FINAL REPORT – FINDINGS AND RECOMMENDATIONS

DECEMBER 2016

ASSESSMENT OF BROWARD COUNTY'S REGIONAL E911 CONSOLIDATED COMMUNICATION SYSTEMS

Submitted by:

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CONSULTANT REPORT

ASSESSMENT OF BROWARD COUNTY'S REGIONAL E911
CONSOLIDATED COMMUNICATION SYSTEMS
DRAFT FINAL REPORT - FINDINGS AND RECOMMENDATIONS

Table of Contents

Attachments

A. Scheduling Matrix Sample
B. Performance Measures
C. Calculation of Answer Delays
D. Erlang Mathematics & Assumptions
E. Quantitation of Workloads
F. Sample Phone Record
G. Sample Records from Fire CAD, LAW CAD, and Radio Statistics
H. Calculation of Surges
I. Erlang Tables of Workstations
J. Monthly Performance Report Format

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. 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) on a performance basis 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 a compilation of findings from the Phase I System assessment and recommendations for the future state of the System - Phase 2 of the project. Phase 1 included an analyses of qualitative and quantitative data as provided by the County and other stakeholders. This final phase of the project/report provides a series of specific recommendations designed to improve overall System effectiveness, efficiency and utilization of industry best practices. The document merges both Phases into this Final Project Report.

As with Phase 1, *FITCH* consultants spent many hours working with Broward County and BSO personnel. We continue to be 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

The Executive Summary of this report brings forward the findings from the Phase 1 report and organizes them into five groupings as follows:

- Observational Findings
- Technology
- Governance and Oversight
- Performance Measures
- Effectiveness and Efficiency

Observational Findings are those that comment on the Regional System and require no further action. These are primarily observed, positive attributes of the Regional System.

Recommendations

The other four categories above address the findings from the Phase 1 report and provide actionable recommendations. Further discussion, intended to provide context and further explanation for the recommendations, should be read in detail and are included in the report section titled Recommendations.

Many of the recommendations will require significant organizational and cultural change. The System, as a whole, will need to recognize that change must be planned, and more importantly each major change, such as implementing Emergency Fire Dispatch, must be executed to completion before additional changes, such as Emergency Police Dispatch, are initiated. In certain circumstances, less significant change processes can be managed concurrently. This is key to the System's ultimate success.

Throughout the report, recommendations to increase resources in certain areas are balanced by recommendations intended to improve the overall efficiency of the System. In total, the current funding of the system is sufficient. There should be no need for further overall funding.

Options Development

This report evaluates three options for both dispatch process configuration and the personnel needed to staff workstations in order to achieve a defined performance level. These options, and the resources required for the current staffing deployed by BSO, are reflected below.

- **Option 0** — reflects the current dispatch configuration, but with performance targets adjusted to achieve new recommended levels for call intake and dispatch positions.
- **Option 1** — reflects the staffing required for the new performance targets, but utilizing a single call intake queue. The County recently modified their systems to now utilize the single queue for 911 calls.
- **Option 2** — utilizes the new performance targets and single call intake queue, but further optimizes the fire dispatch operations by consolidating the number of radio channels required.

Figure 1 below reflects BSO's current staffing as described in BSO reports titled "PSAP Call Analysis" covering the period January 2015 through December 2015. The table compares BSO's reported current staffing with the hours per day required for each of the three Options. The required hours noted below for current staffing and each of the three options reflect the total hours required to be functioning 'in a seat', by position type, over a single 24-hour period.

Figure 1. Comparison of Current and Three Options "Seats" Required

	Current BSO Model			*FITCH* Options - Hours		
	All 3 PSAPs – "Seats" Required	Static or Variable by Hour	Current Staffing Hours	Option 0	Option 1	Option 2
Intake	16.1	Variable	386	493	301	301
F/R Dispatcher	15.0	Static	360	116	116	153
Law Dispatcher	23.0	Static	552	235	235	235
Subtotal	**54.1**		**1,298**	**844**	**652**	**689**
Phone Support	3.0	Static	72	72	72	72
TTY	3.0	Static	72	72	72	72
Support	2.0	Static	48	48	48	48
Supervisor	7.0	Static	168	168	168	168
Subtotal	**15.0**		**360**	**360**	**360**	**360**
TOTAL	**69.10**		**1,658**	**1,204**	**1,012**	**1,049**

Relief staffing not included above*[1]*:

Fire Relief *3*
Law Relief *4*
Intake Relief *5.3*

The Options define the needed personnel by hour-of-day and address surge capacity of the Regional System. In developing the Options, the hours needed in any position do not include relief or staffing multipliers – only the actual number of seats in the dispatch center that must be filled at any hour of the day.[2] It is understood that, as is current practice, BSO must plan for, and the County fund, resources to allow for necessary breaks, training time and other administrative needs.

Option 2 is the preferred recommendation.

[1] Broward County currently provides funding to allow for relief staffing.
[2] Fitch uses hours to represent the hours required for personnel to be activity operating at their workstation at a given time, colloquially referred to as "butts in the seat."

OBSERVATIONAL FINDINGS

Broward Sheriff's Office is an Accredited Center of Excellence as awarded by the International Academies of Emergency Dispatch (IAED). BSO utilizes emergency medical dispatcher (EMD) services – a best practice for 911 centers, and a requirement for ongoing accreditation.

The County has implemented a set of quality assurance and improvement processes that assist in objectively moving the System forward. The County has established process control and quality improvement programs that include members from BSO and the call taker/dispatch union. This allows for efforts to review and implement service quality initiatives. BSO is an accredited organization and utilizes quality assurance processes as prescribed by IAED. Additionally, a number of procedures are in place to manage dispatch issues, review situations and implement training and/or policy changes for improvement.

The number of 911 callers required to be transferred has been essentially eliminated under the consolidated regional system. As a result, total call processing times were reduced by approximately 30 seconds. The National Fire Protection Association (NFPA) sets a best practice goal of 30 seconds to transfer callers from the primary Public Safety Access Point (PSAP) to a different PSAP. By creating a regional system, the transfer step is eliminated and callers only need to explain/discuss their emergency one time, not multiple times as was the case, historically.

The P1 interval (the time from when the call rings in the 911 center until that call is answered), and P3 interval (the time from when the assignment dispatcher receives an emergency call via the computer-aided dispatch (CAD) system until they alert the emergency responder), can be accurately evaluated based on current data in the CAD and telephony system. BSO performs well for these dispatch intervals. On the other hand, the P2 interval (the time from when a 911 call is answered until the information is sent to an assignment dispatcher to alert first responder) must be cautiously evaluated due to the technology and data limitations existing in the current CAD and 911 systems. The County has indicated this issue will be remedied with implementation of the new CAD in early 2017.

FINDINGS AND ACTIONABLE RECOMMENDATIONS

Technology

Findings —

The County's PSAP phone system and CAD system are not effectively linked to allow comprehensive evaluation of System performance.

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.

Technology limitations resulted in only 25.6% of CAD records considered valid for use in analysis of P2/P3 intervals.

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/canned reports, which makes some of the required reporting tedious and error prone.

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

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

Recommendations —

The County needs to insure the missions of technology development and technology sustainment have different focuses and roles. Therefore, the County should provide for a Technology Development Team and a Technology Sustainment Team over the next few years as new technologies are implemented and the system continues to stabilize.

An absolute priority for the County is to develop a link between 911 phone records and the associate CAD incident records.

BSO should maintain EMD certification training for all call takers through the International Academies of Emergency Dispatch (IAED). Call taker personnel should also be trained and certified as Emergency Fire Dispatchers (EFD) and in the system implement EFD in the near future. These certifications are considered industry best practice.

Finally, law enforcement agencies should consider and evaluate the efficacy of Emergency Police Dispatch (EPD) being utilized in the future. This system is emerging as an industry best practice.

Operational Oversight and System Governance

Findings —

BSO's operation of the Public Safety Answering Points is challenged with significant morale problems embedded in issues of staffing, training and management.

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.

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.

Recommendations —

Operational Oversight and System Governance should be redefined to strengthen the role of end-users while balancing the logistical concerns of the Operator (BSO), and the financial and system governance responsibilities of Broward County.

Alternative work schedules are available and should be considered. Attachment A, Scheduling Matrix Sample, provides sample schedules for consideration. Filling vacant positions in a timely manner with the goal of maintaining full staffing will reduce excessive mandatory overtime and the associated stress. This will allow resources to align more closely to demand patterns, thereby improving efficiency in the system.

Supervision on the PSAP dispatch floors should be at a ratio of six to one as opposed to the current ten to one ratio. Greater quality assurance processes are to be handled by BSO dispatch floor supervisors.

Resources for dispatcher training should be increased through reallocation of current funding.

A "base level of 911 services" funded by the County should be more clearly defined by utilizing the current interlocal agreements and *FITCH's* modeling of performance levels as noted in call taking and radio positions. Individual agencies desiring higher levels of service should be able to fund additional staffing hours or technology in order to receive services specific to their jurisdictional needs. The Regional System's management and technology should facilitate these additional services as long as they do not disrupt the base services.

Performance Measures

Findings —

Certain performance measures have been misinterpreted, incorrectly applied, or are inconsistent with current industry best practices.

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

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.

Recommendations —

The County should modify the current monthly performance report format and replace it with a monthly report that focuses solely on data and provides no commentary.

The "busy hour" is to be redefined in a prospective manner based on historical data and is to be reassessed in no less than 12-month intervals. These changes allow for meaningful and actionable information exchanges and provide user agencies with a needed level of oversight.

The County should purchase a performance measurement software package that will provide agencies with ready access to the activities and performance of their respective field units, and simultaneously allow the County and BSO to evaluate system performance at the micro and macro levels.

Only the performance on emergency/911 incidents should be included in the performance reports. The current practice of evaluating duplicate 911 calls on a single incident skews measurement. The true structure of the report should be to present the numbers in a way that highlights the calls where response time is important. Some thought should be given to present response times starting with the call receipt to emergency service arrival on scene. This will give the proper presentation of the caller's experience. Special attention should be paid to high priority incidents.

Regarding reporting performance for various call processing time intervals, once the technology issues are resolved, the P2 and P3 intervals should be reported separately and as a combined metric. The reasoning is that, particularly for fire and emergency medical Delta and Echo life-threatening calls, fast and effective dispatch performance contributes to positive outcomes. Monthly reports should also report P4 (turn-out times) for fire rescue incidents and P5 (travel time) for both fire rescue and law high priority incidents.

In general, dispatch center performance metrics are to focus on optimizing dispatch processes as much as possible, with the end result being to get help moving to emergencies as quickly as possible. The primary objective is to contribute to the potential for positive outcomes for patients and properties.

Effectiveness and Efficiency

Findings —

Current PSAPs, training facility and "flee to" plans have facility limitations, especially related to adequate space.

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

Radio traffic utilization, by both fire/EMS and law enforcement units, is comparatively high. MDTs (mobile data terminals) and MCDs (mobile computing device) are not effectively utilized to reduce radio traffic.

BSO current performance indicates overstaffing in call taker positions based on Erlang modeling.

BSO current performance indicates overstaffing in Fire Assignment positions based on Erlang modeling.

Recommendations —

Call processing staffing should be adjusted to achieve P1/call-taking performance of between three to five seconds at the 90th percentile by adopting the recommended workstation functional reorganization as detailed in the report section titled, Dispatch Operations Models – Options. This adjustment, in conjunction with the already implemented single que for call intake, provides significant efficiencies in the call taking process while maintaining high levels of performance.

Fire-rescue agencies should develop, approve and implement countywide nearest unit response protocols that apply irrespective of jurisdictional boundaries in those incidents involving high priority incidents (e.g. Delta & Echo level EMD calls).

Recommended process changes to radio channel usage include requiring increased usage of Mobile Data Terminals (MDTs) by field responders.

Once the CAD is upgraded to allow automatic computer assignment / recommendation of response units for fire/rescue calls, a single “gatekeeper” function / fire rescue alert channel can be implemented to manually approve the assignment consistent with Option 2. Upon dispatch, pre-defined tactical radio channels would be used for more routine fire incidents and EMS incidents. More significant incidents (structure fires, major/multiple unit responses) would be assigned a dedicated tactical channel. This change in fire rescue radio operations provides significant efficiencies while maintaining high levels of performance.

Law enforcement radio positions should be consolidated to increase efficiency consistent with Option 2.

Long-term capital budgeting programs should be considered as soon as practical to include two new purpose-specific 911 facilities.

METHODOLOGY

The System assessment effort derived 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 and model that performance.

To determine staffing needs, BSO and the County currently utilizes 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. This is very relevant as the County and BSO operate under a performance based contract.

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.

Once the System assessment and modeling of BSO's current operations was complete, *FITCH* consultants then quantified the optimal number of call takers and dispatchers needed to meet certain performance criteria in the Regional E911 System. Three options that indicate staffing levels and recommended performance goals are presented for consideration. Ultimately, 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 practices and local competencies.

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 (EPD)
- Emergency Fire Dispatch Certification (EFD)
- Emergency Medical Dispatch Certification (EMD)

Each certification area provides structured call processing for the respective discipline. IAED sets out 20 points as accreditation requirements. Figure 2 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.

Figure 2. Requirements for IAED Medical Dispatch Center Accreditation[3]

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

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-ACE accreditation requirements contain no time metrics. Requirements for ACE Accreditation are comprehensive and reflect the effort required to achieve and maintain accreditation. Even for the best dispatch centers, accreditation is typically a multi-year process.

[3] https://accreditation.emergencydispatch.org/resources/General/MEDICAL%20Accred-Re-Accred.pdf, June 2016

The Broward Sheriff's Office first accomplished accreditation in 2003. BSO maintained accreditation and was reaccredited for the three-year period 2015 to 2018. Of note, BSO uses only 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.

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 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 is been a 40% increase in overall total emergency calls based primarily on EMS and activated fire alarms.[4] Therefore, the following demographic information provides a context to understand some of the drivers of system demand.

Current and Historical

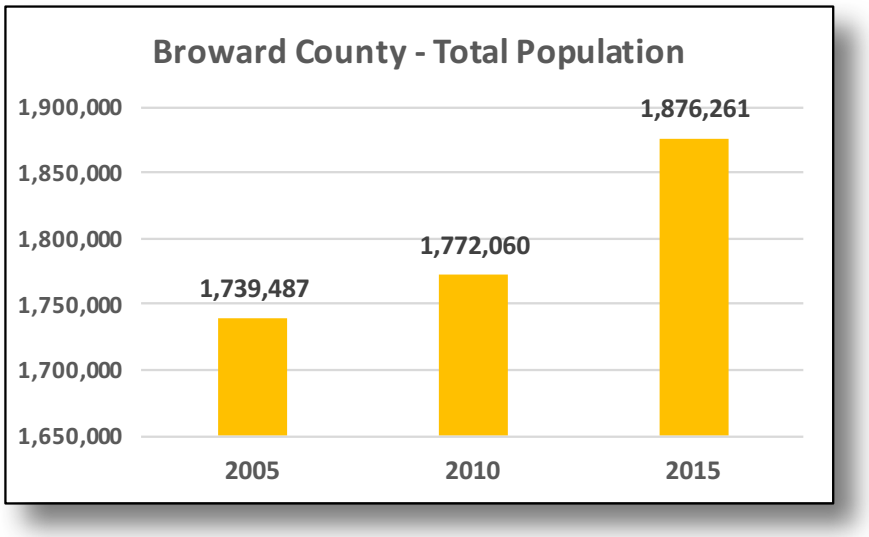
Today, Broward County is a mostly developed, 1,200+ square mile urban area with only 10.5 square miles left of developable land. According to the University of Florida's Bureau of Economic and Business Research (BEBR), the County's total population is estimated at 1,827,367 as of April 1, 2015.[5] Of 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."[6]

Nevertheless, the contrast of added population between 2005 and 2010 and that experienced between 2010 and 2015, is significant. Figure 3 below represents the population growth in five-year increments for 2005 to 2015.

[4] Ahrens, M. (2016). Trends and Patterns of U.S. Fire Loss. N. F. P. Association, National Fire Protection Association.
[5] 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.
[6] Broward-by-the-Numbers, Number 57, page 1, July 2009. Broward County Planning and Redevelopment Division, accessed June 2016.

Figure 3. 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.[7]

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 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.

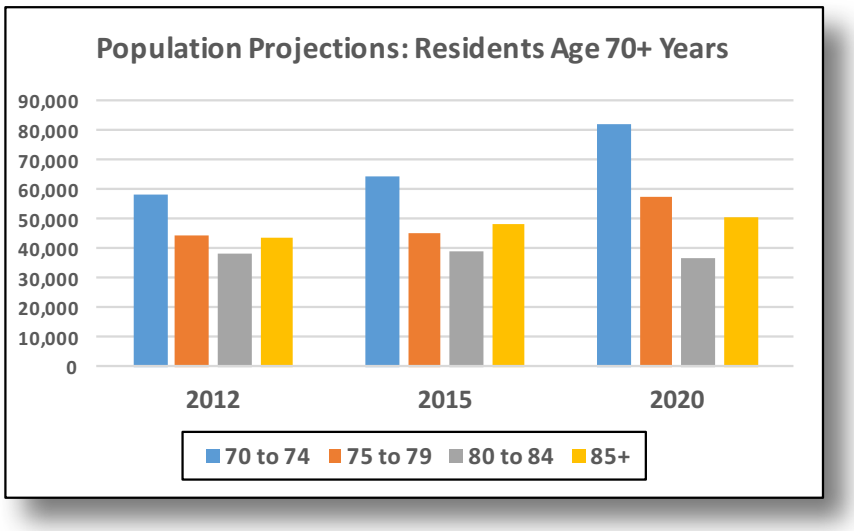
The US Census' American Community Survey for 2007-2011, notes that Broward County is a net exporter of workers in the daytime during the workweek. While the cities of Fort Lauderdale and Pompano Beach experience a significant net increase in their daytime populations, suburban areas tend to lose population 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.[8]

[7] 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.

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

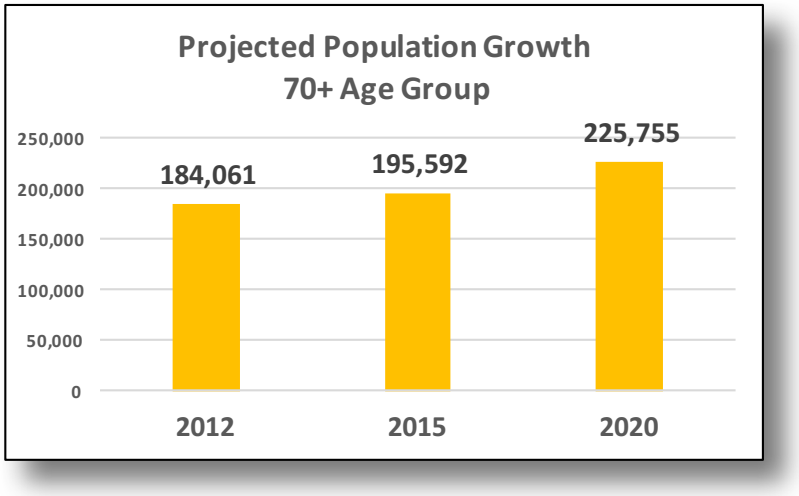
The BEBR population forecasts include data by age groups. Of particular interest is the age cohort of 70+ years, which significantly impacts the need for health care services and, in particular, emergency medical services. BEBR's data regarding age cohorts of 70+ years, provides estimates for 2012 and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

Figure 4. 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. The figure below represents the growth for the entire age group of 70+ years.

Figure 5. 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.[9]

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.[10]

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

[9] 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.

[10] 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.[11]

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 contracted 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, the computer aided dispatch (CAD) system and radio operations technologies. Below are the key issues observed in the initial assessment.

[11] 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 a single queue for has been implemented which networks all three County PSAP facilities. An Automatic Call Distribution (ACD) system has been implemented across the entire network for 911 calls, which will significantly improve the efficiency of call handling and avoid unnecessary delays. The design of the ACD Network Enhancement includes local preference call handling before routing calls to the regional queue.

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 by *FITCH* 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 four hours to complete. 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.

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 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. Dispatch 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 the size and complexity of Broward's 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, and 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. The former 911 center in the Broward Sheriff's headquarters building on W. Broward Boulevard was eliminated as the "flee to" site in large part because the structure has a lower hurricane protection rating. Noting recent incidents where evacuation of an existing site was required, there may be a reason to reconsider that plan.

With regard to the South dispatch facility, 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. Annual budget documents provide sufficient detail to determine the intent of expenditures. The County maintains approval authority of the final budget amount and position count.

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.

The figure below indicates a three fiscal year history of actual expenditures and budgeted expenditures.[12]

Figure 6. BSO Expenditure and Budget History

Appropriation Line Item	FY14/15 Actual	FY15/16 Budget	FY16/17 Budget
Personal Services	$37,878,111	$38,791,420	$40,865,470
Operating Expenses	$214,711	$453,940	$506,680
Capital Outlay	$160,200	$3,230	$0
Total	$38,253,022	$39,248,590	$41,372,150
Positions	443	447	447

The County's FY16/17 budget for the Office of Regional Communications and Technology includes a total of 33 positions and the transfer of funding to BSO for dispatch services. The FY2017 Adopted Operating Budget indicates that ORCAT's position count increased by six positions since FY15/16 as follows:

- Two positions were added in mid-year FY16 to provide "on-site county management and administration of the Public Safety Network."
- One Assistant Director position is added to support ongoing capital project and customer relations.
- Two Information Technology Specialist positions are added to support Public Safety Applications.
- One Communications System Technician is added to support the Local Government Radio System.

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. The County's Fiscal Year 2017-2021 Capital Program includes additional funding for the replacement of the CAD systems, $48.7 million for the replacement of the public safety radio system, and $350,000 for planning and analysis studies regarding PSAP facilities.

[12] Broward County, FL. Fiscal Year 2017 Adopted Operating Budget, BSO Consolidated Dispatch Contract, p. 2-34.

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

Early in the project, 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 Country
- 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.

Figure 7. 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 5 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.[13]

Figure 8. History of Call Transfers Between 911 Centers[14]

	2013Stand 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%)**

[13] See Section 7.4.4 from NFPA 1221 (2016).
[14] 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 and 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 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 B, Performance Measures, 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 provided.

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. This report includes recommendations on what rules should be adopted.

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 pervious 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* found 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 6 below.

Figure 9. Work Locations of Dispatcher and Management Survey Respondents

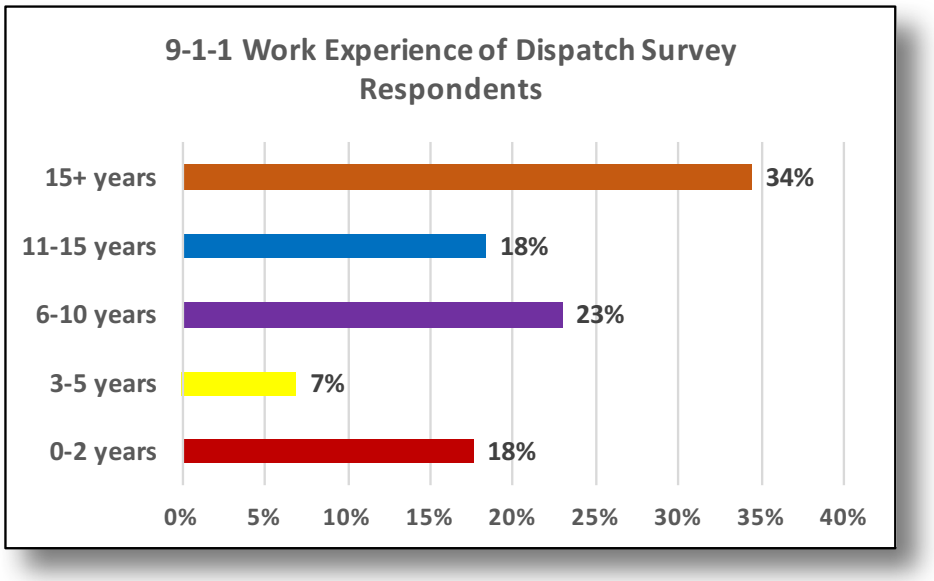
Work Location	% of Dispatcher Respondents	% of Management Respondents
Public Safety Building	8%	20%
North Dispatch	31%	32%
Central Dispatch	26%	20%
South Dispatch	35%	28%

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.

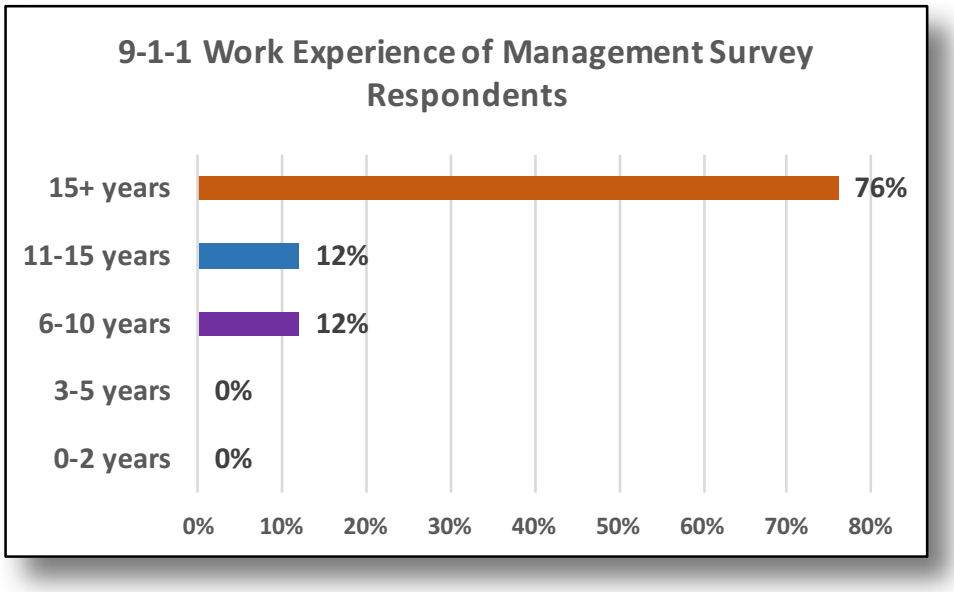
The figures below indicate the percentage of dispatch and management survey respondents and the number of years of experience working in a 911 environment.

Figure 10. 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 11. 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 figures that follow 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

Figure 12. I believe we provide a good level of service to citizens who call 911.

Dispatcher Results	Manager Results
▪ 64% either agreed/strongly agreed ▪ 13% were neutral ▪ 23% either disagreed/strongly disagreed	▪ 69% either agreed/strongly agreed ▪ 17% were neutral ▪ 14% either disagreed/strongly disagreed

Figure 13. Please rate the following: I believe we provide a good level of support to public safety field personnel.

Dispatcher Results	Manager Results
▪ 69% either agreed/strongly agreed ▪ 14% were neutral ▪ 27% either disagreed/strongly disagreed	▪ 76% either agreed/strongly agreed ▪ 7% were neutral ▪ 17% either disagreed/strongly disagreed

Figure 14. Callers for emergency services provide accurate information regarding the ADDRESS of the emergency.

Dispatcher Results	Manager Results
▪ 5% either agreed/strongly agreed ▪ 17% were neutral ▪ 78% either disagreed/strongly disagreed	Not asked of managers

Figure 15. When I began my current job, the initial training I received prepared me well for the work.

Dispatcher Results	Manager Results
▪ 54% either agreed/strongly agreed ▪ 18% were neutral ▪ 28% either disagreed/strongly disagreed	▪ 61% either agreed/strongly agreed ▪ 3% were neutral ▪ 36% either disagreed/strongly disagreed

Figure 16. The ongoing training, I receive continues to enhance my skills.

Dispatcher Results	Manager Results
▪ 39% either agreed/strongly agreed ▪ 24% were neutral ▪ 37% either disagreed/strongly disagreed	▪ 46% either agreed/strongly agreed ▪ 25% were neutral ▪ 29% either disagreed/strongly disagreed

Figure 17. The Regional Communications System is equipped and prepared to handle large scale emergencies such as hurricanes or mass shooting incidents.

Dispatcher Results	Manager Results
▪ 31% either agreed/strongly agreed ▪ 28% were neutral ▪ 41% either disagreed/strongly disagreed	▪ 69% either agreed/strongly agreed ▪ 7% were neutral ▪ 24% either disagreed/strongly disagreed

Workload Statements

Figure 18. The work methods we utilize help improve the efficiency in our work.

Dispatcher Results	Manager Results
▪ 16% either agreed/strongly agreed ▪ 26% were neutral ▪ 58% either disagreed/strongly disagreed	▪ 41% either agreed/strongly agreed ▪ 21% were neutral ▪ 38% either disagreed/strongly disagreed

Figure 19. The technologies we utilize improve our efficiency carrying out our work.

Dispatcher Results	Manager Results
▪ 24% either agreed/strongly agreed ▪ 11% were neutral ▪ 65% either disagreed/strongly disagreed	▪ 17% either agreed/strongly agreed ▪ 35% were neutral ▪ 48% either disagreed/strongly disagreed

Figure 20. Policies and procedures are easily understood and applied.

Dispatcher Results	Manager Results
▪ 19% either agreed/strongly agreed ▪ 16% were neutral ▪ 65% either disagreed/strongly disagreed	▪ 36% either agreed/strongly agreed ▪ 21% were neutral ▪ 43% either disagreed/strongly disagreed

Equipment Statements

Figure 21. I can effectively use technology to locate wireless callers who don't know their location.

Dispatcher Results	Manager Results
▪ 51% either agreed/strongly agreed ▪ 24% were neutral ▪ 25% either disagreed/strongly disagreed	Not asked of managers

Figure 22. The technology and information systems we use are reliable and are appropriate to the job.

Dispatcher Results	Manager Results
▪ 27% either agreed/strongly agreed ▪ 20% were neutral ▪ 53% either disagreed/strongly disagreed	▪ 7% either agreed/strongly agreed ▪ 32% were neutral ▪ 61% either disagreed/strongly disagreed

Figure 23. CAD has the tools I need to handle incidents efficiently.

Dispatcher Results	Manager Results
▪ 34% either agreed/strongly agreed ▪ 20% were neutral ▪ 46% either disagreed/strongly disagreed	Not asked of managers

Figure 24. Equipment problems are handled appropriately and I get feedback on problems I report.

Dispatcher Results	Manager Results
▪ 8% either agreed/strongly agreed ▪ 19% were neutral ▪ 73% either disagreed/strongly disagreed	▪ 32% either agreed/strongly agreed ▪ 14% were neutral ▪ 54% either disagreed/strongly disagreed

Attitude Statements

Figure 25. Other occupants of the building I work at treat me with respect.

Dispatcher Results	Manager Results
▪ 38% either agreed/strongly agreed ▪ 33% were neutral ▪ 29% either disagreed/strongly disagreed	▪ 56% either agreed/strongly agreed ▪ 16% were neutral ▪ 28% either disagreed/strongly disagreed

Figure 26. Upper management supports our operations.

Dispatcher Results	Manager Results
▪ 22% either agreed/strongly agreed ▪ 21% were neutral ▪ 57% either disagreed/strongly disagreed	Not asked of managers

Figure 27. There is clear division between the County and BSO on who manages the communications center.

Dispatcher Results	Manager Results
▪ 48% either agreed/strongly agreed ▪ 21% were neutral ▪ 31% either disagreed/strongly disagreed	▪ 67% either agreed/strongly agreed ▪ 22% were neutral ▪ 11% either disagreed/strongly disagreed

Figure 28. Duty officers and site managers are available and willing to help me with problems or concerns.

Dispatcher Results	Manager Results
▪ 37% either agreed/strongly agreed ▪ 32% were neutral ▪ 31% either disagreed/strongly disagreed	Not asked of managers

Figure 29. I receive feedback on my job performance, including positive acknowledgement.

Dispatcher Results	Manager Results
▪ 27% either agreed/strongly agreed ▪ 23% were neutral ▪ 50% either disagreed/strongly disagreed	▪ 66% either agreed/strongly agreed ▪ 15% were neutral ▪ 19% either disagreed/strongly disagreed

Figure 30. Please rate the following: Different work schedules will improve our current staffing challenges.

Dispatcher Results	Manager Results
▪ 65% either agreed/strongly agreed ▪ 17% were neutral ▪ 18% either disagreed/strongly disagreed	▪ 42% either agreed/strongly agreed ▪ 35% were neutral ▪ 23% either disagreed/strongly disagreed

Figure 31. Public safety field personnel treat the dispatch center personnel professionally.

Dispatcher Results	Manager Results
▪ 22% either agreed/strongly agreed ▪ 33% were neutral ▪ 45% either disagreed/strongly disagreed	▪ 16% either agreed/strongly agreed ▪ 44% were neutral ▪ 40% either disagreed/strongly disagreed

Management Statements

Figure 32. Management gives team members a clear picture of the direction BSO Communications is headed.

Dispatcher Results	Manager Results
Not asked of dispatchers	▪ 55% either agreed/strongly agreed ▪ 26% were neutral ▪ 19% either disagreed/strongly disagreed

Figure 33. Management understands the daily problems we face with our jobs.

Dispatcher Results	Manager Results
Not asked of dispatchers	▪ 44% either agreed/strongly agreed ▪ 11% were neutral ▪ 45% either disagreed/strongly disagreed

Figure 34. Overall, I am satisfied with the job being done by my immediate supervisor.

Dispatcher Results	Manager Results
Not asked of dispatchers	▪ 67% either agreed/strongly agreed ▪ 15% were neutral ▪ 18% either disagreed/strongly disagreed

Figure 35. Management encourages others to propose new and innovative ideas.

Dispatcher Results	Manager Results
Not asked of dispatchers	▪ 59% either agreed/strongly agreed ▪ 22% were neutral ▪ 19% either disagreed/strongly disagreed

Figure 36. Management effectively deals with misconduct or unsatisfactory performance.

Dispatcher Results	Manager Results
Not asked of dispatchers	▪ 30% either agreed/strongly agreed ▪ 22% were neutral ▪ 48% either disagreed/strongly disagreed

911 Center Concerns Rankings

Figure 37. Please rank the following issues in order of importance (1 is your top concern and 5 is the least concern.

Dispatcher Rankings	Manager Rankings
1. Adequate staffing 2. Officer safety 3. Increase in workload 4. Loss of specific community 5. Improved accountability	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

Figure 38. 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
1. CAD 2. 911 telephone system 3. Radio system 4. Records management 5. Communication center facility	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 calculations 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 by *FITCH* 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 it 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 file 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 Call Detail Record (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.

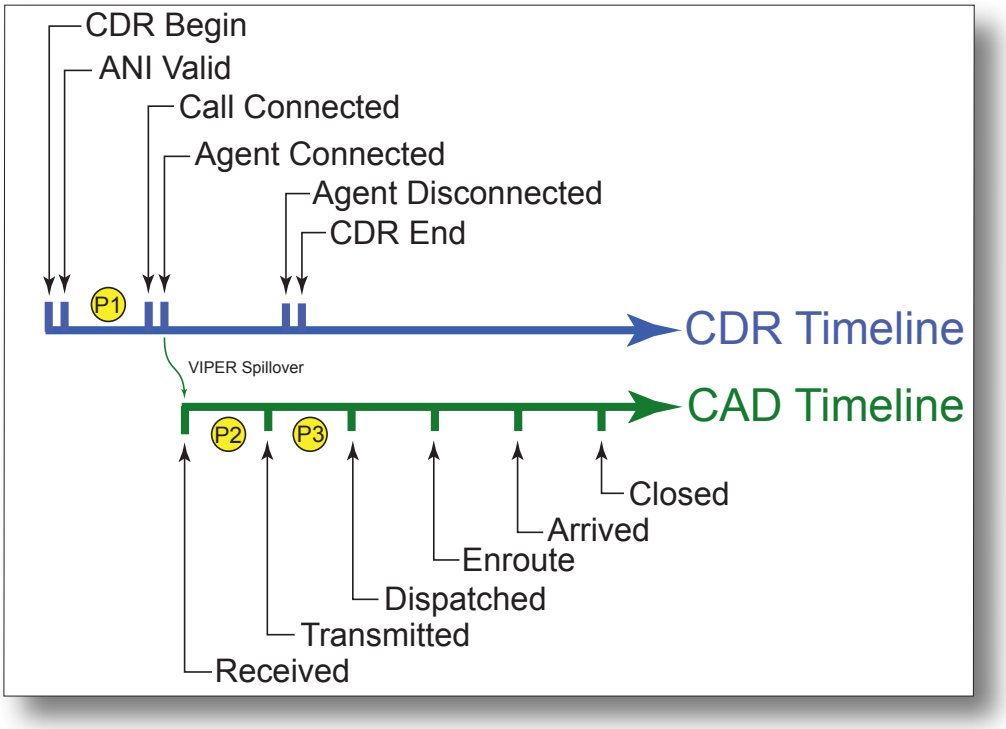
CAD and CDR Timelines

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 below.

The upper timeline 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 shows the names and relative sequence of the timestamps that comprise the record of an incident in the CAD server.

Figure 39. 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

The figure 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.

Figure 40. 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.[15]

[15] 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.

Suitability 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." [16] 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.[17] *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 the figure 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.

[16] The W. Edwards Deming Institute, http://www.blog.deming.org, accessed May 2016.
[17] Donald J. Wheeler, "Understanding Statistical Process Control", SPC Press, 1992. ISBN 978-0-945320-69-2

NENA 56-005

The text of NENA 56-005[18] Section 3.1 is reproduced in Figure 7 below.

Figure 41. 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 'busy 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 to Broward, 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.

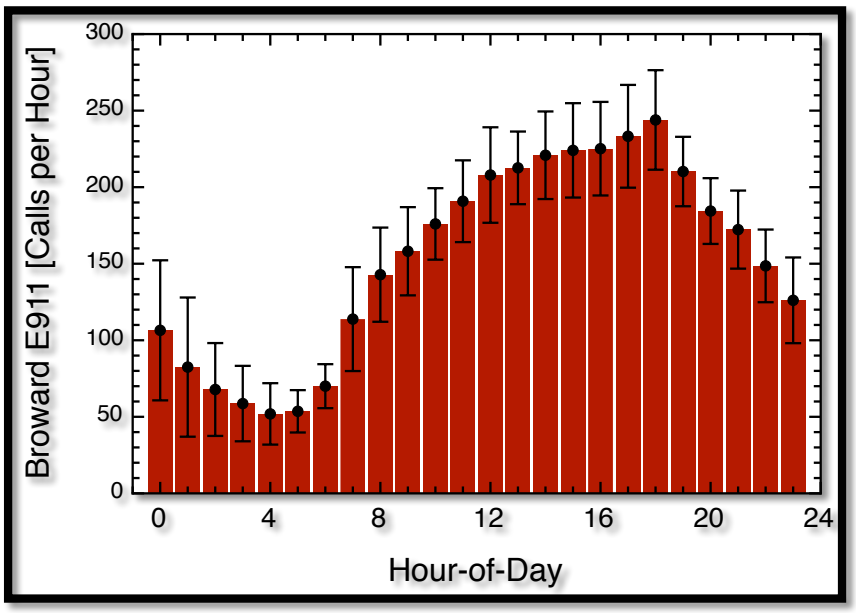
Busy Hour

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.

[18] 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.

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.

Figure 42. 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 the 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 the 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 the issue was subsequently resolved, but after the time period for which data was provided to *FITCH*.

Figure 43. Comparison of ORCAT and *FITCH* Pass/Fail Determination Based on Answer Delays

PSAP	Date	Hour	ORCAT				*FITCH*				
			<10 sec	calls	%	P/F	P/F	<10 sec	calls	%	Ranked 90th %-tile [sec]
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 C, Calculation of Answer Delays.

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.

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 complied the historic answer delays hour-by-hour for Central PSAP on this date. These results are presented below.

Figure 44. 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 Erlangs	Obs'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
	OUT	ADM	911				
	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 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 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 the figure on prior pages above, (Relationship Between CDR and CAD Timelines), the P2/P3 intervals 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.[19]

NFPA 1221 defines two different 'buckets' of call types, and for each 'bucket' has different performance measures. The specifics are outlined in the Association's document, but generally allows EMS and other specialized incidents with a longer call processing time. Within this analysis we define the first group as Emergency Medical Dispatch (EMD), intended to evaluate under one set of criteria eight specific call types including those that require EMD[20]. 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

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

[20] The other call types include 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; calls that require determining the location of the alarm due to insufficient information; and calls received by text message. In aggregate, these other call types represent a small number of occurrences.

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 (which represent the largest category of calls in the Fire queue). the County's reports appear to be extremely precise. They report percent fails in the P2/P3 intervals to ± 0.01% regardless of the number of valid [Received] timestamps they actually have available.

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: ±10%, ±1%, ±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.

The figures below 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.

Figure 45: 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[21]	718
[Rcvd] validated < 166 sec	20,285
50th %-tile	54.72 sec
Average	61.16 sec
Std Dev	±27.47 sec
90th %-tile	100.80 sec
95th %-tile	121.33 sec
99th %-tile	157.79 sec
Compliance	
Count < 91 sec	17,496
% < 91 sec	86.30%
Count < 121 sec	19,331
% <121 sec	95.30%

[21] The P2/P3 intervals for EMD Call Types greater than 165 seconds were assumed to be "purposefully pending" and excluded from analysis.

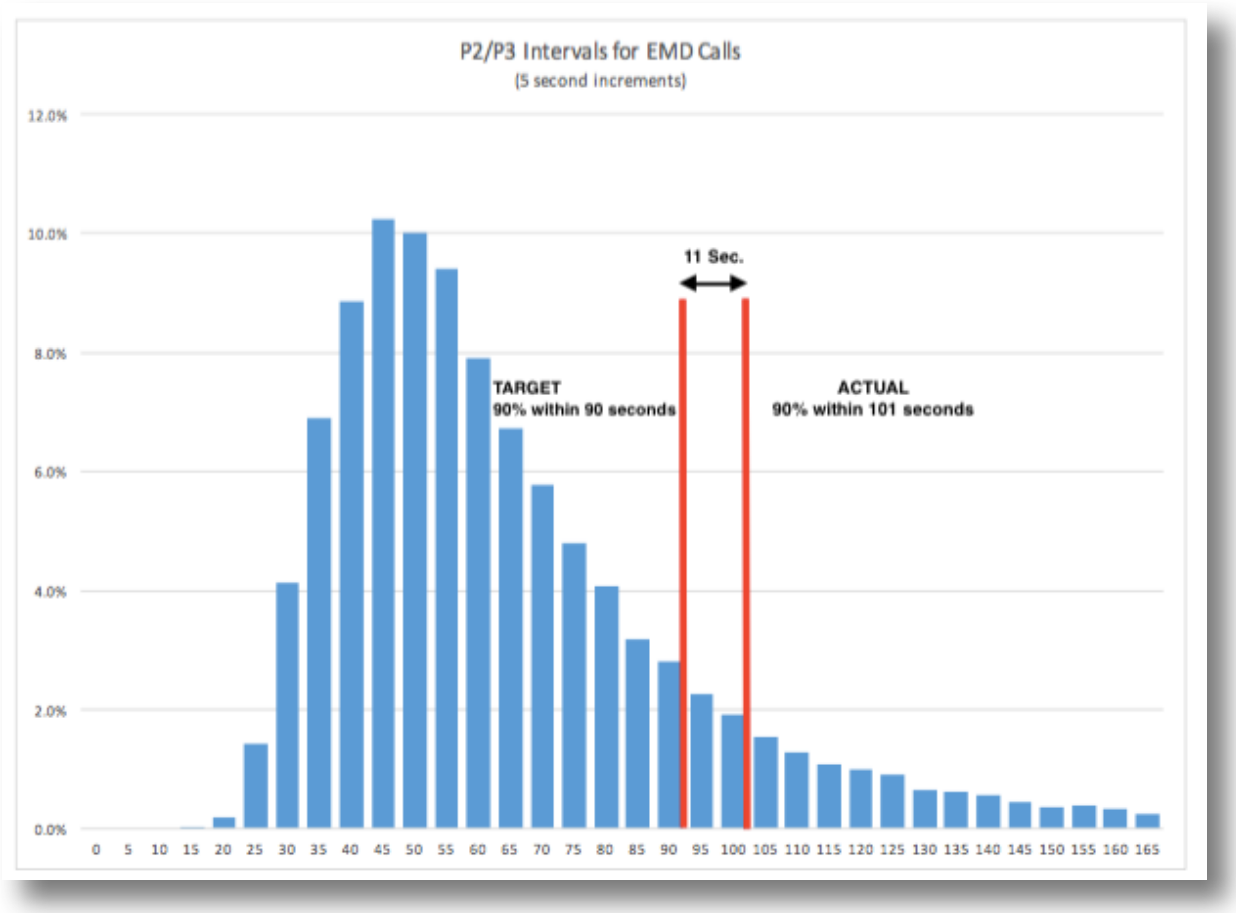
Figure 46: n-EMD P2/P3 Statistics & Performance

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[22]	57
[Rcvd] validated < 181 sec	1,007
50th %-tile	68.70sec
Average	76.54 sec
Std Dev	±33.16 sec
80th %-tile	103.70 sec
95th %-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. The figure below 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. While 11 seconds at the 90th percentile may seem significant it should be noted that this may not be true. The measurement used by the County includes all call types, hot and cold responses. Response time has a limited outcome effect on a very small sub group of calls, namely, what in EMD vernacular is referred to as "Echo and Delta" calls. This subset represents fewer than a quarter of the calls that are being measured. Further, this subset has fewer questions at the call taking point and is usually significantly faster to process than the larger group pf calls.

[22] The P2/P3 intervals for non-EMD Call Types greater than 180 seconds were assumed to be "purposefully pending" and excluded from analysis

Figure 47. P2/P3 Performance for EMD Calls – Target versus Actual



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.

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 below, the performance for the entire system is consistently dismal compared to the benchmark target.

Figure 48. 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 50th %-tile	119.5 sec
Average	143.8 sec
Ranked 90th %-tile	254.1 sec
Ranked 95th %-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.[23] 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.

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

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

for further improvements. As shown below, fire calls take 11 seconds on average and 22 seconds at 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.

Figure 49. P3 Performance Statistics

Discipline	Assignment Interval, P3		Previous NFPA
	Seconds @ 50th %-tile	Seconds @ 90th %-tile	Second @ 90th %-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. Police departments typically have more calls in the queue than available units, thus one of the responsibilities of the dispatch center is to hold lower priority calls while higher priority calls are attended to. Adding to the complexity is that calls in police environments are from two sources: the first is incoming 911 calls and the second is self-initiated calls (traffic stops). This reality means that the dispatcher has to be more fluid for LAW call assignments than for Fire/ EMS. So, 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 below.

Figure 50: Comparison of P4 Averages and 90th Percentiles (data for Nov-Dec 2015)

	Target Performance	Count	Validated	Raw Compliances		Average [sec]	90th %-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

While not part of the Regional E911 System performance, it does impact the caller's experience for public safety service. It is reported here to allow for discussion by stakeholders.

MODELING CURRENT 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, actual dispatchers 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 system 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 provides 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.

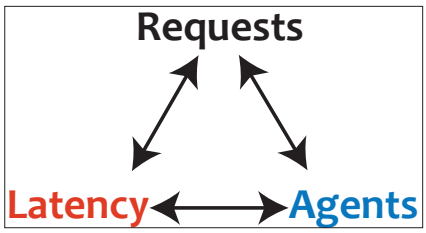
Erlang Analyses

As noted in the APCO RETAINS Workbook:[24]

> 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 the figure below.

Figure 51. 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.

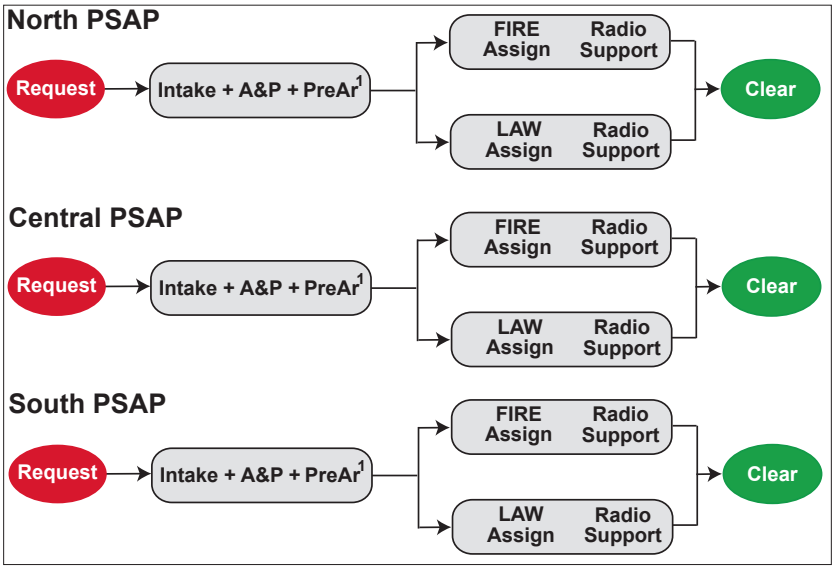
The assumptions, mathematics, and limitations of Erlang queuing theory, as applied to dispatch operations, are treated in greater detail in Attachment D, Erlang Mathematics & Assumptions.

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.[25] These are the second and third types of workstations. The organization of workflows is diagrammed below.

[24] APCO RETAINS staffing and Retention in Public Safety Communications Centers: Effective Practices Guide and Staffing Workbook, page 5, August 2005. APCO International.
[25] The use of FIRE in this report refers to fire suppression and emergency medical services dispatch processes.

Figure 52. Workflows and Workstations in the BSO Dispatch System



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

The rounded rectangles 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

A detailed discussion of workloads at workstations is presented in Attachment E, Quantitation of Workloads. 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 F, Sample Phone Record.

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 G, Sample Records from Fire CAD, LAW CAD and Radio Statistics.

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 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 below.

Figure 53.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 90th %-tile	1.27
ADM / AIM	59	7,313.64	Ranked 95th %-tile	1.42
Outgoing	16	633.91	Average	1.18
Totals	143	15,194.06	± Std Dev	0.20
Active Wkstat'n	16		Predicted 90th %-tile	1.44

North	Count	Processing Σ [sec]	911 Ans Delay	[sec]
911 Trunks	22	1,531.41	Ranked 90th %-tile	1.08
ADM / AIM	53	6,380.67	Ranked 95th %-tile	1.13
Outgoing	9	1,428.50	Average	0.92
Totals	84	9,340.58	± Std Dev	0.33
Active Wkstat'n	10		Predicted 90th %-tile	1.35

South	Count	Processing Σ [sec]	911 Ans Delay	[sec]
911 Trunks	33	2,680.27	Ranked 90th %-tile	1.45
ADM / AIM	61	7,674.92	Ranked 95th %-tile	1.62
Outgoing	17	1,132.05	Average	1.16
Totals	111	11,487.24	± Std Dev	0.33
Active Wkstat'n	13		Predicted 90th %-tile	1.59

Broward County	Count	Processing Σ [sec]	911 Ans Delay	[sec]
911 Trunks	123	11,458.19	Ranked 90th %-tile	1.33
ADM / AIM	173	21,369.23	Ranked 95th %-tile	1.62
Outgoing	42	3,194.46	Average	1.13
Totals	338	36,021.88	± Std Dev	0.28
Active Wkstat'n	39		Predicted 90th %-tile	1.49

Figure 54. 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 below.

Figure 55. 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 56.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 WorkId [sec]	Xmit/Rcv's Count	Radio WorkId [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 WorkId [sec]	Xmit/Rcv's Count	Radio WorkId [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 WorkId [sec]	Xmit/Rcv's Count	Radio WorkId [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 WorkId [sec]	Xmit/Rcv's Count	Radio WorkId [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.

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 2015, in which staffing at the workstations at the Central, North, and South PSAPs were reported by hour-of-day, on average.[26]

Model of Central Intake Workstation

The figure 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.

[26] Broward County Document: PSAP Call Analysis, January 2015.xls through PSAP Call Analysis December 2015.xls.

Figure 57. 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
911	ADM	Out				
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 the figure above. The contents of these columns is as follows:

- Column1 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 below.

Figure 58. 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

911	ADM	Out	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 the above figures is striking. In Figure 57, BSO deployed 198 dispatcher hours OnTask. Figure 58 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 above 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 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 below.

Figure 59. 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

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	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 Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
FIRE	LAW	Radio				
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 60. 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 Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
FIRE	LAW	Radio				
14.35	0.00	156.53	0.419	40	87.24	3.12

Central FIRE Assignment workstations staffed to FITCH specifications

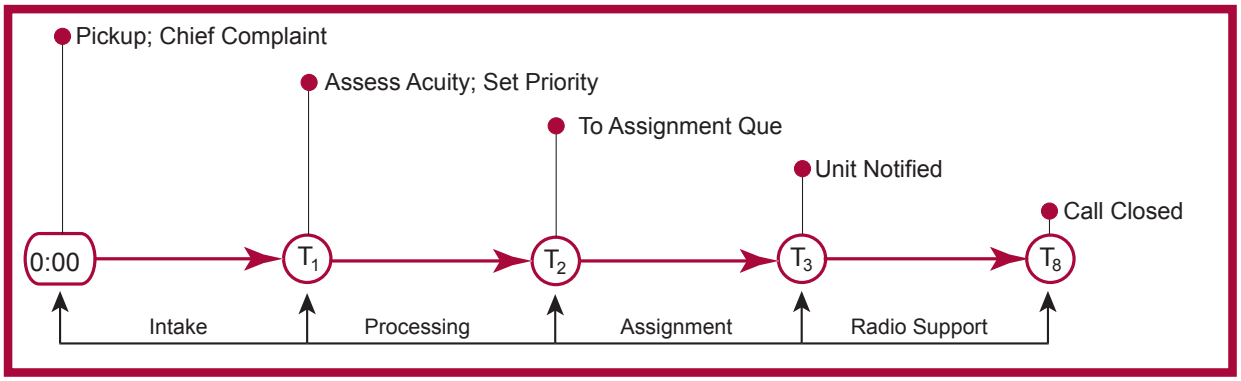
Achieving a 3.12 second latency at the 95% weighted over 24 hours is a respectable level of performance for an assignment workstation. The significant take-away from this model is that a respectable level of latency can be attained using only 40 dispatcher hours OnTask. This is one third dispatcher hours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

FINDING: BSO's current performance indicated overstaffing in FIRE Assignment positions based on Erlang modeling.

DISPATCH OPERATIONS MODELS — OPTIONS

All communications centers that dispatch emergency services must execute four functions in the conduct of their operations. These functions are diagrammed below.

Figure 61. Functions Required In All Emergency Services Dispatch Operations



In the above diagram, "Intake" collects the basic information: What is the chief complaint? Where is the incident located? "Processing" comprises an Assessment of Acuity and a Prioritization of response, "A&P". The incident is then transferred to an "Assignment" queue where unit(s) are chosen to make the response and the unit(s) notified. The last function in the sequence is "Radio Support" for units running incidents in-progress.

The difference between various models of dispatch operations boils down to which of the dispatch personnel execute which of the four functions. In many models, a single dispatcher may be tasked with executing more than one of these functions.

Part of *FITCH's* charter in this project was to propose changes to the conduct of dispatch operations that may lead to improved efficiency. *FITCH's* proposed models of dispatch operations will be referred to as Option 0, Option 1, and Option 2. Option 0 is so named because it includes no changes to way workloads and workstations are currently structured in the PSAPs. The quantitation of the workloads used in the following models is described in Attachment E, Quantitation of Workloads.

Performance Targets

Both the National Emergency Number Association, NENA, and the National Fire Protection Association, NFPA, make *recommendations* concerning the conduct of operations at the Intake workstations. As discussed earlier in this report, the NENA recommendation is not appropriate for the Broward system because it uses variable staffing by hour-of-day. NENA is applicable only to systems using constant staffing at all hour of the day. This leaves NFPA as the applicable recommendation.

NFPA 1221, Section 7.4.1, recommends that the answer delay at the Intake workstations should not exceed 15 seconds at the 95th percentile.

FITCH considers NFPA 1221 to be an "idealistic" recommendation because it is incomplete on two important points.

- First, NFPA 1221 does not clearly specify what time interval is to be sampled to determine compliance with the 15 second @ 95th %-tile recommendation.

- Second, NFPA 1221 is silent on what should happen at the downstream workstations that comprise the remainder of the dispatch functions.

In order to model dispatch operations, *FITCH* developed "Operational Targets" that addressed the deficiencies of NFPA 1221 and are applicable in the real world.

Broward is a unique case in *FITCH*'s experience in that the existing system already performs to very high standards. In fact, the existing system can be said to "over perform" and can be said to be over provisioned with staff. How this came about is discussed in earlier sections of this report.

The current staffing in the system is such that very expensive increments of staffing have led to very small additional increments in dispatch performance, and have led to no discernible improvement to outcomes in the field. Given this unique environment, *FITCH* selected operation targets for the Broward system that "dial back" dispatch performance to a level that is in better balance with field outcomes.

The current answer delay at the intake workstations averaged over all twenty-four hours of the day is 1.42 seconds at the 95th percentile. By way of comparison, across North America an intake answer delay of 15 seconds at the 95th percentile is taken as a distinguishing characteristic of a high performing dispatch system.

With these data as background, *FITCH* decided to "dial back" the answer delay at the intake workstations to 6 seconds at the 95th percentile. While this is slower than current performance, it is still two and half times faster than the national target for a high performing dispatch system.

Performance Targets for Modelling

Measurements of performance at the workstations against the new operational targets requires three calculation steps and application of two criteria:

Intake Workstations:

Answer delays are calculated for each hour-of-day at the 95th percentile.
Hourly answer delays are weighted by the event count in each hour.
The weighted average answer delay is calculated over the whole 24 hours.

First Performance Criteria

Weighted average answer delay (over 24 hours) < 6 seconds @ 95th percentile.

Second Performance Criteria

Answer delay in any single hour < 2 X (6 seconds @ 95th %-tile)

Assignment Workstations:

Latencies are calculated for each hour-of-day at the 95th percentile.
Hourly latencies are weighted by the event count in each hour.
The weighted average latency is calculated over the whole 24 hours.

First Performance Criteria

Weighted average latency (over 24 hours) < 6 seconds @ 95th percentile.

Second Performance Criteria

Latency in any single hour < 2 X (6 seconds @ 95th %-tile)

FR msr Radio Workstation

Latency at the FR msr Radio workstation in Option 2 is a special case. This workstation handles radio support for incidents requiring multi-station responses. This workstation may be otherwise referred to as a tactical support workstation. The consultant assumed that the crews would need no tactical support while they were loading to their apparatus. Chute time in the Broward system on multi-station response incidents averages 02 minutes 15 seconds (02:15). Consequently, latency at the FR msr Radio workstation was designed to average 02:15 or less.[27]

For systems that exhibit random distributions of response times (normal distributions), 2.907 is the factor that converts 95th percentiles to 50th percentiles and vice versa. Therefore, latency of (6.00 sec @ 95th %-tile) = Latency (2.06 sec @ 50th %-tile).

Application to Dispatch Operational Model/Options

In Option 0 and Option 1

The first step in the construction of dispatch models is to collect the averages workloads flowing across each workstation as described in Attachment E, Quantitation of Workloads. *FITCH* then incremented these average workloads in every hour of day by the surge in that particular hour that hits the system one day out of ten. Surges are measured in units of standard deviations represented by the symbol "σ". The methods used to treat surges in this report are presented in Attachment H, Calculation of Surges.

[27] FR radio support functions have been specialized based on whether the incident require a single station response (ssr), or a multi-station response (msr).

With the +1.28 σ surge added to every hour-of-day, the numbers of dispatchers OnDuty was empirically adjusted over the whole 24 hours until the calculated answer delays or latencies conformed to the new operational targets. This number of dispatchers was maintained and the workloads were returned to their average values. The tables in Attachment I, Erlang Tables of Workstations, reflect operations of the system under average conditions of workload, but with the enhanced number of dispatcher Hours-OnTask. This approach to surge capacity was a compromise, in an attempt to design a robust dispatch system without excessive over provisioning of dispatchers. It must be emphasized that a +1.28 σ surge in every hour-of-day, back to back, is a very rare event.

The increase in answer delays and latencies on going from average workload, 0.00 σ, to a +1.28 σ surge is presented below.

Figure 62. Changes in Latencies for +1.28 σ Surges in All Hours-of-Day

Workstation	Answer Delay & Latency Weighted over 24-Hours [sec] @ 90th %-tile	
	0.00 σ	+1.28σ[1]
Central Intake	2.58	5.73
North Intake	2.12	5.37
South Intake	2.03	9.35
Consolidated Intake	5.32	6.00
Central LAW Assign & Radio @ 1.00 Traffic	3.22	6.48
Central FIRE Assign & Radio @ 1.00 Traffic	2.40	4.66
North LAW Assign & Radio @ 1.00 Traffic	2.69	6.09
North FIRE Assign & Radio @ 1.00 Traffic	2.67	5.18
South LAW Assign & Radio @ 1.00 Traffic	2.43	5.55
South FIRE Assign & Radio @ 1.00 Traffic	1.95	4.01
Consolidated FIRE Gatekeeper	1.64	2.39
Consolidated FR tac Radio @ 0.60 Traffic	136.06	515.81
Consolidated FR ems Radio @ 0.60 Traffic	1.35	2.08

[1] A surge of + 1.28 σ was applied at all 24 hours of the day.

In Option 2

The answer delays and latencies for all workstations in Option 2 conform to the restrictions described for Option 0 and Option 1, except the FIRE tac Radio workstation. The specialized function of the FIRE Tac Radio workstation permits latency at this workstation to be multiple minutes without any negative impact on dispatch operations.

The function of the FIRE tac dispatcher is to exclusively monitor a fire related incident in-progress and to intervene as needed. The Fire tac dispatcher is alerted at the same time the responding units are alerted. If the FIRE tac dispatcher is delayed for several minutes before they can begin paying exclusive attention to the incident, it does not matter. The average interval required in the Broward system for fire crews to load to their apparatus is 00:02:19 [hh:mm:ss]. A fire crew does not need tactical radio support when they are still in quarters and have not started rolling en route.

The dispatcher Hours-OnTask at the FIRE tac Radio workstation were adjusted so that the latency reflected this reality.

Impact of Surges

The data below was assembled to illustrate the impact of surges in the system. This table reports how 95th percentile answer delays at the Central PSAP Intake workstations at 1800 hours change in response to changes in surges as well as dispatchers OnDuty. Three levels of surges are included in the table: surges that appear one day in ten; one day in thirty; and one day in one hundred. The incident counts associated with these surges are included in the table.

Figure 63. Dependence of Answer Delays on Surges and Dispatchers OnDuty for Central Intake at 1800 Hours

Incidents/hr	Surge			
	0.00 σ	+1.28 σ	+1.84 σ	+2.33 σ
	145	198	222	242
7	40.53	-----	-----	-----
8	17.20	-----	-----	-----
9	9.79	36.62	-----	-----
10	6.18	15.09	30.55	245.62
11	3.98	8.79	13.28	23.16
12	2.44	5.82	7.92	11.12
13	1.34	4.09	5.35	6.90
14	0.62	2.92	3.84	4.73
15	0.25	2.03	2.82	3.49
Dispatchers OnDuty	Answer Delays [sec @ 95th %-tile]			

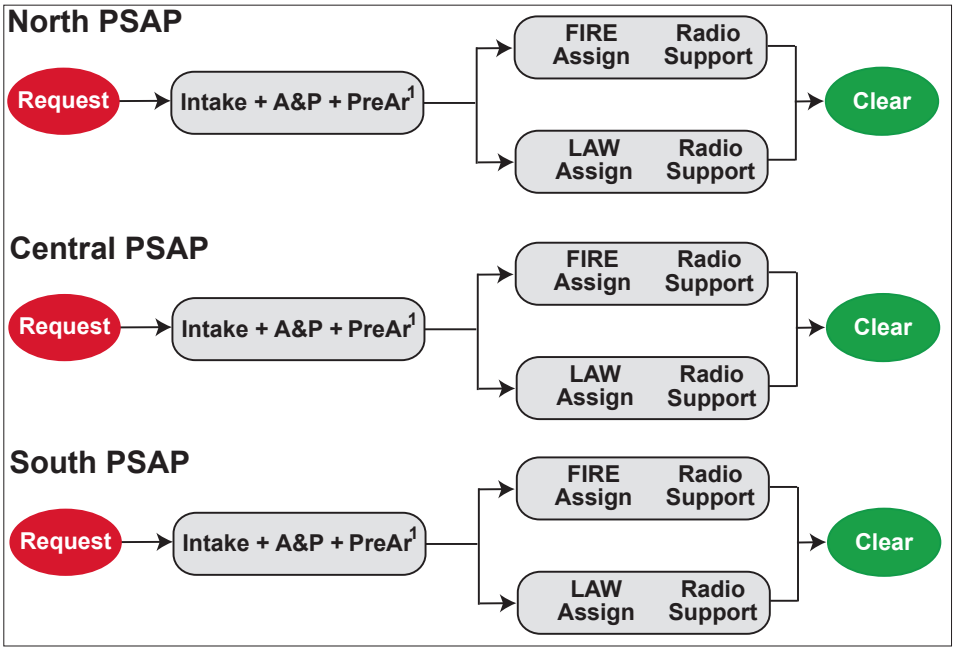
The green shaded cells are acceptable answer delays. The data above illustrates the non-linear relationship between dispatchers and call volume. When a one in one hundred surge comes through the Intake workstations, the incident count jumps from 145 incidents/hour to 242 incidents/hour, a 67% increase. However, the required number of dispatchers increase from 10 to 13, a 30% increase.

The relationship between dispatchers OnDuty and workload is explained in detail in Attachment D, Erlang Mathematics & Assumptions. Depending on the operating point of the specific system, the relationship between changes in dispatcher and changes in workload may be magnified or suppressed. Broward is fortunate in that the operating point of the intake function is in the regime where the system can absorb large changes in workload with much smaller changes in the required number of dispatchers.

Dispatch Model Option 0

The figure below, presents a diagram of the flow of workloads through the Option 0 dispatch model.

Figure 64. Dispatch Model Option 0



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

In the figure above, the red oval represents a request for service from the field after a caller has detected an emergency situation. A single rounded rectangle represents a single type of workstation. There may be several workstations of a single type, all executing the same functions, but in parallel. The text inside each rounded rectangle represents the functions being executed at that type of workstation. The green oval represents the field responders returning to a state of normalcy. The functioning of each type of workstation is characterized by two parameters, workload and latency.

Workload is the first parameter that characterizes a workstation. Workload is the amount of time the dispatcher spends actively executing the functions of that workstation. For purposes of modelling workstations in the Broward dispatch center, workloads were extracted from the historic record.

Latency is the second parameter that characterizes a workstation. Every time a client requests service from a workstation there is the possibility the executions of that request will be delayed by a need to finish processing a previous request for service.

There are two types of clients in the Broward system. The most easily identified is the external client requesting service from the Intake workstation. Latency affecting this transaction is specifically referred to as the Answer Delay or the P1 Interval. There are also internal clients. When an incident is transferred from the Intake workstation to the Assignment workstation, the Intake workstation becomes the internal client and the Assignment workstation becomes the agent. Latency also affects this internal transaction.

The structure of workflows in Dispatch Model Option 0 exactly reflects current operation of the Broward E911 Consolidated Communications System. The durations for the execution of dispatch functions were taken from the historic record. The distinction between Option 0 and current operations is that Option 0 is modelled using numbers of dispatchers that result in latencies that conform to new Operational Targets.

The Erlang tables that comprise Option 0 are presented in Attachment I, Erlang Tables of Workstations. Data from the detailed Erlang Tables is summarized below, representing North, Central and South PSAPs.

Figure 65. North, Central and South Performance and Dispatcher Hours-OnDuty for Dispatch Model Option 0

Workstations	Functions	Dispatchers		Immed Answer	Weighted Average Answer Delay [sec] @ XXth %-tile
		Min / Max	Hours OnTask		
North PSAP Intake	Call Intake, A&P [1], & PreArv [2]	4/7	139	94.16%	5.03 sec @ 95th 1.73 sec @ 50th
North PSAP FIRE Assign	FIRE Assign FIRE Radio Support	1/2	34	90.39%	2.67 sec @ 95th 0.92 sec @ 50th
North PSAP LAW Assign	LAW Assign LAW Radio Support	2/4	65	88.77%	2.69 sec @ 95th 0.92 sec @ 50th
North Hours-OnTask			238		

Workstations	Functions	Dispatchers		Immed Answer	Weighted Average Answer Delay [sec] @ XXth %-tile
		Min / Max	Hours OnTask		
Central PSAP Intake	Call Intake, A&P[1], & PreArv [2]	5/11	204	93.75%	3.96 sec @ 95th 1.26 sec @ 50th
Central PSAP FIRE Assign	FIRE Assign FIRE Radio Support	1/2	42	89.00%	2.40 sec @ 95th [1] 0.83 sec @ 50th
Central PSAP LAW Assign	LAW Assign LAW Radio Support	2/5	92	85.65%	3.37 sec @ 95th [1] 1.16 sec @ 50th
Central Hours-OnTask			338		

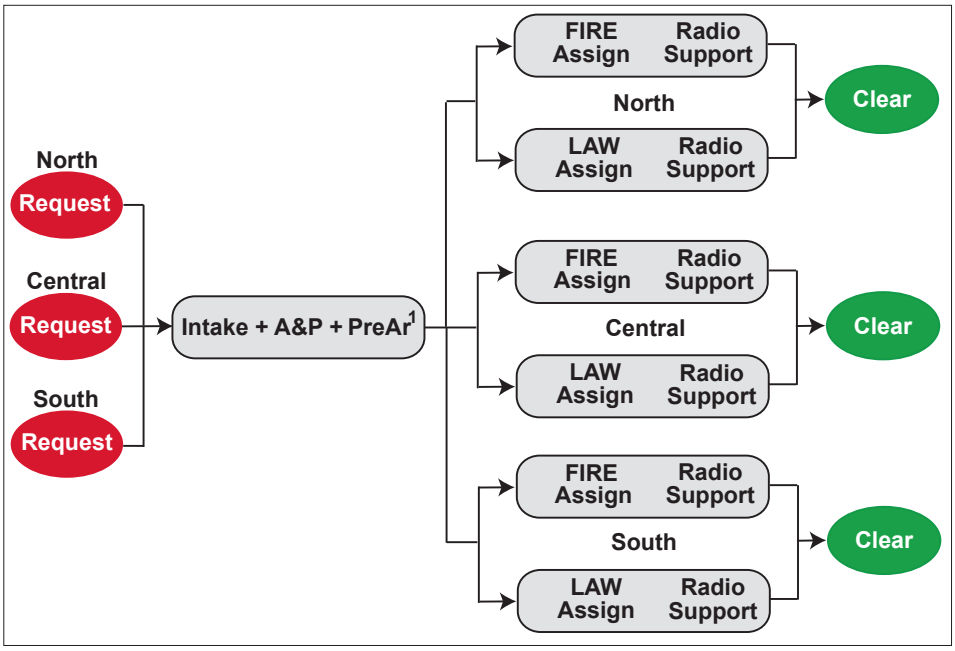
Workstations	Functions	Dispatchers		Immed Answer	Weighted Average Answer Delay [sec] @ XXth %-tile
		Min / Max	Hours OnTask		
South PSAP Intake	Call Intake, A&P [1], & PreArv [2]	4/8	150	95.86%	3.19sec @ 95th 1.10 sec @ 50th
South PSAP FIRE Assign	FIRE Assign FIRE Radio Support	1/2	40	91.76%	1.95 sec @ 95th 0.67 sec @ 50th
South PSAP LAW Assign	LAW Assign LAW Radio Support	2/4	78	88.02%	2.56 sec @ 95th 0.88 sec @ 50th
South Hours-OnTask			268		
Option 0 Hours-OnTask			844		

[1] Assessment of acuity & Prioritization of response. [2]Pre-arrival instruction on Echo, Delta EMS incidents.

Dispatch Operations Model/Option 1

The figure below, presents a diagram of the flow of workloads through the Option 0 dispatch model.

Figure 66. Dispatch Operations Model/Option 1



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

The distinction between Option 0 and Option 1 is that there is a complete rollover of incoming calls between the Intake workstations regardless of which PSAP the intake workstation may be physically located in. The organization of dispatch functions in Option 1 maintains the distinctions of North, Central, and South FIRE and LAW Assignment workstations.

The Broward E911 Communication Center is in the process of beginning a transition towards implementing this model of dispatch operations.

The Erlang Tables that comprise Option 1 are presented in Attachment I, Erlang Tables of Workstations. Data from the detailed Erlang Tables is summarized in Table 53, below, representing North, Central and South PSAPs.

Figure 67. Performance and Dispatcher Hours-OnDuty in Dispatch Model Option 1.

Workstations	Functions	Dispatchers		Immed Answer	Weighted Average Answer Delay [sec] @ XXth %-tile
		Min / Max	Hours OnTask		
Consolidated Intake	Call Intake, A&P [1], & PreArv [2]	7/17	301	93.18%	5.32 sec @ 95th 1.83 sec @ 50th
Intake Hours-OnTask			301		
North PSAP FIRE Assign	FIRE Assign FIRE Radio Support	1/2	34	90.39%	2.67 sec @ 95th 0.92 sec @ 50th
North PSAP LAW Assign	LAW Assign LAW Radio Support	2/4	65	88.77%	2.69 sec @ 95th 0.92 sec @ 50th
North Hours-OnTask			99		
Central PSAP FIRE Assign	FIRE Assign FIRE Radio Support	1/2	42	89.00%	2.40 sec @ 95th 0.83 sec @ 50th
Central PSAP LAW Assign	LAW Assign LAW Radio Support	2/5	92	85.65%	3.37 sec @ 95th [1] 1.16 sec @ 50th
Central Hours-OnTask			134		
South PSAP FIRE Assign	FIRE Assign FIRE Radio Support	1/2	40	91.76%	1.95 sec @ 95th 0.67 sec @ 50th
South PSAP LAW Assign	LAW Assign LAW Radio Support	2/4	78	88.02%	2.56 sec @ 95th [1] 0.88 sec @ 50th
South Hours-OnTask			118		
Option 1 Hours-OnTask			652		

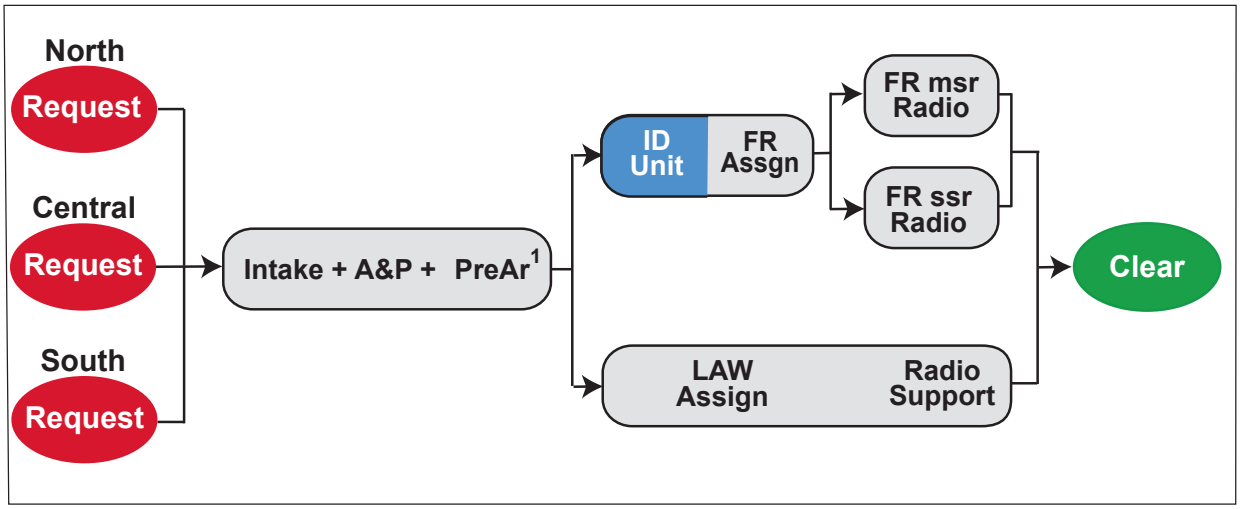
[1] Assessment of acuity & Prioritization of response. [2]Pre-arrival instruction on Echo, Delta EMS incidents.

Comparing Option 1 to Option 0 demonstrates that consolidating a dispatch function uses manpower more efficiently. Under Option 0, conduct of the Intake functions required 493 dispatcher hours-OnTask between the three separate PSAP locations. Under Option 1, conduct of the Intake functions requires only 301 dispatcher Hours-OnTask when incoming calls automatically rollover between the PSAP locations. Under Option 1, the performance of the Intake functions is indistinguishable from Option 0, yet the Intake functions are being executed with 192 fewer dispatcher Hours-OnTask, a 39% reduction.

Dispatch Operations Model/Option 2

The figure below, presents a diagram of the flow of workloads through the Option 2 dispatch model.

Figure 68. Dispatch Model Option 2



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

The distinctions between Option 1 and Option 2 are threefold. First, the CAD software is more fully utilized to automatically recommend units to Fire Rescue responses. Before units are notified, these automatic assignments are subject to a manual review. In effect, this review is a gatekeeper function that limits the number of assignment positions within the dispatch center. This largely eliminates the need for disparate assignment dispatchers to 'shop' for resources to assign. Second, the use of mobile data terminals (MDTs) by FIRE field responders was increased over current practice. The consequence of the increased use of MDTs is presumed to be a 40% reduction in the number of Xmit/Rcv events per incident. Third, the FR radio support functions have been specialized based on whether the incident require a single station response (ssr), or a multi-station response (msr). FR tactical support and FR ems support both have dedicated radio channels and specialized dispatchers. Conduct of operations along the LAW assignment legs has not been altered.

The Erlang Tables that comprise Option 2 are presented in Attachment I, Erlang Tables of Workstations. Data from the detailed Erlang Tables is summarized below, representing North, Central and South PSAPs.

Figure 69. Performance and Dispatcher Hours-OnDuty in Dispatch Model Option 2.

Workstations	Functions	Dispatchers		Immed Answer	Weighted Average Answer Delay [sec] @ XXth %-tile
		Min / Max	Hours OnTask		
Consolidated Intake	Call Intake, A&P [1], & PreArv [2]	7/17	301	93.18%	5.32 sec @ 95th 1.83 sec @ 50th
FR Review (Gatekeeper)	FR Assign Review	1/2	38	96.41%	1.64 sec @ 95th 0.57 sec @ 50th
FR msr Radio*	FR Tactical Radio Support	2/4	67	89.33%	137.07 sec @ 95th 47.17 sec @ 50th
FR ssr Radio*	FR EMS Radio Support	2/2	48	91.99%	2.08 sec @ 95th 0.46 sec @ 50th
North LAW	North LAW Assign N Radio Support	2/4	65	90.95%	2.69 sec @ 95th 0.92 sec @ 50th
Central LAW	Central LAW Assign Central Radio Support	2/5	92	85.65%	3.37 sec @ 95th [1] 1.16 sec @ 50th
South LAW	South LAW Assign South Radio Support	2/4	78	88.02%	2.56 sec @ 95th [1] 0.88 sec @ 50th
Option 2 Hours-OnTask			700		

*FR msr Radio = multi-station response; FR ssr Radio = single station response

Comparing Option 1 to Option 2, there is a net increase in dispatcher Hours-OnTask from 652 to 700. This is a net increase of 48 dispatcher Hours-OnTask. The increase is restricted to the FIRE Assignment and Radio Support leg between the two Options. Comparing the FIRE Assignment and Radio Support leg between Option 1 and Option 2, dispatcher Hours-OnTask increase from 116 to 164.

Consolidating Intake functions between Option 0 and Option 1 results in a reduction in the required dispatcher Hours-OnTask. The inverse affect is seen between Option1 and Option 2, where the radio support functions along the FIRE leg were divided into sub-specialties.

Comparison of Operations Models/Options

The number of dispatcher Hours-OnTask committed to each Option was adjusted so Intake answer delays, P1, and assignment latencies conformed to new operational targets. These targets provide for a capacity to absorb surges in demand sized to reflect actual experience taken from Broward's historic record. The figure below summarizes the requirements for dispatcher OnDuty for Option 0, Option 1, and Option 2.

Figure 70. Comparison of Operations Models / Options

Dispatch Model	Dispatchers	
	Min / Max	Hours OnTask
Option 0: Current Ops with *FITCH* performance targets	22/45	844
Option 1: Consolidated Intake	13/36	652
Option 2: Option 1 with FR Gatekeeper, FR msr Radio, and FR ssr Radio channels	14/38	700

Note: The exact distributions of dispatcher Hours-OnTask by hour of day and workstation are found in Attachment I, Erlang Tables of Workstations.

FITCH believes that the increase in dispatcher Hours-OnTask in Option 2 is justifiable. The purpose of a dispatch center is to facilitate the execution of emergency service responses in the field. Having dedicated communication channels and specialized dispatchers will improve the performance and increase the safety of FIRE and EMS field responders. *FITCH* believes that these benefits outweigh the additional dispatch costs.

RECOMMENDATIONS

Technology

Findings —

The County's PSAP phone system and CAD systems are not effectively linked to allow comprehensive evaluation of System performance.

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.

Technology limitations resulted in only 25.6% of CAD records considered valid for use in analysis of P2/P3 intervals.

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/canned reports, which makes some of the required reporting tedious and error prone.

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

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

Recommendations —

The County needs to insure the missions of technology development and technology sustainment have different focuses and roles. Therefore, the county should provide for a Technology Development Team and a Technology Sustainment Team over the next few years as new technologies are implemented and the system continues to stabilize.

An absolute priority for the County is to develop a link between 911 phone records and the associate CAD incident records.

BSO should maintain EMD certification training for all call takers through the International Academies of Emergency Dispatch (IAED). Call taker personnel should also be trained and certified as Emergency Fire Dispatchers (EFD) and in the system implement EFD in the near future. These certifications are considered industry best practice.

Finally, law enforcement agencies should consider and evaluate the efficacy of Emergency Police Dispatch (EPD) being utilized in the future. This system is emerging as an industry best practice.

Discussion —

Challenges in obtaining data during this project, timely recognition of limitations in technology, and other problems indicate resource constraints within ORCAT to support the significant technology infrastructure required for system of the size. At a minimum, the County needs to ensure separate organizational focus on those personnel dedicated to developing/enhancing technology within the system against those responsible for maintaining/sustaining the existing technology. The County should reorganize ORCAT to ensure these responsibilities are bifurcated. We note that in the FY 15/16 the County funded two additional positions to provide maintenance support to their public safety applications, and in the FY16/17 budget, the County funded six additional positions in the Office of Regional Communications and Technology to support the following: the Public Safety Network, ongoing capital projects, the Radio System, and Public Safety Applications. There may still be a requirement for more resources specific to create a separate 911 technology development group. The opportunity to recapture resources elsewhere in the system allows for this recommendation to be accomplished without any additional overall funding.

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. This technology deficit significantly limits the ability to calculate the P2/P3 call processing intervals. As noted, 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. With the implementation of the new next generation computer aided dispatch (CAD) system anticipated for early 2017, the County should ensure that this flaw is resolved. Since the release of the Phase 1 report, County staff has worked to identify technology changes/upgrades that will rectify the problem. The County and Motorola indicate they have a working solution that will be deployed with the new CAD. The goal should be to link at least 90% of CAD records with 911 records where they exist.

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. Recently, the County has indicated that the new CAD system will contain access to the necessary data from the 911 database. This information will be readily accessible to County staff to allow for more detailed/ad hoc reporting. The County should additionally ensure the same capability exist in the radio system.

BSO currently utilizes the Medical Priority Dispatch System (MPDS) for dispatching emergency medical calls and providing pre-arrival instructions to callers. As an agency accredited by IAED, all of BSO's dispatchers maintain emergency medical dispatcher (EMD) certification. Similar to EMD, The County, BSO and other system participants should adopt and deploy Emergency Fire Dispatch (EFD) in the near future. Utilization of the same vendor, employing similar interfaces and program logic, will allow for this recommendation to be accomplished with relative ease. Since both dispatch personnel and field personnel already utilize EMD, the addition of EFD should be well accepted.

Currently, there is significantly less uniformity in the processing of law enforcement calls for service. This is quite typical across the nation. However, increasing number of law enforcement agencies are employing similar software products as identified above. To provide for greater uniformity in handling law enforcement calls for service, provide defensible and objective guidelines for performance, with quality assurance processes that can be applied and reviewed by management personnel, law enforcement agencies along with BSO should undertake an evaluation of products similar to Emergency Police Dispatch (EPD). Because of the fundamental way in which EPD integrates into the dispatch process, the decision to utilize such a tool would require all law enforcement agencies to actively participate in this evaluation and decision.

Operational Oversight and System Governance

Findings —

BSO's operation of the Public Safety Answering Points (PSAPs) are challenged with significant morale problems embedded in issues of staffing, training and management.

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.

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.

Recommendations —

Operational Oversight and System Governance should be redefined to strengthen the role of end-users while balancing the logistical concerns of the Operator (BSO), and the financial and system governance responsibilities of Broward County.

Alternative work schedules are available and should be considered. Attachment A, Scheduling Matrix Sample, provides sample schedules for consideration. Filling vacant positions in a timely manner with the goal of maintaining full staffing will reduce excessive mandatory overtime and the associated stress. This will allow resources to align more closely to demand patterns, thereby improving efficiency in the system.

Supervision on the PSAP dispatch floors should be at a ratio of six to one as opposed to the current nine to one ratio. Greater quality assurance processes are to be handled by BSO dispatch floor supervisors.

Resources for dispatcher training should be increased through reallocation of current funding.

A "base level of 911 services" funded by the County should be more clearly defined by utilizing the current interlocal agreements and *FITCH's* modeling of performance levels as noted in call taking and radio positions. Individual agencies desiring higher levels of service should be able to fund additional staffing hours or technology in order to receive services specific to their jurisdictional needs. The Regional System's management and technology should facilitate these additional services as long as they do not disrupt the base services.

Discussion —

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. Local officials, especially city managers, police chiefs and fire chiefs, must ensure their communities interests are represented by active engagement within a new governance structure that adjust the perceived balance of control that has existed to this point. What is required is an oversight process that balances end-user concerns for field operations, against BSO's requirements to manage the 911 System operations and Broward County's fiduciary and legislative responsibilities – all while ensuring transparency that all stakeholders require.

There are two general approaches to managing 911 systems. The first focuses on control, which is typically found when only a single agency is the end-user. In this case, the focus is on command and control of field resources, due primarily to limited resources relevant to demand for services. The second approach focuses on support and it serves both single and multi-agency 911 systems well. The goal of this approach is to support field personnel, remain responsive to field needs, and be regarded as a critical component of the public safety system. Broward County has, and should remain with, a 'support approach' in their Regional 911 System.

The County's obligations, and responsibilities, are clear. As the accountable entity, it ultimately has both legislative and fiscal responsibilities to the system. However, consistent with a support philosophy, the County does not need to necessarily 'drive' the system, but rather should adopt a perspective of facilitating and ultimately managing the System's performance. The following discussion provides specific recommendations for future operational oversight and system governance.

The Regional 911 System must serve law enforcement and fire rescue providers and to achieve that goal, field operational oversight must focus on those stakeholders. However, stakeholder's needs must also be balanced with the logistical constraints of BSO, as Operator, and the financial and governance concerns of Broward County. During the first 18 months of operation, the System was seen by stakeholders as too centralized within the County Office of Regional Communications and Technology (ORCAT) and too focused on contractual performance metrics. The requirements of end-users were not being met.

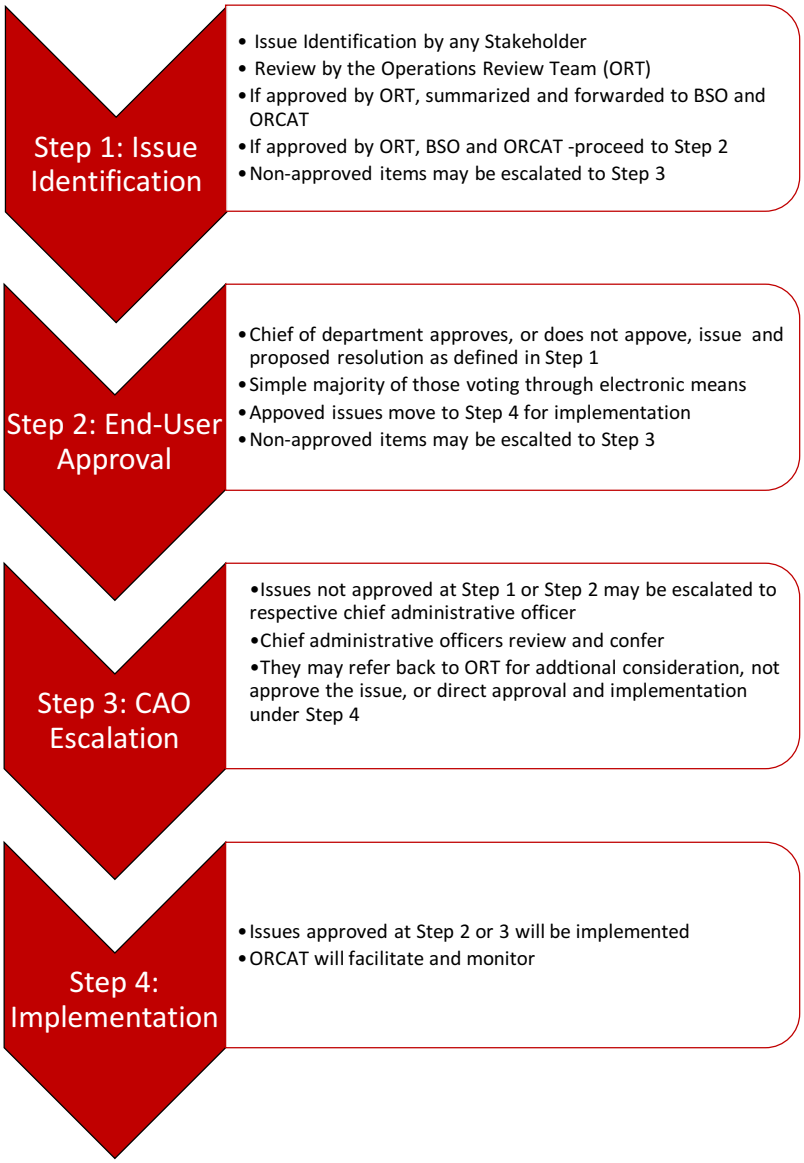
Operational oversight, as used herein, refers to watchful, responsible and accountable supervision of the field operational aspects of the Regional 911 System. This includes policies, procedures and processes that impact the end-user's ability to provide service to residents and visitors. For example, the determination of the number of resources assigned to a specific incident, or the name and definition of complaint types are purely operational in nature. However, where the needs of the end user begin to impact or influence the technology needs of the system, the operations within a 911 center, its required funding or overall system integrity, then other system stakeholders must properly be included.

FITCH suggests that existing processes be redefined to focus more on end-user needs at the inception of operational issues, and allowing BSO and ORCAT to engage later in the process. This shift provides a nimbler environment for end-users and ensures operational issues are fully vetted before considering logistical, financial or governance concerns. As part of the change in focus, ORCAT Communication Managers roles and responsibilities should be revised and clarified. These positions should focus on quality assurance reviews of significant dispatch issues raised by end-users, citizens or others parties; ensuring PSAP facilities and technology are operating at maximum effectiveness; and coordination with BSO Site Managers. To avoid any confusion, the existing ORCAT position titles and job descriptions should be updated accordingly.

The system has utilized a policy level committee, the 4C, during early implementation. For reasons outlined previously, the focus now should properly shift to a more operational perspective. The need for the 4C no longer exists and the County should sunset the group as this new governance model is implemented.

The figure below summarizes the steps in a suggested process for the identification of an operational issue and the steps toward a resolution. The county should maintain a repository of all documentation associated with this process to ensure transparency and archiving of all decisions.

Figure 71. Identifying and Resolving Operational Issues



Recommended Operating Guidelines for Governance

Step 1: Issue Identification and Proposed Resolution

1) A need for the creation and/or revision to a policy, procedure or process of the 911 system can be raised by any of the stakeholders – law enforcement/fire rescue agency as a representative of their municipality; Broward Sheriff's Office; or Broward County.
2) Issues would be considered first by the existing Operational Review Team (ORT).
   a) Each law enforcement and fire rescue agency would have a representative on the ORT. Typically, the ORT would meet by discipline as is current practice – law enforcement or fire rescue.
   b) The ORT would determine if an issue involved only a single agency; a single discipline (law vs. fire); or a regional concern.
      i) If the issue only involves a single agency, the issue would move to sub-paragraph 4.

c) Each ORT group should be chaired by a uniformed member determined by the respective Association. Because of BSO's unique role as Operator in the system, the chair should preferably be from a municipal agency.

3) The ORT would clarify the issue and proposed resolution. The item would be summarized in written form to ensure the issue and proposed course of action are clearly identified.
4) The ORT would recommend approval or denial of the item
5) Upon approval by ORT, the issue would be forward to both BSO and ORCAT for review & comment.
6) BSO and ORCAT would consider the item under the following guidelines:
   a) BSO would evaluate its ability to provide the recommended resolution. They should consider the logistical benefits and challenges, as well as if the proposed resolution can be done with existing resources. If additional resources would be required by BSO, it must identify the financial impact. The final determination of fiscal impact would rest with Broward County's budget office.
   b) ORCAT would consider any logistical impacts from the proposed issue resolution as it relates to the County's technology (i.e. CAD, radio, 911 system, etc.). ORCAT would also consider any potential fiscal impacts, though the final arbiter of funding should reside with the County's budget office. Finally, ORCAT would evaluate the issue and proposed resolution against the Regional 911 System's overarching goals and objectives.
   c) If the issue involved only a single agency (see 2b above) ORCAT and the involved agency would discuss if the municipality desires to fund the change/improvement if the solution is beyond the base services provided by the County.
   d) If the issue is denied by the ORT, the proposer may elect to advance the issue to Step 3.
7) One approved by all three stakeholder groups (ORT, BSO, ORCAT), the issue advances to Step 2.
8) If the issue is not approved by any of the stakeholders in 7) above, the proposer may elect to advance the issue to Step 3.

Step 2: Approval by End-Users

1) Issues approved by all three stakeholder groups will be approved by fire chiefs and/or police chiefs.
   a) While ORT will often be comprised of operational managers from law enforcement and fire rescue agencies, approval at Step 2 requires the specific review and approval from the chief of department for each law enforcement and/or fire rescue as applicable.
   b) Summary of the issue and proposed resolution, as prepared and approved at Step 1, will be sent to the chief of department for law enforcement, fire rescue or both as the issue may require.
   c) Items, as summarized at Step 1, will be balloted to chiefs of department electronically. The chair of the relevant ORT shall ensure the written summary of the issue is forwarded to the respective Association president for distribution to each chief of Department.
   d) Each chief of department is expected to review and approve or not approve the item.
   e) Consistent with the existing practices for both the Fire Chiefs Association and Police Chiefs Association, a simple majority is sufficient for the item to be approved. Ultimately the determination of each professional Association, and of the methods by which they approve items, is left within the purview of that Association.
2) Upon approval at Step 2, the item will move to Step 4 for implementation.

Step 3: Escalation to Chief Administrative Officer

1) Should an issue not garner support for approval at Step 2, the proposer or other stakeholder may elect to escalate the issue to their respective chief administrative officer (city manager, county administrator, or Sheriff) as may be applicable.
2) The chief administrative officer (or designee) of the agency seeking to escalate the issue may elect to uphold the determination made at Step 1 or Step 2, or confer with the chief administrative officers (or designees) of other stakeholders.
3) The chief administrative officers of all three stakeholders, should they agree, may also direct a specific resolution to the issue; request ORT reconsider the issue; or take other actions as they determine in the best interest for their local government.

Step 4: Implementation

1) Issues identified at Step 1, and approved at either Step 2 or Step 3, shall move to Step 4 for implementation.
2) ORCAT will facilitate the implementation with the active support of other stakeholders.
3) ORCAT will monitor and report to all stakeholders the progress and issues approved for implementation.
4) ORT members are expected to keep their respective agencies informed of issues undergoing implementation.

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.

The section of this report titled Dispatch Operational Models – Options, proposes several options that include a number of staffing realignments to address the existing inefficiencies. The opportunity also exists for BSO to alter its current staffing schedule in order to 1) align resources necessary to the actual demand, and 2) provide opportunities for dispatch personnel to work alternate shift schedules, thereby providing greater opportunities for reduced stress and demands of mandatory overtime. An example of one such schedule is contained in Attachment A, Scheduling Matrix Sample, that utilizes a combination of eight hour and 12 hour shifts in order to more closely align staffing levels with actual demand. The system evaluates demand in four hour blocks and by balancing the number of personnel on either eight or 12 hour shifts, dispatch managers and supervisors can devise more efficient schedules. Ultimately, this proposal allows for individual dispatchers, based on contractual seniority and existing methods, to select various work schedules that will more likely align with their personal desires.

911 center operations are extremely stressful and frequently must address unusual or intense incidents. The recommendations regarding supervisory span-of-control are based on the dual roles of dispatch floor supervisors. First, a floor supervisor plays an active quality assurance role in real time. Dispatch processes involve complicated scenarios and in this role, a floor supervisor provides immediate support and adherence to policy/protocols. The second role is that of an active liaison with their equivalent level field personnel. When this role is fulfilled, field supervisors and dispatch supervisors are well informed regarding any issues of the day and that information is passed seamlessly from shift to shift. Characteristics such as these require higher levels of supervision then may be found in other disciplines. Currently, BSO operates with a supervisor to dispatcher ratio of approximately 1:9. For 911 centers, the supervisor to dispatcher ratio should be closer to 1:6. Which the proposed staffing outlined in either Option 1 or Option 2, and keeping existing supervision level constant, will come close to achieving the desired 1:6 ratio. Both BSO and of the County should monitor and reallocate existing resources to achieve this target supervisor level.

Training was also an area identified as requiring more resources. With the recommended adjustments to staffing outlined elsewhere, some resources should be redeployed to enhance BSO's dispatcher training programs. BSO has indicated they are pursuing new approaches and technologies to ongoing training requirements. This is a positive effort, but one that should also include additional personnel in order to more closely support the identified training deficits that come out of other system analysis and reviews. As a BSO implements any new approaches to training, they should identify any additional staffing resources required and seek reallocation of resources from the County

Quality assurance efforts fall within the purview of oversight and are rightfully a responsibility of the County. The County is the body that should conduct quality assurance assessments for current Emergency Medical Dispatch (EMD) functions and for any future deployment of Emergency Fire Dispatch and/or Emergency Police Dispatch protocols. Independent quality assurance processes such as Priority Dispatch's "National Q" are readily available and can provide objective feedback on compliance to protocols. The County is also responsible for ensuring system participant's needs are being met and agreed upon responsibilities being fullfilled. Where appropriate, this includes performing audits to ensure contractual responsibilities are being met. At a minimum, the contracted quality assurance programs should be able to accommodate the following points:

- Focus on evaluating telecommunicator strengths and identify areas for improvement,
- Provide a standardized operation that provides consistent and ongoing improvement,
- Develop a clearly defined process for quality assurance case reviews that include call taking and dispatch activities,
- Assure that case reviews are performed on a regular basis with feedback provided to the telecommunicator, as soon as possible,
- Assure that personnel responsible for performing QA reviews meet minimum qualifications for Quality Assurance Evaluators,

Additionally, the following practices are to be included in the QA program:

- Case review criteria

- Evaluation guidelines
- Oversight Committee as per protocol or agency guidelines
- Program monitoring
- Record keeping
- Reporting and feedback
- Written directives.

Several municipalities have expressed the desire to provide dispatch personnel who are dedicated to handling agency-specific function such as handling police and fire policy issues, dedicated tactical radio operators, or handling non-emergency service requests. Before these requests can be considered, the County will need to clearly define the base service functions. It is understood that the County is responsible for funding the base 911 services. Largely, these base services are currently defined in the Interlocal agreements between Broward County and various municipalities. However, this current definition should be further clarified to incorporate the levels of performance as identified herein. For example, while answering of 911 calls is a base service, the performance level recommended here is to adjust staffing to a level consistent to achieve between 3-5 seconds at the 90th percentile. Similarly, radio channel staffing for fire rescue routine responses has been modeled to reflect 2 seconds at the 95th percentile. Respective municipal agencies should be able to purchase additional staffing-hours in order to achieve the services they desire that are above and beyond base level 911 services.

Performance Metrics

Findings —

Certain performance measures have been misinterpreted, incorrectly applied, or are inconsistent with current industry best practices.

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

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.

Recommendations —

The County should modify the current monthly performance report format and replace it with a monthly report that focuses solely on data and provides no commentary.

The "busy hour" is to be redefined in a prospective manner based on historical data and is to be reassessed in no less than 12-month intervals. These changes allow for meaningful and actionable information exchanges and provide user agencies with a needed level of oversight.

The County should purchase a performance measurement software package that will provide agencies with ready access to the activities and performance of their respective field units, and simultaneously allow the County and BSO to evaluate system performance at the micro and macro levels.

Only the performance on emergency/911 incidents should be included in the performance reports. The current practice of evaluating duplicate 911 calls on a single incident skews measurement. The true structure of the report should be to present the numbers in a way that highlights the calls where response time is important. Some thought should be given to present response times starting with the call receipt to emergency service arrival on scene. This will give the proper presentation of the caller's experience. Special attention should be paid to high priority incidents.

Regarding reporting performance for various call processing time intervals, once the technology issues are resolved, the P2 and P3 intervals should be reported separately and as a combined metric. The reasoning is that, particularly for fire and emergency medical Delta and Echo life-threatening calls, fast and effective dispatch performance contributes to positive outcomes. Monthly reports should also report P4 (turn-out times) for fire rescue incidents and P5 (travel time) for both fire rescue and law high priority incidents.

In general, dispatch center performance metrics are to focus on optimizing dispatch processes as much as possible, with the end result being to get help moving to emergencies as quickly as possible. The primary objective is to contribute to the potential for positive outcomes for patients and properties.

Discussion —

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, supported by a quality assurance and improvement program, should continue. Additionally, greater operational coordination and transparency among System participants has provided qualitative improvements. A suggested monthly performance report, focused on objective performance data and appropriate for dissemination to policy makers, is contained in Attachment J, Monthly Performance Report Format. As noted in the recommended format, response times for high priority law and fire rescue incidents will also be reported – acknowledging the public's perception of service. Stakeholders should note the addition of reporting average values for performance measures. While stakeholders should design, assess and report performance utilizing fractile or compliance performance (e.g. 90% within 10 seconds), members of the public generally are used to performance being reported as an average time. For these reasons,

both are recommended in Attachment J, but stakeholder should be utilizing "Target" and Target Compliance" in their assessment of System performance. This does not preclude additional or more detailed system analysis, but rather is meant to focus on higher level metric of System performance. In addition, while the intent for the monthly performance report is to remain relatively objective by simply reporting metrics, the County continues to have the right and obligation to address performance issues as outlined in the existing interlocal agreements.

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. 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. 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. Once the technology limitations are addressed, the system should focus on P1 answer times only for those incidents that generate a call for service. In this manner, only data from the CAD system would be utilized. Utilizing a prospective definition of P1 also limits random surges in the system to inappropriately lead to conclusions of poor performance in this metric. Based on data elsewhere in this report, the system's current busy hour is 1800 hrs. Additionally, the County has previously identified that call intake times are what generally lead to failures in meeting P2/P3 performance targets. By evaluating each component separately, P2 for call intake times and P3 for unit notification times, the system and operator are better able to identify root causes of performance issues.

While the System is seen as struggling to meet some 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. Attention to performance metrics is a best practice, but must be utilized carefully to avoid emergence of perverse behaviors. The focus of performance measures should be on the timely and accurate collection and transmission of information to first responders. Metrics that assess performance on low priority incidents, while interesting, must be evaluated separately from metrics

designed to measure performance in true emergencies. For example, EMS related calls are categorized through the EMD process – with Delta and Echo determinants representing those emergencies requiring the closest and all vehicles to respond with lights and sirens. In general, dispatch center performance metrics must focus on optimizing dispatch processes as much as possible, with the end result being to get help moving to emergencies as quickly as possible. The primary objective is to contribute to the potential for positive outcomes for patients, residents and properties. The County, BSO and cities require tools that make these distinctions.

The County should provide a web-based performance measurement system that provides feedback to key stakeholders in real time. The system should allow individual communities to monitor performance of the 911 center and their field resources in real time. BSO, as the system operator, should be able to see performance at both the system level and at the individual dispatcher level in order to identify and address performance issues. These systems typically tie into the CAD system and the allow evaluation of P1 through P4 performance metrics. Individual communities would be limited to seeing only their individual agency resources. Both the displays and target goals should be user definable, by agency and discipline. Most providers of the software allow for users to access information from either a desktop or mobile client. The County should consider this capability to be a base service for all system stakeholders.

Efficiency and Effectiveness

Findings —

Current PSAPs, training facility and "flee to" plans have facility limitations, especially related to adequate space.

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

Radio traffic utilization, by both fire/EMS and law enforcement units, is comparatively high. MDTs (mobile data terminals) and MCDs (mobile computing device) are not effectively utilized to reduce radio traffic.

BSO current performance indicates overstaffing in call taker positions based on Erlang modeling.

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

Recommendations —

Call processing staffing should be adjusted to achieve P1/call-taking performance of between three to five seconds at the 90th percentile by adopting the recommended workstation functional reorganization as detailed in the report section titled, Dispatch Operations Models – Options. This adjustment, in

conjunction with the already implemented single que for call intake, provides significant efficiencies in the call taking process while maintaining high levels of performance.

Fire-rescue agencies should develop, approve and implement countywide nearest unit response protocols that apply irrespective of jurisdictional boundaries in those incidents involving high priority incidents (e.g. Delta & Echo level EMD calls).

Recommended process changes to radio channel usage include requiring increased usage of Mobile Data Terminals (MDTs) by field responders.

Once the CAD is upgraded to allow automatic computer assignment / recommendation of response units for fire/rescue calls, a single "gatekeeper" function / fire rescue alert channel can be implemented to manually approve the assignment consistent with Option 2. Upon dispatch, pre-defined tactical radio channels would be used for more routine for fire incidents and EMS incidents. More significant incidents (structure fires, major/multiple unit responses) would be assigned a dedicated tactical channel. This change in fire rescue radio operations provides significant efficiencies while maintaining high levels of performance.

Law enforcement radio positions should be consolidated to increase efficiency consistent with Option 2.

Long-term capital budgeting program should be considered as soon as practical to include two new purpose-specific 911 facilities.

Discussion —

The County's recent Capital Budget includes $350,000 in Fiscal Year 2017 for planning and analysis studies to identify development options for new or reconstructed PSAP facilities. The ultimate goal should be to have two geographically disparate PSAPs[28] both of which are staffed 24/7/365. Failure of one physical location will allow the alternate location to continue to provide essential services. Current facilities, as currently utilized, appear to be for client agencies to cohabitate rather than consolidate. Design efforts that focus on consolidation will be the most successful.

FITCH does not understand from a root cause perspective, the failure by field personnel to make better use of mobile data terminals (MDTs). This practice places a larger demand on the radio system and 911 personnel and further decreases the effectiveness and efficiency of the System. Requiring field personnel to use their unit MDTs instead of radio channels will allow for more efficient use of current dedicated radio channel personnel. The County should ensure that the new mobile client, implemented with the new CAD system in 2017, meets the needs of both fire rescue and law enforcement first responders. Fire chiefs and police chiefs should internally ensure greater utilization of available technology designed to lessen the existing over usage of verbal communications.

[28] NFPA 1221-2016. Section 4.1.5.2

Erlang analyses summarized elsewhere in this report, demonstrates inefficiencies in both the call taking and fire rescue dispatch operations. Adjusting performance targets, and modifying radio operations for fire rescue incidents, both provide potential significant efficiencies. For the public, there should be no discernible impact on the call answering function. For fire rescue personnel there will be a need to adjust to the new radio channel assignments - for example, switching to a EMS working channel immediately upon assignment. In some regards, system participants did not consolidate their 911 centers, but rather simply geographically relocated their operations. The initial configuration of fire and law radio operations simply reflected the then existing practices. To achieve the efficiencies identified here, fire and law enforcement agencies must consolidate radio channels to more sustainable levels. The proposed changes allow for greater capability of tactical operators to handle significant fire-rescue incidents. This should address a concern voiced by both fire personnel and current radio operators.

While the modeling demonstrates that sizable adjustments are available, implementation of changes should occur in a more deliberate and measured manner. The County should request BSO implement any recommended changes in two or three phases – titrating staffing levels while monitoring performance. Ultimately, changes should be able to be fully implemented within 12 months. As noted in the Executive Summary, it is important that the County and BSO assure that each change phase is completely embedded in operational procedures and the organization's culture, before seeking additional change.

The County's Charter, states in part, that the "County shall provide funding for the communications infrastructure and all service providers will utilize the elements of the communications infrastructure. The communications infrastructure shall facilitate closest unit response for life-threatening emergencies . . . ". While there has been some pilot projects, and increased automatic aid for certain incidents, there has not yet been a concerted effort to fully realize the intent of the County's Charter. By limiting the use of nearest-unit response to Delta and Echo incidents, as determined through use of the existing EMD program, this will meet the Charter language of "for life-threatening emergencies" which represent approximately 15% of all EMS calls.

Attachment A

Scheduling Matrix Sample

FITCH
& ASSOCIATES

Attachment A. Scheduling Matrix Sample

One of the more common work schedules for dispatch center personnel is the four-day work week. This schedule provides personnel with a level of work-life balance that is acceptable and appropriate for personnel working in a high-stress environment.

This section provides the steps for building a schedule matrix based on a combination of 12/8-hour shift schedules for a four-day work week and a traditional 8-hour schedule for a five-day week.

- The 4-hour increments start at the time of day the shift work begins.
- Determine the staffing levels needed using the 4-hour increments.
- Determine the staffing levels needed by day of week and hour (4-hour increments) of day base on normal activity.
- The schedule for this example is based on the following sets of days off:
    1. Saturday, Sunday, Wednesday
    2. Sunday, Monday, Thursday
    3. Monday, Tuesday, Friday
    4. Tuesday, Wednesday, Saturday
    5. Wednesday, Thursday, Sunday
    6. Thursday, Friday, Monday
    7. Friday, Saturday, Tuesday

Tables 1 and 2 below provide sample schedules as titled.

Table 1. Sample Combination 12/8 Hour Shift Schedule – 4 Days/Week

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Combination 12/8 Hour Shift Schedule - 4 Days/Week						
X	06-18	06-14	X	06-18	06-14	X
X	X	06-18	06-14	X	06-18	06-14
06-14	X	X	06-18	06-14	X	06-18
06-18	06-14	X	X	06-18	06-14	X
X	06-18	06-14	X	X	06-18	06-14
06-14	X	06-18	06-14	X	X	06-18
06-18	06-14	X	06-18	06-14	X	X
06-14	X	06-18	06-14	X	X	06-18
X	06-18	06-14	X	06-18	06-14	X
X	X	06-18	06-14	X	06-18	06-14
X	10-18	06-18	X	10-18	06-18	X
X	X	10-18	06-18	X	10-18	06-18
06-18	X	X	10-18	06-18	X	10-18
10-18	06-18	X	X	10-18	06-18	X
X	10-18	06-18	X	X	10-18	06-18
X	18-06	18-02	X	18-06	18-02	X
X	X	18-06	18-02	X	18-06	18-02
18-02	X	X	18-06	18-02	X	18-06
18-06	18-02	X	X	18-06	18-02	X
X	18-06	18-02	X	X	18-06	18-02
18-02	X	X	18-06	18-02	X	18-06
18-06	18-02	X	X	18-06	18-02	X
X	18-06	18-02	X	X	18-06	18-02
22-06	X	X	18-06	22-06	X	18-06
18-06	22-06	X	X	18-06	22-06	X
X	18-06	22-06	X	X	18-06	22-06

Table 2. Sample 8-Hour Shift Schedule – 5 Days/Week

8-Hour Shift Schedule - 5 Days / Week						
X	06-14	06-14	06-14	06-14	06-14	X
06-14	06-14	X	X	06-14	06-14	06-14
06-14	06-14	06-14	06-14	06-14	X	X
06-14	X	X	06-14	06-14	06-14	06-14
X	X	14-22	14-22	14-22	14-22	14-22
14-22	14-22	X	X	14-22	14-22	14-22
X	X	14-22	14-22	14-22	14-22	14-22
14-22	14-22	X	X	14-22	14-22	14-22
14-22	14-22	14-22	X	X	14-22	14-22
14-22	14-22	14-22	14-22	X	X	14-22
14-22	14-22	X	X	14-22	14-22	14-22
14-22	14-22	14-22	X	X	14-22	14-22
14-22	14-22	14-22	14-22	X	X	14-22
14-22	14-22	14-22	14-22	14-22	X	X
14-22	14-22	14-22	14-22	X	X	14-22
14-22	14-22	14-22	14-22	14-22	X	X
22-06	22-06	22-06	22-06	22-06	X	X
X	X	22-06	22-06	22-06	22-06	22-06
X	X	22-06	22-06	22-06	22-06	22-06
22-06	22-06	22-06	22-06	22-06	X	X

If the staffing levels need to be higher for the weekend, then build the matrix in reverse order starting with days off (7 through 1). Additional peak times can be added as needed to handle anticipated surges in the system. Figure 1 and Table 3 below give examples of peak staffing based on four-hour blocks.

Figure 1. Graphic of Staffing Changes in 4-Hour Blocks

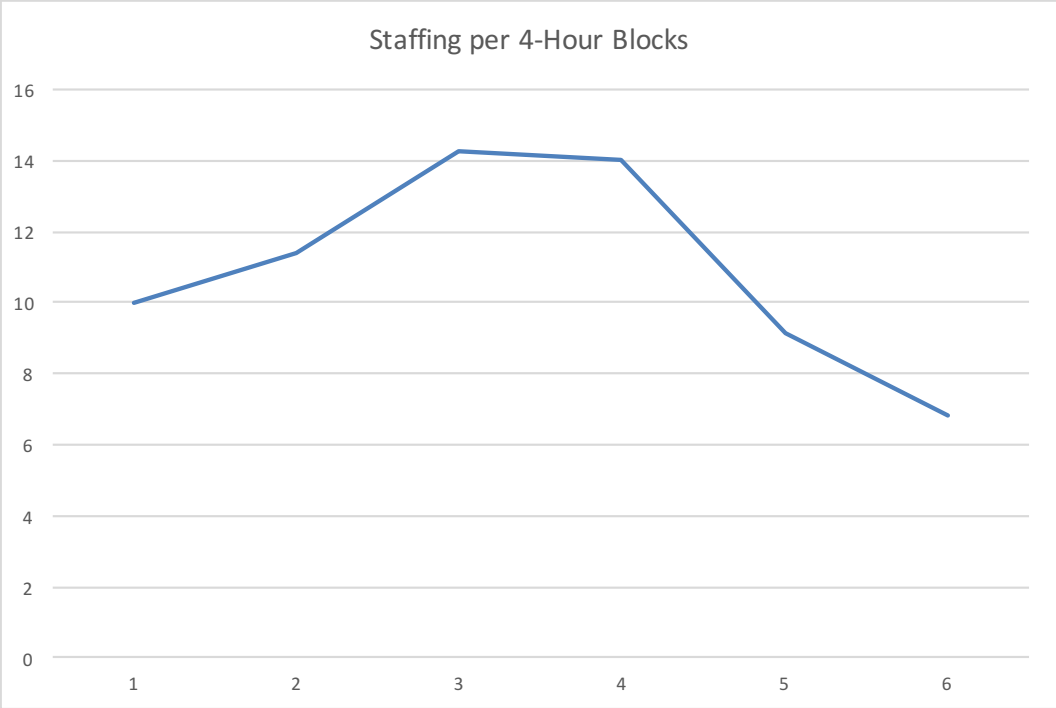


Table 3. Personnel One Duty in 4-Hour Blocks

							4-Hour Block	Avg on Duty
9	9	11	10	10	11	10	06-10	10.0
10	11	12	11	12	13	11	10-14	11.4
14	16	16	11	13	14	16	14-18	14.3
15	16	13	11	13	14	16	18-22	14.0
8	9	9	8	11	10	9	22-02	9.1
6	7	6	7	9	7	6	02-06	6.9

Attachment B

Performance Measures

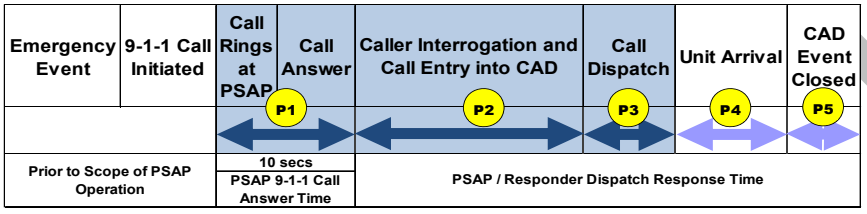
FITCH
& ASSOCIATES

ATTACHMENT [redacted] Performance Measures FROM OPERATOR AGREEMENT [22]

EXHIBIT "D"

PERFORMANCE STANDARDS

The performance of the Consolidated Regional E-911Communications 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-911Communications 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-911Communications 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)

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Law Enforcement Call Process Time Standard:

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Emergency Medical Dispatch Standard:

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- 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

(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 C

Calculation of Answer Delays
Mathematics & Assumptions

FITCH
& ASSOCIATES

Attachment C: 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 )
```

Attachment D

Erlang Mathematics & Assumptions

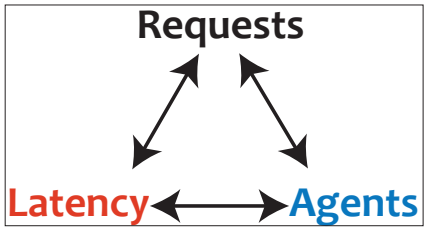
FITCH
& ASSOCIATES

Attachment D: 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 1, below.

Figure 1. 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.[1]

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

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

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.

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

$$P_A = \left(1 - P_Q \right)$$ **Equation 3**

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

$$Q = \frac{P_Q E}{(N-E)}$$ **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".[2] 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

[2] www.easyerlang.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

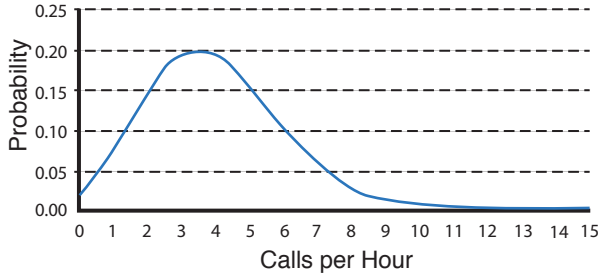
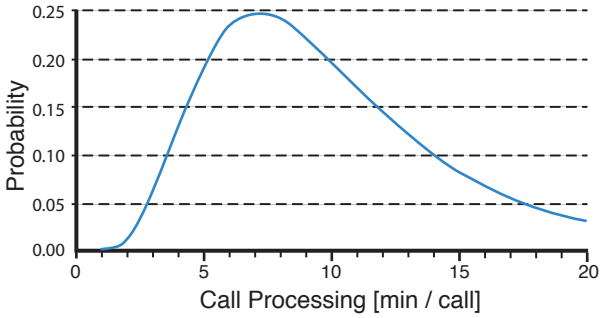
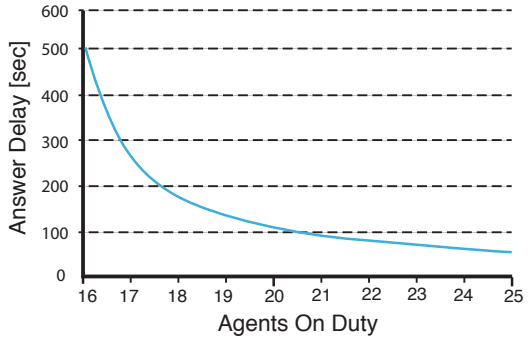


Figure 23. Exponential Distribution of Call Processing Intervals



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.

Table 1: Average Answer Delay Versus Number of Agents

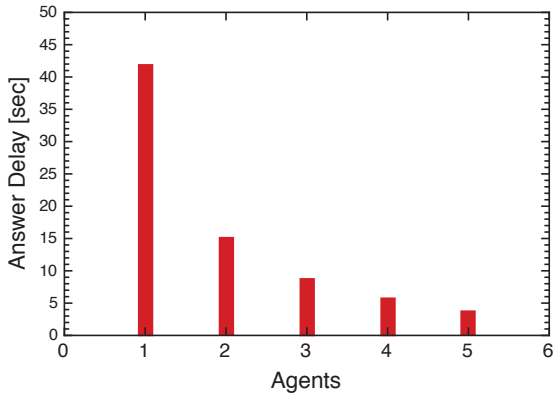


The purpose of this example is to emphasize that the performance of a queueing system changes in a very non-intuitive manner with respect to changes in both staffing and workload.

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 queueing 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).

Table 2: 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 E

Quantitation of Workloads

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Attachment E. Quantitation of Workloads

Intake Workstations

The data table Call Detail Records captures all incoming traffic to the Intake workstations. Counts of emergency and administrative calls were taken from these records summed by hour of year and averaged by hour of day. Hang-ups and nuisance calls are included in these records. Counts were also taken from the Outgoing Phone Log, summed by hour of year and averaged by hour of the day. Depending on the model being calculated, these counts may be segregated by Central, North, and South PSAPs.

The processing time is the summation of the intervals from the [Agent Connected] timestamp to the [Agent Disconnect] timestamp. Additional processing time is the summation of the durations of outgoing calls taken from the Outgoing Phone Log. These processing times were summed by hour of year and averaged by hour of the day. Depending on the model being calculated, these processing durations may be segregated by Central, North, and South PSAPs. For calculation of workloads at the consolidated Intake workstations, counts and processing durations for all three PSAPs were combined.

Assignment & Radio Support Workstations

The count of incidents at the LAW and FIRE Assignment workstations were taken from the CAD, summed by hour of year and averaged by hour of day. The duration of assignment processing was taken as the interval from the [Transmit] timestamp until the [Dispatch] timestamp. These processing times were summed by hour of year and averaged by hour of day. Depending on the model being calculated, these processing durations may be segregated by Central, North, and South PSAPs. FIRE and LAW assignments were tabulated separately.

All radio traffic in the Broward system is recorded. Broward did not make these records available to the consultant. Consequently, the exact radio traffic associated with each specific incident could not be determined.

The workaround was based on a year-end written summary titled “Talkgroups at Zone Summary 150101 – 151231.” This document summarized total air time on each of the FIRE and LAW dispatch channels for the various jurisdictions. It was possible to obtain an incident count from the CAD for each LAW and FIRE jurisdiction. Combining total annual air time with total annual incident counts per jurisdiction permitted calculation of an average amount of air time per incident for all of the FIRE and LAW jurisdictions. These results were stored by agency in a dedicated data table titled “Talkgroup Stats.”

Summing these average air times per incident by hour of year and averaging by hour of day provided the best estimate of the contribution of radio traffic workloads to total workload at the Assignment & Radio Support workstations. Depending on the model being calculated, these workloads may be segregated by Central, North, and South PSAPs.

ID Unit / FR Assign Workstation

In Option 2, the CAD software has been upgraded with the ability to identify the unit(s) most appropriate for executing the response. The time interval for this identification process is assumed to be 1.5 seconds, based on FITCH's experience with identification software in other large metropolitan systems. The recommended units are presented to the FR Assignment Dispatcher for review and notification. The manual review and notification is assumed to require 15 seconds, again, based on FI>TCH's experience in other large metropolitan systems.

FR msr Radio Workstation

This workstation provides radio support for "multi-station response" incidents. These incidents comprise FIRE responses requiring the participation of units from more than one station. The average Time-on-Task for "msr" incidents in the Broward CAD is 00:24:52 [hh:mm:ss]. The radio support dispatcher at this workstation is assumed to be 100% dedicated to the incident for the first half of this interval (00:12:26), and 50% dedicated for the second half of the interval (00:06:13) for an average processing interval of 00:18:39 per msr incident.

The function of this workstation is to provide tactical radio support on responses to complex FIRE incidents. Since crews do not require tactical radio support while loading to their apparatus, the latency used to model this workstation approximated the average chute interval experienced on these incidents.

FR ssr Radio Workstation

This workstation provides radio support for "single station response" incidents. These incidents comprise emergency medical incidents plus the "simple" FIRE responses. The count of incidents was taken from the CAD, summed by hour of year, and averaged by hour of day.

The workload was quantitated by multiplying the average count of incidents by the average duration of radio air time per incident as described in the section titled "Assignment & Radio Support Workstations", above. In Option 2, the radio air time per incident was reduced to 60% of its current amount to reflect an increased use of MDTs compared to current practice.

Attachment F

Sample Phone Records

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Attachment F: Sample Phone Record and Outgoing Phone Log

Table 1. 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: 911009-00291-20151111203010) 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 911009-00291-20151111203010
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 [ TCI]  TRUNK = 911009 / LINE = 9 POS = 012 / STN = 2012
00:00:04.061 [ TCI] CALL CONNECTED BY AGENT =  Adrian, Andrea/15002 ROLE = Central Call-
Taker
00:00:04.061 [ TCI] From PSAP ID = 1 PSAP Name = Central
00:00:43.055 [ CIM] Tandem Transfer
00:00:44.552 [ TCI] Event Logged By POS = 012 / STN = 2012 KEY: TRANSFER SV: 77 LV:
h,9547644357
00:00:44.552 [ TCI]  agencyId: 471 agencyName: BROWARD COUNTY NON-EMERGENCY
agencyTypeId: 9 agencyTypeName: Non-Emer
00:00:48.917 [ TCI] CALL RELEASED BY POS = 012 / STN = 2012
00:00:48.917 [ TCI] CALL DISCONNECTED BY AGENT =  Adrian, Andrea/15002 ROLE = Central
Call-Taker
00:00:48.917 [ TCI] 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	sec	90th
1.254 sec	Answer Delay	sec	95th

00:00:48.917	Agent Disconnected			
00:00:44.856	Agent Processsing	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

Table 2. 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 G

Sample Records from FIRE & LAW
CADs & Radio Statistics

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Attachment G: Sample Records form FIRE & LAW CADs & Radio Statistics

Table 1. Sample Records from 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
Call_Connected	12/10/2015 13:00:32.265
Agent Connected	12/10/2015 13:00:32.973
Rcvd_time	12/10/2015 13:00:35
Create_time	12/10/2015 13:01:45
Transmit_time	12/10/2015 13:02:23
Agent Disconnected	12/10/2015 13:08:48.92
Dispatch_time	12/10/2015 13:06:10
Enroute_time	12/10/2015 13:06:12.4
Arrvd_time	12/10/2015 13:09:46
Closed_time	12/10/2015 13:59:28

Intake_proc	1	00:01:50.027 (P2)
VIPER_spillover		00:00:02.027
Rcvd_offset		00:01:10
Assign_proc		00:03:47 sec (P3)
Assign_workload	2	68 sec
P2/P3 Interval	3	335 sec (P2)/(P3)
Time-on-Task	4	00:53:18
Index	3	335
avg		143.792

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

Table 2. Sample Record from FIRE 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
Call_Connected	12/10/2015 13:00:32.265
Agent Connected	12/10/2015 13:00:32.973
Rcvd_time	12/10/2015 13:00:35
Create_time	12/10/2015 13:01:45
Transmit_time	12/10/2015 13:02:23
Agent Disconnected	12/10/2015 13:08:48.92
Dispatch_time	12/10/2015 13:06:10
Enroute_time	12/10/2015 13:06:12.4
Arrvd_time	12/10/2015 13:09:46
Closed_time	12/10/2015 13:59:28

Intake_proc	1	00:01:50.027	P2
VIPER_spillover		00:00:02.027	
Rcvd_offset		00:01:10	
Assign_proc		00:03:47 sec	P3
Assign_workload	2	68 sec	
P2/P3 Interval	3	335 sec	P2/P3
Time-on-Task	4	00:53:18	
Index	3	335	
avg		143.792	

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

Table 3. 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

Attachment H

Calculation of Surges

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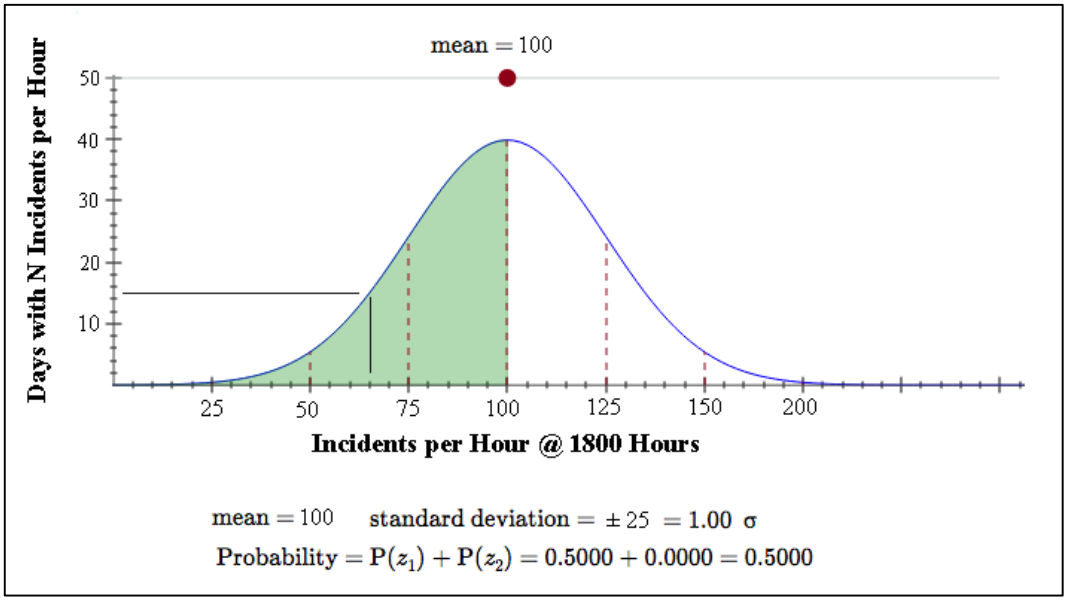
Attachment H. Calculation of Surges

Theoretical Treatment

Emergency services communications centers dispatch responses to defined geographic areas, the service jurisdiction. At a given hour of the day, and from day-to-day, the number of people in the service jurisdiction will be approximately the same. In turn, this condition leads to the historic observation that the number of requests for service will tend towards some daily average in that hour of the day. The next historic observation is that the number of requests in any particular day will vary above and below this long term average. As it turns out, the excursions to higher or lower numbers of requests really are random. The randomness of the excursions is very important because it makes the analyses of the flow of requests much simpler.

Random processes are often characterized by statisticians using a "normal" distribution. A stylized example of a normal distribution is presented in Figure 1.

Figure 1. Normal Distribution of Requests per Hour



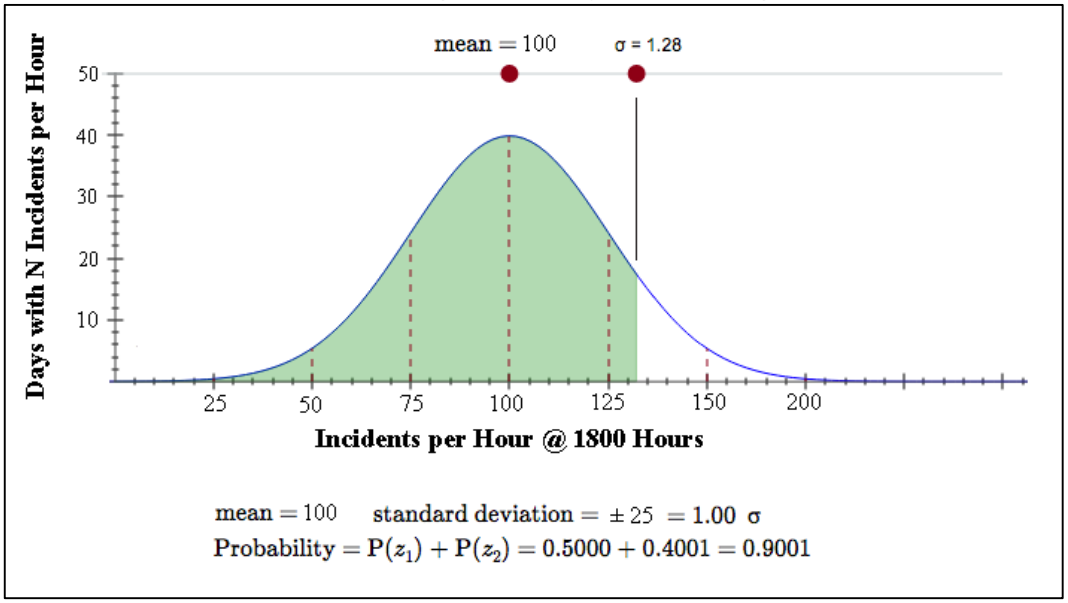
The interpretation of this figure starts with the x-axis, which is the number of incidents per hour. Go to the vertical line at 65 incidents per hour, follow it up to the blue curve. The height of the curve at 65 incidents per hour gives the number of instances, the number of days in which exactly 65 incidents were experienced in the 1800 hour. The average number of incidents per hour is 100. There are exactly 40 days in which 100 incidents occurred in the 1800 hour. The distribution curve in Figure 1 has a width. The standard deviation, symbol σ, characterizes this width. In this example, the standard deviation is 25.

The area under the normal curve from zero to the average is shaded green. The green area is one half the area under the curve. In the context of a dispatch center, the green area means

that one day out of two, there will be 100 incidents, or fewer, in the 1800 hour. Conversely, one day out of two, there will be 100 incidents, or more, in the 1800 hour.

The valuable of the standard deviation, σ, is that it allows the extraction of the size and frequency of surges from the normal distribution. Consider Figure 2 where the green area has been extended to the right as far as [average + 1.28 σ] which happens to be 132 incidents per hour.

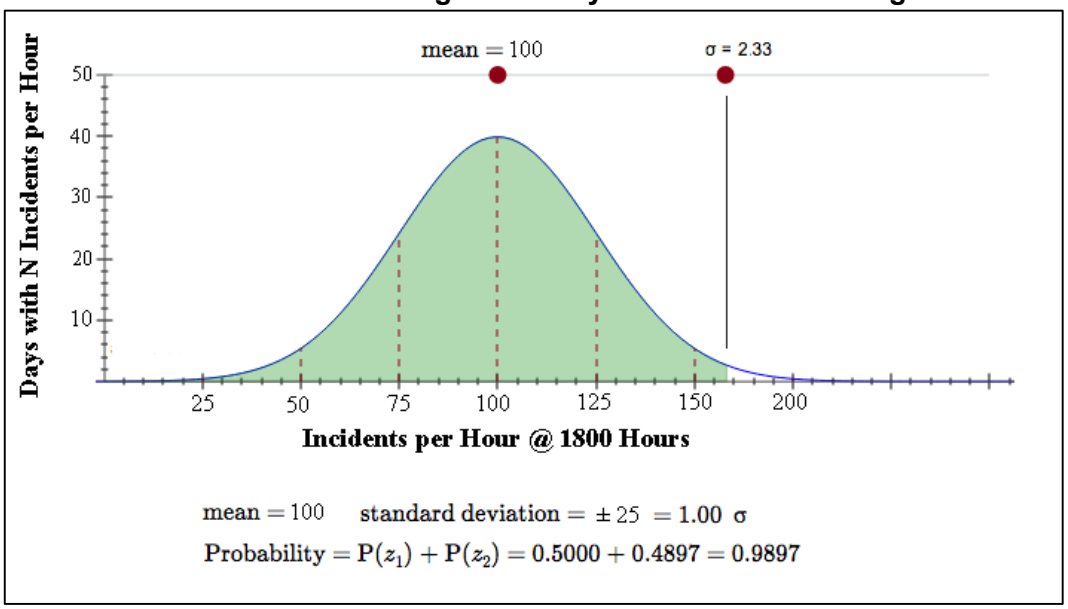
Figure 2. Normal Distribution Showing a One Day in Ten Surge.



The green area now comprises 90% of the area under the normal curve. In the context of a dispatch center, the green area means that nine days in ten there will be 132 incidents, or fewer, in the 1800 hour. Conversely, one day in ten there will be 132 incidents, or more, in the 1800 hour.

In Figure 3, below, the green area has been extended further right to [average + 2.33 σ] or 158 incidents per hour. The green area now comprises 99% of the area under the normal curve. In the context of a dispatch center, the green area now means the ninety-nine days out of one hundred there will be 158 incidents, or fewer, in the 1800 hour. On one day out of one hundred, there will be 158 incidents, or more, in the 1800 hour.

Figure 3. Normal Distribution Showing a One Day in One Hundred Surge.

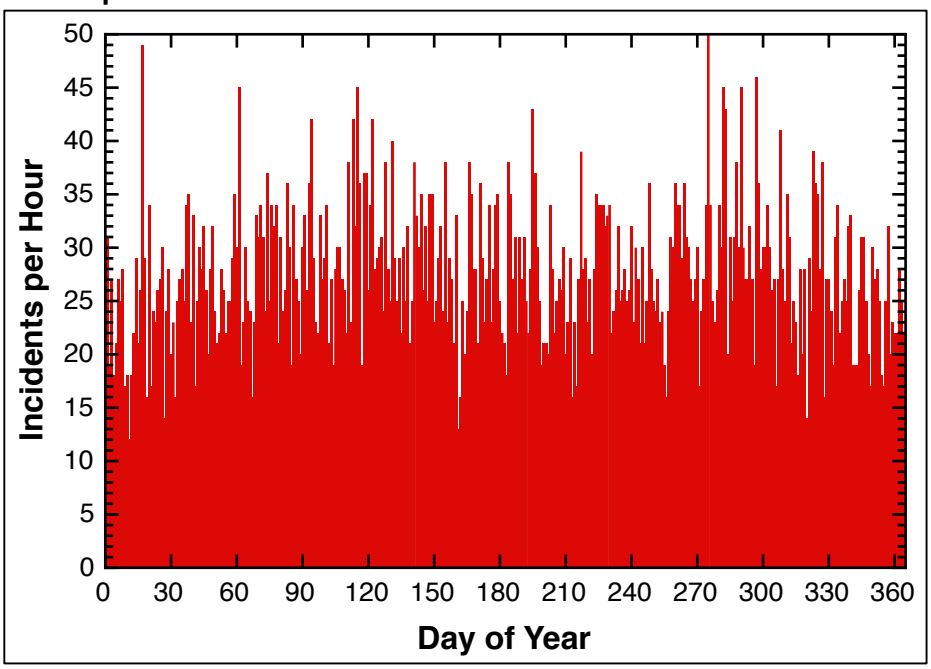


The preceding discussion shows the usefulness of the standard deviation to answer questions of surges in dispatch systems. Once a collection of random incident counts has been converted to an average and a standard deviation, it becomes possible to conveniently extract the frequency and sizes of surges from the original set of data, at least in theory.

Real Example

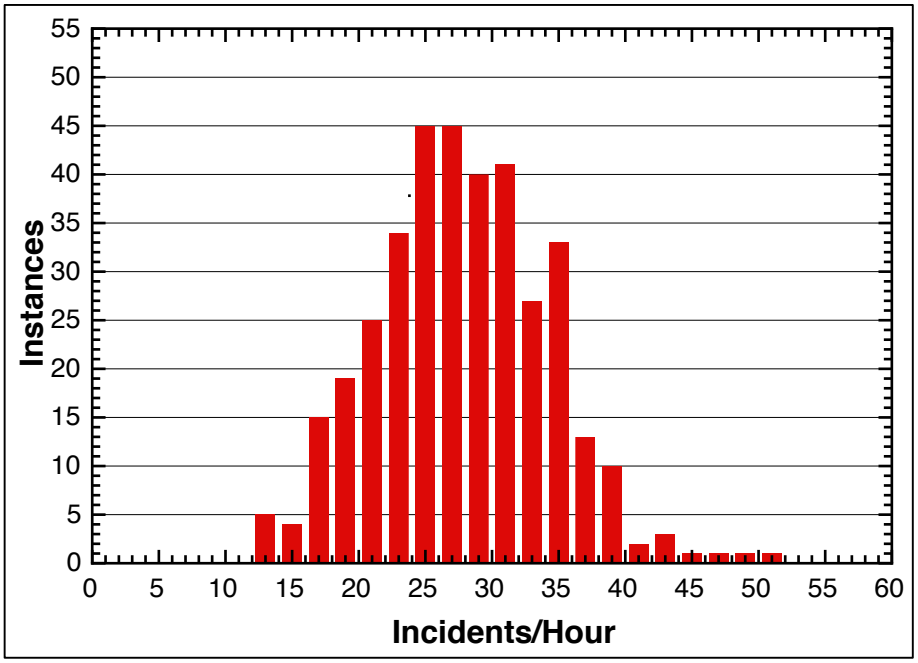
Figure 4, below, presents the number of incidents per hour experienced at a large metropolitan dispatch center at 1600 hours. One year's worth of data is included in the histogram. As can be seen, the day-to-day variability is substantial with a minimum of 12 incidents per hour to a maximum of 50 incidents per hour.

Figure 4. Incident per Hour at 1600 Hours



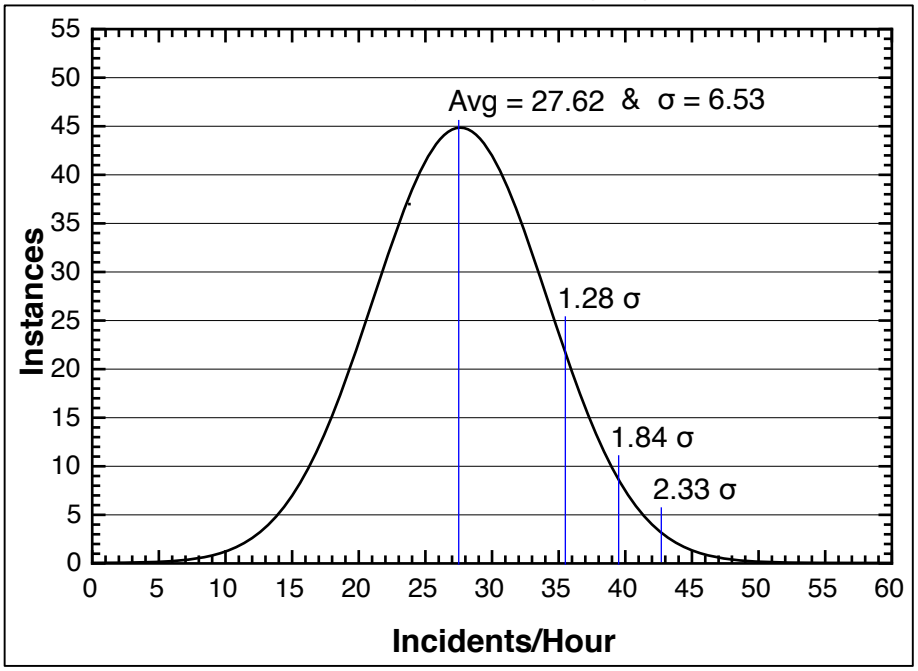
The data in Figure 4 was then consolidated into Figure 5. The process of this consolidation is referred to as "binning". All of the instances where 12 or 13 incidents per hour occurred were counted and the total placed in a "bin" labelled 12-13, and so forth. The outcome of this binning process results in the distribution presented in Figure 5, below. As can be seen, the envelope, or shape, of the distribution of incidents per hour derived from the real data is not as smooth as the distributions treated in the theoretical section above.

Figure 5. Distribution of Incidents per Hour



Numerical methods were next used to calculate the normal distribution curve that most closely follows the contour of the real distribution. The calculated normal distribution is presented in Figure 6, below. Three specific surge limits are specified in Figure 6. The values of these

Figure 6. Normal Distribution Most Closely Conforming Figure 5.



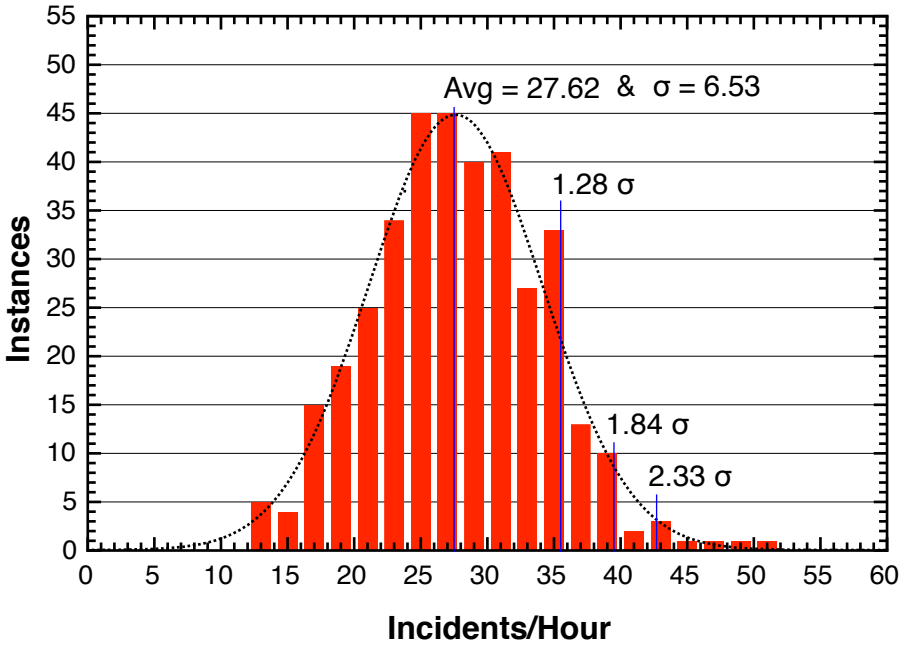
surge limits are presented in Table 1, below. The surge limits may also be discussed in terms of the percentile contributions to the area under the normal curve.

Table 1. Surge Limits Derived from Figure 6.

Frequency	Offset [σ]	Incidents per Hour			%-tile
		Average	Increment	Total	
One Day in 2	0.00 σ	27.62	0.00	27.62	50th
One Day in 10	+1.28 σ	27.62	8.36	35.98	90th
One Day in 30	+1.84 σ	27.62	12.02	39.64	97th
One Day in 100	+2.33 σ	27.62	15.21	42.83	99th

In Figure 7, the calculated normal distribution overlays the distribution of real data.

Figure 7. Comparison of the Real Distribution to a Normal Curve.



As 'lumpy" as the real distribution may appear, it is a respectable approximation of a precisely calculated normal curve. Surges calculated using the theoretical methods described in this section are a good approximation of reality.

Attachment I

Erlang Tables of Workloads

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Attachment I. Erlang Tables of Workstations

Table 1, below, provides an index of Erlang Tables that describe the performance of the workstations comprising the three models of dispatch operations considered in this report.

Table 1. Index to Erlang Tables and Models of Dispatch Operations

Figure	Workstation	Option		
		0	1	2
01#	Central Intake	X		
02#	North Intake	X		
03#	South Intake	X		
04#	Consolidated Intake		X	X
05#	Central LAW Assign & Radio @ 1.00 Traffic	X	X	X
06#	Central FIRE Assign & Radio @ 1.00 Traffic	X	X	
07#	North LAW Assign & Radio @ 1.00 Traffic	X	X	X
08#	North FIRE Assign & Radio @ 1.00 Traffic	X	X	
09#	South LAW Assign & Radio @ 1.00 Traffic	X	X	X
10#	South FIRE Assign & Radio @ 1.00 Traffic	X	X	
11#	Consolidated LAW Assign & Radio @ 1.00 Traffic			
12#	Consolidated FIRE Assign & Radio @ 1.00 Traffic			
13#	Consolidated LAW Assign & Radio @ 0.60 Traffic			
14#	Consolidated FIRE Assign & Radio @ 0.60 Traffic			
15#	Consolidated FIRE Gatekeeper			X
16#	Consolidated FR msr Radio			X
17#	Consolidated FR ssr Radio @ 0.60 Traffic			X

As indicated by the grey cells in Table 1, above, various workstations appear in more than one of the Options for the conduct of dispatch operations.

In all of the Erlang tables below, the empirical adjustments of dispatcher Hours-OnTask by hour-of-day occurred in two stages. First, a workload surge experienced one day in ten, +1.28σ, was added to all hour-of-day. The number of dispatcher OnDuty by hour of day were adjusted so that the calculated latencies conformed to the FITCH operational targets. This number of dispatcher OnDuty by hour-of-day was retained, but the workloads were returned to their average values, +0.00σ. The statistics describing answer delays and probabilities of immediate answer reflect this design process in all models. The end result is a judicious "over-staffing" at all workstations.

Stakeholder may decide that other surge levels and latencies should be built into the models. This certainly could be done. The value of these models is that they demonstrate a process that makes a quantitative connection between manpower deployed and the performance to be expected.

Table 2. Central Intake Workstation

Year	Dispatch Model	Workstation Name	Surge
2015	Option 0 (Current Ops)	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	8	97.48	1.59
	01:00	50.96	18.09	10.82	2.498	7	97.33	1.94
	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	5	96.44	3.59
	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	7	93.69	4.57
	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	9	93.93	3.63
	10:00	101.73	50.92	24.38	4.728	9	92.14	5.14
	11:00	111.80	53.43	25.27	4.996	10	93.71	3.45
	12:00	117.60	52.01	24.84	5.183	10	93.11	3.99
	13:00	124.32	52.59	26.26	5.166	10	93.16	3.76
	14:00	130.46	53.97	27.55	5.292	10	92.80	3.99
	15:00	132.68	57.75	26.02	5.559	10	92.16	4.75
	16:00	132.88	50.15	27.24	5.316	10	92.74	4.10
	17:00	138.77	50.67	25.07	5.579	10	92.11	4.86
	18:00	145.08	50.77	24.22	6.012	12	94.88	2.44
	19:00	125.20	42.35	22.22	5.047	11	95.86	1.93
	20:00	110.58	33.78	21.36	4.535	9	92.82	4.60
	21:00	102.88	29.71	19.54	4.166	9	94.40	3.32
	22:00	90.15	28.55	17.21	3.885	8	92.64	5.35
	23:00	75.87	28.37	15.95	3.613	8	94.08	4.24
		Hourly Averages			Average Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
		911	ADM	Out				
		90.86	35.49	18.63	3.953	204	93.99	3.67

Surge tested to +1.28 std dev at all hours of day.

Table 3. North Intake Workstation

Year	Dispatch Model	Workstation Name	Surge
2015	Option 0 (Current Ops)	North 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	20.34	22.24	5.65	1.616	5	96.58	3.54
	01:00	15.26	15.63	4.67	1.216	4	95.73	5.49
	02:00	13.36	12.88	3.59	1.008	4	97.66	2.77
	03:00	11.57	13.50	3.14	0.974	4	97.91	2.49
	04:00	9.73	11.72	2.86	0.913	4	98.32	2.14
	05:00	10.29	11.83	3.87	0.965	4	97.97	2.59
	06:00	14.35	17.40	5.08	1.148	4	96.42	4.10
	07:00	23.18	26.53	8.08	1.701	5	95.87	3.85
	08:00	28.24	38.89	10.57	2.316	6	95.12	4.13
	09:00	31.57	45.16	10.80	2.607	6	92.77	6.64
	10:00	35.55	48.27	10.78	2.840	6	90.92	9.02
	11:00	36.23	49.82	11.05	2.926	7	94.70	4.10
	12:00	42.50	49.70	11.68	3.012	7	94.12	4.47
	13:00	40.59	49.96	11.11	3.002	7	94.19	4.49
	14:00	42.43	55.02	12.16	3.203	7	92.85	5.75
	15:00	43.42	54.48	13.16	3.194	7	92.91	5.61
	16:00	43.01	56.58	12.97	3.262	7	92.47	6.11
	17:00	44.38	53.46	11.21	3.132	7	93.32	5.19
	18:00	47.72	54.89	11.87	3.334	7	92.02	6.63
	19:00	40.51	46.61	11.35	2.948	7	94.55	4.21
	20:00	34.42	40.75	9.80	2.726	7	96.01	3.14
	21:00	32.54	36.67	9.32	2.383	6	94.59	4.74
	22:00	28.25	32.49	8.28	2.213	6	95.90	3.63
	23:00	24.20	25.55	6.99	1.882	5	94.19	6.46
		Hourly Averages			Average Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
		911	ADM	Out				
		29.74	36.25	8.75	2.272	139	94.16	5.03

Surge tested to +1.28 std dev at all hours of day.

Table 4. South Intake Workstation

Year	Dispatch Model	Workstation Name	Surge
2015	Option 0 (Current Ops)	South 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	22.39	19.40	8.25	1.647	5	96.33	3.77
	01:00	16.25	16.48	6.57	1.301	4	94.77	6.72
	02:00	13.98	12.10	5.29	1.087	4	97.00	3.73
	03:00	12.15	8.41	4.17	0.852	4	98.68	1.51
	04:00	10.63	8.30	4.17	0.788	4	98.99	1.12
	05:00	11.89	9.49	4.08	0.859	4	98.64	1.53
	06:00	13.61	15.03	4.38	1.028	4	97.49	2.75
	07:00	22.58	27.23	8.36	1.703	5	95.85	3.85
	08:00	29.63	37.30	10.16	2.278	6	95.41	3.81
	09:00	34.18	43.79	12.02	2.674	7	96.33	2.64
	10:00	38.71	46.42	13.61	2.808	7	95.48	3.21
	11:00	42.59	45.10	14.93	2.920	7	94.74	3.84
	12:00	47.84	51.37	15.55	3.227	8	96.23	2.32
	13:00	47.71	50.65	15.96	3.236	8	96.18	2.37
	14:00	47.96	51.25	16.16	3.208	8	96.34	2.22
	15:00	47.93	44.38	18.38	3.164	8	96.57	2.12
	16:00	49.25	48.36	18.20	3.461	8	94.93	3.49
	17:00	50.08	46.90	17.38	3.532	8	94.53	3.95
	18:00	51.12	45.18	16.10	3.597	8	94.17	4.44
	19:00	44.50	37.23	15.04	3.107	8	96.86	2.15
	20:00	39.40	31.98	14.21	2.741	7	95.91	3.22
	21:00	36.86	29.79	12.84	2.637	7	96.55	2.74
	22:00	30.17	26.77	10.33	2.210	6	95.92	3.70
	23:00	26.02	22.99	9.75	1.800	5	94.98	5.03
		Hourly Averages			Average Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
		911	ADM	Out				
		32.81	32.33	11.50	2.328	150	95.86	3.19

Surge tested to +1.28 std dev at all hours of day.

Table 5. Consolidated Intake

Year	Dispatch Model	Workstation Name	Surge
2015	Option 1, & 2	Consolidated Intake	+ 0.00 σ

Surge	Hour of Day	Hourly Averages				Workstation Staffing & Performance		
		911	ADM	Out	Σ Erlangs	OnTask	Immediate Answer [%]	Ans Delay @ 50 %-tile [sec]
	00:00	106.49	63.01	27.38	6.240	11	92.63	1.77
	01:00	82.47	50.20	22.05	5.015	10	93.65	1.49
	02:00	67.84	39.10	17.38	4.208	9	94.20	1.47
	03:00	58.64	34.59	14.78	3.702	8	93.59	1.84
	04:00	51.90	31.90	13.91	3.335	7	92.02	2.67
	05:00	53.59	32.85	14.76	3.503	7	91.04	3.19
	06:00	70.01	49.67	18.33	4.105	8	91.63	2.30
	07:00	113.82	83.33	32.10	6.480	10	90.87	2.64
	08:00	142.84	113.22	40.11	8.343	12	92.06	2.20
	09:00	158.14	132.11	44.84	9.549	14	93.21	1.56
	10:00	175.99	145.62	48.77	10.375	14	93.04	1.94
	11:00	190.62	148.35	51.26	10.842	15	93.53	1.56
	12:00	207.93	153.08	52.08	11.423	15	93.46	1.82
	13:00	212.61	153.20	53.33	11.405	15	93.47	1.78
	14:00	220.85	160.24	55.88	11.703	16	93.91	1.37
	15:00	224.04	156.61	57.57	11.917	16	93.89	1.47
	16:00	225.14	155.09	58.40	12.040	16	93.88	1.53
	17:00	233.23	151.03	53.65	12.243	17	94.29	1.21
	18:00	243.91	150.85	52.18	12.943	16	93.82	2.11
	19:00	210.21	126.18	48.61	11.102	15	93.50	1.73
	20:00	184.40	106.51	45.37	10.002	14	93.10	1.85
	21:00	172.28	96.17	41.70	9.185	13	92.61	2.06
	22:00	148.58	87.82	35.82	8.308	12	92.07	2.36
	23:00	126.09	76.91	32.68	7.295	11	91.55	2.54
		Hourly Averages			Average Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
		911	ADM	Out				
		153.40	104.07	38.87	8.553	301	93.18	1.83

Surge tested to +1.28 std dev at all hour of day.

Table 6. Central LAW Assign & Radio

Year	Dispatch Model	Workstation Name	Surge
2015	Option 0, 1, & 2	Central LAW Assign & Radio	+ 0.00 σ

Surge	Hour of Day	Hourly Averages				Workstation Staffing & Performance		
			LAW	Radio	Σ Erlangs	OnTask	Immediate Answer [%]	Ans Delay @ 95 %-tile [sec]
	00:00		32.01	314.60	1.411	3	83.61	4.39
	01:00		26.53	259.68	1.143	3	88.73	2.53
	02:00		21.47	203.74	0.909	3	93.06	1.40
	03:00		19.16	189.70	0.823	3	94.47	1.05
	04:00		17.02	174.25	0.758	2	82.77	5.75
	05:00		15.54	153.27	0.701	2	84.62	5.14
	06:00		18.85	181.63	0.845	3	94.13	1.20
	07:00		33.65	322.58	1.485	3	82.27	5.10
	08:00		44.04	416.34	1.930	4	86.57	2.84
	09:00		49.98	474.74	2.192	4	83.56	3.98
	10:00		53.35	508.71	2.321	4	82.28	4.56
	11:00		55.76	527.47	2.454	4	81.13	5.37
	12:00		55.66	530.95	2.461	4	81.07	5.40
	13:00		57.05	551.44	2.518	4	80.62	5.66
	14:00		58.41	560.91	2.576	5	87.43	2.26
	15:00		60.35	584.99	2.717	5	86.31	2.64
	16:00		59.56	575.07	2.671	5	86.66	2.52
	17:00		59.28	579.27	2.710	5	86.37	2.64
	18:00		58.52	563.94	2.662	5	86.73	2.54
	19:00		54.59	523.74	2.464	5	88.40	2.04
	20:00		47.87	451.34	2.095	4	84.61	3.54
	21:00		45.40	426.37	1.959	4	86.21	2.93
	22:00		42.43	398.92	1.851	4	87.58	2.54
	23:00		37.00	353.00	1.621	4	90.64	1.71

	Hourly Averages			Average Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
		LAW	Radio				
	0.00	42.64	409.44	1.887	92	85.65	3.37

Surge tested to +1.28 std dev at all hours of day.

Table 7. Central FIRE Assign & Radio

Year	Dispatch Model	Workstation Name	Surge
2015	Option 0 & 1	Central FIRE Assign & Radio	+ 0.00 σ

Surge	Hour of Day	Hourly Averages				Workstation Staffing & Performance		
		FIRE		Radio	Σ Erlangs	OnTask	Immediate Answer [%]	Ans Delay @ 50 %-tile [sec]
	00:00	9.96		108.57	0.287	2	96.52	0.18
	01:00	8.84		96.56	0.255	1	74.55	2.97
	02:00	8.05		87.74	0.232	1	76.80	2.63
	03:00	7.44		81.15	0.214	1	78.60	2.37
	04:00	6.93		75.51	0.199	1	80.15	2.15
	05:00	7.32		79.99	0.211	1	78.86	2.34
	06:00	8.69		94.39	0.252	1	74.78	2.97
	07:00	11.85		129.07	0.342	2	95.23	0.25
	08:00	15.00		163.64	0.436	2	92.77	0.41
	09:00	17.14		186.62	0.497	2	90.99	0.53
	10:00	18.79		204.97	0.547	2	89.50	0.64
	11:00	18.73		204.29	0.546	2	89.52	0.64
	12:00	19.01		207.54	0.555	2	89.25	0.66
	13:00	18.72		204.27	0.547	2	89.48	0.64
	14:00	18.55		202.36	0.544	2	89.59	0.63
	15:00	19.14		208.99	0.568	2	88.85	0.70
	16:00	18.37		200.30	0.543	2	89.62	0.64
	17:00	18.72		204.37	0.555	2	89.25	0.67
	18:00	18.57		202.47	0.550	2	89.41	0.65
	19:00	16.96		185.08	0.502	2	90.85	0.55
	20:00	16.31		178.08	0.479	2	91.52	0.49
	21:00	15.45		168.45	0.454	2	92.26	0.44
	22:00	13.93		152.07	0.408	2	93.53	0.36
	23:00	11.96		130.68	0.347	2	95.13	0.26

Hourly Averages			Average Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
FIRE		Radio				
14.35	0.00	156.55	0.419	42	89.00	0.83

Surge tested to +1.28 std dev at all hour of day.

Table 7. North LAW Assign & Radio

Year	Dispatch Model	Workstation Name	Surge
2015	Option 0, 1, & 2	North LAW Assign & Radio	+ 0.00 σ

Surge	Hour of Day	Hourly Averages				Workstation Staffing & Performance		
			LAW	Radio	Σ Erlangs	OnTask	Immediate Answer [%]	Ans Delay @ 95 %-tile [sec]
	00:00		15.30	173.22	0.675	2	85.44	4.12
	01:00		12.06	136.58	0.516	2	90.44	2.34
	02:00		9.51	108.15	0.413	2	93.39	1.53
	03:00		7.92	90.33	0.338	2	95.35	1.01
	04:00		6.75	76.74	0.290	2	96.47	0.75
	05:00		6.89	78.57	0.313	2	95.94	0.92
	06:00		9.05	103.00	0.421	2	93.18	1.70
	07:00		15.44	174.54	0.709	2	84.36	4.72
	08:00		20.16	227.72	0.939	4	98.15	0.24
	09:00		22.16	250.42	1.039	3	90.70	1.89
	10:00		23.55	266.36	1.111	3	89.34	2.26
	11:00		24.76	280.08	1.179	3	88.03	2.66
	12:00		26.06	294.86	1.257	4	95.27	0.71
	13:00		25.46	287.74	1.222	3	87.20	2.94
	14:00		26.15	295.62	1.260	3	86.48	3.18
	15:00		27.37	309.37	1.309	3	85.53	3.48
	16:00		27.25	308.29	1.316	3	85.40	3.56
	17:00		28.11	318.32	1.384	3	84.11	4.11
	18:00		27.95	315.92	1.366	3	84.45	3.96
	19:00		25.49	288.02	1.202	3	87.60	2.77
	20:00		23.36	264.39	1.087	3	89.79	2.11
	21:00		21.64	245.19	1.000	3	91.42	1.68
	22:00		20.11	227.73	0.923	3	92.81	1.35
	23:00		18.02	204.19	0.803	2	81.31	5.90

Hourly Averages			Average Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
	LAW	Radio				
0.00	19.60	221.89	0.920	65	88.77	2.69

Surge tested to +1.28 std dev at all hours of day.

Table 8. North FIRE Assign & Radio

Year	Dispatch Model	Workstation Name	Surge
2015	Option 0 & 1	North FIRE Assign & Radio	+ 0.00 σ

Surge	Hour of Day	Hourly Averages				Workstation Staffing & Performance		
		FIRE		Radio	Σ Erlangs	OnTask	Immediate Answer [%]	Ans Delay @ 95 %-tile [sec]
	00:00	4.65		55.14	0.142	1	85.78	4.12
	01:00	4.12		48.84	0.125	1	87.49	3.53
	02:00	3.61		42.77	0.110	1	88.99	3.07
	03:00	3.52		41.69	0.108	1	89.22	3.02
	04:00	3.34		39.55	0.103	1	89.68	2.89
	05:00	3.53		41.87	0.109	1	89.14	3.05
	06:00	4.19		49.70	0.129	1	87.13	3.69
	07:00	5.96		70.65	0.178	1	82.19	5.27
	08:00	7.51		88.98	0.225	1	77.49	7.09
	09:00	7.94		94.08	0.239	1	76.08	7.71
	10:00	8.51		100.92	0.257	2	97.15	0.40
	11:00	8.45		100.13	0.256	2	97.17	0.40
	12:00	8.48		100.51	0.256	2	97.17	0.40
	13:00	8.90		105.50	0.270	2	96.89	0.44
	14:00	8.60		101.99	0.262	2	97.05	0.42
	15:00	8.43		99.97	0.254	2	97.21	0.39
	16:00	8.50		100.84	0.256	2	97.17	0.40
	17:00	8.39		99.46	0.254	2	97.22	0.39
	18:00	8.42		99.86	0.255	2	97.20	0.39
	19:00	7.70		91.33	0.232	2	97.65	0.33
	20:00	7.31		86.72	0.219	1	78.08	6.84
	21:00	6.73		79.84	0.202	1	79.75	6.21
	22:00	6.08		72.14	0.182	1	81.76	5.44
	23:00	5.40		64.05	0.166	1	83.45	4.94
		Hourly Averages			Average Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
		FIRE		Radio				
		6.59	0.00	78.19	0.200	34	90.39	2.67

Surge tested to +1.28 std dev at all hours of day.

Table 9. South LAW Assign & Radio

Year	Dispatch Model	Workstation Name	Surge
2015	Option 0, 1, & 2	South LAW Assign & Radio	+ 0.00 σ

Surge	Hour of Day	Hourly Averages				Workstation Staffing & Performance		
			LAW	Radio	Σ Erlangs	OnTask	Immediate Answer [%]	Ans Delay @ 95 %-tile [sec]
	00:00		26.39	245.61	1.014	3	91.17	1.74
	01:00		21.63	201.45	0.787	2	81.81	5.53
	02:00		17.39	160.85	0.620	2	87.21	3.37
	03:00		14.94	138.95	0.526	2	90.13	2.39
	04:00		12.71	116.90	0.449	2	92.38	1.78
	05:00		11.94	111.15	0.431	2	92.89	1.66
	06:00		14.22	133.58	0.545	2	89.55	2.77
	07:00		25.04	240.12	1.011	3	91.22	1.76
	08:00		33.46	317.68	1.352	3	84.71	3.74
	09:00		36.69	345.86	1.502	4	92.24	1.28
	10:00		39.88	376.05	1.651	4	90.24	1.73
	11:00		42.24	399.05	1.783	4	88.46	2.20
	12:00		42.68	402.38	1.826	4	87.90	2.39
	13:00		43.35	409.80	1.846	4	87.64	2.45
	14:00		44.33	421.44	1.924	4	86.65	2.78
	15:00		46.65	438.81	1.993	4	85.80	3.04
	16:00		45.34	426.75	1.927	4	86.60	2.76
	17:00		45.08	422.01	1.937	4	86.48	2.84
	18:00		44.38	418.72	1.900	4	86.95	2.67
	19:00		41.41	393.42	1.722	4	89.28	1.95
	20:00		37.53	356.79	1.537	4	91.78	1.36
	21:00		33.47	315.73	1.382	3	84.15	4.05
	22:00		30.75	288.85	1.259	3	86.50	3.19
	23:00		28.82	266.46	1.147	3	88.65	2.49

Hourly Averages			Average Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
	LAW	Radio				
0.00	32.51	306.18	1.336	78	88.02	2.56

Surge tested to +1.28 std dev at all hours of day.

Table 10. South FIRE Assign & Radio

Year	Dispatch Model	Workstation Name	Surge
2015	Option 0 & 1	South Assign FIRE & Radio	+ 0.00 σ

Surge	Hour of Day	Hourly Averages				Workstation Staffing & Performance		
		FIRE		Radio	Σ Erlangs	OnTask	Immediate Answer [%]	Ans Delay @ 95 %-tile [sec]
	00:00	6.22		75.52	0.209	1	79.08	7.08
	01:00	5.37		65.31	0.182	1	81.83	5.97
	02:00	4.61		55.86	0.155	1	84.52	4.91
	03:00	4.51		54.93	0.153	1	84.75	4.83
	04:00	4.28		51.72	0.144	1	85.62	4.51
	05:00	4.56		55.64	0.156	1	84.38	5.02
	06:00	5.38		65.62	0.182	1	81.76	6.00
	07:00	7.33		88.66	0.246	2	97.38	0.40
	08:00	9.86		119.78	0.334	2	95.44	0.74
	09:00	11.31		137.54	0.385	2	94.15	0.98
	10:00	11.95		145.27	0.408	2	93.54	1.10
	11:00	12.32		149.49	0.415	2	93.33	1.13
	12:00	13.10		159.31	0.445	2	92.52	1.30
	13:00	12.52		151.67	0.423	2	93.12	1.18
	14:00	12.79		155.40	0.435	2	92.79	1.25
	15:00	12.47		151.53	0.420	2	93.19	1.16
	16:00	11.97		145.35	0.403	2	93.67	1.06
	17:00	11.90		144.45	0.400	2	93.75	1.05
	18:00	11.75		142.23	0.395	2	93.88	1.02
	19:00	10.85		131.82	0.365	2	94.66	0.87
	20:00	10.27		124.43	0.344	2	95.19	0.78
	21:00	9.14		111.09	0.307	2	96.07	0.62
	22:00	8.26		99.93	0.276	2	96.75	0.50
	23:00	7.10		86.25	0.239	1	76.14	8.38
		Hourly Averages			Average Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
		FIRE		Radio				
		9.16	0.00	111.20	0.309	40	91.76	1.95

Surge tested to +1.28 std dev at all hours of day.

Table 11. Consolidated LAW Assign & Radio @ 1.00 Traffic

Year	Dispatch Model	Workstation Name	Surge
2015		Consolidated LAW Assign & Radio	+ 0.00 σ

Surge	Hour of Day	Hourly Averages				Workstation Staffing & Performance		
			LAW	Radio	Σ Erlangs	OnTask	Immediate Answer [%]	Ans Delay @ 50 %-tile [sec]
	00:00		73.70	733.43	3.101	5	83.94	1.17
	01:00		60.22	597.71	2.446	5	88.57	0.60
	02:00		48.37	472.74	1.942	4	86.42	0.89
	03:00		42.02	418.99	1.687	4	89.75	0.58
	04:00		36.47	367.89	1.496	3	82.06	1.59
	05:00		34.37	342.99	1.445	3	82.99	1.51
	06:00		42.12	418.20	1.811	4	88.10	0.77
	07:00		74.13	737.24	3.205	5	83.45	1.31
	08:00		97.66	961.75	4.221	6	84.84	1.22
	09:00		108.83	1071.02	4.734	7	87.05	0.83
	10:00		116.78	1151.12	5.083	7	86.60	1.01
	11:00		122.76	1206.60	5.416	7	86.31	1.27
	12:00		124.40	1228.20	5.544	7	86.22	1.40
	13:00		125.87	1248.98	5.586	8	88.34	0.71
	14:00		128.89	1277.98	5.760	8	88.20	0.78
	15:00		134.37	1333.18	6.020	8	88.03	0.89
	16:00		132.15	1310.11	5.915	8	88.09	0.84
	17:00		132.47	1319.60	6.032	8	88.02	0.91
	18:00		130.85	1298.59	5.929	9	89.83	0.49
	19:00		121.48	1205.18	5.388	7	86.33	1.24
	20:00		108.77	1072.51	4.719	7	87.07	0.81
	21:00		100.51	987.29	4.341	6	84.63	1.33
	22:00		93.28	915.50	4.032	6	85.25	1.08
	23:00		83.85	823.65	3.571	6	86.69	0.78

Hourly Averages			Average Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
	LAW	Radio				
0.00	94.76	937.52	4.143	148	86.82	0.98

Surge tested to +1.28 std dev at all hours of day.

Table 12. Consolidated FIRE Assign & Radio @ 1.00 Traffic

Year	Dispatch Model	Workstation Name	Surge
2015		Consolidated FIRE Assign & Radio	+ 0.00 σ

Surge	Hour of Day	Hourly Averages				Workstation Staffing & Performance		
		FIRE		Radio	Σ Erlangs	OnTask	Immediate Answer [%]	Ans Delay @ 95 %-tile [sec]
	00:00	20.83		239.23	0.639	2	86.61	2.53
	01:00	18.33		210.71	0.561	2	89.05	1.95
	02:00	16.27		186.37	0.497	2	91.00	1.54
	03:00	15.46		177.77	0.474	2	91.67	1.40
	04:00	14.55		166.78	0.445	2	92.50	1.24
	05:00	15.42		177.50	0.476	2	91.61	1.42
	06:00	18.27		209.71	0.563	2	88.98	1.98
	07:00	25.14		288.38	0.766	2	82.49	3.63
	08:00	32.36		372.40	0.995	3	91.52	1.09
	09:00	36.38		418.24	1.121	3	89.14	1.49
	10:00	39.25		451.17	1.212	3	87.40	1.82
	11:00	39.49		453.91	1.218	3	87.29	1.84
	12:00	40.59		467.36	1.255	3	86.56	1.99
	13:00	40.14		461.44	1.240	3	86.85	1.93
	14:00	39.95		459.75	1.241	3	86.83	1.94
	15:00	40.04		460.49	1.243	3	86.81	1.95
	16:00	38.84		446.49	1.202	3	87.59	1.79
	17:00	39.01		448.27	1.209	3	87.46	1.82
	18:00	38.74		444.56	1.199	3	87.64	1.78
	19:00	35.51		408.23	1.099	3	89.57	1.42
	20:00	33.90		389.23	1.042	3	90.64	1.23
	21:00	31.33		359.38	0.963	3	92.10	1.00
	22:00	28.27		324.15	0.867	2	79.23	4.72
	23:00	24.47		280.99	0.751	2	83.00	3.50
					Average Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
		FIRE		Radio				
		30.10	0.00	345.94	0.928	62	87.80	1.94

Surge tested to +1.28 std dev at all hours of day.

Table 13. Consolidated LAW Assign & Radio @ 0.60 Traffic

Year	Dispatch Model	Workstation Name	Surge
2015		Consolidated LAW Assign rRadio	+ 0.00 σ

Surge	Hour of Day	Hourly Averages				Workstation Staffing & Performance		
			LAW	Radio	Σ Erlangs	OnTask	Immediate Answer [%]	Ans Delay @ 95 %-tile [sec]
	00:00		73.70	440.06	2.344	5	89.53	1.88
	01:00		60.22	358.62	1.829	5	94.70	0.76
	02:00		48.37	283.64	1.454	4	92.87	1.28
	03:00		42.02	251.39	1.255	4	95.30	0.77
	04:00		36.47	220.73	1.117	3	89.23	2.60
	05:00		34.37	205.79	1.091	3	89.71	2.56
	06:00		42.12	250.92	1.380	3	84.18	4.81
	07:00		74.13	442.34	2.449	5	88.54	2.23
	08:00		97.66	577.05	3.234	6	88.31	2.12
	09:00		108.83	642.61	3.633	6	86.45	2.90
	10:00		116.78	690.67	3.900	6	85.58	3.47
	11:00		122.76	723.96	4.176	6	84.93	4.26
	12:00		124.40	736.92	4.281	6	84.73	4.62
	13:00		125.87	749.39	4.302	6	84.69	4.64
	14:00		128.89	766.79	4.448	7	87.57	2.53
	15:00		134.37	799.91	4.648	7	87.19	2.84
	16:00		132.15	786.07	4.568	7	87.33	2.71
	17:00		132.47	791.76	4.675	7	87.15	2.93
	18:00		130.85	779.15	4.594	7	87.29	2.79
	19:00		121.48	723.11	4.149	6	84.99	4.17
	20:00		108.77	643.51	3.616	6	86.51	2.85
	21:00		100.51	592.37	3.326	6	87.81	2.29
	22:00		93.28	549.30	3.091	5	83.99	4.22
	23:00		83.85	494.19	2.721	5	86.29	2.96

Hourly Averages			Average Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
	LAW	Radio				
0.00	94.76	562.51	3.178	131	87.08	3.05

Surge tested to +1.28 std dev at all hours of day.

Table 14. Consolidated FIRE Assign & Radio @ 0.60 Traffic

Year	Dispatch Model	Workstation Name	Surge
2015		Consolidated FIRE Assign rRadio	+ 0.00 σ

Surge	Hour of Day	Hourly Averages				Workstation Staffing & Performance		
		FIRE		Radio	Σ Erlangs	OnTask	Immediate Answer [%]	Ans Delay @ 95 %-tile [sec]
	00:00	20.83		143.54	0.413	2	93.41	1.09
	01:00	18.33		126.43	0.363	2	94.73	0.84
	02:00	16.27		111.82	0.321	2	95.74	0.67
	03:00	15.46		106.66	0.307	2	96.08	0.61
	04:00	14.55		100.07	0.288	2	96.50	0.54
	05:00	15.42		106.50	0.308	2	96.04	0.62
	06:00	18.27		125.82	0.365	2	94.67	0.86
	07:00	25.14		173.03	0.494	2	91.09	1.54
	08:00	32.36		223.44	0.643	2	86.49	2.62
	09:00	36.38		250.95	0.726	2	83.81	3.36
	10:00	39.25		270.70	0.785	2	81.88	3.95
	11:00	39.49		272.35	0.788	2	81.78	3.97
	12:00	40.59		280.42	0.813	2	80.98	4.24
	13:00	40.14		276.87	0.804	2	81.28	4.15
	14:00	39.95		275.85	0.806	2	81.20	4.20
	15:00	40.04		276.29	0.807	2	81.18	4.21
	16:00	38.84		267.89	0.780	2	82.05	3.91
	17:00	39.01		268.96	0.785	2	81.88	3.98
	18:00	38.74		266.74	0.779	2	82.07	3.92
	19:00	35.51		244.94	0.713	2	84.21	3.26
	20:00	33.90		233.54	0.675	2	85.46	2.89
	21:00	31.33		215.63	0.624	2	87.08	2.48
	22:00	28.27		194.49	0.561	2	89.07	2.00
	23:00	24.47		168.59	0.486	2	91.33	1.51
					Average Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
		FIRE		Radio				
		30.10	0.00	207.56	0.601	48	85.66	3.00

Surge tested to +1.28 std dev at all hours of day.

Table 15. Consolidated FIRE Gatekeeper

Year	Dispatch Model	Workstation Name	Surge
2015	Option 2	Gatekeeper FIRE	+ 0.00 σ

Surge	Hour of Day	Hourly Averages				Workstation Staffing & Performance		
		FIRE			Σ Erlangs	OnTask	Immediate Answer [%]	Ans Delay @ 95 %-tile [sec]
	00:00	20.83			0.095	1	90.45	5.06
	01:00	18.33			0.084	1	91.60	4.40
	02:00	16.27			0.075	1	92.54	3.86
	03:00	15.46			0.071	1	92.91	3.66
	04:00	14.55			0.067	1	93.33	3.42
	05:00	15.42			0.071	1	92.93	3.65
	06:00	18.27			0.084	1	91.63	4.38
	07:00	25.14			0.115	1	88.48	6.24
	08:00	32.36			0.148	2	98.99	0.26
	09:00	36.38			0.167	2	98.73	0.33
	10:00	39.25			0.180	2	98.54	0.39
	11:00	39.49			0.181	2	98.52	0.39
	12:00	40.59			0.186	2	98.44	0.41
	13:00	40.14			0.184	2	98.47	0.40
	14:00	39.95			0.183	2	98.49	0.40
	15:00	40.04			0.183	2	98.48	0.40
	16:00	38.84			0.178	2	98.57	0.38
	17:00	39.01			0.179	2	98.55	0.38
	18:00	38.74			0.178	2	98.57	0.38
	19:00	35.51			0.163	2	98.79	0.32
	20:00	33.90			0.155	2	98.89	0.29
	21:00	31.33			0.144	2	99.05	0.25
	22:00	28.27			0.130	1	87.04	7.14
	23:00	24.47			0.112	1	88.79	6.06
		Hourly Averages			Average Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
		FIRE						
		30.10	0.00	0.00	0.138	38	96.41	1.64

Surge tested to +1.28 std dav at all hours of day.

Table 16. Consolidated FR msr Radio

Year	Dispatch Model	Workstation Name	Surge
2015	Option 2	FR msr Radio	+ 0.00 σ

Surge	Hour of Day	Hourly Averages				Workstation Staffing & Performance		
		FR tac			Σ Erlangs	OnTask	Immediate Answer [%]	Ans Delay @ 95 %-tile [sec]
	00:00	1.56			0.484	2	91.39	184.62
	01:00	1.31			0.406	2	93.58	130.93
	02:00	1.14			0.354	2	94.94	100.00
	03:00	1.12			0.349	2	95.07	97.17
	04:00	1.00			0.310	2	96.01	76.84
	05:00	1.11			0.346	2	95.15	95.31
	06:00	1.52			0.472	2	91.74	175.77
	07:00	1.98			0.615	3	97.33	36.42
	08:00	2.81			0.875	3	93.64	97.31
	09:00	3.63			1.128	3	89.01	190.95
	10:00	3.66			1.139	3	88.81	195.42
	11:00	3.78			1.174	3	88.14	211.13
	12:00	3.60			1.118	3	89.21	186.52
	13:00	3.72			1.156	3	88.49	203.01
	14:00	3.84			1.195	3	87.73	221.02
	15:00	3.62			1.126	3	89.06	189.84
	16:00	3.36			1.044	3	90.61	156.09
	17:00	3.53			1.098	4	96.90	34.76
	18:00	3.60			1.120	4	96.69	37.34
	19:00	3.22			1.001	3	91.42	139.59
	20:00	2.96			0.920	3	92.87	111.49
	21:00	2.70			0.838	3	94.24	86.60
	22:00	2.25			0.700	3	96.28	52.57
	23:00	1.76			0.546	3	98.04	25.91
		Hourly Averages			Average Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
		FR tac						
		2.62	0.00	0.00	0.813	67	91.99	137.07

Surge tested to +1.28 std dev at all hours of day.

Table 17. Consolidated FR ssr Radio @ 0.60 Traffic

Year	Dispatch Model	Workstation Name	Surge
2015	Option 2	FR ssr Radio	+ 0.00 σ

Surge	Hour of Day	Hourly Averages				Workstation Staffing & Performance		
				Radio	Σ Erlangs	OnTask	Immediate Answer [%]	Ans Delay @ 50 %-tile [sec]
+	00:00			132.58	0.313	2	95.94	0.20
+	01:00			116.79	0.275	2	96.78	0.16
+	02:00			103.45	0.244	2	97.42	0.12
+	03:00			98.53	0.232	2	97.64	0.11
+	04:00			92.79	0.219	2	97.89	0.10
+	05:00			98.52	0.233	2	97.63	0.11
+	06:00			115.20	0.273	2	96.83	0.16
+	07:00			159.47	0.377	2	94.36	0.30
+	08:00			203.91	0.482	2	91.44	0.48
+	09:00			225.91	0.535	2	89.87	0.59
+	10:00			245.07	0.579	2	88.48	0.69
+	11:00			246.83	0.584	2	88.34	0.70
+	12:00			255.93	0.606	2	87.65	0.76
+	13:00			251.38	0.595	2	88.01	0.73
+	14:00			249.36	0.590	2	88.14	0.72
+	15:00			251.06	0.594	2	88.02	0.73
+	16:00			244.88	0.579	2	88.50	0.69
+	17:00			244.57	0.578	2	88.53	0.69
+	18:00			241.85	0.572	2	88.73	0.67
+	19:00			222.53	0.526	2	90.14	0.57
+	20:00			213.52	0.504	2	90.78	0.52
+	21:00			197.32	0.466	2	91.91	0.45
+	22:00			178.87	0.422	2	93.14	0.37
+	23:00			156.39	0.369	2	94.57	0.28

Hourly Averages			Average Erlangs	Req'd Hrs OnTask	Weighted % Immed Ans	Weighted Ans Delay
		Radio				
0.00	0.00	189.45	0.448	48	90.95	0.53

Surge tested to +1.28 std dev at all hours of day. In this model air time on the radio channels has been reduced to 60% of current usage by increased data transfers via mobile data terminals.

Attachment J

Monthly Performance Report Format

FITCH
& ASSOCIATES

RECOMMENDED MONTHLY PERFORMANCE MEASURES

METRIC	Count	Average	TARGET	TARGET COMPLIANCE
P1 Call Answer Time - Busy Hour of 1800 hrs. (NENA 56-005)			90% Within 10 Seconds	
P1 Call Answer Time - Number of Days Meeting Busy Hour Performance			All Days in Month	
P1 Call Answer Time - All 911 Calls (NENA 56-005)			95% Within 20 Seconds	
P1 Call Answer Time - All 911 Calls (NFPA1221-2016)			95% Within 15 Seconds	
P1 Call Answer Time - All 911 Calls (NFPA1221-2016)			99% Within 40 Seconds	
P1 Call Answer Time - All 911 Calls (State of Florida)			90% Within 10 Seconds	
P1 Call Answer Time - Alarm Lines			95% Within 15 Seconds	
P1 Call Answer Time - Alarm Lines			99% Within 40 Seconds	
Transfer to Secondary PSAP (NFPA1221-2016)			95% Within 30 Seconds	
P2 EMS Call For Service Processing Time - Delta & Echo Calls Only			90% Within 70 Seconds	
P2 Law Enforcement Call For Service Processing Time - Priority 1 & 2 Calls Only			Report 90th% - No specific target	
P3 EMS Call For Service Processing Time - Delta & Echo Calls Only			90% Within 20 Seconds	
P3 Law Enforcement Call For Service Processing Time - Priority 1 & 2 Calls Only			Report 90th% - No specific target	
P2/P3 EMS / Specialized Call For Service Processing Time (NFPA1221-2016)			90% Within 90 Seconds	
P2/P3 EMS / Specialized Call For Service Processing Time (NFPA1221-2016)			99% Within120 Seconds	

P2/P3 Fire Call For Service Processing Time (NFPA1221-2013)			80% Within 60 Seconds	
P2/P3 Fire Call For Service Processing Time (NFPA1221-2016)			90% Within 64 Seconds	
P2/P3 Fire Call For Service Processing Time (NFPA1221-2016)			95% within 106 Seconds	
P2/P3 EMS Call For Service Processing Time - Delta & Echo Calls Only			90% Within 90 Seconds	
P2/P3 Law Enforcement Call For Service Processing Time - Priority 1 & 2 Calls Only			Report 90th% - No specific target	
P4 (newly defined) EMS Turnout Times - Delta & Echo Calls Only (NFPA 1710-2016)			Report 90th% - No specific target	
P5 (newly defined) EMS & Fire Travel Times - Delta & Echo Calls Only (NFPA 1710-2016)			Report 90th% - No specific target	
P5 (newly defined) Law Enforcement Travel Times - Priority 1 & 2 Calls Only			Report 90th% - No specific target	
EMD Case Entry Compliance			95%	
EMD Total Complaince Rate			90%	
EMD Quality Assurance - Cases Reviewed			1%	

NOTES:

Busy hour defined as 1800-1900 hrs.

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