Performing the architectural flip-flop

Dr Joseph Profeta, Director,
Product Management, Aerotech

There are two basic architectures for supervisory and control automation: distributed and centralised. In distributed systems, intelligence is pushed to the edges of the system – to the point closest to the process, action or movement. For centralised architectures, all information is directed to a central controller for processing and decision-making.

Historically, design patterns have migrated between these two architectures and will continue to do so in the future. But will one win out? The drivers of these two architecture patterns include technology, the nature of the problem, and cost.

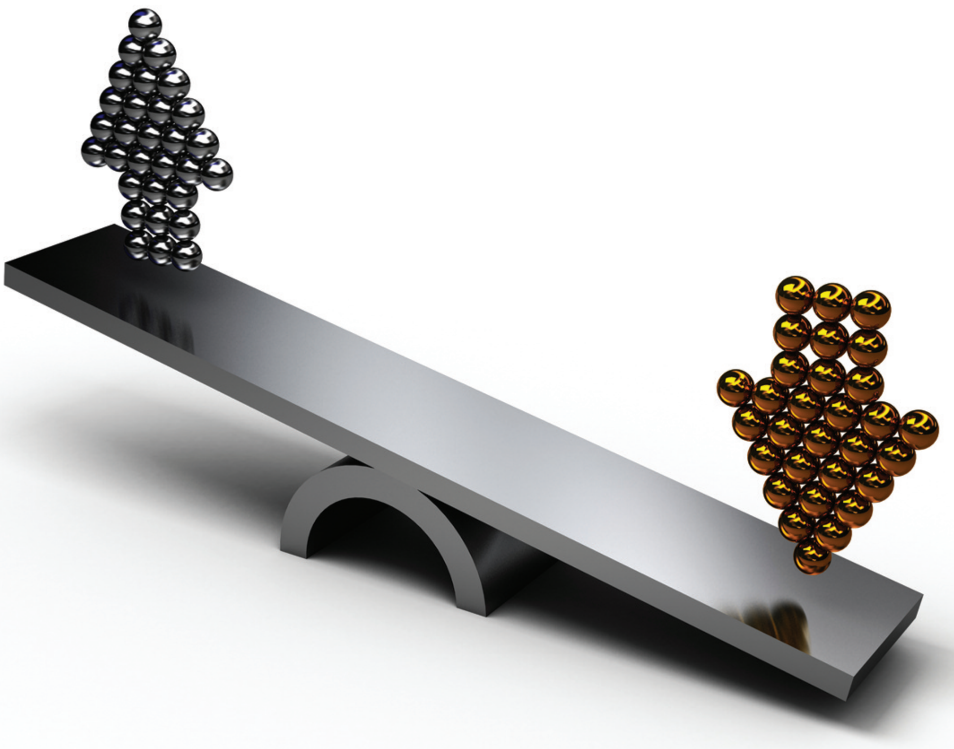
Trends driving the choice of architecture include: the continuing reduction in the size of electrical components; the increasing capabilities of high-speed networks, computers and processors; and innovations in software.

- **Smaller** Electronics have been reducing in size for equivalent functionality for past 20 years. This trend will continue.
- **Increased connectivity** New protocols, inexpensive sensors and robust networks and busses are continually improving connectivity performance. It is now possible to measure more information and share this information with other parts of a system.
- **Improved functionality in a single package** The designs of a decade ago needed many components: a supervisory computer, a network, a controller, drives, motors and so on. With the decreasing sizes of chip-level features, and more sophisticated chip fabrication, System-on-a-Chip (SoC) becomes an attractive reality. Combining multiple and dedicated cores for motion control with on-board sensors will simplify the design of automation controls.

These three trends will continue driving the architecture model to flip-flop between the centralised and distributed structures.

As connections increase in speed and reliability, more information can be processed reliably, pushing the preference towards centralised architectures with data flowing from, and back towards, the centre. Conversely, as more functions can be combined on one chip, these "whole systems" will drive towards distributed architectures that place more intelligence at critical nodes that can be synchronised periodically with other intelligent nodes

The nature of the problem also impacts the ultimate design pattern: can automation be parallelised and broken into pieces that can be distributed easily? When it can, the decentralised architecture may be attractive. If it cannot, the centralised will prevail. For instance, when controlling a coupled, non-linear, multi-axis system, the axes can be controlled individually, ignoring the interaction and settling for less performance, or it can be treated as a multi-variant control problem with a centralised controller that computes all the axis commands centrally.



For the foreseeable future, as more functionality is included on a single chip, and as network speeds and reliability increase and parallel computing matures, the architecture of choice will depend on the relative progress of each of these technologies.