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MITEN5G MUUTTAA VERKKOJA JA PALVELUJA – 5G SERVICES AND BEYOND

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Why we need 5G

Diverse requirements from different use cases \rightarrow 4G has trouble meeting these needs

Very large number of connected devices

- Small and non-delaysensitive tx
- Low cost devices
- Very long battery life



Ma. sive Machine Type Communications

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throughput, latency, and availability





Source: GSMA Intelligence

How 5G will achieve this?

Evolution of radio access network

- New spectrum for 5G
- Advances in radio technology
 - Many physical layer improvements for improved spectral efficiency
 - Beamforming and Massive MIMO
- Cell densification
- Cloud RAN

Flexible core network

- Service-Based Architecture
- Network slicing
- Mobile edge computing
- In-network AI







Key developments that are converging





Cloud computing: distributed clouds, general edge computing, DevOps

Cellular networks: cloud RAN, O-RAN, network slicing, Mobile Edge Computing (MEC), private networks



AI: distributed techniques: federated learning, transfer learning, differential privacy, forthcoming regulation

Flexible Network Slices

Drones and other autonomous sensors



Edge computing is a form of cloud computing and part of the 5G architecture

Edge computing facilitates application and service logic running on **edge servers near end-devices**

Network slices support programmability of the network and enable flexible placement and configuration of virtualized network functions

Smart, digital and virtual factories and connected industries

Virtualization across the environment: virtual front haul, back haul, compute, storage, network slicing

Edge Server



Core Network Cloud Data Center

A 5G network slice for air pollution sensing platforms

- Accurate 3D location
- sensors

Builds on: Station for Measuring Earth Surface-Atmosphere Relations (SMEAR) https://www.atm.helsinki.fi/SMEAR/

Green path navigation

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Centralized cloud for Al

Xu, D., Li, T., Li, Y., Su, X., Tarkoma, S. and Hui, P., 2020. A Survey on Edge Intelligence. arXiv preprint

Edge Intelligence

Applications/slices	5G eMBB URLLC mMTC
Devices	Smartphones, IoT, vehicles and drones
Spectral and energy efficiency	10x
Data rate	DL 20Gb/s UL 10Gb/s
End-to-end latency	eMBB: 4ms URLLC: 1ms
Frequency bands	Sub-6GHz MmWave
Architecture	Early cloud cloud-native and cloud RAN, private networks
ΑΙ	Edge Intelligence

Inspired by Walid Saad, Mehdi Bennis, and Mingzhe Chen. A Vision of 6G Wireless Systems: Applications, Trends, Technologies, and Open Research Problems. IEEE Network Magazine

Anticipated for 6G

- New applications including XR/AR/VR, massive-scale sensing and IoT, autonomous robotics, combination of applications. Capability to generate slices with desired radio, network and application capabilities
- Versatile and more heterogeneous consumer and industrial equipment
- 1000x

1Tb/s

<1ms

Sub-6GHz

MmWave

THz band

Non-terrestrial communications

Fully distributed cloud native with orchestration of fine-grained functions and containers, continuous development and testing, sustainability a key consideration

Ubiquitous Intelligence

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