1

Project	**IEEE 802.20 Working Group on Mobile Broadband Wireless Access** **http://grouper.ieee.org/groups/802/20**	
Title	**802.20 SRD: data rates, spectral efficiency and frequency assignments**	
Date Submitted	**2004-01-10**	
Source(s)	Marianna Goldhammer Tel Aviv, HaBarzel 21 Israel	Voice: +972 3 645 6241 Fax: Email: marianna.goldhammer@alvarion.com
Re:		
Abstract	The 802.20 SRD fails to define the channel width, which is essential for interoperability and roaming of mobile systems. There is no consistence between the data rates and frequency block assignments and the spectral efficiency is not optimally defined for FDD systems. This contribution tries to improve the 802.20 SRD, by introducing the multi-carrier concept and flexibility on data rates and spectral efficiency with TDD/FDD, according to the actual allocations. New text is provided.	
Purpose	The scope of this contribution is to improve the 802.20 Requirement document.	
Notice	This document has been prepared to assist the IEEE 802.20 Working Group. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.	
Release	The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.20.	
Patent Policy	The contributor is familiar with IEEE patent policy, as outlined in Section 6.3 of the IEEE-SA Standards Board Operations Manual <http://standards.ieee.org/guides/opman/sect6.html#6.3> and in *Understanding Patent Issues During IEEE Standards Development* <http://standards.ieee.org/board/pat/guide.html>.	

2

3

4

5

6

802.20 SRD: data rates, spectral efficiency and frequency assignments

Marianna Goldhammer, Alvarion

1 Introduction

The 802.20 SRD fails to define the channel width, which is essential for interoperability and roaming of mobile systems. There is no consistence between the data rates and frequency block assignments and the spectral efficiency is not optimally defined for FDD systems.

This contribution tries to improve the 802.20 SRD, by introducing the multi-carrier concept and flexibility on data rates and spectral efficiency with TDD/FDD, according to the actual allocations. New text is provided.

2 Relevant IEEE 802.20 existing SRD text

The relevant parameters and the associated texts are :

2.1.1.1 User Data Rates - Downlink & Uplink (Closed)

The AI shall support peak per-user data rates in excess of 1 Mbps on the downlink and in excess of 300 kbps on the uplink. These peak data rate targets are independent of channel conditions, traffic loading, and system architecture. The peak per user data rate targets are less than the peak aggregate per cell data rate to allow for design and operational choices.

Average user data rates in a loaded system shall be in excess of 512Kbps downlink and 128Kbps uplink. This shall be true for 90% of the cell coverage or greater.

2.1.2 System Spectral Efficiency (bps/Hz/sector) (open)

[Sustained spectral efficiency is computed in a loaded multi-cellular network setting. It is defined as the ratio of the expected aggregate throughput (taking out all PHY/MAC overhead) to all users in an interior cell divided by the system bandwidth. The sustained

spectral efficiency calculation shall assume that users are distributed uniformly throughout the network and shall include a specification of the minimum expected data rate/user.]

[Downlink > 2 bps/Hz/sector**]**

[Uplink >1 bps/Hz/sector**]**

2.1.3 Support for Different Block Assignments (open)

The AI shall support deployment of 802.20 systems in the following sized block assignments:

FDD Assignments	2 x 1.25 MHz 2 x 5 MHz 2 x 10 MHz 2 x 20 MHz
TDD Assignments	2.5 MHz 5 MHz 10 MHz 20 MHz 40 MHz

3 Discussion – Spectral efficiency

Let's analyze the spectral requirements, in up-link and downlink, for FDD systems having:

- 2 bit/s/Hz/sector spectral efficiency in down-link and 1bit/s/Hz/sector spectral efficiency in up-link, according to the spectral efficiency requirement

- 1/4 lower data rates in up-link, according to average data rate requirement

If the downlink bandwidth is taken as reference, the up-link necessary bandwidth results to be:

$$BW_{UL} = 1/4 * BW_{DL} * SE_{DL} / SE_{UL} ,$$

where SE is the spectral efficiency.

Results, for $SE_{DL} = 2$ and $SE_{UL} = 1$, that the necessary bandwidth in up-link is 0.5 of the bandwidth used in down-link.

This leaves for FDD systems 50% of the up-link channel un-used. A good use of the band will be to allow (in up-link) for lower spectral efficiency, in order to increase the cell size, by using lower modulations. A suitable frequency efficiency would be 0.5 bit/s/Hz/sector. As result, in deployment environment limited by the mobile terminal transmitted power, noise and interference, the cell size will be significantly increased. In down-link, the cell size increase will be compensated by increased transmitted power.

4 Proposed text change – Spectral efficiency

Uplink >1 bps/Hz/sector, for TDD systems, and 0.5 bps/Hz/sector for FDD systems.

5 Discussion – number of PHY modes and the variety of allocations

We should minimize the number of PHY modes and supported channel spacing, in order to allow roaming between operators. In order to do this, it is proposed the multi-carrier approach, using only 1.25MHz and 5MHz carriers.

With the ITU-R M. 1225 channel models, for all the defined multi-path models, 5MHz channel width is enjoying good spectral diversity. Narrower channels will request higher fade margin, wider channels will not improve it. The following table shows an example for the applicability of the 5MHz multi-carrier approach, per allocation and per sector, when using 3 sectors deployment and no guard bands inside the allocation.

		1.25 MHz carrier	5 MHz carrier	Carriers per sector
FDD Assignments	2 x 1.25 MHz	N = 1		1
	2 x 5 MHz		N = 1	1
	2 x 10 MHz		N = 2	1
	2 x 15MHz		N = 3	1
	2 x 20 MHz		N = 4	2
TDD Assignments	2.5 MHz	N=2		1
	5 MHz		N = 1	1
	10 MHz		N = 2	1
	20 MHz		N = 4	2
	30 MHz		N = 6	2
	40 MHz		N = 8	3

Note 1: the requested spectral density mask will determine the actual number of sub-carriers and channel spacing.

If the allocation does not accommodate exactly the 5MHz carriers, a mix of 1.25MHz and 5MHz carriers may be provided, for improved spectrum use.

6 Proposed text change – Support for Different Block Assignments

The AI shall support deployment of 802.20 systems in the following sized block assignments:

FDD Assignments	2 x 1.25 MHz 2 x 5 MHz 2 x 10 MHz 2 x 15MHz 2 x 20 MHz
TDD Assignments	2.5 MHz 5 MHz 10 MHz 20 MHz 30 MHz 40 MHz

For systems using channelization, the channel width shall be 1.25MHz and 5MHz. A mix of 1.25MHz and 5MHz channels may be used, to accommodate specific allocations and power density masks.

7 Discussion - Number of users and data rates per user

Considering 3 sectors, reuse factor = 1, and effective channel bandwidth of 80%, the average user number / per Base Station becomes, considering the spectral efficiency of 2bit/s/Hz down-link and 1bit/s/Hz up-link:

		Users /BS	Users/sector	Channel BW
FDD Assignments	2 x 1.25 MHz	5	1-2	0.4 MHz
	2 x 5 MHz	20	6-7	1.6 MHz
	2 x 10 MHz	40	13	3.3 MHz
	2 x 15MHz	60	20	5 MHz
	2 x 20 MHz	80	27	6.6 MHz
TDD Assignments	2.5 MHz	6	2	0.8 MHz
	5 MHz	13	4	1.6 MHz
	10 MHz	26	9	3.3 MHz
	20 MHz	52	14	6.6 MHz
	30 MHz	78	26	10 MHz
	40 MHz	104	35	13.3 MHz

For FDD one average user needs minimum 256kHz, while for TDD one average user needs minimum 512/2+128 = 384kHz.

When using the minimum rate, should be at least 20 users per sector. Using the agreed data rates, for allocations up to 15MHz FDD or 24MHz TDD, the user number will be too small.

The user data requirements should be modified, to accommodate the frequency allocations and keep consistence between frequency allocation and the number of users per sector.

8 Proposed change – Data rate per user

User Data Rates - Downlink & Uplink

The AI shall support peak per-user data rates in excess of 1 Mbps on the downlink and in excess of 300 kbps on the uplink. These peak data rate targets are independent of channel conditions, traffic loading, and system architecture. The peak per user data rate targets are less than the peak aggregate per cell data rate to allow for design and operational choices.

Average user data rates in a loaded system shall be in excess of 512Kbps downlink and 128Kbps uplink, when the allocated spectrum for both up-link and downlink is higher than 30MHz. The data rates per user should be scaled for other allocations.

~~This~~ The mentioned rates shall be true for 90% of the cell coverage or greater.

9 Conclusion

This contribution defined improved requirements:

- Spectral efficiency for FDD systems, to optimally use the up-link bandwidth
- Multi-carrier concept based on 1.25MHz and 5MHz carriers, to allow for roaming and optimum spectrum use, and limit the number of PHY modes.
- Scalable user traffic requirements, to fit actual spectrum allocations.