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Site Survey and Implementation Plan

Community Wireless Network
Nakaseke Telecentre



Version 1.1
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1. Introduction

Change log version 1.1

- Correction of misspellings of partner names.
- Change of radio equipment in the central hub to be a SmartBridges outdoor access point with QoS.
- Change of Ethernet cable to be of outdoor type for all client installations.
- Eliminated the use of PVC conduits for the central hub.
- Budget for a UPS to the Nakaseke Telecentre.

This document provides an implementation plan (v. 1.1) for the Community Wireless Network of Nakaseke Telecentre, Uganda.

The plan includes a detailed specification of hardware needed for each of the partner sites of the network. Additionally, practical advices for each installation are provided. For each site, a *Comment* section highlights what important issues that require special attention.

2. Network hub: Nakaseke Telecentre

The Nakaseke Telecentre will constitute the hub of the network. Currently, the Telecentre is equipped with a VSAT connection of 64 kbps to AFSAT for 250 USD per month.

The Telecentre has a solar system installed which uses a pure sine wave inverter that protects the equipment against power surges.

Since the Telecentre is not hooked to the national power grid, no UPS's are used.

The Telecentre does not have a backup system to the solar energy system. However, the current system has enough capacity and is stable.

There is a 25m tall tower raised on the compound of the Telecentre. The tower is owned by UTL which also hosts its equipment (PBX for fix telephony, generator) in the premises of the Telecentre.

There is currently a good relationship between the Telecentre and UTL and hence, a good opportunity for the Telecentre to use the tower for the wireless network. However, there must be a written agreement between the both parties for mounting the radio equipment of the wireless network in the tower before the implementation phase starts.

Assuming an approval from UTL, the radio equipment will be placed in the UTL tower. The tower will be equipped with an outdoor access point (SmartBridges) that supports PoE (Power over Ethernet). An external omni-directional antenna will be connected to the access point which will provide coverage to its surrounding partners.

Hardware specification

| | |
|--------------------|---|
| Location of radio | Approx. 20m up in radio tower on the Telecentre's compound. |
| Mounting equipment | Pole: L-bracket |
| Radio unit | smartBridges, AirPoint NEXUS PRO TOTAL, N-female |
| Antenna | Omni-directional, 12 dBi, N-female |
| RF cable | Connectors: N-male / N-male |
| | Length: 1 m |
| Network cable | 100 m (outdoor) |

Comments

- 1) Legal agreement with UTL for using the tower.
- 2) Ensure proper lightening rod in tower.
- 3) Find appropriate structure to mount in the tower for hosting the access point and the omni antenna.
- 4) Discuss whether a professional climber should be hired or if CWRC should perform the tower installation themselves.

3. Sub-county Headquarters (SCHQ)

The sub-county Headquarters is located less than 100m from the Telecentre with no obstructions between the both sites. Therefore, it can be connected by means of Ethernet cable protected with a PVC conduits.

The pipe must be dig down to a depth of at least 50 cm assuming that the trench will not be trafficked by heavy loads.

When digging a trench of this scale, it is normal procedure to put more capacity than what is needed for the moment as the cable itself is relatively cheap compared to making another trench. Also, this practice is good in terms of redundancy. If one cable fails, you have two more chances. For these reasons, three Ethernet cables will be put in each conduits.

Each individual PCV pipe needs to be glued together with its surrounding pipes to avoid that water leaks in or that insects/animals enter the pipe. Rats and termites are common enemies to any type of cables. Additionally, water that leaks into the PCV tube can lead to that roots

from trees and bushes enter and eventually break the pipe as they grow.

Hardware specification

| | |
|---------------|--------------------|
| Network cable | 3 x 100 m (indoor) |
| PCV conduits | 100 m |

Comments

- 1) Measure the distance between the Telecentre and the Sub-county Headquarters before the implementation to make sure that the total length of the network cable needed does not exceed the maximum length of the network cable you are using.

4. Nakaseke Hospital (NH)

Nakaseke Hospital is located approximately 250 m away from the Telecentre with clear line of sight to the tower.

The site will be connected to the Telecentre by means of wireless technology using an (indoor) access point equipped with an external sectoral panel antenna (9 dBi, 65 degrees).

There are two options for mounting the antenna:

- 1) On a pole attached to the wall of the administration building of the hospital *or*
- 2) On a pole dig down in the ground (grass, soil) in front of the administration building.

Mounting the pole on the wall under the roof can be difficult as the roof is “hanging” over with approx 60 cm.

Despite of where the pole will be placed, a radio cable will connect the antenna with the access point which will be placed inside of the administration office (indoors).

Hardware specification

| | |
|--------------------|---------------------------------------|
| Location of radio | Rooftop of administration building |
| Mounting equipment | Pole: 5 m |
| | Brackets: TBD |
| Radio unit | WP54G (Indoor, Compex), RP-SMA female |
| Antenna | Panel, 9 dBi, SMA-female |
| RF cable | Connectors: RP-SMA male / SMA male |
| | Length: 7 m |
| Network cable | 3 m (outdoor) |
| Surge protection | Yes |

Comments

- 1) The exact location of the mast and how it should be mounted must be decided. The

length of the radio cable will depend on the decision.

5. Jesus is Lord Complex (JLC)

Jesus is Lord Complex (guest house and restaurant) is located approx. 300 meters away from the Telecentre with clear line of sight to the tower.

The site will be connected to the Telecentre by means of wireless technology using an (indoor) access point equipped with an external sectoral panel antenna (65 degrees).

The exact location of the radio equipment has not yet been decided as the site was only visited from outside during the site survey. However, due to its advantageous location, the equipment can be placed (almost) in any part of their facilities as long as it is facing the communication tower at the Telecentre.

Hardware specification

| | |
|--------------------|---------------------------------------|
| Location of radio | TBD |
| Mounting equipment | Pole: 2,5 m |
| | Brackets: Wall mounted |
| Radio unit | WP54G (indoor, Compex), RP-SMA female |
| Antenna | Panel, 9 dBi, SMA-female |
| RF cable | Connectors: RP-SMA male/ SMA-male |
| | Length: 5 m |
| Network cable | 3 m (outdoor) |
| Surge protection | Yes |

Comments

- 1) Decide exact location of installation and specify requirements of mounting brackets, RF cable length and pole.

6. Nakaseke Primary Teachers' Training College (PTC)

The Nakaseke Primary Teachers' Training College is located approx. 1200 m from the Telecentre with near line of sight to the tower (some vegetation covers).

The site will be connected to the Telecentre by means of wireless technology using an (indoor) access point equipped with an external sectoral panel antenna (65 degrees).

The antenna will be mounted to a pole attached to the wall of the computer room. Since the roof is tilting over the wall, the pole needs to be mounted at least *60 cm* away from the wall.

The access point will be placed in the computer room under the inner ceiling. The radio cable connecting the antenna with the access point will be going through a small window in the wall to a space between the roof and the ceiling.

Hardware specification

| | |
|--------------------|--------------------------------------|
| Location of radio | In computer room |
| Mounting equipment | Pole: 5 m |
| | Brackets: Wall mounted |
| Radio unit | WP54G (Indoor, Compex) RP-SMA female |
| Antenna | Panel, 9 dBi, SMA-female |
| RF cable | Connectors: RP-SMA male / SMA-male |
| | Length: 7 m |
| Network cable | 20 m (outdoor) |
| Surge protection | Yes |

Comments

- 1) A network switch is not needed in this case as the computer room is well equipped already with network components.

7. Nakaseke International College School (NIC)

The Nakaseke International College School will act as a repeating hub to Mazzolid School and hence be equipped with two radio units.

The radio equipment will be placed on top of a water tower placed on the school's compound. As two outdoor access points will be used in this installation (with Power-over-Ethernet support), there is no need to bring power up to the water tower.

However, an Ethernet cable must be drawn from the network switch installed in a suitable location in the School, to the water tank. The cable length must not exceed the maximum operational length of the network cable used. Furthermore, the cable should be dig down in the same manner as the case of the Sub-country Headquarters to avoid external impact.

The WPP54AG (outdoor access point) is equipped with a 8.5 dBi directional antenna. Hence, there is no need of using external antennas.

Furthermore, the WPP54AG has two Ethernet ports and can therefore be interconnected via a crossed Ethernet cable. The second interface of (of one of the access points) will be used to provide NIC with wired Internet access.

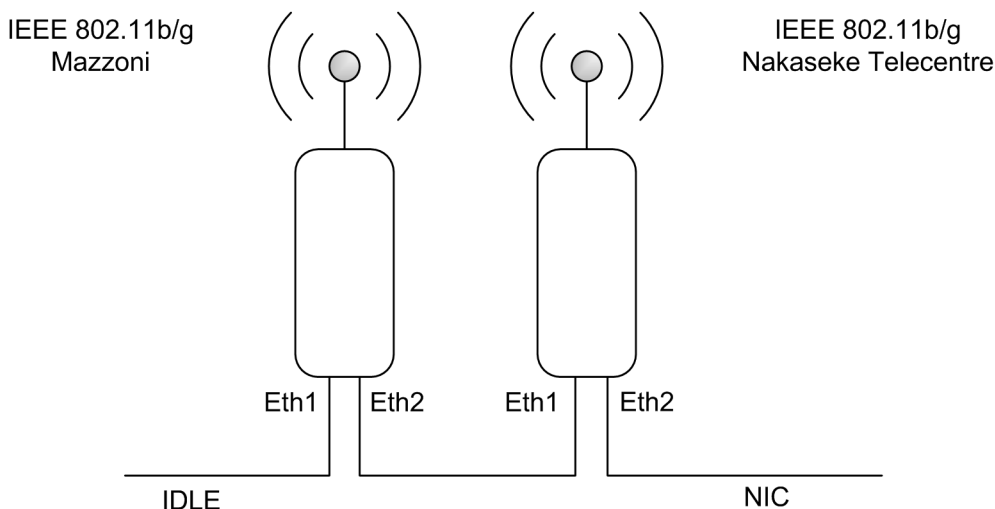


Image1: Two outdoor access points will be interconnected via a crossover Ethernet cable to constitute a wireless repeater at the Nakaseke International College School.

Hardware specification

| | |
|--------------------|---|
| Location of radio | In water tower |
| Mounting equipment | Pole: 2.5 m |
| | Brackets: Hose clamps |
| Radio unit | 2 x WPP54AG-6C (Outdoor, Compex), RP-SMA female |
| Antenna | None (using internal antenna of WPP54AG-6C) |
| Network cable | 3 x 100 m (indoor) |
| PVC conduits | 100 m |
| Surge protection | Yes |

Comments

- 1) Decide the exact location of the network switch, the PoE unit and the UPS.
- 2) Investigate what kind of brackets are needed to mount the pole to the water tower.
- 3) Prepare for digging of the trench.

8. Mazzolid Primary and Secondary School (MZ)

The Mazzolid Primary and Secondary School will be connected to the Telecentre via the Nakaseke International College School (NIC) by means of wireless technology using an (indoor) access point equipped with an external sectoral panel antenna (65 degrees).

The site includes a secondary school, a primary school and a church. At this point, it is not

decided which building that will be connected to the wireless network. During the site survey in November 2006, the buildings were not visited from inside since the contact person was not available. Hence, detailed information about the site was never obtained.

All three buildings should have line-of-sight to the water tower of Nakaseke International College school. In terms of infrastructure and potential users, the secondary school is the most appropriate building to connect.

Hardware specification

| | |
|--------------------|--------------------------------------|
| Location of radio | TBD |
| Mounting equipment | Pole: 5 m |
| | Brackets: Wall mounted |
| Radio unit | WP54G (Indoor, Compex) RP-SMA female |
| Antenna | Panel, 9 dBi, SMA female |
| RF cable | Connectors: RP-SMA male / SMA male |
| | Length: 7 m |
| Network cable | 3m (outdoor) |
| Surge protection | Yes |

Comments

- 1) It must be decided which building that should be connected to the network and the exact location of the installation.

9. Nakaseke S.D.A Secondary School (SDA)

The Nakaseke S.D.A Secondary School has no clear line-of-sight to any other partner of the network due to thick vegetation in front of low buildings. Hence, the site can not be connected without a small mast/tower of 10-15m being erected on the school's premises. Because of this, the site will not be included in this first Implementation plan since the cost of such a tower is not covered in the budget.

After the implementation of the first 6 sites in Nakaseke, new simulations will be done to give a more exact specification of what is needed to get the site connected.

10. Christ the Rock (CR)

Christ the Rock has no clear line-of-sight to any other partner of the network. Hence, the site can not be connected to the network without a small mast/tower (10-15m) erected on its premises.

Because of that, the site will not be included in this first Implementation plan since the cost of such a tower is not covered in the budget.

After the implementation of the first 6 sites in Nakaseke, new simulations will be done to give a more exact specification of what is needed to get the site connected.

An option for Christ the Rock, is to discuss a model of cooperation with World Vision, an NGO located just 100 m from the school. World vision has currently a working VSAT connection which could be shared wireless.

11. Network systems

The network will be built on three different network “systems”; a central hub, a set of wireless clients and one repeating hub.

11.1 Central hub

The central hub of the network will be at the radio tower at Nakaseke Telecentre's compound. The tower will be equipped with two AirPoint NEXUS PRO TOTAL base stations from SmartBridges. The base station is a ruggedized unit (outdoor) with PoE support and IEEE 802.11e QoS.

The AirPoint is equipped with an internal sectoral antenna of 12 dBi, 90 degrees. In order to cover 360°, an external omni-directional antenna will be used.

| Unit | AirPoint NEXUS PRO TOTAL (smartBridges) |
|------------------------|---|
| Antenna | Omni directional, 12 dBi external |
| Transmitted power (Tx) | +36 to +8 dBm @ 1 Mbps +33 to +8 dBm @ 54 Mbps |
| Receiving sensibility | -109 dBm @ 1 Mbps -85 dBm @ 54 Mbps |
| Total line loss | 1 dB |
| Height | 20 m |
| Surge arrestor | Yes |

Table 1: Technical specification of the central hub.

11.2 Wireless Client

The following sites will act as wireless clients: Nakaseke hospital, Jesus is Lord Complex, PTC and Mazzolid.

As mentioned earlier, the sub-county headquarters will be connected via Ethernet cable, not by wireless.

| | |
|-------------------------------------|-----------------------|
| Transmitted power (T _x) | 19 dBm (IEEE 802.11g) |
| Antenna | Panel antenna, 9 dBi |
| Height | 5 m |
| RF cable | 0,52 dB/m, 1 m |
| Receiving sensibility | -95 dBm |
| Total line loss | 4 dB |
| Surge protection | Yes |

Table 2: Technical specification of a wireless client.

11.3 Wireless repeater

The Nakaseke International College School (NIC) will act as a wireless repeater and repeat the radio signals to Mazzolid. It will be equipped with two identical radios (WPP54AG-6C, Compex outdoor) to receive the radio signals from the central tower and relay it to Mazzolid.

| | |
|-------------------------------------|------------------------|
| Transmitted power (T _x) | 20 dBm |
| Antenna | Panel antenna, 8,5 dBi |
| Height | 12 m |
| RF cable | N/A (internal antenna) |
| Receiving sensibility | -95 dBm |
| Total line loss | 2 dB |

Table 3: Technical specification of the wireless repeater.

12. Network topology

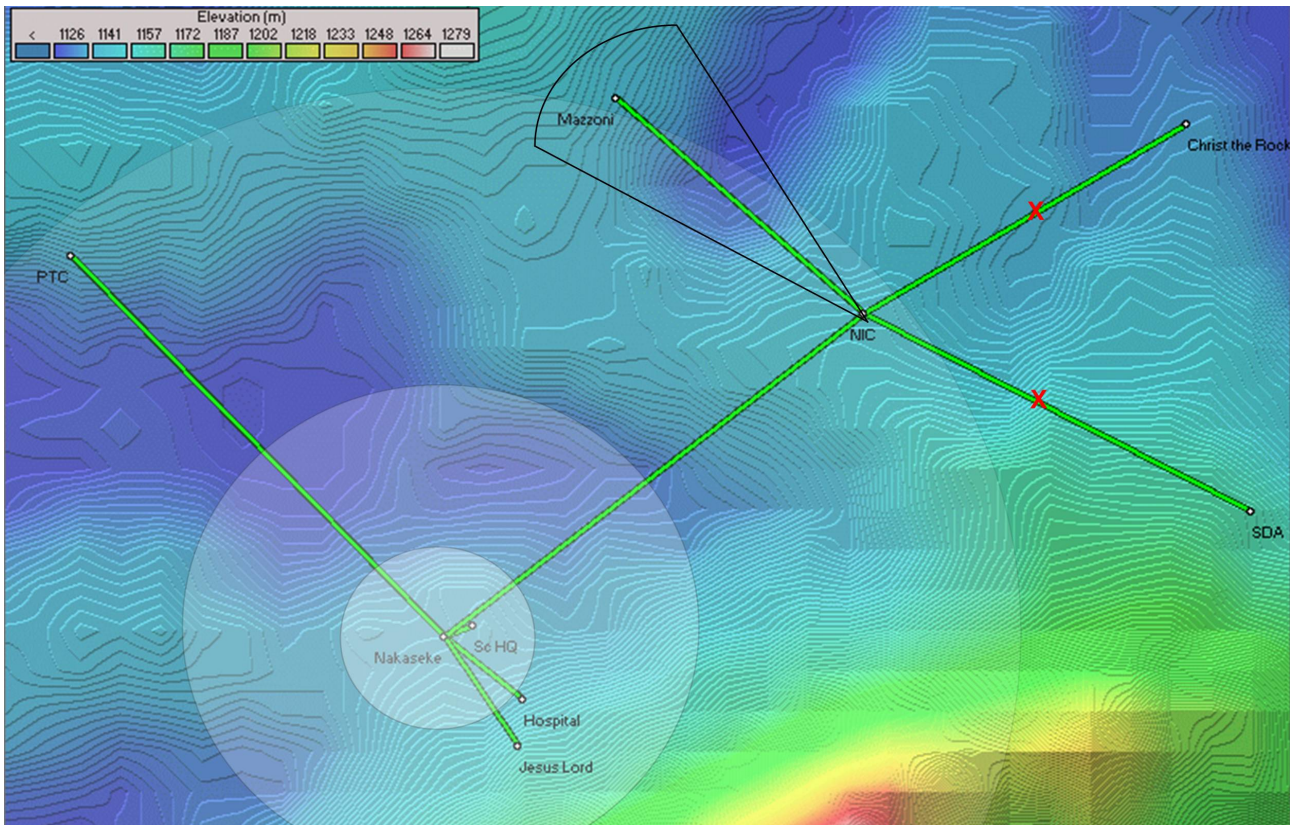


Image 2: Network topology of the Wireless network of Nakaseke. An omni-directional antenna placed in the central tower at Nakaseke Telecentre will provide toroidal coverage to its surrounding partners. A sectoral antenna placed in NIC will give coverage to Mazzolid.

| Site 1 | Site 2 | Distance [m] | Fresnel zone [5m] | Fresnel zone [10m] |
|------------|-----------------------|--------------|-------------------|--------------------|
| Telecentre | Sc HQ | 70 | 6.5 | |
| Telecentre | Hospital | 230 | 4.4 | |
| Telecentre | Jesus is Lord Complex | 300 | 4.4 | |
| Telecentre | PTC | 1200 | 3.2 | |
| Telecentre | NIC | 1200 | 2.4 | |
| NIC | Mazzolid | 750 | 3.2 | |
| NIC | SDA | 1000 | 0.9* | 1.7 |
| NIC | Christ is Rock | 860 | 1.8** | 2.4 |

Table 4: The table shows the distance of each link in the network and the worst Fresnel zones for a client height of 5 respectively 10m.

* A clear Fresnel zone of at least 1.0 is required for a functional link. The sites with lower values than 1.0 will require a higher mast.

** Although the simulation shows that Christ the Rock could be connected to NIC with a mast of 5m, reality looks different. Due to thick vegetation and buildings between the two sites, Christ the Rock will most likely need a 10m tower to achieve line-of-sight to the water tower.

13. Hardware Budget

The table below shows an estimated hardware budget for the Nakaseke Wireless network. The fields marked in yellow specifies equipment that should be procured locally in Uganda. The grey fields shows equipment that will be procured in Sweden and shipped to Uganda.

| Equipment | Specification | TC | SCHQ | NH | JLC | PTC | NIC | MZ | Total | Price |
|------------------------------|-----------------------|-----|------|----|-----|-----|-----|----|-------|-------|
| AirPoint NEXUS PRO TOTAL | Outdoor, SmartBridges | 1 | | | | | | | 1 | 1440 |
| WPP54AG, 8.5 dBi | Outdoor, Compex | | | | | | 2 | | 2 | 610 |
| WPP54AG, no antenna | Outdoor, Compex | | | | | | | | | |
| WP54G | Indoor, Compex | | | 1 | 1 | 1 | | 1 | 4 | 392 |
| RF cable, 1m | N-male N-male | 1 | | | | | | | 1 | 30 |
| RF cable, 1m | RP-SMA male/N-male | | | | | | | | | |
| RF cable, 7m | RP-SMA male/SMA-male | | | 1 | | 1 | | 1 | 3 | 150 |
| RF cable, 5m | RP-SMA male/SMA-male | | | | 1 | | | | 1 | 40 |
| Antenna, omni, 12 dBi | N-female | 1 | | | | | | | 1 | 125 |
| Antenna, panel, 9 dBi | SMA female | | | 1 | 1 | 1 | | 1 | 4 | 204 |
| Surge arrestor (panel 9dBi) | SMA-male SMA-female | | | 1 | 1 | 1 | | 1 | 4 | 60 |
| Surge arrestor (omni 12 dBi) | N-male N-female | 1 | | | | | | | 1 | 15 |
| 8-port switch | Compex | | 1 | 1 | 1 | | 1 | 1 | 5 | 136 |
| 8-port switch | Other brand | 1 | | | | | | | 1 | 89 |
| Mounting pole | 5m | | | 1 | | 1 | | 1 | 3 | 90 |
| Mounting pole | 2,5m | | | | 1 | | 1 | | 2 | 30 |
| Mounting pole | 1m | | | | | | | | | |
| Brackets | L -bracket | 1 | | | | | | | 1 | 10 |
| Brackets | hose clamps | 4 | | 2 | 2 | 2 | 4 | | 14 | 7 |
| Brackets | wall mount | | | ? | 1 | 1 | | 1 | 3 | 30 |
| UPS | 400 VA | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 7 | 1,540 |
| Cat 5e indoor [m] | | | 300 | | | | 300 | | 600 | 498 |
| Cat 5e outdoor [m] | | 100 | | 3 | 3 | 20 | | 3 | 129 | 194 |
| PCV conduct [m] | | | 100 | | | | 100 | | 200 | 500 |

TOTAL: 6,190

Table 5: Hardware budget for the Nakaseke Wireless Network.

14. Way forward

The main issue of the Nakaseke implementation is to get permission to use the tower owned by UTL. This issue must be taken care of immediately as the implementation is fully depending on having access to that tower.

While the CWRC are awaiting the delivery of technical equipment from Sweden, an additional site survey should be done to determine the exact location of the implementations at Mazzolid and Jesus is Lord Complex.

Furthermore, it should be investigated what kind of mounting equipment is needed for the water tower at Nakaseke International College School and Nakaseke Hospital.