NEWFOUNDLAND AND LABRADOR HYDRO

TELECOMMUNICATION PLAN

REVISED AUGUST 20, 2002

Prepared By: IS&T

FORWARD

This revised Telecommunications Plan dated August 20, 2002 has been prepared to reflect the work that has been completed and to present an update to the original Telecommunications Plan prepared in 1997. In order to highlight the accomplishments to date and to identify all design modifications to Hydro's telecommunications infrastructure, the main body and format of the original report is retained.

There have been many changes, both in technology and the organizational structure of Hydro, since the original telecom design concepts were presented in 1997. Information transport technology, with the advent of the Internet, has taken a new direction towards the Internet Protocol (IP). This new protocol has now become the default standard for the transport of voice and data between communication devices. This revised report recognizes and incorporates the changes in technology during the past five years.

In 2000, Hydro repositioned all its skilled information technology and telecommunications personnel into one department, Information Systems and Telecommunications (IS&T). This new department resulted from the merger of three former separate departments namely Management Information Systems (MIS), Telecontrol, and Energy Management Systems (EMS). This Revised Telecommunications Plan is adjusted from the original 1997 concept to meet the IS&T vision:

> "The Hydro Group of Companies will have a single, unified IT infrastructure that manages the core production and support functions in an integrated manner, and that enables all employees to leverage the investment that has been made in the IT Infrastructure by enhancing their ability to perform their job functions."

This report provides an overview of the telecommunication infrastructure plan and the basic philosophy for providing the infrastructure. Details on project justification are provided in Hydro's Capital Budget Proposal documentation prepared for Public Utilities Board (Board) submittal.

TABLE OF CONTENTS

.

1.0 EXECUTIVE SUMMARY

This report is presented as a long term strategic Telecommunication Plan. The system design, described herein, will provide the telecommunication infrastructure to ensure that Newfoundland and Labrador Hydro (the Company) is in a position to provide a reliable cost effective source of electric power to its customers on the island.

The Telecommunication Plan will be implemented in six phases as follows:

Phase I:

All infrastructure replacements associated with Phase I of the plan have been completed. The following is a summary of the infrastructure components replaced under Phase I:

- o digital microwave radio equipment system connecting the Bay D'Espoir Plant with Central and Western stations.
- o additional voice/data collection nodes at the Deer Lake and Stony Brook terminal stations.
- o upgrade of all existing voice/data collection nodes, to the latest technology.
- o cycle charge diesel prime power source at the Gull Pond Hill microwave repeater site.
- o Power Line Carrier (PLC) systems between Bay D'Espoir and Sunnyside terminal station.

Phase II:

All sites associated with the East Coast Microwave Radio system, with the exception of the Chapel Arm Hill to Argentia radio link, have been completed in 2001. The new radio system consists of four new radio repeater sites and eleven links of digital radio that connect all Hydro facilities on the Avalon Peninsula.

Under the 1997 Telecommunications Plan the Argentia radio system would have been installed to meet the needs of the Voisey Bay Smelter. All costs associated with this radio system will be incurred by a separate project when and if the smelter and terminal station are constructed.

Phase III:

- Establish East-West Interconnection Microwave Radio System between the existing Sandy Brook Hill and the new Bull Arm repeater sites during the year 2002/2003.

  With Board approval for this phase of the plan, the initial engineering work will be completed in 2002 and the infrastructure installed and commissioned in 2003.

Phase IV:

- Replace ageing PLC equipment on the West Coast section of the Island. This work will be continuous over a five-year period during the years 1999 through 2004.

Phase V:

- Replace the existing VHF mobile radio system, in the years 2004/2005, originally planned for 2002-2003.

Phase VI:

- Converge the existing voice and data networks used to support administrative and operational requirements into one unified network. This would be a three-year program during the years 2003 through 2005.

The proposed Telecommunication Plan presented herein, will provide an economically viable solution for the replacement of old and unserviceable equipment that will support not only the operational voice and data traffic associated with the power system but also the majority of administrative voice and data circuits between the Company's area offices.

2.0 INTRODUCTION

Telecommunications form an integral part of the basic support service of all power utilities to ensure the availability of operational, control and protection facilities that are critical in maintaining a reliable and secure power grid. Since its inception Newfoundland and Labrador Hydro has maintained the philosophy that the reliability of the power system is contingent on the availability of the telecommunication network. To guarantee this high availability criteria the majority of the telecommunication network is owned and maintained by the Company with alternate routing of critical voice and data circuits leased from Aliant Communications (Aliant).

The reasons that power utilities support the cost for its private telecommunication network are based on the follows:

1) Teleprotection of the power grid is the primary requirement for a reliable and secure telecom network. The policy of ownership and control of teleprotection circuits is based on reliability concerns with the view that common carriers are geared to supporting the general public and would not meet the reliability and security criteria of the power system.

2) Remote control and monitoring of the power system must be conducted using telecom facilities that are independent of the source that is being controlled. Commercial power failures can, and often do, result in the loss of telephone and data services to the general public.

3) The mandate of the common carrier is to provide public telecommunication. In the event of a major disruption of these communications facilities there is a problem in determining which circuits are to receive priority during restoration.

4) By providing privately owned and maintained telecom facilities power utilities are not adversely effected in the event of a labour dispute by a third party.

5) All telecom maintenance activities must be co-ordinated and controlled by the utility to ensure both the power system availability and the safety aspects of live line permits are not jeopardized. This would not be possible with the common carrier controlling the telecom facilities.

6) In order that the computing power of EMS systems can be fully utilized,

high-speed Remote Terminal Unit (RTU) data channels are required. Due to the isolated locations of many generating and terminal stations, common carriers are not often present with the required digital technologies.

7) Demand for bandwidth in order to support administrative requirements are increasing as new applications are being deployed. With area offices widely dispersed, many utilities are achieving economic rewards by connecting these remote locations using spare bandwidth on a telecom network that was initially installed for the support of the power system.

8) Mobile radio communication is an integral part of a utility's telecommunication network and is a necessity for the safety of the workers and maintenance of the power system. With the installation of fiber cables common carriers are in the process of decommissioning or selling radio sites that are not required by CRTC regulations. To eliminate the dependency on outside parties, that have their own interests with regard to the shape of the telecom infrastructure, utilities have taken control and planned their own future.

In order to maintain this philosophy and ensure that the Company is in a position to take full advantage of modern technologies emerging in both the operational and administrative areas the proposed Telecommunication Plan will consist of replacing the existing systems and components that, because of their age and design, can no longer be maintained by the Company. Critical telecommunication infrastructure that was installed in the late 1960's and 1970's are no longer supported by the manufacturers and are a liability to the security of the power system.

3.0 TELECOMMUNICATION INFRASTRUCTURE

This Telecommunication Plan includes the design, supply and installation of a variety of systems and technologies. The following sections provide some high level discussion on the systems to be installed.

3.1 West Coast Microwave Radio System

The original West Coast Microwave Radio System, which consisted of ten hops of microwave radio, was installed in 1979 as part of the Hinds Lake and Upper Salmon hydro developments to carry all operational voice and data for the control and monitoring of these two remote hydro plants to the Provincial Control Centre at the Bay D'Espoir plant, reference Appendix A, Figure 1. The rebuild of the West Coast Microwave System was completed in 1999. The system is now used to carry all the operational voice and data traffic for the western and central areas to a data collection node at the Stony Brook Terminal Station for leased transport to the Energy Control Centre (ECC) in Hydro Place.

The microwave system consists of two types of basic infrastructure:

1. Towers, antennas and buildings
2. Electronics - radios and multiplexers

A 1997 consultant's review of the tower, antennas and buildings indicate that this infrastructure is in very good shape. With regular preventative maintenance, the infrastructure should be viable for an additional twenty-plus years.

During the project review and design process in 1997, Aliant Telecom (formally Newtel Communications) was involved with the design of back-up communication from the Bay D'Espoir area. During this phase of the project Aliant voiced some concern on the status of its existing infrastructure between Grand Falls and the south (Bay D'Espoir Area) and central (Buchans Area) areas of the province. It became apparent to both Companies that a single Hydro owned infrastructure would support future needs of both companies. Based on projected bandwidth requirements the Stony Brook to Bay D'Espoir section of this radio system was upgraded to SONET OC-3 capacity with Aliant owning 2/3 of the bandwidth. The synchronous radio between Sandy Brook Hill and Buchans was upgraded to a 16-DSI radio with Aliant owning ½ of the bandwidth. Aliant paid all incremental costs associated with the upgrade.

The advantages associated with a joint venture such as the West Coast Microwave Radio System Upgrade are numerous. The following lists some of these advantages:

- A single infrastructure resulting in less support and customer costs to remote parts of the island;
- Aliant is able to provide digital services such as Internet to its remote customers;
- Aliant is able to provide improved telephone and long distance access to its remote customers'
- Hydro has an improved infrastructure and additional bandwidth at no additional costs.
- Hydro generates non-traditional revenue and reduces operation and maintenance costs with income generated by the agreement.

Table 1 provides the status of the existing West Coast Microwave Radio system.

WEST COAST MICROWAVE RADIO SYSTEM		
FROM SITE A	**TO SITE B**	**CAPACITY**
Upper Salmon (USL)	Godaleich Hill (GDH)	MDR 6000 (8DS1)
Godaleich Hill (GDL)	Bay D'Espoir Hill (BDH)	MDR 6000 (8DS1)
Bay D'Espoir Hill (BDH)	Bay D'Espoir Plant (BDE)	MDR 4000 S (OC-3)
Bay D'Espoir Hill (BDH)	Gull Pond (GPH)	MDR 4000 S (OC-3)
Gull Pond Hill (GPH)	Sandy Brook Hill (SBH)	MDR 4000 S (OC-3)
Sandy Brook Hill (SBH)	Stony Brook (STB)	MDR 4000 S (OC-3)
Sandy Brook Hill (SBH)	Mary March Hill (MMH)	MDR 6000 (16 DS1)
Mary March Hill (MMH)	Blue Grass Hill (BGH)	MDR 6000 (8 DS1)
Mary March Hill MMH)	Buchans (BUC)	MDR 6000 (16 DS1)
Blue Grass Hill (BGH)	Hinds Lake (HLK)	MDR 6000 (8 DS1)
Blue Grass Hill (BGH)	Deer Lake (DLK)	MDR 6000 (8 DS1)

Table 1

The Gull Pond Hill microwave radio site was equipped with a dual cycle charge diesel generator system as described in the 1997 Plan.

3.2 Power Line Carrier

Power Line Carrier (PLC) systems are designed for low speed, low capacity tail circuits to provide operational voice, data and teleprotection circuits between stations that are remote to a high capacity communications backbone. The Company has used the technology associated with PLC communications since its inception in the mid 1960s.

The voice, data and teleprotection signals are combined in a single 4kHz bandwidth using frequency division multiplexing, which limits SCADA data speeds between 150 and 600 bps.

Currently there are three vintages of PLC equipment in operation:

i) ASEA Brown Boveri - ETA/B: 1960's Design
ii) ASEA Brown Boveri - ETI: 1980's Design
iii) ASEA Brown Boveri - ETL: 1990's Design

An original inventory of the PLC systems used on the island as of 1997 is provided in Appendix B. An updated replacement status, as of July 2002, is provided in Table 2.

The Asea Brown Boveri model ETA/B PLC units are no longer supported by the manufacturer and spare modules cannot be purchased. The equipment is presently being supported with the Company's inventory of spare parts. However, during recent maintenance, it was identified that due to the age of the spare parts these components are unreliable and in some cases do not function properly. As these parts are used they are not being replenished. Since this equipment is well beyond the manufacturer's recommended service life of fifteen years and to ensure the viability of the telecommunication links with stations remote to the West Coast Microwave Radio System it is proposed to replace the majority of the ETA/B units with PLC equipment of the latest design.

The PLC systems to be replaced are included in two capital budget proposals:

i) PLC REPLACEMENT - CENTRAL: This work was included within Phase I of the Telecommunication Plan and consisted of the

replacement of PLCs on TL202 and TL206 between Bay D'Espoir and Sunnyside. The PLCs on TL204, TL205, TL231 and TL232 between Stony Brook and the Bay d'Espoir and Buchans terminal stations were replaced as part of the West Coast Microwave Radio project.

ii) WEST COAST PLC REPLACEMENT: Referenced as Phase IV of the Telecommunication Plan, the ETA/B models of PLC on the west coast of the island will be replaced during the years 1998 through 2004, inclusive.

The geographical locations of the systems to be replaced are shown in Appendix A, Figure 4. The updated project summary for the years 2002 through 2004 is provided in Table 2.

Power Line Carrier technology has its place as a telecommunication medium as demonstrated with the 1995 installation of six PLC systems on the Great Northern Peninsula as part of the St. Anthony/Roddickton Interconnection project. The equipment provides excellent support for the 138kV/69kV radial transmission systems where residential and commercial customers are widely dispersed. The cost associated with providing fiber optic or microwave radio technology into areas of the west coast of the island, as a replacement for the ageing PLC is prohibitive.

However, in the central and eastern areas of the island including the Avalon Peninsula where the bulk generation and 230kV transmission facilities are predominate, Power Line Carrier technology is not an alternative. The limitations imposed on the teleprotection and control systems by this 1960s technology have proven to be a liability for the Company's customers on the Avalon Peninsula. Based on this conclusion it was recommended that the aging PLC systems on the east coast be replaced with a digital microwave radio system as provided for in Section

3.3 - East Coast Microwave Radio System.

POWER LINE CARRIER – STATUS				
LINE	YEAR	SYSTEM	EQUIPMENT	BUDGET
TL202	Complete	Bay D'Espoir – Sunnyside	Replaced with ETL 500 PLC	
TL206	Complete	Bay D'Espoir – Sunnyside	Replaced with ETL 500 PLC	
TL 204	Complete	Bay D'Espoir – Stony Brook	Replaced with West Coast Microwave Radio	
TL 231	Complete	Bay D'Espoir – Stony Brook	Replaced with West Coast Microwave Radio	
TL 233	Complete	Buchans – Bottom Brook	Replaced with ETL 500 PLC	
TL 228	Complete	Buchans – Massey Drive	Replaced with ETL 500 PLC	
TL 214	Complete	Bottom Brook – Doyles	Replaced with ETI PLC from TL233	
TL 209	Complete	Bottom Brook – Stephenville	Replaced with ETL 500 PLC	
TL 211	Complete	Bottom Brook – Massey Drive	Replaced with ETL 500 PLC	
TL 205	Complete	Stony Brook – Buchans	Replaced with West Coast Microwave Radio	
TL 232	Complete	Stony Brook – Buchans	Replaced with West Coast Microwave Radio	
TL 223	2002	Springdale – Indian River	ETL 500 PLC	$326,600
TL 224	2002	Indian River – Howley	ETL 500 PLC	$326,600
TL 207	Complete	Sunnyside – Come By Chance	Replaced with East Coast Microwave Radio	
TL 203	Complete	Sunnyside – Western Avalon	Replaced with East Coast Microwave Radio	
TL 237	Complete	Western Avalon – Come By Chance	Replaced with East Coast Microwave Radio	
TL 217	Complete	Western Avalon – Holyrood	Replaced with East Coast Microwave Radio	
TL 201	Complete	Western Avalon – Hardwoods	Replaced with East Coast Microwave Radio	
TL 236	Complete	Hardwoods – Oxen Pond	Replaced with East Coast Microwave Radio	
TL 242	Complete	Hardwoods – Holyrood	Replaced with East Coast Microwave Radio	
TL 218	Complete	Ocean Pond – Holyrood	Replaced with East Coast Microwave Radio	
TL 243	2003	Hinds Lake – Howley	West Coast Microwave Radio	$1,009,000
TL 245	2003	Howley – Deer Lake	West Coast Microwave Radio	
TL 247	2004	Deer Lake – Cat Arm	ETL 500 PLC	$353,000
TL 234	2004	Bay D'Espoir – Upper Salmon	Digital Teleprotection on West Coast Radio	$ 66,000

Table 2

3.3 East Coast Microwave Radio System

The East Coast Digital Microwave Radio System, completed in 2001, was originally presented in the 1997 Telecommunications Plan as an

alternative to the replacement of the eight links of the thirty-year-old ETA PLC technology and the leasing of digital data services from Aliant to support administrative services. With reference to Appendix A, Figure 4 and 5, the East Coast Microwave Radio system consists of four new repeater sites and eleven digital radio links. All sites as identified in Table 3, are supported with site development, towers, prime power, back-up power and electronic equipment.

The installed microwave radio solution combined with optical data transport protocols will provide a long-term technically acceptable solution at a reasonable cost. Existing PLC technology fails when trying to support reliable teleprotection signals, fast SCADA data channels and quality voice communications circuits.

EAST COAST MICROWAVE RADIO SYSTEM			
	FROM SITE A	**TO SITE B**	**CAPACITY**
	Sunnyside (SSD)	Bull Arm Hill (BAH)	MDR 6000 (8 DS1)
	Bull Arm Hill (BAH)	Come By Chance (CBC)	MDR 6000 (8 DS1)
	Bull Arm Hill (BAH)	Chapel Arm Hill (CAH)	MDR 4000 S (OC-3)
	Chapel Arm Hill (CAH)	Western Avalon (WAV)	MDR 6000 (8 DS1)
(1)	Chapel Arm Hill (CAH)	Whitbourne Office (WBO)	MSR FT1 (512K)
	Chapel Arm Hill (CAH)	Four Mile Hill (FMH)	MDR 4000 S (OC-3)
	Four Mile Hill (FMH)	Holyrood Plant (HRP)	MDR 6000 (8 DS1)
	Four Mile Hill (FMH)	Petty Harbour Hill (PHH)	MDR 4000 S (OC-3)
	Petty Harbour Hill (PHH)	Hardwoods (HWD)	MDR 6000 (8 DS1)
	Petty Harbour Hill (PHH)	Oxen Pond (OPO)	MDR 6000 (8 DS1)
	Petty Harbour Hill (PHH)	Energy Control Centre (ECC)	MDR 4000 S (OC-3)
(2)	Chapel Arm Hill (CAH)	Argentia (ARG)	Future

Table 3

Notes for Table 3:

(1) The Chapel Arm To Whitbourne Office consists of a low capacity 1/2 DS-1 radio and multiplexer configured in hot-standby.

(2) The Chapel Arm to Argentia Terminal Station microwave radio link is not included in the existing five-year capital plan and has not been submitted to the Board for approval. The design of the East Coast Microwave System includes the probability that such at communications link will be required at some future date.

During the preparation of the 1997 Telecommunications Plan fiber optic ground wire technology (OPGW) was investigated as a possible technology alternative to digital microwave radio. This technology can provide adequate performance but because Hydro's existing transmission lines are not equipped with an overhead ground wire it was estimated that an OPGW installation would have been in the order of $27,500,000.00 (1997 direct dollars). To ensure that the Company is equipped with an adequate technology at a reasonable cost the East Coast Microwave Radio System budget proposal was submitted to the Board for consideration in 1999.

The justification for the East Coast Microwave Radio System as the preferred alternative for Company telecommunications on the Avalon Peninsula may be itemized as follows:

i) With the majority of the electrical load located on the Avalon Peninsula and the possible development of additional thermal generation the Company must be in a position to provide adequate

protection and control of the power system in order to maintain service to its customers. Microwave radio will provide the bandwidth to provide advanced teleprotection and control schemes to ensure high availability and fast restoration of the power system.

ii) The installation of the microwave radio support infrastructure will enable the Company to relocate existing VHF mobile repeaters from Aliant sites. This will ensure the long-term viability of the VHF system and reduce the Company's operating costs with the elimination of tower, building and circuit leasing at selected sites.

iii) The microwave radio solution will provide a long-term solution with the latest in technology. It will ensure that the Company is not restricted in the future due to telecommunication constraints now in place with thirty year old PLC technology and the service offering and technology restrictions that are often encountered in remote areas with Aliant.

iv) With the deployment of new business application suites such as J.D. Edwards and Lotus Notes for administrative functions the requirement for bandwidth between area offices, to support these new products, will increase. The proposed microwave system will offset additional operating costs for leased facilities to support administrative data requirements.

v) Long distance telephone costs between area offices on the island will be reduced with the proposed installation. The proposed microwave system combined with the efficient use of leased tail circuits will reduce the Company's operating costs.

3.4 East-West Interconnection Microwave Radio System

With the relocation of the Energy Control Centre (ECC) to St. John's from the Bay D'Espoir (BDE) hydro plant, the Company owned and maintained telecommunication network, used for remote control and monitoring of the provincial power grid, was severed from the processing power of the controlling mainframe. To circumvent this situation an interim solution using leased facilities was proposed in order to extend the telecommunication backbone from Bay D'Espoir to St. John's. Leased satellite services were installed in 1990 to extend all west coast voice and data traffic to the control centre. Because of the low availability of satellite technologies, route redundancy was implemented with the use of leased analog lines from Aliant Communications. This leased solution was designed to meet the short-term goals of the Company and to provide communications to the west coast of the island for a five year period.

Our experience, during the period 1987 through 1998, with leased services has been less than favourable. During weather related power disturbances both the satellite link and the Aliant analog lines are adversely affected. At times communication with the west coast stations was not available. The power grid and the leased telecommunication facilities are not mutually exclusive systems; during severe weather conditions both are adversely affected and both systems are dependent on the health of the other.

The long-term objective of this Telecommunication Plan is to reduce the Company's reliance on leased services and thus improve system availability and reduce operating costs. To meet this goal it was proposed and approved by the Board to install an East-West Interconnection

Microwave Radio System between the existing Sandy Brook Hill and the new Bull Arm repeater sites. The system will consist of five links of high capacity digital radio as detailed in Appendix A, Figure 4 and Table 4.

EAST-WEST INTERCONNECTION MICROWAVE RADIO SYSTEM	
FROM SITE A	**TO SITE B**
Sandy Brook Hill (SBH)	Southwest Brook
Southwest Brook	Jonathans
Jonathans	Glovertown
Glovertown	Shoal Harbour
Shoal Harbour	Bull Arm (BAH)

Table 4

In addition to the high capacity radio system between Bull Arm Hill and Sandy Brook Hill this project will also connect the radio system with Hydro's Bishops Falls Office, as shown in Figure 4. By providing a high bandwidth, privately owned telecommunications link to the Bishops Falls Office the full potential of the network can be leveraged to reduce the leased costs associated with administration traffic.

The justification for the proposed East-West Interconnection Microwave Radio System may be itemized as follows:

i) Digital microwave radio facilities will provide a reliable and secure teleprotection circuit between the Bay D'Espoir generating station and the industrial load on the Avalon Peninsula. To improve the overall performance of the power system it is recommended to relocate the teleprotection for TL202 and TL206 from the PLC

systems to a microwave radio link consisting of bandwidth on the West Coast, East Coast and East-West Interconnection Microwave Radio Systems.

ii) The infrastructure, such as towers, buildings, etc., installed for the microwave radio system will enable the Company to relocate approximately half of its VHF mobile radio repeaters to Company owned facilities. This will better position the Company to be able to react to the downsizing of Aliant's infrastructure.

iii) The infrastructure and the available bandwidth will reduce the Company's dependency on a third party.

Fiber cable technology was also evaluated as a possible interconnection solution. However, the costs associated with installing an OPGW on TL206 between Bay D'Espoir and Sunnyside terminal stations, including retrofitting the transmission line structures, was estimated at $13,500,000.00.

A capital budget proposal for the year 2002/03 has been submitted for the East-West Interconnection Microwave Radio System consisting of five links of high capacity radios and the upgrade of the Sandy Brook Hill tower at an estimated cost of $8,941,500.00, inclusive of all project indirect costs. The design phase started in 2002.

3.5 Operational Data and Voice Network

In keeping with the IS&T vision, as presented in the IT Technical Architecture Strategy, of "a single IT infrastructure that manages the core

production and support functions in an integrated manner" the existing General Datacom Ltd. (GDC) Time Division Multiplying (TDM) network used to support the operational network will be replaced. The strategy for the network components is to continue a migration to the Internet Protocol (IP) applications and support devices. The existing Local Area Network (LAN) design, which is based on IP addressable devices, will be extended to voice and data equipment located across the Wide Area Network (WAN). The existing GDC equipment will be replaced with IP accessed routers and switches, thus providing a single infrastructure for both the LAN and WAN interface devices. All GDC nodes currently deployed will be replaced with redundant CISCO routers and switches such that all existing and future network devices (ie. PC's, Revenue Meters, Power System Remote Terminal Units, AS400, Printers, etc.) will be Ethernet connected, regardless whether the device is installed in an area office, Hydro Place, terminal stations or a generating plant. A high level concept of the future network is shown in Appendix A, Figure 6.

In further support of replacing the General DataCom Ltd. Data nodes, GDC has indicated that it has moved the strategic direction of the company to a "network access" supplier rather that its traditional "network transport" role that it has held for the past 20 years. The company has stated "Since Nov. 1,2001 General Datacom has successfully re-organized its operations to exclusively deliver high quality access products". The network transport equipment that Hydro has installed over the past fifteen years is no longer under development by GDC and many components have been manufactured discontinued for a number of years, as shown in Table 5:

GENERAL DATACOM NETWORK TRANSPORT EQUIPMENT		
Equipment	**Development Plans**	**Manufacture Discontinue Date**
TMS 3000	NONE	To Be Determined (TBD)
TMS COMPACT	NONE	Sept. 30,1999
OCM 2000	NONE	Sept. 30,1999
METROPLEX	NONE	TBD
NMS MODEMS	NONE	Sept. 30,1999
GTS CONTROLLER	NONE	TBD
NETSWITCH	NONE	1995

Table 5

The Capital Budget Proposal for this program will consist of two dependant projects. During 2003, Phase 1 the technical issues will be investigated and the detailed design and costing completed. Phase 2, the network installation, will be completed in the years 2004 and 2005 with a three-stage implementation into regional offices, radio sites and terminal generating sites.

The total cost for this program is summarized as follows:

System Design, Phase 1	2003	$291,800.
System Install, Phase 2	2004	$971,000.
	2005	$1,247.000.

3.6 Voice, Data and Teleprotection

With the installation of the proposed infrastructure there will be a vast improvement in data speeds for both operational and administrative traffic. As detailed in Section 3.5 - Data Network Upgrade, the

functionality of the network will remain the same however bandwidth to terminal stations and area offices that are interfaced with the radio backbone will not be restricted. RTUs on the Avalon Peninsula that are presently operating at 300 bps may be increased to 9600 bps or Ethernet speeds with no additional capital investment. Recent discussions with an Energy Management System (EMS) consultant indicate that 9600 bps will be the minimum requirement for data channels supporting the new generation of EMS.

With the installation of the proposed network the majority of terminal and generating stations will be equipped with adequate bandwidth to support IP voice circuits. It is felt that the proposed design will greatly improve the quality of the operational voice traffic.

The existing teleprotection circuits are carried primarily on the PLC facilities. As the new digital teleprotection equipment, as standardized on the West Coast and East Coast Microwave Radio systems, requires a minimum of 64kbps digital data channel it cannot be used with PLC facilities. The inherent constraint of analog PLC technology does not support a secure power system protection scheme. High noise levels that appear on a transmission line during fault conditions often prevent the required tripping signals from operating. With the installation of the proposed network the teleprotection signals will be placed on the radio system that is not affected by power line fault noise. Again, this is a complete departure from the existing working philosophy for teleprotection, as protection circuits will be routed through multiple sites in order to achieve the same functionality. This is quite an acceptable practice, however; some changes to the operational and maintenance procedures may be warranted.

For the area offices on the island and the terminal and generating stations connected to the recommended digital microwave infrastructure, bandwidth will be available at little or no cost for at least thirty years. Any additional bandwidth required to support administrative (financial) applications or the use of such features as substation automation, video conferencing, remote engineering support, video surveillance and distance learning/training will be possible without future increases to the telecommunication operating budget.

3.7 VHF Mobile Radio System

The VHF Mobile Radio System is also an integral part of the telecommunication infrastructure that supports power system maintenance activities. It is designed primarily to provide a voice circuit between field personnel and the Energy Control Centre and is a tool to be used for the efficient operation of the power system as well as the safety of employees. Hydro's Work Protection Code requires that the Energy Control Center have immediate and guaranteed voice communications with field crews that are working on or near live transmission facilities. This is absolutely critical from a safety perspective. The only proven solution to meet this requirement is a VHF mobile radio system.

Appendix A, Figure 2 provides a geographical representation of the present VHF Mobile Radio System infrastructure that can be summarized as follows:

- the Company owns all twenty-nine VHF repeaters and paging equipment as well as the interconnecting switch.

- the VHF equipment for twenty-five repeaters is installed in Aliant microwave sites; four repeaters are installed in Company owned radio sites. The VHF switch is installed in Aliant's office in Gander.

- Aliant provides all maintenance for the repeaters and switch on a time and materials basis. The Company is allowed access to Aliant sites on an accompanied basis and has to pay Aliant the going rate for accompaniments.

- the Company owns all of its mobile and portable VHF radios, with maintenance out-sourced as necessary.

- as of Dec. 2001 the Company paid a monthly leasing rate of $18,000.00 to cover trunk costs (circuits which connect repeater sites to the Gander switch) as well as towers and accommodation costs which covers rental space for the antenna and equipment at each site. Aliant Telecom has increased the operating costs for VHF mobile services to $21,000/month in 2002, with a further increase to $26,000/month in 2003.

  By relocating the VHF mobile radio infrastructure to Hydro owned facilities the Company has control over operating costs such as these that are increasing at a 20-25% annual rate. The Company presently recovers $15,000 a month by leasing excess capacity to Works, Services and Transportation (WS&T).

There are a number of concerns regarding the present leasing agreement with Aliant Communications and the long term viability of the Company's VHF Mobile Radio system; namely:

1) The original ten-year contract with Aliant expired in February 1999. Aliant have failed to renegotiate this agreement. Because of the possible elimination of Aliant's microwave infrastructure, the Company may be put in position to purchase Aliant sites, develop its own infrastructure, or provide no coverage in certain areas.

2) With the downsizing of its maintenance staff, Aliant can no longer provide the response times to ensure the availability of the Company's VHF Mobile Radio System.

3) Aliant is getting out of the mobile radio business and concentrating primarily on cellular. This technology is not a viable alternative for a generation and transmission utility.

4) Aliant's equipment subcontractor, ATI, is no longer in existence. The holding company, Telus, has indicated that hardware and software support for the switch and repeater control equipment has been terminated. This means that the system is no longer expandable or able to be functionally upgraded and that the system is at the end of its physical life.

In February 2001, the Department of Works, Services and Transportation informed Hydro in writing to provide "confirmation of the Department of Works, Services and Transportation's intention to participate in the finding and usage of the proposed new Hydro mobile radio system". During 2002/03 it is planned to finalize the details of this arrangement prior to issuing a tender document for the new system.

The "VHF System Replacement" is included in the Plan for 2004-2005 to ensure that Hydro has a reliable and efficient mobile communications system that can service the needs of its transient work force. As pointed

out previously, it is critical from a safety and a maintenance perspective, that Hydro have a VHF mobile radio system. A new mobile radio system will service Hydro's requirements for the next fifteen (15) years.

When the original budget for this project was prepared in early 1997 the scope of the project was to replace only the central switch in 2000. The estimate at that time was approximately $1.2 million. The scope of this project was revisited in 1998, after the Corporation became aware of the manufacturer's intent to discontinue the radio site repeater equipment, and a decision was made at that time that the most viable alternative was to replace the system completely, as much of the equipment was reaching the end of its useful life and would have to be replaced in future years in any case. At that time a capital estimate of approximately $8.2 million was submitted. Further refinement of the estimate for resubmission caused the estimate to change to its current value of $8.7 million.

In late 1999, a consultant undertook the analysis of the Company's mobile communications requirements to determine the most cost effective solution. The consultant that was hired has extensive experience in the design and analysis of mobile radio systems.

The consultant's report is contained in Appendix D, attached. In summary, it demonstrates that a standards-based mobile radio system is the most cost effective solution to the mobile communication needs of the Company.

All costing details and justification for the project are included in Appendix D – Business Case for VHF Mobile Radio Replacement.

3.8 Cost Summary

Project Status and Capital Costs 2002-2005

Table 6 provides a summary of the capital projects completed to date and the capital expenditures, inclusive of Corporate Overhead, AFUDC, Escalation and Contingency, through to the year 2005:

TABLE 6
PROJECT STATUS AND
CAPITAL BUDGET PROPOSAL SUMMARY (YEARS 2002 - 2005)

Capital Budget Proposal	1997	1998	1999	2000	2001	2002	2003	2004	2005
PHASE I									
- Backup Communications	Completed								
- West Coast Microwave	Completed	Completed							
- Replace Ormat - GPH		Completed							
- PLC Upgrade - Central		Completed	Completed						
- Data Network Upgrade		Completed							
PHASE II									
- East Coast Microwave				Completed	Completed				
PHASE III ($8,941,500)									
- Interconnect East-West Microwave						$268,500	$8,673,000		
PHASE IV ($2,081,100)									
- West Coast PLC Upgrade			Completed	Completed	Completed	$651,000	$1,009,000	$419,000	
PHASE V ($8,721,200)									
- VHF System Replacement								$3,048,000	$5,802,000
PHASE VI ($2,753,600)									
- Voice & Data Network							$291,800	$971,000	$1,247,000
Total by Year	$134,000	$2,433,000	$1,665,000	$1,212,150	$10,342,000	$919,500	$9,973,800	$4,438,000	$7,049,000
Total Proposal Years 2002-2005									$22,380,300

4.0 CONCLUSIONS

Telecommunications infrastructure is an integral part of the power utility business and as such, it must be designed to ensure a high degree of availability in order to support the power grid. It is viewed that the costs associated with the

implementation of a private telecommunication network for the teleprotection, monitoring and control of the power grid should be a part of the core business economic plan and these costs should be justified in the same manner, and included with, new sources of generation and transmission facilities. This basic philosophy for an owned and maintained Telecommunication Infrastructure is held by all major utilities across Canada, as confirmed with the Utility Survey in Appendix C.

Utilities that have made an investment in a high capacity private network, primarily for the control of the power system, are now realizing the economic benefits that are available to their administrative departments. The demand for bandwidth over the past number of years has exploded as new applications are being implemented to support the day-to-day functions of these companies. Companies will be forced to provide the required bandwidth if they wish to purchase and run industry standard applications. With a privately owned high capacity telecommunication network bandwidth is readily available for internal high-speed data transfer or for the generation of additional revenue by leasing any excess bandwidth to third parties.

The conclusions of this report may be summarized as follows:

1. Moving the teleprotection from the PLC systems to digital microwave for most of the 230 KV bulk delivery system will provide the Company with an inherently more reliable power system. This also gives the flexibility to add addition protection schemes in the future that will not be possible with PLC.

2. Power system performance can be greatly improved by providing high-speed data channels between the EMS mainframe and the Remote Terminal Units (RTU) located at each switching and generation station.

3. The Telecommunication Plan allows the Company to take ownership of a significant portion of its communications and controls infrastructure that supports its core business.

4. The long term Telecommunication Plan provides an infrastructure that will meet a significant portion of the short term and long-term requirements for the operational and administrative voice and data services for the Company.

5. The Telecommunication Plan isolates the Company from most increases in operating costs associated with the future requirement for increased bandwidth to our area offices and terminal stations.

6. The Telecommunication Plan puts in place a basic infrastructure that can be expanded and thus will allow the Company to react more effectively to downsizing of the common carriers infrastructure as they re-align to their strategic direction.

7. The Telecommunication Plan positions the Company to take maximum advantage of emerging technologies such as video conferencing, remote training, substation automation and other broadband applications.

8. The proposed network will provide a business opportunity for the Company. High capacity microwave radio systems installed to support the reliability criteria for the power system have the potential to generate additional revenue with the sale of bandwidth to third parties.

   The above predictions made in 1997 have become a reality with Hydro's West Coast Microwave Radio system installed in 1999. This radio system is now used to carry commercial voice, data and Internet traffic to

approximately seventeen communities in the south and central region of the island. By collaborating with Aliant Communications and installing a single high-speed microwave radio system to these areas of the Province; Hydro, Aliant and the people of these communities benefit from this new technology.

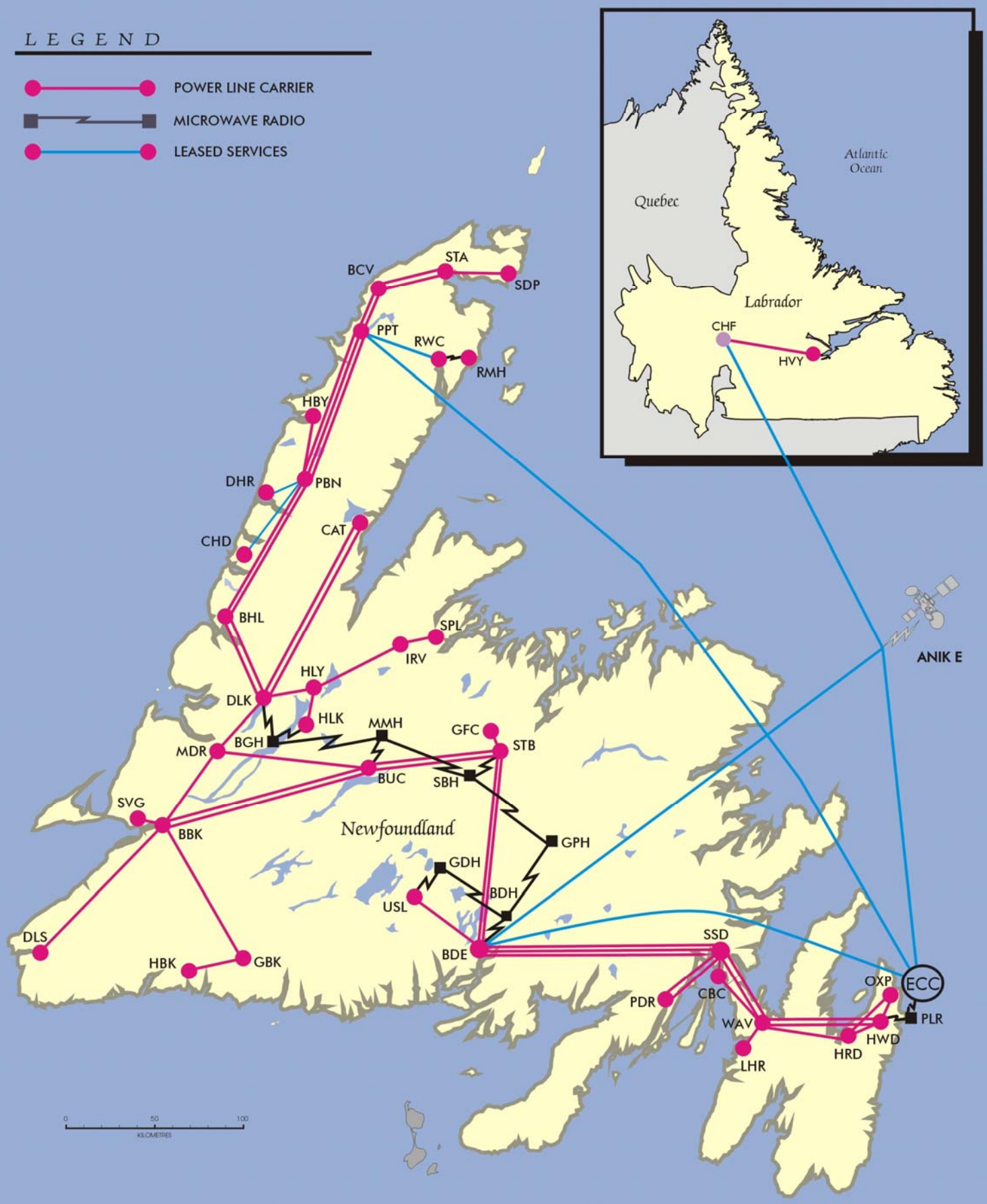
5.0 RECOMMENDATIONS

1. The Company continue with the phased implementation of the Telecommunication Plan as put forward in Table 5.

2. The Company continue to investigate and initiate joint partnerships that would result in a reduced total cost of ownership for its telecommunications infrastructure.

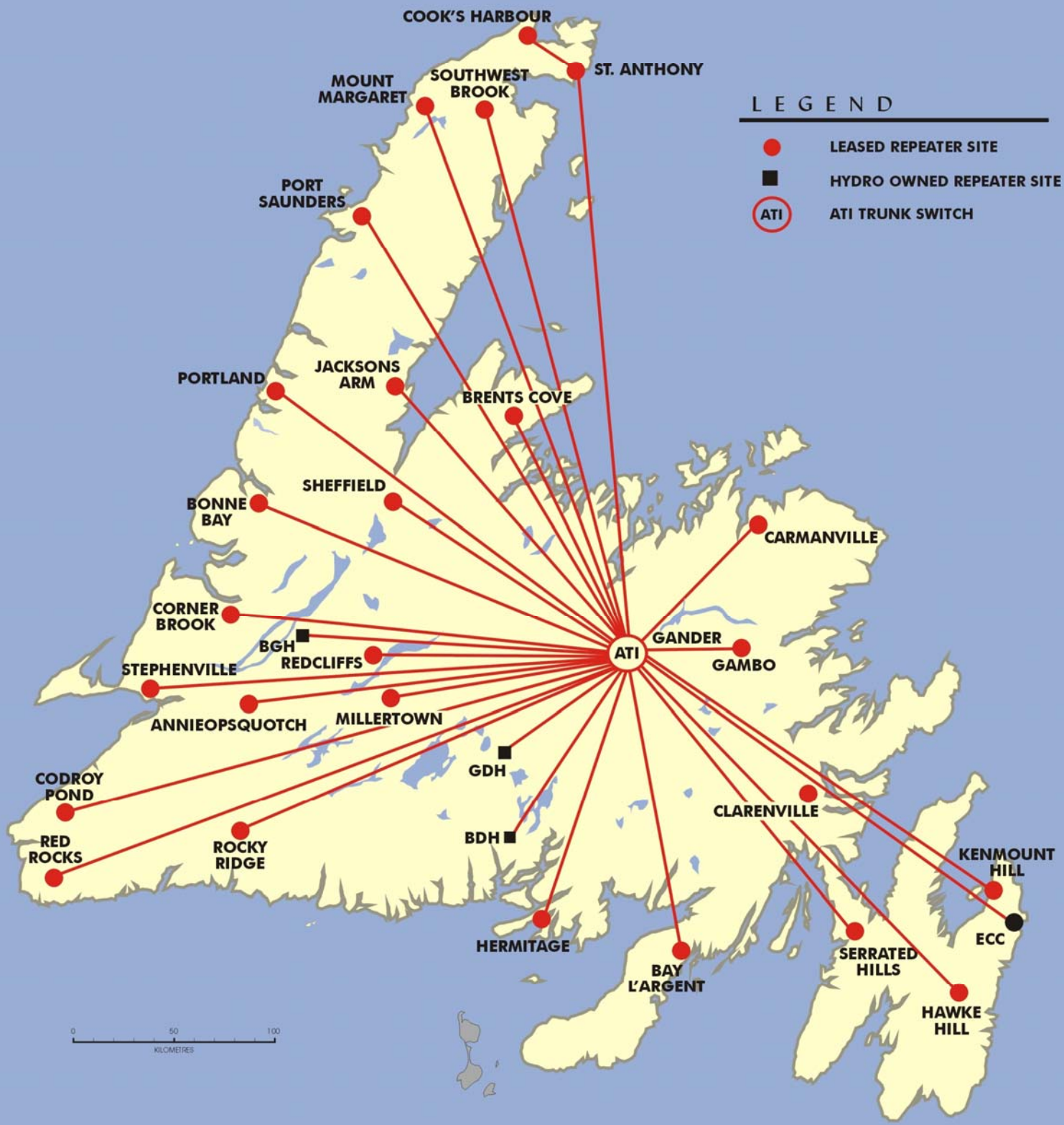
3. The Company continue to leverage its investment in high capacity transport system to reduce operating and capital expenditure in the Information System areas. By providing a single unified network architecture as presented in this revised plan the Company will move in the right direction.

APPENDIX A - DRAWINGS



Existing Telecommunication Facilities(1997)

Figure 1

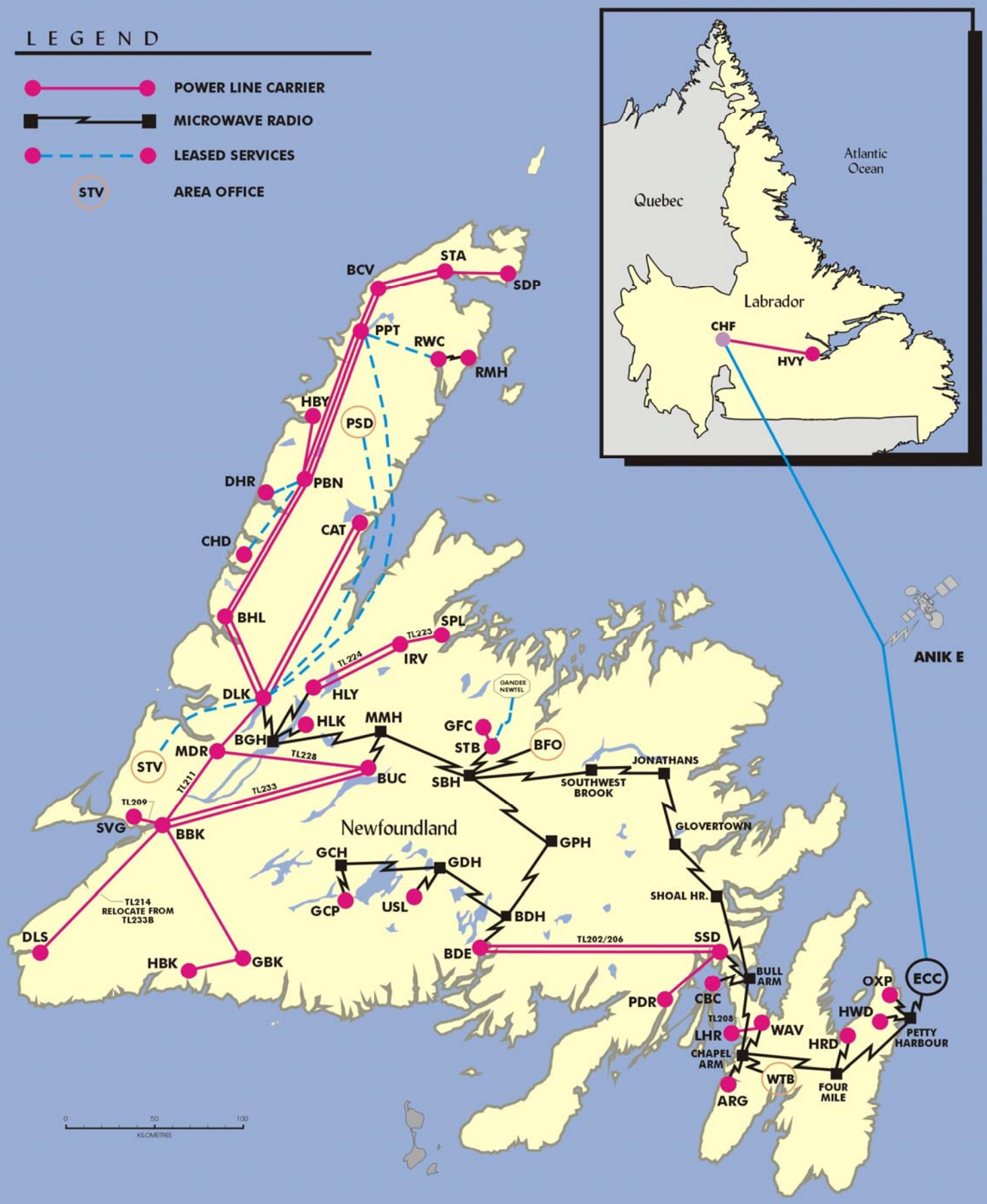


Existing VHF Mobile Radio System

Figure 2

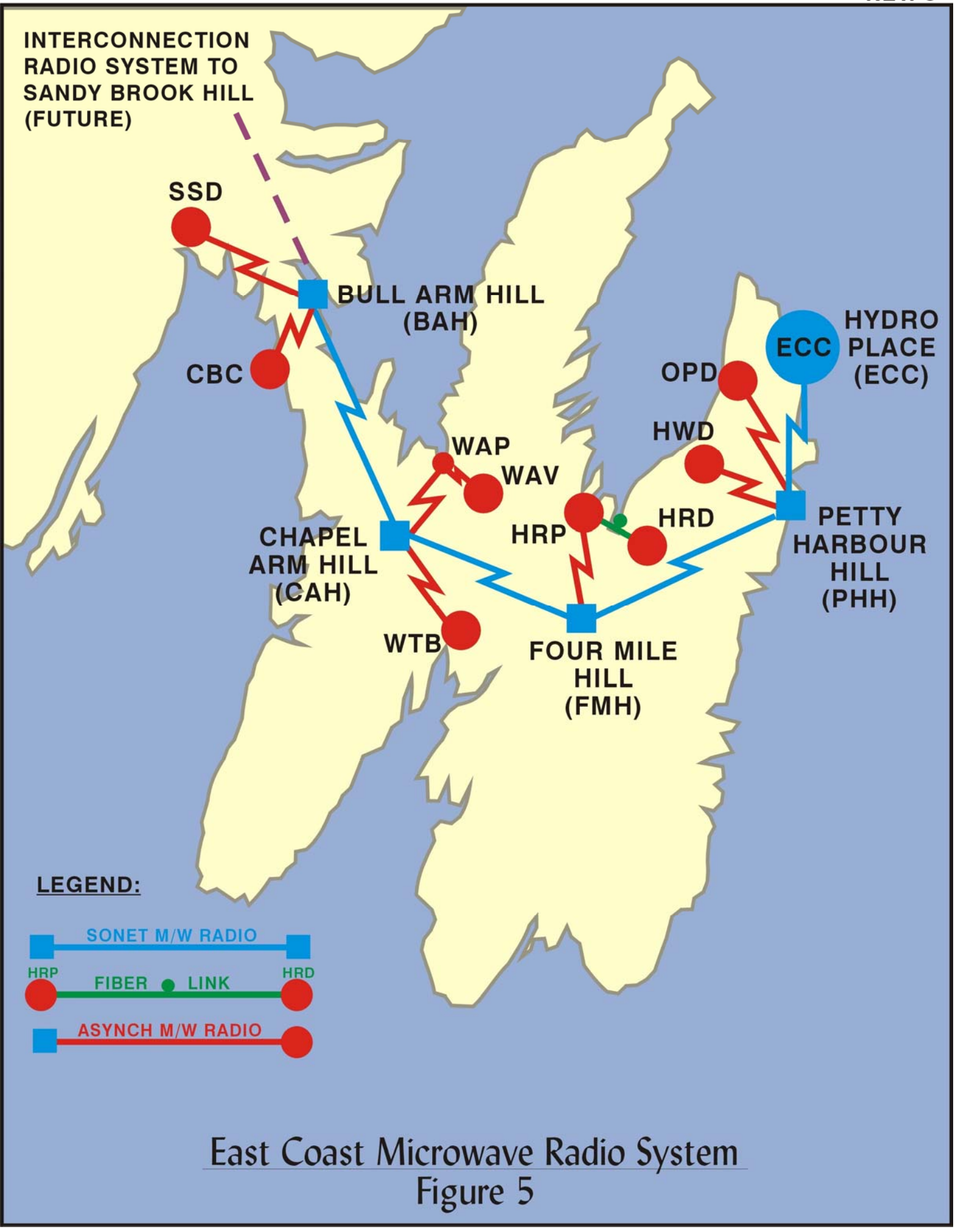
Proposed VHF Mobile Radio System

Figure 3



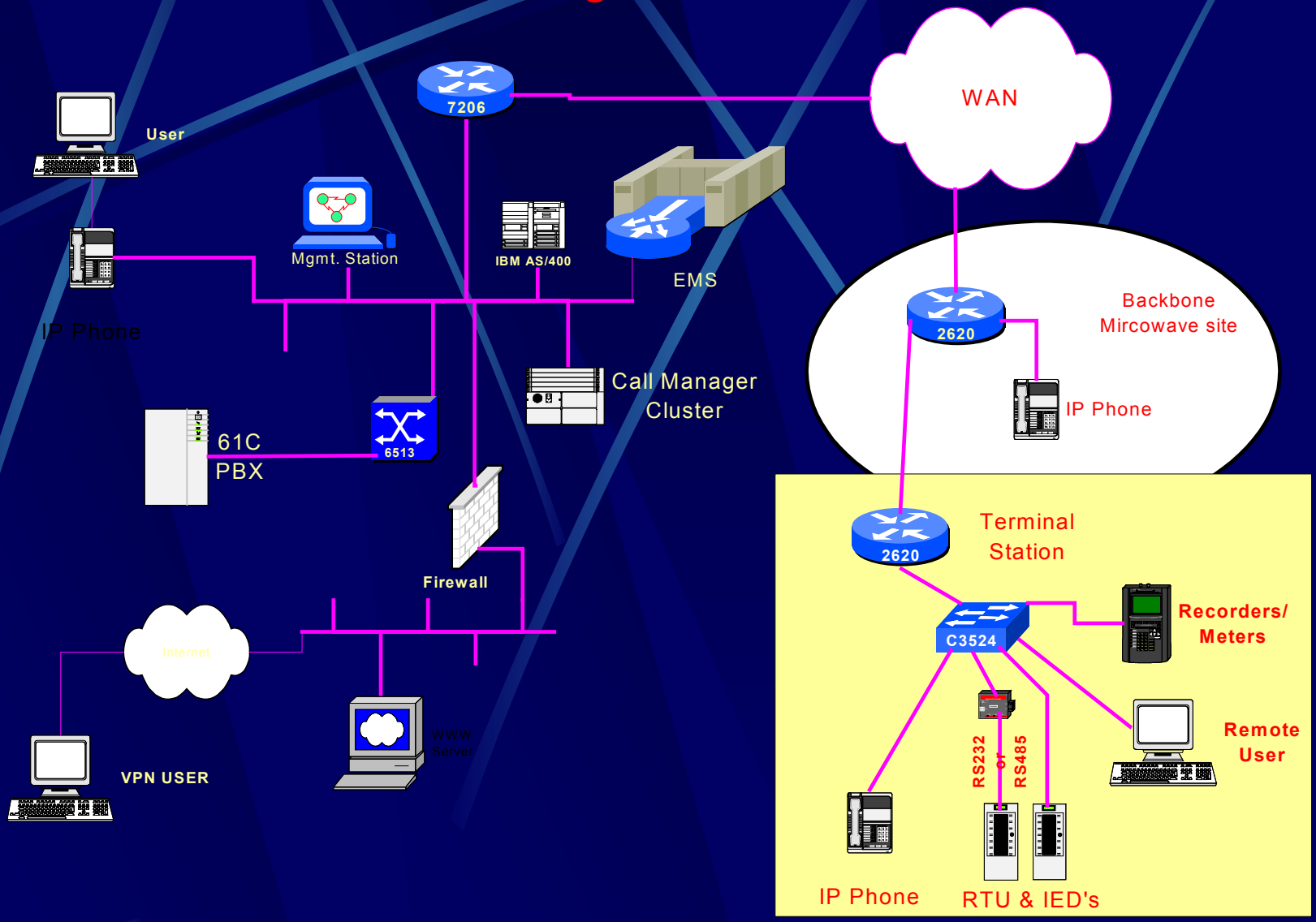
Proposed Telecommunication Plan - Final

Figure 4



East Coast Microwave Radio System
Figure 5

Future IP Converged Network
Figure 6



APPENDIX B - PLC INVENTORY (1997 DATA)

POWERLINE CARRIER INVENTORY - CENTRAL/WEST		
Transmission Line	**Terminal Stations**	**Date Purchased**
TL204A	Bay D'Espoir - Stony Brook	1967
(1) TL204B	Bay D'Espoir - Stony Brook	1967
TL234	Bay D'Espoir - Upper Salmon	1979
11(2) TL233A	Buchans - Bottom Brook	1968
(2) TL232	Stony Brook - Buchans	1968
(2) TL205	Stony Brook - Buchans	1977
(1) TL231	Bay D'Espoir - Stony Brook	1977
(3) TL233B	Buchans - Bottom Brook	1990
(2) TL228	Buchans - Massey Drive	1967
TL250	Bottom Brook - Grandy Brook	1987
TL255	Grandy Brook - Hope Brook	1987
(2) TL214	Bottom Brook - Doyles	1968
(2) TL209	Bottom Brook - Stephenville	1968
(2) TL211	Bottom Brook - Massey Drive	1967
(2) TL223	Springdale - Indian River	1966/80
(2) TL224	Indian River - Howley	1966/80
(2) TL245	Howley - Deer Lake	1980
(2) TL243A	Howley - Hinds Lake	1980
(2) TL243B	Howley - Hinds Lake	1980
TL248	Massey Drive - Deer Lake	1985
TL247A	Deer Lake - Cat Arm	1985
TL247B	Deer Lake - Cat Arm	1985

Table B-1

Notes for Table B-1:

1. *PLC systems were replaced in 1999 under Capital Budget proposal "PLC Replacement".*

2. *PLC systems being replaced under Capital Budget proposal "West Coast PLC Replacement" in 1999 to 2004. The links removed will be used as spares to sustain 5 links left in service.*

3. *This link will replace TL214.*

POWERLINE CARRIER INVENTORY – GNP		
Transmission Line	**Terminal Stations**	**Date Purchased**
TL239A	Deer Lake - Berry Hill	1990
TL239B	Deer Lake - Berry Hill	1990
TL259A	Berry Hill - Peter's Barren	1995
TL259B	Berry Hill - Peter's Barren	1995
TL221	Peter's Barren - Hawke's Bay	1995
TL241A/B/C	Peter's Barren - Plum Point	1995
TL244A/B	Plum Point - Bear Cove	1995
TL256A/B	Bear Cove - St. Anthony Airport	1995
TL261	St. Anthony Airport - St. Anthony	1995

Table B-2

POWERLINE CARRIER INVENTORY - EAST COAST		
Transmission Line	**Terminal Stations**	**Date Purchased**
(3) TL202A/B	Bay D' Espoir - Sunnyside	1967
(3) TL206	Bay D'Espoir - Sunnyside	1979
TL207	Sunnyside - Come By Chance	1967
TL203A/B	Sunnyside - Western Avalon	1967/79
TL237	Western Avalon - Come By Chance	1968
(1) TL208	Western Avalon - Long Harbour	1968
TL217	Western Avalon - Holyrood	1970
TL201A/B	Western Avalon - Hardwoods	1968
TL236	Hardwoods - Oxen Pond	1967
TL242	Hardwoods - Holyrood	1979
TL218	Oxen Pond - Holyrood	1967
(2) TL212A/B	Sunnyside - Paradise River	1989

Table B-3

Notes for Table B-3:

1. *This link will be left in service and supported by spares from links removed.*
2. *This link will be left in service. This is a more recent technology.*
3. *These links were replaced in 1998 under capital budget proposal "PLC Replacement".*

APPENDIX C – TELECOMMUNICATIONS SURVEY OF CANADA'S MAJOR GENERATION AND TRANSMISSION UTILITIES.

UTILITY TELECOMMUNICATIONS SURVEY
JANUARY 2001

Technology	Utility	Number of Links		Services		
		Existing	Planned	Teleprotection	SCADA	Misc.
UTILITY OWNED OPGW	NF Hydro	0	0	-	-	-
	NB Power	0	0	-	-	-
	Hydro Quebec	54	10	X	x	x
	Hydro Ont.	30	20	X	x	x
	Sask. Power	2	0	X	x	x
	Manitoba Hydro	4	0	X	x	x
	Atco. Electric	2	0	X	-	-
	BC Hydro	0	0	-	-	-
UTILITY OWNED FIBER	NF Hydro	5	2	x	x	x
	NB Power	2	1	x	x	x
	Hydro Quebec	375	25	x	x	x
	Hydro Ont.	20	20	x	x	x
	Sask. Power	40	2	x	x	x
	Manitoba Hydro	25	0	x	x	x
	Atco. Electric	0	0	-	-	-
	BC Hydro	8	6	-	-	-
UTILITY OWNED ASYNCHRONOUS MICROWAVE RADIO	NF Hydro	11	9	x	x	x
	NB Power	2	0	x	x	x
	Hydro Quebec	30	41	x	x	x
	Hydro Ont.	4	1	x	x	x
	Sask. Power	0	0	-	-	-
	Manitoba Hydro	60	0	x	x	x
	Atco. Electric	45	3	x	x	x
	BC Hydro	8	0	-	-	-
UTILITY OWNED SONET MICROWAVE RADIO	NF Hydro	4	8	x	x	x
	NB Power	16	15	x	x	x
	Hydro Québec	11	87	x	x	x
	Hydro Ont.	4	16	x	x	x
	Sask. Power	0	0	-	-	-
	Manitoba Hydro	4	0	x	x	x
	Atco. Electric	0	0	-	-	-
	BC Hydro	40	50	-	-	-
UTILITY OWNED MISC. RADIO UHF, VHF & SPREAD SPECTRUM	NF Hydro	7	1	x	x	x
	NB Power	many	0	-	x	x
	Hydro Québec	25	0	-	x	x
	Hydro Ont.	2	0	-	x	-
	Sask. Power	4	0	-	-	x
	Manitoba Hydro	27	2	-	-	x
	Atco. Electric	30	0	-	x	x
	BC Hydro	Many	0	-	-	-
LEASED/OWNED SATELLITE	NF Hydro	2	0	-	x	x
	NB Power	1	0	-	-	x
	Hydro Québec	10	0	-	-	x
	Hydro Ont.	70	0	-	x	x
	Sask. Power	4	0	-	x	x
	Manitoba Hydro	10	0	-	-	x
	Atco. Electric	0	0	-	-	-
	BC Hydro	15	0	-	-	x

Technology	Utility	Number of Links		Services		
		Existing	Planned	Teleprotection	SCADA	Misc.
UTILITY OWNED POWER LINK CARRIER	NF Hydro	30	4	x	x	x
	NB Power	2	0	x	x	x
	Hydro Québec	80	0	x	x	x
	Hydro Ont.	250	30	x	x	x
	Sask. Power	82	0	x	x	x
	Manitoba Hydro	29	2	x	x	x
	Atco. Electric	3	0	-	x	-
	BC Hydro	80	0	-	-	-
LEASED COMMON CARRIER CIRCUITS	NF Hydro	60	24	-	x	x
	NB Power	4	0	Note 1	-	-
	Hydro Québec	900	0	-	x	x
	Hydro Ont.	600	100	Note 2	x	x
	Sask. Power	16	0	-	Note 3	-
	Manitoba Hydro	365	0	Note 1	x	x
	Atco. Electric	6	0	-	x	x
	BC Hydro	Many	Many	Note 4	Note 4	Note 4

NOTE 1: Backup teleprotection circuit, main teleprotection circuit on owned facilities

NOTE 2: Non-critical circuits only

NOTE 3: City distribution substations only

NOTE 4: Used when there is no other practical alternative

APPENDIX D – BUSINESS CASE FOR VHF MOBILE RADIO SYSTEM REPLACEMENT

BUSINESS CASE

FOR

VHF Mobile Radio System Replacement

August 20, 2002

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

Newfoundland & Labrador Hydro presently owns a VHF mobile radio system which serves both its employees and the provincial Department of Works, Services, and Transportation with mobile radio services for their respective personnel and vehicles. This system has been in service since 1988 and has now reached the end of its useful life, owing primarily to the unavailability of parts and service for the equipment.

It is proposed to replace this system with a trunked radio system. Unlike the existing conventional system, trunked radio allows users to share radio channels, thereby providing economies of scale when multiple radio channels are required for traffic requirements. Trunked radio is also much more user friendly than conventional radio, with a user interface similar to a telephone.

Alternatives evaluated to provide mobile communications include cellular telephone, satellite telephone, and mobile radio; mobile radio has been demonstrated to be the only feasible alternative for a variety of reasons.

The estimated capital cost of this system, including indirect costs, is $8.7 million, with $5.7 million in direct costs. Annual operating costs of $690,000 (2005 dollars) are also anticipated. WST will share in the capital and operating costs of the system on a prorated number of users basis.

Based on this analysis, it is recommended that the Corporation purchase and install a trunked VHF mobile radio system that provides coverage on the Island of Newfoundland. The proposed trunked radio solution has a Net Present Value of approximately $130,000 more than a conventional system, however this technology is capable of meeting Newfoundland and Labrador Hydro's present and future requirements for mobile communications.

2.0 PROJECT DEFINITION

2.1 Purpose

The purpose of this project is to replace Newfoundland & Labrador Hydro's (the Corporation's) existing VHF Mobile Radio System (MRS). The existing system was installed in 1988 and has reached the end of its useful life. It will be replaced by a trunked radio system capable of providing service to the corporation's employees and its' current, as well as future, customers.

The MRS will provide mobile radio service on the Island of Newfoundland and the southern coast of Labrador. Coverage (the area of service) will include major roads, communities, and the Corporation's transmission lines and generating stations.

2.2 Justification

Mobile communication is a fundamental requirement for the efficient deployment of a transient workforce. Mobile communication is used for employee dispatch, status communications, communication between crews working separately on a geographically distributed asset, such as a transmission line, and for emergency communications. The Corporation has used a mobile radio system since at least the 1970's; the existing system is at least the second generation of MRS owned and operated by the Corporation. The Corporation's users regard the system as an absolute necessity in the performance of daily operations.

An MRS is the worldwide standard for emergency communications. Electric utilities, along with public safety services such as fire departments and police departments, use the MRS because it is the only viable technology for emergency communications. In emergency situations, utility personnel frequently require group communications, for situational updates and for safety information. These features are frequently unavailable in telephone style systems, and when they are, require cumbersome manipulation to perform. It is also unacceptable to expect an emergency worker to use a telephone in outdoor, harsh weather situations when a push to talk (PTT) feature such as is provided by a MRS allows the user to immediately communicate with all relevant parties with the push of one key. In such instances, not only is public safety at risk, but also the safety of the workers themselves can often be jeopardized if proper communications are not easily available.

With the requirement for mobile communications established, the next issue is the necessity of replacement of the existing system. The existing MRS is one of a handful that were installed in Canada, and is the last known system in service today. It consists of a central switch located in Gander, and 29 repeaters scattered across the Island of Newfoundland; each repeater consists of one site controller, one mobile transmitter/receiver, and one transmitter for paging. The switch/site controller system was Manufacturer Discontinued (MD'd) in 1991, and service and spare parts are impossible to obtain now. The system is non-redundant, meaning that catastrophic failure of a key component can render the entire system inoperable. The transmitters and receivers were MD'd in 1996, but they are very common and can be replaced with compatible equipment should they fail. Replacement of the existing MRS is an absolute requirement to maintain mobile communications; no other options exist.

When the original budget for this project was prepared in early 1997 the scope of the project was to replace only the central switch in 2000. The estimate at that time was approximately $1.2 million. The scope of this project was revisited in 1998, after the Corporation became aware of the manufacturer's intent to MD the repeater equipment, and a decision was made at that time that the most viable alternative was to replace the system completely, as much of the equipment was reaching the end of its useful life and would have to be replaced in future years in any case. At that time a capital estimate of approximately $8.2 million was submitted. Further refinement of the estimate for resubmission caused the estimate to change to its current value of $8.7 million.

In late 1999, a consultant undertook the analysis of the Corporation's mobile communications requirements and determination of the most cost effective solution. The consultant that was hired has extensive experience in the design and analysis of MRS.

The consultant's report is contained in Appendix C attached. In summary, it demonstrates that a standards-based trunked radio system is the most cost effective solution to the mobile communication needs of the Corporation. It also contains cost estimates that were used in the preparation of the capital job cost, as well as the cost-benefit analysis contained in Section 6 of this document.

2.3 Objectives

The objectives of this project are as follows:

- To provide the most cost-effective, reliable mobile communications system for the Corporation's workforce and customer;
- To maximize the life and minimize installation and operating costs by using standards-based technology wherever possible;
- To maintain and where feasible increase coverage of the system;
- To utilize Hydro-owned facilities wherever possible to minimize installation and operating costs.

2.4 Scope/Major Deliverables

This is a one-phase project to be implemented over two years. The major deliverables include the following:

- Trunked MRS infrastructure, including but not limited to standards-based switching equipment, site controller equipment, and system management hardware/software;

- Mobile repeater equipment, including transceivers, antennas, filtering equipment, and all associated hardware;
- Approximately 700 mobile and portable radios, distributed roughly equally between the Corporation and WST users, and apportioned in the approximate ratio of 70% mobile and 30% portable;
- Increased coverage where required, as long as it is demonstrated to be economically and technically feasible;
- User and maintenance training;
- Spare parts.

2.5 Assumptions

Assumptions used in the development of this business case, the project capital job cost, and related documentation include the following:

- Repeaters will be installed at microwave radio sites owned by the Corporation whenever it is technically sound;
- The system will be designed to maximize the use of interconnect facilities owned by the Corporation, as opposed to leasing these facilities;
- Ongoing maintenance of the system will be performed by a third party at sites not owned by the Corporation, and by internal personnel at sites owned by the Corporation.

2.6 Constraints and Prerequisites

Constraints on this project include the following:

- Service must be maintained on the existing system during the installation and commissioning of the new system, in order to minimize outage time for users;
- The East-West Microwave Interconnect project must be completed in advance of installing facilities in the Central, Western, and Northern Newfoundland areas in order to provide the required facilities;
- Available VHF channels may be restricted in certain areas by Industry Canada licensing restrictions.

3.0 STRATEGIC ALIGNMENT

3.1 Specific Strategic Initiatives

The corporation's Mission Statement is as follows:

Newfoundland & Labrador Hydro is a Crown Corporation committed to providing cost-effective and reliable energy services to our customers for the benefit of all people of the province.

Our skilled and committed employees will use innovative methods and technologies, and will maintain high standards of safety and health, and environmental responsibility.

The project maintains this mission by allowing employees to perform their work more efficiently, while helping maintain a safe working environment when operating remotely.

Strategic initiatives addressed by this project include Performance, Growth Strategies, Customer Service, and more specifically, the following Corporate goals:

- To be a customer focused organization;
- To optimize corporate performance.

3.2 Project Stakeholders

The project stakeholders include IS&T from a management, installation, and maintenance standpoint, and all divisions of the Corporation, as well as WST, from a business user standpoint.

Within IS&T, Software & Client Support is responsible for the maintenance and ongoing support for all software. Computer Operations is responsible for maintenance of any control computers that will be required. Technology Planning and Integration is responsible for standards compliance and integration into the overall IS&T Strategic Plan. Project Delivery is responsible for project management of the installation, and Network Services is responsible for the asset management, installation support and maintenance of the switching equipment and all radio equipment.

4.0 APPROACHES

4.1 Identification of Alternatives

In preliminary analysis of this project, the following alternatives were identified:

- Cellular telephone;
- Satellite telephone;
- Replace existing switch and maintain radio equipment;

- Install new radio system.

4.2 Comparison of Alternatives

Cellular Telephone

Cellular telephone has not proven itself to be an acceptable alternative to a VHF mobile radio system. Having said this, the possibility of using cellular telephone was still studied as a potential alternative. Cellular telephone could provide some of the capability of a mobile radio system, but not all. While cellular would certainly be less expensive than mobile radio, its drawbacks preclude its serious consideration as an alternative solution. The major problems with cellular are:

Poor Coverage

Coverage is required for example in all remote areas where our transmission lines are located. Cellular coverage does not extend to many of the areas where the Corporation requires mobile communications, including central Newfoundland and large portions of the West Coast and Northern Peninsula, as well as southern Labrador. The coverage is not possible by cellular.

Insufficient Facilities

As a shared communications system, cellular telephone, like traditional telephone networks, does not have sufficient resources to permit all its users to communicate simultaneously. Instead, channels are allocated based on an acceptable level of service and statistical analysis of usage patterns. In practical terms, in a major emergency, or any time when a large number of users try to access the system simultaneously, many users will not receive service. This alone is enough to eliminate cellular as a meaningful alternative. Emergency situations like major storms are the times when the Corporation's personnel, as well as WST, need guaranteed communications. By forcing our users to compete with everyone else for service at critical times, maintenance and repair work would suffer as well as the safety of the field staff would be placed in jeopardy, which is unacceptable.

Lack of Functionality

Some features of mobile radio systems greatly assist operations such as line maintenance, where several personnel at different locations have a need to communicate simultaneously. These are functions which cellular telephone does poorly, if at all.

For the reasons given above, it was determined that cellular telephone was not a viable replacement for a Corporate mobile radio system and it was given no further consideration.

Satellite Telephone

Satellite telephone systems address the issue of coverage that limits the usefulness of cellular telephony, but the other disadvantages remain. In addition, there are some other significant issues that render satellite telephony an unacceptable option.

When discussing satellite telephony it is important to distinguish between two types of service. Geostationary (GEO) satellite service requires a directional antenna with a clear view to the southwest and is unsuitable for backcountry mobile service required by Hydro. Low Earth Orbit (LEO) services are second generation and are not directional. LEO services are discussed herein.

Stability of Service Providers

Most LEO satellite service providers are operating on the edge of insolvency. The customer numbers that were envisioned when the original business plans for these systems never materialized, as cellular telephony coverage increased. As well, the high cost of satellite service has deterred many potential customers. Iridium, the original low earth orbit satellite telephony service, declared bankruptcy shortly after providing its original service, and was only saved from total destruction by a last minute contract from the United States government. Globalstar, the second satellite service to be placed in service, declared bankruptcy in February of 2002, and is still operating at a loss. To attempt to use either of these services as a mobile communications system would be an extremely high-risk proposition.

Availability of Advanced Services

LEO satellite telephones are acceptable for point-to-point communications; however, a large proportion of the calls made on a typical MRS are multipoint calls, involving several users. In addition, a supervisor may from time to time wish to monitor calls made by a group of workers. Also, network management requires visibility of the service to determine if the service is working or not. These are just three examples of services that are required for a critical communications system that are not available using satellite telephony.

Replacement of Switch Only

One possible solution to the problem of switch obsolescence would be to replace the switch only, and leave the rest of the system intact. This scenario

was originally proposed in the Corporation's Telecommunications Plan of 1997. This could be achieved without changing the functionality of the system a great deal. Under this scenario, mobile and repeater radios would not change until they were replaced as they began to fail.

This scenario, while less expensive than an outright system replacement, has several significant disadvantages.

Age of Equipment

The remaining mobile and repeater radios are at the end of their useful lives, and as a result, maintenance costs are increasing. While it would be possible to delay their outright replacement for a few years, associated maintenance costs will continue to increase as in-service units begin to fail more often and require more repair and replacement. In the end, the wholesale replacement of the system could be delayed for another few years, perhaps, after which all the equipment would have to be replaced in any case.

Lack of Functionality

By replacing the switch now and leaving the rest of the system intact, the Corporation would be unable to take advantage of any of the modern features that a replacement system would have to offer. Essentially, we would be restricting ourselves to the same technology for at least ten years, the minimum life of the new switch. The Corporation would be totally unable to take advantage of the anticipated efficiencies that a new system would have to offer, such as privacy, individual calling, remote unit registration, and ease of expansion, as well as the ability to provide mobile data capability to personnel.

Additional coverage requirements have been identified for the Granite Canal, Southern Labrador and Happy Valley/Goose ay areas. The existing switch can not be expanded to meet these existing service requirements.

While this option is less expensive than a complete system replacement, it is felt that a better solution can be obtained which will meet both the Corporation's current and future requirements for mobile communications.

Complete Radio System Replacement

Over the past several years, the Corporation has worked with Newtel Mobility to solicit support from major provincial users of mobile radio systems for a province wide VHF mobile radio system. This initiative has not been successful, and therefore the Corporation has no choice but to proceed with a replacement of the existing system alone.

Replacing the existing system with a new solution allows the Corporation to give its employees and customers an advanced, private system that meets both current and planned needs for mobile communications. In the short term, this is the most expensive solution considered; however, it is also the most viable solution.

Coverage

Both internal users and WST have indicated a desire to see the coverage, i.e. the geographical area of service availability, of the existing system increased. In particular, the southern Avalon Peninsula and the South Coast of Labrador have been identified as areas where additional coverage will be needed. In order to achieve this, six additional repeaters have been included in the budget. The actual number of sites will be determined upon performance of detailed coverage analysis.

In addition to extra repeaters, the second variable that determines the coverage for a given power level and tower height is the frequency of the transmitted signal. Analysis has demonstrated that the VHF (170 MHz) mobile band currently used by the Corporation's mobile radio system will provide the best coverage using the minimum number of repeater sites, compared to the UHF (450MHz) and 800 MHz bands sometimes used in other jurisdictions.

4.3 Recommended Alternative

It is recommended that a complete, Island wide trunked radio system be installed to replace the existing conventional radio system. Trunked radio refers to a mobile radio technology whereby a single repeater location may have more than one radio channel for user traffic. The channels are shared between users in a manner that permits more simultaneous conversations than the total number of channels, a feat that is achieved by reallocating a channel to a new conversation as soon as the user is finished, instead of having the traditional "hold time" of a conventional radio channel.

Technology Alternatives

Several types of trunked radio system are available, each with its own unique properties. A consultant was hired in early 2001 to assist with the evaluation of the alternatives. Broadly speaking, the trunked radio systems can be classed as either proprietary or standards-based. Standards based systems are, in general, less expensive owing to the availability of multiple vendors, and it was decided that a standards-based solution would be pursued.

5.0 RESOURCE REQUIREMENTS

5.1 Human Resource Requirements

The attached is an order of magnitude estimate of the effort involved in the design, installation, and commissioning of this project.

Role	Responsibility	Time Commitment	Duration	Source (internal, external)
Project Manager	Overall coordination of project	1 person year	2 years	Internal
Technical Lead	Project engineering	1.5 person years	2 years	Internal
Technologist	Installation/commissioning	3 person years	2 years	Internal
Project Manager	Coordination of supplier effort	1 person year	2 years	External
Design Engineer	Detailed design of proposed solution	1 person year	2 years	External
Installer	Installation/commissioning	3 person years	2 years	External

5.2 Material/Equipment Procurement

The proposed solution will be obtained through a detailed design/supply/install/commission contract. This is the approach normally taken by IS&T in a system of this magnitude. This allows the Corporation to take advantage of the skills normally contained in-house by a reputable supplier, and at the same time focus its resources on the areas in which it has expertise.

6.0 Cost/Benefit Analysis

6.1 Preliminary Net Present Value Calculation

The preliminary NPV analysis contained in Appendix A attached shows a comparison of the cost over 15 years of a conventional radio system, such as the existing system, and a trunked radio system. Two alternatives are presented: one with WST contributing 50% of the operating and maintenance costs, and the second with WST contributing nothing. As shown, over the assumed 15-year life, the trunked radio system cost is slightly higher than the conventional system, owing to higher leasing costs for the assumed configuration. If however the required number of leased circuits were to

increase, the increased cost for trunked radio is proportionally lower, meaning that this estimate is probably conservative.

The following table summarizes the results for the scenario under which WST makes no contribution:

Option	Capital	Operating	Total
Trunked	$5,700,000	$5,127,896	$10,827,896
Conventional	$6,625,000	$3,972,828	$10,597,828
Difference			$230,068

As shown, the difference in total cost is negligible (approximately 2%) compared to the total cost of ownership of the system over 15 years.

If it is assumed that WST bears 50% of the total cost, the difference is halved:

Option	Capital	Operating	Total
Trunked	$2,850,000	$2,563,948	$5,413,948
Conventional	$3,312,500	$1,986,414	$5,298,914
Difference			$115,034

Again, the difference for trunked radio compared to conventional is on the order of 2% of the total cost of ownership.

6.2 Benefits

Benefits of the proposed solution have already been enumerated; however, in summary form, the major benefits are as follows:

- The system will provide the Corporation's mobile communications needs for the foreseeable future;
- The modular nature and standards-based design of the proposed solution ensures that future expansion needs will be met;
- The same system can be used to provide communications for CF(L)Co in future, thereby ensuring that the most efficient solution for both organizations is maintained;
- The trunked solution will be able to be expanded to include mobile data capability, thereby improving the efficiency of the mobile workforce.

7.0 BUSINESS IMPACT

7.1 Changes to the Business Process

Changes to business processes will be minimal. Staff complements in St. John's, Bishop's Falls, and Deer Lake already possess the necessary skills to

operate and maintain the system, needing only training on the specific equipment being provided. Engineering support and software/hardware support will be provided with existing complement, primarily from St. John's.

Because the replacement system is similar to the existing MRS in size and complexity, process changes will be minimal. Preventive Maintenance, which is currently performed on the existing system, will be adapted to the new system, and Network Management will be performed using the resources of the Network Management Centre located in St. John's.

7.2 New Staff Training Needs

As with any new installation, some training will be required. All users will have to be trained on the use of the system. Network Services Engineering and Maintenance personnel will be trained on the maintenance and service of the equipment. The cost of this training is included in the capital cost estimate.

7.3 Changes with Stakeholders

In preliminary discussions, WST has indicated a desire to participate in the venture by contributing to the cost, to be prorated based on the number of radios each party uses. In the current installation, the radios are divided roughly evenly between the Corporation and WST; it is therefore reasonable to assume that WST will shoulder approximately half the capital and operating cost of the system.

Discussions with Newfoundland Power personnel indicate that they are not interested in proceeding as a partner in the development of this system; however, they may wish to participate as a user once the system is installed and operating.

Discussions with other parties, e.g. provincial government agencies, on the possibility of participation in this system are ongoing.

8.0 RECOMMENDATIONS

It is recommended to proceed with the purchase of a Trunked Mobile Radio System to replace the existing conventional system. This technology will provide the required mobile communications for Newfoundland and Labrador Hydro to conduct its business in an economical and efficient manner, while ensuring the system remains expandable and has the maximum useful life.

APPENDIX A

VHF Mobile Radio Replace[illegible]t (No WST involvement)

Study Discount Rate: 9.60%

Year	Trunked Radio System Capital Costs	Trunked Radio System O&M Costs	Trunked Radio System Total	Trunked Radio System CPW to 2004	Conventional Radio System Capital Costs	Conventional Radio System O&M Costs	Conventional Radio System Total	Conventional Radio System CPW to 2004	NPV Comparison (Alt. 2 - Alt. 1) CPW to 2004
2004	3,000,000		3,000,000	3,000,000	3,000,000		3,000,000	3,000,000	$ -
2005	2,700,000	689,250	3,389,250	6,092,381	3,625,000	551,250	4,176,250	6,810,447	$ 718,066
2006		689,250	689,250	6,666,175		551,250	551,250	7,269,357	$ 603,182
2007		689,250	689,250	7,189,709		551,250	551,250	7,688,071	$ 498,361
2008		689,250	689,250	7,667,386		551,250	551,250	8,070,108	$ 402,722
2009		689,250	689,250	8,103,223		551,250	551,250	8,418,683	$ 315,460
2010		689,250	689,250	8,500,885		551,250	551,250	8,736,726	$ 235,841
2011		689,250	689,250	8,863,715		551,250	551,250	9,026,910	$ 163,196
2012		689,250	689,250	9,194,764		551,250	551,250	9,291,678	$ 96,914
2013		689,250	689,250	9,496,816		551,250	551,250	9,533,254	$ 36,438
2014		689,250	689,250	9,772,411		551,250	551,250	9,753,670	$ (18,741)
2015		689,250	689,250	10,023,866		551,250	551,250	9,954,779	$ (69,087)
2016		689,250	689,250	10,253,296		551,250	551,250	10,138,273	$ (115,023)
2017		689,250	689,250	10,462,630		551,250	551,250	10,305,695	$ (156,935)
2018		689,250	689,250	10,653,628		551,250	551,250	10,458,452	$ (195,176)
2019		689,250	689,250	10,827,896		551,250	551,250	10,597,828	$ (230,068)

Notes:

1. Trunked Radio System estimate based on figures used in Captial Job cost. Conventional Radio System estimate based on typical costs for a system of this nature.
2. Operations and Maintenance costs are assumed to be fixed for a 15 year contract with a third party supplier.
3. Maintenance costs for both systems are assumed to be identical.
4. 15 year life span of system assumed.
5. It is assumed that the Provincial Department of Works, Services, and Transportation (WST) does not contribute to the capital and maintenance costs of the system.

$ -
$ -
$ -
$ -
$ -
$ -

VHF Mobile Radio Replacement (With WST involvement)

Study Discount Rate: 9.60%

Year	Trunked Radio System Capital Costs	Trunked Radio System O&M Costs	Trunked Radio System Total	Trunked Radio System CPW to 2004	Conventional Radio System Capital Costs	Conventional Radio System O&M Costs	Conventional Radio System Total	Conventional Radio System CPW to 2004	NPV Comparison (Alt. 2 - Alt. 1) CPW to 2004
2004	1,500,000		1,500,000	1,500,000	1,500,000		1,500,000	1,500,000	$ -
2005	1,350,000	344,625	1,694,625	3,046,191	1,812,500	275,625	2,088,125	3,405,224	$ 359,033
2006		344,625	344,625	3,333,087		275,625	275,625	3,634,679	$ 301,591
2007		344,625	344,625	3,594,855		275,625	275,625	3,844,035	$ 249,181
2008		344,625	344,625	3,833,693		275,625	275,625	4,035,054	$ 201,361
2009		344,625	344,625	4,051,612		275,625	275,625	4,209,342	$ 157,730
2010		344,625	344,625	4,250,442		275,625	275,625	4,368,363	$ 117,920
2011		344,625	344,625	4,431,857		275,625	275,625	4,513,455	$ 81,598
2012		344,625	344,625	4,597,382		275,625	275,625	4,645,839	$ 48,457
2013		344,625	344,625	4,748,408		275,625	275,625	4,766,627	$ 18,219
2014		344,625	344,625	4,886,205		275,625	275,625	4,876,835	$ (9,371)
2015		344,625	344,625	5,011,933		275,625	275,625	4,977,390	$ (34,543)
2016		344,625	344,625	5,126,648		275,625	275,625	5,069,137	$ (57,511)
2017		344,625	344,625	5,231,315		275,625	275,625	5,152,847	$ (78,468)
2018		344,625	344,625	5,326,814		275,625	275,625	5,229,226	$ (97,588)
2019		344,625	344,625	5,413,948		275,625	275,625	5,298,914	$ (115,034)

Notes:

1. Trunked Radio System estimate based on figures used in Captial Job cost. Conventional Radio System estimate based on typical costs for a system of this nature.
2. Operations and Maintenance costs are assumed to be fixed for a 15 year contract with a third party supplier.
3. Maintenance costs for both systems are assumed to be identical.
4. 15 year life span of system assumed.
5. It is assumed that the Provincial Department of Works, Services, and Transportation (WST) contributes 50% of the capital and maintenance costs of the system.

APPENDIX B

MOBILE RADIO SURVEY - DECEMBER 2001

AREA	Question #1	BC Hydro	Atco Elec.	Trans Alta	Sask. Power	Manitoba Hydro	Hydro One	Hydro Quebec	NB Power	NS Power	Nfld. Hydro
Private System	1	Yes	Yes	Yes	Leased	Yes	Yes	Yes	Yes	Yes	Yes
Technology	2	CONV.	LTR	LTR	TRK	CONV.	CONV.	TRK/CON	NR	CONV.	CONV.
Frequency	3	VHF/UHF	VHF	VHF	800	VHF	VHF	VHF/800	VHF	VHF	VHF
Data	4	No	No	Yes	No	No	No	No	No	No	No
Cellular/Satellite	5	No	No	No	Yes (2)	Yes(2)	Yes(2)	No	Yes(2)	Yes(2)	Yes(2)
Consider Leased	6	Maybe	Note 1	No	Yes	No	Yes	No	Yes	Yes	No
Evaluation	7	Yes	No	No	No	Yes	No	No	In Progress	In Progress	No

NR – No Response

Questions

1. Do you presently own and maintain a private mobile radio system?
2. Is the system best described as
   (a) Conventional (b) Trunked (c) LTR – Logical Trunked Radio (d) Other
3. Is the system
   (a) VHF (b) UHF (c) 800 MHz (d) other
4. Is the system used to carry data? If yes, please describe the applications.
5. Does your utility use Cellular or Satellite phones for mission critical functions such as power switching, system restoral, etc?
6. Would your utility consider the use of a leased solution as the prime mobile radio system for mission critical functions?
7. Has your utility prepared an evaluation on the use of lease system versus a private system for mobile communications.

Notes:

1. Only if we (ATCO) had priority (last off, first on) and the service could be shown as reliable and economic as our own, and the right penalty clauses were in place.
2. All utilities using cellular or satellite phone do so to compliment the coverage of the Mobile Radio System.

APPENDIX C

Technical Report
on the
Newfoundland & Labrador Hydro
Mobile & Radio Paging System Replacement
2001 February 26

The Reader is advised that pricing, included in this Report have been provided by suppliers on the understanding that information is treated as CONFIDENTIAL. Co-OPERATION of equipment suppliers, in providing accurate information, enables this Report to provide best estimate accuracies; it is, therefore, necessary for Readers to keep the pricing, contained herein, CONFIDENTIAL.

CONFIDENTIAL

Prepared for: Newfoundland & Labrador Hydro
Information Systems & Telecommunications

Prepared by: Norman Cook, P.Eng.

Date: 2001 February 26

File:NLHMORPT.COVER

TABLE of CONTENTS
FINAL REPORT

ATTACHMENTS

1 INTRODUCTION

The most important requirement of a mobile radio system is **Access. Access** is determined by two factors:

1. Geographical area coverage.
2. Adequate channel capacity to handle traffic.

This Report is prepared to summarize a study of the Newfoundland & Labrador Hydro ("NLH") Radio System (the "System"), in accordance with the **Tasks and Responsibilites - Section 2**, below, and to recommend the best method, based on available technology, to meet the existing, and future, operational needs of NLH.

The Writer is aware that discussions have been held with NewTel Mobility, to determine if there are any plans to implement a Province-wide mobile radio system, as exists in the other 3 Atlantic Provinces. With the Newfoundland & Labrador RCMP implementation of their own hybrid trunked mobile radio system, and with the RNC as the joint user, it is unlikely that NewTel will have enough anchor tenants to justify the infrastructure costs of a Province-wide trunked mobile system infrastructure. In all other Atlantic Provinces, the RCMP comprises a significant portion of anchor tenants.

The following **Sections 2 and 3** discuss the Tasks, Responsibilities, and Methodology used in the Study. **Section 4, 5, and 6**, the pros, and cons, of the various frequency bands, radio coverage, and existing peak site traffic, **Section 7**, the current and future operational requirements of the System, including supplementary coverage requirements, and **in Section 8** the alternatives, and associated costs of upgrades, meeting NLH requirements, are reviewed.

With the alternatives identified, estimates for these alternatives are prepared, comparing these alternatives in **Section 9.** Finally, **Sections 10,11, & 12**, summarize the results of the Study, and provide recommendations for subsequent decisions, and implementation.

A **List of References - Attachment 3**, is used throughout this Report, and referred to as a listed item number shown in square "[ ]", brackets following the related text.

Prior to the preparation of this Report, NLH had met with the Writer and identified the following current assessment:

> The existing mobile switch, manufactured by ATI, was placed in service in 1989, and with only a few in operation, spares are very difficult, if not, impossible, to

obtain.

Of the existing mobile and portable radios in inventory, most are in excess of their anticipated service life of 8-10 years.

In addition to selection of new sites in areas of coverage shortfall, the following coverage areas require particular attention:

The Great Northern Peninsula including the adjacent Labrador Coastline.

Happy Valley - Goose Bay area, if feasible to integrate with the Island portion.

The current joint operation of NLH, and WST, works well since seasonal peaks of each Agencies' activity occur at different times which, effectively, reduces repeater traffic conflicts - refer to **Traffic Data - Attachment 4**. The Great Northern Peninsula, however, has occasionally become somewhat congested, with NLH & WST joint usage.

Where possible, the needs of the existing co-user, Works, Services, & Transportation (WST), shall be integrated with replacement, if feasible; however, the priority is for NLH year 2002 implementation, with, or without, joint users.

Mobile radio network issues to be reviewed are as follows:

Review radio paging requirements and recommend a solution(s).

Review/identify mobile data requirements, for issuing switching and field orders, direct to mobile data terminal, MDT, operators via the current NLH AS400 Network (MDTs, which are ruggedized notebook computers, with floor mounted pedestals). This Report identifies network integration with the assistance of NLH Information Systems and Telecommunications ("IS&T").

Automatic Vehicle Location (AVL), which uses Geostationary Positioning Satellites for time/date stamping vehicular location data, to be available to the IS&T network users.

NLH indicated that a mobile repeater, to cover areas which may be too

remote for normal mobile repeaters to service, would be a valuable asset for remote construction, and repair, operations.

2. TASKS & RESPONSIBILITIES

2.1 General

The Scope of this Study is contained in this Section, and summarized, in the form of task responsibilities, as follows

2.2 NLH Responsibilities:

2.2.1 Compile Mobile traffic data from existing sites.

2.2.2 Identify existing NLH & third party sites used for existing coverage.

2.2.3 Identify existing sites which may be feasible for supplementary coverage to NLH owned sites, replacement for third party sites, or for areas where coverage does not exist. Sites shall be identified for access & hydro power status.

2.2.4 NLH shall arrange separate meetings with Works, Services, and transportation, and Newfoundland Power, to determine if there are advantages to share the new mobile network, especially with co-use of potential Newfoundland Power radio sites.

2.3 Writer Responsibilities:

2.3.1 Review availability of radio bands for a 10 year study life replacement NLH mobile radio system, including bandwidth availability in user equipment.

2.3.2 Review paging requirements and options, utilizing the mobile network if feasible.

2.3.3 Review NLH mobile data requirements, and GPS automatic vehicle location options for the NLH system.

2.3.4 Review NLH mobile radio system alternatives suitable for replacement of

existing system.

2.3.5 Prepare cost estimates of alternatives in 2.3.4, and include site costs, in accordance with coverage requirements identified in 2.2, above.

2.3.6 Present recommendations for the replacement mobile network.

3 METHODOLOGY

3.0 General

3.0.1 A preliminary meeting with the IS&T team provided the terms of reference, as described in **Section 2 - Tasks and Responsibilities**, above.

3.0.2 The first task is to define NLH coverage requirements, with the initial requirements determined from NLH in-house coverage maps prepared several years ago. The maps were reviewed within NLH to obtain a comfort level for the computer generated accuracy of the maps, based on the field experience of knowledgeable radio users, thereby providing the Writer with a more accurate assessment of existing coverage. Hence, with a better appreciation of actual coverage, additional sites were specified, and cost estimates of alternative technologies were completed to determine the preferred mobile replacement technology, and for the estimated number of existing & supplementary sites determined.

3.0.3 The various radio bands were assessed, within the terms of reference of mobile voice, data, growth, coverage capability, and for new, and future, equipment availability, and service life. Meetings with Industry Canada's Spectrum Management Section were held to assess which band is preferred, based on year 2000 NLH traffic measurements, and projected requirements.

3.0.4 Traffic data was reviewed to determine the number of repeaters which are needed at each site to serve the traffic activity of various mobile zones of operation. The quantity of repeaters are significant in the overall costs of alternative mobile technologies, since different technologies utilize different site equipment configurations.

3.0.5 Mobile data rate was determined based on the identified applications to be implemented over the 10 year study life. Data rate is an important consideration since each alternative mobile technology offers different data rate capability. A review of existing voice/data mobile networks was completed to determine if data was typically operated as a separate radio system, or could operate, in harmony with mobile voice.

3.0.6 An assessment of available, and NLH preferred paging technology, was then completed to define the preferred solution.

4 INDUSTRY CANADA FREQUENCY BANDS & POLICY

4.1 General

There are 3 frequency bands allocated by Industry Canada, for mobile radio use, including trunked radio systems, as follows:

1. VHF 150 MHZ - Existing System
2. UHF 450 MHZ
3. UHF 850 MHZ

Table A, below, lists a summary of advantages, and disadvantages, of the frequency bands', 150, 450, & 850 MHz parameters.

Table A.

Freq. Band	Coverage	Radio Cost	Dispatch	Expansion	Software	Replacement
150 conv.	Best area & range from repeater	Not expensive	Not expensive	Urban channels unavailable	Minimum need, if any	Multi supplier availability
450 conv.	Less area/range than VHF	Approx VHF +10%	Same as VHF	Urban channels available	Same as VHF	Same as VHF. TETRA radios are in this band.
LTR 150 or 450	Same as above	Not expensive	Same as above.	Same as above.	Dispatch, mobiles, and repeaters	Multi supplier availability.
850 trunk	Same line of site mobile coverage as 450 but improved portable coverage in malls, & metal clad buildings with small windows	Expensive	Expensive	Additional channel availability virtually unlimited	Regular upgrades required	Current sole source supplier, except for LTR which has multi source radio availability

4.2 Industry Canada Policy

In a January 2001 meeting with Industry Canada, the mobile replacement plan was discussed to determine any licensing policy issues which might affect selection of the preferred band, radio bandwidth, or policies relating to joint use of, not only the mobile radio network, but the microwave backhaul facility, since microwave is an integral part of mobile radio services. Industry Canada was requested to respond advising of any issues to be considered, for NLH joint use expansion plans.

Another important consideration for continued use of the 150 MHZ band, in the Avalon area, near St. John's, is that future growth in VHF channel capacity may not be possible, due to the saturation of this band's use. Growth of channels in the greater St. John's area is critical to the decision to operate in VHF mode, even though the benefit of VHF band Province-wide operation is significant due to provisioning of 30 % more sites in the 450 MHz & 850 MHz bands (the 450 MHz and 850 MHz bands exhibit essentially the same coverage area) - refer to **Attachment 1 - Radio Coverage comparison**.

Another issue, discussed with Industry Canada, for retention of the VHF band is the progress of narrow band equipment from 25 kHZ to 12.5 kHz, and further reduction to 7.5 Khz; however, mobile data rates for the narrow band radios would be reduced as well, for a given modulation scheme. Selection of minimum mobile data rate within NLH for the next 10 years is, therefore, critical.

5 RADIO COVERAGE

5.1 General

Discussion, in this Section, applies whether the radio is conventional, or trunked, except that, as a rule of thumb, trunked radios operating in the digital mode, exhibits reduced coverage from that of trunked systems operating in analogue mode. Initial discussions indicate that NLH does not require voice privacy, which avoids problems of varying coverage (from 0.5 to 5km range) when a radio is switched from analogue to digital.

The existing 150 MHZ band is the best for radio coverage exhibiting about a 30% increase in coverage area compared with 450 MHz & 850 MHz, and requiring less sites to cover a specific area - refer to **Attachment 1 - Radio Coverage Comparison**.

The 850 MHZ band has only about 1/3 the simplex range of a 150 MHz, or 450 MHz radios in dense forested areas, primarily die to clutter loss, and licensed output power, of this band. The 850 MHZ band exhibits superior portable repeater reception (talkout) performance because of an empirically observed lower body loss, and also exhibits better penetration into buildings which are of metal construction having small windows, which are common characteristics of warehouses, and places such as malls which have several embedded corridors, and storage areas. Whichever band is chosen for urban use, rf amplifiers are generally used to improve coverage in urban structures, such as malls.

The ability of a trunked radio to switch sites ('handoff automatically') to adjacent

base/repeater provides a 'virtual' better coverage to an inexperienced, or infrequent, radio user, who is not familiar with the geographical channel switching points for adjacent sites.

It is important for the reader to be aware that no frequency band provides 100% radio coverage, rather, systems are generally designed for 90% area coverage, for 90% of the time, and 90% of location (both time & location being randomly selected) **[2]**. The objectives for public safety are 95% of time and location, however these objectives are seldom met in the Atlantic Provinces due to availability of infrastructure funding to achieve 95% area coverage.

5.2 Coverage Criteria

5.2.1 Paging

5.2.1.1 Digital (Alpha-numeric) Paging

The technical criteria for alpha-numeric paging coverage, is the range at which the Bit Error Rate (BER) does not exceed a specified value. For example, the MTT pager, Motorola Advisor Gold requires field strength of 5uV/m (512bps) to 10uV/m (2400bps); the PerComm Model PA8002, requires an analogue field strength level of 5 uV/m (512 bps), to 7 uV/m (1200 bps). Hence, for maximum range, the data rate should be reduced. Body loss is a significant factor for 150 MHz & 450 MHz band paging.

5.2.1.2 Analogue (Tone & Voice) Paging

Same criteria as analogue mobile, see 5.2.2, below.

5.2.2 Analogue Mobile Criteria

In public safety mobile radio systems, the acceptable coverage range, or boundary, is defined [2], where voice quality is subjectively described as follows:

"Speech understandable with repetition only rarely required. Some Noise/Distortion" This is technically referred to as Delivered Audio Quality (DAQ) of 3.4, which is a figure of merit used in the industry.

In practice, the above is too costly to achieve, and the following subjective description criteria is accepted as suitable:

"Speech is understandable with slight effort. Occasional repetition required due to Noise/Distortion" This is technically referred to as DAQ of 3.

5.2.3 Path Variations

Because of the larger mobile antenna, and greater mobile transmit power; the repeater talk-out signal exhibits greater range of transmission than the mobile transmitter talk-back range to the repeater. The excess repeater talk-out power (125w ERP max allowed for 150 MHz) is required to activate reception of the belt mounted portable which experiences an additional 17 dB of (body) attenuation for VHF radio frequencies, and less body attenuation as the frequency band increases; once the portable is raised to head level for talk-back response to the repeater, the body loss attenuation reduces to a lessor level (head attenuation) hence increasing the talk-back range of the portable. This demonstrates the elusive user concept of coverage.

5.3 Radio Design Criteria

As in the Introduction, **Access** is the single most important objective, regardless of which features are added.

Radio coverage is usually reviewed by a well established computer prediction model, which has proven industry accuracy in the telecommunications industry for about 20 years. The computer prediction model provides for radio coverage changes based on seasonal weather activity, and facilitates plotting of coverage areas on standard topographic, or other scaled, maps. The prediction model is suitable for remote wide area predictions, unfortunately there is no model available for predicting coverage inside complex structures in an urban area, or areas such as inside the Holyrood Thermal Generating Plant, since steel and concrete structures play havoc with computer modeling variables. Urban coverage must be dealt with on a case by case basis, and after the basic system is installed.

This Report is permitted neither the time, nor the scope, to prepare coverage predictions of existing, or alternate sites. Data previously completed within NLH is used, and supplemented with best guesstimates, in order to provide the basic system configuration,

required to prepare estimates for the quantity of sites estimated.

The channel capacity of a radio system is critical when a local 'incident specific' situation which is serviced by a single site, becomes heavily accessed by radios, for example, the situation on the Great Northern Peninsula, where there are times when NLH as well as WST are trying to access the limited repeater resource, will be addressed in this Report's configuration, and cost estimates. This could also occur if a large construction project is being completed adjacent to a site used for daily operational radio traffic.

The amount of voice traffic anticipated under the specific incident will determine whether a single radio voice channel, or multiple channels are required at a remote site. The existing system, for the most part, has operated successfully, in the past while being shared with the Dept. Of Works, Services, & Transportation. Any expansion to other users will inevitably, if not initially, require additional repeaters at high traffic sites, therefore necessitating the provisioning of a suitable sized switch to handle additional repeaters. For purposes of this Draft report, the new microwave system is anticipated adequate to handle the backhaul capacity of future growth.

Secondary, other operationally important issues are also addressed as part of technology review, include the following:

1. Ease of radio use - physical, and technical.
2. Durability of radios for work environment (i.e. US MIL Spec. Standards).
3. Initial, and ongoing equipment costs.
4. System user training needs.
5. System maintenance service provider minimum requirements.
6. Planned obsolescence of selected technology through support.

5.4 Simplex (talkaround) Operation in the 850 MHz Band

The latest Motorola Mobile Trunking System is called **SmartZone^{SM} (SZ)** in this System the trunking control channel cannot be used for voice - initially, all remote sites, in **SZ** will provide a minimum of 1 control, and 2 voice channels. If simplex channel mode is provided for to reduce traffic on a repeater, and keeping in mind that an 800 MHZ simplex radio, has only about 1/3 the line of site range as VHF, **making the 850 MHz equipment undesirable for local site communications beyond an approximate distance of 2 km (less in highly treed areas).**

6 EXISTING RADIO SYSTEM & ALTERNATIVES

6.1 Paging System Description

6.1.1 NLH utilizes an analogue tone & voice system having transmitters independent from the mobile system.

6.1.2 Two types of paging systems are available, as follows:

6.1.2.1 Tone & Voice analogue paging (same as NLH existing).

Tone & Voice pagers are becoming obsolete; however, they have the advantage of encoders which use mobile repeaters, as paging transmitters. Many T & V users find that they can use the pager as monitors for the repeaters transmitted mobile voice signal as well. Some agencies do not condone this use of pagers as a simple form of 'scanner', i.e. as in the volunteer organizations. NLH's existing paging system is independent of the mobile system, thereby having a backup communications system, albeit one-way.

6.1.3.2 Alpha-numeric digital paging.

Alpha-numeric paging requires 'digital ready' transmitters, or transmitters which have either FSK or have a true FM modulator (response down to DC), and with minimum rise time of 250 us for reliable POCSAG code operation. There are adapter kits which claim to adapt analogue transmitters for digital paging, however this is not recommended unless more investigation to assess known operating systems using this approach.

Digital (alpha-numeric) pagers are approximately 1/3 the cost of T & V pagers.

6.2 Paging System Selection

6.2.1 Selection of a paging transmitter to carry alphanumeric format paging is more critical than for analogue tone & voice due to the requirement for fast transmitter rise times (i.e. wider bandwidth)

for the digital signals.

6.2.2 The Writer is aware of one manufacturer, **Multitone**, who provides a multi- format paging system which can be configured for most paging formats required.
Outputs of this particular model can be zoned with different paging formats based on groups of transmitters, or coverage areas.

6.2.3 Highlight Comparisons of Paging Systems, are summarized in **Table B,** following:

Table B

Feature	Encoder		Transmitter, Unit $		Pager, Qty $	
Pager Type	T & V	Alpha-Numeric	T & V	Alpha-N	T & V	Alpha-N
Message	Tone Sequence Voice	Digital	Standard	Digital Ready	Audio	Display 1 - 4 Lines
Message Storage	NA	NA	NA	NA	Some	Many
Time/Date Stamp	NA	NA	NA	NA	No	Yes
Cost	Attach 5	Attach 5	$ 5,000	$ 40,000	$ 450	$ 150
Package Media	Desktop, EIA Rack	Desktop, EIA Rack	Stand alone, EIA	Stand alone, EIA	Audio	Small Characters
Size	NA	NA	NA	NA	Med.	Small

6.3 Mobile Radio

6.3.1 Review of the existing NLH Multi Department Mobile Radio System Description **[1]**, indicates that it is trunking system, with the exception that a single repeater is employed at each site. Although this defeats the concept of trunking, the system has the necessary features to operate with a central switch (the Gander ATI Switch), and to perform the necessary

telephone interface functions which are available on all the trunked systems being considered as alternatives.

The alternative trunked radio networks to be compared, and considered for replacement, are briefly, as follows.

6.3.2 The TETRA digital trunked radio network, an open standard, multi mobile supplier European Digital System. Beginning introduction in Canada, with the nearest supplier in Halifax, NS.

6.3.3 The ComNet Ericsson's EDACS analogue/digital trunked radio proprietary network. Province-wide systems exist in Canada, and having locally supported equipment.

6.3.4 The Motorola SmartZone analogue/digital trunked radio proprietary network. Province-wide systems exist in Canada, and having locally supported equipment.

6.3.5 The E.F. Johnson LTR radio system is also an open system for which several vendors can supply radio equipment. Several systems exist in North America, having local service support. In Newfoundland & Labrador, a supplier, or NLH, would require technical training on the LTR Network.

6.4 Current User Equipment Quantities

6.4.1 General

Existing radio system assessment is provided in **Attachment 2 - Radio Equipment List**, to complete user equipment quantities in order to select the suitable model radio/pager, and to assign appropriate cost estimates, which are model dependent. For example, an model equipped with a data port, and automatic vehicle location features will be more costly than a basic model which is best for many user tasks.

6.4.2 Pagers

Existing pagers are analogue T&V type, with an independent

infrastructure, which includes dedicated transmitters. Quantities are shown with mobile equipment quantities in **Attachment 2 - Radio Distribution List** .

6.4.3 Mobile

The **Attachment 4 - Radio Distribution List**, is supplied from current records, and is the starting point for radio equipment replacement estimates

The generally accepted mobile telecommunications equipment service lives are considered as follows, and provided that manufacturer continues product support:

Fixed Equipment	12-15 years	
Mobile Radios	10 years	
Portable Radios	8 years	(batteries 2-4 years for 8 hr. shifts 5-5-90 duty cycle)

The above equipment lives apply to conventional radio equipment; in the final economic analysis it may be necessary to reduce the lives of programmable equipment, such as trunked radios, because of the rapid changes technology undergoes. User equipment service life is critical to economic analysis since replacement capital injection may be required sooner, or more frequent, in the economic model, compared with conventional equipment replacement. Care must be taken in planning for trunked radio service lives with the rapid change in technology. Trunked systems require mandatory software upgrades, in most cases, are required to keep manufacturer warranties effective. The best protection to avoid obsolescence during our 10 year service life is to define, and to specify, in detail, the manufacturer/supplier conditions up front, in the Specifications/Contracts.

7 EXISTING AND FUTURE OPERATIONAL REQUIREMENTS

This Section discusses existing, and future, operational requirements of NLH.

Since radio access, which includes coverage and voice channel loading, is the most important requirement of any radio system, these requirements are discussed, in this Section, before the other issues.

7.1 Existing Requirements

7.1.1 Radio coverage.

7.1.1.1 Existing coverage requirements do not meet the area encompassed by NLH [9], and in malls where VHF coverage has been a problem. Since paging is the limiting factor in achieving good wireless coverage (due to the lack of good antenna and hip location on the body, resulting in reduced effective receiver sensitivity); if paging coverage is met by selection of a specific site, then portable coverage should be adequate. Review of NLH paging coverage identifies sites adequate for NLH's mobile/portable radio coverage.

7.1.2 Radio Access

7.1.2.1 Existing traffic data, and NLH feedback indicates that previous repeater access problems with W,S, & T have been resolved, with the exception of the Great Northern Peninsula, GNP, where some improvements could be made to augment the needs on the GNP.

The Labrador south shore shall be included as an area to augment coverage on the GNP.

7.2 Future Requirements

7.2.0 Site Traffic Capacity

A review of the existing traffic on peak usage sites is found in **Attachment 4- Traffic Data**. Results show the complimentary seasonal site activity of NLH and

W,S, & T radio usage. Unless other user(s) are considered for joint system usage, there should not be a need for expansion of repeaters other than site additions required for radio coverage. A few sites could improve call queue time for access improvement, fortunately, Kenmount Hill traffic peaks at only 50% of the traffic of some of the network's busier sites; this is critical since Kenmount would be the most difficult site to obtain approval for an additional VHF frequency pair license.

7.2.1 Physical Size of User Equipment

Recent technology has reduced physical size, and weight of pagers and portable radios; it will be necessary, prior to going to Tender, for Department operations personnel to have a 'hands on' exposure to various models to determine if the smaller physical radio sizes do not cause a problem for the radio user, especially while using heavy gloves, or having other apparel, required by the radio user tasks. Some recent field trials have reported difficulty of some pager users to read the small 4 line text displays.

7.2.2 Mobile Data

Physically, an RS232 port is found on LTR, EDACS, and TETRA, mobile radio, with TETRA having an equivalent port on its portable radios. The port is duplicated at the dispatch end, or some suitable terminating PC on the Mobile data networks, require a processor which operates independently of the voice trunked switch, and somewhat like a router (Data Controller) - refer to **Attachment 12 - Dedicated Data System Block Diagram**. The Data Controller is an option on TETRA, and EDACS, which assigns an IP address to each mobile. The Data Controller would provide the necessary interface with the NLH AS400 Network. EDACS currently offers the data 'router' in only TCP/IP protocol.

The future major application of mobile data is anticipated to be email access, with field orders being attached as in normal email applications. It is anticipated that this application would find that the mobile user requiring higher speed data rates approaching those available to home computers, these data rates are only becoming available on such European Trunked Radio Networks such as TETRA, which is beginning to appear in North America now (data rates typically 28.8 kbps = 19.2 kbps throughput) approx 30 % throughput reduction results from the integrity of forward error correction code - FEC, and protocol bits). The Writer

feels that 2 kbps throughput is sufficient for brief text based email services, as for filling of form masks in MDTs (provided, of course, that the system is not misused, as experienced initially for voice communications, when operators were not made aware of the limited time resource available for unnecessary wireless voice communication!). Mobile data connection, limited to the NLH AS400 Server, would limit use to work related text activity. NLH may want to limit mobile data to Corporate use only, and not extend use to W,S, & T, unless the feature was proven to reduce access time resources.

For operational requirements, such as issuance of field orders, the data transfer can be greatly reduced by having any common form resident on the MDT, and just transmitting the data required to 'fill in the blanks', requiring mobile software data development.

If transmission of graphics is required, it will be necessary to select the higher speed mobile data systems initially, to avoid future 'growing pains' and associated expenses.

Some public safety first responder agencies use a redundant mobile data on the Cellular Digital Packet Data (CDPD) network for redundancy. CDPD operates at a 19.2 kbps (throughput approx 12 kbps) and is currently found to be an expensive service.

7.2.3 GPS Automatic Vehicle Location (AVL)

Geostationary Positioning Satellite data is an application of low speed mobile data, requiring a GPS receiver added to the radio data port. This option is available from radio suppliers, or may be third party units. One supplier adds the option for about $1000 for each mobile. GPS data is usually superimposed on applications software, such as topographic, and municipal maps, on a desktop PC, for Computer Aided Dispatch operations.

7.2.4 Portable Repeater

The EDACS alternative suppliers a mobile repeater option. In addition, third party mobile repeaters are currently being developed for trunking systems requiring trunked system access to conventional systems. RF repeaters are also used to improve coverage in urban areas such as malls.

8 RADIO SYSTEM ALTERNATIVES

8.1 Paging

The older Tone and Voice (T&V) Pager is becoming replaced with Alpha-numeric digital pagers. An advantage of T&V pagers is that they can use any existing mobile transmitter and can be used to monitor voice on the repeater talkout channel, however the T&V pager is expensive ($450.00/ea. In large quantities compared with $150/ea. for alpha-numeric pagers).

A disadvantage users find with Alpha-numeric pagers is the size of the display, some pagers offer a zoom feature to overcome this problem.

This Report focuses on the application of the alpha numeric pager since they have features that include the following:

8.1.1 Avoids the problem of missed voice syllables, or need to repeat voice messages.

8.1.2 Information remains in the pager until cleared by the user, avoiding missed messages, or enabling recall of messages.

8.1.3 Permits use of vibrating alert, avoiding the need for user to turn it off under certain private meetings, or appointments, for etiquette reasons.

8.1.4 Features Time/date stamping of incoming information.

8.1.5 Memory backup prevents loss of messages if battery fails.

8.1.6 Backlit displays for reading recalled messages at night.

8.1.7 Messages can contain more instructions due to memory capacity of pager; messages can also be stacked until cleared by user.

Paging allows maximum user access for the dollar spent. A disadvantage with one-way paging is that the dispatcher does not have confirmation that the page had been received. Paging coverage is less than portable coverage due to the body loss observed with the pager's reduced receive signal, and typical belt mount location on the body.

8.2 Mobile Radio

This Section briefly describes the configuration of the following 4 alternatives:

.1 TETRA - European Digital Trunked Open Standard Radio System.

.2 Motorola SmartZone[SM] Trunked Radio System.

.2 ComNet Ericsson EDACS[SM] Trunked Radio System.

.3 LTR[SM] Trunked Radio System.

Estimates are prepared, and economically compared in the next **Section 9 - Cost Estimates of Alternatives & Assumptions.**

LTR[SM] is an open system trunking standard, originally introduced by Transcrypt (formerly E.F. Johnson). Many radio suppliers make compatible user equipment.

The remainder of this Report will analyze the latter factors towards recommending the diligent choice of technology for NLH.

The above alternative radio system configurations, available to meet the radio requirements of NLH, are now discussed in more detail.

8.3 Generic Trunked Mobile Radio System

8.3.1 General

During Report preparation of the **Attachments 6 through 10**, which are Block Diagrams of the Existing, and Trunked Mobile Radio System (TMRS) Alternatives being considered as replacements can be represented by a generic trunked radio network since they function similarly.

The existing NLH mobile radio system is a TMRS, except that there is only one repeater at each site, thereby not meeting the basic requirement for a TMRS. All TMRSs have the capability to interface with either a Private Branch Exchange

(PBX), or the existing Public Switched Telephone Network (PSTN). The ATI switch, is simply the 'Redundant Switch, or Controller" shown in all the alternative Trunked Mobile Radio (TMR) Networks. Features contained in the existing TMRS allow interconnection with a PBX, or the PSTN.

Its interesting to note that the existing TMRS is also data capable, except that the MDMRS Console Workstation Operator (CWS) must set up the mode manually, unlike the new replacement alternatives discussed in this Report.

All trunked radio systems can be hybridized with conventional radio systems. A proprietary system, such as Motorola SmartNet[SM], SmartZone[SM], or ComNet Ericsson EDACS, and TETRA interfaces with conventional through a console patch; the conventional channel is represented by an icon on the console PC display, and is simply 'affiliated', by dispatch operator software, with the trunked system talkgroup which is also a display icon. A more sophisticated, and expensive, infrastructure, is required for proprietary trunked systems.

The Hybrid Conventional/Trunked Mobile Radio System provides for an easy transition to Logic Trunked Radio (LTR), which is an economical trunked radio system. LTR has the necessary features, and multi supplier sources, to enable competitive tendering of equipment throughout the service life (Section 6, above). The LTR also has low speed data port with selected mobile radio models. LTR & EDACS trunked systems utilizes a control channel which can also be used for voice communications.

Configuring the conventional system to an LTR radio system requires simply the addition of a controller at the repeater site, acquisition of the necessary number of repeaters for voice/data traffic expansion needs, acquisition of LTR compatible mobiles and portables, acquisition of a compatible LTR dispatch computer software, and programming of the system to function as a trunked radio system, complete with talkgroups.

There are 2 major trunked radio systems currently operating in Canada, and the United States, as follows:

.1 Motorola SmartNet[SM]/SmartZone[SM] System
- used in Nova Scotia Province-wide by NLH & the Province, NLH, respectively; also Manitoba.

.2 ComNet Ericsson EDACS System

- used in British Columbia, Saskatchewan, Ottawa-Carlton, Newfoundland Province-wide by RCMP & RNC

Both systems above are proprietary, the ComNet Ericsson utilizes their radios only. Motorola SmartZone[SM] Radios can be second sourced, but user capability may be limited unless negotiated prior to final contract signing, and may be non-negotiable if the user want to add specific features, including software upgrades, later in the radio service Contract.

The decision for selection of the desired configuration is based on the relative operational features, and cost of acquisition and maintenance. Both Motorola SmartZone[SM], and ComNet Ericsson EDACS[SM] utilize expensive central trunking switches, both systems have features generic to trunked radio systems. Both systems utilize a control channel at each site. The Motorola control channel is dedicated for site control, a minimum of 2 additional voice channels are usually provided at each site; EDACS[SM] can utilize the control channel as a voice channel. The EDACS[SM] dual use of the control channel permits remote, low usage sites, to be trunking configured, with features such as roaming, while only requiring a single channel.

Because of the high cost of a central switch for each proprietary trunked radio system, application of these systems is usually confined to province, or city, -wide usage with more than one user group sharing the cost of the infrastructure.

There are 2 major European trunked radio systems beginning to make inroads to the North American market, but introduction is slow, and support is sparsely located across North America. These systems are known as MPT 1327 (a mature analogue system of about 12 years), and TETRA (a major digital trunking system, plans for penetration in Canada/US end 2001); both of these European systems are open architecture configured with closely monitored evolution by an independent agency, resulting in multi suppliers, hence, more competition, and less cost of user equipment.

The MPT 1327 has not been considered in this Report, primarily due to the lack of support services in Atlantic Canada.

9 Cost Estimates of Alternatives & Assumptions

9.1 Radio Paging

This Section lists the configuration, and associated costs - refer to **Attachment 5 - Cost Estimates**, showing the paging alternatives considered, as follows:

9.1.1 Tone & Voice Paging - refer to **Attachment 11.**

9.1.2 Alpha Numeric (POCSAG) Paging - refer to **Attachment 11.**

During the writing of this Report a dual function paging system, developed in the UK and currently used in Canada, was reviewed. The advantage of this Multitone Access 3000 system is that it offers T & V, as well as alphanumeric paging utilizing standard transmitters in a proprietary format. The encoder can also provide standard T & V paging, as well as the standard POCSAG alphanumeric paging. This dual function paging system is included for the paging cost estimates in Attachment 5.

9.2 Mobile Radio

This Section lists the configuration, and associated costs - refer to **Attachment 5** showing trunked mobile radio alternatives considered, as follows:

9.2.1 TETRA^{SM} Digital Trunked System - refer to **Attachment 7**.

9.2.2 Logic Trunked Radio LTR^{SM} - refer to **Attachment 8.**

9.2.3 Motorola SmartZone^{SM} Trunked Radio System - refer to **Attachment 9.**

9.2.1 ComNet Ericsson EDACS^{SM} - refer to **Attachment 10.**

9.3 Assumptions

9.3.1 The following assumptions are used in the completion of cost estimates for the above alternatives:

9.3.1.1 Terrestrial links (backhaul) shall be considered as having adequate capacity at NLH owned sites. Where NLH must use third party sites, either rented lines, or radio links shall be provided by NLH to the nearest interface point to NLH's microwave network, including the new Eastern portion. Costs for all backhaul facilities are not included in this Report.

9.3.1.2 The system design shall provide for alarm circuits to each radio site to report any major, and minor alarms to a 7/24 monitored alarm center. The existing NLH 7/24 center would be the logical location for having all mobile radio network alarms to appear. In general, trunking systems have ports available for network alarms, which may be in standard SNMP protocol format, or operating on standard MicroSoft Windows NT; alternately the local microwave alarm system can be utilized for available mobile equipment major & minor alarms. Central alarm equipment is considered NLH supplied.

9.3.1.3 Existing & new NLH primary radio sites, required for necessary mobile coverage, and third party supplementary coverage sites, can facilitate the following mobile radio infrastructure requirements:

- Adequate floor space for mobile/paging equipment, and associated equipment, such as space for equipment links to third party adjacent sites.
- Adequate power from the primary power source, and necessary backup time in supplementary power sources.
- Towers sufficient to meet CSA S37 tower loading requirements, and provisioning to ensure that third party towers are capable of meeting the same requirements.
- Provisioning for the necessary site access of NLH, and third party sites, to meet the standby power requirements

for extended prime power outages.

- Coverage areas, on which the number of repeater sites are determined for cost estimates is based on maps which are not fully confirmed in the field. These maps are assumed for estimate preparation for this Study.

- The middle cost radio model (tier) is used in estimate preparation. Features of trunking radios are very dependent upon the model used, with significant pricing variations.

9.3.1.4 It is unlikely that the future addition of Labrador sites will require an addition to the central mobile switch, since Labrador requires special mountain top repeater configurations which are design to work with the low availability of power available at these sites.

Labrador mobile solutions require a separate design philosophy than the Island portion found in **Attachment 5 - Cost Estimates**.

10 Conclusions

Paging

10.1 General

This Section discusses the most cost effective alternative for **paging**, and with consideration to the relative merits, and demerits, of the features.

10.1.1 NLH must determine the user/operations preferred method of paging; this can be achieved with a local evaluation field trial on an existing digital paging network, and using a 4 line digital pager, preferably with a display zoom feature. The zoom feature is required for many users who have difficulty reading small font messages, on the typical small pager packaging size.

10.1.2 The costs of alphanumeric pagers are 1/3 that of T&V pagers, and many features are desirable operationally, such as time/date message stamping (POCSAG standard). The down side is that digital paging transmitters are more expensive, including a requirement for more antenna filtering at

sites shared with other analogue radios (i.e. mobile). **Attachment 5, Sheet 2.** Use of a third party Province-wide paging network, and digital pagers is the most cost effective way to proceed.

10.1.3 It is apparent that the cost of existing, or new, infrastructure required to operate the relatively small number of paging receivers (Qty = 47), used within NLH, is not justified. It would be more beneficial to provision an additional mobile radio transmitter for each site, replacing the paging transmitter, and providing a portable radio in place of pagers for each existing paging system user. The latter configuration provides the site equipment redundancy presently achieved by the existing separate paging transmitter existing at each site now.

Mobile

10.2 General

10.2.1 **Detailed Cost Estimates - Attachment 5,** were prepared for each of the 4 available trunked radio systems.

10.2.1 Tendering generally drops the costs used for preparing estimates; a reduction of 25 % can be expected in the normal tendering process; however there are unknown factors, arising from assumptions which dictate leaving the estimates as they are for alternative selection purposes.

10.2.3 Forthcoming negotiations, following a Memorandum of Understanding that the Dept. Of Works, Services, & Transportation (W,S, &T) plan to continue with a modified joint use arrangement with NLH, with some coverage expansion, means that the VHF band is preferred, unless significant future traffic increases are identified. W,S, & T has indicated that they may add an approximately 100, currently simplex, radios to the NLH network. NLH must review the areas in which these additional radios are located, to assess the repeater traffic loading impact.

10.2.4 Further to 10.2.3 above, if future join users are considered by NLH, especially in core, or high radio traffic areas, any new service equipment may be isolated from NLH by placement on any frequency band; while this option does not grow the core NLH/WST Network in an optimized trunking manner, it does provide for NLH revenue, utilizing the infrastructure, since the infrastructure is frequency independent, with the

exception of requiring the repeaters to be the band of the user equipment (i.e. mobiles, portables).

10.2.5 Implementation with the LTR open system trunked radio system, will permit reuse of existing transmitters, utilizing the Zetron Model 452/459 repeater controller. This will provide for the most cost effective solution, while maintaining a solution which is supported by a multi-supplier user equipment source of radios which operate in both the narrow band 12.5 kHz, and existing band 25 kHz VHF frequencies. Repeaters which meet the new narrow band requirements can be installed, and integrated operationally, with existing repeaters using the Zetron Models 452/459 controllers. For the busier sites, found in ATTACHMENT 4 - Traffic Summary 2000, a second channel LTR can be added, enabling dual channel & dual mode conventional radios, and LTR radios to share site repeater facilities.

11 Recommendations

11.1 General - Paging

This Section recommends the rollout of the paging network with consideration to the fact that mobile upgrade/replacement will be implemented simultaneously.

The following recommendations are offered for consideration by NLH IS&T:

11.1.1 The infrastructure required to support the 47 existing pagers is not justified. Third party Province-wide PSTN dial-up paging systems should be utilized where coverage permits. Where third party coverage does not meet NLH operations, the current NLH pager user should be given a portable radio on the new Network.

11.2 General - Mobile

11.3 Mobile System Recommendations

11.3.1 A specification be prepared for tendering Request for Proposals. Generic function definitions of radio models, and associated price breakdown requested based on quantity range. **While this Report offers the best estimates at this stage, the Writer is aware of planning, and corporate affiliations which could cause a change in technology, and costs, overnight, which is consistent with the rapid growth, and aggressive competition in the trunked radio market.**

11.3.2 The Specification should provide for mandatory requirements, but also identify options which are not covered in immediate implementation. This will facilitate the decision making process for implementing the final network within approved budgets, and budgeting for what is necessary. Any options, not initially approved by IS&T, are therefore identified for future annual budgeting, with vendor cost commitments 'up front'.

11.3.3 The preferred frequency band for the 10 year study life is VHF.

11.3.4 The preferred mobile radio system is LTR.

11.3.5 Quantities of specific mobile radio models must be decided for NLH users, with attention paid to future applications/needs (i.e. data, Automatic Vehicle Location -AVL, using GPS), since costs are more sensitive to variations, compared with existing conventional mobile radio.

11.3.6 Continued shared use with W,S, & T, since growth should not change, except fo the addition of approximately 100 radios currently used for simplex operation only (as identified by WS&T in a Meeting with NLH dated 2001 02 15, and to be confirmed with a follow-up Letter to the Meeting) .

11.3.7 Industry Canada Policy for join use must be considered both for mobile and microwave joint use, since, depending who is jointly

using the network(s), mandatory, unlimited use may be enforced by Industry Canada - refer to Industry Canada's Policy letter - **Attachment 14 - Industry Canada's Policy Letter.**

Further discussion shall be completed with Industry Canada, in the event Newfoundland Power wishes to become a joint owner of the NLH mobile radio system. Newfoundland Power would be required to pool their VHF frequencies for implemetation of a shared mobile radio system upgrade. Consideration to phase in 12.5 kHz radios is required for future expansion, with consideration to required data throughput.

11.3.8 Since the radios are data pipes only, it will be necessary to identify NLH data requirements from a data infrastructure (IT) requirement. If a complete current mobile data assessment of needs/applications is not fully identified now, particularly for bandwidth requirements, a separate radio system may be required, or added later, since data rates are alternative dependent.

11.3.9 The requirement for status messaging is significant in the long term mobile system. These requirements should be obtained from radio users, and included in the Specification, and as add-on options in the long term implementation, as costs are dependent upon the user equipment model provisioned, and dispatch configuration.

11.3.10 Radio coverage prediction should be completed prior to preparation of the Specification, especially prior to preparation of costing, to add Newfoundland Power, since redundant sites have been determined in preliminary technical discussions with Newfoundland Power (i.e. Meeting 2001, February 23).

11.3.11 Radio coverage measurements shall be completed as part of final commissioning, and compared with predictions, for future reference of coverage variations.

11.3.12 An Implementation Plan, including supplementary coverage site work, for radio paging & mobile system be completed as the next step following a decision of IS&T to proceed. The schedule for the Final Implementation Plan be completed following acceptance of

the preferred mobile radio proposal.

12 Implementation

12.1 General

12.1.1 Supplement coverage areas with portables, for existing pager users.

12.1.2 Identify all supplementary sites required to complete total radio coverage needs, and provide for infrastructure work to be completed. This work must be scheduled to match installation times for adjacent backbone trunked radio installations. This is required to entertain the addition of Newfoundland Power as a joint owner, since many sites have been found redundant with NLH. Further discussions are required with Newfoundland Power.

12.1.3 Low bandwidth radio links to third party supplementary sites shall be required to fulfill coverage objectives. Licensing applications for fixed links shall be completed and submitted to improve authorization lead time.

12.1.4 Once approval is obtained from IS&T to proceed, an Implementation Schedule shall be completed for the tendering process, supplier delivery, and shall include prioritization of sites (coverage areas) to be installed. Newfoundland Power traffic requirements must be determined for the areas within their operational areas.

12.1.5 The process to prepare mobile specifications, tender, review proposals, award the tender, manufacture the equipment, and begin implementation will take an estimated 12 - 18 months.

12.1.6 Completion of site work, including third party tower analysis of third party & supplementary sites, and necessary reinforcement, should be completed first; budgets for tower upgrade can be allocated and this work can be completed while the mobile radio system is being manufactured. Site space & power upgrade can be installed in supplementary coverage sites, in readiness for the mobile radio installation and commissioning.

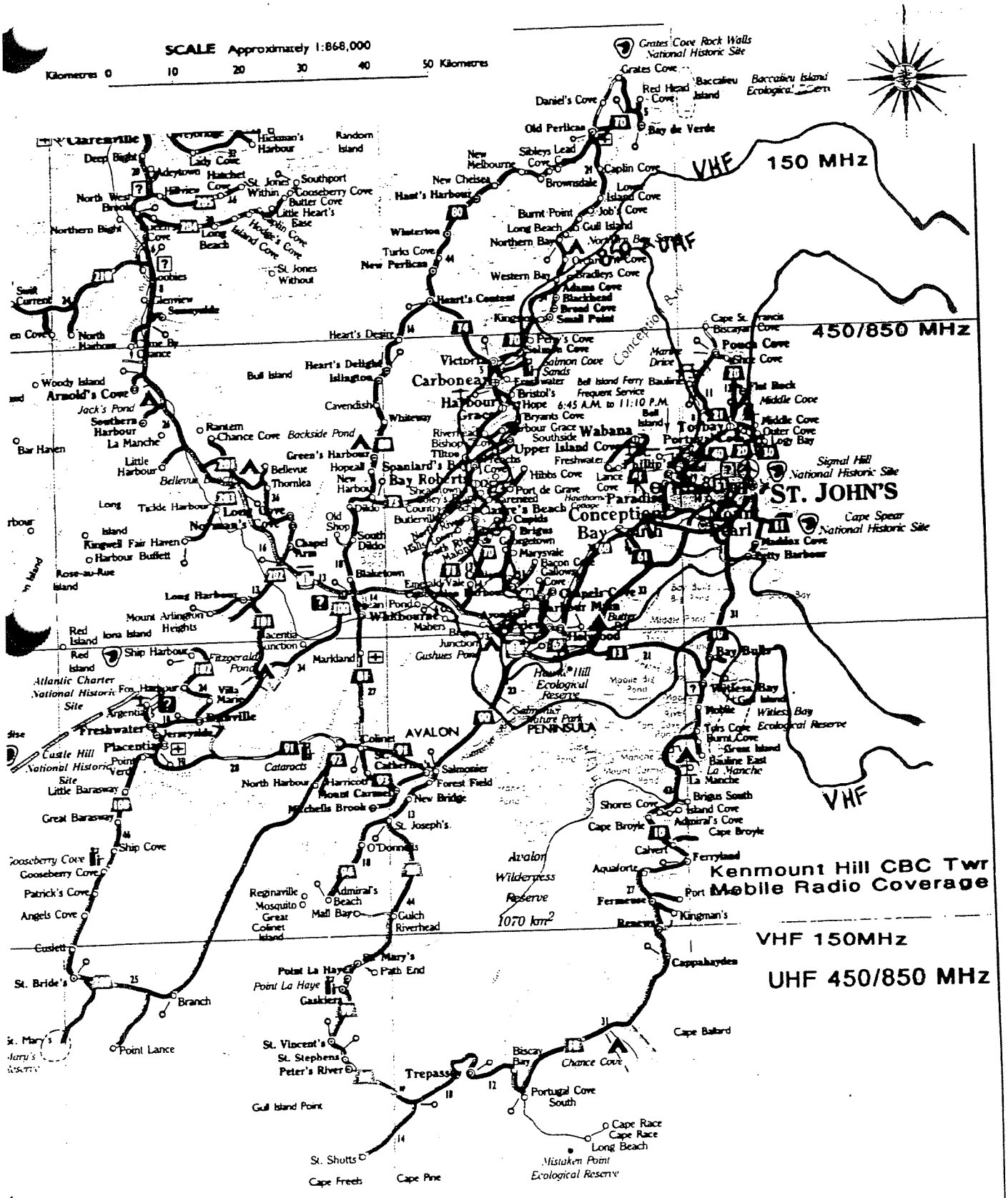
12.1.7 Microwave links should be equipped with the necessary mux cards, and associated end-to-end paging & mobile circuits commissioned.

12.1.8 A decision for the location of the trunking switch should be made, and building

readiness can be planned to merge with the overall schedule.

12.1.9 The overall Schedule can be finalized, with milestones and critical paths, when firm deliver dates are provided in the tender evaluation process.

ATTACHMENT # 1



ATTACHMENT 2

Radio Distribution List

Area Offices	Pagers	Mobiles	Portables	Base Stations
St. John's - ECC	19	39	10	4
Bay D'Espoir	12	25	21	2
Bishop's Falls	2	90	15	5
Churchill Falls				
Happy Valley		17	4	4
Holyrood	2		3	2
Port Saunder's	5	21	8	3
St. Anthony	3	20	13	1
Stephenville	2	16	6	4
Wabush		6	2	2
Whitbourne	2	15	3	6
Totals	47	249	85	33

ATTACHMENT # 3

List of References

1. NLH (MDMRS) System Description, Issue 3A, Aug. 7, 1990.

2. EIA/TIA TSB88 -1, Wireless Communications Systems - Performance in Noise and Interference Limited Situations - Recommended Methods for Technology-Independent Modeling, Simulation, and Verification (including Addendum 1), December 1998.

3. User Group (Site Traffic) Comparison for NLH, Year 2000.

ATTACHMENT # 4

ATTACHMENT #
Sheet 1 of 3.

Newfoundland & Labrador Hydro - Mobile Traffic Summary, Year 2000

Peak Usage Shown

2000 Month	Site(s)	W,S, &T		N&LH		TOTAL	
		PEG	Usage,min.	PEG	Usage,min.	PEG	Usage,min.
Jan	Bay D'Espoir Hill	566	727	959	847	1525	1574
	Bonne Bay	2261	2271	114	105	2375	2376
	Clarenville	2701	2636	48	36	2749	2672
	Corner Bk.	2626	2309	30	29	2656	2338
	Mt. Margaret	2886	3497	322	360	3208	3857
	Red Cliff	2873	3744	524	506	3397	4250
	All Sites Totals	**28029**	**30795**	**4831**	**4590**	**32860**	**35385**
Feb	Bay D'Espoir Hill	232	301			232	301
	Bonne Bay	1813	1703	77	75	1890	1778
	Clarenville	2198	1924	20	17	2218	1941
	Corner Bk.	2370	2143	37	32	2407	2175
	Mt. Margaret	3013	3929	338	391	3351	4320
	Red Cliff	1366	1678	342	277	1708	1955
	St. Anthony	1662	1753	325	282	1987	2035
	All Sites Totals	**20357**	**21842**	**4353**	**3983**	**24710**	**25825**
Mar.	Bay D'Espoir Hill	310	411	1055	950	1365	1361
	Bonne Bay	1002	919	154	161	1156	1080
	Clarenville	2356	2127	26	26	2382	2153
	Corner Bk.	1330	1189	62	63	1392	1252
	Mt. Margaret	2192	2561	468	502	2660	3063
	Red Cliff	1719	2267	640	538	2359	2805
	St. Anthony	1437	1264	1222	1327	2659	2591
	All Sites Totals	**17226**	**18081**	**6996**	**6681**	**24222**	**24762**
April	Bay D'Espoir Hill	140	181	1062	1003	1202	1184
	Bonne Bay	385	374	393	416	778	790
	Clarenville	1088	995	37	25	1125	1020
	Corner Bk.	723	576	13	12	736	588
	Kenmount Hill	1062	816	260	181	1322	997
	Mt. Margaret	900	980	541	630	1441	1610
	Red Cliff	484	519	509	493	993	1012
	St. Anthony	400	327	356	374	756	701
	All Sites Totals	**7665**	**7372**	**5688**	**5497**	**13353**	**12869**
May	Bay D'Espoir Hill	74	89	836	641	910	730
	Bonne Bay	406	360	371	465	777	825
	Clarenville	887	735	51	28	938	763
	Corner Bk.	842	663	39	37	881	700
	Kenmount Hill	1084	873	122	65	1206	938
	Mt. Margaret	705	842	402	460	1107	1302
	Red Cliff	683	758	605	528	1288	1286
	St. Anthony	301	253	289	270	590	523
	All Sites Totals	**7041**	**6536**	**5160**	**4736**	**12201**	**11272**

ATTACHMENT # 4

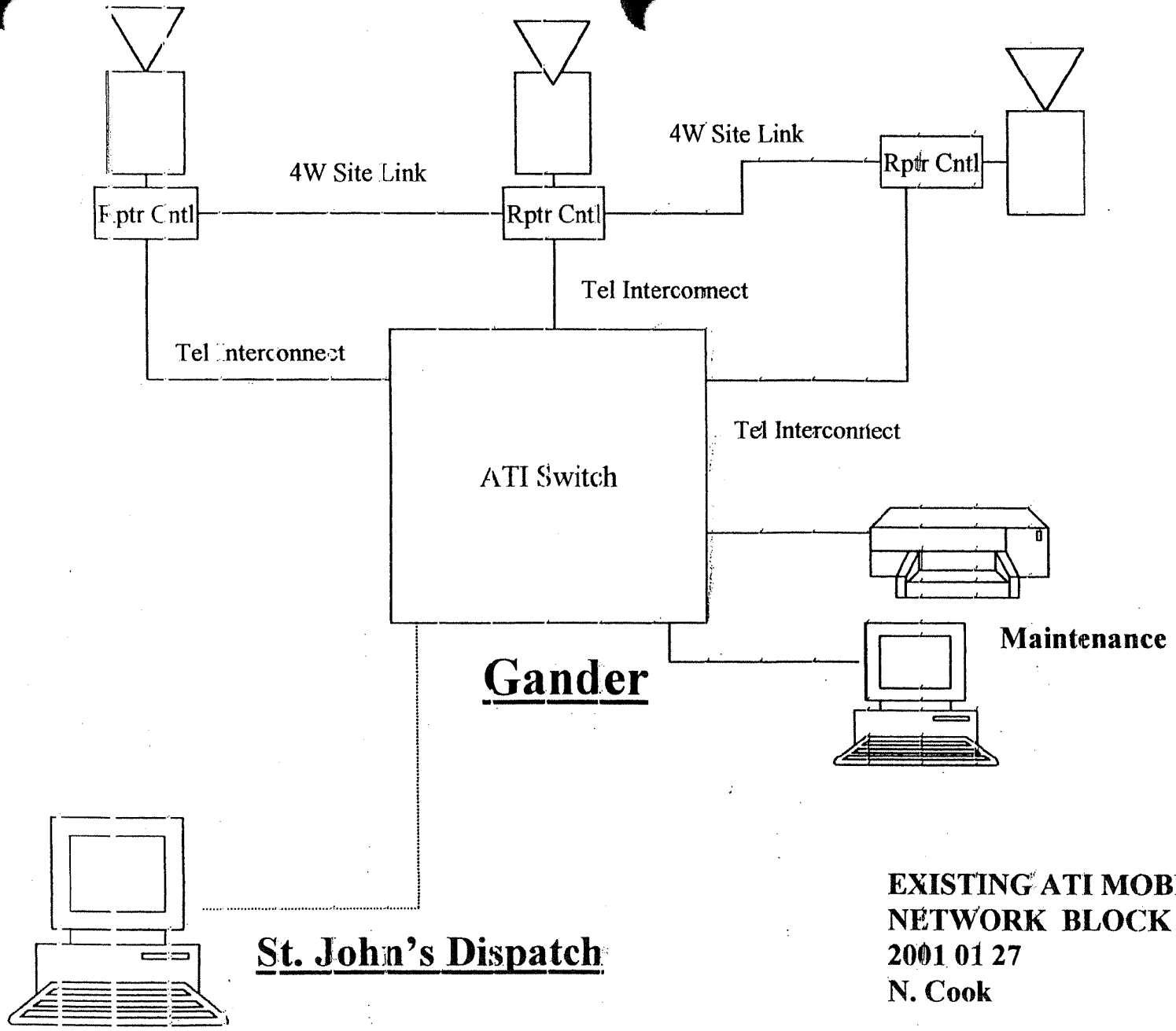
2000									
Month	Site(s)	W,S, &T			N&LH			TOTAL	
		PEG	Usage,min.		PEG	Usage,min.		PEG	Usage,min.
June	Bay D'Espoir Hill	44	49		937	770		981	819
	Bonne Bay	363	242		327	321		690	563
	Clarenville	809	610		129	98		938	708
	Corner Bk.	832	729		132	123		964	852
	Kenmount Hill	1333	1125		195	121		1528	1246
	Mt. Margaret	448	433		595	616		1043	1049
	Red Cliff	690	637		680	601		1370	1238
	St. Anthony	136	108		395	410		531	518
	All Sites Totals	**6391**	**5453**		**6829**	**6224**		**13220**	**11677**
July	Bay D'Espoir Hill	88	102		1596	1377		1684	1479
	Bonne Bay	237	171		229	227		466	398
	Clarenville	851	672		38	27		889	699
	Corner Bk.	605	451		73	78		678	529
	Kenmount Hill	959	841		105	67		1064	908
	Mt. Margaret	436	382		567	716		1003	1098
	Red Cliff	457	419		573	557		1030	976
	St. Anthony	216	180		377	373		593	553
	All Sites Totals	**5083**	**4230**		**6840**	**6948**		**11923**	**11178**
July	Bay D'Espoir Hill	88	102		1596	1377		1684	1479
	Bonne Bay	237	171		229	227		466	398
	Clarenville	851	672		38	27		889	699
	Corner Bk.	605	451		73	78		678	529
	Kenmount Hill	959	841		105	67		1064	908
	Mt. Margaret	436	382		567	718		1003	1100
	Red Cliff	457	419		573	557		1030	976
	St. Anthony	216	180		377	373		593	553
	All Sites Totals	**5083**	**4230**		**6840**	**6948**		**11923**	**11178**
Aug.	Bay D'Espoir Hill	78	99		1038	811		1116	910
	Bonne Bay	201	129		144	149		345	278
	Clarenville	937	766		30	22		967	788
	Corner Bk.	551	508		231	306		782	814
	Kenmount Hill	932	748		62	35		994	783
	Mt. Margaret	211	212		447	569		658	781
	Red Cliff	686	663		566	551		1252	1214
	St. Anthony	82	60		545	607		627	667
	All Sites Totals	**5528**	**4694**		**6879**	**7035**		**12407**	**11729**

ATTACHMENT # 4

2000									
Month	Site(s)	W,S, &T			N&LH			TOTAL	
		PEG	Usage,min.		PEG	Usage,min.		PEG	Usage,min.
Sept.	Bay D'Espoir Hill	112	127		1151	991		1116	910
	Bonne Bay	150	103		202	197		345	278
	Clarenville	1143	950		61	44		967	788
	Corner Bk.	633	508		115	111		782	814
	Kenmount Hill	2976	2610		68	41		994	783
	Mt. Margaret	241	235		369	394		658	781
	Red Cliff	759	761		644	623		1252	1214
	St. Anthony	123	86		525	502		627	667
	All Sites Totals	**7547**	**6609**		**7083**	**6682**		**12407**	**11729**
Oct.	Bay D'Espoir Hill	96	139		1229	1219		1263	1118
	Bonne Bay	264	174		281	280		352	300
	Clarenville	784	668		70	42		1204	994
	Corner Bk.	806	634		78	84		748	619
	Kenmount Hill	902	759		52	34		3044	2651
	Mt. Margaret	482	572		589	653		610	629
	Red Cliff	822	819		485	452		1403	1384
	St. Anthony	207	142		421	425		648	588
	All Sites Totals	**6245**	**5691**		**6823**	**6804**		**14630**	**13291**
Nov.	Bay D'Espoir Hill	175	206		1042	907		1325	1358
	Bonne Bay	557	418		316	293		545	454
	Clarenville	1368	1087		29	17		854	710
	Corner Bk.	1449	1175		215	223		884	718
	Kenmount Hill	860	655		99	57		954	793
	Mt. Margaret	321	288		521	564		1071	1225
	Red Cliff	896	941		577	552		1307	1271
	St. Anthony	260	224		398	376		628	567
	All Sites Totals	**9313**	**8230**		**6344**	**5951**		**13068**	**12495**
Dec.	Bay D'Espoir Hill	166	214		264	242		1217	1113
	Bonne Bay	1025	905		24	25		873	711
	Clarenville	1403	1352		19	20		1397	1104
	Corner Bk.	1322	1257		21	15		1664	1398
	Kenmount Hill	188	128		31	20		959	712
	Mt. Margaret	1024	1328		196	205		842	852
	Red Cliff	1150	1517		137	155		1473	1493
	St. Anthony	607	598		108	105		658	600
	All Sites Totals	**11296**	**12264**		**1747**	**1688**		**15657**	**14181**

ATTACHMENT 5

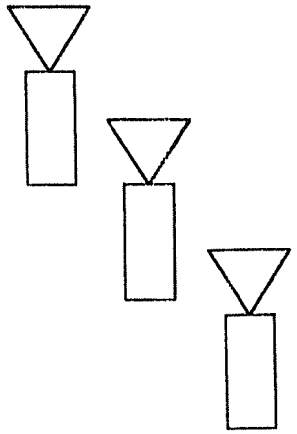
This page has been deleted as per the Confidentiality Agreement



EXISTING ATI MOBILE NETWORK BLOCK DIAGRAM
2001 01 27
N. Cook

ATTACHMENT # 6

TETRA Redundant Switch

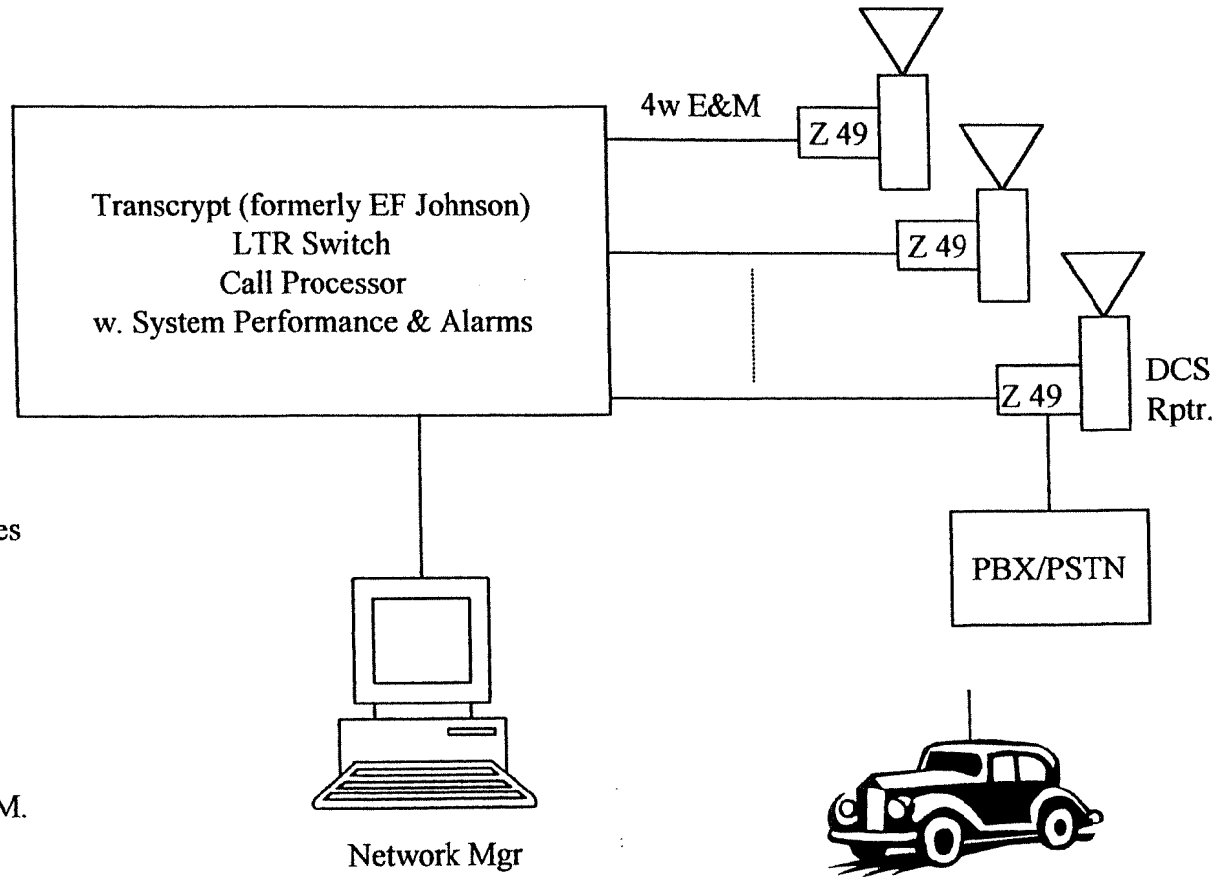


TETRA Features
-TDMA
-Mobile Data 28.8kbps (19.2kbps throughput))
-Redundant w. triple mission critical processors
-Inique Open Standard MOU–ETSI 1995
-Many Radio Manufacturers
-Few Systems in North America
-Central or Distributed Processing
-450 MHz Band (Europe)

TETRA
Block Diagram NLH IST
2001 01 24
N. Cook

TO BE COMPLETED

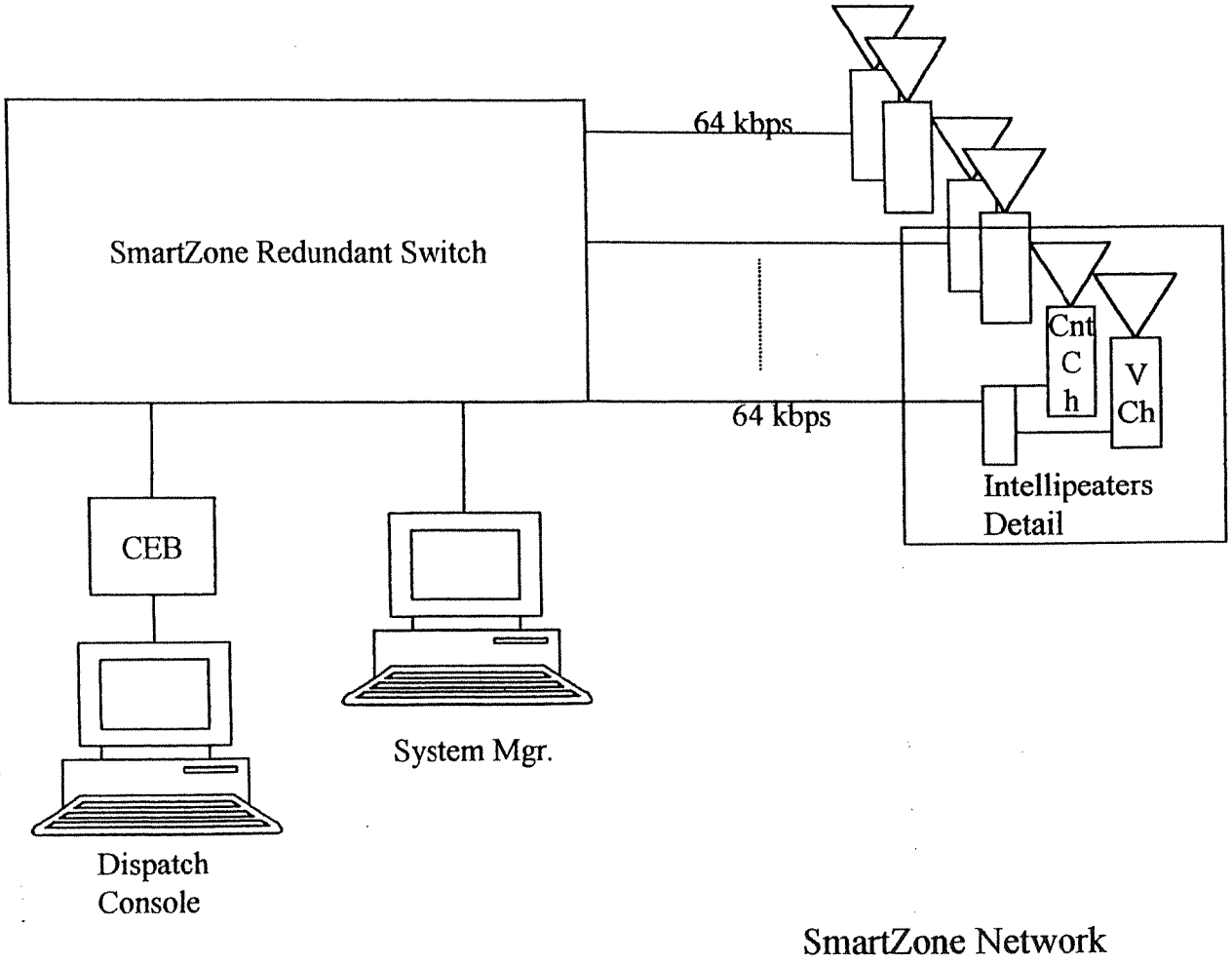
ATTACHMENT 7



Logic Ttrunked Radio LTR Features
-Analogue
-FDMA
-Mobile Data 1.4 kbps/2.4 kbps
-Redundant ???
-Open Standard E.F Johnson
-Local Service
-Zetron 49 Site Cntt I/F Tel,4wE&M.
- & Site Stats.
-Inexpensive Radios
-Many Radio Manufacturers
-Radios 12.5/25 MHz BW Program
-Central or Distributed Processing
-150/450/850 MHz Band
-Subscriber Manager Activity Logger

LTR Mobile Radio
Block Diagram NLH IS&T
2001 01 24
N. Cook

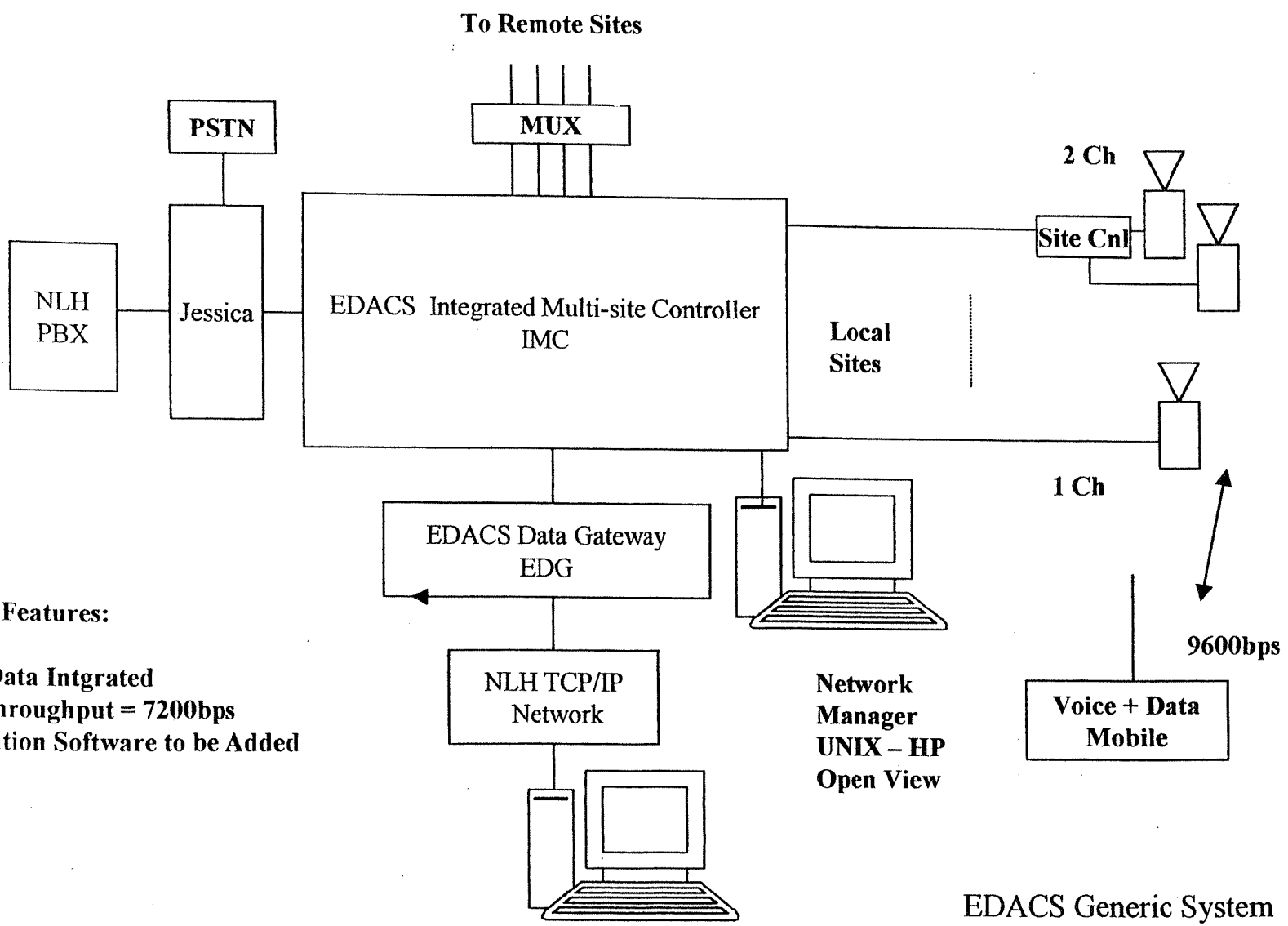
ATTACHMENT 8



SmartZone Features
-FDMA
- Msoft NT Network Protocol
-Mobile Data 2kbpson Cntl Channel
-Dedicated Control Channel
-Minimum 2 Chs per Site
-Proprietary Network
-Many Systems in North America
-Central Processing, fault tolerant
-150/450/850 MHz Band

SmartZone Network
Block Diagram NLH IST
2001 01 24
N. Cook

ATTACHMENT # 9

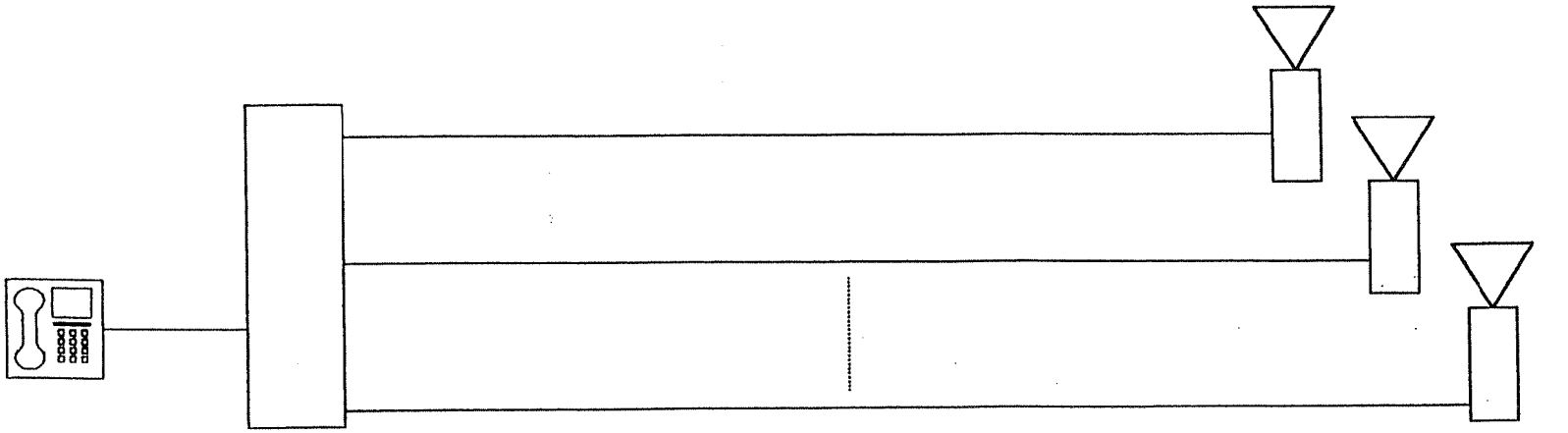


EDACS Features:

-Voice/Data Intgrated
-Data Throughput = 7200bps
-Application Software to be Added

EDACS Generic System
Block Diagram NLH IST
2001 01 24
N. Cook

ATTACHMENT # 10



Paging Features:

-Tone &Voice (NLH)
- Limited voice storage.
- Redundant/separate to Mobile System

-Disadvantage – no confirmation
-Many Radio Manufacturers

-Existing is VHF (max coverage)
-Pagers are expensive

DIGITAL OPTION

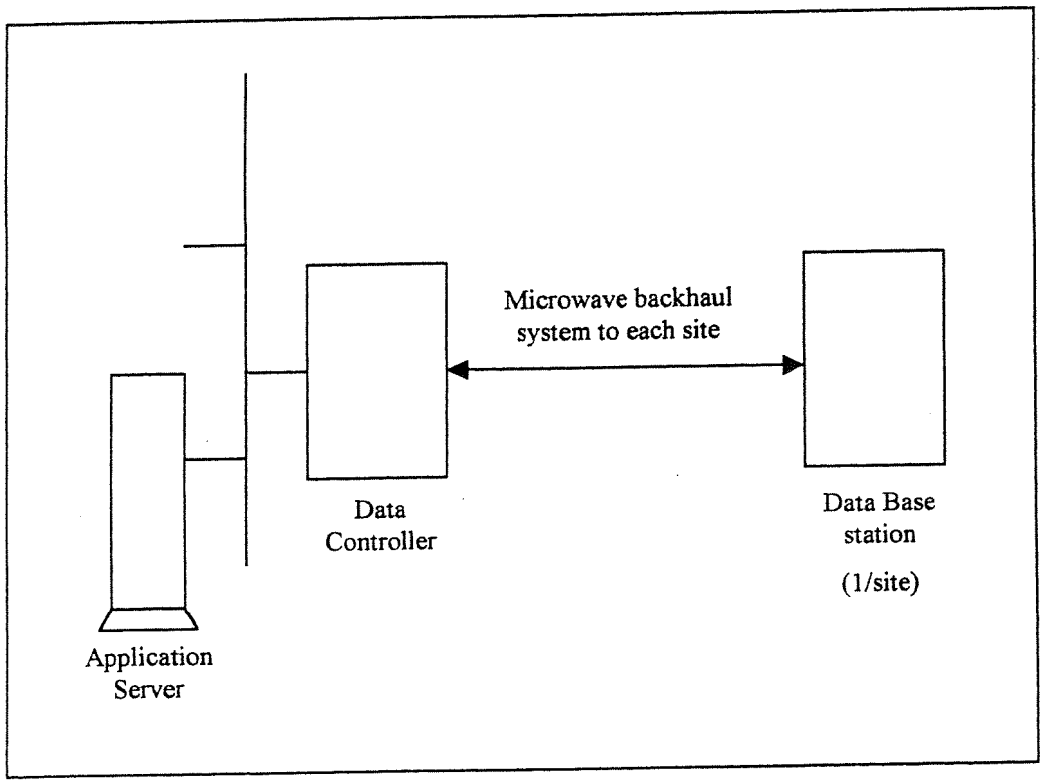
POCSAG (Alpha Numeric)
- Many message storage capability
- Pagers store many messages
- Time/Date Stamp
- Disadvantage – no confirmation
- Displays difficult to read exc. zoom
- Many Radio Manufacturers.
- Digital Ready Transmitters Req'd.
- Pagers 1/3 cost of T&V

Paging Network

Block Diagram NLH IST
2001 01 24
N. Cook

ATTACHMENT # 11

ATTACHMENT # 12



Dedicated Data System Block Diagram

ATTACHMENT # 13

& Lab Hydro Existing Repeater Sites

Site Name	Latitude (N)	Longitude (W)	Elevation (m AMSL)	Owner	Tower Ht. (m)	ERP (W)	TX Freq	RX Freq	Notes
Annieopsquotch	48 15 05	57 43 26	558	RCMP?	50	12	162.63	170.19	Twr. ht. Incorrect?
Bay d'Espoir Hill	47 59 42	55 46 5	262	NLH	54	77.6	164.22	170.28	
Bay l'Argent	47 32 11	54 51 34	244	NTM	40	102	162.63	170.19	
Blue Grass Hill	49 03 31	57 11 13	434	NLH	48	95.5	163.08	172.29	
Blue Mountain	51 29 31	55 45 58	unknown	NLH	15	126	164.79	170.52	
Bonne Bay	49 22 10	57 44 16	480	NTM	40	105	163.86	170.22	Three Tom
Brent's Cove	49 54 37	55 40 23	198	NTM	50	102	164.22	170.28	
Carmanville	49 25 13	54 17 27	89	NTM	45	105	163.23	170.49	
Clarenville	48 11 21	54 02 17	290	NTM	88	93.3	162.75	170.34	Shoal Hr.
Codroy	48 03 31	58 51 27	389	NTM	31	110	163.08	172.29	
Corner Brook	48 55 11	57 58 15	381	NTM	71	60.3	172.53	167.43	
Gambo	48 49 49	54 22 04	207	NTM	43	102	163.08	172.29	
Godaleich Hill	48 15 28	56 10 00	350	NLH	48	15	163.23	170.49	
Hawke Hills	47 19 19	53 07 32	290	NTM	29	102	163.08	172.29	Four Mile
Hermitage	47 33 32	55 56 21	274	NTM	25	112	163.86	170.22	
Jackson's Arm	49 52 57	56 47 06	290	NTM	13	117	163.62	170.01	
Kenmount	47 32 01	52 47 27	255	NTM	20	74.1	172.53	167.43	Ht. Approx
Millertown	48 48 36	56 31 45	232	NTM	96	87.1	163.86	170.22	
Mount Margaret	51 01 05	56 48 47	279	NTM	60	105	162.75	170.34	
Saunders	50 38 58	57 17 51	79	NTM	124	102	162.63	170.19	
land Creek	50 08 41	57 37 39	172	NTM	20	115	164.79	170.52	
Red Cliff	48 57 13	55 47 43	199	NTM	137	70.8	164.79	170.52	
Red Rocks	47 40 35	59 18 10	197	NTM	71	95.5	163.62	170.01	
Rocky Ridge	47 51 20	57 39 08	488	NTM	21	29.5	163.62	170.01	
Serrated Hills	47 40 26	53 51 48	213	NTM	46	10	163.62	170.01	
Sheffield	49 21 42	56 33 24	468	NTM	94	89.1	162.75	170.34	
Southwest Brook	51 01 14	56 08 47	92	NTM	65	95.5	163.62	170.01	
St. Anthony	51 20 56	55 36 36	132	NTM	46	112	163.86	170.22	
Stephenville	48 31 38	58 29 13	130	NTM	36	105	164.79	170.52	

& Lab Hydro Owned Potential New Repeater Sites

Site Name	Latitude (N)	Longitude (W)	Elevation (m AMSL)	Tower Ht. (m)	Year Avail.	Potential Site Replacing	Notes
Gull Pond Hill	48 17 29	55 28 31	285	82	Immed	None	
Sandy Brook Hill	48 52 36	55 47 24	283	93	Immed	Red Rocks	
Mary March	48 49 12	56 43 15	335	115	Immed	Millertown	
Deer Lake	49 10 38	57 24 21	59.5	20	Immed	Bonne Bay	
Petty Harbour	47 30 53	52 44 22	160	40	2002	Kenmount	
Four Mile	47 19 42	53 07 30	290	82	2002	Hawke Hill	
Chapel Arm	47 30 38	53 43 22	224	82	2002	Serrated Hill	
Bull Arm	47 49 45	53 56 19	145	90	2002	Clarenville/Serrated	
Granite Canal	48 11 51	56 49 18	332	30	2003	Annieopsquotch	Tower ht. TBD
Burnt Dam	48 9 46	57 20 20	321	30	2003	Annieopsquotch	Tower ht. TBD
Grandy Brook	47 46 59	57 39 32	318	TBD	2002	Rocky Ridge	New Site
Shoal Harbour	48 11 21	54 2 17	263	40	2003	Clarenville	Tower ht. TBD
Glovertown	48 40 34	54 4 40	191	40	2003		Tower ht. TBD
Johnathan's Pond	49 3 53	54 30 21	126	40	2003		Tower ht. TBD
Southwest Brook	49 10 43	55 2 42	73	60	2003		Tower ht. TBD

ATTACHMENT # 14

Industry Canada's Joint Use Policy Summary Letter

ATTACHMENT #14

rm Cook, P.Eng.

From: <Guerrette.Rene@ic.gc.ca>
To: <CSEL@CSEL.nf.ca>
Sent: Tuesday, February 06, 2001 1:53 PM
Subject: FW: Microwave Licensing Policies

Norm,,
Hope this helps

René

> -----Original Message-----
> From: Guerrette, Rene: STJ
> Sent: Monday, February 05, 2001 12:36 PM
> To: Cook Norman (E-mail)
> Cc: Richard, Roland: MCN; Leblanc, Mike: MCN
> Subject: Microwave Licensing Policies
>
>
> Norm,
>
> As per our discussions, I looked a little further into the policies
> involved in Nfld.. Hydro changing it's status from a microwave user to a
> microwave carrier. We also discussed the possibility of NFLD Hydro
> becoming a full fledged service provider. The policies with regards to
> becoming a service provider on the mobile side of the operations are
> separate and even less restrictive. We can discuss this aspect of the
> requirements if and when you are ready. For the purpose of furthering your
> inquiry into the possibilities offered under the microwave, please refer
> to the following policies; RP 015, RP 017, RP 018, RP 022. Radio
> communications Act(RA), Telecommunications Act(TA) and the Broadcasting
> Act(BA). I mention the BA only since the RP 022 asks for comments on
> combining the 3 policies into the one in an attempt to further liberalize
> the policy on microwave licensing.
>
> The other 2 acts, TA and RA provide the requirements from an ownership
> control perspective for Canadian companies wishing to operate as common
> carriers. As a CC, companies fall under the regulatory aspect of the CRTC.
> A visit to their web site may provide more info on the implications of
> being regulated under the TA. As well, there may be provincial PUB issues
> that could affect the carriers of telecommunications.
>
> Feel free to call me if you have any further questions.

Regards,
>
> René
>

APPENDIX E – TECHNICAL REPORT: WEST/EAST MICROWAVE RADIO INTERCONNECTION

TECHNICAL REPORT:
WEST/EAST MICROWAVE RADIO INTERCONNECTION

August 20, 2002

TABLE OF CONTENTS

EXECUTIVE SUMMARY

As stated in the Telecommunication Plan - Revised August 20, 2002, Newfoundland and Labrador Hydro has elected to maintain the philosophy that a privately owned and maintained telecommunications infrastructure is an integral part of the power system; they are one and the same. This view is held by all major generation and transmission utilities across Canada. To ensure that Newfoundland and Labrador Hydro has the capability to provide a reliable source of electric power to the people and industries of the Province, in the most economical manner consistent with the required reliability, a secure and highly available protection and control scheme complete with supporting telecommunications infrastructure is required.

With the completion of the West and East Coast Microwave Radio projects, the Microwave Radio Interconnection is the next logical step in providing the required infrastructure to support both the generation capacity on the western side of the island and the major load centres on the Avalon Peninsula. It is imperative that Newfoundland and Labrador Hydro maintain control of its telecommunication resources so that in the event of a power outage or a system disturbance its personnel can manage business continuity plans in an optimum manner. Newfoundland and Labrador Hydro considers it essential to invest in an island wide telecommunication infrastructure that will provide the reliability to a degree that can be obtained only with a privately owned and maintained system. This philosophy is consistent with all other major generation and transmission utilities in Canada.

1.0 INTRODUCTION

The Microwave Radio Interconnection Project will complete Newfoundland and Labrador Hydro's (Hydro) cross-island telecommunications network by connecting the West Coast Radio system commissioned in October 1999 and the East Coast Radio System commissioned in December 2001. The Interconnection Project will establish a high capacity (SONET OC-3) radio system between the Energy Control Centre (ECC), St. John's and the Company's largest source of island generation, the Bay d'Espoir Hydro Plant.

The project, which was fully documented in Hydro's Telecommunication Plan 1997 and 2002, shall consist of the development of four (4) new microwave radio repeater sites. With reference to Figure 1, radio sites complete with towers, building, batteries and chargers, stand-by diesel generators and electronic equipment will be established at Shoal Harbour Hill, Glovertown Hill, Jonathan's Pond Hill and Southwest Brook Hill. These four (4) new sites will connect with the existing Sandy Brook Hill site in the central region and the Bull Arm Hill site in the eastern region, thus completing the cross-island telecommunication network.

The completion of the project shall provide Hydro with the telecommunication infrastructure that:

i) supports high speed and secure teleprotection circuits for its bulk 230-kV transmission system from the West Coast to the East Coast;
ii) provides facilities which will support most of Hydro's SCADA circuit requirements that support its Energy Control Centre;
iii) supports approximately 50% of its VHF mobile radio infrastructure which is required to ensure the safety of personnel and operational integrity of its transmission and distribution system; and
iv) supports administrative voice and data traffic between Hydro Place, St. John's and regional offices.

2.0 HISTORY

Newfoundland and Labrador Hydro has always installed and maintained a private telecommunications network for protection and remote control and monitoring of the provincial power grid. Analog Power Line Carrier (PLC) systems were installed in the late 1960s as the original infrastructure with the development of the 230-kV transmission grid. The teleprotection and remote control schemes consisted of slow speed data channels, voice circuits and transmission line protection channels that improved the reliability and system restoration of the power system.

In a continuous cycle to improve the reliability of the power grid, Hydro installed its first computer based Provincial Control Centre in the Bay d'Espoir Plant during the late 1970s. It soon became apparent that reliable, secure high-speed telecommunications channels were required to provide remote automated control and restoral of the power system, especially during power disruption and forced outages.

In the early 1980s with the development of the Hinds Lake Power Plant, Hydro installed an asynchronous digital microwave radio system between the Provincial Control Centre (PCC) and the Hinds Lake Plant and the Buchans Terminal Station. Major terminal and generating stations were now serviced with high-speed data channels which provide faster dispatcher response times during power disturbances. With the construction of the Upper Salmon and Cat Arm Hydro Plants the microwave radio system was again expanded to accommodate the new generating facilities. All operating telecommunications facilities used for the remote control and protection of the power systems were owned and maintained by Hydro. This philosophy was established during the years that the PCC was located in Bay d'Espoir, and has been maintained ever since.

With the relocation of the PCC from Bay d'Espoir to St. John's in 1990 and the establishment of the Energy Control Centre (ECC) in Hydro Place, Hydro's existing telecommunications network, used for remote control and maintaining the provincial power grid, was severed from the controlling mainframe. Because of the cost associated with extending the microwave radio system to St. John's, an interim solution (4-7 years) was proposed using leased facilities. A leased digital satellite service, as the primarily link, and leased analog terrestrial circuits, as a back up service, were installed to extend the west coast traffic to the new Energy Control Centre. The experience with the leased service was less than favourable. Outages on both the satellite and leased circuits occurred on a regular basis. During weather related power

disturbances, when telecommunications were most needed, both the satellite and terrestrial circuits were adversely affected.

During 1996 it was realized that Hydro had to make some major decisions on the future of its telecommunications infrastructure. The leased facilities between Bay d'Espoir and St. John's were not acceptable for power system control. The west coast Marconi radio system was manufacturer discontinued and prone to major outages, and the PLC systems on the east coast were thirty years old and not supported by the manufacturer. A Telecommunications Discussion Paper was prepared that provided a number of alternatives for the future direction of telecommunications. These alternatives ranged from a leased infrastructure to an owned and maintained infrastructure.

Based on the consensus of senior management and system users a five-phase, seven-year Telecommunications Plan was written that established a framework for a private digital microwave radio system to connect the major 230-kV terminal stations and generating stations in the West, Central and East areas of the island with the Energy Control Centre in St. John's.

The long-term objective of the Telecommunications Plan would be to contribute to improved overall power system availability and reduce Hydro's dependence on leased services. The Microwave Interconnect is phase three of that Plan.

3.0 OWNERSHIP: OWNED VERSUS LEASED

The philosophy adopted by Newfoundland and Labrador Hydro to own and maintain a private telecommunications network is consistent among all major generation and transmission utilities across Canada. This was confirmed in January 2001 with the Utility Telecommunications Survey where eight (8) of the major power utilities clearly stated that teleprotection and SCADA traffic is carried on privately owned and maintained facilities. Leased services are not used.

A reliable telecommunications network is paramount to Newfoundland and Labrador Hydro's ability to provide electric power in the province. Reliability is a matter of degree and is a product of these special considerations:

i) quality of telecommunications system design and equipment, including liberal design safety factors and back-up equipment;
ii) ability to carry teleprotection, SCADA and voice traffic during power system disturbances;
iii) maintenance of telecommunication and teleprotection equipment, including the number, location and intensity of training for maintenance staff; and
iv) commitment of such equipment and maintenance to a single and clearly defined goal.

The required reliability, in the order of 99.999% availability on a per system basis, is not economically attainable on leased facilities. Common carriers, in an attempt to serve disparate segments of the population, provide an overall degree of reliability unacceptable to generation and transmission utilities because of their diluted attention to any one user's requirements and their need to make a profit on the equipment and its maintenance.

As an example, Aliant Telecom has limited back-up power as they are relying on a stable and available source of station service. During extended power outages, the ability to maintain communications is limited to the capacity of a single battery system that, in some cases, has failed resulting in the loss of telecommunications. Such a situation is not acceptable to a power utility responsible for maintaining the provincial power grid.

The philosophy pursued by a telecommunications common carrier has a considerable bearing on the provision and assignment of the circuits it operates. The carrier's basic goal is to provide good communications for the transfer of information between people, whether by voice or data transmission. A short interruption to a communication circuit, operating in accordance with this philosophy, while it may cause inconvenience, aggravation and possibly even lead to financial loss

in some business transactions, does not involve the risk or immediate costly physical damage and harmful cascading effects which such a failure may cause on a power system such as that of Hydro.

Common carriers therefore accept short outages and lower quality circuits in order that they may maintain a tariff rate generally acceptable to the public and industry for the class of service provided. Typical end-to-end availability for carrier's circuits is in the order of 99.5% to 99.9%. Were they to attempt the extremely stringent reliability required for control of the provincial power grid, they could not maintain acceptable tariff rates for the rest of their customers. This would not be in the best interest of the general public.

4.0 ALTERNATIVES

As with the West and East Coast Microwave Radio projects a number of technologies were evaluated as possible alternatives for the microwave systems interconnection, namely:

1. ADSS (All Dielectric Self Support) Fibre
2. OPGW (Optical Ground Wire) Fibre
3. Microwave Radio
4. Leased Dark Fibre

4.1 ADSS/OPGW FIBRECABLE

Both of the fibre alternatives require redundancy to ensure the availability criteria. The capital cost for the technology is based on the following:

ADSS/meter	:	$11/meter-fiber + $16/meter-pole line	=	$27/meter
OPGW/meter	:	$30/meter-fiber + $60/meter-line upgrades	=	$90/meter

The capital cost for multiplexing equipment for both of the fibre optic alternatives is approximately $200,000 per end. In addition, at least one repeater site would have to be utilized due to signal degradation over the 200+ km distance. A typical repeater site, similar to that used for the East Coast Microwave system, is approximately $500,000.

Direct cost for a redundant ADSS link between the Bull Arm Hill Microwave Repeater and Stony Brook Terminal Station via the Trans Canada Highway route of 240 km is:

ADSS Contract	:	$54/meter X 240 km	=	$13,000,000.00
Multiplexers	:	$200,000/unit X 8 units	=	$1,600,000.00
Repeater Site	:	$500,000/site X 1 site	=	$500,000.00
		TOTAL	=	$15,100,000.00

Direct cost for an OPGW via the transmission line TL206 and a ADSS cable between Stony Brook and Bull Arm Hill:

OPGW + ADSS Contract	=	($90/m X 145 km) + ($27/m X 240 km)
	=	$13,000,000 + $6,500,000
	=	$19,500,000.00
Multiplexers (8)	=	$1,600,000.00
Repeater Site (2)	=	$1,000,000.00
TOTAL	=	$22,100,000.00

There are annual costs incurred with the Operation and Maintenance of an optical fibre link. For a repeater site, these costs include environmental permit renewals for the diesel generators, electricity, diesel fuel, fibre inspections, preventative and corrective maintenance of the building, electronics, etc. For a typical repeater site, these costs amount to approximately $20,000 annually. For a single site system as proposed for the redundant ADSS alternative, the net present worth of the Operation and Maintenance costs over a 15-year period, assuming the O/M remains constant, is approximately $161,000. For an OPGW + ADSS solution, the Operation and Maintenance costs would be $40,000 annually due to the requirement for two separate routes and two repeater sites, giving a net present worth of about $322,000. Thus, the total cost for the two alternatives, including both direct and O/M costs is as follows:

ADSS Contract (directs only)	=	$15,100,000.00
Operation and Maintenance	=	$161,000.00
TOTAL	=	$15,261,000.00

OPGW + ADSS Contract (directs only)	=	$22,100,000.00
Operation and Maintenance	=	$322,000.00
TOTAL	=	$22,422,000.00

4.2 MICROWAVE RADIO

Digital microwave radio systems have been traditionally used by power utilities to provide sufficient reliable voice and data bandwidth between their facilities. The impetus for providing

private radio systems was the installation of teleprotection equipment that protected millions of dollars of capital infrastructure costs and greatly improved the overall reliability of the power grid. The interconnect radio system shall consist of a redundant radio link with a path propagation availability of 99.9999% and total system availability of 99.999%.

There are annual costs incurred with the Operation and Maintenance of a microwave radio system. These costs include spectrum licensing fees, environmental permit renewals, electricity, diesel fuel, tower inspections, preventative and corrective maintenance, etc. For a typical microwave repeater site, these costs amount to approximately $25,000 annually. For a four-site system as proposed for the microwave interconnection, the net present worth of the Operation and Maintenance costs over a 15-year period, assuming the O/M remains constant, is approximately $806,000. A detail breakdown of the capital costs for the project is included in the Appendix.

Microwave Radio Interconnect (direct costs)	=	$7,106,500.00
Operation and Maintenance	=	$ 806,000.00
TOTAL	=	$7,912,500.00

4.3 LEASED DARK FIBRE

The concept of leasing facilities is not acceptable, however the following costs are presented to give an appreciation of the extremely lucrative opportunities associated with leasing telecommunications facilities.

Dark fibre refers to individual fibres within a fibre optic cable that are not used by the common carrier to carry public correspondence. They are in fact excess infrastructure that is tariffed under CRTC 6716. The fibre is routed through the common carrier exchange but all electronics to “light” the fibre are provided by the user. This alternative is not a recommended method by which generation and transmission facilities carry traffic but is presented as an indicator of leasing costs for such facilities.

To ensure high circuit availability with the use of path redundancy between Bull Arm Hill Microwave Repeater and Stony Brook Terminal Station, the leasing costs, excluding electronics, engineering and installation, is based on the following:

Monthly Lease (4 fibre)	=	$1.56/meter/month X 250 km
Month Lease	=	$390,000.00/month
Five (5) Year Leasing Costs	=	$23,400,000.00
Multiplexers (4)	=	$800,000.00
TOTAL	=	$24,200,000.00

The annual preventative and corrective maintenance on the multiplexing equipment is approximately $2,000. This amounts to $16,000 over a 15-year period, assuming a constant O/M cost.

4.4 COST SUMMARY

The following net present value of direct costs (exclusive of Corporate Overheads, Interest During Construction, Contingency and Escalation) is based on order-of-magnitude analysis. Due to the excessive capital expenditure (all in 2002 dollars) required to install any of the first three options, only the microwave radio detailed cost estimate was prepared as shown in the Appendix.

Net Present Value – 15 Year Life			
ALTERNATIVE	**DIRECT COST**	**OPERATION/MAINTENANCE**	**TOTAL**
Leased Dark Fibre	$24,200,000.00	$16,000.00	$24,216,000.00
ADSS	$15,100,000.00	$161,000.00	$15,261,000.00
OPGW	$21,100,000.00	$322,000.00	$21,422,000.00
Microwave Radio	$7,106,500.00	$806,000.00	$7,912,500.00

5.0 APPLICATIONS

The following applications are presented to give an understanding of the systems that are used by Hydro, to ensure that the industrial and residential customer has the highest level of power system availability.

5.1 TELEPROTECTIVE RELAY SCHEMES

To ensure that a power system fault is removed within the critical fault clearing times is one of the most crucial factors in the planning and operation of a power system. Major economies can be achieved within the power system by utilizing faster fault clearing times. With the installation of digital teleprotection schemes on either microwave radio or fibre optic cable, a power utility such as Hydro is able to decrease the probability of the collapse of the island grid due to individual line problems, by ensuring fast trip times.

When equipment or power lines are faulted, the protective devices must function to detect the fault, send information to other terminals, compare similar information received from other terminals to ensure the correct location of the faulted section and isolate the faulty line or equipment by simultaneously opening the appropriate circuit breakers in the assigned fault clearing time. This requires extremely fast and secure telecommunications facilities between the terminals.

Hydro has standardized on the RFL IMUX 2000 digital teleprotection module that require a T1 (DS1) channel between stations. A comparison of the operating performance of the digital protection versus the analog PLC units is provided.

System	Operate Time	Security (Probability of unwanted trip signal)
IMUX 2000	3 ms	10^{-22}
PLC NSD-50	> 16 ms	10^{-12}

5.2 POWER SYSTEM CONTROL

The Energy Control Centre (ECC) is responsible for the operation of the provincial power grid and directly controls the generation and bulk delivery of power to the major load centres throughout the Province. The ECC also takes the responsibility for the control and operation of the sub-transmission and distribution in the island portion of the province where it has been mandated to service.

Communication channels between the ECC and remote stations provide a complete picture of the exact status of every high voltage device, transmission line and generating unit in our system, plus provide immediate direct remote control of these devices. The communications channels required for system control must have the highest order of availability. This is particularly true during a system disturbance or a major power failure. Without the telecommunications facilities, power cannot be restored quickly or efficiently, thus aggravating the effect on the public. This is precisely the time when common carrier communications facilities are likely to be overloaded or not operating. With the installation of the Microwave Radio Interconnection Hydro will own and maintain approximately 95% of the circuits used to support the power system restoration capabilities of the ECC.

With future applications such as substation automation, which integrates the protection, monitoring, control, diagnostics and measurement of the various systems at a terminal station, additional demands will be placed on the telecommunication systems. Preliminary estimates indicate that minimum bandwidth requirements are in the order of 128 kbps between each terminal station and the ECC. This technology, supported by a private telecommunications system, would further minimize customer outages and reduce operating and maintenance costs.

5.3 OPERATIONAL VOICE COMMUNICATIONS

Reliable voice communications between the ECC and all terminal and generation stations is required, especially during emergency situations. Hydro provides two independent and private voice links, VHF mobile radio and switched telephone service to each station so that voice communications can be maintained with the central power system control authority (i.e. ECC).

It is also imperative that voice communications exist between the ECC and our field service crews and line crews to ensure that repairs can be initiated and completed safely and in the minimum time. This is accomplished with Hydro's extensive and reliable VHF mobile radio system.

To ensure the availability of the voice and data circuits to each VHF repeater, the mobile radio facilities shall be integrated with the microwave radio system in the East, West and Central (i.e. Microwave Interconnect) areas of the island.

5.4 ADMINISTRATIVE VOICE AND DATA COMMUNICATIONS

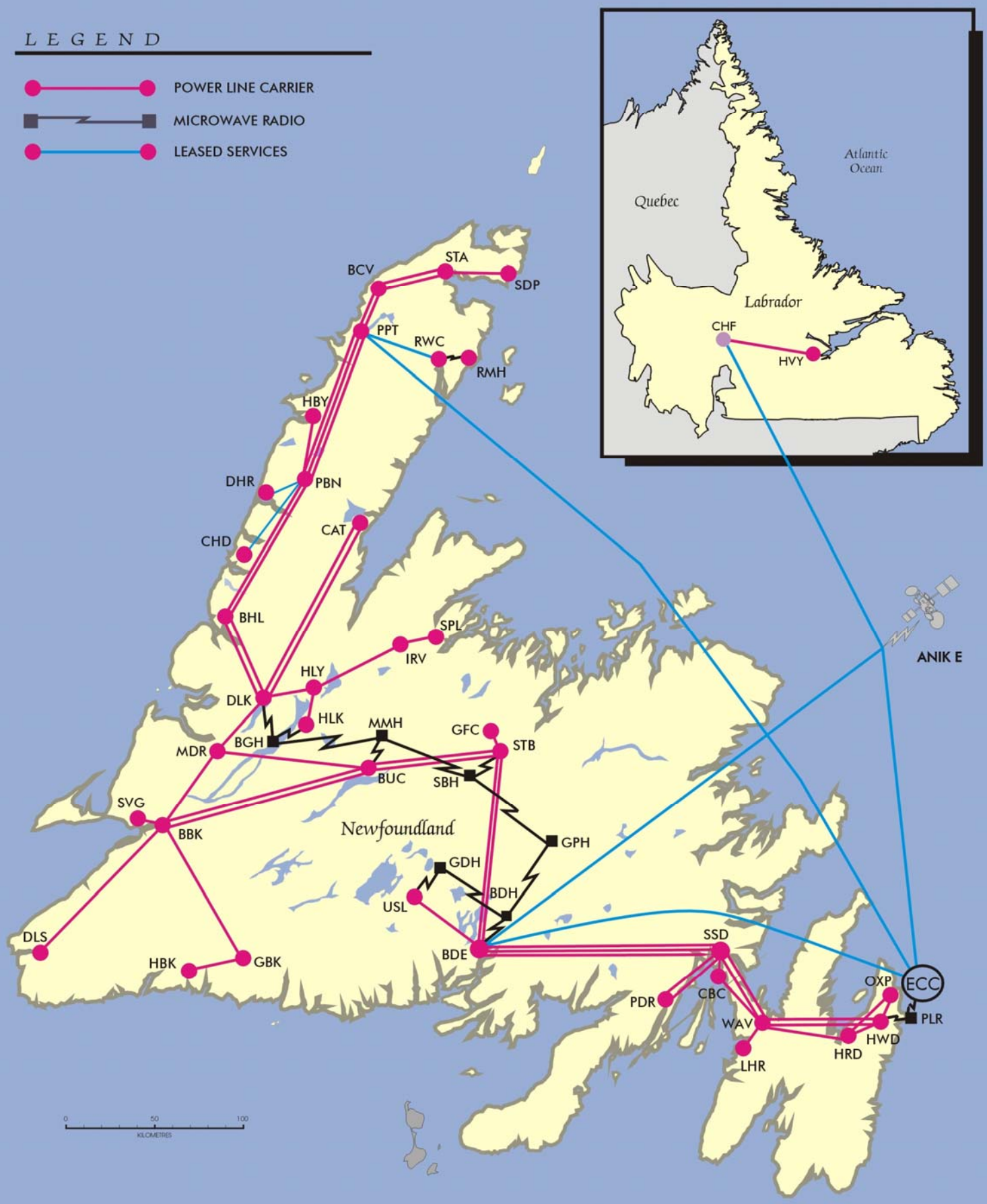
The requirement to have access to centralized data such as switching orders, centralized inventory, manufacturer data, etc. for the supervisors and field staff located in Hydro's ten remote offices has become more critical in recent years. Remote workers rely on administrative and operational databases that reside in Hydro Place, St. John's, in order to restore power to their respective areas. For the most part these voice and data channels are leased. With the completion of the microwave interconnection radio system, the three major Hydro generating stations (Bay d'Espoir, Upper Salmon, Hinds Lake), the future Granite Canal generating station and the Holyrood Thermal plant will be connected directly with the data centres in St. John's. Area offices will be connected with voice and data circuits at the nearest microwave radio site, thus reducing operating cost with the removal of leased facilities.

6.0 CONCLUSIONS

It is the position of Newfoundland & Labrador Hydro to be consistent with all major generation and transmission utilities across Canada in that telecommunications channels used for the protection and control of the power system must be considered an integral part of the electric power system and not a severable appendage that is operated and maintained in a separate environment. The reliable operation of Hydro's provincial power grid requires specialized techniques and equipment for the control and protection of their major facilities. This fact is recognized by the Federal Government, through the special and privilege licensing of frequency diversity radio systems by Industry Canada, for exclusive use by utilities that require high levels of system availability. Power utilities across Canada have lobbied Industry Canada for years to provide and maintain this privilege access to radio spectrum.

With the installation of the West and East Coast Microwave Radio systems the majority of 230-kV terminal stations, hydro generation and terminal plants on the island will have adequate bandwidth to support the remote control and restoration schemes required to minimize power system outages. The Microwave Radio Interconnection is the next logical step to ensure that the source of generation on the island (i.e. Bay d'Espoir, Upper Salmon, Hinds Lake, Cat Arm and Granite Canal) have a reliable and secure telecommunications link with both the Energy Control Centre in St. John's and the major load area of the Avalon peninsula.

APPENDIX



Existing Telecommunication Facilities(1997)

Figure 1

WEST-EAST MICROWAVE INTERCONNECT
ENGINEERING ESTIMATE, SCHEDULE OF PRICES

	REPEATER SITES:	SUPPLY & INSTALL CONTRACT	INTERNAL ENGINEERING	INTERNAL CONSTRUCTION	MATERIALS
1.0	Energy Control Centre (ECC)				
1.1	Network Management System	$100,000			
1.2	1603 MUX Upgrade	$10,000			
1.3	Voice and Data Equipment	$20,000			
1.4	PBX Upgrade	$20,000			
1.5	IS&T Engineering		$22,000		
1.6	IS&T Installation			$25,000	
1.7	Network Access Equipment				$15,000
1.8	Voice/Data Equipment Misc.				$5,000
2.0	Bull Arm Hill (BAH)				
2.1	MDR-4000 Radio	$130,000			
2.2	1603 MUX Upgrade	$30,000			
2.3	Voice and Data Equipment	$15,000			
2.4	Antennas & Cables	$100,000			
2.5	IS&T Engineering		$18,000		
2.6	IS&T Installation			$26,000	
2.7	Network Access Equipment				$15,000
2.8	Voice/Data Equipment Misc.				$5,000
3.0	Shoal Harbour Hill (SHH)				
3.1	MDR-4000 Radio	$260,000			
3.2	1603 MUX	$60,000			
3.3	Voice and Data Equipment	$60,000			
3.4	DC Battery System	$50,000			
3.5	Site Development	$50,000			
3.6	Road Construction	$10,000			
3.7	Site Fencing	$20,000			
3.8	Site Grounding	$20,000			
3.9	Radio Building	$50,000			
3.10	Diesel Building	$30,000			
3.11	Foundations (Buildings)	$15,000			
3.12	Diesel Generator c/w Controls	$80,000			
3.13	RTU Supervisory	$10,000			
3.14	Fire Protection	$45,000			
3.15	80-metre guyed tower	$315,000			
3.16	Antennas and Waveguides	$200,000			
3.17	AC Distribution Line	$40,000			
3.18	IS&T Engineering		$23,000		
3.19	IS&T Installation			$26,000	
3.20	TRO Engineering		$12,000		
3.21	TRO Installation			$3,000	
3.22	Civil Engineering		$8,000		
3.23	Civil Inspector			$4,000	
3.24	Network Access Equipment				$45,000
3.25	Voice/Data Equipment Misc.				$15,000

	REPEATER SITES:	SUPPLY & INSTALL CONTRACT	INTERNAL ENGINEERING	INTERNAL CONSTRUCTION	MATERIALS
4.0	Glovertown Hill (GVH)				
4.1	MDR-4000 Radio	$260,000			
4.2	1603 MUX	$60,000			
4.3	Voice and Data Equipment	$60,000			
4.4	DC Battery System	$50,000			
4.5	Site Development	$50,000			
4.6	Road Construction	$10,000			
4.7	Site Fencing	$20,000			
4.8	Site Grounding	$20,000			
4.9	Radio Building	$50,000			
4.10	Diesel Building	$30,000			
4.11	Foundations (Buildings)	$15,000			
4.12	Diesel Generator c/w Controls	$80,000			
4.13	RTU Supervisory	$10,000			
4.14	Fire Protection	$45,000			
4.15	80-metre guyed tower	$315,000			
4.16	Antennas and Waveguides	$250,000			
4.17	AC Distribution Line	$10,000			
4.18	IS&T Engineering		$23,000		
4.19	IS&T Installation			$28,000	
4.20	TRO Engineering		$12,000		
4.21	TRO Installation			$3,000	
4.22	Civil Engineering		$8,000		
4.23	Civil Inspector			$4,000	
4.24	Network Access Equipment				$45,000
4.25	Voice/Data Equipment Misc.				$15,000
5.0	Jonathan's Pond Hill (JPH)				
5.1	MDR-4000 Radio	$260,000			
5.2	1603 MUX	$60,000			
5.3	Voice and Data Equipment	$60,000			
5.4	DC Battery System	$50,000			
5.5	Site Development	$50,000			
5.6	Road Construction	$10,000			
5.7	Site Fencing	$20,000			
5.8	Site Grounding	$20,000			
5.9	Radio Building	$50,000			
5.10	Diesel Building	$30,000			
5.11	Foundations (Buildings)	$15,000			
5.12	Diesel Generator c/w Controls	$80,000			
5.13	RTU Supervisory	$10,000			
5.14	Fire Protection	$45,000			
5.15	90-metre guyed tower	$400,000			
5.16	Antennas and Waveguides	$250,000			
5.17	AC Distribution Line	$10,000			
5.18	IS&T Engineering		$23,000		
5.19	IS&T Installation			$27,000	
5.20	TRO Engineering		$12,000		
5.21	TRO Installation			$3,000	

	REPEATER SITES:	SUPPLY & INSTALL CONTRACT	INTERNAL ENGINEERING	INTERNAL CONSTRUCTION	MATERIALS
5.22	Civil Engineering		$8,000		
5.23	Civil Inspector			$4,000	
5.24	Network Access Equipment				$45,000
5.25	Voice/Data Equipment Misc.				$15,000
6.0	Southwest Brook Hill (SWH)				
6.1	MDR-4000 Radio	$260,000			
6.2	1603 MUX	$60,000			
6.3	Voice and Data Equipment	$60,000			
6.4	DC Battery System	$50,000			
6.5	Site Development	$50,000			
6.6	Road Construction	$10,000			
6.7	Site Fencing	$20,000			
6.8	Site Grounding	$20,000			
6.9	Radio Building	$50,000			
6.10	Diesel Building	$30,000			
6.11	Foundations (Buildings)	$15,000			
6.12	Diesel Generator c/w Controls	$80,000			
6.13	RTU Supervisory	$10,000			
6.14	Fire Protection	$45,000			
6.15	110-metre guyed tower	$500,000			
6.16	Antennas and Waveguides	$250,000			
6.17	AC Distribution Line	$20,000			
6.18	IS&T Engineering		$23,000		
6.19	IS&T Installation			$26,000	
6.20	TRO Engineering		$18,000		
6.21	TRO Installation			$3,000	
6.22	Civil Engineering		$12,000		
6.23	Civil Inspector			$6,000	
6.24	Network Access Equipment				$45,000
6.25	Voice/Data Equipment Misc.				$15,000
7.0	Sandy Brook Hill (SBH)				
7.1	MDR-4000 Radio	$130,000			
7.2	1603 MUX Upgrade	$30,000			
7.3	Voice and Data Equipment	$15,000			
7.4	Tower Upgrade	$50,000			
7.5	Antennas & Cables	$100,000			
7.6	IS&T Engineering		$18,000		
7.7	IS&T Installation			$25,000	
7.8	TRO Engineering		$1,500		
7.9	TRO Inspections			$2,000	
7.10	Network Access Equipment				$15,000
7.11	Voice/Data Equipment Misc.				$5,000
	TOTALS:	$6,350,000	$241,500	$215,000	$300,000

G. Hicks
02-06-28

WEST/EAST MICROWAVE INTERCONNECT

Study Discount Rate: 9.00%

	Microwave Radio				ADSS				NPV Comparison (Alt. 2 - Alt. 1)
Year	Capital Costs	O&M Costs	Total	CPW to 2003	Capital Costs	O&M Costs	Total	CPW to 2003	CPW to 2003
2003	7,106,500		7,106,500	7,106,500	15,100,000		15,100,000	15,100,000	$ 7,993,500
2004		100,000	100,000	7,198,243		20,000	20,000	15,118,349	$ 7,920,106
2005		100,000	100,000	7,282,411		20,000	20,000	15,135,182	$ 7,852,771
2006		100,000	100,000	7,359,629		20,000	20,000	15,150,626	$ 7,790,996
2007		100,000	100,000	7,430,472		20,000	20,000	15,164,794	$ 7,734,322
2008		100,000	100,000	7,495,465		20,000	20,000	15,177,793	$ 7,682,328
2009		100,000	100,000	7,555,092		20,000	20,000	15,189,718	$ 7,634,627
2010		100,000	100,000	7,609,795		20,000	20,000	15,200,659	$ 7,590,864
2011		100,000	100,000	7,659,982		20,000	20,000	15,210,696	$ 7,550,714
2012		100,000	100,000	7,706,025		20,000	20,000	15,219,905	$ 7,513,880
2013		100,000	100,000	7,748,266		20,000	20,000	15,228,353	$ 7,480,087
2014		100,000	100,000	7,787,019		20,000	20,000	15,236,104	$ 7,449,085
2015		100,000	100,000	7,822,573		20,000	20,000	15,243,215	$ 7,420,642
2016		100,000	100,000	7,855,190		20,000	20,000	15,249,738	$ 7,394,548
2017		100,000	100,000	7,885,115		20,000	20,000	15,255,723	$ 7,370,608
2018		100,000	100,000	7,912,569		20,000	20,000	15,261,214	$ 7,348,645

WEST/EAST MICROWAVE INTERCONNECT

Study Discount Rate: 9.00%

	Microwave Radio				OPGW				NPV Comparison (Alt. 2 - Alt. 1)
Year	Capital Costs	O&M Costs	Total	CPW to 2003	Capital Costs	O&M Costs	Total	CPW to 2003	CPW to 2003
2003	7,106,500		7,106,500	7,106,500	22,100,000		22,100,000	22,100,000	$ 14,993,500
2004		100,000	100,000	7,198,243		40,000	40,000	22,136,697	$ 14,938,454
2005		100,000	100,000	7,282,411		40,000	40,000	22,170,364	$ 14,887,953
2006		100,000	100,000	7,359,629		40,000	40,000	22,201,252	$ 14,841,622
2007		100,000	100,000	7,430,472		40,000	40,000	22,229,589	$ 14,799,117
2008		100,000	100,000	7,495,465		40,000	40,000	22,255,586	$ 14,760,121
2009		100,000	100,000	7,555,092		40,000	40,000	22,279,437	$ 14,724,345
2010		100,000	100,000	7,609,795		40,000	40,000	22,301,318	$ 14,691,523
2011		100,000	100,000	7,659,982		40,000	40,000	22,321,393	$ 14,661,411
2012		100,000	100,000	7,706,025		40,000	40,000	22,339,810	$ 14,633,785
2013		100,000	100,000	7,748,266		40,000	40,000	22,356,706	$ 14,608,441
2014		100,000	100,000	7,787,019		40,000	40,000	22,372,208	$ 14,585,189
2015		100,000	100,000	7,822,573		40,000	40,000	22,386,429	$ 14,563,856
2016		100,000	100,000	7,855,190		40,000	40,000	22,399,476	$ 14,544,286
2017		100,000	100,000	7,885,115		40,000	40,000	22,411,446	$ 14,526,331
2018		100,000	100,000	7,912,569		40,000	40,000	22,422,428	$ 14,509,859

WEST/EAST MICROWAVE INTERCONNECT

Study Discount Rate: 9.00%

	Microwave Radio				Leased Dark Fibre				NPV Comparison (Alt. 2 - Alt. 1)
Year	Capital Costs	O&M Costs	Total	CPW to 2003	Capital Costs	O&M Costs	Total	CPW to 2003	CPW to 2003
2003	7,106,500		7,106,500	7,106,500	24,200,000		24,200,000	24,200,000	$ 17,093,500
2004		100,000	100,000	7,198,243		2,000	2,000	24,201,835	$ 17,003,592
2005		100,000	100,000	7,282,411		2,000	2,000	24,203,518	$ 16,921,107
2006		100,000	100,000	7,359,629		2,000	2,000	24,205,063	$ 16,845,433
2007		100,000	100,000	7,430,472		2,000	2,000	24,206,479	$ 16,776,007
2008		100,000	100,000	7,495,465		2,000	2,000	24,207,779	$ 16,712,314
2009		100,000	100,000	7,555,092		2,000	2,000	24,208,972	$ 16,653,880
2010		100,000	100,000	7,609,795		2,000	2,000	24,210,066	$ 16,600,271
2011		100,000	100,000	7,659,982		2,000	2,000	24,211,070	$ 16,551,088
2012		100,000	100,000	7,706,025		2,000	2,000	24,211,990	$ 16,505,966
2013		100,000	100,000	7,748,266		2,000	2,000	24,212,835	$ 16,464,570
2014		100,000	100,000	7,787,019		2,000	2,000	24,213,610	$ 16,426,591
2015		100,000	100,000	7,822,573		2,000	2,000	24,214,321	$ 16,391,749
2016		100,000	100,000	7,855,190		2,000	2,000	24,214,974	$ 16,359,783
2017		100,000	100,000	7,885,115		2,000	2,000	24,215,572	$ 16,330,457
2018		100,000	100,000	7,912,569		2,000	2,000	24,216,121	$ 16,303,553

APPENDIX F – TECHNICAL REPORT: WEST COAST PLC REPLACEMENT

TECHNICAL REPORT:
WEST COAST PLC REPLACEMENT

August 20, 2002

TABLE OF CONTENTS

Appendix

EXECUTIVE SUMMARY

As stated in the Telecommunication Plan - Revised August 20, 2002, Newfoundland and Labrador Hydro has elected to maintain the philosophy that a privately owned and maintained telecommunications infrastructure is an integral part of the power system; they are one and the same. This view is held by all major generation and transmission utilities across Canada. To ensure that Newfoundland and Labrador Hydro has the capability to provide a reliable source of electric power to the people and industries of the Province, in the most economical manner consistent with the required reliability, a secure and highly available protection and control scheme complete with supporting telecommunications infrastructure is required.

In 2002, three of the five years of the Power Line Carrier (PLC) equipment replacement plan for the West Coast of the Island will be complete. Over the next two years, the majority of the remaining 20+-year-old PLC infrastructure will be replaced. In order to support the generation capacity on the western side of the island at Upper Salmon, Cat Arm and Hinds Lake Generating Stations, a mix of analog PLC and digital microwave radio will be installed to provide higher speed, more reliable teleprotection and to transport voice and data to the Energy Control Centre (ECC) via the existing microwave radio network. The proposed PLC replacement plan is summarized below.

Location	Year	Existing	Proposed	Budget Amount
TL243 TL245	2003	Analog PLC	Digital Microwave Radio	$1,009,000
TL247	2004	Analog PLC	Double-channel, analog PLC	$353,000
TL234	2004	Analog PLC	Digital Teleprotection over microwave	$66,000

1.0 INTRODUCTION

The West Coast Power Line Carrier (PLC) Replacement Project will provide Newfoundland and Labrador Hydro (Hydro) with improved communications to the generating and terminal stations located on the Island's west coast. In the first three years of the five-year PLC replacement plan the groundwork was laid by replacing the PLC equipment for low-capacity tail circuits bordering the high-capacity microwave radio network in order to provide the required upgraded infrastructure for remote stations. In the remaining two years, the equipment connecting the remote generating stations at Upper Salmon, Hinds Lake and Cat Arm will be replaced.

The project, which is fully documented in Hydro's Telecommunication Plan – Revised August 20, 2002, shall consist of the replacement of a number of PLC links located on the west coast of the Island. As more fully detailed in this document, alternatives for the replacement of three of the four PLC links are discussed, including a single microwave radio hop to replace two PLC links and an analog PLC with digital teleprotection over the existing microwave radio network for the third. These alternatives to PLC equipment provide increased communication availability as they are not affected by forced or planned transmission line outages.

The completion of the project shall provide Hydro with the telecommunication infrastructure that:

i) supports higher speed and more secure teleprotection circuits for its bulk 230/138-kV transmission system on the West Coast; and
ii) provides facilities which will support most of Hydro's SCADA circuit requirements that support its Energy Control Centre.

2.0 HISTORY

Newfoundland and Labrador Hydro has always installed and maintained a private telecommunications network for protection and remote control and monitoring of the provincial power grid. Analog Power Line Carrier (PLC) systems were installed in the late 1960s as the original infrastructure with the development of the 230-kV transmission grid. The teleprotection and remote control schemes consisted of slow speed data channels, voice circuits and transmission line protection channels that improved the reliability and system restoration of the power system.

In a continuous cycle to improve the reliability of the power grid, Hydro installed its first computer based Provincial Control Centre in the Bay d'Espoir Plant during the late 1970s. It soon became apparent that reliable, secure high-speed telecommunications channels were required to provide remote automated control and restoral of the power system, especially during power disruption and forced outages.

In the early 1980s with the development of the Hinds Lake Power Plant, Hydro installed an asynchronous digital microwave radio system between the Provincial Control Centre (PCC) and the Hinds Lake Plant and the Buchans Terminal Station. Major terminal and generating stations were now serviced with high-speed data channels which provide faster dispatcher response times during power disturbances. With the construction of the Upper Salmon and Cat Arm Hydro Plants the microwave radio system was again expanded to accommodate the new generating facilities. All operating telecommunications facilities used for the remote control and protection of the power systems were owned and maintained by Hydro. This philosophy was established during the years that the PCC was located in Bay d'Espoir, and has been maintained ever since.

With the relocation of the PCC from Bay d'Espoir to St. John's in 1990 and the establishment of the Energy Control Centre (ECC) in Hydro Place, Hydro's existing telecommunications network, used for remote control and maintaining the provincial power grid, was severed from the controlling mainframe. Because of the cost associated with extending the microwave radio system to St. John's, an interim solution (4-7 years) was proposed using leased facilities. A leased digital satellite service, as the primarily link, and leased analog terrestrial circuits, as a back up service, were installed to extend the west coast traffic to the new Energy Control Centre. The experience with the leased service was less than favourable. Outages on both the satellite and leased circuits occurred on a regular basis. During weather related power

disturbances, when telecommunications were most needed, both the satellite and terrestrial circuits were adversely affected.

During 1996 it was realized that Hydro had to make some major decisions on the future of its telecommunications infrastructure. The leased facilities between Bay d'Espoir and St. John's were not acceptable for power system control. The west coast Marconi radio system was manufacturer discontinued and prone to major outages, and the PLC systems on the east coast were thirty years old and not supported by the manufacturer. A Telecommunications Discussion Paper was prepared that provided a number of alternatives for the future direction of telecommunications. These alternatives ranged from a leased infrastructure to an owned and maintained infrastructure.

Based on the consensus of senior management and system users a five-phase, seven-year Telecommunications Plan was written that established a framework for a private digital microwave radio system to connect the major 230-kV terminal stations and generating stations in the West, Central and East areas of the island with the Energy Control Centre in St. John's, and for the replacement of existing low-capacity PLC tail circuits to remote stations with state-of-the-art PLC equipment.

The long-term objective of the Telecommunications Plan would be to improve overall power system availability and reduce Hydro's dependence on leased services. The West Coast Power Line Carrier Replacement Project is Phase Four of that Plan.

3.0 OWNERSHIP: OWNED VERSUS LEASED

The philosophy adopted by Newfoundland and Labrador Hydro to own and maintain a private telecommunications network is consistent among all major generation and transmission utilities across Canada. This was confirmed in January 2001 with the Utility Telecommunications Survey where eight (8) of the major power utilities clearly stated that teleprotection and SCADA traffic is carried on privately owned and maintained facilities. Leased services are not used.

A reliable telecommunications network is paramount to Newfoundland and Labrador Hydro's ability to provide electric power in the province. Reliability is a matter of degree and is a product of these special considerations:

i) quality of telecommunications system design and equipment, including liberal design safety factors and back-up equipment;
ii) ability to carry teleprotection, SCADA and voice traffic during power system disturbances;
iii) maintenance of telecommunication and teleprotection equipment, including the number, location and intensity of training for maintenance staff; and
iv) commitment of such equipment and maintenance to a single and clearly defined goal.

The required reliability, in the order of 99.999% availability on a per system basis, is not economically attainable on leased facilities. Common carriers, in an attempt to serve disparate segments of the population, provide an overall degree of reliability unacceptable to generation and transmission utilities because of their diluted attention to any one user's requirements and their need to make a profit on the equipment and its maintenance.

As an example, Aliant Telecom has limited back-up power as they are relying on a stable and available source of station service. During extended power outages, the ability to maintain communications is limited to the capacity of a single battery system that, in some cases, has failed resulting in the loss of telecommunications. Such a situation is not acceptable to a power utility responsible for maintaining the provincial power grid.

The philosophy pursued by a telecommunications common carrier has a considerable bearing on the provision and assignment of the circuits it operates. The carrier's basic goal is to provide good communications for the transfer of information between people, whether by voice or data transmission. A short interruption to a communication circuit, operating in accordance with this philosophy, while it may cause inconvenience, aggravation and possibly even lead to financial loss

in some business transactions, does not involve the risk or immediate costly physical damage and harmful cascading effects which such a failure may cause on a power system such as that of Hydro.

Common carriers therefore accept short outages and lower quality circuits in order that they may maintain a tariff rate generally acceptable to the public and industry for the class of service provided. Typical end-to-end availability for carrier's circuits is in the order of 99.5% to 99.9%. Were they to attempt the extremely stringent reliability required for control of the provincial power grid, they could not maintain acceptable tariff rates for the rest of their customers. This would not be in the best interest of the general public.

4.0 ALTERNATIVES

As the majority of PLC use on the West Coast of the Island is for the connection of remote generating and terminal stations to the high-capacity microwave network, the most economically feasible solution for those links completed to date was for the replacement of the existing PLC infrastructure with state-of-the-art PLC equipment. For three of the four systems slated for replacement in 2003 and 2004, there are more feasible alternatives as described below. The PLC link between Cat Arm Generating Station and Deer Lake Terminal Station will be replaced with a new double-channel PLC, as there is no economic alternative.

1. TL243 (Hinds Lake Generating Station-to-Howley Terminal Station) & TL245 (Howley Terminal Station-to-Deer Lake Terminal Station)
   Due to the proximity of the Howley Terminal Station to the existing Blue Grass Hill Repeater, a decision was made to replace the PLCs for TL243 and TL245 with a single asynchronous digital microwave radio hop. This radio link would provide additional bandwidth capacity for the Howley, Indian River and Springdale Terminal Stations, and high-speed teleprotection for the two transmission lines. This replacement would take place in 2003.

2. TL234 (Upper Salmon Generating Station-to-Bay D'Espoir Terminal Station)
   In 1979 when the West Coast microwave radio system was initially installed, the decision was made that transmission line teleprotection would not be carried over the microwave radio system because, at that time, the technology was not proven. As a result, PLC equipment was installed to provide this service. For example, the Upper Salmon Generating Station is currently serviced by an asynchronous digital microwave radio for SCADA data and voice traffic while a PLC is utilized for teleprotection.
   Since the replacement of the West Coast Microwave System and the installation of the East Coast Microwave System, the requirement for PLC equipment to provide teleprotection equipment is no longer required due to the increased availability and reliability of the new digital microwave systems. Based on this, the decision was made to replace the TL234 PLC with an RFL IMUX 2000 T1 Multiplexer in 2004. This will provide higher speed, more reliable teleprotection for the Upper Salmon Generating Station. This change in scope of the 1997 Plan will result in cost savings in capital and operation/maintenance expenditures.

4.1 TL243 AND TL245

The capital cost (directs only) for the two technologies, i.e. PLC vs. microwave, is given below (see attached engineering estimate for detail):

Power Line Carrier	=	$684,400
Digital Microwave Radio	=	$825,300

Although the capital cost for the installation of a microwave radio hop is about 20% higher than the PLC alternative, the microwave alternative is preferred for the following reasons:

- it provides a higher system availability (e.g. communications are not lost when the transmission line is removed from service due a forced or planned outage);
- the performance of the teleprotection is greatly improved in reliability, security and speed; and
- it provides increased bandwidth for existing and future operational and administrative voice and data traffic.

The PLC alternative provides little opportunity to increase the bandwidth to the Howley, Indian River and Springdale Terminal Stations for future power system or administrative applications such as substation automation or WAN connectivity over Hydro-owned facilities.

There are annual costs incurred with the Operation and Maintenance of the telecommunications infrastructure. For the microwave radio hop, these costs include spectrum licensing fees, tower inspections, preventative and corrective maintenance, etc. For a typical microwave site located in a terminal station, these costs amount to approximately $3,000 annually. The spectrum licensing fees are estimated to be $1,200 annually. For a PLC link, these Operation and Maintenance costs are approximately $2,000 annually for preventative and corrective maintenance.

ALTERNATIVES	DIRECT COSTS	ANNUAL OPERATION/ MAINTENANCE	NET PRESENT WORTH
Power Line Carrier	$684,400	$2,000	**$700,500**
Microwave Radio	$825,300	$4,200	**$859,000**

4.2 TL247

The capital cost (directs only) to replace TL247 is $282,700 (see attached engineering estimate for detail). As this is the current technology in use for communications with the Cat Arm Generating Station and due both to its remote location and distance from the existing microwave network, PLC is the most economical alternative over microwave radio or optical fibre which can both run in excess of $1,000,000 for the terrain in this area.

4.3 TL234 TELEPROTECTION

The capital cost (directs only) for the two technologies, i.e. IMUX and PLC, is given below (see attached engineering estimate for detail):

Power Line Carrier	=	$266,600
IMUX Teleprotection	=	$52,300

As stated previously, the annual costs incurred with the operation and maintenance of a PLC system is approximately $2,000. The annual costs for the IMUX teleprotection are approximately half of that for a PLC system, or $1,000, due primarily to the reduced complexity of the IMUX equipment and less components (PLC system includes the PLC itself, line matching units and wavetraps). For both cases, the only annual costs are for preventative and corrective maintenance.

ALTERNATIVES	DIRECT COSTS	ANNUAL OPERATION/ MAINTENANCE	NET PRESENT WORTH
Replace with PLC Teleprotection	$266,600	$2,000	**$282,700**
Replace with IMUX Teleprotection	$52,300	$1,000	**$60,400**

4.4 COST/BENEFIT SUMMARY

The following net present worth values (exclusive of Corporate Overheads, Interest During Construction, Contingency and Escalation) are based on order-of-magnitude analysis and include the annual operation and maintenance costs, as derived from JD Edwards. The net present worth assumes a constant Operation/Maintenance cost over the 15-year equipment lifespan. In addition, the advantages and disadvantages for each alternative are presented.

ALTERNATIVES	NET PRESENT WORTH	ADVANTAGES/DISADVANTAGES
TL243/TL245		
Power Line Carrier	$700,500	Advantages: • Lower annual operation/maintenance cost Disadvantages: • Low bandwidth; no excess to provide other services • Lower availability as voice, data and teleprotection circuits are interrupted during planned or forced transmission line outages • Slow, less reliable & secure teleprotection • Low-speed data channels for power system control • Low-quality, party-line voice communications
Microwave Radio **(preferred)**	$859,000	Advantages: • Higher bandwidth for present and future operational and administrative applications to remote stations • Higher availability as voice, data and teleprotection circuits are not affected during planned or forced transmission line outage • Fast, more reliable & secure teleprotection • High-speed data channels for power system control • High-quality, switched voice communications Disadvantages: • Higher annual operation/maintenance cost
TL234 TELEPROTECTION		
Replace with PLC Teleprotection	$282,700	Advantages: • None Disadvantages: • Excessive infrastructure to provide teleprotection • Slow, less reliable & secure teleprotection • Significantly higher capital costs

Replace with IMUX Teleprotection **(preferred)**	$60,400	Advantages: • Utilizes existing microwave radio hop • Fast, more reliable & secure teleprotection • Significantly lower capital costs Disadvantages: • None

Although the microwave radio alternative for the replacement of the TL243 and TL245 PLCs has about 20% higher net present worth, the benefits for the microwave installation outweigh the cost difference. As mentioned previously, with the microwave alternative, the system availability will be higher, a more secure and reliable teleprotection scheme will be utilized, and the increased bandwith will enhance existing operational and administrative voice and data traffic and allow for future power system applications such as substation automation. For the other replacement proposals, the preferred options of replacing the TL247 PLC with a new PLC, and replacing the TL234 PLC with the IMUX teleprotection over the microwave system are both more cost effective.

5.0 CONCLUSIONS

It is the position of Newfoundland & Labrador Hydro to be consistent with all major generation and transmission utilities across Canada in that telecommunications channels used for the protection and control of the power system must be considered an integral part of the electric power system and not a severable appendage that is operated and maintained in a separate environment. The reliable operation of Hydro's provincial power grid requires specialized techniques and equipment for the control and protection of their major facilities.

With the installation of the West and East Coast Microwave Radio systems and the replacement of the low-capacity PLC links to remote stations, the majority of the 230-kV terminal stations, hydro generation and terminal plants on the island will have adequate bandwidth to support the remote control and restoration schemes required to minimize power system outages. Where it is not economically or technologically feasible for high-capacity microwave radio links, the PLC equipment in the Hydro communications network has been replaced with state-of-the-art PLC equipment with an estimated lifespan of 15-20 years. This new PLC equipment greatly improves the voice, data and teleprotection facilities provided to the remote stations over the low-capacity tail circuits. The work outlined in this document is an important step to ensure that the source of generation on the island (i.e. Bay d'Espoir, Upper Salmon, Hinds Lake, Cat Arm and Granite Canal) has a reliable and secure telecommunications link with both the Energy Control Centre in St. John's and the major load area on the Avalon Peninsula.

APPENDIX

Estimated By: G. Hicks

This estimate covers the directs costs only, for the replacement of 4 BBC PLCs over a period of two years.

Summary:

	CJC Budget Year 1 (2 PLCs)	Year 2 (2 PLCs)
Total Material:	$757,100	$268,800
Total Installation:	$33,700	$39,200
Total Engineering:	$34,500	$27,000
Total of Directs:	**$825,300**	**$335,000**

	Years 1-2 (4 PLCs)
Total Material:	$1,025,900
Total Installation:	$72,900
Total Engineering:	$61,500
Total of Directs:	**$1,160,300**

Project Overview

The table below provides an overview of the proposed replacements of PLC equipment in 2003-2004.

TL and Sites	Year	Existing	Proposed
TL243 HLY-HLK	2003	PLC	Digital Microwave Radio c/w antenna supporting structure at Howley
TL245 HLY-DLK	2003	PLC	
TL247 CAT-DLK	2004	PLC	Double Channel PLC
TL234 USL-BDE	2004	PLC	IMUX 2000 for teleprotection over existing uW
where			

HLY = Howley Terminal Station
HLK = Hinds Lake Generating Station
DLK = Deer Lake Terminal Station
CAT = Cat Arm Generating Station
USL = Upper Salmon Generating Station
BDE = Bay D'Espoir Terminal Station

Base Costs:

#	Description	Original	Escln	Cost
1	Taxes			0.00%
2	Engineering / at headquarters / 37.5 hour week (Schedule of Labour & Expenses for Est. / 00-01-10)	$2,200.00		$2,200.00
3	Engineering / at headquarters / hour (Calculated from above)			$58.67
4	Internal Forces / at headquarters / 60 hour week (Schedule of Labour & Expenses for Est. / 00-01-10)	$2,200.00		$2,200.00
5	Internal Forces / at headquarters / hour (Calculated from above)			$36.67
6	Drafting / 40 hour week (Schedule of Labour & Expenses for Est. / 00-01-10)	$1,500.00		$1,500.00
7	Drafting / hour (Calculated from above)			$37.50
8	Per Diem (P&P Manual / EMR 11 / 96-11-20)	$43.00		$43.00
9	Hotel / night (Schedule of Labour & Expenses for Est. / 00-01-10)	$107.00		$107.00
10	ar Rental / day (Rough estimate / 00-11-03 / GH)	$100.00		$100.00
11	Fleet van, car or pick-up / day (Schedule of Labour & Expenses for Est. / 00-01-10)	$100.00		$100.00
12	Fleet van, car or pick-up / hour (Calculated from above)			$12.50
13	Fleet boom truck or light truck / hour (Schedule of Labour & Expenses for Est. / 00-01-10)	$25.00		$25.00
14	US exchange rate (Rough estimate / 00-02-21 / PJ)			1.47

Quotes

#	Description	Original	EscIn	Cost
1	Single Channel Analog Power Line Carrier (ABB Quote N0203181429 /02-03-21)	$47,500	0.00%	$47,500
2	Double Channel Analog Power Line Carrier (ABB Quote N0203181429 /02-03-21)	$55,000	0.00%	$55,000
3	High Power, Double Channel Power Line Carrier (PO 20485 /Item 3 /2000)	$50,000	0.00%	$50,000
4	Digital Multiplexer for PLC (ABB Quote N0203181429 /02-03-21)	$28,500	0.00%	$28,500
5	Line Matching Unit (PO 23588 /Item 1 /2000)	$5,000	0.00%	$5,000
6	Wavetrap (PO 19693 /Item 1 /1999)	$10,000	0.00%	$10,000
7	FAT at Vendor's Premises (ABB Quote N0203181429 /02-03-21)	$2,700	0.00%	$2,700
8	Installation Support (ABB Quote N0203181429 /02-03-21)	$15,000	0.00%	$15,000
9	Triaxial Cable ($/foot) (PO 22527 /Item 1 /1999)			$1.00
10	5 kV Power Cable (3D-0401-TAPE) ($/metre) (Anixter Quote by Telephone /May 2000)			$5.00
11	Optocouplers for SOE (Entrelec Quote by email /00-10-03)			$35
12	CVT (PO 20183 /Item 3 /2000)	$10,000	0.00%	$10,000
13	CVT Support Structure and Foundation (PO 25527 /2000)			$1,700
14	Miscellaneous cable and hardware (TRO/IS&T) (Estimate by G. Hicks based on CJC 10530)			$2,000
15	Air Travel to Deer Lake/Gander and return (Estimate from Provincial Airlines/AC websites)			$500
16	IMUX 2000 with MTS (Estimate from Contract 2000-16242)	$10,000	0.00%	$10,000
17	DC Distribution (Fuse Panels and Rack) (Estimate from Contract 2000-16242)	$5,000	0.00%	$5,000

18	Network Access Equipment (Estimate from Contract 2000-16242)	$70,000	0.00%	$70,000
19	Antenna Supporting Structure and accessories (Estimate from Contract 2000-16242)	$120,000	0.00%	$120,000
20	Antenna, Waveguide and accessories (Estimate from Contract 2000-16242)	$25,000	0.00%	$25,000
21	Digital Microwave Radio and accessories (Estimate from Contract 2000-16242)	$120,000	0.00%	$120,000
22	Digital Multiplexer and accessories (Estimate from Contract 2000-16242)	$50,000	0.00%	$50,000
23	Geotechnical Investigation (Estimate from Contract 2000-16242)	$4,000	0.00%	$4,000
24	Fial RTU and accessories (Estimate from Contract 2000-16242)	$11,000	0.00%	$11,000

Summary:

	Year 1 2003
Total Material:	$757,100
Total Installation:	$33,700
Total Engineering:	$34,500
Total of Direct Costs:	**$825,300**

Estimated By: G. Hicks

Material:

#	Description	Quantity	Unit Cost	Item Cost
1	Digital Microwave Radio and accessories	2	$120,000	$240,000
2	Digital Multiplexer and accessories	2	$50,000	$100,000
3	Antenna Supporting Structure and accessories	1	$120,000	$120,000
4	Antenna, Waveguide and accessories	2	$25,000	$50,000
5	Network Access Equipment	2	$70,000	$140,000
6	Fial RTU and accessories	2	$11,000	$22,000
7	DC Distribution (Fuse Panels and Rack)	1	$5,000	$5,000
8	IMUX 2000 with MTS	4	$10,000	$40,000
9	Miscellaneous cable and hardware (TRO/IS&T)	2	$2,000	$4,000
10	Miscellaneous (% of above)	5%		$36,050
	Sub-Total:			$757,050
	Taxes:			$0
	Total Material:			$757,050

Installation:

#	Description	Units	Quantity	Sites	Item Cost
1	Supervise tower, antenna and W/G installation (hours)	60	1	2	$4,400
2	Supervise equipment installation (hours)	60	1	2	$4,400
3	Witness commissioning (hours)	60	1	2	$4,400
4	Cutover Voice, Data and Teleprotection to MW (hours)	60	2	2	$8,801
5	Travel Time (hours)	2	2	2	$293
6	Per Diem (days)	30	2	2	$5,160
7	Hotel (nights)	29	1	1	$3,103
8	Drafting (hours)	20	1	2	$1,500
9	Miscellaneous (% of above)	5%			$1,603
	Total Installation:				$33,661

Estimated By: G. Hicks

Engineering:

#	Description	Units	Quantity	Item Cost
1	Design, including site visits (hours)	60	1	$3,520
2	Specification (hours)	100	1	$5,867
3	Equipment Ordering (hours)	40	1	$2,347
4	Work requests (hours)	40	1	$2,347
5	Project management, including FAT (hours)	40	1	$2,347
6	Commissioning (hours)	60	1	$3,520
7	Travel Time (hours)	5	1	$293
8	Per Diem (days)	11		$473
9	Hotel (nights)	10		$1,070
10	Car Rental (days)	11		$1,100
11	Air Travel (tickets)	4		$2,000
12	Geotechnical Investigation (HLY and BGH)	2		$8,000
13	Miscellaneous (% of above)	5%		$1,644
	Total Engineering:			$34,528

Estimated By: G. Hicks

Summary:

	Year 2 2004	TL247	TL234
Total Material:	$268,800	$245,600	$23,200
Total Installation:	$39,200	$23,600	$15,600
Total Engineering:	$27,000	$13,500	$13,500
Total of Direct Costs:	**$335,000**	$282,700	$52,300

Estimated By: G. Hicks

Material:

#	Description	Quantity	Unit Cost	Item Cost
1	Double Channel Analog Power Line Carrier	2	$55,000	$110,000
2	Line Matching Unit	4	$5,000	$20,000
3	Wavetrap	4	$10,000	$40,000
4	FAT at Vendor's Premises	1	$2,700	$2,700
5	Installation Support	1	$15,000	$15,000
6	Triaxial Cable ($/foot)	600	$1	$600
7	5 kV Power Cable (3D-0401-TAPE) ($/metre)	30	$5	$150
8	Optocouplers for SOE	4	$35	$140
9	CVT	4	$10,000	$40,000
10	CVT Support Structure and Foundation	2	$1,700	$3,400
11	IMUX 2000 with MTS	2	$10,000	$20,000
12	Miscellaneous cable and hardware (TRO/IS&T)	2	$2,000	$4,000
13	Miscellaneous (% of above)	5%		$12,800
	Sub-Total:			$268,790
	Taxes:			$0
	Total Material:			$268,790

Installation:

#	Description	Units	Quantity	Sites	Item Cost
1	Remove existing coupling equipment (hours)	4	6	2	$1,760
2	Install new coupling and PLC equipment (hours)	8	7	2	$4,107
3	Cutover Voice, Data and Teleprotection to PLC (hours)	8	2	2	$1,173
4	PLC Commissioning (hours)	10	1	2	$733
5	PLC Wrap-Up (hours)	2	7	2	$1,027
6	PLC Travel Time (hours)	5	7	2	$2,567
7	Boom Truck (hours)	19	1	2	$950
8	Install IMUX equipment (hours)	16	2	2	$2,347
9	Cutover Teleprotection to M/W (hours)	8	2	2	$1,173
10	Teleprotection Commissioning (hours)	3	1	2	$220
11	IMUX Wrap-Up (hours)	2	2	2	$293
12	IMUX Travel Time (hours)	4	2	2	$587
13	Per Diem (days)	9	7	2	$5,418
14	Hotel (nights)	8	7	2	$11,984
15	Drafting (hours)	20	1	4	$3,000
16	Miscellaneous (% of above)	5%			$1,867
	Total Installation:				$39,207

Estimated By: G. Hicks

Engineering:

#	Description	Units	Sites	Item Cost
1	Design, including site visits (hours)	37.5	2	$4,400
2	Specification (hours)	37.5	2	$4,400
3	Equipment Ordering (hours)	7.5	2	$880
4	Work requests (hours)	37.5	2	$4,400
5	Project management, including FAT (hours)	37.5	2	$4,400
6	Commissioning (hours)	13	2	$1,525
7	Travel Time (hours)	5	4	$1,173
8	Per Diem (days)	10		$430
9	Hotel (nights)	10		$1,070
10	Car Rental (days)	10		$1,000
11	Air Travel (tickets)	4		$2,000
12	Miscellaneous (% of above)	5%		$1,284
	Total Engineering:			$26,964

Estimated By: G. Hicks

Summary:

Alternatives	Cost	Notes
TL243 & TL245		
Power Line Carrier		
- Single Channel PLC for each line	$533,200	
- Addition of Digital Multiplexer for each line	$119,700	
- Change to double channel for each line	$31,500	
	$684,400	
Digital Microwave Radio	**$825,300**	
TL234		
Power Line Carrier	**$266,600**	
IMUX 2000 Teleprotection	**$52,300**	

Summary:

Single Channel PLC

Total Material:	$229,800
Total Installation:	$23,300
Total Engineering:	$13,500
Total of Direct Costs:	**$266,600**

Material:

#	Description	Quantity	Unit Cost	Item Cost
1	Single Channel Analog Power Line Carrier	2	$47,500	$95,000
2	Line Matching Unit	4	$5,000	$20,000
3	Wavetrap	4	$10,000	$40,000
4	FAT at Vendor's Premises	1	$2,700	$2,700
5	Installation Support	1	$15,000	$15,000
6	Triaxial Cable ($/foot)	600	$1	$600
7	5 kV Power Cable (3D-0401-TAPE) ($/metre)	30	$5	$150
8	Optocouplers for SOE	2	$35	$70
9	CVT	4	$10,000	$40,000
10	CVT Support Structure and Foundation	2	$1,700	$3,400
11	Miscellaneous cable and hardware (TRO/IS&T)	1	$2,000	$2,000
12	Miscellaneous (% of above)	5%		$10,946
	Sub-Total:			$229,866
	Taxes:			$0
	Total Material:			$229,866

Installation:

	Description	Units	Quantity	Sites	Item Cost
	Remove existing coupling equipment (hours)	4	6	2	$1,760
2	Install new coupling and PLC equipment (hours)	8	7	2	$4,107
3	Cutover Voice, Data and Teleprotection to PLC (hours)	8	2	2	$1,173
4	PLC Commissioning (hours)	10	1	2	$733
5	PLC Wrap-Up (hours)	2	7	2	$1,027
6	PLC Travel Time (hours)	4	7	2	$2,054
7	Boom Truck (hours)	18	1	2	$900
13	Per Diem (days)	5	7	2	$3,010
14	Hotel (nights)	4	7	2	$5,992
15	Drafting (hours)	20	1	2	$1,500
16	Miscellaneous (% of above)	5%			$1,113
	Total Installation:				$23,369

Estimated By: G. Hicks

Engineering:

#	Description	Units	Sites	Item Cost
1	Design, including site visits (hours)	45	1	$2,640
2	Specification (hours)	37.5	1	$2,200
3	Equipment Ordering (hours)	7.5	1	$440
4	Work requests (hours)	37.5	1	$2,200
5	Project management, including FAT (hours)	37.5	1	$2,200
6	Commissioning (hours)	8	1	$469
7	Travel Time (hours)	5	2	$587
8	Per Diem (days)	5		$215
9	Hotel (nights)	4		$428
10	Car Rental (days)	5		$500
11	Air Travel (tickets)	2		$1,000
12	Miscellaneous (% of above)	5%		$644
	Total Engineering:			$13,524

WEST COAST PL[redacted]EPLACEMENT

Study Discount Rate: 9.00%

Year	TL243 & TL245 Microwave Radio				TL243 & TL245 PLC				NPV Comparison (Alt. 2 - Alt. 1)
	Capital Costs	O&M Costs	Total	CPW to 2003	Capital Costs	O&M Costs	Total	CPW to 2003	CPW to 2003
2003	825,300		825,300	825,300	684,400		684,400	684,400	$ (140,900)
2004		4,200	4,200	829,153		2,000	2,000	686,235	$ (142,918)
2005		4,200	4,200	832,688		2,000	2,000	687,918	$ (144,770)
2006		4,200	4,200	835,931		2,000	2,000	689,463	$ (146,469)
2007		4,200	4,200	838,907		2,000	2,000	690,879	$ (148,027)
2008		4,200	4,200	841,637		2,000	2,000	692,179	$ (149,457)
2009		4,200	4,200	844,141		2,000	2,000	693,372	$ (150,769)
2010		4,200	4,200	846,438		2,000	2,000	694,466	$ (151,972)
2011		4,200	4,200	848,546		2,000	2,000	695,470	$ (153,077)
2012		4,200	4,200	850,480		2,000	2,000	696,390	$ (154,090)
2013		4,200	4,200	852,254		2,000	2,000	697,235	$ (155,019)
2014		4,200	4,200	853,882		2,000	2,000	698,010	$ (155,871)
2015		4,200	4,200	855,375		2,000	2,000	698,721	$ (156,654)
2016		4,200	4,200	856,745		2,000	2,000	699,374	$ (157,371)
2017		4,200	4,200	858,002		2,000	2,000	699,972	$ (158,030)
2018		4,200	4,200	859,155		2,000	2,000	700,521	$ (158,634)

WEST COAST PLC REPLACEMENT

Study Discount Rate: 9.00%

Year	TL234 PLC Capital Costs	TL234 PLC O&M Costs	TL234 PLC Total	TL234 PLC CPW to 2003	TL234 IMUX Capital Costs	TL234 IMUX O&M Costs	TL234 IMUX Total	TL234 IMUX CPW to 2003	NPV Comparison (Alt. 2 - Alt. 1) CPW to 2003
2003	266,600		266,600	266,600	52,300		52,300	52,300	$ (214,300)
2004		2,000	2,000	268,435		1,000	1,000	53,217	$ (215,217)
2005		2,000	2,000	270,118		1,000	1,000	54,059	$ (216,059)
2006		2,000	2,000	271,663		1,000	1,000	54,831	$ (216,831)
2007		2,000	2,000	273,079		1,000	1,000	55,540	$ (217,540)
2008		2,000	2,000	274,379		1,000	1,000	56,190	$ (218,190)
2009		2,000	2,000	275,572		1,000	1,000	56,786	$ (218,786)
2010		2,000	2,000	276,666		1,000	1,000	57,333	$ (219,333)
2011		2,000	2,000	277,670		1,000	1,000	57,835	$ (219,835)
2012		2,000	2,000	278,590		1,000	1,000	58,295	$ (220,295)
2013		2,000	2,000	279,435		1,000	1,000	58,718	$ (220,718)
2014		2,000	2,000	280,210		1,000	1,000	59,105	$ (221,105)
2015		2,000	2,000	280,921		1,000	1,000	59,461	$ (221,461)
2016		2,000	2,000	281,574		1,000	1,000	59,787	$ (221,787)
2017		2,000	2,000	282,172		1,000	1,000	60,086	$ (222,086)
2018		2,000	2,000	282,721		1,000	1,000	60,361	$ (222,361)