OFDM (FFT 256) Fixed & Mobile System Considerations

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Base Document:

Purpose:
Explain authors view on fix-mobile convergence and backward compatibility issues

OFDM (FFT 256) Fixed & Mobile System Considerations

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Alvarion

Scope

- Identify the differences between the fixed and mobile environment
- Propose requirements for the 802.16e system, including target devices and data rates
- Propose deployment models
- Propose impulse response models

Regulatory requirements

- Channel spacing:
  - 1.25MHz..10MHz
    - Focus: 3.5MHz - 5MHz
- Both FDD and TDD

Operating environments

- **3GGP** (ETSI TR 101 112)has defined the following operating environments:
  - **Indoor environment** – served by **pico-cell**, indoor Base Station;
  - **Outdoor-to-indoor and pedestrian** – served by **micro-cell;**
  - **Vehicular and high antenna** – served by **macro-cell;**
  - **Mixed -** macro-cells overlaying micro-cells.
- The macro/micro/pico cell definition is:
  - Pico - cell hex radius (r) < 100 m;
  - Micro - 100 m < (r) < 1000 m;
  - Macro - (r) > 1000 m.

Indoor environment

- Indoor pico-cells
  - A lognormal shadow fading, standard deviation (sigma) of 12 dB
  - Both Rayleigh and Rician fading
  - Walking speed Doppler
- Indoor equipment should be similar to WLAN solution (low cost BS)
  - OFDM UL –OFDM DL
  - Target devices: PDA, Laptop with PCMCIA cards, Phones

Outdoor to Indoor and Pedestrian Environment

- Log-normal shadow fading with a standard deviation of 10 dB is reasonable for outdoors and 12 dB for indoor.
- Building penetration loss averages 12 dB with a standard deviation of 8 dB.
- Symmetrical traffic applications expected (e-mail, file exchange)
- Target devices: PDA, Laptops with PCMCIA cards, Phones, embedded antenna (0dBi)
  - UL OFDMA is necessary
  - Needed gain: 15dB (BS Power: 30dBm, PCMCIA card power: 14-17?dBm)

Vehicular and High Antenna Environment

- **larger cells** and **higher transmit power**.
- "Log-normal shadow fading with 10 dB standard deviation are appropriate in urban and suburban areas." ETSI TR 101 112
- Full Doppler profile for vehicular speeds
- Target devices: PDA, Laptops, phones
- Stronger UL OFDMA need:
  - BS power: 10W (with 3G also 20W-40W)
  - At cell margin UL data rate will be lower

Mixed Environment

- a "vehicular environment" (macro cells) and an "outdoor to indoor environment" (micro cells) in the same geographical area.
  - fast moving terminals (vehicles) should probably be connected to the macro cells to reduce the handoff rate (number of hand-offs per minute)
  - slow moving terminals (pedestrians) should be connected to the micro cells to achieve high capacity

Repeater cells

- The **repeater-cells** are cells created by Repeaters, being possible in both **indoor** and **out-door** environment.
- The Repeater should be based on a SU solution, to allow for low-cost (symmetrical SU-AU solution). Only one stream should be used in UL or DL.

Path-loss models

- The “mobile” models are defined for freq <2GHz
- Stanford model is:
  - Frequency scalable
  - Takes into consideration antenna height
  - Can be used in Rural and Suburban
  - **Still needed an urban path-loss model**
- 802.16e should chose:
  - a propagation model
  - values for shadowing standard deviation
  - Outdoor-to-indoor penetration loss
  - Wall loss

Channel Impulse Response Models

- ITU-R, 3GGP and ETSI: same models
- One tapped-delay model for each radio environment (3 models)
  - Up to 2 multi-path channels (A and B), with Doppler
  - Worst-case included
    - Long delay spread
    - Occur infrequently

- Design and evaluation focus:
  - Up to 70km/h
  - Indoor environment(A and B)
  - Outdoor-to-indoor and pedestrian (A and B)
  - Vehicular and high-antenna (only A)
- Informative performance
  - 120km/h and 250km/h
  - Vehicular and high antenna – (A and B)

The high antenna and vehicular model

- For indoor and pedestrian – see document C 80216e_03/07
  - (max delay: 3.9us, at –24dB)
- Vehicular and high antenna is:

Tap	Channel A		Channel B		Doppler Spectrum
	Rel. Delay (nsec)	Avg. Power (dB)	Rel. Delay (nsec)	Avg. Power (dB)	
1	0	0.0	0	-2.5	CLASSIC
2	310	-1.0	300	0	CLASSIC
3	710	-9.0	8900	-12.8	CLASSIC
4	1090	-10.0	12900	-10.0	CLASSIC
5	1730	-15.0	17100	-25.2	CLASSIC
6	2510	-20.0	20000	-16.0	CLASSIC

FWA versus mobile deployment

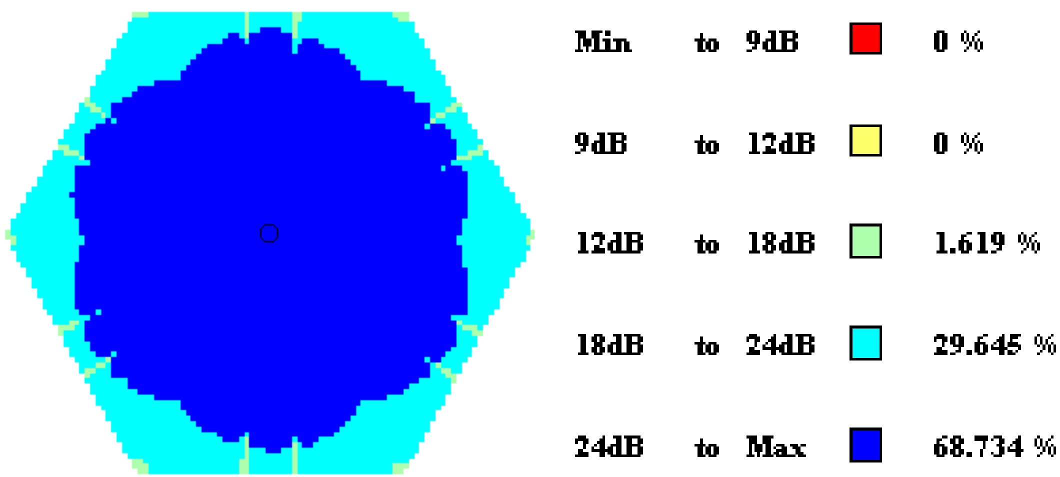
- Subscriber antenna
  - 0dB gain in indoor/pedestrian and 6-10dB if car mounted, instead of 8-20dB gain
  - No front to back isolation
- UL Tx power:
  - 14 – 17? dBm instead of > 20dBm
- 4..6 frequency channels, instead of 1..3 channels

Cellular deployment simulation

- Scope: study interference limitations in DL

- Standford B, shadowing margin of 10dB
- 3.5GHz, 3.5MHz
- Base Station antenna:
  - 35m, 4degree tilt
  - Gain of 14/ 17dBi, 120 /60 degrees beam width
- Subscriber antenna
  - 1m, 0dB gain, 360 degree

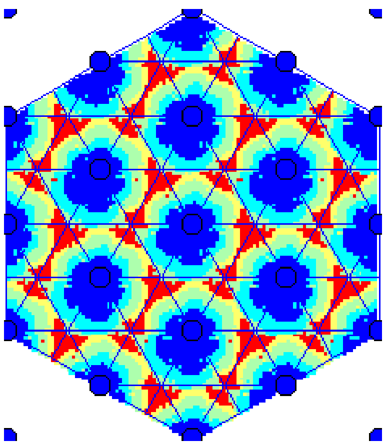
Single cell, 6 sectors, 6 channels



Tx=10W

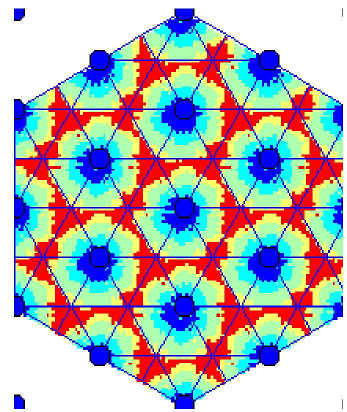
- Average data rate: 61.2Mb/s
- Spectral efficiency: 2.9bit/s/Hz

Multi-cell with mobile SS, 6 sectors, 6 channels



Min	to	9dB	14.11 %
9dB	to	12dB	12.207 %
12dB	to	18dB	23.31 %
18dB	to	24dB	22.633 %
24dB	to	Max	27.737 %

Tx=10W



Min	to	9dB	24.076 %
9dB	to	12dB	17.505 %
12dB	to	18dB	30.309 %
18dB	to	24dB	17.182 %
24dB	to	Max	10.925 %

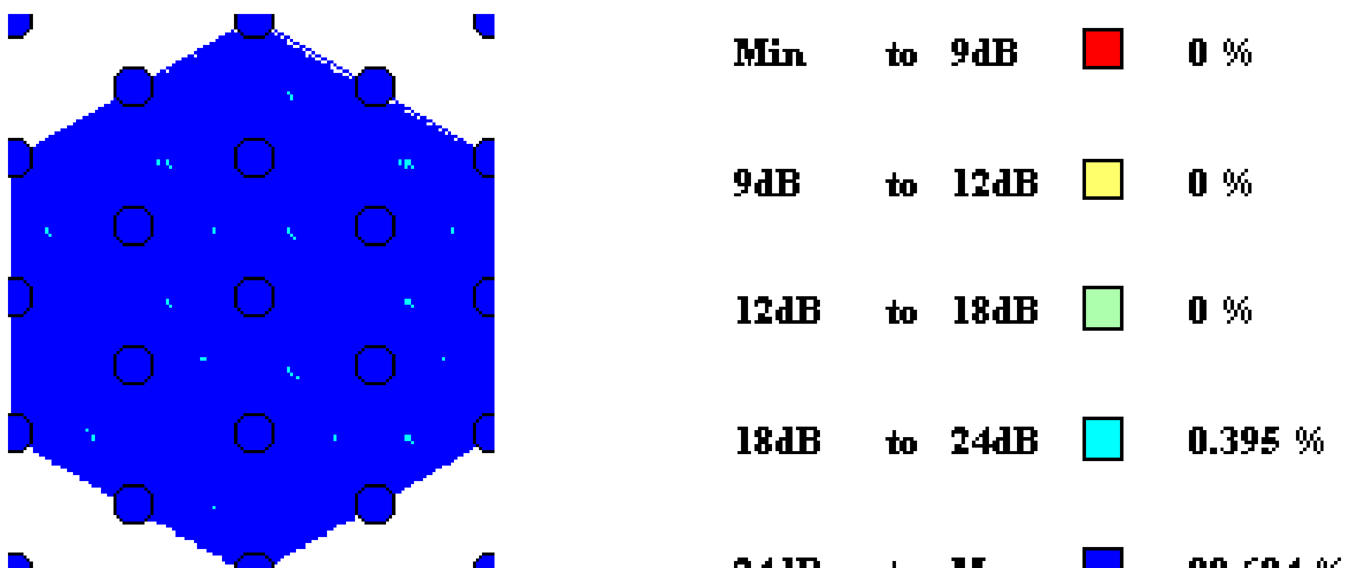
Tx=1W

Multi-cell with mobile SS

- 6 sectors, 6 channels
  - 28% of the covered area will work at high rates, at Tx=1
  - 50% of the covered area will operate at high rate at Tx=10W:
  - Capacity: 30Mb/s
  - Spectral efficiency: 1.4 bit/s/Hz/cell
- 6 sectors, 3 channels
  - Capacity: 24.6Mb/s
  - Spectral efficiency: 2.3 bit/s/Hz/cell
- 3 sectors, 3 channels
  - Capacity:15Mb/s
  - Spectral efficiency: 1.4bit/s/Hz./cell

Multi-cell with FWA subscriber

- Antenna gain: 17dBm
- 1W DL transmitted power



Interference reduction

- How to resolve the interference problem?
  - Larger number of narrower channels
    - Lower peak-rate
    - Careful cellular planning
  - DL OFDMA
    - Lower peak-rate
    - Higher implementation complexity
    - Issue for further study and discussion
  - UL OFDMA
    - Lower peak rates are not a problem with asymmetrical traffic
    - Lower implementation complexity

Optimum number of frequency channels

- The most spectrum demanding situation is mixed deployment
  - 3 channels for macro-cell
  - 3 channels for micro-cell
  - 1 channel for isolation
- The best cell spectral efficiency is obtained with 6 channels
- Conclusion: 7 channels will fulfill all the situations

Combined FWA and Mobile deployment

- Alvarion view:
  - same MAC frame shall include 2 burst profiles, fixed and mobile
  - Each burst profile will include its own MAP
  - details in the submission: "**Co-existence of Fixed and Mobile Services**" – **C80216e_03/02**

Mobile Services

- Multimedia streaming;
- Browsing;
- E-mail;
- Games;
- Video conference;
- Voice.

Traffic and delays

	Max. DL	Min. DL	Max. UL	Min. UL	Max. Delay
IP Streaming	1.5Mb/s	128kb/s	384kb/s	32kb/s	300ms
Internet	6Mb/s	128kb/s	1.5kb/s	32kb/s	See [1],sec.1.2.2
E-mail	1.5Mb/s	64kb/s	1.5Kb/s	32kb/s	See [1],sec.1.2.2
Games	1.5Mb/s	384kb/s	384kb/s		50ms
Video-conf	384kb/s	32kb/s	384kb/s	32kb/s	50ms
IP Voice	40kb/s	12kb/s	40kb/s	12kb/s	50ms

Traffic and Delays – we need an 802.16e common view

- Maximum DL / user?
- Minimum DL / user?

- Maximum UL / user?
- Minimum UL / user?

- Relation between channel size and traffic requirements?

QoS – ITU-R/3GPP view

- Mobile IP services, QoS classes:
  - Conversational class (real time reach media conversation);
  - Streaming class (relaxed delay requirements);
  - Interactive class (e.g. WEB browsing);
  - Background class (e.g. e-mail).
- Should we improve 802.16 MAC? Fast ARQ needed?

Power saving support

- Add the power saving (sleeping) related messages
- Define the power control at wake-up
- Define the ranging at wake-up
- Define suitable OFMA UL:
  - Low PAPR

How to move fast towards a good solution?

- Define 802.16e requirements
  - this meeting
- Define parameters for simulations, as needed for PHY/MAC proposal evaluation
  - this meeting
- After all the contribution presentations, discuss the participants views on possible PHY/MAC changes
- Work in teleconferences between meetings