

Project	<b>IEEE 802.20 Working Group on Mobile Broadband Wireless Access</b> < <a href="http://grouper.ieee.org/groups/802/20/">http://grouper.ieee.org/groups/802/20/</a> >	
Title	<b>Channel Requirements For MBWA</b>	
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Re:	MBWA Call for Contributions	
Abstract	This contribution proposes additional details and considerations for the MBWA requirements.	
Purpose	For information	
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# Technical Requirement Definitions for IEEE802.20 Standards

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May 13, 2003

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## Outline

- Current System Requirements
- Clarification and Expansion of the System Requirements
  - Link Budget
  - Spectrum Efficiency
  - Channel models
  - Granularity of data rate and maximum simultaneous users
  - Airlink RTT
- Conclusion and Recommendations

## Current Requirements on IEEE 802.20

- Peak data rate: DL: >1Mbps, UL: >300Kbps for 1.25MHz  
Expansion: Requirements for path loss, frequency reuse, channel conditions and cell loading.
- Mobile speed up to 250KM/H  
Expansion: Characterization of the channel conditions LOS, rural, suburban or dense urban. Specifications for the minimum data rates, fade margins, spectrum efficiency, and capacity loss.
- Sustained spectrum efficiency 1b/s/Hz  
Expansion: Need to determine the loading assumptions of the neighbor cells.
- The current requirements represent a good set objectives but we are now at the stage where the next level of clarification and definition need to begin.

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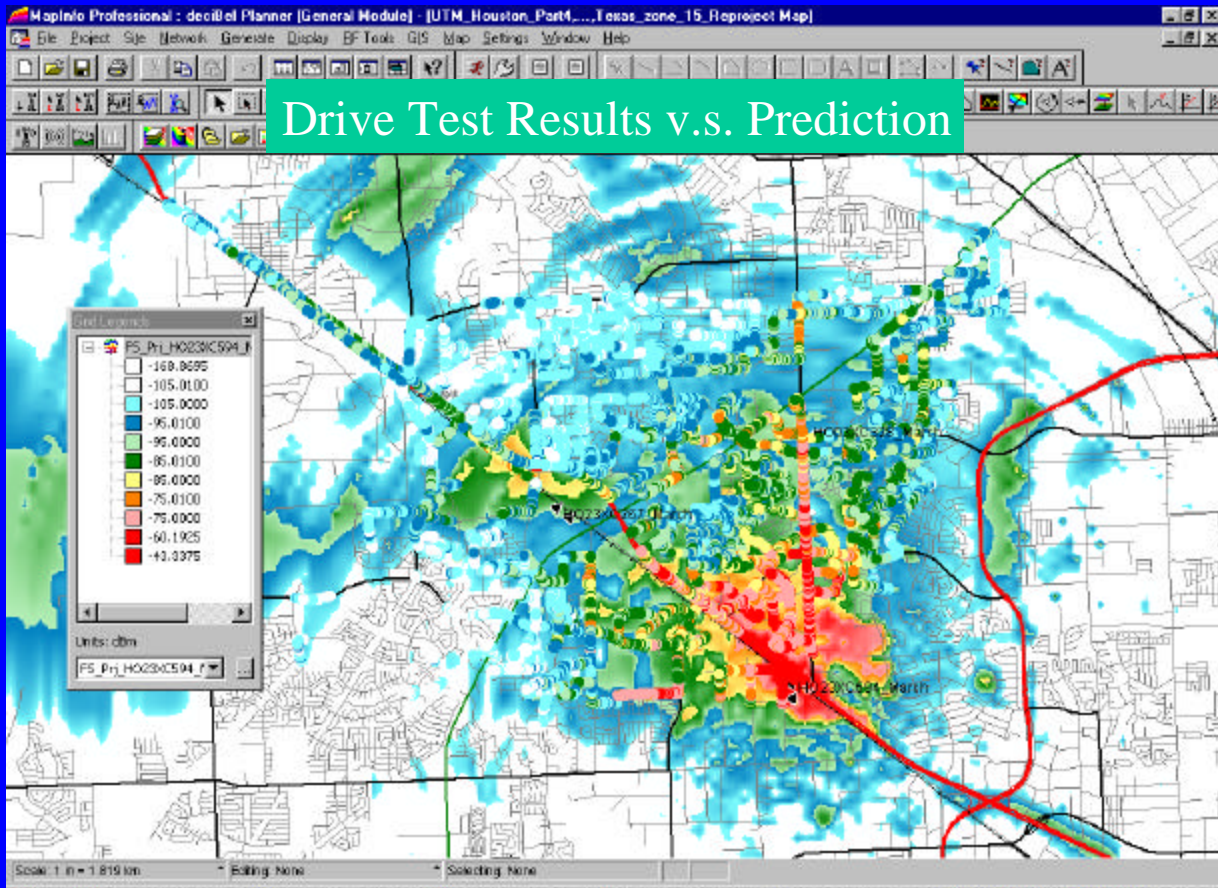
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## Link Budget Importance

- Data rate requirement for cellular 14.4Kbps on average.
- Data rate requirement is 300Kbps (UL) and 1Mbps (DL).
- There is a difference of  $300/14.4=20$  times or 13 dB difference for uplink.
- There is a difference of  $1000/14.4=70$  times or 18 dB difference for downlink.
- To have the similar coverage and to support the same number of simultaneous users as in cellular, we need to have 13dB more link budget in uplink and significantly more link budget for downlink.
- CDMA uplink power is 24dBm or 300mW. Without fundamental technology upgrade, the IEEE802.20 terminal will require  $24+13=37$ dBm 5 Watt transmit power.

# Field Pathloss Measurements

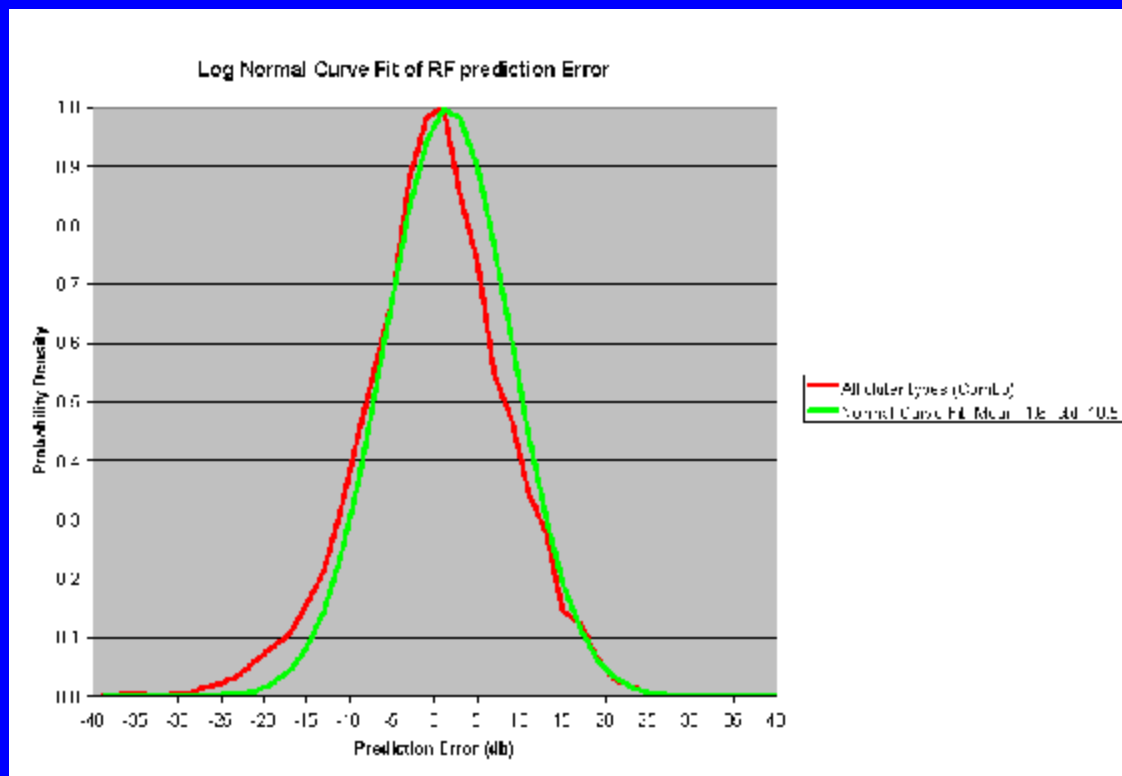
Drive Test Results v.s. Prediction



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## Field Pathloss Measurements



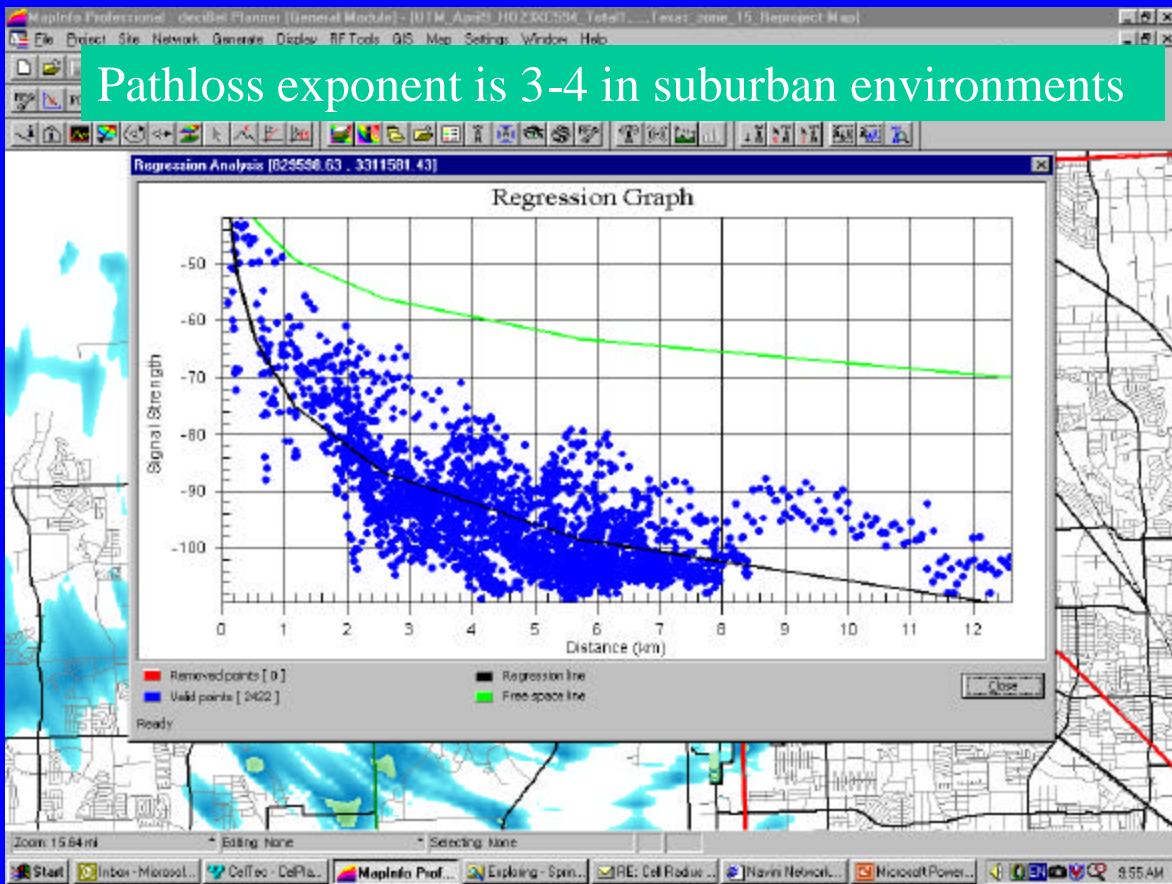
- Average prediction accuracy of 2.9 db with an average standard deviation of 9db

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# Field Pathloss Measurements

Pathloss exponent is 3-4 in suburban environments



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## Link Budget Clarifications

- Link budget should take account of the modulation scheme.
  - For example, QAM16 may typically require 6dB more power than QPSK to deliver the same data rate. The link budget for QPSK and QAM16 may be different.
- Link budget should take account of the coding overhead.
  - For example, Turbo coding with the coding rate  $\frac{1}{2}$  may reduce the SNR requirement and increase the link budget. However it takes twice as much resource, i.e., number of code channels, time slots and frequency bins leading to loss of overall system capacity or goodput.
- Link budget should be linked to the user minimum data rate.
  - For example, the link budget for uplink data rate of 100Kbps is 10dB higher for the uplink data rate of 1Mbps.
- Link budget should be linked to the system goodput.
  - For example, the link budget for 4Mbps total downlink goodput is 3dB lower than the total downlink goodput of 2Mbps.

## Link Budget Proposal

- We define the link budget as the system gain to overcome path loss, shadowing loss, indoor loss and lognormal fading with the following conditions or assumptions:
  - Assume all the simultaneous users are uniformly located in the cell coverage and the base station (sector or omni) can operate at the capacity of at least 800Kbps aggregate uplink goodput for 1.25MHz and 4Mbps aggregate downlink goodput for 1.25MHz (FDD).
  - Assume certain path loss models such as IEEE802.16 model or COST 231 model.
  - Assume the uplink minimum data rate to be 64Kbps at the edge of the cell.
  - Assume the total uplink goodput of 800Kbps and total downlink goodput of 4Mbps.
- We require at least 13dB better link budget at the minimum data rates than cellular systems.

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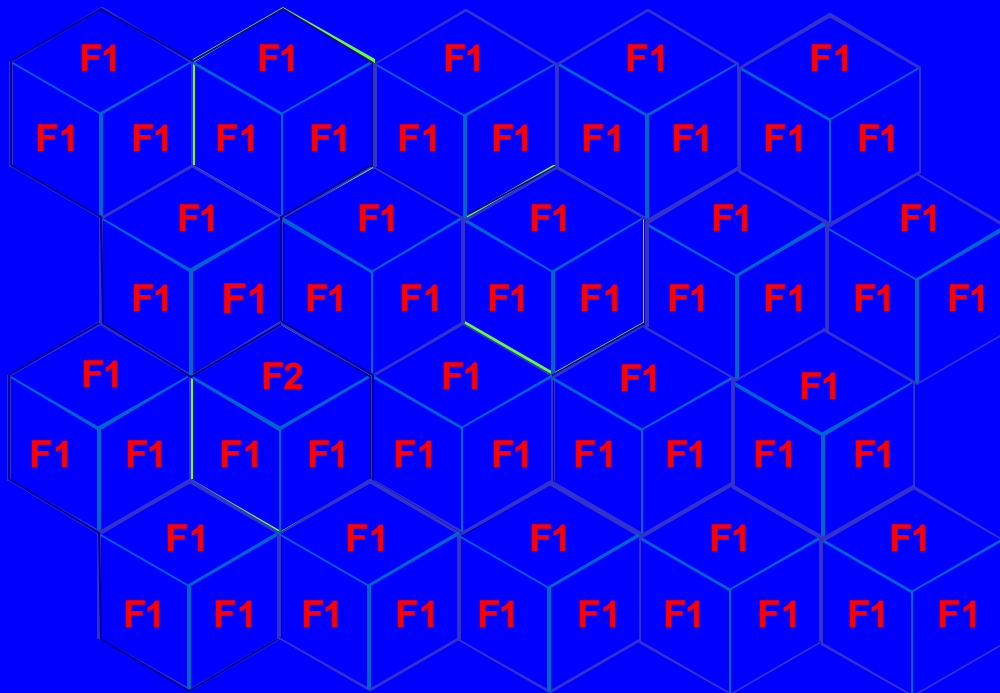
## Spectrum Efficiency Clarifications

- Spectrum efficiency depends on applications.
  - For example, the system efficiency for mobile applications may be lower than the portable and fixed applications.
- Spectrum efficiency depends on deployment pattern.
  - For example, the spectrum efficiency of an isolated cell may be significantly higher than the multiple cell deployment with  $N=1$  or  $N < 1$ .
- Spectrum efficiency depends on system loading.
  - The spectrum efficiency will be lower after we fully load the current cell and the neighboring cells.
- Spectrum efficiency depends on power budget or link budget.
  - Since higher QAM enables higher spectrum efficiency but also demands higher power or link budget to deliver the same data rates. If all the higher QAM modulations are enabled, the system may run out of power before running out of the resources such as code channels or frequency bins.

## Spectrum Efficiency Simulation Benchmark

- We shall define two types of spectrum efficiency, i.e., mobile spectrum efficiency and portable spectrum efficiency
- The spectrum efficiency should be evaluated under the following conditions or assumptions:
  - Three sectors per cell and each sector use the same carrier frequency.
  - Each sector has 10 simultaneous outdoor subscribers and they are uniformly distributed in each sector.
  - Each subscriber is assigned the same NET data rates for uplink and downlink.
  - Each sector is fully loaded to meet the minimum goodput requirements for both links.
  - The pathloss exponent of 3 to 4 should be assumed.
  - For portable applications, we assume a lognormal fading; for mobile applications, we assume a fast fading model.

# Cell Site Arrangements for N=1 Simulations



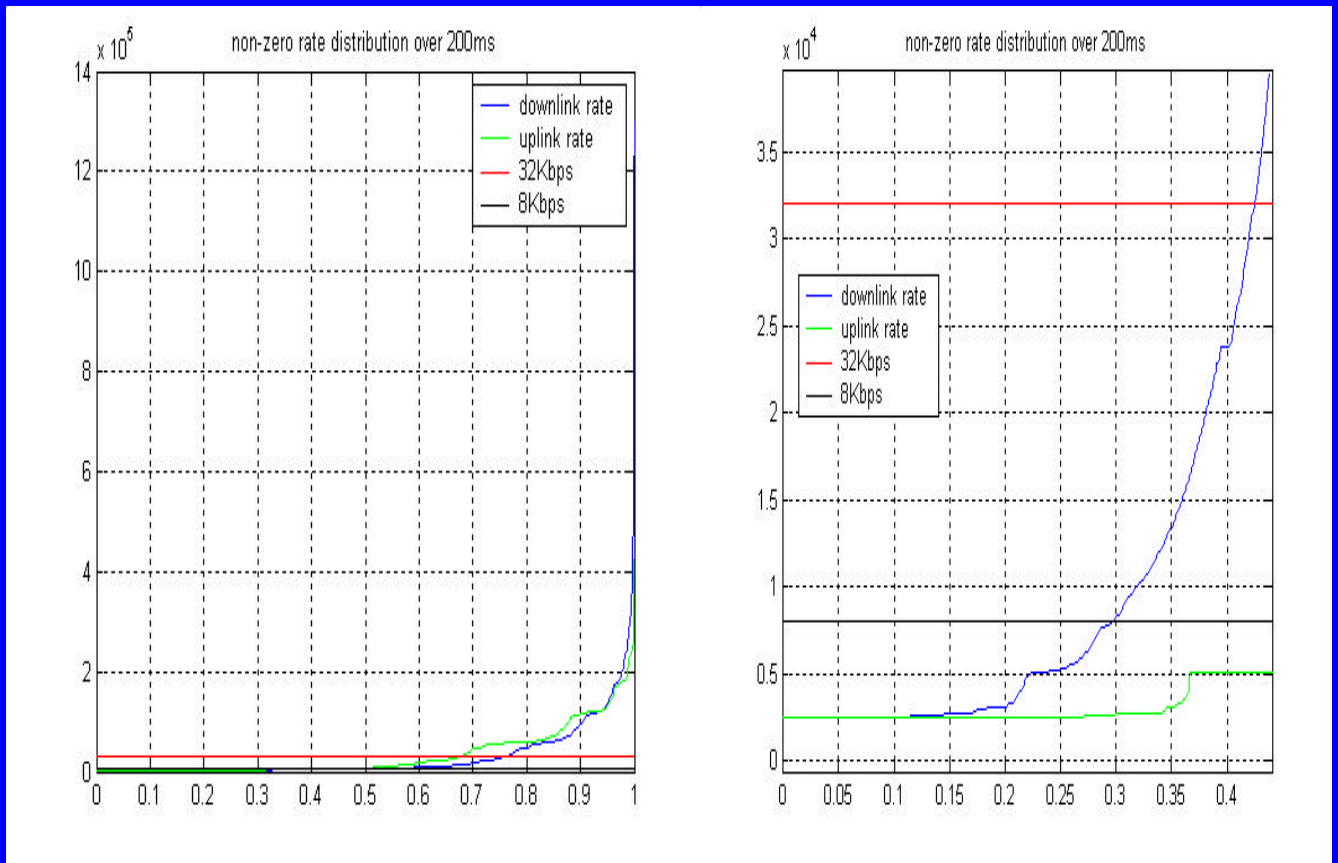
## Channel Models

- We should adopt the ITU 3G channel models (only model A not model B)
- The simulation should assume that 50% subscribers are stationary and 50% mobile.
- For the mobile subscribers, we should assume that their speeds are uniformly distributed between 20KM/H to 100KM/H.
- All the subscribers of one cell are uniformly located within the sector.

## Granularity of Bandwidth Assignment

- The mixture of narrowband and broadband is important due to voice applications and low data rate file sharing protocol.
- Each subscriber can be assigned at least 1Mbps peak data rate.
- Each subscriber can be assigned the minimum data rate of no greater than 8Kbps with the increment of no greater than 8Kbps.
- The system should be able to allow each subscriber to have the minimum data rate while maintaining the minimum system capacity with the same downlink power limitation.

# Typical Data Statistics in One Site



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## Airlink RTT

- System latency is one of the most important specifications of a broadband data access system.
- Airlink RTT is only one of many factors impacting the system overall latency. Other more important factors include system wake up time, system access time, system congestion level, and airlink quality.
- In the slow fading environment, we may need to interleave the packets for a longer period of time, say 10ms to 20ms to overcome the channel fading in order to reduce the system latency by eliminating or reducing retransmission.
- Therefore, we propose to replace this with more meaningful specifications to characterize the system latency.
- For example, we can set certain benchmark tests for certain well defined traffic patterns or traces and set the overall system delay specifications based on these benchmark tests.

## Conclusion and Recommendations

- Link budget requirements should be included in the current requirement due to the huge gap of the data rate difference between the current cellular systems and MBWA systems.
- Multipath channel models need to be defined and we propose to adopt the ITU models (Type A only). The doppler frequency characteristics must be specified based on the speed requirements for different channel models.
- Spectrum efficiency and peak data rate specifications need to be measured in terms of goodput or NET data rate by stripping away all the overhead.
- The spectrum efficiency should be measured by the simulations with well defined assumptions such as network loading, terminal mobility, and power limitation ...
- The granularity of the bandwidth assignment need to be specified and we recommend to set the minimum assignable bandwidth to be 8Kbps with an increment of 8Kbps to cover voice and low data rate applications.
- The airlink RTT specification should be replaced by a more meaningful set of system latency specifications based on some well defined bench mark test assumptions.