Local Area Networks and Future Process Control Systems

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In K.J. Åström's insightful survey [1], it is believed that one main issue was overlooked: the influence of Local Area Networks (LANs) on future process control systems. While point-to-point communication channels in large-scale complex processes lead to the usual decentralized/hierarchical control structure that is recalled by Astrom (Fig. 1a), the recent emergence of Local Area Networks has undoubtedly modified this picture (Fig. 1b).

LANs provide cheap and effective communication media between microprocessors and/or microcomputers over the range of a whole plant. Born in the data processing industry, LANs had to adapt to the process industry where they operate in a much more aggressive environment and where some messages (e.g., alarms) must be transmitted immediately and safely. Industrial LANs are thus characterized by improved protections and increased reliability.

The main feature of LANs is the interconnection of all stations on one medium, the LAN shared physical channel. Just as digital computers motivated modern control theory, LANs will strongly affect the field of large-scale systems control. Figure 1a implicitly refers to a decentralized information structure. At lower levels, local units process local information to compute a local decision. Any coordinating action is passed (and postponed) to a more centralized upper level. This basic structure remained unquestioned for years simply because information exchanges at lower levels implied extra wiring (one new information channel means one extra wire). Wiring costs precluded any development in this direction.

It is here that the LANs break through. An extra communication channel is now obtained by a software modification, often as simple as adding one name in an address memo: information exchanges at lower levels can be implemented at virtually no extra cost.

This affects the very foundations of large-scale control theory. The axiom "the information structure is tailored on the physical structure of the plant" no longer holds. It is replaced by a new question "how to select the best information structure for given control purposes?" Unexplored research studies are then called for. What is the value of information in a distributed control system? Under what rules should information be selected?

Finally it must be noted that the plant design itself will be largely affected by LANs. Today in many process industries, for example, the chemical industry, a usual practice is to insert large buffers, or more generally storage capacities, between plant subsystems so that they behave almost like decoupled units. The reason is simply that the available local information cannot provide decoupling actions from the controller. This leads to stock management problems and results in sluggish overall performance. Due to LANs, decoupling can now be charged to control: with the information exchanges allowed by the LAN, control algorithms can be found to obtain decoupling actions at the lower levels. Increased productivity and economic benefits are then obvious.

It is time to look into the implications of LANs on control methods, since LANs are already appearing in many modern control systems (e.g., Modumat-800 of Schlumberger, Teleperm-M of Siemens, Micro-Z of Control Bailey, Spectrum of Foxboro, etc.), where they are too often underused only because there is a lack of control algorithms suited to distributed systems with a LAN. In this instance, technology has largely preceded research, and one may wonder why the control community has been so slow to face these challenging unsolved questions.

Reference