

## REAL TIME AND TIME SERIES SCADA SYSTEMS

*Understanding Performance Issues in Utility SCADA Systems*

### Traditional Telemetry Systems

Early telemetry systems were based on poll only systems. This meant that a master station would sequentially request updated information from a series of remote stations. Any changed data since the last poll request would not be determined until the subsequent poll sequence.

In this era usually the intelligence resided in the master station or an attached decision engine. For efficiency, a check code was often used to determine if new data was required from the outstation. If so, another request from the master was initiated and updated information uploaded. All of these tasks were performed in real time. The major drawback with this strategy became obvious as a large number of sites were to be polled. The net affect was a loss of resolution and therefore a requirement for increased bandwidth.

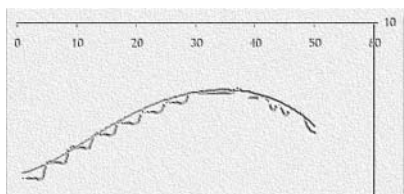
In time, exception based systems and distributed intelligence were added to the remote functionality.

Today, high performing systems operate using a combination of techniques including:

- Periodic polling (used for background health checking and recover of historical data)
- Dynamic field exception based reporting on events
- Remote intelligence
- Pre-processed inputs
- Fully automated control including remote and local user interaction.

### Real time Verses Time Series Data

A real time system allows users to view plant and equipment with current live information. It is a virtual description because there is a finite time required to update information. The telecommunication infrastructure and bandwidth capabilities usually determine data throughput and operator access times. On a typical manufacturing floor an operator would expect to have better than a one second resolution of all data whereas a mining company managing a 1000km pipeline may benchmark at 3 second updates. All of these performance measures are the basis of design for both the infrastructure and the associated messaging systems.



Real time systems are mandatory for most factory automation systems. High-speed data highways allow control equipment to manage plant efficiently and automate the process. Because events must be reported to the HMI system as they occur and unattended decisions made by intelligent controllers, there is a probability that more than one event will attempt to report at the same instance in time. For this reason message lengths determine the overall time resolution of recorded data. Adding field points to such systems implies consideration of how the system was designed and that acceptable performance will result after additions are made. Other than the performance issues relating to communications latency as outlined above, real time processing is a simple concept...

Time Series systems use a method of time and date stamping events that occur at the plant. This may be used in both factory automation and distributed control applications. When an event occurs at the control equipment location, a snap shot is created. Either triggered by the event itself or reported using defined system rules, the event data is forwarded to its intended location. Some systems retain a copy in the remote device in a FIFO buffer arrangement and some systems remove messages when they are delivered to its intended destination. Whatever the case, the original time and date stamp is retained and used in the HMI processing engine. More advanced information system databases support time series data also.

When designing SCADA and Information Reporting Systems it is important to choose system components that support time and date stamped data at both the initiating control device and the destination software application. Even after this is determined the communications protocol must also support transferring the blocks of data.

Some of the benefits of time series data are:

- Non-urgent data can be captured and not reported on occurrence. This allows data packing to occur. Even though the messages include the overhead of time and data stamps usually the overhead is far less than the overhead associated with smaller messages being reported on occurrence.
- Off line storage methods allow various communications media to be used.
- Off line storage methods allow monitoring system failure recovery without loss of event data.
- Control equipment may also be used as a data logger.

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Some of the difficulties with time series data are:

- Not implicitly supported by many HMI or Information Reporting System databases.
- More difficult to design the communications messaging system.
- More difficult to tune the communication system for optimum performance.
- Sequential data processing of blocks of data with its associated time stamps can add latency when used for user annunciation.

Perhaps stating that real time systems are simple in concept is a simplification itself. Ironically the discipline of real time system development must be embodied and balanced when performing time series system development. Tradeoffs must be made and based on sound judgements and performance requirements.

Mentioned earlier, data time resolution is determined in real time systems by the data message lengths. Similarly time series systems suffer with degraded access times. This latency is usually more severe with time series data transfers because blocked data messages are much longer in length. The significant difference with time series is that although access times are compromised, the data integrity is maintained. So despite the probable loss of access time, the time at which events occurred in history is recovered when the messages "eventually" arrive.

A compromising approach including the combination of both real time and time series data is the optimum solution.

A suggested format for such a system is as follows:...

1. Initially, report event occurrence using real time data messaging. This overcomes the inherent delays in processing sequential data in minimal time. It then provides relatively responsive information updates to users. Real time messaging is always used for control sequencing and making decisions for automation. Of course a real time request may potentially collide with blocked event time and date stamped data and this should be considered within the tolerance of any area wide automation

2. Secondly, follow the real time annunciation with the blocked event time and date stamped data. This resolves the correct time of occurrence. It is important with such systems that the original arrival time (real time based) is not used in historical logging. This combination offers the best of both worlds. Applying this design approach, the following example illustrates a real application operating real time and time series, for both an operational and back end information system requirement

### Performance Example

A system that illustrates bandwidth planning, data management strategy and both real and historical data logging for over 270 intelligent field devices. Only one of three channels is discussed here.

100 RTUs operating on a single 1200bd FSK open channel talk through repeater, with spare capacity;

- Access times 1.8-2.0 seconds for status.
- HMI driver capable of +1.7M transactions/day/9.6Kbps link from server to Master RTU.
- Integrity poll time average = 25 minutes.
- Port Utilisation 40%.
- Real time and time series data methods employed.

### Features

The system has Area Wide Controls based on a decision engine. This implies additional control messaging requirements. The highest priority messages are allocated for controls and reporting by exception. The decision engine is a second tier function and is therefore dynamically enabled when network traffic permits. The design of messaging priorities avoids compromising system management under all conditions of plant operation.

- Redundant Servers and data links to each Master RTU allow for backup of most likely single point of failures. No data loss occurs on HMI changeovers as time and date stamped data can be read from multiple sources simultaneously if required. In contrast real time only drivers and systems must be actively scanning when any event occurs to secure the actual occurrence time. During redundancy switching there is a higher probability of data loss, especially on systems that do not duplicate IO Servers.
- Backend reporting systems make use of actual occurrence data. Data modellers may correlate accurately any network wide or selective conditions down to less than 40 ms accuracy and 1 ms resolution over the radio network.