OPC UA (Unified Architecture)

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1. OPC Unified Architecture

• New generation of OPC
• Replaces DCOM communication specific TCP/IP protocols
  – Enables OPC in any OS and language
  – Enables OPC in devices (embedded software)
  – Enables WAN (Secure Internet/Intranet/Extranet)
  – Improves Security Management

• Combines all previous protocols to a common (unified) data model

• Standardised 2011 as IEC 62541
2. Applications

- MES
- ERP
- Mobile Apps
- Alarm Beeper
- Custom App
- Control Center
- Device Driver
- DCS
- Historical database
- Trend Display
- Fieldbus protocols, OPC UA
- PLC, Field devices, etc.

OPC UA connections throughout the diagram.
3. Specification

- Layered design
3.1 Base Specifications

- Part 1 – Concepts
  - A short white-paper like overview of UA
- Part 2 – Security
  - A non-normative introduction to the threats and countermeasures
- Part 3 – Address Space Model
  - Building block constructs of UA (Nodes, Objects, Events …)
- Part 4 – Services
  - Service methods exposed by UA Servers and called by UA Clients
- Part 5 – Information Model
  - UA defined objects (e.g. Diagnostic Object, Audit Events)
- Part 6 – Mappings
  - Details that allow implementation on current technology (e.g. UA Binary, HTTPS)
- Part 7 – Profiles
  - Defines conformity groups for implementation and certification
3.2 Information Model Specifications

- **Part 8 – Data Access**
  - Adds OPC-DA constructs (e.g. Engineering Units, Ranges…)

- **Part 9 – Alarms and Conditions**
  - Adds stateful Alarm and Condition types

- **Part 10 – Programs**
  - Adds long running executable entities

- **Part 11 – Historical Access**
  - Adds Historical Data and Event constructs

- **Part 12 – Discovery**
  - Details about UA Discovery Servers and interaction with UA apps

- **Part 13 – Aggregates**
  - Aggregating functions for e.g. Historical Data
3.3 Companion specifications

- OPC UA For Devices (DI)
  - Common model for devices and components

- OPC UA For Analyser Devices (ADI)
  - Information model for analysers (spectrometers, chromatographs, etc)

- OPC UA For IEC 61131-3 (PLCopen)
  - Information model for PLC devices

- OPC UA For ISA95
  - Information model for MES/ERP data

- BACNet, AutomationML, AutoID, MDIS, etc.
4. Basic Information Model

OPC UA Object

- Variables
  - ___
  - ___
  - ___

- Methods
  - ___()
  - ___()
  - ___()

- Events
  - ⚡
  - ⚡
  - ⚡

OPC DA and HDA

Variable Services

OPC A&E

Event Services

OPC Commands

Method Services

OPC Subscriptions
4.1 Address Space

- Combines the old DA & AE address space information
- Network, Plant & other hierarchies available at the same time
4.2 Type Information

- Servers also declare supported data types in the address space.
- Servers may define custom data types.
- Standard information models can be defined in server address spaces:
  - FDT
  - PLCopen
  - ISA S95/88
  - MIMOSA
  - ...
5. Communication Model

- **Abstract UA Model Specification**
  - Business Model, Adaptable to Platform Independent Messaging Models (e.g. WSDL)
  - Scalable Platform Independent Messaging Model
  - Portable C/C++ Version
  - Java Version
  - .NET (WCF) Version

- **WSDL / SOAP or TCP / Binary Services Binding**

- **Proxy / Stubs**
  - Tool or Language Dependent (e.g. .NET)

- **API**

[Thomas Burke]
5.1 Protocols

- **Transport**
  - TCP/IP
  - HTTPS (New: 1.02)
  - HTTP
- **Messaging**
  - UA TCP, optimized binary protocol
  - HTTPS, binary/XML encapsulated in standard HTTP
  - SOAP, generic messaging (Deprecated: 1.03)
- **Message Security**
  - UA Security (UA TCP)
  - TLS Security (HTTPS)
  - Web Service (WS) Security
- **Message encoding**
  - UA Binary
  - UA XML
- **Open for additional protocols in future**

(IP Port numbers not fixed)
5.2 Security

• OPC Unified Architecture includes full public key based security features in OPC clients and servers
  – Authentication of client & server applications by X.509 certificates
  – Authentication of users by X.509 certificates or UserName/Password or external tokens
  – Optional message signing & encryption
• Binary and HTTPS communication via one (configurable) TCP/IP port, which can be opened in Firewalls as necessary
• Alternative security algorithms defined for signing and encryption
• HTTPS protocol enables standard TLS security applied
• OPC UA Proxy and Wrapper components can be used to “tunnel” DCOM-based OPC traffic securely
5.3 Robustness

• Keep-alive (heartbeat) messages
  – Clients can detect a connection failure

• Life-time monitoring
  – Servers can detect connection failures

• Message buffering
  – Clients can detect missing data
  – Missing messages can be re-requested

• Redundancy support
  – Can be built to both clients and servers
6.1 Server Profiles

- OPC UA Profiles defined to allow clients and servers with different capability levels
- Applications define which profiles they support, e.g.:
  - Subscriptions
  - Security
  - Redundancy
  - Data Access
  - Alarms & Conditions
  - Historical Access
- Compliance testing verifies applications against the supported profiles
- End-users can purchase products that include the functionality they need by looking at the supported and certified profiles
6.2 Development Platforms

- **AnsiC**
  - UA Binary communication
  - HTTPS communication
  - Open SSL Security
  - Platform specific parts (Windows, Linux, etc)
  - SDKs for C/C++ (Unified Automation, Softing)

- **.NET**
  - UA Binary communication
  - HTTPS communication
  - (HTTP/SOAP communication with WS Security)
  - .NET Security
  - SDKs for .NET (Unified Automation, Softing, etc.)

- **Java**
  - UA Binary communication (pure Java)
  - HTTPS communication
  - Java Security
  - SDK for Java from Prosys
6.3 Application capabilities

- Communication Stacks provide interoperable communication
- SDKs provide standard implementation of UA services
6.4 UA & DCOM

- Smooth transfer of application technology from DCOM OPC to UA should not be a problem
- UA Proxy & Wrapper components enable communications between UA and DCOM versions of OPC applications
- UA Gateway
  - commercial implementation
References, literature


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