ATIS STANDARD

ATIS-0500035

ATIS Standard on -

Guidelines for Testing Dispatchable Location

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Guidelines for Testing Dispatchable Location

Alliance for Telecommunications Industry Solutions

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Abstract

This document provides guidelines specific to testing and evaluation of dispatchable location within the framework of the 9-1-1 Location Technologies Test Bed. It should be viewed as an extension to ATIS-0500031.v002, *Test Bed and Monitoring Regions Definition and Methodology*.

Foreword

The Alliance for Telecommunications Industry Solutions (ATIS) serves the public through improved understanding between carriers, customers, and manufacturers. The Emergency Services Interconnection Forum (ESIF) provides a forum to facilitate the identification and resolution of technical and/or operational issues related to the interconnection of wireline, wireless, cable, satellites, Internet, and emergency services networks.

The mandatory requirements are designated by the word *shall* and recommendations by the word *should*. Where both a mandatory requirement and a recommendation are specified for the same criterion, the recommendation represents a goal currently identifiable as having distinct compatibility or performance advantages. The word *may* denotes a optional capability that could augment the standard. The standard is fully functional without the incorporation of this optional capability.

Suggestions for improvement of this document are welcome. They should be sent to the Alliance for Telecommunications Industry Solutions, ESIF, 1200 G Street NW, Suite 500, Washington, DC 20005.

At the time of consensus on this document, ESIF, which was responsible for its development, had the following leadership:

S. Sherwood, ESIF Chair (Verizon Wireless)

R. Hixson, ESIF 1st Vice-Chair (NENA)

R. Marshall, ESIF 2nd Vice-Chair (Comtech)

J. Green, ESIF ESM Co-Chair (Sprint)

K. Springer, ESIF ESM Co-Chair (AT&T)

The **Emergency Services & Methodologies (ESM)** Subcommittee was responsible for the development of this document.

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1 Introduction

The development of the National Emergency Address Database (NEAD) is in response to the requirements established in the FCC's fourth Report and Order, which aim to improve the accuracy of indoor wireless 9-1-1 location. It is intended that the wireless network interfacing to the NEAD be able to deliver a dispatchable location during 9-1-1 calls. Testing the reliability and accuracy of dispatchable location is a critical step in validating the NEAD concept and the performance of the elements involved in the determination of dispatchable location. This document provides the methodology framework for testing dispatchable location.

2 Scope, Purpose, & Application

2.1 Scope

This document presents guidelines for the testing and evaluation of dispatchable location within the framework of the 9-1-1 Location Technologies Test Bed. These guidelines identify baseline methodologies to be used in the testing process as well as the evaluation methods used to determine the level of 9-1-1 indoor location performance achieved from utilizing the NEAD. The NEAD is populated with the civic addresses and additional information associated with Wi-Fi Access Points (APs) and Bluetooth beacons.

These guidelines are based on the assumption that testing will be conducted in various types of indoor structures reflecting the characteristics found in the four morphologies: Dense Urban, Urban, Suburban, and Rural.

2.2 Purpose

The purpose of this document is to develop the framework for testing dispatchable location in the Test Bed. The document defines the methodology for performing the testing and the approach to evaluating the test results and determining the level of precision of the dispatchable location delivered, i.e., Dispatchable Location Level 2 (DL2), Dispatchable Location Level 1 (DL1), Civic Address. It also provides for determination of the accuracy of the geodetic location delivered along with the dispatchable location.

2.3 Application

The guidelines in this document are to be used in defining the test procedures to be followed for testing dispatchable location in the Test Bed. They are also to be followed in interpreting and assessing those results.

3 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

FCC 15-9, PS Docket No. 07-114, 4th Report and Order, *Fourth Report and Order In the Matter of Wireless E911 Location Accuracy Requirements.*[1]

ATIS-0500031.v002, *Test Bed and Monitoring Regions Definition and Methodology,* February 2017.[2]

ATIS-0700028v1.1, *Location Accuracy Improvements for Emergency Calls,* October 2016.[3]

4 Definitions, Acronyms, & Abbreviations

For a list of common communications terms and definitions, please visit the *ATIS Telecom Glossary*, which is located at: < http://www.atis.org/glossary >.

4.1 Acronyms & Abbreviations

3GPP	3rd Generation Partnership Project
A-GNSS	Assisted Global Navigation Satellite System
ALI	Automatic Location Identification
AP	Access Point
ATIS	Alliance for Telecommunications Industry Solutions
CMA	Cellular Market Area
CoS	Class of Service
CVC	Civic Address
DL	Dispatchable Location
DL1	Dispatchable Location Level 1 (medium level quality dispatchable civic location)
DL2	Dispatchable Location Level 2 (highest level quality dispatchable civic location)
ECID	Enhanced Cell ID
ELOC TF	ATIS Emergency Location Task Force
ELS	External Location Service
eNodeB	Evolved Node B
ESIF	Emergency Services Interconnection Forum
ESM	Emergency Services Methodology
E-SMLC	Enhanced Serving Mobile Location Center
FCC	Federal Communications Commission
GMLC	Gateway Mobile Location Center

[1] This document is available from the Federal Communications Commission, 445 12th Street, SW, Washington, DC 20554, at: < http://www.fcc.gov >.

[2] This document is available from the Alliance for Telecommunications Industry Solutions, 1200 G Street, NW Suite 500 | Washington, DC, 20005, at: < https://www.atis.org/docstore/product.aspx?id=28279 >.

[3] This document is available from ATIS at: < https://www.atis.org/docstore/product.aspx?id=28273 >.

ISP	Internet Service Provider
Le/CS	Interface between GMLC and Legacy Emergency Services Network
Le/ici	Interface between GMLC and NG9-1-1 Emergency Services Network
LNG	Local Network Gateway
LS	Location Server
MAC	Media Access Control
MME	Mobility Management Entity
NEAD	National Emergency Address Database
NEAM	National Emergency Address Manager
Nm	Interface between the NEAD and NEAM
Np	Provisioning interface between the NEAM and external data sources
Nq	Query interface between the LS in the Serving Core Network and the NEAD
OTDOA	Observed Time Difference of Arrival
PDA	Public Device Address
PSAP	Public Safety Answering Point
RP	Reference Point
RSSI	Received Signal Strength Indicator
SR	Selective Router
UE	User Equipment
URI	Uniform Resource Identifier

5 Architecture of the NEAD-Based Dispatchable Location Solution

5.1 Description of Element/Entities Involved in DL Determination

The NEAD is a database that stores and makes available to the wireless network the civic addresses of provisioned Wi-Fi access points and Bluetooth beacons. It is queried by the Location Server (LS) of the wireless network to obtain addresses of Wi-Fi APs and Bluetooth beacons that are visible to the handset placing a 9-1-1 call, and whose identifiers are relayed over the wireless interface to the LS.

ATIS-0700028v1.1 provides the detailed definition of the architecture and interfaces of the NEAD as part of the wireless 9-1-1 environment. Figure 5.1 depicts the high-level architecture reference diagram for the NEAD (from ATIS-0700028v1.1). Table 5.1 describes the salient interfaces.

The National Emergency Address Manager (NEAM) shown in Figure 5.1 is a management function specified in ATIS-0700028v1.1. It provides the Np interface and the supporting validation and administration functions required for provisioning into the NEAD Wi-Fi and Bluetooth civic address data from outside sources (e.g., Internet Service Providers [ISPs], wireless and wireline carriers, etc.).

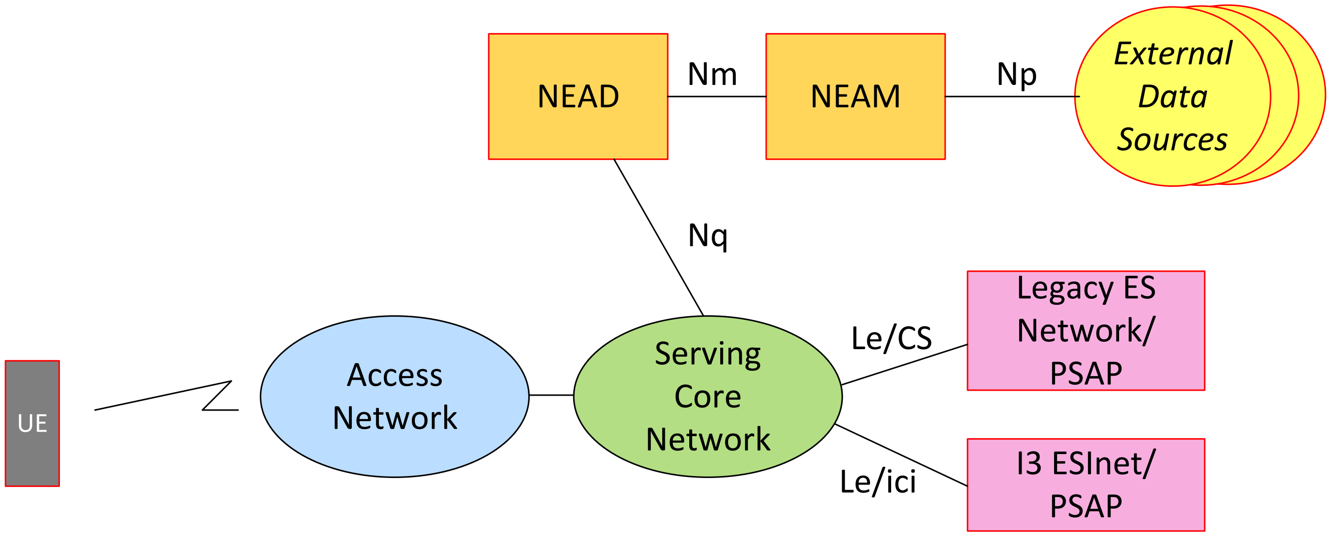

Figure 5.1 – NEAD Architecture Reference Diagram (from ATIS-0700028v1.1)

Table 5.1 – Interface References to the NEAD and Dispatchable Location

Interface Reference	Client	Server	Description
Np	External Data Source(s)	NEAM	Provisioned MAC Address + Civic Location
Nm	NEAM	NEAD	(Internal NEAD platform interface – not specified)
Nq	Serving Core Network (LS)	NEAD	Transactional Query I/F
Le/CS	ALI/SR	GMLC (shown as part of the Serving Core Network)	E2 interface (J-STD-036-C)
Le/ici	LNG	GMLC (shown as part of the Serving Core Network)	E2 interface (J-STD-036-C)

A typical simplified call flow diagram for a wireless 9-1-1 call that results in querying the NEAD, determining a dispatchable location (DL), and forwarding it to the PSAP is shown in Figure 5.2. The steps are summarized below using the numbered steps shown in the figure.

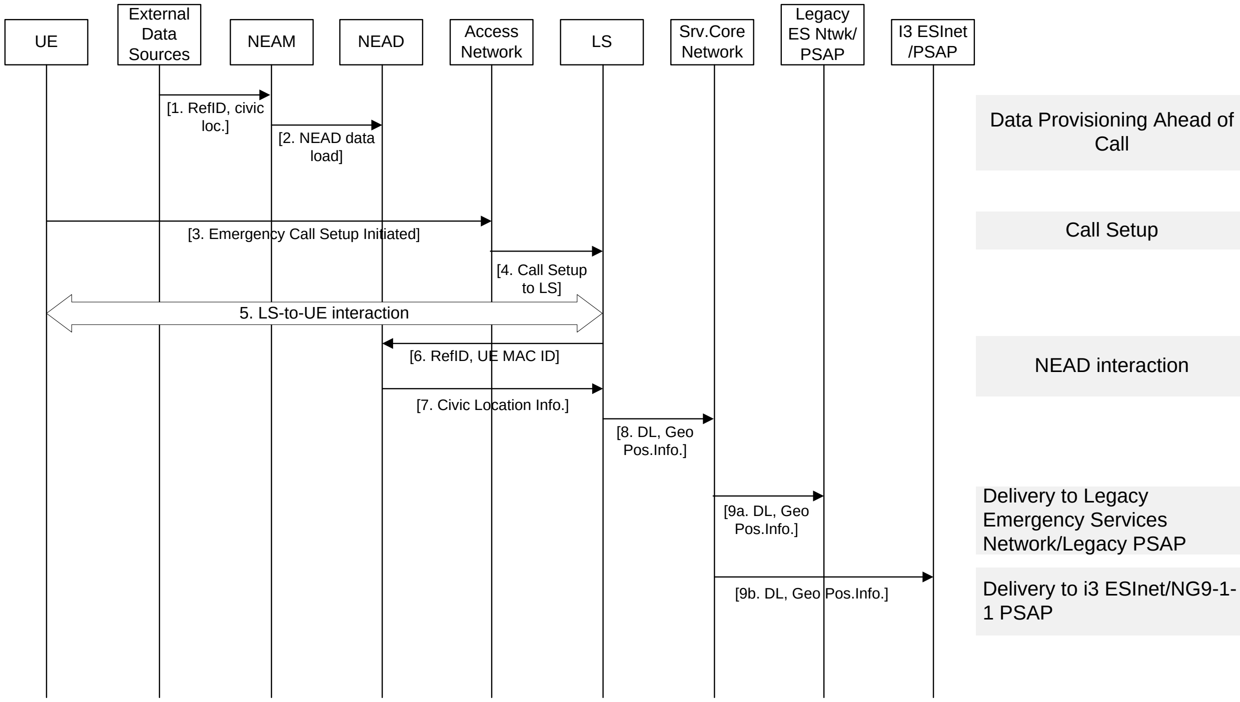

Figure 5.2 – Simplified Call-Flow Diagram for DL

1. Provisioning of NEAM ahead of the 9-1-1 call with civic addresses and related information.
2. NEAM to NEAD data load upon validation of the address information.
3. Emergency call initiated.
4. Access network (e.g., Evolved Node B [eNodeB]) to core network (e.g., LS) messaging.
5. Location processes including conveyance of UE measurement data and Reference IDs (e.g., observed MAC addresses) to LS.
6. Nq query from LS to NEAD, includes Reference ID.
7. Nq response from NEAD, includes civic address of candidate DL.
8. LS to serving core network, includes information for determined (final) DL information and computed geodetic position information.

9a. Dispatchable location information and geodetic position information provided to downstream Legacy Emergency Services Network and toward a legacy PSAP.

9b. Dispatchable location information and geodetic position information provided to downstream i3 ESInet toward an NG9-1-1 PSAP.

5.2 Future Extensions to NEAD Architecture & Capabilities

An extended NEAD architecture is currently undergoing standardization within the ATIS Emergency Location (ELOC) Task Force to extend the capabilities of the NEAD to support External Location Services (ELSs), which primarily support enterprises. The ELS provides management services for certain enterprises and would retain the civic address information for their Wi-Fi and Bluetooth beacon assets. For an ELS-managed (e.g., enterprise) Wi-Fi AP or Bluetooth beacon, only a URI is retained in the NEAD to point to the appropriate ELS to obtain the civic address information. This information is then relayed to the wireless network in response to the query from the LS.

Since implementation of the NEAD ELS or enterprise capability is likely a few years away, it will not be addressed in the current DL test methodology. Adaptations to the current methodology to handle the enterprise case will be addressed in a future revision of this ATIS standard.

6 Assumptions for DL Testing

1. ESIF ESM and the 9-1-1 Technologies Test Bed are concerned primarily with assessing the quality of dispatchable location. This assessment evaluates how well the whole process related to DL works and its eventual results. This includes, in an integrated fashion, the result of the various interactions and logical processes involved in eventually determining a DL, which encompass: interactions between the location server and the handset, the effectiveness of the Location Server (LS) querying the NEAD for certain MAC addresses observed by the handset calling 9-1-1 (or a test call emulating it), the quality and quantity of the candidate dispatchable locations returned by the NEAD as function of its provisioning, and the eventual logic in the LS that determines the delivered DL.

2. Since testing is done at the output of the LS, with the output of the NEAD an input to the LS, and the LS is typically carrier-specific in its implementation, testing of all the wireless carriers using the NEAD will be required. This includes at least the 4 national wireless carriers (upon their readiness).

3. This end-to-end assessment of DL on a carrier-by-carrier basis more explicitly assumes:

    a. The NEAD Platform development has been completed and that the platform is deployed and in an operational (production) configuration in conjunction with the various wireless networks it will interact with in the Test Bed.

    b. The Nq interface has been implemented and has been acceptance-tested for integrity as part of the NEAD development program. Furthermore, in the event that acceptance testing is not performed with every carrier participating in DL testing, similar validation tests will have been performed to ensure proper operation of the Nq interface to each carrier participating in DL testing, i.e., it is not the purpose of DL testing in the Test Bed to troubleshoot NEAD interface implementation.

    c. The LSs in the wireless networks under test have been upgraded to support the necessary interactions with both the handsets and the NEAD and to implement the various necessary logical processes. This includes first to query the NEAD with a subset or all IDs received from the handset, and second, to process the returned candidate dispatchable locations returned by the NEAD to arrive at the eventual DL result. Implicit in this assumption is that the LS in each wireless carrier network has been adequately tested by the wireless carrier and its LS vendor during a typical validation or acceptance testing process for such a significant capability upgrade.

    d. The handsets to be used in DL testing are versions of commercial handsets in which upgrades to the wireless protocol stack, and as needed the operating system, have been implemented to support relaying to the LS the Wi-Fi MAC addresses and Bluetooth Public Device Address (PDAs) observed by the handset. It is also assumed that these handsets can provide to the LS ancillary information to support the logic implemented in the LS related to determining an eventual DL. Such ancillary information could be signal strength measurements or a serving flag associated with a MAC address, or the like.

    e. The NEAD has been provisioned with adequate civic address data, consistent with the deployment milestones of the NEAD Platform, and for Test Bed purposes provisioned in at least the Cellular Market Area (CMAs) where the Test Bed regions are located (CMAs 7 and 27 for San Francisco/San Jose and CMA 17 for Atlanta). However, the Test Bed is intended and assumed to be an accurate reflection of conditions elsewhere; hence, the level of provisioning in the Test Bed regions is assumed to be similar, except for normal regional variations, to that in other CMAs intended to be provisioned in the same timeframe.

4. Testing the quality of DL entails determining, among other things, its level, e.g., whether a DL Level 1 or DL level 2 or a civic location is delivered and its veracity relative to established truth. Hence the test methodology is to be designed to provide this level of granularity.

5. While the purpose of DL testing is not to troubleshoot, or analyze in detail the performance of each element of the DL ecosystem, a DL test campaign in the Test Bed is an invaluable opportunity to gather as much data as possible to enable refinement of the logical processes or algorithms in the elements critical to the determination of DL.

6. The results of DL testing will have to be interpreted in the context of the degree to which the NEAD has been provisioned with reference point records and the typical level of detail achievable in those records. It may not be possible, for example, in a DL test campaign to examine the effects of details not yet available in the provisioned reference point records, such as Place Type (i.e., classification of building type). It should be noted that the data included in the NEAD database from a given provider belong to that provider, and other parties, e.g., affiliated with NEAD management, would not be in a position to add information into such records. Furthermore, the Test Bed's central premise is representative testing. Attempting to manually add details in certain NEAD records within the Test Bed that do not reflect processes followed broadly elsewhere would deviate from that principle. That approach is therefore not followed in the current test methodology.
7. Multiple sequential DL test campaigns may be required to establish the long-term performance of DL as the NEAD provisioning matures, more details are included in some of its records, and the algorithms of location servers are refined. A DL testing event is not intended to be a pass/fail type of test but rather it is intended to establish DL performance in the given time frame of testing. It is also intended to provide quantitative data and performance insights to wireless carriers and developers to support future efforts to improve achievable performance.

7 Dispatchable Location Test Methodology

Dispatchable location is inherently different from geodetic (latitude/longitude or x/y) location. DL refers to a certain civic address of a building or a specific unit or specific part and floor within a given building with a civic address and subaddress elements. DL is also affected by different system provisioning and environmental factors from geodetic location. For example, multipath encountered by distant signals and wireless network provisioning play key roles in geodetic location, whereas proximity to one or more Wi-Fi access points or Bluetooth beacons, the prevailing density of such reference points provisioned in the NEAD, and the neighboring environment are much stronger factors affecting DL and its quality. As such, factors that are to be taken into account in DL testing are, to a significant degree, different or prioritized differently from those affecting geodetic location. A modified test process distinct from x/y testing is therefore required. This Clause with its sub-clauses presents the framework of this test methodology and its relevant details without being overly prescriptive on test point selection to allow a degree of flexibility in DL test implementation.

7.1 Where to Test

The methodology developed for the 9-1-1 Location technologies Test Bed in ATIS-0500031.v002 has selected the San Francisco and Atlanta regions for the Test Bed. This combination is also sufficiently diverse, from a dispatchable location perspective, to continue to be recommended as the Test Bed regions for DL testing. Urban Atlanta does not look like urban San Francisco and neither do the respective suburban or rural areas look alike. Accordingly, testing in these distinct test bed regions explores not only the effects of distinct construction methods and materials on Wi-Fi signals, but also the effects of regional differences in provisioned data, their sources, and their densities. This East-West combination of test bed regions continues to provide sufficient diversity to be a good representation of a large majority of the nation.

In each region, different building types and environmental densities affect dispatchable location. This is often through the density of reference points in the area and the penetration or diffusion of Wi-Fi signals from such reference points. Although Wi-Fi-based positioning is promising in the context of metric threshold-based accuracy in challenging urban environments, it can be susceptible to indicating an erroneous structure. This depends on a number of factors, including building type and size and proximity to other buildings with Wi-Fi transmitters, as well as the algorithms implemented in the wireless network's location server. This has to be tested thoroughly in the context of DL, including the effects of what level of provisioning in the NEAD, as well as decisions by the wireless location servers.

Testing of DL therefore has to be performed in different morphologies to capture the distinct densities and predominant building use types. For example, a dense urban area typically has a high density of taller business/commercial buildings, whereas urban areas, which may have buildings of similar heights in some places, have a lesser density with a mix of commercial and residential buildings. The use type of the building, whether commercial or residential, affects dispatchable location in three ways: (i) the distinct density of provisioned Reference Points (RPs) between residential and commercial, depending on their available provisioning sources; (ii) differences in the internal structure of the building as well as its actual internal and external construction materials; and (iii) the presence of neighboring residential or commercial buildings surrounding the target building.

Not only is it necessary to test in the four well-established distinct morphologies, but it is also necessary to include sufficiently diverse elements of each morphology, e.g., in a suburban morphology conduct tests in a suburban home surrounded by other suburban homes as well as in a suburban home next to one or more large apartment complexes. These two example cases may not behave differently for Assisted Global Navigation Satellite System (A-GNSS) but can behave quite differently for dispatchable location.

7.2 Distribution of Test Buildings & their Types

To have a good representative statistical sample in each region, 20 buildings should be selected and distributed across the four morphologies in that region. (Specific recommendations will be provided in Clause 7.9).

Both residential and commercial buildings need to be included in the sample in each morphology, reflecting its typical mix of buildings, e.g., more commercial than residential in a dense urban setting. Different size commercial and residential buildings should also be selected in each morphology. If possible, the sample should also include different surrounding buildings. For example, a commercial mid or high rise building under test containing a modicum of reference points provisioned in the NEAD situated next to a heavily provisioned residential high rise is a different scenario from the same commercial building surrounded by similarly or more lightly provisioned commercial buildings. The selected sample of test buildings should strive to cover the various scenarios encountered in each test bed region.

A good geographic distribution of test buildings should also be included in larger test polygons. This ensures that, to the extent possible, neighborhoods of different socioeconomic level (which may have different broadband penetration) are represented.

7.3 Distribution of Test Points in Test Buildings

Since testing DL needs to examine the degree of fidelity of the delivered DL; e.g., is it DL1 in the correct zone of the building and within +/-1 floor, or DL2 in the correct unit, or only a civic location; the distribution of test points in each building needs to support such determination. It is recommended that a number of points per building and per test floor larger than have been used in Stages 1 and 2 of the Test Bed be identified as test points. (This is partially offset by significantly fewer test calls needed at each test point.)

Test points on a given floor need to be as much as possible in specific units in specific zones of the building. They also need to be in both interior and exterior parts of the building. Interior and exterior parts of a floor will have different Wi-Fi environments and likely different DL behavior. A test point inside a given unit can serve as both in that unit as well as in that quadrant of the building where the unit lies for the purposes of DL1 and DL2 classification of results. For larger units, e.g., a large suite occupying half a floor or more, testing in more than one room with different surroundings should be planned as well.

While testing in interior hallways or near elevators of commercial or residential buildings is acceptable for geodetic location testing, it can often lead to ambiguous results for dispatchable location. The preference therefore is for test points in specific addressable units in such buildings. However not every test point needs to be in a very specific addressable unit; occasionally a test point can be in a clearly identifiable zone or quadrant of a building, e.g., main first floor hallway by rear exit (in northwest quadrant). In large, more public buildings, e.g., arena or museum, clearly identifiable segments of space or rooms in the building can be used, e.g., section 5 of the 2nd level of the seating area, employee training room, 3rd floor cafeteria, or the like.

In taller buildings, testing needs to be performed in low floors, middle floors, and upper floors. Testing in at least 2 consecutive floors in each floor range is recommended. A minimum of 2 and preferably 3 test points per floor are recommended, even more for buildings with large footprints (e.g., an arena). The range of test points per building will be from 4 in a 2-story house to approximately 20 in larger high rises. Specific recommendations for the different building types and corresponding numbers of test points are provided in Clause 7.9.

It is clear that the test building and test point requirements for testing DL are distinct from those of testing geodetic location accuracy. Buildings that have been identified for geodetic location testing could be leveraged if they meet the various requirements for DL testing, regrading access and adequate availability of provisioned reference points in the NEAD.

7.4 NEAD Reference Point Requirements for Test Buildings

In general, smaller test buildings should have one or more potential reference point records in the NEAD. If there are none, then it is known beforehand that the DL results in that building will likely be erroneous or null. The null case, when a building has no RPs and is far from other buildings, is not interesting and wasteful of test resources. However, the other case when a building has no provisioned RPs and is close to another that has RPs provisioned in the NEAD is an interesting case that could be encountered with some frequency. It is therefore recommended that one to two such buildings, preferably, of different sizes be included among the set of 20 buildings in each Test Bed region. At the other end of the required RP density, a commercial high rise should have multiple potential records that are representative of the prevailing level of provisioning in the NEAD. What matters is that the chosen sample of buildings in a given morphology polygon be representative of similar buildings and the overall morphology in the Test Bed region.

The fundamental premise of testing in the Test Bed is to perform representative testing, in the sense that this testing attempts to replicate the conditions and location system performance that would prevail in other parts of the country, e.g., in the six monitoring regions, as well as other areas across the country. Testing dispatchable location in the Test Bed is no different. The Test Bed should be viewed as a microcosm for the nation, hence no special procedures affecting performance, e.g., extra RP provisioning density, localized provisioning, calibration, etc. affecting the Test Bed areas exclusively should be attempted. It should be stated, however, that regional variation, e.g., in sources of provisioning NEAD data, will exist and it is not the intent to avoid this natural variation from occurring.

In each of dense urban, urban, and suburban morphologies in the two Test Bed regions it is expected that sufficient reference point records will be provisioned in the NEAD prior to the start of DL testing. It is also expected that within the polygons currently defined in each of these morphologies, as specified in ATIS-0500031.v002, there will be adequate reference point records for effective DL testing. Special Considerations for the Rural Environment.

7.5 Special Considerations for the Rural Morphology

In the rural Atlanta polygon it is expected that adequate records are likely to be available, although if challenges arise in securing the relatively small required number of test buildings, expansion of that polygon might be needed. As for the rural polygons of the San Francisco region per ATIS-0500031.v002, those lie in CMA 339, which is not likely to be provisioned in the NEAD in the time frame for early dispatchable location testing. It is recommended that a rural portion of southern Santa Clara County, e.g., in the area between or adjacent to Morgan Hill and Gilroy, be used to define an alternate rural polygon for DL test purposes. The main reason behind selecting rural polygons further away for the San Francisco Region, i.e., in the foothills of the Sierras or the Central Valley, is a lower prevailing cell site density like many rural parts of the nation. Cell site density is a factor much more relevant to testing geodetic location and does not apply significantly to DL. Hence, testing DL in an essentially rural environment in southern Santa Clara County would be acceptable and recommended. The definition of this alternate SF Region rural polygon is provided in Annex A.

7.6 Test Handsets

Since testing of DL is performed for each wireless carrier participating in a DL test campaign, multiple representative handsets should be used for each such carrier to capture variations in the sensing and relaying of Wi-Fi and Bluetooth signals to the network location server. It is recommended that 4 distinct handset models, if possible using different handset operating systems or different implementations of the relevant 3GPP standards for exchanging the information between location server and handset, be included in the test.

7.7 Number and Duration of Test Calls

Since DL results at a given test point are expected to exhibit much less variability than geodetic location that is not Wi-Fi based, it is not necessary to use a large number of test calls (e.g., 100) from each test device at a given stationary test point. In fact, it is likely that repeated results with interdependence between successive calls will be exhibited (analogous to Device Based Hybrid). Hence, 10 calls per test device per test point are expected to suffice and is recommended. This number would also help manage the scope of the testing campaign. It is recommended that the test call duration be similar to the duration used in testing geodetic location technologies in the Test Bed. Handsets should generally be power cycled between test points.

7.8 Ground Truth Requirements for Test Points

A precise ground truth survey is required at one test point (primary test point) per test floor. Ground truth of reduced accuracy (goal 1 meter, upper bound 3 meters) would be acceptable for secondary test points on the same floor, as long as such inaccuracy in ground truth would not result in the test point being interpreted to potentially fall in a unit other than the one it is actually in.

7.9 Recommended Test Building Types & Test Point Counts

As described above, key factors that are likely to affect DL performance are strongly influenced by building type and environment; they include commercial versus residential use, building height, horizontal footprint, and internal structure, as well as building's surrounding density and environment, including the dominant types of buildings surrounding a given test building. Indirectly included in all of these factors is the anticipated variation in density of provisioning of the NEAD reference point records during the time frame relevant to the testing.

To capture this range of variation across the various morphologies, the building types shown in Table 7.1 are recommended. The corresponding number of recommended test points in each building type is also included in the table. It varies with the size and type of building and attempts to capture the range of scenarios, from a DL perspective, that are likely to be encountered in each type of building.

It should be noted that "Hotel" and "Residential" are two categories that are typically quite different for DL. One is likely to have an enterprise or public Wi-Fi system and the other a collection of private and non-uniform installations in individual units. It is therefore not appropriate to substitute one for the other.

Table 7.1 – Recommended Test Building Types and their Number of Test Points

	Morphology	Recommended Building Types	Recommended # of Test Points
1	DU	Commercial high rise – concrete	20
2	DU	Commercial high rise – glass	20
3	DU	Hotel (Commercial) mid/high rise	15
4	DU	Apartment/condo high rise	15
5	DU	Commercial mid rise	15
6	DU	Commercial low rise surrounded by High rises	6
7	U	Commercial mid/high rise	18
8	U	Residential mid or high rise	15
9	U	Residential low rise(3-4 story)	10
10	U	Stadium/arena	15
11	U	Museum/Exhibition hall	10
12	U	Mall/commercial center	10
13	S	Commercial mid or high rise	12
14	S	Residential mid or high rise	12
15	S	Apt/condo complex 3-4 story, bigger foot print	10
16	S	Hotel/Motel standalone 2 story	6
17	S	Individual home in middle of single family homes	4
18	S	Individual home next to larger apartment complex	4
19	R	Residential 2 story	4
20	R	Public or retail 2-story (or equivalent)	4

Total	225

DU: Dense Urban; U: Urban; S: Suburban; R: Rural

It should be noted also that the set of building types listed in Table 7.1 is not intended to map 1-to-1 or cover all the cases of "Place Types" included in ATIS-0700028v1.1. Although as shown in Table 7.2, most of the twenty building types selected here will map to one such Place Type or another, e.g., Commercial Multi-Story (CMM) or Multi-Tenant Residential – Multi-Story (MTM), which are broad characterizations, a few building types in the above list could be satisfied by one or more possible Place Types. It is not the intent here to test the efficacy of Place Type or any logic related to it, since Place Type data is not anticipated to be present in the NEAD for some years. It would not be difficult, however, to adapt the current methodology to encompass such objective in the future.

Table 7.2 – Correspondence between Selected Test Building Types and their Place Types

	Morphology	Recommended Building Types	Place typein ATIS-0700028v1.1
1	DU	Commercial high rise - concrete	CMM
2	DU	Commercial high rise - glass	CMM
3	DU	Hotel mid/high rise	CMM
4	DU	Apartment/condo high rise	MTM
5	DU	Commercial midrise	CMM
6	DU	Commercial low rise surrounded by High rises	CMM or MUM
7	U	Commercial mid/high rise	CMM or MUM
8	U	Residential mid or high rise	MTM
9	U	Residential low rise(3-4 story)	MTM
10	U	Stadium/arena	CMM
11	U	Museum/Exhibition hall	CMM
12	U	Mall/commercial center	CMM
13	S	Commercial mid or high rise	CMM
14	S	Residential mid or high rise	MTM
15	S	Apt/condo complex 3-4 story	MTM
16	S	Commercial standalone 2 story	CMM
17	S	Individual home in middle of single family homes	RSS or RMS
18	S	Individual home next to larger apartment complex	RSS or RMS
19	R	Residential 2 story	RMS
20	R	Public or retail 2-story (or equivalent)	CMS

For reference, the place types currently defined in ATIS-0700028v1.1 are listed in Table 7.3. For further detail on these definitions, please consult ATIS-0700028v1.1. It should be noted that the place type definitions are still undergoing refinement and may change in future versions of that standard.

Table 7.3 – Place Types (From ATIS-0700028v1.1)

Code	Description
RSS	Single Family Residential – Single story
RMS	Single Family Residential – Multi-story
MTS	Multi-Tenant Residential – Single story
MTM	Multi-Tenant Residential – Multi-story
CMS	Commercial – Single story
CMM	Commercial – Multi-story
MUM	Multi-Use– Multi-story (building with both commercial & residential occupants)
MUS	Multi-Use– Single story (building with both commercial & residential occupants)

8 Data to be Collected

As stated in Clause 6 outlining the DL testing assumptions, while the purpose of DL testing is not to troubleshoot, or analyze in detail, the performance of each element of the DL eco system, a DL test campaign in the Test Bed is an invaluable opportunity to gather as much data as possible to enable gaining insight into DL determination and refinement of the logical processes or algorithms supporting its determination. With that objective in mind, two sets of data elements to collect are identified, one as a minimum required set and the other an advisable set to obtain if possible, at least for the benefit of the wireless carrier being tested and their location server vendor.

The minimum data elements to collect include:

- The delivered civic address with all its sub-elements (when available) constituting the Location server's determination of the DL for the test call.
- The geocoded location delivered by the NEAD along with the DL.
- The DL location method determined by the LS for the test call with one of: DL2, DL1, Civic Address (CVC), and such that the total data collected for each method in a given morphology constitutes a statistically significant sample to enable the evaluation described in Clause 9.1.
- The geodetic (computed) latitude and longitude obtained by the location server and delivered with or without the DL for the given test call and its reported uncertainty at 90% confidence.
- The type (position source code) of the geodetic fix (e.g., A-GNSS, OTDOA, Enhanced Cell ID [ECID], etc.)
- Time stamp or time stamps for the determination of the DL and the geodetic coordinates associated with it.
- The number of MAC addresses and BT PDA observed by the handset and relayed to the LS over the air interface.
- Whether a serving flag was included with the relayed MAC addresses to the LS.
- The number of MAC addresses and BT PDA sent in queries to the NEAD over the Nq interface for the location transaction in the given test call.
- The number of civic addresses returned in response to these queries by the NEAD.
- The last four items listed above are critical to distinguish between possible issues in LS implementation and potential limitations or deficiencies in the level of provisioning of the NEAD. All of the above data elements should be possible to obtain from logs of the LS (generally the Enhanced Serving Mobile Location Center [E-SMLC]) as reflected in the representative system block diagram of Figure 8.1.

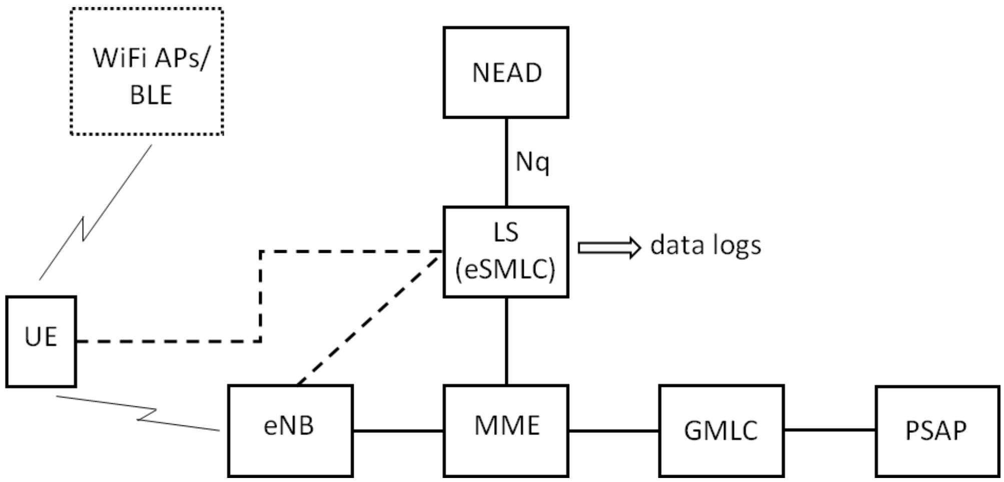

Figure 8.1 – High Level System Block Diagram

Apart from the data identified above, data gathered at the test handset side or by the test executor should include the ID of the test point, its ground truth, method the ground truth was determined, the actual civic address and description of the test point, the IDs of the test handsets, the number of test calls placed from each test handset, the time stamp for the initiation of each test call, the duration of each test call, and any other information about the conditions in the field that may affect test operation or its outcome. The time stamps at both test handset and LS should enable the computation of the time to obtain the DL and geodetic (x, y) result at the output of the LS.

In addition to the minimum required set of data elements listed above, it would be desirable for the wireless carrier undergoing the DL testing to obtain for its internal analysis:

- The actual list of Wi-Fi MAC addresses relayed by the handset to the LS during each test call.
- Their corresponding signal levels detected at the handset and reported to the LS.
- The specific MAC address(s) for which a serving flag is provided.
- The actual list of MAC addresses used to query the NEAD on the Nq interface.
- The set of civic addresses and corresponding geocoded locations returned from the NEAD in response to these queries.
- The set of responses indicating “record not found” and their corresponding correlation IDs.
- The time stamps of the returned civic addresses.
- The geodetic location technologies (fix types) available for use in the LS during the given test call.

Since dispatchable location technology is still in its infancy, the wireless carriers are encouraged to demand strong logging capabilities from their LS vendors to support the collection of all of the above data. This level of detail will be crucial to the analysis of LS algorithms’ performance and their subsequent refinement. It will also be a rich source of information that will provide invaluable insights into how DL works in wide array of scenarios and the expectations the stakeholders should have of it.

9 Approach to Assessment of Results

Once testing of dispatchable location systems has been completed in the Test Bed, as described in previous sections of this document, wireless providers will need to assess the results as part of their overall compliance evaluation.

There are two key criteria to be assessed through Test Bed evaluation of dispatchable location systems:

1. The percentage of test 9-1-1 calls in the Test Bed resulting in a dispatchable location that consists of the street address of the calling party, plus additional information such as suite, apartment, or similar information necessary to adequately identify the location of the calling party.

2. The level of precision of the dispatchable location result. This is directly correlated to the Class of Service (CoS) designators expected to be assigned (CVC, DL1, DL2).

Each of these criteria are further discussed in the following sections.

9.1 Dispatchable Location Veracity

As described in detail in ATIS-0500031.v002 Clause 8 ("How to Analyze Test Results"), the Test Bed is utilized to assess the accuracy performance of each positioning method deployed to locate 9-1-1 callers. Specifically, the Test Bed establishes the proportion of indoor fixes that are either dispatchable locations (as defined in the FCC 4th Report and Order) i.e., for address-based solutions, or are coordinate-based locations less than or equal to 50 meters from the ground truth of the test call compared to the total proportion of completed test calls using each technology.

For dispatchable location outputs, rather than computing an error distance relative to the known ground truth location of the test call, an evaluation is made to determine whether or not the reported civic address information meets the criteria for being 'dispatchable', as defined in the 4th Report & Order and further specified in ATIS-0700028v1.1 ("Location Accuracy Improvements for Emergency Calls") and within the ESIF ESM subcommittee.

By way of summary, the following conceptual agreements have been reached within ATIS ELOC TF and ATIS ESIF on assessing when a civic address location response is sufficient to 'adequately identify the location of the calling party', and therefore be considered consistent with the definition of dispatchable location.

The following conditions will be determined for each test call:

- **Condition 1** – Is the caller within 50 meters of the calculated (geodetic) X/Y location?
- **Condition 2** – Is the provided civic address the street address of the caller (to the building level) and if applicable, in the right zone?
- **Condition 3** – For multi-story buildings, is the provided civic location within plus/minus one floor of the caller?
- **Condition 4** – For multi-unit buildings, does the provided civic location include the correct unit of the caller?

For purposes of compliance assessment in the Test Bed, either Condition 1 (for coordinate-based systems) or Condition 4 or Conditions 2 plus 3 (for address-based systems) are sufficient.

Using these criteria, the percentage of adequate dispatchable location results will be established within the Test Bed for each morphology (dense urban, urban, suburban, rural) for each dispatchable civic address location method (i.e., CVC, DL1, or DL2). In terms of compliance assessment, dispatchable location systems are analyzed in the same manner as any other positioning method – i.e., the percentage of a DL1 or DL2 fix determined in the Test Bed to be a correct DL is multiplied by the yield (availability) of DL1 or DL2 results, respectively, in each morphology relative to the total number of 9-1-1 calls placed within the six monitoring regions (using live call data), and the results are summed to determine an overall compliance percentage (see ATIS-0500031.v002 Clause 8.2, and Clause 9.2 below for a discussion of CVC).

Either an adequate dispatchable location or a geodetic location within 50 meters contributes toward compliance with the FCC mandate. It is recommended that geodetic location also be acquired and tested in the Test Bed at the same time as DL. However, establishing compliance in general is through applying the live call yield (availability) for each individual positioning method against the Test Bed accuracy results as described in ATIS-0500031.v002. In the context of compliance evaluation, DL and geodetic location are assessed independently in the indoor Test Bed and outdoor testing, then combined through the defined blending process for an overall location performance benchmark.

9.2 Dispatchable Location Class of Service Precision

A second purpose for evaluating dispatchable location in the Test Bed is to assess the precision of the assignment of a location method parameter in the LS which is reflected as a Class of Service indicator within the Automatic Location Identification (ALI) for civic address results. As specified in ATIS-0700028v1.1 (Table 8.6), three location method tokens have been defined that correlate to CoS designations.

DL designators (with location method token values):

1. Civic Address: CVC (location method token=NEAD-CVC).
2. Dispatchable Location Level 1: DL1 (location method token=NEAD-DL1).
3. Dispatchable Location Level 2: DL2 (location method token=NEAD-DL2).

For discussion purposes, it is beneficial to employ the use of a generic term when comparing differences in civic street address information, whether considering the location method token values or the CoS designators. Therefore, this document refers to the values CVC, DL1, and DL2 as DL designators to differentiate between the three levels of resolution presented as indicated in the above list.[4]

Since the test data is assumed to be acquired at the output of the LS and ahead of the ALI or PSAP, this document treats location method token values in a similar way as the ALI refers to CoS designators.

The Civic Address (CVC) DL designator is intended to describe civic address information from the LS which may not be considered to be independently actionable for first responders. An example would be a simple street address for a multi-story building without any indication of which floor the caller was located on. CVC responses from the LS will not be considered dispatchable locations for compliance assessment purposes.

Two actionable DL designators (DL1 and DL2, considered assurance levels) have been established for dispatchable location results. These designators, along with their targeted location content, are summarized below.

“DL1” – Medium level quality dispatchable civic location

- Civic address of the caller.
- Floor (plus or minus one floor) of the caller.
- Building Zone/Quadrant (NW, SW, NE, SE) of the caller.
- Within 50 meters of the caller.

“DL2” – Highest level quality dispatchable civic location

- Civic address of the caller.
- Room/Suite/Unit of the caller (for multi-unit buildings).
- Including floor where present in civic address elements.
- Within 50 meters of the caller.

The DL designations are assigned in the wireless provider’s network to convey the level of specificity of the civic address information later provided to the PSAP. The DL assignments are determined through the use of algorithms designed into the wireless provider’s location system. Various parameters are input to the DL determination algorithm, such as ‘Place Type’, ‘Serving Flag’, reference point type and RSSI, the quantity and consistency of individual NEAD results returned, consistency with other independent geodetic location results, etc., with the appropriate DL designation provided as an output.

As these DL determination algorithms will be stochastic in nature, it is important that they be ‘calibrated’ and fine-tuned over time to maximize the likelihood of producing the correct DL designator a high percentage of the time in

[4] In practice, each of the above location method tokens are applied by the LS and delivered to the downstream processing elements (e.g., GMLC) along with the DL information. Each location method token is mapped to a specific PositionSource value at the GMLC and sent toward the PSAP over the E2 interface. The ALI performs a mapping from PositionSource to Class of Service designator that is delivered to the PSAP. The actual CoS values are similarly labeled WCVC, WDL1, WDL2.

response to actual 9-1-1 calls. The Test Bed evaluation of the dispatchable location system performance relative to the known location of test handsets within various test buildings will provide important insight back to the wireless provider to enable refinements of the algorithm and improved performance of the DL location system.

Annex A
(normative/informative)

A Alternate Rural Polygon for San Francisco Test Bed Region

The rural polygons of the San Francisco Test Bed region defined in ATIS-0500031.v002 are either in the Central Valley of California or the foothills of the Sierras south of Yosemite. Both lie within the boundary of CMA 339, which is not among the top 50 CMAs population-wise, and which is therefore not likely to be provisioned in the NEAD in the time frame of early dispatchable location testing (late 2017/early 2018). The main reason behind selecting rural polygons that are geographically distant from San Francisco/San Jose is the lower prevailing cell site density, which is representative of many rural parts of the U.S. Cell site density, however, is a factor much more relevant to testing geodetic location and does not apply significantly to DL. Hence, testing DL in what can be easily considered a rural environment in southern Santa Clara County is the recommended approach during DL testing.

Two factors have entered into the selection of the rural polygon presented herein. First is an analysis of the prevailing morphology in that area, particularly the density of structures, and whether homes or commercial structures are interspersed by open fields or open space versus those structures being organized in what resembles suburban concentrations (e.g., rows of homes). Second is an analysis of reference points likely to be provisioned in the NEAD during the expected timeframe of the DL testing. The intent is to ensure that while the selected area within the rural polygon is sufficiently sparse, it contains a reasonable number of likely records that can translate into success in identifying and acquiring actual suitable test buildings per the requirements in Section 7. These call for 2 buildings, one residential and one commercial or public, both 2 stories or equivalent.

The proposed rural polygon in southern Santa Clara County is depicted in the Figure A.1. It is also provided in Google Earth format in the attached .kmz file.

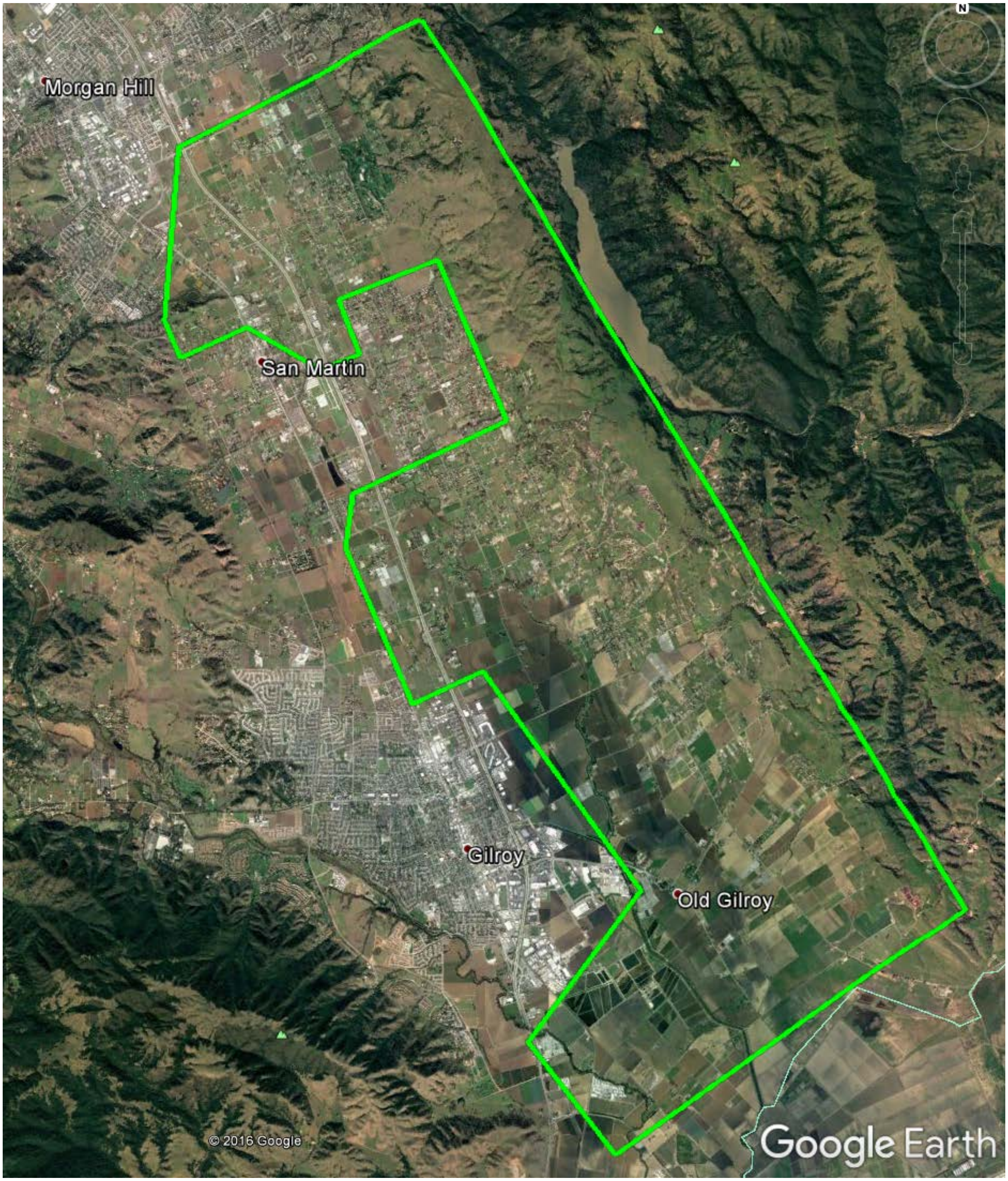

Figure A.1 – Proposed Rural Polygon in Southern Santa Clara County for DL Testing