NFC LIKE WIRELESS TECHNOLOGY FOR MONITORING PURPOSES IN SCIENTIFIC/INDUSTRIAL FACILITIES*

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Introduction

When cabling is not really needed for performance reasons, wireless monitoring is a good choice for large scientific facilities like particle accelerators. Wireless systems offer several advantages: flexibility, mobility, scalability, reduced costs. ease of maintenance and a quick implementation. There are several wireless flavors: ZigBee, WiFi etc. depending on requirements of specific application. In this work, a wireless monitoring system for EPICS based on an Android device is presented. It is done trough WiFi. The task is to monitor the vacuum control system of ISHN project at ESSBilbao, where control system variables are acquired over the network and published in a mobile device. This allows the operator to check process variables everywhere the signal spreads, avoiding the necessity of a central computer. In this approach, a Python based server acts as a bridge between EPICS and Android. It is continuously getting EPICS variables via CA protocol and sending them through a WiFi network using ICE middleware. ICE is a toolkit oriented to develop distributed applications. Finally, the mobile device acts as a client, requesting data from the server and bringing it to the operator. The security of the communication is ensured by a limited WiFi signal spread, following the same idea as in NFC for larger distances. With this approach, local monitoring and control applications are easily implemented, useful in starting up and maintenance stages.

Proposed approach

Security is critical when designing a wireless network. Even more when talking about large scientific facilities like particle accelerators, where intrusions may result in harmful or even disastrous situations due to the large amount of power involved in equipment consumption. A way to provide the security of a wireless network, besides typical message encryption and node verification, is adjusting transmit-power level to control signal spillage beyond the plant walls. So, if the radio signal is "invisible" beyond the limits of the facility, it becomes very difficult to steal or intercept the signal. That means a physical security against attacks. This idea is represented in Figure I, where the mobile device located outside the transmission range cannot reach the wireless signal, therefore it is impossible to access information. It also allows to spread signals only in certain areas of the facility depending on the authorization level. So, a limited field communication approach can lead to a secure installation, limiting the transmission power accordingly to the characteristics of each area.

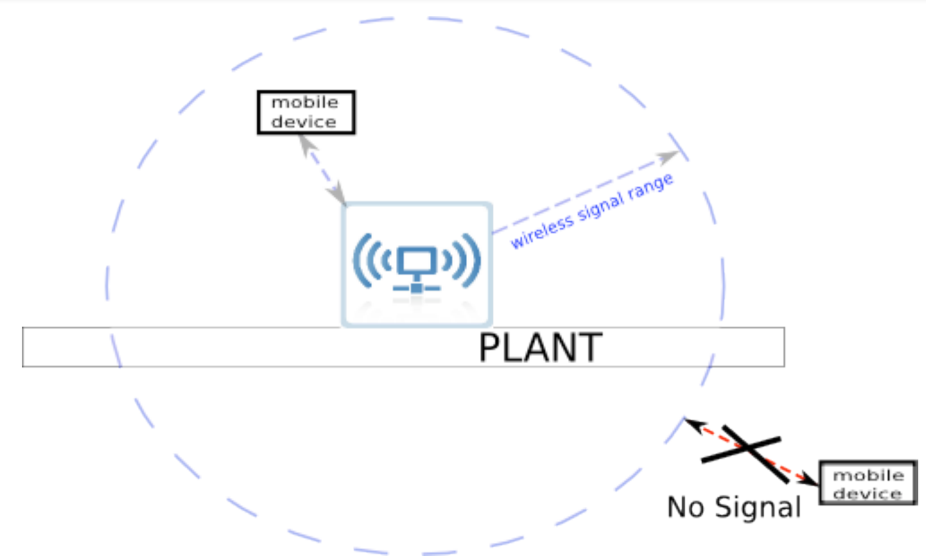

Figure I: graphic representation of the Limited Field Communication approach. Security is based on adjusting transmit-power level.

Proposed implementation

EPICS is a control solution based on middleware approach, oriented to distributed control systems. It is used worldwide to create soft real time control systems, specially in large scientific facilities, as it allows to manage large systems involving elements of very different behavior. EPICS can be defined as an architecture for building scalable control systems, a collection of tools and codes and a collaboration between major science labs and industry. The networked control system is based on a TCP network due to several advantages, such as ease of implementation and costs, but it has non-deterministic characteristics. The use of EPICS minimizes these disadvantages.

The proposed schema is the following:

A Python based server is used as a bridge between EPICS and the mobile device. It gets the desired EPICS Process Variables by a polling procedure and packages it to ensure a proper throughput. Moreover, this program initializes the ICE host application, creating the object for passing to the ICE client, hosted on the Android device. It is done by mean of a WiFi network with limited transmission power. Finally, the client is running in an Android mobile device. This application, written in Java, creates a proxy to connect to the server via ICE and calls the object which is wanted to read/write. The user interface displays the desired information to the operator and will allow to write to EPICS PVs easily using the touch screen.

Figure II: Client/Server communication using the ICE middleware

Vacuum system monitoring and control

The presented application is intended to be used on a large scientific facility, to ease the task of the operators during normal operation and in maintenance stages. The main idea is to allow them to control and monitor the main variables of a vacuum system wherever they are inside the spread radius, depending on the transmission power. This fact allows to avoid the dependence of a central computer. Specifically, it has been designed to monitor the vacuum control system of the ISHN (Ion Source Hydrogen Negative) project at ESSBilbao.

ISHN project consists of a Penning type ion source which will deliver a H- beam to a linear accelerator, which finishes generating neutrons by means of spallation process (currently under design). The vacuum system is considered critical on the project, as any failure could cause a high voltage breakdown.

Figure III: GUI sample showing data related to the turbo pumps

In order to reach the desired vacuum level two mechanical and two turbo pumps are used. The PLC manages the variable related to the pumps an publishes them over the network using a Modbus TCP/IP server. An EPICS IOC accesses all of the data by Modbus TCP/IP calls, which acts as a wrapper for Twido communication. Even if Modbus communication is present, any call to vacuum system can only be done through EPICS, ensuring that capabilities offered by EPICS are always met. In such configuration, the devices controlled with EPICS are two mechanical pumps, two turbo pumps, a vacuum sensor and two vacuum gates.

The GUI of the Android application displays to the operator all the variables of each device (On/Off, Warnings, Rotation frequency...) under control of EPICS, arranged into tabs.

Future upgrades

The following upgrades are planned:

- Encrypted communications and authentication through SSL/TLS protocol
- Integration of the EPICS monitor system in a Python based server, to avoid polling
- Two-way communication between Android mobile device and EPICS