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Honorable Members of the City Council
c/o City Clerk
200 North Spring Street, Room 300
Los Angeles, CA 90012

Dear Honorable Members:

LAFD Automatic Vehicle Locator (AVL) System Project

At the October 16, 2017 meeting, the Budget and Finance Committee considered a verbal report by the Los Angeles Fire Department (LAFD) on the status of the Automatic Vehicle Locator[1] (AVL) System project in response to a Motion (Bonin/Englander; C.F. 13-0862-S1). The LAFD was instructed to report back on several issues raised by Council Members related to the LAFD use of AVL technology and funding needed to complete this critical project. Provided below are responses to those issues along with other pertinent information on the implementation steps leading to the current status; future project direction; and additional comments.

1. AVL SYSTEM PROJECT MILESTONES

The LAFD began installing AVL-related equipment in 2013 as part of an effort to improve situational awareness at both Metro Fire Communications (MFC) and in the field. At that time, GPS devices were installed in vehicles and software was developed to show units on a map at MFC; however, that project did not involve using AVL for dispatch.

In January 2016, the LAFD began a project to upgrade the mobile data network (MDN) infrastructure by replacing aging and unsupported equipment. The MDN is a City-owned radio system that supports all LAFD data transmissions between the mobile data computers (MDC) and the LAFD Computer Aided Dispatch (CAD) system including incident information, unit status changes, messages and vehicle location information (AVL). As part of this project, new MDC software and radio modems with updated GPS devices were installed in LAFD vehicles. Completing this upgrade was a necessary prerequisite to using the AVL system for dispatch and resource management. The first phase of the MDN upgrade was completed in January 2018.

[1] Automatic vehicle locator (AVL) refers to the device and systems that make use of the Global Positioning System (GPS) to enable remote tracking of a fleet. For the purpose of this report the term "AVL" is all-encompassing of the GPS devices and related technologies.

The GPS devices originally installed in 2013 were connected to antenna using consumer-grade USB cabling, making them easy to unplug and susceptible to accidental disconnect. As part of the MDN upgrade, the LAFD began to actively monitor the condition of the GPS devices and analyze the AVL data in preparation for the next phases of the project. An initial analysis of GPS data in August 2017 found inaccurate location reports from approximately 22 devices out of more than 300 ranging from reporting locations in other countries to vehicles 'jumping' between two points at improbable speeds. Further review identified malfunctioning equipment, mostly broken antennas, missing cables or dead GPS units to be the cause of the erroneous location reports. The LAFD has since repaired or replaced the defective equipment and, in October, conducted another accuracy analysis over a seven-day period and found no location accuracy issues in any of the more than 380 active vehicles in the fleet.

As part of the MDN project, the LAFD implemented several measures to identify and address the possibility of equipment failures and GPS errors, such as: the LAFD developed software to monitor the health and status of the AVL equipment and a process to replace defective equipment when found, mostly 'dead' GPS devices or disconnected cables; older GPS devices are being replaced with the GPS built into the new radio modems; the consumer-grade USB cabling is being replaced with commercial-grade serial cabling, making the devices more reliable and the cable connections more secure and less susceptible to accidental disconnect; the MDC software has been modified to create a boundary to detect major location discrepancies (e.g., out of the country) and to report GPS data more frequently to CAD so that location errors or "jumps" can be detected and corrected for; and the CAD software has been modified to 'fall back' to a unit's assigned station location when the GPS device is identified as malfunctioning. In addition to these steps, the LAFD continues to evaluate other potential redundancies and failsafes that may be incorporated into future phases of the AVL project.

While the MDN upgrade was taking place, the LAFD began the design of the AVL-dispatch system and conducted a series of small, experimental, short-term projects to evaluate various AVL and mapping technologies. The LAFD team contacted other large agencies who were successfully using AVL, such as FDNY and Phoenix Fire, as well as commercial CAD vendors to identify best practices and lessons learned from their implementations. From March to May 2017, the LAFD conducted a 90-day proof-of-concept with a vendor to evaluate the potential uses of both in-vehicle mapping software and external, third-party routing algorithms (see Findings 4 and 5 in Section 2 below).

As a result of this work, the LAFD designed the CAD-AVL integration to leverage existing CAD capabilities and provide the flexibility needed to make changes as new technologies become available without having to redesign or replace existing components that are working well. The design also allows for an incremental implementation of AVL in order to manage risk and minimize disruption to the field. The LAFD began development work in July 2017 and conducted a short citywide field test from October 31 to November 6, 2017. As a result of this test, the LAFD made changes

to both the CAD and the MDC software and is planning the next citywide field test for late February 2018.

During the MDN project the LAFD also developed a new, more advanced CAD map to replace the two maps being used at MFC with a single, more functional map using modern mapping technology. The new CAD map is in the final stages of testing and scheduled for implementation in early February 2018.

The MDN upgrade, the AVL-CAD system design and development, and the new CAD map were each prerequisites to implementing AVL for dispatch. Now that these projects are complete, the LAFD's plan is to incrementally release changes to CAD so that certain dispatch recommendations will use a resource's AVL-reported location instead of the estimated distance from the closest Fire Station. The LAFD expects that the more precise location information from AVL will not only improve response times, but will also greatly enhance field operations and MFC's ability to manage LAFD resources.

2. PRESENT FINDINGS OF THE AVL PROJECT

Finding 1: The experience of the past year and lessons from other agencies tells us that there is no single "AVL solution" available from one source that solves every problem or addresses every concern. The success of LAFD's AVL project is dependent on a robust, reliable technical infrastructure that includes the mobile data network (MDN), mobile data computer (MDC) software, in-vehicle GPS equipment, mapping and geographical information system (GIS) tools, CAD software and other related system hardware and software. Each of these components plays a critical role and must be well integrated, thoroughly tested and continuously monitored. Instead of relying on a single vendor, the LAFD must act as its own integrator, leading the design, development and integration of the best available components in order to ensure a complete, robust, reliable and cost-effective solution.

Finding 2: The AVL project will be complete when the basic building blocks of the system have been installed and reliably tested in early 2018, but the evolution of how the LAFD uses this technology will be part of an ever-changing dispatch ecosystem. As we proceed, we will learn how these systems effect our operation and as technology advances we will adapt in order to make the best use of it. After the initial implementation of AVL is complete, we expect changes to be ongoing and forever, constantly enhancing and adjusting based on the needs of the Department, the same way we do with our other mission-critical technologies. The AVL project, especially how AVL is used for dispatch, will never be "done", but will continue to evolve over time.

The LAFD's dispatch algorithms (e.g., how CAD determines which units to send) are complex and have been developed over several decades. A unit's distance from an incident is just one of many variables considered at the time of dispatch to select the most appropriate resources to send. Today, the LAFD expects that not all call types are appropriate for 'closest-unit' dispatch and that some call types may continue to respect district boundaries and other operational factors where the closest unit would not

necessarily be the most appropriate first choice. For this reason, the AVL system design must be flexible and able to adjust quickly as operational needs change and experience is gained from field use.

Finding 3: There will be many operational benefits of AVL beyond just finding the 'closest' unit at time of dispatch. In speaking with other agencies about the many benefits of AVL, the LAFD expects to also greatly enhance the ability to manage and track resources when they are not assigned to calls, providing greater situational awareness for MFC dispatchers and field commanders. AVL will enable the LAFD to use CAD to enhance resource management, for example, making automatic notifications of units reporting inaccurate status and the ability to change a unit's status based on their location and movement.

Finding 4: In-vehicle mapping and driving directions should be considered a second phase of the AVL project and not a dependency of the initial AVL rollout. While the new MDC software does have basic mapping features, we learned during the proof-of-concept valuable insights about both the opportunity and challenges of more advanced mapping and driving directions in the LAFD environment. We learned that the way in which maps and driving directions are used in the field is much different from how consumers use their smartphone, for example: familiarity with first-in and surrounding districts is a highly valued and continuously trained skill in the LAFD and is relied on most for driving directions; that there is still an important role for paper maps, primarily to be used as a back-up in the event of equipment failure; that driving directions are most needed when operating in unfamiliar areas; that 'consumer' directions optimized to avoid traffic are not always practical for emergency vehicles responding with lights and siren; that more robust turn-by-turn directions and map features will require significantly more bandwidth than what's available on the MDN and broadband technology will be required to fully implement these features; and we gained a much better understanding of which map features are more and which are less important to Firefighters.

The proof-of-concept was limited to 10 of the LAFD's 106 Fire Stations. Any Department-wide implementation of advanced mapping and driving directions will require additional evaluation, consideration and testing by a larger group of users in order to best determine LAFD's operational needs. For now, the LAFD has prioritized its resources on completing the first phase of the AVL project, focusing on dispatch and resource management. The next phase of the project will focus on in-vehicle broadband and enhancements to mapping and driving directions.

Finding 5: There is no one "perfect" algorithm for determining the closest unit at time of dispatch. Determining the closest unit in sub-second time is not trivial and there are several competing theories and algorithms available, each with their own advantages and challenges, especially in the LAFD environment. Deciding which units are 'closer' based on driving time, distance, traffic or potentially hundreds of other factors is the subject of much study and an area where the science and available technology is changing rapidly. During our design phase, the LAFD team evaluated several available algorithms and learned the importance of carefully considering the very specific LAFD

use cases and unique operating conditions. In other words, what works well for a commercial driving service may not work as well for fire trucks and ambulances. For example, algorithms that estimate travel time based on the 'fastest driving route' or that consider real-time traffic may not be as applicable to emergency vehicles that will avoid certain roads or disregard certain traffic restrictions when operating emergency. When compared, the operationally significant differences in the travel time estimates between the various available algorithms were much less than expected. Other factors, such as cost, ease of integration and development flexibility were found to be equally important considerations in determining the 'best' algorithms to use in the LAFD environment.

During the design phase, the LAFD team researched several different available algorithms, reviewed published studies, spoke to CAD vendors and interviewed companies that specialize in routing to identify potential algorithm alternatives. The most significant takeaways were: there is no one 'perfect' algorithm; the technology is changing rapidly; and the LAFD AVL design must be flexible enough to be able to change or 'swap' routing algorithms easily as new ones become available without having to make major changes to the underlying CAD system.

Finding 6: Commercial GPS technology available on cell phones and tablets is not yet practical or reliable enough to be used as the primary source of location information for dispatch. While commercial smartphone technology is ubiquitous and familiar to the general public, there are several problems that make it not suitable for emergency dispatch. There are still many areas throughout the City of Los Angeles where cell phone coverage is spotty or unreliable. By contrast, the MDN radio network provides reliable coverage throughout the City. Integration with commercial carriers is more complex and can create a dependency on one vendor, making it more difficult to switch as new technologies become available. The cost of smartphones or tablets would be prohibitive if done all at once. Finally, the installation of any more devices into already cramped vehicle interiors could be problematic and create other operational issues.

This is not to say smartphones and commercial broadband will not have a place in the overall LAFD mobile technology, they likely will. The LAFD team is working closely with each of the major carriers and evaluating how commercial broadband can be used to not only augment GPS information, providing a redundant source of location data, but to also support many other valuable features such as video streaming and advanced mapping. The LAFD is also planning to field test smartphone versions of the MDC software to augment the MDC fleet, especially for specialized units such as bike medics and command staff. These early rollouts will help to inform future phases of the AVL and broadband evolution, but will not become a dependency for the initial AVL rollout.

Finding 7: The AVL equipment, like any technology, is susceptible to failure and the proper failsafes must be in place. The LAFD's plan to ensure reliability of this advanced method of dispatching is not dissimilar to that of all of our mission-critical technology such as our radios, CAD and 911 phones. We assume that errors and equipment malfunctions will occur and have designed the AVL system to account for these possibilities and reduce both the likelihood and the impact of such problems.

It's very important to note that AVL is a large project that involves not only complex technology, but also significant operational changes. Past history, industry best practice and advice from peers all provide evidence that these projects are most successful when done incrementally. Attempting to make major changes all at once to very complex processes and systems introduces undue risk and increases the likelihood of project failure. The LAFD is approaching the AVL in a methodical, incremental and iterative manner so that we can deploy small changes more frequently and learn from those changes to inform next steps.

3. ***AVL TECHNOLOGY***

a. AVL System Features

The GPS devices currently provide location (lat/lon), velocity, direction of travel and time. We do not expect the current devices to provide any additional information, as this is sufficient for dispatch purposes. However, this information can be made available to other systems as they are developed, such as the fleet management or fire prevention systems. Since the LAFD is the owner of this data and has full control over its access, we will continue to explore possible uses throughout the Department and expect the data to become more valuable over time as other systems are able to make use of it.

b. Currency of AVL Technology and Integration to the Dispatch System

ITA has evaluated the GPS devices and found them to be current and suitable for LAFD's intended use. ITA has recommended that the LAFD make use of the newer GPS device that is integrated within the new MDC radio modem and the more permanent antenna connection to reduce maintenance cost and complexity. The LAFD is doing both as part of the AVL project.

ITA found that the AVL and CAD can be integrated without elaborate modification to the CAD programming. ITA has advised the LAFD that adding AVL has the potential to cause system capacity issues and requires thorough testing. The LAFD is working closely with ITA and the vendor to create a suitable test environment and testing methods for exercising system load and bandwidth capacity. The LAFD is confident after initial testing and recent system loads during the major fire events in December 2017 that the system is adequately sized and capable of performing with the additional AVL data. The LAFD plans to continue active monitoring of system performance and to perform periodic system load tests in the test lab prior to making enhancements that could affect system performance.

c. ITA's Role in Developing AVL System and Integrating with LAFD Computer Aided Dispatch System

ITA's primary role is to design, install, support and maintain the data radio system network infrastructure and MDC devices. ITA has been fully involved in the MDN project upgrade and has advised the LAFD on system configuration, integration and performance.

4. REQUIRED RESOURCES AND FUNDING

The AVL System project was funded in FY 2016-17 with $600K that was reappropriated to FY 2017-18. The FY 2017-18 Adopted Budget includes a line item in the Unappropriated Balance providing $1.7M for CAD and AVL enhancements contingent on receipt of additional revenue above $6M from the Intergovernmental Transfer (IGT) program for FY 2015-16 Medi-Cal transports. In November 2017, the City received IGT net revenue of $6.94M.

Additional revenue for FY 2016-17 Medi-Cal transports, projected at $6M, is pending notification to IGT participants by the State Department of Health Care Services of the fund transfer for the federal match. Notification is projected to occur in April 2018, with revenue to be received in July/August 2018.

The LAFD projects a year-end budget shortfall of $17M, with a significant amount attributable to sworn overtime expenditures due to mass deployment of resources to the series of severe fire events. The Department has applied for eligible federal reimbursements for responses to the declared emergencies, which may not be received until next fiscal year. Nonetheless, the LAFD projects increased revenue of $9M from other sources this fiscal year. The CAO indicates, however, that any additional revenues should be applied to address the shortfall prior to consideration of CAD/AVL projects.

For Council's consideration, the Department has provided a breakdown of project priorities for which partial funding could be applied this fiscal year:

Project 1. Critical 911 Phone System Upgrade - $650,000

Funding to upgrade the LAFD 911 phone system that has reached end-of-life. The cost to upgrade the 911 phone system is estimated to be $2.15M, of which $1.5M would be paid by the State 911 Fund on the condition that the project is completed by June 2018. This upgrade coincides with LAPD's 911 phone system upgrade and will significantly reduce current call transfer times between LAPD and LAFD, and enhance 'end to end' call processing reporting by interconnecting the two systems on the same platform, thereby improving call processing and response times. If the LAFD is unable to upgrade the 911 phone system by June 2018, we must reapply for State 911 Funds in 2019, placing the City at risk of receiving less in reimbursement due to changes being considered by the State as to how reimbursements for 911 equipment are calculated. We would also risk being 'out-of-sync' with LAPD, as they are planning their upgrade for this fiscal year.

Project 2. Completion of AVL System - $700,000

$150,000 broadband data equipment and services in rescue ambulances
$400,000 broadband data equipment and services in engines / trucks
$150,000 licenses, professional development services

Funding to purchase equipment needed to enable in-vehicle broadband services required for advanced mapping with turn-by-turn directions (improving response times), and redundancy of GPS data for AVL (an additional failsafe in the event of GPS device errors or failures).

Project 3. CAD Continuity of Operations/Back-up Center Upgrades - $350,000

Funding would provide hardware/software/professional services for critical infrastructure upgrades at the back-up dispatch center, and development of additional resiliency/high-availability capability that allows for remote CAD operations. The back-up dispatch center is vulnerable to failure due to the aging equipment.

The Department recommends $1.35M funding this fiscal year to complete Projects 1 and 2 for the following reasons:

- Completing the 911 phone upgrade avoids loss of $1.5M State 911 Funds.
- Upgrading 911 phone system significantly reduces transfer time between LAPD and LAFD, improving call processing/dispatch/response times.
- Completing the next phase of the AVL project adds broadband to vehicles in order to:
    - Enable in-vehicle mapping and turn-by-turn directions, improving responses times and situational awareness;
    - Provides redundancy in the AVL-GPS data, providing additional failsafes in the event of GPS device errors or failures;
    - Upgrades antennas and cabling to commercial grade, reducing breakage and repair costs, increasing reliability of GPS and avoiding having to fall back to closest fire station when the GPS is inoperable.

The Department recommends funding for Project 3, providing critical enhancements to the CAD and back-up center in order to enhance resiliency and reduce the risk of back-up equipment failing when needed, be considered as part of the LAFD FY 2018-19 Budget Request.

Sincerely,

Ralph M. Terrazas

RALPH M. TERRAZAS
Fire Chief