Manage your KPIs over the Web and Smartphones

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KEYWORDS

Client, cloud engineering, Distributed Control Systems (DCS), distributed processes, Ethernet, HTTP, Human Machine Interface (HMI), I/O, iPad SCADA, iPhone SCADA, Java, MES, ModbusTCP, OPC, real-time dashboards, Real-time performance monitoring, Real-time software technology, Server, software as a service, Supervisory Control and Data Acquisition (SCADA), TCP/IP, Webserver, Wireless, XML

ABSTRACT

This paper will give three "real-world" examples of using the web and smartphones to allow plant operators, engineers, and managers to take the plant HMI with them when they leave the control room, the plant, and even the town or continent.

Session attendees will be given a step-by-step process to translate their HMI displays to the web and/or their smartphones.

This paper which can be given as a tutorial will have hardware and software available to allow attendees to actually see how to program the systems.

This paper and the associated tutorial will show the reader and/or tutorial attendee how to design, program, implement, and troubleshoot the equipment from representative vendors by showing the respective software used to program and communicate with each of the hardware devices with screen prints from the programs as well as sample third-party interface software (i.e.; HMI's) that can be used by operators, technicians, engineers, and managers. In this paper and tutorial, Modbus TCP and OPC communication will be used.

The hardware used for the tutorial are all commercially, off-the-shelf (COTF) that all have long and successful histories of providing industrially-proven instrumentation controllers, signal conversion devices, isolators, and connectors to both end-users and OEM manufacturers.

In this tutorial Microsoft Windows- and Apple iOS-based software is used to communicate with and program each of the equipment. In the following pages, screen prints from the programs will show the basic steps necessary to bring the hardware and software into operation.

With the many instrument & control vendors offering these relatively low-cost, modular, ethernet I/O systems that can be configured quickly and communicate with each other AND other computers with off-the-shelf ethernet hubs, switches, and/or routers the internet can be used as a method of bringing field devices from your plant into a computer SCADA or control system and viewed from a browser or application across the ethernet, sometimes VERY remotely using private and/or public addresses via Wi-Fi and/or cellular technology to extend the ethernet to remote field devices.

Hopefully this tutorial has provided a starting point for the industrial automation professional beginning a long study and career implementing applications on tablets and smartphones. In this author's opinion, the future of industrial instrumentation and automation visualization will surely move toward greater use of industrial wireless[1] and cellular ethernet for communication between devices, controllers, operator interfaces, and maintenance tools.

Currently, many instrument & control vendors offer modular, ethernet I/O and visualization systems that can be used as a relatively low-cost method of bringing field devices from your plant into a computer SCADA or control system via the ethernet. These systems can be configured quickly and communicate with each other AND other computers over standard ethernet using off-the-shelf ethernet hubs, switches, and/or routers and viewed from a browser, a spreadsheet, or HMI on mobile devices like smartphones, iPads, and tablets. Learn how to configure AND implement ethernet I/O systems for your plant. This tutorial will have hardware and software to allow attendees to actually program the systems.

INTRODUCTION

Industrial automation professionals use the same steps today as they have been using since the first pneumatic control system nearly seventy years ago and the first electronic distributed control system nearly thirty years ago. Today, instead of running pneumatic tubes or electronic wires from each device in the field, each field device can have a unique address and be connected via the Ethernet. The industrial automation professional still must keep track of each device, program (and often reprogram), and maintain all these devices.

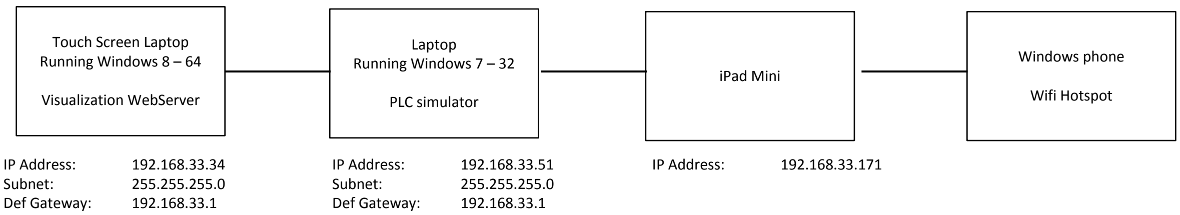
With the proliferation of the internet infrastructure and the increased capabilities of internet communication, new equipment and the associated programming software for that hardware are becoming increasingly available to industrial automation professionals to implement in plants giving plant operations real-time process information from those plant processes. These Key Performance Indicators (KPI) include process control parameters, alarms, and trending. Measurement and control devices distributed in the field (sometimes very remotely) can be connected to each other, to central monitoring facilities, and to remote sites where technicians can maintain and troubleshoot problems with the equipment via the internet.

This paper and the associated tutorial will show the reader and/or tutorial attendee how to design, program, implement, and troubleshoot the equipment from several representative vendors by showing the respective software used to program and communicate with each of the hardware devices with screen prints from the programs as well as sample third-party interface software (i.e.; HMI's) that can be used by operators, engineers, and technicians. In this paper and tutorial, Modbus TCP and OPC communication will be used.

HARDWARE

The hardware used for the tutorial was is representative of typical vendors all with long and successful histories of providing industrially-proven instrumentation controllers, signal conversion devices, isolators, connectors, and visualization products (HMIs) to both end-users and OEM manufacturers.

These four devices communicate in a local (private) network:



The equipment could also be connected to an off the shelf wireless router and switch.

SOFTWARE

In this tutorial [2] Microsoft Windows-based software is used to communicate with and program each of the equipment. In the following pages screen prints from the programs will show the six basic steps necessary to bring the hardware into operation:

1. identify and address the interface hardware (give it a unique TCPIP address) across the Ethernet
2. let the interface hardware identify and address input/output modules
3. determine which communication protocol will be used and how the I/O is mapped
    - Modbus TCP
    - OLE for Process Control (OPC)
4. Program the controller
5. Configure the OPC Server - if OPC is used
6. Configure a Human Machine Interface (HMI) of some kind
    - Graphical displays supplied by the hardware provider
    - Graphical displays supplied by a 3rd-party provider
    - HTML
    - XML
    - Custom Visual Basic and/or Visual C++ and/or C# application

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COMMUNICATIONS

Several means of communications are available between the controller and the visualization (HMI) including:

- Private Network

  The examples here are built using a private network with the 192.168.x.x format and is inaccessible to the internet

- Public Network

  A public network would be identical to the private network except that it has a router allowing access to the internet through a firewall or VPN

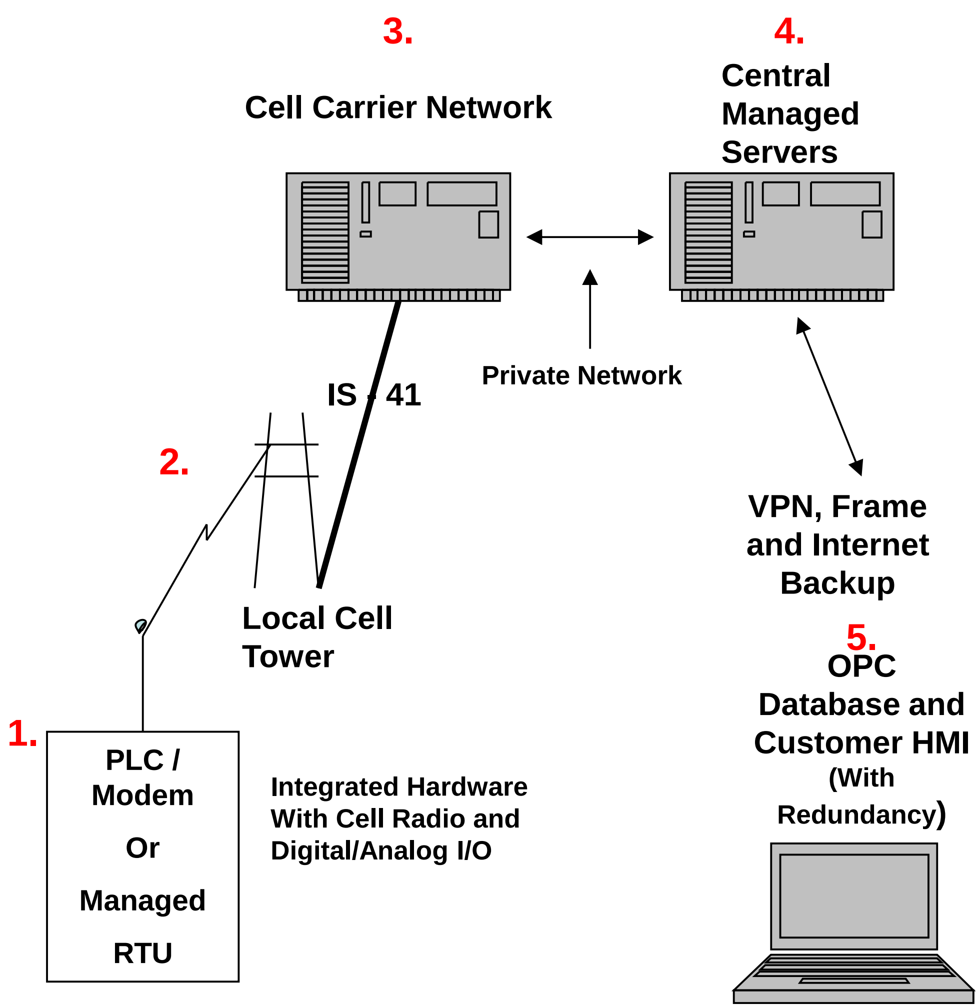
- WiFi [3] and Cellular [4] are both wireless [5] and only differ in that the Wifi has a wireless router and access points whereas the cellular router[6] version has a cellular modem in addition to the wireless router and access points.

- SMS [7] (Short Message Service) and MMS (Multimedia Message Service) and Email

  SMS (Short Message Service) and MMS (Multimedia Message Service) and Email can be used in place of the application

[8] How Does Managed Cellular SCADA Work?

1. Field RTU
   - Standardized
   - Power Supply, Radio, I/O, Modbus
   - Connects to Controller or PLC
2. Cell Tower
   - Cellular, But Not Voice
   - New 3rd Generation Data: GPRS & CDMA
   - Available On All Cell Providers
3. National, Wireless Data Networks
   - Private “Pipes”, Increased Security
   - Flexibility for Permanent Connections
4. Managed Central Servers
   - All Carrier Issues/Data Managed
   - Flat Fees
5. OPC Database at Customer HMI
   - HMI Scans RTU Tags
   - Redundant Servers Can Retrieve Data



SMARTPHONE/TABLET APPLICATIONS

This paper will assume that the Smartphone/Tablet application has already been written (as most suppliers have created their apps[9] (These apps are written in Visual C++/C#/.Net) and they can be downloaded from the Marketplace or iTunes app store).
[10] [11] Many vendors have Smartphone/Tablet Applications already written that are easily implemented.

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CASE STUDY 1 – SMS Relay[12,13,14]

To meet state water quality requirements, a 77-member community water company on the Olympic Peninsula of Washington had the need to find a solution to receive timely tank high- and low-level and pump alarms from their water storage tank and pump house. Given their small size and limited budget, a traditional SCADA system was impractical; a single 6 - I/O, relay that could send and receive text messages between pre-configured cellular phones was the best option.

CASE STUDY 2 – iPad mini

BUILDING THE PROJECTON THE SERVER

Just like any conventional HMI, as you can see in the screen print below; there are eight items in the menu to the left that need to be configured:

1. **Tags**
2. **Security**
3. **Devices**
4. **Alarms**
5. **Datasets**
6. **Scripts**
7. **Displays**
8. **Reports**

Tags The tags can be actual instruments from the controller (in this example a PLC) or “soft” internal tags

Devices

Each Device has three parameters to be defined:

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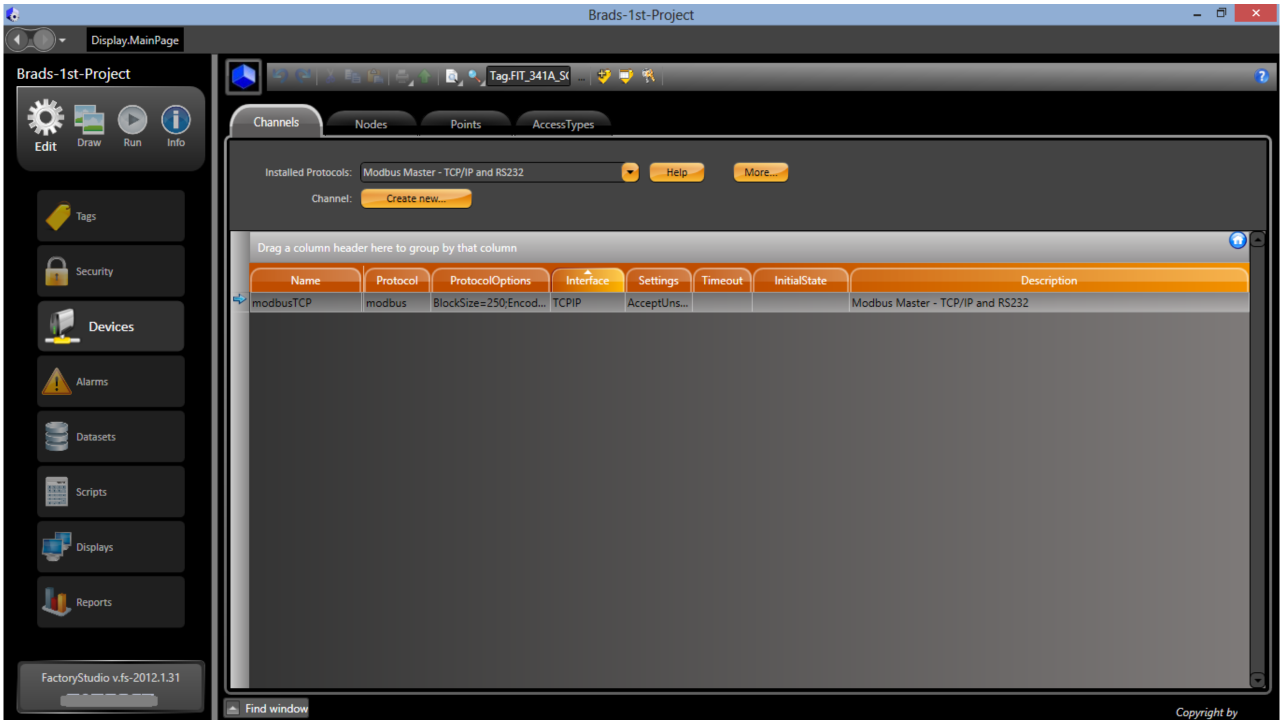
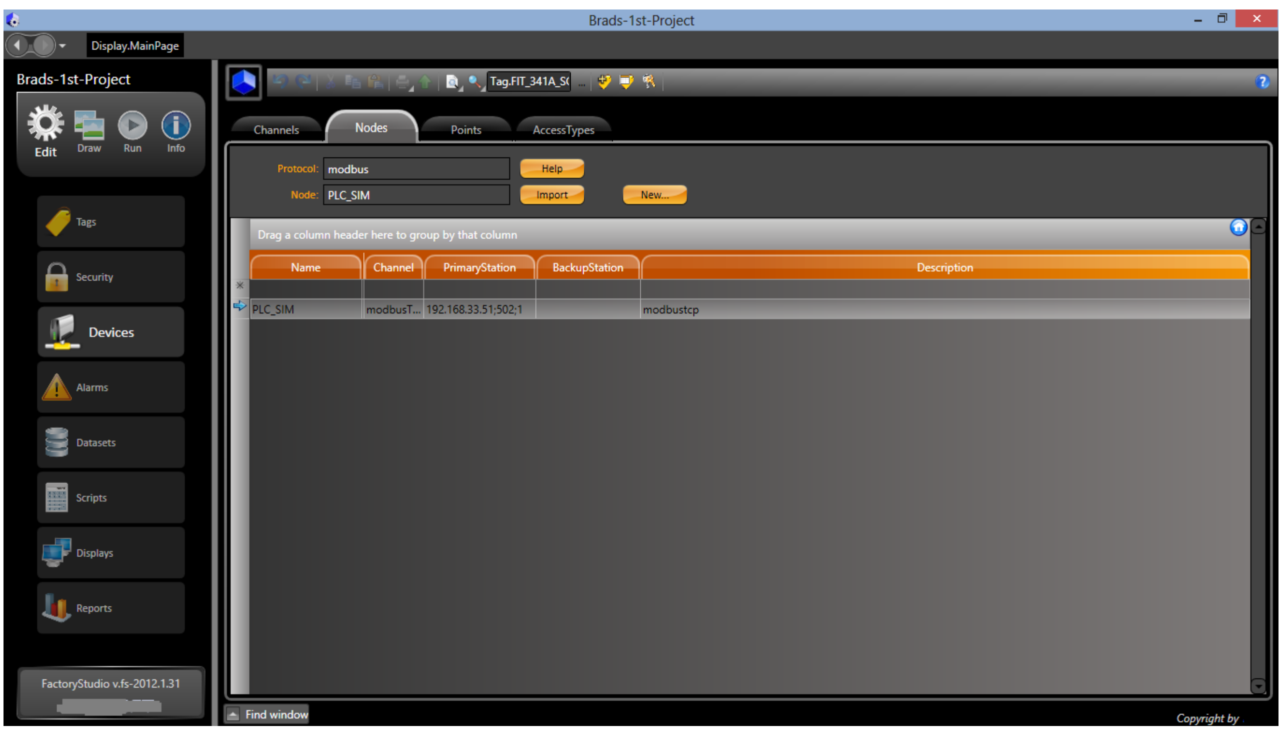
- Channels – where the protocol is set, in this case ModbusTCP



- Node – where the IP address is defined



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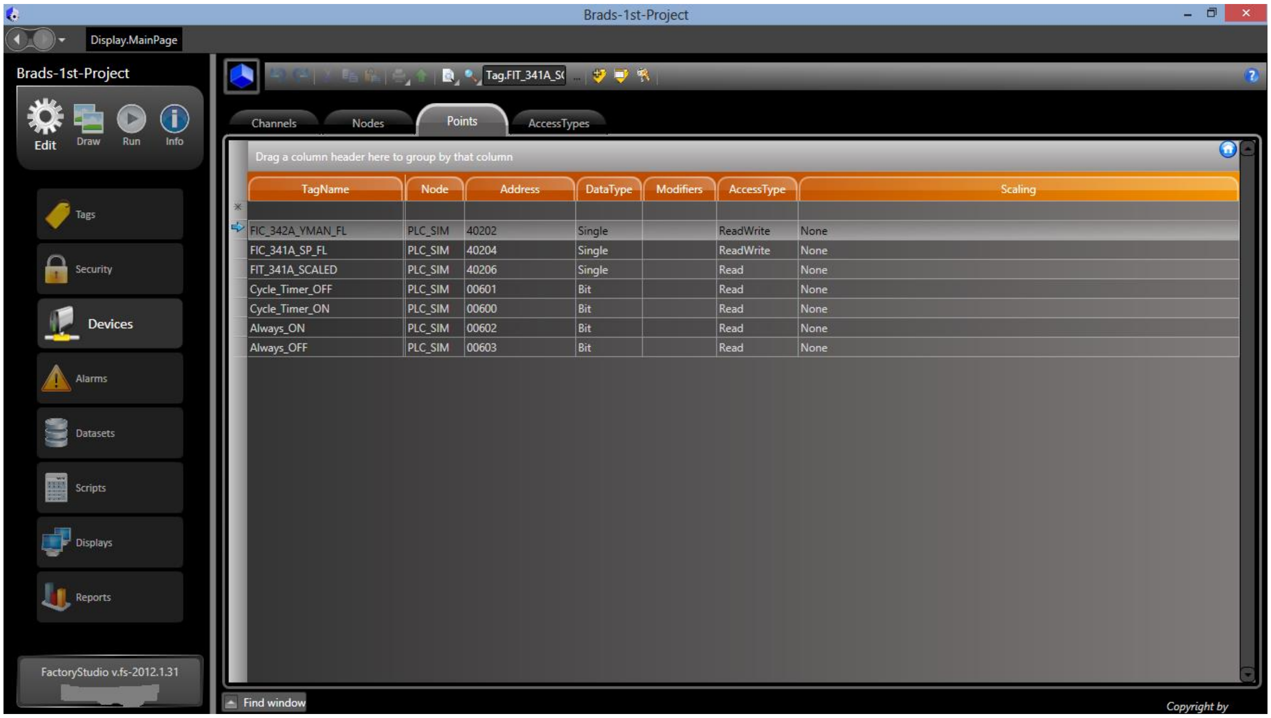
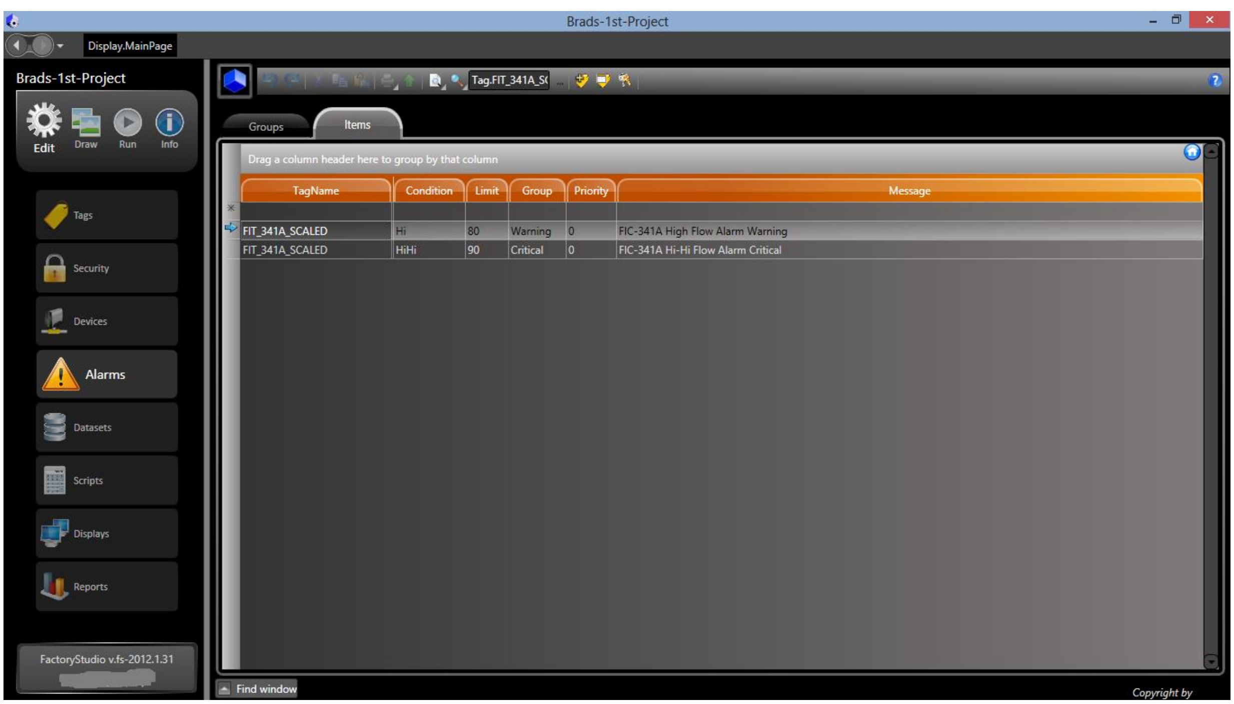
- Point – where each tag is matched with the PLC register address



Alarms

Each Alarm has two parameters to be defined:

- Groups – Warning, Critical, and System Event (these do not change)
- Item – where the alarm point and description are defined



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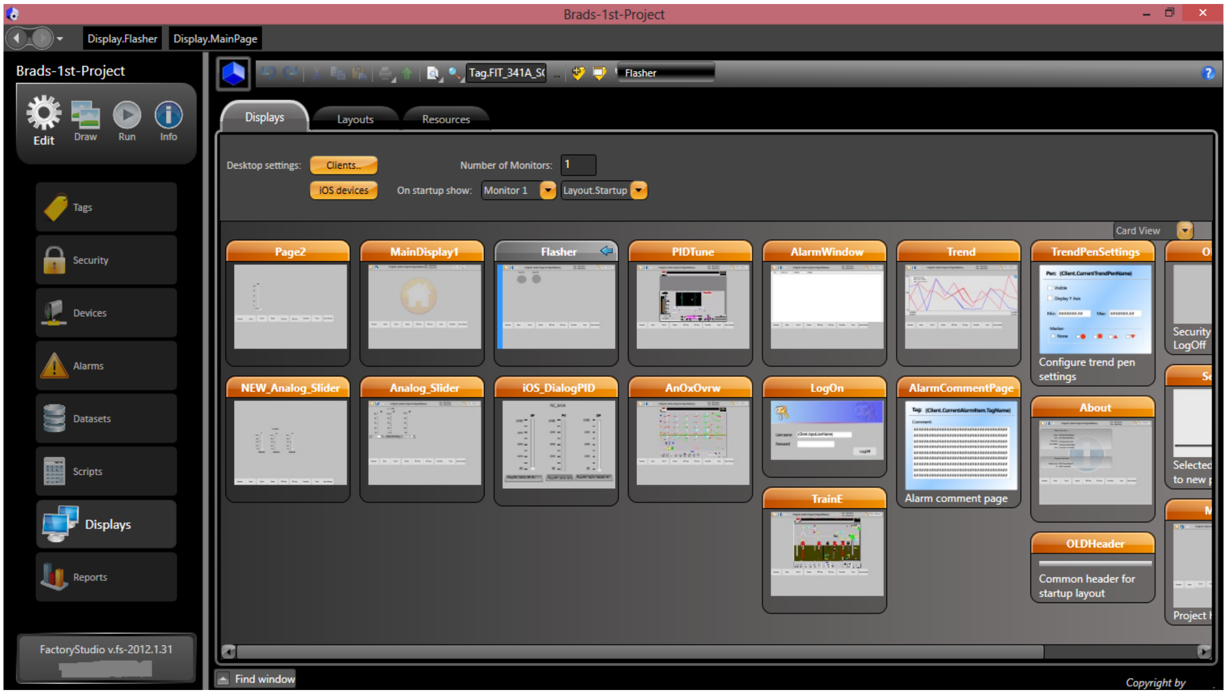
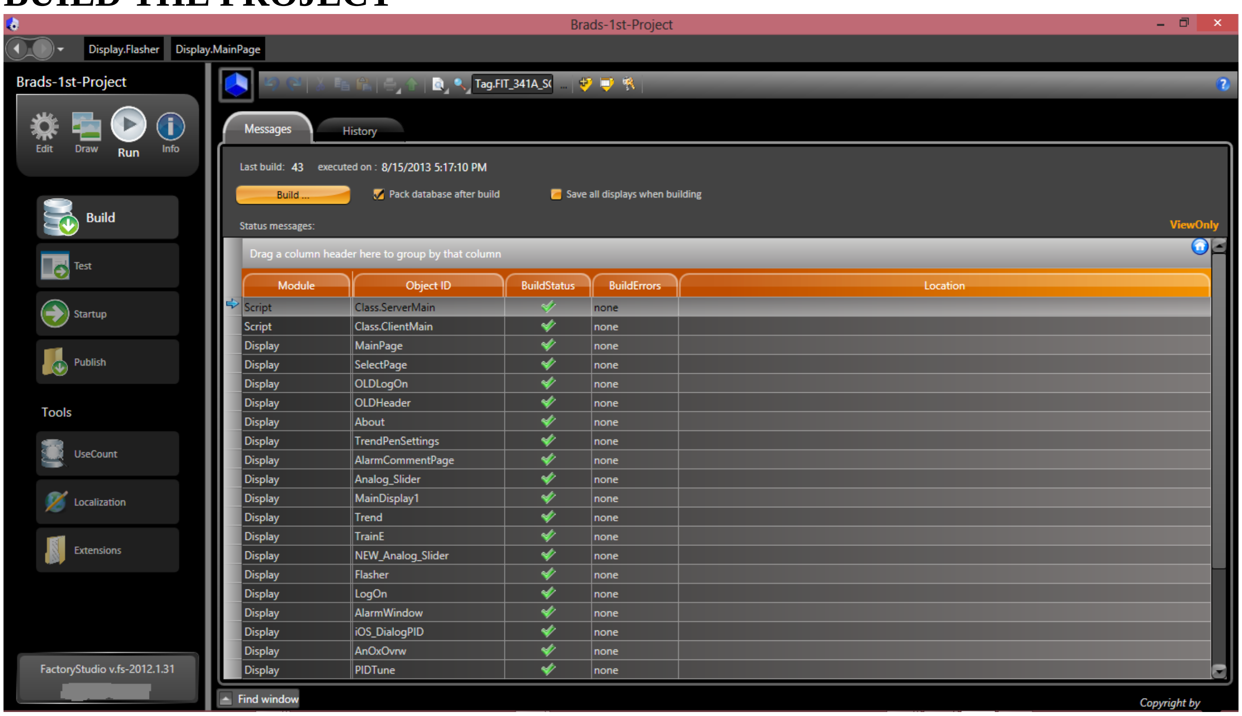
Displays

The displays are created and the edited in the “Draw” window



The design and layout of the displays that will be sent to the smartphone / tablet

BUILD THE PROJECT



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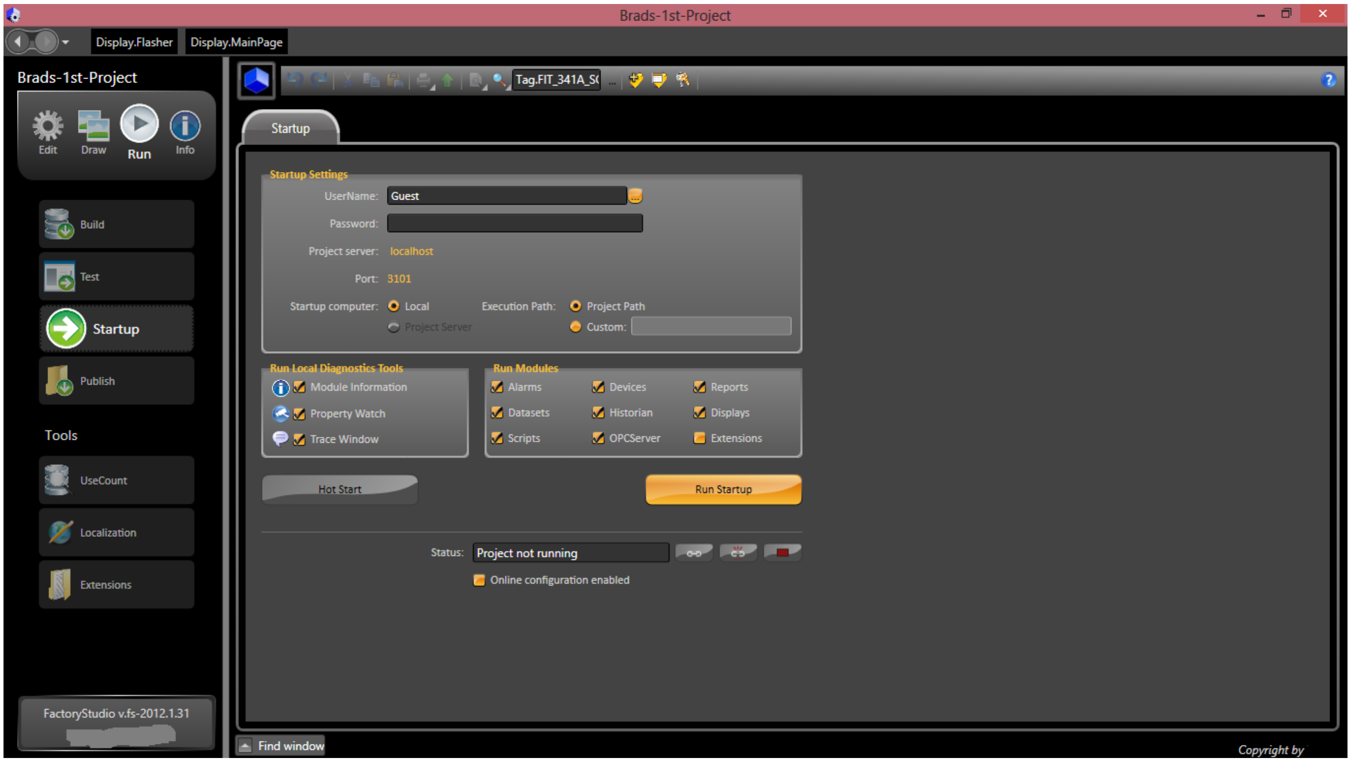
START THE SERVER



CASE STUDY 3 – Windows 8 Tablet PC

[15] Open system software packages based on Microsoft Windows and industry standardized networking protocols allow real-time data to be viewed on Windows 8 Tablet PCs. Listed below are some applications and functions within the software packages:

- Displays process data in near real-time
- Monitors events and alarm conditions
- Logs historical data for analysis

These software packages allow you to construct Graphical User Interfaces (GUIs) in a visual object-oriented development environment. Your displays can model your processes or systems such that controls look and feel just like real devices. These software packages mask the complexity of the underlying data in a way that it displays only the information that an operator needs, which uses configuring controls and presents them in a meaningful, instantly recognizable way. You can change flows with simulated dials, observe temperatures with simulated thermometers, check tank levels with a cut-a-way figure showing the water level in the tank-- practically anything you can think of!
With scripting, aliasing (variables), reusable Microsoft .NET Framework components, open standards, and being web-enabled, these software packages work seamlessly in a multi-vendor environment. Once you learn how to use these software packages, you can reuse components, apply complex shapes and controls with mouse click, and rapidly develop the displays you need.

CONCLUSIONS & FUTURE POSSIBILITIES

With the many instrument & control vendors offering these relatively low-cost, modular, ethernet I/O systems that can be configured quickly and communicate with each other AND other computers with off-the-shelf ethernet hubs, switches, and/or routers the internet can be used as a method of bringing field devices from your plant into a computer SCADA or control system and viewed from a browser across the ethernet, somewhat VERY remotely if telephony and/or radio frequency devices are used to extend the ethernet to remote field devices.

Hopefully this tutorial has provided a starting point for the industrial automation professional beginning a long study and career implementing ethernet I/O. In this author’s opinion, the future of instrumentation and automation will surely move toward greater use of ethernet for communication between devices, controllers, operator interfaces, and maintenance tools.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Advanced Industrial Wireless Guidebook; P/N: 1900040901050; 2009; http://www.moxa.com
[2] Tatsoft FactoryStudio: Engineering on the Cloud QuickStart Guide; Tatsoft llc.; Houston, TX
[3] "Wireless Data Communications for SCADA Systems"; Dan Ehrenreich, Motorola; presented at BCWWA Conference in Vancouver, November 28-29, 2005
[4] "Cellular Digital Packet Technology for SCADA and Telemetry Applications"; Bob Halford; Twin Cities Technologies; presented at the 2001 American Society of Gas Measurement Technology conference
[5] "Wireless for Automation"; Hunter Harrington; PROFINET Consulting Engineer, PIC / PTO
[6] "Implementing early warning of toxic chemical intrusion into a WWTP by using remote toxic chemical sensors communicating over cellular wireless telemetry into a central SCADA system with advanced alarming and voice notification"; Hiram Tanner & Muminu Badmus, District of Columbia Water & Sewer Authority and Bob Rutemiller, Automation Consulting & Education, Inc.
[7] "Utilizing cellular technology with SCADA applications"; By Michael Meirovitz; Control See www.controlsee.com ; http://www.automation.com/library/articles-white-papers/hmi-and-scada-software-technologies/utilizing-cellular-technology-with-scada-applications
[8] "Hybrid SCADA: Combining Traditional SCADA with Cellular Telemetry Or Managed Cellular to Web SCADA"; John K Collings; MISSION Communications
[9] "Building an App for Both Windows Phone and iOS"; Andrew Whitechapel; http://msdn.microsoft.com/en-us/magazine/jj658972.aspx
[10] ProSoft i-View Mobile Process Monitoring and Control User Manual; Application; Version 2.0.2
[11] GROOV SERVER USER'S GUIDE; Form 2078-130730—July 2013; Temecula • CA 92590-3614; http://www.opto22.com
[12] "Cellular Communications for SCADA Applications"; by: Ira Sharp, Phoenix Contact; Pumps & Systems Magazine; http://www.pump-zone.com/topics/instrumentationcontrols/cellular-communications-scada-applications
[13] RDP180-C CELLULAR RTU Installation and Operation Manual; Open Control Solutions, Inc. Melbourne, FL 32934
[14] "Mobile Communications Data transmission in industry"; © 2012 Phoenix Contact GmbH & Co. KG, 32823 Blomberg, Germany; ISBN 978-3-00-037387-9
[15] GENESIS64 Standard Training Manual; Version 10.61, Rev. B; Document Number: TM-GWX64-Advanced-1001; © 2012 ICONICS, Inc.