

Private Switch 9-1-1 Overview

This document contains useful information in the event a full PS911 implementation is desired, whether it is done proactively as a PBX service “enhancement”, to satisfy an applicable 9-1-1 mandate under state law, or to mitigate 9-1-1 call processing issues discovered by dialing test 9-1-1 calls.

1.0 Generic Requirements for Private Switch 9-1-1 Service

The Basic Assumptions applicable to the PS911 service configurations described in this document are:

- The local community has enhanced 9-1-1 service (E9-1-1)
- The E9-1-1 system includes Automatic Number Identification (ANI), Automatic Location Identification (ALI), and Selective Routing (SR) features
- The E9-1-1 system utilizes a centralized ALI database management system.
- Every station line associated with the PBX has the ability to dial 9-1-1 or 9-9-1-1. It is incumbent on the owner-operator of a PBX to test the ability to dial 9-1-1 and assess the need for the PS911 service enhancement. Please refer to Section 7.0 of this document for recommended procedures for conducting test 9-1-1 calls from PBX station lines.
- The PS911 service enhancement is mandatory for PBX switches that provide telephone service to residential end users (*ref. Texas Health and Safety Code Section 772*), but is strongly recommended by Tarrant County 9-1-1 as an optional upgrade to all PBX switches equipped with digital trunks (PRI-ISDN).

2.0 Private Switch 9-1-1 Call Processing in the PBX

The processing of a 9-1-1 call that originates from a PBX station line begins with the PBX’s recognition of the dialed digits (i.e. 9-9-1-1 and 9-1-1) as an emergency call. The subsequent processing steps critical to a successful PS911 service are:

- Recognition of station lines that are assigned full 10-digit, NANP-valid DID numbers and station lines that are “intercom-only” stations or non-assigned stations (e.g. “outdial” lines and “rollover” lines).
- Programming in the PBX must ensure that station lines that are not assigned full 10-digit numbers are associated with an active 10-digit, NANP-valid number that will be transmitted as CLID or CPN when a 9-1-1 call is made from a non-DID station line.
- Programming in the PBX must route 9-1-1 calls to the switch ports associated with the PRI outdial trunks or the dedicated 9-1-1 trunks, depending on the chosen PS911 trunk configuration.
- When using the PRI trunk configuration, the PBX must transmit specific CLID or CPN in the call setup message.

- When using the dedicated CAMA-type trunk configuration, the PBX must transmit 8-digit ANI following the CAMA signaling protocol described in Section 6.1 of this document.

When using the dedicated CAMA-type trunk configuration, the PBX must also be programmed to route 9-1-1 calls over regular PBX trunks should the dedicated CAMA-type trunks be unavailable due to “out of service” or “traffic-busy” conditions. (Note that calls not routed over dedicated CAMA-type trunks will not deliver the PS911 enhancements.)

3.0 PS911 Call Processing in the 9-1-1 Selective Router

The processing of 9-1-1 calls by the 9-1-1 Selective Router should be the same regardless of whether the call was delivered to the 9-1-1 Selective Router via message trunks serving a Central Office Switch or via dedicated CAMA-type trunks that connect a PBX directly to the 9-1-1 Selective Router.

The call processing steps are:

- Programming is written in the 9-1-1 Selective Router for each incoming trunk group. This programming includes assigning a single numbering plan digit (NPD) that is used to identify the area code that goes with to the 7-digit number in the ANI transmitted by the PBX to construct a full 10-digit number.
- The 9-1-1 Selective Router uses the NPD + 7-digit ANI to search the selective routing database for the code to use in routing the call to the appropriate 9-1-1 trunk group that serves the appropriate 9-1-1 answering point.
- The Selective Router transmits the full 10-digit number to the 9-1-1 answering points in the Tarrant County 9-1-1 District.
- A default routing code is assigned to each incoming 9-1-1 trunk group to enable the 9-1-1 Selective Router to complete calls in the event of ANI failures. When using the dedicated CAMA-type trunk configuration, the default routing code ensures calls are routed to the 9-1-1 answering point that serves the location of the PBX.
- All call control features of the Selective Router, such as Fixed Transfer, Selective Transfer, Manual Transfer, Alternate Routing, Speed Dial, Forced Disconnect, etc. work the same on 9-1-1 calls from PS911 sites as other 9-1-1 calls.

4.0 PS911 Database Requirements

In addition to successfully delivering 10-digit ANI to the 9-1-1 answering point, the PS911 service enhancement requires the creation and maintenance of database records in the designated 9-1-1 database management system. Each and every telephone number that may be transmitted as ANI from a PBX site must be uploaded to the 9-1-1 database management system in accordance with the NENA Recommended Standard 02-010 or a locally approved alternative. Tarrant County 9-1-1 has designated Southwestern Bell Telephone as the 9-1-1 database management system provider. Detailed methods and procedures for PS911 database maintenance will be provided upon execution of a PS911 Service Agreement with Tarrant County 9-1-1.

4.1 Other Database Considerations

Some PBX environments present more complex challenges. The PS911 service may not be able to accommodate off-premises station lines, for instance, if the lines are terminated at locations outside the geographic area served by the 9-1-1 selective router. In very large PBX system configurations, there may be multiple PBX switches and/or remote modules that are networked to serve multiple locations with a common numbering plan using DID numbers out of the same NPA/NXX. **These unique situations must be dealt with on a case-by-case basis with the participation of the PBX vendor, the dial-tone provider, the 9-1-1 network and database provider(s), Tarrant County 9-1-1, and sometimes other 9-1-1 agencies if overlaps with other jurisdictions are involved.**

5.0 Implementing PS911 for PBX Switches Using PRI-ISDN Trunks

A PBX equipped with PRI-ISDN trunks may, or may not, normally deliver station level ANI to a 9-1-1 answering point when the originating station line dials 9-9-1-1 or 9-1-1. Tarrant County 9-1-1 has specified in contracts executed with local exchange telephone service providers that the billing telephone number (BTN) be transmitted as the 9-1-1 ANI whenever the serving central office of the PRI trunks routes a call to the 9-1-1 Selective Router via the dedicated 9-1-1 trunks serving that central office if the PBX customer has not implemented a PS911 service enhancement through the 9-1-1 District. Thus, the 9-1-1 Selective Router uses the BTN to query the selective routing database for the routing code that identifies the 9-1-1 answering point that will receive the call. The CPE at the 9-1-1 answering point then uses the BTN to retrieve the ALI record associated with the BTN from the 9-1-1 database. This record contains the name and main address of the PBX owner/operator. Note that this is the desired 9-1-1 call processing for any PBX that has not implemented a PS911 enhancement.

It must be noted, however, that certain programming in the PBX and/or in the serving central office that provides the PRI trunks can adversely affect the processing of a 9-1-1 call. In cases where a PBX is programmed to send calling line identification (CLID or CPN) on outgoing calls to enable outgoing caller identification, there is a possibility that the CLID or CPN would be transmitted as the ANI on a 9-1-1 call. Whenever this occurs, the SR tandem may not route the call to the correct 9-1-1 answering point, and the ALI display will read “No Record Found” when the call is answered by the 9-1-1 dispatcher. These are the end results if ALI records have not been uploaded to the 9-1-1 database management system for every number the PBX might transmit as CLID or CPN.

THE NEED TO TEST THE ABILITY TO PLACE 9-1-1 CALLS FROM EVERY PBX THAT USES PRI-ISDN TRUNKS CANNOT BE OVER EMPHASIZED.

5.1 Considerations for Successfully Transmitting Calling Station Number Identification on 9-1-1 Calls From PBXs With PRI Trunks

The Generic Requirements PS911 Service in Section 1.0 of this document apply to all trunking alternatives, including the PRI alternative. Careful attention must be paid to configuring PRI trunks to successfully transmit CLID or CPN to a serving central office, and have the CLID or CPN transmitted as 9-1-1 ANI when the serving central office routes the emergency call to the 9-1-1 Selective Router.

There are several issues to consider when seeking to utilize PRI in lieu of dedicated CAMA-type circuits to implement PS911. The following questions should be answered when evaluating whether or not PRI is an option or best practice.

- The PBX owner must consider the type of lines providing service within the PBX. Does the PBX have non-Direct Inward Dial (non-DID) lines behind the PBX? If the answer is “yes”, then the PBX owner must take the necessary steps to either map the non-DIDs to specific DIDs for ANI on a 9-1-1 call or convert the non-DID lines to DIDs. If the PBX does not have the mapping capability then an adjunct station translation box may be acquired and added to the PBX to ensure the correct DID is passed.

Example: Non-DID numbers cannot form an outgoing number like DID numbers from a PBX. It is not valid to make a 7-digit number by prefixing the DN with the NXX. For example: A PBX has an NXX of 972 and a DID range of 1000-1999. An extension within this DID range, e.g. 1010, will form a calling number of 972-1010 which is valid and unique. However a non-DID telephone e.g. DN 2500, would form a calling number of 972-2500. Because this is outside the DID range of 1000-1999, this number will most likely misroute because it could be allocated to a different subscriber or not be in the system at all. Thus special arrangements need to be made for non-DID telephones within the PBX

5.2 PRI Signaling Protocols

Because there are various ways to pass information between a PBX and the serving central office on a PRI, it is essential to achieving proper switch translations that the telephone company identify what Protocol is used by the PBX. The specific protocol must be communicated to the dial-tone provider in order to obtain proper translations at the end office switch.

- It is becoming a common practice for a PBX to transmit station level ANI over PRI trunks to support the delivery of Caller Line Identification (CLID) on regular calls. It is important to understand how this feature could have an adverse impact on 9-1-1 calls. If the serving central office does not support separate translations for CLID on non-emergency calls and CLID on 9-1-1 calls, there is a degradation of the 9-1-1 system if an ALI record for the station level ANI has not been pre-loaded into the 9-1-1 database. Precisely how the serving central office switch handles CLID on emergency calls versus regular local calls is a question the dial tone provider must answer.
- Software within the switch may be used to facilitate proper billing of the customer for long distance calls. The telephone company must be certain to evaluate any modifications in the serving central office switch to accommodate PS911 for PBXs using PRI trunks to assess any impact the modifications may have on PBX translations tables associated with billing systems.
- In the area served by the Tarrant County 9-1-1 District, placing a 9-1-1 call from a PBX over PRI trunks requires a full 10-digit calling number to be included in the calling party information element of the call setup message.

- Delivery of the calling station number to the 9-1-1 Selective Router may preclude the blocking of calling line identification if the serving central office is a Nortel DMS switch unless the NI2 PRI protocol variant is used.

6.0 Implementing PS911 Using Dedicated 9-1-1 Circuits With CAMA Signaling

6.1 Specifications for Dedicated CAMA-Type Trunks for PS911 Service

In instances where the PS911 service cannot be implemented by transporting 9-1-1 calls over the outgoing PRI trunks, Tarrant County 9-1-1 requires the dedicated CAMA-type trunks to be connected at the 9-1-1 Selective Router.

A minimum of two (2) CAMA-type trunks must be installed for each PS911 site. The CAMA-type trunks may be connected directly to the PBX or may be connected to an adjunct device positioned between the PBX and the 9-1-1 Selective Router. The use of an adjunct device is indicated when the PBX lacks the ability to perform the necessary CAMA signaling protocol, or when the PBX lacks the ability to translate non-DID station lines with pre-determined DID numbers to transmit as ANI when 9-1-1 calls are made from non-DID station lines.

ANI, in this case, refers to the ability of the PBX to pass station-level number identification to the public switched network. For 9-1-1 emergency telephone calls, the calling party's station identification would be translated by the PBX as the seven-digit DID number associated with that station. This DID number would be passed via multifrequency tones (MF) along the voice path of the PBX outgoing CAMA-type trunk to the 9-1-1 Selective Router. Along with the calling party's telephone number, the PBX must send a single-digit ANI information digit. The information digit will be a zero (0) or a two (2) transmitted from the PBX. Transmitting a 0 (zero) followed by the calling party's 7-digit number indicates a successful automatic identification. Transmitting a 2 (two) indicates an ANI failure at the PBX, and no additional digits will be sent.

The format of the ANI signal is KP-I-NXX-XXXX-ST

Where:	KP	indicates a Key Pulse signal
	I	information digit
	NXX	the prefix of the telephone number (exchange)
	XXXX	the caller's PBX station number
	ST	indicates a ST (Start Pulse)

(the hyphens are inserted for clarity only and are not transmitted)

All of this information is sent via Multifrequency (MF) Pulsing. MF Pulsing is a method of communicating call set-up information over telephone trunks by various combinations of two out of six frequencies in the voice band. Each combination of two frequencies is sent as a pulse of tone intended to represent a digit or a control signal such as the KP or ST. The signals are transmitted over the regular talking (voice) path of each trunk circuit. MF receivers detect the pulses and transfer the digit information to switching control equipment and/or data collection systems. MF signals are not the same as DTMF signals. They are

combinations of different frequency tones. The six MF frequencies are 700, 900, 1100, 1300, 1,500, and 1700 Hz.

When CAMA-type trunks are installed, the following details must also be specified:

- Are circuits to be engineered as 2-wire or 4-wire circuits? (as determined by the CPE vendor)
- Is E & M signaling needed? (as determined by the CPE vendor)

7.0 Testing 9-1-1 Call Processing For PBX Systems

7.1 Testing is needed for all PBX systems, whether or not a Private Switch 9-1-1 Service enhancement has been implemented

It is recommended that every PBX vendor that installs and maintains PBX systems, as well as local service providers that provide PBX trunks, test the ability to dial 9-1-1 from the station lines associated with PBX systems at the time the systems and/or new PBX trunks are installed or upgraded.

THE IMPORTANCE OF TESTING IS EVEN GREATER WHENEVER A PBX IS SERVED BY PRI-ISDN TRUNKS, due to the potential effect of feature interaction of the digital trunk signaling messages (which often include outgoing Calling Line Identification) with 9-1-1 ANI signaling protocols because it can result in DID numbers being sent as ANI on 9-1-1 calls. This condition can exist without the PBX owner/operator being aware until an actual 9-1-1 call is made and one of two adverse effects occurs:

- there is a 9-1-1 ANI failure that potentially causes the call to route to the wrong 9-1-1 answering point with no ANI or ALI displayed at the call-taker position
- the 9-1-1 answering point receives a DID number as 9-1-1 ANI for which no 9-1-1 ALI record has been created, resulting in “No Record Found” in the ALI display at the call-taker position

Discovery of adverse conditions during testing should lead the PBX owner/operator to obtain a detailed assessment of the cause(s) from the PBX vendor and the dial-tone provider. This assessment should include consideration of implementing the PS911 enhancements described in this document.

7.2 Testing Methods and Procedures

In developing a test regimen, there are considerations that apply to all non-emergency calls placed to 9-1-1. Guidelines are offered here to help ensure that a test call does not jeopardize the accessibility of the 9-1-1 system to anyone who may have an actual emergency.

7.2.1. Ground Rules for 9-1-1 Test Calls

Rule Number 1: Never dial 9-1-1 as a test call and just hang-up once the call is answered. The 9-1-1 communication center has an automatic display of the telephone number and associated location identification record. On hang-up calls, because the nature of the call is

unknown, resources will be allocated to call the number back to determine if there is an emergency. This reduces the number of people available to answer true emergency calls, and in some jurisdictions may result in fines being assessed to the party who made the 9-1-1 hang-up call. If a call-taker is unable to re-contact a hang-up caller, resources are dispatched to the location displayed for the call. This further stresses the ability of the agency to respond to true emergencies, and has been known to result in doors being knocked down unnecessarily.

Rule Number 2: Always contact the local Police Department via their non-emergency number and ask to speak to the 9-1-1 communications supervisor to request permission to place a 9-1-1 test call. Ask to coordinate test calls during their non-peak calling hours. Many centers allow test calls between 9:00 a.m. and 11:00 a.m., 1:30 p.m. to 3:30 p.m., 7:00 p.m. to 9:00 p.m., and 3:00 a.m. to 5:00 a.m.

Rule Number 3: Before making the test call note the telephone number and address information of the station line that will be used to make test calls, and determine which 9-1-1 answering point should answer the test call.

7.2.2. Test Call Checklist

A test call should be made from at least one station line from each identifiable category of station lines working in the PBX. These could include any combination of the categories listed here, depending on the configuration and size of the PBX and the user organization:

- A single-line phone with a DID number.
- A single-line phone with a non-DID number.
- A multi-line phone with more than one station lines, all of which have full DID numbers.
- A multi-line phone with more than one station lines, some of which have DID numbers and others do not.
- An attendant console.
- A station line located off-premises (OPX station).
- Each of the above categories may be classified as restricted from placing outgoing calls. Be sure to test the ability of such station lines to dial 9-9-1-1.
- Any other special class of service used in the PBX configuration.

A test call should be made by dialing 9-9-1-1 as well as 9-1-1. Document the results and assess the implications.

When making test calls from a PBX site after implementing the PS911 enhancement using two (2) dedicated CAMA-type trunks, it will be necessary to place at least three (3) simultaneous test calls in order to test the overflow routing of the third call when the CAMA-type trunks are traffic busy.

Make sure that it is understood prior to placing test calls exactly what is supposed to happen on a call from each category of station lines, and in particular what is supposed to happen on the overflow routing. Otherwise, it will not be immediately clear whether the test call succeeded or failed.

7.2.3. Placing a 9-1-1 Test Call

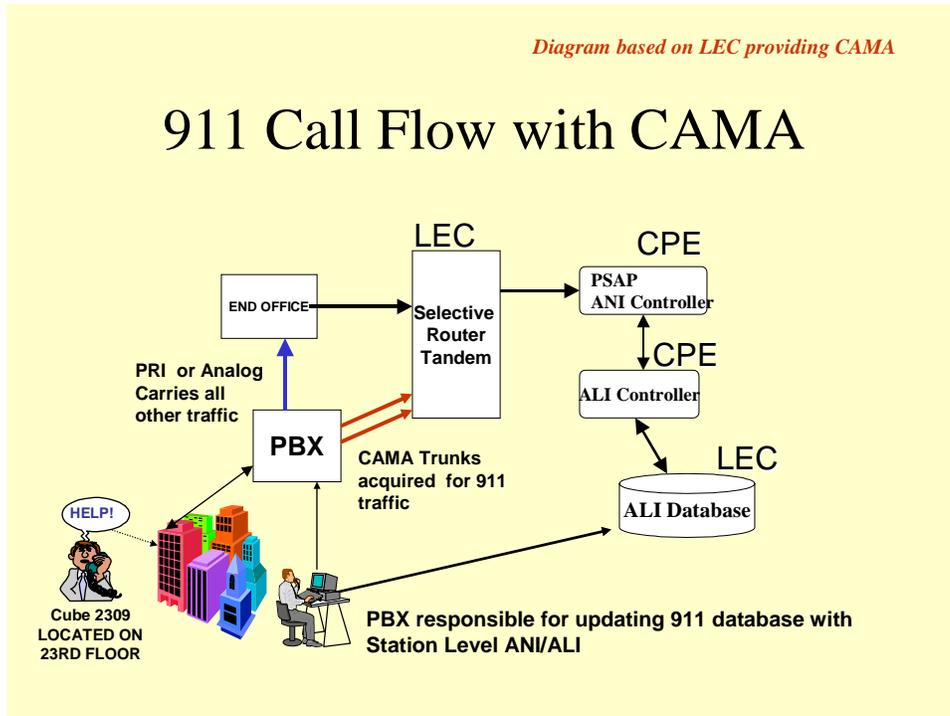
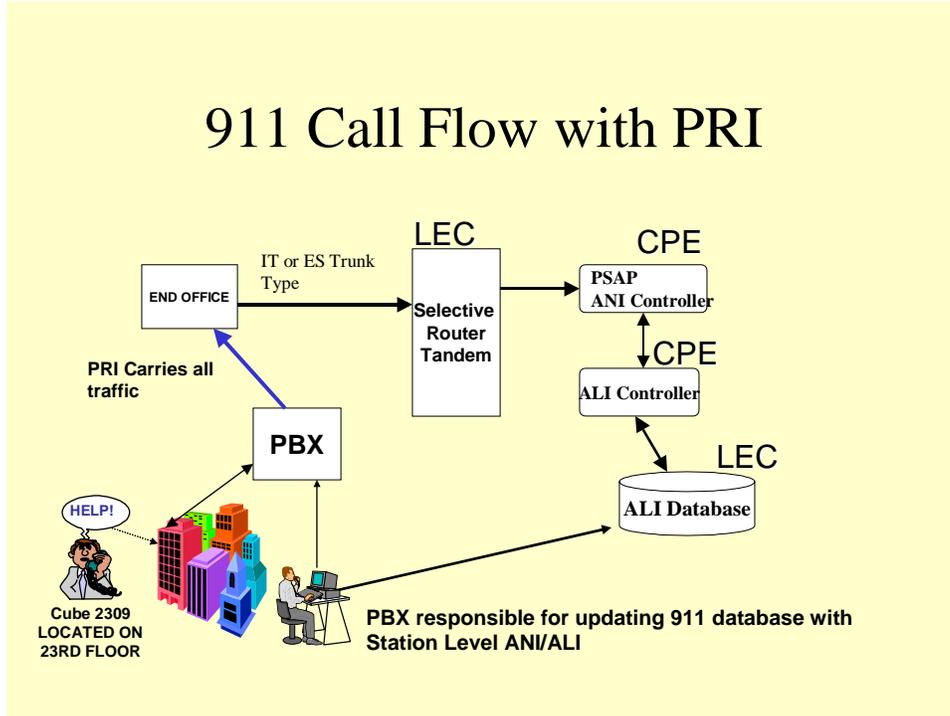
Dial 9-1-1-1 or 9-1-1. As soon as the 9-1-1 call is answered, immediately state "this is a test call, no emergency." Then ask the call-taker to verify the telephone number and address that displays. Some 9-1-1 answering points will tell you the information, while others may only confirm what you tell them, thus the requirement to know the telephone number and address in advance. If the call was answered at the correct 9-1-1 answering point and both the ANI and ALI display correctly, the test is a success.

Document the test results. The test call is considered a failure unless the information elements listed below are accurately and completely displayed.

- The telephone number that is displayed as ANI at the 9-1-1 answering position.
- The ALI record displayed includes the correct phone number, subscriber name, address, community name, class of service code, and name of the telco (dial-tone provider).
- Note any error message the 9-1-1 call-taker may have received, such as the pseudo-ANI (formatted as NPA-911-0xxx) that the 9-1-1 system displays in the event of ANI failure.
- Ask the call taker whether 9-1-1 calls requesting Fire or EMS response are normally transferred to a secondary 9-1-1 center. If the answer is yes, ask the call taker to execute the transfer(s) as a part of the test call, then re-verify the information displayed at the secondary answering point.
- The date and time of the test call.
- The name of the 9-1-1 answering point that received the test call.

It is key to note whether the station-level ANI displayed but the error message "Record Not Found" is displayed. If you are testing a PS911 enhancement, this usually means that the database record(s) was (were) not successfully uploaded to the 9-1-1 database management system. If you are making test calls from a PBX that has not implemented the PS911 enhancement, this means that there is a problem with the programming of the PBX, the signaling protocol of the PRI trunks, the programming of the C.O. switch, and/or the signaling protocol of the trunks connecting the C.O. switch to the 9-1-1 Selective Router.

8.0 PS911 Trunk Configuration Diagrams -



Resources

All questions regarding the testing of 9-1-1 calls from sites located within the following list of communities should be referred to Richard Atkins, ENP, Assistant Director, Tarrant County 9-1-1 District at 817-820-1182 or ric@tc911.org.

1. City of Arlington
2. City of Azle
3. City of Bedford
4. City of Benbrook
5. City of Blue Mound
6. City of Burleson
7. City of Colleyville
8. City of Crowley
9. D/FW Airport
10. City of Dalworthington Gardens
11. City of Edgecliff Village
12. City of Euless
13. City of Everman
14. City of Forest Hill
15. City of Fort Worth
16. City of Grand Prairie
17. City of Grapevine
18. City of Haltom City
19. City of Haslet
20. City of Hurst
21. City of Irving
22. Joint Naval Air Station (JNAS)
23. City of Keller
24. City of Kennedale
25. City of Lake Worth
26. City of Lakeside
27. City of Mansfield
28. City of North Richland Hills
29. City of Pantego
30. City of Pelican Bay
31. City of Richland Hills
32. City of River Oaks
33. City of Saginaw
34. City of Sansom Park
35. City of Southlake
36. City of Watauga
37. City of Westlake
38. City of Westover Hills
39. City of Westworth Village
40. City of White Settlement
41. Unincorporated Tarrant County

Note: All portions of the cities listed above are included, even when a portion of a city overlaps into an adjacent county.