A Case Study in Linkage Between Information Technology and Business Planning

by

David Horspool

B.Comm., The University of British Columbia, 1982

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF MASTERS OF SCIENCE

in

THE FACULTY OF GRADUATE STUDIES

Faculty of Commerce and Business Administration

We accept this thesis as conforming

to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

April 1996

In presenting this thesis in partial fulfilment of the requirements for an advanced degree at the University of British Columbia, I agree that the Library shall make it freely available for reference and study. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by the head of my department or by his or her representatives. It is understood that copying or publication of this thesis for financial gain shall not be allowed without my written permission.

FACULTY OF COMMERCE AND BUSINESS ADMINISTRATION

~~Department of~~ _____

The University of British Columbia
Vancouver, Canada

Date 4/24/96

DE-6 (2/88)

Abstract

There is widespread agreement that planning at all levels of a business can be beneficial. Information Technology (IT) Planning is a critical activity that defines the priorities and actions of the IT department. In order for IT planning to be effective in helping business managers to achieve their business objectives, there must be linkage between IT plans and objectives and organizational plans and objectives. In several studies linkage of IT plans and objectives to organizational plans and objectives has been consistently identified as among the top few problems for IT managers. The objective of my thesis is to increase our understanding the factors that influence linkage.

In this study I review current research on factors that influence linkage, document the circumstances surrounding linkage in a single case, analyze the findings of the case based on a proposed model to guide research into linkage, and suggest additional factors that may influence linkage between IT and business objectives.

The case study was conducted at an international resource company with interests in nearly twenty mines located on four different continents. The company is organized into five divisions, one for each continent plus a fifth division which is responsible for exploration and special projects world-wide.

The company has a history of decentralized management. This has had an enormous impact on the development of the IT environment. Each division has its own IT function and each has been managed independently of each other. The company executives have become aware of corporate wide IT limitations. This has resulted in a corporate wide

reevaluation of both the IT strategy, and the telecommunications strategies and capabilities of the company. The data gathered for this study was gathered as part of the telecommunications review.

The model used for this case analysis is a comprehensive model to guide research into the factors that influence linkage developed by Reich (1992). When applied to the company, this model to guide research into linkage appears to be consistent and predictive except for two aspects: the ability of the model to differentiate some important characteristics of the factors influencing linkage, and the impact of time on linkage.

Reich's (1992) model to guide research into linkage combines many of the factors that were treated as separate constructs in other research. The analysis of the company uncovered two cases where combined factors limited the ability of the model to differentiate important characteristics of the individual factors influencing linkage. The model is also very sensitive to the time period that it is applied to an organization. The model is like a single snapshot - it describes the levels of observed linkage at a single point in time, but it does not describe what has happened in the past, nor is it prescriptive about the future.

The events at the company point towards two additional causal factors that explain the change in the level of linkage between IT and business objectives; the *attitudes towards IT held by the CEO* and the *increase in the "Information Intensity"* of the company's value chain. I suggest that these two factors exist in other organizations and should be included in the model as additional factors that influence linkage.

Table of Contents

List of Tables

List of Figures

Acknowledgements

I would like to thank the following people:

1. *The Company CIO* - provided me with the opportunity to work on this project with the company and provided assistance and direction throughout.
2. *Al Dexter* - introduced me to the company and acted as my thesis advisor providing me with invaluable advice.
3. *The Executives and Managers of the company* - who spent time to answer questions and helped me to understand the company environment and requirements for mobile computing and communication technology.
4. *Ric Jones of TeleAdapt, Inc. and John Mitchell of Motorola* - provided information about the mobile computing and communication technology industry, the products available on the market and pointed me to other sources of information.
5. *Carson Woo* and *Gordon (Skip) Walter* - members of my thesis committee who provided valuable input to this study.
6. *Blaize Horner Reich* - whose Ph.D. dissertation provided me with an excellent framework for my study.

1. Introduction

"In preparing for battle I have always found that plans are useless, but planning is indispensable."

Dwight D. Eisenhower (1890–1969), US general, Republican politician, President. One of Eisenhower's favorite maxims. Quoted by Richard Nixon in: *Six Crises,* "Krushchev" (1962)

The American Heritage Dictionary (1992) defines planning as follows: "**planned, planning, plans** *verb, transitive*

1. To formulate a scheme or program for the accomplishment, enactment, or attainment of: *plan a campaign.*
2. To have as a specific aim or purpose; intend: *They plan to buy a house.*"

1.1 The Importance of Linkage

There is widespread agreement that planning at all levels of a business can be beneficial. Several surveys (Brancheau and Wetherbe, 1984; Index Group, 1988; Niederman, Brancheau and Wetherbe, 1991) found that Information Technology (IT)[1] planning has been rated as one of the most important issues by IT managers.

[1] Throughout the research on linkage, several terms are used to define the Information Technology (IT) function. Information Systems (IS) and Management Information Systems (MIS) are examples. For consistency, I have chosen to use the acronym "IT" whenever appropriate throughout this paper.

Information Technology (IT) Planning is a critical activity that defines the priorities and actions of the IT department. It is a complex task that has many potential pitfalls (Reich, 1992). One pitfall that is consistently identified as among the top few problems is the linkage of IT plans and objectives to organizational plans and objectives (Galliers, 1987; Lederer and Mendelow, 1986).

1.2 Current Research on Linkage

In the literature there are several terms used to describe linkage: ***coordination*** (Lederer and Mendelow, 1989), ***fit*** (Das, Zahra and Warkentin, 1991) and ***alignment*** (Galliers, 1987; Henderson and Venkatraman, 1989; Henderson and Venkatraman, 1992). The intent of all of these concepts is to describe a connection between plans at different levels within the same organization. The term *linkage* has gained public acceptance, so that is the terminology I will use throughout this study.

The American Heritage Dictionary (1992) defines linkage as follows:

"**linkage** *noun*

1. **a.** The act or process of linking. **b.** The condition of being linked.
2. A connection or relation; an association.
3. A negotiating policy of making agreement on one issue dependent on progress toward another objective."

Linkage, as a theoretical construct applied to IT planning has been described as "the degree to which the IT mission, objectives, and plans reflect the business mission, objectives and plans." (Reich, 1992) In the context of this case study, it is not critical which

words we use to define linkage (e.g. reflect, connect, relate, associate, make dependent, influence, etc.) as there is no intent to quantify or apply a measurement of linkage. The focus of this study is to gain further understanding of the **factors that influence** linkage.

The importance of linkage has been explored both as a general concept and specific to IT planning. Emery (1969) theorized that organizations were systems governed by a hierarchy of plans and that "lower-level activity must be governed by a hierarchy of higher-level planning constraints." Cresap, McCormick and Paget Co. (1983) found that the linkage of IT objectives with business objectives was a critical success factor for IT planning. Davis and Olson (1985) suggest that the organizational strategic plan must be the basis for developing the IT strategic plan. They also state that "alignment of MIS planning is one of the central problems of MIS planning".

Although linkage is considered important, relatively few organizations are successful in creating the linkage between IT plans and business plans. Conrath, Ang, and Mattey (1992/93) found that only 31% of the Canadian respondents based their IT plans on corporate plans. A UK study (Earl, 1987) found that 41% of the respondents linked their IT plans with their long-range business plans. In the US, Cresap, McCormick and Paget Co. (1983) found that when asked if their "IS Plan refers to Business Plans" only 29% answered "applies precisely", 55% responded "applies somewhat" and 16% replied "does not apply".

Reich (1992), in her investigation of linkage, states that "Although the need for linkage has been established and companies report low success rates in attaining it, there are few studies of how companies perceive the linkage issue or how they actually organize and act to achieve linkage." (p. 2)

2. Framework for Analysis

In this study I review current research on factors that influence linkage, document the circumstances surrounding linkage in a single case, analyze the findings of the case based on a proposed model to guide research into linkage, and suggest additional factors that may influence linkage between IT and business objectives.

2.1 Factors that Influence Linkage

There has been a wide range of research into IT planning that provide insights into the factors that influence linkage. To simplify this discussion I have placed the factors into three categories: organizational structure, communication, involvement.

2.1.1 Organizational Structure

Several organizational factors have been suggested as having influence over linkage. Lederer and Mendolow (1989) found that the rank of the Chief Information Officer (CIO) did not affect the level of linkage, but a mandate from the CEO was a significant enabler of linkage. Raghunathun and Raghunathun (1989) found a significant relationship between the level to which the IT plan was linked to organizational concerns and the rank of the CIO, when the CIO reports directly to the CEO. These findings suggest that the CEO plays an important role in establishing linkage, but this role is not clearly defined.

The role of an IT Steering Committee is also unclear. Lederer and Mendolow (1989) found no relationship between the existence of an IT Steering Committee and linkage. Raghunathun and Raghunathun (1988) found a relationship between the existence of an IT Steering Committee and the level to which the IT plan was linked to organization concerns. Gupta and Raghunathun (1989) found a significant relationship between the existence of an IT Steering Committee and the extent of "strategic" IT planning. While consulting, I have worked with over forty organizations that have had IT Steering Committees. My observation is that the existence of a steering committee does not determine whether the steering committee influences linkage. What is important in determining influence is the quality (e.g. the make-up, the mandate, the resources, the authority, etc.) of the steering committee.

A third organizational factor is the level of decentralization of the IT function. Raghunathun (1985) suggested that the more the IT function was integrated into the business, the more likely that IT planning would be done at a "strategic" level.

2.1.2 Communication Between Business and IT Executives

Several studies suggest that the level of communication between IT and business executives has a significant impact on linkage. Calhoun and Lederer (1990) found that high levels of communication of the business plan have a positive impact on the "comprehensiveness" of the IT plan. Lederer and Mendolow (1989) found that lack of communication between the IT function and top management inhibits linkage. Jang (1989) suggest that ease of access by the IT executive to the CEO increases the extent of business strategy in the IT plan. Reich (1992) suggests that communication between business and IT executives will have a direct impact on the level of linkage.

2.1.3 Involvement of Business Management in IT Planning and IT Management in Business Planning

Both direct and indirect involvement have been suggested as factors that influence linkage. Lederer and Mendolow (1989) found that a mandate from the CEO was a significant enabler of linkage and Raghunathun and Raghunathun (1988) found that "top management support" increased the emphasis placed on "strategic" IT planning. These are examples of indirect involvement of executives in the IT planning process.

Direct involvement was explored by Galliers (1987) who found that reported levels of linkage are lower when business planners do not get involved in IT planning and when there is no formal review of IT plans by business executives. Lederer and Mendolow found that lack of IT management involvement in business planning inhibits linkage. Jang (1989) looked at user management involvement in IT planning but did not include this as a factor in the extent of business strategy in the IT planning process. Reich (1992) suggests that the connections between (shared processes) IT and business planning has a direct influence on the level of linkage.

Levels of involvement were explored in several other studies that looked primarily at the "success" rates of various methods of planning. Cresap, McCormick and Paget Co. (1983) found a strong relationship between business planning practices like wide distribution of the business plan, commitment of top management to planning, perceptions that plans were realistic, monitoring performance based on a business plan, and IT planning success. Pyburn (1983) found that the success of IT planning is affected by senior management style and status, and proximity of the IT manager to business executives.

2.1.4 Additional Factors

In the same study Pyburn (1983) also identified complexity of the IT environment and volatility of the business environment as having an impact on IT planning success. Lederer and Sethi (1990) found that the reported level of strategic IT planning was the best discriminator between IT planning satisfaction and dissatisfaction. Reich (1992) suggests that the level of satisfaction with the implementation of previous IT plans affects the level of linkage in current plans.

2.2 An Integrated Model to Guide Research into Linkage

In a very thorough investigation of the linkage between business objectives and IT objectives, Reich (1992) proposed an integrated model to guide research into linkage. Reich (1992) summarized the factors into slightly different categories than I have. The table below shows the equivalent categories that Reich (1992) identified:

Table 1: Comparative Categorization of Factors That Influence Linkage

Comparative Categorization of Factors That Influence Linkage	
Horspool	**Reich**
• Organizational Structure	• Characteristics of IT in the Organization
• Communication between IT and Business Executives	• Communication between IT and Business Executives
• Involvement of Business Management in IT Planning and IT Management in Business Planning	• Connections between the IT and Business Planning Systems
• Additional Factors	• External Influences • Implementation of Previous IT Plans

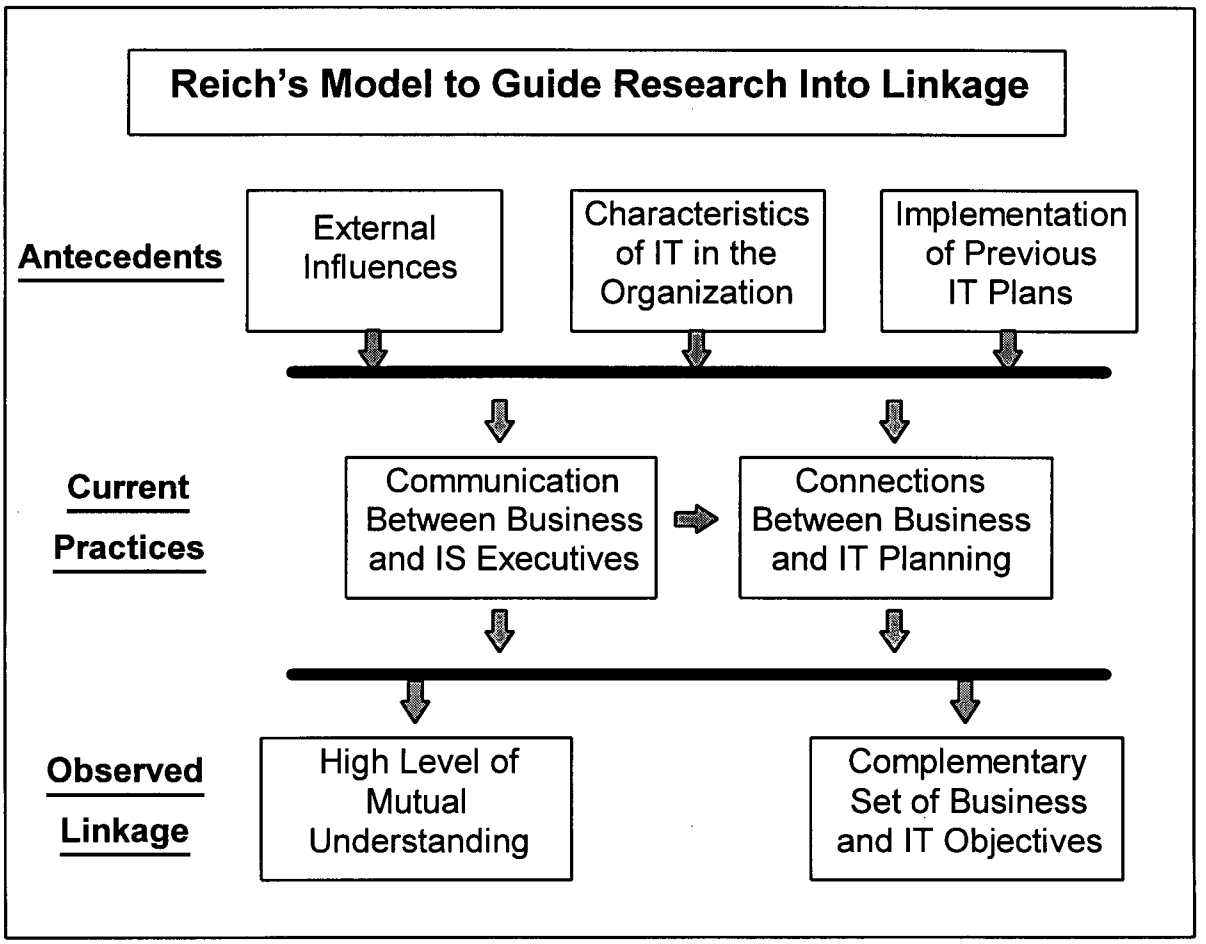
There is little difference between the categorizations. The following table from Reich's (1992) analysis shows the complete list of factors identified in current research which may influence linkage and places each factor in the appropriate category:

Table 2: Factors Which May Influence Linkage (Reich, 1992)

Factors Which May Influence Linkage	
Factor Group	**Independent Variable**
External Influences	• environmental turbulence • complexity of the IT environment
Characteristics of IT in the Organization	• maturity of the IT function • perceived strategic grid position • infusion and diffusion of IT in the organization • IS-knowledgeable line manager
Connections between the IT and Business Planning Systems	• availability of the business plan to IT planners • timing between IT and business planning • particular methodologies or techniques which connect IT planning and business planning • involvement of senior management and business planners in IT planning • involvement of the senior IT manager in business planning • review and approval of the IT plan • monitoring the progress of the IT and business plan
Communication between IT and Business Executives	• access/proximity of the senior IT manager to senior management • top management support for IS • status/reporting level of the senior IT manager • presence, composition and usage of the IT Steering Committee
Implementation of Previous IT Plans	• level of success in implementing the IT plan

Based on the above construct definitions, Reich (1992) proposed the following model to guide research into linkage:

Figure 1: Reich's (1992) Model to Guide Research Into Linkage



In this model the factors are divided into two stages: Antecedents and Current Practices. The Antecedents are anticipated to affect the dependent variable (observed linkage) indirectly, through their impact on Current Practices, while Current Practices are anticipated to have a direct impact on observed linkage.

I selected this model for analysis in this case study because, in my experience, it has a high degree of face validity. While consulting to business organizations, I repeatedly saw the behaviours described by Reich's (1992) model to guide research into linkage and the resulting success or failure of the IT strategy.

Reich's (1992) study focused "on the measurement of the "social process" dimension of linkage." The original model to guide research into linkage was modified to exclude the "External Influences" and "Characteristics of IT in the Organization" factors, and to include another factor, "Shared knowledge between Business and IS Executives".

Reich (1992) found that linkage between IT and business objectives could not be treated as a single construct across an organization. Instead, it was made up of linkage between Corporate IT and Corporate Business objectives, as well as linkage between Corporate IT and Business Unit objectives. There was a difference in the perceptions of linkage between corporate executives and business unit executives.

At the corporate level, Reich (1992) found that "the involvement of the CEO in the management of IT had a direct result on communication, connections in planning and, ultimately, on the mutual understanding dimension of linkage. ... In an environment characterized by an involved CEO, the corporate IS group created and enforced strong policies and programs." (p. 372)

At the business unit level, she found that the existence of a corporate "double-bind" (Argyris, 1970) had an indirect influence on the level of linkage. An IT related corporate double-bind occurs when IT managers at the business unit level desire stronger leadership

at the corporate level, but at the same time, resent and resist any displays of corporate leadership that limit their autonomy. In other words, business unit IT managers say one thing (e.g. "we want leadership from head office"), but do another (e.g. ignore or resist requests from head office).

At both levels Reich (1992) found that shared experience between business and IS executives increased the observed level of linkage. At the corporate level it was also found that shared expectations about the value of IT between business and IT executives was an emergent factor.

3. Research Methodology

3.1 Objective of the Study

The intent of this study is to increase our understanding of linkage between IT objectives and business objectives and the factors that influence this linkage. The approach I will follow is to apply Reich's (1992) model to guide research into linkage to the circumstances of a single case, analyze the findings of the case based on the proposed model to guide research into linkage, and propose additional factors that may influence linkage between IT and business objectives that are suggested by the analysis of the case.

3.2 Case Selection

The company[2] management offered to participate in a study because of established relationships with the University of British Columbia Faculty of Commerce and Business Administration. The company management had a specific technical problem. In the process of assisting them with their problem I was able to gather data on the issue of linkage between IT and business objectives.

As part of long term (three to five years) IT planning the company CIO initiated a project to review and upgrade their corporate wide telecommunication capabilities. A significant short term (within one year) goal of this project was to create a toolkit of technology (laptop computer, modem, cables and adapters) that could be carried by traveling executives and

[2] To protect the identity of the company and the individuals involved in this case I will address the subjects as "the company", "the CEO", "the CIO", etc..

geophysicists to enable world-wide access to the company's voice and data network. It was in the course of assisting them with this project that the study evolved into a review of linkage between IT and business objectives. The detailed description of this case is in Appendix 1. The activities and scope of the project are described in the "Project Charter" in Appendix 2.

3.3 Data Collection

There were two methods of data collection used in this study; review of existing documentation and structured interviews with informants. The company does not currently have, nor has it ever had, a corporate-wide IT planning process that produces documented plans; therefore the interviews were the primary source of information.

3.3.1 Documentation

As mentioned, the company does not have a corporate-wide IT plan. I was not able to gain access to the company business plan. The documents that were helpful in verifying the findings of the interviews were published documents, such as the company Annual Statement and 1995 Corporate Profile, and internal documents, such as the Request for Proposal sent out to several telecommunications organizations and the list of hardware and software used by all the different the company divisions.

3.3.2 Interviews

Interviews were conducted with a wide range of informants within the company. In total eleven interviews were conducted with seven individuals from different levels and divisions within the company. The range of interview subjects allowed me to increase the level of

confidence I had in the informants' comments and identify differences in opinion within the organization.

Since the sanctioned scope of the company project was focused on mobile computing and communication technology the primary focus of the interviews was also on mobile computing and communication technology. A customizable interview guideline is included in Appendix 3 and the results of the interviews are included in Appendix 4.

The primary users of mobile computing and communication technology within the company are executives and geophysicists. The IT management is responsible for delivering this capability. As will be discussed later in this report, it is the strategic nature of the mobile computing and communication technology objectives that evolved this project into a study on linkage.

The following table lists the individuals that were interviewed:

Table 3: List of Informants

List of Informants	
The Company	• Chief Executive Officer • Chief Financial Officer • Corporate CIO - (*primary informant*)
Division 2	• Chief Geophysicist • Geophysicist
Division 1	• IT Manager • IT Technical Support

4. Findings

This chapter has two sections. In the first section I examine the case description and summarize the facts and events that appear to have some influence on the linkage (or lack of linkage) between IT and business objectives. In the second section I analyze the case using Reich's (1992) model to guide research into linkage.

4.1 Findings From the Case

I have summarized the key findings from the case that are pertinent to this study. The detailed description of the case is included in Appendix 1.

4.1.1 The Company Business Objectives

The published business goals and objectives of the company are to sustain significant growth while maintaining cost control. This growth in production will come from locations around the world that are not yet determined. This growth will continue to be managed in a decentralized manner.

Key finding:

- These objectives all point to an increased requirement for communication and coordination throughout the company. As stated by the CEO and the CFO, mobile communication and computing technology will play a vital role in enabling the management at the company to meet these goals and objectives.

4.1.2 Executive Perspective

During the interviews with the company executives several benefits of mobile computing and communication technology to the company were identified. The CEO of the company identified "staying in contact" and responding quickly to requests as key benefits. He added that communication is a key to staying successful and also "a great stress reliever". The VP of Finance of the company stated that a common problem for the company executives is that they are out of the office for weeks at a time and most of their mail just waits until they return. He saw mobile computing as part of a solution that would enable them to deal with this and provide faster response.

However, while the CEO currently uses a laptop and carries it with him when he travels, and is "very dependent" on electronic mail - not all of the company executives like to use it. There was a recent example of a five day delay between the time an important electronic mail message was sent between executives, and the time it was read. This and other similar examples have undermined the perception of reliability of using electronic mail. The CFO states that he is very concerned about the level of service and reliability of their voice and electronic mail system. Among the majority of the executives there is still a degree of fear and a lack of understanding of the capabilities of this type of technology. Some of the executives never carry a laptop with them.

Key Finding:

- There is no consensus among the executive group at the company about the importance of mobile computing and communication technology and a corporate wide data communication infrastructure.

- The current CEO is a strong advocate of mobile computing and communication technology and is pushing the rest of the executive group to take advantage of new technologies.
- The CEO is knowledgeable about IT and convinced of the importance of IT, but this awareness and attitude about IT is not shared by all of the executives.

4.1.3 The Company Information System Environment

The history of decentralized management has resulted in the IT staff of divisions, branch offices and mine sites installing computer hardware and networks that focus on solving local problems without concern for the impact on inter-office and corporate-wide data communications.

Key Finding:

- The decentralized management approach has impinged on the company's data communication network evolution. Only recently has upper management recognized this as a problem and initiated a project to review and upgrade the corporate wide telecommunication capabilities.

4.1.4 The Company Computer and Network Systems

Each division has its own IT network and staff. There is a mix of UNIX systems, IBM compatible PC's, MAC PC's and proprietary systems, like the IBM AS/400. The systems are connected on a variety networks including Novell Netware, Sun TCP/IP, PC-NFS,

Appletalk and others. Most, but not all, electronic mail is done using Lotus cc:Mail and there is limited use of Lotus Notes for document sharing.

At the present time the company has no coordinated data communication infrastructure. This leaves the company in a very difficult position for implementing corporate wide data management. Currently data communication from one corporate location to another is difficult, and cross location data management is almost impossible. Upper management is aware of this and is taking steps to move towards a more cohesive IT strategy. A CIO has been hired to represent the corporate-wide view of IT and establish architectural and technical standards that will enable a data communication infrastructure.

Key Finding:

- The company fits in the "Turnaround" quadrant of the Strategic Grid framework (McFarlan, McKenney and Pyburn, 1983),. In the past the company has viewed IT as an expense that will help to make operations more cost effective, but not as a strategic investment that improves the company's competitive position.

An example of the importance of data management to the company comes from the interview with the Chief Geophysicist. One of the keys to effective mineral exploration and production is timely analysis of accurate data about potential and established mineral sites. Currently, accessing data that is stored at another location often takes days and uses time that would be better spent on data analysis.

Key Finding:

- Exploration and production data is perceived as strategic by users of the data and some executives, but not by IT managers or other executives.

Another significant impact of the lack of IT infrastructure is that the company executives and geophysicists visiting branch locations cannot use the computers at the remote location to access their electronic mail and data files. They even have difficulties using their laptops in the remote offices.

Key Finding:

- Expectations of users of mobile computing and communication technology have far outstripped the company capability to support mobile computing and communication technology.

In the past there has been little coordination of the hardware and software installed across the divisions. In this environment mobile data communication will, by definition, be limited to electronic mail access and file transfer until the company builds up the IT infrastructure.

Key Finding:

- In the past there has been no executive level focus or support or mandate for the company to put a data communication infrastructure in place.

4.1.5 The Company's Current use of Mobile Computing Technology

The company does not currently have a corporate strategy for enabling mobile computing and communications.

One important finding from my interviews is that there are many pockets of expertise on mobile computing throughout the company and its divisions. There are many geophysicists that have spent years in the field who have had to come up with creative solutions to enable remote communications. There are also IT technical people who have had to respond to requests from traveling executives and managers. As a result there are many different pieces of hardware and software being used across the company for mobile computing and communication.

Key Finding:

- In the absence of a corporate strategy piecemeal solutions have been used to fill the demand for mobile computing and communication technology.

Several of the interviewees reported a sense of distrust with the company's electronic mail system as an explanation of why some of the executives do not travel with laptops. Most blamed this distrust on behaviour (others not reading or responding to electronic mail in a timely fashion) but one executive felt the system itself was unreliable. Whatever the reason for the distrust, it is certainly undermining the effectiveness of the company's electronic mail system. The company will need an effective electronic mail system if they hope to have effective mobile communications.

Key Finding:

- In the absence of clear executive support for a corporate data communication infrastructure the resulting attempts to provide mobile computing and communication technology have undermined the effectiveness and credibility of the IT staff and the technology.

The geophysicists rely more heavily on computers. Laptops are always carried while traveling, but they experience the same frustrations while trying to establish a modem connection in many of the destination countries. They have taken more advantage of global network systems, such as the Internet and CompuServe, to enable access to electronic mail and data file transfer.

At remote locations (e.g. exploration sites) some satellite telephone technology is currently used although, according to some of the executives I spoke with, this is not a technology that is well understood or used extensively. The company does not currently have a standard configuration of telephone, computer and software that they use at remote project locations.

Key Finding:

- The professional staff at the company who have more computer expertise and experience found their own alternate solutions to mobile computing and communication technology. While IT Management stated that use of the Internet was "limited" and that sending corporate data over open networks like Internet and CompuServe was not appropriate, the geophysicists were doing it all the time because it worked!

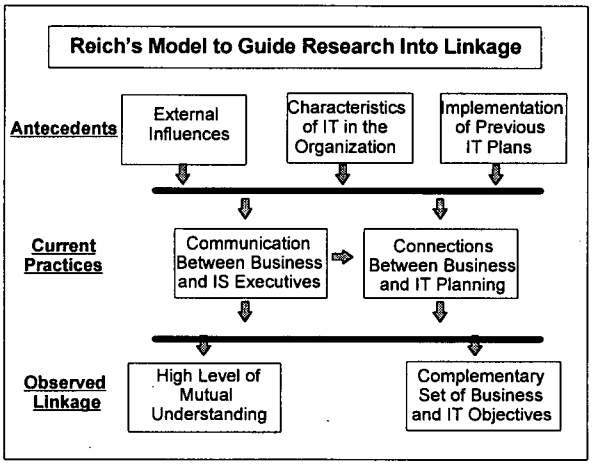
Table 4: Summary of Key Findings

Summary of Key Findings	
Business Objectives	• These objectives all point to an increased requirement for communication and coordination throughout the company organization. As stated by the CEO and the CFO, mobile communication and computing technology will play a vital role in enabling the management at the company to meet these goals and objectives.
Executive Perspective	• There is no consensus among the executive group at the company about the importance of mobile computing and communication technology and a corporate wide data communication infrastructure. • The current CEO is a strong advocate of mobile computing and communication technology and is pushing the rest of the executive group to take advantage of new technologies. • The CEO is knowledgeable about IT and convinced of the importance of IT, but this awareness and attitude about IT is not shared by all of the executives.
Information System Environment	• The decentralized management approach has impinged on the company's data communication network evolution. Only recently upper management recognized this as a problem and initiated a project to review and upgrade their corporate wide telecommunication capabilities.
Computer and Network Systems	• If we analyze the company using the Strategic Grid framework the company clearly fits in the Turnaround quadrant. In the past the management has viewed IT as an expense that will help to make operations more cost effective, but not as a strategic investment that improves the company's competitive position. • Exploration and production data is perceived as strategic by users of the data and some executives, but not by IT managers or other executives. • In the absence of clear executive support for a corporate data communication infrastructure the resulting attempts to provide mobile computing and communication technology have undermined the effectiveness and credibility of the IT staff and the technology. • In the past there has been no executive level focus, support or mandate for a data communication infrastructure.
Current Use of Mobile Computing Technology	• In the absence of a corporate strategy piecemeal solutions have been used to fill the demand for mobile computing and communication technology. • In the absence of clear executive support for a corporate data communication infrastructure the resulting attempts to provide mobile computing and communication technology have undermined the effectiveness and credibility of the IT staff and the technology. • The professional staff at the company who have more computer expertise and experience found their own alternate solutions to mobile computing and communication technology. While IT Management stated that use of the Internet was "limited" and that sending corporate data over open networks like Internet and CompuServe was not appropriate, the geophysicists were doing it all the time because it worked!

4.2 Case Analysis Using Reich's (1992) Model to Guide Research Into Linkage

Figure 2: Reich's (1992) Model to Guide Research Into Linkage (condensed)

In this section I will analyze the situation at the company using Reich's (1992) model to guide research into linkage. While looking at each proposed factor that may influence linkage I will also examine Reich's (1992) propositions for the accuracy of their predictive power.



4.2.1 External Influences

Environmental Turbulence

- The company has faced a period of relative stability over the past decade. Prices and demand for gold has remained high and the company has been consistently profitable. There have been some significant changes, such as, access to new exploration territory (former USSR), and increased globalization, but the company's business has not changed dramatically.

Complexity and Turbulence of the IT Environment

- There a two aspects of the IT environment that impact the company: the administrative support systems and the exploration / production systems. A single location (branch office or mine site) does not require complex IT systems, but when the company is

compared with other multinational companies who use corporate-wide Decision Support and Executive Information Systems, the environment can be characterized as complex. As well, the company's geophysicists are using state of the art exploration and production systems to evaluate potential mine sites. This is very complex, specialized technology which is experiencing a period of high turbulence.

Reich (1992) suggests that external influences have an *indirect* effect on linkage by affecting current practices. She makes two propositions about external influences. "In a turbulent IT and business environment, one might expect that companies (in which IT is of critical importance) will: ... [1] have their IT and business planning systems tightly connected ... although both may be short term in nature, and ... [2] exhibit high levels of communication between IT and business executives". (p. 30-31)

Reich's (1992) propositions do not take into account any differences in the level of turbulence between the business and IT environments. Since the company has a relatively stable business environment but an increasingly complex and turbulent IT environment, the propositions are not predictive of the circumstances at the company. It could be argued that these propositions suggest that, since IT is not of critical importance to the company, IT and business planning systems will not be tightly connected and there will not be high levels of communication. In this case this is true.

The company has had no connection between IT and business planning and very little communication between IT and business management until recently. Another explanation might be that the company has been operating profitably in a stable environment. There has been little motivation for doing things in an innovative way.

4.2.2 Characteristics of IT in the Organization

Maturity (Level of Sophistication) of the IT Function

- The term "maturity" creates some confusion. In the development of the model to guide research into linkage, Reich (1992) refers to the maturity of the IT function as being a measurement of age (in number of years). In industry, the term maturity is typically used to indicate a well-managed and effective IT function. Jang (1989) concluded that the extent of business strategy in the IT planning process is a function of IT access to business management and the maturity of the IT function. He defined maturity as a function of the sophistication of data processing, telecommunications and office automation.
- To be clear, I will refer to the level of *sophistication* of the IT function. I did not look at the office automation technologies at the company, but I looked briefly at data processing and extensively at telecommunications. Although there are individual users (e.g. some geophysicists) who are very sophisticated users, overall the level of sophistication of data processing and telecommunications across the company is low.

Perceived Strategic Grid Position

- As mentioned in my key findings the company perceives itself as being in the Turnaround quadrant of the Strategic Grid model. Hiring a corporate IT Manager and initiating the telecommunications infrastructure review represent the beginning of the strategic investment in IT by the company.

Infusion and Diffusion of IT in the Organization

- Infusion, as defined by Sullivan (1985), is the "strategic value of IT to the company". The company shows low infusion. The company executives have regarded IT as an accounting function for decades and only recently started to view IT as having strategic value.
- Diffusion, as defined by Sullivan (1985), is the level of distribution of IT technology throughout the company. The company cannot be described as having *either* high or low levels of diffusion, because it exhibits both. The technical areas of the company (engineering and exploration) have very high diffusion of IT while the rest of the company (administration, finance, marketing, etc.) has very low diffusion of IT.

IS-Knowledgeable Line Managers

- The company is typical of other companies in the mining and petroleum industries. Management in the operation and production divisions of the organization have little experience with IT, but managers on the exploration side are highly technically competent and highly dependent on IT. The operations managers come from mining, logistics and finance backgrounds while the exploration managers have geophysical and engineering backgrounds.

Reich (1992) suggests that this factor will have an *indirect* effect on linkage and makes three propositions about the characteristics of IT within the organization: 1) "Organizations in which IT is mature, highly diffused, and perceived to be central to organizational objectives would exhibit higher levels of connection between business and IT planning systems", (p. 31) 2) "Organizations exhibiting high levels of diffusion or infusion of IT within the organization will exhibit high levels of communication between IS and business

executives", (p. 31) and 3) "Organizations in which there is a high level of shared experience among the senior business and IS executives will lead to high levels of communication between them." (p. 31 - 32)

As described above, the situation at the company is that the IT function is not sophisticated, there is low infusion of IT, and there are mixed levels of diffusion of IT across different functional areas. There has been little connection between business and IT planning and little communication between the company executives and IT management.

With the exception of the mixed levels of diffusion of IT, Reich's (1992) propositions are consistent with the circumstances at the company. An IT function that is not sophisticated, and has low levels of infusion and few shared experiences between IT and business management results in little connection between IT and business planning, and little communication between IT and business executives.

4.2.3 Implementation of Previous IT Plans

Level of Success in Implementing the IT Plan

- At the company there are no corporate IT plans. Each division of the company has reacted to local problems and issues. The new CIO was recruited from *outside* of the company. The inference is that company executives do not have a positive view of the capabilities of the IT managers and could not claim that IT has a track record of success in helping the company meet its strategic objectives.

Reich (1992) suggests that this factor will have an *indirect* effect on linkage and makes the following propositions about success in implementation of previous IT plans: 1) "A recent history of strategic IT success will lead to tighter connections between IT and business planning", (p. 32) and 2) "A recent history of operational IT success will lead to increased levels of communication between IS and business executives. Conversely, a history of operational IT failure will lead to reduced levels of communication between IS and business executives." (p. 32)

Reich's (1992) final statement that operational IT failure will lead to reduced levels of communication between IT and business executives turns out to be the exact opposite of the circumstances at the company. When the level of IT failure (specifically, the inability of executives and senior geophysicists to effectively communicate data and e-mail from outside of head office) was perceived to have a negative impact on the company, the executives acted to fix the problem. They hired an IT Manager who reports to the corporate executive group and has better access and more frequent communications with the executives.

4.2.4 Communication Between IT and Business Executives

Access / Proximity of the Senior IT Manager to the Senior Management

- In the past IT mangers at the company had no access or proximity to senior management. IT managers were relegated to the role of administrative support in the divisions of the company. Typically they reported to the Finance department at the division level. Today there is a CIO at the corporate level who reports to the CFO. In several visits to the company my perception is that the CIO still does not have free

access to the executive group. The CIO's office is several floors away from the executive offices.

Top Management Support for IT

- There has not been consistent support for IT at the executive level at the company. The current CEO is attempting to change this, but many of the other executives still do not appear to recognize the importance of the IT function.

Status / Reporting Level of the Senior IT Manager

- As discussed, the company has never had a CIO responsible for IT across the entire organization until this year. The recently hired CIO now reports to the VP of Finance of the company.

Presence, Composition and Usage of the IT Steering Committee

- The company does not have, nor did I find any evidence that they ever had, an IT steering committee.

Reich (1992) suggests that this factor will have *direct* affect on linkage and makes two propositions about communication between IT and business management; 1) "high levels of communication will lead to high levels of connection between the IT and business planning systems", (p. 32 - 33) and 2) "high levels of communication will lead to high levels of mutual understanding of objectives and similar visions of the future role of IT." (p. 33)

In this instance the propositions are strong predictors of the circumstances at the company. There were low levels of communication between IT and business management and little or

no connection between IT and business planning systems, and low levels of mutual understanding of objectives and vision about the future of IT at the company.

4.2.5 Connections between the IT and Business Planning Systems

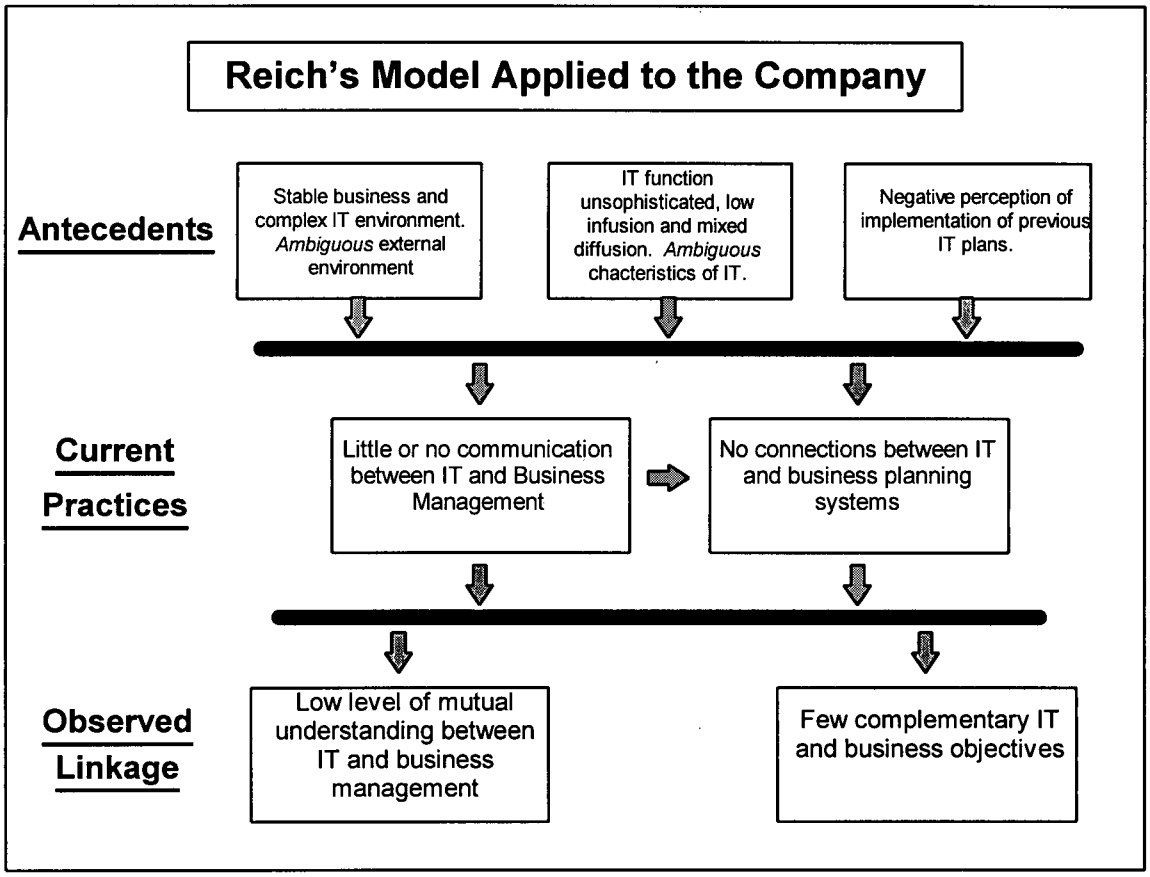
There are many individual factors (see Table 2) that Reich (1992) combines to define this construct. I will not list each of these individual factors because none of these factors are applicable at the company. The company has not done any IT planning at the corporate level and, since there has never been a corporate level CIO, the CIO has never been involved in the business planning. The newly hired CIO has several immediate objectives, one of which is to create the first strategic IT plan for the company.

Reich (1992) suggests that this factor will *directly* influence linkage and makes two propositions about the connections between IT and business planning systems; 1) "high levels of connection between business and IT planning systems will lead to a high quality, complementary set of IT and business plans", (p. 33) and 2) "high levels of connection between business and IT planning systems will lead to high levels of mutual understanding and a shared vision for IT between IS and business executives." (p. 33)

These propositions are strongly predictive of the circumstances at the company. There are low levels of connection between business and IT planning and no complementary sets of IT and business plans, little mutual understanding, and no shared vision for IT between IT and business executives. This situation is starting to improve with the hiring of the CIO.

4.2.6 Summary of Case Analysis

Figure 3: Reich's (1992) Model to Guide Research into Linkage Applied to The Company



When applied to the company, this model to guide research into linkage appears to be consistent and predictive except for two aspects: differences in the level of turbulence between the business and IT environments, and the mixed levels of diffusion of IT. The constructs "external environment", and "characteristics of IT in the organization" are both amalgamations of several contributing factors. This amalgamation in the definition of the constructs and in Reich's (1992) propositions assumes congruency between levels of turbulence in an organization's business and IT environment, as well as, between infusion and diffusion of IT.

5. Conclusions

In this section I have several observations about Reich's (1992) model to guide research into linkage and some conclusions based on the analysis of the company, including suggestions for additional factors that should be considered for their influence on linkage, and suggestions about further research into linkage.

5.1 Observations About Reich's (1992) Model to Guide Research Into Linkage

Reich's (1992) model to guide research into linkage goes a long way in explaining the factors that influence linkage of IT and business objectives. Reich (1992) has done a very complete review of existing research on IT planning and the concept of linkage, and developed a comprehensive model that builds on the research. Two observations I have about the model to guide research into linkage are in regard to; 1) the grouping of factors, and 2) the impact of time.

5.1.1 The Grouping of Factors

Reich's (1992) model to guide research into linkage combines many of the factors that were treated as separate constructs in other research. The analysis of the company uncovered two cases where combined factors limited the ability of the model to differentiate important characteristics of the factors influencing linkage. The two conflicts occurred in the analysis of the factors "External Influences" and "Characteristics of IT in the Organization".

The External Influences factor was defined as containing "environmental turbulence" and "complexity of the IT environment". Environmental turbulence was referred to as "a turbulent IT and business environment". This definition assumes congruency between the levels of turbulence in the business and IT environments. The company was found to have a relatively stable business environment, but a turbulent and complex IT environment. It is unclear from the model how the single External Influences factor can (or if it should) reflect these ambiguous contributing factors.

A similar situation arises in the Characteristics of IT in the Organization factor. This factor is defined by combining several related factors including infusion and diffusion of IT, and levels of decentralization of the IT function in an organization. The company was found to have little infusion of IT, mixed levels of diffusion of IT and high levels of decentralization of the IT function. Again, it is unclear from the model how the single Characteristics of IT in the Organization factor can (or if it should) reflect these ambiguous contributing factors.

By combining fifteen different factors affecting linkage, studied in fourteen different research papers, into five constructs representing factors that influence linkage between IT and business planning, Reich (1992) was able to greatly simplify and clarify how linkage is created. The trade off is that the model may have lost some ability to differentiate certain relevant circumstances.

5.1.2 The Impact of Time

The second observation I have about the model to guide research into linkage is that descriptions of the levels of linkage are sensitive to the time period that the model is applied

to an organization. In this case the model was applied as a single snapshot - it describes the levels of linkage at a single point in time, but it does not describe what has happened in the past, nor is it prescriptive for what should happen in the future.

The situation at the company reveals this aspect of the model in the analysis of the factor "Communication Between IT and Business Management". The company has a history of no communication between IT and business management. This was not a conscious decision on the part of the company executives to manage the IT function in this way, it was simply an outcome of their reliance on a highly decentralized management style. Very recently, the company started to increase the level of communication between IT and business management which, in turn, appears to be increasing the connection between IT and business planning.

By measuring the level of communication and connection between IT and business management and planning today, the model would suggest that the company will have some evidence of linkage. A measurement from one year ago would suggest that there was no linkage. If we use the model to guide research into linkage to analyze linkage at several points in time and use it as a tool to pinpoint different levels in the various factors that influence linkage, it may prove more useful than a single snapshot. Reich (1992) did measure various factors over time in order to make some inferences about causality.

The context of this change in the level of communication and connection between IT and business management at the company is the strong demand by senior executives and geophysicists for a corporate-wide data infrastructure that will support their needs and requirements. During the interviews the executives voiced concern over the ability of the IT

function to deliver. Reich (1992) suggests that "a history of operational IT failure will lead to reduced levels of communication between IT and business executives". This turns out to be the exact opposite of the circumstances at the company. When the level of IT failure (or inability to deliver) was perceived to have a negative impact on the company executives, the executives acted to fix the problem. They hired a CIO who reports to the corporate executive group and has better access and more frequent communications with the executives.

5.2 Conclusions From the Case Analysis

The analysis of the company using the model to guide research into linkage show us that the company has had, in the past, little or no linkage between IT and business plans, but is currently attempting to increase this linkage. So far I have explored the factors influencing linkage and discussed the way they have changed over time, but I have not discussed an explanation for the change in linkage at the company.

5.2.1 Additional Factors that Affect Linkage

The events at the company point towards two major causal factors that explain the change in attitude of the company executives towards the importance of linkage between IT and business objectives:

- the attitudes towards IT held by the CEO and;
- the increase in the "Information Intensity" of the company's value chain.

When I interviewed the current CEO of the company I was struck by how comfortable and knowledgeable he is with computers and IT. He is one of the most progressive and persistent of the company executives in using mobile computing and communication technology. He carries his laptop computer with him whenever he travels. When confronted with a technical problem he attempts to solve the problem himself - he even carries a variety of cables, adapters and screwdrivers with his laptop.

The CEO joined the company in 1994. He is very different than his predecessor in his attitudes towards IT. The CEO is the person at the company who made the decision to hire the corporate CIO. He is the one who is advocating the use of electronic mail and mobile computing and communication technology by the executive group and is setting the example through his daily reliance on IT. He is the executive that has voiced concern over the inability of the various IT functions in all the different divisions of the company to share data quickly and effectively.

I believe that the interaction and influence between executives at the company is typical of most organizations. The CEO has a significant influence on the attitudes of the entire executive group towards the importance of IT. The CEO can be the determining factor in the level of infusion of IT in an organization. Most importantly, it is the CEO who can make quick decisions, such as the decision to hire a corporate CIO and change the reporting structure of IT at the company. It is this type of change that will create the levels of communication and connection between IT and business management that is required to achieve effective linkage.

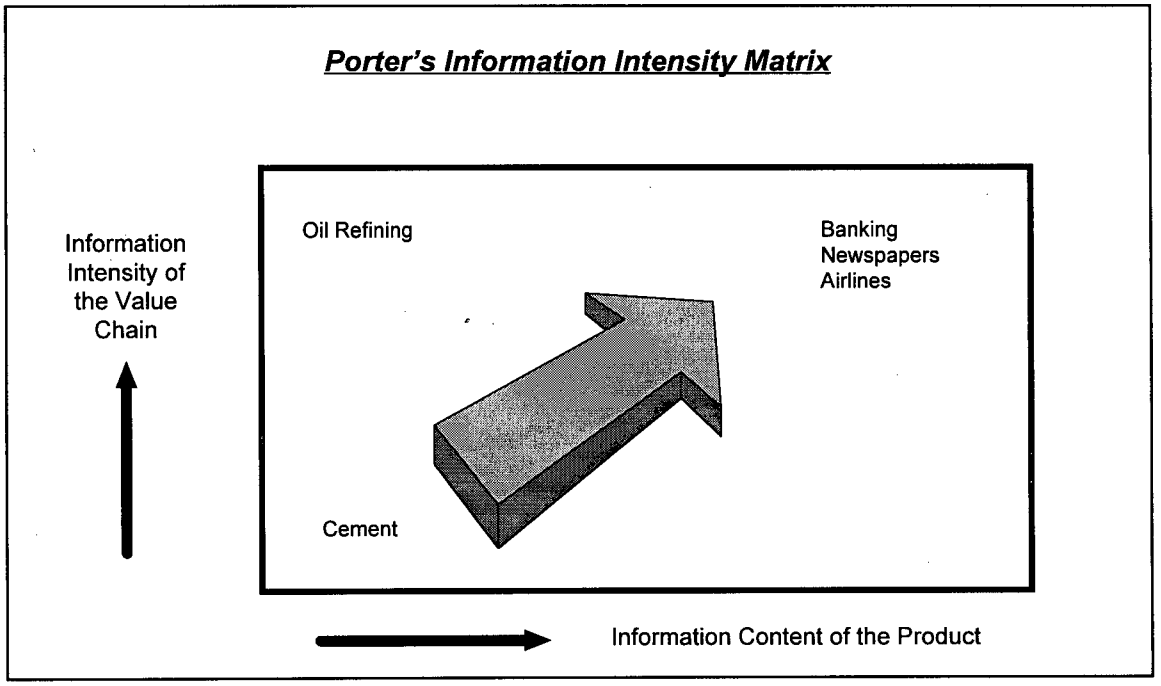
Hypothesis:

- The attitudes of the CEO towards IT is *the most significant* direct factor in determining the level of linkage between IT and business planning. I expect that a high level of IT knowledge and a positive attitude towards IT by the CEO will lead to increased linkage, while a low level of IT knowledge or negative attitudes towards IT will lead to decreased linkage.

Reich's (1992) study showed that "shared experience between business and IS executives" and "shared expectations about the value of IT" were both emergent factors that influenced the level of linkage. These may explain part of the influence of the CEO. I suggest that CEO attitudes should be explored as a separate construct.

The second factor that influenced the change in attitudes of the executive at the company towards IT, the increase in the increase in the "Information Intensity" of the company's value chain, was more subtle. Porter (1985) developed the following model:

Figure 4: Porter's Information Intensity Matrix



Porter (1985) suggests that, in general, products and services are moving towards the upper right side of this graph - the level of information required to produce products and services, and the information content of the products and services is increasing over time. He also segments industries in the same way.

In the mining industry the information content of the products has remained relatively constant, but the level of information used to locate, extract and refine minerals has increased dramatically. The technology used to increase the efficiency and effectiveness of the exploration and production process has become very complex and heavily reliant on computers for information processing. At the company, the geophysicists spend more time on their computers acquiring, manipulating and analyzing data than they spend in the field looking at rocks! This has had a dramatic impact on view of the technical staff about the importance of IT.

This change in perception at the technical level is also filtering up through the organization and having an influence on the perceptions held by executives. The increase in the level of information used to locate mineral deposits has had an indirect effect on the linkage between IT and business planning by raising the level of awareness of executives about the importance of IT.

I believe that we can apply this model to other organizations and define another factor that influences the linkage between IT and business planning:

Hypothesis:

- A high level of information intensity in the value chain or high information content of products or services has an indirect effect on linkage between IT and business planning by raising the awareness of the executives about the importance of IT.

5.2.2 Further Research into Linkage

Both of the hypothesis stated above represent opportunities for further research into linkage. The first hypothesis could be tested by looking at the level of linkage exhibited in organizations with CEO's with a high level of IT knowledge and a positive attitude towards IT versus those with a CEO with a low level of IT knowledge or a negative attitude towards IT. The second hypothesis could be tested by looking at organizations with a high level of information required to produce products or services or high information content of products or services versus those with a low level of information required to produce products or services or low information content of products or services. The difficulty in both cases will be holding all other factors constant so that we can isolate the effect of the factors being tested.

Another area that requires further research is the question of the impact of time on the analysis of linkage. There is a requirement for longitudinal work to gain a better understanding of the way levels of linkage change over time. By understanding why changes happen we can create better strategies to increase levels of linkage. Reich's (1992) model to guide research into linkage may be an effective tool to aid in this longitudinal research.

6. Summary

The objective of this study is to increase our understanding of linkage between IT objectives and business objectives and the factors that influence this linkage.

Reich (1992) defines linkage between IT and business planning as a combination of two observable factors: mutual understanding between IT executives and business executives, and high quality sets of IT and business missions, objectives and plans. Past research has shown repeatedly that linkage is desirable. It has also shown that most organizations do not do an adequate job of creating and maintaining linkage between IT and business plans.

In this study I used Reich's (1992) model to guide research into linkage in order to analyze a single case and look for additional factors that influence linkage. I found the model to guide research into linkage to be consistent and predictive except for two aspects: levels of turbulence in the business and IT environments, and the mixed levels of diffusion of IT. The constructs "external environment", and "characteristics of IT in the organization" are both amalgamations of several contributing factors. This amalgamation in the definition of the constructs and in Reich's (1992) propositions assumes congruency between levels of turbulence in an organization's business and IT environment, as well as, between infusion and diffusion of IT. This assumption of congruency became problematic in this case.

I suggest two additional factors that influence linkage and require further research. I believe that the attitude of the CEO towards IT is *the most significant* direct factor in determining the level of linkage between IT and business planning, and that a high level of information intensity of the value chain, or high information content of products or services has an

indirect effect on linkage between IT and business planning by raising the awareness of the executives about the importance of IT.

6.1 Implications for IT and Business Executives

The focus of business and IT executives should be on increasing the level of linkage in their organizations. Reich's (1992) model to guide research into linkage suggests five key factors as having influence. Two of these factors (external influences and past implementation), cannot be changed. The other three factors (characteristics of IT, communication between IT and business management and connections between IT and business planning systems) are essentially political processes.

Common sense tells us that in many situations the fastest way to cut through politics is to go directly to the most senior decision maker - the CEO. This case study documents a situation where a change in the CEO created a dramatic change in the level of linkage between IT and business planning. One implication is that to increase linkage, the most efficient and effective way may be to increase the level of knowledge about IT held by the CEO.

7. Bibliography

The) American Heritage® Dictionary of the English Language, Third Edition copyright © 1992 by Houghton Mifflin Company. Electronic version licensed from InfoSoft International, Inc. All rights reserved.

Argyris, C., Innovation, Technology Communications Inc., 1970

Baker, Paul, "Cost Remains the Biggest Inhibitor", Computing Canada, 21:6 (1995): 39

Berman, A.S., "The Quest for the Universal In-Box", Communications Week, 545 (1994): 50

Brancheau, J.C., and J.C. Wetherbe, "Key Issues in Information Systems - 1986", MIS Quarterly, 11:1 (1987): 23-46.

Calhoun, K.J., and A.L. Lederer, "From Strategic Business Planning to Strategic Information Systems Planning: The Missing Link", Journal of Information Technology Management, 1:1 (1990): 1-6.

Chernicoff, David P., "CDPD Two-way Wireless Service Will Keep Remote Workers Connected", PC Week, 12:10 (1995): 12

Cinnock, Chris, "Color to Go", Byte, 20:6 (1995): 115-126

Clarke, Peter, "Satellite Group Tips Mobile-Phone Plan", Electronic Engineering Times, 817 (1994): 32

Conrath, D.W., J.S.K. Ang, and S. Mattey, "Strategic Planning for Information Systems: A Survey of Canadian Organizations", INFOR - The Canadian Journal for Information Processing and Operations Research, 1992/93.

Cresap, McCormick, and Paget Company, "Information Systems Planning to Support Business Objectives: A Survey of Practices", New York: Cresap, McCormick, and Paget Co., 1983

Daniel, Dianne, "Users See a Place for Remote Access in the Real World", Computing Canada - Internetworking: Supplement to Computing Canada, April 1995

Das, S.R., S.A. Zahra, and M.E. Warketin, "Integrating the Content and Process of Strategic MIS Planning with Competitive Strategy", Decision Sciences, 22 (1991): 953-984.

Davis, G.B., and M.H. Olson, Management Information Systems: Conceptual Foundations, Structure and Development, 2nd ed. McGraw-Hill Inc., 1985.

Derfler, Frank J. Jr., "The Art of Being Remote", PC Magazine, 14:14 (1995): 279-326

Earl, M.J., Information Strategy Formulation, Critical Issues in Information Systems Research, ed. R.J. Boland and R.A. Hirschheim, Chichester: Wiley, 1987.

Emery, J.C., Organizational Planning and Control Systems, London: Collier-MacMillan Limited, 1969.

Fitzgerald, Michael, "Mobile Computing Changes Business", ComputerWorld, 28:16 (1994): 26

Galliers, R.D., "Information Systems Planning in Britain and Australia in the mid-1980s: Key Success Factors", Ph.D. dissertation, University of London, 1987

Gantz, John, "Mobile Computing Raises Bar for Enterprise Applications", ComputerWorld, 28:45 (1994): 35

Gosling, D.H., "Data Architecture: A Blueprint for Managing Your Business", CMA Magazine, October 1993

Gupta, Y.P. and T.S. Raghunathan, "Impact of the IT Steering Committees on IT Planning", Decision Sciences, 20 (1989): 777-793.

Henderson, J.C., and N. Venkratraman, "Strategic Alignment: A Framework for Strategic Information Technology Management", working paper, Massachusetts Institute of Technology, 1989.

Henderson, J.C., and N. Venkratraman, "Strategic Alignment: A Model for Organizational Transformation Through Information Technology", Transforming Organizations, ed. T.A. Kocham and M. Useem, Oxford University Press, 1992.

Hertz, Frank, "Good Things Come in Small Packages", VAR Business, 1108 (1995): 87

Howard, Bill, "Information To Go, Please", PC Magazine, 14:4 (1995): 141

Howard, Bill, "Road Warrior's Companion", PC Magazine, 14:4 (1995): 141-143

Howard, Bill, "Your Portable Persona", PC Magazine, 14:4 (1995): 102-213

Hubbard, Holly, "Global Growth for Mobile Computing - Study: Increased Demand from Europe, Pacific Rim over Next Five Years", Computer Reseller News, 561 (1994): 44

Johnston, Stuart J., "Tapping in From the Road", ComputerWorld, 29:2 (1995): 64

Index Group, Critical Issues of Information Systems Management in 1988, January, 1988.

Jang, S.Y., "The Influence of Organizational Factors on Information Systems Strategic Planning", Ph.D. dissertation, University of Pittsburgh, 1989.

Lederer, A., and A. Mendelow, "Issues in Information Systems Planning", Information and Management, (May 1986): 245-254.

Lederer, A., and A. Mendelow, "The Coordination of Information Systems Plans with Business Plans", Journal of Management Information Systems, (Fall 1989): 5-19.

Lederer, A., and V. Sethi, "The Implementation of Strategic Information Systems Planning Methodologies", MIS Quarterly, 12:3 (September 1988): 445-461.

Louderback, Jim, "Personal Assistance (personal digital assistants) (Let's Get Small)", Windows Sources, 3:5 (1995): 91-95

Louderback, Jim, "Practical Palmtops. (palmtop computers) (Let's Get Small)", Windows Sources, 3:5 (1995): 105-111

Maize, Kennedy, "FCC Approves Low-Orbit Satellite Licenses", Newsbytes, Washington - News, February 1, 1995

Mallory, Jim, "Productivity No Longer Tied to a Desk - Survey", Newsbytes, Denver - News, May 31, 1995

McFarlan, F.W., J.L. McKenney, and P. Pyburn, "The Information Archipelago - Plotting a Course", Harvard Business Review, (January 1983): 145-156.

Mohan, Suruchi, "The Stuff of Nightmares", ComputerWorld, 29:1 (1994): 66

Needleman, Raphael, "Tales from the Trip", Byte, 20:6 (1995): 159-161

Newman, Mark, "GSM Takes on the World", Communication Week International, 123 (1994): 32

Newman, Mark, "Asia Shows Fastest Rise in Cellular", Communications Week International, 142 (1994): 27

Niederman, Fred, James Brancheau, and James Wetherbe, "Information Systems Management Issues in the 1990's", MIS Quarterly, 15:4 (December 1991): 474-500.

"The OmniTRACS System", EDGE, On & About AT&T, 10:339 (1995): 40

Perratore, Ed, "Comparison Report: Pentium Portables", Mobile Office, 6:5 (1995): 72-82

Phillips, Barry, "Pumping Data into Cellular", OEM Magazine, 210 (1995): 32

Porter, Michael E., Competitive Advantage, New York: Free Press, 1985.

Pyburn, P., "Linking the MIS Plan with Corporate Strategy: An Exploratory Study", MIS Quarterly, 7:2 (June 1983): 1-14.

Quain, John R., "Simon Sends (Simon PDA from Bell South Cellular)", Home Office Computing, 13:2 (1995): 42

Raghunathan, T.S., "An Empirical Validation of Information Systems Planning and Its Relationship to Information Systems Performance", Ph.D. dissertation, University of Pittsburgh, 1985.

Raghunathan, B., and T.S. Raghunathan, "The Impact of Top Management Support on IT Planning", Journal of Information Systems, (Spring 1988): 15-23.

Reich, Blaze Horner, "Investigating the Linkage Between Business Objectives and Information Technology Objectives: A Multiple Case Study in the Insurance Industry", Ph.D. dissertation, University of British Columbia, 1992

Reich, Blaze Horner and Izak Benbasat, "Measuring the Linkage Between Business and Information Technology Objectives", working paper, University of British Columbia, 1995

Reinhardt, Andy, "From Here to Mobility", Byte, 20:6 (1995): 100-102

Rogers Cantel Inc., "Cellular Travel Guide", Document # 2015-51-11, November 1994

Santalesa, Richard, "PDAs Today, What You Need to Know", Mobile Office, 6:8 (1995): 42-50

Strom, David, "Wireless Networking: The mobile workforce is demanding universal connectivity from wireless services", InfoWorld, 15:34 (1994): 48

Sullivan, C. Jr., "Systems Planning in the Information Age", Sloan Management Review, (Winter 1985): 3-12.

Swartz, Jeffrey, "Portable Systems Still Problematic", Communications Week, 543 (1995): 37

Wirbel, Loring, "Satellite Services Eye PCS Pie", Electronic Engineering Times, 835 (1995): 27

Zyskowski, John, "Wireless datacom helps, but PDAs still seek users' nod: lack of business buyers keeping market sluggish", Computer Shopper, 15:4 (1995): 49-50

Appendix 1

"The Company"

Case Description

1. The Case Description

The data for this study was collected as part of a project conducted to define a long term mobile computing and communication technology strategy for an international resource company. This appendix contains a large subset of the detailed project documentation (including a review of the technology and specific recommendations) contained in the report that was delivered to the company.

1.1 Case Introduction

The review of the telecommunications strategy at the company has a long term planning (three to five years) component and a short term (one year) component. In the long term the company has to define a standard architecture to build a company wide data communication infrastructure. In the short term the company has initiated a project called the "Rugged Office". The objective of the "Rugged Office" project is to create a toolkit of technology that will allow the company employees to communicate quickly and easily via voice and data to and from anywhere in the world.

There are three specific groups that have the requirement for this type of technology: executives, geophysicists and project personnel. The executives of the company travel extensively and need to be in constant contact with their home office and other executives. Their primary requirements are for voice communication and electronic mail.

Geophysicist require both voice and data communication. They have the same requirement for voice that the executives have and are much more dependent on electronic mail and data file transfer. There is a specific requirement to move large amounts of data from field exploration sites to the company office locations.

Project personnel are often required to set up project sites in remote locations that remain at the same location for several months. The project personnel typically include geophysicists that have the same requirements described above - electronic mail and large data file transfer.

The telecommunications industry does not provide effective global solutions for the company. Today, cellular coverage is restricted to the most populated areas in each country. As for the global travel with cellular telephones, European telephones can't be used in the United States or Japan; and visitors from those countries can't use their mobile telephones in Europe.

Global mobile communications is available today - but at a very high price and with limited data transfer capability. Around $15,000 US will buy you a briefcase full of equipment that, after a few minutes' setting up, links up to the Inmarsat satellite system and enables you to make calls from anywhere in the world. However, this price is more than most consumers are prepared to pay and data transfer speeds are restricted to 2400 bps.[3]

[3] Global Mobile, 1994 - opening address - Personal Communications in a Global Perspective, Dr. Lars Ramqvist, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)
Please Note: References from the World Wide Web (WWW) include titles, page addresses (URLs), and authors and dates when available. As WWW references are not consistent with published references, I have used footnotes for clarity.

The company has a very simple requirement - telephone contact from anywhere in the world. Unfortunately, telecommunications technology has not reached the level of maturity to easily fulfill this requirement. The company is certainly not alone in its desire for better global communication.

The rapid advance of information technology has raised the expectations of many individuals and organizations. The demand for easy, global mobile communications is very high. The current information technology infrastructures, specifically land based telephone and cellular telephone, cannot meet this demand. Many telecommunication vendors are spending a lot of money on projects intended to fulfill this need for a global infrastructure of mobile computing and communication technology.

1.2 The Needs and Requirements

1.2.1 Introduction to the Company

The company is an international resource company that is focused primarily on mining. The company is organized into five divisions, one for each continent plus a fifth division which is responsible for exploration and special projects world-wide.

In 1994 the company worldwide sales were approximately $900 million. The company has interests in nearly twenty mines world-wide and employs over 7,000 people.[4]

[4] Excerpt from "The Company Corporate Profile"

1.2.2 Goals and Objectives

In the context of this study it is worth paraphrasing the published goals and objectives of the company:

"The company will increase its annual production rate to 2.5 million ounces of gold by the year 2000, at cash costs in the lower third of the world average. We will conduct exploration and acquisition of our primary targets, gold and gold/copper deposits, on a worldwide basis to increase our reserves to a 10-year base at the increased rates of production."

"The company will operate as a decentralized company but the prioritization of exploration targets will be centrally managed. In order to ensure consistent technical excellence throughout the corporation, our project development group will provide support as a vital central resource."[5]

The company plans significant growth while maintaining cost control. This growth in production will come from locations around the world that are not yet determined. This growth will continue to be managed in a decentralized manner. These plans all point to an increased requirement for communication and coordination throughout the company organization. Mobile communication and computing will play a vital role in enabling the management at the company to meet these goals and objectives.

[5] Excerpt from "The Company Corporate Profile"

1.2.3 The Company Information System Environment

The company has a history of decentralized management. This has had an enormous impact on the development of the IT environment at the company. There has been no central authority to set internal standards or establish a company-wide IT architecture. This has resulted in the company divisions, branch offices and mine sites installing computer hardware and networks that focus on local problems rather than inter-office data communications.

1.2.4 The Company Computer and Network Systems

The following is a brief description of the specific systems installed in the company divisions.

The company head offices are located in a medium-sized city on the west coast of North America. All the divisions have their own IT network and their own staff to support them.

Division 1 has a mix of UNIX systems (IBM and Sun) and IBM compatible PC's. The systems are connected on a network running Novell Netware. Most, but not all, electronic mail is done using Lotus cc:Mail and there is limited use of Lotus Notes for document sharing. Division 1 also has several mine sites across Canada with a similar mixed (UNIX / PC) environment.

Division 2 has a mix of UNIX and PC systems as well as two UNISYS mini-computers. It has an Ethernet network running Novell Netware, TCP/IS, NFS and Ethertalk. The

Ethertalk software supports several Apple PC's. Electronic mail is supported by UNIX electronic mail, Select Mail and Lotus cc:Mail. Both Division 1 and Division 2 have access to the Internet via a dial-up connection to a Internet Service Provider.

The Division 3 head office in the US has twenty two IBM compatible PC's connected to a UNIX mini-computer using Novell Netware. All of the US mine sites have a mix of PC's and UNIX (Sun) systems. Four of the mine sites are networked via Sun TCP/IS and PC-NFS. The other three mine sites have no network installed. Division 3 makes extensive use of Lotus cc:Mail.

Division 4 also has a mix of PC's and UNIX (Sun, SGI and Unisys) systems across its head office and mine locations. It is networked with Novell Netware, Sun Netware and Appletalk. Division 4 makes use of Lotus cc:Mail for electronic mail and has a single site using Lotus Notes.

Division 5 has a wider mix of computer systems installed in their head office and mine sites. They have a mix of PC's and UNIX (Sun and SGI) systems as well as two IBM System 36's and an IBM AS/400. The three IBM systems are all located at mine sites and have a total of 123 devices directly attached to them. It also makes use of Novell Netware for PC networking.

1.2.5 Information System and Data Communication Infrastructure

At the present time the company has no coordinated data communication infrastructure. This leaves the company in a very difficult position for implementing corporate wide data

management. Senior management is aware of this and is taking steps to move towards a more cohesive IT strategy. Currently data communication from one corporate location to another is difficult, and cross location data management is impossible.

An example of the importance of data management to the company comes from an interview with the Chief Geophysicist. According to him, one of the keys to effective mineral exploration and production is timely analysis of accurate data about potential and established mineral sites. Currently the only way for a geophysicist at head office to access data that is stored at another location is to telephone the site, find out who is responsible for the data, find out what format the data is stored in and make arrangements for it to be manually transmitted and reformatted. This process often takes days and uses time that would be better spent on data analysis.

Another significant impact of the lack of IT infrastructure is that the company executives and geophysicists visiting branch locations cannot use the computers at the remote location to access their electronic mail and data files. They even have difficulties using their laptops in the remote offices. They cannot use the LAN to connect to their home systems and even finding a telephone jack to plug a modem into is difficult because of the office PBX systems. Often they have to wait until the fax machine can be unplugged and use that direct line for modem access.

1.2.5.1 Summary

The company has a variety of computer hardware and software installed across its office and mine locations. In the past there has been little coordination of the hardware and

software installed across the divisions. This has resulted in an IT environment where corporate-wide data communication is difficult and corporate-wide data management is impossible. In this environment mobile data communication will, by definition, be limited to electronic mail access and file transfer until the company builds up the IT infrastructure.

1.2.6 Current use of Mobile Computing Technology

The company does not currently have a corporate strategy for enabling mobile computing and communications. I spoke with executives, geophysicists and managers of the company and found that they use a variety of methods and technologies.

One important finding from my interviews is that there are many pockets of expertise on mobile computing throughout the company and its divisions. There are many geophysicists that have spent years in the field who have had to come up with creative solutions to enable remote communications. There are also IT technical people who have had to respond to requests from traveling executives and managers. An example is a technical support person in Division 1 who arranged for the purchase of a TeleAdapt Executive Telekit for an executive in Division 1.

The executive group of the company travel extensively both in and out of North America. This limits the usefulness of cellular telephones so few of them carry them when traveling. None of the people I spoke with had ever rented a cellular telephone at their destination. There is a range of use of portable computing technology. This mirrors the range of use of computer technology in the office. Some executives, like the CEO of the company, carry a

laptop computer, a PDA (Personal Digital Assistant), adapters, cables, screwdrivers, etc. that enable connectivity, while other executives do not even carry a laptop computer.

Several of the interviewees reported a sense of distrust with the company's electronic mail system as an explanation of why some of the executives do not travel with laptops. Most blamed this distrust on behaviour (others not reading or responding to electronic mail in a timely fashion) but one executive felt the system itself was unreliable. Whatever the reason for the distrust, it is certainly undermining the effectiveness of the company's electronic mail system. the company will need an effective electronic mail system if they hope to have effective mobile communications.

The geophysicists rely more heavily on computers in the office and while they travel. Laptops are always carried while traveling, but they experience the same frustrations while trying to establish a modem connection in many of the destination countries. They have taken more advantage of global network systems, such as the Internet and CompuServe, to enable access to electronic mail and data file transfer.

At remote locations (e.g. exploration sites) the company is currently using some satellite telephone technology although, according to some of the executives I spoke with, this is not a technology that is well understood or used extensively. According to the Chief Geophysicist, the satellite telephone they are using at an exploration site is limited to 2400 bps for data communication which makes it ineffective for large data file transfer. The company does not currently have a standard configuration of telephone, computer and software that it used at their remote project locations.

Throughout my interviews a common emotion used to describe the capabilities of current technologies and methods was frustration. The company is not alone in this. Needleman (1995) details common problems in the industry in his article "Tales from the Trip".

1.3 Summary of Needs and Requirements

1.3.1 The Big Issues

Before addressing the specific requirements for enabling mobile computing and communications it is important to summarize the larger issues that will have a tremendous impact on the success of the Rugged Office implementation. There are three issues that were repeated by the people I interviewed. These are:

- the need for an improved corporate data communication infrastructure;
- the need for improved corporate data management; and
- the requirement for raising the level of knowledge and trust in the corporate electronic mail system.

In the short run we can provide the company executives and geophysicists with better tools so they can communicate more easily and effectively while traveling. In the long run the Rugged Office has to be part of the company IT strategy to deal with these three big issues.

1.3.2 The Need for Better Tools

In my discussions with the company executives and geophysicists many different requirements were identified that would help to enable mobile computing and communication. These requirements can best be summarized by paraphrasing the VP of

Finance: "There are three different requirements for this technology at the company: executives need to stay in constant voice and electronic mail contact and require the ability to do limited data manipulation, geophysicists need to stay in constant voice and electronic mail contact and require the ability to do large amounts of data manipulation and data transfer, and project engineers and "deal-makers" need to set up an "instant office" for voice and data communication in remote locations that will stay in one place for two to three months."

Executives and geophysicists who do a lot of traveling will have their own laptop computers that meet their own requirements for limited or complex data manipulation. If we take this into account these requirements can be met by creating two Rugged Office toolkits: one for travelers and one for projects. The traveling toolkit will need to contain all the components required to connect a laptop computer to a telephone system anywhere in the world. The toolkit for remote projects will need to contain a computer and whatever components are required to establish a high speed voice and data communication link from remote sites that may not have access to a telephone system.

As well as the hardware contained in the toolkits there are several other procedural requirements for mobile computing and communication to be effective. These are:

- Standards must be adopted for the hardware and software to be used by traveling executives and geophysicists (e.g. laptop computers and PDAs to be used for mobile communication must support an industry standard PCMCIA slot, the software used for electronic mail must be Lotus cc:Mail, etc.).

- Technical support must be provided for the standard hardware and software adopted by the company. This support must be available 24 hours a day because help may be needed from many different time zones.
- Dial up and login scripts (small automated programs) must be developed, tested and piloted with the hardware and software that will be used. Using scripts will greatly simplify the connection procedure for those users that are not technically inclined.
- Training must be provided for users of the toolkits. The training should include an introduction to the components of the toolkit, how they are used, and what to do when things don't work!
- Coordination across all divisions of the company. The Rugged Office initiative will be more cost effective is if the standards, support, and training are corporate wide.

1.4 Mobile Computing Technology

1.4.1 The State of the Mobile Computing Industry

Business communications networks are no longer seen as a necessary service, but as a strategic tool: advanced and effective telecommunications systems give companies an edge over their competitors. They shorten decision-making processes, reduce time-to-market for new products and services, and make companies more accessible and responsive to their customers.

Most organizations today depend on telecommunications to such an extent that they could not function without them. Even short breaks in service can have serious consequences. And many companies have realized the value of advanced communications solutions in increasing customer satisfaction.[6]

To meet this increased dependence on telecommunications the mobile communications industry is in a period of unprecedented growth. In fact, it is the fastest growing telecommunications phenomenon of the past decade. During the last decade, the annual increase of cellular subscribers in the world has been approximately 40 percent or more. Around the year 2000, predictions point to between 150-250 million cellular/PCS/PCN subscribers worldwide. At that time, more than 50 percent of all new public subscriptions will be wireless connections. However, some countries have already passed the 50 percent level.[7]

Cellular technology is prominent in all three main economic regions of the world: North America, Europe and Asia/Pacific. Together, these regions have more than 95 percent of all mobile subscribers. Other public mobile services, such as wide-area paging and mobile data, are also expanding at high growth rates. By the year 2000, the present 36 million wide-area paging subscribers in the world are expected to grow to some 100-120 million. Mobile data will grow from some hundred thousand users to between 10 and 15 million in 2000.[8]

---

[6] Ericsson in Business Networks, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)
[7] Ericsson - Toward a New Era in Mobile Communications, Torbjorn Nilsson, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)
[8] Ericsson - Toward a New Era in Mobile Communications, Torbjorn Nilsson, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)

1.4.2 Mobile Computing Technology Overview

The most important thing to understand about global voice and data communication technology is that it is a mess! The reason it is a mess is the many different *standards* that have been adopted by different countries, competing telecommunication vendors and individual international companies.

The phrase, *standards* requires a brief description. *Standards* are generally accepted norms. For example, the *standard* business greeting is a handshake. Telephones and computers have to have generally accepted norms for exchanging information. With telephones and computers these *standards* have to be detailed and exact so that the computers can recognize and interpret information correctly.

Currently there are too many telecommunications standards, each with a small percentage of the market share. There is no widely accepted global standard. The result is many different types of land based telephones and telephone connectors and many different cellular telephone systems used in different countries. See Appendix 5 for an overview of the many different cellular telephone standards in use today.

The two leaders in telecommunications, Europe and North America have contrasting attitudes to standards. In Europe, there is a high degree of standardization and regulation. One result is GSM (Global System for Mobile Communications), which allows the use of one mobile telephone while roaming through sixteen countries in Europe. It also means a very large market, which produces scale economies for manufacturers and lower prices for end-users.

GSM took a very long time to arrive. The standardization effort was huge, involving many interested parties and long discussions. GSM attempted to encompass a very broad range of functions, including messaging and data communications which added to the delay.[9]

North America has much less regulation, and a more dynamic market. Innovations reach consumers more quickly: progress is faster and the possibilities are greater, but too many alternatives can make potential users confused and delay adoption of innovations. To someone from Europe who is familiar with GSM or NMT (Nordic Mobile Telephone standard), it is a surprise to discover how difficult it is to roam within the USA. Nationwide roaming came relatively late to North America: it was pioneered by McCaw Cellular, using technology from Europe.[10]

Despite the challenge of dealing with many different standards there are many things we can do to enable mobile communication and computing. The rest of this section discusses the various technologies available to us and their respective strengths and weaknesses.

1.4.3 Land Based Telephone

There are profound changes taking place in the public telecommunications industry. Changes that will have a major impact on manufacturers, network operators, service providers and end users. Between 1990 and 2000, the number of telephone exchange lines in the global network is expected to double to 1 billion. That means that it will take just 10

[9] Global Mobile, 1994 - opening address - Personal Communications in a Global Perspective, Dr. Lars Ramqvist, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)
[10] Global Mobile, 1994 - opening address - Personal Communications in a Global Perspective, Dr. Lars Ramqvist, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)

years to add as many lines as were added during the first 100 years of public telecommunications.[11]

At the same time, there are fast-moving developments in technology and standards to be absorbed; and fundamental changes in the market environment, resulting from deregulation, liberalization and privatization.

In financial terms, the world telecommunications market is expected to grow by an average annual rate of over 10 percent to reach US$ 1,200 billion in the year 2000. Services will grow at a faster rate than equipment sales, and by the end of the century account for over 80% of the total.[12] All this change is being imposed on an industry that in the past has been accustomed to change at a slow rate, and on a modest scale.

Land based telephone systems were designed to carry voice communications, i.e., sounds, or audio tones, that we can hear. Because of this, they cannot naturally handle more sophisticated signals such as computer data. In order to transmit computer data over these systems, the data must be converted to audio tones, or "analog" signals.

Modems convert computer data to audio tones and vice versa so the data can be transmitted over regular telephone lines. Current traffic demand is for computer to computer or fax communication so many land based telephone systems are being upgraded to digital technology.

---

[11] Ericsson - Industry, Technology and Network Development Trends, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)

[12] Ericsson - Industry, Technology and Network Development Trends, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)

1.4.3.1 Strengths

The strengths of the land based telephone system are:

- There is a highly developed, global infrastructure already in place.
- It is the least expensive technology for voice or data communication.
- In developed countries the reliability and availability of the system is very high.
- There are many vendors producing an amazing variety of devices to attach to the land based telephone system.

1.4.3.2 Weaknesses

The weaknesses of the land based telephone system are:

- The infrastructure only covers populated areas in developed countries, and urban areas in developing countries. The majority of locations that the company is likely to conduct mineral explorations do not have access to telephone connections!
- In many developing countries the quality of the telephone system is not adequate for high speed data communication.
- There are many places where an RJ-11 modular jack (the standard output jack on modems) is not available or is not accessible - hotel telephones, pay telephones and cellular telephones to name a few. And, in most foreign countries, RJ-11 jacks are not used at all.
- Modems communicate with "analog" (sound or audio) signals while most new telephone systems use digital signal processing. The telephone desk sets in many of these systems convert the sounds we speak into digital signals and send these signals to the main telephone switch console. Digital systems cannot process analog modem signals without some kind of conversion, so modems cannot communicate directly through

these systems. In fact, if you make a direct (or "hard-wired") connection to a digital telephone system, one of three things will occur:

- Best Case: It just won't work.
- Next best case: It won't work and the modem will be destroyed.
- Worst case: It won't work, the modem will be destroyed, and the telephone system will "go down".[13]

1.4.3.3 Existing Technologies

As mentioned, there are a variety of devices available that enhance voice communication or enable data communication over the land based telephone system. I will mention a few that may be of specific interest to the company:

- Security devices for voice communication.
- PCMCIA (credit card size) modems for laptop computers.
- International telephone adapters and power plug adapters that convert modems from RJ-11 (US Standard) to modular plugs for any country.
- Acoustic telephone couplers plug into your portable computer's modem and attach to virtually any telephone so you can do data communicate over pay telephones, cellular telephones, hotel telephones, digital and foreign telephones. No modular telephone jack is required.
- Digital modem connectors that allow analog modems to be used on digital telephone systems (e.g. using a modem on a multi-line office telephone system).
- Simultaneous Voice over Data (SVD) is worth mentioning because it is so practical and useful. SVD enables a user to make a standard telephone call while a modem stays

[13] A Basic Primer of Modem/Telephone Connecting Problems, Road Warrior Outpost Home Page, (http://warrior.com/cpplus/cpp001.html)

turned on in the background. You can switch over to transfer files or launch a remote control session while talking. Creative Labs, Diamond and other vendors have already announced related products.

1.4.4 Cellular Telephone

The cellular telephone is *the* mobile voice communication solution today.

Cellular radio is undoubtedly one of the most exciting and dramatic technological developments of the late 20th century. The number of cellular subscribers world-wide has grown from zero to 40 million in twelve years and a recent forecast estimated that there would be 160-200 million cellular subscribers in over 120 countries by the year 2000. Mobile technology, in particular, cellular-based systems will increasingly become the first line of communication for many new subscribers. Already some 40 per cent of new lines being installed in developing countries are using cellular technology.[14]

Today, the advanced markets for mobile telephony have approximately ten per cent penetration. In many countries, competition is driving prices down fast, so that a mobile telephone becomes a personal, rather than a business purchase. Large sections of the population in these countries can now afford a personal mobile telephone. By August 1, 1994 Europe had 60% more cellular users than a year before. Germany had 99% and Italy 85%.[15]

---

[14] Ericsson - An Overview of Cellular Technology, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)

[15] Global Mobile, 1994 - opening address - Personal Communications in a Global Perspective, Dr. Lars Ramqvist, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)

1.4.4.1 Strengths

The strengths of Cellular Telephone technology are:

- There is widespread acceptance and use of cellular technology.
- The small size of the telephone devices make them very mobile and convenient.
- There are many additional services available for voice communication (e.g. messaging, call forward, limited national and international roaming).
- Some of the new Cellular Networks are using digital protocols (GSM, CDMA) specifically designed for data communication

1.4.4.2 Weaknesses

The weaknesses of Cellular Telephone technology are:

- Costs, although falling rapidly, are still considerably higher than land based.
- Coverage is still limited. Cellular networks generally only cover the greatest concentrations of people. This is well-suited to the needs of local business users, but not to an international traveler. There are three big deficiencies in coverage:
    - In-door coverage needs improvement. Even in cities, cellular quality is poor indoors.
    - International travel is still very difficult. Lack of a widely accepted global standard means that we cannot buy a cellular telephone or subscribe to a single cellular provider that will enable worldwide access. There are several competing analog and digital standards in use in various countries. I have provided a brief description of these standards in Appendix 5.
    - There is no cellular coverage in remote areas. Where there are few people (i.e. few paying customers) there is no service!

- We have a long way to go with quality. You can get a good connection if you hold the telephone in the right position, or if you are patient and make several tries. But if a mobile telephone is really going to compete seriously with a wired telephone, it has to achieve the same levels of call and speech quality.[16]
- Limited services - today's cellular networks are only able to offer voice telephony, with a few additional benefits such as messaging services. Other features, such as fax, electronic mail, video-conference and data communications are still in their infancy.[17]

1.4.4.3 Existing Technologies

Besides the cellular telephones themselves there are two products that are of interest to the company:

- Cellular Fax/Modems - several manufactures are now supplying Fax/Modems that comply to the PCMCIA (Credit card size) standard for laptops. They range in features, speed and price.
- Personal Digital Assistants (PDA) - small hand-held computers or PDAs are now being equipped with basic communication services. Several products are using cellular fax/modem technology to enable electronic mail and other simple data communication services.

Both of these products suffer from the limitations described above. What is needed to overcome the geographical limitations is a cellular telephone that will support many different standards so can be used in many different countries. I spoke with John Mitchell at

[16] Global Mobile, 1994 - opening address - Personal Communications in a Global Perspective, Dr. Lars Ramqvist, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)
[17] Global Mobile, 1994 - opening address - Personal Communications in a Global Perspective, Dr. Lars Ramqvist, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)

Motorola who told me that they are currently developing such a product and hope to market it in the "near future".

In the mean time there is a demand for cellular telephone mobility worldwide. To fill this demand cellular telephone rental services are available in most major airports and from the major car rental firms.

1.4.5 Radio Based Wireless Networks

We are seeing many new wireless products being announced. Some are based on infrared technology used for very short distance, low volume data transfer (e.g. Timex Data Watch, wireless keyboards, etc.). The majority are based on radio technology.

Radio based local area networks are now available that eliminate the cost of wiring buildings, provide additional flexibility and enable network access between nearby buildings. Most important for those requiring mobile communications, we are starting to see a new wave of radio based voice and data communications services (PCS, messaging, paging, etc.) reaching the market.

These services offer new possibilities for voice and data communications. Trade magazines are full of "Anytime, Anywhere" advertisements pushing the advantages of true mobile communications.

In Europe digital Personal Communications Networks (PCN) are being introduced in several countries to complement and to compete with the existing cellular networks. PCN is

primarily designed for hand portable voice and data terminals which use low-power technology, works well indoors and outdoors, and is priced to be attractive to both small businesses and the consumer market.[18] In North America a similar solution, designated Personal Communications Service (PCS) is under way.

1.4.5.1 Strengths

The strengths of radio based wireless communication are:

- Radio is a well understood, mature technology.
- The devices required to receive and decode radio communications are small and light, so are very portable.
- Radio waves can penetrate buildings without interference so devices can be used indoors without losing reliability.
- The infrastructure is less costly to put in place than wire based technology.

1.4.5.2 Weaknesses

The weaknesses of radio based wireless communication are:

- Coverage, coverage, coverage - the only areas that are currently serviced by radio data communication networks are North America and Europe. Additional coverage will certainly be provided to urban areas where the density of potential customers justifies the cost of providing the infrastructure.
- Performance may be an issue. The services provided on current radio data communication networks are limited to messaging, paging, faxing and electronic mail. I

[18] Ericsson - Toward a New Era in Mobile Communications, Torbjorn Nilsson, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)

have not seen large data file transfer offered as a service by any of the current providers.

1.4.5.3 Existing Technologies

Following is a brief description of several different categories of radio based technologies. Unfortunately, none of these services have adequate global coverage to meet the needs of the company.

1.4.5.3.1 Mobile Data

Dedicated mobile pocket data communication networks first appeared in the mid-1980s. One of the systems introduced was the Mobitex standard. Mobitex is now mainly used in North America and in Europe, giving traveling business people (via their portable PCs) instant access to electronic mail. Mobitex is also used for dispatch applications.[19]

There are several competing networks in the US: RAM Mobile Data Inc., Ardis and CDPD (Cellular Digital Packet Data). RAM and Ardis are completely based on radio technology. RadioMail, which provides mobile access to electronic mail, Internet, paging, faxing, and daily news, is an award winning service being provided on the Ardis network in the US.

CDPD is a new network service that will directly compete with the mobile wireless packet networks, such as RAM Mobile Data Inc. and Ardis. CDPD offers more than twice the bandwidth of either RAM Mobile Data or Ardis, but independent performance data on CDPD is not currently available (Chernicoff, 1995).

---

[19] Ericsson - Toward a New Era in Mobile Communications, Torbjorn Nilsson, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)

CDPD is an open standard and can run applications with little or no modification. There are two fundamental components used to connect users via CDPD. The first, the AirLink, is a radio-based connection; the second, the network, represents the physically wired portion of the environment. The hard-wired network section takes care of traditional network physical layer issues, higher-level applications, and behaves like any other wired network. This allows applications to run without modification. AT&T and McCaw Cellular Communications Inc. plan to offer nationwide CDPD coverage, much like cellular telephone coverage (Chernicoff, 1995).

1.4.5.3.2 Messaging/Paging

Wide-area paging, a low-cost mobile service, has an annual growth of more than 20 percent. The trend is to provide more advanced messaging services, with two-way communication capabilities.[20]

An example of this service is AirNote, based in the US. AirNote provides a complex set of message forwarding services. They provide you with a pager with a small LCD panel for text display. Messages from the following sources are then send directly to the pager for your review:

- Transcribed voice messages (AirNote provides voice operators).
- Internet electronic mail messages.
- Direct electronic mail (anyone with SendNote software and your PIN number can reach your text pager directly).
- Voice mail paging (when a message is recorded, your pager notifies you that a voice mail message is waiting).[21]

---

[20] Ericsson - Toward a New Era in Mobile Communications, Torbjorn Nilsson, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)

[21] AirNote Product Information, AirNote Home Page (http://www.airnote.net/product/airnote-list.html)

1.4.5.3.3 Personal Communication Services

In the USA Personal Communications Services (PCS) have been defined purely as a concept - without reference to any specific technology. PCS is seen as a low-cost mobile communications service based on lightweight pocket telephones targeted at the ordinary end user. It will be a true mass market mobile service aimed at providing personal communications to improve people's lifestyles.

The Federal Communications Commission (FCC) describes PCS as encompassing "a broad range of radio communications services that free individuals from the constraints of the wires and enable them to communicate when they are away from their home or office telephone."[22]

The goal is to allow a person to use a lightweight portable telephone at home, in the office, and in an outdoor environment. Users could then be reached under one number at any place and any time. It is this development "towards person-to-person rather than station-to-station" communications that the FCC regards as the most important feature of PCS. The FCC´s decision to avoid imposing standards and let market forces rule is intended to encourage the rapid provision of a wide array of mobile services. This approach may end up cultivating market segmentation rather than integration.

Both cellular and cordless technologies have been offered as possible PCS solutions. Although cordless systems can offer benefits in densely crowded urban areas or central

[22] Ericsson - The PCS Initiative, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)

business districts, their low power and lack of range inhibits their use in wide area applications.[23]

1.4.5.3.4 Personal Communications Network (PCN)

In Europe the equivalent technology to PCS is PCN. Many European governments and regulators felt that mobile communications could benefit ordinary domestic users, but cellular radio tended to be perceived as a business tool rather than a mass market technology. PCN was introduced to begin the process of widening the market in the UK. This was adopted by the European standards bodies and has been deployed in Germany as well. Networks are being installed in Thailand and possibly Australia. The recent European Commission Green Paper gave PCN a major boost by recommending that all EU members license at least one PCN network.[24]

1.4.6 Satellite Communications

Satellites have been used since the 1960's to monitor the surface of the Earth (e.g. weather satellites, "spy satellites", etc.) and as transmitters to broadcast television signals over wide areas. It is relatively recently that they have been used for public two-way voice and data communication.

There are two organizations that are most heavily involved in this industry. Inmarsat is an internationally owned cooperative that evolved from a maritime safety service to a worldwide

[23] Ericsson - The PCS Initiative, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)
[24] Ericsson - An Overview of Cellular Technology, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)

communication provider. Qualcomm is the world's largest provider of location and communication services to the land based transportation industry (trucking and rail).

1.4.6.1 Strengths

The strengths of Satellite based communication are:

- Coverage, coverage, coverage - The Inmarsat system does cover most of the globe. As long as you can obtain line-of-sight to the satellite you will be able to use voice and data communications.
- There are a range of satellite communications devices available from many different manufacturers. They are all mobile and can be set up nearly anywhere.

1.4.6.2 Weaknesses

The weaknesses of satellite based communication are:

- Cost is significant. The telephone devices required to send and receive voice and data cost approximately $15,000 US and transmission time is approximately $5 US per minute.
- Performance of data transfer can be very slow. Briefcase size devices range from 600 to 2400 bps, although larger devices support up to 64 Kbps. These bigger, faster devices cost from $30,000 to $60,000 US. Prices are expected to decline in the future.
- Weight of the devices is also significant - twenty pounds is considered very light. This is not a problem if you are part of an exploration team that is going to be in a remote location for weeks or months, but it is not appropriate for an executive or geophysicist who is only traveling for several days.

1.4.6.3 Existing Technology

There are two major satellite technologies available today: Inmarsat and Omnitracs.

1.4.6.3.1 Inmarsat

Inmarsat is an internationally-owned cooperative providing worldwide mobile communications. Set up in 1979 to serve the maritime community, Inmarsat has since evolved to become the only provider of global mobile satellite communications for commercial, distress and safety applications at sea, in the air and on land. With headquarters in London, Inmarsat has 75 member countries and approximately 40,000 customers worldwide.

The services supported by the Inmarsat satellite network include direct-dial telephone, telex, fax, electronic mail and data connections for maritime applications; flight-deck voice and data, automatic position and status reporting, and direct-dial passenger telephone connections for aircraft; two-way data communications, position reporting, electronic mail and fleet management for land transport.[25]

"Uptake of Inmarsat's mobile data service for briefcase-sized terminals proves that a market exists", said Marc van der Heyden, a telecommunications analyst with High Key Communications, in Amsterdam. At the end of 1993, Inmarsat had a monopoly on satellite-based mobile data, with about 6,000 maritime and 3,800 land mobile terminals accessing its two-way data service, which operates at 600 bps. Now, there are almost 10,000 maritime

[25] About Inmarsat, Inmarsat Home Page (http://www.worldserver.pipex.com/inmarsat/about.htm)

and 5,700 land mobile terminals, according to Inmarsat ("Satellite Services Eye PCS Pie," 1995).

1.4.6.3.2 OmniTRACS

QUALCOMM, who operates the OmniTRACS system, is the world's largest provider of satellite communications services to the land transportation industry. QUALCOMM now operates more mobile satellite terminals than all other service providers combined.

When OmniTRACS was first launched in 1988, the commercial use of two-way satellite-based communication was virtually unheard of. Pioneering the use of this technology, the trucking industry was instrumental in establishing satellite communications as a viable commercial product.

By 1990, as QUALCOMM delivered its 10,000th terminal, one billion miles had been logged by vehicles using the OmniTRACS system. As transportation companies began to reap the benefits of improved operations, system installations multiplied, topping 30,000 units in 1992 and 60,000 by the end of 1993.

More than 450 transportation companies and other users are employing the OmniTRACS system, with more than two million messages and position reports being processed daily through the Network Management Center located in San Diego.

The system continues to expand internationally, with service now available in 25 countries on four continents, including Brazil, Canada, Japan, Malaysia, Mexico, Russia and 18 European countries (Austria, Belgium, the Czech Republic, Denmark, Finland, France,

Germany, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, Switzerland, Turkey and the United Kingdom) ("The OmniTRACS System," 1995).

The two service providers mentioned above supply the satellite network capability for voice and data communication. There are several manufacturers of briefcase or suitcase size portable telephone devices.

1.4.7 The Future of Mobile Computing Technology

"The future success of mobile communications in a competitive environment can only be built on solutions that meet the personal needs of the users. People want to call people, not places. They want to reach people anywhere and anytime, live or through messages. People want easy-to-use services with good quality and a high level of privacy. Basic services, including both terminals and charges, must be cheap. Services should be personalized, with the user in control.

To fulfill these needs, a vision of a new kind of user-based service portfolio will emerge; personalized and portable telecommunications services anywhere, anytime, using any media. Consequently, true personal mobile communications must be characterized by seamless coverage and availability; personal number(s); personalized services for both business and residential use; and small user-friendly, light and cheap pocket communicators.

To accomplish this vision, several technologies and services must be combined and/or used. In the area of network infrastructure, the convergence of cellular, cordless, mobile data, paging and wire technologies and services is inevitable, since each of them takes on

technology and service characteristics of the other(s). Furthermore, personal communications also mean convergence of telecommunications applications and the world of personal computing."[26]

This is starting to happen to the hardware devices we use to enable mobile computing and communication. For example Bell South's Simon comes the closest of any product on the market to meeting customer's expectations of what a PDA should do. This 18-oz, 8-by-2.5-by-1.5-in device looks like a cellular telephone with a 5-by-1.5-in LCD touch screen. Users can enter notes, perform personal organizing chores and send and receive electronic mail, faxes and cellular calls. The DOS-based desktop accessories include an address book, scheduler, calendar, calculator and world clock. A $149 connectivity kit allows Simon to communicate with a PC. Made for Bell South by Mitsubishi/IBM, Simon retails for $899 US (Quain, 1995).

Over the next few years (possibly months) we will see a continued convergence of functions and services available to us through pagers, cellular telephones, PDAs and laptop computers. Soon vendors will be providing us with a single device that will meet all of our mobile computing and communication needs.

Despite this, there will continue to be a bewildering array of individual products. Consumers will continue to have specific needs that can best be met with a single product. Vendors will differentiate their products through pricing and functionality. It all means grater choice and greater convenience in the future.

---

[26] Ericsson - Toward a New Era in Mobile Communications, Torbjorn Nilsson, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)

The productivity and flexibility benefits of mobile communications are being recognized. Businesses are starting to understand that competitiveness can be improved by using ever more mobile communications.[27] Mobile communications will be come more tightly linked with business plans and strategies as the technology becomes more pervasive.

Business mobile communication needs are being addressed by wireless PBXs, wireless LANs, company internal cellular business communications services, company-internal services combined with the regular wide-area coverage network, and locally-based messaging and paging services. These local services will expand to national, and eventually global coverage in combination with wide area networks.

The present digital cellular-based standards all have the capabilities to evolve into a high-capacity, multi-services platform offering personal communications services anywhere and anytime. During the 90s, this second generation of mobile systems and networks will evolve into personal communications solutions.

In order to support this we will see the following improvements to the wireless infrastructures and devices over the next several years:

- Improved network performance (coverage, capacity and quality)
- Improved security avoiding unauthorized access to personal services, or unauthorized listening in on calls.
- New media, such as mobile data, fax, text, graphics and paging capabilities.
- Lightweight, easy-to-use personal communicators not only for voice, but also as an integrator of new media and personal computing.

[27] Ericsson - Toward a New Era in Mobile Communications, Torbjorn Nilsson, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)

- Worldwide standardization.

In the short term the market is going to remain chaotic. There will continue to be many vendors competing with similar (but not the same) products and services. These vendors will continue to claim "anytime, anywhere" when they really mean "anytime, within an urban area within the continental US"! There will be cellular products available within the next 12 to 24 months that will support multiple standards. Only then will we have wireless mobile communications devices that are practical for the international traveler.

1.4.7.1 The Promise of Satellite Technology

The best hope for mobile voice and data communications from rural and remote areas is satellite technology. Cellular and radio networks will continue to focus on urban areas because of the cost of putting the infrastructure in place.

Inmarsat, the major player in satellite communications, has progressed a long way in a short time. Three years ago, receivers were suitcase-sized. Now they are briefcase-sized. In two years' time, they'll be the size of a laptop, and by the year 2000, they'll be hand held (Maize, 1995).

Inmarsat is forming a majority-owned subsidiary to build a system for global personal mobile communications by the year 2000. Inmarsat plans to launch 12 satellites into an intermediate orbit. It is said to be simpler than alternative systems in that each satellite will connect the user directly to one of 12 ground stations to link into the terrestrial telephone network (Clarke, 1994).

The most anticipated wireless technology of the future is LEOS - Low Earth Orbit Satellites. Pushing the advent of worldwide wireless communications, the US Federal communications Commission has awarded licenses to three companies that plan to launch fleets of small, LEO satellites: Iridium, a consortium headed by Motorola; Globalstar, a Loral and Qualcomm joint venture; and TRW.

Iridium plans a system of 66 satellites, beginning in 1998. Partners include Sprint, Bell Canada, and a German telecommunications company. Globalstar would orbit 48 satellites, using simpler satellites than Iridium. TRW has proposed a using 12 satellites. It would provide owned, data and fax service in the US, beginning in 1999 (Maize, 1995).

Teledisc is another, more ambitious system backed by McCaw Communications Corp. chairman, Craig McCaw and Microsoft Corporation chairman, Bill Gates. Teledisc proposes to launch 840 low earth orbit satellites at an initial deployment cost of $9 billion (Clarke, 1994).

1.4.8 Conclusions

The future promise of mobile computing and communication technology is huge. The reality today is that it is complex and difficult to make it work once you step outside of North America. Only the very motivated, persistent and technically competent individuals are going to make it work themselves. The rest of us need as much help as we can get.

In the short term mobile computing will mean carrying around a bag of modems, cables, adapters, plugs and tools in order to get connected. This is not likely to change in the next 12 months, but we certainly will see the evolution of the current products into devices that are much easier to work with and most important - *wireless.* The industry is growing rapidly and new products are being announced daily. Laptops, PDAs, cellular telephones and pagers will all start to blend together.

In this rapidly changing environment the company cannot expect each end-user to be content with a single solution. Different people have different expectations and priorities and will choose different products and services to meet them. Despite this the company must set standards and provide support and education for a range of specified products and applications.

For at least the next year cellular devices will continue to be restricted by geography. If users know they are traveling within North America then it is worthwhile carrying their cellular telephone; otherwise it is just dead weight. Currently, there are two ways of providing cellular telephones to international travelers: renting at the destination, or activating a shared corporate cellular telephone in every country that the company executives and geophysicists travel.

The technology is available to provide people with a choice of a laptop or a PDA to enable simple data communication. Now that PDAs support PCMCIA technology they are capable of the same communication that a PC is. Individual users will need to decide if they are willing to carry the weight in order to get the power and function of a PC, or if they can make do less computer power and go with a PDA.

Establishing a physical connection to enable data communication will continue to be a complex task. It comes down to having the right adapters, connectors and cables and the know-how to make it all work. In response to this many of the best hotels are now supplying data ready RJ-11 telephone jacks and travel kits are readily available that package the various connection devices.

1.5 Recommended Mobile Computing Technology

1.5.1 The Rugged Office Concept

The company needs to establish two standards for mobile computing and communication technology toolkits; one for executives and geophysicists traveling outside of North America, and the other to be used at project sites that need to establish offices in remote locations. The specific hardware component decisions should be made with a clear understanding that the effective life of these components will be at most one to two years because of the rapid evolution in mobile computing and communication technology.

The remote office toolkit only needs two components;

- a rugged, full function laptop computer with appropriate modem and software; and
- a portable satellite telephone equipped for high speed data transfer.

If these components are set up in a standard configuration the company personnel will be able to use the system for effective voice and data communication no matter which project site they are at or which home office they are from.

The traveling toolkit will need to contain all of the components required to enable mobile computing and communications from most urban areas worldwide. Specifically, it should contain the following components:

- International telephone and power plug adapters;
- Digital / PBX telephone connector;
- Acoustic telephone coupler; and
- the tools and instructions to make it all work.

Individual users should determine if they carry a laptop or a PDA to enable data communication. the company should recommend laptops and PDAs that support a PCMCIA fax/modem with a standard RJ-11 connection and ensure that standard communication software is used that will work with the components of the toolkit. At this time I do not think that the company should include a cellular telephone as part of the traveling toolkit concept.

The following sections discuss each of the different components and their role in the toolkit in more detail.

1.5.2 Cellular Telephones

Over the next 12 to 24 months cellular telephones that work in many countries will reach the market. Once these products are available cellular network providers will rush to offer comprehensive international roaming agreements. Until this service is available it is just not practical for the company to package cellular telephones as part of the traveling toolkit for the following reasons:

- Cellular telephones can only be active in one geographical area at a time. Travel is often to several different countries in a single trip. Coordinating the telephone activation with the schedule of the traveler is a very difficult task. This has been tried by the Division 1 Manger of IS, using Cantel's current international roaming service and found to be very inflexible and of limited use.
- The travel done by the company executives and geophysicists is often done to a large city where they have easy access to telephones in hotels and branch offices. When traveling to a project or exploration site they are most often outside the coverage of cellular network providers so the cellular telephone would not work.
- With the exception of the well developed areas (Europe and North America) that have installed digital cellular networks, data communication by cellular modem is very slow because of the poor quality of the analog cellular signal.
- Indoor use of cellular modems further reduces the quality of the signal which may render cellular data communication totally impractical in many locations.
- If someone is in a situation where they must have access to a cellular telephone they can easily rent it in the destination country.

1.5.3 Portable (Laptop) Computers

A Laptop computer is a lightweight, portable computer that is typically powered either by rechargeable batteries or from a wall socket. They range from four to ten pounds and are small enough to fit inside a briefcase.

The objective of laptop computer manufacturers is to provide a portable computer that will do everything a desktop computer can do. Although there are some excellent products on

the market they face some challenges to meet that objective. The three most severe restrictions laptops face are: battery life, screen quality and weight (Reinhardt, 1995).

Battery life currently ranges from as little as one hour to as much as four hours. Battery technology is fairly mature so most gains in battery life are coming from better power management by the laptops (Reinhardt, 1995). Screen quality has improved dramatically in the last two years. Active-matrix LCD (liquid crystal display) screens provide the best quality, but they are twice the price of a passive-matrix LCD and draw more power. LCD based technology will continue to dominate the market for the next few years and will continue to improve (Cinnock, 1995).

An important innovation that has boosted the usability and flexibility of laptops is the agreement of manufacturers to the PCMCIA standard for peripherals. All major laptop manufacturers now include at least one PCMCIA slot for attachment of modems, network adapters, additional hard drives, etc. Because of this we now see a flood of products available that provide additional functionality to laptop computers. For the company it means that they can purchase credit card sized high speed modems that will enable connectivity from the laptops.

1.5.3.1 Product Highlights

A laptop that has generated a lot of interest recently is the IBM Thinkpad 701 (unofficially known as the "butterfly"). Included below are some quotes from the IBM Home Page on the Internet that discuss the features of the laptop:

"The latest addition to IBM's award-winning Thinkpad family - weighing in at 4.5 pounds ... The 701C combines a full-size keyboard and the largest color screen in a mobile computer with the size and weight of a sub-notebook computer. When you open the unit, two keyboards ingeniously spread and interlock to form a keypad two inches wider than the unit itself. The ... keyboard overhangs the unit's case by about one inch on each side and provides the full-size, 85-key typing surface previously found only in larger, heavier mobile computers.

No fancy add-ons or extras are required to transform this new Thinkpad into a full-function speakerphone and fax machine. Just plug it into a telephone jack. And with built-in infrared, users can print documents and send files with no wires or cable connections."[28]

In a recent review of laptop computers the editors of PC Magazine had mixed feelings. They "loved the "butterfly" keyboard and small [size], but its mediocre performance and abysmally short battery life [1.6 hours] were disappointing" (Howard, 1995). In the same review they selected the following laptop computers as their "Editor's Choice":

- Texas Instrument's TravelMate 5000 75mhz Pentium TFT as the best "full featured" laptop.
- Micro Express NP92DX4 as the best "value" laptop.
- IBM Thinkpad 755CD as the best "multimedia" laptop.
- Gateway Liberty DX4/100 Best Buy as the best "sub-notebook" (small and light - 5.4 lbs) laptop (Howard, 1995).

[28] The IBM Thinkpad, IBM Home Page (http://www.pc.ibm.com/thinkpad/index.html)

Laptop computers are rapidly evolving products. In May, Mobile Office magazine did a review of the first four Pentium based laptops on the market (they chose the Toshiba T4900CT as their "Mobile First Class" product). By the time the August PC Magazine review was done, a full twenty out of eighty laptops they reviewed were Pentium based.

To enable mobile computing it doesn't matter which specific laptop the company chooses, as long as it supports the PCMCIA standard and the communication software the company adopts as a standard. What is more important is that the company chooses a vendor that fits in with their overall IT strategy. I understand that the company has a relationship with Compaq and that Compaq has recently released a new line of laptop computers.

1.5.4 Personal Digital Assistant

PDAs (also called palmtop computers) are small, light (eight to 30 ounces) computing devices. They typically come with a range of functions built in, like organizers, spreadsheets, electronic mail, etc.

PDAs are improving in quality but still have some significant limitations that restrict their popularity. One such limitation is the inconsistent quality of the recognition technology that enables pen-based input. The limited keyboards on some models are also difficult to use and lack a specific feel and sound. Most PDAs also have reflective light screens and not backlit screens so they are difficult to see in dim or diffused lighting. The processors in PDAs have become smaller and more powerful but still perform too slowly and consume too much power. Most PDAs are also limited by the need to be linked remotely to desktop

systems with interfaces that do not support a wide variety of desktop applications (Louderback, 1995).

The market for PDAs remains sluggish even though some vendors are now incorporating wireless data communications, long regarded as 'killer applications,' into the products. Consumers do not think the $600-and-up machines are worth the money, and business users have not yet recognized their potential value.

"Early PDA developers like Apple never had their target audience correct - they were going after consumers, when it should have been business," says Tim Bajarin, president of Creative Strategies, a market-research firm in San Jose, California.

Analysts agree PDAs' eventual success in the consumer market will come in 1998 or later, but the road to get there runs straight through the business community. "Consumers don't mean a thing right now - the momentum has to build in the business market first," says Samuel May, mobile-computing analyst at the Yankee Group in Boston.

While price is an issue to business users, it isn't as critical to them as to consumer buyers. Rather, business customers need better wireless communication and desktop connectivity capabilities, which the original PDAs lacked (Zyskowski, 1995).

1.5.4.1 Product Highlights

There are many different products available today. Most run one of three graphical operating systems designed specifically for PDAs: Apple's Newton Intelligence, General

Magic's Magic Cap or Geoworks' Geos. These systems use a combination of icons, character recognition and artificial intelligence to enable pen based or touch screen data input with varying degrees of success.

The industry leader is the Hewlett-Packard 200LX which bucks this trend by using DOS as its operating system. This has proven to be a very good strategy as the HP 200LX has captured 27% of this market (Santalesa, 1995). The HP 200LX also supports other industry standard applications (Lotus 1-2-3 and Pocket Quicken) as well as having a PCMCIA slot for adding a modem or additional memory.

Data exchange with desktop computers makes palmtops practical. For example, the 200LX has a serial port you can use to connect to a modem or printer. There are good connectivity programs available like, IntelliLink for Windows. It supports the HP and has the ability to transfer data directly to many programs (including dBASE, Echo, Excel, Lotus 1-2-3, and Word). The HP 200LX also supports two-way wireless, using software from RadioMail and a brick-size modem from Motorola or Ericsson/GE (Louderback, 1995).

It makes sense for the company to adopt the HP 200LX as the PDA of choice for the present. It is already used by two of the company executives, it supports industry standard applications and communications and it is easy to customize scripts to automate connectivity.

1.5.5 Making the Connection

The key components in the traveling toolkit are the adapters and connectors that make it possible to connect a North American RJ-11 based modem to a telephone system in any country in the world. There are three different components that are required to ensure worldwide access:

- International telephone adapters and power plug adapters that convert modems from RJ-11 (US Standard) to modular plugs for any country.
- Digital connectors that allow analog modems to be used on digital telephone systems (e.g. using a modem on a multi-line office telephone system).
- Acoustic telephone couplers that plug into your portable computer's modem and attach to virtually any telephone so you can do data communicate over pay telephones, cellular telephones, hotel telephones, digital and foreign telephones. No modular telephone jack is required.

1.5.5.1 Product Highlights

There are three major suppliers of this technology: TeleAdapt Inc., Unlimited Systems Corporation Inc., and Road Warrior. All of the information I was able to obtain on the products was either sales brochures, press releases or brief mentions in related articles. I was not able to find any independent reviews of these products so I cannot recommend specific products based on the strength of the technology.

I do recommend TeleAdapt for other reasons. They have the broadest range of products that support connectivity and they are more flexible in the way they package them. They also provide classroom training and very detailed user guides for all of their products. Most

importantly, they provide 24 hour 1-800 telephone support that will be very useful for the company executives.

1.5.6 Satellite Telephones

As discussed earlier, Inmarsat is the dominant public access two way satellite voice and data communications carrier. They provide a range of communications services through independent service providers.

1.5.6.1 Product Highlights

The two types of satellite telephones that the company needs to consider for its remote office toolkits are briefcase size or suitcase size. Briefcase size satellite telephones are 15 to 20 pounds, provide voice communications, but are limited to 2400 bps or less for data communication. A suitcase size satellite telephone using the Inmarsat-B service is capable of data communications at 64 Kbps. The following quote from the Mobile Satellite Products Home Page on the Internet provides a brief description of the capabilities of the larger units:

"With a LYNXX Transportable Earth Station Terminal you can access your corporate information network from anywhere, anytime, and pay only a low, on-demand air-time rate for the minutes you actually use. You can operate at 64 Kbps for high-speed data; transmit and receive medium-speed asynchronous data at 9.6/16 Kbps; Group III fax at 9.6 Kbps; 16 Kbps toll-quality duplex voice which will also transparently pass Group III fax and data up to 2.4 Kbps; and even have optional support for 9.6 Kbps STU-III available. A LYNXX Unit will pass 4.8 Kbps STU-III calls transparently without any special interface.

With optional accessories, a LYNXX Transportable Earth Station Unit can also be used for compressed color video, video-conferencing, 15 kHz broadcast audio, up to 8 voice and data channels, or Group IV fax.

About the size of an overnight bag or airplane carry-on luggage, your complete LYNXX Transportable Earth Station Terminal goes wherever you go. Simply open the case, deploy the self-contained antenna directly on the unit, or up to 50 feet away using the Optional Remote Antenna Mounting Kit, connect power, aim at a satellite and you are ready to communicate worldwide. Operation is simple, with full control at your fingertips using the cellular-type handset and user-friendly menus."[29]

I was not able to find any independent reviews of these products so I cannot recommend specific products based on the strength of the technology.

1.6 The Business Impacts of the Rugged Office

1.6.1 The Benefits of Mobile Computing and Communication

The following quotes summarize the potential for benefit from this technology:

"Business communications networks are no longer seen as a necessary service, but as a strategic tool: advanced and effective telecommunications systems give companies an edge over their competitors. They shorten decision-making processes, reduce time-to-

[29] The LYNXX, Mobile Satellite Products Corporation Home Page (http://www.mobilesat.com/lynxmnu1.htm)

market for new products and services, and make companies more accessible and responsive to their customers."[30]

"Remote access is about working anywhere. It is about sales reps using tools from customer sites or road warriors working from hotel rooms" (Derfler, 1995). A 1994 study found that mobile computing systems can provide those that implement early with competitive advantage. Respondents reported that order processing rates have been cut by as much as 50% and sales transactions are completed in fewer visits when sales staff was provided with mobile computing and communication technology (Gantz, 1994).

"Here's how it might work if you're a pharmaceuticals rep on an out-of-town business trip. While you're asleep, your PCMCIA pager card receives updated price lists and inventory status on your most critical products. When you turn your notebook PC on in the morning, it automatically updates your price-list database. En route to your first appointment, you get headline news on the health-care industry that keeps you abreast of your competitors and gives you a good conversation starter. Throughout the day, the subject lines and the first sentences of all electronic mail messages marked "urgent" or from your boss are forwarded as well" (Howard, 1995).

1.6.1.1 The Company Specific Benefits

During the interviews with the company executives several benefits to the company were identified:

[30] Ericsson in Business Networks, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)

- the CEO of the company identified "staying in contact" and responding quickly to requests as key benefits. He added that communication is a key to staying successful and also "a great stress reliever".
- the VP of Finance of the company stated that a common problem for the company executives is that they are out of the office for weeks at a time and most of their mail just waits until they return. He saw mobile computing as part of a solution that would enable them to deal with this and provide faster response.
- the Chief Geophysicist of the company pointed out that there are geophysicists spread around the world (Canada, Australia, US and South America) who need to communicate (voice and data) on a constant basis. He felt that mobile communications would help to make this as easy as possible to encourage the sharing of information and ideas. He also stated that another difficulty of voice communication is time-zones - both parties have to be able to connect in real time. Electronic mail can be sent and received any time.

Each of the interviewees pointed out the difficulties in using branch office computers to access their electronic mail and files at head office. They all wanted to have technology that would either enable access through (or bypass) the branch networks and telephone systems.

1.6.2 The Issues Associated with Mobile Computing and Communication

According to approximately 150 vendors and analysts surveyed at the 1995 Mobile Industry conference, using portables computers in the field is "relatively difficult" compared with working in an office. Similarly, *providing software and network support* for those in the field

will remain a headache for the foreseeable future. Managing users in the field has been problematic - "We have gotten to the point that rather than call it plug and play, we call it plug and pray," said Mike Radigan, a manager at Xerox Corp. (Swartz, 1995).

According to a study presented at the same conference, the two most significant complaints mobile computing users have is *battery life* for their laptop computers and *dissatisfaction with remote access*, said Bruce Stephen, an analyst at International Data Corp., a Framingham, Mass., research company (Swartz, 1995).

Another big issue that organizations must deal with is *security*. When employees can dial in to the computer network it means others will likely try. Security consultants suggest that remote access is the most critical issue for computer network protection and that maintaining security can be a cumbersome, labour intensive job (Mohan, 1994).

John Girard, a research director at the Gartner Group, points out that remote access technology is still in its infancy and is being constantly improved, but for now the *performance* of remote connections is "lousy". Dave Altounican, Director of Portable Product Marketing at Dell Computer Corp. says that *cost* is the biggest problem facing mobile computing technology (Baker, 1995).

1.6.2.1 The Company Specific Issues

There are several issues that are significant barriers to the company using mobile computing and communication technology effectively:

1.6.2.1.1 Data Communication Infrastructure

The poor state of the company's data communication infrastructure will continue to make it difficult to exchange electronic mail and data files throughout the company in a timely and cost effective way despite the introduction of mobile computing and communication technology.

1.6.2.1.2 Data Management

The lack of data management practices and tools have a negative impact on the company personnel on a daily basis. Exploration site data files are being duplicated in ways that make it difficult to track the most recent versions. Professionals are spending time tracking down data when they should be spending time on analysis.

1.6.2.1.3 Lack of Trust in Information Systems

Mobile computing and communication technology can provide the tools to access the company's computer systems, but cannot guarantee that key people will use it. Until there is trust in the systems it will be difficult to get commitment to using them.

1.6.2.1.4 Ownership / Responsibility

Currently, the responsibility for enabling and supporting mobile computing and communication technology at the company is spread throughout the organization. Many of the executives and geophysicists have done their own research and purchased products that fit their personal requirements (e.g. HP 200LX PDA). Others have asked the IT staff in their division to recommend and buy products for them. There is no single strategy and no central ownership for mobile computing and communication technology.

1.6.2.1.5 Technical Support Personnel

The people currently using mobile computing and communication technology are the company executives and geophysicists. There are no IT technical support people specifically assigned with the responsibility of supporting mobile computing and communication technology. The result is that executives end up testing their own equipment, attempting to resolve problems with no technical support, get frustrated with the equipment and finally, stop using it. It is critical that technical support be available and that support people are given the time and resources to develop easy-to-use procedures for the toolkit, test them in the field , resolve problems and train users.

1.6.2.1.6 Technology Just Part of the Solution

The company executives need to stay in touch with other executives and events at head office while traveling. Mobile computing and communication technology can provide part of the solution, but other aspects of the executive "information management" process should be reviewed. For example, how is paper mail / meeting minutes / department status reports currently dealt with? Are these processes effective? Can we improve?

1.6.2.1.7 Solution is Complex

Data communication is still a highly technical complex endeavor. The toolkit must include software that automates as many steps as possible. Mobile computing and communication technology vendors often package communications scripts as part of their products. The company should test them and use them whenever possible and develop their own when none are available. Some of the company personnel will require individual training, encouragement and incentives to get them past their reluctance to use the toolkit.

1.7 Implementing the Rugged Office

The company management has some large challenges to overcome before being able to use mobile computing and communication technology to its best advantage. Implementing the Rugged Office will require a long term commitment. I will briefly summarize what must be done in the long term before providing specifics for the short term implementation of mobile computing and communication technology at the company.

1.7.1 Long Term Action Plan

1.7.1.1 Organization Structure

The 1995 corporate profile states, the company "will operate as a decentralized company but the prioritization of exploration targets will be centrally managed. In order to ensure consistent technical excellence throughout the corporation, our project development group will provide support as a vital central resource."[31]

In the IT area the company has been operating in a decentralized manner. Unfortunately, the steps have not been taken to ensure "consistent technical excellence throughout the corporation". If management of the company has aspirations of adopting mobile computing and communication technology, or any other emerging IT in an effective way they must restructure the IT staff.

The objective of the restructuring should be twofold: 1) reinforce the ability of the IT staff to react to local (e.g. division, branch office, mine site, etc.) needs and requirements, 2)

[31] "The Company Corporate Profile", April 1995

centralize the authority and responsibility for setting the long term IT architecture and standards directions.

1.7.1.2 Data Communication Infrastructure

Currently the company has no overall strategy for the physical movement of electronic data throughout the organization. This is a major issue that will take a significant amount of time, money and effort to resolve. The company has already recognized this as an issue and has taken several steps towards resolving this, including creating a partnership with MCI Networking.

1.7.1.3 Corporate Wide Data Management

Corporate wide data management is a very enterprising undertaking that the company should not enter lightly. To implement data management across all the company locations will require months of effort by IT staff in all divisions as well as replacement or upgrades of a significant portion of the company's hardware and software. However, every day that the company delays implementing some form of data management perpetuates the wasted time and effort being applied to finding data, moving data, converting data from one format to another, transcribing and duplicating data.

Over time the company must create a corporate wide data architecture for its financial data and put in place standards for collecting, analyzing and reporting the ongoing operations of the organization. "A good data architecture is an essential first step in providing the information base necessary to manage effectively and strategically" (Gosling, 1993). In the near term there are two areas that the company should consider for smaller scale

implementations of data management: 1) exploration / production data used by the geophysicists, and 2) shared project information.

Exploration / production data is all the data currently being collected about exploration and mining sites. This information is typically large files of data (e.g. core sample analysis, seismic analysis, etc.) that are used by geophysicists to evaluate the potential of a site or improve the production of an existing site. These files are typically used by more than one geophysicist in more than one physical location either for comparison purposes or by review by someone with special expertise.

Shared project information consists of all the electronic mail, reports, proposals, findings and reviews created about a significant project. The company undertakes a variety of projects (e.g. to review exploration sites, possible acquisitions, adopt new technologies, etc.). Typically project teams are formed that form the core staff working on the project and information is created and filed by the team members and other about the project.

Both exploration / production and significant projects could be more effective with proper data management. The groupware product, Lotus Notes is designed specifically for this type of situation. Several divisions of the company have Lotus Notes installed for local applications. The company should review the potential for Lotus Notes to be implemented company wide to support exploration / production and significant projects.

1.7.2 Short Term Action Plan

There are several specific steps that the company needs to undertake to implement the Rugged Office toolkits. These steps must be implemented using mechanisms for implementation and integration that fit within the culture of the company. Examples of these "mechanisms" are:

- identifying several clusters of users that represent the different major uses of mobile computing and communication technology;
- creating cross-functional user groups to encourage the development and sharing of mobile computing and communication technology techniques;
- identifying experts or specialists (e.g. experienced users, technical support staff, etc.) to join the various user groups; and
- developing a reporting structure so that user group initiatives can be coordinated by the CIO.

The following is a brief description of the short term actions the company should take:

1.7.2.1 Restore Trust in the Electronic Mail System

The foundation application that will support the company's mobile computing and communication technology strategy is the electronic mail system. There is no point in providing people with technology if they will not use it.

The company should undertake several actions to get people using the electronic mail system:

- educate key end-users about the benefits of electronic mail. This is best received if delivered by a respected peer rather than a technical person;
- provide training and instant, helpful response to "how-to" questions;
- provide quick fixes for problems and communicate problems to end-users; and
- lead from the top - if people see the CEO and all the other executives relying on the electronic mail system they will be more likely to use it!

1.7.2.2 Create a Single Owner

There must be a single owner of the Rugged Office concept and technology if there is any hope of creating a single standard throughout the company. The owner must be someone who regularly interacts with the executive group, since this is one of the key user groups for the technology, and the owner must also be provided with the budget for ongoing testing and support of the Rugged Office components. Testing and support of mobile computing and communication technology should be done by someone with PC and communications expertise that reports directly to the Rugged Office owner.

1.7.2.3 Customize the Toolkits

Purchase the components for several traveling toolkits that include both a laptop and a PDA. Develop communication scripts that automate the dial up, electronic mail log on and file transfer from several different countries. Package the toolkits in a single traveling bag.

1.7.2.4 Pilot the Toolkits

Provide the toolkits to several users who are willing to document their success and failures with the toolkits. The pilot users should not be from the executive group. They should be technically oriented (e.g. geophysicists or IT managers) so they can recognize the source of

problems. They should be willing to spend some time "playing" with the toolkits so it can be improved, and they should be people who are traveling to South America, Asia, etc..

Based on the results of the pilot the toolkit components and customized scripts should be refined and improved.

1.7.2.5 Develop End-user Training and Documentation

End-users must be provided with training that covers the following three aspects of the Rugged Office toolkit: an introduction to the various components of the toolkit, how to use each of the components, and the actions they should take when things don't work as planned. The training should be developed so it can be given in either a seminar format or one-on-one so that the trainer can be responsive to the needs of the end-users.

Documentation that covers use of each of the toolkit components and basic trouble-shooting must also be included with each toolkit.

1.7.2.6 Proceed with a Phased Introduction

A single significant problem or failure with the wrong user can create a strong barrier to a successful implementation of any new technology. Users who fear new technology will latch on to stories of previous disasters as perfect excuses for refusing to try new ways of doing things. Currently the company has this problem with members of the executive group who will not use the electronic mail system.

There must be a careful selection of who will get the toolkit and when. I recommend that a gradual roll-out be adopted. Provide the technology to a small number (four to six) of

technically oriented executives and geophysicists who have shown willingness to experiment. Work with this group to refine scripts, deal with problems, identify locations where the toolkit is not effective and improve the training and documentation.

After problems are identified and dealt with provide the next small group of users with the toolkit. Provide adequate time (e.g. six to ten weeks) between the groups so that training and support can be provided effectively.

1.7.2.7 Provide Ongoing Support

Current rates of successful communication from laptop to the company head office by executives and geophysicists is as low as 40 percent. This is clearly not acceptable and is a large deterrent to successful roll-out of the Rugged Office toolkit. It is difficult to convince someone to carry an extra ten to fifteen pounds of luggage when they know they will have a less than 50 percent chance of making a connection.

The successful connection target rate should be something above 80 percent. A high success rate will convince those resistant to using the toolkit that it is effective. A critical success factor is high quality, timely support to help end-users get connected. This will be difficult because of the effect of time zones. Support will have to be available 24 hours per day to help end-users in other time zones.

The company support staff could offer this level of support by carrying pagers and being on call. This does not appear to be a cost effective solution. For this reason, companies such as TeleAdapt Inc., do offer 24 hour support. I suggest evaluating their support offering for cost, quality and availability.

1.7.2.8 Key Process Reengineering

There are many business processes that will be substantially affected by the implementation of the Rugged Office concept. Two key processes that were identified during the interviews with the company executives and geophysicists were the process to manage the flow of information to and from executives (e.g. paper mail, reports, meeting minutes, etc.), and the process to capture, analyze and share exploration and production data.

To make these processes more effective they need to be better understood, then updated to reflect new technologies and the increasing need for responsiveness and competitiveness.

1.8 Case Summary

The company is a global organization that is managed in a decentralized fashion. This has led to a series of independent decisions about the computing hardware and software that has been installed throughout the company. The decisions, although appropriate for the local situations, have created an IT environment where there is no data communication infrastructure and corporate wide data management is impossible.

The company, like many other global organizations, is experiencing an urgent demand for mobile computing and communication technology to enable more constant communication and faster response by key executives and professionals in the firm. Individuals throughout the company have been experimenting with cellular telephones, laptop computers and PDA products available on the market with limited success. The lack of common standards and

common approaches to mobile computing and communication technology is creating a high level of frustration with the current technologies.

The mobile computing and communication technology industry is reacting rapidly to fill the needs of organizations like the company. This is resulting in a myriad of products, technologies and standards that are available. This range of products is evolving very quickly so the company must choose a standard approach to mobile computing and communication technology that can evolve with the industry. The company must recognize that products will have a short life cycle so will need to be replaced every 12 to 18 months.

The company would like to create a standard toolkit of mobile computing and communication technology products that they will call the Rugged Office. I recommend that there be two versions of this toolkit: the traveling version for use by executives and geophysicist who travel frequently, and the mobile office version that will be used at project sites that are occupied for several months.

Critical to making the Rugged Office concept successful for the company is a well thought out implementation plan. In the long term the company must develop an organization structure that facilitates their strategy of decentralized management, but enforces a set of corporate standards and architectures for IT. This will enable the company to implement a global strategy for data communication and data management.

In the short term the following steps must be incorporated into the Rugged Office implementation:

- create a single owner for the company mobile computing and communication technology strategy and support;
- purchase and customize several toolkits;
- pilot these toolkits with carefully selected end-users;
- develop end-user training and documentation;
- proceed with a slow, gradual roll-out of the toolkit;
- provide high quality, 24 hour support; and
- reengineer key communication processes to take advantage the new mobile computing and communication technology.

Appendix 2

Rugged Office

Project Charter

The Company Rugged Office Project

Business Objectives:

- Provide a combination of hardware and software (a "rugged office") to the company employees who travel that enables them to do mobile computing. Specifically the rugged office must support easy-to-use voice and data communication and support the capture and appropriate analysis of business information.

Project Objectives:

- Identify the telecommunications infrastructure, hardware and software needs and requirements of the company to implement mobile computing.
- Identify the technology options available to implement mobile computing.
- Analyze and evaluate the available technology options based on risks, costs and benefits in the context of the company needs and requirements.
- Design a mobile computing solution (the rugged office) that meets the needs and requirements of the company.
- Evaluate the impact of the rugged office on the business processes and culture of the company.
- Develop an Implementation Plan for the rugged office that includes the appropriate steps to ensure an effective dissemination of this new technology at the company.
- Provide a review of emerging telecommunication technologies with an analysis of the impact of these technologies on the company telecommunications strategy.

Project Scope Includes:

- A review of current the company telecommunication capabilities.
- A review of the current the company telecommunication strategy.
- A review of trade journals and other appropriate publications for examples of best-of-breed implementations and uses of mobile computing.
- Interviews of several key users and Information Systems personnel to determine the company needs and requirements for mobile computing.
- Initial contact of mobile computing vendors for descriptive information of telecommunications infrastructure, hardware and software.
- Work with mobile computing vendors to identify options best suited to the company needs and requirements.
- An analysis and evaluation of the mobile computing technology options, including the risks, cost and benefits of each, in the context of the company needs and requirements.
- Work with the selected the company telecommunications partner to design mobile computing hardware and software that best fits their telecommunication infrastructure and the company needs and requirements given the result of the analysis and evaluation.
- Work with the company telecommunication partner to implement a prototype of the rugged office. (***optional - depends on time available***)
- A Demonstration of the rugged office prototype to a focus group of key users and Information Systems personnel to gather feedback on design. (***optional - depends on time available***)
- Identification of the company business processes that will be effected by the rugged office.

- A review of the business processes that will be effected by the rugged office.
- Interviews of several key users and Information Systems personnel to determine the business impact and requirements for change management during implementation of the rugged office.
- Work with the company Information Systems personnel and the company telecommunications partner to develop a comprehensive Implementation Plan for the rugged office.
- Identification of emerging telecommunication technologies that will impact the company telecommunication strategy.
- Work with the company telecommunication partner to understand the potential impact of these emerging technologies on the company.

Project Scope Excludes:

- A formal Request for Proposal (RFP) process. The time frame of this project precludes a formal RFP process for vendors of mobile computing telecommunications infrastructure, hardware and software. The deliverables of this project can be used as input to a formal RFP process if required.

Deliverables:

- A report on the mobile computing needs and requirements of the company.
- A report that identifies options available to meet the mobile computing needs and requirements of the company, evaluates these options and recommends a specific strategy for implementing a rugged office at the company.
- An Implementation Plan that includes change management strategies.
- A prototype of the rugged office. (***optional - dependent on time available***)

- A report that summarizes emerging telecommunication technologies, their potential for impact on the company and recommendations on how the company can position themselves to take advantage of these new technologies.

Project Risks:

- Limitations of the current mobile computing technologies.
- Limitations of the current telecommunications infrastructure in some areas (e.g. South America, Asia, etc.).
- Reliance on a single telecommunications vendor.
- Applying complex, sophisticated technology to provide a simple, easy-to-use tool for end-users.
- Management/moderation of the expectations of users of mobile computing.
- Understanding and acceptance of the ongoing maintenance and support required for effective mobile computing.

Project Concerns:

- ***Time and Money!!***

Project Reporting Structure: (to Manager, Information Systems)

- Frequency
  - Weekly
- Content

- Project progress
- Interesting Findings
- Project Costs
- Project Issues

- Format

  - Verbal discussion
  - Written updates (as required)

Appendix 3

Mobile Computing Users

Interview Guide

The Company Rugged Office - Needs and Requirements

Interview Outline

Introductions:

- Introduce myself
- Brief overview of Rugged Office project
- Ask interviewee to briefly describe job function

Travel:

- Where do you typically travel to?
- Where is the most remote location you have been recently?
- Do you typically rent a car?

Telephone requirements:

- Do you ever take your cell phone with you? What limitations?
- Have you been able to get access to a phone when you need to?
    - What access? ... hotel, branch office, car rental?
- Do you need to have more immediate access to a phone?

Data Communication requirements:

- Do you take a laptop with you?
- What do you use it for? What limitations?
- What would you like to use it for?
- Do you need to send and receive faxes when you travel?
- How do you currently do it? What limitations?
- If you could easily prepare, send and receive faxes on a laptop would this be of value to you?
- Do you need to send and receive e-mail when you travel?
- How do you currently do it? What limitations?
- If you could easily prepare, send and receive e-mail on a laptop would this be of value to you?
- What is the nature of the information you deal with? Need for security?

Suggestions:

- Have you seen or read about any technology that I should investigate?

Appendix 4

Mobile Computing Users

Interview Notes

Chief Executive Officer - June 27, 1995

The major points made by the CEO through the course of the interview were as follows:

- He currently uses a laptop and carries it with him when he travels. He primarily uses it for sending and receiving electronic mail and working on spreadsheets. He does not do much data transfer as he carries a lot of his important data files on his laptop.
- He is "very dependent" on electronic mail but not all of the Placer Dome executives like to use it. There was a recent example of a five day delay between the time an important electronic mail message was sent and the time it was read. This and other similar examples have undermined the perception held by several executives of the reliability of using electronic mail.
- He travels to many different locations (e.g. North America, South America, Australia, New Zealand, Papua New Guinea, Khazistan, Thailand, England, etc.), but almost always has access to hotel or branch office telephone.
- He has about a 60% success rate at getting connected from remote locations. Developed countries that have well established telephone systems are easy to make modem connections from, but places like South America, Thailand and Khazistan can be impossible.
- He has found that establishing the physical wire connection from laptop modem to the hotel (or branch office) telephone system is the single biggest problem. He has found several telephone cable adapters that he carries with him to make this connection work.
- Having to set up an electronic mail connection over a hotel phone is also very expensive because of the typical hotel markup on long distance charges, but this is money well spent because of the value in staying in contact and responding quickly to requests. Communication is a key to staying successful and also "a great stress reliever".

- He uses fax technology often but not just from his laptop. He also uses hotel and branch office faxes. He is very aware and concerned about the lack of confidentiality when sending and receiving faxes.
- Confidentiality is also a concern with cellular telephones, but not with land line telephones.
- Other technologies that he feels may offer better solutions are cellular telephones and faxes and Personnel Digital Assistants (He is currently using an HP 200LX, but not for communication). He also expressed an interest in acoustic modems.

Chief Financial Officer - July 7, 1995

The major points made by the CFO through the course of the interview were as follows:

- He has been pushing for mobile computing/communications solutions as he feels it is very important to the company.
- There are three different requirements for this technology at the company:
    - Executives need to stay in constant voice and electronic mail contact and require the ability to do some data manipulation.
    - Geophysicists need to stay in constant voice and electronic mail contact and require the ability to do large amounts of data manipulation and data transfer.
    - Project Engineers and "deal-makers" need to set up an "instant office" in remote locations that will stay in one place for two to three months.
- From the executive point of view he sees mobile computing technology as just part of a solution for the executive group to deal with all paper documents (mail, forms, reports, etc.) while away from the office. This is a common problem as many of the executives are out of the office for weeks at a time. Today, most mail just waits until the executive returns although the critical mail will be faxed to a hotel or branch office location.
- He is very concerned about the level of service and reliability of their voice and electronic mail system.
- He does carry a laptop with him when traveling but only has about a 40% success rate of connecting to the electronic mail system.
- He rarely carries his cellular telephone unless he knows that he his is traveling within North America only. He usually has access to a hotel or branch office telephone.
- Travel includes North America, Australia, England, France, Switzerland, Philippines, Papua New Guinea, Venezuela.

- Weight of computing gear is a concern. Currently he carries the laptop and three batteries. If he also caries his cellular telephone with extra batteries it all adds up to almost twenty pounds.
- Carrying all of this gear would not be such a concern if he had confidence that he could use it more than 40% of the time. In other words he is willing to carry an extra couple of pounds if it means that he can connect 70-80% of the time.
- He suggests that a the company communication infrastructure improvement may help as well. For example, rather than phoning back to head office to retrieve electronic mail and faxes why not just telephone the closest branch office.
- The technology must not be looked at in isolation. There is still a degree of fear and a lack of understanding of the capabilities of this type of technology. Some of the executives never carry a laptop with them. Training is required to help and encourage people to use electronic mail more effectively.
- Security is a concern with cellular telephone technology and faxes, but of little concern over land line telephones.
- Other technologies he feels are worth investigating are Personnel Digital Assistants, Multiple Protocol cell telephones and satellite telephones. He would also like to be able to retrieve fax images from his laptop so he can avoid using hotel and branch office fax machines.
- In closing he commented that technology is moving very quickly and the company must be cautious about introducing a solution that will require major changes within a few months. Training people on one system then expecting them to change may introduce more problems than it solves.

Chief Geophysicist and a Geophysicist - June 15, 1995

The major points made throughout the course of the interview were as follows:

There are geophysicists spread around the world (Canada, Australia, US and South America) who need to communicate (voice and data) on a constant basis. The Chief Geophysicist wants to make this as easy as possible to encourage the sharing of information and ideas.

- the company has gone through an evolutionary dissemination of information that has resulted in many different, incompatible networks installed throughout the company. the company progressed from a centralized mainframe to distributed UNIX workstations to PCs and now PC LANs.
- From the geophysicists perspective this has created a major problem - very large amounts of useful data scattered around the world in such a way that nobody can get access to it!
- There is no standard for data management. Data is being stored in a variety of formats (UNIX and DOS, as well as a variety of application formats) with no indexing of the information. Many copies of a single file may exist and often it is impossible to figure out which is the most recent. This makes data analysis unreliable.
- Currently information is being exchanged, but with a lot of operator intervention (e.g. long distance telephone calls to identify and locate files).
- The Chief Geophysicist suggested that the company develop an internal model similar to the Internet, only completely separate and secure. A single copy of information would be posted on the network, the company employees would be able to search for and access posted information by using all of the tools already available on the Internet. Two advantages he cited are that anybody could get access to information from

anywhere, and that all the tools already exist and are being used on the Internet - there would be no need for the company to develop new products.

- Travel done by geophysicists is on average 50% to other offices and 50% in the field. Most of the geophysicist specialize in office or field work so on an individual basis this split does not hold up.
- These two geophysicists do take laptops when traveling but never take cellular telephones. They do not rent cellular telephones in destination countries, instead they rely on using branch office telephones, hotel telephones or satellite telephones at field sites.
- They find it very difficult to use the laptop for communication when traveling because of modem incompatibilities and poor telephone systems, so typically rely on it for personal use. Where ever possible they use a branch office workstation to get access to their electronic mail and to upload or down load data. This is also difficult because of the different network systems in different offices.
- The Chief Geophysicist thought that the geophysicists are not making effective use of electronic mail possibly because of the difficulties when traveling mentioned above. He also stated that another difficulty of voice communication is time-zones - both parties have to be able to connect in real time. Electronic mail can be sent and received any time.
- They also pointed out that geophysicists have one unique requirement for communication - large volume. Currently there is a field project in Venezuela that is sending 10 to 20 Mb of data per day to Vancouver over a Satellite telephone. This data is also being sent on to an outside consultant for processing via the Internet.
- The Chief Geophysicist thought that all field sites have satellite telephones. The older models supported 54 Kbps data transfer, but a couple of new telephones that were

bought only support 2.4 Kbps. The company buyer of these telephones would be the Logistics Manager (San Jose?).

- A kit for each field site that included a permanently setup telephone and laptop that could send and receive electronic mail, faxes, data files quickly and easily would be very beneficial. This would have to be supported by easy to use software and corporate wide data management to be most effective.
- When asked for other technologies worth investigating they suggested:
- Bell South has advertisements for cellular service that "covers the Americas"
- LEOS
- Computer based video conference capability that supports document and image viewing, pointing and updating
- Review what is being done in Australia. All geophysicists there have CompuServe ids that provides them with electronic mail and data transfer access from a wide range of locations.

Division 1 IT Manager - July 14, 1995

The major points made by the IT Manager through the course of the interview were as follows:

- There are several people throughout Placer Dome that are already doing something to enable mobile computing, but there is no coordination.
- In looking at mobile computing technology he sees three issues:
    - the "toolkit" (e.g. laptop, modem, connectors, etc.)
    - the telephone infrastructure
    - alternatives to the telephone infrastructure (e.g. wireless, satellite, etc.)
- He is working on a two things: improving the toolkit by upgrading the laptop and desktop equipment that the executives use and improving the telephone infrastructure by providing international local dial up support for X.25 digital telephone lines through Sprint (each traveler gets a list of telephone numbers for most cities worldwide).
- Currently the level of success the executives have varies by executive. Some executives are willing to learn enough about the technology to make things work under less than ideal conditions while others don't even check their electronic mail when they are in the office.
- Also successful connection depends on the quality of the telephone systems. In Europe and North America connecting is usually straight forward, but in South America and Asia it can be impossible.
- The executives must make time to get proper training on mobile computing if they believe it is important.
- The primary use for the executives is electronic mail. If they need a data file it is typically attached to an electronic mail message.

- He would like to see the company network improved to the point where there is standardization between branches and a connection to the local office would provide access to anywhere else on the company network. He feels it will be very expensive to do this so it will not happen quickly, but it must happen eventually.
- The capability to offer standard connections from most the company branch offices is there, but there has been no priority on making it available - also it would require training.
- One of the problems in upgrading the telecommunications capability for branch offices is the lead times required by some telephone companies. For example, the Sprint system has taken eight months to put in place. In Venezuela they have been told that it will take eight years to put a new telephone line in.
- Several things have been tried to enable remote communication:
- A technical support person in Division 1 has purchased a TeleAdapt Executive Travel Kit for use by an executive.
- He has used Cantel's "Phone Ahead International Roaming" to provide executives with cellular service while traveling, with limited success. The service requires a five day lead time and set up is for exact dates - the company executives often end up traveling on short notice to many different locations so cannot use the service.
- He is currently looking at implementing a three level approach to proving computing power to the executives:
    - a top of the line desktop system
    - a high end laptop with removable disk drives for easy data transfer
    - a PDA (HP 200LX)
- The desktop is required for high end applications (e.g. Reuters and Lotus Notes), the laptop will be used for normal travel and the PDA will be used for short trips. He feels

the trade off between power and battery life (weight) means that today's laptops will not do the whole job.

- An issue created by this strategy is data management - a process will have to be developed to ensure data files are managed across the three platforms.
- The company office network will also have to be improved to support various levels of support:
    - dial in for electronic mail
    - dial in for data stored on network disks
    - dial in to operate the desktop system from a remote location
- Expectations are very high among the executives. Training is required so they know what is possible today.

Appendix 5

Cellular Standards

An Overview

Cellular Standards - An Overview

The history of cellular radio has been marked by the development of different technological standards, producing a world picture of mutually incompatible systems. The enormous growth in demand for cellular created pressure on the first analogue systems and it became increasingly difficult to accommodate the ever-growing numbers of subscribers. The solution was to develop digital technologies which, in addition to offering much higher capacity, also provided other benefits such as speech security and advanced data services.

It was not possible to agree on a single world-wide digital cellular standard and three technologies have emerged with others waiting in the wings. A short overview of the different analogue and digital technologies is given below:[32]

NMT

Although the concept of cellular radio was developed in the Bell Laboratories in the United States, the first commercial cellular systems were launched in the Nordic countries of Sweden, Denmark, Finland and Norway in 1981. The technology used for these systems was NMT - the Nordic Mobile Telephone standard - which was developed jointly between the operators in the four Nordic countries. The first NMT systems operated in the 450 MHz frequency band and were vehicle-based. Later the NMT standards was developed to work at 900 MHz and was able to support hand portable terminals.

[32] The contents of this appendix are based on an overview of cellular technologies provided by Ericsson Radio Systems on their World Wide Web Home Page. Ericsson - An Overview of Cellular Technology, Telefonaktiebolaget LM Ericsson Home Page (http://www.ericsson.com/)

From the beginning, NMT was intended to provide full international roaming between all the Nordic countries. For reasons of culture and geography, cellular radio proved enormously popular in the Nordic countries and today, these countries have the highest levels of cellular penetration in the world.

The NMT technology also proved extremely popular outside the Nordic countries and has been implemented in cellular networks in Western Europe, the Asia- Pacific region and Australia. More recently, NMT has become the technology of choice in Eastern and Central Europe and this demand has stimulated new interest in NMT, particularly NMT450. Ericsson has been developing and upgrading this analogue technology and the new NMT450i systems offer similar features to NMT900 and support hand portable terminals. With this level of support and interest, NMT technology will continue to be a major force in the cellular market for some years to come.

AMPS

The standard developed for cellular radio in North America was the Advanced Mobile Phone Service (AMPS) which operates in the 800 MHz frequency band. As in the Nordic countries, cellular proved extremely popular and the USA is now the largest cellular market in the world with over 19 million subscribers, a penetration level of over seven per cent. AMPS has also been adopted outside the USA, throughout South America, Asia, Oceania and the former Soviet Union (CIS). The AMPS technology has also been developed by Ericsson to offer subscriber service in fixed cellular applications. Demand for cellular service in the

USA was so high that the industry quickly realized the importance of moving to digital technology and began developing the standard which became D-AMPS.

TACS

The Total Access Communications System (TACS) is a standard derived from AMPS but operating in both the 800 and 900 MHz frequency range. It was first implemented in the UK, which is still the largest TACS market, and was subsequently adopted throughout Europe. As well as being installed in Europe, there are also TACS systems in China, Hong Kong, Singapore and the Middle East. A variation of the TACS standard was used for analogue cellular in Japan. Other parts of the 900 MHz band are often allocated for E(Extended)TACS systems.

The move to digital:

The development of digital cellular technology was prompted by a number of factors. The analogue systems around the world were beginning to exhibit capacity constraints; digital technology is more efficient in its use of the scarce radio spectrum and can provide a wider range of service offerings than analogue. Work began on developing digital cellular in the mid-1980s and the first systems began operation in 1992.

GSM

The European digital cellular standard, GSM - the Global System for Mobile Communications - operates in the 900 MHz band. The development of GSM was started by

CEPT - the European PTT group - instigated by the realization that the incompatibility of Europe's analogue cellular systems was inhibiting market growth.

The aim of the GSM development program was a single standard which would be adopted everywhere within Europe. This would create a massive potential market for equipment and terminal suppliers, leading to economies of scale, falling prices and stimulation of the market. GSM also offers international roaming, provides a high level of speech quality and security and enabled the introduction of advanced features.

The development of GSM is an example of excellent pan-European technological cooperation with every manufacturer, operator and supplier being involved. Over 120 operations in 80 countries have signed the GSM Memorandum of Understanding and are implementing GSM networks. This worldwide market provides manufacturers and suppliers with significant economies of scale.

GSM was originally designed as a standard for Europe, but it has spread its influence much further: operators are now licensed in 60 countries, though with the notable gaps of North and South America, and Japan.

D-AMPS

In its move to digital, the USA took a different route than Europe. Rather than invent a completely new technology, the existing AMPS standard was developed into a digital standard - D-AMPS (also called TDMA (Time Division Multiple Access)), which operates in the same area of spectrum in the 800 MHz band. The advantage of this approach is that the

introduction of D-AMPS into an existing AMPS analogue network is easily accomplished. Dual mode analogue/ digital terminals have been developed, allowing operators to include both analogue and digital base transceivers in their networks, often sharing the same base station. Digital channels can easily be added to an existing AMPS network and any number of analogue channels can be made digital without disturbing the level of service. This smooth migration from analogue to digital allows a network operator to choose the speed and timing of his transition.

However, although the US cellular industry developed IS-54, there was some support for an alternative standard based on CDMA (Code Division Multiple Access) technology. This support for CDMA was sufficient to encourage the development of a second digital cellular standard known as IS-95. The Federal Communications Commission (FCC) has adopted a technology neutral stance so that US operators are free to use either standard.

CDMA

CDMA (Code Division Multiple Access) is an all-digital system that can effectively handle data as well as voice. Data is broken into packets of information and every packet has an identifier, so the base station can recognize whether it is voice or data. The difference in processing is whether the base station sends the packet on to a vocoder for speech decoding, or whether it is sent straight through as bits. In contrast, other standards are basically a clever way of interspersing data within today's analog transmission channels.

Where CDMA differs from all other systems is in the quality and reliability of transmission and in the low power requirement. By keeping the power low, you interfere less with other

users and also maximize your battery life. The next generation of handsets should see very long battery life - on the order of eight hours.

CDMA systems are just reaching the market in 1995. U S West made a decision to go digital with CDMA. PacTel, which is now AirTouch [in San Francisco], followed shortly thereafter. The equipment is being provided by Motorola. In Korea, the country's second cellular license will be CDMA. AT&T, which has been working on CDMA for some time, has accepted two orders for trial systems. One is in Manhattan by Nynex, and the other is in Austin, Texas, from GTE.

PDC

Japan also wished to move to digital cellular but decided to pursue its own approach. A new digital cellular standard was developed, originally known as JDC - Japan Digital Cellular - but now called PDC - Personal Digital Cellular. The main standardization work was carried on by the Research and Development Center for Radio Systems (RCR) which defined the digital cellular standard in detail. Specifications were drawn up for PDC to operate in two frequency bands, 800 MHz and 1,5 GHz. Although currently confined to Japan, there are possibilities of the standard being adopted elsewhere in Asia-Pacific as the 1500 MHz band is less congested in many countries than 900 or 1800 MHz. 9

Summary

The rapid growth of mobile communications up to now mainly represents three analogue cellular systems: AMPS, which is used by more than half of the world's subscribers, TACS and NMT.

With the introduction of digital cellular standards, the rapid growth and development are expected to continue. These new standards have been developed regionally: GSM in Europe; D- AMPS in North America; PDC in Japan. In the beginning of 1994, there were more than 1.3 million GSM subscribers, and more than 100,000 D-AMPS subscribers.