Meridian 1

Electronic Switched Network

Signaling guidelines

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Contents

Introduction

Reference list

The following are the references in this section:

- *Electronic Switched Network transmission guidelines (309-3001-181)*

The Electronic Switched Network (ESN) is a private communications network intended for use by large business customers with distributed operation locations.

This Nortel Networks technical publication describes the signaling guidelines and considerations applicable to Electronic Switch Networks (ESNs). You can use the information presented here to determine the compatibility of a switch that is to be incorporated as part of an ESN network. To determine transmission requirements, refer to *Electronic Switched Network transmission guidelines (309-3001-181)*. Use this companion publication in conjunction with this publication.

PBX networks

PBX networks have three basic elements:

— telephones

— a PBX switch

— transmission facilities

Each telephone is connected to a PBX switch that establishes connections between the telephones. Connections between telephones on different switches in a PBX network are established over a transmission facility (such as a trunk) between the pair of switches, or over a tandem connection of transmission facilities and intermediate switches.

A user establishes a call to another telephone by dialing a string of digits that direct the connection to that telephone. In tandem tie trunk networks (TTTNs), the dialed digits steer the connection through the network. A string of successive access codes cause facilities to connect in tandem until the switch that connects to the destination telephone is reached. Each time a switch connects a new facility in tandem, it passes on the digits to the connected facility.

In a Meridian 1 network, the Electronic Switched Network (ESN) node switches collect all digits of the called number, and pass the full-called number between switches. The called number is dialed in a Uniform Dialing Plan (UDP) format. Users at switches connected to Meridian 1 ESN nodes may have to dial in a tandem tie trunk network (TTTN) format to reach the node before dialing the called number in UDP format. Similarly, the ESN node may control routing to connected switches by transmitting a sequence of access codes, followed by the called number.

Switches are also provided with trunks to the public network. Calls to telephones in the public network (and to other switches) can be placed by these trunks. However, trunks between switches (tie trunks) are normally provided because the calling can be performed at a lower cost.

PBX designations

PBX switches in a network configuration have designations that depend on the network function. Designations used include the following:

— node

— main

— satellite

— Common Control Switch Arrangement (CCSA) tandem

Node switch

Node is the designation in an ESN network for a Meridian 1 switch with the ESN Network Alternate Route Selection (NARS) software package. The Meridian 1 ESN node has the full capabilities for selecting trunk routes, while other non-mode switches have only limited route selection capabilities.

Main switch

A main switch is a switch that has an outgoing trunk route to only one node. This route can be both incoming and outgoing, but routes to other nodes must be incoming only to the main PBX, since the main PBX cannot select between nodes for the routing of network calls. A main PBX can have central office (CO), foreign exchange (FX), and wide area transmission service (WATS) trunks, as well as tie trunks to other switches.

A PBX that has outgoing trunk routes to more than one node, but does not meet the requirements for classification as a node, is also classed as a main PBX. The outgoing routes can be assigned different access codes, leaving route selection to the user, or can be selected by an automatic route selection capability.

Tributary switch

A tributary switch is a PBX that has a trunk route to a main PBX, but not to a node. A tributary PBX can have central office (CO), foreign exchange (FX), and wide area transmission service (WATS) trunks, as well as tie trunks to other switches.

Satellite switch

The only difference between a satellite and tributary PBX switch is that the satellite switch has neither incoming central office (CO) trunks nor attendant service. In this document, satellite and tributary PBX switches are treated the same.

CCSA tandem switch

A Common Control Switch Arrangement (CCSA) tandem switch is the major switching vehicle in a CCSA network. The tandem switch performs trunk to trunk switching only. Its function is similar to that of a Meridian 1 ESN node, except that a Meridian 1 ESN node can support telephones in addition to trunk to trunk switching. Switches with tie trunks to the tandem switch are called main switches. The CCSA network supports a dialing plan similar to the ESN Uniform Dialing Plan (UDP).

The Common Control Switch Arrangement (CCSA) tandem switch is the interface point between the ESN network and a CCSA network. The two networks can be arranged to function as a single integrated network.

Supervision

Supervision is a binary signal associated with each direction of transmission on a trunk facility. The two states are on hook and off hook, analogous to the condition of a telephone on hook (hung up) or off hook (in use).

Each switch connected to a trunk sends a supervision signal to, and receives a supervision signal from, the connected switch. Thus, the trunk has four supervision states. The trunk is idle when both directions are on hook. Off hook is sent when a call is initiated on an idle trunk. This action is called “seizing” the trunk. The distant switch receives the off hook signal and prepares to receive digits. A momentary off hook condition returned from the destination switch can occur during call setup, but a steady off hook is not transmitted until the called telephone answers. This off hook signal is called “answer supervision.” The supervision changes to on hook when the called telephone hangs up or is disconnected.

When a switch serves as an intermediate (tandem) connection between trunks, it normally sends the supervision signal it receives from each incoming trunk to the connected outgoing trunk. It also monitors for a disconnect signal so that the trunks can return to an idle state and wait for new calls.

In some cases, no provisions are made for returning an answer supervision signal from the destination when the called telephone answers. If this occurs, an off hook signal can be returned from an intermediate switch. This off hook signal is called “substitute answer supervision.” This signal is provided to remove transmission impairments associated with the on hook condition on some trunk facilities and to distinguish a call that has been blocked from one that might have reached a destination party.

A connection by a public network trunk is a typical case where a called telephone answer indication is not returned. The PBX switch that connects the call to the public network trunk must be configured to provide an off hook signal to the incoming trunk after sending digits to the public network trunk.

Digit transmission

In an ESN network, digits of the called number are transmitted between pairs of switches in one of two modes:

— dial pulse (DP)

— dual tone multifrequency (DTMF)

In dial pulse (DP) mode, each digit is represented by a string of pulses. The digit 0 is represented by ten pulses. Each other digit is represented by the corresponding number of pulses. The pulses are transmitted as interruptions of direct current.

In dual tone multifrequency (DTMF) mode, digits are transmitted over the speech path by a tone code. Digit transmission takes place at a higher rate than dial pulse (DP) mode (typically two to ten times faster).

Modern PBX switches are compatible with either mode. Older equipment is only compatible with DP mode. ESN uses dual tone multifrequency (DTMF) mode wherever practical, to take advantage of its higher transmission speed. However, DP mode is sometimes required. Furthermore, there are some transmission impairments associated with DTMF. These impairments are normally only important when equipment is still connected after conversation begins to take place. The impairments are removed when the receiving equipment is disconnected.

Modes of operation

A PBX switch can operate in one of two modes when routing a call over a tie trunk:

— cut-through

— senderized

Cut-through mode

With cut-through mode, a trunk is accessed immediately following an access code. Subsequent digits are forwarded to the trunk as dialed. The telephone user monitors call progress tones from connected switches. Because of a blocking tone, the user may be required to pause in dialing to monitor for a dial tone, or may be required to abandon the call before completing dialing.

Pure cut-through mode provides the greatest flexibility for providing compatible operation for calls originating at main and tributary switches. The number of digits transmitted to the node can be flexible. The node can prompt for additional digits when required for the authorization code features.

DTMF to DP conversion

A variation on cut-through mode is to provide DTMF to DP conversion. The user dials DTMF digits, but DP are transmitted to the trunk. The converter can block transmission in the caller to called party direction while waiting for digits. The converter can detach to remove these transmission requirements. Because the last digit can not be detected easily, timing is often used to determine the end of dialing.

When the switch has completed outpulsing, it waits a specified time for additional digits. If no digits are received in that interval, conversion is disabled. The timing may not properly distinguish a pause in dialing from a last digit, prematurely canceling the forwarding of digits. Extending the timing causes transmission impairments during conversation if the called party answers quickly.

The Meridian 1 ESN nodes combine cut-through and senderized modes of operation. The switch collects the access code and enough digits to select a trunk. During this interval, the operation is very close to a register sender mode. The trunk is accessed and a string of digits outpulsed (not necessarily the same as those dialed). Subsequent digits are forwarded to the trunk as dialed, in a receive and resend mode, which is closer to cut-through operation.

Senderized mode

With senderized mode, all digits of the called number are collected before an outgoing trunk is accessed. The trunk is accessed, and digits are transmitted to set up the call. The transmitted digits need not be the same as those dialed for example, as a result of Network Alternative Route Selection (NARS) digit manipulation. The user does not receive call progress tones until all digits are transmitted. No tones are provided during dialing other than a locally generated dial tone following the trunk access code.

Senderized mode limits flexibility. The main PBX must be programmed to determine how may digits to collect before forwarding those digits to the node. Usually, no more than 12 digits can be collected and forwarded.

Outpulsing control

After a tie trunk is seized, digits of the called number are normally transmitted. The only exception is a manual trunk, which rings a designated telephone when seized. However, most terminating equipment requires a variable time interval to prepare for the reception of digits. This time interval often depends on the switch’s call-processing load. Therefore, a fixed delay before sending digits is unreliable. There are four commonly used ways of handling start dial control, as described in the following sections.

Immediate start

Immediate start applies in those cases where a short fixed delay is required for the switch to prepare to receive digits.

Delay for dial tone

A dial tone is provided when the switch is ready to receive digits.

Wink start

A momentary off hook signal is sent when the terminating equipment is ready to receive digits.

Delay dial

An off hook signal is sent to signify that the switch is not ready to receive digits. An on hook signal is sent when the switch is ready to receive digits.

The delay for dial tone is used when a user controls digit sending, as in a tandem tie trunk network (TTTN). Wink start and delay dial are used in registerized digit sending. Normally, only one start dial control is used. However, on some switches, a dial tone may be combined with any of the other three.

The Meridian 1 switches in an ESN network can work with any of the start dial signals.

Call setup sequences in ESN

The following sections describe the various call setup sequences that can occur between conventional PBX equipment and a Meridian 1 ESN node, with emphasis on signaling compatibility. Calls are described (1) to the node, (2) between nodes, and (3) from the node. Several cases are included, reflecting variations, such as the type of machine involved (cut-through or senderized), and whether or not tandeming is involved.

The Meridian 1 PBX without ESN main or ESN node software is treated as a cut-through PBX in the following discussion. The Meridian 1 PBX with ESN main software is not addressed.

Calls to the node

Case 1

This case describes a call to the Meridian 1 ESN node from a telephone at a cut-through main switch.

— The user at the main PBX goes off hook, receives a dial tone from the main PBX, and then dials the network access code.

— The main PBX seizes a tie trunk to the Meridian 1 ESN node and provides audio transmission to the caller. This permits subsequent call-progress tones from the node to be heard by the caller.

— The node returns a dial tone to the caller when it is ready to receive digits.

— The user dials the desired number and, if required, the authorization code. The digits are transmitted to the node as dialed. The node provides an Authorization Code Request Tone only if the authorization code is required. If not, the routing takes place immediately following the last digit of the called number.

— The node proceeds to set up the call.

Case 2

This case describes a call from a cut-through non-senderized tributary PBX to the Meridian 1 ESN node by a cut-through non-senderized main PBX. Whenever practical, a direct trunk group to the Meridian 1 ESN node should be provided to avoid using the main PBX as a tandem switch.

— The user at the main tributary PBX goes off hook, receives dial tone from the tributary PBX, and dials a tie trunk access code to access the main PBX.

— The tributary PBX seizes a tie trunk to the main PBX and provides audio transmission so that tones from the main PBX can be heard by the user, and dialed digits from the user can pass to the main PBX. The main PBX normally provides a dial tone to incoming tie trunks.

— After receiving a dial tone from the main PBX, the user then dials the ESN network access code and the desired number. The call setup proceeds as in Case 1, except that the user’s dialed digits and the tones from the node pass through both cut-through switches.

Case 3

This case describes calls from stations at a senderized main PBX to a Meridian 1 ESN node.

— The user goes off hook, receives a dial tone, dials the ESN access code, receives a second dial tone from the main PBX, and then dials the desired number.

— The senderized main PBX does not seize a tie trunk to the node after receiving the access code. Instead, it collects the digits of the called number and seizes a tie trunk to the node. The node does not provide a dial tone.

— The senderized main PBX and the node are mutually arranged to use either a wink start or delay dial signal as a start dial signal to initiate outpulsing.

— When the main PBX receives the appropriate start dial signal, it outpulses the called number to the node and connects the user so that subsequent ringing signals can be heard.

The Meridian 1 authorization code is not supported in this case. The following limitations prohibit the authorization code:

— The senderized main PBX has no provision to provide the authcode request tone for authorization code digits.

— The senderized main PBX does not have the capability to register enough digits for the authorization code and the called number.

— It is impractical to forward additional digits after the senderized main PBX has outpulsed the called number to the node.

Case 4

This case applies to calls from a cut-through tributary PBX to the Meridian 1 ESN node by a senderized main PBX. This case is similar to calls from a senderized main PBX. The user at a cut-through tributary PBX dials a tie trunk access code to reach the main PBX and receives a dial tone from the main PBX. From this point on, the call is handled as though it originated at the senderized main PBX.

Case 5

This case applies to calls from a senderized tributary PBX to the Meridian 1 ESN node by a cut-through main PBX. This is not permitted because of signaling compatibility problems. The tributary cannot provide the proper outpulsing control for routing the call through the main to the node. Direct trunks must be provided from the tributary PBX to the node in this situation. By definition, the tributary then becomes a main PBX.

Case 6

In this case, both the main PBX and tributary PBX are senderized. This is also not permitted because of compatibility problems similar to Case 5. Direct trunks must be provided to the node from the tributary PBX. The tributary PBX thus becomes a main PBX.

Call completions

Call completions to stations on the node, stations at other nodes, and public network trunks from the node and from the connected nodes are handled in the normal manner.

The node completes calls, by tie trunks to the main PBX, to the following destinations:

- stations at the main PBX
- stations at a tributary PBX connected to the main PBX
- off-network stations by public network trunks terminating on the main PBX
- off-network stations by public network trunks terminating on the tributary PBX

In all cases, call routing to the main is initiated by an off hook signal sent to the tie trunk. The basic sequences for call completion are as follows:

- To reach a telephone at the main PBX, outpulse the Directory Number (DN).
- To reach a telephone at the tributary PBX, outpulse an access code for a tie trunk to the tributary, pause if necessary, and outpulse the Directory Number (DN).
- To reach a public network telephone by a CO trunk terminating on the main, outpulse the access code for the CO trunk, followed by the public network number.
- To reach a public network telephone by the tributary PBX, the node outpulses an access code for the main to tributary tie trunk, followed by the access code to the CO trunk, followed by the public network number.

Case 1

This case applies to a call from a Meridian 1 ESN node to a telephone at either a cut-through or a senderized main PBX.

— The node seizes a tie trunk to the main PBX and then pauses, waiting for the main PBX to become ready to receive digits.

— The Meridian 1 then outpulses the telephone Directory Number (DN) digits to the main PBX.

Case 2

This case involves a call from a Meridian 1 ESN node to a tributary PBX by a cut-through main PBX. This is similar to Case 1, except the initial digit(s) outpulsed by the node is an access code for a tie trunk connecting the main PBX to the tributary PBX.

— The node inserts a fixed pause (for a delay for a dial tone) after the access code, unless both main and tributary PBXs are step-by-step (SXS) switches.

— The node resumes outpulsing either when the fixed pause interval elapses or a dial tone is detected.

— The resumed outpulsing is the DN at the tributary PBX.

Case 3

This case involves a call from a Meridian 1 ESN node to an off-network telephone by a cut-through main PBX.

— The access code outpulsed by the Meridian 1 ESN node is for a CO trunk, instead of tie trunk as in Case 2.

— A fixed pause or a delay for a dial tone after the access code is required, even when both the main PBX and the CO are step-by-step (SXS) switches.

— The resumed outpulsing consists of the public network number rather than a PBX number.

Case 4

This case applies when the main PBX is senderized and tandems a call from the Meridian 1 node to a tributary PBX or to a CO.

The beginning of the call setup sequence when the main PBX is senderized is the same as in the previous case. However, once the node begins outpulsing, it outpulses all of the digits without pausing. If the main PBX can receive DTMF digits, outpulsing should be DTMF digits regardless of the capability of the tributary PBX or CO. The senderized main PBX collects the digits, translates, prefixes, and completes the call to the next switch.

Calls to other private networks

Tandem tie trunk networks (TTTN)

Calls to a TTTN are engineered similarly to calls to a main PBX with tributaries. The maximum number of switches connected in tandem is five in a TTTN setup. Thus, up to three access codes with pauses may have to be outpulsed. To avoid the requirement for outpulsing a large number of digits, arrange trunks to several switches in the TTTN so that no more than two trunks in tandem are required to reach any telephone in the TTTN.

Common control switching arrangement (CCSA)

A Meridian 1 ESN node with tie trunks to a CCSA switch is arranged to outpulse seven digits to the CCSA switch to complete network calls to a telephone in that part of the network. Optionally, the Meridian 1 ESN node can outpulse ten digits to complete off-networked calls by the CCSA switch.

Calls from other private networks

A Meridian 1 ESN node is able to function as a TTTN switch for calls from a TTTN. The user in a TTTN dials access codes sequentially to add trunks in tandem.

Calls from a TTTN do not require different engineering than calls from a main PBX, other than a Meridian 1 Route Data Block option to arrange the incoming trunk for TTTN operation. TTTN operation is currently supported by Meridian 1 and is not changed for ESN.

Calls from a CCSA switch can be arranged to terminate on a Meridian 1 ESN node or any other switch that is part of the Coordinated Dialing Plan (CDP). Current Meridian 1 CCSA trunk options can accommodate this. Tie trunks from a CCSA switch must be provided to all switches in the ESN network (including those that are part of the CDP) to be accessible from the CCSA switch. An unambiguous numbering plan encompassing both the ESN network and CSSA must be arranged. The Meridian 1 ESN node routes calls in the CCSA numbering plan to the CCSA switch.

Requirements for dialing pauses

When outpulsing to main PBX and to a TTTN, the Meridian 1 ESN nodes are occasionally required to pause at various points in the digit strings to allow for trunk access and register attachment. Failure to pause causes missed digits and calls to connect to wrong numbers or to be lost altogether.

The Meridian 1 ESN software provides for pauses following trunk access codes in the Network Alternate Route Selection (NARS) translation tables. The general rule is that each trunk access code outpulsed must be followed by a pause. However, there are a number of situations where the pause is not required.

In determining whether the pause is required, you must consider the following:

— what type of PBX is reached in the dialing

— what piece of equipment is accessed

Pauses are not required in the following situations:

- The access code is for connecting a step-by-step (SXS) PBX to an SXS PBX.
- The access code is for connecting a Meridian 1 PBX to any other PBX, providing that subsequent pauses are not required.
- The access code is 9 for a CO trunk by a Centrex PBX, but not to other CO trunks.
- The access code is for an automatic route selection on any PBX.

A potential problem can occur when a trunk access code requiring a pause is made after the call is routed through one or more Meridian 1 switches. While the Meridian 1 ESN node need not pause between access codes for routing through the Meridian 1 switches, if it does not, a problem occurs at the point where the pause is required.

The Meridian 1 switches that are connected insert the proper delay after the access code before resending digits. However, the time spacing between digits is not maintained. The trailing digits “catch up” with the leading digits. The time delay required after an access code is eliminated. To avoid this problem, the Meridian 1 ESN node must insert pauses after each access code for this call routing.

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