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Is DNP3 The Ideal HMI/SCADA Protocol?

Competition between technologies is a battleground. The technology that dominates often makes off with the bulk of the business and profits.

For electric and other utilities in North America and much of the rest of the world, DNP3 is the dominant Human-Machine Interface (HMI)/ Supervisory Control and Data Acquisition (SCADA) protocol. It has a rich set of features and a self-sustaining development and support network that contributes to its ongoing success.

Background and Basics

The real key to DNP3's success – it offers greater assurance of accuracy and timeliness.

DNP3 is shorthand for Distributed Networking Protocol, v.3.00. Developed in 1990 by Westronic, Inc. of Canada (now GE Power Systems), it was based on the IEC 60870-5 standard that has the same overall functionality, but was years from being available.

DNP3 made it possible for electric utilities to implement an improved and open SCADA network protocol, designed specifically for the North American market. Vital functions beyond the reach of then-current fieldbus technologies were implemented. Parts of IEC 60870-5 that missed the mark for North American operations or hindered hardware compatibility were added to, changed or dropped.

Ownership was turned over to the DNP Users Group in 1993. The user group's technical committee took charge of the DNP development process. By November 1995 when the IEC standard was ready to roll, DNP3 already had a substantial base of users.

DNP3 is most typically used by electric, water, sewer and gas utilities. It's not uncommon to also find installations in the petrochemical industry, and it has been used successfully in rail transportation. Essentially, it could be used anywhere SCADA is needed.

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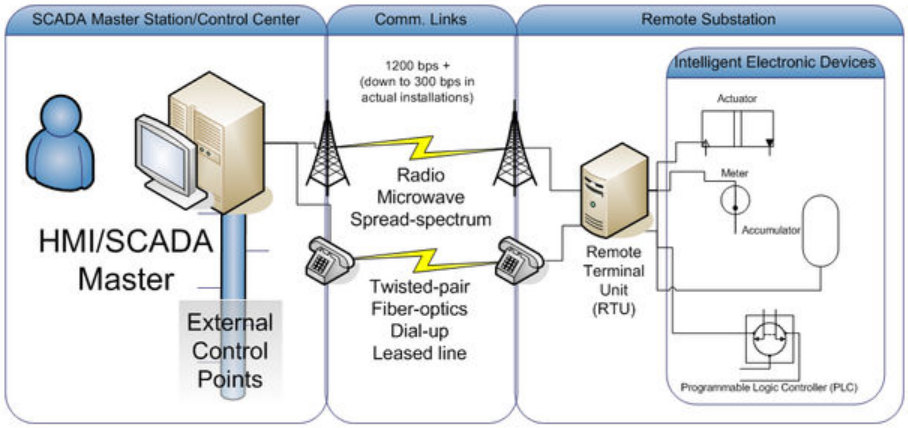

Source: http://en.wikipedia.org/wiki/DNP3

Standards Based, Open and Independent

DNP3 was developed to allow the integration of new and useful technology, focusing on the need of real users. This focus on practical solutions continues to this day.

DNP3 avoids being blinded by the OSI 7-layer networking model. It crosses the lines between layers to ensure data integrity and determinism.

The DNP Users Group is the reason for its ongoing success. With encouragement for active users of DNP3 to join and give feedback, this group has a sense of ownership and pride in what is possible. While participation in the technical committee on changes is voluntary, any member may contribute. Utilities and suppliers at the core of the group have incentives and resources to improve DNP3 as needed.

DNP3 was designed to allow interoperability between different vendors' SCADA equipment. It's still better at this than Modbus or IEC 60870-5. The software itself is a group of C++ programs, distributed under the MIT free software license.

DNP3 has succeeded by providing a superior product in actual practice, making vendor profits dependent on cooperation and compatibility, having the most effective software free to all comers, and actively encouraging participation and feedback in the development process. It's a striking success on all these counts.

A Significant Advance from Legacy SCADA

DNP3 prioritizes data and communications in such a way that speed and efficiency are enhanced, not sacrificed, by its increased capabilities.

In many ways DNP3 is the logical successor of Modbus. They are similar in the fact that they were privately developed and freely distributed. Modbus is still the most used industrial control protocol. In fact, Modbus is the second most popular communications protocol among the same electrical utilities that developed and support DNP3.

DNP3 does everything Modbus does, down to the same capability for serial communications, but does it faster and with greater assurance of accuracy and timeliness. And while the huge installed base of legacy

devices means Modbus isn't going away any time soon, it seems likely that as the range of devices enabled for DNP3 increases and costs go down, DNP3 networks will be possible everywhere.

The Power and Flexibility of DNP3

While DNP3 is more efficient, compatible and capable, it's also more complex than legacy Modbus or similar programs. And while DNP3's more advanced functions are beyond the scope of this brief intro, here are some of the basic but powerful benefits.

Data and Control Reliability
DNP3 involves multiple layers of the seven-layer networking model. This enables a variety of means to organize and confirm link reliability and data integrity, for greater assurance that communications and control will be accurate and occur in a set period of time.

DNP makes especially heavy use of Layer 2 Cyclic Redundancy Checks in detecting and correcting data errors to overcome potential poor data transmission quality.

Report by Event
Faster data transfer and efficient bandwidth use are achieved by prioritizing data from field devices. DNP3 sends an initial request to get data from every device on the network. After that only changes need to be communicated.

By late 2008 DNP3 achieved full compliance with the most up-to-date security standards.

A Remote Terminal Unit (RTU) can be programmed to send event data without waiting for a request. This is especially useful if needed to set off an alarm or start an automated intervention. Requests or polls for change data are most frequent. Less frequently static data may be requested, to confirm device and data link status.

In Modbus networks this data is communicated only upon request, and the response is sent whether or not there is any change.

Time/Date Stamping
All events are recorded and transmitted with a time and date stamp. This allows for coordination between devices and network segments. If communications with a device or network are lost, event and time data may still be fully recovered when the link is restored.

Addressing
Every DNP3 message specifies both the sending and receiving devices. The receiving device therefore knows where to send a response. 65,520 unique addresses are possible.

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Multiple Data Types

DNP3 can handle multiple data types, and as necessary send these in a single transmission, by converting data from various formats into generic values. For example:

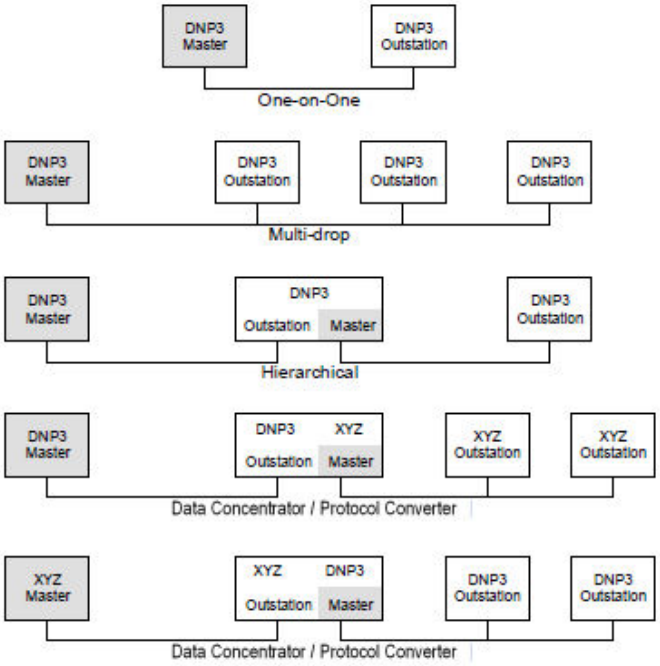
- Binary input data monitoring two-state devices, i.e. a circuit breaker closed or tripped or a pipeline pressure alarm.
- Analog input data such as voltage, current, tank level or temperature.
- Count input data reporting kilowatt hours or fluid volume.
- Files with configuration data.
- Outbound control commands to close or trip a circuit breaker, start or stop a motor, open or close a valve, or analog output values to set a regulated pressure or a desired voltage level.

Architectures

There are real reasons to suspect that DNP3 may be the ultimate HMI/SCADA protocol of the future.

Some common system architectures are represented below. These are only the tip of the iceberg. An amazing array of complexity is possible.

Intermediate computers may serve as data historians and collection points, and expedite direct communications from DNP masters to the most remote devices through other intermediate devices, or change roles depending on context, and more.



Source: DNP Primer, DNP Users Group ©2005

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Security Enhancements

A recent addition to DNP3's capability is the handling of security concerns. The original perception was that SCADA systems were only used in closed networks, so security breaches were not a significant concern.

But the pressure to beef up security in most network settings changed all this. The IEC 62351-5 standard was designed to address security issues of the IEC 60870-5 standard, and any protocols related to it.

In early 2007 a security revision of the DNP3 standard was released. By late 2008 full compliance by DNP3 with the IEC 62351-5 standard was achieved.

Summary

DNP3 is secure, compatible, efficient and robust. Implementing DNP3 could well be the next step for more industries, as replacement of legacy protocols and devices becomes necessary.

DNP3 has succeeded by mandating cooperation, compatibility, community participation and feedback.

It's a model that other technology areas could benefit from.

As SCADA itself evolves, it must be able to effectively deal with very complex as well as very simple configurations. DNP3 is scalable and able to handle the requirements of either.

With momentum and market share, the major players guaranteeing continued improvements, and an effective framework to plan, build, test, review and fully implement changes, it seems likely that DNP3 will continue to evolve and succeed.

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