OPC UA Device Support

Spring 2024 Update

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

OPC UA Features

- 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 (X.509)
  - encrypt, sign, authenticate
- Remote procedure calls
  - with parameters and results

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 Siemens 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 UA SDK 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

History

- 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

- Current implementation, using a design that allows integrating different low-level client libraries

- Recent major contributions from PSI, HZB/BESSY and ESS

Low-Level OPC UA Client Choices

- Stable: Use of 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
  - Newest versions (1.7.9 and 1.8) have issues

- Experimental: Use of free open62541 SDK client libraries
  Work by Dirk Zimoch (PSI) and Carsten Winkler (HZB/BESSY)
  - Not trivial to set up
  - More complexity on the Device Support side
  - Less documentation than the UA SDK

Status

- Requirements Specification v1.1: https://bit.ly/opcua-srs-11

- Design done (no formal doc yet)

- Implementation nearly complete
  - All basic data types and arrays thereof (*read/write/subscribe*)
  - Supporting all applicable EPICS 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 (as of 2022)

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

Roadmap

- Started:
    - Wiki pages: List of servers that have been integrated with "useful tricks"
    OPC UA users: This needs your help !!

- Currently working on:
    - Integration of (free) open62541 client library
    first part merged (v0.9.5); second part is in an open Pull Request;
    will be available in next release
    Work by Dirk Zimoch (PSI) and Carsten Winkler (HZB/BESSY)
    - User Manual
    ~30% done: Integration of README files and Cheat Sheet
    work still on a branch; first merge for the next release

Roadmap

- Currently working on:

  - Extend support for arrays
    Ensure that both client libraries handle both types of OPC UA arrays,
    add support for arrays of structures
    Work by Dirk Zimoch (PSI)

  - Support for server-side run-time changes of OPC UA structures
    Work by Karl Vestin (ESS)

- Soon (fall 2024):

  - Support for OPC UA methods (remote execution of PLC code)

Download

- Under EPICS license
- Upstream repository, Wiki pages, binaries (future manual):
  https://github.com/epics-modules/opcua

!! The GitHub download area has statically linked binaries
containing the UA SDK client
(i.e., shared libraries to link your IOCs against)
  - Easy to use, fully functional, free forever
  - Needs to match your Linux distro and EPICS Base versions