

LTE multi-mode Terminal Testing Challenges & Solutions

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ROHDE & SCHWARZ

Outline

LTE multi-mode Terminal Testing

I Introduction

- I LTE Network Operator Deployments
- I LTE Multi-mode Terminals

I Technical Challenges

I Inter-RAT Handover Tests

- I Introduction
- I 3GPP Test Specifications
- I GCF / PTCRB Certification Tests
- I Network Operator Tests

I Test Equipment

- I Requirements
- I Solutions

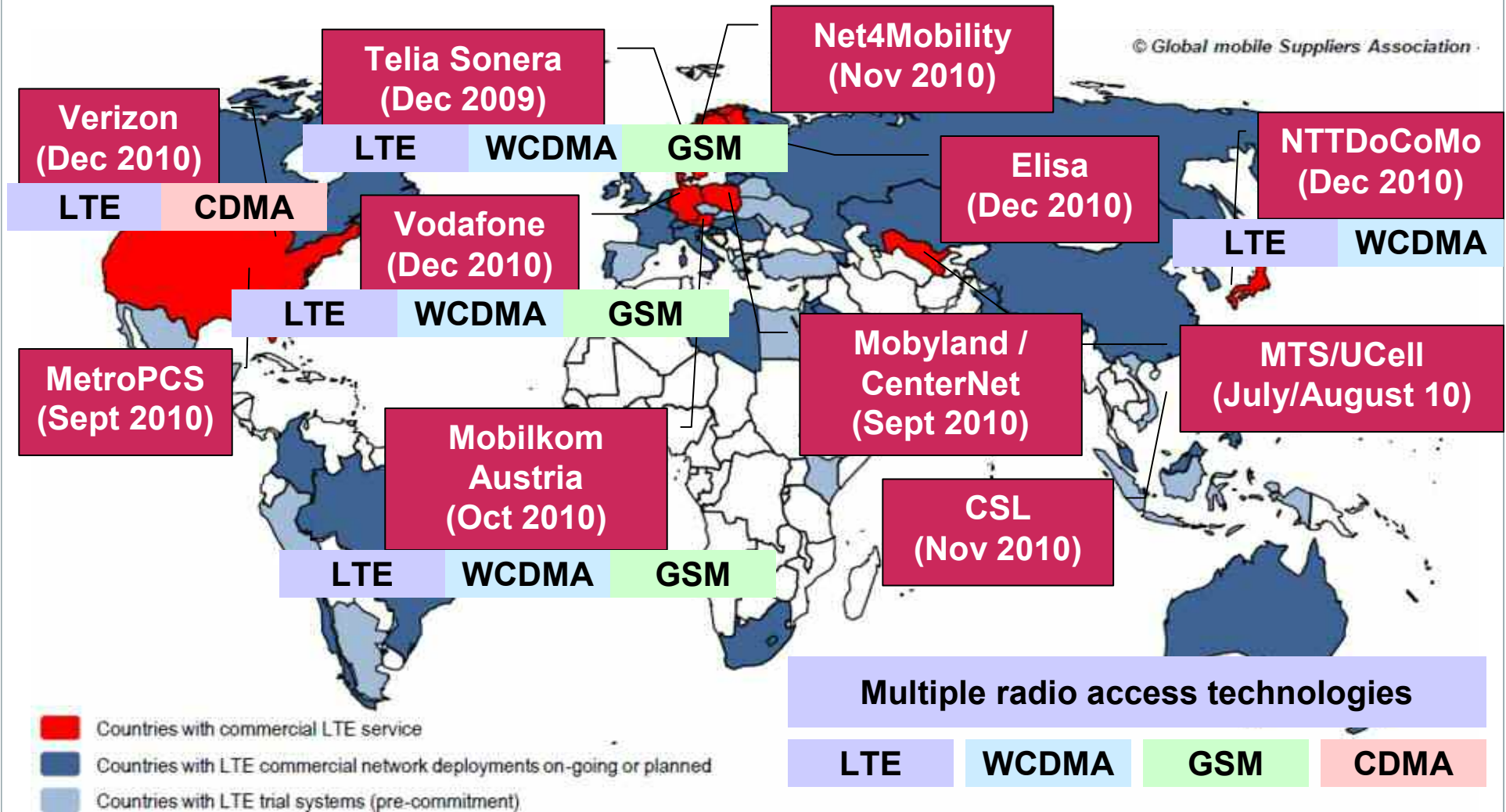
I Conclusion



Introduction

17 commercial LTE networks launched by end 2010

© Global mobile Suppliers Association



Introduction

63 LTE devices launched by Feb 2011

Supplier	Model	Form Factor	Freq	Other modes
AnyDATA	DTP960S LTE	Module	TBC	HSPA+
LG	WM300	Module	700	TBC
LG	L2000	Module	700	TBC
Novatel Wireless	Expedite E362	Module	700	HSPA+ EV-DO
Novatel Wireless	Expedite E371	Module	700 AWS	HSPA+ EV-DO
Sierra Wireless	Airprime MC7700	Module	TBC	HSPA+
Sierra Wireless	Airprime MC7710	Module	TBC	HSPA+
Sierra Wireless	Airprime MC7750	Module	TBC	HSPA+ EV-DO
ST-Ericsson	M720	Module	TBC	HSPA+
ST-Ericsson	M700	Module	Quad	TBC
Acer	Iconia Tab A500	m-Tablet	700	TBC
Cisco	Cius	m-Tablet	700	EV-DO
Motorola	Xoom	m-Tablet	700	EV-DO
Samsung	Galaxy Tab LTE	m-Tablet	700	EV-DO
ZTE	Light2	m-Tablet	TBC	HSPA
ZTE	Light LTE	m-Tablet	700	EV-DO
GammaTech	D12C	Notebook	700	TBC
HP	Pavilion dm1-3010nr	Notebook	700	TBC
HP	Compaq CQ10-688nr	Notebook	700	TBC
Samsung	N350	Notebook	TBC	TBC
Samsung	N150	Notebook	TBC	TBC
Samsung	X430	Notebook	2600	HSPA
Fujitsu	Xi F-06C	PC Card	1500	HSPA
HTC	Thunderbolt	Phone	700	EV-DO
LG	VS910 Revolution	Phone	700	EV-DO
Motorola	Droid Bionic	Phone	700	EV-DO
Samsung	Galaxy S 4G LTE	Phone	700	TBC
Samsung	Craff SCH-R900	Phone	AWS	EV-DO
Samsung	Galaxy S SCH-R910	Phone	AWS	EV-DO
Cradlepoint	CBA750	Router	700	TBC
Cradlepoint	CTR500	Router	700	HSPA EV-DO
Cradlepoint	MBR1000	Router	700	HSPA
Cradlepoint	CBA250	Router	700	TBC

Almost all devices support multiple radio access technologies (LTE / WCDMA / GSM / CDMA)

Multi-mode support for different radio access technologies is a mandatory for LTE devices

Reasons

- Extended network coverage by seamless handover to other standards
- Voice services
- Roaming

Introduction



- I **NGMN (Next Generation Mobile Networks) specification**
“Next Generation Mobile Networks Initial Terminal Definition”
(published 12 November 2010)

- I During the initial deployment phase in general the **support of further RATs is considered mandatory** to achieve sufficient overall coverage.
- I The desired device for the initial deployment is a **multi-mode / multi band / dual mode FDD/TDD device**.
- I The following **technology combinations** should be considered for the initial devices.
 - I **LTE and HSPA* (Japan/Korea)**
 - I **LTE and CDMA2000 (US/Japan/Korea)**
 - I **LTE and HSPA* and EDGE (Europe, US, Japan)**
 - I **LTE TDD, LTE FDD and EDGE (China)**
 - I **LTE TDD, LTE FDD and TD-HSPA and EDGE (China)**

Source: NGMN, Nov 2010



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Technical Challenges

Technical challenges for a multi-mode device

I Multi-RAT baseband

- I Single-chip solution
- I Multi-chip solution (dual-chip)

I Multiple RF front-ends

- I 5 LTE frequency bands
- I 5 WCDMA frequency bands
- I 4 GSM frequency bands
- I Interference to WLAN, GPS, Bluetooth

I Antenna design

I Power consumption

I Integration and testing effort

- I Multiple effort for a LTE, WCDMA, GSM, C2K multi-mode terminal
- I Complex handover tests between radio access standards



Outline

LTE multi-mode Terminal Testing

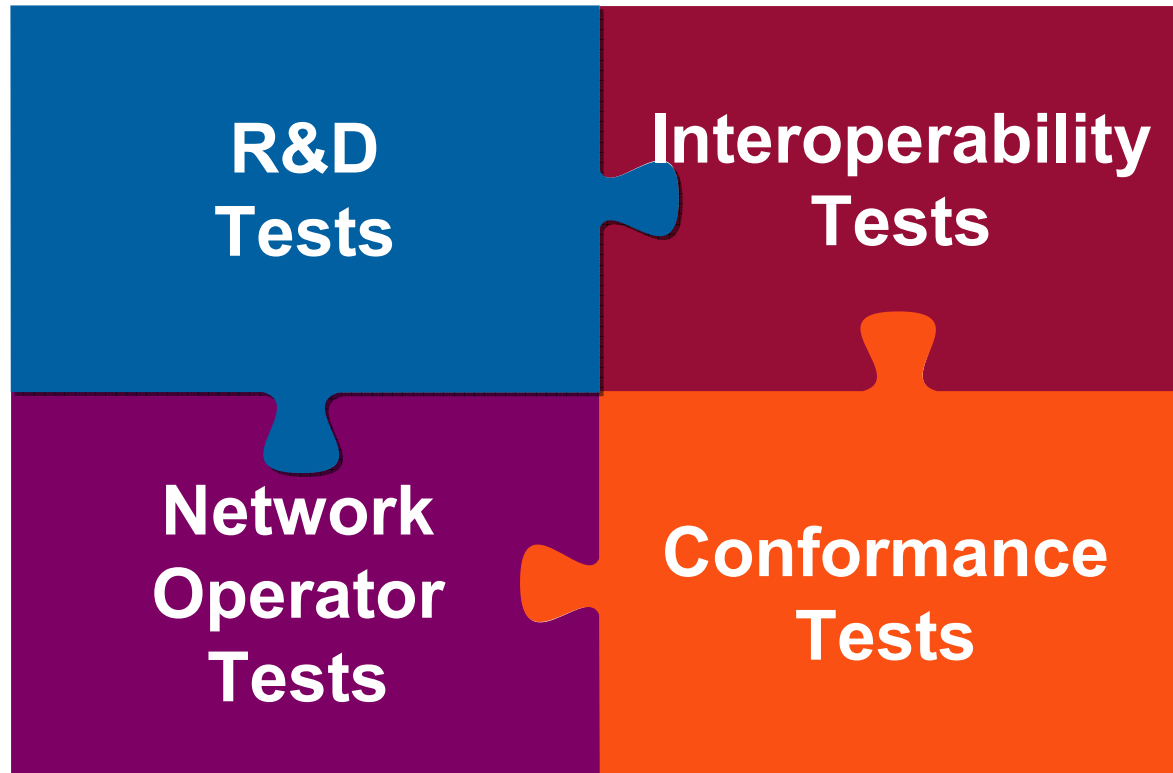
- I Introduction
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Inter-RAT Handover Tests

Introduction

I Tests during multi-mode UE development cycle



- I Inter-RAT handover tests are crucial at each stage of UE development to ensure quality of a multi-mode device.

Inter-RAT Handover Tests

Introduction

I Idle-mode tests

- I Cell selection / reselection
- I UE measurement reports
- I Redirection
- I Cell change order

I Connected mode tests

- I PS active mode handover

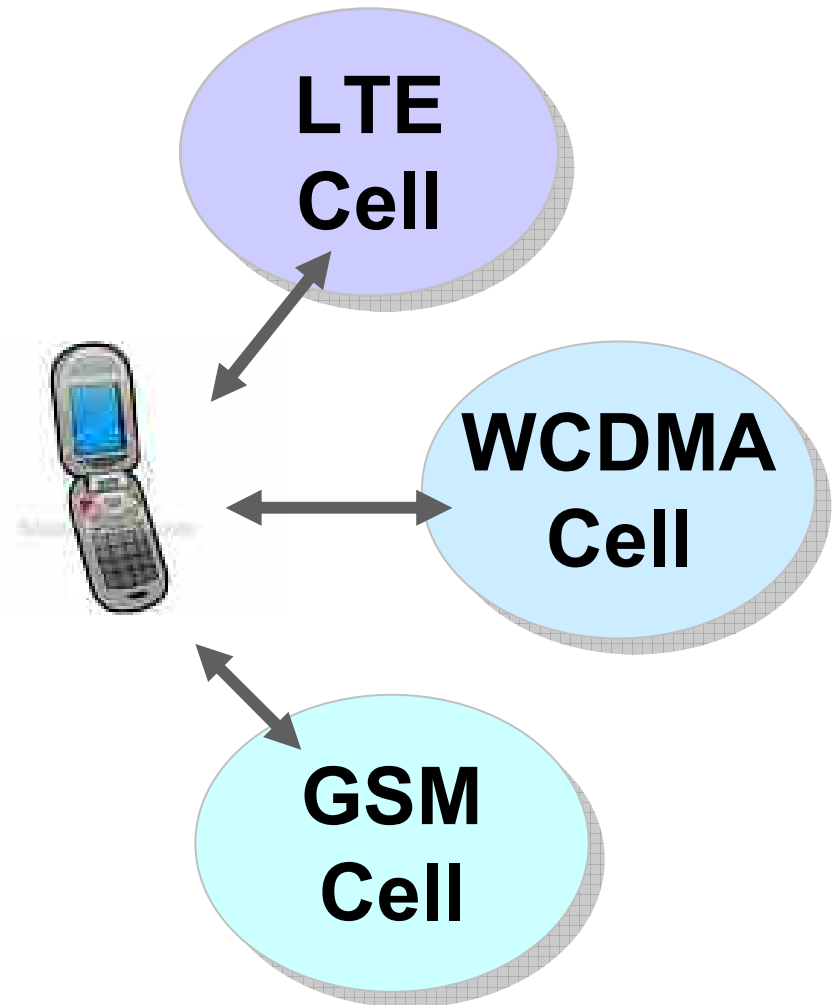
I Failure / recovery tests

I Performance tests

I Circuit switched voice fallback

- I Mobile originated / mobile terminated
- I Redirection or PS handover based

I Both LTE FDD and TDD mode are tested



Inter-RAT Handover Tests

3GPP Test Specifications



- I **3GPP inter-RAT tests are defined in TS 36.52x / TS 34.12x specifications**
- I **RF conformance tests (RCT)**
 - I RF conformance tests – no Inter-RAT tests
- I **RRM conformance tests**
 - I **TS 36.521-3:** LTE → WCDMA / GSM / C2K conformance tests
 - I **TS 34.121:** WCDMA → LTE conformance tests
- I **Protocol conformance tests**
 - I **TS 36.523:** LTE → WCDMA / GSM / C2K conformance tests



Inter-RAT Handover Tests

Global Certification Forum / GCF

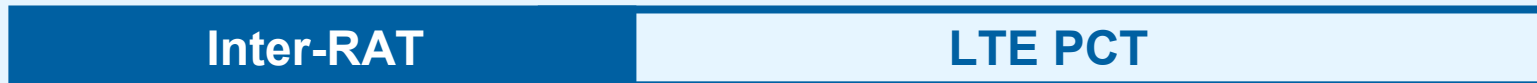


I GCF Certification Testing (Global Certification Forum)

- I GCF (Global Certification Forum) has selected RCT & PCT conformance tests for LTE terminal certification
- I In total 500 test cases in 4 priorities P1 – P4
 - Total 470 test cases for protocol conformance testing
 - 150 test cases are Inter-RAT tests for LTE / WCDMA / GSM / C2K
 - 31 triple RAT tests cases LTE / WCDMA / GSM

Number of IRAT tests for GCF terminal certification

LTE / WCDMA	LTE / GSM	LTE / CDMA	Total IRAT
64 tests	59 tests	27 tests	150 tests



Inter-RAT Handover Tests

Network Operator Specifications



- I Network operators have strict inter-RAT test requirements**
- I Verizon Wireless US test plan**
 - “LTE / CDMA Inter-RAT operations”**
 - I 40 inter-RAT test cases**
 - LTE idle / eHRPD dormant
 - LTE idle / 1xRTT idle
 - LTE active / eHRPD idle
 - LTE active / 1xRTT idle
- I Inter-RAT data throughput performance tests**
- I Simultaneous Voice Data (SVLTE) tests**
- I EVDO Rev. A and Rev. B tests**



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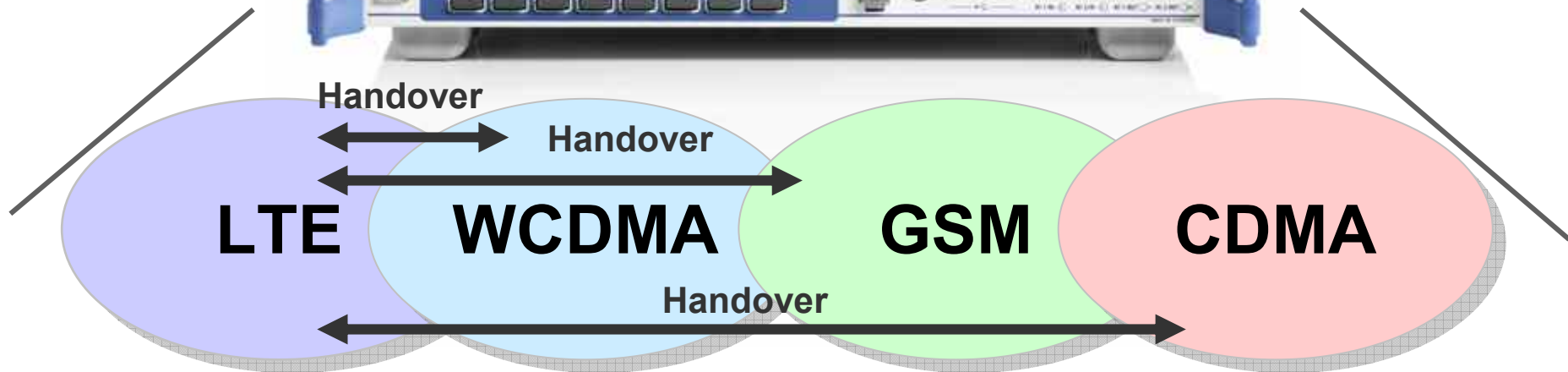
Test Equipment Requirements



- **Requirements on test equipment for multi-mode and inter-RAT handover terminal testing**
 - 4 radio access network standards
 - Multiple cells
minimum 2 cells, often 3 – 4 cells
 - RF measurements
 - Protocol test support incl. handover procedures
 - Data throughput measurements
 - Protocol logging for all RATs
 - Consistent programming API across all standards

Test Equipment

Rohde & Schwarz CMW500 Protocol Tester



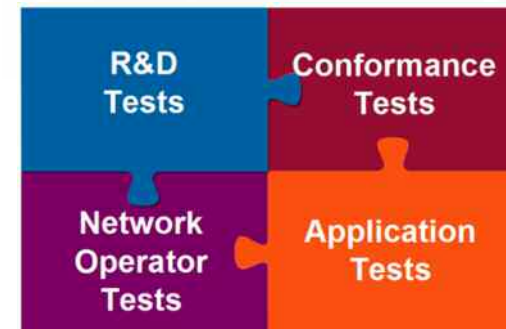
4 radio access network standards in one instrument

Test Equipment

CMW500 Protocol Tester Key Features

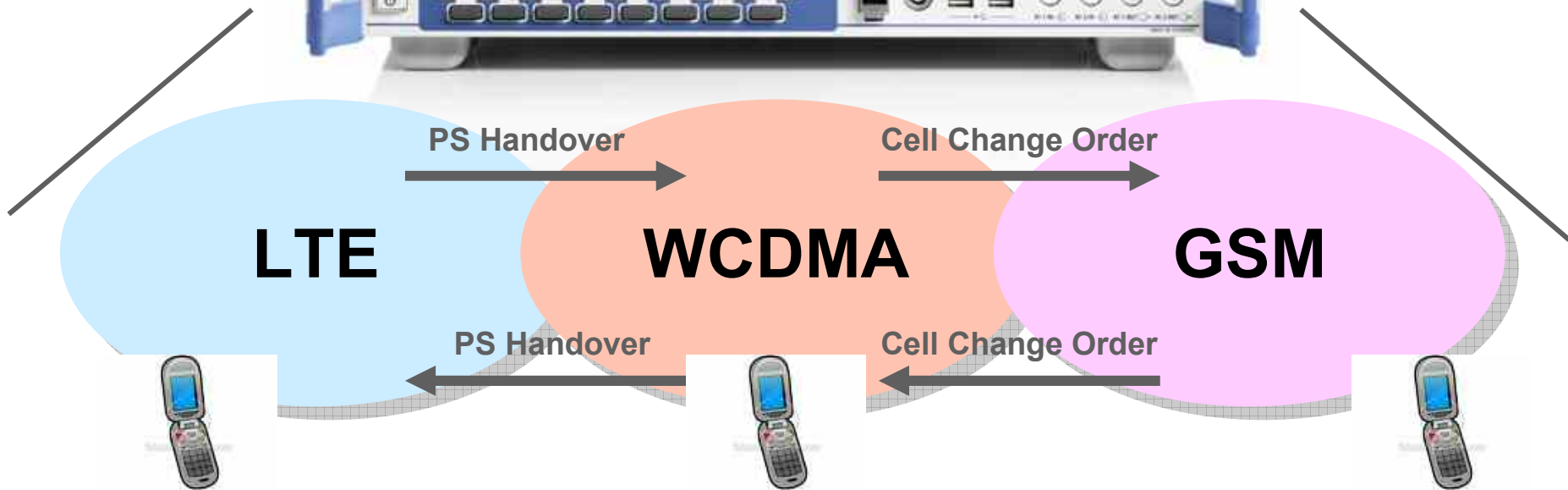
I Key Features

- I **LTE, WCDMA, GSM, CDMA** multi-mode support
- I 2 independent cells (can be extended up to 6 cells)
- I Frequency range up to 6 GHz
- I RF measurements on each standards
- I Protocol and inter-RAT handover tests
- I Integrated IP application server (IMS, VOIP, HTTP, iPerf, Video streaming)
- I Data throughput tests across all standards
- I Consistent programming API across all RATs
- I **Supports all stages of multi-mode terminal development**
- I **Validated test platform in GCF and PTCRB**

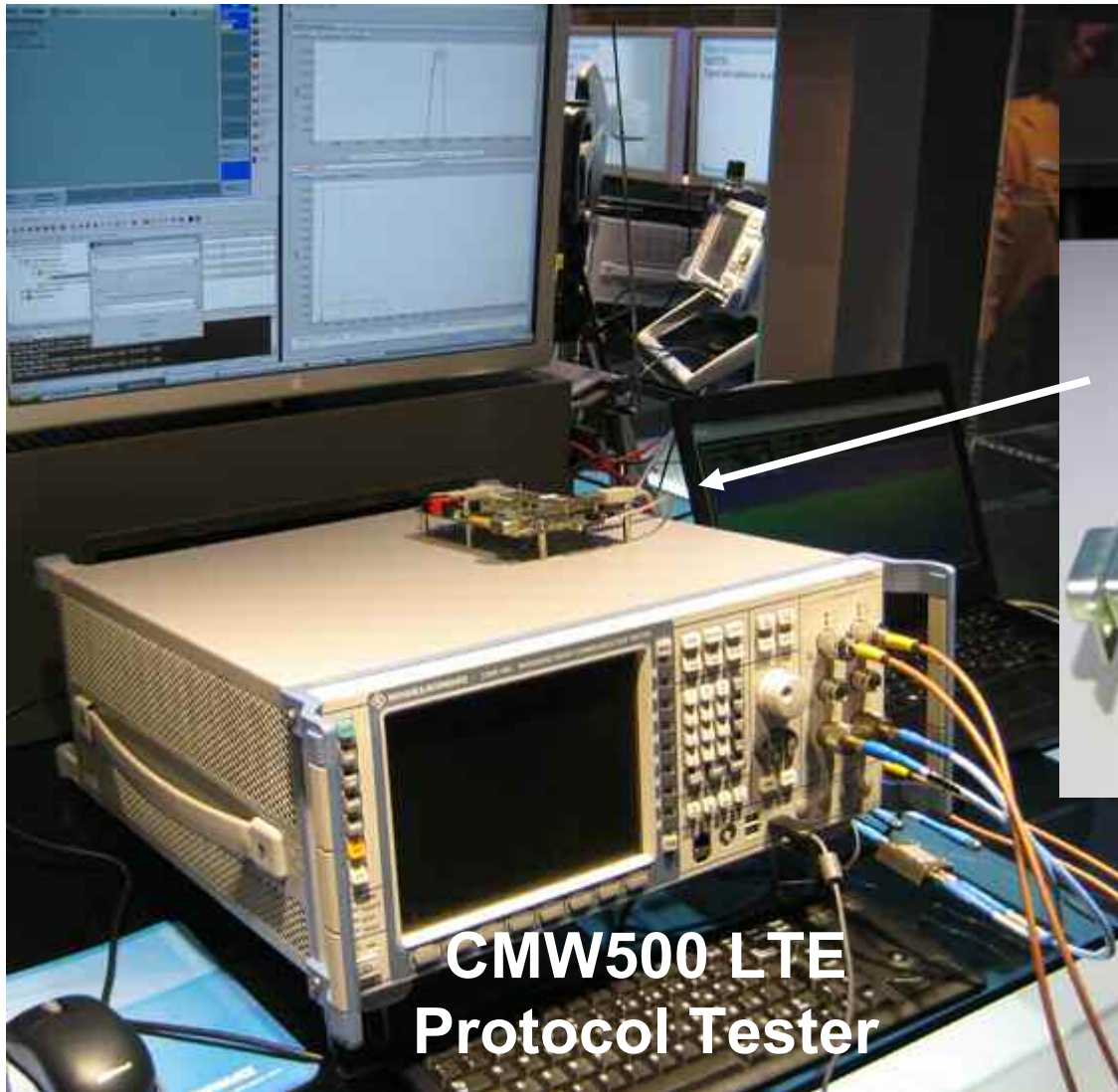


Mobile World Congress, Barcelona, Feb 2011

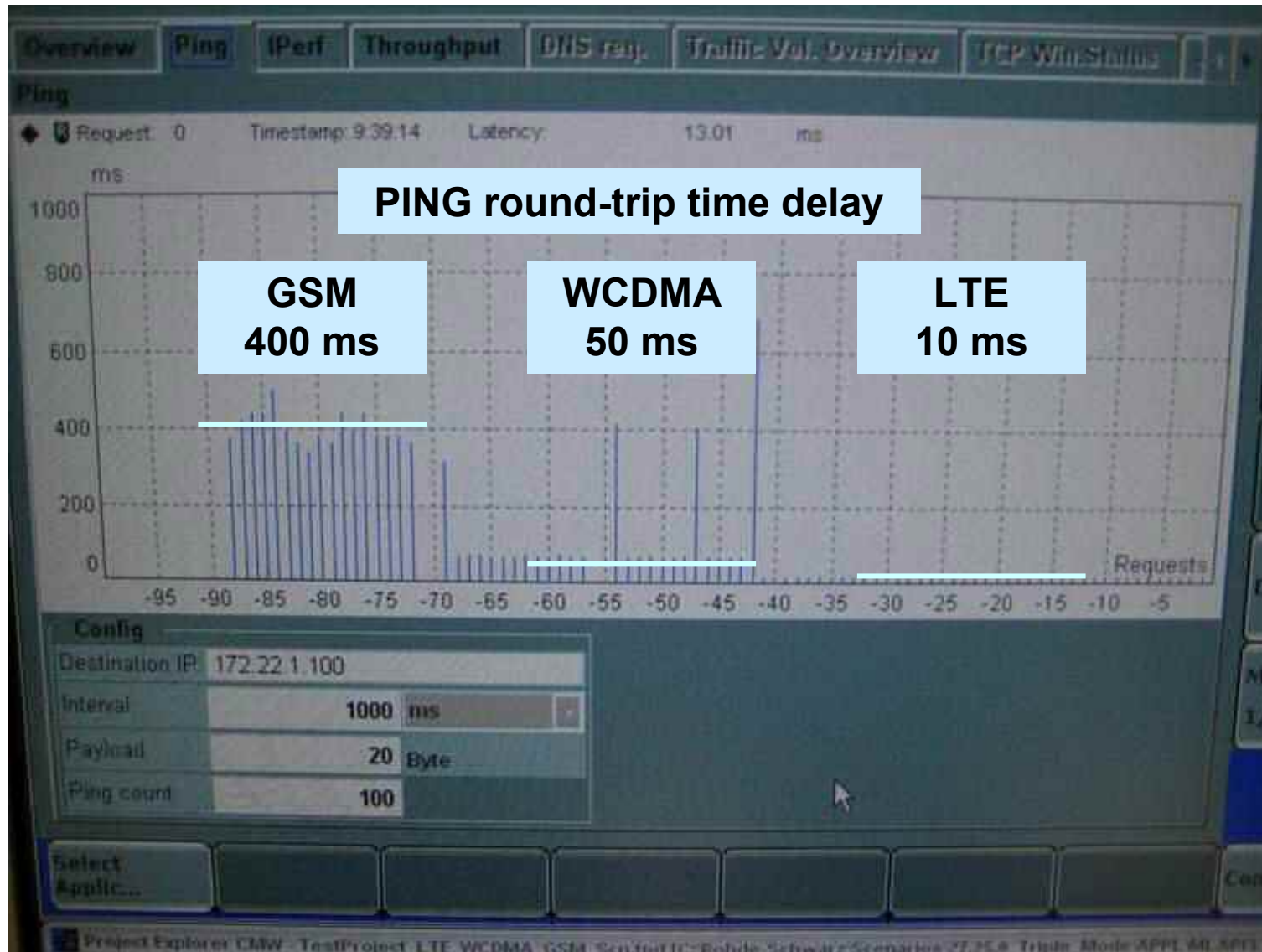
R&S CMW500 Triple-RAT Handover Demonstration



MWC 2011 - CMW500 Triple-RAT Handover Setup



MWC 2011 - Triple-RAT Latency Measurement



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Conclusion

LTE operators deploy multi-standard networks (LTE, WCDMA, GSM, CDMA)

LTE terminals have to support multiple radio access technologies

**Increasing test requirements
Complex Inter-RAT handover tests**

Rohde & Schwarz offers test solutions to meet these multi-mode requirements





**Thank you
for your attention**

