3GPP TSG-RAN WG1#8
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**Source:** TSG RAN WG1

**Title:** Liaison on Physical Layer Service Implementation Capabilities

**To:** TSG RAN WG2

**Cc:** TSG T WG2, TSG SA WG4

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TSG RAN WG1 has reviewed the tables 8 and 9 from TSG T WG2's technical report TR 21.904, "Terminal capability requirements", v.0.0.4. and would like to propose following modifications to them, shown in tables 1 to 4 below. For FDD the original tables are proposed to be split into two separate tables, one for AMR and one for CS data up to 64 kbps, in order to allow more specific definitions of the required capabilities.

TSG RAN WG1 is aware that in the last TSG RAN meeting a new technical report was decided to be created, TR 25.926, UE Radio Access capabilities , for which TSG RAN WG2 will be in charge [1]. It is not clear to TSG RAN WG1, whether these proposed updated tables below could be directly included to this TR 25.926 or not. However, the tables are sent for information to TSG RAN WG2, since it is seen beneficial that TSG RAN WG2 is aware of TSG RAN WG1's view on the required Physical layer capabilities for AMR and CS data.

Some explanatory comments to the contents of the tables 1-4 are given below. There is also one question to WG2 related to the number of transport channels for AMR, that can the number of the transport channels be higher than 4 in uplink, or higher than 5 in downlink. Please see the detailed explanation below for the question. TSG RAN WG1 would appreciate if TSG RAN WG2 could give their opinion on this issue.

**1) Explanatory comments to table 1: FDD / capabilities for AMR.**

Error detection: For error detection, it has been identified that at minimum 12 bits CRC is needed to ensure good performance with BRD. However, it should be possible for the network operator to use also 0, 8 or 16 bit CRCs, if desired.

Channel coding: convolutional coding has been seen to give adequate performance.

Number of transport channels higher than 4 in uplink, or higher than 5 in downlink ?: There has been a proposal in WG1 that the number of transport channels in the transport format combination set could be higher than the maximum number of transport channels in one frame. In that way the coding could be optimised for different AMR modes, by having different transport channels carrying the same bit class in different modes. (e.g. TrCH1 would carry class A at 12.2 k mode and TrCh5 would carry class A at 7.95 k mode). In this way the coding could be changed when changing the mode. There is not yet a consensus on this issue whether this can be acceptable. Thus TSG RAN WG1 would like to hear what is the opinion of TSG RAN WG2, whether they see this as an acceptable feature.

Transmission of mode command bits: There is not yet a consensus in TSG RAN WG1 how these bits should be transmitted in Layer 1. A separate liaison explaining the alternatives will be sent to TSG RAN WG2 on this issue.

Transport format detection by TFCI or BRD: The support of transport format detection with TFCI has to be mandatory for all terminals both with fixed and flexible TrCH case. However the support of blind transport format detection with flexible position case is not possible with the present rate matching algorithm, since in the case of flexible positions, the fixed rate matching pattern is not defined to be possible. On the other hand there is no point to require blind transport format detection with fixed positions at SF=256, because then there is no possibility to fit signaling together with AMR. This means that the only possible case where the support of Blind transport format detection can be required at the moment is SF=128 with fixed positions. Thus the present status is suggested to be included to TR. It can be updated later if desired, and if the downlink rate matching algorithm is updated to have the possibility for flexible positions & fixed rate matching pattern at the same time.

Number of transport formats to be supported: All 8 AMR modes should be supported + 1 mode for SID frames + 1 mode for

DTX. For dedicated signaling channel there should be possibility for 2 modes, e.g. on / off. This will mean totally : 2*(8+1+1)=20 transport format combinations. In downlink it is not clear yet, whether the transport channel carrying mode command bits can have 2 modes, i.e. on/off, since the whole transmission scheme for the mode command bits is still an open issue in Layer 1. If it will be possible, then totally 40 transport format combinations has to be supported in downlink.

**2) Explanatory comments to table 2: FDD / capabilities for CS data up to 64 kbps**

Error detection: For CS data services all possible CRC lengths: 0, 8, 12, 16 and 24 bit CRC has to be supported. There is no reason why some CRC length would not be needed.

Channel coding: The support of turbo coding is required, since BER requirement for CS data services is $< 10^{-3}$. However, it should be noted that the smallest possible turbo interleaver size is for a block of 320 bits. For this reason, convolutional coding has to be supported also, to allow data rates below 32 kbit/s & 10 ms interleaving (or <16 kbit/s & 20 ms interleaving etc).

Multiplexing: The number of transport channels that all terminals has to support is 2, in order to support CS data services. This includes one transport channel for CS data and one transport channel for dedicated signaling channel. The support of TTI={10 ms, 20 ms, 40 ms, 80 ms}for all transport channels has to mandatory for all terminals

Transport format detection : All terminals have to support the transport format detection by TFCI, both with fixed and flexible TrCH positions. The support of detecting 1024 transport format combinations is mandatory for all terminals. The reason for this requirement is that it is quite difficult to probably agree a lower value for that.

**3) Explanatory comments to table 7: TDD / capabilities for AMR and CS data up to 64 kbps.**

Error detection: All possible CRC lengths: 0, 8, 12, 16 and 24 bit CRC have to be supported. There is no reason why some CRC length would not be needed and the additional effort seems to be quite limited.

Channel coding: For AMR convolutional coding has been seen to give adequate performance. For CS data the support of turbo coding is required, since BER requirement for CS data services is $< 10^{-3}$. However, it should be noted that the smallest possible turbo interleaver size is for a block of 320 bits. For this reason, convolutional coding has to be supported also, to allow data rates below 32 kbit/s & 10 ms interleaving (or <16 kbit/s & 20 ms interleaving etc).

Number of transport channels higher than 4 or 5 in uplink and downlink, respectively ?: There has been a proposal in WG1 that the number of transport channels in the transport format combination set could be higher than the maximum number of transport channels in one frame. In that way the coding could be optimised for different AMR modes, by having different transport channels carrying the same bit class in different modes. (e.g. TrCH1 would carry class A at 12.2 k mode and TrCh5 would carry class A at 7.95 k mode). In this way the coding could be changed when changing the mode.

Multiplexing: The support of TTI={10 ms, 20 ms, 40 ms, 80 ms}for all transport channels has to be mandatory for all terminals since this should not cause to much additional complexity but allows more flexibility regarding variable interference.

Transmission of mode command bits: There is not yet a consensus in TSG RAN WG1 how these bits should be transmitted in Layer 1. A separate liaison explaining the alternatives will be sent to TSG RAN WG2 on this issue.

Transport format detection by TFCI: The support of transport format detection with a variable TFCI length of 0, 4, 8, 16 and 32 bits is mandatory for all terminals, where a TFCI length of 0 bits means that only one TFC is possible. The support of detecting 1024 transport format combinations is mandatory for all terminals, since it offers higher flexibility for resource assignment without adding to much additional complexity.

The use of (P)USCH during the establishment of a connection for circuit switched data has been omitted, therefore any reference to this channel has been removed from table 7.

**4) Updated tables**

**Table 1. FDD mode Physical Layer Service implementation capabilities for support of ~~the default~~AMR speech service ~~and of CS data services up to 64 kbps~~**

| Service Implementation Capability | Specification | Section(s)[1] | Comments |
|---|---|---|---|
| **Physical Layer UE procedures and measurements:** | | | |
| Handover | 25.215<br><br><br>25.212 | 6.1.1, 6.1.4, 6.1.5, 6.1.9, 7.1.1.2, 7.1.2, 7.1.3<br>4.4 | Support of soft handover is mandatory for all terminals~~ supporting CS services~~. Support of Inter-Frequency handover is mandatory for all terminals. Support of intra-frequency hard handover is FFS. Terminals shall support measurements commensurate with their mode/system capabilities, to facilitate inter-frequency, inter-mode & inter-system handover. |
| Power control | 25.214<br>25.215 | 5.1.2, 5.2.3<br>6.1.1, 6.1.3, 6.1.6, 6.1.7 | Support of closed loop power control is mandatory for all terminals. |
| Error detection | 25.212 | 4.2.1 | Support of 0, 8, 12 and 16 bits CRC per transport block is mandatory for all terminals. |
| ~~Multiplexing and~~ Channel Coding | 25.212 | 4.2.3.~~2~~, ~~4.2.4 – 4.2.15, 4.3~~ | ~~Turbo coding to be used for BER requirement of less than $10^{-3}$.~~ Support of no coding and convolutional coding with rates ½ and 1/3 is mandatory for all terminals. |

[1] The list of references to the 25.2 series should not be considered exhaustive. References will need to be refined and updated as the standard is further elaborated.

| | | | |
|---|---|---|---|
| Multiplexing | 25.212 | 4.2.4 - 4.2.14 | In single service case, with only AMR and dedicated signaling channel, it is mandatory for all terminals to support at minimum 4 transport channels in uplink, of which 1-3 is reserved for AMR and 1 for dedicated signaling.<br><br>In single service case, with only AMR and dedicated signaling channel, it is mandatory for all terminals to support at minimum 5 transport channels in downlink, of which 1-3 is reserved for AMR, 1 for mode commands and 1 for dedicated signaling.<br><br>< Note: This is a working assumption, since it is still FFS whether there could be more than 4 or 5 transport channels in uplink and downlink, respectively, in the transport format combination set, so that different coding can be applied to the bit classes in different modes.><br><br><Note: This assumes that fast mode control is required to be signalled in the downlink direction only.><br><br><Note: It is still FFS how the transport channel carrying mode command bits is transmitted in downlink in Layer 1. ><br><br>Support of TTI=20 ms for each transport channel is mandatory for all terminals. |
| Transport format detection | 25.212 | 4.2.15 | In downlink, the support of transport format detection with TFCI is mandatory for all terminals both with fixed and flexible TrCH positions.<br><br>In downlink, when SF=128 and fixed TrCH positions is used in the single service case, with only AMR and dedicated signaling channel, the support of blind transport format detection is mandatory for all terminals.<br><br>In the single service case, with only AMR and dedicated signaling channel, it is mandatory for all terminals to support at minimum 2*(8+1+1)=20 transport format combinations during the connection in uplink and downlink, of which 8 is reserved for AMR modes, 1 for SID frame, 1 for DTX and the multiplication of 2 is due to dedicated signaling channel having two possible rates (e.g. on/off).<br><br><Note: For downlink, it is still an open issue, whether the transport channel carrying mode command bits can have two modes, ie. on/off. If that will be the case, then all terminals would have to support 40 transport format combinations in downlink.> |
| Modulation | 25.213 | 4.4.3 | |

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|---|---|---|---|
| Spreading and Scrambling Code Generation | 25.213 | 4.3 | For the single service case, with only AMR and dedicated signaling channel, it is mandatory for all terminals to support SF=128 and SF=256 in downlink, and SF=256…64 in uplink. In multiple service case the required spreading factor depends on the data rates of the services to be supported simultaneously. ~~Required Spreading Factor is dependent on channel coding rate, and on whether services are to be supported simultaneously. Terminals shall support all spreading factors between the maximum (256) and minimum (SFs of 16 & 64 are required for support of individual 64 kbps and 16 kbps services respectively). There is no specified manner for mapping given data rates to physical channels. That function is performed in Layer 2/3.~~ |
| Code de-spreading and de-scrambling | 25.213 | 5.2 | |
| Support for downlink Transmit Diversity | 25.211<br>25.214 | 5.3.2<br>8 | Support of ~~feedback mode~~open loop and closed loop transmit diversity is mandatory ~~in~~ for all ~~T~~terminals. ~~supporting dedicated channels.~~ |
| Support for Site Selection Diversity Transmission | 25.214 | 5.3.2.4 | Support of SSDT is mandatory for all terminals ~~supporting soft handover~~. |
| **Transport channels required:** | | | |
| Dedicated channel (DCH) | 25.211 | 4.1.1, 6 | |
| **Physical channels required:** | | | |
| Dedicated Physical Data Channel (DPDCH) | 25.211 | 5.2.1, 5.3.2, 6 | |
| Dedicated Physical Control Channel (DPCCH) | 25.211 | 5.2.1, 5.3.2, 6 | |

**Table 2. FDD mode Physical Layer Service implementation capabilities for support ~~of the default speech service and~~ of CS data services up to 64 kbps**

| Service Implementation Capability | Specification | Section(s)[2] | Comments |
|---|---|---|---|
| **Physical Layer UE procedures and measurements:** | | | |
| Handover | 25.215<br><br><br>25.212 | 6.1.1, 6.1.4, 6.1.5, 6.1.9, 7.1.1.2, 7.1.2, 7.1.3<br>4.4 | Support of soft handover is mandatory for all terminals supporting CS services. Support of Inter-Frequency handover is mandatory for all terminals. Support of intra-frequency hard handover is FFS. Terminals shall support measurements commensurate with their mode/system capabilities, to facilitate inter-frequency, inter-mode & inter-system handover. |
| Power control | 25.214<br>25.215 | 5.1.2, 5.2.3<br>6.1.1, 6.1.3, 6.1.6, 6.1.7 | Support of closed loop power control is mandatory for all terminals. |
| Error detection | 25.212 | 4.2.1 | Support of 0, 8, 12, 16 and 24 bits CRC per transport block is mandatory for all terminals. |

[2] The list of references to the 25.2 series should not be considered exhaustive. References will need to be refined and updated as the standard is further elaborated.

| | | | |
|---|---|---|---|
| ~~Multiplexing and~~ Channel Coding | 25.212 | 4.2.3~~.2, 4.2.4 – 4.2.15, 4.3~~ | ~~Turbo coding to be used for BER requirement of less than $10^{-3}$.~~ Support of turbo coding with code rate 1/3 for coding block sizes greater or equal to 320 bits is mandatory for all terminals.<br><br>Support of no coding and convolutional coding with rates ½ and 1/3 is mandatory for all terminals. |
| Multiplexing | 25.212 | 4.2.4 – 4.2.14 | The number of transport channels that all terminals have to support is 2, 1 of which is for CS data and 1 for dedicated signaling.<br><br>Support of TTI={10 ms,20 ms ,40 ms,80 ms} for each transport channel is mandatory for all terminals. |
| Transport format detection | 25.212 | 4.2.15 | It is mandatory for all terminals to support transport format detection by TFCI, with fixed and flexible TrCH positions.<br><br>Support of 1024 transport format combinations is mandatory for all terminals. |
| Modulation | 25.213 | 4.4.3 | |
| Spreading and Scrambling Code Generation | 25.213 | 4.3 | Required Spreading Factor is dependent on channel coding rate, and on whether services are to be supported simultaneously. Terminals shall support all spreading factors between the maximum (256) and minimum (SFs of 16 & 64 are required for support of individual 64 kbps and 16 kbps services respectively). There is no specified manner for mapping given data rates to physical channels. That function is performed in Layer 2/3. |
| Code de-spreading and de-scrambling | 25.213 | 5.2 | |
| Support for downlink Transmit Diversity | 25.211<br>25.214 | 5.3.2<br>8 | Support of ~~feedback mode~~ open loop and closed loop transmit diversity is mandatory ~~in~~ for all ~~T~~terminals ~~supporting dedicated channels~~. |
| Support for Site Selection Diversity Transmission | 25.214 | 5.3.2.4 | Support of SSDT is mandatory for all terminals ~~supporting soft handover~~. |
| **Transport channels required:** | | | |
| Dedicated channel (DCH) | 25.211 | 4.1.1, 6 | |
| **Physical channels required:** | | | |
| Dedicated Physical Data Channel (DPDCH) | 25.211 | 5.2.1, 5.3.2, 6 | |
| Dedicated Physical Control Channel (DPCCH) | 25.211 | 5.2.1, 5.3.2, 6 | |

**Table 7. TDD mode Physical Layer Service implementation capabilities for support of the ~~default~~ AMR speech service and of CS data services up to 64 kbps**

| Service Implementation Capability | Specification | Section(s)[3] | Comments |
|---|---|---|---|
| **Physical Layer UE procedures and measurements:** | | | |

[3] The list of references to the 25.2 series should not be considered exhaustive. References will need to be refined and updated as the standard is further elaborated.

| | | | |
|---|---|---|---|
| Handover | 25.225 | ~~6.1.3, 6.1.4, 6.1.5, 6.1.6, 6.1.9, 7.1.1.2, 7.1.2~~ 5 | Support of Intra and Inter Frequency hard handover is mandatory for all terminals. Terminals shall support measurements commensurate with their mode/system capabilities, to facilitate inter-frequency, inter-mode & inter-system handover. |
| Dynamic Channel Allocation | 25.225 | ~~7.1.3~~5 | Terminals shall support measurement of SIR in different timeslots. |
| Power control | 25.224<br>25.225 | 4.3<br>~~6.1.4, 6.1.7~~5 | Support of closed loop control for DL power.<br>Support of open loop control for UL power. |
| Error detection | 25.222 | 6.2.1 | Support of 0, 8, 12, 16 and 24 bits CRC per transport block is mandatory for all terminals |
| ~~Multiplexing and~~ Channel Coding | 25.222 | 6.2.3~~.2, 6.2.4 – 6.2.11, 6.3~~ | ~~Turbo coding to be used for BER requirement of less than $10^{-3}$.~~<br>Support of no coding and convolutional coding with rates ½ and 1/3 is mandatory for all terminals.<br>For coding block sizes greater or equal to 320 bits Support of turbo coding with code rate 1/3 is mandatory for all terminals. |
| Multiplexing | 25.222 | 6.2.4 – 6.2.13 | In single service case, with only AMR and dedicated signaling channel, it is mandatory for all terminals to support at minimum 4 transport channels in uplink, of which 1-3 is reserved for AMR and 1 for dedicated signaling.<br><br>In single service case, with only AMR and dedicated signaling channel, it is mandatory for all terminals to support at minimum 5 transport channels in downlink, of which 1-3 is reserved for AMR, 1 for mode commands and 1 for dedicated signaling.<br><br>< Note: This is a working assumption, since it is still FFS whether there could be more than 4 or 5 transport channels in uplink and downlink, respectively, in the transport format combination set, so that different coding can be applied to the bit classes in different modes.><br><br><Note: This assumes that fast mode control is required to be signalled in the downlink direction only.><br><br><Note: It is still FFS how the transport channel carrying mode command bits is transmitted in downlink in Layer 1. ><br><br>For CS data service the number of transport channels that all terminals have to support is 2, 1 CS data and 1 for dedicated signaling.<br><br>Support of TTI={10 ms,20 ms ,40 ms,80 ms} for each transport channel is mandatory for all terminals. |

| | | | |
|---|---|---|---|
| Transport format detection | 25.222 | 6.2.13 | The support of transport format detection with a TFCI length of 0, 4, 8, 16 and 32 bits is mandatory for all terminals.<br><br>Support of 1024 transport format combinations is mandatory for all terminals |
| Spreading and Scrambling Code Generation | 25.223 | 6 | Terminals shall support spreading factors 8 and 16 for uplink transmission of speech and data services up to 16 kbps. SF4 of shall be supported by Terminals supporting 64 kbps data. Simultaneous transmission of up to two codes shall be supported. |
| Code de-spreading and de-scrambling | 25.223 | 6 | Terminals shall support simultaneous reception of up to 2 codes using spreading factor 16 for speech. Up to 5 codes with SF 16 shall be supported simultaneously by terminals supporting 64 kbps. |
| Support for Downlink Transmit diversity | 25.221<br>25.224 | 5.2.4<br>4.8 | Support channel estimation on different midambles |
| Timing Advance | 25.224 | 4.4 | Support of TA adjustment according to higher layer signalling |
| Discontinuous transmission | 25.224 | 4.7 | Each mobile must be capable to switch of transmission in those physical channels which are not needed to transmit the instantaneous TFC. |
| **Transport channels necessary for the above:** | | | |
| DCH | 25.221 | 4.1.1, 6 | |
| ~~USCH~~ | ~~25.221~~ | ~~6.2.8~~ | ~~The requirement for USCH in the case of CS connections is for further study.~~ |
| **Physical channels necessary for above:** | | | |
| Dedicated Physical CHannel (DPCH) | 25.221 | 5.2, 6 | |
| ~~PUSCH~~ | ~~25.221~~ | ~~5.5~~ | ~~The requirement for USCH in the case of CS connections is for further study.~~ |

References:

[1] TSGR#5(99)577, Proposed scope of Technical Report 'UE radio access capabilities definition'