FAPESP ENGINEERING RESEARCH CENTER (ERC)*

SMARTNESS

(SMART NEtworks and ServiceS for 2030)

*CPE (Centros de Pesquisa em Engenharia)
http://www.fapesp.br/cpe/home

Objective

The **SMARTNESS (SMART NEtworks and ServiceS for 2030) FAPESP Engineering Research Center (ERC)** aims to develop cutting-edge research in communication networks and advanced digital application services.

SMARTNESS is focused on innovative networking and computing technologies that enable the realization of valuable yet challenging use cases in Internet scenarios for industry and society with a 2030 horizon view.

Justification

Rationale for **SMARTNESS 2030**: a networking-centric FAPESP ERC

Towards “6G”

- The 2030 networking paradigm has begun

Increasingly Multidisciplinary

- HW, SW, AI, cloud, as a Service, cloud, UX, Smart-X, IoX - Internet of Everything

The Network

- critical in any modern engineering system (industry 4.0, automotive, etc. etc.)
- a gap in FAPESP ERCs (and similar excellence research hubs in Brazil)

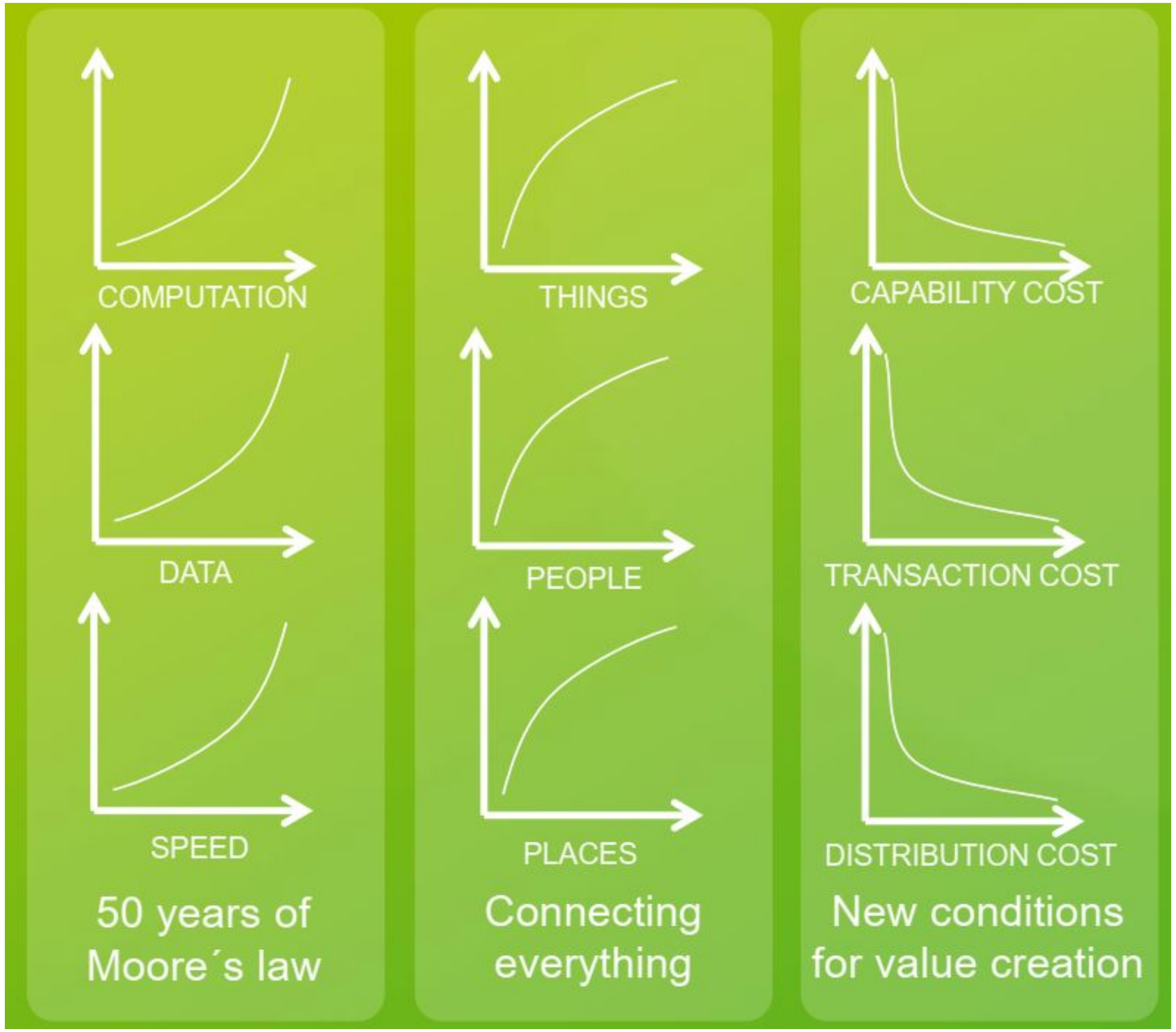
Ericsson-Unicamp seeds in excellence research *ready* to *scale up* and *out*

- INTRIG/UNICAMP results and international presence (e.g., talented HR, Research Awards, impact open source SW for research and education, standardization, IPR)
- Ericsson Research Branch in Indaiatuba (highly qualified researchers in network architectures and protocols and artificial intelligence)
- Scale up in size and out through strong research partners from UFSCAR and USP

Research Topics

SMARTNESS Vision and Scope

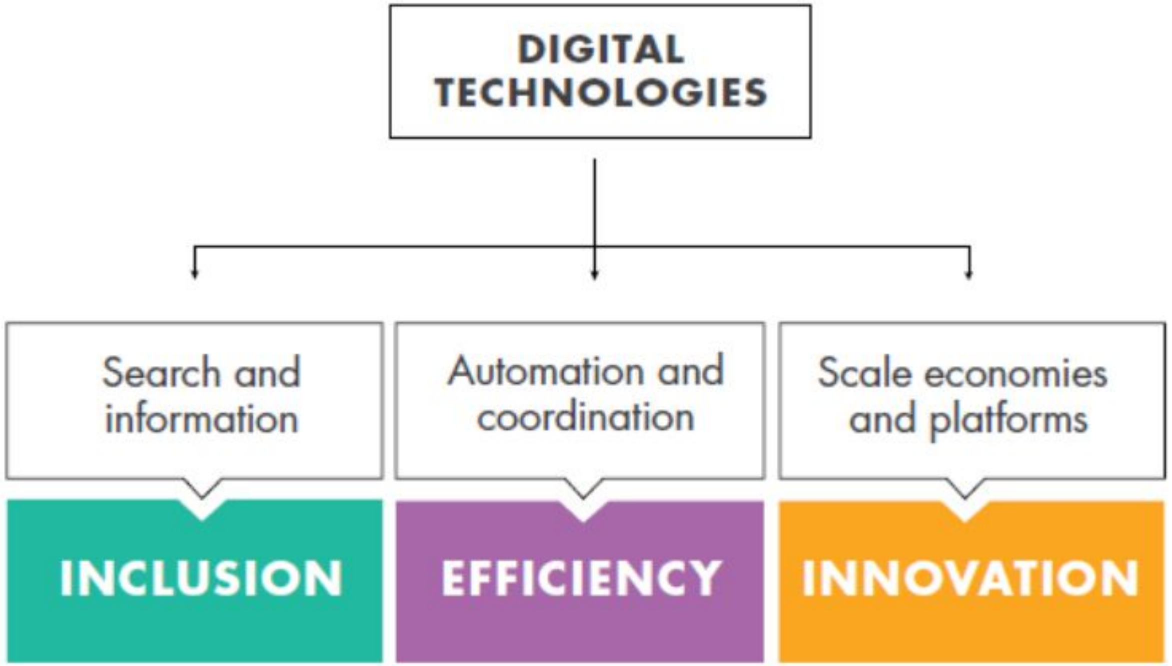
Digital Transformation



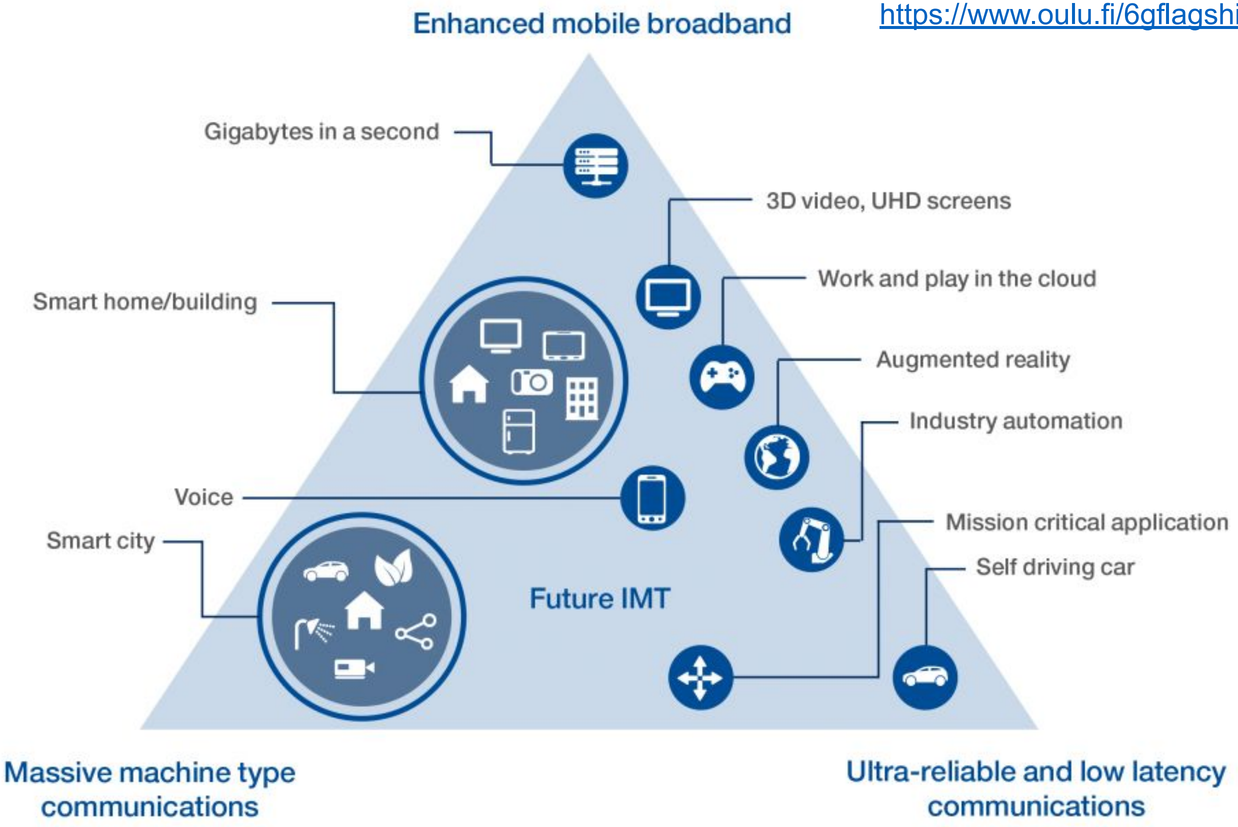
Source: Developing national capabilities for successful transformation ICT ENABLED policy framework for national development, Ericsson, 2016

From Digital Transformation accelerated by 5G towards 6G

Source: https://www.oulu.fi/6gflagship/



Source: World Bank, WDR 2016



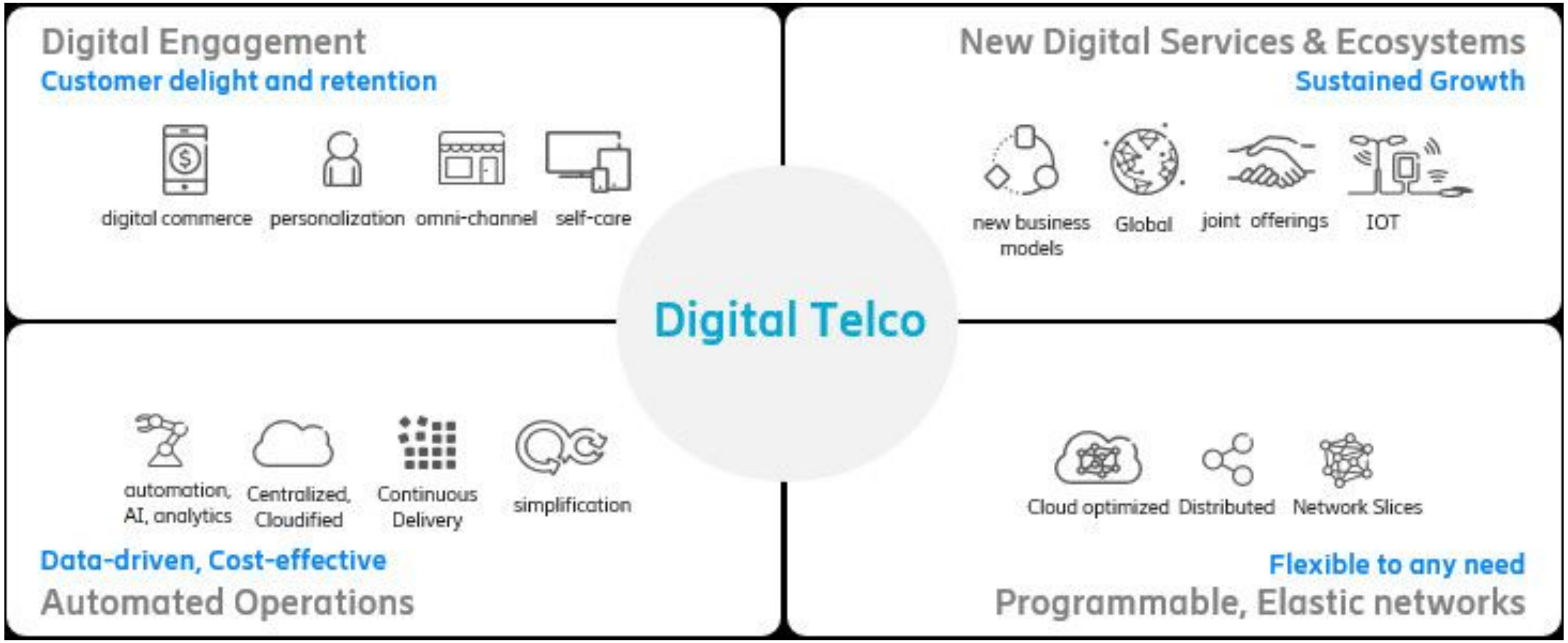
Source: ITU-T, 20165

Source: ITU 2015.

Digital Telco

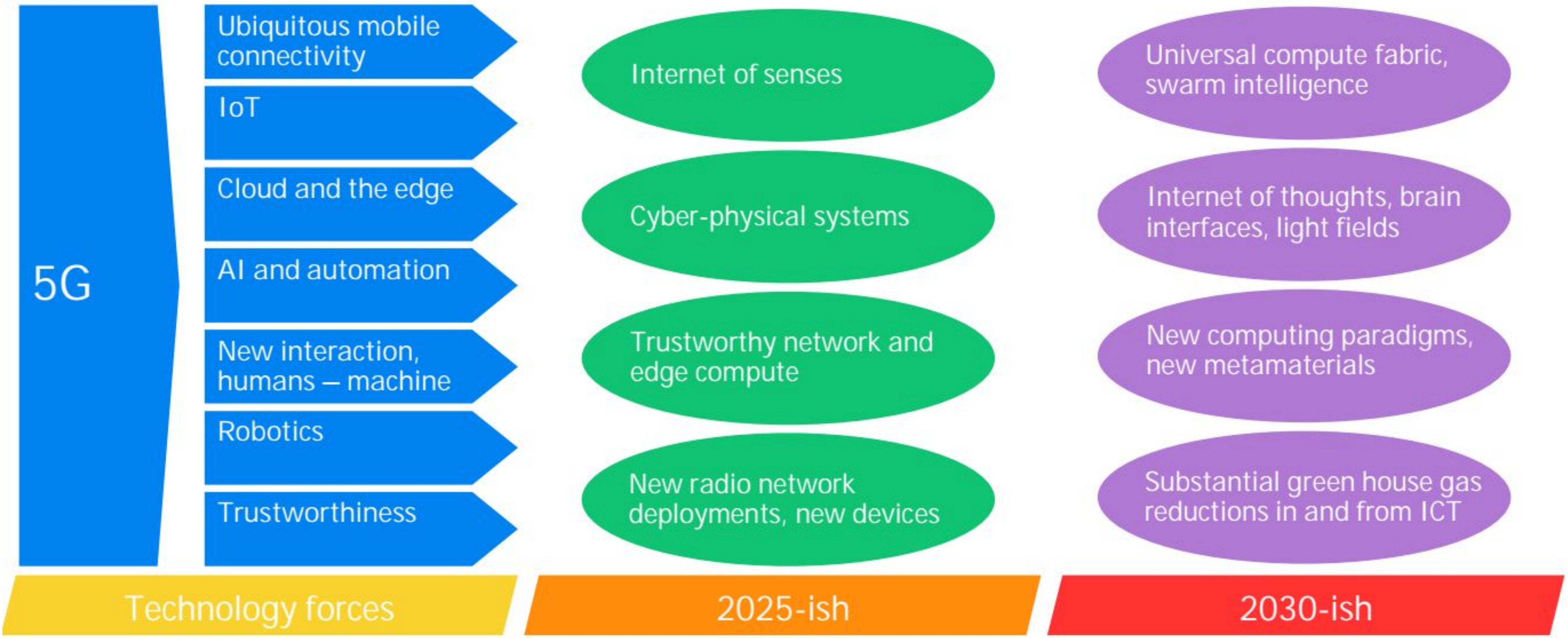
Due to digital transformation, networks are becoming increasingly complex, as are the services delivered by them.

To meet this challenge, operators need to evolve to *fully digital telco*.



Source: https://www.ericsson.com/en/blog/2018/2/digital-transformation-in-the-telecom-industry

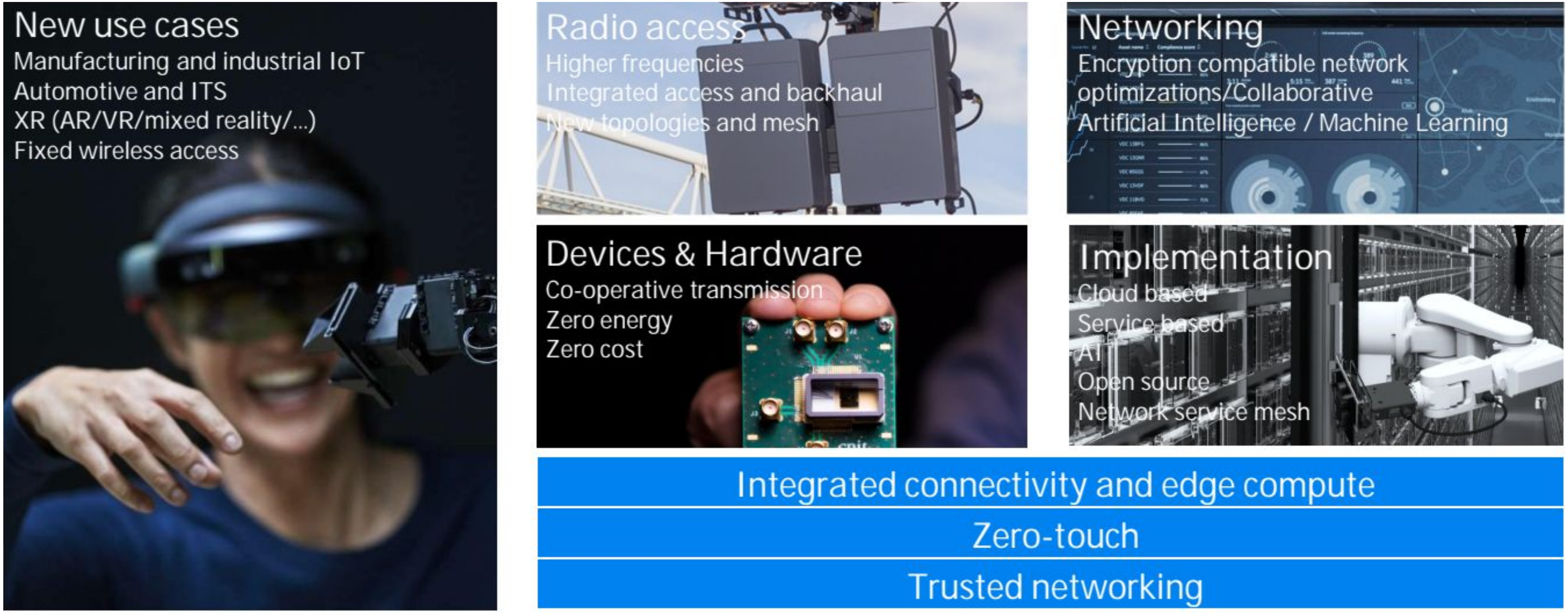
From 5G to 2030 / 6G



Source: Towards a connected intelligent future. Dr. Magnus Frodigh. Head of Ericsson Research, VP. Ericsson Research. 2019-03-26. Ericsson.
http://www.6gsummit.com/wp-content/uploads/2019/04/Day3_Session2_Frodigh_Ericsson.pdf

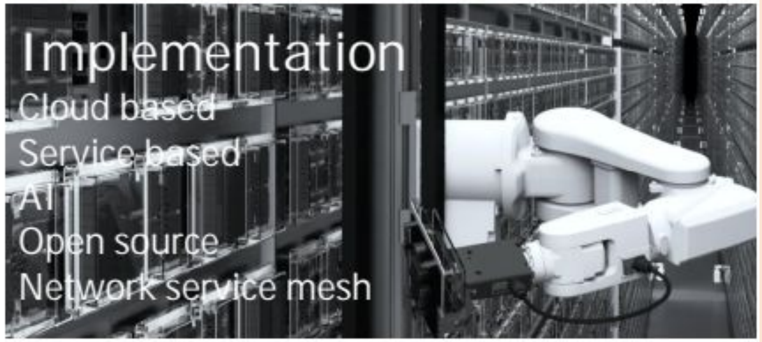
Towards 2030 / 6G
(Ericsson Vision)

ERICSSON



Source: Towards a connected intelligent future. Dr. Magnus Frodigh. Head of Ericsson Research, VP. Ericsson Research. 2019-03-26. Ericsson.
http://www.6gsummit.com/wp-content/uploads/2019/04/Day3_Session2_Frodigh_Ericsson.pdf

Towards 2030 / 6G
(Ericsson Vision vs. Scope of SMARTNESS)



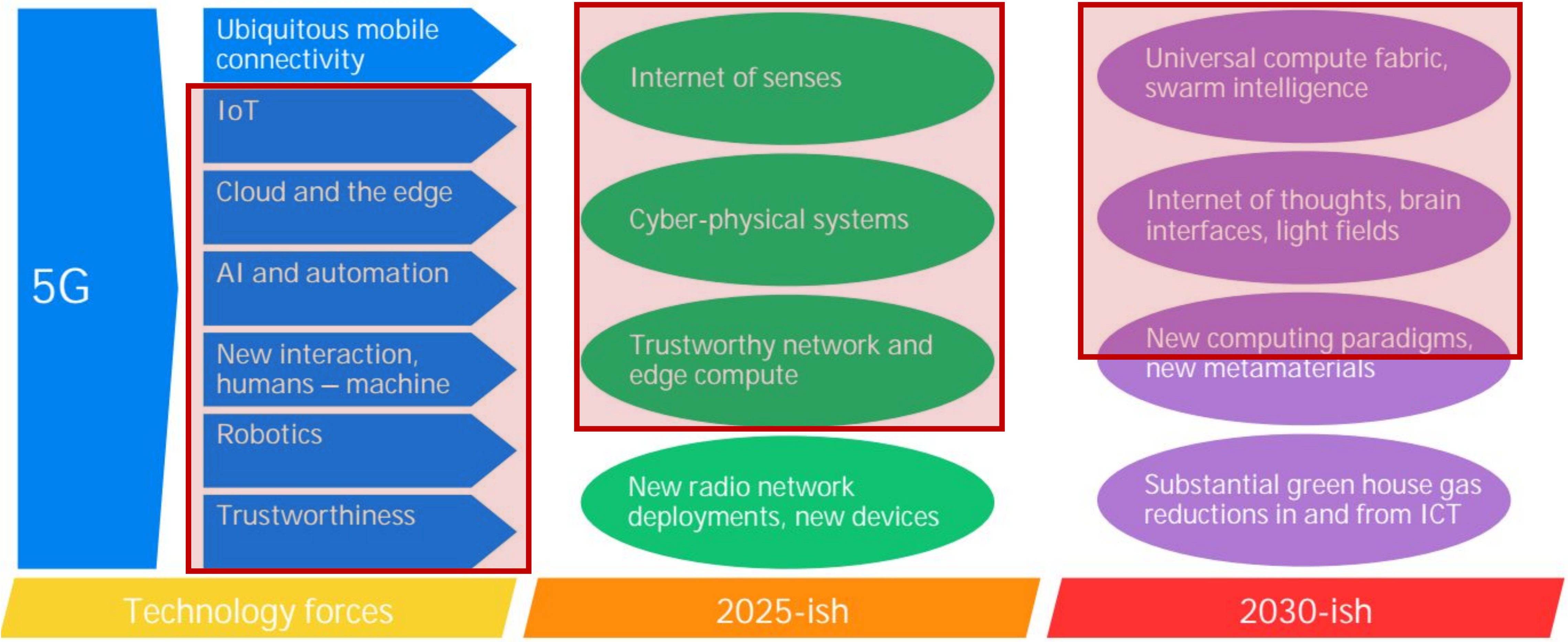
Integrated connectivity and edge compute

Zero-touch

Trusted networking

From 5G to 2030 / 6G

SMARTNESS Scope



Source: Towards a connected intelligent future. Dr. Magnus Frodigh. Head of Ericsson Research, VP. Ericsson Research. 2019-03-26. Ericsson.
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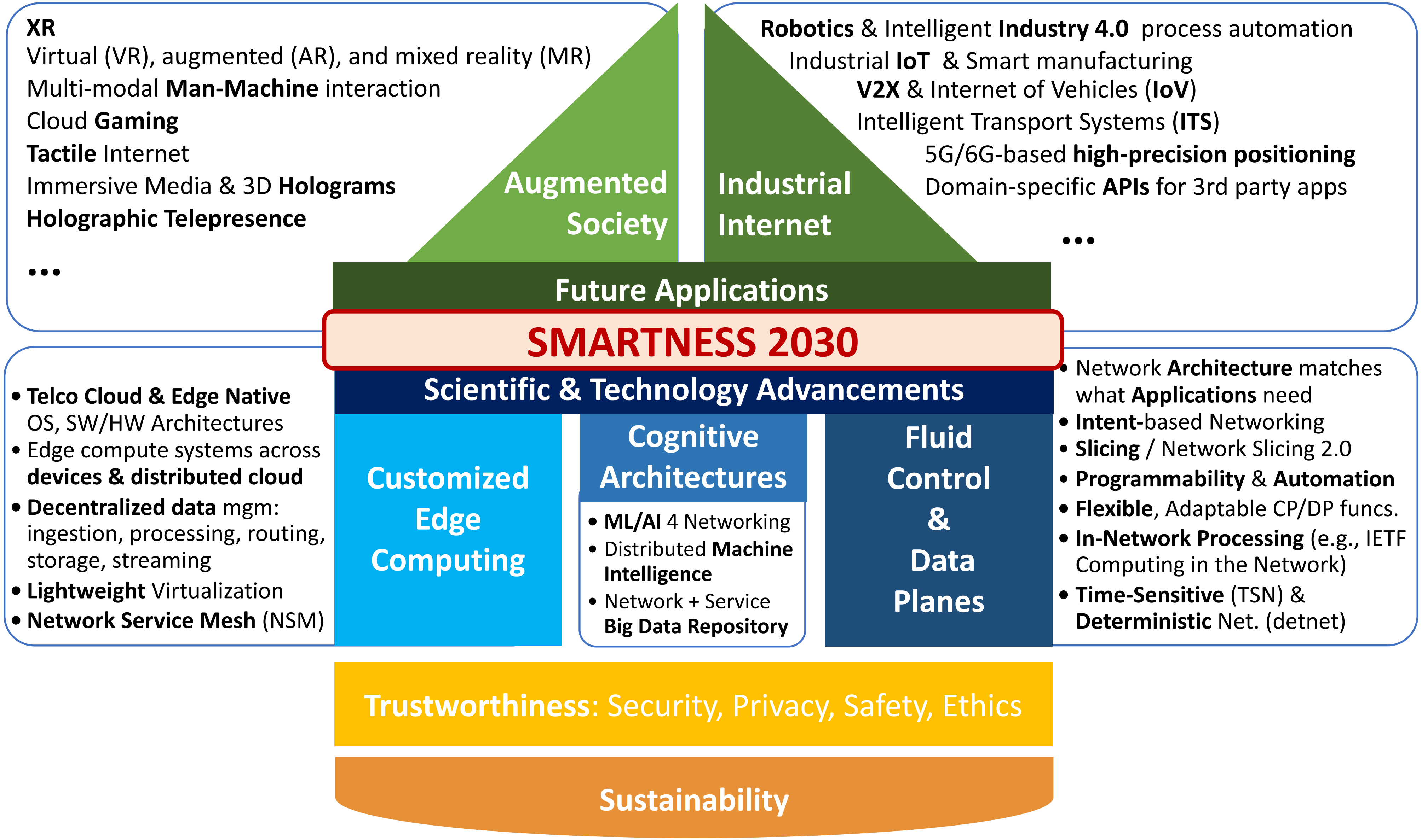
SMARTNESS

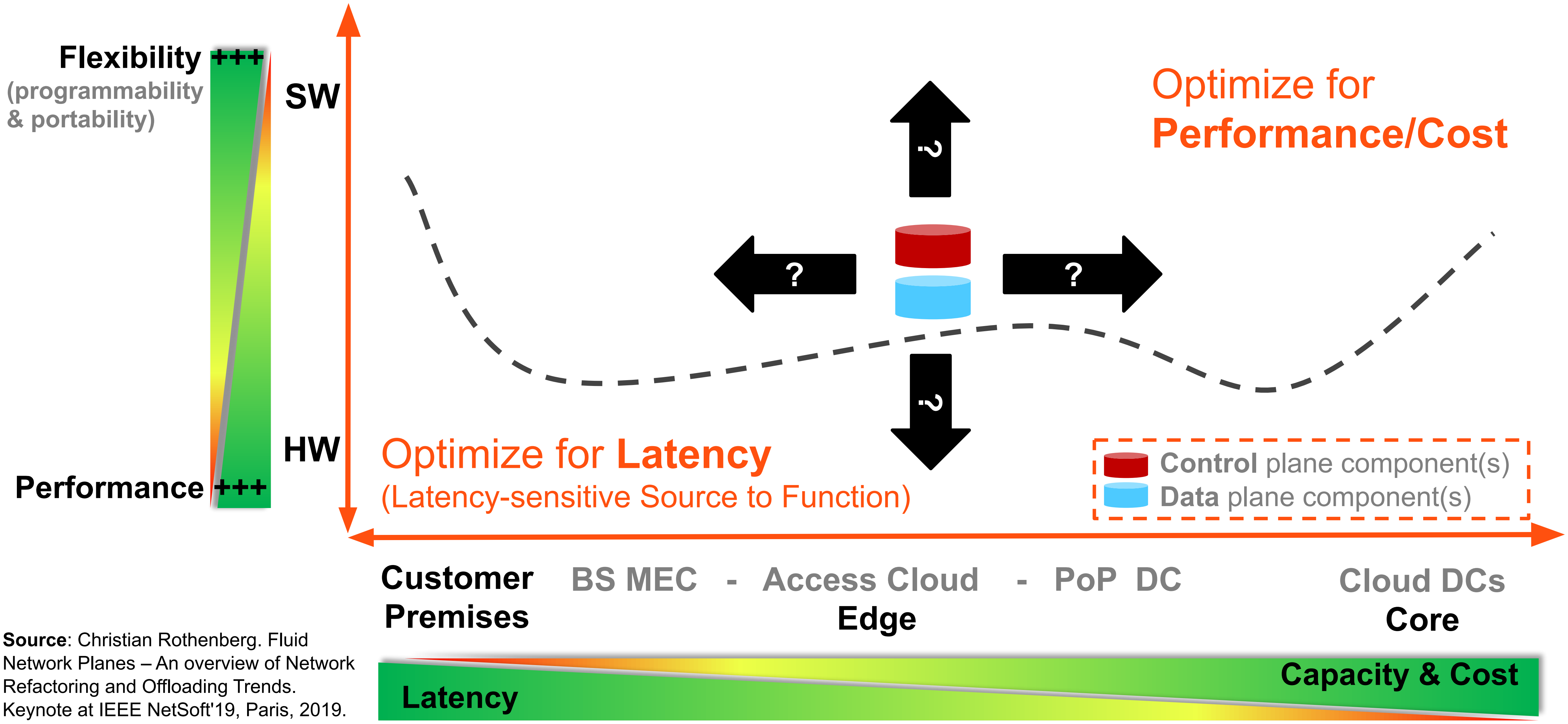
SMART NEtworks and ServiceS for 2030

SMARTNESS (Smart Networks and Services for 2030)



SMARTNESS 2030

Fluid network architectures tailored to Sliced Services



Source: Christian Rothenberg. Fluid Network Planes – An overview of Network Refactoring and Offloading Trends. Keynote at IEEE NetSoft'19, Paris, 2019.

SMARTNESS timely embraces next-gen (i.e 6G / 2030) distributed computer networking vision and challenges

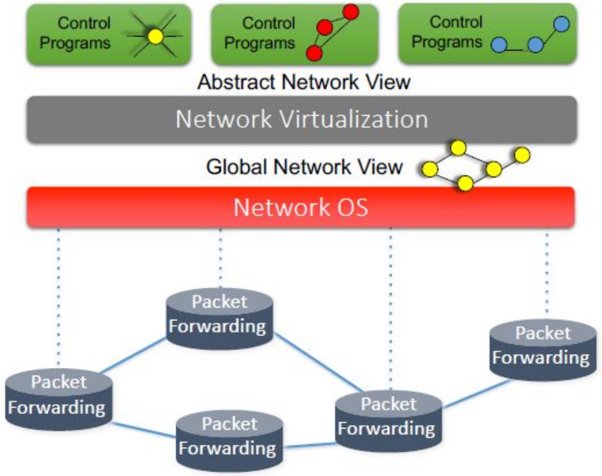
Fully distributed computer networking

Edge cloud controller

Disaggregation: from cloud core to edge

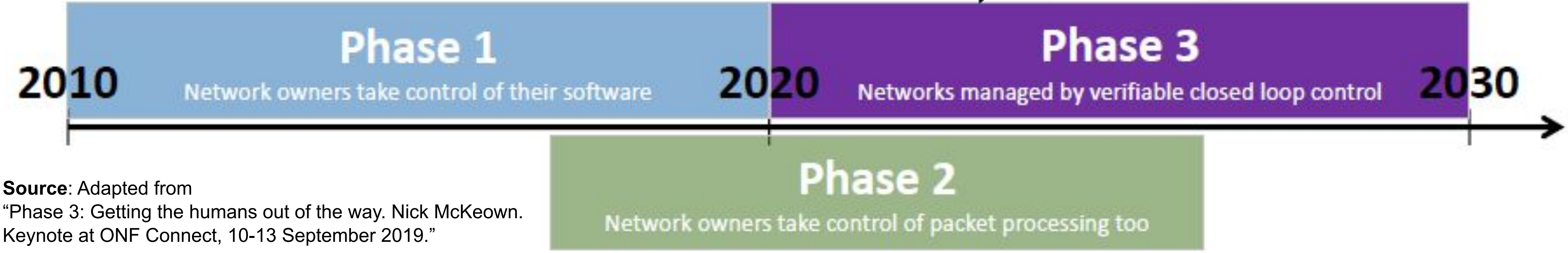
In-network computing

Distributed matching engine



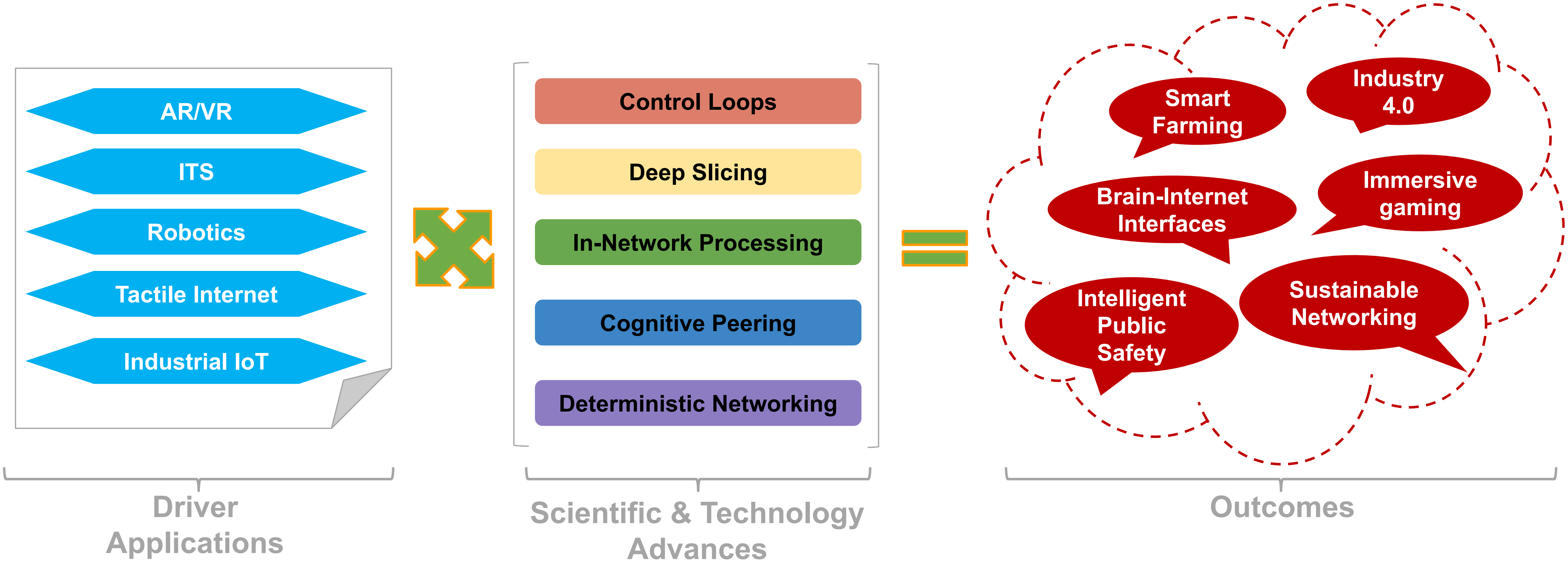
Teaching computer networking should change in the next 10 years.

Less protocols and more network computing programming!

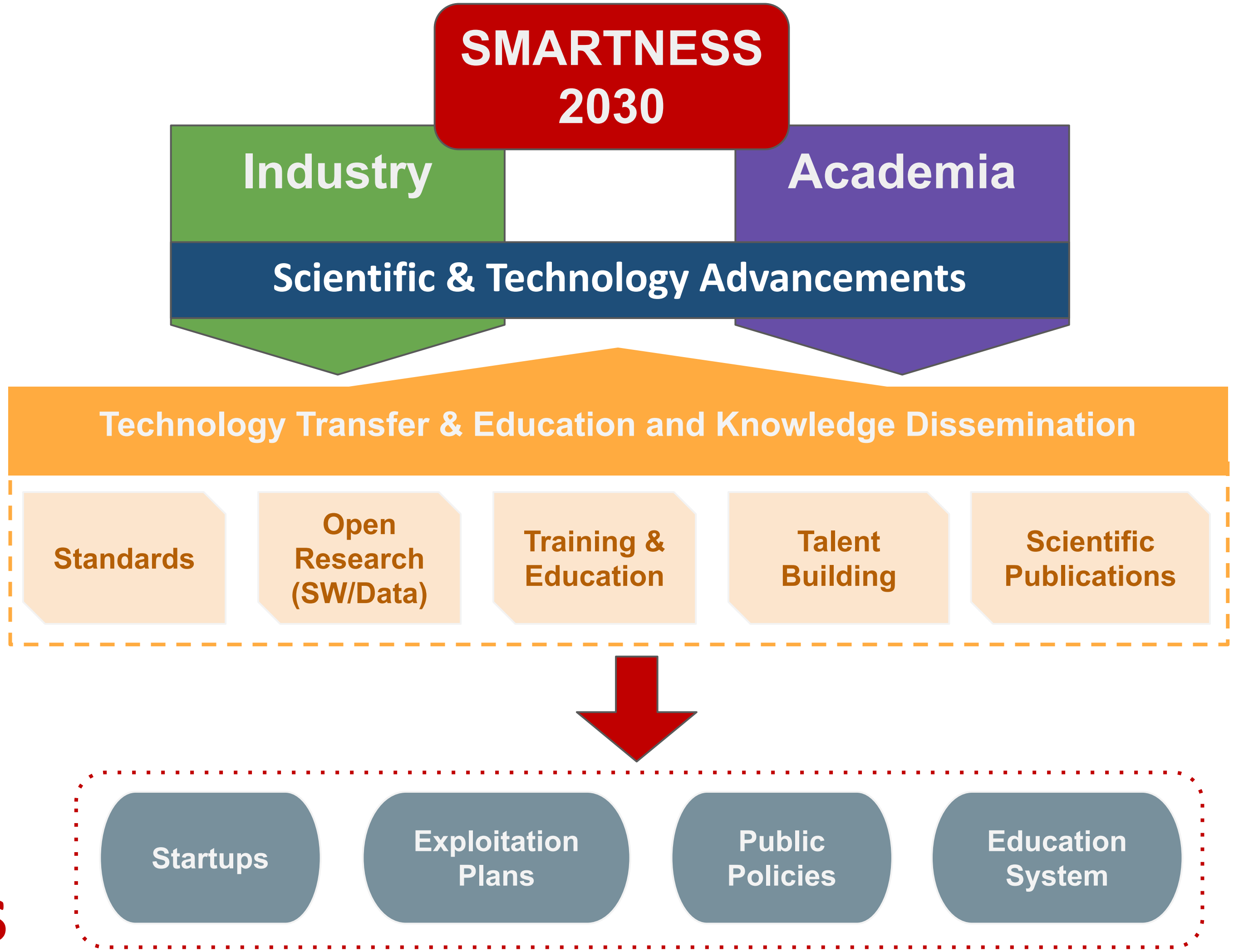


Source: Adapted from
"Phase 3: Getting the humans out of the way. Nick McKeown. Keynote at ONF Connect, 10-13 September 2019."

SMARTNESS Advances beyond the State of the Art



SMARTNESS Impact Setting

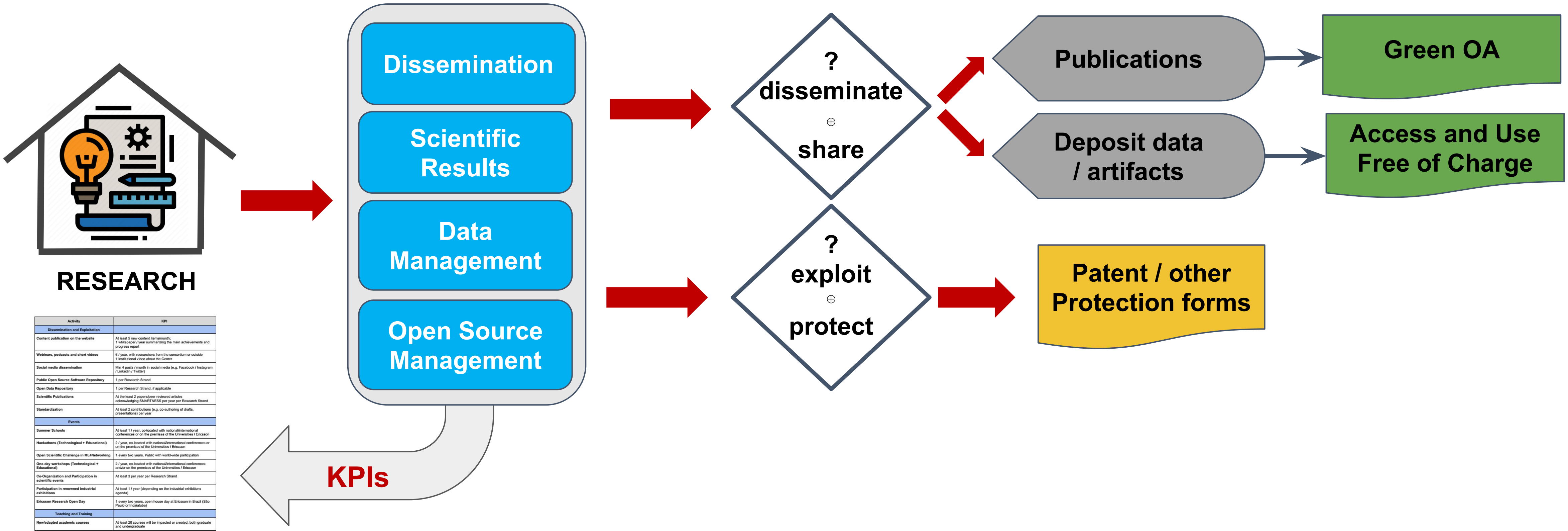


IMPACT Outcomes

SMARTNESS

OPEN access to scientific publications, code and data

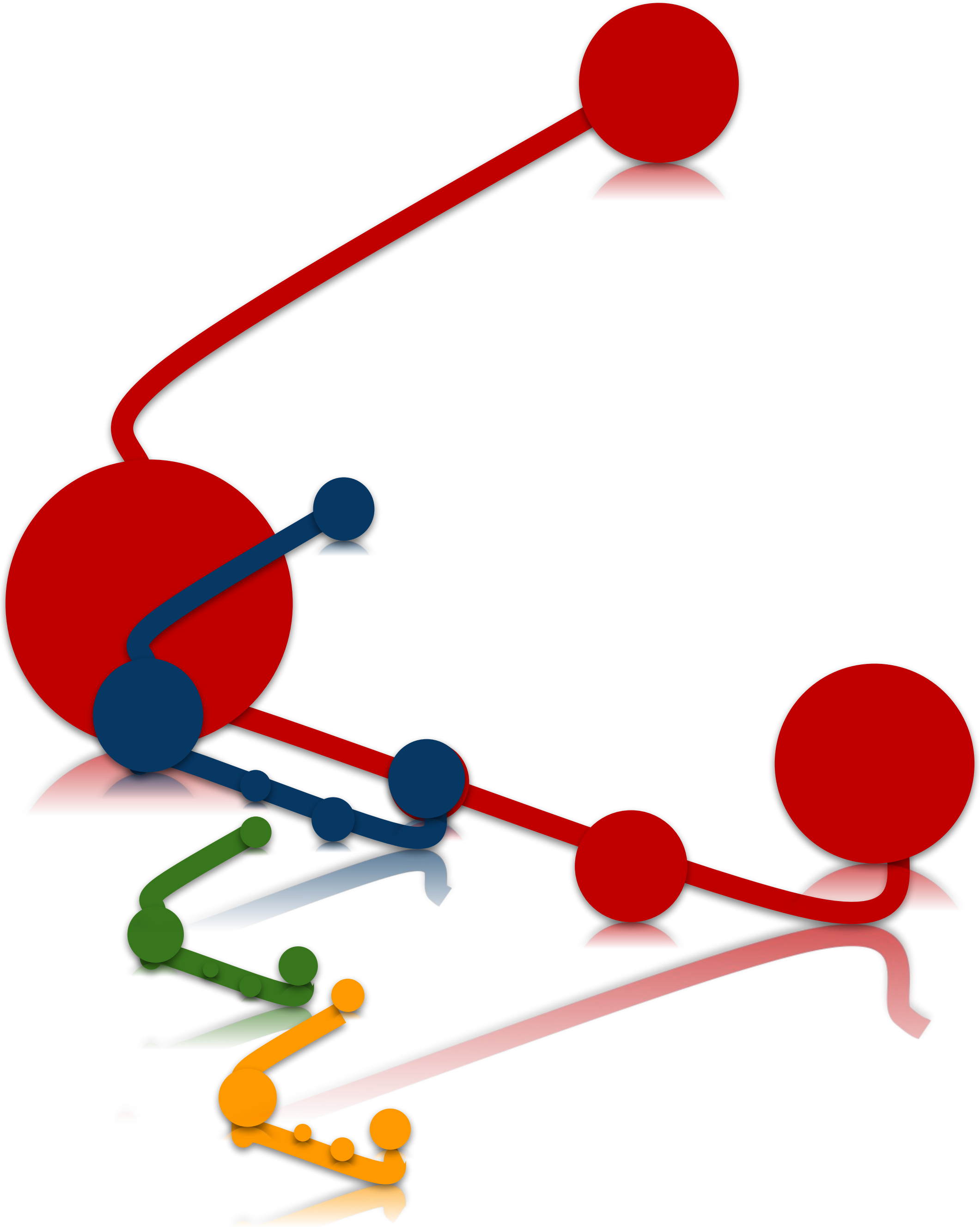
+ IPR generation



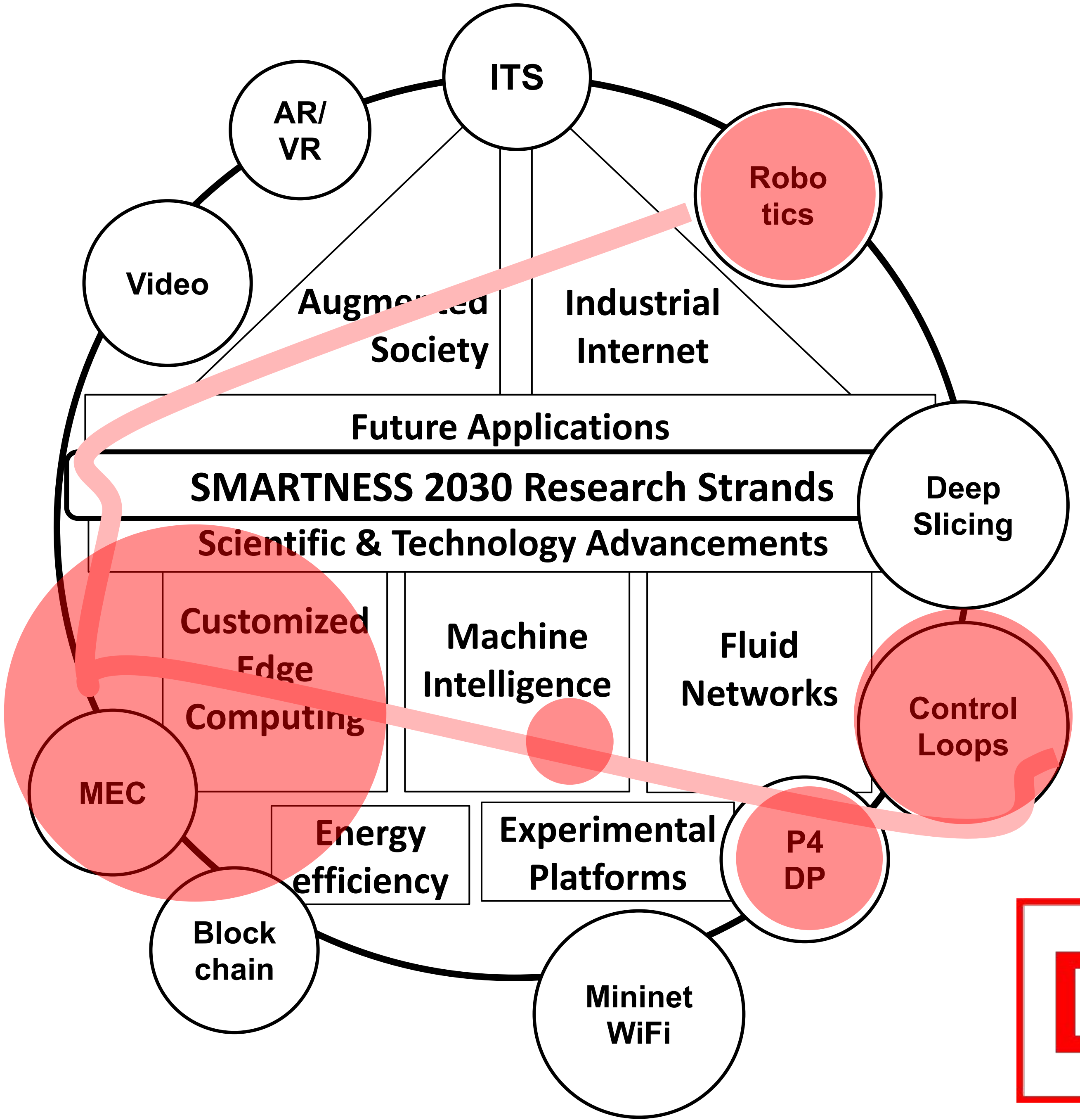
Activity	KPI
Dissemination and Exploitation	
Content publication on the website	At least 5 new content items/month; 1 whitepaper / year summarizing the main achievements and progress report
Webinars, podcasts and short videos	6 / year, with researchers from the consortium or outside 1 institutional video about the Center
Social media dissemination	Min 4 posts / month in social media (e.g. Facebook / Instagram / Linkedin / Twitter)
Public Open Source Software Repository	1 per Research Strand
Open Data Repository	1 per Research Strand, if applicable
Scientific Publications	At the least 2 papers/peer reviewed articles acknowledging SMARTNESS per year per Research Strand
Standardization	At least 2 contributions (e.g. co-authoring of drafts, presentations) per year
Events	
Summer Schools	At least 1 / year, co-located with national/international conferences or on the premises of the Universities / Ericsson
Hackathons (Technological + Educational)	2 / year, co-located with national/international conferences or on the premises of the Universities / Ericsson
Open Scientific Challenge in ML4Networking	1 every two years. Public with world-wide participation
One-day workshops (Technological + Educational)	2 / year, co-located with national/international conferences and/or on the premises of the Universities / Ericsson
Co-Organization and Participation in scientific events	At least 3 per year per Research Strand
Participation in renowned industrial exhibitions	At least 1 / year (depending on the industrial exhibitions agenda)
Ericsson Research Open Day	1 every two years, open house day at Ericsson in Brazil (São Paulo or Indaiatuba)
Teaching and Training	
New/adapted academic courses	At least 20 courses will be impacted or created, both graduate and undergraduate
Teacher training	1 every two years, short seminars to pre-college teachers
Pre-college in-class and out-of-class activities	1 / year, short seminars to pre-college students
São Paulo School of Advanced Science	1 every three years
Startups	

Research Strands

SMARTNESS Approach

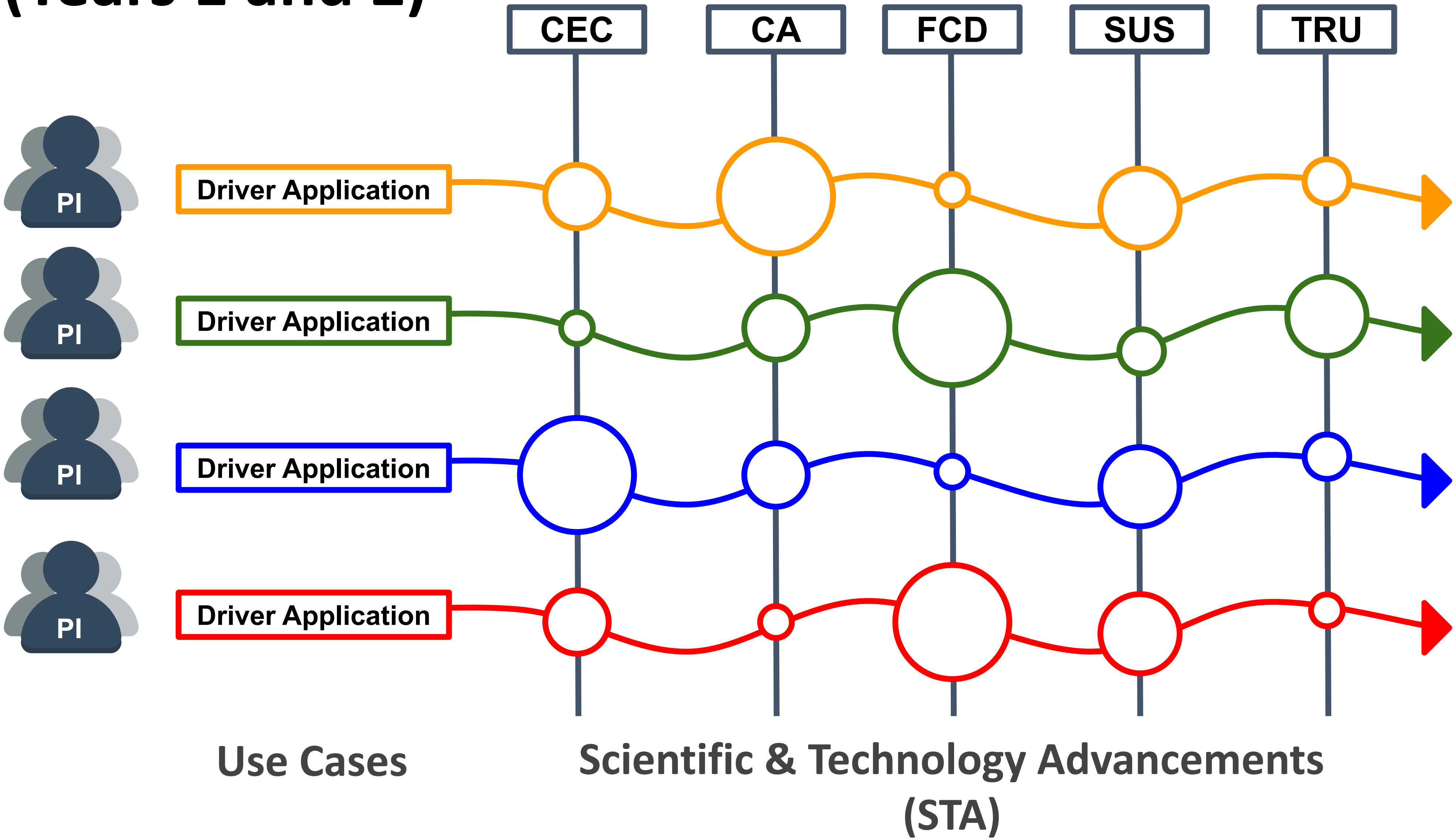


Research Strands Approach

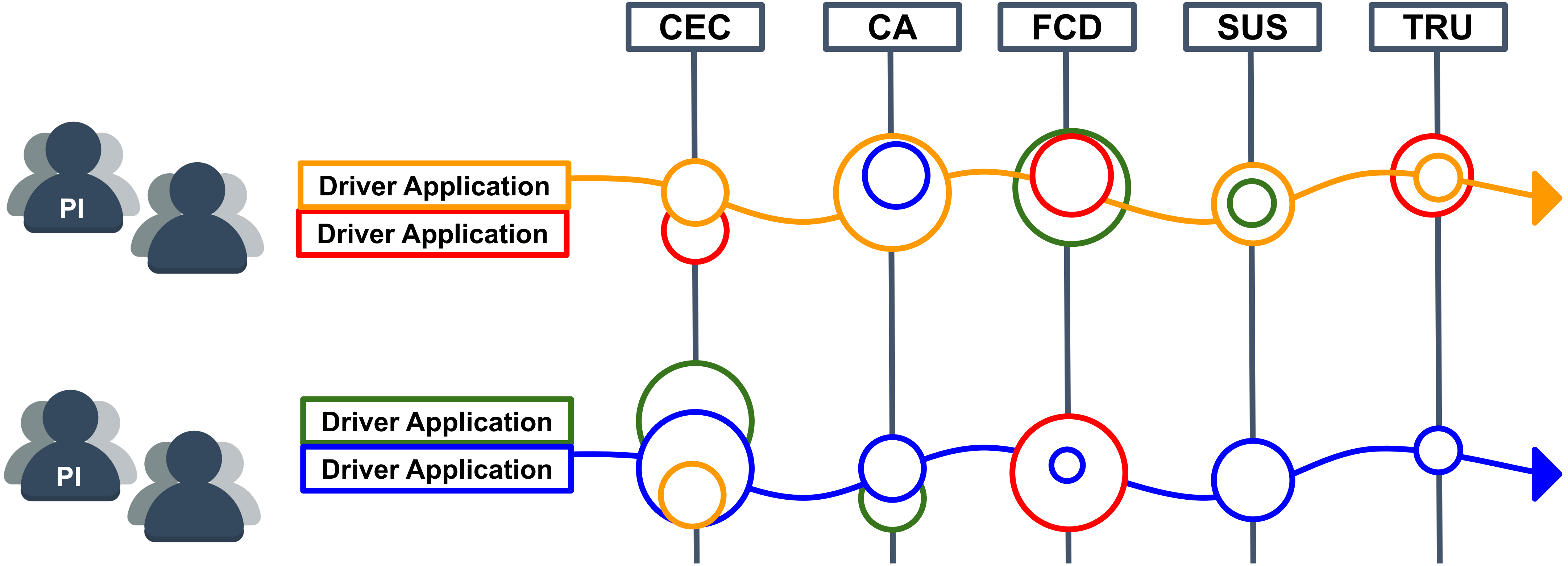


DRAFT

Schedule & Methodology (Years 1 and 2)



Schedule & Methodology (Years 3 to 5)



Integrated Use Case **Pilots**

Aggregation of Multidisciplinary Scientific & Technology Advancements

Research Strand

NEWTON: iN Edge netWork indusTrial automatioN

Objectives:

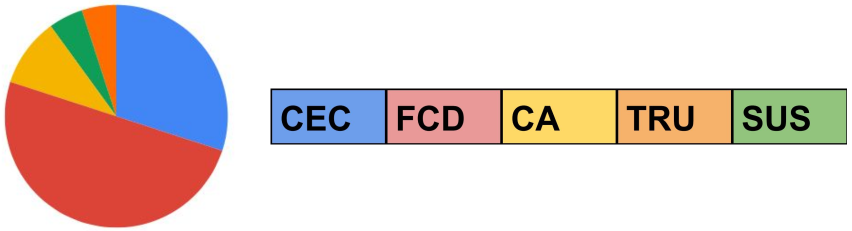
- Explore industrial automation scenarios where robot control logic and telemetry processing functions are offloaded to edge programmable hardware
- Driving use case: ULL robot control

Topics:

- CEC - Customized Edge Clouds: 25%
- FCD - Fluid Control & Data Planes: 50%
- CA - Cognitive Architectures: 15%
- TRU: 5%
- SUS - Sustainability: 5%

Contributions:

- System architectures to accelerate control processing functions to in-network HW devices that parse and extract payload data, perform calculations, filtering, and even crafting custom control messages sent to target endpoints.
- Programmable TSN with in-time and on-time packet delivery methods for target throughput and packet loss
- Cloud Network Digital Twin Operations
- Open source and standardization activities, e.g., P4, IETF COIN, TSN/Detnet.



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Research Strand

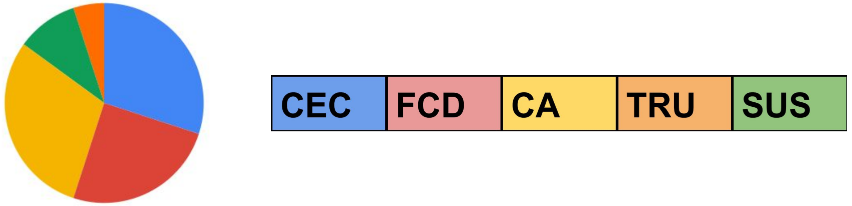
C3LA - Cognitive Close Control Loops Architecture for Edge IoV

Objectives:

- Closed Control Loops (CCLs) architectures featuring advanced monitoring (aka. Data Collection) and SLA verification (aka. Analytics) for QoE intents
- Driving use case: Edge-based vehicular services with stringent QoE intents

Topics:

- CEC - Customized Edge Clouds: 30%
- FCD - Fluid Control & Data Planes: 40%
- CA - Cognitive Architectures: 20%
- TRU: 5%
- SUS - Sustainability: 5%



Contributions:

- Edge cloud infrastructures with CCLs capabilities using intent-based network service monitoring methods
- Fluid networking and compute infrastructure managed as a IoV-tailored slice
- ML methods for CCL for QoE inference and prediction of IoV services based on network-level data collection, as well as for root cause analysis
- Demo of IoV use case showcasing the fluidity and joint self-optimization capabilities of the computing and networking infrastructure.

DRAFT

Research Strand

ADVENTURE: Adaptive and Secure Network Applications over Sliced Networked Environments

Objectives:

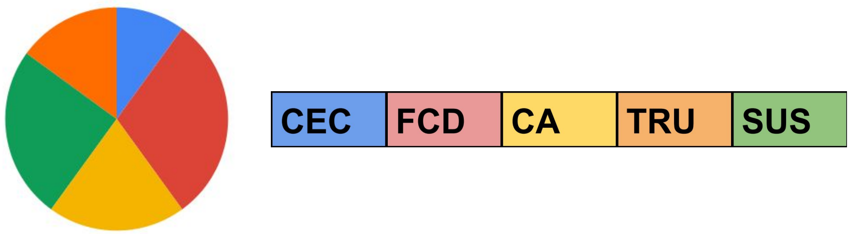
- To advance the state of the art in network applications and mechanisms in a 5G (and post-5G) network environment based on SDN and cloud network slicing
- Driving use case: Smart Power Grid (SPG)

Topics:

- CEC - Customized Edge Clouds: 10%
- FCD - Fluid Control & Data Planes: 30%
- CA - Cognitive Architectures: 20%
- TRU: 25%
- SUS - Sustainability: 15%

Contributions:

- Network architecture delivering efficient 'machine-type-comms' (mMTC) between smart devices in SPG
- SPG applications based on current smart objects software platforms
- Methods based on fuzz testing to evaluate the security of smart objects SW
- Self-adaptive SDN testbed to improve QoS and QoE of SPG



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Research Strand

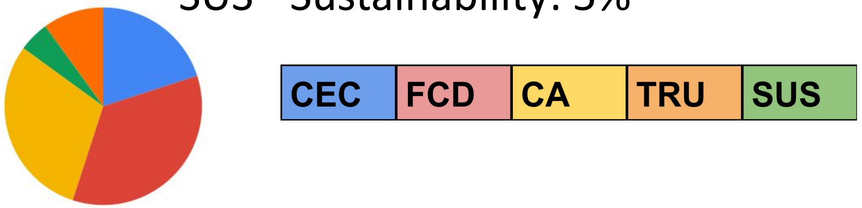
DisCoNet: Distributed Computer Networking

Objectives:

- Usage of the network not only for data forwarding but also to process functions and store data (network as a computer).
- New solutions for putting computation at convenient places in a network topology, at the edge and/or core, using traditional virtualization approaches, HW acceleration, and offloading techniques.
- Driving use case: Extended Reality Applications

Topics:

- CEC - Customized Edge Clouds: 40%
- FCD - Fluid Control & Data Planes: 15%
- CA - Cognitive Architectures: 30%
- TRU - 10 %
- SUS - Sustainability: 5%



Contributions:

- For a chosen application, experimental verification of the benefits obtained by offloading the functions to the edge and understand the role of the data plane programmability in this type of service. Use case demo specifically addressing the VR/AR/XR application.
- Inference at the edge: Inference at the edge is the capability of "feeling" a behavior and then adapting the quality of a given service, such as adaptation of images
- ML algorithms to predict behaviors: the inference can be improved by using ML algorithms so to anticipate bad situations.
- ML-optimized interactive application demo: The usage of ML inference algorithms implemented and deployed at the edge must be deeply evaluated to showcase the benefits obtained.

Research Strand

DEMIST: Distributed Edge Computing Swarm Intelligence

Objectives:

- To investigate mechanisms to manage the edge computing infrastructure, namely edge computing or fog computing, to turn it into an intelligent computing layer acting as a swarm between data producers/consumers and the cloud.
- Driving use case: Decentralized Data Management for Smart City Services (e-Health, e-Learning)

Topics:

- CEC - Customized Edge Clouds: 40%
- FCD - Fluid Control & Data Planes: 30%
- CA - Cognitive Architectures: 20%
- TRU: 5%
- SUS - Sustainability: 5%

CEC | FCD | CA | TRU | SUS

Contributions:

- New adaptive decision-making mechanisms that must allocate data collected into edge computing resources, but also auto-configure the networking and computing infrastructures to cooperate and achieve the necessary QoS for widely heterogeneous applications.
- Autonomic, intelligent swarm able to tune data collection needs, e.g. increasing or decreasing sensing frequency, and determine how edge nodes data should be combined and distributed at the edge to be able to: (i) fulfill applications quality of service; and (ii) run intelligence-based algorithms with the same quality and efficiency as in data farms.

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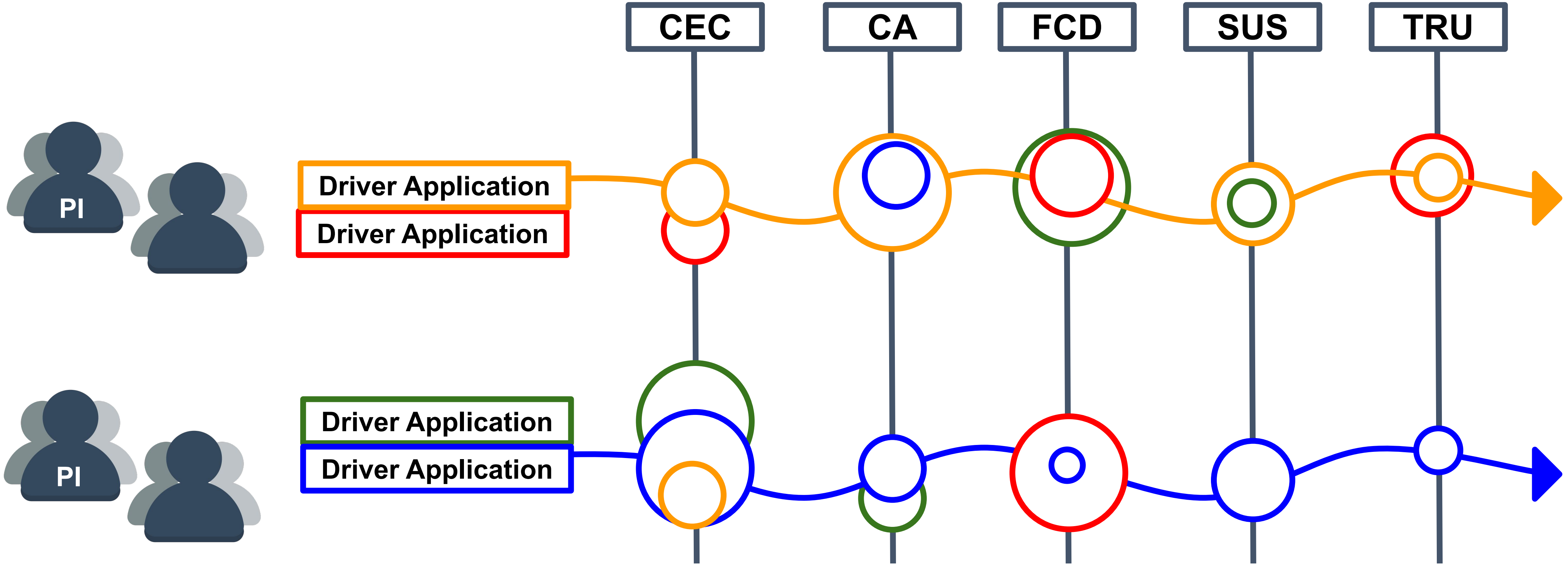
Schedule & Methodology (Years 3 to 5)



Integrated Use Case **Pilots**

Aggregation of Multidisciplinary Scientific & Technology Advancements

Research Strands vs Topics & Lifecycle