

## Natural Gas Utility SCADA using Kingfisher

### **Introduction**

Automation and monitoring in the natural gas utility industry are among the common applications of Semaphore's Kingfisher RTU products.

Through an extensive communications protocol assortment in firmware, Kingfisher provides broad compatibility with SCADA software on the market today. A Kingfisher RTU can readily "drop in" to most, existing SCADA systems.

The Kingfisher G30 RTU is a very compact model that provides up to 32 I/O points. The G30 is appropriate to most installations including metering stations, regulator stations, LNG plants and peak-shaving plants.

For larger installations, the Kingfisher Plus+ is a modular RTU that supports over 1000 I/O points. For high availability requirements, Kingfisher Plus+ is available in three levels of redundancy, including processor, power supply and communications.

A third model, the LP-3, is a low power-consuming RTU that uses solar power and is perfectly suited to locations, which lack commercial power.

### **System Overview**

In gas utility systems, Kingfisher RTU products provide the following functions:

- Interface with a wide variety of SCADA master station software for operations.
- Support common applications including asset management, automated billing, customer service, dispatch, forecasting, maintenance management and system modeling.
- Meter interfacing, flow calculations and data support for electronic billing.
- Pressure monitoring and regulator control.
- Alarm management, event reporting and live, system-wide monitoring.
- Automation of LNG plants and peak shaving plants.
- Security monitoring.

### **Meter Interfacing and Flow Calculations**

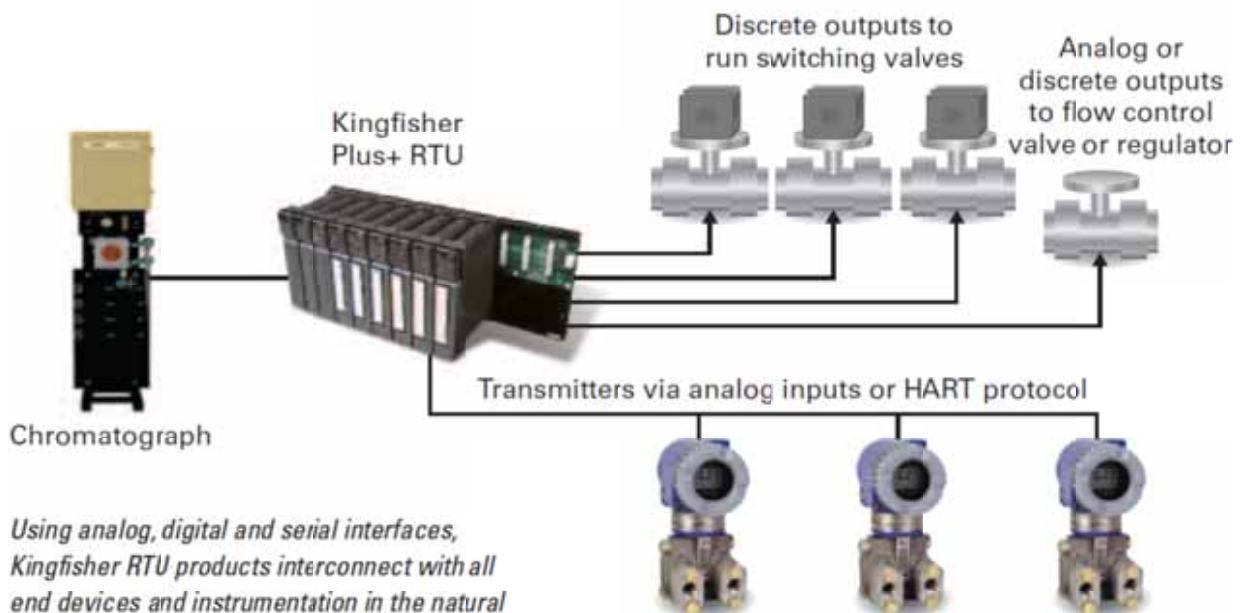
RTU products such as Kingfisher are typically employed at stations, which meter gas for large industrial users.

A Kingfisher RTU performs corrected flow calculations according to the American Gas Association (AGA). These calculations are described in comprehensive reports that are available from the AGA.

In the Kingfisher products, the AGA calculations are provided by preconfigured function blocks:

- AGA3 — Report for orifice meters.
- AGA5 — BTU energy content calculation.
- AGA7 — Report for turbine and PD meters.
- AGA9 — Report for ultrasonic metering with the same calculations as AGA7.
- AGA11 — Report for Coriolis metering.
- NX19 — Super compressibility.
- AGA8 — Compressibility using gross and detailed methods.

The Kingfisher RTU also performs flow/pressure control, odorant control, and sampler control. Most functions are similar to those in a pipeline M&R station. For further information, please refer to Semaphore’s application brief, “Pipeline M&R Station Automation using Kingfisher.”



*Using analog, digital and serial interfaces, Kingfisher RTU products interconnect with all end devices and instrumentation in the natural gas utility industry. A Kingfisher RTU will automate meter stations, regulator stations, LNG plants and peak shaving plants.*

### **Alarming and Data Support**

The large memory model in the Kingfisher RTU allows storage of historical information over an extensive time. While typical requirements at meter stations call for hourly and daily storage for two months, a Kingfisher RTU can provide significantly longer durations.

The historical data combined with the alarms and events comprises the “audit trail.” While most requirements call for maintenance of 400 alarm and event messages, Kingfisher can meet extreme requirements by storing over 200,000 messages.

In case of a communications failure, a Kingfisher RTU is also able to upload missing data in the SCADA master station once the network is back in service. This is dependent on the communications protocol. Please see the discussion on DNP3 that follows under “SCADA Network.”

### **SCADA Network**

Kingfisher RTU products have been installed in natural utility networks using a wide variety of communications networks and protocols.

DNP3 has recently emerged as a highly-capable protocol with numerous features that have direct benefits to the pipeline industry.

DNP3 is an open, intelligent, robust, and efficient modern SCADA protocol. It can:

- Request and respond with multiple data types in single messages.
- Segment messages into multiple frames to ensure excellent error detection and recovery.
- Include only changed data in response messages.
- Assign priorities to data items and request data items periodically based on their priority respond without request (unsolicited).
- Support time synchronization and a standard time format.
- Allow multiple masters and peer-to-peer operations.
- Allow user definable objects including file transfer.

A key advantage of DNP3 is that it is an open, standard protocol with oversight by a vendor-independent user group. With the oversight of a technical committee, DNP3 is able to evolve through the addition of new technology while assuring backward compatibility so that existing systems don't find themselves obsolete.

Unlike de facto standard protocols such as Modbus, DNP3 is not subject to vendor-specific variants, which are incompatible with existing installations. While suppliers are not required to completely implement all DNP3 functionality, the implementations have to fall within very well-defined subsets.

### **Network Architectures**

DNP3 uses the term outstation to denote remote computers or devices as are found in the field. The term master is generally used for the computers in the control centers. DNP3 supports a variety of network architectures, including point-to-point, multi-drop, hierarchical and data concentrator.

DNP3 also allows multiple masters and peer-to-peer operations.

Using DNP3, a master gathers data from outstations primary by sending requests, which is known as polling. This keeps the data base in the master up-to-date with respect to the data bases in the outstations.

One master station may communicate with multiple outstation devices. Conversations are typically between the master and one outstation at a time. The master requests data from the first outstation, then moves onto the next outstation for its data, and continually interrogates each outstation in a round robin order. The communication media is a multi-dropped telephone line, fiber optic cable, or radio. Each outstation can hear messages from the master and is only permitted to respond to messages addressed to itself. Outstations may or may not be able to hear each other.

DNP3 also allows an outstation to send unsolicited messages to a master. This best allows immediate notification of an important occurrence such as an alarm.

### ***Master and Outstation Functionality in the RTU***

Among the broad variety of SCADA system architectures accommodated by DNP3 is a hierarchical network. Since Kingfisher supports master and outstation functionality in the same RTU, it fully supports hierarchical networks. These are often used to suit SCADA system layouts with clusters of installations in a number of remote regions. Since the overall SCADA system master links with a much smaller number of devices than it would in a flat network, communications costs on networks such as cellular and satellite can be significantly reduced.



### ***Data Concentrator Functionality***

The terms, “data concentrator,” and “protocol converter” are used for a device that gathers data using one protocol and transmits it using a different protocol. SCADA systems using DNP3 often also include intelligent end devices, otherwise known as intelligent electronic devices, which use different protocols. These devices can be wireless sensors or hard-wired devices that interface with serial ports or Ethernet.

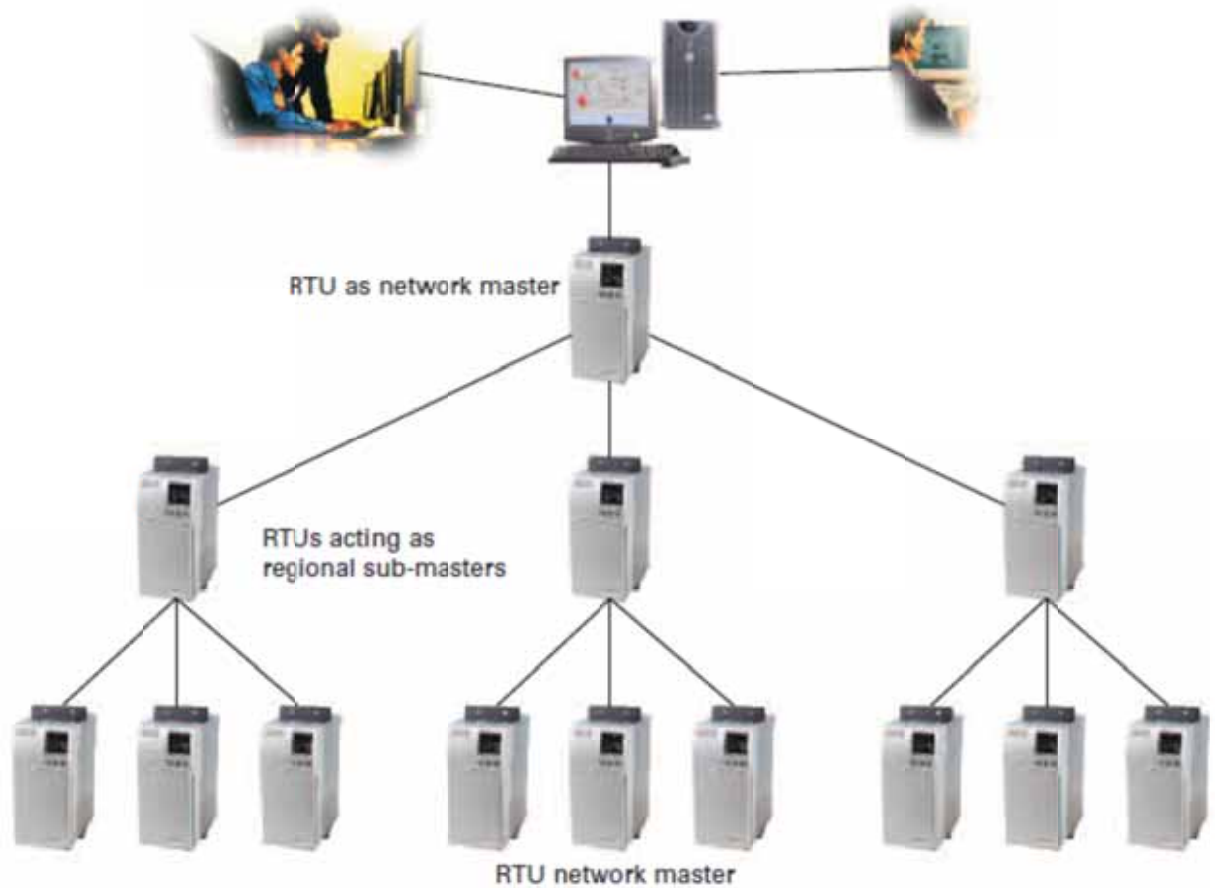
Data concentrators are often also used in systems, which are evolving to DNP3 from an older, perhaps proprietary, protocol. Since an entire, system-wide protocol conversion is usually not feasible, data concentrators allow the conversion to be done in a step-wise manner.



### ***Network Master Functionality***

As a network master, a Kingfisher RTU can provide functionality that is not available in, or is a very expensive addition to, the SCADA host software. For example, DNP3 Secure Authentication may not be available. Using the RTU as a network master, the SCADA system can implement secure authentication, end-to-end, even though it is not a feature of the host software.

In a hierarchical network, other RTUs can be both masters and outstations. In that capacity, they are often referred-to as “sub-masters.”

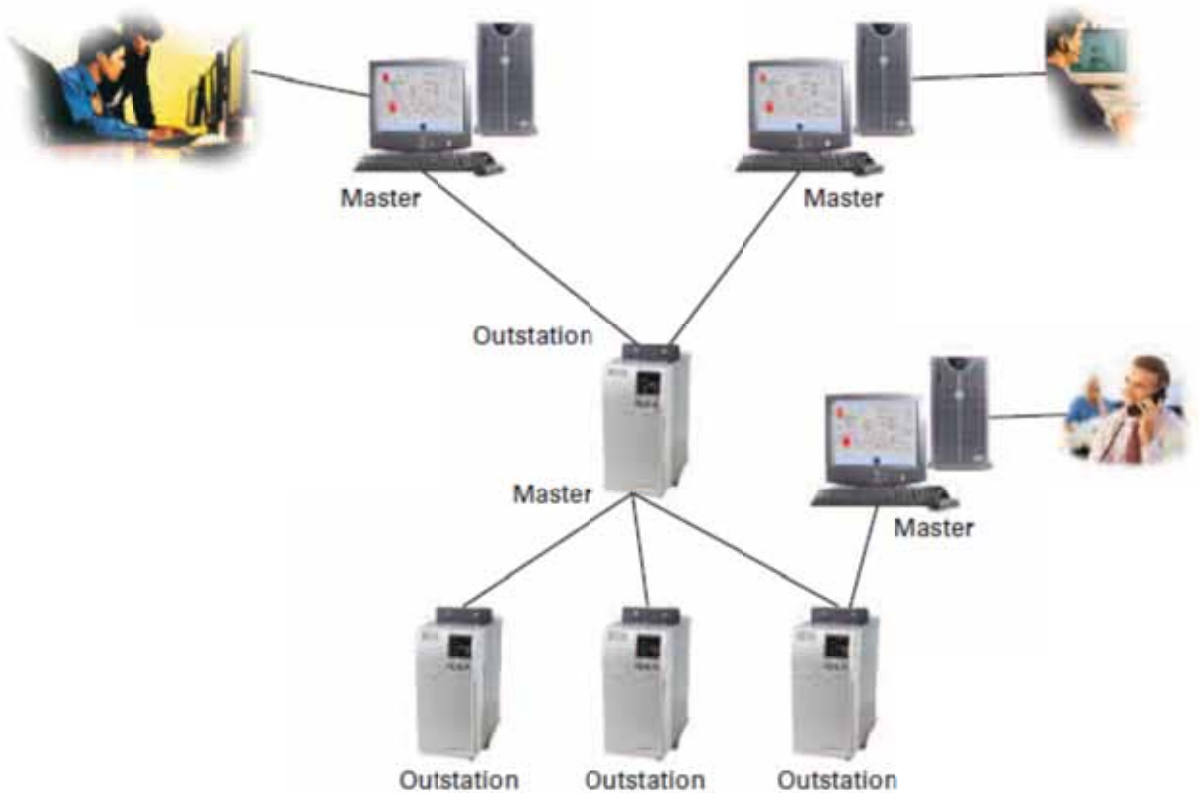


### ***Multi-master Support***

A multi-master architecture is among the methods for implementing redundancy at the host level and also allows third-party users to link to one or more RTUs in the SCADA system. In a hierarchical network, multiple masters can be employed at any level. An outstation RTU can communicate with a SCADA host computer system and another RTU, both of which are masters.

The RTU uses a single communication port and distinguishes the masters by the source address. This implementation provides a secondary advantage in that if a master station changes the interface it is employing for communications with the outstation, it can seamlessly resume communications from the point it left off.

Multi-master support provides a simple way to allow third-party access, e.g. by a major customer, to a particular RTU in the system.



**Peer-to-peer Communication**

Kingfisher RTU products fully support DNP3 peer-to-peer communication. SCADA systems commonly include distributed control or distributed data bases, which require information transfer from one RTU to another. This information may or may not be included in the host data base. Since DNP3 messages include a source address and a destination address, one RTU can send a message directly to another RTU. Peer-to-peer messaging is often used between nearby sites such as regulator stations.



## **REPORT BY EXCEPTION AND UNSOLICITED MESSAGING**

The Kingfisher DNP3 implementation supports two types of messaging, which are often confused with each other:

Exception reporting or report-by-exception (RBE).

The outstation is polled by a master but only reports values that have changed since the prior poll. RBE can substantially decrease the amount of information that is transmitted, reduce communications costs, and decrease turn-around time.

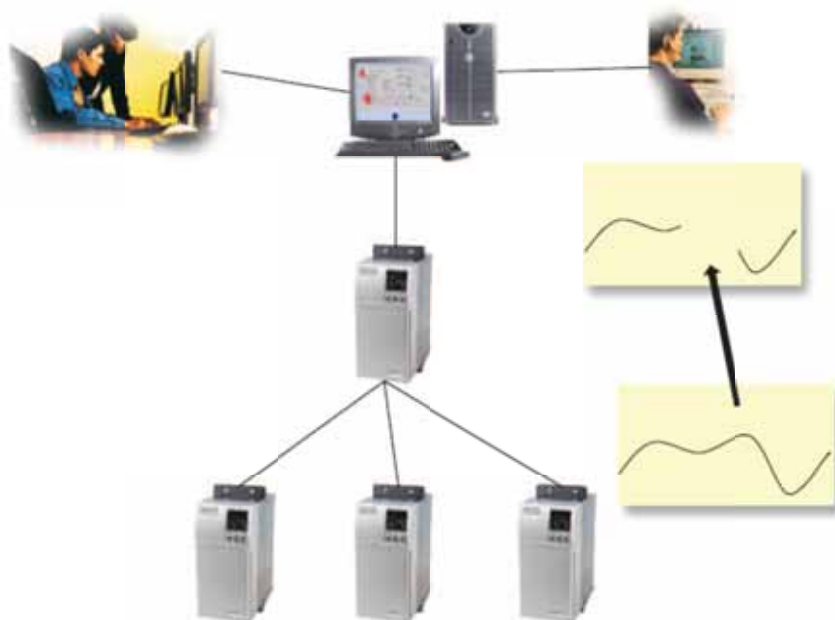
Respond without request, unsolicited messaging or push communications.

The outstation initiates a message without being polled by a master. This is best for alarms, emergencies, operations failures or any, critical messages, which should not wait for the master to get around to the outstation on its polling cycle.

### ***Historical Data Back-fill upon recovery from a Communication Failure***

Using DNP3, a Kingfisher RTU can automatically upload missing data upon restoration of communications after a failure. The DNP3 driver in the SCADA host software must support this capability. Systems are currently operating using a wide variety of communications media, including Ethernet, ISDN, private telephone lines, PSTN and radio.

To test or demonstrate this capability, the communication link between the RTU and a PC can be disconnected for a period of time and then reconnected. DNP3 communications will be restored and the data stored in the RTU during the communications outage will be sent to the software on the PC.





### **DNP3 Secure Authentication**

Since security is a high priority in the utility industry, DNP3 has risen to the challenge by incorporating secure authentication. This process prevents spoofing attempts, in which a third-party attempts to access the SCADA network and send commands to an RTU.

DNP3 Secure Authentication uses a challenge process to ensure that commands originate from a legitimate node on the SCADA network. When a command, e.g. to open a valve or start a compressor, is received from the server (blue arrow in the accompanying diagram), the RTU challenges the server to be sure it is a legitimate node on the network (yellow arrow in accompanying diagram).

The Server responds with an authentication message (green arrow to the RTU).

If the server authenticates correctly, only then will the RTU perform the action (green arrow to the compressor).

The authentication key is updated at regular intervals in order to prevent old keys from being stolen and re-used.



### **Conclusion**

Kingfisher RTU products are currently operating in natural utility systems throughout the world. In order to meet the requirements of even the largest stations, Kingfisher RTU products employ high-performance processing with large memory models. While the G30 model is most cost-effective for small, one or two-run stations, Kingfisher Plus+ serves large installations using up to 16 communications ports and 1024 I/O points. For sites lacking commercial power, the LP-3 model operates on solar power systems.