9-1-1 Tutorial

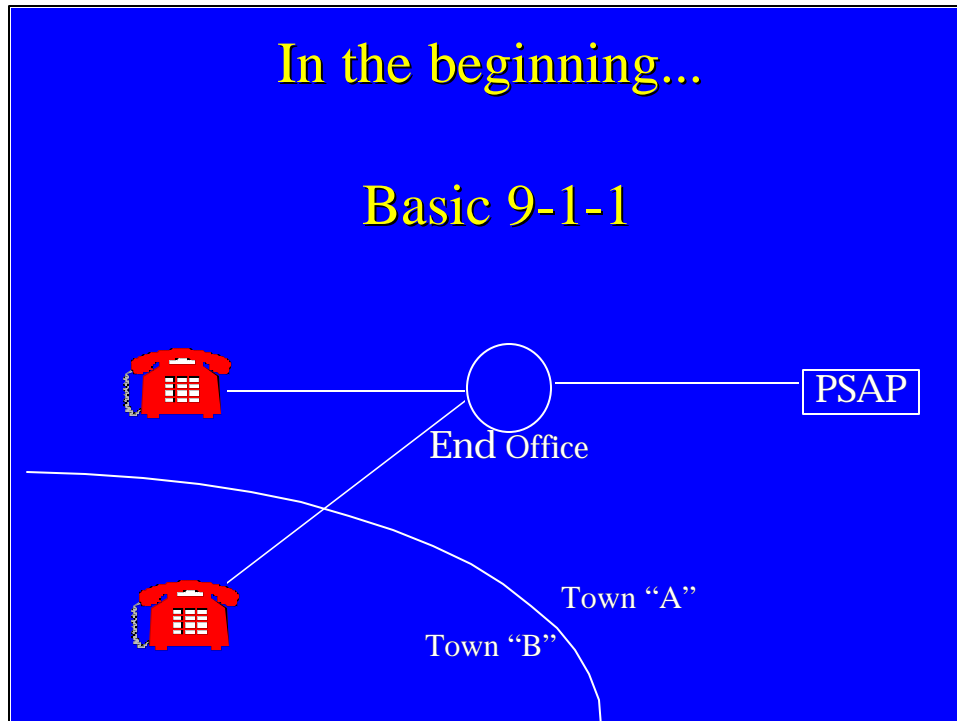|	
Billy Ragsdale	NENA Technical Liaison
	Chair, PSAP CPE Technical Committee
Bob Gojanovich	Chair, Network Technical Committee
Barb Thornburg	Chair, Database Technical Committee
Roger Hixson	Chair, ALEC/PS Technical Committee

NENA TDC — TECHNICAL DEVELOPMENT CONFERENCE

In the beginning...

Basic 9-1-1

In the beginning, there was Basic 9-1-1. The telephone company end office (also known as a "central office" or "Class 5 office") is programmed to point all 9-1-1 calls to a single destination.

The good news is, all 9-1-1 calls from any telephones served by the end office will complete to the PSAP.

The bad news is, end office serving areas rarely line up with political jurisdictions. The office may serve subscribers in neighboring towns, or the end office may not serve all the residents of the town. These conditions are known, respectively, as overlap and underlap.

The original Basic systems (some of which are still in operation) provided no identification of the caller.

Basic 9-1-1 service, delivered in this configuration (via a local central office) will not support interconnection to any other telecommunications providers, including Independent telcos, ALECs or Wireless Carriers. Its days are numbered for that reason.

Basic 9-1-1 with Automatic Number Identification (ANI)
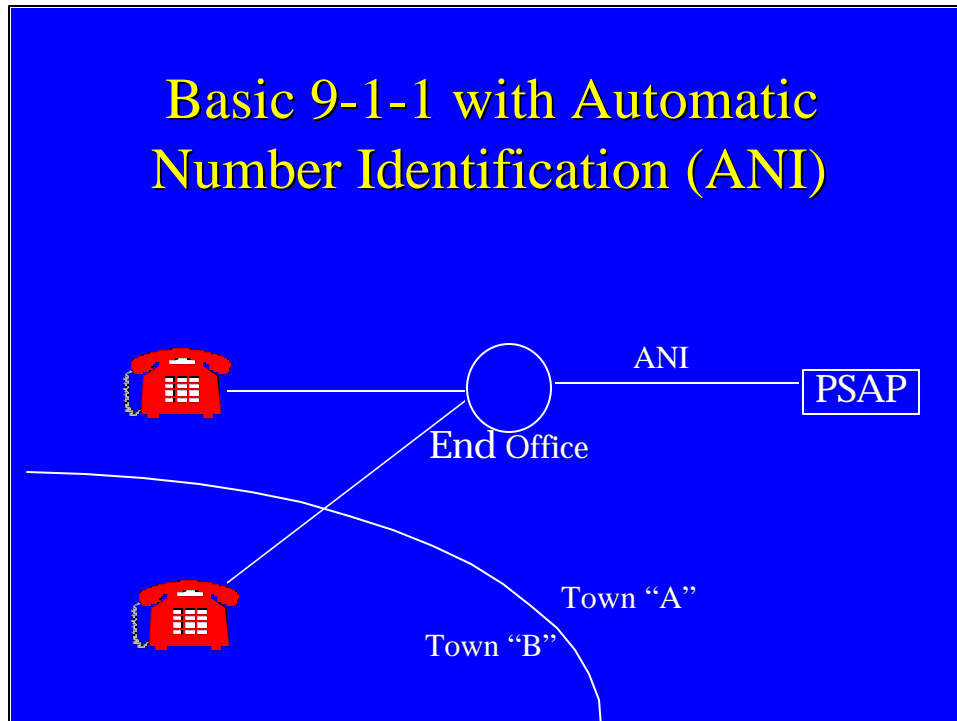
The introduction of ANI added a new dimension to 9-1-1 service. Now the caller's telephone number could be delivered with the call and displayed at the PSAP. It could be used to identify the caller, if the caller were unable to do so, and for callback.

A signaling scheme known as Centralized Automatic Message Accounting, or CAMA, originally used to identify the originator of a long distance call for billing purposes, was borrowed to facilitate ANI delivery to the PSAP. CAMA uses multi-frequency (MF) signaling to deliver eight digits to the PSAP. The first digit, called the Number Plan Digit or NPD, specifies one of four possible area codes. Digits 2-8 represent the caller's 7-digit telephone number. The ANI is framed with a "Keypulse" at the beginning and a "Start" at the end, in the format "KP-NPD-NXX-XXXX-ST".

A commonly asked question is, "The real name for Touch Tone dialing is "Dual Tone Multi-Frequency" or DTMF. Are DTMF and MF the same thing?"

The answer is no. Both use a combination of two specific tones to represent a digit or other character, but the tones are different. There are 16 DTMF tones (0-9,#,*,A,B,C,D) and a greater number of MF tones (including 0-9, KP, ST, ST', ST'' and others). The reason for the difference is that DTMF tones represent signals from a user to the network, and MF tones are control signals within the network.

**Basic 9-1-1 with ANI and Automatic Location Identification (ALI)**
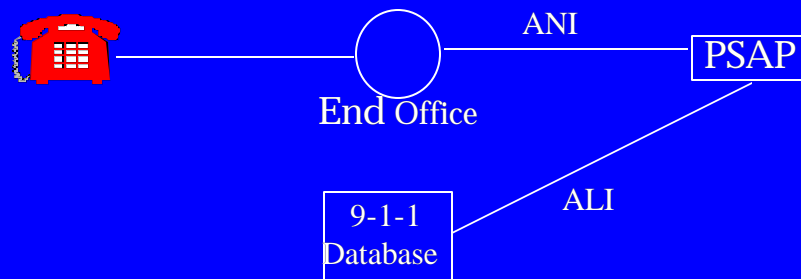
Once the caller's telephone number was available to the PSAP, name and address data could be accessed using it. After all, telephone companies store subscriber data based upon telephone number.

New equipment (and a new data circuit) at the PSAP takes the telephone number, wraps it in a data message, and uses it to query the ALI database, which has been specially constructed for this purpose. This configuration facilitates the automatic delivery of the name, address and telephone number of all 9-1-1 callers.

9-1-1 ALI databases are typically operated by the telephone company serving the PSAP. If there are multiple telephone companies, one may act as host for the others. There may also be multiple ALI databases (like in California), but that is the exception rather than the rule.

Don't be fooled! This is not Enhanced 9-1-1. This system identifies callers, but we are still only addressing a single end office serving area. What if there are several telephone company offices serving the town or county?

Basic 9-1-1 with Multiple
End Offices
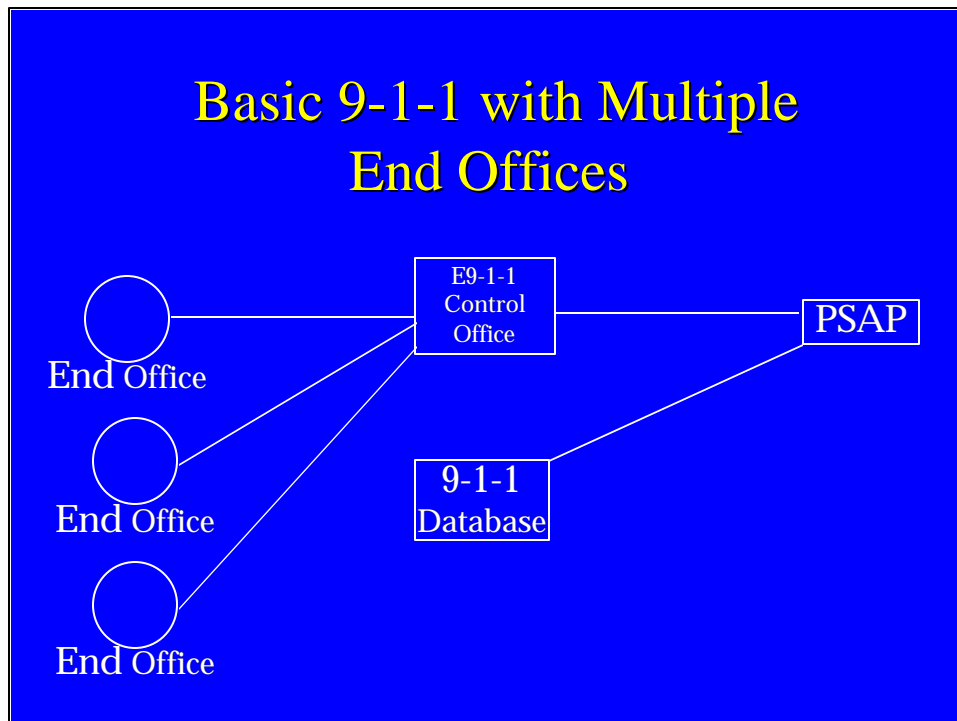
It is not efficient to build trunks from multiple central offices to a PSAP. Instead, trunks from the end offices are concentrated at a "tandem" office, from which a single trunk group serves the PSAP. This concentration reduces the size, and thereby the cost, of the PSAP telephone equipment.

A "tandem" is a telephone company switch that provides an intermediate concentration and switching point. Tandems are used for a number of purposes, including intra-LATA toll (sometimes called "short distance"), and access to other local exchange carriers (LECs), long distance carriers and telephone operators. A tandem office that provides Enhanced 9-1-1 services is known as an E9-1-1 Control Office.

This type of configuration has been used all over the country.

NOTE: From this point forward, the terms "end office" and "central office" may refer to offices operated by incumbent wireline telephone companies (ILECs), like Bell Atlantic and Sprint, or those operated by ALECs. Their function and connections are virtually identical. The main differences are that where an ILEC end office will serve a specific area with a pair of 9-1-1 trunk groups, an ALEC end office may serve an entire state with individual or pairs of 9-1-1 trunk groups for each county.

Also from this point forward, the terms E9-1-1 Control Office, Selective Router, Selective Routing Tandem, and 9-1-1 Tandem are used interchangeably. "E9-1-1 Control Office is the generic term, but it is called by many names across the country.

Basic E9-1-1 Data Terms

- ANI - Automatic Number Identification
- ALI - Automatic Location Identification
- DB - Database
- DBMS - Data Base Management System
- ESN - Emergency Service Number
- ESZ - Emergency Service Zone
- MSAG - Master Street Address Guide
- PSAP - Public Safety Answering Point
- SP - Service Provider
- SR - Selective Routing
- SRDB - Selective Routing Database

OK, lets take a short break from techy stuff to review some 9-1-1 terms associated with Enhanced 9-1-1 databases

•Automatic Number Identification (commonly referred to as ANI) is the Telephone Number associated with the access line from which a call originates.

•Automatic Location Identification (commonly referred to as ALI) is the Automatic display at the PSAP of the caller's telephone number, the address/location of the telephone and supplementary emergency information.

•A Database (DB) is an organized collection of information, typically stored in computer systems, comprised of fields, records (data) and indexes. In 9-1-1, such databases include MSAG, telephone number/ESN and telephone customer records (commonly referred to as the ALI Database).

•The Data Base Management System (commonly referred to as DBMS) is a system of manual procedures and computer programs used to create, store and update the data required to provide Selective Routing and/or Automatic Location Identification (ALI) Data services.

Basic E9-1-1 Data Terms

- ANI - Automatic Number Identification
- ALI - Automatic Location Identification
- DB - Database
- DBMS - Data Base Management System
- ESN - Emergency Service Number
- ESZ - Emergency Service Zone
- MSAG - Master Street Address Guide
- PSAP - Public Safety Answering Point
- SP - Service Provider
- SR - Selective Routing
- SRDB - Selective Routing Database

•An Emergency Service Number (ESN) is a three to five digit number representing a unique combination of emergency service agencies (Law Enforcement, Fire and Emergency Medical Service) designated to serve a specific range of addresses within a particular geographical area, or Emergency Service Zone (ESZ). The ESN facilitates Selective Routing and selective transfer, if required, to the appropriate PSAP and the dispatching of the proper service agency(ies).
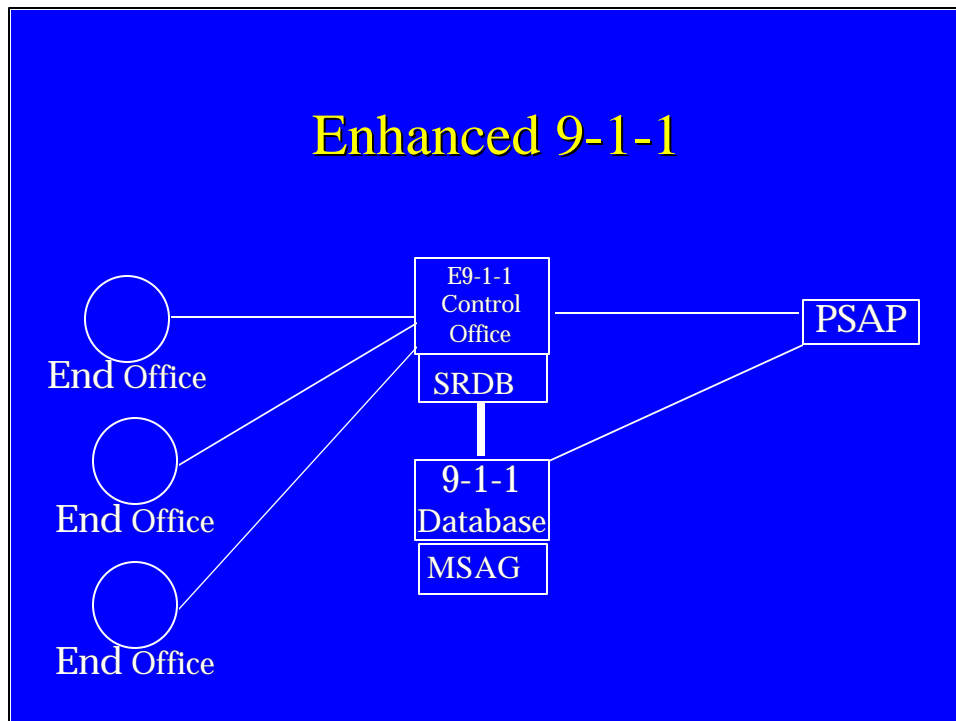
•A Master Street Address Guide (commonly referred to as an MSAG) is a database of street names and house number ranges within their associated communities defining Emergency Service Zones (ESZs) and their associated Emergency Service Numbers (ESNs) to enable proper routing of 9-1-1 calls.

•A Public Safety Answering Point (commonly referred to as a PSAP) is a facility equipped and staffed to receive 9-1-1 calls. A Primary PSAP receives the calls directly, If the call is relayed or transferred, the next receiving PSAP is designated as a Secondary

•A Service Provider (SP) is an entity providing one or more of the following   9-1-1 elements: Network, CPE, or Database service.

•Selective Routing is the routing of a 9-1-1 call to the proper PSAP based upon the location of the caller. Selective Routing is controlled by the ESN which is derived from the customer location.

•The Selective Routing Database (commonly referred to as the SRDB) is the routing table that contains telephone number to ESN (TN/ESN) relationships which determine the routing of 9-1-1 calls.

Enhanced 9-1-1

E9-1-1 Control Office — SRDB — End Office — End Office — End Office — PSAP — 9-1-1 Database — MSAG

The feature that separates Basic 9-1-1 from Enhanced 9-1-1 is Selective Routing. Basic systems may have both ANI and ALI, but are not considered Enhanced until Selective Routing is added.

Generally speaking, Enhanced 9-1-1 systems will feature Selective Routing, ANI, ALI, Selective Transfer and Fixed Transfer. Selective Transfer enables one-button transfer capability to the Police, Fire and EMS agencies listed on the ALI display. Fixed Transfer is another name for speed dialing.

Enhanced 9-1-1 requires the addition of three components to our diagram - the Master Street Address Guide (MSAG), a link from the database to the 9-1-1 Selective Routing Tandem, and a Selective Routing Database (SRDB) associated with the tandem.

Selective Routing is the process by which 9-1-1 calls are delivered to a specific PSAP based upon the street address of the caller. Selective Routing Tandems (aka E9-1-1 Control Offices), however, don't understand addresses - they understand numbers. This means that street addresses have to be converted into numbers the Router can use.

For E 9-1-1, street address ranges are associated with Emergency Service Zones representing unique sets of Police, Fire, and EMS jurisdictions. These Zones are numbered with Emergency Service Numbers (ESNs), and DBMS processing then provides TN-ESN data relationships - the SRDB data that controls ANI-based call routing in the Selective Routing switch.
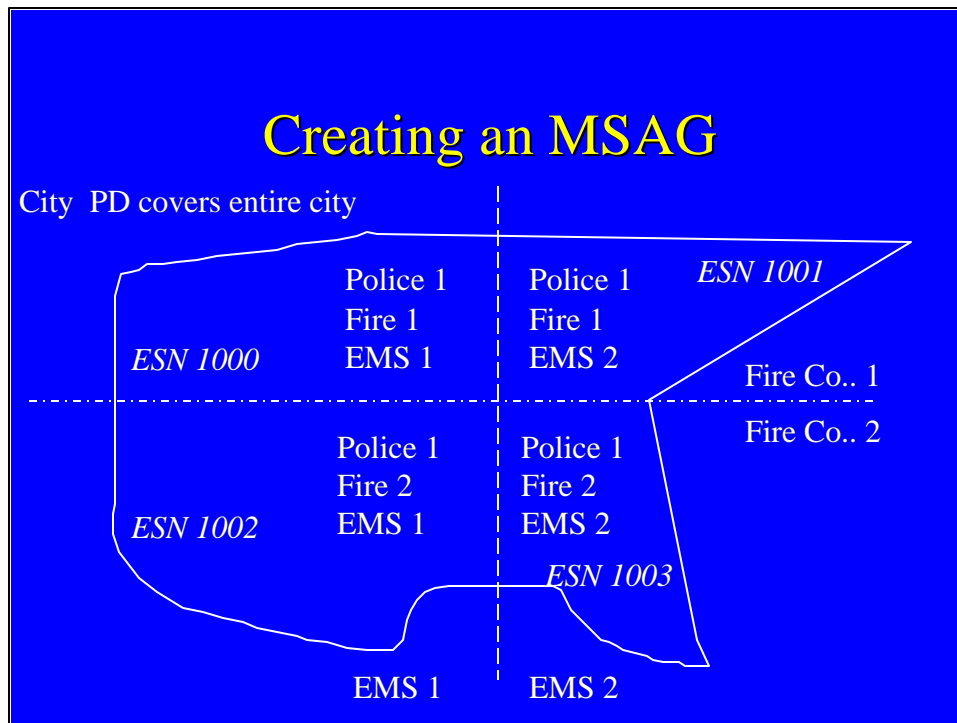
Creating an MSAG

City PD covers entire city

Fire Co..... 1

Fire Co... 2

EMS 1   EMS 2
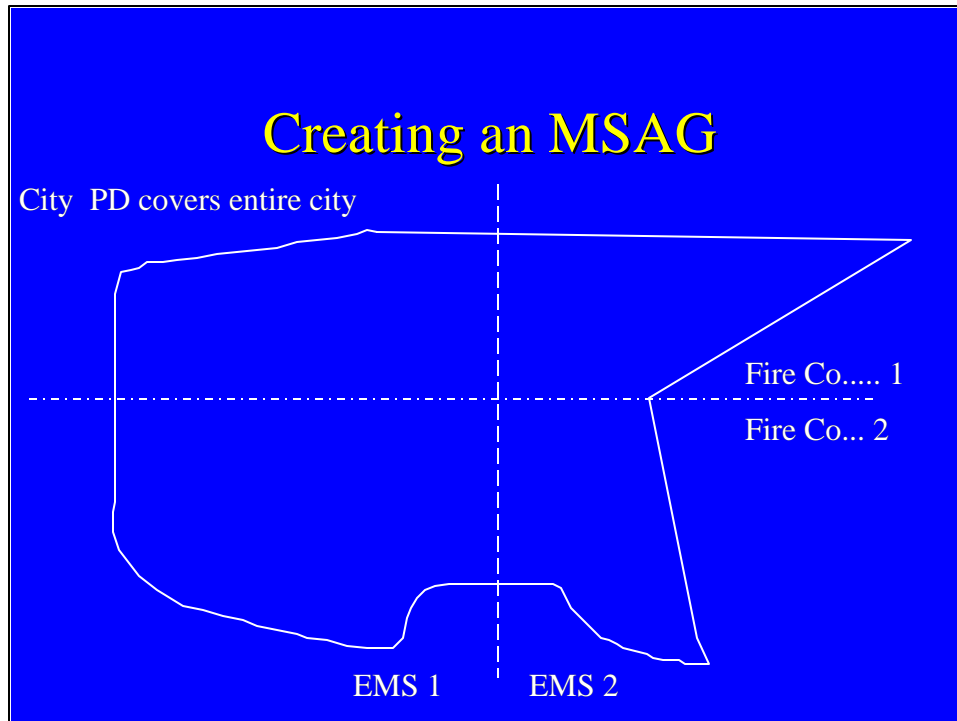
When the response areas of the agencies are overlaid, they form geographic zones, each served by one particular combination of Police, Fire and EMS agencies. These zones are called Emergency Service Zones or ESZ's. Each ESZ contains the set of street addresses served by the three agencies.

In our example above, the City Police Department serves the entire city. Fire Company 1 serves the northern half of the city and Fire Company 2 serves the southern half. EMS 1 and EMS 2 split the city on an east-west basis.

Creating an MSAG

City PD covers entire city

ESN 1001

Police 1 | Police 1
Fire 1 | Fire 1
EMS 1 | EMS 2

ESN 1000

Fire Co.. 1

Fire Co.. 2

Police 1 | Police 1
Fire 2 | Fire 2
EMS 1 | EMS 2

ESN 1002

ESN 1003

EMS 1 | EMS 2

This configuration creates four Emergency Service Zones (ESZ), each having a distinct combination of emergency services within the municipal boundary. ESZs may be any size, from a single address to an entire municipality. Some particularly creative uses of ESZs have been developed to handle wireless, and will be discussed later.

The ESZs are now assigned three, four or five digit numbers. These numbers are called Emergency Service Numbers or ESNs.

MSAG Example

Dir.	Street Name	St Suffix	Low Range	High Range	O/E	Community	ESN
N	Adams	St	1	999		Anytown	1000
S	Adams	St	1	799		Anytown	1002
	Baker	Ave	500	1599	E	Bakersville	1003
	Baker	Ave	501	1598	O	Bakersville	1003
E	Main	St	1	1999		Anytown	1001
W	Main	St	1	2299		Anytown	1000
W	Main	St	2300	3799		Bakersville	1000

Now that the ESZ's/ESN's have been identified the MSAG can be created. All of the address ranges within a specific ESZ are identified and assigned their ESN.

Each street range (Directional, street name, street suffix and community for example) is entered into the MSAG along with it's associated ESN. Once the MSAG is completed with street entries covering the entire service area, it is ready to be utilized for processing of the telephone company subscriber information.

The processing of records performs edits on the data being processed and assigns the appropriate ESN to each telephone company record, if the record contains an address which finds an exact match of an street entry in the MSAG. This file of data is now known as the Automatic Location Identification (ALI) database.

If the record does not find an exact street name match in the MSAG the record is placed into an error file for further manual handling. *The lesson here is that the telephone company record MUST have an MSAG valid address to be assigned the appropriate ESN for Selective Routing purposes and be added to the 9-1-1 ALI database.* This is how the Selective Router knows where to send the 9-1-1 call.

Enhanced 9-1-1
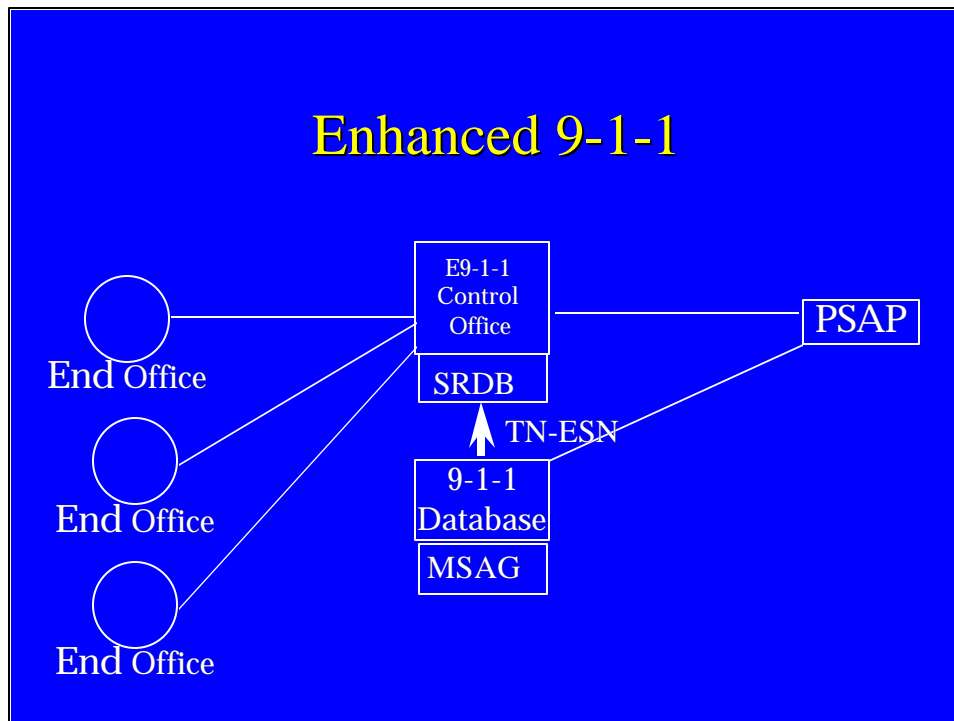
Usually, a default ESN will be created for each municipality. Unrecognized addresses (no house number, number out of range, unknown street name) may be assigned the default ESN. In some systems, all default ESNs begin with a zero (0001-0999) to make them immediately identifiable.

An agency file (there are several names for this file "English Translations File" to name one) is created for each ESN. This file contains the names of the emergency agencies, may contain their telephone numbers, and will be delivered to the PSAP with any 9-1-1 calls from this ESZ.

Once the ALI database is created, a sub-set of that data is uploaded to the Selective Routing Data Base (SRDB). Depending upon the selective router used, the SRDB may be resident in the switch, in an adjunct processor, or in the ALI database.

In the selective routing tandem, the ESN is used for several assignments:

 1. Assignment to a specific Primary PSAP.

 2. Programming of destinations for Police, Fire and EMS Selective Transfer keys.

 3. Assignment of alternate PSAPs (Optional).

At this point, a 9-1-1 call can be selectively routed to an assigned PSAP, the customer and emergency agency data can be transmitted to the PSAP, and the Selective Transfer keys are available for use.

Enhanced 9-1-1
End office Diversity
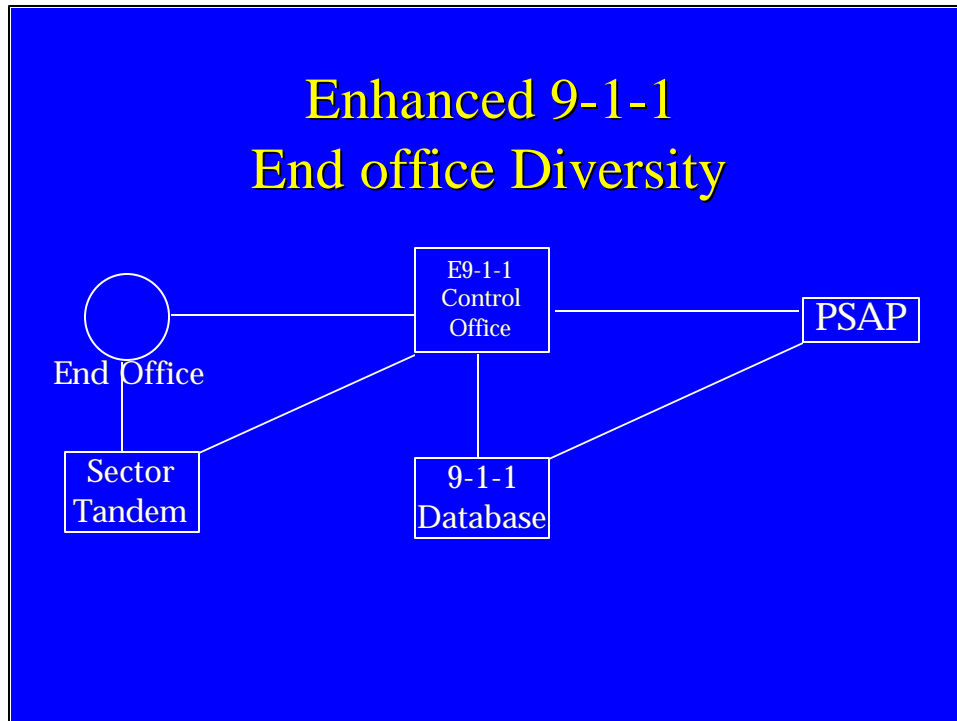
9-1-1 systems are expected to function without interruption. However, expecting every network and PSAP component to work perfectly forever is unrealistic. Stuff happens - things break. Reliability, then, is achieved through diversity and redundancy.

One method of achieving reliability is to build redundant, diversely routed trunk groups from each end office to its 9-1-1 tandem. Each trunk group should be large enough to carry the entire traffic load for that end office.

In this example, a primary 9-1-1 trunk group is built from the end office directly to the 9-1-1 tandem. A secondary, or overflow group, is built to the sector tandem that serves the end office. Many other end offices have overflow trunks to the sector tandem which, in turn, has a large common trunk group to the 9-1-1 tandem.
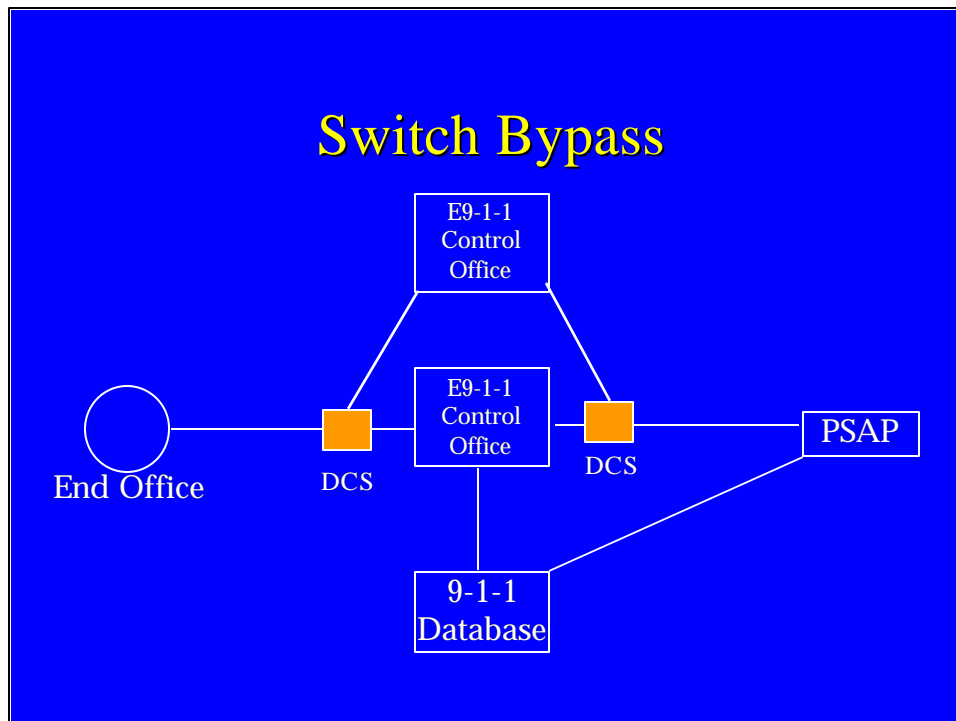
Depending upon local convention or regulation, the primary and overflow trunk groups may each be large enough to provide a P.01 grade of service, or may provide a P.01 grade of service in total. "P.01" means that, during the average busy hour of an average week, one call out of one hundred will be blocked due to an all-trunks-busy condition.

Yes, 9-1-1 calls sometimes get blocked. However, if trunk groups are engineered correctly, blocking will only occur under extraordinary circumstances that generate abnormal volumes of 9-1-1 calls - many of which are redundant. This "congestion control" (sometimes called "choking") is necessary to protect the rest of the network and the PSAPs.

Mated 9-1-1 Tandems
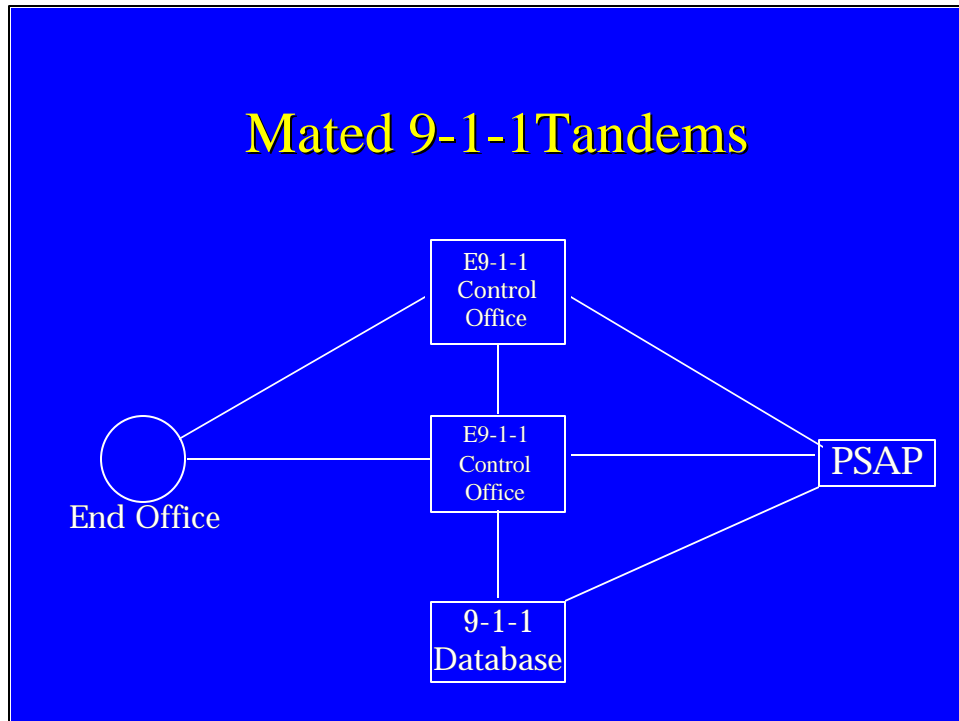
Many 9-1-1 tandems are "mated". Each end office is trunked to both tandems, and both tandems are connected to the PSAP. If one of the tandems fails, the PSAP remains in service. Call handling capacity is reduced by 50%, but there is no interruption of service.

Switch Bypass

E9-1-1 Control Office

E9-1-1 Control Office

End Office

DCS

DCS

PSAP

9-1-1 Database

Switch Bypass is another method to survive a tandem failure. If a tandem fails, end office trunks and PSAP circuits are moved, via digital cross-connect systems (DCS), from the failed tandem to a backup tandem. This switching is done at the DS-3 level. That means that 672 circuits are switched in a single motion. The backup tandem is a mirror image of its mate. A single command activates the ports on the backup tandem.

There is an interruption of service for a few minutes until the switchover is complete. Once completed, however, call handling capacity is restored to 100%.

New Jersey has the only system of this type. It is the only state that can lose two of four 9-1-1 tandems and still maintain 100% call handling capacity. The backup system, like all backup and disaster recovery systems should, is exercised several times per year to ensure it will work when really needed. A typical Switch Protection test will involve the movement, reconnection and reactivation of between 800 and 900 end office trunks, PSAP trunks and printer circuits, all in a matter of minutes.

**Instant Network Backup
(INB)**

End
Office
Switch

INB

E9-1-1
Control
Office

PSAP
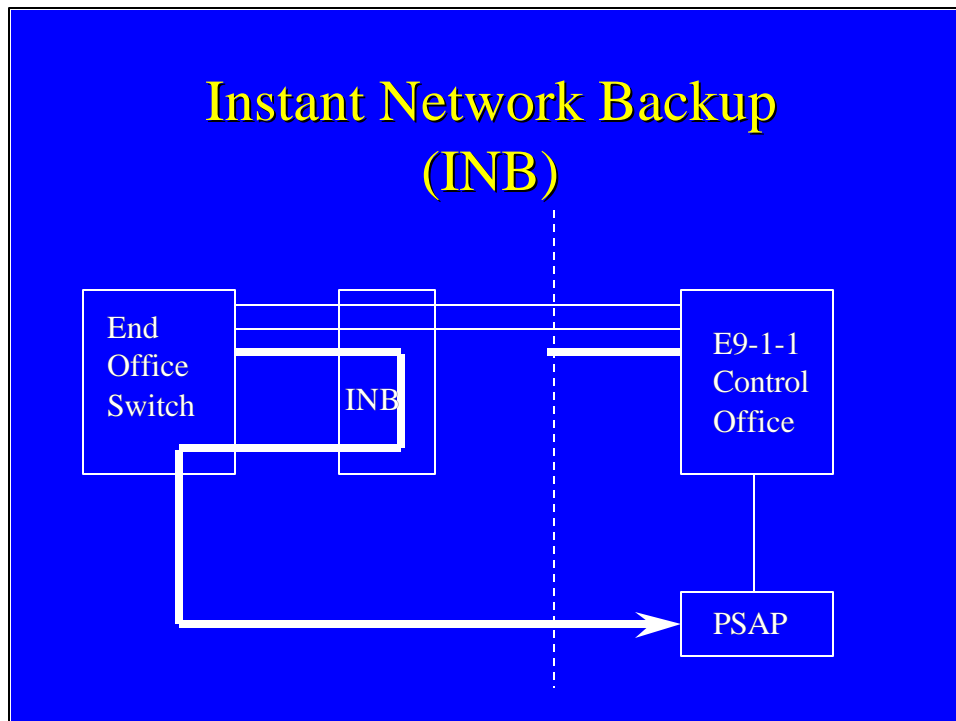
Another layer of network protection, sometimes called a "call diversion" system, is depicted above. One type is called an Instant Network Backup or INB system.

(NOTE: Proctor & Associates markets a unit called "9-1-1 INB". The reference in this tutorial to Instant Network Backup refers to the service in New Jersey for which the unit was originally built. It is not an endorsement or recommendation of the Proctor & Associates product. There are other manufacturers of this type of unit.)

The INB is a unit attached to the primary 9-1-1 trunk group at the LEC end office. It monitors the completion of 9-1-1 calls over that trunk group. If a call does not complete to the 9-1-1 network for any reason (trunk failure, facility problem, 9-1-1 tandem failure or port failure), the INB takes over and completes the call to a 7 or 10 digit number. ANI and ALI are not delivered, but the call is completed to a local public safety agency, usually the local PSAP.

Since the original development, INB technology has matured. INBs can now be purchased that will deliver ANI to a PSAP, or use cellular service to bypass the failed trunk and complete the call to the 9-1-1 tandem.
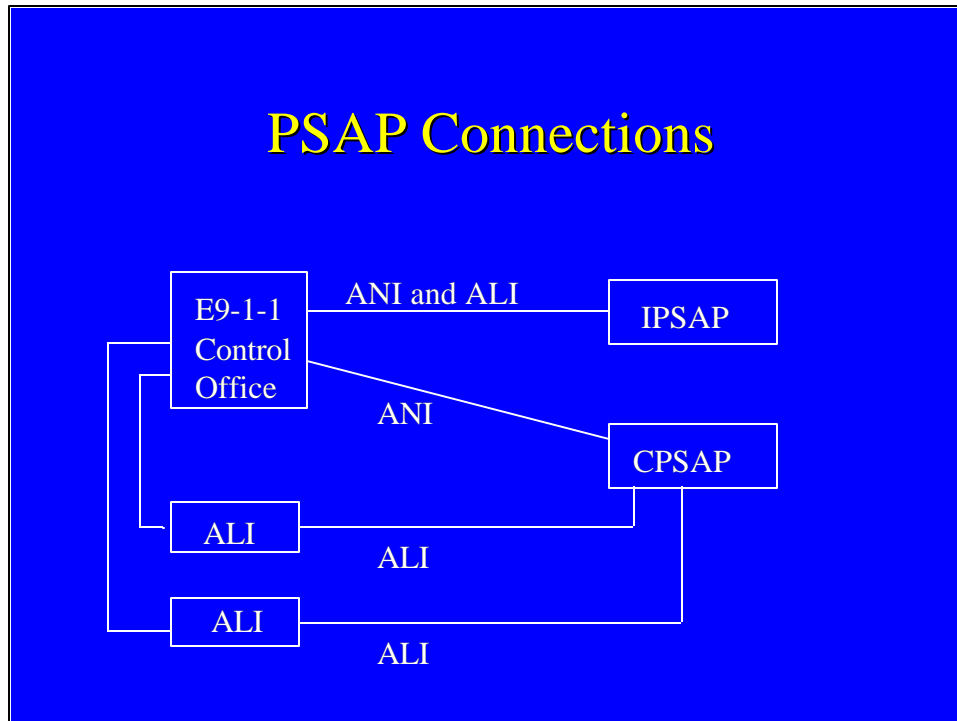
Operator (0-) Handled Emergency Calls
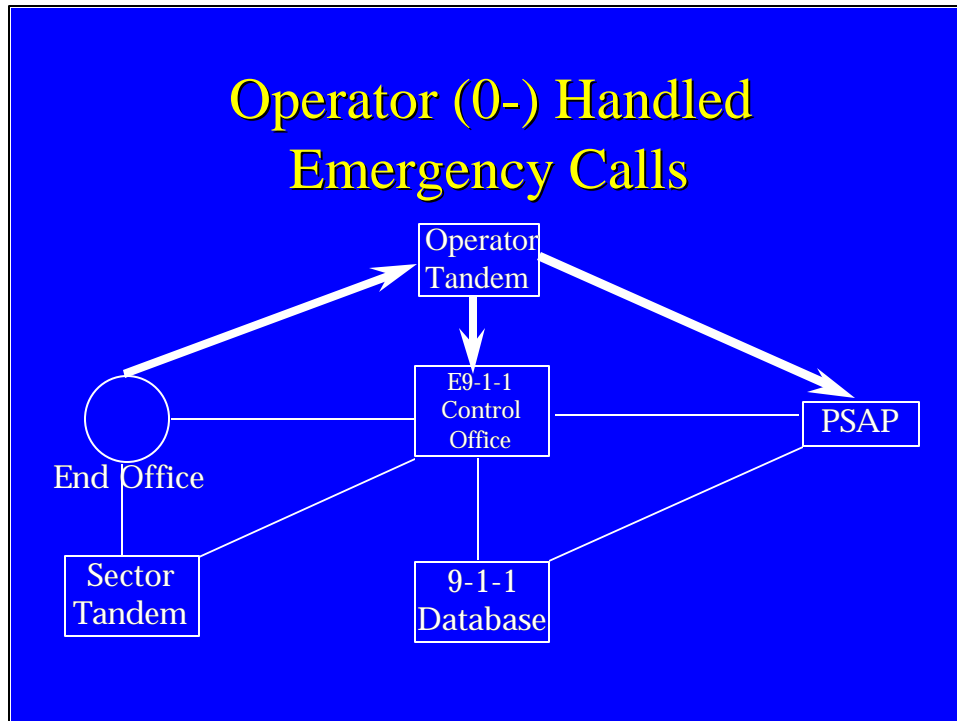
There are several ways for Operator handled calls to be completed to the PSAP. In at least two statewide networks, there is a direct connection between the Operator Tandem and the 9-1-1 Tandem. The operator forwards the call, with the caller's ANI, to the 9-1-1 Tandem. The 9-1-1 Tandem treats the call as if the caller had dialed 9-1-1.

A second way is through the use of pseudo numbers. A pseudo number is a telephone number that, when dialed, will reach a specific PSAP as a 9-1-1 call, and have some special ALI information associated with it. For example, there is a pseudo number associated with each municipality in a state. Dialing that number (usually from outside the lata) will generate a 9-1-1 call to the PSAP for that municipality. The ALI display will say that it is a third party conference call from an unknown address in that town. The caller is not identified, but the call goes to the PSAP for where the caller is believed, or claims, to be. These numbers can be used by ALEC operators who may be located anywhere in the country.

A third method is through the public switched telephone network, dialing the directory number for the PSAP. This is sometimes referred to as a "back-door" number by ALECs.

A fourth method, is for the operator to instruct the originating end office to generate a 9-1-1 call using the caller's ANI. This is under study by some of the switch manufacturers.

PSAP Connections

```
                    ANI and ALI
  E9-1-1  ─────────────────────────  IPSAP
  Control
  Office ───────┐
            ANI  └──────────
                            CPSAP
  ALI ──────────────────
            ALI
  ALI ──────────────────────
            ALI
```

PSAP equipment falls into two basic types - Conventional and Integrated.

Conventional equipment (CPSAP) receives ANI over the voice trunk at the beginning of the call. The PSAP equipment sends a query (using the caller's ANI) to the ALI database system over dedicated data links. The ALI is returned over one or both of the links (This is dependent on the database configuration and the type of equipment at the PSAP. Most PSAP CPE can accept two responses.)

Examples of Conventional PSAPs are Plant Equipment, Lucent, Motorola, CML, Emergitech, Positron and TCI.

Integrated PSAPs receive both ANI and ALI from the 9-1-1 tandem. The tandem queries the ALI database as the call is processed. Depending on manufacturer, the connection between the tandem and the PSAP may be one circuit or two. Selection of Integrated PSAP equipment is dependent upon the tandem. Also, depending again on manufacturer, additional automatic call distribution (ACD) features (call queuing, announcements, equitable call distribution, management reports) may be provided by the tandem. Examples of Integrated PSAPs are Rockwell, KML, (which require a Rockwell tandem) CML (which requires a CML tandem) and NorTel (which requires a NorTel tandem).
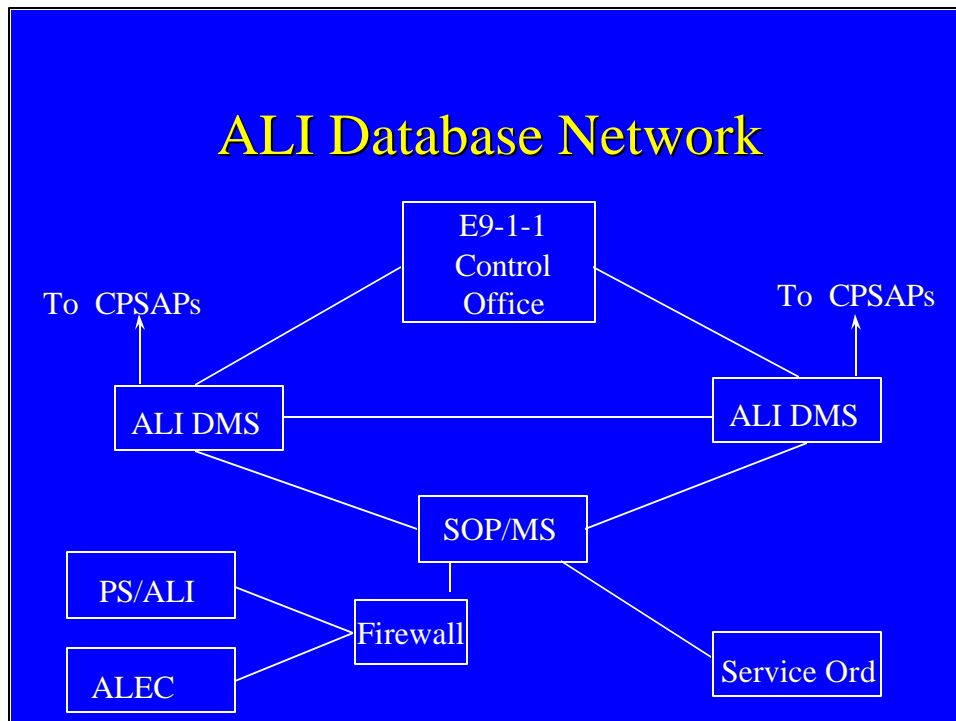
Inter-Tandem Calling
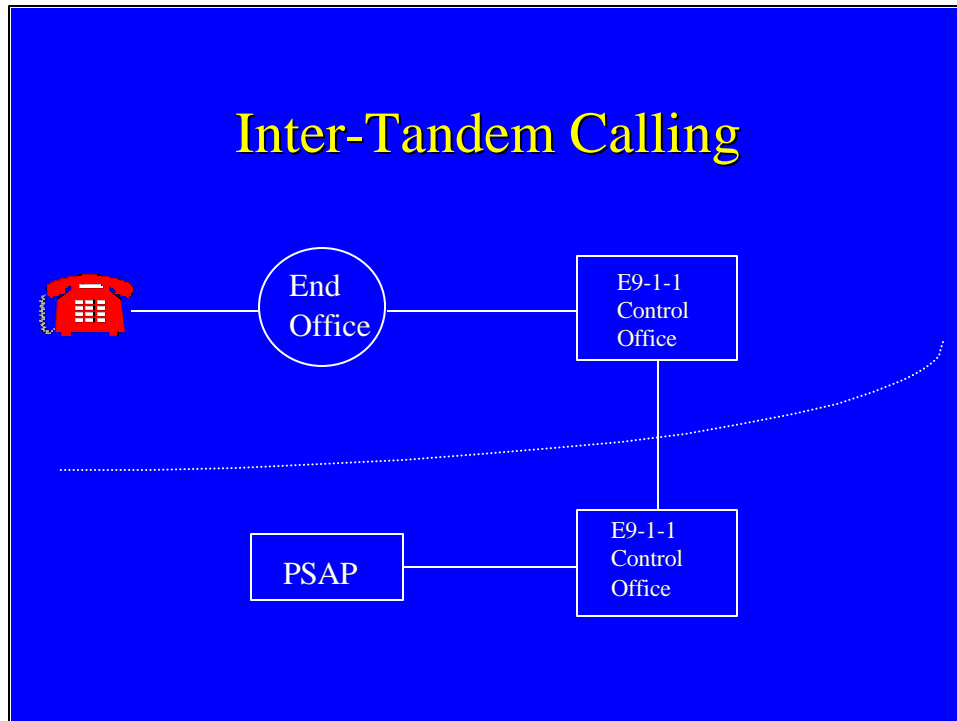
As mentioned earlier, telephone network boundaries do not match with political boundaries. Some residents of the town may live in an area served by a different 9-1-1 tandem than the one that serves their local PSAP. There are two solutions. One is to build a trunk group from the "foreign" 9-1-1 tandem to the PSAP. This is expensive and inefficient, but sometimes unavoidable.

The other solution is inter-tandem networking. If the tandems are capable, calls from those subscribers travel from one tandem to the other on "inter-tandem" or "inter-machine" trunks (IMTs). This removes the 9-1-1 tandem boundaries as an obstacle to effective deployment of Enhanced 9-1-1.

IMTs are also often used to transfer calls between the PSAPs served by the two tandems.

ALI Database Network

E9-1-1 Control Office

To CPSAPs

To CPSAPs

ALI DMS

ALI DMS

SOP/MS

PS/ALI

Firewall

ALEC

Service Ord

This diagram depicts a specific ALI database network, but many networks use this type of architecture.

There are three sources of input to the 9-1-1 database system. The first is the service order system used by the incumbent telephone company. As customer orders for service are processed, the pertinent information is extracted from the service orders by a Service Order Processor (SOP) or Management System (MS). Exact names vary by vendor.

The second source of input is ALECs operating in the area. Their customer records are transmitted to the SOP, often through a secure access system (or "firewall") , in NENA standard format (Current standards are NENA-2 or NENA-3).

The third source is Private Switch ALI (PS/ALI) systems. These systems identify telephone stations behind PBX's and will be covered in more detail later. PS/ALI systems also transmit their records in NENA standard format.

The SOP processes the inputs and uploads the customer records to the ALI DMSs (database management systems). Usually, two "mirror image" ALI DMSs are deployed with redundant and diverse communications links. (Diversity + Redundancy = Reliability)

The ALI nodes transmit the telephone number-to-Emergency Services Number (TN-ESN) assignments to the 9-1-1 tandems. The ALI nodes also process ALI queries from the tandems (for Integrated PSAPs) and the Conventional PSAPs.

1. Load the customer record:
   732-555-6366 = John Q. Public
   4 Skiles Ave
   Phillipsburg, NJ

2. Compare address to MSAG:
   1-500 Skiles Ave = ESN 2640

3. Send to Tandem:
   732-555-6366 = ESN 2640

As discussed earlier, the first job in building an accurate selective routing system is the creation of the MSAG. Once the MSAG is complete and verified, database loading can begin.

When the customer record is loaded into the ALI database, (and this process is the same for ILEC, CLEC and wireless) the customer address is compared to MSAG. If the address does not match the MSAG, the load process stops and the record is returned to the originator. Either the customer address is wrong and must be corrected, or the MSAG is wrong and must be updated.

If the address does match the MSAG, the ESN for that address is assigned to the record and a message is sent to the selective routing database with the telephone number-to-ESN (TN-ESN) assignment. The selective routing database is usually resident in the tandem, but may be in an outboard processor or even in the ALI database.

ALI Database System and Selective Routing

4. Already in the E9-1-1 Control Office:
      ESN 2640 = PSAP 718
      F1 = Police number/Secondary PSAP
      F2 = Fire number/Secondary PSAP
      F3 = EMS number/Secondary PSAP
      1st Alt = PSAP A
      2nd Alt = PSAP B
      3rd Alt = PSAP C
      4th Alt = PSAP D
      5th Alt = 10 digit number

As part of the MSAG development process, the selective routing database has been loaded with (TN/ESN) assignments based upon the MSAG. These assignments include the Primary PSAP, the Selective Transfer Key assignments and Alternate Routing assignments.

Selective Transfer is the formal name of the feature that enables the use of the "Police", "Fire" and "EMS" transfer keys. As 9-1-1 calls are answered, they may be transferred to the dispatchers for the Police, Fire or Emergency Medical Services agencies listed on the ALI display, even though the agencies may change from one call to the next. Selective Transfer is like a speed dial button that is automatically reprogrammed with each incoming call. The feature gets its information from the ESN assignment in the selective routing database.

Depending on the network, and the extent of cooperation between PSAPs, the Primary PSAP may have one or more alternate answering points. These alternates may be other PSAPs or 10 digit numbers. Alternate routing normally takes place automatically when the PSAP is busy, set inactive (Night Service) or out of service.

Each PSAP should have at least one alternate PSAP. Additionally, depending on the 9-1-1 tandem, alternate routing assignments can be associated with either PSAPs or ESNs. A PSAP may have all of its calls routed to the same alternate PSAP, or may route calls to several alternates based on originating ESN.

ALI Delivery

Deliver Customer Record Plus the Agency File:

Customer: 732-555-6366   (time)   (date)
               JOHN Q. PUBLIC
               4 SKILES AVE
               PHILLIPSBURG TOWN   NJ
               Pilot # 732-555-6366   LEC BelAt

Agency: PHILLIPSBURG POLICE ESN 2640
               P'BURG PD   908-454-1121
               P'BURG FIRE   (number)
               P'BURG EMERG SQD (number)

We've discussed how the ESN is used to facilitate Selective Routing, Selective Transfer and Alternate Routing within the selective routing tandem. It is also used again by the ALI database system during ALI delivery.

The agency information for each ESN (called the Agency File or English Translation), which includes the names (and, in some systems, phone numbers) of the PSAP, Police, Fire and Emergency Medical agencies, is the same for every subscriber located in that ESZ. It would not be efficient to include this data in each customer record - it would require more memory than really needed.

When a 9-1-1 call is made, the caller's ANI is used to query the ALI database. The telephone number accesses the customer information, which includes the ESN. The ESN is then used to access the Agency File. When the ALI is transmitted to the PSAP, it arrives as a single transmission, but is actually data from two separate files, sent to the PSAP in a prescribed format. These ALI PSAP displays come in as many different formats as there are PSAPs. The display pictured above is but one version of a format.

The other benefit to storing the agency data in its own file, is that agency data can be changed with the modification of a single file. If a Rescue Squad closes and another takes its place, or if a town using the State Police creates its own Police force, we only have to change the Agency File once, as opposed to changing thousands of subscriber records.

Database Warning Messages

```
*CAUTION*   POSSIBLE TDD CALL
*CAUTION*   CELLULAR CALL
*CAUTION*   PAY PHONE
*CAUTION*   PBX CALL
*CAUTION*   CENTREX CALL
*CAUTION*   OFF PREMISES EXTENSION
*CAUTION*   FOREIGN EXCHANGE
*CAUTION*   OUTGOING LINE ONLY
*CAUTION*   COMMUNITY CENTREX
```

Where used, Database Warning Messages are triggered by the subscriber's Class of Service and can be displayed on the first line of the ALI display. Normally, they are displayed in inverse video to get the call taker's attention. The ASCII "bell" control character (BEL) may also be sent as part of the warning message. This causes the ALI display device to emit a bell sound or tone, if equipped to do so.

Database Warning Messages indicate to the call taker that special handling procedures may be required for this call:

"POSSIBLE TDD (TTY) CALL" indicates that the caller subscribes to the discount telephone companies offer to hearing and speech impaired people who need a TTY to communicate. It does NOT mean the caller is definitely using a TTY. (Remember: All silent calls should be treated as possible TTY calls, regardless of Warning Message.)

"OFF PREMISES EXTENSION, PBX CALL, CENTREX CALL, and COMMUNITY CENTREX" messages remind the call taker to use extra care in confirming the location of the caller, since they may not be at the address shown on the ALI display.

"OUTGOING LINE ONLY" tells the call taker that the line used to make the 9-1-1 call cannot be called back. Check the Pilot Number and confirm with the caller. This incoming call restriction also applies to many pay phones.

"FOREIGN EXCHANGE" is dial tone from a distant central office.

PBX Interconnection (PS/ALI)
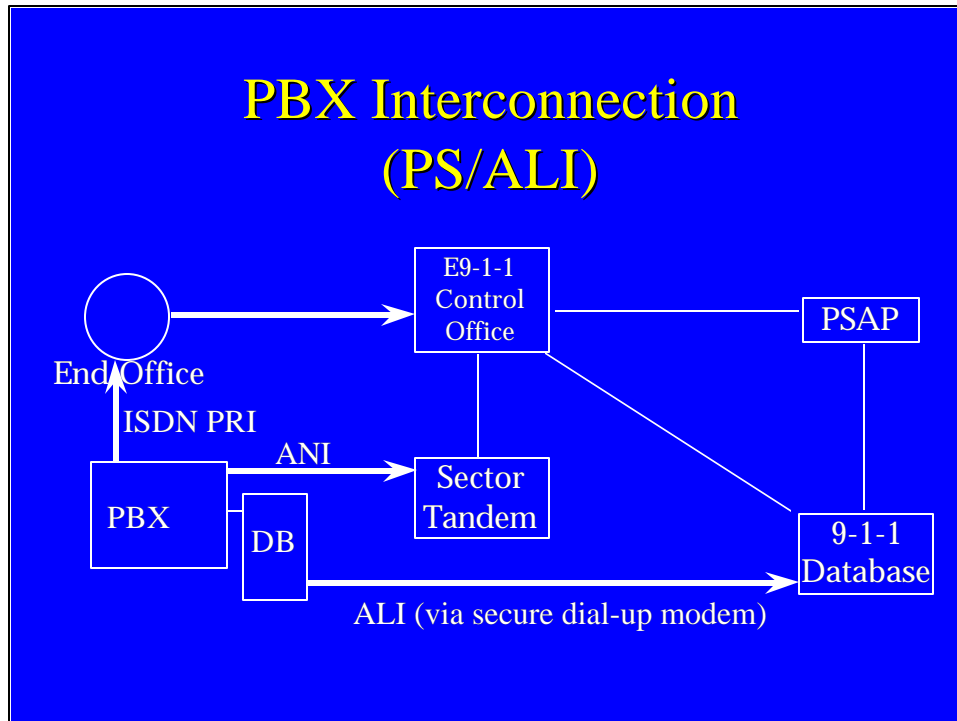
PBXs (Private Branch Exchange) create a special challenge for 9-1-1. Telephone stations behind a PBX don't normally have unique telephone numbers, and even if they did, the telephone company operating the 9-1-1 ALI database may have no idea what they are, and the PBX owner may not be obligated to tell them. 9-1-1 calls from PBXs will route to the PSAP that serves the address where the PBX is and only identify the PBX trunk used to make the call. The individual station is unknown. PS/ALI changes the way 9-1-1 calls are handled from a PBX.

First, directory numbers (typically Direct Inward Dialing [DID] numbers) are assigned to the PBX stations. The PBX owner is responsible for creating customer records, preferably in NENA standard format, that identify caller locations. These records are usually uploaded to the 9-1-1 SOP/MS via secure, dial-up modems. Essentially, PBXs use the same interface as ALECs.

Second, one of two network connection types is established. For newer PBXs, a Primary Rate ISDN connection can be used. The beauty of this service is that it can handle normal incoming and outgoing calls, but will generate individual ANIs for 9-1-1 calls. These calls enter the 9-1-1 network over the regular end office trunks.

For older PBXs, an adjunct unit is installed that uses dedicated 9-1-1 trunks that connect the PBX directly to the 9-1-1 tandem, or to a telephone company end office or sector tandem. Calls arrive at the PSAP with the customer-created ALI. Adjunct units are made by Telident, Proctor, Xtend and others.

ALEC/CLEC/TC/LSP

- Wireline local exchange carriers
- One switch may serve an entire state
- ANI failure default by county
- NRF default by rate center (NXX)
- Number Portability

In most states, ALECs are required to connect to 9-1-1 tandems in a similar, if not identical, fashion to the incumbent LEC.

Where mated or backup 9-1-1 tandems are deployed, ALECs typically build a pair of diversely routed trunk groups per county. One trunk group is built to the primary 9-1-1 tandem that serves the particular county, and the other is built to the mated or backup 9-1-1 tandem. Either trunk group should be large enough to provide a P.01 grade of service by itself. It is also desirable to have diversified paths within each trunk group, where practical.

If the call cannot reach the primary 9-1-1 tandem due to a facility or tandem problem, the call can be automatically re-routed (route advanced) to the backup or mated tandem.

In the event of an ANI failure, calls are routed to a designated default PSAP for that county.

If the ANI is delivered but not recognized (no ALI record), the call may default based on the NXX code, which identifies the rate center. Right now, all LECs have dedicated NXX codes per rate center. This "default by NXX" will work until local (and later, geographic) number portability begins to significantly degrade accuracy by rate center. At that point, default routing must be based on trunk group only.
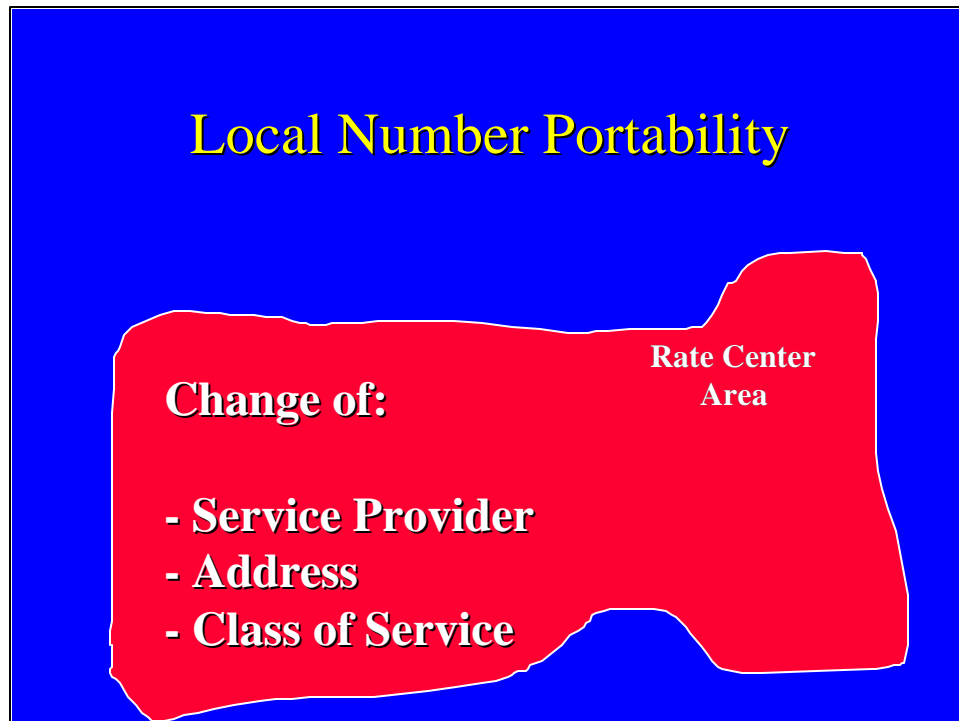
Interim Number Portability

- Moves a customer to a new carrier using a new TN, with the old TN forwarded to the new TN.

Local Number Portability Using Interim Number Portability

INP requires 2 switch numbers; the original customer's number and a new one at the new carrier. Calls to the original customer number are remote call forwarded to the new carrier number, where the customer has been provided new service by the new carrier. This technique has no direct effect on outbound 9-1-1 calls. However, it is desirable to display both the new ANI number and the old alternate number at the ALI screen, in order to lessen potential confusion about the caller's actual callback number.

INP transitions to full LNP, where the caller has only the original number, which is literally moved or `ported' to the new carrier's end office switch.

Local Number Portability

Change of:

- Service Provider
- Address
- Class of Service

Rate Center Area

Local Number Portability is the ability to allow an end user to change their Service Provider without having to change their telephone number. This eases complications for the customer by allowing choice of local exchange carrier without requiring a number change.

Local Number Portability has three variations:

- Service Provider (change of local service provider)

- Location (move to a different address)

- Class of Service (change type of service, such as from wireline to wireless)

The geographic location of the number is limited to the Rate Center. A database dip from the switching system to a special LRN (Local Routing Number) database will occur to determine where to terminate a call (to what switch). 9-1-1 originated calls are not affected, since the originating central office sends these calls to its dedicated 9-1-1 trunk group.

What does LNP do to 9-1-1 service?

Inconsistent with original E 9-1-1 design - drives new requirements for call routing control and data base management

Impacts of LNP on 9-1-1

- Caller's TN (or ANI) information remains
  unchanged

- Different Company ID & record responsibility in
  ALI Database

- PSAP needs access to or an updated list of
  Company IDs, 24X7 telephone numbers, and contact
  persons at carriers

- PSAP will see addition of Company ID code on ALI
  screen display

- PSAP needs acccess to the NPAC IVR system, which indicates what
   company owns each ported TN

Rate Center Consolidation

The expansion of Rate Center boundaries to allow use of NXXs in a wider geographic area.

With Rate Center Consolidation, multiple traditional Rate Centers are formed into a new single Rate Center, or consodlidated.   This allows a given NXX's 10,000 TNs to be utilized across a wider geographic area, and delays the need for new NXXs to be assigned.

If this is done within the service boundaries of an E 9-1-1 Selective Router switch, the main impact on E 9-1-1 service is a significant complication in the management of call routing in the end office (class marking) and in default call control at the Selective Routing switch (ANI failure and No Record Found conditions).   Class marking in the end office is typically a manual process, and error prone in comparison to mechanized Selective Routing control. And, when an NXX is no longer limited to a small geographic area, default call control at the NXX level for No Record Found Selective Routing situations is negatively impacted. This forces attempts to identify a PSAP to become the call taker for default calls across a much wider geographic area than before, with associated liability and call handling time concerns.

Number Pooling

- NXX - 1000 to 1999 ⟶ Telco A

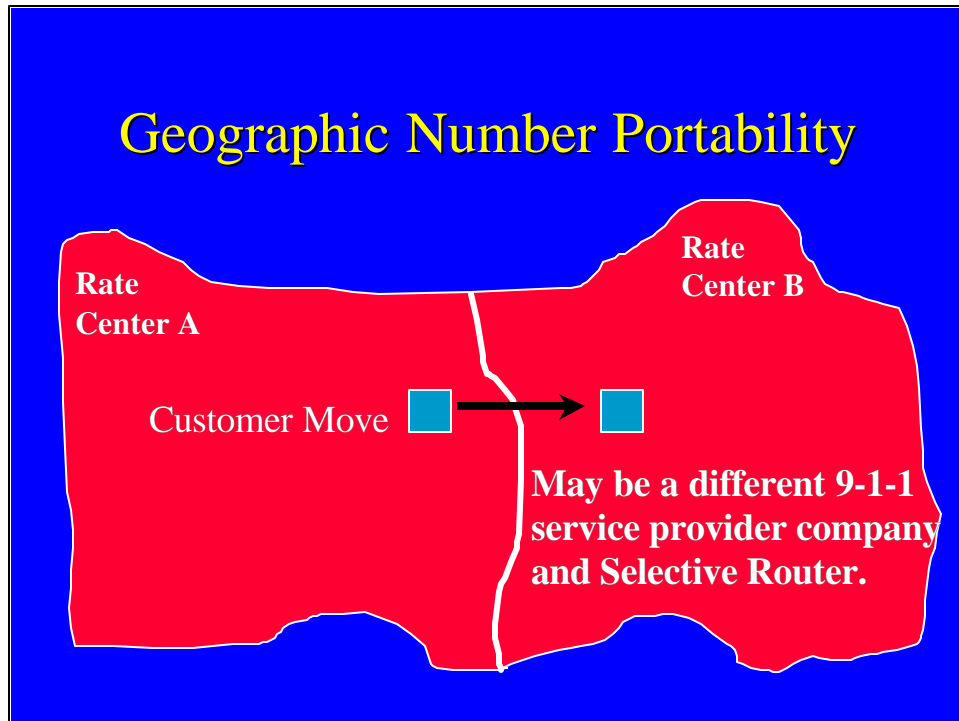- NXX - 2000 to 2999 ⟶ Telco B

- NXX - 3000 to 6999 ⟶ Telco C

Number Pooling

This is a number conservation technique to make better use of available NNX number sets among carriers, so that requirements for new NPAs can be delayed. Basically, rather than a whole NXX of 10,000 numbers being assigned to a single carrier, each 1000s group is available for assignment to different carriers. This makes more efficient use of the number sets if service needs for a given carrier do not require all of the thousands groups from a full NXX.

Contaminated Number Pooling

- NXX thousands group ownership change where some numbers are already in use.

`Contaminated' number pooling is a term used to describe a case where a 1000s number set is already in minimal use by a carrier, but a decision is made to reassign that 1000s group to another carrier. The general rule of thumb is that a 1000s group where the carrier is using less than 10% of the numbers can be available for reassignment. When this is done, the original carrier must use number portability techniques to `bring their in-use numbers back' to their records. No impact on 9-1-1 data base is involved, since the customer has not changed and the Company ID has not changed.

Geographic Number Portability

Rate Center A

Rate Center B

Customer Move

May be a different 9-1-1 service provider company and Selective Router.

Geographic Number Portability

Geographic Number Portability is currently defined as number portability across more than one Rate Center, or the application of an NPA-NNX telephone number set among more than the Rate Center area originally assigned under the national numbering plan.

The implications for 9-1-1 include the need for additional end office to Selective Router trunk groups so that the originating end office can send calls to different 9-1-1 Selective Routing switches, based on the address of the caller. Under the current design of E 9-1-1 switching control, added trunking is forced. When 10 digit ANI for 9-1-1, and Intelligent Network components are available for use in 9-1-1 service, some of these additional requirements will be eased.

Since the customer could move to a different SR operated by a different 9-1-1 service provider, significant data base coordination will be involved for geographic number portability.

PSAP EQUIPMENT (CPE)
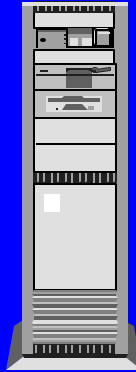
9-1-1 ANI/ALI CONTROLLER

Equipment that is located at the customers location (on-premises) is usually called Customer Premises Equipment (CPE). The term "CPE" normally covers all equipment related to the receipt of a 9-1-1 call. Some of the common equipment considered to be CPE are ANI / ALI displays, printers, TDD/TTY equipment and telephone answering equipment.

PSAP EQUIPMENT (CPE)

9-1-1 TRUNKS

9-1-1 ANI/ALI CONTROLLER
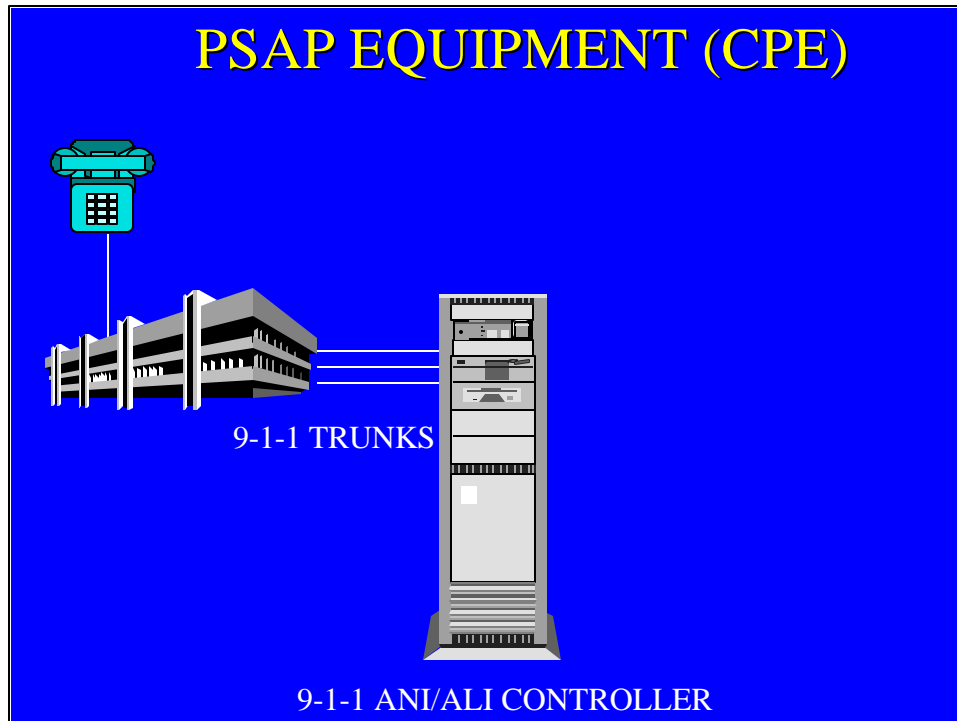
When a caller dials 9-1-1, the call is routed through a serving end-office, 9-1-1 tandem office, then to the PSAP. Trunks attached to the 9-1-1 ANI/ALI Controller are often called Emergency Management (EM) trunks. ANI and voice are delivered to the PSAP over these trunks.

PSAP EQUIPMENT (CPE)

REMOTE ALI DATABASE

9-1-1 ANI/ALI CONTROLLER
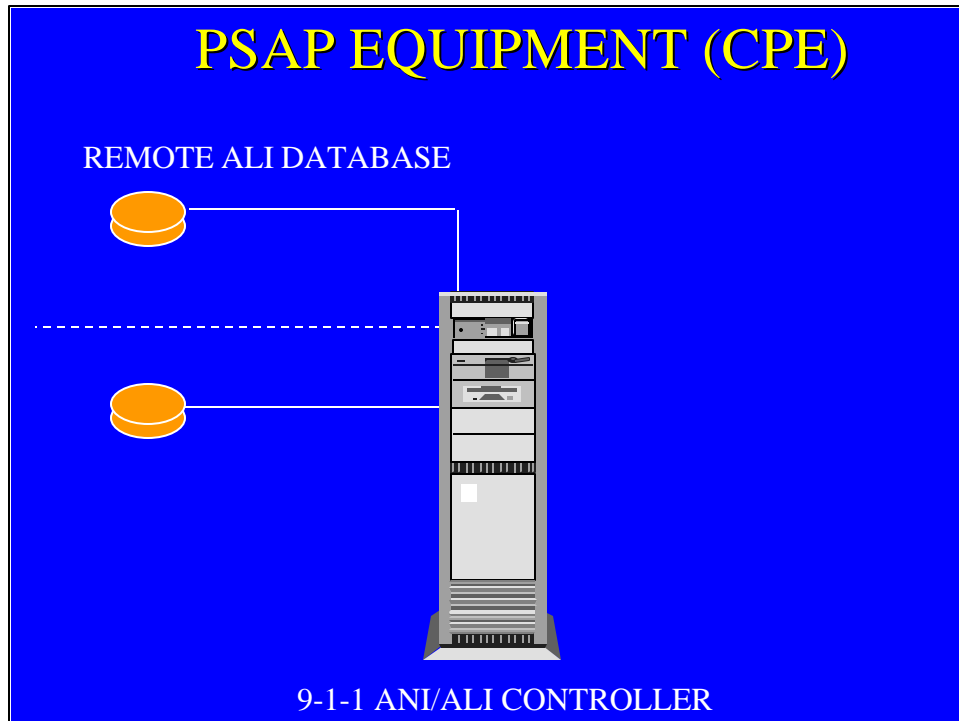
There are multiple interfaces on the ANI/ALI Controller. The following slides will go through the different interfaces and equipment attached to the 9-1-1 controller.

When ANI is received, the controller sends the number (ANI) to a database for an ALI look up. Typically, there are two data links going to redundant and diverse databases.

This drawing shows two diverse databases that are located off premises.

PSAP EQUIPMENT (CPE)

OFF SITE ALI DATABASE   ON SITE DATABASE

9-1-1 ANI/ALI CONTROLLER
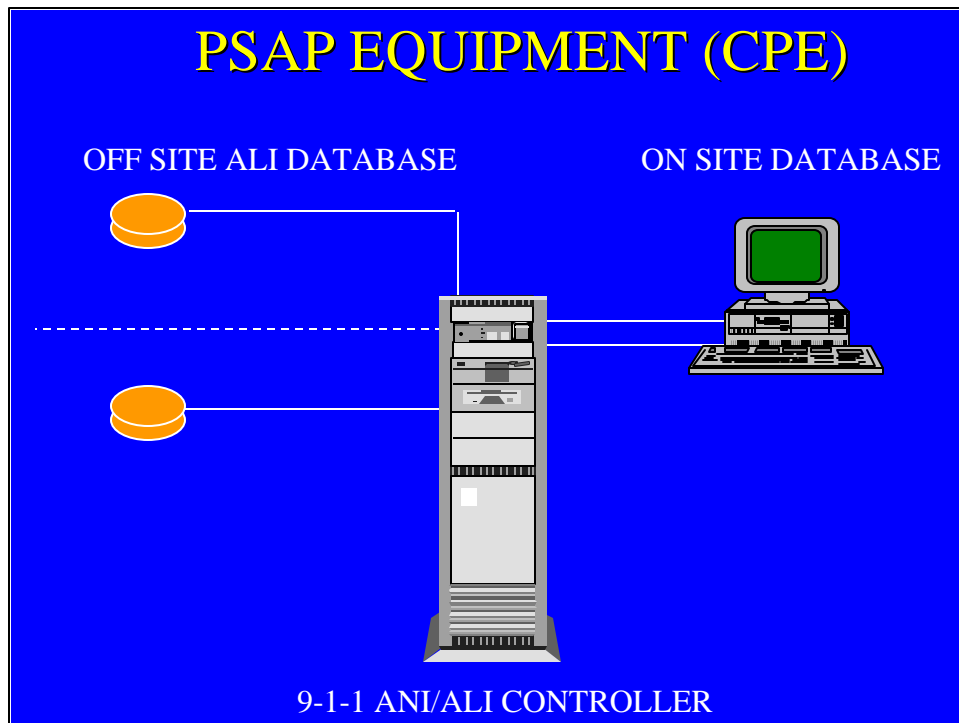
Some PSAP have an on-site database. Updates are sent via a dial-up or private line data circuit.

There are sites that may have connections to more than one data base. This arrangement may be required where there is more than one service provider.

PSAP EQUIPMENT (CPE)

ANI / ALI DISPLAY

TELEPHONE ANSWERING SET

9-1-1 ANI/ALI CONTROLLER
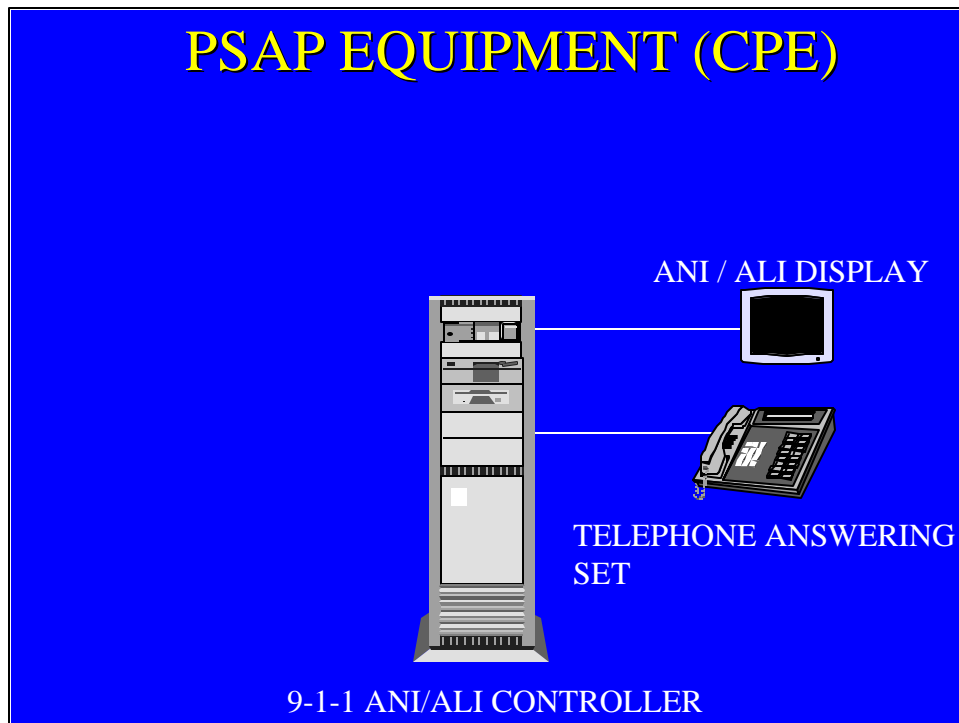
Each answering position has a Telephone Answering Set and an ANI / ALI Display connected to the controller.

PSAP EQUIPMENT (CPE)

REMOTE ANI / ALI DISPLAY

ANI / ALI DISPLAY

TELEPHONE ANSWERING SET

9-1-1 ANI/ALI CONTROLLER
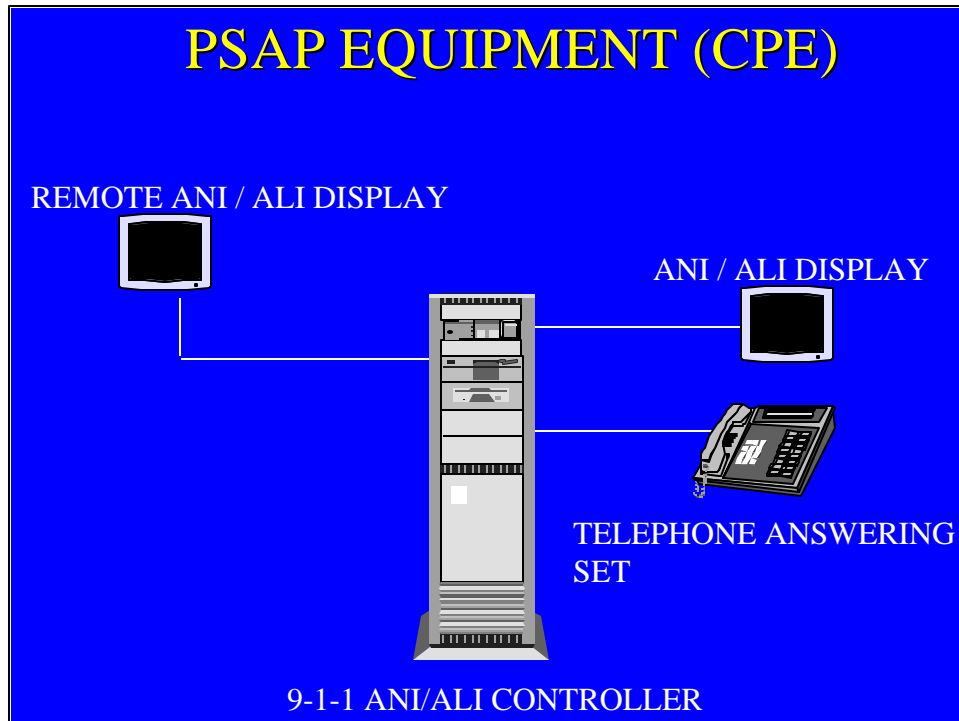
There may also be a remote ANI/ALI display. Call data can be sent to a remote location via a dial-up or private line data circuit. Typically, remote ANI/ALI displays are located at Fire Stations, EMS or other non 9-1-1 dispatch centers.

PSAP EQUIPMENT (CPE)

INTEGRATED WORKSTATION

ANI / ALI DISPLAY

TELEPHONE ANSWERING SET

9-1-1 ANI/ALI CONTROLLER
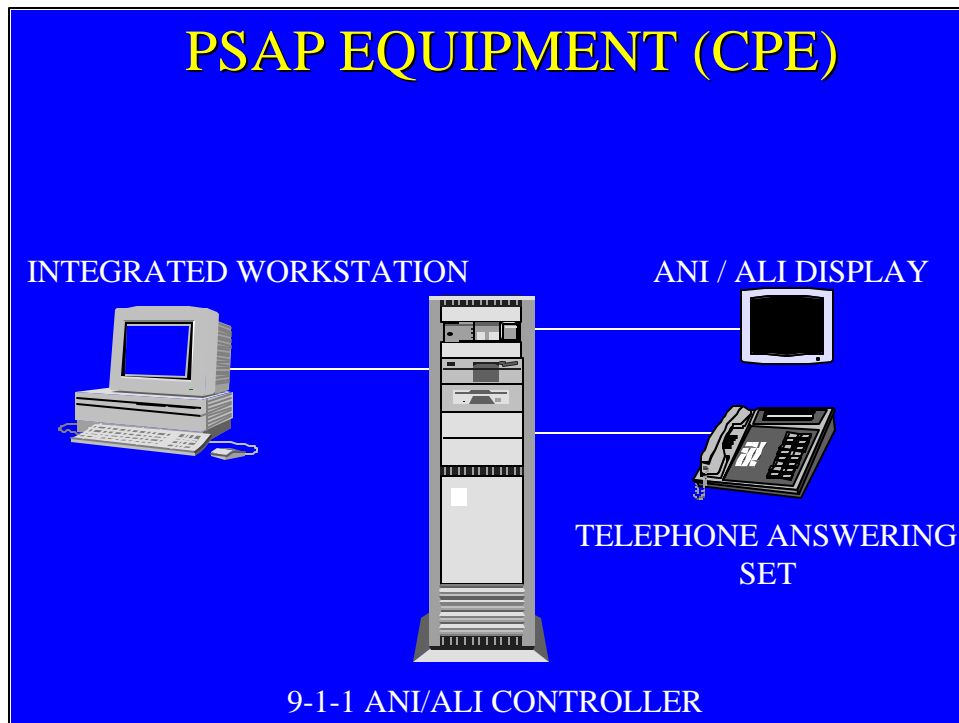
ANI/ALI Displays, Telephone Answering Sets and other call taker interfaces may be part of an Integrated Workstation. Integrated Workstations may also be called an Intelligent Workstation (IWS).

PSAP EQUIPMENT (CPE)

TELEPHONE / RADIO INTERFACE

TELEPHONE ANSWERING SET

ANI / ALI DISPLAY

INTEGRATED WORKSTATION

9-1-1 ANI/ALI CONTROLLER
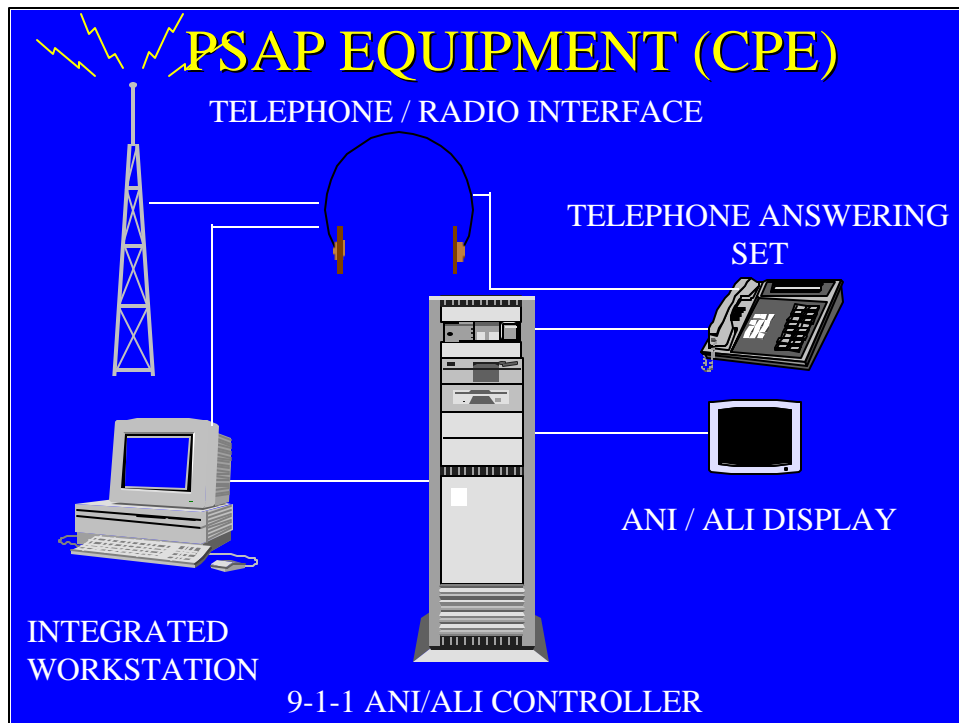
A Telephone/Radio Interfaces allows a call taker or dispatcher to wear one headset and communicate via both radio and telephone. Typically, radio traffic is present on the headset until a call is answered or placed via the telephone set. When the call taker or dispatcher is on the phone radio traffic is usually diverted to an external speaker on the radio. If the transmit is pressed on the radio while a call is in progress, the telephone transmitter is muted.

PSAP EQUIPMENT (CPE)

INTEGRATED WORKSTATION

ACD

ANI / ALI DISPLAY

ACD ANSWERING SET

9-1-1 ANI/ALI CONTROLLER
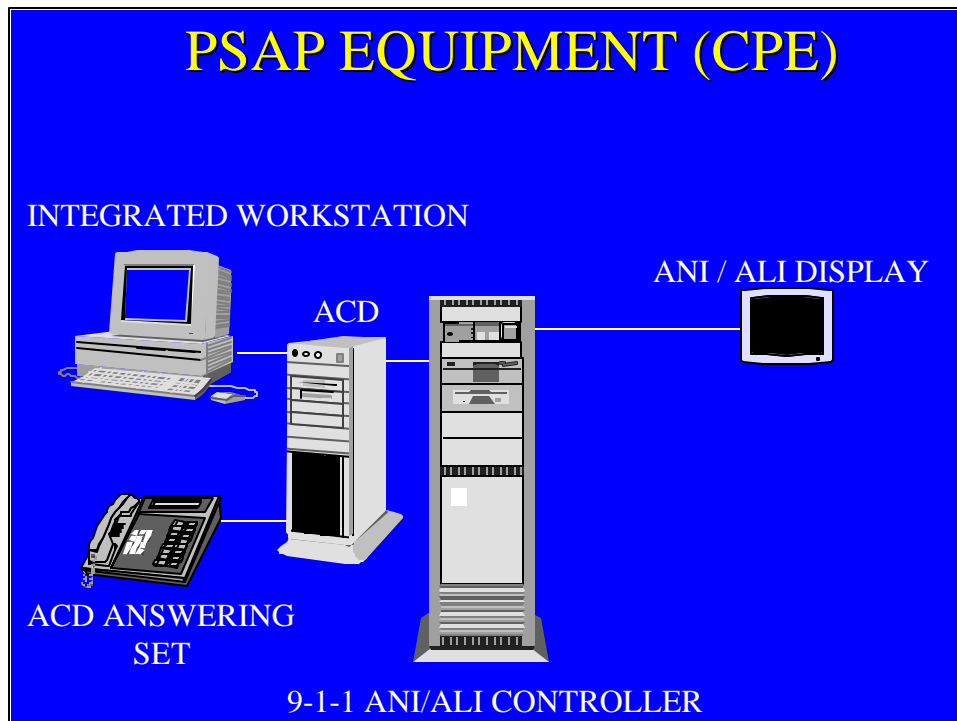
An Automatic Call Distributor (ACD) allows calls to be routed automatically to an available call taker. The ACD may be integrated with a workstation or may be located off premises in a central office, with a workstation at the PSAP. ACDs are normally only found in larger, high call volume PSAPs, although some smaller PSAPs do use ACDs.

PSAP EQUIPMENT (CPE)

MASTER RECORDER

9-1-1 ANI/ALI CONTROLLER
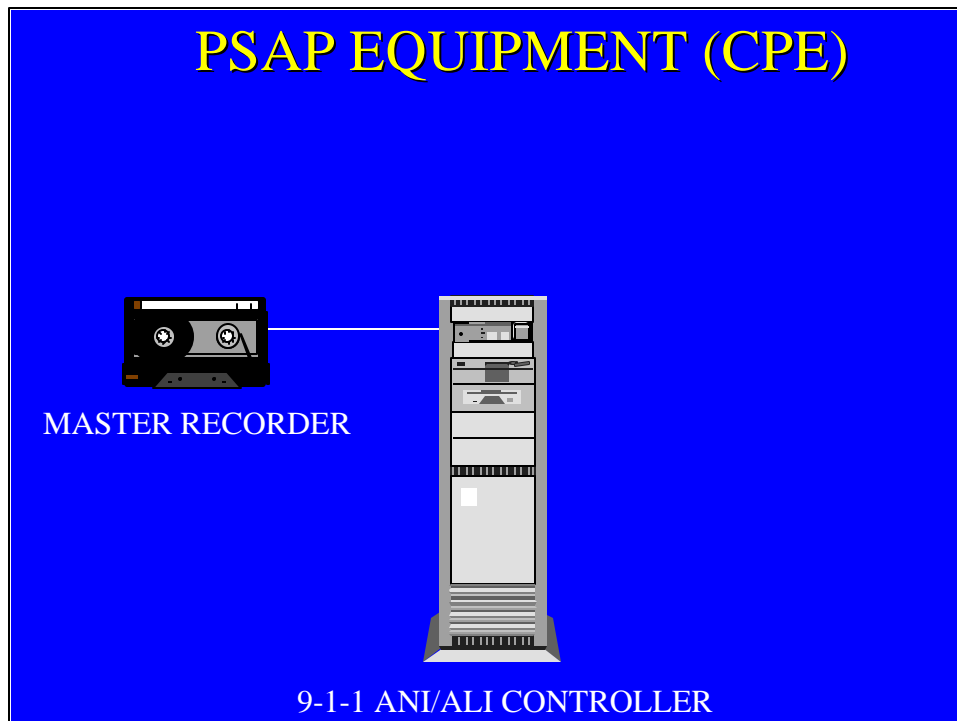
Master Recorders are used to record all calls and radio traffic in the PSAP. Master recorders have multiple channels that can be set up to record each line on a telephone, each position's telephone, each radio channel or a combination of the different interfaces. In addition to the master recorder, instant recall recorders may be placed at each position to allow the call taker to instantly listen to previous few minutes of telephone calls or radio traffic.

PSAP EQUIPMENT (CPE)

COMPUTER AIDED DISPATCH (CAD)
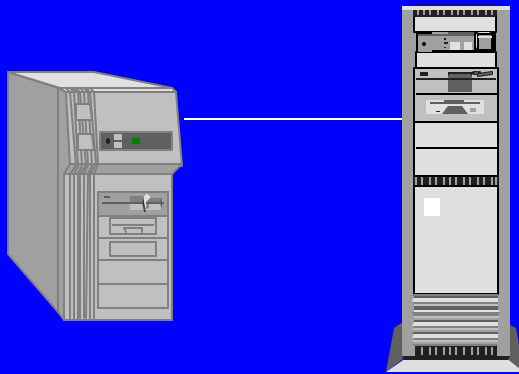
9-1-1 ANI/ALI CONTROLLER

The 9-1-1 controller sends the call takers position ID and ALI information to the CAD system via an asynchronous ASCII interface.

The Computer Aided Dispatch (CAD) system is used to log call information, track fire, police, EMS or other units that are dispatched or available. Some CAD systems can automatically assign units depending on the location of the call and automatically send the call to a CAD terminal in the unit being dispatched. The CAD terminal may be a separate terminal or integrated into an Intelligent Work Station.

PSAP EQUIPMENT (CPE)

MASTER PSAP CLOCK

88:88
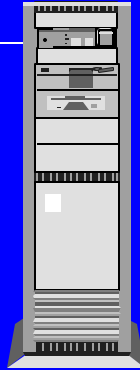
9-1-1 ANI/ALI CONTROLLER

To insure consistency of time stamps added to event records, reports and voice recordings, a common time stamp source is required to synchronize equipment such as CAD, ANI/ALI controllers, voice recorders, radio ronsoles, etc..

The Master PSAP Clock is traceable to Coordinated Universal Time (UTC).

The Master PSAP clock provides outputs for RS-232 serial and Inter Range Instrument Group (IRIG) interfaces.

Additional master clock information is available in the "NENA PSAP Master Clock Standard" (NENA-04-002) document.

PSAP EQUIPMENT (CPE)

CALL DETAIL
REPORT PRINTER

MAINTENANCE
PRINTER

9-1-1 ANI/ALI CONTROLLER
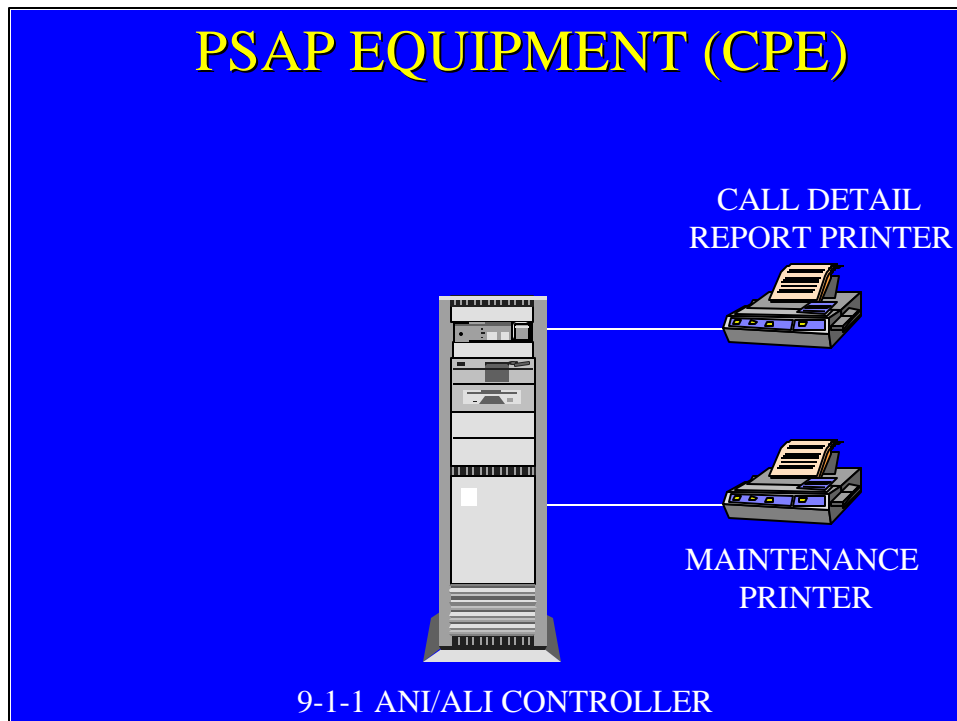
Call Detail Report Printer (CDR) - The CDR printer provides a hard copy of call time stamps, ANI received, ALI received, trunk number call was presented to, position number that answered call and call disconnect time.

Note: The output may vary between the different PSAP manufacturers.

Maintenance Printer - The maintenance printer provides a hard copy of system alarms, call progress messages, system status messages and may also provide call count reports.

PSAP EQUIPMENT (CPE)

TDD EQUIPMENT
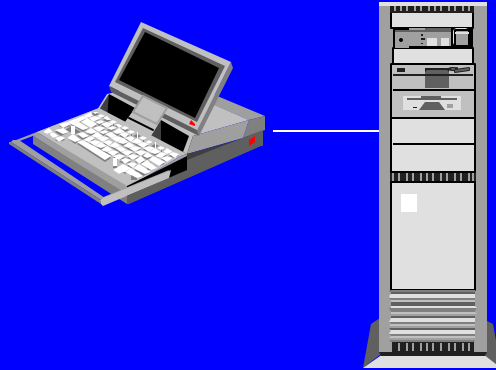
9-1-1 ANI/ALI CONTROLLER

TDD/TTY equipment is used to communicate with the hearing and speech impaired. The TDD/TTY equipment may be:

• integrated into the 9-1-1 controller,

•attached to an interface on the telephone answering set,

•integrated in an Intelligent Work Station,

•directly connected to the emergency lines,

•acoustically coupled to a handset,

•a stand-a-lone unit with dial tone attached.

PSAP EQUIPMENT (CPE)

•AC POWER
•AC LIGHTNING PROTECTION
•UPS
•EMERGENCY GENERATOR

AC POWER
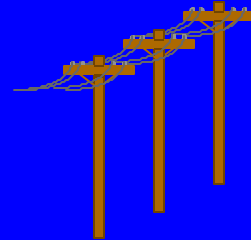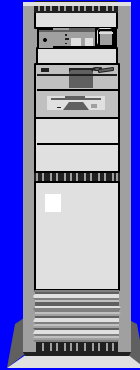
9-1-1 ANI/ALI CONTROLLER

When a new PSAP site is being planned or a site review is performed, the AC power and protection is a critical area. In addition to the "normal" AC power, UPS (uninterruptable power source) and an emergency generator should be considered.

There are at least two different configurations for the emergency generator:

•Automatic start - When AC power is lost the generator automatically starts and provides the AC power.

•Manual Start - When AC power is lost someone has to manually start the generator and switch the AC panel to the generator.

•In both cases, power is disrupted until the generator is on line. If an in-line UPS is installed, the UPS provides uninterrupted power in the event AC power is lost. Normally, batteries in the UPS will provide power until the generator can be brought on line. Larger UPSs or additional run time can be added to an existing UPS if desired.

Different levels of AC surge protection are available. Primary protection can be installed at the main AC service panel, AC sub panel, or at the wall outlet. AC surge protection helps to prevent an AC over voltage surge or ground fault from damaging equipment in the PSAP.

PSAP EQUIPMENT (CPE)

THE FUTURE THAT IS HERE TODAY
- 10 DIGIT ANI
- 20 DIGIT ANI
- LOCAL NUMBER PORTABILITY
- ISDN
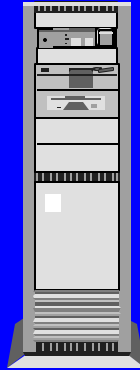
9-1-1 ANI/ALI CONTROLLER

The future is here today. PSAP directors have to deal with 10 and 20 digit ANI, LNP and ISDN.

Some existing 9-1-1 controllers is not capable of accepting 10 and 20 digit ANI. Equipment upgrade or replacement will be required.

Additional database links may be required to receive ALI for ported callers. Additional 9-1-1 trunks may be required from an alternate provider's 9-1-1 tandem office.

There are multiple interfaces and equipment requirements that require standards to ensure all the piece parts will work together. The NENA Generic Standards for E9-1-1 PSAP Equipment (NENA-04-001) addresses these interfaces and provides manufacturers with an industry standard.

Wireless 9-1-1 Today
9-1-1 "Routing"

"9-1-1"   MSC   10 Digit DN   Access Tandem

Cell

E9-1-1 Control Office

PSAP

9-1-1 Database
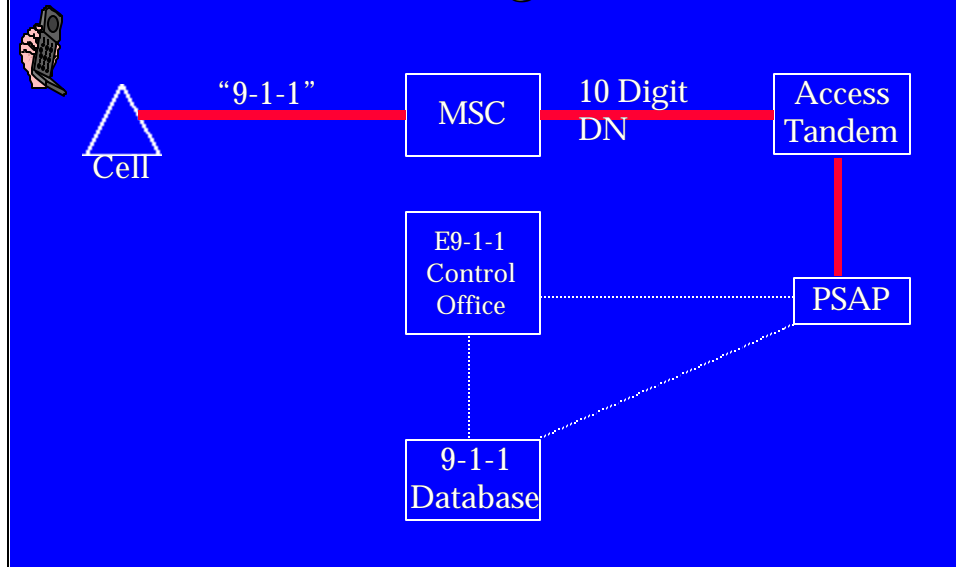
In most of North America, 9-1-1 calls from wireless phones are treated as if 9-1-1 was a speed dial code - 9-1-1 is translated by the Mobile Switching Center (MSC, the wireless equivalent of a central office) to a preset 7 or 10-digit number. Calls bypass the 9-1-1 network and arrive at the PSAP via the public switched telephone network. Some wireless carriers are now offering Caller ID, but typically, there is no information delivered with the call.

**Integration Begins.
Pseudo ANI (Phase Zero/.5)**

"9-1-1" — MSC — 908-250-1234 — Access Tandem

Cell

E9-1-1 Control Office

PSAP

9-1-1 Database
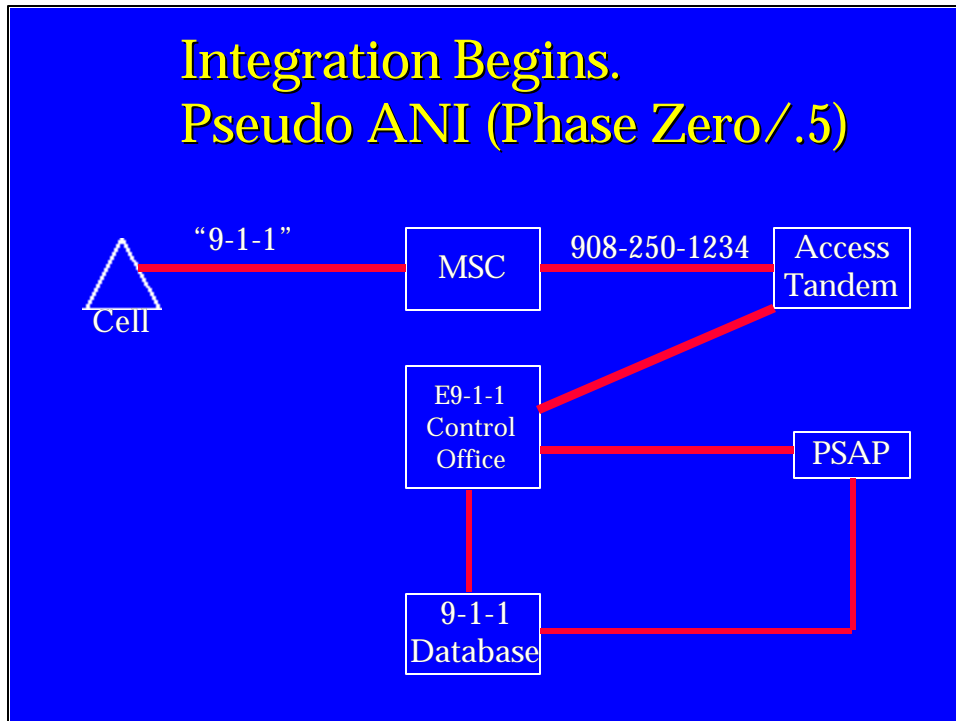
The use of pseudo numbers was discussed earlier as a method for telephone operators to access a specific PSAP based on the municipality of the caller.

Another way pseudo numbers, or pseudo ANIs (pANI) are used is to identify the cell tower and sector from which a wireless 9-1-1 call originated. In fact, this was the first use of pANIs.

In most circles, the term pANI has been replaced with ESRD (Emergency Services Routing Digits) or ESRK (Emergency Services Routing Key), depending upon the implementation.

The typical wireless (cellular or PCS) antenna is triangular. Each face of the triangle is called a sector. The wireless MSC is aware of which sector the call originated from and is capable of translating 9-1-1 to a unique number based on that information.

By associating a unique pANI with each sector, the 9-1-1 tandem can be programmed to send calls from a specific cell sector to a specific PSAP. Since the pANI is unique, a "pseudo-ALI" record can be built in the ALI database that identifies the carrier, location of the cell and a general description of its serving area. This may include latitude/longitude of the tower; serving radius; compass bearing of sector; perhaps even a free form text description.

The location data still leaves much to be desired, but at least the PSAP knows the call is from a wireless phone and has a "hint" of what area the call came from.

This "hint" is sometimes referred to as the caller's "general location". This is a gross overstatement. To most people, "general location" means "at the mall", or "at the park". The area may actually be as large as 26 square miles.

Integration, "Phase One"
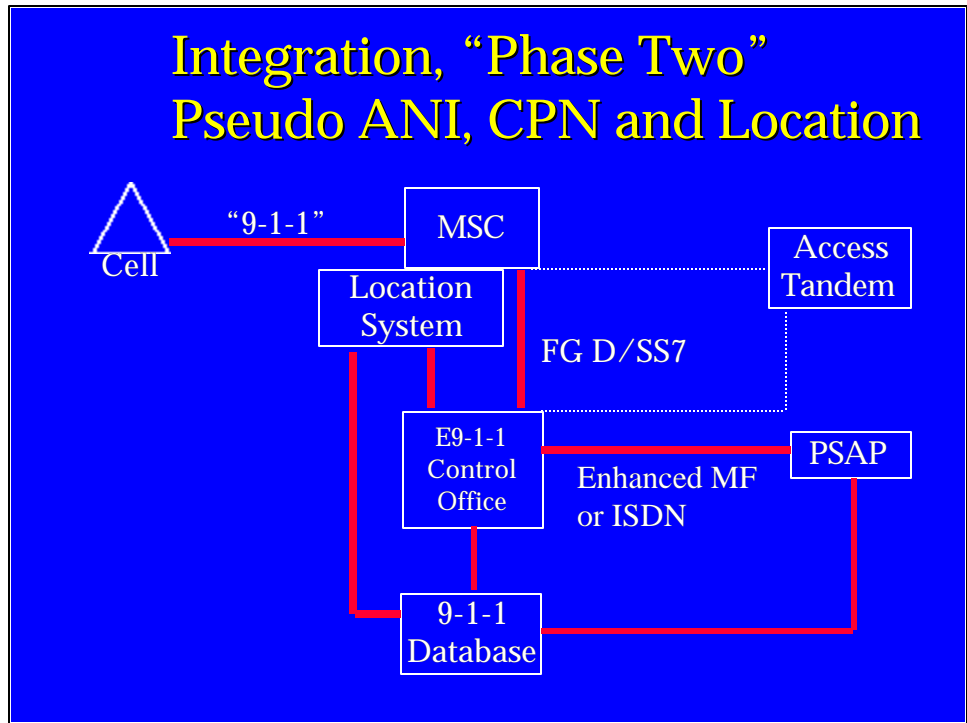Pseudo ANI + CPN
Call path Associated Signaling
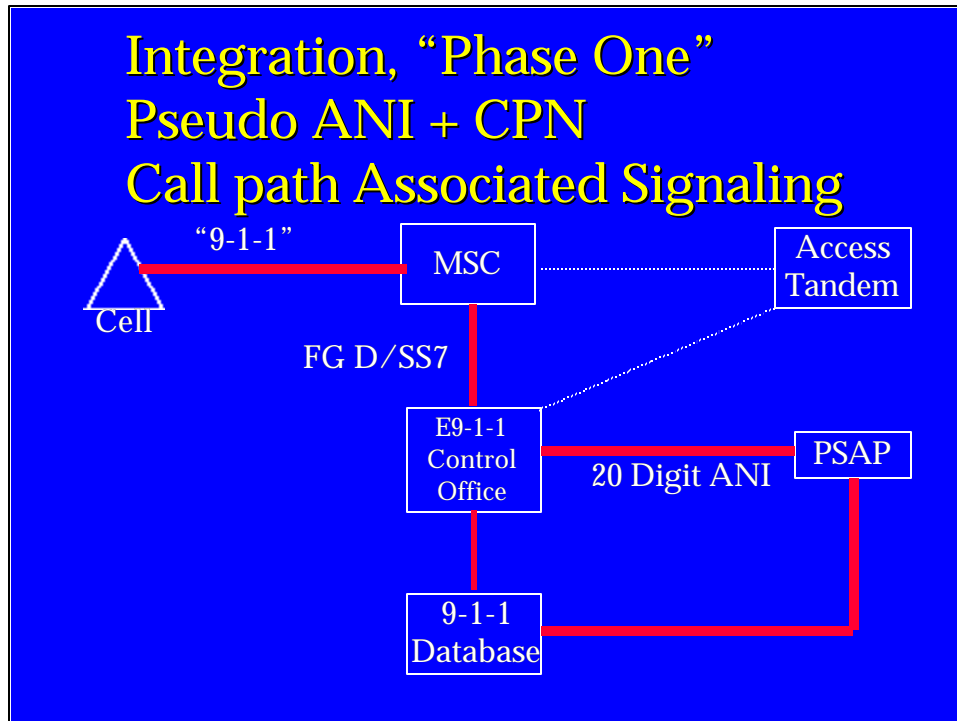
FCC Report and Order 96-264 requires that wireless 9-1-1 service be provided in two stages. Phase I, which carried a target date of April 1, 1998, calls for the delivery of cell/sector information, as discussed on the previous slide, plus a callback number for the mobile phone.

To accomplish this, the pANI plus the callback number must be delivered to the PSAP. However, the voice trunks typically used for 9-1-1 until now are only capable of delivering one, 8-digit number (NPD plus 7 digit ANI).

There are two choices for trunks that can carry two, ten-digit numbers from the MSC to the 9-1-1 tandem. Signaling System 7 (SS7) is the digital version and Feature Group D signaling (also referred to as Enhanced MF) is the analog version. Selection of one method over the other is based upon the capabilities of the two switches.

The signaling method between the 9-1-1 tandem and the PSAP also has to be upgraded to carry a minimum of 20 digits. The digital method, used today in a very small number of pilot PSAPs is ISDN. The analog version, developed by the NENA Network Technical Committee, is called Enhanced MF Signaling. This method is now being supported by all the major switch and CPE manufacturers.

Once the two numbers are delivered to the PSAP, the pANI is used to query the ALI database for the cell/sector data, and the callback number is displayed to the call taker on the ANI display.

Integration, "Phase Two" Pseudo ANI, CPN and Location

Cell — "9-1-1" — MSC

Location System

Access Tandem

FG D/SS7

E9-1-1 Control Office
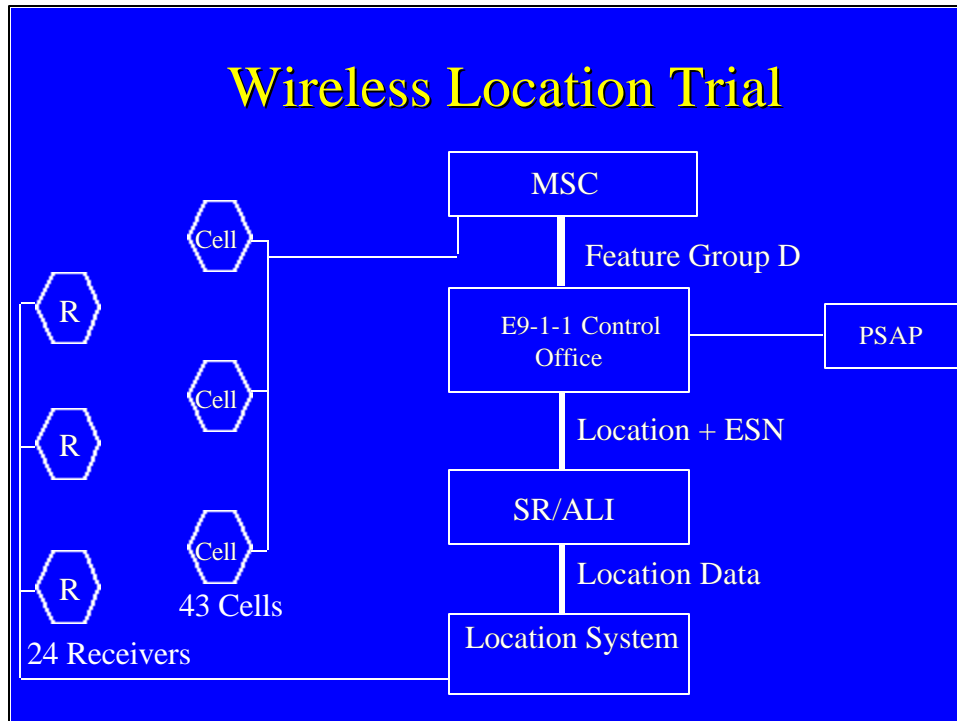
Enhanced MF or ISDN

PSAP

9-1-1 Database

In Phase II, the caller's X and Y coordinates, with accuracy requirements set by the FCC, are delivered with the call. That data may come from location determination technology (LDT) associated with the wireless network, or directly from the handset. In either event, the location data must be delivered to the 9-1-1 tandem to be used for Selective Routing of the call. That delivery may be direct or via the ALI database.

For network based location systems, the accuracy requirement is within 100 meters 67% of the time and within 300 meters 95% of the time. For handset based location systems, the accuracy requirement is within 50 meters 67% of the time and 100 meters 95% of the time.

One of the advantages of SS7 is that it is capable of delivering pANI, callback number and coordinates with the voice call. Other methods require separate delivery paths for location data. Delivery to the PSAP may be via ISDN or through the ALI database

Wireless Location Trial

MSC

Cell

R

Feature Group D

E9-1-1 Control Office

PSAP

Cell

R

Location + ESN

SR/ALI

Cell

R

Location Data

43 Cells

24 Receivers

Location System

This slide shows the architecture of a wireless location trial that kicked-off in January of 1997.

Location receivers identified the location of the wireless 9-1-1 caller. That information was passed to a selective routing/ALI system which translated X,Y coordinates to ESN.

The SR/ALI system sent the ESN and pALI record to the 9-1-1 tandem. The tandem routed the call, which arrived at the tandem on Feature Group D type trunks with pANI and callback number, to one of three PSAPs based on the ESN provided by the SR/ALI system. A workstation at the PSAP drew a map of the area, complete with an "X marks the spot" for the X and Y coordinates delivered.

Wireless Location Trial

Wireless ANI/ALI

609-342-5678　　　09:30:25　　　01-22-97

COMCAST CELLULAR COMMUNICATIONS

000000　　　　　　　　　U S ROUTE 40

　　　　　　　　　　　　　　RT

RADIUS 5 MILES

ELMER BORO　　　　　　　　　　XX

39-35-51N   75-10-28W

DIR 124   SPEED 048　　　　　　CELL

ROAM NO 302-740-7626　　　　ESN 5397

SALEM COUNTY COMMUNICATIONS

ELMER POLICE DEPT　　　　　935-0057

ELMER FIRE DEPT ST-21　　　　358-8881

ELMER AMBULANCE　　　　　358-8881

This slide shows a sample of the ALI delivered during the trial.

The warning message "Wireless ANI/ALI" identifies the call as coming from the trial area.

The callback number has been inserted into the telephone number field on line 2.

The street address data refers to the cell tower, but the latitude, longitude, direction and speed are associated with the caller.

The roam number is provided for the PSAP to use in calling back travelers that have "roamed" into the area (if required).

Notice that the state field shows "XX" instead of "NJ". Sometimes, cells are located on top of or next to buildings. Because the coverage area of the cell may extend into multiple jurisdictions, calls from the wireline phones in the building may need to route to one (municipal) PSAP while wireless calls from that cell need to go to another (county or state) PSAP. Since both have the same street address, which would result in the same ESN and PSAP assignment, we sometimes "fool" the network by creating an MSAG entry that uses the same street and municipality address, but uses the state of "XX". To the MSAG, this is a completely different ESZ and gets its own ESN.
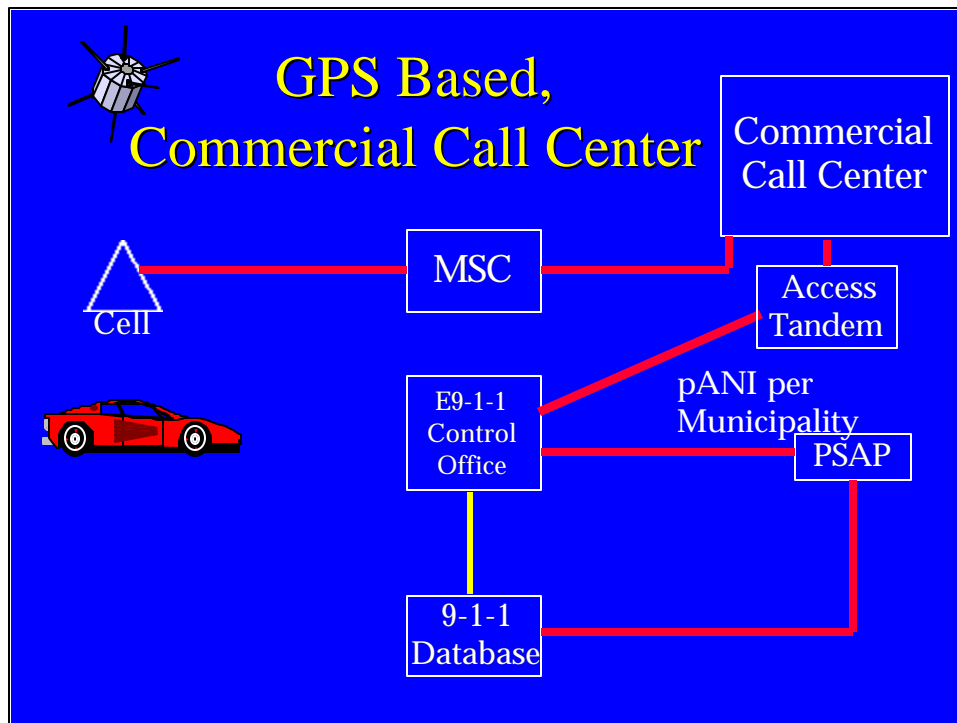
Non Call path Associated Signaling
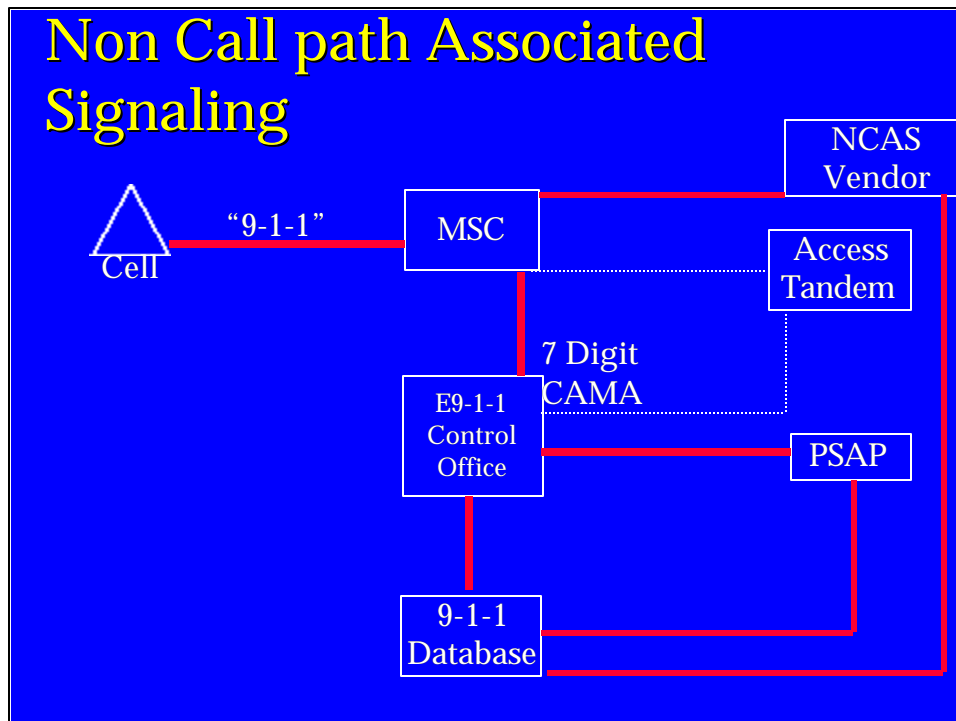
The delivery of pANI and callback number via SS7, Feature Group D signaling, ISDN and Enhanced MF is called "Call path Associated Signaling", or CAS. With CAS, the pANI that identifies the cell/sector and the callback number are delivered to the PSAP with the voice call.

An alternative is NCAS, or "Non-Call path Associated Signaling". NCAS was devised as a method to deliver the same information to a PSAP that could not afford upgrades to the selective router and PSAP, or where the selective router and/or PSAP were not upgradable. Instead, an upgrade is made to the ALI database to accept call related data from an outside source, "on the fly", for delivery to the PSAP.

When a wireless 9-1-1 call is placed, the MSC queries the third party vendor for routing information. The NCAS vendor supplies a routing number which is transmitted as a pseudo-ANI to the 9-1-1 tandem. This number may identify the cell/sector; may be one of a block of numbers associated with a cell/sector (ESRD); or may be one of a block of numbers that only identify the destination PSAP or ESN (ESRK). When the receiving PSAP queries the ALI database with that number, the pALI record and callback number, supplied by the vendor, is delivered to the PSAP.

The positive about NCAS is that it does not require upgrades to the 9-1-1 tandem and PSAP CPE, which may be expensive. The negatives are that the ANI delivered with the call may mean nothing if the ALI does not arrive, and that it supports wireless but does nothing for number portability or area code exhaust. ISDN and Enhanced MF support all three through the delivery of one or two full ten digit numbers.
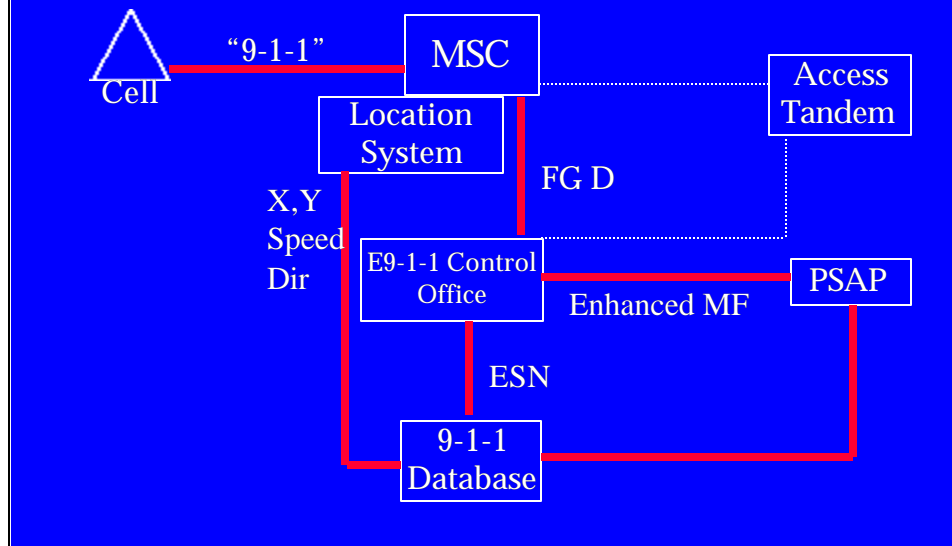
GPS Based, Commercial Call Center

Commercial Call Center

MSC

Cell

Access Tandem

E9-1-1 Control Office

pANI per Municipality

PSAP

9-1-1 Database

Another group that has entered the wireless 9-1-1 arena are the "Commercial Call Centers". Systems like Lincoln Rescu and GM OnStar use a specially designed cellular telephone equipped with a Global Positioning Satellite (GPS) receiver. When a button in the vehicle is pushed, the cellular phone dials an 800 number to access the service bureau. Once connected, a microcomputer in the vehicle transmits GPS location data plus vehicle identification data. At the service bureau, call takers use a GIS system to identify the caller's location and local emergency services.

Remember the pseudo numbers used by operators to access specific PSAPs based on the caller's municipality? These same numbers can be used by the Commercial Call Center to connect to the PSAP that serves the municipality where the GPS/GIS systems have located the caller.

The real beauty of this system is that the pseudo numbers are associated with the municipality, not the PSAP. PSAPs can open, close, expand or consolidate but the municipal pANIs stay the same. If the PSAP for a town changes, that change is made in the 9-1-1 network. No changes are required at the Commercial Call Center. Never again will service be delayed because a relay service or operator service was not advised of a change in PSAP assignment and dialed a directory number that went to intercept.

Another benefit is that the call arrives at the PSAP as a 9-1-1 call, which guarantees priority handling over administrative lines.

CAS/NCAS Hybrid
Phase II Wireless 9-1-1

```
        "9-1-1"        MSC                      Access
 Cell                                           Tandem
               Location
               System
                              FG D
    X,Y
    Speed   E9-1-1 Control                        PSAP
    Dir         Office      Enhanced MF
                   ESN
                 9-1-1
                 Database
```

Another scenario under consideration for deliver of Phas II service is a CAS/NCAS Hybrid. The Hybrid uses a CASarchitecture for delivery of Phase I service but delivers caller location data in an NCAS manner.

Feature Group D type or SS7 trunks will carry the voice call, pANI and callback number to the 9-1-1 tandem. The tandem will forward the two numbers to the 9-1-1 database. Simultaneously, the location determination system will transmit the caller's coordinates, speed and direction of travel to the 9-1-1 database(s). (If SS7 trunks are utilized, the location data may be passed over the SS7 trunks, through the E9-1-1 Control Office to the 9-1-1 Database system.)

The 9-1-1 database will translate X and Y to ESN, and send the ESN to the tandem to be used for selective routing. The database will then retrieve the pALI (cell sector) record, insert the callback number and location data and wait for a query from the PSAP.

The tandem will use Enhanced MF Signaling to forward the voice call, pANI and callback number to the PSAP.

The PSAP then queries the 9-1-1 database using the callback number. The database delivers the record, with the caller's location data, to the PSAP.

A computer at the PSAP will display a map showing the caller's location.

What's Next?

- **Inter-networking**
  - 911 as an NXX
  - 9-1-1 User Needs

The implementation of Signaling System 7 across North America will present some new possibilities for 9-1-1. Two significant possibilities are; (1) the ability to transfer a 9-1-1 call, with ANI and ALI, to any PSAP in North America, and; (2) the ability to selectively connect to any PSAP from an operator position, emergency relay service or other authorized agency.

911 as an NXX

The NENA Network Technical Committee has petitioned the North American Numbering Plan Administrator to reserve 9-1-1 as an NXX code to be used for 9-1-1 inter-networking across North America.

Establishing 9-1-1 as an NXX in every area code yields 10,000 numbers in the form "NPA-911-0000 to 9999".

Each PSAP and each municipality would be assigned a unique number. The PSAP numbers would be used for PSAP to PSAP transfers. The municipal numbers would be used by authorized agencies (operators, relay services, poison control centers, medical insurance companies) to transfer callers to their respective PSAPs, based on the municipality in which they live. This represents the extension of today's pseudo numbers across the entire 9-1-1 community in North America.

Internetworking:
9-1-1 User Needs

- Transfer a 9-1-1 caller, with ANI and ALI, to any other PSAP.
- Transfer an emergency caller, with ANI and ALI from a Commercial Call Center to any PSAP.
- Transfer an emergency caller, with ANI, from a telephone operator to any PSAP.

PSAPs need the ability to transfer a 9-1-1 caller, with associated ANI and ALI, from one PSAP to any other, without regard to distance or network provider.

Terrestrial and satellite based wireless networks serve areas larger than PSAP jurisdictions. Attempted suicides sometimes require assistance from distant agencies. The elderly sometimes call their children instead of 9-1-1 when they need help.

Commercial Call Centers need the ability to transfer an emergency caller, with associated ANI, ALI and additional data (if available) to any PSAP in North America. Emergency calls from subscribers are answered at a single answering point. Examples: Lincoln Rescu, GM OnStar, MCS, Cross Country.

Telephone operators need the ability to transfer emergency callers, and their associated ANI, to any PSAP. ILEC telephone operators sometimes have direct access to 9-1-1 networks. This is not true for ALECs or long distance carriers. Sometimes, in their panic, people dial "0" or "00".

This proposal envisions the SS7 network as the vehicle with which to deliver 9-1-1 transfer capabilities. It assumes the eventual universal provision of 9-1-1 service via SS7, in an IN (Intelligent Network) or AIN (Advanced Intelligent Network) environment.

All locations capable of initiating or receiving transfers must be connected to the SS7 network. Only specified locations (PSAPs, Private PSAPs and telephone operators) would be able to initiate a transfer. The general public would not have access to NPA-911-XXXX.

Methodology

Assign each PSAP in North America a directory number in the form NPA-911-XXXX. A directory will be maintained by NENA.

These numbers would be used by one PSAP to transfer calls to any other PSAP. The ANI and ALI associated with the emergency caller would be transferred with the call and displayed at the receiving PSAP.

Assign each municipality in North America a pseudo-ANI in the form NPA-911-XXXX. A directory will be maintained by NENA.

These numbers would be used by Private PSAPs, ILEC operators, ALEC operators and long distance operators to transfer emergency callers to a PSAP based upon the municipality from which the call originated. The call would arrive at the PSAP with the caller's ANI and an ALI message that indicates the call to be a three-way conference transfer of a caller at an unknown address in a specific municipality. Optionally, Private PSAPs will be able to forward location data.

Benefits

- Calls arrive as 9-1-1 calls
  - ANI/ALI   - Priority
- Transfer call anywhere
  - Wireless crosses county and state lines
  - Suicides   - Elderly

- Commercial Call Centers / Operators
- Transfer based on municipality
- No need to know PSAP
- No updates to distribute

All calls transferred in this fashion arrive at a PSAP as a 9-1-1 call, providing information about the caller and receiving priority handling. Calls delivered to administrative directory numbers receive no priority and carry no data.

Wireless (Cellular, PCS) calls from cells that serve more than one PSAP jurisdiction could be easily transferred to neighboring PSAPs, even across state lines. This is of particular value for satellite based systems, whose footprints can cover several states.

Sometimes, people attempting suicide and elderly people with a medical emergency, call a friend or family member who lives in an area served by a different PSAP than their own. This system would enable a 9-1-1 call from the friend or family member to be transferred to the PSAP serving the victim.

Emergency calls received by Commercial Call Centers can be transferred to the PSAP serving a specific community. Since these numbers are associated with the municipality, as opposed to the PSAP, no updating of the numbers is required. As PSAPs close, consolidate or expand, the local 9-1-1 service provider redirects the numbers to the proper PSAP. There is decreased danger of emergency response being delayed because the Private PSAP is using an outdated directory.

Emergency calls to telephone operators - ILEC, ALEC and long distance - can be forwarded to a specific PSAP. As with Private PSAPs, the operator need only ascertain the municipality from which the call originated

Benefits

- Versus dedicated conventional directory numbers:
  - No need for NANP number resources
  - Additional Functionality
    - Call handling requirements
    - Access security
  - Cost Control
    - Less software development
    - Simpler implementation and administration

Versus dedicated conventional directory numbers installed at each PSAP:

> Relieves demand for additional NANP numbers. Since 911 is not in use as an NXX today, the demand for NPA-911-XXXX
> numbers places no demand on NANP number resources.

> Additional functionality requirements:

> The translations required to enable ANI/ALI to be forwarded to one conventional directory number, but not another, would be cumbersome and difficult to administer. Using 911 as an NXX immediately identifies specific call handling requirements.

> Easier to keep "private".

> Using 911 as an NXX enables simple screening to ensure use by authorized agencies only.

Versus using some other routable, but non-dialable numbering scheme:

> Some switches still cannot deal with NXX codes below "200." The only other codes available are the N11 codes. Since this is for access to 9-1-1 systems, why not use 911, which is already non-dialable as an NXX?

What's Next?

- Inter-networking
  - 911 as an NXX
- Advanced Intelligent Network (AIN)
 - 9-1-1 Without Tandems

Network 9-1-1
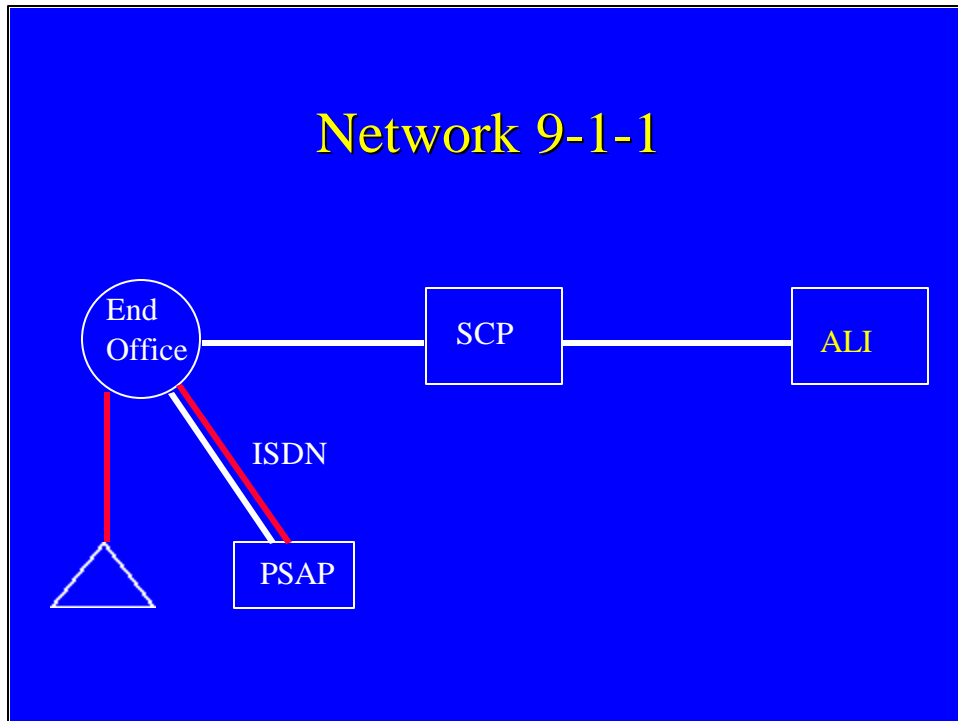
The public telephone network is evolving toward a model known as AIN or Advanced Intelligent Network. This is the architecture that will provide 9-1-1 service in the not too distant future.

In an AIN network, the functions of local central offices are controlled by Signal Transfer Points (STP, often implemented in the local central office) and Signal Control Points (SCP). These are computers that instruct the network switches how and when to construct, operate and delete network connections. AIN takes the architecture already being deployed with SS7, and adds additional intelligence.

The result is that end office switches require less intelligence and therefore become less expensive, and new features can be deployed faster since they are deployed in a much smaller number of SCPs.

For 9-1-1, AIN heralds several significant changes.

1. No more 9-1-1 tandems. The switching of 9-1-1 calls is handled by the end offices serving the subscriber and the PSAP, under the control of the SCP. The SCP tells the offices how to route the calls and what features to provide.

2. No more analog trunks. All trunks between end offices are digital SS7 trunks, which connect 40% faster with, virtually, zero ANI failures. PSAP trunks are digital ISDN (which means new CPE), carrying voice, ANI and ALI (including coordinates) to the PSAP all at once.

3. No more data links to the 9-1-1 ALI database. The databases still exist, but are connected to the SCPs, for selective routing and ALI delivery.

Full Network Design
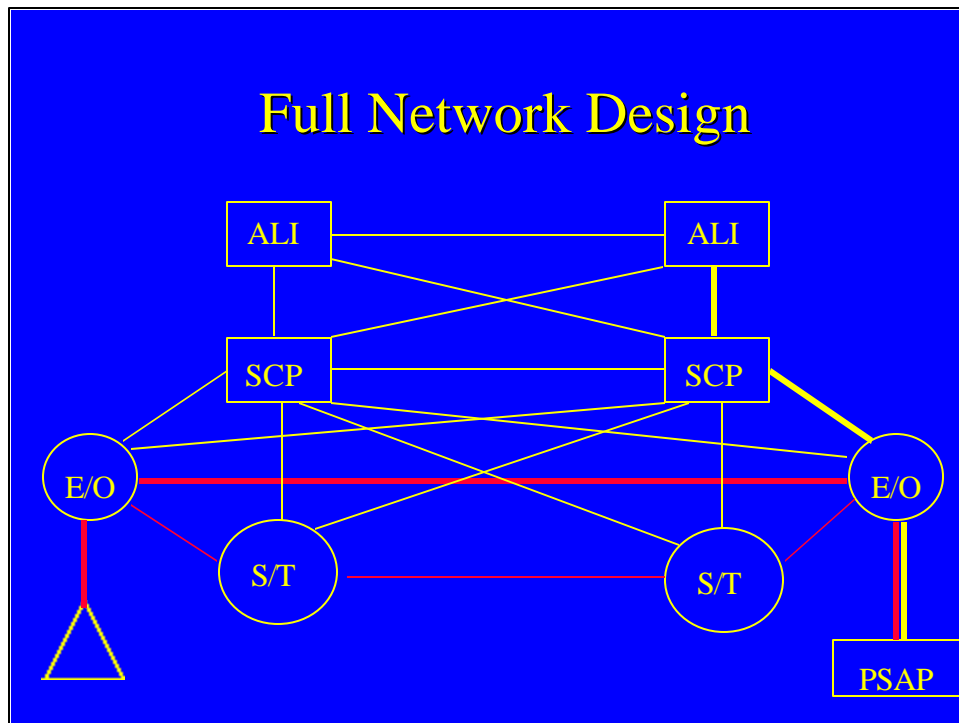
This diagram depicts a possible Advanced Intelligent Network configuration. The red lines represent voice paths (trunks). The yellow lines represent data paths over which call handling instructions and information may be transmitted. The drawing is intended to illustrate how the principles of redundancy and diversity could be applied in the delivery of "N9-1-1" (Network 9-1-1).

What's Next?

- Inter-networking
  - 9-1-1 as an NXX
- Advanced Intelligent Network (AIN)
  - 9-1-1 Without Tandems

- **Truly "Personal" Communicators**
  - Don't carry it...Wear it!
  - Implant it!

Most people agree that wireless is taking over the world. As of early 1999, there are about 62 million wireless phones in America, and the number is growing steadily.

Wireless phones have evolved, in a very short time, from vehicle based units, to transportable ("bag phones"), to portable, pocket-sized handsets. Nippon Telephone sells a small "wristwatch" unit with speakerphone and voice activated dialing. Move over Dick Tracy!

The trend will be toward personal communicators that are worn, with the ability to transmit personal telemetry. Imagine receiving a 9-1-1 call from a wrist-mounted wireless phone that transmits the caller's pulse, blood pressure, body temperature, plus personal medical history and home address! The technology already exists.

The next logical step is semi-permanent implantation. Perhaps an ear implant and a transmitter in a hollowed tooth? How about sensors implanted in strategic organs, providing a complete medical picture of a 9-1-1 caller?

Who knows what the future holds? Stay tuned!