ICT Innovatie Platform
Duurzame ICT

Energy & Wireless Communication: an interesting Couple

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Where innovation starts

Energy & Wireless Communication:

An interesting couple:

Conflicting interests?

Or
A Perfect Pair?

Sign of the times?

A Generic Problem

How bad is it today?

Cell phones only (2011):

- 6 10^9 cell phones
- 4.5Wh battery
- Recharge 1x per day
- Average charging power (100% efficiency):

1.1 GW

1.5 billion battery replacements per year (2011)

45000 m^3

But there's more:

Total power dissipation cellular basestations:

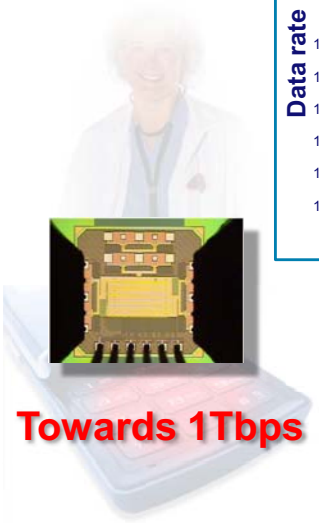
20 GW

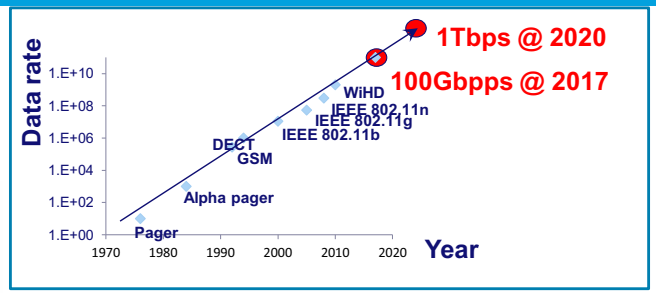
Solar panel (150W/m²):

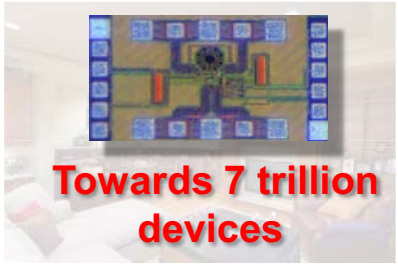
133000000 m²

Cellular only…

And we want even more:







More and Moore Problems

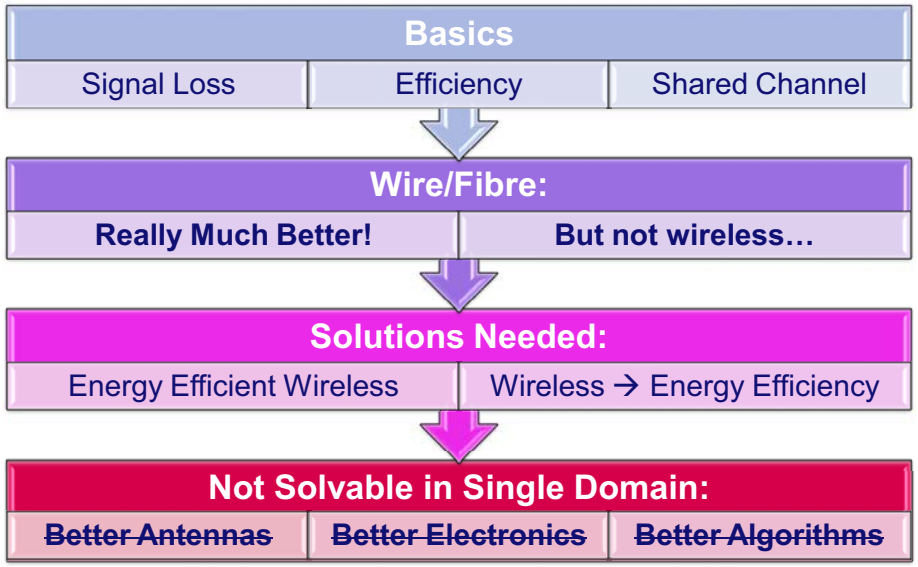
- 1 Tbps / device
- 7 trillion devices
- Shared channel

→

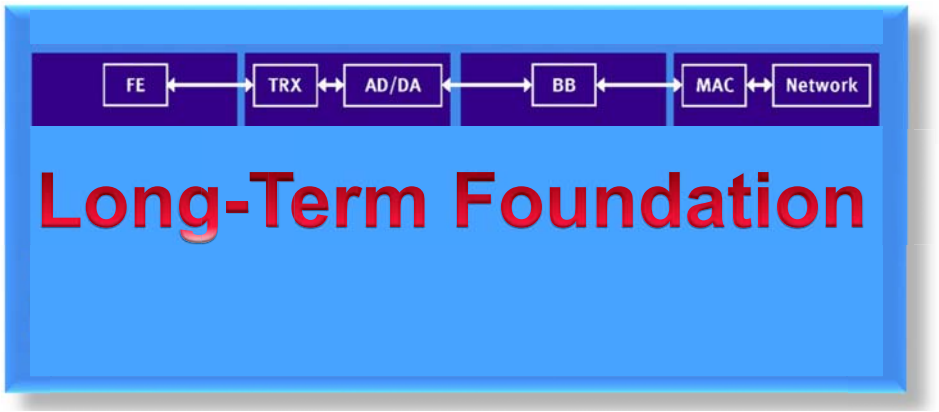
- More robustness
- More complexity
- More power

Moore doesn't help To Automatically Achieve Less Power! (in analog & RF electronics)

Basics of the problem



Managing Wireless Complexity



Coupling Energy & Wireless: Solutions

Shared Channel

- Room at the Top
- Path Loss Reduction
- Interference Reduction

Battery-less

- Pico-Burst
- Wireless Energy Xfer

Wireless → Energy Efficiency

- Many applications:
  - Traffic
  - Home/office
  - Environment

Achievable data rate versus bandwidth

Shannon:

$$C = BW \log_2(1+SNR)$$

Transmission:

$$P_{RX} = P_{TX} G_{RX} G_{TX} \left(\frac{\lambda}{4 \, pi \, r}\right)^{\alpha}$$

$$R \le BW \log_2\left(1+\frac{P_{TX} G_{RX} G_{TX} \left(\frac{\lambda}{4\pi r}\right)^{\alpha}}{k \, T \, BW}\right)$$

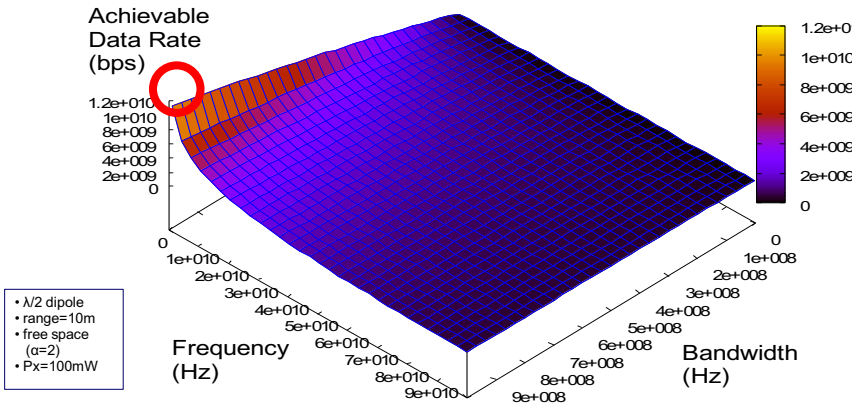
Data rate

Frequency

Bandwidth

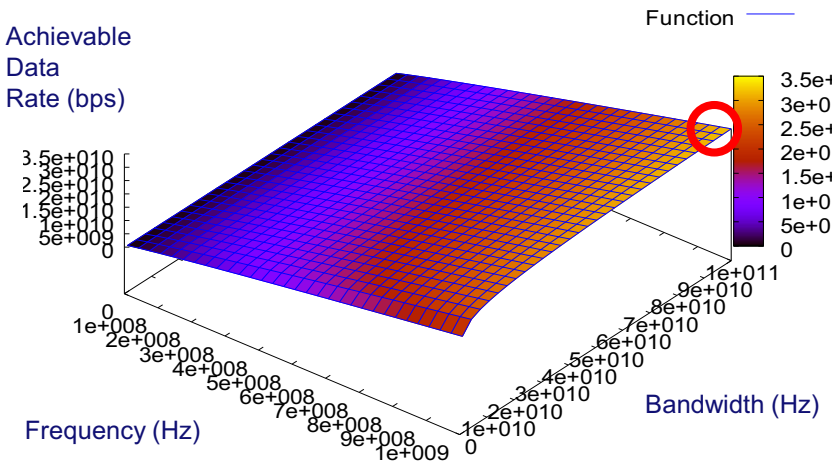
Room at the Top?

Traditional view (omnidirectional)

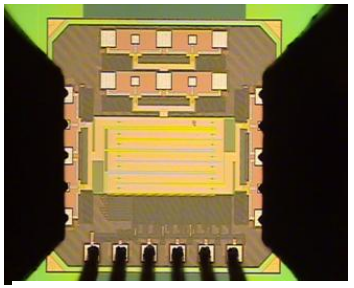


Room at the Top!

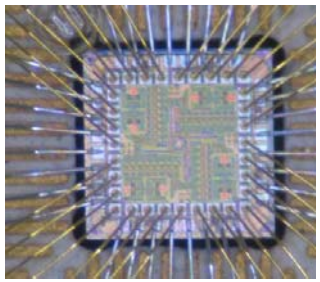
Spatial Confinement: "Wireless Wire"



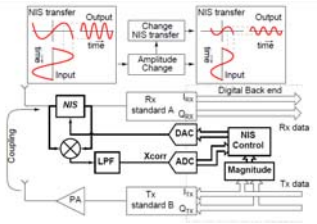
On the road towards the Top



60GHz beamformer, Antennas, algorithms

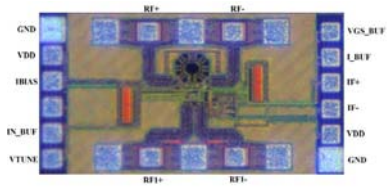


RF MIMO Interference Nuller + Algorithms

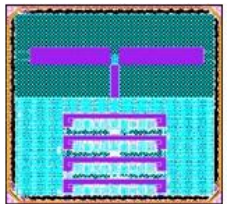


RF Interference Suppressor + Algorithms

On the road towards Batteryless

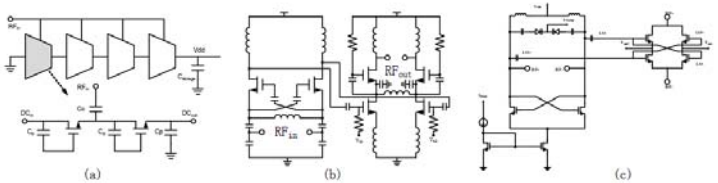


60GHz Wake-up Receiver



On-chip antennas

60GHz Battery-less Sensor Node



Conclusions

Energy & Wireless:

Starting from Conflicting Interests, …

… with the right approach &
a Lot of Work …

…Can become a Perfect Match

We are working hard to make it happen!

Acknowledgements

- CWTe groups & researchers
  - Xia Li
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  - Ulf Johanssen
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Thank you for your attention!

Do you have any questions?

Centre for Wireless Technology, Eindhoven

Battery Empty

Shutting down...