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Village Telco

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Submission date: March 2014
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Abstract

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Introduction

1.1 Motivation

Village Telco is an organization that aims to provide affordable communication in forms of data and voice services where no other companies can, or are willing to do so. Village Telco provides a "plug-and-play" solution with low cost voice and data service. While designed for the developing world, Village Telco's solution can be applied anywhere where people wish to take control of their own telephone infrastructure.

This solution is delivered using an inexpensive fixed mesh WiFi delivery system called the Mesh Potato. The Mesh Potato unit is based on the open-source operating system, OpenWRT. Open Source telephony software combined with the latest wireless networking technology creates the potential for people to operate their own community phone systems. Mesh Potato networks have no dependence on existing telecom infrastructure, and can relatively easily be deployed anywhere in the world. It can either be deployed as a stand-alone solution or as an extension to existing technologies. Village Telco's solution has been deployed in several countries around the world: from East-Timor and Nepal in Asia to several African and South America countries. The installed bases vary from 10 to several hundreds of Mesh Potatoes.

As of now the Mesh Potato has mainly been permanently deployed in small villages where the existing telecommunication systems are limited, non existent or too expensive. There are many scenarios where there is need for a solution that easily and fast can provide people with telephone communication and Internet, both within a community, and with the outside world. These scenarios span from natural disasters, post-conflict situations, temporary refugee camps and IDP camps, to the use at festivals, when a mobile tower is non-functioning, or during a blackout.

Our idea is to make an "emergency box" that consist of a Mesh Potato, a telephone, rechargeable battery, on/off switch and a solar panel to charge the battery. All this will be contained inside a robust and waterproof suitcase. All packed together and

ready to go in any situation, at any time, anywhere in the world.

Our main focus is to provide the people with Internet access, it is crucial to have the possibility to communicate with the outside world during an emergency situation. In order to get Internet into the mesh network formed by the Mesh Potatoes, at least one of the Mesh Potatoes must be connected to an access network. Which type of access network that is available depends on the location. Some places there might exist stable landlines, other places not. Then an option could be to use satellite or cellular networks.

We hope to expand the potential of the Mesh Potato through our portable solution. We want to make it quick and easy to deploy, thus making it more useable in emergency situations. This does not only benefit the locals, but also makes the job easier for relief organizations. We want to provide communication where there are none, and believe that with the "emergency box" time would be spared and lives can be saved.

1.2 Problem Description

Village Telco is an organization that aims to provide affordable communication in forms of data and voice services where no other companies can, or are willing to do so. Village Telco provides a "plug-and-play" solution with low cost voice and data service. While designed for the developing world, Village Telco's solution can be applied anywhere where people wish to take control of their own telephone infrastructure.

This solution is delivered using an inexpensive fixed mesh WiFi delivery system called the Mesh Potato. The MeshPotato unit is based on the open-source operating system, OpenWRT. Open Source telephony software combined with the latest wireless networking technology creates the potential for people to operate their own community phone systems. Mesh Potato networks have no dependence on existing telecom infrastructure, and can relatively easily be deployed anywhere in the world. It can either be deployed as a stand-alone solution or as an extension to existing technologies. Village Telco's solution has been deployed in several countries around the world: from East-Timor and Nepal in Asia to several African and South America countries. The installed bases vary from 10 to several hundreds of Mesh Potatoes.

An area that has not been fully explored is the use of Mesh Potatoes in emergency situations, like natural disasters, post-conflict situations, etc. Another area to be considered is the use of Mesh Potatoes in refugee camps, where many people quickly gather in a new location. In both situations, the need for communication is essential. Key factors of usage are quick roll-out and usability. Easy to use communication is extremely important in crisis situations, both communication within the camp and

outgoing communication with the rest of the world. It is important that all affected have easy access to helpful information, as this could mean the difference between life and death in some situations. In refugee camps with thousands of people, registering and reuniting people can be a difficult task to solve. Communication technology, like the Mesh Potato, could be revolutionary in situations like these.

We will look into how communication is handled by Norwegian emergency relief organizations today, what tools they are using, and if their way of communication could be improved with the Mesh Potato. In addition to this, we will look into other existing tools, and explore the possibilities to combine them with the Mesh Potato for a better product.

Research questions - How can the Mesh Potato be used in an emergency situation like a natural disaster?

- How can an emergency box be developed?

- How is the situation, and what are the needs when it comes to communication after a natural disaster?

1.3 Methodology

1.4 Limitations

- Time -

Chapter 2
Background

2.1 Village Telco

2.2 Mesh Potato

The Village Telco concept was developed in June 2008 during a workshop at the Shuttleworth Foundation. The main goal was to figure out how to develop an inexpensive system to provide rural and under-served areas with affordable telephone communication [3]. The workshop included participants like open hardware pioneer Dawid Rowe, and Elektra, the developer of B.A.T.M.A.N. [4]. The purpose of the workshop was to develop a business model, as well as a prototype for a Village Telco. Initially the idea was to use low cost VoIP headsets. At that time it was the most viable and convenient way to deliver telephone services to the customers. The wireless VoIP telephones have small antennas, which became a problem. The nodes could not be more than 100 meters away from each other in order to have a reliable connection. This required more nodes in order to cover the desirable area. This factor drastically increased the start-up costs for a village. In order to keep the cost down, it was also important to keep the number of access points (APs) down. A mesh network has a larger range, and one suggestion was to use a small mesh device like an Open Mesh AP and connect a SIP phone to it. This solution would solve a lot of the problems regarding range, antenna and number of access points, but the idea was still an expensive option. The challenge was to create something that would be simple enough to be configured and scaled by local entrepreneurs with limited technical skills. In addition to this it was important to keep the cost down. The two key cost factors that emerged in the scale-up of a Village Telco were the cost of the customer's phone and the power supply. It was clear that the power supply was the most important factor, and that they had to look at other, and cheaper options regarding the customers phones [4]. During the debating, Rael Lissoos took an Analogue Telephone Adapter (ATA) and an Open Mesh AP, held them together and said *"we need these two devices in one"*. This point was the birth

of the Mesh Potato, fully based on customized open hardware and open software design. The name "Mesh Potato" comes from combining the words mesh, POTS (Plain Old Telephone) and ATA. "Patata" is the Spanish word for potato, and hence the name Mesh Potato. The Mesh Potato is a mesh enabled Wi-Fi device, with the possibility to connect any inexpensive regular phone and IP device. [5]

The first generation of the Mesh Potato is shown in Figure 2.1. This device is designed to be used in rural areas. It can be deployed and run anywhere in the world, relying only on a low, but stable, power supply. The Ethernet port, the Foreign eXchange Station (FXS) ports and the power port are robust and designed in order to handle all weather conditions, poor power conditions, lightening and static electricity. In addition to this, the Mesh Potato comes in a waterproof box for outdoor mounting [6].

The Mesh Potato combines the features of a 802.11bg Wi-Fi router with an Analogue Telephone Adaptor (ATA) [7]. The ATA converts the signal from a standard telephone, into the digital signal needed to connect to the Internet and use the SIP protocol [3]. The device is based on the Atheros chipset that is used by OpenMesh, and runs OpenWrt (see section 2.3.1 for more information) and B.A.T.M.A.N. (see section 2.3.5 for more information). Each Mesh Potato provides a single fixed telephone line to the end user. The MPs are connected together via a mesh Wi-Fi network, and configure themselves automatically to form a peer-to-peer network, greatly extending the range of the network over regular Wi-Fi. This enables the phone calls to be made independent of landlines and telephone towers, and creates the basis for the "plug-and-play" solution.

As mentioned, the Mesh Potato is open and based on open hardware, as well as open software design. Everything is kept open in order for any third party to test,

Figure 2.1: The first generation Mesh Potato, MP01.

set standards, and give feedback. Key goals during the development was to minimize the binary blobs (a closed source binary-only driver that has no publicly available source code [8]), minimize closed software and make the hardware open.

The mesh network can be connected via a backbone link to the rest of the world by using VoIP gateways. No cell phone towers, no land lines, and no telecommunication companies are required. A Village Telco is a community owned telephone service, allowing a local entrepreneur to roll out the Village Telco system only needing a server and the wanted amount of Mesh Potatoes. The mesh network is self-healing and self-organizing, meaning if one node goes down, B.A.T.M.A.N. routes the calls through other available nodes in the network [9]. In order to provide internet access, a super node has to be placed in connection with an internet connection. The internet signal enters the server in the Village Telco, this could for example be an existing internet café, with a broadband, link or satellite connection. The signal is transmitted to the super node. The super node consists of three external access points, and is placed high over ground, giving 360 degree coverage, with approximately 1 km range. The internet signal is then carried through the network from one Mesh Potato to another.

Mesh Potato 2.0

The first generation of the Mesh Potato has sold over 2500 copies, and is deployed all over the world. In order to keep up with time, the constant technical development and the demand from the users, a new version of the Mesh Potato was introduced. The second generation became available to users August 2013. This device comes in a smaller box, as shown in Figure 2.2, and is sold to half the price of the first generation. One of the biggest differences is that the second generation has two Ethernet ports and is built on a new, and faster, chipset. It is also operating on new firmware.

Figure 2.2: The second generation Mesh Potato, MP2.

Difference between MP01 and MP02?

Example Mesh network

An example of how to set up a simple network is shown in Figure 2.3. The network consists of two regular telephones connected to each their Mesh Potato. The MP devices has been assigned static IP addresses, these addresses are not part of the LAN address space. The IP addresses are allocated in a predefined default address space 10.130.1.xxx. To administrate the MP devices one can use a workstation linked together with any of the MPs in the network (either by using a Ethernet cable or Wi-Fi). This workstation must be assigned a static address within the same address space as the MP devices. Phone calls may be done between the Mesh Potatoes by dialling the last octet or the whole IP address. See the user guide in Appendix for a more detailed description of how to set up the Mesh Potatoes and how different networks can be built.

2.3 Relevant Technologies

In this section we will go through some of the most relevant technologies used to develop and run the Mesh Potatoes. In order to understand how the Mesh Potato works, it is important to have a certain knowledge about the underlying technology.

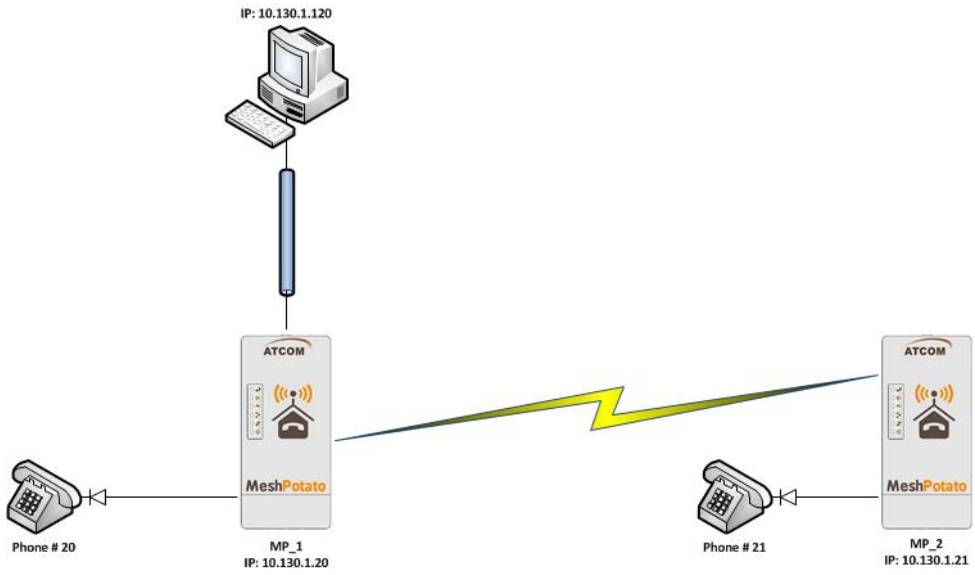


Figure 2.3: Simple mesh network. This figure illustrates a simple mesh network with the use of Mesh Potatoes.

2.3.1 OpenWrt

OpenWrt is an embedded open-source operating system for routers distributed by Linux [10]. It is extensible and can easily be modified to suit any application, since it offers a file system with a package manager. OpenWrt provides (1) Free and open-source, (2) Easy and free access, and are (3) Community Driven [10]. This means that the source code is free and available to everyone, and that everyone has the opportunity to contribute to it.

2.3.2 Mobile Ad Hoc Networks

Mobile ad hoc networks (MANETs) are networks that do not rely on an underlying and fixed infrastructure (access points and routers), in other words "infrastructure-less". MANETs acts in a shared wireless media [12]. The structure of these networks change dynamically, and key factors describing MANETs is self-configuration, self-organization, self-discovery, and self-healing [13]. The members of the network are mobile and are free to join or leave the network at any time [11], and therefore these factors are important. MANETs are based on multi-hop forwarding. Each node acts not only as a host, but also as a router. The nodes themselves establish and maintain routes, and forward packets to other nodes if necessary. This enables communication between nodes that are originally not within each other's range [11]. MANETs are suited for use in situations where there is no fixed underlying infrastructure. A MANET can operate as a stand-alone solution, but can also be attached to the Internet. This makes room for numerous of services.

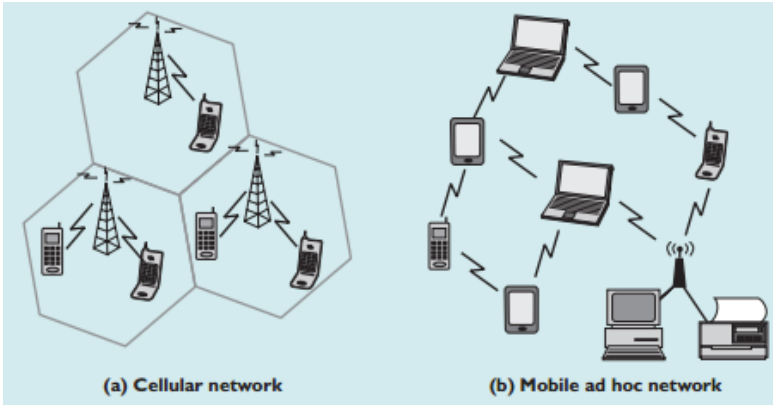


Figure 2.4: Cellular network vs. MANET. This figure illustrates the difference between a regular cellular network and a mobile ad hoc network [11].

2.3.3 Wireless Mesh Networks

A wireless mesh network (WMN) is a type of MANET [13]. The objective of a WMN is to serve a larger number of users with high bandwidth access. As mentioned before, MANETs are "infrastructure-less" and they have self-configuration, self-organizing, self-healing and self-discovering features. WMNs share all these characteristics, except from the infrastructure part. WMNs, on the contrary to MANETs, are often a collection of routers called mesh routers (MRs). These MRs are usually stationary. The MRs can be employed for different use. One MR could for example be connected via cable to Internet, and then become a Internet gateway. Then this MR can provide Internet connectivity to the other MRs in the mesh network. A wireless mesh network consists of two parts [13]; the backbone of the mesh (the MRs) and the clients of the mesh. An example of a WMN architecture is shown in Figure 2.5.

2.3.4 Routing Protocols

Ad hoc networks and mesh networks creates several challenges when it comes to routing protocols. The routing protocols must be able to adapt quickly due to the topology changes. Figure 2.6 shows the different groups of the ad hoc protocols that exist. It is important that a routing protocol do not cause excessive overhead (extensive use of computer resources). Under the category flat routing, there are two types of routing protocols; proactive and reactive. *Proactive routing protocols*

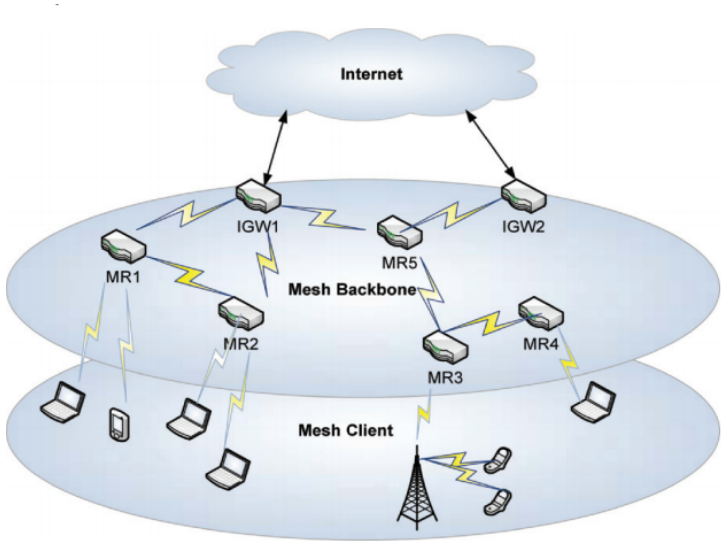


Figure 2.5: Example of a Wireless Mesh Network. This figure illustrates the architecture of a typical WMN [13].

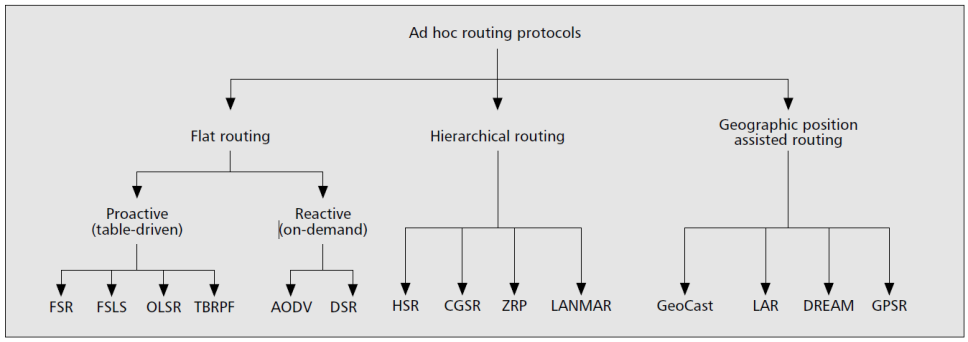


Figure 2.6: Different groups of ad hoc routing protocols [12].

(e.g. OLSR) are table driven [14]. Every network node has a routing table for the forwarding of data. To obtain stability, each node broadcasts and modifies the routing table periodically. Proactive routing protocols are suitable when there are few nodes in the network. The routing table is periodically updated, hence the overhead exceeds the desired value when there are a high number of nodes in the network. In contrary to the proactive routing protocols, *reactive routing protocols* (e.g. AODV) are on demand. Since they are on demand, the overhead is significantly lower. These protocols utilize flooding. The network is flooded with the route request (RREQ) in order to set up the route. The reactive routing protocols do not have a up-to-date routing table like proactive routing protocols [14]. Routes are only set up to nodes they communicate with, and these routes are only kept alive while they are needed [11]. As shown in Figure 2.6, there are several different protocols under proactive and reactive.

2.3.5 B.A.T.M.A.N

Better Approach To Mobile Adhoc Networking (B.A.T.M.A.N) is the routing protocol utilized in the networks formed by the Mesh Potatoes. B.A.T.M.A.N is a proactive routing protocol for wireless ad hoc networks. This includes MANETs [15]. This protocol was developed as an alternative to OLSR (Optimized Link State Routing) [16]. Like mentioned before, routing protocols must be able to adapt quickly to topology changes. B.A.T.M.A.N was made to be a more efficient routing protocol in this area, since it employs a new method for discovering routes. The nodes in the network broadcasts a OGM periodically, like shown in Figure 2.7. A OGM is a Originator Message which contains:

- The address of the node
- Sequence number

– TTL (Time to live)

The address and the sequence number enables identification of a packet and duplicate detection.

Information about the nodes that are accessible via single-hop or multi-hop are maintained and updated [15]. Every node updates its routing table each time it receives an OGM. The routing table includes information about [16]:

– **Originator Address:** This is the source address of the node that sent the OGM.

– **Current Sequence Number:** The sequence number of the last OGM. This is used to discover if there are any duplicates or any information that is outdated.

– **Sliding Window:** A list of sequence numbers that is stored for each originator and each previous hop, i.e. for the neighbour node that forwarded or originated the OGM, as shown in Figure 2.7. This is used to decide which next hop is best for each destination.

When a node receives an OGM it will decrease the TTL, and then forward it to the neighbour nodes. The same OGM can arrive to a node, but from different paths. In this case, only the first copy is preserved.

RO.B.IN

RO.B.IN (Routing Batman Inside) uses the B.A.T.M.A.N routing algorithm. It is a project based on open source, and is intended for wireless mesh networks. It runs on Atheros AP51 routers running OpenWrt. RO.B.IN has the ability to spread wired internet (e.g. DSL) throughout a specific area, for example a village or a school [17].

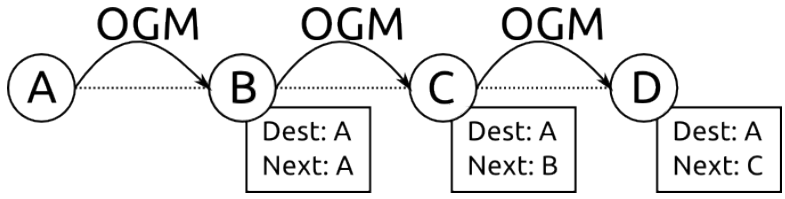


Figure 2.7: Originator Message used in B.A.T.M.A.N [16].

Simple Unified Dashboard for mesh networks

Simple Unified Dashboard (SPUD) for mesh networks is a tool for visualization made for B.A.T.M.A.N mesh networks, and for the users of the networks [18]. The Simple Unified Dashboard is, like the name insinuates, a dashboard based on PHP which is designed to be simple. It communicates with the B.A.T.M.A.N visualization server. The dashboard makes it possible to monitor the link status of the networks, by displaying real time wireless link status. Other features are client management and customization. The software is written in CakePHP and for visualization SPUD uses Google Maps API 1.3 [18].

2.4 The Cost Structure and Revenue Model(s) of Village Telco Today

2.5 Comparison of Village Telco and other Telecommunication Companies

Chapter 3
Refugees and IDPs

Our initial approach for the report was to look into refugee camps, with the focus on Norwegian relief organizations. The aim was to get an understanding of how refugee camps are run and how the communication is both within the camp and to the outside world. We wanted to look into how the Mesh Potatoes could be utilized to better the communication. We conducted some research trying to get an overview and general understanding. In addition we carried out interviews with people form Norwegian organizations namely Care and the Norwegian Refuge Council. This gave us more information and understanding on the area, but also showed us that refugee camps is an extremely large area, and the differences in the unique camps are huge depending on country and government law, size of the camp, lifetime of the camp, etc. In some countries the Internet and GSM infrastructure is well established, and people have smartphones and laptops. While in other countries this is far from the case, and their only way of receiving news is buy radio or mostly by word of mouth. Some camps are under strong technological restriction because of country law.

The differences are so big it is hard to find general information, simply because there are no general information. No camp are the same, no situation can be compared to each other. Which made it hard to decide in what direction to focus. A research, as the one first intended, would require a close collaboration with a relief organization to give full proceeds both to us and the research we are conducting on behalf of Village Telco. It was also difficult to create a stable connection and collaboration with one of the Norwegian help organizations. A collaboration like this would require a lot more time than what we have a disposal.

During our research and work in the first months we could see our report had to go in a different direction. The area became to big to get a grip on. We decided to direct out focus onto natural disasters, and the how a emergency box can be used to quickly get internet access and in that way coordinate help, more on this in chapter 4. This chapter contains the research we have done on refugee camps. We will go through some general statistics to get an idea of the life in the camps and the

development the over the last years, and summaries of the interviews with Care and Norwegian Refugee Council.

We therefore chose to co-operate with a smaller organization called Making Change. Making Change is a non profit relief organization where military veterans can use their experience to make a change somewhere in the world.

3.1 Definitions

It is fairy common to think of every person that is displaced as a refugee, but this is not the case. It is important to separate between a refugee and and internally displaced person.

Refugee. The definition of a refugee is a person who have been forced to leave their home country because of war, violence or persecution. A refugee often has a justifiable fear of persecution for reasons as religion, political opinion, race, nationality or membership in a certain social group. For these reasons they are not able to, or afraid to return to their home country. The leading reasons for refugees fleeing their home country is war and ethnic, religious and tribal violence [19].

Internally Displaced Person. An internally displaced person (IDP) is a person that has been forced to leave their home and village for some reason and are a refugee in its own country. The man distinction between an IDP and a refugee is that the person has not crossed any country borders. Unlike refugees, the IDPs are not protected by any international laws nor are able to receive many types aids. in the last years the number of IDPs have drastically increased, mostly due to the conflicts between countries [19].

A stateless person is someone who does not have citizenship in any country. A citizenship is a legal bond between an individual and the government in that country.

3.2 Statistics

We have looked at some of the refugee statistics presented by UNHCR from 2010 and 2012. The following section will enlighten some of their findings.

In 2010 the majority of the refugees came from Afghanistan, Iraq and Somalia [1]. In both 2010 and 2012 Pakistan was the country which hosted the most refugees. By the end of 2012 45.2 million people were displaced by force. According to UNHCR is this the largest number in 20 years. The report for 2012 show that 55 % of the registered refugees came from countries affected by war as Syria, Afghanistan, Sudan, Iraq and Somalia. The crisis in Syria has been a major factor to displacement, the

whole of 647,000 people have be forced out of the country [2]. Table 3.1 shows the drastic increase of Syrian refugees from 2010 to 2012.

An observation made is that the number of Somali refugees has increased for 770,154 refugees in 2010 to 1,136,100 refugees in 2012. There has been an ongoing conflict in Somalia ever since the Siade Barre regime collapsed in 1991. Since 1991, many Somalis have been displaced. The number of displaced persons have gone in waves. In 2011-2012 there was a famine in Somalia, and this caused not only many deaths, but the displacement of many humans [20]. This is one of the reasons for the increase of Somali refugees from 2010 to 2012.

In contrary to the increase of Somali refugees between 2010 and 2012, the number of Iraqi refugees had decreased from 1,683,579 refugees in 2010 to 746,400 refugees in 2012. Before the Syrian civil war started in 2011, there were many Iraqi refugees who had fled to Syria due to the invasion led by the U.S. When the Syrian civil war began, the situation reversed. Many Syrian people sought shelter in Iraq, and many of the Iraqi refugees returned to their homeland. This is one reason for the drastic decrease of Iraqi refugees from 2010 to 2012. Although many Iraqi refugees went back to Iraq, they remain displaced. This situation have brought the number of Iraqi IDPs up to approximately 2.8 million [21].

Table 3.1: Refugee statistics - Comparing 2010 and 2012 [1, 2]

Information	**2010**	**2012**
Number of people forcibly displaced worldwide	43.7 million	45.2 million
Number of refugees from Afghanistan	3,054,709	2,585,600
Number of refugees from Somalia	770,154	1,136,100
Number of refugees from Iraq	1,683,579	746,400
Number of refugees from Syria	18,452	728,500
Number of refugees hosted by Pakistan	1,900,621	1,638,500
Percentage of refugees that are female	47%	48%
Percentage of refugees that are children (below 18)	47%	46%
Number of individual asylum applications lodged by unaccompanied or separated children	15,500	21,300

3.3 Interview with CARE - Dadaab Refugee Camp

We got in contact with Mary Muia from CARE. She is a program assistant at CARE International in Dadaab, Kenya. We sent her a questionnaire with questions

about Dadaab refugee camp, with focus on means of communication. The following paragraphs contains information both from different articles referred to in the text, and from the answers from the questionnaire. See Appendix A for the full questionnaire. Dadaab is the largest refugee camp in the world, and is located in Daadaab, Kenya [22]. It was created in 1991 [23]. Dadaab was created by the government of Kenya and UNHCR to host Somali refugees displaced by civil war. Over the years, the camps have also hosted other nationalities, from the Horn of Africa, the Great Lakes and East African regions. These people constitute less than two percent of the camp population. In April, 2013, there were 423,496 registered refugees in the Dadaab camps. 51 % of these were female and 58 % were younger than 18 years old. Also in 2013, UNHCR and its partners decided to conduct a verification exercise to ascertain the current population. The reason for this was that many of those who had arrived in 2011 due to the famine had returned home. As of February, 2014, the current population stands at 369,294. The lead agency for this camp is the UN High Commission for Refugees (UNHCR) [22]. In addition to UNHCR, major international humanitarian agencies like Care, Save the Children and the International Rescue Committee are active helpers in the Dadaab refugee camp. These agencies provide the refugees with critical services (e.g. food, housing, sanitation and medical help). This is an extremely challenging task in refugee camps, especially when they reach this size. During the recent years, the terror group Al Shabaad (Somali-based) have intensified their misdeeds in and around the Dadaab refugee camps. This has made the situation even tougher for the refugees and the relief agencies. Muia stated that the biggest challenges in the camps are lack of enough space to accommodate everyone, and lack of enough funds to take care of all the needs of the refugees. Another challenge is the language barrier between the humanitarian staff and the refugees. Many of the staff members neither speak nor understand the Somali language, and as many as 95.6% of the refugees are Somali.

Muia explains how the registration process is handled; When a new refugee enters the camp, the refugee reports to a UNHCR reception desk. There the refugee is given a temporary registration, while pending full registration. Upon arrival, the refugees are given information about available services, and which agency is handling what service. Immunizations, medical attention, emergency food supply, tarpaulins, sleeping mats, jerrycans for fetching water and kitchen sets are issued to new arrivals. This is to help them start their new lives in the camp.

To improve the situation in Dadaab, communication is crucial. In 2011, a group consisting of people from NetHope, Inveneo and the USAID Global Broadband and Innovations Program gathered to discuss ways to improve the means of communication in Dadaab [22]. NetHope is a consortium of over 30 international Non-Governmental Organizations (NGOs) [24]. NetHope works with improving connectivity, with the help of information technology, among relief agencies. The aim of this project, called

DadaabConnect, was to bring forward more reliable Internet, and find ways for agencies to communicate better internally [22]. The group put together teams that travelled to Kenya to investigate the conditions in the refugee camps, and to find out what they could implement. It was clear from the feedback they got that a better communication system was needed, and that it would make the humanitarian work much easier. It would improve the coordination and the security in the camps. Improvements of these aspects gives the humanitarian agencies better working conditions, and makes it easier for them to help the refugees with critical services. Inveneo started working with Cisco's Tactical Operations (TacOps) to install and configure a local high-speed network [25]. They also entered a partnership with a local Kenyan mobile and landline telecommunications service provider called Orange. The reason for this was that they wanted to extend the Dadaab compound with new data services. This could be done by using Inveneo's long-distance Wi-Fi solutions. The data services that were added included services requested from the Dadaab aid community. "DadaabNet", a high-speed network, was created in cooperation between Inveneo and TacOps. This network connected the NGOs locally, and made it possible for the agencies to easier communicate internally (VoIP telephony, file sharing etc.). Following this, in March 2012, they started the training of technicians. These technicians were people from Orange, from the technical staff of the NGOs and from Inveneo's staff. The training took place both in classrooms and in the field, in order to give the technicians a wide understanding. The results from DadaabConnect has been great. The humanitarian agencies has gotten better working conditions, due to the improvements in means of communication. Other positive outcomes is that the network is more reliable and cost effective.

Muia did not specifically mention this project in her answers, but answers on our questions about means of communication within the camp, and with the outside world. She states that CARE as an organization has invested in communication systems in cooperation with ISPs in the capital city of Kenya, Nairobi. Through this cooperation the camp staff are assured to get access to Internet for both official and social use. Several Kenyan telecommunication companies have put up equipment in the camp area, and the camps are therefore provided with access to mobile communication and Internet. Although this is set up, Internet and telephone service outages are fairly common. In addition to mobile communication and Internet, there are radio station services and access to digital television. CARE use telephone services to reach out to refugee staff. 50% of the refugees have access to mobile phone services. Posters and radio are also used to reach out. Word by mouth (e.g. over speakers) is also a communication technique employed. There are two main telecommunication providers in Dadaad, hence little competition. This makes the prices higher. We asked Muia how the refugees can afford having their own mobile phone, when the costs are high. She says that many refugees have been in the camps for a long time, and therefore have had the time to establish small businesses which gives them some

profit. While others get money sent from their relatives.

3.4 Interview with Norwegian Refugee Council

We had a Skype interview March 12, 2014, with Katrine Wold from the Norwegian Refugee Council (NRC). The aim of the interview was to hear a little bit about her work in refugee camps and how the situation in the refugee camps are today, with main focus on means of communication. Katrine Wold has been working for NRC for many years, and also has a background from United Nations (UN). She has worked in emergency and crisis situations abroad. She is specialized in camp management and coordination. In recent years she has been responsible for education, and have had the main focus on youth. We asked her which refugee camps NRC is working in, but she could not give us a clear answer on that question. The reason for this is that NRC works in over 24 countries, and have, as of 2013, reached out to 4.4 million people. She makes it clear that there is a difference between internally displaced persons (IDPs) and refugees. An official refugee must cross a boarder, or else you are internally displaced. NRC works both with refugees and IDPs, and also with people who are affected by having refugees in their local area. NRC does not only help with operational issues in the camps, but they mainly offer services the refugees need. When dealing with refugees there exists international laws and regulations. These also states what kind of human rights exists. Everyone have rights! The vast majority of countries have ratified the UN refugee commission, which has been formed by the international society, UN, and authorities via UN's forums. The commission is an important premise when working with refugees. It is important to know which rights you have as a humanitarian worker, and which rights the refugees have.

We ask her about how communication within the camp is conducted. She takes Kenya as an example. NRC has been working in the largest refugee camp in the world, Dadaab Kenya, for many years. Some have the main responsibility for what is going on in the camp, and that is the authorities. They often ask the international community (e.g. NRC) for help. Wold states that it is then important to establish a good communication and information flow between the ones working in the camp (the different organizations). This communication takes places by either establishing coordination meetings and by other types of mechanisms. These meetings includes the relief organizations working in the camp, and the authorities. The goal is not to make a permanent home for the refugees, but that it is safe when they are in the camps and that they move on (either go home or find another place to live). Living in camps is a temporary life situation. She states the different types of communication; internally between the workers in the camp and communication with the refugees. It is important to establish open transparent coordination mechanisms, in other words ensure good forums where the refugees can communicate and inform the workers in the camp what their needs are. This can only be achieved by recognizing that

refugees is not a large mass, but individuals with different needs and different life situations. The humanitarian and authorities try to establish some sort of local elections. This means that the refugees can choose representatives who's job is to be in communication with the primary humanitarian managers in the camp. The reason for this is that it is impossible for the humanitarians to talk to 500 000 people. The communication between the representatives and the managers be done either through meetings, or in an informal manner. Overall, this creates a communication pattern in the refugee camps. Wold states that there a few places without mobile coverage, and that the majority of the refugees have a mobile phone. Mobile phones are used frequently in terms of distribution. Mobile phones are often used as a tool when goods (access to money, food etc.) gets distributed to the refugees. They can "add credit" to their card, and use this as "payment". This an up-and-coming way of doing distribution. Mobile phones are also used to collect information, for example by sending the refugees surveys on their mobile phone.

In general, Wold states that methods of communication can be via mouth, radio, billboards, data communication, but this all depends on which camp and what is allowed in the camp. The law in the refugee camps depends on the national authorities. In some camps it is allowed to establish a data communication center, but in other camps this is illegal. It is important that when the refugees arrive to a camp that they get informed of the current situation, and what rights they have. The distribution of this information takes places primary by someone called the camp management agency. They have the daily coordination responsibility for what is going to take place in the camp. It must be made clear to the refugees where they can obtain different types of services, and also what is expected of the refugees. It is important that the refugees at an early stage get the opportunity to contribute positively in the camp, or else they can end up with something called "dependency syndrome" (they feel incompetent and get totally dependent on external assistance).

Another question we asked her is how the refugees get registered in the camps. Here she states the importance of distinguishing between official and unofficial camps. The definition of a camp is that people are gathered together and live there. Registration is done in official camps, and then there are someone who is responsible for the operation of the camp. When refugees are registered they get an ID card. This ID card is very valuable, because it indicates that you, as a refugee, have access to the goods that are available in the camp. The registration procedures can vary, but most often there exists computer systems for the registration.

3.5 Life in Camps for Refugee Women

In this section we will shortly present some answers found in research done by Mari Maasilta, a Swedish post doctoral researcher, most relevant to our assignment. She

have looked at the use of oral and mediated communication by women living in refugee camps in Eastern-Africa.

Women are in general in a more vulnerable position when living in a camp, especially if they are single mothers. They may be solely responsible for taking care of the children in addition to sick and elderly family members, maintaining the household, preparing food, acquire water, and securing firewood. Collecting firewood for cooking is a necessity, but it forces women to walk far away, hence making them vulnerable for sexual assault. they have to turn to sex and other unhealthy and dangerous means in order to survive [26].

The means of communication vary greatly in the different camps. Some have internet connection and satellite TV, other barely have access to a radio. Even though radios are the most common media for communication, it is not given that all citizens in a camp have access to one. Often people would gather around the few radios that exists in a camp. One issue that limits the usage is the batteries. They are very expensive and hard to acquire. The women were interested in news regarding their place of origin. The use of cell phones are increasing. Even though the prises are extremely high it does not stop people from calling relatives in Europe and other places in the world [26].

Information walls and word of mouth is often used in order to spread practical information within the camp and about camp activities. Word of mouth is also used in order to retrieve information about the world outside the camp. People visiting the camp were used as sources for information. Earlier studies have shown that social connections with neighbours works as an important medium to transport information, resources and services between individuals. These kind of networking have been used to find lost family members in big camps, as well as get financial help from abroad [26].

Chapter 4
Main Work

Make a best practice for quick roll out, by the use of a MultiBox.

4.1 Set-up of the Mesh Potatoes

4.2 The Emergency Box

Table 4.1: The components of MultiBox

Component	Description and purpose
Mesh Potato	
Suitcase/box	
Power supply	
Plain old telephone	
Junction box	
Solar panel	
Solar panel regulator	

4.3 Up-Link

Our main focus when deploying the emergency boxes, is to provide Internet to the mesh network. This is because it is crucial to have the possibility to communicate with the local community and the outside world during an emergency situation. In 2011, UN declared Internet access a Human Right [27]. This says something about the extent of the Internet, and the importance of connectivity. In order to provide Internet to the mesh network formed by the emergency boxes, at least on the the Mesh Potatoes must be connected to an access network via an uplink. An

uplink connects a device or a LAN to a larger network [28]. Which type of access network that is available depends of the location. Some places there might exist a stable landline, other places not. Then an option could be to use satellite or cellular networks. It is therefore important that the emergency box has high adaptability in order to fit different scenarios. The availability of the different uplinks is not the only thing that vary. The up-link speed and the price also varies from place to place, but also varies between the types of uplinks. In the following sections, we will look at some of the uplinks available, and how Internet access can be provided to the mesh network.

4.3.1 Internet via Telephone-line

The most common way of getting Internet access is via a landline. The telephone lines are most often used for this, since they can be converted to broadband. In this way it can be used for phone calls and Internet simultaneously [29]. The line is usually in the form of twisted pairs (copper lines). These lines support broadband up to 10 Mbps, and are often in form of ADSL, or other digital subscriber line of type x (xDSL) technologies [30]. Internet via telephone lines can be provided as a stand-alone solution, or it can be provided together with television or/and phone service. The latter option is usually cheaper. Internet through landlines have a high reliability [31]. We will now shorty describe some technologies for getting Internet access via a telephone line; dial-up Internet connection, ISDN, and DSL. Although dial-up Internet connection is practically extinct in developed countries, we will include it here due to the different application scenarios for the emergency box.

Dial-up Internet connection Dial-up is an analogue technology that utilizes the telephone line. A telephone wall jack is used as a fixed point of connection, and the computer is connected to a voiceband modem. With this technology, the data is transmitted over the same frequencies used for phone calls. Hence, if you only have one telephone line, you cannot take a phone call and use Internet at the same time [32]. Along with the digital era, better internet technologies were introduced; ISDN and DSL.

ISDN Integrated Services Digital Network (ISDN) is a fixed internet connection, which also utilizes the telephone lines. When using ISDN, as with dial-up, a telephone wall jack is used as a fixed point of connection. But ISDN utilizes a ISDN terminal adapter instead of voiceband modem. This ISDN terminal adapter sends out digital signals. The data speed varies between 64 Kbps - 129 Kbps. The speed of the data is symmetric, which means upstream and downstream data rates are the same. In contrary to dial-up, ISDN allows voice calls and transmission of data simultaneously. ISDN is faster than dial-up, but the speed is nothing compared to the speed obtained using DSL [32].

DSL Digital subscriber line (DSL) is, like the name insinuates, a digital high-speed technology for Internet access that allows simultaneous voice and data transfer. Like dial-up and ISDN, DSL also run over the telephone lines. With DSL the data is not converted between analogue and digital signals. Despite this, the signals are modulated in order to be transferred on non-voice frequencies. DSL is an always-on technology, and differ from the previous technologies mentioned in this way. Only a small part of the telephone line is used for voice signals. The DSL technology allows utilization of a unused frequency spectrum of an telephone line, hence making it possible to transmit data faster. When the voice and data signals arrive at the telephone company's local switching station, they are separated and routed differently; voice to regular telephone system and data to the ISP, and then the Internet. A connection must be within approximately 5 kilometres of a station in order for DSL to work. The speed depends on many factors. Data can be transported up to 6 Mbps (distance of approximately 2 kilometres). Relevant factors that have an impact on the speed is distance to the switching station and the quality of the telephone line. Like mentioned earlier, there are different types of DSLs. The most common is ADSL, where the A stands for asymmetric; the downstream speed is faster than the upstream speed [32].

4.3.2 Cellular Network Technologies

It is getting more and more common to use cellular technologies for broadband. Around 2011 number of mobile-broadband subscriptions grew to twice as many as the number of fixed-broadband subscriptions. In developed countries it is common to

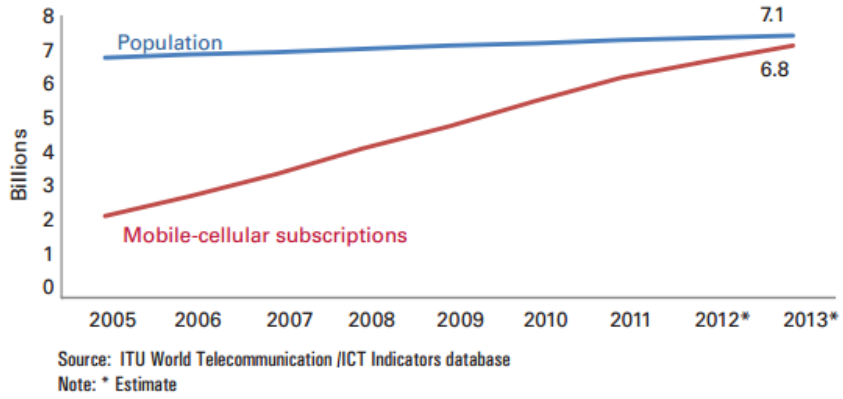


Figure 4.1: Number of mobile-cellular subscriptions The figure shows that the growth of mobile-cellular subscriptions have increased drastically during the last decade, and show that there are almost as many as there are people in the world [33].

have a fixed-broadband connection, and use a mobile-broadband network in addition to the fixed. In developing countries on the other hand, it is not a given that there is access to a fixed-broadband connection. Then mobile-broadband can be the only method of access available. In 2011, 90 % of the world's population had 2G coverage, and 45 % had 3G coverage [34]. By 2013, the number of mobile-cellular subscriptions had reached a high lever, and were approaching the number of people in the world, like shown in Figure 4.1. From 2011 to 2013, the number of mobile-broadband subscriptions more than doubled in developing countries [33].

Through mobile network technologies, high-speed Internet access can be provided via a portable devices. In order to get a mobile broadband, there must be a cellular network (GSM, CDMA) service available. The key technologies when talking about mobile broadband is 3G and 4G (respectively third and fourth generation wireless networks) [35]. With 3G the average speed 0.5 to 1.5 Mbps, and with 4G the average speed 2 to 12 Mbps. These vary, due to different versions of each technology, underlying service etc.. And like with everything else, the actual and realistic speed differ from the peak speed [36].

4.3.3 Satellite

Internet from satellites are offered by a satellite Internet provider [31]. The satellite are orbiting the Earth, and get signals from a land based Internet connection. To get Internet access via satellite you need a satellite dish. The main advantage of using satellite is that it provides an universally available Internet access [37]. Since it is universally available, it is fitted for use in rural regions where there exists no landlines or other options for connecting to the Internet. But like with everything else, there also exists disadvantages with using satellite-Internet. Since it is a shared medium, privacy concerns arise, and the speed are dependent of simultaneous use. Also the connection can be affected by bad weather, unlike for a wired connection, hence it is not as reliable as cable.

4.3.4 Summary Up-Links

Table 4.2: Advantages and disadvantages - Up-links []. MÅ FINNE EN GOD KILDE HER SOM SAMMENLIGNER LITT

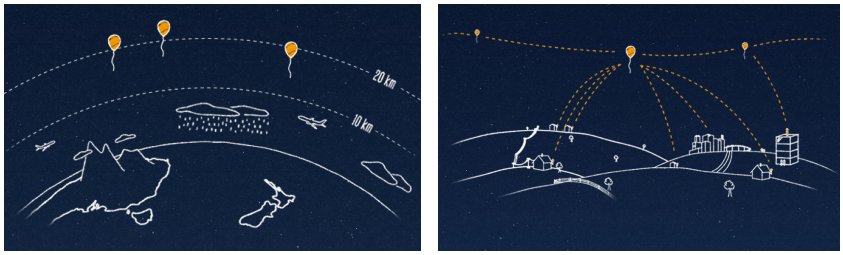
Up-links	**Advantages**	**Disadvantages**
Landline/xDSL	High reliability, cheap.	Low availability in rural areas
Cellular networks	High availability	Expensive
Satellite	High availability	Not as reliable as landline, and generally more expensive

4.3.5 Apple's Mesh Network

In March 2014 a new iOS app was released, FireChat. This app enables the possibility to chat with people "off-the-grid" [38]. FireChat utilizes Apple's Multipeer Connectivity Framework introduced in iOS7 [39]. The Multipeer Connectivity framework provides support for discovering services provided by nearby iOS devices using peer-to-peer Wi-Fi, infrastructure Wi-Fi networks and bluetooth to communicate with those services. This communication could either be message-based data, streaming data and resources such as files [40]. These technologies have a short range, but this range can be greatly extended by a chain of users that creates a mesh network, see section 2.3.3 for more information about mesh networks. AirDrop is a product that have been out there for a little while and also utilizes mesh networks. The Main difference is that FireChat is fully decentralized and peer-to-peer. When there are multiple users in one area FireChat relay messages in the same way as Internet, from node to node, just in this case it is from phone to phone. This, not only, enables two users to chat with each other without Internet connection, but also far beyond Wi-Fi and Bluetooth range from each other, using the chain of users (phones). For example if Bob is connected to Alice, and Alice is connected to Carol, Bob and Carol can send messages to each other. This chain can be indefinitely long. As long as no one device goes out of Wi-Fi range, all the devices can communicate with each other.

This new framework will mainstream wireless mesh networking. Internet can now become available in places where it earlier was non existent. This could for example be a hotel basement, cave or rural areas where there are no cellphone towers, or disaster situations where Wi-Fi or mobile broadband is no longer available. There are many benefits with the use of mesh networks. Mesh networks does not require a centralized infrastructure, there are no need for all the devices to be connected to a access point (as a router). Another benefit is that the mesh network is really easy to set up - everybody just uses the app FireChat (or similar applications like AirDrop), the network is created and everybody is connected. Simple as that!

The possibilities for this feature are enormous. Both in the creation of applications but also the area of usage. In a lot of countries Internet and mobile broadband connection is extremely expensive, people might afford a used cellphone but not the cost to connect. With this new feature Internet connectivity can be spread through the mesh network needing only one node (phone) to have internet access. This way of spreading connectivity can open the possibility for people in rural, poorer areas like slums and small villages to stay connected. But not only the poor and rural areas can benefit from this new mesh-networking feature. Young people that does not have a phone can use an iPad or similar to talk to their friends. Or teens with



(a) The Balloons are situated in the stratosphere. **(b) Connecting to the Internet**

Figure 4.2: Project Loon: Balloon-powered internet for everyone.

restricted cell contracts can still connect with their friends, just with the help of the neighbours kids phone. Since FireChat enables communication without the use of internet it can be a useful tool to communicate privately and also to send sensitive data.

It is not only Apple that is seeing the enormous potential in main-streaming mesh networking. Google has also expressed that they are working on a home mesh network [41]. FireChat and AirDrop is just the beginning. We believe more extensive and mind blowing applications are to come.

4.3.6 Internet Balloons

The majority of the world today is not connected to the internet. Two thirds of the worlds population does not have access to the Internet. Project Loon, a Google project, is a network of high altitude balloons travelling in the stratosphere, and through this network be able to give Internet to the Entire world. Cost effective, reliable and inexpensive internet connection to everybody. The project started in June 2013 as a experiment in New Zealand [42].

The balloons are 15 meter in diameter. They travel about 20 km up in the air, in the stratosphere, twice as high as airplanes and weather, this is shown in Figure 4.2a. At this altitude there are many layers of wind, each varies in direction and speed. By regulating which wind the balloons are flying in it is possible to control their position, and steer them in the desired direction. Figure 4.2b show that people can connect to the Internet shared by the balloons by having a special antenna attached to their house. From this antenna the signal bounces to one balloon which again bounces through the other balloons and down to the Local Internet Provider on earth. This creates a network in the sky.

In order to control the altitude of the balloon, there is a special designed control

system is designed. The system is controlled remotely from the ground. By either pumping air in or letting air out the balloon, one can decide in what layer of air the balloon should be in. Letting air in and out is not the only way to decide is the balloon should go up or down, but it is the only way to do so in huge scale. A GPS is attached each balloon in order to keep track of precise positions and see how the winds are changing. There are enormous amounts of data collected. The balloons are flying at the same speed as the wind.

The balloons contains specially designed antennas and radio. This in order to receive signals from Project Loon only, in order to achieve high bandwidth over land distances. Satellites are geostationary and stay at the same place and at the same altitude.This means that the satellite dish can be mounted in the right direction. This is not the case with the balloons, they move and they also vary in attitude. A fixed pointing dish would therefore not work. The antenna needs more sensitivity to an angle than it does straight up, which results a uniform signal strength.

Since the balloons are in constant movement, it is important to make sure that there allays is a balloon available and one ready to move in when one move out so that the connectivity always are available. If not this project would not be of much use. Every balloon contains information about all the other balloons in order to spread out nicely. Think of it as a flock of birds, they always look at the one next to them and space out nicely.

The balloons are solely run on solar power and are controlled by a mission control on earth. The balloon works as a communication tower in the sky. The solar panels catches the sunlight that is available running the day, as well as charging up the lithium-ion battery to last the night. In the stratosphere it is -70 degrees Celsius, these extreme cold conditions are not ideal fro the lithium battery. In order to make sure that the battery does not loose its effective battery capacity it is important that the battery is kept warm. The battery pack is insulated to reflect the heat that comes of the electronics to stay warm. This is still under development.

When it comes to lifetime, the goal is that the balloons stay alive for a 100 days, or 3 laps around the globe. It is important to make sure that the balloon is leak free. The material is under a lot of stress, air is constantly being pumped in and out to control the position of the balloons. As well as the extreme cold and warm temperatures.

Bot on the way up and down the air traffic control in the specific country have to be contacted since they go through airspace. Project loon requested permission to land on Norwegian soil according to Teknisk Ukeblad, a Norwegian science magazine. This permission was approved. [43]

4.4 Different Scenarios Where a Quick Roll-out is Necessary

Everyday there are situations all over the world that in some way affects the modern communications systems, or causes a need for one. These situations can range in everything from big natural disasters like the tsunami in Japan or the volcano outbreak in the Philippines, where either parts of the communication system is not functioning or there is a desperate need for one. To temporary refugee camps and IDP camps, and situations where a mobile tower is down, or blackouts. Also more festive situations can have use of the quick roll-out system. Imagine a big group gathered at a festival in another country. It is expensive to call or use mobile data, to be able to use cheap internet via the mesh Potatoes would save the users for a lot of money.

4.4.1 Natural Disasters

A Natural disaster id defines as; *any event or force of nature that has catastrophic consequences, such as avalanche, earthquake, flood, forest fire, hurricane, lightning, tornado, tsunami, and volcanic eruption* [44].

4.4.2 Blackouts

4.4.3 Temporary Refugee and IDP camps

Not all refugee and IDP camps are as well established, like the ones in Dadaab. Many camps are temporary, and are therefore in more need of a temporary communication system.

4.4.4 Breakdown of Mobile Towers

The 10th of June 2011 one of Telenor had problems with one of its servers in Oslo. This problem caused a down time of 18 hours and affected 3 000 000 Telenor users [45]. Not only was this the biggest problem Telenor have had since they opened their mobile network in 1993, but also the longest downtime and highest number of affected users recorded in Norway. In addition to this it all happened in a period with severe flooding in big parts of the eastern Norway, and made it difficult to reach emergency numbers. The fact that the problems occurred during the flooding just made the situation much worse. [46]

4.4.5 Mountain Areas - Avalanches

4.4.6 Festivals

4.4.7 Differences/relation between different scenarios

4.5 The Process of Quick Roll-out

4.5.1 How are telephone numbers assigned?

4.5.2 Training of People

References

[1] A. Sedghi and S. Rogers, "Unhcr 2011 refugee statistics: full data," June 2011. http://www.theguardian.com/news/datablog/2011/jun/20/refugee-statistics-unhcr-data, accessed 24.03.2014.

[2] A. Sedghi, "Unhcr 2012 refugee statistics: full data," June 2013. http://www.theguardian.com/news/datablog/2013/jun/19/refugees-unhcr-statistics-data, accessed 20.03.2014.

[3] J. Dempsey, "The mesh potato network," 2008. http://ictupdate.cta.int/en/Feature-Articles/The-mesh-potato-network, accessed 26.02.2014.

[4] Village Telco, "Village telco workshop," 2008. http://villagetelco.org/2008/07/village-telco-workshop/, last accessed 24.02.2014.

[5] Village Telco, "The origin of the mesh potato," Last edited: 2013. http://villagetelco.org/2008/06/the-origin-of-the-mesh-potato/, accessed 21.02.2014.

[6] Village Telco, "Background village telco," Last edited: 2013. http://wiki.villagetelco.org/Background, accessed 20.02.2014.

[7] Village Telco, "Mesh potato," 2013. http://store.villagetelco.com/mesh-potatoes/mesh-potato.html, last accessed 20.02.2014.

[8] Wikipedia, "Binary bolb," Last modified December 2013. http://en.wikipedia.org/wiki/Binary_blob, accessed 05.03.2014.

[9] D. Rowe, "The mesh potato part 1," 2008. http://www.rowetel.com/blog/?p=70, accessed 26.02.2014.

[10] OpenWrt Wiki, "About openwrt." http://wiki.openwrt.org/about/start, accessed 03.03.2014.

[11] J. Hoebeke, I. Moerman, B. Dhoedt, and P. Demeester, "An overview of mobile ad hoc networks: Applications and challenges," 2004.

[12] X. Hong, K. Xu, and M. Gerla, "Scalable routing protocols for mobile ad hoc networks," *IEEE*, 2002.

[13] J. Wang, B. Xie, and D. P. Agrawal, *Journey from Mobile Ad Hoc Networks to Wireless Mesh Networks*, pp. 1–30. Springer London, 2009.

[14] B. D. Shivahare, C. Wahi, and S. Shivhare, "Comparison of proactive and reactive routing protocols in mobile adhoc network using routing protocol property," *International Journal of Emerging Technology and Advanced Engineering*, 2012.

[15] A. Neumann, C. Aichele, M. Lindner, and S. Wunderlich, "Better approach to mobile ad-hoc networking (b.a.t.m.a.n.)," 2008. http://tools.ietf.org/html/draft-wunderlich-openmesh-manet-routing-00, accessed 21.02.2014.

[16] Freie Universität Berlin, "Better approach to mobile ad hoc networking (b.a.t.m.a.n.)." http://www.des-testbed.net/content/better-approach-mobile-ad-hoc-networking-batman, accessed 24.02.2014.

[17] P2P foundation, "Robin." http://p2pfoundation.net/ROBIN, accessed 05.03.2014.

[18] Village Telco, "Spud – simple unified dashboard for mesh networks." http://villagetelco.org/2011/06/spud-simple-unified-dashboard-for-mesh-networks/, accessed 26.02.2014.

[19] The UN Refugee Agency, "What is a refugee?." http://www.unrefugees.org/site/c.lfIQKSOwFqG/b.4950731/k.A894/What_is_a_refugee.htm, accessed 20.03.2014.

[20] Refugees International, "Somalia." http://refugeesinternational.org/where-we-work/africa/somalia, accessed 24.03.2014.

[21] Refugees International, "Iraq." http://www.refugeesinternational.org/where-we-work/middle-east/iraq, accessed 24.03.2014.

[22] Inveneo, "How better connectivity can help dadaab, the world's largest refugee camp," 2012. http://www.inveneo.org/2012/06/how-better-connectivity-can-help-dadaab-the-worlds-largest-refugee-camp/, accessed 10.03.2014.

[23] Care, "Dadaab refugee camps, kenya." http://care.org/emergencies/dadaab-refugee-camp-kenya, accessed 11.03.2014.

[24] Wikipedia, "Nethope," Last edited: 13 May 2013. http://en.wikipedia.org/wiki/NetHope, accessed 11.03.2014.

[25] Inveneo, "Dadaabconnect." http://www.inveneo.org/projects/dadaabconnect/, accessed 11.03.2014.

[26] M. Maasilta, "Outsiders or active citizents? the role of oral amd mediated ommunication in african refugee camps," ?

[27] D. Kravets, "U.n. report declares internet access a human right." http://www.wired.com/threatlevel/2011/06/internet-a-human-right/, accessed 14.03.2014.

[28] B. Mitchell, "What is an uplink(port)?." http://compnetworking.about.com/od/homenetworking/f/uplink-port.htm, accessed 14.03.2014.

[29] Digital Unite, "How to connect to internet." http://digitalunite.com/guides/using-internet-0/connecting-internet/how-connect-internet, accessed 27.03.2014.

[30] J. A. Audestad, *Technologies and Systems for Access and Transport Networks*. Artech House, Inc., 2008.

[31] A. Chianis, "Cable vs. satellite — which internet connection serves your business best?." http://www.businessbee.com/resources/news/technology-buzz/cable-vs-satellite-internet-connection-serves-business-best/, accessed 14.03.2014.

[32] J. J. Parsons and D. Oja, *New Perspectives on Computer Concepts 2010:Comprehensive*, pp. 313–315. Course Technology, 2010.

[33] International Telecommunication Union, "The world in 2013: Ict facts and figures." http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2013-e.pdf, accessed 28.03.2014.

[34] International Telecommunication Union, "The world in 2011: Ict facts and figures." http://www.itu.int/ITU-D/ict/facts/2011/material/ICTFactsFigures2011.pdf, accessed 28.03.2014.

[35] B. Mithcell, "What is mobile broadband?." http://compnetworking.about.com/od/internetaccessbestuses/f/what-is-mobile-broadband.htm, accessed 28.03.2014.

[36] Diffen, "3g vs 4g." http://www.diffen.com/difference/3G_vs_4G, accessed 28.03.2014.

[37] E. S. Cohen, ed., *Broadband Internet: Access, Regulation and Policy*, pp. 80–81. 2007.

[38] FireChat, "app store: Firechat." https://itunes.apple.com/us/app/firechat/id719829352?mt=8&ign-mpt=uo%3D8, accessed 27.03.2014.

[39] M. Elgan, "How an under-appreciated ios 7 feature will change the world," March 2014. http://www.cultofmac.com/271225/appreciated-ios-7-feature-will-change-world/, accessed 25.03.2014.

[40] Apple, "About multipeer connectivity," September 2013. https://developer.apple.com/library/ios/documentation/MultipeerConnectivity/Reference/MultipeerConnectivityFramework/Introduction/Introduction.html, accessed 25.03.2014.

[41] M. Elgan, "Why google is working on home mesh networking," March 2014. http://www.eweek.com/cloud/why-google-is-working-on-home-mesh-networking.html, accessed 27.03.2014.

[42] Project Loon, "Projet loon: Balloon-powered internt for everyone." http://www.google.com/loon/, accessed 27.03.2014.

[43] R. Ramsdal, "Google fikk ja til å sende internett-ballonger over norge," March 2014. http://www.tu.no/it/2014/03/22/google-fikk-ja-til-a-sende-internett-ballonger-over-norge, accessed 23.03.2014.

[44] Dictionary.com, "Natural disaster." http://dictionary.reference.com/browse/natural+disaster, accessed 19.03.2014.

[45] Wikipedia, "Liste over nedetid i mobilnettet i norge." http://no.wikipedia.org/wiki/Liste_over_nedetid_i_mobilnettet_i_Norge, accessed 19.03.2014.

[46] Nettavisen.no, "Telenor: Feilen i mobilnettet er rettet." http://www.nettavisen.no/nyheter/3168897.html, accessed 19.03.2014.

Appendix A
Interview with Care

This appendix contains the summary from the interview conducted on Mary Muia (CARE International in Kenya | Program Assistant Refugee Assistance Programme | Dadaab).

1. Approximately how many people are there in the Dadaab refugee camp? And how long have it been in operation?

   The Dadaab complex of refugee camps, considered the world's largest, was created in 1991 by the Government of Kenya and UNHCR to host Somali refugees displaced by civil war. Over the years, the camps have also hosted other nationalities from the Horn of Africa, the Great Lakes and East Africa regions but they constitute less than two percent of the camp population. The original camps were Dagahaley, Ifo and Hagadera and were intended to host 90,000 refugees. However, in 2011, there was an influx of new refugees from Somalia due to severe drought and new camps were created; Ifo 2 and Kambioos, to cater to the over 175,000 new arrivals and at the peak of the influx in 2011, the camps hosted more than 463,000 refugees, including some 10,000 third-generation refugees born in Dadaab to refugee parents who were also born there. However, in 2013, UNHCR and its partners conducted a verification exercise to ascertain the current population since some of those who had arrived in 2011 due to the famine had returned home. As at February, 2014, the current population stands at 369,294.

2. How do you connect and communicate with the outside world?

   CARE as an organization has invested in communication systems in liaison with Internet Service Providers in the capital city of Nairobi who ensure that all staff have access to internet for both official and social usage.

3. How are the communication inside the camp (communication flow)?

Several telecommunication firms in Kenya have put up their machinery in the area thus there is access to both mobile communication and access to internet services. There are also radio station services and access to digital televisions. CARE uses telephone services to reach out to refugee staff (50%) of the refugees have access to mobile phone services - either owned or through a bureau) posters and radio to reach out to its beneficiary population. In addition, there is word of mouth done through loud speakers during major gatherings like food distribution days and also road shows within the camps.

4. How does the refugees receive information?

   As 3 above.

5. Can you exlain what happens when a new person enters the camp?

   Upon arrival, a new refugee would report to a UNHCR reception desk whereby they are given temporary registration pending full registration and location of their relatives is they have any already in the camp. UNHCR fully briefs the new arrival on all the services available and which Agency is handling what service. Immunizations, medical attention, emergency food supply, tarpaulins, sleeping mats, jerrycans for fetching water and kitchen sets are issued to such new arrivals to help them start their new lives in the camps. UNHCR then hands over the new arrivals to the respective Agency doing camp management in the specific camp they are allocated so that they can be shown where to pitch their tents. The camps are well demarcated into numbered sections and blocks thus at any given time, UNHCR would inform you where a particular refugee resides and the family size. Each Agency working in Dadaab has their own mode of communicating the services they provide to their target beneficiaries. However, UNHCR holds regular meetings with the refugee leaders of each respective camp whereby information is shared with them for dissemination to the entire refugee population.

6. What are the biggest challenges in a refugee camp?

   Lack of enough space to accommodate everyone and lack of enough funds to take care of all the needs of the refugees.

7. What is the biggest challenge when it comes to communication/information spreading in the refugee camp?

   Language barrier between the humanitarian staff and the refugees since many of the staff do not speak/understand the Somali language while 95.6% of the refugees are Somali. Internet and telephone service outages are also common in the area and response by the service providers sometime take a while.

8. What means of communication do you use in the refugee camp?

Mobile phones and computers for both telephone and internet access. Radios and television services.

9. We have the impression that there are not many telecom providers offering telecommunication services in Africa, and hence little competition. Which in general makes the prices higher. How does the ones living in the camp afford to have a phone?

   (a) There are two main telecom provides here so yes, little competing thus high rates (b) Many refugees who have been here for over a long period of time have established small scale business (some supported by the NGO's i.e. IGA's (Income Generating Activities) thus make some little profit. Others have established business through the support of their relatives who have been resettled in other countries thus send them some cash while others who may have been businessmen back in Somalia made it to take some of the cash they had at the time of fleeing their country.

10. Is it "Internet cafes" that people have to pay to be able to use?

    Yes some refugees have set up small internet cafes in the markets thus people who need the services have to pay for it. CARE like other NGO's here has Community Development Projects which include ICT training where we train the youth on ICT and upon successful completion, we support then by providing them with start-up kits to establish their own small cafes for both business and training others youth.

11. How long does it take to set up a communication system?

    N/A since I am not a technical person

12. Do you use video surveillance?

    No

13. Have you heard of something called Freedom fone?

    No

14. Have you heard of the company Village Telco?

    No

15. Do you have anything else to add that can be of interest for our master thesis?

    No