

# Lessons Learned in Managing ICT Systems for Online-Learning

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## ABSTRACT

*This paper discusses the challenges faced and lessons learned during the management of an online educational network in Sri Lanka. In all aspects of learning, technology can make a significant impact. Technology, when used appropriately, can be very effective in terms of interactivity among learners, between learners and the content and between learners and teachers, especially in contrast to print-based traditional distance education. Most difficulties that arise are due to constraints of scale, time and space and can be effectively addressed using technology. When implemented effectively, learners, teachers and educational institutions all benefit. Opportunities created in such a context for a country like Sri Lanka are enormous. At the same time, any failure to access teaching/learning material can create a very negative impression and is instantly compared with the face-to-face learning environment. Managing Information and Communication*

*Technology (ICT) systems to cater to the above requirements is a challenging task. A major national initiative in Sri Lanka, the National Online Distance Education Service (NODES) is discussed in this context.*

## **KEY WORDS**

*Managing ICT systems, online learning, e-learning, technology, content delivery, interactivity, opportunities, challenges, distance education*

## **1. Introduction**

According to the statistics of the University Grants Commission in Sri Lanka [1], every year there are about 125,000 qualified students who fall into the category of “higher education opportunity less” due to the fact that the conventional university system does not have the capacity to accommodate them. Education is well known to be a life-long process. Consequently, a segment of those who are employed continue to engage in learning to keep abreast with the latest knowledge and skills in their own fields. As a result, there are a large number of professionals, scattered across the country, who seek higher education opportunities as well as continuing professional development for which no opportunities can be found in their respective geographical areas. In addition, most of the employers operating in the developed western province need to train their employees in other provinces. All of the above issues regarding the limited enrolment capacity of conventional institutions and the lack of continuing education opportunities are affected by access to content and to tutors and mentors who can facilitate learning at a distance.

Based on experience elsewhere in the world [2], online learning has proven to be an effective way to address the challenges noted above. Even though the concept is not new, it is new in the Sri Lankan context. As with the introduction of any new technology,

the needs of learners and organizations that use the learning system must be addressed [3]. Based on our experience, the items below are crucial to the successful implementation of online learning.

- *Availability*  
: Regardless of the time of day, learners must always have access to online educational resources. Communication and data access delays should be minimized.
- *Responsiveness*  
: How fast the system responds to learner requests depends on the speed or bandwidth of the communication link and how quickly teachers or online tutors respond to queries. The shortest response time is preferred and guidelines should be established for the provision of learner feedback.
- *Trust*  
: The extent to which key stakeholders trust the system to meet their needs and deliver what is promised is crucial to the success of e-learning systems. Every opportunity must be taken to establish, build, and sustain trust.

This paper addresses the role of technology and technology selection to achieve a networked environment that is accessible, responsive, and reliable or trusted by the stakeholders. It is based on the establishment of the National Online Distance Education Service (NODES, <http://www.nodes.lk>) which was funded by the Asian Development Bank to increase access to educational opportunities, particularly to post-secondary students and working professionals. The paper covers the following:

- *Stakeholder expectations*  
: The key stakeholders in an online learning system and their expectations are discussed as well as the expectations of those in traditional face-to-face systems.
- *Selecting technologies*  
: A number of hardware and software options are reviewed. Both commercial and open-source software is discussed.
- *Managing and monitoring ICT systems*

- : If the system is to be managed effectively and efficiently, pro-active management is crucial.
- *NODES Management Information System*
  - : Briefly covered is the need to provide information to all stakeholders.
- *Conclusion*
  - : Key observations are summarized.

## **2. Stakeholder expectations**

Online education is all about the effective delivery of learning material to the end users and an equally effective way of evaluating the learner. Thus, it involves these stakeholders: learners, teachers, the institution for which the teacher works, and the ICT infrastructure or network. This organization too becomes a key stakeholder, hereafter referred to as Partner Institute (PI). The organization managing the entire ICT infrastructure through which the programs are delivered is the last stakeholder. In this case it is NODES.

The learner has the following expectations: accessibility to learning materials from anywhere in the country or world, the capability to interact freely with fellow learners, the ability to submit assignments online, the ability to interact and receive responses to queries from the results of evaluations completed anywhere and easy access to administrative information. This information may include the course module the learner is registered in, the list of modules already taken, and the amount of fees paid and/or need to be paid. Similarly, a teacher has a list of expectations that may include the following: managing the learning materials, managing the online assignments submitted by students, making available the evaluation results and accessing resources from anywhere and at anytime.

In order to determine whether the online program is on the right path, the PI needs to know the capability of the system to register

and track students and to monitor the activity of learners and teachers who use the system. Concurrently, a PI would like to know the availability of key online resources on which the entire teaching/learning environment is based on. This is primarily information about the availability of key servers which hold the learning material, how secure these contents are and the availability of connectivity to these servers. This information is a key ingredient for the building of trust which was mentioned in the previous section.

Finally, NODES needs to have reliable mechanisms to ensure that all the above expectations of stakeholders can be attained. The trust stakeholders place on the system depends on the extent to which the above expectations are met.

In order to address all of the above, the ICT network infrastructure should have the following features: high availability, redundancy, back-up facilities, network management and monitoring facilities, and help desk or hot line services. The technology selection to achieve the above is discussed in the next section of this paper.

### **3. Selecting technologies**

It is important to understand the context within which one has to select the technologies to achieve the required objectives. NODES act as an intermediary between learners, who want to obtain a particular educational qualification (at the certificate, diploma or degree level) and organizations who have educational/professional programs that can deliver what the learners expect. The learners could range from school leavers, who want to obtain the required educational qualifications to seek employment, to those who are already employed and want to enhance their professional career through furthering knowledge in specific areas.

An organization could offer multiple programs and each program could accommodate from one to several hundred students. Add to these complexities are different demands placed by the organizations on students. For example, academic institutions may

require students to participate in a minimum number of online interactive sessions, to adhere to assignment deadlines, or to participate in online real-time evaluations during which the enrolled students can sit for the assessment at the nearest NODES Access Center (NAC). Additionally, an organization could demand that main servers be made available 99% of the time as a pre-condition for making their program available through NODES.

Scalability is another important aspect that needs to be considered. In the NODES environment, the number of organizations offering programs could increase over time and the total number of students accessing the learning management servers will increase correspondingly. Each program can place varying loads on the servers as well as the network but all students/teachers accessing the servers must experience a system response that is well within human tolerable limits.

High-speed connectivity to the servers that host learning materials and to other networked locations is fundamental to satisfy the anywhere, anytime accessibility requirement of learners and teachers. Since the ultimate objective of NODES is to increase the higher education opportunities available to all school leavers, it is mandatory to consider all areas of the country rather than a selected set of provinces. To this end, NODES has established 26 NODES Access Centres (NACs) around the country with state-of-the-art facilities that include high quality video conferencing. These NACs are expected to remove the main obstacle that many rural students face – lack of access to high-quality computing resources. [4]

The selection of technologies to satisfy multi-stakeholder expectations is not an easy task. The sustainability of the entire system depends on the ability of NODES to generate sufficient revenue to meet the recurrent expenses and build up sufficient reserves.

Considering all of the above requirements, NODES has decided to deploy a mix of proven open-source technologies along with some commercial software. In terms of hardware – active network

equipment and servers – redundant configurations have been adopted for increased resilience.

The online teaching/learning environment is provided through the open-source Moodle Learning Management System [5]. This is a proven system used in many institutions around the world [6]. The number of migrations from well known commercial learning management systems to Moodle in many developed countries has justified the selection of the system.

Some of the open-source operating systems and software that have been used are: FreeBSD and Linux, Apache Web Server, Postfix SMTP server, PostgreSQL Database, Nagios Network Monitoring software, MRTG (Multi Router Traffic Grapher) to monitor traffic in Internet and VPN links. Windows Active Directory Server is used for authentication and access control.

Considering the criticality of the need to back-up the system in case of an emergency/disaster, NODES required a disaster recovery (DR) site. Despite the high initial investment that was required for this site, it was and is essential to the success and reliability of the network. If the main system fails, a DR site will provide redundancy by mirroring and backing up all the services provided by NODES.

#### **4. Managing and monitoring ICT systems**

Thousands of learners and teachers currently use NODES online resources and it is mandatory they be given the best possible service in terms of average system response time. Some organizations insist on signing service level agreements with respect to the availability of the network and servers.

All these requirements lead to the establishment of appropriate systems for the continuous monitoring of ICT systems. NODES makes use of a pro-active approach towards the management and monitoring of ICT systems. The following sub-systems are in use for this purpose:

- Multi-Router Traffic Grapher to monitor the network traffic on VPN link to each NODES Access Centers [Refer Figure 1 below]
- Open Source Nagios Network Monitoring tool for the availability and load on all ICT systems at NODES and within the NODES Virtual Private Network. [Refer Figure 2 below]
- A commercial network monitoring tool with powerful visualization ability to see the complete logical network with real-time indication of any failures [Refer Figure 3 below]

The above monitoring tools and their alert systems keep the NODES technical staff informed about the system status at all times.

When operating a complex ICT system, the key to building up the trust is to establish mechanisms for the technical staff to be aware of the problems prior to the actual detection by key stakeholders (in the case of NODES, learners and teachers). In a pro-active monitored system, possible system failures are detected before they actually occur and immediate remedial measures can be taken. As an example, technical staff can investigate high network link utilization and can take appropriate measures before the congestion leads to lengthy response times.

## **5. NODES Management Information System (NMIS)**

NODES role as a technology facilitator for online education does not end at the provision of ICT resources for online education. Catering to different information requirements of multiple stakeholders is a daunting task. NODES Management Information System has been developed exactly to meet these requirements. NMIS caters to all stakeholders and allows them to retrieve all the information they require through a user friendly web based system. Without the management information system, one would need to resort to traditional methods in finding that information with

associated delays. NMIS would be another factor to improve the overall trust, different stakeholders have on NODES.

## 6. Conclusion

This paper discussed the lessons learned in managing an ICT system that was designed to deliver a novel concept in Sri Lanka – online education. Meeting multi-stakeholder expectations in a technology-based teaching/learning environment is a difficult task. However, when accurate needs assessments are conducted and expectations determined, it is possible to identify the overall system requirements and select technologies that can meet all needs and expectations.

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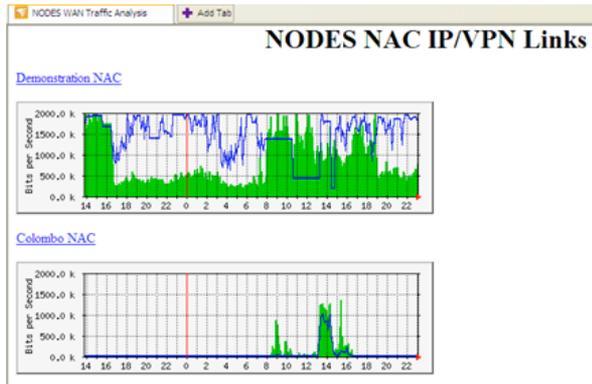


Figure 1 - Network Link Utilization using MRTG

Nagios - Microsoft Internet Explorer

Address: https://nms.nodes.ik/nagios/

Current Network Status  
 Last Updated: Mon May 11 23:00:04 IST 2009  
 Updated every 90 seconds  
 Nagios® - [www.nagios.org](http://www.nagios.org)  
 Logged in as dempeaces

Host Status Totals

| Up | Down | Unreachable | Pending |
|----|------|-------------|---------|
| 16 | 9    | 0           | 3       |

Service Status Totals

| Ok | Warning | Unknown | Critical | Pending |
|----|---------|---------|----------|---------|
| 5  | 0       | 0       | 0        | 0       |

Host Status Details For All Host Groups

Display Filters:  
 Host Status Types: All problems  
 Host Properties: Any  
 Service Status Types: All  
 Service Properties: Any

| Host                   | Status | Last Check          | Duration       | Status Information                           |
|------------------------|--------|---------------------|----------------|--|
| ambastanton_cisco_1801 | DOWN   | 05-11-2009 22:59:50 | 0d 6h 24m 44s  | CRITICAL - Plugin timed out after 10 seconds |
| amnap_cisco_1801       | DOWN   | 05-11-2009 22:55:30 | 0d 5h 28m 4s   | CRITICAL - Plugin timed out after 10 seconds |
| ball_cisco_1801        | DOWN   | 05-11-2009 22:57:00 | 1d 6h 19m 35s  | CRITICAL - Plugin timed out after 10 seconds |
| ball_cisco_1801        | DOWN   | 05-11-2009 22:57:20 | 0d 6h 43m 45s  | CRITICAL - Plugin timed out after 10 seconds |
| binrayak_cisco_1801    | DOWN   | 05-11-2009 22:57:30 | 0d 6h 53m 44s  | CRITICAL - Plugin timed out after 10 seconds |
| binrayakva_cisco_1801  | DOWN   | 05-11-2009 22:58:10 | 0d 6h 41m 55s  | CRITICAL - Plugin timed out after 10 seconds |
| binrayakva_cisco_1801  | DOWN   | 05-11-2009 22:59:20 | 40d 7h 13m 59s | CRITICAL - Plugin timed out after 10 seconds |
| binrayakva_cisco_1801  | DOWN   | 05-11-2009 22:59:30 | 40d 7h 12m 18s | CRITICAL - Plugin timed out after 10 seconds |
| binrayakva_cisco_1801  | DOWN   | 05-11-2009 22:59:40 | 40d 7h 10m 38s | CRITICAL - Plugin timed out after 10 seconds |

Figure 2 - Online Resource Availability through Nagios

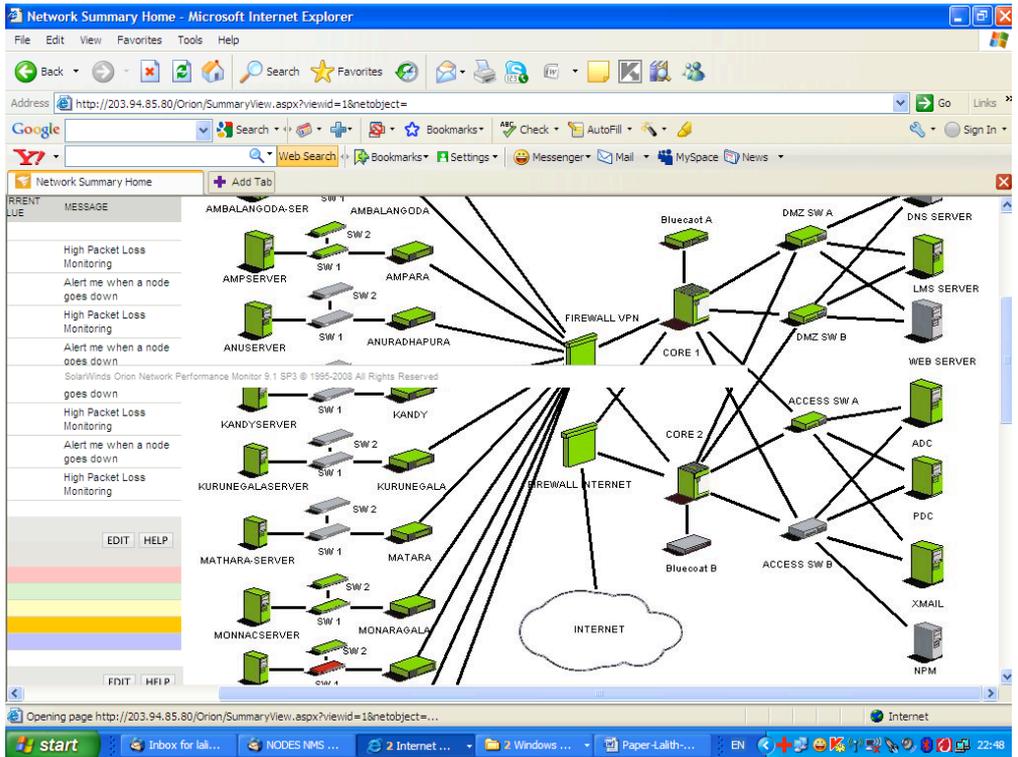


Figure 3 - Logical Network of all Online Resources