Technology Review

Global Asset Visibility: What is New?

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The growing resistance to government imposed compliance costs will probably make it less likely that security mandates will be issued in the near future. The recent cancellation of programs like Maritime & Supply Chain Security: US DHS Global Trade EXchange (GTX) Pilot supports this view.

Competitive differentiation based on its own commercial merits rather than imposing government mandates will likely play a larger role. The simple fact is that many global asset visibility services can improve security while saving money on operations. This is clearly a win-win situation for both industry and concerned government agencies. Currently, technologies and services that enable ISO 28000 (Safe & Secure Supply Chain) will reduce liability and enhance consumer confidence, particularly for food and drug suppliers. The key is to understand the roll-out and adoption strategy that allows this to happen. Clearly there are a very large number of market segments with different needs and priorities regarding the creation of a positive value proposition involving global asset tracking. Plasma TVs coming from China into the US has a different set of needs as compared with the recycled material being shipped from the US to China on return shipment. NAFTA trade transiting the US between Canada and Mexico like duty-free goods transiting any intermediate country has specific needs for tracking and security. To effectively address these extremes, flexible service offerings and a family or suite of technologies and device types is required. It is not possible to meet the broad spectrum of demands with a "one size fits all" approach.

This article will endeavor to explore and describe: flexibility in GAV, what are its characteristics, who needs it, and how to determine what configuration of services best suits the applications specific to your company or agency. We begin by describing the different attributes and characteristics of a flexible GAV system, examining the various components. Then we will consider some evaluation criteria which public and private enterprises should employ to determine the most useful solution for their particular needs.

Overview of Applications

"Asset Visibility" has a variety of meanings, depending on your business or mission objectives. It can mean simple verification of a unit ID, as indicated by a barcode or passive RFID tag. It could also entail the ability to be in continuous two-way communications via data-link and/or voice. In global situations, visibility might also involve the continuous monitoring and receipt of real-time reports on any anomalies, events or out of tolerance situations that might occur.

The need for "global asset visibility" really depends upon the extent to which your company or agency has or wants **dispersed regional operations**, meaning whether or not company activities occur in regions not easily supported by existing communications infrastructure or a single mode of communications. If management cannot predict between which locations it might have to provide asset visibility, it meets the criteria for dispersed regional operations and is a strong candidate for GAV.

For first responders (police, fire, ambulance and corporate security), emergency care-givers (FEMA, Red Cross, and other relief agencies) and deployed military personnel, asset visibility is the ability to maintain cognizance of the location and status of every resource and supply item via continuous two-way communication, regardless of where it is and where you are. An example of visibility would be the logistical capability to track the inventory of relief supplies in a distribution trailer as they are handed out and to know exactly what should be sent and where to send it. This kind of **situational awareness** is critical to effectively deploy and manage operations involving various kinds of assets.

For supply chain management, asset visibility would also include in-transit visibility from the factory door through delivery to the customer. Suppliers, buyers, shippers, insurance brokers, and third party logistics firms all need continuous visibility to increase efficiency, reduce costs, improve dependability and timeliness, monitor quality of handling, and insure security and continuous chain of custody. Regardless of whether the items are critical components to support just-in-time inventory for manufactured goods, high value items like pharmaceuticals or electronics, or perishable food products, global asset visibility is becoming a must to remain competitive in today’s economy.

The shipment of hazardous materials is another category for which continuous visibility is extremely critical. Remote monitoring for security and material status, coordination with local authorities during transit, event notification and contingency planning all require redundant means to maintain constant visibility. Movement in remote locations demands GAV.

The monitoring and control of remote, fixed assets such as utility and communications equipment, the monitoring of fishing fleets to verify territorial compliance, and the tracking and monitoring of “high value” leased assets such as yachts, planes and off-road vehicles are all examples where continuous visibility is becoming increasingly important. Whatever the situation, dispersed regional operations require a global tracking capability.

Requirements Overview

The key to successfully achieving GAV is the proper identification of specific user requirements. The following introduces the categories of requirements, the types of products and services that are available, then explores the attributes of each. Finally, we introduce evaluation criteria helpful in making optimal decisions regarding the type of system best suited to your particular needs.

Sensors

While specific requirements vary widely, some basic categories can be identified for GAV. In most situations, the status of an asset is very important. For personnel, this is straight forward since they can report directly, assuming they have a means of communication. However, even for personnel, sensors are often used to allow passive monitoring without direct communications.

Sensors are primarily used to determine or monitor the physical status of assets. Whether simple sensors like temperature and humidity, more moderate sensors like g-shock, power, power state (on/off, internal/external source, battery level) and vehicle fuel level or more sophisticated sensors such as bio/chemical and radiation detectors, all sensors need some form of mechanical housing, a means to read and possibly report the data or conditions, and often an independent power supply. To be power-efficient, many sensors incorporate a duty-cycle or sample rate, so they don't stay "on" all the time.

Sensor report thresholds can also be set to indicate an out-of-tolerance event. Often these thresholds will depend upon the asset being monitored. For example, the vertical g-load tolerance for a load of vehicles is considerably higher than for consumer electronics. The allowable temperature range is different for a shipment of ice cream than for fresh fruit. Thus, the ability to set sensor threshold specific to your needs is very important. It may be desirable, if not mandatory, to do this remotely through a sensor support uplink command.

Sensors monitor security by detecting unauthorized access to or use of an asset. For example, to detect unauthorized entry into cargo shipping containers, the most common application is a door state sensor. However, additional sensors might be required to detect entry by means other than through the door.

Position

For mobile assets, knowledge of location is imperative. While the required position accuracy may vary, knowing the location of an asset is a fundamental part of GAV. The most common means for determining position is through the Global Positioning System (GPS).

While GPS is available everywhere, it requires a clear view of the sky to see at least four satellites. Without clear sky visibility, GPS position information will be much less accurate or not available at all. Other means of position tracking use the E911 feature of cell networks. And yet others use general position information provided by satellite network providers, like Iridium.

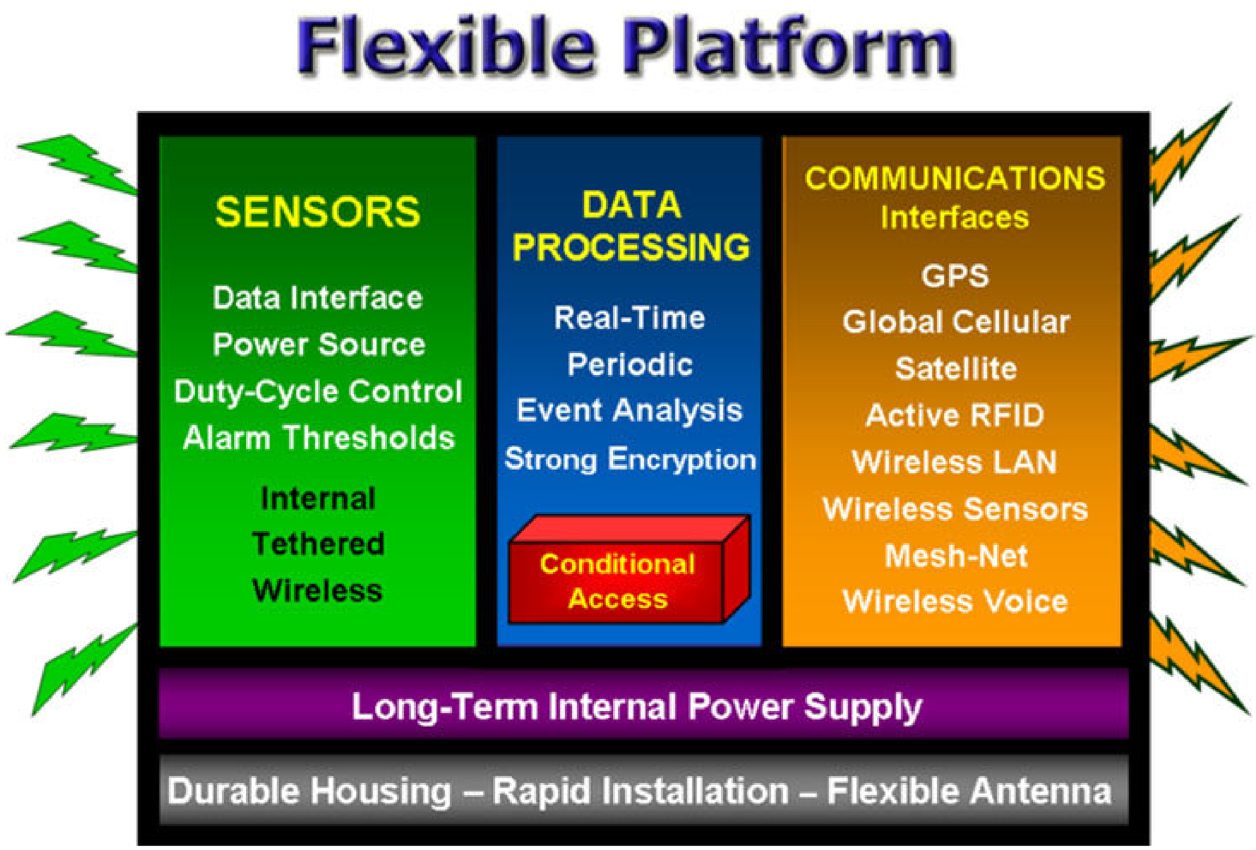
Associated with knowing the position is the capability to view a position history or "breadcrumb trail" through a geographic information system or GIS interface. GIS allows users to easily zoom in and see the details of the location using map symbols or satellite imagery. The speed and direction of an asset's movement may also be important, or the fact that an asset has changed motion state from moving to stopped or vice versa. Here again, thresholds and event notification may be important for position and speed as well. By defining geozones for an anticipated area of use or route of travel, alarm messages can be sent when the asset position deviates. The same can be done for speed limits. Again, remote configuration of these parameters makes it very convenient.

Power Management

Environmental requirements and service-free operating life have major influence on GAV system design. If the asset of interest is in a controlled environment, like a warehouse or command center, and external power is available, the system can take advantage of that fact and relax "hardening" and power efficiency to reduce costs. However, if the asset will experience all the challenges that Mother Nature can provide and must operate on internal power only, the system design must account for these challenges. Even devices designed to run from external power should incorporate power-efficient modes and internal back-up power to counter external power failure.

Closed or Fixed Vs Open System Architecture

The basic architecture of a GAV system is also a critical consideration. At the highest level, a system can be characterized as having a **closed or fixed architecture** as opposed to an **open one**. These terms can mean a lot of different things, depending upon context. In this context, a closed or fixed system is one which does not have the ability to easily add or change system functionality or operating characteristics. For example, if a GAV system has only one way to communicate, only uses sensors provided by the system vendor, and the communication paradigm (what is reported and how often) is hard-wired, then this is a closed or fixed architecture system.



Characteristics of an Open System Architecture

If, on the other hand, the GAV system allows a plug-n-play selection of different network communication transceivers with sensors from multiple vendors and lets the user easily change how the deployed system devices operate and communicate, this is an open architecture system. Most systems will have a varying degree of each.

Committing to a closed or fixed system design will likely save money in procurement, and near-term operational costs may be lower. In contrast, an open architecture by design may require (and allow) some amount of user-specific tailoring. The procurement cost difference between a fixed vs. open system will likely be more than offset when you make (or try to make) your first change or enhancement to the system.

Communications Capability

Communication is likely to be one of the major requirements to drive the performance, effectiveness and cost of a GAV system. Communications requirements can be characterized in a number of ways:

1. What needs to be communicated: data, voice, video?
2. What is the required data message payload size or data bandwidth: a few bytes or a stream of compressed high definition video at 19 million bits per second?
3. What are the security requirements for the data: probability of intercept, encryption at the network level or data level?
4. Are communications one-way or two-way? If two-way, can either end of the communications link initiate it (data poling) or is it sufficient that only the asset end initiates communications (data push)?
5. How often must communications be available: periodically at scheduled times, only at specific locations or anytime, such as when an event occurs?
6. What is the allowable latency of data receipt: days, hours, near-real time (minutes) or real-time (voice)?
7. Between what two regions must the communications take place: local, intra-continental, inter-continental or global (non-deterministic)?
8. What is the need for redundancy to avoid system failure due to a single communications network problem?
9. To what extent is there a need to be independent of terrestrial infrastructure, such as in the case of regional disasters (e.g., hurricanes, floods, fires, earthquakes and armed conflicts) or extremely remote location?

The answers to these specific communications requirements will greatly influence your GAV system selection. The good news is that there are system solutions available to satisfy all of these communications needs. The challenge is in getting a system that is capable of satisfying your current requirements yet, flexible enough to meet future needs at an affordable price. In short, the more time you invest in understanding your company’s needs, the better the resulting system will perform.

Solutions Overview

Given the broad definition of a Global Asset Visibility system, the solutions are as equally extensive. A synopsis by solution categories will provide valuable insight into the options available starting with the simplest and leading to the more sophisticated.

The basic two categories are systems based upon "fixed reader infrastructure" and those incorporating "autonomous communications", meaning they don't require a close-proximity interrogator in order to report asset information.

Fixed Reader Infrastructure Systems

Barcode and RFID tag systems fall in the category of being "fixed reader infrastructure" in that they can only be interrogated at specific locations and only at times when a compatible reader is available. Determining the location and status of an asset is only possible at specific stations. It also means that considerable investment is required to deploy a compatible RFID fixed reader infrastructure at all points where asset information is desired. RFID systems currently use a number of frequencies and proprietary protocols. While ISO standard 18000-6 will begin to bring commonality and compatibility across the RFID industry, there is still a long way to go.

Barcode

Barcodes are an inexpensive and easy way to identify items using a 12-digit ID number. Applications range from the relatively simple for product ID to more elaborate barcode schemes representing significantly more data, like that contained on a driver's license. While the tag itself costs a penny, barcode readers and network connectivity are still needed to move the data to a central server for processing. A significant disadvantage for this technology in wider applications is that the barcode reader must be in the line-of-sight with the tag and at close range, usually less than 12 inches.

Radio Frequency Identification (RFID)

Passive RFID systems work very much the same way as barcode systems, except that a clear line-of-sight between the scanner and the tag is not necessary since radio waves travel through most materials. Passive RFID tags have limited identification memory but are relatively inexpensive since they have no battery. Their radio frequency (RF) response is powered by the energy captured from the interrogator. Depending on the size of the reader antenna, passive tags can be read from a distance of up to 2 meters. In practice, the successful read rates currently run at roughly 80%, due to radio wave attenuation caused by the products and packaging.

Semi-Active RFID tags are similar to passive tags except they have a small battery to deliver the RF response. As a result, the reader antenna can be considerably smaller and still have similar or greater interrogation range compared to a passive tag.

Active RFID tags have an internal power source capable of producing the RF response to an interrogation. It is also much more "intelligent" than a passive or semi-active tag, and can establish a session with the interrogating reader, reducing error rates significantly. The internal power source also allows a longer response range, extending up to 100 meters. The active tag has more memory and, in some cases, can retain a several hundred item manifest like those associated with cargo containers. Recently, sensors have been integrated with active RFID tags, allowing an interrogator to obtain current state and some historical data, including largest g-force or highest temperature measured.

Readers or interrogators are required as part of any barcode or RFID system. Readers can be either handheld or fixed mount. In either case, the reader must communicate data with a central data server; one-way in the case of barcodes and passive RFID tags, and potentially two-way for active RFID tags with memory storage. This data communication can occur in a number of ways, including use of a "sneaker net" whereby a portable handheld reader is physically carried to a server interface and plugged in, wired or tethered via a connection such as a serial or Ethernet cable. In the case of a wireless connection, it could be made via a LAN, but could also use an autonomous communications device to allow for longer distance, remote reader deployments where terrestrial network infrastructure is unavailable. With a power-efficient design and a renewable power source like solar, a reader interrogator could be deployed virtually anywhere. This technology is now used along remote highway corridors or unattended border crossings to monitor tagged trailers and cargo containers. It has also proved useful in monitoring the distribution of relief supplies in a disaster area where normal communications has been disrupted.

Autonomous Communications Systems

GAV systems incorporating autonomous communications have several advantages over fixed infrastructure system. Primarily these systems can communicate asset information virtually anytime within the constraints of the communication network(s) they use. Most also incorporate GPS tracking so that the asset position is updated with every report.

Cellular

A common communications network used for GAV is the same one used by cell phones, with GSM becoming the dominate network due to its global compatibility. Virtually every region of the world is deploying GSM networks. The cost of data modems is quite reasonable as is the data bandwidth. Rate plans directly from the service providers have yet to be established for individual, low volume, global data users. The monthly minimum charge can make the cost-per-data-message quite high. However, some Value Added Resellers are beginning to bundle services at reasonable rates. The real downside is that cellular networks still have significant gaps in service coverage, particularly in rural areas and maritime environments.

Satellite

Integrating satellite communications in a GAV system is more expensive, but it is the only practical way to achieve ubiquitous network coverage. Caution, however, should be exercised since satellite communications networks vary significantly in their coverage, performance and reliance on terrestrial infrastructure. Satellite communications are generally either Geostationary or Low Earth Orbit.

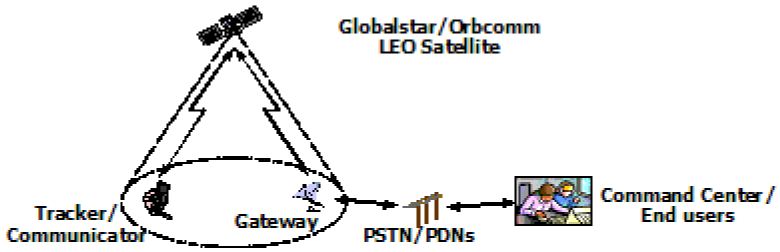
Geostationary systems can cover a relatively large fixed region of the globe. Because of their distance from the earth (35,786 KM) and fixed orbital location over the equator, geostationary satellites require a relatively expensive transceiver system which combines a powerful transmit amplifier, sensitive receiver circuitry, and a larger antenna pointed toward the satellite. Using larger, fixed-mount antennas, they work well for GAV systems tracking fixed assets but are less practical for most mobile applications. Also, for truly global functionality versus regional operations, a GAV system would have to incorporate transceivers and antennas for multiple geostationary satellite service providers.

Low Earth Orbit (LEO) systems usually employ multiple satellites in a constellation orbiting the earth multiple times per day at a distance of 200-900 KM, usually passing near the earth's poles. In this way the satellite covers a new section of the earth on each orbit as the earth rotates east. How often a particular region is covered depends on the number of satellites in the constellation, the orbital period and antenna coverage. As a result, a LEO system with few satellites in its constellation will have considerable latency - *dead time or delays between data capture and actual transmission* - when communicating asset data. Data message size and support for two-way communications will also vary between service providers.

Two largest commercial LEO systems are Iridium with 66 satellites plus spares, and Globalstar with 40 satellites. Other companies offer less global/more regional coverage. Again, your performance criteria will dictate one system's feasibility for your purposes over another. However, there are still considerable differences in functionality and performance, which will impact GAV.

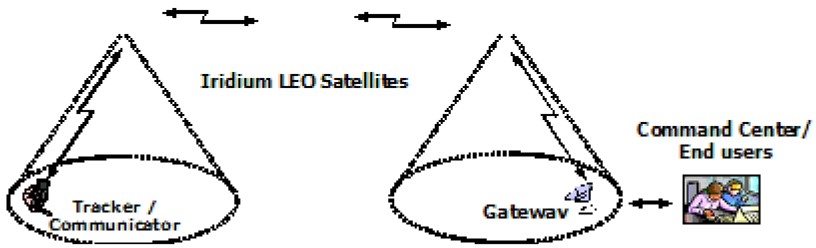
Globalstar's satellite orbits are inclined as opposed to being truly polar; meaning that the orbital paths do not pass over the poles. Thus, Globalstar does not cover above 70 degrees north latitude or below 70 degrees south latitude - not a problem if your assets remain with these latitudes. Globalstar has deployed a lower cost modem, but it only allows one-way communication and supports a relatively small data payload. Moreover, there is no way for the transmitting device to verify successful message receipt; therefore, it must attempt to send the message several times.

This has an adverse effect on battery life for stand-alone devices. The system also has a varying amount of latency, in some cases several hours. In addition, Globalstar's "bent-pipe" architecture means that a user on the ground must be near a satellite ground station which is in the antenna footprint of the satellite they are communicating with. As a result, a bent-pipe system is more susceptible to regional outages, if the ground station for that region is damaged or has a service problem.



Flow of information using the "bent-pipe" network architecture

In contrast, the near polar orbits of the IRIDIUM constellation provide complete global coverage. Iridium is also the only commercial LEO system in which satellites are networked together by inter-satellite links (ILS), meaning that its customers are not required to be within the same satellite footprint in order to gain access to the network. Consequently, the dependence on terrestrial infrastructure is minimized. By eliminating the dependency on ground infrastructure for traffic links, ISL can make communications virtually impervious to disasters on the Earth, such as earthquakes, hurricanes, floods, other natural disasters, and even man-made disasters such as terrorist attacks.

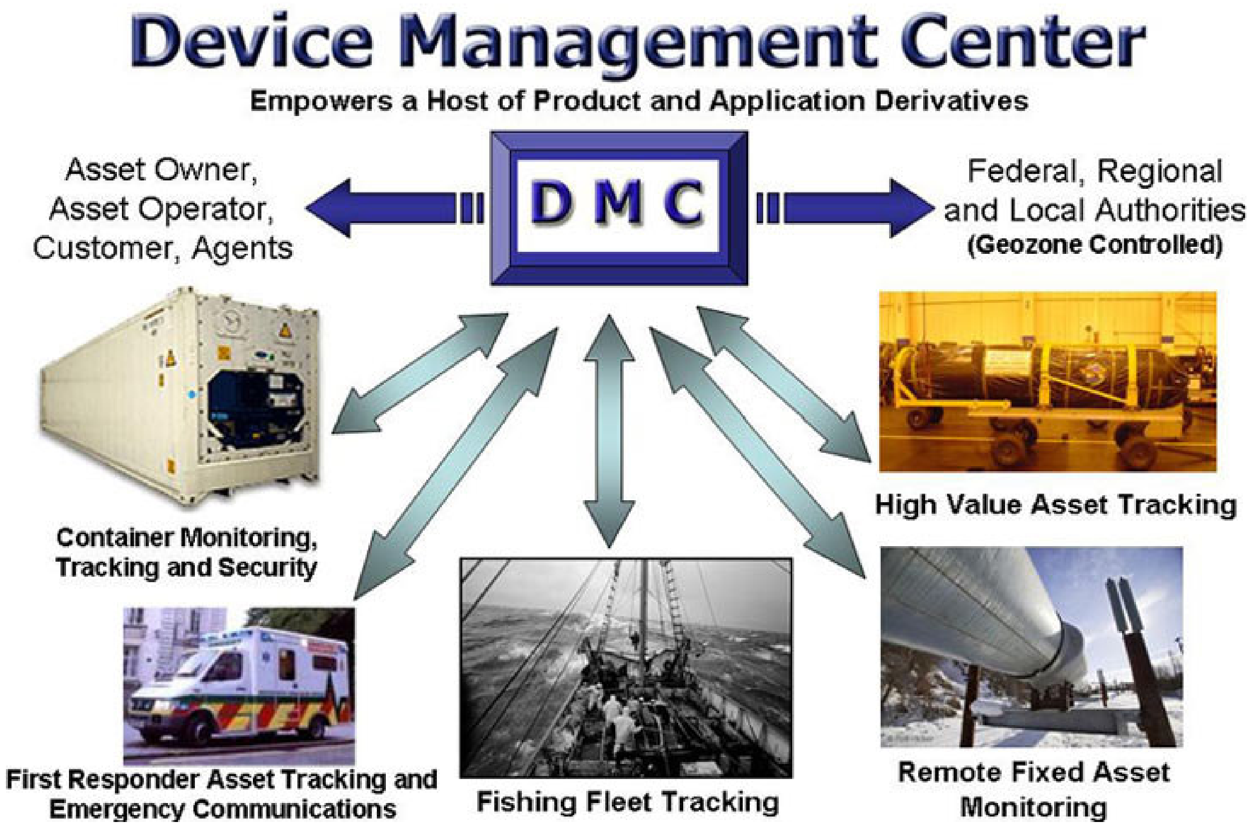


Flow of information using the inter-satellite link (ISL) network architecture

While Iridium provides reasonable rates for two-way communications in a number formats, ranging from voice to short-burst-data packets of ~200 bytes, their modems are more expensive. Even their new short-burst-data-only modem comes at a premium price compared with Globalstar and Orbcomm. However, if your GAV system requirements dictate the need for true global coverage, two-way data transmission, minimum latency, power efficiency and terrestrial infrastructure independence, Iridium is the optimal (and virtually only) solution available.

Device Management Centers

Unless you're in the satellite tracking and communication business or have a substantial in-house IT division, your agency or company will most likely need to outsource its GAV system communications. This duty is the bailiwick of a shared Device Management Center (DMC), capable of communicating with your GAV and transmitting data common across multiple applications. DMC functionalities include message handling and life-cycle management for deployed devices, decryption and key management as well as data processing and analysis. It can also include tiered levels of data accessed on a "need to know" basis, hosting of secure web-portals for data display applications, and event notifications by event type and/or location. Finally, a DMC can facilitate XML data distribution to customers and their agents for integration with existing back-office applications. Since DMC can service multiple user-agencies and client/customers, your firm can realize considerable cost savings by outsourcing critical functions without sacrificing services. However, if desired, these same functions can be handled in-house, hosted on your server, behind company firewalls with the support of a specialized IT department



Summary

Whether working with a qualified systems integration firm or working through the decision process on your own, it is critical to first establish your company's requirements by answering a basic set of questions (what-when-where- and how-often) relative to asset visibility. While fixed platforms have their uses, it is more likely that you'll want to insist on retaining the flexibility of an open architecture and platform design solution which will allow for changes over the life of the GAV system. Also consider the benefits of a hybrid solution, a system which combines one or more of the solution options. By doing so, you can greatly increase the GAV system's redundancy and reliability while capitalizing on legacy functionalities, like RFID, and "future proofing" your investment.

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