STUDIES RELATED TO THE MODERNIZATION OF THE
GOVERNMENT OF CANADA TELECOMMUNICATIONS NETWORK

STUDIES RELATED TO THE MODERNIZATION OF THE GOVERNMENT OF CANADA TELECOMMUNICATIONS NETWORK

SET OF DELIVERABLES
SUBMITTED BY
NORTHERN TELECOM CANADA LTD

IN FULFILLMENT OF CONTRACT DATED JUNE 29th 1983

SERIAL OEZ83-06002

RN 36100-2-4446

EC 7616-81001-2201

P
91 DD 4429851
C655 DL 4433739
S89
1983

List of Deliverables

1. Service Availability
3. Survivability in Private Networks
6. Evolution of Private Networks
7. Cost Effective Useful Life
8. Impact Analysis - Non-NT products in an NT ESN Environment
9. Field Reliability
10. Transmission Plan for GOC Intercity Network
11. Organization Standards for Inside Telephone Wiring
12. Functions of a Network Control Centre
13. Presentative Maintenance
15. Acceptance Testing
16. Implementation Planning
17. Feasibility of a Proposed Uniform Dialing Plan
18. Information Bidders Should Provide in Response to the RFP
19. Jacks and Plugs
20. Telecommunication Standards for the Federal Government
21. Operation of a Telecommunication Service

NOTE: Deliverables 2,4,5, and 14 were deleted at contract initiation.

Deliverable 1

Service Availability

TABLE OF CONTENTS

1. INTRODUCTION

In this deliverable, service availability as defined in reference 4, Figure 1 is applied to the Government of Canada network and in particular, the Vancouver - Victoria consolidation. The whole quality of service indicator in reference 4, appears in some form throughout the set of GTA deliverables. Thus aspects, of service support appear in deliverables 3 and 13, of service operability in deliverables 8 and 17, of service reliability in deliverable 9, and of transmission performance in deliverable 10.

Within the context of the GTA study, the requirement is to provide criteria of availability which the network designers should aim to meet given that the media of communications is leased Telco lines (trunks) and leased or owned (digital) switches. That is, the network designers will have to illustrate what "predicted" performance their proffered design will meet.

In what follows, we describe common practice in defining service availability performance in public and private networks and contrast it with the CCITT recommendation in reference 4. We observe that, for the most part, use of availabiliy criteria in the network design process has been more implicit than explicit*. Thus while it has become accepted practice to design to P05 and P10 (deliverable 3) in private networks, propagation performance has been taken as given owing to extensive testing and development carried out by the telecommunications media. Moreover, the current approach to providing private networks has considered availability performance in the light of always having the public network to fall back on.

Given the above caveat, section 2 describes in some detail current practice. Section 3 gives those availability indicators which are current practice (trafficability), which can be derived (availability) and which still require some debate to arrive at a suitable definition (propagation).

* Not unexpected - the telecommunications systems has been around a long time - Recommendation G106 only for three years.

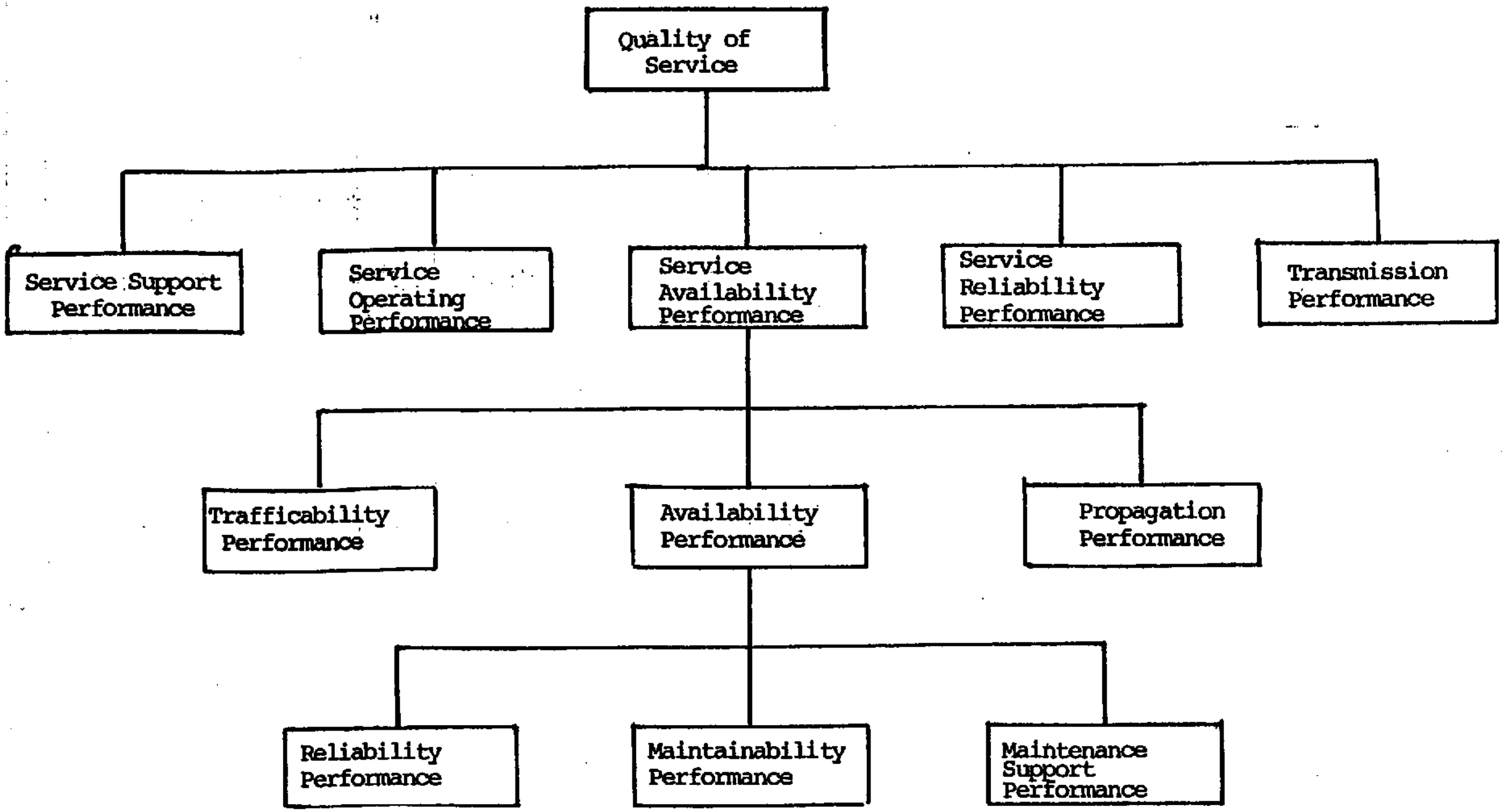


Figure 1: CCITT Recommendation G106 on Quality of Service

2. SERVICE AVAILABILITY: CURRENT PRACTICE

2.1 Quality of Service and Availability in Public Networks

Implicitly and in the context of public telephone switching systems, availability has been defined as a failure resulting in denial of basic telephone service. Denial of basic telephone service does not include impairments such as long dial-tone-delay, blocking above design levels, or failures of very short duration causing call interruption. The rationale is that provided calls can be placed and connections established and maintained, basic service is available. It is also customary to exclude failure of short duration (under one minute). Acceptable levels are given in table 1. For the most part, common practice has restricted the term availability to a more narrow application than the requested 'service availability'. However the broader area of concern is included in 'Quality of Service Indicators' as specified by the Canadian Radio-Television and Telecommunications Commission (1). Table II gives a set of measurements for application to public telephone service such that 90% of customers will be satisfied. Technology affects the type of measurement possible and economical, so indicators vary over companies.

To date, therefore, the 'Quality of Service Indicators' are as experienced by users. There has been work towards planning the public telephone networks on user-based measures but the bulk of switched networks operating traffic information is equipment oriented. Private networks are almost exclusively provisioned on equipment oriented grades-of-service. A comprehensive network study with user-oriented end-to-end measures is very rare. Section 3 indicates how this might be achieved.

2.2 Private Network Quality of Service: Current Practice

Private telephone networks (other than military) in Canada are installed as lower-cost alternatives to the individual line service and message toll service. Where alternate routing by user choice is available through the public network, the blocking grade-of-service for this part of a private network is reducible to a least-cost decision. Dimensioning tie trunks overflowing to DDD public toll service is an example.

When there is no public network alternative due to architecture (lines and PBX appearance) or due to access restrictions (network grade-of-service), then quality of service is an issue.

Within wide bounds, the quality of service objectives are implicit and at the discretion of the customer. Network management practices, systems plans and implementation, and manufacturers equipment affect actual quality of service. The business effects of impairments are balanced against costs of extra capacity or of measurement equipment in setting service objectives.

Common practice is to have a comprehensive study periodically (1-2 years) to consider architecture charges such as new switching arrangements. Otherwise capacity is adjusted in accordance with complaints and in light of limited monitoring of equipment utilization.

3. AVAILABILITY PERFORMANCE CRITERIA

3.1 Grade of Service (Trafficability)

In private network design, grade of service (GOS) criteria vary from country to country and from company to company. Thus in Canada, practice and experience dictate a G.O.S. of P05 on trunks and P10 on access* lines. In the United States an end-to-end G.O.S. of P07 has been found satisfactory for most private networks. Within each country, variations have occurred according to the particular needs of a specific company. For example a Fortune 100 company requires a P02 service on some links to accommodate senior executives, a financial institution in Canada required a P02 end-to-end GOS for one of its subsidiaries even though the subsidiary did not meet cost effectiveness criteria to be included in the private network at all. However, without any specific executive requirement, GOS on the Government of Canada networks should be constrained to

P05 on trunks
P10 on access lines

as a design requirement.

3.2 Availability Performance

A critical area where quality of service is not recoverable by operational and network design practices is in the availability of switches and lines. Since a telephone gains access to service only through its serving switch, the availability of the entire switch and of individual lines directly affects the availability of telephone service.

Availability is usually stated in terms of its complement. Unavailability is the xpected fraction of time the failure makes the service unavailable. A convenient user parameter system of unavailability is downtime (hours) per year and expected number

---

* For Tandem-tie-trunk networks, access lines are those lines accessing the tandem switch from a local PBX.

of failures requiring manual action per year.

Availability is stated under two conditions. Intrinsic downtime, Di, includes the mean-action-repair-time, but excludes administration and logistic delays between failure detection and repair start. Operational downtime, Do, include all delays in addition to mean-action-repair-time. Specifications of Di and Q (failures per year requiring manual restoral) permits the derivation of Do when time to begin repair is not zero.

In terms of the operational downtime, the figures for lines are as given in deliverable 9.

Trunks or lines affected	Downtime for all causes
entire office	3 min/year
n1	t1 min/year
n2	t2 min/year
.	
.	
.	
24	20 min/year
1	28 min/year

For a single line, then the availability is 0.999947 whereas for a modular 24 trunk, the availability is 0.999962. For a switching system, unavailability for the switch is designed to be no greater than 0.003 i.e., availability of 0.997 (c.f. deliverable 9). The design requirement for a network can thus be derived as follows:

Given the loss planning requirement (analog lines) - deliverable 10 - that no more than 3 switches and 4 lines should separate both ends of a call, then design availability on mod 24 should be

$$A = (.997)^{3} \quad (.99996)^{4}$$

$$= 0.9909.$$

Note 1: While such a value is derived for analog lines, the network should be so designed whether the offering is heirarchial or CCSA-type or even if there is a DDD fall-back.

Note 2: This availability is for the whole network. GTA need to estimate availability of the network outside of Vancouver - Victoria so that the figure for the particular consolidation can be entered in the RFP.

3.3 Propagation Performance

The above figure (A=0.9909) for availability included, by definition (Note 1), the noise, interference, loss etc., for a network which is fully functioning. Given GTA's concern with survivability, however, similar figures for availability in degraded mode operations can be established once the degraded modes are fully defined. These modes would have to be defined by GTA and would include a requirement, for example, for acceptable GOS and acceptable availability under the various types of failure defined in deliverable 3. However, it is recommended that, for the Vancouver - Victoria RFP, no consideration be given at this time to the impact of system failures on propagation performance either in the sense of planning for loss on reconfigured networks or in establishing degraded modes and the corresponding enumeration of availability figures.

Note 1: By this we mean that the choice of 4 links and 3 switches in 3.2 arises from the need to minimize loss, noise, etc.)

4. SUMMARY AND CONCLUSION

CCITT recommendation G106 has been used to define service availability performance. Current practice, which presumably led up to the recommendation, does not apply the definitions consistently in network design. Trafficability performance in terms of Grade of Service indicators is commonly used and availability performance can be derived. Propagation performance is a component part in this derivation but its applicability to network propagation of failure is not as yet standard.

Table 1

Examples of Capacity Determination Performance

Switching Systems	Time Consistent	ABSBH	10HDBH	HDBH
Dial Tone Delay >3sec.		1.5%calls	8%calls	20%
Incoming Digit Receiver Delay >3sec.		.5%calls		5%
Outgoing Matching Loss		1.0%calls		20%
Terminating Matching Loss		2.0%calls		20%
Intra Office Matching Loss		4.0%calls		20%
Tandem Matching Loss		1.0%calls		20%
Toll Tandem:				
Incoming Digit Delay >3sec (MF&DTMF)			.5%	2%
Tandem Matching Loss			.5%	2%

Trunks (Private Network Typical)

Central office trunks	1-5% blocking (20 TCHR)
Tie trunks	5-20% blocking*
Bypass trunks	5-20% blocking*
WATS trunks	5-50%*

* economically provided

Trunks, Public Network, Typical

Final choice trunk group	1% (ABSBH)

Switched Network (public modelling assumption)

End-to-end grade-of-service .5% origin switch to terminating switch.

Table II

Quality of Service Indicators (CRTC)

Provision of Service:

- % connection requests convenient to customers.	91.6% out of 50/district-month completed orders.
- % connection requests met	93.8% out of 50/district-month requests.
- held orders per 100 inward movements	85-90%, 2.4-3.3% total sample each NNX; aggregate by customer service and regrade requests.

Repair

- Incidence per month of trouble reports.	4.2%
- Subsequent reports before action	12%
- Repeated trouble report after action	14.7% 10-20%
- % out-of-service conditions cleared within 24 hours	75-85% 80%
- Commitments met	90.1%

Local Service

% dial-tone-delay >3seconds.	2%-1.5%
Switched without failure	98-99%

Table II

Quality of Service Indicators (Cont'd)

Toll Network Service

% without blockage or failure	96.5% 96-98%

Operator Service

Average answering time	7.5 seconds, <6.6 seconds (BC Tel)
Intercept accuracy	98% (BC Tel)
% satisfied with service	Standard to be developed
Directory Service	93.8%, 200 interviews published directory, weighted by size of directory (Bell)
Billing Accuracy	95%, total business account without (Bell) adjustment

The cost and benefits of service monitoring information combined with planning is sensitive to the technology, scale, and organizational effects of communication impairments. Such a study could, but has not been, addressed as an operational issue.

5. GLOSSARY OF TERMS

ABSBH	Average Busy Season Busy Hour
THDBH	Ten High Day Busy Hour
HDBH	High Day Busy Hour
Matching Loss	Net probability of not being able to establish a network path between an originating line or incoming trunk and a terminating line or trunk when the terminating line or trunk is idle.

6. REFERENCES

1. Quality of Service Indicators for Use in Telephone Company Regulation, TELECOM DECISION CRTC 82-13, Canadian Radio-Television and Telecommunications Commission, November 1982.

2. G.J. Fitzpatrick and L.A. Pound, 'Toward and End-to-End Grade-of-Service', Proceedings of the National Telecommunications Conferences, New Orleans, November 1981.

3. S.S. Katz, 'Improved Traffic Network Administration Process Utilizing End-to-End Service Considerations.

4. "Concepts, terms and definitions related to Availability and Reliability Studies" Recommendation G106 CCITT, Geneva 1980.

Deliverable 3

Survivability in Private Networks

TABLE OF CONTENTS

1. INTRODUCTION

Survivability is a term originally coined to identify the ability of a network to function in the event of enemy attack (1). It is closely related to network availability but imposes a more severe condition on network architecture and design by considering degraded performance as well as complete failure of the system. Thus availability can be improved through careful placement of parallel 'hot standby' equipment so that normal maintenance and restoral procedures can reconstruct the original network. Network survivability, on the other hand, is only enhanced if critical links in the network can be bypassed without significant network degradation (In this case repair procedures constitute a complete rebuilding of the network).

For example, in Figure 1, network A, a non-hierarchical network is highly survivable whilst network B - the usual two-level private network is not. Of course A is considerably more costly than B.

Since not only enemy attack but also terrorist action, fire, EMP and earthquakes impact the network function, survivability has come to mean more generally:

"The ability of the network to function under adverse conditions".

Service survivability, with which the deliverable is concerned, is therefore the ability of subscribers to use the network under adverse conditions.

In section 2, we provide a short background to the state-of-the-art in private network survivability studies. In section 3 we look at possible measures of networking survivability (given that GTA has a basic network design requirement) whilst in section 4 we identify those measures which we believe a vendor could be assessed in the RFQ evaluation.

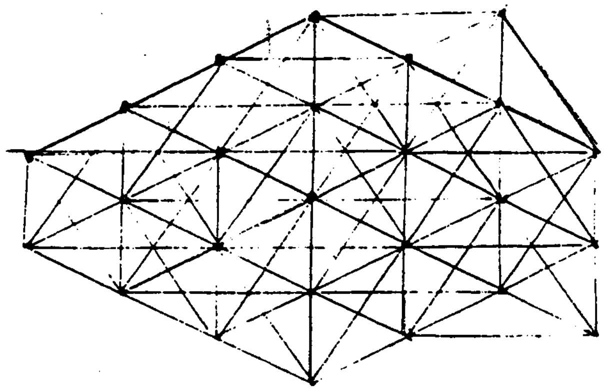


Figure 1: A SURVIVABLE CONNECTED NETWORK

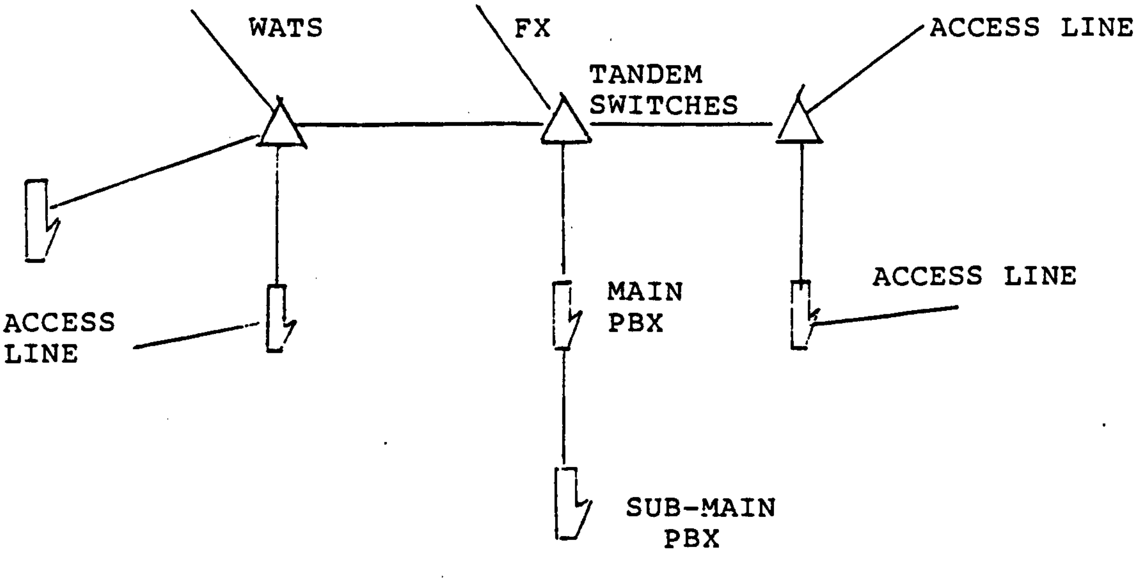


Figure 2: A TWO-LEVEL HEIRARCHICAL NETWORK

2. BACKGROUND

Survivability of private telecommunication networks has not been of much concern to customers who have a capability to fall-back on the public DDD network. Moreover, the grade of service on the public network is much better than that normally offered to private customers, so that use of fall-back mode is only constrained by cost.

Survivability of military private networks has been the object of some study. These studies (and eventual implementations) have concentrated on physical security and/or protection: for example EMP protection through the use of Faraday cages: physical security against sabotage: normal manufacturer hardening against blast and earthquake, as well as distributed redundancy.

The state-of-the-art in public network survivability is exemplified by reference 2. The immaturity of the art implies a diversity of approach even in the public network where survivability is implicit in conservative design, network dimensioning with reserves and alternate routing. That is, the network design approach and emergency network management adopted in North America provides a designed redundancy sufficient to meet all but the most improbable catastrophic failure.

The trend towards voice/data integration in networks, the more immediate trend toward end-user responsibility for their own networks and the potential high cost of losing service may induce survivability standards which move some way toward the military requirements. However, the same level survivability may be reached with the public networks as back-up*.

* Note, however data security may impose different priorities.

3. DEFINITIONS AND MEASURES

3.1 Definitions

Survivability in private (or public) networks is the ability of the network to function under adverse conditions where

- A functioning network is one which can be used by a subscriber.
- Adverse conditions are defined in terms of minor, major and catastrophic failures based on a line, trunk or equipment outage affecting a single node or link in the network.

Types of failure are

- Minor - Telephone instrument failure
  Subscriber line failure
  Partial PBX failure

- Major - Total PBX failure
  PBX-Tandem Access line failure
  Tandem trunk group failure
  Partial tandem switch failure

- Catastrophic - Total tandem switch failure
  Transmission span (multiple simultaneous trunk group) failure

Note: (1) The type of failure conditions above are correlated to the incurred cost to the user as he awaits repair. This cost comprises the extra cost in using public network facilities plus any (implicit) cost in not having services customized to his private network requirements.

(2) To a particular subscriber the failures will either appear as the inability to receive dial-tone or as worse than normal blockage i.e., a network disconnect or a lower grade of service. The type of failure is not correlated to what the user experiences. For example subscriber line failure (no dial-tone) may appear to the user as more catastrophic than tandem trunk group failure where he observes only increased blocking.

3.2 Measures

We have indicated in 3 that failure in adverse conditions can result in network disconnect or in a network grade of service lower that the designed requirement. In both cases the measure "traffic exposure to blocking" in reference 2 is an appropriate measure and is defined as E where

E = % traffic that is exposed to more than Y% blocking.

A further measure not considered in reference 2 applicable to private networks is the cost associated with the blocking. Experience in private networks in the US and Canada suggests that satisfactory network performance for the user occurs when blocking is between 5% and 10%. The cost associated with blocking probabilities greater than this is the cost of going to DDD. Thus in appropriate survivability measure is C where

C = "DDD cost associated with that proportion of traffic experiencing blocking of more than 10%".

C is cost per day, based on an assumption that major and catastrophic failures will take at least one day to repair. It may be that, for the purposes of the government, these measures are insufficiently detailed. For example, even though the network is Canada-wide, it may be that most of the telecommunications business conducted is fairly local so that a trunk group failure on the backbone tandem network may not affect to any great extent business in Vancouver - Victoria. It may, therefore, be desirable to break down the cost and balance the point-to-point traffic by areas (say WATS-BAND equivalents) which experience blocking above 10%. This method allows a more precise definition of types of failure.

Finally, a further measure which might be introduced and which is meaningful to the end-user is the % personnel affected by a particular type of failure. Such a measure would, however, only have meaning if differing categories of government employees have differing access to local and long distance facilities (since a catastrophic failure in the tandem trunk network would therefore affect all employees).

4. REQUIREMENTS ON VENDORS

If network/service survivability, excluding need for physical and electrical protection is an obligation to be placed on vendors*, then survivability requirements could be phrased as follows in the RFQ.

For the minor, major and catastrophic failures as defined in section 3.1, vendors shall indicate

- Extent of network disconnection (if any) in terms of % of traffic experiencing 100% blocking.
- Extent of network performance degradation in terms of % of traffic experiencing more than 10% blocking.
- Length of time to restore a normal level of network performance for each type of failure (Notes: 1, 2, 3)
- Possible methods to avert the impact of failure on network performance either through suitable distributed redundancy capability or by describing how fall back to the public network can be achieved.

Vendors shall briefly describe where in their network design the simulated features ocurred and why these were considered the critical points.

NOTES:

1. Restoral time for a sliced cable depends on the capability to find where the break occurred. Once the break is found, then cable splicing can take place and restoral takes only a few hours.
2. Replacement of a complete switch is dependant on the manufacturers ability to supply. Restoral of service can take from 6 hours for a 3000 line PBX.
3. For example, interconnect companies offer as a normal part of their contract, a one hour response time in emergency with 24 hour commitment from the time they call. This commitment

---

* Considering the current state-of-the-art, this obligation may be unfair since vendors may not have available the necessary software tools to carry out the investigation.

could include (if arranged by contract) dealing with the common carrier on behalf of the customer, should trouble be located say, in the trunking. Moreover should a complete PBX be affected, then interconnect companies are prepared to supply a replacement service (at some level of capability) until a new PBX can be installed e.g. a key system.

5. REFERENCES

1. Telecommunications Transmission Engineering Volume 1 Bell System for Technical Education 1977.

2. Evaluating network survivability through exposure McMenamin, P.G. and Fitzpatrick, G.J. I.T.C. Conference 10 1983.

Deliverable 6

Evolution of Private Telephone Networks

<u>TABLE OF CONTENTS</u>

1. INTRODUCTION

Private telecommunication networks are usually associated with large, multi-location businesses or institutions. Interconnecting these corporate locations, a private network provides internal corporate telecommunication services as well as access to the outside world.

These networks have provided many benefits:

- Maximization of station user efficiency in intercity calling.
- Control and allocation of communications expense.
- Ability for communications managers to manage and control systems.
- Optimal use of lowest-cost intercity facilities.

User requirements to be met by private networks will expand as a result of evolution towards office automation. The rest of this report discusses the expected future requirements and services which the private network should support. Also, directly in the GTA context, future projections are supplied for number of network calls, and number of telephone sets, as well as data terminals.

1.1 Office Automation and Private Networks

The enhanced functionality of network switching vehicles will provide private network users with improved benefits in areas such as:

- Advanced office applications,
- Messaging services,
- Teleconferencing,
- Document processing,
- Database access,
- Voice/data integration at workstation and facility levels,
- Building management and many others.

Distributed architectures allow these services to be applied to many locations, providing further economic benefit. Some of these value-added services (VASs) are discussed in Section 5 of the report.

Another major effect of office automation on private networks will be the change in user-station instruments. Alongside the telephone set at a user's desk, there will increasingly appear data business instruments, ranging from dumb terminals to personal computers and voice/data work stations. This trend is quantified in Section 4 of the report.

2. PROJECTIONS OF GTA INTERCITY NETWORK CALLS

The GTA has supplied, in a Planning Element Memorandum, figures for number of intercity network calls from fiscal year 1979-80 to 1986-87. The figures are:

FISCAL YEAR	TOTAL INTERCITY NETWORK CALLS
1979-80	25,200,000
1980-81	25,600,000
1981-82	27,600,000
1982-83	28,700,000
1983-84	31,000,000
1984-85	34,800,000
1985-86	36,800,000
1986-87	39,800,000

Using linear regression, these figures have been projected out to the year 2000 (see Figure 1). Some sample values are:

1989-1990	45,300,000
1994-1995	56,100,000
1999-2000	67,000,000

ACTUAL AND FORECASTED NETWORK CALLS

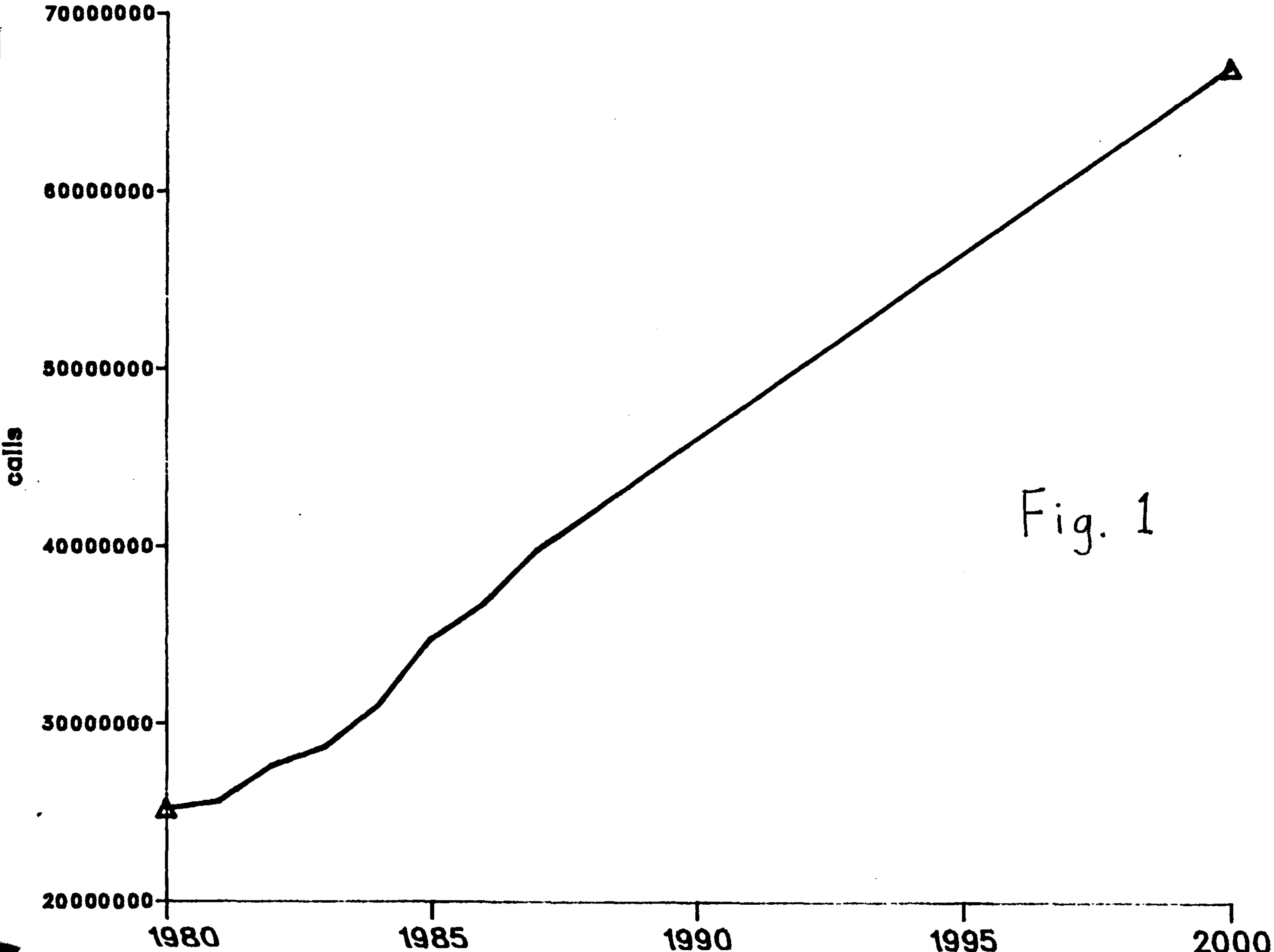


Fig. 1

3. PROJECTIONS OF GTA TELEPHONE SETS

The GTA has supplied, in a Planning Element Memorandum, figures for number of telephone sets from fiscal year 1979-80 to 1986-87. The figures are:

FISCAL YEAR	NUMBER OF TELEPHONE SETS
1979-80	133,897
1980-81	134,230
1981-82	138,359
1982-83	142,000
1983-84	149,500
1984-85	154,000
1985-86	157,800
1986-87	161,000

Using linear regression, these figures have been projected out to the year 2000 (see Figure 2). Some sample values are:

1989-1990	174,000
1994-1995	196,000
1999-2000	217,000

ACTUAL AND FORECASTED TELEPHONE SETS

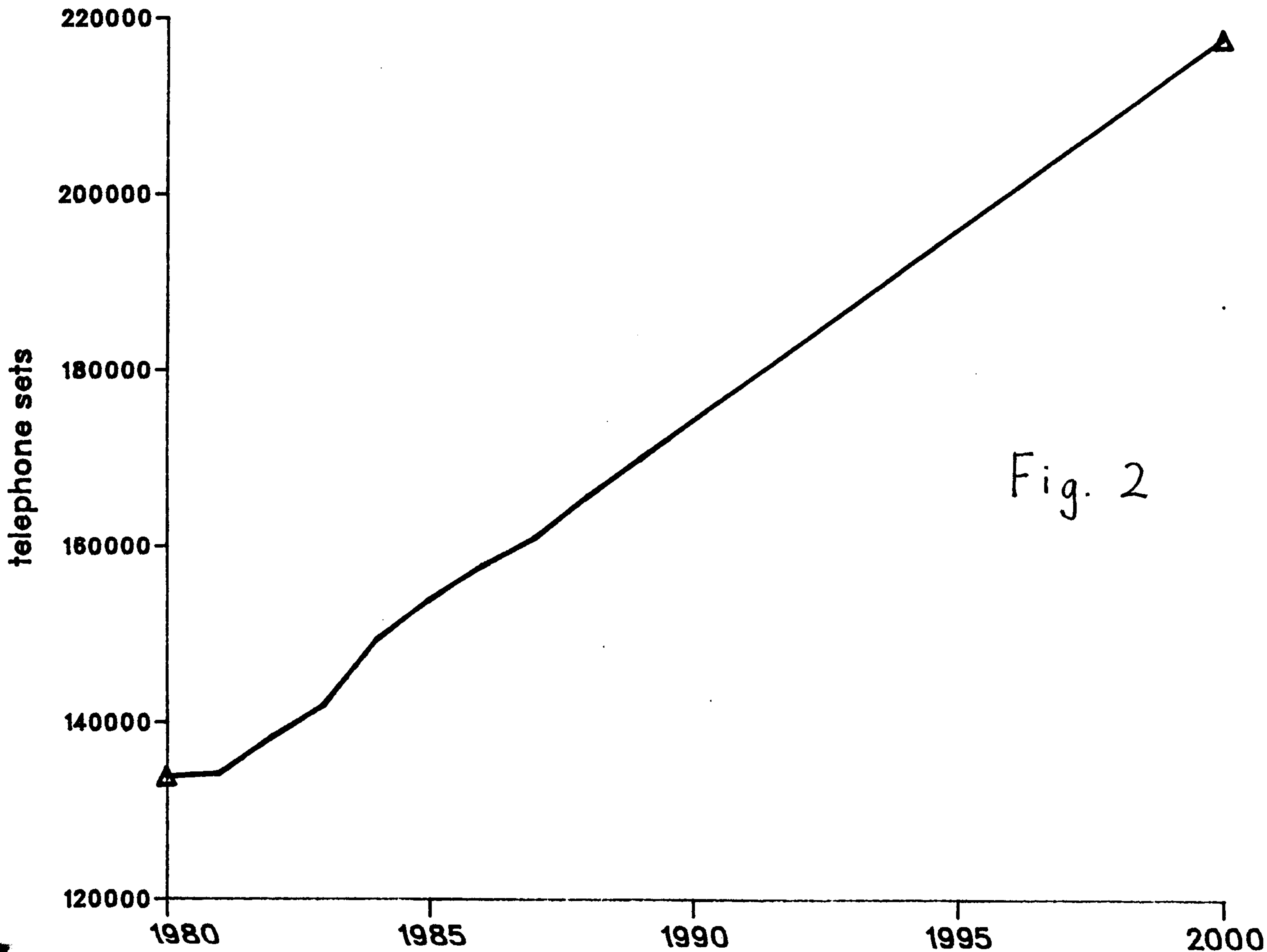


Fig. 2

4. ESTIMATES OF GTA FUTURE DATA TERMINAL REQUIREMENTS

A variety of data terminals will proliferate in future automated offices. The term data terminals is meant to include dumb terminals and 3270-types, communicating personal computers, and multifunction work stations with voice and data communications capabilities.

Each office worker will primarily use only one terminal. However, different categories of office worker will have terminals with different sets of capabilities. For example, upper management might use a no-keyboard graphics terminal with a ten-key pad, touch-screen or voice recognition feature. Middle management workstations might be equipped with a keyboard and have graphic display capability. Professionals might use personal computers with soft-copy fax capability. Secretaries are likely to have terminals in the form of word processors, with soft-copy fax and graphics capability and a printer/plotter for hard-copy production.

Internal BNR estimates and secondary market research indicate that by 1985, the ratio in U.S. offices of data terminals to telephone sets will be 1:6. By 1990, the ratio is expected to attain 1:3. Beyond 1990, the ratio should continue to rise, but no credible estimates are available.

Applying these ratios in the GTA context, we arrive at the following estimates:

FISCAL YEAR	NUMBER OF TELEPHONE SETS	NUMBER OF DATA TERMINALS
1984-85	154,000	25,700
1989-90	174,000	58,000

By the year 2000, it is reasonable to assume that every office worker will be equipped with a data terminal.

5. VALUE-ADDED SERVICES AND PRIVATE NETWORKS

As the use of office information systems increases, there is likely to be an increased usage of electronic communication services. These value-added services will have an impact on private network facilities, required to carry these diverse forms of traffic. There will be an increase in the number of intersite data circuits, and the bandwidth of these circuits.

5.1 VASs and Network Requirements

The following list is representative of communication service offerings which will be found in the future automated office environment:

1. Text Messaging
2. Voice Messaging
3. Teleconferencing
4. Document Processing
5. Database Access

Each service will be defined and its network requirements discussed.

5.1.1 Text Messaging

Text messaging is the asynchronous communication of text information electronically from one person to another or to a group of people. It is probably the most popular communications alternative to real-time voice communications used today and will likely experience considerable growth in the future. Text messaging requires each user to have access to a terminal through which the messaging system is used.

The use of a text messaging system can result in two types of traffic. In a centralized system which provides both the intelligence to compose and review messages and the storage capacity to hold messages, users typically access the system via non-intelligent terminals. In this implementation, a connection is required between the user's terminal and the host for the composition and review of messages. In a system in which the intelligence resides locally, messages are composed locally then stored and forwarded to the recipients.

As PBX-based VAS processors providing text messaging services proliferate in the intra-office environment, there should be an increased desire for inter-office communication of text messages. This will likely be handled on a store-and-forward basis. Such text messaging traffic should not be significant, and 9.6 kb/s channels should easily provide the required bandwidth. Store-and-forward is an excellent way to load balance a network, by transmitting low priority messages during off hours when the demand placed on the network is low.

5.1.2 Voice Messaging

Voice messaging, or voice mail, allows asynchronous voice communications from one person to one or more people who only need access to a voice messaging system via a standard telephone set. Voice messaging systems use voice digitization techniques analogous to the PCM techniques used in digital telephony, though usually at a lower bandwidth, such as 32 or 16 kb/s. The digital encoding allows a small computer system to store the messages on disk and in conjunction with a PBX to control all operations of the system. The message can be retrieved by the called party at the time of his choosing.

A voice messaging system can be implemented as a single centralized system. If it is to serve a large geographically dispersed community of interest in the same way the PBX serve voice communications today, multiple and distributed voice message systems co-located or integrated with a PBX using a store-and-forward capability may be preferred.

Depending on the choice, traffic characteristics will vary. The traffic characteristics for a distributed implementation using store-and-forward will likely be similar to the same type of implementation for text messaging. The inter-site traffic will have relatively little impact on the network. Also, depending on the urgency of the voice message, it could also be forwarded during off-peak hours.

The terminal aspects of voice messaging are relatively simple. Voice messaging can, in principle, be used by anyone with a telephone set. Some upstream control signalling will be required to provide certain user control features, such as message editing, filing, retrieval and deletion. The significant incremental requirement on the network for implementation of voice messaging will be the provision of voice storage facilities. In addition, some voice response and control capability will be required.

5.1.3 Teleconferencing

A teleconference is a remote interaction between three or more people set up either automatically or by an operator. There are four types of teleconference:

a) Audio Conference

b) Audio Visual Conference

c) Video Conference

d) Computer Conference

Audio conferencing is verbal communication between three or more people. Audio visual conferencing gives the additional feature of having text/graphic/image communication as well. This could include the use of facsimile to reproduce, in hard copy or display form, documents at different conference locations. Video conferencing is the use of video for face to face communications and for conveyance of full motion video. A computer conference includes the use of text messaging, which could be used either simultaneously or asynchronously with the conference.

Audio conferencing has been available for some time. It is currently of great interest because of the improved digital bridges being developed which greatly enhance the voice quality available. Audio conferencing is currently being used in some situations which might better be served by audio visual or video conferencing if those services were more available or economical. It is expected that by 1990, audio visual and video conferencing will surpass audio conferencing in popularity. With video conferencing, it is likely that head offices of organizations will have an internal video conference room, while branch locations would rely on hotels or other off-site shared facilities.

The terminal and network requirements for audio teleconferencing are fairly simple. Normal telephone sets, loudspeaker telephones and group audio conference terminals will satisfy the requirements. The transmission requirements can be satisfied by the 3 KHz telephone network, although it is anticipated that some higher bandwidths for improved transmission performance will be offered in the future. The network resource of most significance for this service (and for the visual enhancements to follow) is the provision of voice bridging capability in the network, to enable point to multipoint connections to be established. Teleconferencing bridges, in addition to their basic function, will be required to support enhanced features, such as selection of the loudest speaker, compensation for network transmission losses, user control features, generation of statistical records and billing data.

The simplest level of visual enhancement to audio teleconferencing will use display terminals for text and graphics. This level of visual enhancement can easily be supported in a network with data transmission capability between 1.2 and 4.8 kb/s. Some form of data bridging will be required in the network, to permit point to multipoint operation. Although there are analogies with voice bridging in broad functional terms and in terms of features such as user control, record-keeping and billing, it is expected that data bridging will need to be based upon a well defined data communications protocol structure.

The terminal and network requirements for video conferencing are quite different, at present, from those for audio and audio visual teleconferencing. Currently, point to multipoint operation of video conferencing has not been achieved by bridging, in the voice and data senses of the term. However, point to multipoint (broadcast) systems for unidirectional operation already exist, and two-way systems exist for point to point applications. Point to multipoint two-way operation can be expected to become available by 1990.

One significant factor which will ease development of two-way multipoint video conferencing will be reduction in bandwidth required. Although bandwidth requirements for video conferencing have decreased from 45 Mb/s to 1.5 Mb/s, there has, until recently, been some doubt about the adequacy of the quality at these lower speeds. However, it is now forecasted that by 1990, good quality video conferencing will be possible at speeds between 256 kb/s and 56 kb/s.

5.1.4 Document Processing

Document processing refers to all communications resulting from the creation and distribution of reports and documents within an organization. Thus, all communications in support of word processing are included, such as retrieval of old or partially completed documents from file storage via the communications network. It also includes electronic printing as a way of electronically transmitting newly composed (or old) documents to the appropriate recipients.

Channels of 9.6 kb/s bandwidth should be sufficient to carry document processing traffic.

5.1.5 Database Access

This service provides for individual users to interact with local and remote databases in a uniform way, with a simple set of rules, to select and move the desired information. It also involves the updating of databases in different locations, to ensure that the information from one corporate database is duplicated elsewhere.

The requirements for database access can be simply stated in terms of a data terminal, modem and a database or alternatively, a database, a subsidiary database, and a communication link between the two. The information to be retrieved could be presented in the form of voice, text, graphics or high resolution image (facsimile). The network transmission requirements could vary from 1.2 to 4.8 kb/s for text and/or graphics, through 3 KHz for voice information, to 9.6 to 64 kb/s for image and high resolution graphic information.

5.2 VAS Traffic Estimates - 1990

No estimates to be available for VAS traffic beyond the 1990 timeframe. Internal BNR forecasts of value added service traffic for a typical office circa 1990 are as follows:

VAS TRAFFIC (AVERAGE)

SERVICE	BUSY HOUR CCS/USER
Text Messaging	1.6
Voice Messaging	1.0
Teleconferencing	1.8
Document Processing	2.2
Database Access	1.8
Real Time Voice	3.2

The following estimates of session data have also been produced:

SESSION DATA

SERVICE	DURATION	DATA CONTENT	OTHER
Real Time Voice	180 Secs.	64 kb/sec.	
Text Messaging	1800 Secs.	<1 kbyte/ Message	2.7 Address/ Message
Voice Messaging	90 Secs. (Compose) 60 Secs. (Read)	120 kbyte/ Message 4:1 Compression	
Teleconferencing	1800 Secs.	64 kb/sec.	4.5 Conferees/ Call
Document Processing	420 Secs./ Edit	<1 kbyte/ Edit	
Database Access	3600 Secs.	40 kbyte/ Hour	

5.3 Network Impact of VAS Implementation Modes

The impact on private network facilities could be significant if VAS processors are centralized with respect to a geographically dispersed user community. When VAS processing intelligence is distributed and intersite messaging handled on a store-and-forward basis, the impact upon network facilities is trivial. The time taken to transmit a given message is much less than the time taken to compose or read the message.

In all cases where there is a geographically dispersed community with common communications interest, and where the interaction between sites could impact the network facilities linking them together, a communications manager will have to study the economics of incurring the additional carriage costs vs. the costs for acquiring and distributing the VAS capability.

The mode in which multi-media communication occurs will also affect the impact on the network. In real-time communications using true multiple media, high demands will be placed on the network because of the response time, synchronization and bandwidth requirements. In non real-time single media communications (store-and-forward), the response time for message delivery is a minor concern, synchronization is not required, lower bandwidth channels can be used, and transmission can occur during off-peak hours.

6. NETWORK REQUIREMENTS OF OFFICE AUTOMATION/DATA APPLICATIONS

To plan for the future, every corporation should ensure that its private telecommunication network can, in the future, accommodate high speed data switching and transmission. The present level of office automation already demands efficient, low-cost means of interconnecting terminals, hosts and other devices, if only at the local level. The previously mentioned value-added services are examples of emerging applications that require long-distance switched data communication between local areas.

Integration of voice and data is necessary to provide multi-media conferencing. As well, sharing switch capacity and transmission bandwidth significantly reduces cost. Digital switching and transmission technology is presently available, and products are becoming more economical as demand and competition increase. End-to-end digital techniques are essential for general data communication to permit buffering, to preserve bit integrity and for economic reasons. Of the necessary building blocks, digital switches, coaxial cable and digital microwave radio are mature economical products. Satellite and fiber-optic transmission are rapidly maturing wideband technologies.

When discussing the design of private networks, it is convenient to think of data communication in terms of two distinct but inter-related aspects: local area distribution and inter-location networks. For local area distribution, computers and data terminals will be connected to digital PBX's without use of modems. Future PBX's will provide bandwidths exceeding one megabit/second to user terminals, sufficient for multi-media conferencing needs. Another possibility for local area distribution is a coax or fiber-based local area network conforming to an IEEE standard.

Whatever the local distribution system, it should provide access to the inter-location network at the local PBX or communications controller. To enable the integration of data communication and future products and services, the network should consist of digital switches at all levels, be able to accommodate digital transmission links and the interfaces should conform to North American industry standards.

7. REFERENCES

1. Smith, S.A. and Benjamin, R.I., "Projecting Demand for Electronic Communications in Automated Offices", ACM Transactions on Office Information Systems 1,3 (July 1983), 211-229.

2. Spinrad, R.J., "Office Automation", Science 215, (12 February 1982), 808-813.

3. Richer, I., Steiner, M., and Sengoku, M., "Office Communications and the Digital PBX", Computer Networks 5,6 (December 1981), 411-422.

4. Northern Telecom OPEN World Announcement, 1982.

Deliverable 7

Cost-Effective Useful Life

TABLE OF CONTENTS

1. INTRODUCTION

The purpose of this deliverable is to assess expected cost effective useful life of different switches and also to indicate the payback period normally used in this time of rapid technological changes.

The cost effective useful life of a PBX or switch is determined by its inherent capability to evolve to meet the possible impact of a new technology. This impact may occur either as a result of a significant reduction in costs or as an inability for the in-place technology to meet organization and PBX feature growth. That is, new switches may offer greater feature sophistication, higher reliability and reduced size. Thus the characteristic most responsible for reducing obsolescence is design flexibility - the ability to modify feature operation easily. Such machines can be expected to be retrofitted with new software and additional hardware to meet the organizational requirements, extending the useful life of the PBX or switch and delaying obsolescence.

In this time of rapid technology change, an organization installing a switch now would like to have a minimum payback period and longer cost effective useful life to maximize its rate of return. A payback period of the switch under consideration can be estimated based on the organizational existing communication layouts but expected cost effective useful life depends upon technology and design flexibility of the switch selected and the faith in vendor's future commitments.

This section will provide to GTA, information gathered on the life cycles of PBX installations in North America and will also provide different switch vendors' commitments as published.

2. LIFE CYCLE OF PBX INSTALLATIONS

Studies conducted some years ago (in 1970s) by the U.S. Government indicated that the average age of PBX installations in the U.S. Government was 16 years. Probably the average age of PBX equipment in the U.S. at large was around 15 years in the late 1960s and it was fairly typical for this equipment to be depreciated over twelve or thirteen years.

In 1981, of the 23,000 new PBXs manufactured, 89% were analog, 11% were digital. The steadily increasing replacement activity in PBXs, in which old switchboards are being torn out and replaced by electronic PBX systems from the telephone company or from interconnect suppliers, has greatly reduced the average age of the installed PBX population from fifteen years of the late 1960s to perhaps eight years today. However, it is too early to tell what the typical lifetime of this new PBX equipment will be. Users seem to be choosing anywhere between six and ten years as the period over which they plan to depreciate the purchase price of newly-installed electronic PBX equipment. It seems very unlikely that a typical user would replace a PBX before the end of its depreciation period unless he has special needs for expansion capability or other functions (which his present equipment would not provide).

An interconnect PBX may be resold and the following percentages typically could be assumed over eight years of the installed life of a PBX installation. The figures could be used to estimate the predicted salvage value of the newly installed PBX.

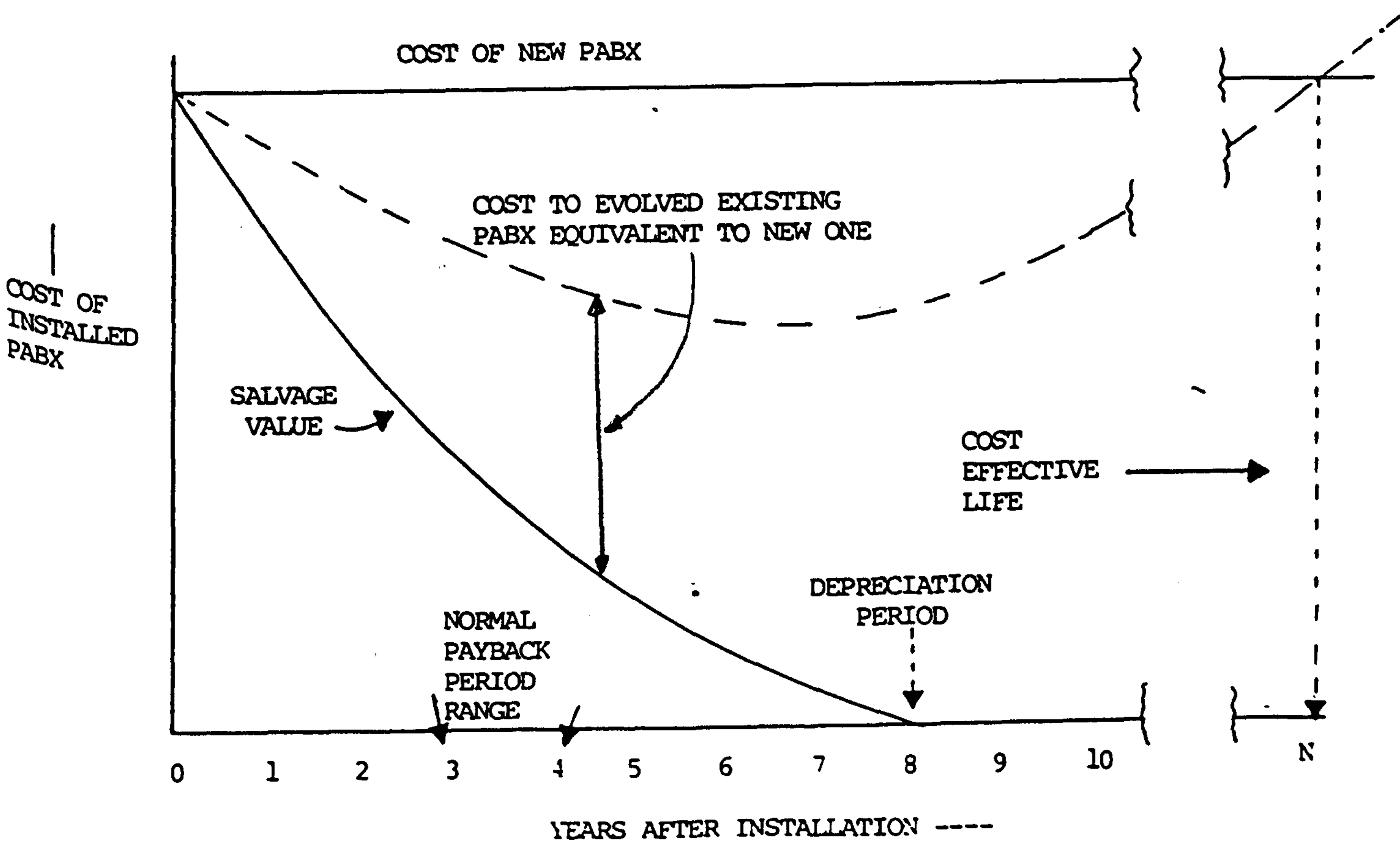
Years after installation	% of original cost as salvage value
1 year	60%
2 years	50%
3 years	33%
4 years	25%
5 years	20%
6 years	15%
7 years	10%
8 years	0%

The issue of depreciation period and product lifetime is of very crucial interest to planners in the PBX industry because of economics and future needs of the organization. A planner currently considering analog PBX should assume a much smaller installed life due to the evolutionary trend (i.e., the resale value of analog PBX's will depreciate) from analog to digital

PBXs. For example trends indicate that digital PBX installations will increase from 11% in the 1980's to 99% in the 1990's and installed life will decline to about 7 years.

The state-of-art PBX is digital. A digital PBX properly designed with properly provisioned future requirements should last well into the decade or maybe to the next decade.

The salvage value percentage indicates that 80% of the PBX price should be recovered in 5 years. But in practice, considering benefits from owning PBX equipment and benefits from the PBX features, the payback period normally may be between 3 to 5 years. The planners would like to recover not 80% but 100% cost of the PBX installed within 5 years. The payback period depends upon many factors but 3 to 5 years payback is the norm for the PBX with cost reduction features. The depreciation period for planners will be higher than the payback period and the actual life of the equipment may be much higher than the depreciation value normally considered. Considering the same cost per line of the PBX by 1990 as it is today, payback period, depreciation period and cost of acquiring equivalent new PBX could be graphically represented as follows:



3. VENDORS' COMMITMENT

The installed life of the PBX installation depends upon

- Limitation on line and trunk terminations
- Memory capacity
- Processor speed
- Vendors' commitment to support its equipments.

Assuming line and trunk terminations are adequate for future growth, typical areas which need expansion over the life of a PBX design are memory capacity and processor speed. Additional memory if often required because of the explosive demand for more and more features. Greater processor speed may be required if future, yet undefined features, require excessive processing time. Fortunately, semiconductor technology is improving in both areas. Higher-speed processors and larger memories are being introduced constantly and this trend will continue into the future. To utilize such breakthroughs, a PBXs basic architecture must be flexibly designed. A switch implemented with modern flexible hardware and software techniques should have a longer, profitable life. Along with a flexible design the truly successful manufacturer must be committed to an aggressive policy of continuing product enhancement. The development must continue throughout the life of the product with the addition of new fatures and improvement of existing features and capabilities. A vendor' commitment to evolve the implemented switch to new generation by adding more hardware and/or update software to fulfill the client's requirement will prolong the cost effective useful life of the switch.

3.1 Northern Telecom's Commitment

In last November, Northern Telecom Limited made a commitment to develop the OPEN World Information System. Continuity, compatibility, congeniality, control and cost-effectiveness are the five criteria that form the essence of the OPEN world planning framework. The announcement made by NTIL can be summarized as follows:

- In early 1984, NT will introduce an OPEN world family of terminals. They will range from simple electronic telephone sets with a few features to more sophisticated telephones with display capability and a large number of features. A year later, NT will introduce an even more powerful terminal that will include graphics and image capability, as well as voice and text.

- The growth in the use of terminals and the transmission of graphics and images will require higher capacity connections between the various devices. NT will fill that need in stages. First in 1984 the company will add modular enhancements to its digital switches that will provide a digit capacity of up to 64 Kb/s. This increased local connection capacity will be available through either the DMS family of central switches or the SL family of business communications systems. In 1985, NT will substantially increase the bandwidth used on twisted pair wire, the same wire which telephones use and which is already installed in almost every building. Under the direction of a digital controller, the existing telephone wiring can become a very powerful local area network.

  NT has committed to providing a gateway connection that can connect commercial local area networks into the rest of the system. NT has also committed to accommodating the equipment of other manufacturers on OPEN world systems. Northern Telecom's OPEN world system will support a number of proprietary protocols including IBM's Systems Network Architecture (SNA). NT will also support equipment using the X.25 protocol for packet data switching. This commitment will make it possible for a wide range of systems and terminals to communicate with each other through the medium of a NT business communication system (SL Family).

- NT intends to offer a variety of OPEN world enhanced communications services available through either a DMS-100 central office based system or a system controlled by an SL PBX. Services such as integrated messaging, teleconferencing, advanced integrated data base management, multi-media messaging will be offered by OPEN world.

- NT OPEN world products, such as digital switches and PBXs will evolve to meet future requirements and to accommodate future technological developments, thus providing continuity and avoiding obsolescence.

3.2 ROLM's Commitment

Similar to Northern Telecom, ROLM Corporation made certain commitments in the month of May of this year, ROLMs commitment covers enhancement of its CBX in areas of data and voice application evolving its CBXs towards Distributed Digital Network. ROLMs commitments will be fulfilled by the end of this year and that can be summarized as follows:

- ROLM Corporation will provide a gateway from its CBX into IBM mainframes. The gateway will perform protocol conversion so low cost ASCII terminals and personal computers can look like 3270 devices. ASCII terminal users are connected to a ROLM data terminal interface (DTI). This allows users to access other data resources such as minis and mainframes, connected to the CBX. This will also allow ROLM to access SNA through its CBX.

- ROLM CBX will be equipped with X.25 protocol interface permitting users to link directly to packet networking.

- ROLM wll also provide a data network management and control software package that is the functional equivalent of a voice telecommunications control system. This package provides comprehensive usage statistics and current status information.

- By the end of the year, ROLM will have a ROLMNET software package. It is the on-net numbering plan for the VLCBX only. This software will add two more networking capabilities: 1) On-net Alternate Routing and 2) ETN/ESN Travelling Class Mark/Travelling Class of Service Translation. This will allow ROLM Corporation to install VLCBX as a tandem switch in ETN/or ESN networking environment.

- ROLM will provide new software "off-system station forwarding" on its 8000 processor in CBXs. This will allow users to station forward their telephones to any local or long distance number. Users can activate this feaure either locally by dialling the access for station forwarding or remotely by dialling the access code for control of station features. Calls forwarded off-system makes full use of the system's route optimization, toll restriction and digit translation.

- UNCHECKED FAC is a new software package announced last May by ROLM. That will provide ROLM customers with several new capabilities in the areas of cost allocation and control. This will allow customers to implement different account codes for bill-back purposes.

3.3 Commitments by Mitel and Plessey

Last year, Mitel made an announcement to deliver its SX-2000 digital switch, but that commitment has been delayed to the end of this year.

To the best of our knowledge, Mitel and Plessey have not made any other commitment worthwhile to impact announcements made by NTL and ROLM.

4. CONCLUSION

Evaluating the evolution of products, track records of the vendors and vendors commitments to evolve the implemented switch to new generation, the observation can be drawn:

- ROLM is chasing NTL to maintain its share. They both are going to keep on developing and announcing new hardware and software to maximize their market potential.
- For planning purposes, the depreciation period of NT and ROLM could be considered to be the same (i.e. may be between 6 to 9 years) and the payback period may be between 3 to 5 years.
- Because of higher capacity of line terminations and long-term commitment, Northern Telecom switches will provide much longer cost effective useful life than ROLM switches.
- The current absence of commitments from Mitel and Plessey affect the payback, depreciation and cost-effective useful life periods for their switches. For planning purposes today, the payback period will be longer, the recommended depreciation period shorter and the cost-effective useful life also shorter.

5. REFERENCES

1. John F. Malone 'What's the outlook for PBXs in the next 10 years'. Telephone Engineer and Managemen, March 1982.

2. Charles H. Divine 'Stored Program Control - PBX Fountain of Youth'. Telephone Engineer and Management, March 8, 1981.

3. International Resources Development INS. 'PBX, Interconnect and the Future Office Controller'. Volume 1, Market Review and Analysis, 1980.

4. NTL 'The OPEN World. A corporate commitment. News Release November 1982.

5. ROLM 'ROLM's First Public Teleconference'. May 1983.

6. EMM 'RPLM Plugs CBX into IBM World'. Electronic Mail & Message. Volume 7, No. 9, May 1983.

Deliverable 8

Impact Analysis-Non-NT Products in NT ESN Environment

TABLE OF CONTENTS

1. INTRODUCTION

Given that it is GTA's objective to move towards a national, uniform, transparent and eventually digital network by using Northern Telecom switches in most of consolidation areas identified, the purpose of this deliverable is to assess short and long term impacts on (the Vancouver - Victoria consolidation's) services and network functions if GTA implements other manufacturer's switches (NON-NT). The impacts to be assessed are in the following areas:

- Uniformity of services
- Uniformity of the dialing plan established over the national network
- Capability to centralize national network monitoring control and management functions
- Evolution towards a Common Control Switching Arrangement (CCSA) network topology
- Extent of intelligent exchange of management control and class of service information between the switches.

To analyze the impacts it is assumed that if non-NT switches are installed in the Victoria - Vancouver consolidation they will have to interact with ESN implemented on NT switches nationwide.

BNR endeavors to use the most accurate, up-to-date information available in the preparation of this deliverable. The views expressed are based on public information as represented by announcements and published documents. Where no such announcement or document has been available on for example, the provision of a PBX feature by a specific company, then BNR has assumed that the feature does not currently exist.

2. BACKGROUND INFORMATION

The results of our analyses are tabulated in Table 1, Annex A. In this section we describe some of the features offered by Northern Telecom's Electronic Switched Network (ESN) used as the basis of comparison, and where appropriate give examples of the impact of other vendor's switches.

2.1 Uniformity of Dialing Plan

Northern Telecom products offer a uniform Dialing Plan (UDP) for a nationwide network and Coordinated Dialing Plan (CDP) for local or metropolitan consolidated areas.

The UDP allows users at ESN locations, and directly connected access locations, to dial on-net or off-net calls in a uniform manner, regardless of the calling party or the route which the call will take. An on-net call is one which terminates at a station attached to the Northern Telecom's ESN network. The called on-net location may be physically or virtually connected to the network. An on-net location is physically connected to the network through direct access via tie trunks. A virtually connected on-net location is achieved through public facilities, but this is transparent to the user.

The format for a UDP call is AC * LOC + XXX where

AC	Access code for on-net or off-net
LOC	Location code or NXX number
XXXX	Extension number or Four digit telephone number

The CDP feature enables a customer with one ESN switch in a network to coordinate the dialing plan for stations at this switch, which are typically in local or metropolitan areas. CDP allows a station at a PBX to call a station at another PBX in the one consolidated area by dialing a 3-to-7 digit number. No access codes or pauses for dial tone are required when CDP is implemented. Several key elements are utilized in the implementation of a coordinated dialing plan

- steering codes
- conventional switch access

• special CDP routing

A CDP steering code is a one-, two-, three- or four-digit code, distinct from assigned ESN access codes, which the CDP software uses to determine where a call needs to be routed within a CDP group.

If a conventional switch (any switch without the CDP feature software such as ROLM, PLESSY K2, SX-2000 etc.) is integrated as part of CDP group the steering codes from a CDP-equipped switch to the conventional switch may be repeated or absorbed by the CDP switch. The steering codes are repeated if the conventional switch is identified by more than one steering code. The conventional switch uses the digits (steering code) as a trunk access code and outpulses the remaining digits after trunk seizure. At the CDP switch, the steering code digits are inserted on the incoming tie trunk from the conventional switch and the call is completed.

2.2 Class of Service

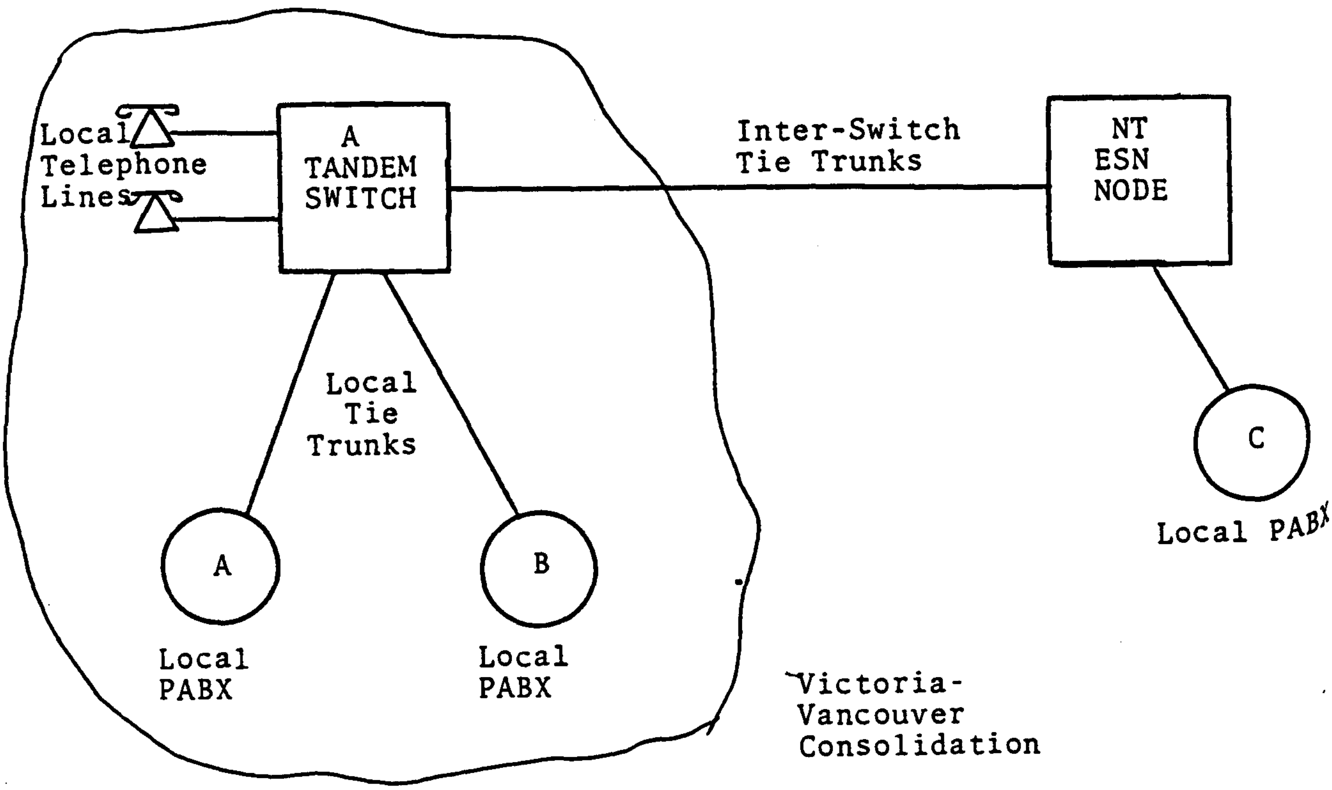
When a call from ESN local PBX(C)(Figure 1) is originated, the PBX usually sends the NCOS (Network Class of Service) index and the called number to the ESN node on its proprietary signalling path. The ESN node translates the NCOS index into its TCOS (Travelling Class of Service) index or called FRL (Facility Restriction Levels) and sends the information to the (Victoria - Vancouver consolidation) tandem switch. The tandem switch uses this TCOS or FRL to select the route to complete the call.

If the tandem switch is Plessey K2 or SX-2000, they will not understand ESN TCOS or FRL priveleges. ROLM VLCBX's new software (available in 1983) will however be able to accept and to translate ESN TCOS or FRL into action. ROLM software converts its own FRL into ESN FRL and vice versa. The following table shows this translating capabilities.

VLCBX FRL RANGE	ESN FRL	VLCBX FRL EQUIVALENT
0-10	0	10
11-20	1	20

VLCBX FRL RANGE	ESN FRL	VLCBX FRL EQUIVALENT
21-30	2	30
31-40	3	40
41-50	4	50
51-55	5	55
56-60	6	60
61-64	7	64

Figure 1



For outgoing calls, the VLCBX FRL is translated into a ESN FRL using the VLCBX FRL range column. For example, a call with a VLCBX FRL of 35 routed over a tie line coded ESN would have a ESN FRL of 3 automatically appended to it. For incoming calls, the ESN FRL is translated into a VLCBX FRL range using the VLCBX FRL Equivalent column. For example, an incoming call with a ESN FRL of 5 would be given a VLCBX FRL of 55.

ROLM VLCBX only accepts ESN FRL ranges and translates them into the appropriate format. NCOS originated by ESN PBX has to be translated into ESN FRL before ROLM VLCBX does any translation. Hence when ROLM VLCBX is placed as a tandem switch in Vancouver - Victoria, say, all local PBX's (A&B) should be of the ROLM family if a class of service has to be assigned to individual telephone sets at the local PBX (otherwise local trunks will be assigned COS and those will be used by ROLM VLCBX). One cannot also implement call back queueing feature if local PBXs are not from the ROLM family

2.3 Other Features

There are quite considerable limitations on the ability of non-NT tandem switches to offer ESN-type networking features. Plessey K2 offers none of these features while Mitel has none available now nor have any been announced for the future. Only ROLM has any capability.

For example, ROLM VLCBX offers call-back queueing but only to those users connected to the ROLM CBX local PBX. Thus to implement this feature in Vancouver - Victoria, GTA will need ROLM CBX's everywhere in the consolidation. Moreover, since only VLCBX provides software controlled tandem switching, none of ROLMs other switches (2 Wire CBX switching) can be considered as a network hub or tandem switch. This limitation also applies to other features such as speed calling, coordinated numbering plan etc.

In respect of other features - uniform dialing plan and network control - ROLM can provide a capability. Thus ROLM's UDP is little different from that of ESN and a reasonable assumption is that ROLMs can be modified to make it ESN compatible. If all tandem switches are ROLM VLCBX, it is easy to centralize network management control functions. However, since most of GTA's network is NT based, then additional software will be needed to convert network management information to a common NT format. This could be expensive.

3. IMPACT ANALYSIS

Based on the information given in previous sections. This section identifies the impacts in specified areas if non-NT switches are installed for PBX functions only or for PBX and Tandem functions combined. The results are summarized in table 3.1.

"Yes" in the table means no impact for that particular item in that particular position of the switch.

"No" means one can not have that item in that position.

"ROLM Network" means ROLM CBXs (As PBX) connected to ROLM VLCBX (as Tandem switch in metropolitan area).

N/A means the item is not applicable

3.1 Other Implications

Sometimes it is cheaper in a short term to mix different vendors' products but in a long term properly selected single vendor products pay off.

Deliverable 7 addresses long term commitments by different vendors. In a multi-vendor situation the problem of compatibility will have to be addressed for each separate case. When a vendor introduces new software or new capabilities of switching equipments, the customer has to solve the problem of compatibility to gain the benefits from the new release.

From the network control or maintenance point of view, the customer needs different skill resources, needs to create different environmental conditions etc.

To date Northern Telecom is the only vendor under consideration to make a total commitment to support each and every product in the new digital world of switching.

If non-NT switches are used as tandems, there is a problem in accessing call-back queueing by all users. Plessey K2 does not offer this feature. ROLM VLCBX offers call-back queueing to all those users who are directly connected on the PBX side of that tandem switch and to the users who are connected to the ROLM CBX local PBX. This means that if GTA needs this feature in a Vancouver - Victoria consolidation area then, with a ROLM VLCBX tandem switch, GTA needs ROLM CBXs everywhere in Vancouver - Victoria area. Similarly, for ROLM speed calling feature, coordinated numbering plan etc., the local network must be ROLM based.

Mitel does not currently offer any networking features and has not announced any future plans to do so yet. It is assumed GTA will not want these features if SX-2000 is installed as tandem switch.

3.2 Other Capabilities

In ROLM CBXs series only VLCBX provides software controlled tandem switching. Except VLCBX, all smaller CBXs of ROLM are equipped with 2 Wire switching. It means only ROLM VLCBX can be considered for a networking HUB or tandem switch. Though ROLM's Uniform dialing plan is a little different that NT ESN dialing plan, it is assumed that ROLM's software control dialing plan can be modified and make it compatible with NT switches.

If all tandem switches are ROLM VLCBXs, it is easy to centralize network management control functions. But with a primarily Northern Telecom network, GTA needs outside processor and software to convert all network management information to integrate with information received from NT switches, and we believe substantial cost will occur in doing so.

4. SUMMARY AND CONCLUSIONS

Based on a primarily ESN network, the Vancouver - Victoria requirements were studied in light of the impact of introducing other vendors equipment as tandem switches or local PBX's.

It is illustrated that of the three vendors (ROLM, Mitel, Plessey), only ROLM VLCBX has the capability of acting as a tandem switch offering the various ESN features. However, to date, these features are offered with limitations such as the need to have all local PBX stations installed with ROLM CBX's in turn implying a requirement for back-end processing of network control information.

On the other hand, installation of a Northern Telecom product as the tandem switch allows GTA to have the flexibility of acquiring any of the other vendor's products as local PBX's (in terms of networking features). Thus the only question that remains in mixing vendor's equipments is future compatibility.

5. REFERENCES

1. NTL ESN Features documentation (ESN Release 2) 1982 November

2. NTL "ROLM First Public teleconferences" May 1983

3. NTL "The Open World" - A corporate committment. News release November 1982.

Annex A

TABLE 1

Impact on services if different manufacturer's product is installed in Vancouver/Victoria consolidation when NT's ESN is implemented on the rest of the network:

ITEMS	ROLM VLCBX		PLESSY K2		SX-2000	
	TANDEM SWT.	LOCAL PBX	TANDEM SWT.	LOCAL PBX	TANDEM SWT.	LOCAL PBX
Uniformity of Services						
- NCOS	Yes	Yes	No	Yes	No	Yes
- ARS	Yes	Yes	Yes	Yes	Yes	Yes
- DISA	Yes	N/A	No	N/A	Yes	N/A
- DID	Yes	Yes	Yes	Yes	Yes	Yes
- CAS	Yes	N/A	Yes	N/A	Yes	N/A
- Off-Hook Queuing	Yes	Yes	Yes	Yes	Yes	Yes
- Call-Back Queuing	Yes if ROLM Network	Yes	No	Yes	No (?)	Yes
- Data Switching (LS)	Yes	Yes	Yes	Yes	Yes	Yes
- Centralized WATS	Yes	N/A	Yes	N/A	Yes	N/A
- Call Transfer (Via Tie Trunk)	No	Yes	No	Yes	No	Yes
- 3-Way Conference	Yes	Yes	Yes	Yes	Yes	Yes
- Speed Calling	Yes if ROLM Network	Yes	No	No	No	No

Impact on services if different manufacturer's product is installed in Vancouver/Victoria consolidation when NT's ESN is implemented on the rest of the network:

ITEMS	ROLM VLCBX		PLESSY K2		SX-2000	
	TANDEM SWT.	LOCAL PBX	TANDEM SWT.	LOCAL PBX	TANDEM SWT.	LOCAL PBX
Uniformity of Dialling Plan						
- Coordinated Dialing Plan (For Metropolitan Area)	Yes-Serves Small Number of Locations in Metro-politan Area (5 to 6) Within RDLM Network	Yes-Can be Served by ESN CDP	No	Yes	No	Yes
- Uniform Dialing Plan (For Nationwide Network)	Yes Compatible With ESN UDP	Yes-Can Be Part of ESN UDP	No	Yes	No	Yes

Impact on services if different manufacturer's product is installed in Vancouver/Victoria consolidation when NT's ESN is implemented on the rest of the network:

ITEMS	ROLM VLCBX		PLESSY K2		SX-2000	
	TANDEM SWT.	LOCAL PBX	TANDEM SWT.	LOCAL PBX	TANDEM SWT.	LOCAL PBX
Tandeming Function						
- Automatic Tandeming	Yes	N/A	Yes	N/A	Yes	N/A
- L1 Wire Tandeming	Yes	N/A	Yes	N/A	Yes	N/A
- Oirect Interface TO with T1	Yes	Yes	Future	Future	Yes	Yes
- OC Trunk Interface						
One Way Two Wire	Yes	Yes	Yes	Yes	Yes	Yes
Four Wire	No	No	No	No	No	No
- Data Switching	Yes	Yes	Future	Future	Yes	Yes
- X.25 Protocol Interface	Yes	Yes	No	No	Yes	Yes

Impact 'on services if different manufacturer's product is installed in Vancouver/Victoria consolidation when NT's ESN is implemented on the rest of the network:

ITEMS	ROLM VLCBX		PLESSY K2		SX-2000	
	TANDEM SWT.	LOCAL PBX	TANDEM SWT.	LOCAL PBX	TANDEM SWT.	LOCAL PBX
Capability to Centralize National Network Monitoring Control and Management Functions						
- Automatic Trunk Testing	Yes	N/A	Yes	N/A	Yes	N/A
- Traffic Recording	Yes	N/A	Yes	N/A	Yes	N/A
- CDR						
Built into System	Optional	Optiona	Yes	Yes	Yes	Yes
Different Format than ESN	Yes	Yes	Y Yes	Yes	Yes	Yes
Remote Polling	Yes	Yes	Yes	Yes	Yes	Yes
- Remote Maintenance	Yes	N/A	Yes	N/A	Yes	N/A
- Can be Integrated into Centralized Management Centre Without Substantial Extra Cost	No	Yes	No	Yes	No	Yes

Impact on services if different manufacturer's product is installed in Vancouver/Victoria consolidation when NT's ESN is implemented on the rest of the network:

ITEMS	ROLM VLCBX		PLESSY K2		SX-2000	
	TANDEM SWT.	LOCAL PBX	TANDEM SWT.	LOCAL PBX	TANDEM SWT.	LOCAL PBX
Evolution Towards a Common Control Switching Arrangement Network Topology						
- Signalling Compatability	Yes	N/A	No	N/A	No	N/A
- Compatable for Network Control Functions	Yes	N/A	Yes	N/A	Yes	N/A
- Can be Evolved Towards CCSA Network Topology Without Network Control Functions	Yes	N/A	Yes	N/A	Yes	N/A

Impact on services if different manufacturer's product is installed in Vancouver/Victoria consolidation when NT's ESN is implemented on the rest of the network:

ITEMS	ROLM VLCBX		PLESSY K2		SX-2000	
	TANDEM SWT.	LOCAL PBX	TANDEM SWT.	LOCAL PBX	TANDEM SWT.	LOCAL PBX
Extent of Intelligent Exchange Between Switches Class of Service) be Transmitted Between Switches (ESN Switch and this Switch)						
- Can NCOS (Network Class of Service) be Transmitted from a Local PBX of this Switch to ESN Tandem Switch)	Yes (Assigned to Trunk Group) No Assigned To Telephone Sets	Yes (=) No (=)	Yes (=) No (=)	Yes (=) No (=)	Yes (=) No (=)	Yes (=) No (=)

(=) implies the same caveat as in column i under the same item

Deliverable 9

Field Reliability

TABLE OF CONTENTS

1. INTRODUCTION

The purpose of this deliverable is to outline service and reliability/availability criteria used by telephone companies to support central office centrex services.

This section will provide to GTA the criteria used by Telcos like AT&T and Bell Canada to meet for their local system switching requirements. The switching system under question is a medium size switch with about 10,000 lines.

2. SERVICE/PERFORMANCE REQUIREMENTS

The major underlying rationale of the service requirements are to ensure that longstanding service objectives are not defeated and that the system has a smooth load/performance curve.

The performance requirements stated are overall system requirements. They apply to distributed processing systems, modular architectures and time division and space division switches. They are fundamental requirements in that they are independent of whether software, firmware or hardware is used to implement a function. In determining whether a switching system meets the performance requirements, a fully operational system shall be assumed (i.e. no component failures). Where facilities in excess of those provided to meet performance requirements are supplied to meet reliability objectives, the excess facilities shall not be included in performance calculations.

Three time frames in common use today by Telco's are termed as follows:

- Average Busy Season Busy Hour Load (ABSBH)
- Ten High Day Busy Hour (THDBH)
- High Day Busy Hour (HDBH)
- These time frames are defined in terms of load volumes and, implicitly, there is always a corresponding service criteria.

2.1 Dial Tone Delay Requirements

Dial tone delay is a measure of the time it takes a telephone switching system to return dial tone to an originating subscriber after the subscriber goes off-hook.

On an ABSBH basis, no more than 1.5% of attempts should have to wait over 3 seconds for dial tone. On a THDBH basis, no more than 8% of attempts should have to wait over 3 seconds for dial tone. At HDBH load, no more than 20% of attempts should have to wait over 3 seconds for dial tone. The ABSBH dial tone delay should not exceed 0.6 seconds on the average.

2.2 Network Service Requirements

Local system standard network service requirements are defined for four types of call connections under ABSBH conditions. The standard network service requirement, called the overflow or matching loss standard is expressed as the net probability of not being able to establish a network path between an originating line or incoming trunk and a terminating line or trunk when terminating line or trunk is idle.

- Line-to-Trunk Connection (outgoing)

  The matching loss on outgoing connections should be less than 0.01 (ABSBH).

- Trunk-to-Line Connections (incoming)

  The matching loss on incoming connections should be less than 0.02 (ABSBH).

- Line-to-Line Connections (intraoffice)

  The matching loss averaged over all intra office connection classes should be less than 0.02 (ABSBH). A connection class is a group of network terminals distinguished by their relative locations in the switching network, e.g. all lines on a single switch, all lines on a single concentrator.

- Trunk-to-Trunk (tandem)

  The matching loss on trunk-to-trunk connections should be less than 0.02 (ABSBH).

2.3 Incorrect Treatment Requirements

Incorrect treatment is a category of call set up irregularities caused by switching system errors.

The number of call attempts accorded incorrect treatment should not exceed one in 10,000 when switching is operating at ABSBH-engineering load.

2.4 Post Dialing Delay Requirements

Post dialing delay is the time interval between the end of dial-ing and occurrence of an audible network response.

It is desirable that the portion of the post dialing delay intro-duced by an originating switching system not exceed 0.4 seconds (ABSBH) and that the portion of the delay introduced by a termi-nating system not exceed 0.4 seconds.

2.5 Cutoff Calls Requirement

A cutoff call occurs when an established connection is broken for some reason. In switching systems cutoffs can be caused by hard-ware or software failures or procedural errors or in the case of time-divisions switching system, digital signal impairments such as slips, misframes, and errors.

The overall requirements is that, for all causes within the switching system, the probability that a stable call will be cutoff should not exceed 0.000125.

3. RELIABILITY REQUIREMENTS

This section provides reliability requirements a telco specifies when installing a local centrex switching system. The objectives are specified in three categories:

- Customer service objective which specify impairment levels experienced by customers due to failures within the switching system.
- Objectives for frequency of ocurrence and duration of subscriber line outages caused by equipment failures within the switching system.
- Downtime objectives of portions of the switch which specify downtime as a function of the number of trunks or lines affected by a failure in the switch.

The objectives in this section are based on the relationship between the more traditional measures of reliability performance, such as downtime and mean time between failures, and impairments perceived directly by customers due to system and subsystem failures. Customers do not experience failure frequency or downtime as such, but rather, calls in progress are cut off at the onset of a failure and ineffective attempts may occur at the start of and throughout the duration of a failure. Some failures may also affect subscriber lines and isolate customers from their serving areas. Reliability objectives are only means for ensuring that equipment operates satisfactorily for achievement of certain customer service goals.

Different switching system architectures and designs may lead to failures that are perceived by customers in other ways. For example, in a space-division system, a call might fail to be connected. This will be perceived later by the customers as a line outage and it should therefore be controlled by the line reliability requirements.

The customer service objectives specify long-term performance levels for cutoff calls and ineffective attempts. Traditional reliability objectives for downtime and failure frequency are important in so far as they influence the cutoff call and ineffective attempt rates for the system. These objectives serve two major purposes:

- They can be used to evaluate and compare different subsystem failure characteristics and system configurations.

- They serve as benchmarks that can be used in customer service measurement plan for operational systems.

The line reliability objectives apply to individual customer line failures caused by switching failures. These failures are particularly important from a service viewpoint because they tend to isolate users. Analysis of customer trouble report data has shown relatively little change in the rate of reported line troubles over a period of ten years. Furthermore, line outages are critical as they isolate the customer from all service and because the customer is apt to perceive them as failures. Failures in other parts of the network have less direct impact on the user and may not be noticed at all in some cases.

The downtime objectives are of primary use to the designer and specify the allotted downtime for a given failure mode. No attempt has been made to specify the percentage of total downtime that should be allocated to hardware failures, although general guidelines are given.

3.1 Customer Service Objectives

This section contains requirements for cutoff calls and ineffective attempts, customer service parameters that are influenced by the system and subsystem failures.

Cutoff calls and ineffective attempts in a switching system have three causes:

- System and subsystem failures causing complete or partial loss of capacity.
- Digital signal impairments in the case of a time-division system.
- Other equipment malfunctions and errors not covered above.

The overall objective for cutoffs in a switching system is that, for all causes, the probability that a stable call in the system will be cut off should not exceed 0.000125 when the average call holding time is 3 minutes. Cutoff calls occur at the time of failure, therefore, the cutoff call objective is of primary use in determining the maximum permissible rate of failures.

The overall objective for a local switching system is that for all causes, the long-term average ineffective machine attempt rate should not exceed 0.003 ineffective attempts per attempt. Ineffective machine attempts occur during the period that a failure is in progress. Thus, the effective attempt rate objective is of primary use in determining the maximum permissible total outage time for various types of outages.

3.2 Downtime Objectives

The objectives in this section specify the long-term average downtime for a given failure mode (i.e. the number of trunk or lines affected by a failure). The figures are for all causes: hardware, software, procedural error and others. It is generally realized that as the failure modes decrease in size from, say the entire office down to a single trunk or line; the percentage allotted to hardware and firmware faults will increase.

The downtime objectives are as follows:

Trunks or lines affected	Downtime for all causes
entire office	3 min/year
n1	t1 min/year
n2	t2 min/year
.	
.	
.	
24	20 min/year
1	28 min/year

Where 24 --- n2, n1 are the total number of trunks or lines. Each of the times is cummulative and includes the time directly above. For example, a single trunk should experience on the average no more than 28 minutes of downtime per year for all causes while a failure mode which affects any one trunk is alloted up to 28-20 = 8 minutes per year on average. With the exception of the end points, the failure mode sizes and corresponding downtimes have not been specified. The primary reason is to allow flexibility in the design process by not requiring that a system have particular mode sizes.

Any downtime caused by maintenance activity should be counted against those downtime objectives.

Here it is assumed that for any switching fault which causes a line or trunk isolation, repair must begin as soon as after the fault is detected.

3.3 Line Reliability Objectives

The line failure rate and duration objectives given in this section apply to individual customer line failures caused by switching system and subsystem malfunctions and exclude problems that occur in the station set or wiring, outside plant or loop electronics. Such line failures can isolate an individual user and may produce conditions of no dial tone, the inability to break dial tone or the inability to be called.

The objective is that the long-term failure rate for all causes in the switching should not exceed 15000 failures in 10 E 9 hours per line. These failures are considered critical from a customer service point of view because there is no alternate routing from that station equipment to the switching system.

4. SYSTEM UNAVAILABILITY REQUIREMENTS

The objectives for the parameters of unavailability for GTA switching system failures which causes all lines to be down simultaneously should not be more than 2 hours in 40 years (or downtime per year 0.05 hours).

For information, other administrations or manufacturers follows the following standards:

- Italian Administration - 2.5 hrs/40 years
- Fujitsu, Hitachi, Thompson CSF - 1 hr/20 years
- GTE, Western - 2 hr/40 years

5. CRITERIA FOR SWITCHING SYSTEM EVALUATION

The service and reliability objectives described in previous sections are the ones used by AT&T for local switching system. GTA should request this information from the bidder and evaluate each of the parameters, thus maximizing responses to the RFQ. The critical parameters to be summarized from the previous sections are as follows:

A. Service Requirements

1. Dial Tone Delay (in ABSBH & HDBH)
2. Incorrect Treatment (in ABSBH)
3. Cutoff Calls
4. Ineffective Attempts

B. Reliability Requirements

5. Downtime for line group affecting all failures.
6. A line failure rate per year (or some fixed time frame).
7. System downtime in 20 years.

On receiving information from different bidders for particular line size switch fulfilling GTA traffic demand it will be easier to evaluate different switching system on the same basis.

6. REFERENCES

1. LSSGR "Local System Switching General Requirements".
Service Standards July 1981
Reliability December 1980
AT&T.

Deliverable 10

Transmission Plan for GOC Intercity Network

TABLE OF CONTENTS

1. INTRODUCTION

The purpose of this section is to define overall transmission planning objectives for the GOC Intercity network, with particular emphasis on a loss-switching plan for the digital tandem switch proposed at the Vancouver - Victoria consolidation.

The GOC Intercity Network is configured as a two-level tandem tie trunk network (see Figure 1). Traditionally the upper (or tandem) level has largely been implemented by leased centrex switches, and the lower level by PBX's or tel sets/key sets. Leased tie trunks or FX trunks are used to interconnect On-Net locations and WATS lines or CO/TO trunks used for Off-Net access.

Several options could be followed for network modernization at the tandem switch level. This paper addresses the three most likely options which are seen as:

1. Establish large digital PBX's (DPBX's) on GOC premises,

2. Establish large DPBX's on Telco premises,*

3. Continue with leased centrex, using digital switches.

The implication for network transmission planning differs in each case. Options (1) and (2) require that GTA establish an overall cohesive transmission plan for which it maintains responsibility - these would be minor differences betwen the plans because of the different loop characteristics. Option (3) on the other hand would remove the responsibility and capability of overall transmission planning from GTA as each Telco would implement its normal centrex loss planning scheme.

This paper addresses option (1) as the most likely scenario for modernization of the Vancouver - Victoria consolidation and establishes a Fixed Loss Plan encompassing both switches (software - controlled loss) and trunks (fixed loss). It also briefly examines option (2) and establishes a complementary Fixed Loss Plan. Lastly it gives an example of a Loss Plan that a typical Telco (Bell Canada) has implemented in a digital centrex switch.

---

* This option has we believe been implemented in the U.S. However, nothing in CRTC decision 82-14 indictes this is a real option, nor is there any reason to assume that Canadian Telcos could be forced to comply with the option.

2. CATEGORIES OF CONNECTIONS

Within the general GOC network depicted in Figure 1 there are four distinct categories of connections, depending on the point of origin, point of destination, and the network routing rules. These categories are shown diagrammatically in Figure 2(a) - 2(d) as:

On-Net to On-Net,
On-Net to Off-Net,
Off-Net to On-Net,
Off-Net to On-Net to Off-net

Each category establishes a set of permissable point-to-point switch connections which will be utilized below to outline standard trunk design. While the transmission plan developed here will give good transmission quality on most connections there are limitations, depending on the connection paths which may be permitted within the GOC network. These limitations are:

a) Acceptable On Net - On Net transmission quality presumes that a maximum of two tandem switches are allowed in a connection.

b) On Net - Off Net and Off Net - On Net transmission quality will in general be optimised by utilizing Head End Hop-Off and Tail End Hop-Off* routing arrangements, respectively.

c) Because of its ability to override the normal routing restrictions, the use of DISA (Direct Inward System Access) facilities will sometimes result in degraded transmission performance.

* Tail end hop-off is not offered for DDD but is for WATS or FX.

3. DIGITAL PBX LOSS PLAN (OPTION 1)

3.1 General

Draft objectives for transmission loss in Digital PBX-based tandem to trunk networks are currently being finalized by the EIA (Electronic Industries Association) (1). They define a loss matrix for main and tandem PBX's which, when combined with typical On-Net and Off-Net trunk losses, results in good transmission quality on end-to-end connections (2). The EIA Plan is regarded by the telephone industry as a standard. It is used to define switch and trunk loss objectives here.

This section firstly outlines the EIA loss matrix for main and tandem PBX's, then follows with relevant interconnecting trunk design for On-Net and Off-Net connections.

The PBX Loss Plan assigns TANDEM PBX status to the upper switching level, and MAIN PBX status to the lower switching level. Such an approach dictates that all PBX tie trunks be designed to a high standard that allows easy conversion to a structured ESN - style network at a later date.

All values of loss are related to a nominal 1000 Hz inserted connection loss (ICL). Negative values of loss indicate gain.

3.2 Loss Matrix for Digital PBX *

The EIA Loss Matrix for a digital PBX, when used in either main or tandem configurations, is shown in Table A together with relevant port definitions. The loss indicated shall be inserted, under software control, in each direction of the 4 Wire transmission path.

There is no standardization yet as to whether the inserted loss should be implemented in analog or digital form. However, it is preferable that whenever possible it be implemented in analog form. It is also very desirable that, should any losses be implemented in digital form, there be no tandeming of such digital pads in any network connection.

3.3 Loss Insertion for Conventional PBX*

Conventional PBX's used at the Main PBX level of the GOC network hierarchy shall have the normal 2dB pad switching capability. This capability shall ensure that the 2dB pad is switched in for connections between long-haul tie trunks and station sets or non-transmission compensated CO/FX/WATS trunks.

3.4 Loss Plan for Associated Trunks

As indicated in Figure 2, the tandem PBX is required to interface with PBX's, centrexes and CO's for On-Net connections, and with CO's or TO's for Off-Net connections. This section specifies loss objectives for all associated trunks which, when combined with PBX or centrex switch loss, will provide comparable transmission quality to the DDD network.

---

* Within the context of this report, the definitions of CPBX, DPBX follow the approach taken by the EIA:

- A conventional PBX has only analog interface capability, regardless of its internal switching mode. It possesses no internal transmission level control function except for 2dB switchable pads.

  A digital PBX has the capability of a direct digital interface in addition to the normal analog interface. It is characterized by having internally controlled software-controlled) transmission level functions.

Trunks shall be designed on an analog, combination or digital basis, characterized in the EIA Loss Plan as follows:

	Tandem Switch Interface	Transmission Facility	PBX Switch Interface
Analog Trunk	Analog	Either	Analog
Combination Trunk	Digital	Digital	Analog
Digital Trunk	Digital	Digital	Digital

The loss objectives for analog trunks utilize VNL - based designs, and those for digital or combination trunks utilize fixed - loss designs.

3.4.1 Transmission Level

Transmission level points throughout the GOC network shall be as specified for the DDD network and EIA Loss Plan:

Tandem Switch (2 Wire input to line card)	0 TLP
CPBX (2 Wire input to line card)	0 TLP
DPBX (2 Wire input to line card)	+3 TLP
Central Office (2 Wire input to line card)	0 TLP
Analog Toll Office (4 Wire send)	-2 TLP
Digital Toll Office (Analog 4 Wire send)	-3 TLP

3.4.2 Tie Trunks to Other PBX's

Tandem tie trunk loss objectives are specified in the three tables following. To clarify the implementation design, typical examples are given in Figure 3, 4 and 5. These examples are not exhaustive and are intended to illustrate typical design processes only.

3.4.3 Central Office/Toll Office Access Trunks

Loss objectives for these trunks are the responsibility of the relevant Telco. However, to illustrate the interaction of software-controlled DPBX loss (as per loss matrix) with typical trunk losses, an example is given in Figure 6.

3.4.4 FX/WATS Access Trunks

Likewise, loss objectives for this class of trunk if the responsibility of relevant Telco. A typical example of a long-haul WATS line is given in Figure 6 for purposes of illustration only.

DIRECT TIE TRUNK LOSS

Direct Tie Trunks provide the connection between two main or tandem PBX's serving as end PBX's, i.e., they connect a station at one main/tandem PBX to a station at another main/tandem PBX or to a DDD access facility. A trunk which can function as an Intertandem Tie Trunk as well as a Direct Tie Trunk requires long-haul design and must utilize 4 Wire facilities throughout. Trunk losses are given below. See Figure 3 for a typical design.

PBX1	PBX2	Trunk Transmission Facility	Trunk Loss (dB) Short-Haul	Trunk Loss (dB) Long-Haul	
CPBX	CPBX	Analog	3	VNL+4S	(1)
CPBX	DPBX	Analog	3	VNL+2S	(1)
DPBX	DPBX	Analog	1	VNL	
CPBX	DPBX	Combination	--->-2+2S*		(1,2)
			<--- 4+2S*		
DPBX	DPBX	Digital	0		(2)

Notes: (1) 2dB switched pad at each CPBX is switched in for connections to ONS, OPS. Also switched in for connections to PSTN where PSTN access facility loss is less than 2dB or PBX fails to meet terminal balance requirements.

(2) Combination and digital trunks use fixed loss whether short or long-haul.

TANDEM TIE TRUNK LOSS

Tandem Tie Trunk provide a connection between a main PBX (serving an end PBX function) and a tandem PBX (for connecting to another tandem tie trunk or an intertandem tie trunk). Trunk losses are given below. See Figure 4 for typical designs. Trunks which can function as an Intertandem Tie Trunk as well as a Tandem Tie Trunk shall be constructed to long-haul standards and utilize 4 Wire facilities throughout.

Main PBX	Tandem PBX	Trunk Transmission Facility	Trunk Loss (dB) Short-Haul	Trunk Loss (dB) Long-Haul	
CPBX	CPBX	Analog	3	VNL+2S	(1)
CPBX	DPBX	Analog	3	VNL+2S	(1)
DPBX	CPBX	Analog	3	VNL	
DPBX	DPBX	Analog	1	VNL	
CPBX	DPBX	Combination	-->-2+2S*		(1,2)
			<-- 4+2S*		
DPBX	CPBX	Combination	--> 4		(2)
			<-- -2		
DPBX	DPBX	Digital	0		(2)

Notes: (1) 2dB pad switched in on connections to ONS, OPS, or substandard CPBX - CO trunk. See notes to Direct Tie Trunk.

(2) Combination and digital trunks use fixed loss whether short or long-haul.

INTERTANDEM TIE TRUNK LOSS

Intertandem Tie Trunks provide the connection between two tandem PBX's connecting to Tandem Tie Trunks. Intertandem Tie Trunks are designed on a long-haul basis only (this restriction applies only to analog facilities) and must utilize4 Wire facilities throughout. Trunk losses are given below. See Figure 5 for typical designs.

Tandem PBX 1	Tandem PBX (2)	Trunk Transmission Facility	Trunk Loss (dB) (Long-Haul)
CPBX	CPBX	Analog	VNL
CPBX	DPBX	Analog	VNL
DPBX	DPBX	Analog	VNL
CPBX	DPBX	Combination	--> -2
			<-- 4
DPBX	DPBX	Digital	0

Notes: (1) The trunk loss objectives specified here also apply to the case where one tandem switch is a (conventional) centrex. The situation regarding digital centrex switch with a specialized, Telco-specified loss plan, is dealt with in sections 4.

4. LOSS PLAN FOR DIGITAL PBX ON TELCO PREMISES (OPTION 2)

4.1 General

Should this option be exercised it dictates a fundamental change to the EIA Loss Matrix established for customers - located DPBX's in Section 2. This is caused by the unavoidably larger subscriber loops, and results in a centrex loss plan being required for the DPBX. In this case the loss plan shall be specified by GTA, It is outlined in this Section. It will be referred to as the GTA Centrex Loss Plan and will specify a loss matrix for the tandem centrex plus associated objectives for trunk loss.

4.2 Loss Matrix for Digital Tandem Centrex

The loss matrix for a digital tandem switch, located on Telco premises, is shown in Table B together with relevant port definitions. The indicated loss shall be inserted under software control, in each direction of the 4 WIre transmission path.

The loss matrix is based on both the EIA Loss Plan and the Fixed Loss Plan of the DDD network, and compensates for the higher loss of what are, in effect, centrex subscriber loops.

As with EIA Loss Plan it is preferable that

a) Inserted loss be implemented in digital form whenever possible.

b) There be no tandeming of digital pads.

4.3 Loss Plan for Associated Trunks

The comparable Loss Plan for PBX Tie Trunks is shown in Table C. It is similar in concept to that for the EIA Loss Plan in Section 2.4 and is included for completeness. Design examples are not given in this case because of the similarity with Figure 3, 4 and 5 - these should be used with appropriate amendments.

While DDD Access Trunks are the responsibility of the relevant Telco, the digital tandem loss matrix has been derived on the basis of a specific set of centrex - DDD trunk loss objectives. The combination will optimize transmission quality and should be noted. They are listed in Table D. Any variation to the values indicated will require a corresponding variation in the digital tandem loss matrix.

5. LOSS PLAN FOR DIGITAL CENTREX SERVICE (OPTION 3)

In this case GTA will continue with a leased centrex service, presumably implemented by Telco digital switches with software controlled loss insertion capability. Since under normal conditions the centrex switch will cater for other customers as well as GTA needs, it is most unlikely that GTA could influence the loss plan utilized by the Telco for its centrex switch.

Under these conditions it is not intended to specify a separate centrex loss plan. End-to-end connection transmission quality will be determined by individal Telco centrex loss plans. However, as a benchmark, the centrex loss plan of Section 3 (based on Bell Canada design) offers good end-to-end transmission quality and should be matched by other Telco's.

6. ASSOCIATED TRANSMISSION CONSIDERATIONS

6.1 Terminal and Through Balance Design Objectives

Since the tandem switch is 4 Wire, through balance measurements are not required.

Terminal balance tests shall be performed at the 4 Wire tandem switch on circuits to 2 Wire PBX's and 2 Wire CO/CTRX switches. These circuits shall be designed to meet the terminal balance objectives specified below.

	ERL(dB) Minimum	SRL(dB) Minimum	Circuit Terminal
Long-Haul Tie Trunk to 2 Wire PBX/CTRX	18	10	900+ 2.16 UF at distant PBX
FX/WATS trunk to 2 Wire C.O.	18	10	900+2.16 UF at distant C.O.
OPS Line	12	8	Station receives of hook.

6.2 Subscriber Loops

Tandem switch subscriber loops supporting 500-type telephone sets shall be designed according to conventional practices for 2 Wire centrex loops, i.e., 5.0 dB maximum loss @ 1000 Hz.

PBX subscriber loop shall be designed according to the relevant Telco standard. These standards will typically give the following limits for insertion loss @ 1000 Hz:

On-premises extension - Maximum 2.0dB
Off-premises extension - Maximum 4.0dB
(Short-Haul)
Minimum (VNL+4.5)dB
Maximum 6.0dB
(Long-Haul)

For PBX loops there is also an overall limit which applies from the serving C.O. to the extension telephone set. This is typically 7.0dB @ 1000 Hz.

Central Office subscriber loops (which will apply for On-Net locations served by FX Lines) are the responsibilities of the relevant Telco.

6.3 Echo Control

The following general rules shall apply in the GTA network. Echo control shall be taken to indicate digital echo cancellers in preference to echo suppressors.

a) Analog Terrestrial Trunks

Echo control shall be provided where the VNL of an individual trunk exceeds 3.5dB. It shall also be provided where combinations of long haul trunks produce VNL factors of more than 4.5dB - in such a case the echo control should be provided on the trunk with the greatest VNL contribution.

b) Digital and Combination Terrestrial Trunks

Echo control shall be provided where an individual trunk, or a combination of trunks in tandem, exceeds 2400km. In the latter case echo control should again be provided on the longest trunk.

c) Satellite Trunks

Echo control shall be provided on all satellite trunks.

6.4 Data Transmission

The standards for network loss and terminal balance in this document will allow satisfactory operations of voiceband data services, typically up to 2400 bit/s, dependent on the performance of the interconnecting transmission facilities. Higher speeds necessitate careful attention to SRL at 4 Wire/2 Wire conversion points to achieve the required stability margin around the 4 Wire loop.

For modem speeds of 4800 and 9600 bit/s, the stability margin around the 4 Wire loop portion of the overall connection shall be 25dB minimum.

Transmission of digital data throughout the GOC network requires the preservation of bit integrities in all transmission and switching facilities. Digital signal processors, digital alteration in tandem switches or DPBX's, and digital echo control devices shall have such preservation capability.

In all cases, detailed circuit designs shall be as per EIA or TCTS industry standards.

7. SUMMARY OF DELIVERABLE 10

This delivery specifies Transmission Planning standards for a modernized GTA network using digital switches at tandem switching points (consolidations). The standards developed for switch and trunk loss objective, will result in good transmission quality on most On-Net connections, and within certain bounds, will also give transmission quality of Off-Net calls comparable to DDD.

The standards are developed on a fixed-loss basis and are derived from both the DDD Fixed Loss Plan and the EIA LOss Plan for digital PBX's. They meet the following objectives:

- Compatibility is maintained with DDD VNL and Fixed Loss Plans, as well as existing and future loss plans for private networks.
- Loss asymmentry is minimized
- Echo control is adequate for satisfactory transmission quality.

Three optional approaches are taken to modernization of consolidations, depending on the tandem switch ownership and its locations. Transmission requirements are then developed for the digital tandem switch in accordance with the above transmission plans, as follows:

- Option 1

  Stand alone tandem PBX located on GOC premises. Transmission requirements are based on the EIA Loss Plan, an industry standard.

- Option 2

  Stand alone tandem PBX located on Telco premises. Transmission requirements are developed from the DDD FLP and EIA Loss Plan, allowing for the longer subscriber loops.

- Option 3

  Centrex service leased from Telco i.e., a continuation of the present situation. In this case transmission requirements are specified by the particular Telco, and are outside GTA's control.

Finally, associated specifications for trunk balance, echo control, data transmission and subscriber loops are given to complete the document.

8. REFERENCES

1. EIA Standrds Project PN-1429. Digital Private Branch Exchange (Proposed Addition to RS-464). PBX Switching Equipment for Voiceband Applications.

2. A Makleff, J. Schick, "Transmission Planning Considertions for Evolving Mixed Analog/Digital Private Networks". Conference Record ICC 1981.

APPENDIX

TABLE A: MAIN OR TANDEM DPBX LOSS PLAN

		ONS	OPS	A/TT	D/TT
ONS	-->	6	3	3	3
	<--	6	3	3	9
OPS	-->	3	0	2	0
	<--	3	0	2	6
A/TT	-->	3	2	0	-3
	<--	3	2	0	3
D/TT	-->	9	6	3	0
	<--	3	0	-3	0
'CO	-->	0	0	0/2 (Note 1)	-3/0 (Note 1)
	<--	0	0	0/2	3/6
D/CO	-->	3	0	2	0
	<--	3	0	2	6
A/TO	-->	6	3	0	-3
	<--	6	3	0	3
D/TO	-->	9	6	3	0
	<--	3	0	-3	0

(Values in dB)

INTERFACE DESTINATIONS

- ONS - Line interface to on-premises line
- OPS - Line interface to off-premises line
- A/TT - Analog trunk interface to analog tie trunk
- D/TT - Digital trunk interface to digital or combination tie trunk (defined in section 2.3)
- A/CO - Analog trunk interface to analog Central Office trunk (including FX, WATS)
- D/CO - Digital trunk interface to digital or combination Central Office trunk (including FX, WATS)
- A/TO - Analog trunk interface to analog Toll Office trunk
- D/TO - Digital trunk interface to digital or combination Toll Office trunk

NOTE (1) It is desirable that the low - loss option (0/0 or -3/3) be used when the PBX - CO trunk loss is greater than or equal to 2dB and terminal balance standards (specified in section 5.1) are met.

TABLE B: LOSS MATRIX FOR CO - LOCATED DIGITAL PBX

		ONS OPS	LCO	CO	A/TO	D/TO	ITT	A/TT	DTT	S/H FX, WATS	L/H FX, WATS
ONS, OPS	→	0									
	←	0									
LCO	→	1	*								
	←	0									
CO	→	3	*	*							
	←	0									
A/TO	→	5	*	*	*						
	←	0									
D/TO	→	6	*	*	*	*					
	←	0									
ITT	→	6	5	3	0	0	*				
	←	0	0	0	0	0					
A/TT	→	3	2	0	0	0	0	0			
	←	3	3	3	5	6	6	0			
D/TT	→	6	5	3	1	0	0	3	0		
	←	0	0	0	0	0	0	-3	0		
S/H FX/WATS	→	3	2	0	0	0	0	3	0	0	
	←	0	0	0	2	3	3	0	3	0	
L/H FX, WATS	→	6	5	3	1	0	0	3	0	3	0
	←	0	0	0	0	0	0	-3	0	0	0

(Values in dB)

* This connection not allowed under normal routing rules

INTERFACE DESIGNATIONS

As for Table A plus:

LCO - Local CO, located on same premises as tandem FX

ITT - Intertandem Trunk

S/H FX, WATS - Short Haul FX, WATS

L/H FX, WATS - Long Haul FX, WATS

TABLE C LOSS PLAN FOR PBX TIE TRUNKS
(DIGITAL PBX on TELCO PREMISES)

Remote PBX		Digital Tandem PBX	Trunk Transmission Facility	Trunk Loss (dB) Short-Haul	Trunk Loss (dB) Long-Haul	
Direct Tie Trunk						
CPBX	--	DPBX	Analog	0	VNL+2S	(1)
DPBX	--	DPBX	Analog	0	VNL	
CPBX	--	DPBX	Combination	--> -2+2S		(1,2)
				<-- 4+2S		
DPBX	--	DPBX	Digital	0		(2)
Tandem Tie Trunk						
			Trunk Loss as Above			
Intertandem Tie Trunk (3)						
CPBX		DPBX	Analog		VNL	
DPBX		DPBX	Analog		VNL	
CPBX		DPBX	Combination		--> -2	
					<-- 4	
DPBX		DPBX	Digital		0	

Notes:

(1) 2S represents 2dB switched pad at CPBX - see section 2.3.2.

(2) Combination and Digital loss objectives apply for both short and long-haul cases.

(3) Loss objectives are defined for long-haul ITT's only.

TABLE D: LOSS OBJECTIVE FOR DDD ACCESS TRUNKS
UNDER NETWORK OPTION B
(DIGITAL PBX ON TELCO PREMISES)

From Digital Tandem To:	Trunk Transmission Facility	Trunk Loss (dB) Short-Haul	Long-Haul
A/CO	Analog	---> 3 <--- 0	
A/CO	Combination	---> 3 <--- 0	
D/CO	Digital	0	
LCO (Analog)	Analog	---> 1 <--- 0	
LCO (Digital)	Digital	0	
A/TO	Analog	---> 3 <-- -2	
A/TO	Combination	---> 3 <-- -2	
D/TO	Digital	0	
FX/WATS	Analog	---> 3 <--- 0	--->VNL+6 <---VNL
FX/WATS	Combination	---> 3 >--- 0	---> 6 >--- 0
FX/WATS	Digital	0	0

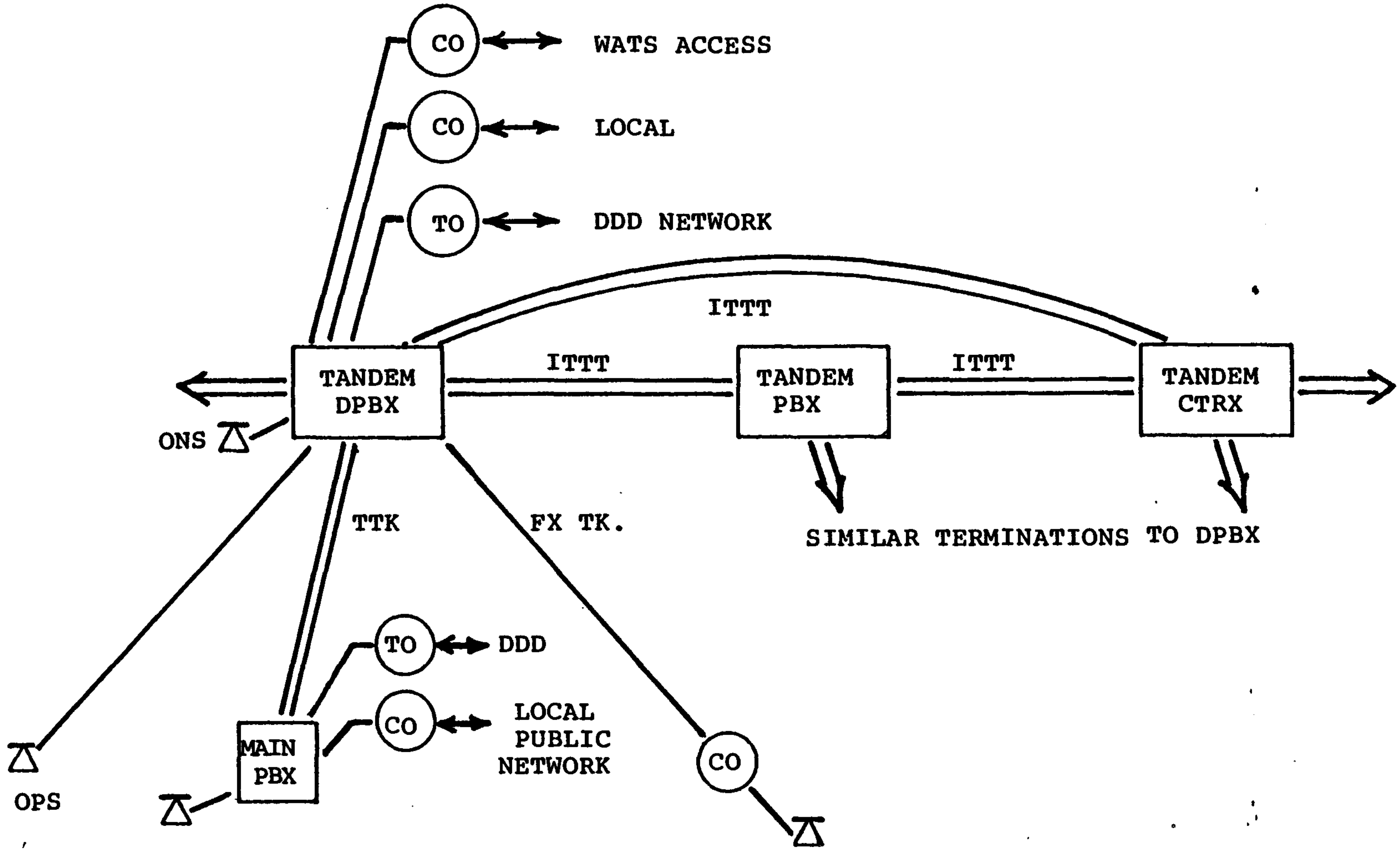


FIGURE 1: OVERALL GOC INTERCITY NETWORK

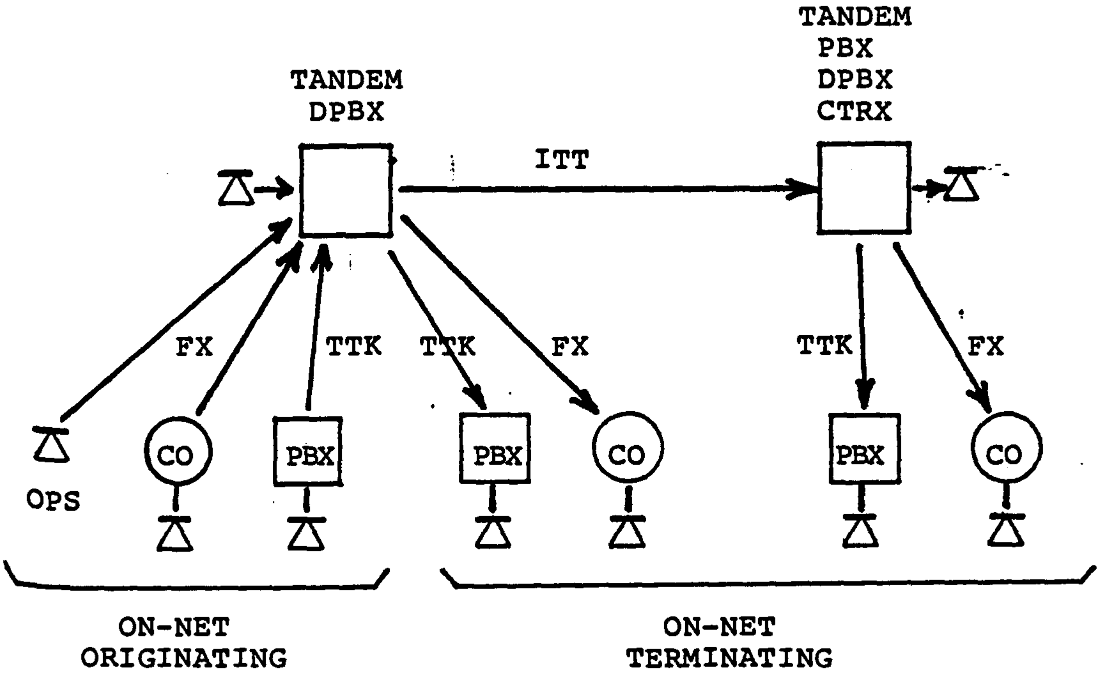
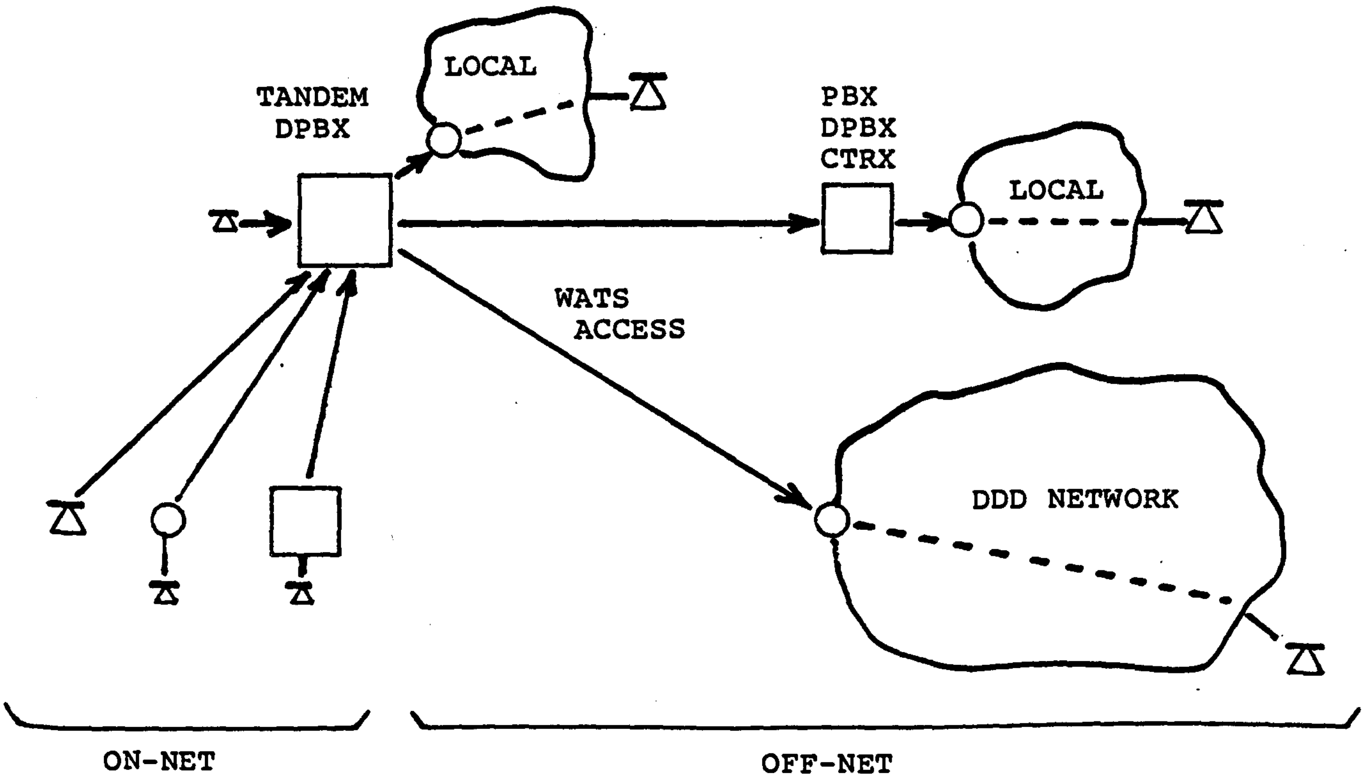


FIGURE 2(a): ON-NET TO ON-NET ROUTING

FIGURE 2(b): ON-NET TO OFF-NET ROUTING



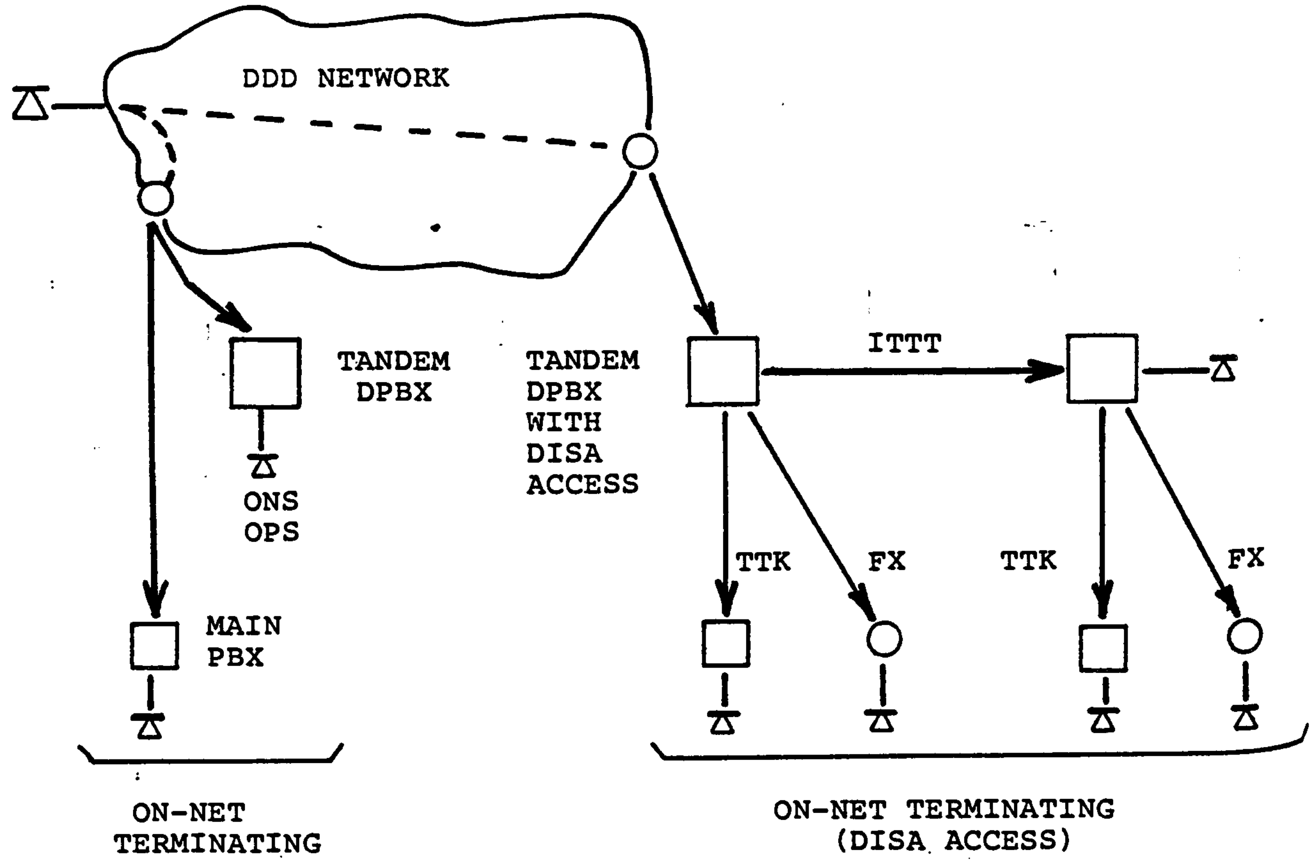


FIGURE 2(c): OFF-NET TO ON-NET ROUTING

FIGURE 2(d): OFF-NET TO ON-NET TO OFF-NET ROUTING

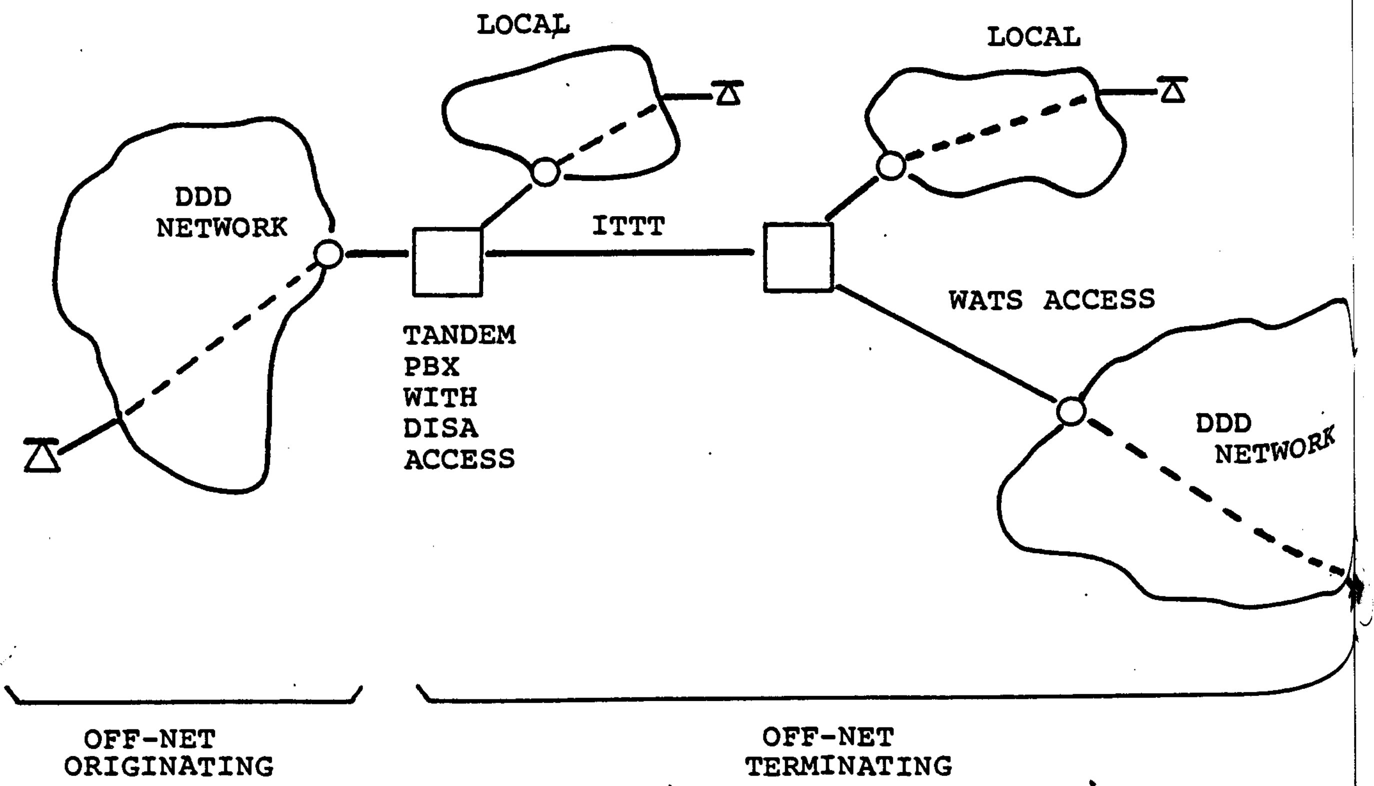


Figure 3: TYPICAL EXAMPLES OF DIRECT TIE TRUNK DESIGN

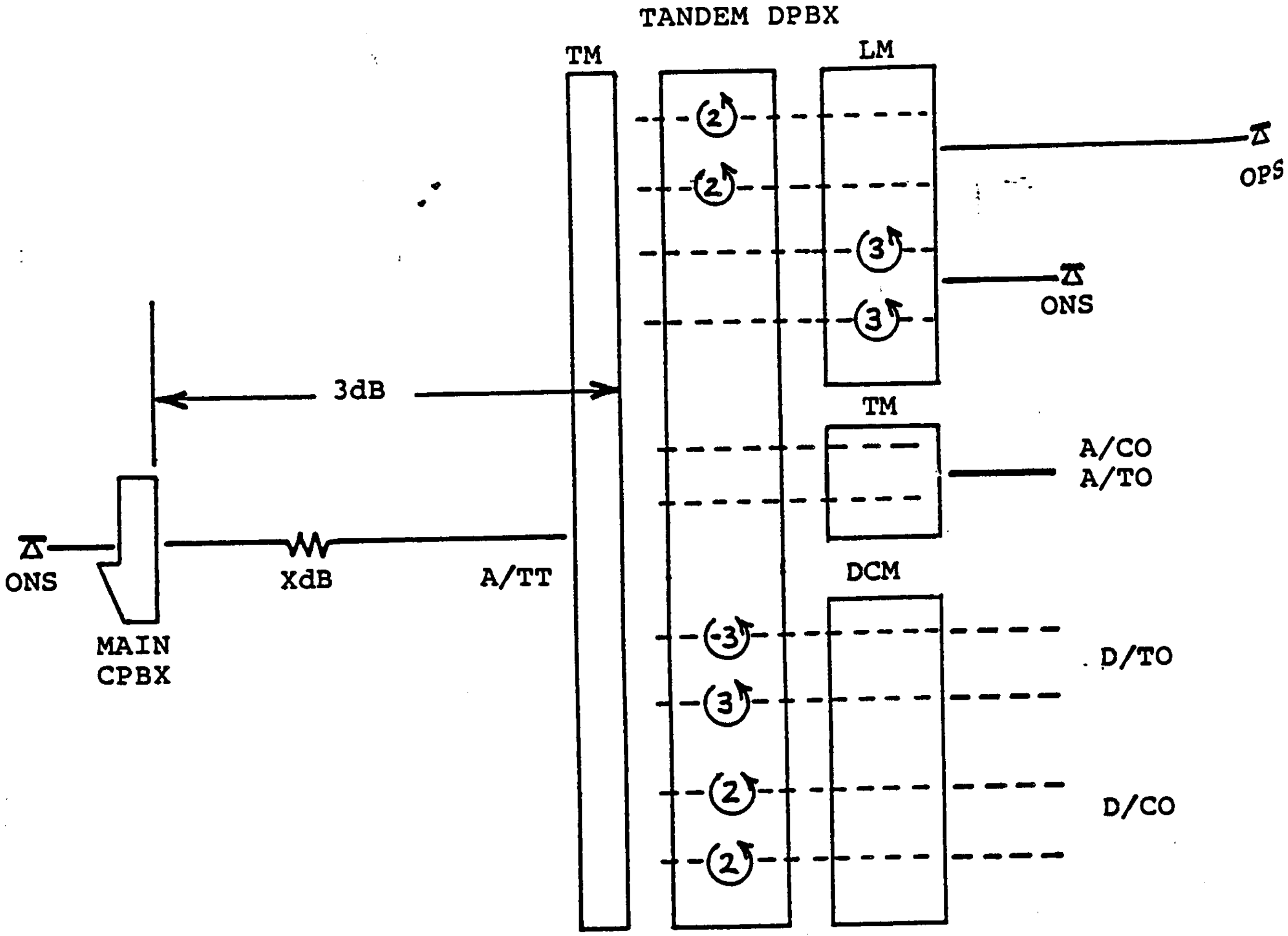


Figure 3(a) Short or Long-Haul Digital DTT Connecting DPBX'S

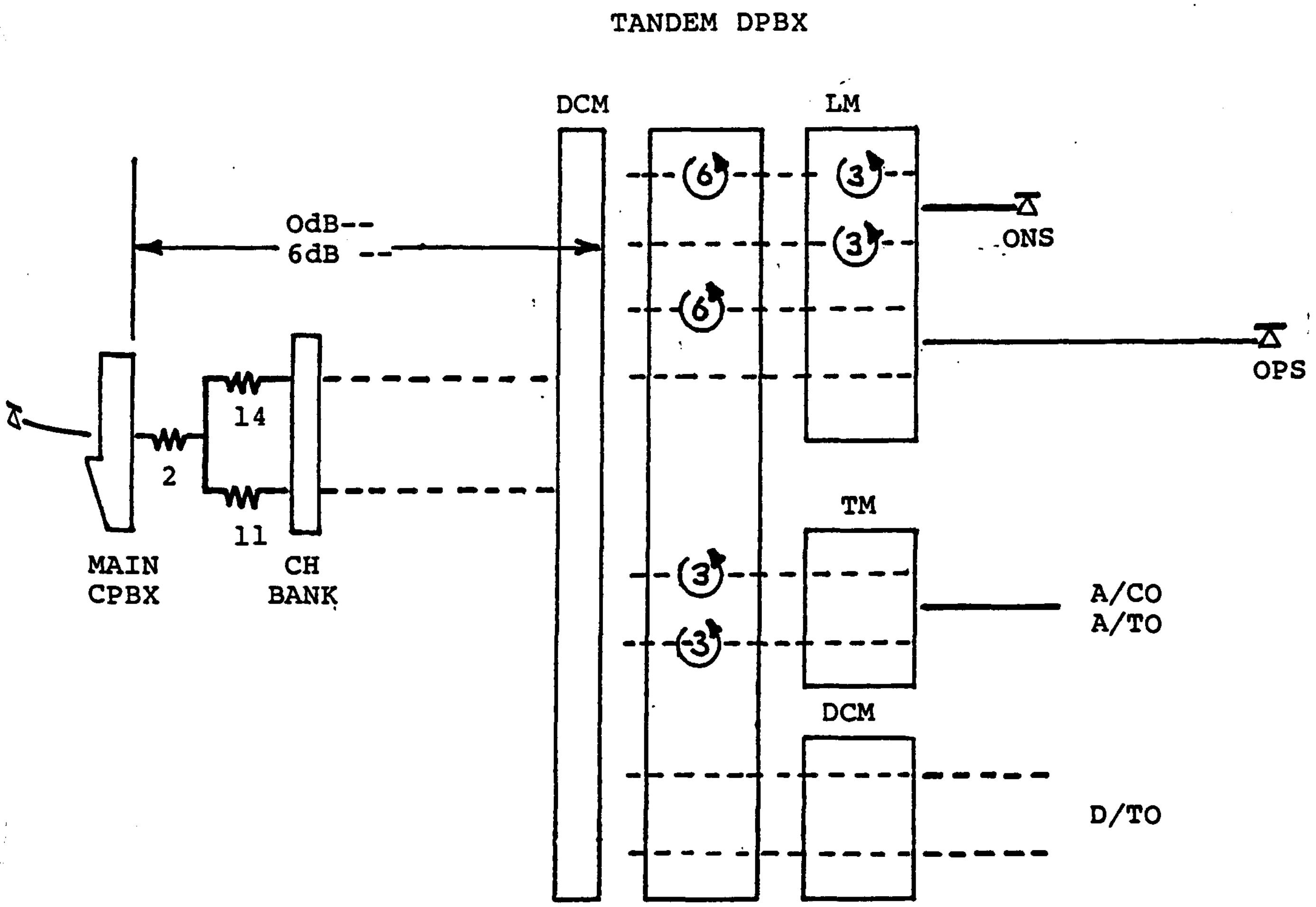


FIGURE 3(b): SHORT OR LONG HAUL COMBINATION DDT CONNECTING CPBX AND DPBX

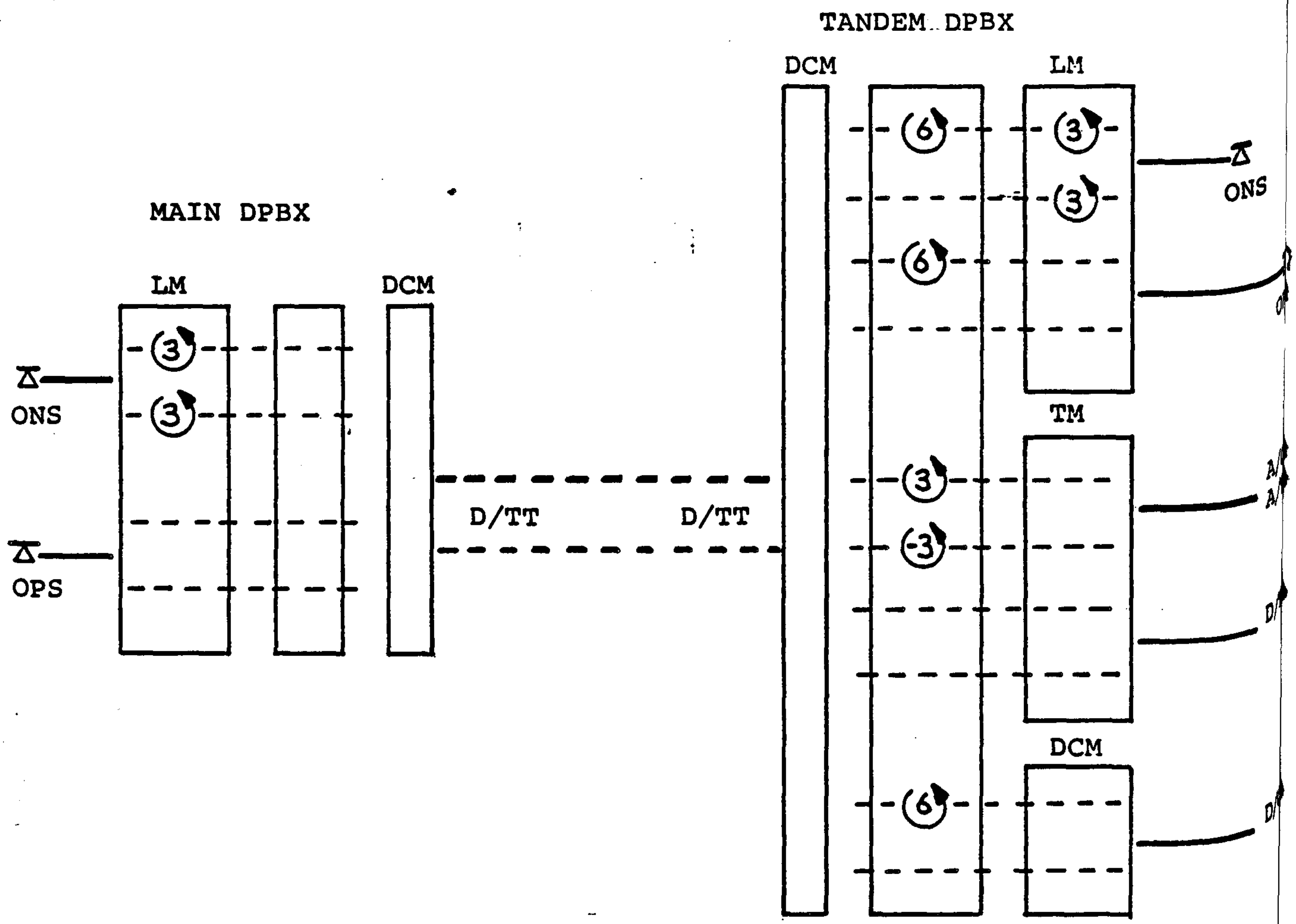


FIGURE 3(c): SHORT OR LONG HAUL DIGITAL DTT CONNECTING DPBX's

LM	Line Module interfaces with analog loop
TM	Trunk Module interfaces with 2 or 4 Wire analog trunk
DCM	Digital Carrier Module interfaces with T1 carrier
--- I ---	Fixed Loss
--- 3 ---	Software-Controlled Pad (SCP)

Notes: (1) The Trunk Module is required to have loss adjustment capability (either internally or associated external to adjust the physical facility loss to the required trunk loss - 3dB in this case.

(2) The 3dB SCP shown in the Line Module represents a typical EIA implementation approach where a 3dB switched analog pad can be permanently associated with the LM. Alternative arrangements may be offered.

Notes on Figure 3

Figure 4 TYPICAL EXAMPLES OF TANDEM TIE TRUNK DESIGN

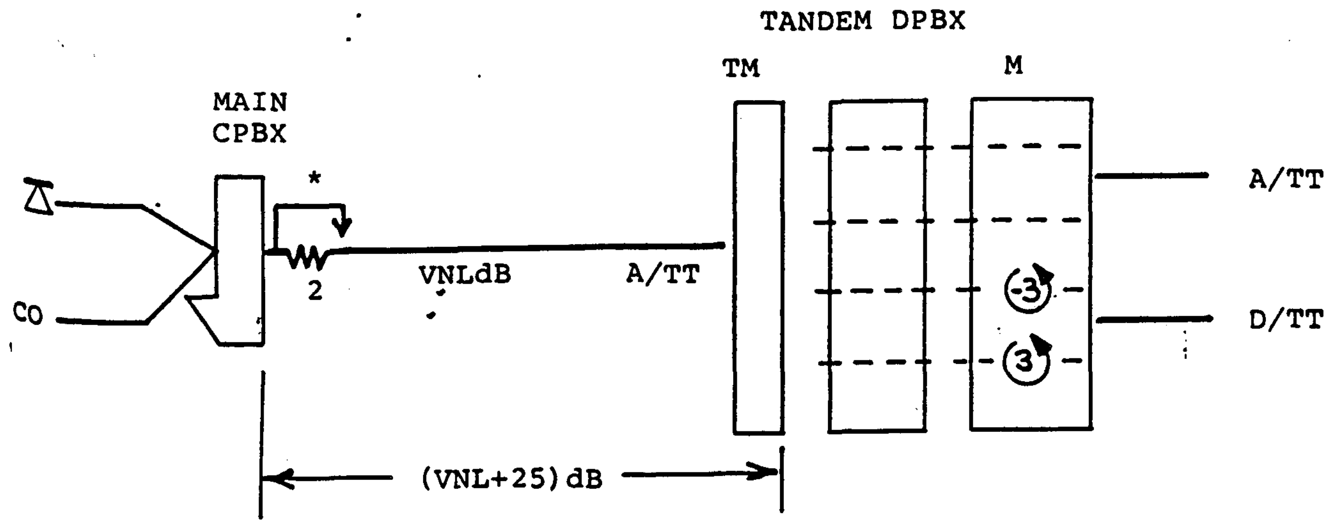
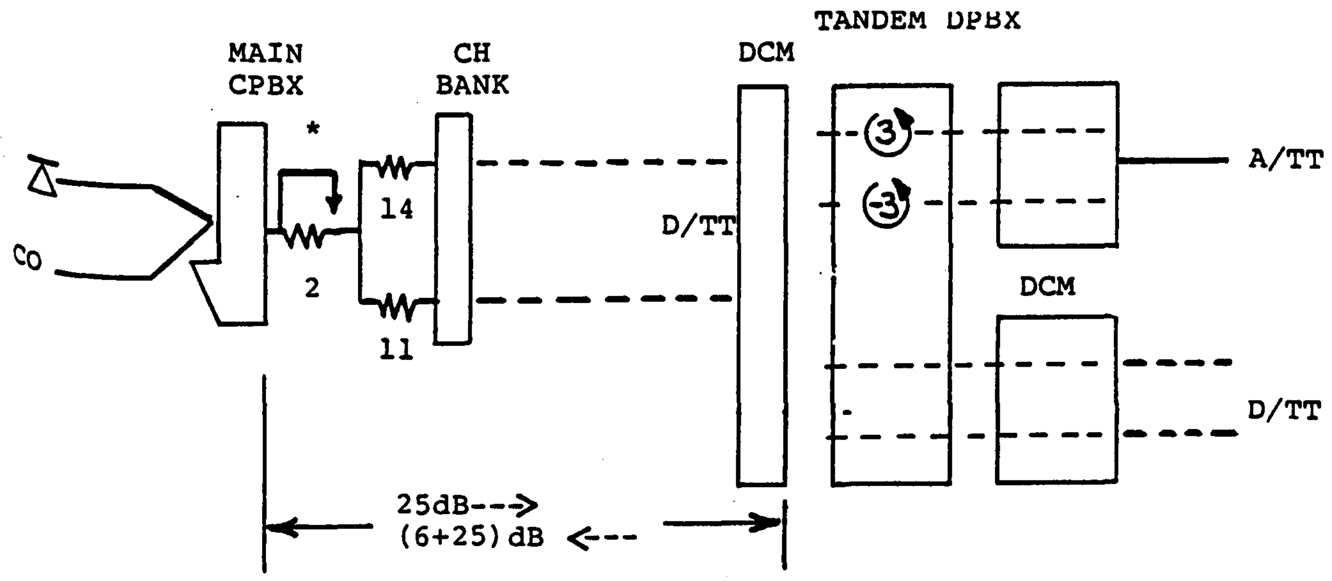


Figure 4(a) Long-Haul Analog Tandem Tie Trunk (TTT) Connecting Main CPBX and Tandem DPBX



* The 2dB stability pad (25) is switched in for connections to stations, as to low loss CO trunks. See text.

Figure 4(b) Short or Long-Haul Combination (TTT) Connecting Main CPBX and Tandem DPBX

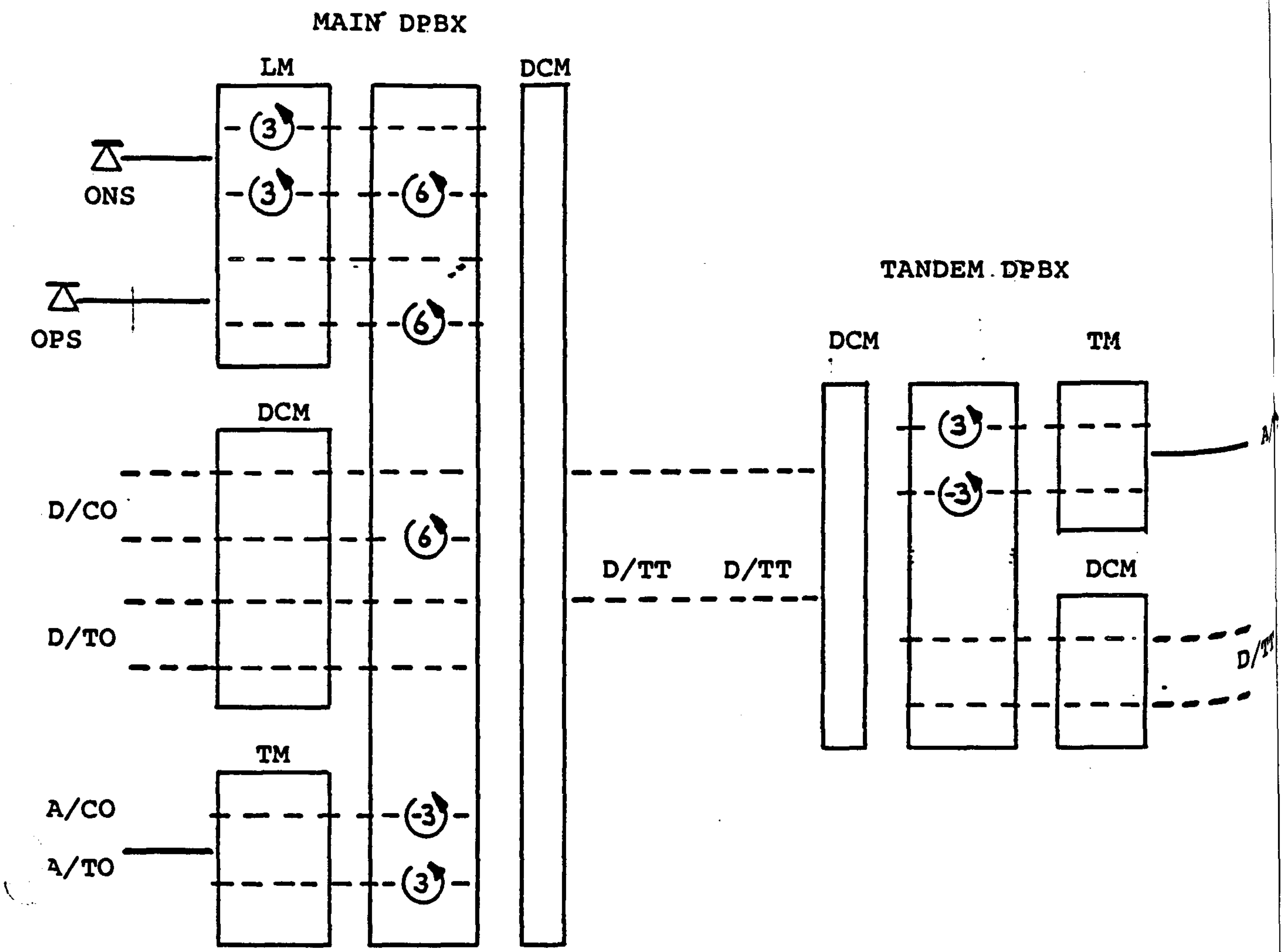


Figure 4(c) Short or Long-Haul Digital (TTT) Connecting Main and Tandem DPBX's

Figure 5 TYPICAL EXAMPLES OF INTERTANDEM TIE TRUNK DESIGN

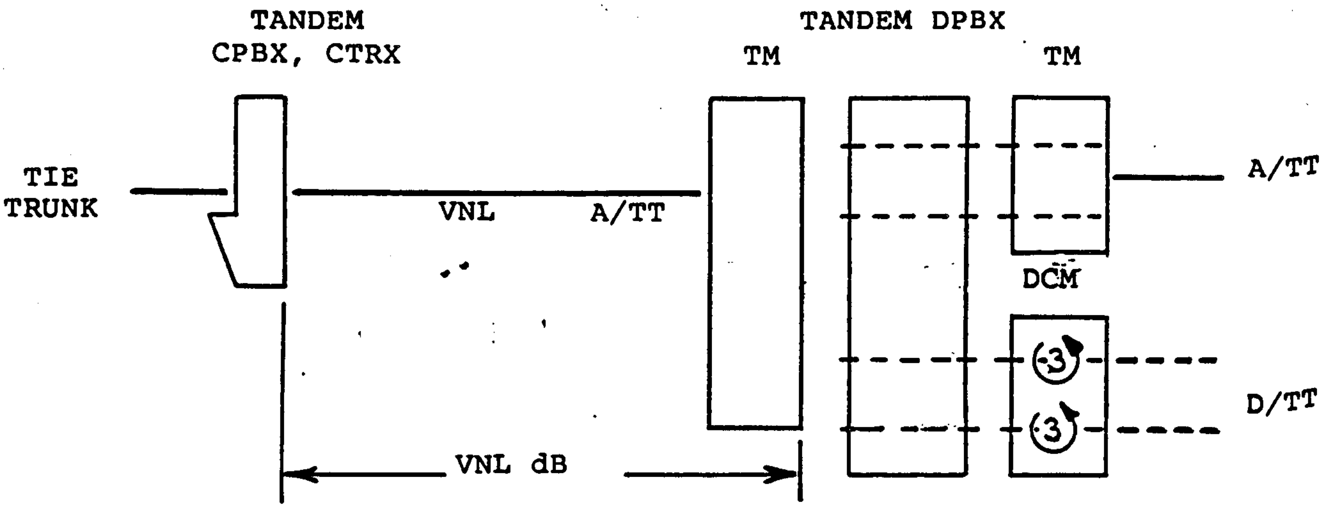


Figure 5(a) Long-Haul Analog Intertandem Tie Trunk (ITT) Connecting CPBX, DPBX Tandem Switching

Figure 5(b) Long-Haul Combination (ITT) Connecting CPBX, DPBX Tandem Switches

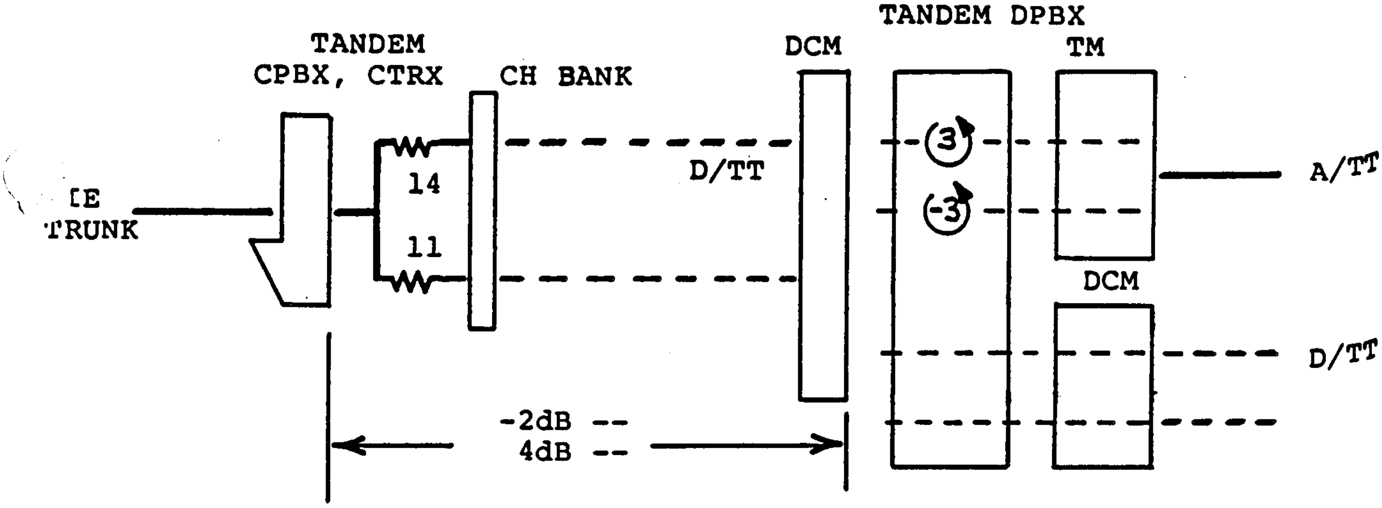
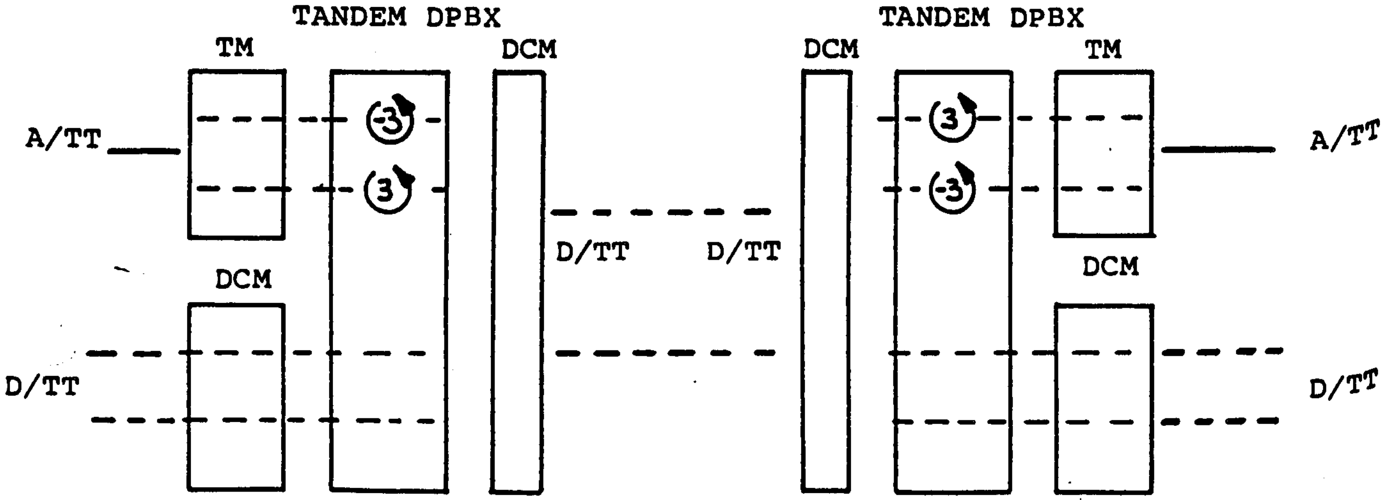


Figure 5(c) Long-Haul Digital (ITT) Connecting Two DPBX Tandem Switches



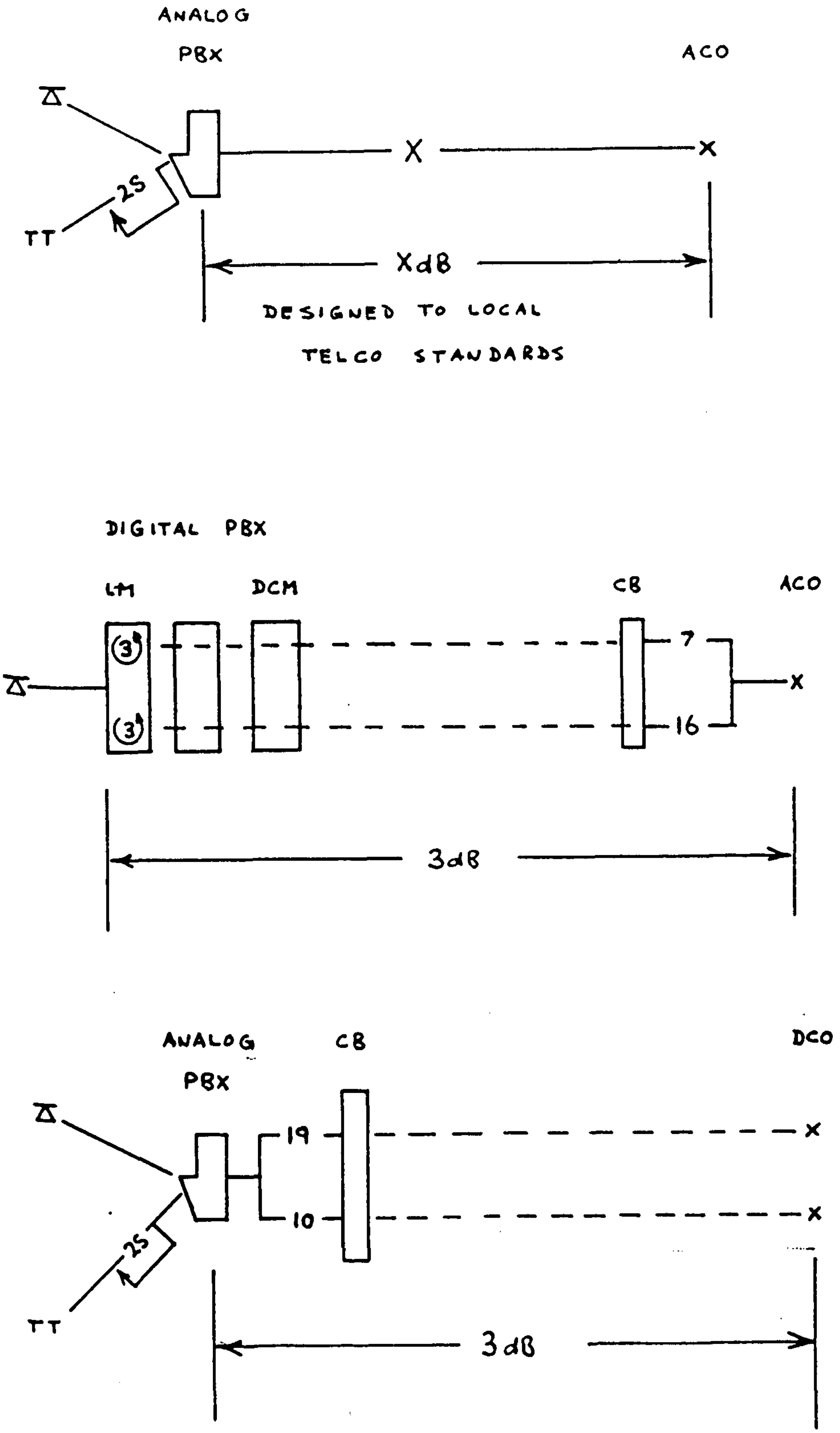


FIGURE 6A : Representative PBX - Central Office Trunks

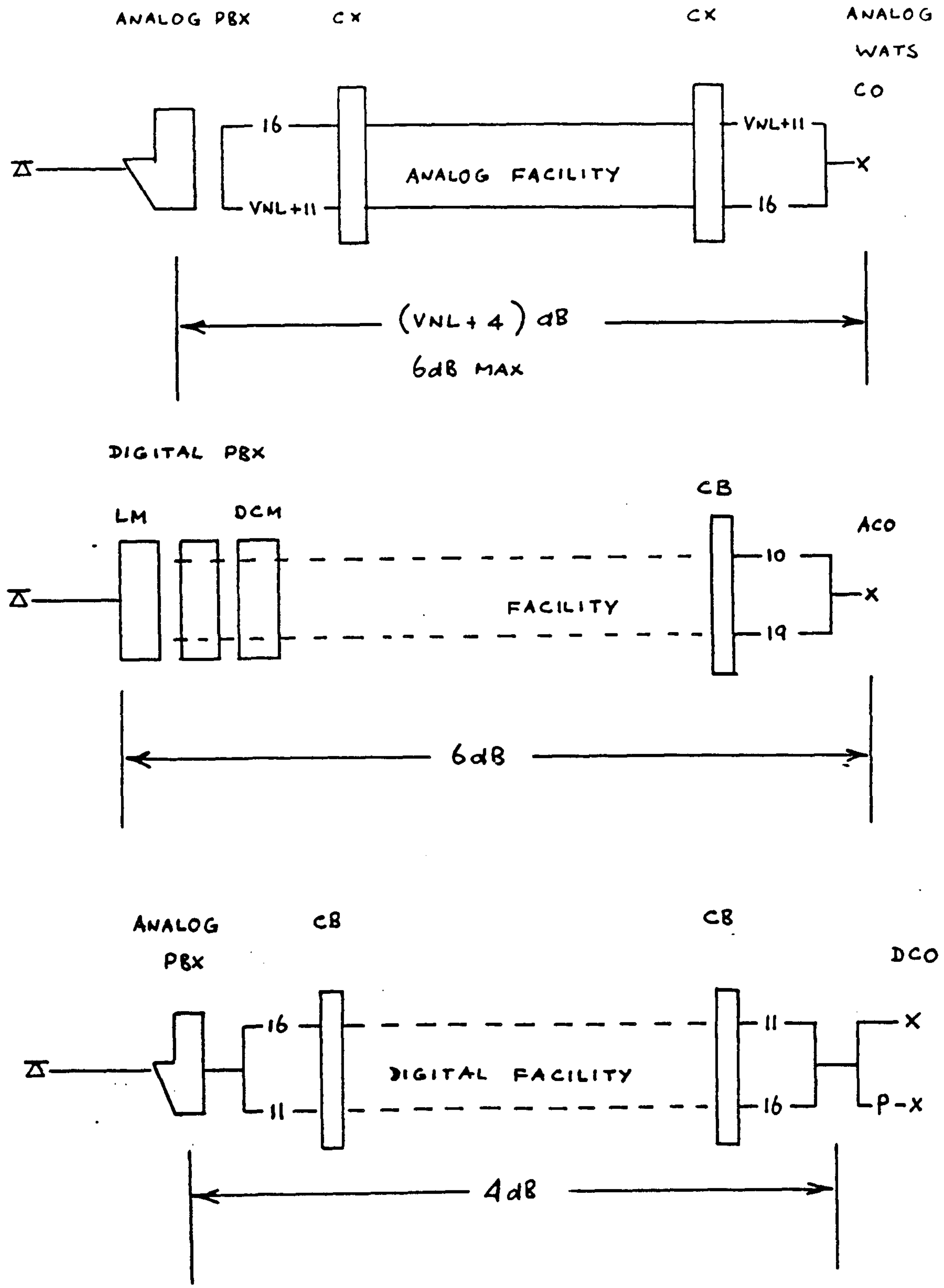


FIGURE 6B : Representative Long-Haul WATS Trunks

Deliverable 11

Organization Standards for Inside Telephone Wiring

TABLE OF CONTENTS

1. INTRODUCTION

Published standards for the inside telephone wiring are currently confined to electrical and fibre safety (1) and interconnection of equipment (2).

The majority of information on installation practices are the property of telephone company. The Building Industry Consulting Services (BICS) offered by Canadian telephone companies offers a series of booklets and consulting services for ensuring that the building can accommodate modern communications equipment.

In the current move to customer owned building wiring as an option, there will eventually be a published standard corresponding to telephone company practices, but at present this knowledge is proprietory. Consultants with telephone company experience, as well as the telephone company, are competent in these practices. At present, there is no inspection authority other than the telephone company for its own installation.

Consultation with the Department of Public Works (DPW) indicated that each provincial electrical inspection may have different interpretations of the electrical code. For instance:

- In Quebec, power and telephone equipment rooms are required to be separated.
- Labour inspection may have some conditions or practices.
- Specialized buildings such as hospitals or schools may have, in some places, additional standards.
- Security inspection may be required in Canadian Forces and Department of National Defence installations. However, in general the DPW approach has been to use BICSfrom the local telephone company.

Enquiries to the Province of British Columbia electrical inspection branch were made. The Canadian electrical code (1) is applied, with no added standards for telephony functions. Some use of American (NEC) markings for communication cables has been made as a stopgap in awaiting Canadian standards for cable. Minor changes reflecting the opening to ownership of inside wiring have been made to the electrical code. The exception from inspection of the telephone company installed wiring does not apply where the wiring is not owned by the telephone company.

The BC Buildings Corporation of the British Columbia government has no telephone wiring standards. The corporation relies on the advice of BC Tel.

2. REFERENCES

1. Section 60, Canadian Electrical Code, Canadian Standards Association

2. "Equipment Electrically connected to Telecommunications Network" CSA, C22.2 No. 0.7.

3. Building Industry Consulting Service Planning Handbook GTE Switching and Telephone Products, 1980

Deliverable 12

Functions of a Network Control Centre

TABLE OF CONTENTS

1. INTRODUCTION

The objective of this deliverable is to describe the functions of a centralized network control centre for the government telecommunications network. The approach taken is to list and explain these functions as they are generally defined in, for example, ESN, ETN and IBN networks with the understanding that the capability to carry out all the functions depends on the recording capability of the various switches that will make up the Government network particularly in Vancouver - Victoria. Thus implementation of the Network Control Centre will eventually depend on the overall network design. For example, the choice remains whether or not to build a hierarchy of control centres with the main one being in Ottawa, say, supervising other centres in the various consolidations.

2. GENERIC FUNCTIONS OF A NETWORK MANAGEMENT CENTRE

2.1 Network Management Centre

A Network Management Centre is a stand-alone facility which centrally operates, maintains, controls and administers the private network to decrease overall networks cost while improving network performance.

The telecommunication manager of a private interconnect network is solely responsible for: (i) the operations and maintenance of network switches and trunks; (ii) responding to complaints from network users; (iii) administering network features; (iv) managing switch database modifications; (v) monitoring and controlling traffic in real-time; (vi) collecting call detail records (CDR) and traffic reports and (vii) ensuring that the network is providing the desired grade-of-service in the most cost-effective fashion. These tasks are further complicated by multiple network nodes which are geographically dispersed.

The objectives of the NMC are met by:

1. Centralized trunk testing facilities which automate the detection and localization of trunk failures.

2. Automated switch failure detection and analysis capabilities which decrease maintenance costs and enhance system availability.

3. Centralized traffic monitoring and control facilities for relieving traffic congestion to improve grade-of-service.

4. Traffic data analysis reports which recommend the addition or deletion of trunks to achieve the desired grade-of-service at the lowest cost.

5. Centralized switch database and network feature administration, which allow the telecommunications manager to control and allocate expensive communication resources.

6. Automated and centralized collection of call detail records (CDR) which avoid the operational costs of manual CDR collection.

7. Computer assisted management aids such as alarm logs, trouble tickets, summary reports etc., which assist in trouble track-

ing and rapid trouble clearing to improve service and lower cost.

8. Centralization of many tasks, once done at the switch to the NMC, which reduces skilled labour costs at the switch sites.

2.2 Network Management Centre Configuration

As the NMC is a stand-alone facility, it needs not be co-located with a switch node. Thus it may be located to accomodate administrative concerns rather than technical constraints.

The NMC usually consists of a main processor, memory, disk, operator station, dynamic colour graphic display, trunk test system, line and character printers, magnetic tape facilities and data-link communications facilities. The NMC communicates with the network switches using dedicated data links or by dial-up polling.

2.3 Network Performance Monitoring and Maintenance

The NMC provides network performance monitoring and centralized maintenance to ensure maximum availability of network facilities. This is accomplished by:

- Providing continuous on-line performance monitoring of switch nodes and providing alerting mechanisms to indicate critical conditions.

- Providing the NMC operator with the ability to detect, diagnose and localize network problems to a particular switch or trunk so that corrective action may be taken.

- Providing mechanisms for the coordination of maintenance activities and ensuring management control through the use of reports.

2.4 Alarms

The network switches route all maintenance information to the NMC. Every message from each switch is compared with predefined alarm conditions. If there is a match, an alert is immediately generated. Network alarm status and traffic information is dynamically displayed via colour graphics, giving the operator an overview, at a glance, of current network alarm status and traffic conditions.

2.5 Automatic Trunk Testing

The NMC provides centralized capability to test each individual trunk in the network for noise and gain, and reports those results to the operator in an organized manner. Trunk testing is necessary as most carriers do not regularly test leased trunks. Thus, if a trunk is defective, not only is an expensive facility going idle, but service is degraded.

2.6 Traffic Control and Analysis

The NMC has two major traffic related functions:

1. The NMC facilitates real-time traffic monitoring to allow effective use of traffic congestion relief measures.

2. The NMC produces monthly traffic analysis reports to maintain the desired grade-of service at minimum costs.

In the first function, if the operator finds that traffic is building up and all trunks are busy for longer time, he can take some of congestion relief measurers such as:

- Routing and translation table modification
- Time-of-day routing
- Route reservation controls
- Code blocking
- Queue controls

3. MANAGEMENT OF A MIXED OWNED LEASED NETWORK

In the United States, AT&T are offering a customer network control centre as part of their Enhanced Private Switched Communications Service (EPSCS). In this, the centre permits the customer to monitor and control network activity etc extracted from the EPSCS switching mechanisms and supported by AT&T Customer Service Administrative Control Centre (CSACC).

In Canada, the ESN offering for private networks can be supplemented, if required, by a communications management centre (CMC) which can be owned by the customer or leased from a telco. In the Government of Canada network where ownership of a CMC may be the required policy, interfaces with telco-leased equipment with impact on the operation of that CMC. Thus, for example, the data taken off switches at an ESN node, say, must be processed and transferred over data links (usually dedicated) to the Control Centre. To facilitate this, maintenance and control of the processing and distribution will necessitate negotiation on lines of demarcation not clearly covered by the CRTC decision 82-14 on customer premises equipment. Thus on the Vancouver - Victoria consolidation, the functions of a network management centre (whether a CMC or not) would have to be implemented in agreement with TCTS and the various Telcos. The extent, therefore, to which they can be implemented realistically (and in real time) will itself impact on the routing of Government calls through, for example, telco centrex services.

Deliverable 13

Preventative Maintenance

TABLE OF CONTENTS

1. INTRODUCTION

Preventative maintenance functions are to be considered in three categories:

a) Manually Initiated Tests

These are tests which can be executed on demand by maintenance personnel. For example, should a fault (hardware or software) have been discovered on similar equipment in another installation, then on demand testing may be indicated and required by the supplier.

b) Scheduled Tests

These are tests which will be executed by equipment according to a schedule which may be defined and modified as necessary by the provider of preventive maintenance services. All interconnect suppliers should offer a regular maintenance schedule as part of the sales contract.

c) Automatic Tests

These are tests executed by the equipment, as a result of irregularities detected by the equipment. These are preventative in the sense that irregularities may proceed more serious faults, requiring a monitoring capability to minimize potential downtime. In the following three sections, we describe the three categories in more detail highlighting what GTA should expect in terms of preventative maintenance from the supplier.

2. MANUALLY INITIATED TESTS

Should a need for manually initiated tests arise from faults on similar equipment or from a GTA requirement to expand the switch function or for any other reason, the capability to test equipment must be readily available. Thus maintenance personnel, whether involved in first line maintenance (i.e. operating personnel) or contracted on a regular basis from the supplier, say, must have access to procedures and to training in these procedures. Moreover application of the maintenance function must have been carried out on the specific switch consolidation. That is, this preventative maintenance function is in part the ready capability to carry out corrective maintenance. Typically the procedures fall into two classes

2.1 How to communicate with the system.

2.2 Fault detection, isolation and repair.

2.1 Communication with the system

To maintain a system properly, one must be able to communicate with it. This is done by giving commands to, and receiving information back, from the system. Two devices typically may be used to communicate with the system.

1. a teletypewriter (TTY) or other terminal device

2. a proprietary telephone set designated as a maintenance set in the configuration record.

When a TTY is used all commands are input from the TTY keyboard, and system responses are output on the TTY printer.

When a telephone set is used all commands are made using the dial pad of the telephone set, or by pressing maintenance auto dial (MDL) keys if they exist. All commands are unique allowing one key of a dial pad to be used for more than one input.

2.2 Fault Detection, isolation and repair

a) Fault Detection. Fault detection may be determined either by self-monitoring circuitry generating an alarm, a code on the maintenance display, an output on the teletypewriter (TTY), or by a customers complaint.

b) Fault Isolation. By using system indicators and diagnostic routines, most faults can be traced and isolated to replaceable apparatus. Faults which are not isolated by the system indicators and diagnostic routines are isolated through given test procedures.

c) Fault Repair. Fault repair consists of replacing the defective apparatus, normally a plug in circuit pack, with a known good one. When the fault has been cleared, tests are performed to ensure that the equipment is operating satisfactorily.

The fault can be isolated to replaceable apparatus by following for example, a step-by-step flowchart instruction. All fault clearing begins with a fault classification flowchart. Use of the fault classification flowchart quickly classifies the fault to a particular section of the system, such as the power supply, the Common Equipment (CE), the Peripheral Equipment (PE), etc. After the fault has been classified, a separate flowchart, located in each equipment maintenance section, is followed to clear the fault.

3. SCHEDULED TESTS

Suppliers typically offer an extended warranty period and a scheduled maintenance program. Typically each month, maintenance personnel will

a) Check readings on stand-by batteries, test their specific gravity, clean battery terminals and replace when warranted.

b) Identify and replace contaminated or faulty circuit packs.

c) Inspect and clean filters in the cooling system filter unit.

d) Inspect tape units and clean magnetic tape heads.

e) Examine records of intermittent and minor faults and apply corrective procedures.

f) Run diagnostic programs as described in section 4.

g) Ensure switch room is clean and tidy, and that temperature and humidity are within tolerances.

h) Re-initialisation, which can consume up to three minutes while the sytem reloads.

4. AUTOMATIC TESTS

Each system is equipped with a set of maintenance aids to indicate the presence of a fault and to initiate maintenance procedures. These aids can be described as alarm messages which follow automatic testing activity and identify system irregularities. They appear as, for example, a two character display for irregularities in CPU, as a magnetic tape output, as a circuit breaker tripping, or as output on the teletype.

Automatic testing routines resident in the system typically include call processing error monitors; overload monitors; trunk diagnostics; I/O diagnostics and a special program to allow periodic diagnostics to be carried out on various system components. This latter program, apart from periodic use, is run during scheduled visits of the suppliers maintenance personnel (section 3).

Usually once a day, during a low usage time period (e.g. midnight) the program produces diagnostics on several of the switch functions such as:

- Network and Signalling
- RPE
- CE
- Tone
- I/O
- Conference circuits
- CDR
- Software Audit
- Data Dumps

5. SUMMARY

Preventative maintenance on modern digital switches operates at three levels of activity from routine visits by maintenance personnel; through training of operations and maintenance staff to carry out fault detection isolation and repair; to automated testing by the equipment itself in order to pinpoint minor irregularities. The supplier should provide the required maintenance staff and should ensure that procedures are known and can be carried out on the switch site.

Deliverable 15

Acceptance Testing

TABLE OF CONTENTS

1. INTRODUCTION

Acceptance testing is ultimately the responsibility of the buyer i.e., is he satisfied with switch performance? Is he satisfied that the vendor has covered aspects which would ensure, to the extent possible, reasonably trouble free operation in the real environment.

It is clear that at some point the buyer must take over responsibility for the switch. It is also clear that the vendor must have a completion date for the installation. It is in both parties interest to ensure that testing is as thorough as possible.

All suppliers therefore engage in comprehensive testing from the design of the switch to installation and commissioning. Moreover since a switch comprises interconnection of hundreds of separately manufactured parts, testing during installation and commissioning in repeat sales is equally essential and thorough as for the first sale of a new equipment. Suppliers, thus, have well documented and detailed testing procedures which are completely open to the buyer after a contract to purchase has been signed.

There are two main considerations the buyer must take into account:

- acceptance testing for proven hardware and software - i.e., other buyers have found the product satisfactory.
- acceptance testing for new (less than one year in production and sales) products and for new software additions for old products.

While it is unlikely that the vendor will knowingly offer a product which will not perform, unproven hardware/software needs more careful consideration. Thus during contract negotiations, the buyer should specify a requirement for trouble-free operation, say, for a month, when the product is unproven.

In Canada, the buyer is normally the telephone company (telco). The telco, over time, has developed its own test procedures which are aimed at those equipments and the manufacturers claimed functions of the system. It may well be that the telco acceptance tests are the same or sufficiently similar to the commissioning tests that they can be carried out in parallel or even that the telco waives acceptance. However even for those tests which are different, it is normal that the vendor is aware of the test implications and will assist in carrying them out.

The introduction of the interconnect option in Canada raises some difficulties in acceptance testing for the buyer and ultimate owner. Since the testing procedures defined, for example, by Bell Canada occupy many thousands of detailed pages developed over a long period of time, it is unlikely that a buyer from interconnect will be able to be as comprehensive. In this case three possibilities exist:

- Rely on the vendors installation test procedures but define specific functional requirements which have to be met. Such a procedure will have to include agreement with the vendor that these requirements can be implemented.

- Obtain, if possible, a professional consultant (from the telco or externally) and commission him to oversee the acceptance testing.

- Within the contract negotiations, identify an extended warranty period for the operation of the switch.

This deliverable presumes that GTA is not in a position to define its own detailed acceptance procedures. Moreover, while some of the generic procedures are described in Annex A, the main GTA concern is a description of those activities it can engage in so as to retain some control over acceptance should it go interconnect.

The purpose of the deliverable is to provide some technical guidelines to GTA on its role in accepting a switch. The content of contractual negotiations is outside the scope of the deliverable. In section 2, therefore, we describe typical testing done by the manufacturer of a switch from production to commissioning. Section 3 identifies options on the roles of installer and telco in the commissioning phase since this is common practice today. Section 4 recommends the steps GTA should take were it to purchase from an interconnect company, while Section 5 identifies typical statements that can be put into an RFQ for switch procurement.

2. PRODUCTION TO COMMISSIONING - VENDOR RESPONSIBILITY

There are normally four stages of testing that a switch goes through prior to cutover to field operation.

1. Pre-release Testing during which the switch manufacturer ensures that the design requirements have been met. Testing would have been done on a switch prototype.

2. In-plant testing where the separate subsystems of the switch are tested to screen out defective hardware components as well as ensuring that software modules perform satisfactorily.

3. Field testing where,

   a) check similar to those in 2) above are performed

   b) operational and functional tests are run in simulation of the proposed real environment,

   c) Assessment tests whose purpose is to emulate in-service traffic under controlled conditions to evaluated switch performance and reliability.

4. Acceptance tests after which the switch ownership and responsibility is passed to the buyer.

While the deliverable is ostensibly only concerned with (4), participation by GTA in the other four will considerably reduce the perceived risk should GTA wish to own the switch.

Concern with pre-release and/or in-plant testing need only occur when the potential choice of switch is one not already proven in the field. In this case some form of demonstration of switch capability prior to purchase should be observed. Such a demonstration may be set up by the manufacturer/vendor as a matter of course or it may be possible for the buyer to request demonstrations of particular capabilities to ensure that the vendor has responded correctly to the buyers requirements.

In the main, however, acceptance testing for GTA begins with observation of field tests accompanied by evaluation of the installation plan and the vendors quality control procedures (the latter should be part of the information provided by the vendors in their response to an RFQ). The installation plan to be monitored by the buyer will constitute a CPM chart outlining events that will occur between installation start and job completion prior to formal acceptance; the events constituting the completion of an installation task or test. Accompanying the CPM chart, the buyer may have access to a commissioning bar chart comprising a summary of the test interval times, customized for each job relating to the CPM events.

The objectives of field testing are to:

i) Compliment pre-release and in-plant verification

ii) Verify hardware using diagnostic programs

iii) Verify call processing and maintenance features

iv) Test for switch data output indirectly through call processing and give to buyer for validation

v) Perform the assessment

vi) Ensure a reliable switch is handed over to the customer

In general testing comprises four phases:

- Testing the physical installation i.e., wiring and connections, power supply
- Hardware tests on the various modules e.g., CPU, Line, Trunk and Trunk Modules
- Data dumps during the various call through tests
- Operational and Functional tests
- Assessment tests

Of major concern to GTA are the latter three which indicate viability of the switch for the buyers purposes.

2.1 Data Dumps

During simulated call through, whose characteristics are perhaps determined by the buyer, the data from the switch is output to a printer for validation against the input.

2.2 Operational and Functional Tests

These include:

- call through in a per trunk group basis where this is relevant
- sample call through to verify routing, alternate routing, translations, screening and code conversion
- calls to verify features such as multiparty lines, PBX, Inwats
- checking tones and announcements
- verification of office alarms
- checks on service analysis and network management
- call processing under faulty conditions e.g., one CPU etc.

2.3 Assessment tests

These tests use simulated traffic of various types originated and terminated on a representative sample of line and trunk types, destinations and features usually over 3 consecutive 8-hour shifts. This letter may be varied to three 8-hour shifts on different days (often an interconnect option).

Again the testing method and approach should be available to the buyer beforehand so that he can understand the simulated approach and impact the sample. For example, one test requested by an interconnect buyer required the system to be tested at 125% of its nominal capacity.

Completion of the Assessment tests represents the final stage of the vendors programme to ensure reliable operation of the switch. From the summary description above it is clearly in the buyers interest to be involved as much as possible even to the extent of direct participation in the testing phases.

Acceptance testing, the subject of the next section, could therefore be a formality. However current practices between a telco and a vendor give several options which GTA may wish to adopt. Section 3 therefore, summarizes these practices.

3. ROLES OF INSTALLER AND TELCO IN ACCEPTANCE

Three acceptance options exist, each providing a selected degree of assurance to the telco that the commissioned equipment and related software complies with specified performance and reliability standards. There are

- Joint acceptance
- Buyer acceptance
- Waived acceptance

3.1 Joint Acceptance Option

Using this option, the telco elects to participate as an observer, in the joint operational tests identified in Section 2 and in Annex A. This option is intended to provide the telco maintenance personnel with basic familiarization.

3.2 Telco Acceptance Option

This option indicates that the telco has elected to waive participation in installer tests. This option is intended to accommodate the telco in arranging training facilities for maintenance personnel who are performing facilities line up and cutover tests. The telco then performs acceptance and cutover tests after installation is complete and prior to putting the switch in service.

3.3 Waived Acceptance Tests

By selecting this option, the telco waives all acceptance tests and accepts the installers verification reports and test results for the completed installation. However he may still participate in the assessment test. The telco performs the required cutover and facilities line-up procedures prior to in-service use. The costs of joint testing or Telco acceptance are avoided with this option. It is selected by telephone companies that view their line up and cutover preparation as meeting their acceptance requirements for the switch performance.

4. SUMMARY AND RECOMMENDATIONS/GUIDELINES FOR GTA

The 1982 decision on interconnect has opened the way for GTA to own its own switches. Up until then, there was no apparent need for user intervention in the procurement and in the telecommunication services offered. Moreover, it is still a feasible option to let the various telcos within Canada to provide the required service. However, even if GTA opt to proceed with BC Tel in the Vancouver - Victoria Consolidation, it is now appropriate that they should participate in the procurement, acceptance and management of their network if only to leave their options open for future ownership.

The scope of these recommendations/guidelines relate only to acceptance testing. The purpose is to enable GTA to develop practices which will eventually provide a solid baseline for future procurements of high technology equipment. This baseline is sufficient knowledge of the procedures in acceptance to allow a decision as to whether the necessary expertise should reside within GTA or be procured on a subcontract basis.

Section 2 and Annex A indicates the thoroughness of the testing procedures carried out by the manufacturers and by Canadian telcos. (Interconnect companies have slight variations in that they test the switch only up to the physical interconnect block which represents the external dividing line between the telco and the buyer).

To ensure future availability of the interconnect option, even if not taken this time, GTA's approach to acceptance testing is clear.

A. At this time GTA should prepare for the future by familiarizing itself with the processes that occur from production to final cutover of a switch. This familiarization may in the first instance be carried out through the use of subcontractors until GTA policy can be set.

B. The first stage of "acceptance testing" for GTA, is to identify its immediate requirement (i.e., Vancouver - Victoria) with the switch capability. This identification may be done either through discussions with other organizations or directly (if the switch is unproven) with the manufacturer or vendor. Implicit in this is a need for GTA to specify its requirements in detail so that practical tests on capability can be undertaken.

Note: This is a familiar process in the multi vendor world of computer system technology.

C. Since we do not expect GTA to maintain its own switches (interconnect companies offer a waranty and extended maintenance plan) GTA's role in the installation tests need only be that of monitoring the installation plan and the commissioning bar chart if the latter is available.

D. GTA should, however, participate heavily in the installers assessment testing (e.g. waived acceptance option in Section 3), in operational and functional tests, and in assessing the validity of the switch data output. This would imply effort on the part of GTA to translate its user requirements into system requirements and define practical test procedures which can be carried out during the 24 hour evaluation period (Section 3).

E. For the present, it is difficult to see how GTA can technically participate in cutover. Contractual agreement that cutover will occur by a certain date is the obvious process to follow, though observation of the process will be of great assistance to GTA in the future.

F. Finally, to ensure that the functional and operational tests were adequate, in the first instance, and to prepare for any future procurement, a GTA information capability could be set up to monitor a sample of the first year of operation.

In acceptance testing as in many of the other requirements of the GTA RFQ, the telecommunications end-user is entering a field of endeavor which has been hidden from him by the all enbracing nature of the telephone companies. However, many of the approaches he must take to the new multi-vendor, high-technology society, are already parallelled in the data processing world. It is from that world that GTA can perhaps extract many of the procedures which will ensure reception of an adequate product.

5. INFORMATION FROM BIDDERS

5.1 Quality Assurance

5.1.1 Quality Assurance Program

The supplier shall submit an outline of the quality assurance program used to ensure the integrity of both hardware and software delivered under the contract. A list and description of the various tests applied to hardware and software as part of the quality control process must be included.

5.1.2 Quality Control Records

Records must be maintained on the status of hardware and software subjected to the various quality control tests. These records shall be made available on request; they will establish that the quality assurance contractual requirements are met.

5.1.3 Reject and Retest

When any component, module or subsystem of either hardware or software fails to meet the requirements of quality assurance or acceptance tests jointly established under contract, system acceptance shall be withheld until the cause of failure is corrected. After correction of the failure, all failed tests shall be repeated and completed prior to final acceptance and at no cost to GTA.

5.1.4 Quality Evaluation Period

The first year of system operation shall be considered as a quality evaluation period. During this period, the supplier shall:

a) document the type of failure and necessary corrective action for all hardware elements returned under warranty.

b) document all software changes applied to the system after final acceptance.

c) submit copies of this documentation to GTA

d) establish a field change verification procedure

e) take necessary corrective action to ensure that any major or recurrent failures due to improper design or component quality are permanently rectified and retrofitted.

Items b, c and d apply throughout the life of the equipment.

5.2 In-plant and Field Acceptance Tests

5.2.1 In-plant Acceptance Tests

The supplier will be requested to demonstrate the successful operation of principal system entities prior to delivery to the installation site. The supplier is requested to provide, for review a list of acceptance tests which may be performed in the factory.

5.2.2 On-site Acceptance Tests

On-site acceptance tests will be required to demonstrate that the system is performing within specifications. These tests are an extension of factory acceptance tests and are aimed at verifying successful completion of installation and overall system performance prior to in-service.

5.2.3 Feature Tests

GTA will verify the operation of the individual system features. GTA reserves the right to request and receive the assistance of the supplier in demonstrating the successful operation of any of the features.

5.2.4 Fault Insertion Tests

In order to verify the operation of maintenance and fault recovery procedures, GTA may introduce temporary fault conditions into various subsystems. The nature of these tests will make participation and assistance of the supplier's personnel essential.

5.2.5 Load Tests

GTA requires that the supplier demonstrate system behaviour under sustained traffic load conditions before the system is placed in service. GTA may assist in this process by introducing traffic from the telephone network side. The supplier shall provide information on the procedures, program tools and test sets required for such load tests.

6. REFERENCES

1. Standard for terminal equipment, systems and connectors Government of Canada, Department of Communications CS-03 issue 4, 30 November 1982.

2. Deliverable 20 - Installation Standards etc - this series.

Annex

Examples of acceptance tests

(The table also indicates those tests which would normally be carried out on a joint acceptance basis)

Item No.	Commissioning Test Description	Acceptance
1	CPU Micro-code Tests	
2	CPU Maintenance Test	
3	CPU Store Test	
4	Network Maintenance Test	
5	Magnetic Tape Drive Test	
6	Printer Test	
7	Terminal Controller Test	
8	Continuity Test	
9	Power Verification	
10	Recorded Announcement Test	
11	System Loading	
12	Network Commissioning	
13	Network Trouble Shooting Aids	
14	Misc. Circuit Diagnostic	
15	Trunk Diagnostic tests	
16	Automatic Trunks Testing	
17	System Detected Alarms	
18	Data Dumping	
19	Manual Action Emergency Procedure	
20	Spare Circuit Pack Testing	
21	Custom Calling Feature Tests	Joint

Item No.	Commissioning Test Description	Acceptance
22	Business line and PBX feature tests	Joint
23	Local Feature tests	Joint
24	CDR tape tests	Joint
25	Special Features	Joint
26	Fault location tests	Joint

Deliverable 16

Implementation Planning

TABLE OF CONTENTS

1. INTRODUCTION

Implementation planning for a network as complex as that of the Government is a continuing activity which must take place from initiation of the intent to modernize right through to the final switch cutover. Apart from its size and scope, the complexity of the network arises from the potential number of players involved - the manufacturer, the Telcos, the long haul carriers and inter-connect companies as well as the various Government departments and sites. Coordination of network implementation with these various groups is not a task to be undertaken lightly and will almost certainly require a program office and a steering committee to ensure success. For example, on the basis of its operational plan. GTA must identify lead times for ordering circuits and switches, estimate times for switch installation, testing and cutover, evaluate likely impact on quality of service available during implementation as well as the risks associated with not meeting the plans.

The formation of a steering committee, of a program office and the use of personnel to be associated with network implementation is a matter of policy for GTA and is outside the scope of this deliverable. Moreover since key factors in switch installation have been addressed in Deliverable 15 on acceptance testing, the deliverable is constrained to the study of activities leading up to switch cutover from initial production of a GTA RFQ.

1.1 Implementation Planning

Implementation planning is simply a matter of coordination and communication among different groups of people and different activities. During change over, some of the activities are to be completed by the vendor, some by the telephone company and some by GTA. The plan sets a realistic completion date for the project then works backwards to the project beginning, allocating the available time and resources in the optimal manner.

Activities involved in implementation planning are shown in Figure 1.1. The boxes in figure represent major activities. Time to finish an activity can be shown on the line coming to the activity box. The time allocated to each activity depends upon firm cutover date and manpower available. Some of activities shown are self explanatory. The following paragraphs list the activities shown in Figure 1.1 and discuss some of subactivities leading up to those activities.

1. R.F.Q. sent out to vendors

2. Analysis of RFQs received from vendors

3. Contract signed

4. Organizational committee meeting

   - People from Vendor and Telcos should be included in committee
   - Tentative cutover date to be set
   - Anticipated trunking routes and requirements should be established
   - Overview of installation process should be established
   - Allocation of tasks and responsibilities should be done
   - Trunk design specifications drawn up

5. Telco order placed for trunks

6. Compatible issues resolved

   - Vendors of existing systems and new system should resolved compatible issues, if any such as
     - Interface with different technology (microwave, optical links etc.)
     - Stand-alone application support if any e.g. Automatic Call Distributor or Network Management Centre

7. Floor Plan Ready

   - First priority is to establish who gets what.
   - Set installation points marked on the plan
   - Switch installation room should be located on the plan

8. Firm cutover date set

   - Cutover date should be set to allow the supervisors of different activities to project their time requirements.

9. Equipment room prepared

- Necessary air conditioning, heating, plywood, electrical outlets and power supply etc. should be completed to prepare the equipment room properly.

10. Database development for Networking Features

    - It is a vendor's activity
    - Formats of databases are established
    - Features for individual are programmed
    - Normally vendors takes 4 to 8 weeks for programming
    - The database

11. Material Received

    - The switch, sets and other peripheral hardware are received. The receiving data depends upon manufacter's volume of sales and backlog.

12. TELCO order received

13. Pre-cutover trunk tested

14. IDFs (Intermediate Distribution Frames) in place

    - It is often less expensive to construct IDFs throughout a building than to run each telephone set's wiring to the main distribution frame. Maintenance and trouble-shooting are facilitated by using IDF's.

15. MDF (Main Distributing Frame) in place

    - Wiring from IDFs to MDF should be completed

- Freeze changes

    - Prior to testing, moves and changes should be frozen to avoid confusion until cutover.
    - Additions will again be allowed but not deletions

17. Switch installed

    - Physical installation of the switch and connections to MDF should be completed.

18. Database programmed and received on site

19. User training completed

20. Sets installation

21. Switch tested

- Installers should test the switch with the final database
- Check the functionality of sets and switch
- Bugs in database should be removed

22. Switch tested on intercom basis

- Users can call other users locally via a switch (no use of trunks)
- Overlooked programming bugs can be identified
- Hardware difficulties if any can be discovered
- Users also gain some familiarity with new system

23. Cutover trunks

24. Acceptance

- It is post-cutover management activity
- Troubled calls are collected for investigation
- Changes are allowed under control
- Monitoring acceptance of the system

25. Removal of old system

DELIVERABLE 16

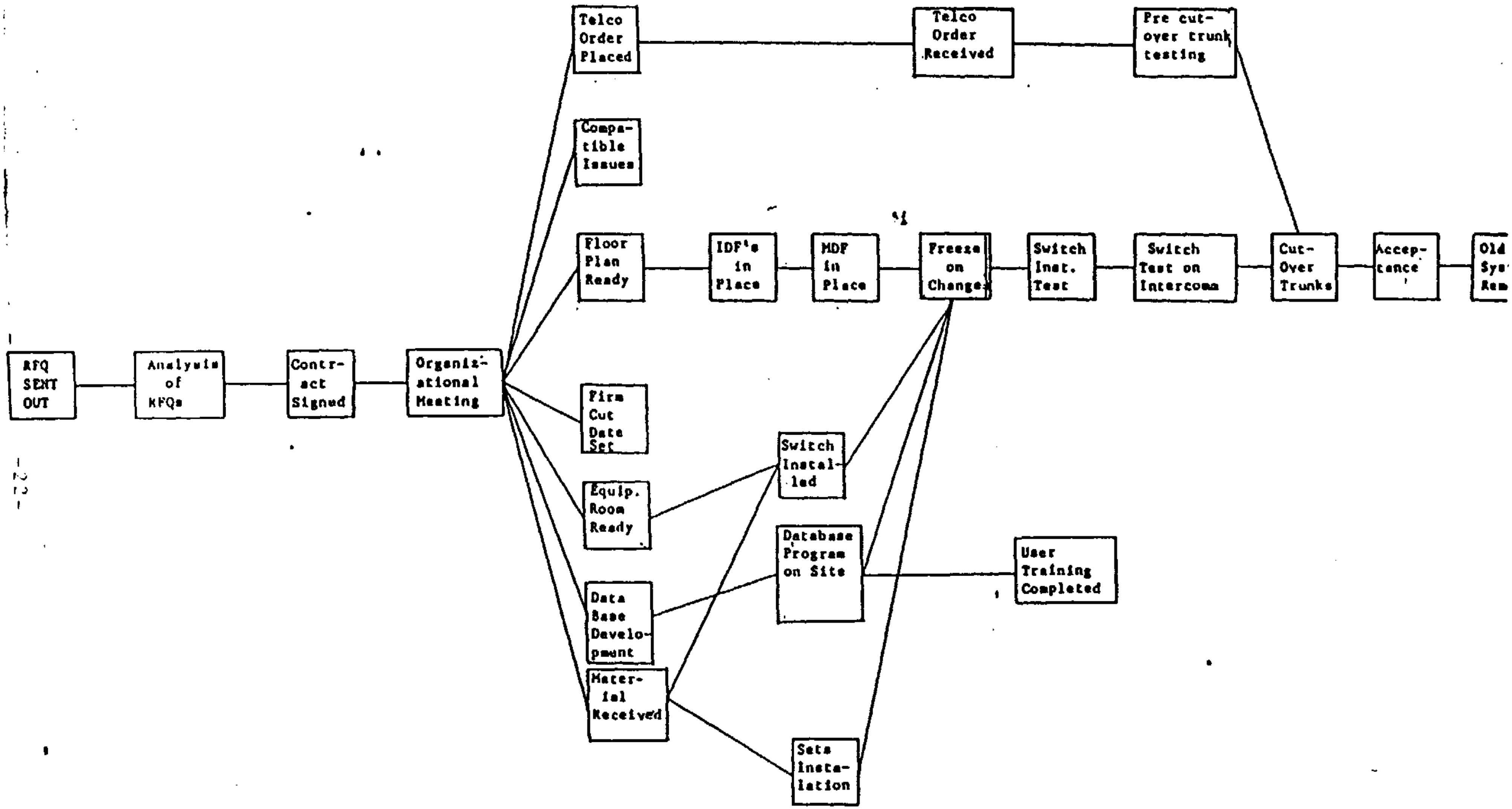


Fig. 1.1 CUTOVER PLANNING

Deliverable 17

Feasibility of Proposed Uniform Dialing Plan

TABLE OF CONTENTS

1. INTRODUCTION

The system planning and development group of the Government Telecommunications Agency has the GTA National dialing plan with the following characteristics:

- Each main station should have a unique address
- That the address be convenient to use and readily understandable
- Each address should be identical in format to all other main stations connected to the network.

After evaluating different dialing plans, the system planning group has recommended a national dialing plan for the GTA voice network and that prefixes "90", "91", "9" and "1" be used as access codes.

The objective of this deliverable (17) is to examine the feasibility and limitations of a modern Government consolidated telephone service in Vancouver and Victoria composed of a number of modern stored program switches such as SL-1, S1-100, SX-2000, ROLM VLCBX and Plessey K2 interlinked together to accommodate the proposed dialing plan.

1.1 Proposed GTA Dialing Plan

One possible uniform numbering plan that GTA has identified fits more readily into the existing government network numbering plan is to use "9" and "1" as prefixes. Existing dialing procedures use "9" as an access digit for the teleco networks, whereas "1" is used as the 1st digit of the IX routing codes. Thus existing abbreviated dialing arrangements avoid the use of "9" or "1" as a first digit.

The government network proposes to have a national dialing plan based on the use of NPA codes of the public network and that prefixes "90", "91, "9" and "1" be used as access codes i.e.,

0 - PBX operator
XXXX - Internal PBX (on-Net)
9-411/611 - Local DA or repair (off-Net Special No.)
9-0 - DDD or local operator
9-NNX-XXXX - Local Calls (Off-Net)

1-0	- IX operator
1-NPA-NNX-XXXX	- HNPA & FNPA (On-Net)
1-NPA-IXX-XXXX	- HNPA & FNPA (On-NET) Non-Coordinated address
9-1-NNX-XXXX	- HNPA (Off-Net) DDD
9-0-NNX-XXXX	- HNPA (Off-Net) Operator Assist. DDD
9-1-NPA-NNX-XXXX	- FNPA (Off-Net) DDD
9-1-800-NNX-XXXX	- Toll Free (Off-Net)
9-0-NPA-NNX-XXXX	- FNPA (Off-Net) Operator Assist. DDD
9-01-CC-NN	- International (Off-Net) Operator Assist.
9-011-CC-NN	- International (Off-Net) DDD

2. ESN UNIFORM DIALED PLAN (UDP)

The Uniform Dialed Plan allows users at ESN locations and directly connected access locations (FX's) to dial on-net or off-net calls in a uniform manner, regardless of the calling party or the route which the call will take.

ESN Dialed Formats for UDP Calls

Call Types	Dialed Format
On-Net	AC1*LOC+XXX
DDD	AC1*NPA+NXX+XXXX
Operator Assist. DDD	AC1*0+NPA+NXX+XXXX
International DDD	AC1+011+CC+NN
Operated Assisted International DDD	AC1+01+CC+NN
Network Speed Call	AC1+NSC+LLL
DDD Operator (Public Net)	AC2+0
Local Calls	AC2*NXX+XXXX
Special Numbers	AC2*SPN (411 or 611)
Toll free calls	AC2*800+NXX+XXXX

where

- AC1 - Access Code for on-net and long distance calls. Typically the digit 8 is used but AC1 can be either one or two digits.
- AC2 - Access Code for all local calls. Typically the digit 9, but AC2 can either be one or two digits.
- LOC - Location Code for each network location in UDP.
- NPA - Numbering Plan Area Code in the form of N1 * or NO *
- NXX - Local Exchange Code
- XXXX - Four digit extension number
- CC - Country Code
- NN - National Number
- NSC - Network Speed Call list access code (1 to 3 digits)
- LLL - Network Speed Call list element number (000-999)

Each switch in the network is referenced by a unique 3-digit location code. No conflict can exist between the location code number and NPA codes. More than one location can be assigned to an ESN switch if necessary.

ESN Provides 256 possible location codes. This allows up to 256 route lists per switch and up to 8 outgoing routes WATS, DDD, etc., are provided per route list. For ESN locations, NARS (Network Alternate Route Selection) allows local, long distance, international and special number calls to be processed in the ESN routing software. For conventional local PBX (a PBX without ESN signalling package), the access code for network calls (ACI) is used as the access code for this trunk group. The ESN trunk group inserts ACl on each incoming call from the switch. This procedure is transparent to the user.

If an ESN switch is installed in a tandem tie trunk (TTTN), other switches in the network are able to tandem through the ESN switch using the same access codes for the TTTN trunks, provided that no dialing conflicts exist between the TTTN access codes and the dialing plan implemented.

3. ROLM UNIFORM DIALED PLAN

VL ROLMNET is the on-net numbering plan for the ROLM VLCBX. VL ROLMNET provides two new networking capabilities:

1. On-net/Off-net alternate routing

2. ETN/ESN Traving class mark translation

On-net/Off-net dialing formats are similar to the formats of ESN ones.

On-net dialing	AC1 * LOC+XXXX
Off-net dialing	AC2+NPA+NNX+XXXX

Users dial an access code (usually '8'), a location code (usually a 3 digit RNX) and an extension number (usually 4 digits) for every station on the network.

VL ROLMNET provides uniform dialing and least cost routing for on-net calls. The CBX, once digits are dialed, routes the call over the most cost-effective route available. The actual routing is transparent to the user. The On-net dialing plan is defined as NP2 and the off-net dialing plan is called NP1 Plan.

ROLM NET services list up to 512 location codes. Each location code references one of 512 route lists. Route lists are shared between on-net and off-net numbering plans. Any route list can be referenced by any number of NP1 service area lists and/or NP2 network service location codes. The first choice could be to outpulse the on-net number over a tie line. The second and third choices could be to convert the on-net number to a public listed telephone number and to outpulse the public number over WATS and DDD respectively.

4. IMPLICATION OF THE GTA UNIFORM DIALING PLAN

A uniform dialing plan should enable users to dial all remote sites in the same manner, independent of the location of the calling party or the route which the call will take. The uniform dialing plan is both a convenience for the user and a cost reduction feature. It also encourages use of the network, for the numbers dialed to reach a specific destination do not change as a caller moves to different places served by the network. It eliminates complicated tie line access codes that change whenever the network is reconfigured.

The first implication of the uniform dialing plan is that the switches must have the capabilities to

- tandem automatically
- translate the dialed number and select an appropriate network route.

To take maximum benefit of the uniform dialing plan, the switch should interact with other features. These other features are mainly

- Alternate Route Selection
- Network Class of Services
- Travelling Class of Services or Travelling Class Mark or Facility Restriction Levels

If the appropriate network route is busy, the switch should select the alternate route to the dialed destination. The selection of the alternate route depends upon the caller's network class of service level allocation. Therefore the success of dialing plan objectives in Vancouver - Victoria consolidation depends upon the capabilities of modern switches installed and interlinked together. For the switches under consideration as tandem switches, SX-2000 and Plessey K2 do not have their own networking capabilities but ESN and ROLM as discussed before can accomodate other PBXs and achieve most of the networking features.

The GTA dialing plan is based on the use of NPA and NXX codes with prefixes "90", "91", "1" be used as access codes for off-net calls. It allows the user to dial less number of digits for on-net calls and the machine has to translate a lesser number of digits. ESN switching machines and ROLMNET switching machines both have 10-digit translation capabilities. As far as GTA dialing plan's feasibility is concerned, we see no problem. But there are impacts on implementation:

1. In processing most of intercity on-net calls, the switch has to translate the first six digits. In some cases 10 digits translation would be necessary. For example, when two government locations under the same NPA NXX codes and with no centrex the switch has to translate all 10 digits to route the call to the right destination.

2. The GTA proposed dialing plan along with Automatic route selection may create route table storage limitation problems if the tables and architecture are not designed properly . Every NNX of every NPA number must be present in these route tables, even in some cases even the last four digit numbers should be included in the tables.

3. When an off-net long distance number is dialed by a user, a switch must have a capacity to screen the off-net number before it goes off-net, to make sure that the destination is not a part of the free calling area of another on-net switch location.

5. CONCLUSION

The objectives of the GTA dialing plan can be achieved in Vancouver-Victoria by installation of a proper tandem switch.The ESN uniform dialing plan(SL-1) provides 256 possible location codes which allows up to 256 route lists per switch while ROLMNET provides up to 512 route lists per switch. These may not be enough for GTA's objectives. SL-100 for example carries hardware from DMS-100 which is used for class 5/4 switch and the software developed in SL-100 has sufficient capacity for possible location codes and route lists. The objectives of the dialing plan based on NPA and NNX codes can be fulfilled by this tandem switch.One can install SL-100 with its software and can also have ESN feature capabilities.Such concerns will likely occur in other consolidations.

6. REFERENCES

1. NTL - ESN features documentation (ESN Release 2) 1982 November

2. GTA - GTA National Plan & Guidelines System Planning & Development Information Report. 7412-2, February 1983.

3. ROLM - "ROLM's" First Public Teleconference May 1983.

Deliverable 18

<u>Information Bidders Should Provide in Response to the RFP</u>

TABLE OF CONTENTS

1. RESPONSE TO THE RFQ

Parties replying to a request for proposal should supply the following information in a separate section of the response:

A. Proposal Contents

To facilitate evaluation of replies to the RFP received from different parties, the Government Telecommunications Agency would like to have a document with the following contents:

- Response Introduction
- Price Schedule and Delivery
  - Bid Summary Sheet
  - Pricing Detail Sheets
  - Delivery, Installation & Commissioning Period
- Network Architecture
  - Existing & Future Demand
  - Intracity Network (Vancouver - Victoria)
  - Interface with Intercity Network
- System Operations
  - Numbering Plan
  - Networking Features
  - Station Features
  - Console Features
- Technical Compliance
  - Compatibility
  - Transmission
  - Signalling
  - Performance

- Reliability, Maintainability and Availability

- Network Management
  - Billing and Operational Measurements
  - Traffic data measurements
  - Trunk Testing
  - Maintenance and Alarms
  - Network Monitoring and Central

- Electrical and Environment Requirements (of vendors equipment)
  - Space and flooring requirements
  - Power supply requirements
  - Environmental requirements
  - Inhouse wiring requirements

- Evolution
  - Evolution to recommended architecture
  - Methodology and time frame
  - Installation and Commissioning
  - Pre and Post Test Period & Methodology

- Acceptance Tests

- System Support
  - Software updates
  - Engineering Technical Support
  - Training
  - Operation & Maintenance Support
  - Documentation & Practices

- Committments for the future
  - Warranty
  - Cost-effectiveness useful life
  - Miscellaneous

B. Bid Summary Sheet

The Bid Summary sheet should indicate

1. Total System Price
   - Purchase
   - Lease ___ Years
   - Rent
   - Maintenance
   - Connecting Arrangement
   - Lease Rate Factor (Interest)
2. Service Itemization
   - Delivery and Freight
   - Installation
   - Warranty for ___ Years
   - Training
   - System Network Analysis Support

C. Pricing Detail Sheets

Pricing detail sheets should cover (for features)

- each of the mandatory requirements:
- each of the desirable requirements:
- each additional available feature (unmentioned):
- switching equipment itself (in modules of lines).

Note: The pricing detail can be supplied on a per line equipped or a total system basis.

2. OPTIONS

As there are several possible network configurations which could satisfy the Vancouver - Victoria intercity facilities requirements to varying degrees, parties replying to the RFP can submit for consideration quotations for various network configurations meeting all mandatory requirements. For each configuration, the bidder should indicate which requirements cannot be fully met and submit:

- all pricing information described above: and
- an outline of the method to be employed to provide the mandatory requirements such as the UNP, NCOS, network management information etc.

In the case of network management information, the key government requirements of sufficient information for billing and assurance of equipment reliability may be met by alternative means to those described herein. Responders are encouraged to be creative in making such proposals to the government.

Responders are requested to outline the impact of the proposed new architectures on the government uniform dialing plan.

Deliverable 19

JACKS and PLUGS

TABLE OF CONTENTS

1. INTRODUCTION

The CRTC Telecom decision 82-14 (1982) on the interconnection of customer owned equipment states (pg 41 paragraph (b), (iv) on inside wiring).

> "The interim decisions* require the attachment of subscriber provided terminal equipment to be made by means of a jack and plug arrangement at an interface point agreed upon by the subscriber and the carrier".

Further down in the same paragraph,

"The Commission CONTINUES to consider that subscriber - provided terminal equipment and associated wiring should be connected to the network only by means of a jack and plug arrangement".

Both decisions (80-13, 82-14) directly relate to the required emphasis on this deliverable - the advantages and disadvantages of jack and plugs over direct wiring and the impact upon theft. In the study, therefore, we consider the effect of the decisions on the supply of telephone sets: the type of interconnection that will be available and the resulting options available to GTA: and examine the advantages gained, for example, by BNR, through a more flexible set connection policy.

* CRTC Telecom decision 80-13

2. IMPACT ON THE SUPPLY OF TELEPHONE SETS

As a result of decision 82-14, telecommunication customers are allowed to purchase their own equipment up to and including their own PBX. Although deliverable 10 of this series raises the possibility of installing a customer owned PBX on telco premises, the decision implies that the equipment in question normally resides on the customer's premises. Thus the interface to the public network will also be on cutomer premises.

The impact of the decision is therefore

1. If the customer wishes to own only single line sets and key sets, then the interface point is at a set of interconnect blocks on each floor or office within the customers premises.

2. If the customer wishes to own his PBX and the telephone sets, then the interface point will likely be in the basement of his premises (decision 82-14 page 36 paragraph 2, paragraph 4).

As a result of the decision and of the various options open to a customer, Bell Canada has agreed with the commission that

a) For residential customers, all single-line sets to be put in place after June 1983, will be terminated by a jack and plug connection. For sets connected prior to June, Bell will be responsible to maintain them up to that point where a customer changes the contract agreement.

b) For business customers, all single-line sets to be put in place after September 1983, the same termination standard will hold, Bell still acting in a "grandfathering* role:.

Hence the option of hard wiring of single line sets will not exist after September 1, 1983. Other types of sets and interconnections are discussed in section 3.

---

* Grandfathering permits equipment already in place to remain in service without further attestation or certification.

3. TELEPHONE SETS IN THE GTA ENVIRONMENT - POST 1983

Three types of sets, their interconnection and the likely impact on theft are examined - single line 500 type sets: key sets: and proprietary sets.

1. Single-line Sets

   As we have stated these will have a jack and plug arrangement post September 1983. Consultations with Bell Canada and BNR security have indicated that the theft of telephone sets has not been a problem to date but that it does comprise a matter of concern. Several approaches have been discussed ranging from physical security where briefcases, shopping bags etc., are subject to random/routine searches when employees leave a building: to the manufacture of a clamp to attach the wire to an adjacent wall in order to make theft more difficult. No such clamp is currently available.

2. Key Sets

   The sets are connected by a standard amphenol connector (Figure 1) to the key system which enables the choice of internal circuits. The theft of a key set is an unlikely event unless the objective is to remove the whole system.

3. Proprietory Sets

   A common approach amongst digital PBX vendors is to supply proprietory "single line" sets with their PBX though, of course normal 500 type sets can be used. These sets usually have three wire pairs connected through connectors constructed similarly to 4 in Figure 1. One wire pair carries the voice conversation: the second is used for signalling whilst the third (option) is used for powering an add-on module, say, for data. In the case of an add-on data module, the data transfer is multiplexed with the signalling channel. The theft of (single-line) proprietory sets is not of concern since they will only work with the relevant digital PBX.

4. ADVANTAGES OF JACKS AND PLUGS

Apart from questions of theft, the advantages of not hard wiring telephone sets are fairly clear. Office environments particularly in the realms of (non-routine) knowledge workers have tended to become more and more flexible particularly when staff rotate among departments and departments are regularly reorganized to meet the changing business environment. Thus

- Office designers and organization developers can allow flexibility both in the possible locations of phones and in the number of phones within a particular office area.
- The repair and replacement of telephone sets is facilitated without any real hindurance to the end-user.
- Movement, of personnel within the office area, who have restricted access to the telephone network is effected readily.
- Standardized connectors increases options on the purchase of telephone sets from different manufacturers.
- Standardized connectors will improve the flexibility of the new voice-data office environment. For example, for the simple voice jack and plug, a capability exists to readily use a data terminal with a modem from any office location.

5. CONCLUSIONS

The effect of CRTC telecom decision 82-14 has been to standardize telephone set connections within the office environment. This has several advantages (section 4) but raises the difficulty of theft prevention with respect to standard single-line telephone sets. The incidence of theft in a jack and plug environment is a new phenonemon and methods of prevention have not yet been fully explored. Moreover reported theft has as yet not been significant and the extent to which it may happen in future may be exacerbated by too much visible concern.

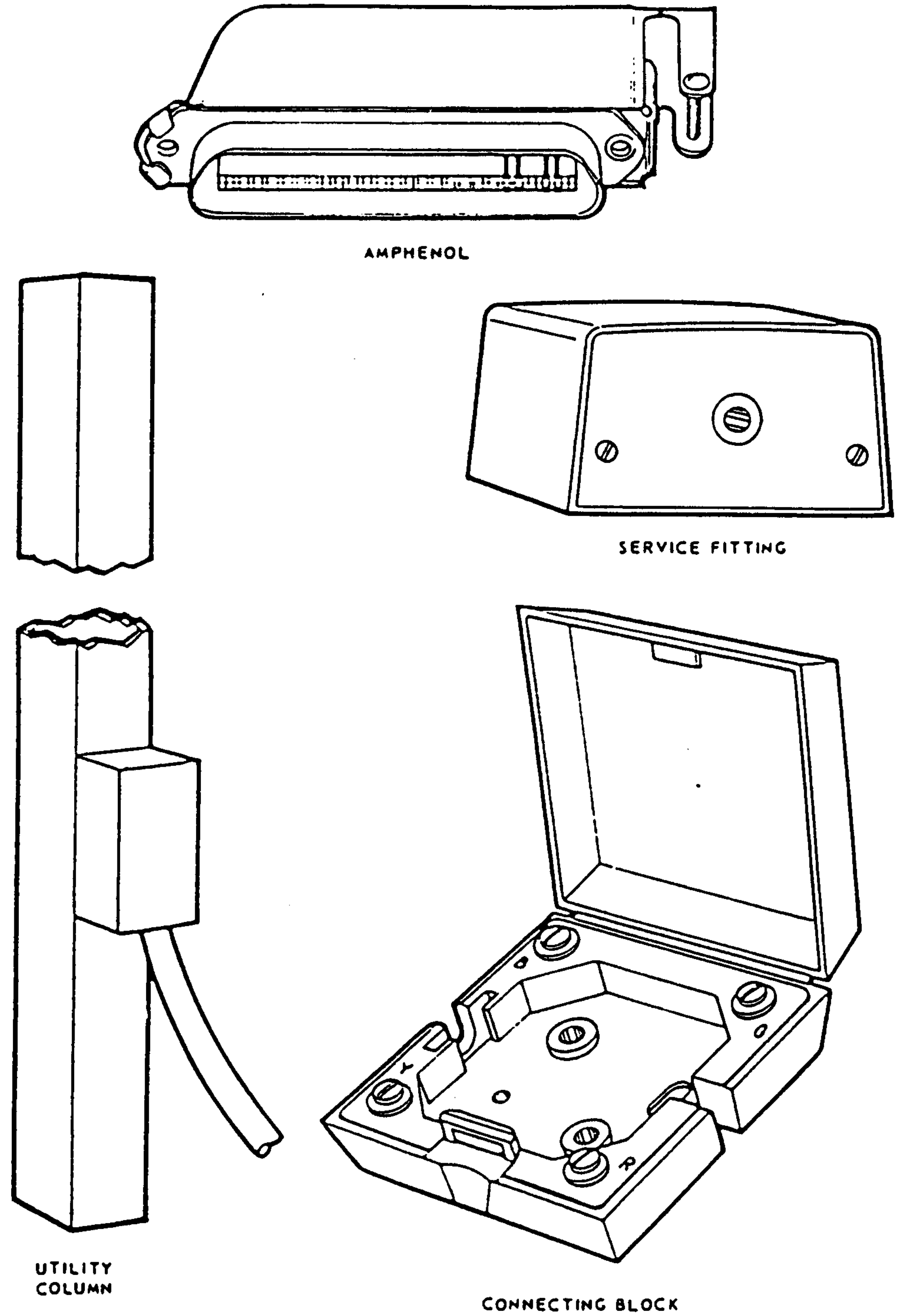


Fig. 1 - Miscellaneous Designated Apparatus

6. REFERENCES

1. "Attachment of Subscriber-Provided Terminal Equipment" Telecom Decision CRTC 82-14.

2. "Bell Canada - Interim Requirements regarding the Attachment of subscribers-provided Terminal Equipment" Telecom Decision CRTC 80-13.

Deliverable 20

<u>Telecommunication Installation Standards for the Federal Government</u>

TABLE OF CONTENTS

1. INTRODUCTION

The scope of this deliverable was defined to include installation standards for cabling, wiring and terminal attachment for use by GTA in assessing its future communication needs. The plethora of terminating devices combined with the certain amount of confusion in the telecommunication market place, imposed a restriction on this deliverable in terms of the amount of detail that could be offered. The deliverable therefore concentrates on providing guidance to GTA on those factors which may need to be taken into account when commissioning the modernization of the Vancouver - Victoria (and other) consolidations.

There are three section to the deliverable. Firstly we examine installation wiring with those standards derived from the Department of Communications document CS-03, issue 4 (from which design specifications may be obtained). Within the section, we also examine the factors involved in moving toward uniform wiring.

In section 3, we consider the question of communications preplanning so that GTA will be aware of the option involved in installing inside wiring. Finally in section 4, we summarize the requirements for terminal attachment and reference the relevant documents where specific details may be obtained.

Until a greater knowledge of the precise communication requirements in Vancouver - Victoria is obtained, the range of application of these standards will not become clear.

2. TERMINAL EQUIPMENT INSTALLATION WIRING

2.1 Introduction

Several standards/standard procedures are being and have been developed since the incidence of allowing subscriber owned equipment. These procedures evolved in part from an FCC rules document 47 CFR68 in which the potential for damaging the public network through improperly connected subscriber apparatus - the apparatus not being under telco control, through CRTC decision 80-13 on interim requirements for attachment as proposed by Bell Canada, to D.A.C. documents CS-01, CS-02, CS-03.

As is clear the objectives of these standard procedures is to protect the public network. CS-03 issue 4 is the latest in the public documents to identify the procedures, however CS-03 issue 5 is due to be published anytime. A summary of the points covered follows.

3. CS-03 REQUIREMENTS

3.0.1 Safety

Installation shall be in accordance with the most recent version of the Canadian Electrical Code - Part 1 issued by the Canadian Standards Association.

3.0.2 Network Point of Connection

Insulated conductors and connecting devices shall be of a type recommended by the manufacturers as being suitable for the location and conditions under which they are employed.

The point of connection shall be at telco provided jacks at an accessible location mutually agreed upon by the telco and the customer. The rationale behind this is to ensure there is adequate space and access, that the environment is sufficient and that there is reasonable security from unauthorized access to the public network.

Services to the customer on this aspect are provided by the CTCA Building Industry Consultant Service (BICS) - (c.f. Section 3).

3.0.3 Wiring Limitations (c.f. Deliverable 10)

Total loss of equipment and wiring from the network point of connection to the furthest station apparatus shall not exceed 0.5dB, with a maximum resistance count of 50 ohms - equipment to about 300 meters of 24 guage cable. For 19, 22 and 26 guage cable the wire length is approximately 1000, 475 and 185 meters respectively.

3.0.4 Communication Ground

Equipment requiring a communications ground (apart from the power safety ground (green wire) shall, in order to minimize the introduction of noise, have a low impedence path to the main building ground source separate from that provided by the carrier for its equipment.

3.0.5 Qualifications of Installation Supervision

The person responsible for the direct supervision of the personnel performing the installation shall have the following qualifications

- six months on-the-job experience in installing similar equipment and wiring.
- training from the equipment manufacturer or alternatively distributers or agents shall provide the necessary training.
- be familiar with the Canadian Electrical Code, part 1.

3.0.6 Acceptance Tests (c.f. Deliverable 15)

Each terminal equipment network interface shall be subjected to a series of acceptance tests, as outlined in the appropriate documents using a station apparatus which forms part of the installation connected behind the equipment, at the time of connection to the network. A typical acceptance test will require:

1. Reception of dial-tone
2. Ability to break dial-tone
3. Ability to dial and successfully reach a pre-arranged telephone number using dial-pulse or DTMF signalling, as applicable.
4. Dial an incoming call to the network interface under test from outside the system being installed, busying out other ports as required to reach that port.
5. On receipt of ringing, go off-hook and confirm ability to trip ringing.
6. Verify ability to conduct two-way conversation without impairment.
7. Monitor for audible hum or excessive noise under all of the above test conditions.

The carrier may require the monitoring of the acceptance testing on-site, from its test centre, or elsewhere.

3.0.7 Right of Inspection

The carrier, in accordance with approved tariffs, may reserve the right to inspect the equipment installation and wiring at the time of installation or at any other time.

In the event of non-compliance, the carrier may, at its discretion, apply the remedies available to it under tariff.

3.0.8 Notification of change

The customer may be required to advise the carrier of any significant additions or changes to the installation or wiring that are made subsequent to acceptance testing.

3.1 Toward Uniform Wiring

In the main, the above wiring procedures and standards apply to telephone terminal equipment. However, wiring to interconnect data terminals has greater variety, for example coax and fibre, and the requirements depend on particular manufacturers equipment and equipment configuration. For example

- "Dumb" terminals connected directly.to a mainframe or mini or multiplexed via an intelligent controller require high-bandwidth to the controller to assure speed of response for screen refreshments etc.

- "Intelligent" terminals, personal computers requiring perhaps batch access to a mainframe/mini can often satisfactorily operate over twisted pair.

- Intelligent work stations from part of a high speed local area network require coax or fibre for example to cope with computer-computer communication.

GTA's requirement to move to a uniform building wiring plan is, however, possible, was given the potential need for coax and fibre. At least one manufacturer (Northern Telecom) has commited to providing a twisted pair capability for value added services (c.f. Deliverable 6) involving both voice and data. Thus current inside wiring can remain in place and is useful.

4. BUILDING STANDARDS

Apart from the types and specifications of inside wiring, installation standards also require consideration of how the wire and cable is to be laid to ensure safety and to maximize flexibility of use of the wiring.

In section 2 of this deliverable, we observed that the planning and installation of the network point of connection was a function offered by the carrier's Building Industry Consulting Service (BICS). Planning and installation of inside wiring is a further service offered primarily to architects and engineers involved in the design and construction of offices and other buildings. However the service is not usually offered directly to the customer (end-user), though were the customer to decide to use Telco leased equipment, arrangements could be made. In a similar vein, interconnect companies (e.g. BCSI) will offer an equivalent service though, at this time, only after an agreement to purchase has been signed.

In respect of GTA requirements to access these standards, two points should be made.

- A communication distribution plan incorporating the sizing of equipment rooms, user system, apparatus closets etc., is primarily a matter for the office designer/architect and the respective telecommunications consultant. This approach will be satisfactory except perhaps in the rare case of GTA wishing to retain choice of supplier, prior to the construction of a new office building. In this case, it is possible that GTA may need to access independent resources outside the interconnect or carrier organizations.

- CRTC decision 82-14 allows GTA to purchase the wiring in place from the carrier at a fair market price. For the forseable future this would be adequate for most Government Buildings. In other situations then recourse to the first approach above can be made.

5. TERMINAL ATTACHMENT STANDARDS

In deliverable 19 of this series, we noted that, as from September 2 1983, all single line telephone sets will be terminated by a jack and plug as required by CRTC decision 82-14. Specifications are available in Department of Communications Document CS-03.

With respect to data terminal equipment, three standards are available depending on whether the terminal is connected to an analog circuit switched network, to a digital circuit switched network or to a packet switched data network. Currently the PSTN in North America still consists primarily of analog facilities so that the main standard of interest is the EIA standard interface RS232-C (CCITT V24). However in both the US and Canada there are specific networks (DATAROUTE and DATAPAC) which require cleaner interfaces to data terminal equipment. The relevant interfaces as defined by CCITT are X21 for circuit switched and X.25 for packet switched. Reference 8, 9, 10, 11 in the bibliography identify the characteristics of these interfaces while reference 12 provides a detailed discussion of their evolution.

6. BIBLIOGRAPHY

1. "Bell Canada - Interim Requirements regarding the attachment of subscriber provided terminal equipment" CRTC Telecom Decision 80-13.

2. "Attachment of Subscriber - Provided Terminal Equipment" CRTC Telecom Decision 82-14.

3. "Standard for Terminal Equipment, Systems and Connectors" Department of Communications CS-03 issue 4.

4. "Canadian Electrical Code - Part 1".

5. "Communications preplanning for the modern building" IBM 1982 Canadian Telecommunications Carrier Association 1980.

6. "A building planning guide for communications wiring".

7. "The Open World" Northern Telecom announcement 1982.

8. "Interface between Data Terminal Equipment and Data Communication Equipment Employing serial binary data Interchange", EIA Standard RS-232-C. Engineering department, Electronics Industries Association, Washington, D.C. August 1969.

9. "International Specification for interface between Modems and Terminals" CCITT Interface recommendation V24 (Functionally similar to RS-232-C but not identical).

10. "Recommendation X21 (Revised) General purpose interface between Data Terminal Equipment and Data Circuit - Terminating Equipment for Synchronous Operation an Public Data Network" CCITT Document A PVI-No 55-E, Geneva (1976).

11. "Draft recommendations X.25, Interface between Data Terminal Equipment (DTE) and Data Circuit - Terminating Equipment (DCE) for terminals operating in the packet mode on Public Data Networks CCITT Document A PVI - No -55-E, Geneva (1976).

12. "Communications Architecture for Distributed Systems" R.J. Cypser Addison-Wesley 1978.

Deliverable 21

Management and Operations of a Telecommunications Service

TABLE OF CONTENTS

1. INTRODUCTION

Managing, planning, operating and maintaining a private telecommunications service requires a sophisticated organization to ensure that the overall number of personnel involved does not become so large as to make owning a private network non cost-effective. The provision by North American vendors and telcos of a centralized network management (control) centre is a move to reduce this cost as is the provision of maintenance personnel by, for example, interconnect companies. However, even with these capabilities provided, there is considerable personnel cost associated with policy, procurement, billing, leasing with vendors, telcos etc., and operating each switching centre where such a centre is privately owned.

For this deliverable, we were asked to list and explain the functions involved in management etc., of a private network. Since the functions of a network control centre have already been described in deliverable 12 of this series and since maintenance functions appear in deliverable 13, this deliverable will concentrate on the respective personnel functions involved as a prelude to estimating man-year requirements. However excluded from the deliverable will be any estimate of internal Government provision of personnel required to monitor and control departmental use of the telecommunications service. Thus it is assumed that the concern is the role of GTA in overseeing the whole network including presumably central or local liaison with the various departments using the service. Section 2 therefore considers the network control centre giving a general view of the personnel involved; Section 3 examines the operations and maintenance of the network components whilst Section 4 examines the central role of those GTA staff responsible for the intercity and local networks.

2. NETWORK CONTROL CENTRE (NCC)

Deliverable 12 lists the functions of a network control centre as

- Centralized trunk testing
- Automated switch failure detection and analysis
- Centralized traffic monitoring and control
- Traffic data analysis
- Network feature administration
- Data base administration
- Call Detail Records Collection
- Computer-assisted management aids - alarm logs, trouble tickets etc.
- Remote administration/maintenance of switches
- Network personnel directory administration

In order to collect, display and analyze the data, several work-stations (standard and graphical) will be required. Deployment of work stations to functions and of NCC operators to work stations has yet to be defined. However, typically for the GOC size of network, and given centralized control, we would expect a need for 5-7 personnel during daily operation reducing to 2-4 during the evening. Thus given 8 hour shifts, total man-year estimates would 10-15 operating man-years plus 3 supervisory man-years plus one NCC managerial man-year.

3. OPERATIONS AND MAINTENANCE OF THE NETWORK COMPONENTS

Network components in the Government of Canada network comprise tandem switches, private branch exchanges, long haul and short haul transmission facilities, telephone sets, terminals and internal building wiring. Functions revolve around the various personnel given below:

- Installation personnel for initial installation and replacement of equipment - switches and terminals.
- Operations personnel trained in operational procedures such as data changes in PBX/tandem switch to accommodate office changes and the introduction/replacement of terminals.
- Maintenance personnel involved both in preventative and corrective maintenance of switches, terminals and transmission links. Deliverable 13 describes these functions as essentially fault detection, isolation and repair as well as routine scheduled maintenance.
- Attendants (telephone operators) to assist staff in placing their calls.
- Assistance personnel to provide responses to queries and complaints from network users and where warranted to record significant problems and initiate action.
- Management personnel, capable of dealing with the above technical and clerical staff.
- Administrative personnel to coordinate activity between the owned and leased parts of the network.

Within the Government of Canada network, currently proposed to be a mixed owned-leased service, some of the above functions will be contracted out. Thus, for example, deliverable 15 of this series recommends that GTA merely observe the installation of switches by interconnect companies and notes that maintenance is offered as part of contracts with either interconnect or telephone operating companies. Moreover transmission links (except perhaps for inside wiring) will be leased from the telcos; inside wiring, if owned, is also covered by interconnect contracts.

In terms, therefore, of the installation maintenance and operation functions GTA should need no staff directly involved in the technical activity. However, the authority will need staff both to liaise with each supporting company and to coordinate activity between the owned and leased parts of the network. No estimate of total numbers of personnel involved in this activity can be given because no decision as to the degree of mixed own-lease has been made. However two people per operating company should be sufficient. These people could also deal with queries and complaints from users.

Management personnel have been included in the above estimates. The remaining function is therefore PBX attendants to help with calls. The number of attendants is of course dependent on the number of lines served by the PBX, and as the requirements of the organization. For example, maximum numbers of attendants on Northern Telecoms SL1 and SL100 are 15 and 255 respectively. An organization will choose its attendant numbers depending on the service needed but should of course organize to minimize this number. (There is, of course, possibly no need for attendants at all).

4. CENTRAL MANAGEMENT AND PLANNING ROLE

The personnel functions are listed below:

- Network planning and engineering personnel to specify circuits and equipment necessary for growth and rearrangement of the network. These would analyze traffic data, compare actual with desired network, specify reconfiguration of the network and develop evolution designs.

- Circuit control personnel to administer the interfaces between owned and leased equipment. Thus, for example, changes in circuit requirements, impact of disagreements between operating and interconnect companies as to responsibility and the transport of network control data from centrex switches to the NCC, will require careful diplomacy.

- Maintenance personnel responsible for transmission, signalling or equipment problems affecting the network as a whole (see note).

- Database control personnel responsible for coordination of routing data changes in the network as a whole (see note).

- Analysis personnel to interpret the operation measurement billing and trouble report data.

- Administrative personnel to interface with vendors or lessees.

- Clerical and administrative staff to implement departmental billing (assuming that this is the intended approach).

- Management personnel capable of dealing with technical staff.

Note: Maintenance and databases control personnel in the central staff imply that the NCC will not control, in near real time, the operation of the network.

In estimating number of personnel associated with each of these functions, we are really only capable of giving rough estimates for technical staff. Department billing requirements, for example, are not transparent.

We would expect that network planning and engineering could be done by three people full time plus a manager. This assumes that a basic set of analysis tools is available e.g., tariff database with perhaps some development of simple design models. Where any concentrated development activity was needed, the best approach would be to contract this out.

Circuit control personnel would analyze the impact of changes to the network in terms of the interface and carry out the necessary liaison. Given the need to keep records and to perhaps travel extensively, this could occupy two people and a manager. Included within this group could be the operational analysts, and the maintenance and database control personnel, who would in total comprise perhaps another five staff plus a manager.

Table 1 summarizes the estimates excluding internal government billing administration. We have tried to keep the numbers as small as possible based on our experience of what is potentially feasible. However, the difficulty of identifying the man-year requirements for what is a new era in Canadian telecommunications given the geographical spread and the large numbers of suppliers cannot be overstated.

Table 1

Estimates of Man-Years Required per Year

Function	Staff (my)	Supervisors (my)	Management (my)
NCC	10-15	3	1
Operations & Maintenance (excluding attendants)	12	6	1
Central Management (excluding billing needs)	10	-	3
Total	32-37	9	5

5. SUMMARY

In this deliverable we have identified the functions of managing a private network in terms of the personnel functions involved. Where appropriate we have identified those technical personnel functions by referring to other deliverables in this series. Should GTA decide to involve only operating companies in the provision of their network {Table 1 are estimates for a mixed owned-leased network}, then the numbers of personnel needed would be dependent on how much GTA was involved in network control. If GTA allowed the telephone companies to continue operating and managing the network then a total staff of ten should be sufficient.

ANNEX

QUESTIONS AND RESPONSES ON THE FOREGOING DELIVERABLES

Annex A

1 Deliverable No.1 (service availability)

A clear definition of service availability must be provided. Should service availability include the trunk lines, access lines and intra switch traffic blocking probability?

Article 3.1 - What is meant by "access lines"?
- Has a difference been observed between the grade of service of Government and industry private networks?

Article 3.2 - How can Do be derived from Di and Q?
- Provide typical values for Q.
- Explain what is meant by operational downtime. Is it Do? Is it the time required to restore the service availability or the time elapsed from the start of failure to the repair of the faulty equipment even if by means of backup equipment the service may have been restored at an earlier time?
- "End Grade of Service" - Does this not refer to availability only since it does not include blocking?

Article 3.3 - What figure is referred to by "the above figure"?
- Clarify the relationship between availability under various survivability mode scenarios and propagation performance.

Article 4.0 - Provide the CCITT G06 definition of service availability.

Table 1 - Clarify definitions of time consistent ABSBH, IOHDBH, HDBH and provide examples as to how they are calculated. Define "bypass trunks".

2 Deliverable #3 (survivability)

Note 2 - Specify the range of restoral service times taken for a 3000 line PBX

3 **Deliverable #6 (evolution of user requirements)**

Page 11 - Confirm your statement that by 1990 good quality video conferencing will be possible at speeds between 56 and 256 Kbs.

Article 5.2 - Can it be concluded from your VAS traffic forecast that a total of 11.6 ccs will be spent by each user during the busy hour for VAS in 1990. If no, to what extent would a user use each VAS service then?

Page 15 - Will the 1 megabit/second bandwidth between the PBX and the user terminals only apply within the building where the PBX is located or also to distant terminals linked with OPXs.

Relate the information provided with the development of the Integrated Switched Digital Network (ISDN).

4 **Deliverable #7 (cost effective useful life)**

Article 2 - To what extent does the expected cost effective or installed PBX life depends on the size of the PBX. For example would an SL-1S have a different cost effective life than a 30,000 line SL-100 PBX? Telephone companies used to keep their switching equipment for far longer than 20 years. How long will their new SL-100 switches be expected to last?

You state that the average age of installed PBX today is perhaps 8 years and that depreciation period varies between 6 to 10 years. Explain then why you state (in the paragraph above the graph on page 51 that the actual life of the equipment may be much higher than the depreciation value normally considered.

Graph page 5 - The graph contains some inconsistencies. The cost to evolve existing PBX to equivalent new ones should be zero when you purchase a PBX. The cost effective life points towards much more than 10 years, whereas you state earlier that it should be between 7 or 8 years.

Article 3.1 - "Substantially increase the bandwidth". How much and over what distance?

"Providing gateway connection". What type of connection (protocol, bandwidth, distance)? How is concentration provided by the switch?

5 **Deliverable #8 (Impact of Non NT products in NT ESN environment)**

Article 2.1 - Clarify and give an example of on net and off net stations. Is a station behind a non ESN sub PBX connected to the ESN network via trunks considered on net or off net? What is the maximum number of ESN SL-1/SL-100 nodes allowed in an ESN network?

To what extent will the availability of CCS #7 alleviate the need for switching equipment to be of the same make in order to assure a uniform, transparent and efficient network?

Concerning the uniformity of telephone sets, do you see the current development of incompatible proprietary intelligent terminals by each switch manufacturer continuing?

Table 1 - Provide details on how you ascertained that the Plessy K2 and the SX2000 did not have a signalling compatibility and that they had network control function capability to evolve towards a CCSA network topology.

6 Deliverable #9 (Field reliability)

You have provided service/performance requirements for a 10,000 lines switch. How would the values of those changed for switches of 5,000, 1000 and 500 and 200 lines size?

Article 2.2 - The network service requirements quoted seem high. Could you provide some substantiation? Why is incoming & outgoing matching losses different? Explain the relationship between these matching losses and terms such as non blocking & virtual non blocking.

Article 3.1 - Deliverable 1 states unavailability of the switch to be no greater than 0.003 where this represents % of total service time. Here, the objective is expressed as .003 as a percentage of ineffective attempts per attempt. Is there a relationship between these two figures and if so what is it?

Article 3.2 - Is our understanding correct that trunk or line failures whose duration can count against the downtime objective stated are only those related to failures of any nature between the end user telephone set or originating switch and the line or trunk card of the other end switch? Explain how you arrive at the conclusion that a failure mode which affects any one trunk is alloted 8 minutes.

Article 3.3 - The duration of 10E9 hours (or 184,000 years) seems very long. Could you provide substantiation for the objective of 15,000 failures in 10E9 hours?

Article 4 - Is the maximum of 2 hours of outage in 40 years of downtime applicable to any switch sizes?

Article 5 - Explain "downtime for line group affecting all failures".

7 Deliverable #10 (Transmission plan for GOC)

Article 2 - Explain how you arrived at the conclusion that to preserve transmission quality, only a maximum of two tandem switches is allowed.

It is our understanding that tail end hop-off to DDD is offered by Telco. Please indicate your sources which say the contrary. Is there a difference in transmission quality using TEHO to WATS versus DDD?

Explain why on net - off net and off net - on net transmission quality can be optimized by the use of Head End hop-off and Tail End hop-off respectively?

Explain with an example why the use of DISA will sometimes result in degraded transmission performance.

Article 3.2 - Why it is preferable that the inserted loss be implemented in analog rather than digital form and why no tandeming of digital pads is recommended.

Article 3.43 - Figure 6 is missing.

Article 4.1 - Explain the difference in loss plan between DPBX on TELCO premises and customer located.

Article 4.2 - "Inserted loss be implemented in digital form" - this appears to be contrary to (b) which states there be no tandeming of digital pads. Explain.

Page 9 - In VNL + 4S, what does the "S" stand for?

Page 15 - Explain the abbreviations ERL, SRL, UF.*

Article 6.1 - Reference is made to 900+2.16uf balance network. We understand that digital class 5 switches are being provided with a choice of two types of balance networks (one for loaded & one of non loaded). This is for the purpose of providing better return loss on intraswitch connections than the previous 900r+2.16uf networks. Is this new standard being applied to DPBXs as well? If so, what are the new values? If these new networks become standard, will this not improve the long haul ERL & SRL requirements and by how much?

Article 6.4 - Explain stability margin and what should be the SRL objective at the 4 wire/2 conversion points for 4800 and 9600 BPS corresponding to a stability margin of 25 DB minimum.

- Identify the names of the relevent TCTS standards.

Table B - What does the asterisk stand for?

- Provide the end to end transmission requirements requested in the contract.

8 Deliverable #11 (Organization standards)

We have heard that provincial fire codes also apply to telecommunication equipment and wiring and that these are different for each municipality and province. Please confirm.

9 Deliverable #15 (acceptance testing)

NTL must have delivered switches or network of switches to users other than telcos. Provide specifications on acceptance procedures used by those users to accept those switches or network of switches.

Page 4 - Provide Annex A.

10 Deliverable #16 (implementation plan)

Page 3 - Provide figure 1.1

11 Deliverable #17 (GTA uniform dialing plan)

Article 2 - What is meant by directly access location?

- What is meant by : up to 8 outgoing routes are provided per route cost.

Article 4 - Can ESN and ROLM Net accommodate the requirement to reach any off net or on net stations outside the originator free-calling area with the following single uniform dialing procedure:

1 - NPA - NNX - XXXX

Page 9 - What are the specific limitations of the SX-2000 & Plessey K2 with respect to ESN & ROLM networking capabilities? How does this affect the proposed GTA UDP?
- Item 3: Is this not part of any switches normal digit & translation routing function? Why then is this a concern?

Conclusion - Explain why you say that there may not be enough location codes to accommodate GTA's objectives. In making this statement, was it assumed that control would be passed on to the terminating switch, thus avoiding the need to store all terminating NNXs in the originating switch?

12 Deliverable #19 (jacks and plugs)

Article 2 - Has there been any similar agreement between BC Tel and CRTC. Provide relevant contact names and telephone numbers in BC Tel and Bell Canada.

Is our understanding correct that after Sep 83 all single line sets installations in Bell Canada for business customers will be terminated by a jack and plug connection?

Article 3 - Figure 1 is missing.

13 <u>Deliverable #20</u>

Article 3.0.3- Where in deliverable 10 is this addressed? Deliverable 10 only specifies 5 db for subscriber loops.

14 <u>Deliverable #21 (operation of telecom services)</u>

Additional details are needed.

15 <u>General</u>

1. The deliverables contain a large number of spelling and grammar errors. Figures and annexes are missing. The deliverables must be proofread and the errors corrected.

2. In accordance with article 3.3 of the contract, a copy of each reference document to which the contractor holds title, copyright or the right to distribute shall be supplied by the Contractor.

3. The statement: "BNR assumes no responsibility for any hidden information on non-NT products" made on page 3 of deliverable 8 is not acceptable and shall be removed. The responsibility of the contractor is stated in the terms and conditions of the contract. No disclaim or unilateral interpretation statement made by the contractor can alter those.

ANNEX A

RESPONSE

Deliverable 1 (Service Availability)

Article 3.1

- Access lines are all lines which access the tandem switch from a local PBX.
- No

Article 3.2

- Do = Di + QM where M is the time period from observation of switch going down until maintenance personnel reach site. (For example, interconnect companies offer one hour service plus travel time).
- Typical values for Q are .05 (2 hours in 40 years)
- Yes: Do is operational downtime. Do is time elapsed from start of failure to repair of faulty equipment.
- End Grade of Service is a typographical error and should not be in the document.

Article 3.3

The paragraph now reads as follows:

The above figure (A=0.9909) for availability included, by definition (Note 1), the noise, interference, loss etc for a network which is fully functioning. Given GTA's concern with survivability, however, similar figures for availability in degraded mode operations can be established once the degraded modes are fully defined. These modes would have to be defined by GTA and would include a requirement, for example, for acceptable GOS and acceptable availability under the various types of failure defined in deliverable 3. However, it is recommended that, for the Vancouver-Victoria RFP, no consideration be given at this time to the impact of system failures on propagation performance either in the sense of planning for loss on reconfigured networks or in establishing degraded modes and the corresponding enumeration of availability figures.

Note 1:

By this we mean that the choice of 4 links and 3 switches in 3.2 arises from the need to minimize loss, noise, etc.)

<u>Article 4</u>

This is a typographical error and should have read G106

<u>Table 1</u>

The time frames Average Busy Season Busy Hour, Ten High Day Busy Hour, and High Day Busy Hour are defined in terms of load volumes. There is in addition an implied service criterion. In the following procedural definitions, "hour" refers to 60 contiguous minutes starting on the clock hour or half-hour; "month" refers to a 4 week service observing month.

ABSBH - (Notes 1,2) Select the 3 highest traffic months to obtain an approximately 60 day sample of business days (the busy season).

From the busy season traffic, select the time consistent (the same hour in each day) average hour having the highest load. This is the ABSBH load.

THDBH - (Note 2) Select the 10 highest traffic days of the year, excluding holidays and unusual non-receiving event days. The time consistent hour having maximum traffic is the Ten High Day Busy Hour Load.

HDBH - Select the one day among the 10 high days having the highest (annually recurring) traffic during the THDBH. The traffic level in the busy hour of the high day is the High Day Busy Hour.

Examples cannot be compactly given since they span 24 x 365 sample hours of traffic.

Notes:

1. For trunk engineering a one month, sliding, 4 week busy season is used.

2. THDBH and ABSBH performance standards are not based directly on these loads. Engineering to the loads needs to include an allowance for variation from theoretical traffic distributions.

Deliverable 3

Restoral time for a 3000-line PBX ranges from 0 to 0.5 hours measured from the time maintenance personnel arrive on site. The thorough checking at the factory added to equal thoroughness during commissioning and cutovers makes that range reasonable for vendors to meet. Of course, the range given excludes failures due to deliberate sabotage or a major accident.

Deliverable 6

Item 1) See attached EMMS article re: WidCom's videoconferencing codec.

Item 2) Yes, the conclusion is that the average user will spend 11.6 CCS in the busy hour for VAS in 1990.

Item 3) (a) The one megabit/second bandwidth between the PBX and the user terminal does not apply to distant terminals linked with OPX's but it does apply to terminals within one local PBX system (approximately 6,000 ft. radius).

(b) Relation to ISDN: Digital facilities will become more common in the public network, and will be available for use in inter-location networks if so desired.

The ISDN refers primarily to projected developments in the public telecommunications network, not to private network capabilities.

Deliverable 7

Article 2

2.1 To the extent that one can forsee the varous applications of a specific PBX, built in flexibility of design (article 3) should ensure no difference between the cost-effective life of various size PBX's. Moreover, where there is a family of PBX's with the same fundamental hardware architecture (for example, the Sl-1 family), increases in number of lines can be accomodated within the concept.

Significant changs in the numbers of lines accessing a PBX, say from 400 to 10,000, could be viewed as impacting the cost-effective life. However, it would be more reasonable to view such a change as impacting the network architecture as a whole so that upgrading an SL-1 to SL-100, for example, does not become a serious question. In fact, such an upgrade could not be done as the switch architectures are different.

In general, therefore, determination of PBX cost-effective useful life must be considered within the context of the network as a whole. The choice of PBX at a location depends on the current needs and the evolution to future requirements so that significant changes to the line requirements of a specific PBX does not occur.

SL-100 switches have a cost-effective useful life of greater than 20 years.

2.2 The length of time over which a PBX is cost-effective depends on its capability to be modified (by software and the addition of hardware modules) as requirements evolve. The depreciation period considered is that for the initial PBX installation.

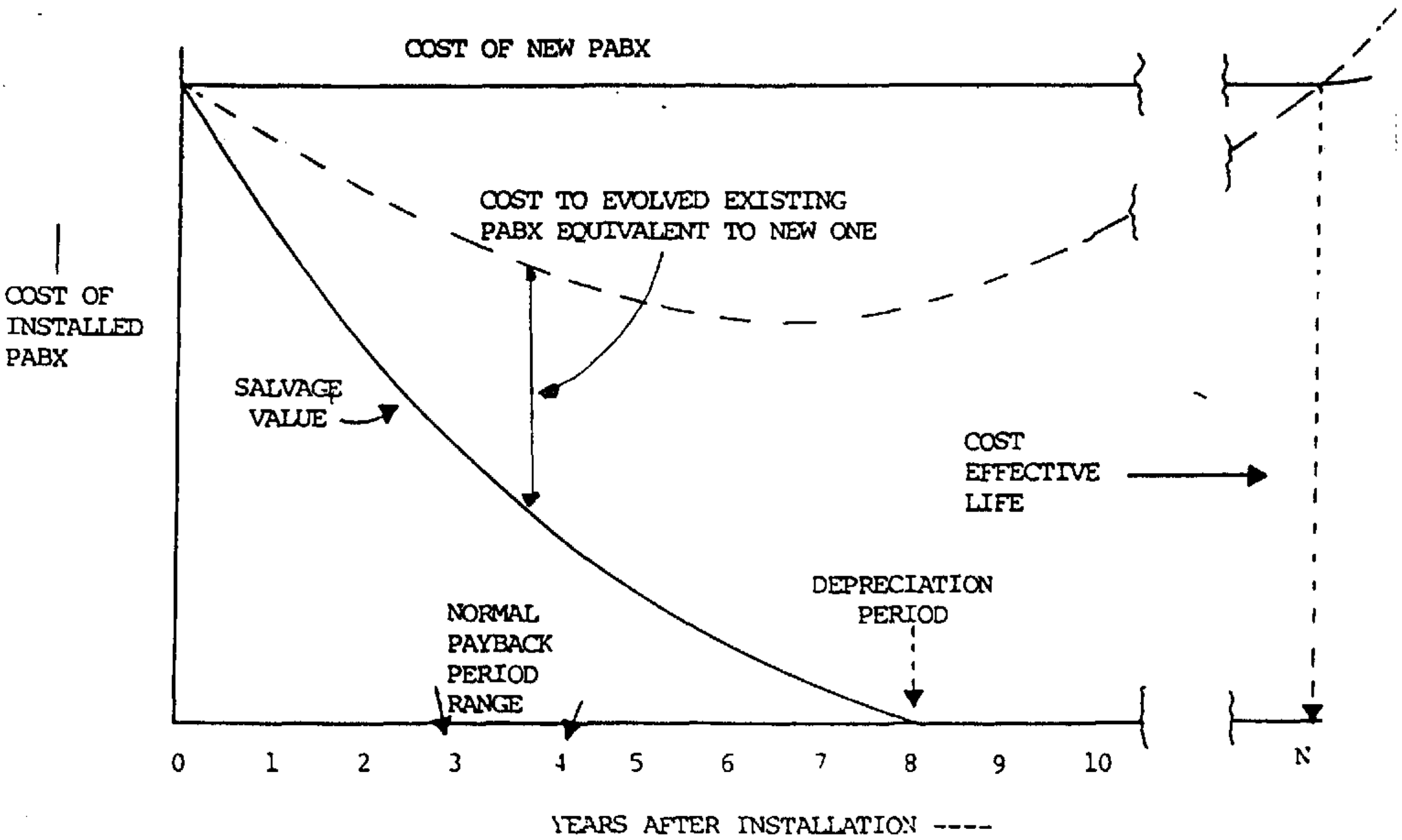
Graph Page 5

The change is enclosed

3.1 - Bandwidth will increase up to 1 Mbps on twisted pair in local area with the distance constraint of the SL-1 family (i.e., up to 6000 to 8000 ft.).

- The gateway connection will be protocol conversion to allow other manufacturers equipment and local area networks, to be accessed via SL-1 and DMS family.

- For concentration on bisynch transaction oriented terminals, the switch provides access and contention capabilities to a cluster controller rather than provide concentration itself. For pure circuit switched activity, NT submits that it provides sufficient voice grade line switching capability that multiplexing is unnecessary. Thus there is access from 19.2 Kbs Asynch and 56 Kbs Synch to a 24 x 64 Kbs T1 Carrier.



COST OF NEW PABX
COST TO EVOLVED EXISTING
PABX EQUIVALENT TO NEW ONE
COST OF
INSTALLED
PABX
SALVAGE
VALUE
COST
EFFECTIVE
LIFE
DEPRECIATION
PERIOD
NORMAL
PAYBACK
PERIOD
RANGE
0
1
2
3
4
5
6
7
8
9
10
N
YEARS AFTER INSTALLATION ----

Deliverable 8

Article 2.1

Off-net stations are those connected to an off-net PBX, which in turn is not connected to the network via tie-lines or trunks. That is the off-net PBX would access on-net locations via WATS, DDD. Off-net stations may also be attached to an on-net location via an FX. The station behind, for example, a non ESN sub PBX connected to the ESN network via trunks is considered an on-net station. The limit on PBX locations on a fully featured network is 256 locations. There is no clear limit on number of ESN nodes (tandem switches) but it probably should be less than 256.

When CCS #7 signalling becomes available, most of the incompatability between switches will be removed. The CCS #7 trunk will be used to transmit the differing signals and the networking information (e.g. NCOS) while the tie-lines will only carry the normal dialed digits. This approach will of course require software to translate proprietory networking into the common format. However, to the best of our belief, the development of proprietory terminals will continue.

Table 1

The network control function referred so here is the one which controls routing (TCOS) and privileges (NCOS, OFF-HOOK QUEUEING) of accessing different facilities. Plessey K2 and Mitel SX-2000 do not have (or have not announced) the signalling compatibility to transmit or receive this information. A CCSA (Common Control Switching Arrangement) - type network is one in which part of the (tandem or centrex) switches are dedicated to a private customer. Thus the control is merely the normal switching and routing control basic to any digital or electronic switch. Plessey and Mitel meet this requirement.

Deliverable 9

We have provided service/performance requirements which are those normally used by a telco whose switches on average have 10,000 lines. GTA should abide by these requirements in their vendor evaluation whether the switch is 30,000 or 300 lines.

Article 2.2

The network requirements quoted are indeed high but they are what a telco demands. There is no reason why private customers should not demand the same, particularly as the corporate communication network is an essential part of a company's infrastructure.

Matching loss is defined as the net probability of not been able to establish a network path between two items in consideration. The difference between out going and incoming matching losses is explained by the following.

For outgoing matching loss, .01(ABSBH) is the probability that there will be final failure (in connection) after one or more retrials on different idle trunks.

Incoming matching loss, is the probability that there will be failure on the first retrial.

A true (ideal) non-blocking switch has a matching loss of zero.

A virtual non-blocking switch (a term recently introduced by manufacturers) is a switch in which the blocking is much lower than normal - 1 in 10,000 as compared to 1 in 100.

Article 3.1

The .003 figure is the same for both cases. (There was a typographical error in deliverable 1 in the referenced deliverable i.e., should have been deliverable 9 rather then deliverable 4).

Article 3.2

The downtime objectives should read

Trunks or Lines Affected	Downtime for all Causes
Entire Office	
n1	3min/year
n2	T1 min/year
.	T2 min/year
.	.
.	.
.	.
nm	Tm min/year
24	20 min/year
1	28 min/year

The implication of this table is as follows:

On a 24 line/trunk group set, line card and other failures affecting the set is a whole has a downtime of 20 min/year. A failure affecting only one trunk in the set has a downtime of 8 min/year. Thus for a 1 trunk/line group set, the downtime is 20 min/year for all failures up to line card plus 8 min/year for failure of the trunk alone (i.e., 28 min/year).

Article 3.3

15000 failures in 10EQ hours is poetic license. It represents a failure rate of 1 in 7.5 years, calculated as follows.

Given the objective of 8 minutes downtime per year (article 3.2) with about 60 minutes repair time per failure on average, then the downtime objective can be met only through 1 failure every 7.5 years (i.e., 60-8)

Article 4

Yes

Article 5

Downtime for different line groups affected by all types of failures.

Deliverable No. 10 - Comments

Article 2

- Maximum of Two Tandem Switches

  This is not an absolute limit - the rationale is to firstly retain some control over unstructured routing in a TTTN, and secondly to ease future conversion to an ESN or CCSA - style network in which a maximum of two tandem switches is the norm. In addition, network dialling instruction for the Vancouver/Victoria consolidation implied this (two tandem) arrangement already took place in the GTA network.

  For a long-time TTTN, transmission quality progressively deteriorates as additional tie trunks are placed in a connection. In general there should be a realistic limit set that will strike the best balance between transmission quality, network cost and dialling complexity.

  AT&T recommend a maximum of four tie trunks in tandem for satisfactory voice and signalling performance, and a maximum of only two tie trunks in tandem for voiceband data over 300 bauds (See Telecom Transmission Engineering Volume 3).

- Tail End Hop Off to DDD

  It is BNR's understanding that while Tail End Hop Off to DDD is technically possible it is not normally offered because of the administrative complexity in correctly assigning DDD network charges to the calling source. Tail End Hop Off via an operator can be used to avoid this drawback.

  However, it is still not favoured from a transmission viewpoint unless the DDD "tail" is short - within the local NPA. Long DDD or WATS tails, when added to a long TTTN connection, will degrade quality due to the additional loss, noise, delay encountered. WATS is preferred in this case to DDD because of its fixed loss design.

- TEHO and HEHO Optimization

  Offnet calls are an unkown quantity. From a transmission planning quality point of view, a (possible) long haul offnet connection should not be switched to a similar longhaul on-net connection. As both portions of the end-to-end connection will be designed to optimize transmission quality in themselves, switching both portions together will severely degrade that quality. Either the On-net portion or the Off-net portion should be kept short to avoid this, and one practical method is to utilize HEHO and TEHO routing accordingly. See Figure C1 attached.

- DISA

  DISA is a further development of the previous argument. It can be used to circumvent standardized routing procedure. Consider as an example, a longhaul DDD connection to a DISA switch, which is then routed longhaul within the TTTN and finally off-net again to the required DDD subscriber. See Figure C2

Article 2

- Digital Pads

  Digital pads are a necessary evil in the evolving digital network. They cause additional quantization distortion which is perceived as noise. They require software controls to ensure they are switched out on digital data connections. The tandeming restriction noted is not absolute, but preferred.

Article 3.3

- Figure 6

  Figure 6 was omitted in error. It has now been provided.

Article 4.1

- CU-Located DPBX vs CO-Located DPBX

  The difference in loss plans is due to the longer subscriber loops (5dB maximum) allowed with CO-located DPBX's compared to the shorter loops (typically dB maximum) characteristic of CU-located DPBX's. For a given end-to-end connection loss the CO-located DPBX Loss Plan will have inherently less inbuilt loss compared to the CU-located DPBX Loss Plan.

Article 4.2

- Digital Loss

  The text here was in error. It has been corrected to agree with the comment of Article 3.2 above, i.e., "Inserted loss should be implemented in analog form whenever possible".

Page 9

- VNL + 4S

  The term "4S" refers to the 4dB switchable loss made up, in this case, of 2dB switchable pads located in the trunk circuit module of analog PBX's. These pads are switched into connections when short terminating tie trunks are encountered, or when terminating tie trunk balance is below minimum standards.

Page 15

- ERL stands for Echo Return Loss
  SRL stands for Stability Return Loss
  UF stands for microfarads.

Article 6.1

- Balance Networks

  The 900 Ω + 2.16 μF network refers to terminal balance measurements made at a tandem PBX, looking toward a terminating tie trunk. See Figure C3.

  The double balance networks referred to are utilized in subscriber line terminations (not trunks) on Northern Telecom DMS100 central office switches and SL-100 DPBX's.

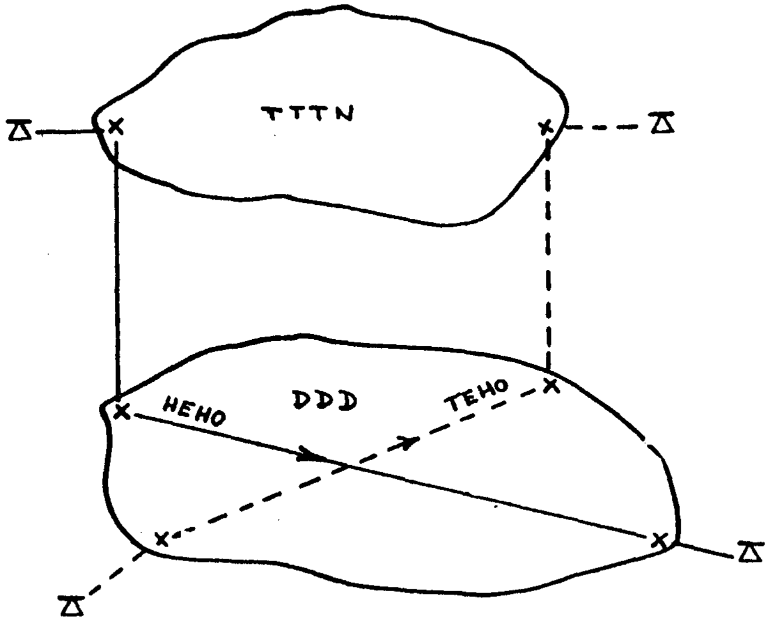


Figure C1

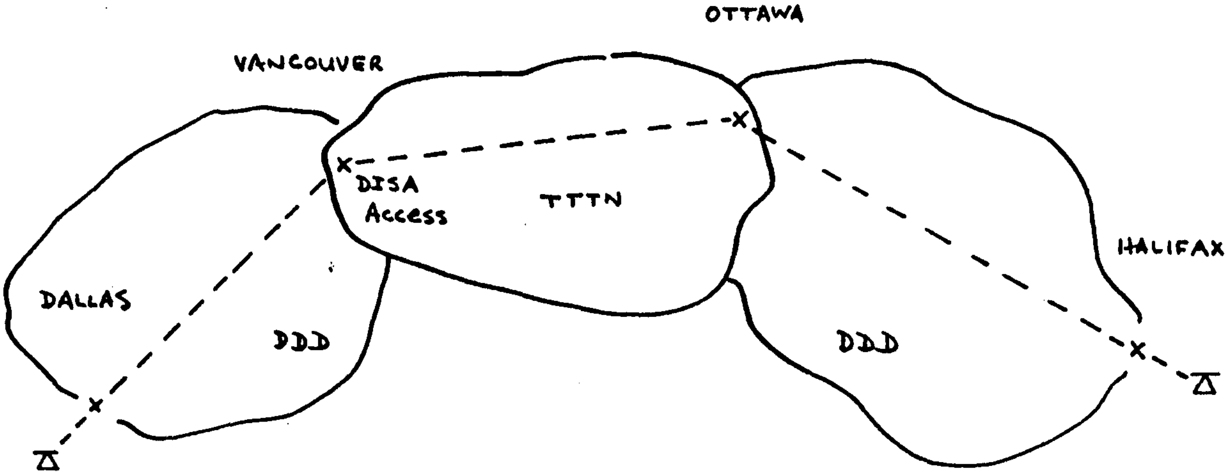


Figure C.2

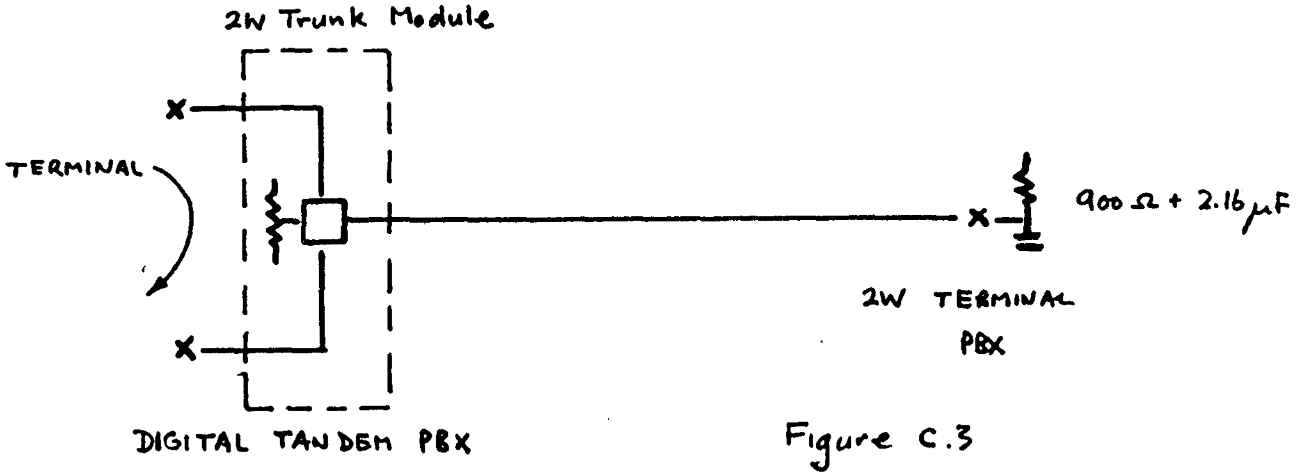


Figure C.3

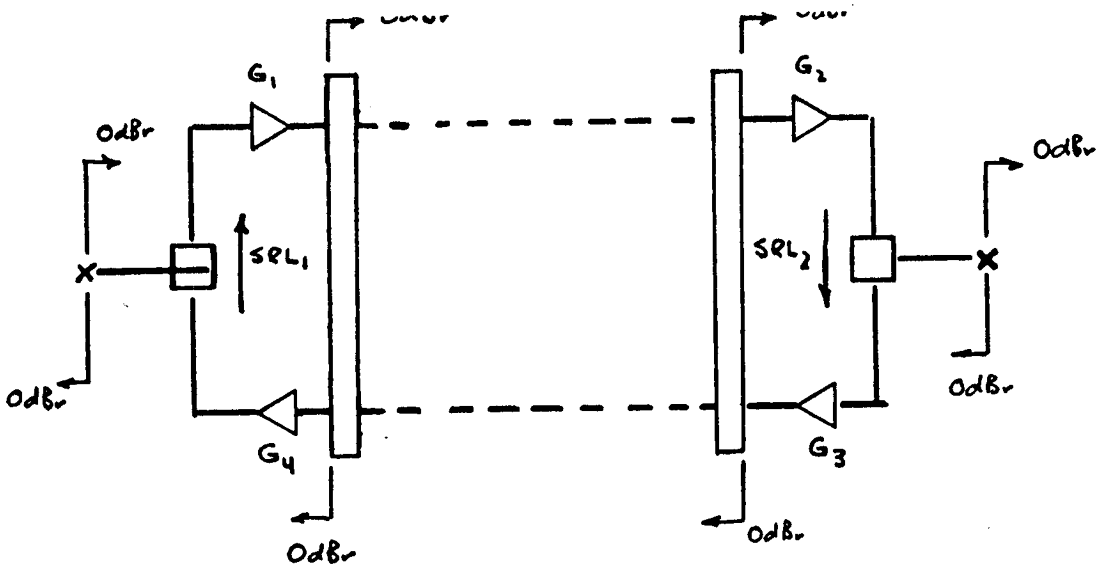


Figure C4.

Article 6.4

- Stability Margin

  Stability margin is the protection against instability in a 4-Wire loop which utilizes directional gain. It is the difference between the summed losses in the loop (pads, stability return loss) and the summed gained. See Figure C4.

  Stability Margin = 4 Wire Loop Loss - 4 Wire Loop Gain

  The limiting case is normally a zero loss 4 Wire trunk as illustrated in Figure C4. As pointed out in Deliverable 10, a 25dB stability margin is required to pass 4800 and 9600 bits/sec voice band data, and this will require SRL objectives as follows:

  $$25dB = SRL1 + SRL2 - 12$$

  For equal SRL values, SRL = 18dB minimum.

- TCTS Standards

  The relevant TCTS standards are in fact proprietary information and cannot be released. It is suggested EIA and USITA standards be addressed instead.

Table B

- The asterisk refers to the footnote on page A5.

- End to End Transmission Requirements

  Detailed end-to-end transmission requirements relate to a specific set of end-to-end connections and cannot practically be provided for an analog GTA network. Instead a range of values for loss, noise, delay and echo path loss have been provided. See attachment.

Deliverable 10

Characterization of End-to-End Transmission Performance in the GTA Network

Any given connection between an originating and terminating user in a public private voice network can be characterized by a set of transmission performance parameters the major ones being loss, noise and echo delay. Extension of this set of parameters to the general case clearly needs to allow for the variability that access with each of the many transmission facilities involved - as an example electrical loss could vary between 1-2 dB on intra-PBX connections to 16-17 dB longhaul inter-PBX connections.

Characterization of end to end tranmission performance on a network basis can therefore only be done by estimating the expected range that results when the individual loops, trunks, switches etc., are designed according to a certain set of implementation rules. The particular set of implementation rules specified in this document are in accordance with those laid down by the EIA (1,2) which are directed at optimizing end to end performance for the majority of connections.

The ranges of end-to-end transmission performance parameters to be expected in the GTA network, under the specified implementation rules, are shown in Figures 1 and 2 attached. They are shown in pairs because of the callers subjective reaction to two impairments at the same time - for example loss and noise figures both combine to determine a specific perception of connection quality in a callers mind. Likewise, echo path and echo path delay are similarly bracketed.

Loudness Loss

Measures the end-to-end electroacoustic loss of a connection and takes into account the acoustic conversion efficiency of the telephone set transmitter and receiver. To a first approximation it can also be taken as the end-to-end electrical loss.

Equivalent Noise

Is measured at the terminating telephone set and is C-message weighted.

Talker Echo Path Delay

Measures the round-trip delay as perceived at the originating end of the connection. The reflection point is specified to be the 4 wire-2 wire transition at the remote terminating PBX.

Talker Echo Path Loudness Loss

Similarly measures the loudness loss of the talker echo path described above.

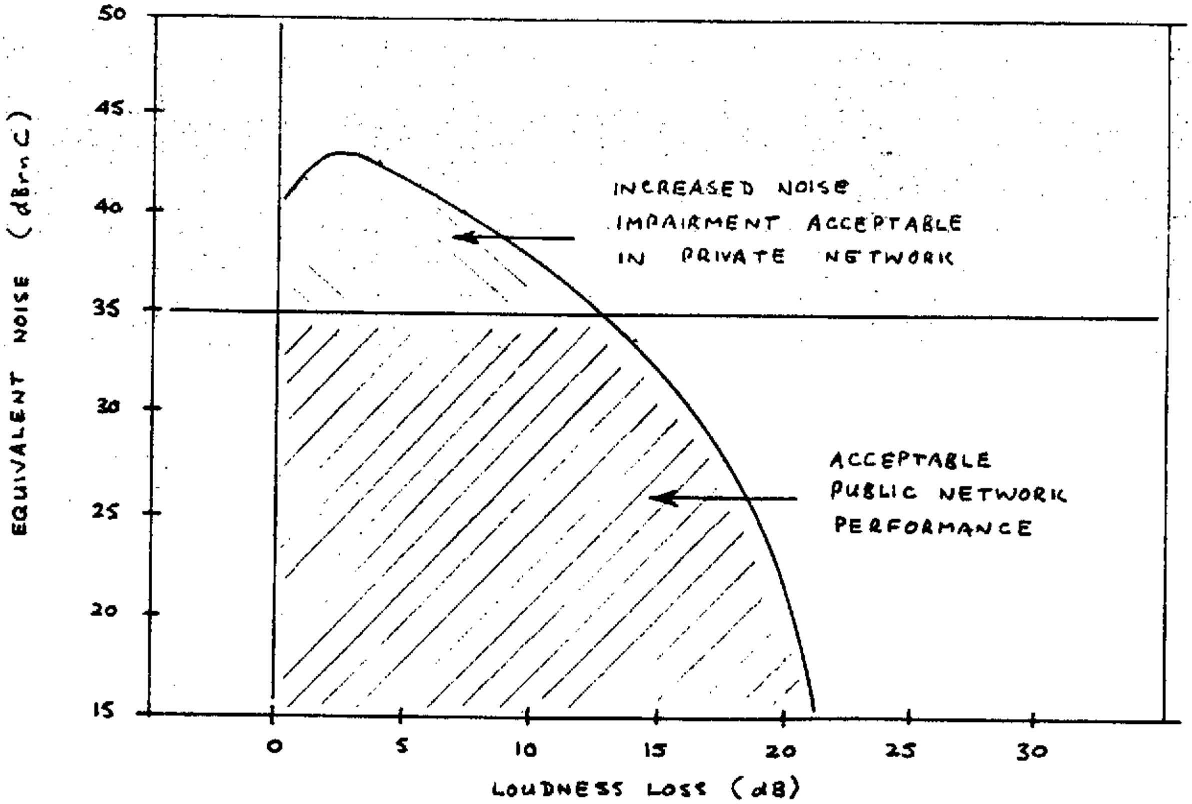


Figure 1: Acceptable Ranges of Loss and Noise in Private Networks

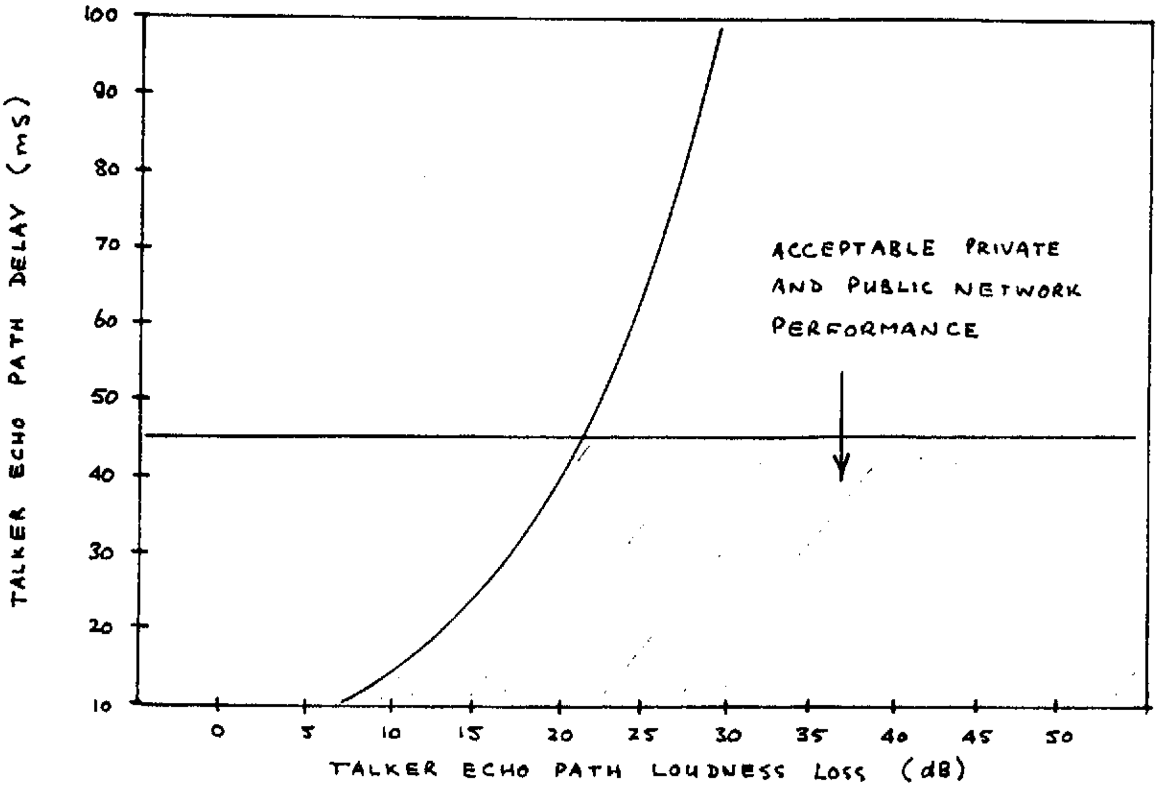


Figure 2: Acceptable Ranges of Echo Path Delay and Loudness Loss in Private Networks

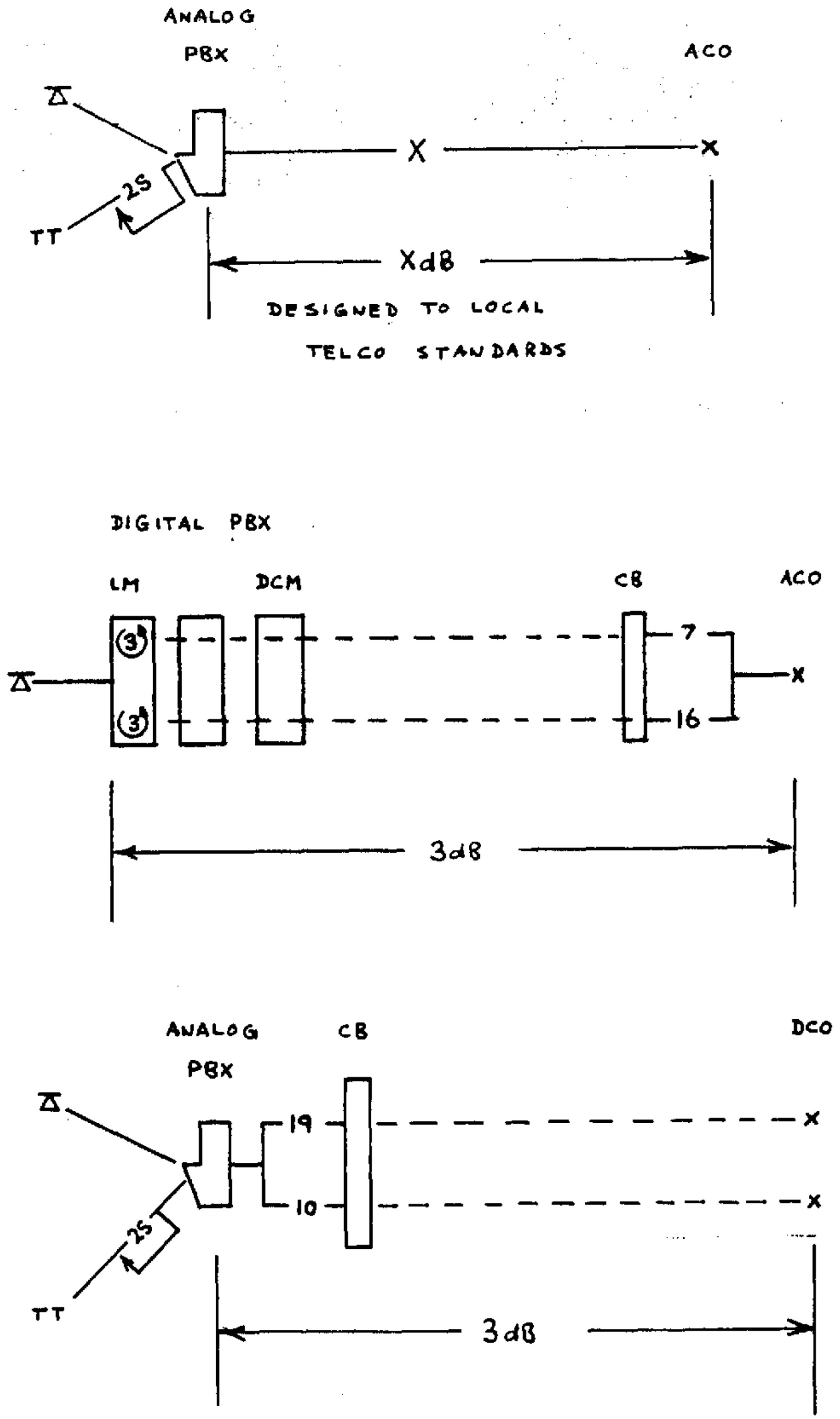


FIGURE 6A : Representative PBX - Central Office Trunks

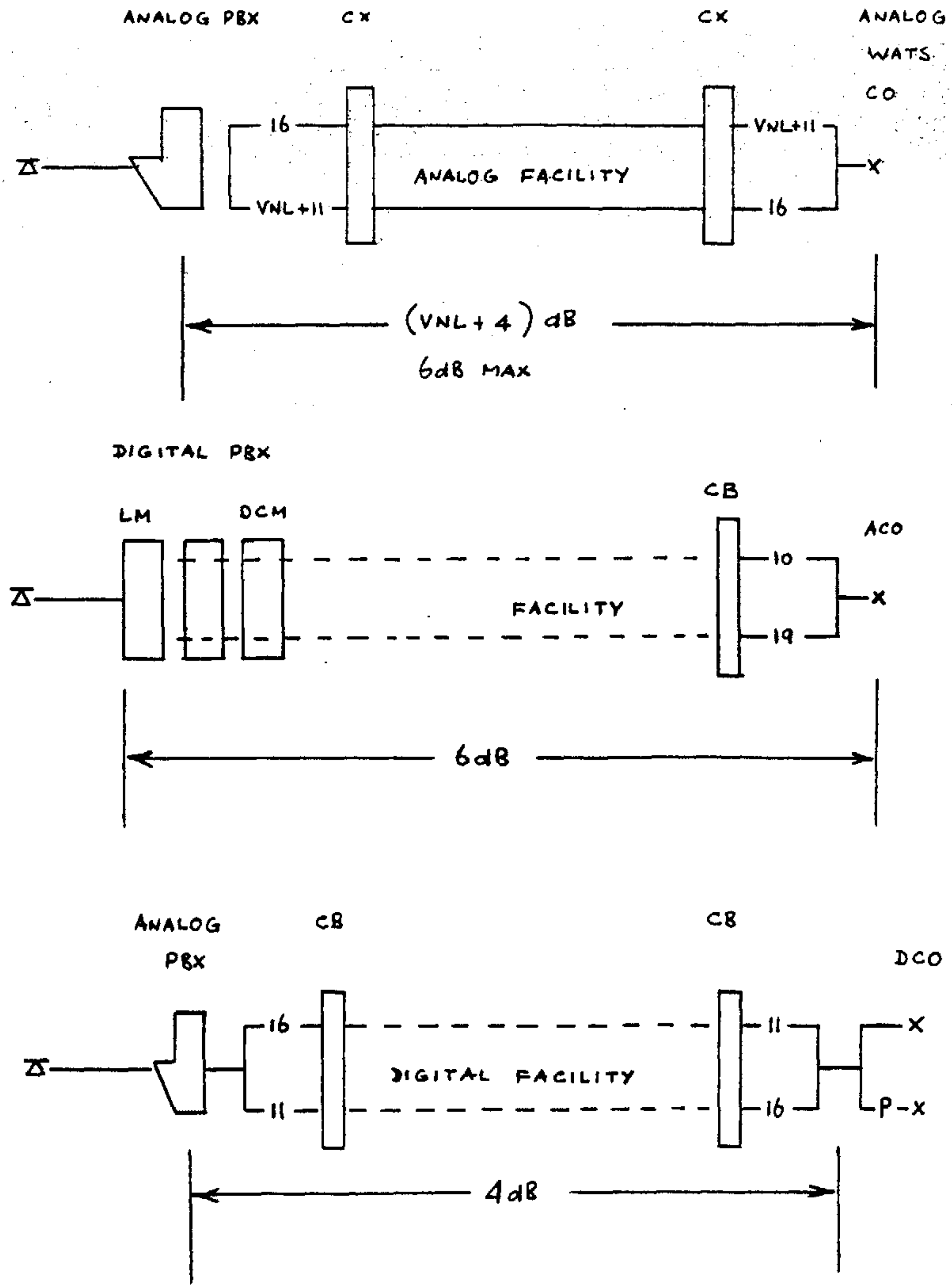


FIGURE 6B : Representative Long-Haul WATS Trunks

Deliverable 11

Provincial fire codes do exhibit differences from province to province. However we understand that application of the codes by installation personnel from manufacturers or telco is standard throughout all provinces.

Deliverable 15

As was stated in the deliverable, acceptance testing procedures as carried by NTL or by Telco's comprise many thousands of detailed pages which no end-user could replicate. Moreover, the high quality demanded by telcos should be sufficient assurance that, for the next few years, these standard testing procedures are adequate (which I have suggested GTA observe). In respect of end-user requirements, these are specific to the end-user, (for example, running switch at 125% nominal load). Moreover we have no simple way of relating tests done by NTIL to the actual requirement. That is, why the end-user in the above case wanted to test at this level of nominal load is not known.

* Annex Enclosed

Deliverable 17

Article 2

- Directly connected access locations are those on-net locations which have a non-ESN PBX but are directly connected to an ESN node - (see deliverable 8, this response).

- This should have read "per route list"

Article 4

Both ESN and ROLMnet have the capability of matching the necessary translations. Their existing dialing does not accomodate 1-NPA-NNX-XXXX for on-net locations. However we do not evisage any problem in modifying the software for these purposes.

DELIVERABLE 16

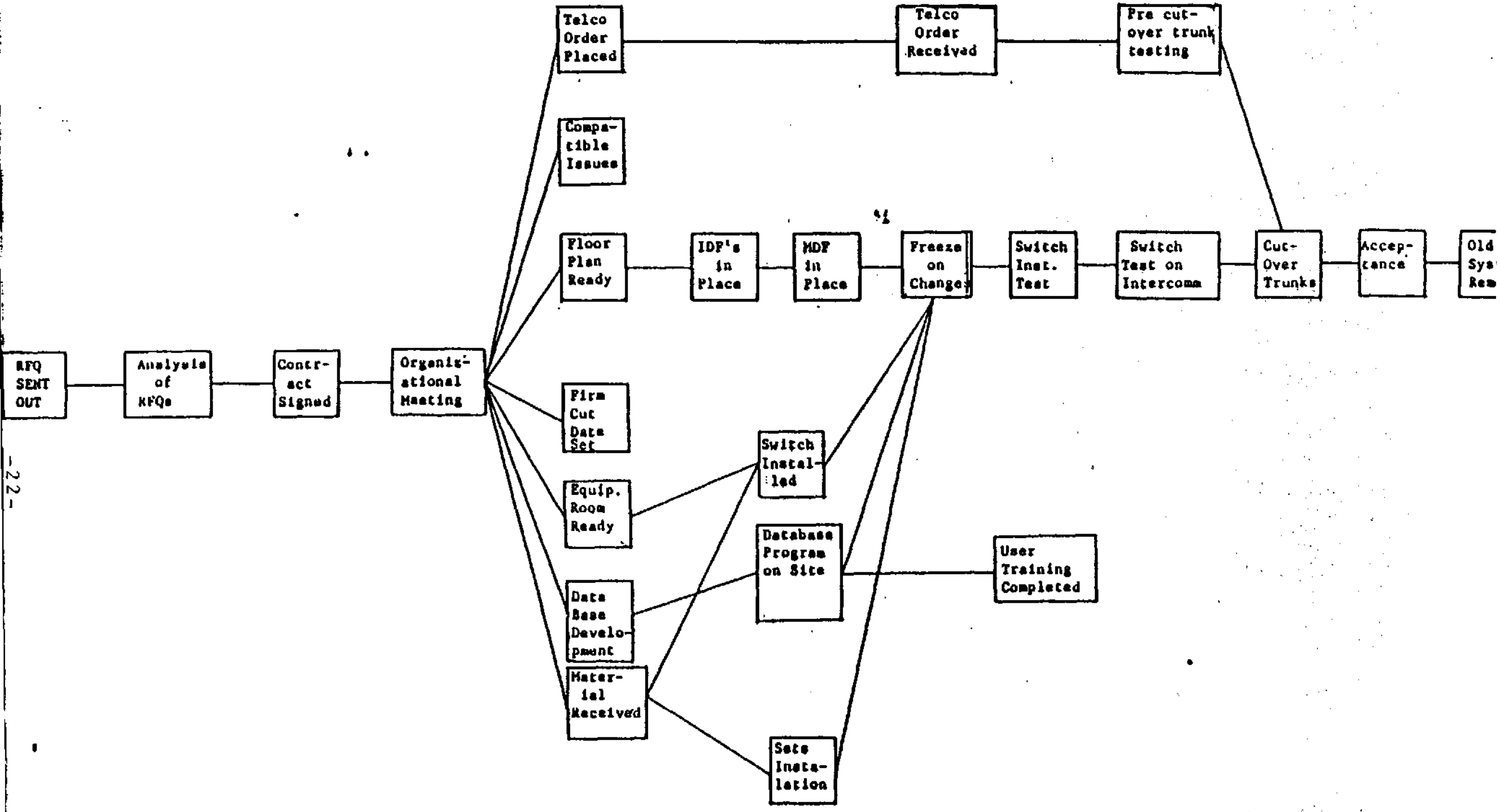


Fig. 3.1 CUTOVER PLANNING

Page 9 Signalling compatibility (to carry information for network control functions (Deliverable 8 this response)) is the specific limitation.

With respect to the impact on the GTA UDP, as all stored program switches have digit translation capability, all those considered should be able to implement the UDP. However we do not have detailed information on how many digits K2 or SX2000 can translate.

Item 3 The item refers to the free calling area of those on-net switch locations which correspond to the terminating switch.

Conclusion

At present ESN allows 256 locations and ROLMnet allows 512 locations. If GTA designs a distributed intracity network i.e. a PBX at most of the locations in the city and if the number of PBX locations within Canada goes beyond 512, then there are not enough location codes to accommodate GTA objectives (there are approximately 5000 NNX in Canada). In the case of a consolidated or a mix of consolidated and distributed networks, then there will be sufficient location codes on both ESN and ROLMnet.

Deliverable 19

Article 2

The statement that there is an agreement between Bell Canada and CRTC was given to BNR by telephone. The written confirmation of this agreement was CRTC decision 82-14. That is Bell Canada have put into motion a programme which conforms to the need expressed CRTC 82-14.

With respect to BC Tel, presumably the same intention applies. Due to the method by which this contract RFP came about, our dealings with BC Tel have been circumspect - no confirmation is available.

No agreement was reached (or asked for) on quoting directly Bell Canada contacts, as any information received from Bell, in our view, had to be substantiated in written form - CRTC 82-14 is that substantiation.

Article 3

Figure is enclosed

Deliverable 20

Article 3.0.3

The statement as a whole is taken from CS-03. Subscriber loop is the wiring from the network point of connection to the station apparatus.

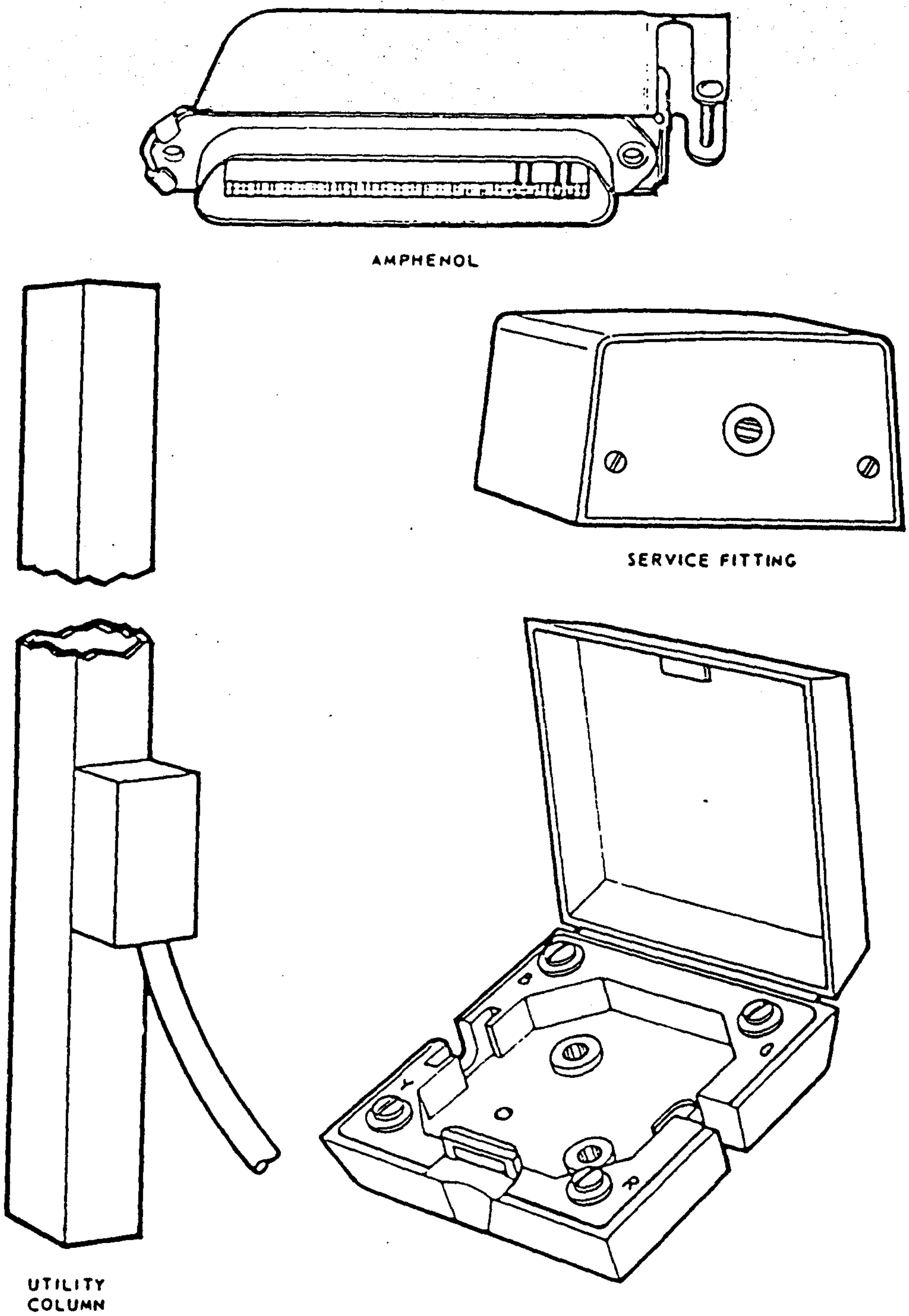


Fig. 1 - Miscellaneous Designated Apparatus

Annex

Examples of acceptance tests

(The table also indicates those tests which would normally be carried out on a joint acceptance basis)

Item No.	Commissioning Test Description	Acceptance
1	CPU Micro-code Tests	
2	CPU Maintenance Test	
3	CPU Store Test	
4	Network Maintenance Test	
5	Magnetic Tape Drive Test	
6	Printer Test	
7	Terminal Controller Test	
8	Continuity Test	
9	Power Verification	
10	Recorded Announcement Test	
11	System Loading	
12	Network Commissioning	
13	Network Trouble Shooting Aids	
14	Misc. Circuit Diagnostic	
15	Trunk Diagnostic tests	
16	Automatic Trunks Testing	
17	System Detected Alarms	
18	Data Dumping	
19	Manual Action Emergency Procedure	
20	Spare Circuit Pack Testing	
21	Custom Calling Feature Tests	Joint

Item No.	Commissioning Test Description	Acceptance
22	Business line and PBX feature tests	Joint
23	Local Feature tests	Joint
24	CDR tape tests	Joint
25	Special Features	Joint
26	Fault location tests	Joint

EMMS 35

ELECTRONIC MAIL & MESSAGE SYSTEMS

A twice monthly newsletter covering technology, user, product and legislative trends in graphic and record communications.

JUNE 15, 1983 **VOL. 7, NO. 12**

IS FACSIMILE'S BUST TELECONFERENCING'S BOOM?

Remember Compression Laboratories (San Jose, CA), which made lots of noise in the facsimile market in the late 1970s/early 1980s with digital compression equipment? It had great hopes in the fax market but never really got out of the starting box. Indeed, its founders, one by one, either bailed out entirely or gave up on fax and turned to other media.

On To Teleconferencing: Facsimile's bust may turn into videoconferencing's boom. Compression Labs and its alumni have recently been making some big news in the fledgling videoconferencing field. CLI, for example, has introduced a portable teleconferencing system that can be moved from room to room and has also turned much of its facsimile research into products that can be used for videoconferencing.

Its portable conferencing system is called the MCS (Mini-Conference System), and it supposedly can be used to support a one- to three-person conference at each site, replacing the need for a fixed system priced in the $175,000 range. The MCS, in contrast, is priced at $35,000, which includes the cost of the telecommunications equipment (the other does not).

IN THIS ISSUE:

ird

Limited Motion Processing: The firm has two video transmission products, both digital codecs used to convert a video signal into a digitized stream. Labeled the VTS 1.5 and VTS 1.5E, they are designed to operate with 1.544 Mbps T1 digital channels. What they do is digitize the video signal and analyze the changes in bit patterns between frames. Then they transmit only the changes to the frames, which allows normal teleconferencing actions like head shots to be shown with almost no blurring. As motion increases, so, too, does blurring.

While the limited motion codecs are very expensive, they reduce the need for full video channels, which take up to 3 MHz, trading off th cost of the codec for the lowered cost of the channel. A 3 MHz satellite transponder, for example, leases for $2 million or so per year and can only handle one full motion video signal. It can, however, accommodate a minimum of four T1 signals multiplexed together. The digital codecs lower line costs from $165,000 per month to about $50,000 per month. Thus, simultaneous conferences can be broadcast on the same transponder, increasing capacity and lowering channel cost. The codecs, however, are in the $150,000 range, which means a firm must be committed to videoconferencing before it makes a purchase. Payback is in a few months.

OK Item 1

The Robert Widergren Codec & Split: One of Compression Labs' best engineers, as well as its founder and executive vice president, was Robert D. Widergren, who left the firm in 1980 to pursue development on his own. Widergren's company, WidCom, is on the verge of possibl revolutionizing videoconferencing by developing a digitizing codec that will allow limited motion conferencing on 56 Kbps channels, representing a compression ratio of 1400:1 and thus changing the entire videoconferencing cost picture.

Widergren has already shown prototypes of his codec and has been given a $790,000 production contract by the Department of Defense to produce it commercially. In effect, DoD has provided WidCom with venture capital (isn't it just horrible how the Japanese government funds its high tech industries, but the U.S. government leaves its t fend for themselves?).

If the codec can be produced properly, it will allow costs to plumme from the $50,000 per moth range for a 1.5 Mbps channel to the $2,000 $3,000 per month range. While the production price of the Widergren codec isn't known yet, it will be a bargain even if it is double the cost of Compression Labs' 1.5 Mbps model. The additional $150,000 would be paid for in less than four months of operation.

More importantly, it will allow videoconferences to be held on the growing base of 56 Kbps channels now being installed by major companies nationwide -- indeed, internationally in some cases.

What's It Mean? Videoconferencing may soon be coming out of the closet with a vengeance. Widergren's codec will reduce line costs by an order of magnitude. In terms we can relate to, this is like going from a walking speed of 6 mph to a driving speed of 60 mph. It will move videoconferencing into the same cost realm as audioconferencing.

But there's a caveat. While it will make videoconferencing cost effective, it may not make it that much more popular. Remember, videoconferencing isn't much more effective than audioconferencing in terms of how users react to it. Seeing the face on TV isn't the same as seeing the person live. So while the cost may drop an order of magnitude, videoconferencing itself is not likely to have an order of magnitude greater effect on us, although the market will certainly pick up. Still, the day is quickly coming -- and may have been hastened -- when each one of us will have the chance to be a video star.

FACSIMILE MARKET TO SURPRISE CRITICS

Being down on the market for facsimile is popular these days. The technology is often considered to be a bit dated, out-of-step with the technologies now being integrated in the office of the future. Thus, stand-alone facsimile is often looked at as a technology whose days are numbered.

Stand-Alone Fax To Surprise The Critics: EMMS publisher IRD has recently published its sixth multi-client research study on facsimile dating back to 1972, making it the company that has covered the field the longest. The study, "Facsimile Markets" concluded the following:

1. Facsimile is not likely to decline during the decade or be merged into other office automation technologies too rapidly. There are too many key companies with their own graphic standards on their personal computers for the fax Group standards to be adopted wholesale in integrated products. Instead, the stages of the merger are being set by the development of select standards for handling multi-media documents. Such standards are not likely to have an effect, however, until late in the decade at the earliest.

2. Group 1 facsimile at 4/6 minutes has already died in the market; only one company, Exxon, still sells Group 1 machines. Group 2 (2/3 minutes) is on its way out as digital facsimile with low speed modems (2,400 to 4,800 bps) becomes price competitive. These digital machines transmit pages in 40 to 60 seconds. In effect, there are now two segments in the digital market: 9,600 bps modem units and 2,400 or 4,800 bps units.

STUDIES RELATED TO THE MODERNIZATION OF THE GOVERNMENT OF CANADA TELECOMMUNICATIONS NETWORK.