The National 911 Program and California Office of Emergency Services

Next Generation 9-1-1 (NG9-1-1) Lessons Learned

Washington, DC
November 2022

DOCUMENT CHANGE HISTORY

The table below details the change history of this Lessons Learned Report document.

Version	Publication Date	Description
1.0	November 2022	Initial Release

Table of Contents

Executive Summary

The California Office of Emergency Services (Cal OES) 9-1-1 Emergency Communications Branch is charged with ensuring 9-1-1 emergency call delivery within the state of California. In 2017, Cal OES began the transition from a legacy copper-based enhanced 9-1-1 environment to an Internet Protocol (IP)-based Next Generation 9-1-1 (NG9-1-1) model conforming to the National Emergency Number Association's (NENA) i3 standard for NG9-1-1.

The Cal OES model was designed to segregate the state into four similar-sized regions of NG9-1-1 service, each to be served by an independent regional network service provider (RNSP). To create full Next Generation Core Services/Emergency Services IP network (NGCS/ESInet) redundancy, Cal OES also selected a prime network service provider (PNSP) that will provide a secondary level of service to all 449 public safety answering points (PSAPs) in the state. The benefit of this model is that every PSAP would have service from its region's NGCS/ESInet providers and redundant service from the prime NGCS/ESInet provider.

The Cal OES approach established a lab environment in which all prospective NGCS and call-handling equipment (CHE) providers would be required to conform to the PNSP-created interface control document (ICD) and pass the certification path provided in the Cal OES Lab. Each PSAP, when ready to move to NG9-1-1, would select CHE from a list of providers that achieved certification in the Cal OES Lab.

In early 2012, Congress passed the Next Generation 9-1-1 Advancement Act of 2011 (Act), directing the Department of Commerce's National Telecommunications and Information Administration (NTIA) and the Department of Transportation's National Highway Traffic Safety Administration (NHTSA) to establish and jointly manage a 911 Implementation Grant Program. The National 911 Program (Program), within NHTSA's Office of Emergency Services, administered the grant program. Cal OES was awarded a portion of the grant to further NG9-1-1 initiatives in the state of California. Mission Critical Partners, LLC (MCP) was tasked by the Program to formulate lessons learned from Cal OES as it navigated the process from concept to the precipice of deployment. In doing so, MCP reviewed the test plans, interconnection documents, contracts, and met with the Cal OES 9-1-1 team to develop these lessons learned from their experiences with the project to date.

Introduction/Background

The NHTSA Program's mission is to provide leadership and coordination in supporting and promoting optimal 9-1-1 service throughout the country. The Program recognizes the challenges the 9-1-1 industry faces in the transition to NG9-1-1. The approach and design of NG9-1-1 environments are complex and varied, and present many challenges as states, regions, and localities aim to interconnect their systems and improve interoperability. MCP was tasked through the Program to create a document of lessons learned related to procurement and subsequent implementation of interoperable NG9-1-1 solutions.

In support of that goal, the 9-1-1 Emergency Communications Branch of Cal OES agreed to share discoveries based upon deployment of the statewide NG9-1-1 solution in California. The Cal OES solution represents a multi-regional approach that uses three different NGCS cores with four different NGCS providers in an interoperable model. This unique approach involving multiple providers presented an opportunity for the 9-1-1 community to learn more about the challenges and successes Cal OES experienced with interoperability among NG9-1-1 providers.

Approach/Methodology

The Cal OES NG9-1-1 model divided the state into four regions, each to be served by an independent RNSP. To ensure redundancy, the model also included plans for a PNSP to create a full NGCS/ESInet statewide. In this approach, each PSAP receives calls from both the PNSP and the RNSP as they are both capable of delivering all calls at any given time. During normal operations, the RNSP delivers calls from wireless providers and legacy incumbents to the PSAP and the PNSP delivers competitive local exchange carrier (CLEC) and Voice over IP (VoIP) originated calls. The fact that the RNSP and PNSP have separate unique paths to each PSAP and are required to have ESInet-to-ESInet call delivery capabilities between them allows this to function seamlessly to the PSAP.

Cal OES split the procurement process into two requests for proposals (RFPs)—one for the PNSP and one for the RNSP. There were differing areas of responsibilities between the PNSP and RNSP contractors, with the PNSP expected to have more leadership and coordination roles. RNSPs could be awarded multiple regions and were permitted to deploy the NGCS functional elements (FEs) of another provider. The contractor awarded as the PNSP was ineligible for award as a RNSP. One RNSP won two of the four regions and another RNSP is deploying with the NGCS FEs of another regional winner. Cal OES required any respondent to the RFPs to accept Cal OES' terms and conditions prior to submitting a proposal for consideration.

In the RFPs, Cal OES established that the PNSP would be the authoritative source for defining an ICD for all core service providers to exchange data. The ICD was required to be based upon NENA i3 standards.

The PNSP also was accountable for developing lab testing plans for NGCS/ESInet connectivity and interoperability with CHE. This testing included two phases, with the first phase focused on basic functionality and the second focused on operational testing. CHE providers seeking lab certification were required to pass both phases of testing against two NGCS providers. This provision prevented CHE vendors from only validating against their own NGCS. This methodology ensured that basic interoperability would be lab tested before deployment could begin.

NG9-1-1 has strict security requirements and mandates the use of Transport Layer Security (TLS) communications between NGCS FEs once they enter an NGCS provider's ESInet. California was farther along in its testing and development than the NG9-1-1 Interoperability Oversight Commission (NIOC) was in bringing the PSAP Credentialling Authority (PCA) online. To meet this requirement, Cal OES required the PNSP to be the credentialling authority after it developed a Certificate Policy (CP) that all NGCS and CHE providers would be required to follow to receive certificates and pass traffic across the Cal OES ESInet. In the short term, this required that the PNSP act as the root certificate provider to all entities on the Cal OES network until transitioned to a nationwide approach requiring verification from the PCA's root certificate.

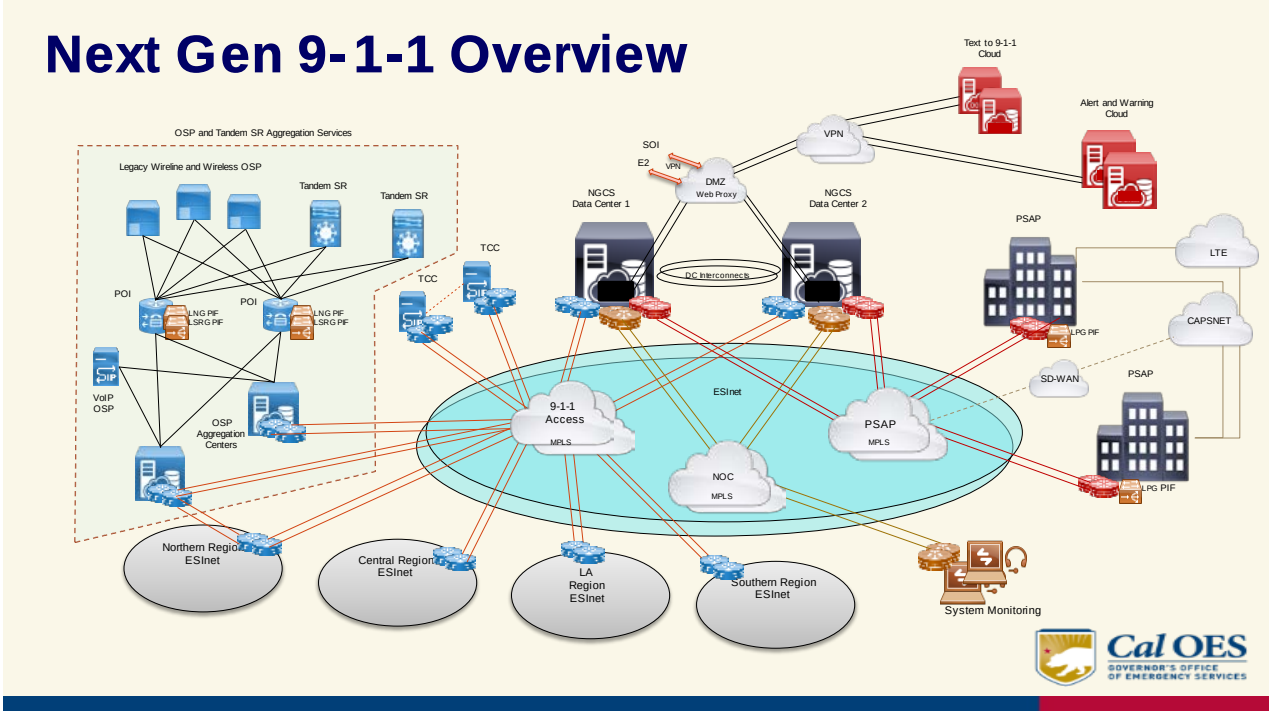

Figure 1: California NG9-1-1 Overview (provided by Cal OES)

Findings/Results

Table 1: Lessons Learned Matrix

Challenge/Finding	Lessons Learned	Recommendation
Requirements		
Records were loaded into the location database (LDB) in different formats.	Ensure all stakeholders involved understand the LDB records format.	Require compliance with NENA CXLDF[1] for all LDB records.
It is difficult to determine if CHE vendors are really i3-capable across NGCS platforms.	Vendors state CHE is i3-compliant, but testing demonstrates it is not, or is only i3-compliant using its NGCS FEs.	Very specific RFP questions and follow up. With which NGCS providers have you deployed i3 interoperability? What were the issues during deployment and the methods adopted to ensure they do not arise in the future?
There were some challenges identifying which vendor (ESInet or NGCS provider) was accountable for the demarcation point at the PSAP, and which was accountable to provide the firewall.	The contract requirements did not clearly define the demarcation point between the NGCS provider and CHE.	Define specific demarcation points for handoff from the ESInet provider to the CHE. CHE vendors will need to follow the NGCS ICD for connectivity.
Legacy CHE may have software that has reached end of life (EOL) and will not be updated.	Have a plan for EOL CHE if it is not part of the deployment.	RFP specifically states NGCS provider will deploy legacy PSAP gateways (LPGs,) and have a longer-term plan in place to update all CHE.
Current deployed CHE is not IPv6-capable.	Some CHE providers have not deployed IPv6 capabilities.	Identify if NGCS provider will deploy with IPv6; if so, the contract should include a requirement for an IPv4 interoperability plan.

[1] Civic Location Data Exchange Format

Challenge/Finding	Lessons Learned	Recommendation
Project Management		
The connection costs for originating service providers (OSPs) to connect to the points of ingress (POI) were established within the NG9-1-1 contract. The contract also established the respondent/NG9-1-1 service provider could not charge the OSP a connection fee.	This prevented OSPs from having to pay connection costs to the NG9-1-1 network and attempting to seek funds for connection (i.e., cost recovery).	Consider contract language that prevents OSPs from seeking cost recovery for connections to designated POIs. Collaborate with your state or local regulatory agency, if applicable.
Some vendors were not willing to adjust to the terms and conditions required in the contract.	It was beneficial to require vendors to agree to the terms and conditions of the contract prior to engaging them in the procurement process. This saved time and effort for all parties involved.	Consider strategies that make it desirable for vendors to agree to the terms and conditions of the contract prior to engaging in procurement. This ensures a procuring agency does not invest months in procurement to reach an impasse and have to re-initiate the procurement process. *Note: if this is mandatory, it may exclude viable solutions from consideration.*
Testing and validation processes involving PSAP staff presented some challenges due to the varying levels of understanding with NG9-1-1 capabilities and changes, especially regarding class of service (COS) and wireless device location delivery and accuracy.	PSAP education needs to be a key part of the change management strategy. Education needs to be an early and ongoing focus throughout the project. Identifying differences between presentation and maintenance of legacy 9-1-1 versus NG9-1-1.	Ensure PSAP education is part of the change management strategy and that any PSAP staff assisting with testing are educated on changes to location information format and presentation.

Challenge/Finding	Lessons Learned	Recommendation
At times, there were inconsistent field-testing results with line personnel due to a lack of knowledge with the NGCS/ESInet project and expected change impacts.	NGCS/ESInet go-live events occur in the background and often PSAP staff are not aware the transition has occurred. It was discovered later that some data elements changed or were not present.	Ensure PSAP management and line personnel are integrated into the change management process and educated on changes ahead of the change occurring.
Progress slowed with vendors between the initial deployment and start of service.	More clarity on what is needed to keep the project moving was needed.	The project plan should have milestones tied to service level agreements (SLAs) between initial deployment and the start of services to ensure continuous progress.
Having multiple NGCS providers involved in the design solution led to interoperability issues. A single NGCS provider with CHE may want differing interconnection types.	Cal OES wrote into its contract that the PNSP had the authoritative ICD for testing and that all others had to comply. The contract language needed to be stronger. Ensure all parties know which entity will be creating the ICD in accordance with NENA i3.	In environments where there are multiple providers, incorporate language that identifies the authoritative entity for defining interfaces and other aspects defined in an RFP.
Competing projects led to resource constraints with vendors.	With a large-scale project, it may be prudent to require that the vendor identify a dedicated project management resource. If not fully dedicated, then define the percent of time that named resource will be focused on the project.	Depending on scale of the project, ensure project resources are committed to support the demands of a large-scale initiative by requiring a dedicated resource or a defined percentage of time resources will be committed to the project.

Challenge/Finding	Lessons Learned	Recommendation
Policy-based routing is a capability within NG9-1-1 that can help strengthen the resiliency of 9-1-1 call delivery, but many PSAPs were not prepared operationally to implement and utilize this function.	There is a need to educate PSAP leadership on strategies for continuity of operations that can be supported through NG9-1-1 capabilities.	Engage PSAPs in change management and operational discussions focused on continuity of operations in advance of deployment.
Testing		
All vendors had to complete acceptance testing within the Cal OES Lab. Each vendor would normally have its own test plan; however, with multiple vendors, allowing this would have introduced inconsistencies to the process.	A single test plan to test the core requirements in the contract brought consistency to the testing process and worked well to ensure compliance with requirements.	When multiple vendors are involved, work from a single test plan to ensure consistent results. In a multi-vendor environment, the agency or designee will need to facilitate a neutral approach to a comprehensive test plan that considers input from all involved vendors.
Cal OES built a lab and established a requirement that vendors/respondents must pass testing before deployment. Payment triggers were tied to lab demonstration and a successful pass.	Vendors were committed to the testing and validation process as it was tied to payment triggers.	Structure payment terms around demonstration of successful compliance with requirements prior to production.

Challenge/Finding	Lessons Learned	Recommendation
Testing call delivery directly into the NGCS core does not accurately reflect reality.	Non-production test cases only test sunny-day scenarios. They do not account for small differences in SIP[2] or HTTPS[3] messaging or timing. Call fields may experience configuration changes as they pass through aggregation points that can cause issues with call delivery and receipt.	In testing/validating test calls, ensure injection of the call occurs ahead of any aggregation points, not directly into the NGCS core. Establish expectations that deployment may identify additional considerations not seen in test/sterile environments.
It is difficult to fully replicate a real environment for testing in the lab.	Some issues were not discovered until in the production environment due to the level of nuance. For example, a wireline call may pass lab testing but then present issues with an apartment number in production.	Ensure either calls from OSPs in the area or OSP-simulated calls, including ones that cause failures, are tested for proper remediation. Whenever possible, test with real network calls and text.
Design		
Interoperability between neighboring NGCS and ESInet providers has challenges due to the varying solutions and approaches to network design and how i3 is interpreted.	NENA i3 allows room for interpretation and NG9-1-1 vendors approach solution design differently. This presents interoperability challenges with network-to-network interfaces across regions and states.	Contract language should define that interoperability with immediate neighbors is part of the deployment and attach a final milestone to this.

[2] Session Initiation Protocol
[3] Hypertext Transfer Protocol Secure

Challenge/Finding	Lessons Learned	Recommendation
There were interoperability issues between NGCS and CHE providers when new NGCS were introduced.	A vendor's claim that NGCS and CHE are i3-complaint does not guarantee interoperability will be successful.	Agencies should complete due diligence and request a list of CHE providers that have deployed and/or tested with the desired NGCS providers. This should be specific to i3 deployments and detail the version of CHE software. Agencies may consider requesting supporting documentation from interoperability testing.
All vendors were required to follow NENA-STA-010.2-2016, *NENA Detailed Functional and Interface Standards for the NENA is Solution.*	While different providers may read the specifications and interpret them differently, it is critical that they begin with the same requirements as a blueprint.	Include in the contract that all vendor partners begin with the same specification versions.

Key Takeaways

Testing

Testing and validation demonstrate that while core service providers and CHE providers may both be capable of i3 functions, some accomplish it using different information or different programming approaches in messages for information delivery. This is why deployment-specific interoperability testing is important.

- Interoperability between NGCS, ESInet, and CHE providers is not a plug-and-play operation. Interoperability is complex due to varying approaches to network design and interpretation of i3 standards. Lab testing, acceptance testing, and a plan for continued testing as new releases and features come about must be completed to validate vendor claims of i3 compliance and interoperability between their NG9-1-1 solutions.
- The lab testing environment and approach taken by Cal OES to certify its vendors helped to create a known stable environment for all potential vendor partners and ensured due diligence to vet the capabilities of each vendor partner before they were allowed to provide products/services to the PSAPs.

- As helpful as the lab environment is to ensuring vendor compatibility and quality control, some issues will not be discovered until in a production environment and why there is also an emphasis on acceptance testing. Whenever possible, test with real network calls and text.

Design

- California's deployment model of full redundancy with regional and primary NGCS providers and unique ESInets is original and highly effective for ensuring physical and logical diversity is provided from call inception to termination for all California PSAPs equally.
- Interoperability between neighboring NGCS and ESInet providers has challenges due to the varying solutions and approaches to network design and how i3 is interpreted. Agencies should complete due diligence and request a list of CHE providers that have deployed and/or tested with the desired NGCS providers.
- California identified and awarded vendor partners that fit with its design. It mandated vendors to provide "show your work" interoperability in the Cal OES Lab and stated the results would need to meet Cal OES' satisfaction before network deployment could begin.

Contract and Project Management

The RFP and contract should identify PSAPs and network demarcations. They should clearly state which entity will develop the ICD and which is responsible for developing, testing, and executing, the test plans.

Consider strategies that make it desirable for vendors to agree to the terms and conditions of the contract prior to engaging in procurement. This ensures a procuring agency does not invest months in procurement to reach an impasse and have to re-initiate the procurement process. If this is mandatory, however, it may exclude viable solutions from consideration.

- PSAP education needs to be a key part of the change management strategy and an early focus. Ensure that PSAP leadership is well informed of NG9-1-1 impacts to the way call/caller information is received, presented, and shared, as well as new capabilities the NG9-1-1 environment provides, such as policy routing.
- Procuring agencies should consider contractual strategies that make it desirable for vendors to agree to the terms and conditions of the contract prior to engaging in procurement. This will prevent an impasse months into the procurement process and having to begin the process anew.

- Procuring agencies should consider including contract language that does not allow the NG9-1-1 service provider to charge OSPs connection costs and seek cost recovery connections to designated POIs.
- Vendor commitment can wane over time and slow project progress. Tying financial incentives to key milestones will ensure vendors remain committed to tasks through to completion.

Conclusion

Cal OES approached its statewide deployment of NG9-1-1 purposefully, leveraging the NENA i3 standard with a focus on building a redundant and resilient solution for California. Through the procurement and implementation of its design, Cal OES identified lessons learned that may aid other agencies in their NG9-1-1 transition. Those lessons learned have been captured throughout this report in the areas of establishing and testing requirements, technical design, and project management. Each agency and jurisdiction will have its own journey in the transition to NG9-1-1.

Many state and regional programs are in the transition to NG9-1-1. Through communicating lessons learned with the broader 9-1-1 community as to what is working well and what needs to improve, continuity of NG9-1-1 deployments will continuously improve. It is the objective of the National 911 Program and Cal OES to promote information sharing with colleagues across the Nation. The call to action for all agencies, jurisdictions, and states is to continue the dialog and communicate through available platforms what is working well and where improvements can be realized.