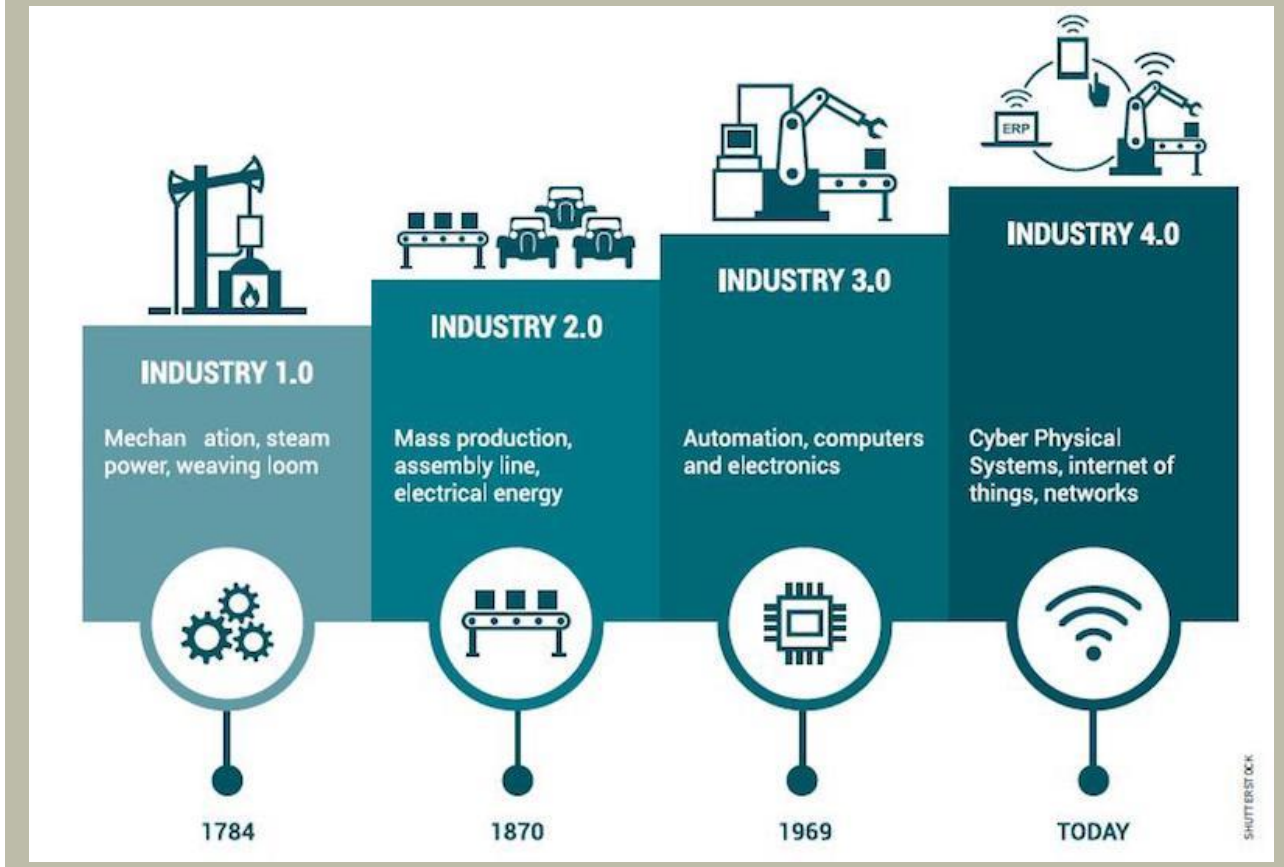
Industry 4.0

Changes in society, changes in customer needs.

Technology is just the enabler.



Industry 4.0 challenges

Mass tailor made production

From one car for all...

...to a unique car for each of us

Industry 4.0 challenges

- *Lack of trained technical staff.*
- *Global competition low-income countries.*
- *Processes becoming more complex and error intolerant.*

Conversion towards I4.0 implies reducing the overall human effort on the whole product life cycle, and rethinking how to design, engineer, produce and service our make industry.

Industry 4.0 challenges

Disruptive industry

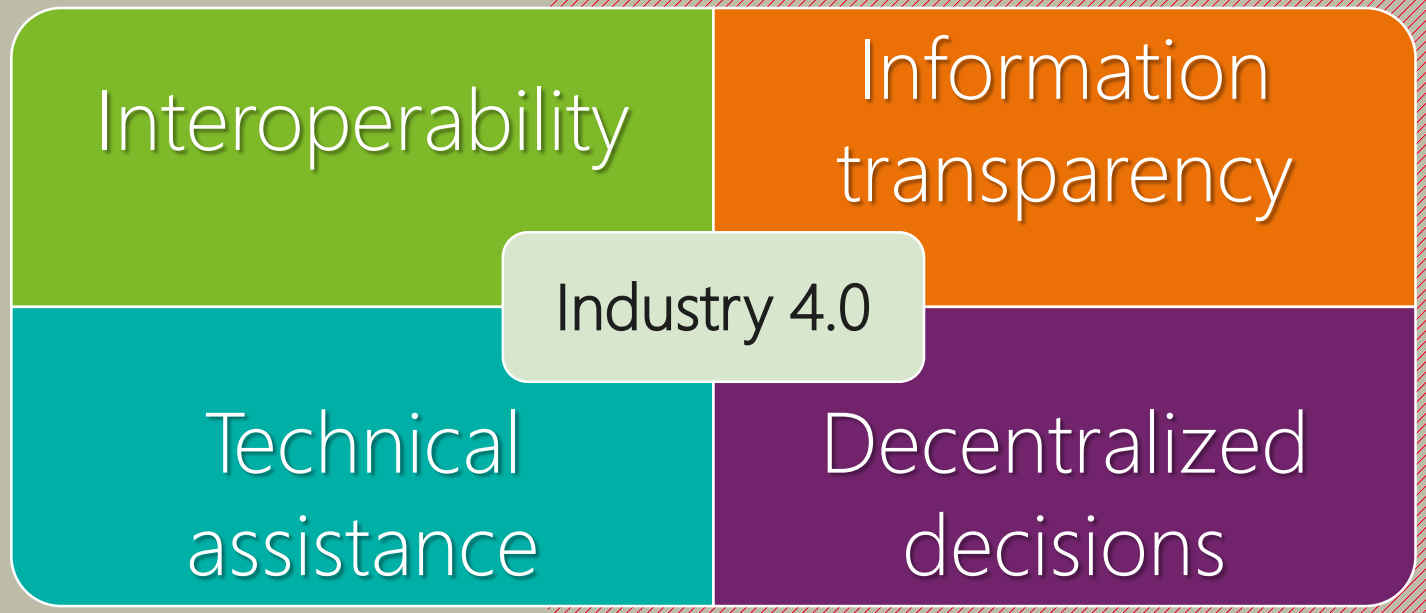
	1999 Kodak	2013 Instagram	
Rolls of film sold	800,000,000	60,000,000	Avg. Photos/Day
Images/Roll	27	365	Days in year
Total Images Processed	21,600,000,000	21,900,000,000	Total Images Processed

	1999 Kodak	2013 Instagram	
Rolls of film sold	800,000,000	60,000,000	Avg. Photos/Day
Images/Roll	27	365	Days in year
Cost/Roll	$5.00		NA
Cost/Developed Roll	$5.00		NA
Cost/Processed Image	$0.37	$0.00	Cost/Processed Image
Total Images Processed	21,600,000,000	21,900,000,000	Total Images Processed
Total Imaging Costs	$8,000,000,000	$0.00	Total Imaging Costs

Industry 4.0

Design principles and compliance check for the maker industry

vives University of Applied Sciences



1. **Interoperability & Connectivity througd industry standards**
2. **Information transparency by standard information models**
3. **Decentralized decesions by means of smart devices.**
4. **Technical assistance CAE – digital Twins, VR, AR**

Industry 4.0 focuses on the use of well proven technologies, not necessarily new technologies!

Connectivity

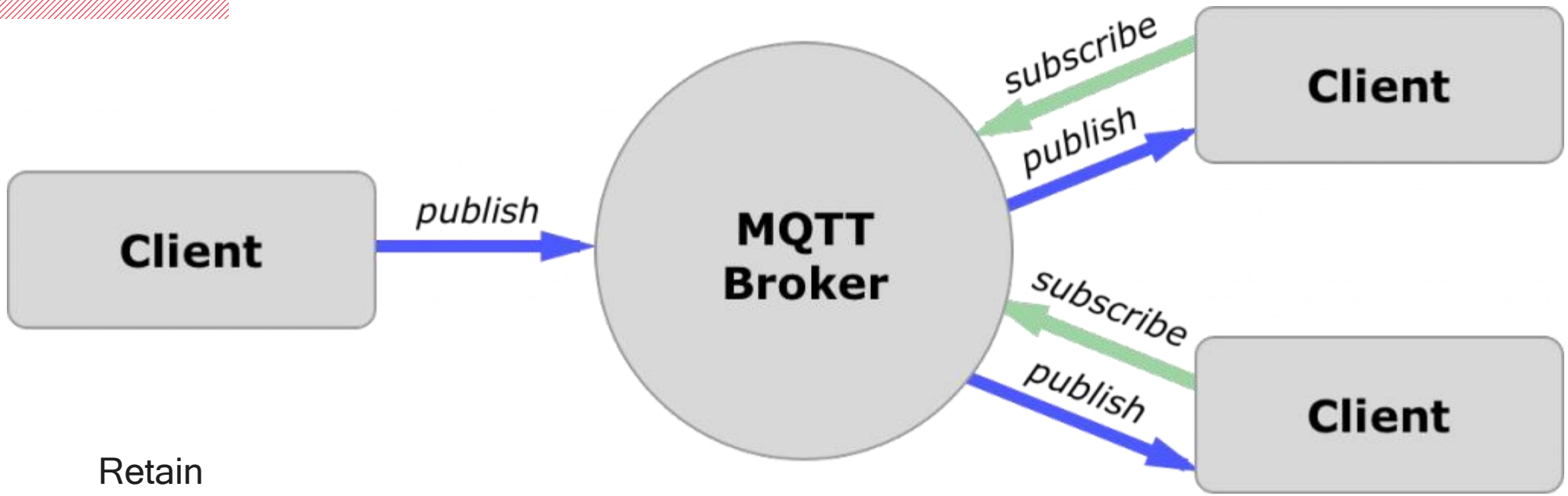
Use standards to garantee interoperability and interchangeability

- Data Communication Standards
  - MQTT
  - (REST) API's
  - WebHooks
  - OPC -UA
  - Modbus (RTU/TCP)
  - ....

- Remote connectivity.
  - VPN router (third party tunnel web service)
  - Exposing local host (cfr localtunnel)
  - Jump boxes (third party exposing local subnet)

MQTT

Communication model



Retain
QoS (at most once, at least once, just once)
Clean Session
User ID + PW
Last will – birth message

MQTT broker

Use mqtt webclient to debug

You can access the MQTT broker securely at:

Host: `broker.hivemq.com`

TCP Port: `1883`
Websocket Port: `8000`
TLS TCP Port: `8883`
TLS Websocket Port: `8884`

MQTT

Principle

msg.topic + msg.payload

payload content -> no rules, content agnostic.

URL endpoint broker (on-prem or cloud)

Supports tree structured topics

Supports wildcard multi topic subscriptions (single [+] and multilevel [*])

MQTT clients locally managed or third party.

MQTT broker : locally managed or cloud.

Broker :... *A message broker is an architectural pattern for message validation, transformation and routing. It mediates communication amongst applications, minimizing the mutual awareness that applications should have of each other in order to be able to exchange messages, effectively implementing decoupling.*

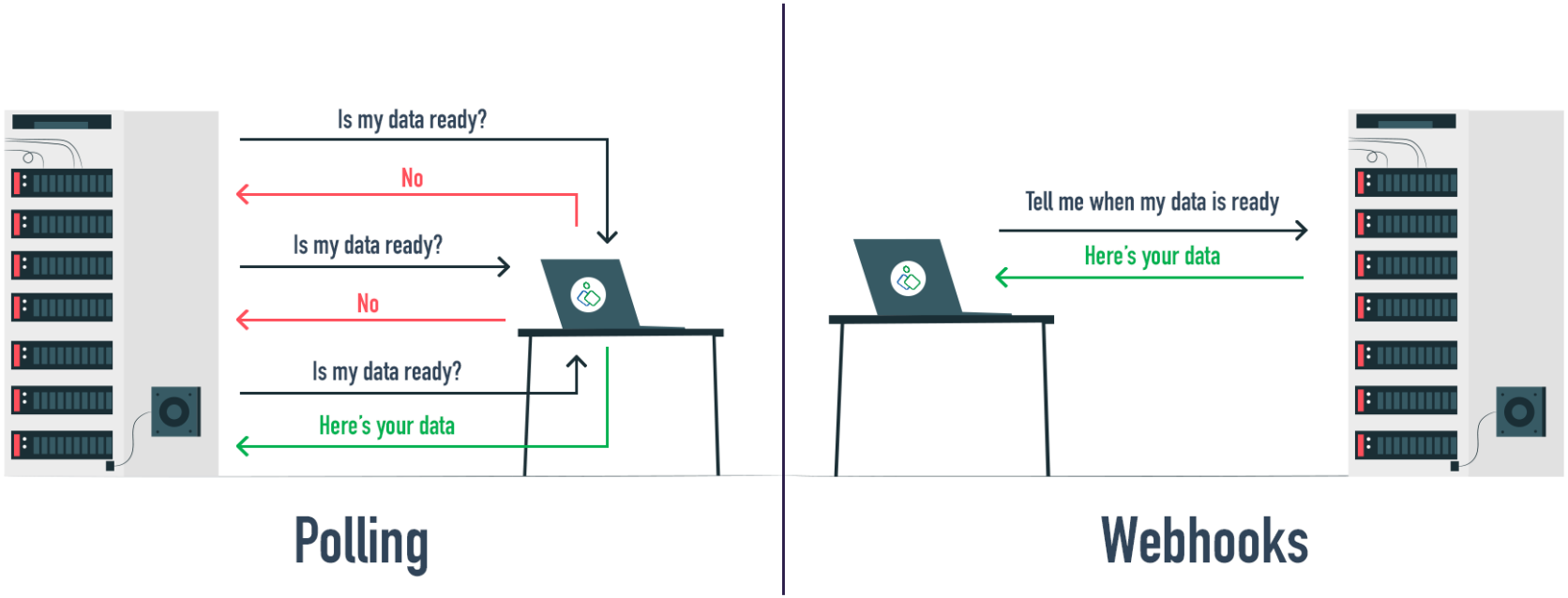
Web services.

Using third party data sources

- **REST API (polling)**
- **Webhooks (event based)**

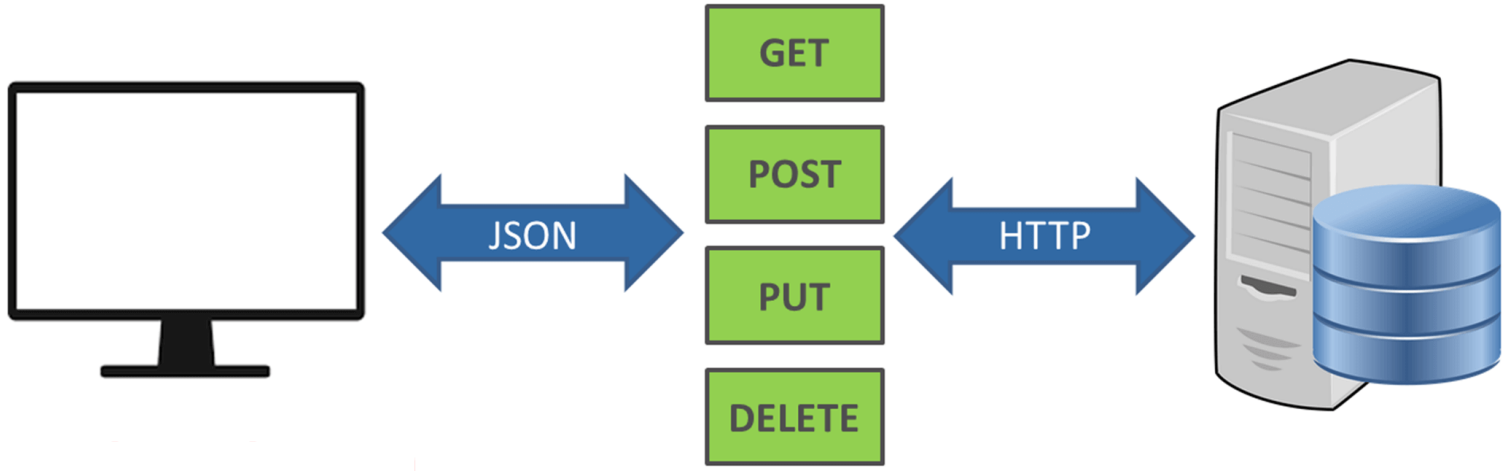
API vs WebHooks

Polling vs event change



(REST) API

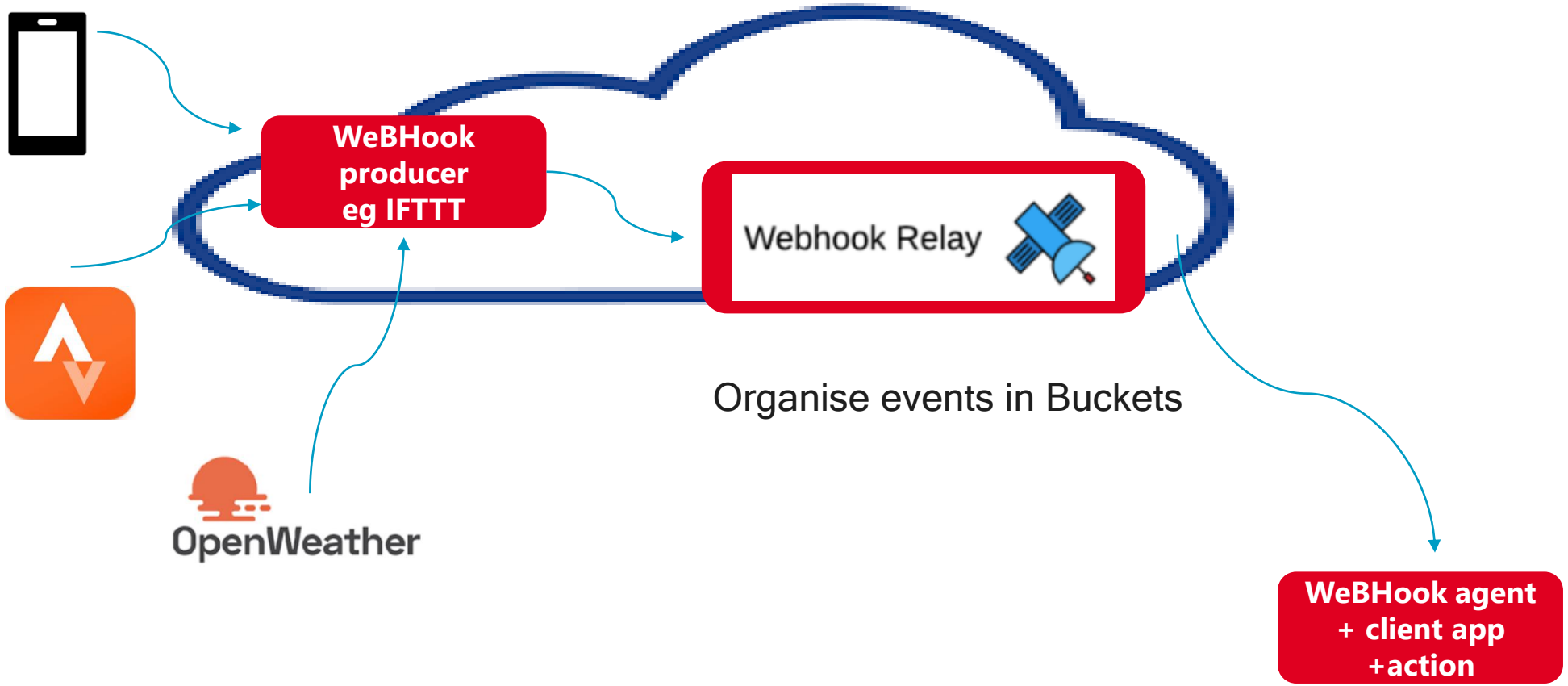
Design principele



https://openweathermap.org/ sign in using API-Key

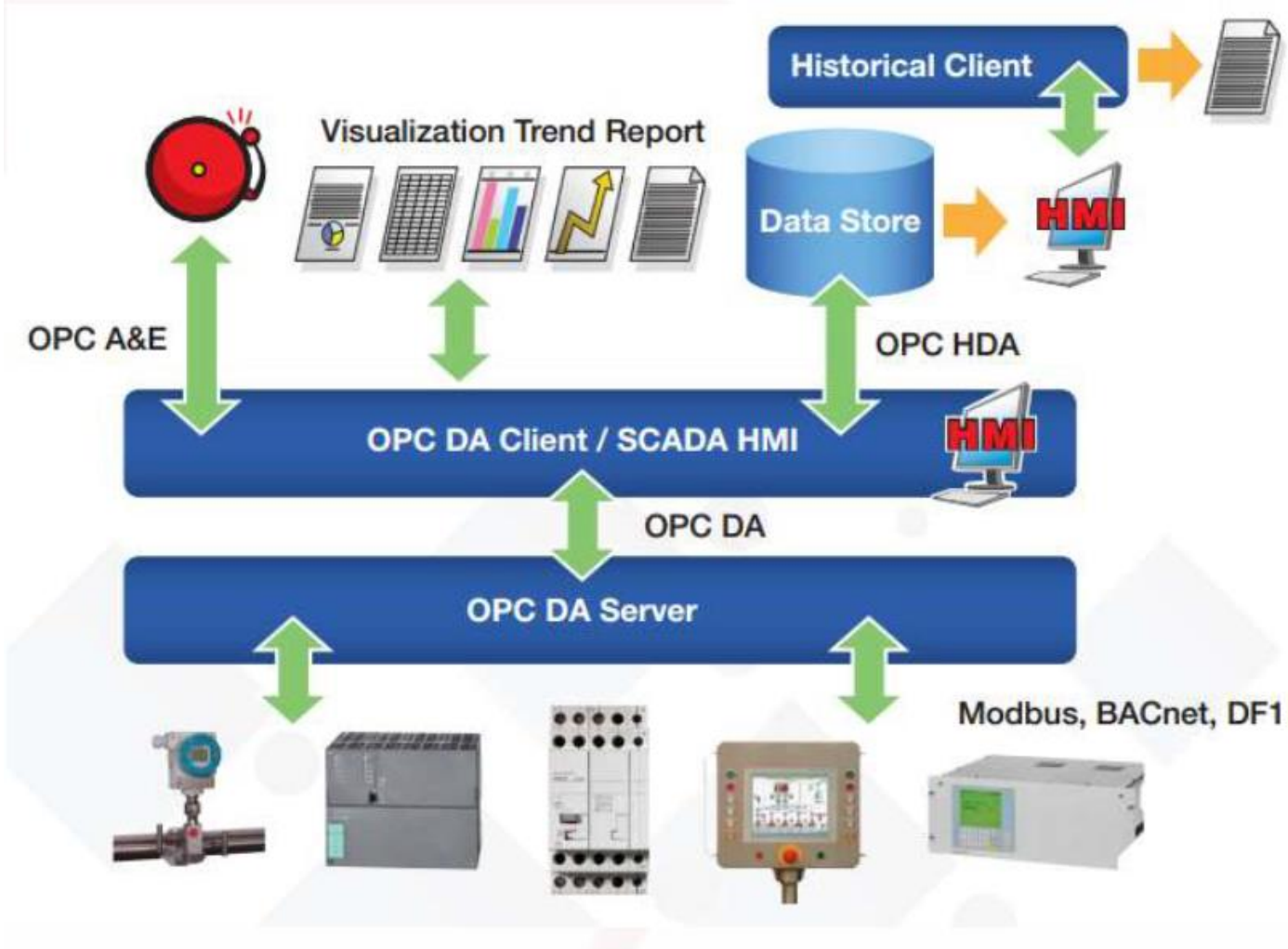
Webhooks

Event triggered messages



OPC UA

Client server peer to peer information model exchange



— OPC UA

Design principle

Open communicatiestandard ; www.opcfoundation.org and information model using objects, datatypes, methods.

www.youtube.com/watch?v=pFfyjpexa2o&feature=youtu.be

https://www.youtube.com/watch?v=-tDGzwsBokY

https://www.youtube.com/watch?v=6uEJgYhYpYA

Vendor independent.

Requires minimal one server and one client

OPC is “Plug &Play”, no additional software dev. required

Reducing commissioning.

reusable, scalable, protection of investment (modular)

Sub standards

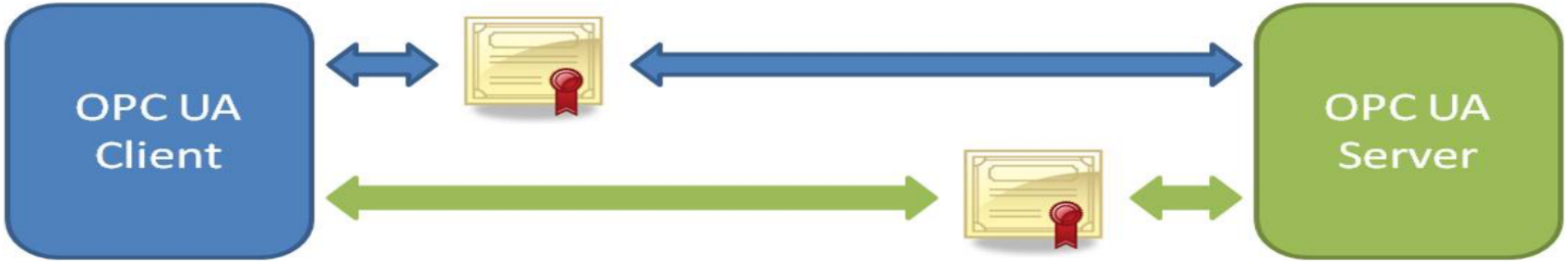
DA (realtime data)

HA (historical data)

AE (alarmen en events)

OPC UA

Security



- OPC UA requires handshaking between clients and servers using X.509 Web standard certificates for authentication before they are able to talk with one another.
- To communicate between the server and client, the user can choose from three kinds of messaging modes: None, Sign, Sign and Encrypt.
- OPC UA can communicate through any standard HTTP or UA TCP port. Through this standardization, OPC UA can connect securely over a VPN and through firewalls to allow seamless, remote client-to-server connectivity. http://www.ni.com/white-paper/13843/en/

Modbus RTU /TCP

Master Slave communication

Flat data source list grouped by registers and coils, only read (inputs) and read/write (outputs)

Mainly used in PLC controleers.

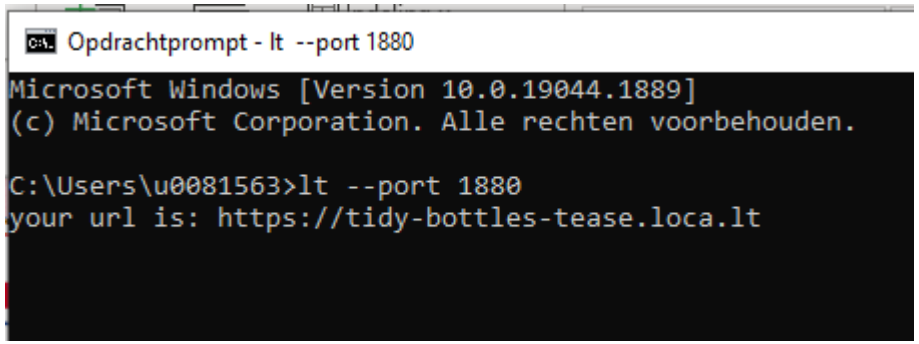
Master request includes function code, adresses of coils or registers.

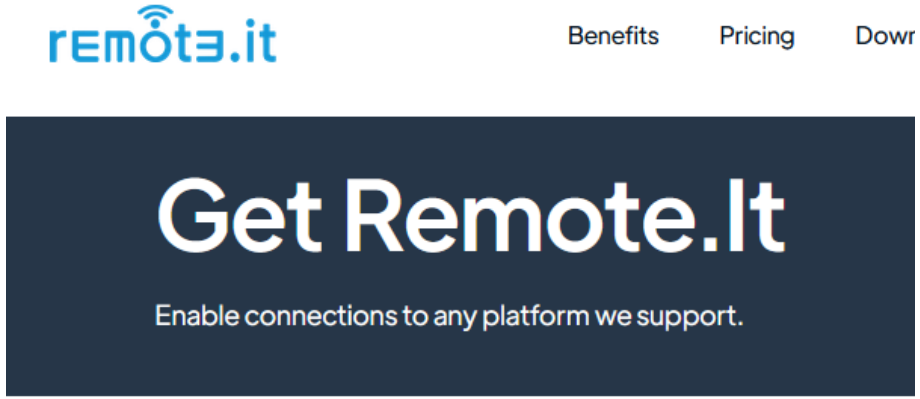
Slave answer contains data or confirmation.

FUNCTION CODE	WHAT THE FUNCTION DOES		VALUE TYPE	ACCESS TYPE
01 (0x01)	Read DO	Read Coil Status	Discrete	Read
02 (0x02)	Read DI	Read Input Status	Discrete	Read
03 (0x03)	Read AO	Read Holding Registers	16 bit	Read
04 (0x04)	Read AI	Read Input Registers	16 bit	Read
05 (0x05)	Write one DO	Force Single Coil	Discrete	Write
06 (0x06)	Write one AO	Preset Single Register	16 bit	Write
15 (0x0F)	Multiple DO recording	Force Multiple Coils	Discrete	Write
16 (0x10)	Multiple AO recording	Preset Multiple Registers	16 bit	Write

Remote connectivity

Exposing localhost/ exposing local subnet





Information transparency

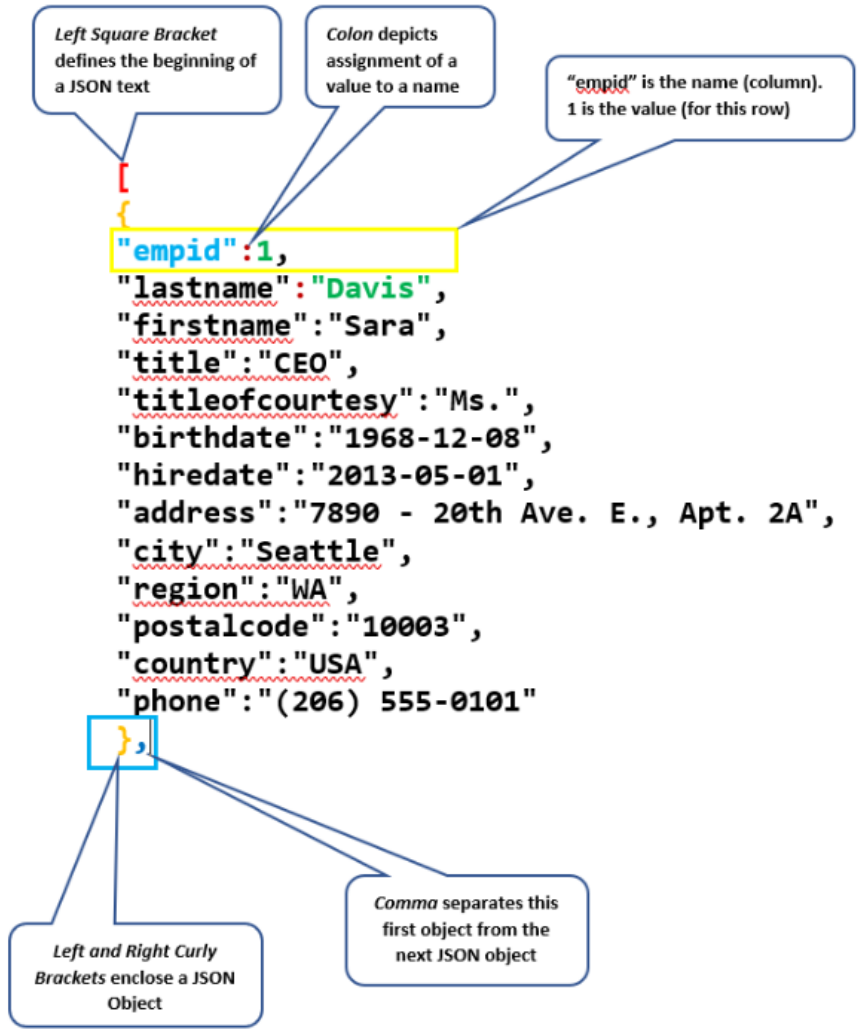
Semantic data, open webaccess

- JSON
- JSONata
- MongoDB
- InfluxDB (TSDB)

JSON

description

Assembly of key/value pairs assembled in structs and arrays . (cfr python : dictionaries and lists)
Contains structuring markers : [ ] { }
Single Key/value seperation with :
Pairs separated by ,
JSON can be combined using [ ]



JSON

Advantages and usage

Content is open, human readable.

Database (use JSONata to queury data)

Image

(enriched) Text (eg generating PDF docs)

Imbedded in Qrcode

Suppoprted by web application

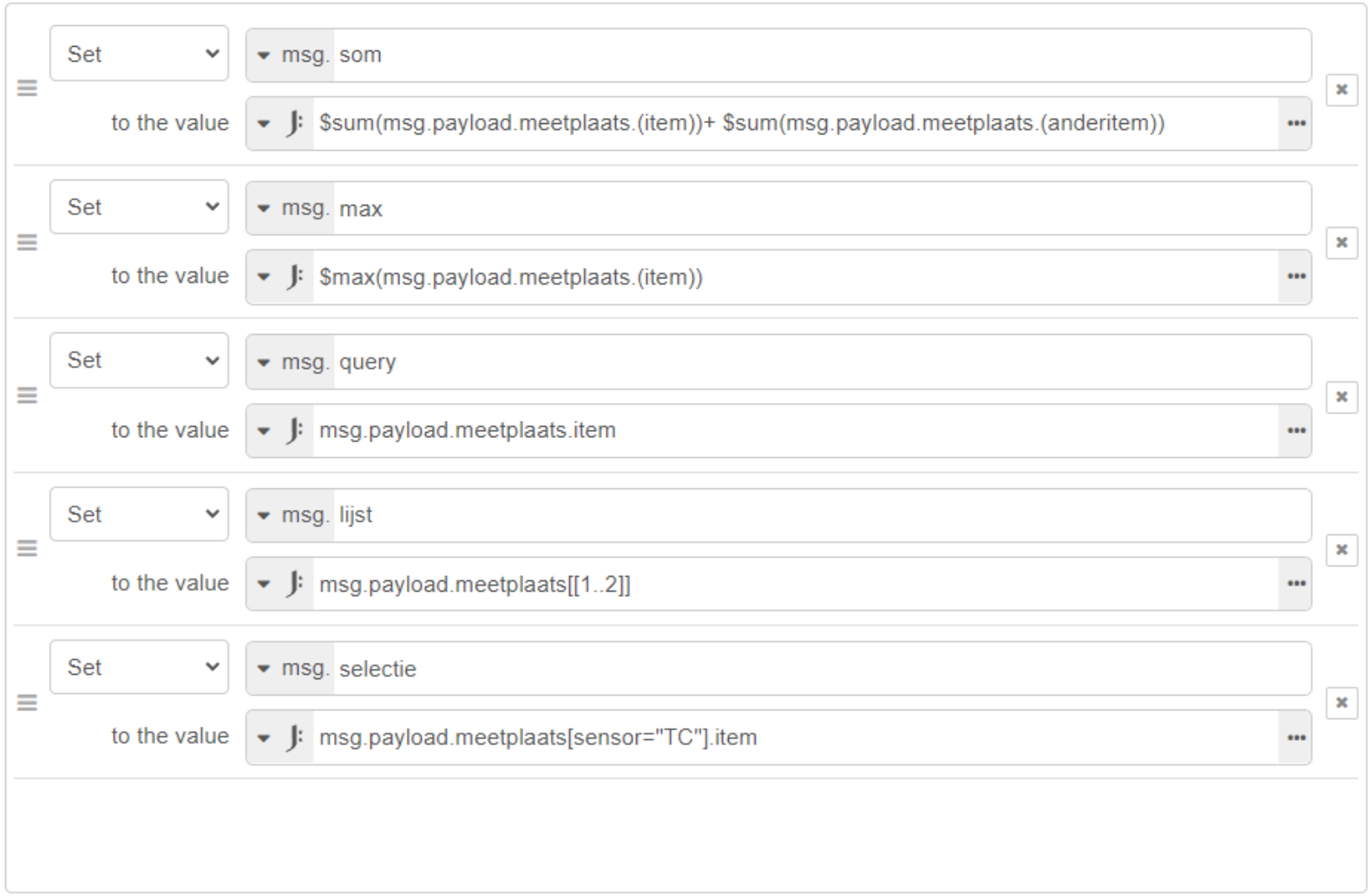
Supported by programming tools, JS, python,...

...

JSONata

Querying data inside JSON models

JSONata.org



MongoDB

NO –SQL database

Stores non predifined JSON documents.

Build in query language

Web access, no client software needed only webbrowser.

Build in web client as administration tool/query designer. (compass).

Can be deployed on prem or in cloud.

InfluxDB

Time series data base influxDB

Auto time stamp generation/ordering.(bucket principle)

Designed fot datacapture/logging.

Webaccess

CLI management tool.

Works wel with grafana dashboard.

API client node-red; python; …

Write query influxDB

Predefined layout

Integration IIoT tools

Building the industry 4.0 with Node-Red

Node-RED is a visual programming tool that allows users to design and implement flows for integrating various devices, services, and APIs without the need for extensive coding. Built on Node.js, Node-RED provides a web-based, drag-and-drop interface to wire together different nodes (functional units) to create workflows. Its power lies in its flexibility, simplicity, and the extensive library of available nodes, making it particularly useful for rapid development and prototyping, especially in IoT (Internet of Things) projects and automation tasks.

https://nodered.org/