Synchronization in the Mobile standards
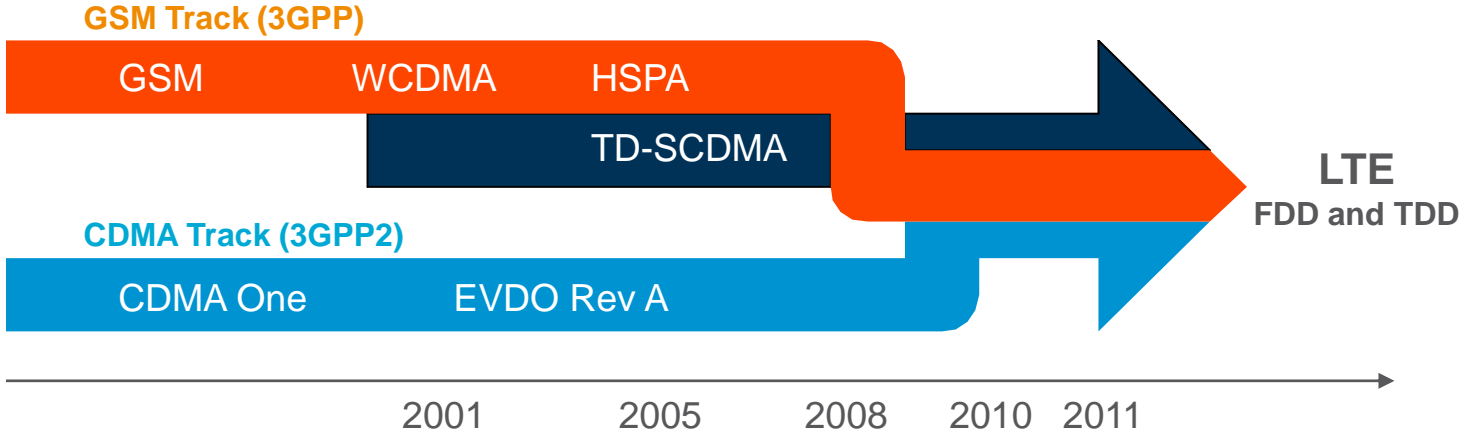
ITSF – 2012, Nice

Stefano Ruffini, Ericsson

Mobile Applications and Synchronization
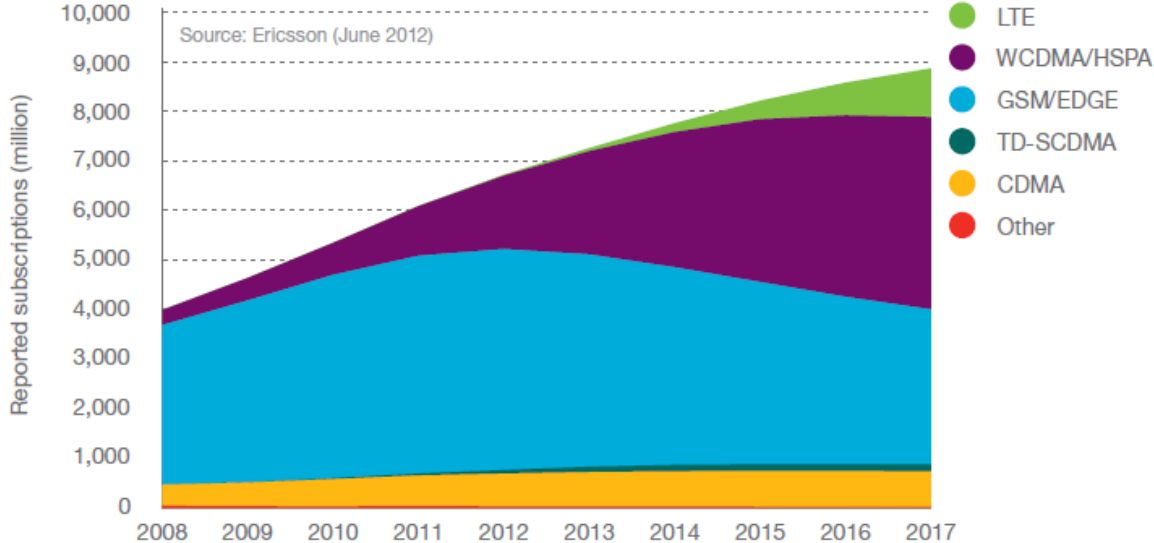
› The needs of mobile networks are driving most of the current synchronization related efforts in the standards

› 3GPP is the main body for mobile applications

– Increased interaction with ITU-T Q13/15

› New services and architectures may lead to new sync requirements

– CoMP

– Heterogeneous networks/Small Cells

– Etc.

Evolution of mobile technologies

GSM Track (3GPP)

GSM   WCDMA   HSPA

TD-SCDMA

CDMA Track (3GPP2)

CDMA One   EVDO Rev A

LTE
FDD and TDD

2001   2005   2008   2010 2011

Mobile subscriptions
by technology

Source: Ericsson (June 2012)

Reported subscriptions (million)

- LTE
- WCDMA/HSPA
- GSM/EDGE
- TD-SCDMA
- CDMA
- Other

10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0

2008 2009 2010 2011 2012 2013 2014 2015 2016 2017

Source Ericsson, Traffic and Market Report, http://www.ericsson.com/traffic-market-report

Internal structure of 3GPP

Project Co-ordination Group

TSG GERAN
GSM EDGE
Radio Access Network

GERAN WG1
Radio Aspects

GERAN WG2
Protocol Aspects

GERAN WG3
Terminal Testing

TSG RAN
Radio Access Network

RAN WG1
Radio Layer 1 spec

RAN WG2
Radio Layer 2 spec
Radio Layer 3 RR spec

RAN WG3
Iub spec, Iur spec, Iu spec
UTRAN O&M requirements

RAN WG4
Radio Performance
Protocol aspects

RAN WG5
Mobile Terminal
Conformance Testing

TSG SA
Service & Systems Aspects

SA WG1
Services

SA WG2
Architecture

SA WG3
Security

SA WG4
Codec

SA WG5
Telecom Management

TSG CT
Core Network & Terminals

CT WG1
MM/CC/SM (Iu)

CT WG3
Interworking with external networks

CT WG4
MAP/GTP/BCH/SS

CT WG6
Smart Card Application Aspects

3GPP™
A GLOBAL INITIATIVE

Developing Technical Specifications and Reports with sync related contents

Source: www.3gpp.org

# WCDMA Base Station TX Frequency Error

TS 25.104/5:

"Base Station (BS) radio transmission and reception (FDD/TDD)"

- The Base Station shall use the same frequency source for both RF frequency Generation and the chip clock .

- The modulated carrier frequency is observed over a period of one timeslot for RF frequency generation

BS class	Accuracy
Wide Area BS	±0.05 ppm
Medium Range BS	±0.1 ppm
Local Area BS	±0.1 ppm
Home BS	±0.25 ppm

Y < 0.05-0.25 ppm

NodeB
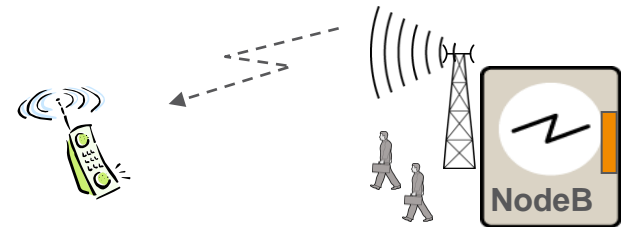
The requirement applies to the radio interface

Base Station Tolerance

TS 25.411: "UTRAN Iu Interface Layer 1"

› The synchronisation reference extracted from the Iu may be used as UTRAN synchronisation reference.

› The jitter and wander on the interface in accordance with network limits for output wander at <u>traffic</u> interfaces of ITU-T Rec. G.823 or G.824

› General recommendation is to supply a traceable synchronisation reference according to reference ITU-T Rec. G.811

  – In principle (and in any case during loss of traceability from PRC), lower accuracy is sufficient (e.g. 16 ppb, as per Stratum 2).

 – ITU-T has recently defined an MTIE mask that is applicable to packet timing (G.8261.1)

TDM

NodeB

Network Limits

From G.8261.1

MTIE

16ppb

18 μs

9 μs

0.05 0.2   32 64   1125

Observation interval τ (s)
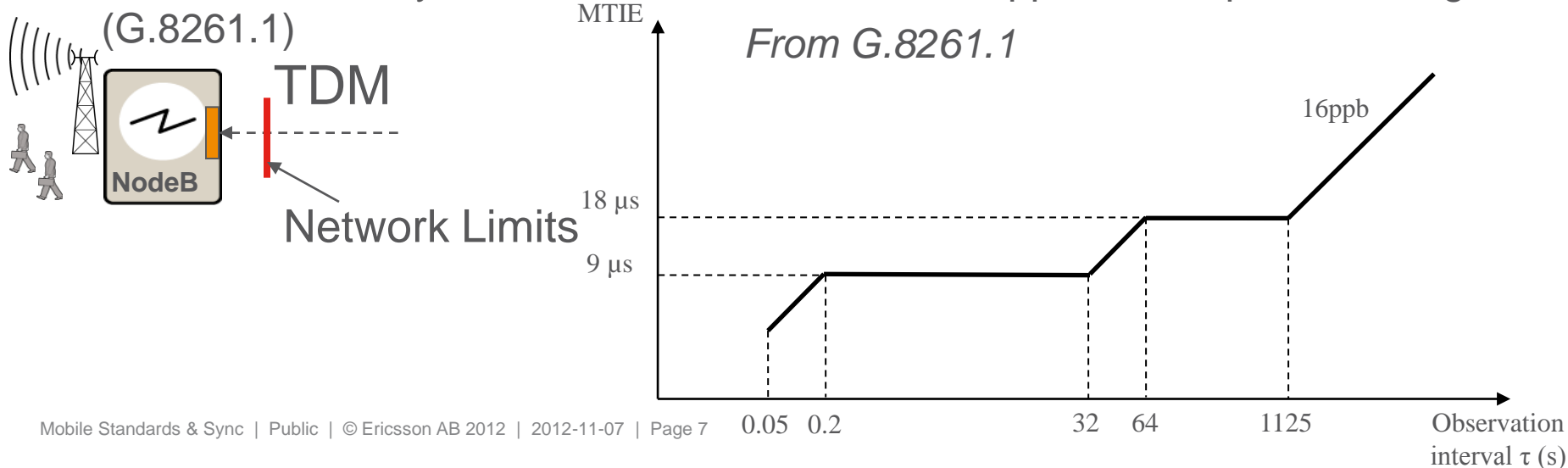
LTE Base Station TX Frequency Error

TS 36.104: "Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception

› Frequency Synchronization (Radio Interface) requirements:
  – The same source shall be used for RF frequency and data clock generation.
  – The modulated carrier frequency of the BS observed over a period of one subframe (1ms) shall be accurate to within

BS class	Accuracy
Wide Area BS	± 0.05 ppm
Local Area BS	± 0.1 ppm
Home BS	± 0.25 ppm

Y < 0.05-0.25 ppm
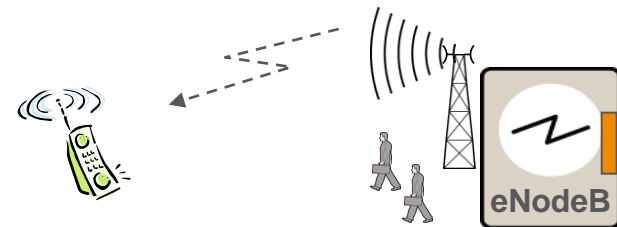
eNodeB

Requirements at the input of the eNodeB depends on the actual implementation

The requirement applies to the radio interface

LTE-TDD Phase Synchronization Requirements

TS 36.133: *"Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements for support of radio resource management*
TS 36.922: *"Evolved Universal Terrestrial Radio Access (E-UTRA); TDD Home eNode B (HeNB) Radio Frequency (RF) requirements analysis"*

	Maximum absolute deviation in frame start timing between any pair of cells on the same frequency that have overlapping coverage areas
LTE-TDD (Wide-Area BS)	- **3usec** for small cell (< 3km radius), - **10usec** for large cell (> 3km radius)
LTE-TDD (Home-Area BS)	- **3 usec** for small cell (< 500m radius). - **1.33 + *Tpropagation* μs**, for large cell (> 500m radius), *Tpropagation:* propagation delay between the Home BS and the cell selected as the network listening synchronization source
LTE-TDD to CDMA handovers (Synchronized E-UTRAN)	- eNodeB shall be synchronized to GPS time. - With external source of CDMA system time disconnected, the eNodeB shall maintain the timing accuracy within $\pm$ 10usec of CDMA system time for a period of not less than 8 hours

Future requirements (LTE Advanced)

__TR 36.814:__ " Evolved Universal Terrestrial Radio Access (E-UTRA); Further advancements for E-UTRA physical layer aspects"

› Phase/Time requirements for the applications listed below are currently under study:

  › Carrier Aggregation

  › Coordinated Multipoint Transmission (aka Network-MIMO)

  › Relaying function

› Increased interest on Small Cells scenarios

  › Possible specific synchronization requirements

› Recent feedback from 3GPP (TD710/3, Geneva 09/2012): *RAN WG4 has currently <u>not defined any new synchronization related requirement</u> with a potential impact on the solutions for synchronisation in packet networks (i.e. Frequency error on the transmitted signal as per TS 36.104, or cell phase synchronization accuracy as per TS 36.133 still apply).*

Others

› Mobile sync needs are adressed in several others Standardization Bodies, e.g. MEF anf BBF

› MEF: industry alliance promoting the adoption of Carrier-class Ethernet networks.

– Application of Carrier Ethernet Networks to Mobile Backhaul applications is one of the main study point in MEF

– MEF 22.1 Mobile Backhaul IA includes details frequency synchronization

– MEF 22.2 (Phase 3 projected for 2014 approval) includes time/phase synchronization as one of the main items in the scope.

– New Project on PDV Metric to map FPP (Floor Packet Percentage) to MEF metrics (FDR, Frame Delay Range)

› BBF: Consortium aiming at driving broadband wireline solutions.

– WT-221 MPLS Mobile Backhaul - Architectural studies involving sync aspects