Embedded web technology

adding a new dimension to protection and control

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Since the first relays featuring integrated protection and control functionality appeared some years ago, more and more relays with dual functionality have come onto the market. Soon, however, even these units will find it hard to compete in certain areas of application. A new class of relay is on the way.

The first web-enabled relays are making their way into the marketplace, and the benefits they offer are enormous. Besides letting users remotely monitor substations, the relays themselves can be controlled and parameterized from a remote location. And the possibilities are not restricted to Internet functionality; GPS, CAN bus, LON and Ethernet technologies will also play a role in future substation development. A good example of this new kind of protection and control device is ABB's multifunctional relay, REF542*plus*.

Control and protection equipment for utility and industrial substations, often referred to as 'secondary technology', has gone through a revolution of late. Microprocessors have made it possible to unify their separate functions in one single unit and then configure the combined functionality, via software, on a PC.

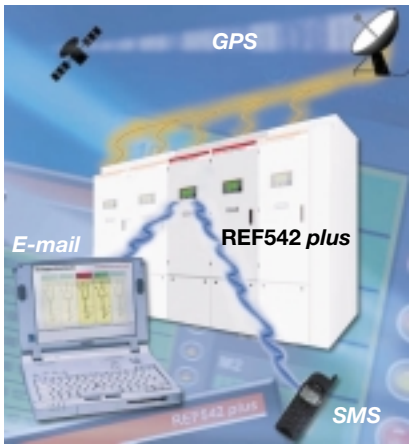
This is what ABB has done in its 'REF542*plus*' – a new-generation relay for medium- and high-voltage installations. Its technology platform not only allows control functions and their logic to be configured with user-friendly FUnction PLAn (FUPLA) software, but also the numerous protection functions and their parameters to be selected and parameterized using the same method. Protection and control functions are treated separately to reflect the separation of these tasks in a utility.

Now, Internet technology is entering the field of protection and control. Anticipating this trend, ABB has web-enabled the REF542*plus* to prepare it for the new era. Although talk here is mainly of the Internet, there are a whole host of other technologies that have to be seen as options for substation owners (*see box*).

Embedded web-server

Of all the changes that are taking place, the most revolutionary is the use of embedded web technology to turn units into Internet appliances. These can then be connected to a computer network to access and store data, and can be managed and controlled remotely.

Why, the question could be asked, would a company want to turn an already successful product into an Internet appliance? The obvious answer is to share the data it collects with other computers in the user's company, but a better reason is to make the front panel accessible everywhere, allowing the operator to monitor and control the instrument from, for example, another building. An embedded web-server makes this possible. All the user needs is



The REF542*plus* protection and control device can be used with many new and emerging technologies.

a computer with a standard web browser enabling communication with the instrument – in other words, the PC becomes the device's front panel.

Some utility managers will, of course, raise the objection that 'Anyone with web access can shut down my substation.' These worries are unfounded. It is important to remember that the solution is web technology, *not* the World Wide Web.

Web technology is all about using mature, well-known Internet technologies and standards, such as HTML, Extensible Markup Language, XML, and HTTP for industrial electronics and protection and control equipment. In other words, the web client software used in browsers can communicate with any server using the HTTP (web) server protocol and displaying HTML pages. The XML protocol – the very latest in file formatting – allows dynamic rather than static file display.

The embedded web-server delivers HTML-formatted graphic pages to web browsers and communicates with other servers on the network. There are two possible ways to integrate software in an embedded electronic device in order to obtain this kind of web-server:

- Integrate minimal web functionality on the embedded electronics and set up a link to a separate PC which contains the actual web server. This solution makes sense when a local PC is anyway available.
- Integrate all the web functionality in the embedded system for a genuinely embedded web-server. Although this requires extra memory space and calculating power, more and more of today's protection and control devices are able to handle this.

Using a PC and standard browser, parameters can then be read and changed, or commands sent, in a way with which the user will already be familiar. The web server forms the interface to the real data in the embedded system. There is absolutely no need for the PC to be installed locally!

Many advantages can, of course, already be gained with an integrated web-server for local access, without any remote connection. For instance, a technician carrying no more than a standard notebook with a standard browser can walk through a plant and link up to protection and control devices via any interface (eg, RS232, Bluetooth, etc) in order to read values, send commands and change parameters. And he can be sure of maximum security,

Apart from the Internet, technologies likely to influence future substation development are:

GPS (Global Positioning System)
Originally introduced by the US military, a high-precision version of this system has been available for civilian applications since May of last year. It will be used in substations mainly for highly accurate time stamping and synchronization.

Mobile communication
Although conceived for personal use, more and more embedded applications offer this feature, allowing communication with installations in locations without easy access to standard telephone lines.

CAN bus (Controller Area Network)
This was invented for the automotive sector, but is used today in many industrial fields.

LON (Local Operating Network)
Developed for home automation, the LON has already found its way into a broad array of industries.

Ethernet
Originally intended for networking computers, the Ethernet has extended its reach to points much closer to the process.

Web user interface. The REF542*plus* relay is fitted with an embedded web-server that allows it to be accessed, via a browser, on a notebook.

since the different levels can only be accessed with passwords or hardware keys.

Although this method applies only to local access, it still has numerous advantages:

- There is usually no need for a dedicated local command interface – at the very least, it is reduced to an absolute minimum – as the notebook browser takes over this functionality.
- Only standard software and hardware (the browser and notebook) are needed. These are usually already provided for other purposes.
- There are no weak points which could be vulnerable to external interference as a local, physical connection to the device is used.

Security strategy

The more often remote access is used, the more important security becomes. While the means for achieving the required level of security are available already today, they still have to be applied rigorously. A network specification is therefore incomplete without details of the security and privacy measures to be taken.

The importance of security cannot be emphasized enough. First and foremost, a *strategy* has to be drawn up which covers every conceivable aspect. It should include the kind of tools that may be used (hardware, software, protocols) and the people allowed to access the installation, giving details of when and how. Whether a connection to the World Wide Web is likely or not, all possible points of attack must be identified. Several security options are available to users, and some of these are looked at in the following.

Closed network

Connecting protection and control units via a closed network based on Ethernet has several special advantages for security.

This is nothing new, of course, and many of today's installations are equipped with a control system based at least to some extent on Ethernet, yet there are hardly any at all which use Ethernet at all levels! Ethernet tends to be preferred for office automation, although components are available today with both the real-time capability and the environmental compatibility demanded for industrial applications.

Against this background, Ethernet-based closed networks are certain to find much wider use in substation automation. Many advantages are to be gained by integrating embedded web-servers in field devices and running standard browsers on PCs, especially since the PC can be installed anywhere to allow remote monitoring, remote diagnosis and even remote control and parameterization. And since the network is closed, all points of possible attack are confined locally. (It is, however, still advisable to have additional mechanisms (authentication, passwords, plausibility checks) in place as protection against any 'internal' attacks.)

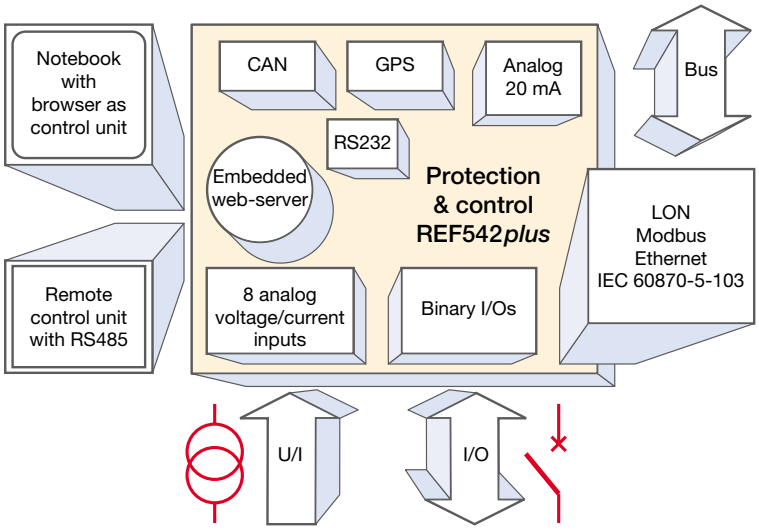
Callback

If an operator or service engineer has to be able to connect to an installation via his browser from anywhere in the world, then the network will obviously have to be open to the world. A link to the telecom network with authorization for callback connections only, offers the best security here. The operator can then access the plant from either his home or office using his PC and modem, or from anywhere else using his notebook. 'Callback' guarantees that only certain telephone connections have substation access. The phone number has to be kept secret to prevent so-called 'denial of service' attacks, in which someone with bad intentions tries to block access by repeatedly dialing the number.

Read-only access

If the substation network is connected to the Internet by means of a gateway, an operator can access the installation from any Internet-enabled PC, regardless of where it is located.

One possible security strategy here is to provide only read-only access to external connections. This gives the person connected to the installation a clear picture of the state of the plant, allowing conclusions to be drawn and action to be taken if necessary. Although there is a risk of 'denial of service' attacks with such a strategy, the damage



Block diagram of the REF542*plus*

these could cause is limited since the means of access remains intact.

Cryptology, firewalls

If every Internet-enabled PC is to have full substation access – allowing remote control and remote parameterization via the World Wide Web – efforts will have to be made at every level to prevent attack by people with malicious intent. For example, all data transfers will have to be encrypted. (Data encryption is already widely used on the Internet, although in applications like online banking that do not make the same real-time demands on the system that industrial plants and substations do.) It is anyway advisable only to send commands over the Internet which, if tampered with, would cause little or no damage. In addition, there will be security mechanisms in place which have been developed specifically for automation technology.

Internal networks (Intranets) are often protected by so-called firewalls – hardware and/or software units which filter all external traffic according to configurable rules. To some extent, these filtering mechanisms can be integrated in the software of embedded web-servers.

'REF542*plus*'

The REF542*plus* is representative of the new generation of combined protection and control relays. ABB engineers have designed it to accommodate many of the technologies mentioned above:

- A real web-server is integrated within the device.
- Different options exist for local control: with browser or local control unit.
- Synchronization via GPS is possible.
- Interfaces for CAN or LON are available, as is an Ethernet interface.
- Alarm functions via SMS or e-mail are possible.
- Communication via embedded GSM can be enabled for locations where there are no standard telecom lines.

Although designed with emerging technologies in mind, the REF542*plus* can, of course, also be used in a conventional environment. Its eight analog voltage and current inputs can be used to connect conventional voltage and current transformers as well as the latest sensors, resistive voltage dividers and Rogowski coils. All kinds of transducers can be combined.

Obviously, the demands vary with the application. The relay's modular structure takes care of this problem. For example, the type and number of binary I/Os can be extended as required. And a large number of protocols and interfaces are available for linking the relay to the higher-level control system.

Borrowing to go forward

Technologies originally developed for other applications continue to find their way into the protection and control field. The benefits this is bringing are evident already in ABB's new combined protection and control device, REF542*plus*. This web-enabled relay is a prime example of a product which, through the integration of cutting-edge technologies from other sectors, has raised the bar for remote monitoring of substations.

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