STRATUM 4

ENGINEERING
INTELLIGENT AUTOMATION SYSTEMS

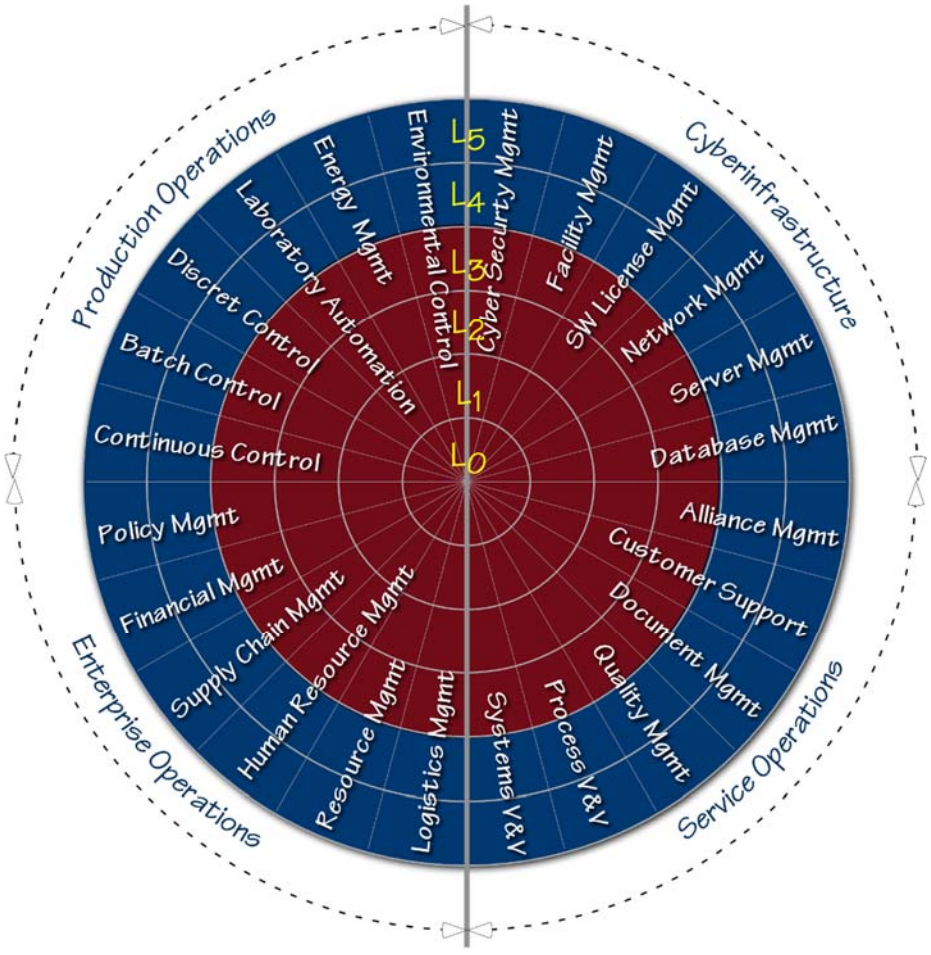
Stratum 4 Newsletter

As a strategic technology consultancy, Stratum 4 is focused on innovation in the engineering of intelligent industrial automation products, systems and services. In this issue of the *Stratum 4 Newsletter* we discuss automation concepts related to the science, technology, engineering and strategies associated with the *Internet-of-Things* (IoT) and *Cyber-Physical Systems* (CPS). These standards and methods enable development of intelligent *decentralized industrial organizations*. DIO provide distributed governance (monitoring and control) in federated systems by achieving consensus and trust among services that collaborate to govern the states and behaviors of production processes.

Industrial Automation

Automation of industrial production processes is a complex web of mission-critical, data-specific and engineered applications, typically developed over varied timeframes to serve isolated process and end-user requirements under distinct authorities.

As idealized in the figure below, automation hardware and software provide for supervisory and regulatory controls that span IoT devices at L_0 through enterprise-wide applications at L_5. Applications within and across these six automation levels serve four general operational domains: *enterprise* (e.g., finance), *production* (e.g., manufacturing), *service* (e.g., support) and *cyberinfrastructure* (e.g., cybersecurity).



Except for development of new "greenfield" industrial facilities, automation takes place incrementally, often spread over years in isolated projects, each with distinct requirements, employing generations of technology, often performed using *ad hoc* systems integration activities. Consequently, the result at any given point is a compound and brittle infrastructure, typically without benefit of a single unifying architecture and. therefore costly to maintain and upgrade.

Addressing this situation warrants novel approaches to engineering applications for both legacy and new automation systems—a principal motivation behind international *Industry 4.0*, IoT and CPS strategies, sciences and technology standards. These technology standards are generally focused on the lower automation domains (rings L_0-L_3) shown in the figure.

These inner rings are domains where *artificial intelligence* (e.g., machine learning) and *distributed ledger technologies* (e.g., blockchain) aid in the engineering of value-production systems requiring more agile, time critical, high-availability and distributed operations.

DIO

Decentralized industrial organizations are federations of sovereign enterprises, each operating as a member of a permissioned, peer-to-peer production network (i.e., *supply and command chains*) without need of a central authority. As sovereign entities DIO contain intelligent agents that employ AI applications to achieve and maintain degrees of *situational awareness* needed to implement trusted, resilient and agile process management regimes. DIO produce, share, analyze and learn from large operational datasets with support of data warehouses (*data lakes*), distributed ledgers (*blockchains*) and data science algorithms (*machine learning*).

DIO are typically operate on the *edge* in large-scale cloud-hosted *service systems*. As such, they necessarily share common cybersecurity requirements, policies and mechanisms, internally (intranet) and at their application program interfaces (extranet) through which they share operational imperatives through *rules-of-engagement* (e.g., smart contracts.) A DIO ecosystem is a graph linked horizontally along producer-consumer supply chains and vertically along superior-subordinate asset management chains.

DIO are cognitive to the degree they continuously maintain awareness of, and with predictable performance effectively respond to a range of situations that unfold within their operational ecosystem. DIO may be stationary or mobile (in cyberspace-time), whether their services are stand-alone, embedded as components in other systems, or function as distributed "end system" interfaces of a DIO service system.

Consequently, using modern software and systems engineering principles, DIO provide a coherent means of framing requirements for and implementations of upgrades to legacy systems and architectures and implementations of new L_0-L_3 production systems.

Systems Engineering News

- IEEE Systems, Man & Cybernetics Society
- IEEE Control Systems Society
- Communications of the ACM
- IEEE Systems Council
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