Massive MIMO for increasing energy/spectral efficiency of BS

MIMOSA Virtual Lab.

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- Who are we?
- What MIMO means?
- Context
- Potential of Massive MIMO
- Scientific challenges

Who are we?

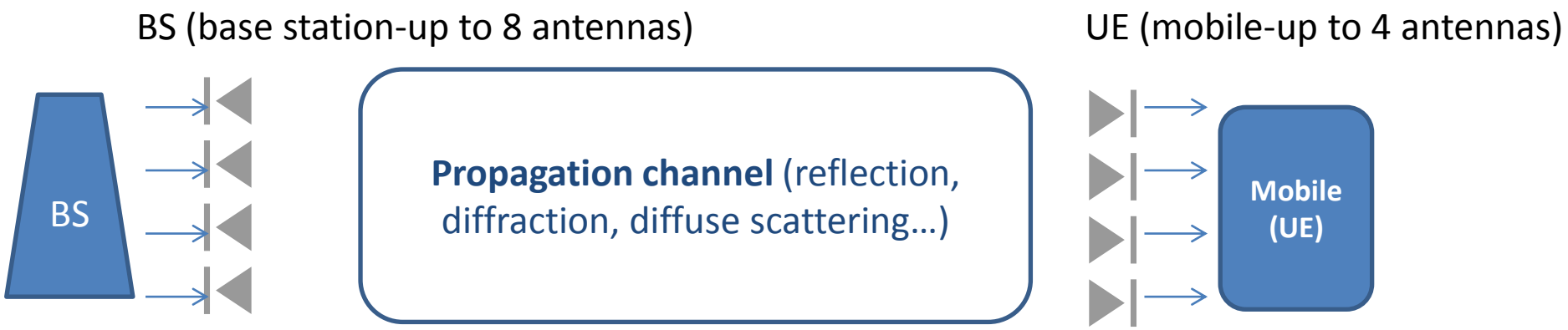
- MIMOSA virtual Laboratory (since 2012) -10 pers:
  - University of Lille/Telecom Lille/IEMN-Telice group
  - University of Gent/iMinds/WICA group

74 km

- Development of real time MIMO channel sounder based on a highly flexible software (16x16).
- PhD in Co-tutelle (1), joint scientific papers (10), Interreg Project (Wise), PHC project (Tournesol)

Multiple input-Multiple output (MIMO)

- MIMO is already introduced in the LTE and LTE-A standards.



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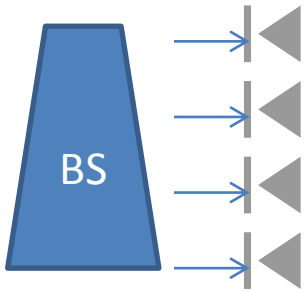
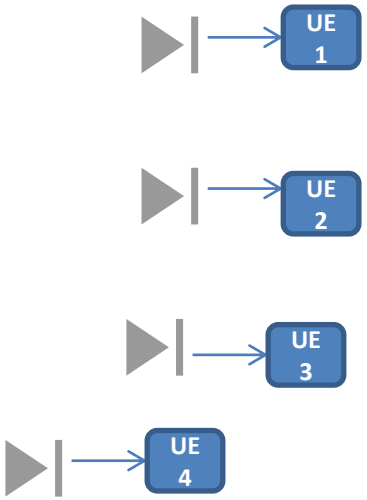
BS (base station-up to 8 antennas)



Propagation channel (reflection, diffraction, diffuse scattering…)

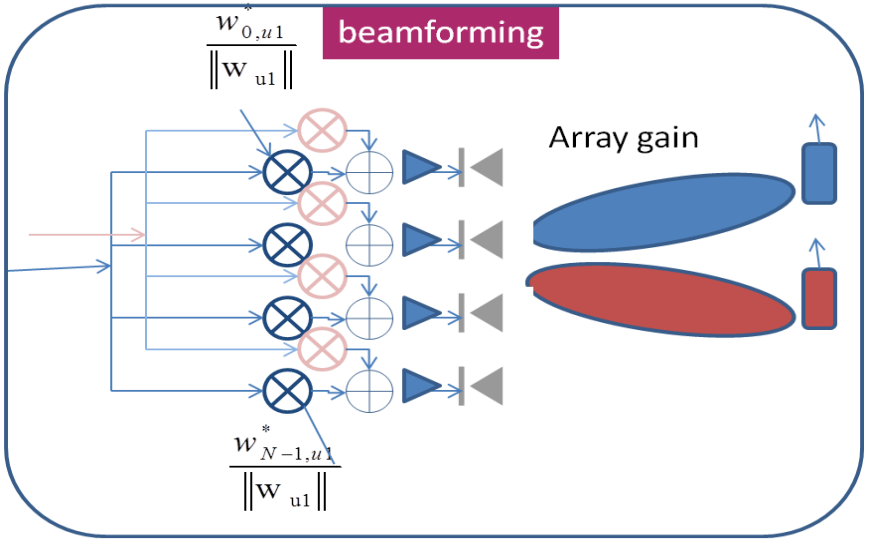
4 UE = 4 distributed antennas

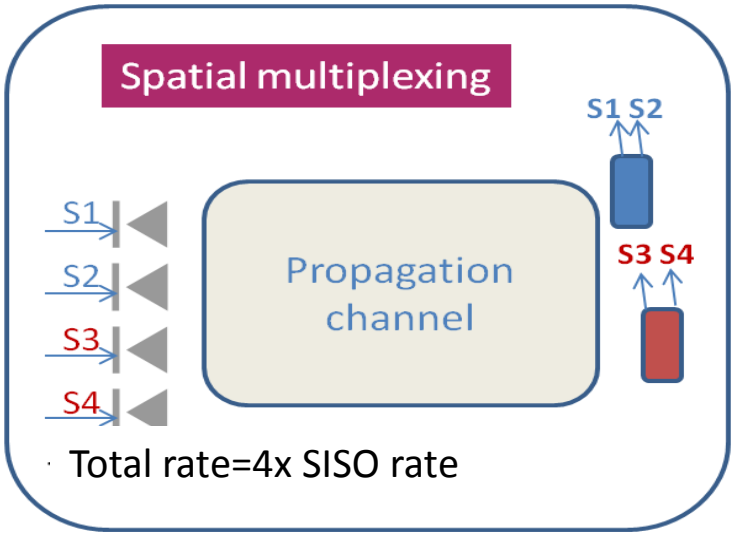


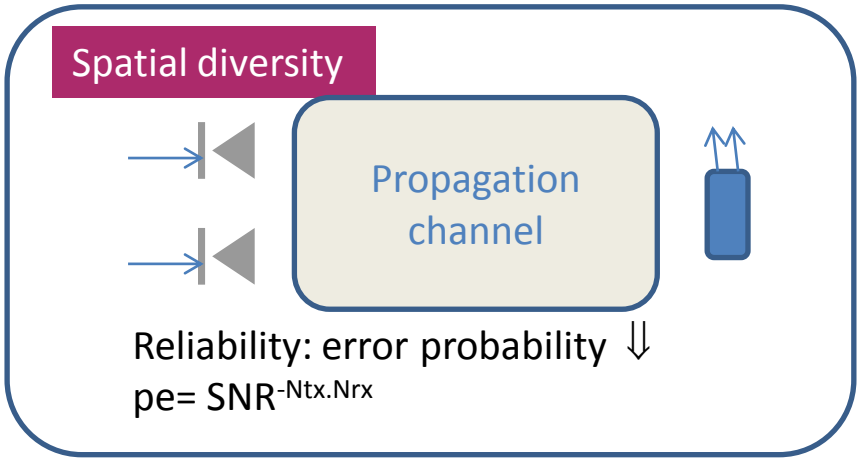
Multi user MIMO= MU-MIMO

What can we do with MIMO?

Major advantages of using MIMO:
- Increase reliability and rate with the same power and bandwidth as for SISO (1 ant (BS) and 1 ant (UE))







As an example

- Consider a very rich environment (lot of possible paths between BS and the mobile)
- Consider a capacity of 75 Mb/s in 10 MHz and error free

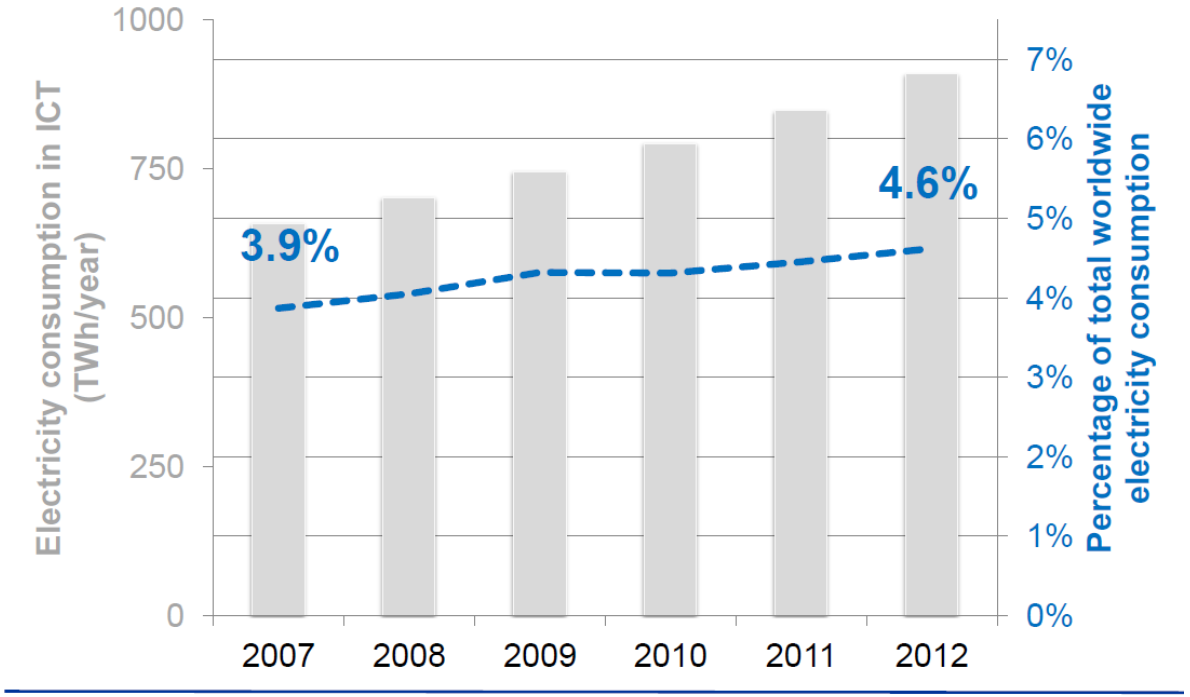
SNR=Received signal power/ noise power

Antennas (BSxUE)	1x1	4x4
SNR (dB)	23	6

Gain 17 dB

Context (1)

Joint footprint - % of electr. consumption

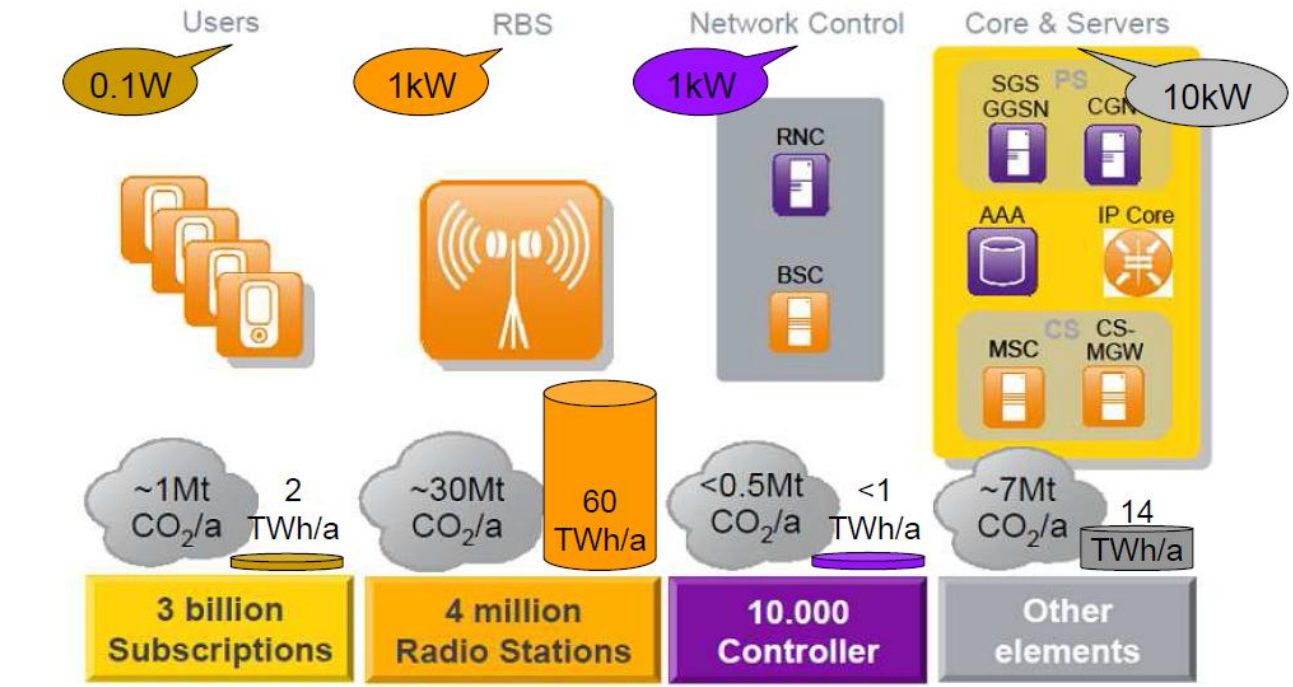


TREND Final Workshop
Brussels, October 24, 2013

11

From Bart Lannoo, IMinds

Context (2): where is the power going



CO_2 emission from cellular networks

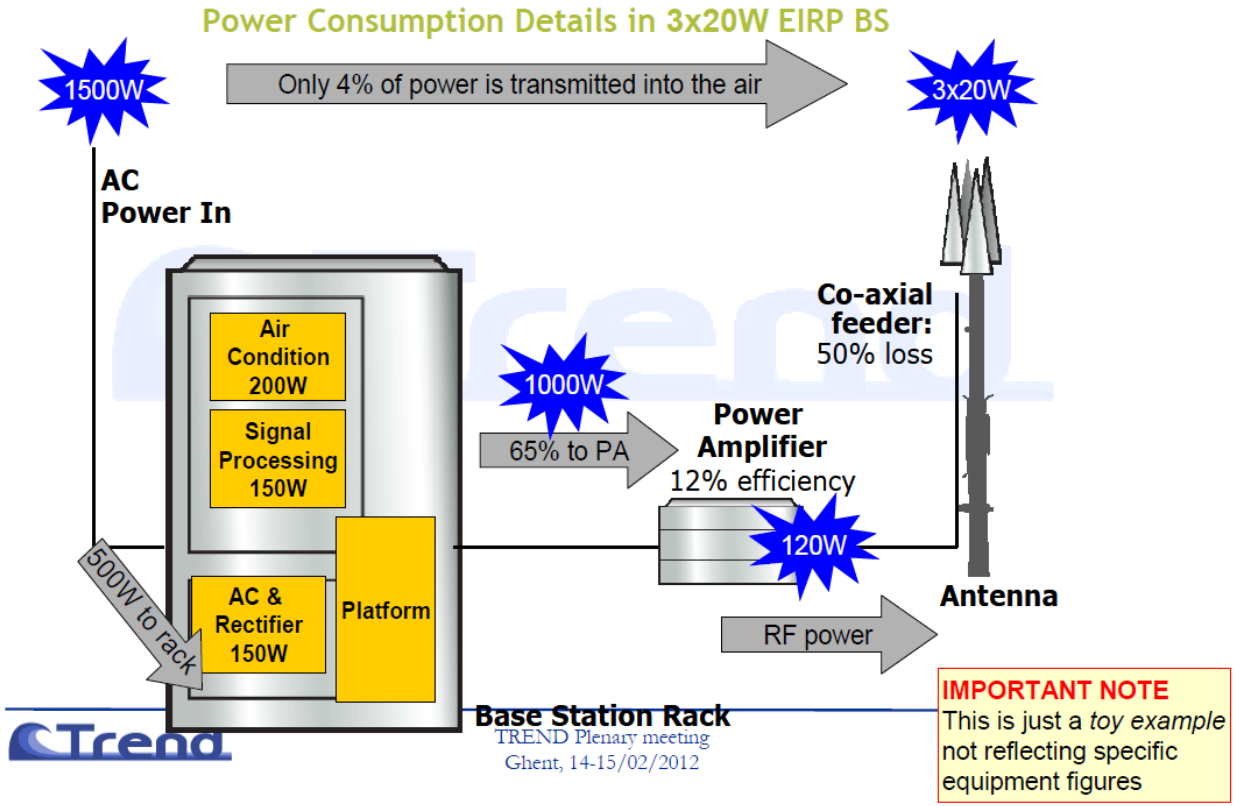
Based on: ETSI_RRS05_024, NSN

More than 90% is used to power the radio sites !!

Alberto CONTE
Alcatel-Lucent Bell Labs France, TREND Plenary meeting
Ghent, 14-15/02/2012

BS consumption

Macro BS energy consumption breakdown
- Toy example



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Why developing Massive MIMO?

- Bottleneck: increasing both *energy efficiency (bit/s/J)* and capacity or *spectral efficiency (bit/s/Hz).*
- Possible solution: colocated Massive MIMO (M-MIMO) or distributed MIMO (not presented)

Possible structure of colocated M-MIMO: Rectangular,linear or cylindrical array.
Each antenna unit
would be small and active.

Increase efficiency of the power amplifier

- The power amplifier (PA) is replaced by M low cost, low output power non linear amplifiers: ultra linear 50 W amplifier $\Rightarrow$100 low cost mW range (integrated with antenna)+ low cost coaxial cable (IF)

- Advantages:
  - Adjust the number of antennas and or BS according to the trafic load $\Rightarrow$ each PA works at its nominal power
  - Robust to failure of a few PAs
  - The M RF parts could be powered by solar/wind sources
- Need to transmit signal of nearly constant envelop (low PAPR)

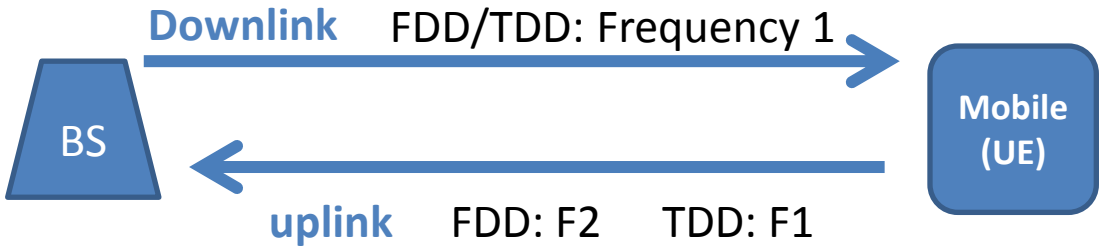
Increase spectral efficiency

- Focused energy towards terminals.

- 10 times higher than in conventional MIMO because many tens of terminals are served simultaneously in the same time-frequency resource.

Some challenges (1)…

- Channel state information (CSI): Amount of needed time-frequency resources for DL increases with the number of antennas.
- Solution: TDD mode uses channel reciprocity.



  - Pb the hardware chain (Tx/Rx) not reciprocal⇒BS receiver calibration
  - Pb with high mobility (Doppler spread/shift) ⇒short stationary time!
  - If OFDM based signal: possible pilotes (CSI) contamination due to the large number of channels

Some challenges (2)…

- M-MIMO Models are needed for solving systems issues…but well-known conventional MIMO channel models are not suited

- MIMOSA team could contribute to:
  - Experimental Channel characterization
    - correlation properties of the numerous channels= low correlation gives rise to large spatial diversity gains
    - Antennas array/sub array configuration ⇒ characterization of large scale fading
  - Analytical M-MIMO propagation models

Thank you!