applications and security issues. The test bed was built based on virtualization concept and therefore we called it Virtual IPv6 Test Bed(VIPNet). We believed that deploying IPv6 is delayed mainly due to the lack of supportive application, security issues and the hardware cost. In order to develop IPv6 applications, we must have a cost effective test bed. Building such test bed by using real hardware is very expensive for a developing country. On the other hand IPv6 simulators and emulators available in the market are also expensive and they focus on the IP network layer. Thus we have developed VIPNet.

VIPNet is a simple open source IPv6 application testing and teaching tool. IPv6 application developers can use VIPNet to test their applications. Security auditors can use it to test and solve security issues and academics can use it as an education tool.

The concept of VIPNet is completely different from the existing IPv6 test beds. By using VIPNet interface, the required network topology and the machine configurations can be specified and the VIPNet deploys the network using virtual machines. VIPNet has several advantages than most of the existing virtual environments and testbeds. Among them having good performance, user friendliness and ability to work with multiple operating systems are the major advantages. Since it has more enhanced features than the existing virtual environments VIPNet will become popular among the most of the users.

The first version of the VIPNet software can be obtained from score.ucsc.lk/vipnet web site. Web site has links to download user manuals, guided videos and sample laboratory exercises. We also host a demonstration application, thus users can create sample IPV6 networks and practice the exercises.

In addition to the development and deployment of VIPNet, we have completed a research paper and conducted a training program for the internal people. We are planning to host few other training programs for

industry and government organizations in coming months. Based on the feedback of these training programs, we have planned to complete another research paper by end of the year 2011.

Justification

University of Colombo School of Computing (UCSC) has been a pioneer in cooperating with Internet Society (ISOC), the Canadian International Development Research Centre (IDRC), Japan International Cooperation Agency (JICA), Swedish Agency for International Development Cooperation (SIDA)/The Department for Research Cooperation (SAREC), The Swedish Program for Information and Communication Technology in Developing Regions (Spider) and Information Society Innovation Fund (ISIF) in the area of computer science by establishing some of the major ICT research and development projects.

We believe that one reason for the delay in the IPv6 deployment is the lack of applications with IPv6 support. In addition, it is essential to study the behavior of applications and operating systems that supports IPv6. To facilitate the IPv6 deployment, IPv6 training programs should be conducted. Without these activities IPv6 cannot be successfully deployed in the region. Thus IPv6 application testing tools and education tools are required. However, it is very expensive to deploy a network test bed. One solution is to use emulators and simulators. There are several IPv6 simulators and emulators available in the market. However, most of these tools are expensive and they focus on the IP network layer.

Thus we have built the low cost IPv6 application test bed (VIPNet), which can be used to test IPv6 applications and security issues. It should also be mentioned that VIP Testbed could also be used as a Virtual Learning Environment for course units such as Networking, Systems Administration and Security where students can apply and practically experience concepts of the subjects. Moreover, since VIPNet provides a comprehensive Graphical User Interface to create and manage the network environment, even a novice user can easily setup required environment and manage it by him/herself.

Project objectives

The degree of fulfillment of objectives is as follows:

- **Developing a cost effective IPv6 testbed for IPv6 application developers:** The first version of the VIPNet was implemented. The software and the other materials were published on the <http://score.ucsc.lk/vipnet/> Web site. We are continuously testing and improving the tool in the laboratory. In order to develop the software high end server and few PCs have purchased. A laptop computer and a multimedia projector have also purchased to conduct the training programs.
- **Conducting the training programs and providing necessary tools to find and solve IPv6 related security issues:** The initial training program for the internal staff has conducted. This training program focus on the fundamentals of IPv6. In order to conduct this training, several laboratory exercises were developed. The testing IPv6 enabled applications has started. At present we study on IPv6 related security issues. A set of tools has identified by using existing open source software to simulate the IPv6 security issues. We have planned to conduct few other training programs for the industry and the government organizations in coming months.
- **Developing an education tools to teach IPv6 protocols and application development:** Development of the user manual has completed. The first version of the software, user manual, videos clips published on the <http://score.ucsc.lk/vipnet/> Web site. Several IPv6 laboratory exercise sheets were developed and additional exercise materials are still on the way.

- **Helping the deployment of IPv6 networks by enabling IPv6 applications:** The initial training workshop was conducted for the internal staff on the fundamentals of IPV6 by using VIPNet. We have planned to conduct at least two other public workshops to train the IPv6 application developers and teachers. We believe that it will help to speed up the deployment of real IPv6 networks.

Project implementation

The following table shows the overall progress of each activity.

Project objectives	Activities	Time required for activities implementation	Overall assessment
Developing a cost effective IPv6 testbed for IPv6 application developers	Designing and verifying the VIP architecture	We have spent 6 months to finalize the architecture	In the first phase of the activity, we attended few IPV6 training programs. Then we developed few prototypes based on various virtualization methods. Finally, we opted to use Xen Hypervisor. Xen is a Virtual machine monitor which supports several microprocessor architectures such as x86, AMD64, etc.
	Training the UCSC staff	Through out the project	The fundamental training programs were completed in August 2010. In addition to that Dr. Chamath attended SIGCOMM conference and workshops. However, our resource persons attend IPV6 and network related training programs through out the project. Knowledge gained from these training programs was helpful in developing our own training materials.
	Preparing specification of the equipments	We have spent a month to finalize the specification of the required equipments.	Required equipment list with the specification forward to purchasing at the beginning of the project since that process is time consuming. We borrowed equipment from the University until the new equipment arrived.
	Purchasing the equipments	We have spent six months to finalize it.	We purposely delayed the purchasing of the deployment server toward the end of the project since server performance usually improves with time.
	Developing the VIP Software	Through out the project	Software development started at the beginning of the project but we are still improving it. The first version was released in May 2011. IPv6 application testing has started in June 2011.

Project objectives	Activities	Time required for activities implementation	Overall assessment
Conducting the training programs and providing necessary tools to find and solve IPv6 related security issues	Training the UCSC staff	Through out the project	Our resource persons attend IPV6 and network related training programs though out the project. Knowledge gained from these training programs was helpful on developing our own training materials.
	Deploying the IPv6 Test Bed in the research Laboratory	We have started it in May 2011 and will continue until we reach the stable version	The deploying the VIPNet was started in May 2011. One instant of the application is available on score.uscs.lk/vipnet web site to the community.
	Preparing application testing methodologies	We have started it in April 2011 and will continue this task even after the project funding.	We have published the basic manual and the exercises on the web site. However, we should develop better methodologies and materials on IPV6 application testing.
	Preparing learning exercises	We have started it in April 2011 and will continue even after the project funding.	We have published the basic manual and the learning exercises on the web site. We will improve it based on the user feedback.
	Conducting training programs	We have conducted the initial training program in May 2011.	We organized training for the internal staff. However, we will conduct two other training programs for industry and government organizations. After we conduct these training programs, we should enhance the system by including the user feedback.

Project objectives	Activities	Time required for activities implementation	Overall assessment
Developing an education tools to teach IPv6 protocols and application development	Preparing learning exercises	We have conducted this activity in June 2011.	Several exercises were developed. However these materials need to be fine-tuned. We will continuously develop new materials based on the demand. We also expect, people may contribute to the VIPNet by developing their own teaching materials.
	Conducting a training program	We have conducted the initial training program in May 2011.	We organized training for the internal staff. However, we will conduct two other training programs for industry and government organizations. After we conduct these training programs, we should enhance the system by including the user feedback.
	Publishing research papers	The first research paper has completed in June 2011.	We have planed to publish at least three (3) research papers based on our findings. The first paper was completed in June 2011 and will submit to a conference in early July. We are writing two other research papers and we expect to publish it during this year.
Helping the deployment of IPv6 networks by enabling IPv6 applications	Conducting training programs	We have conducted the initial training program in May 2011.	We organized training for the internal staff. However, we will conduct two other training programs for industry and government organizations. After we conduct these training programs, we should enhance the system by including the user feedback. We have initiated the discussion with APNIC to conduct the join training programs.
	Conducting IPv6 Application testing	This activity has started in June 2011 and will continue even after the project funding.	We have started testing few applications but we have to find out some generic methodologies to do that. The manual, which describes the application testing procedures, is yet to complete.
	Publishing research papers	The first research paper has completed in June 2011.	After we conduct the training programs, we will publish two other research papers.

Project outputs and dissemination

Even though we have completed the first version of the VIPNet software, all the activities must be continued to enhance the project outputs. Thus all project outputs are listed as working progress.

Project outputs	Status	Assessment	Dissemination efforts
VIPNet Software tool kit	Work in progress	The first version of VIPNet tool was published. However, we continuously improving the VIPNet software.	The first version was published at the score.ucsc.lk/vipnet web site.
The manual of the VIPNet.	Work in progress	The first version was published. Since we continuously improving the VIPNet software manual have to change accordingly.	The manual was published at the score.ucsc.lk/vipnet web site.
Teaching materials such as laboratory sheets.	Work in progress	We have developed several laboratory sheets for fundamental IPV6 training. We will develop more laboratory sheet based on future requirements. We also expect IPV6 community will propose possible exercises.	The laboratory sheets were published on the score.ucsc.lk/vipnet web site. Printed copies of the laboratory sheets are given to the workshop participants
IPV6 training workshops.	Work in progress	We organized training for the internal staff. However, we will conduct two other training programs for industry and government organizations. After we conduct these training programs, we should enhance the system by including the user feedback.	Training materials are published on the web site. Participants can use the on-line version or download the VIPNet and install their own version.
Research papers publish at international conferences	Work in progress	The first research paper has completed in June 2011.	After we conduct the training programs, we will publish two other research papers.

Lessons learned from project implementation

When we started the project, the project team did not have good knowledge on IPv6. One of the first activity we did was trained our internal staff. Having technically competent human resource is quite import on this type of project.

Our software development stage took more time than expected since we have to identify the suitable virtualization technology. Even though we have released the first version, our tool lit need to be further improved. We are expecting user feedback to do so.

Publishing research papers requires more time than we expected. Specially we should have end user feedback to publish a good research paper. However, we have completed an initial research paper.

Project management and sustainability

Dr. Kasun De Zoysa, senior lecturer at UCSC, works as the principle investigator/advisor of the VIPNet research projects. Dr. Chamath Keppitiyagama, senior lecturer at UCSC, works as the advisor for the research project. Mr. Kenneth Manjula and Mr. Manula Waidyanatha work as a Research Assistant and Programmer.

We have started the training of permanent UCSC staff interested on IPv6. Under this training program, Dr. Chamath Keppitiyagama visited ACM SIGCOMM 2010 conference in India.

After the project period, VIPNet will be maintained as open source project supported by the open source community in the world. We believe organizations that support IPv6 activities will provide necessary financial support. Any IPv6 software development institute or an education institute in the world will be able to use VIPNet free of charge.

Impact

The knowledge gain and software developed in this project directly help IPv6 application development community. In addition, education institutes will also get the benefit of the project. Since we conduct the local training program, it helps IPv6 network deployment in Sri Lanka.

Overall Assessment

The virtual network creation methodology and the software toolkit (VIPNet) are the main findings of the project. The first release of the VIPNet available at score.ucsc.lk/vipnet/ web site. VIPNet can be used as IPv6 application deployment and testing tool as well as teaching tool. As mentioned, the IPv6 teaching materials were developed and a training program was conducted. However, more teaching materials will be developed and more training programs will be conducted in coming months.

Recommendations

ISIF funding program provides great opportunity to the researches live in an Asian country to conduct an innovative research. The funding amount is reasonable to conduct a quality work in a developing country. However we feel that time period is too short to get a quality publication in competitive conferences and journals. In addition, formal financial procedures at the local institutes and the Asian countries may affect the process of fund transferring and purchasing equipments. Therefore we would like to recommend 24 months

funding period instead of 12 months with AUD 50,000.00 budget.

The most of the funding agencies will withdraw from Asian region in near future. Thus we would like to recommend ISIF to be self-funded. In order to do that, ISIF can make arrangements with research and development unit in the leading companies.