EMF measurements of LTE

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Peter Fritschi, Jean-Michel Vannay, Hugo Lehmann
Swisscom (Switzerland) Ltd.
Beat Mühlemann
Federal Office of Metrology (METAS)
Markus Riederer
Federal Office of Communications
(OFCOM)

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Motivation: Compliance with legal requirements

814.01

Bundesgesetz
über den Umweltschutz
(Umweltschutzgesetz, USG)

vom 7. Oktober 1983 (Stand am 1. August 2010)

814.710

Verordnung
über den Schutz vor nichtionisierender Strahlung
(NISV)

vom 23. Dezember 1999 (Stand am 1. September 2009)

Source: Federal Authorities of the Swiss Confederation

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Motivation Swisscom: first LTE field trail in Switzerland

20 minuten ONLINE

LTE

07. Oktober 2010 15:49; *Akt: 07.10.2010 15:49*

Mehr Speed im mobilen Netz

Die Swisscom testet zurzeit das Mobilfunknetz der nächsten Generation. Wann darüber telefoniert werden kann, steht noch in den Sternen - entsprechende Geräte sind auch kaum vorhanden.

Swisscom-Manager Christian Petit demonstrierte am 7. Oktober in Grenchen die Vorteile eines LTE-Netzes. (Bild: Stefan Weber)

Die Abkürzung LTE steht für Long Term Evolution. Dahinter verbirgt sich das Mobilfunknetz der vierten Generation. Es erlaubt Übertragungsraten von bis zu 100 Mbit/S, womit das mobile Surfen viel flüssiger vonstatten geht. Das auf dem Swisscom-Netz übertragene Datenvolumen verdoppelt sich derzeit alle sieben

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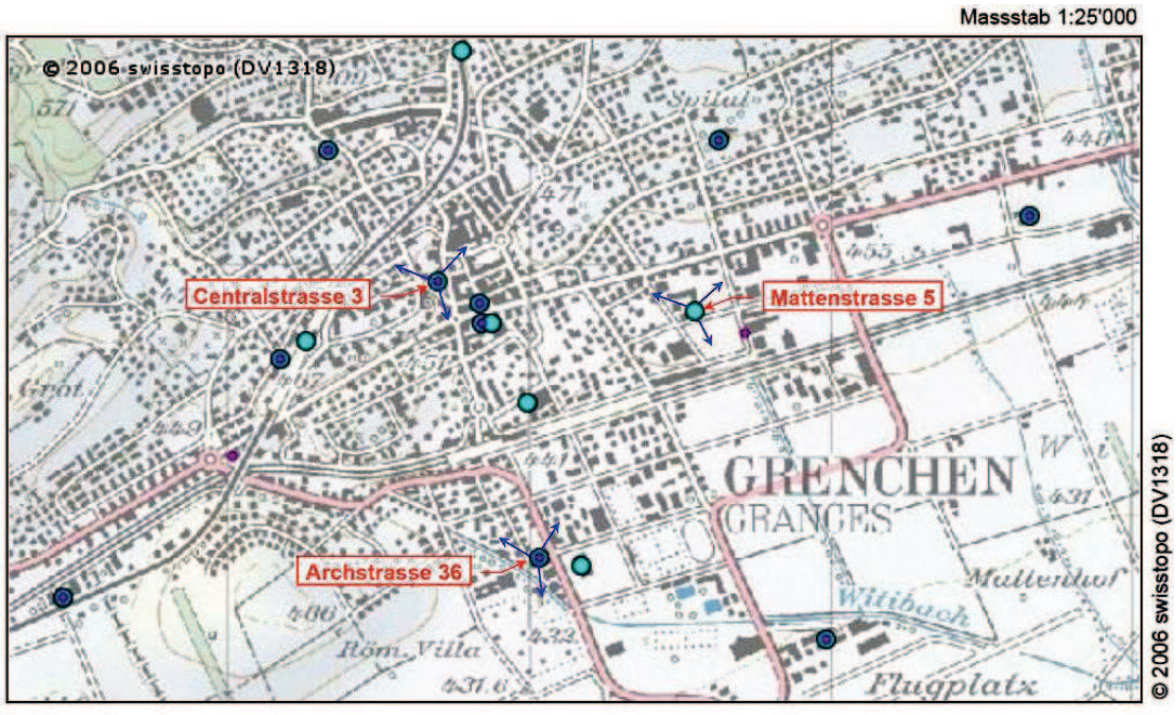
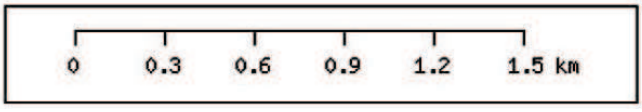
LTE Proof of concept field trial in Grenchen:



Map source:
Federal Office of Communications



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Some on site impressions:

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Operating band in field trial:

5.5 Operating bands

E-UTRA is designed to operate in the operating bands defined in Table 5.5-1.

Table 5.5-1 E-UTRA operating bands

E-UTRA Operating Band	Uplink (UL) operating band BS receive UE transmit			Downlink (DL) operating band BS transmit UE receive			Duplex Mode
	F_{UL_low}	–	F_{UL_high}	F_{DL_low}	–	F_{DL_high}	
1	1920 MHz	–	1980 MHz	2110 MHz	–	2170 MHz	FDD
2	1850 MHz	–	1910 MHz	1930 MHz	–	1990 MHz	FDD
3	1710 MHz	–	1785 MHz	1805 MHz	–	1880 MHz	FDD
4	1710 MHz	–	1755 MHz	2110 MHz	–	2155 MHz	FDD
5	824 MHz	–	849 MHz	869 MHz	–	894MHz	FDD
6	830 MHz	–	840 MHz	875 MHz	–	885 MHz	FDD
7	**2500 MHz**	**–**	**2570 MHz**	**2620 MHz**	**–**	**2690 MHz**	FDD
8	880 MHz	–	915 MHz	925 MHz	–	960 MHz	FDD
9	1749.9 MHz	–	1784.9 MHz	1844.9 MHz	–	1879.9 MHz	FDD
10	1710 MHz	–	1770 MHz	2110 MHz	–	2170 MHz	FDD
11	1427.9 MHz	–	1452.9 MHz	1475.9 MHz	–	1500.9 MHz	FDD
12	698 MHz	–	716 MHz	728 MHz	–	746 MHz	FDD
13	777 MHz	–	787 MHz	746 MHz	–	756 MHz	FDD
14	788 MHz	–	798 MHz	758 MHz	–	768 MHz	FDD
…							
17	704 MHz		716 MHz	734 MHz		746 MHz	FDD
…							
33	1900 MHz	–	1920 MHz	1900 MHz	–	1920 MHz	TDD
34	2010 MHz	–	2025 MHz	2010 MHz	–	2025 MHz	TDD
35	1850 MHz	–	1910 MHz	1850 MHz	–	1910 MHz	TDD
36	1930 MHz	–	1990 MHz	1930 MHz	–	1990 MHz	TDD
37	1910 MHz	–	1930 MHz	1910 MHz	–	1930 MHz	TDD
38	2570 MHz	–	2620 MHz	2570 MHz	–	2620 MHz	TDD
39	1880 MHz	–	1920 MHz	1880 MHz	–	1920 MHz	TDD
40	2300 MHz	–	2400 MHz	2300 MHz	–	2400 MHz	TDD

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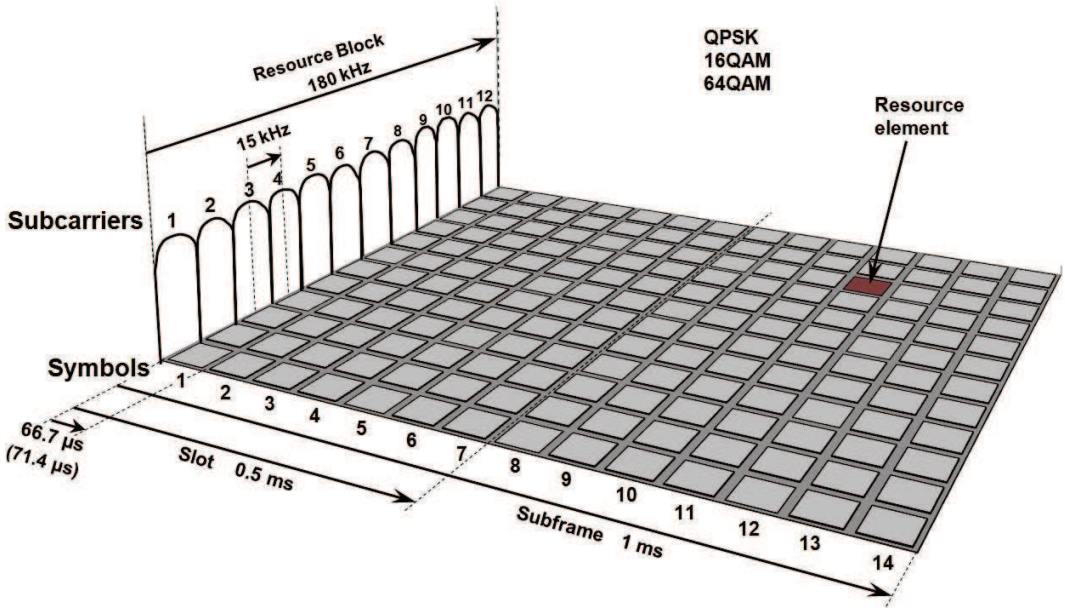
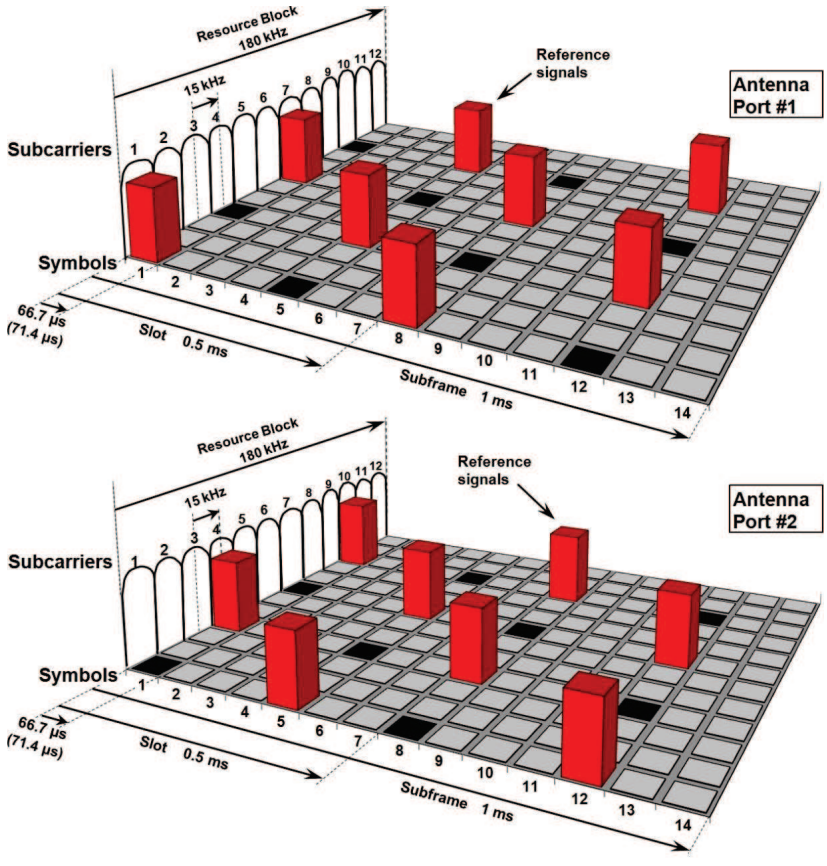
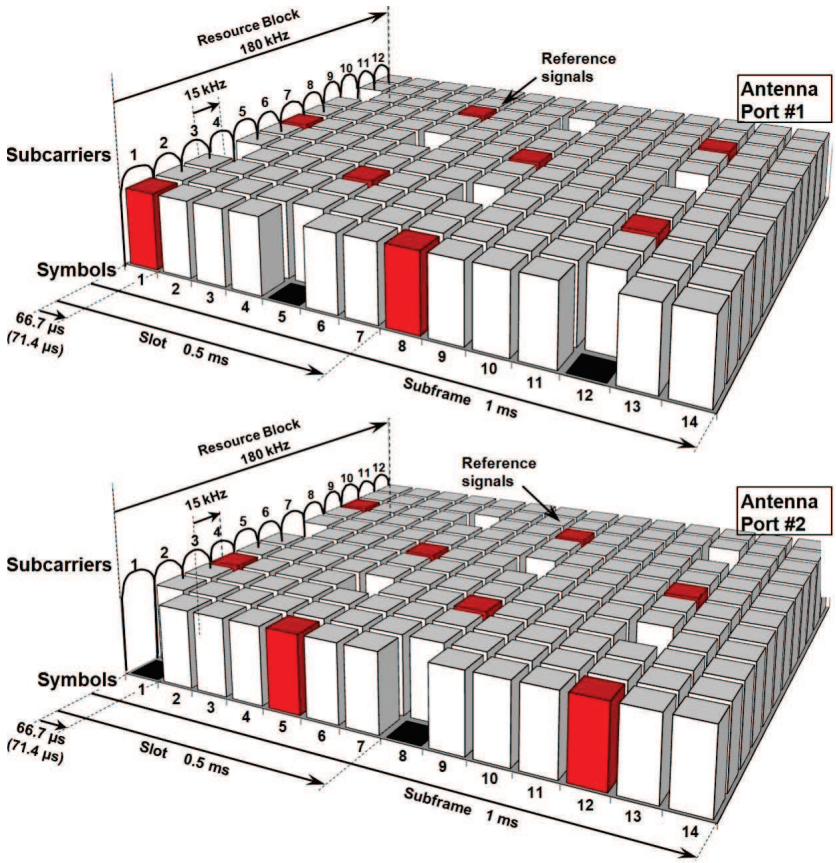
Scheduling block:



Signalling: Reference Signals (downlink):



Scheduling block on duty (downlink):



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Total signal -> «Patchwork»:

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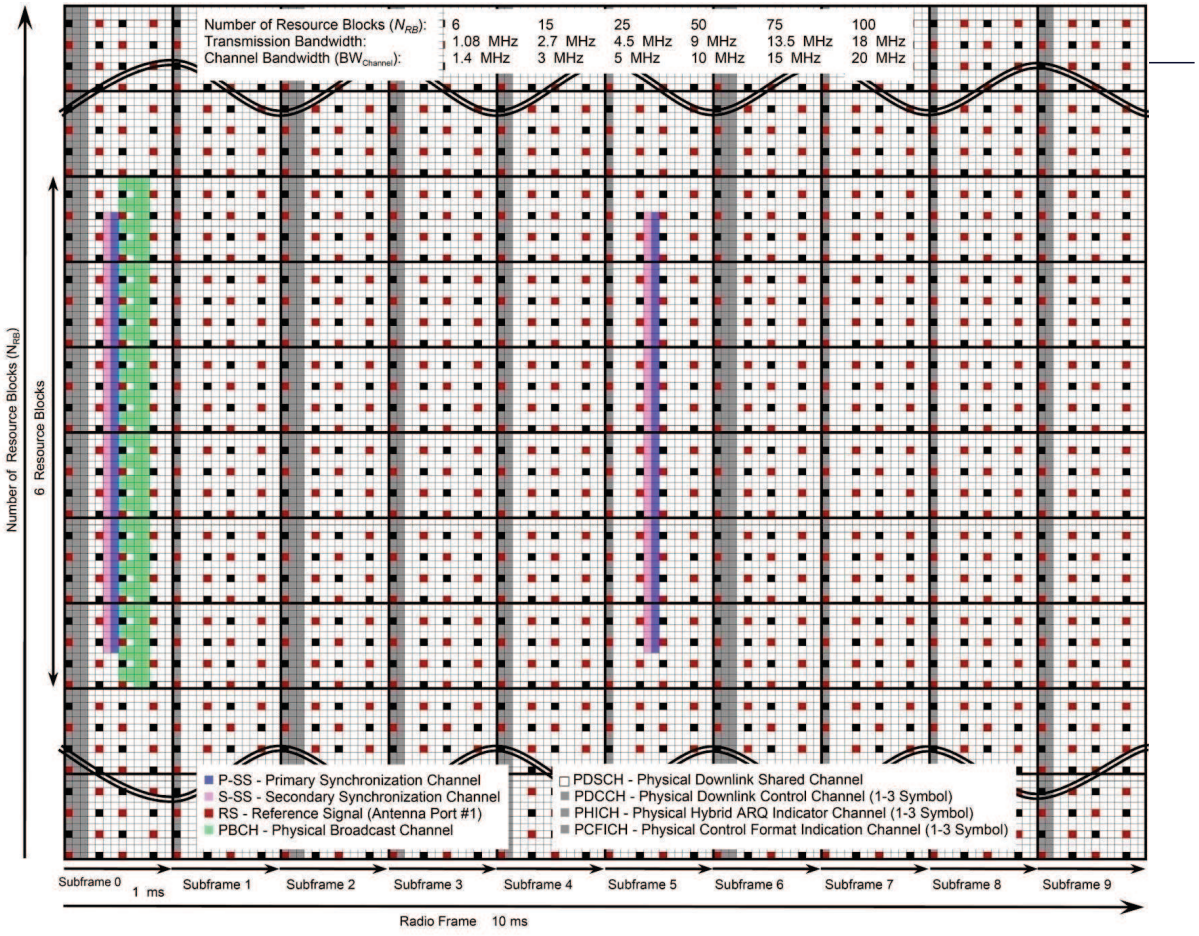
Signalling: Total signal (downlink):



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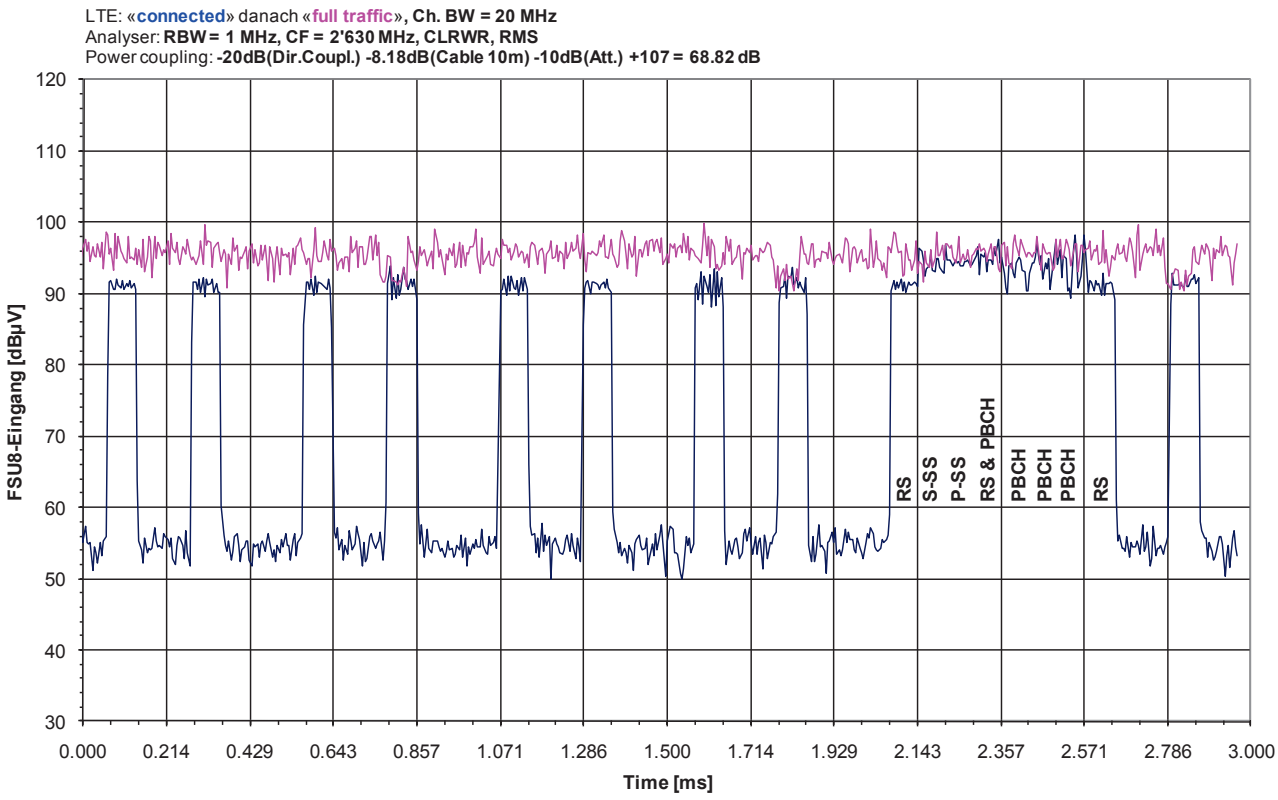
Signal measured with a spectrum analyzer:



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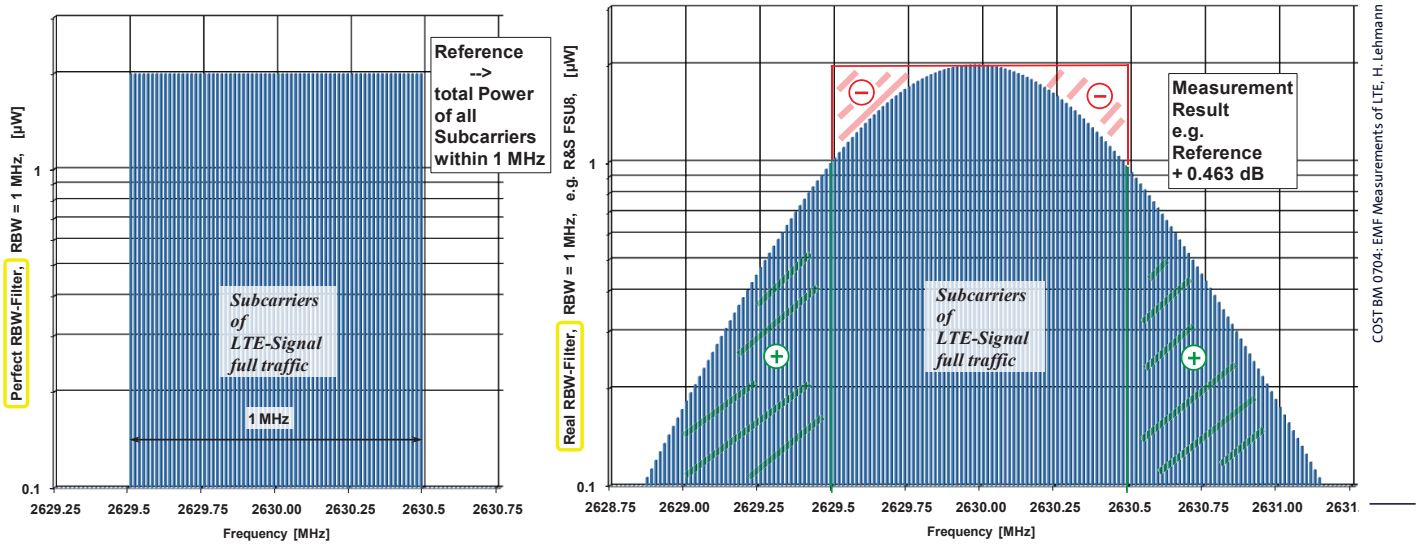
Difficulties of spectrum analyzer measurements (i):

≠

Theoretical RBW filter

Real RBW filter



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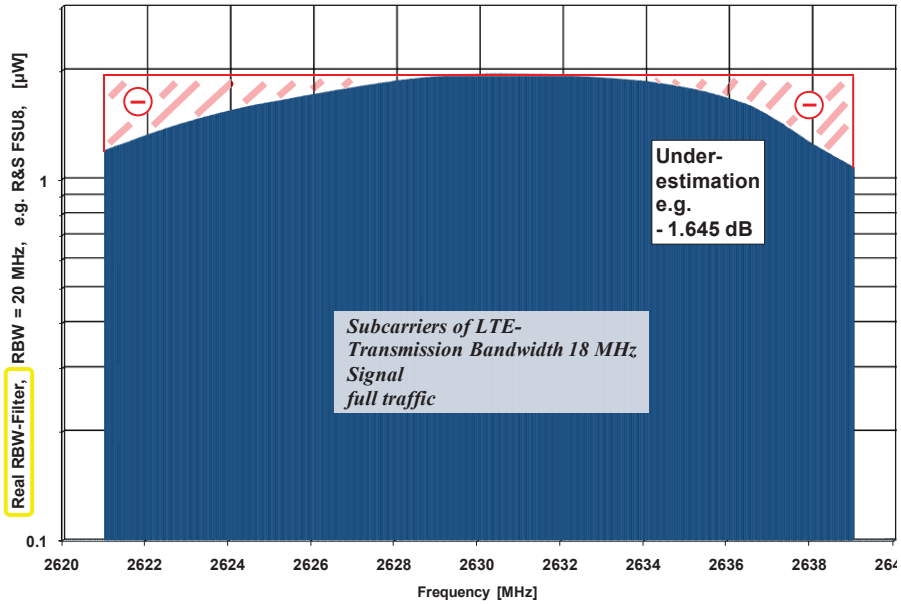
Difficulties of spectrum analyzer measurements (ii):

Real RBW filter



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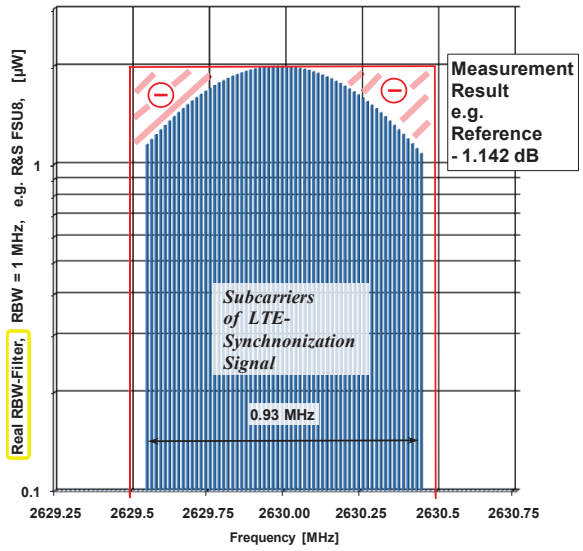
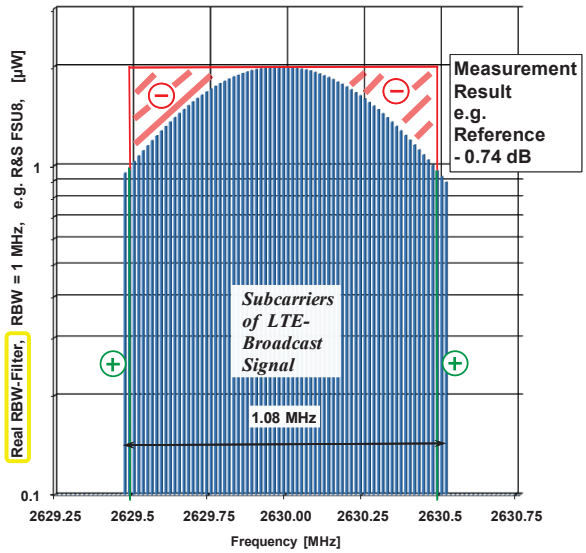
Difficulties of spectrum analyzer measurements (iii):

Real RBW filters





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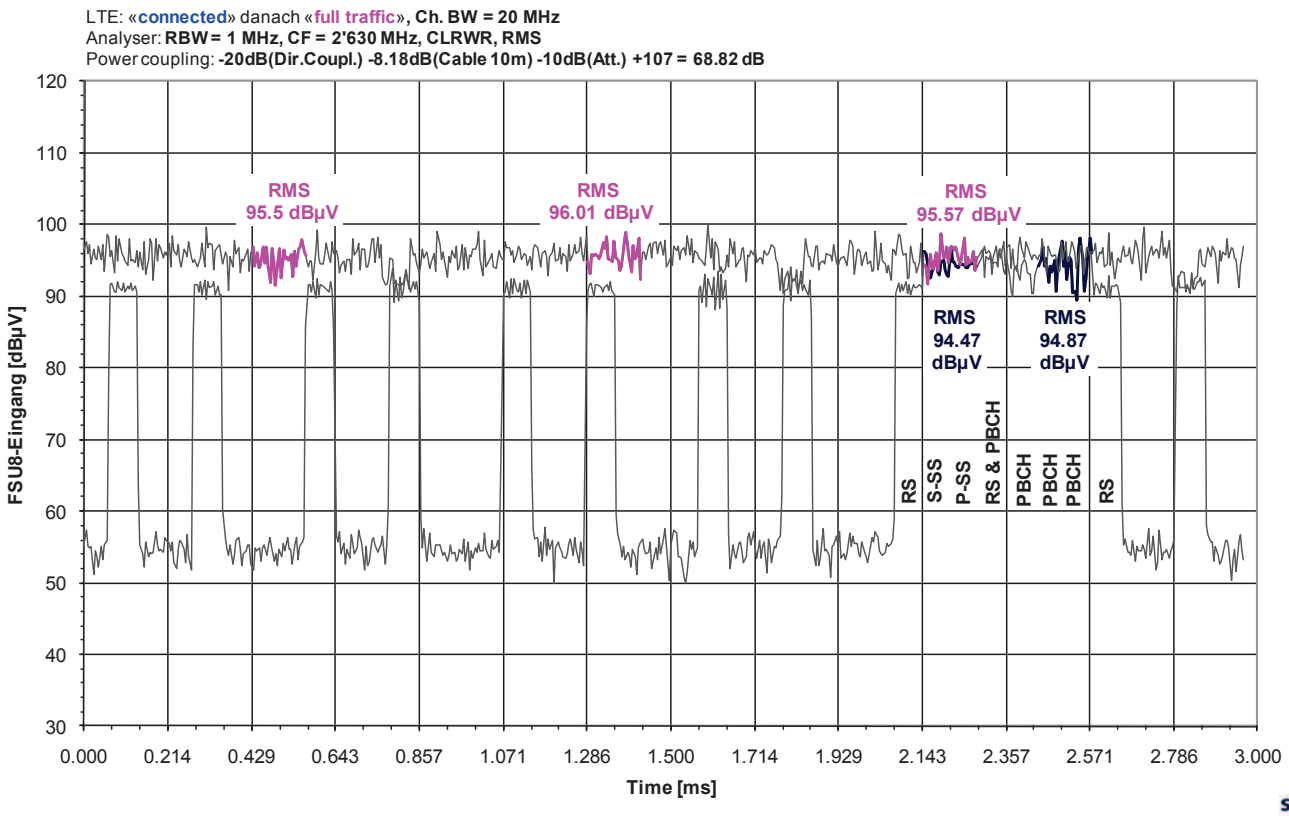
Spectrum analyzer: a closer view



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Signalled LTE parameters (downlink):

REFERENCE SIGNAL Energy Per Resource Element:

‚*Reference-signal-power*'(*) = ‚referenceSignalPower'(#)

PHYSICAL DOWNLINK SHARED CHANNEL Energy Per Resource Element:

P_B(*)	=	p-b(#)	downlink
P_A(*)	=	p-a(#)	user dependant

The cases according Table 5.2-2 (*) show, which PHYSICAL DOWNLINK SHARED CHANNEL Resource Elements are affected.

Table 5.2-1(*) respectively P_B(*) show the linear Level Ratio between ρ_B(*) and ρ_A(*).

ρ_A(*) can be derived from P_A(*) (P_A(*) in [dB])

(*) TS 36.213, Chapter 5.2

(#) TS 36.331, ca. Page 119

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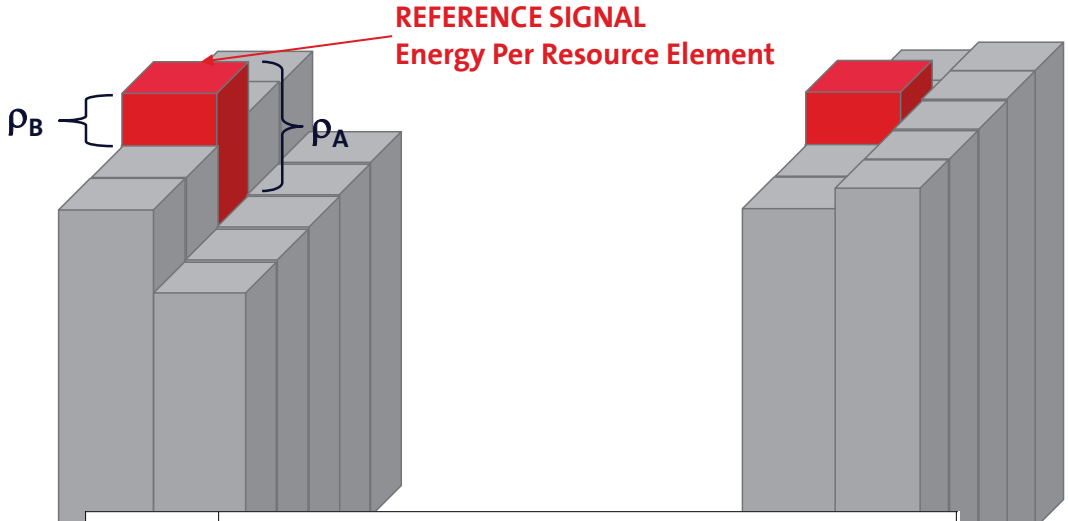
These parameters give the following information:



P_B	ρ_B / ρ_A	
	One Antenna Port	Two and Four Antenna Ports
0	1	5/4
1	4/5	1
2	3/5	3/4
3	2/5	1/2

Table 5.2-1: The cell-specific ratio ρ_B/ρ_A for 1, 2, or 4 cell specific antenna ports

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Other LTE parameters (downlink):

- Spectrum analyzer measurements (and its worst case extrapolation) are not influenced by LTE-traffic if every single level of:

lower or equal:

- **PHYSICAL DOWNLINK SHARED CHANNEL** Energy Per Resource Element(*)
- **REFERENCE SIGNAL** Energy Per Resource Element(#)
- **PHYSICAL DOWNLINK CONTROL CHANNEL** Energy Per Resource Element
- **PHYSICAL HYBRID ARQ INDICATOR CHANNEL** Energy Per Resource Element
- **PHYSICAL CONTROL FORMAT INDICATION CHANNEL** Energy Per Resource Element

≥

higher or equal:

- **PRIMARY SYNCHRONIZATION CHANNEL** Energy Per Resource Element
- **SECONDARY SYNCHRONIZATION CHANNEL** Energy Per Resource Element
- **PHYSICAL BROADCAST CHANNEL** Energy Per Resource Element

(*) includes both ρ_B and ρ_A

(#) strictly speaking: Average Physical Downlink Shared Channel Energy Per Resource Element across one single Symbol of the Antenna Port

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«Code-selective» measurement of LTE:

and probably many more...

Source: manufacturers

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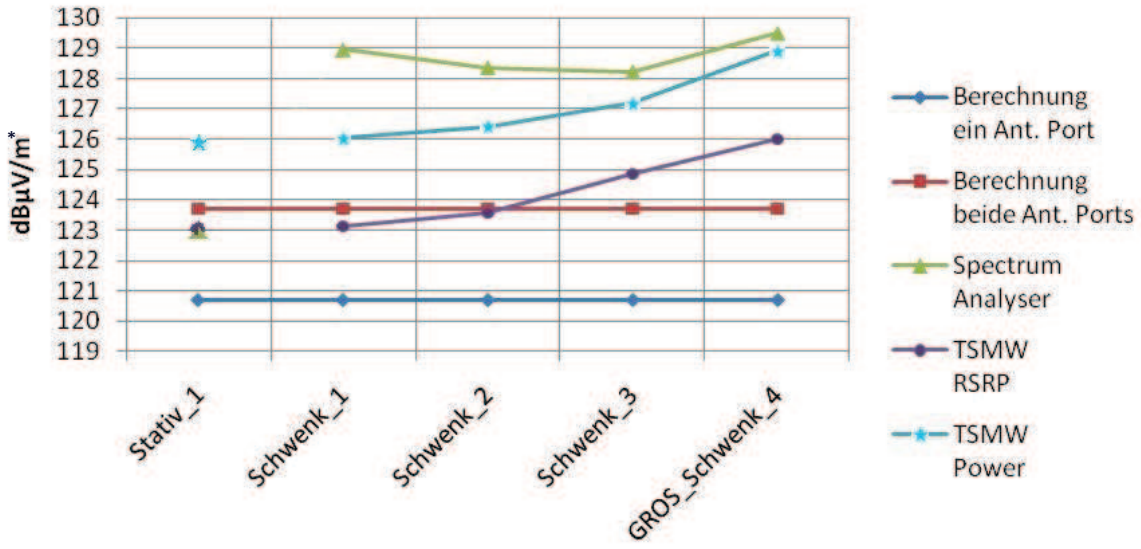
LTE measurements field strengths (location close to Mattenstr. 5):



(* extrapolated to total transmitted bandwidth power)

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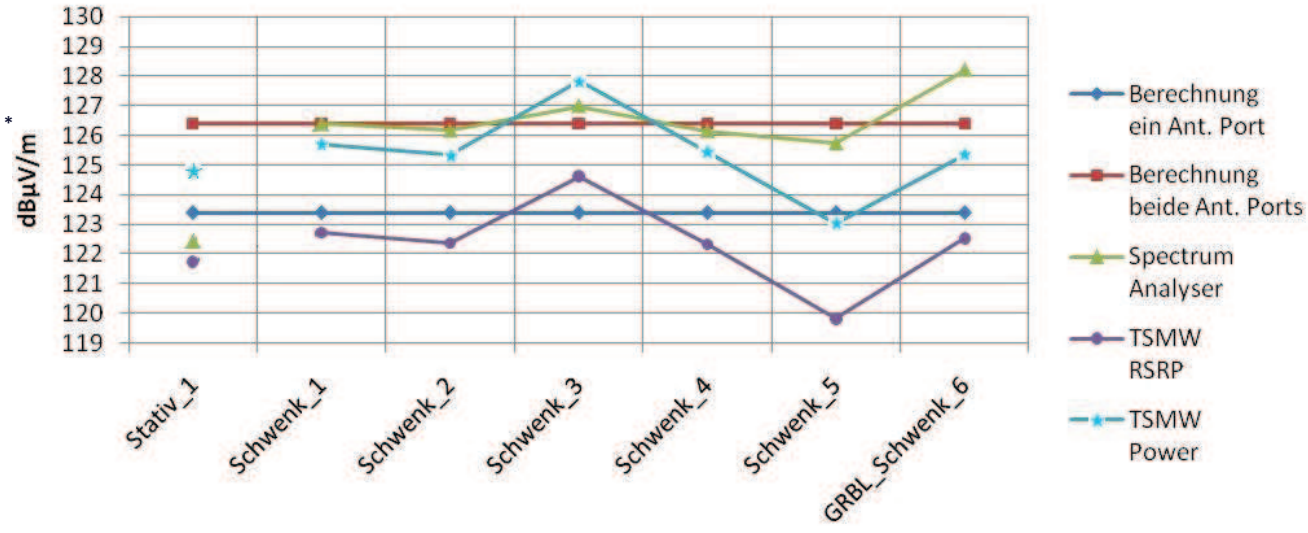
LTE measurements field strengths (close to Archstr. 36):



(* extrapolated to total transmitted bandwidth power)

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Conclusions:

- Our analysis shows that legally required measurements for LTE can be performed with the same order of precision and quality as commonly (at least in Switzerland) expected and required for GSM and UMTS measurements.
- Even though spectrum analyzer measurements for LTE are less traffic dependant than for UMTS, it will never be possible to distinguish the contribution from different cells in the network.
- Furthermore, to check the conditions in which a spectrum analyzer measurement might give correct results and to derive the correction factors for a given spectrum analyzer is somehow cumbersome.
- Moreover, this process represents an important source of error for the measurement.
- Therefore a “code selective” method seems to be the best solution.
- There are still open questions to be answered:
  - How have the different signal paths to be handled?
  - ...?

Questions?

Parts of this presentation can be found in a previous presentation hold at the LTE-Workshop of the „Forschungsstiftung Mobilkommunikation“ available under www.mobile-research.ethz.ch/dienstleistungen.htm

(--> hugo.lehmann@swisscom.com)

References:

Standardization: http://www.3gpp.org

TS 36.101	Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception
TS 36.104	Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception
TS 36.141	Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing
TS 36.211	Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation
TS 36.212	Evolved Universal Terrestrial Radio Access (E-UTRA); Multiplexing and channel coding
TS 36.213	Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures
TS 36.214	Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer; Measurements
TS 36.331	Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification

TR 21.905	Vocabulary for 3GPP Specifications

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Checking

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Release

Version	Date	Changed by	Remarks/Nature of the change
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Contact information

Swisscom (Switzerland) Ltd.
Hugo Lehmann
SCS-SIS-INI-ENV
Postfach
CH-3050 Bern

Phone +41 79 616 04 32
Fax +41 31 931 98 20
Mail hugo.lehmann@swisscom.com

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