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5G Evolution and Beyond

A Verticals Perspective

Harish Viswanathan, Thorsten Wild, Mikko Uusitalo

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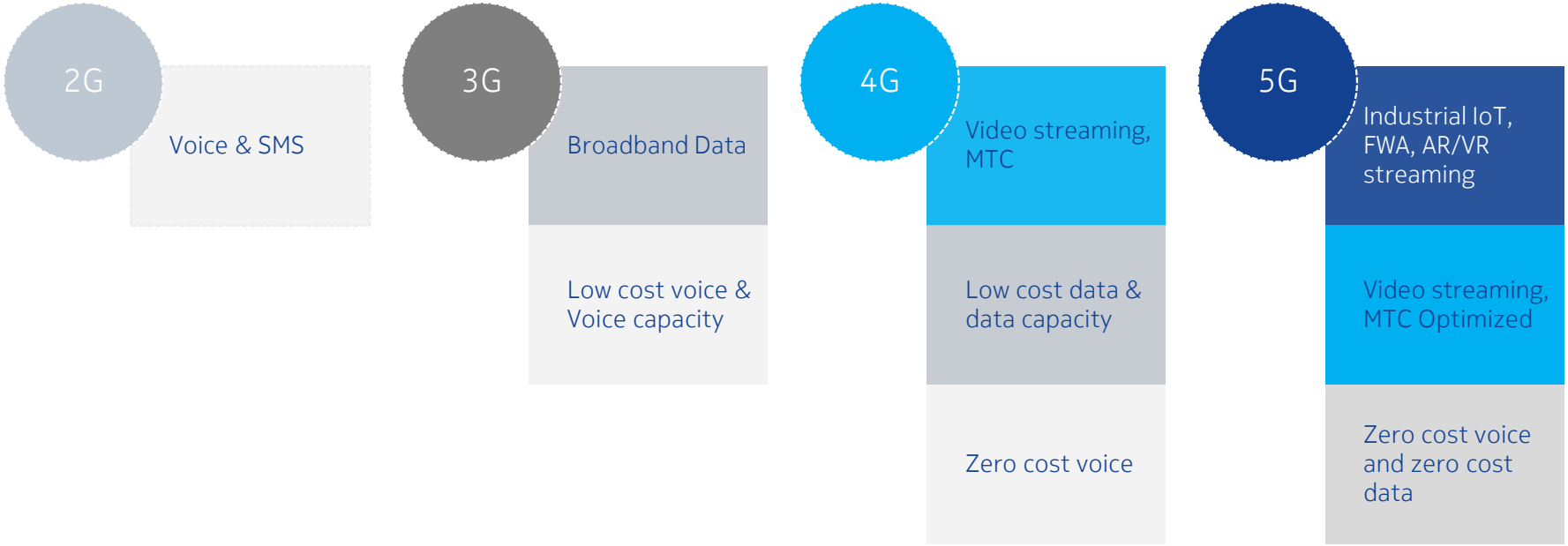
Historical Perspective



Each new generation is about optimizing the new use case of the previous generation to reduce cost and introduction of new platform capabilities

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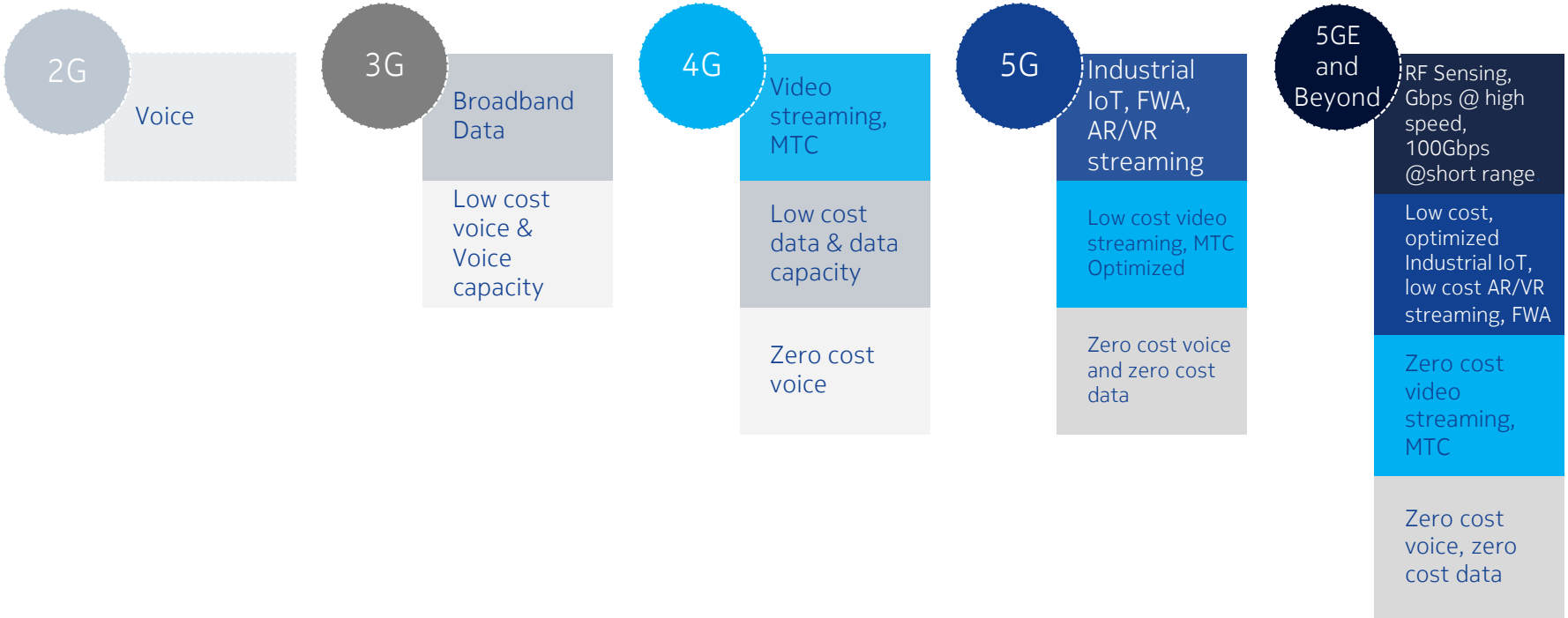
Extending into the Future

What new platform capabilities to enable?



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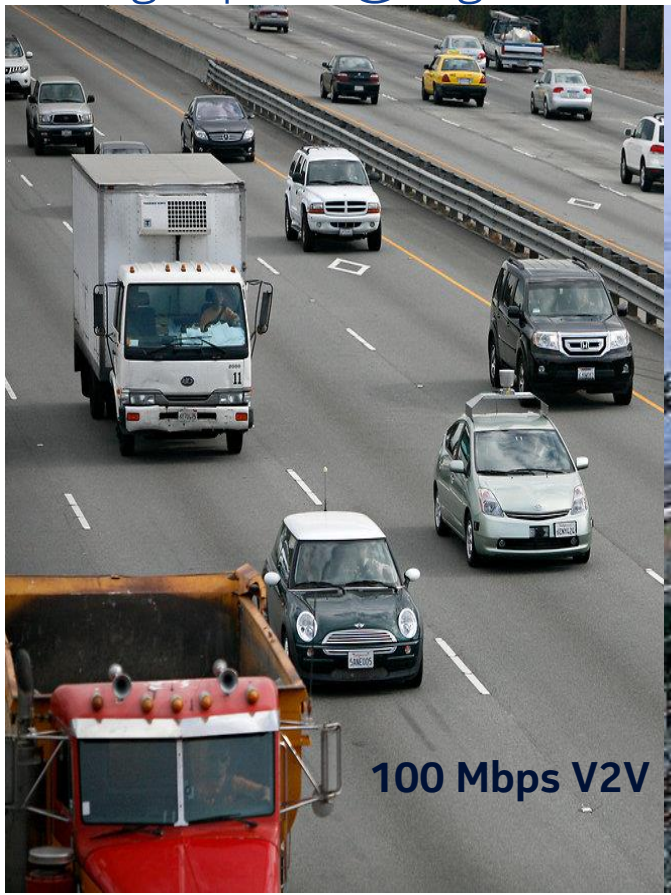
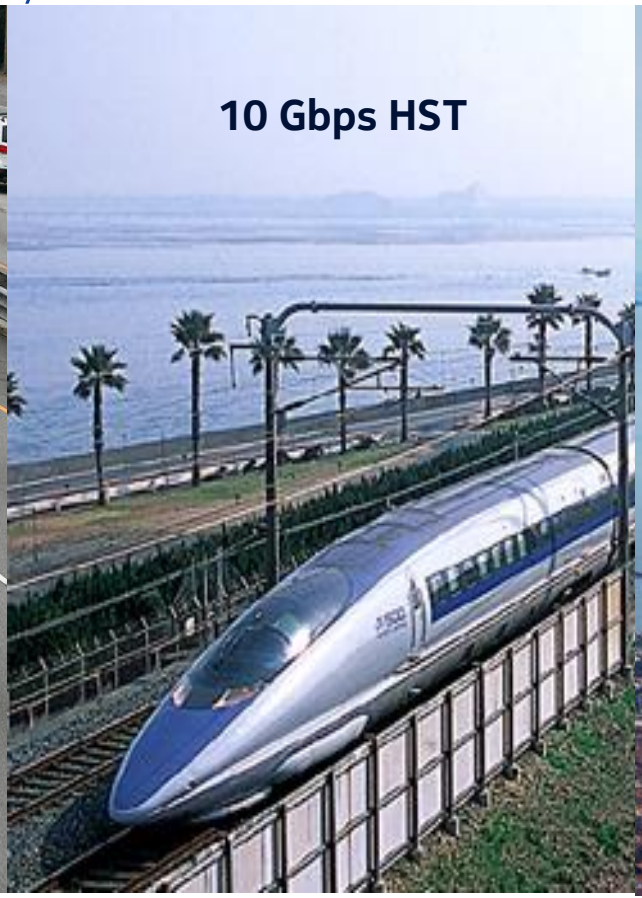
High speed @ High mobility





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RF sensing indoor and outdoor

- Presence
- Activity
- Heart Rate
- Location
- Patterns

- Estimate Density of cars/people
- Localization & Tracking
- Mobility rates
- Identify empty parking spots

See beyond what a camera can see

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Is there a place for wireless in the data center

- Network interconnecting top of rack switches for fast path between applications
  - ~500 Gbps over ~10 meters
- Inter-blade communication – wireless backplane

Supporting rapid deployment of compute pods and reduce TCO

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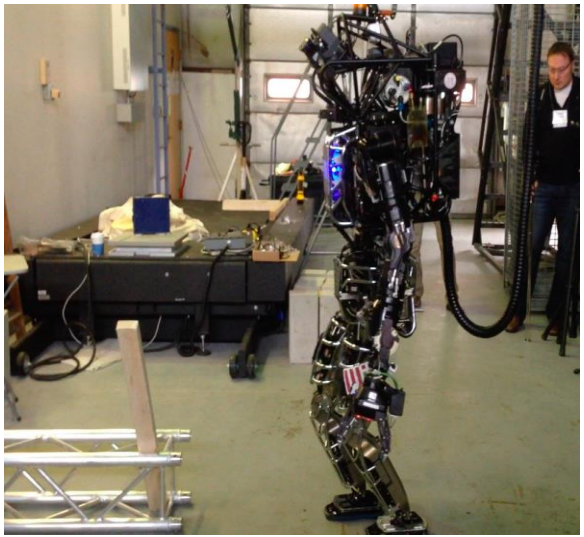
Robot Wireless Nervous System
Large Scale Pico Area Networks



- 100s to 1000s of sensors are needed on humanoid robots
- Lots of wires needed to connect all the sensors
- What if we could make the sensor network wireless
  - 1000s of devices in less than 1 Cu. Meter need to talk to the “brain” reliably
  - Low data rate and high data rate
- Similar concept for in-vehicle network

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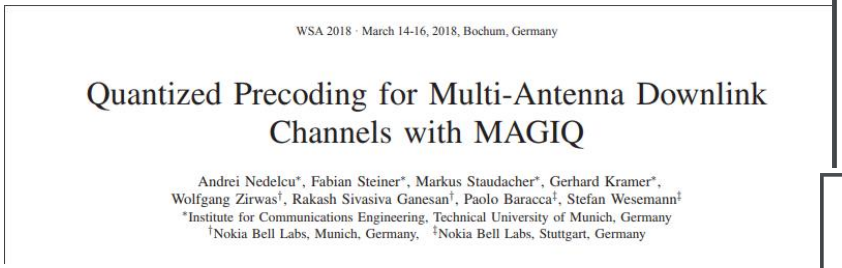
Truly disruptive technologies are published >10 years before product realization



WSA 2018 · March 14-16, 2018, Bochum, Germany

Quantized Precoding for Multi-Antenna Downlink Channels with MAGIQ

Andrei Nedelcu*, Fabian Steiner*, Markus Staudacher*, Gerhard Kramer*,
Wolfgang Zirwas†, Rakash Sivasiva Ganesan†, Paolo Baracca‡, Stefan Wesemann‡
*Institute for Communications Engineering, Technical University of Munich, Germany
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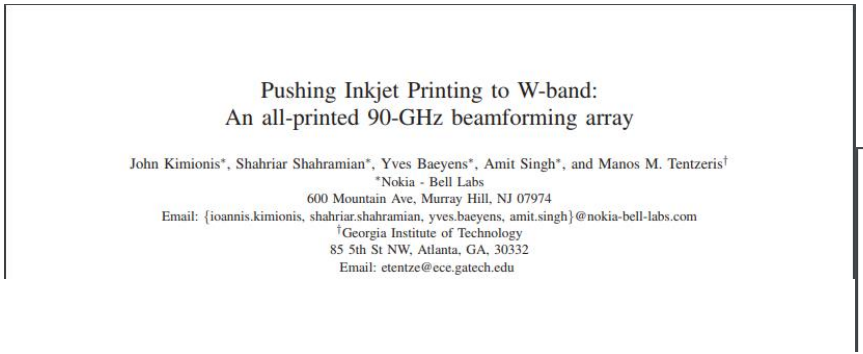

An All-Digital, Single-Bit RF Transmitter for Massive MIMO

Daniel Markert, Xin Yu, Holger Heimpel, and Georg Fischer

Pushing Inkjet Printing to W-band: An all-printed 90-GHz beamforming array

John Kimionis*, Shahriar Shahramian*, Yves Baeyens*, Amit Singh*, and Manos M. Tentzeris†
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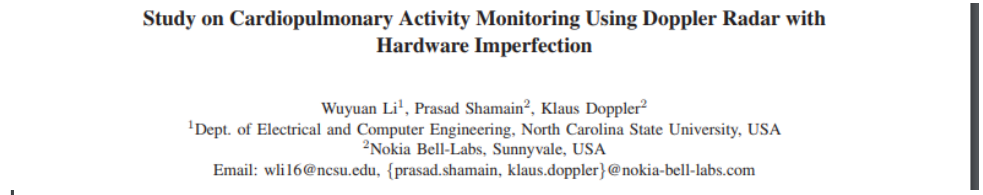
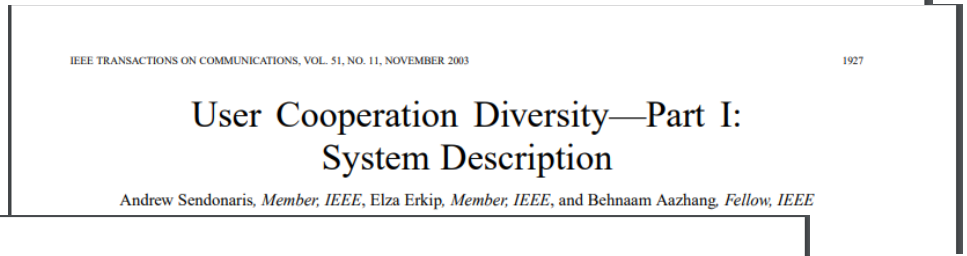


Study on Cardiopulmonary Activity Monitoring Using Doppler Radar with Hardware Imperfection

Wuyuan Li[1], Prasad Shamain[2], Klaus Doppler[2]
[1]Dept. of Electrical and Computer Engineering, North Carolina State University, USA
[2]Nokia Bell-Labs, Sunnyvale, USA
Email: wli16@ncsu.edu, {prasad.shamain, klaus.doppler}@nokia-bell-labs.com

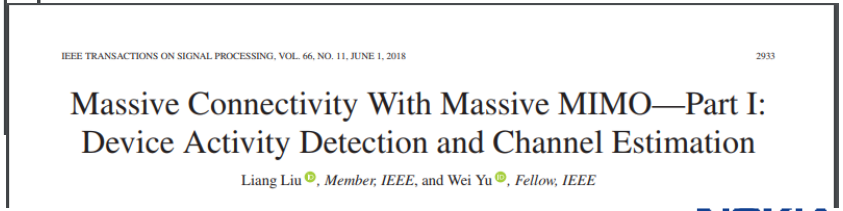
Deep Learning Based Communication Over the Air

Sebastian Dörner, Sebastian Cammerer, *Student Member, IEEE*, Jakob Hoydis, *Member, IEEE*,
and Stephan ten Brink, *Senior Member, IEEE*



User Cooperation Diversity—Part I: System Description

Andrew Sendonaris, *Member, IEEE*, Elza Erkip, *Member, IEEE*, and Behnaam Aazhang, *Fellow, IEEE*



Massive Connectivity With Massive MIMO—Part I: Device Activity Detection and Channel Estimation

Liang Liu, *Member, IEEE*, and Wei Yu, *Fellow, IEEE*

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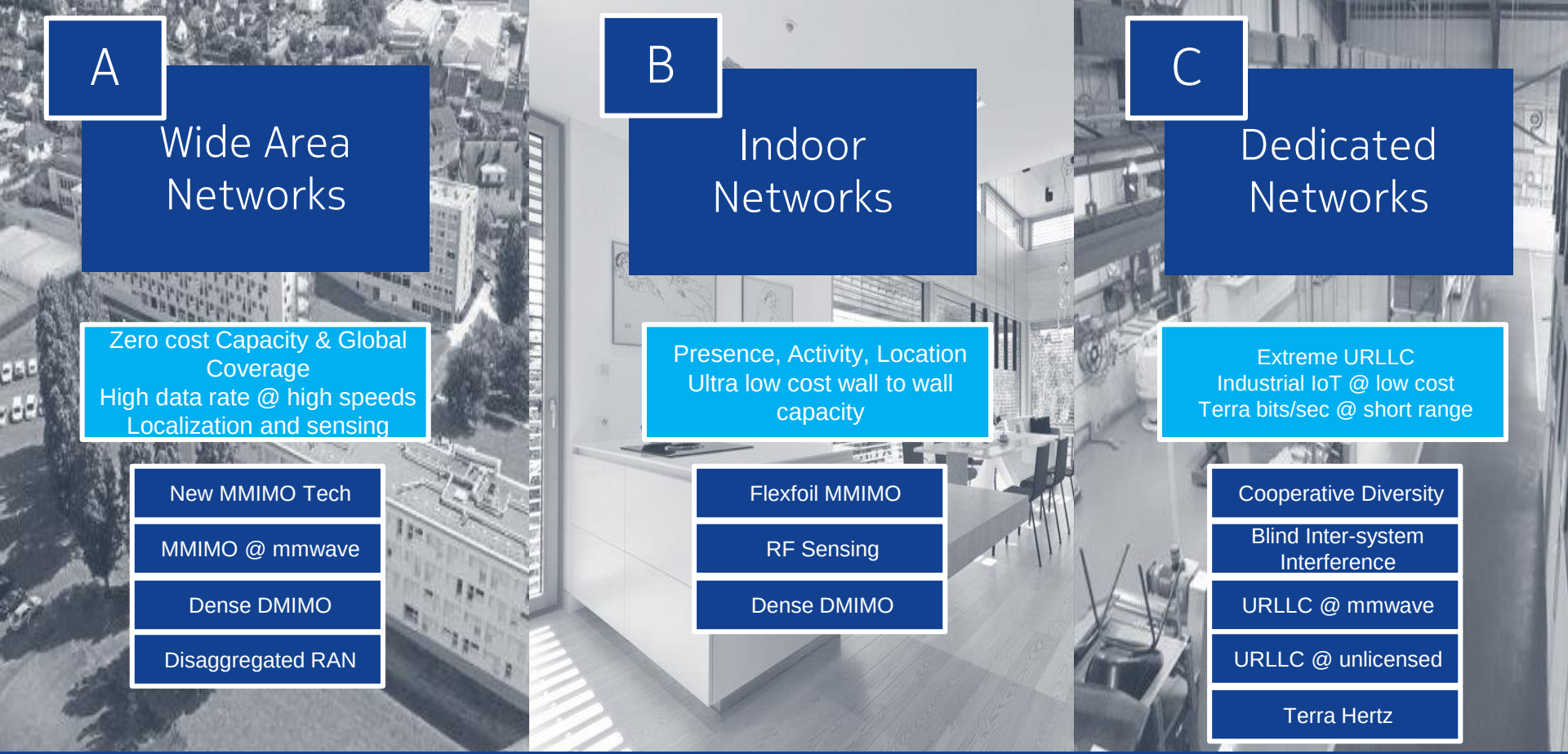

A

Wide Area Networks

Zero cost Capacity & Global Coverage
High data rate @ high speeds
Localization and sensing

- New MMIMO Tech
- MMIMO @ mmwave
- Dense DMIMO
- Disaggregated RAN

B

Indoor Networks

Presence, Activity, Location
Ultra low cost wall to wall capacity

- Flexfoil MMIMO
- RF Sensing
- Dense DMIMO

C

Dedicated Networks

Extreme URLLC
Industrial IoT @ low cost
Terra bits/sec @ short range

- Cooperative Diversity
- Blind Inter-system Interference
- URLLC @ mmwave
- URLLC @ unlicensed
- Terra Hertz

A network with one framework but highly optimized for each scenario

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