The Architecture of the SCADA Mobility Infrastructure

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The Rise of Smart Mobile Devices

Mobile workers have long benefitted from the evolution of telecommunications particularly with regards to improvement in end devices.

For many years the standard for remote connectivity to Supervisory Control and Data Acquisition (SCADA) systems was a dial-up modem and a desktop copy of one of the remote access packages such as pcAnywhere[1]. Following the evolution of connectivity in general, the standard for SCADA connectivity has also evolved. Dial-up connections gave way to Ethernet and end devices became more mobile via the adoption of laptops. These technologies moved the standard to be a SCADA Client connected by virtual private network (VPN) or Remote Desktop Services (RDS) to a SCADA host. An alternate method, depending on the capabilities of the SCADA host, has been to use web browser connectivity to access the host and then navigate to the relevant information according to the user's needs.

Today, mobility is associated with smart devices, most notably phones and tablets. They are increasingly the preferred communications device for remote workers. The way in which people interact with mobile devices differs from the way in which they interact computers. Historical approaches to monitor, diagnose, maintain and control industrial and building assets must be reconsidered.

Smart device evolution is occurring in the ever more connected world of the Internet of Things (IoT) or as applied to the industrial automation world, the Internet of Industrial Things (IoIT). Geo-tag technologies including Bluetooth Low Energy (BLE) Beacons, Near Field Communication (NFC) and QR-Codes (a barcode format) were developed as part of the IoT infrastructure known as Indoor Positioning Systems (IPS).

IPS and the long-standing Global Positioning System (GPS) are now standard on modern smart mobile devices. Using IPS and/or GPS, the mobile device is able to determine its current location. If an app on the device validates and maintains the user's credentials, the device is now able to determine and communicate the user ID and location back to the SCADA host in real-time.

In the distributed environment of many SCADA applications and Building Management Systems, there are different servers providing information and controls for various zones of control. A zone of control may refer to all the equipment in a physical zone such as a floor in a facility, or it may refer to an automation system.

In today's world, a mobile worker is required to know what assets are included in each zone as well as how to connect to the specific server for that zone in order to access relevant information and controls. Given the many different publishers of the server software, it is unlikely that the zone servers will have information organized in a consistent way or have a consistent user interface. This greatly complicates the process and the time required for a mobile worker to perform their role in the use, operation or maintenance of a building or industrial facility.

[1] now part of Symantec Corporation

The Architecture of the SCADA Mobility Infrastructure

A new architecture to serve the remote SCADA user is needed. The SCADA Mobility Infrastructure (SCADA/MI) embraces the smart mobile device to increase the value and capability of the entire system. It consists of Geo-tags deployed in the zones of control, a smart mobile device app deployed with each mobile worker and a central server with real-time connections to equipment and other assets.

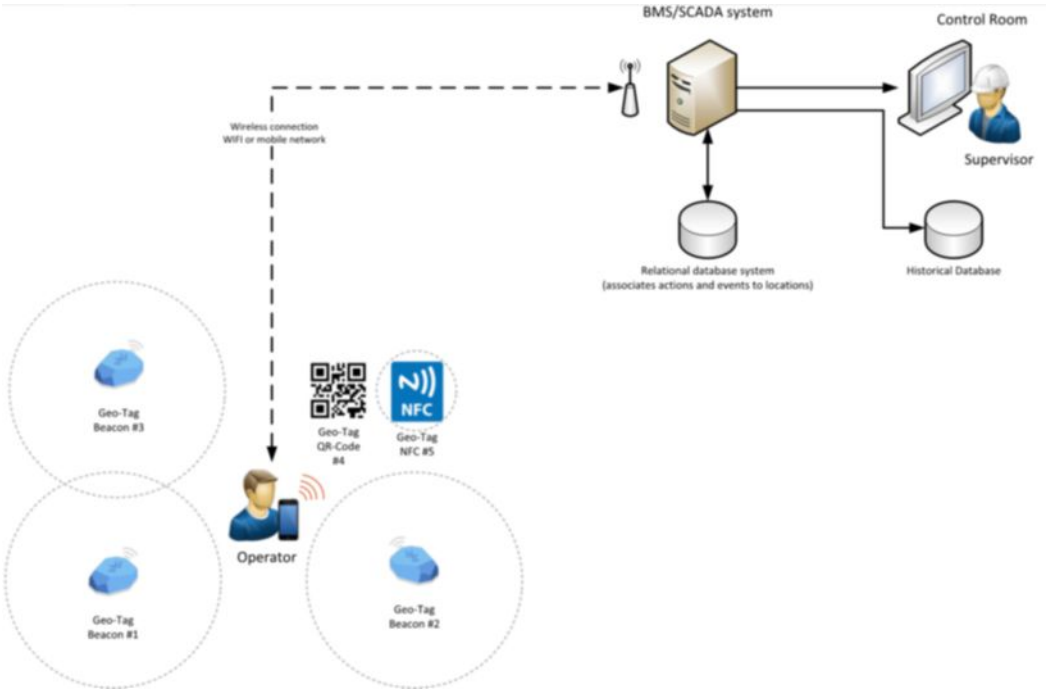

Figure 1 Mobility Architecture for SCADA

The SCADA Mobility Server

The cornerstone of SCADA/MI is the SCADA Mobility Server (SMoS). The mobility server aggregates information from distributed zones to provide a consolidated view of the SCADA or BMS and a single point of connection for the mobile worker. The SMoS also tracks the movement of the devices as they move about the zones under management of the SCADA or BMS.

The SMoS takes actions and sends information to the worker in the context of the worker's responsibilities at their current location. The information may include real-time status or control of nearby equipment. It may suggest additional resources (drawings, schematics, etc.) needed by the worker in the performance of their duties.

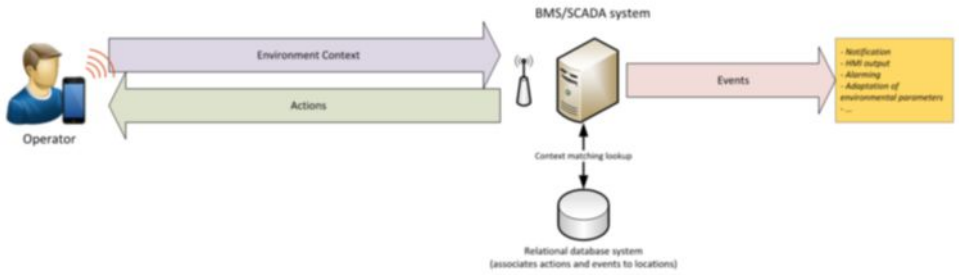

Figure 2 SCADA Mobility Server Flows

The SCADA Mobile Device App

The mobile device is connected to the SMoS via an app employing standard network connections. Geo-tags identify the device location and tagged assets near to the device. The app supplies proximity services to the SMoS such as updating and recording movement of the device holder, the existence of tagged assets in the holder's zone, or any change of the user credentials.

Security is a prime consideration with several levels of authentication working in concert to create a secure environment. These 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 wearable sensor such as a BLE beacon.
    - Confirm validity via Geo-tag attached to equipment such as a QR-Code

The Architecture of the SCADA Mobility Infrastructure

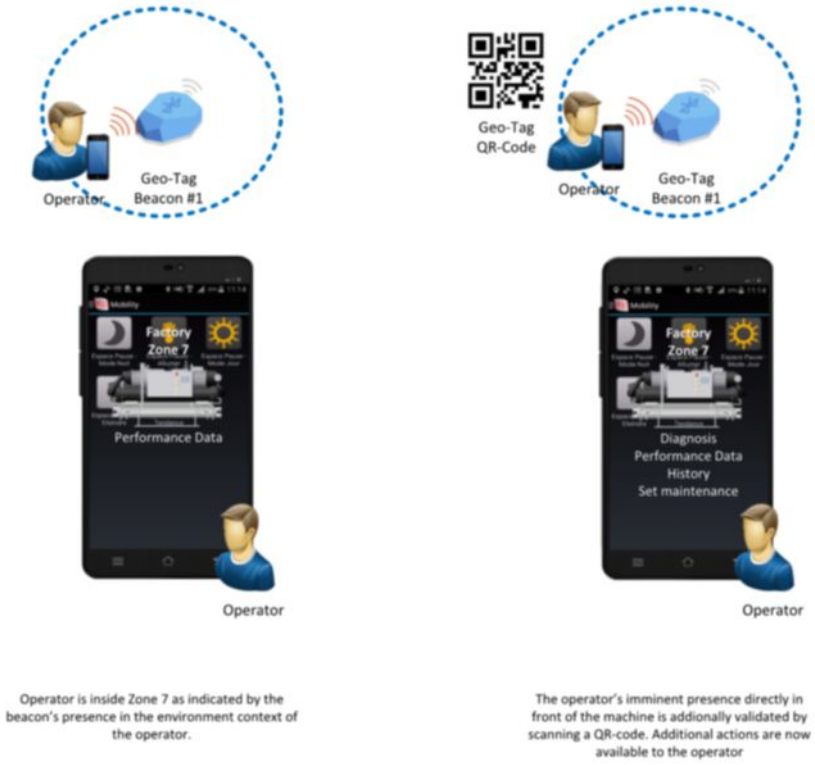

Figure 3 Validator Tags Determine User Rights within Zones

If the logic of the SMoS determines that the environmental context requires new information or actions, they are proactively sent to the smart device. Some examples are:

- Display a graphical symbol of an asset
- Show list of measurement values.
- Show the trend of one or more values.
- Display and/or modify a schedule of events.
- Manage Alarms
- Initiate commands to the BMS or SCADA system.
- Launch a web page, display a file or invoke other operating system resources.

Benefits to Mobile Workers

The benefit to mobile workers is twofold. On one hand SCADA/MI improves the mobile workers efficiency by eliminating the time necessary to filter through the entire SCADA system. There is also a safety benefit that is a result of the central server knowing the workers location. Safety related warnings can be directed to the remote worker and the worker will be accounted for in the case of an emergency at their location.

The Architecture of the SCADA Mobility Infrastructure

Performance Monitoring

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

In the diagnostics case, the maintenance worker is monitoring one or several zones. As the worker moves they are provided the information relevant to their current location based on their area of responsibility. This area of responsibility is in the context of both the physical orientation (nearby, lift equipment zone, full facility, etc.) but also on the role of the user, which may be defined by department, training or other certifications.

The SMoS is aware of all of the remote maintenance workers and is able to intelligently dispatch alarms to the maintenance worker who is best positioned to respond. The proximity rules that are available to the SMoS create new ways of thinking about how to organize a maintenance strategy. New ways to combine proactive and reactive aspects of maintenance based on a real-time assessment of resources and proximity may now be implemented in straightforward manner.

In the case of maintenance, an 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 app synchronizes with the SMoS which responds with candidate 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.

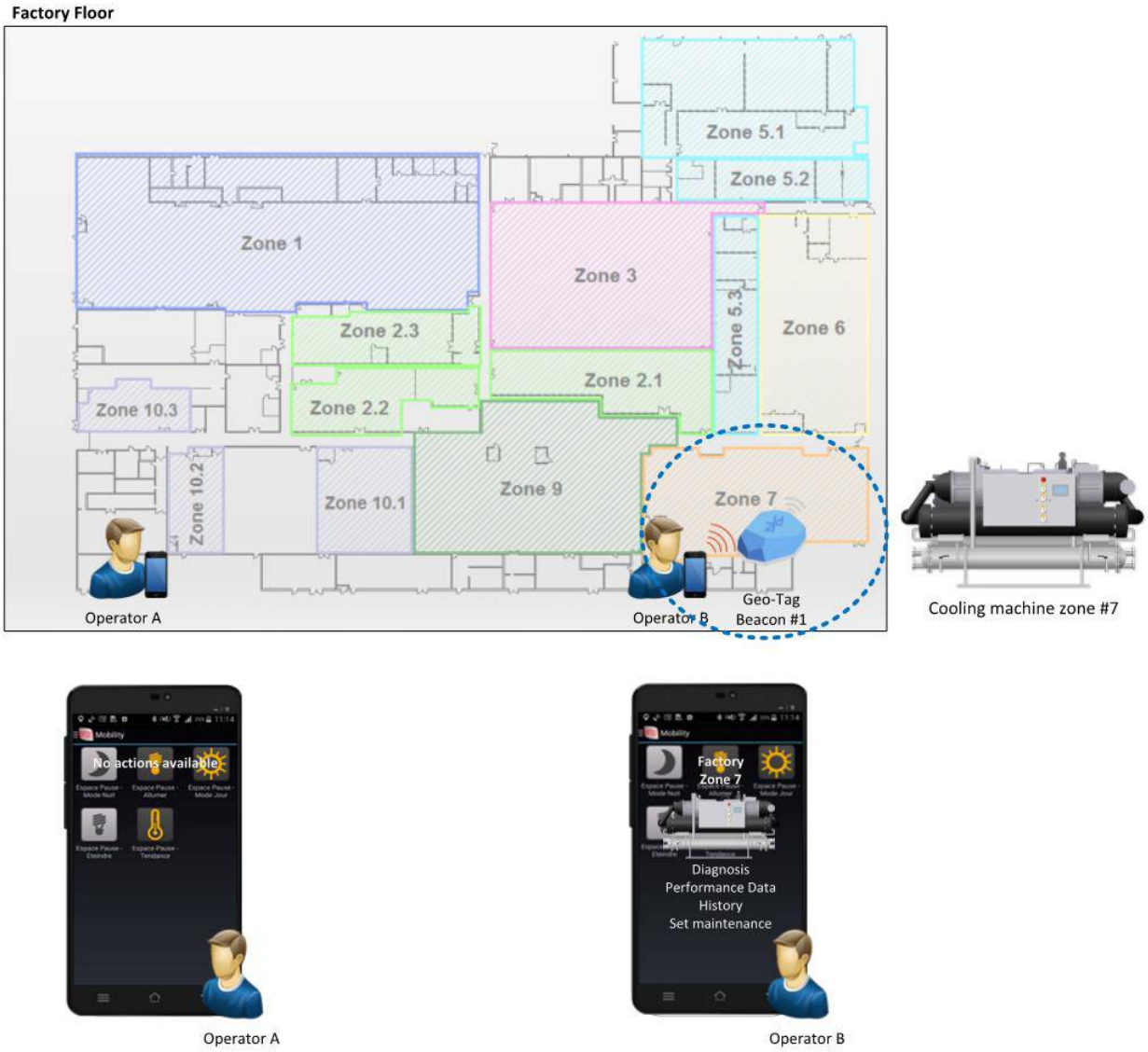

Figure 4 Maintenance Worker

Commissioning

Commissioning of an HMI/SCADA or BMS can be a tedious processes. Typically one worker is at the central SCADA control room using a radio to communicate with a field worker to directly verify the status of the component being commissioned. With SCADA/MI, there is the possibility for commissioning to be done with only a single worker. The mobile worker is provided with an equipment Human Machine Interface (HMI) for operating the equipment and access to resources such as commissioning checklists, electrical diagrams and startup procedures automatically as the worker approaches the equipment.

Access Control

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

The term "Geo-Fencing" originally associated with outdoor positioning systems, defines the user rights management for individual zones. The alarm notification system raises an alarm when individual persons are entering or leaving the zone (crossing the virtual fence). The SCADA/MI supports the concept of zone based user rights. The rights of a worker are allowed to change depending on the current zone or area as well as the system state or other environmental factors.

Benefits to Central Management

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.

Worker Location Tracking

Tracking worker movements is a natural extension of the proximity services of the mobile devices. 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 displayed on 2D or 3D maps. Actions of the SMoS as a result of tracking workers position may be:

- Raising a security alarm
- Adjust environmental controls.
    - Temperature
    - Air flow
    - Lighting
- Perform energy balancing

The SCADA/MI also supports components of life safety. The SMoS is able to coordinate and monitor the progress of any required evacuations including providing information about the best evacuation route given the real-time situation. The central server is able to monitor for any workers left on the scene or alert workers moving in the wrong direction.

Asset Tracking

Geo-tags associated with assets are registered in SMoS. 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 SCADA/MI was created from our customer's voices to design SCADA solutions which leverage the growing adoption of Smartphones and Tablets. The mobility strategy for PcVue Solutions is built on SCADA/MI and enabled by the SnapVue™ mobile app. SnapVue™ incorporates the proximity services required to realize the SCADA/MI 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.

Authors

Pierre de Bailliencourt is the founder of ARC Informatique and the ARC Group. Pierre serves as President and CEO of ARC Informatique located on the southwest of Paris in Sevres, France. ARC Informatique is the publisher of the innovative PcVue Solutions for SCADA/HMI; a platform used extensively in Building Management Systems, Energy Management Systems and many other traditional and non-traditional forms of SCADA and HMI. PcVue Inc. is the North American affiliate of the ARC Group and is located near Boston in Woburn, Massachusetts. Edward Nugent is the Chief Operating Officer of PcVue Inc. Ed is the lead author for the article and is the winner of a 2015 Silver Scribe Award from the Energy and Telecommunications Association. Armin Kaltenbacher, is the Managing Engineer of PcVue GmbH, the German affiliate located in Altdorf, Bavaria. Armin led the design and development of the mobility focused PcVue® WebScheduler™ solution. Armin is a global leader and frequent contributor to the PcVue Solutions for Mobility research and development effort.