THE NETWORKED SOCIETY
- 5G AND BEYOND

ERICSSON

Torsten Larsson
Manager ASIC Implementation, BNEW DNEW RA RPVLd ASIC Implementation

TODAY'S PRESENTATION

Introduction

This is Ericsson

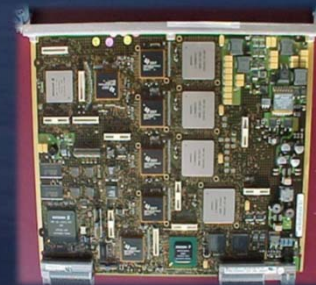**The Networked Society**

5G and beyond

Making it happen

LUND RADIO DESIGN

› [Q] – What do you think we do when "designing hardware" for Ericsson Radio Systems?

› [Q] – What type of engineering competences do you think are needed for a hardware designer?
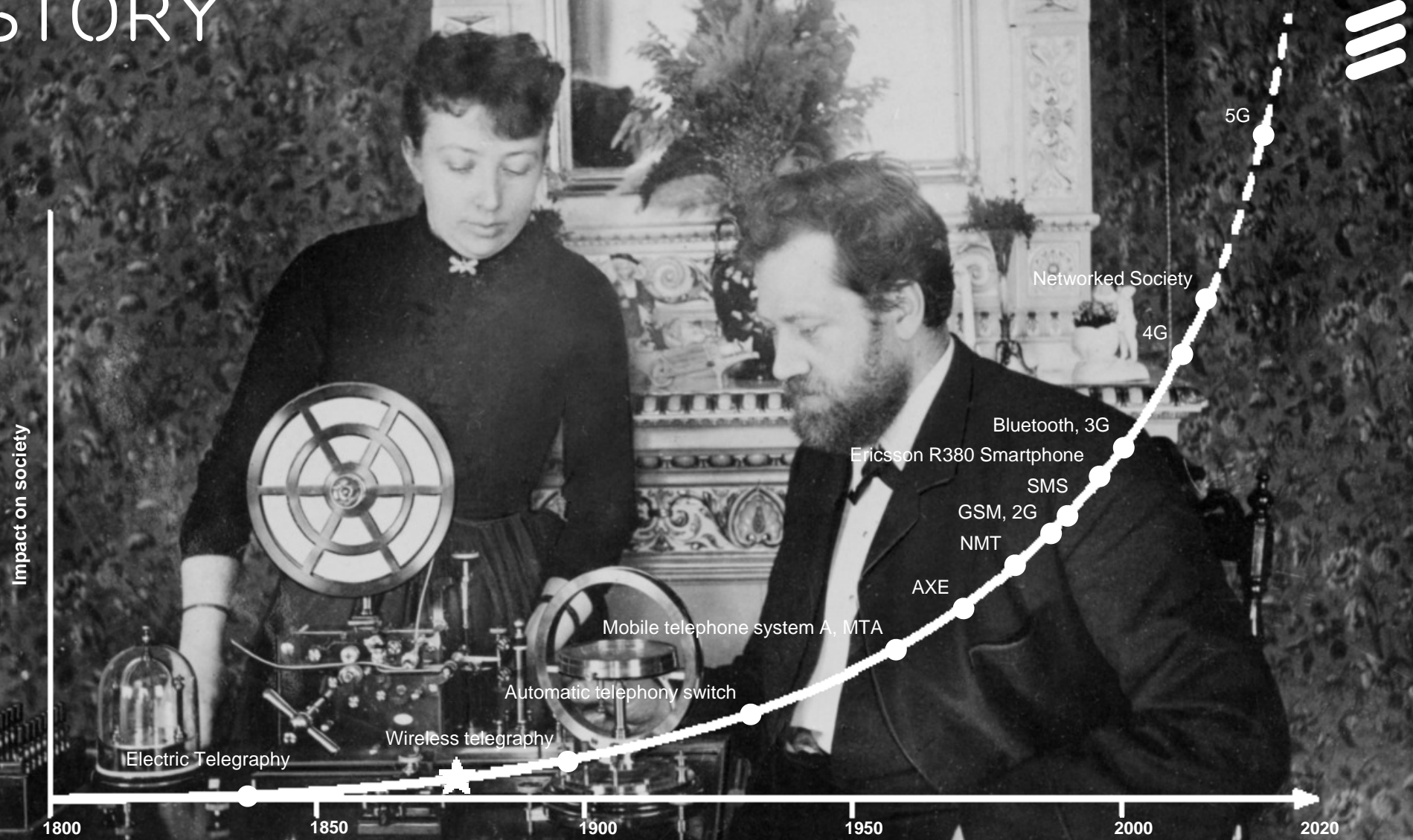
› [Q] – Any idea what type of products we design?

ERICSSON RADIO SYSTEMS

2G
3G
4G

Radio Base Station

What people see

Baseband Enclosure Backhaul Small Cell
Software SW
Radio Power Fronthaul Site

Ericsson Network Manager

THIS IS
ERICSSON

HISTORY

Impact on society

5G

Networked Society

4G

Bluetooth, 3G

Ericsson R380 Smartphone

SMS

GSM, 2G

NMT

AXE

Mobile telephone system A, MTA

Automatic telephony switch

Wireless telegraphy

Electric Telegraphy

1800   1850   1900   1950   2000   2020

ERICSSON AT A GLANCE

NETWORKS
Create one network for a million different needs

IT
Achieve business agility with Transformative IT

MEDIA
Delight the TV consumer every day

INDUSTRIES
Connected solutions for industry transformation

42,000		Patents
25,600		R&D Employees
36 B. SEK		In R&D

1 BILLION		Subscribers managed by us
2.5 BILLION		Subscribers supported by us
65,000		Services professionals

223 B. SEK		Net Sales
180		Countries with customers
110,000		Employees
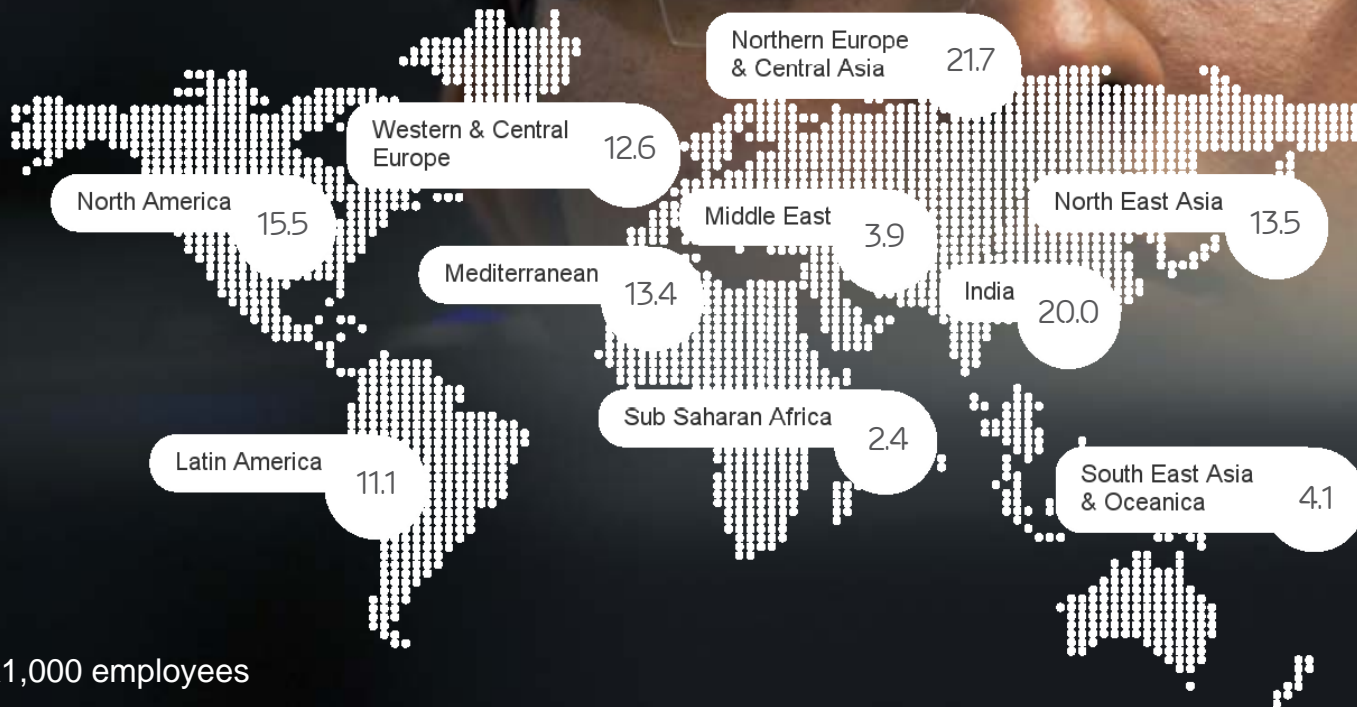
2014 Annual Report figures

ORGANIZATION

CEO
Börje Ekholm

GROUP FUNCTIONS
Finance & Common Functions – Carl Mellander   **Marketing & Communications** – Helena Norrman
Human Resources – MajBritt Arfert   **Legal Affairs** – Nina Macpherson
Technology & Emerging Business – Acting Niklas Heuveldop
Sustainability & Public Affairs – Elaine Weidman-Grunewald

Business Area
Networks
Fredrik Jejdling

Business Area
Digital Services
Ulf Ewaldsson

Business Area
Managed Services

Peter Laurin

MEDIA
Media Solutions
Angel Ruiz

Market Areas

North America
Niklas Heuveldop

Europe & Latin America
Arun Bansal

Middle East & Africa
Rafiah Ibrahim

South East Asia, Oceania & India
Nunzio Mirtillo

North East Asia
Chris Houghton

Broadcast & Media Services

Chairperson Magnus Mandersson

CUSTOMERS

OUR STRATEGIC FOUNDATION

VISION   A Networked Society where every person and every industry is empowered
to reach their full potential

MISSION   We lead transformation through mobility

VALUES   Trust – Performance – Innovation

ERICSSON LUND

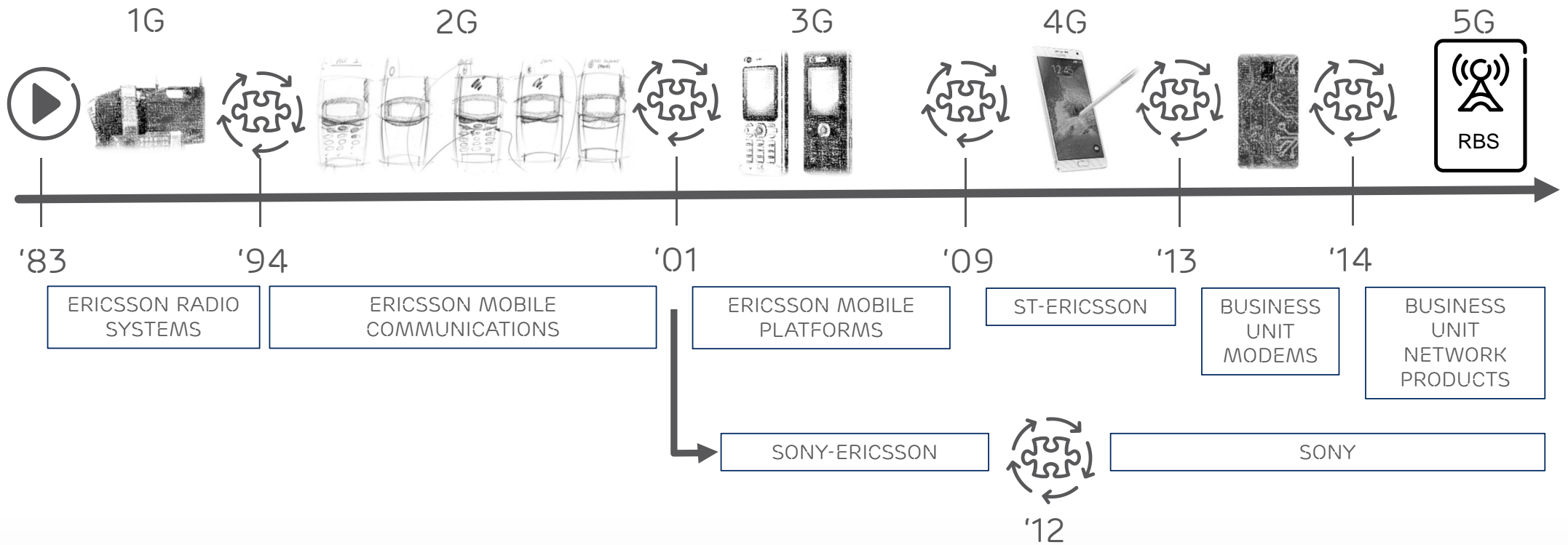# ERICSSON IN LUND
30+ YEARS OF EXPERIENCE

A billion devices…

- **From GSM to 3G, 4G and now 5G**
- **Cost, size and energy focus**
- **Major IPR contribution**
- **Customer understanding**

LUND SITE – TIMELINE

| 1G | 2G | 3G | 4G | 5G |

'83   '94   '01   '09   '13   '14

| ERICSSON RADIO SYSTEMS | ERICSSON MOBILE COMMUNICATIONS | ERICSSON MOBILE PLATFORMS | ST-ERICSSON | BUSINESS UNIT MODEMS | BUSINESS UNIT NETWORK PRODUCTS |

SONY-ERICSSON   SONY

'12

COMPETENCE AND CAPABILITY

Systems & Technology | 45

› Product & System Architecture
› RF Technology
› Radio Access Technology
› Chipset and SW Technology

PDU Radio | 200

› Radio and Digital Systems Design
› Radio Design and Validation
› RFIC Design and Validation
› Digital ASIC & FPGA IP Development
› SoC Architecture and Systemization
› ASIC Implementation

PDU 4G5G RAN | 270

› RAN System
› Baseband SW development for LTE and NR
› Baseband Infrastructure
› System Performance and Energy Efficiency

Ericsson Research | 100

› Radio Access Research
  – NR / LTE / IEEE Standardization
  – Multi Antenna Algorithms
› RFIC Research
› Cloud Research
› Security Research

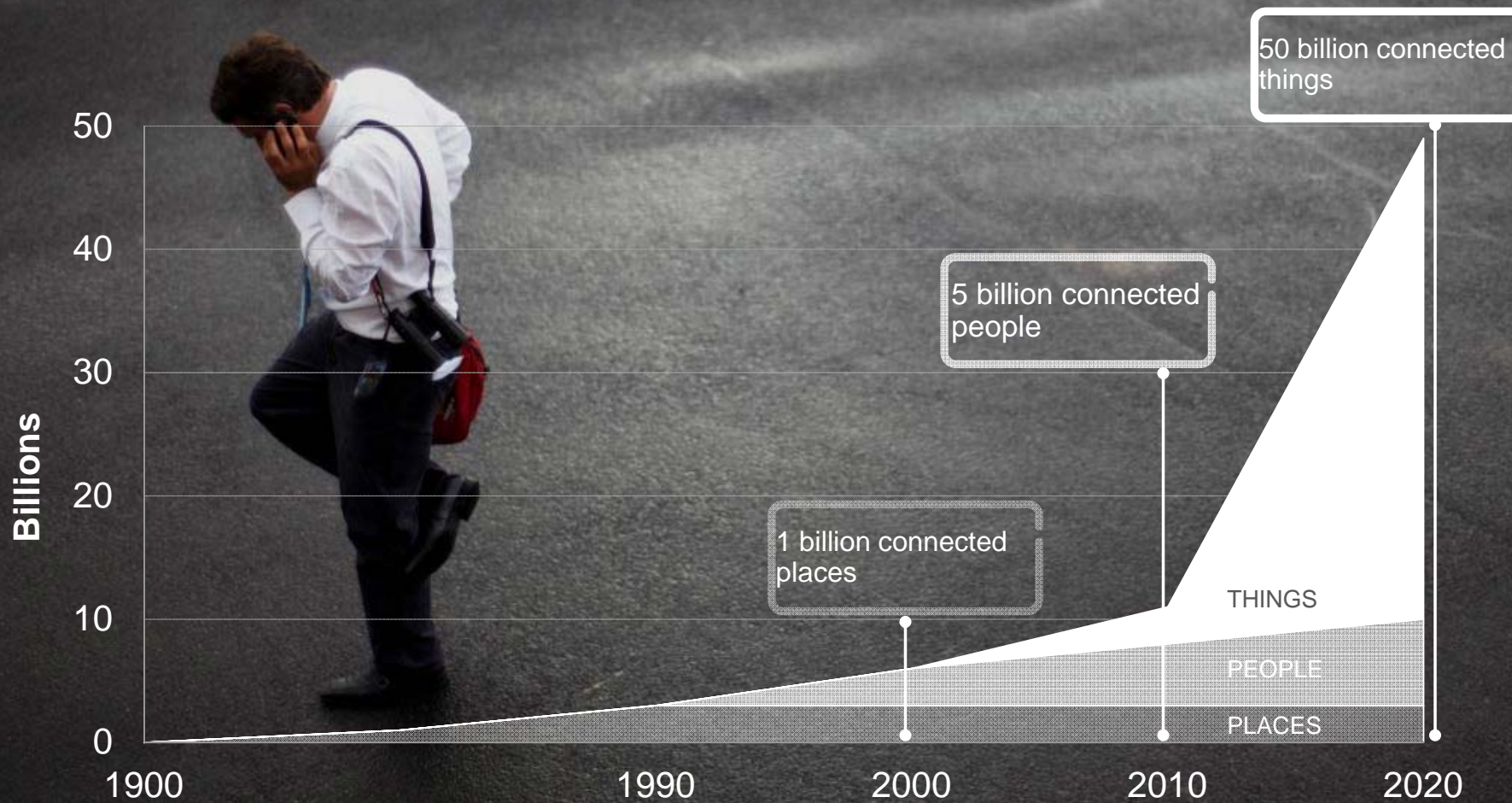IOT   IPR & Licensing   EITTE & IT   Other

~600

~40

THE
NETWORKED
SOCIETY

PACE OF CHANGE

50 billion connected things

5 billion connected people

1 billion connected places

THINGS

PEOPLE

PLACES

Billions

50
40
30
20
10
0

1900   1990   2000   2010   2020

4X DATA CONSUMPTION
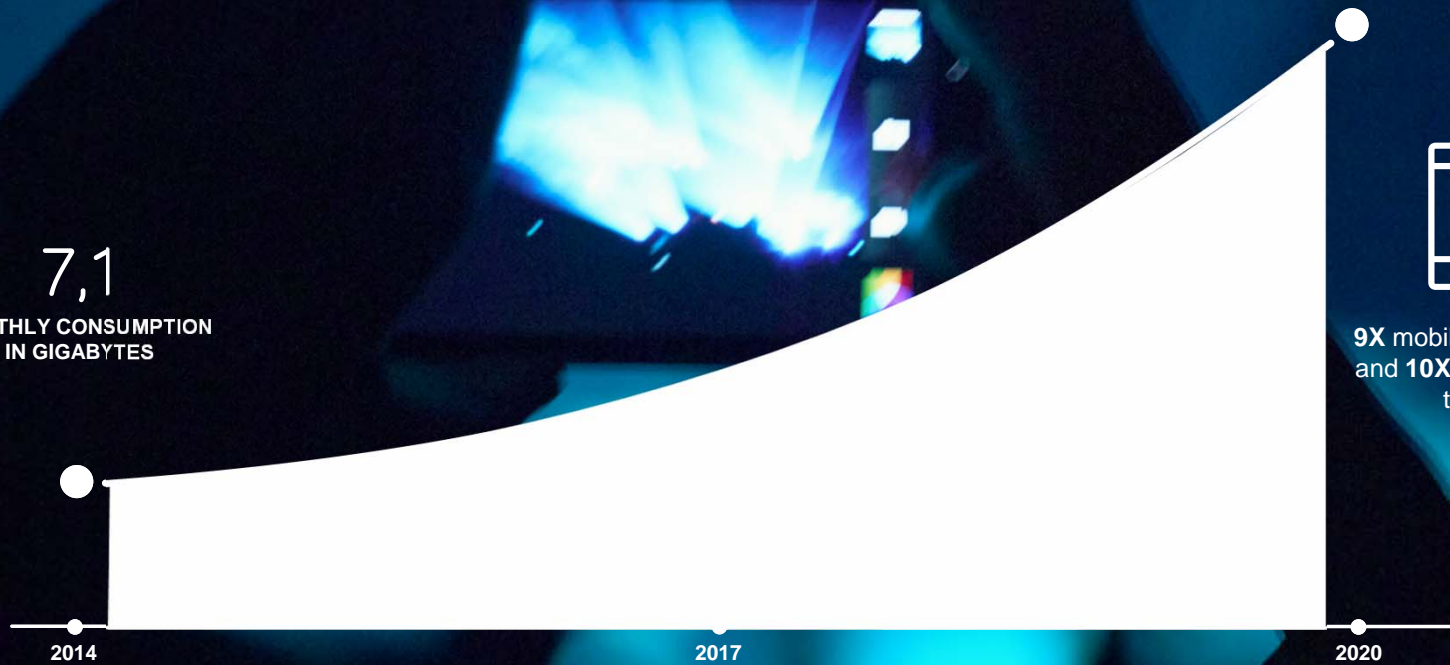
30,6 MONTHLY
CONSUMPTION
IN GIGABYTES

7,1
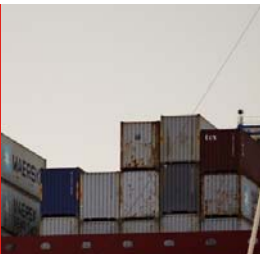MONTHLY CONSUMPTION
IN GIGABYTES

9X mobile data traffic
and 10X smartphone
traffic

2014   2017   2020

Smart Vehicles,
Transport & Infrastructure
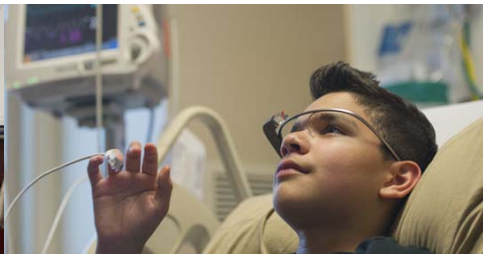
Broadband Experience.
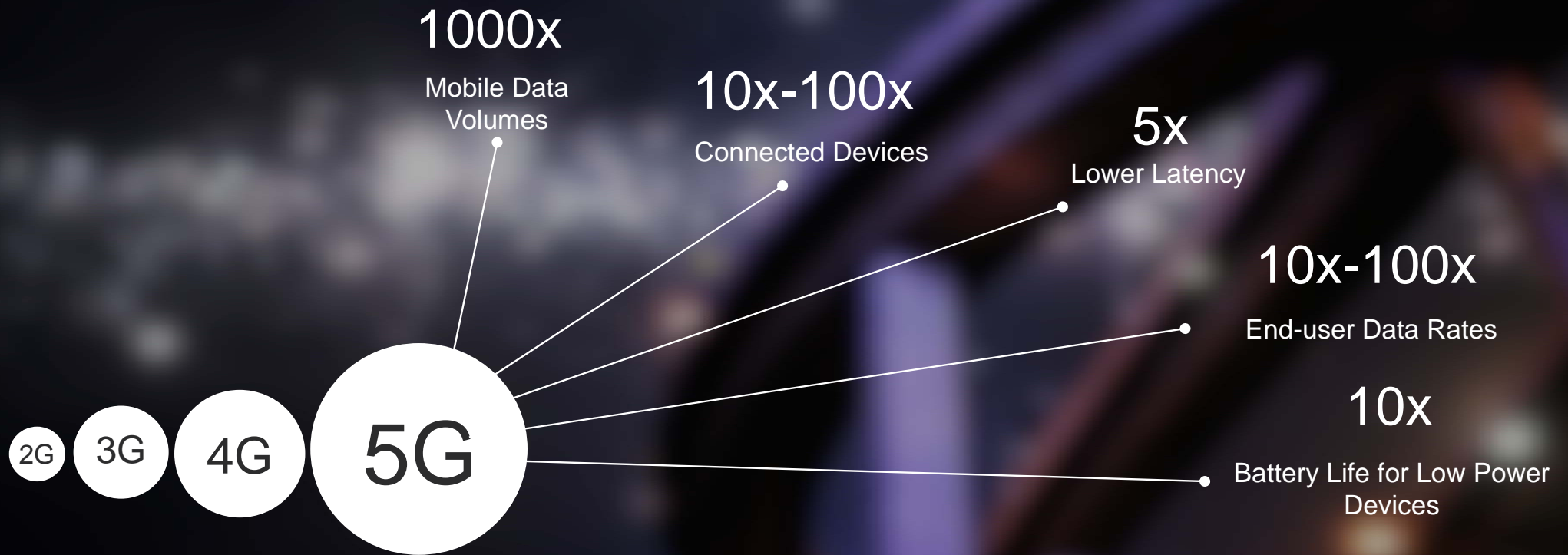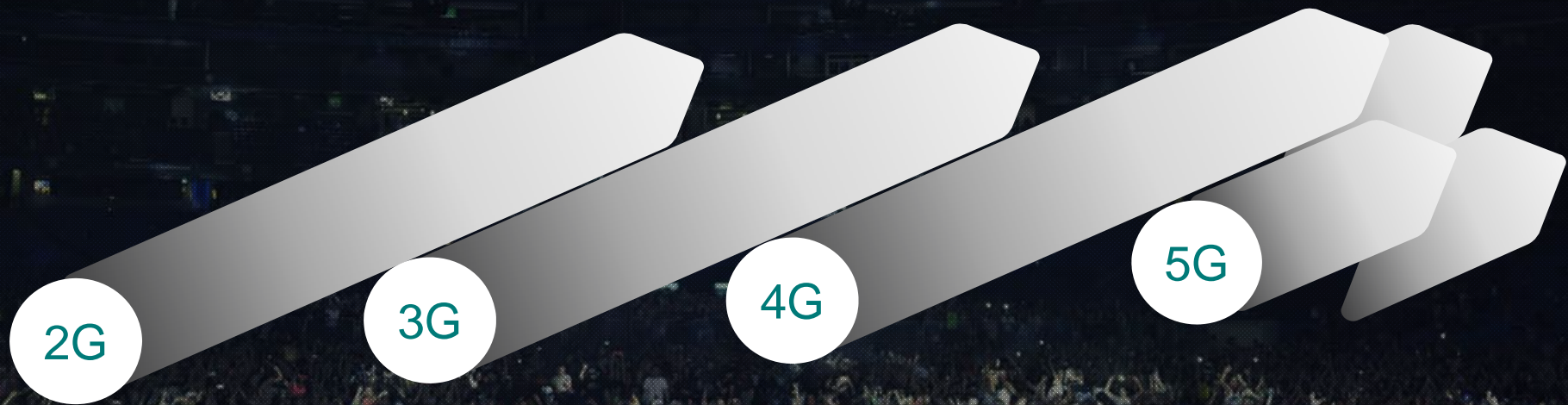Everywhere, Anytime.

Interaction
Human - IOT

Critical Control of
Remote Devices

Media Everywhere

DIVERSE OPPORTUNITIES WITH 5G

2G

3G

4G

5G

VOICE

Massive mobile
voice communication

BROWSING

Feature phones and
mobile broadband
introduction

VIDEO

Smartphones
popularization and
mobile data traffic
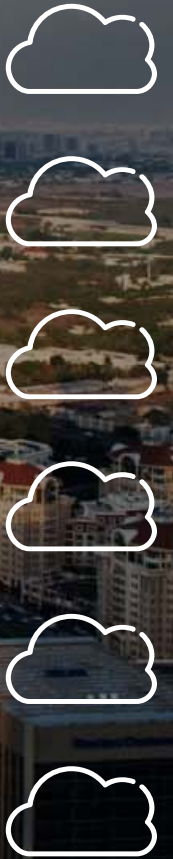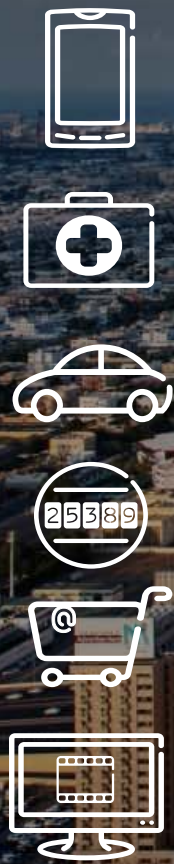exponentially increase

MULTIPLE INDUSTRIES

Any device can provide access
to the content and enable
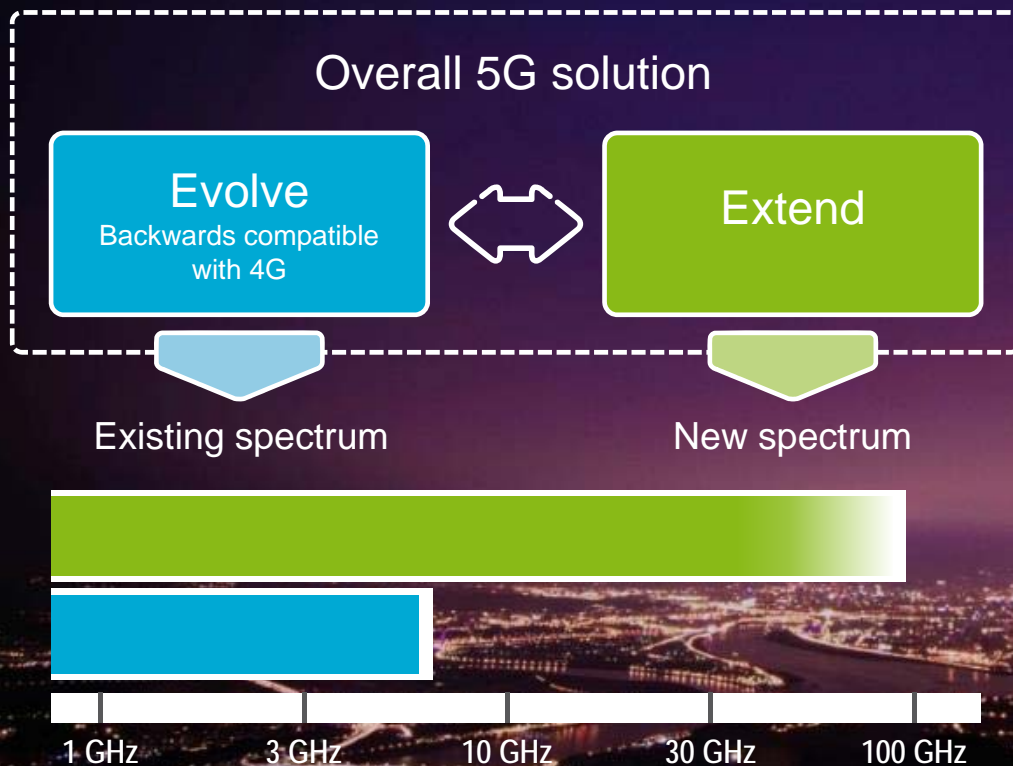new business opportunities
across industries

5G AND BEYOND

ONE NETWORK – MULTIPLE INDUSTRIES

A common network platform with dynamic and secure Network Slices

5G RADIO ACCESS

Overall 5G solution

Evolve
Backwards compatible with 4G

⟷

Extend

Existing spectrum

New spectrum

1 GHz   3 GHz   10 GHz   30 GHz   100 GHz

› Evolution of existing technology adding new RAN technology

› Combined allows rapid switching based on radio conditions

› Gradual migration of new technology into existing spectrum

5G CONCEPT ON TODAY'S NETWORKS

4G — LTE and LTE-A

- Up to 3GPP Release 12
  - Up to 8x8 MIMO
  - Carrier aggregation up to 1Gbps
- Services
  - VoLTE
  - eMBMS
  - Mid-tier MTC (Cat 0)

LTE-E

Backward compatible with LTE and LTE-A

- Unlicensed
- Low latency
- Lean design concepts
- Massive MTC (Cat-M, NB-LTE)
- Vehicular (V2X)

5G — NR

Not backward compatible with LTE and LTE-A

- High frequency bandwidth
- Large bandwidth
- Massive beamforming/MU-MIMO
- Ultra low latency
- Ultra lean
- Critical MTC
- Migrate over time to low frequency spectrum (replacing LTE-E)

Enhanced dual connectivity

Split architecture

5G
USE CASES

BROADBAND EXPERIENCE
EVERYWHERE, ANYTIME
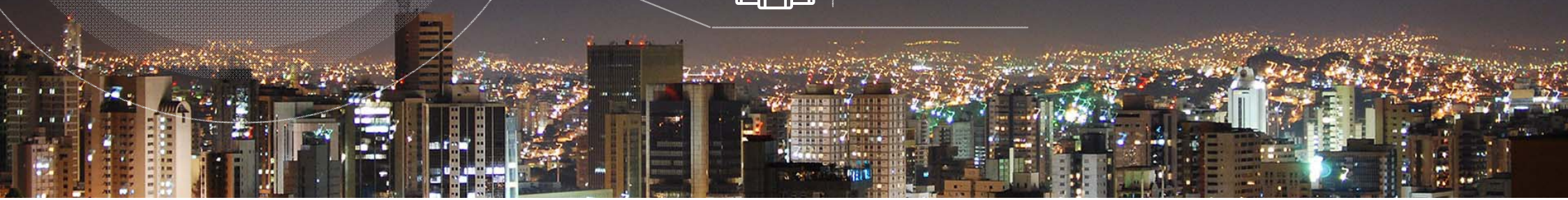
MEDIA
EVERYWHERE

SMART VEHICLES,
TRANSPORT & INFRASTRUCTURE

CRITICAL CONTROL
OF REMOTE DEVICES

INTERACTION
HUMAN-IOT

ERICSSON MAKING IT HAPPEN

5G TECHNOLOGY

BEAMFORMING

› Traditional base station antennas light a broad beam over its sector

  Typically 120 degrees beamwidth

  Good since

  › Simple and robust

  › User stay in the same beam a long time

  But bad since

  › Only one user served at a time

  › If deployed too densely, a lot of interference created
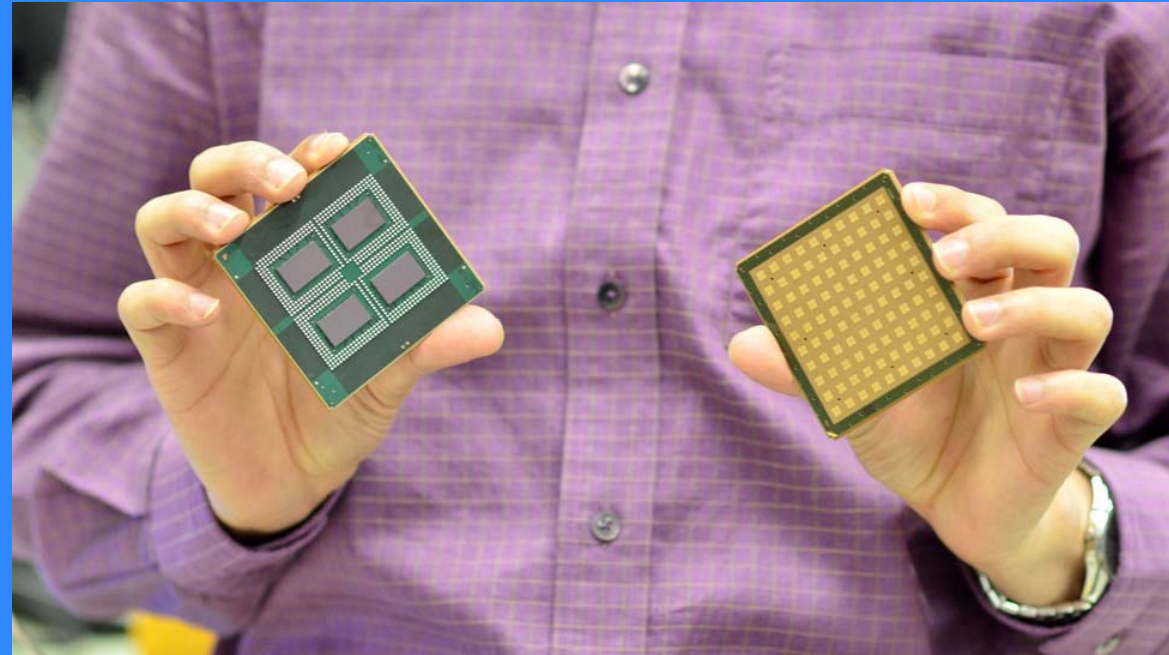
› Create narrow beams instead – beamforming
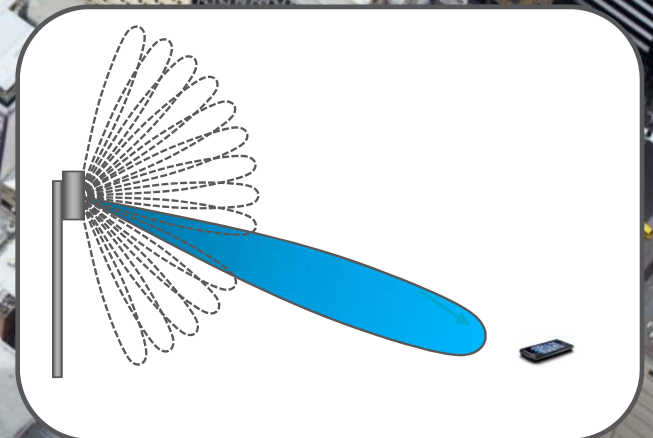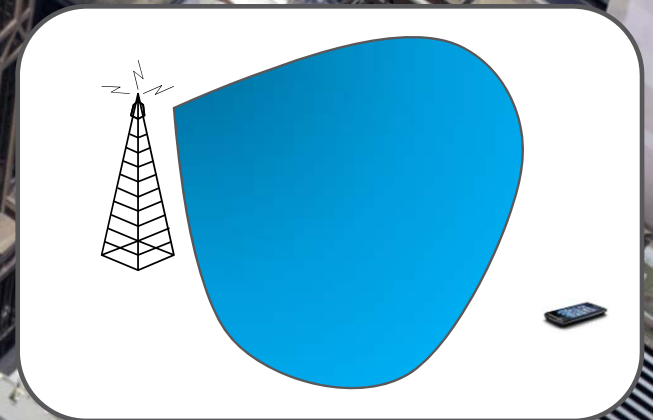
HIGH FREQUENCY

› New challenges
- Size
    › HF gives smaller antennas
- Power
    › Heat dissipation in small boxes
- Integration level
    › Allow modular approach
- Propagation
    › line of sight
- Testing other the air, OTA

DESIGNING A SYSTEM

Digital ASIC and FPGA

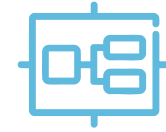Radio Design and I&V

Radio System

RF IC Design

ARCHITECT SYSTEM

SOC IP CORES D&V

CHIP D&V

BOARD D&V

SW TOOLS

PLATFORM & APP

Radio Products & Variants Lund

Baseband → Digital Radio → Radio

ASIC & FPGA USAGE IN A SYSTEM

	Baseband	MIB	DFE	ADC/DAC	Up/Dw Conv1(IF) / Up/Dw Conv2(RF)	Comb/Split, Phase Shifter	PA/LNA/Switch	Ant
LF(<6GHz) 4G:	BB processing	N/A	Radio ASIC	Transiver	N/A		PA, LNA, SW	An t
LF(<6GHz) AAS:	BB processing	Ant. ctrl	Radio ASIC	Transiver	N/A		PA, LNA, SW	An t
HF Alt 1:	BB processing	Ant. ctrl	Radio ASIC	Transiver	RF IC			An t

WHEN 5G WILL HAPPEN?

| WRC-15 | | | | WRC-19 | Spectrum allocation by regulators on national basis | | |

ITU | Requirements | WS | Proposals | Specs | IMT-2020 process

Rel-14 | Rel-15 | Rel-16 | Rel-17 | **3GPP** A GLOBAL INITIATIVE

5G Ph1

| 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |

Pre-commercial trial networks

First commercial products

Indoor deployments

Commercial deployment WRC´19 bands > 6 GHz

Multi-city roll-out

LAST WEEK IN OTTAWA

AIR 6468
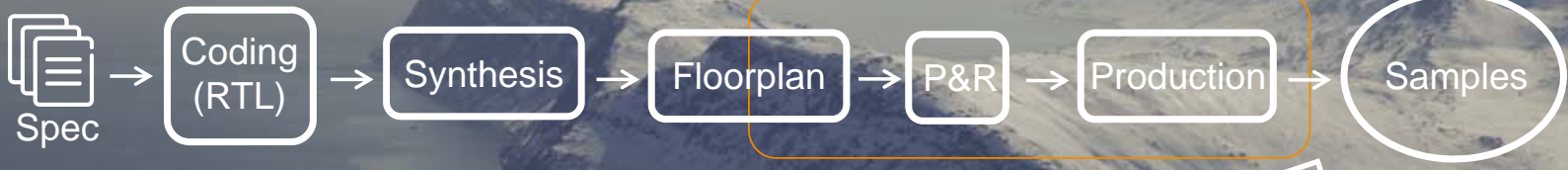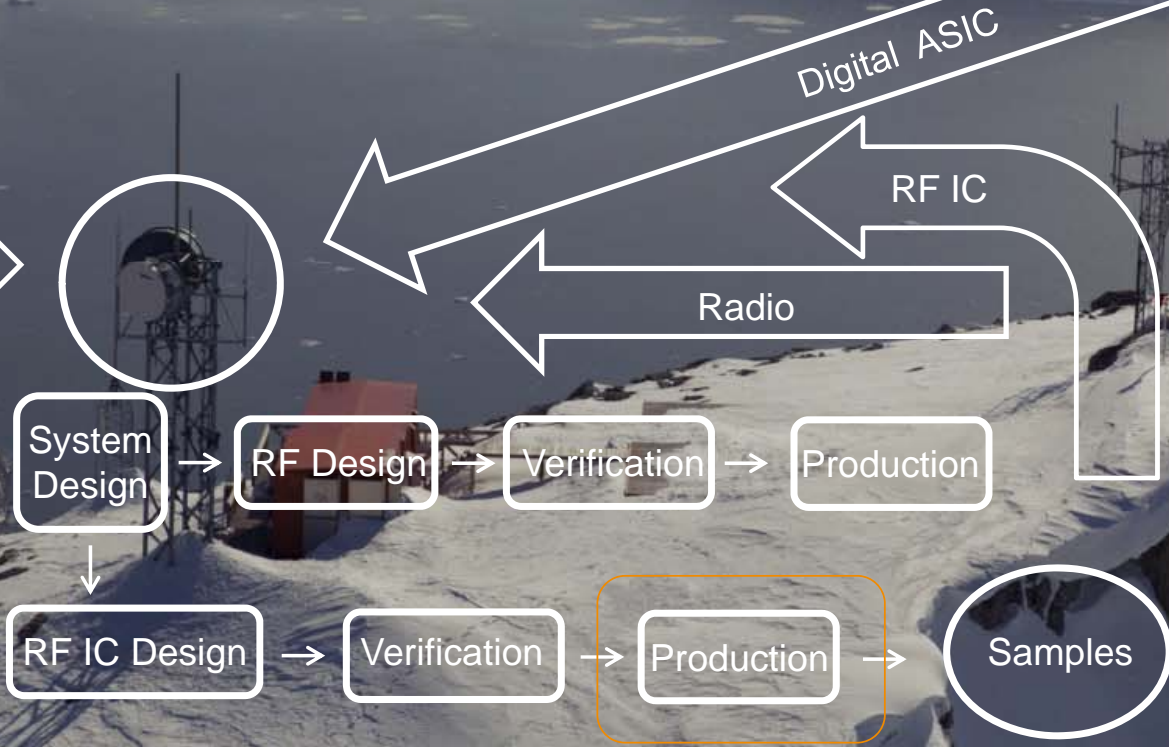
SUMMARY

The foundation of Mobile telephony

Mobile telephony for everyone

The foundation of mobile broadband

The future of mobile broadband

The Networked Society

1G 2G 3G 4G 5G

1980 1990 2000 2010 2020

Next Generation Wireless? We will make it work. As always!

OUR OPEN POSITIONS

All positions are on Ericsson job site and LinkedIn

Manager Product Development Baseband SW 4G5G	Lund, M, SE
New engineers as Digital ASIC/FPGA Developer	Lund, M, SE
Ericsson Lund is looking for talented experienced developers for LTE/5G development	Lund, M, SE
Senior Digital ASIC/FPGA Developer	Lund, M, SE
HW Developer	Lund, M, SE
Product Development Leader	Lund, M, SE
Researcher within Research Area Radio	Lund, M, SE
Ericsson Lund is looking for Young Talented LTE/5G Developers	Lund, M, SE
Radio Designer Developer Job stage 6	Lund, M, SE

Current list – more will added continuously during the year.