

 **OPC UA**™ **Device Support**

Connecting Controllers

Ralph Lange, ITER Organization

Disclaimer: The views and opinions expressed herein do not necessarily reflect those of the ITER Organization

Motivation

Existing EPICS interfaces to Siemens S7 PLCs:

- s7plc: TCP Data Block Transfer
 - needs programming on the PLC
 - complete data blocks only
- s7nodave: Snap7 based (S7 protocol)
 - no need for PLC side programming
 - access to the whole PLC memory
- Both work fine, but have disadvantages
 - low level configuration (byte offsets into data blocks)
-> address mismatch may have drastic consequences!
 - pretty specific/proprietary solutions

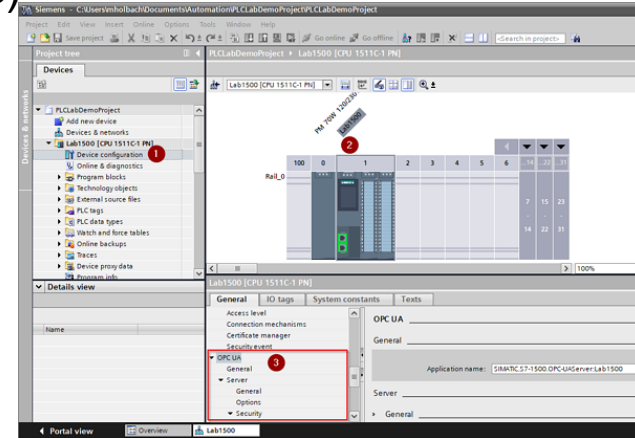
Requirements / Wish List

- Symbolic addressing
 - names, not numbers
- No PLC programming
 - keep contractors happy
- Industrial standard
 - one to connect them all
- Portability
 - at least Linux, Windows
- User-defined structures
 - for reusable PLC objects
- Subscription mechanism
 - update on change
- Server-side queues
 - handle bursts well
- Browsing support
 - find variables easily
- Security (TLS, X.509)
 - encrypt, sign, authenticate
- Remote procedure calls
 - with parameters and results



OPC UA

- Industrial standard (2006) to interface SCADA to PLCs
 - Covers data, alarms, events, historical data, remote methods
- Based on OPC Classic (Microsoft; 1996), plus
 - Portability → UA does *not* require DCOM/Windows like Classic
 - Safety/security (authentication, encryption)
 - Information modeling (user defined structures)
 - Remote method execution
- Gaining momentum in industrial context as universal integration standard
- Siemens S7-1500 series PLCs include an embedded OPC UA server

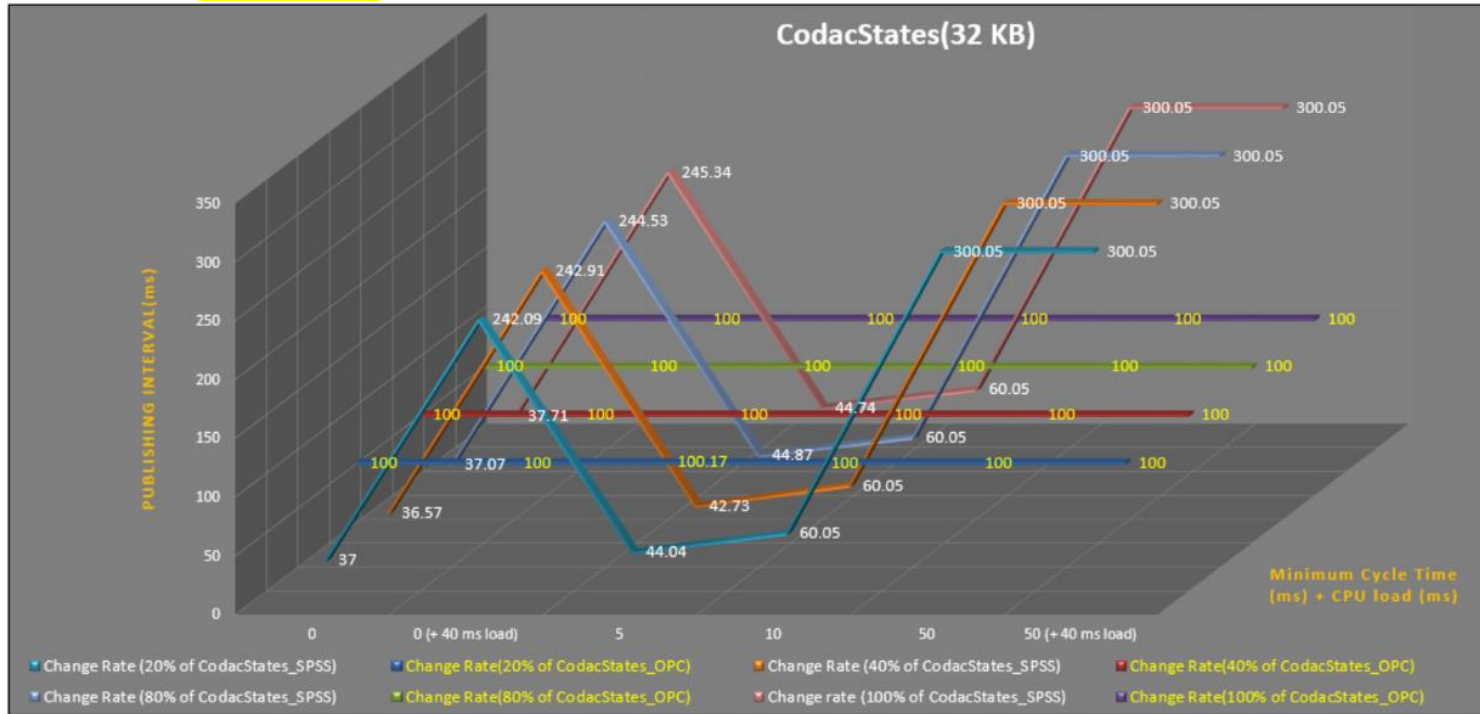


Performance

- It all depends – mostly on the server

early tests by TCS, comparing TCP Data Block transfer with OPC UA:

“big” S7-1518, 32kB data (integers), “empty” / 40ms cycle artificial load



Performance

- Test in 2021 for ITER building automation integration
 - Trying to verify realistic conditions
 - 3x the estimated size (500kB data, mixed types)
 - On a mid-size S7-1516
 - 250ms sampling/publishing period
 - No performance fine-tuning
- Results:
 - Fit for this purpose
 - Best performance when using few large structures

Limitations

- Mostly found on the server end
 - S7-1500: depends on the model (S/M/L) and data organization
 - How many, how large, how often?
 - Client-side fine tuning available
 - e.g., “registering” items to cache server-side name resolution*
 - Servers separate from PLCs introduce additional latency
- Found one limit in the client
 - LabView serving 600 arrays of 7500 doubles each (~36MB data)
 - > SDK client has a limit of ~16MB for the serializer
 - workaround: 3 subscriptions of 200 arrays each

EPICS Device Support

- Based on commercial C++ Client SDK by Unified Automation
 - 4k€ for source code and 1 year support (extend support: 20% per year)
one developer/many products or many developers/one product
 - Binaries can be deployed/distributed royalty-free
 - Platforms: Windows and Linux
 - Evaluation bundles available
- Evaluation of client library options and Device Support prototype
Bernhard Kuner (HZB/BESSY)
- ITER use cases tested by F4E (Spain) and TCS (India)
 - Against S7-1516/1518 embedded OPC UA server
 - Against WinCC-OA embedded OPC UA server

Status

- Requirements Specification v1.1: <https://bit.ly/opcua-srs-11>
- Design done (still no formal doc)
- Implementation nearly complete
 - All basic data types and arrays thereof (*read/write/subscribe*)
 - Supporting all applicable record types (bidirectional outputs)
 - User-defined structures (*read/write/subscribe*), timestamps from data
 - Server-side queues, configurable connection behavior
 - OPC UA Security (encrypt, sign, authenticate)
Lots of testing help by Roland Fleischhauer (HZB/BESSY)
 - Integrated end-to-end test against a software server
Work by Ross Elliot and Karl Vestin (ESS)

Users

Facility	OPC UA Server	Status
ASIPP	LabVIEW	production
	PLC Siemens S7-1500	production
Australian Synchrotron	PLC Siemens S7-1500F	near production
	PLC Siemens S7-1500	production
BESSY II @HZB	Phoenix Contact	production
	Softing uaGate	production
	PLC Siemens S7-1500	development
CHIMERA @CCFE	LabVIEW	development
	PLC Siemens S7-1500F	production
ESS	ABB Power SCADA	near production
	Siemens DESIGO	development
	Kepware KEPServerEX	testing
Fermilab	PLC Siemens S7-400	development
	PLC Siemens S7-1500	testing
IPR	PLC Siemens S7-1500	production
	Siemens WinCC OA	production
	PCVue	production
ITER	LabVIEW	prototyping
	PLC Siemens S7-1500	development
KATRIN @KIT	PLC Siemens S7	production
	PLC Beckhoff	production
PSI		
Varian ProBeam		

Roadmap

- Currently working on:
 - Merging the integration of (free) open62541 client library
Work by Dirk Zimoch (PSI) and Carsten Winkler (HZB/BESSY)
- Soon:
 - Support for OPC UA methods (remote execution of PLC code)
 - User Manual
- Under EPICS license
- Upstream repository and statically linked binaries containing the UA client (shared libraries to link against your IOCs):
<https://github.com/epics-modules/opcua>