TSG-RAN Working Group1 meeting #2

***TSGR1#2(99)0XX***

Yokohama 22-25, February 1999

**Agenda Item:**

**Source:** Lucent Technologies

**Title:** A final comparison among the 4-state SCCC, 4-state PCCC, and 8-state PCCC

**Document for:** Discussion

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## Introduction

In this document we present, in a schematic tabular form, the main positive and negative characteristics of the three considered codes, 4-state SCCC, 4-state PCCC, and 8-state PCCC, in the areas of performance, implementation complexity, and system aspects.

The tables have been constructed making use of extensive simulation results presented in previous document by all companies, and in particular the following documents by Lucent Technologies:

[1] Tdoc SMG2 UMTS-L1 655/98
[2] Tdoc SMG2 UMTS-L1 656/98
[3] Tdoc SMG2 UMTS-L1 2x99-031
[4] Tdoc SMG2 UMTS-L1 2x99-032
[5] Tdoc SMG2 UMTS-L1 2x99-033
[6] Tdoc SMG2 UMTS-L1 2x99-034
[7] Tdoc SMG2 UMTS-L1 2x99-035
[8] TSGR1#2(99)036
[9] TSGR1#2(99)037
[10] TSGR1#2(99)038
[11] TSGR1#2(99)039

| | 4-state SCCC | | 4-state PCCC | | 8-state PCCC | |
|---|---|---|---|---|---|---|
| | **Pros** | **Cons** | **Pros** | **Cons** | **Pros** | **Cons** |
| **Performance** | Interleaving gain for both FER ($N^{-1}$ ) and BER ($N^{-2}$) | | | No interleaving gain for FER and $N^{-1}$ for BER | | No interleaving gain for FER and $N^{-1}$ for BER |
| | Large free distances for all block sizes | | | Very small free distances for all block sizes | | Small free distances for all block sizes |
| | Small sensitivity to the choice of the interleaver | | | Large sensitivity to the choice of the interleaver | | Large sensitivity to the choice of the interleaver |
| | Robust to puncturing for rate compatibility and to decoding algorithm suboptimalities | | | Sensitive to puncturing and to decoding algorithm suboptimalities | | Sensitive to puncturing and to decoding algorithm suboptimalities~~Very small free distances for all block sizes~~ |
| | No apparent error floor for both BER and FER | | | Evident error floor for both BER and FER very close to the performance measures | | Evident error floor for BER slightly below $10^{-6}$ and FER below $10^{-4}$ |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Significant gain @ FER=$10^{-5}$ | Looses from 0.1 to 0.3 dB @ BER=$10^{-6}$ | | Significant loss at both FER=$10^{-5}$ and BER=$10^{-6}$ | Gain from 0.1 to 0.3 dB against 4-state SCCC @ BER=$10^{-6}$ | |
| | Steep BER and FER curves versus $E_b/N_0$ | | | | | |
| | Parallel behavior of FER and BER curves for all $E_b/N_0$ and block sizes | | | Diverging FER and BER curves for increasing $E_b/N_0$ and block sizes | | Diverging FER and BER curves for increasing $E_b/N_0$ and block sizes |

| | 4-state SCCC | | 4-state PCCC | | 8-state PCCC | |
|---|---|---|---|---|---|---|
| | **Pros** | **Cons** | **Pros** | **Cons** | **Pros** | **Cons** |
| **Implementation Complexity** | Lowest arithmetic complexity | | Lowest arithmetic complexity | | | Highest arithmetic complexity (~100 %) |
| | | Highest (~10%) memory requirements for all block sizes. | Lowest memory requirements for all block sizes | | Lowest memory requirements for all block sizes | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Overall implementation complexity lower than 8 state PCCC. The differences reduces with increasing block sizes | Overall implementation complexity lower than 4 state PCCC. | Lowest overall implementation complexity for all block sizes | | | Highest overall implementation complexity for all block sizes |
| | Overall power consumption lower than 8 state PCCC. (~60% for the arithmetic part). The differences reduces with increasing block sizes | Overall power consumption higher than 4 state PCCC (~20% for the arithmetic part). | Lowest power consumption. | | | Highest power consumption |

| | 4-state SCCC | | 4-state PCCC | | 8-state PCCC | |
|---|---|---|---|---|---|---|
| | **Pros** | **Cons** | **Pros** | **Cons** | **Pros** | **Cons** |
| **Others** | A unique, simple, highly performing and versatile code for low-high data rates and service qualities | | | | | |
| | Suitable to very high-quality services ($BER<10^{-6}$, $FER < 10^{-5}$), like ISDN | | | Unsuitable to very high-quality services ($BER<10^{-6}$, $FER < 10^{-5}$), like ISDN | | Unsuitable to very high-quality services ($BER<10^{-6}$, $FER < 10^{-5}$), like ISDN |
| | Highly suitable to ARQ (e.g., for data packet services) because of low achievable FER | | | Unsuitable to ARQ (e.g., for data packet services) because of high FER error floor | | Less suitable to ARQ (e.g., for data packet services) because of relatively high FER error floor |
| | Published in open literature without patents | | | Patents on the coding and decoding schemes | | Patents on the coding and decoding schemes |