Japan’s 6G Frontier: The Future of Mobile Infrastructure

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DOCOMO Communications Laboratories Europe GmbH

MEng, Information Sys. Engineering (Imperial College London, UK)
MBA (ESADE Business School, Spain)

[Bio]

- 2004: Joined DOCOMO R&D
- 2007: Core NW Standardisation, one of the main contributors in 3GPP
- 2011-2015: GSMA Network Group SWG (LTE/VoLTE Roaming) Chair
- 2015-2017: MBA
- 2017-2021: Senior Manager, Roaming & International Services
- 2021-2023: Senior Manager, HR (People Dev and Innovation)

We Bridge.

Useful Standards

Business Growth

DOCOMO Group & NTT

Stake-holders
- MNOs
- Vendors
- Media & Events
- Vertical Industries

Organis a-tions
- 3GPP
- ETSI
- ORAN
- GSMA
- 5G-ACIA
- 5GAA
- One6G
- Academia

Busine ss Proces s
- Strategy
- R&D
- Deployment
- Operations
- BizDev

Expertise
Knowledg
Leadership
Diversity
Workplac e

Region s
- Europe
- Japan

Ideas
- Emerging Technologies
  - AI/ML
  - AIaaS
  - Automation/Intent
  - 6G
  - Computing
  - Edge
  - Cloud
  - NW APIs
  - NTN
  - A/I-IoT
  - Energy Tech
- Thought-Leadership
- Insights

Global Impacts

Innovation

Worlds Through Unified Standards

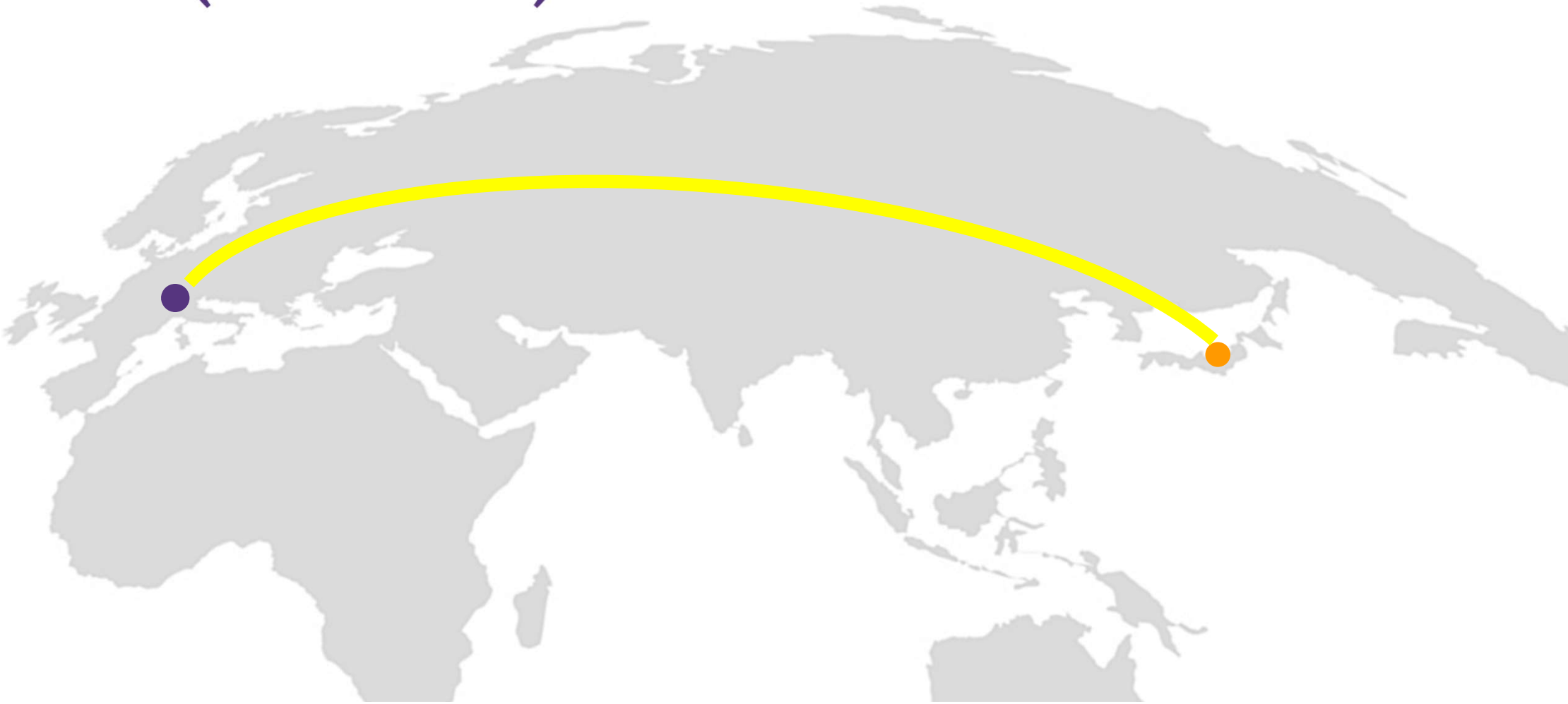
Bridging Fragmented Telecom Worlds

We need a unified direction and deployment for:

- All the people on the globe to access economical mobile services
- Customers' business to scale globally
- Telecom industry to overcome supply chain and geopolitical challenges

(one6G)

XGMF



MoU Signed on 1 Sept 2025

XGMF Activities for 6G

Takehiro Nakamura
Leader of XGMF 6G Promotion Project
Chief Standardization Officer, NTT DOCOMO, Inc.

XGMF Launched

5G Mobile Communications Promotion Forum (5GMF)

Beyond 5G Promotion Consortium (B5GPC)

Incorporated

From April 1, 2024

XG Mobile Promotion Forum (XGMF)

https://xgmf.jp/en/

Co-chair
Prof. MORIKAWA, Hiroyuki (The UNIVERSITY OF TOKYO)
Prof. NAKAO, Akihiro (The UNIVERSITY OF TOKYO)

Number of members: 193 (as of June 18, 2025)

Global Collaboration

Collaboration partners

5G ACIA

WWRF

Indonesia 5G Forum

*IMT-2020(5G) Promotion Group

5GTR Forum

NBTC

5GAA（LOI）

MTSFB

FFPA

IMT-2030(6G) Promotion Group

6G Forum

Open6G

6G Flagship

6G Platform Germany

Bharat 6G Alliance

*5G Forum

*telebrasil

TNO

Next G Alliance

*6G-IA

one6G

To be collaboration partners

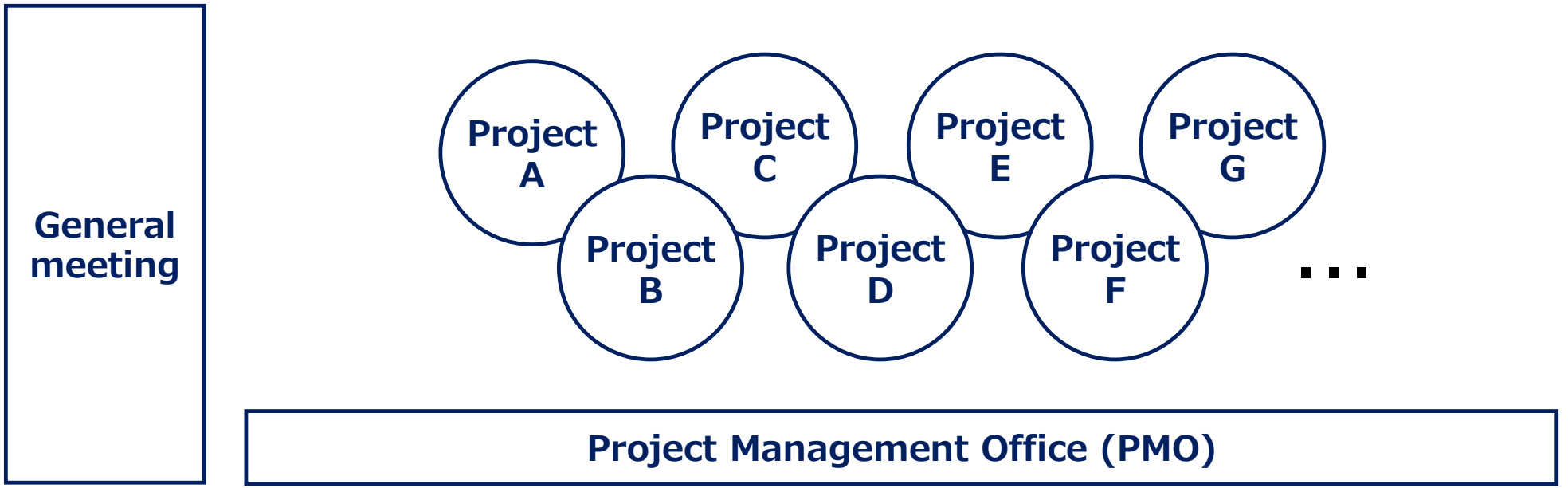
Institute for Information Industry(III)

SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

MoU : Memorandum of Understanding
LOI : Letter of Intent
＊ : ”5G Global Event” related forums

XGMF organizational structure

- **Project : Unit of activity established based on XGMF member proposals for each mission**
- **The Project Management Office (PMO) : Supports project activities and makes decisions on general Forum management matters**



★General meeting: Decision-making body for important matters (business plans, income and expenditure accounts, election of directors, etc.)

XGMF Projects

Currently 20 projects on 6G, mmWave, Local 5G, NTN, verticals, …

NTN Promotion Project
Leader: TOYOSHIMA, Morio NICT

6G Promotion PJ
Leader: NAKAMURA, Takehiro NTT DoCoMo

Planning for a city-sized large-scale living laboratory
Leader: NISHIMURA, Hiroki , NEC

Creation of 5G×OT business use cases for industry
Leader: ISHII, Takanori SOFTBANK Corp.

6G Network Architecture Project
Leader: ISOBE, Shinichi, NTT DoCoMo

6G Radio Technology Project
Leader: OHTSUKI, Tomoaki Keio University

Terahertz Wave Wireless Technology Project
Leader: HOSAKO, Iwao NICT

XG-Supply Chain Management Project
Leader: NATSUME, Shinobu Gems Co.,Ltd.

StarNet Earth
Leader: TAKAHASHI, Madoka NTT, Inc.

Agriculture × XG Project
Leader: KANO, Kayo ON BOARD Co., Ltd.

Local 5G Licensing Process Shortening Project
Leader: MASHIYAMA, Daishi NTT EAST, Inc

Space-Time Synchronization Project
Leader: IDO, Tetsuya NICT

ODAIBA IX Core
Leader: IWANAMI, Gota INFOCITY, Inc., NAKAMURA, Takehiro NTT DOCOMO

The Social Infrastructure in the Decreasing Population Era
Co-leader: NAGATA, Satoshi NTT DOCOMO, IIZUKA, Rumi Multimedia Promotion Center, HATAKAWA, Yasuyuki Deloitte Tohmatsu Consulting LLC

Project for realization of cross-industry orchestration
Leader: ISHIZU, Kentaro NICT

Project on creation of mechanisms for linking technology with social and economic value
Leader: HASEGAWA, Fumiki Mitsubishi Electric Corporation

Space × Ground Use Case Study Project
Leader: FUJIMOTO, Koichirou NEC

Local 5G testbed for smart manufacturing
Leader: SAKAMOTO, Yosuke NEC

OSHIKATSU x 5G (millimeter wave and local 5G)
Leader: YOSHII, Daijiro Murata Manufacturing Co., Ltd.

Next generation telecom issues × Material project
Leader: MIMURA, Kenichi National Institute of Advanced Industrial Science and Technology (AIST)

6G-Related Projects

NTN Promotion Project

Leader: TOYOSHIMA, Morio NICT

Subleaders: TSUDA, Yuya SOFTBANK Corp.

6G Promotion PJ

Leader: NAKAMURA, Takehiro NTT DoCoMo

Subleaders: KISHI, Yoji KDDI Research
Kashima, Tsuyoshi Ericsson Japan
SHIROTA, Masakazu Qualcomm Japan

Advisor: NAKAO, Akihiro The University of Tokyo

6G Network Architecture Project

Leader: ISOBE, Shinichi, NTT DoCoMo

Subleaders: KUWABARA, Takashi FUJITSU
TAKAHASHI, Hideaki Nokia Solutions and Network Japan

Advisor: NAKAO, Akihiro The University of Tokyo

6G Radio Technology Project

Leader: OHTSUKI, Tomoaki Keio University

Subleaders: SUYAMA, Satoshi NTT DOCOMO
KANNO, Issei KDDI Research

Terahertz Wave Wireless Technology Project

Leader: HOSAKO, Iwao NICT

Subleaders: KAWANISHI, Tetsuya Waseda University
SHOJI, Yozo NICT

Space-Time Synchronization Project

Leader: IDO, Tetsuya NICT

Subleaders: HARA, Motoya NICT
SHIGA, Nobuyasu NICT

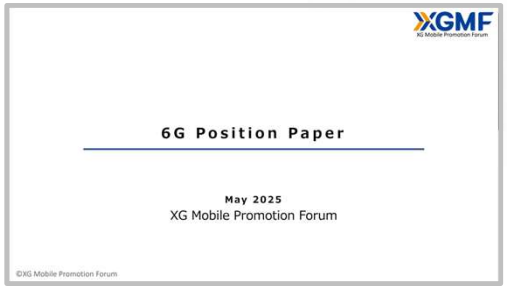
6G Promotion Project

Promotion of International Collaboration

- Global Information Exchange
- Pre-Standardization Consensus Building
- Industry-Academia Global Collaboration

Collaborate with other 6G PJs to promote 6G discussions

Coordinate and discuss topics which are related to multiple 6G PJs, e.g. AI, 6G frequencies



Developed Japan's 6G Position Paper

- Formulate and publish Japan's vision and direction for 6G

XG Mobile Promotion Forum

6G Position Paper

May 2025

XG Mobile Promotion Forum

Introduction

With the advancement of next-generation mobile networks, 6G is expected to drive new innovations and bring about transformations in society, industry, and individual lives.

This position paper aims to organize the key technical issues that need to be addressed with 6G, considering the direction of Japan's future development and anticipated societal challenges. It seeks to deepen mutual understanding among industry, academia, and government, and to broadly communicate Japan's 6G concept both domestically and internationally.

Through this effort, the goal is to promote sustainable growth and innovation, and to accelerate discussions and initiatives toward the realization of next-generation mobile networks.

The direction of Japan's future development

Here are the items considered important regarding the direction of Japan's future development, to which mobile networks can particularly contribute, and the direction of the evolution of mobile networks, along with the customer value they realize.

Direction of future development and evolution	Customer values
Advanced mobility	MaaS (Mobility as a Service), Automation of transportation infrastructure (automobiles, railways), Improvement of user communication experience while on the move
Promotion of the content industry	Advancement on the consumer side, such as AR/XR, Advancement on the production side (e.g., wireless production studios, remote editing)
Advancement of primary industries	Smart agriculture, smart fisheries, smart forestry, etc.
Development based on AI	Platforms for utilizing AI, AI-native networks, etc.

Societal challenges

On the other hand, there are also numerous societal challenges. Below are the priority areas where mobile networks are expected to contribute to their resolution, along with the customer value to be realized in addressing these challenges.

Societal challenges	Examples of customer value for problem solving
Population Decline Labor Shortage Low Productivity	Manpower saving, Remote Monitoring, Remote Control Automation, Industrial Digital Transformation
Environmental Impact of Industry, Sustainability	Industrial Optimization (e.g., through data collection and analysis) Smart Logistics, Utilization of IoT and AI
Disaster Resilience	Disaster Prevention, Disaster Mitigation （e.g., Emergency Alerts, Damage Prediction, Evacuation Information） Recovery, Resilient Infrastructure
Maintenance of Infrastructure in Depopulated Areas	Mobility and Logistics Optimization (e.g., Autonomous and Remote-Controlled Buses) Infrastructure Monitoring
Maintaining Urban Functionality in Densely Populated Cities	Enhancement of Urban Functions Sufficient Communication Capacity Traffic Congestion Mitigation Efficiency in Infrastructure Development and Maintenance
Shortage of Medical Resources, Healthcare Access Disparities	Remote Medical Consultation, Telesurgery
Aging Population (Healthy Life Expectancy)	Preventive Medicine, Health Management

Future directions/Social issues, value, and technology

XG Mobile Promotion Forum

Future directions

- Advanced mobility
- Promotion of the content industry
- Advancement of primary industries
- Development based on AI

Social issues

- Population decline, labor shortage, low productivity
- Environmental impact of industry, sustainability
- Disasters, resilience
- Infrastructure maintenance in depopulated areas
- Maintaining functionality in overcrowded cities
- Shortage of medical resources and disparity in access
- Aging population (healthy life expectancy)

Technology Value

- High speed and large capacity
- Low latency and low jitter
- Massive connectivity
- High reliability
- Mobility
- Low power consumption
- Coverage area improvement
- Resilience

Technologies

- Advanced/Distributed M-MIMO
- Air interface enhancement by AI
- Sensing
- cmW/mmW
- SubTHz
- All Photonic Network
- AI/Compute/Network Fusion
- NFV/Cloudification/SRv6
- NTN/HAPS

6G Radio Technology Project

Drive 6G innovations

- Foster development of cutting-edge radio technologies

Global outreach efforts

- Share knowledge and build international presence

Identify emerging challenges

- Detect early-stage technical and regulatory issues

Enhance academia-industry collaboration

- Strengthen ties between international industry and academic institutions

Bridge gaps between research and practical deployment

- Work closely with other 6G-related projects to unify discussions

Plan proof-of-concept trials

- Prepare and execute demonstration tests

Number of PJ members: 178 from Academia and Industries (76% from Industries)

WGs of 6G Radio Tech. Project

- Wireless Relay and Reflector Technology WG
- Radio Propagation WG
- Advanced MIMO WG
- Wireless Sensing WG
- Application of AI and Digital Twin WG
- Terminal Cooperative Technology WG
- Radio Devices WG

Download: XGMF White Paper "Beyond 5G White Paper 6G Radio Technology Project "
@ Download Center | XG Mobile Promotion Forum XGMF

NTN Promotion Project

Update roadmap

- Track and adjust plans based on global trends

Study technical issues

- Resolve barriers to NTN deployment

Clarify user needs

- Understand communication requirements for remote areas

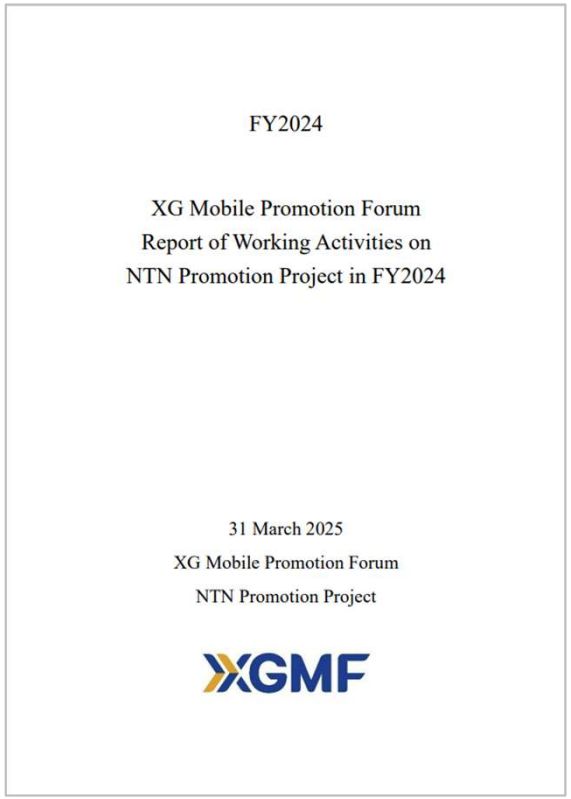
Formulate proposals

- Suggest cross-industry solutions and standards

Draw up a Grand Design

- Utilize satellites, HAPS, drones, or other aeronautical platforms.

NTN Promotion Project Materials


FY2024

XG Mobile Promotion Forum
Report of Working Activities on
NTN Promotion Project in FY2024

31 March 2025
XG Mobile Promotion Forum
NTN Promotion Project


NTN Technology Roadmap
(2024 version)

NTN Promotion Project
XG Mobile Promotion Forum
Revised in July, 2025


NTN Use Cases
(2024 version)

NTN Promotion Project
XG Mobile Promotion Forum
Revised in July, 2025

Download: NTN related materials
@ Download Center | XG Mobile Promotion Forum XGMF

6G Network Architecture Project

Study 6G use cases

- Identify future needs and analyze 5G gaps

Collaborate globally

- Build partnerships across academia, industry, and governments

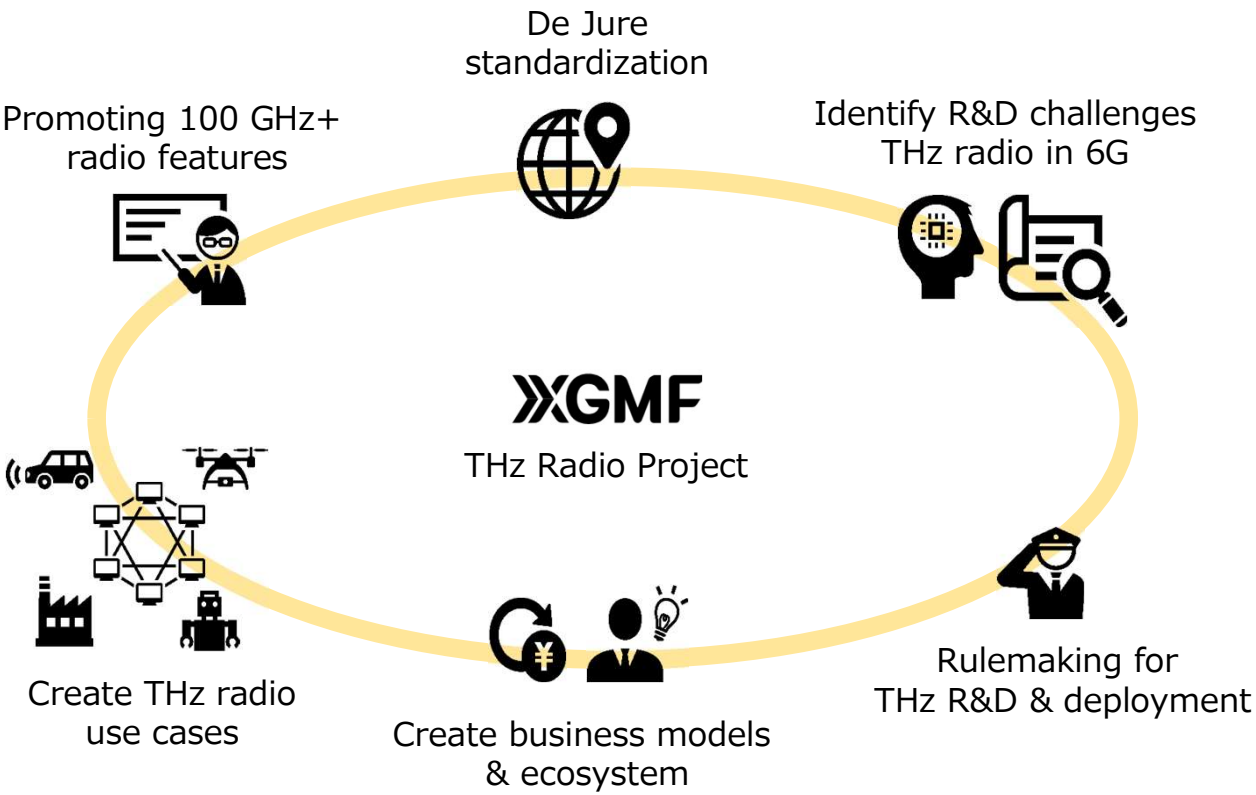
Apply APN/DCI technologies

- Share knowledge and build international presence

Participate in conferences

- Present and engage in key international events

Terahertz Radio Project



■ Positioning of the THz radio (incl. mmW)

- Important frequency resources to realize ultra-broadband & ultra-low latency communications in 6G (Day 2).
- One aspect of key technologies is device and material technology.
- Another key aspect is how to overcome and effectively utilize the characteristics of narrow beams and high propagation loss.
- To clarify requirement for THz radio, the project focused to discuss possible use cases last FY.

Space-Time Synchronization Project

Share roadmap

- Provide long-term development plans

Standardization strategy

- Build unified global specifications

Monitor global trends

- Stay informed about international progress

Create collaboration platform

- Connect technology providers with users

Thank you for your attention

We Bridge.

Useful Standards

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DOCOMO Group & NTT

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- Vertical Industries

Organis a-tions
- 3GPP
- ETSI
- ORAN
- GSMA
- 5G-ACIA
- 5GAA
- One6G
- Academia

Busine ss Proces s
- Strategy
- R&D
- Deployment
- Operations
- BizDev

Expertise
Knowledg
Leadership
Diversity
Workplac e

Region s
- Europe
- Japan

Ideas
- Emerging Technologies
  - AI/ML
  - AIaaS
  - Automation/Intent
  - 6G
  - Computing
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- Thought-Leadership
- Insights

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Innovation

Worlds Through Unified Standards

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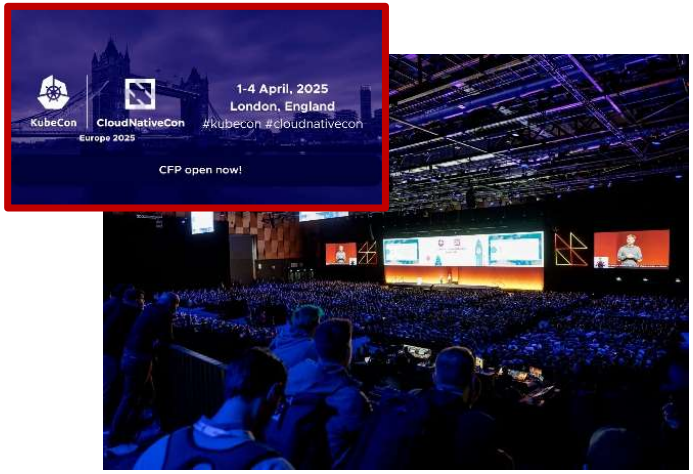
MOBILE
WORLD CONGRESS
MWC

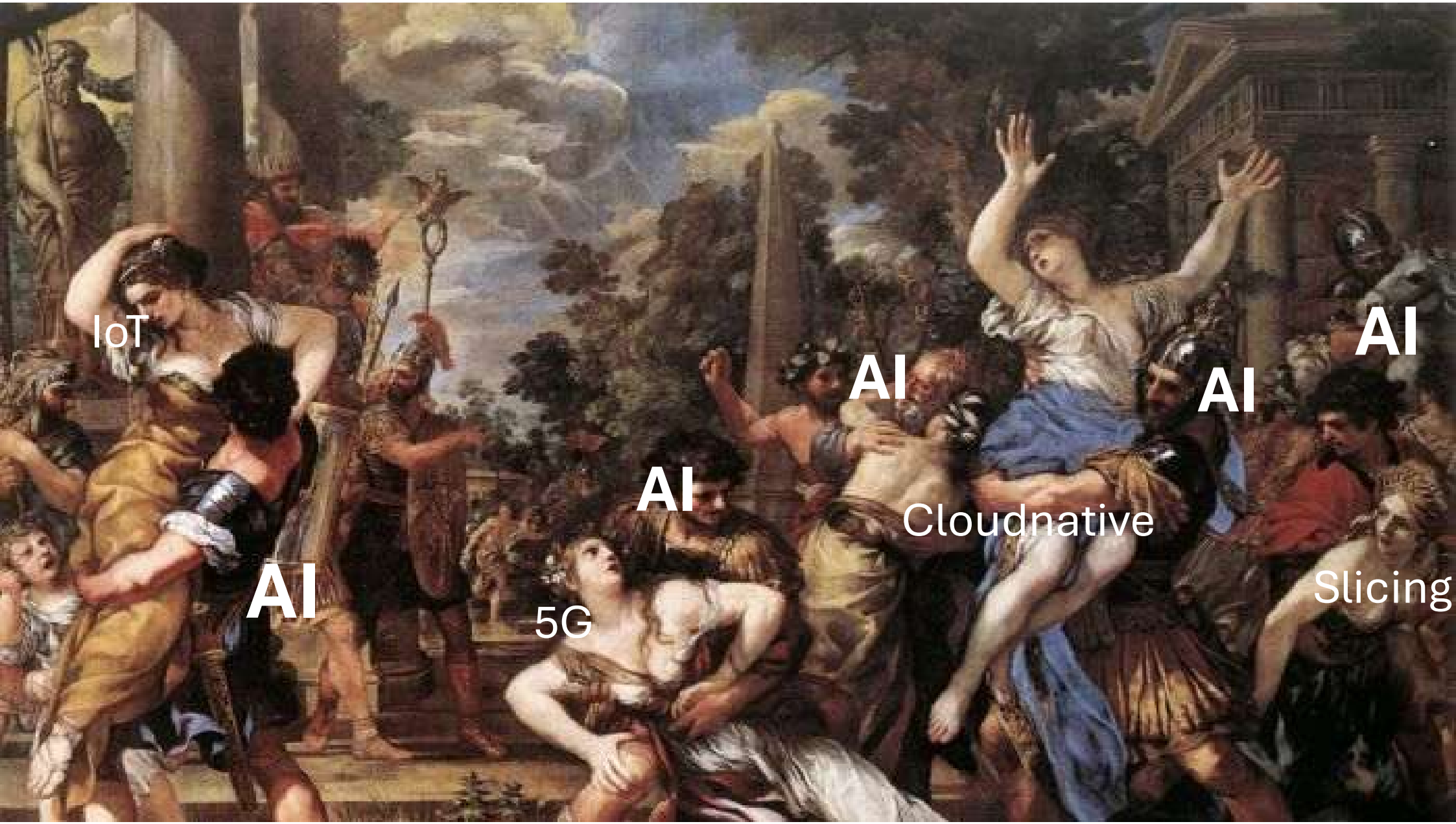

KubeCon
CloudNativeCon
Europe 2025
1-4 April, 2025
London, England
#kubecon #cloudnativecon
CFP open now!


GITEX
EUROPE
Berlin
21 – 23
MAY 2025
MESSE BERLIN

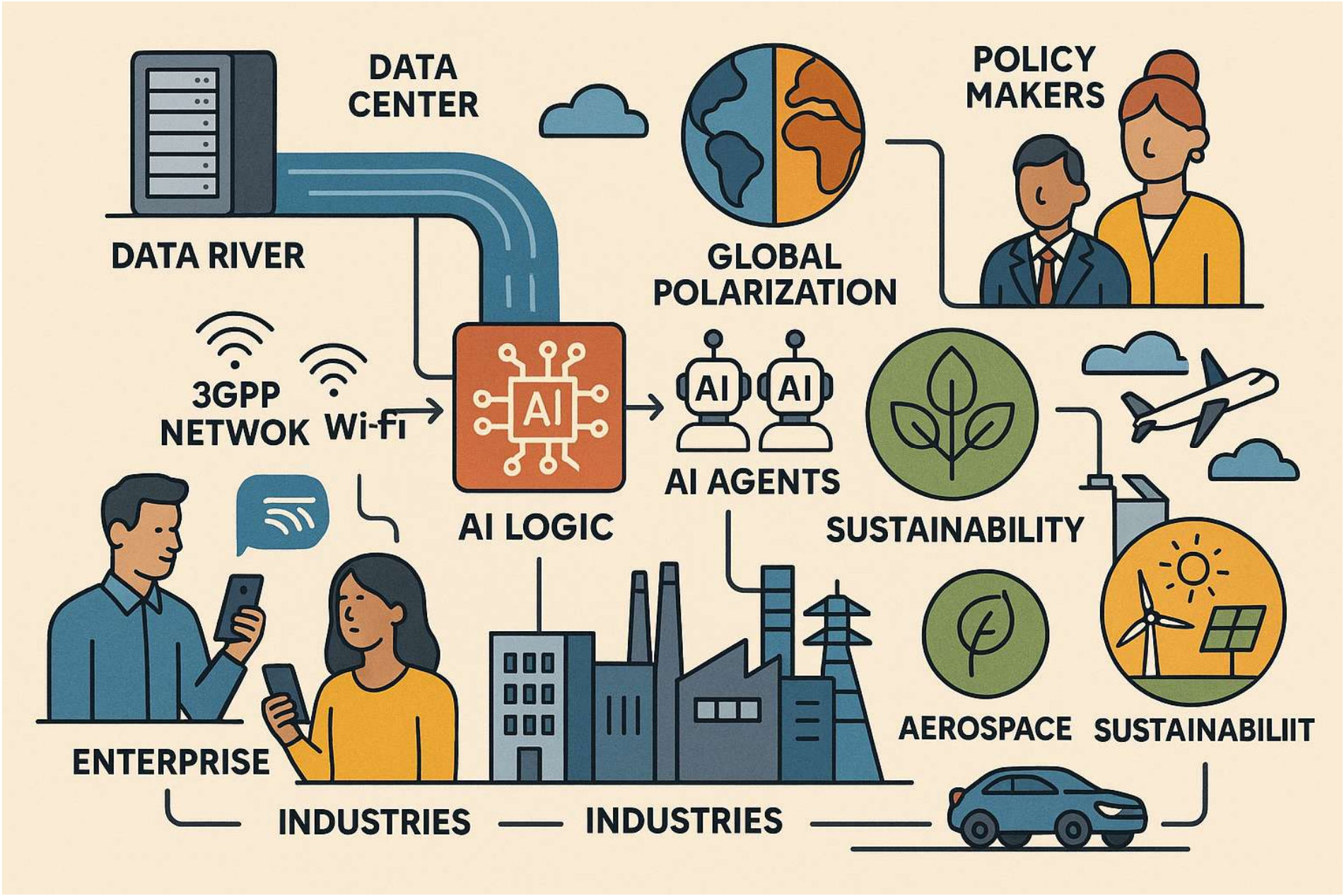

dtw
tmforum
ignite
17–19 June 2025
Copenhagen


VIVA
TECHNOLOGY
11–14 JUNE 2025 / PARIS


2025 Tech Event Word Cloud
Metaverse
6G
Edge Computing
AI
Digital Twin
Cloud Native
AR/VR
Open RAN
Zero Trust
Sustainability
Smart Infrastructure
Private 5G
Cybersecurity
NTN
LLM
Automation
Kubernetes
API Exposure
Intent-based Networking
Digital Sovereignty
Generative AI
MedTech
Robotics
5G
Cloud
Green Tech
Health Tech
Network Slicing
Quantum Computing
Autonomous Networks

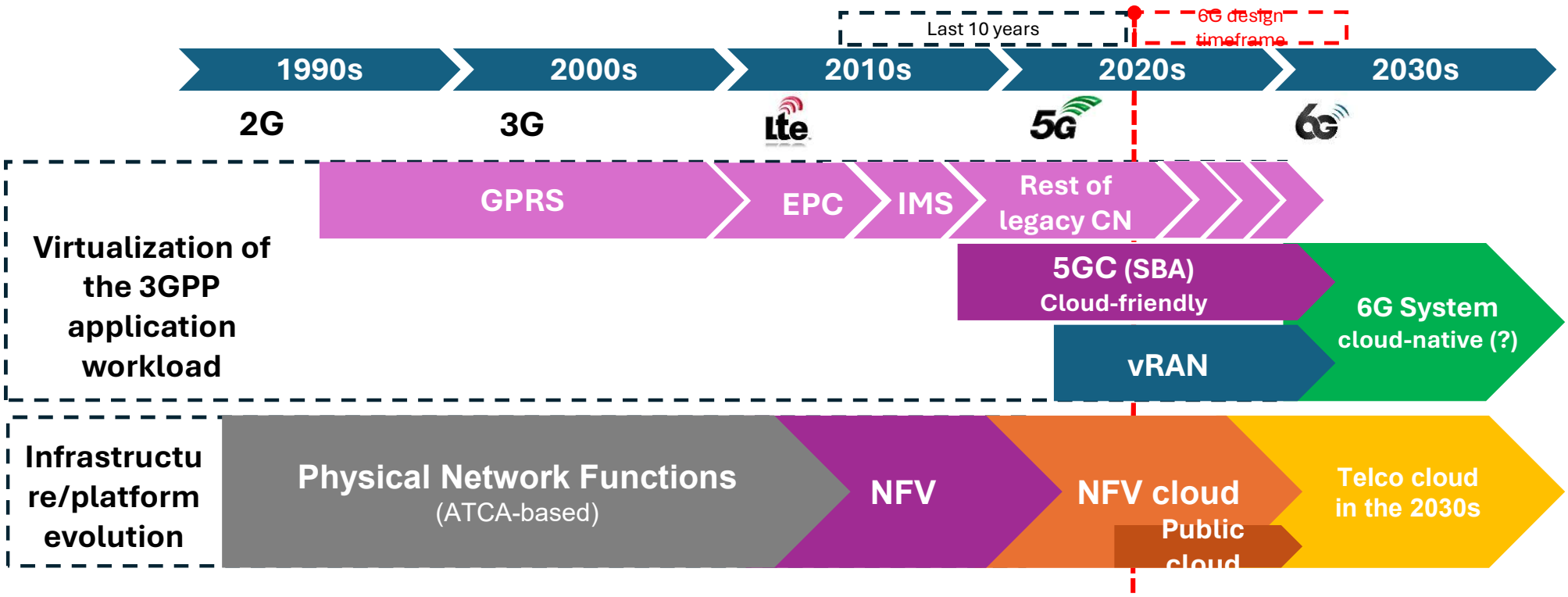

IoT
AI
AI
AI
AI
AI
Cloudnative
5G
Slicing

So, what is 6G, now?

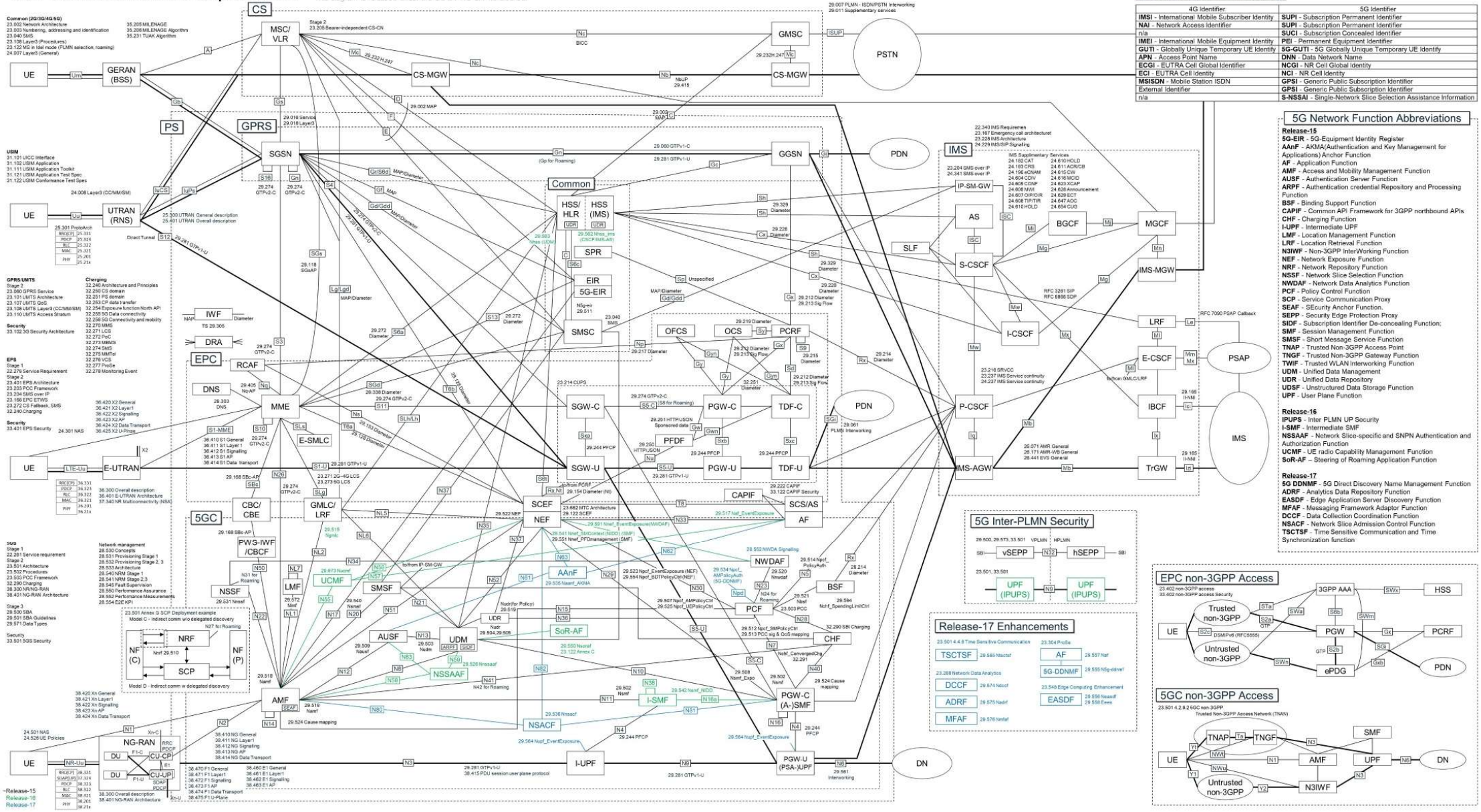

DATA CENTER
POLICY MAKERS
DATA RIVER
GLOBAL POLARIZATION
3GPP NETWOK
Wi-fi
AI
AI
AI
AI AGENTS
AI LOGIC
SUSTAINABILITY
AEROSPACE
SUSTAINABILIIT
ENTERPRISE
INDUSTRIES
INDUSTRIES

Mobile network infrastructure evolution

= Incremental Evolution



3GPP Overall Architecture and Specifications



4G and 5G Identifier mapping

4G Identifier	5G Identifier
IMSI - International Mobile Subscriber Identity	**SUPI** - Subscription Permanent Identifier
NAI - Network Access Identifier	**SUPI** - Subscription Permanent Identifier
n/a	**SUCI** - Subscription Concealed Identifier
IMEI - International Mobile Equipment Identity	**PEI** - Permanent Equipment Identifier
GUTI - Globally Unique Temporary UE Identify	**5G-GUTI** - 5G Globally Unique Temporary UE Identify
APN - Access Point Name	**DNN** - Data Network Name
ECGI - EUTRA Cell Global Identifier	**NCGI** - NR Cell Global Identity
ECI - EUTRA Cell Identity	**NCI** - NR Cell Identity
MSISDN - Mobile Station ISDN	**GPSI** - Generic Public Subscription Identifier
External Identifier	**GPSI** - Generic Public Subscription Identifier
n/a	**S-NSSAI** - Single-Network Slice Selection Assistance Information

5G Network Function Abbreviations

Release-15

5G-EIR - 5G-Equipment Identity Register
AAnF - AKMA(Authentication and Key Management for Applications) Anchor Function
AF - Application Function
AMF - Access and Mobility Management Function
AUSF - Authentication Server Function
ARPF - Authentication credential Repository and Processing Function
BSF - Binding Support Function
CAPIF - Common API Framework for 3GPP northbound APIs
CHF - Charging Function
I-UPF - Intermediate UPF
LMF - Location Management Function
LRF - Location Retrieval Function
N3IWF - Non-3GPP InterWorking Function
NEF - Network Exposure Function
NRF - Network Repository Function
NSSF - Network Slice Selection Function
NWDAF - Network Data Analytics Function
PCF - Policy Control Function
SCP - Service Communication Proxy
SEAF - SEcurity Anchor Function.
SEPP - Security Edge Protection Proxy
SIDF - Subscription Identifier De-concealing Function;
SMF - Session Management Function
SMSF - Short Message Service Function
TNAP - Trusted Non-3GPP Access Point
TNGF - Trusted Non-3GPP Gateway Function
TWIF - Trusted WLAN Interworking Function
UDM - Unified Data Management
UDR - Unified Data Repository
UDSF - Unstructured Data Storage Function
UPF - User Plane Function

Release-16

IPUPS - Inter PLMN UP Security
I-SMF - Intermediate SMF
NSSAAF - Network Slice-specific and SNPN Authentication and Authorization Function
UCMF - UE radio Capability Management Function
SoR-AF – Steering of Roaming Application Function

Release-17

5G DDNMF - 5G Direct Discovery Name Management Function
ADRF - Analytics Data Repository Function
EASDF - Edge Application Server Discovery Function
MFAF - Messaging Framework Adaptor Function
DCCF - Data Collection Coordination Function
NSACF - Network Slice Admission Control Function
TSCTSF - Time Sensitive Communication and Time Synchronization function

5G Inter-PLMN Security

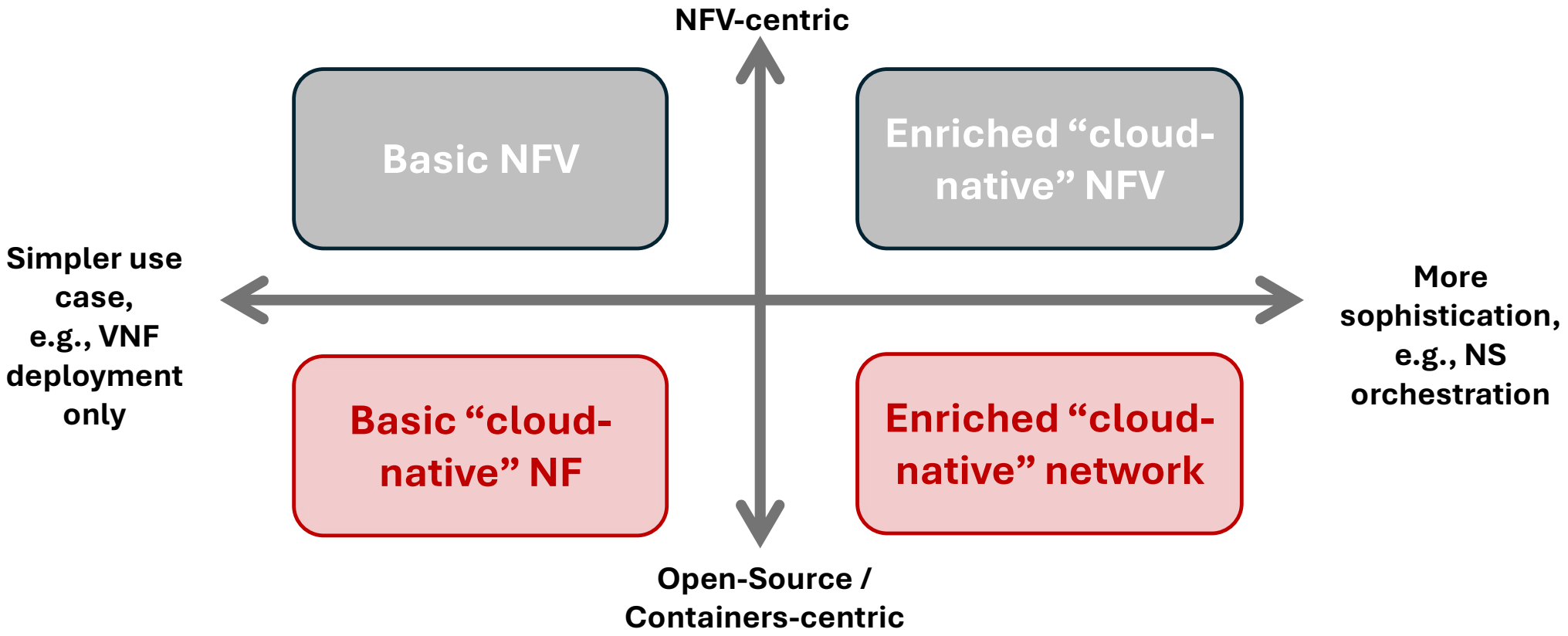
Release-17 Enhancements

EPC non-3GPP Access

5GC non-3GPP Access

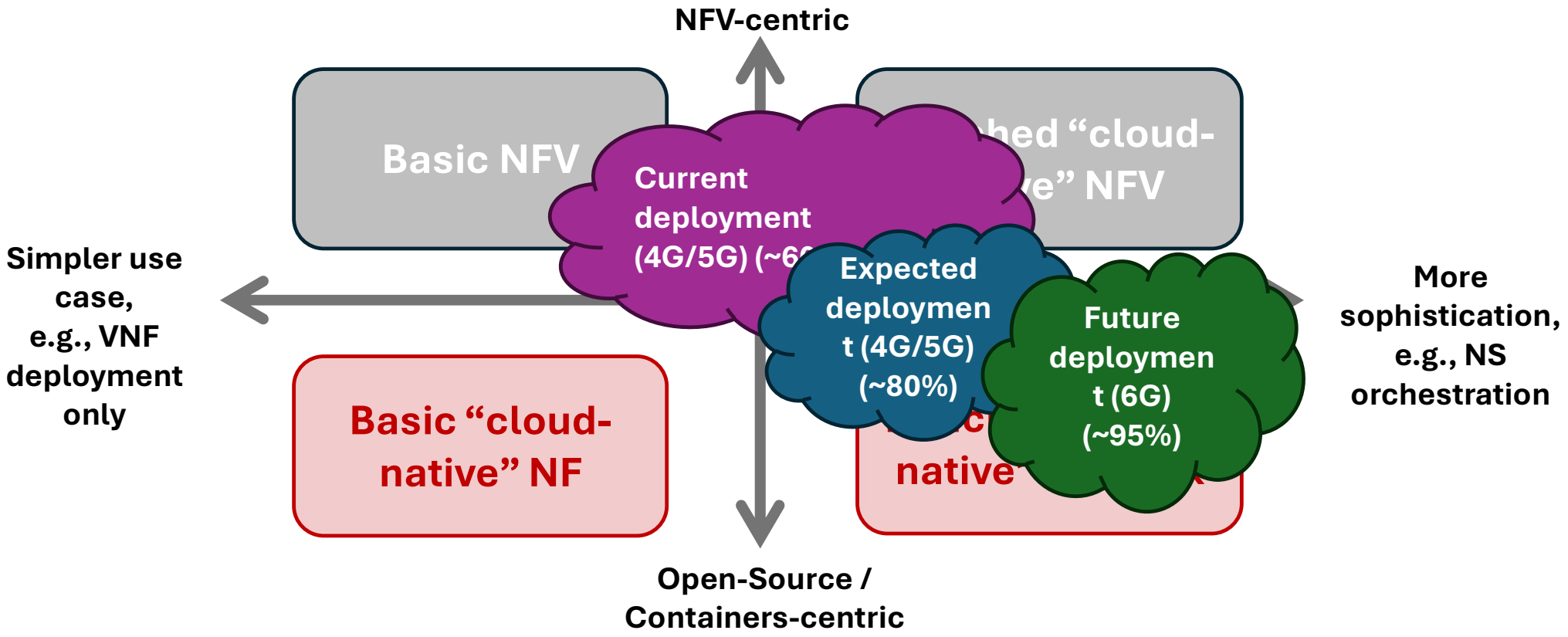
Evolutionary Paths of Network

Rather **Darwinian** evolution



Evolutionary Paths of Network

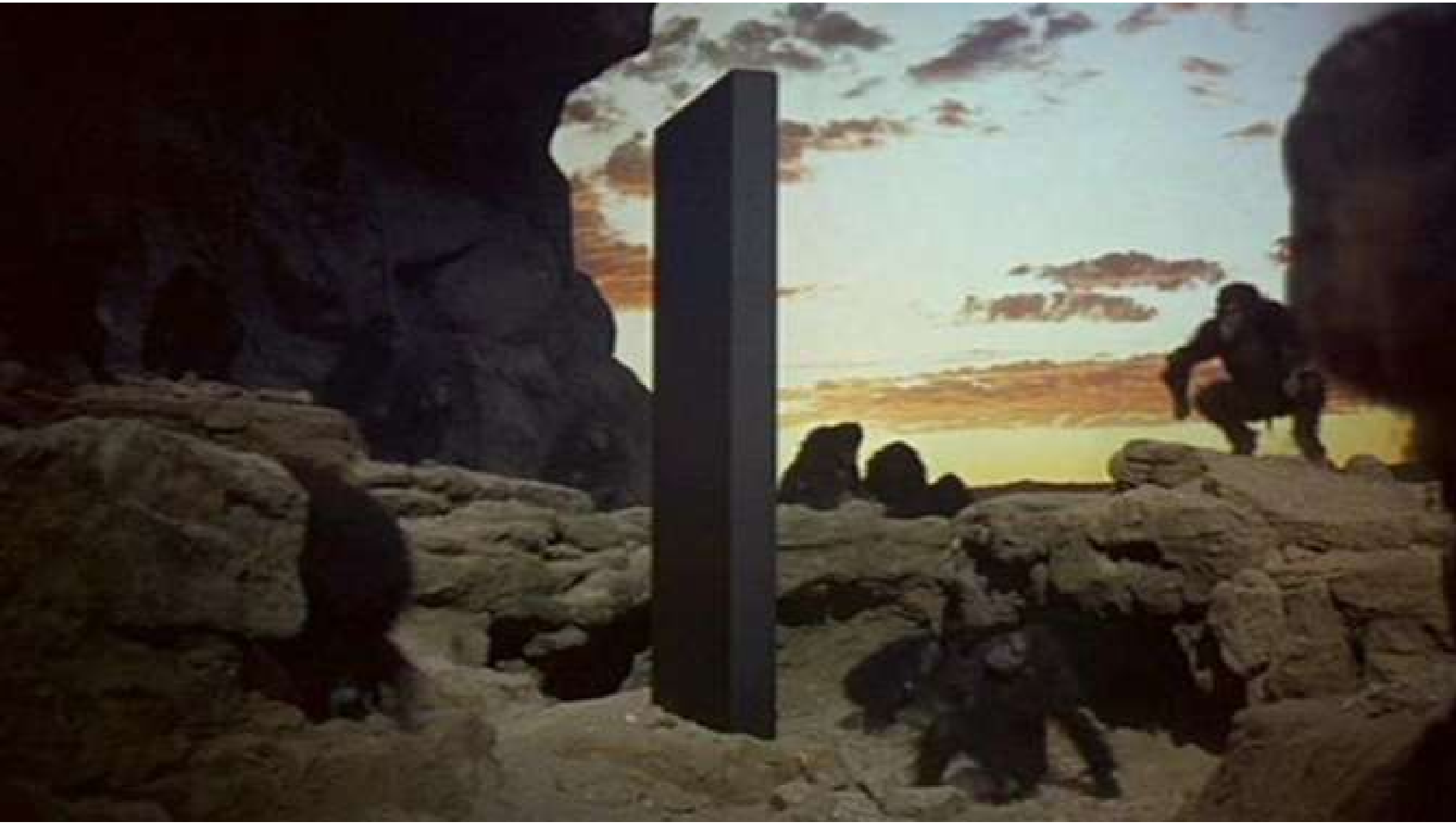
Rather **Darwinian** evolution



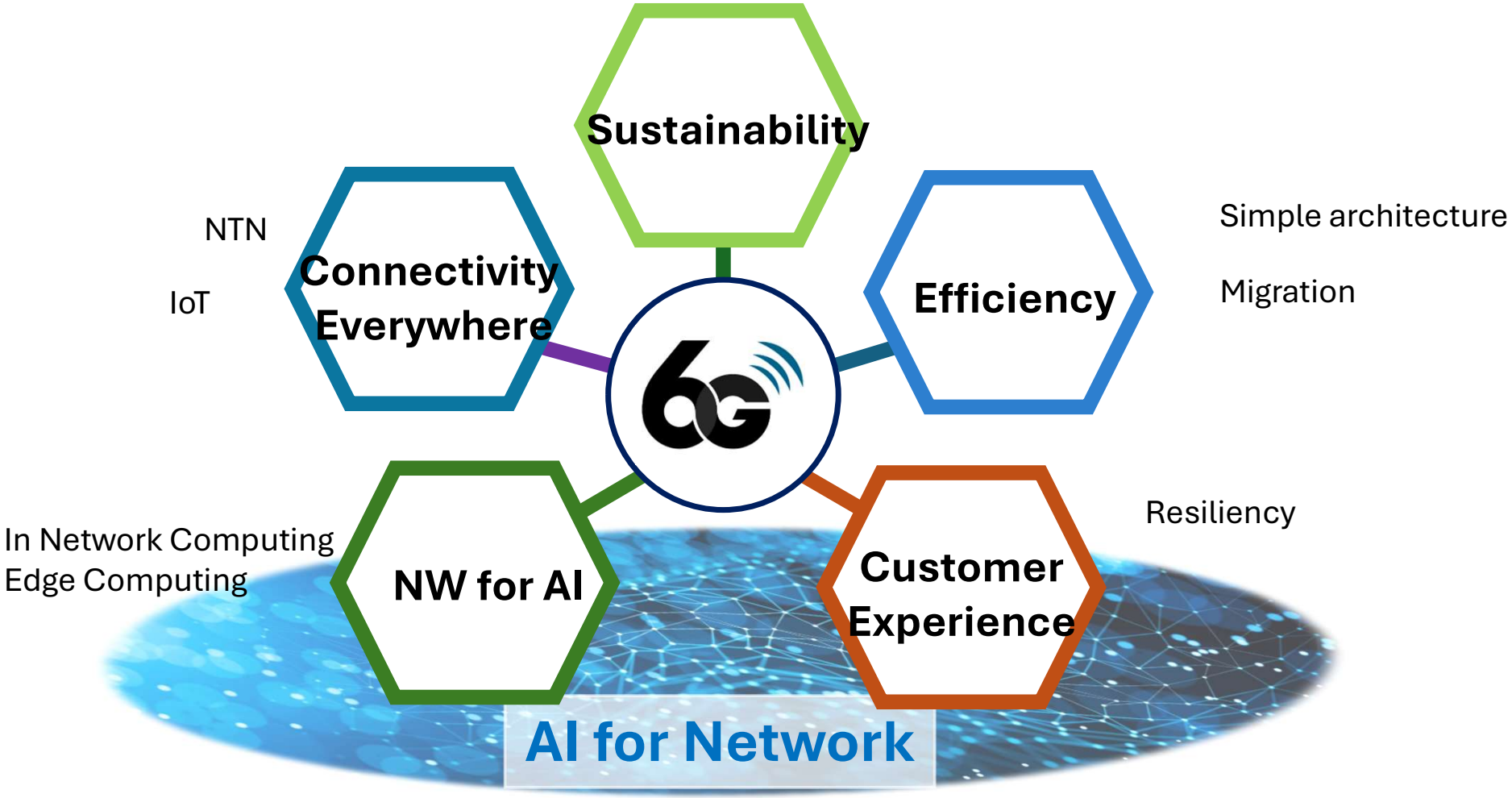
But change doesn't always follow the paths we expect

What new questions can we be asking about 6G

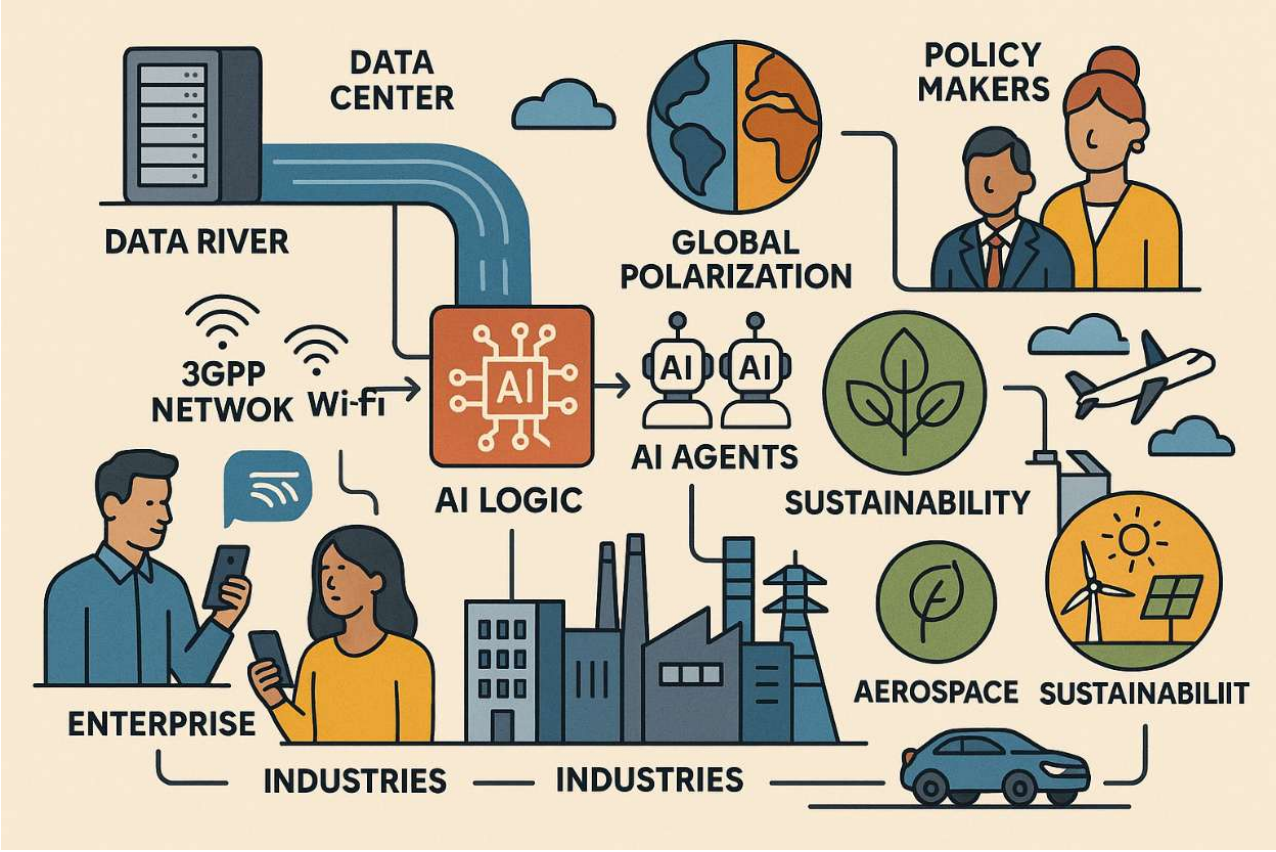
to ensure we're prepared not only to respond —but to **lead in a world of unexpected disruption?**



The value of 6G still stands, but…



Need Industry-Level / Ecosystem Grand-Design Here!



How can we be successful TOGETHER

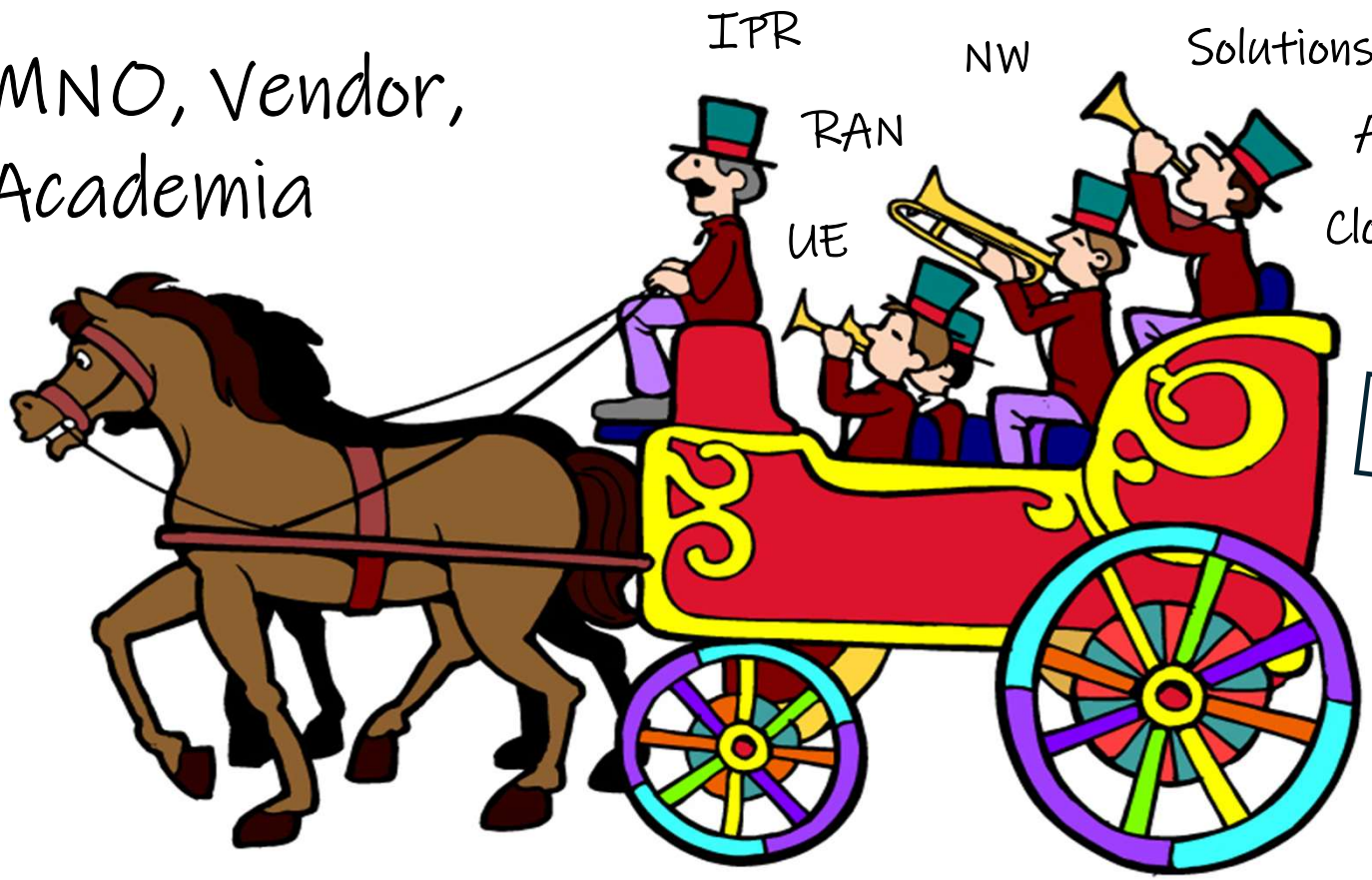
Business Model
Ecosystem
Regulations & Policy Making
3GPP
Non-3GPP (WiFi, Fixed)


“The best way to predict the future is to invent it”
— Alan Kay

If you want to go fast, go alone.

If you want to go far, go together.

MNO, Vendor, Academia



Industries

Lessons from 5G

Customer Insights