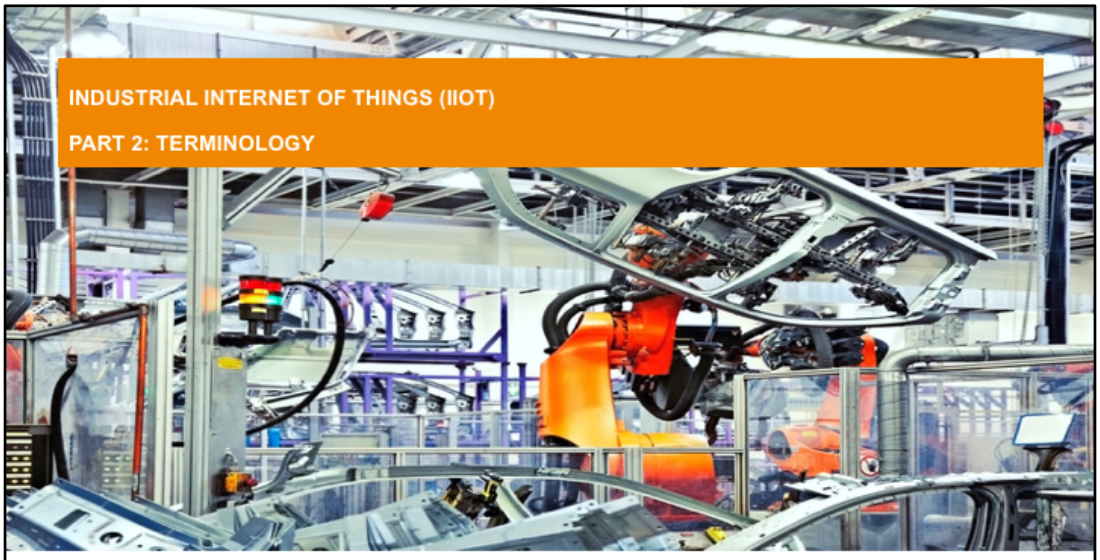


INDUSTRIAL INTERNET OF THINGS (IIOT)

PART 2: TERMINOLOGY

AV Lecture in Summer Term 2018
Dr.-Ing. Alexander **Willner**

Fraunhofer FOKUS
Technische Universität Berlin

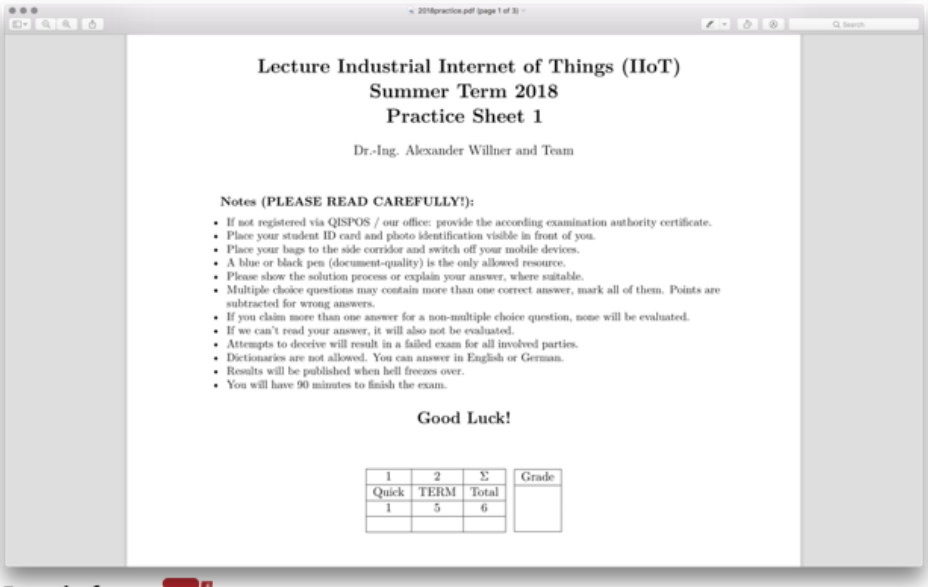
THE LAST LECTURE AND CURRICULUM

Questions? Registered at ISIS?

PRACTICE SHEETS

5 minutes

LOOKS LIKE THE EXAM



Lecture Industrial Internet of Things (IIoT)
Summer Term 2018
Practice Sheet 1

Dr.-Ing. Alexander Willner and Team

Notes (PLEASE READ CAREFULLY!):

- If not registered via QISPOS / our office: provide the according examination authority certificate.
- Place your student ID card and photo identification visible in front of you.
- Place your bags to the side corridor and switch off your mobile devices.
- A blue or black pen (document-quality) is the only allowed resource.
- Please show the solution process or explain your answer, where suitable.
- Multiple choice questions may contain more than one correct answer, mark all of them. Points are subtracted for wrong answers.
- If you claim more than one answer for a non-multiple choice question, none will be evaluated.
- If we can't read your answer, it will also not be evaluated.
- Attempts to deceive will result in a failed exam for all involved parties.
- Dictionaries are not allowed. You can answer in English or German.
- Results will be published when hell freezes over.
- You will have 90 minutes to finish the exam.

Good Luck!

1	2	Σ	Grade
Quick	TERM	Total	
1	5	6	

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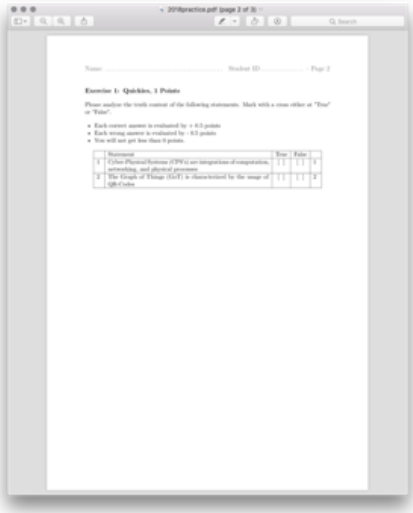
- Practice sheets / exercises will be released after each lecture
- On voluntary basis, no submission
- Will be discussed in the last lecture before the exam
- Purpose: lern what to expect from the exam

INCLUDES “QUICKIES”



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- Quickies: Quickly to be answered questions

INCLUDES MULTIPLE CHOICE AND REGULAR QUESTIONS

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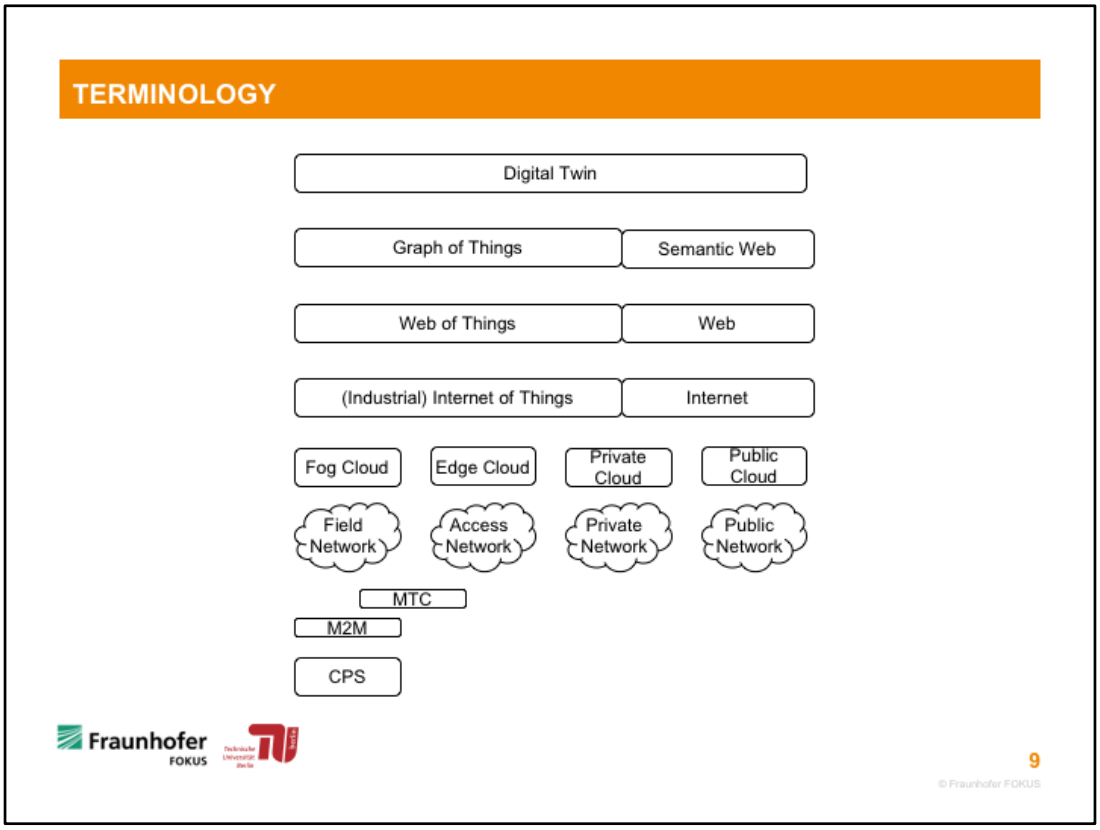
- Text based questions
- Multiple choice questions

PRACTICE SHEETS

Will be updated after each lecture

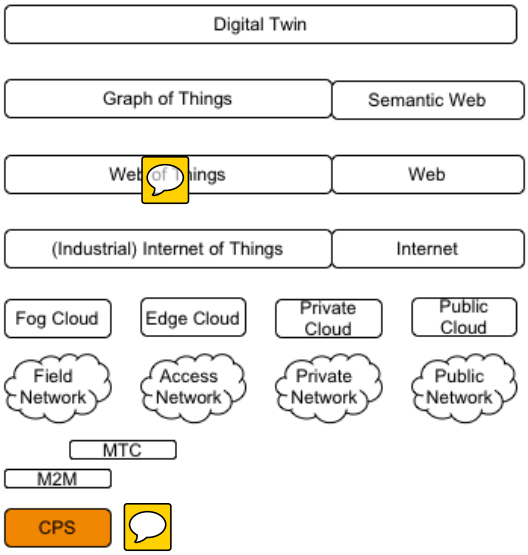
OVERALL TERMINOLOGY

80 Minutes



- This is the overall structure of the terminology for this lecture

TERMINOLOGY



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CYBER-PHYSICAL SYSTEMS (CPS)
USE SOFTWARE TO MAKE THINGS SMART

Cyber-Physical Systems (CPS) are integrations of computation, networking, and physical processes [http://cyberphysicalsystems.org]. Term itself was coined around 2006 within a National Science Foundation (NSF) Workshop in the US. The term cybernetics that lay the foundations for the design of CPS was coined already 1950.

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What are examples of Cyber-Physical Systems?

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CYBER-PHYSICAL SYSTEMS (CPS)

https://youtu.be/eu2ewxZ9lbY

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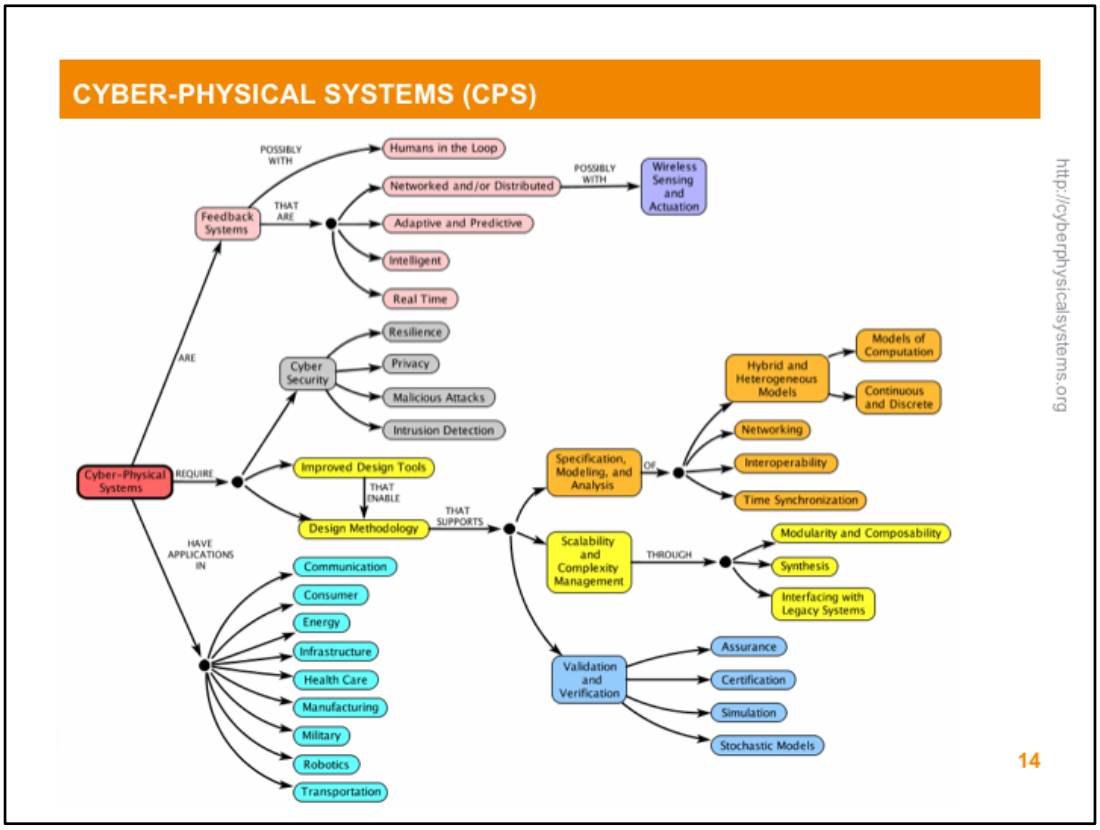
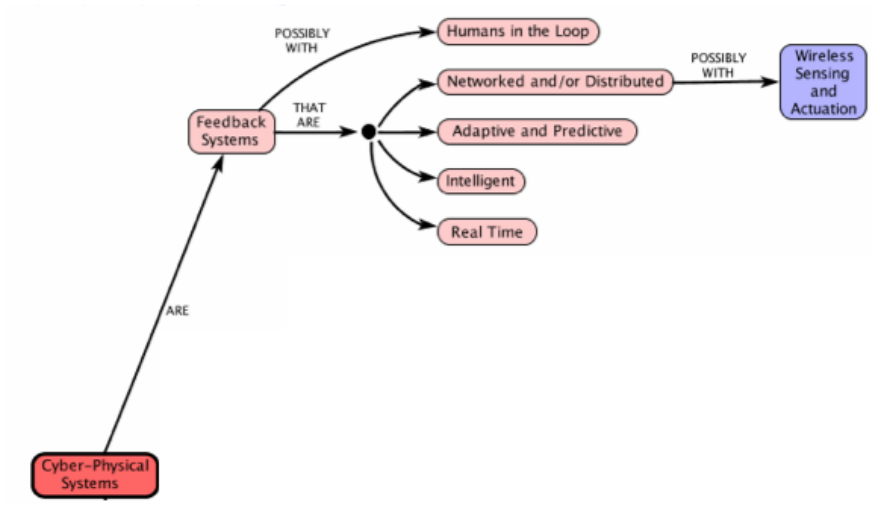
- Short video giving a (funny) example for an autonomous CPS



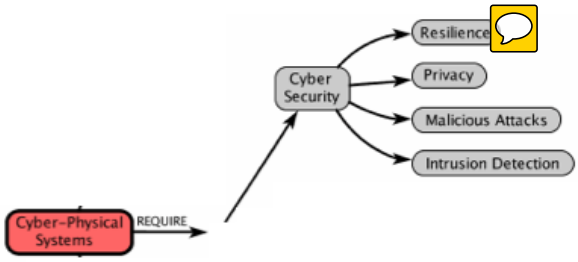
- A more formal description of the attributes of a CPS

CYBER-PHYSICAL SYSTEMS (CPS) ARE FEEDBACK SYSTEMS

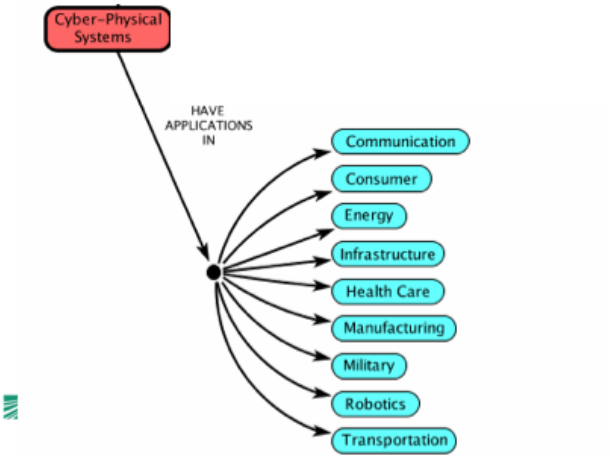


http://cyberphysicalsystems.org

CYBER-PHYSICAL SYSTEMS (CPS) REQUIRE CYBER SECURITY

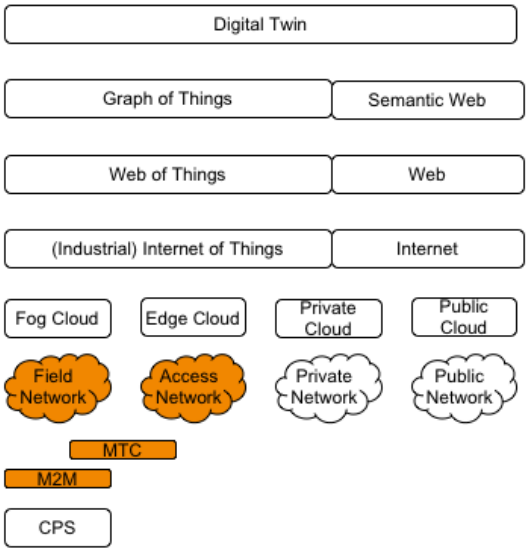


CYBER-PHYSICAL SYSTEMS (CPS) HAVE MANY APPLICATIONS



http://cyberphysicalsystems.org

TERMINOLOGY



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MACHINE-TO-MACHINE (M2M) COMMUNICATION
USE OF DIRECT COMMUNICATION (NFC, QR, LTE-M)

Machine-to-machine (M2M) communications is used for automated data transmission and measurement between mechanical or electronic devices [http://www.gartner.com/it-glossary/machine-to-machine-m2m-communications].

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What are examples for M2M communication?

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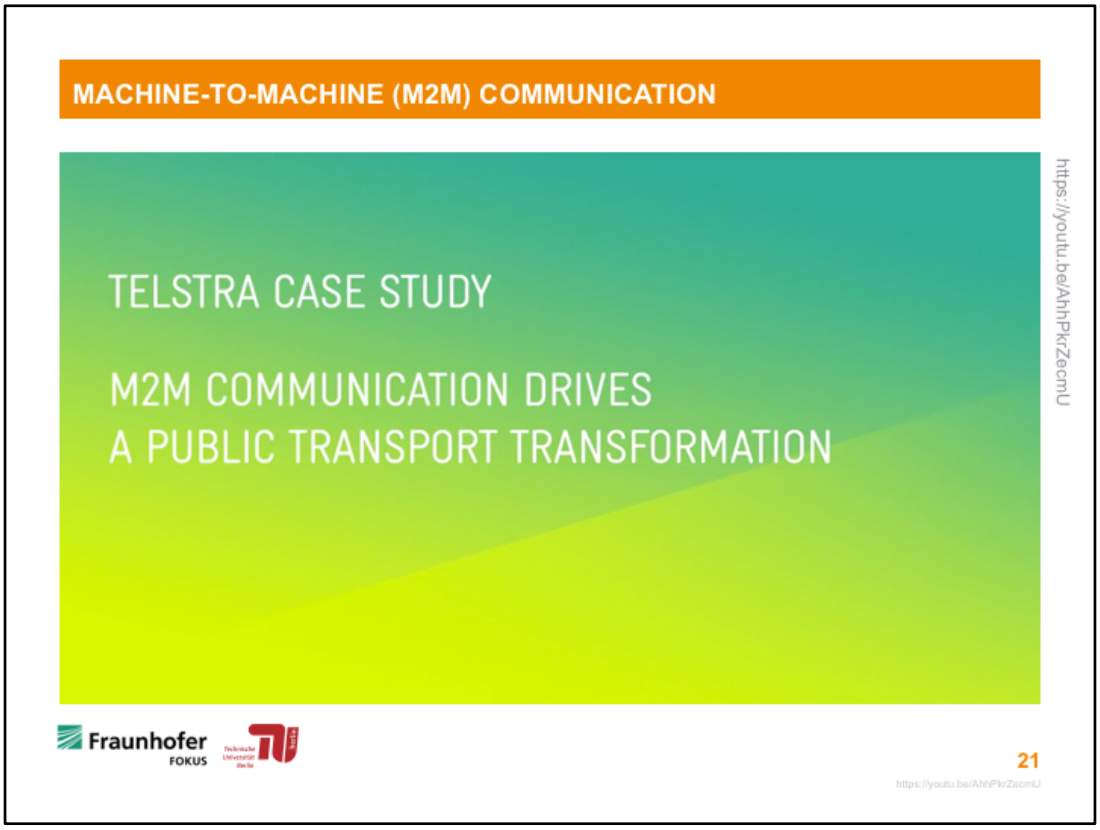
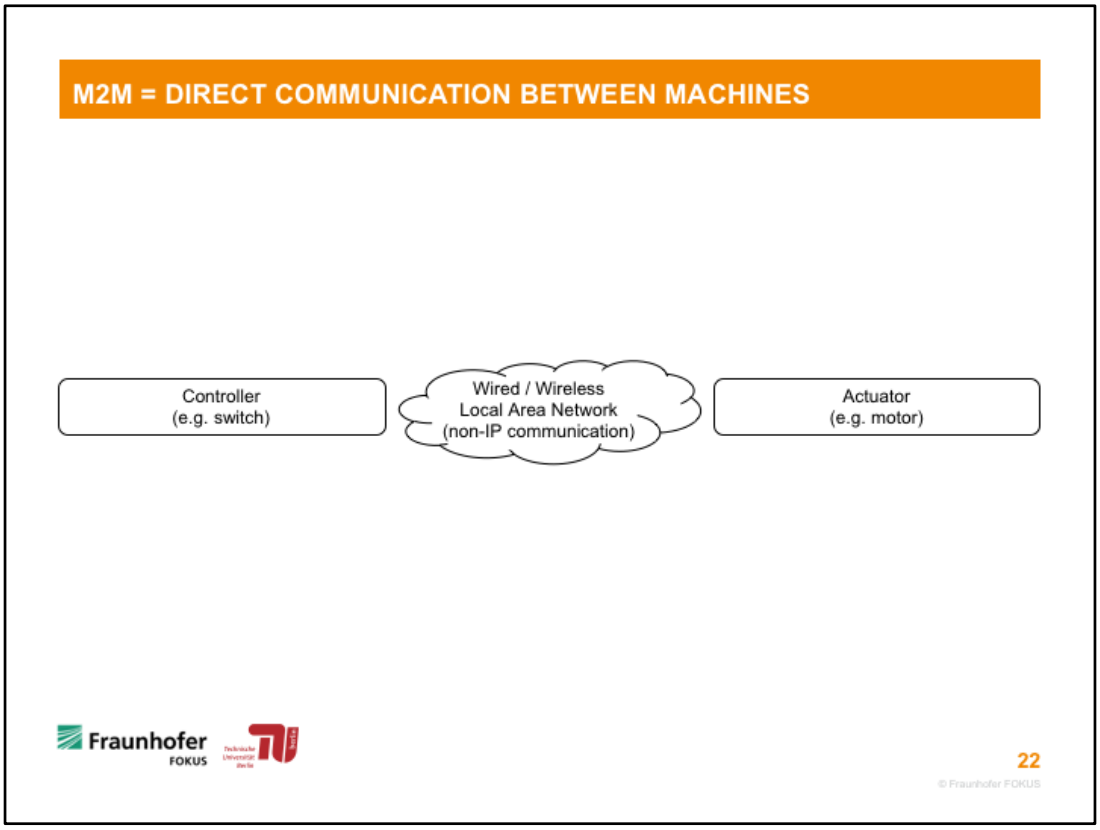
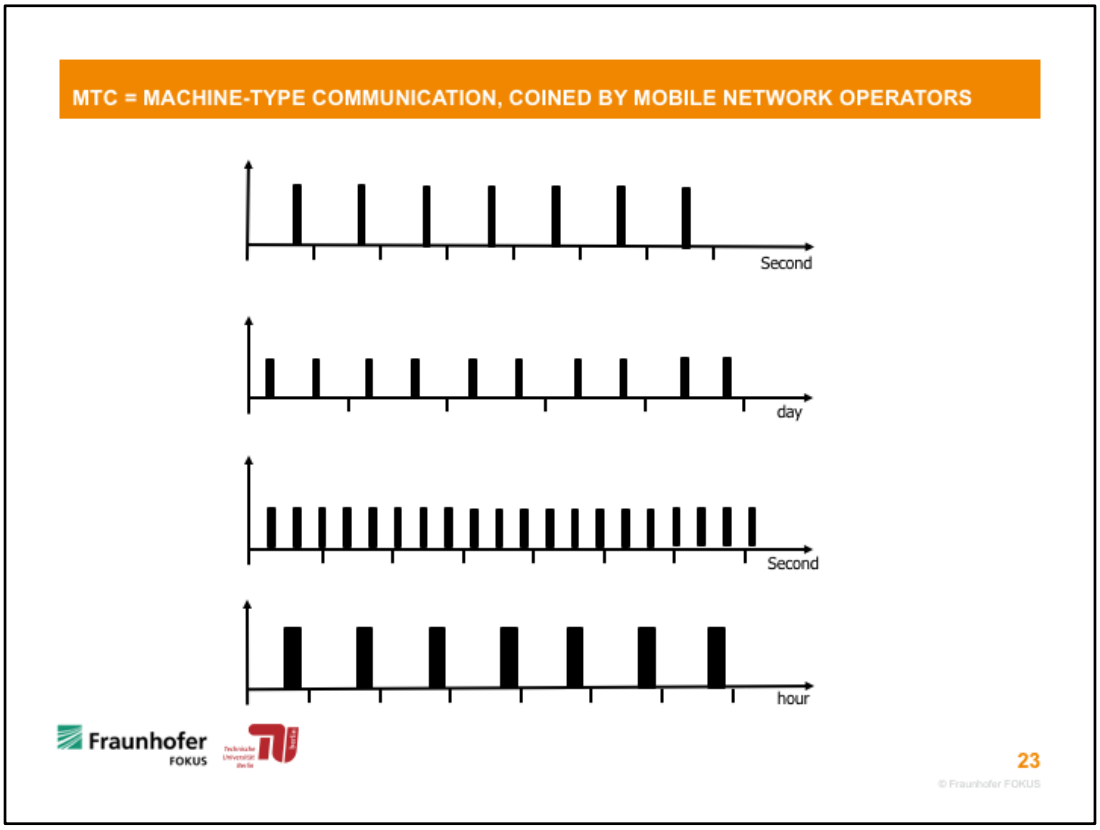


- Short video giving an example for M2M communication

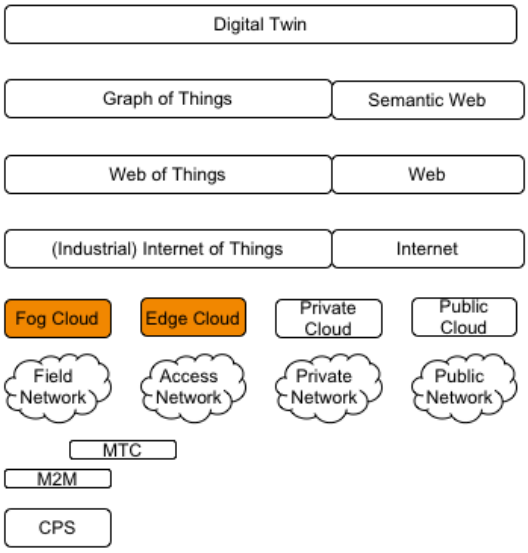


- Note: local network, typically non-IP communication



- Term used in the MNO context for characterizing the communication of machines using the network

TERMINOLOGY



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CLOUD DEPLOYMENT MODELS
USE OF VIRTUALIZATION AT DIFFERENT LEVELS

Cloud Computing is a style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service using Internet technologies [https://www.gartner.com/it-glossary/cloud-computing].

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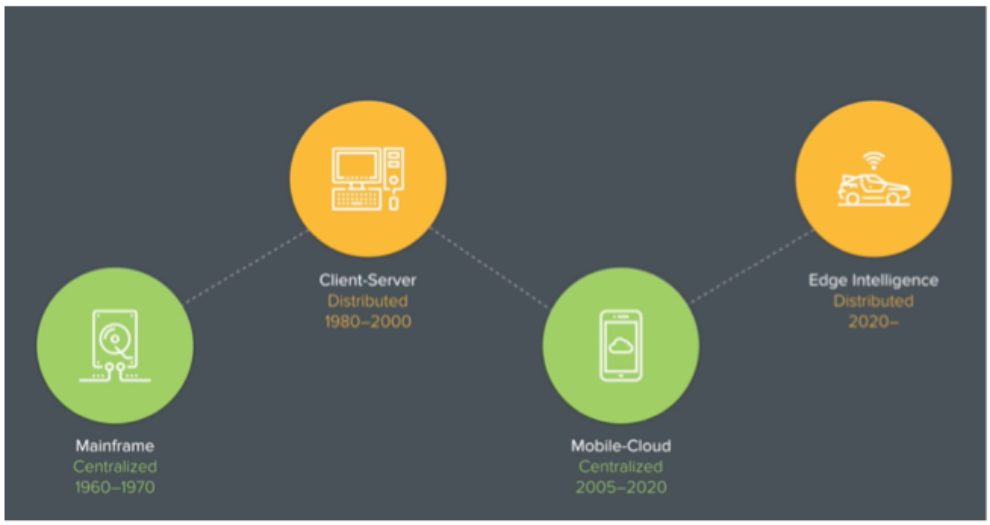
BACK TO THE FUTURE



Peter Levine: Return to the Edge and the End of Cloud Computing

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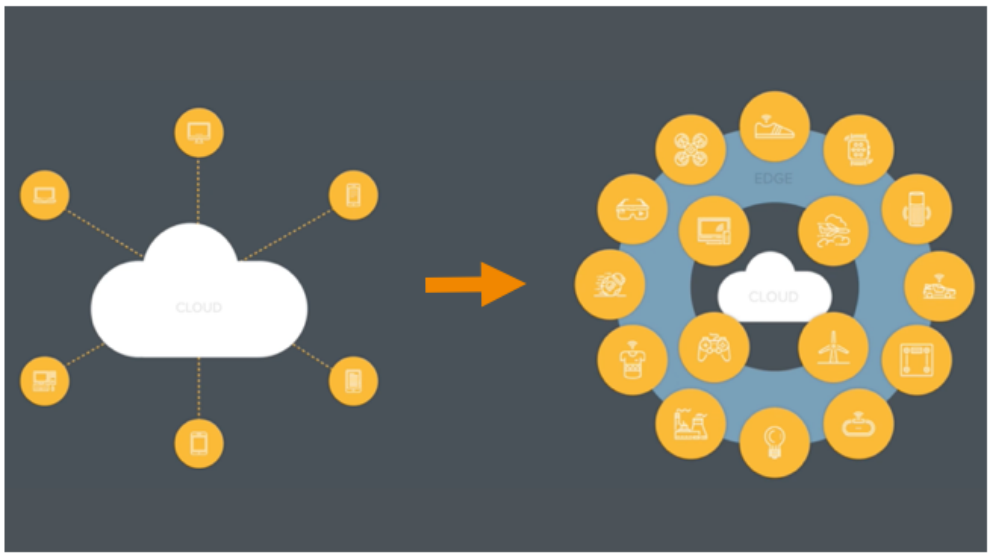
- Started in 1960th with mainframe system
- Now again distributed paradigm

FROM CENTRAL CLOUDS TO PEER-TO-PEER FOG CLOUDS



Peter Levine: Return to the Edge and the End of Cloud Computing

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Warning: the following terminology is not carved in stone.

There is no single correct school of thought when it comes to these terms.

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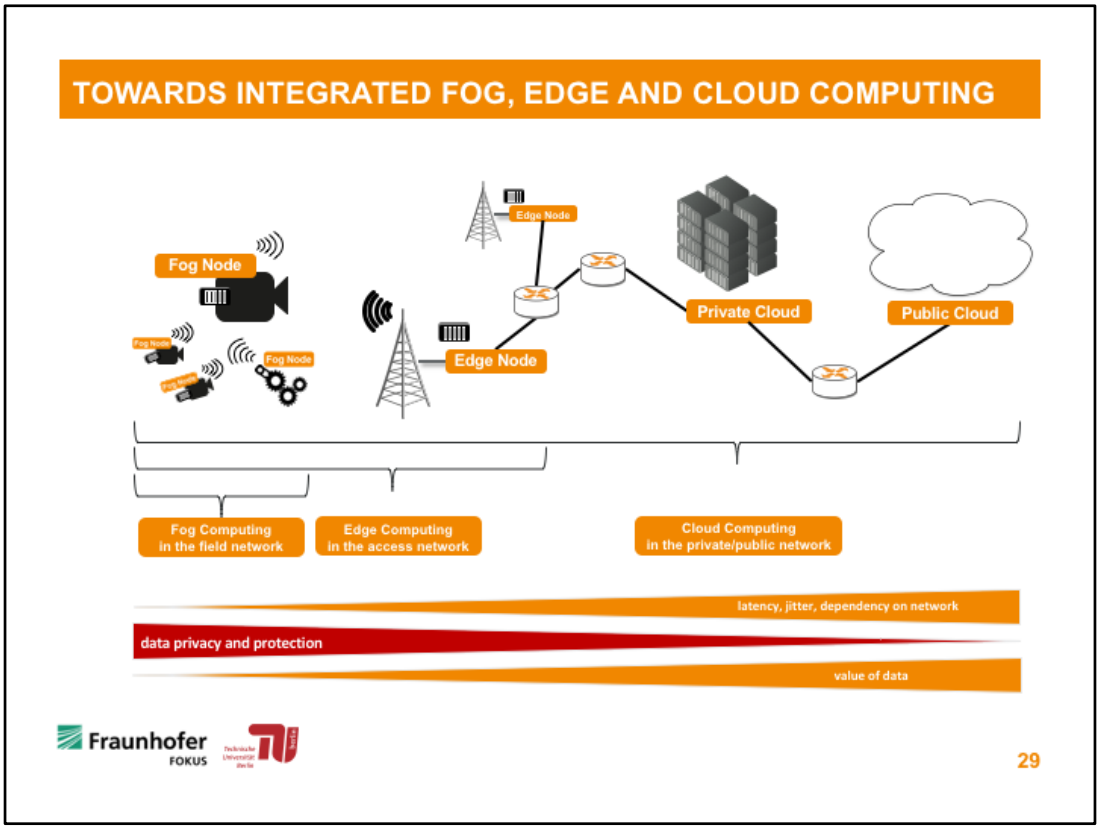
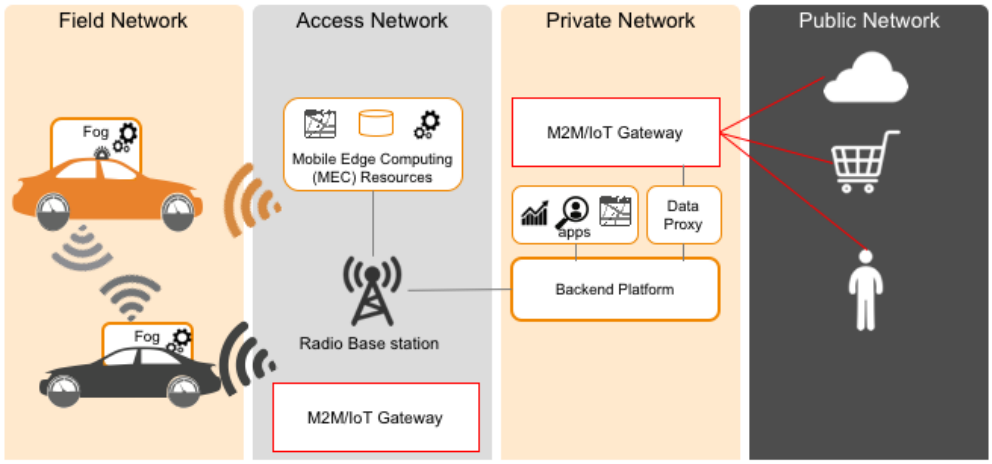


- In particular the differentiation between Fog and Edge computer often change, depending on your source/context

DEPLOYMENT VIEW



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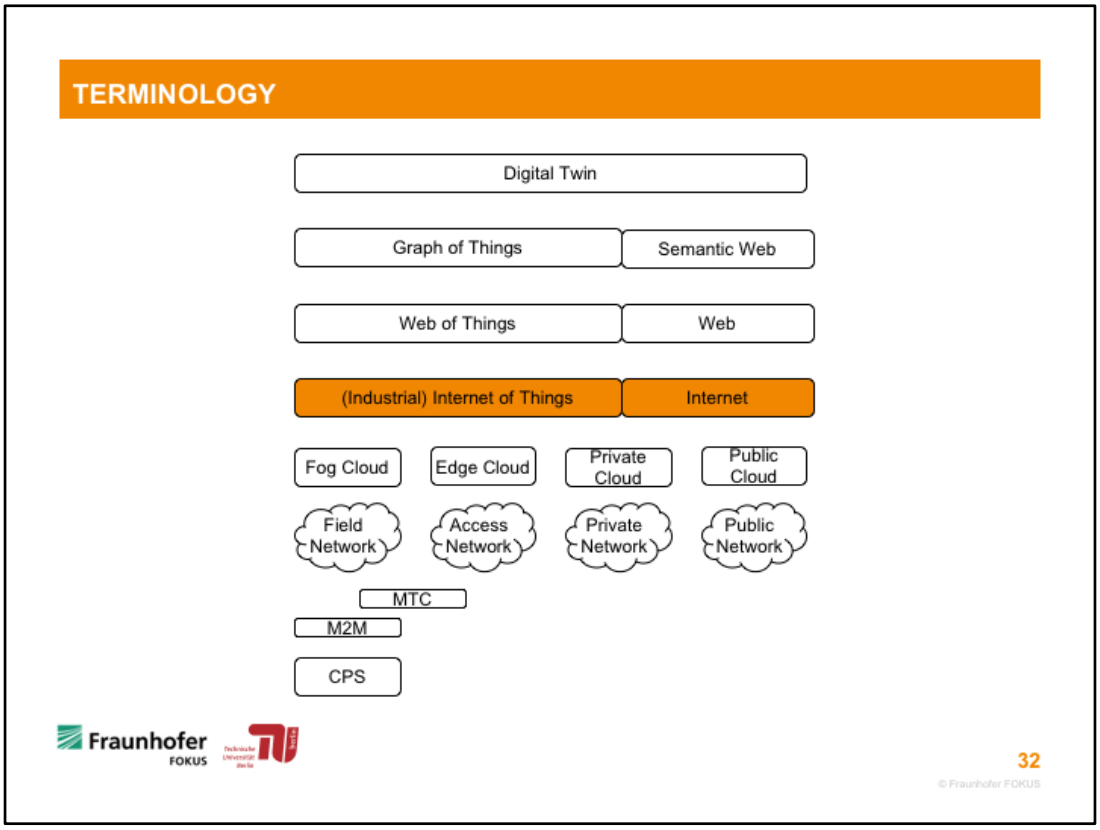

- IoT -> Things using the Internet to communicate

INTERNET OF THINGS (IOT)
USE OF IP TECHNOLOGIES FOR COMMUNICATION

The Internet of Things (IoT) is the network of physical objects—devices, vehicles, buildings and other items—embedded with electronics, software, sensors, and network connectivity that enables these objects to collect and exchange data [https://en.wikipedia.org/wiki/Internet_of_Things]. The term was coined in 1999 by Kevin Ashton in the context of using Radio-frequency identification (RFID) tags.

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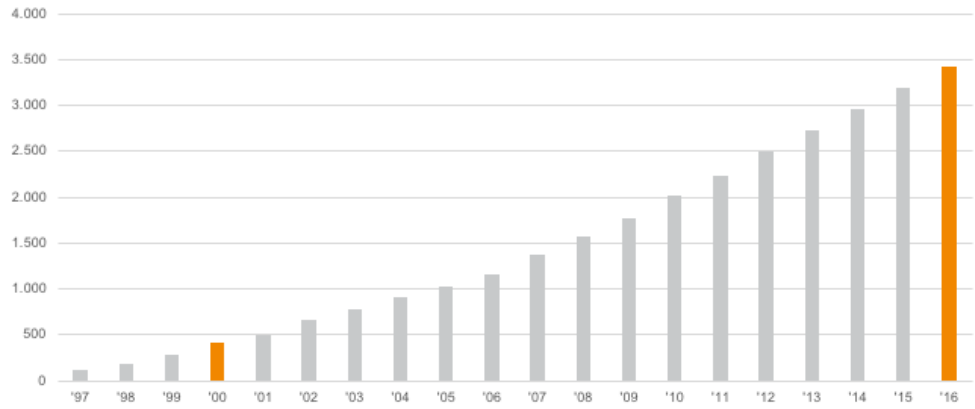
NUMBER OF WORLDWIDE INTERNET USERS IN MILLIONS



ITU; World Bank; United Nations

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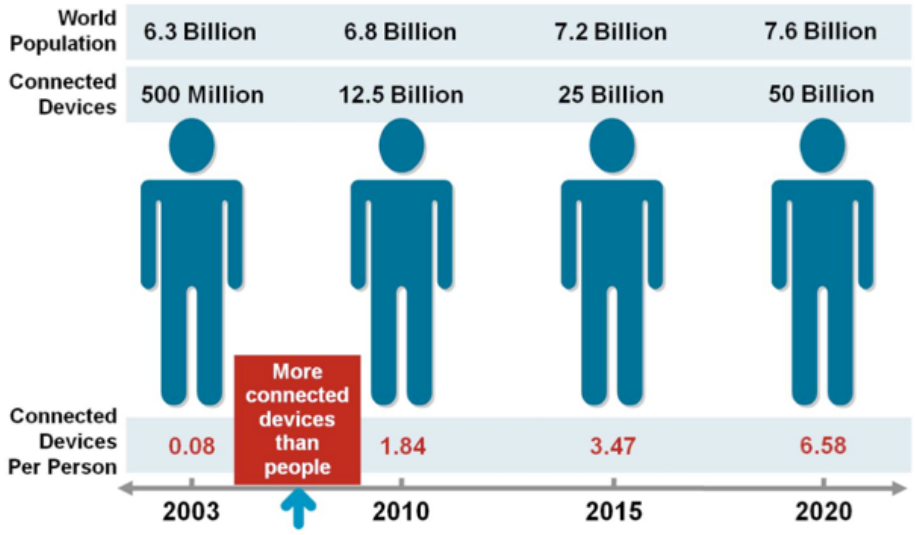
SINCE 2006: MORE CONNECTED DEVICES THAN PEOPLE



Cisco IBSG, April 2011

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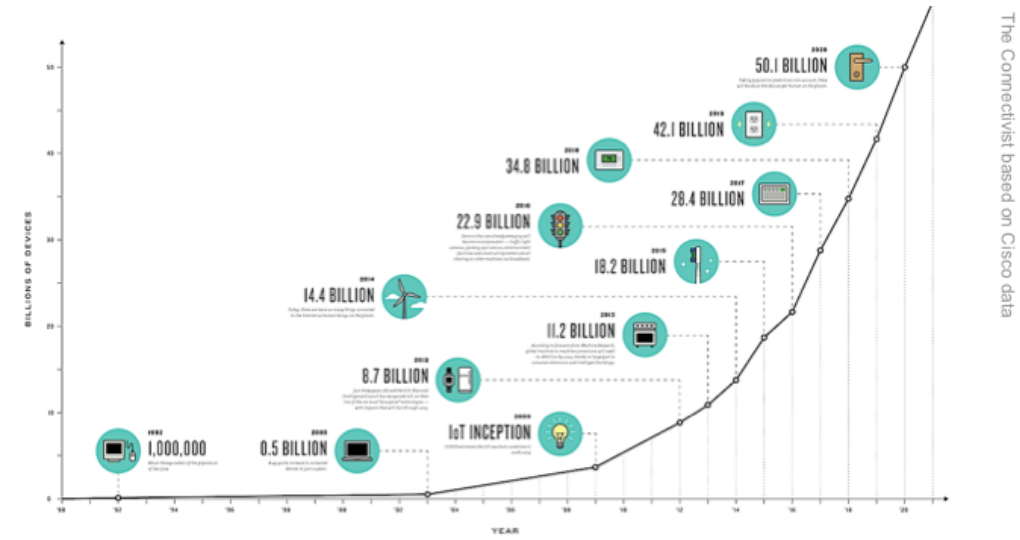
THE INTERNET OF THINGS



The Connectivist based on Cisco data

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- A rather broad topic and sometimes too hyped

THE IOT LANDSCAPE

Matt Turck & Sutian Dong

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- Many aspects to cover in the IoT context

What are examples for the Internet of Things?

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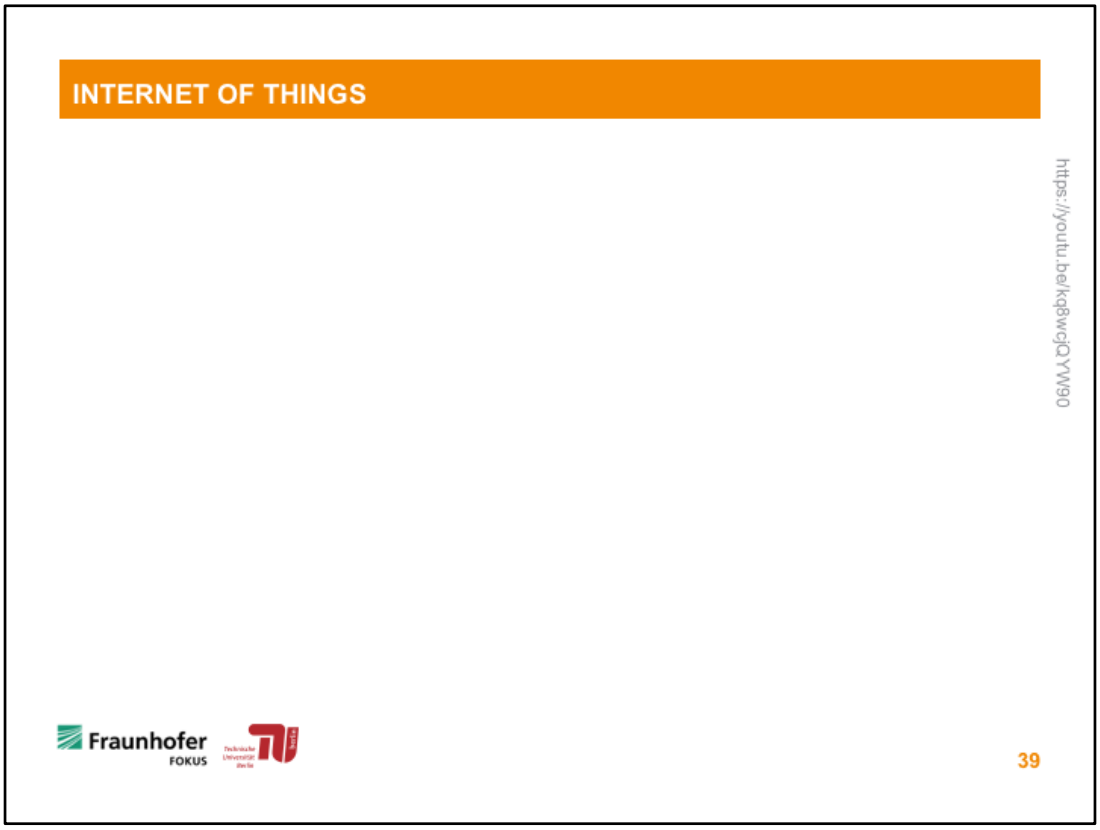
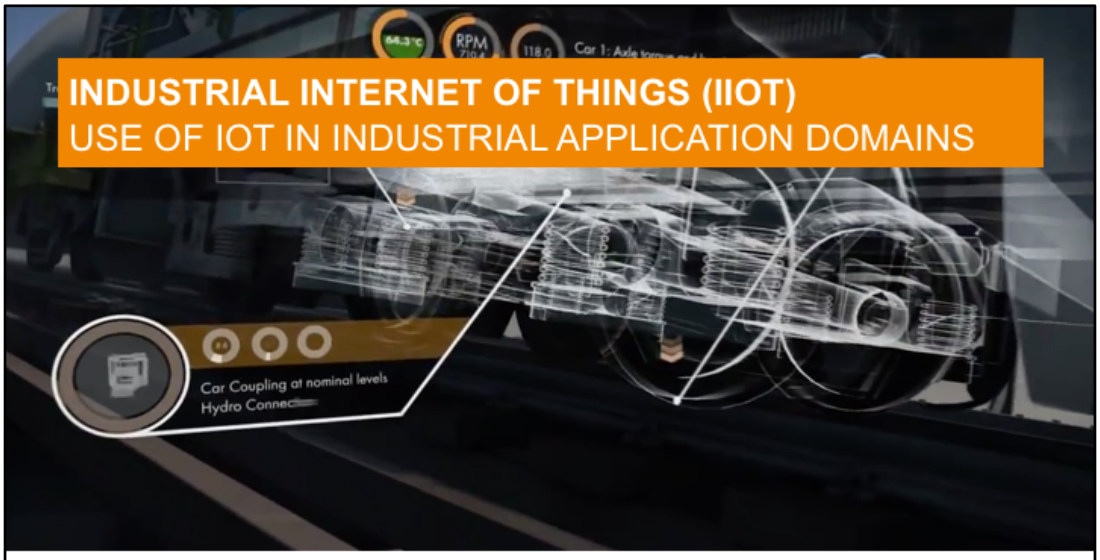


- Short video giving a (funny) vision about the IoT



INDUSTRIAL INTERNET OF THINGS (IIOT)
USE OF IOT IN INDUSTRIAL APPLICATION DOMAINS

The **Industrial Internet of Things (IIoT) or Industrial Internet (II)** is the use of IoT technologies in an industrial system [http://internetofthingsagenda.techtarget.com/definition/Industrial-Internet-of-Things-IIoT]. The term Industrial Internet was coined by GE in late 2012.

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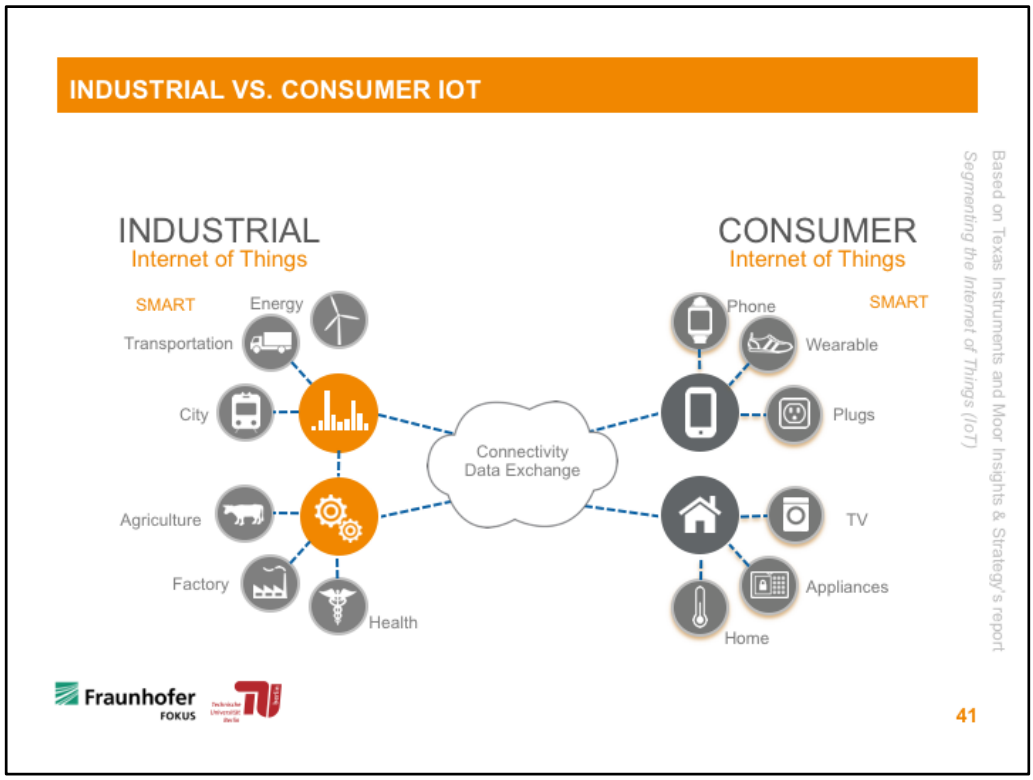
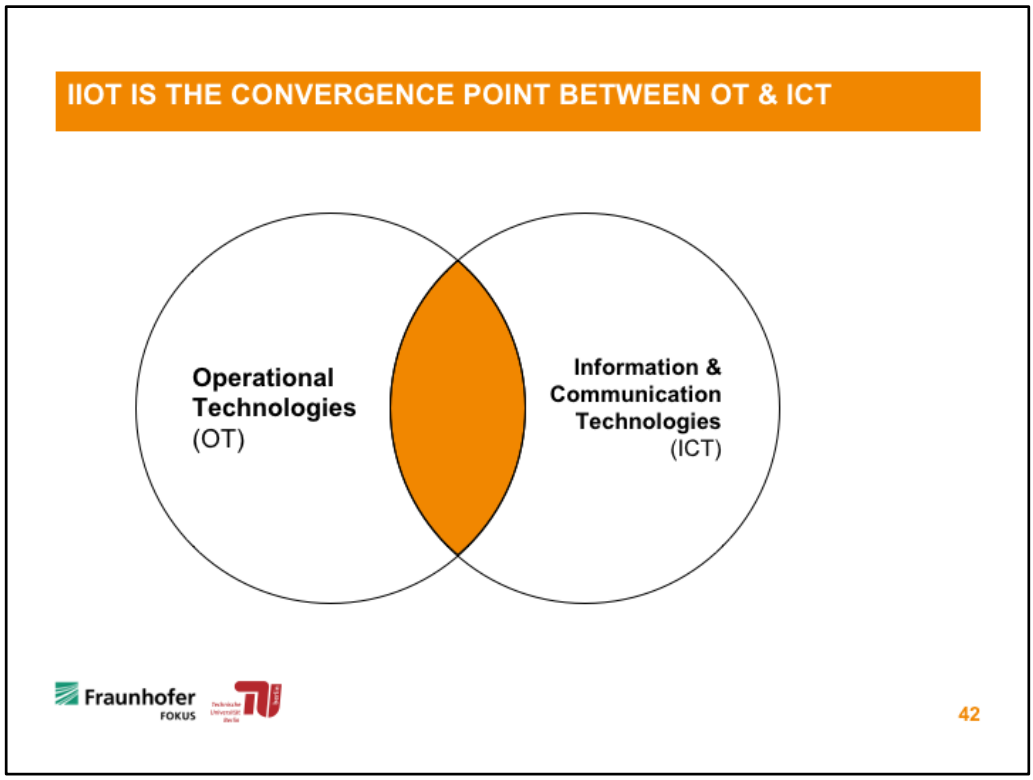
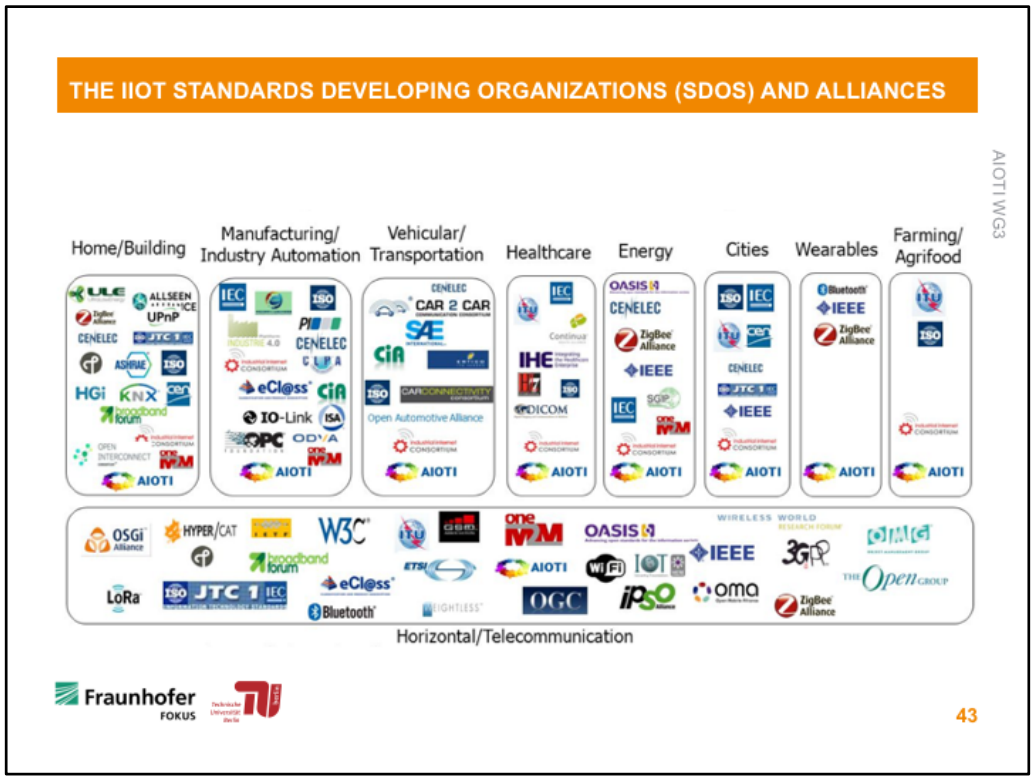


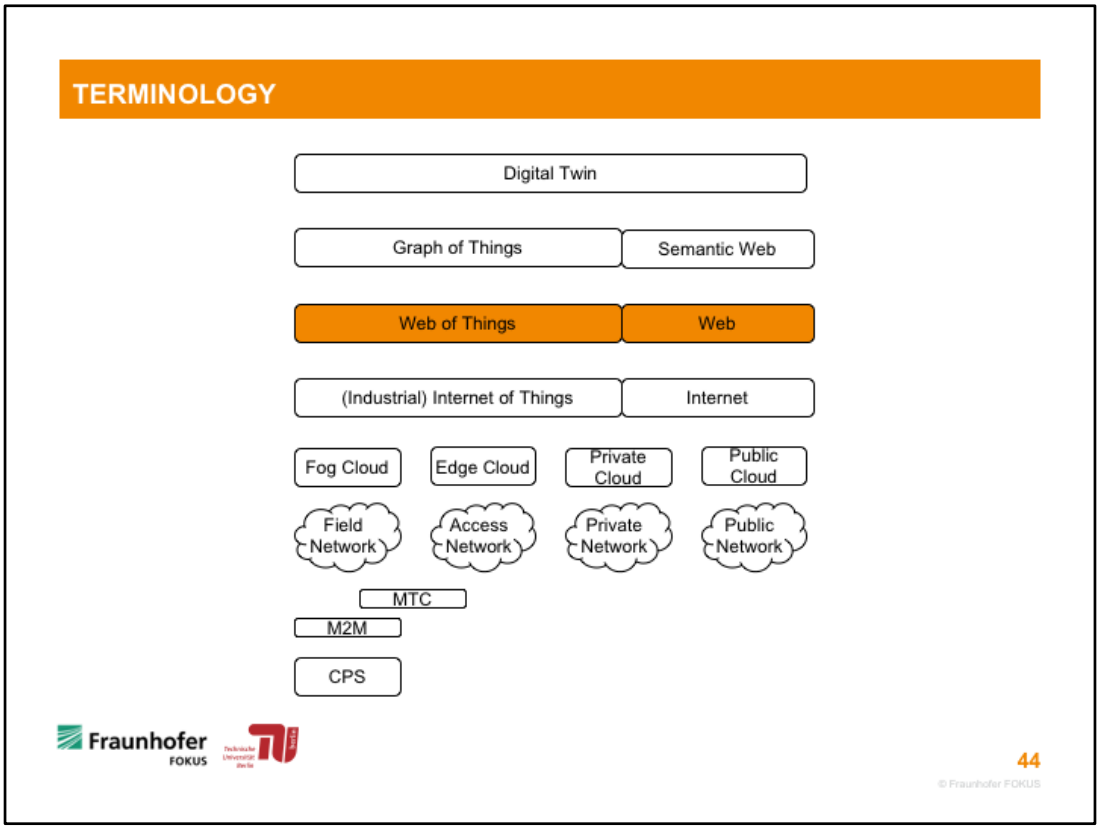
- IIoT = Application of IoT technologies in industrial domains



- IIoT is the most interesting part of IoT, as this sweet spot here in the middle is the source of many interesting challenges for the years to come



- Also in the IIoT context the complexity is reasonably large
- In particular most verticals have their own standards



- WoT -> Things using Web technologies to communicate

WORLD WIDE WEB (WWW)
A NETWORK OF DOCUMENTS (DNS, URI, HTTP, …)

The **World Wide Web (WWW)** is an information space where documents and other web resources are identified by Uniform Resource Locators (URLs), interlinked by hypertext links, and can be accessed via the Internet [https://en.wikipedia.org/wiki/World_Wide_Web].

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WEB OF THINGS (WOT)
USE OF WEB TECHNOLOGIES WITHIN THE IOT

The **Web of Things (WoT)** is a term used to describe approaches, software architectural styles and programming patterns that allow real-world objects to be part of the World Wide Web [https://en.wikipedia.org/wiki/Web_of_Things]. There is also a World Wide Web Consortium (W3C) WoT Working Group since 2014.

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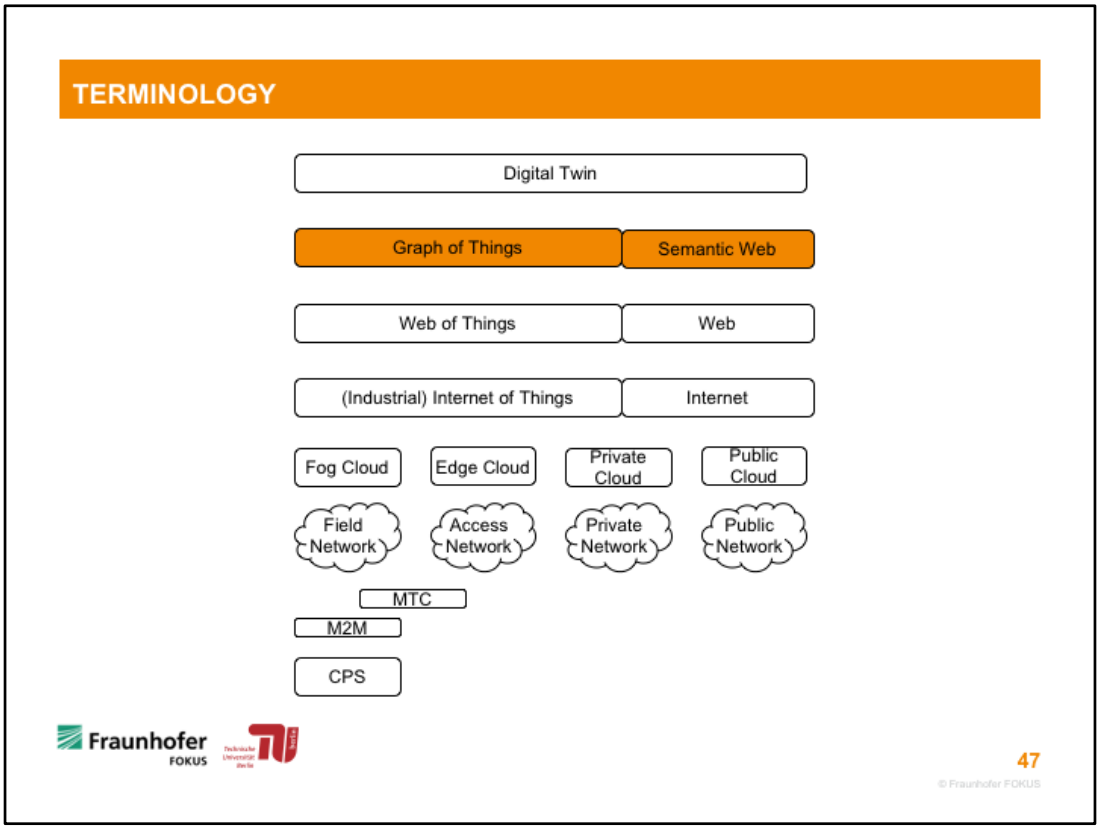

- GoT -> Things using Semantic Web technologies to communicate with each other

GRAPH OF THINGS
USE OF THE SEMANTIC WEB WITHIN THE IOT

The **Semantic Web** is the extension of the World Wide Web that enables people to share *content* beyond the boundaries of applications and websites [http://semanticweb.org].

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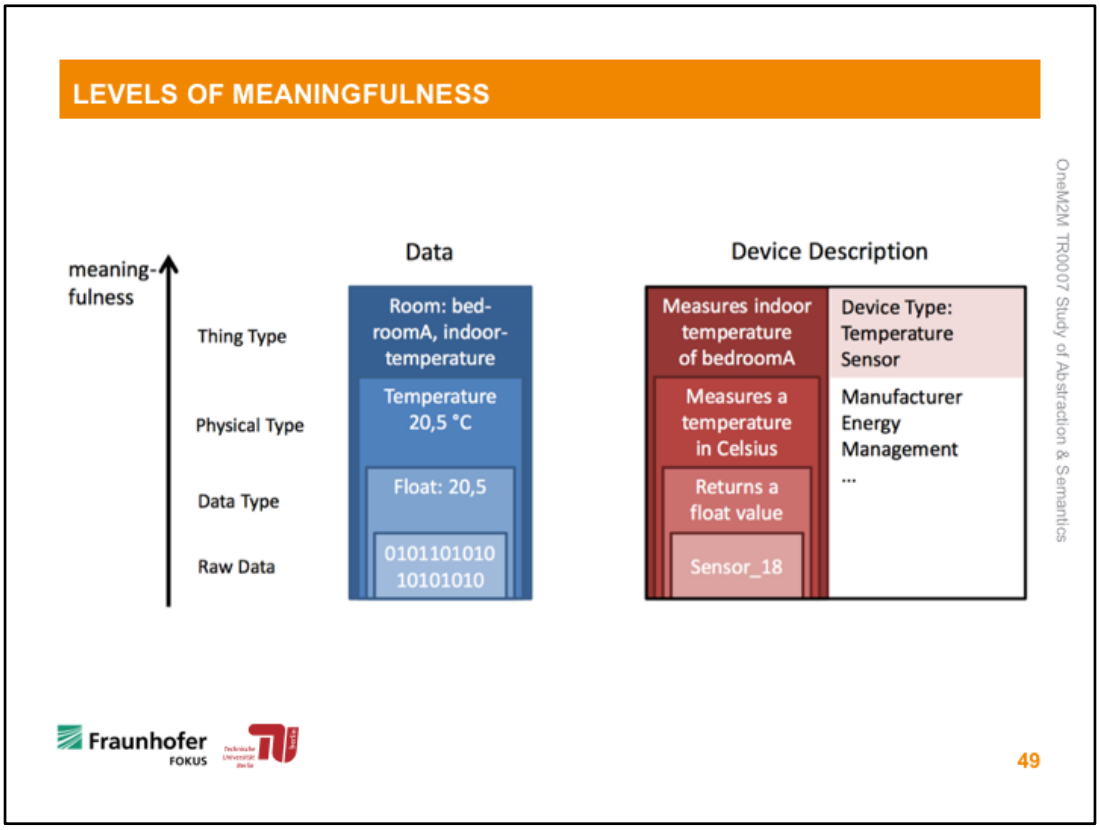
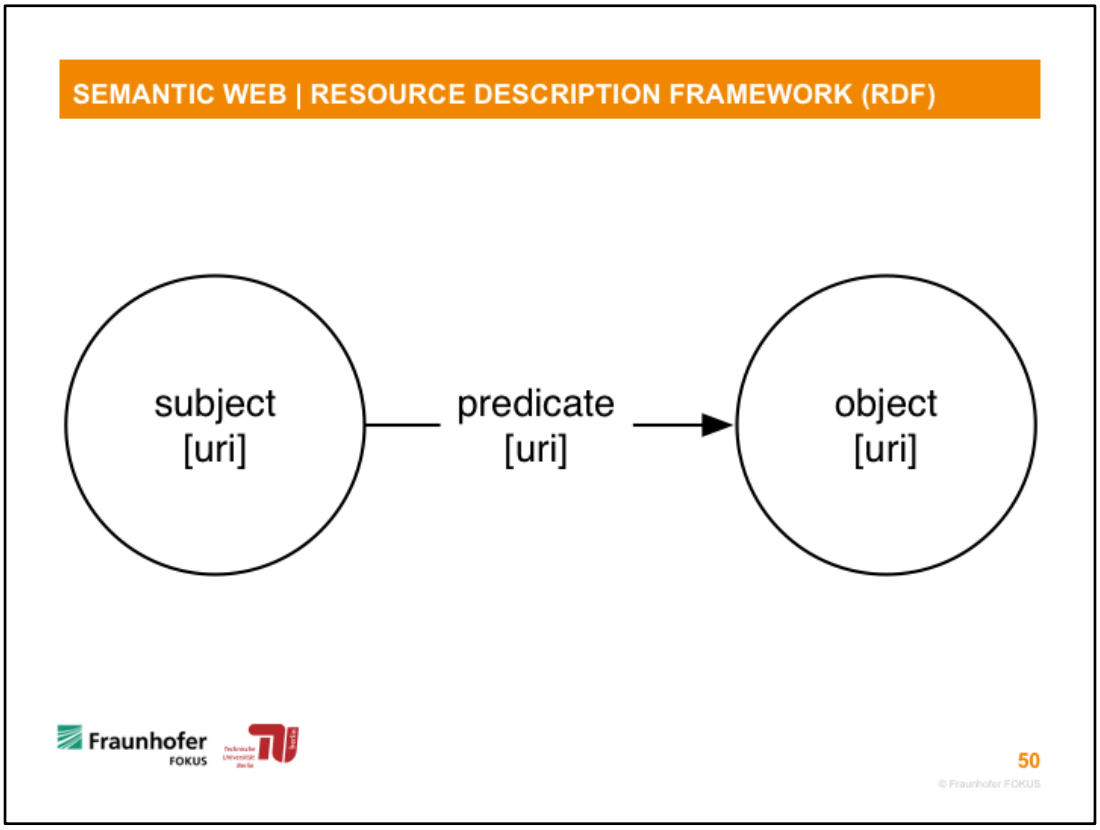
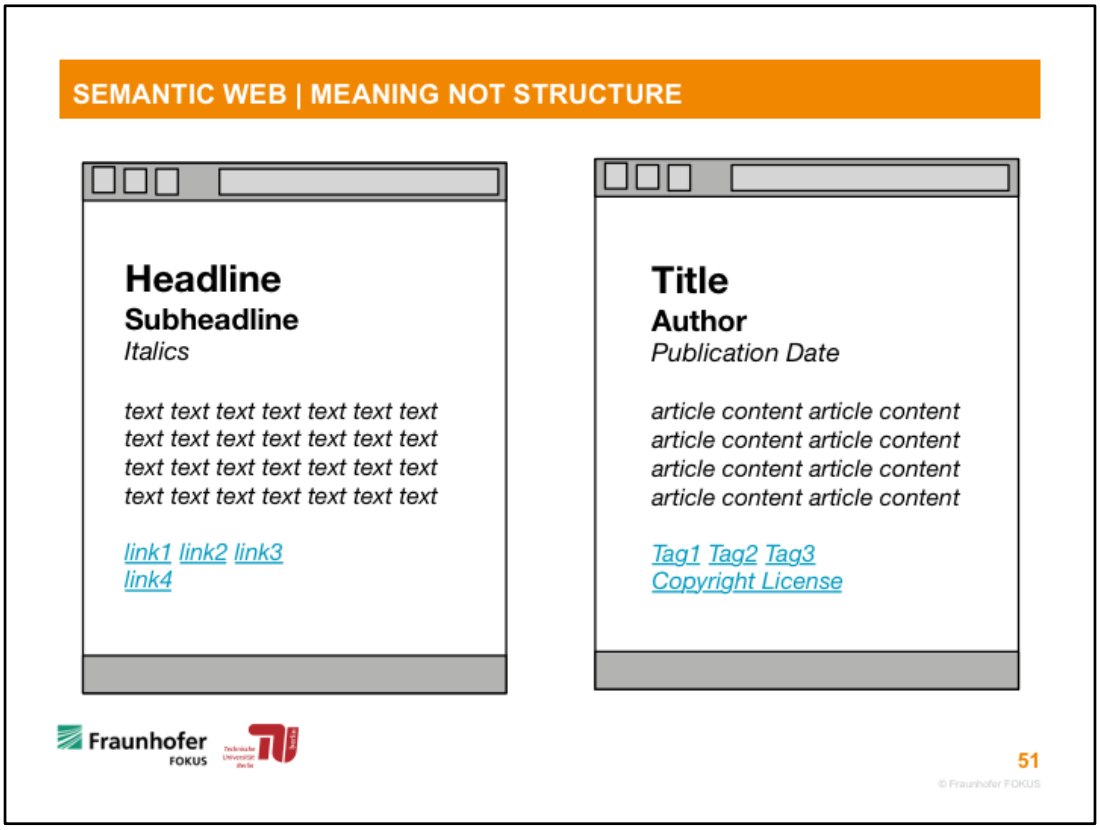


- Raw data: a list of "0" and "1
- Data type: Interpretation of the raw data → probably already known
- Physical type: Metadata on the meaning of the data
- Building on this, an ever-growing knowledge graph of metadata can be generated → room temperature in Building X in City Y with Mayor Z born in Year A, as well as writer B, who ...

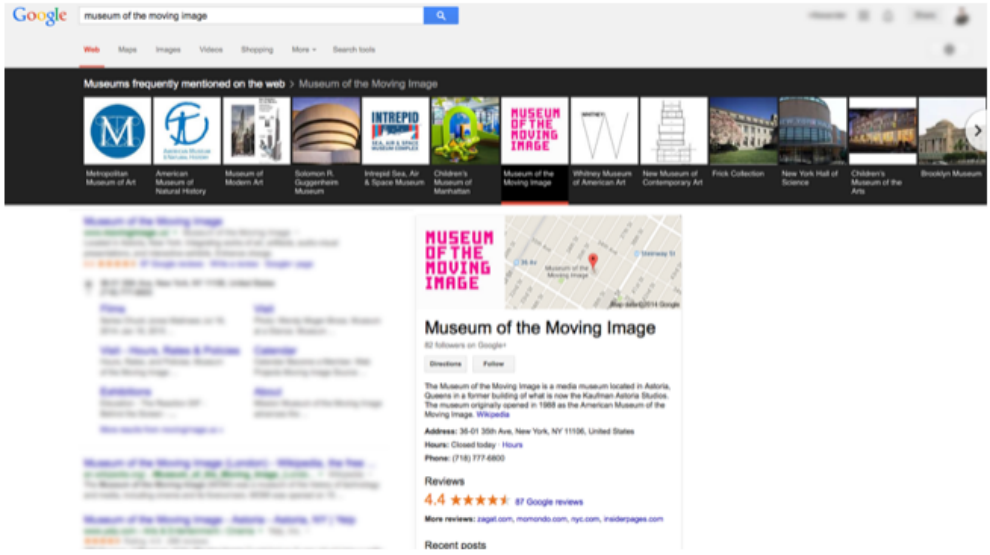


- URI = Uniform Resource Identifier
- Concept known from 2nd grade



- Semantic Web is NOT only about annotating meaning to semi-structured information in web pages
- It is ONLY ONE example

GOOGLE KNOWLEDGE GRAPH



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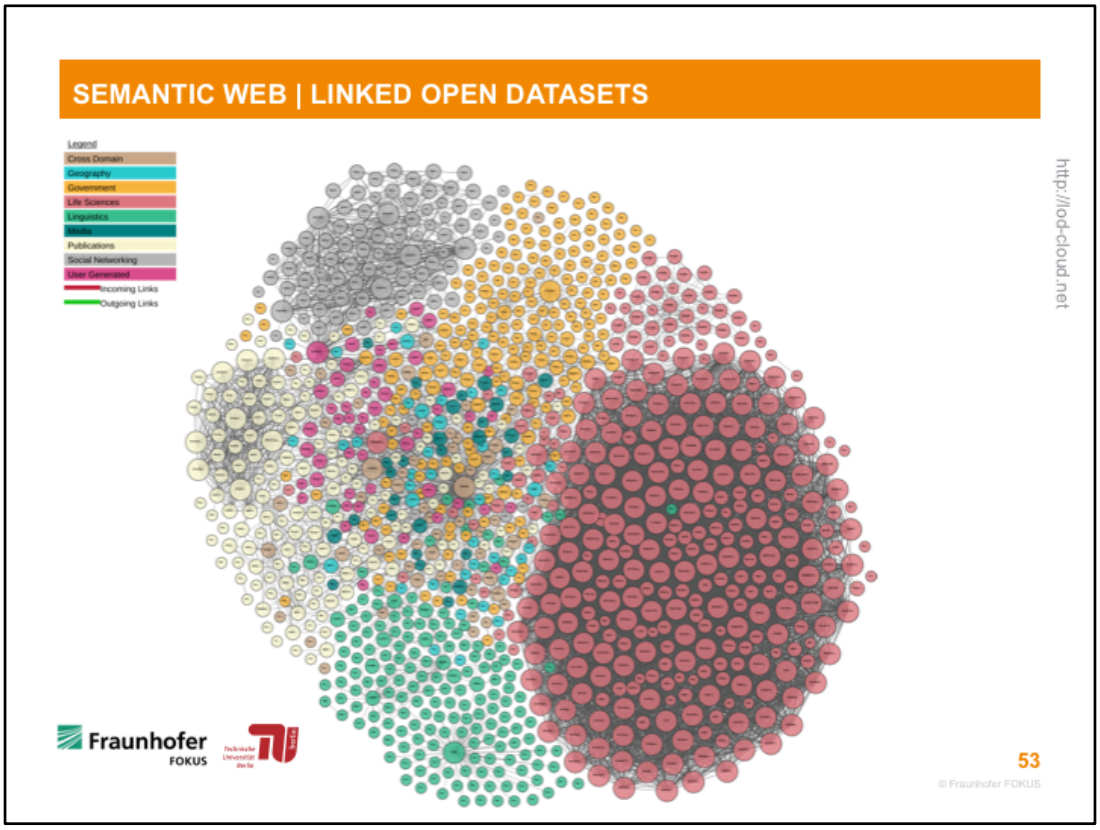
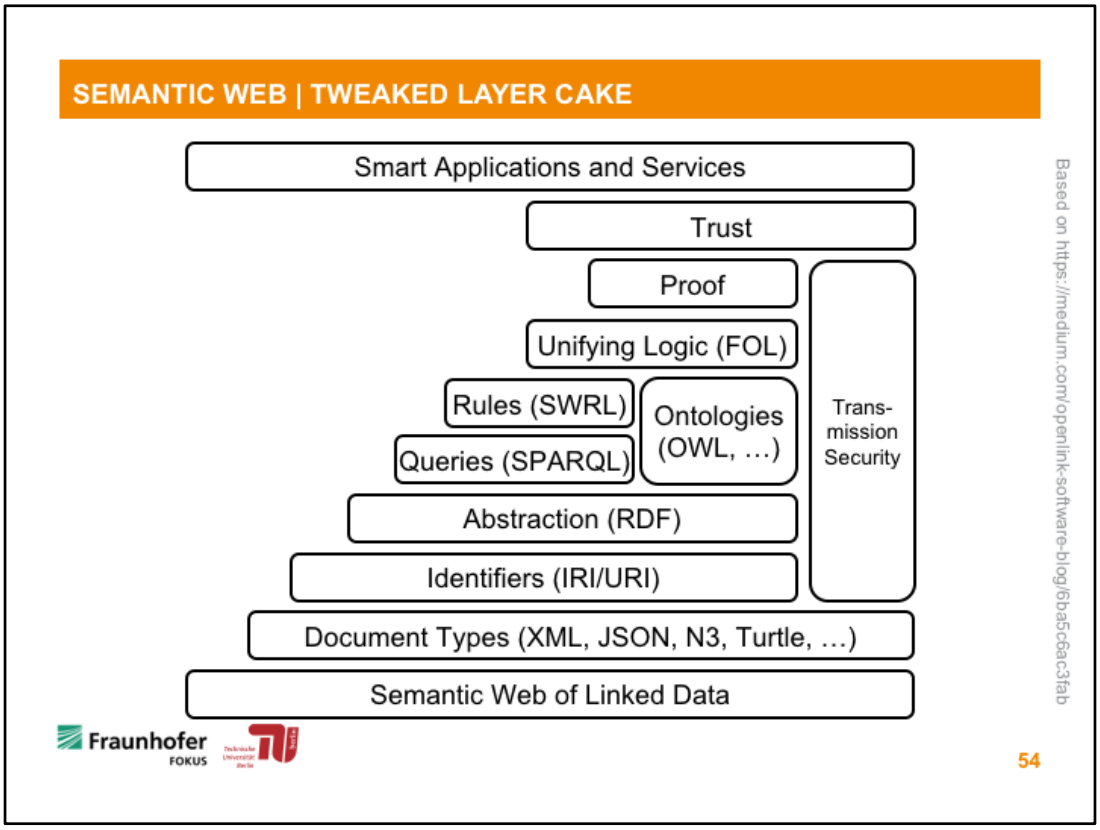
- This Google search result has two areas
- Bottom left: classic document search
- Right: Knowledge graph. Structured information on the "museum of the moving image"
- Top: Knowledge graph. Other instances strongly associated with the "Museum" concept

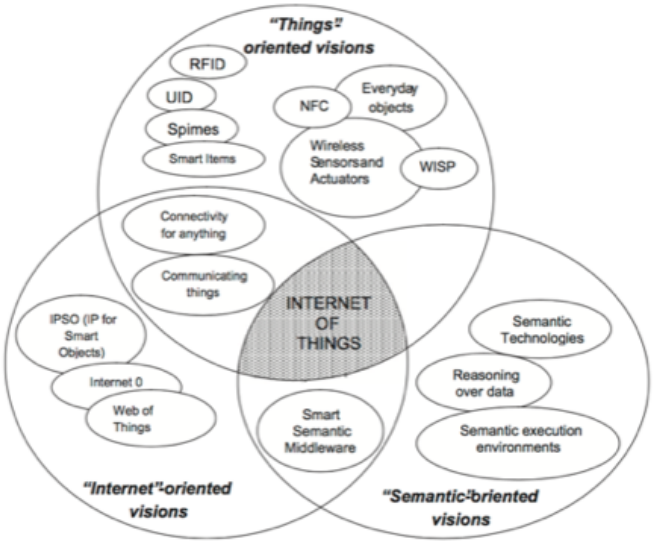


- The colors represent formalized knowledge of a particular domain
- The data must meet certain requirements for admission
    - There must be resolvable http:// (or https://) URIs.
    - You must resolve RDF data in one of the common RDF formats.
    - The data set must contain at least 1000 triplets.
    - The data set must be connected via RDF links to an existing data set in the diagram (at least 50 links).
    - Access to the entire database must be possible via RDF crawling, via an RDF dump or via a SPARQL endpoint.



- The exciting thing, however, is the underlying technology stack -> part of further lectures
- Resource Description Framework (RDF) -> Graph-based data model (previously named subject predicate object)
- Web Ontology Language (OWL) -> formal information model
- Semantic Web Rule Language (SWRL) -> rules based on it. What are rules?

GRAPH OF THINGS | CONVERGENCE OF DIFFERENT VISIONS



Atzori, Luigi: The Internet of Things: A survey (2010)

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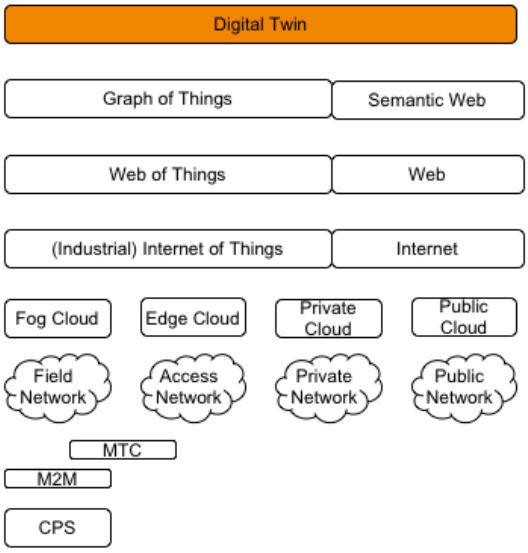
- The three components of the IoT
- Note the different terminology used in this example!

TERMINOLOGY



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DIGITAL TWIN
DIGITAL REPRESENTATION OF PHYSICAL ASSETS

The **Digital Twin** provides both the elements and the dynamics of how an Internet of Things device operates and lives throughout its life cycle [https://en.wikipedia.org/wiki/Digital_twin]. The term was coined around 2011 / 2002 (virtual mirror). Mainly used for upfront testing and simulations.

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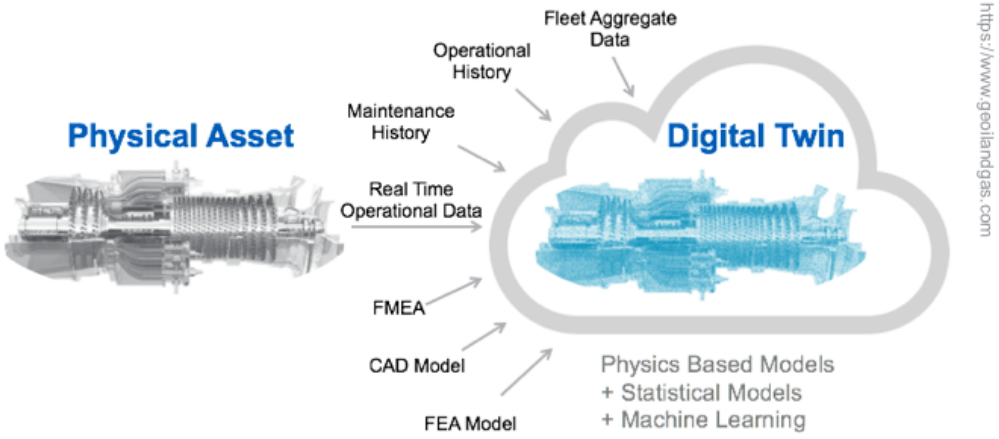
DIGITAL TWIN



Source: https://www.geoilandgas.com

FMEA = Failure Mode Effect and Analysis
FEA = Finite Element Analysis
CAD = Computer Aided Design

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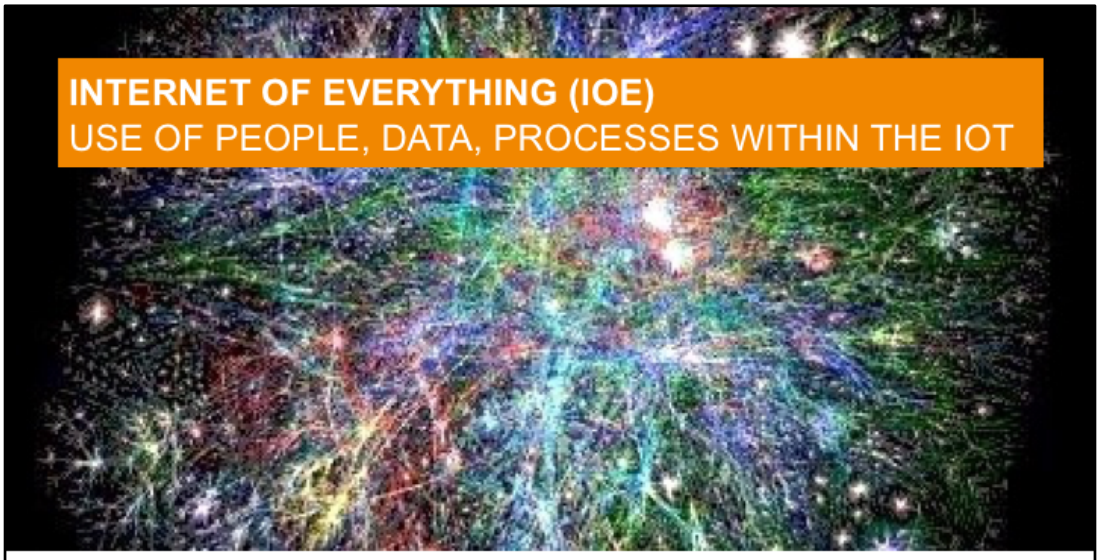
- Concept for initial simulation
- Augmented by further static and dynamic information



INTERNET OF EVERYTHING (IOE)
USE OF PEOPLE, DATA, PROCESSES WITHIN THE IOT

The **Internet of Everything (IoE)** brings together people, process, data, and things to make networked connections more relevant and valuable than ever before-turning information into actions that create new capabilities, richer experiences, and unprecedented economic opportunity for businesses, individuals, and countries [http://www.cisco.com].

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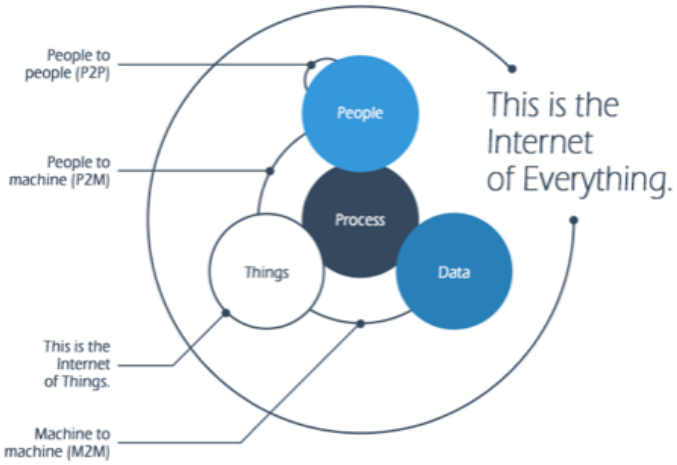
INTERNET OF EVERYTHING



AoykaSystems

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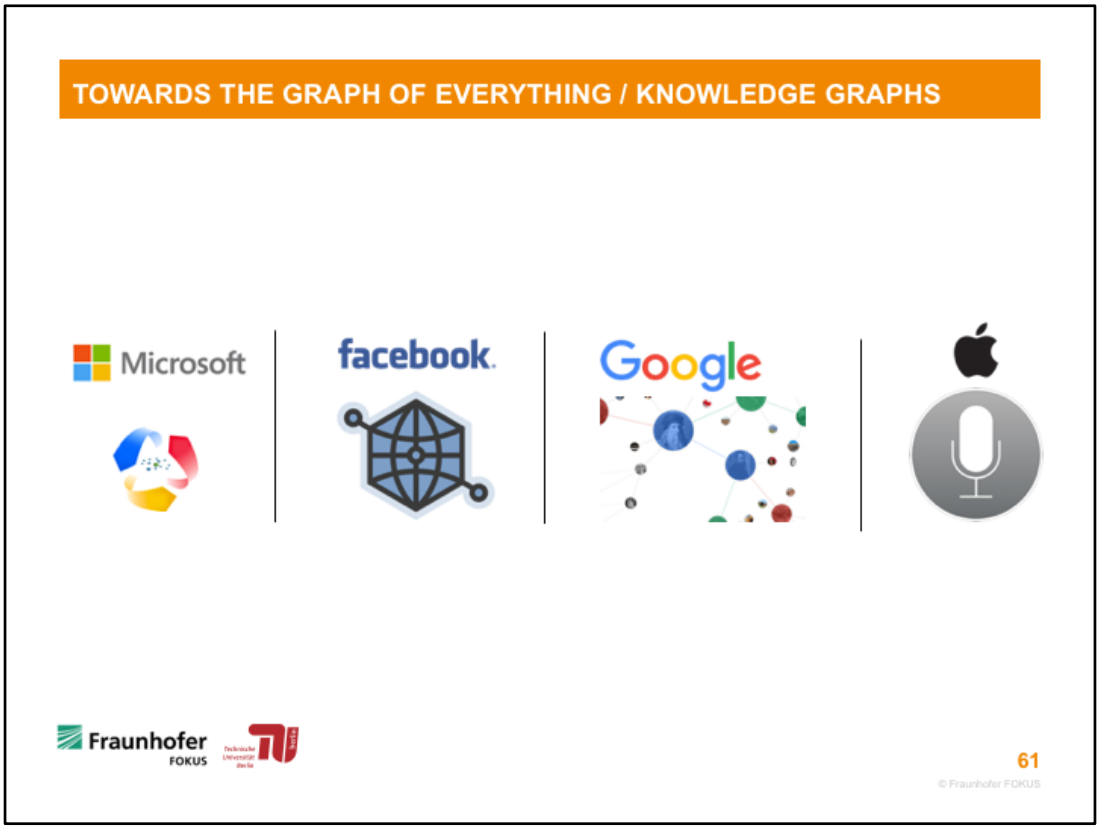

- Underlying concept used in various industrial applications

TOWARDS THE GRAPH OF EVERYTHING

Federated Grids	Federated Testbeds	Federated Clouds	Federated Networks	Federated Things
				
HP Computing	Future Internet	Interclouds	Multidomain SDN	Cyber Physical Systems

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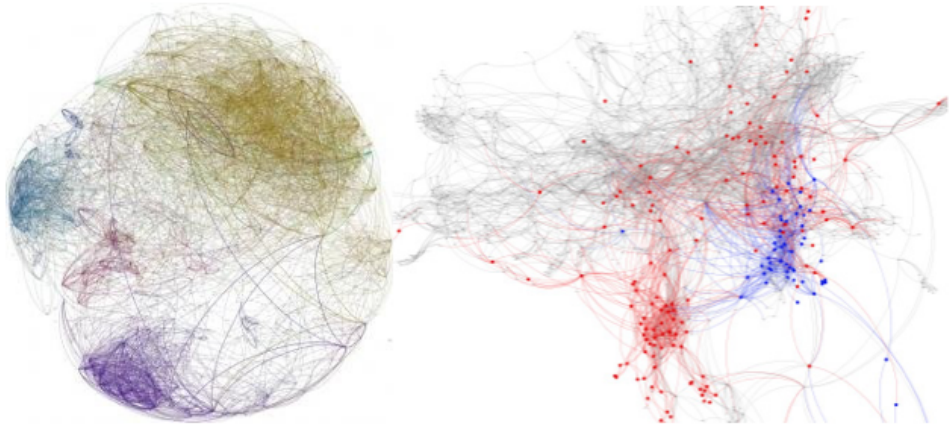
- Underlying concept used in various research areas

TOWARDS THE GRAPH OF EVERYTHING



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- Eventually, everything will be part of a large interconnected semantic graph

OVERALL TERMINOLOGY

End