



ICALEPCS 2015

International Conference on Accelerator
& Large Experimental Physics
Control Systems

Standards-Based Open-Source PLC Diagnostics Monitoring

Brice Copy
CERN Engineering Department, CH

THHD3005

22nd October 2015

ICALEPCS 2015 - MCEC, Melbourne, AU



What are your PLCs up to when you're not home ?

- I/O Performance issues ?
- Intermittent cycle time issues ?
- Maintenance flags ?
- Unreported diagnostic messages ?



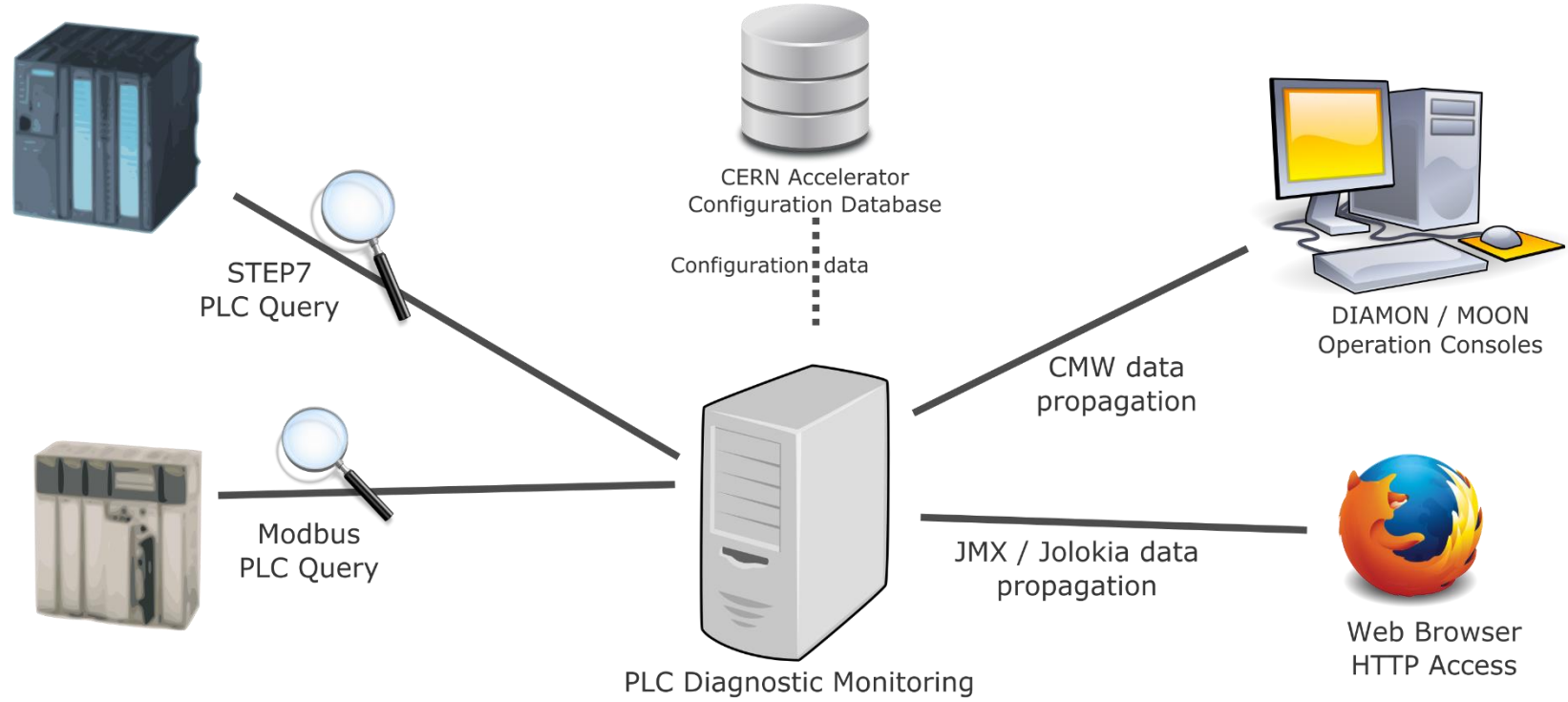


Collecting diagnostics information from PLC devices ?

- Proprietary access to diagnostics data, how to get to it ?
- Mixed brands and models of devices, how to manage your inventory ?
- Where to aggregate this information ?
- How to impact as little as possible process management ?



PLC Diagnostics Agent





Open-source diagnostics solutions

- CERN employs primarily two brands of PLCs :
 - Schneider Electric Unity series
 - SIEMENS Step7 series
- Schneider equipment supports diagnostics via plain Modbus
- SIEMENS equipment supports diagnostics via Step7
 - LIBNODAVE is an open-source Step7 client library that allows the retrieval of internal diagnostics.



Collecting and propagating metrics

- The PLC Diagnostics Agent queries diagnostics information regularly :
 - Propagates the resulting information through Publisher modules (DIM, CMW but also JMX and HTTP/JSON for third-party compatibility)
 - Publishes its own heartbeat for continuous availability
 - Provides metadata about the PLC monitoring process itself (probe count, number of devices under monitoring, last known replies etc...)



Collecting and propagating metrics (2)

← → × <https://moon.web.cern.ch/moon/>

SBS	IceDev	IceInf	ExpCool	ExpCryo	MCS	NA62	REMUS	TE	VAC
-----	--------	--------	---------	---------	-----	------	-------	----	-----

Overview Alarms Daily reports Long-term reports Alarm Statistics Notifications Subscriptions

- [-] SBS
 - [+] CIET
 - [+] CIRCUIT
 - [+] CRYO
 - [+] Central
 - [+] P2
 - [+] P18_182
 - [+] Supervision
 - [+] PLCs
 - CFP-BA7-QSD
 - CFP-PM18-QUI
 - CFP-PM18-QURCB
 - CFP-PM18-QURCBCC
 - CFP-SD18-COM
 - CFP-SD18-QSRB
 - CFP-SHM18-QSAB
 - CFP-SHM18-QSCB
 - CFP-SHM18-QSCCB
 - [+] P18_12
 - [+] P2_22
 - [+] P2_23
 - [+] P4
 - [+] P6
 - [+] P8
 - [+] CV
 - [+] LHC
 - [+] P1
 - [+] P18
 - [+] Supervision
 - [+] PLCs
 - CFP-2165-FSSF18
 - CFP-3183-FSRF18
 - CFP-3183-FSST18
 - CFP-2184-USSH18

CFP-SHM18-QSAB

[LAN DB Info](#)

Manufacturer: SCHNEIDER

IP: 172.18.24.6

PLC Time: PLC CURRENT TIME: 20/10/2015 00:34:12



Collecting and propagating metrics (3)

The screenshot displays the Java Monitoring & Management Console window, titled "Java Monitoring & Management Console - cs-ccr-moni:9010". The "MBeans" tab is selected, showing a tree view on the left and a table of attribute values on the right.

Tree View (Left):

- cern.ice.plcMonitoring
 - Agent
 - COL
 - CRYOEXP
 - CRYOPLC
 - CV
 - GCS
 - PICWIC
 - RF
 - TEEPC
 - VACUUM
 - PLC
 - alimcp001
 - alimcp003
 - atlmcp100
 - atlmcp102
 - atlmcp103
 - cfp-150-ciwleir1
 - cfp-152-gcslinac4
 - cfp-157-gcscloud (selected)
 - Attributes
 - Operations
 - Notifications
 - cfp-157-useast
 - cfp-163-cr
 - cfp-170-ciwviso1
 - cfp-170-ciwviso2
 - cfp-170-vrex01
 - cfp-180-fsdemi
 - cfp-192-usb192
 - cfp-193-vad01
 - cfp-197-fsed
 - cfp-198-fsem
 - cfp-198-fsep
 - cfp-198-ushie
 - cfp-199-ushiebat170

Name	Value
Category	GCS
Connected	false
ConnectionStatus	1
DiagString	PLC Last Stop: 17/09/2015 16:27:00 (Code 0x0004: Power outage or memory card lock operation) CPU ...
Hostname	cfp-157-gcscloud
InMonitoringError	false
InfoString	IP: 172.18.236.224Commercial version of Processor: 3.00Firmware version of Processor: 4xway address...
IpAddress	172.18.236.224
LastKnownError	
LastKnownQueryResults	{SC_CONN=1, SC_MODE_RUN=1, SC_MCB_APP=1, SC_BATT=0, SC_MCB_DAT=0, SC_IE_IO...
MetricsPrefix	SC_
ModeRun	1
Name	cfp-157-gcscloud
PlcTime	PLC Current Time: 21/10/2015 00:41:38
PlcType	DRIVER_TYPE_MODBUS
ReplyStatus	1
SleepTime	0

Refresh



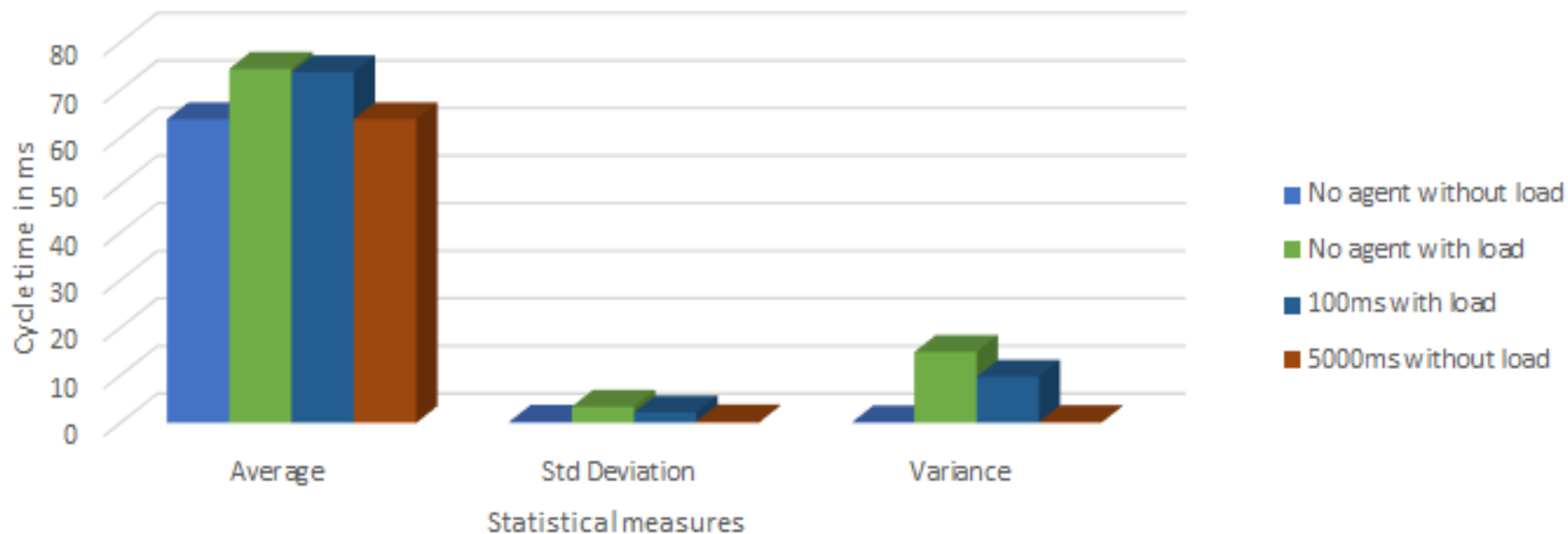
Impact on device under monitoring

- Performance measurements over 3 000 cycles :
 - Diagnostics probe cycle tested at 200 Hz and 0.2 Hz.
 - Impact is negligible on high-end devices.
 - Significant but manageable on low-end devices.
- Stability measurements over 3 000 000 cycles.
 - PLC process control was not affected.
 - Resource usage is kept to a bare minimum (one active connection, poll every 30 seconds).



Impact on device under monitoring (2)

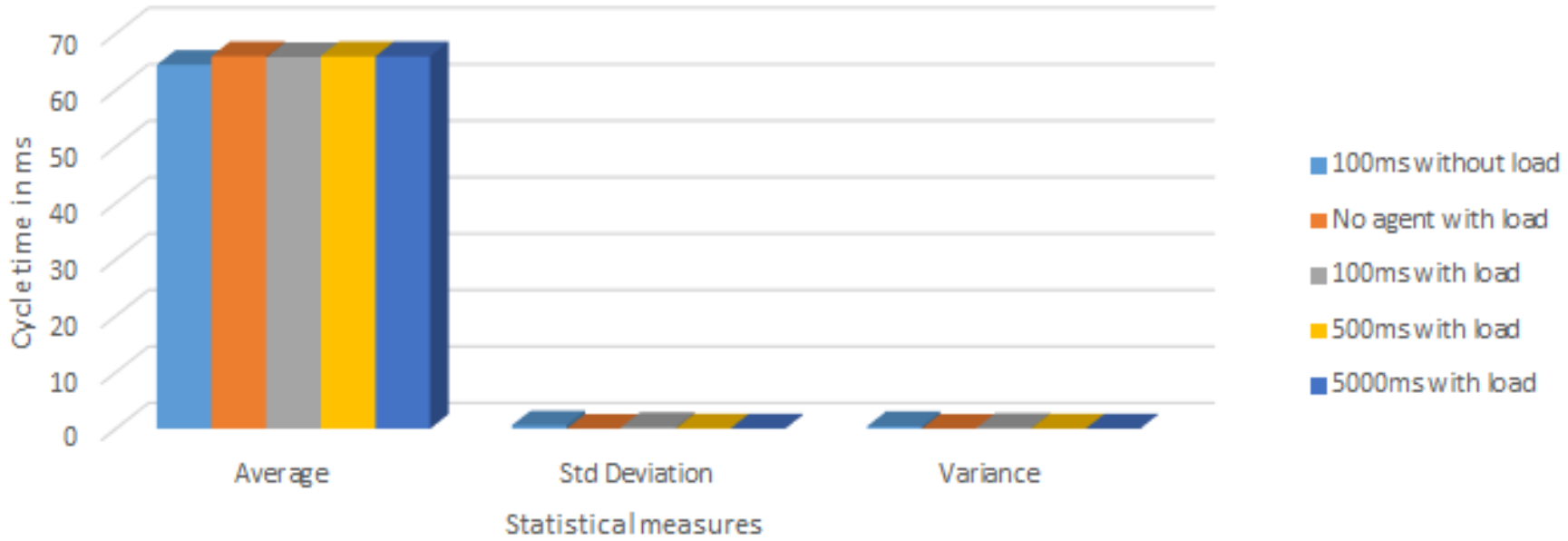
Impact of Diagnostics Monitoring on a SIEMENS PLC S7-315-2PN/DP





Impact on device under monitoring (3)

Impact of Diagnostics Monitoring on a SIEMENS PLC S7-414-2





Conclusions

PLC Diagnostics Agent can easily be integrated in your environment :

- Single Linux RPM package or DockerFile, deployable on any Linux platform.
- Device inventory configuration via local JSON or CSV files.
- Publication of diagnostics data via Java Monitoring Extensions or HTTP / JSON (via Jolokia)
 - Integration with the ELK Stack (ElasticSearch / Logstash / Kibana) for the rapid production of availability dashboards.



Questions ?

- Thank you for your attention.



Media attributions

- "Dog shaming" by PPE - Flickr: Shameful Dogs. Licensed under CC BY-SA 2.0 via Commons - https://commons.wikimedia.org/wiki/File:Dog_shaming.jpg#/media/File:Dog_shaming.jpg
- "Globe of Science and Innovation, Cern" by Tryfon Kar - Own work. Licensed under CC BY-SA 3.0 via Commons - https://commons.wikimedia.org/wiki/File:Globe_of_Science_and_Innovation,_Cern.jpg#/media/File:Globe_of_Science_and_Innovation,_Cern.jpg
- "Siemens Simatic S7-416-3" by Mixabest - Own work. Licensed under Public Domain via Commons - https://commons.wikimedia.org/wiki/File:Siemens_Simatic_S7-416-3.jpg#/media/File:Siemens_Simatic_S7-416-3.jpg