APPLICATION NOTE

OPC UA FOR MEASUREMENT SYSTEMS

CONNECTING AUTOMATION AND DATA ACQUISITION

DEWETRON

ABSTRACT

The Open Platform Communications Unified Architecture (OPC UA) is a standardized, platform-independent communication standard that enables seamless data exchange between devices, machines, and software applications. Officially launched by the OPC Foundation in 2008, OPC UA has become the definitive backbone for Industry 4.0. Its core strengths include modern communication protocols, high security standards, platform independence, scalability, and manufacturer independence.

This whitepaper provides a comprehensive overview of how OPC UA operates and highlights its integration into high-precision measurement systems from DEWETRON.

INTRODUCTION

In modern industry, networking heterogeneous systems and machines from different manufacturers is a fundamental requirement for effective monitoring and control. Historically, a multitude of proprietary interfaces and protocols led to significant connectivity issues, high integration costs, and frequent data loss. To overcome these barriers, four major automation companies joined forces in 1995 and released the original OPC standard (now known as OPC Classic) in 1996. This initial version relied on Microsoft Windows COM/DCOM technology, limiting its deployment strictly to Windows-based systems.

To achieve true platform independence and fundamentally improve security and reliability for industrial architectures, the OPC Foundation redesigned the standard from the ground up. This resulted in OPC UA (Unified Architecture), officially released in 2008. With the native implementation of this standard, DEWETRON measurement systems seamlessly integrate into OPC UA networks, acting flexibly as an OPC UA Server to publish high-accuracy data or as an OPC UA Client to receive external data streams.

BASIC FUNCTIONALITY AND CLIENT-SERVER RELATIONSHIP

Industrial environments often feature a complex mix of legacy control systems, modern machinery, and IoT nodes. An OPC UA Server acts as a universal translator, consolidating data from various IoT platforms, gateways, and sensors into a single, unified language that the entire enterprise network understands. This classic architecture relies on a highly structured client-server relationship:

- The OPC UA Server maps out and exposes the system data (the address space) and waits for requests.
- The OPC UA Client initiates the connection, explores the address space via a browse interface, and requests specific data points.
- Beyond synchronous data polling, the client can establish subscriptions to receive data changes triggered by real-time events.

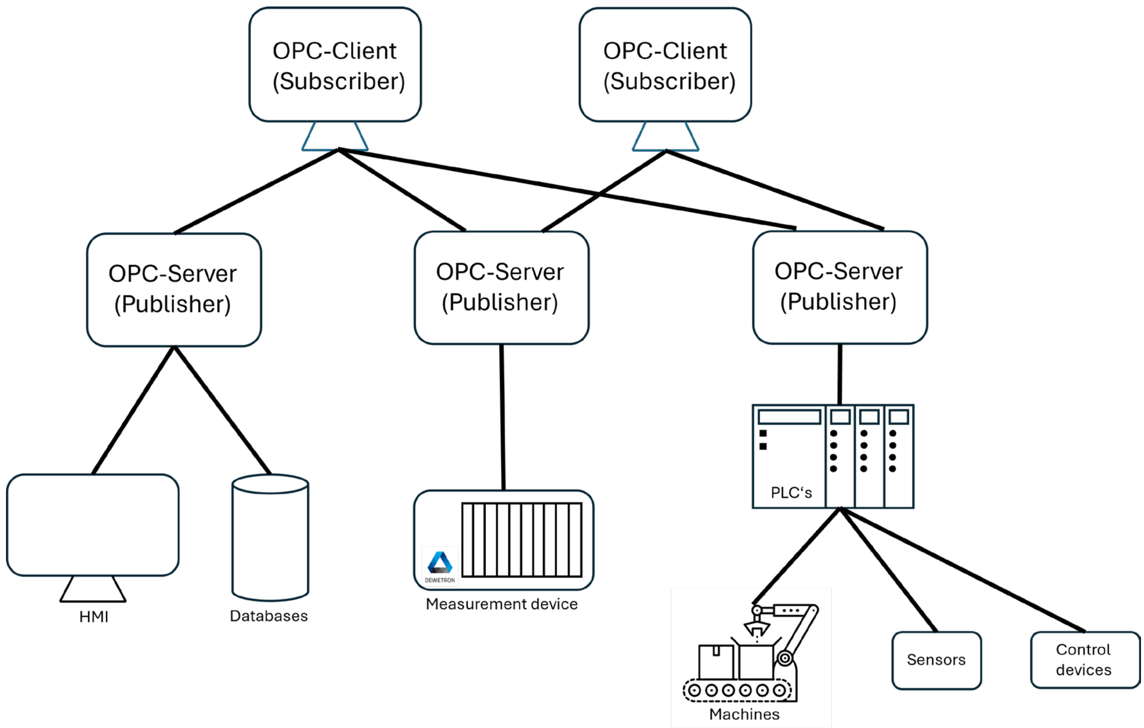

Fig. 1: OPC UA Schema

OPC UA SUBSCRIPTION MODEL

The OPC UA subscription mechanism is the most efficient data transmission method available within the standard. Instead of forcing the client to constantly poll the server for new data, the server pushes data only when a value has actually changed (Report-by-Exception). This drastically reduces network overhead and minimizes CPU utilization on both sides.

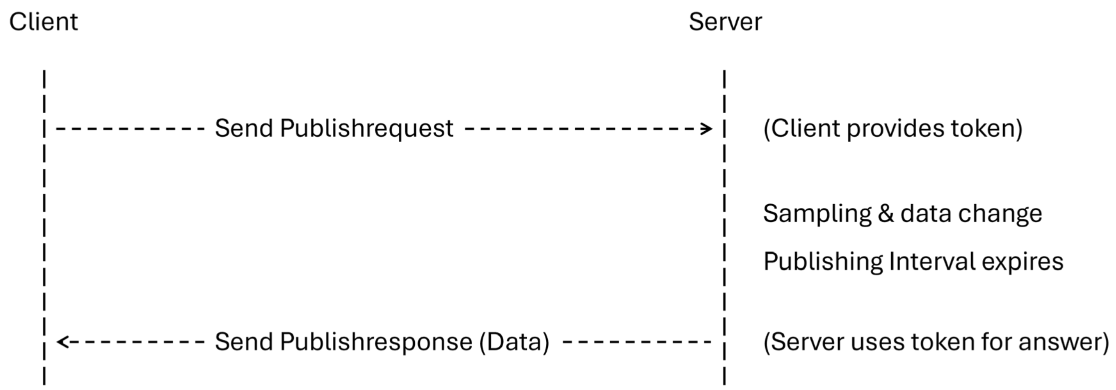

Fig. 2: Client - Server communication

Setup and Monitoring (Sampling)

- Subscription Creation: The client requests the server to set up a subscription with a specific publishing rate (e.g., Publishing Interval = 1000 ms).
- Adding Monitored Items: The client maps specific variables (e.g., voltage, current, temperature) to the subscription and defines how often the server should check the physical source (Sampling Interval = e.g., 100 ms).

- Sampling & Filtering: The server reads the sensor value at the defined sampling interval. It evaluates the value using a configurable noise filter (Deadband). Only significant data changes are pushed into the monitored item's internal queue.

Data Transfer (Publishing Mechanism)

Data transmission uses a specialized „push-on-trigger" token-passing mechanism:

- Publish Requests as Tokens: The client proactively sends multiple PublishRequests to the server. The server does not reply immediately; it holds onto them as active response tokens.
- Interval Expiration: When the publishing interval expires and the queues contain modified data, the server retrieves one of the pending PublishRequests from its stack.
- Data Transmission: The server bundles all recent queue changes into a single PublishResponse and returns it to the client, consuming the token.
- Keep-Alive: If no data changes occur before the interval ends, the server stands by. After a preset time frame (Max Keep-Alive Count), it sends an empty heartbeat message to verify it is online.

OPC UA SECURITY

A major advantage of OPC UA over legacy protocols is its built-in security architecture, which has been validated by independent security authorities like the German Federal Office for Information Security (BSI). It implements a multi-layered security concept addressing protection at the network, application, and user levels.

Transport Level (Firewalls, TLS, Port Blocking, IP Filtering)

Application & User Level (User Tokens, RBAC, Audit logs

Communication Level (X.509 Certificates, Sign & Encrypt, PKI)

Fig. 3: OPC-UA Security layer

Transport Security (Network Level)

Security begins at the network perimeter. Firewalls and IP access lists restrict connections to known automation components. The default port for binary OPC UA communication (opc.tcp://) can be isolated and monitored. Alternatively, the architecture supports encapsulation via HTTPS/TLS for secure web-routing.

Application Security (Secure Channel Layer)

Before any payload data is exchanged, application instances must verify their identities. This mutual authentication uses X.509 digital certificates, managed either via self-signed methods or a centralized Public Key Infrastructure (PKI).

OPC UA organizes data protection through distinct Message Security Modes:

- None: No encryption or signing is applied (restricted to test environments).
- Sign: Messages are digitally signed to guarantee data integrity and prevent tampering.
- Sign & Encrypt: Messages are both signed and encrypted using robust asymmetric (e.g., RSA) and symmetric (e.g., AES) algorithms, ensuring complete confidentiality.

Cryptographic suites are grouped into Security Policies (such as Basic256Sha256 or Aes256_Sha256_RsaPss) to stay aligned with modern IT security standards.

User Authentication and Auditing

Once the application channel is secure, the identity of the operator or client application is checked using User Tokens (Username/Password, User Certificates, or OAuth2/JWT tokens).

At the data node layer, role-based access control (RBAC) restricts permissions, defining precisely who can read, write, or execute specific system methods. Concurrently, integrated auditing logs all security-relevant operations to provide full traceability for compliance audits.

OXYGEN MEASUREMENT SOFTWARE

Seamless OPC UA Integration in Practice with OXYGEN

While the underlying architecture of OPC UA ensures high security and efficiency, implementing it in industrial environments often introduces significant configuration complexity. DEWETRON eliminates this barrier by natively embedding both an OPC UA Server and Client directly into its OXYGEN measurement software, reducing complex network deployment to an intuitive, plug-and-play workflow.

OPC UA integration provides a standardized and secure communication framework for data exchange between OXYGEN instances. Furthermore, OXYGEN is not limited to communication within its own ecosystem; it can interact with any third-party device, machine, controller, or software application that supports the OPC UA standard, ensuring maximum interoperability and future-proof system integration

OXYGEN as an OPC UA Server: High-Accuracy Data Provisioning

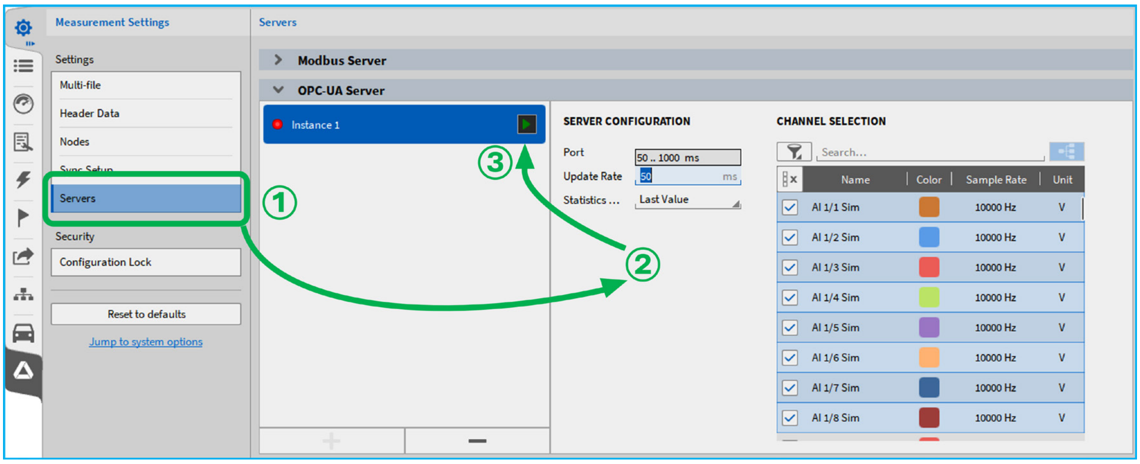

Fig. 4: OPC-UA Server in OXYGEN

Setting up a secure data stream from an OXYGEN-powered measurement system requires only three simple steps within the software user interface:

- Section Navigation: Access the dedicated server configuration panel directly within the system settings.
- Parameter and Channel Selection:
  - Flexible Channel Mapping: Users can select individual analog, digital, or calculated channels via simple checkboxes to define the server's address space.

- Bandwidth Optimization (Statistics Modes): To dramatically reduce network overhead, OXYGEN can transmit data not only as raw „last values“ but also via pre-calculated statistical metrics—such as minimum, maximum, average, or RMS values.
- Adjustable Publishing Rates: The server’s transmission frequency (publishing interval) can be adjusted precisely to match the deterministic requirements of the receiving client application.

- Instant Activation: Launching the live OPC UA Server requires a single click of the start button, immediately exposing the selected data nodes to the network.

OXYGEN as an OPC UA Client: Efficient Data Subscription

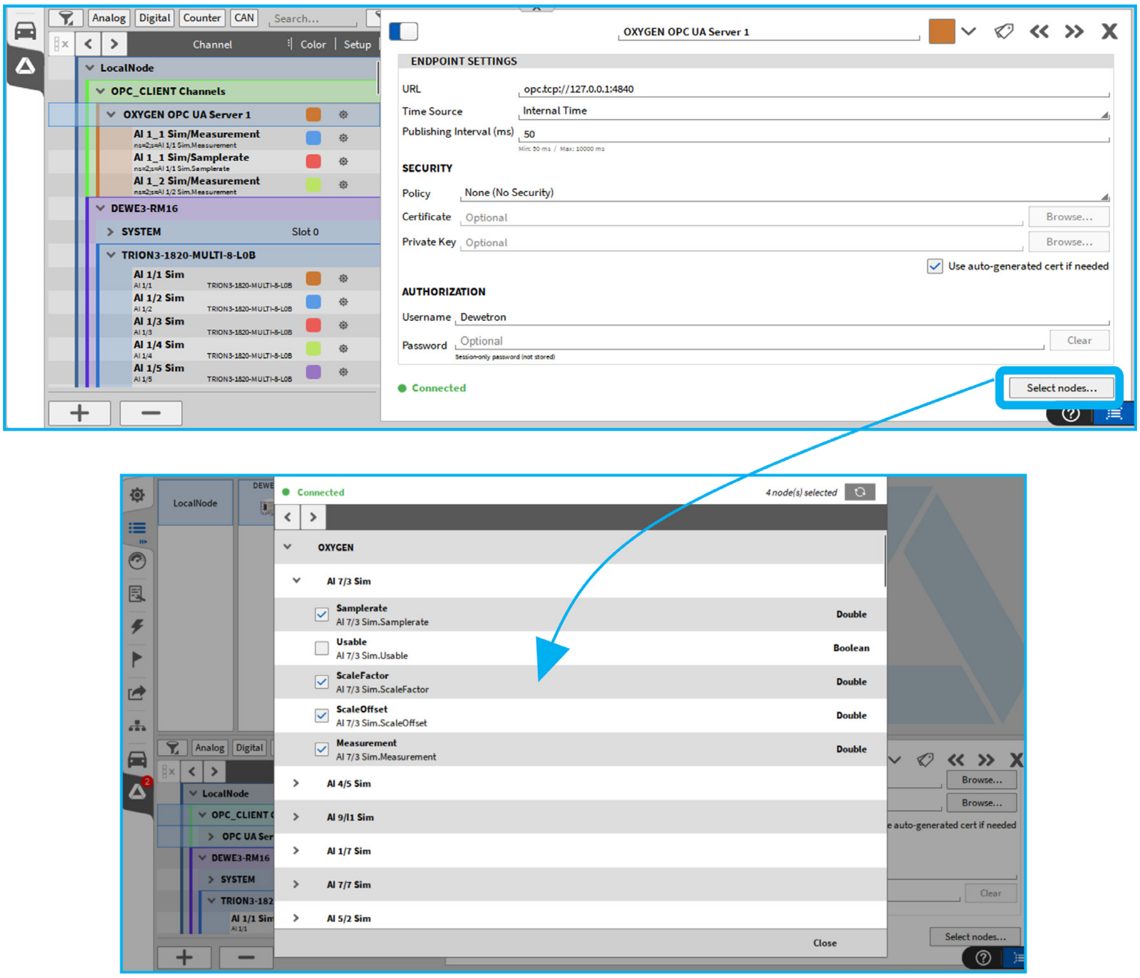

Fig. 5: OPC-UA Client in OXYGEN

When acting as an OPC UA Client, OXYGEN utilizes the highly efficient subscription mechanism to ingest external data streams without continuous polling overhead:

- Advanced Time Synchronization: Users can choose whether incoming data is time-tamped by the client (local measurement system) or the server (the external source system). This capability is critical for precise temporal correlation and phase-accurate data alignment on multi-system test benches.
- On-the-Fly Security Management: Cryptographic certificates and authentication parameters can be modified directly within the active session. Communication updates with the target server occur automatically in the background without requiring a system restart.
- Dynamic Metadata and Intuitive Browsing: Node selection is handled via an interactive browse interface that automatically generates channels using the minimal unique path of each node. Beyond raw measurement values, every monitored channel dynamically updates rich metadata—including data types, engineering units, display names, and measurement ranges—on the fly without interrupting active recording sessions.

By combining DEWETRON's high-precision DAQ hardware with the versatile connectivity of OXYGEN, operations can effortlessly acquire high-accuracy mixed-signal data while maintaining full monitoring and control capabilities across the entire industrial OPC UA network.

SUMMARY

OPC UA breaks down the boundaries of proprietary industrial protocols. Its efficient subscription model makes it an ideal fit for data-intensive, precision measurement tasks, while its mature security architecture ensures safe deployment within modern Industrial IoT (IIoT) frameworks. By embedding this standard natively into DEWETRON hardware and software, users benefit from a future-proof, highly precise, and completely secure data acquisition workflow.

AUTHOR

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Michael Fuchs has worked as an application engineer for a Graz-based company in the automotive supply industry since 2011. During his employment, he specialized in the post-processing of measurement data from emission test systems in accordance with global technical regulations. In 2022, he joined DEWETRON as an application engineer for automotive, e-mobility, energy applications, test benches, and general test and measurement solutions.

ABOUT DEWETRON

DEWETRON is a manufacturer of precision test and measurement systems and part of the globally operating Anritsu Group. Our reliable measurement data help customers worldwide make processes more predictable, efficient, and safer.

Our strength lies in customized measurement solutions: ready to use right away while remaining flexible to adapt to dynamic testing requirements in the energy, automotive, transportation, and aerospace industries.

More than 35 years of experience and innovation have made DEWETRON a trusted partner in the global test and measurement market.

More than 25,000 DEWETRON measurement systems and over 400,000 measurement channels are in continuous use at leading companies worldwide.

DEWETRON's quality is certified according to ISO 9001 and ISO 14001.
The high integrity of the measurement data is guaranteed by our own accredited calibration lab according to ISO 17025.

THE MEASURABLE DIFFERENCE.

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