Understanding OPC: Basic Overview

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Understanding OPC: Basic Overview

Agenda – 60 Minutes

- Original problem – How to share data
- Original solutions
- OPC Solution
  - Open and Industrial
  - Client/Server Architecture - COM
  - PC to PC connections – DCOM
  - What can you do with OPC Now
- Answers to some common questions
- Future Direction
- Questions & Answers
Original Problem: How to share data?

1) How to share data from equipment like PLC’s?

2) How to share data between programs and PC’s?
Connectivity means…. 

Enterprise Application
Accessing plant-floor data

User Interface
displaying plant-floor data

Transport Layer
Ethernet, RS232, RS485, Radio etc.

PLC / Device
Allen-Bradley, Siemens, GE, Modbus, Automation Direct etc.
1) How to share data from equipment like PLC’s?

Each vendor has implemented their own Protocol driver.

Inconsistent implementations, i.e. features supported and reliability

Vendor A HMI / SCADA
- Modbus Driver
- DF1 Driver
- Other Driver

Vendor B HMI / SCADA
- Modbus Driver
- DF1 Driver
- Other Driver

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2) How to share data between programs and PC’s?

- Data inaccessible to other systems
- Self-customization limitations, or inability
- Expensive customizations often required
- Data sharing via *.CSV import/export
First Solution, DDE

- Protocol drivers were no longer within HMI
- DDE Server contains protocol definition
- HMI connected using DDE Topics
- HMI tells DDE Server “read this”, “write that”
- DDE Server responsible for all I/O
- Different HMIs can connect to a DDE Server
- Some Data sharing possible
DDE, Scalable Solution?

- Different systems can connect to a DDE Server
- Accessible over the Network using NetDDE
- Add more DDE Servers
  - More device support
  - Load distribution
DDE, Good Solution?

- Decoupled HMI from Protocol drivers
- DDE Server market emerged
- More “driver” choice
- HMI vendors could focus on their core product
- Accessible to Any DDE Application

- Performance issues
- NetDDE reliability
- No Standards on tag database
- No Browsing!
- No quality information
- No Client control of Poll rates
- No timestamp
- No security
- Not easy for network configuration and usage
- Limited number of client/topic connections
A Standard Was Needed!

- Software to Software interface (Problem 2)
- Keep Client/Server model used with DDE
- Better performance needed
- Security needed
- Needed to support more sophisticated data types (variants and structures etc.)
- Needed to be more scalable
- Internet capable
- A more “future-proof” framework was needed
OPC, the new Standard

- OPEN Standards based
- The OPC Foundation controls the standards
- Automation Industry Organization
- Not controlled by any one company – managed by board of directors elected by the membership
- Volunteer effort
- Created 1996 – by 6 founding members
- Companies from all over the globe
- Software Toolbox - a charter member, joining in the foundation’s first year
OPC, the Promise

- Industrial Automation Focus
- Timestamp support
- Quality flags – Ensuring Data Integrity
- Interoperability: Testing & Certification
- Client/Server architecture
- Scalable solution
- Flexible means of data access
- Easy for end-users
- Security using Microsoft standards
OPC Solution, Similar to DDE, but better

- Same client/server architecture
- OPC Server contains protocol definition
- Tag Database clearly defined
- HMI makes OPC calls to tell the Server saying "read this", "write that" and how often
- Performance gains
- Quality and timestamp information now accessible
- Easy configuration for the end-user.
• Standard software to software interface
• One connection: OPC
• Communications infrastructure decoupled from the HMI/SCADA
• Microsoft Security
• Improves performance
• Flexibility
• Choices
What’s in a Tag/Item?

- OPC Server exposes PLC memory addresses as “Tags”
- Tags are a friendly name, that maps to a memory register in the PLC.
- Decouples the OPC Client from the underlying Device Protocol and Memory Register knowledge.
Browse computer for available OPC Servers
Browse the server for available Tags
Read 1..x Tags in a single call
Write 1..x Tags in a single call
Subscribe to Tags and receive updates when their value(s) change.
OPC DA, Data Acquisition

- **Synchronous I/O**
  - Blocking call
  - Good for round-robin polling-type applications

- **Asynchronous I/O**
  - Faster method, compared to Synchronous
  - Development requires different way of thinking

- **Different Locations**
  - Cache
  - Device

Read these 1…x Tag(s) one time, TELL ME when you have results.
OPC DA, Data Acquisition

- Subscriptions offer best optimization
- OPC client requests a subscription
- OPC Server does the polling
- OPC Server sends change notifications to the client

These tags have changed values....
OPC Quality Codes

- Specifies if the Tag value is something you can trust or not.
- 16-bit Bitmask of values (*low 8 bits*):
  - 0 = Bad (00000000)
  - 64 = Uncertain (01000000)
  - 128 = Reserved (10000000)
  - 192 = Good (11000000)
- High word is reserved for Vendor use.
OPC, How does it Work?

- Any OPC Client
- HMI/SCADA
- Custom Application

- OPC Client connects to an OPC Server.
- Client adds a “Group”.
- Client adds “Tags” to Group.
- The poll-rate is set in the Group.
- You can add multiple Groups.
Client/Server and OPC DA

- The Client Consumes data services
- The Server Provides data services
- COM is the Middle Man
- OPC Servers and Clients in most cases are separate programs now
- OPC Servers only act on commands from an OPC Client
 OPC, Dependent upon COM

- An OPC Client connects to an OPC Server through COM
- An OPC Client connecting to an OPC Server on a different machine connects through DCOM and must be authenticated.

PC – 1 OPC Client

I want to connect to you.

Tell me your login name and password!

My user name is "fred" and password is "*****"

Let me check my Access Control List….

Yes, you are on my list… I will grant you access!
OPC DA, Scalable Architecture

- A server can support multiple Clients, concurrently
- Many servers can exist on the network
- Attach OPC Systems to other OPC Systems
Can I use OPC across different Domains?
Does re-configuring DCOM open security holes on my computer?
Does a Tunneller help get OPC data through a firewall and over the internet?
How do I know if my PLC/Device is offline?
Can OPC work on Linux?
Is OPC DA still valid now OPC UA is coming?
How much data can an OPC Server transfer?
Can OPC Servers run as Windows Services?
OPC, more than 1 standard

- OPC Data Access (DA)
- OPC Historical Data Access (HDA)
- OPC Alarms & Events (A&E)
- OPC XML Data Access (XMLDA)
- OPC Data Exchange (DX)
- OPC Complex Data
- OPC Commands
- OPC Security
OPC Provides Industry-Standard interoperability Performance & Connectivity

ERM, SAP ... Corporate Enterprise

Manufacturing, Production and Maintenance

OPC

Adv. Control

HMI

MES

SCADA

Batch

PC-Based Control

OPC (DCOM)

PLC
DCS

Industrial Networks

Data Acquisition

Other... (DB, SQL)

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OPC, Quality Assurance!

- OPC Compliance Testing
- Interoperability Testing
  - Annual event
  - Vendors attend with source code
- OPC Self-Certification
- Independent Test Lab Certification

Learn more about OPC Certification:
http://www.opcfoundation.org/Certification.aspx
Future Direction

**OPC UA**
- Single, abstract set of objects
- Backward compatible with all existing OPC standards
- Service Oriented Architecture (SOA)
- Embeddable, within a PLC/Device
- Security and encryption built-in
- Designed to take plant-floor data to the Enterprise.
What Does OPC UA Mean for OPC DA?

OPC UA Doesn’t Replace OPC DA/HDA/A&E
It Complements Them!
Want to learn more?
“Using OPC” Webinars

◆ Using OPC DA Applications:
  www.softwaretoolbox.com/opcdawebinar

◆ Building OPC Applications in Visual Studio.NET
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Some Terminology

- **HMI** – Human Machine Interface
- **SCADA** – Supervisory Control & Data Acquisition
- **OPC**
  - OLE for Process Control (circa 1996)
  - Openness, Productivity, Connectivity
  - Today, the acronym underlying words is meaningless – OPC a standardized technology is for open software connectivity in industrial automation
- **COM** – Component Object Model – circa mid 90’s Microsoft term for the way Windows software parts talk to each other under the hood
- **DCOM** – Distributed COM – same concept but allowing software parts on different computers to talk to each other
More Terminology

- **PLC** – Programmable Logic Controller – hardware used to control many industrial processes and machinery
- **DCS** – Distributed Control System – used for same purposes as a PLC, but highly optimized for process control, i.e. chemicals, oil/gas, food/beverage, pharmaceutical
- **RTU** – Remote Terminal Unit – traditionally proprietary hardware – today PLCs can be used for RTU’s – any device put in a remote location that controls and/or gathers data for collection at a central host – usually a SCADA system
- **Protocol** – as set of defined instructions or commands used to exchange data with a device over a serial or Ethernet connection
- **Register** – a memory location in a PLC or DCS. To some a register is a 16 bit word of data. Often used generically to refer to a memory location in any type of device you are exchanging data with
- **Tag**, or Item – a single unit of data – can be digital or analog values, in some cases can even be arrays of digital or analog values