Trends in Industrial Edge Computing

IoT ONE

About IoT ONE

Our mission is to increase the competitiveness of our clients by helping them to realize the opportunities and manage the threats that are created by digitalization.

Will you disrupt or be disrupted by the Internet of Things?

The first Internet wave disrupted retail, media and finance. Traditional market leaders declined and new leaders emerged.

The second Internet wave is now disrupting how products and operations create value. It will impact every company that builds or operates physical infrastructure, assets and devices. We help companies evolve and grow their businesses.

We are known for:

- Expertise in the interface between technology and business.

- A strong foundation in detailed, bottom-up research.

- Deep engagement with domain experts and tech ecosystems.

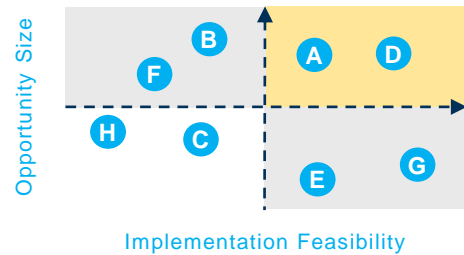IoT ONE delivers research services globally and innovation plus implementation in Asia.

Boston London Lausanne **Munich** Singapore Shenzhen **Shanghai**

● **Regional HQ** ● Project Office
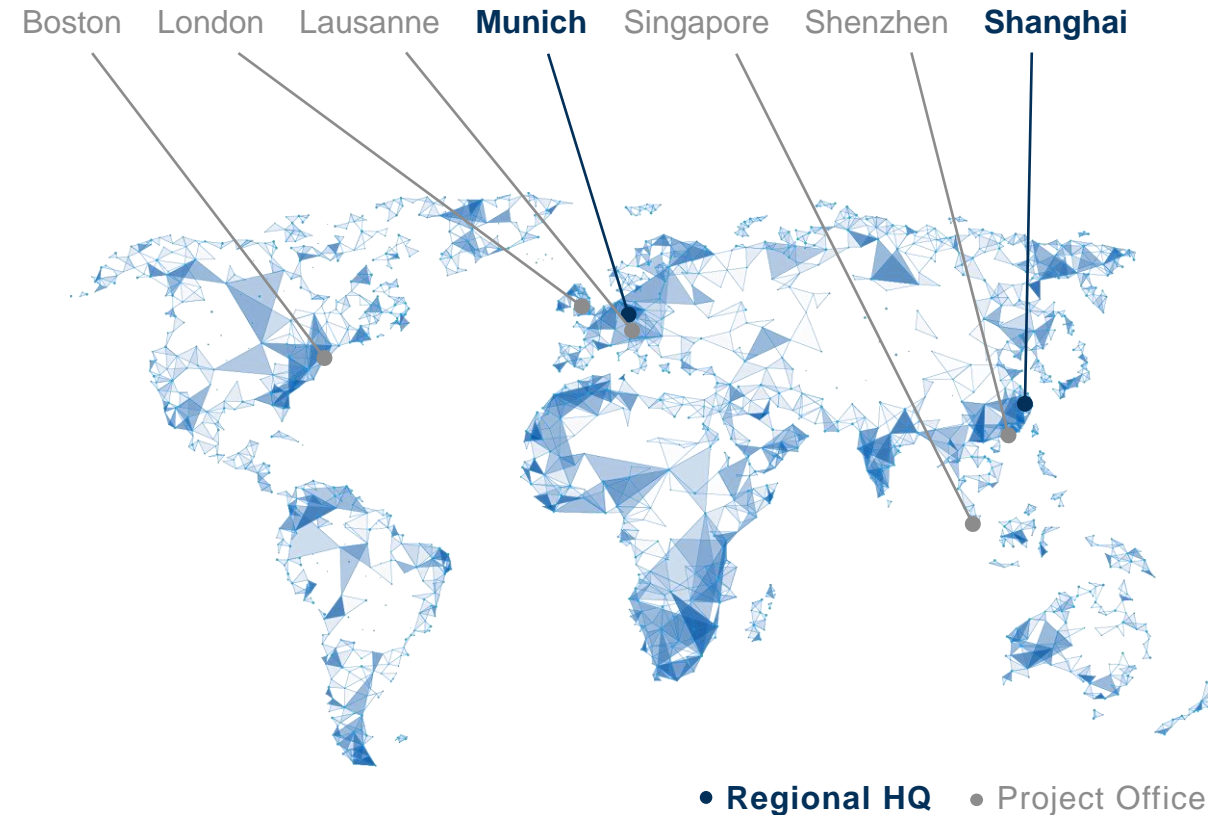
IoT ONE knowledge domains

Microenvironment

Use Cases
What problems can you solve for your customers or operations?

Opportunity Size
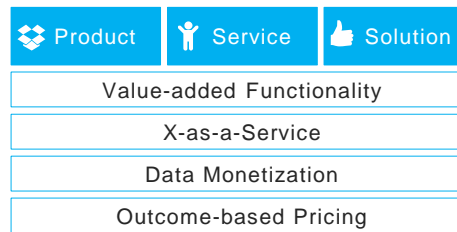
Implementation Feasibility

Technology Stack
Which technologies enable your use case?

☁ Platforms	🖥 Applications
</> Device Software	🗄 Device Hardware
📶 Communications	
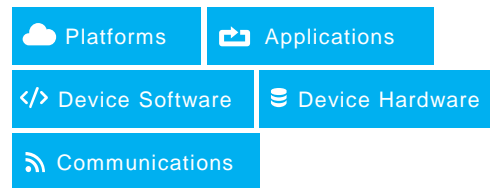
Business Models
How do you package, price and sell digital offerings?

🔀 Product	🧍 Service	👍 Solution
Value-added Functionality		
X-as-a-Service		
Data Monetization		
Outcome-based Pricing		

Company Ecosystems
Which companies are relevant to your strategy?

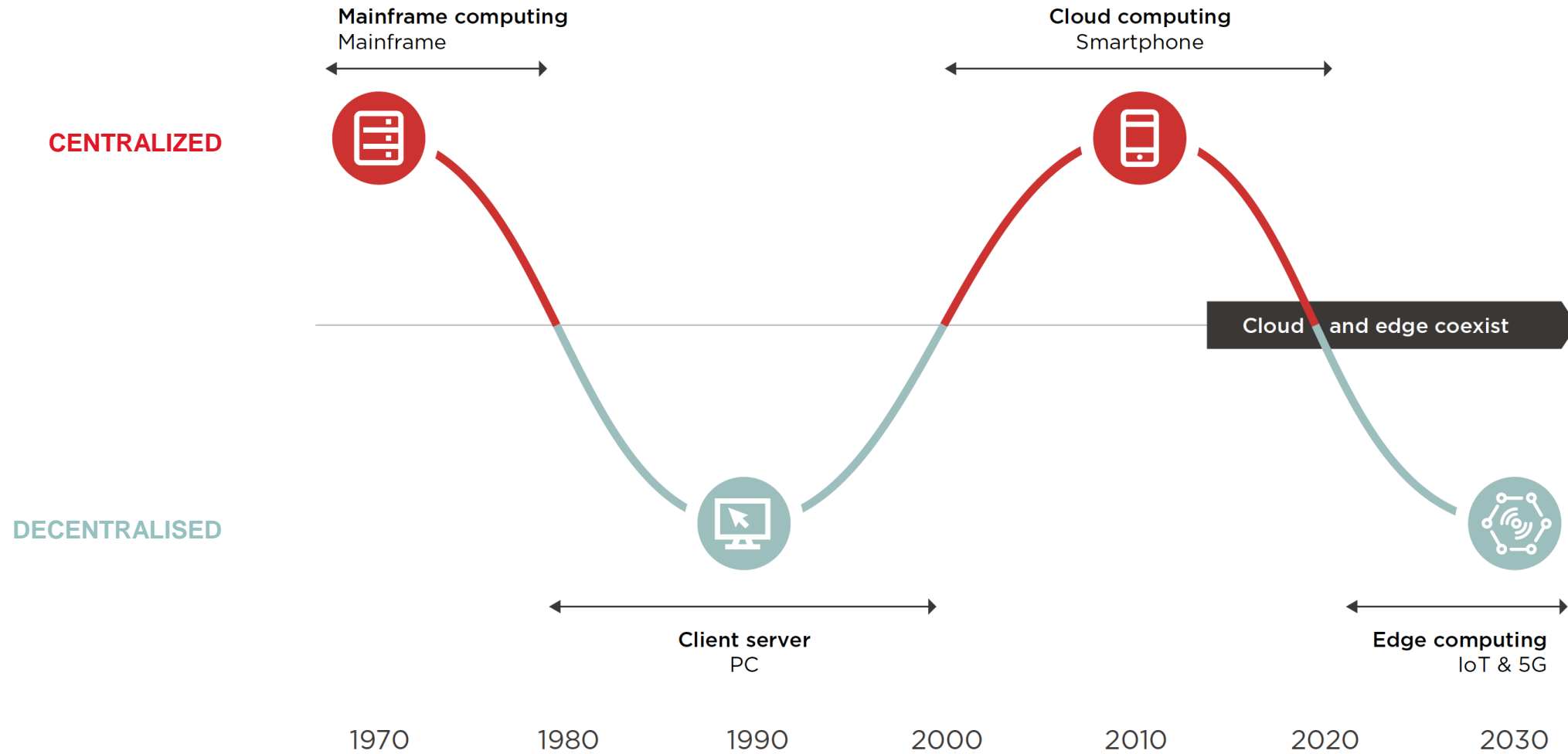| 🚀 Startups | $ Venture Capital | </> Software Vendors |
| 🗄 Hardware Vendors | System Integrators | ☁ Cloud Providers |
| Connectivity Providers | 🎓 Domain Experts | Research Institutes |
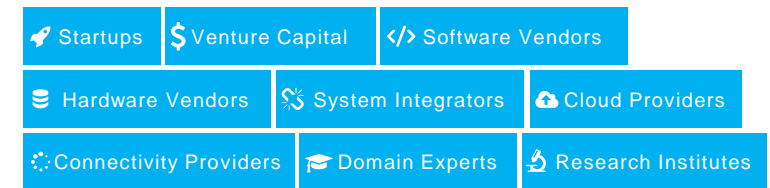
Macroenvironment

What external factors impact solution development, market adoption or system deployment?

| ¥ Economic | 🏛 Regulatory / Legal | Demographic |
| ⚙ Technical | 🔖 Cultural / Social | 🌐 Environmental |

Edge is the next computing cycle evolution

Mainframe computing
Mainframe

CENTRALIZED

Cloud computing
Smartphone

Cloud and edge coexist

DECENTRALISED

Client server
PC

Edge computing
IoT & 5G

1970   1980   1990   2000   2010   2020   2030

What is edge computing?

Edge computing involves

hardware and software technologies

that enable storage, computing, processing and networking

close to the device that generates or consumes data.

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'Close' is a relative term that could include:

servers co-located with cell towers,

on premise servers,

gateways, and

operational devices.

Edge computing moves compute power closer to the data generation source, but computing can be done at multiple points in the computing stack.
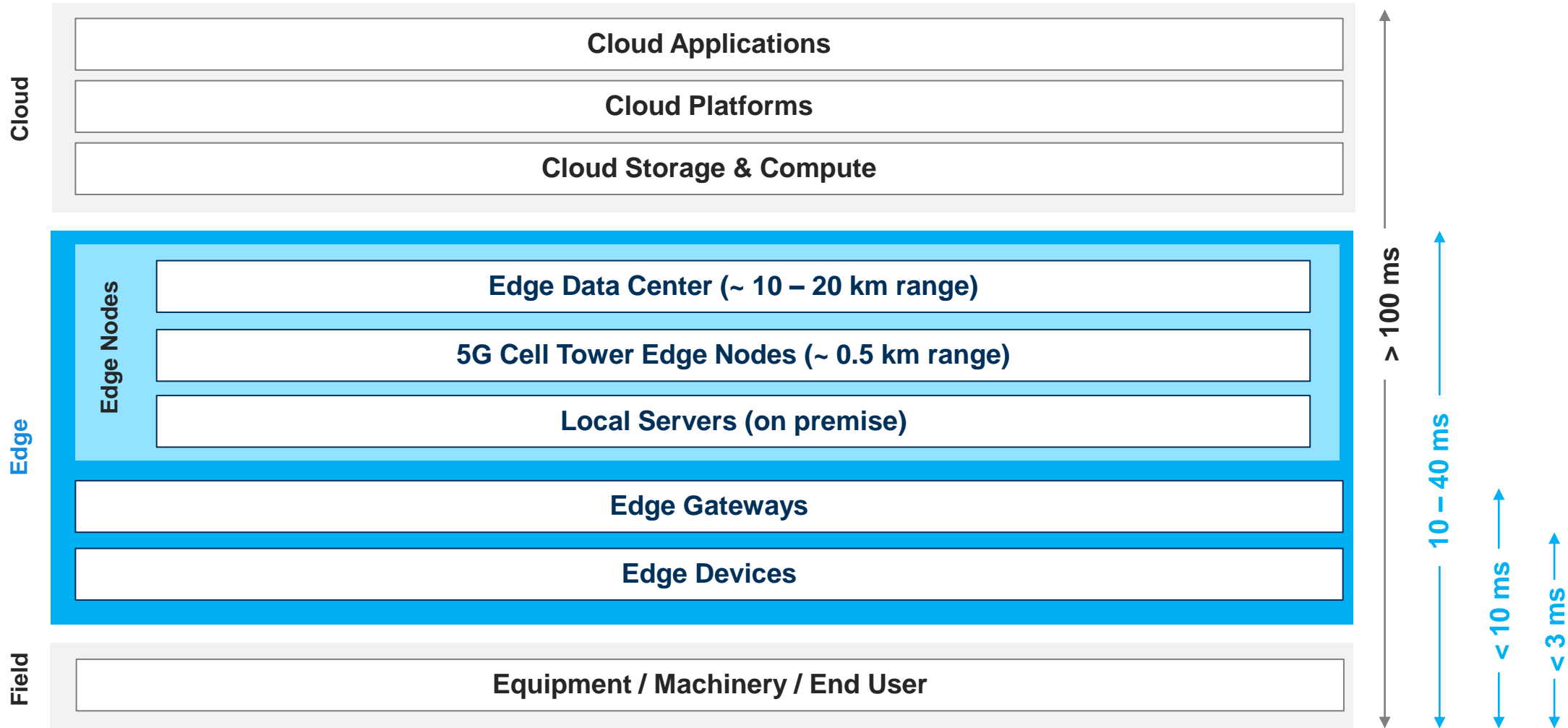
Cloud & edge applications for advanced mobility

Cloud & edge applications for facility management
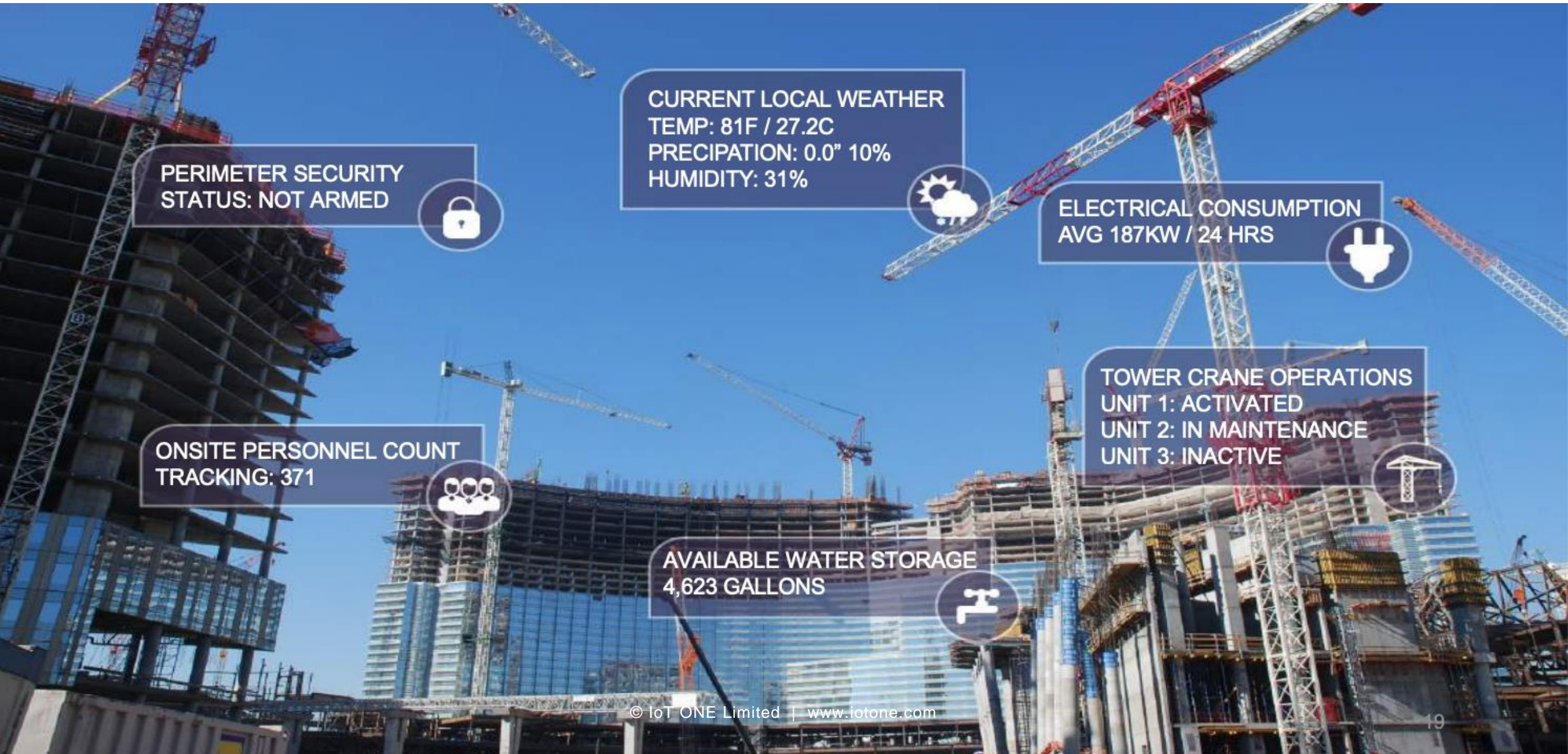
PERIMETER SECURITY
STATUS: NOT ARMED

CURRENT LOCAL WEATHER
TEMP: 81F / 27.2C
PRECIPITATION: 0.0" 10%
HUMIDITY: 31%

ELECTRICAL CONSUMPTION
AVG 187KW / 24 HRS

TOWER CRANE OPERATIONS
UNIT 1: ACTIVATED
UNIT 2: IN MAINTENANCE
UNIT 3: INACTIVE

ONSITE PERSONNEL COUNT
TRACKING: 371

AVAILABLE WATER STORAGE
4,623 GALLONS

Many use cases could use edge or cloud computing with tradeoffs between architectures. Cloud is the default today but the market is trending toward edge.

20 Common IIoT Use Case	Total	Deployment
Digital Twins for Process Modeling	85	Cloud + Edge
Predictive Maintenance	72	Cloud + Edge
Process Control & Optimization (PCO)	68	Cloud
High-throughput Experimentation Automation	62	Cloud + Edge
Machine / Asset Condition Monitoring	61	Edge
Robotic Picking, Sorting & Positioning	55	Edge
Digital Twins for Asset Lifecycle Management	41	Cloud
Process Monitoring	35	Edge
Quality Testing & Inspection	32	Edge
Material Handling	31	Edge
Sensors-based Manufacturing KPI Reporting	31	Edge
Factory Operations Visibility & Intelligence	31	Cloud
Robotic Assembly	24	Edge
Robotic Palletizing & Packaging	23	Edge
Remote Maintenance Support	23	Cloud
Track & Trace for Industrial Tools & Assets	18	Cloud + Edge
Energy Monitoring and Management	17	Cloud + Edge
Onsite Human Safety Management	15	Cloud
Robotic Disassembly	11	Edge
Continuous Emission Monitoring Systems	8	Edge

Columns: Production, Maintenance, R&D, Warehouse, Logistics, Quality, Operation, HR

N = 734

Who is active in edge computing markets?

Application Layer

Functional Applications — samsara, Bright Wolf, AUVESY., saviant, Particle, FORCAM we speak machine, Apptricity

Cloud Layer

Platform as a Service (PaaS) — C3 IoT, thingworx, Ayla, arrayent, ROOTCLOUD, CLEARBLADE We Connect the Things., software AG Freedom as a Service

Infrastructure as a Service (IaaS) — aws, Azure, Alibaba Cloud, Google Cloud, ORACLE

Edge Layer

Automation & Control — SIEMENS, ADVANTECH, rti

Edge Intelligence — intel, NXP, arm, ADVANTECH

Actuators — Honeywell, PHOENIX CONTACT, DENSO, ST

Sensors — Texas Instruments, Libelium, BOSCH, TE connectivity

Physical World

Assets — TESLA, GE, ABB, FUJITSU, HITACHI, CAT

Devices — DJI, TOSHIBA, PHILIPS, Hewlett Packard Enterprise, SAMSUNG ELECTRONICS

Infrastructure — Emirates, FLUOR, bp, RioTinto

Wearables — ZEBRA, magic leap, PROGLOVE, realwear

Supporting Technologies

Analytics & Modelling — IBM, TERADATA, sparkcognition, FOGHORN, machine metrics, devicepilot, VERTICA, snowflake, CLOUDERA, ThingSpeak, telliant Intelligent Software. Delivered.

Application Infrastructure & Middleware — LINKSMART, DDS FOUNDATION, senseone, MuleSoft, WSO2, Zerynth

Cybersecurity & Privacy — Bastille, Symantec, KASPERSKY, gemalto security to be free, NOZOMI NETWORKS, MOCANA, Barracuda, TRUSTONIC, paloalto

Networks & Connectivity — AT&T, CISCO, HUAWEI, Vodafone, Telit, ERICSSON, sigfox

Case study: Edge server integration with 5G cell towers
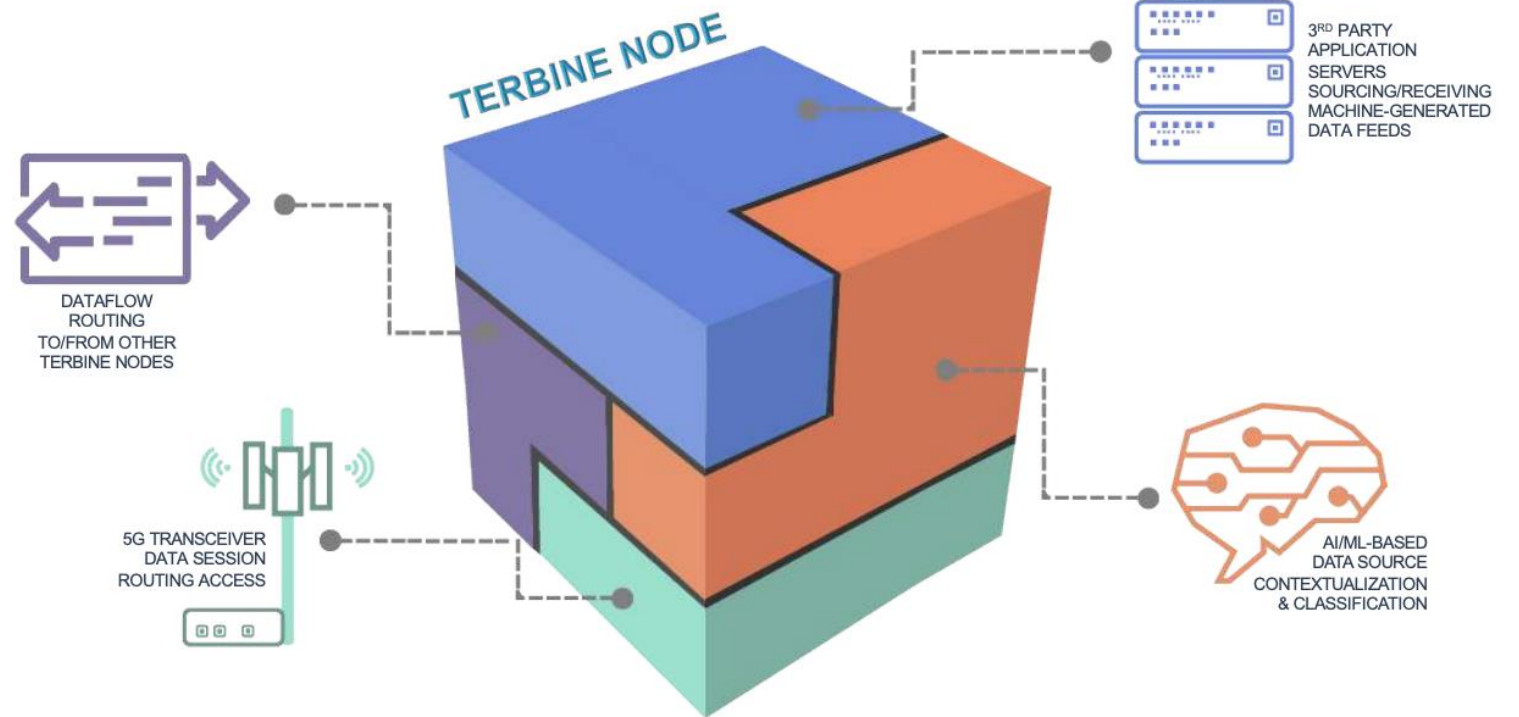
Terbine manages IoT data transactions on the edge

Edge computing enablers in China

$180
billion 5G CAPEX

Chinese operators will invest up to $250 billion in mobile capex between 2018 and 2025, of which $180 billion will be on 5G networks. Nearly 20% of global 5G network investment will be in China.
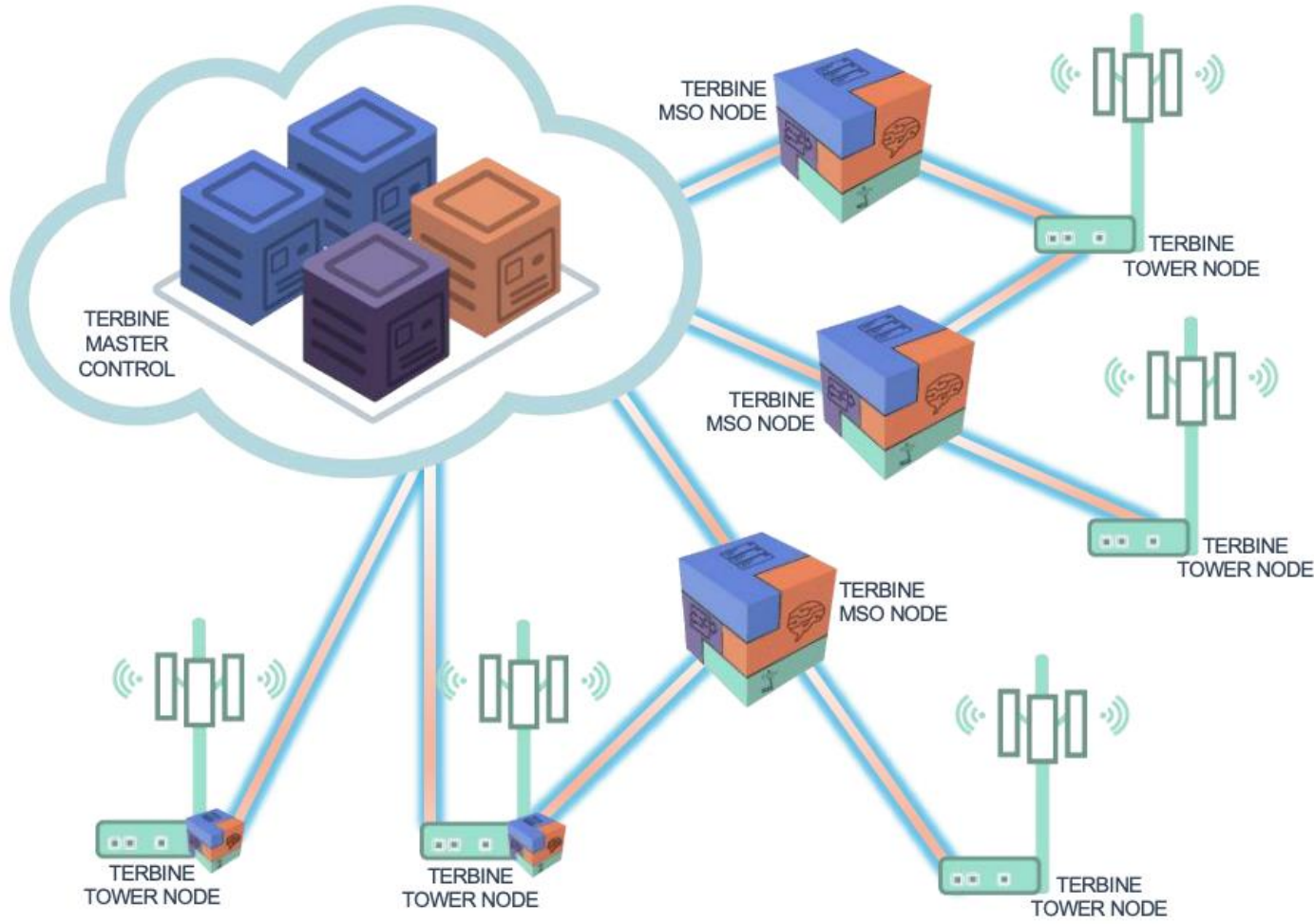
1.9 billion
cellular IoT connections

By 2025, China will be home to 1.9 billion licensed cellular IoT connections, more than any other country. Three quarters of Chinese enterprises have already deployed IoT – the highest proportion globally.

~90% of companies
## expect to generate incremental revenue

Nearly 90% of the companies participating in the survey see edge computing as an opportunity to generate new revenues in the 5G era. Two thirds expect to generate value from operational efficiencies.

Who is leading edge development in China?

The Edge Computing Consortium (ECC) is a China-led alliance of more than 260 industrial and academic organizations that promotes research, development and adoption of edge technologies.

260 member companies
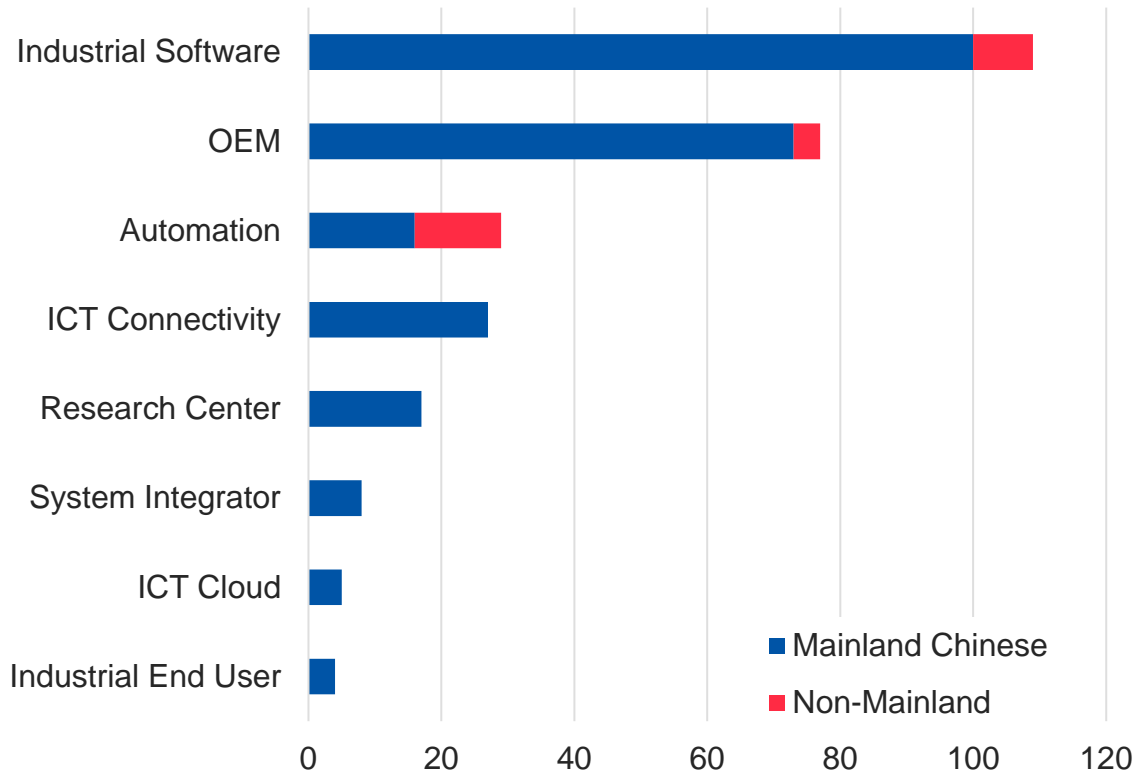
Six founding organizations:

- Huawei
- Shenyang Institute of Automation, Chinese Academy of Sciences
- China Academy of Information and Communications Technology
- Intel Corporation
- ARM Holdings
- iSoftStone Information Technology

26 non-mainland member companies

- ABB
- ADLINK Technology
- Advantech
- Arm Limited
- B&R Industrial Automation
- Emerson Electric
- Endress+Hauser Group Services
- Foxconn Technology
- Honeywell International
- Infosys Technologies
- Intel
- Lattice Semiconductor
- McAfee
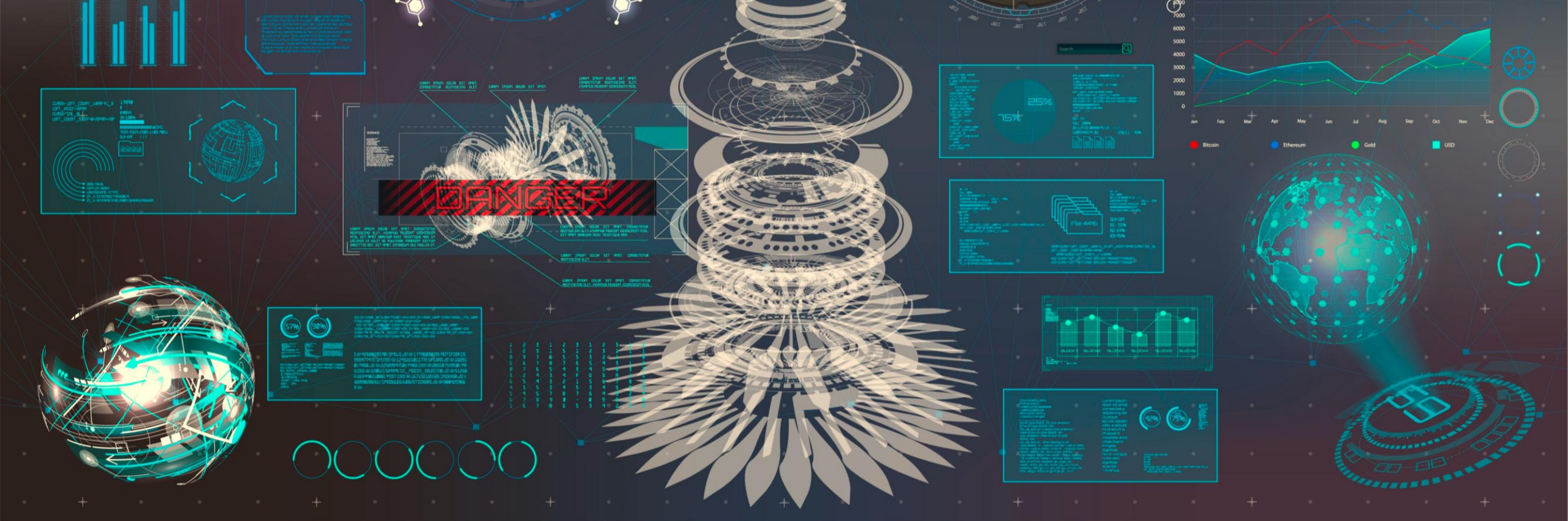
- Mitsubishi Electric
- National Instruments
- OSIsoft
- Phoenix Contact
- Robert Bosch
- Robustel
- Rockwell Automation
- Schindler Management
- Schneider
- Seagate
- Siemens
- Wind River System
- Xilinx

Market players leverage ecosystems to enable cross-selling with legacy products, enlarge product portfolio, and build end-to-end solutions.

	Automation	OEM	End User	ICT Cloud	ICT Connectivity	Industrial Software
Example companies	Honeywell / ADVANTECH	三一集团 / XCMG	Haier / Lenovo	阿里云 / QINGCLOUD青云	HUAWEI / H3C	ptc / 江行智能
Ecosystem Strategy	Cross-selling with legacy products and increase product portfolio.	Enhance go-to-market capability and add equipment management services.	Augment technology and go-to-market ability.	Capture developers' creativity into product growth and utilize partners' vertical expertise.	Build end-to-end solutions and augment go-to-market ability.	Engage with customers via community and build go-to-market ability by partner program.

Ecosystem Influence

	Automation	OEM	End User	ICT Cloud Leaders	ICT Cloud Followers[1]	ICT Connectivity	Industrial Software Leaders	Industrial Software Followers
Market Place	Low	Low	Low	High	Low	Low	High	Low
Community	Low	Low	Low	High	Medium	Medium	High	Low
Partnership	High	Medium	Medium	High	High	High	High	Low

◔ Low   ◑ Medium   ● High

Edge Portfolio

- Edge Hardware
- Horizontal Software
- Vertical Software
- Connectivity

Automation: 29%, 20%, 38%, 14%

OEM: 36%, 26%, 38%, 0%

Enduser: 22%, 22%, 57%, 0%

ICT Cloud: 9%, 50%, 41%, 0%

ICT Connectivity: 31%, 21%, 16%, 33%

Inudstrial Software: 17%, 35%, 48%, 0%

1. Leaders: Companies with revenue above 1 Billion EUR. Followers: Companies with revenue less than 200 Million EUR.

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