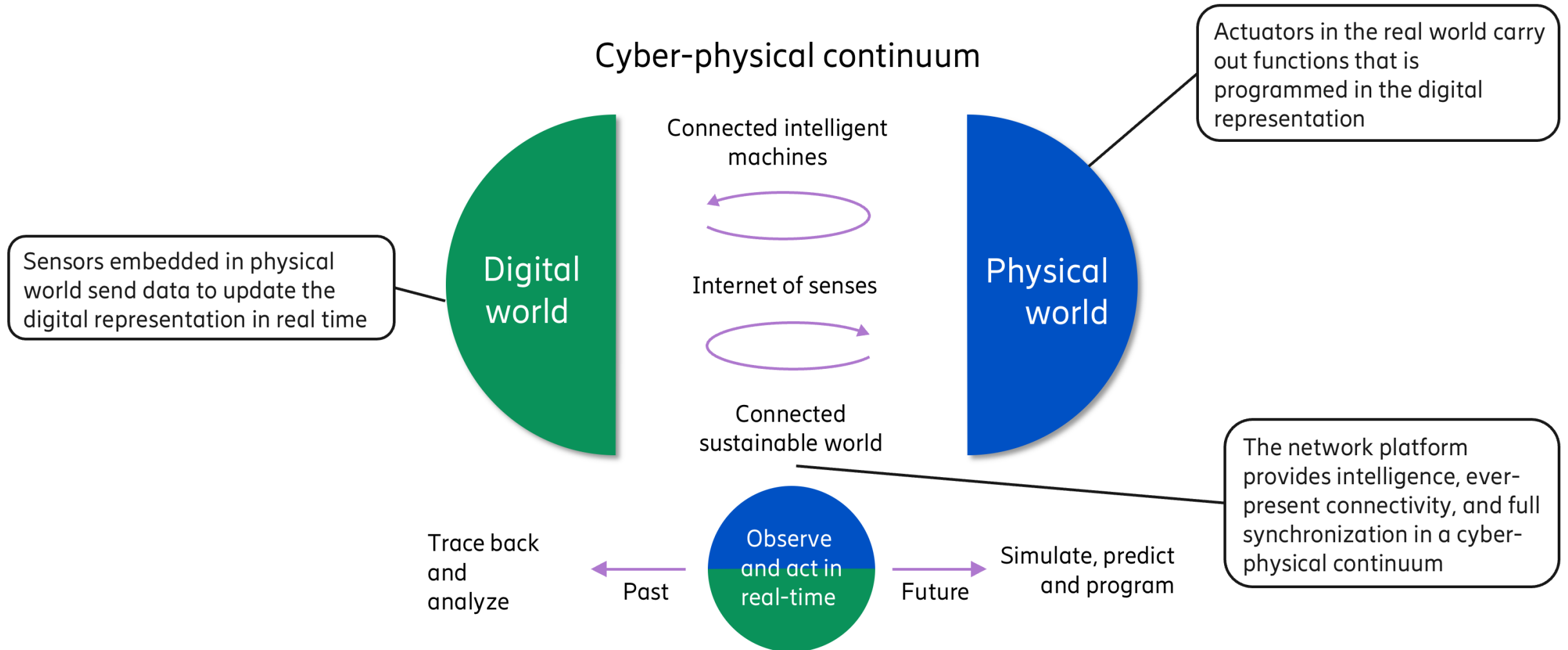


THz Frequencies and Mobile Networks – a good blend?



Fredrik Tillman
Ericsson Research

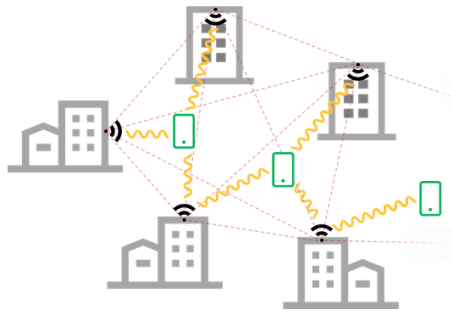
Connecting a cyber-physical world



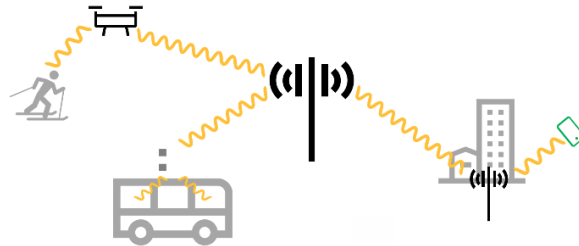
Pushing network performance



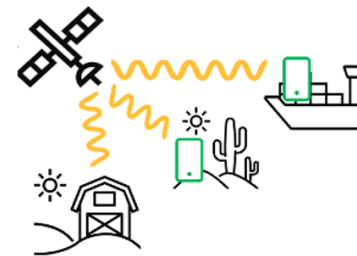
- Extreme data rates in specific scenarios
- Wide-area coverage of future 6G services
- Spectrum co-existence with legacy 5G systems



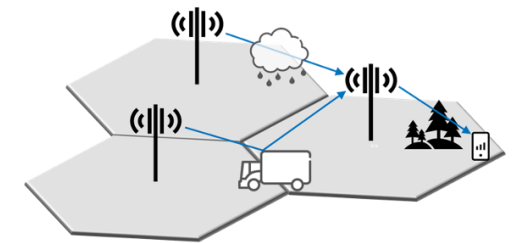
Multi-point
connectivity



Multi-hop
connectivity

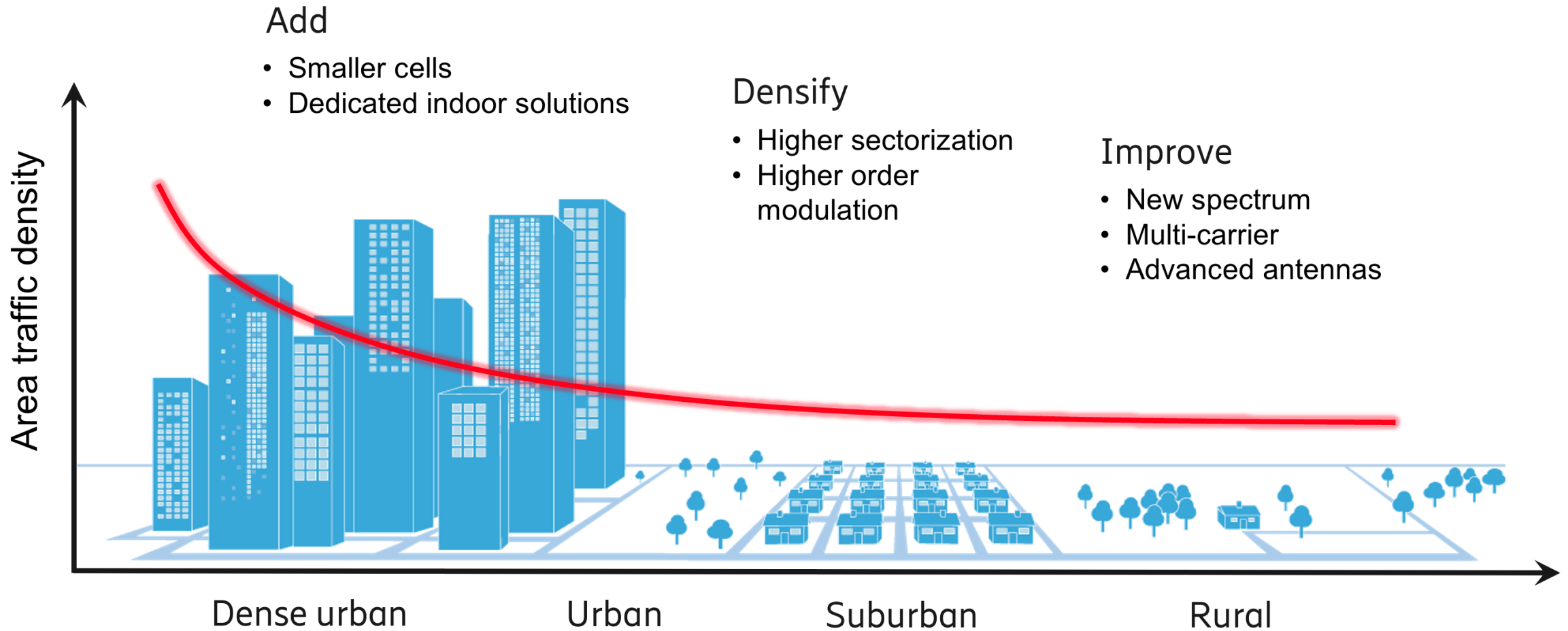


Complementary
satellite component

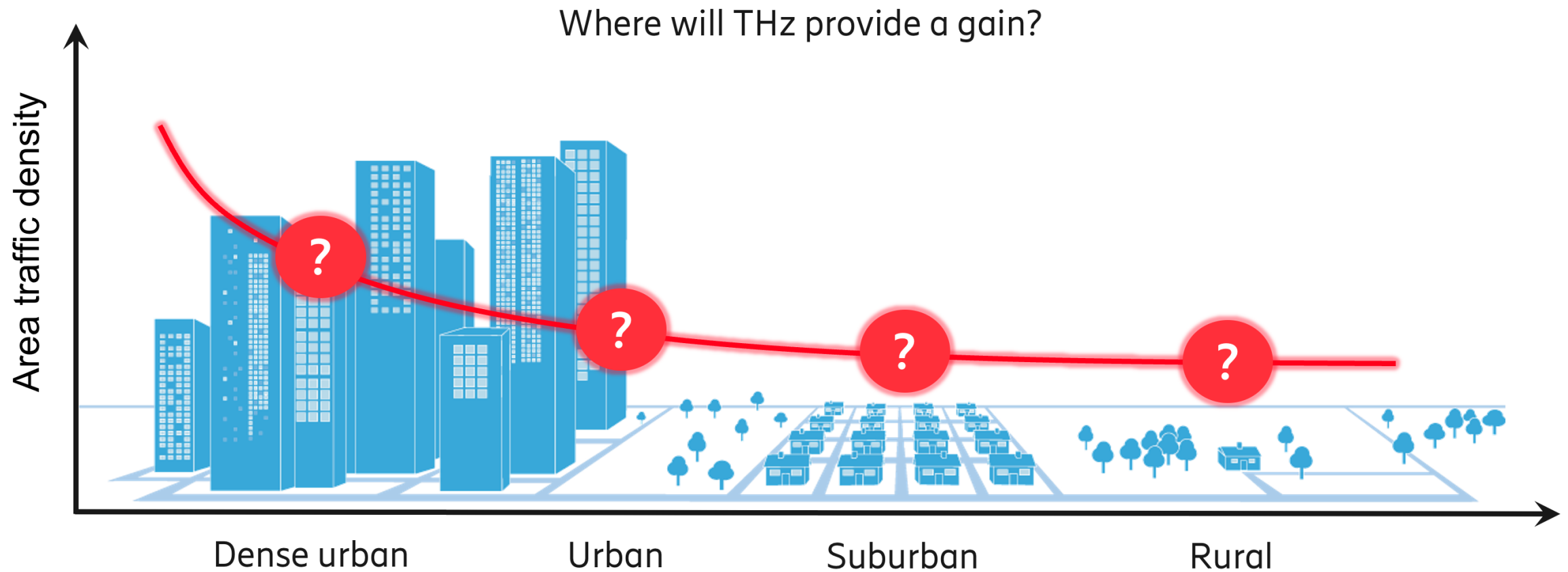


Joint communication
and sensing

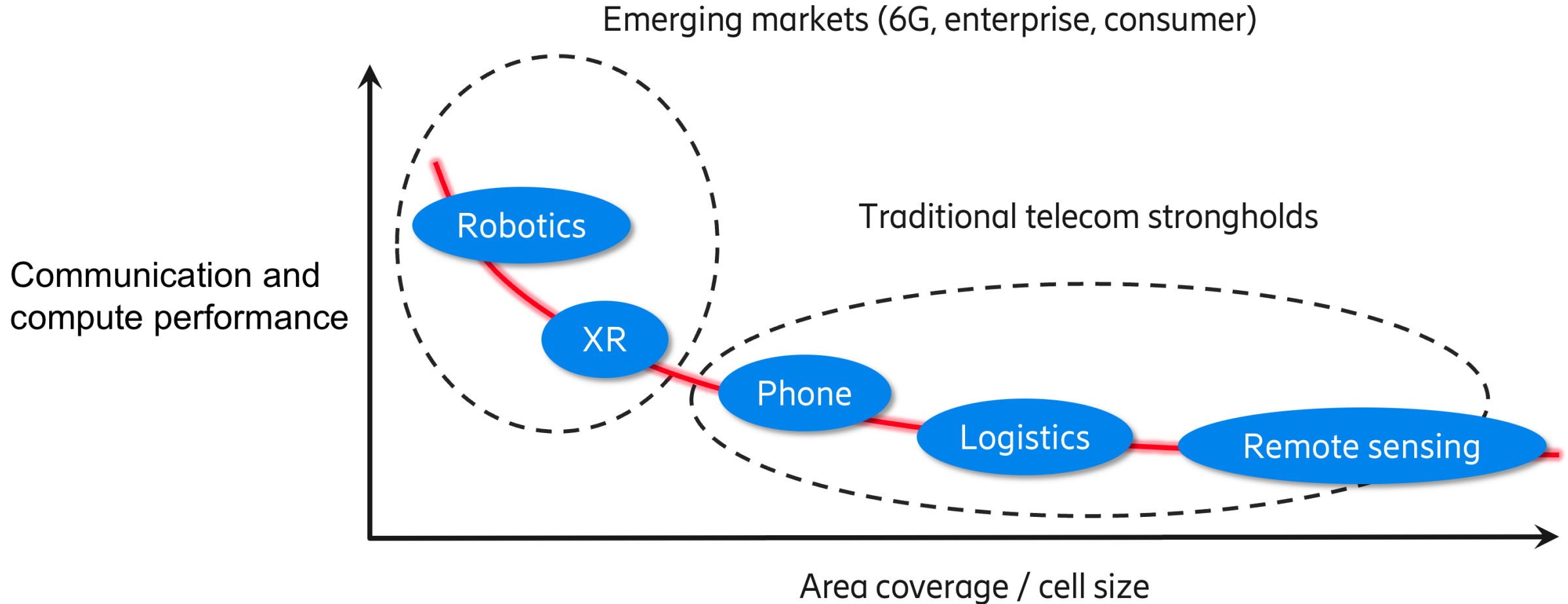
Deployment strategies today

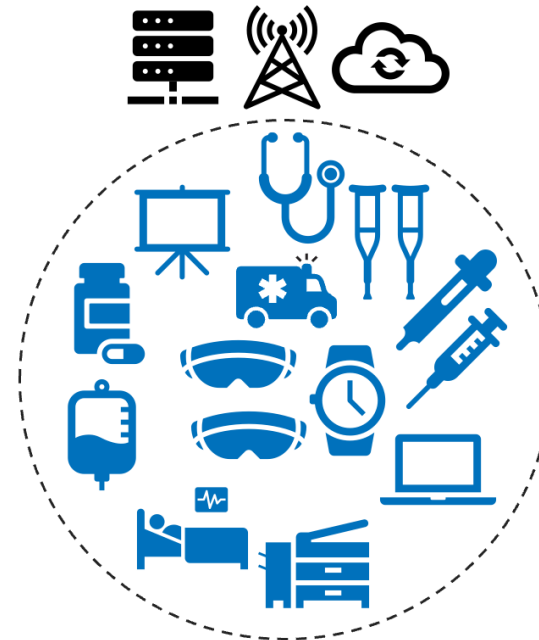
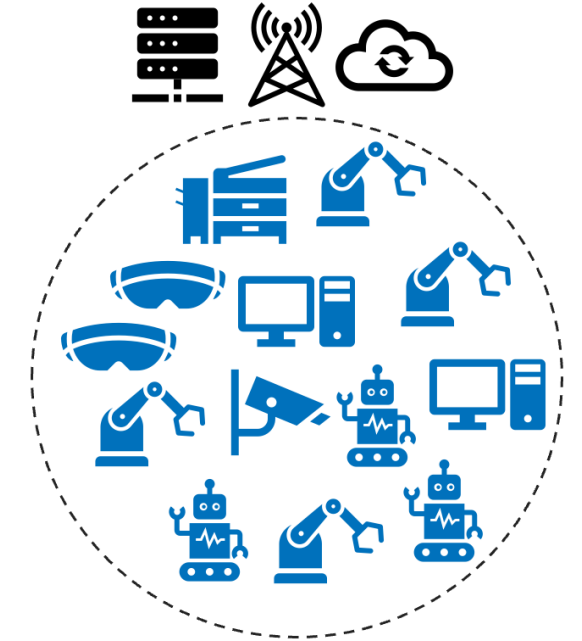
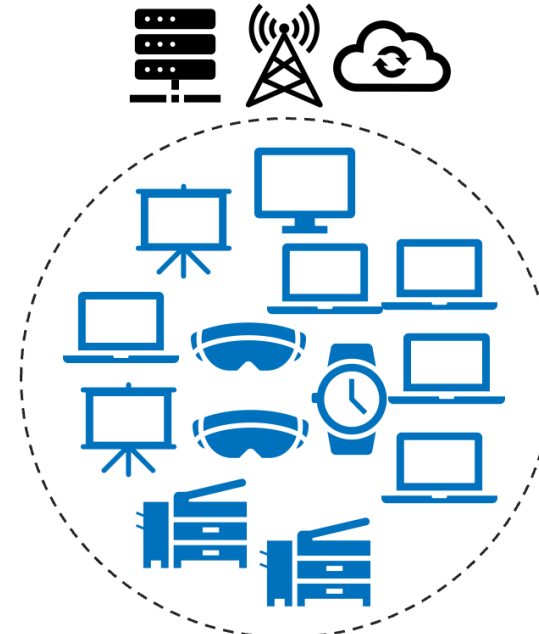


Deployment strategies tomorrow



But what might change down the road?



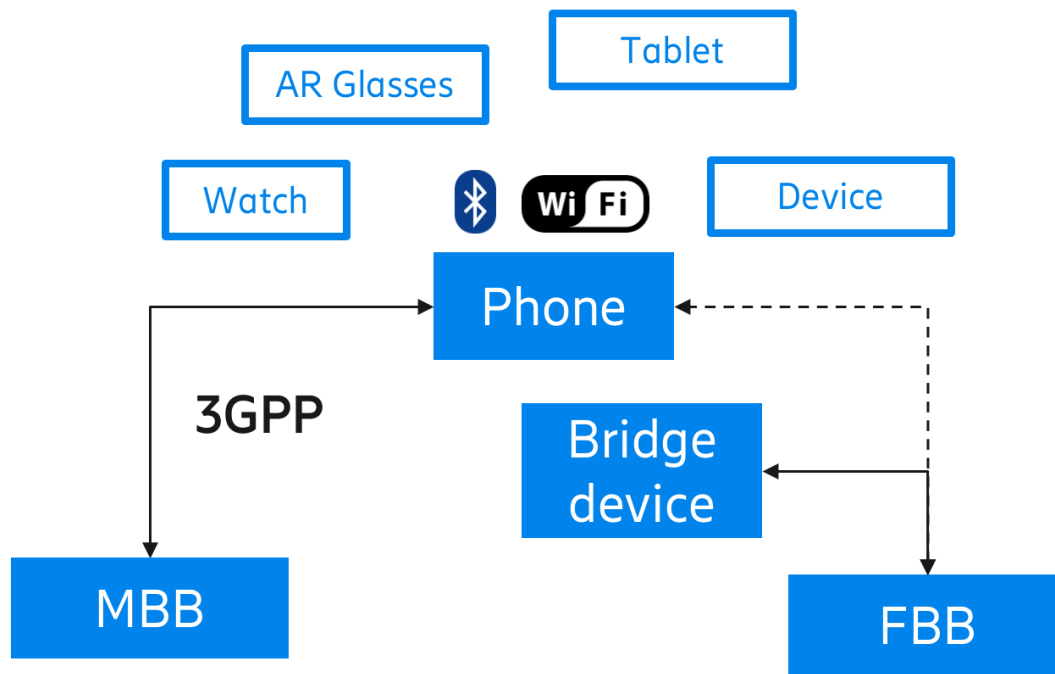


Factory floors
Offices
Classrooms
Hospitals
Retail
Home

Towards a local connect and compute paradigm

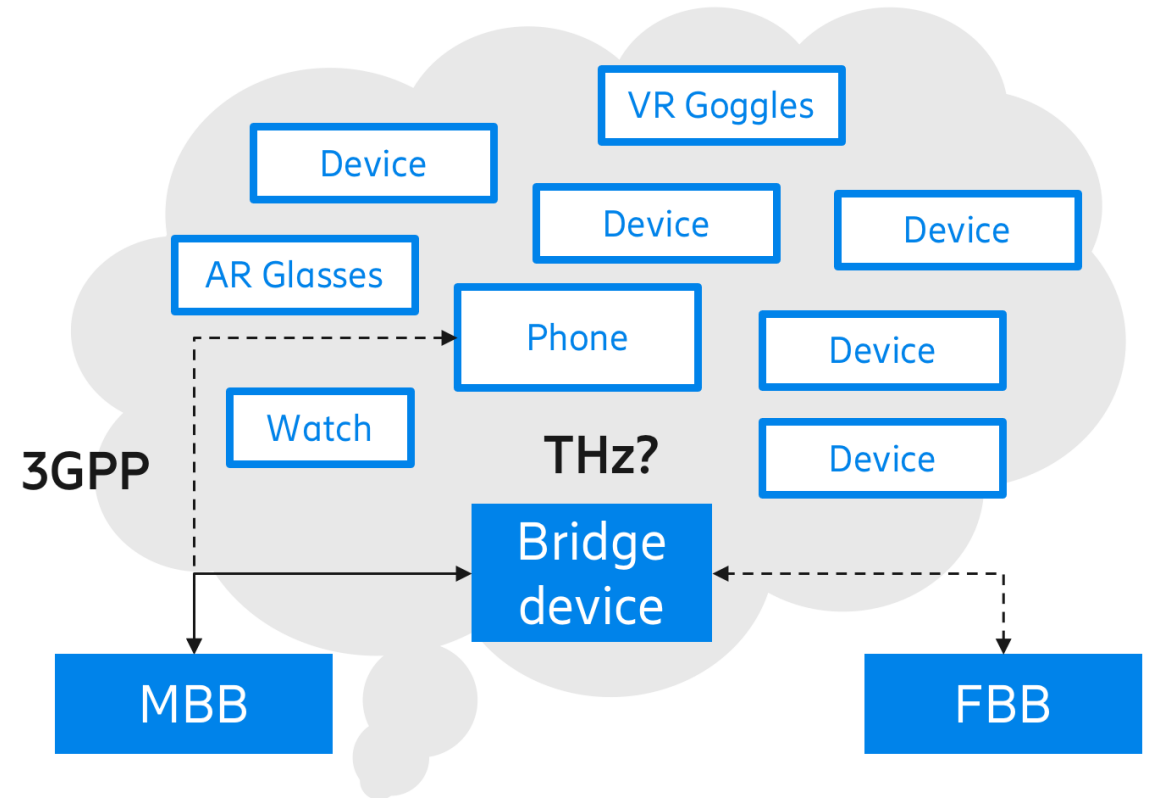


2022



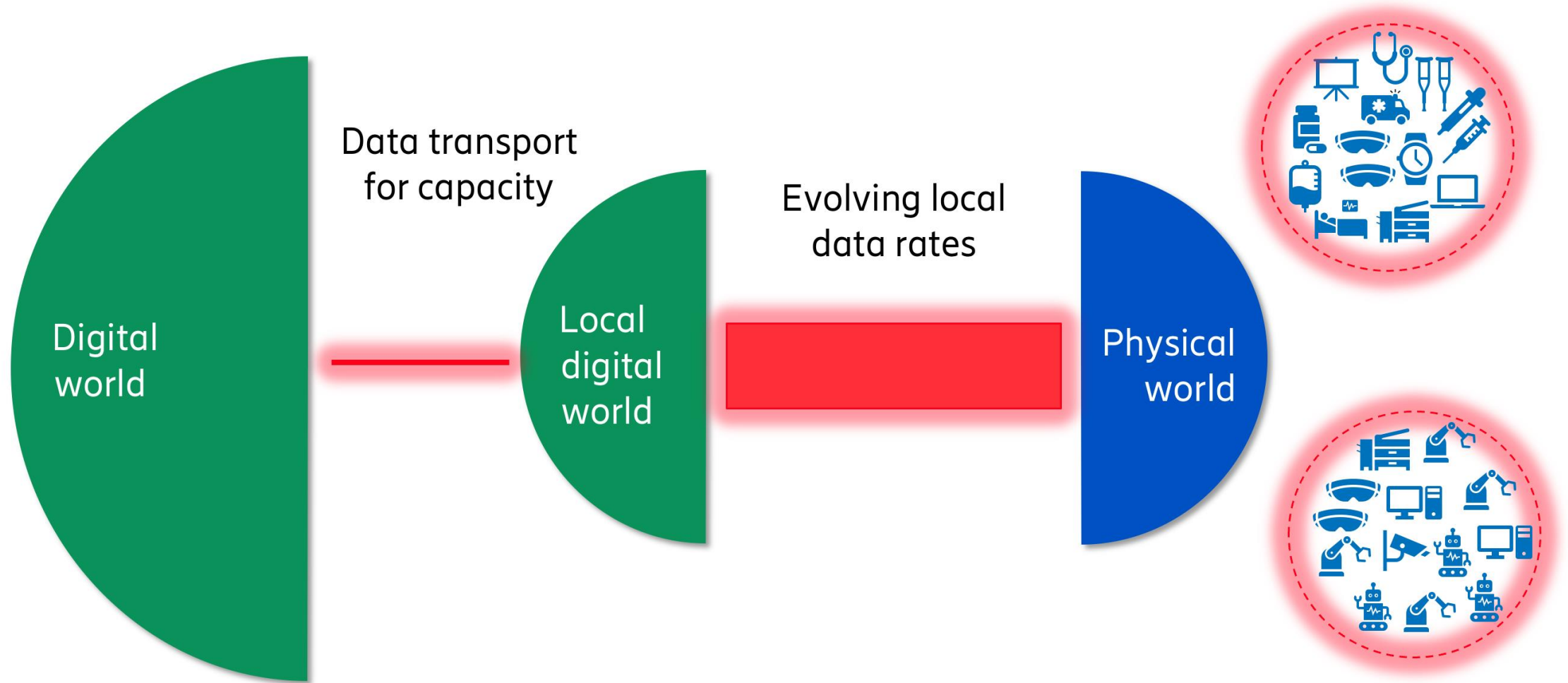
Phone software ecosystem

2030



Evolved software ecosystem

What does this mean for technology?

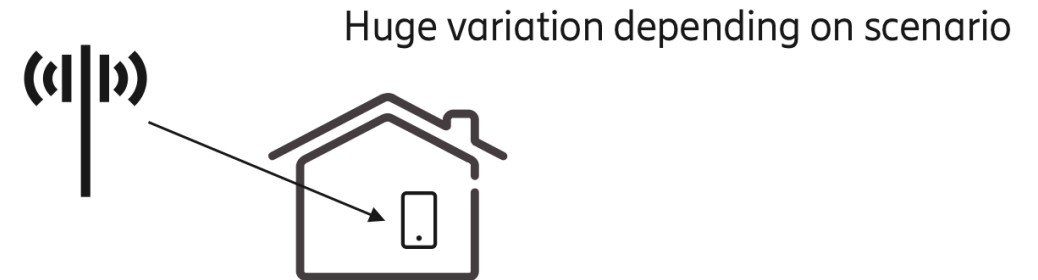
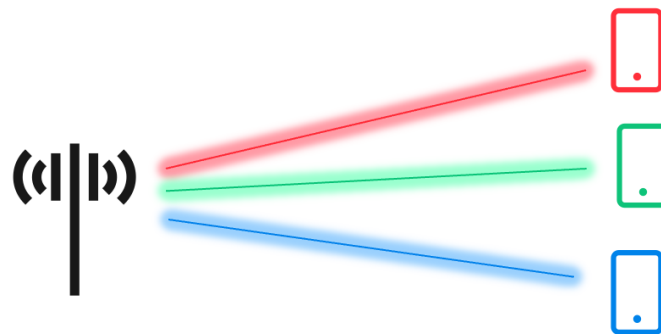
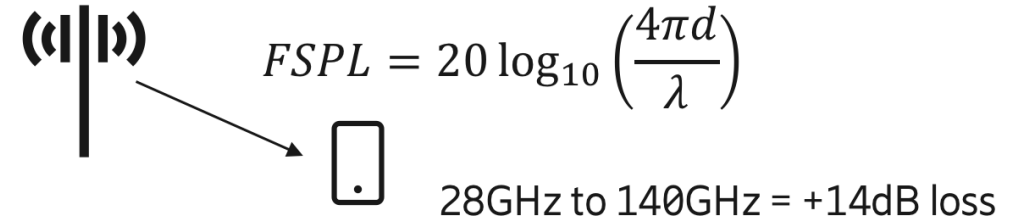


Deployment challenges



Classic things to combat 😊

- Free space
- Diffraction
- Penetration
- Pencil beams

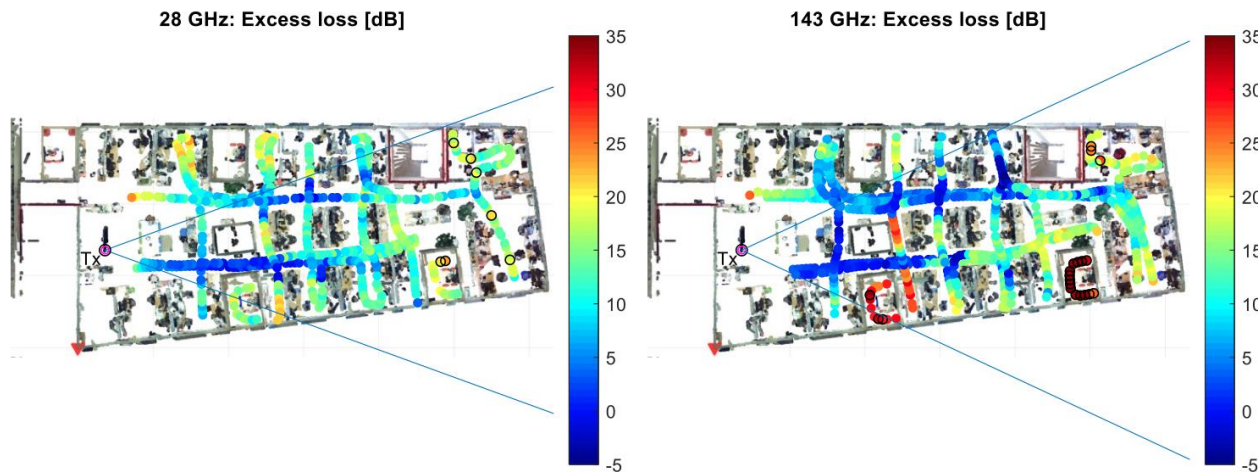


Link budget → antenna gain → narrow beams

Propagation measurements

- Similar reflection losses for 28 and 140GHz
- Noticeably higher penetration loss for 140GHz
- Similar excess loss in an open office for 28 and 140GHz, but difficult to get coverage in closed meeting rooms @ 140GHz

Open office coverage



B-E. Olsson et al., "Radio Propagation in an Office Environment at 140GHz and 28GHz", European Conference on Antennas and Propagation (EuCAP), 2021



Office scenario 1		
	28GHz	140GHz
Penetration: Drywall A	3-7	11-15
Penetration: Wooden door A	8	>50
Penetration: Glass in wooden door A	1.5	12
Penetration: Wooden door B	15	>50
Penetration: Indoor glass wall A	1.9	15
Penetration: Curtain (thin)		0.4
Penetration: Sweatshirt		0.8
Penetration Cardboard box		3.3
Penetration: aluminum foil		>50
Penetration: Computer monitor		>50

Office scenario 2		
	28GHz	140GHz
Penetration: Drywall B	6	17
Penetration: Drywall B + heavy curtain	8	30
Penetration: Big indoor glass wall	3	8.5
Penetration: Indoor glass wall B	5	17
Penetration: Drywall B + whiteboard	25	35

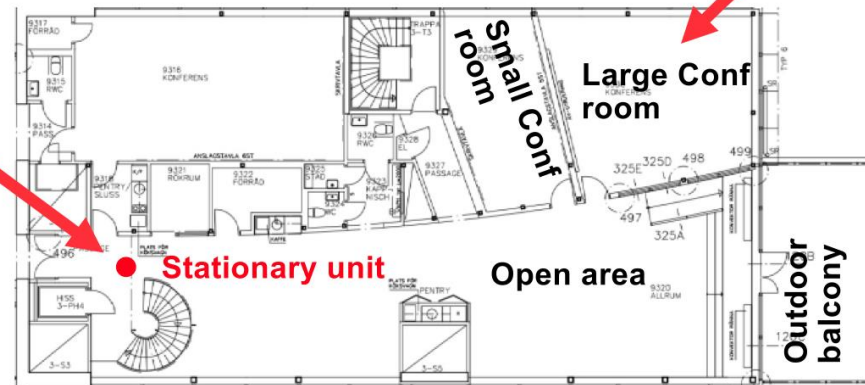
Office scenario 1		
	28GHz	140GHz
Reflection: Drywall A	6.5	9-11
Reflection: Wooden door A	10	12-15
Reflection: Glass in wooden door A	3.5	6.5

Office scenario 2		
	28GHz	140GHz
Reflection: Whiteboard on wall	0	0
Reflection: Drywall B	6	9
Reflection: Big indoor glass wall	7	8

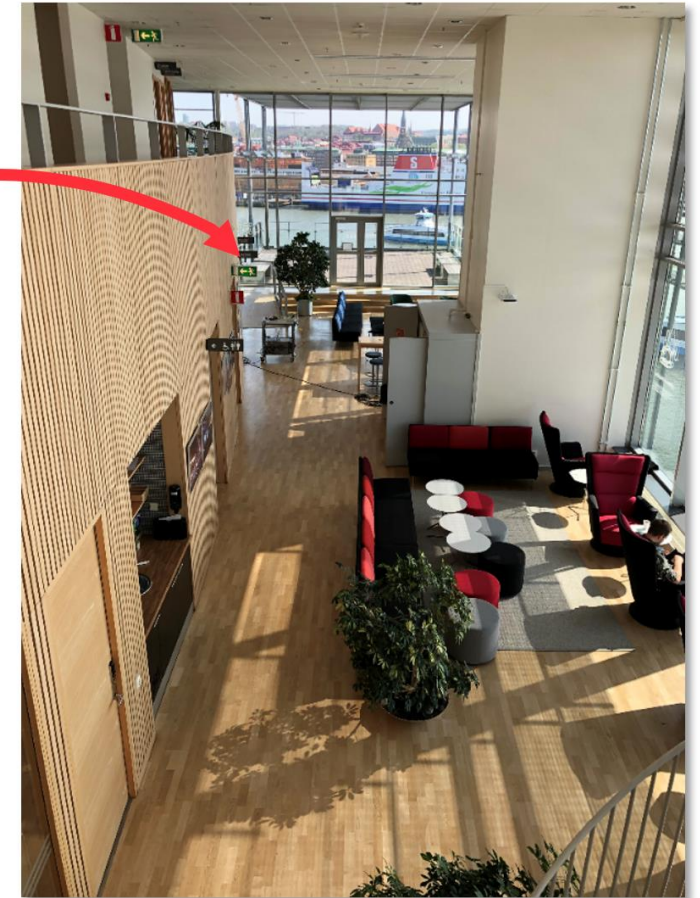
Open area with conference rooms



Tx

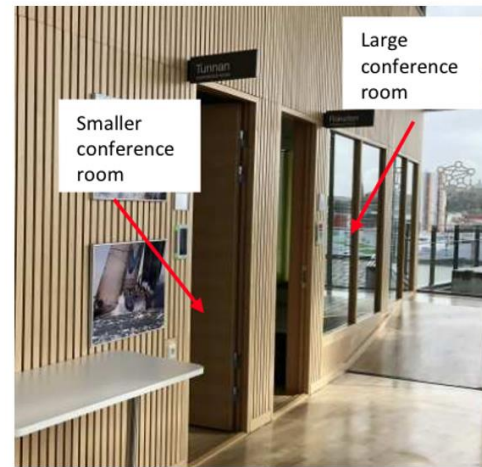
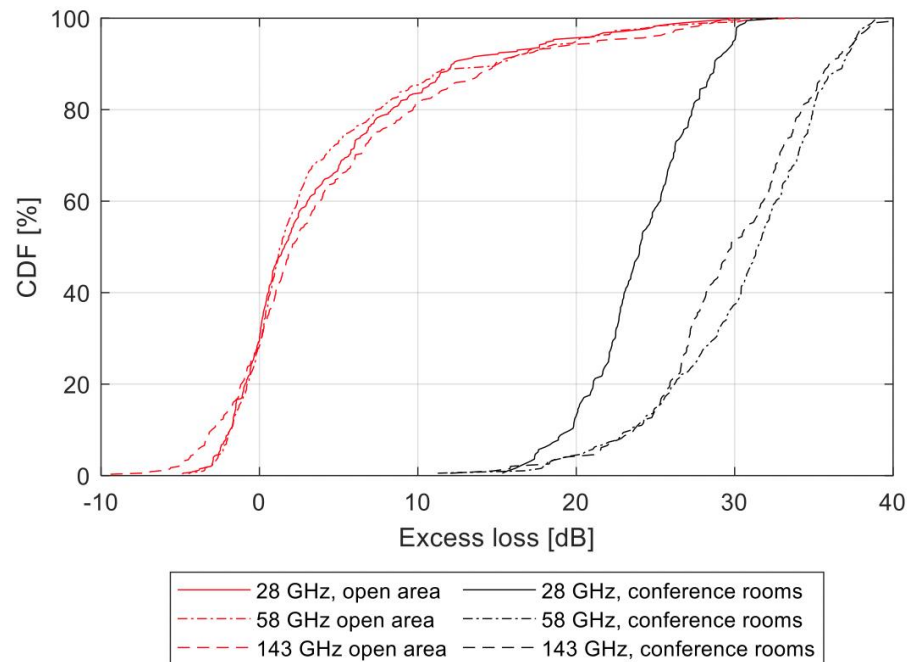


Conf room not LOS



Coverage

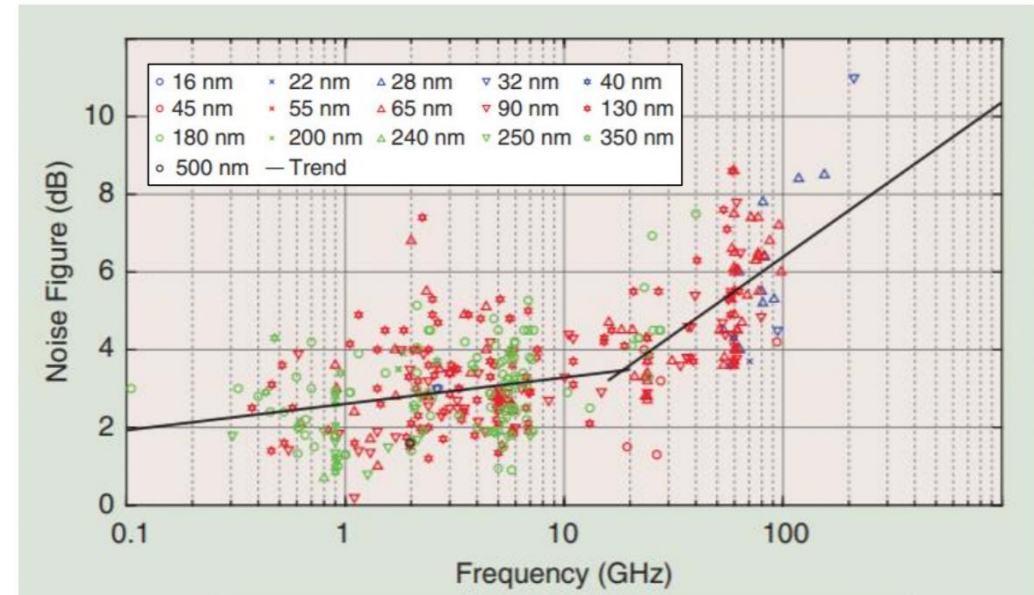
- Open area very similar for all 3 frequencies
- Higher loss in conference rooms for 58 and 143 than 28GHz
- Very similar excess loss in the conference rooms @ 58 and 143GHz



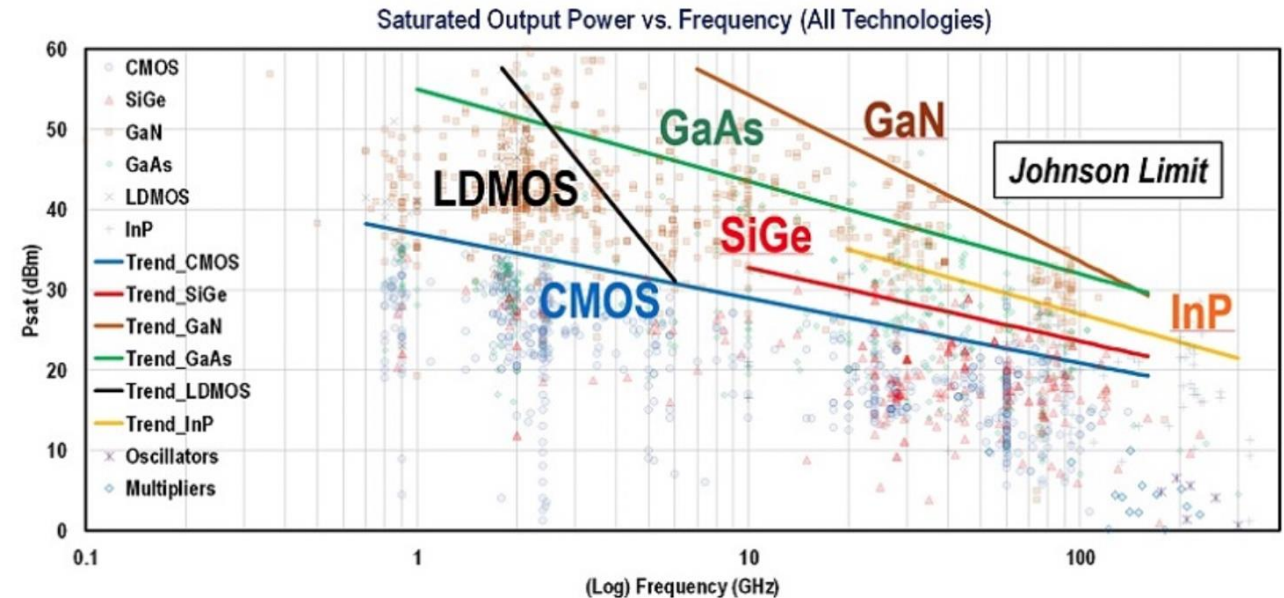
Hardware challenges

“Not a question whether something is possible or not - more when things become business viable”

- Transmit power
- Sensitivity
- Phase noise
- Data converters
- # antennas
- Building practice

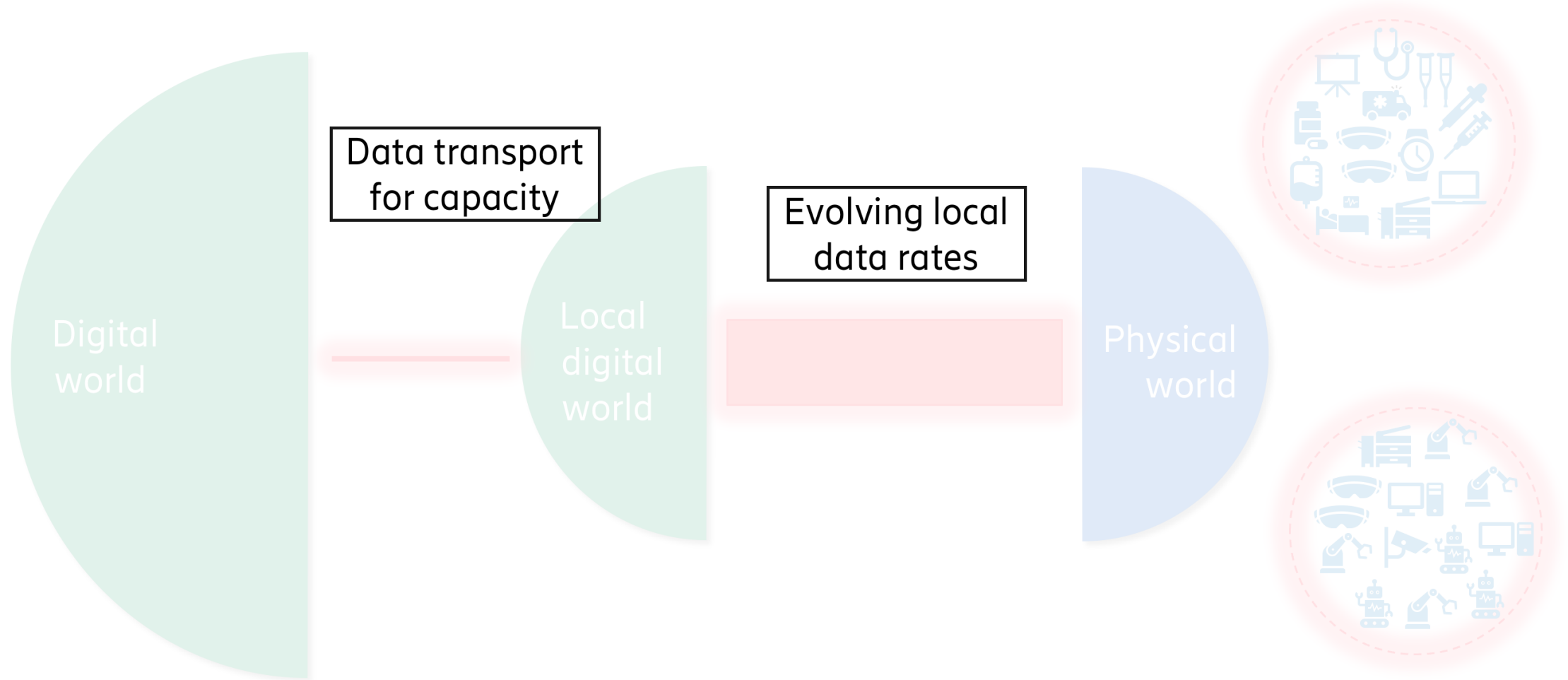


L. Belostotski, et al., "Low-noise-amplifier (LNA) performance survey"



H. Wang et al., "Power Amplifiers Performance Survey 2000-Present"

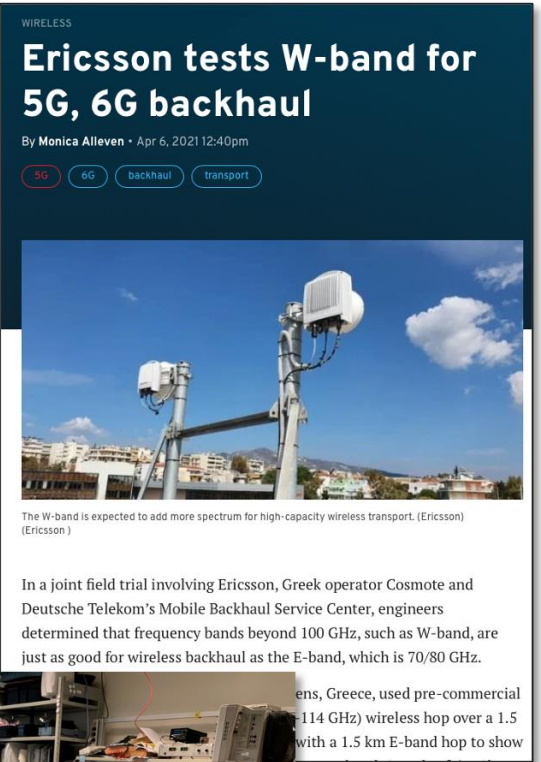
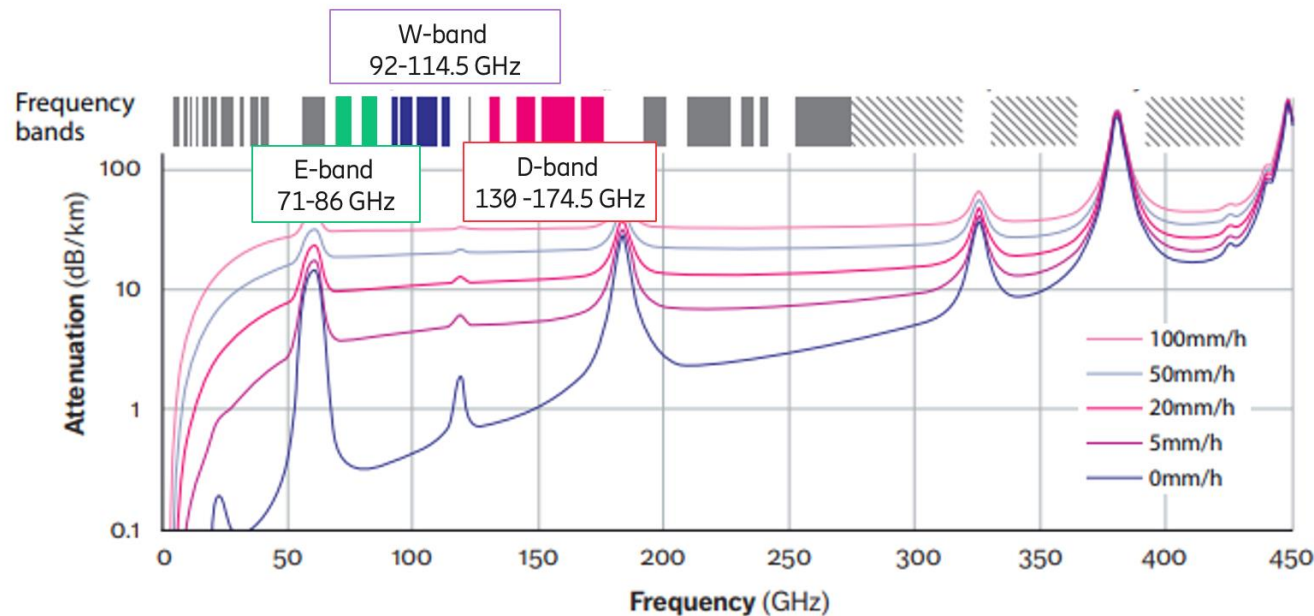
How is this addressed today?



Wireless backhaul

<https://www.fiercewireless.com/operators/ericsson-tests-w-band-for-5g-6g-backhaul-partners-greece>

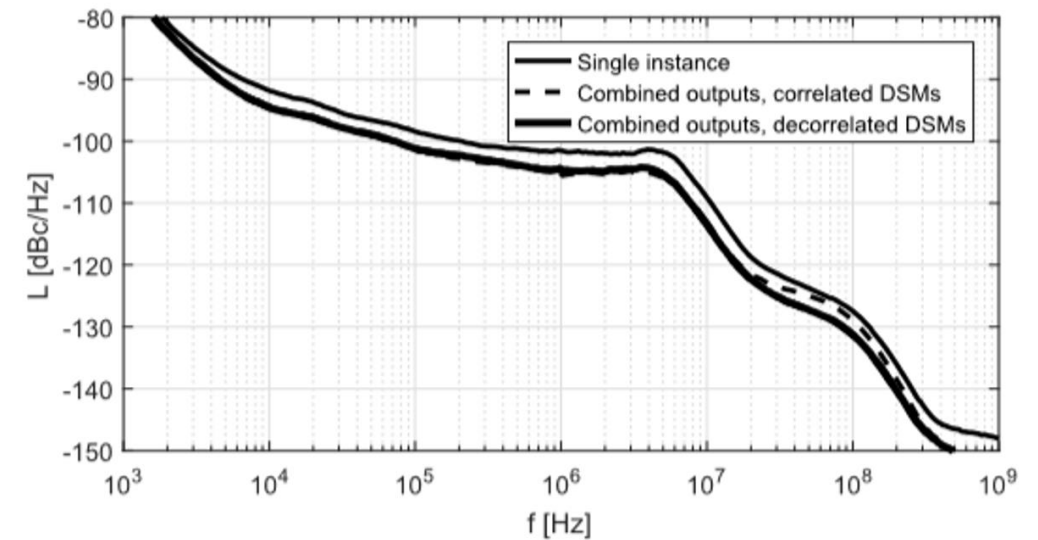
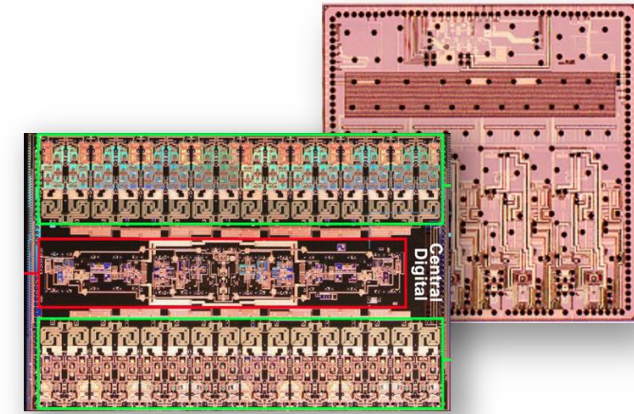
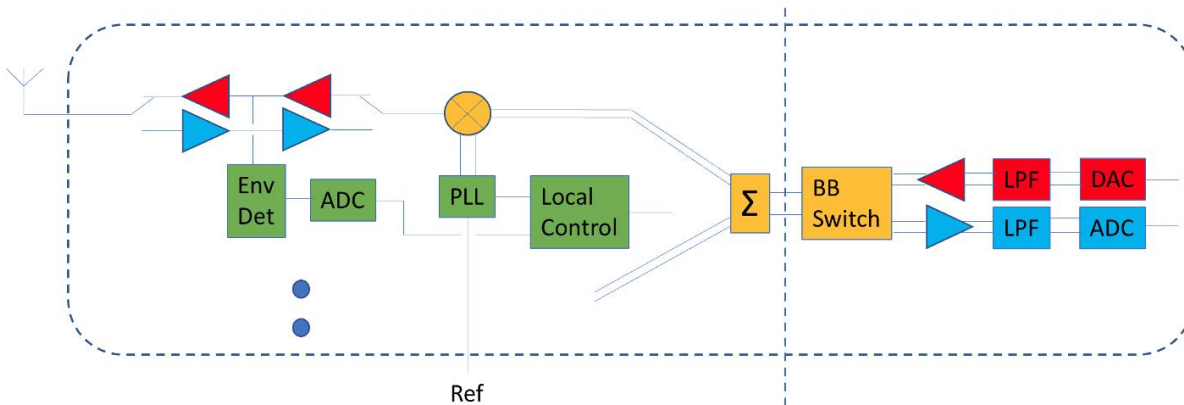
- 6% of all deployed links are E-band (1% 2017)
- 20% of all shipped links will be E-band in 2025 (25% 2027)
- 1.8 times as much spectrum in W-band as in E-band
- 5 times as much spectrum in W-band and D-band compared to E-band



Ongoing D-band trials

Radio access

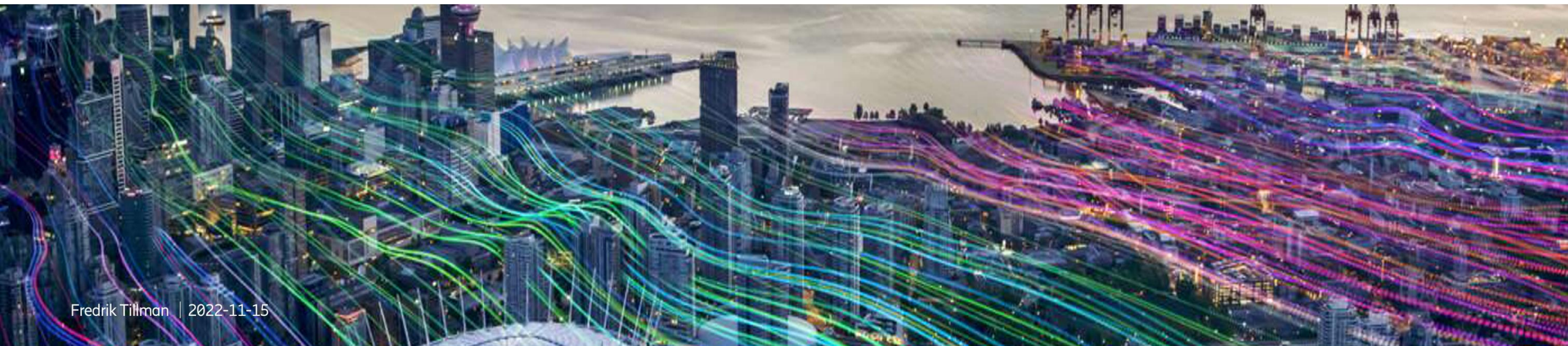
- 5G NR FR2 (24.25 - 71GHz) shipping today and in product development
- Accelerating research and trials on sub-THz
 - First step ~100GHz
 - Architectures to handle thousands of antennas
 - Viable semiconductor technologies



Summary

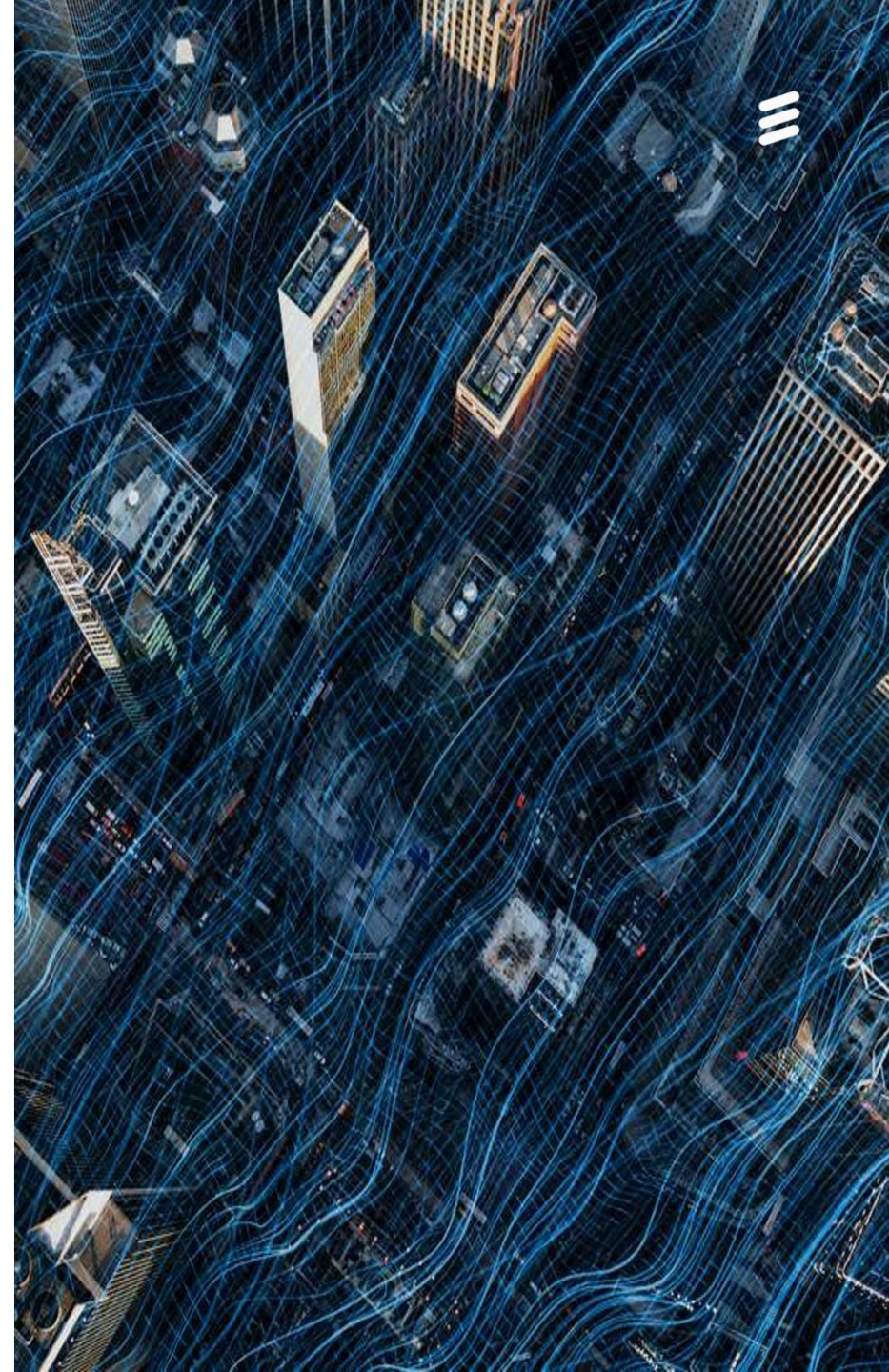


- A cyber-physical world will push technology requirements
- Sub-THz will play a role in “beyond 5G”, but exactly how remains to understand
- Specific scenarios and applications
- Everything becomes tough - we need to work on all fronts



References

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- B-E. Olsson et al., "Radio Propagation in an Office Environment at 140GHz and 28GHz", European Conference on Antennas and Propagation (EuCAP), 2021
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- S. Ek, et. al, "A 28-nm FD-SOI 115-fs Jitter PLL-Based LO System for 24-30-GHz Sliding-IF 5G Transceivers", IEEE Journal of Solid-State Circuits, Vol. 53, No. 7, pp. 1988-2000, July 2018
- M. Hörberg et al., "A W-band, 92–114 GHz, real-time spectral efficient radio link demonstrating 10 Gbps peak rate in field trial", IEEE International Microwave Symposium (IMS), 2022





Imagine Possible