

# Edge Computing Standardisation and Initiatives

Axel Rennoch & Dr. Alexander Willner | IACS Workshop / GI-Jahrestagung | 28.09.20

# Agenda

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Background

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Edge Computing (EC)

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Conclusion

The background of the slide is a dark blue color. Overlaid on this background is a complex, abstract network of thin white lines. These lines connect various points, creating a series of interconnected triangles and polygons of different sizes. The network is denser in some areas and more sparse in others, giving it a dynamic, web-like appearance. In the center-left of the slide, there is a white square containing a large, bold, dark blue number '1'. To the right of this square, the word 'Background' is written in a white, sans-serif font.

1

## Background

# Fraunhofer Society

Fraunhofer is Europe's largest application oriented research organization:



> **28.000**

Employees



**74**

Institutes and research units



> **2.8 billion €**

Budget (1/3 government, 1/3 public, 1/3 industry)

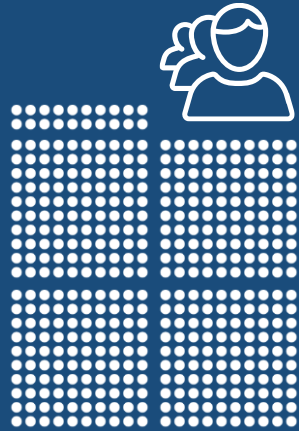
- Not a university (transfer of knowledge to industry)
- Not a start-up (large project volumes w/ high impact\*)
- Not a company (non-profit, no products)

\* examples: MP3, white LEDs, LCD, airbag inflation, ...

Fraunhofer Institute  
for Open Communication Systems (FOKUS)

**We connect everything**  
secure, reliable, sustainable

# Fraunhofer FOKUS is the largest Fraunhofer ICT institute



~ **450**

Employees



**26**

EU projects



~ **120**

Industry partners



~ **230**

Industry projects





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## Edge Computing (EC)

The Edge Computing market  
is estimated to be worth 26 Billion EUR by 2024\*

\* take this with a grain of salt.

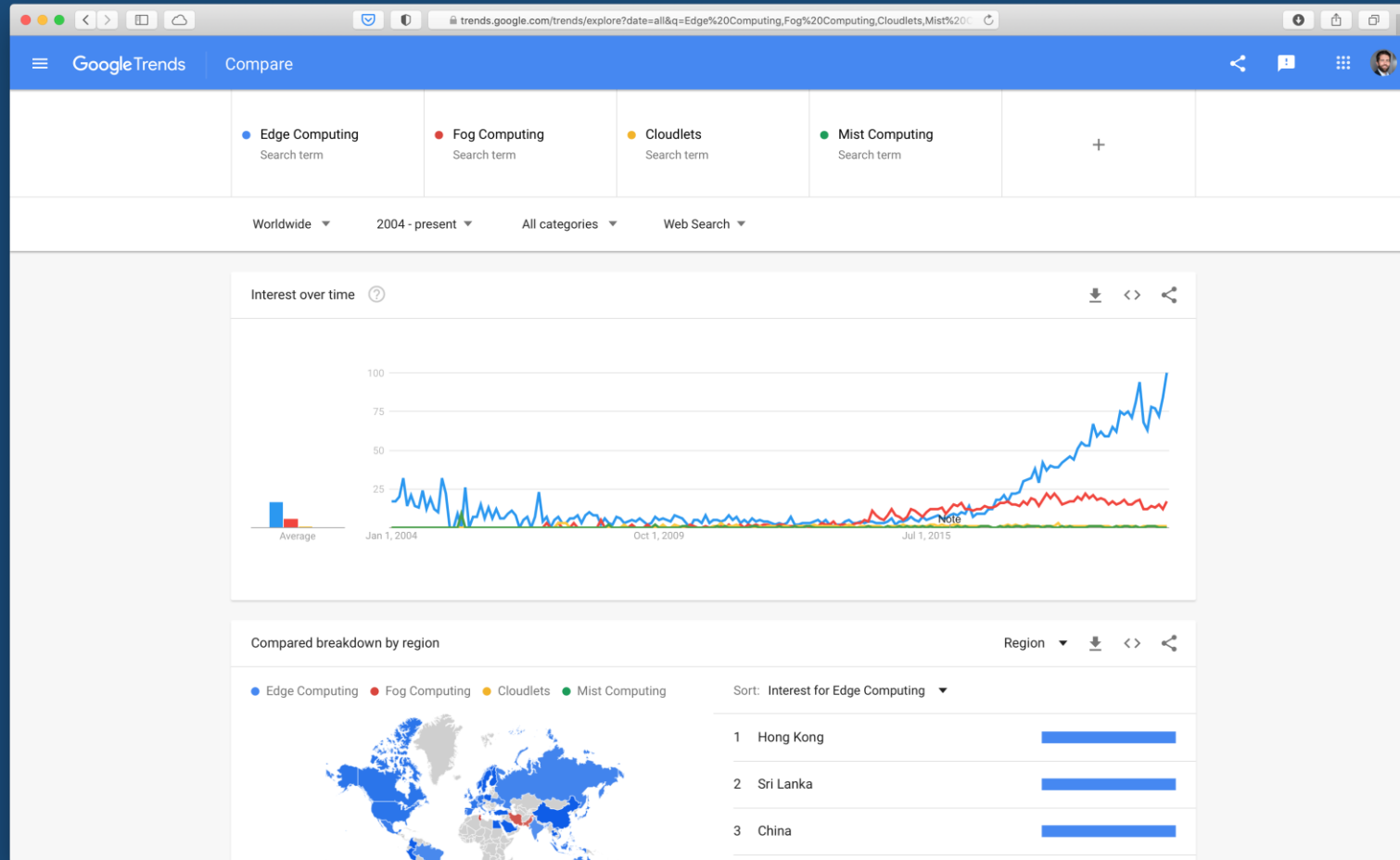
Source: Grand View Research (2019): „Edge Computing Market Size, Share & Trends Analysis [...] Forecasts, 2019 – 2025“

# What is Edge Computing\*?

\* or Fog Computing, Mist Computing, Cloudlets, ... for that matter

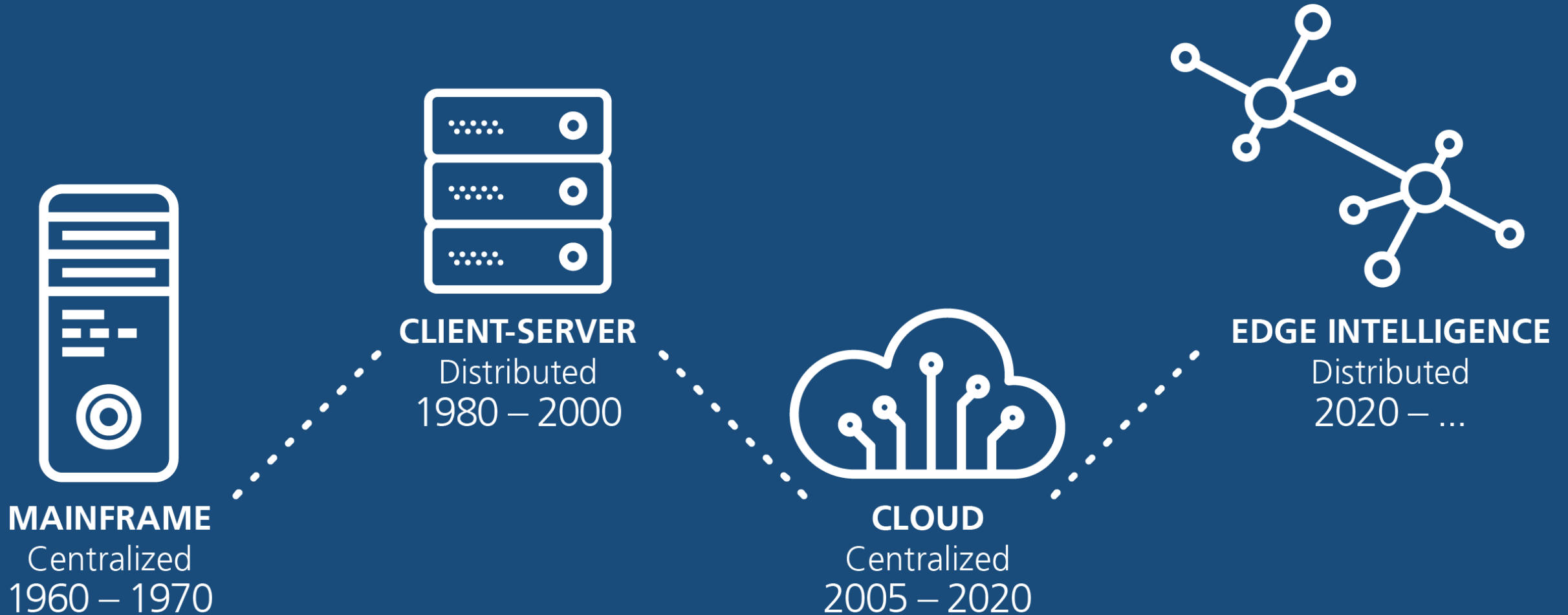


# Edge Computing in Google Search\*



\* For today: Edge Computing, Fog Computing, Mist Computing, Cloudlets, ... are the same to us

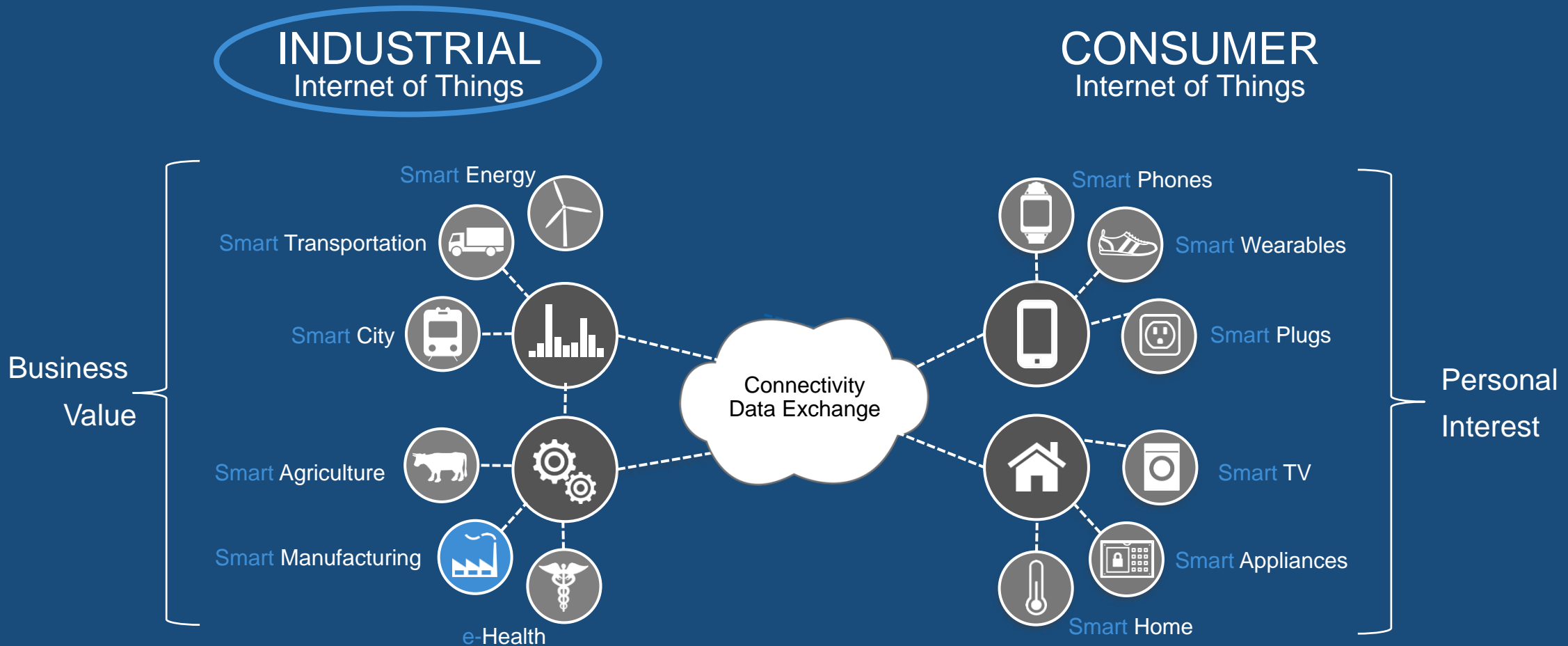
# Edge Computing: A Distributed Cloud Computing Paradigm



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

# Who needs Edge Computing?

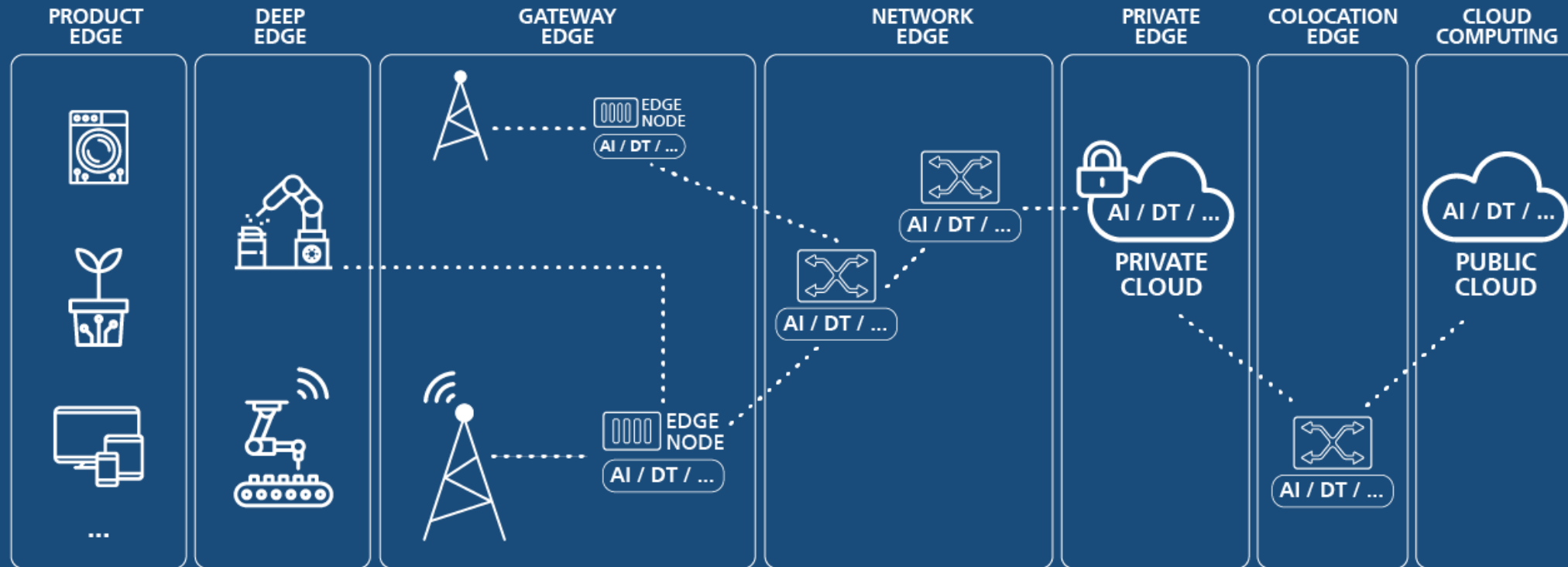
# Various application domains with specific requirements



Source: Based on Texas Instruments and Moor Insights & Strategy's report Segmenting the Internet of Things (IoT)

Where is the Edge?

# Where is the Edge?



LATENCY, JITTER, NETWORK DEPENDENCY, BACKHAUL TRAFFIC

DATA PRIVACY AND PROTECTION, CONTEXT AWARENESS, AUTONOMY

VALUE OF DATA

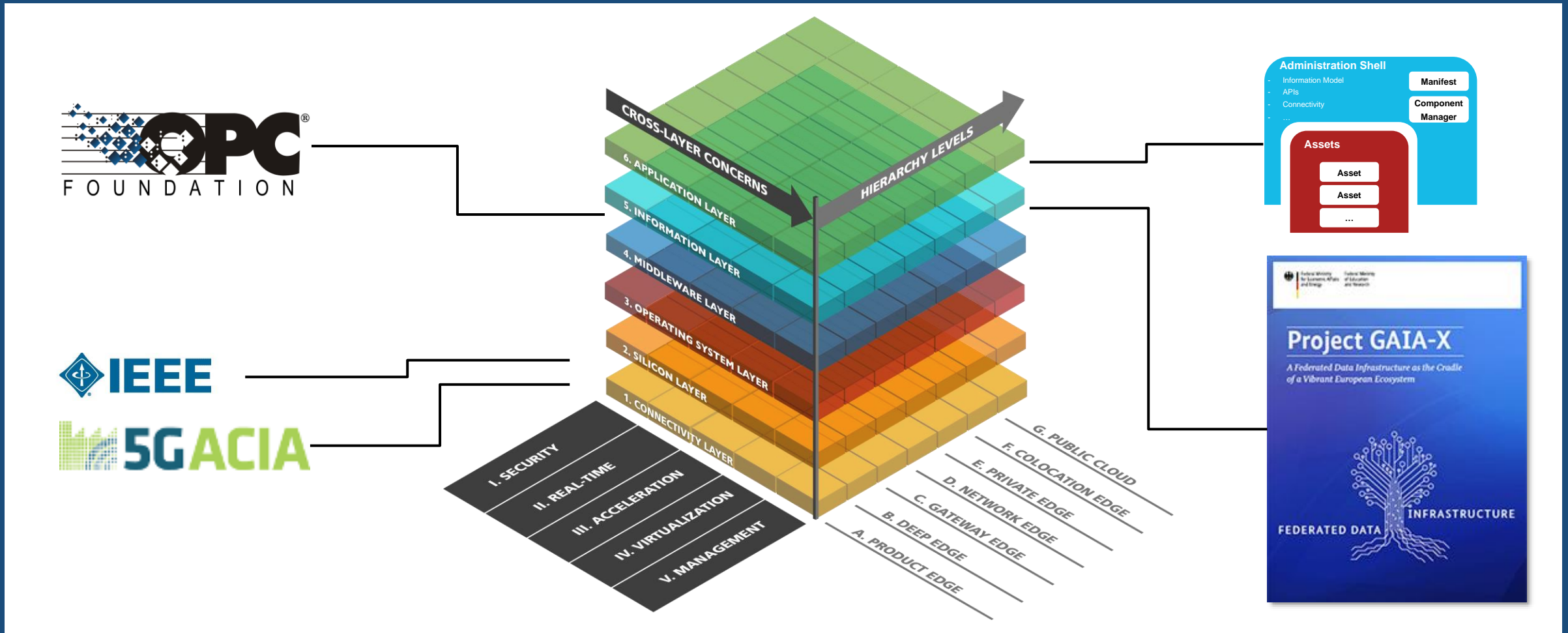
COSTS, RELIABILITY

DT = DIGITAL TWIN | AI = ARTIFICIAL INTELLIGENCE

Is there more?



# The Reference Architecture Model Edge Computing (RAMEC)



Similar to the Smart Grid Architecture Model (SGAM) and Reference Architecture Model Industry 4.0 (RAMI4.0), the RAMEC is NOT a technical system architecture but an orientation guide for a multi dimensional problem space. Examples for visualization purposes only.  
To be published at IEEE Communications Standards Magazine in December 2020.

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"Edge Computing"

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## EC Initiatives

# A rather broad community

- 3GPP (5G)	- ISO/IEC SC38 / SPEC 92222	- Factories (IC4F)	- Linaro / Ledge	- Open Industry 4.0 Alliance	- StarlingX
- 5G Alliance for Connected Industries and Automation (5G ACIA)	- DMTF for Open Virtualization Format (OVF)	- Industrial Internet Consortium (IIC)	- LNI Testbed Edge Configuration / TSN MobileEdgeX	- Open Manufacturing Platform (OMP)	- Taiwan Smart Machinery
- 5G Automotive Association (5GAA)	- Eclipse 4Diac / BaSysx / ioFog / IoT	- Industrial Technology Research Institute (ITRI)	- Multi Stakeholder Platform (MSP)	- Open Network Automation Platform (ONAP)	- Telecom Infra Project (TIP): Edge Application Developer Group / Edge Computing Group
- Alliance for the Internet of Things Innovation (AIOTI)	- Edge Computing Consortium (ECC)	- Interessengemeinschaft Automatisierungstechnik der Prozessindustrie (NAMUR)	- National Institute of Standards and Technology (NIST)	- Open Platform for NFV (OPNFV)	- The Discovery Initiative
- Alliance Industrie du Futur	- EdgeCross	- International Electrotechnical Commission (IEC) 62541 (OPC UA) / 61131 / 61499	- New Zealand IoT Alliance	- Open Platform Forum (OPF)	- The German Federation of Industrial Research Associations (AiF)
- Alliance of Industrial Internet (All)	- ETSI MANO / MEC	- International Telecommunication Union (ITU) Q.5001 / SG11	- Object Management Group (OMG)	- Open Process Automation Forum (OPAF)	- VDI/VDE GMA 7.20 / 7.21 / 7.21 UAG Computing Infrastructure
- Automotive Edge Computing Consortium (AECC)	- European Processor Initiative (EPI)	- Internet Engineering Task Force (IETF) IIoT-SFC-Edge-Computing	- ODVA NewTec	- Open Source Automation Development Lab (OSADL)	- Verein Deutscher Ingenieure / Verband der Elektrotechnik Elektronik Informationstechnik (VDI/VDE)
- AUTomotive Open System ARchitecture (AUTOSAR)	- Falling Wall	- Institute of Electrical and Electronics Engineers (IEEE) 1934 / TSN	- oneM2M	- OpenStack Edge	- Verein deutscher Maschinenbau-Anstalten (VDMA)
- AVNU Alliance	- FIWARE Foundation / FogFlow	- ISO/IEC 62541 / PDTR 23188 / SC38	- OPC Foundation / FLC / I4AAS	- Plattform Industrie 4.0 Österreich	- Verein deutscher Werkzeugmaschinenfabriken (VDW)
- Azure IoT Edge	- Flexible Factory Partner Alliance (FFPA)	- Kinetic Edge Alliance	- Open Container Initiative (OCI)	- Plattform Industry 4.0 (PI4.0)	- Zentralverband Elektrotechnik- und Elektronikindustrie (ZVEI)
- Bitkom	- GAIA-X	- LF Akraino / Core Infrastructure Initiative (CII) / Edge / Edge Virtualization Engine (EVE) / EdgeXFoundry / Kubernetes KubeEdge	- Open DeviceNet Vendor Association (ODVA)	- Przemysł 4.0	
- Central Office Re-architected as a Datacenter (CORD)	- GSM Association (GSMA)		- Open Edge & HPC Initiative (OEHI)	- Rail Way Automation (RWA)	
- Cloud Foundry Foundation	- Heterogeneous System Architecture (HSA)		- Open Edge Consortium (OEC)	- ROS Industrial	
- Cloud Native Computing Foundation (CNCF)	- I-KOREA 4.0			- ServerReady	
- DIN NA043-01-38AA /	- IC4.0 (Spain)			- Smart FactoryKL	
	- Industrial Communication for			- Standardization Council Industrie 4.0 (SCI)	

List is still in progress and incomplete.

# An initial approach to cluster the activities

## Initiatives

- International (IIC, ECC, EECC, ...)
- EU (GAIA-X, EPI, ...)
- Germany (PI4.0/ LNI4.0/SCI4.0/Bit kom/ZVEI/...)
- France (AIDF)
- Italy (I4.0)
- Austria (I4.0Ö)
- Spain (IC4.0)
- Poland (Przemysł 4.0)
- Netherlands (Smart Industry)
- UK (4IR)
- Ukraine (APPAU)
- ...

## Software Focus

- LF Edge: Akraino, Baetyl, EdgeX Foundry, EVE, Fledge, HomeEdge, Open Glossary
- LF ELISA
- Linaro
- ONF CORD
- OEC
- OSADL
- OpenStack EC
- KubeEdge
- Discovery
- ...

## Verticals

- 5G-ACIA
- SmartFactoryKL
- OPC Foundation
- ODVA NewTec
- FFPA
- OI4.0
- AECC
- 5GAA
- MobileEdgeX
- TIP EC
- OPAF
- ...

## Standards

- ETSI (MEC)
- ETSI (MANO)
- IEEE (TSN)
- IEEE (1934)
- ISO/IEC (SC38)
- ISO/IEC (62541)
- ISO/IEC (61499)
- DIN (92222)
- ...
- IETF
- OMG
- ITU
- NIST
- MSP
- ...

## Selection (non standardisation groups)

- Alliance for Internet of Things Innovation (AIOTI)
- Bitkom e.V.
- Standardization Council Industrie 4.0 (SCI)
- Verein Deutscher Ingenieure / Verband der Elektrotechnik Elektronik Informationstechnik (VDI/VDE)
- Verein deutscher Maschinenbau-Anstalten (VDMA)
- Zentralverband Elektrotechnik- und Elektronikindustrie (ZVEI)
- 5G Alliance for Connected Industries and Automation (5G ACIA)
- European Processor Initiative (EPI) and GAIA-X
- French Alliance Industrie du Futur, Industria 4.0 (Italy), Przemysł 4.0 (Poland) Industria Conectada 4.0 (Spain), or the Association of Industrial Automation of Ukraine
- Software around the Linux Foundation, Kubernetes KubeEdge and the international Eclipse Foundation

The background of the slide is a solid dark blue. Overlaid on this background is a complex, abstract pattern of thin white lines. These lines form a network of interconnected triangles and polygons of various sizes, creating a geometric, crystalline structure that resembles a low-poly landscape or a molecular model. The lines are distributed across the entire slide, with some areas being more densely connected than others.

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## EC Standardisation



# ISO/IEC JTC1 & IEC

- SC38: Cloud Computing
  - TR 23188: Cloud computing - Edge computing landscape, Edition 1.0 (2020-02)
- SC41: Internet of Things
  - TR 30164: Internet of things (IoT) – Edge computing, Edition 1.0 (2020-04)
- SC27: Information security, cybersecurity and privacy protection
- Advisory Group on JTC 1 Emerging Technology and Innovation (JETI)
- IEC: 61499, 62443, 62541

## Selection (international) Standardisation (support)

- ETSI: Industry Specification Group (ISG) on Multi-access Edge Computing (MEC)
- GSM Association (GSMA) Foundation
- 3rd Generation Partnership Project (3GPP): 5G Specifications
- Distributed Management Task Force (DMTF): Open Virtualization Format (OVF)
- Institute of Electrical and Electronics Engineers (IEEE): 1934 / TSN
- International Telecommunication Union (ITU): Q.5001 / SG11
- Internet Engineering Task Force (IETF): IIoT-SFC-Edge-Computing
- oneM2M
- Object Management Group (OMG)

The background of the slide is a solid dark blue color. Overlaid on this background is a complex, abstract pattern of thin white lines. These lines form a series of interconnected triangles and polygons of various sizes, creating a geometric, crystalline structure that resembles a network or a stylized landscape. The pattern is most dense in the lower half of the slide and extends towards the left and right edges.

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## Conclusion

# Summary

- Multiple different aspects of EC are under discussion
- Various working groups of standardization bodies and industrial associations
- Technical viewpoints differ due to the various stakeholders
- Landscape documents already support the interested experts and public community
- A need for harmonization and common strategies

# Edge Computing Consortium (EECC): in Europe, in preparation

- Saving research and development efforts by providing technology stacks for Edge Nodes
- Specification of a Reference Architecture Model for Edge Computing (ECCE RAMEC)
- The development of reference technology stacks (ECCE Edge Nodes)
- Identification of gaps and recommendation of best practices
- Synchronization with related initiatives/standardization organizations

<https://econsortium.eu/>

# Thank you for your attention!

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