
Industrial data communication in the era of the Internet of Things

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TOMOCON

Smart Tomographic Sensors for
Advanced Industrial Process Control



Industrial Communications Networks

The word cloud includes the following words:

- Security
- dashdb
- Cybersecurity Standards
- Local Network Interconnect
- Java
- Industrial Area
- Networking Communication
- Containers
- Cloudant
- Wide
- Mobile
- Deployment
- Streaming
- Openwhisk
- Software
- Data
- Eclipse
- Models
- Iot
- Fieldbuses
- Serial
- Client
- API
- Foundry
- Cloud
- Devops
- Docker
- Kubernetes
- Concepts
- Serverless Node
- Conference
- Liberty
- Database
- Microservices
- Cloud

Agenda

- Industrial Process Supervision
- Industrial Connectivity Standards
- Internet of Things
- IoT Standards and Protocols
- Demo – Let's make an IoT solution

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Industrial process supervision

- The connection of low voltage devices is required in:
 - automated industrial processes
 - large industries
 - oil & gas applications
 - smart grid networks



Agenda

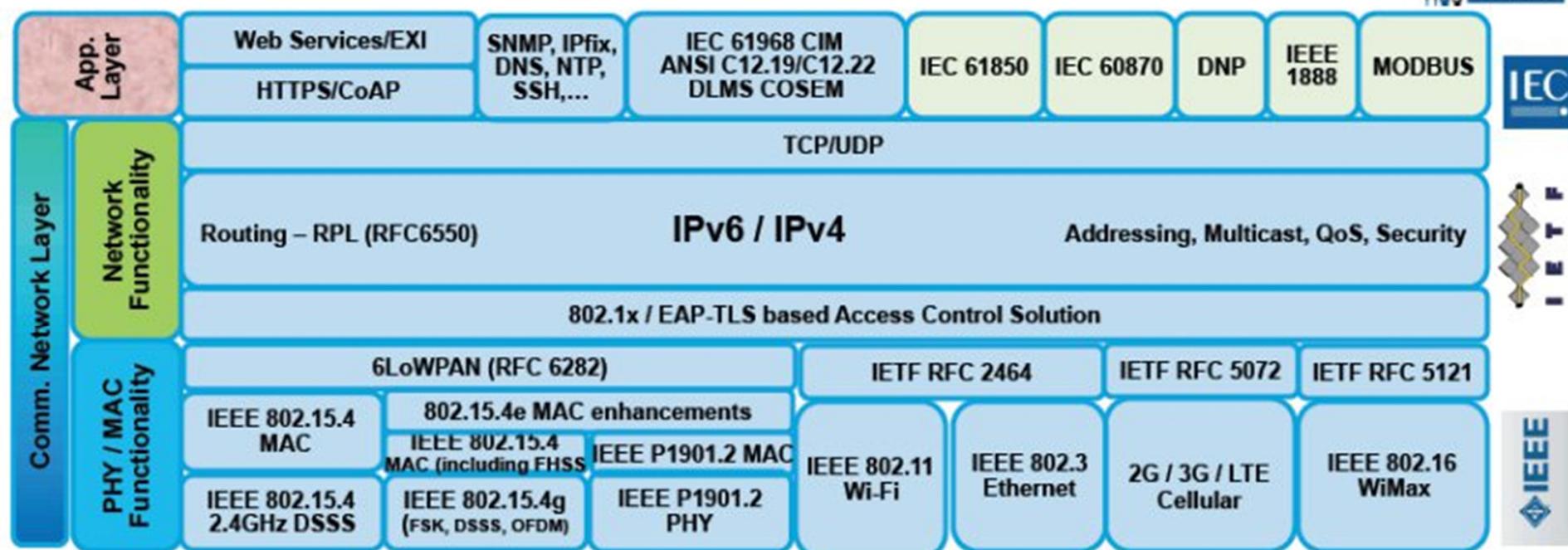
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Open Standards Reference Model

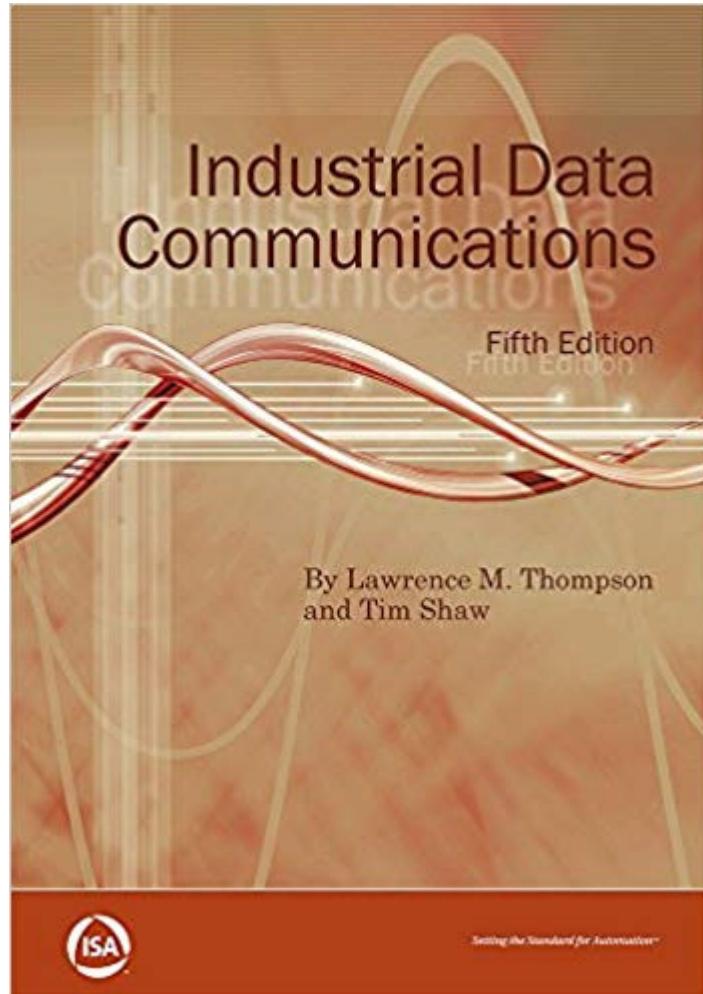


[David E. Culler - The Internet of Every Thing - steps toward sustainability CWSN Keynote, Sept. 26, 2011](#)



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Fundamentals You Can Find Here

<https://automation.isa.org/2016/05/qa-with-authors-of-isa-book-industrial-data-communications/>



Internet of Things

„The Internet of Things (IoT) is the interconnection of physical devices, vehicles, home appliances, sensors, actuators, and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these things to connect and exchange data over the Internet, creating opportunities for more direct integration between the physical world and computer networks, resulting in efficiency improvements, economic benefits, and reduced human exertions.“

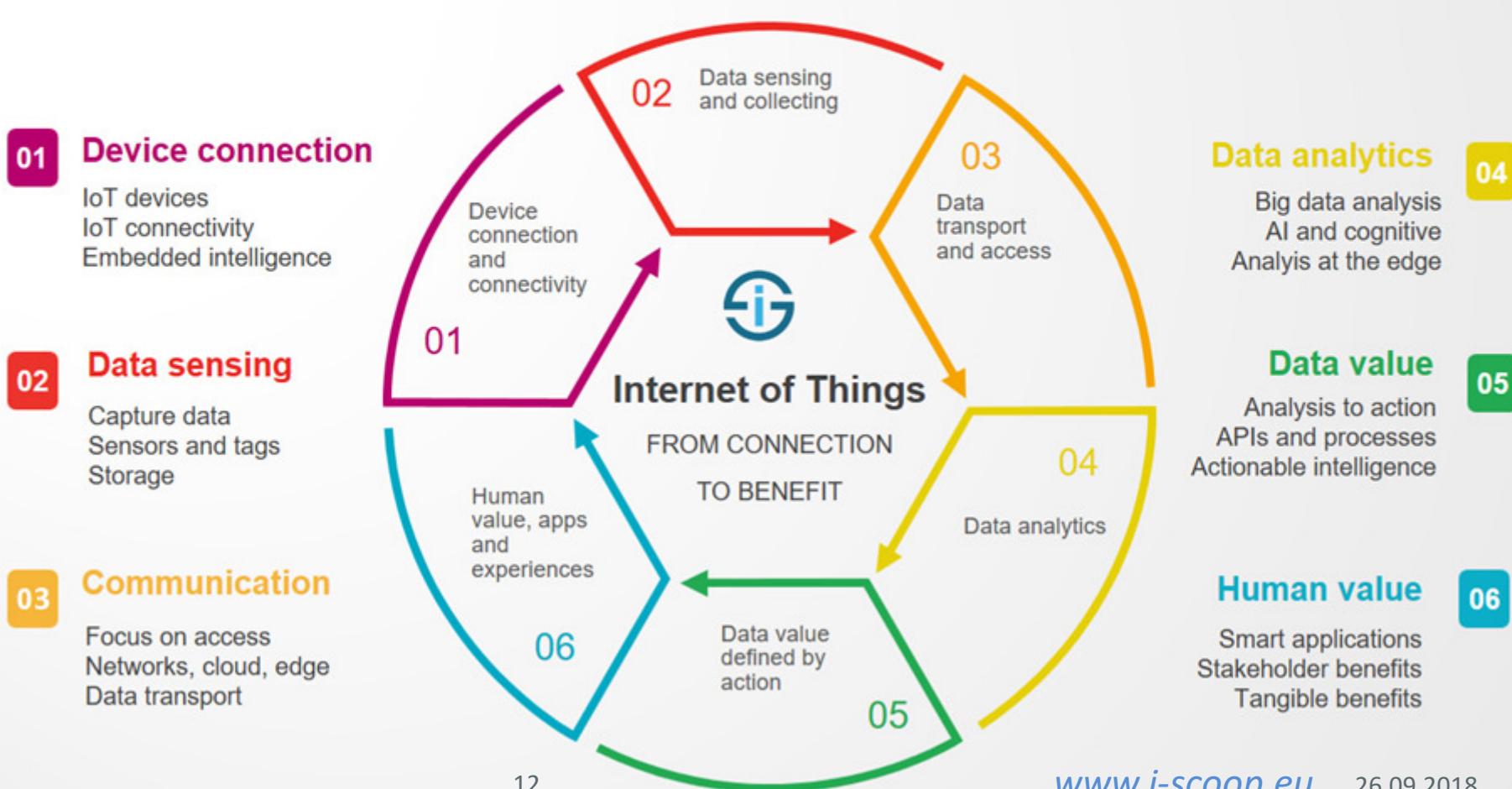


[Wikipedia](#)



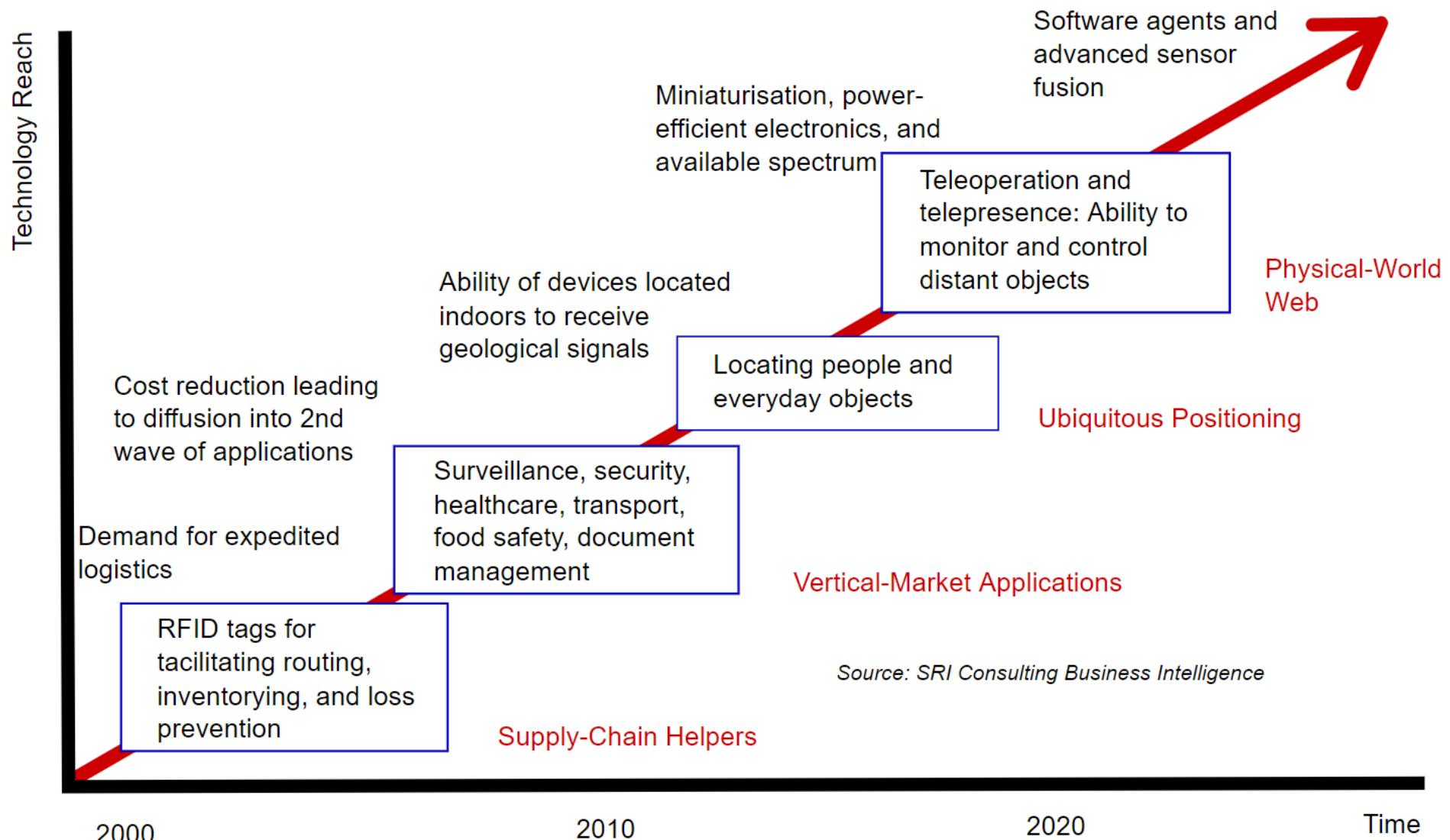
The Internet of Things

From connecting devices to human value



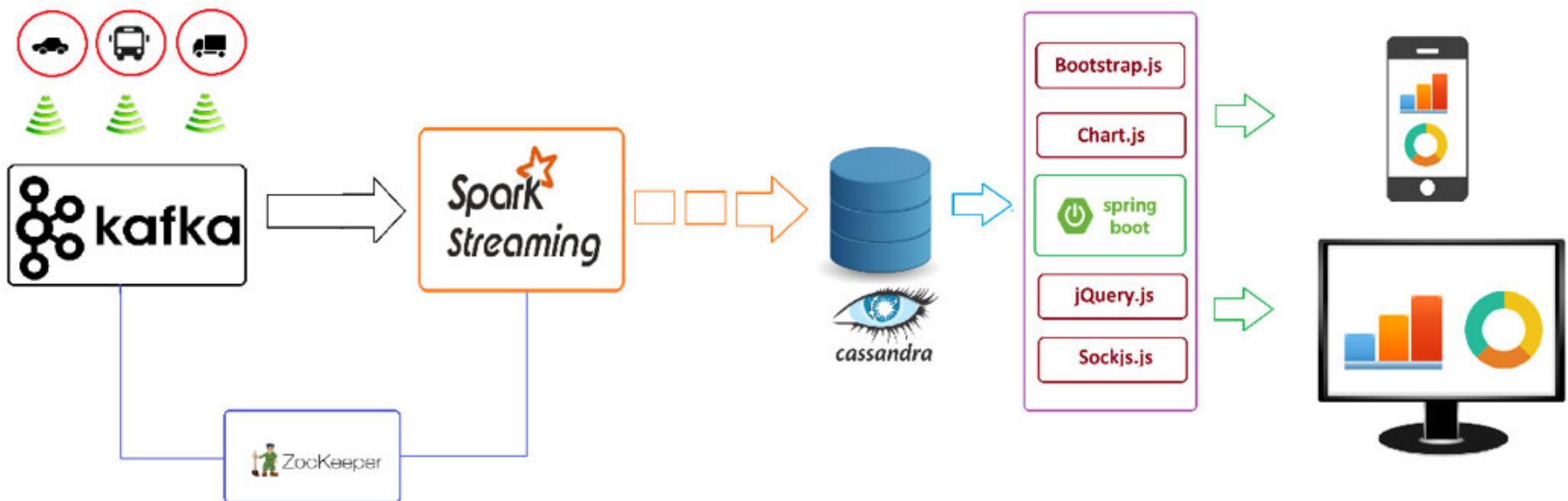


Technology roadmap: The Internet of Things





IoT Data Pipeline



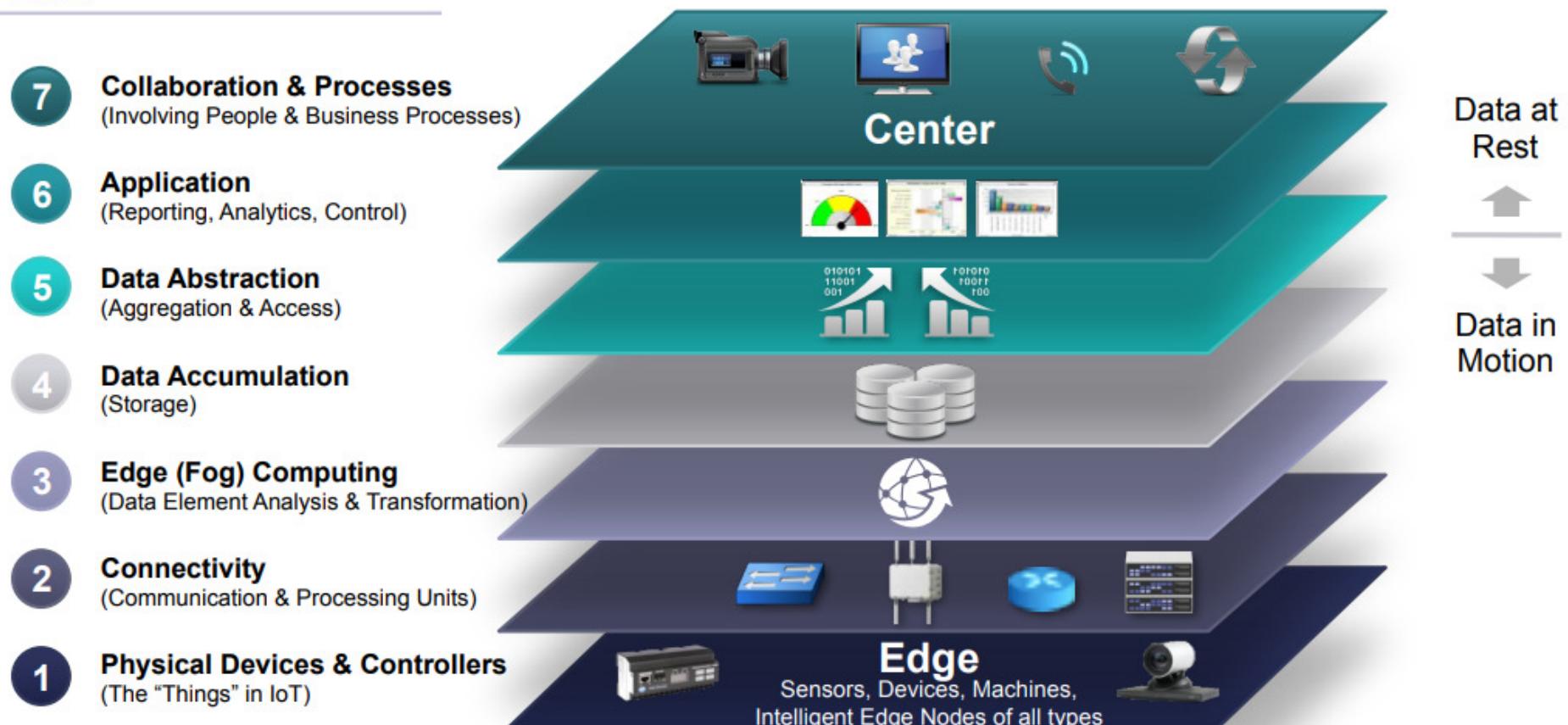
www.infoq.com

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Internet of Things Reference Model

Levels



www.cisco.com

IoT Protocols

- **Discovery** (ex: Physical Web, mDNS, DNS-SD, UPnP)
- **Infrastructure** (ex: 6LowPAN, IPv4/IPv6, RPL)
- **Identification** (ex: EPC, uCode, IPv6, URIs)
- **Comms / Transport** (ex: Wifi, Bluetooth, LPWAN)
- **Device Management** (ex: TR-069, OMA-DM)
- **Semantic** (ex: JSON-LD, Web Thing Model)
- **Security** (ex: OTrP, X.509)
- **Data Protocols** (ex: MQTT, CoAP, AMQP, Websocket, Node)

Physical Web

mDNS,

DNS-SD

UPnP

DISCOVERY

Physical Web

The Physical Web is an open approach to enable quick and seamless interactions with physical objects and locations.



See what's useful around you



Any object or place can broadcast content

6LowPAN

IPv4/IPv6

RPL

INFRASTRUCTURE

IPv6 over Low power Wireless Personal Area Networks

- "the Internet Protocol could and should be applied even to the smallest devices"
- encapsulation and header compression mechanisms that allow IPv6 packets to be sent and received over IEEE 802.15.4 based networks
- IEEE 802.15.4 devices provide sensing communication-ability in the wireless domain

- Ethernet
- WirelessHart
- DigiMesh
- IEEE 802.15.4
- NFC
- ANT
- Bluetooth
- ZigBee

COMMUNICATION / TRANSPORT LAYER

ZigBee

- protocol uses the 802.15.4 standard
- operates in the 2.4 GHz frequency range with 250 kbps
- maximum number of nodes in the network is 1024
- range up to 200 meters
- use 128 bit AES encryption



IOTDB

SensorML

Semantic Sensor Net Ontology

RAML

SENML

LsDL

SEMANTIC

Sensor Markup Language (SENML)

- defines media types for representing simple sensor measurements and device parameters
- representations are defined in
 - JavaScript Object Notation (JSON),
 - eXtensible Markup Language (XML)
 - Efficient XML Interchange (EXI)
- media type used in protocols such as HTTP or CoAP to transport the measurements of the sensor or to be configured

Sensor Markup Language (SENML)

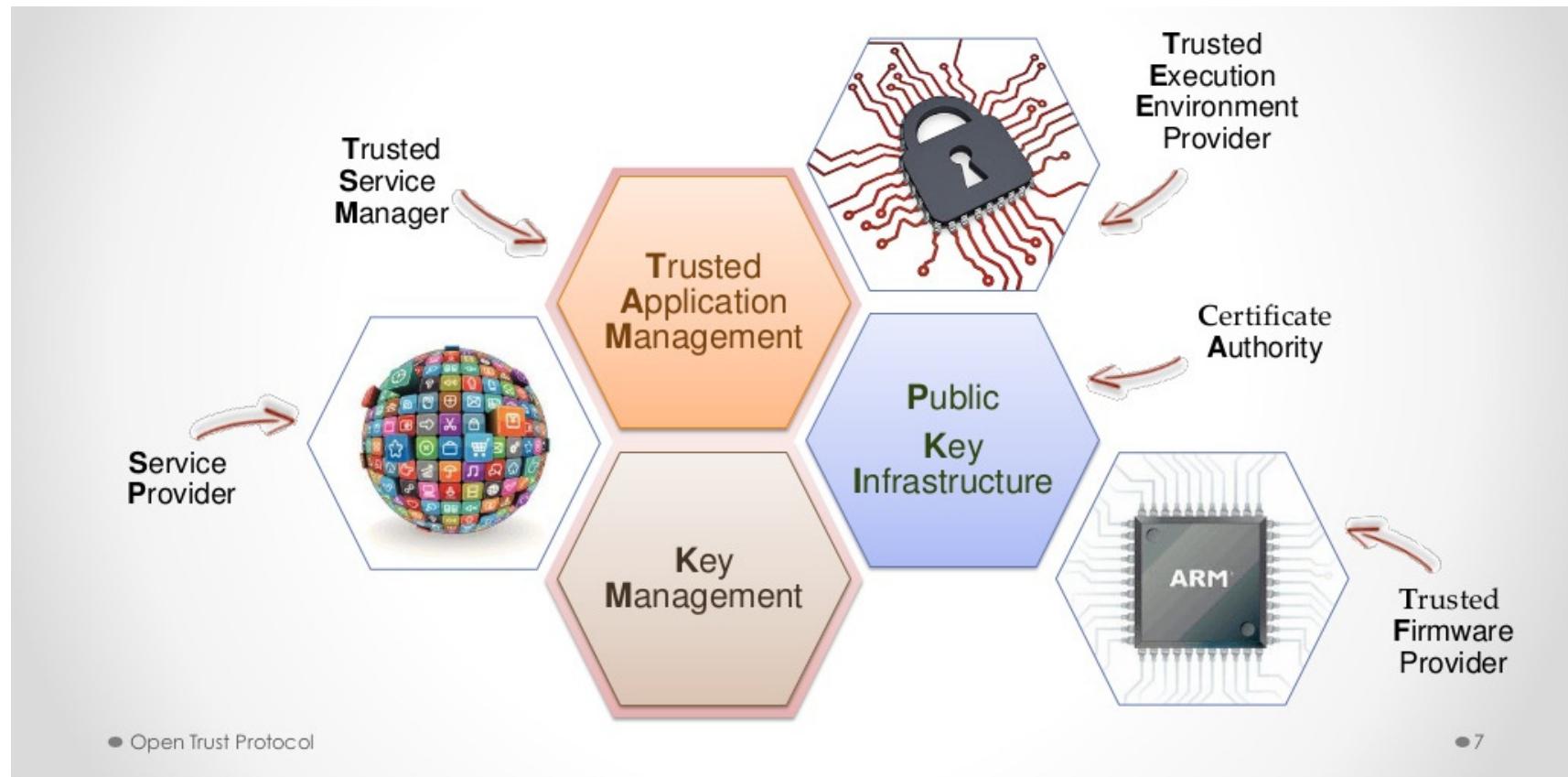
- Single datapoint example
 - shows a temperature reading taken approximately "now" by a 1-wire sensor device that was assigned the unique 1-wire address of 10e2073a01080063:

```
{"e": [{ "n": "urn:dev:ow:10e2073a01080063", "v": 23.5 }]}{}
```

OTrP,
X.509

SECURITY

Open Trust Protocol (OTrP)



IoT protocol landscape

Protocol	CoAP	XMPP	RESTful HTTP	MQTT
Transport	UDP	TCP	TCP	TCP
Messaging	Request/Response	Publish/Subscribe Request/Response	Request/Response	Publish/Subscribe Request/Response
2G, 3G, 4G Suitability	Excellent	Excellent	Excellent	Excellent
LLN Suitability (1000s nodes)	Excellent	Fair	Fair	Fair
Compute Resources	10Ks RAM/Flash	10Ks RAM/Flash	10Ks RAM/Flash	10Ks RAM/Flash
Success Stories	Utility Field Area Networks	Remote management of consumer white goods	Smart Energy Profile 2 (premise energy management/home services)	Extending enterprise messaging into IoT applications

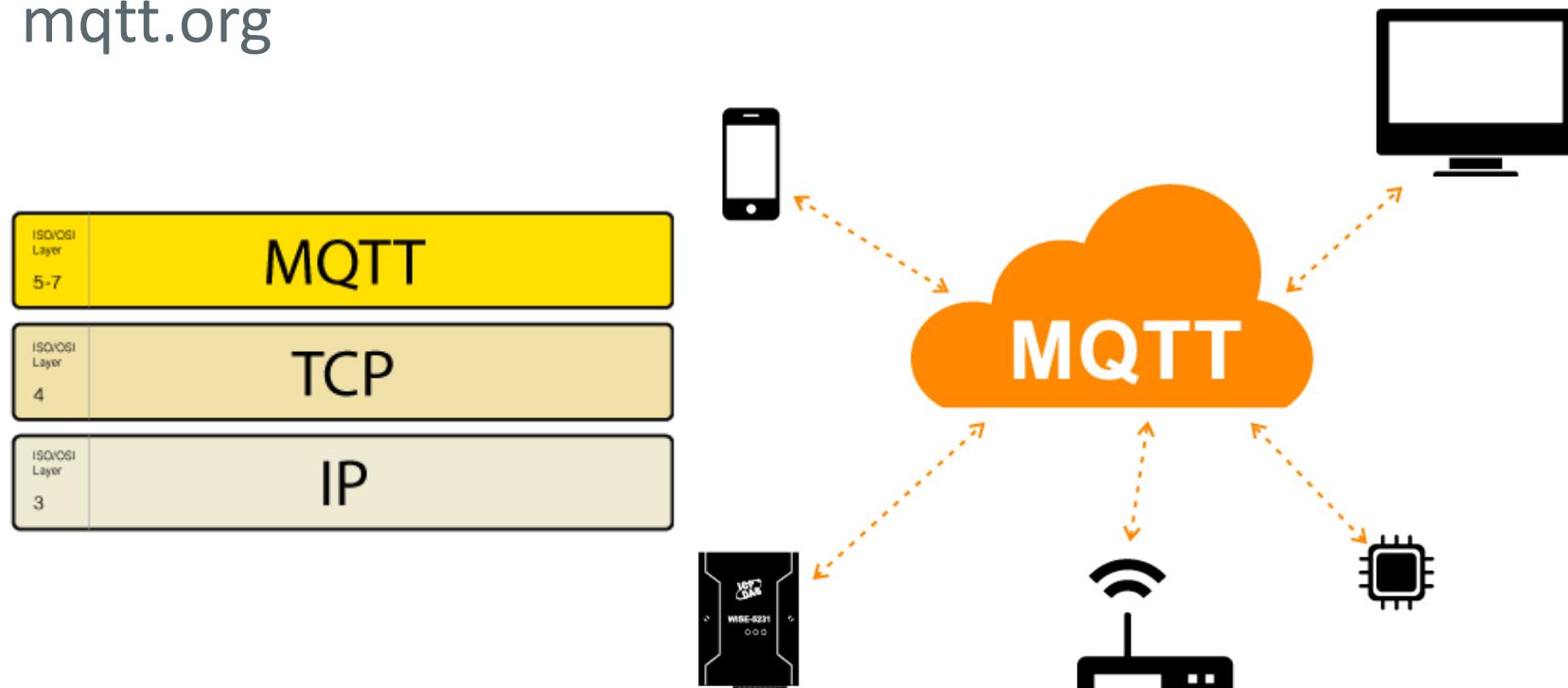
Few more words about CoAP



- Constrained Application Protocol (CoAP) - specialized web transfer protocol for use with constrained nodes and constrained (e.g., low-power, lossy) networks
- runs on devices that support the User Datagram Protocol (UDP)
- designed for machine-to-machine (M2M) applications such as smart energy and building automation
- used for managing devices using The Open Mobile Alliance's (OMA) Lightweight Machine-to-Machine (LWM2M) and ZigBee protocols

Connectivity Protocol for the Industrial Internet of Things

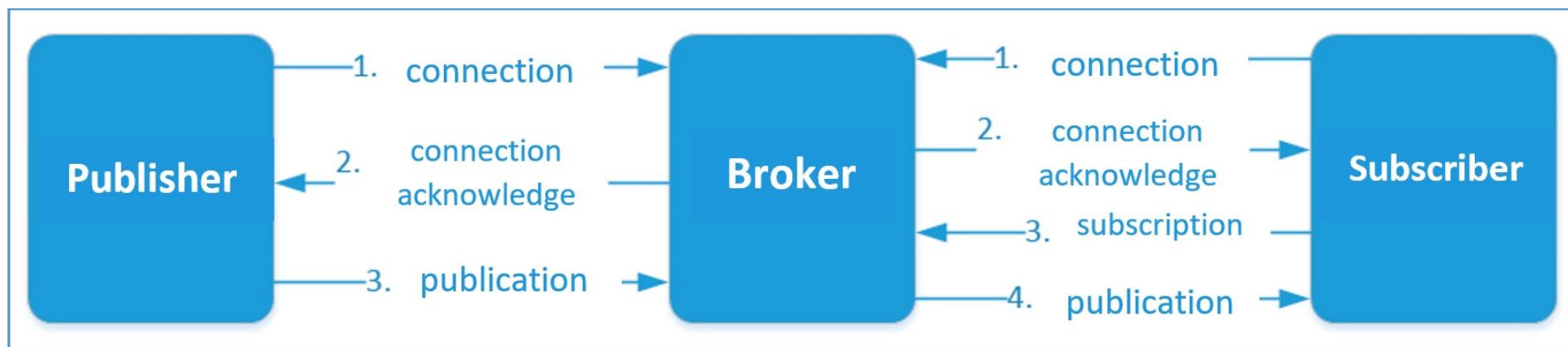
mqtt.org



ipc2u.com

MQTT Short Description

- originally developed for the low-bandwidth, high-latency, unreliable data links
- at the beginning used in the oil and gas industry
- publish/subscribe protocol
- MQTT is bidirectional



MQTT Short Description

- fast - update rates in the 100-millisecond range are possible even with external cloud-based brokers
- data discovered and delivered to, any number of clients (many to many)
- short time of client development
- maintains stateful session awareness
- permission based security
- data agnostic

MQTT Open-Source Projects

- Clients
 - Eclipse Paho project
- Brokers
 - Mosquito
 - HiveMQ
- IoT platforms
 - Mainflux
 - DeviceHive



MQTT Commercial Applications

- Facebook Messenger
- Amazon IIoT
- IBM Watson IoT
- ThingsBoard
- Google Cloud IoT

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Demo



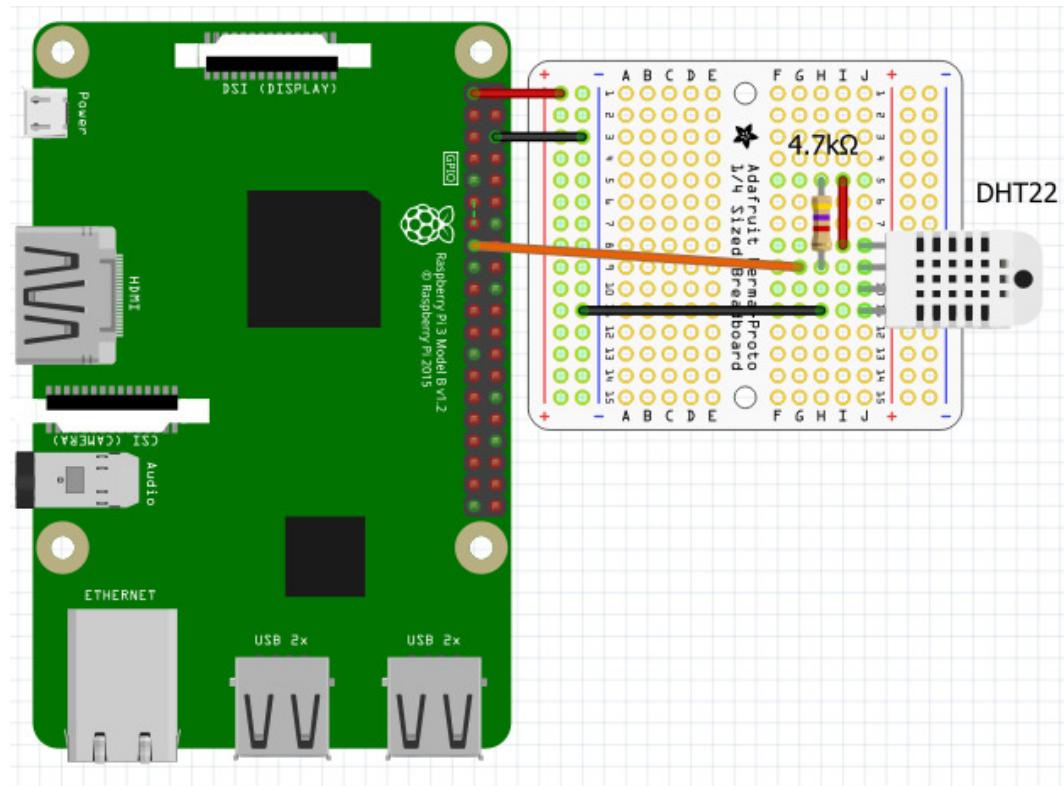
Let's make a simple IoT solution

Demo Scenario

- Make Raspberry Pi 3 communicating with data sensors
- Convince Rpi3 to send data to MQTT broker
- Build a client using Node-Red, where data will be:
 - taken from MQTT broker
 - stored in database
 - visualized in dashboard



Basic Setup



- Raspberry Pi 3 + DHT22
- Python 3 + Paho MQTT + AdaFruit DHT
- MQTT Spy
- IBM Cloud + Node-Red
- Cloudant
- Node-Red-Dashboard

Questions?

THANK YOU FOR LISTENING

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Acronyms

- 6LoWPAN - IPv6 over Low power Wireless Personal Area Networks
- UDP - User Datagram Protocol
- QUIC - Quick UDP Internet Connections
- DTLS - Datagram Transport Layer Security
- NanoIP - nano Internet Protocol
- mDNS - multicast Domain Name System
- UPnP - Universal Plug and Play
- AMQP - Advanced Message Queuing Protocol
- XMPP - Extensible Messaging and Presence Protocol
- DDS - Data-Distribution Service for Real-Time Systems
- LWM2M - Lightweight M2M
- REST - Representational state transfer - RESTful HTTP
- SOAP - Simple Object Access Protocol
- RAML - RESTful API Modeling Language

Words Cloud

- Industrial Data Communications, Communication Concepts, Communications Models, Serial Communications Standards, Local Area Networks, Network Software, Industrial Networks and Fieldbuses, Wide Area Networks, Internetworking, Cybersecurity, analytics api apps client cloud cloudbuild cloud foundry conference containers dashdb database deployment devops docker eclipse Cloud interconnect iot java Kubernetes liberty microservices mobile node.js openwhisk security Serverless streaming-analytics