<table>
<thead>
<tr>
<th>Project</th>
<th>IEEE 802.20 Working Group on Mobile Broadband Wireless Access</th>
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| Title  | **IEEE C802.20-11/85**  
Multi-antenna Support for Air Interface Specifications in 802.20 |
| Date Submitted | 2005-NOV-09 |
| Source(s) | Michael Youssefmir  
ArrayComm, LLC |
| Voice: | Fax: |
| Email: | mike@arraycomm.com |
| Re: | MBWA Call for Contributions |
| Abstract | This partial proposal proposes the use of physical and MAC layer concepts and functionality within the 802.20 air interface in order to facilitate the use of multi-antenna systems (MAS) within a TDD 802.20 air interface. |
| Purpose | An 802.20 Partial Proposal |
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Scope

• This is a partial proposal
• Proposes the use of physical and MAC layer concepts in order to facilitate the use of multi-antenna systems within an 802.20 air interface
• Applicable to TDD and FDD with multiple antennas at the BS or Terminal
• Requires careful incorporation into other proposals
Multi-antenna Operation

- Could be at BS or Terminal
- For example…

\[ \sum \text{Adaptive Control Algorithms}(\theta) \]

\[ w_0, w_1, \ldots, w_M \]
# Benefits of Multi-antenna Operation

<table>
<thead>
<tr>
<th>Gain</th>
<th>System-Level Significance</th>
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<tbody>
<tr>
<td>User Selective Uplink Gain</td>
<td>Increased Range, Improved Coverage, Increased Link Margin</td>
</tr>
<tr>
<td>Uplink Interference Mitigation</td>
<td>Improved Signal Quality</td>
</tr>
<tr>
<td>Selective Downlink Gain</td>
<td>Increased Range, Coverage, Link budget</td>
</tr>
<tr>
<td>Downlink Interference Mitigation</td>
<td>Improved Signal Quality</td>
</tr>
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</table>
Principles

• Design objective is to provide “hooks” for extraction of channel state information (CSI) for effective operation of multi-antenna systems
  – Known transmitted waveforms in both directions
  – Estimate downlink CSI from uplink training sequences is a core concept in this partial proposal.
Comments

• Spatial Division Multiple Access (SDMA).

• Multiple antennas can be at either or both ends of the links
  – Does not require use of multiple antennas at the subscriber terminal
    • Cost and Form Factor Flexibility
Separation of Directive and Non-directive channel

• Important to design logical channels to take into whether spatial selectivity is possible or necessary
  – Some information (eg. on traffic channels) is amenable to spatial selectivity – “directive spatial processing”
  – Some information (eg. on broadcast channels) requires spatial non-selectivity – “non-directive spatial processing”
# Directive and Non-directive Channels

<table>
<thead>
<tr>
<th>Channel</th>
<th>Direction</th>
<th>Typical Function</th>
<th>Spatial Processing Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uplink Traffic Channel</td>
<td>Uplink</td>
<td>Traffic exchange on uplink</td>
<td>Directive</td>
</tr>
<tr>
<td>Downlink Traffic Channel</td>
<td>Downlink</td>
<td>Traffic exchange on downlink (coupled with uplink training)</td>
<td>Directive</td>
</tr>
<tr>
<td>Broadcast Channel</td>
<td>Downlink</td>
<td>Cell and System information</td>
<td>Non-directive</td>
</tr>
<tr>
<td>Paging Channel</td>
<td>Downlink</td>
<td>Paging to initiate downlink data.</td>
<td>Directive or Non-directive</td>
</tr>
<tr>
<td>Uplink Resource Request/Assignment</td>
<td>Bidirectional</td>
<td>Request to initiate uplink traffic transfer and subsequent resource assignment</td>
<td>Directive</td>
</tr>
</tbody>
</table>
The Goal

BS1

BS2

BS3

Traffic

Page

Random Access

Assignment

u1

u2

u3

u4

u5

u6

u7
Uplink Training

Terminal

uplink training

uplink data

BS

Estimate uplink channel
Determine uplink data
Uplink Training

• Uplink training enables estimation of channel state information for the user transmitting data
  – Enables spatial selectivity
Uplink Training – User 2
Uplink Training For Downlink

Terminal

uplink training

donlink data

BS

Estimate uplink channel
Estimate downlink channel
Determine downlink transmit strategy
Uplink Training For Downlink

- Uplink training enables estimation of channel state information on the *downlink* for future transmission of data
  - Enables spatially selective transmission of information
Uplink Training For Downlink User 1

Note: Downlink training Not Shown
Uplink Training For Downlink User 2

Note: Downlink training Not Shown
Uplink Training
Temporal and Spectral Proximity

• Uplink training should be in close temporal proximity to the uplink or downlink transmission to which it corresponds.

• The uplink training data should be in close spectral proximity to the data to which it corresponds.
Uplink Training Quantity

- The number of independent uplink training symbols shall be enough to maximize spatial selectivity without using excessive resources for the training.
Uplink Training
Cross Correlation

• The uplink training data shall have low cross correlation
  – Across different users within RF reach (in-cell and out-of-cell)
Uplink Training – Multi antenna Terminal

• The uplink training data should allow a mode for low cross correlation training across different antennas at the same user terminal.
  – Allows spatial discrimination of signals out of each antenna
Downlink Training

• Similar to Uplink
Broadcast

• Need balanced link when compared to channels that can inherently benefit from directivity
  – More robust coding rates
  – limited amount of information so as to restrict use of spectral resources
  – spatial/temporal diversity

• Should not share radio resources for the broadcast channel with those for directive channels such as traffic or paging across a network of base stations.
Paging

- Need balanced link when compared to channels that can inherently benefit from directivity
  - More robust coding rates
  - Limited amount of information so as to restrict use of spectral resources
  - Spatial/temporal diversity
- Should allow pages to be sent on bursts that may be shared with other traffic bursts.
Link Quality Reporting

- Link quality reporting for directive and non-directive channels shall be supported.
Resource Allocation

1. The air interface shall utilize SDMA, shall utilize TDMA, and shall utilize FDMA or OFDM.
Random Access

- Allow random access bursts to be shared on the same resources as uplink traffic bursts.