Contextual Mobility For SCADA Systems

Whitepaper

The Rise of Smart Mobile Devices

Smart mobile devices, most notably smartphones and tablets, are taking over the world. According to Thomas Barnett, Director of Thought Leadership at Cisco **"The number of mobile users is growing four times faster than the global population itself"**, and by 2019, more than half of all devices connected to the mobile network will be "smart" devices, up from 26 percent in 2014[1].

Smart devices evolution is occurring in the ever more connected world of the Internet of Things (IoT) or as applied to the industrial automation world, the Industrial Internet of Things (IIoT). Sensors can be now connected to networks using various types of technologies such as wireless Bluetooth or WiFi and can also have wide area connectivity such as 3G or LTE cellular.

Cisco Internet Business Solutions Group (IBSG), predicts there will be 25 billion devices connected to the Internet by 2015 and 50 billion by 2020[2].

The rapid adoption of smart mobile devices in the professional world along with the growing number of connected devices and the associated increased flow of data raise new opportunities and also new challenges.

The systems generate more and more data that have to be filtered to bring relevant information on smart devices using limited size screens. Moreover, the way in which people interact with smart devices differs from the way in which people interact with traditional laptops and workstations.

Historical approaches to monitor, diagnose, maintain and control industrial and building assets must be reconsidered.

[1] http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.pdf

[2] http://www.cisco.com/web/about/ac79/docs/innov/IoT_IBSG_0411FINAL.pdf

What is the Impact on the SCADA?

In the distributed environment of monitoring and control, there are typically independent servers for each physical area or zone of control. A zone may refer to all the equipment in an area, such as a floor in a facility, or it may refer to a specific automation system.

The people responsible for these systems are increasing required to be on the move.

They typically use their smart devices to access equipment and other assets located in each zone. They must know how to connect to the control server responsible for that zone in order to get relevant information and controls. Given the many different publishers of control server software it is unlikely that the zones will have information organized in a consistent way or have a common user interface. This greatly complicates access and increases the time required for a mobile worker to carry out their responsibilities.

The responsibilities of the mobile worker are defined by their organizational role and they may vary by zone of control. For example, a person may be responsible for operating equipment in one zone and may only monitor equipment in another. Likewise, within any given zone, there is a difference between the information needed by maintenance personnel than that required by operators.

The information and controls required are therefor in the context of the person's role and their location.

Reinventing SCADA MOBILITY

What is needed is a system that is proactively and securely presenting the right contextual information, to the right person, at the right location and at the right time.

In addition, it can be difficult navigating a complex SCADA application from a mobile device. The users want, above all, to be notified of events that concern them and have information relevant to the tasks they have to perform according to their location in the facility.

Geolocation is a long established technology for determine the longitude and latitude coordinates of an outdoor location. It relies on Global Positioning System (GPS) found on most mobile devices.

Micro-geolocation using geo-tag technologies including (but not limited to) Bluetooth Low Energy (BLE) Beacons, Near Field

Communication (NFC) and QR- Codes (a 2D matrix barcode) were developed as part of the IoT infrastructure known as Indoor Positioning Systems (IPS). Proximity-based services enabled by micro-geolocation for IPS are growing quickly.

The IPS technology market alone is estimated to reach $5 billion in revenues by 2017 and to represent over 200,000 installations of infrastructure equipment, including Wi-Fi hotspots, Bluetooth antennas, and more than 800 million mobile apps.

Figure 1 - Location devices

This technology has made possible the practical deployment of contextual Human Machine Interfaces (HMI). Contextual HMI creates the opportunity for new more efficient work processes for those who rely on SCADA to perform their job.

Navigating an HMI designed for a workstation while using a much smaller mobile device can prove difficult given the limited screen size and mechanism for managing the mouse. What is needed is a mobility infrastructure which eliminates this problem via the

presentation of only relevant information and controls in the context of role and place. It must provide a dynamic HMI that automatically changes as the worker moves through the workplace. In a plant scenario, such a system is aware which floor a worker is on and automatically sends the status and controls of equipment in that worker's proximity. It is a very pro-active approach that is recognized to improve the efficiency of commissioning, operation and maintenance of automation systems.

For safety, it is critical that the SCADA knows the current location of workers. With the ready availability of geolocation signals, IPS indoors and GPS outdoors, it is possible to monitor and record location by simply archiving the device's position over time. Safety and dispatch tracking are natural functions of the system which relies on position in order to create contextual HMI.

The SCADA Mobility Infrastructure

The Mobility Infrastructure (MI) presented below leverages smart devices to increase the value and capability of the entire system.

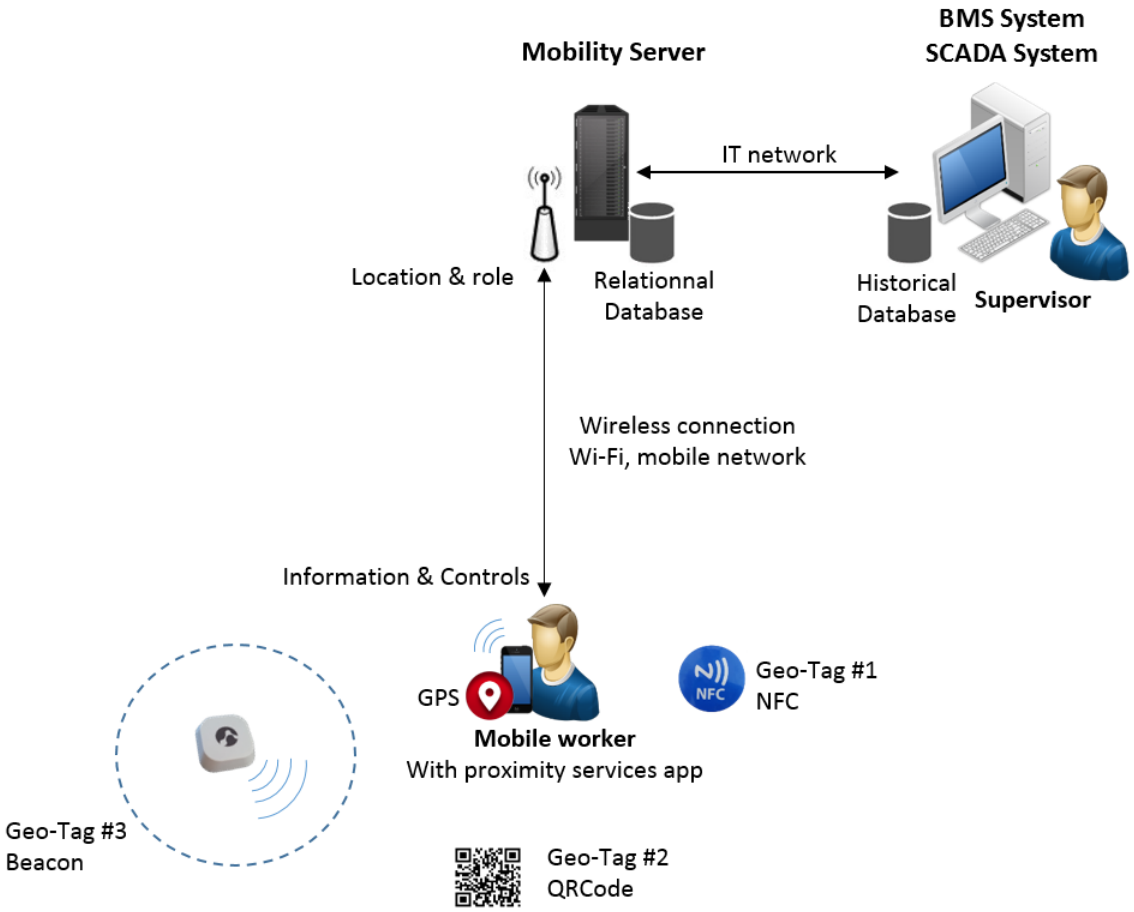

Figure 2 - Mobility Infrastructure for SCADA

The Mobility Infrastructure consists of geo-tags deployed in zones of control, a Proximity Services application on the mobile devices and a Mobility Server responsible for evaluating the appropriate contextual response.

The Mobility Server is connected to a SCADA system or BMS which manages the communications to monitor and control equipment and other assets. The mobile devices communicate with the Mobility Server using standard wireless network connections.

The mobile app on the phone, which is equipped with proximity services, updates Mobility Server with the user's credentials, GPS coordinates or geo-tags detected nearby.
The server then uses an internal database which associates locations and user roles with actions and events.
Using IPS or GPS, the Mobility Server determines the mobile device's current location. While the app on the device validates and maintains the user's credentials, the Mobility Server determines both the role of the user and his real-time location.

In order to track the location of mobile assets a mobile device may be installed on the asset. In addition, if geo-tags are installed on the mobile asset, the app is able to sense those assets that are in the proximity.

The Mobility Server

The cornerstone of the infrastructure is the Mobility Server and its Contextual Logic Engine (CLE).

The Mobility Server determines the appropriate actions and distributes information and control elements to the mobile worker in the context of the where they are and their responsibilities at that location. The information may include real-time status or control of equipment. It may suggest additional resources (drawings, schematics, etc.) needed by the worker in the performance of their duties.

The Mobility Server also tracks the movement of the devices as they move about the zones under management of the SCADA or BMS system.

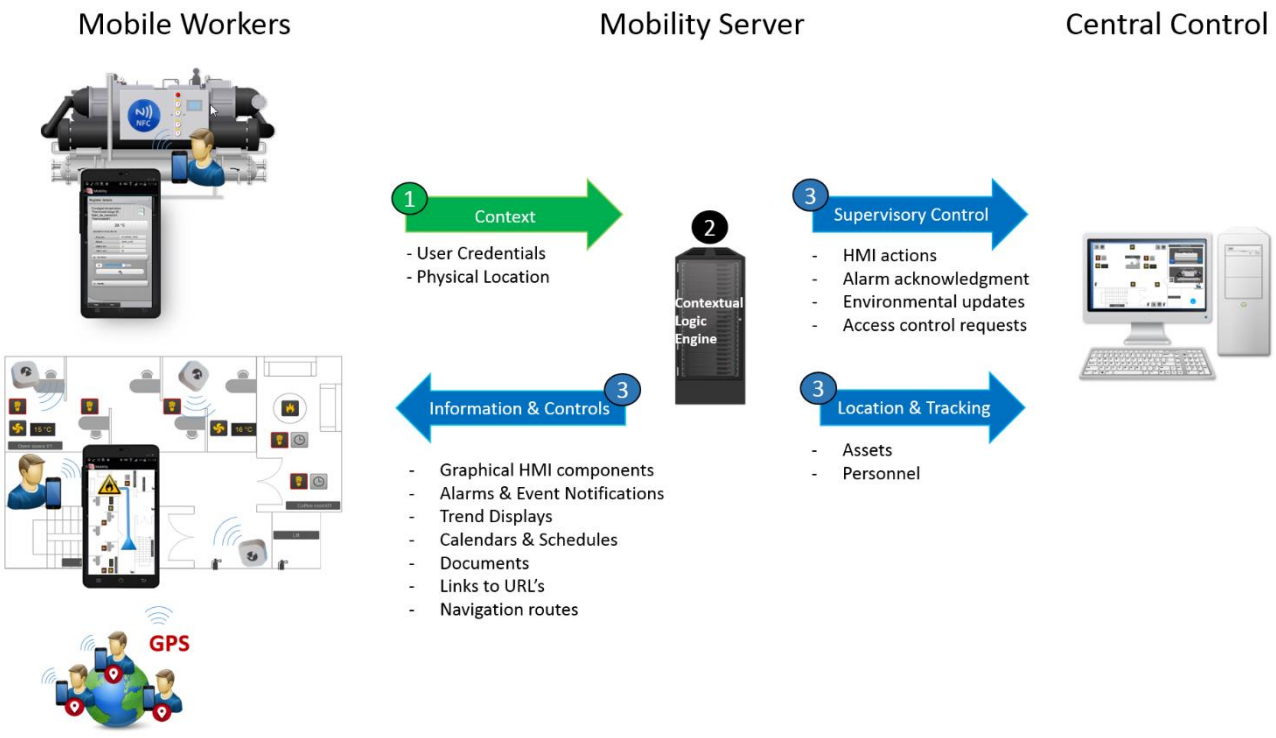

Figure 3 - Contextual Logic Engine

The figure above shows how the CLE of the mobility server dispatches information to the users:

1) A mobile worker starts the mobile app and logs on. The worker enters a zone and the app detects nearby BLE Beacon tags and WiFi Access Points, or scans a NFC tag, or a QR Code. The app sends the Mobility Server the environmental context and the mobile worker's credentials.
2) The Mobility Server maintains a database which associates locations and users roles with actions and events. Using the information transmitted by the app, the Mobility Server is able to determine the mobile device current location and the role of the user.
3) The Mobility Server automatically sends the mobile device relevant information based on the mobile worker's location and role. The Mobility Server provides the SCADA or BMS system with:
   - All real-time data needed for supervisory control
   - Real-time location of the devices and assets as they move

The mobility server can play automatic sequences depending on contextual events. For example in case of an important event in a zone, an alarm will be automatically broadcasted to any mobile worker in the zone. The mobility Server also maintains status/counters for each zone and send actions to the Scada Server when these status change. For example when the last person leaves a zone, light is turned off.

Figure 4 - The mobility server

The SCADA Mobile Device App

SnapVue is the app installed on the mobile device which exchanges with the mobility server:

- Collecting and transmitting context
- Receiving and displaying information and controls
- Removing out of context information and controls

Securing the Mobile Device

Cyber Security concerns are paramount in any information system and as in any network it is important to provide the full range security measures such as firewalls and active user rights management. Additional considerations must be considered when deploying a mobility solution. Specific features within the framework of the Mobility Infrastructure include:

- User sign-on required to use the smart app.
- Re-authenticate before control actions are performed.
- Validation before critical actions are performed.
    - Validate proximity of the user to the device with GEO-tag such as a BLE Beacon.
    - Confirm validity via Geo-tag attached to equipment such as a QR-Code.
- GEO fencing to remove out of context information and controls.

Mobile worker is inside the technical room as indicated by the beacon's presence in the environment context of the mobile worker

The Mobile worker imminent presence directly in front of the Boiler is additionally validated by tapping a NFC tag. Because the mobile worker is part of the maintenance team additional actions are now available on the mobile.

Figure 5 - Validator Tags Determine User Rights within Zones

Benefits

Many benefits are realized with the deployment of a Mobility Infrastructure. These include benefits to all users and benefits specific to certain worker responsibilities. There is also benefit to the entire organization in safety, security, comfort and efficiency which are discussed below.

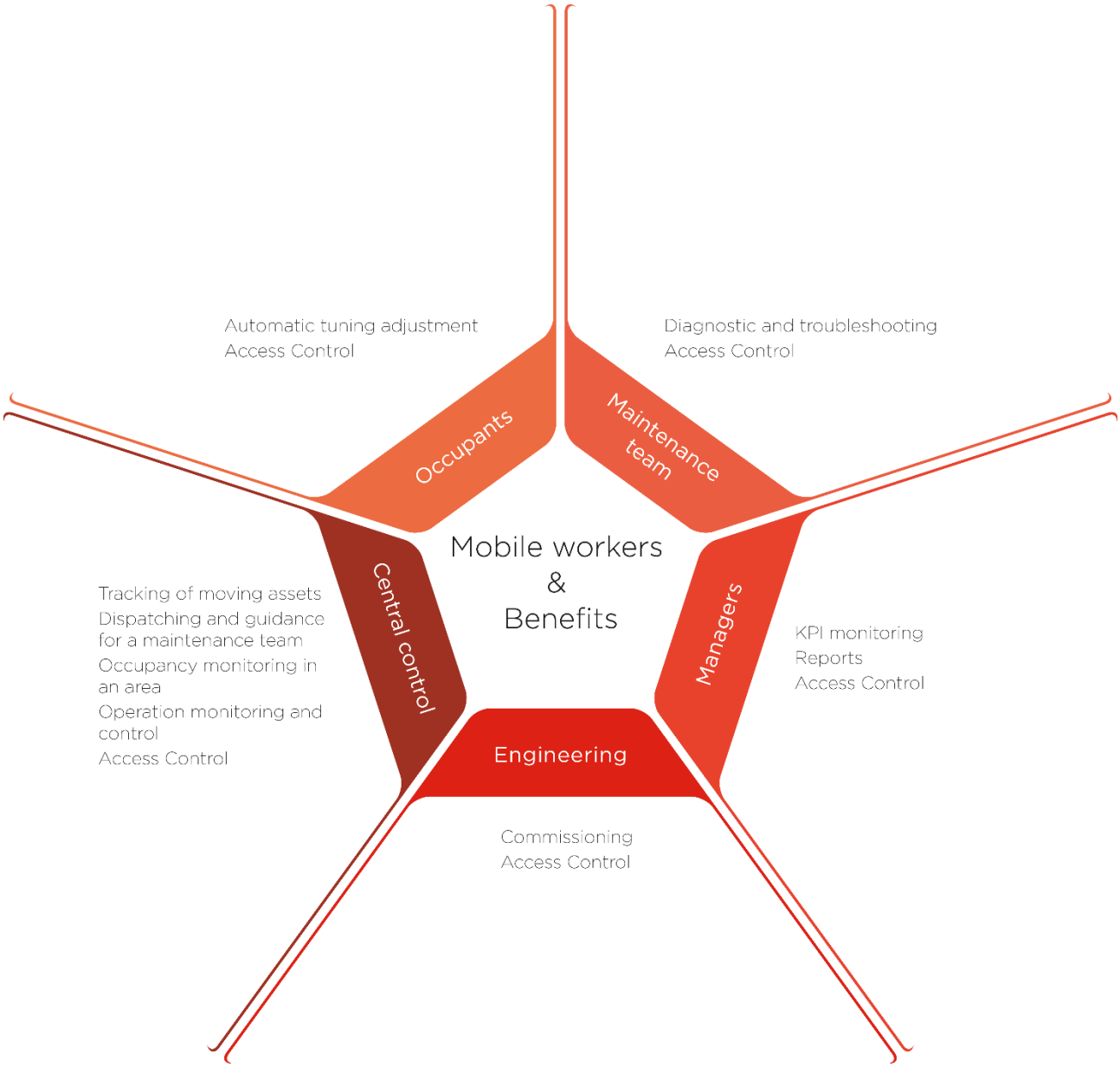

Figure 6 - Mobile workers & benefits

Benefits to Mobile Workers

Operation Monitoring and Control

Operators are able to move out of the control room and work closer with the systems they manage. This is possible with the ability to see key characteristics on their mobile device refreshed as they move about the building or industrial facility. This is also possible while continuing to maintaining awareness and receive alarms across the entire SCADA supervised system or any subzones of interest. Trends can be viewed, set points changed and any other operator actions can be performed. When out of the zone of operational responsibility, the operator's rights may allow viewing operations without access to control of those particular assets.

Diagnostics and Maintenance

The Mobility Server is aware of the location of remote maintenance personnel and is able to intelligently dispatch alarms to the person who is best positioned to respond. The proximity rules enable innovative thinking about organizing a maintenance strategy. New ways to combine proactive and reactive aspects of maintenance based on a real-time assessment of resources and proximity are possible.

In a recent study by Fraunhofer USA[3] the benefits of mobility were explored with industry experts who specify and design BMS and EMS systems. What emerged was that supervisory systems can be a double edged sword for maintenance workers. The information needed for maintenance is in the system, but it can be difficult to access and it can be difficult to understand, given the format of the information. The promise of mobility to proactively deliver the needed information in an understandable format and to guide the maintenance worker to solve the problem was identified as a major benefit.

As the maintenance worker moves they are provided updated contextual tools. These tools are in the context of both the physical orientation (nearby, lift equipment zone, full facility, etc.) but also factored to provide the most useful tools for that user based on training and certifications.

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[3] *The Fraunhofer Center for Sustainable Energy Systems (CSE) is an applied research and development laboratory that assists industry and government clients with a focus in building energy technologies, solar photovoltaics, distributed electrical energy systems, start-up assistance, and technical validation. Fraunhofer is partnered with PcVue in evaluation of Contextual Mobility at the intersection of Technology and Behavior.*

For example, a maintenance engineer may be monitoring an asset that is suspected or known to have malfunctioned. The component is uniquely identified its location determined by one or more Geo-tags. When approaching the Geo-tags the Proximity Services app synchronizes with the Mobility Server which responds with contextual information and control actions. The information and control actions related to nearby assets include:

- Access to real-time and historical information.
- Display of the trend for any variable of interest.
- Access to the asset's alarm list.
- Ability to put the asset into maintenance mode.
- Access to technical documentation for the asset.

Commissioning

Commissioning can be labor intensive and time consuming. Typically one worker located at the control room uses a radio to communicate with a field worker to relay the status of the equipment. A participant in the Fraunhofer report noted, "I don't need two people to do something one can now do". The mobile worker is provided with a HMI for operating the equipment and access to resources such as commissioning checklists, electrical diagrams and startup procedures automatically delivered to the mobile device as the worker approaches the equipment.

Access Control

The Mobility Server knowledge of workers credentials and current location provides the baseline for access control. When a facility visitor requires access to a zone, the request is known to the Mobility Server based on the person's proximity to a Geo-tag associated to the access point. The Mobility Server may grant access and verify that the user has in fact entered the zone.

Geo-fencing refers to the management of user rights as they move through different zones. The Mobility Server enforces the Geo-fences. The rights of a worker are allowed to change depending on the current zone. An alarm may be raised when persons are entering or leaving a zone (crossing the virtual fence) without prior authorization.

Benefits to Central Control

The aggregate view of the location of mobile workers and the current location of movable assets is valuable for tracking and other asset management purposes.

Safety and dispatching

Tracking changes of location over time is an extension of the proximity services. By monitoring the real-time location of the worker, traffic analysis such as the density of workers in an area, can be visualized in real-time and displayed on 2D or 3D maps. According to the designers who participated in the Fraunhofer study, this is the future of the industry. This is particularly true in high value facilities such as multi-use buildings, hospitals, labs, vivarium, and facilities and campuses with large central plants or chillers. Actions of the Mobility Server as a result of tracking asset location include:

- Raising a security alarm
- Adjust environmental controls for temperature, lighting, etc.
- Perform energy balancing
- Dispatch assistance providing current location, qualifications

The Mobility Infrastructure also supports life safety. It is able to coordinate and monitor the progress of any required evacuations including providing information about the best route given the real-time situation. The Mobility Server is able to monitor workers remaining in danger zones and alert workers moving in an unsafe direction. Safety related warnings can be directed to the mobile user and that person will now be accounted for in the case of an emergency.

Assets Tracking

Geo-tags associated with assets are registered in Mobility Server. The relationship with the position of the asset Geo-tag compared to other Geo-tags associated with fixed areas and zones makes it possible to track moving assets, even inside a building or facility. As in previously described use cases, the central SCADA or BMS may react to the repositioning of a moving asset automatically through alarming, visualization or recording information (archiving).

Conclusion

The rise of smart mobile devices that are now familiar to almost all workers has started a trend. This trend is away from managing a system with SCADA workers stationed in a central control room to a distributed SCADA form enabled by smart mobile devices.

The different way in which mobile device users interact with their devices compared to operator's interactions with control room monitors requires a new SCADA architecture for mobility workers who rely on SCADA or BMS systems in order to perform their job function.

With the ready availability of location sensors, IPS indoors and GPS outdoors, it is now possible to track remote workers location and drive contextual information and controls based on their credentials and location.

The Mobility Infrastructure came about from listening to customer's request to design SCADA solutions which leverage Smartphones and Tablets. The mobility strategy for PcVue Solutions is built on Mobility Infrastructure and enabled by the SnapVue™ mobile app. SnapVue™ incorporates the proximity services required to realize the Mobility Infrastructure and working in concert with PcVue®, as the SCADA Mobility Server, provides a platform for world class mobility solutions for SCADA and Building Management System projects.

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