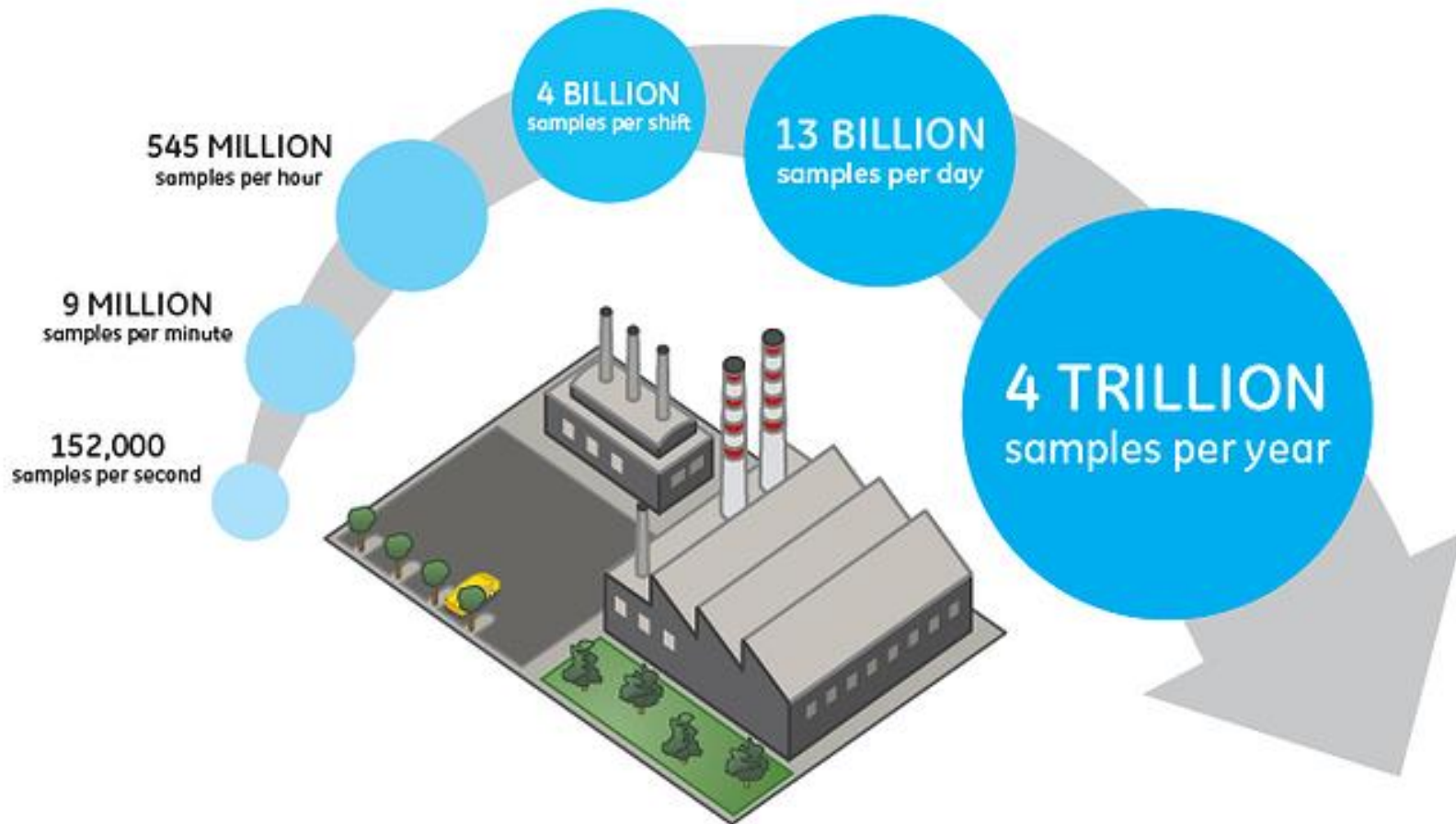




Dr.-Ing. Thomas Goldschmidt, ABB Corporate Research, Ladenburg, Germany

The Automation Cloud

Motivation



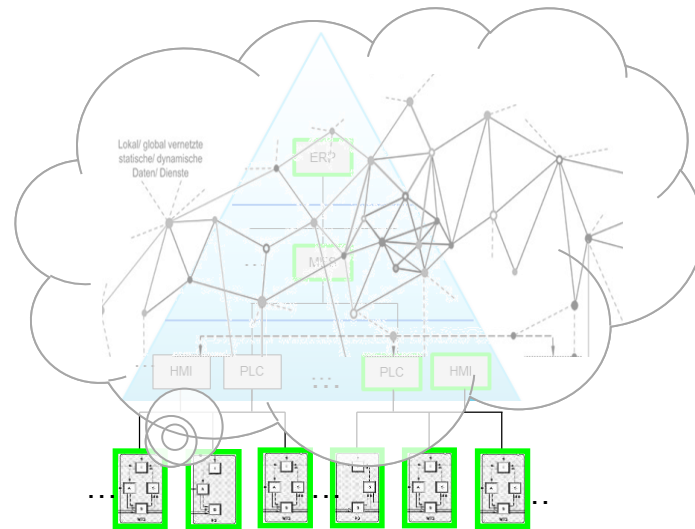
Source: GE White Paper on Industrial Internet



Application Cases

Application Cases Overview

- Embedded Systems
 - PLC, RTU, IED (for low-level, fast control)
 - Cloud-managed firmware updates
- Information Systems
 - SCADA, MES, ERP, etc.
 - Cloud with common data storage enables fleet management, social engineering, preventive maintenance
- Mobile Systems
 - Mobile apps for maintenance personal and operators
 - APIs for third party extensions



SCADA Advantage on the iPhone

SCADA Systems

ABB SCADA Vantage for Oil & Gas Industries



ABB SCADA Vantage | **LUFKIN SAM RPC** | User: A42 SAM

Well Name: **A42 SAM** | Motor Status: **Running**
 Connectivity: **Normal** | Well Status: **Normal**

Programming/Calibration Parameters

Max. GP	DPFL	MPL	
4	5	3	
Consecutive Malfunctions Allowed	0	0	0
Cumulative Malfunctions Occurred	0	0	0
Consecutive Malfunctions Occurred	0	0	0

Peak (Maximum Load) - Pounds: **26000** | **21630** | **21000**
 Minimum Load - Pounds: **5500** | **4600** | **4320**

Hours	Minutes	Seconds
0	0	0

Start Window: **6** | **0** | **0**
 Gauge Off Time - Production/Event: **0** | **0** | **0**
 Power On DLY: **0** | **0** | **0**
 Time On Time Mode: **3**
 Time Off Time Mode: **5**

Load	Position	Strokes	
30288	65	0	
Malfunction Setpoint	18061	47	10

Pump Diameter - inches: **1.75**
 SWT Klavort: **1.00**

Elapsed Time: **00** | **00** | **00**

STEP START | OPERATOR | CONTROL
 Host ON | Normal | Shutdown
 STOP | Normal | Surface
 START | Trip | Shutdown
 Motor | Motor

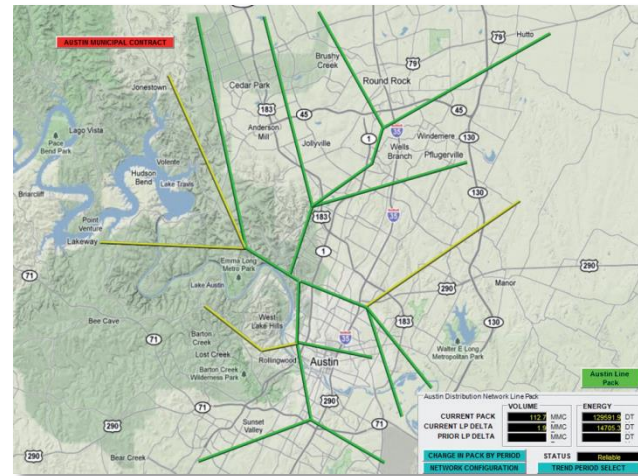
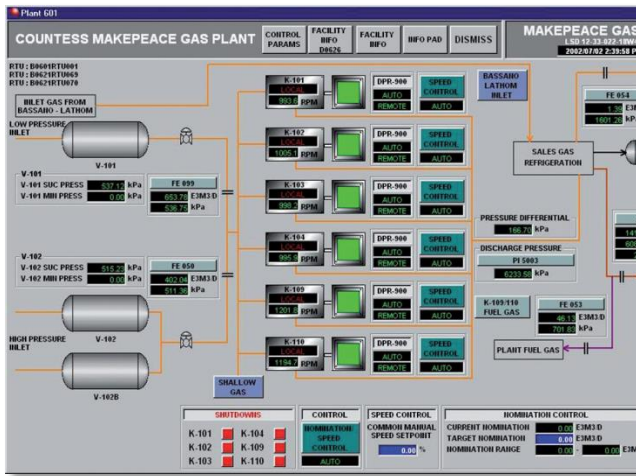
DYNOCARD | Info Pad

ABB | EXIT | Logout | SCREEN | Report | Comm | ESO | Other | NE/SE | General
 Change PW | Login | Alarms | AREA 300 | System | Event Log | Aman | Falak | Meliha



SCADA Systems

ABB SCADA Vantage for Oil & Gas Industries



[APPR00] Hourly Gas History Properties [Meter000-001]

General | Trend | Parameters | 48 rows

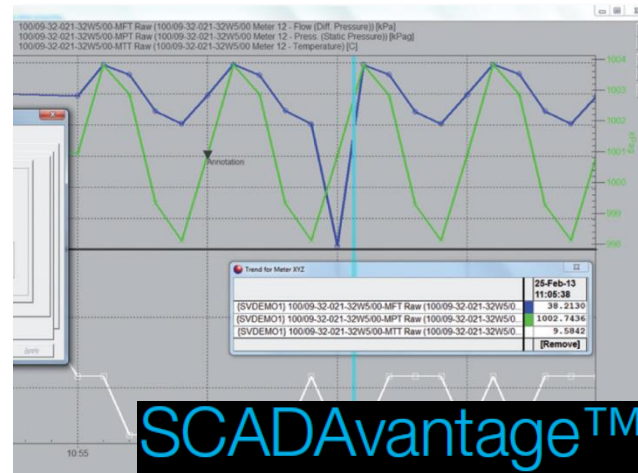
Meter Id: Meter000-001 Date From: 7/4/2011 Date To: 7/5/2011

Filter: None currently applied

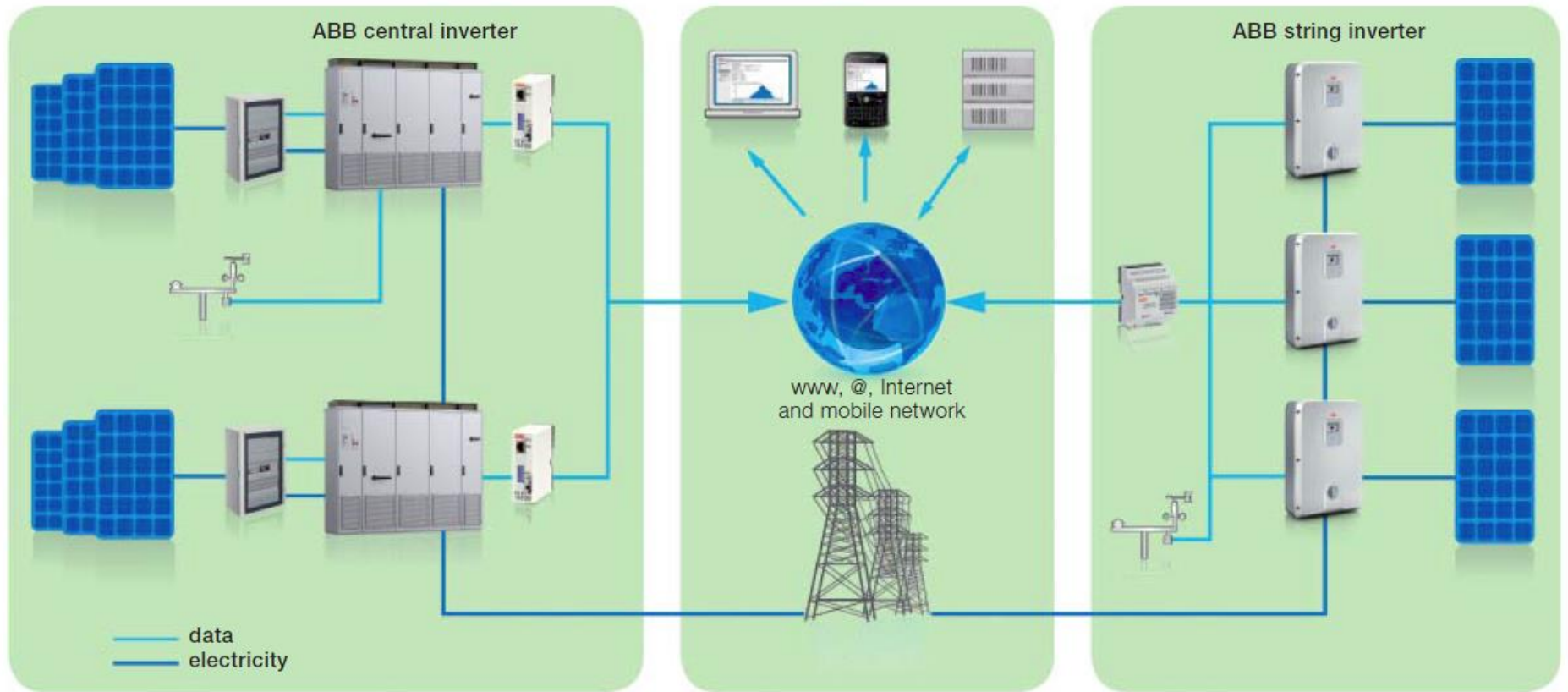
Hourly Meter History

Meter [x-1]	Date For	Volume (cuhr)	Differential Pressure (kPa)	Static Pressure (kPa)	Temperature (C)	Time on Production (hrs)	Pulse Count	Quality	Reason for Change
Meter000-001	Jul-05-2011 07:00	140.07	11.07	9100.07	50.07	95.01		Original	
Meter000-001	Jul-05-2011 08:00	140.06	11.06	9100.06	50.06	95.01		Original	
Meter000-001	Jul-05-2011 09:00	140.05	11.05	9100.05	50.05	95.01		Original	
Meter000-001	Jul-05-2011 10:00	140.04	11.04	9100.04	50.04	95.01		Original	
Meter000-001	Jul-05-2011 11:00	140.03	11.03	9100.03	50.03	95.01		Original	
Meter000-001	Jul-05-2011 12:00	140.02	11.02	9100.02	50.02	95.01		Original	
Meter000-001	Jul-05-2011 13:00	140.01	11.01	9100.01	50.01	95.01		Original	
Meter000-001	Jul-05-2011 14:00	140.00	11.00	9100.00	50.00	95.01		Original	
Meter000-001	Jul-05-2011 15:00	140.23	11.23	9100.23	50.23	95.01		Original	
Meter000-001	Jul-05-2011 16:00	140.22	11.22	9100.22	50.22	95.01		Original	
Meter000-001	Jul-05-2011 17:00	140.21	11.21	9100.21	50.21	95.01		Original	
Meter000-001	Jul-05-2011 18:00	140.20	11.20	9100.20	50.20	95.01		Original	
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Meter000-001	Jul-05-2011 21:00	140.17	11.17	9100.17	50.17	95.01		Original	
Meter000-001	Jul-05-2011 22:00	140.16	11.16	9100.16	50.16	95.01		Original	
Meter000-001	Jul-05-2011 23:00	140.15	11.15	9100.15	50.15	95.01		Original	
Meter000-001	Jul-05-2011 00:00	140.14	11.14	9100.14	50.14	95.01		Original	
Meter000-001	Jul-05-2011 01:00	140.13	11.13	9100.13	50.13	95.01		Original	
Meter000-001	Jul-05-2011 02:00	140.12	11.12	9100.12	50.12	95.01		Original	
Meter000-001	Jul-05-2011 03:00	140.11	11.11	9100.11	50.11	95.01		Original	
Meter000-001	Jul-05-2011 04:00	140.10	11.10	9100.10	50.10	95.01		Original	
Meter000-001	Jul-05-2011 05:00	140.09	11.09	9100.09	50.09	95.01		Original	
Meter000-001	Jul-05-2011 06:00	140.08	11.08	9100.08	50.08	95.01		Original	
Meter000-001	Jul-05-2011 07:00	140.07	11.07	9100.07	50.07	95.01		Original	
Meter000-001	Jul-05-2011 08:00	140.06	11.06	9100.06	50.06	95.01		Original	
Meter000-001	Jul-05-2011 09:00	140.05	11.05	9100.05	50.05	95.01		Original	
Meter000-001	Jul-05-2011 10:00	140.04	11.04	9100.04	50.04	95.01		Original	
Meter000-001	Jul-05-2011 11:00	140.03	11.03	9100.03	50.03	95.01		Original	
Meter000-001	Jul-05-2011 12:00	140.02	11.02	9100.02	50.02	95.01		Original	
Meter000-001	Jul-05-2011 13:00	140.01	11.01	9100.01	50.01	95.01		Original	

1 Unavailable | About Request | Update History | Save | Cancel

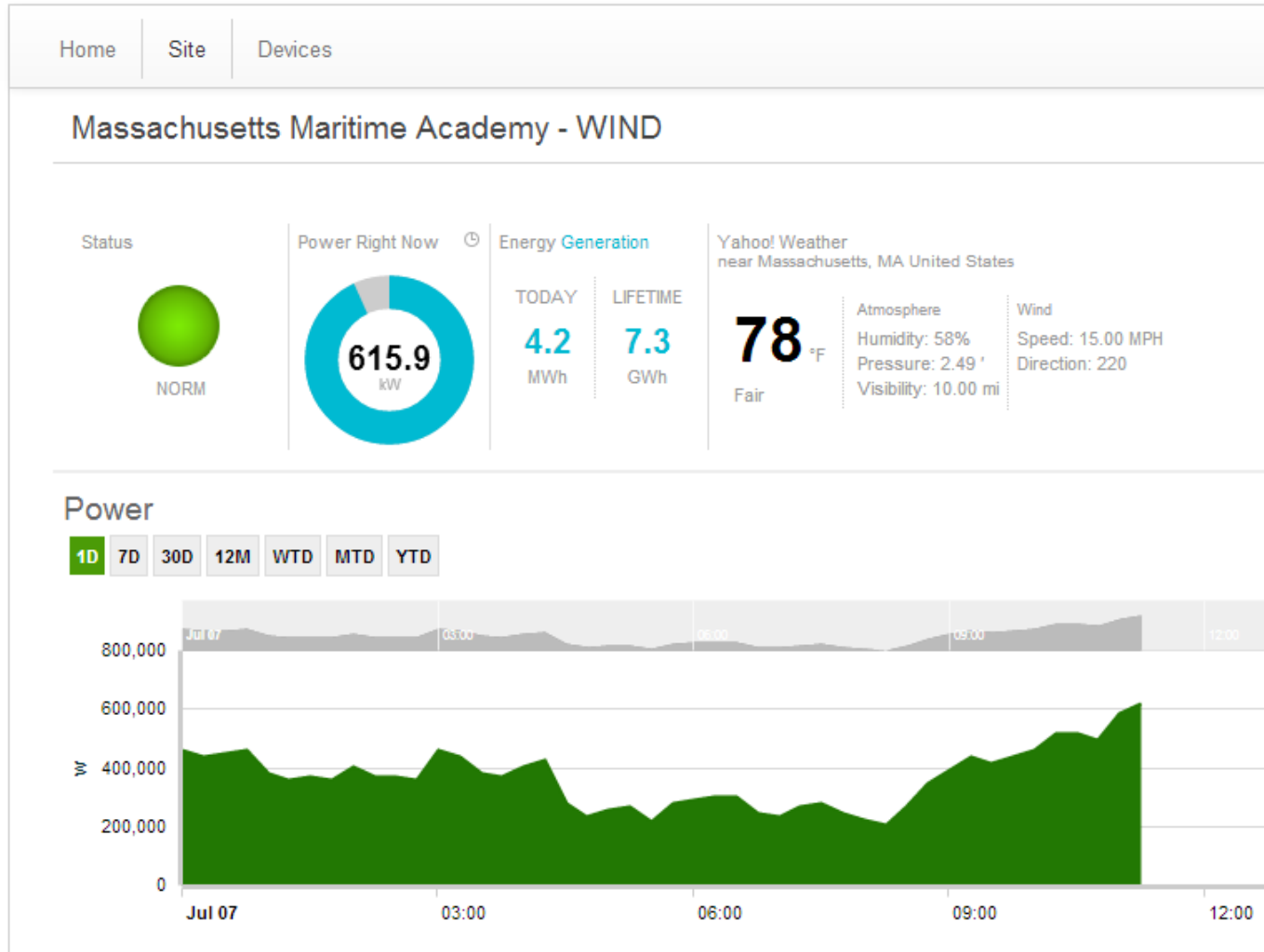


Remote Monitoring Solar Inverters



Remote Monitoring Aurora Vision Portal

Plant Viewer



EV Fast Charging



EV Fast Charging

ABB Power and automation for a better world™

Web solutions

The modules below provide you with greater insight into the status, configuration and statistics of your chargers.

Home | My Chargers | Statistics | Card Management | My Chargers Map

Search: [Search All] [Search] [Advanced Search...]

Create New: [Dropdown]

Recent items: [List of items]

Analytics Live Chargers

Map of the Netherlands showing charger locations. A tooltip for a charger in Eindhoven shows: Name: 06 Jan 2011, Charger status: Unknown.

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ABB Power and automation for a better world™

Web solutions

The modules below provide you with greater insight into the status, configuration and statistics of your chargers.

Home | My Chargers | Statistics | Card Management | My Chargers Map

Search: [Search All] [Search] [Advanced Search...]

Create New: [Dropdown]

Recent items: [List of items]

Charts

Number of charge sessions per day, accumulated for all chargers

Start Date: 23-8-2013 11:48 | End Date: 23-8-2013 11:48

[Refresh Chart] [Export]

Energy delivered (kWh) (Left Y-axis, 0 to 18000)

Number of Charge Sessions (Right Y-axis, 0 to 8)

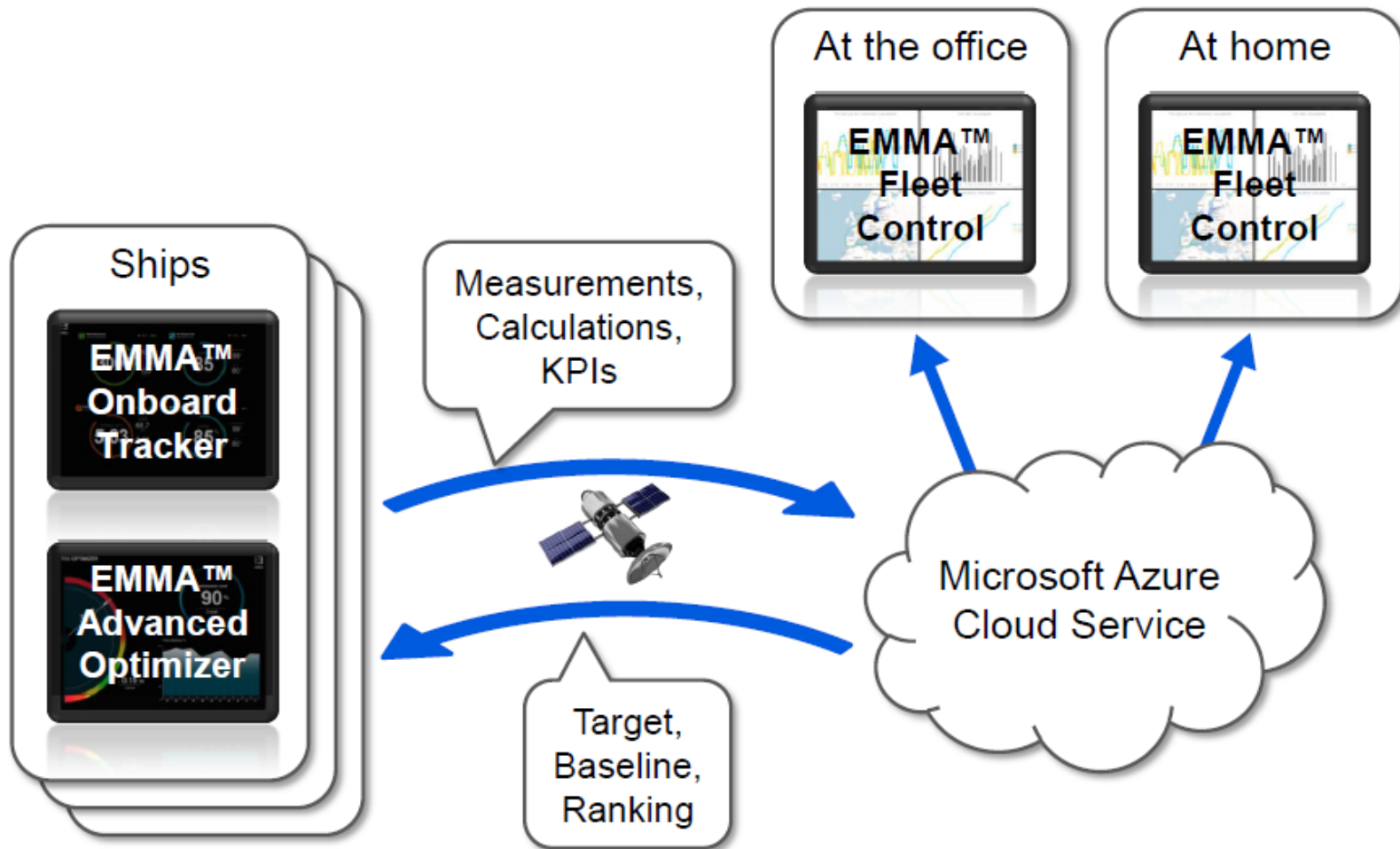
Date (X-axis)

Legend: ■ Number of charge sessions for all chargers, ■ Energy delivered (kWh)

Date	Number of Charge Sessions	Energy Delivered (kWh)
2013-08-23 11:48	0	0
2013-08-23 12:48	0	0
2013-08-23 13:48	0	0
2013-08-23 14:48	0	0
2013-08-23 15:48	0	0
2013-08-23 16:48	0	0
2013-08-23 17:48	0	0
2013-08-23 18:48	0	0
2013-08-23 19:48	0	0
2013-08-23 20:48	0	0
2013-08-23 21:48	0	0
2013-08-23 22:48	0	0
2013-08-23 23:48	0	0
2013-08-24 00:48	0	0
2013-08-24 01:48	0	0
2013-08-24 02:48	0	0
2013-08-24 03:48	0	0
2013-08-24 04:48	0	0
2013-08-24 05:48	0	0
2013-08-24 06:48	0	0
2013-08-24 07:48	0	0
2013-08-24 08:48	0	0
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2013-09-05 06:48		

Optimization of Marine Vessels

EMMA™ Advisory Suite



Optimization of Marine Vessels

EMMA™ Fleet Control





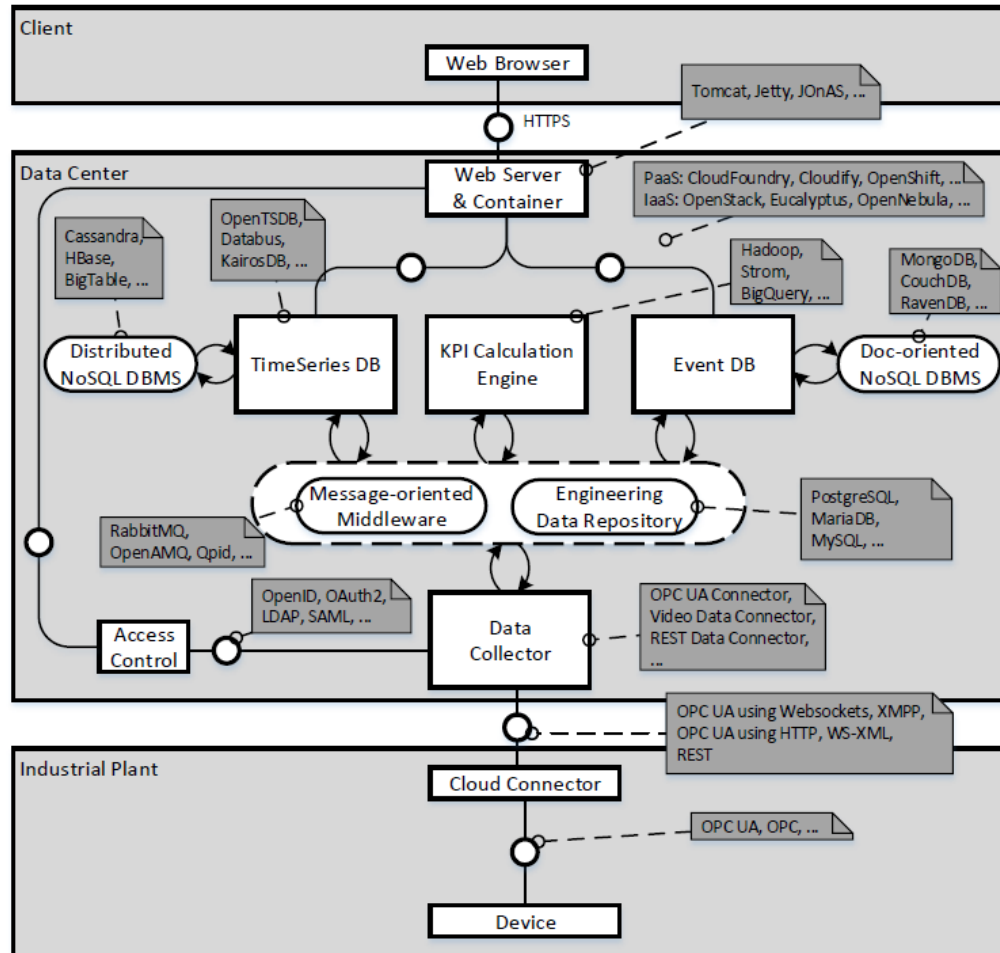
Toward an Automation Cloud Platform Technical Challenges



Time-Series Databases

Do they scale to cloud size?

Architectural Overview



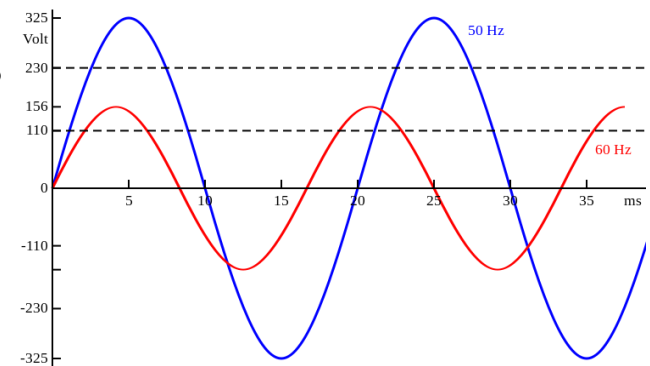
Time-Series Databases

In the context of industrial automation

- For example, process history within a SCADA system.
- Storing massive amounts of time-stamped sensor data, events, user inputs.
- Query and processing for visualizations, reports, analyses, optimization applications.
- Important properties other than scalability:
 - Durable storage
 - High availability
 - Fault tolerance
 - Fast / near-real time queries

Load Scenarios PMU

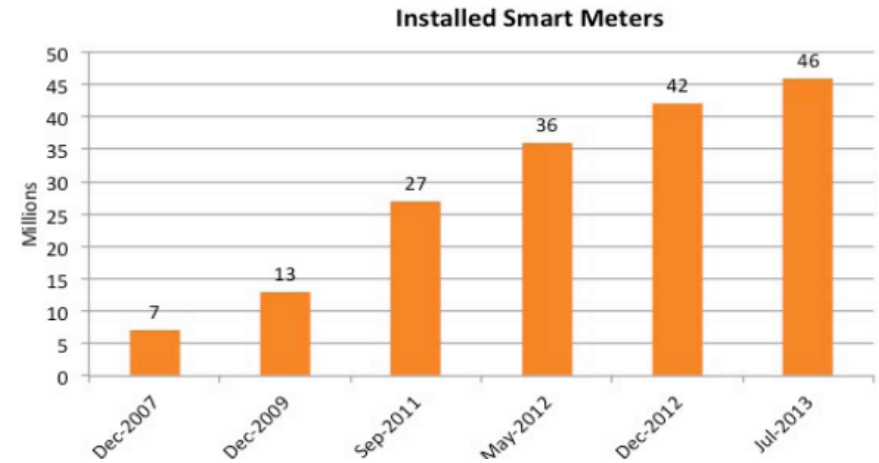
- Phasor Measurement Unit (PMU)
- Installations to grow in the smart grid area to stabilize power grid.
 - <http://www.greentechmedia.com/articles/read/a-synchrophasor-boom>
- Benchmark scenario:
 - Every second, a PMU uploads 15 float values of a sinus curve per 20ms (750 values/s).
 - PMU uploads are distributed over time.



Load Scenarios

SmartMeter

- Distribution of Smart Meters increases rapidly
- Data is gathered by aggregators and then forwarded to the backend system.

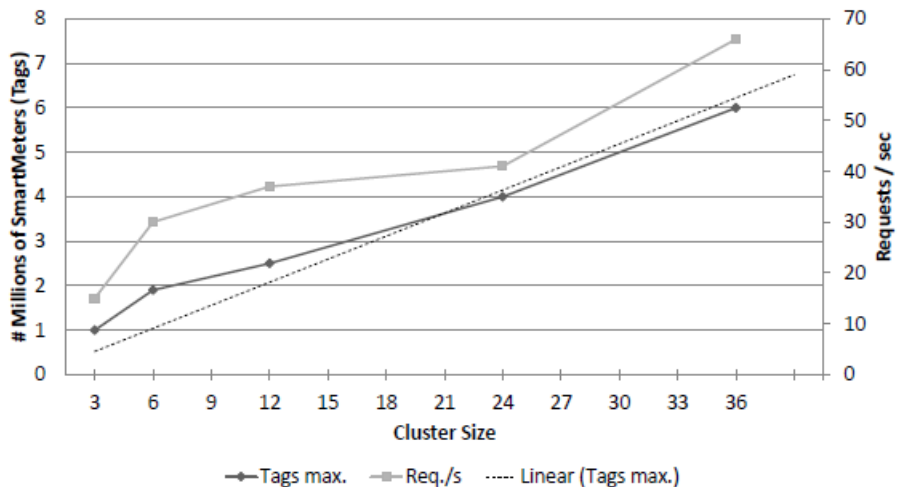
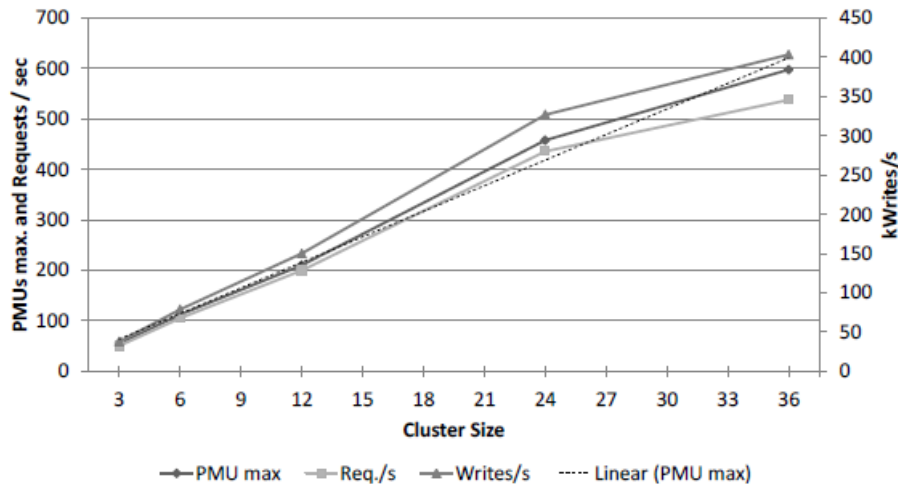


Source: http://www.edisonfoundation.net/iee/Documents/IEE_SmartMeterUpdate_0813.pdf

- Benchmark scenario:
 - Every 15 minutes, a smart meter sends 1 float.
 - All smart meter uploads happen in a 2 minute window every 15 minutes.



Benchmark Results Summary

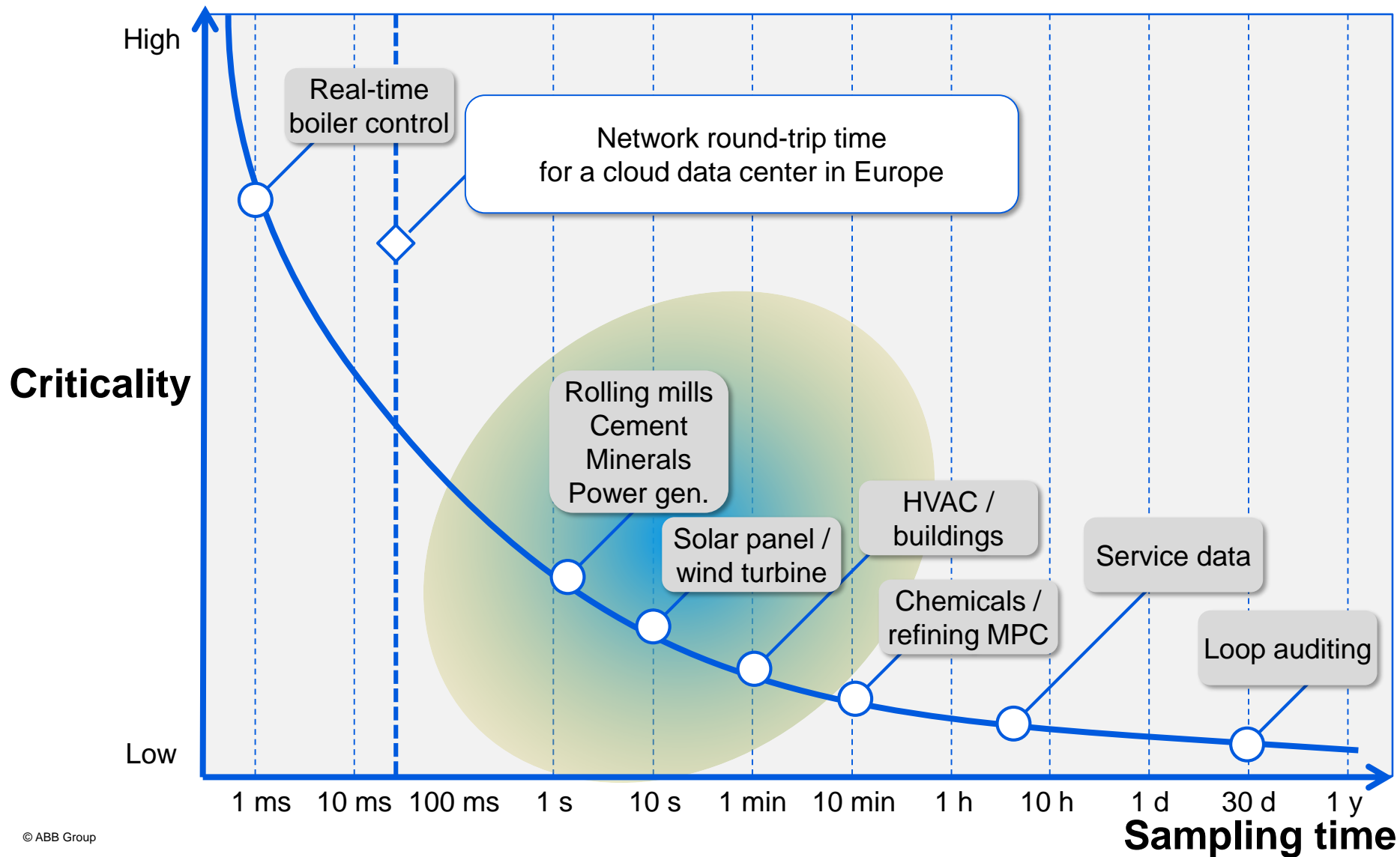


- **Linear scalability:** KairosDB, showed a good near-linear scaling behaviour.
- **Industrial workloads:** KairosDB was able to handle both workloads with realistic cluster sizes
- **Workload independence:** For both types of industrial workloads KairosDB scaled in a similar, linear way.
- **Resiliency:** Even with one or two instances down KairosDB could continue working.
- **Read/write independence:** Combined read/write throughput even above the write only performance.



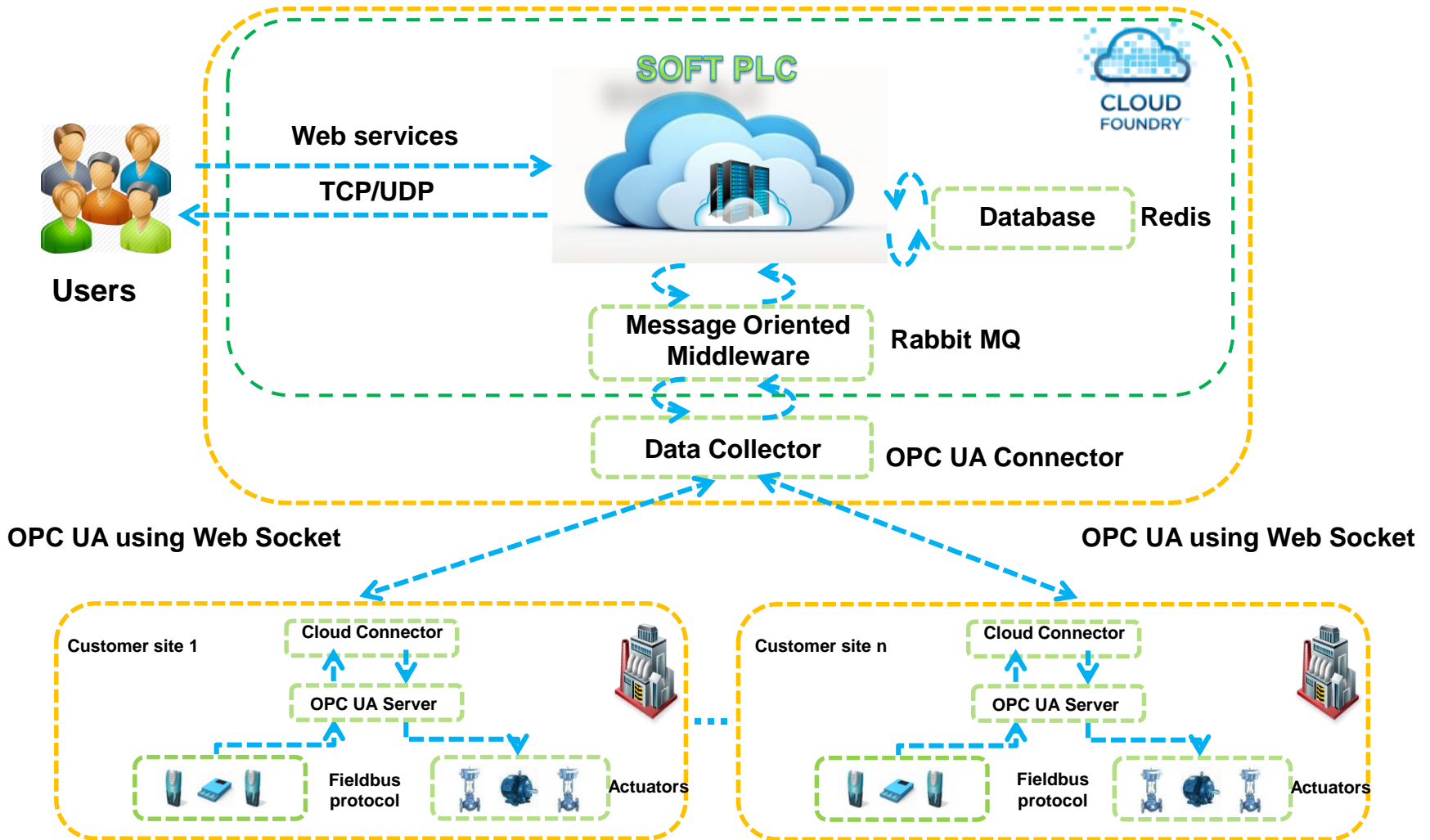
Control in the Cloud?
Is it possible?

Control in the Cloud Latency



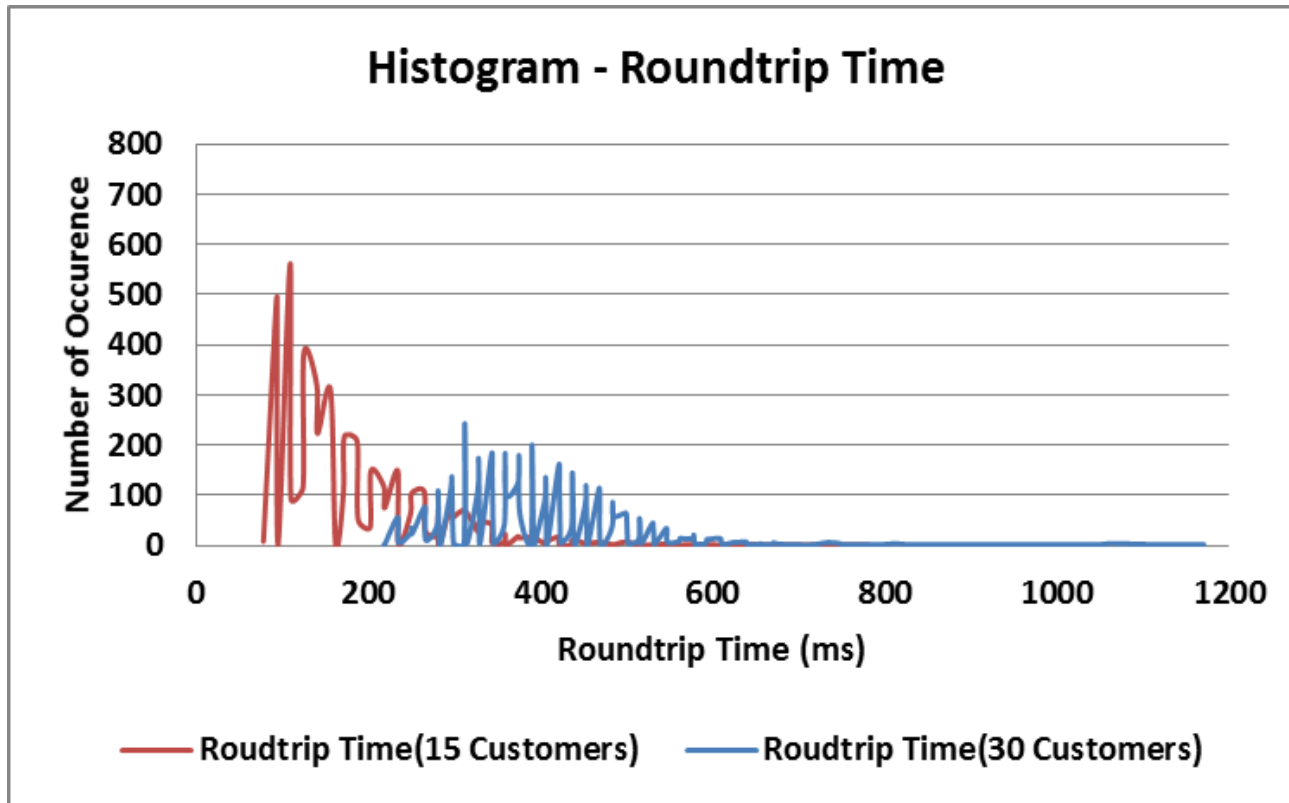
Control in the Cloud

Multitenant Architecture



Control in the Cloud

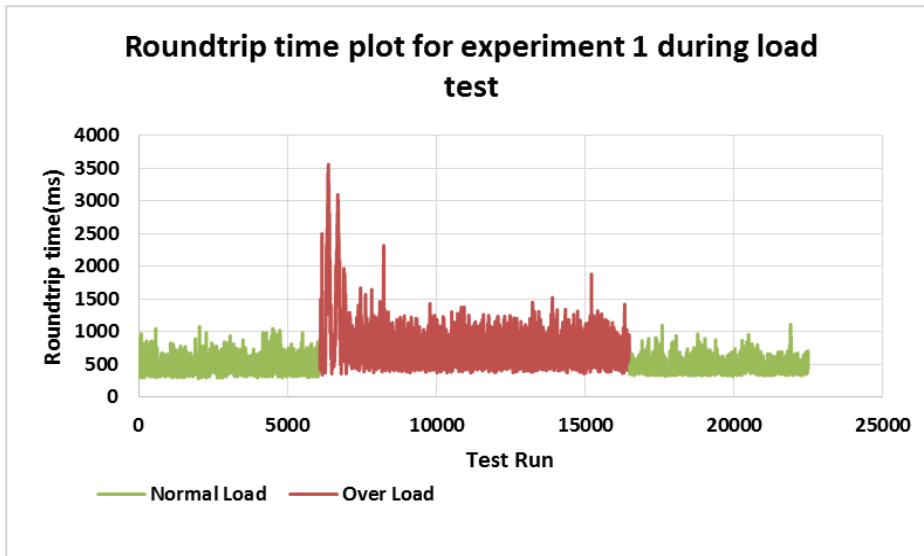
Roundtrip Times



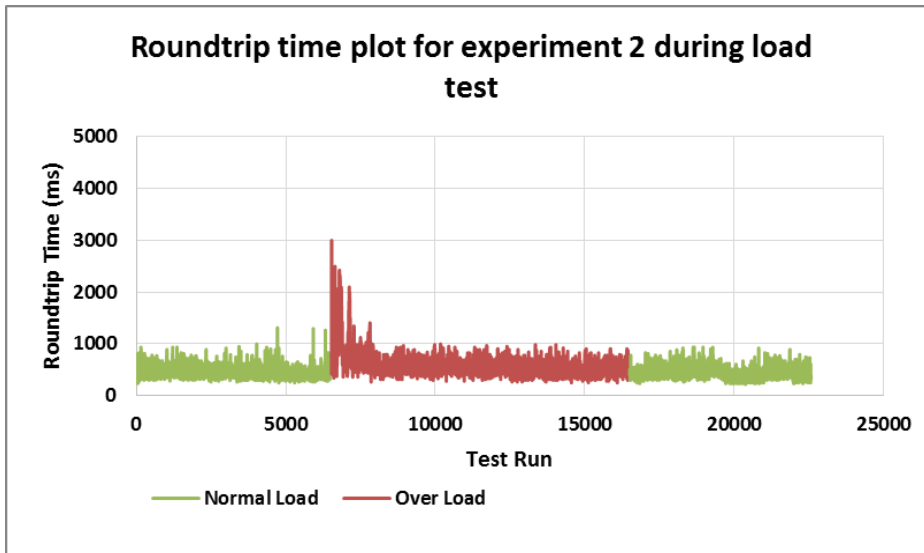
- Average round trip time for 15 customers/programs 193ms
- Average round trip time for 30 customers/pograms 453ms

Control in the Cloud

Horizontal Scaling – Roundtrip Time



- Experiment 1 :
 - Running cloud based soft-PLC application without enabling automatic scaling
 - Roundtrip time exceeds 1000ms during over load condition

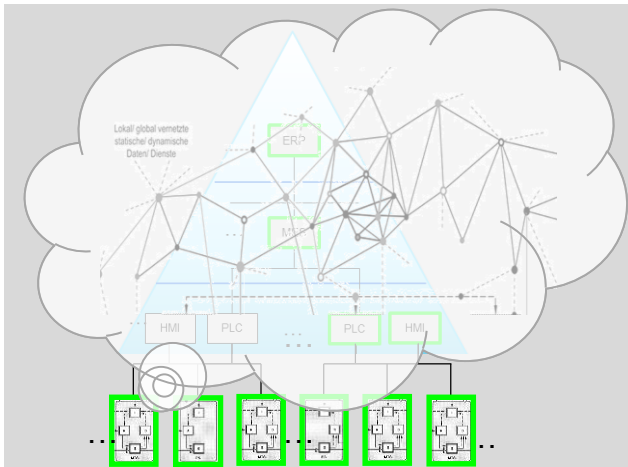
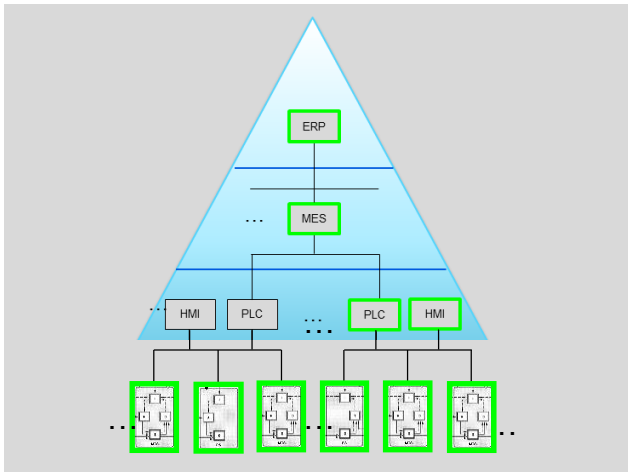


- Experiment 2 :
 - Running cloud based soft-PLC application with automatic scaling enabled
 - Roundtrip time exceeds 1000ms only before scaling

Conclusions

Conclusions

Towards the Automation Cloud



- Automation Pyramid affected by cloud computing capabilities
- Architecture Challenges
 - What control task can be executed remotely?
 - How to secure a SCADA system in the Internet?
 - How to effectively apply multi-tenancy?
- Future: emergence of an Automation Cloud Platform?

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