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Technical Report

3rd Generation Partnership Project;
Technical Specification Group Radio Access Network;
Scalable UMTS FDD Bandwidth
(Release 12)

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Contents

Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

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Introduction

This clause is optional. If it exists, it is always the second unnumbered clause.

1 Scope

This document is related to the technical report for the study item “Scalable UMTS FDD Bandwidth” [3]. The scope of the present document is given in [3].

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] RP-122017: "Proposed SID: Study on Scalable UMTS".

[3] RP-130221: "Revised SID for Scalable UMTS FDD Bandwidth".

[4] R4-133349, “BS Tx coexistence aspects for S-UMTS”, Huawei

[5] R4-133351, “SEM analysis for Scalable UMTS carrier”, Huawei

[6] R4-133852, “Time-Dilated UMTS: BS emissions”, Ericsson, ST-Ericsson

[7] R4-133350, “BS Rx coexistence aspects for S-UMTS”, Huawei

[8] R4-132338, “ Co-existence issue for S-UMTS”, Huawei

[9] R4-133846, “Further study on co-existence of Scalable UMTS”, NSN

3 Definitions, symbols and abbreviations

Delete from the above heading those words which are not applicable.

Clause numbering depends on applicability and should be renumbered accordingly.

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

Definition format (Normal)

<defined term>: *<definition>.*

example: text used to clarify abstract rules by applying them literally.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

Symbol format (EW)

<symbol> <Explanation>

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

4 Objectives

This document captures the outcome of the RAN WG1 study about Scalable UMTS FDD bandwidth. This study aims at identifying target scenarios, and to investigate candidate solutions considering benefits and technical complexity. The detailed objectives are described in [3].

5 Scenarios of Scalable UMTS

5.1 Description

In standalone scenario, Scalable UMTS carrier can be supported as standalone utilization.

The multi-carrier scenario refers to the mode of operation where the 5 MHz carrier acts as the primary carrier, and the Scalable UMTS carrier is usable as the secondary HS-DSCH carrier in downlink.

5.2 Deployment Scenarios

The two tables below are listing the scenarios of Scalable UMTS.

1) The first deployment scenarios to consider

Table 5.2-1: The first deployment scenarios for Scalable UMTS

Mode of Operation	Bandwidth	Comments	Bands
Standalone	2.5 MHz (corresponds to N=2)	Support for DCH shall be considered.	Band VIII as the first band to consider
Standalone	1.25 MHz (corresponds to N=4)	HSPA data only	Band VIII as the first band to consider
Multi-carrier	5 MHz + 1.25 MHz (corresponds to N=4) 5 MHz+ 2.5 MHz (corresponds to N=2)	6 MHz of contiguous band to consider first	Band VIII as the first band to consider
Standalone	2.5 MHz (corresponds to N=2)	To understand the impact of band	Band I as the first band to consider

2) Additional scenario that may be considered

Table 5.2-2: Additional scenario may be considered for Scalable UMTS

Mode of Operation	Bandwidth	Comments	Bands
Multi-carrier	5 MHz + 2.5 MHz (corresponds to N=2)	For example 3x5MHz + 1x2.5MHz in 15 MHz of band	Band I as the first band to consider

Note: 5 MHz + 2.5 MHz multicarrier is not applicable in 6 MHz scenario.

6 Evaluation Methodology

6.1 Channel Model

The chip rate of time-dilated UMTS could be reduced to ½ or ¼ from the existing 3.84 Mcps operation. Typically, in a UMTS link simulator, the wireless multipath resolution is in units of the over sampling frequency K/Tc at the output of the transmitter filter where Tc = 1 UMTS chip and K is the oversampling factor. This is shown in Figure 6.1-1.

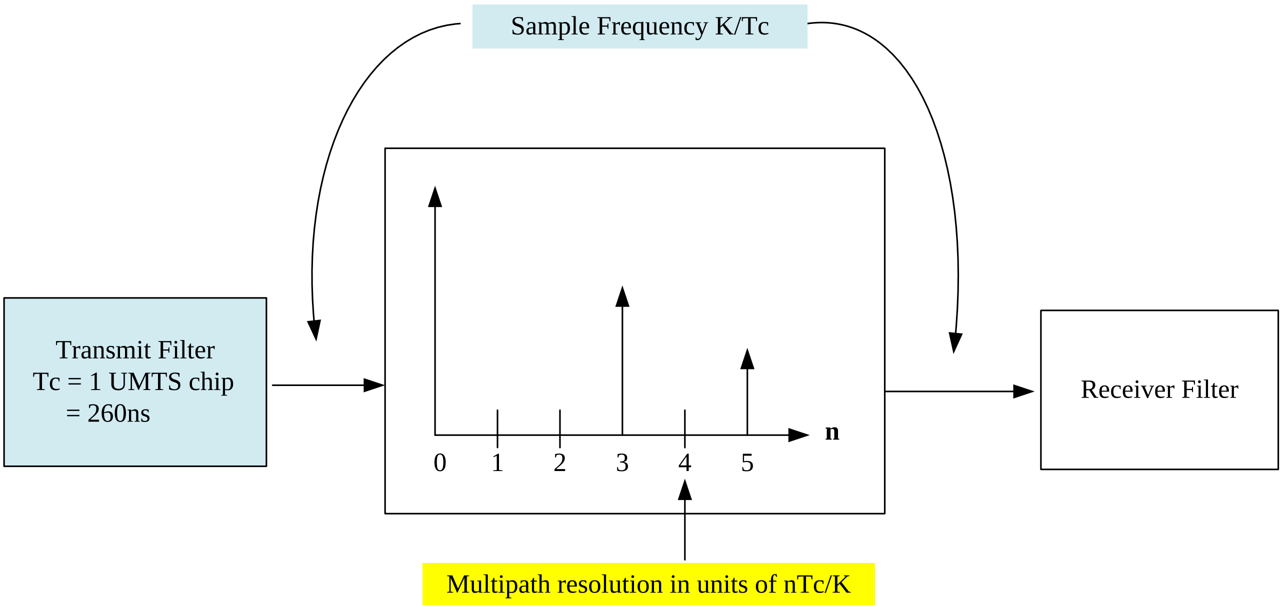

Figure 6.1-1: Sampling frequency at Tx filter output in UMTS.

Channel multipath resolution should be invariant in different time-dilated UMTS bandwidths, which could be realized by using the same channel sampling rate as in the legacy UMTS system. Via this way, the existing PA, PB and VA channel designed for legacy UMTS evaluation can be reused for time-dilated UMTS.

For example, when K=4, the oversampling frequency is 15.36MHz in legacy UMTS system. If it maintains the same multipath resolution, the time-dilated UMTS oversampling frequency will be (K*N)/ Tc` = (K*N) / N*Tc = K / Tc. Therefore, the oversampling in time-dilated UMTS is also 15.36MHz. This is illustrated in Figure 6.1-2.

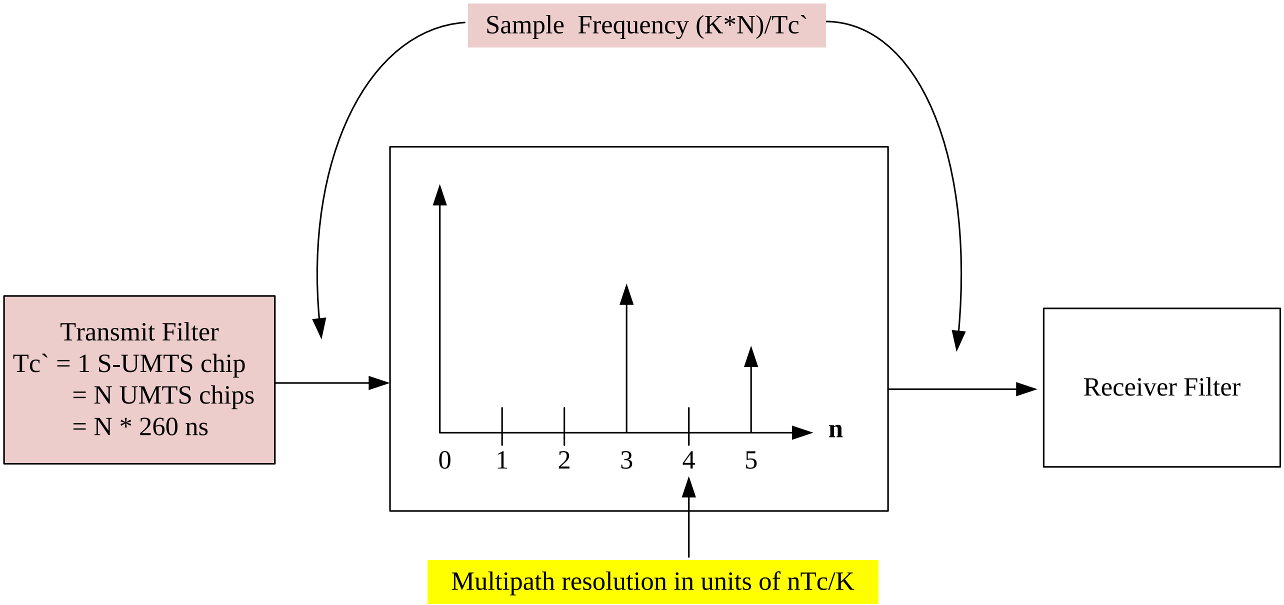

Figure 6.1-2: Sampling frequency at Tx filter output in time-dilated UMTS to maintain the same multipath resolution as in UMTS.

6.2 Link Level Simulation

Link-level simulation assumptions and performance metrics for time-dilated UMTS are defined in this section, for both the downlink (DL) and uplink (UL). Specifically, the standalone DL, standalone UL & carrier aggregation DL cases are covered. It should be noted that time-dilating control channels is a method for trading off overhead to latency.

6.2.1 Simulation assumptions

6.2.1.1 Downlink Simulation assumptions

The baseline parameters to be used for link-level simulations of standalone time-dilated UMTS DL are listed in Table 6.2.1.1-1. For all DL link-level assumptions, residual frequency error shall be 0 ppm.

Table 6.2.1.1-1: General Simulation Assumptions for standalone time-dilated UMTS Downlink

Parameter	Value
Carrier Frequency	900 MHz, 2GHz
Scaling factor	1; UMTS carrier 2; Time-dilated UMTS carrier 4; Time-dilated UMTS carrier (HSPA data only)
P-CPICH_Ec/Ior	-10dB
P-CCPCH_Ec/Ior	-12dB per P-CCPCH code
SCH_Ec/Ior	-12dB
PICH_Ec/Ior	-15dB
HS-SCCH_Ec/Ior	-12dB
HS-PDSCH_Ec/Ior	Remaining power so that total transmit power spectral density of Node B (Ior) adds to one

Spreading factor for HS-PDSCH	16
Modulation	QPSK, 16QAM, 64QAM
TTI [ms]	DCH: 20ms
TBS	Variable for HS-PDSCH AMR12.2K for DCH
HSDPA Scheduling Algorithm	CQI based
Geometry	[-5 0 5 10 15 20]dB
CQI Feedback Cycle	1TTI, 2TTIs
CQI feedback error	1% CQI error means CQI erasure, in which case the Node B uses the previous CQI
HS-DPCCH ACK/NACK feedback error	1%
Maximum number of HS-DSCH codes	Up to 15*SF16 for TTI=2ms*Scaling factor per carrier for HS-PDSCH
Number of HARQ Processes	6
Maximum HARQ Transmissions Time	50ms * Scaling factor
HARQ Combining	Incremental Redundancy
First transmission BLER	10% after 1 transmission
Number of Rx Antennas	2
Channel Encoder	3GPP Turbo Encoder for HSDPA Convolutional for DCH
Turbo Decoder	Log MAP
Number of iterations for turbo decoder	8
CQI Feedback delay	8ms*Scaling factor (the case TTI length is increased); 8ms (the baseline)
Propagation Channel Type	PA3,VA3, VA30,VA120 in specific cases AWGN simulations could be used
Channel Estimation	Realistic
Noise Estimation	Realistic
UE Receiver Type	1-Rx Rake and 2-Rx LMMSE (Type 3)
Antenna imbalance [dB]	0
Tx Antenna Correlation	0
Rx Antenna Correlation	0
Number of transmit antennas	1

Table 6.2.1.1-2 lists the general parameters to be used for time-dilated carrier aggregation DL link simulations.

Table 6.2.1.1-2: General Simulation Assumptions for time-dilated carrier aggregation Downlink

Parameter	Value
Scaling factor	Primary Cell: 1; Secondary Cell: 2; 4
P-CPICH_Ec/Ior	-10dB
P-CCPCH_Ec/Ior	Primary Cell: -12dB Secondary Cell: OFF
SCH_Ec/Ior	Primary Cell: -12dB Secondary Cell: OFF
PICH_Ec/Ior	Primary Cell: -15dB Secondary Cell: OFF
HS-SCCH_Ec/Ior	-12dB
HS-PDSCH_Ec/Ior	Remaining power so that total transmit power spectral density of Node B (Ior) adds to one on each cell
Spreading factor for HS-PDSCH	16
Modulation	QPSK, 16QAM, 64QAM
TBS	Variable for HS-PDSCH
HSDPA Scheduling Algorithm	CQI based
Geometry	[-5 0 5 10 15 20]dB
CQI Feedback Cycle	1TTI, 2TTIs
CQI feedback error	1% CQI error should be explained to mean CQI erasure, in which case the Node B uses the previous CQI
HS-DPCCH ACK/NACK feedback error	1%
Maximum number of HS-DSCH codes	Up to 15*SF16 for TTI=2ms*Scaling factor per carrier for HS-PDSCH
Number of HARQ Processes	6
Maximum HARQ Transmissions Time	50ms * Scaling factor
HARQ Combining	Incremental Redundancy
First transmission BLER	10% after 1 transmission
Number of Rx Antennas	2
Channel Encoder	3GPP Turbo Encoder
Turbo Decoder	Log MAP
Number of iterations for turbo decoder	8
CQI Feedback delay	8ms*Scaling factor (the case TTI length is increased);

	8ms (the baseline)
Propagation Channel Type	PA3,VA3, VA30,VA120 in specific cases AWGN simulations could be used
Channel Estimation	Realistic
Noise Estimation	Realistic
UE Receiver Type	1-Rx Rake and 2-Rx LMMSE (Type 3)
Antenna imbalance [dB]	0
Tx Antenna Correlation	0
Rx Antenna Correlation	0

6.2.1.2 Uplink Simulation Assumptions

Table 6.2.1.2-1 lists the general parameters to be used for UL link simulations, including DCH for voice traffic evaluation and E-DCH for data traffic evaluation. For all UL link-level assumptions, residual frequency error shall be 0 ppm.

Table 6.2.1.2-1: General Simulation Assumptions for standalone time-dilated UMTS Uplink

Parameter	Value
Physical Channels	E-DCH: E-DPDCH, DPCCH, EDPCCH DCH: DPCCH, DPDCH
Scaling factor	1; UMTS carrier 2; Time-dilated UMTS carrier 4; Time-dilated UMTS carrier (HSPA data only)
TTI [ms]	E-DCH: (2ms/10ms)*Scaling factor DCH: 20ms
TBS[bit]	DCH: AMR12.2K for DCH
Maximum HARQ Transmissions Time	50ms * Scaling factor
Operating Point	E-DCH: HARQ 1% Residual BLER within maximum HARQ transmission time. DCH: 1% BLER
E-DCH Scheduling Algorithm	RoT based
RoT	6dB

Number of Rx Antennas	2
Channel Encoder	3GPP Release 6 Turbo Encoder for E-DCH Convolutional for DCH
Turbo Decoder	Log MAP
Number of iterations for turbo decoder	8
DPCCH Slot Format	1 (8 Pilot, 2 TPC) for E-DCH 0 (6 pilot, 2 TFCI, 2 TPC) for DCH
Inner Loop Power Control	ON
Outer Loop Power Control	ON
Inner Loop PC Step Size	±1 dB
UL TPC Delay (sent on F-DPCH)	E-DCH: 1.33ms*Scaling factor
UL TPC Error Rate (sent on F-DPCH)	4%
Propagation Channel	PA3, VA3, VA30, VA120 in specific cases AWGN simulations could be used
NodeB Receiver Type	LMMSE, Rake
NodeB Rx Correlation	0
UE DTX	OFF
Number of transmit antennas	1

6.2.2 Performance evaluation metrics

For DCH voice traffic, the following metric should be considered:

- DL

  - BLER v/s Ec/Ior

- UL

  - Residual BLER v/s Transmitted Ec/No.

  - Residual BLER v/s Received Ec/N0.

For HSPA traffic, the following metrics should be considered:

- Throughput.

- For latency:

  - Compute transmission delay CDF for L1 delay.
  - CELL_DCH latency
    - Compare the CDFs of the average number of the transmissions and then take into account the increase in the TTI lengths to evaluate the latency.
  - Access latency
    - Consider with and without additional power/overhead.

- For coverage:

  - CELL_DCH coverage
    - Examine performance at different geometries.
  - Access coverage
    - Consider with and without additional power/overhead.

Inter-Carrier Interference (ICI) should be taken into account. The ICI model is described in R1-131588. The interference rise metric should be considered.

In time-dilated UMTS link-level simulation, the performance metrics shall be carrier specific.

6.3 System Level Simulation

6.3.1 Simulation assumptions

6.3.2 Performance evaluation metrics

7 Solutions of Scalable UMTS

7.1 Time Dilation Solution for Scalable UMTS

7.1.1 Description

The Scalable UMTS time dilation solution comprises increasing the UMTS chip period by a time dilation factor N, where N is equal to 2 or 4. Consequently, the Scalable UMTS chip period is increased to $N*T_c$, where T_c is the UMTS chip period (i.e., 0.26 μs). This results in the Scalable UMTS chip rate being reduced by a factor of 1/N relative to the UMTS chip rate of 3.84 Mcps and the Scalable UMTS spectrum bandwidth being reduced by a factor of 1/N relative to the UMTS spectrum bandwidth of 5 MHz. For example, in a 2.5 MHz bandwidth (referred to as Scalable UMTS N=2), the chip rate is reduced by a factor of 2 relative to UMTS to 1.92 Mcps. In this sense, time dilation is used as a means of achieving a smaller spectrum bandwidth. In this TR, this solution is referred to as time-dilated UMTS. Figure 7.1.1-1 illustrates the time dilation concept.

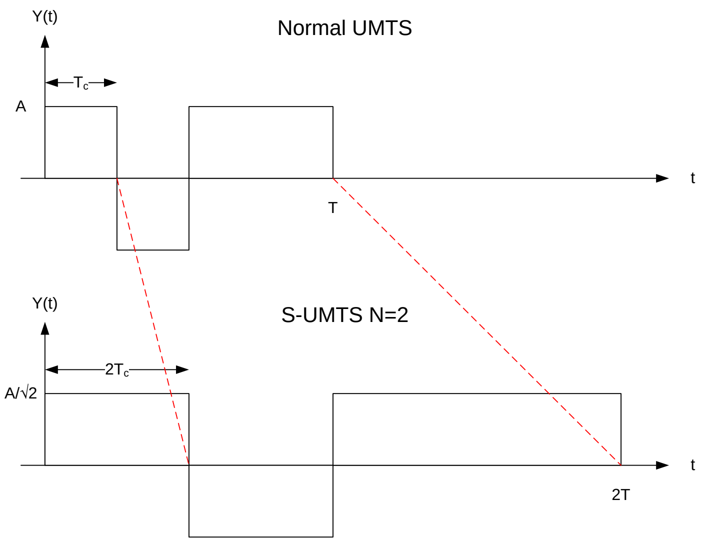

Figure 7.1.1-1: Time-dilated UMTS FDD waveform

Time-dilated UMTS reuses the UMTS FDD physical layer specifications to as large extent as possible. However, due to time dilation, all time-related physical layer parameters in time-dilated UMTS are scaled accordingly (i.e., dilated N times relative to UMTS). For example, in the case of time-dilated UMTS N=2, the radio frame duration increases from 10 ms to 20 ms. This is illustrated in Figure 7.1.1-2. Also, the HS-PDSCH subframe duration increases from 2 ms to 4 ms as shown in Figure 7.1.1-3.

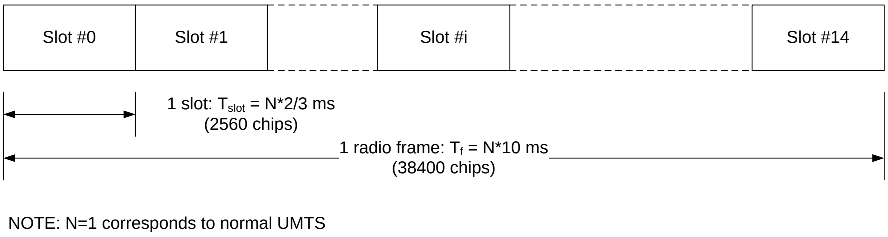

Figure 7.1.1-2: Radio frame structure for Scalable UMTS time dilation solution

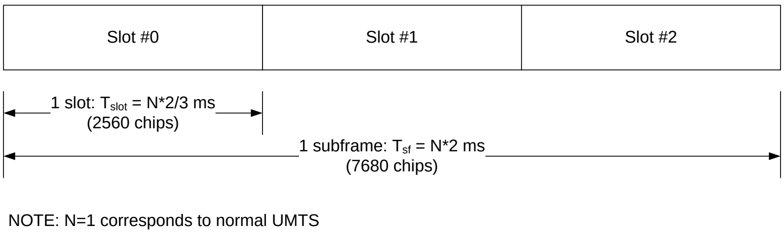

Figure 7.1.1-3: HS-PDSCH subframe structure for Scalable UMTS time dilation solution

7.1.1.1 Power Spectral Density of Scalable UMTS Systems

In this section, different options for power spectral density are discussed for standalone and dual carrier time-dilated UMTS systems. Since the bandwidth of the time-dilated UMTS waveform is reduced, the power spectral density (PSD) of time-dilated UMTS system can be increased so that the total power of the time-dilated UMTS system is the same as the total power of the equivalent UMTS system. On the other hand, PSD of the time-dilated UMTS system may also be increased to be comparable with the UMTS system. These options are reviewed in this section.

7.1.1.1.1 Standalone time-dilated UMTS in downlink

Figure 7.1.1.1.1-1 shows the Scalable UMTS system based on the time dilation solution, with the same PSD as normal UMTS system. In this scenario, time-dilated UMTS system NodeB power is smaller than the UMTS system. In this case, the power of time-dilated UMTS system with N = 2 is half, and in N = 4, the power is one-fourth of the total power of the equivalent normal UMTS system. This is illustrated in Figure 7.1.1.1.1-1. For example, for the uplink, if the normal UMTS UE transmit power is 23 dBm, then the time-dilated UMTS UE transmit power is 23 dBm – $10\log_{10}(N)$ (i.e., 20 dBm for time-dilated UMTS N=2 and 17 dBm for time-dilated UMTS N=4). In the downlink, if the normal UMTS Node B/cell transmit power is 43 dBm, then the time-dilated UMTS Node B/cell transmit power is 43 dBm - $10\log_{10}(N)$ (i.e., 40 dBm for time-dilated UMTS N=2 and 37 dBm for time-dilated UMTS N=4).

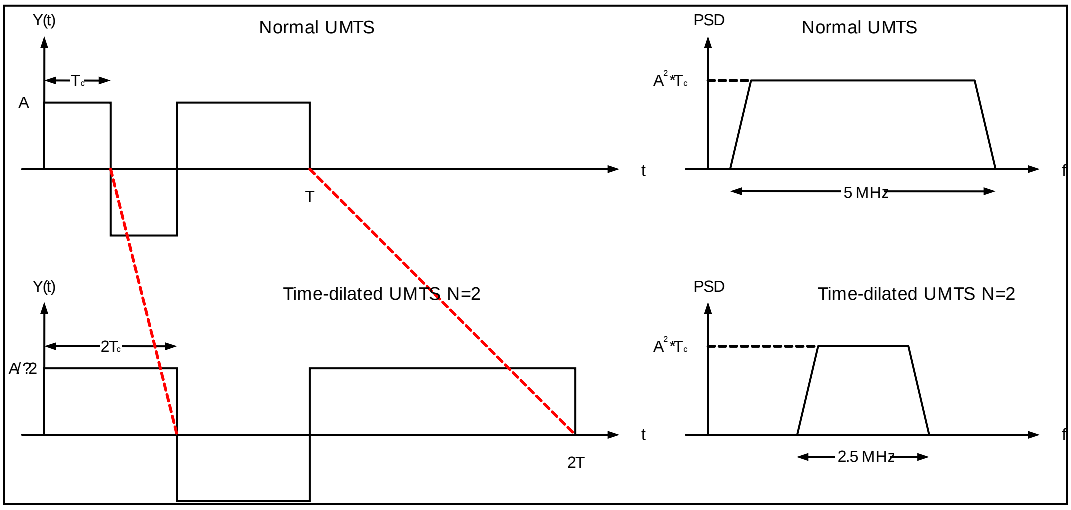

Figure 7.1.1.1.1-1: Scalable UMTS N=2 time dilation solution, with the same PSD. The same principle applies to N = 4.

Figure 7.1.1.1.1-2 shows the Scalable UMTS system based on the time dilation solution, with higher PSD. In this scenario, time-dilated UMTS system has the same power as compared with the UMTS system. The PSD of time-dilated UMTS system with N = 2 is twice, and in case of N = 4, is four times the PSD of equivalent UMTS system, giving the time-dilated UMTS the same power as the equivalent UMTS system. For example, in DL, if the normal UMTS Node B/cell transmit power is 43 dBm, then the time-dilated UMTS Node B/cell transmit power is also 43 dBm (for both Scalable UMTS N=2 and N=4). In UL, if the normal UMTS UE transmit power is 23dBm, then the time-dilated UMTS UE transmit power is also 23dBm (for both N =2 and N = 4).

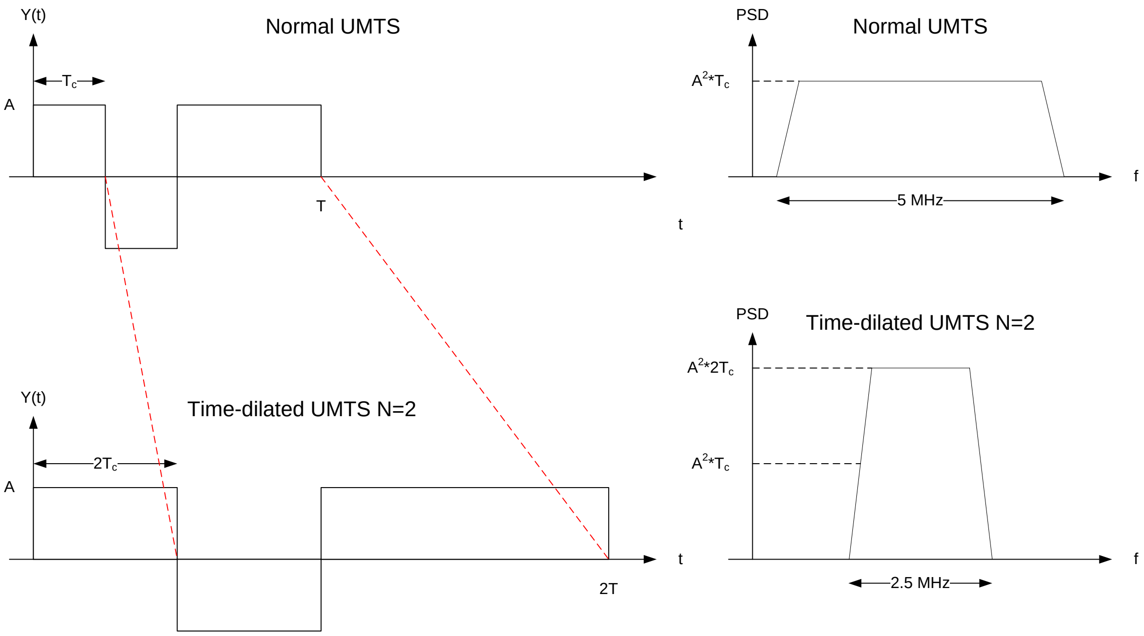

Figure 7.1.1.1.1-2: Time-dilated UMTS PSD scaled by N relative to normal UMTS (i.e., time-dilated UMTS transmit power same as normal UMTS)

7.1.1.1.2 Multi-Carrier Scalable UMTS in downlink

The PSD level of dual carried Scalable UMTS depends on whether additional power is available for the time-dilated UMTS carrier, or the total power is shared between legacy UMTS and time-dilated UMTS systems. In Table 7.1.1.1.2-1, a summary of possible scenarios for multi-carrier UMTS system is considered. Extra NodeB power may be dedicated to the time-dilated UMTS carrier, with higher PSD or the same PSD level. Alternatively, time-dilated UMTS and legacy UMTS may share the total NodeB power. These options are summarized in Table 7.1.1.1.2-1, and further explained in this section.

Table 7.1.1.1.2-1: Scenarios for multi-carrier Scalable UMTS system

Total NodeB Power	Time-dilated UMTS vs UMTS Carrier PSD	Note
Extra Power for Time-dilated UMTS Carrier	Same PSD between Time-dilated UMTS and Legacy UMTS	eg., separate PA, without increasing Time-dilated UMTS PSD
Shared Power between Time-dilated and Legacy UMTS Carrier	Same PSD between Time-dilated UMTS and Legacy UMTS	eg., single PA, reducing PSD of both UMTS and Time-dilated UMTS
Extra Power for Time-dilated UMTS Carrier	Higher PSD for Time-dilated UMTS as compared to Legacy UMTS Carrier	eg., separate PA, with increasing Time-dilated UMTS PSD

Figure 7.1.1.1.2-1 represents the PSD of a dual carrier Time-dilated UMTS system with increased total power, and same PSD for Time-dilated UMTS carrier. In this case, the PSD of the Time-dilated UMTS system is at the same level of the PSD of the UMTS system. The overall power of the combined system is increased, with extra power dedicated for the Time-dilated UMTS carrier.

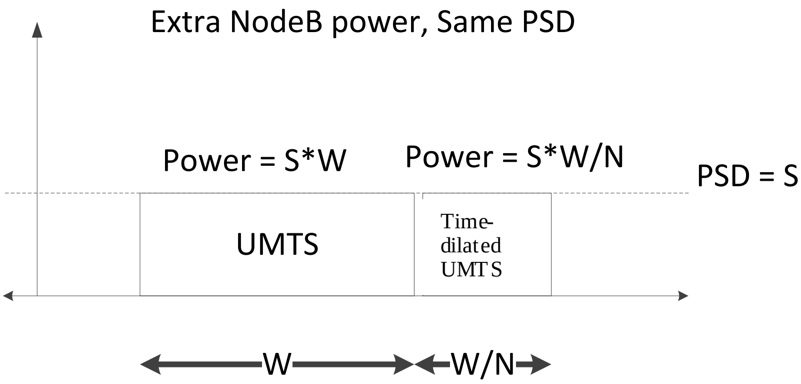

Figure 7.1.1.1.2-1: Multi-carrier UMTS system with the same PSD, with additional power dedicated to Time-dilated UMTS carrier. N = 2 or 4.

Figure 7.1.1.1.2-2 represents the PSD of a multi- carrier Scalable UMTS system in case of shared power between normal UMTS and Scalable UMTS carriers. The total NodeB power remains unchanged in this scenario, while PSD of both normal UMTS and Scalable UMTS is reduced. This scenario can be attractive for example, if there is not additional NodeB power available for Time-dilated UMTS carrier.

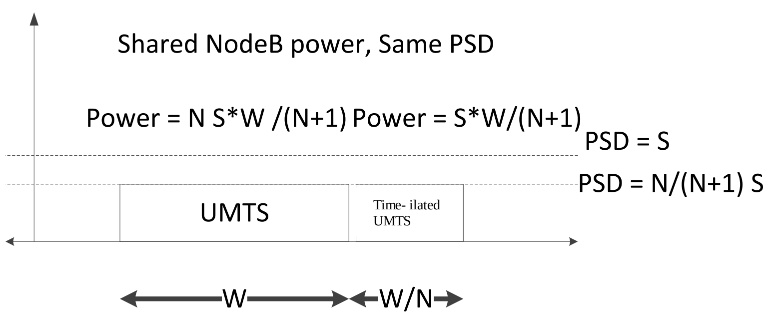

Figure 7.1.1.1.2-2: Multi-carrier UMTS system with reduced PSD, and shared PA. N = 2 or 4.

Figure 7.1.1.1.2-3 represents the PSD of a multi-carrier Scalable UMTS system with increased total NodeB power, and increased PSD for the Scalable UMTS system. In this case, the Time-dilated UMTS carrier has the same total power as the UMTS carrier. The overall NodeB across carriers is increased.

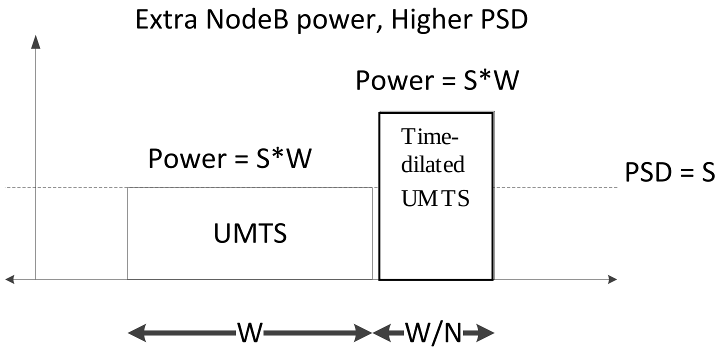

Figure 7.1.1.1.2-3: Multi-carrier UMTS system with increased PSD, and shared PA. N = 2 or 4.

7.1.1.2 Design Options for PCCPCH Channel

In this section, several design options are reviewed for the PCCPCH channel with the time dilation solution. Two approaches are discussed, based on reduction of the spreading factor, or addition of secondary PCCPCH channels.

7.1.1.2.1 Single PCCPCH channel with reduced spreading factor

In this approach, the spreading factor of the PCCPCH is channel is scaled down by a factor of N, N = 2 or 4. In conjunction of reduction of spreading factor, the power allocated to the PCCPCH channel is scaled up by a factor of N.

7.1.1.2.2 Multiple PCCPCH channels

In this approach, multiple PCCPCH channels are provision in N = 2 or N = 4 scenarios. These secondary PCCPCH channels use the same spreading factor and power as standard PCCPCH channel in normal UMTS system. Two cases of N = 2 and N = 4 are discussed in this section.

7.1.1.2.2.1 Time-dilated UMTS N=2

For Time-dilated UMTS N=2, the multiple PCCPCH mechanism consists of using a total of two SF=256 PCCPCHs in order to support the same BCH user data rate as normal UMTS (i.e., 12.3 kbps). Since two SF=256 PCCPCHs are required, 3 dB more power must be allocated to the Time-dilated UMTS N=2 broadcast channel. As an alternative to two SF=256 PCCPCHs, a single SF=128 PCCPCH could be used.

Table 7.1.1.2.2.1-1 lists the Time-dilated UMTS N=2 time dilation solution BCH parameters if two SF=256 PCCPCHs are used.

Table 7.1.1.2.2.1-1: Time-dilated UMTS N=2 time dilation solution BCH parameters using two SF=256 PCCPCHs

Transport block size	246 bits
CRC and tail bits	16 bits + 8 bits
Coding	CC, coding rate = 1/2
TTI	20 ms (i.e., 1 time-dilated radio frame)
Number of channelization codes	2
SF	256
Channelization code for P-CCPCH1	$C_{ch,256,TBD}$
Channelization code for P-CCPCH2	$C_{ch,256,TBD}$
Channel symbol rate	13.5 ksps
Channel bit rate	27 kbps
User data rate (not including CRC and tail bits)	12.3 kbps

7.1.1.2.2.2 Time-dilated UMTS N=4

For Time-dilated UMTS N=4, the multiple PCCPCH mechanism consists of using a total of four SF=256 PCCPCHs in order to support the same BCH user data rate as normal UMTS (i.e., 12.3 kbps). Since four SF=256 PCCPCHs are required, 6 dB more power must be allocated to the Time-dilated UMTS N=4 broadcast channel. As an alternative to four SF=256 PCCPCHs, a single SF=64 PCCPCH could be used.

Table 7.1.1.2.2.2-1 lists the Time-dilated UMTS N=4 time dilation solution BCH parameters if four SF=256 PCCPCHs are used.

Table 7.1.1.2.2.2-1: Time-dilated UMTS N=4 time dilation solution BCH parameters using four SF=256 PCCPCHs

Transport block size	246 bits
CRC and tail bits	16 bits + 8 bits
Coding	CC, coding rate = 1/2
TTI (two transport blocks per TTI)	40 ms (i.e., 1 time-dilated radio frame)
Number of channelization codes	4
SF	256
Channelization code for P-CCPCH1	$C_{ch,256,TBD}$
Channelization code for P-CCPCH2	$C_{ch,256,TBD}$
Channelization code for P-CCPCH3	$C_{ch,256,TBD}$
Channelization code for P-CCPCH4	$C_{ch,256,TBD}$
Channel symbol rate	13.5 ksps

Channel bit rate	27 kbps
User data rate (not including CRC and tail bits)	12.3 kbps

7.1.1.3 CS Voice in Time-dilated UMTS

Since the spreading factor is maintained on all of the channelization codes, the data rates are also reduced by a factor of 1/N for time-dilated UMTS. However, for time-dilated UMTS N=2, for delay sensitive radio bearers such as the standalone 3.4 kbps signalling radio bearers on DCH, the same bit-rate as UMTS should be maintained.

In UMTS, a voice packet is produced every 20 ms from the vocoder and is transmitted with a 20 ms TTI over the air interface. Together with the voice packet, the SRB packet could also be transmitted over the air interface but with a different TTI e.g. 40 ms TTI, as illustrated in Figure 7.1.1.3-1.

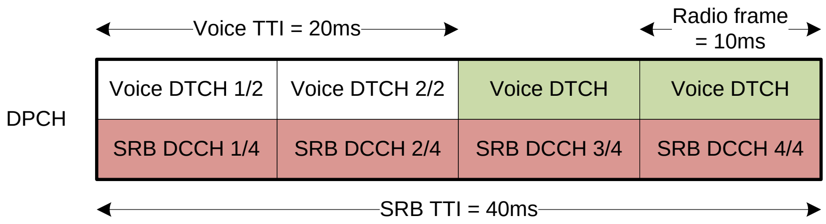

Figure 7.1.1.3-1: CS voice in UMTS

With the introduction of Time-dilated UMTS, it is expected that the vocoder function is to be kept unchanged. The voice packet should be transmitted over the air interface with the same TTI as in UMTS i.e. 20 ms. Since with time-dilated UMTS *N*=2, the radio frame is 20 ms, the voice packet transmission in stand-alone time-dilated UMTS can be re-designed as follows.

Option 1: DPCH SF unchanged. The same DPCH spreading factor as in the legacy system is used. To maintain the same voice quality, multiple codes for DPCH are to be used for one user. It is shown in Figure 7.1.1.3-2: CS voice in stand-alone time-dilated UMTS option 1: DPCH SF unchanged, SRB TTI = 40 ms 7.1.1.3-2. Two DPCHs per user are allocated for voice packet transmission. The SRB is transmitted in both the DPCHs with TTI being kept unchanged i.e. 40 ms as in the legacy system.

Option 2: DPCH SF reduced. The DPCH spreading factor is half of that used in the legacy system, as illustrated in Figure7.1.1.3-3. One DPCH per user is allocated for voice packet transmission, with reduced SF compared with UMTS, e.g. SF=64 in downlink in time-dilated UMTS N=2.

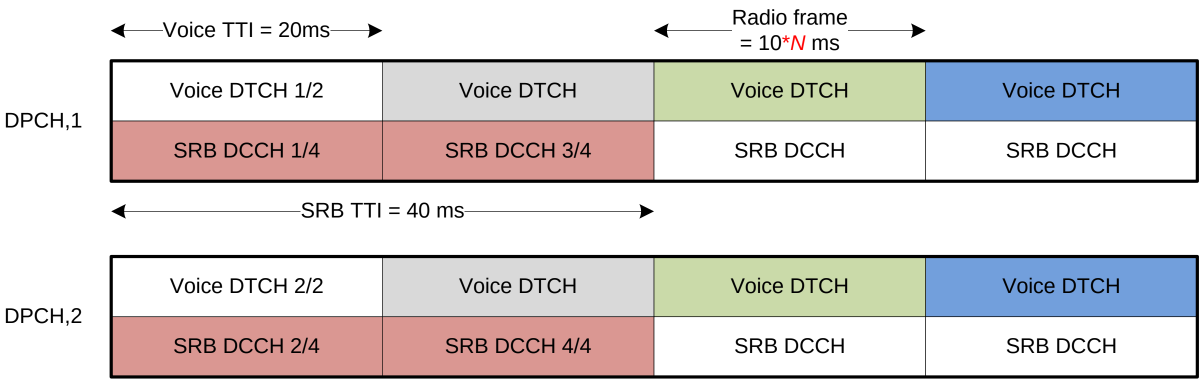

Figure 7.1.1.3-2: CS voice in stand-alone time-dilated UMTS option 1: DPCH SF unchanged, SRB TTI = 40 ms

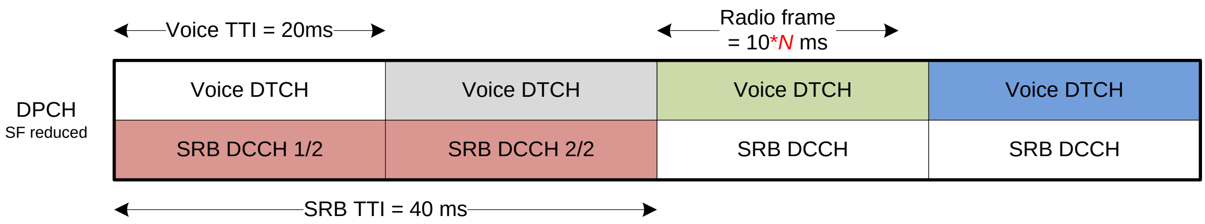

Figure 7.1.1.3-3: CS voice in stand-alone time-dilated UMTS option 2: DPCH SF reduced, SRB TTI = 40 ms

Standalone time-dilated UMTS with N=2 supports CS voice over DCH using either of the two options above. However, the voice capacity of time-dilated UMTS is expected to be reduced when compared with UMTS.

7.1.1.4 PRACH and AICH

The PRACH is used to carry the RACH. The AICH is used to carry the Acquisition Indicator (AI).

7.1.1.4.1 PRACH/AICH Timing Relation

Figure 7.1.1.4.1-1 illustrates the timing relationship between the AICH and PRACH access slots for UMTS (i.e., N=1) and time-dilated UMTS N=2 and N=4. The preamble-to-AI distance τ_{p-a} is defined in Table of this contribution. As depicted in figure 7.1.1.4.1-1, the PRACH and AICH access slot lengths for time-dilated UMTS N=2 are increased from 1.33 ms to 2.67 ms relative to UMTS. For time-dilated UMTS N=4, they are increased from 1.33 ms to 5.33 ms relative to UMTS. Also, the radio frame length for time-dilated UMTS N=2 is increased from 10 ms to 20 ms relative to UMTS while for time-dilated UMTS N=4 it is increased from 10 ms to 40 ms relative to UMTS.

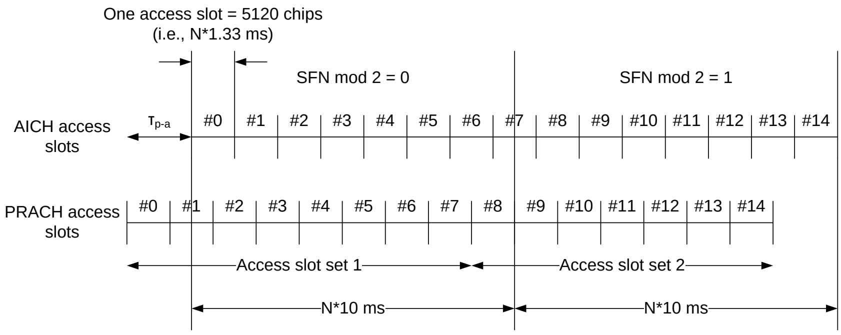

Figure 7.1.1.4.1-1: Timing relation between AICH and PRACH access slots for UMTS and time-dilated UMTS N=2 and N=4

7.1.1.4.2 Random Access Procedure

Figure 7.1.1.4.2-1 illustrates the UMTS (i.e., N=1) and time-dilated UMTS N=2 and N=4 random-access procedure. The preamble-to-preamble distance τ_{p-p}, preamble-to-AI distance τ_{p-a} and preamble-to-message distance τ_{p-m} are defined in Table 7.1.1.4.2-1. As shown in Table , τ_{p-p}, τ_{p-a} and τ_{p-m} for time-dilated UMTS N=2 and N=4 are increased by a factor of N (i.e., 2 and 4) relative to UMTS. Also, the PRACH message part radio frame for time-dilated UMTS N=2 is increased from 10 ms to 20 ms relative to UMTS while for time-dilated UMTS N=4 it is increased from 10 ms to 40 ms relative to UMTS.

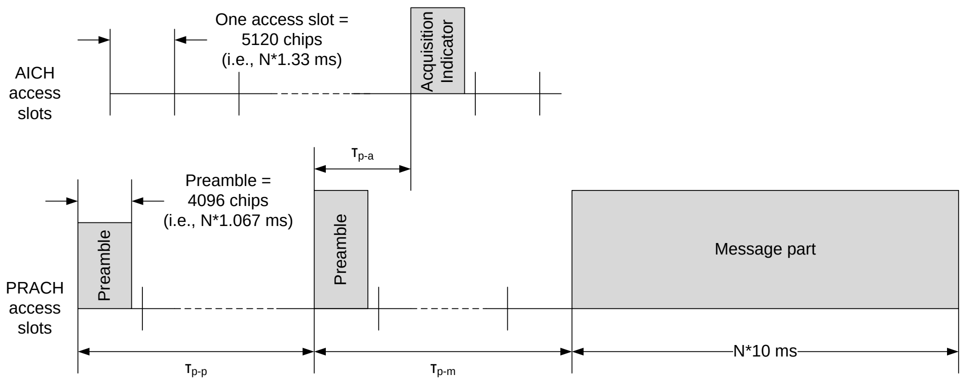

Figure 7.1.1.4.2-1: UMTS and time-dilated UMTS N=2 and N=4 random-access procedure

Table 7.1.1.4.2-1: UMTS and time-dilated UMTS N=2 and N=4 τ_{p-p}, τ_{p-a} and τ_{p-m}

	AICH_Transmission_Timing					
	0			1		
τ_{p-p}	> 15360 chips			> 20480 chips		
	N=1	N=2	N=4	N=1	N=2	N=4
	> 4 ms	> 8 ms	> 16 ms	> 5.33 ms	> 10.67 ms	> 21.33 ms
τ_{p-a}	7680 chips			12800 chips		
	N=1	N=2	N=4	N=1	N=2	N=4
	2 ms	4 ms	8 ms	3.33 ms	6.67 ms	13.33 ms
τ_{p-m}	15360 chips			20480 chips		
	N=1	N=2	N=4	N=2	N=2	N=4
	4 ms	8 ms	16 ms	5.33 ms	10.67 ms	21.33 ms

7.1.1.4.3 Random Access Procedure

Figure 7.1.1.4.3-1 illustrates the structure of the PRACH message part radio frame for UMTS (i.e., N=1) and time-dilated UMTS N=2 and N=4. The N*10 ms message part radio frame is split into 15 slots, each of length T_{slot} = 2560 chips. Each slot consists of two parts, a data part to which the RACH transport channel is mapped and a control part that carries Layer 1 control information. The data and control parts are transmitted in parallel. An N*10 ms message part consists of one message part radio frame, while an N*20 ms message part consists of two consecutive N*10 ms message part radio frames. The message part length is equal to the TTI of the RACH transport channel in use. This TTI length is configured by higher layers (e.g., in SIB5).[1] As depicted in Figure 7.1.1.4.3-1, the PRACH message part radio frame for time-dilated UMTS N=2 is increased from 10 ms to 20 ms relative to UMTS while for time-dilated UMTS N=4 it is increased from 10 ms to 40 ms relative to UMTS.

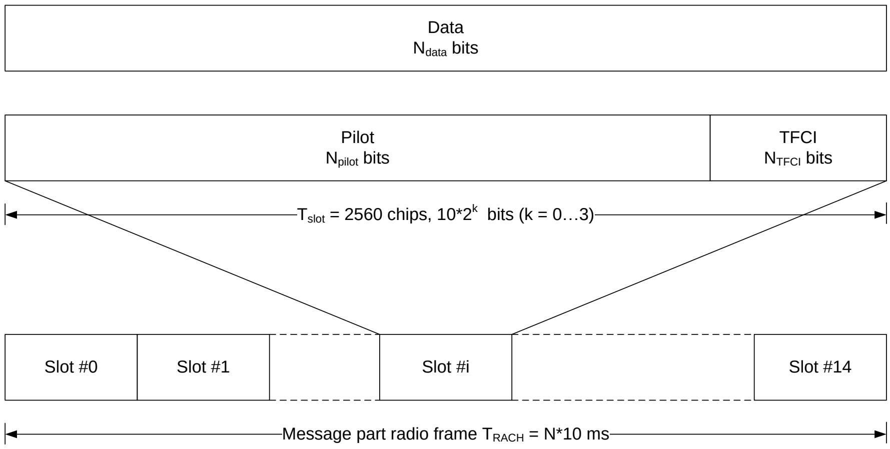

Figure 7.1.1.4.3-1: UMTS and time-dilated UMTS N=2 and N=4 PRACH message part radio frame structure

Table7.1.1.4.3-1 lists the random-access message data fields and Table 7.1.1.4.3-2 lists the random-access control fields for UMTS (i.e., N=1) and time-dilated UMTS N=2 and N=4. Note that the channel bit rate and symbol rate are reduced by a factor of 1/2 for time-dilated UMTS N=2 relative to UMTS. For time-dilated UMTS N=4, they are reduced by a factor of 1/4 relative to UMTS. Consequently, the SF for all slot formats stays the same.

Table7.1.1.4.3-1: UMTS and time-dilated UMTS N=2 and N=4 random-access message data fields

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{data}
0	15/N	15/N	256	150	10	10
1	30/N	30/N	128	300	20	20
2	60/N	60/N	64	600	40	40
3	120/N	120/N	32	1200	80	80

Table 7.1.1.4.3-2: UMTS and time-dilated UMTS N=2 and N=4 random-access message control fields

Slot Format #i	Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/ Frame	Bits/ Slot	N_{pilot}	N_{TFCI}
0	15/N	15/N	256	150	10	8	2

1 During the RRC Connection Establishment procedure, the PRACH message part carries the RRC CONNECTION REQUEST message.

7.1.2 Evaluation results

7.1.3 Applicable scenarios

7.1.4 Impacts on the network and UE

7.1.4.1 UE Receiver

Scenarios for time-dilated UMTS are divided to two cases, standalone and multicarrier operation. It is justifiable to assume that time-dilated UMTS UE would need to support also legacy UMTS. The complexity aspects discussed in the following sections apply when UE is operating in the time-dilated UMTS mode. The UE still needs to be dimensioned to support also legacy UMTS operation.

The simulated time-dilated UMTS system in this TR assumed the same sampling rate as the UMTS system. This complexity analysis is based on scaled-down sampling rate, which is considered to be feasible.

7.1.4.1.1 RF and Digital Front-end

Figure 7.1.4.1.1-1 illustrates examples of RF and digital front end receiver portions for the UMTS receiver that is also capable of receive diversity. An example of front end implementation of standalone time-dilated UMTS is shown in Figure 7.1.4.1.1-2.

- In both cases, a single local oscillator implementation is assumed for the purpose of RF down-conversion.
- The analog low pass filter (LPF) is now a narrower bandwidth (5/N MHz) when compared to the baseline case (5 MHz bandwidth).
- The ADC sampling rate decreases linearly in accordance with the analog LPF bandwidth.
- The complexity of the digital filter is 1/N to an FIR implementation of the UMTS FDD Square Root Raised Filter (roll-off factor = 0.22)

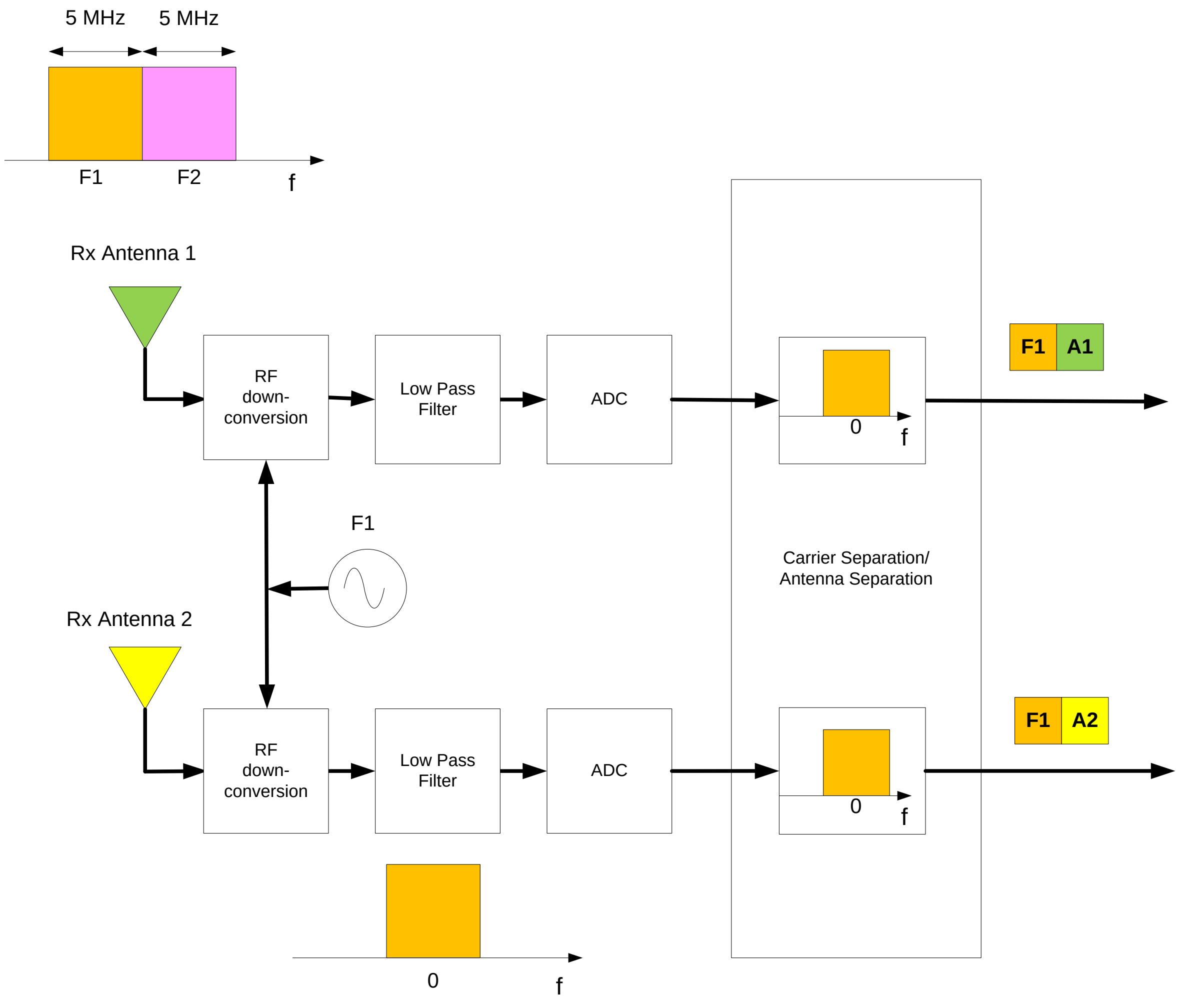

Figure 7.1.4.1.1-1: RF/Front End Block Diagram for a UMTS receiver

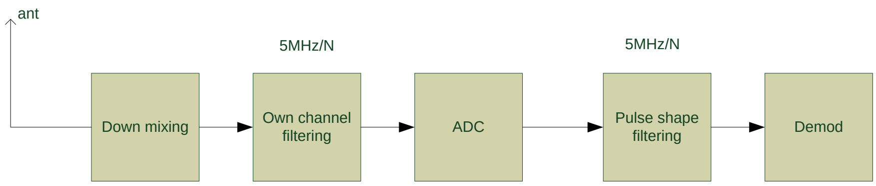

Figure 7.1.4.1.1-2: Front end implementation for standalone time-dilated UMTS

An example of the front end implementation for multicarrier time-dilated UMTS is shown in Figure 7.1.4.1.1-3. This example assumes similar frond end implementation as has been used in dual cell HSDPA. This implementation can be used only in case two carrier signals are within the front end sampling bandwidth. Therefore carriers should be adjacent or nearly adjacent. Carrier C1 has here been assumed to be the legacy carrier and C2 is the time-dilated UMTS carrier. Hence carrier separation for C1 is similar to legacy DC-HSDPA and only rotates signal to base band. Carrier separation for C2 needs to be slightly changed from legacy since the centre frequency of the time-dilated UMTS carrier can be different. Similar to the standalone case, the sampling rate can be reduced and is beneficial for the rest of the receiver chain.

So far it has been assumed that in time-dilated UMTS bandwidth reduction is handled by changing carrier distances within operators own band. Hence additional filtering may not be needed. However, additional filtering, if needed, would result in additional complexity. In any case filters are required to support half and/or quarter bandwidths.

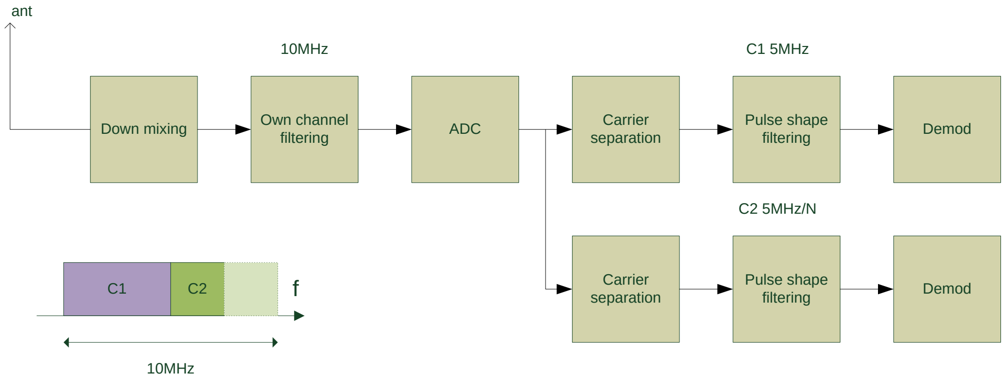

Figure 7.1.4.1.1-3: Front end implementation for multicarrier Time-dilated UMTS

7.1.4.1.2 Base-band Detector

The differences in base-band processing of the HS-PDSCH detector between the baseline and time-dilated UMTS receiver structures are examined in this section.

The legacy UMTS UE receiver can be assumed to employ a linear MMSE receiver operating in diversity mode as shown in Figure 7.1.4.1.2-1. Both the UMTS and time-dilated UMTS UE receivers are required to estimate the channel impulse response on the two receiving branches.

However, since the time duration of time-dilated UMTS is dilated by N times, the length of the channel impulse response (CIR) in unit of chips is reduced to 1/N of the CIR length for the UMTS receiver. Furthermore, because the sampling rate of time-dilated UMTS receiver is 1/N of the UMTS receiver, the complexity of searcher while searching for the CIR timing and channel estimator is $1/N^2$ of the UMTS receiver.

The complexity of LMMSE processing is scaled with the CIR length and sampling rate. Similar to the searcher and channel estimation complexity, the length and sampling rate of the linear equalizer in the time-dilated UMTS receiver are both 1/N of the linear equalizer in the UMTS receiver. So the complexity of LMMSE processing is also reduced to $1/N^2$ of the UMTS receiver. The allocation of the fingers in the rake receiver or the decision how to measure the impulse response in the type 3/3i receivers may need some fine tuning for different sampling rates and bandwidths.

When doing initial synchronization the UE may need to search time-dilated UMTS and legacy UMTS bandwidths, which could increase searcher complexity. However, the complexity may be limited by signalling information on possible bandwidths in each band. The same applies for neighbour cell measurements.

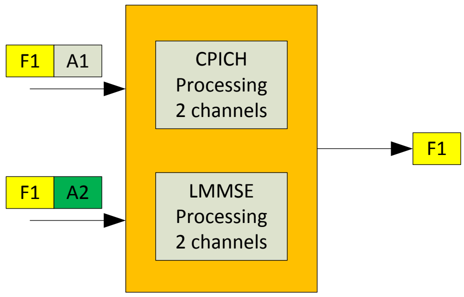

Figure 7.1.4.1.2-1: UMTS Receiver: Base-band Detector Block Diagram

7.1.4.1.3 Base-band Decoder

Since the data throughput and peak rate are expected to be 1/N of the UMTS FDD system, the decoder complexity is also expected to be reduced to 1/N of the UMTS decoder. Figure 7.1.4.1.3-1 illustrates a high level block diagram of the base-band decoding process for both the UMTS and the time-dilated UMTS receivers. For time-dilated UMTS, the IR buffer requirement is the same as UMTS but the Turbo decoder speed requirement is reduced to 1/N.

Complexity of DCH decoding remains the same as legacy assuming that DCH content remains the same, e.g. data rate of speech call is not affected by time-dilated UMTS.

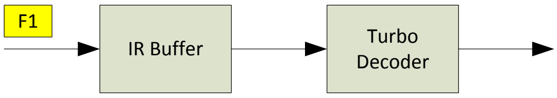

Figure 7.1.4.1.3-1: UMTS Receiver: Base-band decoding

7.1.4.2 UE Transmitter

Uplink of time-dilated UMTS is assumed to be using reduced bandwidth only in standalone case whereas legacy bandwidth is used in multicarrier. Changing the system bandwidth has impact to transmission filters and possibly PA implementations depending on the maximum transmission power.

In multicarrier scenarios, the HS-DPCCH feedback for the time-dilated UMTS carrier needs to be accounted for. Assuming time dilation, there is feedback for the secondary carrier in every Nth TTI. Feedback timing for the time-dilated UMTS carrier needs to be defined.

In case UE supports only time-dilated UMTS and not legacy UMTS, the following physical layer changes may be expected on the UL transmitter implementation:

- Reduction of the physical layer processing speed by 1/N
- Reduction of the digital pulse shaping filter sampling rate by 1/N
- Reduction of the analog filter bandwidth to 1/N of UMTS FDD sampling rate

7.1.4.3 BS Receiver

7.1.4.3.1 RF and Digital Front-end

One example of front end implementation for UMTS and time-dilated UMTS receiver is shown in Figure . Received Signal is filtered to the LPF after RF down-conversion and then is sampled to generate digital signals (ADC) for the rest of the receiver chain, i.e. carrier separation, pulse shaping filter and demodulation.

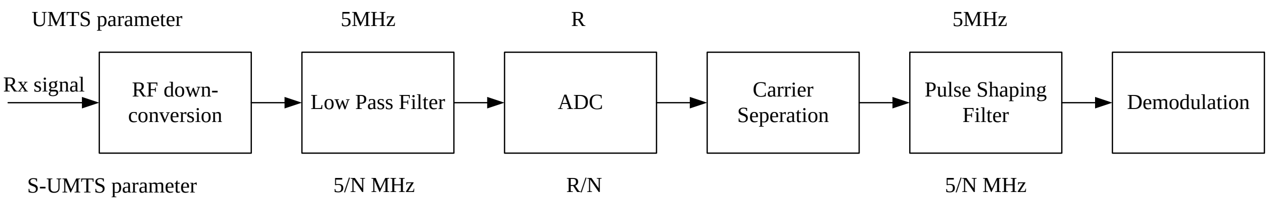

Figure 7.1.4.3.1-1: Example Block Diagram of RF and digital Front-end

Comparison:

- The analog low pass filter (LPF) handles a narrower bandwidth (5/N MHz) for time-dilated UMTS and 5 MHz bandwidth for baseline UMTS.
- The ADC sampling rate decreases to 1/N of the baseline.
- The pulse shaping filter handles a narrower bandwidth (5/N MHz) for time-dilated UMTS and 5 MHz bandwidth for baseline UMTS.

7.1.4.3.2 Base-band Detector

The processing of decoder of time-dilated UMTS is the same as UMTS for a transport block with a specific size per TTI, which means the peak rate or throughput is 1/N since the TTI length of time-dilated UMTS is dilated by N times, hence the complexity is 1/N of the UMTS FDD system.

7.1.4.4 BS Transmitter

7.1.4.4.1 Base-band process

The transmitter need perform encoding, modulation, spreading, scrambling and so on. All the same operation, assuming for the same TBS, is processed in N time longer TTI for time-dilated UMTS, comparing to UMTS FDD system, therefore the total complexity of time-dilated UMTS is 1/N of UMTS system.

7.1.4.4.2 RF and Digital Front-end

Similar to the same part of receiver, the time-dilated UMTS system requires a narrower bandwidth (5/N MHz) low pass filter, lower sampling rate(1/N) ADC and narrower bandwidth (5/N MHz) pulse shaped filter.

7.1.5 Impacts on specifications

7.1.5.1 Impact to RAN1 specifications

The assumptions made include the following:

- HS-SCCH and HS-PDSCH TTI: N*2 ms on time-dilated cell
- No MBMS support in time-dilated cell
- No STTD support on dedicated channels in time-dilated cell
- No change is done to uplink/downlink timing relation at UE to enable e.g. lower TPC delay in time-dilated cells
- SFN (and also CFN) is increased by one every radio frame, i.e. SFN clock is running with different absolute rate on UMTS and time-dilated UMTS cells
- No need for compressed mode patterns with more than one transmission gap per radio frame when time-dilated UMTS is introduced
- No impact on ACK/NACK & CQI coding with introduction of time-dilated cells.
- Maximum carrier aggregation is one UMTS carrier + one time-dilated UMTS carrier

If the above assumptions would not hold, there may be additional specification impact.

Further, it has been assumed that time-dilated UMTS shall offer similar level of functionality as normal UMTS, so that the existing specifications and structure can be reused.

TS 25.201

The sections of TS 25.201 that are impacted by the time-dilated UMTS solution are listed in Table 7.1.5.1-1. The changes required primarily comprise scaling all time values by a factor N and the FDD bandwidth/chip-rate value by a factor 1/N (e.g., 10 ms becomes N*10 ms and 3.84 Mcps becomes 3.84/N Mcps where N=1, 2 or 4). In addition, the entire concept of additional operation modes for UMTS FDD needs to be introduced. These additional operation modes can be described as different chip rate options similar to the different UMTS TDD chip rates. A complication here is that with carrier aggregation multiple chip rates are used simultaneously, so exactly how to introduce and describe these new modes of operation is TBD.

Table 7.1.5.1-1: Impacts to TS 25.201 specification

Section number	Section title
4.2.1	Multiple Access
4.2.3	Modulation and spreading

TS 25.211

The sections of TS 25.211 that are impacted by the time-dilated UMTS solution are listed in Table 7.1.5.1-2. The changes primarily comprise scaling all TTI values and all radio frame time values by a factor N (e.g., 10 ms becomes

N*10 ms where N=1, 2 or 4), and these changes are not explicitly mentioned below. See comment below section title for other types of changes.

Table 7.1.5.1-2: Impacts to TS 25.211 specification

Section number	Section title
3.1	Symbols
3.3	Definitions Most likely something is needed in here to define concepts related to different operation modes of UMTS and aggregation of normal UMTS carriers and time-dilated UMTS carriers.
5	Physical channels and physical signals
5.2.1.1	DPCCH and DPDCH
5.2.1.2	HS-DPCCH
5.2.1.3	E-DPCCH and E-DPDCH
5.2.2.1.1	Overall structure of random-access transmission If it is concluded that improvements are needed to improve time-dilated UMTS access latency there may be additional changes needed, e.g. introducing a shorter radio frame to keep the message part at 10 ms even with scaling factor N.
5.2.2.1.3	RACH message part See 5.2.2.1.1 comment. Further, if there is a need to keep the current RACH data rate even with scaling factor N, there may be a need for additional slot formats, lower spreading factors, etc.
5.3.1	Downlink transmit diversity Applicability of transmit diversity on time-dilated UMTS carriers shall be listed.
5.3.2	Dedicated downlink physical channels
5.3.2.4	E-DCH Relative Grant Channel
5.3.2.5	E-DCH Hybrid ARQ Indicator Channel
5.3.2.6	Fractional Dedicated Physical Channel (F-DPCH)
5.3.3.1	Common Pilot Channel (CPICH)
5.3.3.3	Primary Common Control Physical Channel (P-CCPCH) If P-CCPCH spreading factor reduction is required to fit all SIB data with acceptable impact on latency then a new slot format with lower spreading factor needs to be specified.
5.3.3.4	Secondary Common Control Physical Channel (S-CCPCH)
5.3.3.5	Synchronisation Channel (SCH)
5.3.3.7	Acquisition Indicator Channel (AICH)
5.3.3.10	Paging Indicator Channel (PICH)
5.3.3.12	Shared Control Channel (HS-SCCH)

5.3.3.13	High Speed Physical Downlink Shared Channel (HS-PDSCH)
5.3.3.14	E-DCH Absolute Grant Channel (E-AGCH)
5.3.3.14B	E-DCH Rank and Offset Channel (E-ROCH)
7.1	General
7.3A	UL/DL timing relation for Enhanced Uplink in CELL_FACH state and IDLE mode
7.7.1	Timing when Multiflow is not configured Since the uplink DPCH/HS-DPCCH on normal UMTS carrier have a different radio frame duration than HS-PDSCH on time-dilated UMTS carrier, care needs to be taken in specifying these timing relations.
7.7.2	Timing when Multiflow is configured See 7.7.1 comment.
7.8	HS-SCCH/HS-PDSCH timing See 7.7.1 comment.
7.10	E-HICH/P-CCPCH/DPCH timing relation
7.11	E-RGCH/P-CCPCH/DPCH timing relation
7.12	E-AGCH/P-CCPCH timing relation

TS 25.212

The sections of TS 25.212 that are impacted by the time-dilated UMTS solution are listed in Table 7.1.5.1-3. The changes required primarily comprise scaling all TTI values and all radio frame time values by a factor N (e.g., 10 ms becomes N*10 ms where N=1, 2 or 4), and these changes are not explicitly mentioned below. See comment below section title for other types of changes.

Table 7.1.5.1-3: Impacts to TS 25.212 specification

Section number	Section title
3.1	Definitions Most likely something is needed in here to define concepts related to different operation modes of UMTS and aggregation of normal UMTS carriers and time-dilated UMTS carriers.
3.2	Symbols
4.2	General coding/multiplexing of TrCHs
4.2.5.2	1st interleaver operation
4.2.6	Radio frame segmentation
4.2.7.2.2.1	Calculations for normal mode, compressed mode by higher layer scheduling, and compressed mode by spreading factor reduction
4.2.7.3	Bit separation and collection in uplink
4.2.8	TrCH multiplexing

4.2.13.2	Random Access Channel (RACH)
4.2.13.6	Broadcast channel (BCH) Contents of this section may need update if new P-CCPCH format is employed. It may e.g. be reasonable to have more than one transport block per TTI.
4.2.13.7	Forward access and paging channels (FACH and PCH)
4.2.13.8	High Speed Downlink Shared Channel (HS-DSCH) associated with a DCH
4.2.13.9	Enhanced Dedicated Channel (E-DCH)
4.3.1	Blind transport format detection
4.4	Compressed mode
4.4.3	Transmission time reduction method
4.4.5	Transmission gap position for E DCH
4.4.5.1	E DPDCH Transmission Gap Position during Initial Transmissions
4.4.5.3	E DPCCH Transmission Gap Position
4.5	Coding for HS-DSCH
4.7.4.1	Physical Channel mapping for HS-DPCCH HARQ-ACK How the HARQ-ACKs are mapped onto HS-DPCCH for the case of aggregation of one time-dilated UMTS carrier needs to be specified. A complication is that the subframe length will be different on the two carriers.
4.7.4.2	Physical Channel mapping for HS-DPCCH PCI/CQI How the PCI/CQIs are mapped onto HS-DPCCH for the case of aggregation of one time-dilated UMTS carrier needs to be specified. A complication is that the subframe length will be different on the two carriers.
4.7.4.3.1	Physical Channel mapping for HS-DPCCH HARQ-ACK and PCI/CQI when the UE is configured with one serving and one assisting serving HS-DSCH cell Potentially some updates are needed here as well due to the same reasons as in 4.7.4.1 and 4.7.4.2
4.7.4.4.1	Physical Channel mapping for HS-DPCCH HARQ-ACK How the HARQ-ACKs are mapped onto HS-DPCCH for the case of aggregation of one time-dilated UMTS carrier needs to be specified. A complication is that the subframe length will be different on the two carriers.
4.7.4.4.2	Physical Channel mapping for HS-DPCCH NTBP/PCI/CQI How the NTBP/PCI/CQIs are mapped onto HS-DPCCH for the case of aggregation of one time-dilated UMTS carrier needs to be specified. A complication is that the subframe length will be different on the two carriers.
4.8.4.1	Determination of SF, modulation scheme and number of PhCHs needed
4.8.4.3	HARQ Rate Matching Stage
4.8.7	Physical channel mapping for E DCH
4.9.2.2	Information field mapping of retransmission sequence number
4.9.5	Physical channel mapping for E DPCCH

4.10.5	Physical channel mapping for E AGCH
B.1	Idle lengths for DL, UL and DL+UL compressed mode for DPCH

TS 25.213

The sections of TS 25.213 that are impacted by the time-dilated UMTS solution are listed in Table 7.1.5.1-4. The changes required primarily comprise scaling all TTI values and all radio frame time values by a factor N (e.g., 10 ms becomes N*10 ms where N=1, 2 or 4), and these changes are not explicitly mentioned below. See comment below section title for other types of changes.

Table 7.1.5.1-4: Impacts to TS 25.213 specification

Section number	Section title
3.1	Symbols
4.2.2.2	PRACH message part If it is concluded that improvements are needed to improve time-dilated UMTS access latency there may be additional changes needed, e.g. introducing a shorter radio frame to keep the message part at 10 ms even with scaling factor N.
4.3.1.3	Code allocation for PRACH message part If there is a need to keep the current RACH data rate even with scaling factor N, there may be a need for additional lower spreading factors, new code mapping rules etc
4.3.2.5	PRACH message part scrambling code See comment for 4.2.2.2
4.3.3.3	Preamble signature See comment for 4.3.2.5. With lower SF the number of signatures may be reduced.
4.4.1	Modulating chip rate
5.2.1	Channelisation codes If P-CCPCH spreading factor reduction is required to fit all SIB data with acceptable impact on latency then a new slot format with lower spreading factor needs to be specified. Then there is a need to define a new channelization code mapping for P-CCPCH.
5.2.2	Scrambling code
5.3.1	Modulating chip rate

TS 25.214

The sections of TS 25.214 that are impacted by the time-dilated UMTS solution are listed in Table 7.1.5.1-5. The changes required primarily comprise scaling all TTI values and all radio frame time values by a factor N (e.g., 10 ms becomes N*10 ms where N=1, 2 or 4), and these changes are not explicitly mentioned below. See comment below section title for other types of changes.

Table 7.1.5.1-5: Impacts to TS 25.214 specification

Section number	Section title
3.1	Definitions Most likely something is needed in here to define concepts related to different operation modes of UMTS and aggregation of normal UMTS carriers and time-dilated UMTS carriers.
4.2.5	HS-DSCH cell timing when Multiflow is configured “Same radio frame timing” is currently assumed between serving and secondary serving HS-DSCH cell. This is no longer possible when the radio frame themselves have different lengths, so some new concept is needed here.
4.3.1.2	Downlink synchronisation primitives Values for the thresholds Qin and Qout (to be defined implicitly by TS 25.101) are for further study. Synchronization related times like “previous 40 ms period”, “160 ms period”, “previous 240 slots”, “20 most recently received transport blocks” etc most likely needs modification and are for further study.
4.3.2.3A	Synchronisation procedure AA Values for the thresholds Qin and Qout (to be defined implicitly by TS 25.101) are for further study. Synchronization related times like “first 40 ms period” etc most likely needs modification and are for further study.
4.3.2.4	Synchronisation procedure B It is for further study if frame timing margin of ±148 chips is needed when chips are longer in time with time-dilated UMTS.
4.3.4	Transmission timing adjustments Values for the maximum rate of uplink TX time adjustment (to be defined implicitly by TS 25.101) are for further study.
5.1.2.2.1	General It is for further study if new TPC step sizes are required with the reduced inner loop power control update frequency that comes with time-dilated UMTS.
5.1.2.2.1.1	Out of synchronisation handling Values for the thresholds Qin and Qout (to be defined implicitly by TS 25.101) are for further study. Synchronization related times like “last 160 ms period”, “last 240 slots”, “40 ms period” etc most likely needs modification and are for further study.
5.1.2.2.3.1	Derivation of TPC_cmd when only one TPC command is received in each slot It is for further study if still 5 TPC commands shall be combined with the reduced inner loop power control update frequency that comes with time-dilated UMTS.
5.1.2.2.3.3	Combining of TPC commands from radio links of different radio link sets It is for further study if still 5 TPC commands shall be combined with the reduced inner loop power control update frequency that comes with time-dilated UMTS.
5.1.2.3	Transmit power control in compressed mode It is for further study if behaviour needs to be changed due to the reduced inner loop power control update frequency that comes with time-dilated UMTS. E.g., is the formula

	$\delta_i = 0.9375\delta_{i-1} - 0.96875TPC\_cmd_i \Delta_{TPC} k_{sc}$ $\delta_{i-1} = \delta_i$ and power steps like "If PCA has the value 1, Δ_{RP-TPC} is equal to the minimum value of 3 dB and $2\Delta_{TPC}$. If PCA has the value 2, Δ_{RP-TPC} is equal to 1 dB." still valid? Simulations used to derive these values have assumed 1500 Hz power control update rate.
5.1.2.5B.1	E-DPCCH/DPCCH
5.1.2.5B.2.4	E-DPDCH/DPCCH adjustments relating to compressed mode
5.2.1.2.2	UTRAN behaviour It is for further study if new TPC step sizes (or mandatory step sizes) are required with the reduced inner loop power control update frequency that comes with time-dilated UMTS.
5.2.1.3	Power control in compressed mode It is for further study if behaviour needs to be changed due to the reduced inner loop power control update frequency that comes with time-dilated UMTS. E.g., are power steps like "Δ_{RP-TPC} is equal to the minimum value of 3 dB and $2\Delta_{TPC}$." still valid? Simulations used to derive these values have assumed 1500 Hz power control update rate.
6.1	Physical random access procedure
6.1.1	RACH sub-channels
6.1.2	RACH access slot sets
6.1A	Physical random access procedure for Enhanced Uplink in CELL_FACH state and IDLE mode
6A.1	General procedure Most likely the list of parameters signaled to physical layer in UE and Node B has to be extended with information about time dilation factors. Clarify statements like "This ordered deactivation or activation of the HS-SCCH-less operation is applied by the UE 12 slots after the end of the HS-SCCH subframe delivering the order." "If the higher layers set DTX_DRX_STATUS to TRUE (as described in [5]) then UE_DTX_DRX_Enabled is FALSE until Enabling_Delay radio frames have passed. After the higher layers have set DTX_DRX_STATUS to TRUE (as described in [5]) and Enabling_Delay radio frames have passed then UE_DTX_DRX_Enabled is TRUE. Otherwise UE_DTX_DRX_Enabled is FALSE." "If the UE is not configured with multiple uplink frequencies, HS-SCCH ordered deactivation or activation of the secondary serving HS-DSCH cell(s) is applied by the UE 12 slots after the end of the HS-SCCH subframe delivering the order, and any transient behaviour related to this change should take place before this point in time." "If the UE is configured with multiple uplink frequencies, HS-SCCH ordered deactivation or activation of the secondary serving HS-DSCH cell(s) is applied by the

	UE 18 slots after the end of the HS-SCCH subframe delivering the order, and any transient behaviour related to this change should take place before this point in time." "The maximum allowed interruption time for the downlink cells and uplink frequencies configured in this frequency band is 1 slot. The interrupt shall take place during the next downlink HS-SCCH slot after the end of the HS-DPCCH slot that contains the HARQ-ACK information acknowledging the HS-SCCH order. The corresponding change of the HS-DPCCH channel coding scheme as specified in [2] is applied by the UE at the first HS-DPCCH subframe boundary after the activation or deactivation has been applied." when different slot length is applied to different cells. In general this is a completely new aspect with time-dilated UMTS that needs careful specification.
6A.1.1	UE procedure for receiving HS-DSCH and HS-SCCH in the CELL_DCH state Clarify statements like "From the serving HS-DSCH cell, the UE shall be able to receive up to one HS-DSCH if MIMO mode and MIMO mode with four transmit antennas is not configured or two HS-DSCHs if MIMO mode is configured or four HS-DSCHs if MIMO mode with four transmit antennas is configured or one HS-SCCH order. - In addition, from each of the activated secondary serving HS-DSCH cells, the UE shall be able to simultaneously receive up to one HS-DSCH if MIMO mode and MIMO mode with four transmit antennas is not configured or two HS-DSCHs if MIMO mode is configured or four HS-DSCHs if MIMO mode with four transmit antennas is configured or one HS-SCCH order. - The maximum number of HS-SCCH orders simultaneously received by the UE across the serving HS-DSCH cell and all the activated secondary serving HS-DSCH cells is 2." when different slot length is applied to different cells, thus making statements referring to "simultaneous" ambiguous. In general this is a completely new aspect with time-dilated UMTS that needs careful specification.
6A.1.2.1	CQI reporting procedure in case the UE is not configured in MIMO mode
6A.1.2.2	Composite PCI/CQI reporting procedure in case the UE is configured in MIMO mode
6A.1.2.3	Composite NTBP/PCI/CQI reporting procedure in case the UE is configured in MIMO mode with four transmit antennas
6A.2	Channel quality indicator (CQI) definition It is for further study if a 3-slot reference period is still valid when slots become longer in time with time-dilated UMTS.
6A.2.1	CQI definition when the UE is not configured in MIMO mode and not configured in MIMO mode with four transmit antennas It is for further study if a 3-slot reference period is still valid when slots become longer in time with time-dilated UMTS.
6A.2.2	CQI definition when the UE is configured in MIMO mode It is for further study if a 3-slot reference period is still valid when slots become longer in time with time-dilated UMTS.
6A.2.2A	CQI definition when the UE is configured in MIMO mode with four transmit antennas It is for further study if a 3-slot reference period is still valid when slots become

	longer in time with time-dilated UMTS.
6A.2.3	CQI tables Time-dilated UMTS will introduce new UE categories, and this needs to be reflected in table 7a. If new UE categories use different N_IR values than existing, new CQI mapping tables are needed.
6A.3	Operation during compressed mode on the associated DPCH or F-DPCH Behaviour due to different subframe lengths on the serving and secondary serving cell needs to be clarified. It is for further study if a 3-slot reference period is still valid when slots become longer in time with time-dilated UMTS.
6B	E-DCH related procedures
6B.3.1	10 ms E-DCH TTI
6B.3.2	2 ms E-DCH TTI
6B.4.1	Uplink compressed mode
6C	Discontinuous transmission and reception procedures Complications for CPC due to different slot/subframe lengths on serving and secondary serving cells due to time-dilated UMTS are for further study.
6C.2.1	Uplink DPCCH burst pattern
6C.3	Discontinuous downlink reception Complications for CPC due to different slot/subframe lengths on serving and secondary serving cells due to time-dilated UMTS are for further study.
6C.3.1	Discontinuous downlink reception when the UE is in Multiflow mode Complications for CPC due to different slot/subframe lengths on serving and secondary serving cells due to time-dilated UMTS are for further study.
6C.4	HS-SCCH orders Complications for CPC due to different slot/subframe lengths on serving and secondary serving cells due to time-dilated UMTS are for further study.
6C.5	Operation during compressed mode Complications for CPC due to different slot/subframe lengths on serving and secondary serving cells due to time-dilated UMTS are for further study.
8.2	Parameters of IPDL
10.2	Downlink TPI transmission and control timing It is for further study if a 3-slot TPI information update rate is still valid when slots become longer in time with time-dilated UMTS.
10.6	HS-SCCH orders It is for further study if a maximum allowed interruption time of 2 slots is still valid when slots become longer in time with time-dilated UMTS.
11	Uplink MIMO

Annex C	Cell search procedure Text should be extended with information that all the chip rates need to be covered in cell search

TS 25.215

The sections of TS 25.215 that are impacted by the time-dilated UMTS solution are listed in Table 7.1.5.1-6. The changes required primarily comprise scaling all TTI values and all radio frame time values by a factor N (e.g., 10 ms becomes N*10 ms where N=1, 2 or 4), and these changes are not explicitly mentioned below. See comment below section title for other types of changes.

Table 7.1.5.1-6: Impacts to TS 25.215 specification

Section number	Section title
5.1.8	SFN-CFN observed time difference The current definition of this measurement only works if radio frame length is same on all involved cells. With time-dilated UMTS this will no longer be true, so there will be complications for this measurement. It is for further study how to make this to work.
5.1.9	SFN-SFN observed time difference The current definition of this measurement only works if radio frame length is same on all involved cells. With time-dilated UMTS this will no longer be true, so there will be complications for this measurement. Another complication is that the SFN clocks will be running at different speeds in different cells, so the OFF value cannot be measured as a difference between two SFNs since the SNF values are diverging over time. Also, relative chip number comparisons do not make sense when the chips are of different lengths. It is for further study how to make this to work.
5.1.10	UE Rx-Tx time difference It is for further study if this measurement is impacted by time-dilated UMTS.
5.1.12	UE GPS Timing of Cell Frames for UE positioning It is for further study if this measurement is impacted by time-dilated UMTS, due to the longer radio frames.
5.1.15	UE GANSS Timing of Cell Frames for UE positioning It is for further study if this measurement is impacted by time-dilated UMTS, due to the longer radio frames.
5.2.8	Round trip time It is for further study if this measurement is impacted by time-dilated UMTS, due to the longer radio frames.
5.2.9	UTRAN GPS Timing of Cell Frames for UE positioning It is for further study if this measurement is impacted by time-dilated UMTS, due to the longer radio frames.
5.2.10	PRACH Propagation delay It is for further study if this measurement is impacted by time-dilated UMTS, due to the worse chip resolution in time.

5.2.14	SFN-SFN observed time difference The current definition of this measurement only works if radio frame length is same on all involved cells. With time-dilated UMTS this will no longer be true, so there will be complications for this measurement. It is for further study how to make this to work. It cannot be excluded that a completely new measurement has to be defined.
5.2.18	UTRAN GANSS Timing of Cell Frames for UE positioning It is for further study if this measurement is impacted by time-dilated UMTS, due to the longer radio frames.
6.1.1.1	Use of compressed mode for monitoring It is for further study if the statement "one single measurement purpose for one transmission gap pattern" still holds with time-dilated UMTS. Can inter-frequency measurements on normal UMTS and time-dilated UMTS carriers be done with one pattern?
6.1.1.2	Parameterisation of compressed mode It is for further study if these parameters are impacted by time-dilated UMTS. Note that both cases of UE on normal UMTS carrier measuring on time-dilated UMTS carrier and vice versa need to be considered. It is for further study if measurement purpose "FDD" needs to be split into "FDD 3.84 Mcps" and "FDD 3.84/N Mcps". It is for further study if the statement "UE shall support one compressed mode pattern sequence for each measurement purpose while operating in FDD mode" still holds with time-dilated UMTS. Can inter-frequency measurements on normal UMTS and time-dilated UMTS carriers be done with one pattern? In addition, it is for further study if the total number of transmission gap patterns running in parallel needs to be increased.

7.1.5.2 Impact to RAN4 specifications

In summary RAN4 foresees impact on the following RAN4 specifications with introduction of time-dilated UMTS.

- **Base Station:** Base Station (BS) radio transmission and reception (FDD) (25.104). The impact is due to new BS core requirements (or extension of the existing requirements to time-dilated UMTS case) and new BS performance requirements. The BS conformance testing specification will be affected accordingly (25.141). Additionally the corresponding MSR specifications will be affected (37.104 and 37.141)**.**

- **User Equipment:** User Equipment (UE) radio transmission and reception (FDD) (25.101). The impact is due to new UE core requirements (or extension of the existing requirements to time-dilated UMTS case) and new UE performance requirements.

- **25.133:** Requirements for support of radio resource management (FDD). RRM core and performance requirements.

- **36.133:** Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements for support of radio resource management.

Additionally RAN4 foresees potential impact on other RAT specification which needs to be further investigated as follows:

- **36.104:** Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception, because of coexistence and also depending on whether new interferer types need to be introduced.

- **36.101:** Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception, because of coexistence and also depending on whether new interferer types need to be introduced.

Additionally RAN4 foresees potential impact on the following specifications, however detailed analysis has not been provided and needs to be further investigated:

- **25.106:** UTRA repeater radio transmission and reception (and accordingly the repeater conformance testing specification 25.107).
- **25.111:** Location Measurement Unit (LMU) performance specification; User Equipment (UE) positioning in UTRAN.
- **25.113:** Base station (BS) and repeater electromagnetic compatibility (EMC) and the corresponding MSR specification (37.113).
- **25.144:** User Equipment (UE) and Mobile Station (MS) over the air performance requirements.

7.1.5.2.1 General

Time-dilated UMTS carriers with 1/2 or 1/4 of the chip rate of a normal carrier need to be distinguished from each other and from the normal carrier that has the same center frequency. This means the same UARFCN alone cannot be used for all cases. Several solutions could be considered, i.e. to assign a new UARFCN to each new chip-rate variation for every possible channel position or other solutions. The solution defined in RAN4 may have implications in RAN2.

RAN4 also has identified open aspects related to UARFCN as follows:

- Discuss whether the current UARFCN range is sufficient (currently the UARFCN range is 0…16383. The largest reserved value to date is 10849 (from [TS 25.101 v11.3.0])).
- Whether to consider the same channel raster or additional channel raster finer than 200 kHz may be considered for time-dilated UMTS in order to provide deployment flexibility within the spectrum operator owns.
    - The final decision on the channel raster has implication on the multi-carrier scenarios agreed in RAN1. It may or may not affect conclusions in RAN1 study for the multi-carrier scenario.
    - It should be noted that if a finer frequency raster is necessary for the RF analog part of the radio, the comparator frequency of the synthesizer may need to be lowered depending on implementation. In this case the synthesizer spurs will have a lower frequency content and the loop filter of the synthesizer needs to be lowered. This may have implications related to phase noise on some implementations.

It should be noted that this aspect requires coordination with RAN2.

7.1.5.2.2 BS RF core and performance requirements

For BS core and test requirements, the specifications impacted due to introducing time-dilated UMTS include TS 25.104, TS 25.141, TS 37.104 and TS37.141.

The time-dilated UMTS configurations will be introduced in the specification depending on the feasibility analysis. The same Tx-Rx separation as in legacy UMTS would be applicable for time-dilated UMTS.

7.1.5.2.2.1 BS transmitter core requirements

Due to the new bandwidth for time-dilated UMTS, the majority of the transmitter requirements will need to be redefined.

The BS output power of small power class may need some modifications to take into account the decision on PSD level.

No impact is foreseen for frequency error, primary and secondary CPICH power accuracy requirement.

The available power range for the code domain compared to the total power shall be kept unchanged in order to keep the same flexibility of code domain power adjustment for time-dilated UMTS. The minimum total power when no traffic channels are activated is determined by the minimum power of basic control channel and also shall be kept unchanged for time-dilated UMTS. Therefore, power control dynamic range and total power dynamic range compared to the maximum total power can be unchanged.

Output RF spectrum emissions will be highly affected by the introduction of time-dilated UMTS. In particular this will depend on the assumptions related to time-dilated UMTS, i.e.

- nominal bandwidth
- assumptions in terms of PSD

The following provides a brief initial assessment of the impact for each individual requirement present in TS 25.104.

- Occupied bandwidth requirement for time-dilated UMTS with new scalable chip rates needs to be introduced.
- New SEM requirements for time-dilated UMTS should be defined. The definition should take into account co-existence study result and base station implementation feasibility. See discussion in Clause 7.1.6.1. The ACLR is a direct measure of the interference which is leaking in adjacent spectrum. New ACLR requirements for time-dilated UMTS should be defined. The type of adjacent channel should be studied for time-dilated UMTS carrier when defining ACLR requirement for each chip rate of time-dilated UMTS. ACLR is directly linked to ACIR which directly impact the interference generated by time-dilated UMTS to other carriers, other RATs or other operators and hence it should be studied carefully. Note also that the ACLR is defined by considering an integration bandwidth of 5MHz for both the wanted signal and the interfering adjacent carrier. With the introduction of time-dilated UMTS new type of adjacent channel should be considered. In particular ACLR may be defined for symmetric adjacent channels (same channel bandwidth as the wanted time-dilated UMTS carrier) and for legacy UMTS adjacent carriers.
- Spurious emission requirements include regulatory and co-existence requirement. Regulatory requirements are mandatory for deployment and must therefore be met. Co-existence requirement depend on the noise figure of the receiver of protected system. Appropriate values and measurement bandwidth for the spurious emission need to be considered by taking into account the time-dilated UMTS itself and other RATs systems protection needs. Additionally the introduction of time-dilated UMTS may impact other RATs spurious emissions (to protect Scalable UMTS systems).
- The transmit intermodulation is the capability of the transmitter to inhibit the generation of signals in its non linear elements caused by presence of the wanted signal and an interfering signal reaching the transmitter via the antenna. The interfering signal is defined currently as a UTRA modulated signal. The transmit intermodulation requirements will be affected by the introduction of time-dilated UMTS. Namely, the type of interfering signal and offset values needs to be redefined for time-dilated UMTS carrier.
- Transmit modulation requirements are determined by the system performance requirement. Analysis has not been conducted to understand whether the same EVM requirements as for legacy UMTS can be considered also for time-dilated UMTS. Hence, while it is desirable to keep them unchanged, analysis is needed in order to understand the implication of this choice.
- The transmit pulse shape filter can be reused for time-dilated UMTS if the same roll-off factor as for legacy is considered. However, the chip rate needs to be modified for time-dilated UMTS.
- The peak domain error may need to be re-evaluated in order to take into account the new waveform corresponding to the new nominal bandwidth.
- Time alignment error requirement is for ensuring the demodulation performance of diversity, MIMO and carrier aggregation. For time-dilated UMTS, the TAE requirement between each branch in MIMO and the TAE between UMTS and time-dilated UMTS carrier may be kept unchanged. It should be noted that multi-carrier operations should be taken into account for the definition of the core requirements, by considering 37.104 and 25.104.

7.1.5.2.2.2 BS receiver core requirements

The time-dilated UMTS can be deployed either as stand-alone or in carrier aggregation with UMTS carriers. In case of standalone time-dilated UMTS deployment the uplink follows the time-dilated UMTS carrier scaling. Due to the new bandwidth for time-dilated UMTS, all the receive requirements will need to be redefined. In case of multi-carrier operation when time-dilated UMTS is deployed together with legacy UMTS, the study item considers a single uplink carrier anchored to the 5MHz downlink carrier. Hence for multi-RAT scenarios a limited impact is foreseen.

The following provides a brief initial assessment of the impact for each individual requirement.

- New reference measurement channels for time-dilated UMTS need to be defined first and all the receiver requirement need to be specified based on the new reference measurement channels.

- REFSENS is specified so far supporting that modulated signal is occupying 5MHz case. For time-dilated UMTS carrier, the same noise figure of base station receiver should be kept (due to the same hardware design) but new study would be needed on the demodulated SNR. Hence new REFSENS values will be defined.

- Receiver dynamic range is the receiver ability to handle a rise of interference in the reception frequency channel. The wanted signal power needs to be studied on the demodulated SNR for time-dilated UMTS and interference level should be determined depending on UE power decision. The ACS, in-band blocking and intermodulation requirement is defined in current specification for an interferer with 5MHz UMTS modulated signal. When introducing time-dilated UMTS, the interferer bandwidth shall be changed in order to consider the presence of Time-dilated UMTS interferer, the offset levels should be changed in order to take into account new bandwidth. Moreover the interferer power level should be studied further, depending on the uplink PSD decision.

- The narrow-band blocking and out-of-band blocking requirement is defined in current specification for an interferer either GMSK modulated signal or CW signal to capture the co-existence with GSM system in the same band and any other system in other bands. These two requirements will need to be redefined for time-dilated UMTS. The offset level should be changed in order to take into account new bandwidth. The interferer levels can be reused.

- The RX spurious emissions follow the TX spurious emissions. Therefore, the same applies.

New test requirements for time-dilated UMTS, corresponding to the core requirements which are mentioned above should also be introduced. Test model defined in TS 25.141 also need to be changed for time-dilated UMTS.

The below table summarized the requirements impact for BS core specification:

Table 7.1.5.2.2-1: Summary of the requirements impact for BS core specification

Requirement	**No of carriers**	**Requirements for time-dilated UMTS**	**New requirements for UMTS carrier**
Base station output power	Standalone	New requirements need to be introduced for certain cases.	No
	Multi-RAT scenarios	New requirements need to be introduced for certain cases.	No
Frequency error	Standalone	Current requirement can be reused	No
	Multi-RAT scenarios	Current requirement can be reused	No
Occupied bandwidth	Standalone	New scalable chip rates needs to be introduced	No
	Multi-RAT scenarios	New scalable chip rates need to be introduced	No
Spectrum emission mask	Standalone	New requirements need to be introduced.	No
	Multi-RAT scenarios	New requirements need to be introduced.	No
ACLR	Standalone	New requirements need to be introduced.	New requirement may need to be considered to protect time-dilated UMTS.
	Multi-RAT scenarios	New requirements need to be introduced.	New requirement may need to be considered to protect

			time-dilated UMTS.
Tx Spurious emissions	Standalone	New Co-existence requirement may need to be introduced to protect time-dilated UMTS.	New Co-existence requirement may need to be considered to protect time-dilated UMTS.
	Multi-RAT scenarios	New Co-existence requirement may need to be introduced to protect time-dilated UMTS.	New Co-existence requirement may need to be considered to protect time-dilated UMTS.
Transmit intermodualtion	Standalone	New requirement need to be introduced.	No
	Multi-RAT scenarios	New requirement need to be introduced.	No
EVM	Standalone	Analysis need to be done.	No
	Multi-RAT scenarios	Analysis need to be done.	No
PCDE	Standalone	Analysis need to be done.	No
	Multi-RAT scenarios	Analysis need to be done.	No
transmit pulse shape filter	Standalone	New scalable chip rates needs to be introduced	No
	Multi-RAT scenarios	New scalable chip rates needs to be introduced	No
TAE	Standalone	Current requirement can be reused	No
	Multi-RAT scenarios	Current requirement can be reused	No
Reference sensitivity level	Standalone	New requirement need to be introduced.	No
Dynamic range	Standalone	New requirement need to be introduced.	No
Adjacent Channel selectivity	Standalone	New requirement need to be introduced. New time-dilated UMTS interferer may need to be introduced.	New time-dilated UMTS interferer may need to be considered.
In band blocking characteristics	Standalone	New requirement need to be introduced. New time-dilated UMTS interferer may need to be introduced.	New time-dilated UMTS interferer may need to be considered.
Out of band blocking characteristics	Standalone	New requirement need to be introduced.	No
Narrow band blocking characteristics	Standalone	New requirement need to be introduced.	No
Intermodulation	Standalone	New requirement need to be	New time-dilated UMTS interferer may need to be

characteristics		introduced. New time-dilated UMTS interferer may need to be introduced.	considered.
Rx Spurious emission	Standalone	Current requirement can be reused	No

7.1.5.2.2.3 BS performance requirements

The BS performance requirements will be affected for standalone time-dilated UMTS scenarios when the UE uses time-dilated UMTS to transmit the data. Both legacy UMTS and HS-related requirements would be affected, as time-dilated UMTS would be used to carry both HS traffic and UMTS.

BS performance requirements in TS25.104 are currently defined under several assumptions specifically developed for the 5 MHz channel bandwidth. Changing the bandwidth would imply changes of some of the assumptions (depending on RAN 1/RAN 4 agreements), which in turn will impact the BS performance requirements. Extensive simulation work is needed to set new requirements in accordance to the new assumptions.

For the time being no impacts on BS performance requirements for multicarrier time-dilated UMTS scenarios is foreseen.

The channel propagation conditions and the path positions should be carefully reviewed to avoid more adverse conditions. The fading propagation channels which are aligned with the chip rate shall be redefined (Case 3, 4). For these channels the path delay position is the chip positions for 3.84Mcps, that is, 260 * N [ns]. If the chip rate is changed, the path delays are put on the sub-chip position because of the possible extended chip duration and it causes inter-symbol interference which may lead to different demodulation performance. Also in cases of other multipath propagation conditions, where the path delays are not assigned to chip positions, extension of chip duration will lead to different timing relations between the delay of particular path and chip positions, however in these cases redefinition of channel models is not required. Nevertheless, this behaviour may cause different demodulation performance as well.

All BS performance requirements are defined for particular reference measurement channels which shall be modified due to chip rate scaling. Modifications of reference channels shall apply at least to spreading factor or information bit rate which scale with the same factor as chip rate.

Taking the above into account, the table below presents list of BS performance requirements of TS25.104 which would need additional minimum values due to potential introduction of time-dilated UMTS.

Table 7.1.5.2.2.3-1: BS performance requirements of TS25.104 which would need new minimum values for time-dilated UMTS

Section	Requirement	Justification
8.2	Demodulation in static propagation conditions	New minimum requirement needed due to: • modification of reference measurement channels for UL DCH (12.2 kbps, 64 kbps, 144 kbps, 384 kbps).
8.3	Demodulation of DCH in multipath fading conditions	New minimum requirement needed due to: • modification of reference measurement channels for UL DCH (12.2 kbps, 64 kbps, 144 kbps, 384 kbps), • different timing relations between the delay of particular path and chip positions in multi-path fading propagation conditions (Case 1, Case 2), • redefinition of path delays positions aligned with chip

		positions in multi-path fading propagation conditions (Case 3, Case 4).
8.4	Demodulation of DCH in moving propagation conditions	New minimum requirement needed due to: • modification of reference measurement channels for UL DCH (12.2 kbps, 64 kbps), • different timing relations between the delay of Path1 and chip positions in moving propagation conditions.
8.5	Demodulation of DCH in birth/death propagation conditions	New minimum requirement needed due to: • modification of reference measurement channels for UL DCH (12.2 kbps, 64 kbps), • different timing relations between the delay of Path1/Path2 and chip positions in Birth-Death propagation conditions.
8.5A	Demodulation of DCH in high speed train conditions	New minimum requirement needed due to: • modification of reference measurement channels for UL DCH (12.2 kbps).
8.7	Performance requirement for RACH	New minimum requirement needed due to: • redefinition of path delays positions aligned with chip positions in multi-path fading propagation conditions (Case 3).
8.10	Performance of ACK/NACK detection for HS-DPCCH	New minimum requirement needed due to: • modification of reference measurement channel for HS-DPCCH, • different timing relations between the delay of particular path and chip positions in multi-path fading propagation conditions (Case 1, Case 2), • redefinition of path delays positions aligned with chip positions in multi-path fading propagation conditions (Case 3).
8.10A 8.10B	Performance of ACK/NACK detection for 4C-HSDPA HS-DPCCH Performance of ACK/NACK detection for 8C-HSDPA HS-DPCCH	New minimum requirement needed due to: • modification of reference measurement channel for 4C-HSDPA HS-DPCCH, • different timing relations between the delay of particular path and chip positions in multi-path fading propagation conditions (Case 1).
8.11	Demodulation of E-DPDCH in multipath fading condition	New minimum requirement needed due to: • modification of E-DPDCH Fixed reference channels

		(FRC1, FRC2, FRC3, FRC4, FRC5, FRC6, FRC7, FRC8). • different timing relations between the delay of particular path and chip positions in multipath fading propagation conditions for E-DPDCH and E-DPCCH (PA3, PB3, VA30, VA120).
8.12	Performance of signaling detection for E-DPCCH in multipath fading condition	New minimum requirement needed due to: • modification of E-DPDCH Fixed reference channels (FRC1, FRC4), • different timing relations between the delay of particular path and chip positions in multipath fading propagation conditions for E-DPDCH and E-DPCCH (PA3, PB3, VA30, VA120).

Table 7.1.5.2.2.3-2: Additional modifications of TS25.104 required by time-dilated UMTS

Section	Measurement channels	Justification
A.1	Summary of UL reference measurement channels	Change of spreading factor or other parameters due to scaling of chip rate.
A.2	UL reference measurement channel for 12.2 kbps	Change of spreading factor or other parameters due to scaling of chip rate.
A.3	UL reference measurement channel for 64 kbps	Change of spreading factor or other parameters due to scaling of chip rate.
A.4	UL reference measurement channel for 144 kbps	Change of spreading factor or other parameters due to scaling of chip rate.
A.5	UL reference measurement channel for 384 kbps	Change of spreading factor or other parameters due to scaling of chip rate.
A.8	Reference measurement channel for HS-DPCCH	Change of values of parameters connected with data rate (information bit rate and physical channel bit rate) due to scaling of chip rate.
A.8A	Reference measurement channel for HS-DPCCH for 4C-HSDPA	Change of values of parameters connected with data rate (information bit rate and physical channel bit rate) due to scaling of chip rate.
A.9	Summary of E-DPDCH Fixed reference channels	Change of values of parameters connected with data rate (max information bit rate) due to scaling of chip rate.

A.10	E-DPDCH Fixed reference channel 1 (FRC1)	Change of values of parameters connected with data rate (max information bit rate) due to scaling of chip rate.
A.11	E-DPDCH Fixed reference channel 2 (FRC2)	Change of values of parameters connected with data rate (max information bit rate) due to scaling of chip rate.
A.12	E-DPDCH Fixed reference channel 3 (FRC3)	Change of values of parameters connected with data rate (max information bit rate) due to scaling of chip rate.
A.13	E-DPDCH Fixed reference channel 4 (FRC4)	Change of values of parameters connected with data rate (max information bit rate) due to scaling of chip rate.
A.14	E-DPDCH Fixed reference channel 5 (FRC5)	Change of values of parameters connected with data rate (max information bit rate) due to scaling of chip rate.
A.15	E-DPDCH Fixed reference channel 6 (FRC6)	Change of values of parameters connected with data rate (max information bit rate) due to scaling of chip rate.
A.16	E-DPDCH Fixed reference channel 7 (FRC7)	Change of values of parameters connected with data rate (max information bit rate) due to scaling of chip rate.
A.17	E-DPDCH Fixed reference channel 8 (FRC8)	Change of values of parameters connected with data rate (max information bit rate) due to scaling of chip rate.
Section	**Propagation conditions**	**Justification**
B.2	Multi-path fading propagation conditions	Redefinition of path delays positions aligned with chip positions in multi-path fading propagation conditions (Case 3, Case 4) due to scaling of chip rate.

Additional minimum values of BS performance requirements in TS25.104 caused by introduction of time-dilated UMTS have to be followed by appropriate changes in BS conformance testing specification. Due to that, the following sections of TS25.141 have to be modified.

Table 7.1.5.2.2.3-3: BS conformance testing requirements of TS25.141 which would be affected by modifications of corresponding requirements in TS25.104 due to introduction of time-dilated UMTS

Section	Requirement	Justification
8.2	Demodulation in static propagation conditions	Modifications due to corresponding changes in section 8.2 of TS25.104.
8.3	Demodulation of DCH in multipath fading conditions	Modifications due to corresponding changes in section 8.3 of TS25.104.
8.4	Demodulation of DCH in moving	Modifications due to corresponding changes in section 8.4 of

	propagation conditions	TS25.104.
8.5	Demodulation of DCH in birth/death propagation conditions	Modifications due to corresponding changes in section 8.5 of TS25.104.
8.5A	Demodulation of DCH in high speed train conditions	Modifications due to corresponding changes in section 8.5A of TS25.104.
8.6	Verification of the internal BLER calculation	Appropriate scaling of values of parameters connected with data rate and signal level due to scaling of chip rate.
8.8	RACH performance	Modifications due to corresponding changes in section 8.7 of TS25.104.
8.11	Performance of signalling detection for HS-DPCCH	Modifications due to corresponding changes in section 8.10 of TS25.104.
8.11A 8.11B	Performance of signalling detection for 4C-HSDPA HS-DPCCH Performance of signalling detection for 8C-HSDPA HS-DPCCH	Modifications due to corresponding changes in sections 8.10A and 8.10B of TS25.104.
8.12	Demodulation of E-DPDCH in multipath fading condition	Modifications due to corresponding changes in section 8.11 of TS25.104.
8.13	Performance of signalling detection for E-DPCCH in multipath fading conditions	Modifications due to corresponding changes in section 8.12 of TS25.104.

Table 7.1.5.2.2.3-4: Additional modifications of TS25.141 required by time-dilated UMTS

Section	Measurement channels	Justification
A.1	Summary of UL reference measurement channels	Change of spreading factor or other parameters due to scaling of chip rate.
A.2	UL reference measurement channel for 12.2 kbps	Change of spreading factor or other parameters due to scaling of chip rate.
A.3	UL reference measurement channel for 64 kbps	Change of spreading factor or other parameters due to scaling of chip rate.
A.4	UL reference measurement channel for 144 kbps	Change of spreading factor or other parameters due to scaling of chip rate.

A.5	UL reference measurement channel for 384 kbps	Change of spreading factor or other parameters due to scaling of chip rate.
A.9	Reference measurement channel for HS-DPCCH	Change of values of parameters connected with data rate (information bit rate and physical channel bit rate) due to scaling of chip rate.
A.9A	Reference measurement channel for HS-DPCCH for 4C-HSDPA	Change of values of parameters connected with data rate (information bit rate and physical channel bit rate) due to scaling of chip rate.
A.10	Summary of E-DPDCH Fixed reference channels	Change of values of parameters connected with data rate (max information bit rate) due to scaling of chip rate.
A.11	E-DPDCH Fixed reference channel 1 (FRC1)	Change of values of parameters connected with data rate (max information bit rate) due to scaling of chip rate.
A.12	E-DPDCH Fixed reference channel 2 (FRC2)	Change of values of parameters connected with data rate (max information bit rate) due to scaling of chip rate.
A.13	E-DPDCH Fixed reference channel 3 (FRC3)	Change of values of parameters connected with data rate (max information bit rate) due to scaling of chip rate.
A.14	E-DPDCH Fixed reference channel 4 (FRC4)	Change of values of parameters connected with data rate (max information bit rate) due to scaling of chip rate.
A.15	E-DPDCH Fixed reference channel 5 (FRC5)	Change of values of parameters connected with data rate (max information bit rate) due to scaling of chip rate.
A.16	E-DPDCH Fixed reference channel 6 (FRC6)	Change of values of parameters connected with data rate (max information bit rate) due to scaling of chip rate.
A.17	E-DPDCH Fixed reference channel 7 (FRC7)	Change of values of parameters connected with data rate (max information bit rate) due to scaling of chip rate.
A.18	E-DPDCH Fixed reference channel 8 (FRC8)	Change of values of parameters connected with data rate (max information bit rate) due to scaling of chip rate.
Section	**Propagation conditions**	**Justification**
D.2	Multi-path fading propagation conditions	Redefinition of path delays positions aligned with chip positions in multi-path fading propagation conditions (Case 3, Case 4) due to scaling of chip rate.

According to presented study, most of existing UTRA BS performance requirements need modification due to introduction of time-dilated UMTS.

Impact on BS performance requirements of TS36.104 and BS conformance testing requirements of TS36.141 due to introduction of time-dilated UMTS is not foreseen.

Direct impact on BS performance requirements of TS37.104 and BS conformance testing requirements of TS37.141 due to introduction of time-dilated UMTS is not foreseen.

7.1.5.2.3 UE RF core and performance requirements

7.1.5.2.3.1 UE Transmitter Core Requirements

Several transmitter core requirements will be affected by the introduction of time-dilated UMTS. Note that the only in case of standalone time-dilated UMTS the UE is required to transmit by using a reduced bandwidth. In the following the analysis is mainly applicable to standalone time-dilated UMTS case.

The maximum transmit power depends on the PA characteristics. Unless a dedicated PA is considered as baseline architecture the maximum achievable transmit power could be considered to be the same also for Time-dilated UMTS. However, the maximum transmit power used by the UE for Time-dilated UMTS may be affected pending the decisions on same PSD or higher PSD for Time-dilated UMTS.

The CM characteristics will change for Time-dilated UMTS. The ranges of CM will need to be revisited as well as the reference waveform. Consequenctly the amount of allowed MPR will need to be rediscussed.

No major changes foreseen for relative code domain power accuracy.

For the following requirements:

- frequency error
- minimum output power
- output power dynamics,
- inner loop power control
- out of synchronization handling of output power
- transmit ON/OFF time mask,
- change of TFC
- power setting in uplink compressed mode
- HS-PDCCH transmitter power step tolerances

transients and measurement periods are defined according to the legacy WCDMA system. Depending on the final solution chosen in RAN 1, e.g. dilation of timing, these will need to be revisited in order to achieve similar performance as for legacy UMTS.

Additionally minimum output power and ON/OFF time mask may be affected because of the required power level when a reduced bandwidth is considered.

The occupied bandwidth will change according to the decided nominal bandwidths.

SEM may need to be redesigned by taking into account that for Time-dilated UMTS the bandwidth is reduced wrt to the 5MHz bandwidth used so far (the requirements are defined starting from 2.5MHz away from the carrier). See Clause x.y.z for some initial discussion on SEM. Note that the SEM is a regulatory requirements and the emission levels of Time-dilated UMTS will need to comply with the necessary limits in various country.

The ACLR is a direct measure of the interference which is leaking in adjacent spectrum. The same analysis as for BS ACLR for standalone Time-dilated UMTS is applicable for UE ACLR.

For spurious emissions it should be noted that new values may need to be defined in order to protect Scalable UMTS systems (e.g. changing on the integration bandwidth and analysis of the value needed to protect other Scalable UMTS is required);

For transmit intermodulation the same discussion as for BS transmitter is applicable.

For transmit modulation (pulse shape filter, EVM, peak and relative code domain power) the same discussion as for BS transmitter is applicable.

If the same PA is considered for the UE supporting Time-dilated UMTS phase discontinuity requirements may not be affected.

A table capturing the detailed summary of the new requirements which needs to be introduced is missing.

7.1.5.2.3.2 UE Receiver Core Requirements

In the Time-dilated UMTS downlink, the UE would be required to receive the signal according to several possible configurations. In particular, the UE can receive a single Time-dilated UMTS carrier in a *standalone* configuration, or a Time-dilated UMTS carrier as a supplemental downlink carrier in a multi-carrier configuration. The scenarios and the configurations agreed will need to be introduced in the specifications and captured depending on the capability of the UE.

Changes in channel bandwidth may require changes in the UE RX RF filters. Since the concept of *flexible bandwidth* is already used in LTE, there is no technical reason why this cannot be done in UMTS; however, ,the receive channel filtering may need to be optimized for UMTS with the new bandwidth. In the following an initial assessment of the impact of Time-dilated UMTS on the UE receiver core specification is provided for main RF UE core requirements.

Multi-carrier scenarios can be introduced in the specification by considering the exact operator scenario as shown in the above section or by considering the nominal spacing between the center carriers. In case exact operator configurations are considered the spacing between the center carriers is reduced.

REFERENCE SENSITIVITY LEVEL: New requirements need to be specified for Time-dilated UMTS for both standalone and multi-carrier scenarios.If the multi-carrier scenarios as described in the above sections are introduced as such into the specification then new REFSENS requirements may be needed for the legacy UMTS carrier in the multi-carrier scenarios for some cases (potential impact for N=2).

One of the main UE receive core requirement is the Reference Sensitivity level (REFSENS). REFSENS is the basis for most of the UE receiver core requirement. ACS, Blocking and Intermodulation requirements in fact are all based on the sensitivity level. These values are defined with units of dBm/3.84MHz, i.e. they assume UMTS chip rate. These requirements should be re-written for any change in chip rate and bandwidth. In addition, a new corresponding Reference Measurement Channel (RMC) for each new Time-dilated UMTS chip rate needs to be defined in order to be able to measure REFSENS. Since the SNR requirement for these new RMCs may differ from the existing one for 3.84 Mcps, the REFSENS requirements need to be re-evaluated for each new chip rate.

The REFSENS depends on how the physical layer will be defined in RAN1.New requirements will be needed also for the multi-carrier configuration agreed with Time-dilated UMTS and UMTS carriers.

REFSENS values could be influenced by the exact filter design of the front-end analog filter for Time-dilation UMTS. However, these aspects aresubject to implementation.

MAXIMUM INPUT LEVEL: New requirements need to be specified for Time-dilated UMTS.

The maximum input level is defined in TS 25.101 equal to -25dBm /3.84MHz. The maximum input level is implicitly a requirement on the ADC to make sure that the ADC is capable of handling a certain dynamic range. If the ADC linearity region can be considered the same as for legacy UE then the Time-dilated UMTS UE will be able to handle the corresponding input level (w.r.t. to nominal bandwidth which will be agreed). It can be discussed further whether the maximum input level is rescaled depending on the nominal bandwidth (as it is done for multi-carrier aggregation in legacy WCDMA up to dual carrier) or if it is considered as an absolute value (independent from the bandwidth as in LTE and for legacy WCDMA for number of carriers>2).

The minimum requirements in terms of throughput vs Ec/Ior will need to be re-evaluated for both standalone carriers and multi RAT-configurations.

ADJACENT CHANNEL SELECTIVITY: New requirements need to be specified for Time-dilated UMTS for standalone and multicarrier configurations. New requirements mayneed to be considered for legacy UMTS

carrier in the multi-carrier scenarios depending on the blocker assumption. .New requirements for the legacy UMTS carrier when Time-dilated UMTS is the blocker may be needed.

The introduction of Time-dilated UMTS may require the definition of new interferer types which corresponds to Time-dilated UMTS carrier with different nominal bandwidth. The ACS is defined in two different cases with a UMTS modulated interferer located at 5MHz wrt the center of the wanted carrier. In the case of Time-dilated UMTS the same requirements will need to be defined at least for a Time-dilated UMTS wanted carrier with a Time-dilated UMTS modulated interferer located at an offset which is at least equal to the Time-dilated UMTS bandwidth. It will need to be discussed further whether the power levels of the interferers with respect to the wanted signal could be possibly maintained, or whether changes are needed. Additionally the characteristics of the Time-dilated modulated interferer may need further discussion pending decisions in RAN1 (compared to the WCDMA modulated interferer defined in Table C.7 in TS 25.101).

The requirement will need to be defined for all the Time-dilated UMTS bandwidths which will be introduced in the specifications.

Whether or not to introduce ACS requirement for all the combinations of Time-dilated UMTS bandwidth for the wanted signal and the interference signal need to be decided. It may be possible to limit the number of test cases as done in E-UTRA specification (ACS requirements for carrier bandwidth xMHz are defined only for an interferer xMHz wide).

New requirement will need to be defined also for the multi-carrier scenarios for configurations based on the aggregation of Time-Dilation UMTS and UMTS carriers. The definition of new Time-dilated UMTS interferer types may have some implications also on other RAT specifications, e.g. discussions are needed whether the introduction of new interferer types requires the introduction of new requirements for legacy UMTS (and other RATs) in the presence of Time-dilated UMTS interferers.

BLOCKING REQUIREMENTS: New requirements need to be specified for Time-dilated UMTS standalone and multi-carrier configurations. New requirements may be needed for legacy UMTS carrier in the multi-carrier scenarios.

Blocking requirements include in-band blocking, out of band blocking and narrowband blocking requirements. In general new definition of blocking requirements are required for a Time-dilated UMTS carrier when the blocker is a Time-dilated UMTS carrier with at least equal bandwidth for both standalone and multi-carrier scenarios.

The requirement will need to be rewirtten by taking into account new channel bandwidths for the interferer and the wanted signal. As for ACS power levels and offset values need further discussions and evaluations.

In LTE for example the offset w.r.t. the REFSENS value depends on the channel bandwidth, while the interferer is kept constant. The same approach could be considered for Time-dilated UMTS; more analysis is needed on this topic. The requirement (the BER level) shall be re-evaluated depending on the new test conditions.

For all the blocking requirements, in case of multi-carrier scenarios new requirements need to be defined not only for the Time-dilated UMTS carrier but also for the legacy UMTS carrier.

The in-band blocking requirement is defined for a W-CDMA modulated interferer. The new requirements shall be based on a new Time-dilated UMTS modulated interferer whose characteristics may need to be modified to capture differences in power settings for the Time-dilated UMTS system. The out of band blocking requirement is defined for a CW interferer located at frequencies which are more than 15MHz below or above the UE receive bands for legacy UMTS systems. The out of band blocking requirements for standalone Time-dilation UMTS and for multi-carrier scenarios will need to be defined. Note that the number of exceptions for the out of band blocking requirements may need to be re-evaluated when Time-dilated UMTS is considered.

The aim of the narrowband blocking requirement is to make sure that the legacy UMTS UE can cope with a GSM-like interfering signal located very close to the wanted carrier. Hence, so far, this requirement is defined only for certain bands where GSM deployment is possible. In particular the requirement is defined for Bands II, IV, V, X, XXV, XXVI, III, VIII, XII, XIII and XIV. New narrowband blocking requirements need to be specified for the Time-dilated UMTS wanted signal with appropriate frequency offsets..

SPURIOUS RESPONSE: New requirements need to be specified for Time-dilated UMTS standalone and multi-carrier scenarios.

Same comments apply as for blocking requirements and in particular out of band blocking.

INTERMODULATION CHARACTERISTICS: new requirements need to be specified for Time-dilated UMTS standalone and multi-carrier scenarios. New requirements needed for legacy UMTS carrier in the multi-carrier

scenario. New requirements for legacy UMTS may be needed (with different configuration compared to legacy narrowband intermodulation test) at least in all the bands where no narrowband intermodulation is defined.

For wideband intermodulation the same comments as for the blocking requirements (in particular in -band blocking) apply.

For narrowband intermodulation the same comments as for the blocking requirements (in particular narrowband blocking) apply.

SPURIOUS EMISSIONS: Evaluation of the applicability of the existing requirement is needed for Time-dilated UMTS. The new measurement granularity may need to be considered.

Spurious emissions depend on the RF circuitry and RF filters in the UE receive chain. It is needed to verify whether the same levels are applicable for Time-dilated UMTS. Additionally the measurement bandwidth and measurement granularity (200 KHz) may need to be modified to take into account new Time-dilated UMTS bandwidth.

It should be noted that most of the blocking requirements (a part from out of band blocking) are defined for both single uplink and dual uplink for legacy multi-carrier UMTS. If use cases are defined in the future with more than one downlink legacy UMTS carrier aggregated to Time-dilated UMTS, dual uplink case would be applicable. Hence, in this case, the blocking requirements for Time-Dilation UMTS may be affected by dual uplink depending on the position of the Time-Dilation UMTS carrier in the multi-carrier configuration. In case dual uplink case is considered within the scope of the work, these requirements will need to be introduced.

Summary

Requirement	**No of carriers**	**Requirements for Time-dilated UMTS**	**New requirements for UMTS carrier**
REFSENS	Single carrier/Standalone	New requirement needed	No
	Multi-carrier scenarios	New requirement needed	New requirement needed for the UMTS carrier(s) participating in the multi-carrier aggregation configuration with a Time-Dilation UMTS carrier for N=2.
Maximum input level	Single carrier/Standalone	New requirement needed	No
	Multi-carrier scenarios	New requirement needed	No
ACS	Single carrier/Standalone	New requirements needed bandwidths of interferer may be considered	New requirement may be needed with Time-dilated UMTS interferer for legacy UMTS.
	Multi-carrier scenarios	New requirements needed. Different bandwidths of interferer may be considered	New requirement may be needed for the UMTS carrier participating in the multi-carrier configuration with a Time-dilation UMTS carrier.
In-band Blocking	Single carrier/Standalone	New requirements needed Different bandwidths of interferer may be considered	No
	Multi-carrier scenarios	New requirements needed Different bandwidths of interferer may be considered	New requirement may be needed for the UMTS carrier participating in the multi-carrier configuration with a Time-dilation UMTS carrier.
Out of band Blocking	Single carrier/Standalone	New requirement needed	No
	Multi-carrier scenarios	New requirement needed	No

Narrowband Blocking	Single carrier/Standalone	New requirement needed	No
	Multi-carrier scenarios	New requirement needed	No
Spurious Response	Single carrier/Standalone	New requirement needed	No
	Multi-carrier scenarios	New requirement needed	No
Wideband Intermodulation	Single carrier/Standalone	New requirement needed	No
	Multi-carrier scenarios	New requirement needed	No New requirements may be needed for legacy UMTS carrier in the multi-carrier scenario.
Narrowband Intermodulation	Single carrier/Standalone	New requirement needed	New requirements for legacy UMTS may be needed (with different configuration compared to legacy narrowband intermodulation test) at least in all the bands where no narrowband intermodulation is defined.
	Multi-carrier scenarios	New requirement needed	New requirements may be needed for legacy UMTS carrier in the multi-carrier scenario. No
Spurious emissions	Single carrier/Standalone	Evaluation of the applicability of the existing requirement is needed. The new measurement granularity need to be considered.	No
	Multi-carrier aggregation	Evaluation of the applicability of the existing requirement is needed. The new measurement granularity need to be considered.	No

7.1.5.2.3.3 UE performance requirements

General

In TS25.101, existing demodulation requirements are organised into section 8 (performance requirements for release 99 channels), section 9 (performance requirements for HSDPA, section 10 (performance requirements for E-DCH) and section 11 (performance requirements for MBMS). Depending on RAN1 decisions on the functionality of a possible Scalable UMTS work item, it is anticipated that these sections would need to be extended with requirements for Time-dilated UMTS operating at all relevant chip rates. In general, the following tasks would need to be performed to extend the specification for other chip rates.

- Discussion and agreement on the relevant reference receiver types for Time-dilated UMTS, e.g. whether all of type 0, type 1, type 2, type 3 and type 3i receiver types are relevant for Time-dilated UMTS implementations. However, since all enhanced receiver requirements currently defined in 25.101 are extensions and enhancement of type 0 requirements, it is anticipated that the baseline type 0 performance needs to be accounted.

- Discussion and agreement of the general framework and test case list for Time-dilated UMTS. Not all test cases for 3.84 Mcps may be relevant for Time-dilated UMTS depending on future decisions about the functionalities that are defined for Time-dilated UMTS. For example, it is necessary to understand whether release 11 or release 12 UTMS features are included in Time-dilated UMTS in the first instance. In addition, the UE demodulation performance may be considered partially verified already by the existing test cases, assuming that all Time-dilated UMTS UEs are also required to support 3.84Mcps operation. However, it would also be necessary to ensure good requirements coverage at fractional chip rates, to ensure the expected Time-dilated UMTS system performance in practical deployments.

- Discussion and agreement of reference measurement channels and OCNS modelling for Time-dilated UMTS
- Discussion and agreement of propagation conditions for Time-dilated UMTS. This has been discussed to an extent during the study item and further considerations are provided below
- Alignment simulations of Time-dilated UMTS cases.
- Simulation of impairment margins and agreement of requirements based on some agreed methodology e.g. averaging of results.
- Change requests to introduce Time-dilated UMTS requirements to TS25.101

Channel modelling

Existing test cases in chapter 8 of 25.101 use chip spaced channel models for case 1-4 and case 6 as shown in table 7.1.5.2.3.3-1

Table 7.1.5.2.3.3-1: Propagation Conditions for Multi path Fading Environments (Cases 1 to 6)

Case 1		**Case 2**		**Case 3**		**Case 4**		**Case 5 (Note 1)**		**Case 6**	
Speed for Band I, II, III, IV, IX, X and XXV: 3 km/h		Speed for Band I, II, III, IV, IX, X and XXV: 3 km/h		Speed for Band I, II, III, IV, IX, X and XXV: 120 km/h		Speed for Band I, II, III, IV, IX, X and XXV: 3 km/h		Speed for Band I, II, III, IV, IX, X and XXV: 50 km/h		Speed for Band I, II, III, IV, IX, X and XXV: 250 km/h	
Speed for Band V, VI, VIII, XIX, XX and XXVI: 7 km/h		Speed for Band V, VI, VIII, XIX, XX and XXVI: 7 km/h		Speed for Band V, VI, VIII, XIX, XX and XXVI: 282 km/h (Note 2)		Speed for Band V, VI, VIII, XIX, XX and XXVI: 7 km/h		Speed for Band V, VI, VIII, XIX, XX and XXVI: 118 km/h		Speed for Band V, VI, VIII, XIX, XX and XXVI: 583 km/h (Note 2)	
Speed for Band VII: 2.3 km/h		Speed for Band VII: 2.3 km/h		Speed for Band VII: 92 km/h		Speed for Band VII: 2.3 km/h		Speed for Band VII: 38 km/h		Speed for Band VII: 192 km/h	
Speed for Band XI, XXI: 4.1 km/h		Speed for Band XI, XXI: 4.1 km/h		Speed for Band XI, XXI: 166 km/h		Speed for Band XI, XXI: 4.1 km/h		Speed for Band XI, XXI: 69 km/h		Speed for Band XI, XXI: 345 km/h (Note 2)	
Speed for Band XII, XIII, XIV 8 km/h		Speed for Band XII, XIII, XIV 8 km/h		Speed for Band XII, XIII, XIV 320 km/h		Speed for Band XII, XIII, XIV 8 km/h		Speed for Band XII, XIII, XIV 133 km/h		Speed for Band XII, XIII, XIV 668 km/h	
Speed for Band XXII: 1.7 km/h		Speed for Band XXII: 1.7 km/h		Speed for Band XXII: 69 km/h		Speed for Band XXII: 1.7 km/h		Speed for Band XXII: 29 km/h		Speed for Band XXII: 143 km/h	
Relative Delay [ns]	**Relative mean Power [dB]**	**Relative Delay [ns]**	**Relative mean Power [dB]**	**Relative Delay [ns]**	**Relative mean Power [dB]**	**Relative Delay [ns]**	**Relative mean Power [dB]**	**Relative Delay [ns]**	**Relative mean Power [dB]**	**Relative Delay [ns]**	**Relative mean Power [dB]**
0	0	0	0	0	0	0	0	0	0	0	0
976	-10	976	0	260	-3	976	0	976	-10	260	-3
		20000	0	521	-6					521	-6
				781	-9					781	-9

NOTE 1: Case 5 is only used in TS25.133.

NOTE 2: Speed above 250km/h is applicable to demodulation performance requirements only.

Case channel models are also used for CQI test in multi-path fading and HS-SCCH-less demodulation of HS-DSCH as shown in table 7.1.5.2.3.3-2

Table 7.1.5.2.3.3-2: Propagation Conditions for CQI test in multi-path fading and HS-SCCH-less demodulation of HS-DSCH

Case 8, Speed for Band I, II, III, IV, IX, X and XXV: 30km/h Speed for Band V, VI, VIII, XIX, XX and XXVI: 71km/h Speed for Band VII: 23km/h Speed for Band XI, XXI: 41km/h Speed for Band XII, XIII, XIV: 80 km/h Speed for Band XXII: 17 km/h	
Relative Delay [ns]	Relative mean Power [dB]
0	0
976	-10

To develop corresponding channel models for Time-dilated UMTS, two possible approaches can be envisaged. The relative delay may be scaled according to the chip rate (e.g. multiplied by 2 or 4 for ½ or ¼ chip rate Time-dilated UMTS). In principle this should give quite similar performance to the 3.84Mcps performance level since the channel profile is scaled equivalently to the chip rate itself. Alternatively, if the channels are considered to have physical meaning based on typical conditions experienced in deployments, they may be used unscaled which means that the Time-dilated UMTS receiver will experience shorter relative delays in units of chips, compared to the full chip rate receiver. Thus, somewhat different performance levels can be anticipated.

For HSDPA, ITU channel models are used to verify the performance as shown in table 7.1.5.2.3.3-3

Table 7.1.5.2.3.3-3: Propagation Conditions for Multi-Path Fading Environments for HSDPA Performance Requirements

ITU Pedestrian A **Speed 3km/h** **(PA3)**		**ITU Pedestrian B** **Speed 3km/h** **(PB3)**		**ITU vehicular A** **Speed 30km/h** **(VA30)**		**ITU vehicular A** **Speed 120km/h** **(VA120)**	
Speed for Band I, II, III, IV, IX, X and XXV 3 km/h		Speed for Band I, II, III, IV, IX, X and XXV 3 km/h		Speed for Band I, II, III, IV, IX, X and XXV 30 km/h		Speed for Band I, II, III, IV, IX, X and XXV 120 km/h	
Speed for Band V, VI, VIII, XIX, XX and XXVI 7 km/h		Speed for Band V, VI, VIII, XIX, XX and XXVI 7 km/h		Speed for Band V, VI, VIII, XIX, XX and XXVI 71 km/h		Speed for Band V, VI, VIII, XIX, XX and XXVI 282 km/h (Note 1)	
Speed for Band VII 2.3 km/h		Speed for Band VII 2.3 km/h		Speed for Band VII 23 km/h		Speed for Band VII 92 km/h	
Speed for Band XI, XXI: 4.1 km/h		Speed for Band XI, XXI: 4.1 km/h		Speed for Band XI, XXI: 41 km/h		Speed for Band XI, XXI: 166 km/h (Note 1)	
Speed for Band XII, XIII, XIV 8 km/h		Speed for Band XII, XIII, XIV 8 km/h		Speed for Band XII, XIII, XIV 80 km/h		Speed for Band XII, XIII, XIV 320 km/h	
Speed for Band XXII: 1.7 km/h		Speed for Band XXII: 1.7 km/h		Speed for Band XXII: 17 km/h		Speed for Band XXII: 69 km/h	
Relative Delay [ns]	**Relative Mean Power [dB]**	**Relative Delay [ns]**	**Relative Mean Power [dB]**	**Relative Delay [ns]**	**Relative Mean Power [dB]**	**Relative Delay [ns]**	**Relative Mean Power [dB]**
0	0	0	0	0	0	0	0
110	-9.7	200	-0.9	310	-1.0	310	-1.0
190	-19.2	800	-4.9	710	-9.0	710	-9.0
410	-22.8	1200	-8.0	1090	-10.0	1090	-10.0
		2300	-7.8	1730	-15.0	1730	-15.0
		3700	-23.9	2510	-20.0	2510	-20.0

Since the ITU channel models have relative delays which are not related to the chip rate of the UE and are representative of conditions experienced in deployment, it would not be appropriate to scale the relative delays of channel taps. Therefore, the UE performance can be expected to be somewhat different from 3.84Mcps performance, even in alignment simulations, since the UE receiver experiences a different tap delay relative to its own chip rate.

Subject to the availability of MBMS and MBSFN with Time-dilated UMTS in the work item, similarly channel models used for MBMS (TS25.101 table B.1.D) and MBSFN (TS25.101 table B.1.E) testing are based on conditions which may be considered relevant for practical deployment, and would not be scaled for Time-dilated UMTS.

A number of channels have been defined for stress testing of the UE receiver and need special consideration. These are moving propagation conditions (B.2.3), birth death propagation conditions (B.2.4) and high speed train condition (B.2.5). For moving propagation conditions and birth death propagation conditions, RAN4 should discuss the relevant stress tests for a lower chip rate receiver. For high speed train condition, the characteristics depend on train velocity, distances between the node Bs and distance between each node B and the track. Therefore it is not anticipated that high speed train propagation condition would be modified for the work on Time-dilated UMTS, although the UE performance with the different chip rates needs to be simulated.

Finally, MIMO propagation conditions defined in TS25.101 annex B.2.6.1, B.2.6.2 and B.2.6.3 may be straightforwardly reused for Time-dilated UMTS since the channels are all single tap channel.

7.1.5.2.4 RRM requirements

A number of existing RRM requirements defined for the UE and Node B measurements are met over certain physical layer measurement period or evaluation time. These existing RRM requirements are defined for the current chip rate and bandwidth of 3.84 Mcps and 5 MHz respectively. Furthermore a number of RRM requirements are defined under certain side conditions or signal levels e.g. SCH Ec/Io, CPICH Ec/Io, CPICH RSCP, Io levels etc.

In Time-dilated UMTS due to reduction in chip rate for bandwidths smaller than 5 MHz the information will be sent over a time period longer than that used in case of legacy UMTS (i.e. 5 MHz) assuming the spreading factor remains the same. For example P-CPICH in time-dilated UMTS is sent using the existing SF=256 but will be spread over time if the chip rate is reduced to 1.92 Mcps for channel bandwidth of 2.5 MHz. For Time-dilated UMTS, it is desirable to keep the side conditions the same to ensure same coverage as in the legacy UMTS. Impact on UE and Node B related RRM requirements due to introduction of Time-dilated UMTS is analyzed in the next subsections.

In order to verify the RRM core and performance requirements a number of test cases are defined in the annex A of TS 25.133 and TS 36.133. Therefore any impact on the RRM core or performance requirements will affect the corresponding test cases defined in the annex A of TS 25.133 and annex A of TS 36.133. The RRM conformance tests in TS 34.121 and TS 36.521-3 are developed by RAN5 based on RRM tests in the annex A of TS 25.133 and TS 36.133 respectively. Therefore any impact on the RRM core or performance requirements will also affect RAN5 specifications TS 34.121 and TS 36.521-3.

7.1.5.2.4.1 UE RRM requirements

Two major concerns were raised on Time-dilated UMTS RRM performance.

- L1 measurement period and corresponding measurement accuracy
- Additional signalling overhead w.r.t. the time-dilated factor

Both aspects have been extensively addressed in [R4-134138] and [R4-134139].

Based on one company's extensive simulation results, it was shown that almost all UE RRM measurement requirements defined in TS 25.133 are not affected if the measurements on Time-dilated UMTS carrier are also time-dilated. The exception was the measurement requirements in CELL_FACH state when HS-DSCH discontinuous reception is ongoing with 2nd DRX. It should be noted that 2nd DRX is an optional feature in Rel-11 and this impact may be eliminated by some searcher optimization. The analysis assumed a natural time-dilated of measurements compared to the legacy UMTS measurements implying potential additional current consumption due to the increase in ON time for measurements.

On the other hand, if the duration of each measurement on Time-dilated UMTS carrier is kept the same as the existing UMTS [R4-132165, R4-132166], the following list of UE RRM requirements defined in TS 25.133 may be expected to be affected if measurement is done on Time-dilated UMTS carrier. Due to lack of adequate studies and analysis under this assumption, it will require detailed analysis to confirm the impact.

- Evaluation period in cell reselection:
    - o Intra-frequency case in idle, CELL_PCH and URA_PCH states

    - Inter-frequency case in idle, CELL_PCH and URA_PCH states
- Cell identification delay related requirements:
    - Intra-frequency cell identification delay in CELL_FACH and CELL_DCH states
    - Inter-frequency cell identification delay in CELL_FACH and CELL_DCH states
- UE measurement related requirements: delay and measurement accuracies:
    - Intra-frequency CPICH measurements (CPICH RSCP and Ec/No)
    - Inter-frequency CPICH measurements (CPICH RSCP and Ec/No)
    - Intra-frequency SFN-CFN observed time difference
    - Inter-frequency SFN-CFN observed time difference
    - Intra-frequency SFN-SFN observed time difference Type 1 and Type 2
    - Inter-frequency SFN-SFN observed time difference Type 1 and Type 2
    - UE Rx-Tx time difference type 1
    - UE Rx-Tx time difference type 2
    - UE transmission power headroom
    - System information acquisition for intra-frequency CSG cell
    - System information acquisition for inter-frequency CSG cell
- Inter-RAT Time-dilated UMTS carrier when serving cell is E-UTRA.
    - Evaluation period in cell reselection:
        - Inter-RAT UTRA FDD case in RRC_IDLE state
    - Cell identification delay related requirements:
        - Inter-RAT UTRA FDD cell identification delay in RRC_CONNECTED state
    - UE measurement related requirements: delay and measurement accuracies:
        - Inter-RAT UTRA FDD CPICH measurements
            - CPICH RSCP and
            - CPICH Ec/No
        - System information acquisition for inter-RAT UTRA FDD CSG cell

7.1.5.2.4.2 BS RRM requirements

Similarly to UE RRM requirements impact, it is expected that NodeB RRM measurement requirements defined in TS 25.133 are not affected if the measurements on Time-dilated UMTS carrier are also time-dilated. This implies potential additional current consumption due to the increase in ON time for measurements.

On the other hand, if the duration of each measurement on Time-dilated UMTS carrier is kept the same as the existing UMTS, a number of base station related RRM measurement requirements defined in TS 25.133 is expected to be affected for measurements on time-dilated UMTS carrier. These measurement requirements are defined in terms of physical layer measurement period and corresponding accuracy to be met under certain side conditions. The BS measurement related requirements potentially to be affected are:

- Received total wideband power
- SIR
- Transmitted carrier power

- Transmitted code power
- Round trip time
- UTRAN GPS Timing of Cell Frames for UE positioning
- SFN-SFN time difference
- Transmitted carrier power of all codes not used for HS-PDSCH, HS-SCCH, E-AGCH, E-RGCH or E-HICH transmission
- DL Transmission Branch Load
- Received scheduled E-DCH power share (RSEPS)

Due to lack of adequate studies and analysis under this assumption, it will require detailed analysis to confirm the impact.

7.1.5.2.4.3 Additional observation related to RRM

For the signaling overhead w.r.t. the time-dilated factor, an efficient signalling mechanism could be designed for the communication of the Scalable UMTS time-dilated factor N, where N is equal to 2 or 4 for Scalable UMTS N=2 and Scalable UMTS N=4, respectively. For example, a signalling mechanism has been proposed in [R4-134139]. Hence a Scalable UMTS carrier becomes nothing but an inter frequency in a different band from an existing RAT perspective. As a result, the work required for introducing additional band can be expected to happen in standards to introduce Scalable UMTS in certain bands.

A Time-dilated UMTS capable UE will have to perform blind search of the chip rate used on UMTS carriers searched during an initial cell search procedure aka frequency search or band scanning. However, it should be noted that this is similar to have additional band scanning for a multi-band capable UE compared to a single-band capable UE. For example, if the UE supports legacy UMTS and Time-dilated UMTS N=2 in the same band, the complexity of band scanning would be similar to the case when the UE supports legacy UMTS in two different bands.

7.1.5.3 Impact to GERAN1 specifications and coexistence

7.1.5.4 Impact to RAN3 specifications

Different NodeBs may not support the same chip rates. Furthermore, there will also be mixture of legacy NodeB and new NodeB capable of additional chip rate(s) operating in the same coverage area. In order for the RNC to communicate chip rates on different cells or carriers to the UE for measurements, the RNC will have to acquire the NodeBs capability of supporting different chip rates and also the currently used chip rate in the NodeBs. This may also affect signaling and procedures defined in RAN3 specifications covering NBAP, Iur, and Iu; e.g. TS 25.433, TS 25.423, TS 25.434, TS 25.435 etc. Therefore we foresee implication of time-dilated solution also on the procedures defined in RAN3.

- It is foreseen that the RNC needs to communicate chip rates on different cells or carriers to the UE for measurements. Therefore the RNC also needs to acquire the NodeB's capability of supporting different chip rates and also the currently used chip rate used by different NodeBs, which are included in the neighbour cell list signaled to the UE for measurements
- Capability signaling (impact AUDIT RESPONSE message)
- SRNC needs to find out the time-dilated UMTS related parameters (e.g. chip rate, …) for external cells
- The "Neighboring UMTS Cell Information" IE needs be modified to contain time-dilated UMTS information
- The INFORMATION EXCHANGE INITIATION REQUEST message which can be used by one RNC to request another RNC to provide information about indicated cells
- The Requested Data Value IE or the ANR Cell Information IE in the Requested Data Value IE in the INFORMATION EXCHANGE INITIATION RESPONSE message needs be updated to allow inclusion of time-dilated UMTS information for the requested cells
- Potential need to update the UPLINK SIGNALLING TRANSFER INDICATION.

7.1.5.5 Impact to RAN5 specifications

For all impact on L1, L2, L3 and RF/RRM, this will spread to the RAN5 test cases to 1) provide test coverage for time-dilated UMTS aspects; and 2) to create variants or update existing test cases that do not specifically verifies time-dilated UMTS to be able to be run on UEs supporting time-dilated UMTS. Note that one cannot just insert a scaling factor of "N" everywhere. E.g. 34.108 needs to be updated with all new bearer combinations that are needed.

New tests specific to time-dilated UMTS would be introduced, but also a number of basic or legacy tests won't work. Hence, there is a need to redefine all tests for any core/performance requirements which would be affected by time dilation solution. For instance, with introduction of MIMO, one does not have to add new tests for legacy requirements, like cell reselection, measurement accuracy, cell search etc. For time-dilated UMTS, there might be a need to redefine lots of basic tests for each new chip rate introduced – i.e. even those tests which were developed in R99. A particular challenge arises in 34.108 if absolute bit rate should be kept same with time-dilated UMTS solution. Doing 12.2 kbps AMR requires new RB mapping since one needs to have one AMR frame per 20 ms (UMTS: 2 radio frames, time-dilated UMTS: 1 radio frame). Also, SRB 3.4 kbps is low already today, reducing that to 1.7 kbps is not good, hence new mappings of SRB are needed. Thus, there might be a need to create variants for a number of prioritized DCH RB combinations. Any impact on the RRM core or performance requirements will affect the corresponding test cases defined in the annex A of TS 25.133 and annex A of TS 36.133. For example, if cell identification delay is extended for lower chip rate, then test requirements in the tests verifying such requirements will have to be modified. For example, test times that are tailored for the test requirements (e.g. delay/measurement period) need to be modified, new reference measurement channels to be defined and new parameters like chip rate, bandwidth, etc., will have to be included. For clarity, a good approach would be to redefine a new set of test cases for all lower chip rates. This will however heavily affect RAN5 conformance testing.

Impacted specifications are:

- 34.108 (common test environment, default messages, radio bearer definitions)
- 34.121-1 (RF/RRM test cases)
- 34.121-2 (Applicability, Implementation Conformance Statements (ICS) for RF/RRM test cases)
- 34.123-1 (Protocol test cases)
- 34.123-2 (Applicability, Implementation Conformance Statements (ICS) for protocol test cases)
- 34.123-3 (TTCN test model for time-dilated UMTS solution)

7.1.6 Impacts on coexistence

According to the LS sent by RAN1, the following scenarios are potential for Time-dilated UMTS to be deployed:

Table 7.1.6-1: Potential scenarios for Time-dilated UMTS

Mode of Operation	Bandwidth	Comments	Bands
Standalone	2.5Mhz (corresponds to N=2)	Support for DCH shall be considered.	Band VIII as the first band to consider
Standalone	1.25Mhz (corresponds to N=4)	HSPA data only	Band VIII as the first band to consider
Multi-carrier	5MHz + 2.5 MHz (corresponds to N=2) 5 MHz+ 1.25 MHz (corresponds to N=4)	6 MHz of contiguous band to consider first	Band VIII as the first band to consider
Standalone	2.5Mhz (corresponds to N=2)	To understand the impact of band	Band I as the first band to consider

Note 1: Multi-carrier 5 MHz + 2.5 MHz in 6 MHz can be de-prioritized.

Note 2: Assumption on Occupied BW for a single Scalable UMTS carrier:

- *$B_{Scalable\ UMTS}(x) = (5MHz/N - x)$, x=0 as the common assumption.*
- *Interested companies can study x>0. Results and conclusion can be captured in the TR for each case.*

Note 3: For multi-carrier case, half of the occupied BW of each carrier shall be maintained toward the edge of the available spectrum.

In RAN 4 #67 it was decided to investigate the following area:

- NodeB transmitter characteristics against the existing TS 25.104 (Standalone) and TS 37.104 (Multi-carrier)
  - Metric: ACLR, UEM
  - Scenarios: Multi-carrier and Standalone
- UE transmitter characteristics against the existing TS 25.101
  - Metric: ACLR, SEM
  - Scenarios: Standalone
- NodeB receiver blocking compared to the existing TS 25.104 (Standalone) and TS 37.104 (Multi-carrier)
  - Metric:
    - Band I: ACS and in-band blocking
    - Band VIII: ACS, in-band blocking and narrow band blocking
  - Scenarios: Standalone
- UE receiver blocking compared to the existing TS25.101
  - Metric
    - Band I: ACS and in-band blocking
    - Band VIII: ACS, in-band blocking and narrow band blocking
  - Scenarios: Multi-carrier and Standalone

Under the following assumptions

- PSD: Same PSD, Same Power, Other PSD
- PA for multi-carrier BS: A common PA, separate PAs
- BS: Wide area BS
- Multi-carrier BW assumption
  - Nominal spacing
  - 6 MHz
- Note that the following assumptions are considered in RAN 1 for the analysis:
  - The distance from the center carrier frequency to the band edge should be at least 2.5 MHz for legacy UMTS carriers and 2.5/N MHz for 5/N MHz ~~S-UMTS~~Scalable UMTS carriers.
  - A 5 MHz nominal bandwidth shall be considered for legacy UMTS
  - For the 3.84/N Mcps carrier, a 5/N MHz bandwidth is assumed. The carrier separation depends on the specific scenario.

7.1.6.1 BS transmitter characteristics

ACLR and SEM are two requirements which limit the interference level to adjacent systems. RAN 4 has conducted initial evaluation considering current UMTS SEM and ACLR requirement for Time-dilated UMTS carrier. The following observations were made:

- As the bandwidth decrease, the margin between signal spectrum and UMTS mask at the bandwidth edge also decrease;
- The margin between spectrum and UMTS mask at the bandwidth edge is smaller for the same power case than that for the same PSD case;
- For FCC regulatory requirement, -13dBm requirements shall be fulfilled in narrower bandwidth.

In addition, several options of spectrum emission mask for time-dilated UMTS are also discussed [R4-133349][R4-133351][R4-133852]:

- Option 1: UMTS mask
    - One company's results show that UMTS mask (without additional offset) can be met [R4-133349][R4-133351]. However, UMTS mask feasibility for Time-dilated UMTS as minimum requirements requires further study.
- Option 2: MSR BC2 mask applied for all the bands
    - It is feasible to meet MSR BC2 mask defined in 37.104 for Time-dilated UMTS for all the bands.
- Option 3: Follow MSR specification (as done for LTE with narrow carrier), i.e. BC1 mask for BC1 bands such as band I and BC2 mask for BC2 bands such as band VIII
    - It is feasible to meet MSR BC1 mask for BC1 bands Time-dilated UMTS and BC2 mask for BC2 bands Time-dilated UMTS
    - According to BC1 mask defined in 37.104 the requirements for receiver and transmitter shall apply with a frequency offset from the lowest and highest carriers to the RF bandwidth edges ($F_{offset, RAT}$) equal to $BW_{Channel}/2$ + 200 kHz . This implies that the distance from the center carrier frequency to the band edge should be at least 2.5/N +200KHz MHz for 5/N MHz Time-dilated UMTS carriers. Additional offset introduced by this mask may have implication on the multi-carrier scenarios agreed in RAN1. It may or may not affect conclusions in RAN1 study for the multi-carrier scenario.
- Option 4: MSR BC1 mask for all the bands
    - It is feasible to meet MSR BC1 mask for Time-dilated UMTS. Same comments as for option 3 apply.

For ACLR requirement, based on one company's measurement results [R4-133349], we have observations as below:

- Time-dilated UMTS (same PSD or same power) has comparable ACLR toward UMTS and Time-dilated UMTS systems when compared to UMTS.
- UMTS has comparable ACLR toward Time-dilated UMTS systems when compared to UMTS to UMTS ACLR.

7.1.6.2 BS receiver characteristics

From BS receiver side, legacy UMTS/LTE BS receiver performance such as ACS and in-band blocking requirements should be investigated in presence of Time-dilated UMTS interference because of the closer interference frequency offset from the RF bandwidth edge and possible higher interference PSD level. It may cause additional interference to the receiver and impact performance of existing receivers of those in-field BS as currently there is no requirement to satisfy rejection of signal with such parameters.

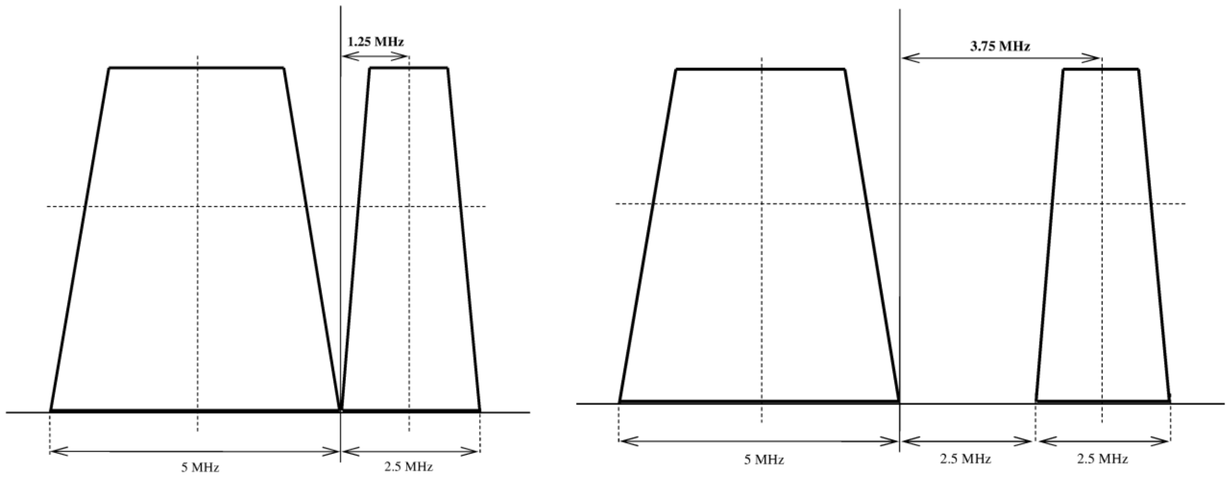

Figure 7.1.6.2-1 Minimum offset of adjacent channel signal for 2.5MHz ~~S-UMTS~~Scalable UMTS

Based on the analysis from two companies [R4-132338][R4-133846], in current specification, narrow band blocking requirement is more stringent than ACS requirement with interference of Time-dilated UMTS carrier. The narrow band blocking interference with GMSK modulated signal has higher interfering power, narrower interfering bandwidth and closer frequency offset compared with adjacent Time-dilated UMTS interference, but shares the same sensitivity degradation with current ACS requirement (6dB desensitisation). From this point of view, for the BS in the band which has narrow band blocking requirement like Band VIII, the impact of introducing Time-dilated UMTS carrier would be further reduced because of the stricter design to resist narrow band blocking interference. For the band which has no narrow band blocking requirement, further analysis needs to be done, for example for Band I. Another issues might be connected with existing blocking performance as currently there are no requirements to satisfy rejection of -40dBm interfering signal with the offset of 3.75MHz for N=2 and 1.875MHz for N=4 (see Figure 7.1.6.2-1).

Based on the test results on some commercial BS provided by one company [R4-133350], it is shown that Time-dilated UMTS interfering signal affects legacy BS receiver in a similar way as the legacy UMTS interferer, regardless of whether the Time-dilated UMTS interfering signal has the same power or the same PSD as the legacy UMTS interfering signal. The same conclusion is expected to be valid for LTE and GSM.

7.1.6.3 UE transmitter characteristics

One company has provided analysis on coexistence in [R4-132856, R4-134130] against the existing TS 25.101 requirements.

From the analysis provided in [R4-132856, R4-134130] the following observations can be done:

- For occupied bandwidth: Measurements in [R4-134130] show that the requirements for Time-dilated UMTS occupied bandwidth is consistent with UMTS/N
- SEM: One company observation is that measurements in [R4-134130] and simulation results in [R4-132856] show that UMTS mask can be met without additional offset. As the bandwidth decrease, the margin between signal spectrum and UMTS mask at the bandwidth edge also decrease;
  - The margin between spectrum and UMTS mask at the bandwidth edge is smaller for the same power case than that for the same PSD case;
  - UMTS mask feasibility for Time-dilated UMTS as minimum requirements requires further study.

- ACLR values are comparable to those obtained with legacy UMTS carrier for the first adjacent carrier. The legacy UMTS cannot maintain the performance of legacy alternate channel rejection ratio if the first and second adjacent carriers are Time-dilated UMTS carriers.

7.1.6.4 UE receiver characteristics

One company has provided analysis on UE rx requirements related to coexistence against the existing TS 25.101 requirements. The following observations are derived from the results shown in [R4-134135] by one company, they may not represent averaged results across the companies in RAN 4.

From the analysis provided in [R4-134135] the following observations can be done:

- Time-dilated UMTS UE shows degraded margins wrt to REFSENS compared to legacy UMTS UE.
- For ACS when a Time-dilated UMTS jammer (with same power offset as in legacy test) interferes with a legacy UMTS victim, an increased margin is observed compared with legacy UMTS reception in presence of legacy UMTS jammer.
  - o When the jammer level is decreased (such that the PSD of Time-dilated UMTS jammer is same as the PSD of the UMTS jammer) an increased margin is observed.
  - o ACS for legacy UMTS carrier in presence of N time-dilated interference has not be addressed.
- Time-dilated UMTS (N=2) receiver has decreased margin compared to an UMTS receiver in presence of a UMTS jammer.
- For in-band scenarios, comparable performance was observed for Time-dilated UMTS receiver performance.
- Time-dilated UMTS receiver shows comparable results for narrowband blocking compared to legacy UMTS carrier
- The observation above is applicable for multi-carrier scenarios when the nominal spacing is maintained. If the multi-carrier scenarios as described in the above sections are introduced as such into the specification, further study is needed.

7.2 Time-dilated Solution for Carrier Aggregation Scenarios

7.2.1 Solutions for Carrier Aggregation Scenarios

7.2.1.1 Timing relation of HS-PDSCHs and HS-DPCCHs

Assuming the CPICHs (also HS-SCCHs) of both legacy primary carrier and the small bandwidth secondary carrier are time aligned, the timing relation of HS-PDSCHs is shown in Figure 7.2.1.1-1. The start of any subframe of the small bandwidth carrier with N=2 begins 4/3ms after the start of the nearest subframe of the legacy carrier; and the start of any subframe of the small bandwidth carrier with N=4 is aligned with the start of one subframe of legacy carrier.

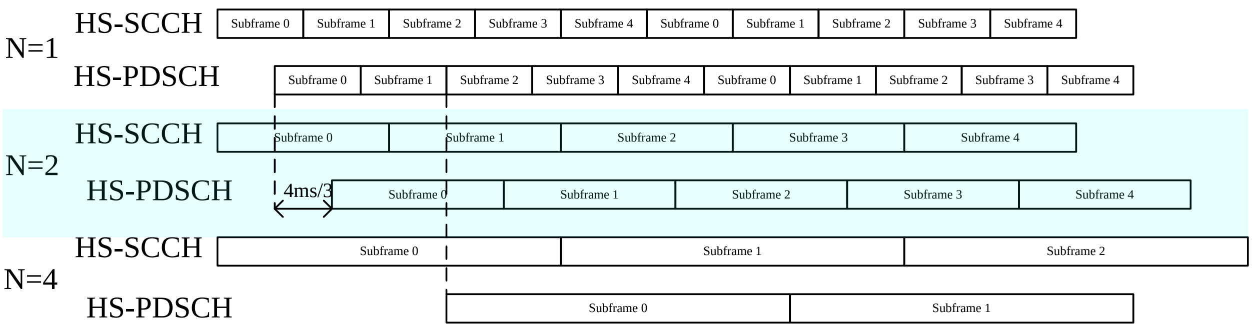

Figure 7.2.1.1-1: Timing relation of HS-PDSCHs

Assuming the timing between HS-PDSCH and HS-DPCCH is kept as Rel-5 (approximately 7.5 slots) in the cell where HS-PDSCH belongs to, the timing of HS-DPCCH for legacy carriers and small bandwidth carriers will be not aligned any more. The timing relation is shown in Figure 7.2.1.1-2.

Figure 7.2.1.1-2: Timing relation of HS-DPCCHs

7.2.1.2 HS-DPCCH solutions

For carrier aggregation of a legacy UMTS carrier with a Scalable UMTS carrier, both single and dual code design solutions can be considered.

- **Solutions of HS-DPCCH design**
    - **Solution 1: Single HS-DPCCH with joint encoding for ACK and TDM for CQI of carriers**
    - **Solution 2: Dual HS-DPCCHs with each corresponding to one downlink carrier**

The illustration of Solution 1 is shown in Figure 7.2.1.2-1 and Figure 7.2.1.2-2 for scaling factor N=2. In this solution joint encoding for ACK and TDM for CQI is adopted and time adjustment is used to follow the timing based on legacy UMTS feedback occasions. Note that the exact time adjustment for ACK or CQI can be further studied.

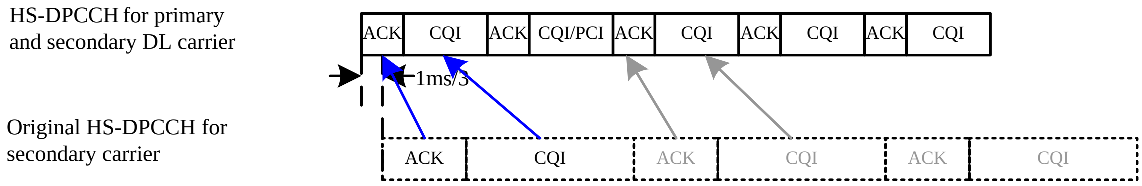

Figure 7.2.1.2-1: Single HS-DPCCH for dual carrier with Scalable UMTS as secondary carrier, N=2

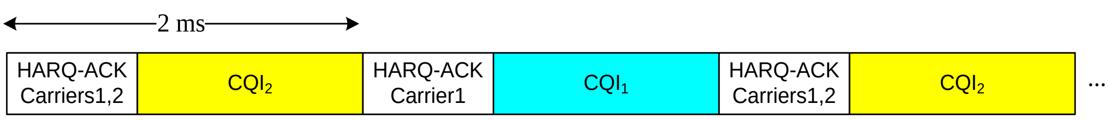

Figure 7.2.1.2-2: Single code HS-DPCCH design, ACK joint encoding and CQI TDM, N=2

The illustration of the Solution 1 is shown in Figure 7.2.1.2-3 and Figure 7.2.1.2-4 for scaling factor N=4. In this solution joint encoding for ACK and TDM for CQI is adopted and time adjustment is used to follow the timing based on legacy UMTS feedback occasions. Note that the exact time adjustment for ACK or CQI can be further specified.

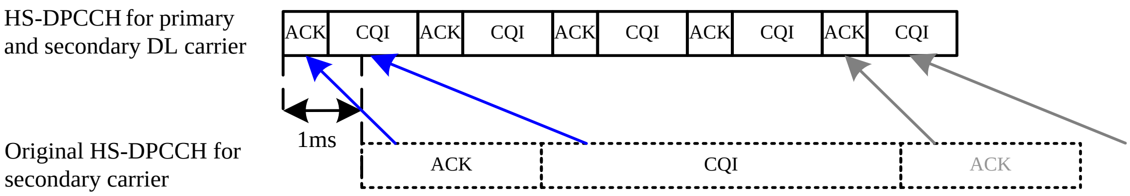

Figure 7.2.1.2-3: Single HS-DPCCH for dual carrier with Scalable UMTS as secondary carrier, N=4

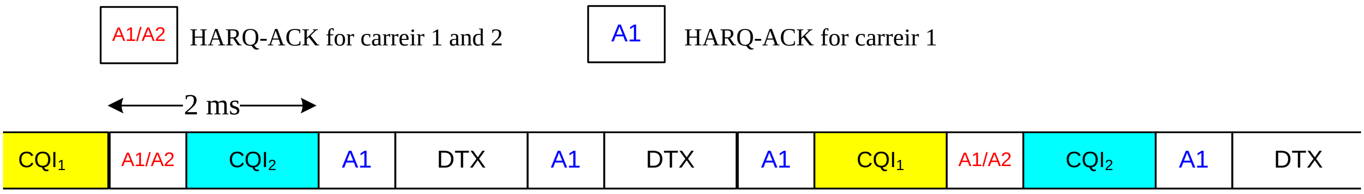

Figure 7.2.1.2-4: Single code HS-DPCCH design, ACK joint encoding and CQI TDM, N=4

The illustration of the Solution 2 is shown in Figure 7.2.1.2-5 for scaling factor N=2. In this solution two separate HS-DPCCHs are used corresponding to different HS-DPCCH timings in different carriers, wherein for each cell legacy HS-DPCCH feedback delay (approximately 7.5slots is kept.)

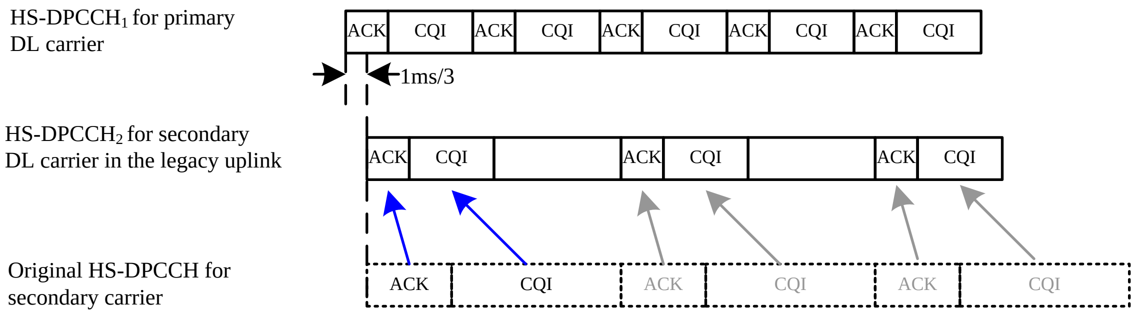

Figure 7.2.1.2-5: Dual code HS-DPCCHs for dual carrier with time-dilated UMTS as secondary carrier, N=2

The illustration of the Solution 2 is shown in Figure 7.2.1.2-6 for scaling factor N=4. In this solution two separate HS-DPCCHs are used corresponding to different HS-DPCCH timings in different carriers, wherein for each cell 7.5 slots HS-DPCCH feedback delay is kept.

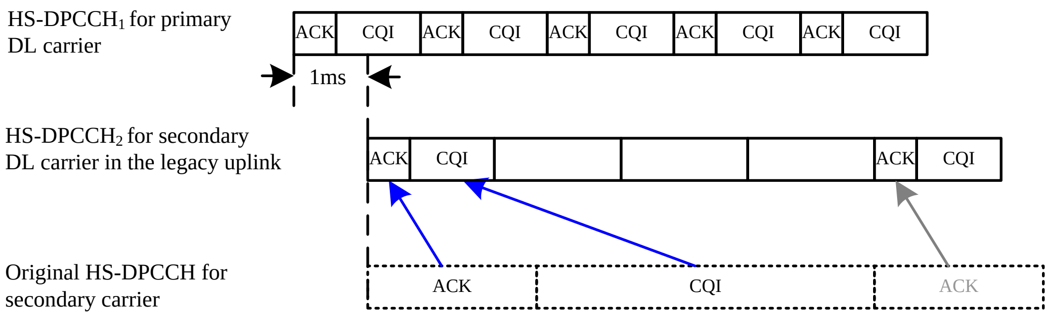

Figure 7.2.1.2-6: Dual code HS-DPCCHs for dual carrier with time-dilated UMTS as secondary carrier, N=4

7.3 Impact on Mobility (idle mode and connected mode)

7.3.1 Carrier identification and UE capability

Time-dilated carriers with N=2 or N=4 of the bandwidth of a normal carrier need to be distinguished from each other and from the normal carrier that has the same centre frequency. This means the same UARFCN alone cannot be used for all cases. The same issues apply to UE capability signalling. For various inter-frequency and inter-RAT procedures and measurement setups, the network needs to know if a UE supports a certain time-dilated carrier.

The RAN2 solution depends on what RAN4 agrees with regards carrier identification. The complexity of this solution may, hence, also depend on the RAN4 solution. Some solutions have been submitted but not yet discussed in RAN2. The impact on RAN2 work depends on the solution(s), once the concrete solution(s) are known better, a more detailed evaluation of the impacts can be performed.

7.3.2 Inter-frequency mobility

Introduction of time-dilated UMTS carriers will impact mobility procedures where there is a need to handover the UE to carriers with different bandwidth. For example:

- Inter-frequency handover within the same frequency band, or to another frequency band
- IRAT Handover to UTRAN from LTE/GSM
- RRC Connection Reject with redirection to other frequency
- RRC Connection Release with redirection to other frequency

For all these use-cases there is a need to provide additional information so that the UE is able to identify the target carrier. For example, if the same frequency band contains both time-dilated and normal UMTS carriers proper signaling indication must be included in all RRC messages that can be used to execute the mobility procedures. In addition, neighbour cell information in NBAP / RNSAP Radio Link Addition/Setup Response / Failure also needs to be extended with information to identify the time-dilated UMTS carrier. There could also be a signalling impact on the corresponding LTE and GERAN specifications in order to support a handover or a redirection to a time-dilated UMTS carrier

To avoid the situation whereas the RNC might redirect the UE to a carrier using a non-supported bandwidth, the UE needs to provide information about supported bandwidths already in the RRC Connection Request message. However, the size of RRC connection request is a limiting factor and the needs for its extension should be evaluated

7.3.3 Impact on Cell Selection and Cell Reselection

The time it takes to detect and evaluate the serving cell and neighbouring cells listed in System Information are controlled by the measurement requirements specified in 25.133.

Measurement requirements may increase the measurement periods for intra-frequency and inter-frequency measurements performed in Idle mode, URA_PCH, CELL_PCH and CELL_FACH states. For a time-dilated UMTS carrier both the DRX cycle as well as the FACH measurement occasion cycle may increase by a factor of N (this is pending on RAN4 analysis).

Longer measurement periods will impact the cell reselection performance.

7.3.4 Positioning

Impact on Positioning should also be evaluated to make sure that countries and regulators requirements are fulfilled.

7.3.5 Other mobility aspects

7.3.5.1 RL Failure or RLC unrecoverable error

Assuming a longer SRB latency, there will be an increased risk to detect Radio link failure and RLC unrecoverable error procedures for time-dilated UMTS Upon detection of a RL failure or RLC unrecoverable error, the UE can move to state CELL_FACH and initiate the Cell Update procedure in order to try to recover. When this happens, there is an interruption time which can be broken down in:

- time to find a suitable cell
- time to acquire system information in case no stored information is available for the selected cell
- transmission of cell update and reception of cell update confirm
- synchronization procedure

For time-dilated UMTS all these components will take longer time and, hence, the total interrupt time may increase.

7.4 Impact on SIBs acquisition

If no latency mitigation techniques are used, the BCH user data rate is scaled by 1/N relative to normal UMTS. This impacts SIBs acquisition time (e.g. assuming a SIB repetition period of 1.28s, for N=2 the total SIB acquisition time is estimated to be at least 2.56 seconds and for N=4 it will take 5.12 seconds for the UE to read all the SIBs). Longer acquisition time will impact, for example, cell reselection and CS Fallback from LTE (CSFB).

Some solutions have been submitted but not yet discussed in RAN2. For example, the following latency mitigation techniques may be used: (1) optimized SIB structure and/or scheduling mechanism; (2) multiple PCCPCH mechanism or single PCCPCH mechanism with SF scaled by 1/N; (3) limit the features which time-dilated UMTS can be configured for.

Feasibility of (1) may depend on if and how much the repetition periods can be optimized, whilst (2) would have an impact of the overall control channel overhead as the existing power and code spent on P-CCPCH needs to be multiplied by a factor of N. New radio configurations for the P-CCPCH would also need to be defined. RAN2 has not evaluated the above solutions.

7.5 Impact on signalling and user plane data

7.5.1 SRB performance

The impact on latency for time-dilated UMTS has been analysed for a few example use-cases.

Only the Uu signalling delay (including TTI alignment) is considered in the analysis. It is assumed that the NBAP/RNSAP and RANAP signalling delay and also the processing times in the UE, RBS, RNC and CN will be the same in both the UMTS and the time-dilated UMTS scenario.

With a scaling factor of N=2 and a minimum radio frame of 20 ms the signalling time will be doubled.

7.5.1.1 Call setup delay for speech AMR NB MM multi-rate 12.2/7.4/5.9/4.95 from idle

For this use case, a stand-alone signalling bearer of 13.6 kbps and TTI 10 ms (34.108, section 6.10.2.4.1.3) is established for the initial signalling. In order to improve the UL coverage and DL capacity a Multi-mode multi-rate AMR NB Speech configuration is likely to be used in a time-dilated UMTS system. When the speech radio bearers are established the SRB is reconfigured to 3.4 kbps with a TTI of 40ms (34.108, section 6.10.2.4.1.4a).

The speech call setup sequence can be broken down in the following RRC signalling:

RRC message	**Nr of PDUs**	**NAS message**	**UMTS time (ms)**	**T-D UMTS time (ms), N=2**
Read SIB7 (average time)	-	-	80	160
1. RRC Connection Request	1 (+ramping)	-	50	100
2. RRC Connection Setup	8	-	45	90

4. RRC Connection Setup Comp.	5	-	55	110
5. Initial Direct Transfer	2	CM Service Request	25	50
6. DL Direct Transfer	3	Authentication Req.	35	70
7. UL Direct Transfer	2	Authentication Resp.	25	50
8. Security Mode Command	2		25	50
9. Security Mode Complete	2	-	25	50
10. DL Direct Transfer	1	Identity Request	15	30
11. UL Direct Transfer	3	Setup	35	70
12. UL Direct Transfer	2	Identity Response	25	50
13. DL Direct Transfer	1	Call Proceeding	15	30
14. Radio Bearer Setup	11		115	230
15. RB Setup Complete on 3.4	1		60	120
16. DL Direct Transfer on 3.4	1	Alerting	60	120
17. UL Direct Transfer on 3.4	4	Connect	180	360
18. DL Direct Transfer on 3.4	1	Connect Ack	60	120
Total time: Note: DCH synchronization time not included			930	1860

For scenarios where the complete System Information needs to be read, the speech call setup time will increase even more

If no solution is adopted, SRB latency would be, logically, scaled up by N.

Some solutions have been submitted but not discussed in RAN2. For example, one option could be to scale SRBs' SF by 1/N (or using additional available power, for the SRBoHS case, by scaling the Scalable UMTS Power Spectral Density). Changing SF may require introducing new radio bearer configurations. RAN2 has not evaluated the above solutions.

It is proposed that solutions for reducing the long speech setup delay for time-dilated UMTS are studied together with consequences for each solution. In specific in relation to emergency calls the increased delay of establishing a speech call needs to be mitigated.

7.5.2 User plane performance

The detailed impacts of time-dilated carriers on user-plane performance have not yet been studied. The expected impacts are:

- Peak Rate: Decrease in peak rate by the same factor as the time-dilation.
- Data Rate and Latency:
    - For PS/data traffic, when the PSD of the Scalable UMTS time-dilated solution is the same as normal UMTS, then the Scalable UMTS data rate and latency are scaled accordingly (i.e., by a factor of 1/N for

data rate and N for latency, assuming that the number of UEs served by Scalable UMTS and normal UMTS are the same). This increase in latency could have an impact on TCP performance.

- o However, some solutions to address these issues have been presented in RAN2 but not discussed or evaluated.

- If the spreading factor of the BCCH and other DL control channels are reduced proportionally maintain the same bitrate for performance reason, the number of codes available for HS transmissions may be reduced, which would impact the maximum DL bitrate.

7.5.3 New radio configurations

For a time-dilated UMTS system where the radio frames are scaled by a factor N=2 or N=4, there is a need to use other radio bearer configurations than those that are specified in 34.108 and 25.993.

7.6 Impact on MAC, RLC and RRC performance, including impact on timers and procedures

RLC impact

RLC protocol may not be impacted, however, this is dependent on the concrete solutions. .

From the performance point of view, RLC and higher protocol performance (TCP) may be affected due to the longer time to receive their SDUs.

MAC impact

MAC impacts will also depend on the concrete solutions Potentially, MAC entities may be impacted if HARQ entities and/or number of HARQ processes are modified, for instance. Performance simulations may be needed in case the number of HARQ processes is reduced as efficiency may be reduced. This may also affect higher layers.

The MAC entities are responsible for in-sequence delivery of data up to the RLC layer. The HARQ round-trip time (RTT) for a regular carrier for the EUL 2ms TTI is 16 ms. For a 1/4-chip-rate carrier, this becomes 64 ms. In multi-carrier operations with a 1/4-chip-rate carrier and a regular carrier, two data streams of quite different rates and RTTs are feeding the same MAC entity. While waiting for a HARQ retransmission on the 1/4-chip-rate carrier, an additional 32 PDUs from the regular carrier will be accumulating in the MAC buffer. Under such a situation, larger buffer size may be needed to avoid overflow of the MAC buffer. A similar situation occurs also on the DL, with slightly different RTT and higher bitrates. Some work may be needed.

RRC performance

Some of the RRC impacts have been outlined in the sections above. It is clear that RRC specifications will be impacted by the introductions of time-dilated UMTS. RRC, RLC, MAC, and layer 1 timers need to be checked to understand if the values in those timers are suitable.

Time and Timers

Certain time/TTI/Timer values can be implicitly or explicitly scaled, or signalled with a different value, to account for the inherent time scaling of the Scalable UMTS time-dilated solution. Scaling would apply especially for the MAC layer timers. RLC timing impacts are expected to be less as compared to MAC.

7.7 Conclusion

The impacts that RAN2 identified are described in the above sections.

8 Conclusions

Annex A: Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2013-01	R1#72	R1-130821			Initial Draft		0.1.0
2013-08	R1#74	R1-133869			Added text in Section 5, 7.1.1, 7.1.2, 7.1.6.4, and 7.1.6.5 based on approved TPs		0.2.0
2013-08	R1#74	R1-133951			Incorporated agreed text proposals at RAN1#74, RAN2#83 and RAN4#68 and from email approval		0.2.1