Technical Capacity Building at KENET

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Abstract

Kenya Education Network (KENET) is the National Research and Education Network of Kenya. It promotes the use of ICT in Teaching, Learning and Research in Higher Education Institutions in Kenya. This includes building the technical and campus networks engineering capacity of the higher education institutions in Kenya.

This paper seeks to highlight the areas of focus of technical capacity building at KENET, the training calendar as well as discussing what it takes to plan, execute and sustain a training program. It will also highlight the impact of the training courses in the past five years.

Keywords: Technical Capacity Building, Technical Training, Twinning Arrangement, NREN Exchange Programme, KENET

1. Introduction

The Kenya Education Network Trust (KENET) is a not-for-profit membership organization that is licensed by the Communications Authority of Kenya as an Alternative Network Facility Provider. It is the National Research and Education Network (NREN) of Kenya and provides broadband Internet services to the higher education and research community in partnership with other licensed telecommunications operators. It also conducts ICT research in education and pilots innovative learning technologies in collaboration with faculty and students in member institutions. KENET has been conducting capacity building initiatives for its community as outlined in this paper.

KENET had connected 152 campuses of higher education in 32 counties in Kenya as of October 2014. The campuses have a combined student enrolment of over 500,000 and the network serves both the faculty and the students. The KENET network has a national distribution capacity of over 25 Gb/s and generates about 5.0 Gb/s of international Internet traffic. It is therefore one of the largest IP networks in Kenya with direct peering with other RENs in Africa and the rest of the world. Some of these RENs include TENET in South Africa, GEANT in Europe and Internet2 in the United States of America.

Since inception, KENET has focused not only on building a physical network but also building a network of people ranging from engineers to IT managers and heads of institutions so as to enhance collaboration. Over the years, the challenges faced by KENET members have varied and changed including limited bandwidth, poorly implemented campus networks and cyber security threats. Without adequate skilled human capacity within KENET membership KENET's objective of transforming higher education using ICT cannot be achieved and every year KENET identifies areas of focus and brings together a network of resources from its membership to share experiences and also to be trained on specific focus areas. With skilled personnel at the campuses, load on KENET helpdesk and network operations (NOC) engineers reduces substantially.

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Apart from capacity building at the campus level, KENET also strives to ensure that it is able to hire, train and retain high end ICT talent within the secretariat. On this front, KENET maintains a pool of highly trained personnel who work in collaboration with well established National Research & Education Networks (NRENs) to gain working experience from international peers in the NREN world. In addition, since the year 2012 KENET has operated a graduate training programme to provide on the job training for fresh graduates. Finally, KENET also works with other UbuntuNet Alliance NREN members as part of technical capacity exchange with other emerging and established African NRENs.

This paper is organized in the following way. Section 2 describes the thematic areas of training and Sections 3 and 4 describes the training courses and model that KENET has adopted. Section 5 describes the training laboratory that has been established at KENET training center in collaboration with the Network Startup Resource Center as well as the method used to develop trainers. Section 7 contains our conclusion and future plans for scaling up the training program and courses.

2. Thematic Areas and training model

KENET has over the years received many requests from Campuses to assist with technical expertise in Campus networks and Systems administration. KENET has developed a model to help improve the technical capacity at the member institutions. This involves carrying out hands on trainings, having a KENET Engineer work with the Campus ICT team on Campus for a period, and offering consultancy services on campus networks.

KENET also conducts annual Heads of Institutions forums where the Heads of Institutions meet to discuss and exchange ideas. KENET trains its technical staff on a regular basis. This includes attending trainings like AfNOG (www.afnog.org), twining programs with other NRENS and attending networking conferences such as TERENA and UbuntuNet Connect. Finally, KENET has partnered with different organisations and NRENs so as to ensure that its capacity building agenda is implemented; these partners include Google, NSRC, DFN, UbuntuNet Alliance, TENET and Kenya ICT Authority among others.

2.1 Classroom & Residential Training

These are a selection of hands-on training held at the KENET training facilities located at the University of Nairobi. They mainly involve having the various network and system administrators from the member institutions on residential setup come in and sit through a number of lecturers and practical sessions.

The main aim of the residential training program is to ensure that a community of techies is built during the training period. In addition, the trainees as well as the trainers are subscribed to a training mailing list to enhance online discussions of training materials and outcome on top of the content available on the training wiki.

KENET has developed a training model that is being able to achieve the following:

- Empower the technical staff at the KENET member institutions with skills to effectively administer and manage the campus network
- Assist the Campus technical team with system and / or network projects where the system/network administrator lacks the skills
- Empower KENET engineers so as to be escalation point for difficult problems in the campuses
- Create a pipeline of young skilled engineers

Based on the requirements, KENET executes the following types of training courses:

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1. Training for technical staff of connected member institutions
   a) Training for engineers from small campuses
   b) Cyber Security Training
   c) Training for ICT Managers

2. Training for KENET engineers and technical staff
   a) Training for experienced engineers - AfNOG
   b) Twinning arrangements & exchanges (DFN, NSRC, TERNET, BERNET, TENET, Indiana University)
   c) Training for entry level engineers (graduate trainee program, internship, on the job training)

2.2 Classroom & Residential Training Planning

1. Course Planning
   a) Developing a training program with the content and timetable
   b) Developing a budget for the training
   c) Assigning topics and tasks to the trainers
   d) Developing content and power point presentations

2. Information Dissemination & Selections
   a) Announcing to the KENET community about the training and receiving nominations from the institutions
   b) Short listing the participants from the nominations received
   c) Inviting shortlisted candidates

3. Financing & Reservations
   d) Reserving Accommodation
   e) Sourcing for funding from training partners

3. KENET Training Courses

KENET has developed a training model that is effective in building skills for the member institutions systems and network administrators and also for building the capacity of the KENET technical Staff as well as ICT Managers. The KENET hands on residential training focuses on the following areas:

1. Systems Administration
2. Network Management & Monitoring
3. Campus LAN & WLAN Design
4. Cyber Security
5. Governance and ICT Policy

3.1 Training of Technical Personnel

3.1.1 Systems Administration & Network Management and Monitoring /BMO

This training is designed to empower the network administrators from the various institutions with skills that will enable them to effectively manage their campus networks. This enables them to ensure the bandwidth they have subscribed to is being used appropriately as well as mitigating the threats and profiling traffic relating to viruses, spam, peer-to-peer traffic and malware.

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After this training the participants are able to install, upgrade, operate and secure a Unix/ Linux operating system and use it to provide essential Internet services. This course targets persons who are technically competent but have no prior experience to Unix/Linux.

3.1.2 Scalable Campus Network

The Scalable Campus Network training equips participants with the practical skills that enables them design and implement a large scale campus network. This course provides the engineers with the necessary TCP/IP skills to design, implement and administer a campus network as well as both knowledge and skills on switching and routing networks.

During the course, participants are taught skills that include virtual private networks (VPNs), virtual local area networks (VLANs), spanning tree protocol (STP), Internet Protocol (IP) routing & management (addressing, IP subnets) amongst others. Finally, troubleshooting methodologies are also handled so as to equip participants with the basic flow of events when troubleshooting campus network problems.

This training is conducted at least once (1) every year and KENET has conducted over six (6) such training in the last five (5) years using an average of five (5) trainers each time made up of KENET trainers and occasionally NSRC trainers.

3.1.3 Scalable Campus Wireless LAN design

This training imparts practical knowledge to the participants in the area of design, implementation and security of a large scale campus wireless local area network (WLAN). The course provides the network administrators with the necessary TCP/IP skills to administer a campus wireless network. The network administrators are be able to design and administer a large scale campus wireless network upon successful completion of the course.

This training has been conducted four (4) times in the last five (5) years and has included wireless equipment donations to participants, industry certification among others. The trainers have mainly been composed of KENET engineers, NSRC engineers and expert consultants from the industry.

3.1.4 Cyber Security

Security within the campus network has become an area that the network and system administrators need to focus more on. The cyber security training focuses on empowering the system administrators on how to secure the services and servers within the campus and also empower the network administrators on how to secure the campus network. This training enables the network and system administrators run secure services within the campus network.

3.2 Onsite Campus Training

In certain instances, KENET members request for onsite campus training in any of the training areas focused on in the hand-on tracks. This involves the KENET engineers travelling to the Campus and is done depending on the demand for the class from the particular Campus. This is cost recovery training and is conducted at the Campus. Figure 1 below shows one of the onsite campus training conducted in 2014.

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Figure 1: Cyber Security Training at Kirinyaga University

Onsite Campus training also involves having at least a KENET Engineer go on campus to assist in troubleshooting campus network bottlenecks and resolving them. KENET engineers, sometimes with selected consulting engineers work with the campus network/systems administrator(s) to do various tasks including troubleshooting campus network issues, identifying network bottlenecks, setting up network monitoring tools and refining the campus network.

3.3 ICT Managers Training & Workshop

Having an ICT master plan and policy is one of the important steps in charting a way for growth and implementation of ICT strategy at the campus. It is important for ICT managers to be well trained on ICT Governance and Policy as well as how to convince top University management to allocate adequate resources for ICT infrastructure deployment and support.

KENET conducts a one (1) day training workshop geared towards ICT heads at the different campuses and inviting industry leaders in policy development and governance to spearhead discussions towards empowering ICT Managers at the campuses with the necessary skills. This is an annual training conducted once every year by KENET for its members.

4. Developing the capacity of KENET staff and trainers

1.1 Graduate Trainee & Internship Program

The graduate trainee program run by KENET involves recruiting graduates from the member institutions and taking them through vigorous one (1) year hands on training at KENET. During the one year the graduate trainee is highly trained on systems and network administration skills handling real-world challenges at KENET. Since the start of the program in 2012, KENET has admitted a total of ten (10) graduates.

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In addition, KENET also conducts and internship program where at least three (3) continuing students are offered a three (3) month hands-on training every quarter on IP networks, Systems Administration, Accounting, Business Administration, among others depending on the university degree the student is pursuing.

Both training programmes adhere to a strict training schedule and the trainees are assigned tasks and supervisors in different departments, in some cases the trainees are seconded to assist at the campus level with network and systems administration tasks. The trainees are also assigned a senior staff to mentor them during the training period and at the end of the training, the students are expected to prepare a report of the tasks and achievements they have made including innovative projects they have implemented or participated in.

1.2 Twinning Arrangements & Exchanges

In collaboration with the German NREN, DFN; KENET has had an ongoing engineers exchange since the year 2009. KENET engineers have visited DFN and gained practical knowledge from their DFN peers in the fields of Network Operations, Project Management, Wireless Network Design & eduroam, Public Key Infrastructures among others. Engineers from Germany have also visited KENET and provided critique on planned projects design especially with fiber networks.

Other twinning arrangements have successfully been done in collaboration with South African NREN, TENET and Indiana University through Global NOC in collaboration with Network Startup & Resource Center (NSRC). During these exchanges, KENET engineers have gained practical knowledge from respective partners.

Finally, KENET also has had engineers exchange with Tanzanian NREN TERNET and Burundian NREN, BERNET where KENET provided engineering and administrative assistance with the planning and possible scenarios of running a sustainable NREN.

1.3 Developing Training Materials

Developing appropriate training material and content is one of the most difficult tasks if done for the first time. However, KENET has been able to leverage on some of the training materials provided by NSRC and adapted them to the training scenarios at KENET. The training material/slides are normally developed or customized and reviewed internally prior to the training. Practical Labs are also tested prior to the actual training class so as to verify that all technologies to be covered will be practically tested.

KENET also maintains wiki pages that keep a knowledge base of installation procedures of the common tools and protocols covered during the training. Finally, registration and prior knowledge of participants is gathered upfront using a registration portal so as to enable trainers adapt the training materials accordingly.

1.4 Training of Trainers and Capacity Building Partners

To be able to successfully conduct training, one of the important resource requirements is a pool of skilled trainers. KENET has created a pool of trainers ranging from its own staff to experienced engineers from the industry as well as its training partners.

Based on the training content to be covered in any training, a specialized team is set up comprising of KENET's own trainers as well as trainers from partners including NSRC for hands on training of members, DFN for twinning exchanges as well as from the industry on

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cyber security. At the onset of hand on training for campuses until year 2012, KENET relied mainly on trainers from NSRC as well as Aptivate.

KENET has been able to establish partnerships that have ensured effective and successful running of trainings for members. The Network Startup Resource Center, NSRC (http://nsrc.org/) has been one of the long standing KENET partners who have donated equipment valued at over $100,000 to setup a training lab that includes network switches, routers and a virtualization server. NSRC also donates some of its highly trained and experienced trainers to come assist with running some of the training programmes.

Google has been able to come in and assist in the budget of the trainings by providing financial assistance to the KENET member institutions that would like to participate in the training programmes. The financial aspect was the main challenge for most members as the ICT department in most campuses is allocated a small budget and only a small fraction of it is allocated to capacity building. With the financial assistance from Google, the Universities are then able to offset the cost of accommodation and meals for the participant for the duration of the training.

The Kenya ICT Authority has also partnered with KENET by facilitating twinning arrangements with DFN, the German NREN as well as funding some of the training participants. On its part, DFN has since the year 2009 executed a successful annual twinning arrangement that has offered KENET engineers a good foundation with NREN network operations as well as core and wireless network design.

Other partners have included TENET and Aptivate who have assisted with twinning arrangements and donating trainers respectively. Finally, the biggest partners have been KENET membership and universities who avail their engineers for training and have trusted KENET with the responsibility of training their staff.

5. KENET Training Lab

KENET successfully built a physical training lab with equipment that was donated by NSRC. The training lab consists of Cisco 3750 switches, Cisco 2901 routers and Mac Mini for virtualisation of servers. The physical training lab was set up jointly by both KENET and NSRC engineers in 2014 and was successfully used to conduct a Scalable Campus Networks hands-on training in October 2014. The training participants were able to get hands-on skills on network administration concepts such as Spanning Tree Protocol, VLAN, OSPF routing and designing campus networks.

The physical training lab will be available online for use by the KENET community, both ICT staff and faculty for their networks training requirements. This will enable remote training from locations that have broadband connectivity back into the training lab and possibly open newer ways of conducting training.

The logical and physical lab setup is as shown figure 2 and figure 3 below:

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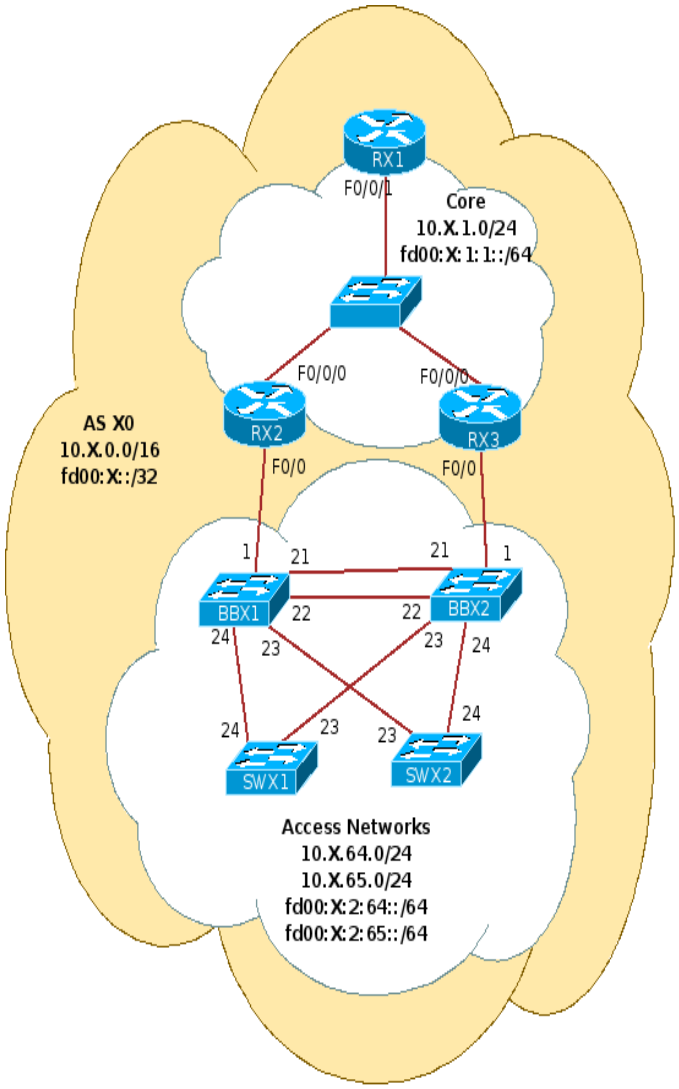

Figure 2: Logical Diagram of KENET Training Lab

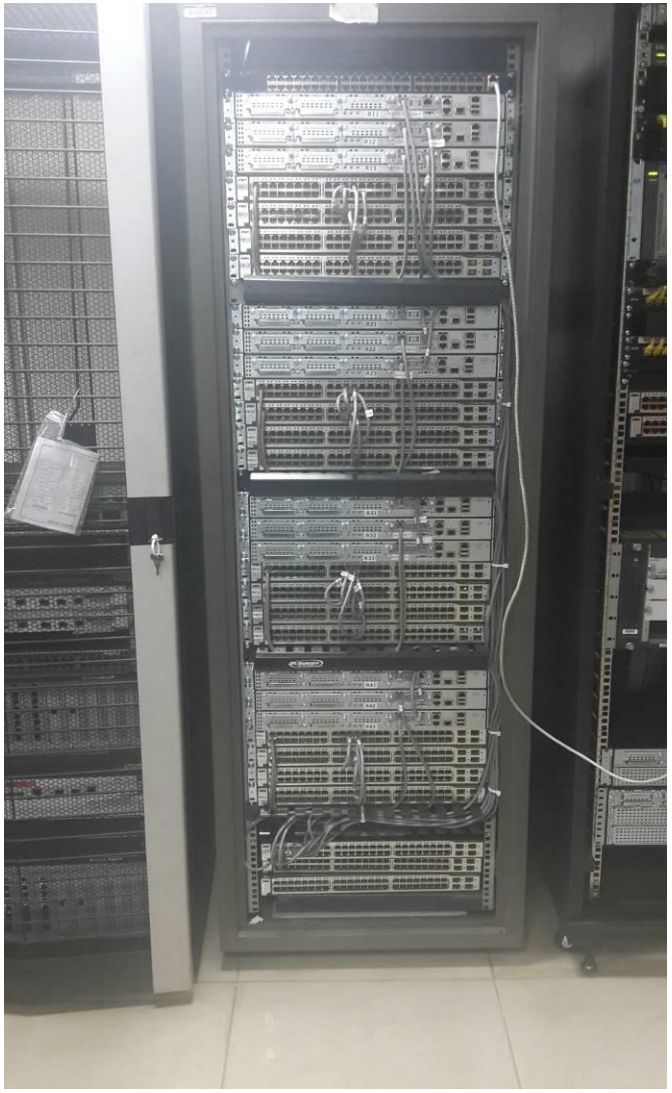

Figure 3: Physical Training Lab Setup

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6. Impact training and lessons learned

There have been a myriad of challenges in planning and executing the capacity building programmes. Some of the challenges experienced so far relating to hands-on training of KENET members have included lack of dedicated trainers where KENET has used experienced NOC engineers to execute the training leaving KENET NOC stretched during training periods. Another challenge has been the training duration where KENET has identified that the ideal training period should be no more than five (5) days to avoid draining the participants. It has also proven very difficult to co-ordinate the logistics for having a residential training every month and there are options of considering online classes or webcasts for training.

At the campus level, the main challenge has been inadequate number of staff thus the universities find it very hard to release their staff for five-day training events. Another challenge has been lack of highly motivated staff which leads to lack of implementation of required changes learnt during the training.

For internal training, the main challenge has been that the host NREN/organization in a twinning arrangement must dedicate engineers out of their busy regular work to be able to assist during visits. There is also the potential risk of staff turnover and being a pipeline for the industry.

7. Conclusion

Capacity building is a critical part of the education sector which an NREN serves. KENET being part of the Research and Education sector plays its role in building the capacity of its engineers and those of member campuses. In addition, to be able to successfully operate a broadband education and campus network; highly trained engineers are required at the NREN level as well as at the universities.

KENET plans to scale up the technical capacity building program in collaboration with partners to ensure that the member universities have readily available high end ICT talent that will be able to design, implement and operate large campus and broadband NREN networks.

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Biographies

Maureen Wanja Njue holds a Bachelor of Science Electronic and Computer Engineering from Jomo Kenyatta University of Agriculture and Technology and is also CCNA certified. Maureen joined KENET in 2008 as an intern and was eventually employed as an Assistant Systems Administrator.

Maureen mainly focuses on Campus networks design and implementation. This includes both LAN and Wireless LAN design and implementation. Maureen is the lead in implementing eduroam in Kenya and also is the lead in the training services offered by KENET to member institutions.

Kennedy Aseda joined KENET in 2008 and currently works as a Network Engineer. He holds a BSc. in Electrical & Electronic Engineering from the University Of Nairobi and is a certified CCNA, CCNP and CCIP (Cisco Certified Internetwork Professional). His primarily works on KENET's core network and focuses on routing, switching and configuration backup of network devices. He also has a passion in process automation of network tasks and notifications.

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