

Radio for THz Communication – what are we up against?



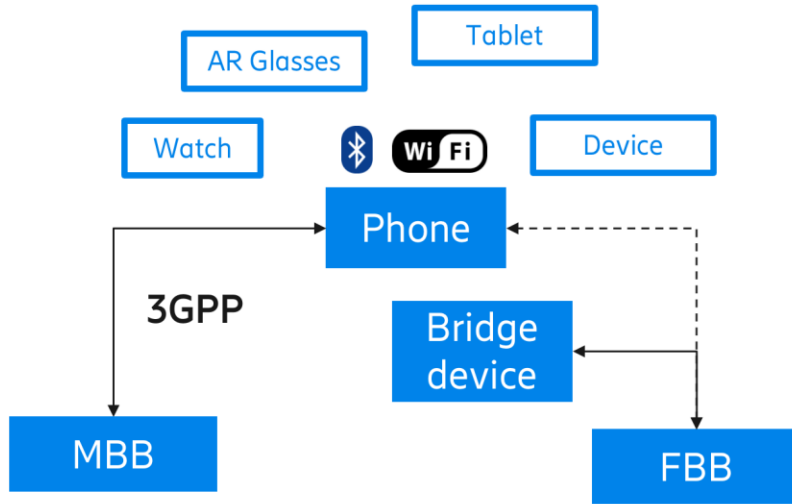
Fredrik Tillman
Ericsson Research



Towards a local connect and compute paradigm

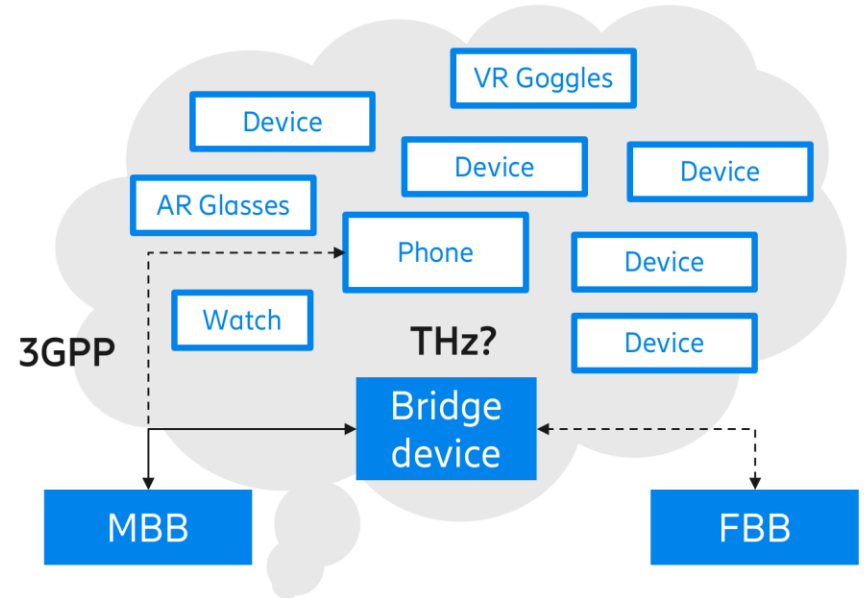


2022



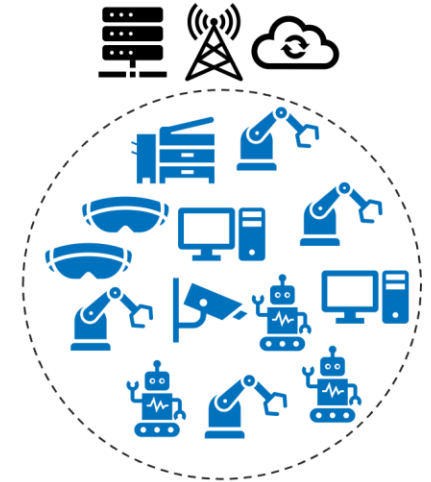
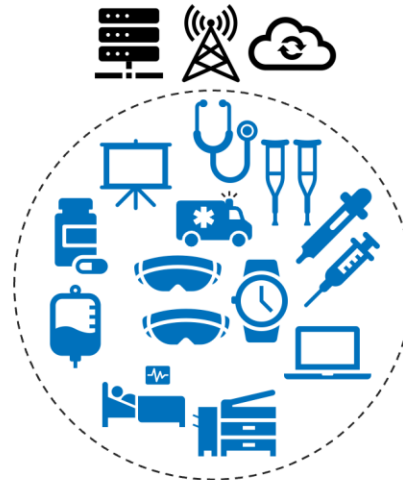
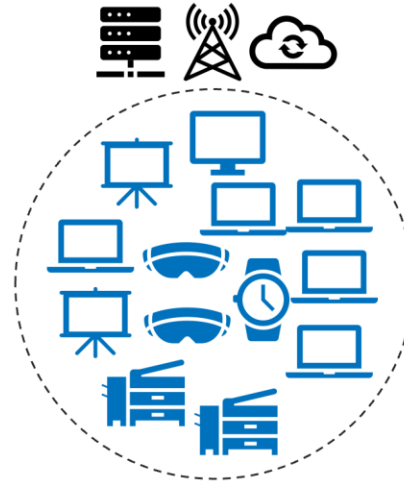
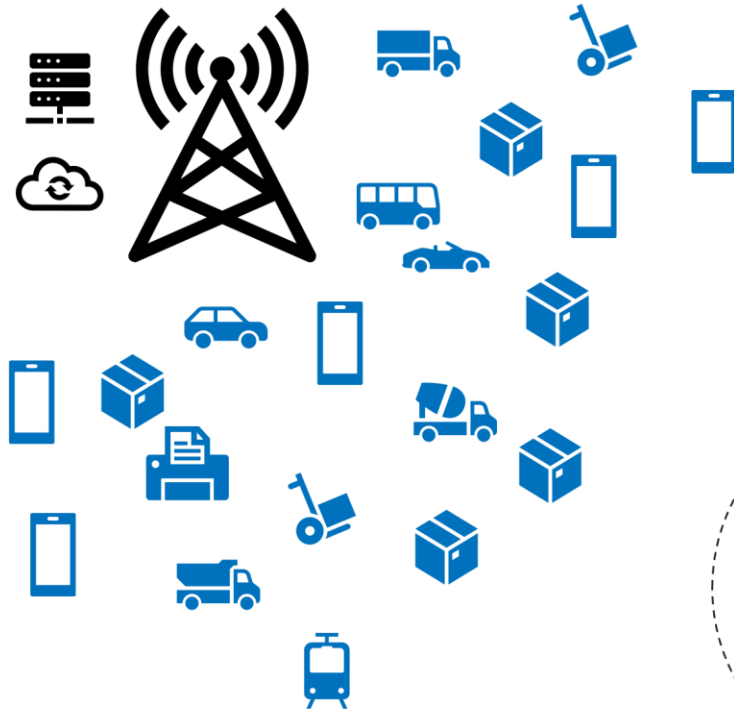
Phone software ecosystem

2030



Evolved software ecosystem

Wide area – local area



Strategic venues

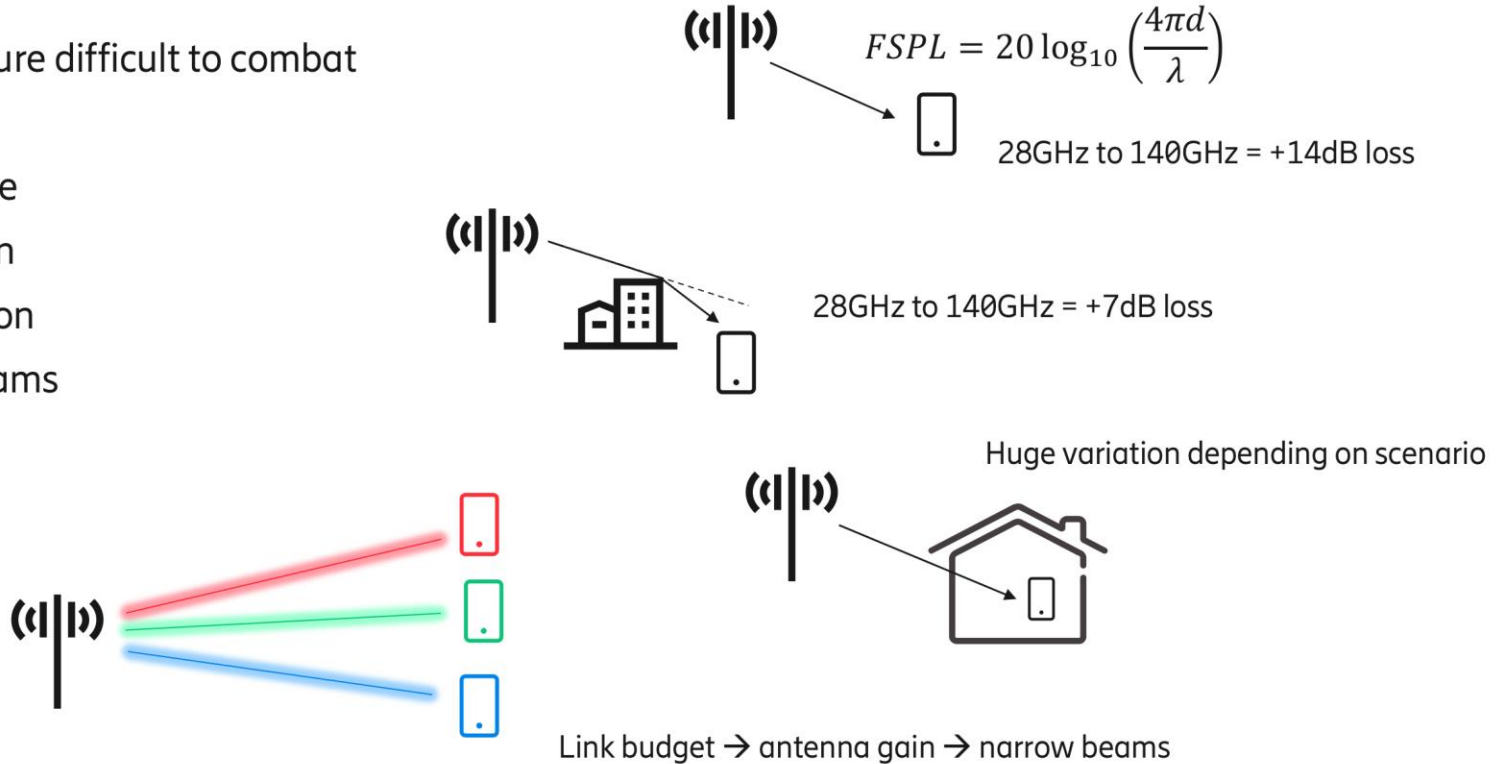
Factory floors
Offices
Classrooms
Hospitals
Retail
Home

Deployment challenges



Laws of nature difficult to combat

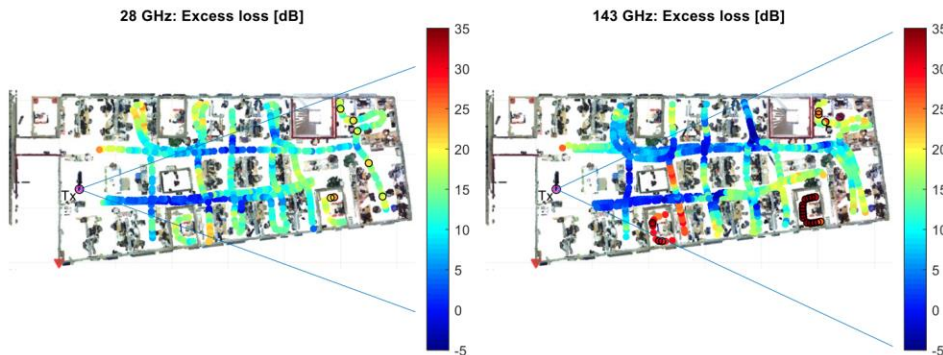
- Free space
- Diffraction
- Penetration
- Pencil beams



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



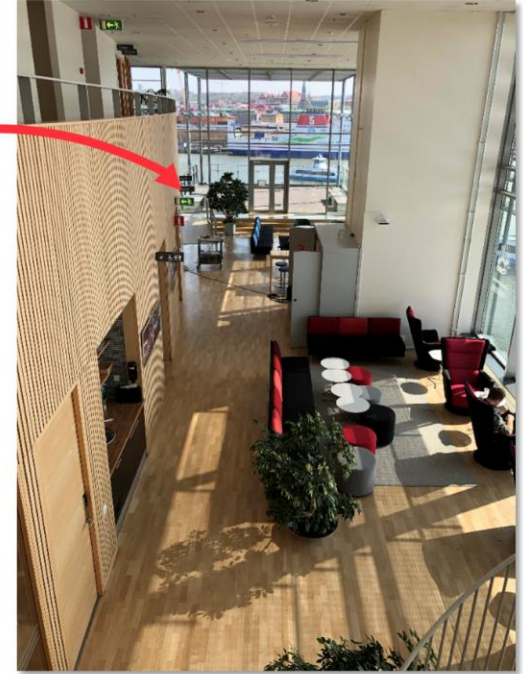
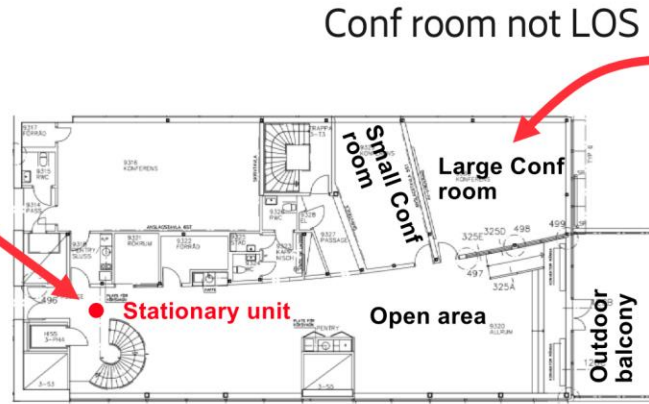
Office scenario 1		
	28GHz	140GHz
Penetration: Drywall A	3-7	11-15
Penetration: Wooden door A	8	>50
Penetration: Glass in wooden door A	1.5	12
Penetration: Wooden door B	15	>50
Penetration: Indoor glass wall A	1.9	15
Penetration: Curtain (thin)		0.4
Penetration: Sweatshirt		0.8
Penetration Cardboard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

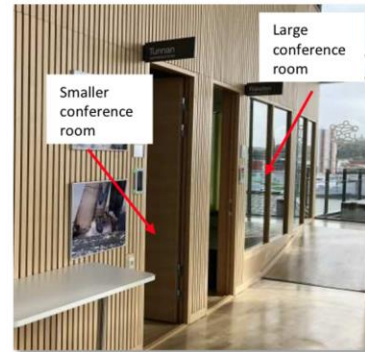
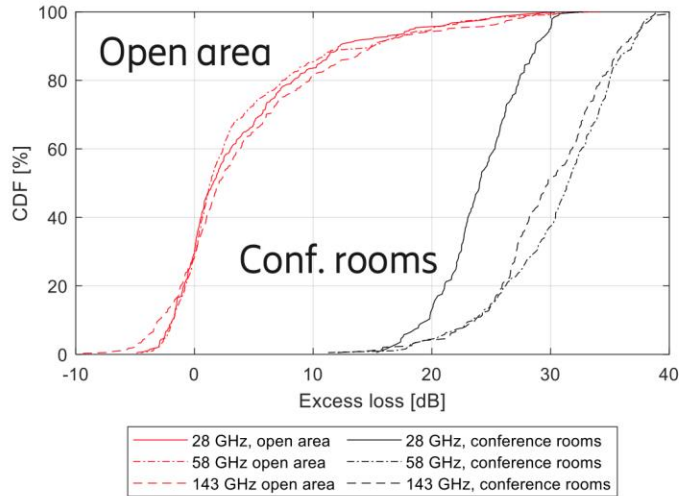
Office scenario 2		
	28GHz	140GHz
Reflection: Whiteboard on wall	0	0
Reflection: Drywall B	6	9
Reflection: Big indoor glass wall	7	8

Open area with conference rooms



Coverage

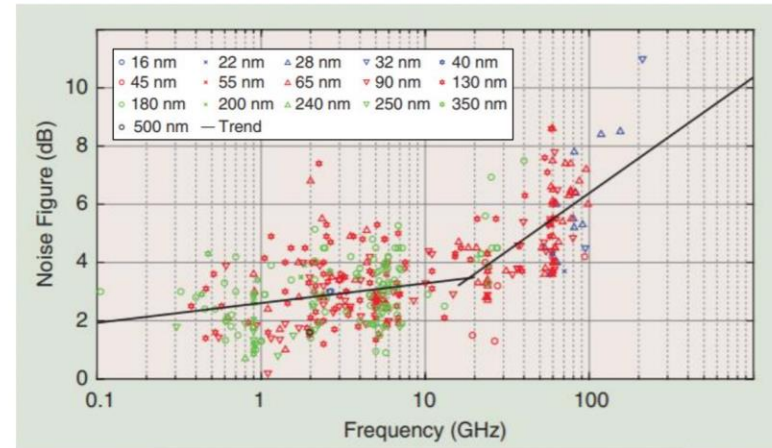
- Open area very similar for all 3 frequencies
- Higher loss in conference rooms for 58 and 143 than 28GHz
- Very similar excess loss in the conference rooms @ 58 and 143GHz



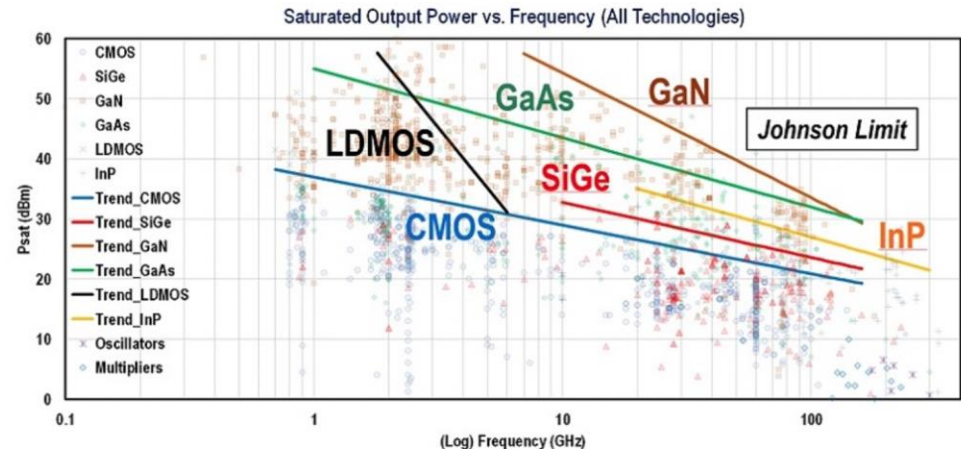
Hardware challenges

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

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



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



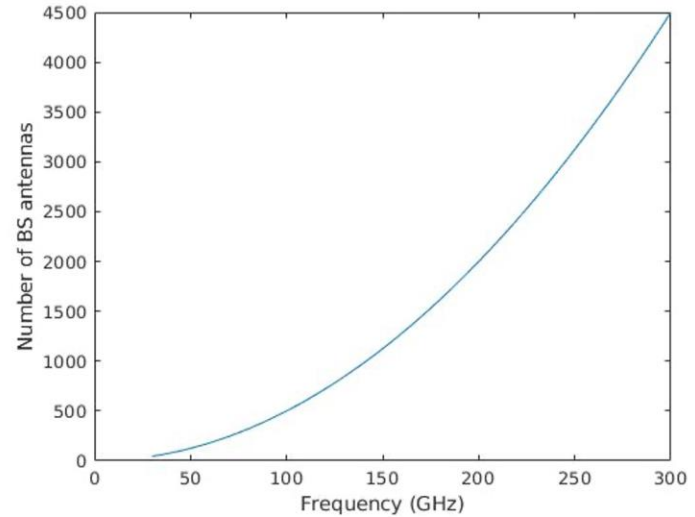
H. Wang et al., "Power Amplifiers Performance Survey 2000-Present"

How do we handle thousands of antennas?



Example

- Distance: 200m
- Bandwidth: 10GHz
- SNR: 30dB (includes margin)
- Antenna element gain: 3dB
- TX power: 5dBm @ 100GHz, and $\sim f^{-3}$
- NF: 9dB @ 100GHz, with excess noise factor $\sim f$
- # Base station antennas = 10x # device antennas



To cover all directions several panels must be used



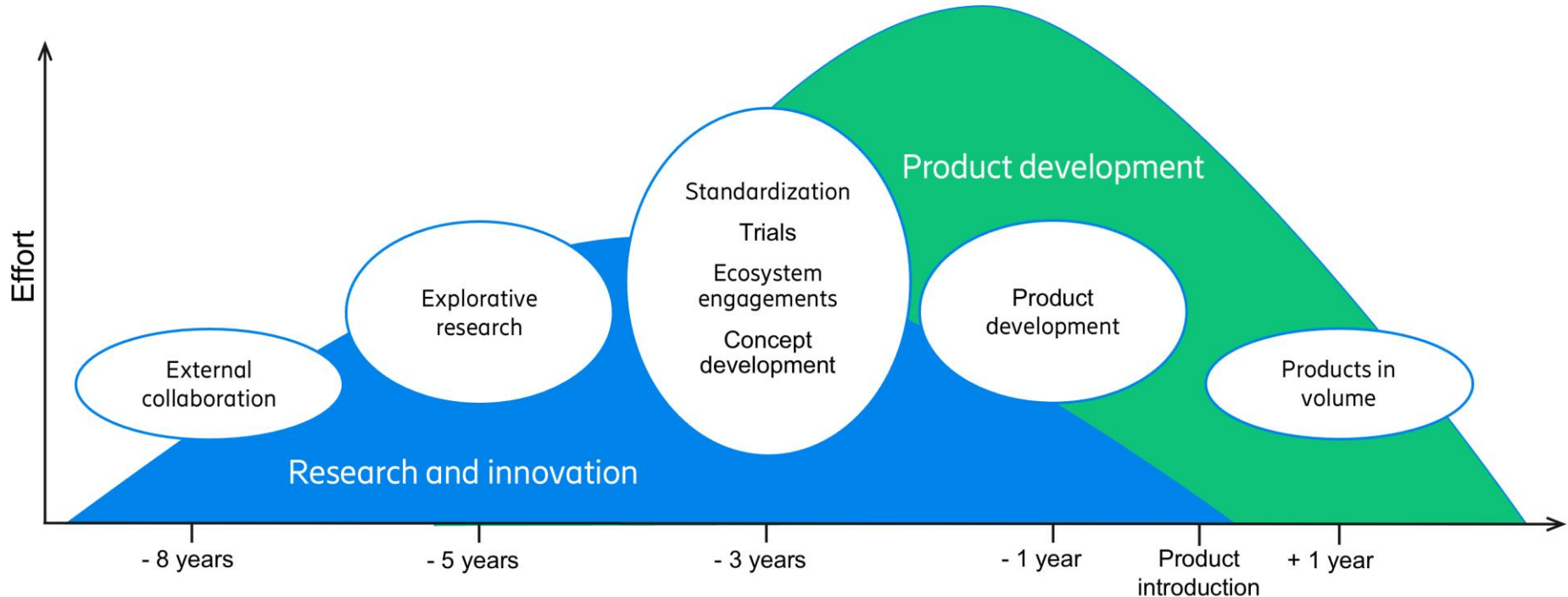
So, what do we need to be successful?



Understand the development cycle



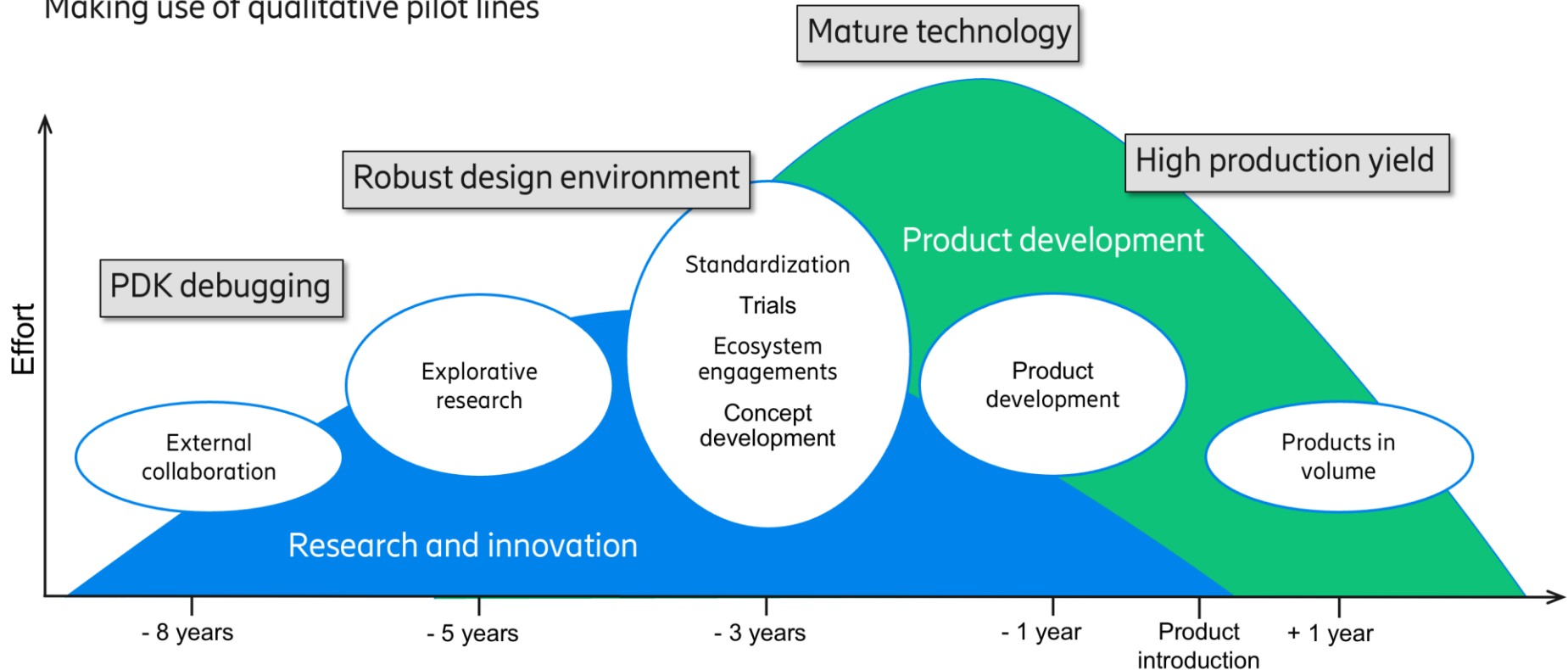
How many technology changes can one afford until the market window is jeopardized?



Understand the development cycle



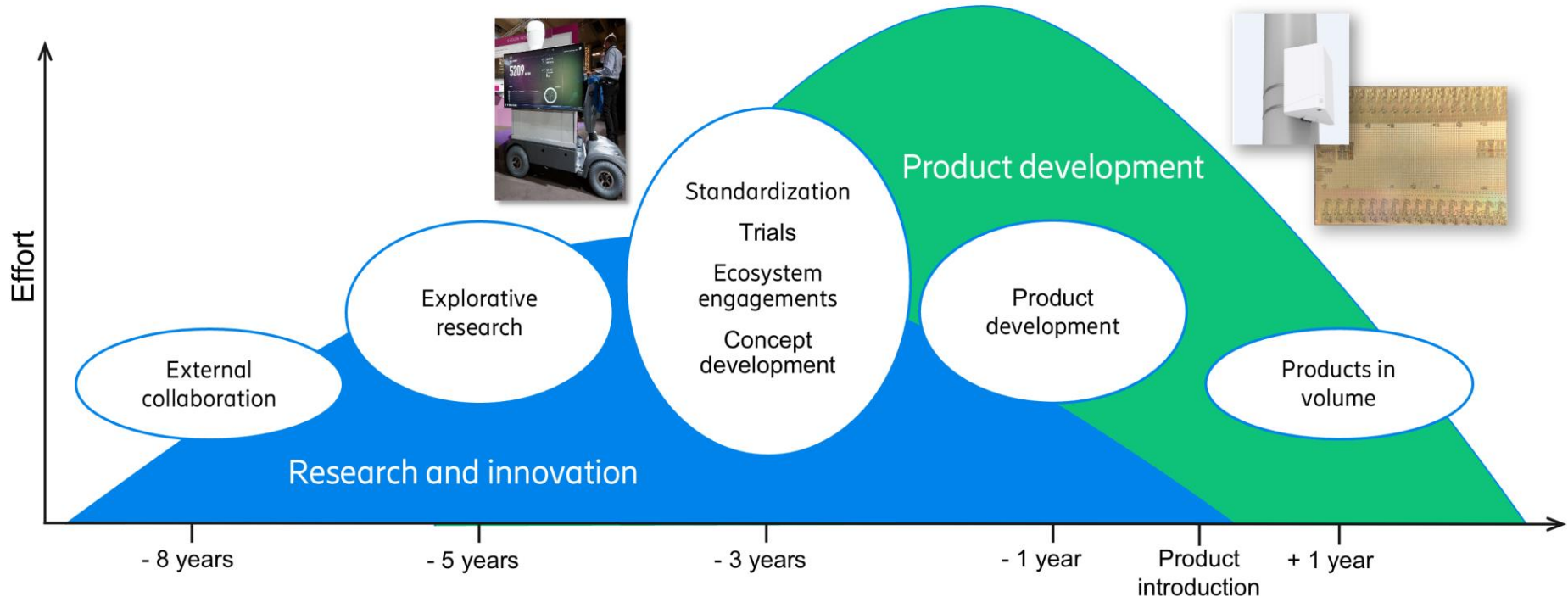
Making use of qualitative pilot lines



Understand the development cycle



...and not forget about heterogenous integration, package, antennas, cooling etc.





Imagine Possible