Routes Administration

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1 GENERAL

1.1 INTRODUCTION

These operational directions give a summarized overview description of the administration of routes. (The same, and more detailed, information can be found in the different referred operational directions.)

The first part of the document consists of definitions and explanations of the used terminology. The second part explains the fundamentals of signaling and routing. The last part explains how to organize and set up routes, and special route applications in general.

External lines are used to connect an MX-ONE with other exchanges, both private (PBX) and public exchanges. External lines with identical characteristics, signaling and direction together form a route.

This document deals with both digital and analog external lines. It also mentions different ways of signaling over an external line. Signaling is the way the exchanges communicate with each other.

1.2 GLOSSARY

For a complete list of abbreviations and glossary, see the description for *ACRONYMS, ABBREVIATIONS AND GLOSSARY*.

2 DEFINITIONS AND TERMINOLOGY

Alternative Routing

By alternative routing it is possible to reach an external destination via different routes. A primary choice route can have several alternative routes to reach the external destination.

If the primary route is not available, the system tries to use the first alternative route and so on. If necessary the system will modify the dialed number (add predigits or delete dialed digits or both) to suite the number to the numbering plan used in the exchange at the other end of the alternative route.

Note: In order to fully utilize the system's netservice capability, alternative routes that support netservices should be initiated as the first choice to the primary route. The requested service will fail if an alternative route not supporting netservices is used. Use the routes that do not support netservices as last alternative route choices.

B-Channel

A 64 kbit/s channel is used in ISDN for transmitting digitally coded speech and data. It is used for circuit switched connections, packet switched connections, and semipermanent connections.

To form an interface, a signaling channel is also needed. A common interface is the 30B+D interface. It consists of thirty B-channels for speech or data and one D-channel for signaling.

BC - Bearer Capability

The bearer capability is set for each outgoing route when initiated. It states the type of calls the line is capable of transmitting, and depends on the bandwidth of the line, if compression is used, and so on.

The bearer capability of a route is set to one or more of the following type of calls:

- 3.1 kHz Audio. Telephony or data calls with modem.

- Speech. Telephony calls only.

- 7 kHz, high quality speech (for example used for sports commentators).

- 64 kbit/s Unrestricted digital channel (64K-C). Modemless data calls. Also called 64 kbit/s Clear channel (hence the C in 64K-C).

- 64 kbit/s Restricted digital channel (64K-R). Modemless data calls, US market.

- 16 kbit/s Unrestricted digital channel. Compressed voice calls and 16 kbit/s subrate data.

In the same way as for the routes, each initiated extension will have a bearer category set. When an external call from an extension is made, a request for an external line with matching bearer capability is made. If there is no such line available the call will be rejected.

If the call is transited over an exchange and onto another external line a matching bearer capability (if it is known) is requested again.

The requested bearer capability is part of the protocol for signaling systems based on Message Oriented Signaling. On CAS systems no information of requested bearer capability is transferred.

Call Metering

The possibility to detect and store call metering (charging) pulses from the public exchange on an outgoing call. As there are many standards for the conveyance of the pulses, different call metering boards (CDUs for 50 Hz, 12 kHz and 16 kHz) are available for analog trunks. There is also the possibility to have call metering equipment directly on the trunk line board.

Note: There are two types of call metering boards; detection boards and the optional filter boards. Also, since one call metering board only can handle a given number of external lines, a number of boards may be necessary.

CAS - Channel Associated Signaling

The traditional method of signaling between two exchanges. The signals necessary for the traffic carried by a channel, are transmitted in the channel itself or in a channel permanently associated with it. In other words: Speech and signals travel together.

CCS - Common Channel Signaling

A method of signaling between two exchanges. Signals relating to a number of channels are transmitted over a single data link, in addressed messages. In other words: Speech and signals travel independently, both in time and media.

CCSS7 - Common Channel Signaling System No. 7

The overall objective of CCSS7 is to provide an internationally standardized general purpose common channel signaling system, optimized for operation in public digital telecommunication networks in conjunction with stored program controlled exchanges.

CCSS7 is a common channel signaling system defined for 64 kbit/s operation between exchanges. The signaling system uses signaling links for transfer of signaling messages between exchanges or other nodes in the telecommunication network served by the system. The system is normally applied with redundancy of signaling links and it includes functions for automatic diversion of signaling traffic to alternative paths in case of link failure. The capacity and reliability for signaling may thus be dimensioned by provision of a multiplicity of signaling links according to the requirements of each application.

Charging

The same as call metering, see above.

CO - Central Office

An exchange in the PSTN. Another name often used is PE (Public Exchange).

CSI - Call Service Information

CSI is used for similar reasons as FRL/TCM.

D-Channel

A 16 or 64 kbit/s channel used in ISDN for signaling, mainly signaling for circuit switched connections. The D-channel itself uses packet switching. When it is not used for signaling it can be used for packet switched data traffic.

DID - Direct In Dialing

Direct In Dialing enables subscribers in the public network to dial a PBX extension directly, that is, without assistance from the PBX operator.

Another term for this feature is DDI, Direct Dialing In.

DISA - Direct Inward System Access

Enables authorized users to call in to a PBX and get access to the PBX's services, except those services that require a procedure.

DISA calls can be established via direct in dialing external lines or via manual external lines (central office external lines).

DPC - Destination Point Code

The destination point code is the part of the label in a CCSS7 signaling message which uniquely identifies the signaling point to which the message is finally addressed.

DPNSS - Digital Private Network Signaling System

DPNSS is a signaling system designed to extend services available for extensions in a single PBX to extensions in other PBX exchanges in a private network. To the user the whole private network will behave like one PBX regarding services.

DPNSS utilize digital external lines and common channel signaling (CCS).

DTMF - Dual Tone Multi Frequency signaling

DTMF is a tone signaling scheme used for signaling from telephones to exchanges and for register signaling between exchanges. Ten decimal digits and two auxiliary characters (* and #) are represented by a combination of two frequencies. A frequency from the low group [697, 770, 852, 941] (Hz) is combined with a frequency from the high group [1209, 1336, 1447, 1633] (Hz). All in accordance with CCITT Q.23 recommendations.

EFM - External Follow Me

EFM enables an extension to temporarily divert calls towards non-CCS private networks and towards the PSTN or public ISDN.

ECMA QSIG - European Computer Manufacturers Association Q-signaling

Part of ISDN as a system for signaling between exchanges within a private network. It is an adaptation of DSS1 for usage between MX-ONE Service Nodes.

Usage of ECMA QSIG enables a MX-ONE Service Node to have ISDN connections to other manufacturer's PBXes, and function as gateway between standard ISDN private networks and public ISDN networks.

E&M Signaling

The E&M interface consists of four to eight wires (when used in an MX-ONE environment), of which two are used only for signaling. These two wires are called E and M, E (Ear) is used for reception and M (Mouth) is used for sending of signals to the co-operating exchange.

Enbloc Sending / Overlap Sending

Expressions used in ISDN.

Enbloc sending means that the exchange waits for the whole external number to be dialed before sending it in one block.

Overlap sending means that the digits are sent one by one, as soon as they are dialed.

ERWT - Expensive Route Warning Tone

ERWT provides a warning tone to the user when the system has selected an expensive route for the outgoing call.

ETE DTMF - End-To-End Signaling DTMF

ETE DTMF is a signaling method in which DTMF tones are transmitted from one end of a multi-link connection to the other end. The DTMF tones are interpreted as signals at the terminating end.

Sending of DTMF tones while in speech state enables communication with, for example, interactive answering machines.

FRL / TCM - Facilities Restriction Level / Traveling Class Mark

Also called *Trunk call barring*, the FRL/TCM enables selective restriction of outgoing traffic. Every user (for example, an extension or incoming route) is given an FRL value which is passed through the private network from one node to another as the user's TCM. Furthermore every route choice that is defined for a given destination is assigned an FRL value.

To be permitted to use a certain route the A-party's FRL value must be the same as or greater than the FRL value of the route.

FRL/TCM is **not** used for restriction purposes in the originating exchange, as opposed to Priority routing. Apart from this, the two features are very much alike.

See also the application system parameter *PARNUM=106*.

Gateway Exchange

A gateway exchange is an exchange used primarily as a switching point for traffic between other exchanges. Specific for the gateway exchange is that in the MX-ONE Service Node environment it connects routes with different signaling systems.

H.323 Signaling System

H.323 is an ITU-T recommendation for all issues related to multimedia communications over packet based networks, like, for example, TCP/IP networks.

Routes initiated following this standard (H.323 routes) allow exchange of signaling and media, if possible, directly through the packet network.

IDNX - Integrated Digital Network eXchange

Used in networks as a complement to the MX-ONE, primarily for cost efficiency on long distance traffic. The IDNX uses mainly voice compression to increase the capacity on an existing transmission media. By not having to add more cables to increase the capacity, or retain capacity with fewer cables (leased at high costs) much money can be saved. This is compared to the cost of an IDNX system.

IDNXes are set up as gateway exchanges near all the exchanges or sites and the long interconnects are between the IDNXes. The IDNX can handle different signaling systems with varying intelligence.

In an ISDN network the Priority routing information is used by a connected IDNX to determine the service profile to be used for the call.

Individual Number Translation

Individual number translation is a part of the PNR facility. The translation data are initiated together with the PNR access code in the PNR destination table.

Each PNR access code is assigned two sets of translation data, one suggested for translation to public directory numbers and the other for additional translation if the MX-ONE Service Node is connected to a second network (public or private).

IP VPN - Virtual Private Network over IP Network

IP Virtual Private Network is a service in a public IP network (like the Internet) that allows proprietary signaling among a number of PBXes that support communications over packet based networks, via a protocol like H.323. The IP VPN enables calls made between the PBXes as if they were made in a private network, with the functionality level of a private PBX network.

ISDN - Integrated Services Digital Network

A fully digital network, providing end-to-end digital transmission from the originator to the final destination, over a limited set of standard user-network interfaces. The network supports both voice and data applications. Public ISDN and private ISDN differ.

LCR - Least Cost Routing

Least Cost Routing allows the private exchange to select the most economical route for an outgoing public call. The exchange will check the dialled number to see if the private network can be used (as described below), and then route the call within the private network as close to the destination as possible.

There are three situations the system recognizes:

- The dialled destination is an extension in the own exchange.

- The dialled destination is in the private network and can be reached completely via the private network.

- The dialled destination can be reached partly via the private network.

The user first have to dial an LCR access code to activate the LCR. The system is then ready to analyze the dialed number.

Loop Avoidance

The loop avoidance feature is necessary in DPNSS networks where each node is allowed to carry out overflow traffic. It is used to avoid that a call is looped back to a node which has already routed the call, thus avoiding an infinite loop in the network.

Each call is assigned a loop avoidance counter which is **decremented** in every node it passes through. When the counter reaches value zero, the call attempt is aborted. The initial value of the counter is set per network. Loop avoidance is used for private network calls.

See also transit counter.

LS - Signaling Link Set

A signaling link set consists of a number of signaling links between two adjacent CCSS7 signaling points.

MCT - Malicious Call Tracing

Used for tracing malicious calls, primarily calls from the public network (ISDN, CCSS7) to a PBX. The tracing is activated by a procedure or programmable key. When activated it will cause an alarm and printout-log in the interworking local exchange (in the public network). The printout-log will contain, for example, the calling number, called number, date and time.

For the CCSS7 signaling system the MCT feature is bidirectional, which means that the public network can initiate MCT on a call originated in a PBX.

MFC - Multi Frequency Compelled

A tone signaling system used for register signaling between exchanges.

The tone signals are created by combining two frequencies from a group of 6 frequencies. A tone signal in the forward direction is created using frequencies from the *forward* group of frequencies [1380, 1500, 1620, 1740, 1860, 1980] (Hz). A backward signal by using frequencies from the *backward* group [1140, 1020, 900, 780, 660, 540] (Hz).

The different combinations allow 15 different signals to be represented in each direction. Another 15 signals in each direction are possible by letting the same 15 tones represent 15 other signals. This is done by changing signal group (ordered with one of the backward signals). The two forward signal groups are Group I and Group II, the backward signal groups are Group A and Group B.

After sending a forward signal the sending exchange awaits a backward signal, from the receiving exchange to confirm reception of the forward signal, before sending the next forward signal. Hence the name *Compelled*.

A forward signal from Group I will be acknowledged with a backward signal from group A, until the backward signal ordering changing of groups is sent. After this Group II and Group B are used. The tones are the same as before, but they now represent other signals.

MFPB - Multi Frequency Push Button

The same as DTMF.

MTP - Message Transfer Part

The message transfer part is the part of the CCSS7 node which ensures the reliable transfer of signaling messages between user parts, for example, TUP. The MTP defines a range of functions by which different signaling network configurations may be realized. Any application of CCSS7 requires that an appropriate of these functions is applied depending on the intended use of the system and the characteristics of the tele-communication network concerned.

OPC - Originating Point Code

The originating point code is that part of the label in a CCSS7 signaling message which uniquely identifies the signaling point in which the message originated.

PBX - Private Branch eXchange

A PBX is an exchange in a private telephone network, as opposed to an exchange in the public network. The MX-ONE Service Node is an IP-based PBX.

Packet-switched Network

Type of network in which relatively small units of data (called packets) are routed based on the destination address contained within each packet. Each packet can follow a different path through the network. Breaking communication down into packets allows the same data path to be shared among many users in the network.

PNR - Private Network Routing

PNR is used for calls terminating within the private network. PNR provides enhanced routing and number translation capabilities for the private network. Several PNR access codes, assigned in the PNR destination table, may use the same RCT to find a way through the private network.

Priority Routing

Priority routing enables selective restriction of outgoing traffic. Every user (for example an extension or incoming route) is assigned a priority routing category called Call Service Information (CSI) which is passed through the private network from one node to another. Furthermore every route choice that is defined for a given destination is assigned an authorization list called Call Service Information Users (CSIU).

To be permitted to use a certain route the A-party CSI value must correspond to the CSIU value of the route.

Priority routing is used for restriction purposes in the originating exchange, as opposed to FRL/TCM. Apart from this, the two features are very much alike.

In an ISDN network the priority routing information can be used in one of two ways. Either for network access restriction as described above, or by a connected Intelligent Digital Multiplexer (IDNX) to determine the service profile to be used for a call. If the feature of network access restriction is required in combination with the IDNX feature, the FRL/TCM feature can be used for network access restriction.

RCT - Route Choice Table

An RCT is a table that consists of a primary route choice and its alternatives. Translation information is provided (SRT, TRC, PRE, ADC, and so on) for each choice.

An RCT is accessed either directly with the dialed external destination code or with a fictitious external destination code provided after an LCR or PNR analysis. There is one RCT for each external destination code.

Rerouting

The expression rerouting is used in the MX-ONE Service Node environment for two different traffic cases.

1. Rerouting of an incoming call, which meets busy, no answer, congestion, and so on, to an answer position in that exchange.

2. Rerouting of an incoming call, which meets busy, no answer, congestion, and so on, to an answer position in another exchange.

Route

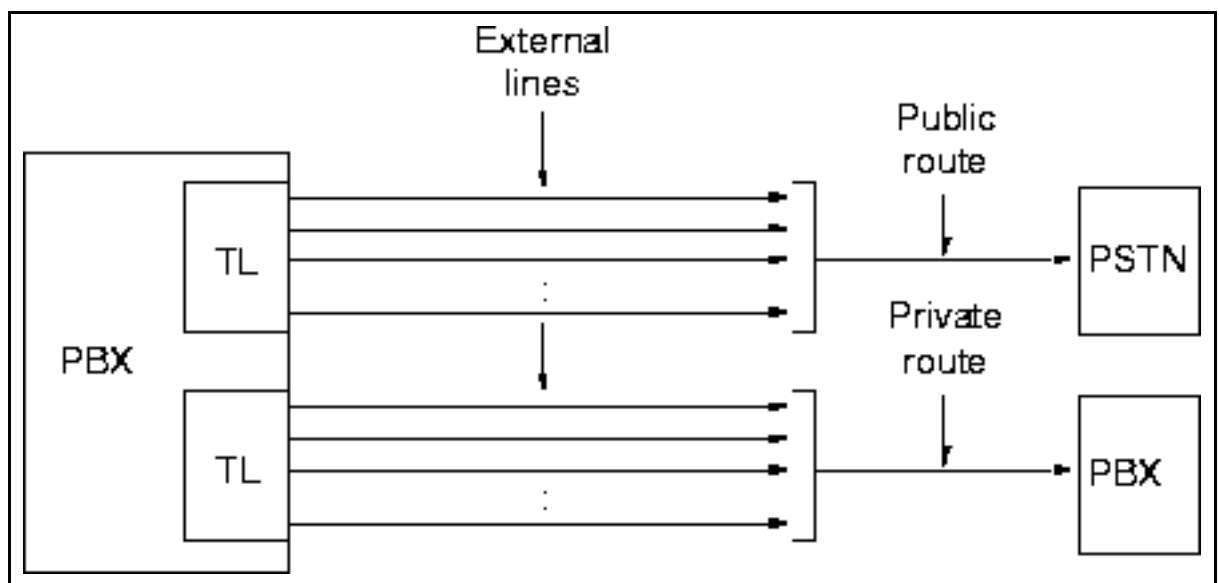A route is a number of external lines with the same characteristics. Together they form a route.

Figure 1: A route

Random Line Selection

Random line selection is a method of selecting lines. The random line selection is only supported by CCSS7 routes.

For random line selection the first choice is to select a line from the group of lines that are controlled by the own exchange, out of that group the line that has been released for the longest time is chosen. First the own LIM is searched, then if no free line is found the other LIMs are searched. However, if all lines controlled by the own exchange are busy, a line will be chosen from the group of lines controlled by the cooperating exchange. Out of that group the line that has been released for the shortest time will be chosen.

SCN - Switched Circuit Network

A switched circuit network is a network in which the communication circuit (path) for the call is set up and dedicated to the participants in that call. For the duration of the connection, all resources in that circuit are unavailable for other users.

SL - Signaling Link

A signaling link is a signaling path between two adjacent CCSS7 signaling points. It is provided by level 1 and level 2 of the message transfer part for the reliable transfer of messages between user parts, for example, TUP.

SP - Signaling Point

The Signaling Point is a CCSS7 node which originates, transfers or receives messages. It is identified by a unique binary code, Signaling Point Code.

Signaling Route

The signaling route is the pre-defined path, consisting of a succession of signaling points or signaling transfer points and the interconnecting signaling links, that a message takes through the signaling network between the origination point and the destination point.

Signaling Route Set

A route set consists of a number of signaling routes with the same origination point and the same destination point. All the signaling routes that may be used between an originating point and a destination point by a message traversing the signaling network is the signaling route set for that signaling relation.

SPC - Semi-Permanent Connections

Semipermanent connections are available in some public networks, as an alternative (usually more cost effective) to leased lines, where netservices over the public network is desired.

An SPC is a single B-channel (with no signaling channel). A leased line is a number of B-channels, with a dedicated D-channel. The word semipermanent comes from the fact that the connections are set up by command between two nodes in the public network. The connections remain *permanent* until removed by command again.

SPCs are used in conjunction with *D over B* signaling. One SPC is used for conveying the D-channel. The other B-channels are used as the B-channels they are, using the *D over B*-channel as their dedicated D-channel. This enables netservices over a public network otherwise not supporting them.

SSP - Start Selection Point

Number of digits in a CCSS7 set-up (initial address) message. The digit appointed by the SSP is the last digit included in the message.

SSPC - Static Semi-Permanent Connections

Static semipermanent connections are used in an MX-ONE system to connect two multiple positions to each other via the switch in a static connection. The effect is the same as if they had been interconnected with a cable.

Transit Exchange

An exchange used primarily as a switching point for traffic between other exchanges.

In a MX-ONE Service Node environment a transit exchange is usually an exchange that interconnects routes with the same signaling system.

Transit Counter

The transit counter feature is necessary in ISDN networks where each node is allowed to handle overflow traffic. It is used to avoid that a call is looped back to a node which has already routed the call, thus avoiding an infinite loop in the network.

Each call is assigned a transit counter which is **incremented** when overflow occurs in a node. When the transit counter reaches a preset maximum value the call attempt is aborted. This maximum value is set per network. The transit counter is used for private network calls.

See also loop avoidance.

TUP - Telephone User Part

The telephone user part is the part of a telephone exchange which uses the CCSS7 signaling system to control telephone calls and circuits.

VPN - Virtual Private Network

Virtual Private Network is a service in a public network (primarily ISDN) situated in between a number of MX-ONE Service Nodes or PBXes. The VPN enables calls to be made between the nodes via the VPN as if the call was made in a private network, with the functionality level of a private network.

The VPN size and capacity are regulated in the agreement between the public network operator and the MX-ONE customer.

3 BASIC SIGNALING

Exchanges that are connected to each other communicate by means of signaling. This is how the exchanges tell each other that a call is being made, what number is dilled, that either party has hung up, and so on.

The communication between different exchanges can be done via either switched circuit networks or packet-switched networks. Traditional signaling systems (for example, ISDN) work over switched circuit networks and are based on either CAS or CCS (see 3.1 CAS and CCS on page 13). However, the signaling system defined in the H.323 recommendation works over packet-switched networks.

3.1 CAS AND CCS

At present there are two signaling principles used in private networks. The division in principles is based on how the signals are transmitted in relation to the speech channels they belong to. The division is sort of a division in old and new.

CAS

Channel Associated Signaling

This is the traditional principle for signaling.

Each speech channel has a fixed and unambiguously defined signal path:

- either attached to the speech channel, that is, the signals are transmitted with the speech channel.

  This is called inband signaling.

- or associated with the speech channel, that is, the signals are transmitted in their own signal channel separate from the speech channel.

  This is called outband signaling.

In other words: Speech and signals travel together.

There is a big variety of different signaling techniques used in CAS, in some cases inband and outband signaling are combined.

CCS

Common Channel Signaling

The speech channels use a common data link for transmission of all signals. A signal is transferred as a signal message to which an address is tied. The address states which speech channel the signal belongs to.

In other words: Speech and signals travel independently, both in time and media.

ISDN, DPNSS, and CCSS7 are examples of signaling systems using CCS.

3.2 LINE AND REGISTER SIGNALING

CAS is traditionally divided into line signaling and register signaling. There is no need for this division in CCS.

Line signals are simple information in contrast to register signals. Line signals are needed during the whole call while register signals are used only during the call set up.

By dividing the signaling equipment into register and line signaling equipment, and using the more complex register equipment only while the address information is transmitted, one register equipment may be used to serve many lines.

Notice the difference between this division based on what information the signals transfer, and divisions based on the different *principles of signaling* (for example, CAS, CCS see above) or *techniques used to transfer the signals* (for example, impulsing, tone code).

Line signaling

Seizure, answer and clearing are examples of line signals.

Examples of techniques used for line signaling are DC signaling (Direct Current) and digital signaling (in time slot 16 on a PCM link).

Register signaling

This is mainly used for conveying the called number.

Examples of techniques used for register signaling are impulsing (decadic pulsing) and tone code (for example, DTMF, MFC).

3.3 EXAMPLE OF SIGNALING

In the figure below is an example of signaling between exchanges using a CAS signaling system. The example shows a basic call from A to B where the B-party hangs up first.
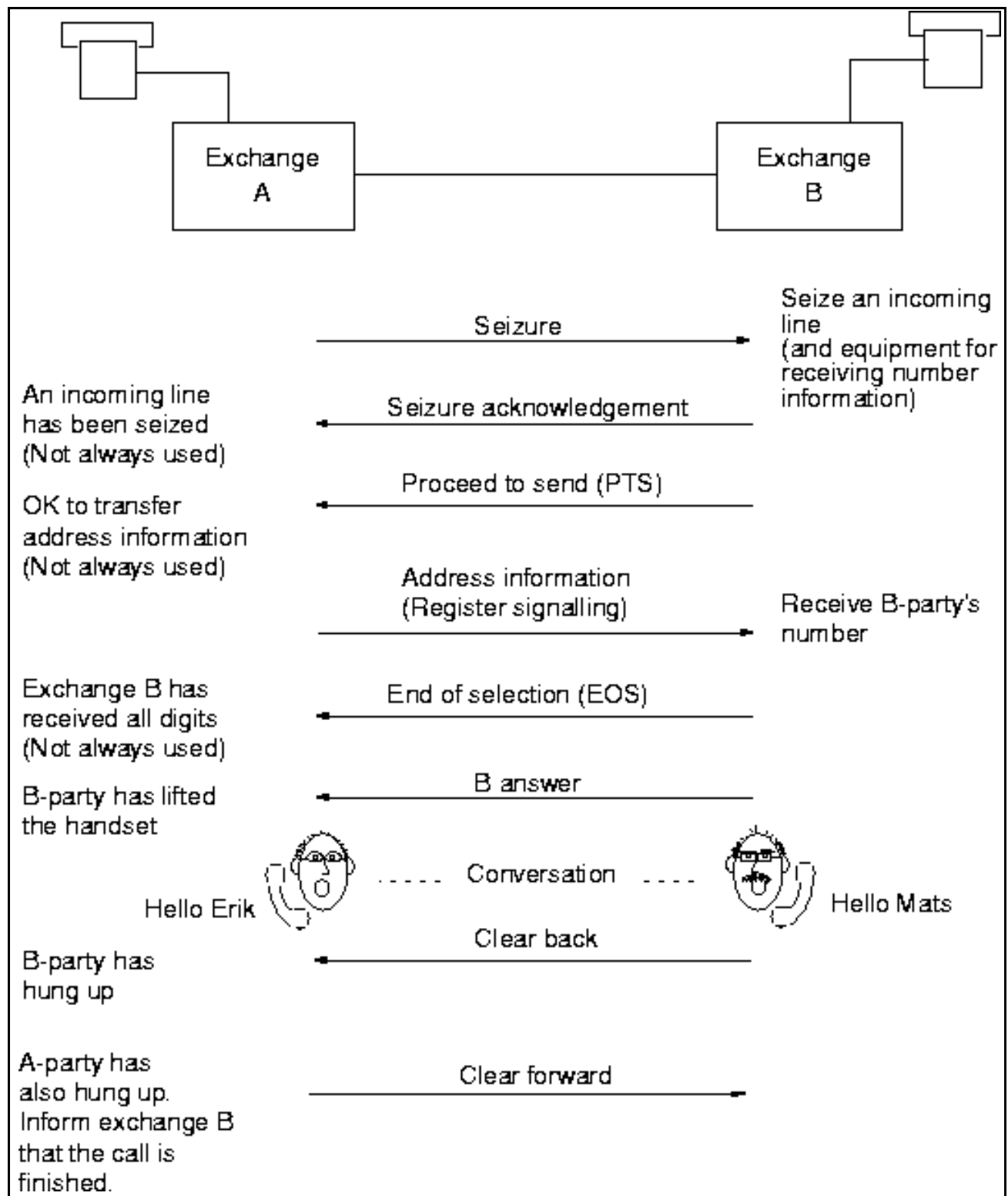
Figure 2:   Signaling for a basic call

4 PREREQUISITES

Network Services are administered with the LC commands.

5 TOOLS

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6 REFERENCES

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7 EXECUTION

7.1 ROUTING, GENERAL

To set up a route in the MX-ONE system, a selection of MML commands are necessary.

A route is identified by the system by its route number which is a fictitious sequence number. The route is given certain characteristics, some characteristics are used by the system (in command *ROCAI*) and others are used by the interface between the system and the external line (in command *RODAI*).

An external line is physically connected to the system either to the front of a TLU board or to the front of the Media Gateway. The H.323 and SIP trunk uses the ordinary LAN connection.

An external line is logically connected to the system by associating a route to an equipment position (by command *ROEQI*). At the same time the external line (equipment position) is given a sequence number based on to which LIM the line is connected. This sequence number is used for outgoing calls at the line selection which can be done in different ways.

A route can have external lines in several media gateways and in several LIMs (servers), providing distribution of the traffic load for the route. The method for selection of the lines can be configured (command ROCAI, parameter SEL).

H.323 and SIP routes represent exceptions to the previous statements. First, these types of routes make use of an IP interface (RTP resource) board (MGU) instead of a TLU board, since it is the same interface as the IP extension. IP interface boards are connected directly to the data network.

There is no association between physical equipment positions in the IP board and external lines. IP interface boards are capable of supporting more calls than equipment individuals, given that not all calls need board media resources and if needed, those resources can be borrowed from another board. So, it is possible to initiate more external lines than board positions. H.323 or SIP external lines are not attached to an equipment position.
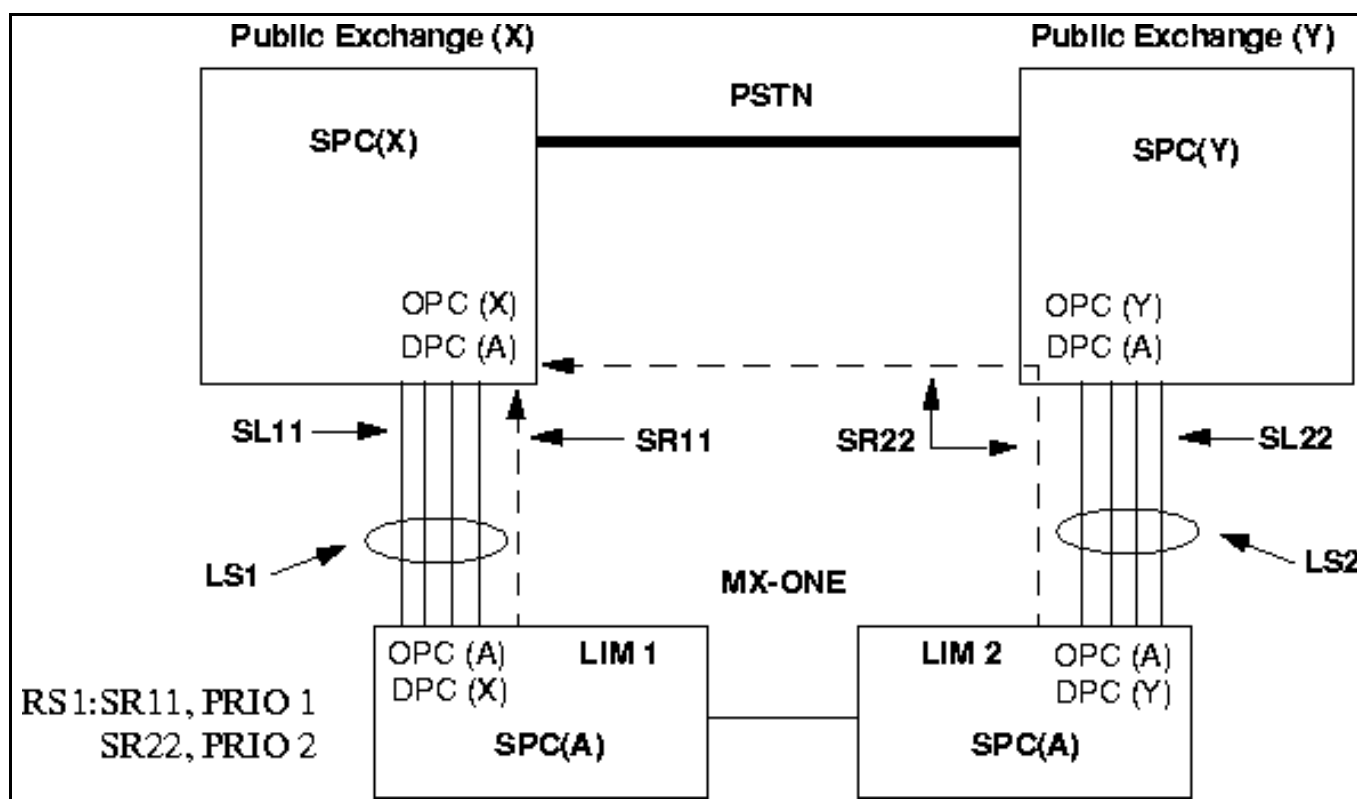
7.2 ROUTING, CCSS7

Figure 3:   Signaling description for CCSS7

Note: LIM 1 and LIM 2 belong to the same PBX but are located at different places. Therefore they may have access to two different exchanges in the public network.

In the figure above the route set RS1 is set up between Signaling Point Code (SPC) (A) and SPC(X). Signaling routes SR11 and SR22 belongs to RS1. A route set RS2 has to exist between SPC(A) and SPC(Y) but that is not shown in the figure.

To set up a CCSS7 signaling link in the MX-ONE system, a selection of MML commands are necessary.

MTSSI

The first thing to do is to initiate a link set with the command *MTSSI*. Parameters of special importance are OPC, DPC and LNKSET.

The parameters OPC and DPC are determined by the SPC values. The SPC values are provided when requesting a CCSS7 access from the public network.

Parameter LNKSET states a specific signaling link set.

MTSLI

Secondly, define the characteristics for the signaling links using command *MTSLI*. Parameters of special importance are LINK, LNKSET, PCMID and SLC.

The parameter LNKSET states a specific signaling link set.

The parameter PCMID states the PCM link identity of the board where the signaling link is situated. The value is used to form the complete circuit identification code (CIC) of all external lines assigned to the board. The parameter value specifies the most signif-

icant seven bits of the CIC. The remaining five bits are determined by the corresponding time slot used for the speech connection of the external lines.

The parameter SLC states the code of a signaling link connecting two points in a common channel signaling system No.7 network. The SLC is sent in message signal units (MSUs) to indicate the signaling link, connecting the destination and originating points, to which the message is related.

MTSTI

Thirdly, the signaling route set shall be initiated with command *MTSTI*. Parameters of special importance are ROUSET, DPC and TEST.

The parameter ROUSET states a signaling route set number.

The parameter TEST states whether a signaling route test will be performed or not.

MTSRI

Next to do is to initiate the signaling routes using command *MTSRI*. Parameters of special importance are SIGROU, ROUSET, LNKSET and PRIO.

The parameter SIGROU states a signaling route number.

The parameter PRIO states what priority the signal route has.

MTSDC

Finally the signaling links shall be activated. This can be done link by link or for the whole link set by using command *MTSDC*. Parameters of special importance are LINK, LNKSET and DEACT.

The parameter DEACT states whether the signaling link shall be deactivated (YES) or activated (NO). If the parameter is omitted the value NO is assumed.

Trunk Lines

After initiating the link set, signaling links, route sets, and signaling routes, the trunk lines shall be initiated following the description in the next section. Variables that are of special importance for CCSS7 are:

- SERV D3: Type of route, shall be set to 0, trunk line.

- SERV D4: Call metering characteristics, shall be set to 1, call metering route.

- ADC D20-D21: Start Signaling Point (SSP).

- SIG D12 - Netservices, has to be set to 0, no net service facilities.

- CNTRL: Decides whether the trunk is controlled by its own (YES) or cooperating (NO) exchange. If the Originating Code Point (OPC) is lower than the Destination Code Point (DPC) and the trunk individual is odd, the CNTRL parameter shall be set to YES.

7.3   BASIC ROUTING

Below there is a description of the different commands that are necessary to initiate a route, in order to provide it with its specific categories and characteristics.

Note: For specific characteristics at route initiation and allowed categories for H.323 routes, see the operational directions for *IP NETWORKING* and also see the description for *IP NETWORKING*.

ROCAI

The first thing to do is to initiate a route with the command *ROCAI*. Parameters of special importance are SEL, SERV and SIG.

For the parameter SEL the following characteristics are of special interest:

- Criteria for rerouting at DID traffic.

  If any rerouting criteria are set, command *RODNI* must be used to define the answering position to which the call should be rerouted.

  For manual incoming routes, the answering position is primarily defined by the commands *OPCTS* and *OPCGS*, see the operational directions for *PBX OPERATOR TRAFFIC*.

- Selection of a line at outgoing traffic.

  For instance, the line selection can be done in the way that the calls are evenly distributed among the external lines.

For parameter SERV the following characteristics are of special interest:

- Whether the system is to handle the route as public (trunk line) or private (tie line).

  Used to provide correct ringing signal and display message at the called party.

For parameter SIG the following characteristics are of special interest:

- Whether dial tone after seizure of the external line is to be generated in the own or received from the co-operating exchange at outgoing call.

- Whether the route has any clear signal.

  Used to check if the parties, that is, a party in the own exchange or an incoming or outgoing route, are allowed to be connected. If both parties lack the clear signal, the connection of the call is prohibited unless the call is extended and supervised by a PBX operator. PBX operator supervision of extended calls is also stated in parameter SIG.

- When the switch should be through-connected

- Type of signaling system, that is, DPNSS, ISDN, H.323, MFC, decadic pulsing/DTMF, or CCSS7

- Whether netservices are supported or not for H.323, DPNSS, or ISDN routes

RODAI

Second, define the characteristics used by the interface between the external line and the system with the command *RODAI.* These characteristics depend on the type of signaling system and can be found in the parameter description for the external line in question.

Note: A value stating a specific characteristic for one type of route does not necessarily have the same meaning for another route.

There are three parameters for the purpose of stating characteristics. Parameter VARC is used for stating common characteristics, parameter VARI is used for stating characteristics specific for incoming traffic, and parameter VARO is used for stating characteristics specific for outgoing traffic.

Typical characteristics are:

- type of signaling

- whether end of selection (EOS) should be sent

- whether B-answer should be sent

- whether B-answer should be received

- characteristics for different time supervisions

- specific differences within the concerned signaling system (protocol)

ROEQI

Third, the external line or lines should be logically connected to the route with the command *ROEQI*.

number_initiate, RODDI

Last, if the route allows outgoing traffic, one or more route access codes for external traffic has to be defined.

The route access code should be initiated as an External Destination number type (ED or EC) with the command *number_initiate*, see the operational directions for *NUMBER ANALYSIS*.

The External Destination number is affiliated to an outgoing route by command *RODDI*.

Parameters of special importance are:

- CHO

  states whether the route is the primary or an alternative route for the stated External Destination. If an alternative route is defined for an External Destination, this route is selected when no free external line exists in the primary route.

- TRC and PRE

  If an alternative route is selected, the called number might be modified to enable a connection to the same destination using another connection path.

  TRC states the number of digits to truncate starting from the first called digit.

  PRE states the new digits which should be inserted as the first digits. The (first part of) PRE must be initiated as an external destination.

  If both TRC and PRE are given, the digits stated in PRE are inserted after the number of digits stated in TRC has been truncated.

- SRT

  states the start position in the called number (possibly modified using TRC and PRE) from which digits should be sent to the co-operating exchange.

  For instance, if number 00 is defined as the route access code for a route and these digits are not to be sent to the co-operating exchange, SRT is set to 3.

7.4 EXTENDED SERVICES FOR OUTGOING TRAFFIC

number_data_initiate

For an external number the following can be stated with command *number_data_initiate*:

- After how many digits a B-answer can be expected.

  This causes reduction of the seizing time on tone receiver or tone sender, which is a common resource used at digit sending and tone detection.

When dialing an external number where one or more PTS signals are expected, the positions of expected PTS signals in the external number can be set with the command *number_initiate*. At these positions the system shall connect a tone receiver and await the detection of the PTS signal before the digit sending does continue. This is not relevant for CCSS7 nor H.323 trunks.

To prevent specific extensions in the system from calling specific external numbers, there is the possibility with the command *number_data_initiate* to define different trunk

call discrimination (TCD) categories for different external numbers. A route is always associated to a TCD category with the parameter TRAF in command *ROCAI.*

7.5 A-NUMBER REQUEST FROM PUBLIC ISDN

7.5.1 GENERAL

In connection to incoming calls from a public ISDN and depending on the signaling system, there is a possibility to request the A-number, which then can be presented on the display of the answering position. This feature is supported by certain MFC protocols (for example, the Swiss MFC) and the US public ISDN signaling system (AT&T 4ESS and 5ESS). The A-number request also depends on the B-party's category, which states if A-number requests are allowed or not.

7.5.2 PREREQUISITES

The trunk block used can be the TL60/SL63, TL72, or TL30. The incoming route is connected to the public ISDN. For TL72 and TL30 register signaling MFC must be used.

7.5.3 EXECUTION

Incoming route support for A-number request is set in parameter SERV, by the command *ROCAI.* The category for the B-party is set in the parameter ADC or in ADC and SERV for the command groups EX, KS, GH, and AC. If the B-party is a PBX operator, *PARNUM=153* in command *ASPAC* states if A-number request is allowed or not.

7.6 A-SUBSCRIBER CHARGING

7.6.1 GENERAL

In connection to incoming calls from a PSTN and depending on the signaling system, there is the possibility to decide if the A-subscriber shall be charged or not. An example is a PTT exchange (PTT PBX) with answer positions for, for example, complaints, information, and so on, so called *free of charge* answering positions. The signaling systems that support this feature are certain MFC protocols like the Swiss MFC. If the A-subscriber shall be charged or not, depends on the B-party's category.

When calling a free party, either MFC backward signal B:6 (which means charging of A-subscriber), or B:7 (which means no charging of A-subscriber) is sent. At answer, and when an answer signal is sent and received in the public exchange, charging or not of the A-subscriber depends on which of the signals B:6 or B:7 that was previously received.

7.6.2 PREREQUISITES

The trunk block used can be TL72. The incoming route is connected to the PSTN, and register signalling MFC is used.

7.6.3 EXECUTION

The category for the B-party is set in parameter SERV for the command groups EX, KS, GH and AC. If the B-party is a PBX operator or data extension, *PARNUM=153* in command *ASPAC* states if the A-subscriber shall be charged or not.

7.7 DISA - DIRECT INWARD SYSTEM ACCESS

7.7.1 GENERAL

DISA permits external users to call in to a PBX and get access to some of its features.

The DISA feature can be accessed via different types of trunks.

- Direct in dialing trunks
- Private tie lines
- Manual trunks

The dialing procedure for a DISA call is:

DISA number *DT* * FC * AUTH.CODE # *DT* Wanted number DISA number *DT* * FC * AUTH.CODE * FC * ACO.CODE # *DT* Wanted number

Table 1 DISA dialing

DT	= Dial tone
FC	= Feature code
AUTH.CODE	= Authorization code
ACO.CODE	= Account code

The DISA user has the possibility to charge a call to an account code (tied to, for example, a particular project, department, or client), instead of charging the called DISA extension (which is default).

A DISA call requires a DTMF telephone instrument with a key pad providing pound (#) and star (*) keys.

After having completed a DISA call the user must hang up, before a new DISA call can be made.

Some MX-ONE features are not available when making a DISA call:

- Features that are accessed by dialing a procedure, except for the account code procedure.
- Any feature activated by suffix dialing.

For more information on DISA, see the directions for use for *DISA*.

7.7.2 EXECUTION

The execution is described using two examples.

The first example is when DID external lines or tie lines are used for DISA.

The second example is when manual external lines are used for DISA.

7.7.2.1 *Example with DID external lines or tie lines.*

Prerequisites

DID external lines or tie lines have been initiated in the MX-ONE with the commands:

ROCAI

RODAI

ROEQI

Command Handling

Initiate a number with number type DI (DISA)

number_initiate **-number 11600 -numbertype di**

Define a category for the DISA extension

*EXCCS***:CAT=50,TRAF=00151515,SERV=00001000000,CDIV=001000000;**

Initiate an authorization code:

A Call Information Logging (CIL) code is used for the call information logging, that is, the calls using this authorization code will be logged on the stated CIL code.

auth_code -i **--customer 0 --auth-code 1234 -cil 11600 --category 50** (In this example the CIL code used is the same as the DISA number)

Initiate an account code (optional):

account_code_init **-customer 0 -code 516** Used for charging an account code instead of charging the DISA extension.

7.7.2.2 *Example with manual external lines.*

Prerequisites

Manual external lines have been initiated in the MX-ONE with the commands:

ROCAI

RODAI

ROEQI

Command Handling

Initiate a number with number type DI (DISA):

number_initiate **-number 11600 -numbertype di**

Define a category for the DISA extension:

*EXCCS***:CAT=50,TRAF=00151515,SERV=00001000000,CDIV=001000000;**

Initiate day and night service position (= DISA number) for the incoming route:

*RODNI***:ROU=10,DAY=11600,NIG=11600;**

Initiate an authorization code:

A CIL code is used for the call information logging, that is, the calls using this authorization code will be logged on the stated CIL code.

auth_code -i **--customer 0 --auth-code 1234 -cil 11600 --categoryt 50** (In this example the CIL code used is the same as the DISA number)

Initiate an account code (optional):

account_code_init **-customer 0 -code 516** Used for charging an account code instead of charging the DISA extension.

7.8 ERWT - EXPENSIVE ROUTE WARNING TONE

7.8.1 GENERAL

The ERWT feature provides a warning tone to the user when the system has selected an expensive route for the outgoing call.

When the user has dialed a complete external number and the system has chosen a route that is marked expensive, the user receives a warning tone. The expensive route is seized and all digits except the last one are sent to co-operating exchange.

At reception of the warning tone the user can either terminate the call or wait for the time out of the warning tone. On time out, the system will continue to process the call by sending out the last digit.

Digits which are dialed during the tone sending (ERWT) are ignored by the system.

7.8.2 PREREQUISITES

-

7.8.3 EXECUTION

Whether the system should send ERWT or not is set in D_{11} in the ADC parameter. The ADC parameter belongs to the *RODDI* command.

7.9 IDNX INTERWORKING

7.9.1 GENERAL

The implementation of IDNX interworking in the MX-ONE depends on if non-ISDN or ISDN routes (external lines) are going to be used between the MX-ONE and the IDNX.

7.10 LCR - LEAST COST ROUTING

7.10.1 GENERAL

LCR is a function that enables the system to automatically select the most economical route for an **outgoing public call**.

The system will detect if the call is made directly to a public network:

- • is to an extension in the own exchange.

- • may be reached completely via the private network.

  (Off-net to On-net routing)

- • may be reached partly via the private network.

LCR will select the cheapest route for the call depending on:

- • the dialed number

- • the time of day (optional).

The function is realized by modifying the dialed public number, based on the information in a number of LCR tables.

A short explanation of how external analysis, RCTs, and destination data records are related:

- • A call made to the public network, will after a first number analysis (where the call is found to be to an external destination) be passed on to external analysis. The external analysis utilizes a table of destination data records (initiated with command *RODDI*), where data about number modification and routing is found.

- • For each destination (possibly fictitious) an RCT with up to eight linked route choices should be initiated. Each route choice uses one of the destination data records in the external analysis.

LCR adds features, and increases the capacity of the external analysis (basic routing). LCR enables that the same set of destination data records can be used for different called numbers.

The LAC

Least cost routing is invoked when a Least cost routing Access Code (LAC) is dialed.

With basic routing only (no LCR), the dialed number is sent for external analysis when the access code for public calls is detected. With LCR, when the LAC is detected, the system modifies the dialed number to begin with a fictitious destination code, before it is sent for external (or internal) analysis.

By specifying the LAC as the standard access code for calls to the public network (for example 9 or 00) the user will not need to remember a special access code to use for LCR calls.

By using basic routing (by command *RODDI*) an LCR-like function could be implemented without using LCR, but it would require initiation of a lot of destination data records, which quickly would use up the limited capacity in the external analysis. Furthermore, it would require the users to use different access codes for LCR calls and non LCR calls.

LCR Number Database Tables

LCR consists of five number data base tables where the dialed number is modified, before it is sent to external or internal analysis. Any number initiated in any of the LCR tables (apart from the FDT, described later) should begin with an LAC that is initiated in the number analysis.

- • The first table is the External Number Table (*LCDDI*:TAB=ENT).

  This table offers basic analysis of conflict numbers, translation of special numbers, and translation to internal numbers and numbers within the own private network (off-net to on-net conversion).

- • The second table is the Number Length Table (*LCDDI*:TAB=NLT). This table should be used when an exchange has a remote LIM in a different area (with an other area code). For the US market the ENT can also be used to distinguish

between conflicting numbers using a combination of timer and number length analysis.

- The third table is the Exceptions Table (*LCDDI*:TAB=DNT1).

  This, and the DNT2 together with the FDT (see below), are where the main LCR function is realized. Most of the numbers or number series that are to be least cost routed are initiated in these tables.

  The DNT1 offers analysis of numbers up to 16 digits long which is good for analyzing exception numbers. Exception numbers are numbers that belong to a number series analyzed elsewhere (in external analysis with or without LCR), but need to be treated individually.

- The fourth table is the Number Table (*LCDDI*:TAB=DNT2).

  This table only analyses numbers up to 8 digits long and is used for number series.

- The fifth table is the Fictitious Destination Table (*LCDDI*:TAB=FDT).

  This table is the link between the DNT tables and the destination data records of the external analysis.

- Finally there is the optional feature to initiate Least cost time zone data in the DNT table (by command *LCTDI*). This feature is called **Time of day**. Basically, it offers the possibility to have a call routed differently depending on the time of day and the day of the week.

Note: The least cost time zone data must be initiated. It may be transparently initiated though, if the feature is unwanted.

The first two tables (ENT and NLT) modify the dialed number before it is sent to internal or external analysis.

The two DNT tables modify the dialed number before sending it to the FDT (possibly via time of day if desired). The DNT further prefixes the previously modified number before sending it on to external analysis.

Whether data should be initiated in each table will be described below in the section Execution.

Toll restriction and Forced Account Code may be applied for any call through LCR (except PDC calls, see below).

PDC

The LCR function also includes handling of the Public Destination access Code (PDC) which is mainly used in the US as a complement to the LAC. When using a PDC the call is **not** least cost routed, but external numbers may be (selectively) barred for calls by using the LCR features, Toll restriction and Forced account code. A comparison to help understanding PDC:

- To use only basic routing (no LCR), the user dials a standard access code to the public network and the dialed number is sent for external analysis. Toll restriction and Forced account code cannot be used since they are LCR features.

  A basic route access code is initiated with the number type ED.

- To use LCR, the user dials an LAC and the dialed number is modified, is Toll restricted, and so on, before the modified number is sent to external analysis.

  An LAC is initiated with the number type LC.

- To use **LCR with PDC**, the user dials a PDC and the dialed number is LCR-analyzed, but only Toll restriction and Forced Account Code are applied on the call. The dialed number is not modified before it is sent to external analysis.

A PDC is initiated with the number type PD.

No other LCR features, for example Time of day, than the two mentioned above may be applied to a PDC call.

7.10.2 PREREQUISITES

Initiate the numbers and number type for LCR, use the command *number_initiate*:

number_initiate **-numbertype lc -number 9**

The number series 9 as LAC is used in US-like numbering plans.

number_initiate **-numbertype lc -number 00** The number series 00 as LAC is used in other numbering plans.

Group the numbers or number series that should be routed the same way, both regarding primary and alternative routing. Create fictitious external destinations, one for each group, and initiate them with number type ED.

For the examples below 0120 to 0125 are chosen to be used as fictitious destinations:

*number_initiate***-numbertype ed -number 0120..0125**

Initiate primary and alternative routing choices with command RODDI for the fictitious destinations initiated above. Consider how to modify the number before sending it to the route, the fictitious destination (or part of it) is usually truncated. It is also possible to prefix the number here.

*RODDI***:DEST=0120,ROU=...** and so on

Initiate the number series and number type for the PDC.

For the example below the number series 01 is selected:

*number_initiate***-numbertype pd -number 01** This call barring is further described below in Example 3, exception number using PDC in the section DNT - Destination Number Table. The number series 01 was randomly chosen.

7.10.3 EXECUTION

7.10.3.1 ENT - External Number Table

The ENT is primarily used to translate external numbers to private network numbers, mainly for off-net to on-net routing. For the US market the ENT can also be used to distinguish between conflicting numbers using a timer called critical timing.

ENT has the ability to analyze the first 16 digits of a dialed number. If the number is found in the ENT the number is translated into a new dialed number. This is the only feature in the system that can achieve this. The unique thing is that the translation results in another dialed number, which means that the number analysis will start all over again for this translated number.

The table is not mandatory and if the dialed number is not found in the ENT the analysis proceeds to the next table, the NLT.

Off-net to On-net Routing

If a user dials the public number to an extension within the own private network this public number should be translated to the corresponding private number within the private network. The ENT is for this case set up to detect number series within the own private network. A number series where all numbers should be converted the same way (using TRC and PRE) is handled by one ENTRY.

LCDDI:**TAB=ENT,ENTRY=0008422,TRC=6,PRE=850;** The user dials 0008422... where 00 is the LAC (least cost routing access code), 08 is the trunk code (area code), and 422... is the subscriber number in the public numbering plan. Since this is an extension within the own private network the ENT should be used to convert this public number into the corresponding private network number, so that the call is routed within the own private network.

When the number 0008422 is detected, the system immediately truncates the first 6 leading digits, leaving the 2 which is the first digit of the extension number within the exchange where the extension is situated. The number is then prefixed with 850 which is the location code to the exchange (where the extension is situated) within the own private network.

Translation to Internal Numbers

If a user dials the public number to an extension within the own exchange this public number should be translated to the corresponding directory number within the own exchange. The ENT is for this case set up to detect number series within the own exchange. All numbers in a number series that can be converted the same way (using TRC and PRE) is handled by one ENTRY.

LCDDI:**TAB=ENT,ENTRY=00422,TRC=4;** The user dials 00422... where 00 is the LAC (least cost routing access code), and 422... is the subscriber number in the public numbering plan. Since this is an extension within the own exchange the ENT should be used to convert this public number into the corresponding internal number.

When the number 00422 is detected, the system immediately truncates the first 4 leading digits, leaving the 2 which is the first digit of the extension number in the own exchange.

Translation of Special Numbers

The ENT can also be used for translation of special (single) numbers to internal (or external) extension numbers. In this case the ENT is used to translate the dialed number into a completely different number, that is, the whole number is replaced. An example for the US application is the emergency number 911. If the destination of the emergency number is located within the own exchange (for example a hotel, mall or campus police), the emergency number is translated into the corresponding internal number and the call is routed to this extension in the own exchange.

LCDDI:**TAB=ENT,ENTRY=911,TRC=3,PRE=11401;** When the number 911 is detected it is immediately translated into the internal number 11401.

Conflicting Numbers

For the US market the ENT offers basic analysis of conflicting numbers. An example in the US numbering plan is operator assistance. It should be possible to select different public operators by dialing either 90 or 900. (9 is the LAC, 0 and 00 are the different operators.)

In a conflict situation like this, a timer called critical timing is used in order to determine whether another digit is dialed or not. (Was 90 dialed, or will 900 be dialed?) The timer is started when the number initiated in the ENT is detected. If another digit is dialed within the critical time, the analysis immediately proceeds to the next table. If no more digits are dialed within the critical time, the dialed number is transformed according to the data (TRC/PRE) assigned to that number in the ENT table.

LCDDI:**TAB=ENT,ENTRY=90,TRC=2,PRE=24000,CONF=Y;** The number 90 (ENTRY=90) is initiated as a conflict number (CONF=Y), if no more digits are dialed after 90 the number is translated according to the assigned TRC and PRE data:

- First two digits are truncated from the dialed number (TRC=2), which in this case means truncation of the digits 90.

- Second the digits that are left (in this case there are no digits left) are prefixed with 24000 (PRE=24000), which in this case means prefixing nothing with 24000.

- The result is that the dialed number 90 is transformed into 24000. The call will once again go through number analysis, but this time with 24000 as dialed number. (In this example the number 24000 is some kind of PBX operator within the own exchange).

7.10.3.2 NLT - Number Length Table

The NLT should be used when an exchange has a remote LIM in a different area (with an other area code).

For the US market the NLT can also be used to distinguish between conflicting numbers using a combination of timer and number length analysis.

The table is not mandatory and if the dialed number is not found in the data base the analysis proceeds to the next table, the DNT1.

Area Code Prefixing

If an exchange consists of LIMs (remote LIMs) situated in different areas (with different area codes), a dialed local public number intends to address different public subscribers depending on in which LIM the number is dialed.

An example: A call to the local public number 20802 from a LIM that is situated in the area code 0455, has to be separated from a call to the local public number 20802 from a LIM that is situated in the area code 0451. When the caller dials only the local public number 20802 (without the area code) this information is not enough to route that call correctly, the exchange that the LIMs belong to cannot see that the calls originated in different area codes. To solve this the dialed number must be modified t o also include the area code of the originating LIM before routing the call.

It is strongly recommended **not** to use customer numbers (parameter CUST in command *RODDI*) to indicate what LIM the call originated in, and then use this information to control the routing of the call. Instead, the NLT should be used to insert the LIMs own area code between the LAC and the subscriber number of the dialed local public number, that is, all dialed local public numbers should be translated into the national format. Then there is no need to treat calls differently depending on which LIM the call originated in when breaking out to the public network. The number will always be in the national format and thus uniquely define the called subscriber, no matter what area code the call originated in.

If the call is to be routed within a private network, the routing should be set up to always forward the dialed number including LCR access code and trunk code (area code) to the next exchange in the private network.

The area code flag, ACF, should be set to Y (as in Yes) to indicate that a dialed number should be prefixed with the own area code:

LCDDI:TAB=NLT,ENTRY=002,.............,ACF=Y; All public numbers beginning with digit 2 (in this example public numbers beginning with digit 2 can only be to local public destinations) will be prefixed with the own area code.

LCLDI:LIM=x,........,AC=0455; The own area code for LIM x is initiated with the LCLDI command, in this example the AC is 0455. This initiation must be done for all LIMs in the exchange, with their respective area codes.

IPGDI:DOMAIN="z",LIM=x,........,AC=0477; The own area code for domain "z", which belongs to LIM x is initiated with the *IPGDI* command, in this example the AC is 0477.

The result is that the dialed local public number 002... is modified into 0004552... if it originates in LIM x.

And it is modified into 0004772... if it originates in domain "z".

This initiation must of course be done for all LIMs and domains in the exchange, with their respective area codes.

In a branch office scenario, the initiation of domain area codes for the branch offices of course requires the initiation of a LIM area code for all LIMs in the main site exchange in order to keep consistency between IP and non IP extensions.

Conflicting Numbers

For the US application the NLT also offers extended analysis of conflicting numbers.

In the US numbering plans a complete public number consists of 10 digits:

*   The first three digits represents the area code (AC).

*   The following three digits represents the office code (OC).

*   The last four digits represents the subscriber number.

The length of the public number is 3+3+4=10 digits. Add the LAC (9) and the total length will be 11 digits.

The shape or pattern of the ACs and the OCs are specific, but when interchangeable ACs or OCs are introduced conflicts may occur.

Below is an example where the number 525-2591 either can be a complete number in the own area:

*   525 is the OC

*   2591 is the subscriber number

    The total length of the dialed number (including the LAC) will be 8 digits.

or a long distance number:

*   525 is the AC

*   259 is the OC

*   1 is the first digit of four in the subscriber number.

    The total length of the dialed number (including the LAC) will be 11 digits.

To be able to distinguish between these two cases a timer is used to decide when the whole number is dialed, and then the length of the number is analyzed. The concluded number length is used by the system in the further handling of the call.

When initiating the number the parameter MIN should state the total length of the number in the own area, that is, 8 digits. The parameter MAX should state the total length of the long distance number, that is, 11 digits.

LCDDI:**TAB=NLT,ENTRY=95252591,CONF=Y,MIN=8,MAX=11;** The number 95252591 is initiated as a conflict number, with two possible lengths, 8 or 11 digits.

After the number length has been determined to either of the two, the call will proceed to a DNT where the number will be transformed, and so on.

The number length analysis can also be combined with the insertion of the own area code. In this case the insertion of the own are code takes place if the length of the dialed number is the same as the length initiated in the parameter MIN. If more digits are dialed the area code is not inserted.

LCDDI:**TAB=NLT,ENTRY=95252591,CONF=Y,MIN=8,ACF=Y;** The number 95252591 is initiated as a conflict number, when this number is dialed the own area

code is inserted. If more digits are dialed the own area code is not inserted and the call proceeds to a DNT for further analysis.

7.10.3.3   *DNT - Destination Number Table*

The DNTs are where the main least cost routing takes place. Instead of letting the dialed number address a destination data record (command RODDI) directly into a fictitious destination that address a destination data record the dialed number is modified in the DNT and FDT.

Different dialed numbers that are to be routed the same way, are transformed into the same fictitious destination. Several entries in each of the DNTs are possible, but since many of them will be transformed into the same fictitious destination they will address the same destination data records. This means that LCR will only use some of the 2500 destination data records available (that has to be shared with basic routing and PNR). This is how LCR increases the capacity of external analysis.

Dialed number 1 is 9-009-46-8-90510 Dialed number 2 is 9-009-47-31-244061

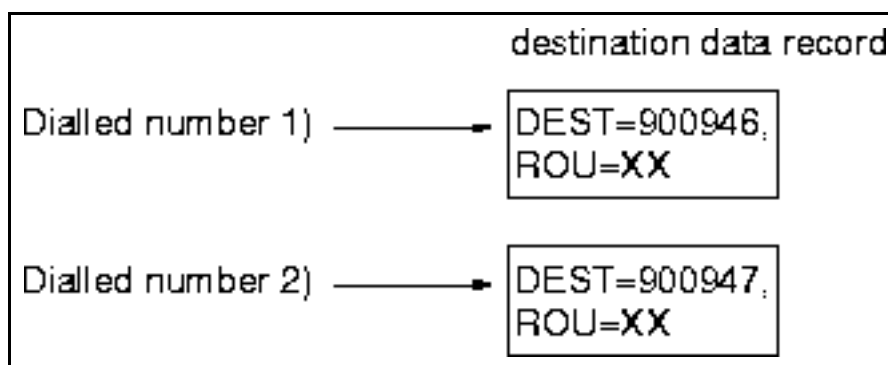**Without LCR:** (One dialed number addresses one destination data record)

Figure 4:   **Use of destination data records without LCR**

With LCR: (Two totally different dialed numbers address the same destination data record)
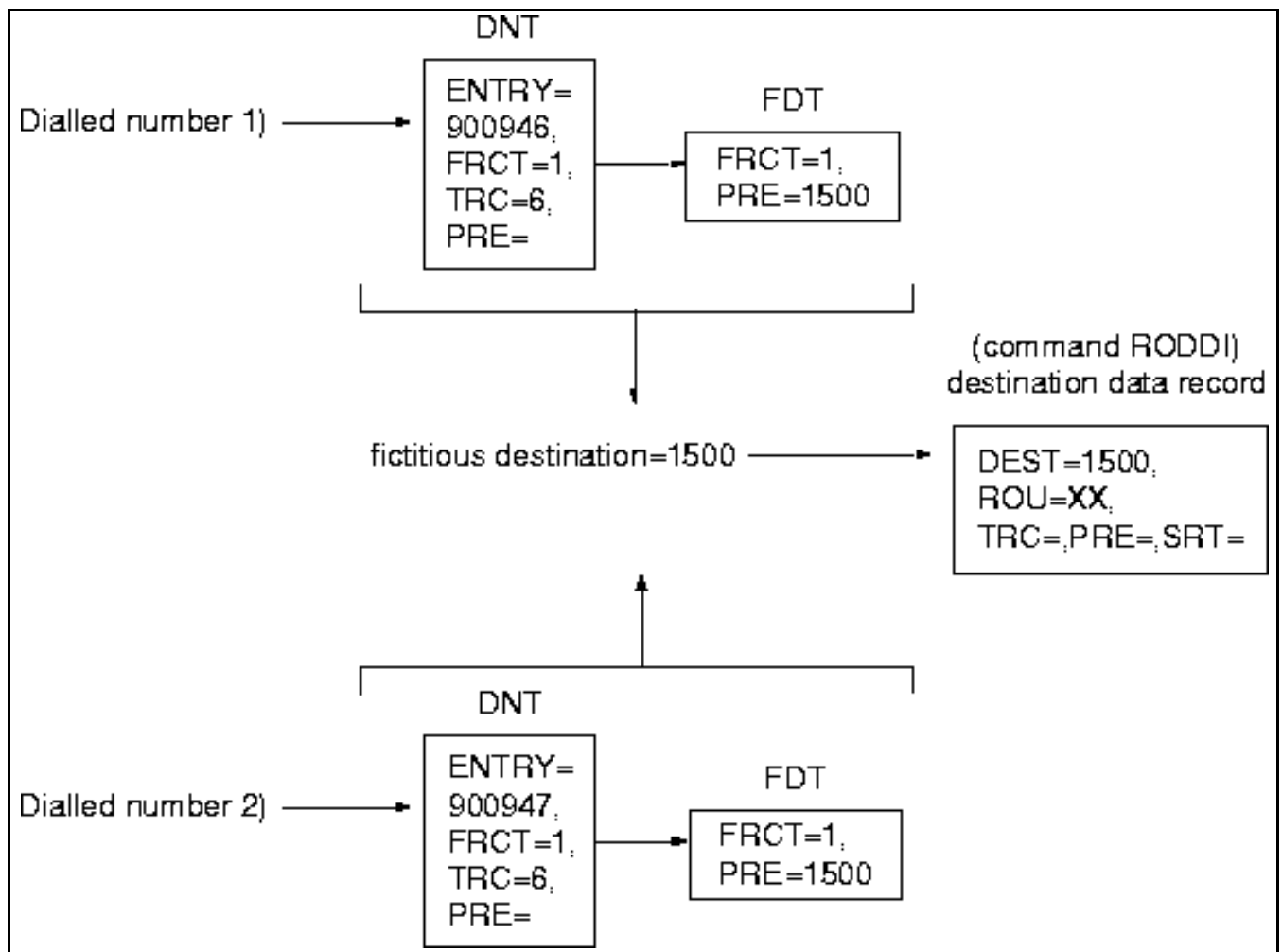
Figure 5:   Use of destination data records with LCR

The savings are perhaps even more obvious if one consider that there may be alternative choices for each destination. For example, if five different numbers (that are to be routed the same way) are initiated with five routing choices each, not using LCR, will require 25 destination data records, while only five destination data records are sufficient if LCR is used.

As can be seen in the figure above there is the possibility to prefix both in the DNT and the FDT. The prefix in the DNT may be used for transit network selection. One example in the US is AT&T that have 288, in Sweden Tele2 have 007. see the example 2 below.

Furthermore there is the possibility to prefix in the destination data record. This is when the number needs to be transformed differently for different route choices. By using a truncation (parameter TRC), prefixing (parameter PRE), and start digit sending (parameter SRT), the number may be modified in all possible ways.

First the PRE in the DNT is applied, then the PRE in the FDT, and lastly the PRE in the destination data record.

The DNT1 and the DNT2

A destination number may be analyzed in either of two levels of depth. The DNT1 table analysis 16 digits depth which is good for analyzing exception numbers (since ENTRY then must comprise the whole number). The DNT2 table analysis 8 digits depth and is used for number series.

• First the dialled number is modified according to the assigned TRC and PRE data (*LCDDI*:TAB=DNTx,ENTRY=,TRC=,PRE=).

- Second, an entry in the DNT tables must have a Fictitious Route Choice Table (FRCT) initiated. The FRCT is not a table but an index to the Fictitious Destination Table (initiated with *LCDDI*:TAB=FDT) where a prefix is found.

  The prefix in the FDT is used for prefixing the previously modified number.

- The result is a fictitious destination to be analyzed, that is, since it is an external destination it will address a destination data record (a DEST initiated with *RODDI*).

Example 1, Basic LCR

The number series in this example is 9 009 46 8, where the digit 9 is the least cost routing access code (LAC), 009 is the international prefix, 46 is the country code to Sweden, and 8 is the trunk code for Stockholm. This number should be initiated in the number table, DNT2, with the appropriate data for addressing a fictitious destination.

Start with creating a fictitious destination to be used for outgoing calls to Stockholm. (In this example the destination used is 0120.) Initiate the FDT that should prefix the dialed number (that previously was modified in a DNT) so that it addresses the above fictitious destination:

LCDDI:**TAB=FDT,PRE=0120,FRCT=22;** Any entry in a DNT that refers to FRCT=22 will be prefixed with 0120.

Initiate the number series with appropriate data regarding the above:

LCDDI:**TAB=DNT2,ENTRY=9009468,TRC=1,FRCT=22;** The leading digit 9, in the number 9 009 46 8 is truncated. The modified number will be 009 46 8.

After that, the FRCT=22 indexes the FDT where the prefix 0120 is found. The result is that the dialed number 9 009 46 8 is transformed into 0120 009 46 8, where the digits 0120 is the fictitious destination used to address a destination data record (initiated with *RODDI*:DEST=0120,..).

The same FRCT may be used by other modified numbers. The result is that calls to different external destinations are now calls to the same fictitious destination.

Example 2, Basic LCR with Transit Network Selection

If different transit networks are wanted for different numbers that are to use the same FRCT, the PRE in the FDT is used. For example, if AT&T transit network is wanted for calls to Stockholm, Sweden, the number should be prefixed with 288 in the DNT.

LCDDI:**TAB=DNT2,ENTRY=9009468,TRC=1,PRE=288,FRCT=22;** The leading digit 9, in the number 9 009 46 8 is truncated, and after that the number is prefixed with 288. With the prefix 0120 in the FDT the result will be the number 0120 288 009 46 8.

Example 3, Exception Number Using PDC

An **exception** is a number within a series, that is barred from calling. The barring is controlled in the toll restriction on a per category basis. With Forced account code which is set per extension, the barring may be further refined (parameter ROC in command *EXTEI*), and this is also valid for generic extensions.

Exceptions may be initiated using LAC or PDC. In this example PDC is used. The PDC make use of the LCR tables, but only Toll restriction (and Forced account code) is used. No least cost routing will take place.

Initiate the number series as in the examples above, but using the PDC=01 instead of the LAC=9.

LCDDI:**TAB=DNT2,ENTRY=01009468,FRCT=X;**

The number in this number series that should be barred from calling is the number to the *speaking clock*. This number is 90510 in Sweden. The complete number 01 009 46 8 90510 is put in the exceptions table (DNT1) and is thereby barred or open for users, as stated in the parameter TOLL (toll restriction).

Toll restriction is a bit map table containing whether a TCD category is allowed or barred from calling a number stated in the DNT1 or DNT2. The toll restriction is set in the parameter TOLL in the DNTs, each bit in TOLL refers to a corresponding TCD category (0-14).

If the parameter TOLL is omitted all categories are allowed to call the stated destination, that is, all bits in the TOLL bit map are by default set to 1.

*LCDDI***:TAB=DNT1,ENTRY=0100946890510,FRCT=X,TOLL=000000000000000;**
Users of all TCD categories are barred from calling the *speaking clock* in Stockholm, Sweden.

Unlike in **Example 1, basic LCR** the dialed number will not be transformed according to the data in the DNT and FDT. In this example a PDC is used, and the **dialed number** is sent for external analysis.

Example 4, Time of Day

If the **Time of day** function is to be used, the parameter TZONE should also be set when initiating the FDT table. By using time of day, different fictitious destinations may be addressed depending on the time zone.

*LCDDI***:TAB=FDT,FRCT=22,PRE=0120,TZONE=1;**

*LCDDI***:TAB=FDT,FRCT=22,PRE=0123,TZONE=4;**

If a call is made during the time period represented by time zone 1 the number will be prefixed with 0120. Likewise, a call during time zone 4 will be prefixed with 0123.

The time zones are initiated with the *LCTDI* command. Further information on the *LCTDI* command can be found in the command description for *LEAST COST ROUTING, LC*

Example 5, Dialed Number Retrieval

Dialed number retrieval can be utilized if it is required that two or several different public numbers should address the same destination data record.

Dialed number retrieval is indicated by the value 3 in D_{16} in the ADC parameter in the *RODDI* command.

*RODDI***:DEST=..., ADC=..............3...;**

When the value 3 is detected in the ADC D_{16} parameter the external number to use is composed by the destination code assigned for the route choice, together with the public part of the dialed external number.

7.11 LOOP AVOIDANCE/TRANSIT COUNTER

7.11.1 GENERAL

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7.11.2 PREREQUISITES

Loop avoidance is used in DPNSS networks.

Transit counter is used in ISDN and H.323 networks.

7.11.3   EXECUTION

The maximum number of transit exchanges a call can be routed through in order to reach the final destination is set in D_{14} and D_{15} of the ADC parameter in the command *RODDI*.

7.12   MCT - MALICIOUS CALL TRACING

7.12.1   GENERAL

Three variants of MCT exist: the simplified (Saudi), MCT for ISDN, and MCT for CCSS7.

7.12.2   PREREQUISITES

The MCT function requires appropriate initiations, of analog or ISDN lines, in the PSTN.

7.12.3   EXECUTION

Set D_{10} =1 in the SEL parameter of the command *ROCAI* (or *ROCAC*) to enable MCT on the stated route.

If it is a CCSS7 route also set D_7 =1 in the VARI parameter of the command *RODAI* to enable MCT on the stated route.

7.13   PNR - PRIVATE NETWORK ROUTING

7.13.1   GENERAL

PNR is used for routing of outgoing external **private network calls**, that is, calls terminating in the own private network. The function is the same as with basic routing, but PNR enables many more destinations to be stated as entry to routing.

In addition to this, PNR enables each destination to have two route choices with enhanced number translation. One route choice can have a PRE of maximum 10 digits, and the other a PRE of maximum 16 digits. This is often sufficient for routing through the public network.

This means that the system is able to handle much bigger numbering plans by using PNR.

In the figure below is an example of the use of PNR for routing through different networks.

1.   is the ordinary route choice in the private network.

2.   is an alternative route choice through a public network (PSTN).

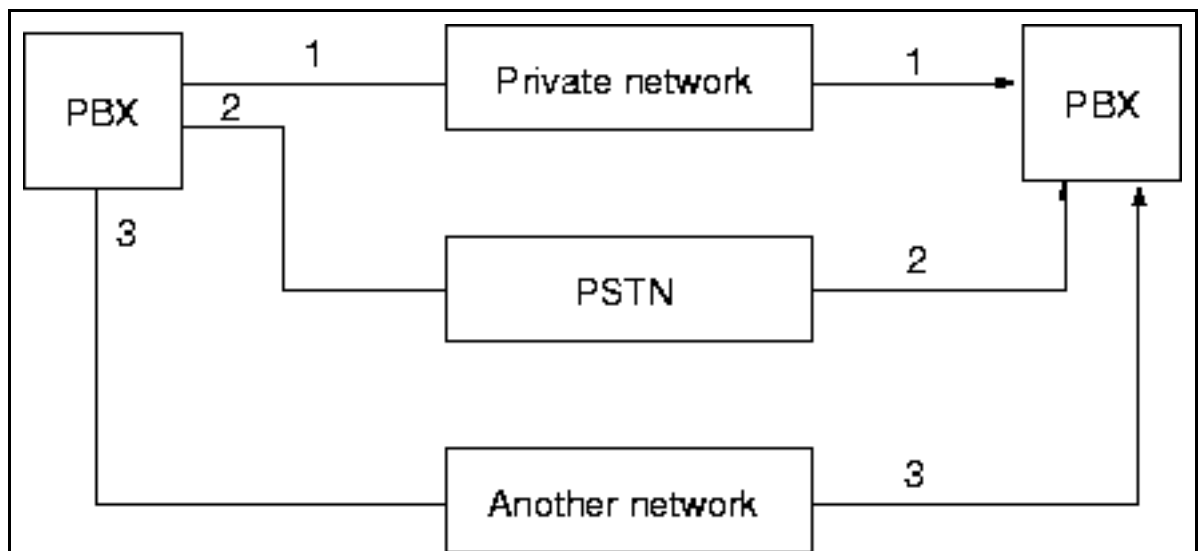3.   is an alternative route choice through another network.

Figure 6:   Example of how PNR can be used to choose the best available route

PNR structure

PNR is basically a preprocessor to the existing basic routing software. The pre-process consists of two tables where the dialed number leads to a prefix, which in turn addresses a Route Choice Table (RCT). Basic routing uses the dialed number directly to address an RCT.

An RCT holds all the route choices for a (fictitious) destination. Each route choice uses one destination data record. The route choices are initiated with the command *RODDI*.

The first PNR table is the PNR Destination Number Table (PR DNT). This is a table with 5000 entries where an entered destination (in parameter ENTRY) will result in an index (parameter FRCT) to the next table, the fictitious RCT. Also the enhanced number translation data are stored in the PR DNT, two sets per destination.

The prefix stored in the fictitious RCT is used to address an RCT. The prefix is used by itself as a destination, it is not used for prefixing.

The purpose of the fictitious RCT is to restrict the addressing of the RCTs.

The purpose with restricting the addressing of the RCTs is that RCTs are taken from the common pool of 2500 destination data records that PNR shares with LCR and basic routing. An RCT may consist of up to 8 linked route choices, where each route choice uses one destination data record (*RODDI*:DEST=,CHO=).

With PNR, one RCT may be used by many entries in the PR DNT. Because of this possibility of efficient utilization of the RCTs there should be enough destination data records for all (PNR, LCR and basic routing) if the PNR-configuration (and LCR-config-uration) is well planned. This will be shown in the examples below.

The PNR data tables are administered by the command group LC and data is set, deleted or printed using the *LCDDI*/E/P commands where the parameter TAB is set to either PNR or RCT.
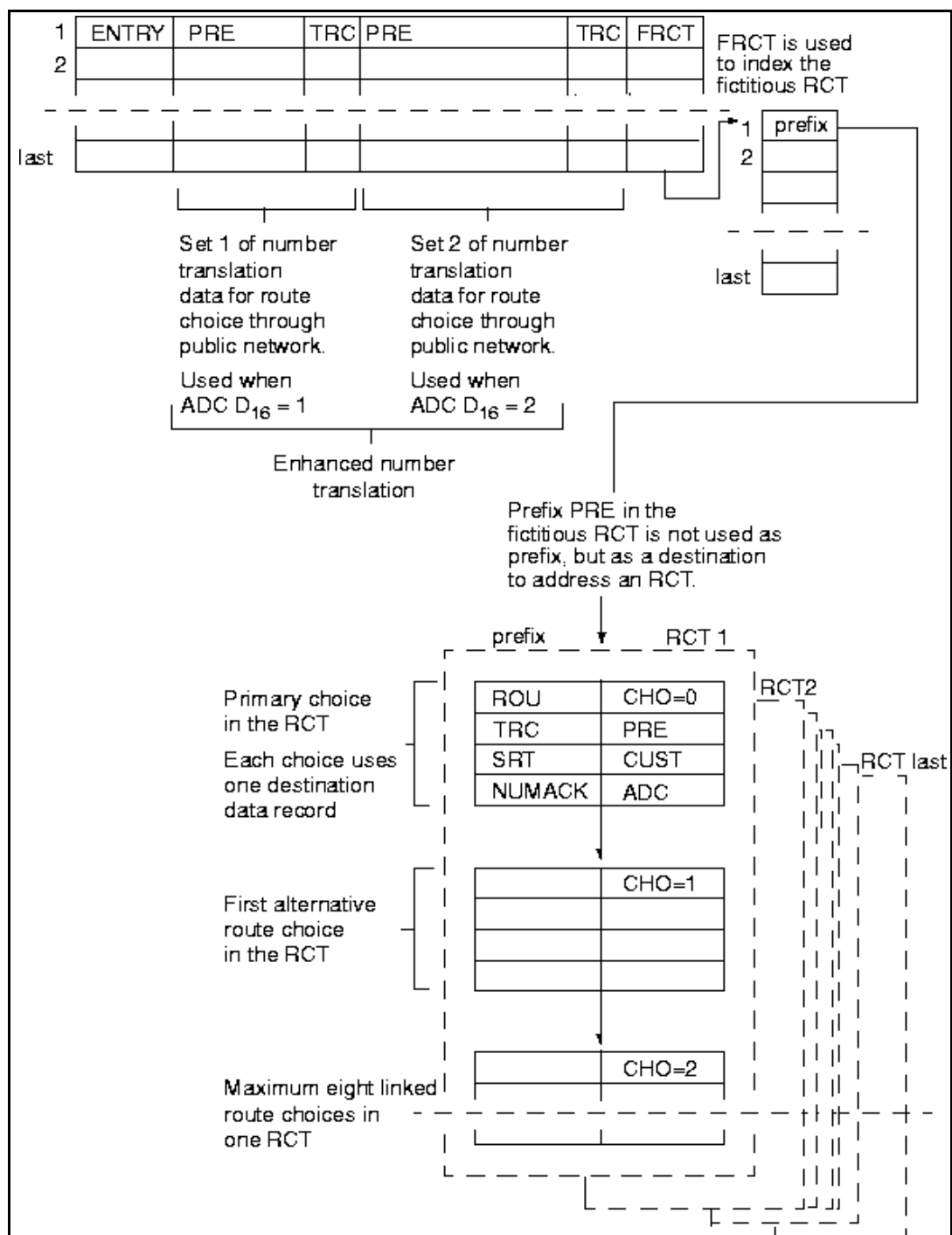
Figure 7: An overview of the PNR data tables

7.13.2 PREREQUISITES

Initiate the external destination number series use the number_initiate command:

number_initiate -numbertype ed -number 85024

number_initiate -numbertype ed -number 85040

These external destination numbers will be used to address the PNR access code in the PR DNT.

If the market dependent parameter (MDP) Destination Check is set to Check the prefix in the fictitious RCT must be initiated as an external destination number. This MDP states if the destination is to be checked in the number analysis or not.

***number_initiate* -numbertype ed -number 0123** This external destination number is used by PNR to address an RCT. It is necessary to initiate it in the number analysis in order to be able to initiate it as a destination in the external analysis.

Initiate the external destination number series for PSTN access use the command *number_initiate*:

***number_initiate* -numbertype ed -number 00**

This external destination is required for overflow to the PSTN, when the dialed number is translated into a public number.

Outgoing routes must be assigned. In the following examples ROU=50 is a tie line route and ROU=20 and 30 are public external line routes.

7.13.3 EXECUTION

Example 1, Initiation of a Tie Line Route

Initiate a route between the location Karlskrona (KA) and the locations Bollmora (BO) and Sundbyberg (SG). (HF is Huvudfabriken, a transit exchange near BO and SG.) The route in this example is a single tie line route.
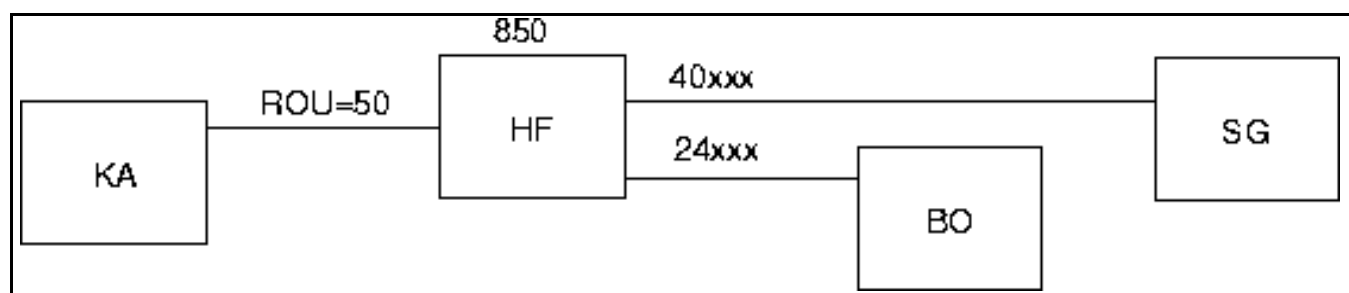

Figure 8:   A tie line route

Initiate the PNR access code for BO and SG. The same FRCT may be used for both BO and SG as they are both reached using the same route. Using the same FRCT means that they will share the same RCT. FRCT may be assigned any value between 1 and 64, X is used in this example.

***LCDDI*:TAB=PNR,ENTRY=85024,FRCT=X;**

***LCDDI*:TAB=PNR,ENTRY=85040,FRCT=X;**

Result:

Table 2   PR DNT - PNR Destination Number Table

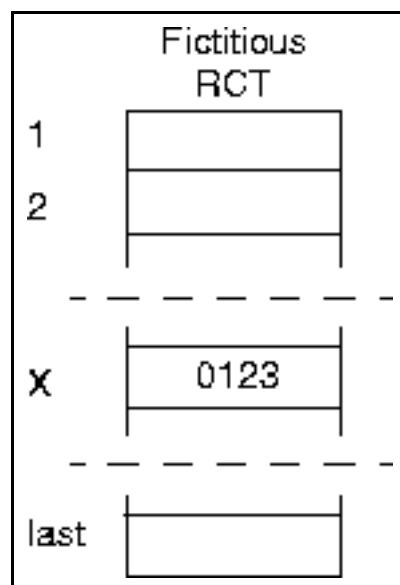| ENTRY	PRE	TRC	PRE	TRC	FRCT
85024					X
85040					X

Initiate the data in position X in the fictitious route choice table for PNR. The digits 0123 are used as prefix (external destination).

Note:
> RCT in the *LCDDI* command is only used as a parameter to distinguish this table from the other tables handled by the *LCDDI* command.

LCDDI:TAB=RCT,FRCT=X,PRE=0123;

Result:

Initiate the RCT in the external analysis.

RODDI:DEST=0123,ROU=50,SRT=5; The SRT value depends on how the numbering plan in the network is set up. If the composed number is passing a transit exchange, the whole number may be sent, and the decision of the further routing is made in that same transit exchange.
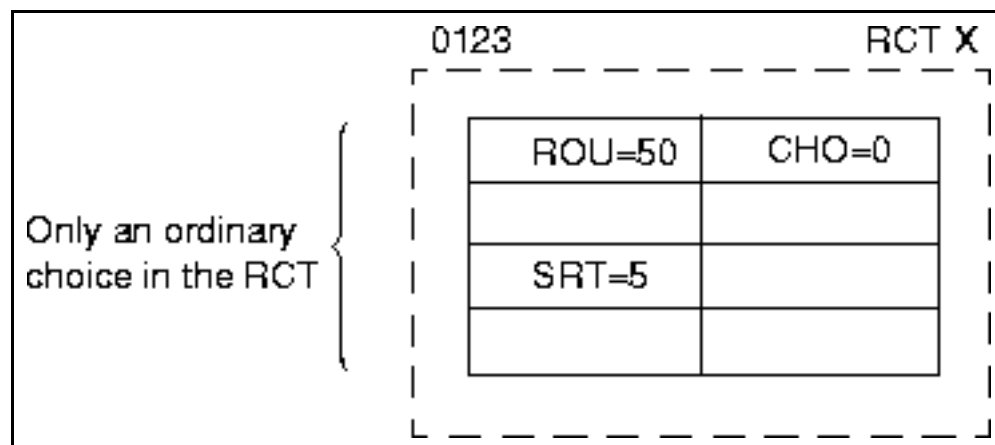
Result:

Figure 9:

Now the single tie line route between KA and BO/SG is initiated. If the user dials 85024 or 85040 followed by the extension number, the system will select route 50 for the completion of the call. The digits sent to the co-operating exchange will be either 24xxx or 40xxx.

Example 2, Initiation of an Alternative Route

Add a public alternative to the single tie line route between the location Karlskrona (KA) and the locations Bollmora (BO) and Sundbyberg (SG).
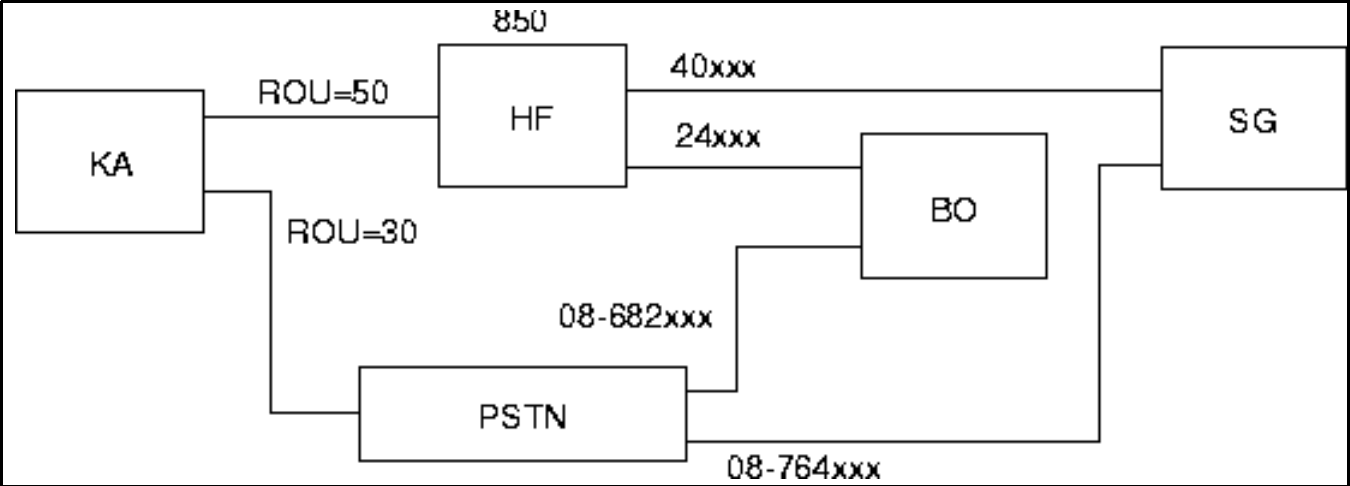
Figure 10:

In this case the private numbers 85024 and 85040 will be translated individually.

The national public directory number for Bollmora is 08-682xxxx and for Sundbyberg 08-764xxx, where 08 is the area code and the following digits is the subscriber number (location code + directory number).

Add an alternative RCT. No editing information (PRE/TRC) is assigned with *RODDI*, instead a **flag** in the route choice indicates that this information will be found in the PNR destination table, under the PNR access code that was used to address the present RCT. The flag is: D_{16} is set to 1 in the ADC parameter. The 1 also refers to set 1 in the PR DNT.

RODDI:**DEST=0123,ROU=50,SRT=5;** (initiated earlier)

RODDI:**DEST=0123,ROU=30,SRT=3,CHO=1,ADC=0000000000000251xxxxxxxxxx ;**

Result:

Figure 11:

Update the PNR access code with the individual number translation information (set 1) for the BO and SG locations.

LCDDI:TAB=PNR,ENTRY=85024,FRCT=X,TRC=3,PRE=000868;

LCDDI:TAB=PNR,ENTRY=85040,FRCT=X,TRC=3,PRE=000876;

Result:

**Table 3   PR DNT - PNR Destination Number Table**

ENTRY	PRE	TRC	PRE	TRC	FRCT
85024	000868	3			X
85040	000876	3			X

Now the public choice is initiated. With alternative routing the route 30 is selected. The number translation information is found in the PR DNT (set 1) as indicated by D_{16} in the ADC parameter.

If the user dials 85024/85040 followed by an extension directory number, and meet congestion at the ordinary choice, the system selects route 30 for completion of the call. The digits sent out to the co-operating exchange will be either 08682xxxx or 08764xxxx as indicated by set 1 of individual number translation information.

Example 3, Initiation of a Second Alternative Route

Add a second alternative to the single tie line route between the location Karlskrona (KA) and the locations Bollmora (BO) and Sundbyberg (SG).
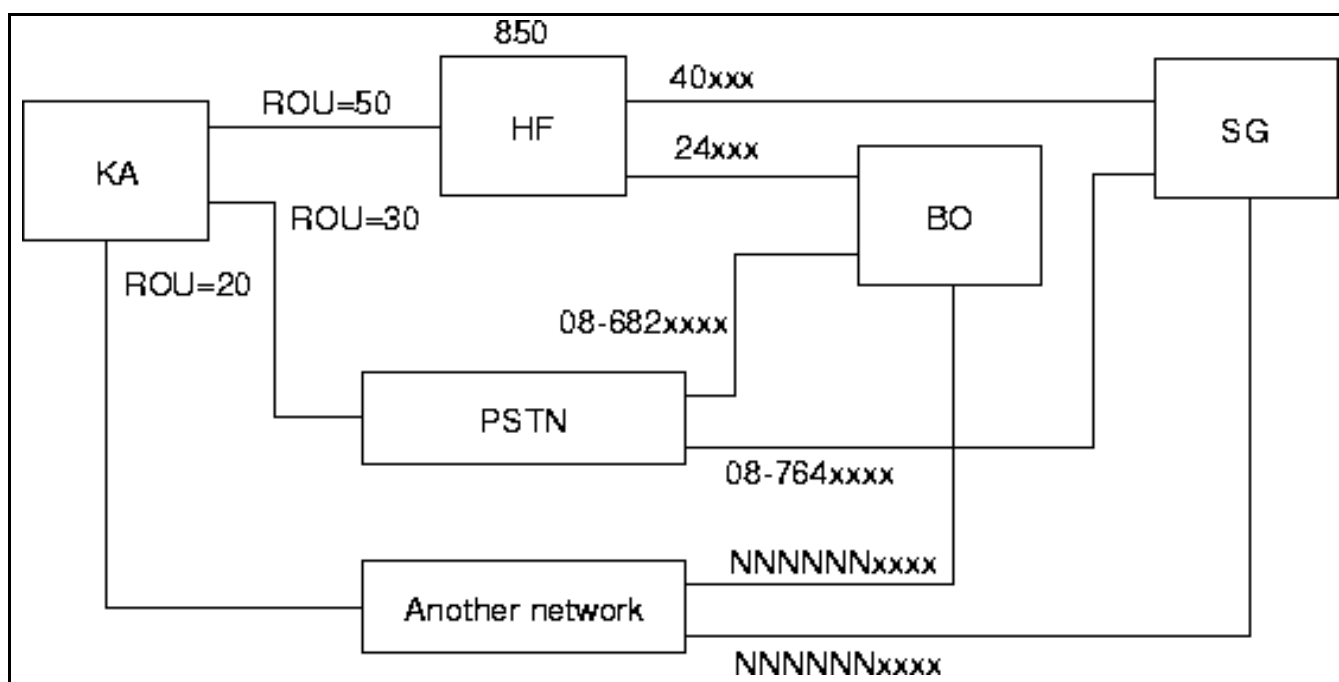

In this example a second set of individual number translation data is assigned to the private numbers 85024 and 85040. As there is no second network between KA and BO/SG in real life, the symbolic national PDN NNNNNN is used in this example.

Add a second alternative RCT. No editing information (TRC/PRE) is assigned with *RODDI*, instead a **flag** in the route choice indicates that this information will be found in the PNR destination table, under the PNR access code that was used to address the present RCT. The flag is: D_{16} is set to 2 in the ADC parameter. The 2 also refers to set 2 in the PR DNT.

RODDI:**DEST=0123,ROU=50,SRT=5;** (initiated earlier)

RODDI:**DEST=0123,ROU=30,SRT=3,CHO=1,ADC=xxxxxxxxxxxxx-251xxxxxxxxxx;** (initiated earlier)

RODDI:**DEST=0123,ROU=20,SRT=3,CHO=2,ADC=xxxxxxxxxxxxx-252xxxxxxxxxx;**

Result:
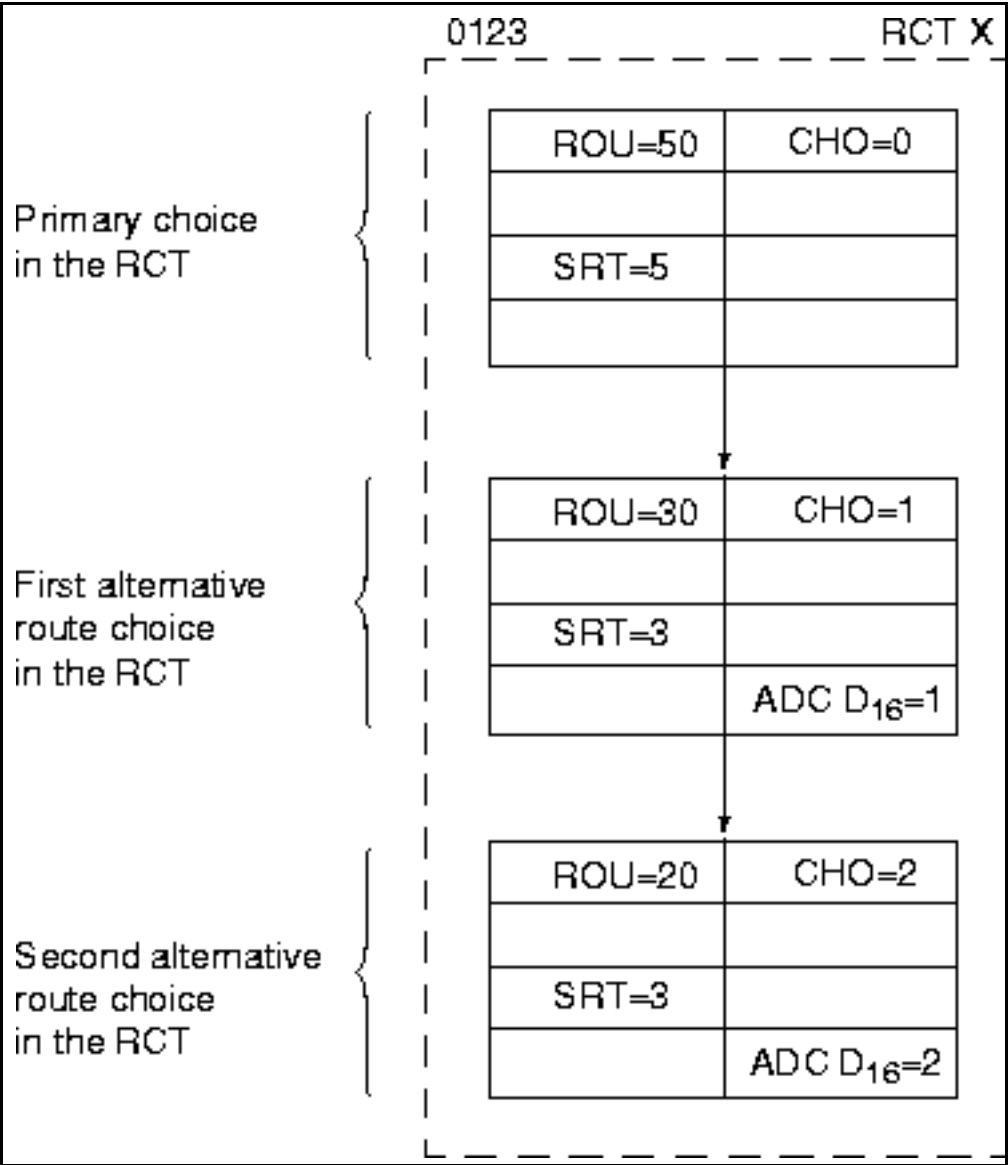
Update the PNR access code with the individual number translation information (set 2) for the BO and SG locations.

LCDDI:**TAB=PNR,ENTRY=85024,FRCT=X,TRC=3,PRE=000868,TRC1=N,PRE1=N NNNNN;**

LCDDI:**TAB=PNR,ENTRY=85040,FRCT=X,TRC=3,PRE=000876,TRC1=N,PRE1=N NNNNN;**

Result:

Table 4   PR DNT - PNR Destination Number Table

ENTRY	PRE	TRC	PRE	TRC	FRCT
85024	000868	3		N	X
85040	000876	3		N	X

Now the second choice is initiated. With alternative routing the route 20 is selected. The number translation information is found in the PR DNT (set 2) as indicated by D $_{16}$ in the ADC parameter.

If the user dials 85024/85040 followed by an extension directory number, and meet congestion at both the ordinary choice and the first alternative choice, the system selects route 20 for completion of the call. The digits sent out to the co-operating exchange will be either NNNNNNxxxx or NNNNNNxxxx as indicated by set 2 of individual number translation information.

7.14   NAME ON ROUTE

7.14.1   GENERAL

Name set for a route shall be used for display, when a calling/connected/called name is not received over the network

The name set for a route has lower priority than the received name or the company name.

7.14.2   PREREQUISITES

The name on routes functionality requires appropriate initiations of trunks in the exchange.

7.14.3   EXECUTION

Example 1, Initiate name for a route without presentation priority

name -i --route 20 --name1 Sweden --name2 India

Example 2, Initiate name for a route with presentation priority

name -i --route 20 --name1 Sweden --name2 India --presentation-priority 1

Here name1 having the higher priority for display.

Example 3, Print name on route

name -p --route 20

Example 4, Erase name on route

name -e --route 20

8 TERMINATION

If exchange data are changed, a dump to the backup media must be performed.