

PHASE I REPORT – QUALITATIVE & QUANTITATIVE FINDINGS

AUGUST 2016



**ASSESSMENT OF BROWARD COUNTY'S REGIONAL E911
CONSOLIDATED COMMUNICATION SYSTEMS**

Submitted by:



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CONSULTANT REPORT

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INTRODUCTION

Broward County retained FITCH & Associates (*FITCH*) to conduct an assessment of the County's Regional E911 Consolidated Communications System (Regional E911 System). As an overall goal, *FITCH* is to initially assess the E911 System through data collection and baseline assessments, external benchmarking, and definition of future state options. *FITCH* is to evaluate the System against industry best practices and opine on the pertinence and attainment of previously established goals.

The Regional E911 System resulted from the consolidation of eight smaller public safety answering points (PSAPs) after extensive technical reviews and engaged public policy debates. The System's formal implementation date was October 2014. In the 23 months since start-up, stakeholders have made progress in meeting goals; yet, there have been concerns about the relevant utility of the current performance metrics and the System's ability to quickly achieve all the ambitious goals initially defined by the various stakeholders. There was significant agreement/consensus in the early stages of the consolidation based on numerous meetings and adoption by all parties of interlocal agreements. However, it is fair to note that such consensus has now dissipated in a number of areas.

The County contracts with the Broward Sheriff's Office (BSO) to operate the Regional E911 System and provide dispatch services. BSO personnel receive and dispatch emergency and non-emergency calls for police, fire, and emergency medical services (EMS) within the County, for all but two of Broward County's 31 municipalities. BSO also provides teletype (queries only), while the municipalities are responsible for any services beyond that level.

This report represents findings from Phase I of the project and includes analyses of qualitative and quantitative data as provided by the County and other stakeholders – in essence an assessment of the current System. Phase 2 of *FITCH*'s scope of work will provide a series of specific recommendations designed to improve overall System effectiveness, efficiency and utilization of industry best practices. Phase 2, once completed, will be added to this report and the two parts will represent the entirety of the scope work.

FITCH consultants have spent many hours working with Broward County and BSO personnel. We are impressed with the dedication of these individuals and clearly see that all understand the importance of their mission and express a desire to provide excellent services.

EXECUTIVE SUMMARY

This report derives its findings from two perspectives. First, is the input received from stakeholders, especially Level 1 (elected, appointed and senior management officials) and Level 2 (directors, managers and supervisory personnel). Information was also gleaned from the considerable time *FITCH* consultants spent directly observing operations in all three regional 911 facilities, in the field and from direct surveys of dispatch personnel.

The second perspective is based on extensive and sophisticated analyses of raw data provided to *FITCH* consultants. The data included 911 center phone records, computer-aided dispatch (CAD) records and radio system records. From this information, *FITCH* was able to assess the Regional E911 System's current level of performance. Additionally, *FITCH* modeled performance and under Phase 2 will quantify the optimal number of call-takers and dispatchers that are needed to meet certain performance criteria in the Regional E911 System. The quantifying of personnel is a participatory process involving stakeholders to set new parameters. This process is key in designing a dispatch center that is based on national best practice and local competencies.

To determine staffing needs, BSO and the County utilize a staffing estimator and retention rate calculator known as RETAINS, a product of the Association of Public-Safety Communications Officials (APCO). The RETAINS title stands for Responsive Efforts to Assure Integral Needs in Staffing. The estimator is respected as a tool for estimating staffing needs and includes some level of complexity. However, its application for Broward's Regional E911 System is significantly limited due to Broward's fluctuations in call volume on an hour-by-hour basis and the changes in staffing used to meet those demands. An easily overlooked limitation of the RETAINS estimator is that it does not include specific performance targets as part of the staffing level calculations.

Of note, there were a number of data deficiencies that limit *FITCH's* ability to complete specific project scope points. For example, while CAD data for all of calendar year 2015 was available, only three months of phone records were available due to a system upgrade. From these two data sets, there were only two months of overlap between the phone records and the CAD data. Radio system information also had limitations that hampered detailed system performance analysis.

Nonetheless, *FITCH* was able to construct detailed models and was able to draw meaningful conclusions. A full accounting of data issues is described in detail under the report section titled Sources of Data.

Initial Findings and Observations

From the intersect of issues derived by stakeholder input and the extensive data analyses, a number of higher level findings of the current System can be determined. More detailed findings of the system can be found throughout other sections of this report.

The discourse regarding system performance between the County, BSO and user agencies has been difficult. Multiple factors including limitations of some performance metrics; operational governance and oversight; and technology limitations, contribute to various problem areas. However, *FITCH* also found areas where there have been noteworthy successes. Contrary to often cited perceptions, the System is performing – quantitatively – better than conveyed by stakeholders. A widely discussed metric that evaluates 911 call-answering times was found to be extremely rapid, some of the quickest *FITCH* has identified in other large systems. Call transfers, that happened with some regularity prior to consolidation and delayed effective system performance, has been virtually eliminated since consolidation. The County’s efforts to ensure quality and efficiency is support by a quality assurance and improvement program. Additionally, greater operational coordination and transparency among System participants has provided qualitative improvements. This report strives to provide a balanced perspective, drawing heavily from our experience working with other large, national and international, emergency communications systems.

From a high-level policy perspective, we found three major areas that should capture the attention of stakeholders moving forward.

Utilization of Performance Metrics

Measures of the System’s performance, as initially drafted by law enforcement, fire and municipal leaders, and implemented by County staff, do not provide an appropriate assessment of the System’s performance. The measure of the P1 busy hour interval – the time from when the 911 phone rings until answered – is a poor representation of System performance and inconsistent with current industry best practices. Further, reports of the P2/P3 interval – the time from answering a 911 call until units are dispatched – that appear to be precise, are in fact flawed due to data limitations. Interestingly though, performance calculated by *FITCH* differed from that calculated by the County by only a few percentage points. The Phase 2 report will provide a specific set of recommended measures for use in evaluating System performance.

While the System is seen as struggling to meet all of its currently defined performance measures, the focus on certain specific areas has resulted in a level of goal displacement. The use of ‘PASS/FAIL’ or ‘YES/NO’ against percentage compliance targets does the County a disservice in that it fosters an expectation that the system can somehow be made perfect. The reality of emergency service systems is that they will be overwhelmed by significant unanticipated events at some point in time, i.e., the recent shootings in Orlando or a tornado in South Florida. Performance measures should be selected such that they contribute to a knowledge base to make the system better, rather than be seen as a value judgement. Another example of goal displacement is the focus on the time necessary to answer a 911 call, known by the moniker P1. This measure has received significant scrutiny. While there are several specific measures to evaluate P1, much of the focus has been on what is known as “busy hour” performance. This single metric has been the source of friction between various parties and likely led to a belief that the only solution is increased staffing. The busy hour measure is a poor representation of performance in the Broward system. When examining the other metrics associated with P1, the

Broward System actually exhibits some of the best performance seen in large 911 centers across the nation. This issue will be discussed in greater detail elsewhere in the report. Attention to performance metrics is a best practice, but must be utilized carefully to avoid emergence of perverse behaviors.

Governance and Oversight

As approved by the County, BSO and municipalities, the System's initial, rapid implementation timeframe required a more centralized oversight/governance process. In the consolidation process, some communities were able to add services that were not provided individually before. For example, the consolidated System utilizes emergency medical dispatching (EMD) services – a best practice for 911 centers. The focus during these initial months was with the County's Office of Regional Communications and Technology (ORCAT). This approach, while arguably needed during early implementation, does not serve the ongoing needs of other stakeholders. Some examples of the County's assumption of operational issues resulted from role ambiguity. And while current perceptions indicate there is a lack of trust among stakeholders, there is also evidence that in other regards the System has now "turned the corner". Future system improvements will benefit from a redefined, collaborative, and simplified governance structure. The challenge for municipal leaders – fire and police chiefs, along with locally elected leaders – will be defining a clear set of expectations shared by all. In Phase 2, *FITCH* will propose an oversight process that will balance end-user concerns for operational control and transparency, against BSO's requirements to manage System operations and Broward County's fiduciary and legislative responsibilities.

FITCH noted the levels of staffing appropriated in the budget process for the Regional E911 System, and the focus of staff's efforts in operating the System. Qualitatively, it was felt that personnel in the 911 centers suffer from low morale and a perceived lack of leadership. Attention has been diverted from more meaningful activities in order to address issues of less importance, and a sense that available resources are not being used effectively. Quantitatively, application by *FITCH* of more definitive staffing models demonstrates opportunities to achieve meaningful performance in the 911 centers – well within existing allocations of personnel, and even with some level of thoughtful reductions. We believe this can be accomplished while the Broward Sheriff's Office remains an Accredited Center of Excellence as awarded by the International Academies of Emergency Dispatch. In the Phase 2 report, *FITCH* will propose a number of staffing realignments to address the existing inefficiencies.

Technology Limitations

The County has, and is, expending significant resources to upgrade Regional E911 System technologies. The phone system was recently completed and major upgrades to the radio and CAD systems are currently underway. However, a number of challenges were encountered in the harvesting of data. The findings regarding technology limitations highlight the need to address some fundamental technology issues as these systems are now undergoing major upgrades.

Generally, stakeholders do not appreciate how these issues impact the ability to effectively manage the System. A major flaw of the current system is the inability to link phone records to CAD records and establish a seamless start-to-finish timeline for an incident. This results in the County basing overall System performance without benefit of all the fire/medical dispatch records. In addition, the County is unable to currently access radio and phone data directly. To ascribe performance evaluations to the entire System based on partial and potentially statistically biased data is questionable. *FITCH* took extraordinary effort to construct data tables from these two data sources in order to assess the system. Pass/fail assessments should be cautiously weighed by decision-makers until all planned technology improvements are in place. County staff should continue to report on the trend-data to establish baseline performance.

Less understood from a root cause perspective is the failure by field personnel to make better use of mobile data terminals (MDTs), and thereby place a larger demand on the radio system and 911 personnel. This practice further decreases the effectiveness and efficiency of the System.

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DISPATCH CENTER BEST PRACTICES

Accreditation by the International Academies of Emergency Dispatch (IAED) is the gold standard for emergency dispatch centers and public safety agencies. Achieving and maintaining status as an Accredited Center of Excellence (ACE) requires top-notch systems, for reporting and reviewing processes, and ultimately benefit patients and the community-at-large. The goal of accreditation is to improve patient care and clinical outcomes. IAED provides the following separate accreditation processes for dispatch personnel:

- Emergency Police Dispatch Certification
- Emergency Fire Dispatch Certification
- Emergency Medical Dispatch Certification

Each certification area provides structured call processing for the respective discipline. IAED sets out 20 points as accreditation requirements. Table 1 below articulates the 20 IAED points of excellence that must be formally documented, described and verified as part of the medical dispatch accreditation/re-accreditation application process.

Table 1. Requirements for IAED Medical Dispatch Center Accreditation¹

Formally describe and document the following –					
1) Communication center overview and description					
2) Medical Priority Dispatch System™ (MPDS) version and licensing confirmation					
3) Current Academy EMD certification of all EMD personnel authorized to process emergency calls					
4) All EMD certification courses are conducted by Academy-certified instructors, and all case review is conducted by Academy-certified ED-Qs					
5) Full activity of Quality Improvement (QI) committee processes.					
6) IAED quality assurance and improvement methodology.					
7) Consistent case evaluation that meets or exceeds the Academy’s minimum expectations					
8) Historical baseline QA data from initial implementation of structured Academy QA processes (first QI Summary Report, if available*)					
9) Monthly average case evaluation compliance levels for the communication center for the six months preceding the accreditation application, with compliance levels at or above accreditation levels for at least the three months immediately preceding application					
		ACE			
High Compliance					
Compliant					
Partial Compliance		10%			
Low Compliance		10%			
Non-Compliant		7%			
Percentage of Deviation Accepted		Critical Deviation	Major Deviation	Moderate Deviation	Minor Deviation
		3%	3%	3%	3%
10) Verification of correct case evaluation and QI techniques, validated through independent Academy review					
11) Implementation and/or maintenance of MPDS orientation and case feedback methodology for all lead personnel					
12) Verification of local policies and procedures for implementation and maintenance of the MPDS. Include all policies relating to EMD practices					
13) Copies of all documents pertaining to your continuing dispatch education (CDE) program					
14) Secondary Emergency Notification of Dispatch (SEND) orientation					
15) Established local response assignments for each MPDS Determinant Code					
16) Maintenance and modification processes for local response assignments to MPDS Determinant Codes					
17) The communication center’s incidence (number of occurrences) of all MPDS codes and levels for the six months immediately preceding application					
18) Appointment and appropriate involvement of the Medical Director to provide oversight of the center’s EMD activities					
19) Agreement to share non-confidential EMD data with the Academy and others for the improvement of the MPDS and the enhancement of EMD in general					
20) Agreement to abide by the Academy’s Code of Ethics, Code of Conduct, and the standards set forth for an Accredited Center of Excellence					

The Broward stakeholders should appreciate that Accreditation guarantees that all the processes needed for high quality patient care are implemented. How promptly they are carried out is a component of performance independent of Accreditation. The IAED-ICE accreditation requirements contain no time metrics. Requirements for ACE Accreditation are comprehensive and reflect the effort

¹ <https://accreditation.emergencydispatch.org/resources/General/MEDICAL%20Accred-Re-Accred.pdf>, June 2016

required to achieve and maintain accreditation. Even for the best dispatch centers, accreditation is typically a multi-year process.

The Broward Sheriff's Office first accomplished accreditation in 2003. BSO maintained accreditation and was re-accredited for the three-year period 2015 to 2018. Of note, BSO only uses the Medical dispatch protocol and is only accredited for medical dispatch.

FINDING: Broward Sheriff's Office is an Accredited Center of Excellence as awarded by the International Academies of Emergency Dispatch.

The Broward Sheriff's Office has also recently been reaccredited for their communications services by the Commission on Accreditation for Law Enforcement Agencies (CALEA).

Other attributes of high performance dispatch centers include daily meetings of dispatch staff to review the prior day's events, refine deployment and review any operational concerns; regular surveys by emergency provider agencies to include questions regarding the dispatch process; continuous feedback loops for improvement throughout the organization; and clinical oversight regarding emergency medical dispatching by a full-time medical director, who has direct involvement with the center's performance and personnel.

In their final Phase 2 report, *FITCH* will provide a series of recommendations based on industry best practices.

CURRENT ORGANIZATION AND ENVIRONMENT

A meaningful analysis of the current System requires an appreciation of the recent historical and current organizations, and their environment. The following sections highlight demographic trends impacting demands for service, existing relationships among stakeholders and technology impacting System performance.

County Demographics

It is important to understand the utilization of emergency services from a historical perspective. Fire rescue departments have seen a significant increase in emergency activity. While reported structure fires are down dramatically, in the last decade alone there has been a 40% increase in overall total emergency calls based mostly on EMS and activated fire alarms.² Therefore, the following demographic information provides a context to understand some of the drivers of system demand.

Current and Historical

Today, Broward County is a mostly developed urban county with only 10.5 square miles left of developable land. According to the University of Florida's Bureau of Economic and Business Research (BEBR), the County's total population is estimated at 1,827,367 as of April 1, 2015.³ Of the 31 municipalities in Broward County, the three largest cities are the City of Fort Lauderdale with a resident population of 178,590, Pembroke Pines, 166,611, and Hollywood, 149,728, (July 1, 2015, US Census data).

Broward County's historic growth peaked in the year 2000 with an average annual growth of 2.72%. Between 2000 and 2005, average annual growth had slowed to 1.44%, resulting in a resident population of 1,739,487 persons. Growth began to slow due in part to sky-rocketing housing costs, followed by the 2008 economic slump. In-migration of residents typically fueled the County's rapid population growth. However, "excessively high housing costs followed by diminishing job opportunities, reduced in-migration and population growth to its smallest level in sixty years."⁴

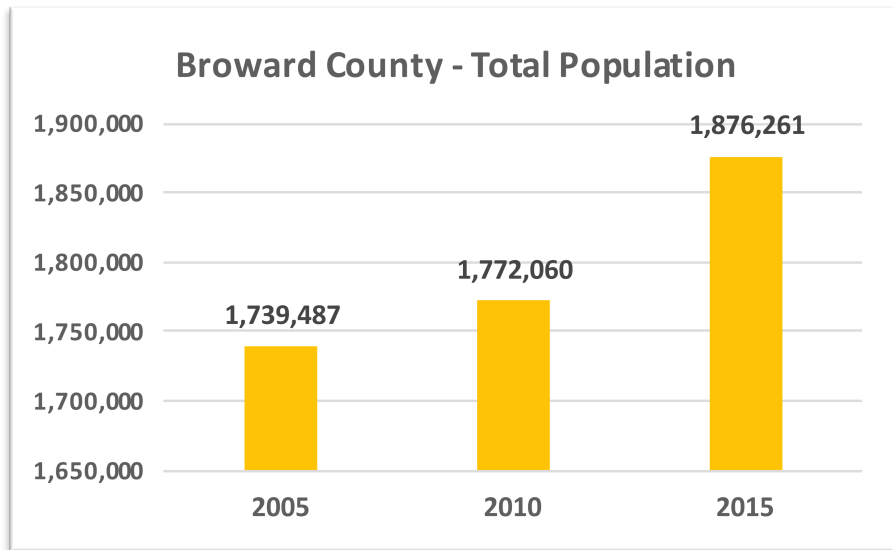
Nevertheless, the contrast of added population between 2005 and 2010 and that experienced between 2010 and 2015, is significant. Figure 1 below represents the population growth in five-year increments for 2005 to 2015.

² Ahrens, M. (2016). Trends and Patterns of U.S. Fire Loss. N. F. P. Association, National Fire Protection Association.

³ Projections of Florida Population by County, 2020-2045, with Estimates for 2015, Florida Population Studies, Vol. 49, Bulletin 174, January 2016. University of Florida, Bureau of Economic and Business Research.

⁴ Broward-by-the-Numbers, Number 57, page 1, July 2009. Broward County Planning and Redevelopment Division, accessed June 2016.

Figure 1. Broward County Population Growth, 2005 to 2015



A total of 32,573 residents was added to Broward’s population between 2005 and 2010, but 104,201 residents were added to the population between 2010 and 2015, representing 5.9% growth for that period.⁵

Projected Growth to 2020

The University of Florida’s Bureau of Economic and Business Research (BEBR), provides annual population forecasts for the state and for all Florida counties. BEBR’s projections of overall population growth in Broward County population is expected to slow in the out years to 2020. BEBR’s January 2016 population projections for Broward County are provided as “low”, “medium” and “high”. The medium projections are thought to generally provide the most accurate forecasts of future population change. BEBR forecasts Broward’s medium population at 1,914,500 as of April 1, 2020, which represents a 2.04% increase over 2015.

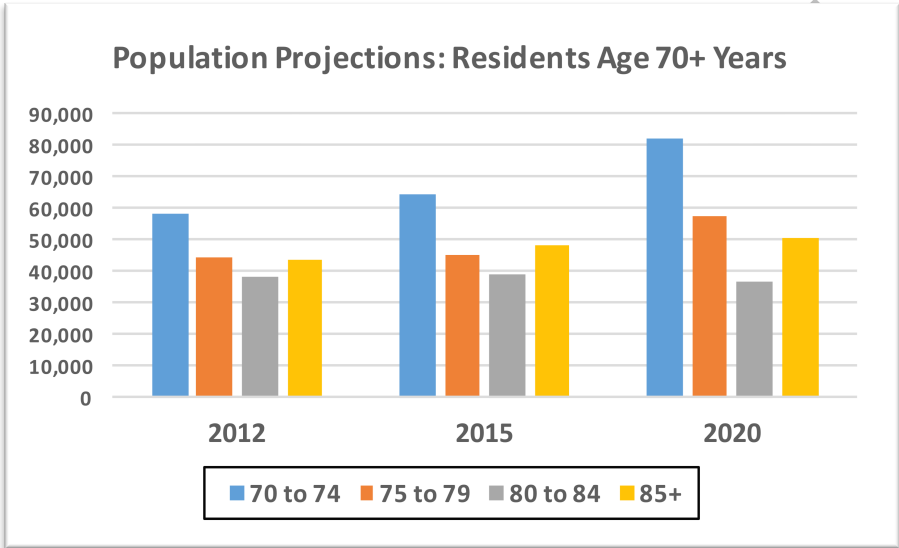
The US Census’ American Community Survey for 2007-2011, notes that Broward County is a net exporter of workers in the daytime during the workweek. While the cities of Fort Lauderdale and Pompano Beach experience a significant net increase in their daytime populations, suburban areas tend to lose population in the daytime due to many workers commuting out of the area. Downtown areas generally see a significant increase in daytime population. The greatest daytime gains are seen in the municipalities in the eastern part of the County, such as Fort Lauderdale and Pompano Beach.⁶

⁵ Population data was derived from the Broward County source noted in the previous Footnote and was used instead of US Census data as it is more complete. Census data and Broward County’s estimates and projections are relatively similar and do not represent a significant disparity.

⁶ Broward-by-the-Numbers, Number 60, page 1, March 2013. Broward County Planning and Redevelopment Division, accessed June 2016.

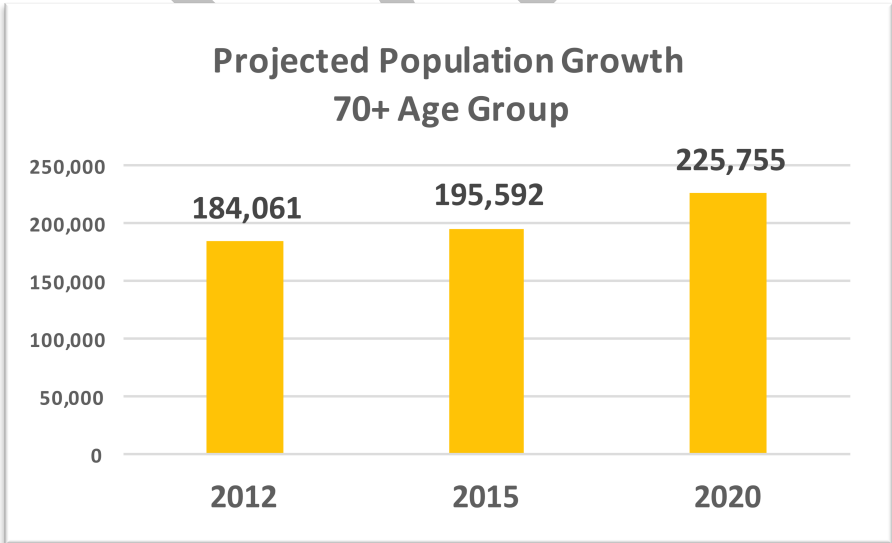
The BEBR population forecasts include data by age groups. Of particular interest is the age cohort of 70+ years, which significantly impacts the need for health care services and, in particular, emergency medical services. BEBR’s data regarding age cohorts of 70+ years, provides estimates for 2012 and projections for 2015 and 2020. The information is presented in Figure 2 below. This trending demographic will have a concurrent impact on 911 services as well.

Figure 2. Population Projections for 70+ Years Age Cohorts



The projected numbers increase over each five-year period and for each age group, except for the age cohort of 80 to 84 years. Overall, the number of Broward residents over the age of 70 years, is expected to increase by approximately 41,700 individuals or 15.4% as estimated between 2012 and projected for 2020. Figure 3 represents the growth for the entire age group of 70+ years.

Figure 3. Population Projections for Residents Age 70+ Years



Intuitively there exists the sense that as the size of the older cohort increases, the number of age related emergency events will also increase. The increased number of people in the 70+ age group, in particular, is expected to drive demand for emergency medical services. The critical question is, *by how much?* Four studies provide insight into the impact of such a demographic trend.

First, the Department of Emergency Medicine, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, conducted a retrospective study of 2.7 million EMS transports to emergency departments across North Carolina in 2007. A major finding of this study was that individuals 65 years of age or older accounted for 38% of all EMS transports to North Carolina emergency departments.⁷

A second study supported by Florida's Pinellas County Mental Health and Substance Abuse Task Force, with cooperation of the Pinellas County Data Collaborative, evaluated the age distribution of emergency medical transports in Pinellas County, FL, from July 1999 through June 2000.

Statistics from the summer months in Pinellas County are equally relevant to Broward County. During this season, the statistics reflect the effects of the stably domiciled, local population. Distortions due to the influx of winter "snowbirds" are absent. According to the United States 2000 Census, Pinellas County had 22% of its domiciled population in the 65+ cohort. During the summer months, when there is no population distortion due to snowbirds, at least 50% of all emergency medical transports involved the 65+ cohort. In Pinellas County, the one fifth of the domiciled population in the 65+ cohort accounted for one half of all emergency medical transports. Similar observations regarding age and emergency medical transports were made in smaller and earlier studies in Forsyth County, North Carolina in 1995, and in Dallas, Texas in 1990.⁸

FITCH believes that the demand for emergency medical services in Broward County, like its Florida west coast neighbor, Pinellas County, will be driven disproportionately by the 65 and 70+ year old cohorts.

Stakeholder Relationships

Participants

Of the 31 municipalities in Broward County, all but two, Coral Springs and Plantation, are participants in the Regional E911 System. The System is the result of a 2002 Charter amendment that called for coordination between the County and municipalities to establish a countywide communications infrastructure for fire and emergency medical services. A primary outcome of consolidation was to

⁷ TF Platt-Mills, B Leacock, JG Cabañas, FS Shofer, SA McLean, *Prehospital Emergency Care*, 2010 Jul-Sep; 14(3): 329-333. doi: 10.3109/10903127.2010.481759. "Emergency medical services use by the elderly: analysis of a statewide database." <http://www.ncbi.nlm.nih.gov/pubmed/20507220>.

⁸ JL Wofford, WP Morgan, MD Heuser, E Schwartz, R Velez, MB Mittelmark, *Am J Emerg Med*, 1995 May, 13(3): 297 - 300. "Emergency medical transport of the elderly: a population-based study" and CE McConnel, RW Wilson, *Soc Sci Med*, 1998 Apr, 46(8): 1027 - 1031. "The demand for prehospital emergency services in an aging society".

enable closest unit responses to life-threatening emergencies and provide support for regional specialty teams.⁹

The current set of stakeholders can be more readily identified as follows:

- Broward County, with legislative and financial responsibilities for the System,
- BSO as the Operator of the System, supplying personnel and direct management of the three public safety access points (PSAPs) located throughout the County, and
- Municipal fire rescue and law enforcement agencies as end users of the Regional E911 System's services, and Broward Sheriff's Office (BSO) as an end user public safety agency.

As will be highlighted from stakeholder input, relations among the three major stakeholders are not optimal. This was emphasized by recent findings from facilitators working with County and BSO staff. They concluded that the design of one team reporting errors on the other team's work does not support a collaborative relationship between the County and BSO. They indicated that the two teams are not positioned to be collaborative in reaching the same goal and will likely cause more expended energy and time in defending their respective perspectives. The facilitators recommended focusing on the redesign of the existing working model to support a collaborative working team.

FINDING: Low levels of trust exist among major stakeholders. Much of this is due to role definitions. Relationships need to be redefined in order for the System to move forward effectively.

It is noteworthy that since the consolidation effort began, current stakeholders have engaged in a sustained discourse on 911 services – something that was rarely discussed before. The outcome of this dialog is that the new system, with greatly increased scrutiny, is now identifying and addressing long-standing issues. It is likely these issues existed before, but individual PSAPs did not have the transparency that exists now. *FITCH* noted that attempts to obtain specific historical performance data from various communities was unsuccessful either because of an inability or unwillingness to provide such information. From one perspective, the tension that exists now can be seen as an outcome of the transparency and progress that is now benefiting the public and first responders.

Technology Review

The technology assessment was accomplished through discussions with technical support personnel and direct observations on-site at the dispatch consoles. The assessment focuses on telecommunications, computer aided dispatch and radio operations technologies. Below are the key issues observed in this initial assessment.

⁹ Broward Sheriff's Office Regional Agreements accessed through Broward.org, Regional Communications and Technology, Broward County Regional 911 and Broward County Charter, Revised November 4, 2008, Article V. Public Safety, Section 5.03(A).

Telecommunications

The Regional E911 System currently operates on an Intrado Power911 telephone system (version 5.5), with a redundant network. Automatic Call Distribution (ACD) and prerecorded answering is in use independently at each facility for 911 calls, while non-emergency calls are distributed across all three PSAPs. *FITCH* consultants were advised that there are plans to network all three County PSAP facilities in the near future and to then deploy Automatic Call Distribution across the entire network for 911 calls. This change will significantly improve the efficiency of call handling and avoid unnecessary delays.

Part of the data required to describe the total timeline of a single incident resides in the phone system and the other part resides in the CAD. A major issue identified in Phase 1 is the failure of the phone and CAD systems to effectively link records associated with a single incident.

The County recently acknowledged the lack of this linkage as an issue of concern, and has indicated they are currently undertaking efforts to effectively address this issue. After a concerted effort with the data provided, *FITCH* was able to link incidents, but for fewer than 50% of the incident records. This technology deficit significantly limits the ability to calculate the P2/P3 call processing intervals. Most important is that the System cannot reliably answer the fundamental question of how long it takes between when a call is made to 911 and when help arrives.

FINDING: County's PSAP phone system and computer-aided dispatch (CAD) systems are not effectively linked to allow comprehensive evaluation of System performance.

During data collection, there were challenges in obtaining direct access to the phone system and the radio system data tables. County staff reported they process their reports through a standardized reporting interface, and lack direct access to phone system data. County staff did advise funding is available to purchase the necessary software to allow direct access to critical system data.

FINDING: County staff is unable to directly access phone and radio system data – thereby limiting their ability to analyze system performance beyond that permitted by pre-designed reports (a 'canned' reporting system) which makes some of the required reporting tedious and error prone.

Computer Aided Dispatch System

The current Motorola PrintTrac CAD system, originally deployed in 1994, serves each of the three PSAP facilities. For some agencies, such as the City of Ft. Lauderdale, this CAD is believed to be a backwards step in technology. The County has acknowledged the age of their current system, and some historical problems with network stability. For these reasons, consultants were advised that there are plans to upgrade to a Motorola Next Gen CAD in the near future, currently reported as early as 2017. The County, BSO and end users are collaborating to identify improvements in the new CAD in order to improve the overall System. At present, the County is risk averse to routinely testing the redundant network design because transferring system processing to the CAD disaster recovery system requires manual intervention, and can take up to 4 hours to complete. And as noted above, the current CAD does not have an effective method to associate records from the phone system to the appropriate CAD record.

FINDING: The CAD network is redundant in the event of a failure. However, it is not tested on a regular basis. This is a current deficiency and is in conflict with best practices.

For 911 personnel to effectively dispatch emergency responders, two essential pieces of information are required – where is the emergency, and what is the emergency. Direct observations and analysis of CAD data reflect that the current ability to obtain an accurate incident location is hampered by a number of issues. Operators struggle to quickly obtain and validate the caller's/incident location. This problem was identified prior to this study and a number of mitigating strategies have already been deployed, mostly related to call taker training. In particular, analysis by the County and BSO note that call takers who 'deviate' from recommended processes, especially in medical calls, take longer to process the call effectively. 911 personnel reported, and FITCH personnel observed, inconsistent performance of mapping technology that decreased the capacity to quickly locate 911 callers. There are a number of technology solutions that will help improve addressing, and therefore overall call processing times. These will be further identified in the Phase 2 report.

Broward Regional 911 System dispatchers are certified as Emergency Medical Dispatchers (EMD) and as such provide pre-arrival instructions to callers in need. As part of that process, BSO maintains a quality assurance (QA) program that includes specialized QA positions and Priority Dispatch's AQUA software that measures, analyzes and documents call processes. The software assists in pinpointing training needs and documents continuous improvement efforts. The QA program should meet criteria identified in Dispatch Center Accreditation Requirements noted in Table 1 in the Dispatch Center Best Practices report section.

Compliance with certain of these recommended standards are reported by BSO to the County for inclusion in monthly reports. There also exist options to have this QA review done by external parties to

ensure objectivity. While the use of EMD is a best practice, the use of similar fire and law enforcement systems are not being utilized within the Broward system.

FINDING: The System utilizes emergency medical dispatching (EMD) services – a best practice for 911 centers. However, no similar program is utilized for either fire or law enforcement call types.

Radio Operations

Different fire, law enforcement and EMS agencies work off separate assignment and tactical channels, often requiring multiple dispatchers for the same emergency incident. As noted elsewhere in this report, there is a high level of radio usage for verbal communications between field personnel and radio operators. This raises questions regarding the utilization of mobile data terminals (MDTs) and the efficiency of the current operations. Staffing can be utilized more efficiently if field agencies agree to utilize one assignment and/or tactical channel.

Regarding fire radio operations, there are multiple fire dispatch channels operating independently of one another. While likely a remnant of pre-consolidation's independent 911 centers, this is not the most efficient or effective way to handle radio operations. Many larger systems limit the number of assignment radio channels, and then quickly move units off to an operating or tactical channel based on the type of incident.

Fire/EMS apparatus have mobile data computers (MDCs) with air cards installed in the units. It appears that responders do not use the MDCs as a means to update unit status changes or communicate routine information. This information exchange is best executed via the mobile data computers. Using MDCs can reduce errors, is a more efficient method to communicate, and can free up radio channels for more critical communications.

FINDING: Radio traffic utilization, by both fire/EMS and law enforcement units, is comparatively high. MDTs and MDCs are not effectively utilized to reduce radio traffic.

Dispatch Facilities

FITCH consultants spent significant time in the three PSAPS, North, Central and South. While Central has the largest footprint of floor space, North and South dispatch facilities must cope with the limited available square footage at their locations. It should be noted that stakeholders undertook a significant evaluation of potential dispatch sites prior to selecting the current PSAP locations. This included

evaluating characteristics such as hurricane ratings, back-up power generators and redundant power feeds. While it is recommended that a system such as Broward have at least two geographically disparate sites, stakeholders were required to select existing facilities that could be modified to minimally achieve the existing needs.

The South dispatch center is not a purpose built-facility designed for high volume dispatch operations. The building is a shared facility combining a fire station and dispatch center operations. Current dispatch center structural challenges include fluctuating heating, ventilation, and air conditioning, inadequate training room size and design, limited restroom facilities and quiet rooms. South dispatch center is designated as one of the “flee to” or backup communication facilities in the event a planned or spontaneous evacuation occurs at one of the other two centers. South dispatch is not designed for sustained long term dispatch operations as a “flee to” center. This is a recent change initiated by Broward County. The former 911 center in the Broward Sheriff’s headquarters building on W. Broward Blvd. was eliminated as the “flee to” site in large part because the structure has a lower hurricane protection rating. However, noting the recent incidents where evacuation of an existing site was required, there may be a reason to reconsider that plan.

With regard to the South PSAP, consultants observed the close proximity of personnel answering calls and dispatching resources. The dispatch room is not conducive for effective call taking and dispatch operations. The room is designed with very little sound absorbing construction. Walls require sounding absorbing elements. Dispatch and call taking personnel are almost in arms reach of each other. Consoles require sound absorbing panels that shield the individual workstations from each other.

The combination of limited acoustic absorbing construction, personnel in close proximity to each other, different individual speaking volumes and the lack of effective noise cancelling headsets for the telephone conversations results in excessive background noise that hampers operations.

FINDING: Current PSAPs, training facility and “flee to” plans have facility limitations, especially related to adequate space.

Financial Structure

The Operator Agreement between Broward County and BSO clearly spells out the means by which BSO, as the contractor, is to be compensated for services rendered. Article 4. Compensation, Section 4.2, of the Operator Agreement, states that the County “shall fund the Capital and Operational Expenses of the System.” This same section notes that the “County shall provide for management, administration, and oversight” of the System.

As part of the County’s annual budget process, BSO develops a detailed line item budget in concert with the County and the budget must be approved by the Board of County Commissioners. The County

maintains final approval authority of the final budget amount and position count. For example, for fiscal year 15/16, BSO requested 472 positions and a \$43.2 million budget, but received approval for 447 positions and \$39.25 million.

The County and BSO maintain strict controls on the budgeted funds. At the beginning of each month, the County advances to BSO an annualized monthly payment based on the approved or amended budget. BSO’s monthly reports of actual expenditures are reconciled against the monthly budget and on a quarterly basis any excess funds are recouped by the County in the following month’s advance. Per the agreement, BSO maintains a separate special fund exclusively for revenue and expenses associated with the E911 System.

Annual budget documents provide sufficient detail to determine the intent of expenditures. For example, the Adopted FY15/16 budget line item categorized as “Prof Svc/Admin” totals \$106,605. A review of the Broward Sheriff’s Office report titled, Expenditure by Cost Center – Memo Detail dated May 28, 2015, indicates that the line item is for contracted services for new hires as follows:

New Hire Costs: Average new hire costs based on FY 13/14 employees processed is \$1,035.00. 445 filled positions X 18% attrition rate + ability to hire into attrition = 23%. 23% of 445 positions = 103 new hire expectation. 103 new hires x \$1,035 - \$106,605.00. The expenses associated with this line item include contracting for new hire psychological testing, medical physicals, fitness and drug testing.

This type of detail is a best practice that provides for comparison of the budget plan with actual expenditures, provides an historical record and allows for better planning year to year. This is an especially important practice for a relatively new contracted entity such as BSO and the Regional E911 System.

The primary expenditures covered in the BSO budget are for personnel, operating supplies, software licenses, memberships, and training. There are no major capital expenditures appearing in the BSO Regional E911 budget. Table 2 below is a summary of the adopted BSO FY15/16 budget.

Table 2. BSO Adopted FY 15/16/ Summary Budget

Summary Line Item	FY15/16 Adopted Budget
Regular Salary	\$25,725,340
Overtime (8.5% of Salaries)	2,186,654
Fringe Benefits	10,879,424
Prof Svs/Admin (Hiring Backfill for Attrition)	106,605
Capital	3,230
Licenses, Memberships, Other Operating	347,331
Total FY15/16 Adopted Budget	\$39,248,584

The budget supports a total of 447 full-time positions, an increase of four positions from the prior fiscal year's budget. Table 3 below, provides the detail of personnel positions and full-time equivalent (FTE) positions.

Table 3. BSO E911 Authorized Full-Time Positions in FY15/16 Budget

Position Title	Number Full-Time Positions
Director	1
Assistant Director	1
Manager	6
Admin Specialist	1
Training Unit	9
Operations Analyst	1
Duty Officer	37
Quality Assurance	9
EMDQ	9
Accreditation	1
Audio Evidence	6
Dispatcher	252
Call taker	114
Total Full-Time Positions	447

The County's FY15/16 budget for ORCAT includes a total of 27 positions and the transfer of funding to BSO for dispatch services. ORCAT positions are as follows in Table 4 below.

Table 4. ORCAT Authorized Positions in FH15/16 Budget

ORCAT Positions	Number Positions
Communications Technology Administration	3
Countywide Public Safety Applications	7
Countywide Radio Communications	11
E911 Contract Management/Oversight	6
Total ORCAT Positions	27

From the positions in Table 4 above, only the six assigned to contract management/oversight are directly related to operation of the PSAPs. The other positions would still be required by the County to manage the significant infrastructure necessary to provide radio and technology to public safety agencies.

Revenue support for the Regional E911 System is derived primarily from 911 communications fees, ad valorem taxes (property taxes), and intergovernmental revenues. Major capital expenditures for the Regional E911 system are a County responsibility and are included in the County's Capital Improvement Plan.

STAKEHOLDER INPUT

Methodology

This report section provides findings and analyses based on qualitative data from stakeholder interviews and surveys. Along with detailed data analyses outlined later, these two data sources were analyzed, and specific attention was paid to intersections between qualitative and quantitative data.

Stakeholder Input

The consultants conducted numerous interviews with County and Broward Sheriff's Office officials and other key management personnel that included:

- Broward County Administrator and senior executives
- Broward Sheriff's Office officials
- Office of Regional Communications Director
- Broward County Chiefs of Police Association
- Fire Chiefs Association of Broward County
- Broward County League of Cities
- Members of Broward City County Managers Association

In addition, consultants interviewed Regional E911 management, communications operators and County staff. Consultants observed dispatch processes and overall operations.

At the end of March 2016, *FITCH* launched a survey tool specifically for Regional E911 Communications Operators and a separate survey for Regional E911 management personnel. Survey invitations were sent to 377 dispatch personnel and obtained a 34.5% response. Fifty-one survey invitations were sent to dispatch management personnel and a 47% response was obtained. Survey responses were anonymous.

Stakeholder Perceptions – Level 1 Interviews

At the inception of this project, and throughout its initial phase, *FITCH* met with senior level stakeholders from Broward County, Broward Sheriff's Office, law enforcement agencies, fire rescue agencies, and municipal leaders. These discussions included both elected officials and senior management personnel. The focus of these discussions was to understand perceptions and key concerns regarding the initial implementation and current operations of the regional communications system. The issues raised in these discussions help to focus the analysis of quantitative data and ensure salient items are captured. From a qualitative perspective, these discussions provided insight into the perceptions among, and working relationships between, major stakeholders.

There was a high degree of consensus on a variety of issues - both positive and negative. While the root cause of some items may be perceived differently by some stakeholders, the consistency of the following items indicates that future attention is warranted to address the issues raised herein.

Positive Issues Related to the Regional E911 System

During discussions leading to consolidation of the disparate Public Safety Access Points into an integrated regional communications system, stakeholders identified eight goals for their new system as noted below.

Table 5. Goals for the Broward Regional E911 System

1. Improve service
2. Employ the best technology available to expedite emergency response
3. Establish consistent performance metrics
4. Reduce delay in transfer of emergency calls
5. Faster emergency response times
6. Enhance interoperability and coordination amongst responding agencies
7. Fewer errors due to standardized call handling and dispatch protocols
8. Save significant amount of taxpayers' dollars

While some of the goals were not met in the first 20 months of operation, it is important to acknowledge that others have been realized. These are summarized below.

- Stakeholders generally agreed that the new system has already established some stringent performance measures, and that these measures are being reported in a consistent manner and disseminated widely. These attributes were absent prior to consolidation.
- The goal to reduce delays related to transferring misdirected 911 callers from one PSAP to another has been dramatically reduced since inception of the System. Quantitatively, there has been a significant reduction in the number of transfers for emergency callers, thereby reducing any delays in getting assistance to persons in need. Table 6 below reflects the significant reduction that has occurred between October 2013 to January 2016. It is generally assumed that call transfers between PSAPs incur a 30-second impact on total call processing times.¹⁰

Table 6. History of Call Transfers Between 911 Centers¹¹

	2013 Stand Alone PSAPs (October 2013)	2014 Consolidated PSAP (October 2014)	2016 Consolidated PSAP (January 2016)	Percent Change 2013 – 2016
Count of 911 Transfers	12,291	7,581	1,690	(86.25%)

¹⁰ See Section 7.4.4 from NFPA 1221 (2016).

¹¹ Derived from presentation to Florida E911 Coordinators found at (<http://www.dms.myflorida.com/content/download/111575/622381/broward>) and January 2016 Consolidated Communications Monthly Report.

FINDING: The number of 911 callers required to be transferred has been essentially eliminated under the consolidated regional system, and reduced total call processing times by approximately 30 seconds.

- End-users acknowledge that collaboration among first responder agencies, both law enforcement and fire rescue agencies, has increased since the regional system began. This collaboration includes greater consistency in dispatch policy & procedures and more common nomenclature among first responders, thereby enhancing coordination and control in the field. Participants also acknowledge the level of transparency in the Regional E911 System is significantly greater than agencies experienced under their former model.
- It was further noted by all stakeholders that Broward County is in the process of upgrading major technological components of the Regional E911 System. The County is making significant investments which will address the computer-aided dispatch (CAD) system, public safety radio system, and fire station alerting system. These upgrades represent significant capital expenditures from Broward County's Capital Improvement Plan (CIP) Budget. While the County has sought to ensure stakeholder input is widespread, some external stakeholders believe that outreach efforts to the end-users need to be further strengthened.

Issues of Concern Related to Regional Communications

It is clear that the majority of stakeholders believe the System has improved its overall performance since Regional E911's formal launch in October 2014. Nonetheless, there remain concerns that existing processes and governance structures keep the system from achieving significant additional improvements.

One of the major concerns shared by all stakeholders is the state of relations among the various parties, specifically the County; BSO in their role as contractor in operating the regional communication system; and end-users, namely, law enforcement and fire rescue personnel who provide direct services to residents and visitors. All parties rely on the Regional E911 System's technology and operations to support their respective missions. While these stakeholder groups are clearly engaged and motivated to achieve the same goals, there is a consensus among the parties that "something is broken". Every group indicated that "there is a lack of trust" between system participants.

Stakeholders other than Broward County attribute much of this to the County's role in system oversight. From the County's perspective, they remain responsible for the overall system.

This responsibility is paramount due to two factors. First, the Broward County Charter, Article V. – Public Safety, Section 5.02. – Fire protection, notes that the County "shall provide funding for the communications infrastructure . . . [that] shall facilitate closest unit response for life-threatening emergencies. . ." The County's responsibilities can only be realistically achieved through coordination

among various providers to ensure a regional approach. This process must include utilization of common technology and application of consistent policies among law enforcement and fire agencies. A regional system is the most effective and efficient method to accomplish this mandate. With the recent consolidation, Broward County is able to provide for closest unit response. However, fire-rescue agencies have not yet adopted the necessary protocols, and therefore the County and BSO are unable to implement this system.

FINDING: The consolidated system is capable of closest unit response to life-threatening emergencies, but protocols are not yet in place to implement this capability.

The second factor is that Broward County funds the regional backbone and carries the financial burden for the technology and infrastructure to achieve regional communications. The County also funds the contract to staff and operate the three Regional E911 sites.

During initial discussions contemplating consolidation to a regional communications system, participants, largely municipal and end-user representatives, drafted a series of stringent performance measures, mostly patterned after various national recommendations including from the National Emergency Number Association (NENA) and National Fire Protection Association (NFPA) and. By almost all admissions, these metrics are relatively aggressive and were designed to reflect the desire of the community that public safety, and specifically 911 services, should meet high standards of performance.

For some, adoption of these measures, as originally drafted and their subsequent adoption as benchmarks for Regional E911's performance, can arguably be considered "stretch goals." These measures are embodied in the Broward County/Broward Sheriff's Office operator agreement titled, "The Operation of Call-Taking, Teletype (Queries Only) and Dispatch Services for the Consolidated Regional E911 Communications System." Attachment A provides the detail of performance measures as outlined in Exhibit D of the Operator Agreement and within the agreements between Broward County and participating municipalities. Additional documents, including the interlocal agreements related to the regional 911 system can be found online at www.broward.org, Regional Communications and Technology, Regional Agreements.

Stakeholders clearly desire strong performance measures, and the County has the responsibility to monitor and report on that performance. Yet, stakeholders external to Broward County government, namely BSO and the participating cities, believe that the County's application of these performance measures has, in some ways, been unreasonable and punitive. County staff believes they have applied the standards consistently and within the language of the applicable interlocal agreements, which can be modified with stakeholder consensus. This issue of relevant and meaningful performance measures is an area of significant friction between the parties. *FITCH* has identified a number of problems in the current assessment of System performance. This issue is discussed in more detail in the Data Analysis

section of this report, with specific recommendations regarding appropriate performance measures to be provided in Phase 2 of this project.

Stakeholders have expressed concern with the quality of services being provided by the Broward Sheriff's Office as the System Operator. Some concerns revolve around dispatcher competency (largely seen as an outcome of the current training received by Regional E911 personnel) and the application of policies and procedures currently used by call taker and radio operator personnel. There is also a perception that collective bargaining/labor issues within the Sheriff's Office have impeded the Sheriff's ability to effectively manage the workforce. These limitations are believed to have led to poorer service and support for field personnel.

Stakeholders outside Broward County perceive that the County's intense process-driven oversight of the system is characteristic of these issues outlined above. Complaints towards County staff include that the County staff is essentially attempting to "run operations" of the law enforcement and fire rescue agencies. These stakeholders cite examples of the County defining and managing processes for system changes.

Upon examining this issue more closely, *FITCH* has identified examples of the County's work intruding into areas that are clearly operational in nature. While there is some validity to these concerns, it must be further noted that end-users of the system, namely, law enforcement and fire rescue agencies, have in many ways acquiesced control to the County by agreeing to a somewhat limited and ambiguous role for input into the system's operations. Most, if not all, protocol changes and guidance of the system occurs after fire and police chief associations have approved of these changes. There also exists an incident management system designed for end-users to identify system issues.

This issue of oversight and roles/responsibilities, in essence the rules of engagement, is one that *FITCH* has identified as requiring more dialog among the parties. *FITCH* will make recommendations on what rules should be adopted in the subsequent Phase 2 report.

Finally, a number of municipal elected and chief executive leaders largely voiced similar concerns to those above. One additional concern by many communities was that too much emphasis is placed on performance metrics in lieu of ensuring the quality of services. However, leaders in Pembroke Pines voiced the opinion that call-processing times (referred to as P2/P3) needed greater attention to more closely mirror their experience prior to consolidation. While municipal leaders do not fully share a common perspective, the prevalent concern by many local leaders of an overemphasis on metrics over quality can be better characterized as goal displacement.

The County's significant focus on performance metrics and managing change processes including some of an operational nature, does not lend itself to fully allow a nimble system be developed that can adjust and ensure quality services and meet end-user expectations. The impact of this goal displacement has

led to the Sheriff's Office expending extraordinary effort to address process issues rather than dealing with more substantive issues of staffing, training, and stronger Regional E911 oversight.

FINDING: The County has inappropriately made, and public safety officials allowed, some operational decisions to be handled by the County that should, instead, be determined by public safety officials.

Stakeholder Perceptions - Level 2 & 3 Interviews

Interviews of mid-level and supervisory personnel were conducted across all three major stakeholder groups: The County, BSO, and end-users. Level 3 interviews with Communications Operators/Dispatchers at North, Central, and South Regional E911 facilities were also conducted in the first half of March 2016. One-on-one interviews were conducted on a voluntary basis using open ended questions.

Positive attributes noted consistently throughout the interviews, were that Regional E911 personnel are dedicated, want to succeed, want to do a good job, and they feel that failure is not an option.

In the interview process, concerns were repeatedly expressed about the following:

- Teamwork
- Personnel integration
- Inefficient procedures/processes
- Ongoing training and accountability
- Quality improvement/assurance
- Equipment failures and emergency procedures
- Staffing and work schedules
- Work environment/respect

Below are summaries of comments regarding each of the above items.

Teamwork

One theme that emerged throughout the Level 2 and 3 interviews can easily be described as silos or the lack of teamwork. Mid-level managers and supervisory personnel were questioned on how their role integrates, or otherwise assists others in resolving system issues. The expression, "I don't look at that," or "someone else deals with that," was a common response. There was little evidence that supervisory and mid-level managers have achieved a more global perspective of the System's fundamental goals. There was also little evidence of a sense of teamwork between various operating units, even within the same employer.

Personnel Integration

Job classification titles and skills of personnel from smaller dispatch centers did not equate to required core competencies needed to achieve success in a regional dispatch center. Initial training was conducted months prior to the regional implementation and it appears that some personnel in the smaller centers received limited initial training that proved inadequate. These factors made integration of personnel difficult at best and, in some cases, continues to impact operational efficiencies.

Inefficient Procedures/Processes

Various procedures are time-consuming and ineffective. The training process of “read and sign” is ineffective due primarily to the volume of documents circulated. Two to three new read and sign documents are published per week that require dispatch personnel acknowledgement and understanding. It was reported that many of these documents either cancel, modified previous policies, or are not applicable to dispatch operations.

The Training Supervisor is required to manually grade training tests and assessments. This is a time-consuming and inefficient process that can be alleviated through the purchase of a relatively inexpensive grading device. This would provide the training supervisor with more actual training time.

Policies affecting fire, law, and EMS agencies are not communicated to field personnel in a timely manner causing conflicts between the field and BSO dispatchers. Duty Officers are mired down in administrative duties and are not focused on supervising dispatch personnel or maintaining situational awareness.

On-going Training and Accountability

Dispatchers expressed as a primary concern what they perceive as a lack of quality on-going training. Personnel reported that the Training Officers have not formally met with the Training Section in two years. This can create gaps in knowledge exchange and new training techniques, and does not allow for discussion of the strengths and opportunities to improve new personnel. It was also reported that dispatch personnel are often held accountable for training they did not receive.

Quality Improvement/Assurance

Personnel expressed that their perception of the BSO Quality Assurance unit is that it is focused more on punitive measures than skills enhancement.

Equipment Failures and Emergency Procedures

CAD operational issues, lock-ups, slow downs, and reboots are a daily part of BSO operations. While there remains a reporting system in place for these types of issues, end-users admit they don't report problems based on their experience of “no response” to prior efforts. Dispatch personnel expressed limited knowledge or training on manual mode procedures in the event of a CAD failure for an extended

duration. Call takers and dispatchers reported no real access to the critical supportive documentation such as map books or run cards in the event of a CAD failure.

Likewise, when dispatcher personnel were queried about hurricane operations and preparedness they expressed little to no knowledge. The one common procedure mentioned is that they are to report to the E911 Center. Personnel could not identify whether on-site supplies or sleeping arrangements are accounted for, nor did they express knowledge of scheduling or special operational expectations.

Staffing and Work Schedules

Inadequate staffing was a recurring theme voiced by dispatch personnel at all levels. Dispatchers report that mandatory overtime is assigned multiple times each week. Personnel voiced that the current work schedule compounded with the frequency of mandatory overtime is creating burnout and high stress levels. It was noted that BSO currently utilizes only 8-hour shift schedules for personnel. This practice is not typically seen in large dispatch centers where 8, 10 and/or 12 hour shifts in various combinations are employed to more effectively align staffing with system demands.

As noted later, *FITCH* did find evidence that BSO adjusts staffing patterns very effectively to address variance in demand. Yet, alternate shift schedules may also provide greater satisfaction to employees and help address current 'burn-out' perceived by many working in the 911 centers. *FITCH* will provide specific recommendations regarding alternate scheduling practices in subsequent reports.

Work Environment/Respect

Regional E911 personnel who are co-located in facilities with other agencies and organizations note that they have limited access to basic building facilities such as restrooms, elevators, parking, and entrance sites. Communications operators noted that some agencies do not tolerate any type of disrespect towards dispatch personnel while others seem to ignore the negative behavior. Personnel perceive excessive involvement by the County in operational issues and mention that a County supervisor occupies an office on the dispatch floor while the North Center site manager is located on a different floor.

Dispatcher and Management Surveys

In an effort to expand outreach to stakeholders, *FITCH* launched two survey tools, one for dispatch personnel and one for dispatch center management. The purpose of the surveys was to obtain a broader range of impressions and opinions from the personnel by means of an anonymous tool.

On March 29, 2016, survey invitations were sent directly from the *FITCH* offices to 377 dispatcher personnel and 51 management personnel. The survey tool was available for two weeks and closed on April 12. The survey addressed service levels, workloads, equipment, attitudes and management. Participants were provided with statements and asked to indicate their agreement or disagreement with the statement using the following choices:

1. Strongly agree
2. Agree
3. Neutral
4. Disagree
5. Strongly disagree

Of the 377 invitations to dispatch personnel, 130 personnel substantially completed the survey resulting in a participation rate of 34.5%. There were 15 additional incomplete surveys and those answers were incorporated into the results. Of the 51 invitations sent to management personnel, there were 24 completed surveys resulting in a participation rate of 47%. There were also 9 incomplete surveys and where applicable, those answers were incorporated into the survey results.

Survey Participant Demographics

Respondents are fairly well distributed across three of the four work locations as noted in Table 7 below.

Table 7. Work Locations of Dispatcher and Management Survey Respondents

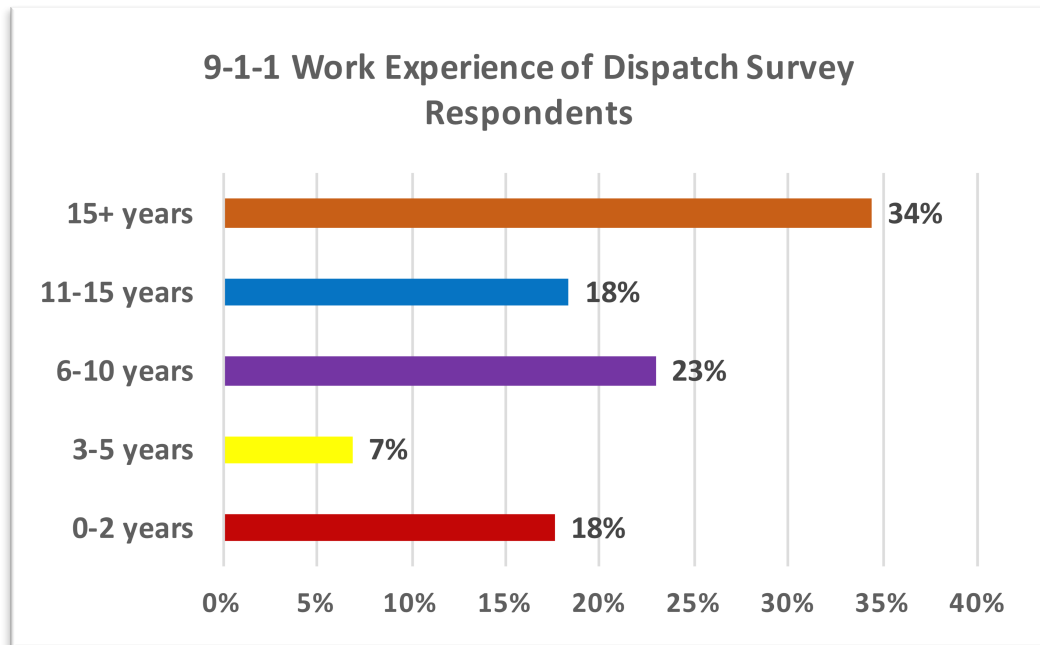
Work Location	% of Dispatcher Respondents	% of Management Respondents
Public Safety Building	8%	20%
North Dispatch	31%	32%
Central Dispatch	26%	20%
South Dispatch	35%	28%

Of the dispatch survey respondents, the largest percentage (47%) worked for BSO prior to consolidation of the Regional Communications Center, and the next largest contingent (14%) previously worked for the City of Fort Lauderdale. Approximately 15% of dispatch survey respondents reported that they had not previously worked for any of the participating cities or for BSO.

Of the management survey respondents, the largest percentage (46%) worked for BSO prior to consolidation and the next largest contingent (25%) previously worked for the City of Fort Lauderdale. Approximately 4% of management survey respondents reported that they had not previously worked for any of the participating cities or for BSO.

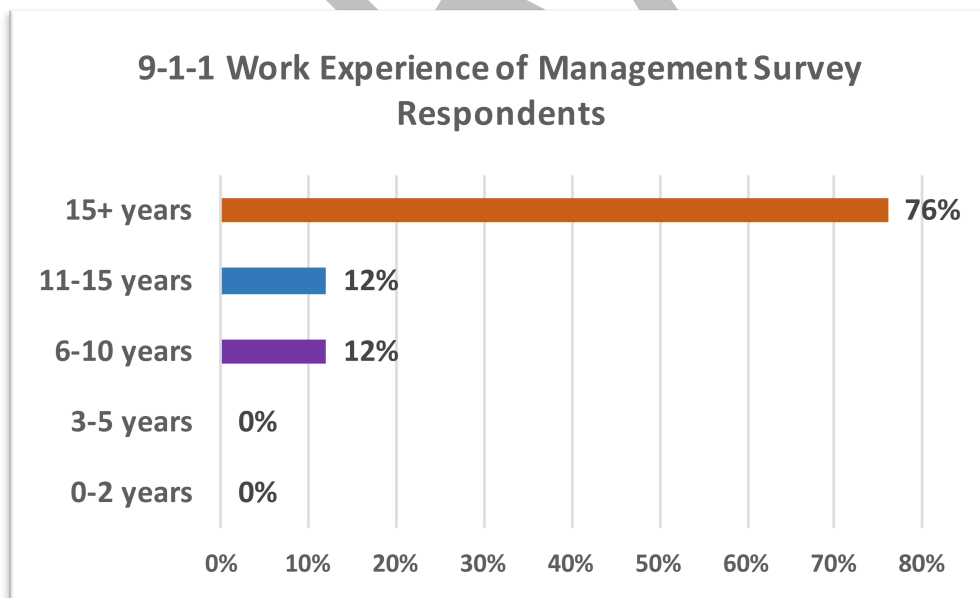
Figures 4 and 5 below indicate the percentage of dispatch and management survey respondents and the number of years of experience working in a 911 environment.

Figure 4. Dispatcher Survey Respondents' 911 Work Experience



Seventy-five percent (75%) of dispatch survey respondents reported that they had worked in a 911 environment for at least six and up to 15 or more years. Eighteen percent (18%) indicated they had two years or less experience working in a 911 environment.

Figure 5. Management Survey Respondents' 911 Work Experience



None of the management survey respondents reported fewer than six years work experience in a 911 environment and the overwhelming majority, 75%, reported at least 15 years of experience.

Summary of Survey Results

For ease of reading, the five ranges of agreement/disagreement with survey statements are summarized into three groups as follows:

1. agree/strongly agree,
2. neutral, and
3. disagree/strongly disagree.

The tables below provide the summarized percentages for both the Dispatch and the Management surveys and results are grouped into three categories as noted above.

Service Level Statements

Table 8. I believe we provide a good level of service to citizens who call 911.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 64% either agreed/strongly agreed ▪ 13% were neutral ▪ 23% either disagreed/strongly disagreed 	<ul style="list-style-type: none"> ▪ 69% either agreed/strongly agreed ▪ 17% were neutral ▪ 14% either disagreed/strongly disagreed

Table 9. Please rate the following: I believe we provide a good level of support to public safety field personnel.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 69% either agreed/strongly agreed ▪ 14% were neutral ▪ 27% either disagreed/strongly disagreed 	<ul style="list-style-type: none"> ▪ 76% either agreed/strongly agreed ▪ 7% were neutral ▪ 17% either disagreed/strongly disagreed

Table 10. Callers for emergency services provide accurate information regarding the ADDRESS of the emergency.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 5% either agreed/strongly agreed ▪ 17% were neutral ▪ 78% either disagreed/strongly disagreed 	Not asked of managers

Table 11. When I began my current job, the initial training I received prepared me well for the work.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 54% either agreed/strongly agreed ▪ 18% were neutral ▪ 28% either disagreed/strongly disagreed 	<ul style="list-style-type: none"> ▪ 61% either agreed/strongly agreed ▪ 3% were neutral ▪ 36% either disagreed/strongly disagreed

Table 12. The ongoing training I receive continues to enhance my skills.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 39% either agreed/strongly agreed ▪ 24% were neutral ▪ 37% either disagreed/strongly disagreed 	<ul style="list-style-type: none"> ▪ 46% either agreed/strongly agreed ▪ 25% were neutral ▪ 29% either disagreed/strongly disagreed

Table 13. The Regional Communications System is equipped and prepared to handle large scale emergencies such as hurricanes or mass shooting incidents.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 31% either agreed/strongly agreed ▪ 28% were neutral ▪ 41% either disagreed/strongly disagreed 	<ul style="list-style-type: none"> ▪ 69% either agreed/strongly agreed ▪ 7% were neutral ▪ 24% either disagreed/strongly disagreed

Workload Statements

Table 14. The work methods we utilize help improve the efficiency in our work.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 16% either agreed/strongly agreed ▪ 26% were neutral ▪ 58% either disagreed/strongly disagreed 	<ul style="list-style-type: none"> ▪ 41% either agreed/strongly agreed ▪ 21% were neutral ▪ 38% either disagreed/strongly disagreed

Table 15. The technologies we utilize improve our efficiency carrying out our work.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 24% either agreed/strongly agreed ▪ 11% were neutral ▪ 65% either disagreed/strongly disagreed 	<ul style="list-style-type: none"> ▪ 17% either agreed/strongly agreed ▪ 35% were neutral ▪ 48% either disagreed/strongly disagreed

Table 16. Policies and procedures are easily understood and applied.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 19% either agreed/strongly agreed ▪ 16% were neutral ▪ 65% either disagreed/strongly disagreed 	<ul style="list-style-type: none"> ▪ 36% either agreed/strongly agreed ▪ 21% were neutral ▪ 43% either disagreed/strongly disagreed

Equipment Statements

Table 17. I can effectively use technology to locate wireless callers who don't know their location.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 51% either agreed/strongly agreed ▪ 24% were neutral ▪ 25% either disagreed/strongly disagreed 	Not asked of managers

Table 18. The technology and information systems we use are reliable and are appropriate to the job.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 27% either agreed/strongly agreed ▪ 20% were neutral ▪ 53% either disagreed/strongly disagreed 	<ul style="list-style-type: none"> ▪ 7% either agreed/strongly agreed ▪ 32% were neutral ▪ 61% either disagreed/strongly disagreed

Table 19. CAD has the tools I need to handle incidents efficiently.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 34% either agreed/strongly agreed ▪ 20% were neutral ▪ 46% either disagreed/strongly disagreed 	Not asked of managers

Table 20. Equipment problems are handled appropriately and I get feedback on problems I report.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 8% either agreed/strongly agreed ▪ 19% were neutral ▪ 73% either disagreed/strongly disagreed 	<ul style="list-style-type: none"> ▪ 32% either agreed/strongly agreed ▪ 14% were neutral ▪ 54% either disagreed/strongly disagreed

Attitude Statements

Table 21. Other occupants of the building I work at treat me with respect.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 38% either agreed/strongly agreed ▪ 33% were neutral ▪ 29% either disagreed/strongly disagreed 	<ul style="list-style-type: none"> ▪ 56% either agreed/strongly agreed ▪ 16% were neutral ▪ 28% either disagreed/strongly disagreed

Table 22. Upper management supports our operations.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 22% either agreed/strongly agreed ▪ 21% were neutral ▪ 57% either disagreed/strongly disagreed 	Not asked of managers

Table 23. There is clear division between the County and BSO on who manages the communications center.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 48% either agreed/strongly agreed ▪ 21% were neutral ▪ 31% either disagreed/strongly disagreed 	<ul style="list-style-type: none"> ▪ 67% either agreed/strongly agreed ▪ 22% were neutral ▪ 11% either disagreed/strongly disagreed

Table 24. Duty officers and site managers are available and willing to help me with problems or concerns.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 37% either agreed/strongly agreed ▪ 32% were neutral ▪ 31% either disagreed/strongly disagreed 	Not asked of managers

Table 25. I receive feedback on my job performance, including positive acknowledgement.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 27% either agreed/strongly agreed ▪ 23% were neutral ▪ 50% either disagreed/strongly disagreed 	<ul style="list-style-type: none"> ▪ 66% either agreed/strongly agreed ▪ 15% were neutral ▪ 19% either disagreed/strongly disagreed

Table 26. Please rate the following: Different work schedules will improve our current staffing challenges.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 65% either agreed/strongly agreed ▪ 17% were neutral ▪ 18% either disagreed/strongly disagreed 	<ul style="list-style-type: none"> ▪ 42% either agreed/strongly agreed ▪ 35% were neutral ▪ 23% either disagreed/strongly disagreed

Table 27. Public safety field personnel treat the dispatch center personnel professionally.

Dispatcher Results	Manager Results
<ul style="list-style-type: none"> ▪ 22% either agreed/strongly agreed ▪ 33% were neutral ▪ 45% either disagreed/strongly disagreed 	<ul style="list-style-type: none"> ▪ 16% either agreed/strongly agreed ▪ 44% were neutral ▪ 40% either disagreed/strongly disagreed

Management Statements

Table 28. Management gives team members a clear picture of the direction BSO Communications is headed.

Dispatcher Results	Manager Results
Not asked of dispatchers	<ul style="list-style-type: none"> ▪ 55% either agreed/strongly agreed ▪ 26% were neutral ▪ 19% either disagreed/strongly disagreed

Table 29. Management understands the daily problems we face with our jobs.

Dispatcher Results	Manager Results
Not asked of dispatchers	<ul style="list-style-type: none"> ▪ 44% either agreed/strongly agreed ▪ 11% were neutral ▪ 45% either disagreed/strongly disagreed

Table 30. Overall, I am satisfied with the job being done by my immediate supervisor.

Dispatcher Results	Manager Results
Not asked of dispatchers	<ul style="list-style-type: none"> ▪ 67% either agreed/strongly agreed ▪ 15% were neutral ▪ 18% either disagreed/strongly disagreed

Table 31. Management encourages others to propose new and innovative ideas.

Dispatcher Results	Manager Results
Not asked of dispatchers	<ul style="list-style-type: none"> ▪ 59% either agreed/strongly agreed ▪ 22% were neutral ▪ 19% either disagreed/strongly disagreed

Table 32. Management effectively deals with misconduct or unsatisfactory performance.

Dispatcher Results	Manager Results
Not asked of dispatchers	<ul style="list-style-type: none"> ▪ 30% either agreed/strongly agreed ▪ 22% were neutral ▪ 48% either disagreed/strongly disagreed

911 Center Concerns Rankings

Table 33. Please rank the following issues in order of importance (1 is your top concern and 5 is the least concern).

Dispatcher Rankings	Manager Rankings
<ol style="list-style-type: none"> 1. Adequate staffing 2. Officer safety 3. Increase in workload 4. Loss of specific community 5. Improved accountability 	<ol style="list-style-type: none"> 1. Adequate staffing 2. Officer safety 3. Training 4. Improved accountability 5. Increase in workload 6. Loss of specific community

Communication Center Equipment Satisfaction Rankings

Table 34. Please rank the following issues in order of importance (1 is the most satisfied to you and 5 is the least satisfied).

Dispatcher Rankings	Manager Rankings
<ol style="list-style-type: none"> 1. CAD 2. 911 telephone system 3. Radio system 4. Records management 5. Communication center facility 	<ol style="list-style-type: none"> 1. Radio system 2. Communication center facility 3. 911 telephone system 4. CAD 5. Records management

In addition to the specific questions summarized above, an open-ended question permitted respondents to voice issues they felt most important. For line personnel the issues of mandatory overtime due to limited staffing and the need for additional training were highlighted most often. Supervisory personnel felt most strongly that the initial consolidation was rushed and this resulted in a multitude of problems that remain today. Overall, the results above highlight an organization that has significant morale problems and frustration with lingering staffing, training and management issues.

FINDING: BSO's operation of the PSAPs are challenged with significant morale problems embedded in issues of staffing, training and management.

DATA ANALYSES

Sources of Data

Background

Dispatch operations in Broward County are conducted at three locations, the North, Central, and South dispatch centers. Dispatch functions in all three centers occur at “intake” workstations and “assignment” workstations. The analyses required to characterize the Broward dispatch operations involves quantitating all the workloads flowing across these workstations by tallying all the processing intervals experienced at these workstations. The primary data required for these quantitations reside in three repositories: The Intrado VIPER telephony server, the Computer Aided Dispatch System, and the radio logs. There also exists a log of outgoing telephone calls.

FITCH entered into this project with the expectation that complete downloads of raw data from these three sources would be available. The actual availability of raw data was significantly less. The single export of data that went smoothly was the outgoing telephone logs. Substantial delays were introduced into the project’s timeline due to exports of incomplete and incorrect data elements provided from County staff. Once identified, these data issues were corrected or appropriate analytical approaches were developed to address any limitations.

The telephony server and radio logs presented more severe problems. In these two cases, Broward did not have the technology to directly export any data from these sources in machine readable formats. Instead, *FITCH* was presented with human readable text documents. *FITCH* had to apply cumbersome workarounds to convert data in human format to data that was usefully machine searchable.

CAD Export

Interpreting the contents of the CAD export was not a smooth process. The primary problem was getting County staff to provide clear definitions of which event along an incident processing timeline was being logged into which timestamp in the CAD. The P1, P2, and P3 time intervals are all delimited by start and stop timestamps. Initial data, when analyzed, had unusual characteristics and was subsequently determined to contain incorrect data fields. New data was quickly obtained once the issue was identified to the County, and *FITCH* was able to verify its usefulness for data analysis. Ultimately, CAD data for FIRE and LAW incidents was provided for January 2015 through December 2015.

Telephony Export

Broward County staff informed *FITCH* that they were unable to output raw data from the Intrado VIPER telephony server. The best they could provide was to output human readable Call Detail Records (CDRs) as text documents. They output one report per dispatch center per day of year from January through October 2015 in the telephony system’s abbreviated “Basic Format”. They output a combined report for all three dispatch centers per day of year for November, 2015 through January 2016 in the telephony system’s “Extended Format”. More than one thousand individual report documents were provided to

FITCH. The reports that were provided were intended to be human readable. As such, the text files that were provided did not conform to the standard text formats routinely used for data transfers between databases. *FITCH* had to convert each of the Broward CDR reports to a machine readable format suitable for input into a database. This required editing the report documents at the level of the hexadecimal bytes comprising the files.

Upon inspection, the Basic Format CDR reports were found to contain insufficient details of telephony operations, and were unsuitable for the analyses required for the conduct of *FITCH*'s studies. Broward informed *FITCH* that Extended Format reports were not available for the period January 2015 through October 2015 due to an upgrade of the telephony system. As a consequence, the analyses of telephony data in this report are limited to the three-month period of November 2015 through January 2016 for which the Extended Format CDRs were available.

Getting the Extended Format Call Detail Records into machine readable format was only the first step. Thereafter, the block of text describing each single incident had to be parsed into individual data fields. *FITCH* reverse engineered the telephony primary data table from the human readable reports that were generated by Broward from the telephony server.

The overlap between the telephony data and the CAD data is limited to November and December 2015. Although not complete, the consultants feel that this is a sufficient sample to come to meaningful conclusions about the behavior of the system over the whole year. This opinion is bolstered by the large number of incidents captured in this time period and the limited impact of seasonality has on performance data in the Broward system.

Radio Export

Broward County staff informed *FITCH* that they were unable to export raw data from the radio logs. The only information they could provide was a 611-page PDF of a year-end summary report titled "Talkgroups at Zone Summary 150101 – 151231". *FITCH* was eventually provided a cross-reference table showing acronyms for the radio channels and the agency being dispatched. Unfortunately, the cross-reference table, as initially provided, was inaccurate. Acronyms appearing in the cross-reference table did not appear in the PDF of the year end summary, and vice-versa. Multiple verbal inquiries were required to finally achieve a consistent picture of acronyms for the radio channels and the agency being dispatched.

Only two pieces of relevant data per dispatch channel were to be found in the document. The first was the total annual transmit-receive time per dispatch channel (air-time), and the second was the average duration per talk-listen cycle. The annual air-time per dispatch channel was combined with the annual incident count per dispatched agency, as taken from the CAD, to obtain the average air-time per incident for each specific agency. These broad averages are sufficient for the calculations of workloads needed in the Erlang modeling for this report.

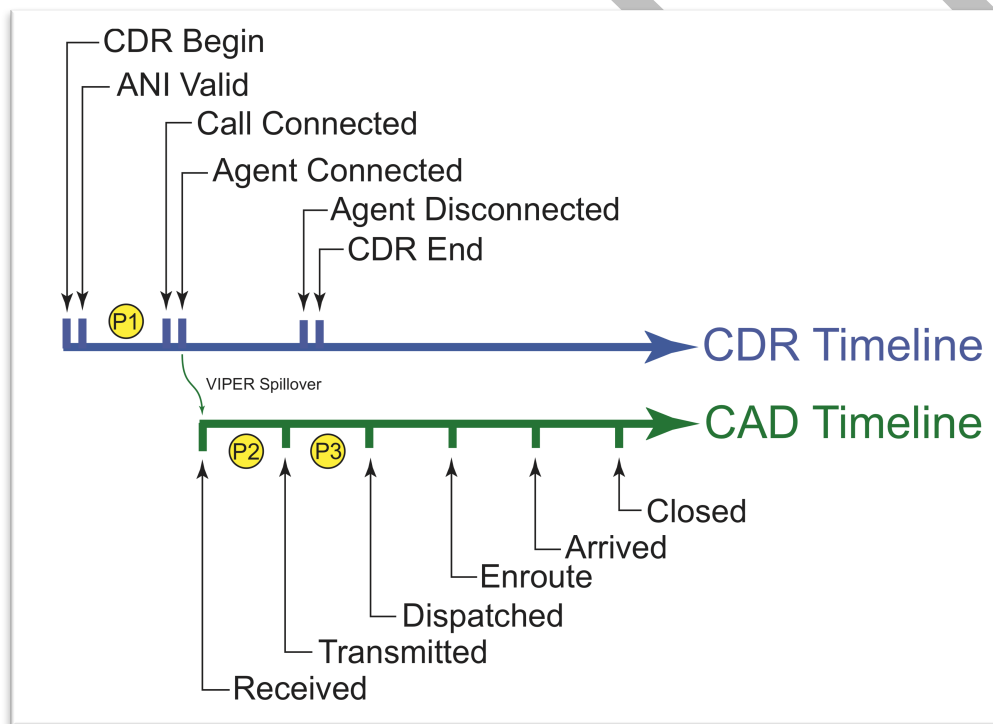
CAD and CDR Timelines

Relationship

Access to data in the Broward system is complicated because there is no single source for all of the factoids required to describe the overall performance of the system. The telephony server and the Computer Aided Dispatch system contain the primary data tables for the system. The relationship of these two data tables is diagrammed in Figure 6.

The upper timeline in Figure 6, below, shows the names and relative sequence of the timestamps that comprise a Call Detail Record, CDR, for an incident in the telephony server. The lower timeline in Figure 6 shows the names and relative sequence of the timestamps that comprise the record of an incident in the CAD server.

Figure 6. Relationship Between CDR and CAD Timelines



The processing of an incident begins when a call rings in to the 911 trunk line at [CDR Begin]. The answer delay interval P1, as defined to *FITCH* by Broward County, extends from when the calling phone number is validated at [ANI Valid] until a call taker is identified as available at [Call Connected]. The intake call taker picks up the call at [AGENT CONNECTED]. The spillover of data from the telephony server (the CDR timeline) to the CAD server occurs at this point. The beginning of the spillover process is logged in the telephony data tables as the [AGENT CONNECTED] timestamp. The end of the spillover process is logged into the CAD data tables as the [Received] timestamp.

It is important to grasp that *there is no change in call taker, that is, the same call taker remains on the line in the spillover from the CDR timeline to the CAD timeline*. To get a complete picture of what an intake call taker actually does, it is necessary to look at timestamps logged into both timelines which, in turn, requires a link between the timelines.

The intake processing interval, P2, extends from the [Received] timestamp to the [Transmit] timestamp when the intake dispatcher releases the incident to the assignment workstations. The assignment processing interval, P3, extends from the [Transmit] timestamp until the [Dispatch] timestamp.

The combined P2/P3 interval extends from the [Received] timestamp until the [Dispatched] timestamp. The critical failure of information technology in the Broward system is that the [Received] timestamp is empty for a significant number of incident records in the CAD.

FINDING: For more than half of the incident records, the event in the CAD cannot be linked to the unique Call Detail Record (CDR) that initiated the incident.

Validation of [Received] Timestamps

Almost half of the [Received] timestamps are missing in the CAD. Those that are missing are blatantly obvious. However, there are corruptions apparent even among [Received] timestamps that are present. There are examples where the [Received] timestamp has the wrong date compared to the other timestamps that comprise the incident record. There are examples in which the [Received] timestamp is chronologically after the [Transmit] timestamp, in large part because the CAD was overwriting timestamps when a call taker rebid the ANI/ALI information. These corruptions became detectable because they are so extreme. The consultants' concern was that less extreme corruptions remained undetected among the [Received] timestamps. For those records where a [Received] timestamp exists, the County uses all those records for their calculation of performance measures. Where a record has a timestamp with an obvious wrong date, Motorola developed a computer script to extract only the time of day from the record to use in its calculation and ignores the erroneous date. *FITCH* determined a validation of data on the received timestamp was necessary to increase the statistical validity of reported performance. This validation process is explained in more detail below.

To validate some subset of the existing [Received] timestamps, the consultants applied the following methodology. A [Received] timestamp in the CAD data tables was considered to be validated when two criteria were met:

There exists an [AGENT_CONNECTED] timestamp in the telephone data tables within the preceding 5 seconds.

AND

The telephone number in the CAD data table matches the telephone number in the telephone data tables.

The [Received] timestamp in the CAD data tables is taken to log the end of the VIPER spillover process from the telephone data tables. The [AGENT_CONNECTED] timestamp in the telephone data tables is taken to log the beginning of the VIPER spillover process. The VIPER spillover process itself requires 2 – 3 seconds to complete. A 5-second window was applied to accommodate any slight offsets in clock time between the data tables.

Statistics for Received Timestamps

Table 35 below provides statistics for the availability of validated [Received] timestamps as well as the numbers of incident records in the CAD that can be clearly linked to the telephone record that initiated the incident.

Table 35. Validated [Received] Timestamps 11/1/2015 through 12/31/2015

Parameter	Count	Percentage
LAW Records	136,595	
With [Received] timestamps	36,417	26.7%
With [Received] timestamps validated	24,131	17.7%
With [Received] timestamps Out-of-Range	890	0.7%
FIRE Records	43,722	
With [Received] timestamps	29,369	67.2%
With [Received] timestamps validated	22,067	50.5%
With [Received] timestamps Out-of-Range	235	0.5%

The [Received] data field contains three categories: NULLS, validated timestamps and non-validated timestamps. Only the validated [Received] timestamps should be used to calculate P2/P3 intervals. Even when a validated [Received] timestamp is used, there is still no guarantee that the P2/P3 interval will be free of reverse bias.¹²

¹² From strict application of industrial engineering and statistical standards, the County can make no assurance that the P2/P3 data provided to *FITCH* and to stakeholders is statistically valid. The inescapable flaw with all current P2/P3 statistics is that they depend on the [Received] timestamp – of which there are only samples. The County is unable to fully identify why/how [Received] timestamps are missing or ‘out of sequence’; does not know if there is a bias for how [Received] timestamps are selected to go missing or allowed to become ‘out of sequence’; does not know if there is a “reverse” bias for the [Received] timestamps that are left to run statistics on (described above as validated) – and therefore cannot statistically prove that remaining [Received] timestamps have been randomly selected. Without proof of randomness, then none of the P2/P3 statistics are credible under strict statistical methods. This is not a unique problem encountered with complex data analysis – yet a problem nonetheless. Notwithstanding this disclaimer, the results reported here are made under an assumption that the remaining sample provided is the result of randomness.

FINDING: Employing the procedures above, FITCH found only 25.6% of CAD records valid for use in analysis of P2/P3.

Performance Targets

Selection of Performance Targets

The Consolidated Dispatch System was launched with high expectations and a concurrent set of aggressive performance targets. The System was designed to include Quality Improvement Teams and quality assurance processes to monitor performance as judged by meeting or not meeting specific targets – essentially a ‘PASS/FAIL’ or ‘YES/NO’ analysis.

While the County does report trend data for certain metrics in their supplemental sections, the focus on percentage ‘PASS/FAIL’ or ‘YES/NO’ against targets does the County a disservice in that it may foster an expectation that the system can somehow be made perfect. The reality of emergency service systems is that they are expected to be overwhelmed at some time or another. Consider the impact recent shootings in Orlando had on their emergency services – or a recent tornado in Broward County.

The initial challenge upon consolidation was learning how to make the system **work**. For example, the County has implemented fairly comprehensive quality assurance / quality improvement processes as part of the consolidated System. The Incident Management Tracking System to identify issues from end users and Operational Review Teams made up of end users, add value to the System. These type of efforts allow for a more clinical perspective on how the System can improve, and has led the consultants to feel that the system has turned a corner. The challenge is now how to make the system **work even better**. Performance targets should be selected such that they contribute to making the system work better.

FINDING: The County has implemented a set of quality assurance & improvement processes that assist in objectively moving the System forward

The interpretation of the current performance targets is from the perspective of a PASS/FAIL cutoff. This concept is borrowed from the industrial engineering community where it is referred to as “Inspection by Attributes”. The most formalized, current embodiment of PASS/FAIL acceptance testing is “Sampling Procedures and Tables for Inspection by Attributes, ANSI / ASQ Z1.4-2008. The methodology used in Broward is classified as a “single sampling plan” wherein a lot is accepted or rejected on the basis of pulling a single group of samples from the lot for inspection.

W. Edward Deming was the industrial statistician who is credited with being a major contributor to the Japanese industrial resurgence after WWII through his introduction of total quality management (TQM). Deming held the use of PASS/FAIL targets in very low regard. He noted that the main use of PASS/FAIL targets was to beat the supplier over the head. The corollary to this is his admonishment to “manage the cause not the result.”¹³ Donald Wheeler, another well-known quality control expert, cautions that you cannot improve the quality in the process stream using PASS/FAIL targets because the method teaches nothing about the process that produced the product.¹⁴ FITCH sees both Deming’s and Wheeler’s dynamics playing out in Broward County. The attraction of PASS/FAIL targets is that they are easy to implement, and, at first glance, appear easy to interpret. The underlying reality is much more complex and less convenient.

FINDING: The County’s use of PASS/FAIL targets provides little in the way of information for continuous quality and performance improvement.

P1 Intervals

The target that has received an inordinate amount of attention from Broward stakeholders goes by the moniker “P1”. In Figure 6 above, (Relationship Between CDR and CAD Timelines), the P1 intervals extends from when the caller’s telephone number has been validated at the [ANI Valid] timestamp until an available intake dispatcher has been identified at the [Call Connected] timestamp. The P1 interval is also referred to as the answer delay. This time interval is the subject of *recommendations* from both the National Fire Protection Association (NFPA) and the National Emergency Number Association (NENA).

Implementation of the P1 Target

As part of the County’s current implementation of the P1 target, dispatch operations of the prior day are reviewed. The “busy hour” of the day is identified, and the answer delay in that hour is compared to the target in order to issue the PASS/FAIL assessment for that hour. For instance, the “busy hour” last Wednesday may have been 1900 hours, while the “busy hour” last Thursday was 0300 hours. Under current practice, the “busy hour” is a variable that is selected **retrospectively**. This implementation is loosely modeled on the recommendation in NENA 56-005 and is well understood by all stakeholders.

This metric alone fails to represent the overall performance of the dispatch intake operation by focusing exclusively on one-off events that randomly impact the system. The outcome of the County’s methodology is that BSO is driven to deploy maximum staffing at all hours of the day and disregard the increased annual cost incurred to fix a one-off problem that happened at 3 AM last Thursday morning. the County’s implementation of the P1 target does not lead to actionable teachings about the functioning of BSO dispatch operations.

¹³ The W. Edwards Deming Institute, <http://www.blog.deming.org>, accessed May 2016.

¹⁴ Donald J. Wheeler, “Understanding Statistical Process Control”, SPC Press, 1992. ISBN 978-0-945320-69-2

NENA 56-005

The text of NENA 56-005¹⁵ Section 3.1 is reproduced in Figure 7, below.

Figure 7. NENA Recommendation

3 Call taking standards

- 3.1 **Standard for answering 9-1-1 Calls.** Ninety percent (90%) of all 9-1-1 calls arriving at the Public Safety Answering Point (PSAP) shall be answered within ten (10) seconds during the busy hour (the hour each day with the greatest call volume, as defined in the NENA Master Glossary). Ninety-five (95%) of all 9-1-1 calls should be answered within twenty (20) seconds.

the County's implementation of the 'bust hour' criteria in NENA 56-005, Section 3.1, focuses solely on the "busy hour" of the day, thus ignoring the other 23 hours of the day. By default, these hours are dealt with through an implied syllogism that may be paraphrased as follows:

IF All is well in the busy hour of the day
THEN All will be well in the remaining hours of the day.

Taken by itself, this sounds reasonable. However, for this to be valid and for NENA 56-005 to apply to Broward, the **same** number of dispatchers must be on duty at the busy hour **and** at all other hours of the day. Confounding the application of NENA 56-005, BSO adjusts its intake staffing on an hour-by-hour basis. The County's implementation of the NENA recommendation does not accommodate this reality.

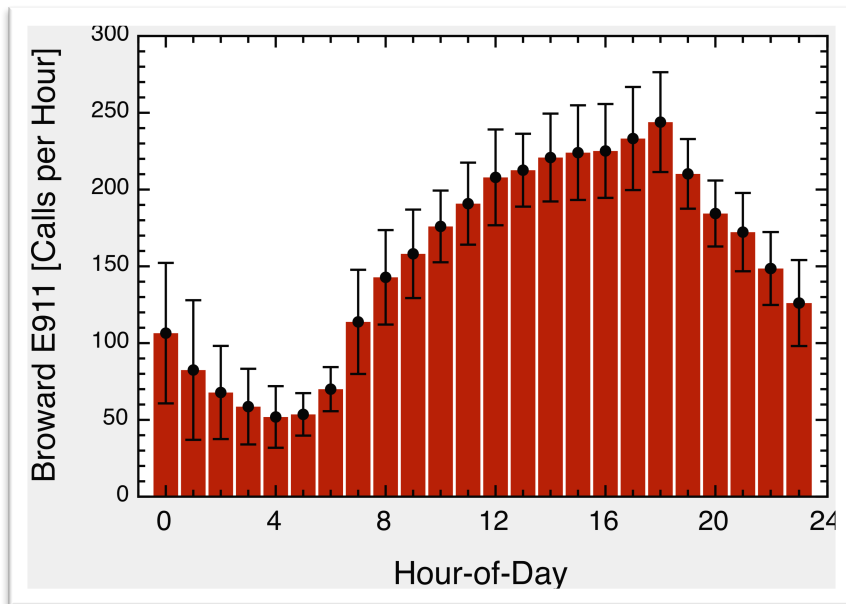
The second criteria in NENA 56-005, Section 3.1 is that 95% of all calls should be answered within 20 seconds. When examining the County's reporting of these two criteria, one must consider the disconnect in their relative performance – "busy hour" performance has largely "FAILED" while the 95% within 20 seconds criteria has PASSED by a statistically large degree. This should cause one to pause and contemplate why.

Busy Hour

Any attempt to implement NENA 56-005 requires that the "busy hour" be determined and then the answer delay in that hour be calculated. Even if NENA 56-005 was the correct metric to evaluate BSO dispatch, the County's determination of the busy hour assumes the County should retrospectively define the previous day's busy hour. By contrast, the "busy hour" is to be determined by examining the historic record and calculating statistics on call counts in each hour of the day across some substantial span of days. The "busy hour" is to be fixed as noted by NENA to be a practice in other PSAPs. It is not a variable. In the case of Broward County, *FITCH* determined the "Busy Hour" of the day to be 1800 hours averaged over CY2015 as shown in Figure 8 below.

¹⁵ NENA Call Answering Standard/Model Recommendation, NENA 56-005, 06/10/2006. National Emergency Number Association (NENA) Standard Operating Procedures Committee, Call-Taking Working Group.

Figure 8. Average Busy Hour Based on Telephone Traffic



FINDING: Certain performance measures are a poor representation of System performance and inconsistent with current industry best practices.

Discrepancies Regarding Workstations

Answer delays are tied to specific workstations, each with its unique identification (ID) number. Then, activities among workstations are aggregated for a specific PSAP. For the answer delay at a PSAP to be valid, the roster of workstations ascribed to the PSAP must be correct.

FITCH conducted a detailed accounting of the numbers and IDs of the active workstations by hour of the day at each PSAP from November 2015 through January 2016. As a cross check, *FITCH* conducted the same accounting across BSO dispatch without regard to the identity of the PSAPs. The two accountings could not be reconciled. The sum of active workstations at the individual PSAP often exceeded the sum of active workstations obtained when PSAP IDs were disregarded. Manually stepping through the records in question revealed the source of the discrepancy. In multiple instances, numbered in the thousands, a single workstation ID appeared under two PSAPs. These instances were manually resolved by consensus: all PSAP-workstation pairings were adjusted to reflect the observed majority PSAP-workstation pairing for each workstation in question. Since the consolidation of the separate telephony networks in February 2016, this workstation ID duplication has been rectified.

Answer Delays

The last step in the implementation of NENA 56-005 is the calculation of the answer delay in the busy hour. The majority of 911 calls entering the system proceed in the normal manner from ring-in to pick-up by the intake dispatcher. On these calls, the County calculates answer delays correctly. However, there are a substantial number of calls in which the **caller** disconnects before the intake dispatcher has the opportunity to connect to the incoming line. On these calls, the County calculates answer delays in a way that could be unfavorable to BSO.

Answer delays on the majority of 911 calls are calculated as the interval from when the call is ready to be presented to when the intake dispatcher picks up. This portion of the tally of answer delays is correct. The problem is encountered on the second set of 911 calls in which the **caller** disconnects before the intake dispatcher picks-up. In these cases, the County keeps the answer delay clock running until the intake dispatcher connects to the dead line. *FITCH* takes the position that it makes no sense to increment the answer delay clock past the point where there is no longer anyone on the incoming line. Regardless of the two methods of calculation noted above, the requirement for hang-up 911 calls to be properly addressed by 911 personnel is met. It turns out that a **FAILS** turn into **PASSES** when the answer delay clock is stopped upon caller hang-up as reflected in a Table 36 example below. Differences were found between the County's calculations and those done by *FITCH* because of the duplicate workstation IDs identified above. The County has indicated that issue was subsequently resolved, but after the time period for which data was provided to *FITCH*.

Table 36. Comparison of ORCAT and FITCH Pass/Fail Determination Based on Answer Delays

PSAP	Date	Hour	ORCAT				FITCH				Ranked 90 th %-tile [sec]
			<10 sec	calls	%	P/F	P/F	<10 sec	calls	%	
South	01/15/16	2000	60	69	87.0	FAIL	PASS	63	69	91.3	9.42

The truth tables required to calculate answer delays with and without caller hang-ups are surprisingly complex. For illustrative purposes, the truth table and coding required to implement the calculation of all answer delays in *FITCH*'s data tables are presented in Attachment B.

Utility of the P1 Target

The application of the P1 busy hour target as a measure of the overall intake performance of the BSO dispatch system is a poor representation of System performance and lacks the statistical validity to meaningfully serve as a guide for balancing costs against performance. A certain level of "overstaffing" in a dispatch center is required to absorb the random surges that are expected in any system.

FINDING: The failure of the current PASS/FAIL or YES/NO P1 busy hour target is that it provides no guidance as to the level of surge capacity that is fiscally responsible to build into the system.

DRAFT

FITCH Assessment of Historic P1

To provide perspective, it is instructive to examine the details of BSO’s historic answer delays on pickup at the intake workstations. From the County’s Non-Compliance Reports, BSO’s Central PSAP received a FAIL rating for 1600 hours on November 7, 2015. *FITCH* went to the Call Detail Records from the telephone server and compiled the historic answer delays hour-by-hour for Central PSAP on this date. These results are presented in Figure 9 below.

DRAFT

Figure 9. Answer Delays at Central PSAP on 11/07/2015

Broward E911 Consolidated Communications System Historic Answer Delays

Date	PSAP Location	ORCAT Assessment
11/07/2015	Central PSAP	FAIL 1600 Hours

Hour of Day	Phone Traffic				Observed Staffing & Performance		
	OUT	ADM	911	Σ Erlangs	Active WkStn's		Ans Delay @ 90 %-tile [sec]
00:00	11	17	81	3.489	15		1.31
01:00	13	19	90	3.109	17		1.38
02:00	6	15	63	2.486	15		1.37
03:00	4	11	54	2.913	12		1.31
04:00	11	8	60	2.582	10		1.58
05:00	1	8	41	1.973	10		1.66
06:00	20	11	57	2.829	12		1.60
07:00	12	35	84	3.227	19		1.37
08:00	26	34	118	3.302	20		1.28
09:00	30	41	173	5.175	17		1.33
10:00	21	38	183	5.612	19		1.59
11:00	25	50	168	6.025	20		1.43
12:00	29	54	166	7.301	21		1.40
13:00	30	55	176	6.873	19		1.49
14:00	10	36	149	4.932	21		1.58
15:00	31	55	188	6.008	25		1.50
16:00	22	46	188	6.067	25		1.37
17:00	30	42	187	6.484	23		1.38
18:00	11	46	166	5.655	23		1.39
19:00	18	42	173	5.393	21		1.41
20:00	10	38	121	4.717	22		1.39
21:00	26	28	133	5.129	21		1.34
22:00	15	35	148	5.301	22		1.40
23:00	22	31	135	6.312	17		1.31
Avg Intakes per Hour				Average	Obs'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
OUT	ADM	911	Erlangs				
18.08	33.13	129.25	4.704	446		1.42	

([CIM] Call Connected) timestasmp - ([CIM] ANI: timestamp) = Answer Delay
 Except: Answer Delay clock stops running when caller disconnects
 as indicated by ([CIM] Caller Disconnected before Supervision) timestasmp

Four points are important in the data presented in Figure 9 above:

1. BSO continuously adjusts the number of active workstations by hour-of-day. BSO does NOT use constant intake staffing.
2. BSO adjusts its intake staffing with great finesse as demonstrated by the consistency of the answer delays in the face of widely varying demand by hour-of-day.
3. BSO did NOT FAIL at 1600 hours when *FITCH* calculated answer delays so as to properly account for caller hang-ups.
4. The answer delays in each hour-of day as well as the weighted answer delay across all 24 hours of the day are all exemplary.

It is *FITCH*'s experience that BSO's answer delays in Figure 9 above are more than comparable to other high performing dispatch systems in North America. BSO's answer delay at the 90th percentile is 1.4 seconds. This means that BSO intake dispatchers pick up the next incoming call before the second ring, nine times out of ten. To put that in perspective, the acceptable answer rate is 90% at 3 rings or 10 seconds

P2/P3 Intervals

The second target that is the subject of attention from Broward stakeholders goes by the moniker "P2/P3". In Figure 6 above, (Relationship Between CDR and CAD Timelines), the P2/P3 interval extends from when the VIPER spillover from the telephony server to the CAD server is completed at the [Received] timestamp until the incident is released by the intake dispatcher to the assignment dispatcher at the [Transmit] timestamp. The P2/P3 interval can also be referred to as the processing interval. This time interval is the subject of a *recommendation* from the National Fire Protection Association.¹⁶

NFPA 1221 defines two different 'buckets' of call types, and for each 'bucket' has different performance measures. The specifics can be found in Attachment A, but within this analysis we define the first group as Emergency Medical Dispatch (EMD), intended to evaluate under one set of criteria six specific call types including those that require EMD. The second 'bucket' is shown here as "n-EMD", and generally includes more typical fire related calls. Unfortunately, the CAD has no manner with precision by which to identify which calls belong in which 'bucket'. For that reason, the County indicates they make assumptions and simply place all medically related calls into the EMD bucket, while everything else goes into the n-EMD bucket. This practice is not completely consistent with the adopted performance measures, but *FITCH* was unable to identify a better process for this additional data limitation

Treatment of [Received] Timestamps

Calculation of the P2/P3 interval depends on the [Received] timestamp. This, of course, presents a problem because only half of the [Received] timestamps can be validated in the CAD for EMS call types. the County's reports appear to be extremely precise. They report percent fails in the P2/P3 intervals to \pm 0.01% regardless of the number of valid [Received] timestamps they actually have available.

¹⁶ NFPA 1221 (2016). Standard for the Installation, Maintenance and Use of Emergency Services Communications Systems.

When numbers of available measured data are restricted, questions regarding precision and confidence must be faced. “Precision” is the interval that will bracket the right answer: $\pm 10\%$, $\pm 1\%$, $\pm 0.01\%$? “Confidence” is the probability that random noise in the sample set has not skewed the answer.

When a limited set of data goes into an average, the precision and confidence level of the calculated average are not a matter of opinion. Rather, they are the subjects of specific calculations, as formally described in the document “Standard Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process”, ASTM 122-09e1. The County does not show the specific precisions and confidences associated with their reported performance metrics.

Implications of the Missing [Received] Timestamps

Counter-intuitively, the missing [Received] timestamps pose more of a problem than the ones present. The missing [Received] timestamps erode the credibility of the P2/P3 intervals that can be calculated from the [Received] timestamps that are available.

The convenient assumption about the P2/P3 intervals, as calculated by the County, is that the numbers automatically serve as a metric for the system as a whole, that the variability in the P2/P3 intervals that they calculate, properly reflects the variability in all the P2/P3 intervals, even the ones not able to be calculated. Unfortunately, this assumption is not necessarily true and should not currently be relied on as a basis for policy decisions.

Again referring to ASTM 122-09e1, for the pulled sub-lot of samples to correctly reflect the properties of the full lot, the process must be in a state of statistical control wherein the sub-lot of samples is influenced by a single source of variability (as imposed by the production process). This procedure cannot treat multi-level sources of variability.

This limitation takes us back to the missing [Received] timestamps. To start with, we do not fully understand why/how these timestamps are missing. We do not know whether there was a specific bias operating to select which timestamps went missing. The first consequence is that a reverse bias would then be imposed on the P2/P3 intervals calculated from the remaining timestamps. The second consequence is that the calculated P2/P3 timestamps would be statistically biased and may not represent the properties of the system as a whole.

Preliminary investigation of the why/how behind the missing timestamps indicates that operator intervention by the intake dispatchers plays a major role in missing timestamps. This is a problem, as human intervention is almost guaranteed to be variable and therefore, statistically biased. Even more confounding, the degree of bias is then almost guaranteed to be operator specific, thereby introducing a time dependent variability to the bias.

Credibility of P2/P3 Statistics

FITCH also learned that the CAD [Received] timestamps become corrupted whenever a 911 call taker rebids or asks the 911 system software to verify and update a caller’s location – essentially overwriting the original timestamp. Fortunately, the validation process *FITCH* employed essentially mitigates that bias. Arguably, the overwriting of the [Received] timestamp should benefit BSO in the County’s reported compliance. However once rejecting these records through the validation process, *FITCH*’s calculation of performance is better than that calculated by the County – indicating there is likely other unknown factors still influencing this performance metric. The County indicated they include all records with [Received] timestamps in an abundance of caution, while *FITCH* employed a validation protocol that excludes some records. While *FITCH* is able to report some P2/P3 performance – readers should remain mindful of the statistical limitations and procedural differences discussed above.

Tables 37 and 38 summarize the analysis of fire-rescue incidents – distinguishing those that have been characterized as EMD related, and those labeled “n-EMD”. Of the total 43,722 records available, only 21,292 are considered valid for use in this analysis.

Table 37: EMD P2/P3 Statistics & Performance

Parameter	Value
EMD Count	39,214
[Rcvd] absent	11,198
[Rcvd] present	28,016
[Rcvd] not validated	7,013
[Rcvd] validated	21,003
[Rcvd] validated > 165 sec ¹⁷	718
[Rcvd] validated < 166 sec	20,285
50 th %-tile	54.72 sec
Average	61.16 sec
Std Dev	±27.47 sec
90 th %-tile	100.80 sec
95 th %-tile	121.33 sec
99 th %-tile	157.79 sec
Compliance	
Count < 91 sec	17,496
% < 91 sec	86.30%
Count < 121 sec	19,331
% <121 sec	95.30%

¹⁷ The P2/P3 intervals for EMD Call Types greater than 165 seconds were assumed to be “purposefully pending” and excluded from analysis.

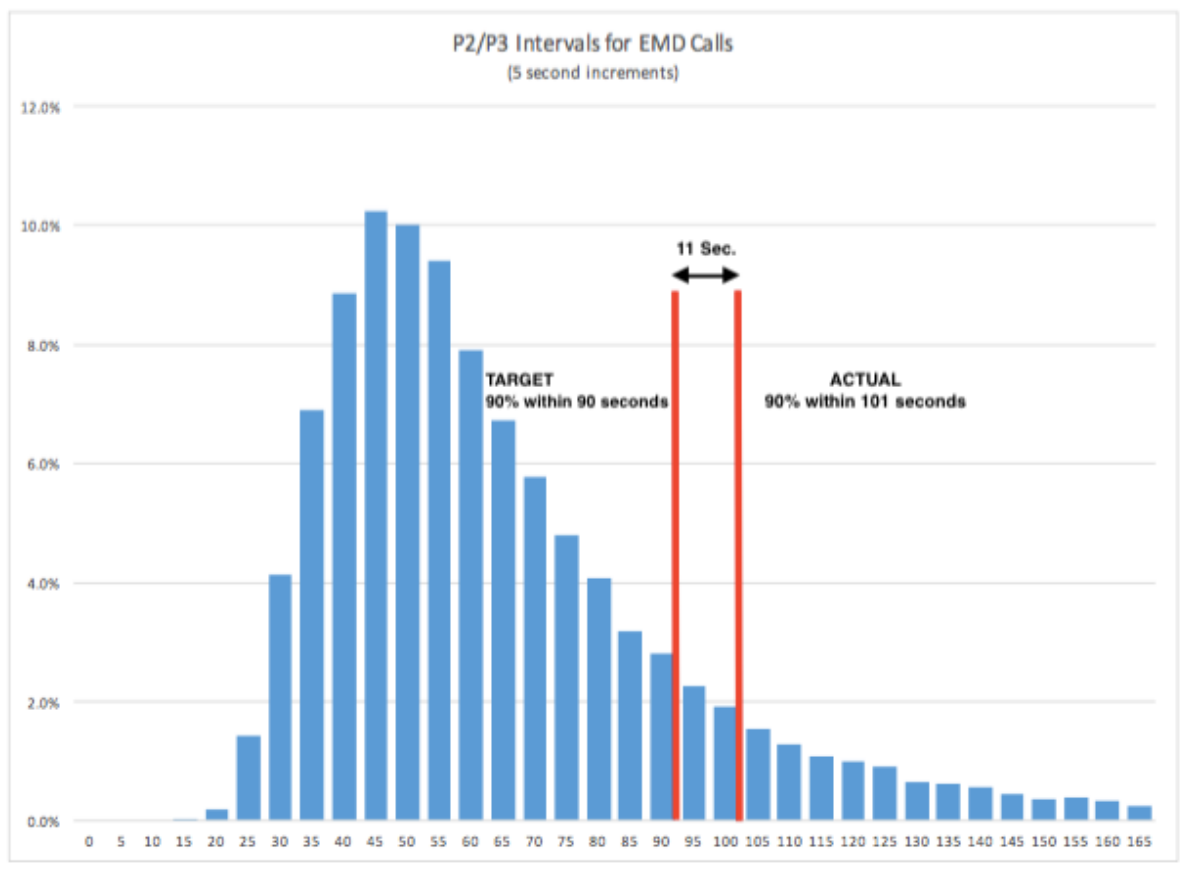
Table 38: n-EMD P2/P3 Statistics & Performance

Parameter	Value
n-EMD Count	4,508
[Rcvd] absent	3,155
[Rcvd] present	1,353
[Rcvd] not validated	289
[Rcvd] validated	1,064
[Rcvd] validated > 180 sec ¹⁸	57
[Rcvd] validated < 181 sec	1,007
50 th %-tile	68.70sec
Average	76.54 sec
Std Dev	±33.16 sec
80 th %-tile	103.70 sec
95 th %-tile	147.00 sec
Compliance	
Count < 91 sec	388
% < 91 sec	38.50%
Count < 121 sec	831
% <121 sec	82.50%

For EMD call types, actual performance fell short of the stated benchmark by 4% at both the 90th and 99th percentile compliance targets. The important question for policy makers is what does that shortcoming represent from a practical perspective. Figure 10 highlights the answer by noting the actual performance would require a goal of almost 101 seconds in order to reach a 90th percentile compliance. Therefore, at the 90th percentile the variance between actual performance compared to the target is just under 11 seconds.

¹⁸ The P2/P3 intervals for non-EMD Call Types greater than 180 seconds were assumed to be “purposefully pending” and excluded from analysis

Figure 10: P2/P3 Performance for EMD Calls – Target versus Actual



Law Enforcement P2/P3

It should be noted that stakeholders were unable to identify any national standards or research that supports the Broward law enforcement goals of handling 90% of Priority 1 and 2 calls within 45 seconds and 90% Priority 3 calls within 90 seconds. These calls represent the most important time sensitive incidents for law enforcement, generally considered ‘in-progress’ type incidents. At present, the County is not reporting on law enforcement P2/P3 performance – and also noteworthy, no police chief interviewed by *FITCH* raised the issue or complained about the lack of reporting.

At the County’s request, *FITCH* undertook an examination of P2/P3 call processing times within the City of Pembroke Pines. According to the data analyzed by Broward County for November and December of 2013, while Pembroke Pines was operating their own center on Broward County’s CAD, performance was well below the target. For Priority 1 and 2 calls, the 45 second target was met less than 1% of the time (0.79%) while the Priority 3 calls met the 90 second target only 12.78% of the time. When examining Priority 1 and 2 calls in Pembroke Pines for November and December 2015, the performance increased to just 1.47% compliance for the 45 second target. As noted in Table 39, the performance for the entire system is consistently dismal compared to the benchmark target.

Table 39: Law P2/P3 Statistics & Performance

Parameter	Value
LAW all Priorities	136,595
LAW all Priorities w Validated Rcvd Timestamp	24,131
Percent with validated Rcvd and valid P2/P3 intervals	17.7%
LAW w Priority 1&2	10,030
LAW w Priority 1&2 with valid Rcvd and valid P2/P3 intervals	5,244
Percentage with validated Rcvd and valid P2/P3 intervals	52.3%
P2/P3 Processing Interval	
Ranked 50 th %-tile	119.5 sec
Average	143.8 sec
Ranked 90 th %-tile	254.1 sec
Ranked 95 th %-tile	322.2 sec

With regard to law enforcement P2/P3 times only, there are no national recommendations on this metric. Stakeholders utilized best judgment, but lacking data appeared to have misjudged the capacity of the System to process the highest level of calls (Priority 1 and 2) within 45 seconds. The historical law enforcement P2/P3 performance reported by the County, and similarly dismal performance currently found, question the use of a 45-second target. In fact only a single study can be identified that examines law enforcement call processing times, published in late 2014.¹⁹ That research, utilizing a similar ranking schemata as in emergency medical dispatch (EMD), did not even consider a 45-second benchmark. Accordingly, there is no basis to assume a 45-second target is an achievable performance standard for law enforcement calls.

Notwithstanding the challenges described above with the [Received] timestamps, the County has indicated two efforts are already being undertaken. The first is a CAD software patch that will prevent the [Received] timestamp from being overwritten when a call taker rebids a call. This is expected to occur within the current CAD system. The second effort will arguably fix the overall issue by clearly associating phone records with the proper CAD record. That fix is currently being worked on as part of the new CAD system deployment.

P3 Interval

The data for the P3 interval is in the CAD, but it is not being considered separately by the Broward system even though it is a valid data source. P3 which focuses on that time from when a call taker sends an emergency request to the radio position until the radio operator dispatches the appropriate units. The value of examining P3 separately is that it can assist system managers in focusing on where to look for further improvements. As shown in Table 40, fire calls take 11 seconds on average and 22 seconds at

¹⁹ Warner, et al. (2014). Characterization of Call Prioritization Time in a Police Priority Dispatch. *Annals of Emergency Dispatch & Response* 2(2):17-23.

the 90th %-tile to process the P3 time interval. Therefore, with up to 90 seconds to achieve P2 and P3, this information indicates the greater opportunity exists in more closely examining the P2 component of call processing times.

Table 40. P3 Performance Statistics

Discipline	Assignment Interval, P3		Previous NFA
	Seconds @ 50 th %-tile	Seconds @ 90 th %-tile	Second @ 90 th %-tile
FIRE	11.0 sec	22.2 sec	60 sec
LAW	45.6 sec	68.4 sec	not app

BSO generally appears to do well on LAW assignments when evaluating P3 alone, although as noted above, there are no formal recommendations for this interval. As with fire rescue calls, the intervals used to calculate the 90th percentile for LAW assignments have been filtered to modify long duration outliers in this data set.

Most of the time, operations in the dispatch center are insulated from events in the field, but not always. Events in the field can “back up” into the dispatch operations. This is known to be a common occurrence in LAW assignments. For example, the next request for service hits the pending screen at the assignment workstation. The assignment dispatcher has a lot going on in the field and determines that the new call is of lesser priority. The dispatcher then decides to put this next request on hold. When field activity decreases, the dispatcher returns to the holding request and executes its assignment. However, the P2/P3 clock keeps running throughout this process, leading to an inflated P2/P3 processing interval that does not reflect the amount of time actually consumed *processing* the incident.

FINDING: The P1 and P3 intervals can be accurately evaluated based on current data in the CAD and telephony systems. BSO performs well for these dispatch intervals. The P2 interval must be cautiously evaluated due to technology and data limitations.

P4 Interval

The data for the P4 interval – that time from when the radio dispatcher alerts emergency responders, typically in the fire station, until they are responding – was reported in the CAD data provided to FITCH. Summary information on this metric is provided in Table 41. While not part of the Regional E911 System performance, it does impact the citizen’s experience for public safety service. It is reported here to allow for discussion by stakeholders.

Table 41: Comparison of P4 Averages and 90th Percentiles

	Nov – Dec 2015	Count	Validated	Raw Compliances		Average [sec]	90 th %-tile [sec]
				Actual Count	%		
Chute	FIRE Response 90% @ 80 sec	6,620	6,620	3,051	46%	138.0sec	197.6sec
Chute	EMS Response 90% @ 60 sec	37,102	37,102	13,787	43%	111.3 sec	174.6 sec

MODELING DISPATCH OPERATIONS

Rationale

The benefit of a model of dispatch operations is that it permits *FITCH*, as well as stakeholders, to pose questions that otherwise could not be addressed in the real world. Computer time is inexpensive compared to conducting the same experiments using the real stream of incoming calls and real PSAPs. The model becomes a cost-effective and timely tool for predicting the behavior of the real system. Of course, the limitation to this approach is the validity of the model.

It must be emphasized that the performance of a dispatch systems has two distinct components that are so tightly intertwined that it is easy to confuse the difference. The first component is the length of time it takes to execute each function of the dispatch process. Within BSO dispatch, the P3 interval is an example of this kind of component. The second component to performance is how long it takes before a dispatcher can begin executing the next request in the queue. Within BSO dispatch, the P1 interval is an example of this kind of component.

Models of Dispatch Operations

APCO RETAINS

APCO RETAINS is a staffing estimator and retention rate calculator produced by the Association of Public-Safety Communications Officials (APCO). The RETAINS title stand for Responsive Efforts to Assure Integral Needs in Staffing. The estimator is a respected tool for judging staffing needs

The outstanding benefit of APCO RETAINS is that in can be implemented using data that is reasonably accessible, often from hardcopy reports that already exist in the system. From this starting point, APCO RETAINS can be used to create a low level model of dispatch operations. Inputs are supplied to the model as broad averages and estimates. For instance, counts of events are used as surrogates for the actual durations required to process each specific event.

The outputs provide a ballpark estimate of the staffing required to make the dispatch process work. The limitation to the utility of these outputs is that they are silent on the performance to be expected from the system. APCO RETAINS provide no guidance to decision makers facing financial and policy questions regarding how much performance will change when the staffing being committed to the system changes.

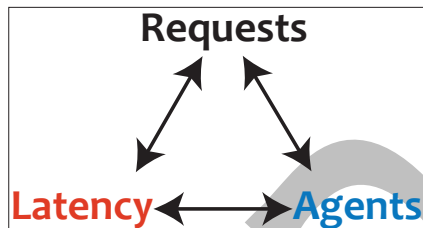
Erlang Analyses

As noted in the APCO RETAINS Workbook:²⁰

Erlang formulas are considered *the* standard for any process that requires an application of queuing theory, such as the nonlinear arrival times of incoming calls in a call center. The Erlang formulas use a statistical solution that addresses the randomness of call arrival time.

Agner Krarup Erlang was a Danish mathematician, statistician, and engineer who invented the field of telephone networks analysis while working for the Copenhagen Telephone Company from 1908 through 1929. The goal of Erlang's queuing analyses is to determine how many service providers should be made available to satisfy users, without over provisioning. To meet this goal, Mr. Erlang had to quantify the three-cornered relationship between requests for service, number of agents, and latency in Figure 11, below.

Figure 11. Queuing Theory Triangle



The concepts and mathematics introduced by Mr. Erlang have stood the test of time. In the modern world, these methods are used to analyze queuing processes in systems as diverse as shoppers using grocery store checkout cashiers to data packet switching through Internet routers at megahertz frequencies.

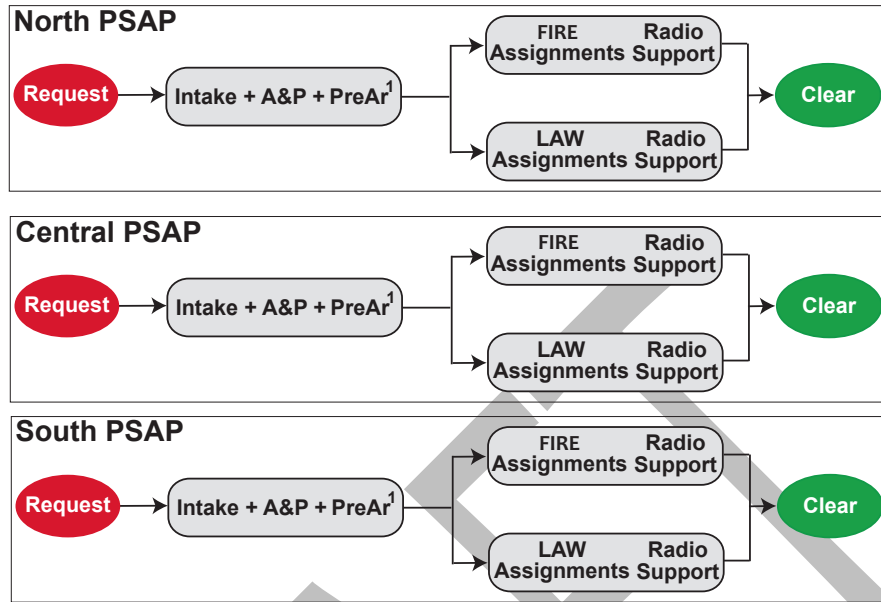
The assumptions, mathematics, and limitations of Erlang queuing theory, as applied to dispatch operations, are treated in greater detail in Attachment C.

Work Stations

The first step in the construction of an Erlang model of the BSO dispatch operations is to identify which types of workstation to include in the model. This process is straightforward for BSO dispatch operations. There are three PSAP locations. At each PSAP there is a group of intake workstations. This is the first type of workstation. There are also a group of LAW assignment and FIRE assignment workstations. These are the second and third types of workstations. The organization of workflows is diagrammed in Figure 12 below.

²⁰ APCO RETAINS staffing and Retention in Public Safety Communications Centers: Effective Practices Guide and Staffing Workbook, page 5, August 2005. APCO International.

Figure 12. Workflows and Workstations in the BSO Dispatch System



¹Pre-Arrival Instructions only on EMS incidents with Echo-Delta determinants

The rounded rectangles in Figure 12 above, represent types of workstations. The text inside each rounded rectangles represents the functions that are executed at that type of workstation. “Intake” refers to the function of determining what is the emergency and where is it located. “A&P” refers to assessment of acuity and prioritization of response. “PreAr” refers to prearrival instructions on emergency medical incidents with Echo-Delta determinants (life threatening). “FIRE Assignment” is the functions of identifying a suitable unit for the response and notification of that unit. “Radio Support” refers to radio communication with units in the field on incidents in-progress. “LAW Assignment” is the functions of identifying a suitable unit for the response and notification of that unit. “Radio Support” refers to radio communication with units in the field on incidents in-progress.

The consultants recognize that the LAW and FIRE Assignment workstations in each PSAP are further subdivided by agency dispatched, at least on the architectural plot plans of the PSAPs. This level of granularity could not be incorporated into the modeling because data available in the CAD contains no identifiers of which assignment workstation is physically responsible for each incident record in the CAD.

Waiting Queues

The configuration of workstations that is used in the regional 911 centers is referred to as a “Triple Queue” model. This nomenclature refers to the three waiting queues that occur in the model. A waiting queue exists when a client requests service from a dispatcher at a workstation. The length of the waiting queue is a measure of how long it takes before the dispatcher at the workstation is able to begin servicing this next request for service.

There are two internal and one external waiting queues in the Triple Queue Model. When an external client (911 caller) requests service from the Intake Workstation, the waiting queue in front of the Intake workstation is referred to as the “P1” interval or the “answer delay”. When the Intake Workstation transmits an incident record to the Assignment Workstation for processing, this action is also a request for service, wherein the client has now become the Intake Workstation sending the call from the call taker to the radio dispatcher. The waiting queue in front of either Assignment Workstation is referred to as “assignment latency”.

Definition of “Erlangs”

The next step in the construction of an Erlang model of the BSO dispatch operations is to identify the workloads flowing across each type of workstation. Each function at a workstation requires a duration for its execution. The sum of all the durations for all of the functions being executed at a type of workstation is the workload flowing across that type of workstation.

In queuing theory, workloads are measured in “Erlangs”. An Erlang is simply the ratio of the summed durations of all the activities at a type of workstation per one hour on the clock. In the modeling that follows, both Erlangs and workloads will be expressed as decimal hours. For example, a workload duration of 15 minutes (00:15:00 hh:mm:ss) will appear as 0.250.

Accounting for workloads may sound simple, but in practice, it is an extensive bookkeeping exercise. The durations of all of the activities at each type of workstations have to be summed for each hour-of-day for each day-of-year. The enormity of all these accountings is the barrier that prevents casual users from attempting Erlang analyses of queuing processes in complex situations such as a dispatch operation.

Quantitation of Workloads

Primary Sources

The durations of functions being executed at the Intake Workstations were obtained from two primary sources: the Call Detail Records for incoming calls from the Intrado VIPER telephony server and the log of outgoing calls. Data exports from these sources were incorporated into the *FITCH* Telephone data table and the Outgoing Phone Log data table. A sample record from the *FITCH* telephone data table and from the Outgoing Phone Log are presented in Attachment D.

The durations of functions being executed at the Assignment Workstations were obtained from two primary sources: the export of data fields from the Computer Aided Dispatch system and the 611-page PDF year-end summary report titled “Talkgroups at Zone Summary 150101 – 151231”. Data from these sources was incorporated into *FITCH*’s LAW Incident data table, the FIRE Incident data table, and the Radio Traffic data table. Sample records from these data tables are presented in Attachment E.

Summation Database by Hour-of-Year

The next step in the modeling process was to create two Summation databases, each one with 8,760 records, one record for each hour of the year. The purpose of the Summation databases was to serve as a repository for data that had been aggregated by hour-of-year. Specialty algorithms were written that queried the primary data tables by hour of year, fetched and summed the activities occurring in that hour, and wrote the results into the corresponding record for that particular hour of the year in the Summation database.

A Summation database was prepared that aggregated durations from the telephone Call Detail Records as well as the Outgoing Phone Log. A sample record from this Summation database is presented in Figure 13, below. A separate Summation database was prepared that aggregated durations from the FIRE, LAW, and Radio Traffic data tables. Sample records from the Summation databases are presented in Figure 14 and Figure 15, below.

Figure 13. Record from Summation Database of Telephone Traffic

Broward E911 Consolidated Communications System Phone Records by Hour of Year							
Date	Mo	Day	Day Name	Day of Wk	Hr of Day	Hour of Yr	Record Number
12/28/2015	12	28	Mon	2	9	8,674	1,378
Central	Count	Processing Σ [sec]	911 Ans Delay		[sec]		
911 Trunks	68	7,246.51	Ranked 90 th %-tile		1.27		
ADM / AIM	59	7,313.64	Ranked 95 th %-tile		1.42		
Outgoing	16	633.91	Average		1.18		
Totals	143	15,194.06	\pm Std Dev		0.20		
Active Wkstat'n	16		Predicted 90 th %-tile		1.44		
North	Count	Processing Σ [sec]	911 Ans Delay		[sec]		
911 Trunks	22	1,531.41	Ranked 90 th %-tile		1.08		
ADM / AIM	53	6,380.67	Ranked 95 th %-tile		1.13		
Outgoing	9	1,428.50	Average		0.92		
Totals	84	9,340.58	\pm Std Dev		0.33		
Active Wkstat'n	10		Predicted 90 th %-tile		1.35		
South	Count	Processing Σ [sec]	911 Ans Delay		[sec]		
911 Trunks	33	2,680.27	Ranked 90 th %-tile		1.45		
ADM / AIM	61	7,674.92	Ranked 95 th %-tile		1.62		
Outgoing	17	1,132.05	Average		1.16		
Totals	111	11,487.24	\pm Std Dev		0.33		
Active Wkstat'n	13		Predicted 90 th %-tile		1.59		
Broward County	Count	Processing Σ [sec]	911 Ans Delay		[sec]		
911 Trunks	123	11,458.19	Ranked 90 th %-tile		1.33		
ADM / AIM	173	21,369.23	Ranked 95 th %-tile		1.62		
Outgoing	42	3,194.46	Average		1.13		
Totals	338	36,021.88	\pm Std Dev		0.28		
Active Wkstat'n	39		Predicted 90 th %-tile		1.49		

Figure 14. Record from Summation Database of CAD and Radio Traffic

Broward E911 Consolidated Communications System CAD Records by Hour of Year							
Date	Mo	Day	Day Name	Day of Wk	Hr of Day	Hour of Yr	Record Number
01/01/2015	1	1	Thu	5	23	24	24

Central PSAP	CAD Count	Assgn Workld [sec]	Xmit/Rcv's Count	Radio Workld [sec]
Law	40	3,415	432.63	3,880.87
Fire	11	100	117.84	999.42

North PSAP	CAD Count	Assgn Workld [sec]	Xmit/Rcv's Count	Radio Workld [sec]
Law	19	757	217.70	1,982.38
Fire	6	74	70.86	579.65

South PSAP	CAD Count	Assgn Workld [sec]	Xmit/Rcv's Count	Radio Workld [sec]
Law	20	1,044	223.48	2,023.87
Fire	7	68	83.52	732.99

Broward County	CAD Count	Assgn Workld [sec]	Xmit/Rcv's Count	Radio Workld [sec]
Law	79	5,215	873.81	7,887.12
Fire	24	242	272.22	2,312.06

Averaged Databases by Hour-of-Day

The next step was to create two Averaged databases, each containing 24 records, one record for each hour-day. The Summation databases were queried by hour-of-day. Each activity in that hour-of-day was averaged over all the days of the year, and the results written into the corresponding record in the Averaged database. Samples records from the Averaged databases are presented in Figure 16 and Figure 17, below.

Figure 15. Record from Averaged Database of Telephone Traffic

Broward E911 Consolidated Communications System Call Details by Hour of Day				
			Hr of Day	
			9	
Central	Count		Processing	
	avg	± std dev	avg	± std dev
911 Trunks	90.86	45.52	9,064.63	4,232.12
ADM / AIM	35.49	18.93	4,293.97	2,494.09
Outgoing	18.63	10.35	872.81	607.96
Totals	144.97	68.88	14,231.41	6,301.04
Intake WrkStn	15.58	4.29		
North	Count		Processing	
	avg	± std dev	avg	± std dev
911 Trunks	29.74	15.78	2,906.29	1,438.21
ADM / AIM	36.25	19.76	4,840.51	2,671.11
Outgoing	8.75	5.96	431.27	495.86
Totals	74.74	36.03	8,178.06	3,720.07
Intake WrkStn	10.89	2.56		
South	Count		Processing	
	avg	± std dev	avg	± std dev
911 Trunks	32.81	22.02	3,567.31	2,336.74
ADM / AIM	32.33	22.23	4,311.92	3,022.00
Outgoing	11.50	8.13	501.05	440.85
Totals	76.63	46.61	8,380.28	5,125.83
Intake WrkStn	10.87	3.83		
Broward County	Count		Processing	
	avg	± std dev	avg	± std dev
911 Trunks	153.40	69.31	15,538.23	6,082.26
ADM / AIM	104.07	54.81	13,446.39	7,255.71
Outgoing	38.87	19.67	1,805.13	1,044.79
Totals	296.34	134.66	30,789.75	12,983.64
Intake WrkStn	36.00	9.01		

Figure 16. Record from Averaged Database of CAD and Radio Traffic

Broward E911 Consolidated Communications System CAD Records by Hour of Day					
					Hr of Day
					23
Central PSAP		CAD Count	Assgn Workld [sec]	Xmit/Rcv's Count	Radio Workld [sec]
Law	avg	37.00	2,677.75	353.00	3,159.42
	± sd	8.84	824.76	94.64	844.43
Fire	avg	11.96	147.51	130.68	1,100.30
	± sd	3.67	73.72	40.23	338.91
North PSAP		CAD Count	Assgn Workld [sec]	Xmit/Rcv's Count	Radio Workld [sec]
Law	avg	18.02	1,030.33	204.19	1,859.55
	± sd	5.77	478.77	65.05	592.38
Fire	avg	5.40	78.74	64.05	517.07
	± sd	2.59	55.53	30.73	247.98
South PSAP		CAD Count	Assgn Workld [sec]	Xmit/Rcv's Count	Radio Workld [sec]
Law	avg	28.82	1,498.91	266.46	2,629.78
	± sd	8.36	639.70	77.70	761.26
Fire	avg	7.10	91.21	86.25	767.82
	± sd	2.71	48.78	33.03	294.21
Broward County		CAD Count	Assgn Workld [sec]	Xmit/Rcv's Count	Radio Workld [sec]
Law	avg	83.85	5,206.99	823.65	7,648.75
	± sd	19.21	1,565.22	193.43	1,793.53
Fire	avg	24.47	317.45	280.99	2,385.19
	± sd	5.82	116.30	66.95	567.58

Erlang Modeling

Erlang Tables

After the two Averaged by hour-of-day databases have been prepared, it is necessary to create the final database to record the results of the Erlang models. In the Erlang database, each record is referred to as an Erlang Table and represents the hour-by-hour performance of a single type of workstation. A complete model of dispatch operations requires one Erlang Table for each type of workstation that comprises the model. From the way BSO dispatch operations are currently organized, a complete model will require nine Erlang Tables because there are nine type of workstations present.

Each Erlang Table is an hour-by-hour compilation the event counts impinging on a workstation as well as the sum of the durations required to process these events. Thus, an Erlang Table is comprised of 24 lines of data fields, one line per hour-of-day. The event counts and durations are retrieved from the Averaged databases and written back to the correct hour in the Erlang Table. These same data are also passed to an algorithm that executes the Erlang probability calculation. The statistics from this calculation are then written to the corresponding hour.

Estimates of Current BSO Staffing

In order to conduct an Erlang model of current operations, it is necessary to know how many dispatchers were actively on duty at their workstation in each hour of the day for the period being modeled. *FITCH* was not provided duty rosters that contained this detailed level of detail for 2015. The workaround was to rely on BSO's call analysis reports for 2015²¹, in which staffing at the workstations at the Central, North, and South PSAPs were estimated by hour-of-day.

Model of Central Intake Workstation

Figure 18, below, presents the Erlang Table for the model of the Intake Workstation at the Central PSAP as staffed using the hourly deployment of dispatchers as indicated in the document PSAP CALL ANALYSIS NOVEMBER 2015.xls.

²¹ PSAP CALL ANALYSIS JANUARY 2015.xls through PSAP CALL ANALYSIS DECEMBER 2015.xls.

Figure 17. Erlang Model of Central Intake

Year	Dispatch Model	Workstation Name				Surge		
2015	Triple PSAP	Central Intake				+ 0.00 σ		
Surge	Hour of Day	Hourly Averages				Workstation Staffing & Performance		
		911	ADM	Out	Σ Erlangs	OnTask	Immediate Answer [%]	Ans Delay @ 90 %-tile [sec]
	00:00	63.76	21.37	13.48	2.978	5	84.60	20.18
	01:00	50.96	18.09	10.82	2.498	5	88.10	13.06
	02:00	40.50	14.12	8.50	2.114	3	73.15	89.11
	03:00	34.92	12.67	7.47	1.876	3	76.07	63.72
	04:00	31.54	11.88	6.88	1.633	3	79.72	42.28
	05:00	31.40	11.53	6.82	1.679	3	78.99	47.10
	06:00	42.05	17.24	8.87	1.929	4	86.59	16.08
	07:00	68.05	29.57	15.66	3.076	7	93.69	3.83
	08:00	84.97	37.02	19.38	3.749	8	93.34	3.65
	09:00	92.39	43.15	22.01	4.268	9	93.93	3.05
	10:00	101.73	50.92	24.38	4.728	10	94.70	2.36
	11:00	111.80	53.43	25.27	4.996	10	93.71	2.89
	12:00	117.60	52.01	24.84	5.183	11	95.38	1.86
	13:00	124.32	52.59	26.26	5.166	11	95.44	1.75
	14:00	130.46	53.97	27.55	5.292	11	95.00	1.92
	15:00	132.68	57.75	26.02	5.559	12	96.22	1.32
	16:00	132.88	50.15	27.24	5.316	12	96.99	1.00
	17:00	138.77	50.67	25.07	5.579	13	97.92	0.64
	18:00	145.08	50.77	24.22	6.012	13	96.73	1.12
	19:00	125.20	42.35	22.22	5.047	11	95.86	1.62
	20:00	110.58	33.78	21.36	4.535	10	95.48	1.99
	21:00	102.88	29.71	19.54	4.166	9	94.40	2.79
	22:00	90.15	28.55	17.21	3.885	8	92.64	4.49
	23:00	75.87	28.37	15.95	3.613	7	90.46	7.43
					Average Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
		90.86	35.49	18.63	3.953	198	93.32	7.10

Central Intake workstations staffed to BSO specs as documented in PSAP CALL ANALYSIS NOVEMBER 2015.xls

There are eight columns in Figure 18. The contents of these columns is as follows:

- Column 1 presents the hour of day.
- Column 2 tallies the average count of calls coming in on the 911 trunks.
- Column 3 tallies the average count of calls coming in on the ADM and AIM trunks.
- Column 4 tallies the average count of outgoing calls.

- Column 5 tallies the total Erlangs of workload flowing across the Central Intake Workstation. The Erlangs are the total of the durations required to process the 911 incidents, the ADM and AIM incidents, and the outgoing calls.
- Column 6 presents the number of dispatchers actively on duty at their workstations (OnTask).
- Column 7 presents the probability that the next request for service will be immediately answered by a dispatcher.
- Column 8 presents the maximum answer delay at the 95th percentile experienced in that hour of day.

The 7.10 seconds appearing at the bottom of the column of answer delays is the “weighted average” answer delay for the whole 24 hours. The answer delay in each hour-of-day is weighted by the incident count in that hour, and the weighted average for the whole day calculated.

The results of this Erlang model present a curious result. The weighted average answer delay of 7.10 seconds at the 90th percentile is extremely divergent from the answer delay of 1.42 second at the 90th percentile that was obtained by referring to the call records in the primary CDR data table and presented in Figure 9 (Answer Delays at Central PSAP on 11/07/2015) in prior sections of this report.

This discrepancy is so severe that the consultants conclude that BSO’s actual deployment of intake dispatchers is substantially higher than indicated in the document PSAP CALL ANALYSIS NOVEMBER 2015.xls.

The consultants employed a reverse Erlang analysis to hone in on the actual deployment of intake dispatchers used by BSO. The approach was to run the model again, retaining all of the workload from the historic record, but adjusting the deployment of dispatchers OnTask until the weighted average answer delay came down into the range of 1.42 seconds. The result of this approach is presented in Figure 19 below.

Figure 18. Erlang Model Central Intake Adjusted

Broward E911 Consolidated Communications System Workstation Performance by Hour-of-Day								
Year	Dispatch Model		Workstation Name			Surge		
2015	Triple PSAP		Central Intake			+ 0.00 σ		
Surge	Hour of Day	Hourly Averages				Workstation Staffing & Performance		
		911	ADM	Out	Σ Erlangs	OnTask	Immediate Answer [%]	Ans Delay @ 95 %-tile [sec]
	00:00	63.76	21.37	13.48	2.978	7	94.35	4.43
	01:00	50.96	18.09	10.82	2.498	6	93.66	5.93
	02:00	40.50	14.12	8.50	2.114	6	96.60	3.07
	03:00	34.92	12.67	7.47	1.876	6	98.00	1.73
	04:00	31.54	11.88	6.88	1.633	6	98.98	0.79
	05:00	31.40	11.53	6.82	1.679	5	96.06	4.18
	06:00	42.05	17.24	8.87	1.929	6	97.73	1.65
	07:00	68.05	29.57	15.66	3.076	8	97.01	1.72
	08:00	84.97	37.02	19.38	3.749	9	96.38	1.91
	09:00	92.39	43.15	22.01	4.268	10	96.58	1.69
	10:00	101.73	50.92	24.38	4.728	11	97.01	1.33
	11:00	111.80	53.43	25.27	4.996	11	96.04	1.81
	12:00	117.60	52.01	24.84	5.183	12	97.41	1.06
	13:00	124.32	52.59	26.26	5.166	12	97.46	0.99
	14:00	130.46	53.97	27.55	5.292	12	97.07	1.14
	15:00	132.68	57.75	26.02	5.559	13	97.97	0.73
	16:00	132.88	50.15	27.24	5.316	13	98.54	0.50
	17:00	138.77	50.67	25.07	5.579	13	97.92	0.76
	18:00	145.08	50.77	24.22	6.012	14	98.27	0.62
	19:00	125.20	42.35	22.22	5.047	12	97.81	0.88
	20:00	110.58	33.78	21.36	4.535	11	97.66	1.04
	21:00	102.88	29.71	19.54	4.166	10	96.99	1.48
	22:00	90.15	28.55	17.21	3.885	10	98.01	0.97
	23:00	75.87	28.37	15.95	3.613	9	97.00	1.75
					Average Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
		90.86	35.49	18.63	3.953	232	97.25	1.43

Central Intake workstations staffed so as to reproduce a 1.42 second weighted average answer delay.

The difference in staffing between Figure 18 and Figure 19 is striking. In Figure 18, BSO deployed 198 dispatcher hours OnTask. Figure 19 contains the number of dispatcher hour OnTask required to reproduce the answer delays taken from the historic record. The number of dispatcher hours OnTask increased from the original 198 hours to 232 hours, a 17% increase. The consultant has no rationalization for why this occurred.

BSO's deployment of dispatchers in Figure 18 and Figure 19 needs to be put into perspective, as judged against other high performing dispatch systems. Achieving 7.10 seconds at the 90th percentile weighted over 24 hours at an intake workstation is a very respectable level of performance. Adding additional dispatchers to take the answer delay down to 1.42 second at the 90th percentile must be viewed as overstaffing.

FINDING: BSO current performance indicates overstaffing in Call taker positions based on Erlang modeling.

Model of Central FIRE Assignment Workstation

The document PSAP CALL ANALYSIS NOVEMBER 2015.xls also specified the staffing at the Central FIRE Assignment workstation. In this case BSO specified a constant level of staffing as 5 dispatchers in each hour of day. The Erlang model for this deployment of dispatcher at the Central FIRE Assignment workstation is presented in Figure 20 below.

The answer delays exhibited by this deployment of dispatchers are 0.00 seconds across the board. These answer delays are completely “off the charts”. In order to place this deployment of dispatchers into perspective, the consultants ran a second Erlang model of the Central FIRE Assignment workstation in which deployments of dispatchers were adjusted downward to bring answer delay into a respectable and realistic range. The result of this model is presented in Figure 21 below.

Figure 19. Erlang Model Central FIRE Assignment Workstation BSO

Broward E911 Consolidated Communications System Workstation Performance by Hour-of-Day								
Year	Dispatch Model		Workstation Name			Surge		
2015	Triple PSAP		Central Assign FIRE			+ 0.00 σ		
S u r g e	Hour of Day	Hourly Averages				Workstation Staffing & Performance		
		FIRE	LAW	Radio	Σ Erlangs	OnTask	Immediate Answer [%]	Ans Delay @ 95 %-tile [sec]
	00:00	9.96		108.57	0.287	5	100.00	0.00
	01:00	8.84		96.56	0.255	5	100.00	0.00
	02:00	8.05		87.74	0.232	5	100.00	0.00
	03:00	7.44		81.15	0.214	5	100.00	0.00
	04:00	6.93		75.51	0.199	5	100.00	0.00
	05:00	7.32		79.99	0.211	5	100.00	0.00
	06:00	8.69		94.39	0.252	5	100.00	0.00
	07:00	11.85		129.07	0.342	5	100.00	0.00
	08:00	15.00		163.64	0.436	5	99.99	0.00
	09:00	17.14		186.62	0.497	5	99.98	0.00
	10:00	18.79		204.97	0.547	5	99.97	0.00
	11:00	18.73		204.29	0.546	5	99.97	0.00
	12:00	19.01		207.54	0.555	5	99.97	0.00
	13:00	18.68		203.84	0.546	5	99.97	0.00
	14:00	18.55		202.36	0.544	5	99.97	0.00
	15:00	19.14		208.99	0.568	5	99.97	0.00
	16:00	18.37		200.30	0.543	5	99.97	0.00
	17:00	18.72		204.37	0.555	5	99.97	0.00
	18:00	18.57		202.47	0.550	5	99.97	0.00
	19:00	16.96		185.08	0.502	5	99.98	0.00
	20:00	16.31		178.08	0.479	5	99.98	0.00
	21:00	15.45		168.45	0.454	5	99.99	0.00
	22:00	13.93		152.07	0.408	5	99.99	0.00
	23:00	11.96		130.68	0.347	5	100.00	0.00
		Hourly Averages			Average	Req'd Hrs	Weighted	Weighted
		FIRE	LAW	Radio	Erlangs	OnTask	% Immed Ans	Ans Delay
		14.35	0.00	156.53	0.419	120	99.98	0.00

Central FIRE Assignment workstations staffed to BSO specs as documented in
PSAP CALL ANALYSIS NOVEMBER 2015.xls

Figure 20. Erlang Model Central FIRE Assignments Workstation

Broward E911 Consolidated Communications System Workstation Performance by Hour-of-Day								
Year	Dispatch Model		Workstation Name			Surge		
2015	Triple PSAP		Central Assign FIRE			+ 0.00 σ		
Surge	Hour of Day	Hourly Averages				Workstation Staffing & Performance		
		FIRE	LAW	Radio	Σ Erlangs	OnTask	Immediate Answer [%]	Ans Delay @ 95%-tile [sec]
	00:00	9.96		108.57	0.287	1	71.28	10.22
	01:00	8.84		96.56	0.255	1	74.55	8.63
	02:00	8.05		87.74	0.232	1	76.80	7.66
	03:00	7.44		81.15	0.214	1	78.60	6.88
	04:00	6.93		75.51	0.199	1	80.15	6.24
	05:00	7.32		79.99	0.211	1	78.86	6.79
	06:00	8.69		94.39	0.252	1	74.78	8.63
	07:00	11.85		129.07	0.342	2	95.23	0.73
	08:00	15.00		163.64	0.436	2	92.77	1.18
	09:00	17.14		186.62	0.497	2	90.99	1.53
	10:00	18.79		204.97	0.547	2	89.50	1.85
	11:00	18.73		204.29	0.546	2	89.52	1.85
	12:00	19.01		207.54	0.555	2	89.25	1.90
	13:00	18.68		203.84	0.546	2	89.51	1.85
	14:00	18.55		202.36	0.544	2	89.59	1.84
	15:00	19.14		208.99	0.568	2	88.85	2.03
	16:00	18.37		200.30	0.543	2	89.62	1.85
	17:00	18.72		204.37	0.555	2	89.25	1.94
	18:00	18.57		202.47	0.550	2	89.41	1.90
	19:00	16.96		185.08	0.502	2	90.85	1.59
	20:00	16.31		178.08	0.479	2	91.52	1.44
	21:00	15.45		168.45	0.454	2	92.26	1.29
	22:00	13.93		152.07	0.408	2	93.53	1.05
	23:00	11.96		130.68	0.347	1	65.34	13.48
		Hourly Averages			Average	Req'd Hrs	Weighted	Weighted
		FIRE	LAW	Radio	Erlangs	OnTask	% Immed Ans	Ans Delay
		14.35	0.00	156.53	0.419	40	87.24	3.12

Central FIRE Assignment workstations staffed to FITCH specifications

Achieving a 3.12 second latency at the 95% weighted over 24 hours is a respectable level of performance for an assignment workstation. The significant take-away from this model is that a respectable level of latency can be attained using only 40 dispatcher hours OnTask. This is one third dispatcher hours that BSO allocates to this workstation. Again, BSO's allocation must be viewed as overstaffing.

FINDING: BSO current performance indicates overstaffing in FIRE Assignment positions based on Erlang modeling

DRAFT

Attachment A

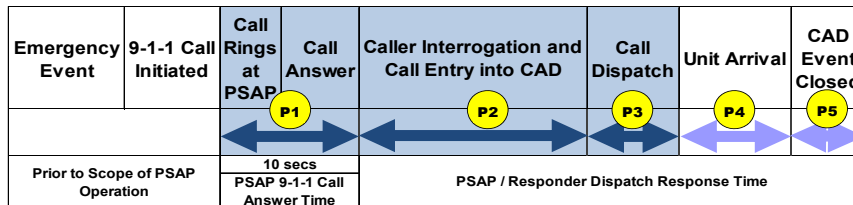
Performance Measures

ATTACHMENT A: Performance Measures FROM OPERATOR AGREEMENT ²²

EXHIBIT "D"

PERFORMANCE STANDARDS

The performance of the Consolidated Regional E-911 Communications System (System) will be based on the Lifecycle of an Emergency Call for calls received on the emergency lines (911 lines). As illustrated in the diagram below, operational performance indicators P1, P2, and P3 will be measured, reported and benchmarked against industry best practice standards. Efficiency (cost) measures will be utilized to evaluate the cost of the System.



- P1** 9-1-1 Call Answer Time
- P2** Time from Call Answered to Call Entered in CAD (and forwarded to Dispatcher)
- P3** Time from CAD Entry until a Unit is Dispatched
- P4** Time from Unit Dispatched until Unit Arrives on Scene
- P5** Time from Unit Arrives on Scene until Incident is Closed

To ensure the performance of the Consolidated Regional E-911 Communications System is evaluated in a reasonable manner, performance standards have been separated based on a transition and post-transition period. COUNTY, OPERATOR and Operational Planning/Implementation Workgroup members will collaborate to provide recommendations to County Administrator on the appropriate operational measures to be used to evaluate the System and establish annual performance targets to ensure incremental progress is being achieved.

Performance Standards will become effective at such time the Participating Community is designated, in writing, by the County as having been migrated to the Consolidated System.

Transition Period

The transition period shall begin upon the proper execution of this Agreement and continue through September 30, 2015, as it relates to those Participating Communities set forth on Exhibit "B" as of September 30, 2013.

²² From Exhibit D of the Agreement between Broward County and Sheriff of Broward County for The Operation of Call-taking, Teletype (Queries Only) and Dispatch Services for the Consolidated Regional E911 Communications System

The following Performance Standards ("Standards") will be utilized to track the efficiency and operational performance of the regional system on a monthly basis during transition phase:

Efficiency Measurements:

- Operational Cost per call for System
- Operational Cost per E911 call received

Time to Answer Emergency (911) Lines Standard:

- Ninety percent (90%) of all 9-1-1 calls arriving at the Public Safety Answering Point (PSAP) during the busy hour shall be answered within ten (10) seconds (P1)

The busy hour is defined as the hour each day with the greatest call volume.

- Ninety-five (95%) of all 9-1-1 calls should be answered within twenty (20) seconds (P1)

Alarms (audible, silent, panic, fire, smoke, medical, etc.) Received on Alarm Lines Standard:

- Ninety-five percent (95%) of alarms received on alarm lines shall be answered within 15 seconds (P1)
- Ninety-nine percent (99%) of alarms shall be answered within 40 seconds (P1)

First Call Process Time Standard:

Emergency alarm processing for the following call types shall be completed within 90 seconds 90% of the time and within 120 seconds 99% of the time (P2 and P3):

- Calls requiring emergency medical dispatch questioning and pre-arrival instructions
- Calls requiring language translation
- Calls requiring the use of a TTY/TDD device or audio/video relay services
- Calls of criminal activity that require information vital to emergency responder safety prior to dispatching units

- Hazardous material incidents
- Technical rescue
- With the exception of the above six call types, 80% of emergency alarm call processing shall be completed within 60 seconds, and 95% of alarm processing shall be completed within 106 seconds (P2 and P3)
- Where alarms are transferred from the primary public safety answering point (PSAP) to a primary and secondary answering point, the transfer procedure shall not exceed 30 seconds for 95% of all alarms processed* (P2)

*Only applicable if non-participating municipalities operate their own primary and secondary PSAP

Law Enforcement Call Process Time Standard:

- Priority one and priority two law enforcement calls shall be processed within 45 seconds, 90% of the time ** (P2 and P3)
- Priority three law enforcement calls shall be processed within 90 seconds, 90% of the time ** (P2 and P3)

Note: Availability of police units shall be considered when reviewing performance. Agencies must adopt standard signal codes to evaluate performance and the authority having jurisdiction shall determine time frames allowed to the completion of dispatch.

**Priority assignments based on current proposed standard

Emergency Medical Dispatch Standard:

- 95% case entry compliance rate
- 90% total compliance rate (case entry, chief complaint, key questions, and post-dispatch/pre-arrival instructions)
- 1% of all cases receive quality assurance case review*

*Based on NAED compliance standard for agencies with a call volume of over 500,000

Post-Transition Period

The post-transition period begins October 1, 2015. The performance targets of the Consolidated Regional E-911 Communications System will be based on the Lifecycle of an Emergency Call for calls received on the emergency lines (911 lines). COUNTY, OPERATOR and Operational Planning/Implementation Workgroup members will collaborate to provide a recommendation to the County Administrator on the appropriate operational measures to be used to evaluate the System and establish annual performance targets to ensure incremental progress is being achieved.

The following Standards will be utilized to track the efficiency and operational performance of the regional system on a monthly basis during the post-transition phase:

Estimated Efficiency Measurements(Subject to Change):

- Operational Cost per call for System (Target: \$9.83)
- Operational Cost per E911 call received (Target: \$14.85)

Efficiency Measurements shall be updated annually by COUNTY

Time to Answer Emergency (911) Lines Standard:

- Ninety percent (90%) of all 9-1-1 calls arriving at the Public Safety Answering Point (PSAP) during the busy hour shall be answered within ten (10) seconds (P1)

The busy hour is defined as the hour each day with the greatest call volume.

- Ninety-five (95%) of all 9-1-1 calls should be answered within twenty (20) seconds (P1)

Alarms (audible, silent, panic, fire, smoke, medical, etc.) Received on Alarm Lines Standard:

- Ninety-five percent (95%) of alarms received on alarm lines shall be answered within 15 seconds (P1)
- Ninety-nine percent (99%) of alarms shall be answered within 40 seconds (P1)

First Call Process Time Standard:

Emergency alarm processing for the following call types shall be completed within 90 seconds 90% of the time and within 120 seconds 99% of the time (P2 and P3):

- Calls requiring emergency medical dispatch questioning and pre-arrival instructions
- Calls requiring language translation
- Calls requiring the use of a TTY/TDD device or audio/video relay services
- Calls of criminal activity that require information vital to emergency responder safety prior to dispatching units
- Hazardous material incidents
- Technical rescue
- With the exception of the above six call types, 80% of emergency alarm call processing shall be completed within 60 seconds, and 95% of alarm processing shall be completed within 106 seconds (P2 and P3)
- Where alarms are transferred from the primary public safety answering point (PSAP) to a primary and secondary answering point, the transfer procedure shall not exceed 30 seconds for 95% of all alarms processed* (P2)

*Only applicable if non-participating municipalities operate their own primary and secondary PSAP

Law Enforcement Call Process Time Standard:

- Priority one and priority two law enforcement calls shall be processed within 45 seconds 90% of the time ** (P2 and P3)
- Priority three law enforcement calls shall be processed within 90 seconds 90% of the time ** (P2 and P3)

Note: Availability of police units shall be considered when reviewing performance. Agencies must adopt standard signal codes to evaluate performance and the authority having jurisdiction shall determine time frames allowed to the completion of dispatch.

**Priority assignments based on current proposed standard

Emergency Medical Dispatch Standard:

- 95% case entry compliance rate

- 90% total compliance rate (case entry, chief complaint, key questions, and post-dispatch/pre-arrival instructions)
- 1% of all cases receive quality assurance case review*

*Based on NAED compliance standard for agencies with a call volume of over 500,000

For a municipality that elects to become a PARTICIPATING COMMUNITY subsequent to September 30, 2013, the development and implementation of the transition plan shall contain provisions to minimize adverse impacts on the System by the addition of such municipality.

REVIEW AND REPORTING OF PERFORMANCE STANDARDS (TRANSITION AND POST-TRANSITION)

Standards shall be evaluated monthly using data from the previous month. Each Participating Community, Police Chief's Association, and Fire Chief's Association shall be provided a report on OPERATOR's performance utilizing this data no later than 30 days following the end of the previous month.

COUNTY shall provide an annual report on OPERATOR's performance to each Participating Community, Police Chief's Association and Fire Chief's Association. A draft of the final version of the annual report shall be delivered to the OPERATOR fifteen (15) calendar days before the intended release date. COUNTY and OPERATOR shall meet within five (5) calendar days thereafter to discuss the annual report's content and attempt to amicably resolve any differences, if any, in the statements, findings, and conclusions, or any combination thereof. If no amicable resolution is reached, OPERATOR shall have five (5) calendar days from the meeting to respond to the annual report and contest the statements and findings therein by providing a written response to COUNTY which response shall be included as an exhibit to the final annual report.

OPERATOR will be evaluated on its ability to achieve the necessary operational and efficiency performance standards, adherence to established actions and overall performance of the Consolidated Regional E-911 Communications System.

FAILURE TO MEET PERFORMANCE STANDARDS (TRANSITION AND POST-TRANSITION):

In the event a Standard is out of compliance in any month, the following shall occur:

- (1) COUNTY shall issue a written Notice of Noncompliance to the OPERATOR.

(2) OPERATOR shall provide to the COUNTY, a written Notice of Mitigating Circumstance(s) if any, within two (2) business days of the issuance of the Notice of Noncompliance. The Notice of Mitigating Circumstances shall include detailed information and documentation to support OPERATOR's position. For the purpose of this Agreement, a Mitigating Circumstance shall be defined as a natural or man-made incident, accident, disaster, or other environmental or situational anomaly that is unpredictable and, in the reasonable opinion of COUNTY, its occurrence causes an overwhelming and unusual emergency response that greatly exceeds the resources of the SYSTEM.

(3) COUNTY shall review any Notice of Mitigating Circumstance(s) that was timely submitted to determine whether the OPERATOR's failure to meet any Standard was due to a Mitigating Circumstance(s). The COUNTY review shall take into account all Mitigating Circumstance(s) that were submitted and their impact on the issue of noncompliance for each Performance Standard. COUNTY shall exercise its discretion to arrive at a reasonable determination that shall be final.

(4) In the event COUNTY determines that the OPERATOR has established, to COUNTY's satisfaction, Mitigating Circumstances related to its failure to achieve a Standard, COUNTY, in collaboration with OPERATOR, shall develop a written action plan to address the noncompliance. The Mitigating Circumstance(s) shall be a factor in the development of the action plan. The COUNTY shall have final approval of all action plans. The action plan may include changes to processes, practices, and procedures and shall include time frames in which the actions must be completed. OPERATOR shall comply with and immediately implement the action plan within the time frames established therein. In the event that OPERATOR shall timely implement all the elements of the action plan to COUNTY's satisfaction, the Notice of Noncompliance subject to Mitigating Circumstances shall be rescinded in writing.

(5) In the event that a Notice of Mitigating Circumstances was not timely submitted by OPERATOR, or following a determination by COUNTY that Mitigating Circumstance(s) were not established, COUNTY, in collaboration with the Operator, shall develop a written action plan to address the noncompliance. The COUNTY shall have final approval of all action plans. The action plan may include changes to processes, practices and procedures and shall include time frames in which the actions must be completed. OPERATOR shall comply with and immediately implement the action plan developed by COUNTY and comply with the time frames established therein.

(6) Compliance with an action plan shall not excuse OPERATOR from compliance with all Standards in a subsequent month.

(7) The written Notice of Noncompliance and the written Notice of Mitigating Circumstances shall be delivered by e-mail to the following e-mail addresses:

For County:

Rick Carpani [rcarpani@broward.org], Director of Office of Communications Technology

For Operator:

Robert Pusins [Robert_Pusins@sheriff.org], Executive Director of Community Programs, and

[Lisa Zarazinski, Lisa \[Lisa_Zarazinski@sheriff.org\], Director of Regional Communications](mailto:Lisa_Zarazinski@sheriff.org)

(8) In the event that the OPERATOR receives a Notice of Noncompliance for any three consecutive months (excluding any Notice of Noncompliance that was rescinded pursuant to the procedures in paragraph 4 above), the OPERATOR shall be deemed to be in breach and the Agreement shall be subject to termination as set forth in Article 7. In the event that COUNTY issues a notice of breach for noncompliance of the OPERATOR for any three consecutive months, the OPERATOR may cure the breach, if the breach is capable of cure, by performing any and all actions required to meet all Standards that were subject of the Notices of Noncompliance within thirty (30) calendar days from the date of notice of breach to COUNTY's satisfaction.

Notwithstanding the right to cure set forth in Article 7, in the event that the OPERATOR receives a Notice of Noncompliance for four months (excluding any Notice of Noncompliance that was rescinded pursuant to the procedures in paragraph 4 above), whether consecutive or not, in any twelve month period, this Agreement may be terminated upon not less than ten (10) days written notice for breach, without the right to cure.

Attachment B

Calculation of Answer Delays

Attachment B: Calculation of Answer Delays

TR = 911	IN = Incoming	IsEmpty S0	IsEmpty E1	IsEmpty E2	E1 – E2	Ans Del
0	0	–	–	–	–	blank
1	0	–	–	–	–	blank
0	1	–	–	–	–	blank
1	1	1	–	–	–	blank
1	1	0	0	1	–	E1-S0
1	1	0	1	0	–	E2-S0
1	1	0	0	0	<0	E1-S0
1	1	0	0	0	>0	E2-S0

With Hang-Ups

The logic for determining answer delays involving hang-ups requires testing the contents of five fields. These are:

TR: Trunk
 IN: Incoming
 S0: [CIM] ANI interval, "Start"
 E1: [CIM] Disconnected, "End1"
 E2: Call Connected, "End2"

The Boolean outcomes of each test and the corresponding answer delay calculation are indicated in the following 6X8 truth table.

The code required to implement this truth table is as follows:

```

Ans_Delay [hh:mm:ss.sss] =
Let ([ var01 = If(Trunk = "911" and InComing = 1 ; 1 ; 0) ;
var02 = not IsEmpty(CIM_ANI) ;
var03 = not IsEmpty(CIM_Disconnected ) ;
var04 = not IsEmpty(Call_Connected) ;
var05 = CIM_Disconnected - CIM_ANI ;
var06 = Call_Connected - CIM_ANI ;
var07 = CIM_Disconnected - Call_Connected ;
var08 = If ( var02 = 1 and var03 = 1 and var04 = 0 ; 1 ; 0 ) ;
var09 = If ( var02 = 1 and var03 = 0 and var04 = 1 ; 1 ; 0 ) ;
var10 = var02 * var03 * var04 ;
var11 = If ( var10 = 1 and var07 < 0 ; 1 ; 0 ) ;
var12 = If ( var10 = 1 and var07 > 0 ; 1 ; 0 ) ;
var13 = Case ( var02 = 0 ; "" ;
var08 = 1 ; var05 ;
var09 = 1 ; var06 ;
var11 = 1 ; var05 ;
var12 = 1 ; var06 ; "" ) ] ;

If ( var01 = 1 ; var13 ; "" )
/*
If ( test=TRUE ; thenresultOne ; elseresultTwo )
  
```

```
Case ( test1 ; result1; test2; result2 ; ... ; defaultresult)
*/
```

Attachment C

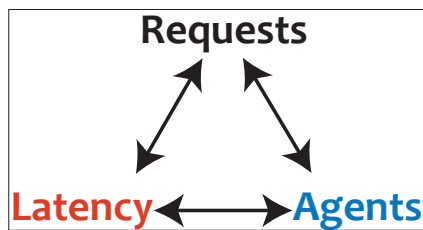
**Erlang
Mathematics & Assumptions**

Attachment C: Erlang Mathematics and Assumptions

History

Agner Krarup Erlang was a Danish mathematician, statistician, and engineer who invented the field of telephone networks analysis while working for the Copenhagen Telephone Company from 1908 through 1929. The goal of Erlang's queuing analyses is to determine how many service providers should be made available to satisfy users, without over provisioning. Mr. Erlang quantified the three-cornered relationship between requests for service, number of agents, and latency as shown in Figure 21, below.

Figure 21:Queueing Theory Triangle



The concepts and mathematics introduced by Mr. Erlang have stood the test of time. In the modern world, these methods are used to analyze queuing processes in systems as diverse as shoppers using grocery store checkout cashiers to data packet switching through Internet routers at megahertz frequencies.

The article authored by Chromy, Misuth, and Kavacky is a concise introduction to the application of the Erlang C formula to analyses of emergency services call centers.²³

Mathematics

For Erlang's analyses to apply to a system, two conditions must be met:

- Users arrive more or less at random intervals;
- Users receive exclusive service from any one of a group of agents without prior reservations

The flow of calls through E911 centers, including Broward's, conform to these requirements.

There are several versions of Erlang analyses depending on the exact model of the traffic flowing through the system. The specific model applicable to the BSO's dispatch operations has users either being served immediately, or waiting in queue until a call taker becomes available. The specific mathematical embodiment of the analysis applicable to the BSO system is referred to as the Erlang-C equation.

Erlang analyses must be conducted over a selected interval of time. In the case of emergency service communications centers experiencing the number of calls seen at BSO this interval is most appropriately one hour. Little insight would be gained by viewing each hour of the year as a special case. The need is for the analyst to consolidate individual hours into groups that present a valid picture of the way the

²³ E. Chromy, T. Misuth, and M. Kavacky, 2011, *Advances in Electrical and Electronic Engineering*, ISSN 1804-3119.

system functions. The consolidation process appropriate to BSO has been described above in this Report.

The Erlang C formula calculates the probability that an arriving call will be diverted to the waiting queue rather than being served immediately. Three common sense parameters go into the Erlang C calculation:

- The average arrival rate of calls during the hours being considered.
- The average length of time the dispatcher spends processing each call.
- The number of dispatchers on duty.

For an Erlang analysis, the workload flowing through the BSO's dispatch operations must be expressed in units of erlangs, E .

$$E = \eta \lambda$$

Equation 1

E : Workload in units of erlangs

η : Average call arrival rate in calls per hour

λ : Average call-processing time in decimal hours per call

The average call arrival rate and average call processing times that are required to calculate Erlangs in Equation 1 are extracted from the historic Computer Aided Dispatch (CAD) system, the Intrado VIPER telephony server, and the written reports of radio usage per channel.

To avoid confusion, the reader should be advised that many of the time parameters appearing in the tabular data presented in this report will be formatted as decimal hours rather than as hours:minutes:seconds, hh:mm:ss. For example, 15 minutes, 00:15:00, will appear as 0.250 hr.

The probability that an arriving call will be diverted to the waiting queue, P_Q , rather than being answered immediately is calculated from the expansion of the Erlang-C equation.

$$P_Q = \frac{\left[\frac{E^N}{N!} \frac{N}{(N-E)} \right]}{\sum_{i=0}^{N-1} \left\{ \frac{E^i}{i!} + \frac{E^N}{N!} \left[\frac{N}{(N-E)} \right] \right\}}$$

Erlang-C Equation 2

E : Workload in erlangs from **Eqn 1**

N : Dispatchers on duty at workstations

Discussions of queueing processes are often tabulated in terms of three additional parameters:

P_A : Probability that an incoming call will be immediately answered.

W : Average answer delay. The time interval that a call is held in queue.

Q : Average number of calls waiting in queue for service.

Once the probability that an arriving call will be diverted to the waiting queue, P_Q , has been calculated using Equation 2, then these three additional parameters can be calculated using the algebraic transformations in Equations 3, 4, and 5.

$$P_A = (1 - P_Q) \quad \text{Equation 3}$$

$$W = \frac{P_Q \lambda}{(N-E)} \quad \text{Equation 4}$$

$$Q = \frac{P_Q E}{(N-E)} \quad \text{Equation 5}$$

Variables P_Q , N , and E are defined above.

Absolutely rigorous application of an Erlang-C analysis requires that three additional conditions be met:

- That callers never hang up while being held in queue.
- That all calls begin and end within a single time interval.
- That callers do not call back after having hung up while in queue.

When these conditions are not met, as will be the case in the real world, then the Erlang-C formula predicts that slightly more call-takers should be used than are really needed to maintain a desired level of service. Thus, the Erlang-C analysis is generally viewed as providing an upper bound to the needed number of call-takers required to service a given flow of incoming traffic.

While this limitation of Erlang C analysis exists, in practice, it results in a negligible increase to the number of dispatchers predicted for BSO's dispatch operations. The flow of offered traffic through the BSO system is modest and the number of dispatchers required is modest. Dispatchers can be added to or subtracted from the system only in integer increments. Under these circumstances, incrementing the number of dispatchers by +1 will always result in such a large increase in answering probability that it overwhelms the propensity of a simple Erlang C analysis to slightly increase the required number of dispatchers.

Workloads, Staffing and Non-Linear Response

A concise presentation of workload patterns and non-linear response of a queueing system is presented in the on-line PDF titled, "Call Center Basics".²⁴ The following is a paraphrase of portions of this article.

A naïve approach to calculating the number of agents needed in a call center is to divide the number of calls expected per hour divided by the average length of a call. For example, if 100 calls arrive per hour and the average time to service a call is 15 minutes, then it appears that 25 agents should be able to service the workload. The flaw in this model is that calls do not arrive in an orderly fashion, one right after the other. Callers, seeking service, act independently of each other, and their calls arrive in a

²⁴ www.easierlang.com/pdfs/call-center-basics.pdf (July 15, 2015)

random pattern surrounding the average spacing between calls. Likewise, the interval required by the agents to process each request for service displays a random pattern surrounding its average value.

For call centers, the arrival rate is best described by a mathematical function called a Poisson distribution. The call processing interval is best described by a mathematical function called an Exponential distribution. Figures 22 and 23 illustrate the shapes of these distributions.

Figure 22: Poisson Distribution of Call Arrival Rates

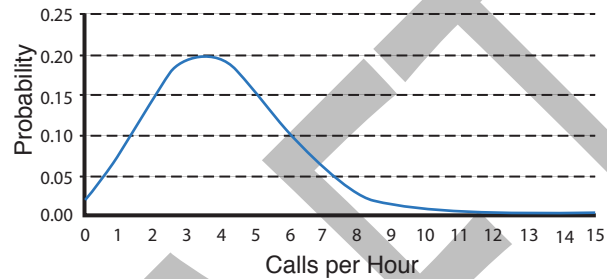
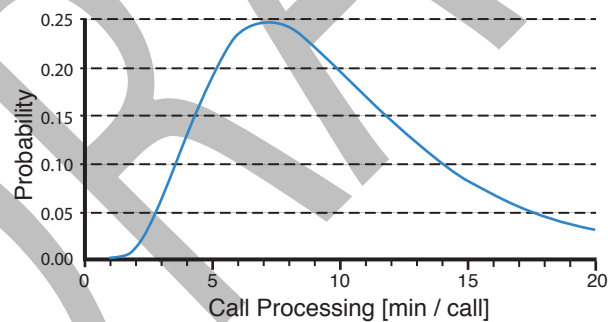
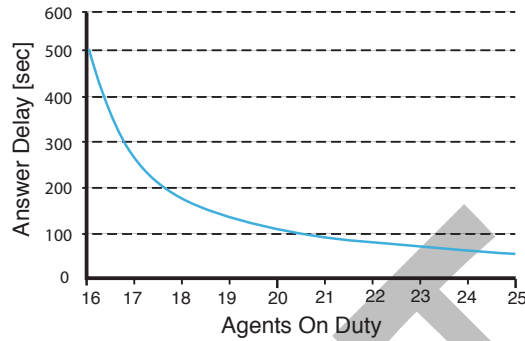


Figure 23: Exponential Distribution of Call Processing Intervals



The statistical behaviors of the call arrivals and call service intervals guarantees that changes in the number of agents will have a non-linear effect on performance of the system. In this hypothetical example, an increase of 10% in staffing will not result in a 10% decrease in the average answer delay. Rather, the average answer delay shows the behavior shown in Figure 24.

Figure 24: Average Answer Delay Versus Number of Agents

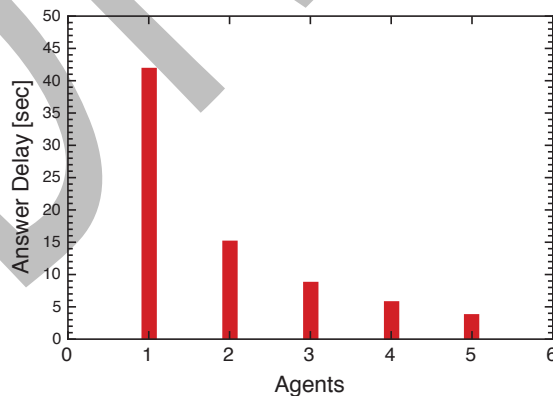


The purpose of this example is to emphasize that the performance of a queuing system changes in a very non-intuitive manner with respect to changes in both staffing and workload.

The dependence of average answer delay on the number of dispatcher is approximately hyperbolic. At constant workload, an increment or decrement of ± 1 dispatcher can result in very magnified or very compressed changes in average answer delays depending on which end of the curve in Figure 3 contains the operating point of the system. There is no substitute for running detailed calculations, using data specific to the system under consideration, in order to accurately predict its queuing behavior.

In systems with large numbers of agents, the relationship between average answer delays and the number of agents on duty is approximately a continuous function. This relationship is very different for small systems (Figure 25).

Figure 25: Answer Delays and Agents in Small Systems



The relationship remains approximately hyperbolic, but the **accessible** answer delays become a step function. The number of agents on duty can only be changed in integer increments or decrements.

Attachment D

Sample Phone Record

Attachment D: Sample Phone Record and Outgoing Phone Log

Figure 26. Sample CDR Phone Record

Broward E911 Consolidated Communications System
 Call Detail Records Extended Format

==== CDR BEGIN : 11/11/15 15:30:10.313 =====

00:00:00.000 [TS] SYSTEM ID = broward
 00:00:00.000 [CIM] Incoming Call (ID: 911009-00291-2015111203010) Offered on Trunk 911009
 00:00:02.269 [CIM] ANI: (40)*9547295989* [VALID] PseudoANI: "" [NONE]
 00:00:02.269 [TS] Initial ALI Request for ANI : 9547295989
 00:00:02.279 [CIM] Call Presented
 00:00:02.898 [VoIP] External Call-Identifier 911009-00291-2015111203010
 00:00:03.100 [VoIP] Routing call QUEUE = 6023
 00:00:03.309 [PAS] Initial ALI Response received / ALI TYPE = 1
 00:00:03.315 [VoIP] Routing call QUEUE = 6020
 00:00:03.523 [CIM] Call Connected
 00:00:03.528 [VoIP] Routing call AGENT = 15002/2012
 00:00:04.061 [TCJ] TRUNK = 911009 / LINE = 9 POS = 012 / STN = 2012
 00:00:04.061 [TCJ] CALL CONNECTED BY AGENT = Adrian, Andrea/15002 ROLE = Central Call-Taker
 00:00:04.061 [TCJ] From PSAP ID = 1 PSAP Name = Central
 00:00:43.055 [CIM] Tandem Transfer
 00:00:44.552 [TCJ] Event Logged By POS = 012 / STN = 2012 KEY: TRANSFER SV: 77 LV: h,9547644357
 00:00:44.552 [TCJ] agencyId: 471 agencyName: BROWARD COUNTY NON-EMERGENCY agencyTypeId: 9 agencyTypeName: Non-Emer
 00:00:48.917 [TCJ] CALL RELEASED BY POS = 012 / STN = 2012
 00:00:48.917 [TCJ] CALL DISCONNECTED BY AGENT = Adrian, Andrea/15002 ROLE = Central Call-Taker
 00:00:48.917 [TCJ] From PSAP ID = 1 PSAP Name = Central
 00:00:50.743 [CIM] Call Disconnected
 00:00:50.753 [CIM] Call Terminated
 00:00:50.753 [TS] Call Completed
 ===== Initial ALI =====

(954) 729-5989 15:30 11/11
 8320 W SUNRISE BLVD

PLANTATION FL 470 WPH2
 SPRINT
 N SECTOR P# 729-5989
 ALT# 954-816-8962 LEC:SPPCS
 WIRELESS CALL
 QUERY CALLER FOR LOCATION
 QUERY CALLER FOR PHONE #
 -080.256994 +26.162771
 ===== CDR END =====

==== CDR BEGIN : 11/11/15 15:30:10.313 =====

Begin Timestamp	Date	Time
11/11/2015 15:30:10.313	11/11/2015	15:30:10.313

Year	Mo	Day	Day Name	Day of Wk	Hr of Day	Hour of Yr
2015	11	11	Wed	4	15	7,552

PSAP	Origin	TTY
Central	WIRELESS	0

Trunk	Phone Number	DNIS	Alarm
911009	9548168962		0

Station	Agent	Name
2012	15002	Adrian, Andrea

Caller Disconnects: 0 Before 0 After Supervision

00:00:02.279	Call Presented		
00:00:02.269	[CIM] ANI		
	Caller Disconnects	1.735 sec	avg
00:00:03.523	Call Connected	20.223 sec	± sd
00:00:04.061	Agent Connected		90th
1.254 sec	Answer Delay		95th

00:00:48.917	Agent Disconnected		
00:00:44.856	Agent Processing	44.856 sec	
	0 On-Hold	0 Parked	
	0 Off-Hold	0 Unparked	

11/11/2015 15:30:13.836	Call_Connected_TS	
11/11/2015 15:30:14.374	Agent_Connected_TS	
11/11/2015 15:30:59.23	Agent_Disconnected_TS	

-80.256994	Longitude
26.162771	Latitude

CDR Text Length

1,822	Char
-------	------

Figure 27. Sample of Outgoing Phone Logs

Broward E911 Consolidated Communications System Outgoing Phone Logs 11/01/2015 - 01/31/2016					
PSAP	Dialed Number	Timestamp	Date	HoD	Processing
Central	(954) 279-0070	12/10/2015 01:04:35	12/10/2015	1	11.176 sec
Central	(954) 260-8290	12/10/2015 01:06:25	12/10/2015	1	10.188 sec
South	(954) 295-2251	12/10/2015 01:06:31	12/10/2015	1	3.436 sec
North	(800) 323-9949	12/10/2015 01:09:39	12/10/2015	1	756.561 sec
South	(954) 927-5287	12/10/2015 01:17:21	12/10/2015	1	2.206 sec
Central	(786) 487-7286	12/10/2015 01:20:17	12/10/2015	1	3.804 sec
North	(772) 626-7768	12/10/2015 01:24:00	12/10/2015	1	14.468 sec
Central	(786) 312-0238	12/10/2015 01:25:02	12/10/2015	1	258.527 sec
Central	(754) 423-5752	12/10/2015 01:39:56	12/10/2015	1	16.657 sec
Central	(954) 439-1070	12/10/2015 01:45:40	12/10/2015	1	38.065 sec
South	(718) 427-4308	12/10/2015 01:49:54	12/10/2015	1	7.559 sec
South	(754) 779-9183	12/10/2015 01:59:22	12/10/2015	1	6.804 sec
Central	(904) 236-2138	12/10/2015 02:16:04	12/10/2015	2	6.867 sec
Central	(954) 706-1753	12/10/2015 02:16:31	12/10/2015	2	32.045 sec
South	(786) 539-8293	12/10/2015 02:17:37	12/10/2015	2	480.740 sec
North	(772) 501-3443	12/10/2015 02:18:25	12/10/2015	2	57.829 sec
Central	(754) 322-8350	12/10/2015 02:19:20	12/10/2015	2	5.420 sec
Central	(754) 321-0161	12/10/2015 02:19:34	12/10/2015	2	46.076 sec
South	(786) 985-0380	12/10/2015 02:19:57	12/10/2015	2	4.558 sec
North	(772) 501-3443	12/10/2015 02:26:54	12/10/2015	2	8.784 sec
South	(954) 650-1660	12/10/2015 02:27:59	12/10/2015	2	2.232 sec
North	(954) 650-1660	12/10/2015 02:28:30	12/10/2015	2	33.352 sec
South	(954) 524-6991	12/10/2015 02:47:13	12/10/2015	2	93.104 sec
Central	(954) 235-9273	12/10/2015 02:48:25	12/10/2015	2	23.403 sec
North	(954) 971-7749	12/10/2015 02:48:28	12/10/2015	2	36.985 sec
South	(832) 335-7572	12/10/2015 02:57:32	12/10/2015	2	14.205 sec
Central	(954) 960-2463	12/10/2015 03:18:51	12/10/2015	3	306.468 sec
South	(954) 454-1472	12/10/2015 03:25:34	12/10/2015	3	4.157 sec
Central	(954) 268-4639	12/10/2015 03:37:23	12/10/2015	3	316.004 sec
Central	(912) 412-8662	12/10/2015 03:42:15	12/10/2015	3	2.145 sec
Central	(954) 245-2606	12/10/2015 03:42:15	12/10/2015	3	13.111 sec
North	(954) 609-4031	12/10/2015 03:52:41	12/10/2015	3	51.182 sec
Central	(561) 368-8462	12/10/2015 03:55:45	12/10/2015	3	397.942 sec

Attachment E

**Sample Records
From Fire CAD**

Attachment E: Sample Records from the FIRE CAD, LAW CAD, and Radio Statistics

Figure 28. Sample Record from the LAW CAD

Broward E911 Consolidated Communications System LAW Incident Records							
Date	Time	Mo	Day	Day Name	Day of Wk	Hr of Day	Hour of Yr
12/10/2015	13:01:45	12	10	Thu	5	13	8,246
Event_number		Dup'd		Caller Phone			
L04151210000721		0		9546245921			
Response_Agency			Code	Disp_Loc	Unit		
BSO			04	Central	4B6		
Priority	Incident_ID	Incident_Description					
2	76	AOA					
4900 W OAKLAND PARK BLVD				Lauderdale Lakes			
Radio_Chn	Avg Talk /Incident	Avg Talk /Xmit/Rcv	Xmit/Rcv's / Incident	Dispatch Duration	Support Duration		
BSO-07-DISP	51.42 sec	9.552 sec	5.38	9.552 sec	41.871 sec		
CDR_Begin	12/10/2015 13:00:28.768	Intake_proc 1	00:01:50.027	P2			
Call_Connected	12/10/2015 13:00:32.265	VIPER_spillover	00:00:02.027				
Agent Connected	12/10/2015 13:00:32.973	Rcvd_offset	00:01:10				
Rcvd_time	12/10/2015 13:00:35	Assign_proc	00:03:47 sec	P3			
Create_time	12/10/2015 13:01:45	Assign_workload 2	68 sec				
Transmit_time	12/10/2015 13:02:23	P2/P3 Interval 3	335 sec	P2/P3			
Agent Disconnected	12/10/2015 13:08:48.92	Time-on-Task 4	00:53:18				
Dispatch_time	12/10/2015 13:06:10	Index 3	335				
Enroute_time	12/10/2015 13:06:12.4	avg	143.792				
Arrvd_time	12/10/2015 13:09:46						
Closed_time	12/10/2015 13:59:28						
Portal to CDR Data Table							
CDR_Begin	Call_Connected	Agent_Connected	Agent_Disconnected				
12/10/2015 13:00:28.768	12/10/2015 13:00:32.265	12/10/2015 13:00:32.973	12/10/2015 13:08:48.92				

Figure 29. Sample Record from the FIRE CAD

Broward E911 Consolidated Communications System FIRE Incident Records

Date	Time	Mo	Day	Day Name	Day of Wk	Hr of Day	Hour of Yr
11/15/2015	07:30:24	11	15	Sun	1	7	7,640

Event_Number	Dup'd	Caller_Phn
FDN151115005805	0	3057648078

Response_Agency	Code	Unit_ID	Disp_Loc
BSOFR	DN	R74	Central

Priority	Call_Type	EMD	Incident_Description	Resp_Cat
6	S67IJ	1	INJURY	EM
5827 PARK RD			Dania	

Radio_Chn	Avg Talk /Incident	Avg Talk /Xmit/Rcv	Xmit/Rcv's / Incident	Dispatch Duration	Support Duration
BCF-D2	96.10 sec	8.818 sec	10.90	8.818 sec	87.285 sec

CDR_Begin	11/15/2015 07:29:03.44	Intake_proc 1	00:01:46.523	P2
Call_Connected	11/15/2015 07:29:06.828	VIPER spillover	00:00:02.523	
Agent Connected	11/15/2015 07:29:07.477	Rcvd_offset	00:01:14	
Rcvd_TS	11/15/2015 07:29:10	Assign_proc 2	16.00 sec	P3
Create_TS	11/15/2015 07:30:24	Assign_Workload	16.00 sec	
Transmit_TS	11/15/2015 07:30:54	Chute_time 3	323.45	
Agent Disconnected	11/15/2015 07:36:42.134	PreAr Interval		
Dispatch_TS	11/15/2015 07:31:10	P2/P3 Interval 4	120.000	P2/P3
Enroute_TS	11/15/2015 07:36:33	Time-on-Task	00:07:11	
Arrvd_TS		Index 4	120.00	elapsed
Closed_TS	11/15/2015 07:38:21		462.06	avg

Portal to CDR Data Table			
CDR_Begin	Call_Connected	Agent_Connected	Agent_Disconnected
11/15/2015 07:29:03.44	11/15/2015 07:29:06.828	11/15/2015 07:29:07.477	11/15/2015 07:36:42.134

Figure 30. Sample Records from Radio Statistics

Broward E911 Consolidated Communications System Talkgroups at Zone Statistics CY2015						
Radio Channel Abbrev	Radio Traffic Xmit/Rcv's	Total Radio Duration [sec/yr]	Average Talk Xmit/Rcv [sec]	Incident Count	Total Talk per Incident [sec]	Talk Count per Incident
BCF-D1	480,434	4,161,542	8.662	36,910	112.75	13.02
BCF-D2	529,742	4,671,511	8.818	48,609	96.10	10.90
BCF-D3	225,762	2,008,058	8.895	20,198	99.42	11.18
BCF-D4	178,202	1,539,092	8.637	14,023	109.75	12.71
BCF-D5	399,290	3,160,509	7.915	30,872	102.37	12.93
BCF-D6	419,797	3,456,751	8.234	32,836	105.27	12.78
FLF-DISP1	656,110	5,252,965	8.006	54,316	96.71	12.08
BCF-D8	447,385	4,070,692	9.099	30,929	131.61	14.46
BCF-D9	288,696	2,525,851	8.749	21,580	117.05	13.38
BCL-COMM	58,333	541,606	9.285	14,940	36.25	3.90
BSO-02-DISP	717,158	6,571,478	9.163	32,778	200.48	21.88
BSO-03-DISP	792,390	7,212,269	9.102	27,162	265.53	29.17
BSO-04-DISP	497,838	4,794,358	9.630	42,827	111.95	11.62
BSO-05-DISP	696,625	7,145,394	10.257	73,975	96.59	9.42
BSO-06-DISP	762,379	7,364,307	9.660	117,985	62.42	6.46
BSO-07-DISP	1,060,432	10,128,828	9.552	196,973	51.42	5.38
BSO-08-DISP	872,305	7,975,457	9.143	75,711	105.34	11.52
BSO-10-DISP	1,004,798	8,527,021	8.486	74,434	114.56	13.50
BSO-11-A1A2	1,605,483	14,618,781	9.106	123,425	118.44	13.01
CKP-MAIN	916,167	8,310,381	9.071	77,097	107.79	11.88
CSF-MAIN	125,578	1,058,964	8.433	10,590	100.00	11.86
HW-P-A1A2	1,377,654	16,514,932	11.988	189,878	86.98	7.26
PPP-MAIN	988,952	9,362,099	9.467	86,900	107.73	11.38
SNP-DISP	825,080	7,195,082	8.720	79,207	90.84	10.42
WMP-TAC-1	30,847	251,695	8.159	2,517	100.00	12.26



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