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Abstract: This deliverable presents a report from the workshop held in Accra (Ghana) on the 7 th and 8 th 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.
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Keywords: IPv6, Support, Training, Testbeds, Modules, 6DISS, 6DEPLOY, 6DEPLOY-2

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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 Accra (Ghana) on 7th and 8th 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.

Table of Contents

- 1. Introduction..... 6**
 - 1.1 6DEPLOY-2 Objectives 6**
 - 1.2 6DEPLOY-2 Workshop Methodology 7**
- 2. The Workshops (general)..... 9**
- 3. The 6DEPLOY-2 Workshop in Accra (Ghana) 11**
 - 3.1 Overview 11**
 - 3.2 Attendees 12**
 - 3.3 Workshop programme 13**
 - 3.4 Presentation material 14**
- 4. Opportunities for Further Co-operation 15**
- 5. Analysis of the Feedback Questionnaires..... 16**
- 6. Conclusions 21**
- 7. References 21**

Figure Index

Figure 1-1: 6DEPLOY-2 methodology (diagrammatically) 7

Table Index

Table 3-1: Accra (Ghana) 13

Table 3-2: Accra (Ghana) Workshop programme..... 14

Table 3-3: Accra (Ghana) Workshop list of modules used 14

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:

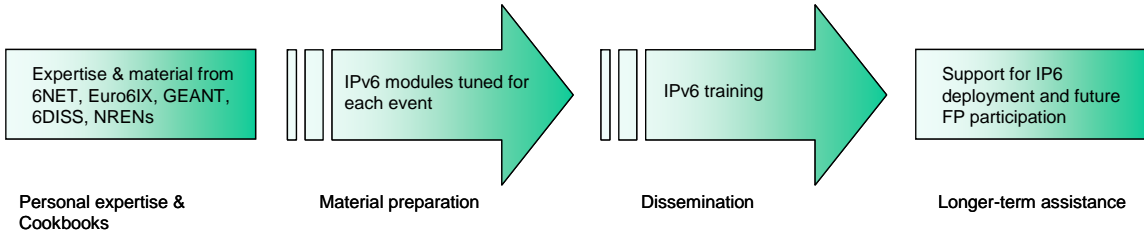


Figure 1-1: 6DEPLOY-2 methodology (diagrammatically)

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 Accra (Ghana) on the 7th and 8th April 2011. The workshop comprised both slide presentations and hands-on exercises using remote testbeds for routing exercises.

Chapter 2 of this document explains the general motivation for running IPv6 workshops, and Chapter 3 describe 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 ACCRA (GHANA)

This IPv6 Workshop was held in Accra (Ghana) on 7th and 8th 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 led the workshop from AfriNIC with some assistance from Ernest Byarunga.

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 and showed clearly that NAT is not a sustainable solution to the problem of IPv4 address exhaustion. Thus, the only alternative is IPv6.

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 where the participants could practise taking an IPv6 prefix, subdividing it and allocating it to the testbed and then proceeding to configure a full dual-stacked network.

3.2 Attendees

	Full Name	Organisation
1	Abraham A. Armarboye	Office of Parliament
2	Andrew Asihene Akwaah	Ministry of Health
3	Augustine Arthur	Forrestry Commision - Ghana
4	Dan Selorm Kwami Ameme	MTN Ghana
5	Daniel Katey Osifo-Due	Ghana Immigration Service
6	Denise Mghoi Madeda	Kenya Data Networks
7	Dennis Ofori	Ministry of Finance and Economic Planning
8	Eben Boadi	Ghana Health Service
9	Ebenezer Sekoh Mensah	Directorate of Communication, Ghana Armed Forces, Burma Camp. Accra
10	Edward Kwabena Tawiah	Ghana Irrigation Development Authority
11	Emmanuel Togo	University of Ghana
12	Eric Nyarko-Aboagye	Ghana Statistical Service
13	Eunice Nortey	Vodafone Ghana
14	Hanna Adanse-Pippim	National Information Technology Agency
15	Ivy Tuffuor Afram	Broad Band Home
16	Jacob Bubune Fenuku	Teledata ICT Ltd
17	Julius Kudzie	Ecoband Networks
18	Justice Ampadu	IS Internet Solutions Ghana Ltd
19	Kevin Kamonye	Kenya Data Networks
20	Nii Okle Afotey-Agbo	Ghana Armed Forces
21	Novisi Dzitrie	University of Cape Coast
22	Rajnish Sharma	Teledataict
23	Rexford Koney	Ministry of Information
24	Yakubu Boabeng	Ghana Armed Forces, Data Processing Centre
25	Benedict Nana Yaw Nyarko	Ghana Multimedia Incubator Center
26	Christopher Addo	KNUST Elearning Center
27	Daniel Ofori	Vodafone Ghana
28	Dean Kwabi	Methodist University MTLRC
29	Edward Bart Simpson	Broad Band Home
30	Emad Aldin Allazem	Sudatel
31	Emmanuel Acha	DigiHUB International
32	Eric Kwame Mante-Bediako	Ministry of Trade and Industry
33	FRANCIS OWIAFIE	NetAfrique Dot Com Ltd
34	Francis Paintsil	Ministry of Energy
35	Fred Kofi de Heer-Menlah	GIMPA

	Full Name	Organisation
36	Isaac Kumfo	Ghana Airports Company Limited
37	Isaac Mensah Addo	GAFMS
38	John K.E. Edumadze	University of Cape Coast
39	Kuassi Mulro DIOGO	LIPTINFOR NIGER SA
40	Lawrence Agbavitor	Ghana health service
41	Maxwell Akornor	Ministry of Education
42	Michael Adotey Codjoe	University of Ghana
43	Michael Asante	KNUST
44	Nathaniel Choful	MTN Ghana
45	Prempeh agyeibi akwasi	Ministry of transport
46	Prince Annan Koomson	Metrofile Ghana Limited
47	Reynolds Oduro-Brako	Ghana Commercial Bank Limited
48	Wisdom donkor	ICT 2 DAYS SERVICES

Table 3-1: Accra (Ghana) Workshop participants

(the highlighted names stayed through both days)

The participants represented a wide range of the ICT community. They were technical people whose knowledge about IPv6 ranged from almost no knowledge at all to having significant experience with IPv6 deployment. Some had already performed IPv6 experiments or were planning some level of deployment at their institutions.

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
06/04/2011 (Half day)	<ul style="list-style-type: none"> • Why NAT is not a sustainable solution to the problem of IPv4 address exhaustion
07/04/2011	<p>[a] IPv6 Addressing</p> <ul style="list-style-type: none"> • Address notation, shortening rules and examples. • Address types and scopes <p>[b] IPv6 Address Planning</p> <ul style="list-style-type: none"> • Sub-netting in IPv6 (reasons, procedure with sipcalc and examples + exercise) • About nibble boundaries • Address planning worked example and class exercise. <p>[c] IPv6 from an IPv4 Perspective</p> <ul style="list-style-type: none"> • IPv6 packet structure (schematic and live packet capture,)

	<ul style="list-style-type: none"> • 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 <p>[d] IPv6 Routing (static, OSPFv3 theory and configuration examples)</p>
08/04/2011	<p>[e] Transition Techniques</p> <ul style="list-style-type: none"> • 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 <p>[f] Hands-on Labs (using testbeds)</p> <ul style="list-style-type: none"> • Sub-netting an IPv6 allocation and assigning sub-nets 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: Accra (Ghana) 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.	AfriNIC

Table 3-3: Accra (Ghana) Workshop list of modules used

The class was divided into 12 groups and each group assigned to one of the routers in the AfriNIC and Consulintel testbeds. Each group was given a printed copy of the handout that details the objectives of the exercises as well as all required information. The trainers supervised the exercises, making clarifications and explanations when required.

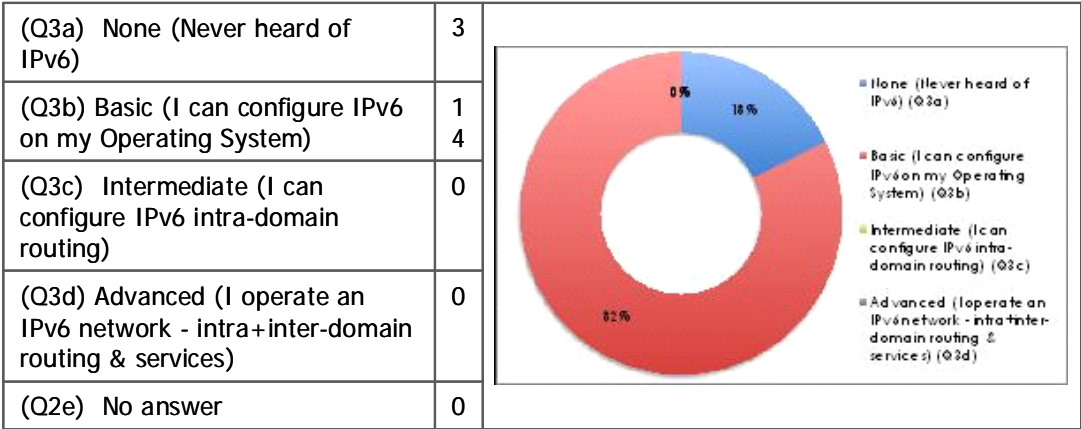
4. OPPORTUNITIES FOR FURTHER CO-OPERATION

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

5. ANALYSIS OF THE FEEDBACK QUESTIONNAIRES

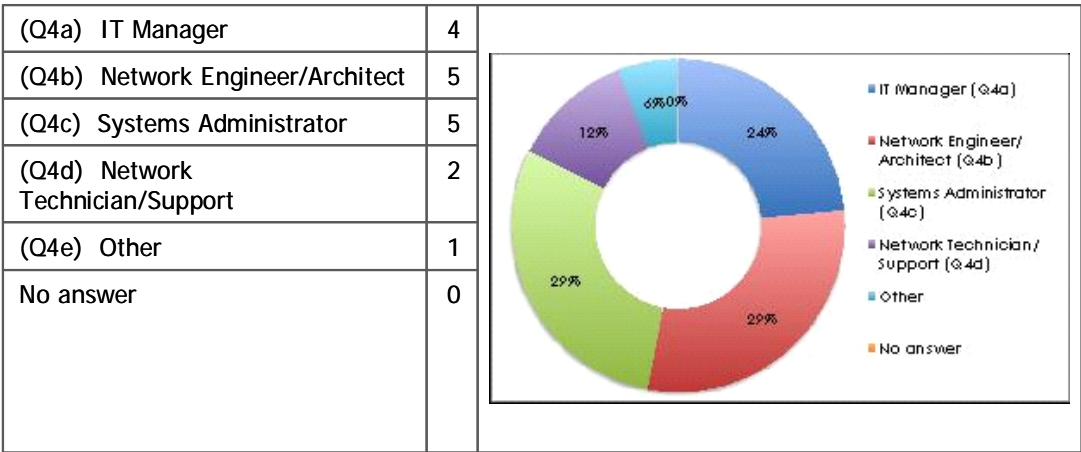
a) Pre-workshop knowledge and skills

82% of the respondents reported that they had basic IPv6 skills prior to the workshop and 18% reported they had never heard about IPv6.



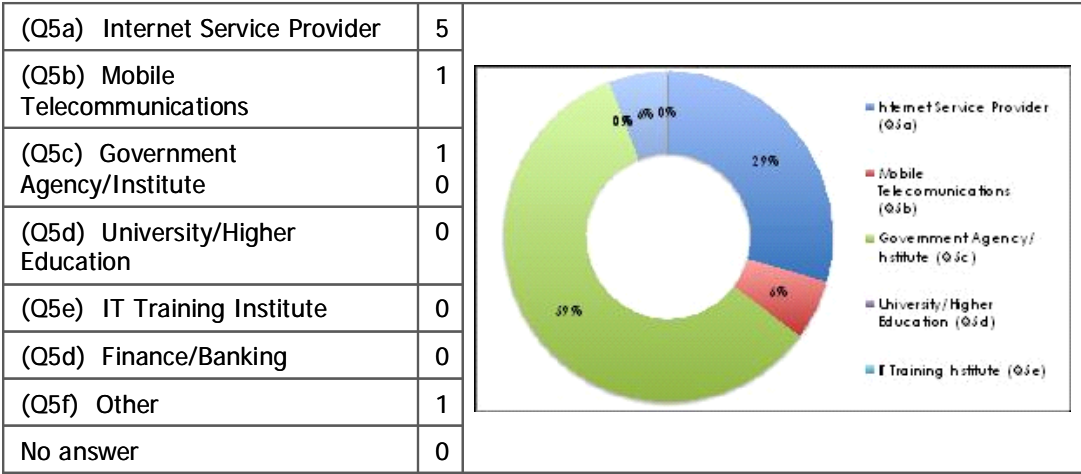
b) Primary role in the organisation

Network engineers and Systems engineers made up 58% of the class, IT managers made up 24% and network technicians 12%.



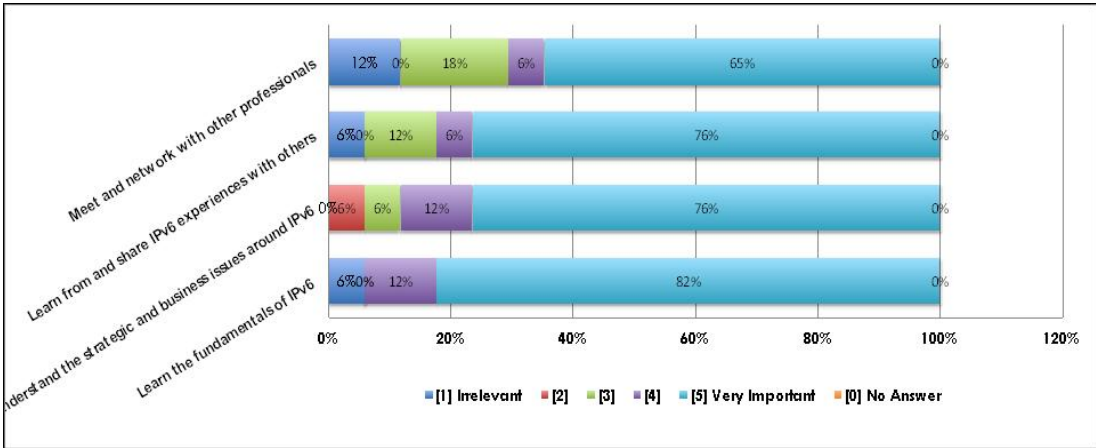
c) Primary industry of the organisations present

More than half (59%) of the participants were IT staff from government agencies and 29% were from the service provider community.



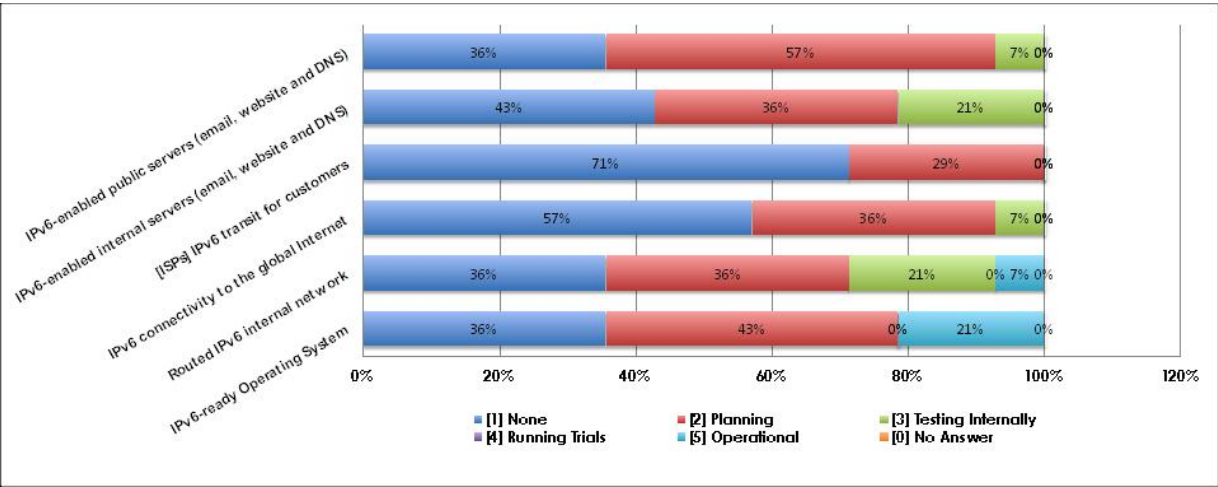
d) Reasons for attending the workshop

The most important reason participants gave for attending the workshop was to learn the fundamentals of IPv6, with 82% stating this was very important. 76% also stated that understanding the strategic and business issues around IPv6 as well as learning and sharing from the IPv6 experience was a very important reason why they attended the workshop. 65% reported networking as a very important reason for attending.



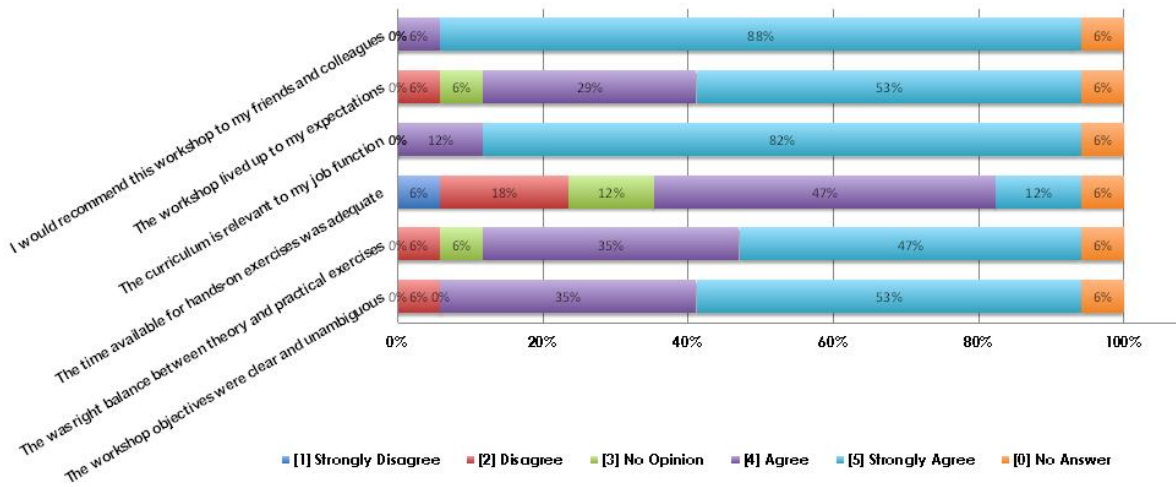
e) Implementation status of related technologies

More than half (57%) of the respondents reported that they were planning to enable public services over IPv6, 7% were testing it internally while 36% had no plans for now. Twenty-one (21%) reported that they were testing IPv6 for internal servers as against 43% of respondents who had no plans and 36% who were planning. 71% of the ISP representatives stated that they had no plans for IPv6 transit to customers while 29% were in the planning stage. 36% of the respondents were planning internal routed IPv6 networks, the same number had no plans, 21% were testing and 7% had operational routed internal IPv6 networks.



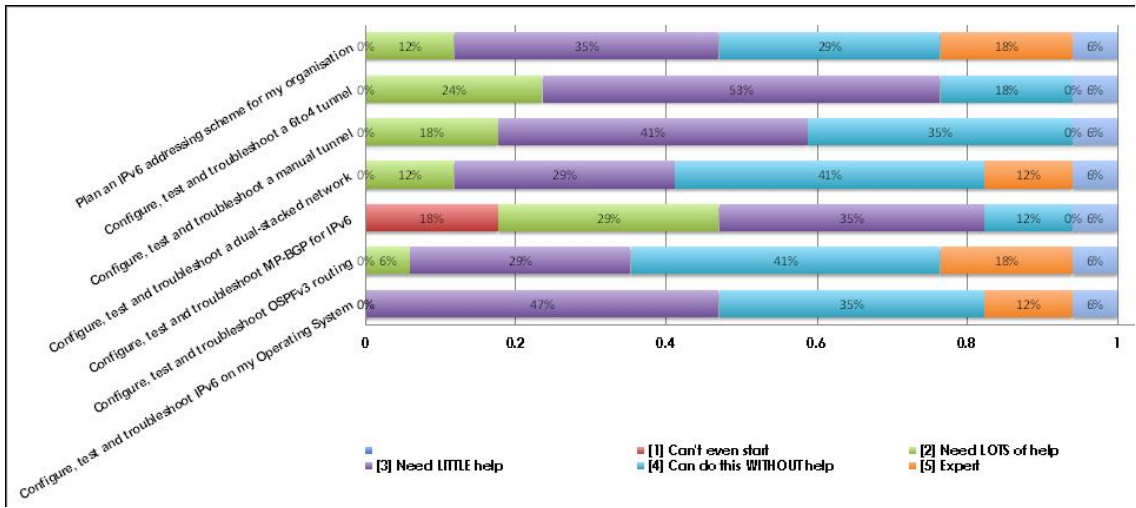
f) The effectiveness of the workshop design

88% of the respondents agreed or strongly agreed (35% and 53% respectively) that the workshop objectives were clear and unambiguous. 82% agreed or strongly agreed that there was a correct balance between theory and practice. There was unanimous consensus that the curriculum was relevant to the various job functions represented and 88% will highly recommend the workshop to friends and colleagues. 24% however would like to see more time allocated to hands-on exercises.



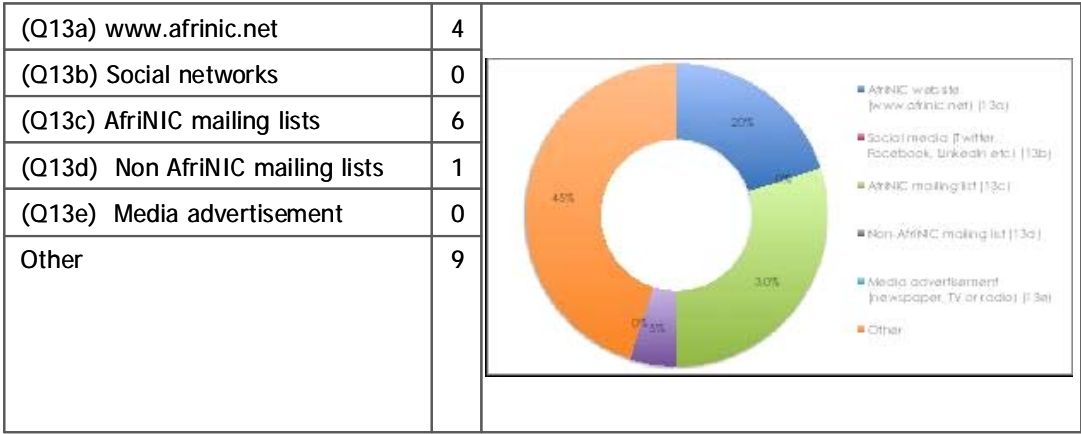
g) Post-workshop knowledge and skills

On each of the non-basic skills cited in the survey, at least 47% reported confidence in planning 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. The least effective skills mastered were the transition techniques and MP-BGP where more than 40% would need help in accomplishing tasks depending on such skills. Compared to the vast majority who reported that at the start of the workshop, their level of IPv6 knowledge was very basic; this was a very effective workshop.



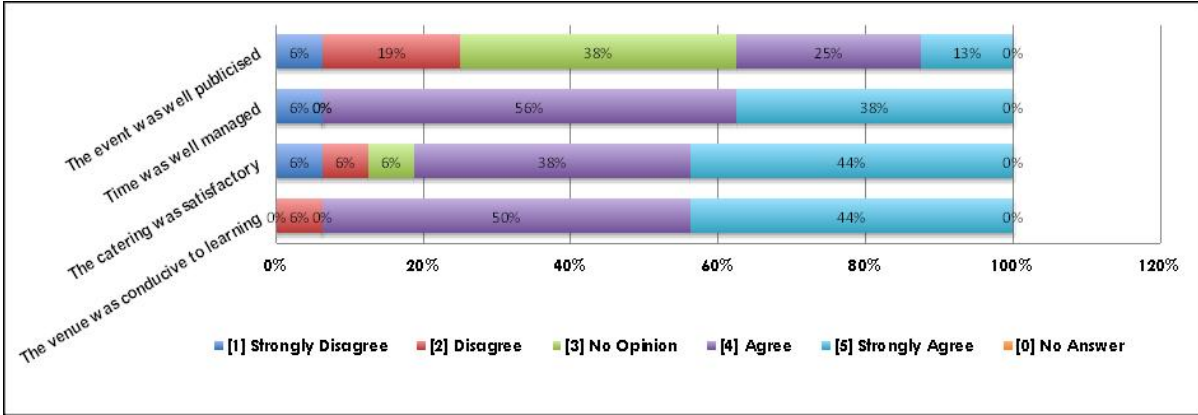
h) How participants learnt about the workshop

Half of the respondents (50%) found out about this workshop either through our website or mailing list (20% and 30%) respectively while 45% found out through other means (most likely invitation letters sent out by local host) and 5% found out from other mailing list. No one heard of the workshop through social networks.



i) 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.



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 Accra, Ghana on April 7th and 8th 2011. This Workshop was held in collaboration with the National Information Technology Agency (NITA) who organize the logistics for the event. AfriNIC led this workshop and used testbeds from the project that are deployed in Mauritius and Madrid (Consulintel)

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>