GPS TIME SYNC

LESSONS LEARNED WHEN THE LIGHTS WENT OUT

The Northern Hemisphere was shocked in 2003 when multiple blackouts occurred; firstly in North Eastern USA and the adjacent Canadian Provinces, then in London, then in Birmingham, followed by Italy, France, Scandinavia and even Malaysia. Despite assurances by the CEO of National Grid in the UK that blackouts like the one in the USA could not happen here, London suffered one of its worst ever outages. Are these events simply a string of "coincidences"?

TWO COMMON THEMES HAVE EMERGED FOLLOWING THE BLACKOUT EVENTS OF 2003.

Firstly, power system grids all over the world are being operated with less reserve capacity than ever before as utility owners strive to gain the best possible economic returns from their existing assets. The second common theme is that the management and supervisory systems set up to operate and control the power systems are struggling to cope with the increasingly complexity of the grid interconnections demanded by the consequences of deregulation of the various energy markets around the world.

The NERC/US-Canada Power System Outage Task Force report on the North American blackout on August 14, 2003 notes that, in many cases, data collected from sub-station equipment was not time-stamped at all, and in other cases, the time stamps recorded were not synchronized across the network.

TIME SYNCHRONIZATION

One of the primary recommendations of the report is that power utilities should take steps to ensure that power plants and substations control and supervisory data recorders are synchronized by signals from the Global Positioning System (GPS).

Time synchronization simplifies the task of fault analysis in the aftermath of a fault situation even between networks. Fault records in the form of oscillographic waveforms and histogram records showing the sequence of protection device operation, provide essential information that can lead to an understanding of just how protection devices operated.

The fault record has become a tool that allows the protection engineer to perform a cross check of the operation of the device against the appropriateness of the settings that were applied.

Time synchronization also increases the accuracy of control decisions by automatic control and protection equipment in the power network, therefore allowing optimal utilization of network assets.

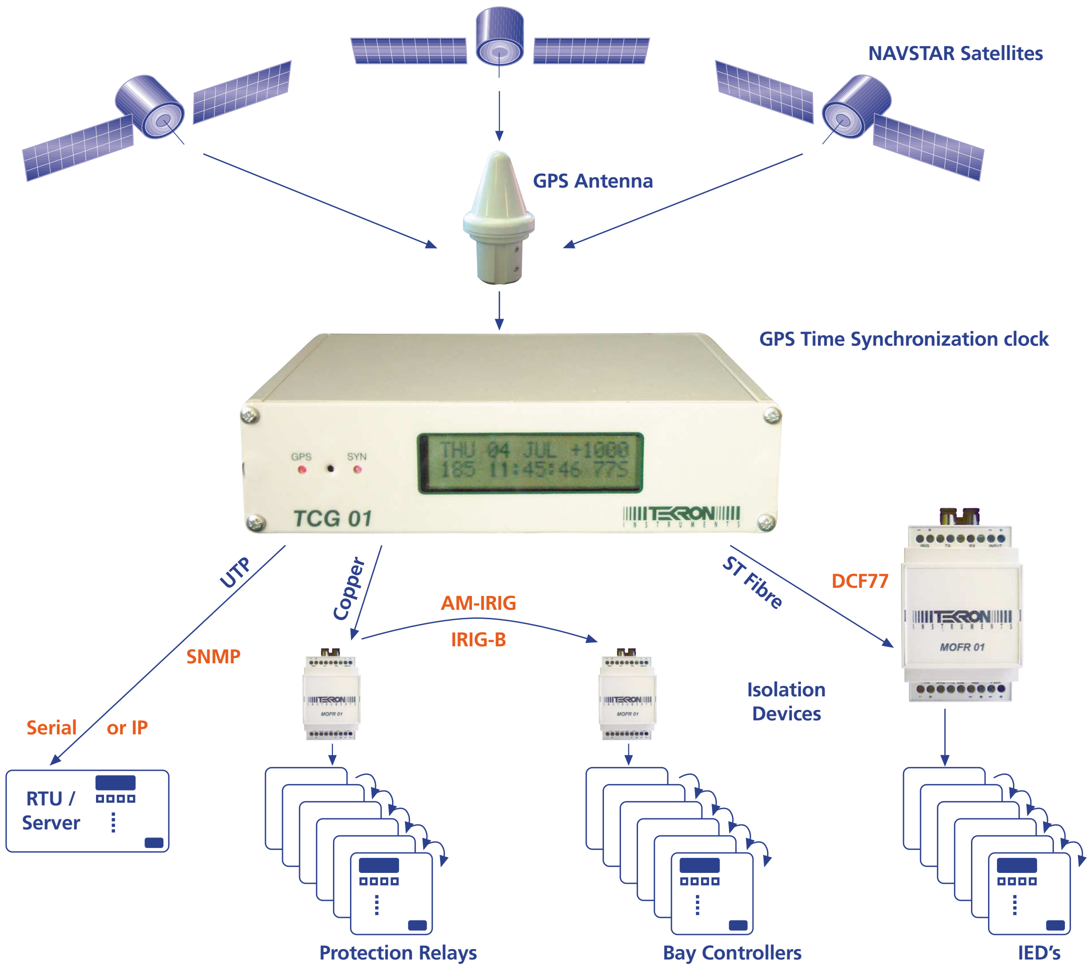
PROTECTION AND CONTROL

While the synchronization of the AC power grid has always been of primary importance to grid operators, somewhat less attention has been paid to the need for synchronization of the protection, control and supervisory equipment that is an essential part of a modern power utility substation.

Historically, primary protection equipment was designed to trip the incoming supply to a substation based on local operating conditions exceeding a set of predefined criteria. Protection relays were largely electromechanical devices.

Automatic recording of data from such devices was simply not available – nor was it seen as particularly important, as the supply grid was a relatively simple network with minimal interconnect paths.

Growth in demand for electricity, together with privatization and increasing de-regulation have led to vastly more complex grid structures in which power can be switched to flow over multiple different paths on a second by second basis. The factors influencing power flow paths within the grid are no longer related solely to technical issues of demand, generation, and optimized grid use, but also to external market issues such as the spot price of power generation offered from competing generating companies and to constraints placed on the grid operators by environmental considerations. Consequently, the need for closer monitoring and control of power utility network assets over a wide area arises, and continues to grow.



CURRENT AND EMERGING PRACTICE

While the basic function of a protection relay remains the same today as it has always been, modern microprocessor based protection relays and other IED (Intelligent Electronic Devices) installed in substations offer a host of monitoring and control functions that can generate large amounts of real time and historic data about the operating state of the power system.

In addition to providing real time measurement of voltage, current and frequency, recording of sequence components, phasor measurements, transients and other parameters relating to power quality is now accepted practice.

In addition to the time stamping of fault records and sequence of events data increasingly manufacturers of protection relays are using time synchronization to maximise the robustness for example of line differential protection techniques and distance protection. The advent of relatively cheap GPS-controlled clocks means that it is now economically viable to deploy a time source that effectively offers close to atomic clock performance in each substation, thus making possible network wide, continent or even world-wide synchronization.

The investment in an accurate GPS-controlled clock in each substation is best utilised by the installation of a dedicated time synchronization bus system delivering time signals directly to all "front-line" equipment such as protection relays and IED equipment. With such a system in place, time stamping is done at the precise point in time and space that an event is first detected by a protection relay or other IED, and the timestamp becomes an integrated part of the data associated with the event.

TIME SYNC IMPLEMENTATION

Most modern Protection Relays and IED's come fitted with a port to accept a time synchronization signal – the most common being the IRIG-B time code.

A time signal bus can be realised by using a single-pair copper cable carrying the time code signal from the GPS-controlled clock output to all of the equipment that requires synchronization on a "multi-drop" basis. Purpose built isolation devices can be used to maintain isolation along the bus. Alternatively optical fibre can be used for the connection between the clock and the IED's, thus overcoming isolation and noise issues.

FUTURE TRENDS

In the latest generation of IED's designed to operate under the new IEC 61850 regime, time synchronization is possible using an NTS – Network Time server clock – which is accessed over the Ethernet IP based "Station Bus" network that connects devices locally in the substation.

The above article has been supplied by Geoff Vaughan from HV Power, the NZ Distributor for Tekron International and was derived from a white paper entitled "Shedding Light on a Black Art – GPS Time Synchronization" authored by Brian Smellie from Tekron International. The paper discusses the various methods of time synchronization employed by utilities, highlighting many of the practical considerations of implementation and it also provides technical details of various time signal formats.

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