WHITE PAPER

Practical steps integrating HMI & SCADA into a Unified Namespace (UNS)

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Executive summary:

Businesses require access to operational data sets that partially overlap yet differ—whether due to use cases or functional department requirements. Each department needs data structures tailored to its unique requirements, ensuring accurate analysis, efficiency, and seamless integration with existing systems.

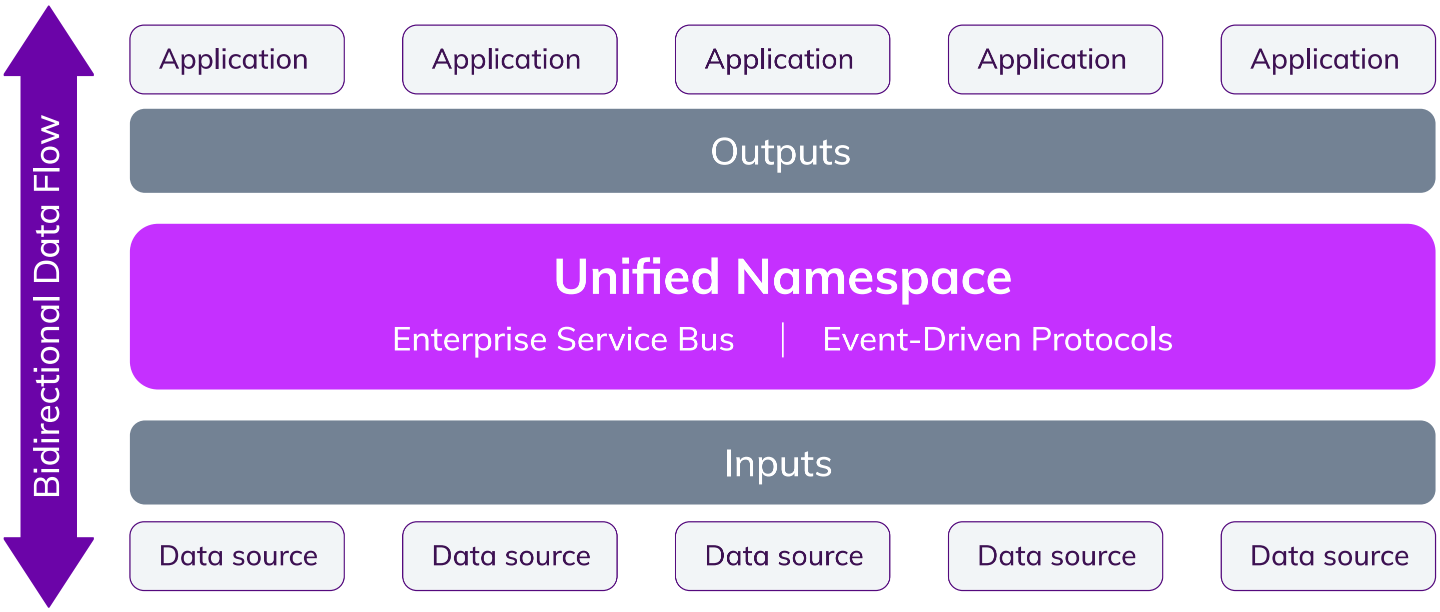
HMI and SCADA systems can play a crucial role in addressing these challenges by enabling data collection, contextualization, and secure integration within a unified namespace (UNS). By adhering to open standards such as ISA-95 / IEC 62264, organizations can effectively bridge operational technology (OT) and information technology (IT) systems, improving efficiency, visibility, and scalability.

UNS is a relatively new terminology that has come to the forefront of architecture design, so it is hardly a surprise that even people working in the industrial automation field can be unfamiliar with this term and the technology stack that typically comprises its architecture. UNS helps companies digitally transform the way they manufacture, improve, and distribute their products, elevating their digital maturity for smart manufacturing. This paper outlines practical steps for leveraging HMI and SCADA within a UNS framework.

Unified namespace introduction

UNS architecture connects devices to applications using an event-driven data exchange. In this exchange, data flows bi-directionally, providing a centralized hub for data access across the enterprise. The foundation of UNS is built upon the semantic hierarchy that digitally represents the business structure and how the business is organized.

UNS architecture provides a standardized real-time data exchange through a centralized namespace which allows for a loosely-coupled data sharing model that unifies the data needed by IT and OT systems. As a corporation digitally transforms and implements UNS, UNS creates intuitively accessible and contextualized data. In this way, UNS enhances transparency and democratizes information, empowering users at all levels.



HMI and SCADA introduction

Human machine interface (HMI) and supervisory control and data acquisition (SCADA) software are essential tools used to provide real-time data collection and visualization for industrial automation. Organizations use them to monitor, control, alarm, and optimize very complex processes across many vertical business types. Because HMI and SCADA software have been available since the development of modern computers and associated operating systems, there is a large and growing customer base for these tools, especially as corporations introduce more automation into their systems. This white paper is not intended to cover the differences between HMI and SCADA systems, as the terms have blurred due to advancements in their software processing capabilities and features, the type of hardware on which they run and intended locations where they perform. Rather, this white paper references HMI and SCADA collectively as a critical system for enterprises' process control.

As HMI and SCADA systems evolved towards design best practices, the International Society of Automation (ISA) formalized a standard across industrial verticals. ISA-95 is now a recognized standard, aligned to enterprise-control system integration, that defines an abstract model of the enterprise, the information exchange and the common terminology for the description of the enterprise layers, including the manufacturing control function and business process functions. Over the years, corporations have invested significantly in these systems, scaling these systems from relatively small projects with a limited dataset to an essential part of the OT infrastructure.

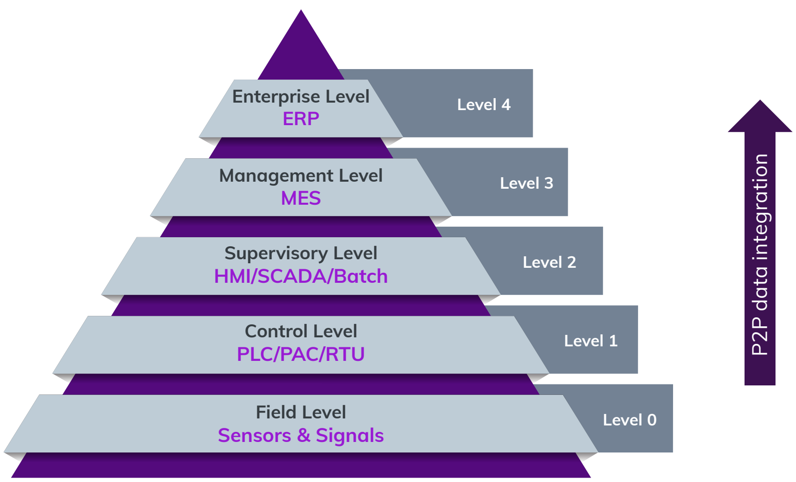
Challenges to data accessibility and standardization

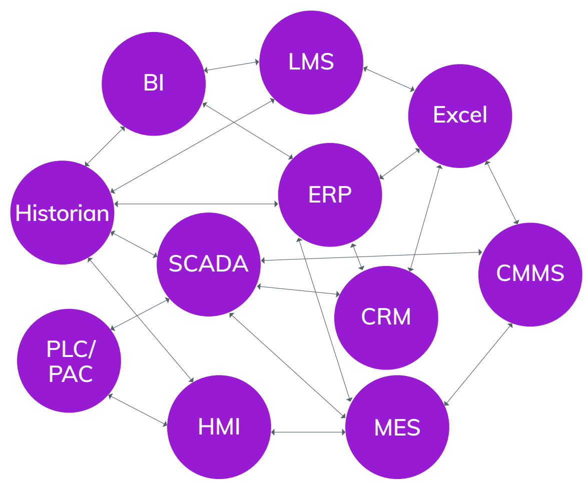
When industrial automation architectures aligned around ISA-95 standards for enterprise-control system integration, these systems typically used point-to-point data integration for their architecture design considerations. Many industries use this form of data integration as it is aligned with the best practices represented as a data flow pyramid and tied to the functional hierarchy defining the operational activities commonly used by manufacturing organizations.

This point-to-point integration approach is based upon each level being dependent upon the data held within the respective functional data repository, with the data passing bidirectionally through each level for data access and control.

This traditional approach to integration has served the industry well for many years, but due to the advancement of industry 4.0 and the industrial internet of things, including more edge-driven communication devices, the traditional point-to-point data flow is no longer an efficient means of integration.

These data flow complexities began to create data fragmentation, where data is often stored in silos across different systems which makes accessing data more difficult.

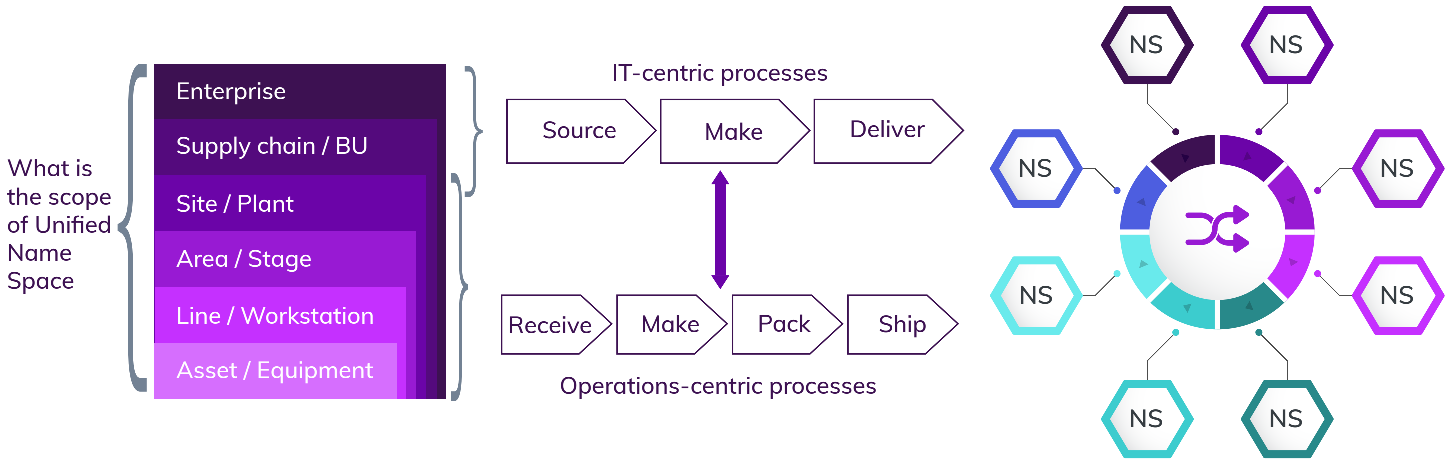




Additionally, there tends to be inconsistent naming conventions used in these various systems, which can lead to inconsistent structure and context creating software sprawl. In such conditions, organizations find it very difficult to maintain their systems and scale them into enterprise-wide solution architecture. To resolve this problem, many corporations have chosen the enterprise approach of enforcing a top-down naming convention standard by leveraging master data management (MDM) in enterprise resource planning (ERP) systems.

An ERP system is software that is integrated into an organization's day-to-day business activities and helps to manage and streamline its business processes by unifying various functions in a single platform.

However, it serves a completely different purpose than that of the namespace in process control systems. In the ERP system, MDM technology attempts to integrate a vast amount of data across various departmental functions (finance, HR, supply chain, manufacturing, sales etc). MDM often creates complex data structures which serve as a trusted master reference model linked to various data sources and is used to run business operations functions. MDM and its models align with IT standards used by the ERP system for data exchange and thereby create a level of abstraction for a proper naming structure that suits the business's needs.



This complex data model and namespace is quite different than that of the namespace allocations typically used within process control networks, which traditionally occur through DCS/PLC/RTU devices. These hardware devices were simple in their naming conventions and mapped via point-to-point integration with HMI or SCADA, where another level of naming standardization occurs, centered around a specific operational control task or operational area. Like the ERP system, HMI and SCADA software provides a layer of abstraction for naming standardization aligned with ISA-95 / IEC 62264 standards for enterprise-control system integration.

As companies embarked on industry 4.0 initiatives, teams confronted complex integration that slowed down the progress towards optimization efforts. Teams quickly identified that naming convention challenges were an issue—mainly due to systems' different needs and uses of the available data. They had to rely on lookup tables and database files to help them map the data between the different systems used on the IT side of the business and the OT side. This mapping created even more friction within organizations as many companies forced standardization from one side or the other—top-down, driven by the IT teams, or bottom-up, driven by the OT teams.

Furthermore, as organizations have integrated more intelligent devices as part of their industry 4.0 programs, duplicate data has proliferated throughout organizations. Businesses now must confront questions of data accuracy, since data has been dispersed from its source into many different systems. Sometimes this data contains different naming standards or context, which, in turn, leads to differing information sets when queried or reported, due to different source systems.

This misalignment of informational context can cause enterprise reporting and analytics to produce inconsistent results.

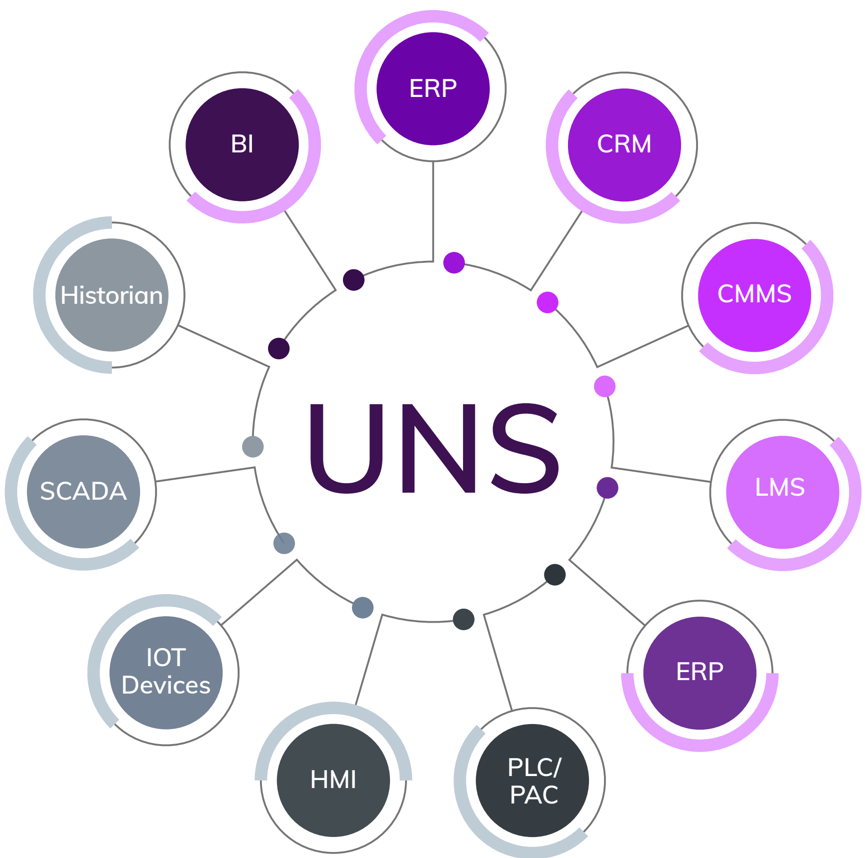
Another exacerbating factor of data fragmentation has been the data security measures that organizations have implemented. Corporations need to secure possible breach points, as their data is their competitive advantage. However, when organizations introduce departmental collaboration barriers amid these valid data security concerns, they only intensify this problem of data fragmentation.

UNS eliminates traditional integration challenges

UNS architecture design helps to eliminate the point-to-point integration complexities by leveraging a centralized event-driven communication hub, through which all real-time data passes. With this hub, there is now a location where the current state of the enterprise is accessible in a hub-and-spoke architecture. Event-driven communication protocols augment the UNS architecture as they are designed to allow decoupled communications for the transmission of asynchronously-published-and-subscribed-to data events.

Data events can be any type of signal or change-in-state of contents transmitted by an application or device.

These new technological advancements have helped the industrial automation field to progress and create a new level of efficiency and productivity. Now data is instantly available to any level that needs the information from within the pyramid structure, thereby bypassing the legacy rules put into place for data exchange.

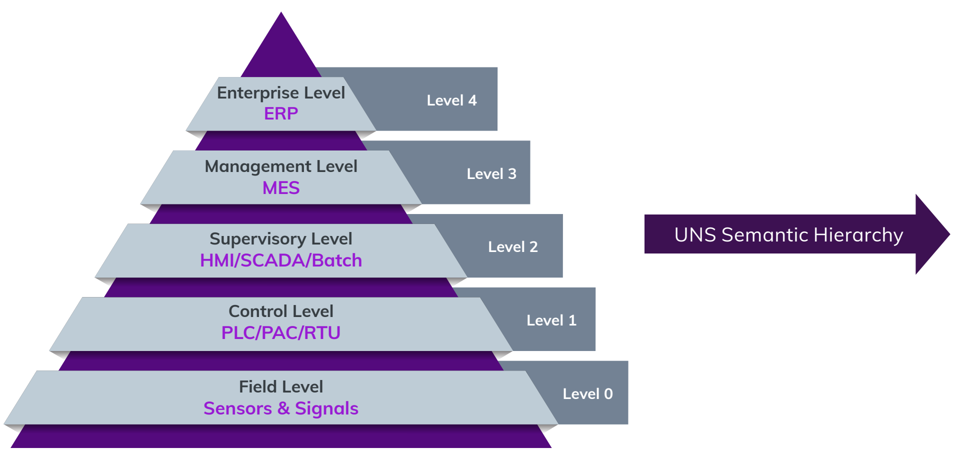


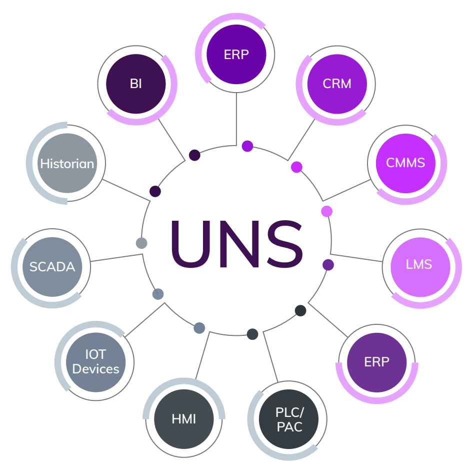
HMI/SCADA augment UNS design principles

Well-designed HMI and SCADA architectures are scalable and flexible, making them essentially future proof. The systems continuously adapt towards integrating a diverse set of hardware and software through a wide range of proprietary and open-standard communication protocols. As new technologies emerge, the standards and architectures quickly evolve towards ways to use these technologies with these best practices in mind. UNS design can now employ these tested, validated and documented systems for process control integration best practices and establish a foundation for future digital transformation.

Consider integration from levels 0-2 of the data flow pyramid. UNS design may disrupt the intended layered architecture from level 0-2, therefore leading to inefficiencies as these systems strategically prioritize real-time control, security, and reliability over other capabilities. Level 1 (control level) devices are also designed for real-time control and optimized with the correctly identified memory, processing power and storage allocated on these devices.

Level 1 devices are, though, ill-suited for handling the larger data sets that are needed or required by the higher-level systems. HMI and SCADA systems (level 2) ensure this level of optimization occurs with respect to level 1 (control level) device communications, which can also provide a level of abstraction and defense-in-depth protection for the data communication hierarchy, preserving the reliability of the two critically important integrated systems. Many of these HMI and SCADA systems are even distributed closely to the originating source and process the data at the periphery of the network. By acting as an edge-driven communication component, HMI SCADA publishes and subscribes to the UNS enterprise message broker or data hub directly while also maintaining a point-to-point connection to devices on the edge. Additionally, with this configuration, established hardware and software can remain in practical use for decades in an enterprise. There are many other use cases to consider where the level 0 and level 1 data is ideally suited for passing through a centralized location. The flexibility of the overall solution is the key to success with digital transformation.





Communication considerations for a UNS

HMI and SCADA systems acquire their data from a variety of sources and use a largediversity of protocols for flexibility in these communications. Based on the needs of the application, they may require a mix of traditional point-to-point architecture for communications alongside a hub-and-spoke architecture.

This also means that there are many variations of these event-driven communication standards available in the market. Some are more prevalent on the traditional IT as opposed to the OT side of the business. But all should be considered for use within a UNS architecture as, dependent on the use case, this allows for the use of best-in-class functionality. This simple design consideration also allows for flexibility in architecture design as we continue to see event-driven communication standards evolve towards their intended use cases. Once the event-driven communication protocol is selected, the data needs to be structured properly to ensure the relevant information, typically referred to as "the payload," is published. The message payload will then need to be processed by other systems and components, so it is important to also have rules that govern how the data is communicated and understood, which is called "the schema."

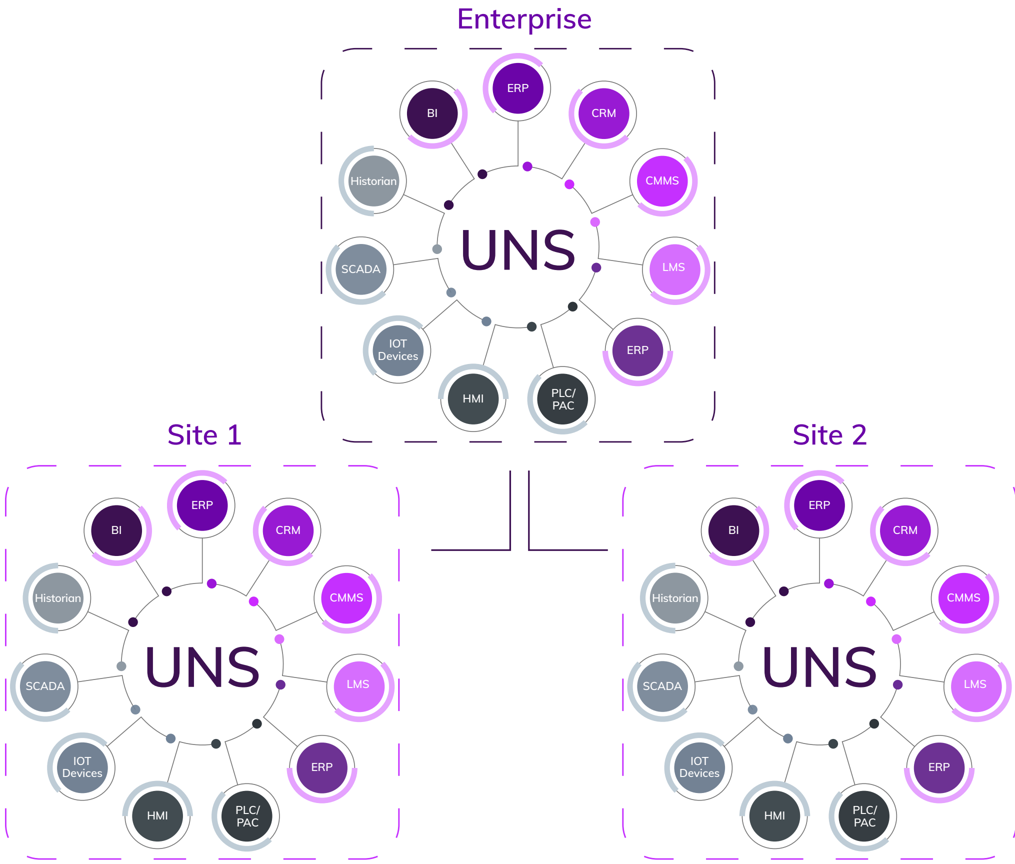
When creating a UNS, the schema is critical to help establish data consistency and accuracy so that the data can be efficiently sent to and interpreted correctly by the subscriber to the data events. HMI and SCADA systems already have well defined data events that can be identified as the payload for a UNS, as well as an established schema (based on part two of the ISA-95 standard) that can be used to help standardize and represent the process control information upon integration, providing the needed consistency and accuracy.

HMI and SCADA data considerations for a UNS

By using part two of the ISA-95 standards, HMI and SCADA systems create a hierarchal data structure. Acquiring real-time data and making associations and correlations to equipment, assets or location-based identifiers, HMI and SCADA systems create a digital representation of the processes that they are monitoring and controlling. This additional meta-data can then be used to trigger alarms or alerts, log events, historize values over time, make assessments for maintenance activities, or capture static data about the physical assets to which they are connected. This rich data set already provides a lot of great information that is clean and contextualized—that is, ready for publishing in the UNS.

HMI and SCADA systems can now begin to publish this information as payloads to the UNS with consistent and standardized publishing schemes, allowing for easier integration and onboarding of this system. HMI and SCADA can publish this data in the "namespace definitions" within UNS as any of three classifications: a functional namespace, an informative namespace or a descriptive namespace. These namespace allocations along with an additional ad-hoc namespace are used within the UNS to help organize the data further depending on the type of content, which can be placed within any level of the semantic hierarchy.

HMI and SCADA systems can publish to the descriptive namespace the type of static data that is typically held in this system, which may describe an asset, system, or static location details. They could publish PLC/RTU firmware revision numbers, or a nameplate of ownership, serial number or manufacturer ID of the machine associated with the real-time data. For maintenance considerations, HMI and SCADA may keep records of a time-stamped service date or interval number that represents a service rotation, which often is used within HMI and SCADA as a trigger to issue a work order for a maintenance task. Essentially, HMI and SCADA publishes to the descriptive namespace referenceable details that help to create identifiable context that could be static or, rarely changing data.



Unified Name Space (UNS)

Enterprise

- Functional namespace
- Information namespace
- Definitional namespace

Site 1

- Functional namespace
- Information namespace
- Definitional namespace
  - Area
    - Line
      - Cell

Site 2

- Functional namespace
- Information namespace
- Definitional namespace
  - Area
    - Line
      - Cell

The functional namespace allocation is where the HMI and SCADA system publishes real-time data to various levels of the semantic hierarchy. The real-time data is produced by the data source to which it is directly connected or the software system creating the data for an operational or business function. Examples of this data could include the operational data generated by the sensors and instrumentation, programmable logic controllers (PLC), building automation controllers (BAC), power meters, industrial internet of things devices, machine readings, or even batch software systems that operate in tandem with HMI and SCADA systems.

It can also include HMI and SCADA alarms, events, alerts, or system notification elements, as well as the configuration data that surrounds the structure of these alerts such as the alarm threshold states for triggers. Importantly, HMI and SCADA will provide not only the data value but also the timestamp for when the data was captured.

HMI & SCADA also includes quality indicator which represents how well the cache value matches the device value. This real-time value, time, quality (VTQ) data published to this functional namespace can now be quickly correlated as it sits directly next to the massive amount of related transactional data in the UNS semantic hierarchy, providing an instantaneous snapshot of the real-time state of the business.

The informative namespace, sometimes referred to as the informational namespace, is where the HMI and SCADA system publishes the data used to annotate the system displays. For example, some industries may view “green” as “open” and “red” as “closed.” However, in other industries these colors represent the opposite. With the informative namespace, teams can code colors as trackable contents to help to identify the information critical to dashboard creation. This type of data can be used to augment the presentation layer and often the standards used within the presentation layer to help operators perform their task while interacting with the equipment.

This informational data is often very relevant context for the UNS as it can be leveraged for other systems to help create common themes for system displays throughout the organization.

The ad-hoc namespace could be used by HMI and SCADA systems to publish data that might be considered the exception to the standard data held within the UNS semantic hierarchy. For example, there could be relevant data specific to one asset, such as a piece of equipment that is identical to the rest but has some variability that needs to be tracked on a temporary basis. An example of this could be a vibration sensor for use in a predictive maintenance pilot project. Another use of this namespace could be to align it with a downtime and maintenance period that occurs, where the temporary data needs to be provided to a separate, allocated namespace. That this ad-hoc namespace can be used for various purposes gives the system flexibility to evolve and scale.

AVEVA Operations Control

An end-to-end solution which helps support the integration of IIoT, edge computing, HMI, SCADA, Historian and Cloud based systems into a Unified Namespace (UNS) architecture. By aligning real-time data across traditionally siloed systems, UNS enables seamless communication and contextualized data sharing across the enterprise.

AVEVA Operations Control defines the productivity software necessary to run any modern real-time operations. AVEVA Operations Control combines process visualization, collaboration and digital knowledge sharing, advanced analytics, operational shift and regulatory reporting, and AI/ML into a comprehensive, unlimited operations software.

Conclusion

UNS architectures help to provide a planning process aligned with the digital transformation goals of the organization. Corporations can plan and construct an information architecture and associated centralized namespace that can be standardized and used across enterprise systems. Organizations can then use HMI and SCADA systems already in place—as well as other major systems—to help augment this digital transformation journey based on UNS design considerations.

About the author

Nathan Slider is a Product Manager at AVEVA for HMI & SCADA product offerings and regarded as a recognized subject matter expert, highly specialized in Supervisory Control and Data Acquisition Software (SCADA). He has over 20 years of experience from a global and diverse marketplace where the application use cases vary in degrees of complexity and use case considerations.
As an AVEVA Product Manager for the HMI & SCADA software portfolio, he contributes towards the lifecycle management of HMI & SCADA offers while defining the overall product vision, product strategy and roadmap in alignment with the larger portfolio.

He also works to help gather and prioritize product features based on feedback from customer requirements, industry segment leaders, other vertical-specific subject matter experts, along with internal collaboration with other industrial automation product managers to be able to work closely with R&D team members to deliver market winning products for the number one (#1) provider of HMI & SCADA software in the world! Additionally, he uses his real-world experience and expertise as a contributing member to the International Society of Automation - ISA 111 (Unified Automation for Buildings) & ISA 112 (SCADA Systems), where he helps develop standards, recommended best practices and technical reports for design implementation and operation of these systems.