Corporate Office
7820 McLaren Avenue
West Hills, CA 91304
Telephone: (818) 999-0980
Fax: (818) 999-0981
support@bellserviceswest.com
www.bellserviceswest.com

E9-1-1 Network Monitoring - More Than Just a Numbers Game

Today, PSAP managers are faced with an increasing diversity of technologies to handle, government requirements to meet, center consolidation plans to develop, and federal grant standards to adhere to. They are also supposed to reduce costs, improve performance, increase responsiveness and, in their spare time, walk on water. They do have a tool at their disposal that can help them manage some of these things: Network Analysis.

E9-1-1 Network management tools such as Reports, Alarms, Call Record and ALI Record analysis can be used to help manage Call Takers, Trunk resources, PSAP Equipment and resolve problems.

Specifically we will be discussing E9-1-1 trunking, ALI data network and Call Taker performance aspects of a PSAP, the concepts described below can apply to the Administrative lines as well.

E9-1-1 Network Designs

It is important to understand how the overall E9-1-1 Network works in order to analyze traffic reports, alarms, Call and ALI Records. Figure 1 shows the configuration of a traditional E9-1-1 network. When callers dial “911”, the local Network Switch routes the call to its E9-1-1 Tandem Switch via dedicated E9-1-1 Trunks. In order to identify the caller, the local switch passes the caller’s telephone number to the E9-1-1 Tandem. The E9-1-1 Tandem uses this number, provided by an ANI (Automatic Number Identification) system, to determine which PSAP the call should be routed to. Once this decision is made, the E9-1-1 Tandem connects the call to the appropriate E9-1-1 PSAP over its E9-1-1 Trunks. The E9-1-1 Tandem passes the ANI to the PSAP Equipment. The PSAP equipment uses the ANI to create an ALI (Automatic Location Identification) Query and passes it to the ALI Database over dedicated modem circuits. The ALI computer looks up the telephone number in its database and returns the caller’s location information as an ALI response. The PSAP Equipment then waits for a Call Taker to pick up the call. When a Call Taker picks up the call, the PSAP Equipment connects it to the Call Taker’s position and displays the ALI information on the Call Taker’s terminal. This process normally takes only a few seconds from when the caller dials “911” to when the Call Taker picks up the call.

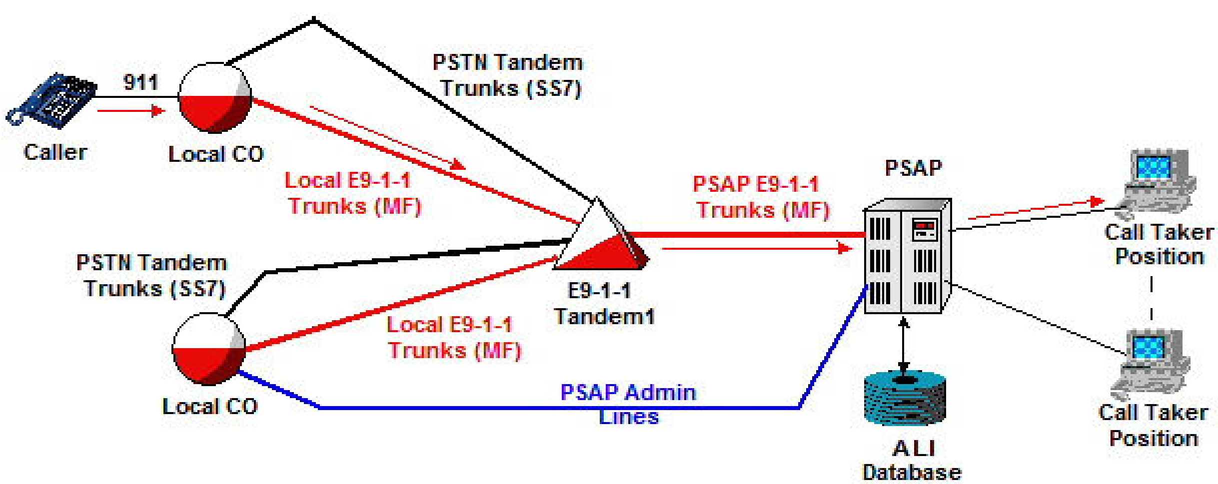

Figure 1 – Traditional E9-1-1 Network

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Fax: (818) 999-0981
support@bellserviceswest.com
www.bellserviceswest.com

E9-1-1 Wink Start MF Trunks

E9-1-1 trunks are unique. They pass what is now called Caller ID (ANI) information as Multi-Frequency (MF) digits. When a caller dials "911" and the E9-1-1 Tandem Switch selects an E9-1-1 PSAP trunk, the E9-1-1 Tandem seizes an idle trunk indicating it has a call. The PSAP Equipment detects the seizure and "Winks" back indicating that it is ready to receive the ANI digits. The E9-1-1 Tandem waits until it sees that "Wink" before it sends the ANI digits.

When a Call Taker picks up the call, the PSAP Equipment then seizes the trunk, answering the call. The Call Taker and the caller can now be connected. When the caller disconnects the call, the E9-1-1 Tandem first releases the trunk on its end and then PSAP Equipment releases its end of the trunk. The trunk is now idle again, ready for another call.

Trunk Groups

A Trunk Group consists of two or more trunks of the same type between two given points (E9-1-1 Tandem to PSAP).

There can be more than one Trunk Group from a given E9-1-1 Tandem to a PSAP. Figure 2 is a generic diagram showing a traditional PSAP that has three Trunk Groups from two different E9-1-1 Tandems. Tandem 1 has two Trunk Groups. One Trunk Group is for all Land Line Calls and the other Trunk Group is for all Wireless Calls. Tandem 2 only has one Trunk Group for Land Line calls.

Trunk Groups are used to carry calls coming from the same end office. The one exception to this rule is VOIP Calls. VOIP Calls typically use the same Land Line Trunk Groups that non-Wireless Calls use.

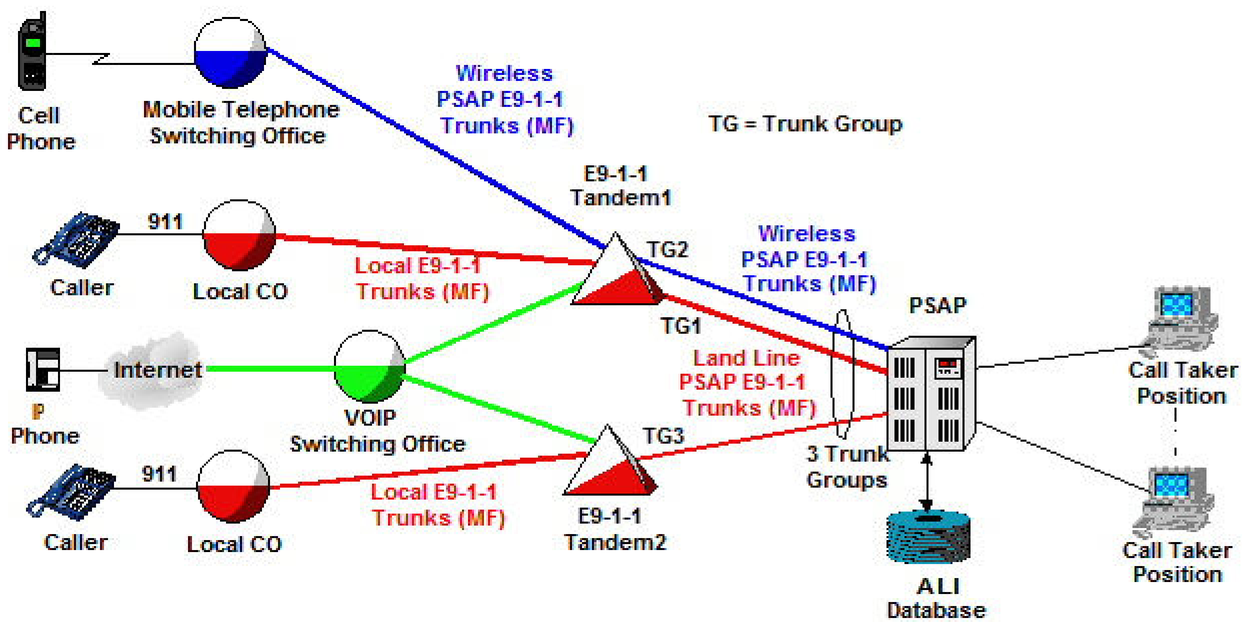

Figure 2 – Traditional E9-1-1 PSAP with Three Trunk Groups

It is very important that the PSAP manager know how many Trunk Groups they have and how many trunks there are in each Trunk Group. It is very easy to be misled into thinking that there are enough trunks to the PSAP by just looking at the total number of calls and the total number of available trunks. For example:

5 trunks carrying 50 calls an hour = 10 calls per hour per trunk or one call every 6 minutes

However, if there are two Trunk Groups and one Trunk Group carries 50 % of the calls and yet has only 40% of the total trunks, then this Trunk Group may be under trunked and some callers may be blocked. For example:

Total trunks = 5, Trunk Group 1 has 2 trunks and Trunk Group 2 has 3 trunk; both Trunk Groups get 25 calls per hour. Therefore, Trunk Group 1 gets one call every 4.8 minutes and Trunk Group 2 gets one call every 7.2 minutes.

Trunk Group 1 has a higher call rate than Trunk Group 2. Trunk Group 1 will reach an "All Trunks Busy" state sooner than Trunk Group 2 and could block calls. Knowing the Call Volume and Blocked Calls trend for both Trunk Groups independently will help determine if additional trunks are needed.

Selective Routers
Basically, Selective Routers use the ANI or pANI (pseudo ANI) to determine the ESN (Emergency Service Number) to be used for the call. An ESN is a unique combination of police, fire, and rescue services, which are geographically determined for purposes of routing the E9-1-1 call to the appropriate PSAP. PSAP Trunk Groups are associated with one or more ESNs. Selective Routers can also be used to interface SS7 trunks, replacing the old Wink Start MF trunks from the Local CO (Central Office). It is the selective Router that determines which PSAP a call is routed to. Typically, only ALI data contains the ESN used to route the call. Therefore, ALI data can be used to identify ESN Assignments in the Selective Router database.

Alternate Routing Strategies
Some Service Providers may offer Alternate Routing Strategies. Some of these strategies can overflow calls from one Trunk Group to another or overflow calls to Admin lines if the trunks in the Primary Trunk Group are all busy. This is a good idea for handling major event scenarios like traffic accidents, power failures, floods, hurricanes, etc. The one down side to this strategy is that it tends to hide trunking inefficiencies.

The View Depends Upon the Point of View
There are a number of "Network Elements" involved in an E9-1-1 call. Each of these network elements has a particular view of what is going on. For example, the PSAP Equipment can see the Network. It can see the incoming seizure and release. It can see the ANI digits, but it can't see the Selective Router or the Local CO ANI digits. It can't even see its own Wink. It assumes it sent the Wink, but it can't validate it. Similarly, the Network can't see the ANI digits; it can just assume they were sent. It is important to understand where the event information originates before analyzing the data. This is why "Finger Pointing" is so common between Service Providers and PSAP Equipment Vendors. Each thinks the other is wrong because "My switch always sends the ANI" and "My PSAP always sends a Wink." Well, there is an old telephone saying, "It's always that way, unless it ain't." Status information from switching equipment cannot always be relied on to provide accurate call event detection.

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There are basically three different views that can provide information about how calls are being handled.

Service Provider View – Can see the PSAP Equipment Wink, Seizure and Release. It cannot see the ANI spill, Network Seizure or Network Release.

PSAP Equipment View – Can see the Network seizure, Network release and ANI spill. It can also see the Call Taker position, call queues, ALI queries and responses. It cannot see the Wink, PSAP Equipment seizure and PSAP Equipment release.

Call Taker View – Can only see the incoming call and ALI data. They may know which trunk carried the call.

E9-1-1 Network Monitoring Strategies

There are both external and internal monitors that can be used to collect call information needed to analyze the performance of a PSAP.

Circuit Monitors

Circuit monitors are non-intrusively connected to the Trunk, Admin Line, Private Lines and ALI modem circuits. They detect and process **real time** voltage events, tuning them into call records and ALI queries and responses. By default, they may be able to capture the conversation in digital form. If required, the conversation can be played back from the collected data. The chief advantage of this type of monitoring is its independence from Network and PSAP Equipment blind spots. The chief disadvantage is the additional equipment costs and labor required to install the monitors – each trunk must be individually monitored. There is also the possibility of service interruption since the connections are half tapped onto the existing circuits. Circuit monitors are the only means available to document every event between the Network and PSAP Equipment – a truly unbiased view. This information is invaluable in resolving “Figure Pointing” problems.

Computer Telephony Interface (CTI)

CTI Ports are accessed via an RS-232 connector on the PSAP or CPE Equipment. A “Y” cable is connected to the RS-232 port and the monitoring equipment (usually a specially equipped PC) is connected to one end of the “Y” cable. CTI data typically consists of **near real time** call events (Trunk Seizure, Dialed Digits, Call On Hold, Call Queue Increment, etc.) used by the PSAP or CPE Equipment to handle the call. Like the Circuit Monitors, CTI monitors process these events, turning them into Call Records. CTI data does not typically contain any ALI information. The chief advantage of this type of monitoring is its ability to document equipment problems and Call Taker activities and its much lower cost since there is no need for each individual trunk to be monitored.

The CTI monitor only sees events the PSAP Equipment **thinks** it saw. It is a lot like letting the fox guard the hen house. Occasionally, a chicken is lost.

Call Detail Record (CDR) Port

Like the CTI Port, the CDR port is an RS-232 connection. It is also accessed via a “Y” cable. Unlike the CTI data, CDR data is created at the end of a call. It is typically a one line Call Record followed by the related ALI Record (E9-1-1 calls only). Admin calls just have the Call Record, without ALI information. CDR data can be read without processing it. The chief advantage of this type of monitoring is its relative simplicity and low monitoring costs. Its chief disadvantage is its lack of call event information. It is not real time and can hide events that could be used to identify troubles.

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ALI Modem Monitor

Some CDR records contain ALI Record information without physically monitoring the ALI Modem RS-232. Otherwise, the ALI Modem RS-232 must be monitored to get this important information.

A good ALI modem monitor will not only capture the ALI queries and responses, it will also monitor the RS-232 control leads. This is important because it is the only way to determine why the ALI modem failed. The chief advantage of this type of monitoring is its real time nature and the ability to alarm ALI modem failures. The chief disadvantage is that the ALI modems must be temporarily disabled, one at a time, to allow the placement of the monitor cable.

Knowing how the E9-1-1 Network works and where call data can be collected is just the first step. The real challenge is to use this information to analyze the PSAP operations.

PSAP Call Record, Call Event and ALI Data Sources

There are many different types of call data available to PSAP Managers. Sometimes this data is only available in canned reports and users do not have access to the raw call data. For the purposes of this section, it is assumed that the raw call data is also available and users can manipulate the data as needed.

CTI Port Data

CTI data contains a wealth of information about E9-1-1 and Admin calls, Call Takers, Call Queues, Positions, Trunks, Lines and CTI failures. Unfortunately, CTI data is usually formatted as a cryptic message that cannot be easily read. CTI data can be event driven data or complete mini Call Records. There is usually no ALI information provided.

CTI data suffers from two major problems:

1. In order to use the data for analysis and reports, it must be processed into Call Records.
2. Call Queue, Call Taker Actions and CTI Alarms need to be processed separately.

Once all the data has been processed and placed in a database, analysis can be performed and reports can be generated. The data by itself is too difficult to use as is. CTI data provides the most comprehensive PSAP information possible from one source.

CDR Port Data

There are many different formats and types of CDR data, though they all basically contain the same information. CDR data is usually "end of call" driven, that is, the CDR record is generated after the call is over. It is not real time or even near real time. CDR data consists of a Call Record for E9-1-1 and Admin calls and usually an ALI Record for E9-1-1 calls. It contains Trunk, Line and Call Taker Position information, but does not track Call Queues or Call Taker Activity (Agent Log On/Off. Wrap On/OFF, Agent Ready/Not Ready, etc.). CDR Call and ALI records do not have to be processed and can usually be imported directly into a spreadsheet or database table. However, the data must be manipulated many times before it can be used.

CTI/CDR Database

Many PSAP and CPE Equipment use a PC or Server to perform control and user interface functions. These controllers often maintain a limited Call Record and ALI Record database. If the PSAP manager can retrieve reports from the controller, then it must have some kind of database. Unfortunately, many PASP Managers are either unaware of the existence of the database or are intimidated by it. PSAP Equipment vendors or PSAP Maintenance Contractors often recommend not going into the database because "it could bring down the whole system". Though anything could happen, there are database access tools that prevent user access from interfering with normal database operation. After all, every time the PSAP Manager runs a report, the report generator is accessing the database and it doesn't bring down the system. Why? Because databases are designed to be accessed.

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Though database access can be very safe, it is not without costs. In order to access the data, the user must be familiar with ODBC (Open DataBase Connectivity) and SQL queries. Though this is not very difficult, it can be frustrating to users that are not familiar with databases. The effort is well worth it. Database access provides days, weeks, months or even years worth of call records. Within a short time, a PSAP can be benchmarked, trend data created and analysis performed. There is no need to wait months before enough call data has been collected to analyze.

PSAP Alarms

Alarms are an important means of alerting PSAP Managers to a condition that will affect the operation of the PSAP. A good alarm should not only indicate a service-affecting event but it should also provide information that will assist the PSAP Manager in identifying the cause and source of the problem. Alarm monitors should also provide weekly or monthly reports that summarize alarm activity. These reports can be used to identify Network Elements that need attention to prevent future alarms and improve performance.

There are potentially many different alarms that can be generated by the Service Provider's switch and PSAP Equipment. Most of these alarms concern equipment operations and do not affect performance. However, some of these alarms could provide PSAP managers with advanced warning about service-affecting problems such as bad trunks, defective equipment and ALI modem problems. The following list of alarms should be provided.

> **No Calls On Trunk Alarm**: Time-based alarm that reports there were no calls on a trunk for a pre-determined period of time. PSAP Equipment cannot tell if a trunk is made busy at the E9-1-1 Tandem so this the only way to know if the trunk is busied out.
> **No Wink Alarm**: Only the Service Provider or External Monitor can generate this alarm. This alarm gives advanced warning that a trunk could be made busy at the E9-1-1 Tandem.
> **Trunk Out Of Service Alarm**: There are potentially two sources of this alarm. The Service Provider can inform the PSAP that they have made a trunk busy and the PSAP Equipment can alarm when it makes a trunk busy. Remember, there are two ends of a trunk. An External Monitor can alarm PSAP Equipment busy but, like the PSAP Equipment, it cannot tell if the E9-1-1 Tandem has made a trunk busy.
> **All Trunks Busy Alarm**: This alarm is useful for tracking overflow conditions. Periodically throughout the day, all trunks could be busy. This condition is normal for a well-provisioned network. However, this alarm should be infrequent and normally occur during Busy Hours only.
> **PSAP Busy/Reorder Alarm**: This alarm should never occur. It indicates that the PSAP Equipment or CPE is congested. Proper trunk configurations will eliminate this problem.
> **Excessive Abandoned Calls Alarm**: There are two types of Abandoned Calls. A call that was answered by a Call Taker and the caller disconnects or a call that was never answered and the caller disconnects.
> **ALI Link Failure Alarm**: This alarm is not usually provided by the Service Provider or PSAP Equipment. However, an external Monitor can provide this alarm. This alarm is important in preventing total ALI failure by alerting the PSAP Manager in time to restore the failed ALI link before the other fails. ALI Failure reports are useful in identifying ALI Links that are marginal and need corrective action.

E9-1-1 PSAP Reports

There are many different kinds of reports available from either the Service Provider, PSAP and CPE Vendor, Call Recorder Equipment or outside consultants. All reports have a few things in common: there are a lot of them; they are usually very big, they are not always understandable and they cannot be easily customized. It can take a great deal of time to go over these reports only to find out there are no problems or, worse, not reviewing the reports only to discover later that there was the beginning of a major problem that could have been avoided.

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Reports can be broken up into two main categories: Network Performance and PSAP Performance. The following list of **key** reports is intended to give an idea of what could be obtained from the Call and ALI Record data. It is not an all-inclusive list nor is it intended to represent a requirement.

Network Performance Reports

Network Performance Reports help PSAP Managers determine the health of their PSAP Network.

Trunk Utilization Report: Lists the number of calls per trunk per hour by Trunk Group for each day of the report period. This report is used to show what trunks were not used during the report period.

Possible supplementary report: Trunk Utilization Trend Report

Trunk Utilization Summary Report: This supporting report shows the number of the available trunks, the number of trunks that were in use and the Percent Utilization trunks (Available Trunks/Required Trunks * 100) by Trunk Group for the report period.

Required Trunks and Blocked Calls Report: Lists the number of calls, Average Answer Time, Average Duration, Number of Required Trunks and Number of Blocked Calls by Trunk Group per hour for each day's Busy Hour of the report period. Required Trunks and Blocked Calls are calculated using Erlang B projection table. This report should also summarize daily Maximum Required Trunks and Maximum Blocked Calls by Trunk Group. PSAP Managers should determine the acceptable number of Blocked Calls (typically one blocked call for every 1000 calls or .1%). Maximum Required Trunks should not exceed the available trunks (Available Trunks/Required Trunks).

Possible supplementary report: Required Trunk Trend Report

Call Completion Report: Lists the Number of Call Attempts, Number of Answered calls, Number of Dropped calls, Number of Abandoned Calls, Number of Caller Abandon Calls, Number of Network False Seizures and percentage of completed calls (Number of Answered calls / Number of Call Attempts) per hour by Trunk Group for each day of the report period. This report is used to identify trunks and Trunk Groups that are having call completion problems.

Possible supplementary reports: Trunk Group Trouble Summary, Network Abandon Calls, PSAP Abandon Calls, Calls Dropped While on Hold, Calls Dropped While on Hold during Busy Hour, Call Completion Trend Report

PSAP Performance Reports

PSAP Performance Reports help PSAP Managers determine the health of their PSAP operations.

Answer Time Summary Report: Lists the number of calls and Average Answer Time by hour for each day of the report period. Answer time is calculated from the time the trunk was seized by the Network and **picked up** by a Call Taker. This report is useful in identifying call pickup problems.

Possible supplementary reports: Average Answer Time by Call Taker, Average Answer Time by Position, Average Answer Time by Call Taker by Shift, Average Answer Time by Shift

Call Duration Summary Report: Lists the number of calls and average Call Duration by hour for each day of the report period. Call Duration affects network load. The longer the call duration, the less calls can be handled during Busy Hour.

Possible supplementary reports: Average Call Duration by Call Taker, Average Call Duration by position, Average Call Duration by Shift

On Hold Times Summary Report: Lists the Average Answer Time, Average Call Duration, Average On Hold Time by Call Taker per hour for each day of the report period. On Hold Time should be the average of the **accumulated** hold times per hour for each Call Taker. The data to generate this report may not be available for CDR records. This report is useful in identifying On Hold Problems that could cause callers to drop off and call back.

Possible supplementary reports: Calls Dropped While on Hold, Calls Dropped While on Hold during Busy Hour

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Fax: (818) 999-0981
support@bellserviceswest.com
www.bellserviceswest.com

Call Taker Performance Report: Call Taker performance can be a very subjective report. Since subjective objectives are difficult to measure, objective measurements should be used. Call Taker performance can be measured based on Position, Average Call Duration, Average Answer Time, Number of Calls Handled, Average Wrap Up time, Average Call Taker Ready Time and Call Taker Log On/Off time for their shift. Some of the data needed to generate this report may not be available for CDR records. This report is useful in identifying training needs and poor performance. There are many possible supplementary reports that can provide more detailed information. If there is a problem with this report, it may require customized reports.

Required Call Takers: This is a supplementary report that documents how many Call Takers are needed to handle the presented traffic load during Busy Hour. This figure is calculated using Erlang C projection tables.

Time in Call Queue Report: Lists the average number of calls and average time a call is in queue by time interval for each day in the report period. The PSAP Manager should determine what time interval to use for this report. The data to generate this report may not be available for CDR records; however, it may be able to be simulated. This report is useful in identifying call pickup problems.

Possible supplementary reports: Average Call Arrival Rate vs. Calls In Queue, Time In Queue by Shift

Busy Hour Performance Report: This report can mean different things to different people. One way to calculate Busy Hour Performance (BHP) is to list the Number of Calls, Trunk Load in Erlangs or CCS, Number of Available Trunks, Number of Required Trunks, Number of Blocked Calls, Number of Call Takers, Number of Required Call Takers, Number of Answered Calls, Number of Non Answered Calls and Percent Call Completion (Number of Answered Calls / Number of Calls) during Busy Hour per Trunk Group per hour for each day of the report period. BHP is one of the most important reports because the PSAP should be designed to handle the load during Busy Hour. This report is useful in determining the number of required trunks and Call Takers. There are many possible supplementary reports that can provide more detailed information. If there is a problem with this report, it may require customized reports.

E9-1-1 Report Analysis

Results analysis can be tedious and time consuming. There are two things that can be done to greatly facilitate this task.

1. Set thresholds for each parameter and have them used in generating the reports. Report field data that exceeds these thresholds should be highlighted so they stand out. If existing reports cannot accommodate this, consider using the call record data to generate the needed reports.
2. Benchmark your network and center. A benchmark is used to compare **what was** with **what is**. Even if the benchmark does not represent optimum performance, it provides a reference for change. Once optimum performance is achieved, then it can be the new Benchmark.

Trunk Utilization Analysis It is important to have Benchmark for the trunks before any analysis is performed. It is the Benchmark that helps you determine how many Trunks Groups there are. The Trunk Utilization Report lists calls by Trunk per hour. By looking at call counts, as data will identify trunks groups, a graph can make it easier to see. Figure 3 shows a call count by trunk graph.

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7820 McLaren Avenue
West Hills, CA 91304
Telephone: (818) 999-0980
Fax: (818) 999-0981
support@bellserviceswest.com
www.bellserviceswest.com

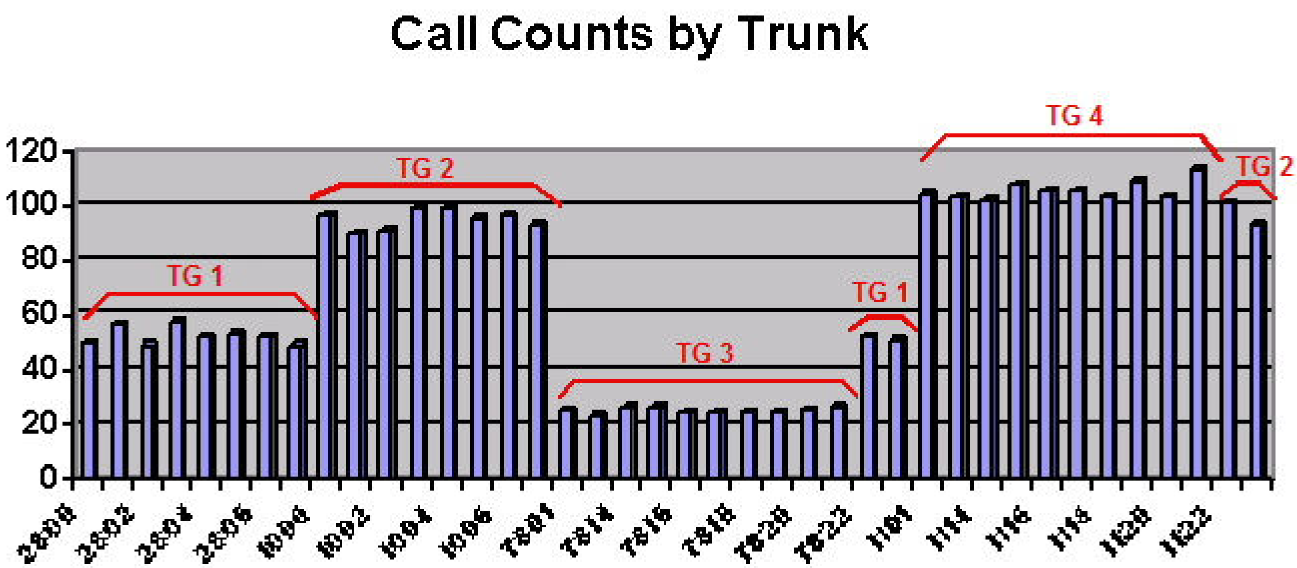

Figure 3 – Call Counts by Trunk Graph

In this case, there are a total of 40 trunks to the PSAP. The call counts indicate that they are not handling the same volume of calls. Since a Trunk Group should spread the call volume evenly through all its members, the differences in call volume will identify the Trunk Groups. In this case, there are four Trunk Groups of ten trunks each. All Network reports should now be modified to represent these Trunk Groups. Now that the Trunk Groups are identified, the analysis can begin. The first question to ask is: are all these trunks being used? The **Trunk Utilization Report** should now highlight any Trunk Group that does not have roughly the same number of calls per trunk per hour. There is no need to check any other Trunk Group, only the one(s) that are not being fully utilized. Use a Trunk Utilization Trend Report to identify trunks that are frequently losing calls over time. These trunks should be either be redesigned or replaced even if they are testing okay now. These trunks are costing money. They influence the number of required trunks because more trunks are needed to cover the down time of these trunks.

If all the trunks have been accounted for, the next question to ask is: are there enough trunks to handle the load? The **Required Trunks and Blocked Calls Report** will highlight any Trunk Group that is either over or under trunked. Under trunked groups need to be addressed as soon as possible. During Busy Hour, calls are being blocked. The Blocked Calls count will show how bad this is. If a Trunk Group is over trunked, then there are too many trunks. Careful here, too many trunks is not necessarily a good thing. Someone has to pay for them. It gives PSAP Managers a false sense of security knowing they have extra trunks. If one goes into trouble, there are plenty more where that came from. You don't get a refund if a trunk is in trouble for long periods of time. PSAP trunks are a priority service and should be fixed or replaced as soon as possible.

A **Call Completion Report** will highlight trunks that have excessive "Bad Calls". These trunks are costing money. They influence the number of required trunks because more trunks are needed to cover for the inefficiencies of these trunks.

PSAP Performance Analysis

Trunk analysis is a straightforward analysis process; find the bad trunk or Trunk Group and fix it. PSAP Performance is a little more difficult. There can be fixed goals like Answer Time, Call Duration, On Hold Times and Time in Queue and there are variable goals like Call Taker and Busy Hour Performance.

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Fax: (818) 999-0981
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Fixed goals can be analyzed logically. If the Answer Times are too high, is it only during heavy call volumes or is it all the time? Use the **Answer Time Summary** report to find out. If Call Duration is too long, use the **Average Call Duration by Call Taker** report to see if it caused by one ore more Call Takers. Again, Call Takers exhibiting excessive Call Duration should be highlighted in the report. On Hold Times and Time In Queue can be analyzed the same way. Find the highlighted fields and determine what or who is responsible for it.

Call Taker performance is a little more complicated because individuals do not perform the same. Each Call Taker may need their own set of goals. Consider generating a supplementary report that lists each Call Taker, their goals as thresholds, their results for each goal and highlight results that exceed the thresholds. It is now a simple matter to find potential problems. Let the report do the work.

Busy Hour is where the rubber meets the road. If there is a problem with the network, PSAP Equipment or Call Taker performance, it should show up during Busy Hour. The **Busy Hour Performance Report** summarizes the overall performance by measuring call completion and blocked calls. Thresholding these two values will help identify if there is a network / equipment problem or if there is a Call Taker problem. Poor call completion on individual trunks or a high number of blocked calls indicate network or equipment problems. Poor call completions across all trunks and Trunk Groups indicate a Call Taker or call handling procedure problem. To further identify the problem, supplementary reports need to be generated addressing the problem areas. Thresholding problem areas will help facilitate analysis.

A Simpler Way

Even this small sample of available reports and their analysis can still be daunting. A simpler way to review all the data in the reports without wasting time is to have the data summarized into a PSAP Summary or "Report Card" report. This weekly or monthly report identifies Key Service Indicators (KSI) that represent major performance objectives. A value of "1" indicates the KSI has been met.

The thresholds developed can be used to establish each KSI. For example:

> The Answer Time Threshold is set for 6 seconds. If every call's Answer Time is less than or equal to 6 seconds, then the Answer Time KSI value is 1. If any call exceeds this threshold, then the KSI is less than 1.

At first, it may not be possible to meet every KSI. It takes time to fix problems, retrain Call Takers, establish new call handling procedures, etc. Therefore, a Goal KSI can be set to offset the threshold used to calculate the KSI. For example,

> If the Answer Time threshold is set for 6 seconds, a Goal can be set for .9 meaning that if 90% of the calls meet the 6 seconds threshold, then the Answer Time KSI =1. Gradually, the Goal can be increased as performance improves until it too equals 1.

Each KSI is supported by one or more detailed reports. The Report Card allows PSAP Managers to quickly review a great quantity of information without having to look at individual reports. Only those reports where the KSI falls short of expected values need to be looked at. **Once a PSAP has been optimized, the Report Card may be the only report the PSAP Manager needs to look at.**

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Fax: (818) 999-0981
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Figure 4 shows an example of a simple PSAP Summary Report. From this report, it is easy to pick out potential trouble spots. PSAP Managers only need to look at the affected reports to find the source of the trouble.

My PSAP Summary Report 12/01/2005 to 12/31/2005

				KSI				KSI
PSAP Performance	**(All Shifts)**	**Threshold**	**Goal**	**0.94**		**Threshold**	**Goal**	
	Answer Time	15 sec	**0.90**	1	**Time in Call Queue**	30 sec	**0.9**	1
	Call Duration	60 sec	**0.80**	1	**Calls in Call Queue**	5	**1**	1
	On Hold Times	120 sec	**0.9**	1	**Busy Hour Performance**	92%	**0.92**	**0.75**
	Call Taker Performance		**0.95**	1				
Network Performance	**(All Trunks)**			**0.988**				
	Trunk Utilization	100%	**1**	1	**Call Completion**	95%	**1**	**0.95**
	Required Trunks	100%	**1**	1				
	Blocked Calls	.1%	**1**	1				

Figure 4 – PSAP Summary Report

In this case, the Busy Hour Performance (BHP) is the most critical problem. Remember, this KSI measures the Call Completion Percentage during the Busy Hour. Overall Call Completion is slightly lower than expected also. Since BHP is figured into the Call Completion measurement, it is safe to assume that both problems are caused during the Busy Hour. Since the Blocked Calls KSI looks fine, the problem must be with the Non-Answered Calls. A supplementary report listing all Non-Answered Calls and their call disposition (Abandon Calls, Caller Abandons, False Seizures, CPE Not Answer, No Wink, etc.) by Busy Hour intervals for each day of the report period may help identify the problem.
All the other KSIs are within limits. There is no need to look at any of the other reports.

Corporate Office
7820 McLaren Avenue
West Hills, CA 91304
Telephone: (818) 999-0980
Fax: (818) 999-0981
support@bellserviceswest.com
www.bellserviceswest.com

In a Perfect World
Though results analysis is not rocket science, it does take time and a certain amount of expertise. The PSAP Summary Report dramatically reduces the amount of analysis needed. Ideally, it would also provide the results analysis the PSAP Manager needs and generate the additional reports that can be used for analysis. Figure 5 shows an example of a PSAP Summary Report with the analysis text included.

My PSAP Summary Report **1201/2005 to 12/31/2005**

Results Analysis for My PSAP

PSAP Performance KSI is off primarily due to the following problems:

Busy Hour Performance is very low. There were excessive Network and CPE False Seizures during Busy Hour. Though these call attempts are counted as calls, their very short duration does not impact call handling performance. Excessive Network and CPE False Seizures should not occur, but they do on some networks. Consider removing Network and CPE False Seizures from the Non-Answered call types list so they will be ignored when calculating KSI values.

Possible Cause: Facility problem, PSAP Equipment problem, Network Switch problem

Results Analysis for Network

Network Performance meets all KSIs.

Call Completion problem due to Busy Hour Performance anomaly.

Figure 5 – PSAP Summary Report Results Analysis

The data needed to provide this kind of results analysis is available at most PSAPs. Results analysis can be added manually using some of the processes described or automatically using outside network analysis tools. Whichever means is employed, the end result is a one or two page report showing the most important performance measurements customized to the needs of the individual PSAP. This simple report is backed up by all the detailed reports, should further analysis be required. The important thing to realize is that once all the KSIs are under control, the PSAP Summary Report is the only report a PSAP Manager needs to look at to insure their center is performing as expected.

Benefits of Performance Analysis
The primary benefit of results analysis is the reduction of time needed to review detailed reports. PSAP Managers do not need to look through stacks of reports to find out how their center is running. Some other benefits are:

- **Reduce Costs** by trimming resources (trunks and Call Takers) to their required levels.
- **Improve Responsiveness** by refining call handling practices through training and guarantee as many calls as possible reach a Call Taker.
- **Improve Efficiencies** by making sure resources are added or removed only if there is a real need and not because a need is assumed.
- **Improve Reliability** by insuring PSAP and Network resources are always available and working properly.
- **Provide Justification** to government agencies and elected officials for additional resources, grant requests, consolidation plans, etc.
- **Reduce Liability Risks** by showing that all efforts have been made to insure the proper operation if the center.

It doesn't take a lot of money or time to the get information needed to run a PSAP; it just takes the time to set up reports that do the analysis for you and quickly show you problem areas. Once this is done, PSAP Managers need only look at the reports that show problems and ignore the rest.