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Intelligent Remote Terminal Unit (iRTU) in the IoT Era

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Introduction

The power of the Internet of Things (IoT) is enabled by the implementation of intelligent electronic devices and sensors on communication networks with real-time data exchange and control functionality between the field and a control center. It allows utilities to have better visibility into the system conditions anywhere and at any time utilizing advanced automated applications that improve system reliability, efficiency, and customer service.

Intelligent electronic devices include - inter alia - all kinds of Remote Terminal Units (RTUs), which are generally defined as a microprocessor-controlled electronic devices that interface objects in the physical world to a distributed control or SCADA system by transmitting telemetry data. Many manufactures of automation instrumentation including Advantech offers RTUs of different size and capabilities to fit into any custom applications. The processing power of RTU devises ranges from small 8 bit processors with minimal memory to larger sophisticated RTUs capable of managing hundreds of I/O points.

RTU aspects and technical details in the era of IoT are discussed in the following. This includes positioning of RTUs in the manifold “landscape” of automation equipment as well as Advantech´s respective hard- and software offerings.

RTUs in the “landscape” of automation equipment

There is a continuous discussion in the automation market about the differences between DCS (Distributed Control Systems), PLC (Programmable Logic Controller), SCADA (Supervisory Control And Data Acquisition), RTU (Remote Terminal Unit) and PAC (Programmable Automation Controller). One basic distinction can be seen already from the expanded acronyms: SCADA includes Data Acquisition in addition to Control, while DCS and PLC contains only Control; and RTU includes Remote. Only PAC is another story.

The designation “Remote Terminal Unit” indicates clearly that the key function of an RTU is to transfer data over wide geographical areas to an automation (in most cases a SCADA system), while PLCs are more suitable for local area control in plants, production lines, etc., where the system utilizes wired communication for control.

Overlapping capabilities

RTUs, PLCs and DCS are increasingly beginning to overlap in features and applications, and vendors sell RTUs with PLC-like features and vice versa. However, RTUs – as a typical feature - are preferably designed to collect and communicate telemetry data over large geographical areas, because they typically use wireless communication technology; PLCs in contrast are commonly implemented in local control applications, like assembly lines in factory automation and plant monitoring. A RTU commonly has more local processing power to work with collected data before it sends information or alerts to a central system.

Furthermore, industry has widely standardized on the IEC 61131-3 for creating programs to run on RTUs and PLCs, although vendors also offer proprietary alternatives and associated development environment, see section about ADAM-3600 Intelligent RTU.

SCADA adopts IoT technology

First and foremost, SCADA is the preferred technology for monitoring processes and events that are spread out across a large geographic area. That's mostly due to the second key distinction: SCADA has distributed intelligence. This allows monitoring and control to continue when communication to the central hub has been lost. Conversely, a traditional DCS system would not be able to operate in a geo-diverse scenario like this one. It is too heavily focused on local events and has no ability to temporarily endure communication outages.

The functionality between SCADA and DCS begins to overlap and the two traditionally disparate technologies are now competing in similar application areas. But there remain distinct benefits in using SCADA as an umbrella layer on top of a DCS core. The strength of a DCS lies in a single database setup with low complexity. On the other hand, the SCADA technology has developed from a simple visualization tool to a point at which it can provide an increasingly object-oriented approach, storing hard input and output (I/O) tags from numerous devices in its databases. Simultaneously, it can maintain its inherent flexibility by storing soft logic operation tags and using these to generate HMI-based mimic diagrams and trend and diagnostic data along with troubleshooting, logistics and maintenance schedules. Advancements in high-power computing have also reduced the complexity of SCADA's multiple database setup and minimized the risk of data redundancy. This means that applications can now take more analytical advantage of the wealth of information available and interpret that data in more intuitive ways. Essentially, DCS systems are sometimes sold under the SCADA label and SCADA is sometimes branded as DCS.

DCS is more an "inside" solution best suited to continuous, PID control- intensive localized applications. In contrast, SCADA can be seen as an "outside" solution, better suited to geographically dispersed environments using commercial off-the-shelf hardware.

RTU Technology and Use

A remote terminal unit (RTU) is a microprocessor-based electronic device used for remote monitoring of field devices spread over a larger area by data collecting and transmitting to a central system. It is typically deployed in an industrial or municipal environment. A RTU is considered a self-contained computer as it has all the basic parts that define a computer: processor, memory and storage. RTUs are sophisticated and intelligent enough to control multiple processes without requiring user intervention or input from a more intelligent device. Because of this capability, the main purpose of the RTU is to interface with distributed control systems (DCS) and supervisory control and data acquisition (SCADA) systems by sending telemetry data from the field to these systems. Remote terminal units are also known as remote telecontrol units.

A RTU typically consists of the following components:

- Power supply and/or a battery for operation
- Analog inputs (AI) of many different types
- Digital or status input (DI)
- Digital or control output DO/CO,
- Analog output (AO) and
- A processor with software and logic control to execute simple programs autonomously without involving a host computer of the SCADA system.

Depending on the manufacturer, purpose and model, an RTU may be expandable or custom fitted with different circuit cards including communication interfaces, additional storage, backup power and various analog and digital I/O interfaces. Because of their widely varying applications, RTUs come in different hardware and software configurations. For example, RTUs used in telecommunication automation may not be usable at all for oil and gas applications as the processes and hardware systems used would be completely different.

In SCADA systems, a RTU is a device installed at a remote location that collects data from connected devices and systems on such variables as temperature, pressure or flow rates. It codes the data into a format that is transmittable and sends the data to a central station. An RTU also collects information from the master device and implements processes by, for instance adjusting of valves. RTUs are equipped with input channels for sensing or metering, output channels for control, indication or alarms and a communications port. A RTU includes also setup software that connects input and data output streams; the software can define protocols and even troubleshoot installation problems.

A modern RTU reports to the master station only data pertaining to significant changes in the monitored variables. Thus, the central computer is released from the time-consuming processing of redundant data and can faster respond and can perform additional tasks.

Reduced equipment maintenance costs are another advantage. Maintenance specialists in a central location can determine from RTU data what to do in order to fix the problem in the most efficient manner. So, upgrading a SCADA with modern RTUs will result in increased efficiency of plant or monitoring system operation.

Intelligent RTU (iRTU) applications in the era of IoT and Cloud

By leveraging the powerful embedded technology, RTU can be integrated more and more functionality and become a new intelligent iRTU to fulfill the application in IoT Era. It can not only replace the PLC to complete the local tasks faithfully, but also communicate with the center master through the available channels with the pre-designed behavior. Face the big data application, iRTU can also help on the data pre- treatment, not only reduce the loading of cloud but also reduce the communication bandwidth. Self-awareness is also a very important improvement as an intelligent remote terminal. As key element of IoT solution, iRTU is usually used to master all the conditions in the field site. However, the most important is the health status of iRTU itself, this factor related to the system stability directly.

With the evolution of the era of big data, IoT technology is being more and more used and its architecture includes cloud computing and intelligent terminals which are dispersed geographically over a wide regional area. Examples are traffic monitoring networks as well as industrial applications in the oil, gas and water industry. In all cases intelligent RTUs are distributed across the area (oil wells, water pumping stations, gas pipelines). Their main task is to ensure a constant delivery process (of water, oil or gas) and safe and cost efficient plant operation to perform, optimize and monitor these tasks, relevant (big) data must be collected and in some cases pre-processed by the terminals and RTUs respectively. The information is then sent to the cloud through wireless communication using Wi-Fi / 3G/Zigbee technologies. Major advantages are:

Plant efficiency: Rapid integration of information in the cloud allows to remotely monitor the production process, data reporting, online planning, equipment diagnosis and so on, effectively improving efficiency and reducing costs.

System reliability: Intelligent RTUs are responsible for collecting and analyzing local data, reducing the load of center handling data, working with the other devices, taking the initiative to report data, status and provide alarms. iRTU can also communicate with each other, quickly handle I/O correlation and collaborate on emergencies to reduce the loss. All is contributing to an overall increased system reliability and availability.

Rapid and cost efficient maintenance: In the remote and wide ranging oil, gas and water applications site maintenance and updating procedures are extremely costly. Intelligent RTU can perform remote monitoring, operation, maintenance and updates via the Internet. iRTUs can perform update, complete delivery tasks at the site, and upload data to the cloud. The cloud server is used to accumulate the huge amount of data and conduct high-speed parallel computing to generate important operation and – if required - preventive strategies and solutions. This may include improvement of production efficiency, monitoring machine operation and distribution state or localizing pipeline leaks. In the past, workers were needed to supervise plant operation. The use of intelligent terminal units can help to install unmanned supervision and control concepts and greatly reduce costs. Major application fields suited for use of IoT technology are:

- Oil wells, offshore platforms, pipeline systems
- Water supply and waste water discharge systems
- Air quality and emission monitoring and control
- Electrical power transmission networks
- Natural gas field and supply networks
- IT system infrastructure (Switches, routers, servers)

IoT/iRTU-Use Case 1: High performance Water supply management

A stable and safe clean water supply depends on the accurate monitoring of water conservation facilities, the use of advanced wireless communication and highly efficient and intelligent terminal equipment to monitor the remote facilities, making local judgments and decisions, using cloud technology to record huge amounts of data to gather data reports, for the sake of applications using standard network technology, comprehensive monitoring and management of water conservation facilities, water pumping stations, water pipelines, water towers and so on, to ensure the normal and efficient operation, and achieve the following objectives.

- Establish a unified management of water production and water use data, to understand the supply and demand situation
- Ensure stable water supply, use the pipe network system to ensure the stability of the existing pipe network pressure
- Use simulation pipe network monitoring systems to understand the changing demand and improve the management of supply.
- Use the SCADA monitoring system to detect the pipeline leakage and loss and reduce the waste of water.
- Use the cost advantage of unmanned stations to effectively improve the efficiency of the water supply, and reduce amount of manpower needed for regular supervision.

Intelligent terminals can monitor the operational efficiency of pumping stations and the machine's status, establishing a clear water network, and further improve the management efficiency of the water supply and improving people's well-being.

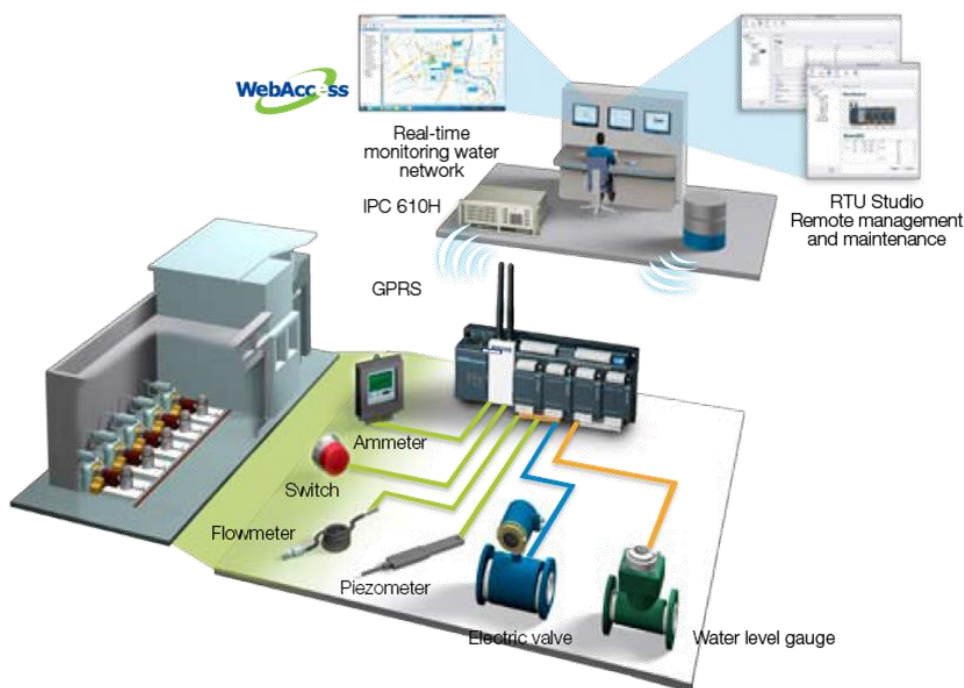


Fig 1: ADAM-3600 in Water Supply application

IoT/iRTU-Use Case 2: Digital Oilfields

With the evolution of the era of big data, Internet of Things (IoT) technology is being widely used and its architecture contains cloud computing and intelligent terminals.

With oil and gas operations reflected in the production architecture, intelligent terminals are distributed across the oil wells and pipelines. To handle delivery tasks in the field, the terminals can collect the relevant data, and send the information back to the cloud server through wired or wireless transmission. The cloud can be used to accumulate the huge amount of data and conduct high-speed parallel computing, to generate important prevention strategies and solutions.

To date, the process of the oil and gas industry, such as the collection, transportation, refining, storage, distribution and end use has already generally been automated; nevertheless, the IoT-architecture will help the oil and gas industries to enter the next intelligent phase, such as:

Comprehensively monitor the operation of machines and tools, reduce the operation time of inefficient machines and tools, and improve production efficiency.

Because transmission and distribution pipelines are located far from civilization, their maintenance is more difficult. Therefore, when pipelines leak, the intelligent terminal can monitor the status of the pipes, instantly provide feedback to the monitoring center, and collect all the pipeline information.

In the past, workers were needed to regularly supervise larger oilfield zones. The use of intelligent terminal unit can effectively identify status of equipment, and greatly reduce costs of man power. Intelligent terminal unit can collect real-time information of production, to provide the basis for the deployment of resources-

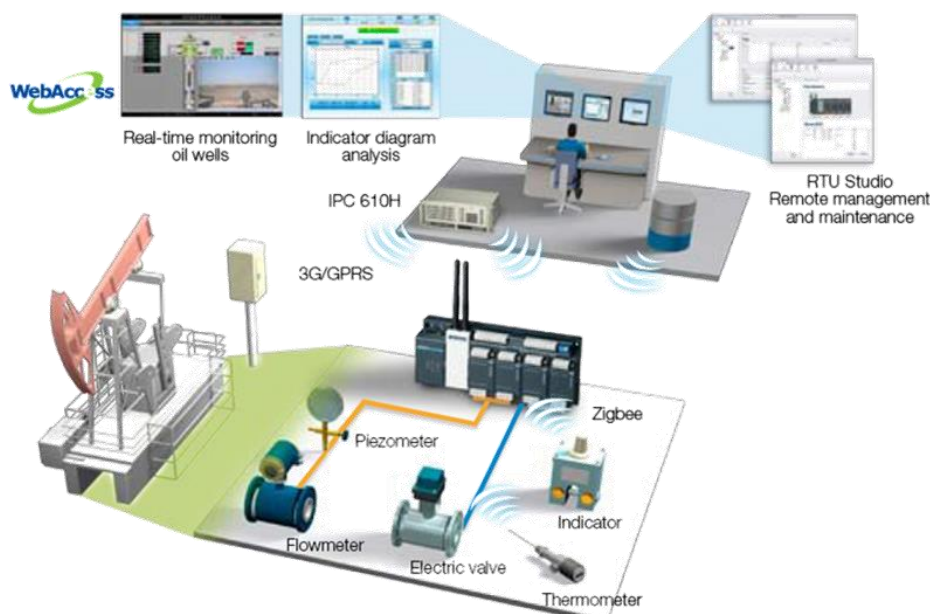


Fig 2: ADAM-3600 in Digital Oilfield application

Advantech's iRTU offerings

Intelligent RTU : ADAM-3600-C2G



Fig 3: ADAM-3600 iRTU

Advantech's ADAM-3600 iRTU is an intelligent device, mainly used in the oil, gas and water industries. Intelligent network nodes in the IoT can control the downstream field devices to complete delivery tasks, transfer data to upstream devices wired or wirelessly. It is the key to connecting devices to the Internet of Things architecture. The ADAM-3600 has a high performance but low power processor, adopts 20 local I/O points and provides wired and wireless communication. Users can collect, process and distribute the local information. ADAM-3600 has a built-in real-time operating system and a real-time database, providing customers with an open interface and supports diverse programming languages. It can be used for outdoor control cabinets and therefore must be able to withstand the heat of summer and the cold of winter.

The ADAM-3600 supports an operating temperature range of -40°C to $+70^{\circ}\text{C}$. The selected components are industrial grade, and have been tested with the strictest environmental control, to ensure that the products have a long life and, stable working in harsh environments. The ADAM-3600 contains a variety of I/O ports and different models provide different local I/O functions. It can provide four expansion slots for multipoint I/O applications and lets users have more rapid and flexible I/O solutions.

Important features include:

- Wide array of on-board I/O and flexible expansion I/O modules supporting different acquisition requirements and providing cost efficiency
- Powerful communication:
 - Wireless: Wi-Fi/ 3G/ GPRS/ Zigbe
 - Wired: Ethernet / RS 232 / RS 485
- Support for Modbus RTU/TCP and DNP3 protocol
- -40° to $+70^{\circ}\text{C}$ operating temperature for use in harsh environments
- USB drive and SD card allow to update the firmware without computer and configuration program

- Intelligent Connectivity Diagnosis Manager (iCD Manager) to remotely monitor the serial and Ethernet ports status and send alarm information to prevent the loss of important data



Fig. 4: WebAccess HMI/SCADA software

WebAccess SCADA Software

WebAccess is an HMI/SCADA monitoring software based on the Internet Explorer browser. The biggest and most useful feature of WebAccess is that all engineering projects, the database settings, drawings and software management are remotely completed by using a standard browser via the Internet or Intranet. WebAccess combines distributed architecture of the monitoring nodes, the redundancy system (SCADA Redundancy), the central database server and multi-layer network security structure, to provide the more complete architecture for all kinds of automation applications. It is used to automate complex industrial processes for situations where remote operations are needed. All the features found in conventional HMI and SCADA software packages are available in an ordinary browser including Animated Graphics Displays, Real-time Data Control, Trends, Alarms and Logs.

Conclusion

Internet connectivity is expanding rapidly and enables not only people to stay connected but also things and machines. Each object connects and communicates with other objects that recognize and respond without human intervention. Machines are increasingly able to make decisions based on built-in rules running locally or remotely. This allows data acquisition, decentralized data analysis, and decision making and actuation and requires both cloud based applications and intelligent terminal nodes which may be realized by iRTUs as part of SCADA systems, most of them in harsh environments.

According to market reports, around 5 billion or more people worldwide use a mobile phone in 2015. Mobile phones act as intelligent nodes in the booming internet Biz between human beings. In parallel, iRTUs will act as intelligent nodes in SCADA networks to enable machines to communicate with each other globally. Considering the growth rate of smart phones leads to promising projections for growing future business opportunities also in the era of machine to machine communication and, consequently, use of iRTUs. Advantech is very well positioned to follow this expected market opportunities.