General Model of a Rural Telecom Company

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Chapter 1

Introduction

This document discusses the arrangement of Rural Telecom Companies from both the engineering and business models point of view. The intended audience are the residents of the "Wheat Belt" regions of WA. It is to these people that this document attempts to make the argument that they should own and control their own telecommunications facilities.

The purpose of the local telecommunications companies should be to provide good quality voice (telephone) and Internet communications. It should do this in a cost effective manner and, at the very least, do so on a break even basis.

In suscessive chapters I will attempt to show how this may be achieved.

Chapter 2

The Case

Why would the residents of a particular region wish to own the means of their own intercommunications facility? The simple answer to this is that this is the only method by which they will achieve anything like decent communications.

The low population densities of the rural areas make them unatractive for the large telecommunications companies. This is true who ever owns the companies. It is true, that by using artifacts such as ”Universal Service Obiligations”, the companies can be forced to offer some service to the rural areas. But the key word here is force. It is difficult to believe that any entity will, under compulsion, offer proactive service under these conditions.

This is the core of the case.

Chapter 3

The Aim

The aim of this system and, therefore, the company that runs it is to supply relatively cheap communications within the network. In addition, communications to the rest of the world will be supplied at a price determined by agreement with a tird party carrier.

The facilities avaliable to each customer should be at least, but not necessarily limited to, a IP network ("Internet") connection of at least one mega bit per second (that is 128 K byte per second), and one, or more voice channels (phone) connections.

Chapter 4

The Solution

4.1 Business Organization

Section 4.2 below describes an equiptment model that is fairly distributed. However, at the very least, it is necessary to have a "company" structure which, at the very least, hold any common property and set standards, technical or otherwise, necessary for access to the network.

Almost any company structure could be formed to address this need. But givern the necessary cooperative structure of the communications, and because the whole idea of the Telecom Company is to provide a service to the local community, it makes sense that the company be owned by the community as a whole. This implies that the ownership is held by either local government or a cooperative.

4.2 Engineering

4.2.1 Introduction

It some times happens that advances in technonolgy present opertuninties that have not been previously avaliable. This has been said before and, I'm sure, you have heard it before. It is not always true that technology solves every problem. It is important to view claims that a particular will solve a particular problem with a critical eye.

Never the less the solution I will propose rests heavily on technologies that are, just now, becoming avaliable at a price low enough to be considered for use in a rural telecomunications role.

The first of these technologies is known as wireless internet or "WiFi". This technology is formally known as "IEEE 802.11b". The IEEE 802.11b specification is [**?**].

The second of the technologies is embedded micro computers. Actually, this technology is not particuarly new. But the prices of suitable embedded computers have been slowly falling over the years to the point that it is becoming feasible to build a distributed system using these.

The third technology is "Open Source Software" [**?**] and the Internet itself (or, rather, the Internet protocols).

These three technologies deserve futher discussion in the context of rural communications.

4.2.2 Internet Protocols

Some of you may have had experience with the Internet. The Internet is basically a number of computers (nodes) each of which is connect to a small number of other like nodes. Each node communicates directly with the others to which it is connected by using a protocol know as "Internet Protocol" (IP). Internet Protocol is implemented by organizing data into "packets" which are transmitted from on node to the next.

The defining characteristic of an IP node is its IP address. This is in the form of a quad dotted number. For instance, 160.148.9.201 is an IP address. Some of you may have seen IP addresses on the Internet. Every IP node must have at least one IP address.

If nodes where able only to communicate to other nodes to which they where directly connected we would not get very far. Nodes need to be able to communicate which other nodes to which they are not directly connected.

This is achieved by IP routing. Routing means forwarding packets from other nodes in accordance with some schema. In effect, two nodes that are not directly connected can communicate with each other because the intervening nodes agree to forward (route) the IP packets between the two. This is illustrated in figure 4.2.2.

In this figure node A has a virtual link to node I via nodes B, E and F. To communicate with node I node A will send packets to node B which will forward them to node E which, in turn, will forward them to node F which will deliver them to node I. This is the essence of IP routing. It should be noted that it would be possible for node A to communicate with node I using a different route. For instance, packets could go via nodes D, G and H. This suggests that this particular network has redundancy and, therefore, a tolderance to equiptment failures. This property will be discussed later.

Internet data is usually thought of in terms of layers in a "stack" with the IP layer approximately in the middle. Figure 4.2.2 shows a simplified representation of these layers. Every computer that can connect to the Internet has such a stack. It is often refered to as the TCP/IP or Internet stack. Typical programs that reside at the Applications level are email clients / servers, Web browsers and servers, and IRC and so on. The Network Interfaces and Hardware consist of software objects that represent the network channels, the drivers and hardware. More about the hardware later.

4.2.3 Topologies for a Rural Network

The topologies avaliable for a network may be classified as centralized or distributed. Both have strengths and weaknesses.

Looking at figure 4.2.3 we can see that one of the features of a centralized system is the use of dedicated hardware (central routers) to transport IP data from one part of the network to another. The stalient properties of a centralized system are:

- There are usually less routing hops between any two nodes.

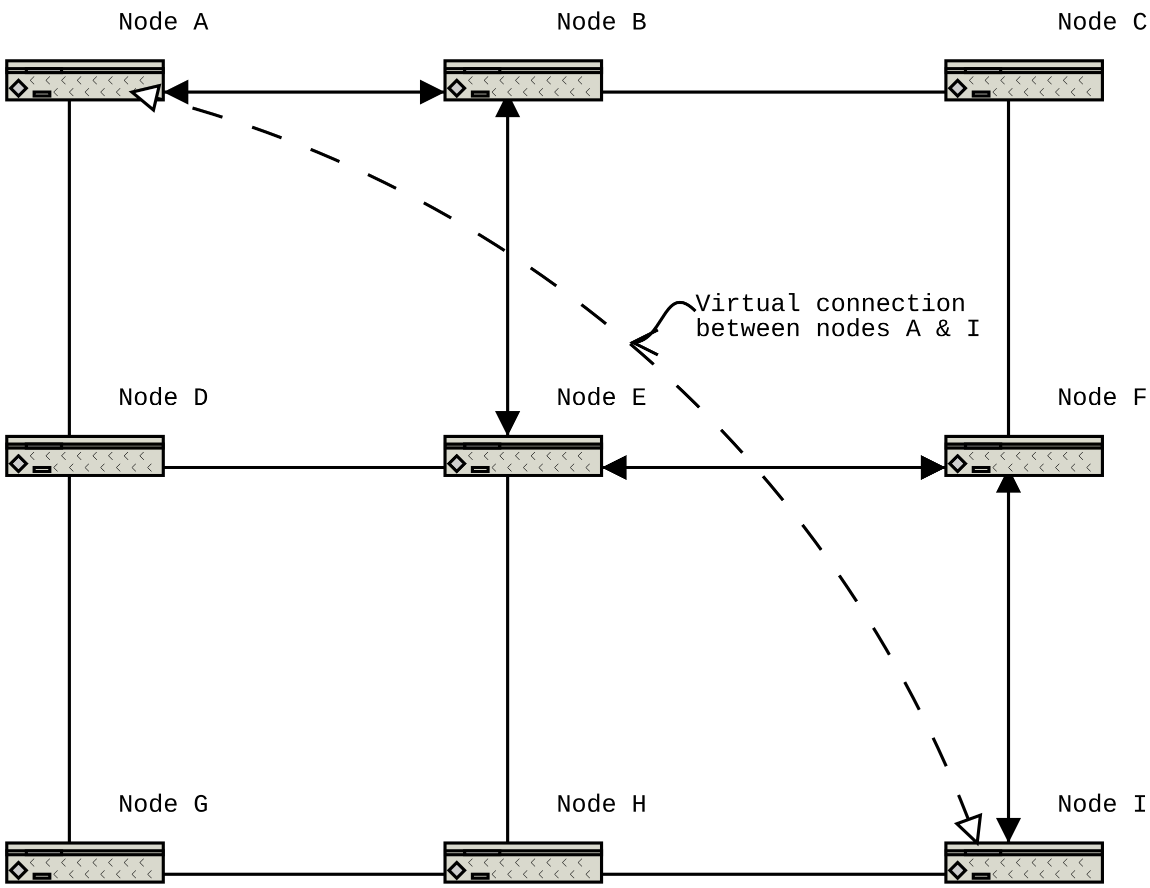

Figure 4.1: Two nodes communicating with each other with the good offices of intervening nodes.

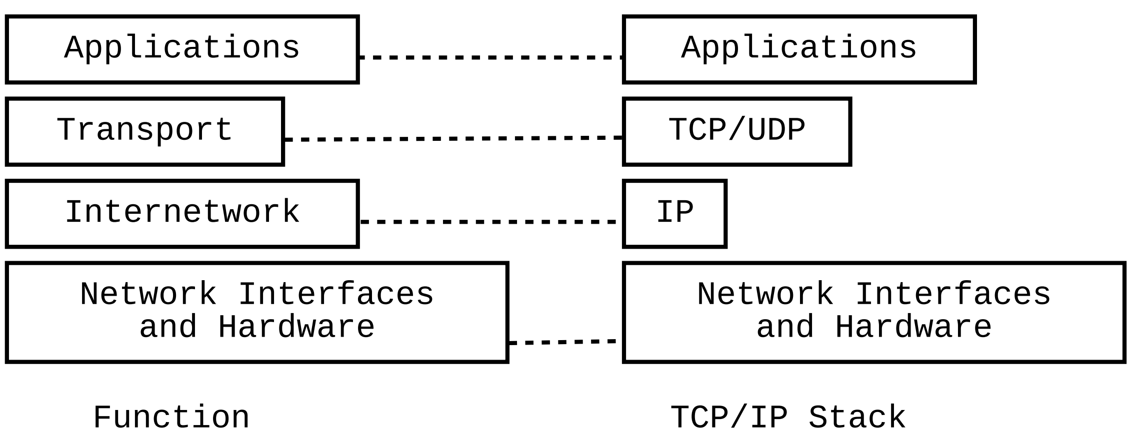

Figure 4.2: Simplified representation of the network stack.

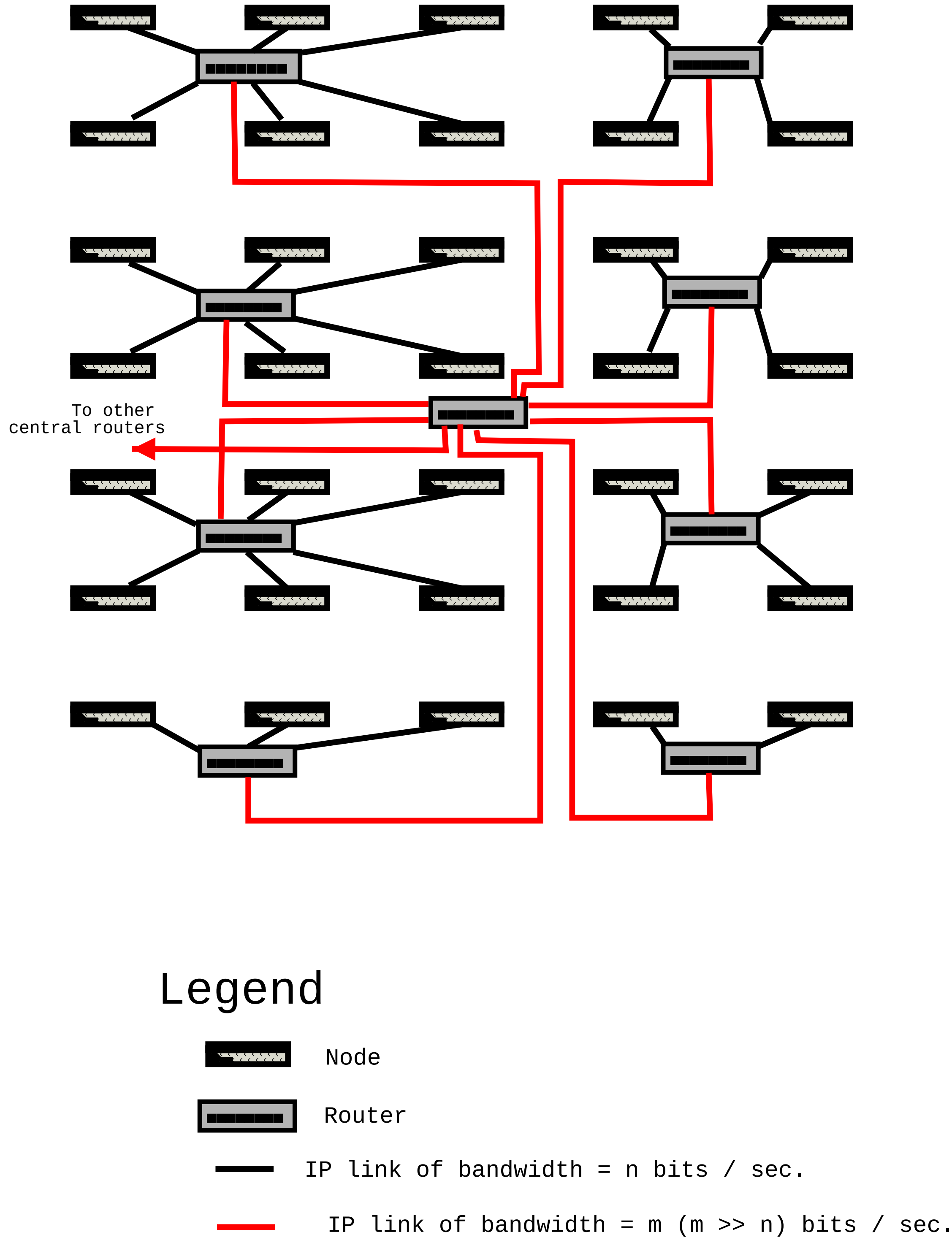

Figure 4.3: A network topology showing a higher degree of centralization.

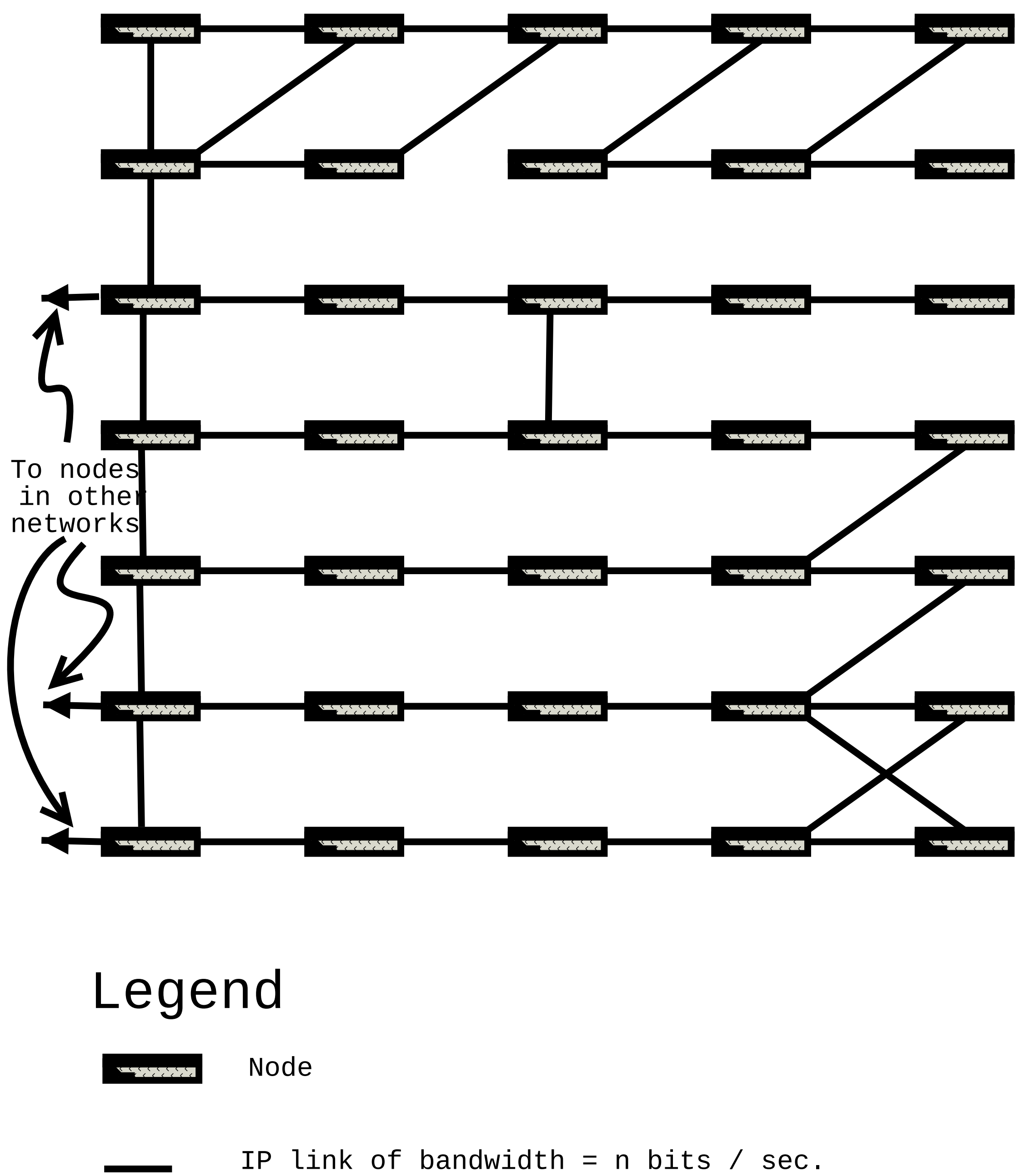

Figure 4.4: A network topology showing a lower degree of centralization.

- Dedicated routing hardware is required.
- Because node IP data is concentrated to a single router the inter router links need to be of a lot higher speed than the node to router links.
- There is no redundancy in the event of the failure of a critical component. For instance the failure of any router in figure 3 will result in, at least, some nodes loosing service.
- Because there is inevidably a maximum distance any particular IP link may have there is a possibility that otherwise under utilized routers may have to be provided to service outlying nodes.

Lookin at figure 4.2.3 we can see that the major feature of a decentralized system is the lack of hareware dedicated to support of the network. The functionality provided by the dedicated routers in the centralized examples is now contained within each and evey node. The stalient properties of a decentralized system are:

- There are, in general, more routing hops between any two nodes.
- No dedicated routing hardware is required.
- Each IP link is of the same speed as all others.
- There is built in redundancy. Because each node is connected to, at least, two others the failure of a single node does not result in the loss of service to other nodes.
- Adding additional nodes is easy and does not require additional dedicated routers.
- The network can be configured to take advantage of unused bandwidth capacity.
- Additional bandwidth can be added easily as, and when, required.

The last two items deserve some expansion. Consider figure 4.2.2. Shown there is a route between node A and node I. However, in this diagram, there are a number of potenetial routes between these two nodes. For instance, a route could be made via nodes B, C and F. Lets consider the case where there is heavy traffic between nodes E and F such that the IP link between the two is used almost to full capacity. It would not be desirable to pass traffic between nodes A and I through this link in addition. However, the B, C, F route could be used to avoid this link as could a route through nodes A, D, E and H or though a number of other routes. The decentralized arrangement allows us to route around problem areas by using otherwise unused bandwith else where. This is just another aspect of the built in redundancy of a decentralized network.

Additional bandwith may be added (geography permitting) simply by adding extra IP links at and near hot spots.

Both models have stregths and weaknesses. The decentralized model is better for areas where the density of nodes is such that most nodes may have at least two connections to others. However, in areas of high node density a more centralized system is more appropiate.

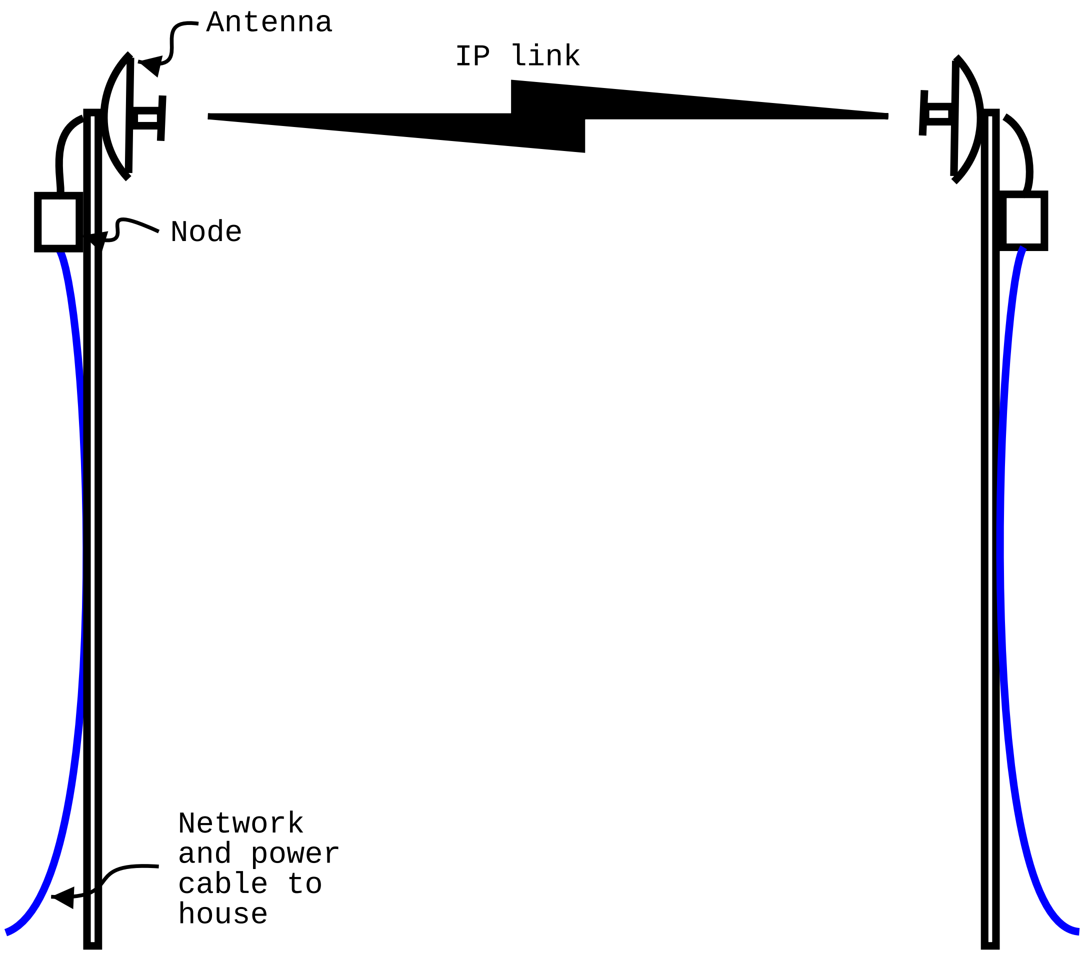

Figure 4.5: Schematic of an IP link.

4.2.4 The Physical Network

Up until now we have been representing IP links and nodes as abstractions. It is time to look at the physical aspects of the network.

The proposal is that the IP links be formed using IEEE 802.11b wireless links. The IEEE 802.11b system operates in the low microwave band (approximately 2.4GHz). Basically, an IP link consists of the RF link between the two nodes (computers). This is illustrated schematically in figure 4.2.4.

Because of the propergation characteristics of the 2.4GHz frequency band used it is necessary for "Line of Sight" (LoS) to exist between the communicating nodes. LoS means that, with your eye next to the antenna, you should be able to see the far antenna visually. Other that LoS feasible link distances are 15km or more.

4.2.5 The Client Network

Essentially, the client network is just a LAN. Clients have at their disposal 254 IP addresses which they may use as they see fit. All of the devices that may be connected to a LAN may used by the client. Devices connected to the client LAN may be visible, or not, on the public network at the clients descretion. For instance, figue 4.2.5 shows a "phone", a PC (which may also be used as a phone) a Web Camera and a vechile connected. Not all these devices need to be connected. Likewise, any number of these, or other, devices may be connected (up the the limits of IP addressing).

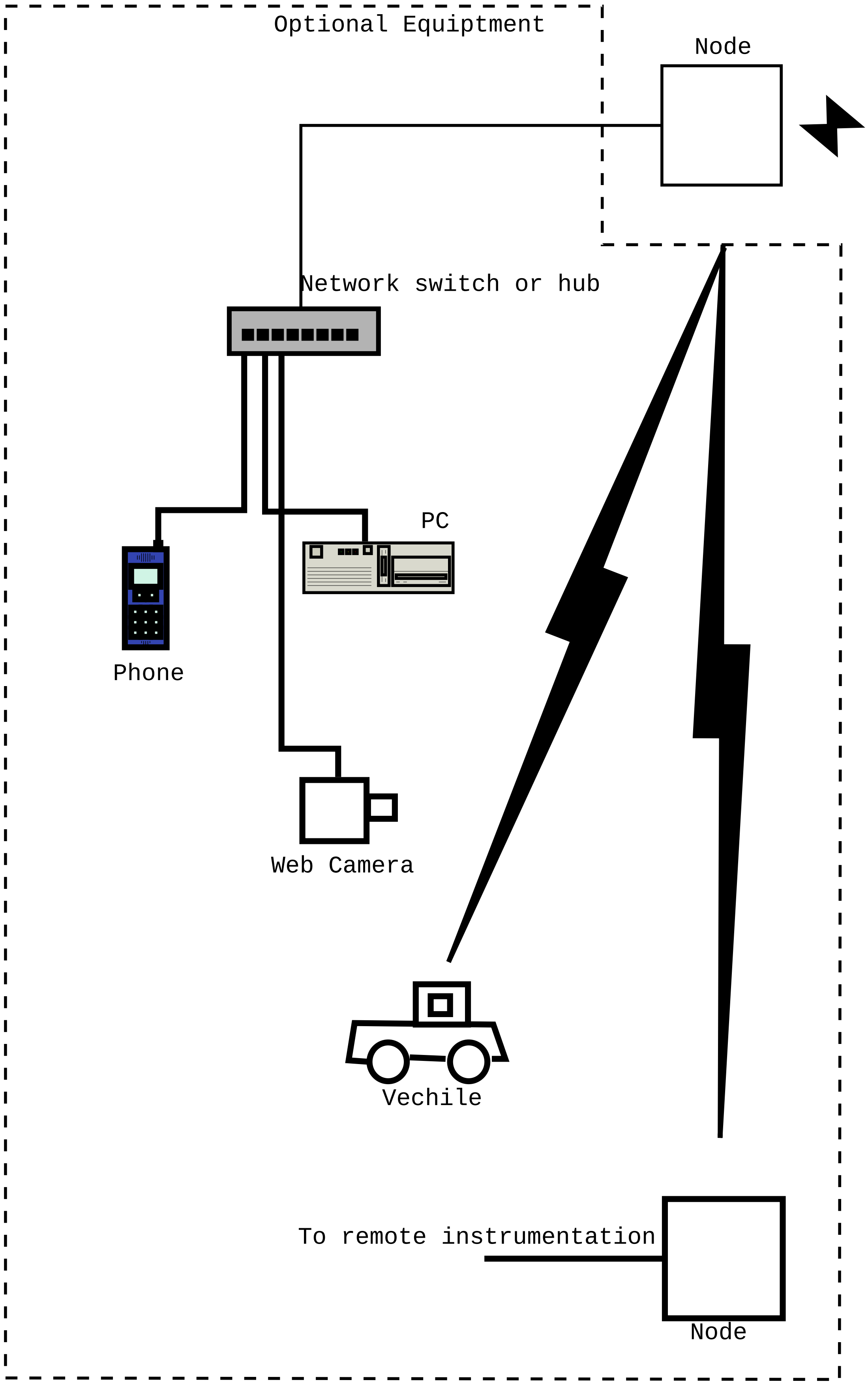

Figure 4.6: Schematic of a client installation.

Chapter 5

The Financial Model

5.0.1 Costs

In general, it is anticipated that the costs will fall into three categories:

- Captital costs.
- Running costs.
- Cost of necessary third party services.

Capital Costs

The capital items consist of:

- Nodes.
- Central servers needed to tie the network together.
- Client equiptment.
- Spares and redundant equiptment in support of the above items.

Running costs.

The running costs consist of:

- Node power.
- Client equiptment power.
- "Carrier License" to the federal government.

Cost of necessary third party services.

The third party services required are:

- External IP connectivity to the Internet.
- External POTS connectivity.

Bibliography