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**Enabling Mobile Technologies on IEC61850**

by

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**SUMMARY**

Nowadays mobile technologies are spread as part of our lives. In addition to this wireless technology, such Wi-Fi (Wireless Fidelity) which is incorporated on mobile devices, supports most of our daily work. It will be ideal to use this kind of technologies to improve Substations Automation System based on IEC61850 Standard. IEC61850 helped out to reduce copper wiring cost sending information via protocol. Additionally it introduced a better architecture and it defined abstract services and different protocols for different purposes. Some protocols like Generic Object Oriented Substation Events (GOOSE) require wired connection because it implements MAC layer multicast packets. There are other protocols like Manufacturing Message Specification (MMS), which is specified to communicate Station Level Equipment with Bay Level devices, and MMS for being an IP Protocol allows wireless connection and it could be used in so many purposes.

Monitoring and controlling Intelligent Electronic Devices (IEDs) using mobile technology brings new possibilities like supervising Process Level equipment from an optimal view, operating switchgear with a better line of sight, and diagnosing IEDs state. The same mobile device could be used to access to different substation information which reduces the quantity of PCs(Personal Computers) needed and additionally it reduces the cost of wiring power DC supplying and Ethernet communication. Security is normally a concern in this kind of implementations and based on IEC 62351 Standard and incorporating mobile security techniques this goal could be achieved.

Movi software is working in enabling mobile technologies on Substation Automation Systems (SAS) based on IEC61850, which supports engineering and maintenance processes. In order to achieve this goal we develop one MMS Server and one MMS client, both of them was implemented on android platform and both apps are being used in different topics like: personal training, laboratory testing and substation maintenance tasks.

**KEYWORDS**

Mobile automation, IEC61850, Agile Maintenance, Mobile SAS, Mobile Substation Automation System, MMS Driver mobile, MMS Client, MMS Server.

## 1. INTRODUCTION

Mobile technologies are increasing nowadays and is being incorporated into multiple routine tasks like schedule a meeting, checking our email, sending messages to family, co-workers, asking for a taxi, etc. If we check the time we spent daily on our smartphones it will be considerably higher than other modern devices as we can see on the Figure 1:

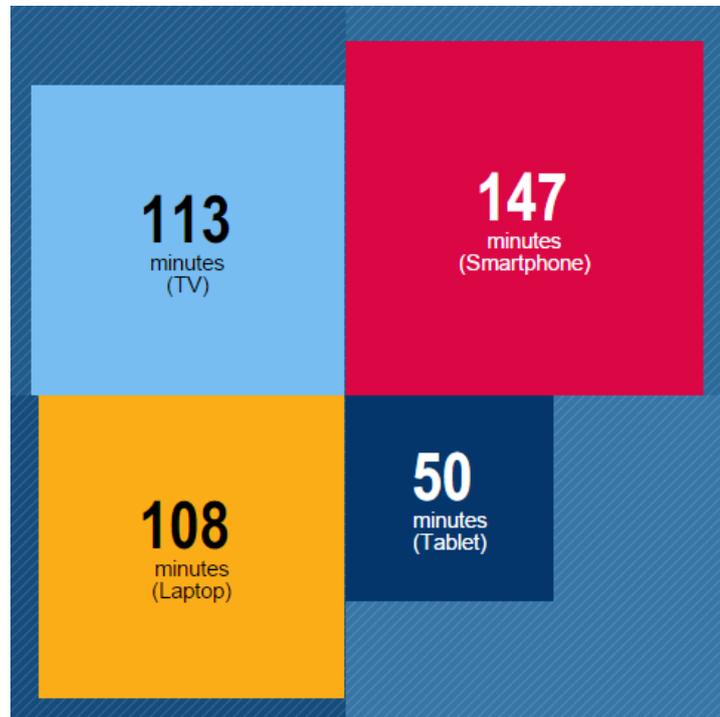


Figure 1. How much are screen used? International survey made in 2014 across 37 countries. Source: [1]

However if we evaluate mobile application incorporation in substation automation there are a few of application who support it. It is convenient to evaluate what possibilities bring mobile technologies to modern Substation Automation Systems (SAS). In order to check this possibilities we are going to see different aspects in which mobile system could be implemented.

## 2. LABORATORY TESTING

In order to test HMI software, OPC system, or specific substation configuration, a simulator brings possibilities to test quickly some features of a SAS installation. Configuring, connecting and enabling an IEC61850 capable IED is a time-consuming activity and sometimes it is not necessary. Real time simulation testing has too many consideration as the latency of the network and it as covered by many authors [2].

IEC61850 specifies a method for configuring SAS parameters called Substation Configuration Language (SCL). A Simulator reads a SCL file and it could understand how needs to act, so the simulation could be configured and initialized. A simulator can be implemented on PC or mobiles devices taking in account that GOOSE messages only could be implemented on devices with Ethernet enabled (Most of modern tablets and smartphones aren't Ethernet enabled).

At a test when only MMS communication is needed and the Wifi latency is not a problem, multiple mobile devices can be used as an IED emulator and supports HMI testing as we can see on Figure 2.



Figure 2. HMI Test mobile architecture

Each simulated server of the Figure 2 has an individual SCL file configuration and it can support the services specified on IEC 61850-8-1 to send information to HMI. MMS Servers tests has been made with reporting features and on-demand request with successful results.

### 3. IEC61850 TRAINING

IEC61850 Standard contains a lot of topics which can be difficult to understand at first time. Integral topics like Project Management, Communication Protocols, Communication abstraction, Communication mapping, Object Model, SCL with xml formatting requires that engineers has good basis on electrical, telecommunication and software concepts.

Using a developed mobile MMS Server and MMS Client IEC61850 concepts can be explained in a very interactive way. Concepts like self-description, SCL Files, datasets, buffered and unbuffered reports [3] are easier to understand with the right tool. In order to explain better SCL concepts the MMS Server we develop includes the battery level of a mobile device as a default implemented logical node called BATT, and it is possible on app to publish this value to access it via report or read it directly using MMS read service.

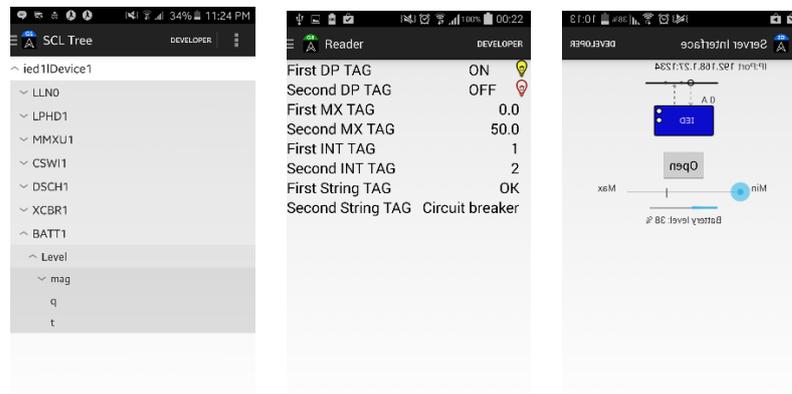


Figure 3. MMS Client and Server prototypes

Both MMS Server and client was used in 2014 to train different engineers in Colombia using different PC and smartphones as servers and clients alternately. The fact of using mobile devices to test standard concepts help to ease knowledge management and to interiorize norm understanding. Trained engineers belongs to different industries between: utilities, mine and cement.

#### 4. SUBSTATION COMMISIONING AND MAINTENANCE

IEC61850 defines different level where different process are defined. Process level is the first level and it has all the heavy hardware normally found in a substation like current transformers, circuit breakers, isolator, transformer and so forth. The second level is called Bay level and normally is the core of the control system and where the IEDs are located. The last one level we found in a substation is Station level which have operator interfaces to supervise and control the substation, and where information exchange with control centre occurs.

Typically a station level architecture looks like exposed on Figure 4 without the dashed rectangle which corresponds to the enabler of mobile access to substation data. Different components of this architecture are explained below.

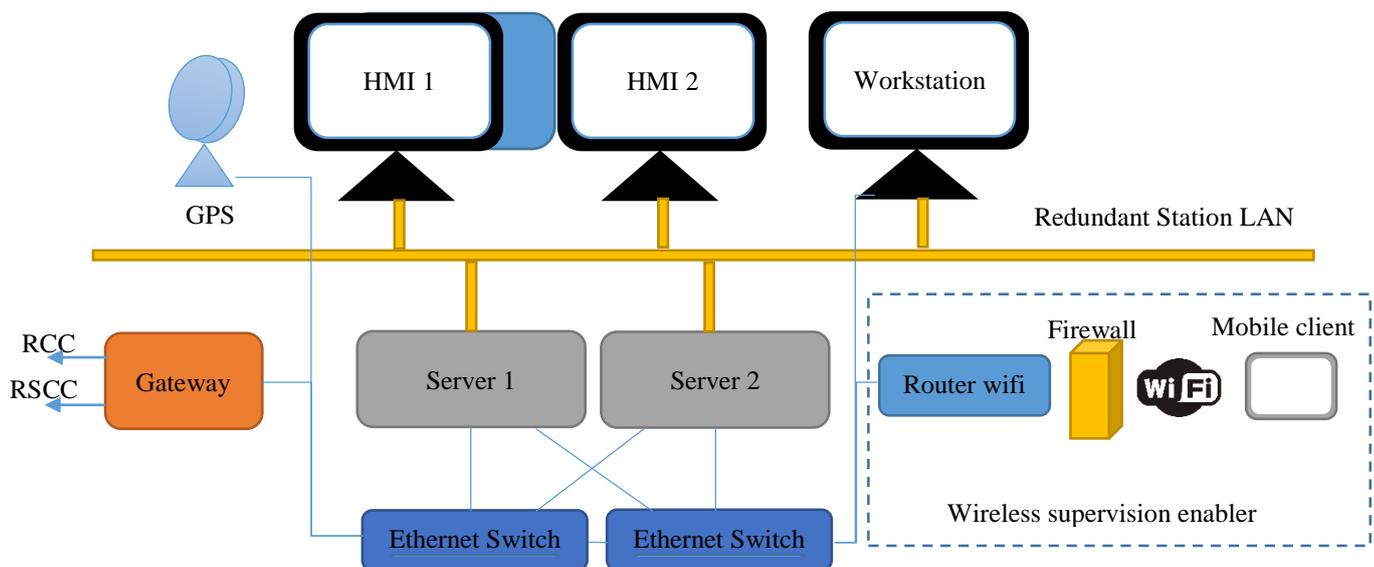


Figure 4. Typical station level substation architecture with mobile access enabled

Where,

**HMI 1-2:** Graphical Interface to supervise and operate substation locally. Despite that normally redundant HMI are found in diagrams [4], is possible that clients prefer to have only one HMI (This is very common on unattended substation).

**Server 1-2:** These are the brain of the station level. All the time are capturing substation data and sending it to HMI. The also receives control commands.

**Workstation:** PC used in maintenance process.

**Gateway:** Interface with remote clients. It normally uses protocols with low bandwidth cost like DNP3, IEC60870-5-101 or IEC60870-5-104.

**RCC:** Remote Control Centre.

**RSCC:** Regional System Coordination Centre.

**GPS:** The clock used to guarantee substation synchronization.

**Server:** Substation equipment to acquire information from IEDs.

The wireless supervision enabler is composed by:

**Wifi router with a built-in firewall:** This component is connected to SAS LAN and is the device which allows wireless access. However, in order to guarantee secure environment, it's very important to take into account next considerations:

- Enable MAC Filtering to allow access only to specific devices
- Blocking ports, allowing only MMS port, which is 102 by default
- Enable secure authentication protocol.
- Strong password policies: Weak password are probable to be cracked by brute-force attack.
- SSID Hidden.

A mobile client: Mobile device such a tablet or smartphone with MMS Reader application installed.

The main advantages to commissioning and maintenance are: better line of sight.

### a. MOBILITY

First advantage of mobile technology is the mobility of the device which monitor substation variables. This brings substation engineers the possibility of having real time access to complete substation state and this represents a minor time in relay, bay or End-to-End testing. There is some substations where due to the immobile HMI and the limited line of sight in front of it, a person have to stand in front it talking by radio with other engineer.

As we can check at the Figure 5 HMI fixed is not as convenient as Mobile technology for testing Bay A. A person could check all the substation variables on a tablet without to call by telephone or radio another partner to get this information, preventing the risk of “broken telephone”.

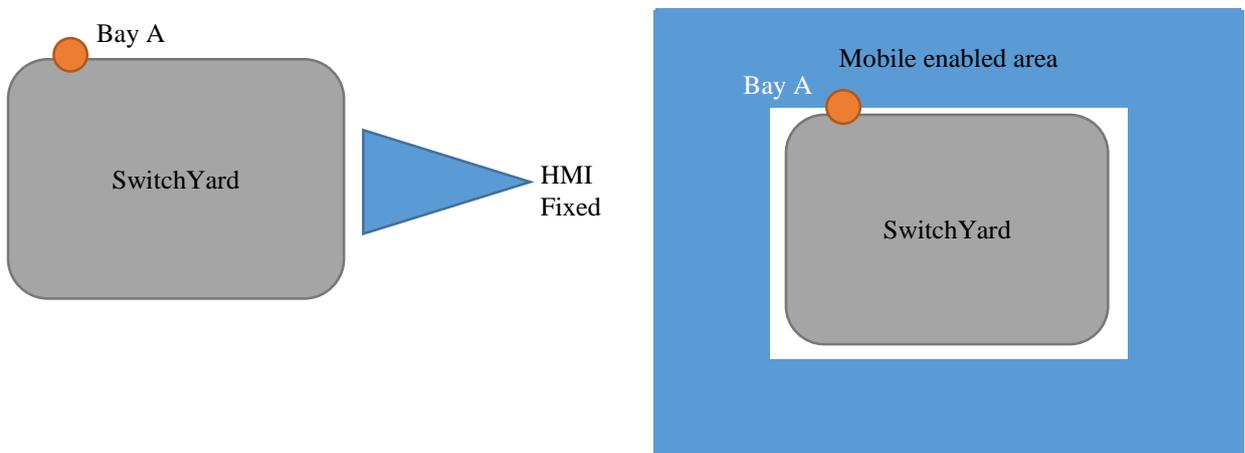


Figure 5. HMI line of sight vs Mobile line of sight

Room of control is the place which normally are located HMI, and depending on substation disposition it could be very difficult to monitor some kind of equipment located on switchyard. This represents more time on all routine operating tasks which requires visual confirmation of equipment operation, because of the limited scope of a motionless PC. Mobile technologies facilitates this kind of work because the operator could check the optimal safe point of view to supervise specific equipment.

### b. REDUCING EQUIPMENT COST

In unattended substation normally HMIs works like a 7 x 24 machine and they have an associated cost of licences, rental of equipment, commissioning and maintenance process (operating system updates, antivirus updates), power supply, etc. Some companies have substation operators which

alternate between different substations leaving another substations unattended to reduce operating cost.

Mobility required in alternating operators benefits the architecture presented because the operator could use a same device to switch between substation and he can supervise and control the substation where he actually is located. The PCs will not be needed and this represents a way to reduce fixed expenses.

### c. SECURITY

Security is a very complex and wide area, and the purpose of this document is not about covering this topic. However we are going to expose some key points which are needed or enabled by mobile technology:

- Mobile devices differs from desktop PCs in single user feature. PCs was thought to allow different users with his specific password access to the same device. Mobile equipment is a more personal device which is thought for a single user access. This feature is a very important key to a safer operation, because it allows the audit of the controlling and monitoring actions and gives more precise information about the sequences of events during a system fail.
- Last mobile devices have fingerprint reader incorporated, and it should be used to prevent unauthorized access to system.
- Centralized authorization: In order to grant security operation a centralized system need to control which device can operate which substation, in what time and when authorization expires.
- In order to prevent accidental equipment operation a password to enter to control mode have to be incorporated on mobile app.
- GIS verification: All modern mobile devices have the geolocation feature. It is possible to use the device position to enable or disable substation operation or monitoring. In order to achieve this goal permission areas need to be configured:  
 $\text{MínYPos} < \text{YPos} < \text{MaxYPos}$  and  $\text{MínXPos} < \text{XPos} < \text{MaxXPos}$   
Where,  
 $\text{MinYPos} - \text{MaxYPos}$  represents the range of Y values allowed by the application to enable supervise or control.  
 $\text{MinXPos} - \text{MaxXPos}$  represents the range of X values allowed by the application to enable supervise or control.  
This prevents a substation operator from operating a diferent substation to where he is located.

## 5. CONCLUSION

In order to enable mobile technologies to IEC 61850 Standard both MMS reader and MMS server was developed. Both application was successfully used to train specialized engineers in Colombia and open new possibilities to substation monitoring and maintenance areas. This areas brings a mobile and comfortable operation and allow to reduce cost in unused substation equipment.

## 6. BIOGRAPHIES

Juan Camilo Cardona Graciano received his B.Sc. in Electronic Engineering in 2009 from the Universidad de Antioquia, Medellín, Colombia. He has implemented automation projects on more than 50 substations in Colombia. Juan Camilo Cardona presently works for Movi Software Company as Chief Executive Manager.

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