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THE LATEST IN COMMUNICATION AND MICROPROCESSOR TECHNOLOGIES HELP THE WATER INDUSTRY KEEP TRACK OF ITS WIDELY DISPERSED RESOURCES

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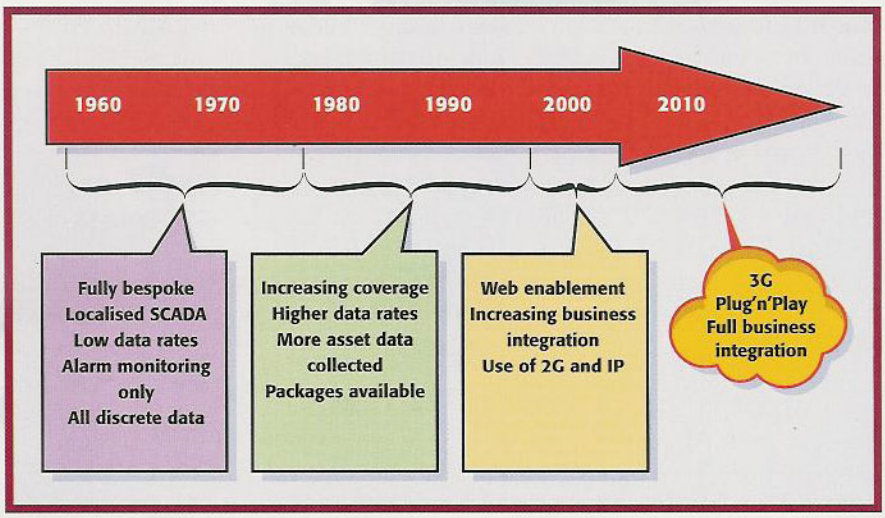
Remote Telemetry Units (RTUs) have been in use in one form or another for over 30 years. They were initially designed to monitor critical signals and raise alarms over very low bandwidth (typically 300 baud) links to a central location. The signals for monitoring were hardwired to the RTU inputs and the entire unit was highly proprietary in its design.

As communications bandwidth increased the demands on RTUs increased. Used more widely in production and distribution networks, RTUs started to provide operational information on the plant that they were monitoring. At the same time, standard packages became available to process this data and along with it some standardisation of features.

The arrival of the Internet had a significant impact on all aspects of business and this included telemetry. At the same time the increasing popularity of GSM (second generation mobile communications or 2G) coupled with the

Telemetry's time line



By Steve Mustard and
Simon Harrison

Future uirements for remote telemetry units

Internet Protocol (IP) made deployment of telemetry data on the World Wide Web a practical option.

Third generation communications (3G) will become widespread in a few years. Given the investment made by the operators it will be made to succeed. The emergence of standard Internet integration technologies such as web services will allow future telemetry services to be delivered in the same way as other business services are today, through the use of web portals accessed via standard off-the-shelf tools and standards. Electronic security will become a more significant issue for telemetry systems with the greater use of Internet technologies.

The traditional telemetry networks were formed out of necessity. Few standards existed and a proliferation of proprietary equipment appeared over the years. The explosion of the Internet, mobile communications and IP has seen a wide range of off-the-shelf equipment appear and vendors such as Cisco become almost household names overnight. The broad consumer acceptance of mobile handsets and networking equipment has forced vendors to standardise and provide easy to understand configuration capabilities.

METCALF'S LAW

Robert Metcalf, one of the founders of network equipment provider 3Com, is credited as being the inventor of Ethernet. His law, although not perhaps as well known as that of Gordon Moore, is very important for the world of telemetry. Metcalf's law states that the value/power of a network increases in proportion to the square of the number of nodes on the network.

For telemetry systems, nodes on a network could be interpreted as RTUs as these provide information equivalent to those nodes in the Internet. Taking the Internet analogy further, the more RTUs deployed on a telemetry network, the more likely the information is to be accessed by users. As a result the more RTUs deployed on a network, the greater the value of that network to the business.

There appear to be two main reasons why telemetry networks do not grow so as to exploit Metcalf's law:

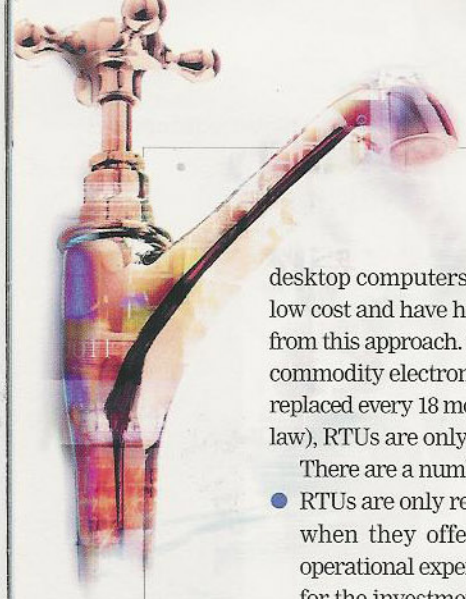
- RTU technology does not always exploit the latest or best technology. As a result, it may not be possible (or cost effective) to deploy existing RTU technology in all locations where it could potentially add value (poor communications channels and lack of power are two typical constraints).
- The installation and configuration of RTUs appears to be more complex than standard IT equipment. RTU installations are often remote and can be physically challenging (e.g. down a sewer). Proprietary configuration tools are often written for specialist staff and therefore not useful to all.

MOORE'S LAW

Gordon Moore, co-founder of Intel, was still director of research at Fairchild in 1965 when he wrote his now famous paper 'Cramming more components onto integrated circuits'. In this paper he claimed that the complexity of an integrated circuit (measured by number of components) doubled every two years. He estimated that this law would remain constant for at least 10 years.

Such rapid developments mean that equipment capabilities continue to increase. Functionality previously not practical becomes achievable given a relatively short time. The cost of technology products reduces over time provided the product in question gains a respectable market. This trend has been observed for products such as video recorders, CD players and mobile handsets and particularly with PC products.

Commodity electronics such as mobile handsets and →



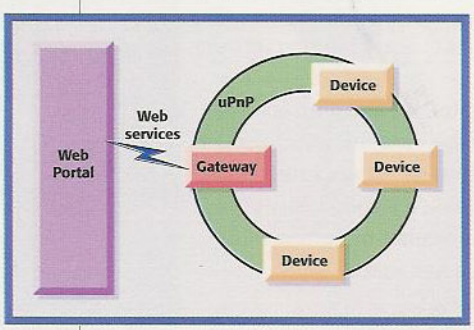
desktop computers are driven by consumer demand to be low cost and have high interoperability. RTUs could benefit from this approach. Comparing the RTU market with typical commodity electronics we can see that whereas the latter is replaced every 18 months to three years (in line with Moore's law), RTUs are only replaced every 10 or even 20 years.

There are a number of reasons why this may be the case:

- RTUs are only replaced when they are unsupportable or when they offer additional benefits in the form of operational expenditure reduction, any savings must pay for the investment within a short timescale such as two years or less.
- The cost of replacing RTUs in typical wide area telemetry systems is high due to the need to visit a large number of geographically dispersed sites.
- RTUs are more complex to install and commission whereas commodity electronics is designed for the average consumer and intended to be simple to use and deploy.
- The RTU market, while containing a reasonable number of options appears not to provide standard solutions to all requirements nor are the range of options interoperable.

PLUG 'N' PLAY

One of the many developments in the consumer electronics market is focused around the delivery of services from simple burglar alarm monitoring to real time video on demand via a single set-top box or gateway. In order to make this a reality there are a number of standards appearing to allow true interoperability and control of the various devices required to provide the range of services envisaged. Universal Plug 'n' Play (uPnP) is intended to ensure that any device connected to a suitable network will be detected and enabled automatically. Web services, already used in industry to simplify the integration of business data and applications, are likely to be used as a means of fronting the services to the users in a standard manner.



Universal plug 'n' play

Without standards such as web services and uPnP it is unlikely that such a variety of home services would be feasible using common elements. Consumer demand for such services is likely to help promote the use of such standards and there may be scope for considering following this lead in the development of RTUs. The aim would be to use these standards, especially uPnP, to simplify equipment configuration, automating more and making the rest more intuitive so that it is achievable by a larger population.

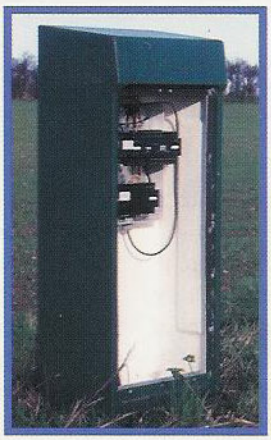
In summary uPnP allows us to:

- Reduce time to deploy equipment to save installation costs.
- Expand choice and increase competition by providing some guarantees around compatibility.

POWER

Another constraint of telemetry RTUs that may reduce the opportunity to exploit Metcalf's law is the lack of mains power at some sites. Where telemetry is required at such sites the options are usually limited to installing a new electricity supply at considerable cost, or using a battery-operated device that may not have all the capabilities required.

There are increasing demands on telemetry such as compliance with new regulations (e.g. DG5 relates to controlling sewer overflows) and a desire for more portable equipment for temporary installations. A key requirement of future RTUs is the ability to operate without mains power for long periods of time while providing full RTU functionality.



A remote RTU station: it shouldn't depend on mains power

One of the reasons why existing RTU platforms are not suited for such applications is that they are often PC- based. The PC is still not designed for low power applications. Intel's Centrino technology may yield something suitable in a few years but for now other options are required.

THE MICROCONTROLLER

The microcontroller is an ideal alternative to the PC microprocessor for use in applications where power is at a premium. The microcontroller is one of the most widely used processing units in the world. They are used in all sectors including automotive, communications and consumer as well as in the office. In 2002 the market in terms of units sold was over 1·5 billion worldwide.

The application of microcontroller technology continues to grow rapidly.

As a result of their incredibly widespread usage in power restricted applications such as mobile handsets microcontrollers have a number of advantages for RTU applications:

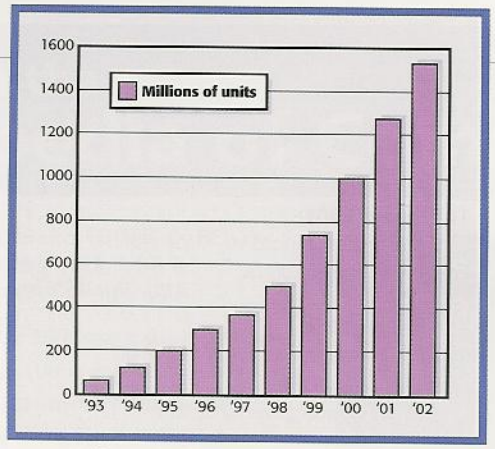
- Very low power
- Powerful yet small
- Very low cost.

Microcontroller based devices are capable of running full RTU applications whilst operating off battery and can be manufactured at very low cost.

Installation is another potential limiting factor to the widespread deployment of RTUs.

RTU installations often have limited space. Installations (especially replacements) are time consuming and quick replacement by semi-skilled staff is rarely an option.

RTU vendors should follow the lead of consumer electronics vendors and make their equipment easy for the



Millions of microcontrollers are available

average person to configure. Reducing the number of different devices to be supported will help with familiarity and training as well as with reduced spares requirements. As devices standardise and usage increases then economies of scale take over and prices reduce further (for example, consider the cost of mobile handsets when they first appeared on the market compared with six months later).

SHOULD RTUS AND PLCS BE COMBINED?

There has been no mention as yet of Programmable Logic Controllers (PLCs), the sister product to the RTU. These devices have been around as long but are intended to perform the function of plant or process control. As a result PLCs do not normally provide RTU functionality. However, RTUs have increased their capabilities where there is now some debate about whether the RTU could provide both RTU and PLC functions in a single unit. There is no definitive answer to this question and it remains a matter of choice for the user.

Some of the pros and cons for both approaches are shown below.

	Pros	Cons
Separate RTU and PLC	Additional redundancy	Extra power, space, spares, maintenance
Combined RTU/PLC	Less maintenance, fewer parts	Single point of failure

The conclusion is that there is no single solution. Each requirement will be best served by one of a number of options. One of the reasons for combining RTU and PLC units is to save money on hardware. This is probably because of the relatively large cost of RTU hardware on top of the cost of the PLC.

An alternative to the two options above could be to have a slightly simplified RTU to meet the requirement in this case. Here the RTU would probably not have any I/O of its own since the PLC has this already. However, the RTU would provide all the RTU functionality that the PLC does not supply, such as alarms, events, trending and integration with the telemetry system (often via a proprietary protocol). The PLC could then be used to focus on its standard tasks relating to process automation. One of the advantages of this approach is that it could greatly simplify such installations and be implemented at minimal cost using simple off-the-shelf PC technology.

THE IEC 6-1131 STANDARD

The International Electrotechnical Commission (IEC) standard 61131 defines the requirements for "programmable controllers". Traditionally this covered PLCs but due to the developments mentioned earlier it can now be assumed to cover RTUs.

There are eight parts identified for IEC 6-1131. Parts 2, 3, 4 and 5 are of particular relevance to RTUs.

Part 2 defines the requirements for programmable controller hardware, including environmental, EMC (Electro Magnetic Compatibility – how electronic equipment functions around other electronic equipment) and electrical safety.

Part 3 defines a common specification for programming of programmable controllers, it is the most well known part of lEC61131 and is adopted worldwide. It defines five programming languages that can be used in programmable devices.

Part 4 provides some guidance on how to deploy (install, use etc.) programmable controllers.

Part 5 provides a specification for communications between programmable controllers.

If RTUs were to comply with IEC61131, and especially with parts 2, 3, 4 and 5, it would be possible to achieve a high level of interoperability. As a result of this compliance, device configuration and installation would be standardised and staff training and familiarisation would be greatly simplified.

WHAT WE NEED TO DO

Greater standardisation would allow the sharing of ideas and practices between organisations and industry sectors in a similar way as the Internet has allowed individuals and organisations to share information.

While RTUs have developed over the past 30 or so years they still generally fail to achieve the level of technological development seen in other electronic devices. Users need to increase the usage of RTUs in their networks if they are to realise the benefits of Metcalf's law that states that the power of a network increases by the square of the number of nodes in that network.

In order to exploit improvements in technology and increase the power of telemetry networks using more RTUs, the RTUs must:

- be based on widely used and commonly available components
- conform to industry standards such as IEC61131
- exploit best aspects of available products such as PCs or microcontrollers
- be easy to deploy, with effective tools and requiring minimal skills and experience.

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