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Abstract:

This deliverable presents a report from the workshop held in Lusaka, Zambia from the 27th - 28th April, 2011. The presentation material is listed, the attendees and their affiliations are given, and the opportunities for further co-operation and follow-up actions are described.

Keywords:

IPv6, Support, Training, Testbeds, Modules, 6DISS, 6DEPLOY, 6DEPLOY-2, Hands-on exercises

Disclaimer

Executive Summary

One of the main activities in the 6DEPLOY-2 project is to organise workshops to train the different Internet communities in the areas of IPv6 deployment, configuration, and usage. This project is a follow up of previous project activities within and outside the Framework Programmes of the European Commission.

This deliverable presents a report from the workshop held in Lusaka, Zambia from the 27th - 28th April, 2011. The following workshop details are described in this report: a) the workshop attendees and their affiliations, b) the programme outline, c) the material presented, d) hands-on exercises, e) an assessment of the opportunities for further co-operation, and f) An analysis of the feedback questionnaires from the participants.

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1. INTRODUCTION

1.1 6DEPLOY-2 Objectives

The following comprise the 6DEPLOY-2 objectives:

- to support the deployment of IPv6, in Europe and developing regions
- to sustain the wealth of 6DEPLOY training material (e-learning package with subtitles in national languages, presentation material, exercises, etc.)
- to create a catalyst of global IPv6 expertise through the installation of strategically-placed sustainable IPv6 training labs
- to synchronise with the training schedules of AfriNIC and LACNIC (and also APNIC) to exploit training opportunities cost effectively in Africa, Latin America and Asia
- to revive the IPv6 Cluster
- to describe deployment examples on the project Website
- to exploit the expertise and high quality training material from 6DEPLOY, including presentations, the e-learning course and the available IPv6 Labs, and - whilst continuing to offer professional training to organisations in Europe and developing countries - focus on supporting real deployments
- to maintain and update the 6DEPLOY material and include new training media, and multiply its training effectiveness through courses which educate other trainers about the basics of IPv6, so that they can teach others ("training trainers")
- to extend to global scale the IPv6 Labs. Sustainability is achieved initially through the careful selection of locations for the installations (e.g. within NRENs) where the connectivity, funding and qualified staff support are all secured
- to support the (human) networking between the Lab managers with regular workshops.

One of the main activities in the 6DEPLOY-2 project is therefore to organise workshops to train the different Internet communities in the areas of IPv6 deployment, configuration, operation, and management. This activity is a follow up of previous project's activities within and outside the Framework Programmes of the European Commission.

1.2 6DEPLOY-2 Workshop Methodology

The 6DEPLOY-2 methodology relating to the workshops is shown in the diagram below:

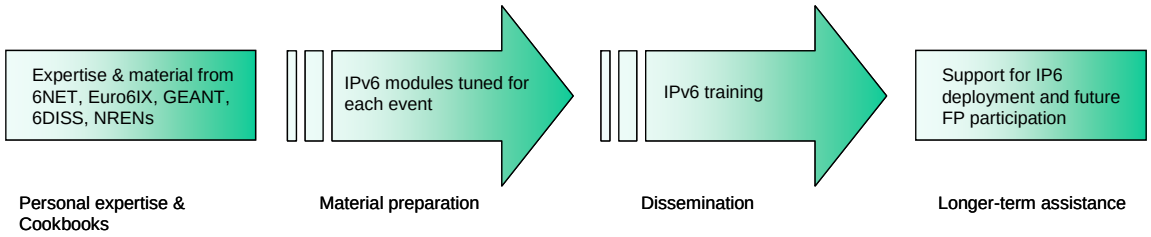


Figure 1-1: 6DEPLOY-2 methodology (diagrammatically)

The approach is to use course material available from 6DEPLOY and elsewhere that relates to IPv6, the e-learning course, and the 6NET IPv6 Deployment Guide book, together which will form the basis of the training material. This training material is supplemented with knowledge from partners' participation in events such as IPv6 Forum meetings, IPv6 Task Force meetings, Internet2 meetings, and the IETF, and from the experience of similar activities brought to the project by the representatives of the Internet Registries in North and South America, the Asia-Pacific region, Africa, and Europe. The knowledge is disseminated through training sessions that, for practical reasons, are often held in conjunction with AfriNIC, LACNIC, APNIC, AfNOG, APRICOT, and ISOC meetings.

After each workshop, feedback reports are collected from the participants, enabling 6DEPLOY-2 to assess the impact of the presentations and to identify any areas that need improvement.

The full set of dissemination materials (including the e-learning course and 2 managed testbeds) is available from 6DEPLOY and partners´ own sources. This includes presentation slides on all issues of Internet deployment and evolution; especially IPv4-IPv6 transition strategies, DNS, DHCP, routing, QoS, MobileIP, multicast, renumbering, auto-configuration, security, monitoring and management tools, and applications. This material was described in the deliverable D1.1.1: "Report of the available training material and the assignment of partners responsible for maintaining each item".

This deliverable presents a report from the workshop held in Lusaka (Zambia) from the 27th - 28th April, 2011. The workshop comprised both slide presentations and hands-on exercises using remote testbeds.

Chapter 2 of this document explains the general motivation for running IPv6 workshops, and chapter 3 describes the specific details of this workshop, in terms of the attendees, the modules that were presented, and the "hands-on" exercises that were performed. Chapter 4

identifies opportunities for further collaboration in the region and follow up actions, Chapter 5 summarises the analysis of the feedback questionnaires that were filled in by the participants, and Chapter 6 provides some general conclusions.

2. THE WORKSHOPS (GENERAL)

Workshops are one of the main mechanisms used by 6DEPLOY-2 to transfer information and to build collaboration.

6DEPLOY-2 is structured to provide an ideal platform for the discussion of deployment scenarios and the exchange of best practices, thereby avoiding duplication of effort, by preventing the waste of time on techniques that are known not to have been deprecated, and generally making the most efficient use of the available resources in a region. Partners in 6DEPLOY-2 have deployed IPv6 on a production basis in their own NRENs and University networks, and have documented their experiences in Cookbooks and in IETF informational/best common practice RFCs. The manufacturer in the consortium is building IPv6 products.

The workshops are not only intended to lead to an improved quality of the Internet infrastructure in developing countries, but will also raise the competence of the attendees and, in exploiting the personal contacts made through 6DEPLOY-2, facilitate and encourage the participation of their organisations in future FP7 calls and beyond.

Impacts from the workshops will include:

- A positive effect towards preventing the “brain drain” from developing countries by bringing interesting and state-of-the-art activities into these regions, thus making information and knowledge resources accessible to scholars both locally and globally;
- An expansion of the conditions for growth by enabling the exchange of ideas, launching joint experiments and projects, disseminating RTD results, and activating market forces; all of which are substantial elements in the process of regional development;
- Making European research and industrial concerns aware of the highly skilled personnel who can contribute to the urgently needed improvement of ICT infrastructures, resulting in an increase of the demand for specialized services provided by the highly skilled academics and researchers of the region; and
- The identification of IPv6 deployment activities in the region and an exchange of information about deployment experiences.

While IPv6 standards and services are quite stable, regional variations in practices and operations will require slightly different approaches for collaboration and dissemination. Therefore, the material for these workshops was collected, and the workshop schedules,

formats, and contents were tailored in conjunction with the local organisers so as to suit the type of participants, the subjects to be addressed, the location, the host organisation, the sponsors, etc.

3. THE 6DEPLOY-2 WORKSHOP IN LUSAKA (ZAMBIA)

This IPv6 Workshop was held in Lusaka (Zambia) from 27th - 28th April, 2011. In the following paragraphs we provide information about the workshop, including the programme outline, and the material that was presented.

3.1 Overview

Mukom Akong Tamon from AfriNIC taught the workshop with some assistance for the hands-on exercises from Ernest Byaruganga of AfriNIC.

The course started with a brief overview of the problem i.e. IPv4 address exhaustion. After sharing the statistics and projections for RIR run out dates, the options for dealing with the problem were presented i.e. NAT and IPv6.

The next session dissected the problems inherent with NAT-based approaches and showed clearly that NAT is not a sustainable solution to the problem of IPv4 address exhaustion. Thus IPv6 is left as the only alternative to the continued growth of the Internet.

The fundamentals of IPv6 were then taught, starting with basic addressing, drawing parallels of equivalent IPv6 protocols to the basic functionality protocols that engineers use today with IPv4, IPv6 sub-netting and address planning, basic routing and transition techniques. The session ended with hands-on labs were the participants practiced taking an IPv6 prefix, breaking it up and allocating it to the testbed and then proceeding to configure a full dual-stacked network (addressing, routing) and then transition techniques (manual and 6to4 tunnelling).

3.2 Attendees

	Full Name	Organisation
1	Evans Silavwe	Realtime Africa Alliance
2	Manikavasagar Sanjeev	Microlink Technologies Ltd
3	Bruce Grobler	Ministro Zimbabwe Pvt) Ltd
4	Clifton Masua	Airtel Zambia
5	James Sakala	Quick Edge Ltd
6	Annabel Kangombe	ZAMNET Communication Systems Ltd
7	Anthony Anyoti	Zambia Telecommunications Company
8	Nyimbwa Eddie	Zambia Telecommunications Company

9	Chaka Phiri	CopperNET Solutions
10	Daniel Kalonga	ZAMNET Communication Systems Ltd
11	Derrick Kawisha	CopperNET Solutions
12	Edwin Chisulo	Realtime Technologies
13	Erik Schoute	Africonnect Zambia Ltd
14	Franklin Phiri	CopperNET Solutions
15	Lincoln Kupila	CopperNET Solutions
16	Matthew Mvula	MTN Business Solutions
17	Musonda Kafwembe	ZAMNET Communication Systems Ltd
18	Nchimunya Muleya	MTN Business Solutions
19	Rachel Chibale Zimba	Realtime Alliance
20	Sililo Mabiya	Airtel Zambia
21	VincenT Mwamba	Africonnect Zambia Ltd
22	Winston Ritson	Africonnect Zambia Ltd

Table 3-1: Lusaka (Zambia) attendance list

The participants represented a wide range of the ICT community. While 56% of respondents said that prior to the workshop, they only had basic knowledge and skills in IPv6, with 13% having never heard of IPv6, at least 46% reported that due to attending the workshop, they were confident (reported they could accomplish specific skills-based tasks without any help) in planning the following activities: an IPv6 addressing scheme for their organisation, configuring, testing and troubleshooting a dual stacked network, OSPFv3 routing as well as IPv6 on client operating systems.

3.3 Workshop programme

The agenda was agreed on after close collaboration with the local organisers. The meeting agenda and the related material were submitted in advance so that the local organisers could decide which topics should be prioritised and so manage the logistics accordingly. The programme of the workshop is presented in the following table:

Date	Modules and Topics Covered
27/04/2011	[a] Why NAT is not a sustainable solution to the problem of IPv4 address exhaustion [b] IPv6 Addressing • Address notation, shortening rules and examples • Address types and scopes [c] IPv6 Address Planning • Sub-netting in IPv6 (reasons, procedure with sipcalc and examples + exercise) • About nibble boundaries • Address planning worked example and class exercise

	[d] IPv6 from an IPv4 Perspective • IPv6 packet structure (schematic and live packet capture) • IPv6 and IPv4 packets compared and contrasted • IPv6 compared to IPv4 with respect to Network access layer, automatic IP host configuration options, Link-layer address resolution, FQDN to IP address resolution, host to router multicast membership protocols, automatic default gateway configuration, routing, minimum MTU size and sending packets to all nodes • Neighbour Discovery – features, mechanism plus live packet analysis • Host configuration (Windows and Linux) – class exercise • SLAAC – theory, advantages and disadvantages over DHCPv4, configuration example and packet analysis • DHCPv6 – how it works, difference from DHCPv4 • Exercise: IPv6 ping sweep, and neighbour cache and mac address discovery [e] IPv6 Routing (static, OSPFv3 theory and configuration examples)
28/04/2011	[f] Transition Techniques • Understanding the need and use cases for transition techniques • Dual stack - overview, 'how it works' and configuration examples • Manual tunnels - overview, 'how it works' and configuration examples • 6to4 - overview , 'how it works' and configuration examples • NAT64 - overview , 'how it works' and configuration examples [g] Hands-on Labs (using testbeds) • Sub-netting an IPv6 allocation and assigning subnets to links of lab network • Configuring, testing and troubleshooting IPv6 addresses • Configuring, testing and troubleshooting static routing • Configuring, testing and troubleshooting OSPFv3 routing • Configuring, testing and troubleshooting manual tunnels • Configuring, testing and troubleshooting 6to4 tunnels

Table 3-2: Lusaka (Zambia) Workshop programme

3.4 Presentation material

The following material was presented:

Modules	Presented by	Affiliation
IPv6 Introduction, IPv6 Addressing, Transition and coexistence, and IPv6 Routing	Mukom Akong T.	AfriNIC
Addressing Practice: Sub-netting	Mukom Akong T.	AfriNIC
Hands –on labs	Mukom Akong T. Ernest Byaruhanga	AfriNIC

Table 3-3: Lusaka (Zambia) Workshop list of modules used

The class was divided into 18 groups and each group was assigned to one of the routers in the AfriNIC, RENATER and Consulintel testbeds. Each group was given a printed copy of the

lab manual that details the objectives of the exercises to be performed with step by step instructions as well as all required supporting information. The trainers supervised the exercises, making clarifications and explanations when required.

4. OPPORTUNITIES FOR FURTHER CO-OPERATION

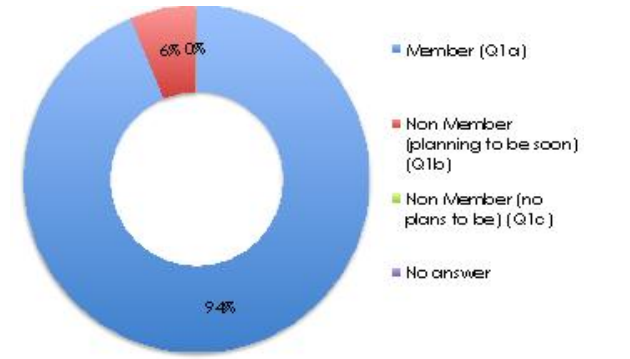
The links to the 6DEPLOY-2 materials were given to the participants. They were also told and shown how to book any of the Labs in the 6DEPLOY-2 project and to practise on their own, either by using the provided lab manual or their own scenarios.

5. ANALYSIS OF THE FEEDBACK QUESTIONNAIRES

1. Characterisation of the participants

94% of the respondents reported themselves to be from organisations that were AfriNIC members and the remaining 6% were from non-member organisations planning to be members soon. This was expected as most participants were from local ISPs and telecommunications companies.

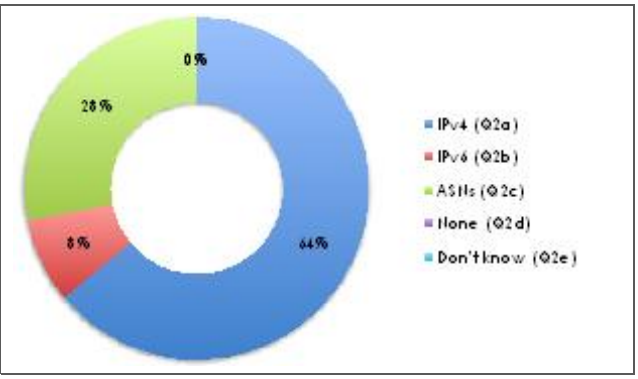
(Q1a) Member	15
(Q1b) Non Member (planning to be a member soon)	1
(Q1c) Non Member (no plans to be)	0
No answer	0



2. Internet number resources being used at participant's organisations

While 64% of the respondents reported they were using IPv4 resources, 8% and 28% reported that they were using IPv6 and ASNs respectively.

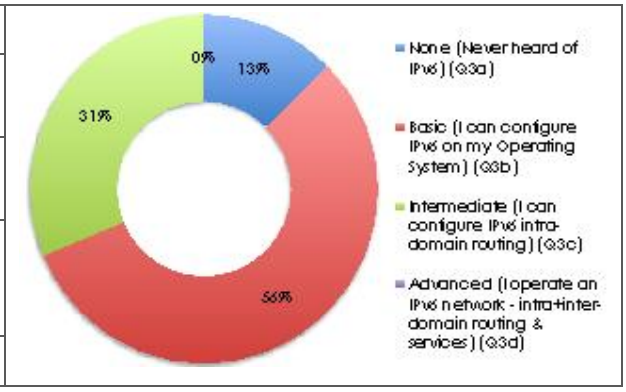
(Q2a) IPv4	16
(Q2b) IPv6	2
(Q2c) ASNs	7
(Q2d) None	0
(Q2e) Don't know	0



3. Pre-workshop knowledge and skills

56% of the respondents reported that they had basic IPv6 skills prior to the workshop and 13% reported they had never heard about IPv6.

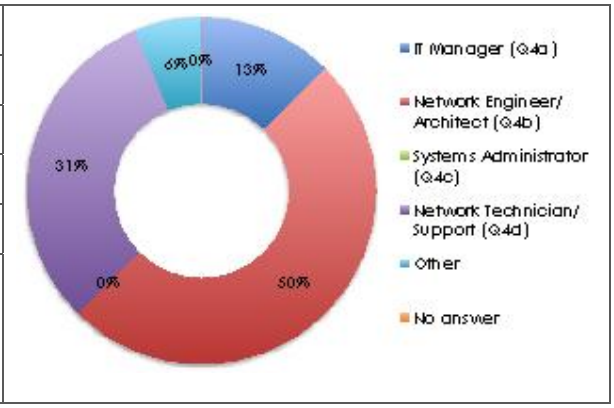
(Q3a) None (Never heard of IPv6)	2
(Q3b) Basic (I can configure IPv6 on my Operating System)	9
(Q3c) Intermediate (I can configure IPv6 intra-domain routing)	5
(Q3d) Advanced (I operate an IPv6 network - intra+inter-domain routing & services)	0
(Q2e) No answer	0



4. Primary role in the organisation

Network engineers and architects made up half the class, 31% were network technicians or support staff and 13% were IT managers.

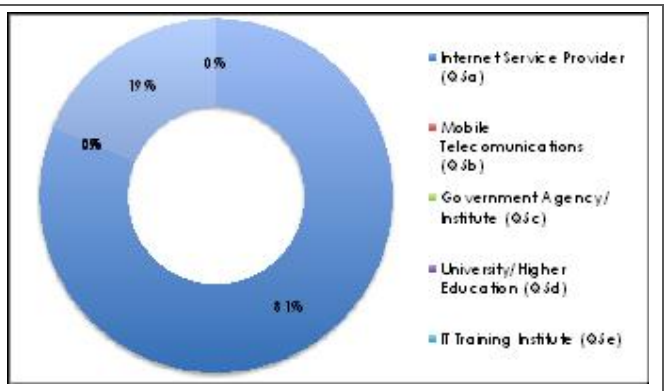
(Q4a) IT Manager	2
(Q4b) Network Engineer/Architect	8
(Q4c) Systems Administrator	0
(Q4d) Network Technician/Support	5
(Q4e) Other	1
No answer	0



5. Primary industry of the organisations present

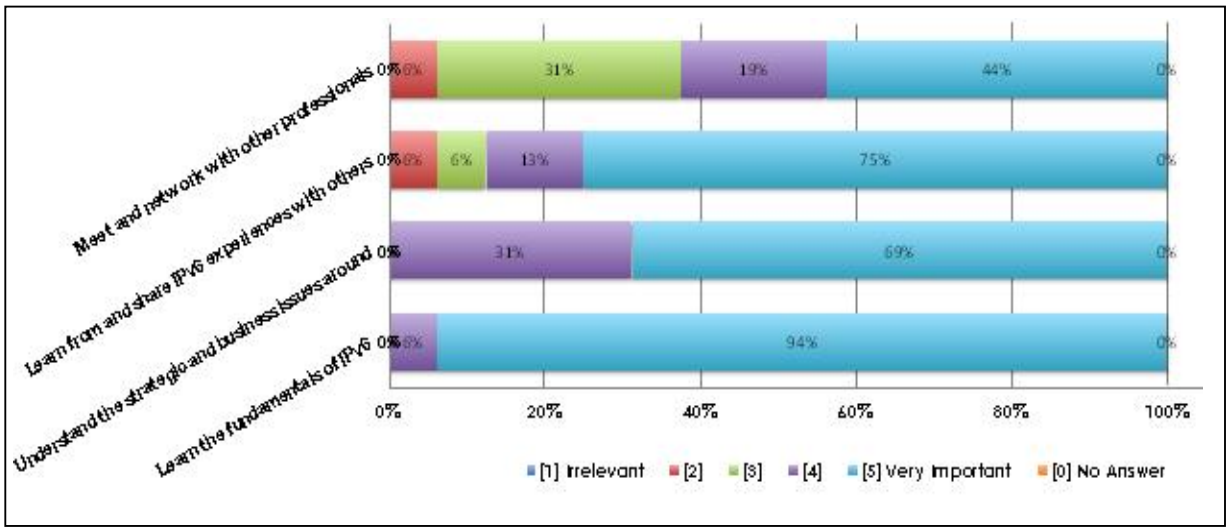
As expected, 81% were ISPs. The other 19% were from combined Telecommunication/ISP training organisations.

(Q5a) Internet Service Provider	13
(Q5b) Mobile Telecommunications	0
(Q5c) Government Agency/Institute	0
(Q5d) University/Higher Education	0
(Q5e) IT Training Institute	3
(Q5d) Finance/Banking	0
(Q5f) Other	0
No answer	0



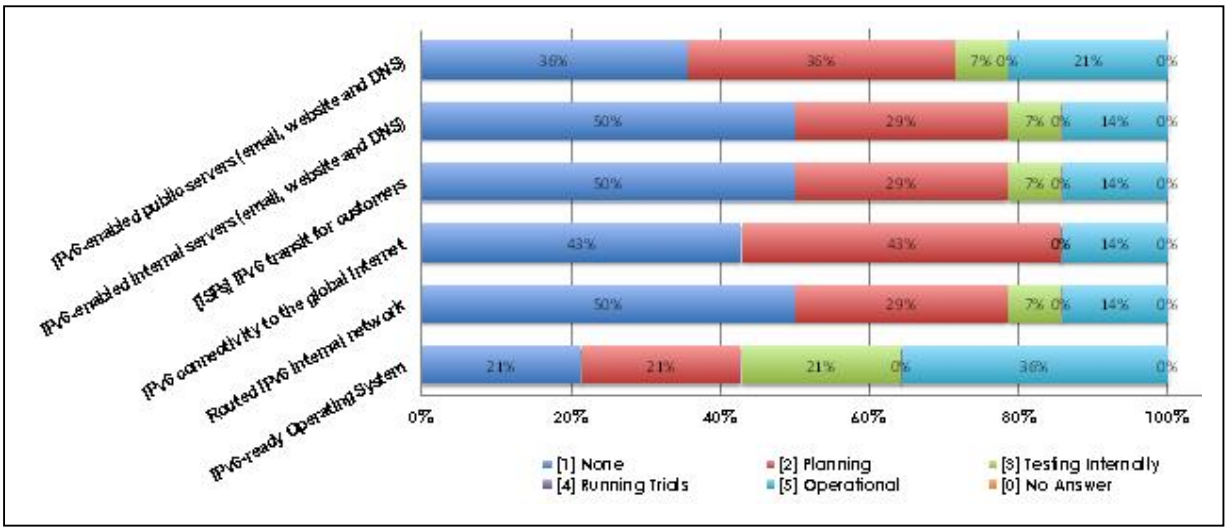
6. Reasons for attending the workshop

The most important reason participants gave for attending the workshop was to learn the fundamentals and understand the IPv6 strategy and learn/share as well the IPv6 experiences of others. Understanding the strategic and business issues in matters of training was the second most important reason for attending, with 69% considering it very important.



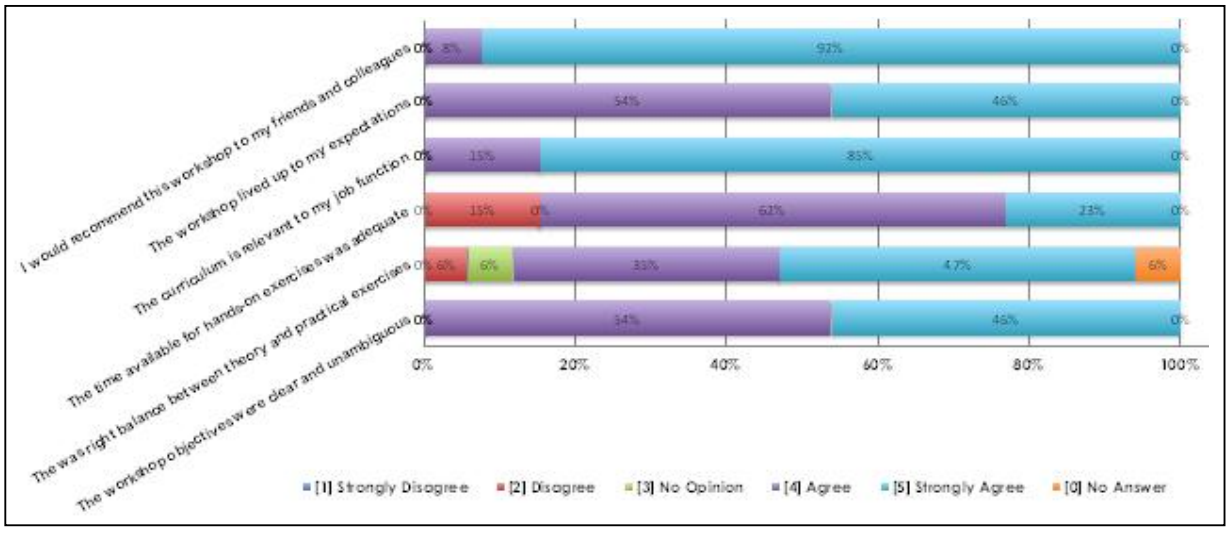
7. Implementation status of related technologies

At least 14% of the respondents had IPv6 enabled networks with services to customers while at least 7% were testing various IPv6 technologies internally.



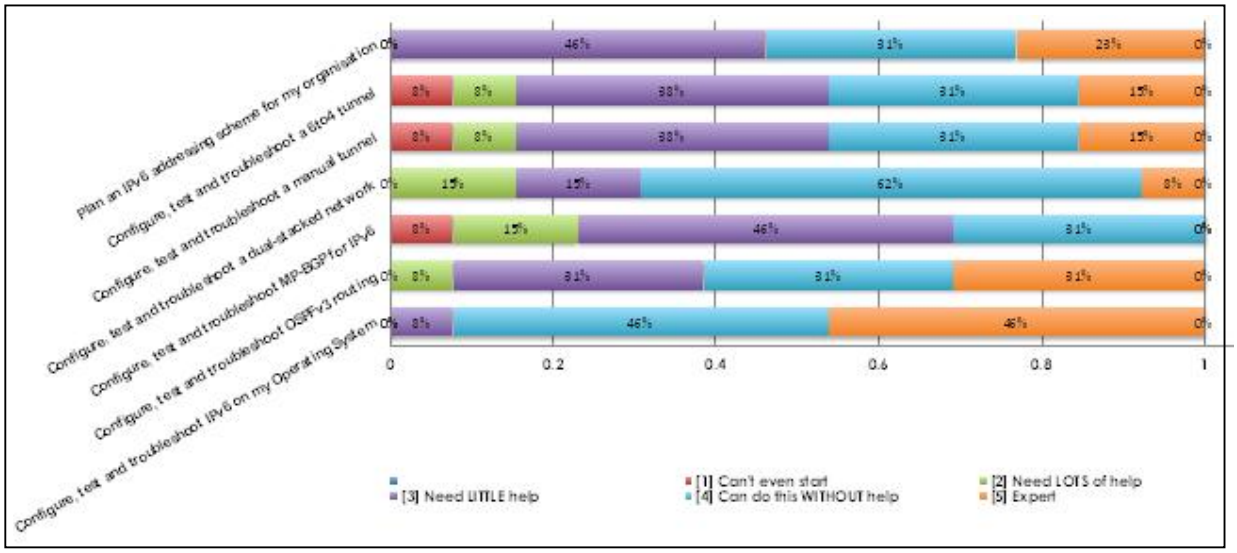
8. The effectiveness of the workshop design

All of the respondents agreed or strongly agreed (54% and 46% respectively) that the workshop objectives were clear and unambiguous. 82% agreed or strongly agreed that there was right balance between theory and practice. There was unanimous consensus that the curriculum was relevant to the various job functions represented and 92% will highly recommend the workshop to friends and colleagues. 15% however would like to see more time allocated to hands-on exercises.



9. Post-workshop knowledge and skills

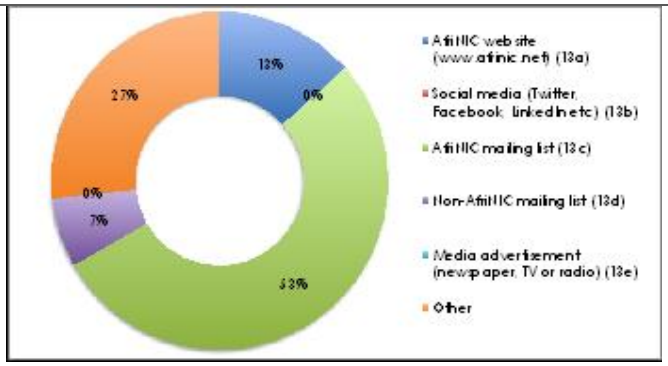
At least 46% of respondents reported confidence at configuring, testing and troubleshooting a dual-stacked network as well as manual tunnels. 44% were confident with IPv6 address planning for their organisations. Compared to the 31% who reported being able to configure intra-domain routing, 62% were able to do so confidently as a result of attending this workshop with a further 31% needing a little help to accomplish the task. Compared to the 56% who reported basic skill at the start of the workshop, 92% expressed confidence in their basic IPv6 capability as a result of attending this workshop.



10. How participants learnt about the workshop

66% of the attendees found out about this workshop either through our website or mailing list (53% and 13%) respectively while 27% found out through local ISP association or their companies and 7% found out through non-AfriNIC mailing lists.

(Q13a) www.afrinic.net	2
(Q13b) Social networks	0
(Q13c) AfriNIC mailing lists	8
(Q13d) Non AfriNIC mailing lists	1
(Q13e) Media advertisement	0
Other	4

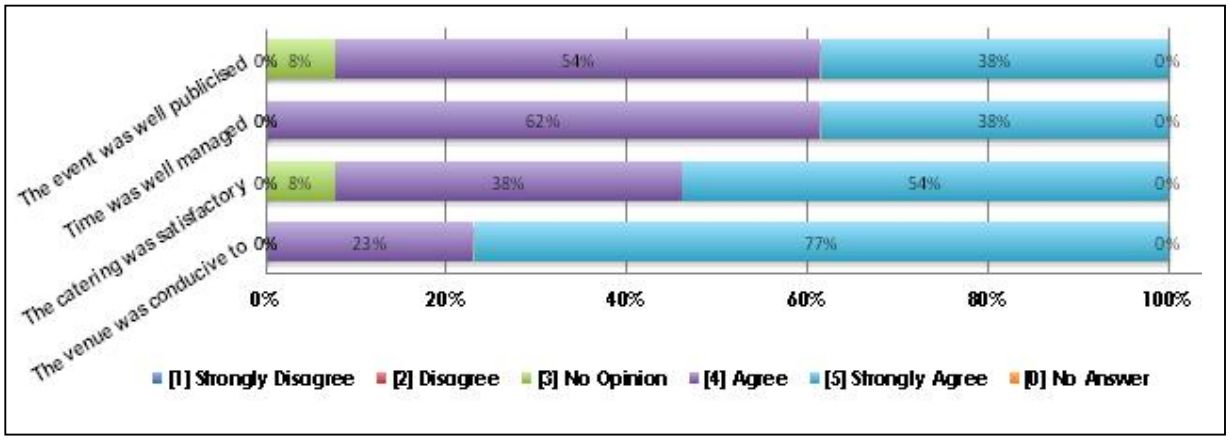


11. Other topics participants would have liked to see treated

a) How to deploy IPv6 in the MPLS networks
b) More hands-on lab exercises especially for the advanced topics
c) MP-BGP for IPv6
d) More days of theory and then practice for the first time attendees.
e) Security

12. General event organisation

The data shows that the event was generally well organised (At least 50% of all respondents rated "Agree" on three of the four characteristics). More effort needs to be put into publicity and time management.



General comments on the event were as follows:

- "Could you include sample configurations form other routers such as Alcatel, etc."
- "Thanks for the important learning IPv6 sessions.... invaluable!!!"
- "More training in Zambia"
- "If such tutorials are not found online, kindly put them for more practice and exposure."
- "Training was short and would suggest that you accord it more time. Thank you the AfriNIC management for according me a chance to attend."

6. CONCLUSIONS

Workshops are a key mechanism through which information, knowledge, and know-how are transferred to less experienced countries and participants. The workshops enable us to build constituencies and raise awareness; disseminate, benchmark, and validate the research results from the EU's Framework Programmes; promote European technologies; exchange best practices; and offer information related to standards and interoperability issues.

The 6DEPLOY-2 workshop took place in Lusaka - Zambia from 27th - 28th April, 2011. This Workshop was held in collaboration with the ISP Association of Zambia (a body that comprises all the service providers in the country and are in charge of the IXP) who organized the logistics for the event. AfriNIC led this workshop and used new testbeds from the project that are deployed in Mauritius, Paris - France and Madrid - Spain.

In summary, this workshop should be considered a success with regard to the dissemination of IPv6.

7. REFERENCES

- 6DEPLOY-2 website: (http://www.6deploy.eu)
- 6DISS website: (http://www.6diss.org)
- Hands-on modules: (http://www.6deploy.eu/index.php?page=hands-on)
- How-to organise an IPv6 workshop: (http://6diss.6deploy.eu/workshops/workshop-guidelines.pdf)
- Training the trainers workshop: (http://6diss.6deploy.eu/workshops/ttt/)
- e-learning package: (http://www.6deploy.eu/index.php?page=e-learning)
- 6DEPLOY-2 Workshops Agenda and detailed information: http://www.6deploy.eu/index.php?page=workshops2