WHAT WILL 6G BRING US?

A TNO VISION ON THE NEXT GENERATION | TOON NORP

20 October 2022

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EACH GENERATION MORE DATA BUT LESS MOBILITY

1G

2G

3G

4G

5G

6G

WHAT DOES G MEANS? WHO DEFINES THEM?

› The 'G' is an abbreviation of 'generation', and they are proposed and defined by the ITU.

› The **International Telecommunication Union (ITU)** is an agency of the United Nations (UN) responsible for global issues of telecommunication technologies. Based in Geneva, Switzerland

› ITU cycle – every ten year define a new generation, starting with **vision statements**.

› ITU coordinates the global use of the **radio spectrum**, and defines **requirements** for next-generation mobile communication technologies. These requirements may include minimum data rates, coverage, reliability, etc.

› **IMT-2000 (**Year of release: 2000) Defines "3G"

› **IMT-Advanced (**Year of release: 2012) Defines "4G"

› **IMT-2020 (**Year of release: 2020) Defines "5G"

6G SERVICES IN THE CONTEXT OF A DIGITAL SOCIETY
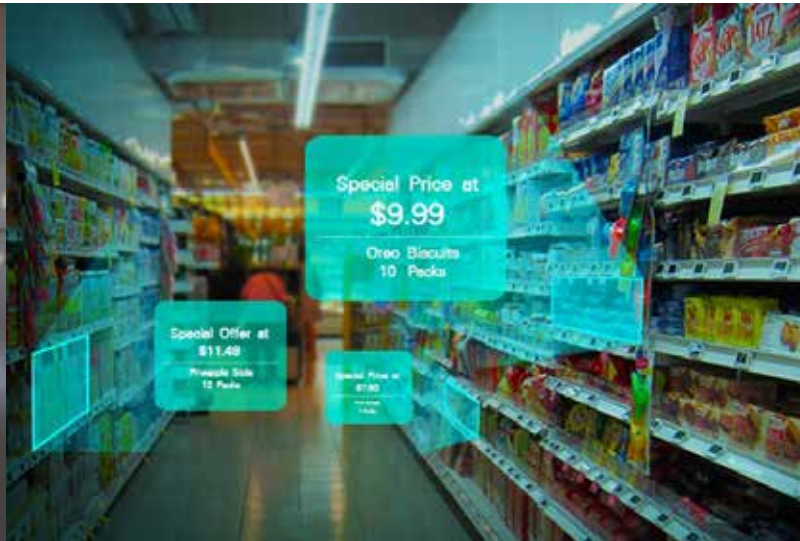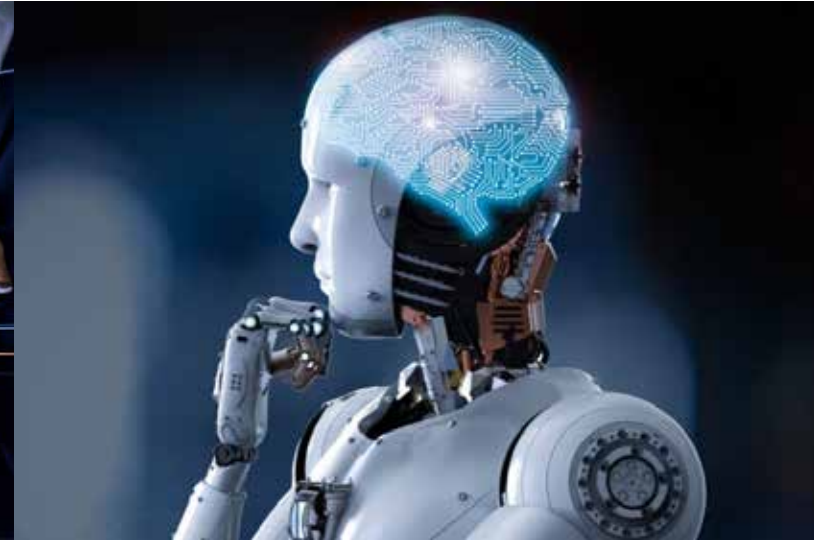
CONNECTED INTELLIGENCE

› Immersive communication, cognition and twinning, imply virtual representations in the digital world of entities in the physical and human world

› Virtual representations are used by AI-applications

› Connections between virtual representations and AI-applications replace connections between mobile end-devices

Digital World

Connected Intelligence

Twinning Control

Immersive communication Cognition

6G

Physical World   **Human World**

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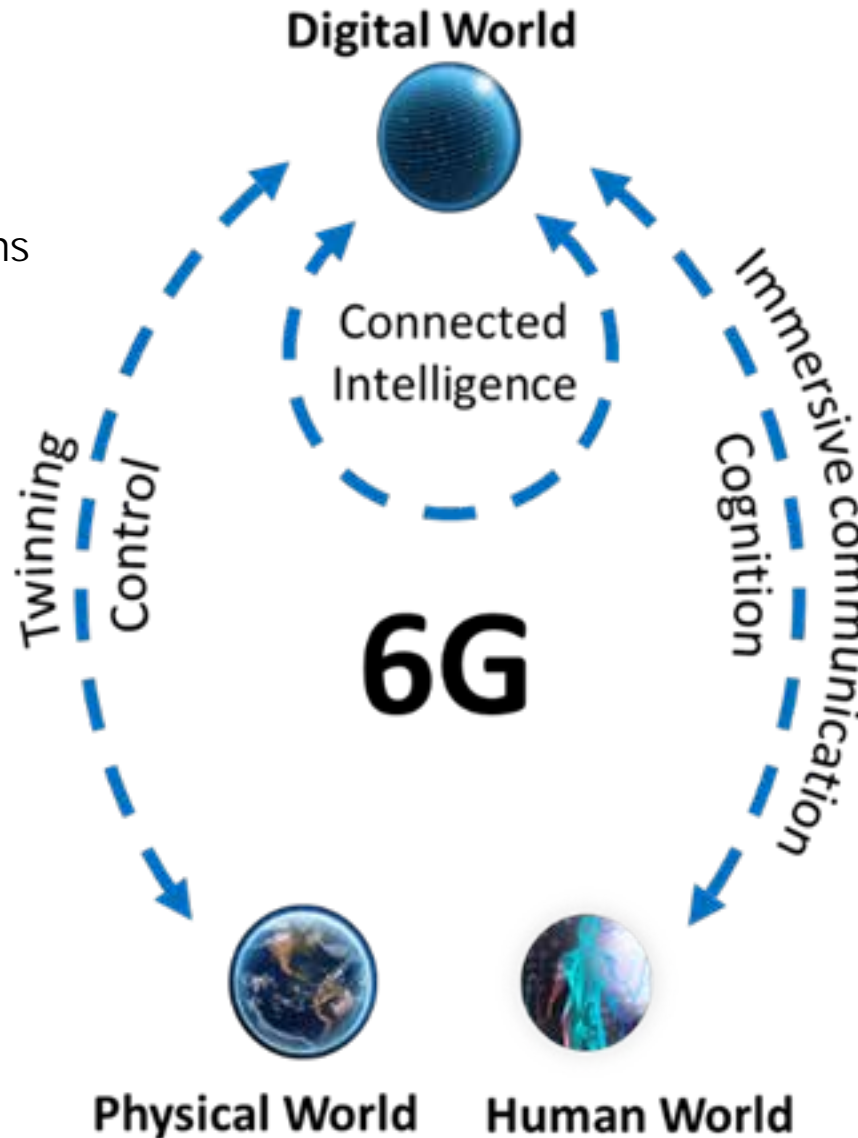
THRUSTWORTHY SOCIETY DEPENDS ON 6G

› Privacy

› 6G needs to protect your data and location

› Availability

› 6G needs to work always

› 6G needs to work everywhere

› Robust and secure

› Protection from cyber attacks

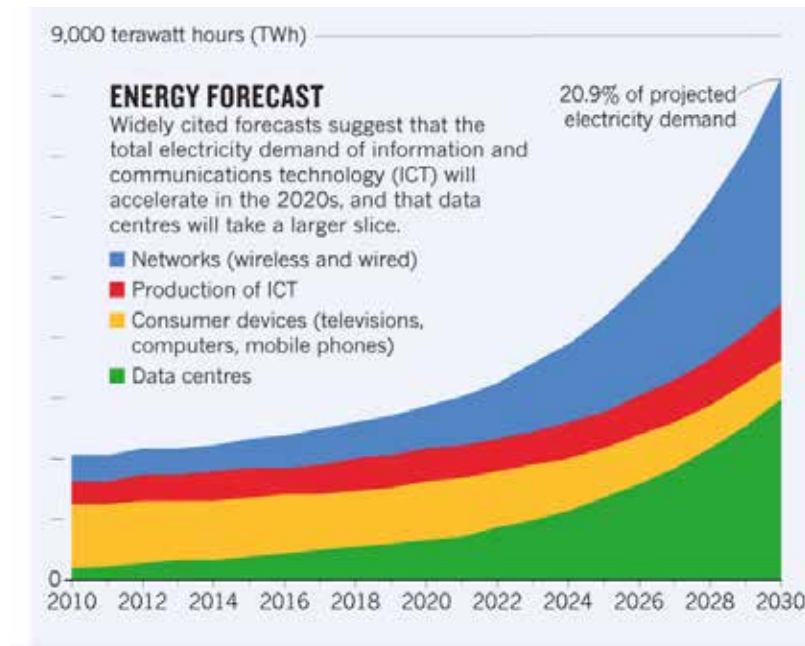› Resilience against disasters

› Societal values

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STRETCHING 5G KPIS

› More devices, more data, and higher data rates imply an increase of overall data traffic and required capacity

› Services like immersive communication and tactile internet require lower latency and higher data rates

› Better location accuracy needed for e.g. augmented reality
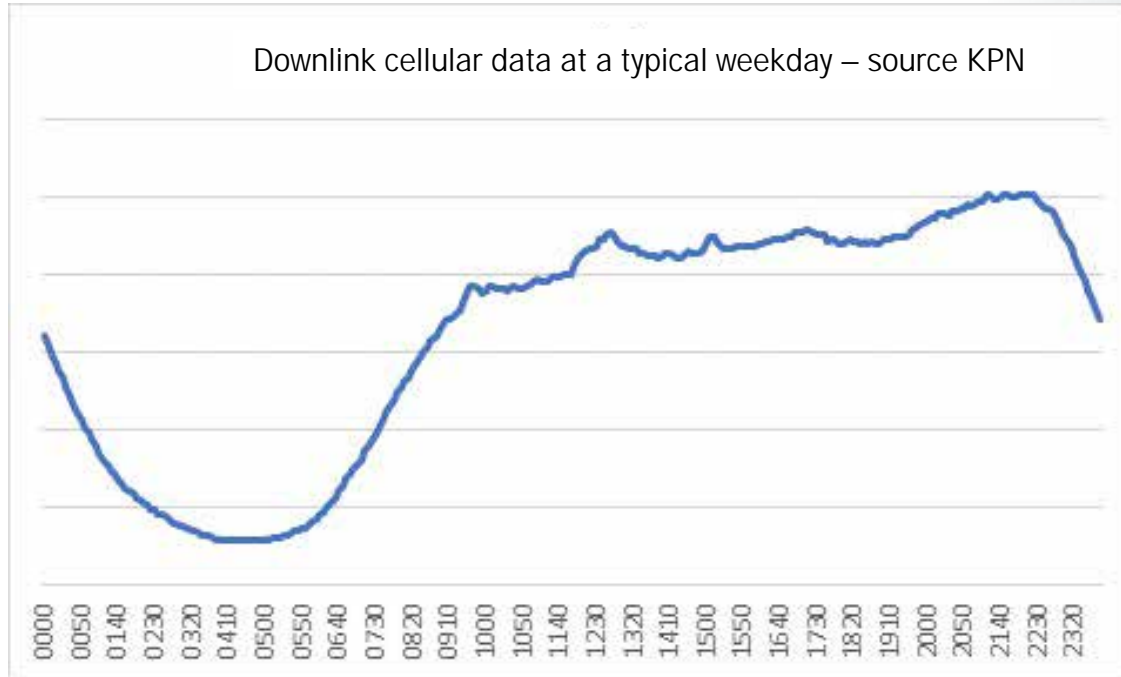
› And all at economically sustainable cost levels
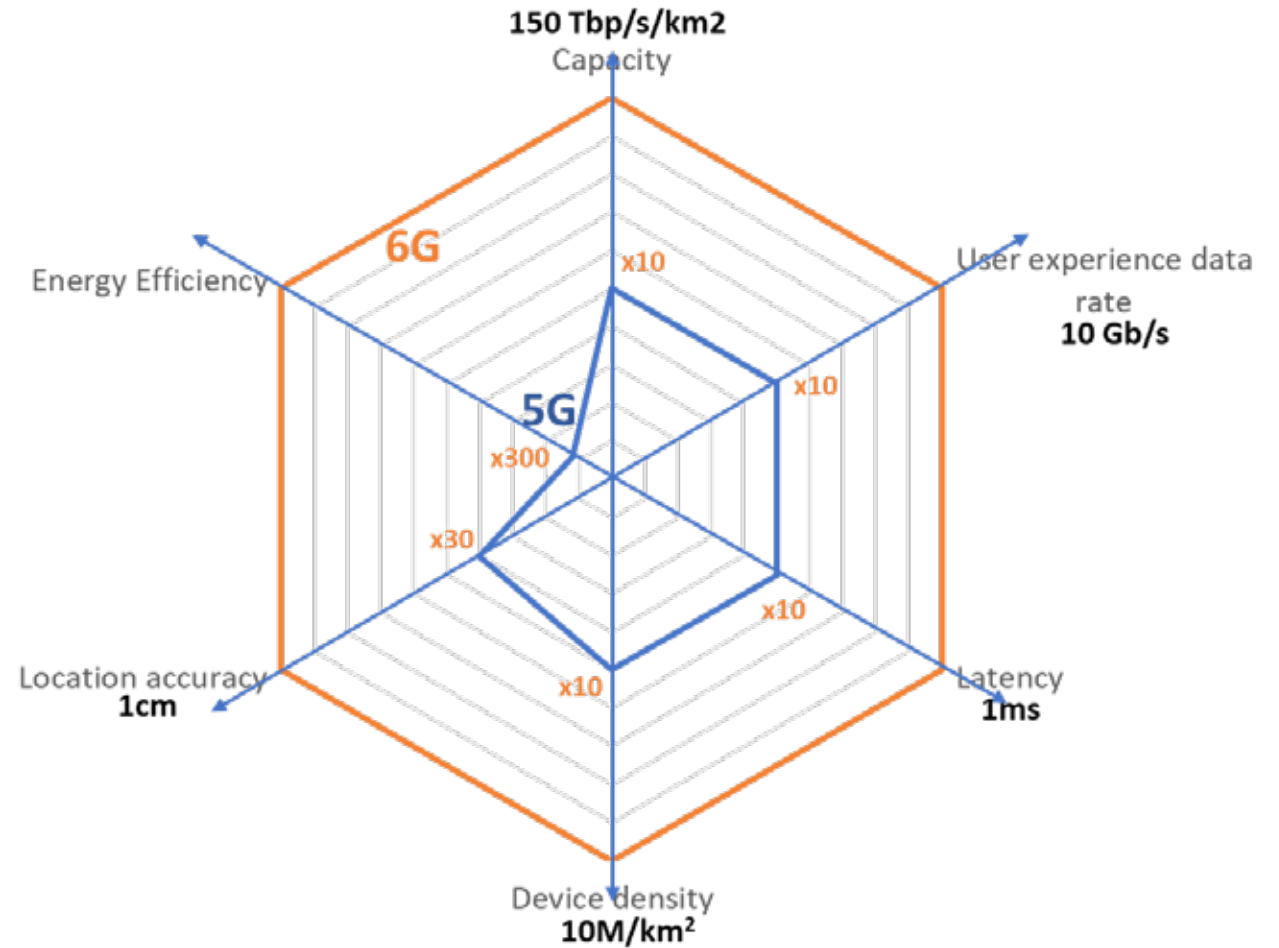
SUSTAINABILITY

› Amount of mobile data is growing at 100-1000x per generation

  › If energy consumption grows with the same rate, this quickly becomes unsustainable

› On the other hand digitization can also help to save energy in other sectors

› Sustainability not only relates to energy consumption
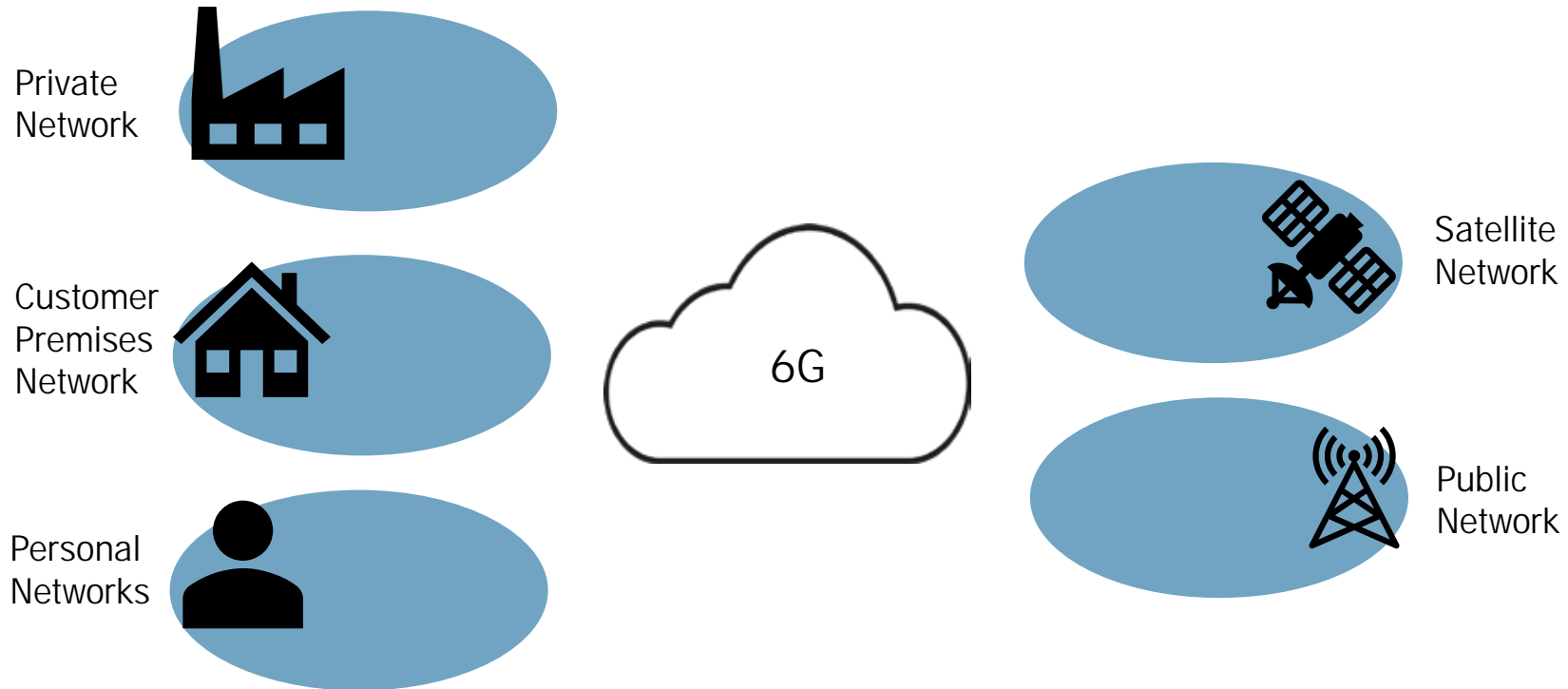
  › Electronic waste

  › Battery materials

9,000 terawatt hours (TWh)

ENERGY FORECAST
Widely cited forecasts suggest that the total electricity demand of information and communications technology (ICT) will accelerate in the 2020s, and that data centres will take a larger slice.

20.9% of projected electricity demand

- ■ Networks (wireless and wired)
- ■ Production of ICT
- ■ Consumer devices (televisions, computers, mobile phones)
- ■ Data centres

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2010 2012 2014 2016 2018 2020 2022 2024 2026 2028 2030

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INDOOR

Downlink cellular data at a typical weekday – source KPN

› Looking at the daily mobile data usage pattern, we see that the peak of mobile data usage is around 11pm. That is when most users are at home!

› 6G will have to be able to provide high capacity indoors

NETWORK OF NETWORKS

Private Network

Customer Premises Network

Personal Networks

6G

Satellite Network

Public Network

MAIN TECHNOLOGY ELEMENTS IN 6G

THz Radio

Cloud

AI

Semiconductors

THZ RADIO TECHNOLOGY

> 6G networks need to handle more data

> > Higher data rates

> > More capacity

> Key enabling technologies for 6G air interface design, e.g.:

> > THz communication

> > Smart antennas and beam forming

> > Enhanced coding and modulation

> > Integrated positioning, sensing and communication

> Higher frequencies

> > Smaller antennas

> > Indoor coverage will be a challenge

CLOUD BASED NETWORKING

› Continuum from device, radio access, edge, core to cloud

› Automatic resource control and orchestration of applications and network functions

› Trade-off between flexibility and performance

› Continuous development and operations

# ARTIFICIAL INTELLIGENCE

› Applications are based on artificial intelligence (AI) and machine learning (ML)

› AI/ML processing and communication distributed over devices, edge and cloud

› AI/ML will be needed for operation cost-effectiveness.

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SEMICONDUCTORS

› Semiconductors already play an important role for mobile devices, now they will also play a more important role in the network

› RF challenges: integrated circuit smart antennas, power efficiency and heat dissipation, high frequencies

› Optical domain challenges: Monolithic integration, photonic devices, new on-chip components.

› Bridge the gap between high-efficiency and high-flexibility programming devices.
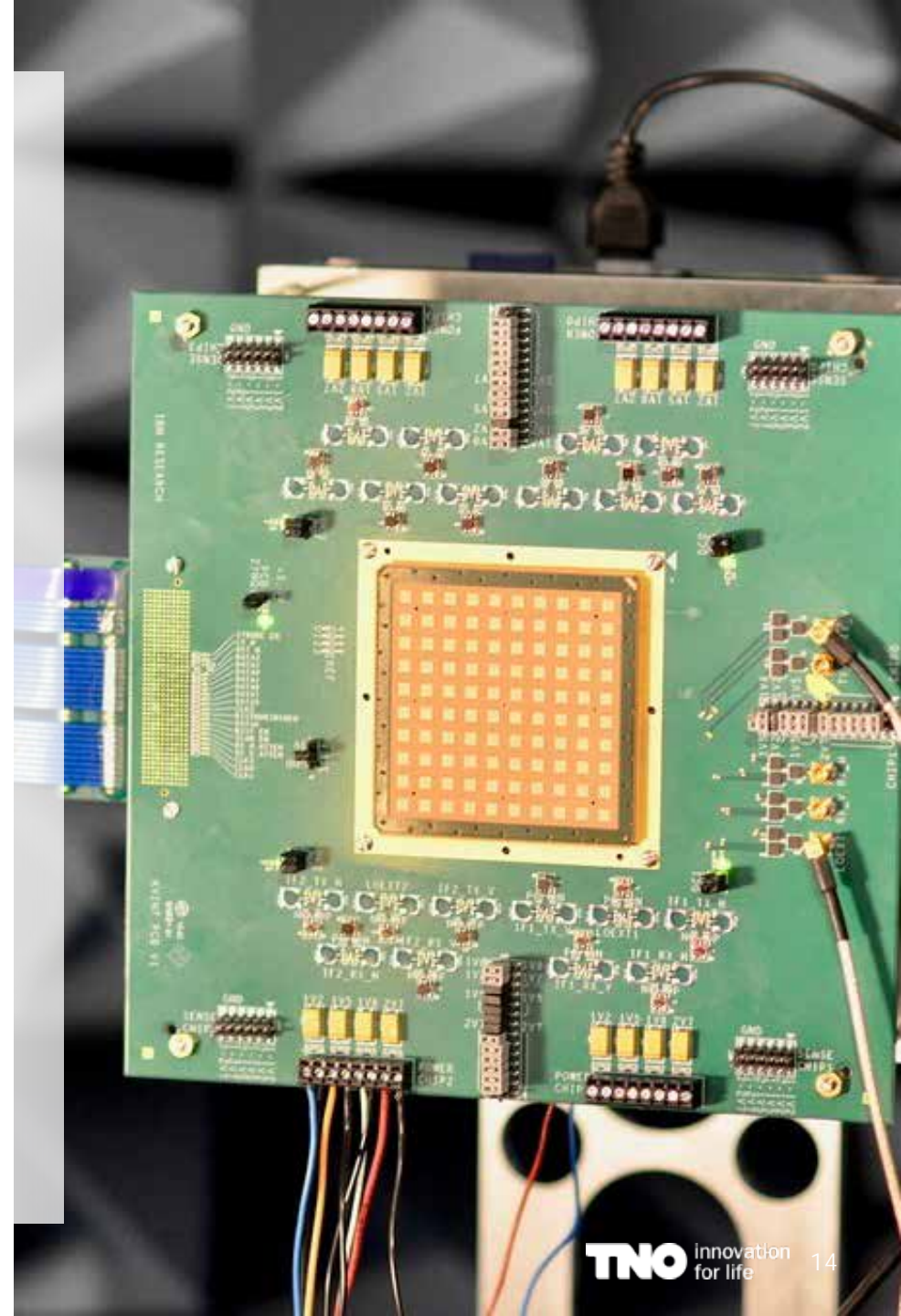
6G STANDARDISATION

› We expect 3GPP to start on 6G in around 2024

  › Specification will likely take two Releases; a first Release with studies only followed by a Release with studies and normative work

  › Each release starts with requirements, followed by architecture and radio architectural aspects
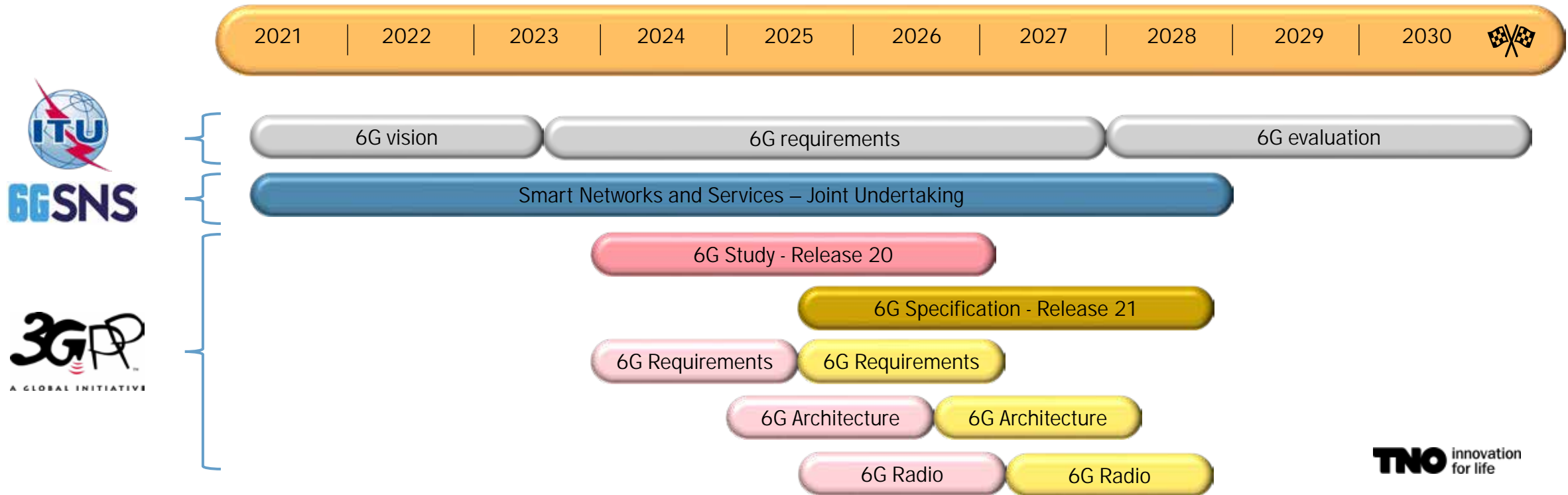
WHY SHOULD WE GET INVOLVED IN 6G?

› National sovereignty of digital infrastructure

  › Critical infrastructure needs to be trustworthy

  › Supply chain security

› EU/NL social values

  › We have different ideas on privacy

  › We have different ideas on what AI should and should not do

› Building / maintaining local knowledge

  › Number of people in The Netherlands with networking knowledge is reducing

  › Without local experts and technical staff there is no national sovereignty

› Opportunities for Dutch semiconductor industry

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FUTURE NETWORK SERVICES: BUILDING A STRATEGIC POSITION FOR THE DEVELOPMENT AND APPLICATION OF 6G NETWORKS
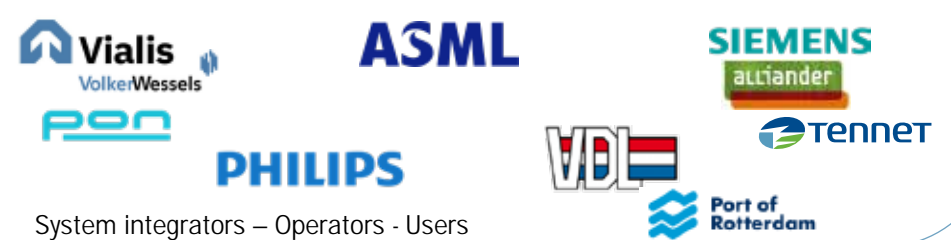
*By becoming a leader in the development of intelligent components and networks,
and their application in the most important sectors of the Dutch economy,
the future earning capacity of BV Nederland will be strengthened.*

Deadline for proposal 180 ME growth fund 3 Februari 2023

THANK YOU FOR
YOUR TIME

5G-IA whitepaper: European Vision for the 6G Network Ecosystem
https://5g-ppp.eu/wp-content/uploads/2021/06/WhitePaper-6G-Europe.pdf

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