

COMPLETE CONTROL

Bill Brownlee, Emerson Process Management, US, highlights ways in which to harness the powerful capabilities of digital bus technology at the power plant.

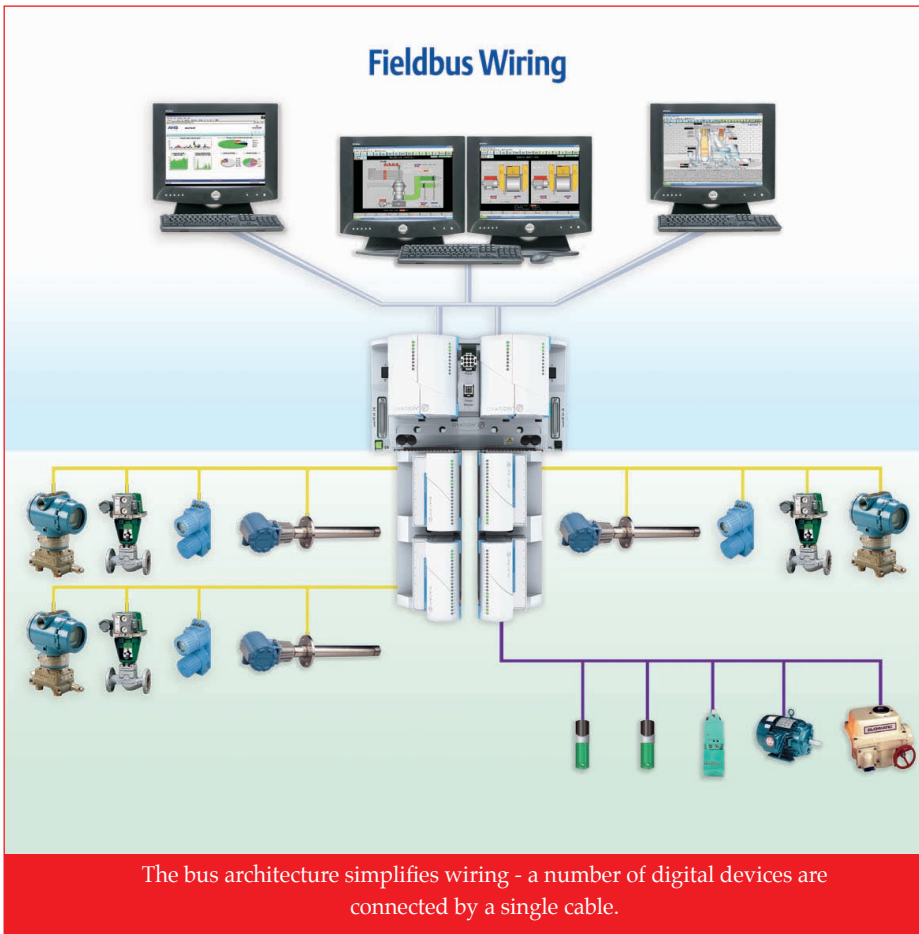


Today's modern distributed control system (DCS) may be the single most important system in a power generating facility. Surprised? If so, consider this.

No other system can provide the breadth and depth of information about what is going on in the plant. Control systems today incorporate complete control capabilities, from mainstream functionality like combustion control, burner management, balance of plant and turbine control, to more

advanced functionality like unit co-ordination, runbacks on equipment failure, plant equipment sequencing and

automatic startup. In addition, many control systems incorporate advanced process control for model-based steam temperature control, mill grinding and delivery modelling, and neural network-based combustion optimisation for NOx reduction and heat rate improvement. Impressive? Yes. And yet, this is just the tip of the iceberg.



The DCS connects to thousands of devices, sensors and actuators in the power plant. Because of this intimate connection to the plant, the control system becomes uniquely capable of becoming the 'information broker' for the plant, providing detailed data on the health and well being of everything in the facility. Furthermore, with the correct equipment, architecture and asset management software, the DCS can provide actionable information to the correct person in a timely manner in order to provide a proactive response to pending events and equipment failures.

The ability to provide actionable information starts at the field device. For many years, pressure, flow, level and temperature transmitters have had embedded microprocessors that handle the conversion of the physical parameter into an electrical signal. This is because it's easier to perform sensor linearisation and compensation for temperature and pressure effects in software rather than in complicated analogue circuitry. So, in effect, for the past 20 years or so, digital

processing capability has existed in field devices that performed all of the signal conversion and conditioning, and then converted the results back to a 4 to 20 mA signal. Recent devices have capitalised on the embedded processing power by adding additional diagnostic capabilities. For example, differential pressure and pressure transmitters contain embedded algorithms that monitor the process variable for process noise and can detect when there is a significant change. This can be useful when trying to identify plugged impulse lines, or a root isolation valve that has been closed for maintenance and not reopened. In addition, there are a number of internal diagnostics that can detect memory faults, processor errors, A/D converter errors and other faults that can be used to provide an indication of instrument degradation or failure. Also, onboard temperature sensing can be used to provide an indication of impulse line freeze protection failure or warn of steam or process leaks from piping in the vicinity of the instrument.

For valves, the ability to provide diagnostics is even more impressive.

Modern valves with digital positioners can provide alarms for valve travel failures, low air supply pressure (which may limit the ability of the valve to fully stroke), tubing leaks, diaphragm leaks and failures of the valve position feedback mechanism. For a standard current-to-pressure (I to P) based positioner, if the feedback lever would fall off due to installation in a high vibration application, it would result in the valve failing in the full open or full closed position. For a digital positioner, the same failure results in the valve reverting to pressure-based positioning based on the pressure versus stem position curve stored on board, a variable that is constantly updated when the valve is moving.

In addition, when these intelligent devices are connected to the DCS using Foundation™ Fieldbus, they can provide proactive alerts and indications on their health and well being, alerting maintenance personnel to what corrective action needs to be taken and providing additional information on how critical the fault is.

How important is this capability? Some time ago a large chemical company undertook an internal study that analysed all of the work orders for routine field device calibration and troubleshooting over a protracted period. What it found was that 35% of the time, personnel who went into the field to recalibrate a device found the device to be within specification. In addition, for field-based troubleshooting activities, 28% of the time the problem was not with the field device. What this means is that approximately 63% of the time a technician is dispatched unnecessarily to perform field-based instrumentation activities. This is a big opportunity for cost reduction, but only if the devices and DCS infrastructure are in place to utilise the intelligence of the smart field devices.

Fully utilising smart field devices requires a DCS architecture that enables and supports them. Bussed architectures are critical: the detailed diagnostics and fault data can't be extracted over a 4 to 20 mA connection. Even Hart technology doesn't provide the same level of proactive alerting that comes from true digital communication-based bus architectures.

Obviously, it is difficult to justify the cost of completely replacing an existing and working DCS infrastructure on a retrofit project, although recent studies

and field evidence are making it easier. For any new construction project, it would be shortsighted not to install a bus-based architecture and smart devices. Studies have not only demonstrated initial savings in the areas of installation, labour and startup but also, and even more importantly, long-term payback from ongoing operations and maintenance savings.

An integrated, digital bus-based architecture has already been well proven in the process industries. And now, the power generation industry's desire to leverage these technologies comes at an opportune time. The US Department of Energy's Energy Information Administration estimates that between 2004 and 2030 worldwide energy demand will increase by more than 57%. This growing demand, coupled with the imminent retirement of existing plants that are nearing the end of their lifespan, is fuelling significant investment in power industry construction. In fact, in the US alone, 121 new coal-fired power plants have been announced or are already in progress, representing approximately 72 GW of power.

In the US and around the globe, Emerson has experienced first hand how power generators are increasingly adopting a digital bus-based approach for new construction. The vast majority of these plants are currently in the planning or construction stage. A number of coal-fired plants that are being built in the Midwestern US are indicative of how power producers are deploying digital automation technologies in their plants. At these plants, Emerson's Ovation® expert control system will monitor and control all significant plant processes and will interface with the turbine control system. The plants will also make extensive use of intelligent field devices utilising Foundation Fieldbus and Profibus or DeviceNet industry standard communication protocols in a number of areas, including feedwater, drum level, spray valves and turbine bypass. Thermocouples are landed on either traditional I/O modules or on Foundation fieldbus modules, while Profibus DP or DeviceNet is employed for motor operated valves, as well as switchgear and motor control centre equipment.

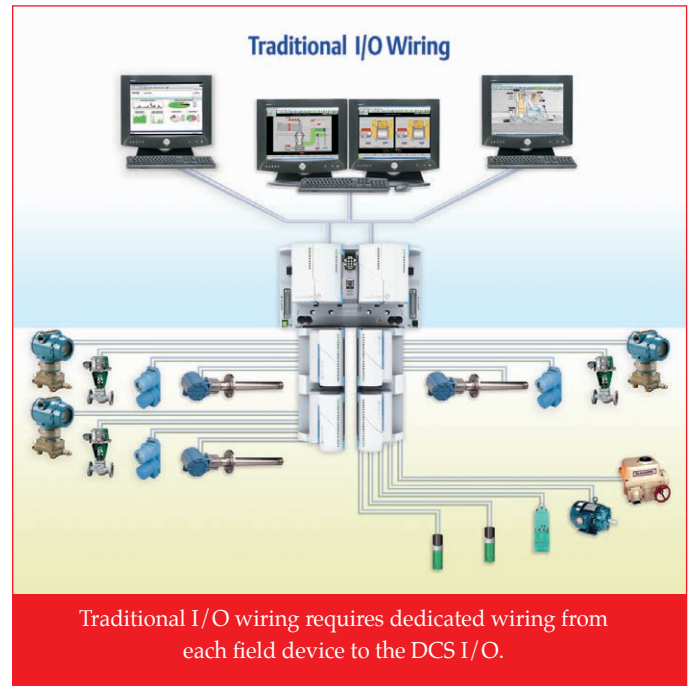
For utilities like those mentioned previously, deploying an integrated digital automation architecture is beneficial during

the plant startup commissioning phase, as it helps lower wiring costs and streamline device installation, communications verification and troubleshooting. However, for utilities, the ongoing O&M benefits are really the bread and butter of implementing a plant-wide digital automation solution.

To better understand why, consider this: in many facilities, there are numerous processes and subsystems that are still not automated. For example, take a circulating water pump startup. On a large unit this can be a multi-step process that can have potential for water hammer damage to the condenser if not done correctly. The operator is forced to manually open the suction valve, verify NPSH requirements, start the lube oil pump, open the seal water valve, open the min flow bypass, crack the discharge valve, start the pump, wait the appropriate amount of time for line and water box fill, open the discharge valve fully, close the min flow bypass, etc. Automating this sequence of events provides advantages and removes the possibility of human error. The DCS will always perform required tasks in exactly the same sequence in the same amount of time. It won't get distracted by a phone call, or a question and have to retrace its steps to figure out where it was and it won't make a costly mistake. There are many examples of similar functions that should be automated in every plant.

Fully automated plant startup routines are just higher-level examples of this that build on top of lower-level sequencing. Proper information exchange with the operator and the ability to show the actual cause of a step fault or alarm is easily built in and the advanced diagnostics from the intelligent field devices make problem identification and solving easier when an equipment failure does occur.

In addition, there are many possibilities to use the DCS to automatically generate



startup and shut down reports, fuel usage reports, equipment maintenance notifications and many other reports.

From these examples, it's clear that a digital automation system can reduce the amount of effort required for normal O&M. In addition, it can take the knowledge that a company's most-skilled workers have and embed it into the automation systems. With many experts soon to reach retirement age, this becomes a strategy to support less-experienced power generation professionals.

From a technical perspective, this is an exciting time for the power generation industry. Integrated digital automation solutions, which employ high-speed communications networks, intelligent field devices, asset management software and bus I/O technologies, are now being deployed for the new generation of power plants. And as this spate of new plants begins to come online, power producers will experience first-hand what has already been proven in other process industries: long-term O&M cost savings due to the efficiencies made possible by operating a highly automated, intelligent plant. ■

References

1. Energy Information Administration, Department of Energy, National Energy Technology Laboratories, United States Government, 2006.



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