



MODELICA WORKSHOP, 03.02.2020

Modelica in the digital world status and perspectives

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Agenda

The digital revolution – coming now to industrial markets

The ABB Ability™ platform

Example: ABB OPTIMAX® for Energy Management

Deployment in the digital world

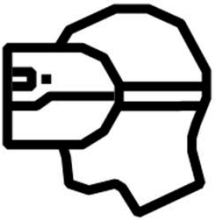
Demo

New requirements for Modelica

Digital technologies are driving new innovation in industrial markets

Media is focused on B2C but the “killer app” is in B2B

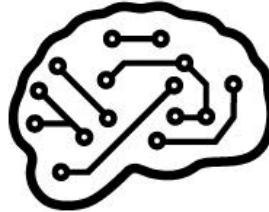
Virtual/augmented reality



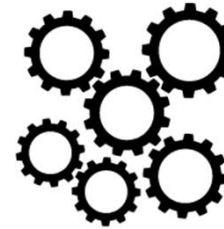
Software-defined machines



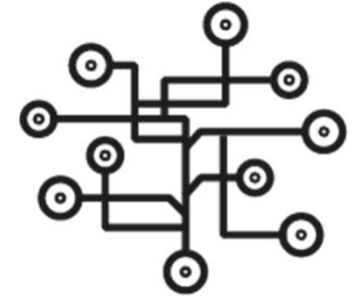
Machine learning



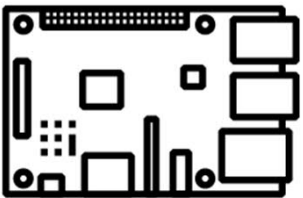
Time-sensitive networking



Big data



Inexpensive computing



Cloud computing



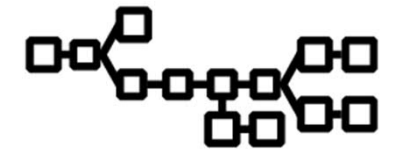
Cybersecurity



Connectivity



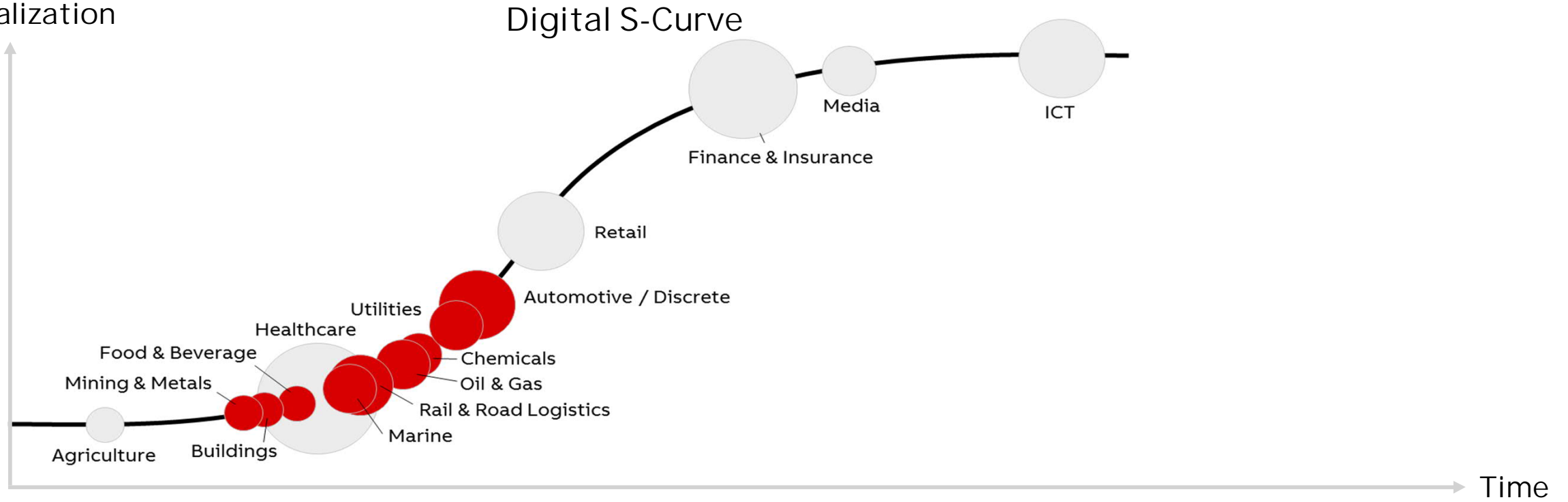
Blockchain



Industrial markets primed to adopt digital technologies

Computing + connectivity + cloud + analytics set to unlock value

Level of digitalization



Unlocking the ABB potential in digital

ABB Ability™: industry-leading digital solutions built on a common set of standard technologies

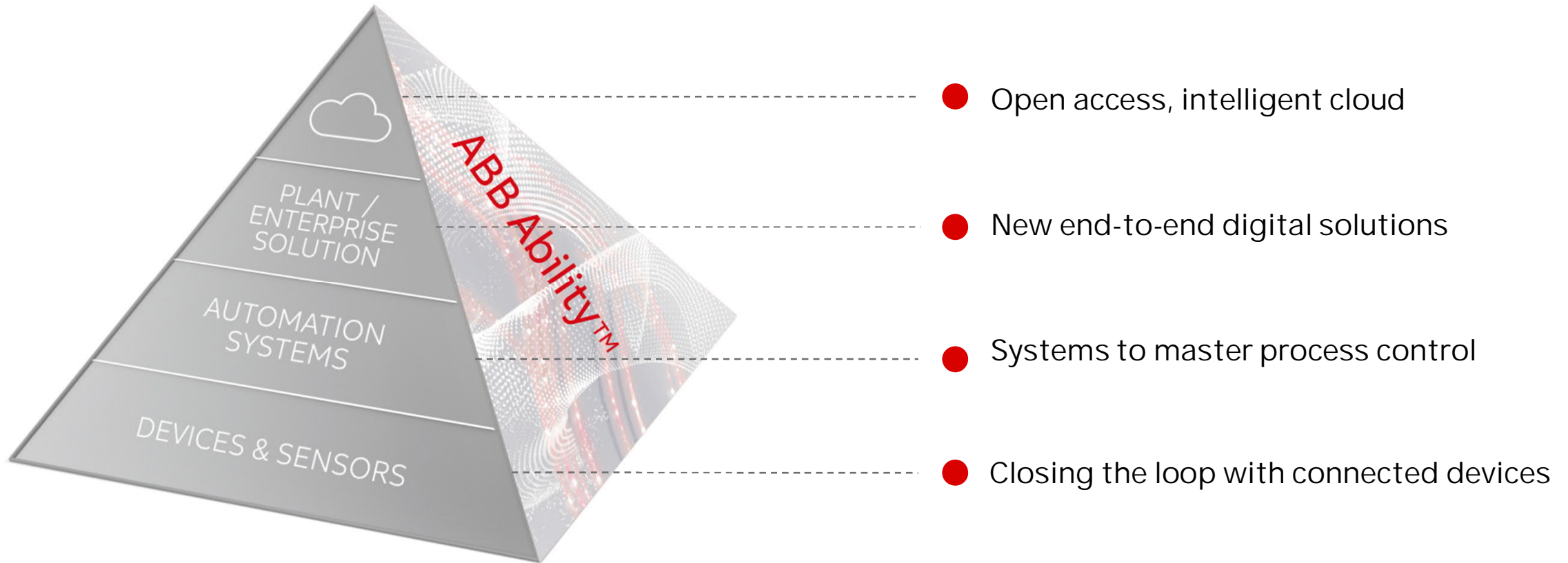


ABB Ability™ Energy Management with OPTIMAX®

Value Proposition

1. Create Visibility
2. Automate Control
3. Optimize Operation

Benefit

- Save energy cost and site emissions
- Save time on reporting and documentation
- Increase revenues by participating in energy markets

For

- Single sites
- Multiple sites
- Virtual Power Plants

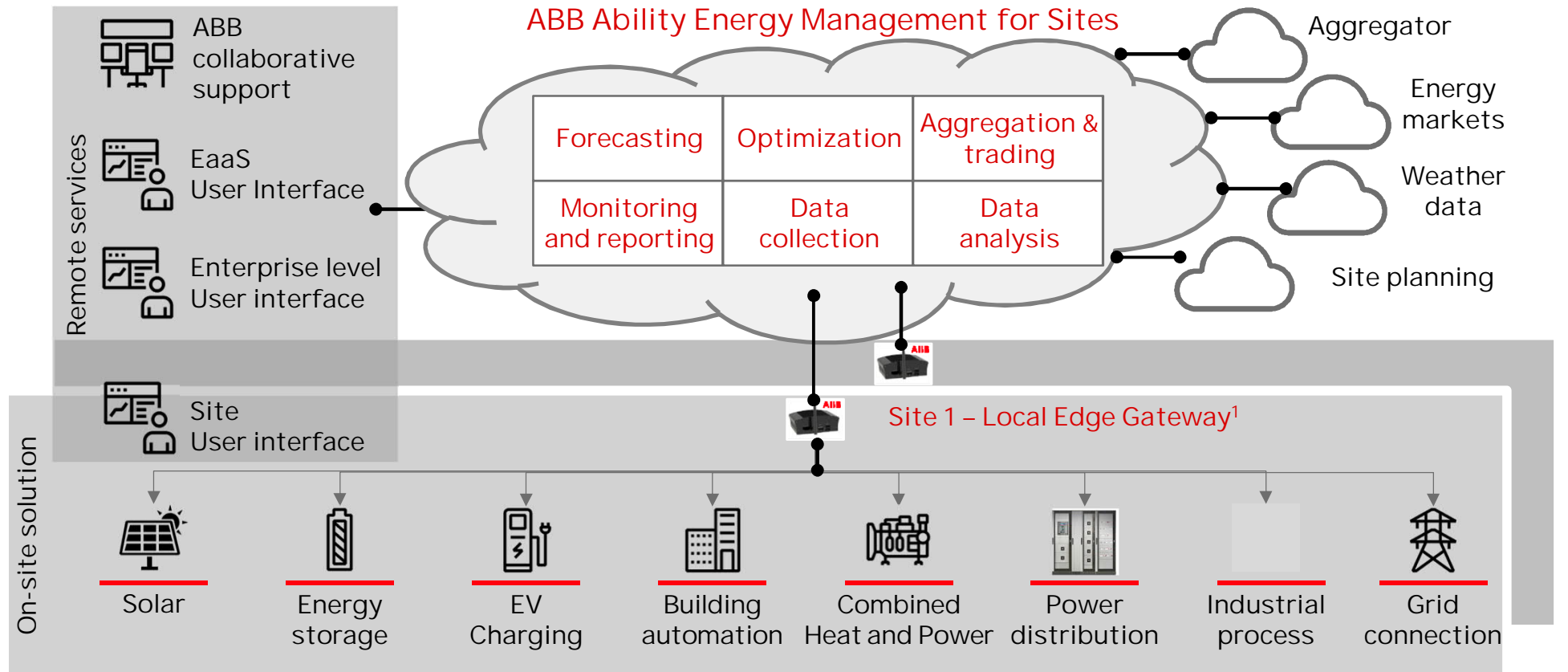
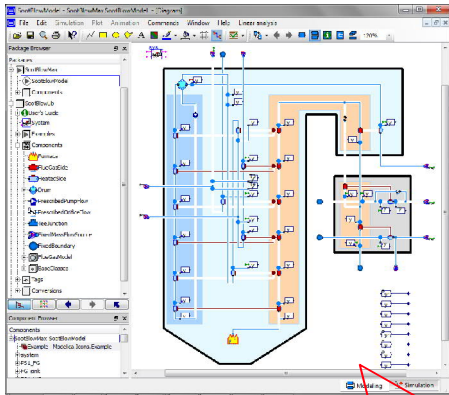


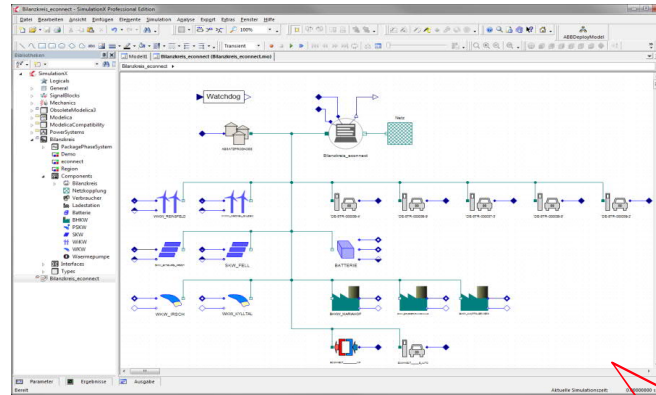
ABB Dynamic Optimization – standardized model-based applications

Basis for several OPTIMAX® application, incl. power plants, power pools and renewables

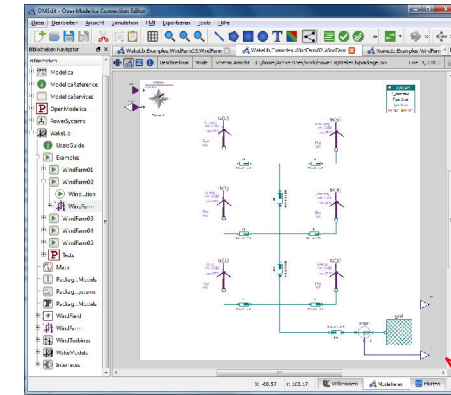
Modelica for application engineering (www.modelica.org)



Power Plants



Power Pools



Renewables

FMI (Functional Model Interface) for deployment (www.fmi-standard.org)



IPC



Server



Cloud

ABB Dynamic Optimization

Treat optimal control programs basing on simulation models

For dynamic system model and sample time points $t_k, t_0 < t_1 < \dots < t_K$
find control u (and/or initial states $x(0)$) that minimize criterion J
subject to mixed discrete/continuous model, initial conditions
and further constraints g

$$J = \sum_{k=0}^K f_0 \left[k, \begin{pmatrix} x_d(k) \\ x_c(t_k) \end{pmatrix}, \begin{pmatrix} u_d(k) \\ u_c(t_k) \end{pmatrix} \right] \rightarrow \begin{matrix} \min \\ x_d(0) \quad u_d(0) \\ x_c(t_0) \quad u_c(t_0) \end{matrix}$$

FMU ME

$$x_d(k+1) = f_d[k, x_d(k), x_c(t_k), u_d(k)], \quad x_d(0) = x_{d0}, \quad k = 0, 1, \dots, K$$

$$\frac{dx_c(t)}{dt} = f_c[t, x_d(k(t)), x_c(t), u_c(t)], \quad x_c(t_0) = x_{c0}, \quad t \in [t_0, t_K]$$

$$y(k) = h[k, x_d(k), x_c(t_k), u_d(k)], \quad k = 0, 1, \dots, K$$

$$g[y(k(t)), u_d(k(t)), u_c(t)] \geq 0$$

Parallel optimization with control vector parameterization

Can scale cloud computing resources on demand

Describe control trajectory with control parameters u^k

Introduce initial states of each interval as optimization variables s_x^k

Parallel solution of initial value and sensitivity problems for each interval

Treat junction conditions between intervals as optimization constraints

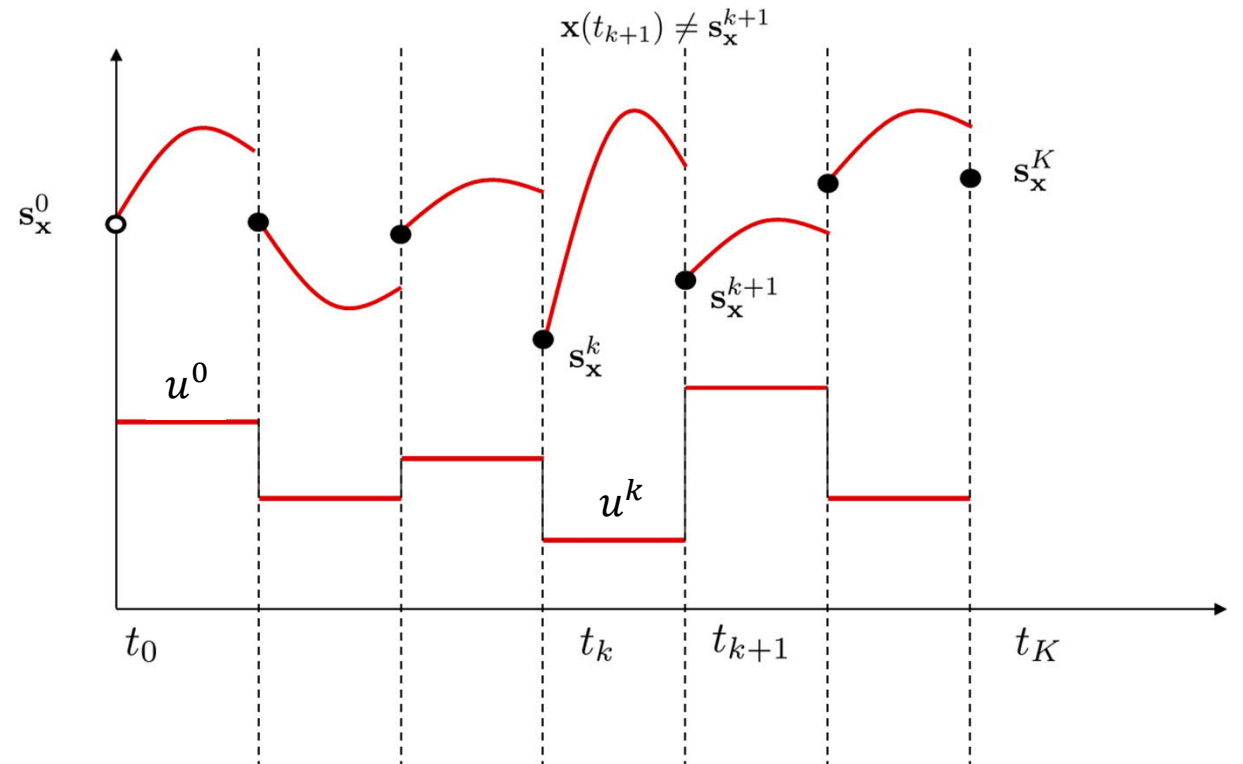


ABB OPTIMAX® – VPP cloud deployment

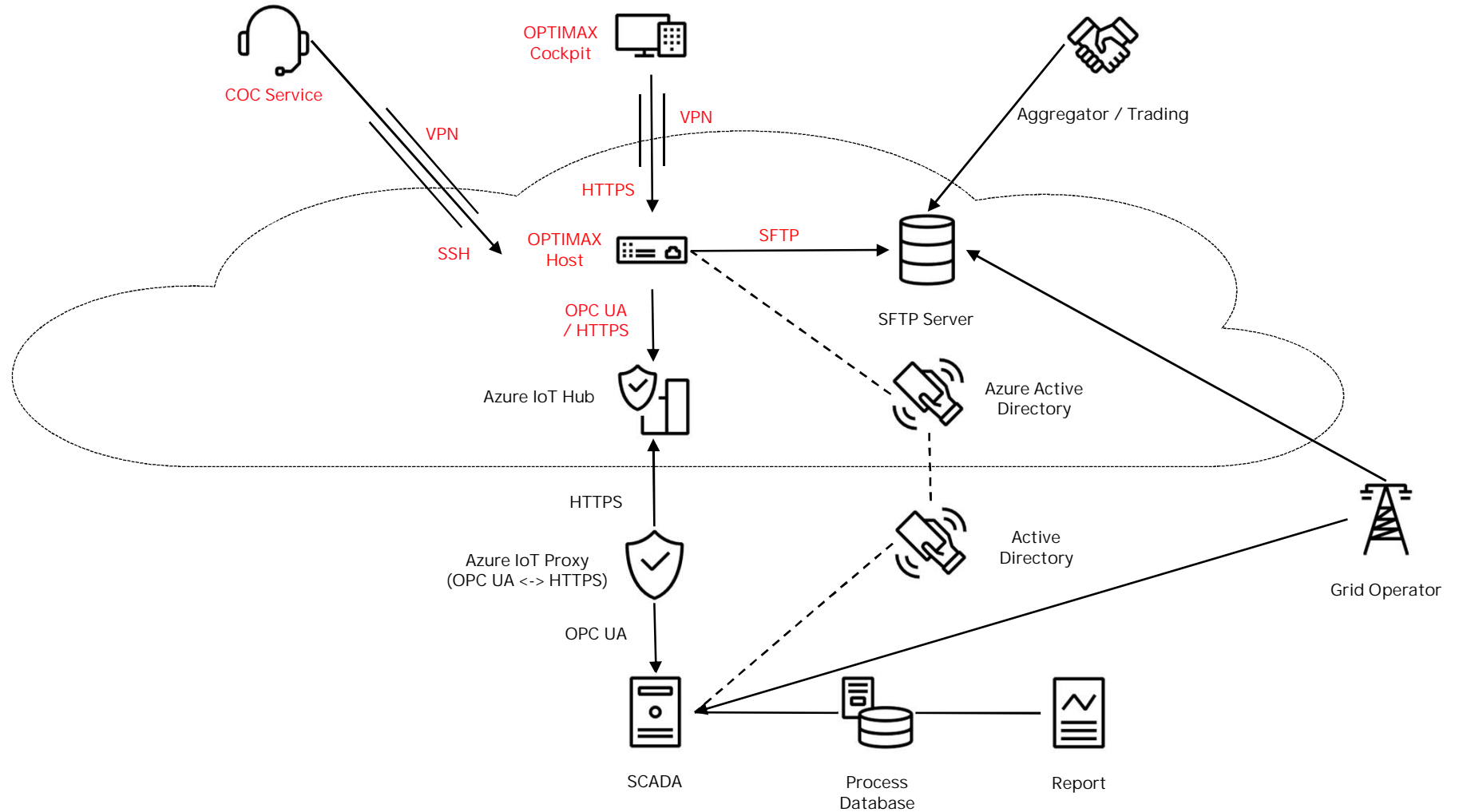
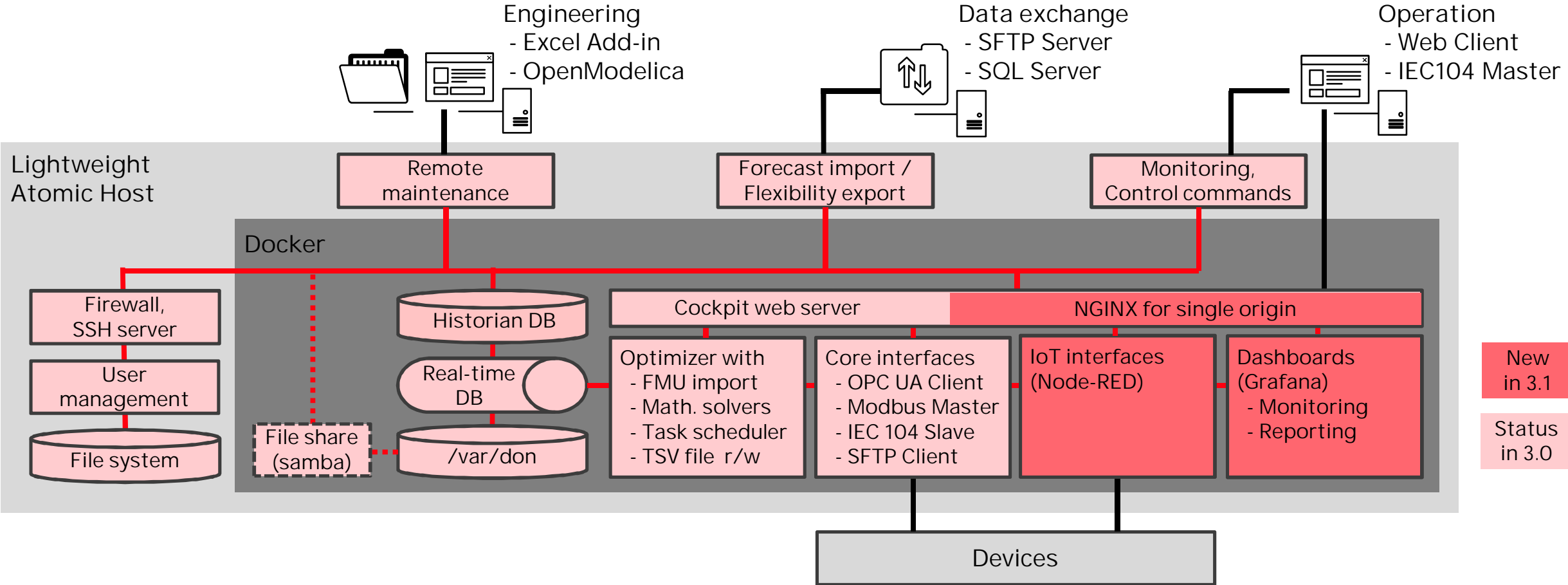


ABB OPTIMAX – implemented as software containers



New in 3.1
Status in 3.0

Node-RED

A visual tool for wiring the Internet of Things – created by IBM – maintained by JS foundation

Open Source visual programming tool

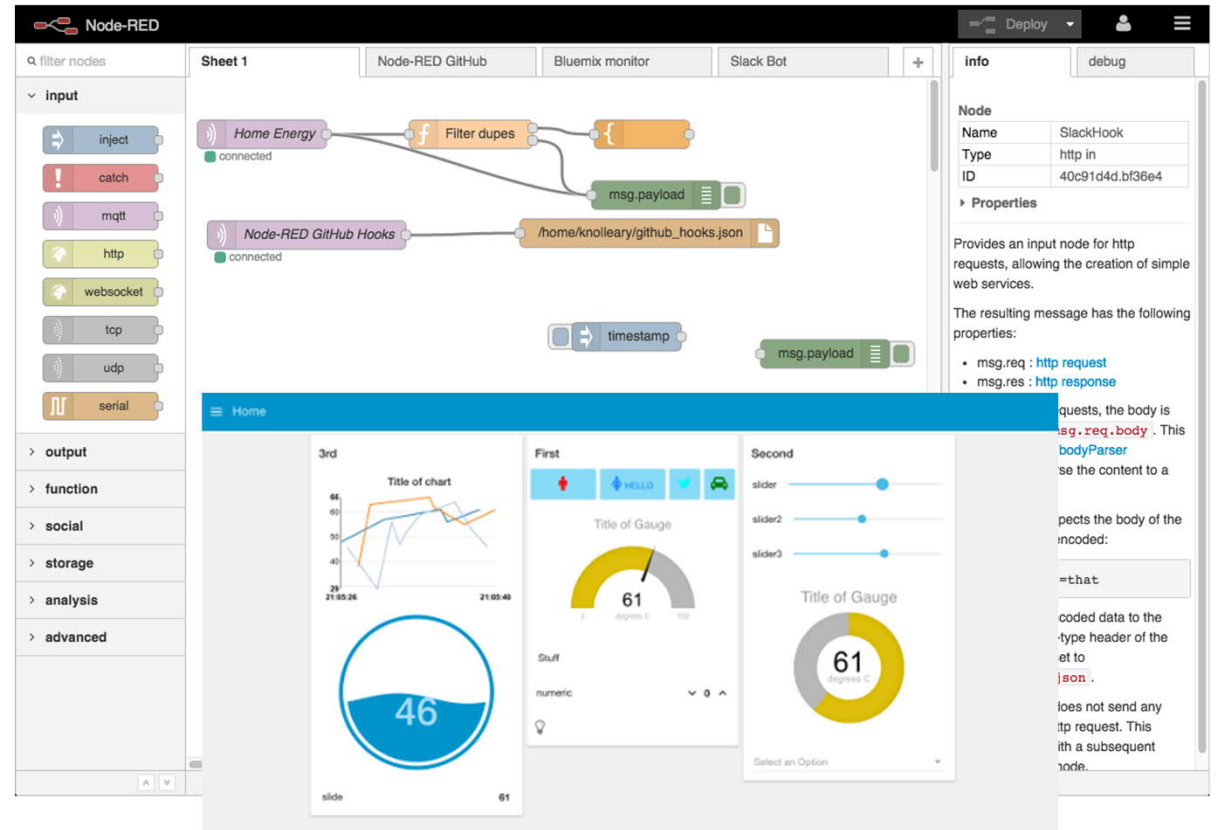
- Based on Node.js
- Graphical flow editor, debugger, browser UI
- Connect devices and online services
- Created by IBM, maintained by JS foundation

Provides interfaces needed by digital applications

- OCPP 1.6
- OpenADR VEN
- KNX
- REST, MQTT, E-Mail, Twitter, ...

Provides simple dashboards

- Inputs, Outputs and Graphs



Source: <https://github.com/node-red>

Grafana

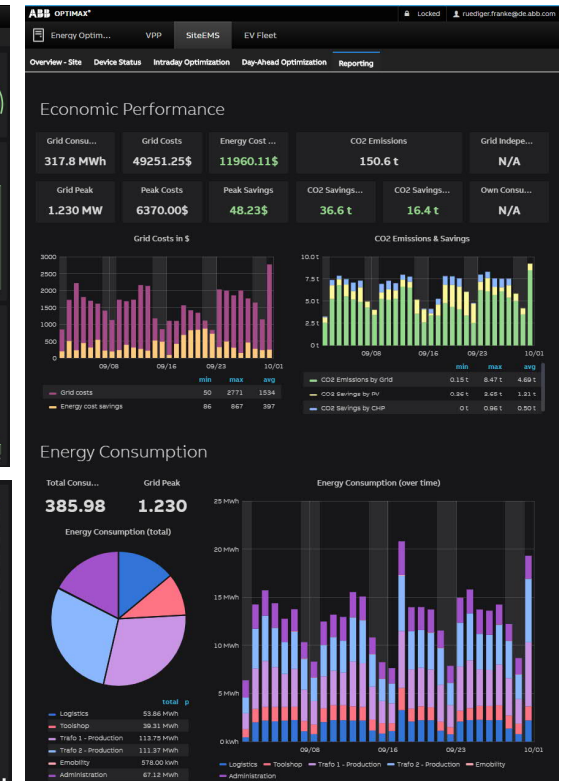
Open Source Analytics and Monitoring Solution for every Database

Open Source dashboard software

- Query different data sources
- Visualize data
- Alerting and notifications

See www.grafana.com

- Query, visualize, alert on and understand your metrics
- Create, explore, and share dashboards with your team and foster a data driven culture.
- Used by thousands of companies to monitor everything from infrastructure, applications, and power plants



Modelica in the digital world

New requirements

General

- Move from one suite attempting to cover everything to components that integrate with other tools
- Focus on added value with Modelica

Models

- Large-scale: exploit technologies like vectorization
- Changes during runtime, just-in-time compilation (cf. Modia, Julia, FMI dynamic array dimensions)

Model building and tuning

- Incorporate Artificial Intelligence
- Provide behavior for Digital Twins

Model Editor

- Run in Web browser (cf. Node-RED, Jupyter)
- Integrate graphical model building with animation



ABB