

Ensuring GIS Compliance for Automated Vehicle Location for US Local Government “Enhancing Public Safety and Accountability through Impactful GIS Compliance”

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Executive Summary

Two organizations have combined their Automated (Automatic) Vehicle Location (AVL) backgrounds to provide a one source document brief (not all sources could be placed in this white paper, the leading sources were included) to access information concerning compliance and data standards for those searching for this type of information. Although a brief, we believe others will continue to build on this body of knowledge and contact us with their questions and additional ideas and information. Since 1994, CompassCom, a specialist in automated vehicle location software, has provided GIS-centric fleet management software solutions to clients globally, leveraging innovative technologies in fleet management and telematics to improve safety, efficiency, accountability, and sustainability for its clients. Global Marketing Insights, Inc. provides GIS and Geospatial Subject Matter Expertise to the US Government and commercial industries focused on leading edge technologies.

1. Introduction

Automated (Automatic) Vehicle Location (AVL) technology involves determining and transmitting the geographic location of a vehicle using automated means. Global Positioning systems (GPS) technology is used in combination with mobile data communication.

These systems have been in use since the 1990s by transit agencies and computer aided dispatching technology. They have also been found to be beneficial for fleet management, vehicle theft protection, first responders and public transportation systems providers such as Uber and Lyft. They have proven to be especially effective in snow services and asset management.

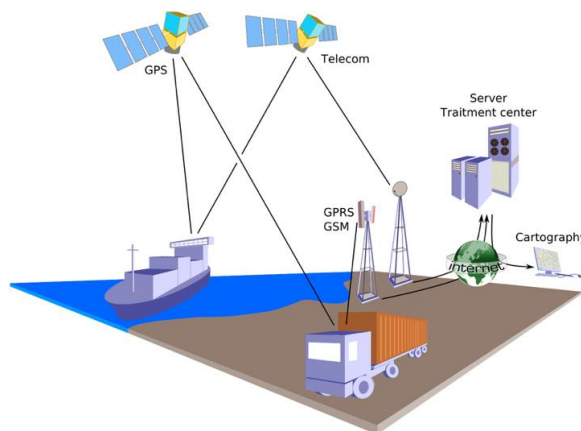


Image Courtesy: Wikipedia

This technology merges on-board diagnostics of a vehicle with satellite-based GPS data and provides critical data for locating a private or public transport vehicle. AVL also proves handy at locating a crew during any on-road emergency situations.

Automatic Vehicle Location Systems (AVL) can be categorized into Radio Navigation, GPS-based, and other methods. Radio Navigation utilizes ground-based radio signals for tracking, offering reliable

performance in urban areas. GPS-based systems provide global coverage, enabling precise vehicle tracking anywhere. Other methods include cellular triangulation and satellite tracking, enhancing system versatility to provide real-time vehicle tracking, monitoring driving behavior, and improving route optimization.

The key benefits to local governments for compliance include:

- Transparency
- Improved Services
- Accountability
- Improved Public Safety -

In addition, utilizing GIS integrated with AVL Systems supports operations at the State and Federal Government levels including:

- Tax Valuations
- Homeland Security – disaster response and recovery
- Public Safety – health, fire emergencies
- Asset Lifecycle Management
- Spatial Data Accuracy and Visualization Mechanism for ease of use

Criteria of Critical Importance to Compliance include the following:

- Data Accuracy
- Law and policy adherence
- Public service ease of use and access for transparency to stakeholders
- Temporal reference
- Measurement of Environmental Sustainability
- Artificial Intelligence Use and Security

2. GIS Compliance Potential Requirements for AVL in local government

Regulatory Standards

In the 2024 legislative session, at least 45 states, Puerto Rico, the Virgin Islands and Washington, D.C., introduced Artificial Intelligence (AI) bills, and 31 states, Puerto Rico and the Virgin Islands adopted resolutions or enacted legislation

The National Institute of Standards and Technology (NIST) develops and maintains standards used within science, technology, and other industries. These standards help federal agencies, contractors and other businesses that work with the government meet the requirements of different frameworks, such as Federal Information Security Management Act (FISMA), which dictates cybersecurity standards. Other organizations in the public and private sector also use these standards as part of their cybersecurity programs.

Examples of NIST standards include the NIST 800 Series as follows:

- **NIST SP 800-53.** This standard pertains to how data is managed and kept safe on federal information systems. This also applies to contractors or third parties that also have access to federal data. It includes security controls such as access control, incident response and configuration management.
- **NIST SP 800-37.** This is the Risk Management Framework for information systems. The standard's goal is to provide criteria for an organizations risk management activities, while outlining the needed structure and processes for managing security, privacy, and risks.
- **NIST SP 800-53/FI.** This creates security standards for federal agencies to

manage programs that protect data and implement FISMA.

- **NIST SP 800-30.** This standard provides guidance for conducting risk assessments. It applies to federal information systems and other organizations and reviews the differences among risks, threats, and vulnerabilities. The standard also examines the chances of risks, threats and vulnerabilities occurring and the effects they may have.
- **NIST SP 800-171.** This standard provides guidance for protecting controlled unclassified information in nonfederal systems or organizations. This includes physical security practices, such as allowing only authorized individuals access to physical systems or operating environments.

“The Blueprint for an Artificial Intelligence (AI) Bill of Rights” is a set of processes and associated practices to help guide the design, use and deployment of automated systems to protect the rights of the American public in the age of artificial intelligence.

These principles are a blueprint for building and deploying automated systems that are aligned with democratic values and protect civil rights, civil liberty, and privacy. The blueprint is non-binding and does not constitute U.S. government policy. However, the five principles stress:

- Safe and Efficient Systems
- Algorithmic Discrimination Protections
- Data Privacy
- Notice and Explanations

- Human Alternatives, Consideration, and Fallback

On October 23, 2023, an “Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence” was announced, designed to harness AI for good realizing its myriad of benefits while mitigating its substantial risks or potential abuse.

While at the State and Local Government levels there is an abundance of both Automated Vehicle and Artificial Intelligence laws and regulations being developed to govern and provide “voluntary guidance to support the development of safe technologies”, over 21 states have followed in Nevada’s footsteps adopting authorization standards (developed in 2011) for autonomous vehicles and the National Highway Traffic Safety Administration (NHTSA) guidance for this fast-paced and high growth industry. Typical topics covered by these state standards include Cybersecurity, Definitions, Insurance and Liability, Operator Requirements, Infrastructure and Connected Vehicles, Operations on Public Roads, Vehicle Testing and Inspection Requirements to name a few. Keep in mind, public safety operators should check their states particular guidance in this area as well.

Data Accuracy and Quality:

- Why is real-time and historical data accuracy in AVL so important?

The data is a historical record, and as such can be used as evidence in legal situations. It is used by law enforcement, fire departments, and other first responders, as well as many other entities. It is legally binding data and as such, accuracy is of supreme importance.

- Key data standards needed today for GIS integration for AVL fall into basic categories of Spatial and Temporal data and include:
 - Precise Geographic Coordinates (Latitude, Longitude)
 - Timestamps
 - Road Network Information Granular Details
 - Vehicle Identification Granular Details
 - Vehicle Status

The AVL GIS Data standards must consider Data Quality Management, Data Integration and Data Granularity depending on the AVL application.

Multiple organizations are focused on GIS Standards and have working groups and committees that are typically easy to join and filled with subject matter experts ready to assist in this complex area consisting of:

- [NENA-National Emergency Number Association](#)
- [OGC \(Open Geospatial Consortium\)](#)
- [FHWA \(Federal Highway Administration\)](#)
- Multiple State GIS Standards Working Groups with this topic focus. [NSGIC \(National States Geographic Council\)](#)

An organization not only must focus on compliance and data standards for the AVL sector but consider the personal impact on individuals in terms of privacy and security as well.

Privacy and Security Regulations:

Regulations in the United States include the following:

- The [Privacy Act of 1974, 5 U.S.C. 552a](#), provides privacy protections for records containing information about individuals (i.e., citizen and legal permanent resident) that are collected and maintained by the federal government and are retrieved by a personal identifier. The Act requires agencies to safeguard information contained in a system of records (SOR). This act was most recently revised in 2022 by the Department of Homeland Security which streamlined and updated the language of several provisions. [Other updates](#) focused on Computer Matching and Privacy Protection and Security occurred in 1988, 1990, 2002, 2014.
- The [Federal Information Security Modernization Act of 2014](#) (amends the Federal Information Security Management Act of 2002, 44 U.S.C. 3541), requires agencies to develop, document, and implement an agency-wide program to provide information security for the information and information systems that support the operations and assets of an agency.
- The [E-Government Act of 2002](#) (44 U.S.C. 3601 *et seq.*) establishes procedures to ensure the privacy of personal information in electronic records.

Internationally, one of the purposes of the European Union's General Data Protection Regulation (GDPR) is to protect individuals' fundamental rights and freedoms, particularly their right to protection of their private data. Broadly, its seven principles are:

- Lawfulness, fairness, and transparency.
- Purpose limitation.
- Data minimization.
- Accuracy.

- Storage limitation.
- Integrity and confidentiality (security)
- Accountability.

Best practices for Data Security

Two prescribed methods to improve data security are encryption and anonymization. Encryption provides a high level of security because the data is transformed into an unreadable format. Data anonymization tools remove personal information from the dataset, altering the data itself to protect individual users from being identified.

At its most basic level, encryption is the process of protecting information or data by using mathematical models to scramble it in such a way that only the parties who have the key to unscramble it can access it.

There are two types of encryption in widespread use today: symmetric and asymmetric encryption. The name derives from whether the same key is used for encryption and decryption.

Encryption is used in the 21st century to protect digital data and information systems. As computing power increased over the years, encryption technology has only become more advanced and secure. However, this advancement in technology has also exposed a potential limitation of today's encryption methods.

Encryption is also used to protect data in transit, for example data being transferred via networks. There have been numerous reports of data in transit being intercepted in recent years. Data should also be encrypted when transmitted across networks in order to protect against eavesdropping of network traffic by unauthorized users.

Data anonymization is a type of information sanitization focused on privacy protection. It is the process of removing personally identifiable information from data sets, so that the people whom the data describe remain anonymous.

Data anonymization has been defined (in ISO:25237) as a "process by which personal data is altered in such a way that a data subject can no longer be identified directly or indirectly, either by the data controller alone or in collaboration with any other party." Data anonymization may enable the transfer of information across a boundary, such as between two departments within an agency or between two agencies, while reducing the risk of unintended disclosure, and in certain environments in a manner that enables evaluation and analytics post-anonymization.

Both of these tools provide data security and should be considered in the use of AVL and GIS programs to protect both data and address privacy issues. In addition, providing cyber certification and training for employees warrants considerations.

3. AVL Systems and Key GIS Features needed for Local Government

As previously discussed, all aspects of data security, standards and governance must be considered in the development of AVL systems for local government. Key areas of system development must include:

Public Facing Portals and Access for Transparency:

A web portal or app is needed to inform citizens and provide transparency.

Interoperability Standards:

AVL must be compatible in GIS systems as well as AutoCAD Systems (of which there are multiple systems)

Applications Protocol Interfaces (API) must be developed for Local Government to interface with their common systems such as Faster Fleet Management to provide easy user interface.

- **Asset Lifecycle Management and Inspection**

Preventative maintenance, frequent inspections, and lifecycle planning of asset replacement can help to lower the overall cost of assets. Having well-maintained equipment, especially that of first responders is of utmost importance, and in many cases critical in life and death situations.

Assets, such as fleets of vehicles, are costly to replace, and scheduled maintenance can help to preserve those assets and give them a longer useful life.

- **Measurement of Level of Service**

AVL Systems with key GIS features allow the measurement of service levels in the areas that are of most concern to city officials and citizens. As this data is collected over time, improvements can be tracked and reported to show the value of the systems. Any number of statistics can be gathered and reported, and dashboards created to inform and educate stakeholders.

- **Historical Route Playback:**

- Data retention and Playback – data is retained from these systems indefinitely, although it may be archived after a certain time period. This allows playback in the event of dispute or an accident.

- Customer service and complaint management. – One especially useful aspect of AVL and GIS systems and the data retention aspect is that there are verifiable records that can be used to provide both customer service and valuable data when researching complaints and disputes. An example is when a snowplow knocks over a homeowner's mailbox. In the past, there would have been no record of that occurrence and there would have been a disgruntled citizen.

Geofencing and Alerts:

- **Regulatory and policy mandates for geofencing in public services** – most policy mandates deal with law enforcement and the issuance of warrants. There is currently no overall restriction of geofencing, although some states prohibit it in certain areas, such as hospitals in order to protect privacy rights.
- **Automated Alert Systems Compliance Protocols** - Geofencing allows government agencies to send targeted emergency alerts based on location. Only those who are or will be affected are notified. Geofencing can lead to faster response times, higher accuracy, and customizable alerts for specific emergencies.

By integrating geofencing with other systems, responding agencies have a more complete picture in a crisis. This is critical during natural disasters, active shooter events and Amber Alerts for missing persons.

- **Accountability** – Geofencing can increase accountability by placing buffer zones that fleets cannot pass through without alerting the fleet management. This can prevent theft, supply pilfering, and other illegal acts by employees, and others.
- **Safety**- In addition to accountability issues, geofencing can also provide a safety net for employees in terms of vehicle hijacking or other similar issues. If the vehicle is taken outside of the geofence, there is a record of that occurrence which could be helpful in many instances.

4. Benefits of AVL Systems for Local Government that are GIS Compliant

Enhanced Public Safety

Communities that have implemented AVL systems that are GIS compliant have reported that they increased public safety in number of ways. Response times by first responders have been decreased, law enforcement have been able to respond more quickly to serious situations, and there have been less issues with equipment failures for snow fighting.

Faster response to all crisis and emergency situations has enhanced public safety and reduced citizen complaints in most communities that have adopted these systems.

Cost Savings and ROI:

Lowering costs by doing preventative maintenance on fleets and using better scheduling and routing programs that reduce fuel costs helps to increase the return on investment for these systems. Reacting more quickly to emergency situations not only has the potential to save lives and

property, but also to reduce costs to the community, in terms of insurance costs and other expenses.

Enhanced Accountability, Decision Making and Transparency:

By being more transparent to the community, these systems may increase confidence in the local government and its leaders and employees. Creation of a web-based or app portal allows citizens to understand and see that the expenditures on these programs improve the community and may increase their property values. This can influence taxpayers to approve additional tax levies in the future.

Sustainable operations of fleet for reduced environmental impact

Beyond real-time tracking, AVL systems store historical data that can be used for performance analysis and future planning. Fleet tracking software compiles information on routes taken, fuel consumption, maintenance schedules, and other metrics. Analyzing this historical data helps local governments and businesses identify trends, optimize routes, and make strategic decisions to improve overall efficiency, reducing environmental impacts.

5. Why is achieving GIS Compliance Difficult at the Local Government:

Financial Constraints:

Although many local governments may be able to see the advantages of achieving GIS compliance, most have many uses for their available funds and responsibility to their constituents to spend those funds in a manner that provides services that are most required by the taxpayers.

However, if they can see the potential return on their investment and how it can produce an improvement in services to their constituents, it becomes easier for them to justify the expense.

Employee adoption of digitization or their workflow:

People are resistant to change, and employees are no exception to this rule. Changing the way people do their jobs, and what they are held accountable for, often makes people uneasy. In cases where a union is involved, the process of changing job requirements can be even more challenging.

Technical Barriers:

Technical compatibility must be achieved between multiple AVL and GIS systems which face typical challenges when integrating multiple data sources (from disparate providers) all the while maintaining location accuracy.

Data Privacy and Security:

Protection of privacy can be costly and time consuming if standards are not developed at the onset of a program. Person privacy and data requirements can change with new standards and regulations, necessitating a revamp of policies and procedures.

Training:

For successful implementation of GIS Compliance in AVL systems there must be employee training. Although training may take time away from other regular duties due to staffing changes and changes to systems and procedures it is one of the most important GIS compliance steps.

6. Successful Case Studies

The following case studies illustrate the benefits that can be gained from the use of AVL and GIS to provide more efficient and effective services.

Illinois Department of Transportation (IDOT)

IDOT has approximately 4,500 maintenance vehicles in use throughout the state equipped with Motorola radio hardware in their vehicles. These include winter maintenance vehicles, paint stripping trucks, sign shop trucks, portable scale trucks, and water pumps used during non-winter maintenance operations.

IDOT has implemented a web-based central software package with CompassCom as the interface that is viewed by agencies responsible for managing vehicle fleets and other equipment through the state. For winter maintenance, IDOT has developed a web-based dashboard through CompassCom that can present several types of information for supervisors to monitor during snow events, including number of vehicles in operations, how many are spreading materials, how much salt has been dispensed, and other information. In addition, IDOT has integrated data from RWIS environmental stations into CompassCom software to provide real-time weather data, as well as data from river gauges that can indicate river height in areas that frequently experience flooding conditions.

In 2022, the costs associated with this system were approximately \$5,050 for the Motorola device and antenna, and overall system maintenance cost was \$90,000.00 annually.

Although there was initial union resistance to the program, it was mitigated by defining and agreeing to a program which stated the system would not be used to initiate discipline by supervisors, and used only to investigate incidents, if needed.

City of Lethbridge Canada

The City of Lethbridge, Alberta, Canada instituted an AVL system to assist in their asset management in conjunction with CompassCom. The system monitors and tracks the location of City vehicles and fleet. The system allows for increased vehicle and equipment efficiencies in usage by:

- Route maintenance optimization
- Improved maintenance activities
- Development of long-range and life cycle planning systems to manage asset portfolios
- Provides geo-location of worksite activities and mobile access to employees



Diagram of City of Lethbridge System

Derry New Hampshire

The Derry, New Hampshire Police Department installed CompassCom's GPS tracking system for police vehicles and handheld radios. CompassTrac Enterprise enhances command and control for first responder resources. GPS location data from Motorola APX Series Radios, Sierra Wireless Radios and Sierra Wireless in-

vehicle modems are viewed in the Esri based CompassTrac viewer that delivers real-time location data in a common operation picture to empower decisions.

The system provides Police Commanders and Dispatchers with real-time location of all assets enabling efficient response and coordination of assets to any call with service as it occurs. This enhances citizen safety and officer safety.

Fort Collins, Colorado

In Fort Collins, Colorado, the use of AVL and GIS has numerous uses as well as providing an asset management system. In addition, Fort Collins uses the systems to improve the sweeping of streets by optimizing routes, arranging for the clearing of parked vehicles, collecting data regarding operational efficiencies, and scheduling.

As snow is a fact of life in this city, they utilize tracking of snowplows, and streets cleared. Citizens can track snowplows in real time via an app provided by the city.

Boone, North Carolina

The Boone Fire Department has the ability to see where their people are staged which enables highly tactical responses to situations such as, an active shooter event which also allows the Fire Department to integrate the local law enforcement department into their system using CACHE radios. This allows for a more coordinated response between departments for improved accountability.

Lessons Learned from the Case Studies:

- **Do not Wait!**
- **Consult others who have implemented these systems.**

- **Determine what is important and essential to your organization.**
- **Try to get the right people on your team and your side.**
- **Work with the right providers who can make it work for you!**
- **Capture the information from your operators experiences.**
- **Standardize your data.**
- **Provide training for everyone involved.**
- **Provide reports and dashboards.**
- **Monitor performance and adjust where required.**

7. AVL Systems Best Practices for GIS Compliance

Technology has changed our lives in many ways and has changed the way many things are done today. Best practices of yesterday are no longer the best practices of today. With the advent of AI and AVL, transportation and fleet management have changed dramatically.

Using the technology for technology's sake does not solve problems, but it does provide a means to help find a solution. Some of the areas where GIS compliance has helped to find solutions are noted below.

Suggestions from practitioners include not searching for a “one-size-fits-all” approach but determining the needs of your specific constituents and community. They also note that “buy-in from all levels of the transportation organization is necessary for successful implementation and that planning, and training need to be worked out from the bottom up as well as from the top-down levels. Suggestions also include that leadership needs to be fully onboard with your AVL and GIS Compliance System.

Although a pilot study may reduce risk, choosing hardware and software partners with significant experience can eliminate the need for this.

Including a public facing website or other means to share information on the status of critical operations is essential. This can be extremely important in times of weather or other emergencies. Completing post-situation analysis to improve operations is also a must.

A quote from the FGDC states that sharing with the public is essential. “Build it once, use it a bunch,” successful programs, including geospatial ones, make their capabilities available to the public.

• Building better “Smart Cities”

The Smart Cities movement has gained traction over the past few years, but what is meant by “smart cities” has still not been definitively decided upon.

Technology alone does not define a “smart city,” but what is done with that technology to enhance the lives of those in that community does.

The technology should not be the driver, it should be the process that brings about the results. The use of AVL systems can enhance the lives of those in a “smart city” by providing more transparency to the citizens, improved services, better use of their tax dollars, and improved public and personal safety.

Phased Approach with Compliance Check:

- Develop strategies to Maintain GIS data quality and what those audits and updates include:

- Perform regular Compliance Audits

Regulatory and legal factors significantly impact the AVL market. Governments worldwide are implementing stringent regulations on vehicle emissions and safety, compelling companies to adopt AVL systems for compliance and efficient fleet management. Additionally, privacy laws concerning data collection and user consent influence the design and deployment of AVL technologies. As businesses strive to enhance operational efficiency, they must navigate these regulations while ensuring customer data is protected.

Technology can help to provide the necessary data to ensure compliance and a clean audit.

- Stakeholder Engagement:

Compliance often involves those who are stakeholders in the process. There will be requirements that will request input from various levels of government as well as community leaders, members, and vendors.

- Training Needs

Training will be an ongoing issue, as requirement for compliance are apt to change with some regularity. In addition, staffing changes will necessitate that training be an ongoing part of these programs.

8. Conclusion

The Automatic Vehicle Location System (AVL) market is experiencing robust growth driven by increasing demand for fleet

management, enhanced public safety, and the rise of smart transportation solutions. Major factors fueling revenue growth include advancements in IoT, rising urbanization, and the need for operational efficiency across various industries.

The Automated Vehicle Location System (AVL) market is anticipated to grow at an annual rate of 4.1% from 2024 to 2031, according to market research conducted by Ideada.

In conclusion, the AVL market continues to grow, driven by technological advancements and regulatory demands. Companies need to stay informed about evolving laws and standards while leveraging AVL systems to improve their services in both passenger and commercial vehicle sectors.

- The ROI for local government indicates a clear need for investment in compliance and the long-term benefits that come from that investment. Stakeholders, in the form of vendors, the community at large, and individual citizens should and will have evolving expectations for these systems. The requirements will change over time and with the introduction of new technologies and new regulations and policies. It is important that their voices be heard and acted upon, where feasible.

Call to Action: CompassCom and Global Marketing Insights, Inc. have developed a brief survey (less than five minutes to complete) accessible at

<http://www.empliant.com/survey/FEA411260-D06E-0040-2BE7/> to assist in furthering the body of knowledge for GIS Compliance in

the AVL and local government communities.

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