DETERMINISTIC6G

Stream B: Technology highlights on KPIs and KVIs

Stream D / Stream B Joint Workshop on KPIs and KVIs

May 2024

DETERMINISTIC6G objectives

The DETERMINISTIC6G objective is to develop a **new architecture optimizing deterministic** E2E communication with 6G to enable innovative use cases

☐ The three pillars of DETERMINISTIC6G:

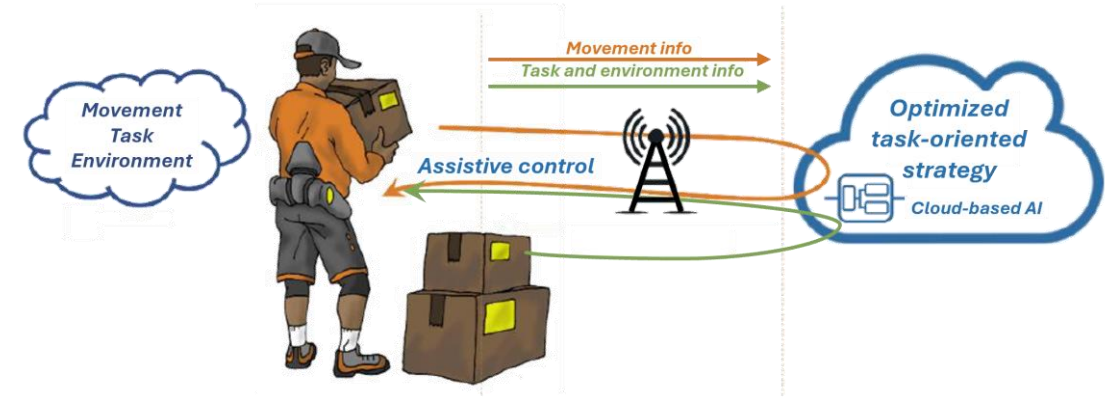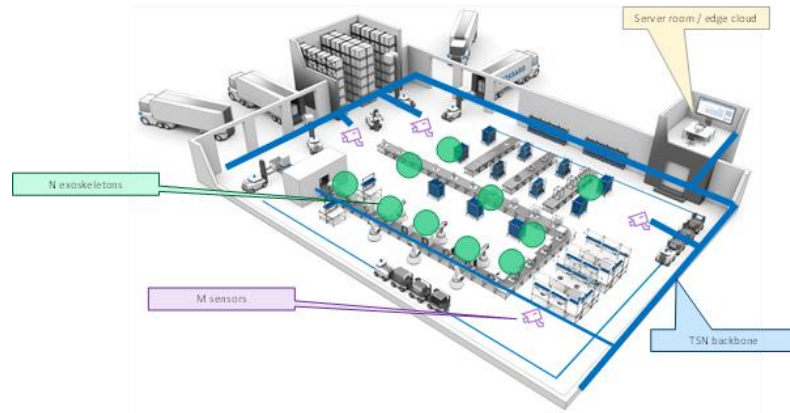Architectural aspects for E2E deterministic communication

Awareness for providing E2E deterministic communication performance

Anticipation for assurance and control of E2E deterministic performance guarantees
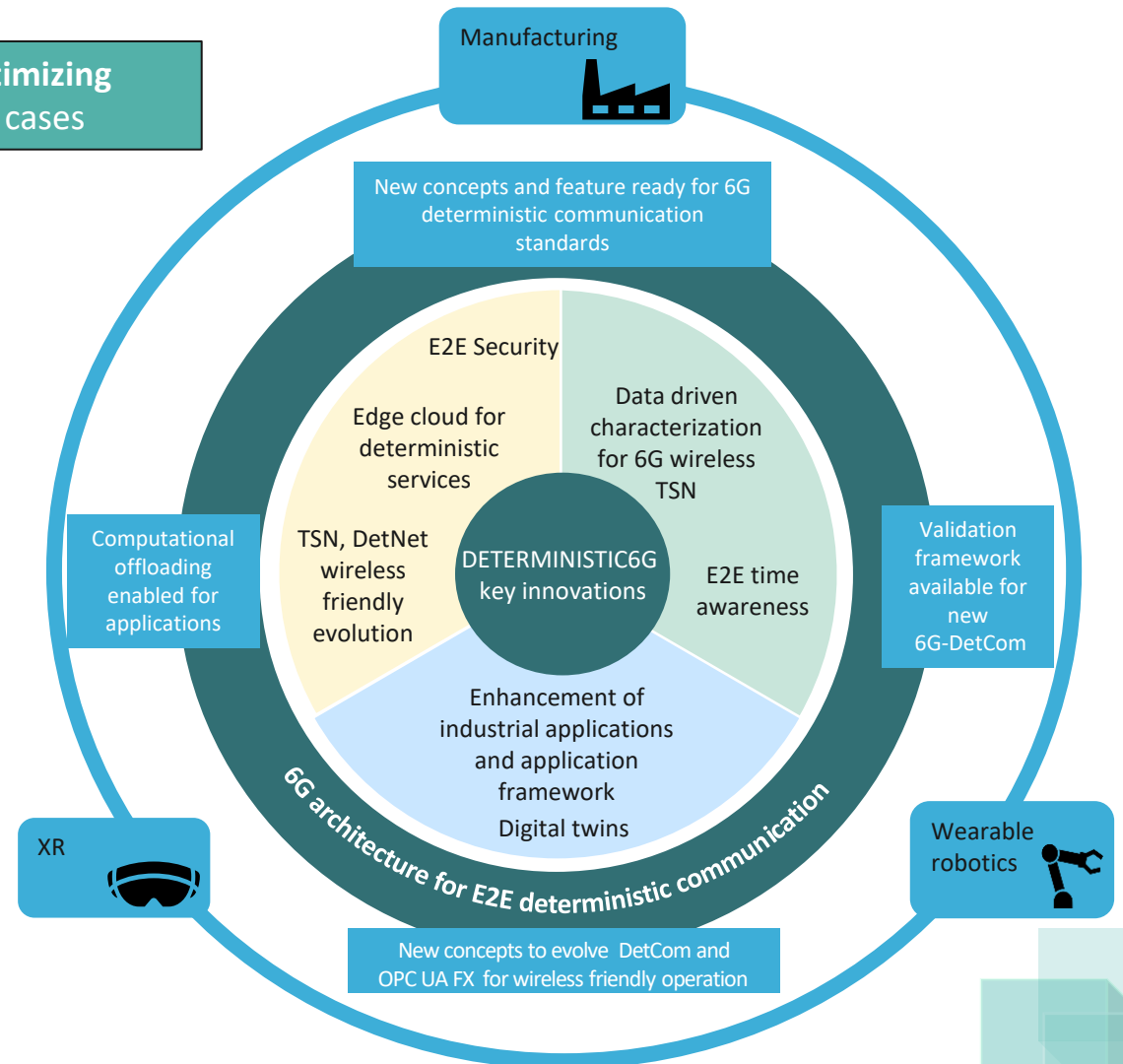
TSN : Time-Sensitive Networking
OPC UA : OPC Unified Architecture
DetNet: Deterministic Networking

Manufacturing

New concepts and feature ready for 6G deterministic communication standards

E2E Security

Edge cloud for deterministic services

Data driven characterization for 6G wireless TSN

Computational offloading enabled for applications

TSN, DetNet wireless friendly evolution

DETERMINISTIC6G key innovations

E2E time awareness

Validation framework available for new 6G-DetCom

Enhancement of industrial applications and application framework
Digital twins

6G architecture for E2E deterministic communication

XR

Wearable robotics

New concepts to evolve DetCom and OPC UA FX for wireless friendly operation

Example Use Cases

- ❑ Adaptive Manufacturing
  - ❑ Demand for **flexible, customer centric production**
  - ❑ Mobile components in production process
    - ❑ **Autonomous vehicles** for transport and production
    - ❑ **Closed-loop interaction** between autonomous components
  - ❑ Deep integration of **humans in the production process**
  - ❑ **Real-time control** including **safety** aspects

- ❑ Exoskeleton in the Industrial Context
  - ❑ Interconnected exoskeletons whose **control system** is partially or fully **offloaded to the edge cloud**
  - ❑ **Task-recognition** in edge cloud based on data acquired from the exoskeletons and from environmental sensors
  - ❑ **Adaptive, task-oriented assistive strategies** computed in the edge cloud
  - ❑ **Digital twin** for monitoring and performance optimizations

Enabling Technologies

- ❑ DETERMINISTIC6G's enablers for E2E deterministic communication
  - ❑ Prediction of stochastic 6G system parameters using AI/ML
  - ❑ Mitigation techniques to reduce influence of stochastic parameters
  - ❑ Wireless friendly evolution of TSN and DetNet
  - ❑ Edge computing for deterministic communication services
  - ❑ E2E security and time synchronization
  - ❑ Service description focusing on dependable service provision
  - ❑ Enhancements for robust scheduling
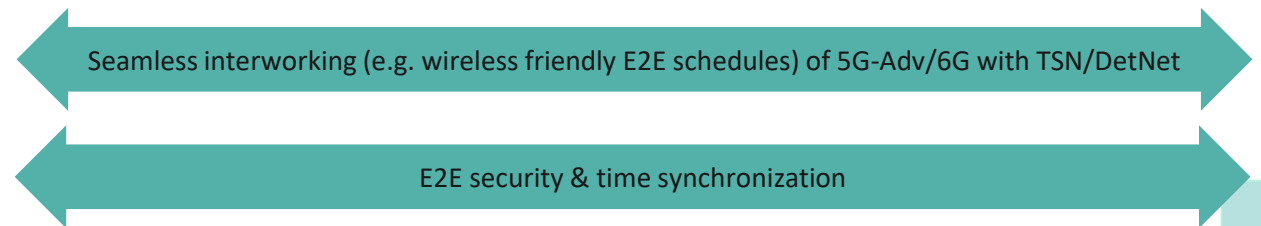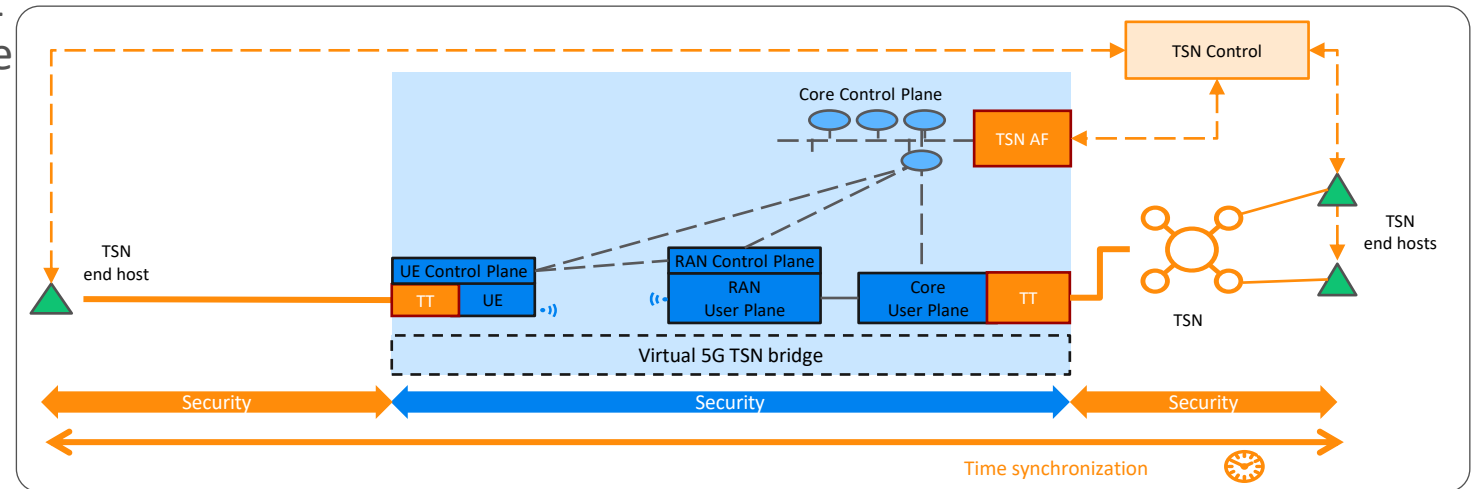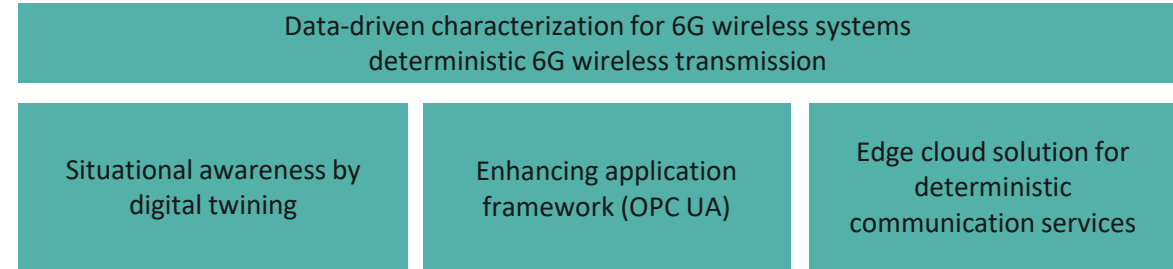
Target Performance (KPIs) – Work in Progress

KPI Category	KPI	Brief Description	Target Value
Latency	**Packet delay**	Time required to transmit packet from sender to receiver	Appl. dependent
	Packet delay variation	Difference between minimum and maximum packet delay	<< cycle time
Dependability	**Packet loss rate**	Percentage of packets lost during transmission	< 10^{-4} %
	Timely delivery rate	Percentage of packets delivered before deadline	>99.9999%
	Mean time to failure	Average amount of time until a failure occurs	Appl. dependent
	Schedulability	Ability to calculate robust schedule for given use case requirements	Appl. dependent
	Predictability	Ability to predict the behavior of the system	>99.9999%

Target Performance (KPIs) – Work in Progress

KPI Category	KPI	Brief Description	Target Value
Capacity	**Guaranteed bandwidth**	Percentage of actually provided bandwidth compared to scheduled bandwidth	>99.9999%
Service	**E2E service latency**	Time needed for an entire real-time control loop including communication and computation times	Appl. dependent
	Reliability	Probability of a service to meet its expected performance metrics	>99.9999%
	Availability	Probability of a service to provide its added value	>99.9999%

Societal Impact (KVIs)

❏ Enabler technology for use case dependent KVIs

❏ Impact dimensions

    ❏ Environmental impact areas, like

        ❏ Resource usage (e.g., energy, material, land, etc.)

        ❏ Emissions (e.g., greenhouse gases, nitrogen, chemicals, etc.)

    ❏ Socio-economic impact areas, like

        ❏ Food

        ❏ Healthcare

        ❏ Well-being

        ❏ Equality

❏ <u>Ongoing:</u> Investigate usage of KVIs in automated control plane mechanisms

Societal Impact (KVIs) - Example

Exoskeleton in Industrial Context

❑ **Key Values (KV)**

    ❑ Personal health and protection from harm

❑ **Key Value Indicators (KVI)**

    ❑ Reduction of the costs for the care of work-related injuries

    ❑ Reduction of number work-related injuries

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