Intelligent Transportation Systems
U.S. Department of Transportation

NG9-1-1

Next Generation 9-1-1 (NG9-1-1) System Initiative



Data Acquisition and Analysis Plan

Washington, D.C.
March 2008

Version 1.0

DOCUMENT CHANGE HISTORY

Version Number	Date	Description
v1.0	March 2008	Final Version

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1 INTRODUCTION

The U.S. Department of Transportation (USDOT) Next Generation 9-1-1 (NG9-1-1) Proof-of-Concept (POC) demonstration will test key features and functionalities of the envisioned NG9-1-1 system. The POC will also serve as a test-bed to validate technical feasibility and acquire important data metrics useful to the greater emergency response community. The POC test-bed equipment will be deployed within the Booz Allen, Texas A&M University, and Columbia University test laboratories and at selected Public Safety Answering Points (PSAP). Data acquisition will require hardware, software, and manual data collection methods. This document describes the data acquisition system, the analysis that will be conducted, and the metrics that will be obtained.

1.1 Document Objective

The objective of this document is to define a comprehensive plan for acquiring and analyzing NG9-1-1 POC data. The plan will assist the NG9-1-1 Project Team and USDOT to evaluate the technical and operational success of the POC. The data acquired from the POC will serve as benchmarks for future large-scale NG9-1-1 technology deployments and further assist in the refinement of the final NG9-1-1 transition plan. The data will facilitate the USDOT, Standards Development Organizations (SDO), industry vendors, PSAP operational community, and future independent evaluators in defining measures of interest for Internet Protocol (IP)-based emergency calling. In addition, this document will identify the data acquisition system put in place to acquire these measures including the software, hardware, and resources required.

1.2 Scope

This document includes the following—

- Documentation of the design of the data acquisition system used for collecting data from call origination, call routing, call termination, and network equipment
- Specification of the commercial off-the-shelf (COTS) and open source products used to implement the data acquisition system
- Descriptions of the data collection and analysis methods for the NG9-1-1 POC
- An outline of the objectives, hypotheses, measures of interest, and data sources for each data analysis method.

1.3 Document Overview

This document includes the data acquisition design and data analysis plan for the NG9-1-1 POC system. The remainder of this document is organized as follows:

- **Section 2—Data Acquisition System:** Details the design and implementation of the data acquisition system. A variety of software, hardware, and user testing methods will be used to collect the data from the POC test-bed.
- **Section 3—Data Analysis Methodology:** Discusses the data analyses that will be conducted over the course of the NG9-1-1 POC. Analysis will concentrate on four primary themes concerning emergency calling: emergency call propagation

and timing, emergency call availability and quality, emergency call scalability, and call taker software usability. Each of these POC analyses and their associated measures of interest are detailed in this section.

- **Appendix A—Definitions:** Lists of commonly used NG9-1-1 terminology and their associated definitions.
- **Appendix B—Glossary:** Lists acronyms used in this document.
- **Appendix C—Source References:** Provides a list of published documents that were referenced while developing this document.

2 DATA ACQUISITION SYSTEM

2.1 Data Acquisition Overview

The USDOT NG9-1-1 POC will host a variety of infrastructure simulating an IP-based emergency call system and modeling the components defined in the NG9-1-1 Architecture. To gain the most benefit from the POC, a solid data acquisition system must be put in place. During the lifespan of the project, it is imperative to acquire functional and performance data for further analysis. This will assist USDOT and the public safety community in determining the technical feasibility of various components and interfaces of the future NG9-1-1 systems. In addition, it will potentially showcase the technical challenges that still must be overcome by currently available emergency response and communication technology. This section lays out the design of the data acquisition system, discusses the various components involved, and documents the products that will be used in the POC.

2.2 Data Acquisition Design

Figure 2–1 presents the design of the data acquisition system.

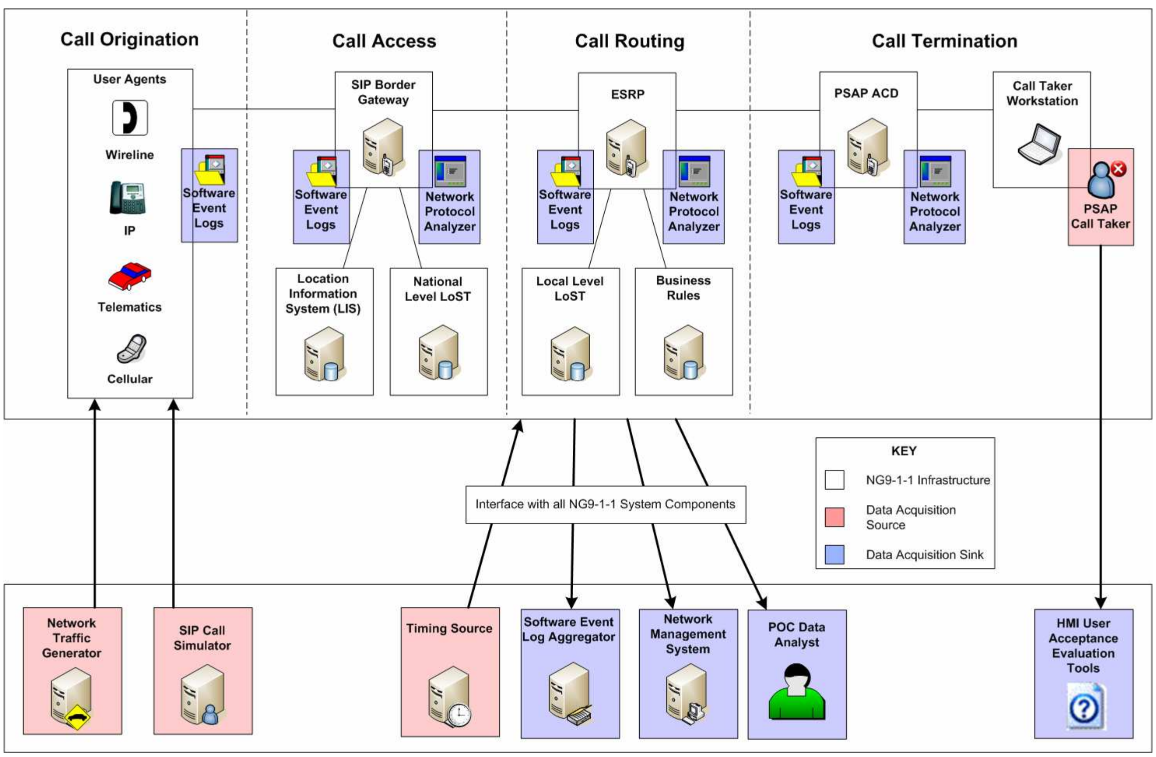

Figure 2–1—NG9-1-1 Data Acquisition Design

From a data acquisition perspective, the NG9-1-1 POC testbed comprises three main entities:

- **NG9-1-1 Infrastructure and Components—**The main functional components of the NG9-1-1 architecture. They provide end-to-end transfer of an emergency call and implement various aspects of the call origination, call access, call routing and call termination processes. The function and performance of these architectural entities are key to a successful demonstration of the NG9-1-1 concept. Therefore, significant effort is expended in acquiring data on the operation of these entities.
- **Data Acquisition Sources—**Tools and resources used to generate data regarding the operation of the NG9-1-1 infrastructure and components. They serve as the catalyst for data collection as well as support the overall data acquisition process. These tools directly interact with the NG9-1-1 infrastructure and components initiating controlled system reactions and data generation. They have varying levels of complexity and may require configuration, automation, manual inspection, or verbal interaction.
- **Data Acquisition Sinks**—Data collection, monitoring, and aggregation tools for the NG9-1-1 POC. They interact with NG9-1-1 infrastructure and components to extract raw data for later processing and analysis. They consist of a combination of hardware, software, and human assets.

The design of the data acquisition system is based on COTS and open source equipment. This modular, standards-based design addresses the plethora of hardware, software, and networking infrastructure that make up the NG9-1-1 POC. This approach provides more flexibility for product selection but still requires POC data analysts to develop an in depth knowledge of the acquired products.

The data acquisition system follows a standard FCAPS (**F**ault, **C**onfiguration, **A**ccountability, **P**erformance, **S**ecurity) approach[1] to system management and monitoring. This model is used by most production telecommunications system providers today. Given the developmental nature of the POC, certain aspects of the FCAPS model are more applicable to the POC and therefore are more heavily emphasized. The FCAPs model for systems management and monitoring is applied to the NG91-1 POC in the following manner:

- **Fault—**It is imperative that the production NG9-1-1 system is deployed in a robust manner. Given the nature of emergency calling, devices and connections must have a high level of availability. For the POC, metrics will be established on the overall uptime of the NG9-1-1 components and their interconnections. However, given the budget and research focus of the POC, redundant links and components will not be procured and no failover capability will be supported. Faults in the NG9-1-1 components will be detected through standard logging procedures (Syslog) and the Simple Network Management Protocol (SNMP). The main tools used for collecting logs and determining proper function of the devices are the SysLog Server and the Network Management System discussed in the subsequent sections.

[1] **FCAPS** is the ISO Telecommunications Management Network model and framework for network management. ITU-T M.3400 - http://www.itu.int/rec/T-REC-M.3400-200002-I/en

- **Configuration—**In a production system, the ability to remotely configure and centrally provision devices is crucial. Given the geographically disparate nature of the NG9-1-1 system, centrally managing the NG9-1-1 infrastructure is a necessity. For the POC, all efforts will be made to allow remote access to the equipment. This is especially important because development and integration is spread across Booz Allen's Center for Network & Systems Innovations (CNSI) Laboratory (Herndon, Virginia), Columbia University's Internet Real-Time (IRT) Laboratory (New York City, New York), Texas A&M University's Internet2 Technology Evaluation Center (ITEC) Laboratory (College Station, Texas) and the selected PSAPs. While numerous enterprise products exist for remote, centralized management and provisioning, this functionality will be provided on a device-by-device basis leveraging each individual product's capabilities. For example, terminal access will be provided for routers, and Remote Desktop Protocol (RDP) ports will be opened for the servers.
- **Accountability—**Accountability focuses on the personnel responsible for maintaining and monitoring infrastructure. In addition, accountability provides mechanisms to ensure contractually agreed upon performance (i.e., bandwidth of 1.44 megabits per second [Mbps] or availability of 99.999 percent uptime) for acquired products or leased connections. Given the scope of the POC, a single person will be responsible for ensuring appropriate operation of the POC equipment. To assist in this task, the Network Management System will be used to remotely monitor uptime of components and leased network connections.
- **Performance—**Performance is one of the main focuses of the POC. To determine the technical feasibility of the NG9-1-1 system, performance metrics must be obtained. For the POC, performance is characterized according to call propagation and timing, call availability and quality, call scalability, and software usability. These metrics are both quantitative and qualitative in nature. To assist in the acquisition of these metrics, a variety of tools will be used. To generate realistic call scenarios and traffic loads on the system, network traffic generators and call simulators will be used. The specifics of these generators are discussed in Section 2.3. Upon injecting traffic into the system, network protocol analyzers and software log files will provide raw data for analysis and acquisition of performance metrics. The Project Team will collect the data manually and with the assistance of software, and conduct qualitative surveys with the call takers to determine software usability. The overall data analysis process is detailed in the Section 3.
- **Security—**Security is important to any production system to ensure appropriate access control, data rights, resource management, and data privacy. Even though the POC is an open, research-oriented initiative, best practices have been put in place to ensure a secure operating environment for the POC. These include creating a virtual private network (VPN) using tunneling, placing firewalls with appropriate access policy at the ingress/egress points of the network, and using strong username and password protection for all servers deployed in the POC. While stronger, more centralized measures should be used for the production system, these were deemed unnecessary for the POC. Although outside the scope

of this effort, the effects of encryption on the performance of IP-based emergency networks should be investigated.

2.3 Data Acquisition Equipment

The follow sections contain details of the required products for the data acquisition system. Each section corresponds to one of the data acquisition entities previously depicted in the Data Acquisition Design, Figure 2–1.

2.3.1 Timing Source

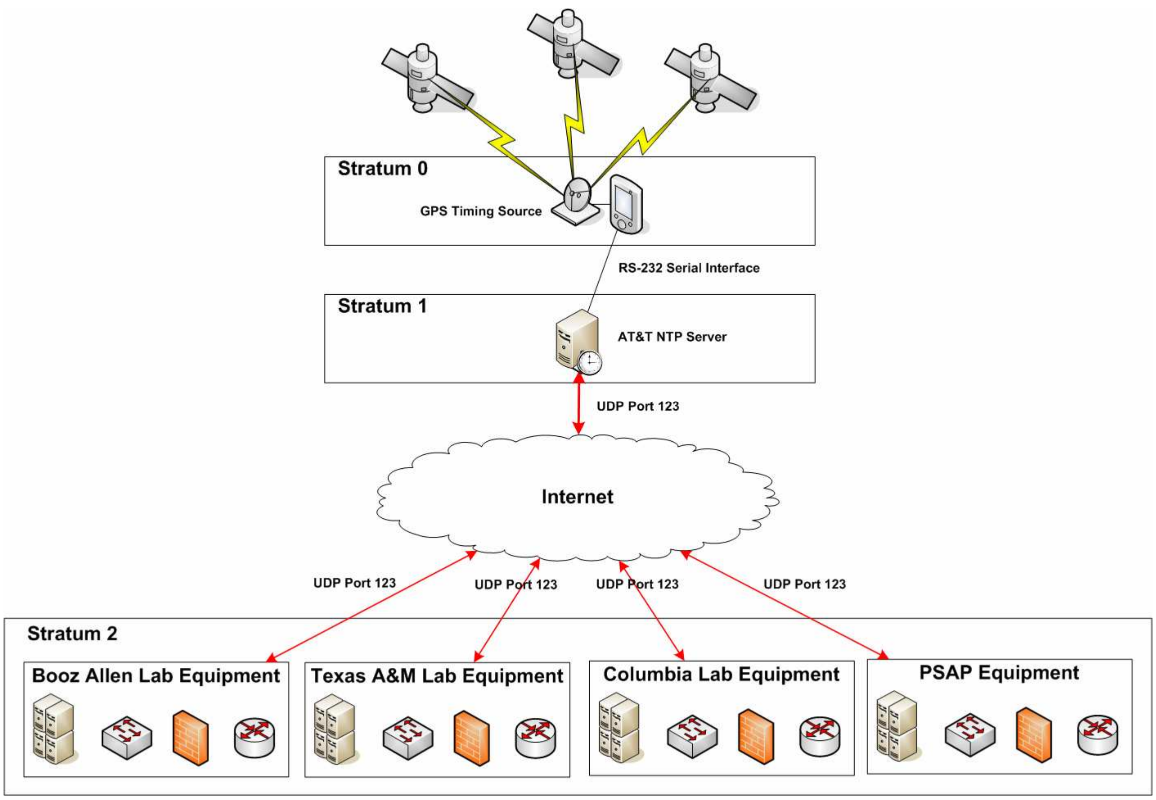

Figure 2–2—NTP Server Architecture for the NG9-1-1 POC

Network Time Protocol (NTP) Server

Product: AT&T Stratum 1 NTP Server
Data Acquisition Type: Source
Description: Stratum 1 NTP servers are computers attached directly to atomic (cesium, rubidium) clocks, Global Positioning System (GPS) clocks, or other radio clocks known as Stratum 0 devices. Normally, they act as servers for timing requests from Stratum 2 devices via NTP. Stratum 1 NTP servers are referred to as time servers and can usually maintain time to within 10 milliseconds (1/100 s) over the public Internet. For the NG9-1-1 POC, all infrastructure devices will be NTP compliant and contact a Stratum 1 NTP Server hosted by AT&T for their timing reference.
Acquirable Data Metrics/System Properties: Synchronized timing across the NG9-1-1 POC Test Environment. Time synchronization is key in tracing events through the POC

system using software logs as well as for acquisition of accurate call propagation and timing metrics.

2.3.2 Network Management System

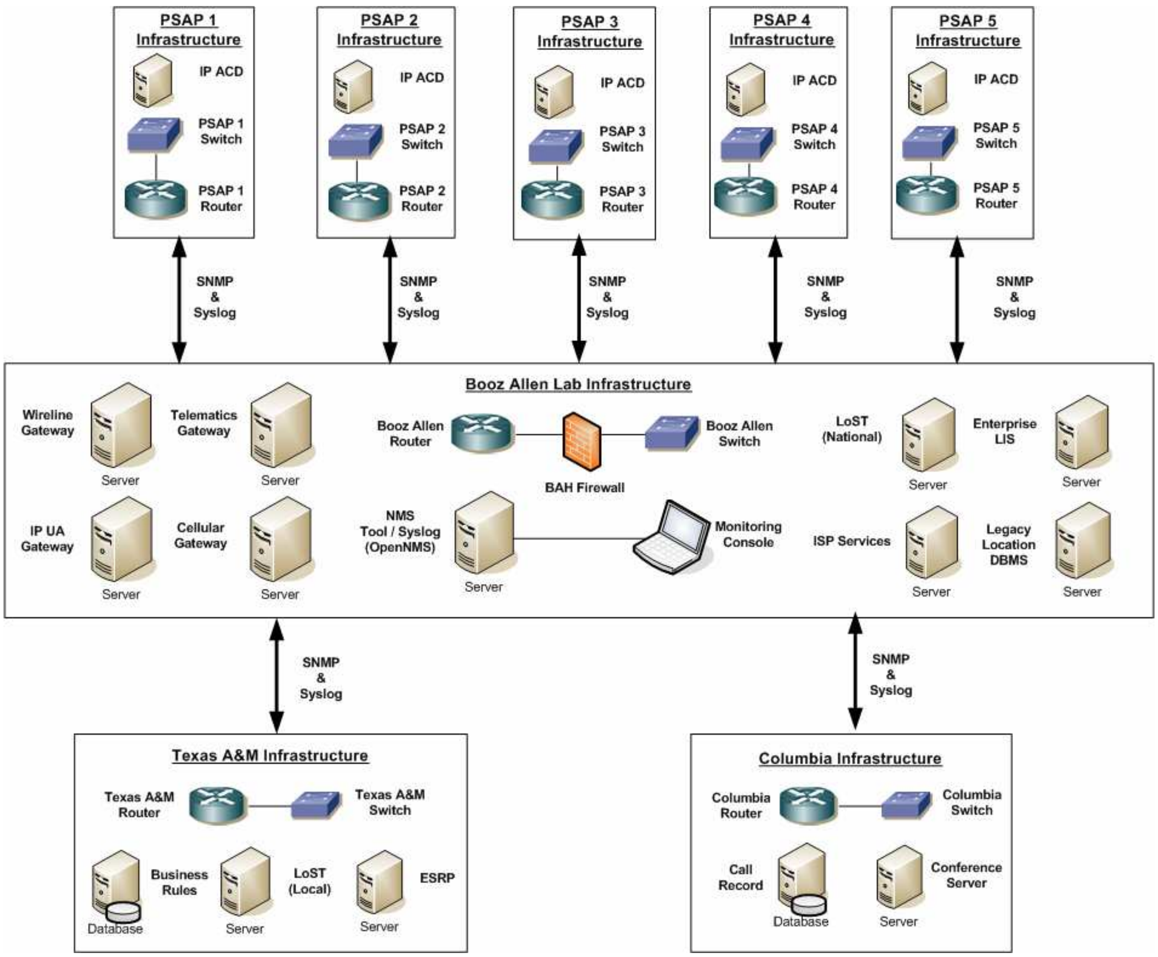

Figure 2–3—Network Management System

Product: OpenNMS™
Data Acquisition Type: Sink
Description: OpenNMS is an enterprise-grade network management platform developed under the open source model. It consists of a community supported open-source project as well as a commercial services, training, and support organization. OpenNMS operates on a scalable platform and provides a software implementation of the FCAPS network management model. For the POC, its main purpose will be for monitoring faults and tracking interface service (e.g., Accountability). Using SNMP, OpenNMS will acquire the availability metrics of the NG9-1-1 components and interfaces.
Acquirable Data Metrics/System Properties: Component Availability/Uptime, Network Connectivity Availability/Uptime
Additional Information: http://www.opennms.com

2.3.3 System and Software Event Logging

Call Origination Software Event Logs
Product: Firsthand Technology - SIPc Software
Data Acquisition Type: Sink
Description: SIPc is a voice over IP (VoIP) software client. SIPc relies on the Session Initiation Protocol (SIP) to establish IP-based telephony services. SIPc supports voice, video, and data media streams between SIP User Agents. SIPc stores software events to the sipc.log file. Events are documented with a textual description and corresponding timestamp.
Acquirable Data Metrics/System Properties: SIP Call Propagation and Timing Metrics, SIPc Error Events
Additional Information: http://www.cs.columbia.edu/irt/sipc

SIP Border Gateway and ESRP Software Event Logs
Product: Firsthand Technology - SIPd Software
Data Acquisition Type: Sink
Description: SIPd serves as the foundation for the SIP Border Gateways and Emergency Services Routing Proxies (ESRP). SIPd is a fully compliant, SIP Proxy Server that handles call session initiations and terminations between SIP User Agents. SIPd stores software events similarly to SIPc with a timestamp and corresponding description; however, it stores the information in a custom MySQL database.
Acquirable Data Metrics/System Properties: SIP Call Propagation and Timing Metrics, SIPd Error Events
Additional Information: http://www.cs.columbia.edu/irt/cinema

PSAP Automatic Call Distribution (ACD) Software Event Logs
Product: PSAPd Software
Data Acquisition Type: Sink
Description: PSAPd is a fully compliant, back-to-back SIP User Agent that handles automatic call distribution at a PSAP. PSAPd stores software events in a custom MySQL database with a timestamp and textual description of the event.
Acquirable Data Metrics/System Properties: SIP Call Propagation and Timing Metrics, SIPd Error Events

System Event Log Aggregator
Product: OpenNMS
Data Acquisition Type: Sink
Description: Event logging for OpenNMS is conducted with three distinct mechanisms: service polling, receipt of unsolicited messages (usually SNMP traps), and threshold evaluated against performance data. OpenNMS also provides a comprehensive “Service Collector Interface” leveraging SNMP, HTTP, and NSClient. These interfaces gather data that can then be used in performance graphs, thresholds, and network latency calculations.
Acquirable Data Metrics/System Properties: Network Performance Management, Fault Management, and Security
Additional Information: http://www.opennms.org

2.3.4 Emergency Call and Network Traffic Generation

SIP Call Simulator

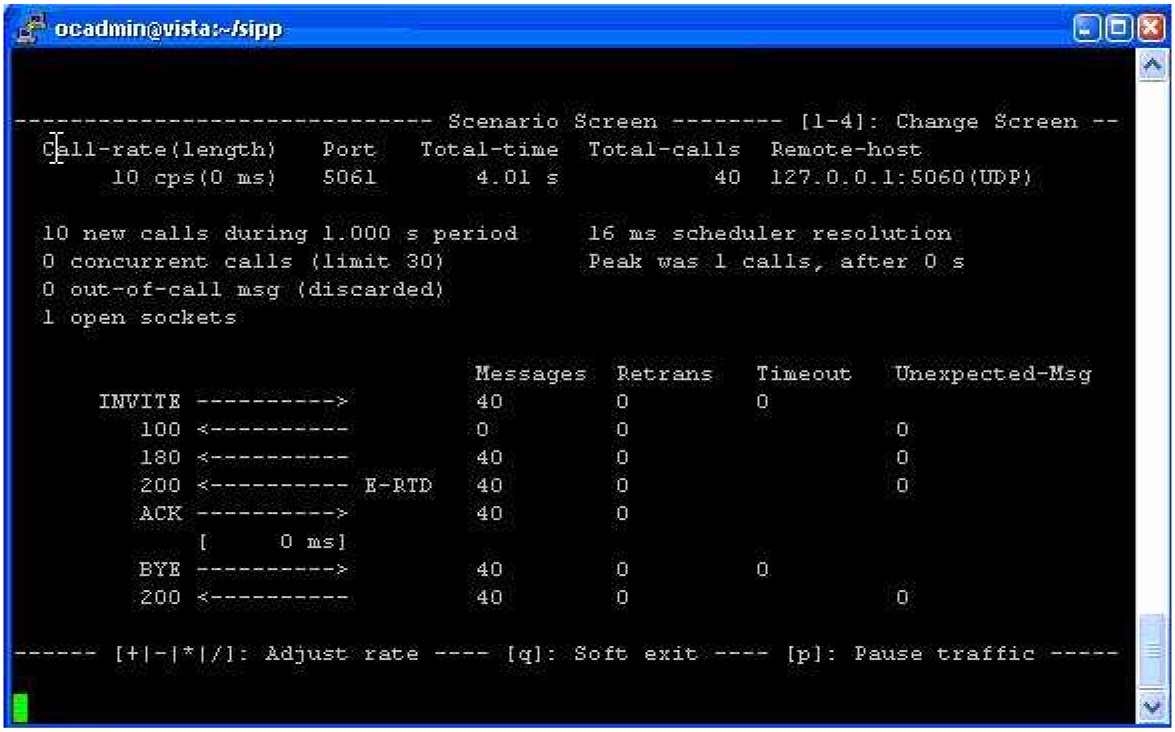

Figure 2-4—SIPp Screenshot

Product: SIPStone—SIPp
Data Acquisition Type: Source
Description: SIPp is an open source test tool and traffic generator for the SIP protocol. It establishes and releases multiple calls with the INVITE and BYE methods. It can also read custom eXtensible Markup Language (XML) scenario files describing simple or complex call flows. It generates information regarding call rate, round trip delay, and message statistics, as well as supports comma-separated statistics dumps, Transmission Control Protocol (TCP)/User Datagram Protocol (UDP) over multiple sockets, and dynamically adjustable call rates.
Acquirable Data Metrics/System Properties: Call Rate, Round Trip Delay, SIP Message Statistics
Additional Information: http://sipp.sourceforge.net/

Network Traffic Generator

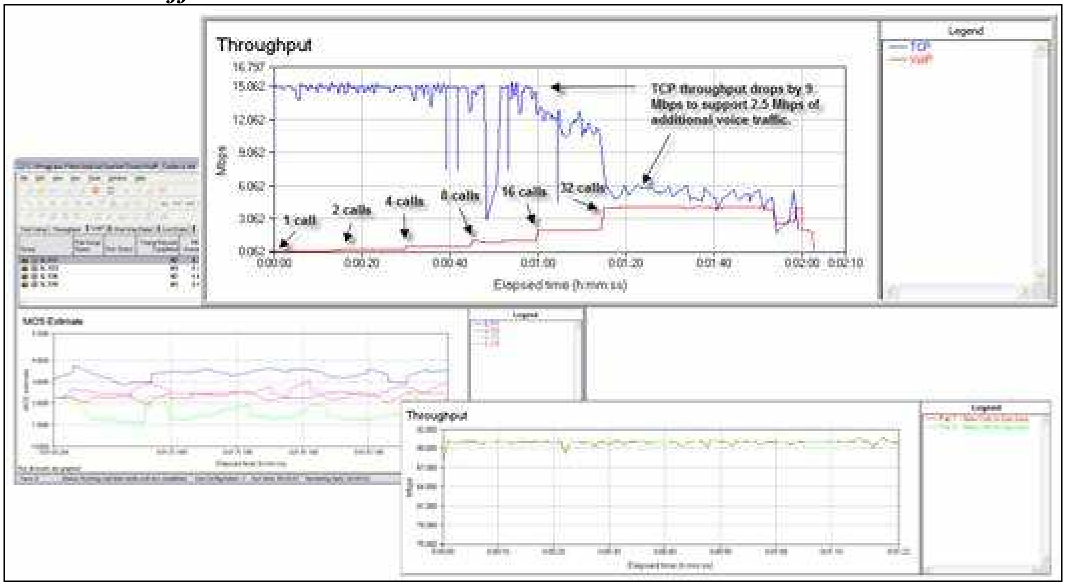

Figure 2–5—IxChariot Console Screenshot

Product: Ixia—IxChariot™
Data Acquisition Type: Source
Description: IxChariot is a test tool and IP traffic generator. IxChariot can emulate real-world applications and protocols to predict system performance under realistic load conditions. IxChariot consists of Performance Endpoints and the IxChariot Console. Using scripted traffic scenarios, Performance Endpoints send data to one another across the system under test (SUT). Upon completion, system metrics are acquired and presented to a data analyst at the IxChariot Console. IxChariot can support tens of thousands of connections representing hundreds of thousands of end users. IxChariot is configurable to generate traffic patterns that simulate converged IP services (voice, video, data) using industry standard protocols (IPv4, TCP/UDP, RTP, VoIP, IP Multipcast). For the POC, IxChariot will be used to obtain network performance data from the Call Origination Source (Booz Allen Laboratory) to the selected PSAPs.
Acquirable Data Metrics/System Properties: Network Throughput (Bandwidth), Jitter, Network Latency (Response Time), Packet Loss
Additional Information: http://www.ixiacom.com/products/ixchariot/

2.3.5 Network Protocol Analyzer

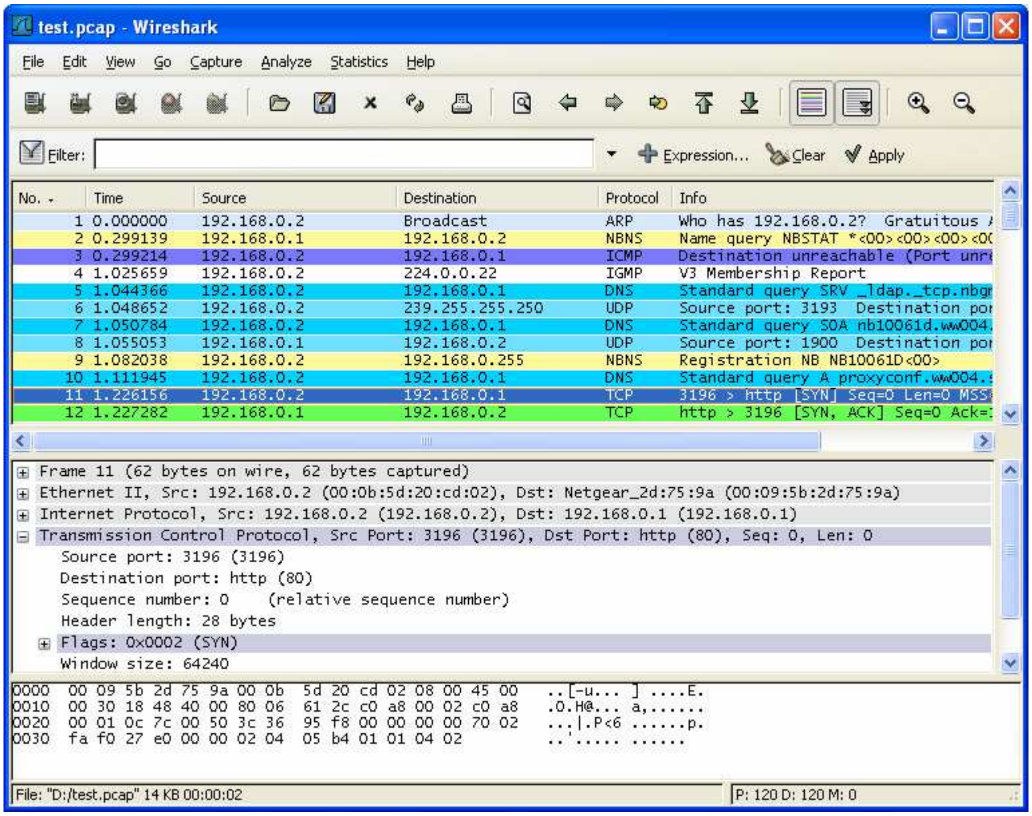

Figure 2–6—Wireshark Screenshot

Product: Wireshark™
Data Acquisition Type: Sink
Description: Wireshark is a graphical user interface (GUI)-based packet sniffer and protocol analyzer. A network protocol analyzer captures network packets and displays their data visually in a time sequential manner. It is used for network troubleshooting, analysis, software and communications protocol development, and education. For the NG9-1-1 POC, Wireshark will be used to capture SIP messages passed to/from Call Origination User Agents, Border Proxies, ESRPs, IP ACDs, and Call Taker Workstations.
Acquirable Data Metrics/System Properties: SIP Protocol Analysis, SIP Call Propagation and Timing Metrics
Additional Information: http://www.wireshark.org/

2.3.6 HMI User Acceptance Evaluation Tools

Acceptance of the Human Machine Interface (HMI) display by the call taker community is critical to the success of the NG9-1-1 solution. A rigorous User Acceptance Testing (UAT) methodology will be employed by the NG9-1-1 testing team to ensure that the HMI solution fully meets the defined usability requirements and standards.

Tools (i.e. Test scripts and Summary/Error Reports) to support the UAT phase will be developed to test the HMI display and acquire information about the HMI components. They also provide a complete evaluation of the HMI display functionality and usability. The data acquisition tools used during the UAT phases include,

- User Acceptance Test Cases and Scripts
- User Acceptance Summary Report
- User Acceptance Consolidated Error Report.

User Acceptance Test Scripts

These scripts are used to test the HMI display to ensure it is usable and supports the NG9-1-1 system requirements. The scripts support a data analyst in gathering user feedback regarding system functionality and usability based on the HMI display design specifications. The scripts contain scenarios and steps identified for testing of the HMI display. The scripts focus on the user's experience with system functionality, layout of the display components, ease of use, availability of necessary information, and screen navigation.

Test Script for NG9-1-1 HMI

Test #:	Version/Release:	Product: NG9-1-1 HMI Area/Features covered: Dispatch Function Call Type: Emergency	Tester: ______________ Date(s): ______________

Setup instructions: This script requires a Tier 1 1-800 CSR that is able to do MA and PDP Disenrollment. To run this script, make sure that the "1800 Disenrollment" responsibility is assigned to the login account. ***Note: You need a HICN with MA-PDP data.***

Requirements/Defects Tested:

Service Area Code	Activity Code	Role	Requirement Code	Requirement Text
DM	SCIER	CT	SCIER-SR-07	They system shall pre-populate the location discrepancy report with the incorrect information.
DM	SCIER	CT	SCIER-FR-06	The system shall pre-populate the location discrepancy report with caller identification information.
CP	IDRES	CT	IDRES-FR-04	The system shall provide the capability to transmit a call record to the selected responder agencies' dispatchers.
CR	TRCIN	CT	TRCIN-FR-01	The system shall provide the capability to transfer a call record.
CP	DTNAT	CT	DTNAT-FR-05	The system shall provide the capability to update the nature of the emergency.
CP	VFLOC	CT	VFLOC-SR-02	The system shall provide the call taker with a capability to document the location of the emergency.
CP	DTNAT	CT	DTNAT-FR-01	The system shall provide the capability to document the nature of the emergency for each call.
CP	DTNAT	CT	DTNAT-FR-02	The system shall provide the capability to document additional information for a call.
CP	IDRES	CT	IDRES-SR-01	The system shall display the emergency responder agencies associated with the emergency location.
CP	IDRES	CT	IDRES-SR-01-01	The system shall display the emergency responder agencies associated with the caller location if the emergency location is not available.
CP	IDRES	CT	IDRES-SR-01-02	The system shall display the emergency responder agencies associated with the nature of emergency (that is, recommended responders).
CP	IDRES	CT	IDRES-SR-01-03	The system shall display the emergency responder agencies associated with the Call Type if nature of emergency is not available.
CP	IDRES	CT	IDRES-SR-01-06	The system shall display the mode of communication capabilities of the displayed responder agencies.
CP	IDRES	CT	IDRES-FR-02	The system shall provide the capability to refresh the list of responders.
CP	IDRES	CT	IDRES-SR-07	The system shall log the selected responder agencies for each call.

Objective of Test: This test script validates the Dispatch HMI function and associated screens. Following the steps in this script, the call taker would be able to send emergency information over to the dispatch unit.

Script:

Step #	Done	RTM #	Step/Data Instructions	Expected Results	Comments	Pass/Fail
Logging into HMI						
1.	❑		Access HMI application from the desktop.	HMI screen is accessible to the user.		❑ Pass ❑ Fail

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Figure 2–7—User Acceptance Test Script

Product: Word Document
Data Acquisition Type: Sink

Description: Test scripts will be created to test all screens and applications of the HMI. The test scripts will also be developed to ensure that all requirements identified for the HMI by the NG9-1-1 Systems Design Document are addressed.
Acquirable Data Metrics / System Properties: Gathers information about the user's experience with the system, including screen navigation, layout, access to application features, and ease of use
Additional Information: N/A

User Acceptance Summary Report

The User Acceptance Summary Report provides a description of all usability errors and issues identified by the user group during UAT. The report allows the testing team to track each identified error from its identification through resolution. The report is a collection of feedback and test results obtained during the UAT activities.

UAT Summary Report

January, 2008

HMI Items:

1. Discussion and Review of New Defects

Impact analysis of defects found during the testing activities.

Issue ID: 15 **Test Group:** UAT **Error Type:** Defect **Status:** Open
Category: Dispatch Function **Severity:** 3
Problem: The dispatch function does not need to list the responder agency.
Reported By: UAT Test Team **Date:** 01/23/2008
Screen/View/Applet Name: Dispatch Function & Screen
Defect Summary: Description of the Error
Actions to Recreate:
Applicable Ticket:
CCB Comments:
Screenshot: Available.

2. Discussion and Review of Open Defects

Continuing analysis of defects found during the testing activities.
Official determination of severity classification.

Issue ID: 2 **Test Group:** UAT **Error Type:** Defect **Status:** Open
Category: HMI Navigation **Severity:** 5
Problem:
Reported By: UAT Test Team **Date:**
Screen/View/Applet Name:
Defect Summary:
Applicable Ticket:
CCB Comments:
Screenshot: Available.

3. Review of Open Defects with Assigned Ticket Numbers

Record of defects found during testing activities that have been assigned Ticket numbers.

Issue ID: 8 **Test Group:** UAT **Error Type:** Defect **Status:** Open
Category: **Severity:** 4
Problem:
Reported By: **Date:**
Screen/View/Applet Name:
Defect Summary:
Actions to Recreate:
Applicable Ticket:
CCB Comments:
Screenshot: Available.

Figure 2–8—User Acceptance Summary Report

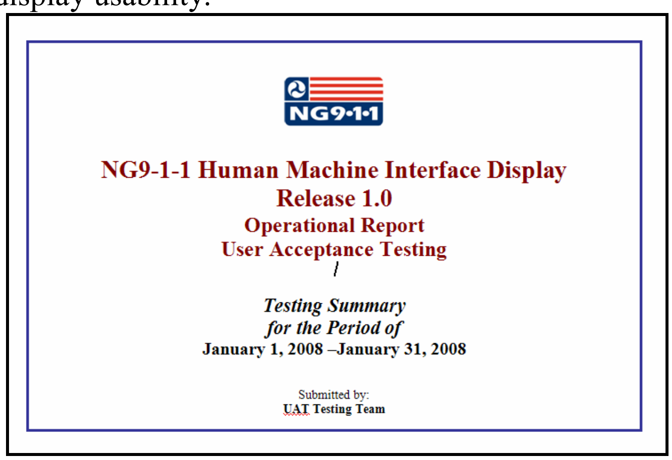
Product: Word Document
Data Acquisition Type: Sink
Description: Summary of errors identified during the UAT testing phase
Acquirable Data Metrics / System Properties: The Summary Report includes the following key fields:

- Problem—(i.e., "unintuitive layout of Call Record display," "agency listing is not necessary on the Main HMI display," etc.)
- Defect Summary—identifies the effect of the error on the call taker operating the HMI display (i.e., "call-takers may not need to view all of the fields currently contained in the Call Record screen, and the large number of fields prevents call takers from finding necessary information quickly," "agency listing available directly from the Main HMI display prevents call takers from viewing other important data," etc.)
- Screen components in which the error occurs—identifies the actual sections of the HMI display that are affected by the error
- Severity of the error—defines the severity of the error with regard to the HMI success and acceptance
- Change Control Board (CCB) Comments—identify resolution approach for the error and priority
- Error Resolution—outlines the steps needed to correct identified error within the HMI display or provides an explanation of the error will be addressed without modifying the display (i.e. training).

Additional Information: N/A

User Acceptance Consolidated Error Report

The Consolidated Error Report is a summary of findings of the HMI Display UAT. The report contains all errors that were identified during the testing period, their resolutions, and their status. The report also includes the testing methodology and the project schedule, as well as a breakdown of the data entry execution. The report is an all-inclusive summary of the UAT effort and findings, presented to the USDOT officials to evaluate the HMI display usability.



NG9-1-1 Human Machine Interface Display
Release 1.0
Operational Report
User Acceptance Testing

Testing Summary
for the Period of
January 1, 2008 –January 31, 2008

Submitted by:
UAT Testing Team

Figure 2–9—User Acceptance Consolidated Error Report

Product: Word Document
Data Acquisition Type: Sink
Description: Formal summary of errors identified during the UAT testing phase for a given period of time. Presented to USDOT for evaluation
Acquirable Data Metrics/System Properties: The report will include the following information:

- Testing Approach—identifies the testing approach and the teams conducting the testing activities. Identifies all phases of the testing process and the phases covered during the testing period.
- Test Execution—Specifies the tests and the affiliated requirements/system components that were conducted during the time frame of the report.
- Findings—Details findings of the testing phase. This will include the summary of usability, navigation, and application access, as well as other findings, based on the discovered errors.
- Recommendations—Contains a listing of recommendations to correct the errors and findings. The recommendations are summaries of CCB recommendations as well as error resolutions.

Additional Information: N/A

3 DATA ANALYSIS METHODOLOGY

3.1 Data Analysis Overview

The NG9-1-1 POC requires a methodical and iterative approach through all levels of data collection and analysis. This section focuses on the process required to execute an effective data analysis methodology. The subsequent sections address the four main focuses of the NG9-1-1 POC:

- **Emergency Call Propagation and Timing—**This subsection examines the need for calls to be routed in an efficient, time-sensitive manner through the NG9-1-1 system.
- **Emergency Call Availability and Quality—**Two subsections investigate NG9-1-1 Component and Interface availability and IP network performances effect on the quality of voice and video calls.
- **Emergency Call Scalability**—This subsection explores the NG9-1-1 system's ability to scale on a need-driven basis with convergence of different media types (voice, video, and data). It also looks at innovative NG9-1-1 call overflow mechanisms and their ability to improve overall system performance.
- **Call Taker Software Usability**—This subsection discusses the usability of the HMI for the PSAP call taker software.

The data artifacts for each section include test case descriptions, data collection procedures, and data analysis templates. The test case descriptions provide a brief overview of each data collection event, a brief list of the NG9-1-1 system components required for that test case, the entrance and exit criteria, and the desired data outputs. The data collection procedures contain the detailed step-by-step process for conducting a specific data collection event. Finally, a template is provided for documenting and analyzing the NG9-1-1 POC data.

3.2 *Emergency Call Propagation and Timing*

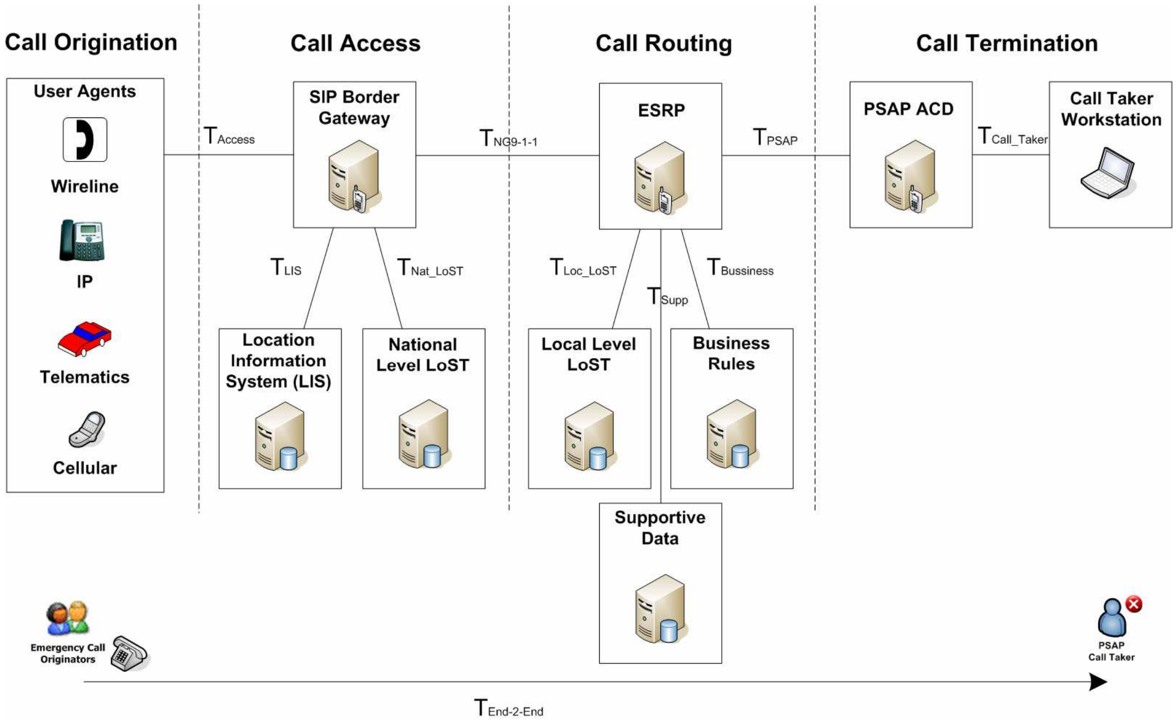


Figure 3–1—Call Propagation and Timing

3.2.1 Objectives and Hypothesis

Call propagation and timing is important to any emergency response system. When an emergency occurs, a matter of seconds can mean the difference between life and death. Currently, within the United States, a wireline emergency telephone call traverses from a call originator to a PSAP call taker in an average of 7 to 12 seconds.

The NG9-1-1 architecture presents a variety of new call origination sources, including IP phones, IP wireless handheld devices, sensor systems, telematics systems, cellular wireless devices and legacy wireline support. In addition, the NG9-1-1 concept allows many different media formats for emergency calling, including a combination of voice, video, and data (i.e. messaging/texting). As these technologies emerge and gain market acceptance, the public end user demands at least the same level of service as defined by legacy wireline calling. However, the call flow and processing of an NG9-1-1 call requires a major change in approach and additional steps compared with those associated with legacy technologies such as wireline telephony. Therefore, it is imperative that during the NG9-1-1 POC, call propagation and timing parameters are defined and tested.

The results of this analysis will assist a number of NG9-1-1 stakeholders. The USDOT or other pertinent Federal agencies can further influence congressional policy for acceptable emergency response system performance; SDOs can leverage these metrics for industry conformance standards; and emergency response vendors and service providers can differentiate their product offerings from those they offer to their other markets.

3.2.2 Measures of Interest

In Figure 3–1 above there are a number of interrelated call propagation metrics. Table 3–1 defines these measures of interest.

Table 3–1—Call Propagation and Timing Measures of Interest

Measure of Interest	Description	Constraints and Relationships
T_{Access}	This parameter represents the time for an emergency call to traverse an access network and arrive at an NG9-1-1 border gateway. It spans the time frame from when a call originator initiates an emergency call to when the border gateway receives the SIP INVITE message.	▸ This parameter is highly dependent on the type of device used by the call originator, the type of access network used by the device, and the conversion mechanism used to convert the call signaling to SIP. ▸ Each type of call origination source must be tested and will yield a unique representation of this parameter. ▸ If a call traverses a shared access/network link, this parameter could be significantly affected by superfluous network traffic. ▸ This parameter could be dissected further using knowledge of the underlying access technology.
T_{LIS}	This parameter represents the round trip time for a border gateway to query and receive location information for a call originator. Upon receipt of an emergency call, a border gateway inspects the call stream for location. If no location is present in the call stream, the border gateway queries a location information server (LIS) using a unique identifier. The LIS will then respond with the location of the call originator.	▸ This parameter is highly dependent on the access technology used by the call origination source. The border gateway must be designed to specifically handle this type of call source. ▸ The LIS will vary depending on type of access technology. For example— - Wired Telephony: LIS = Automatic Location Identification Database (ALI DB) - IP-based Telephony: LIS = VoIP Positioning Center (VPC) DB or Enterprise LIS solution - Telematics: LIS = Telematics Third-Party Call Center DB - Cellular: LIS = Mobile Position Center (MPC) DB ▸ Some IP-based call originators are capable of embedding their location in the call stream. In this case, T_{LIS} = 0. ▸ This parameter could be dissected further for a given access and LIS technology.

Measure of Interest	Description	Constraints and Relationships
T_{Nat_LoST}	This parameter represents the round trip time for a border gateway to acquire a location resolution from a National Location-to-Service Translation Protocol (LoST) server. Using the location of a call originator, the border gateway queries a National LoST server. The National LoST server uses the location information (civic or geospatial) to resolve to an ESRP uniform resource identifier (URI). The border gateway then forwards the call to the appropriate ESRP.	• LoST has been implemented using a Hypertext Transfer Protocol (HTTP) interface. Therefore, T_{Nat_LoST} is bound by the TCP time out window T_{Nat_LoST} < TCP timeout • Theoretically, a border gateway could forward traffic to a statically assigned ESRP, in which case, $T_{Nat\_LoST} = 0$
$T_{NG9-1-1}$	This parameter represents the time for an emergency call to traverse from a NG9-1-1 border gateway to an ESRP server. It spans the time frame from when the SIP INVITE leaves the border gateway to when ESRP receives the SIP INVITE.	• This parameter is highly dependent on the bandwidth and latency of the IP transport network used to forward the emergency call. • If the call traverses a shared access/ network link, this parameter could be significantly affected by superfluous network traffic. Dedicated connectivity is recommended. • This parameter could be dissected further if the network topology of the IP transport network was understood.
T_{Loc_LoST}	This parameter represents the round trip time for an ESRP to acquire a location resolution from a Local LoST server. Using the location embedded within the call stream, the ESRP queries a Local LoST server. The Local LoST Server uses the location information (civic or geospatial) to resolve to a PSAP URI. The border gateway then forwards the call to the appropriate ESRP.	• LoST has been implemented using an HTTP interface. Therefore, T_{Loc_LoST} is bound by the TCP time out window T_{Loc_LoST} < TCP timeout • Theoretically, a border gateway could forward traffic to a statically assigned PSAP, in which case, $T_{Loc\_LoST} = 0$

Measure of Interest	Description	Constraints and Relationships
$T_{Business}$	This parameter represents the round trip time for an ESRP to acquire business rules from the business rules DB. The business rules DB can change the routing of an emergency call based on call stream parameters embedded within the emergency call. In addition, the business rules DB can designate supplemental and supportive data sources for the ESRP to contact. The business rules DB returns these modified routing and data source instructions to the ESRP.	- Business Rules and routing changes for emergency calls should be used sparingly. The more business rules contained within the Business Rules DB the longer the query and its resolution will take. - This parameter is system implementation specific. Time could vary substantially based on the DB implementation (i.e. permanent versus volatile memory storage and access) of the Business Rules DB.
T_{Supp}	This parameter represents the round trip time for an ESRP to acquire supplemental or supportive data. A variety of supplemental and supportive data sources can exist. This information can be passed by value or reference, depending on the criticality of the information.	- This parameter is system and interface specific. Time could vary substantially based on the implementation of the external data source. - A federal mandate or the SDOs should define a maximum threshold for this parameter to ensure timely delivery of emergency calls.
T_{PSAP}	This parameter represents the time for an emergency call to traverse from an ESRP to a PSAP ACD. It spans the time frame from when the SIP INVITE leaves the ESRP to when PSAP ACD responds with a SIP OK.	- This parameter is highly dependent on the bandwidth and latency of the IP transport network used to forward the emergency call. - If the call traverses a shared access/ network link this parameter could be significantly affected by superfluous network traffic. Dedicated connectivity is recommended. - This parameter could be dissected further if the network topology of the IP transport network was known.
T_{Call_Taker}	This parameter represents the time for an Emergency Call to traverse from a PSAP ACD to a call taker's workstation. It spans the time frame from when the call enters the PSAP ACD queue to when the designated PSAP call taker answers the telephone.	- This parameter is dependent on human interaction and call load at a PSAP. If there are periods of unusually high call volume or insufficient resources at the PSAP, the value of this parameter could be significant. - PSAPs should actively monitor this parameter to determine adequate resource staffing.

Measure of Interest	Description	Constraints and Relationships
$T_{End\text{-}2\text{-}End}$	This parameter designates the time it for an emergency call to traverse the whole system from call origination to call reception. It spans the time frame from when a call originator initiates an emergency call to when the Call Taker picks up the telephone at the PSAP.	▸ This parameter designates the summation of all other timing parameters, $T_{End\text{-}2\text{-}End} = T_{Access} + T_{LIS} + T_{Nat\_LoST} + T_{NG9\text{-}1\text{-}1} + T_{Loc\_LoST} + T_{Business} + T_{Supp} + T_{PSAP} + T_{Call\_Taker}$ ▸ This parameter should be within reasonable thresholds as determined by PSAP governing authority.

3.2.3 Analysis Methodologies

Data Collection Test Cases

Test Case	Native IP-based Call Propagation and Timing (ID – DC0001)
Objective	This test case will evaluate the NG9-1-1 system's ability to initiate, propagate, and terminate an IP-based emergency call. The timing parameters discussed in Section 3.2.2 will be obtained to gauge overall system performance.
Description	An IP-enabled source will initiate a SIP-based emergency call into the NG9-1-1 system. The call will traverse the NG9-1-1 system and terminate at the desired PSAP and call taker. As the call traverses the system, component logs (i.e. Call Origination software, SIP Border Gateway software, ESRP software, PSAP ACD software) are generated that record the events of the call. Based on the component logs, timing parameters will be extracted through manual inspection and time difference calculations.
Equipment	▸ NTP Server, SIPc Client Software/IP Phone (SIP-based), IP Telephony Border Gateway, LoST Server, LIS Server, ESRP, IP ACD, Business Rules Database, PSAP Call Taker Software
Entrance Criteria	▸ All components must be present and operating according to the defined NG9-1-1 system design. ▸ Basic network connectivity between laboratory environments must be established. ▸ All hardware time sources must be synchronized using an NTP Server with a GPS or atomic clock source. NTP Server should be able to provide approximately 10 ms accuracy. ▸ All system component log files should record events with millisecond accuracy.
Exit Criteria	▸ The call terminates at the desired PSAP. ▸ Ten iterations of this test case are successfully run.
Data Outputs	▸ Log files are generated for each system component with appropriate timestamps.

Test Case	Legacy Telephony Call Propagation and Timing (ID – DC0002)
Objective	This test case will evaluate the NG9-1-1 system's ability to initiate, propagate, and terminate a Wireline Time Division Multiplex (TDM)-based emergency call. The timing parameters discussed in Section 3.2.2 will be obtained to gauge overall system performance.

Brief Description	An analog telephone source will initiate a TDM-base emergency call into the NG9-1-1 system. The call will be converted to SIP and traverse the NG9-1-1 system, terminating at the desired PSAP and call taker. As the call traverses the system, components logs are generated that record the events of the call. Based on the component logs, timing parameters will be extracted through manual inspection and time difference calculations.
Equipment	• NTP Server, Analog Telephone, Wireline Telephony Border Gateway, LoST Server, Simulated ALI DB, ESRP, IP ACD, Business Rules Database, PSAP Call Taker Software
Entrance Criteria	• All components must be present and operating according to the defined NG9-1-1 System design. • Basic network connectivity between lab environments must be established. • All hardware time sources must be synchronized using an NTP Server with a GPS or atomic clock source. NTP Server should be able to provide approximately 10 ms accuracy. • All system component log files should record events with millisecond accuracy.
Exit Criteria	• The call terminates at the desired PSAP. • Ten iterations of this test case are successfully run.
Data Outputs	• Log files are generated for each system component with appropriate timestamps.

Test Case	**Telematics Call Propagation and Timing (ID – DC0003)**
Objective	This test case will evaluate the NG9-1-1 system's ability to initiate, propagate, and terminate a telematics emergency call. The timing parameters discussed in Section 3.2.2 will be obtained to gauge overall system performance.
Brief Description	A telematics third-party call center will initiate an emergency call into the NG9-1-1 system. The call will be converted to SIP and traverse the NG9-1-1 system, terminating at the desired PSAP and call taker. As the call traverses the system, component logs are generated that record the events of the call. Based on the component logs, timing parameters will be extracted through manual inspection and time difference calculations.
Equipment	• NTP Server, Telematics Third-Party Call Center Telephone, Wireline Telephony Border Gateway, LoST Server, Emergency Crash Notification DB, ESRP, IP ACD, Business Rules Database, PSAP Call Taker Software
Entrance Criteria	• All components must be present and operating according to the defined NG9-1-1 system design. • Basic network connectivity between laboratory environments must be established. • All hardware time sources must be synchronized using an NTP Server with a GPS or atomic clock source. NTP Server should be able to provide approximately 10 ms accuracy. • All system component log files should record events with millisecond accuracy.
Exit Criteria	• The call terminates at the desired PSAP. • Ten iterations of this test case are successfully run.
Data Outputs	• Log files are generated for each system component with appropriate timestamps.

Test Case	Cellular Call Propagation and Timing (ID – DC0004)
Objective	This test case will evaluate the NG9-1-1 system's ability to initiate, propagate, and terminate a cellular emergency call. The timing parameters discussed in Section 3.2.2 will be obtained to gauge overall system performance.
Brief Description	A cellular telephone will initiate an emergency call into the NG9-1-1 system. The call will be converted to SIP and traverse the NG9-1-1 system, terminating at the desired PSAP and call taker. As the call traverses the system, component logs are generated that record the events of the call. Based on the component logs, timing parameters will be extracted through manual inspection and time difference calculations.
Equipment	- NTP Server, Cellular Telephone, Cellular Border Gateway, LoST Server, Simulated MPC DB, ESRP, IP ACD, Business Rules Database, PSAP Call Taker Software
Entrance Criteria	- All components must be present and operating according to the defined NG9-1-1 system design. - Basic network connectivity between laboratory environments must be established. - All hardware time sources must be synchronized using an NTP Server with a GPS or atomic clock source. NTP Server should be able to provide approximately 10 ms accuracy. - All system component log files should record events with millisecond accuracy.
Exit Criteria	- The call terminates at the desired PSAP. - Ten iterations of this test case are successfully run.
Data Outputs	- Log files are generated for each system component with appropriate timestamps.

Test Case	SMS Call Propagation and Timing (ID – DC0005)
Objective	This test case will evaluate the NG9-1-1 system's ability to initiate, propagate, and terminate an SMS emergency text message. The timing parameters discussed in Section 3.2.2 will be obtained to gauge overall system performance.
Brief Description	A cellular telephone will initiate an emergency text message into the NG9-1-1 system. The SMS message will be converted to a SIP message and traverse the NG9-1-1 system, terminating at the desired PSAP and call taker. As the call traverses the system, component logs will be generated that record the events of the call. Based on the component logs, timing parameters will be extracted through manual inspection and time difference calculations.
Equipment	- NTP Server, Cellular Telephone, SMS Border Gateway, LoST Server, Simulated MPC DB, ESRP, IP ACD, Business Rules Database, PSAP Call Taker Software
Entrance Criteria	- All components must be present and operating according to the defined NG9-1-1 system design. - Basic network connectivity between laboratory environments must be established. - All hardware time sources must be synchronized using an NTP Server with a GPS or atomic clock source. NTP Server should be able to provide approximately 10 ms accuracy. - All system component log files should record events with millisecond accuracy.

Exit Criteria	‣ The call terminates at the desired PSAP. ‣ Ten iterations of this test case are successfully run.
Data Outputs	‣ Log files are generated for each system component with appropriate timestamps.

Data Collection Procedure

Because of the similarity in the test cases, only one instance of the data collection procedure will be documented for all of the data collection test cases described above.

Test Case Name	[Native IP Telephony | Legacy Wireline | Telematics | Cellular | SMS] Call Propagation and Timing		
Participants Names:		**Dates:**	
Estimated Execution Time:	**8 hours/Test Case**	**Actual Execution Time:**	
Description: This data collection procedure will acquire the timing metrics associated with a specific call origination device.			
Measures of Interest Acquired: T_{Access}, T_{LIS}, T_{Nat_LoST}, $T_{NG9\text{-}1\text{-}1}$, T_{Loc_LoST}, $T_{Business}$, T_{PSAP}, T_{Call_Taker}			
Setup: 1. Ensure power is supplied to all system components and they are currently powered on. 2. Ensure network connectivity exists between all labs by performing basic PING connectivity testing. 3. Ensure all systems components have a reliable connection to a single NTP Stratum 1 Server. 4. Ensure granular software logging is enabled for all system components.			

Procedure

#	Action	Expected Results	Actual Results/Comments
1	Launch Network Protocol Analyzer (Wireshark) on all applicable system components. (i.e., Call Origination Sources, Border Gateways, ESRPs, PSAP IP ACD, and Call Taker Workstation)	Software should load successfully.	
2	For each component using Wireshark, apply a filter for monitoring IP, SIP, SDP, and HTTP traffic		

#	Action	Expected Results	Actual Results/Comments
3	Initiate an Emergency Call from the Call Origination Source: - IP = SIPc Client Software - Legacy Wireline = Analog Phone - Telematics = 3rd Party Call Center Phone - Cellular = Cellular Phone - SMS = Cellular Phone		
4	Inspect logs on Call Origination or Transition Device to ensure a SIP INVITE was generated and forwarded to the Border Gateways - IP = Laptop w/ Wireshark - Legacy Wireline = Logs on IP Telephony Router (Cisco 2821) - Telematics = Asterix Telephony Gateway w/ Wireshark - Cellular = Logs of Cellular Media Gateway - SMS = Logs on SMS Media Gateway (Pulsewan)		
5	Inspect Wireshark on the [IP | Legacy Wireline | Telematics | Cellular | SMS] Border Gateway to ensure the SIP INVITE was received	Use the time difference between when the SIP INVITE was initiated at the Call Origination Source and when the SIP INVITE was received at the respective Border Gateway to acquire T_{Access}.	

#	Action	Expected Results	Actual Results/Comments
6	Inspect Wireshark on the respective Border Gateway to ensure it acquired location for the Call Origination Source. Border Gateways will interact with the following systems for location acquisition: - IP = LIS Server / Simulated VPC - Legacy Wireline = Simulated ALI DB - Telematics = N/A - Cellular = Simulated MPC - SMS = N/A (New System Required)	Note: Each Call Origination Source is associated with a different location acquisition system. Access methods/interfaces vary for each location acquisition systems. Therefore, different Request/ Response Pairs must be inspected using Wireshark to determine T_{LIS} depending on the executed test case.	
7	Inspect Wireshark on the respective Border Gateway to ensure it successfully performed a LoST query	Use LoST Query Request/Response Pair to determine T_{Nat_LoST}	
8	Inspect Wireshark on the respective Border Gateway to ensure it successfully forwarded the SIP INVITE to the appropriate ESRP		
9	Inspect Wireshark on the ESRP to ensure the SIP INVITE was received	Use the time difference between when the SIP INVITE was forwarded from the Border Gateway and when the SIP INVITE was received at the ESRP to acquire $T_{NG9\text{-}1\text{-}1}$.	
10	Inspect Wireshark on the respective ESRP to ensure it successfully performed a LoST query	Use LoST Query Request/Response Pair to determine T_{Loc_LoST}.	

#	Action	Expected Results	Actual Results/Comments
11	Inspect Wireshark on the respective ESRP to ensure it successfully performed a Business Rules DB query	Use Business Rules DB Query Request/Response Pair to determine $T_{Business}$.	
12	Inspect Wireshark on the ESRP to ensure it successfully forwarded the SIP INVITE to the appropriate PSAP IP ACD		
13	Inspect Wireshark on the PSAP IP ACD to ensure the SIP INVITE was received	Use the time difference between when the SIP INVITE was forwarded from the ESRP and when the SIP OK message was returned to the Call Origination Source to acquire T_{PSAP}	
12	Inspect Wireshark on the PSAP IP ACD to ensure it successfully forwarded the SIP INVITE to an available Call Taker Workstation		
13	Inspect Wireshark on the Call Taker Workstation to ensure the SIP INVITE was received	Use the time difference between when the SIP INVITE was forwarded from the PSAP IP ACD and when the SIP Invite was received at the Call Taker Workstation to acquire $T_{Call\ Taker}$.	
14	Repeat this data collection process 10 times per test case [IP-based | Legacy Wireline | Telematics | Cellular | SMS]		

Data Analysis Template

Call Origination Source	Iteration	T_{Access} (ms)	T_{LIS} (ms)	T_{Nat_LoST} (ms)	T_{NG91-1} (ms)	T_{Loc_LoST} (ms)	$T_{Business}$ (ms)	T_{PSAP} (ms)	T_{Call_Taker} (ms)	$T_{End-to-End}$ (ms)
IP-Based User Agent	1									
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									
	Mean									
	Minimum									
	Maximum									
	Standard Deviation									
Legacy Wireline	1									
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									
	Mean									
	Minimum									
	Maximum									

Call Origination Source	Iteration	T_{Access} (ms)	T_{LIS} (ms)	T_{Nat_LoST} (ms)	T_{NG91-1} (ms)	T_{Loc_LoST} (ms)	$T_{Business}$ (ms)	T_{PSAP} (ms)	T_{Call_Taker} (ms)	$T_{End-to-End}$ (ms)
	Standard Deviation									
Telematics	1									
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									
	Mean									
	Minimum									
	Maximum									
	Standard Deviation									
Cellular	1									
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									
	Mean									
	Minimum									
	Maximum									

Call Origination Source	Iteration	T_{Access} (ms)	T_{LIS} (ms)	T_{Nat_LoST} (ms)	T_{NG91-1} (ms)	T_{Loc_LoST} (ms)	$T_{Business}$ (ms)	T_{PSAP} (ms)	T_{Call_Taker} (ms)	$T_{End-to-End}$ (ms)
	Standard Deviation									
SMS	1									
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									
	Mean									
	Minimum									
	Maximum									
	Standard Deviation									

3.3 Emergency Call Availability and Quality—Component/Interface Availability

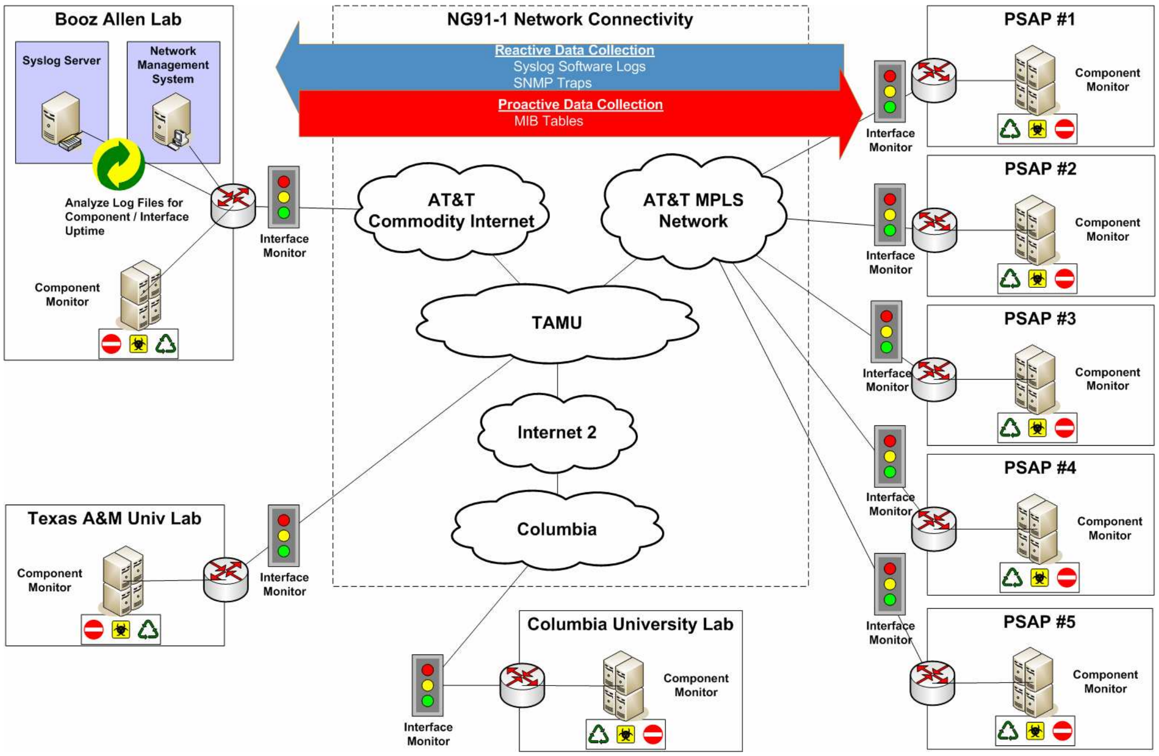


Figure 3–2—NG9-1-1 POC Component and Interface Availability

3.3.1 Objectives and Hypothesis

Proper operation of NG9-1-1 system components and interfaces is vital to an effective emergency response service. As a mission critical system, the NG9-1-1 System must provide near 100 percent uptime. This can be accomplished effectively by building multiple levels of redundancy within the network and the system components. NG9-1-1 system components should have backups and be hot swappable. In addition, there should be redundant network links that automatically failover in the case of failure or can be used for additional bandwidth in case of catastrophic events such as natural disasters or terrorist attacks.

When planning and implementing systems, it is important to know the availability of a single component or interface. These measures are usually acquired through statistical analysis of operational system components. Because the POC is research oriented, no efforts will be made to design a fully redundant or 100% available system. However, software (Syslog servers and Network Management software) will be used to track uptime of the NG9-1-1 system components. This information will prove useful in gathering basic information on component availability. For a production system, these metrics could serve as starting points in determining the number of levels of redundancy needed to acquire a certain level of availability (e.g., 99.999% uptime) for the NG9-1-1 system.

3.3.2 Measures of Interest

Table 3–2—Component and Interface Availability Measures of Interest

Measure of Interest	Description	Constraints and Relationships
Component Availability (Downtime/year)	**Availability:** **2 9's (99%)** = downtime less than 87.6 hours per year **3 9's (99.9%)** = downtime less than 8.8 hours per year **4 9's (99.99%)** = downtime less than 53 minutes per year **5 9's (99.999%)** = downtime less than 315 seconds per year	▸ Component Availability is heavily dependent on reliable hardware, software, and power sources
Interface Availability (Downtime/year)	See above	▸ Interface Availability is heavily dependent on robust networking hardware, software, power sources, and access medium.
System Availability	See above	▸ System Availability is dependent on component and interface availability. Since no redundancy is built into the NG9-1-1 POC all components / interface are consider in series. Therefore, system availability can be calculated by summing the downtime of all the components and interfaces.

3.3.3 Analysis Methodologies

Data Collection Test Cases

Test Case	**Emergency Component/Interface Availability (ID – DC0006)**
Objective	This test case will evaluate the NG9-1-1 component and interface availability. The availability parameters discussed in Section 3.3.2 will be obtained to gauge overall system performance.
Description	Over the course of the POC, a Syslog Server and Network Management System will be deployed to track the uptime of system components and interfaces. This is done through software logs that are harvested by the Syslog Server and through SNMP traps generated by network and server equipment for the Network Management System. Once the POC is complete, these logs will be parsed and a system component or interfaces uptime/downtime can be obtained.

Equipment	▸ All NG9-1-1 system components and interfaces
Entrance Criteria	▸ All components must be present and configured to log system events to their respective operating system (OS) syslog. ▸ The Syslog Server must be installed and functioning properly. ▸ The Syslog Server must be configured to harvest the components' Syslogs at configured time intervals (i.e., Daily, Weekly, Monthly basis). ▸ The Network Management System must be installed and functioning properly. ▸ The Network Management System must be configured to poll system components and interfaces using Management Information Bases (MIBs.) ▸ The Network Management System must be configured to collect SNMP traps from system components and interfaces.
Exit Criteria	▸ Completion of the POC
Data Outputs	▸ Software Log files are generated for each system component and stored within the Syslog Server. ▸ The Network Management System proactively polls devices and creates logs using component and interface MIB tables. The Network Management System reactively stores logs of component and interface SNMP traps.

Data Collection Procedure

Test Case Name	Emergency Component/Interface Availability		
Participants Names:		**Dates:**	**May – June 2008**
Estimated Execution Time:	**6 months**	**Actual Execution Time:**	

Description: This data collection procedure will acquire the availability metrics associated with the NG9-1-1 components and interfaces.

Measures of Interest Acquired: Component Availability, Interface Availability

Setup:

1. Ensure Power is supplied to the Syslog server and Network Management System, and they are currently powered on.
2. Initially ensure network connectivity exists between the Syslog server and Network Management System, and all monitored components by performing basic PING and TRACEROUTE connectivity testing.
3. Ensure all systems components have a reliable connection to a single NTP Stratum 1 Server.
4. Ensure granular Syslog software logging is enabled for all system components.
5. Ensure SNMP services are turned on for all system components.

Procedure

#	Action	Expected Results	Actual Results/Comments
1	Collect component and interface events using the Syslog Server and Network Management System		
2	Parse component log files looking for events that brought the component down or forced it to be restarted	Component Availability metric obtained by summing the downtime across the time span of the POC.	
3	Parse interface log files looking for events that infer the interface was down	Interface Availability metric obtained by summing the downtime across the time span of the POC.	
4	Repeat this action for each component and interface for which logs were collected.		

Data Analysis Template

	Month 1			Month 2		
NG9-1-1 System Component	Number of Incidents	Number of Restarts	Total Down Time	Number of Incidents	Number of Restarts	Total Down Time
Emergency Call Access Technology						
Legacy Telephony Gateway						
Asterix Telematics Gateway						
Cellular Media Gateway						
SMS Media Gateway						
IP SIP Gateway						
Legacy Wireline SIP Gateway						
Telematics SIP Gateway						
Cellular SIP Gateway						
SMS SIP Gateway						
National LoST Server						
Simulated ALI / MPC DB						
IP LIS (RedSky)						

Emergency Call Routing						
ESRP Server #1						
ESRP Server #2						
Local LoST Server						
Business Rules DB Server						
Emergency Call Termination Components						
PSAP #1 IP ACD						
PSAP #2 IP ACD						
PSAP #3 IP ACD						
PSAP #4 IP ACD						
PSAP #5 IP ACD						
Network Infrastructure						
Booz Allen Router						
Texas A&M Router						
Columbia Router						
PSAP #1 Router						
PSAP #2 Router						

PSAP #3 Router						
PSAP #4 Router						
PSAP #5 Router						
Network Interfaces						
Booz Allen Lab						
Texas A&M Lab						
Columbia Lab						
PSAP #1						
PSAP #2						
PSAP #3						
PSAP #4						
PSAP #5						
Overall System Availability						
System Availability – Month 1						
System Availability – Month 2						

3.4 Emergency Call Availability and Quality—IP Network Quality

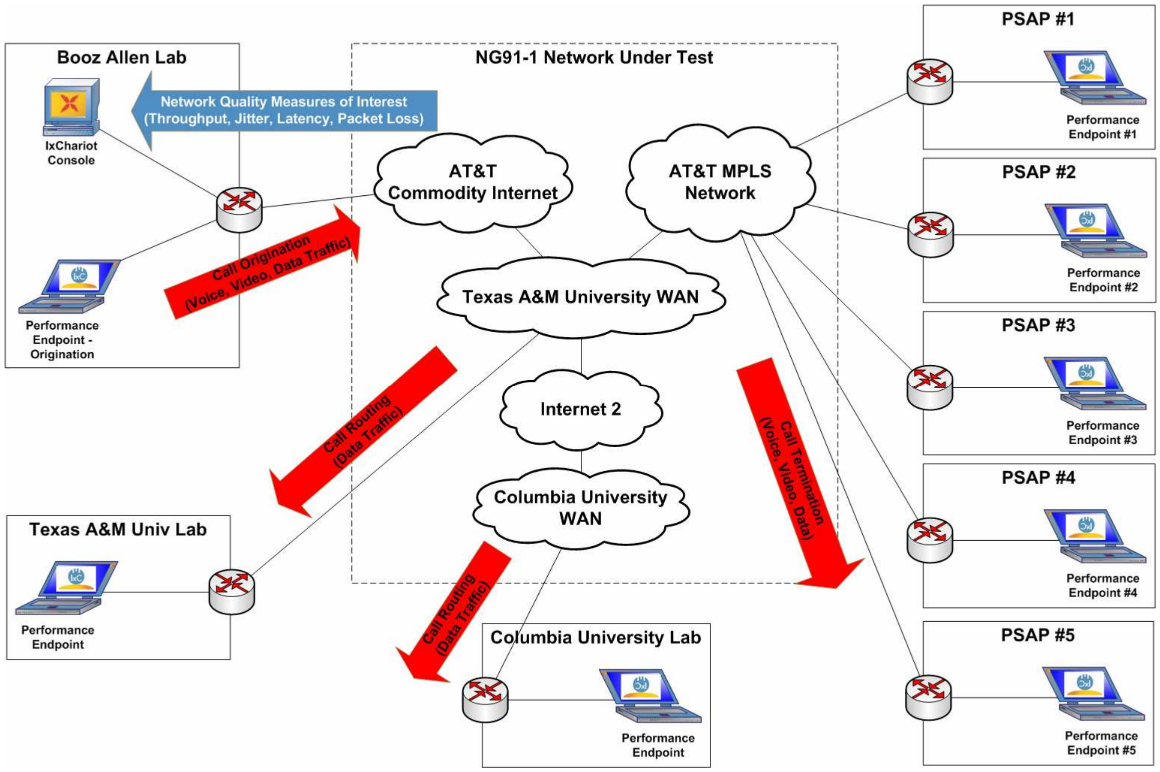


Figure 3–3—Emergency IP Network Quality

3.4.1 Objectives and Hypothesis

Given the NG9-1-1 system's reliance on IP networking for emergency call transport, IP network performance plays a key role in call quality. IP networks were originally designed to transport data packets. However, given the ubiquity of IP-based technology today, these networks are now being used to transport a plethora of converged services, including voice, video, and data. Voice and video traffic confronts unique networking challenges because of its time sensitivity. Lost IP packets quickly degrade the quality of the voice and video streams and retransmission is typically not an option. Therefore, it is imperative that an optimized network exist to transport voice and video call streams especially in an emergency response context.

Given the popularity of IP networks, extensive effort has been expended to characterize network performance. Many network test tools are available to automate testing network performance. For the POC, a combination IP Traffic Generator and Network Analyzer will be used to profile NG9-1-1 network performance. End point software will be installed at each POC laboratory and PSAP. A series of tests will be run from the multiple end points. These end points can be configured to send a variety of voice, video, and data traffic across the network. Based on the traffic scenarios, network performance metrics will be calculated and then forwarded to a console for graphical display. Given the variety of networks an emergency call must traverse, these metrics will be vital in determining call quality and the overall experience of the call originators and call takers.

3.4.2 Measures of Interest

Table 3–3—IP Network Quality Measures of Interest

Measure of Interest	Description	Constraints and Relationships
Throughput (Bandwidth)	The number of bits per unit of time forwarded to the correct destination	• This parameter is highly dependent on the access technology used. An emergency call must propagate across multiple access networks before it is terminated at the appropriate PSAP. • Throughput is measured from an end-to-end perspective from call origination source to PSAP destination. • Throughput is preferred to be at least 85 percent of slowest access network link.
Jitter	The mean statistical deviation of packet inter-arrival times	• This parameter is particularly important to voice and video network traffic. Large amounts of jitter degrade voice and video quality and can render them incomprehensible. • Appropriate buffering at end point applications can assist with jitter constraints. • Jitter should be < 50 ms for voice and video.
Latency (Response Time)	The time needed to complete one request/response transaction	• This parameter measures users' experience when establishing emergency calls. • Latency should be < 100 ms.
Packet Loss	Number of datagrams sent minus datagrams received	• This parameter measures the impact on voice and video applications. Packet loss is directly related to call quality. Time-sensitive UDP-based media such as voice and video cannot handle large amounts of packet loss. • Packet Loss should be < 1 percent.

3.4.3 Analysis Methodologies

Data Collection Test Cases

Test Case	Emergency IP Network Quality (ID – DC0007)
Objective	This test case will evaluate the NG9-1-1 IP network quality. The network quality metrics discussed in Section 3.4.2. will be obtained to gauge overall system performance.
Description	IP traffic generators (Ixia End Point Software) will be installed on a laptop at each laboratory and PSAP location. Traffic scenarios will be defined that create different traffic streams (voice, video, data) on the NG9-1-1 POC network. IP network performance metrics (Throughput, Jitter, Latency, and Packet Loss) will be capture and displayed on a network analyzer console (IxChariot Console).
Equipment	▸ IxChariot Console, Ixia Endpoint Software, 1 Laptop per Laboratory and PSAP Location
Entrance Criteria	▸ All laptop end points must be present and configured with traffic scenarios and the network analyzer console location (IP Address). ▸ The network analyzer console (IxChariot) must be present and operating. ▸ Basic network connectivity between laboratory environments and PSAPs must be established. ▸ All end point and console hardware time sources must be synchronized using an NTP Server with a GPS or atomic clock source. NTP Server should be able to provide approximately 10 ms accuracy.
Exit Criteria	▸ All defined network traffic scenarios have been run and the tests/ metrics have been acquired.
Data Outputs	▸ Network Analyzer Log files for Throughput, Jitter, Latency, and Packet Loss.

Data Collection Procedure

Test Case Name	Emergency IP Network Quality		
Participants Names:		Dates:	
Estimated Execution Time:	1 week	Actual Execution Time:	
Description: This data collection procedure will acquire the IP network quality metrics associated with the NG9-1-1 POC network.			
Measures of Interest Acquired: Throughput, Jitter, Latency, Packet Loss			
Setup: 1. Ensure power is supplied to software end points and console and they are currently powered on. 2. Ensure network connectivity exists between laboratories and PSAPs by performing basic PING connectivity testing. 3. Ensure all end points have a reliable connection to a single NTP Stratum 1 Server.			

Procedure

#	Action	Expected Results	Actual Results/Comments
1	Create traffic scenarios for each end point.		
2	Log into network analyzer console and configure a connection with each end point.		
3	Using the console, load a given traffic scenario into each end point.		
4	Use console to execute network test.		
5	Collect resultant log files	These files will contain the throughput, jitter, latency, and packet loss for a given traffic scenario.	
6	Repeat process for each desired traffic scenario		

Data Analysis Template

Traffic Scenario	Description	Throughput (Mbps)	Jitter (ms)	Latency (ms)	Packet Loss (%)
1	Data Traffic between Booz Allen Lab and Columbia Lab				
2	Data Traffic between Booz Allen Lab and Texas A&M Lab				
3	Data Traffic between Booz Allen Lab and PSAP #1				
4	Data Traffic between Booz Allen Lab and PSAP #2				
5	Data Traffic between Booz Allen Lab and PSAP #3				
6	Data Traffic between Booz Allen Lab and PSAP #4				
7	Data Traffic between Booz Allen Lab and PSAP #5				
8-14	Voice Traffic between two End Points				
15-21	Video Traffic between two End Points				
22-28	Data/Voice Traffic between two End Points				
29-35	Data/Video Traffic between two End Points				
36-42	Voice/Video Traffic between two End Points				
43-49	Voice/Video/Data Traffic between two End Points				
50	Voice/Video/Data Traffic between multiple End Points				

3.5 Emergency Call Scalability

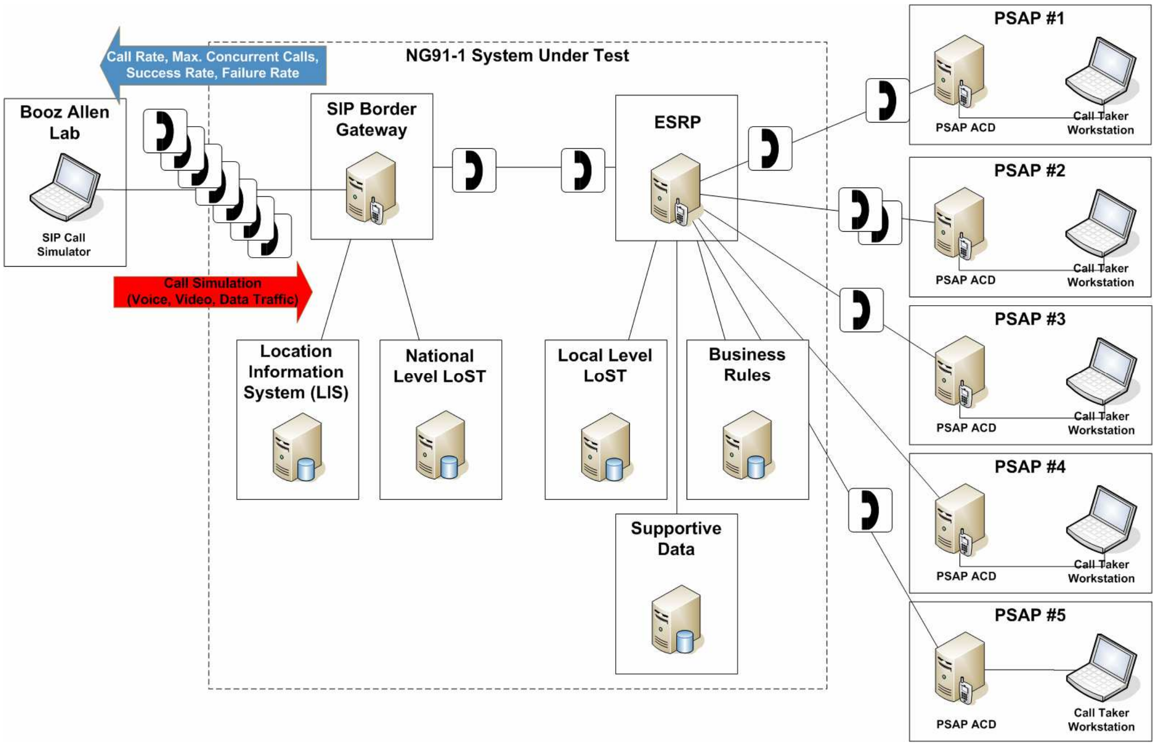


Figure 3–4—Emergency Call Scalability

3.5.1 Objectives and Hypothesis

Capacity planning is an important task for any network, especially in emergency response networks. In these networks, call traffic fluctuates based on a variety of factors. The network should be implemented to support a typical amount of call traffic based on the area and population served by that PSAP. A PSAP's call activity is typically monitored, and these numbers are usually readily available for a given PSAP jurisdiction. During a wide-scale emergency, call traffic abnormally increases, creating a spike in call traffic and stressing the capacity of the network. Designing scalability into an emergency response network is imperative for handling these situations, which, though uncommon and unexpected, must be addressed. In an emergency response network, both the network and system components should be able to handle an additional call load and dynamically scale according to need.

3.5.2 Measures of Interest

Table 3–4—Call Scalability Measures of Interest

Measure of Interest	Description	Constraints and Relationships
Call Rate (Calls/sec)	Number of calls per second a system can handle	▸ This metric depends on the bandwidth of the network, the processing power of the SIP Servers (i.e., hardware), and the efficiency and limitations of the code for the SIP Servers (i.e., Software). ▸ An emergency call must propagate through multiple SIP servers in the NG9-1-1 network. This parameter is bound by the weakest link in the series of SIP Servers.
Maximum Concurrent Calls	The number of concurrent calls that can be simultaneously terminated	▸ This metric is limited by the amount of bandwidth the network supports, the type of calls coming into a PSAP (voice, video, data), the number of call takers that can handle incoming calls, and the queuing technology in the PSAP used to terminate emergency calls.
Call Success (%)	Number of successfully terminated calls divided by the total number of calls sent	▸ For a given call load, this metric is useful in determining the number of calls that can be handled simultaneously.
Call Failure (%)	Number of failed calls divided by the total number of calls sent	▸ There are a number of reasons a call can fail within an emergency response network. These include— - Maximum number of UDP retransmission attempts has been reached - TCP congestion - Recv buffer timeout - Send buffer timeout - A SIP message was received that cannot be associated with an existing call - A SIP message was received that is not expected in the scenario - Unable to send the message (transport issue) This metric captures all of these reasons for failure.

3.5.3 Analysis Methodologies

Data Collection Test Cases

Test Case	Emergency Call Scalability (ID – DC0008)
Objective	This test case will evaluate the NG9-1-1 system's ability to handle large call loads (call scalability). The network metrics discussed in Section 3.5.2 will be obtained to gauge overall system performance.
Description	A SIP Call Simulator (SIPp) will be installed on a laptop at the Origination Location (Booz Allen Laboratory). The Call Simulator will inject call scenarios with different traffic streams (voice, video, data) into the NG9-1-1 POC network. Scalability metrics (Call Rate, Concurrent Calls, Success Rate, Failure Rate) will be captured and displayed on a Call Simulator GUI console (SIPp).
Equipment	▸ SIPp Software, Laptop, NG9-1-1 System Components (SIPp Telephony Gateway, ESRP, IP ACD, Call Taker Workstation)
Entrance Criteria	▸ SIPp must be present and configured with desired call scenario ▸ Basic network connectivity between laboratory environments and PSAPs must be established. ▸ All component hardware time sources must be synchronized using an NTP Server with a GPS or atomic clock source. NTP Server should be able to provide approximately 10 ms accuracy.
Exit Criteria	▸ All defined Call scenarios have been run and the tests/metrics have been acquired.
Data Outputs	▸ Call Simulator capture files for Call Rate, Concurrent Calls, Success Rate, Failure Rate

Data Collection Procedure

Test Case Name	Emergency Call Scalability		
Participants Names:		Dates:	
Estimated Execution Time:	1 week	Actual Execution Time:	
Description: This data collection procedure will acquire the call scalability metrics associated with the NG9-1-1 POC network.			
Measures of Interest Acquired: Call Rate, Concurrent Calls, Success Rate, Failure Rate			
Setup: 1. Ensure power is supplied to system components and call simulator laptop. 2. Ensure network connectivity exists between laboratories and PSAPs by performing basic PING connectivity testing. 3. Ensure all end points have a reliable connection to a single NTP Stratum 1 Server.			

Procedure

#	Action	Expected Results	Actual Results/Comments
1	Create call scenarios for SIP Call Simulator (SIPp).		
3	Using SIPp, load a given call scenario.		
4	Use SIPp to execute a Call Load Test.		
5	Collect resultant log files	These files will contain the Call Rate, Concurrent Calls, Success Rate, and Failure Rate for a call scenario.	
6	Repeat process for each desired call scenario		

Data Analysis Template

Call Scenario	Description	Call Rate (Calls / sec)	Maximum Concurrent Calls	Call Success (%)	Call Failure (%)
1	Data Traffic between Booz Allen Lab and PSAP #1				
2	Data Traffic between Booz Allen Lab and PSAP #2				
3	Data Traffic between Booz Allen Lab and PSAP #3				
4	Data Traffic between Booz Allen Lab and PSAP #4				
5	Data Traffic between Booz Allen Lab and PSAP #5				
6-10	Voice Traffic between two End Points				
11-15	Video Traffic between two End Points				
16-20	Data/Voice Traffic between two End Points				
21-25	Data/Video Traffic between two End Points				
36-30	Voice/Video Traffic between two End Points				
31-35	Voice/Video/Data Traffic between two End Points				

3.6 Call Taker Software Usability

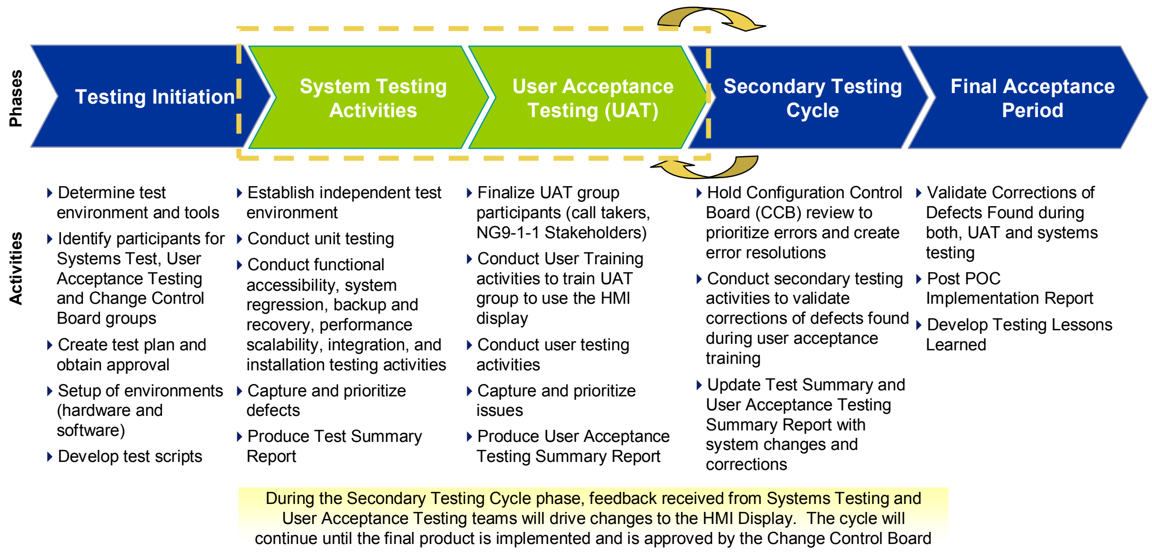


Figure 3–5—HMI System and User Acceptance Testing Phases

HMI System and UAT is vital to the success of the HMI and ensures that the HMI display fully meets the usability and operational requirements of the call takers and other NG9-1-1 stakeholders. A rigorous testing approach will be employed to ensure the proper functionality and operation of the system. The Booz Allen team will use a strict methodology to test the HMI display and adhere to industry best practices and standards to deliver a testing framework that meets the specific needs of the HMI solution. This methodology leverages an iterative approach to reduce risk, eliminate re-work and ease maintenance of test tools (such as test scripts and error reports). Figure 3-5 identifies the key activities that will occur during the HMI User Acceptance Testing phases.

NG9-1-1 stakeholders will be involved throughout all stages of the testing process, to ensure that the HMI solution not only technically meets the defined system requirements, but also provides for an intuitive and user friendly display. As such, the NG9-1-1 POC team will work with the software designers and developers, NG9-1-1 stakeholder community, call takers, subject matter experts, and management to conduct comprehensive System and User Acceptance Test phases and identify acceptance criteria for the HMI solution.

HMI System and User Acceptance Testing activities will be performed by developing and executing comprehensive test cases/scripts and test procedures, and recording this information and results in the Test Summary reports. System Testing will use the "black box" strategy. This implies that the tester does not need to have extensive working knowledge of the code in order to plan for and execute the actual tests. System test cases and scripts can be written, tested, and validated in accordance with the design and requirements without knowledge of the code and internal program structure.

HMI System Testing will be conducted during development and throughout the POC testing phase. New functionality will be validated to ensure that changes applied to prior functionality during development did not have a negative impact on existing operation. This phase will also include testing to ensure that the modified system meets all functional and technical requirements, while validating proper component integration, data quality, and HMI navigation.

The UAT phase will be conducted to test the HMI pilot and its usefulness to the call takers. The UAT cycle is used to test readiness for a production pilot and verify the effectiveness of the display. Selected UAT testing team (which will consist of call takers and NG9-1-1 stakeholders) will conduct functionality and usability testing of the HMI display. The team will identify all potential issues with the HMI and compile a UAT report. The report will be evaluated by the CCB[2], and resolutions will be determined for each of the issues.

Defects will be consistently documented using the Test Summary and UAT Summary reports, to ensure all defects are corrected and retested prior to redeployment of the HMI solution. The reports will document results from test activities to ensure the HMI display is fully tested and has a high degree of quality.

The reports will be evaluated by the CCB to identify the resolution to each of the identified issues. Resolutions for identified issues will be documented and tracked by the System Test Summary and UAT Summary reports. The reports will be presented to the development team to fix the identified issues. Upon completion of system changes, the testing teams will re-test the system. At the conclusion of retesting activities, the CCB will validate correction of defects identified in production, ensure successful deployment of patches and other corrections to HMI applications, and monitor HMI performance.

3.6.1 Objectives and Hypothesis

The UAT approach to testing the HMI offers a comprehensive, yet flexible approach to ensure the usability of the display. The UAT approach will verify that—

- Requirements are tracked and implemented according to specifications
- Software functionality operates as intended
- System quality is measured throughout the life cycle
- Production ready HMI display is delivered to the call-takers and the NG9-1-1 user community.

The UAT will test all functional activities of a call taker operating the HMI display. The activities are based on the end-to-end call flow shown in Figure 3-8 of the *NG9-1-1 System Description and Requirements Document*, which describes the interaction of the

[2] Change Control Board (CCB)—will consist of individuals from the NG9-1-1 Project Team. Please refer to the NG9-1-1 Configuration Management Plan for further details.

call taker with the NG9-1-1 system and provides an overview of the processing of data during the duration of the call. Table 3–5 summarizes the HMI call taker tasks that will be tested.

Table 3–5—User Acceptance Testing of HMI Functional Activities

Service Area	Functional Activity	Definition	Information Needs
Call Answering	Manage Call Queues	Provide the capability to manage call queues and deliver the 9-1-1 call to a call taker workstation.	▸ Call Stream ▸ ACD Rules ▸ Call Detail Record ▸ GIS Display Rules ▸ Geospatial Information ▸ Status Record
	Answer Call	Provide the capability to answer incoming a 9-1-1 call in response to an audible and/or visual indicator.	▸ Call Detail Record ▸ Call Handling Procedures
	Initiate Call Back	Establish communications circuit between call taker and receiving party.	▸ Call Detail Record ▸ ACD Rules/Call Queue Record
Call Processing	Determine Nature of the Emergency	Determine the nature of the emergency and provide an initial assessment of the situation. (This activity involves obtaining the necessary information—the "Five Ws"—to route the caller to the proper person or agency, or to dispatch the proper emergency response.)	▸ Nature of Emergency ▸ Call Handling standard operating procedures (SOP) ▸ List of Potential Natures ▸ Additional Interrogation Information ▸ Geographic Call Locations ▸ Call Status
	Determine and Verify Location of the Emergency	Determine whether an emergency is located at the caller's location or elsewhere. Ensure responders are directed to the correct location.	▸ Caller Location ▸ GIS ▸ Emergency Location ▸ Verifying Location Display Rules
	Update Mobile Caller's Location Information	Receive location information for mobile callers.	▸ Rebidding Rules ▸ Call Detail Record ▸ Display Rules ▸ Caller Location Details
	Identify Appropriate Responding Agency or Service	Select appropriate responders based on the nature and location of the emergency, incident management procedures, and SOPs.	▸ Emergency Location ▸ Responding Agencies ▸ Business Rules ▸ Call Type/Call Handling Procedures ▸ Nature of Emergency ▸ Displayed Agencies

Service Area	Functional Activity	Definition	Information Needs
	Provide Pre-Arrival Instructions to Caller	Provide pre-arrival instructions or other information to call taker. A call taker may distribute pre-arrival instructions to a caller as necessary.	▸ Nature of Emergency ▸ Call Handling SOPs ▸ Additional Interrogation Information
	Establish Conference Call	Establish communications among the call taker, caller, third-party (e.g., telematics) service providers, and appropriate public safety entities.	▸ Call Detail Record ▸ ACD Rules/Call Queue Record
Call Records Management	Record Call	Preserve a detailed record of the interactive communications occurring during a 9-1-1 call.	▸ Real Time Interactive Communications ▸ Record Interactive Communication ▸ Retrieve Call Recording ▸ Call Detail Record
	Obtain Supportive or Supplemental Data Post Call Delivery	Obtain supportive or supplemental data (e.g., medical history, telematics, geospatial, data, or interactive video) after the 9-1-1 call has been delivered to facilitate call processing.	▸ Supportive/Suppleme ntal Data ▸ Call Detail Record ▸ Medical History Data ▸ GIS
	End Call	Terminate existing 9-1-1 call and return to ready to accept next call.	▸ ACD Rules /Call Queue Record
	Transfer Call	Share all essential supportive, supplemental, and/or any manually-entered data concerning the call to the appropriate responding agency dispatch or authorized entity.	▸ ACD Rules /Call Queue Record ▸ Permission Rules ▸ Transfer Protocols/Data ▸ Record of Transmission Success/Failure
Geospatial Visualization	Display Geospatial Visualization	Display the 9-1-1 call location and geospatial information on a map.	▸ Caller Location ▸ Geographic Call Locations ▸ Emergency Location ▸ Verifying Location Display Rules ▸ GIS Display Rules ▸ Geospatial Information
	Manipulate Geospatial Data	Manipulate 9-1-1 call location and geospatial information.	▸ GIS Display Rules ▸ Geospatial Information
Data Management	Submit Caller Information Error Report	Submit caller information error report to the originating data provider for correction.	▸ ACD Rules/Call Queue Record ▸ Call Detail Record ▸ ACD Rules/Call Queue

3.6.2 Measures of Interest

Table 3–6 identifies the testing criteria that the UAT team will evaluate while testing the usability and functionality of the HMI display.

Table 3–6—HMI Usability Measures of Interest

Measure of Interest	Description	Constraints and Relationships
Placement of Data on the Screen	Ensures manageable and intuitive layout of HMI applications and features. The HMI display is complex and contains a large amount of information. Testers should ensure that all "essential" data is available to the call takers	• HMI screen should provide easy access to materials, dispatch unit locators, help files, interrogation questions, departmental listings, and other call taker tools. • HMI screen should provide the call-taker with easy access to message send/forward functions. These functions should be easily accessible from anywhere on the screen and should send the emergency data directly to the appropriate dispatch unit.
Navigation Complexity	Ensures that navigation and processing of information remains manageable given the addition of text, images, and video. Intuitive and quick navigation between applications should be possible.	• Navigation Menu groupings for HMI display applications should be clearly defined and should be intuitive to the call taker. • HMI Navigational Menu should be hierarchical, and have the ability to represent the entire structure of the display. Navigation Menu selection features (drop-down) should be available to improve Menu usability • HMI Navigation Menu should be accessible from any location of the HMI display, to ensure that call takers are able to quickly jump between NG9-1-1 applications. • Call takers should be able to access each application via a single click to ensure that minimal time is spent on retrieving necessary information
Screen Aesthetics	An HMI display should be user friendly but not graphic intensive, which may take away from the call taker's ability to process calls quickly and efficiently. Call takers will test for a user-friendly screen, by evaluating properties such as fonts and color schemes	• HMI display aesthetics, such as fonts and color schemes, should be standardized across all emergency applications tied by the HMI display. • Font size should be easy to read and of a standard font style. • HMI color scheme should enhance the look and feel of the display. Colors should be used to highlight data (i.e., Caller's Phone Number, Location, Emergency Type), to provide call takers with additional tools to quickly and efficiently respond to an emergency.

Measure of Interest	Description	Constraints and Relationships
Data Format	Call takers will test whether the essential information is presented in a standardized manner and across all communication types (i.e., Location, Phone Number, Name, and Service Provider)	• Type of information and presentation of information pulled from various message sources should be similar to the current display of information to facilitate call taker's management of the issue at hand. • Presentation of information on the HMI screen should be similar for all message types (text, image, video, voice, etc.).
Business Rules and Information Sharing Procedures	Call takers will test output to other systems (requests to emergency units/forward of callers and messages) to ensure that they are easily conducted. Call takers will test the location of the Dispatch Unit function on the HMI display	• The HMI screen should provide call takers with easy-to-use functionality to forward messages and to send data to other systems like computer aided dispatch (CAD). • The HMI function should automate message forwarding and minimize the amount of information that the call taker should retype. • The HMI screen design should minimize the amount of user-related errors by implementing a number of preventive measures (i.e., data validation).
Information Management	Call takers will test whether the HMI display contains information that is relevant to the call taker to ensure quick processing and response to the caller. Call takers will also test whether the HMI stores supplemental and supportive data in an intuitive way.	• HMI screen should present/highlight information that is pertinent to the call takers to process the call. The remaining information should be stored and processed when appropriate (i.e., when a message is being sent over to the CAD tool, or forwarded on to the First Response unit). • The HMI screen should display only the information that is relevant to call takers.

3.6.3 Analysis Methodologies

Data Collection Test Cases

Test cases will be created for each of the functional activities of the call taker service areas. The following three test cases specify procedures that will be tested for the call answering activities. The test cases will be tested using the test scripts and summarized in UAT Summary Reports identified in Section 2.3.6.

Test Case	**Manage Call Queue (CA-MNQUE) (ID – DC0009)**
Objective	This test case will provide the capability to manage call queues and deliver the 9-1-1 call to a call taker workstation.

Description	The call taker should be able to— • View a call queue map to identify the geographical location of a call and identify call clusters • Select a call outside of a cluster of calls of possibly related events to prioritize handling of a call relating to a potentially different emergency • Be alerted of the incoming call and be presented with the essential and supportive call data
Equipment	• HMI Display • ACD / CTI
Entrance Criteria	• Call Stream • ACD Rules • Call Detail Record • GIS Display Rules • Geospatial Information • Status Record
Exit Criteria	All test scripts are executed and pass successfully
Data Outputs	• ACD Reports • UAT Summary Reports
Test Case	**Answer Call (CA-ANSCL) (ID – DC0010)**
Objective	This test case will provide the capability to answer a call and place a caller on hold.
Brief Description	The call taker should be able to carry out the following procedures: • Answer an incoming call in response to an audible and/or visual indicator • Place a caller on hold. The system generates user alerts if the caller has been on hold longer than a predetermined threshold time.
Equipment	• HMI Display • ACD/CTI • GIS
Entrance Criteria	• Call Detail Record • Call Handling Procedures
Exit Criteria	All test scripts have been executed and passed successfully
Data Outputs	• ACD Reports • UAT Summary Reports
Test Case	**Initiate Call Back (CA-INTCB) (ID – DC0011)**
Objective	This test case will provide the capability for a call taker to call back a call originator.
Brief Description	The call taker should be able to carry out the following procedures: • Initiate a call back for an abandoned, hung-up, or disconnected call • Use established standards and operational best practices if the connection cannot be reestablished • Initiate call back to a device other than the originating call device, such as to a service provider or third-party call center
Equipment	• HMI Display • ACD / CTI
Entrance Criteria	• Call Detail Record • ACD Rules/Call Queue Record

Exit Criteria	All test scripts have been executed and passed successfully
Data Outputs	▸ ACD Reports ▸ UAT Summary Reports

4 DATA ANALYSIS RESULTS AND CONCLUSION

This document defined a comprehensive plan for acquiring and analyzing NG9-1-1 POC data. It presented a design for the data acquisition system, including suggested hardware, software, and manual data gathering methods. The data analysis plan provided a formal approach using test cases, procedures and suggested data analysis templates. Actual data acquisition and analysis will occur upon completion of POC development and integration work. Results derived from the data analysis efforts will be presented in subsequent documents including the USDOT NG9-1-1 POC Test Plan, USDOT NG9-1-1 Test Report and USDOT NG9-1-1 Transition Plan. The results of this analysis will assist the NG9-1-1 Project Team and USDOT evaluate the technical and operational success of the POC and will serve as benchmarks for future large-scale NG9-1-1 technology deployments. The data will facilitate the USDOT, Standards Development Organizations (SDO), industry vendors, PSAP operational community, and future independent evaluators in defining and analyzing IP-based emergency calling.

APPENDIX A—DEFINITIONS

Term	Definition
9-1-1	A three-digit telephone number to facilitate the reporting of an emergency requiring response by a public safety agency.
Analog	Continuous and variable electrical waves that represent an infinite number of values; as opposed to digital.
Authentication	Determination or verification of a user's identity and/or the user's eligibility to access to a system, network, or data; measures to prevent unauthorized access to information and resources.
Automatic Call Distribution (ACD)	Equipment or application that automatically distributes incoming calls to available PSAP attendants in the order the calls are received, or queues calls until an attendant becomes available.
Automatic Location Identification (ALI)	The automatic display at the PSAP of the caller's telephone number, the address or location of the telephone, and supplementary emergency services information.
Automatic Number Identification (ANI)	Telephone number associated with the access line from which a call originates.
ANI key	A value that is used to correlate the number identified for the call with a query that determines the caller's location via Automatic Location Identification (ALI).
Bandwidth	Capacity of a network line to transfer data packets (includes speed of transfer and number of packets processed per second).
Call	For the purposes of this NG9-1-1 System Description & High-Level Requirements document, any real-time communication—voice, text, or video—between a person needing assistance and a PSAP call taker. This term also includes non-human-initiated automatic event alerts, such as alarms, telematics, or sensor data, which may also include real-time communications.
Callback	The ability to re-contact the calling party.
Call Delivery	The capability to route a 9-1-1 call to the designated selective router for ultimate delivery to the designated PSAP for the caller's Automatic Number Identification (ANI) key.
Call Detail Record	All system (including network) data accessible with the delivery of the call, and all data automatically added as part of call processing. This includes Essential Data (including reference key to network component and call progress records) and Supportive Data. Part of the Call Record.
Caller Location Information	Data pertaining to the geospatial location of the caller, regardless of whether the caller is a person or an automatic event alert system.
Call Record	The electronic documentation of the interactive communication (e.g., audio, video, text, image, data) between the caller, call taker, and any conferenced parties. Part of the Call Record.

Term	Definition
Call Routing	The capability to selectively direct the 9-1-1 call to the appropriate PSAP.
Call Taker	As used in 9-1-1, a person (sometimes referred to as a telecommunicator) who receives emergency and non-emergency calls by telephone and other sources, determines situations, elicits necessary information, and relays essential information to dispatches, staff, and other agencies, as needed, using telephony and computer equipment.
Call Transfer	The capability to redirect a call to another party.
Call Type	Classification of a 9-1-1 call that indicates the call access method, which can affect call treatment, routing, and processing. Call types may include voice caller, short message service (SMS) text, Simple Mail Transfer Protocol (SMTP) text, multimedia, telematics data, ANI, silent alarms, etc.
Computer Aided Dispatch (CAD) system	A software package that utilizes a variety of displays and tools that allows Call Takers at the PSAP locations to dispatch emergency services (Police, Fire, Emergency Medical Service) to the identified emergency location. CAD uses a variety of communication types to dispatch a unit (paging, SMS, radio, etc.).
Customer Premises Equipment (CPE)	Communications or terminal equipment located in the customer's facilities; terminal equipment at a PSAP.
Digital	Signals that represent discrete binary values, a one or zero; as opposed to analog.
Dispatch Operations	The distribution of emergency information to responder organizations responsible for delivery of emergency services to the public.
Emergency Call	A telephone request for public safety agency emergency services that requires immediate action to save a life, to report a fire, or to stop a crime. May include other situations as determined locally.
Emergency Location Information	Data pertaining to the location of the emergency, which may be different from the caller location.
Emergency Medical Service (EMS)	A system providing pre-hospital emergency care and transportation to victims of sudden illness or injury.
Emergency Response	An effort by public safety personnel and citizens to mitigate the impact of an incident on human life and property.
Enhanced 9-1-1 (E9-1-1)	An emergency telephone system that includes network switching, database, and Customer Premises Equipment (CPE) elements capable of providing selective routing, selective transfer, fixed transfer, caller routing and location information, and ALI.
Essential Data	Data that support call delivery and adequate response capability. These data, or a reference to them, is automatically provided as a part of call or message initiation. Examples include location, callback data, and call type.
Human Machine Interface (HMI)	HMI enables direct interaction between the end-user (human) and a system (computer, machine) via commands and inputs, and receives an output from the system based on a specified criteria

Term	Definition
Human Machine Interface (HMI) Display	Graphical and visual User Screen through which Call Takers (end-users) are able to manipulate a system
Geographic Information System (GIS)	A computer software system that enables one to visualize geographic aspects of a body of data. It contains the ability to translate implicit geographic data (such as a street address) into an explicit map location. It has the ability to query and analyze data in order to receive the results in the form of a map. It also can be used to graphically display coordinates on a map (i.e., latitude/longitude) from a wireless 9-1-1 call.
IP Telephony	The electronic transmission of the human voice over IP Protocol, using data packets
Internet Protocol (IP)	The set of rules by which data are sent from one computer to another on the Internet or other networks.
Interoperability	The capability for disparate systems to work together.
Interrogation Questions	Questions that Call Takers ask callers during an emergency call to obtain additional information.
Multi-Media Communication Types	Communication mediums that will be used to receive emergency requests from the public, including text, images, and video.
Navigation Menu	A tool used by a variety of computer systems that contains links to the features and applications available in the system, and allows end-users to access the applications by selecting the feature. Generally is grouped via links / hyperlinks to the application.
Nature of Emergency	Reason for a citizen's request for response from emergency services (e.g., heart attack, vehicle collision, burglary)
Network	An arrangement of devices that can communicate with each other.
Overflow	The telecommunications term for the condition when there are more calls than the primary network path is designated to handle. This condition invokes the need to perform some form of call treatment, such as busy signals or alternate routing.
Public Safety Answering Point (PSAP)	A facility equipped and staffed to receive 9-1-1 calls; a generic name for a municipal or county emergency communications center dispatch agency that directs 9-1-1 or other emergency calls to appropriate police, fire, and emergency medical services agencies and personnel.
Router	An interface device between two networks that selects the best path to complete the call even if there are several networks between the originating network and the destination.
Screen Aesthetics	Look and Feel of the Human Machine Interface. This includes fonts, color schemes, and display layout.

Term	Definition
Selective Transfer	The capability to convey a 9-1-1 call to a response agency by operation of one of several buttons typically designated as police, fire, and emergency medical.
Service Provider	An entity providing one or more of the following 9-1-1 elements: network, Customer Premises Equipment (CPE), or database service.
Short Message Service (SMS)	A text message service that enables messages generally no more than 140–160 characters in length to be sent and transmitted from a cellular telephone. Short messages are stored and forwarded at SMS centers, allowing their retrieval later if the user is not immediately available to receive them.
Supportive Data	Information beyond essential data that may support call handling and dispatch. The addition of this data to the call stream is triggered by one or more of the data or reference items in essential data for a given call type. An example is Automatic Crash Notification (ACN) data such as "vehicle rollover."
Supplemental Data	Information that may complement, but is not necessary for, call handling and dispatch or emergency response.
Telematics	The system of components that supports two-way communications with a motor vehicle for the collection or transmission of information and commands.
Trunk Lines	Analog phone lines coming from the telephone provider into the Public Branch Exchange (PBX) of the PSAP.
Voice over Internet Protocol (VoIP)	A set of rules that provides distinct transfer of voice information in digital format using the Internet Protocol. The IP address assigned to the user's telephone number may be static or dynamic.
Wireless	In the telecommunications industry, typically refers to mobile telephony and communications through handheld devices that make a connection using radio frequency (in particular frequency bands often reserved for mobile communications) for personal telecommunications over long distances.
Wireline	Standard telephone and data communications systems that use in-ground and telephone pole cables. Also known as landline or land-based.

APPENDIX B—GLOSSARY

Acronym	Definition
ACD	Automatic Call Distribution
ALI	Automatic Location Information
ACN	Automatic Crash Notification
CNSI	Center for Network & Systems Innovation (Booz Allen laboratory, located in Herndon, Virginia)
ALI	Automatic Location Identification (Data)
ANI	Automatic Number Identification
CAD	Computer-Aided Dispatch
CCB	Change Control Board
COTS	Commercial Off The Shelf
CPE	Customer Premises Equipment
E9-1-1	Enhanced 9-1-1
EMS	Emergency Medical Services
ESRP	Emergency Service Routing Proxy
FCAPS	Fault Configuration Accountability Performance Security
GIS	Geographic Information Systems
GPS	Global Positioning System
GUI	Graphical User Interface
HMI	Human Machine Interface
HTTP	Hypertext Transfer Protocol
IP	Internet Protocol
IRT	Internet Real-Time
ITEC	Internet2 Technology Evaluation Center
LIS	Location Information System
LoST	Location-to-Service Translation Protocol
MIB	Management Information Base
MPC	Mobile Positioning Center
NG9-1-1	Next Generation 9-1-1

Acronym	Definition
NTP	Network Time Protocol
OS	Operating System
PBX	Private Branch eXchange
POC	Proof of Concept
PSAP	Public Safety Answering Points
PSTN	Public Switched Telephone Network
RDP	Remote Desktop Protocol
RMS	Records Management System
SMS	Short Message Service
SDO	Standards Development Organization
SIP	Session Initiation Protocol
SNMP	Simple Network Management Protocol
SOPs	Standard Operating Procedures
SUT	System Under Test
TCP	Transmission Control Protocol
TDM	Time Division Multiplex
UAT	User Acceptance Testing
UCD	User Centric Design
UDP	User Datagram Protocol
URI	Uniform Resource Indentifier
USDOT	U.S. Department of Transportation
VoIP	Voice Over Internet Protocol
VPC	Voice Over IP Positioning Center
VPN	Virtual Private Network
XML	eXtensible Markup Language

APPENDIX C—SOURCE REFERENCES

The following documents are primary sources of information used in this document.

1. *Next Generation 9-1-1 (NG9-1-1) System Initiative: Concept of Operations.* USDOT ITS JPO. April 2007. http://www.its.dot.gov/press/pdf/911_network.pdf —This is a formal document that provides a user-oriented vision of NG9-1-1 in the context of an emergency services internet work that can be understood by stakeholders with a broad range of operational and technical expertise. It is intended to communicate the vision of the NG9-1-1 system to stakeholders so that they can be actively engaged in its development and deployment.

2. *Next Generation 9-1-1 (NG9-1-1) System Initiative: System Description and Requirements Document.* USDOT ITS JPO. November 2007. http://www.its.dot.gov/ng911/pdf/NG911_HI_RES_Requirements_v2_20071010.pdf — This is a formal document that provides a overview of NG9-1-1 System Operations and requirements.

3. *Next Generation 9-1-1 (NG9-1-1) Architecture Analysis Document.* November 2007. http://www.its.dot.gov/ng911/pdf/1.F2_FINAL_MED_ArchitectureAnalysis_v1.0.pdf —This is a formal document that provides an architectural Analysis for the Next Generation 9-1-1 (NG9-1-1) System (or "system of systems") and presents an evolved 9-1-1 architecture able to support next generation technologies, access methods, and operational capabilities.

4. *Next Generation 9-1-1 (NG9-1-1) Human Machine Interface (HMI) Design Document.* January 2008. — This is a formal document that presents a design for the NG9-1-1 Call Taker Software.

5. *ITU-T M.3400 Telecommunication Managed Network (TMN) Management Fuctions.* August 2001. http://www.itu.int/rec/T-REC-M.3400-200002-I/en — This document defines an International Telecommunications Union (ITU) model and framework for network management.

6. *Network Time Protocol Version 4 Protocol and Algorithms Specification.* November 2007. http://www.ietf.org/internet-drafts/draft-ietf-ntp-ntpv4-proto-08.txt — This Internet Engineering Task Force (IETF) draft defines the standard for Network Time Protocol (NTP).

7. *OpenNMS Official Documentation.* September 2007 http://www.opennms.org/index.php/Official_Documentation — This documentation details the capabilities of the OpenNMS network management software.

8. *SIPp Reference Documentation.* 2008. http://sipp.sourceforge.net/doc/reference.html — This documentation details the capabilities of the SIPp SIP call generation software.

9. *Ixia Chariot User Guide.* 2005. http://www.ixiacom.com/products/ixchariot/ — This documentation details the capabilities of the Ixia Chariot traffic generation software.

10. *Wireshark User Guide.* 2007. http://www.wireshark.org/docs/wsug_html/ — This documentation details the capabilities of the Wireshark network protocol analyzer software.