Building a Cyber Security Emergency Response Team (CERT) for the NREN Community – The case of KENET CERT

Peter MUIA[1], Meoli KASHORDA[1], Kennedy ASEDA[1], Ronald OSURE[1], Martin NJAU[1]
[1]*Kenya Education Network, P.O. Box 30244 - 00100, Nairobi, Kenya*
Tel: + 254 732150500, Email: info@kenet.or.ke

Abstract
Kenya through the regulator, Communications Authority (CA) has setup a national Cyber Security Emergency Response Team (KE-CIRT). This national CERT in Kenya has several sector CERTs with the Kenya Education Network (KENET) having the mandate of setting up and running the education sector CERT in Kenya (Communications Authority of Kenya, 2015).
The purpose of the KENET CERT is to identify threats in the Internet and communicate the same to its community (Kenya Education Network CERT, 2015). It also identifies threats within the community and communicates the same to the rest of the Internet community. Additionally, it provides a mechanism where security incidents can be reported and resolved within the KENET community. Experiences are shared with the community and documented for future reference. The CERT is also responsible for making sure that KENET systems and network are safe from security threats. KENET setup the KENET CERT that is run and operated at KENET by the KENET team. This paper and conference session describes the setup of the KENET CERT, the model of operation and the impact and experiences learned from running an NREN CERT in Kenya.

Keywords
Kenya Education Network, Cyber Security Emergency Response Team, Security, National Research and Education Network

1. Introduction

KENET is the National Research and Education Network (NREN) of Kenya and it is licensed by CA as a not-for-profit operator serving the education and research institutions in Kenya. KENET operates the CERT for the academic community (Kenya Education Network, 2015). The KENET CERT was established in 2014 with a mission to respond to security emergencies on the Internet, serve as a focal point for reporting and facilitating the corrections to security vulnerabilities, analyze security related data to develop and disseminate countermeasures and prevention techniques and raise awareness and understanding of security trends and issues within the KENET community.

A CERT is an organization or a department within an organization formed to study Internet security, discover vulnerabilities and to provide security related assistance to the identified community. The KENET CERT offers emergency response service and shares information for improving web and network security. It strives for a safer, stronger Internet for the education and research community in Kenya by responding to major incidents, analyzing threats, and

exchanging critical cyber security information within the community and also with other CERTs.

2. Motivation for Setting up a CERT at KENET

The number of computer security incidents in the KENET community and the country at large had grown at an alarming rate. Traditional computer security efforts focused on the physical security of systems and the confidentiality of data. As such the risk of denying user's network services or causing a loss of data was rarely addressed, except on a reactive basis when the damage would have already been suffered. With the increase in the use of on line applications by universities and research institution in Kenya, the user base for network computing resources has expanded to such an extent that network availability and data integrity were just as important, and therefore a new approach was needed.

KENET has been providing broadband connectivity to its members and this has been increasing over time. Currently, KENET is distributing 9 Gb/s bandwidth to its members. This is by distributing 4.5 Gb/s International traffic, 4 Gb/s Google Cache and 0.5 Gb/s Akamai traffic. KENET has also grown its shared services and has been providing services such as web hosting, backup services, data recovery sites, DNS services, cloud services and virtual servers. This led to an increase in security threat to not only the KENET infrastructure but also to the services hosted at KENET and the institutions served by KENET. A coordinated method for responding to computer security incidences at KENET was therefore adopted.

3. KENET CERT Services

The Goal of the CERT was to create a team at KENET that would ensure the confidentiality, Integrity and availability of both the network and the systems at KENET. The CERT therefore provides the following services in order to achieve this goal:-

- Facilitate the centralized reporting of incidents – Whenever there is a security incidence affecting the KENET network, the KENET CERT facilitates a quick communication channel through the mailing list, web portal or even Short Message System (SMS).
- Perform training and raise the security awareness of users – The KENET CERT team conducts both the Cyber security training for systems administrators and security awareness training for non-Information Technology (IT) users.
- Resolving security- related tickets as part of the KENET help desk. These issues range from web applications hacks that include defacements, SQL injections, Denial of Service, Cross-site scripting, email spamming, loss of backups among other security- related complaints from the community.
- Promote computer security policies within the KENET community by creating policies such as the web hosting policy and business continuity plan. Additionally, the KENET CERT team is usually represented at the KE CSIRT and any security forums within the country and outside the country whenever it is possible.
- Alerts and Announcements – Periodically, the KENET CERT performs vulnerability analysis of the systems hosted at KENET and also analyses the various logs of both the network devices and the systems logs and intrusion detectors. Any relevant findings are forwarded to the members of the KENET CERT mailing list or to specific

institutions if the information is considered to be confidential.

- Collaboration – The KENET CERT team collaborates with other CERTs by receiving alerts and vulnerabilities that are noted on the Internet. Similarly, when KENET discovers any vulnerability, the same is communicated to other CERTs. KENET also publishes these vulnerabilities on the KENET CERT portal which is publicly available.
- Incident Tracing – In case of a successful security breach, the KENET CERT is involved in doing forensics to determine what actually happened and to advice KENET on how to prevent such incidents in the future. In case an incidence was service affecting, a Reason for Outage (RFO) is prepared and sent to the institution's ICT management.
- Securing the KENET infrastructure by ensuring that network devices and systems are hardened before they go live.

4. Methodology used for setting up the KENET CERT

A phased approach was adopted that included 5 stages as described below. Although these stages are described in isolation, they overlap and the process was seamless and continuous.

4.1 Stage 1 Requirement Analysis and Specifications

This stage entailed understanding KENET as an NREN and the community it serves and the types of computer threats and risks faced. It also involved understanding how universities and research institutions handle security within their organizations. Any security threat that could lead to compromise of data, unauthorized access, and network misuse, denial of services and loss of credibility was identified at this stage. Anything to do with security and security incident handling within KENET was identified at this stage.

4.2 Stage 2 Planning

At this stage, the services to be provided by the CERT to mitigate the threats identified in the first stage were defined. The KENET CERT services that were identified can be grouped into three broad categories:

- **Reactive services**
  These services are triggered by an attack or security ticket request, such as a report of a compromised host, wide-spreading malicious code, software vulnerability, or something that was identified by an intrusion detection or logging system.
- **Proactive services**
  These services provide mechanisms to prepare, protect, and secure the KENET community systems in anticipation of attacks, problems, or events. This is necessary because it reduces the number of incidents in the future.
- **Security quality management services**
  These are services that support computer security within the KENET community such as the IT audit, penetration testing policies or security training of staff.

Research on the operations of other CERTS was carried and benchmarks chosen. The CERTs chosen for benchmarking include:-

4.2.1 DFN-CERT

DFN-CERT offers consulting and services for improved Internet security. This is

by providing the protection of computers and computer networks from attacks and the security of electronic communications. The CERT focuses on security expertise in close cooperation with German and international computer emergency response teams (DFN-CERT, 2015).

4.2.2 Terena TF-CSIRT

TF-CSIRT is a task force that promotes collaboration and coordination between CSIRTs in Europe and neigbouring regions, whilst liaising with relevant organisations at the global level and in other regions. It also develops and provides services for CSIRTs, promotes the use of common standards and procedures for handling security incidents, and coordinates joint initiatives. This includes the training of CSIRT staff, and assisting in the establishment and development of new CSIRTs. The task force further liaises with FIRST, ENISA, other regional CSIRT organizations, as well as defence and law enforcement agencies (TERENA, 2015).

4.2.3 US-CERT

US-CERT is responsible for analyzing and reducing cyber threats, vulnerabilities, disseminating cyber threat warning information, and coordinating incident response activities. It brings advanced network and digital media analysis expertise to bear on malicious activity targeting the networks within the United States and abroad (US_CERT-2015).

4.2.4 FIRST

FIRST brings together a variety of computer security incident response teams from government, commercial, and educational organizations. It aims to foster cooperation and coordination in incident prevention, to stimulate rapid reaction to incidents, and to promote information sharing among members and the community at large (FIRST, 2015).

4.3 Stage 3 Implementation

The implementation phase involved the assembly of a team within KENET with both personal and technical skills of running a CERT. Some of the personal skills considered included communication skills, team work, diplomacy, integrity and problem solving skills while the technical skills considered included knowledge of security principles and incident handling skills.

The tools for vulnerability scanning were identified and a Kali Linux box which has these tools installed. Kali Linux is a Debian-based Linux distribution aimed at advanced Penetration Testing and Security Auditing. Kali contains several hundred tools aimed at various information security tasks, such as Penetration Testing, Forensics and Reverse Engineering (Kali Linux, 2015).

A honeypot box was setup at the KENET data centre. The honeypot consists of data that appears to be a legitimate part of the KENET sites but is actually isolated and monitored, and that seems to contain information or resources of value to attackers. Once the attackers attempt to launch an attack on the honeypot, they are then blocked from accessing the entire KENET network.

A CERT portal was also developed at this stage. The purpose of the portal is to provide an online platform for disseminating information to the CERT members on issues such as current vulnerabilities with applications, protocols, popular content management systems and

operating systems. It also provides alerts and tips for securing systems and networks and simple how-tos for staying safe in the Internet.

All the existing systems at KENET were hardened to prevent or minimize the effects of future attacks. The web applications were installed with the following tools:-

4.3.1 Modsecurity

ModSecurity is one of the Apache server modules that provide website protection by defending from hackers and other malicious attacks by having a set of rules with regular expressions that helps obstruct the processing of invalid data

4.3.2 Mod_evasive

Mod_evasive is an evasive maneuvers module for Apache to provide evasive action in the event of HTTP DoS or DDoS attack or brute force attack. It is also designed to be a detection and network management tool, and can be easily configured to update rules in ipchains, firewalls and routers.

4.3.3 Firewalls

All the servers installed at KENET were installed with host firewalls. The common firewalls installed include iptables, Packet Filter (pf) and ConfigServer Security & Firewall (CSF) firewalls.

4.3.4 Maldetect

Linux Malware Detect is a malware scanner for Linux released under the GNU GPLv2 license, that is designed around the threats faced in shared hosted environments. It uses threat data from network edge intrusion detection systems to extract malware that is actively being used in attacks and generates signatures for detection.

4.4 Stage 4 Operational phase

The services implemented in phase three were launched to the community and a mailing list created with membership of the staff in charge of security from the universities and research institutions served by KENET. Cyber security training curriculum for systems administrators and a computer security awareness training for users were developed.

Policies and procedures for operationalization of the CERT were developed and communicated to the community and the CERT portal was put on line. Penetration testing was done on the KENET systems using an external consultant, and the results and the process used documented.

4.5 Stage 5 Peer collaboration

KENET-CERT works closely with Kenya's National CIRT coordination center (CIRT/CC) as a sector CIRT for the academic institutions. Since KENET was already a member of the KE-CIRT, collaboration within the various sector CERTs in Kenya was already being practiced. Some of these sector CERTs include the banking CERT, the Telco’s CERT run by Technology Service Providers of Kenya (TESPOK), the police CERT among others.

KENET was also a member of various security mailing lists who share security updates on a regular basis especially whenever there is a breach of security anywhere in the world or when vulnerabilities are identified. They also share whenever breaches originate from the KENET network or when open proxies are identified within the KENET network or even when there are infringements in copyright issues originating from the KENET network. All these information is shared with the CERT members as soon as it is received.

5. KENET CERT Organization Model

The KENET CERT was developed using the Internal Distributed CERT model proposed by the European Union Agency for Network and Information Security (ENISA). In this model, an organization utilizes existing staff to provide a "virtual" distributed CERT, which is formally chartered to deal with incident response activities. There is a team leader who oversees and coordinates activities for the distributed team. Across the organization, individuals are identified as the appropriate points of contact for working as part of the distributed team based on their expertise with various operating system platforms, technologies, and applications; or based on their geographic location or functional responsibilities. The distributed team members can perform CERT duties in addition to their regular responsibilities or could be assigned to CERT work on a full-time basis (Killcrece, 2003).

The CERT serves as the single point of contact at KENET in relation to incident or vulnerability reports or activity for both internal and external parties. Using this model, the CERT was established using existing systems administrators and Engineers. This was deliberately done to reduce the cost of running the CERT. The following are the processes in the operation of the KENET CERT.

Incident Reporting

Incidences are reported either by email, the KENET support portal or the helpdesk support line and a ticket is created for all the requests. The CERT contacts are published at the KENET website and the CERT portal.

Incident Handling

A ticket is assigned to a CERT member who works to resolve the issue depending on the severity of the incident. If the incident is severe, the issue is escalated to the CERT team leader who sermons the entire CERT team who collaborate in solving the issue raised. If the incidence was raised as a result of a proactive activity such as vulnerability scan or receiving information from other CERTs, then the same is communicated to the KENET CERT community.

Communication

Communication is done through mailing lists both email and SMS when the CERT wants to pass general information to the community. This information is also posted on the CERT portal. When the information is specific to an institution, then the institution is called from the KENET line and an email send to the person in charge of security in the affected institution. Updates are posted on the KENET ticketing system and tracked until the ticket is closed.

6. CERT Implementation Challenges

Several challenges were encountered during the setup and implementation of the KENET CERT some of which are outlined below:-

- People who are trained and experienced in incident response techniques and practices are difficult to find.

- There is no established education path for professional incident handling staff in existence as of today.
- There was a lack of publicly available sample templates for policies and procedures for use in the day-to-day operations of a CERT.
- There were few tools such as tailored help desk or trouble ticket solutions addressing the specific needs of the KENET CERT.

7. Impact of the KENET CERT

The effect of running a CERT at KENET is already being felt within the KENET community. Some of these effects are highlighted below:-

- Four Trainings have been conducted. These trainings focus on ways of securing the entire institutions infrastructure. These has led to better awareness and better setup of systems and a better knowledge of security threats and ways of mitigating these threats. A session on security has been included in all other KENET trainings.
- Information is disseminated in a timely manner. Universities and Research institutions receive timely information whenever vulnerabilities are identified.
- Quick resolution of security- related tickets because best practices have been identified, procedures developed and documented for the CERT team to follow during resolution.
- Reduction in the number of cyber security tickets
- Awareness and Discussion within the KENET community on cyber security is stronger now
- KENET has established Cyber security champions in each of its member institutions.

8. Conclusion

In any organization, whenever there is a computer security attack, an intrusion is recognized. It is important for the organization to have a fast and effective means of responding to such an incident. One way of dealing with such an incident is to establish a formal incident response capability or a CERT. This would ensure that when incidents occur, damage would be minimized, evidence preserved, quick and efficient recovery is provided. Similar future events are also prevented and the organization gain insight into threats facing it.

NRENs in Africa can benefit by collaborating among each other on issues to do with security by establishing NREN CERTs that can be coordinated regionally as is the case in Europe and America.

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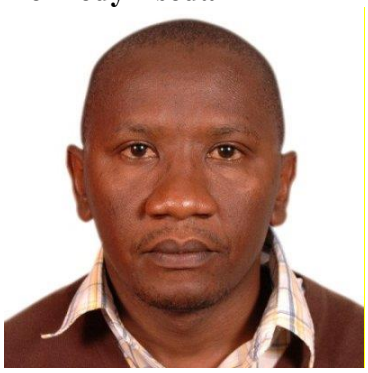
Biographies

Kennedy Aseda



Kennedy Aseda is a Lead Network Operations Engineer at KENET and has been working at KENET since 2008. He holds a BSc. in Electrical & Electronic Engineering from the University Of Nairobi and is a member of Kenya's National IPv6 Task Force as well as National CIRT/CC.

He primarily works on KENET's core network and focuses on routing, switching and configuration backup of network devices, security and virtualization. He also has a passion in process automation of network tasks and notification.

Martin Njau

Martin Njau is a Systems Administrator at KENET with four years experience in systems design and administration. He has worked in the development and administration of the KENET CERT platform and automation of network monitoring tools for the Network

Operations Centre at KENET. He also forms part of KENET Research and Cyber security Team where his role includes identifying and fixing security threats for KENET and the member institutions. Additionally he provides advice on best practices on network and system security.
Mr.Njau is a certified Linux Professional (LPIC) and CCNA Security professional. He pursued his Bachelor of Information Systems and Technology at USIU and has conducted cyber security training for KENET members and staff (2015).

Mr. Peter Maingi Muia

Peter Muia joined KENET in 2008 as an interactive education content developer. He has in the past worked in the setup and administration of learning technologies, advanced infrastructures and network management and monitoring tools for the KENET Network Operations Centre. Currently he is a senior systems administrator at KENET with special focus on systems design, deployment administration and security. He has a lot of experience in systems security and the REN infrastructure and is a founding member of the KENET CERT.

He has a Master of Science and a Bachelor of Science in Computer Science degrees from the University of Nairobi and is a certified Linux systems Administrator.

Prof. Meoli Kashorda

Prof. Meoli Kashorda is currently the Executive Director of KENET. He is also a professor of information systems at USIU University in Kenya with research interests in measuring the Institutional ICT readiness in developing countries, telecommunications regulation and broadband Internet as an innovation platform.

He previously served as Dean of the USIU business school in Nairobi and a

telecommunications expert in the Communications Appeals Tribunal of Kenya. He holds a BS degree in Electrical Engineering from University of Nairobi and a PhD in Electronic Systems Engineering from University of Essex in England.

Ronald Osure

Ronald Osure is an Applications Developer at KENET and has 4+ years of experience in application architecture, design and development methodologies. He has developed solutions to allow the KENET Network Operations Centre leverage on the various Open Source Technologies they use through integrations and customizations. He also works in the research and cybersecurity divisions of KENET.

Mr. Osure is a Certified Ethical Hacker (CEH) in cyber security. He did his Bachelors of Science degree from Egerton University (2011) and attended the Summer School of Networking at Indiana University in 2013 which focused on