

# **Infrastructure Surveillance System for Dandemutande Investments**



**Kudakwashe Joe Manga (R156746B)**

# **Infrastructure Surveillance System for Dandemutande Investments**



**By**

**Kudakwashe Joe Manga (R156746B)**

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Supervisor: **Mrs A. N. Mutembedza**

## **ABSTRACT**

Dandemutande Investments was face with a network management and tracking problem. The issues that were presented by old manual system include, missed service level agreement due to delayed response to network outages and incidences, the support team had to familiarize with several troubleshooting tools, manual compilation of system reports and the system was reactive and action to resolve network issues were only taken after the they had already occurred. The Infrastructure Surveillance System is an online solution that facilitates and simplifies real-time monitoring of systems and services availability. The Infrastructure Surveillance System monitors the availability and compute uptime of entities such as Base Transceiver Stations (BTS), Point of Presence (POPs), monitoring availability of given services running on specific ports on hosted servers in the Data Centre, monitor bandwidth utilization and latency, log the traffic data and create graphs. The system helps to secure and provide efficient means of carrying out interactive and adaptive infrastructure surveillance. After a feasibility study was carried out, it was deduced that though there are constraints involved, the benefits realized from setting up the new system outweigh the total cost incurred. The technical resources and operational logistics at the company's disposal allowed for the new system to be developed. Interviews, questionnaires and observation where used as data gathering methodologies and it was found out that engineers have in the past had to go through a cumbersome and non-efficient manual process of identifying and resolving network related issues. The system was developed using C# proگرامing language, Visual Studio 2017 and SQL Lite for the database. Unit testing, integration and acceptance testing was carried out on the system whereby the following where included, system security, verification and authentication, data validation and basic functionalities. Parallel changeover was implemented whereby the two systems were run concurrently to minimize risks associated with discarding the old system completely. It was recommended that further development be considered to include additional functionality by linking the infrastructure surveillance system to the billing system and introduce additional product offering through on-demand access were customers are only billed for the total time they were online and accessed the system.

## DECLARATION

I, **Kudakwashe Joe Manga**, hereby declare that I am the sole author of this dissertation. I authorize the **Midlands State University** to lend this dissertation to other institutions or individuals for the purpose of scholarly research.

Signature: .....

Date: .....

## APPROVAL

This dissertation, entitled “**Infrastructure Surveillance System for Dandemutande Investments**” by **Kudakwashe Joe Manga** meets the regulations governing the award of the degree of **BSc Honours Information Systems** of the **Midlands State University**, and is approved for its contribution to knowledge and literary presentation.

Supervisor’s Signature: .....

Date: .....

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## **DEDICATION**

I dedicate this work to my family for working tirelessly to afford me the foundation upon which my achievement is built and the moral support and guidance they have given me through the course of my life. These people are special for they could give consistency and solid support without giving up. I say special thanks to you all and may the dear Lord bless you.

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## LIST OF ACRONYMS

IIS Infrastructure Surveillance System

DB Database

SQL Structured Query Language

DFD Data Flow Diagram

ERD Entity Relationship Diagram

ISP Internet Service Provider

IAP Internet Access Provider

POP Point of Presence

BTS Base Transceiver Station

MSU Midlands State University

NOC Network Operations Centre

SMTP Simple Mail Transfer Protocol

CSR Customer Services Representative

DC Data Centre

SLA Service Level Agreement

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# **Chapter 1: Introduction**

## **1.1 Introduction**

Among the primary objectives of the project is to design, develop, implement, document and maintain an adaptive and interactive Infrastructure Surveillance System for the Network Operations Centre (NOC) division located at Dandemutande Investments corporate headquarters. The Infrastructure Surveillance System facilitates and simplifies real-time monitoring of systems and services availability. The Infrastructure Surveillance System will monitor the availability and compute uptime of entities such as Base Transceiver Stations (BTS), Point of Presence (POPs), monitoring availability of given services running on specific ports on hosted servers in the Data Centre such as SMTP (25), POP (110) and so on, monitor bandwidth utilization and track network link load, log the traffic data and create graphs. The surveillance system will incorporate real-time incident notifications through SMS and Email triggers if given thresholds are exceeded. Link performance will be computed through monitoring variables such as Latency and Packet Loss. The system will allow adding and removal of elements to be monitored by IP Address and/or Hostname and assigning different priority classes from normal to critical. Finally, the system will allow for pulling of periodic reports, hourly, weekly, monthly or customs intervals.

## **1.2 Background of the study**

Dandemutande Investments (Pvt) Ltd motivated me to carry out this research to think of better ways of making the monitoring of hardware infrastructure and services availability automated, systematic and efficient. The current procedure involves a technical support personnel manually probing the target system to determine uptime and service availability at random intervals using built in system troubleshooting tools such as ping, traceroute and so on. After the status of the server or services is determined to be down, a more detailed investigation and troubleshooting is conducted to try and restore the service. Then once the service has been restored, the node name and the total downtime is recorded in a Microsoft Excel spreadsheet from which the cumulative downtime will be used to measure SLA targets. Dandemutande Investments (Pvt) Ltd presently operates five brands namely Utande, uMAX, AfricaOnline, iWayAfrica and YoAfrica which previously were independent entities with their own infrastructure hence the need to centrally manage the infrastructure surveillance data since they are all now operated as one entity under the oversight of one Network Operations Centre Department.

### **1.2.1 Background of the Organization**

Dandemutande Investments is one of Zimbabwe's leading Broadband Internet Service Providers, offering incomparable connection quality, true broadband speeds and unbeatable customer service for large corporates, households and other smaller entities alike.

Dandemutande is a privately-owned business founded in July 1997 and a subsidiary of Telerix Communications (Private) Limited whose major stakeholder, is Masawara Plc. Its principal concentration is the delivery of Internet services to the wholesale, corporate and retail market sectors within Zimbabwe. In 2009 Dandemutande Investments was granted an Internet Access Provider Class A telecommunications operator licence with 30MHz paired 2.5GHz spectrum by POTRAZ which is vested with regulatory powers on telecommunications and courier and postal services in Zimbabwe." "In May 2015 Dandemutande Investments merged with two local ISPs, iWayAfrica and Africa Online. The two entities are both subsidiaries controlled by Gondwana, an Information & Communications Technology and Telecommunications service provider head quartered in South Africa with operations throughout the greater Africa. Following the merger, Gondwana has an effective 41% holding in Dandemutande.

Established in 2003, Gondwana International Networks presently serves over 67,000 corporates and an upwards of 20,000 private home customers throughout Africa. Through principal operations, distributor and partner network across the greater African continent, our direct existence spans through 44 African countries. The Group are the owners and managers nine hubs co-located in four teleports in Germany, the UK, South Africa and the USA. Dandemutande Investments presently runs five brands in Zimbabwe serving the corporate and home segments namely uMAX, iWayAfrica, YoAfrica, Utande and AfricaOnline.

#### **1.2.1.1 Organization History and Milestones**

November 2016: Dandemutande acquired a local ISP YoAfrica.

June 2016: Dandemutande acquired BSATT, one of the largest VSAT service providers in Zimbabwe.

May 2015: Dandemutande merged with two local ISPs, Africa Online and iWayAfrica. The two entities are both subsidiaries controlled by Gondwana, an Information & Communications

Technology and Telecommunications service provider head quartered in Johannesburg, SA with operations throughout the greater Africa.

June 2012: Commercial launch of uMAX's home and office Broadband Internet Service.

September 2011: Launch of Utande's world-class Data Centre that now acts as host to the organization's private servers in addition other servers belonging to large corporate customers who depend on Dandemutande to deliver to them an option of recovery in the occurrence of an unforeseen disaster and server hosting facilities.

June 2011: SEACOM connectivity via Mozambique was lit.

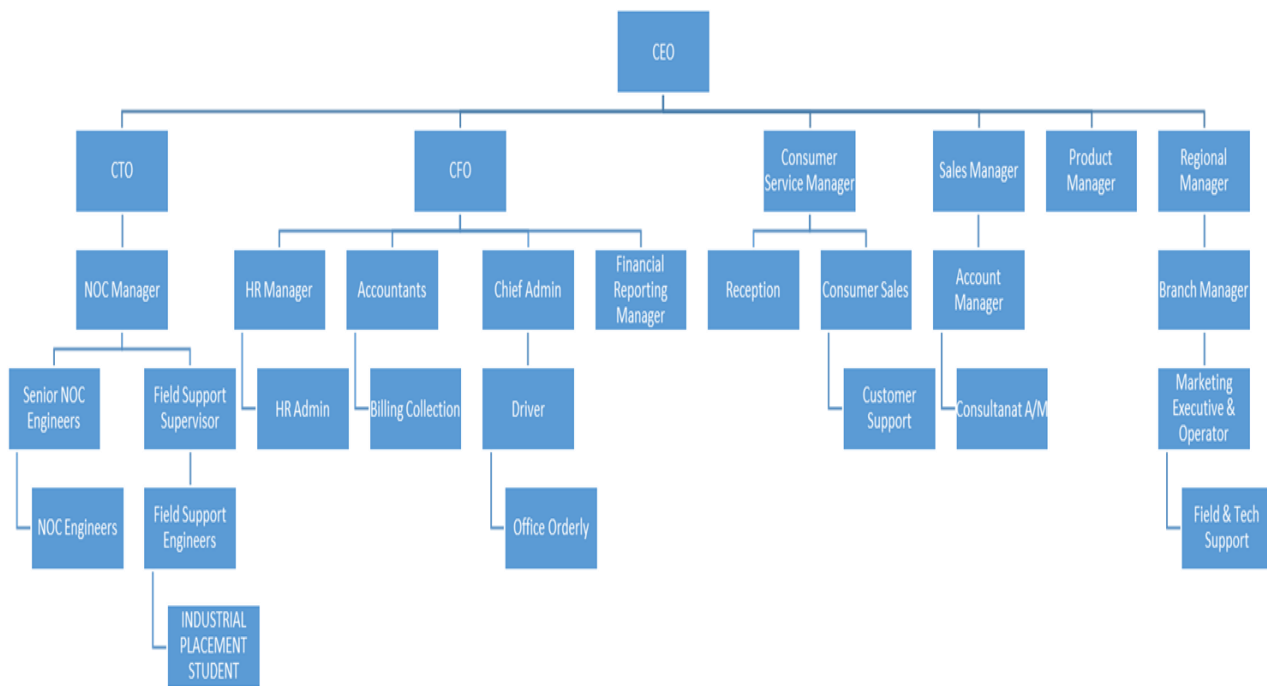
July 2010: Construction of an aerial fibre optic cable from our offices in the Harare CBD to Machipanda in Mozambique through a Capacity Purchase Agreement with Powertel Communications.

July 1999: Rolled out a 250-node countrywide HDSL (Newbridge) network for Delta Corporation Limited and a business-to-business e-Commerce hub in association with ZTA and a international entity, Standard Chartered using its Zimbabwean arm.

July 1997: Founded as a corporate Internet Solutions Provider.

### **1.2.2 Organizational Structure**

Dandemutande has a dynamic structure with management and directors interlinking to effectively shorten the decision-making process and allow for flexibility. The workforce comprises of the marketing team, sales team, customer services team, network, NOC team and field services team. This makes a small and effective community with each member playing a particular role towards the profitability of the company. The following diagram shows an outline of how Dandemutande Investment is structured in Figure 1.1 below.



**Figure 1.1 Organogram**

**1.2.3 Vision**

Dandemutande’s reputation has been built on a history of providing reliable and secure connectivity, vast technical and effective customer support.

**1.2.4 Mission Statement**

The mission of Dandemutande is to simplify life for people around the world through technology.

**1.3 Problem Statement and Definition**

Problem definition involves analyzing a certain system, situation or condition and identifying and outlining the flaws noted within the analyzed domain (McQuain, 2012). The methods currently used for monitoring has these highlighted issues amongst others:

- Missed Service Level Agreements (SLA) due to completely missed or network incidences noticed late.
- The current system requires technicians to be familiar with dozens of tools such as telnet, nslookup, ping, pathping among others and be able to interpret the results.

- The current system is reactive rather than proactive as the engineers and technicians only get to be aware of network issues after they have already occurred.
- The operations teams have to be on their work stations probing network elements to identify network issues as there are no electronic notifications generated.
- Reports of network incidents are currently being manually compiled from reported outages and others brief outages are missed.
- Technicians are forced to memorize multiple IP Addresses of the network nodes to probe them.

#### **1.4 Aim of the Project**

The essential aim of this venture is aimed at building up an automated and interactive Infrastructure Surveillance System framework that is of significance to the whole organization. This infrastructure surveillance system (ISS) is an intranet driven application that will be accessed throughout the whole enterprise and with routed connectivity through the internet gateway will be able to monitor external entities. The periodic crediting of leave is also automated. There are functionalities which include SMS and Email notifications, real-time bandwidth graphing and report producers in this system.

#### **1.5 Objectives**

An objective is statement of aim or desired outcome (Shelly, 2010). Objectives must be smart meaning they must be specific, measurable, attainable, relevant and time based.

The system is going to achieve the following:

- To continually monitor key aspects of network and system performance to provide early warnings and help maintain the quality of services.
- To introduce security by authenticating system users with individual accounts.
- To assist the less technical operations team members in monitoring the network elements through the graphical interface.
- To produce real-time system and network status statistics throughout the day.
- To produce log and reports on request at specified intervals.

- To proactively monitor specified elements and alert configured users via Email when set thresholds are exceeded.
- To allow multiply concurrent users to login to the system and get customized views.
- To run port scanning to check availability of services running on a destination port.
- To facilitate discovery of the actual network paths used by applications to give deep insight into the network components the applications depend on.

## 1.6 Instruments and Methods

To get a better understanding of the status quo and the requirement for the new system, different methods were used to gather the required data and instruments used to develop the system.

### 1.6.1 Instruments

- **C#:** C# is a simple, modern, general-purpose, object-oriented programming language developed by Microsoft.
- **Sendmail:** The Sendmail utility built inside the Linux OS and is utilized to generate e-mails and transmits them to the users from PHP script.
- **MySQL Server:** MySQL is a server for databases that is used to receive requests from the PHP scripts to run SQL statements. This server has got the capability of managing large databases with fixed and records of variable length.

### 1.6.2 Methods

- **Questionnaires:** According to Willimack (2013), a questionnaire is a study tool comprising of a progression of inquiries and different prompts in order to effectively gather the required data for the respondents. These can be utilized to gather both quantitative and subjective information and are regularly intended for factual examination of the responses.
- **Observations:** Bradburn, Sudman and Wansink (2006), defined an observation as an evidential centric approach that is more concerned with the behaviour as compared to the opinions of the clients/users.
- **Interviews:** Clifford (2000), defines interviews as prescribed discussions comprising of no less than two parties with the aim of exchanging information. In an interview, responses to any question are given in real-time with a brief moment for the interviewee to process the question.

## **1.7 Justification and Rationale**

Since this is an intranet driven application, it can be accessed throughout the enterprise regardless of physical location and at the same time does not consume the organization's international bandwidth capacity as the traffic is routed locally. Since this is a client-server implementation it can be accessed through the host server from any internet browser or web client.

The system satisfies the previously stated objectives through:

- Realtime Monitoring – All key infrastructure components will be constantly monitored 24/7 without manual intervention from the engineers.
- Service Level Agreements – No SLAs will be missed as system troubleshooting efficiency will be increased and issues resolved within minimum downtime.
- Graphical User Interface – The system introduces a GUI to all modules of the system hence making it user friendly and much easier to use for the engineers.
- Reporting – The system will produce real-time updates and network statics on demand throughout the day hence more informed business decisions can be made.
- Logs – All incidences on the network infrastructure will be logged and details of the resolution steps thereby creation a knowledge base for future reference.
- Multi-user environment – The system will allow multiply concurrent users to login to the system and get customized views which enhances security by only necessary system rights.

## **1.8 Conclusion**

The system proposal if implemented should significantly lower the total operations time consumed by this support process. For successful implementation, careful planning for the resources needed and the feasibility aspect must be greatly considered. All the problems were identified and the objectives stated very well and the next phase is the planning phase. The Infrastructure Surveillance System, if implemented accordingly must be able to fulfill the above-mentioned objectives. There must be co-operation among the affected parties that is stakeholders and the development team. The planning phase requires us to carry out the feasibility study of the proposed system and to create the project work plan schedule. The feasibility study will determine if it is feasible to carry out the project.

## **Chapter 2: Planning Phase**

### **2.1 Introduction**

In this chapter, the primary focus will be on the planning phase of the Infrastructure Surveillance System that is going to be developed. The primary focus will be on the motives for developing the system and the associated benefits to the organization. The researcher identifies and explains the details of what is going to be built, the people who are going to be involved in the process, how the system is going to be built as well as the timeframe provision to build it. This planning phase critically analyses the project feasibility study which includes social feasibility, economic feasibility, operational feasibility and finally technical feasibility. There will also be development of a work plan to calculate and project the time that will be required to develop and implement the web-based Infrastructure Surveillance System.

#### **2.1.1 Reasons For Building The System**

Following the identification and realization of the drawbacks in the current system, it comes of essence to develop the Infrastructure Surveillance System to address the challenges listed below:

- Automated network surveillance gives the visibility needed to stay one step ahead of potential issues. By showing live network performance data in an easy-to-read interface, the system helps to identify outages that could cause bottlenecks.
- Network monitoring makes problem-solving easier and faster for time-strapped network professionals. Live network maps lead to the origin of problems, and status windows give you performance metrics over time.
- Without the need to manually dig into network performance, staff have time back in their day to work on more critical projects.
- The surveillance system gives that historic insight into how equipment has performed over time. Trends analysis can then be employed to help determine if the current technology can scale to meet business needs, or if there is need to invest in a new technology.
- With the ability to report on performance that the system provides, it can become easier meet the requirements of SLAs and ensure the satisfaction of customers.



- Timeous response and feedback is introduced for efficiency through the integration of the emails notification feature immediately to technicians once a given threshold has been surpassed.

## 2.2 Business Value

Business value refers to expected benefits or additions to the global usefulness of the company that will escalate the position of that business as far as effectiveness is concerned, Stephen (2005). To get a better understanding of projected organizational value, the researcher zoomed in on the unique basis of structured requests and this prompted the researcher to prepare the Project Business Value Table extract shown below.

**Table 2.1: Project Business Value Table**

The system will add:
1. Shareholder Value – Through increased customer acquisition and retention by faster resolution of customer queries, customer base will and market will be maintained and sustainable cashflow maintained.
2. Customer Value – Easier and quicker detection of the customer faults through the automated system will result in delivering a quality service to the customer and better customer experience.
3. Employee Knowledge - Enhance business efficiency and attitude among workers since it will be quicker, exact, and easy to understand and solid. The system logs of all faults and solutions will create a knowledge base for future reference to engineers.
4. Channel Partner Value - Offer acceptable security by using a secure database framework that will thwart connections that are not authorized to the acute data stored.
5. Manager Value - Enable rapid informed corporate decisions to be made through detailed periodic reports at the disposal of management and access to updated incident archives.
6. Societal Value – Because of the proactive nature of the system surveillance nature, the status of all equipment is constantly monitored and maintained and will reduce chances of causing hazards to the environment and the community which host the infrastructure such as wireless base stations.

## **2.3 Feasibility Study**

According to Bentley and Whitten (2007), a feasibility study refers to the extent or degree of practicality the undertaking and implementation of that planned project will be to an enterprise. A feasibility study seeks to address the issue of whether the venture will be possible given the available resources such as assets, monetary and time requirements limitations. To be considered achievable, those foreseen advantages must be exceeding advancement negatives and in addition to the cost of initial setup. Viewpoints such as, the Operational, Economic, Technical and Schedule must be put into consideration for an attainable venture.

### **2.3.1 Technical Feasibility**

According to Bentley and Whitten (2007), technical feasibility addresses questions with reference to having the system developed given the clear imperatives as far as resources and time among numerous other constraints. It envelops the capability to use around date improvement, for example, the latest more capable Personal Computers, regardless of if the recognized user requirements might be satisfied using currently employed encoding styles or apparatus. The accomplishment of this investigation likewise relies upon the possibility that the workers will be enthusiastic to prepare to be trained and will not be resistant to change.

#### **2.3.1.1 Technical Expertise Availability**

Taking into consideration the resources at disposal, the system can be built. An analysis on the accessibility the specialized skills was taken into consideration and it revealed that the organization has resident staff with capabilities to harness the proposed innovation since it is a telecommunications company whose core business is technological. Relevant skills are available and at disposal to keep the computerized system running after it is finished since the venture has a requirement of basic technological skillset requirements in order to setup and keep running, therefore the IT department workforce can debug issues faced in the use of the system.

#### **2.3.1.2 Technical Risk Analysis**

The researcher conducted a preliminary scrutiny of the technical risks relating to the likelihood of a technical breakdown hindering the completion or operation of the system. It was discovered that the venture objectives are not theoretically far-fetched to actualize. The venture is attainable technical as it really intends to bring about a thing for which current technologies exist (software

and hardware is easily accessible). More so is also compatible with current software and hardware which cannot be modified within the prescribed limits of the project.

### 2.3.1.3 Hardware and Software Requirements

Under hardware requirements the researcher will be comparing the hardware that is required and the hardware that is currently available. This will be done in the table below.

**Table 2.2: Hardware and Software Analysis Table**

<b>Item</b>	<b>Specifications</b>	<b>Available</b>	<b>Comments</b>
Database Server	Core i5, 3.1GHz, 8GB Ram, 1TB HDD	NO	Implement a dedicated virtual DB for performance.
Application Server	Core i5, 3.1GHz, 8GB Ram, 500GB HDD	NO	Implement a dedicated virtual server for performance.
Network Switch	2 * 24 Port Cisco Managed	YES	Already in use with the organization.
Ethernet Cables	5 Meters, UTP	NO	Needed to patch new servers to the corporate network
UPS	APS 200 Watts, 300VA, 250v	YES	Already in use with the organization.
Desktop Workstations	Core i5, 3.1GHz, 8GB Ram, 500GB HDD	YES	All staff already have individual PCs.
Monitoring Screen	60" Smart, HDMI	NO	Needed for better visual
Anti-Virus Software	Eset File Security, Eset Nod32	YES	Already in use with the organization.
Microsoft SQL Server	v2008, x64	YES	Already in use with the organization.
Crystal reports		YES	Already in use with the organization.

### **2.3.2 Organizational Feasibility**

According to Bentley and Whitten (2007), organizational refers to the stage that surveys and evaluates the dangers concerning the progression of the project relating to the company workers. The projected framework ought to compliment the general purposes and aims of Dandemutande.

#### **2.3.2.1 Management**

This suggested system will impact the management in a progressive manner. The management's professional processes rely a lot on the dependability and integral qualities of the information and the system in its entirety. Amongst the goals of the venture is the ability of the system to provide precise and updated data for managers. The commissioning of the new system will enable the generation of timeous report and facilitate effective communication. Managers rely on reports and use them as measuring tool for productivity since they offer them control. In this regard the usefulness of the administrative business procedures will be enhanced significantly.

#### **2.3.2.2 Employees**

The effective execution of the planned system will transform the mentality of the workers in respect of their work by being a morale booster. The presently used system has become a hindrance to progress and time consuming for the mainstream workers who have been using it. As soon as all system users are inducted, the workers will be empowered to do away with the cumbersome process that they were accustomed to and constantly going through in network and system monitoring. Employees are going to be assisted swiftly and the chances of errors will in turn be significantly decreased enabling effectiveness.

#### **2.3.2.3 System Engineers and Administrators**

The system engineers' work will be to support the proposed system. Dandemutande will benefit from technical support it will get form the equipped resident engineers and system administrators and this will not be an issue since this group is already highly conversant with systems development and implementation. Drawing from the overhead organizational feasibility investigation, the suggested system would require extra support from the general workforce involved in the venture all in all and chances are high that it will be invited as the new framework will significantly address the vast majority of the present system issues.

### **2.3.3 Operational Feasibility**

According to Bentley and Whitten (2007), operational feasibility refers to the emphasis on the operations of the system as to how useful it is, and also if we have at our disposal the skilled resources to satisfy the project requisites. This as well looks the effects the system will have on the stakeholders in the company and also whether or not it will be fully supported by the managers. More so it assesses if the venture will put the workers' jobs at risk or if it will work in their favour by further widening prospects. Training of system users once it gets operation will be of essence but however a proactive step of attaching a self-help guide built into the system will also be adopted to clarify any grey areas.

Operational feasibility relies on the following:

- Support and management of users.
- Involving users in the planning.

Following the assessment of operational feasibility, we realised that we can work the proposed new system. We have the hands-on staff that meets the venture requirements beginning up from development manager to the system users. In instances of crisis, a reinforcement team has been extended to standby. The identification of organizational stakeholders has been conducted taking into consideration their goals prior to the passing of the ultimate objectives. Widespread support is being received from the stakeholders as they have also come to the realization that the present system is proving to be costly to the institution as well as not delivering any significant benefits the employees.

Be that as it may, the new system will expand worker prospects. Workshops will be conducted to train users on every module of the system once it has been finalized and an accompanying user guide will come as an attachment to the system for users' consultation on system related issues.

### **2.3.4. Economic Feasibility**

According to (Kendall, 2006), economic feasibility study should show viability in costs and benefits of the project before financial resources are allocated thereby providing independent project assessment and enhance project credibility. This study is commonly the final analysis in a number of projects. It seeks to address questions such as whether or not the system should be developed and in the event that it was developed, will there be sufficient financial resources to

see it through. This will hence include every cost that will be related with the development process of the new system. This can be related to the cost – benefit assessment that is cognisant of the measurement of the project’s impact on finances. In the case of Dandemutande Investments, the system will be developed in house using the company’s already available technical, financial and system resources.

### **2.3.4.1 Costs**

#### **2.3.4.1.1 Development Costs**

Costs associated with development are once-off cost that are encountered during the course of the system development, and these can be estimated from the beginning of the venture and can be amended at the conclusion of each stage of the project. Costs of development are tabulated below.

*Table 2.3: Development Costs Table*

<b>Item</b>	<b>Quantity</b>	<b>Total Cost (USD)</b>
Database Server	1	2200
Application Server	1	2000
Ethernet Cables (Metres)	5	10
Monitoring Screen	1	1200
<b>Total</b>		<b>5410</b>

#### **2.3.4.1.2 Operational Costs**

These happen to be incurred through the lifespan of the respective system. An example of this is costs associated with system maintenance. These costs can be further classified as variable costs and fixed costs.

Fixed: These are incurred regularly at rates that do not change for example rentals, staff salaries and software licensing.

Variable: These are incurred at rates directly proportional to the usage for example prorate costs on overheads.

**Table 2.4: Operational Costs Table**

<b>Description</b>	<b>Estimated Cost (USD)</b>
Hardware and software upgrades	300
Training	200
Installation and system changeover	400
<b>Total</b>	<b>900</b>

#### **2.3.4.2 Benefits**

Through the use of the system, the organization is expected to realize the benefits illustrated in the below table.

**Table 2.5: Benefits Table**

<b>Description</b>	<b>Approximate Value (USD)</b>
Reduction in SLA target fines	6000
Reduction in revenue leakage	2000
Reduction in labour costs	4000
Reduction in stationery costs	300
<b>Total</b>	<b>12300</b>

#### **2.3.4.3 Cost Benefit Analysis**

According to Ramia (2014) this is a structured methodology of forecasting and comparing the anticipated costs and benefits of alternative courses of action in order to identify the most effective manner of achieving a stated goal or objective. This phase assesses whether it is financially viable to continue the project.

**Table 2.6: Cost Benefit Analysis Table**

<b>Description</b>	<b>Expected Value</b>
<b>Costs</b>	
Development Costs	5410
Operational Costs	900
<b>Total Costs</b>	<b>6310</b>

<b>Benefits</b>	
<b>Total Benefits</b>	<b>12300</b>
<b>Benefits/(Costs)</b>	<b>5990</b>

Drawing from the table for cost-benefit analysis above it is visible that the first year through to year end will yield positive financial results of \$5 990. We can therefore reach a conclusion that the project implementation proposal is feasible economically.

#### **2.3.4.4 Return on Investment Analysis**

This can be characterized as a money-related measure of the results of a business venture. This is defined as a financial measure of the return from an investment typically conveyed as a percentage of profit delivered through an asset for the sum introduced into the resource. The ROI per annum can be figured out using the following formula.

$$\text{ROI} = \frac{\text{Benefits (Total)} - \text{Costs (Total)}}{\text{Costs (Total)}} * 100$$

$$\text{ROI} = \frac{(12300 - 6310)}{6310} * 100$$

$$= \mathbf{59.90 \%}$$

A high ROI (above average) for the % might indicate that the undertaking shows viability.

#### **2.3.4.5 Net Present Value Analysis**

This scheme takes into consideration the consistency of the venture the cash flow timings. The discount rate factor is used here as well. This is done by applying a discount on future cash flows by a fraction known as the discount rate. This scheme is commonly applied where the projected cash flows are for several years and not just for a single year as it might give a misleading result.



$$\text{NPV} = \frac{\text{Benefits (Total)} - \text{Costs (Total)}}{(1+r)^n}$$

Whereby: Interest Rate = r  
No of Year = n

### Advantages

- Not only are just the benefits and costs considered, they are more so adjusted factoring in the timing.
- Future estimates are also factored in.

### 2.3.4.6 Comments

The prior solution put into comparison with other solutions produced the most favourable Return on Investment. Therefore, from the Return on Investment Analysis perspective, the project viability is visible.

### 2.4 Risk Analysis

This stage classifies, assesses and attempts to bring about resolutions to issues that may go wayward in the venture way before they develop into threats that may become a hindrance to the accomplishment successfully of the project and/or the commissioning of the planned system. The following log of risk analysis is corroborated by the economic, technological and several other classes of risk that can be linked with the commissioning of the new system proposal. The successive logs scrutinize and give recommendations in order to decrease the probabilities of endangering the new system as well as any other tasks linked to it.

**Table 2.7: Risk Analysis Log**

	<b>Risk Statement</b>	<b>Occurrence Probability</b>	<b>Risk Occurrence Impact</b>	<b>Action to Prevent</b>
1	Shortage of resident resources	Low	Delivering less than expected due to mouthing pressure on few human resources	To cease allocation of resources towards the improvement of the old

				system
2	Shortage of resident project management and technical skills	Low	Protracted learning curve  High staff turnover as a result of the exit of skilled workforce	Encourage peer training groups  Recognize necessary trainings and offer it to all relevant team member
3	Poor execution against timetable by project members	Medium	Inability to finish the project inside the planned time and budget, thereby extending the costs of the project	Meticulously evaluate the performance of the developers and in house participants.
4	Inability to forecast deliverable to satisfy requirements	Medium	Inability of the coders to adhere to specifications will in turn lead to delays in the launching of the product	Support a rational joint group of relationship of in-house members and engineers
5	Lack of data integrity	Medium	Will foul up the project execution if the information is taken online without a tidy up	Get an appreciation of data conversion pre-requisites and clean up all the data upon conversion
6	Loss of Equipment	Low	Delay of the project  Increase project costs	Security systems on all equipment  Fire preventive measures on the indoor equipment  Insurance for all equipment

## 2.4.1 Other Risks

### 2.4.1.1 Users

The other risk that the system might face is that the users might have the impression that it may be too challenging and in this case they may risk losing their jobs. There will be need to restore confidence in the users otherwise the system will be bound to fail due to sabotage. With the

Dandemutande proposed system no jobs are threatened instead job opportunities are likely to increase and users will be informed that the new system will not jeopardize any one of their jobs.

#### **2.4.1.2 Technical Risks**

- There is a risk that the system may not meet the user's expectations in terms of the user interface considering that the users would have used different types of systems with differing interfaces.
- The users might find it difficult to maintain the system or restore it in the event of a crash. It being a new system, it will need to be backed up and fully supported. Once the system has been implemented, there would be support for the system and maintenance of the proposed system in the first couple of months till the system is in them and they can fully operate it independently.
- Deployment of the system is going to require the use of sideway compatibility modules for integration with the web based platform on the same system to cater for those users who do not use Android based mobile devices. The two systems will operate at the same time for a short duration of time just until the risk of failure or difficulty for new system is cushioned, especially the accounting side so as to avoid errors of omission and if already done be able to refer to manual process. The technical risks would be of no further importance considering that there is a fall-back plan in case the new system fails to deliver.

#### **2.4.1.3 Economic Risks**

- Costs of hardware and software, which keep escalating can jeopardize the project and may actually be at the risk of termination. If the organization really needs the system, it has to budget for it to avoid shortfalls in the development process. All the resources must be readily available and fully functional. The risk is thus avoided by the allocation of a supplementary budget for the system in the event of prices continuing to escalate.

#### **2.4.2 Feasibility Study Conclusion**

After analysing the feasibility of the proposed system recommendations were passed to go ahead with the development of the proposed system. The benefits outweigh costs and within a year.

## **2.5 Stakeholder Analysis**

Stakeholder analysis is an important step in designing a new program. Stakeholders include individuals, community leaders, groups and other organisations who will be impacted by the program, or who could influence the outcome. Stakeholders are all those who need to be considered in achieving project goals and whose participation and support are crucial to its success. Hence identification of all stakeholders is an important activity of the project manager to ensure project success

### **2.5.1 Users**

The support engineers and customer services representatives disclosed that they had a fear of the unknown but after elaborations of the new system they realized the importance and efficiency of it. The introduction of the new system will improve service efficiency as troubleshooting tools are built into the system and system monitoring will be done in Realtime.

### **2.5.2 Management**

Management expected to be able to pull reports from the system. This requirement has been fulfilled as the management can pull on-demand reports weekly, monthly, quarterly and so on. These reports can help management make business decision like which systems need more attention and investment to gain competitive advantage.

### **2.5.3 Customer**

Customer are also another group of stakeholders to the system. Customer generally expected greater system uptime to be able to access the service they pay for when they want to use it. This system addresses this need by allowing minimal downtime by giving Realtime notifications whenever a tracked entity or node goes down hence prompting rapid response from the engineers to meet the agreed service level agreements with the customers.

## **2.6 Work Plan**

The aim of a work plan is to come up with a schedule of events and expected time of completion of all tasks involved to enable project progress monitoring. The Systems Development Life Cycle shall be used to model the activities that are going to be followed in the system development of the project. The stages of SDLC have time spans allocated considering the amount of time needed for work involved in each task.

- This model has been chosen over other models, since it is a well-documented and widely used approach.
- This is a linear approach involving the stages that are clearly defined at each stage.
- Each phase is given a time allocation from the beginning to the end of the project.
- Targets are easy to set with this approach, and one knows exactly what needs to be done from which period of time.
- There is an elaborately written documentation at each phase, this helps in developing a well-documented system.

### 2.6.1 Project Schedule

*Table 2.8: Project Schedule*

<b>Project Phase / Stage</b>	<b>Start Date</b>	<b>Finish Date</b>	<b>Duration in Days</b>
<b>Proposal</b>	<b>13/10/2017</b>	<b>18/10/2017</b>	<b>5</b>
<b>Planning</b>	<b>19/10/2017</b>	<b>25/10/2017</b>	<b>7</b>
<b>Analysis</b>	<b>26/10/2017</b>	<b>10/11/2017</b>	<b>13</b>
<b>Design</b>	<b>11/11/2017</b>	<b>01/12/2017</b>	<b>21</b>
<b>Implementation</b>	<b>02/12/2017</b>	<b>17/12/2017</b>	<b>15</b>
<b>Maintenance</b>	<b>18/12/2017</b>	<b>Ongoing</b>	<b>1+++</b>
<b>Documentation</b>	<b>28/01/2018</b>	<b>Ongoing</b>	<b>7+++</b>

### 2.6.2 Time Plan Gantt Chart

It shows the time taken to carry out the activities, which are grouped into different phases. The phrases are carried in weeks as shown below.

*Table 2.9: Time Plan Gantt Chart*

Activity / Duration (Weeks)	WK 1	WK 2	WK 3	WK 4	WK 5	WK 6	WK 7	WK 8	WK 9	WK 10	WK 11
Project proposal											
Planning											
Analysis											
Design											
Implementation											
Maintenance											
Documentation											

### 2.6.3 Project Size

The project size should be moderate. The system to be designed should be fairly understood so as to avoid complexities. In this case our (project) proposed system is small and manageable and encompasses on few modules.

### 2.7 Conclusion

Despite the constraints we will face in coming up with the system, it is now clear that it is feasible to carry out the project and hence we are going to proceed to the next phase that is the Analysis phase. The Analysis phase focuses on the detailed study of the current system and its main aim is to determine the importance, complexity and the scope of the problems that exist in the current system giving a go ahead to the logical design of the proposed system.

## **Chapter 3: Analysis Phase**

### **3.1 Introduction**

The examination of a system gave an unmistakable knowledge of how the present framework works, and also the requirements of the users' needs in the system. This also offered an explanation of the present system framework, how procedures are connected inside the present system and also how actions will be facilitated in the anticipated system framework. An arrangement or group of data collection strategies were utilized to gather the information to assist determine how the system really functions. The gathered information was broken down emphasizing the qualities and shortcomings of the present system and substitute solutions to the framework are assessed.

### **3.2 Information Gathering Methodologies**

The procedure of collecting requirements typically goes beyond querying clients of their needs and noting down the responses. The procedure of collecting requirements consists of a well outlined and characterized progression of its own basing on the sophistication of the system. With an end goal of accumulating all the imperative details relating to the present system framework so as to enable its qualities and shortcomings to be realized, the researcher made use of three data collection strategies that highlighted with clarity the shortcomings in the present system framework as well as the system's qualities that should be maintained in the new system framework.

The data collection strategies employed are highlighted below:

- Interview
- Questionnaire
- Observations

### **3.2.1 Questionnaires**

According to Willimack (2013), a questionnaire is a study tool comprising of a progression of inquiries and different prompts in order to effectively gather the required data for the respondents. These can be utilized to gather both quantitative and subjective information and are regularly intended for factual examination of the responses. A collection of questions were set up for specific members of staff relating to the tasks they undertake in the organization and were handed over to these employees to complete on 22 October 2017 with an expectation of having them back by 26 October 2017. The researcher noticed a few points of interest and weaknesses that this data gathering strategy presented.

#### **3.2.1.1 Advantages**

- Respondents are awarded enough time to think through the question and understand before given back responses.
- Arranging and conducting them was easier as compared to interviewing since the requisite for constant personal monitoring was limited.
- A lot of time was saved since a number of participants undertook them at the same time.
- The identities of the respondents were anonymous hence the benefit of getting honest opinions without fear of intimidation.
- Compilation of the data was far much easier as the questions from all documents were structured the same way.

Even though this data gathering strategy had the above advantages, it did not come without its own drawbacks and these are highlighted below.

#### **3.2.1.2 Disadvantages**

- The number of returned questionnaires was not consistent with number of questionnaire that were distributed.
- In comparison with interview, questionnaires take more time as the feedback is not given instantly.
- Respondents only responded to questions they were comfortable with or understood and left out some questions unanswered making it difficult to draw some conclusions.



## **Results from Questionnaire**

Majority of employees responded reviewing that they are facing great challenge with the current system and they are willing to migrate the new infrastructure surveillance system because of the inconveniences of the current system

Some staff said they were comfortable with the current system and there is no need to change it but most of them reviewed that they want a better monitoring and troubleshooting system. The administrator points out that the response time of the current system and its manual processes is the reason they are willing to change it.

### **3.2.2 Interviews**

Clifford (2000), pointed out that interviews are prescribed discussions comprising of no less than two parties with the aim of exchanging information. In an interview, responses to any question are given in real-time with a brief moment for the interviewee to process the question.

Outcomes from the conducted interviews:

A progression of interviews was conducted with a given number of staff members from all the departments which are Network Operations Centre, Customer Services, Field Services, Marketing, Human Capital, Finance and Administration also encompassing input from members from all the branch offices, include other employees who oversee and use the present system. The interviews also assessed the employees' state of mind, responsiveness and insights.

#### **3.2.2.1 Advantages**

- The researcher had one to one conversations with the involved employees and both parties had the opportunity to seek clarity on seemingly vague questions and responses.
- Data was collected instantaneously as all the valid points were noted down as the interview progressed.
- Questions imposed directly give room for probing for particular responses.
- Non-verbal communication by the respondents were also observed such as facial expressions and other body language that helped the interview progress by noting if the respondent was uncomfortable with a certain area.
- Allowed the interviewer to interact with the respondents at a personal level and assure them of confidentiality.

- Only relevant questions were posed to respondents from the pool of question based on department and job roles.
- First-hand information was extracted from the respondents directly who utilize the current system such as:
  - Functionality of the system
  - Currently faced problems
  - Areas that need addressing and improvement.

### **3.2.2.2 Disadvantages**

- Chances of getting incorrect responses as from the question or the way they are delivered the interviewer might have influenced the respondent towards a certain answer.
- Interview take up a lot of time since all the respondent have to be interviewed separately hence in the long-run costly.
- Reliability of results concluded from an interview is questionable due to the use of a single interviewer who might be biased.

### **3.2.2.3 Results from Interviews**

Even though most of the interviewed employees were not free to disclose their full thoughts due to fear, the interviewer managed to get useful information about the current system. It was clear that most of the customers are not happy with the inconveniences caused by system downtimes and well as the time it takes engineers to fully resolve the fault.

The support staff were afraid of the unknown as they feared the introduction of the automated system would threaten their job security by making them irrelevant hence they were not in harmony with the proposed system.

### **3.2.3 Observations**

Bradburn, Sudman and Wansink (2006), states that an observation is an evidential centric approach that is more concerned with the “behaviour” as compared to the “opinions” of the clients/users. Complicated responsibilities are usually not easy to translate words with clarity. Using observations, the researcher identified responsibilities that had been overlooked and/or not accurately presented by the use of the other data gathering methodologies.

### 3.2.3.1 Advantages

- Gave room for the researcher to gather information on his own without interaction with the study population and minimised chances of getting biased information through interaction.
- The normal business operations were not interrupted as it was business as usual whilst the observation was getting on with the data gathering process.

### 3.2.3.2 Disadvantages

- It is not every task or responsibility that can be understood through observation.
- There are chances of that the deduced data could have been manipulated since if someone is aware that they are being monitored they tend to adjust their normal routine.
- There are also chances that some actions could have been misinterpreted.

### 3.2.3.3 Results from Observations

The researcher observed that the current system was complex, time consuming and had poor security which made it less favourable by the support staff, this depicts that the Infrastructure Surveillance System is the solution to the problems currently faced by the organization.

## 3.3 Current System Analysis

Utilizing the information acquired through employing the above three data collection techniques, the researcher identified the preceding processes from the present system. There is no centralized, automated tool being implemented in the organization and the engineers and other support staff rely on several built in Windows for those who use Windows based systems such as ping, traceroute, telnet and so on.

```
Microsoft Windows [Version 10.0.16299.192]
(c) 2017 Microsoft Corporation. All rights reserved.

C:\Users\kmanga>ping 8.8.8.8

Pinging 8.8.8.8 with 32 bytes of data:
Reply from 8.8.8.8: bytes=32 time=36ms TTL=57
Reply from 8.8.8.8: bytes=32 time=37ms TTL=57
Reply from 8.8.8.8: bytes=32 time=38ms TTL=57
Reply from 8.8.8.8: bytes=32 time=42ms TTL=57

Ping statistics for 8.8.8.8:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 36ms, Maximum = 42ms, Average = 38ms
```

*Figure 3.1: Built in Windows Ping Tool*

Continuous pings are sent to critical network elements to determine their uptime and once pings start to get negative replies, it will indicate to the engineers and support staff that the network node has gone offline.

Since there is no Realtime monitoring tool and everything is done manually, the technical team also relies on the information from customers advising that there is an outage. In most cases the customer as a service user would be the first to notice a service outage and call the help line or contact centre, and the issue is investigated by the support engineers.

Clients and fellow employees reports their faults to the support engineers who book them down and gives a manually generated reference number as a confirmation of reporting. The support engineer also manually sets the priority of each fault using their own discretion. When a fault is cleared, the customer is notified by the relevant support engineer and they have to log the details of how the fault was resolved on excel spreadsheets.

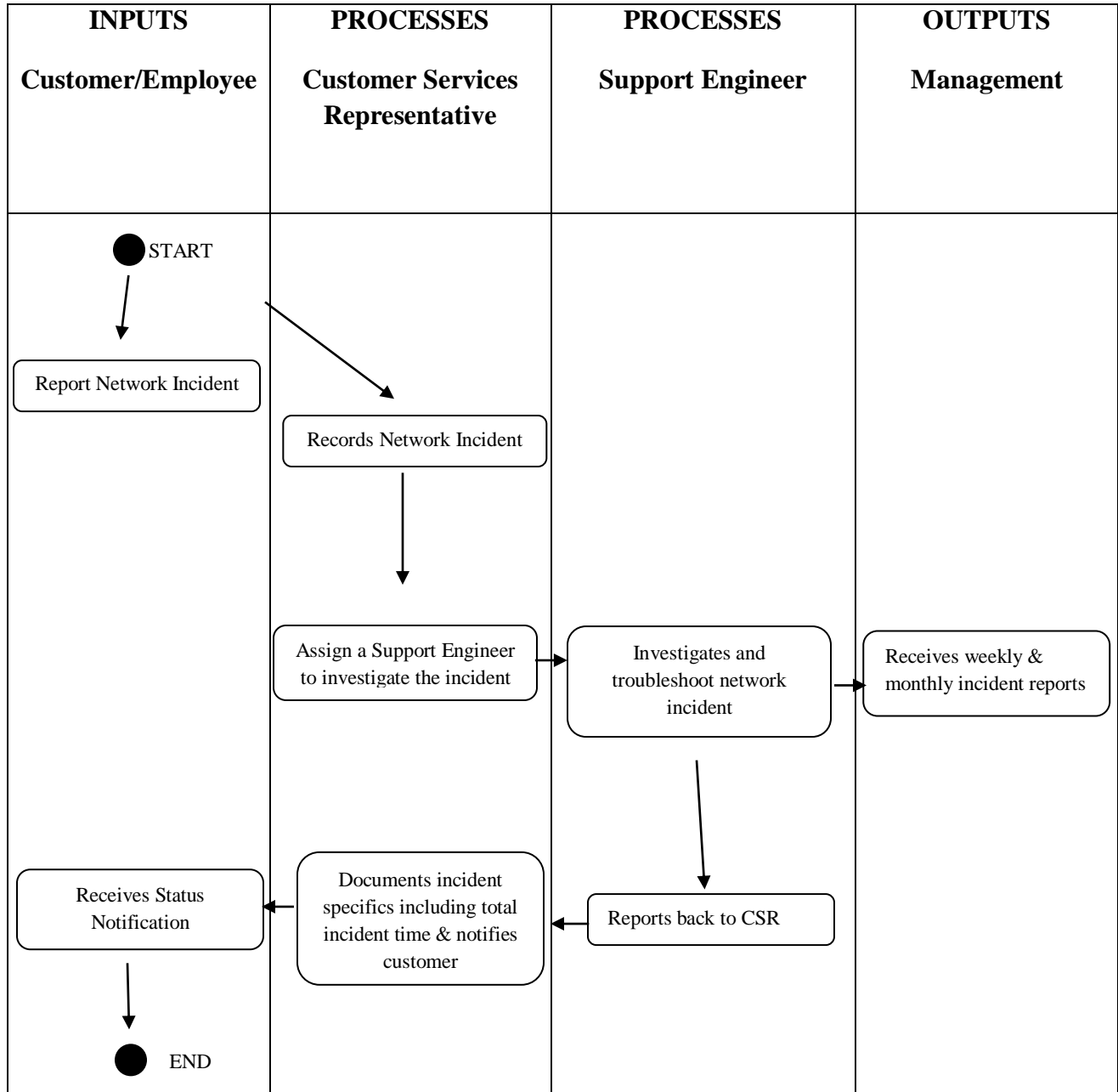
This system has drawbacks in that it depends mostly on the constant manual monitoring by the support staff. Moreso, the current is reactive rather than proactive whereby there is reliance on a fault to occur to first then fixed afterwards rather than detecting issues before they occur and avoid them.

***Table 3.1: Inputs, Processes and Outputs***

<b>Inputs</b>	<b>Processes</b>	<b>Outputs</b>
Engineer Name	User Registration	System uptime report
Admin Name	Ping Host	System event logs
IP Address	Traceroute to destination	Email notification
Host Name	Ping URL	
URL		
Port		
Email Address		
Server ID		

### 3.4 Process Analysis

According to Kendal (2005), activity diagrams are defined as the graphical representation of activities and actions for the purpose to model organizational and computational process transactions and they represent the overall control of activities and workflows in an organization. Activity diagram can help the organization to describe the flow of control of the target system.



**Figure 3.2: Activity Diagram**

### 3.5 Data Analysis

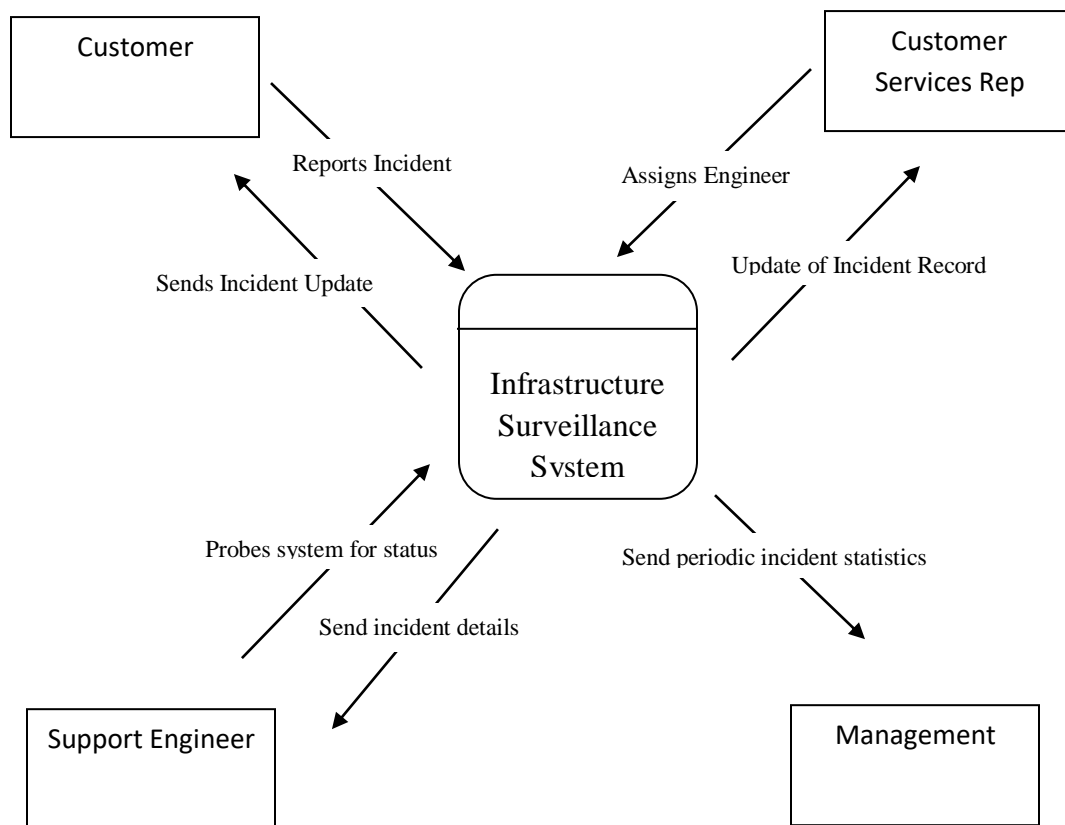
According to Godfrey (2001), data analysis as a process which analyses information process as well as modelling data with the goal of highlighting important information in an organization.

There are two methods of representing inputs, outputs, data and processes, which are:

- Data Flow Diagram
- Context Diagram

#### 3.5.1 Context Diagram

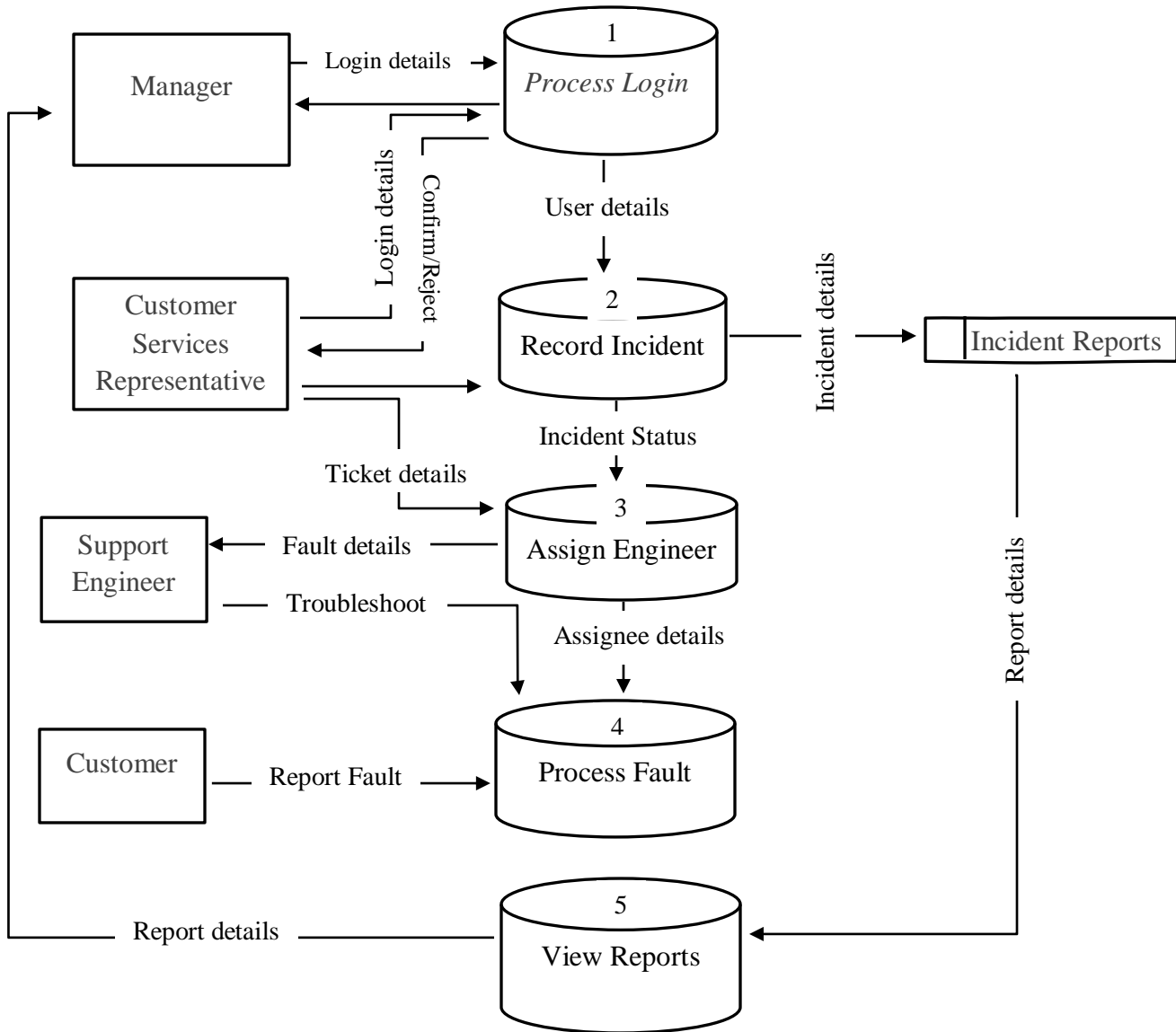
Scott (1999) defines a context diagram as a representation flow of data through the information system. The context diagram of an existing system demonstrates all project boundaries.



**Figure 3.3: Context Diagram**

### 3.5.2 Data Flow Diagram

DFDs are illustration apparatus for the modelling of data in order to facilitate the provision of a clear representation of all organizational functions. This method begins with the general overview of the organization and proceeds to analyze every one of the useful area of concern. The DFD of the present system is illustrated below:



**Figure 3.4: Data Flow Diagram**

### **3.6 Weaknesses of the Current System**

- The current system requires technicians to be familiar with dozens of tools such as telnet, nslookup, ping, pathping among others and be able to interpret the results.
- The current system is reactive rather than proactive as the engineers and technicians only get to be aware of network issues after they have already occurred.
- The operations teams have to be on their work stations probing network elements to identify network issues as there are no electronic notifications generated.
- Reports of network incidents are currently manually compiled from reported outages and others brief outages are missed.
- Technicians must memorize multiple IP Addresses of the network nodes to probe them.

### **3.7 Evaluation of Alternative**

Following the outlining of progressions involved in the present system as well as defining the manner in which data flows in the system, the researcher got a clearer viewpoint of the system requirements. Concurrently other alternatives were assessed to determine the most viable and suitable resolution.

The following alternatives were reviewed:

#### **3.7.1 Outsourcing Software**

This refers to the acquisition of a pre-made, finished software product that addresses the currently faced issues in the organization.

##### **3.7.1.1 Advantages**

- The system changeover process will be quick.
- Technical requirements of this approach are limited to implementation staff.
- Costs associated with product development are eliminated.

##### **3.7.1.2 Disadvantages**

- Initial costs of acquiring these packages are usually high.



- Costs of maintaining the system might rise exponentially especially in the case that the vendor has limited support for the supplied product.
- In turn the high maintenance costs will thereby defy the main objective of bringing down costs within the organization.
- Most of these packages are proprietary hence cannot be fully customized to meet all the requirements of the customers.

### **3.7.2 Improving the Existing System**

According to Ghezzi (2004), improvement is defined as a process whereby the system requirements of a current system were analysed, developed and modified to the new project. Problems in the current manual system are solved in the current project through improvement, implementation and computerization of the system.

#### **3.7.2.1 Advantages**

- Financial resources which would have to be channelled towards the development of a new system will be saved through amendments to the current system.
- The status quo is maintained hence ensuring familiarity with the system users.

#### **3.7.2.2 Disadvantages**

- The manual way of doing things would be carried on which is limiting.
- High costs will continue to be experienced through the printing of the physical form.
- New technology centric features cannot be incorporated into a manual system.
- Time will continue to be wasted as the manual system is time consuming.

### **3.7.3 In-house Development**

Mahapatra and Verma, (2016), defines this as the development of the product or solution that is meant specifically for the given organization to address the known issues and satisfy the identified user needs.

#### **3.7.3.1 Advantages**

- Unlimited control over the development process.
- Tailor made specifications to meet exact need can be incorporated.

- The manual way of doing things is eliminated.
- Duplication of information is eliminated.
- The correctness of data is safeguarded through the enforcement of integrity constraints.
- Overhead costs on stationery are reduced.
- Tailor fitting to user needs and system can be simplified to what the users can basically understand.
- Efficiency is introduced.

### **3.7.3.2 Disadvantages**

- The workers might be resistant to change and reject the system.
- More time is required in development as compared to the other alternatives like buying.
- The initial costs associated with development are also high though cheaper in the long run.

## **3.8 Requirements Analysis**

After thoroughly investigating some of the functions and processes of the present system, the following stage will be identifying the pre-requisites of the present system. These necessities are sub-divided into practical/functional and non-practical/non-functional requirements. The functional aspects address the goals that the system, has to support whereas non-functional aspects address those controls on different qualities of these tasks

### **3.8.1 Functional Requirements**

Functional requirements are composed of different input(s), process(es) and output(s) which are anticipated of the new system. These functional requirements must be inclusive of:

- Management of user accounts and profiles with security mechanisms such as username and passwords.
- Users should have the ability to change their passwords if need be.
- Creation, amendment and deletion of accounts should be possible
- A central data-store to allow on demand access of data relating to leave processes
- Functionality of sending email notifications once an application has been approved.
- Mechanism to facilitate integrity checks to allow for data verification for the data that has been captured in the system.

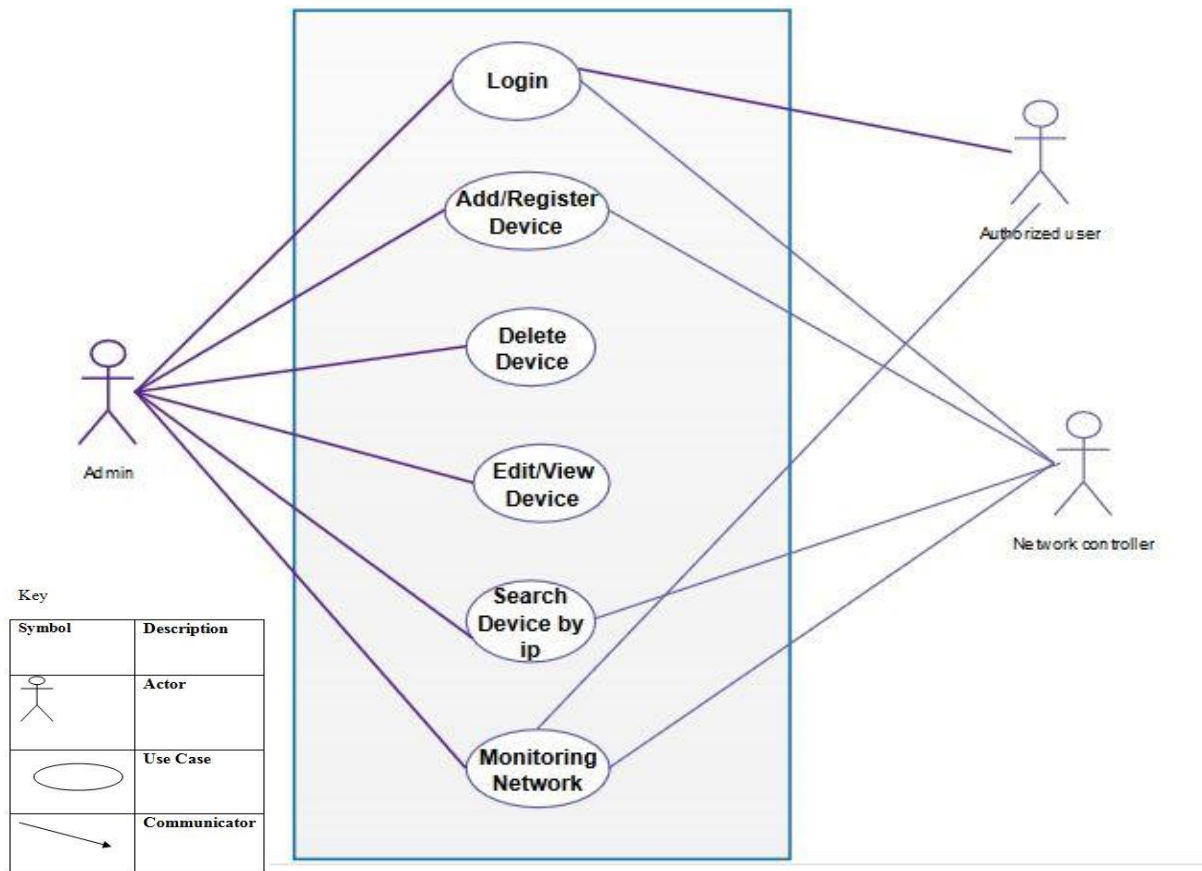
- Encryption of staff personal information when its sent online
- Ability to validate and verify data.

These requirements may be categorized by the use of a case diagram as illustrated below:

### 3.8.21.1 Use Case

According to Gillharm (2008), a case diagram is defined as a graphical representation through interactions among the components or elements of a system project. It was used in system analysis for clarification, modification and to identify system requirements.

This is an explanation of the order of tasks executed by the system for the production of results of an actor. These use cases lay down the anticipated performance but not the actual way of achieving it.



**Figure 3.5: Use Case**

### **3.8.2 Non-Functional Requirements**

When we deduce non-functional requisites relating to a new system the constraint encountered during the system development are taken into consideration. The requirements of the suggested system vary from the expectations of the basic end users to the expectations of the organization's managers.

- Simplicity of the system to learn and use.
- User friendliness of the system should be acceptable.
- Recovery from errors should be error free.
- The system should offer access control through the use of usernames and passwords.
- Granting of different access levels in the system based on organizational roles.
- Should allow password enforcement policies of at least six characters.
- Updating of information in real time.

### **3.9 Conclusion**

Utilizing the information collected using the afore mentioned information gathering methodologies and more so having highlighted the present system's drawbacks and the potential substitutes in order to resolve the issues that were analysed, a conclusion that the in-house development approach of the system was the most suitable way forward to come up with a comprehensive solution to all the issues in the most cost-effective manner. Hence the subsequent stage will be the actual design of the system. Therefore the next step is to proceed to the actual design of the proposed system.

## **Chapter 4: Design Phase**

### **4.1 Introduction**

The design phase entails outlining how the proposed system was developed, configured and deployed. System design is the process of deciding how the system will be implemented and how it will look like. The design process breaks the system into smaller parts that can be implemented independently of each other. This idea seeks to make the system more manageable since it is easier to work with a relatively small piece or part of a system at a time. The design phase gives an outline of the System Design, Physical Design, System Architecture, Database Design, Interface Design and Program Design.

### **4.2 System Design**

This phase should produce an effective, reliable and maintainable system possessing. It looks at how the system will work. Having fully understood the current system there is need to highlight all the functionalities in relation to the functional requirements of our proposed system. The new system will cater for the outlined shortfalls of the current system.

The following are features of a well-designed system:

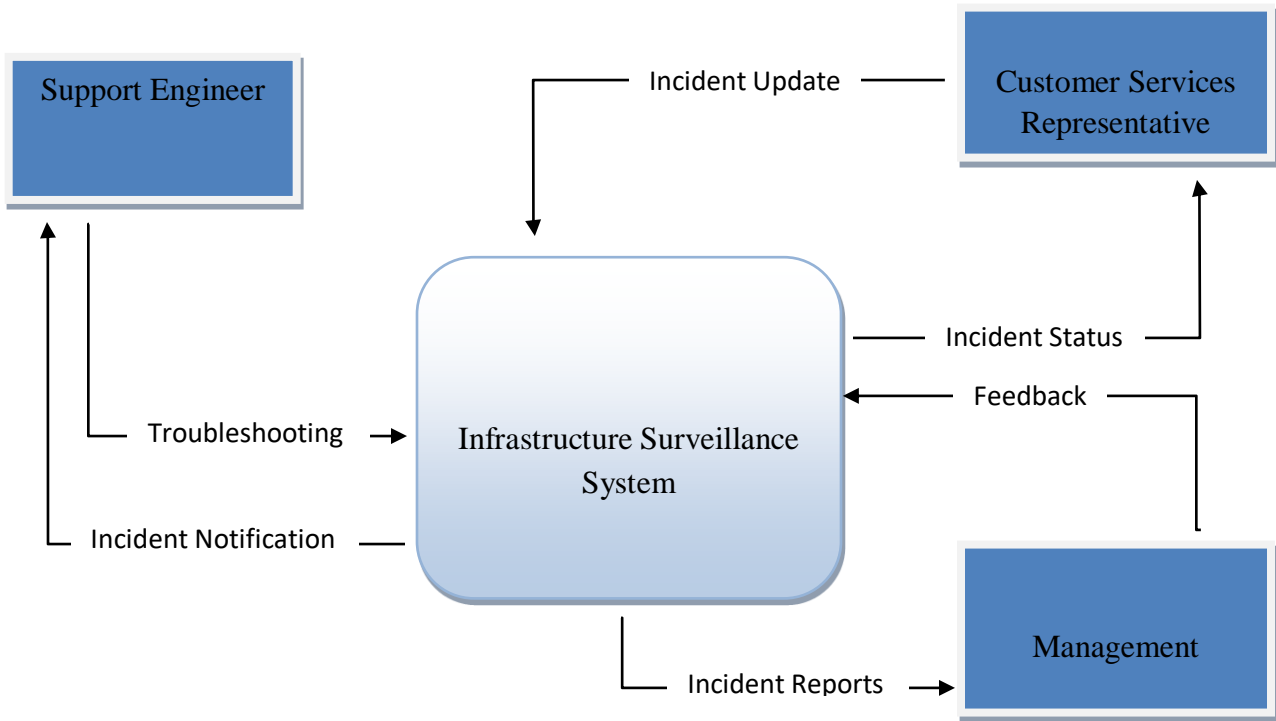
- Maintainability - The system must be easy to maintain, in cases were developments need to be made or new features need to added-on to the system. The need for developments or added on features may arise as a result of changes in the external information technology environment or changing business needs. System must flexibly adapt to changes, making it easy for modifications and updates.
- Ability to meet and satisfy user requirements and specifications.
- Reliability- A well-designed system should be reliable in that it would counter problems encountered in the existing manual system.
- The system should be user friendly meaning that it should be easy to interpret to use
- Speed of transactions and function
- Report generation
- Security of application
- Ability to provide for future modifications and improvements

All these features should be present in the proposed Infrastructure Surveillance System.

### 4.2.1 How the System Works

- A support engineer for the first time creates an account on the system portal and goes through a once off process of populating all the required details such as full name, employee number, department name, job title, contact details and desired username and password.
- A management level user cannot create his/her own account and this can only be done by the system administrator assigning sufficient rights to the system.
- The senior engineers also cannot create their own accounts and this is done by the administrator assign sufficient rights to the account.
- If the employee account already exists on the system, the user logs in with his/her unique username and password and upon successful login the user is redirected to the system dashboard where all the staff details are automatically populated from the user's profile created on registration and assigned relevant login rights on the system.
- The senior engineers and system administrator have the privileges to add network elements and corresponding hostnames and IP address to be monitored as well as define the data polling intervals and defines the emails and mobile numbers where notifications will be sent.
- Operator privileged users such as support engineers and customer services reps are not able to make configuration changes on the system and monitor based on pre-defined entities and thresholds.
- The systems pro-actively probes the defined entities and raises an alarm once the specified threshold is exceeded, for example if a host can be marked as down after losing a minimum of 4 consecutive ping packets.
- A ticket is automatically generated and assigned to an engineer for troubleshooting and resolution.
- Once service to the monitored entity is restored, the dashboard is automatically updated and the icons change from red signifying service outage to green to show service status to up and alerts are also sent to relevant engineers.
- Management reports of daily, weekly and monthly statistics are also sent out to member of the group and can also be accessed on the request from the system portal.

### 4.2.1 Context Diagram



#### Key



Process



Entity



Data Flow

**Figure 4.1: Proposed System Context Diagram**

### 4.2.2 Data Flow Diagram

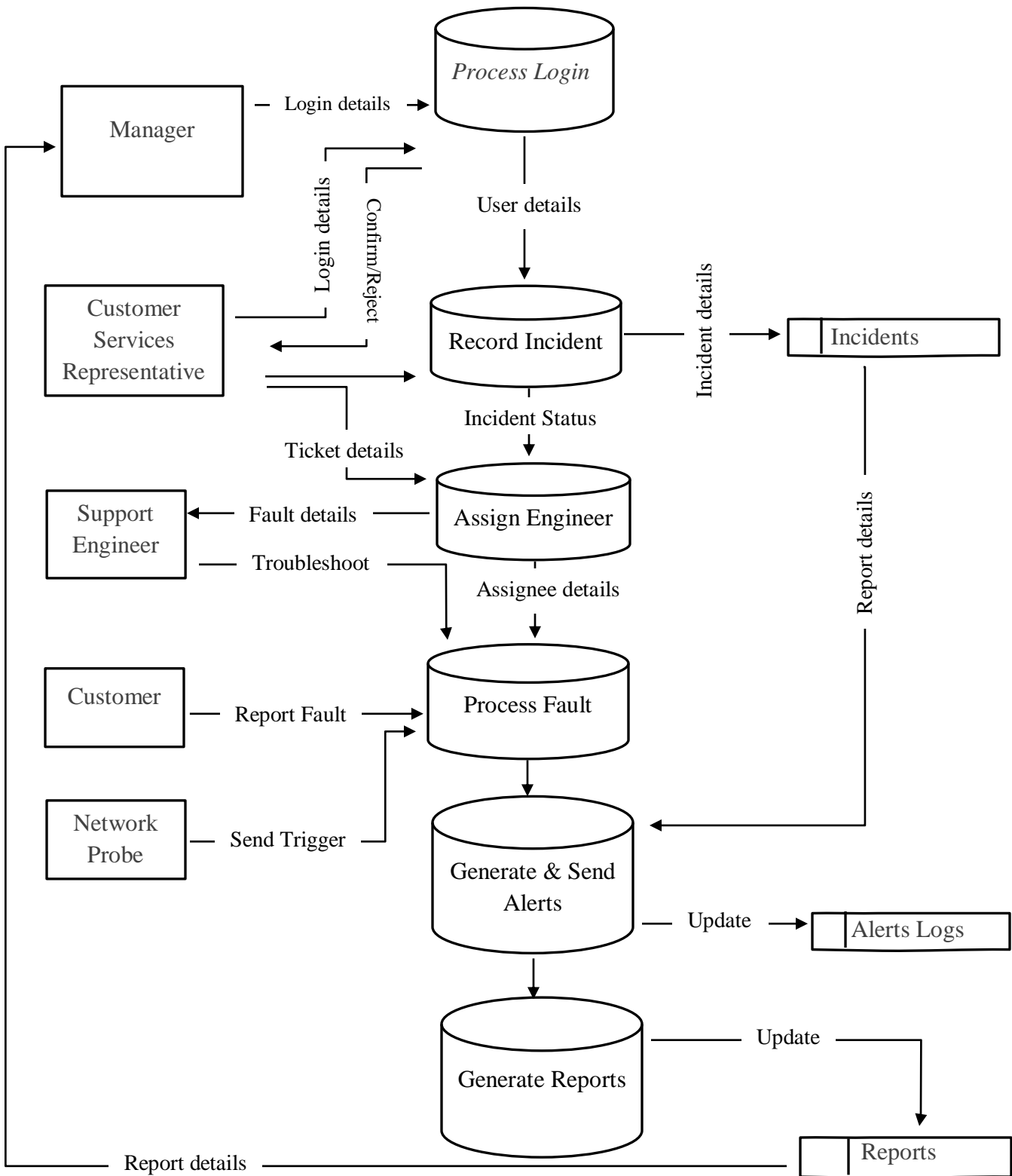


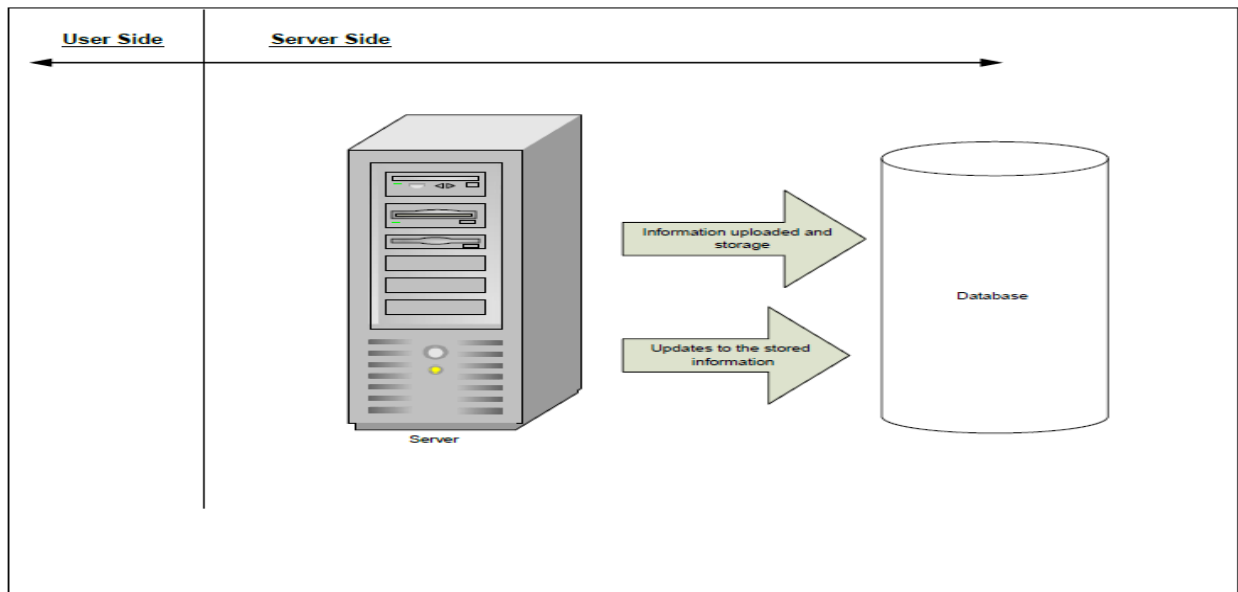
Figure 4.2: Proposed System Data Flow Diagram



### 4.3 Architectural Design

According to Somerville (2004), architecture design looks at the hardware setup and configurations of the proposed system and shows where the major components of the system will be connected and how the several machines and people that make up the system will be connected. It describes the logical and physical layout of the system including the specifications of hardware, software, data, procedures, and the people to be involved. The main aim was to minimize the challenges associated with existing system. Correct measures were considered to reduce vulnerability of system threats and also it was operated on a reliable hardware platform. To secure system information, data backup was carried out in the case that the project corrupted or lost.

For a user to be able to access the contents of the server, he/she has to pass through the barrier between the Client side and the Server side by providing the correct authorization details such as username and password. Once the details are verified and validated as correct the user then can use different functions depending on the task at hand for example checking the status of a given communications port. The illustration below shows the deployment diagram that explores how the Infrastructure Surveillance System is going to be deployed. Employee devices should be able to access the centrally managed application and consequently be able to insert into, retrieve and update the database.

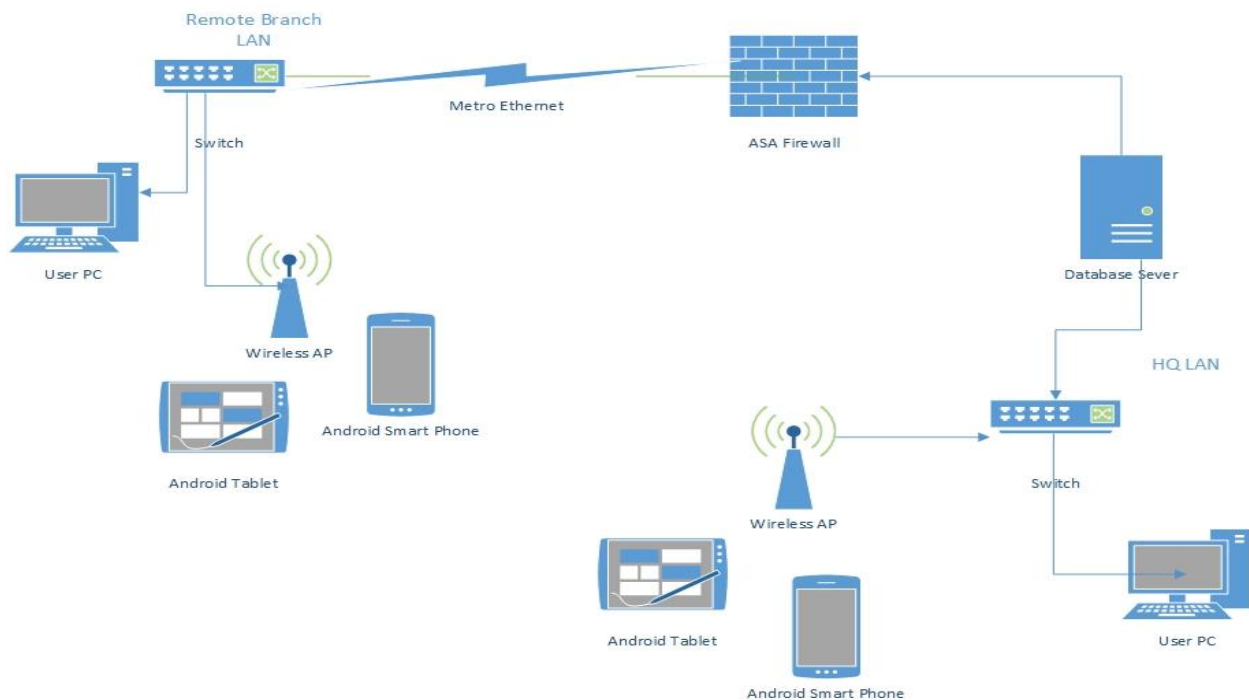


**Figure 4.3: Architectural design**

In order for a user to have access right to the information inside the server, he/she must have authorization credentials such as the username and password and once they are validated to be correct, the user will be allowed to access to information and depending on the access level of the user. The system will reside in the corporate Tier 3 data center behind a Cisco ASA firewall to safeguard it from unauthorized access and intrusions.

#### 4.4 Physical Design

Bleisch (1998), states that it is important to design both the software and hardware environment in which the new system will resides and work in. It is the design that shows how the components are physically connected in different environments. The physical design focuses mainly on the layout of the proposed system in terms of hardware components and the interaction or communication amongst these components. All user mobile devices will be connected to the database server on the intranet together with the rest of the employee devices such as PCs and network printers. The hardware and software components requirement for the system to function and the environment are taken into account, so as to come up with total design of the system.

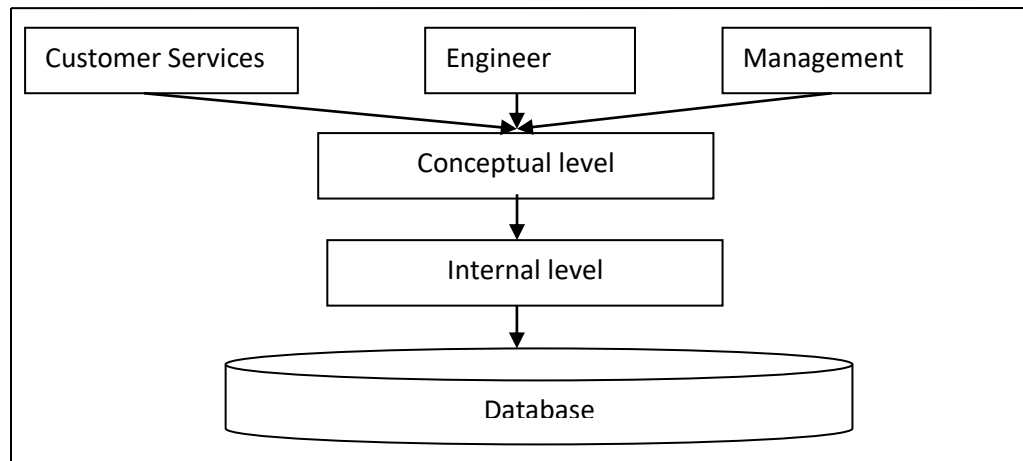


**Figure 4.4: Physical Design**

## 4.5 Database Design

Adams (2010), describes database design as the process of producing a detailed data model of a database. It is a logical data model that contains all the required logical and physical design alternatives and storage parameters needed to generate a design in a Data Definition Language which can then be used to create a database.

### 4.5.1 Physical Database Design



*Figure 4.5: Physical Database Design*

**External Level:** The external level represents the users' view of the database. It consists of a number of different views of the database, that is, one for each user. External schema shows only the part of the database that is important to the user. Tables in the database can have the following relationships, one-to-one, one-to-many, many-to-many.

**Conceptual Level:** The conceptual schema shows the kind of data that resides in the database and the relationships among the data. This is a total view of the data specifications of the organization that is independent of any storage considerations.

**Internal Level:** The internal schema explains the physical representation of the database on the computer and this can be done using a programming language. Internal level shows how the data resides inside the database that is the structures of certain data and the way files are organized in terms of particular data structures and file organizations.

### 4.5.2 Logical Database Design

Logical database design involves identifying the entities and relationships among them. These entities of the system are elaborated showing their attributes. The construction of an entity relationship was done so as to express the outcomes of the logic database design.

An entity-relationship diagram is a data modeling technique which shows the entities graphically and the relationship between these entities within a system and also shows the structures of the proposed system database. Entity relationship clearly defines the interaction between the entities and their dependence on each other and all components relationship are illustrated in an entity relationship diagram. It is structured in an organized manner that makes easy for one to navigate and one will be able to determine and identify the relationships among these entities.

The following table shows an entity-relationship table that represents entities and their attributes.

**Table 4.1: Entity Relationship Table**

<b>Entity</b>	<b>Attributes</b>	<b>Description</b>	<b>Type</b>
<b>Admin</b>	Id	Admin ID	Int (6)
	Username	Admin's Username	Varchar (20)
	Password	Admin's Password	Varchar (20)
	Fullname	Admin's Fullname	Varchar (20)
	Email	Admin's Email Address	Varchar (20)
	Createdon	Creation Date	Date
	Modifiedon	Modification Date	Date
<b>User</b>	Id	User ID	Int (6)
	Username	Username	Varchar (20)
	Password	User's Password	Varchar (20)
	Fullname	Name of User	Varchar (20)
	Email	User's Email Address	Varchar (20)
	Createdby	Name of Creator	Varchar (20)

<b>Node</b>	Createdon	Creation Date	Date
	Modifiedon	Modification Date	Date
	Id	Host ID	Int (6)
	Name	Host Name	Varchar (20)
	Type	Type of Host	Varchar (20)
	Endpoint	Host IP Address	Varchar (20)
	Description	Host Description	Varchar (20)
	Createdby	Name of Creator	Date
	Createdon	Creation Date	Date
	Modifiedon	Modification Date	Date
<b>Event</b>	Port	Target Port Number	Int (5)
	Id	Event ID	Int (6)
	Description	Event Description	Varchar (20)
	Is_good	Event State	Varchar (20)
	Createdon	Creation Date	Date

## Entity Relationship Diagram

Rouse (2005), describes an entity-relationship (ER) diagram as a specialized graphic that illustrates the interrelationships between entities in a database. ER diagrams often use symbols to represent three different types of information. Boxes are commonly used to represent entities. Diamonds are normally used to represent relationships and ovals are used to represent attributes.

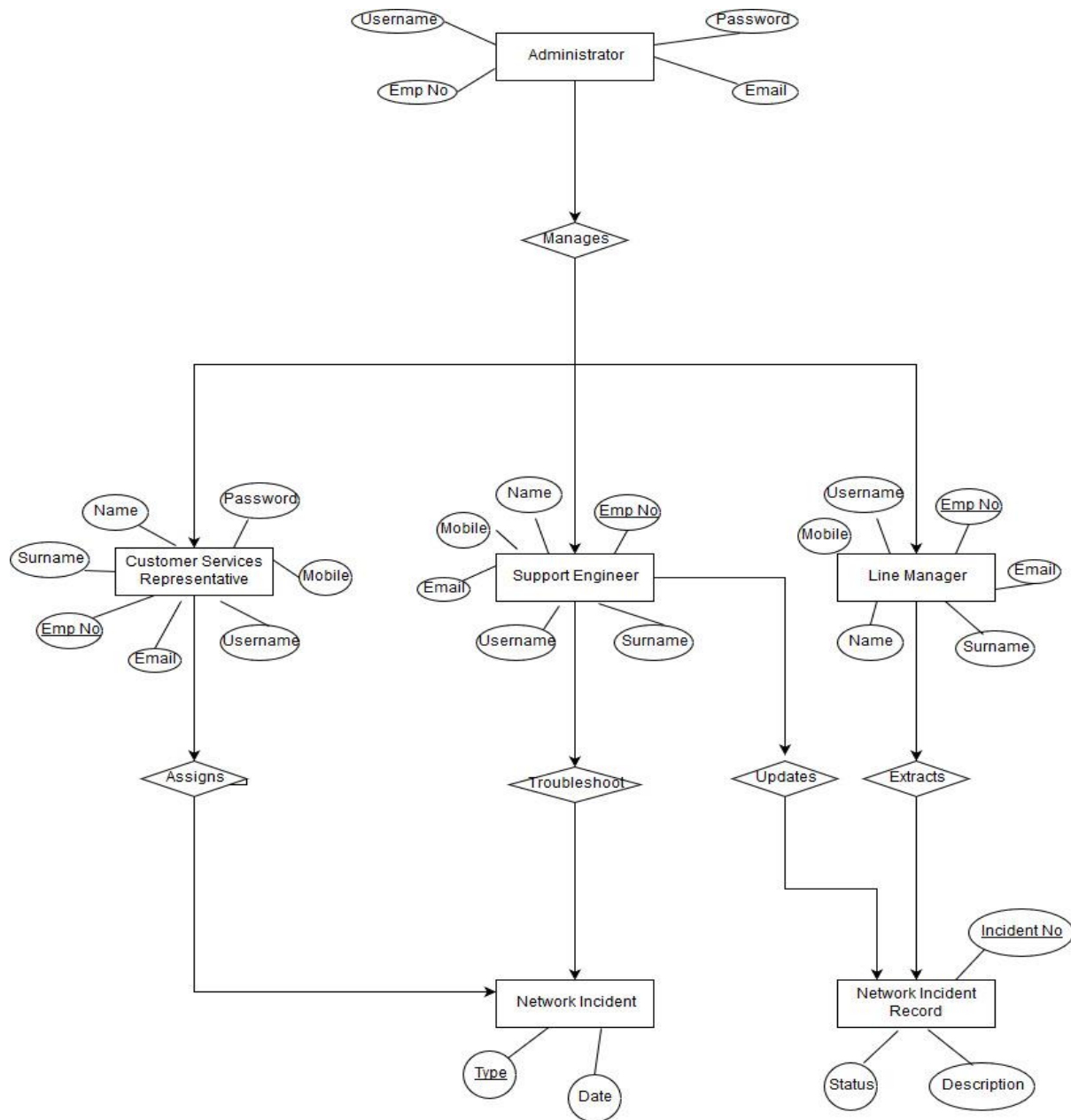
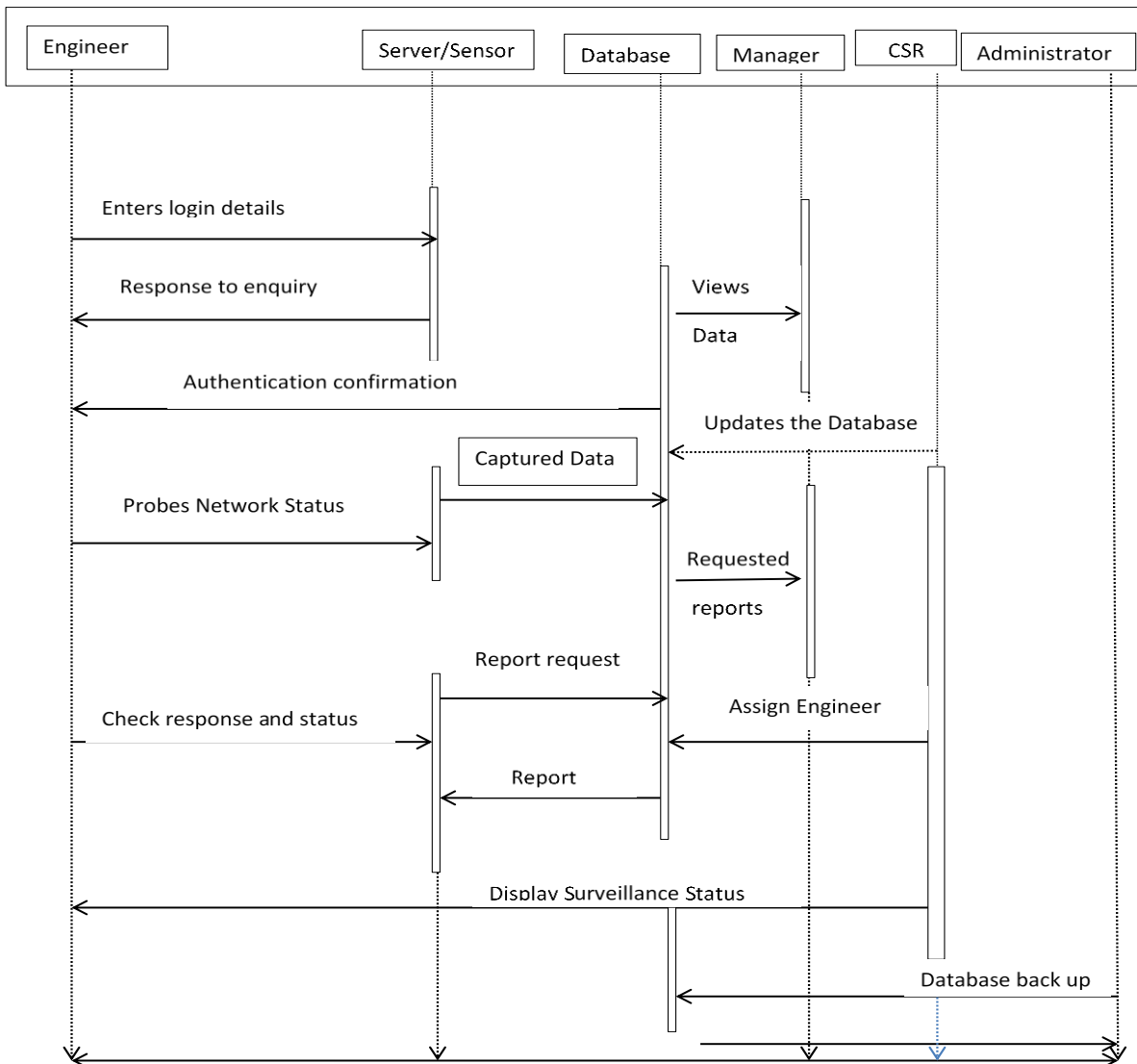


Figure 4.6: Entity Relationship Diagram

## 4.6 Program Design

### Sequence Diagram

Manning, (2004), states that sequence diagram is a diagram that indicates the interaction of processes operating within the system in their organized way. It shows interactions of objects arranged in a sequence of time. On the other side, sequence diagrams can be called event scenarios or event diagrams. In a sequence diagram, entities are represented by rectangles and the bars illustrates the period in which an entity will be active. The diagram below shows the activity sequence diagram.



*Figure 4.7: Sequence Diagram*

## 4.7 Interface Design

The system interface defines how the user interacts with the system. This includes defining internal and external control and data flows. It's highest level of abstraction and hides the complex parts of the system by simplifying the user's interaction with the database by the provision of an interface. Interface design outlines the design for the menus, forms, reports, and the help screens. Interface design is the graphical views of that the user will get to communicate with the system through. Interface design helps the proposed system to progress in a desired manner. This is where users get output from the system which include ideas from other as well reports from the system.

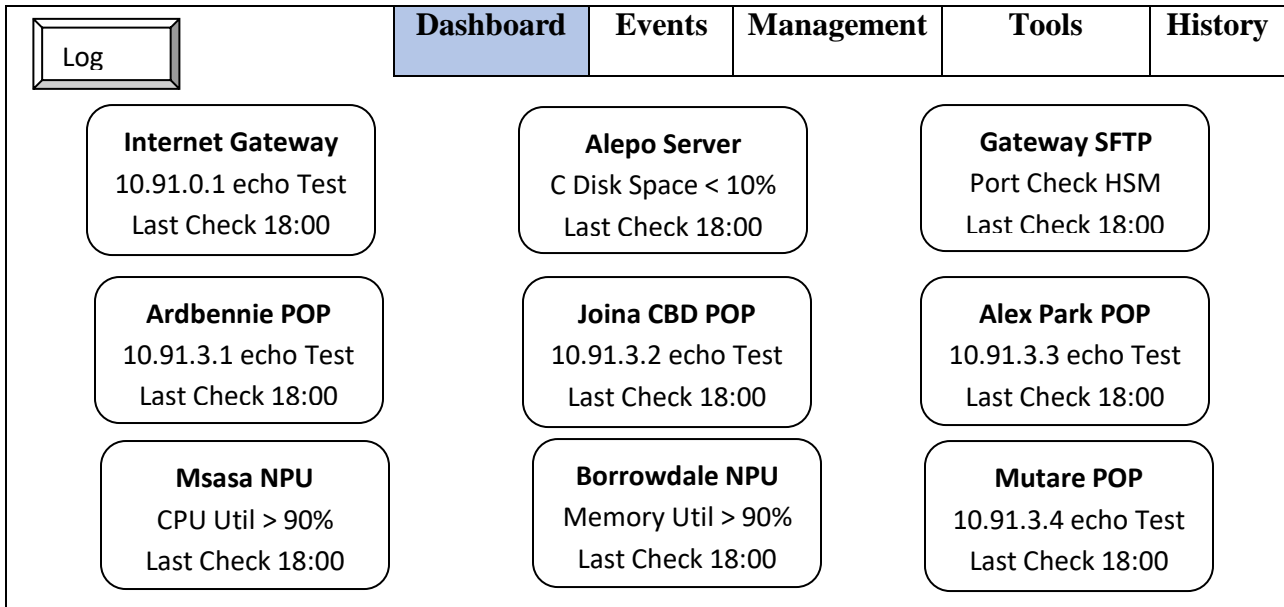
### 4.7.1 Menu Design

		<b>About us</b>	<b>Messages</b>	<b>Incident Records</b>	<b>Help</b>
<b>Username</b>	<input type="text"/>				
<b>Password</b>	<input type="text"/>				
<b>Log in</b>	<input type="button" value="Login"/>				

*Figure 4.8: Main Menu*

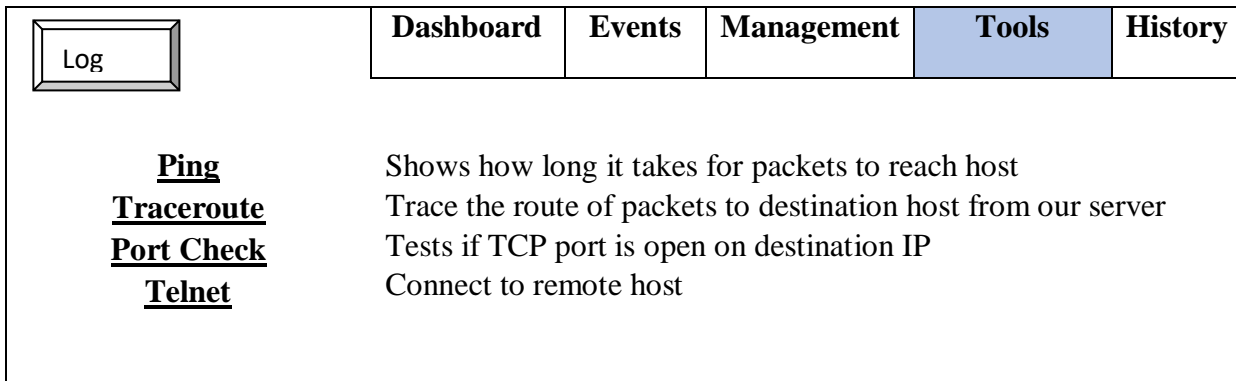
The above login form enables the general supports engineers, customer services rep, managers and the system administrator to login in the system using their logging in credentials. If the username and/or password supplied are incorrect access will be denied.





**Figure 4.9: Dashboard Main Form**

The above form shows the overall system overview of all the monitored entities. It is from this dashboard that a node that exceeds a set threshold is easily identified.



**Figure 4.10: Tools**

The above form depicts the tools sub-menu where the user is presented with four built in troubleshooting tools, ping, traceroute, port check and telnet. The user will be redirected to the corresponding tool once clicked.

Log		Dashboard	Events	Management	Tools	History
ID	Name	Emails	Mobile Numbers	Time Range		
9	Email & SMS(Out Of Office)	kmanga@123.com	0773123456,0772246890	7am-8am,1pm-2pm,5pm-9pm		
8	Email & SMS (Peak Time)	kmanga@123.com	0773123456,0772246890	7:50am-6:00pm		
7	Email & SMS (Critical)	kmanga@123.com	0773123456,0772246890	7am-9pm		
6	Email & SMS (In Office)	kmanga@123.com	0773123456,0772246890	8am-1pm,2pm-5pm		

**Figure 4.11: System Management**

The above form depicts the management sub-menu where the user with system administrative privileges is allowed to define the contact details where all the configured alerts for the triggered incidents will be sent either as an email or SMS.

### 4.7.2 Input Design

The forms are developed to capture data and send it to the main database or queries. The input forms are developed to be user friendly and to enhance accuracy in capturing and updating of data. Warning message should be displayed at the page of entry of data.

	About Us	Home	Messages	Incident Records	Help
First Name	<input type="text"/>				
Surname	<input type="text"/>				
Employee Number	<input type="text"/>				
Mobile Number	<input type="text"/>				
Email Address	<input type="text"/>				
Username	<input type="text"/>				
Password	<input type="text"/>				
<input type="button" value="Log Out"/>	<input type="button" value="Reset"/>		<input type="button" value="Create"/>		

**Figure 4.12: User Creation Form**

The above input form shows the new user creation form. All fields in form are mandatory and should be completed for the user account to be successfully created. However, this is a once off form in which the employee supplies the information only on account creation and once the account has been created on the system all the relevant details will be automatically populated on the form depending on the task to be performed once the correct username and password are supplied to authenticate.

	Dashboard	Events	Management	Tools	History
<b>Ping - Shows how long it takes for packets to reach host</b>					
IP or Host name: <input type="text"/> <input type="button" value="Go"/>					

**Figure 4.13: Ping Details Form**

The above shows data input form for ping information under the tools sub menu. The engineer is prompted to supply the IP address or the qualified host name he/she wishes to prob. Once that is done, the host details are processed and results populated.

	Dashboard	Events	Management	Tools	History
<b>Traceroute - Trace the route of packets to destination host from our server</b>					
IP or Host name: <input type="text"/> <input type="button" value="Go"/>					

**Figure 4.14: Traceroute Details Form**

The above shows data input form for traceroute information under the tools sub menu. The engineer is prompted to supply the IP address or the qualified host name he/she wishes to prob. Once that is done, the route to the destination is plotted and the details are processed and results populated.

	Dashboard	Events	Management	Tools	History
<b>Port Check - Trace the route of packets to destination host from our server</b>					
IP or Host name: <input type="text"/> Port Number: <input type="text"/> <input type="button" value="Go"/>					

**Figure 4.15: Port Check Details Form**

The above shows data input form for port check information under the tools sub menu. The engineer is prompted to supply the IP address or the qualified host name he/she wishes to prob. Once that is done, the status of the port will be displayed as either open or closed.

	Dashboard	Events	Management	Tools	History
<b>Telnet – Connect to remote host</b>					
IP or Host name: <input type="text"/> Port Number: <input type="text"/> <input type="button" value="G"/>					

**Figure 4.16: Telnet Details Form**

The above shows the data input form for port telnet information under the tools sub menu. The engineer is prompted to supply the IP address or the qualified host name he/she wishes to connect to. If a valid and active IP or hostname is supplied, the engineers will be prompted for the login credentials to connect to the host.

**Create Notification Group**

Group Name:

**Notification Channels**

Email Recipient

Mobile Recipient

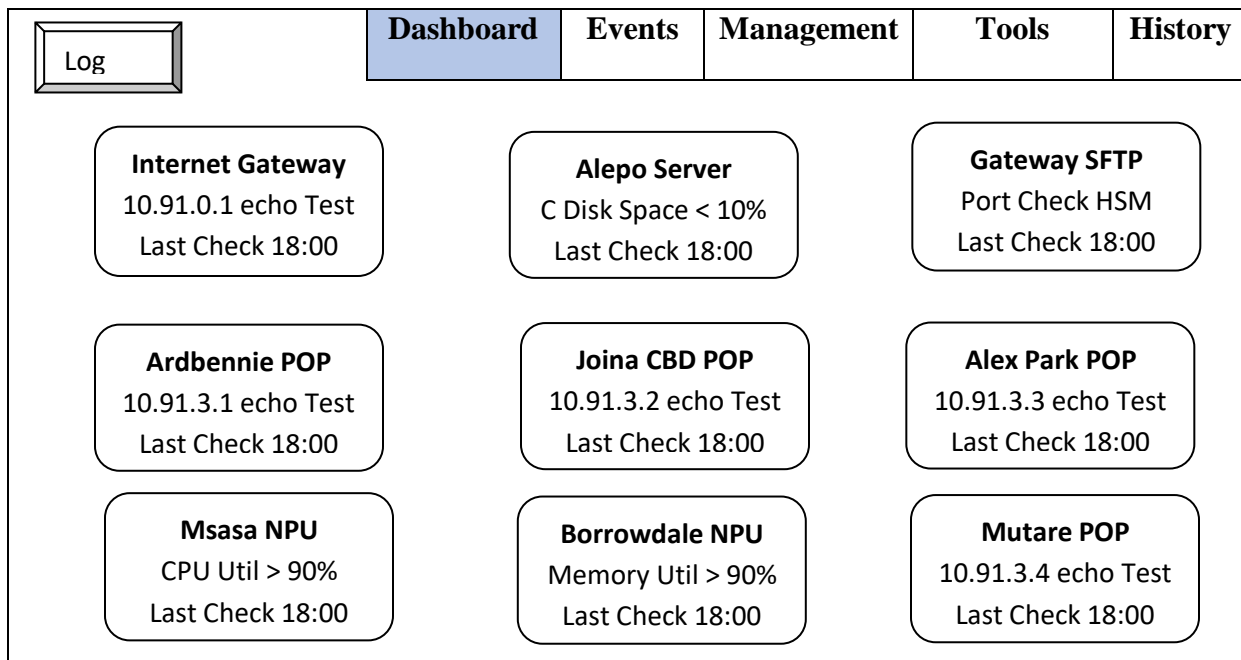
**Time Ranges**

**Figure 4.17: Notification Group Form**

The form prompts for data required for the creation of notification groups. The notification groups are defined by specifying the notification channels which include emails. An engineer can set a trigger to be alerted by either one or both channels given the tracker exceeds the set threshold. Also, time ranges are defined here whereby one specifies the exact time or range of times that the notifications will be set during weekdays and weekends.

### 4.7.3 Output Design

Output forms will allow authorised users to view information that has been entered by others or sent to them by mail. These also display feedback for queries submitted to the system to search for information.



**Figure 4.18: User Dashboard**

The above form shows the overall system overview of all the monitored entities. It is from this dashboard that a node that exceeds a set threshold is easily identified.

	<b>About Us</b>	<b>Home</b>	<b>Messages</b>	<b>Feedback</b>	<b>Help</b>
<input type="button" value="Log Off"/>	<b>BOD LIVE</b> <b>10.91.60.36</b> <i>Total size : 12G , Used : 11G Avail : 1.1G Free :9%</i>				
	<input type="button" value="Close"/>				

**Figure 4.19: Messages Notification**

The above is the feedback form showing the alert message that a support engineer gets in the messages section once a set threshold is exceeded or a given logic is validated to true. Such as the disk space of a given server goes below 10% free space.

	<b>Dashboard</b>	<b>Events</b>	<b>Management</b>	<b>Tools</b>	<b>History</b>
<b>Ping – Shows how long it takes for packets to reach host</b>					
IP or Host name: <input type="text" value="8.8.8.8"/>		<input type="button" value="G"/>			
<pre> ---PING 8.8.8.8 (8.8.8.8) 56(84) bytes of data--- 64 bytes from 8.8.8.8: icmp_seq = 1 ttl = 60 time = 4.85ms 64 bytes from 8.8.8.8: icmp_seq = 1 ttl = 60 time = 4.83ms 64 bytes from 8.8.8.8: icmp_seq = 1 ttl = 60 time = 4.81ms 64 bytes from 8.8.8.8: icmp_seq = 1 ttl = 60 time = 4.85ms  --- 8.8.8.8 ping statistics --- Packet transmitted 4 Received          4 Packet Loss       0% Time              3002ms           </pre>					

**Figure 4.20: Ping Tool Results Form**

The above form shows the output of results from the ping tool. The results can either be positive if the IP is live or negative if the IP is not reachable. The statistics of the test are then computed and displayed in the same window.

## 4.8 Pseudo Code

Neapolitan (2014) defined pseudo code as a detailed readable description of what a computer algorithm should do, presented in natural language rather than in programming language. Pseudo code helps programmers to express program design in detail. The pseudo code for Dandemutande Infrastructure Surveillance System is presented below.

### 4.8.1 User Login

Enter login details

```
If (username and password are correct then)
{
  open ISS user dashboard
}
Else
{
  Show message “login failed”
  Go back to login page
}
```

### 4.8.2 Admin Login

Enter login details

```
If (username and password are correct then)
{
  If (access level is 1)
  {
    Open ISS admin dashboard
  }
  If (access level is 2)
  {
    Open ISS user dashboard
  }
}
Else {Show message “login failed’ go back to login page}
```



### 4.8.3 User Registration

Enter name, surname, email, department, mobile number, employee number

```
If (entered details are valid)
{
Insert name, surname, email, department, mobile number, employee number
Into user table
}
Else
{
Show message "Fill in all required fields"
}
```

### 4.8.4 Adding Network Host

Enter hostname, ipaddress, url, description, port

```
If (entered details are valid)
{
Insert hostname, ipaddress, url, description, port
Into entities table
}
Else
{
Show message "Fill in all required fields"
}
```

### 4.8.4 Retrive Host/Node Status

**Select** hostname, ipaddress, description, status

**From** events table

```
If (selected values are valid)
{
Show current node status on dashboard
}
```

```
Else
{
Show message “Invalid Host”
Go back to dashboard
}
```

## **4.9 Security Design**

Security from the perspective of system development is the continuous process of maintaining confidentiality, integrity, and availability of a system, sub-system, and system data. At a very high level, security design is a continuous process dealing with confidentiality, integrity, and availability on multiple layers of a system.

### **4.9.1 Physical Security**

According to Harris (2003), physical security describes measures designed to ensure the physical protection of IT assets like facilities, equipment, personnel, resources and other properties from damage and unauthorized physical access. The system database server will be housed in the corporate data centre which will be always locked and can only be accessed using dual control by authorized personnel. The use of 24hr video security surveillance will also be employed in the server room to monitor activity in the server room. The room housing the servers will also be equipped with smoke and fire detectors and standby fire extinguishers and alarms will also provide aid in case of fire.

### **4.9.2 Network Security**

Simmonds (2004), states that network security consist of the provision and policies adopted by a network administrator to prevent and monitor unauthorised access, misuse, modification or denial of a computer network and network accessible resources. The full client subnet will reside behind a CISCO ASA firewall. This firewall is an essential aspect of network security of the mobile application.

### **4.9.3 Operational Security**

The users of the mobile application will all have entry access that will be encrypted using database encryption alternatives. Bunch approaches will be implemented to guarantee that users just get into the application and utilises conscious of them utilising the database security reassure. Data about the users of the application will not be uncovered to anybody.

### **4.10 Conclusion**

The design phase has helped the developer to be able to come up with an organized way of how the system to be developed is going to look like. Entity relationships, database, inputs, processes and outputs as well and how data is going to flow in the proposed system were done in this phase. This was all done to ensure that the developer develops a system that is user oriented and a system that will fulfill the intended objectives. The next chapter is implementation which will focus on the newly developed system.

## **Chapter 5: Implementation Phase**

### **5.1 Introduction**

This phase looked at the development, installation, testing and maintenance of the new proposed system. The implementation phase includes user training on the data flow and use of the system to make easy understanding. After the system was done, it was tested repeatedly for errors and errors corrected up until the system reported no errors.

### **5.2 Coding**

This involved turning program logic into specific instructions that are to be executed by the computer system. Java was used for the application and MS SQL database was used as database backend. All the elements in the data dictionary conceptualized during the database design were mapped into the relevant tables.

The system functionality was developed as modules. The modules were finally integrated into one working system. This stage helped developers to gain extra expertise as it introduced them to new areas of programming that they never had a chance to use elsewhere before. Reviews and walkthroughs were conducted to assure that the process was in track, within budget and within the scope of the scope of the project.

### **5.3 Testing**

Testing is a process of checking out if the software being built or developed has errors before implementing it on an organization. Any duty and task is focused in assessing the ability of the system to ensure that it meet the user requirements. System testing is to be done iteratively with qualified engineering team which will mainly focus to preventing faults than to remove them. The following are the methods of testing which are going to be used.

#### **5.3.1 Unit Testing**

Williams (2006), states that testing is where distinct or units of code are tested to see their ability for a selected task. The code will be tested according to its work or functionality. The units must be small for testing to commence and must include one output and input. Black box and white box are the two categories which the unit testing will use, this is explained below. McFarlin

(2012), states that, this includes the close look on individual units on the system to check if all functionality works well. Units might be functions and algorithms that do some actions and give back feedback.

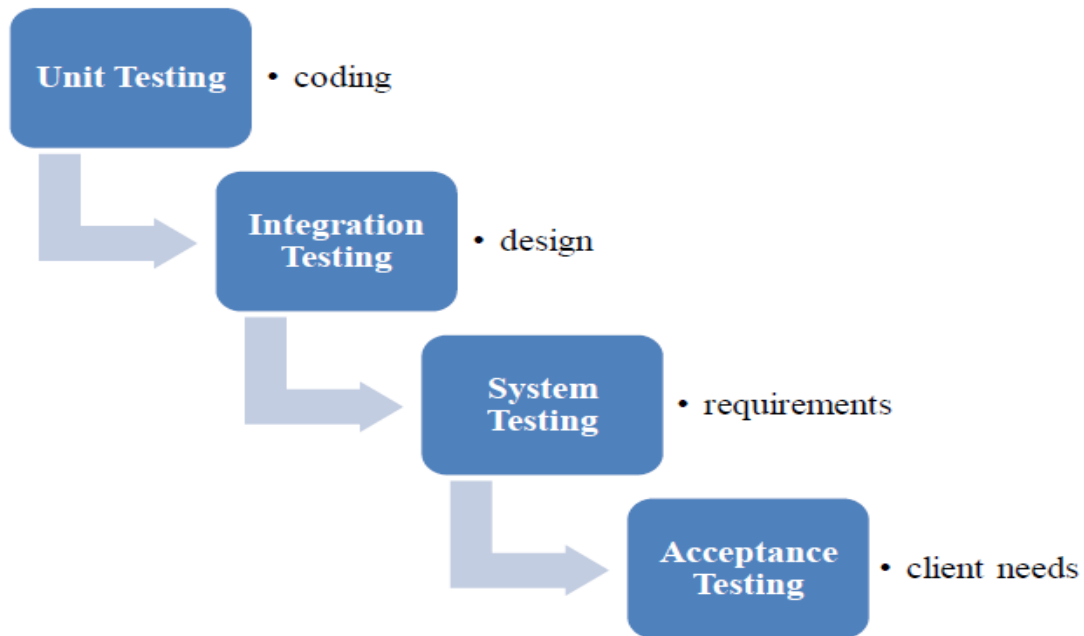
### **5.3.2 Integration testing**

As stated by Microsoft (2004), integration testing of software is an addition of unit testing and units are joined and tested to check out for interface errors. The core reason for this testing is to look for the defects that happen when components integrate. Integration testing was conducted using a bottom-up approach which involved testing smaller combined units followed by bigger combined units called modules. Black box and white box were used for integration testing. The methods that were used for integration testing were black-box testing and white-box testing. Black-box testing was mainly used to test and verify the performance of the interfaces that facilitate the interaction between components of the system.

### **5.3.3 Acceptance Testing**

Powers (2012), states that acceptance testing is mainly focusing on the system users' requirements whereby testing will be done to check if it meets all systems user requirements found on the research findings. Before the operational use of the system can be done, acceptance testing is done and this is the final stage in testing the system. The testing is repeatedly done till satisfied.

The diagram below shows the procedures for testing.



*Figure 5.1: Testing Process*

### **5.3.4 Testing Methods**

There are three methods that the developer will use for testing namely white box, black box and defect testing.

#### **5.3.4.1 Black Box Testing**

According to Beck (2000), black box testing is a technique of testing without having any knowledge of the internal working of the system. This is where the functionality of the system is completely tested. Black box testing involves an exercise of locating errors such as performance, initialization and interface as well as wrong functions in the system.

#### **5.3.4.2 White Box Testing**

White box testing is an examination of the system based on the structure of the code and the interior logic of the code also (Williams, 2006). It only examines the fundamental aspects of the system and has no or little relevance with the internal logical structure of the system (Nancy et al 2004). This involves thorough investigation of the internal structure and logic of the program. This was exercised by individuals who have the knowledge of the internal working of the programs and was done with the aim of identifying snippets of code which misbehaving.

### 5.3.4.3 Defect Testing

Discovering of defects inside the system is very important. The aim of defect testing is to ensure that the system is delivered to the final user perfect.

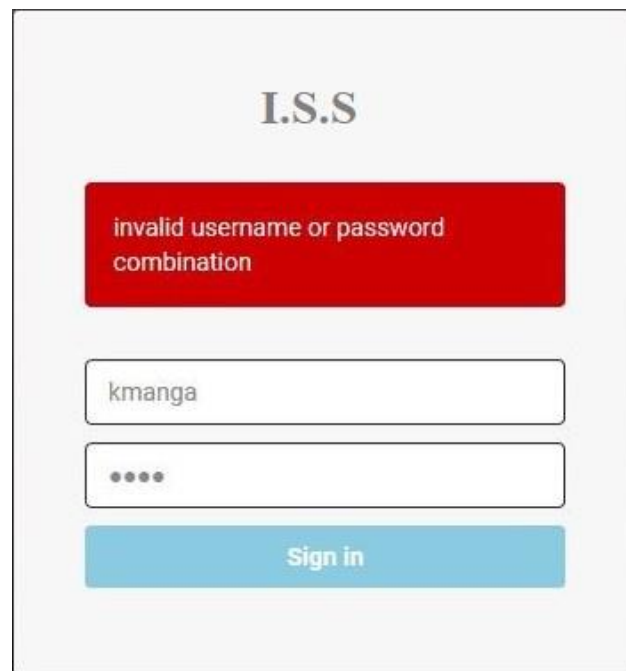
### 5.3.5 Test Cases (Verification and Validation)

#### Verification

Verification is the action that is taken to see if the built computer programs or systems meet all user requirements noted before the developing of the system (Beizer, 2002). Verification and testing work together and it is much important for the system to bring out results expected meeting all objectives correctly. The process was done by looking at the outcome comparing with expected user outputs. This also refers to the process of calculating the products of work done of the development stage to ensure that stated user requirements are met for that stage (Tannenbaum, 1990).

#### Login Verification and Authentication

If wrong login credentials are supplied in the username and password text fields, then the system will give a warning error message to give valid credentials. The below is the login form showing the username and password text fields.



The image shows a login form for a system labeled "I.S.S.". At the top, the text "I.S.S" is displayed in a large, bold, serif font. Below this, a prominent red rectangular box contains the error message "invalid username or password combination" in white text. Underneath the error message, there are two input fields: the first contains the text "kmanga", and the second contains four black dots, representing a masked password. At the bottom of the form is a light blue button with the text "Sign in" in white.

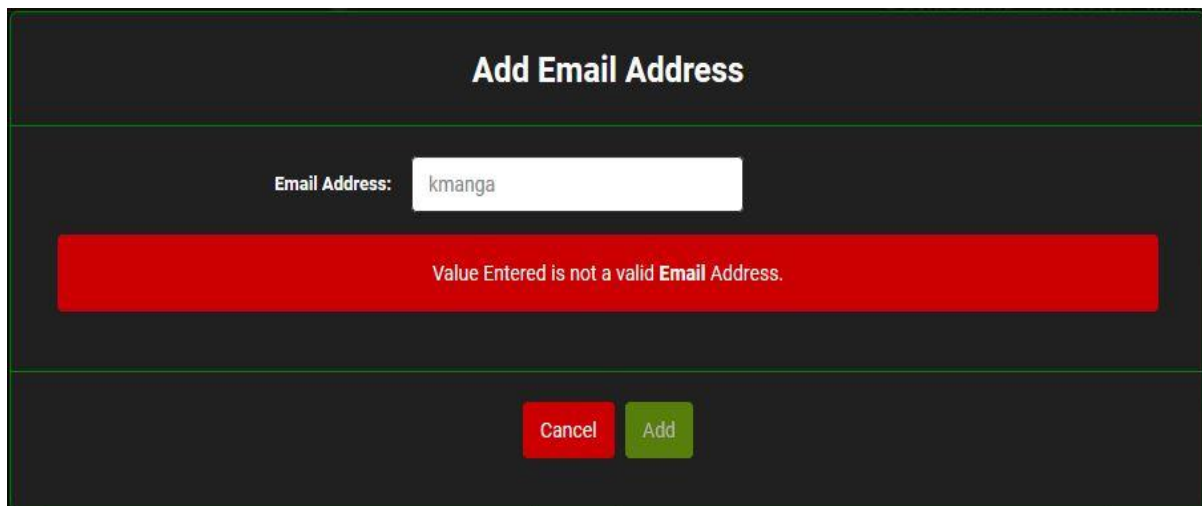
**Figure 5.2: Login Form**

## Validation

The process of making sure that the developed product, program and system satisfies the user needs is referred as validation. The reason for building a new system is to eliminate and remove all drawbacks been faced by system users to build the correct system that will tackle down all the noted challenges. This can be also explained as assessing of a computer system during and at the end of the software during or at the end of the progress stage to ensure stated business requirements are accepted (Dixit, 2002).

## Data Validation

The following will test the system response if the user supplies invalid data for processing. There are some fields such as the email address with integrity constraints and a valid email address should be supplied there in the format xxx@xxx.xxx. The system if working properly should report an error as shown below where it highlights the email is invalid in red fill. This is a mandatory field and hence it had to be validated as this is used to alert engineers of system and network incidences during working hours.

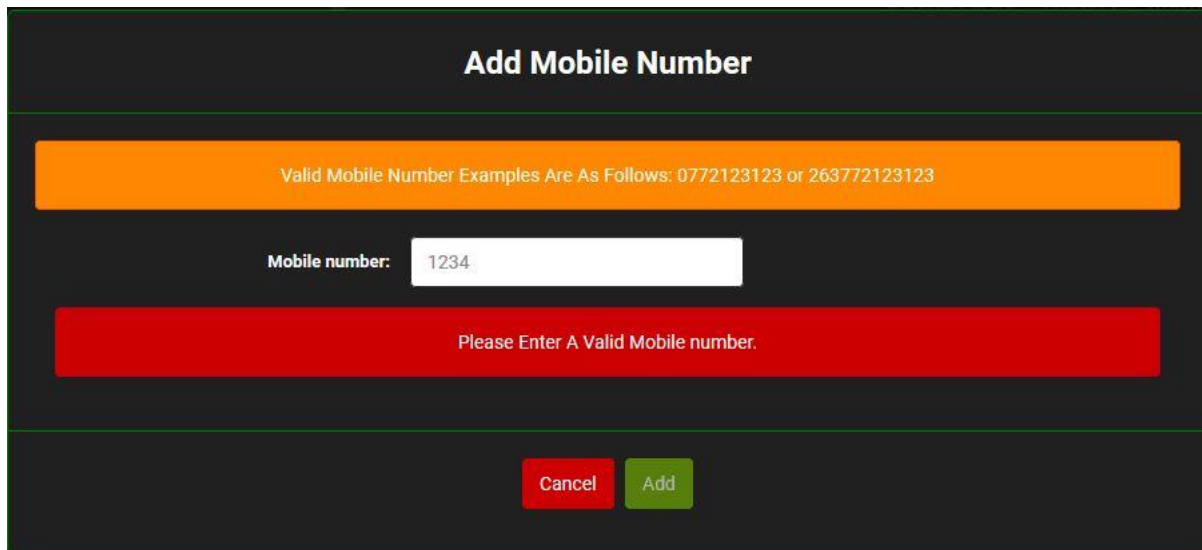


The screenshot shows a dark-themed form titled "Add Email Address". It features a text input field labeled "Email Address:" containing the text "kmanga". Below the input field is a prominent red error message box that reads "Value Entered is not a valid Email Address.". At the bottom of the form, there are two buttons: a red "Cancel" button and a green "Add" button.

**Figure 5.3: Invalid Email Error**

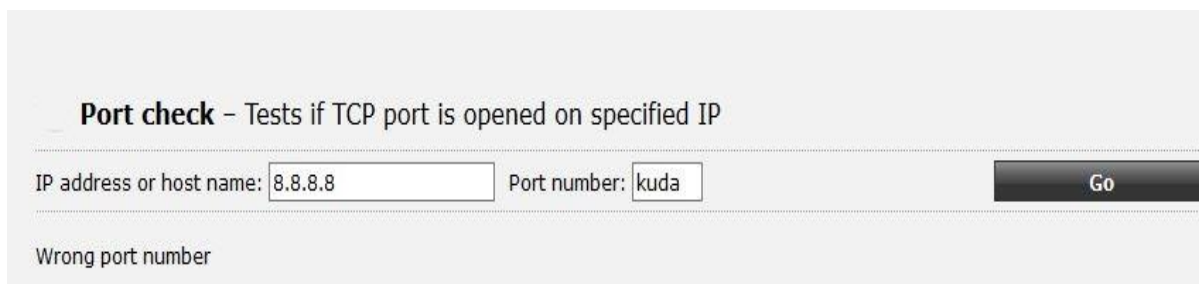
The following test validates if the specified mobile phone number is valid following the specified format. If the mobile number does not follow the correct format, then the system rejects it and notifies the user to input correct phone number. This is also a mandatory field and hence it had to be validated as this is used to alert engineers of system and network incidences after working hours and during weekends.





**Figure 5.4: Invalid Number Error**

The following test validates if the user specified a valid port number to check with the port check troubleshooting tool. If the supplied port is incorrect, then a warning message advising wrong port number is displayed. This is to enhance the query result as trying to process an invalid request would yield undesirable results.



**Figure 5.5: Invalid Port Error**

If both fields, that is IP or Hostname and Port Number are valid, the query is successfully processed without raising error messages as it passes data validation in both fields.



**Figure 5.6: Success Data Validation**

### 5.3.6 System Review

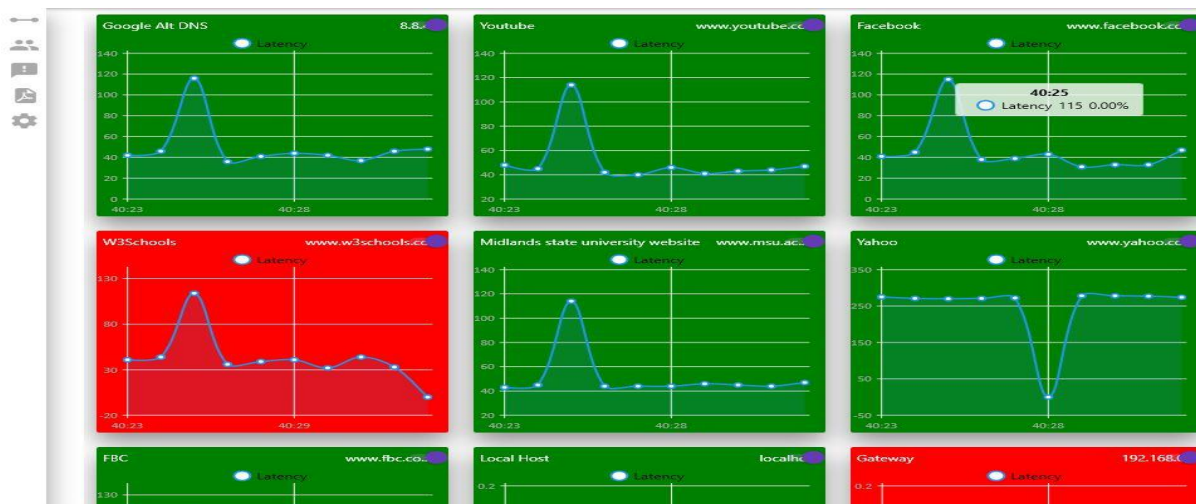
The system was also tested against the entire project objectives. This was done to ensure that the project was actually able to meet the initial objectives set out in the system proposal document. This would serve as proof that the project has been able to satisfactorily solve the problems that were faced by the organization.

Objectives tested for:

1. Realtime monitoring of network elements
2. Produce Realtime network statistics
3. Create a log of all system events
4. Allow concurrent users system access

#### Objective 1: Realtime monitoring

The system managed to provide Realtime automated system monitoring whereby all specified host entities are tracked and displayed on the dashboard.



**Figure 5.7: Realtime Monitoring Dashboard**

## Objective 2: Produce realtime network statistics

The system also managed to generate realtime network statistics such as calculation of host uptime against downtime and display a graphical representation in a pie chart as illustrated below.

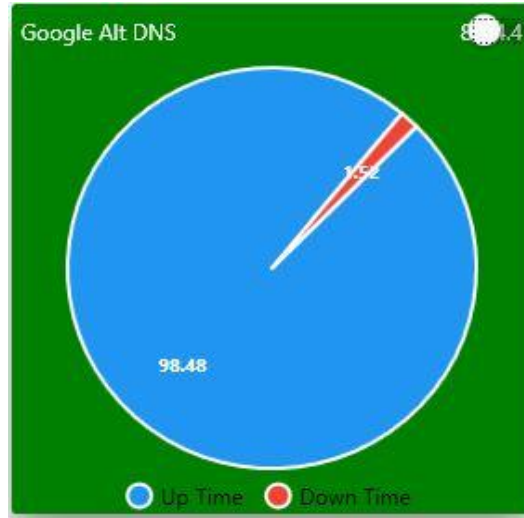


Figure 5.8: Average system uptime chart

## Objective 3: Create a log of all system events

The system also managed to log all system event such as creating a time stamped entry of each time a given node went offline or came back online. This test is shown below from the database extract of the logs.

description	is_good	created_on
Google Alt DNS on 8.8.4.4 is up.	1	2018-04-21 04:53:59.0084365
Google Alt DNS on 8.8.4.4 is down	0	2018-04-21 04:54:47.7710142
Google Alt DNS on 8.8.4.4 is up.	1	2018-04-21 04:54:48.1325467
Youtube on www.youtube.com is up.	1	2018-04-21 05:23:09.1920165
Google Alt DNS on 8.8.4.4 is up.	1	2018-04-21 05:23:09.1920165
Youtube on www.youtube.com is down	0	2018-04-21 05:23:15.7704105
Google Alt DNS on 8.8.4.4 is down	0	2018-04-21 05:23:15.7704105
Youtube on www.youtube.com is up.	1	2018-04-21 05:23:16.2747827
Google Alt DNS on 8.8.4.4 is up.	1	2018-04-21 05:23:16.8976168
Youtube on www.youtube.com is down	0	2018-04-21 05:23:17.7701632
Google Alt DNS on 8.8.4.4 is down	0	2018-04-21 05:23:17.7701632
Google Alt DNS on 8.8.4.4 is up.	1	2018-04-21 05:23:18.8959634
Youtube on www.youtube.com is up.	1	2018-04-21 05:23:18.8959634
Google Alt DNS on 8.8.4.4 is down	0	2018-04-21 05:23:19.7710739
Google Alt DNS on 8.8.4.4 is up.	1	2018-04-21 05:23:19.8944897
Google Alt DNS on 8.8.4.4 is down	0	2018-04-21 05:23:20.2708434
Google Alt DNS on 8.8.4.4 is up.	1	2018-04-21 05:23:20.8660144

Figure 5.9: System event log

## 5.4 Installation

In order to install the new system, it was deemed appropriate to use parallel conversion. Parallel conversion is when a new system will be deployed on a full scale while the existing system will still be running on the other hand (Crocket 2008). This prime advantage of this procedure is that if the new system fails or faces resistance then the old system will be intact to cover the loop hole. This stage also consists of different methodologies such as parallel running, direct change over as well as pilot operation. These will be put into test as well during this phase.

### 5.4.1 User Training

The new Infrastructure Surveillance System has four users namely the system administrator, support engineer, customer services representative and manager. User training is going to be done in two diverse ways since it includes the general staff and the privileged users. Mass user training is going to be conducted to general staff and for the privileged users involved it is going to be done on individual bases. There are levels of training which are going to be used:

- **Module level:** The user must get well versed with each module of the system that the user will access or work with.
- **System level:** The management must appreciate the construction of the system and all the work it can do. Only a few individuals who have full or complete access rights to the entire system must have knowledge of how all the modules within the system work that is its functionality.

#### 5.4.1.1 Training Plan

Training is going to be in-house and is split into three sessions and system administrators will attend all the three sessions since they should have an overview of the entire system for trouble shooting and maintenance purposes as well as further development.

*Table 5.1: Training Session 1*

<b>User Group</b>	Support Engineers, System Administrators
<b>Training Scope</b>	Systems overview, Troubleshooting Tools and Ticket Resolution
<b>Requirements</b>	Two computers and an overhead projector
<b>Trainer</b>	System Developer (Kudakwashe Manga)

**Table 5.2: Training Session 2**

<b>Venue</b>	Dandemutande HQ - Harare
<b>User Group</b>	Customer Services Representatives, System Administrators
<b>Training Scope</b>	Systems overview, Incident Response and Ticket Assignment
<b>Requirements</b>	Two computers and an overhead projector
<b>Trainer</b>	System Developer (Kudakwashe Manga)

**Table 5.3: Training Session 3**

<b>Venue</b>	Dandemutande HQ - Harare
<b>User Group</b>	Management, System Administrators
<b>Training Scope</b>	Systems overview, Reports Generation & Extraction and Logs Review
<b>Requirements</b>	Two computers and an overhead projector
<b>Trainer</b>	System Developer (Kudakwashe Manga)

### **5.4.2 Changeover**

System changeover is the process of taking out the current system replacing with a new system, Huassain (2007). The main reason is to make changes or shift from the old system without having any problems. It also looks on how the existing information can be incorporated with the one of the new system. The below are the types of changeover that can be used and one method will be selected.

#### **5.4.2.1 Pilot Changeover**

Pual et al (2003), states that with pilot changeover the new system will be installed on a small department of the organization and few users will evaluate and see its functionality and performance before it is installed and implemented on the whole organization. Pilot changeover

is said to have low risks since installed on a small part of the organization if risks occurs its cost will be low.

#### **5.4.2.2 Direct Changeover**

According to Krugman (2009), direct changeover is completely ruling off the existing system replacing it with a new system. This change over process is time saving and there are minimized cost but this in accompanied with elevated risk of losing all data since there will be no back up of the current system.

#### **5.4.2.3 Phased Changeover**

Sommerville (2004), states that this is where one part of the system is introduced at a time up until the old system is totally removed. When the part selected is working properly the system is installed to the next up until the current system is overwritten. This encounters fewer risks since one area chosen is affected and its time consuming to affect the whole organization.

#### **5.4.2.4 Parallel Changeover**

Hutchens (2007), states that, parallel changeover is the process of running both the old system and the new system at one time parallel. If the user is satisfied with the performance of the new system the old one is eliminated and ruled off. This changeover process is safe since both systems is used to evaluate if the new system is usable over the old existing one. Parallel method is dare and time wasting since two systems will be running at the same time. Hence the researcher will recommend the parallel changeover to be used.

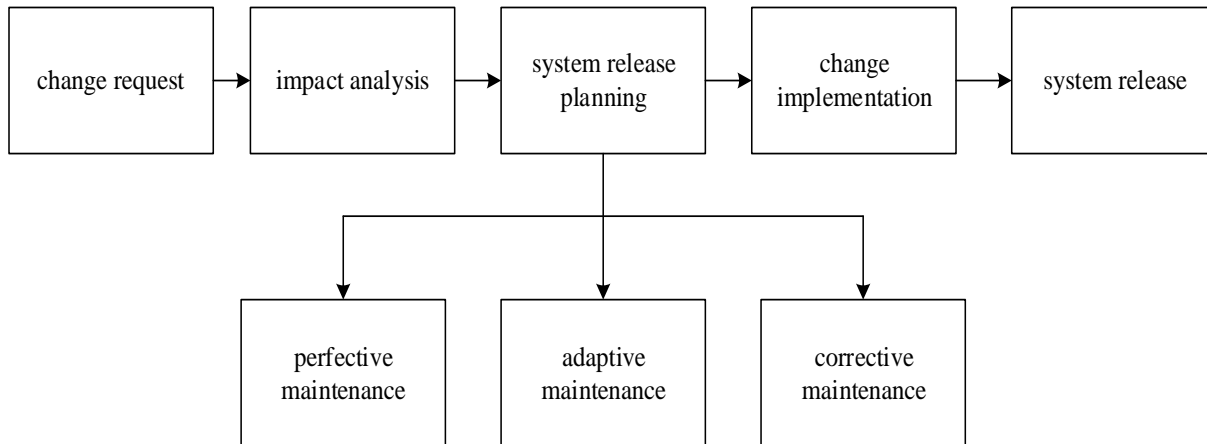
#### **5.4.3 Reasons for choosing Parallel Changeover**

- The changeover has less risks
- Low employees and student stress since they will be still using the old one.
- Gives more time of learning the new system while using the old one.

### **5.5 Maintenance**

The main objectives of the system maintenance are to provide maintenance and improvements for the new system as well as support users and help them to obtain the most value from the new system. It will also entail upgrading; adjusting and modifying the system to keep abreast with the goals of the organization. In brief the maintenance of a system is and always should be an on-

going process that normally involves updating the system. For this to occur, then the system would be expected to have already be deployed and in use. Maintenance types vary, but with this type of system Corrective, Adaptive and Perfective Maintenance will be used.



**Figure 5.10: Software Maintenance Diagram**

### 5.5.1 Corrective maintenance

Its main functionality is to address all adjustments carried out during implementation stage as well as the design stage (Sommerville, 2005). Moreover, corrective maintenance also looked at the type and nature of the errors made by the anticipated users as well as the necessary procedures that were used to make corrective changes. During this phase errors such as coding errors were discovered, for instance a field area had to be adjusted to accept integer's values only.

### 5.5.2 Adaptive maintenance

Edwards and Bramante (2009), states that this type of maintenance will be put into use whenever a change in environment has been encountered. In short, it permits a change in the software whenever changes in hardware or operating system are in question. The main reason for making the changes will be to constantly update the hardware and software platforms so as to meet the ever-changing user requirements and increase the best of quality to services offered. A system administrator is required to be readily available when this type of maintenance is in use since he/she will be tasked with checking the validity of the system in meeting its short and long-term goals.

### **5.5.3 Perfective maintenance**

It is common knowledge to all that once viewed as the best development among a series of others is not always the one to be implemented (Sommerville, 2005). The reasons for not implementing the best development is not because of its design but that in most cases there are neglected due to schedule constraints or even ignorance. Firstly, this type of maintenance assesses the worthiness of the energy to be deployed in perfecting the system to such levels. If the assessment proves to be worthy then design specifications will be drawn down and if there are approved there then should be implemented. Having implemented the design, the next step will be reviewing the implantation and all the necessary activities done in the review will then be documented for future reference. The goal of perfective maintenance is to enhance an application so that it performs efficiently. Like corrective maintenance, perfective maintenance can be carried out by users, management or even the system developer.

### **5.6 Recommendations for Future Development**

It was advisable to recommend perfective maintenance, since this type of maintenance not only modifies system requirements but it also adds to those already in place in regard to the ever-changing business environment.

The system is subject to review and updates and it can be upgraded to accommodate ‘WHAT IF ANALYSIS’ that enhances the management to come up with uncompromised decisions for future organization information sharing and how it is structured within the organization.

The following was recommended for future development:

- To add another module to link the Infrastructure Surveillance System to the billing system and introduce additional product offering through on-demand access were customers are only billed for the total time they were online and accessed the system
- To add SMS notifications for even more interactive notifications and greater reliability as users pay more attention to their mobile phones than their emails.
- To add a compatibility module to allow connectivity from mobile platforms such as Android and IOS based devices.



## **5.7 Conclusion**

The chapter discussed in brief the implementation and coding process of the project. Furthermore, it also looked at the technologies that were used in the system and managed to give a graphical representation of the entire system through the practice of screen shots and code snippets. Tests were carried out in scrutinizing the systems behaviour. To conclude, the project has been executed successfully, though it still requires some perfection soon, this is so because system development is an on-going process.

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## **Appendix A: User Manual**

### **Introduction**

It is a mandate for a user manual to be created so as to supplement on user training as well as providing help to users whenever there interacts with the system.

### **General Requirements of the system**

The system expects each and every user of it to undergo training on how to use the system so that he/she becomes acquainted with it before its' final deployment. Having trained and familiarised with the system, the general staff will have to create an account on their own and privileged users such as senior engineers with system modification right will have to be added into the system by the administrator so that they gain access to the system. A valid and correct username and password are expected from the user so that he gains access into the system. Access level rights functionality is to determine the levels in the system a user is allowed to access.

### **Technology**

The system is built on the following technology:

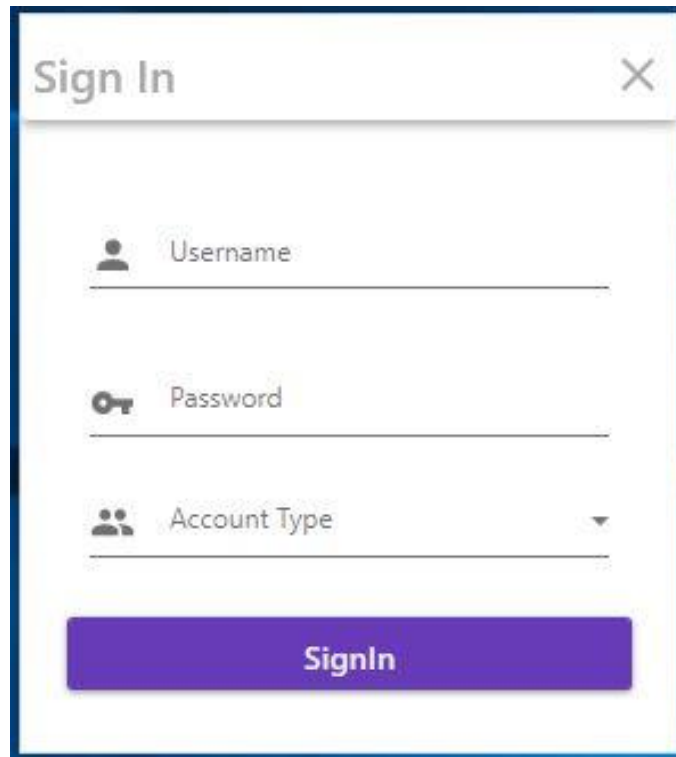
- Java programming language
- SQLite

The system consists of the following modules:

- User module
- Admin Module
- Entity/Node Tracking Module
- Reports Module

## Getting started

Dandemutande Infrastructure Surveillance System can be accessed by running the application from the list of installed applications or from the shortcut on the desktop. The user will then be presented with a login page as shown as below.



The image shows a 'Sign In' window with a white background and a blue border. At the top left, the text 'Sign In' is displayed in a grey font, and at the top right, there is a close button represented by a grey 'X' icon. Below the title bar, there are three input fields. The first field is labeled 'Username' and has a person icon to its left. The second field is labeled 'Password' and has a key icon to its left. The third field is labeled 'Account Type' and has a person icon to its left and a small downward-pointing arrow to its right, indicating a dropdown menu. At the bottom of the form, there is a wide, purple button with the text 'SignIn' in white.

*Figure A1: User Login Form*

## Login

In order for one to use the system, the user has to provide correct login details in the form of a valid username and password. The next thing to do before being allowed to login will be to select the account type by choosing it from the list of pre-specified account types from the drop-down menu. Only accounts already registered on the system can be accessed by supplying the username and password then signing in, otherwise a general employee would have to go to create staff account or otherwise if the account type is an Admin account, refer to the system administrator to have this created.

## Dashboard Overview

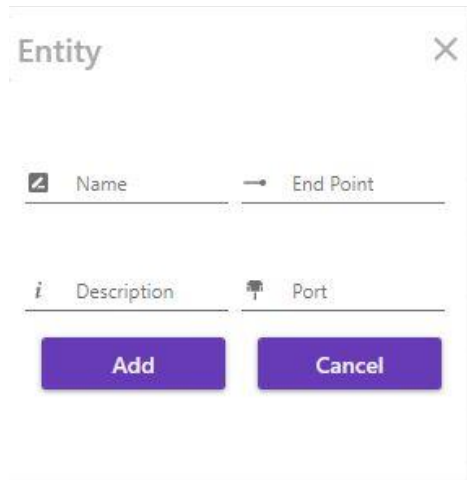


**Figure A2: System Overview Dashboard**

If the user account already registered and the employee successfully logs into the system, they will be presented with the system overview or dashboard as shown above. All configured entities that are being monitored will be presented there as well as their current statuses. Hosts that are detected to be up and online are presented with a green interface and likewise nodes that are marked as down and offline will be represented with a red interface.

On the right-hand side of the system dashboard will be graphical representation of the realime event logs that track system events and records when a monitored node goes offline and comes back online. The logs have a date-time stamp and node details to give a quick overview of recent events that have occurred on the tracked entities.

## Adding Node



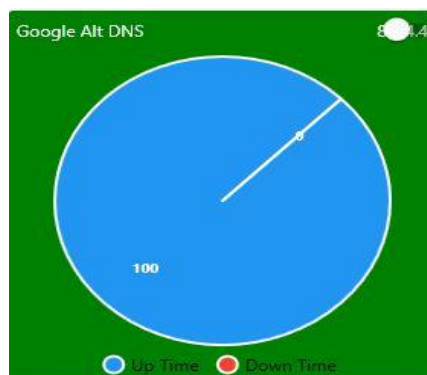
The image shows a web form titled "Entity" with a close button (X) in the top right corner. The form contains four input fields: "Name" (with a checkmark icon), "End Point" (with a right-pointing arrow icon), "Description" (with an information icon), and "Port" (with a pin icon). Below the input fields are two purple buttons: "Add" and "Cancel".

**Figure A3: Node Addition Form**

To add a new node to the system to have it monitored, one has to be logged in as an admin user with the system edit privileges. Click on the Entities icon on the system menu bar and you will be presented with the above entity details form. The Name field is to be populated with the hostname of the server or network element being configured. Endpoint field relates to the valid IP address or URL of the node being added and tracked. Description field is to be populated with a brief description for additional detail about the host.

Once that has been done click Add button and the host will be added to the database as well as the system monitoring dashboard and as soon as the system is refreshed, live monitoring for this host is activated.

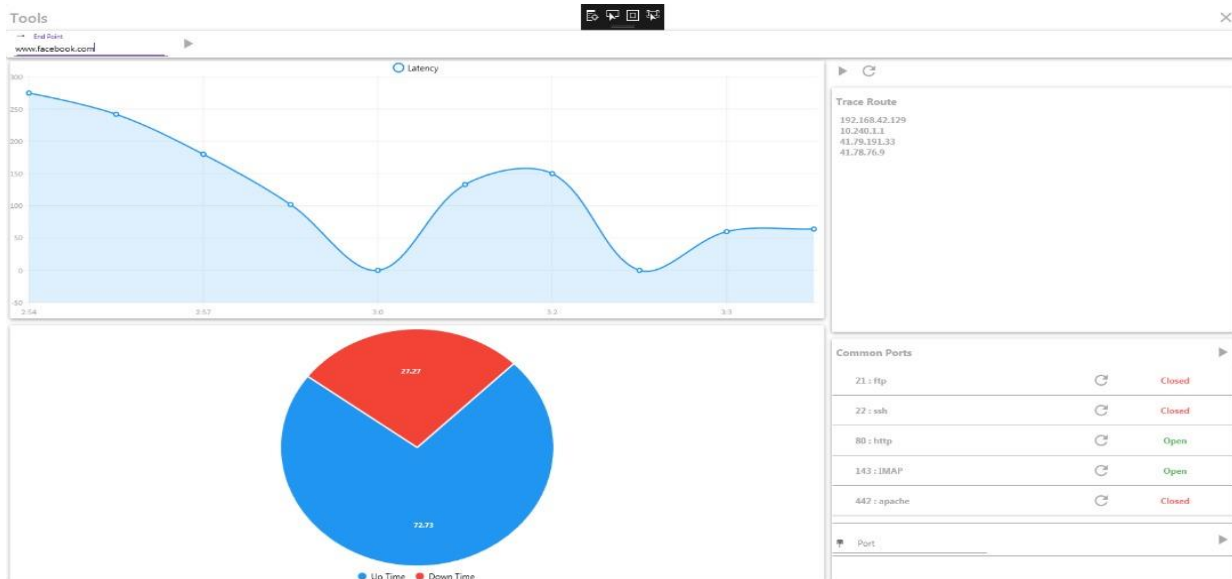
## Viewing Uptime Graphs



**Figure A4: Node Uptime Graph**

To get an overview of realtime graphical representation of a given node's uptime against downtime, click the node on the system dashboard and a pie chart like the one shown above will be displayed calculating the average uptime since the node monitoring was started.

## Troubleshooting Tools



**Figure A5: Built in Tools**

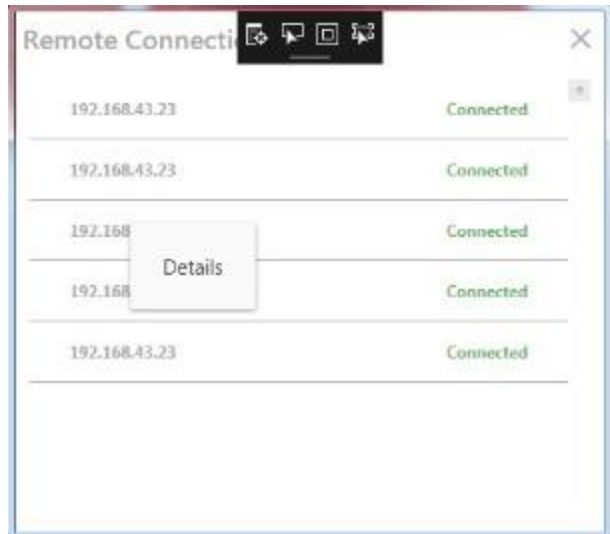
To access the built-in troubleshooting tools such as ping, telnet and traceroute, click on the Tools menu on the system menu. The above window will be displayed, all common port for the given host will be probed for status whether they are open or closed, if you need to probe a custom port, specify it then click the check button.

Specify the IP Address or fully qualified domain name to trace to the click the trace button and a traceroute command will be initiated.

## Viewing Currently Connected Users


The system allows concurrent user access to the system. Therefore, to view the list of all connected user, click on the user button on the system menu and the database will be queried for list of active users and the hostname and /or IP Address the user is connecting from. This is highlighted on the screenshot below.





*Figure A6: Connected Users Overview*

## Signing Out

To log out of all account click on the  icon on the top right-hand corner of the screen and then click on the sign out option that pops out and the user will be successfully logged out as shown below and redirected back to the sign in page.

## **Appendix B: Interview Checklist**

### Interview Question

The following is an extract from some of the interviews that were conducted within Dandemutande:

1. Do you enjoy working with the current manual system and if so why and if not why?
2. What problems are you facing using the current system?
3. What view or opinion do you have about migrating from the current manual system to a fully computerized system do you have?
4. What expectations of the proposed system do you suggest?
5. How do you get notified when your network host or server goes offline?
6. How long does it take to resolve a reported network issue?
7. What do you think the current system's major weakness is and does it affect your efficiency?
8. How easy is the process of collecting data for reporting on the total downtime or average downtime of a given host?
9. Has a network incident ever gone for more than an hour without being noticed or resolved?
10. How many tools are you expected to know to be able to successfully carry out your troubleshooting of network and system issues?
11. Do you think the introduction of an automated infrastructure surveillance system would make the process of network monitoring and troubleshooting less cumbersome?

## Appendix C: Questionnaires

Dandemutande Infrastructure Surveillance System is an online web based solution system that allows the current and future employees to monitor network activity and troubleshoot issues in realtime and receive instant notifications via email once a network node exceeds a set threshold. The information from this study will be used for academic purposes only. Your assistance in filling this questionnaire is greatly appreciated.

### Checklist Section A: Staff

1. How do you rate the current system?

Excellent  Good  Fair  Poor

2. Given the choice to migrate from the current manual application system to a fully computerized system, would you choose to migrate?

Yes  No

If No, what may be the reason \_\_\_\_\_

\_\_\_\_\_

3. Do you feel the current process of network monitoring is time consuming?

Agree  Disagree

4. Have some of employees complained about the current system?

Yes  No

If YES what were the complaints?

\_\_\_\_\_

\_\_\_\_\_

5. What problems are you facing with the current system?

\_\_\_\_\_

\_\_\_\_\_

**Checklist Section B: Management**

1. Are you satisfied with the current manual system that you have been using all along?

Yes  Not at

If YES, give the reason

---

---

2. How do you rate the current system?

Excellent  Good  Fair  Poor

3. Are you pleased with the processing speed of the current manual system?

Yes  No

If No what are the suggestions? \_\_\_\_\_

4. Have you ever failed to get a system report that you required?

Yes  No

5. Do you feel a considerable amount of productive time is lost through the process of manual network monitoring and troubleshooting?

Yes  No

## Appendix D: Observation Scoresheet

Name of Observer: \_\_\_\_\_ Department: \_\_\_\_\_

Date: \_\_/\_\_/\_\_/ Time: \_\_\_\_\_

Observation: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Conclusion: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

## Appendix E: Code Snippet

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Threading.Tasks;
using System.Windows;
using System.Windows.Controls;
using System.Windows.Data;
using System.Windows.Documents;
using System.Windows.Input;
using System.Windows.Media;
using System.Windows.Media.Imaging;
using System.Windows.Shapes;

namespace ISS
{
    /// <summary>
    /// Interaction logic for SignIn.xaml
    /// </summary>
    public partial class SignIn : Window
    {
        mainEntities1 db = new mainEntities1();
        public SignIn()
        {
            InitializeComponent();
        }

        private void btnClose_MouseDown(object sender, MouseButtonEventArgs e)
        {
            Application.Current.Shutdown();
        }

        private void btnSignIn_Click(object sender, RoutedEventArgs e)
        {
            switch (cmbAccountType.SelectedIndex)
            {
                case 0:
                    if (db.users.Where(u => u.username == txtUserName.Text && u.password
                    == txtPassword.Password).Count() < 1)
                        MessageBox.Show("Username and password combination do not
exist.");
                    else
                    {
                        MainWindow m = new MainWindow(false);
                        m.Show();
                        this.Hide();
                    }
                    break;
                case 1:
                    if (db.admins.Where(u => u.username == txtUserName.Text && u.password
                    == txtPassword.Password).Count() < 1)
                        MessageBox.Show("Username and password combination do not
exist.");
                    else
                    {

```

```

        MainWindow m = new MainWindow(true);
        m.Show();
        this.Hide();
    }

    break;
}
}
}
}
}

<Window x:Class="ISS.SignIn"
    xmlns="http://schemas.microsoft.com/winfx/2006/xaml/presentation"
    xmlns:x="http://schemas.microsoft.com/winfx/2006/xaml"
    xmlns:d="http://schemas.microsoft.com/expression/blend/2008"
    xmlns:mc="http://schemas.openxmlformats.org/markup-compatibility/2006"
    xmlns:local="clr-namespace:ARMAS"
    xmlns:materialDesign="http://materialdesigninxaml.net/winfx/xaml/themes"
    mc:Ignorable="d"
    Title="SignIn" Height="300" Width="300" WindowStartupLocation="CenterScreen"
WindowStyle="None">
    <Grid>
        <Grid.RowDefinitions>
            <RowDefinition Height="40px"></RowDefinition>
            <RowDefinition></RowDefinition>
        </Grid.RowDefinitions>
        <Grid Grid.Row="0">
            <materialDesign:Card VerticalAlignment="Stretch"
HorizontalAlignment="Stretch" materialDesign:ShadowAssist.ShadowDepth="Depth2">
                <Grid>
                    <Grid.ColumnDefinitions>
                        <ColumnDefinition></ColumnDefinition>
                        <ColumnDefinition Width="40"></ColumnDefinition>
                        <ColumnDefinition Width="40"></ColumnDefinition>
                        <ColumnDefinition Width="40"></ColumnDefinition>
                    </Grid.ColumnDefinitions>
                    <Label Foreground="DarkGray" FontWeight="Medium"
VerticalAlignment="Center" FontSize="20">Sign In</Label>
                    <Label MouseDown="btnClose_MouseDown" x:Name="btnClose"
Grid.Column="3" VerticalAlignment="Center" HorizontalAlignment="Right"
Style="{StaticResource TopNavIconGridStyle}">
                        <materialDesign:PackIcon HorizontalAlignment="Center"
VerticalAlignment="Center" Kind="Close" Height="25" Width="25"></materialDesign:PackIcon>
                    </Label>
                </Grid>
            </materialDesign:Card>
        </Grid>
        <Grid Grid.Row="1" Margin="10">
            <UniformGrid x:Name="grdMain" Columns="1" Rows="4" >
                <TextBox
                    Margin="20,0,20,0"

                    x:Name="txtUserName"
                    Style="{StaticResource MaterialDesignFloatingHintTextBox}">
                    <materialDesign:HintAssist.Hint >

```

```

        <StackPanel Orientation="Horizontal">
            <materialDesign:PackIcon Kind="Account" Height="20px"
Width="20px" />
            <TextBlock Margin="15,0,0,0">Username</TextBlock>
        </StackPanel>
    </materialDesign:HintAssist.Hint>
</TextBox>
<PasswordBox
x:Name="txtPassword"    Margin="20,0,20,0"
    Style="{StaticResource MaterialDesignFloatingHintPasswordBox}">
    <materialDesign:HintAssist.Hint >
        <StackPanel Orientation="Horizontal">
            <materialDesign:PackIcon Height="20px" Width="20px"
Kind="Key" />
            <TextBlock Margin="15,0,0,0">Password</TextBlock>
        </StackPanel>
    </materialDesign:HintAssist.Hint>
</PasswordBox>
<ComboBox
x:Name="cmbAccountType"    Margin="20,0,20,0"
    Style="{StaticResource MaterialDesignFloatingHintComboBox}">
    <materialDesign:HintAssist.Hint >
        <StackPanel Orientation="Horizontal">
            <materialDesign:PackIcon Height="20px" Width="20px"
Kind="AccountMultiple" />
            <TextBlock Margin="15,0,0,0">Account Type</TextBlock>
        </StackPanel>
    </materialDesign:HintAssist.Hint>
    <ComboBoxItem>User</ComboBoxItem>
    <ComboBoxItem>Admin</ComboBoxItem>
</ComboBox>

    <Button x:Name="btnSignIn" Click="btnSignIn_Click"
Margin="10">SignIn</Button>
</UniformGrid>
</Grid>
</Grid>
</Window>

```

```

using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Threading.Tasks;
using System.Windows;
using System.Windows.Controls;
using System.Windows.Data;
using System.Windows.Documents;
using System.Windows.Input;
using System.Windows.Media;
using System.Windows.Media.Imaging;
using System.Windows.Navigation;
using System.Windows.Shapes;

```

```

namespace ARMAS
{

```



```

/// <summary>
/// Interaction logic for MainWindow.xaml
/// </summary>
public partial class MainWindow : Window
{
    public static MainWindow instance = null;

    private bool isAdmin = false;

    /// <summary>
    /// Defining callback delegate for login monitor events
    /// </summary>
    /// <param name="e">Node monitoring event arguments</param>
    public delegate void UpdateCallBackDelegate(NodeCheckEventArgs e);

    //Instance of callback
    private UpdateCallBackDelegate updateCallback = null;

    //instance of monitor class
    static Monitor m = new Monitor();

    static Views.EntityCardsContainerView entContainer = null;

    mainEntities1 db = new mainEntities1();

    public MainWindow(bool _isAdmin)
    {
        InitializeComponent();

        //Adding callback method to delegate
        updateCallback = new UpdateCallBackDelegate(updateLog);
        updateEventsLog();
        entContainer = entityContainer;

        instance = this;

        isAdmin = _isAdmin;

        lblEntities.IsEnabled = isAdmin;
    }

    public static void _showDialog(string title, UserControl _view, int _height = -1,
int _width = -1)
    {
        //show entities view
        DialogWindow d = new DialogWindow(title, _view, _height, _width);

        try
        {
            d.ShowDialog();
            d.Closed += D_Closed;
        }
        catch { }
        m.refresh();
    }
}

```

```

        entContainer.refresh();

    }

    private static void D_Closed(object sender, EventArgs e)
    {

    }

    public static Monitor getMonitorInstance()
    {
        return m;
    }

    private void Button_Click(object sender, RoutedEventArgs e)
    {
        m = new Monitor();
        m.onNewEvents += M_onNewEvents;
        m.start(UpdateCallback);
    }

    private void M_onNewEvents(object sender, DateTime e)
    {
        updateEventsLog();
    }

    /// <summary>
    /// Function called on every check event
    /// </summary>
    /// <param name="e">Node chekcing events</param>
    void updateLog(NodeCheckEventArgs e)
    {
        // txtLogger.Dispatcher.BeginInvoke((Action)(() => {

                //txtLogger.Text += string.Format("Host : {0} Status : {1} Latency :
{2} Description : {4} {3} ", e.nNode.EndPoint, e.isUp.ToString(), e.latency,
Environment.NewLine, e.nNode.description);

            // }));
    }

    void updateEventsLog()
    {
        // txtEventLogger.Dispatcher.BeginInvoke((Action)(() => {

                // txtEventLogger.Text = "";

                // foreach (var e in db.events)
                // {
                //     txtEventLogger.Text += string.Format("Name : {0} Status : {1}
Description : {2} {3}", e.entity.name, e.is_good, e.description, Environment.NewLine);
                // }
            }
    }

```

```

        // }));
    }

    private void lblClose_MouseDown(object sender, MouseButtonEventArgs e)
    {
        m.start(updateLog);
    }

    private void lblEntities_MouseDown(object sender, MouseButtonEventArgs e)
    {
        //show entities view
        _showDialog("Entities", new Views.Entities());
    }

    private void btnClose_MouseDown(object sender, MouseButtonEventArgs e)
    {
        Application.Current.Shutdown();
    }
}
}

```

```

using LiveCharts;
using LiveCharts.Defaults;
using LiveCharts.Wpf;
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Threading.Tasks;
using System.Windows;
using System.Windows.Controls;
using System.Windows.Data;
using System.Windows.Documents;
using System.Windows.Input;
using System.Windows.Media;
using System.Windows.Media.Imaging;
using System.Windows.Navigation;
using System.Windows.Shapes;

```

```

namespace ARMAS.Views
{
    /// <summary>
    /// Interaction logic for EntityCardView.xaml
    /// </summary>
    public partial class EntityCardView : UserControl
    {

        private List<int> xValues = new List<int>();
        private List<string> xLabels = new List<string>();

        private Node activeNode = null;

        public SeriesCollection SeriesCollection { get; set; }
        public SeriesCollection PieSeriesCollection { get; set; }
        public List<string> Labels { get; set; }
        public Func<double, string> YFormatter { get; set; }
    }
}

```

```

public string upPerc { get; set; }
public string downPerc { get; set; }

private System.Timers.Timer Time = new System.Timers.Timer();

public EntityCardView(Node n)
{
    InitializeComponent();
    activeNode = n;

    Labels = new List<string>();

    for (int i = 0; i < 10; i++)
    {
        xValues.Add(0);
        Labels.Add("");
    }

    lblEndPoint.Content = n.EndPoint;
    lblName.Content = n.Name;

    row1.Height = new GridLength(250);
    row2.Height = new GridLength(0);

    SeriesCollection = new SeriesCollection
    {
        new LineSeries
        {
            Title = "Latency",
            Values = new ChartValues<int>(xValues.ToArray())
        }
    };

    PieSeriesCollection = new SeriesCollection
    {
        new PieSeries
        {
            Title = "Up Time ",
            Values = new ChartValues<ObservableValue> { new ObservableValue(50)
},
            DataLabels = true
        },
        new PieSeries
        {
            Title = "Down Time",
            Values = new ChartValues<ObservableValue> { new ObservableValue(50)
},
            DataLabels = true
        }
    };

    pcMain.Series = PieSeriesCollection;
    pcMain.DisableAnimations = true;
    latencyChart.DisableAnimations = true;

```

```

n.OnStatusChange += N_OnStatusChange;
n.onCheck += N_onCheck;

Time.Interval = 1000;
Time.Elapsed += Time_Elapsed;

// Time.Start();
DataContext = this;
}

private void Time_Elapsed(object sender, System.Timers.ElapsedEventArgs e)
{

}

private void N_onCheck(object sender, NodeCheckEventArgs e)
{

    Console.WriteLine(e.latency);

    this.Dispatcher.Invoke(() => {

        SeriesCollection[0].Values.RemoveAt(0);
        SeriesCollection[0].Values.Add(e.latency);

        Labels.RemoveAt(0);
        Labels.Add( DateTime.Now.TimeOfDay.Minutes.ToString() + ":" +
DateTime.Now.TimeOfDay.Seconds.ToString());

        upPerc = (100 - e.nNode.avgDownPer).ToString() + "%";
        downPerc = (e.nNode.avgDownPer).ToString() + "%";

        pcMain.Series[1].Values.RemoveAt(0);
        pcMain.Series[1].Values.Add(new ObservableValue(e.nNode.avgDownPer));

        pcMain.Series[0].Values.RemoveAt(0);
        pcMain.Series[0].Values.Add(new ObservableValue(100 -
e.nNode.avgDownPer));

    });
}

```

```

private void N_OnStatusChange(object sender, NodeCheckEventArgs e)
{
    updateStatus(e.isUp);
}

void updateStatus(bool status)
{
    crdMain.Dispatcher.BeginInvoke((Action)(() =>
    {
        switch (status)
        {
            case true:
                crdMain.Background = Brushes.Green;
                break;
            case false:
                crdMain.Background = Brushes.Red;
                break;
        }
    }));
}

private void ToggleButton_Click(object sender, RoutedEventArgs e)
{
    if(chartToggle.IsChecked == true)
    {
        row1.Height = new GridLength(250);
        row2.Height = new GridLength(0);
    }
    else
    {
        row2.Height = new GridLength(250);
        row1.Height = new GridLength(0);
    }
}
}
}

```

```

using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Threading.Tasks;
using System.Timers;
using System.Windows.Forms;

```

```

namespace ARMAS
{
    /// <summary>
    /// Contains ALL the Information About Monitoring Entities
    /// </summary>
    public class Monitor
    {
        //private mainEntities1 db = new mainEntities1();

        public List<Node> nodes = new List<Node>();
    }
}

```

```

MainWindow.UpdateCallBackDelegate LogCallBack = null;

private System.Timers.Timer dbTime = new System.Timers.Timer();

//Queue of events that need to be saved to the database
private List<@event> EventQueue = new List<@event>();

//the default monitoring frequency for each node
public static int monitorFrequency = 1000;

//the database update frequency
public static int dbUpdateFrequency = 5000;

//Event raised everytime the node is checked
public event EventHandler<DateTime> onNewEvents;

public Monitor()
{
    nodes = new List<Node>();
    using (var db = new mainEntities1())
    {
        foreach (entity e in db.entities)
        {
            nodes.Add(new Node(e));
        }
    }

    dbTime.Interval = dbUpdateFrequency;
    dbTime.Elapsed += DbTime_Elapsed;
}

public void refresh()
{
    nodes = new List<Node>();
    using (var db = new mainEntities1())
    {
        foreach (entity e in db.entities)
        {
            nodes.Add(new Node(e));
        }
    }
}

private void DbTime_Elapsed(object sender, ElapsedEventArgs e)
{
    //Saves Changes to the database every 5 seconds
    //so as to avoid duplicates when different threads
    //raise a database updating event at the sametime
    Task.Factory.StartNew(() =>
    {
        using (var db = new mainEntities1())

```

```

        {
            if (EventQueue.Count() > 0)
            {
                using (var context = new mainEntities1())
                {
                    try
                    {
                        foreach (@event evt in EventQueue)
                        {
                            context.events.Add(evt);
                        }
                        context.SaveChanges();
                        EventQueue.Clear();
                        onNewEvents?.Invoke(this, DateTime.Now);
                    }
                    catch {
                    }
                }
            }
        }
    };
}

public void start(MainWindow.UpdateCallBackDelegate d)
{
    LogCallBack = d;
    foreach (var i in nodes)
    {
        i.startMonitoring();
        //providing function for node check event
        i.onCheck += D_onCheck;
        //providing function for node status change event
        i.OnStatusChange += I_OnStatusChange;
    }

    dbTime.Start();
}

/// <summary>
/// called whenever the status of a node changes
/// </summary>
/// <param name="sender">The node that raised the event</param>
/// <param name="e">Node check event argumanets</param>
private void I_OnStatusChange(object sender, NodeCheckEventArgs e)
{

```



```

        @event evnt = new @event()
        {
            created_on = DateTime.Now,
            event_id = e.nNode.ParentEntity.id,
            is_good = e.nNode.isUp ? true : false,
            description = string.Format("{0} on {1} is {2}", e.nNode.Name,
e.nNode.EndPoint, e.nNode.isUp ? "up." : "down")
        };

        //Queing events before they are saved to database
        EventQueue.Add(evnt);

        onNewEvents?.Invoke(this,DateTime.Now);
        //Console.WriteLine("Status Changed On {0}", DateTime.Now);

    }

    /// <summary>
    /// function called whenever status of node chagnes
    /// </summary>
    /// <param name="sender">The node that raised the event</param>
    /// <param name="e">Node check event arguments</param>
    private void D_onCheck(object sender, NodeCheckEventArgs e)
    {
        LogCallBack(e);
    }

}
}

```