



Terminal information to improve network performance

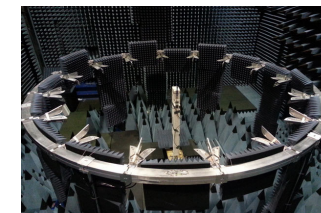
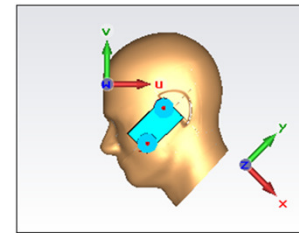
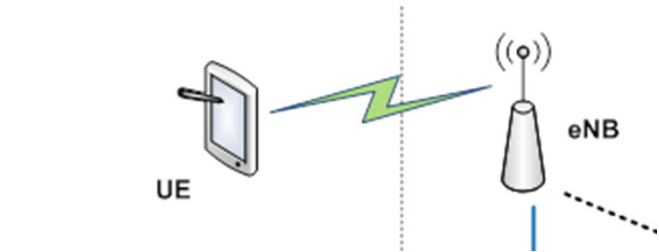
Per Hj. Lehne, Telenor Research

Fornebu, Norway

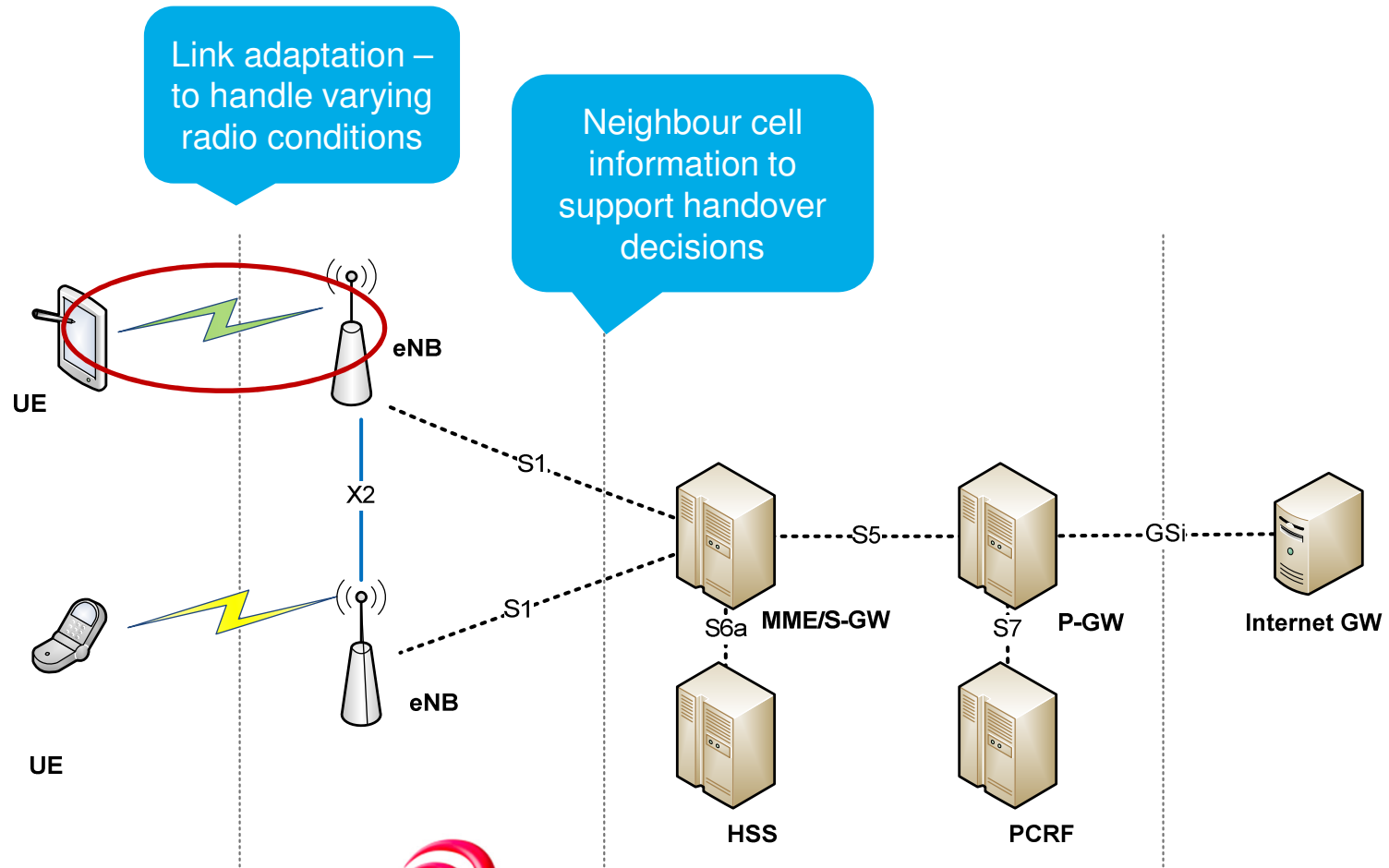
*IoT Enabling Technologies Conference
2 April 2014*

Terminal information to improve network performance

- The interaction between terminals and the network
- Understanding user behaviour
- Next generation test methods for terminals and network nodes

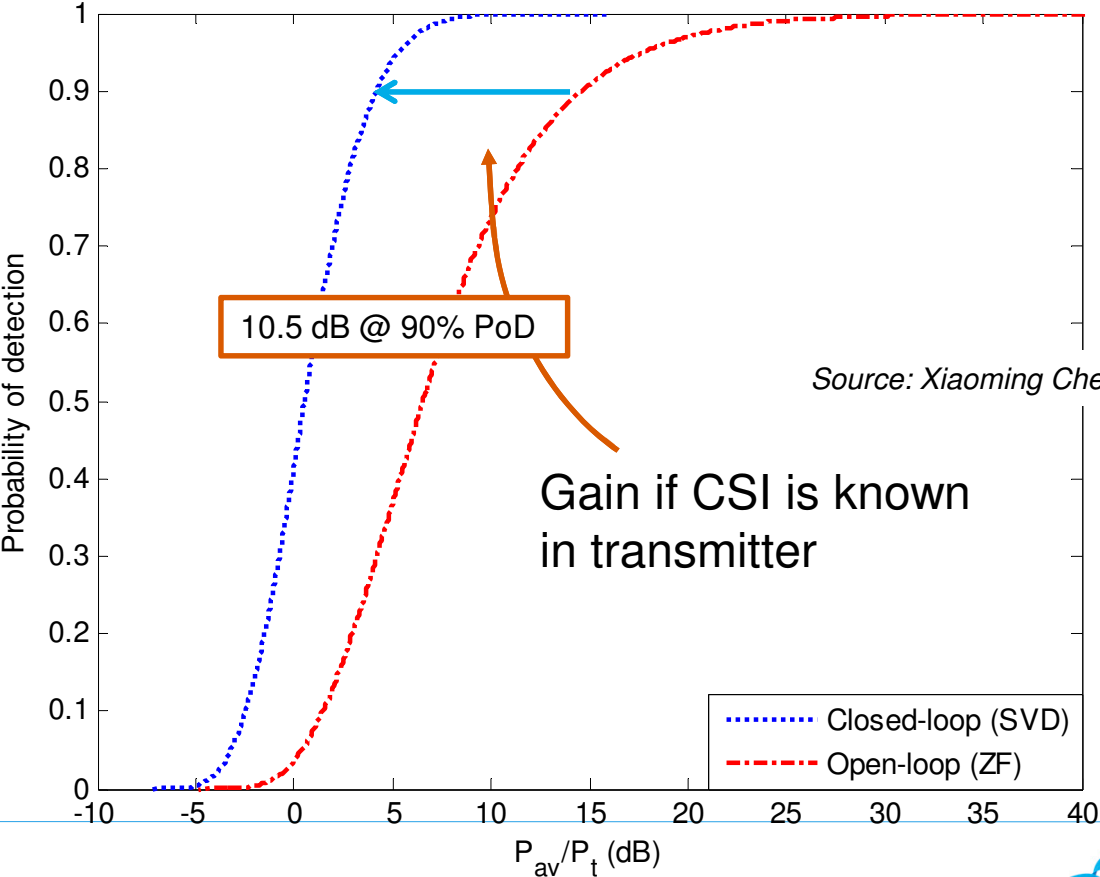


Mobile networks 'work' because there is an interplay between the terminals and the network



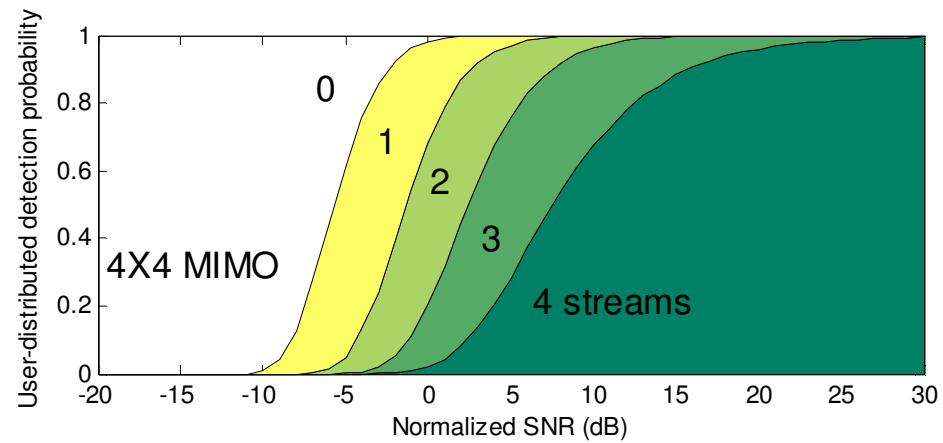
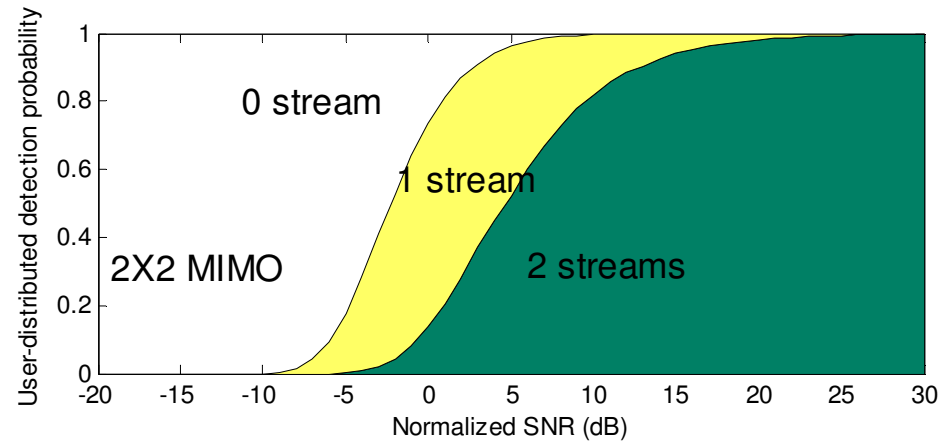
The gain of channel knowledge at the transmitter side

- A significant increase in Probability of Detection (PoD)
- Throughput = PoD



* CSI: Channel State Information

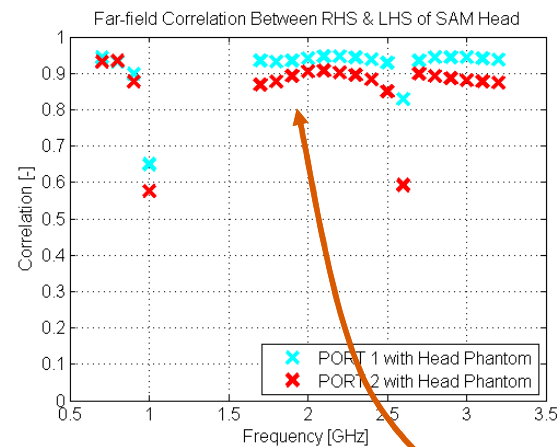
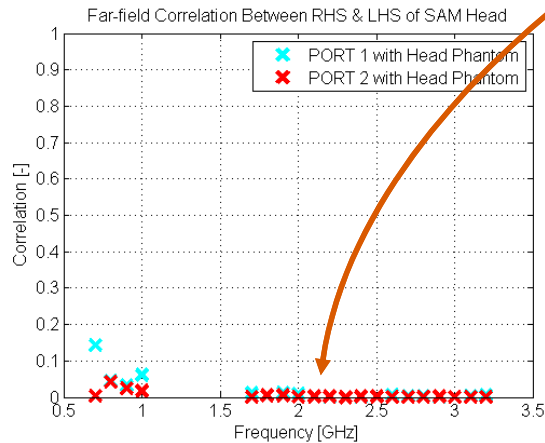
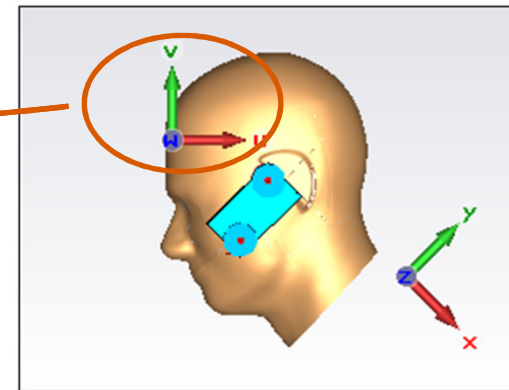
Probability of Detection (PoD) of multiple streams



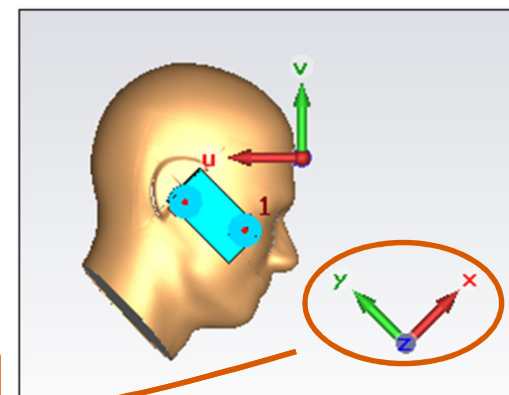
Understanding the phone performance in real environments and based on actual user behaviour

- Does it matter which side of the head you hold your phone?
 - Or: «Correlation Between Far-field Patterns on Both Sides of the Head of Two-port Antenna on Mobile Terminal»

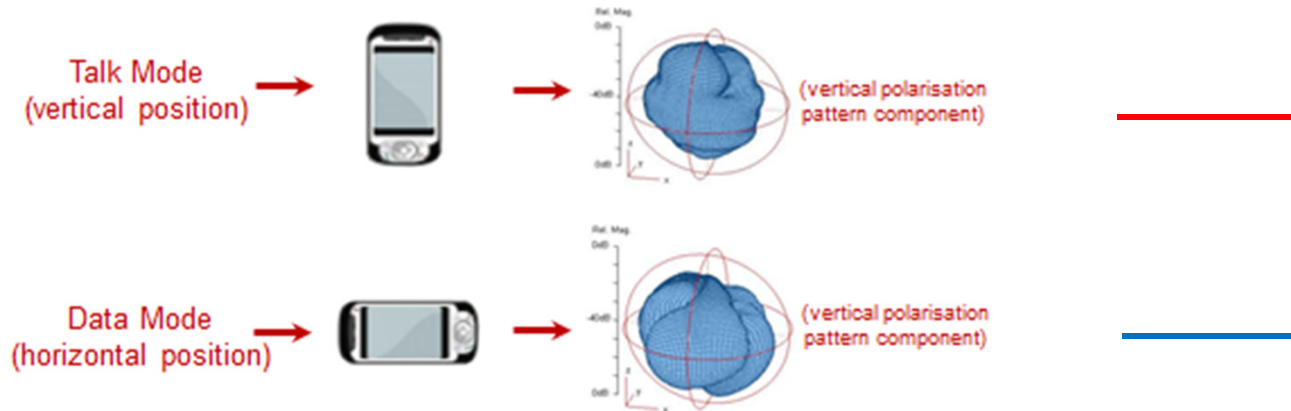
The far-field can be very different on the two sides of the head



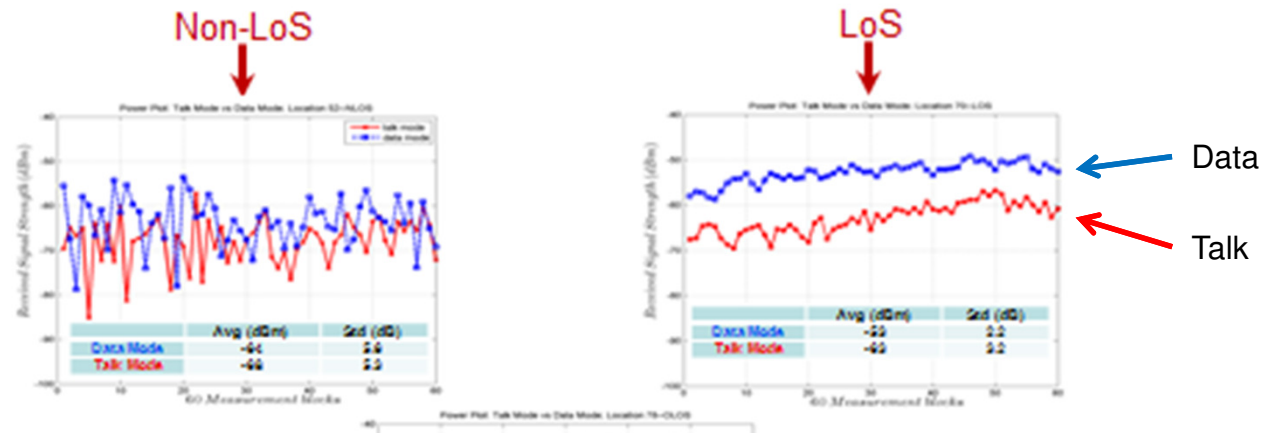
The effect of the head is almost identical except for the rotation



Rotating the terminal device influences the performance significantly



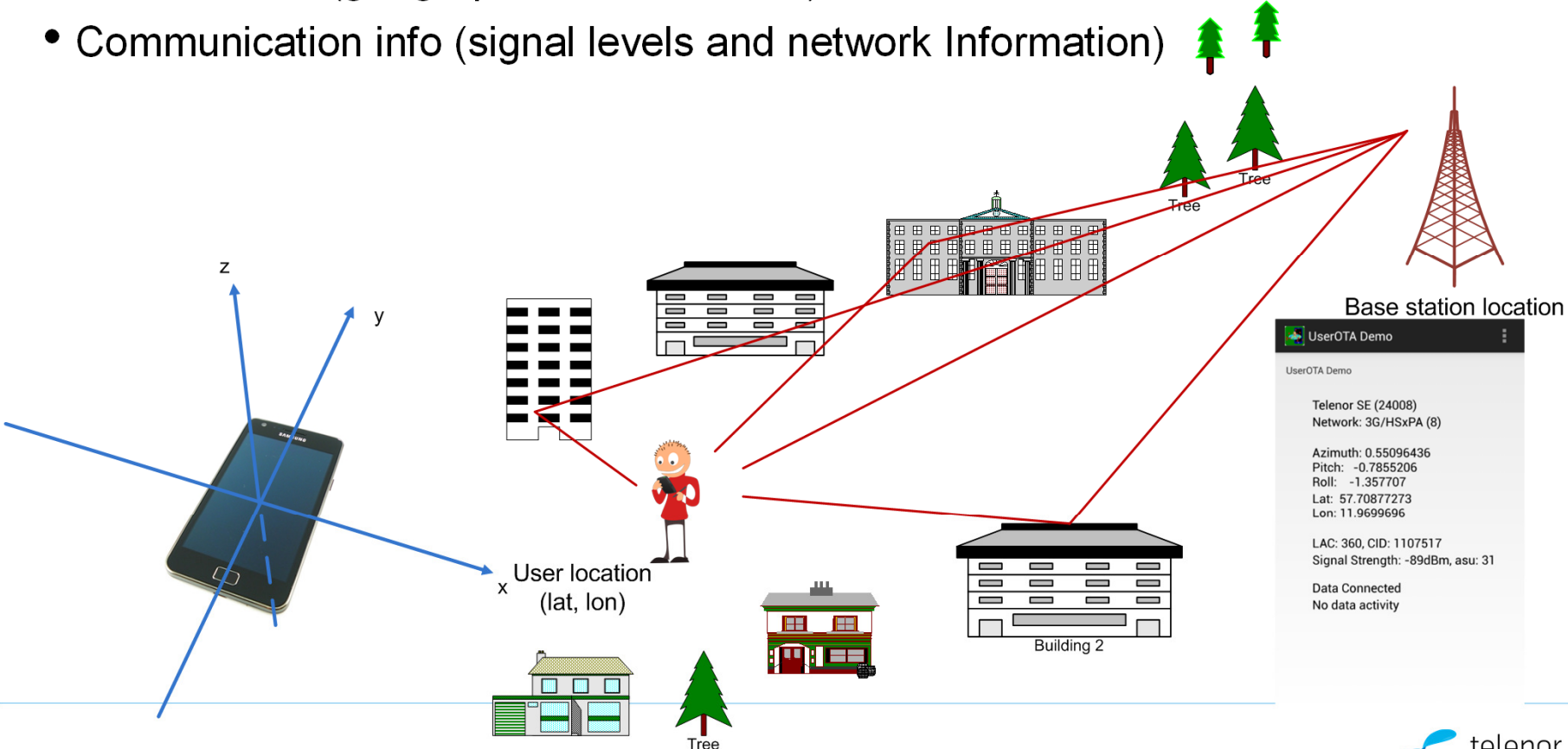
Received signal variation over 60 samples in the three example user locations



- Source: Mellios et al. Impact of Terminal Orientation on System Performance in an Indoor and in a Cellular Environment. COST IC1102 (VISTA) and COST IC1004 Joint Workshop “Terminal Antenna Systems for 4G and Beyond”, Ghent, Belgium, 25 Sep 2013.

The environmental context for the terminal is important

- Terminal orientation (x,y,z)
- User location (geographical coordinates)
- Communication info (signal levels and network Information)



Using a smartphone application to collect statistics on user behaviour

- «User-randomness» is less known
- Data from *a measurement app* can also be an entry-point to understand how better terminal reports can enhance network performance:
 - 'Big Data' analytics
 - Improved real-time network optimization
- Smart phones constitute a 'world of sensors' to be utilized
- Chalmers Antenna Systems Excellence Centre – CHASE:
 - *Capacity Optimization of LTE Wireless Systems Using OTA Testing with Statistical User-Data (UserOTA)*



A negative trend on smart phone antenna performance has been observed

Source: http://vbn.aau.dk/files/168617784/MobilephoneTest2013Ver2_2_4_.pdf

Mobile Phone Antenna Performance 2013



Version 2.2, 28 November 2013
Curt Freilind Pedersen
Professor, PhD
Aalborg University

Phone ranking	Model	GSM900 TIS Performance	UMTS900 TIS Performance	GSM1800 TIS Performance	UMTS2100 TIS Performance
	Doro Phone Easy 605	-98.8 dBm	N/A	-97.7 dBm	N/A
	Sony Xperia Z	-98.1 dBm	-100.8 dBm	-104.0 dBm	-105.4 dBm
	Sony Xperia Go	-97.7 dBm	-99.6 dBm	-101.6 dBm	-101.6 dBm
	Samsung Galaxy III mini	-97.5 dBm	-99.5 dBm	-101.4 dBm	-102.3 dBm
	LG A250	-97.5 dBm	N/A	-101.5 dBm	N/A
	Nokia Asha 300	-97.2 dBm	-100.3 dBm	-102.4 dBm	-103.7 dBm
	Nokia Lumia 620	-97.2 dBm	-100.8 dBm	-101.9 dBm	-103.8 dBm
	HTC One	-96.2 dBm	-100.8 dBm	-101.0 dBm	-103.0 dBm
	Huawei Y300	-96.0 dBm	-96.9 dBm	-101.5 dBm	-102.0 dBm
	HTC One mini	-95.5 dBm	-99.5 dBm	-97.8 dBm	-104.3 dBm
	LG Optimus	-95.4 dBm	-97.8 dBm	-100.0 dBm	-101.5 dBm
	Huawei Ascend P2	-95.1 dBm	-98.8 dBm	-104.4 dBm	-105.0 dBm
	Nokia Lumia 920	-94.7 dBm	-97.7 dBm	-102.2 dBm	-104.5 dBm
	Samsung Galaxy note II (4G)	-94.5 dBm	-97.2 dBm	-102.8 dBm	-102.8 dBm
	Samsung Galaxy note II (3G)	-94.5 dBm	-97.4 dBm	-102.5 dBm	-104.8 dBm
	Samsung S4 (4G)	-94.5 dBm	-97.3 dBm	-101.3 dBm	-105.0 dBm
17	HTC Desire X	-94.4 dBm	-94.4 dBm	-100.9 dBm	-103.3 dBm
18	Samsung S4 mini	-94.0 dBm	-96.8 dBm	-101.0 dBm	-101.0 dBm
19	Nokia Lumia 820	-93.0 dBm	-98.8 dBm	-100.9 dBm	-101.1 dBm
20	iPhone 5C	-92.3 dBm	-100.9 dBm	-95.8 dBm	-99.9 dBm
21	iPhone 5S	-90.2 dBm	-98.9 dBm	-88.3 dBm	-100.3 dBm
22	Nokia Lumia 925 (second phone as an extra test)	-88.1 dBm	-94.5 dBm	-102.2 dBm	-105.8 dBm
23	Nokia Lumia 925	-88.0 dBm	-92.3 dBm	-102.0 dBm	-106.0 dBm

• Ex UMTS 2100 TIS*:

• -105.4 dBm

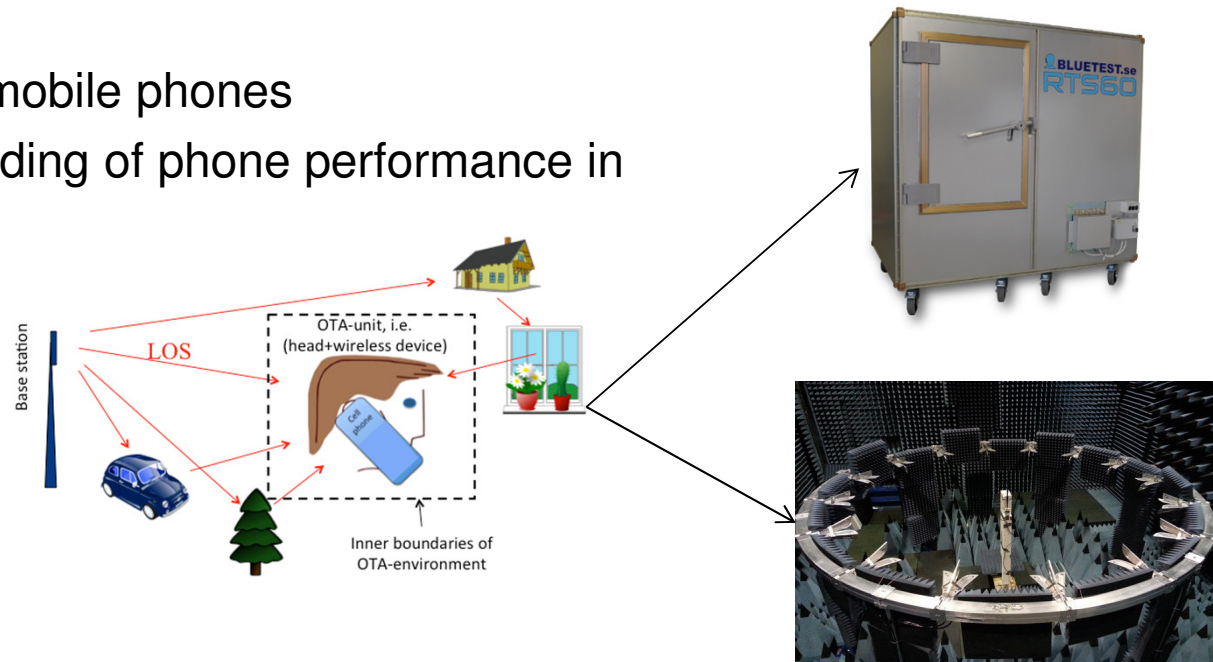
- Delta: 5.5 dB

• -99.9 dBm

* TIS: Total Isotropic Sensitivity

Measurement reports from user devices will be of increased value in 5G

- Better test methods for mobile phones
 - Improve the understanding of phone performance in real environments

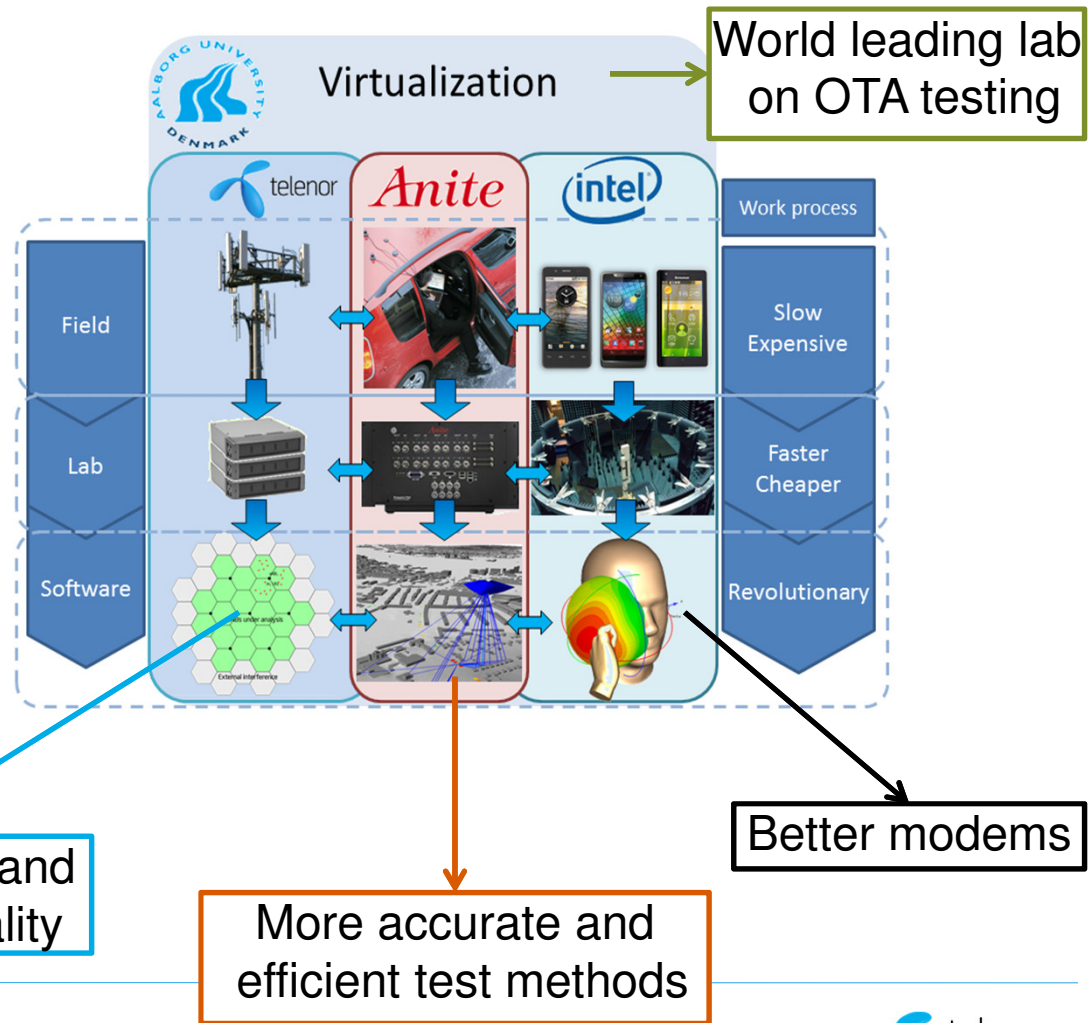


- System gain of improved terminal reporting
 - Richer context information from the phone

A revolutionary approach to device and network testing: *Virtualizing testing of terminals and network equipment*

VIRTUOSO - Virtualized environment for communication system development and optimization

... moving the complexity of wireless systems design from hardware to software and realistic models.



Faster roll-out and improved quality

More accurate and efficient test methods

Better modems

Future networks must utilize terminals better

- **In the future, terminals must deliver more reports about the context:**
 - Radio performance and environment
 - User behaviour and preferences
- **Networks must exploit context information:**
 - Supporting resource management, e.g. dynamic spectrum access
 - Collecting and analyzing demand patterns
 - Supporting end-user experience predictions
 - «You are now entering an area of reduced service quality»
- **Test methods must be more realistic, accurate and efficient**
 - Virtualizing multi-user, multi-cell scenarios

The ThanQ Slide

Tack

obrigado

Danke
schön

감사합니다

kiitos
köszönöm

آپ کا شکریہ

Thank You!!

धन्यवाद

شکرا

merci

謝謝

mulțumesc

gracias

takk

धन्यवाद

با تشکر از شما

grazie

Vielen
Dank

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