# WiMAX Forum Evaluation Group (WFEG) for IMT-Advanced

## Evaluation Progress Update

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17 May 2010

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# Outline

- WFEG Activities since Feb. 2010
- Updated Simulation Results
- Comments on IEEE's RIT Proposal
- Conclusion

# WFEG Activities since Feb. 2010

- Invite members to submit updated calibration and simulation results
  - Updated simulation results from LG Electronics, ETRI and ITRI
  - Updated calibration results from NEC

- Xian F2F meeting
  - April 20, 2010 at Xian (西安), China.
  - Review the comments received during Feb. ITU-R WP5D meeting
  - Review the updated calibration and simulation results
  - Discuss the comments on IEEE's RIT proposal
  - Authorize WFEG Chair to draft final report to ITU-R WP5D

# Updated Simulation Results

**Cell/cell-edge user spectral efficiency in the TDD downlink**

| Test Environment | ITU Requirement | | Source 1 | Source 2 | Source 3 | Source 5 | Average |
|---|---|---|---|---|---|---|---|
| Indoor (InH) | Cell | 3.0 | 6.75 | 5.82 | | 7.10 | 6.557 |
| | Cell-Edge User | 0.10 | 0.235 | 0.126 | | 0.286 | 0.216 |
| | | | | | | | |
| Microcellular (UMi) | Cell | 2.6 | 3.45 | 3.72 | 3.30 | 3.28 | 3.438 |
| | Cell-Edge User | 0.075 | 0.087 | 0.108 | 0.107 | 0.112 | 0.104 |
| | | | | | | | |
| Base Coverage Urban (UMa) | Cell | 2.2 | 2.62 | 2.78 | 2.53 | 2.41 | 2.585 |
| | Cell-Edge User | 0.06 | 0.071 | 0.074 | 0.081 | 0.069 | 0.074 |
| | | | | | | | |
| High Speed (RMa) | Cell | 1.1 | 3.58 | 2.81 | | 2.88 | 3.09 |
| | Cell-Edge User | 0.04 | 0.095 | 0.069 | | 0.092 | 0.085 |

# Updated Simulation Results

**Cell/cell-edge user spectral efficiency in the TDD uplink**

| Test Environment | ITU Requirement | | Source 1 | Source 2 | Source 3 | Source 5 | Average |
|---|---|---|---|---|---|---|---|
| Indoor (InH) | Cell | 2.25 | 5.20 | 5.59 | | 6.79 | 5.860 |
| | Cell-Edge User | 0.07 | 0.361 | 0.203 | | 0.491 | 0.352 |
| | | | | | | | |
| Microcellular (UMi) | Cell | 1.8 | 2.6 | 2.98 | 2.53 | 2.62 | 2.683 |
| | Cell-Edge User | 0.05 | 0.137 | 0.096 | 0.091 | 0.106 | 0.108 |
| | | | | | | | |
| Base Coverage Urban (UMa) | Cell | 1.4 | 2.38 | 2.51 | 2.49 | 2.86 | 2.560 |
| | Cell-Edge User | 0.03 | 0.113 | 0.097 | 0.091 | 0.123 | 0.106 |
| | | | | | | | |
| High Speed (RMa) | Cell | 0.7 | 2.45 | 2.10 | | 2.87 | 2.473 |
| | Cell-Edge User | 0.015 | 0.125 | 0.061 | | 0.114 | 0.100 |

# Updated Simulation Results

## Cell/cell-edge user spectral efficiency in the FDD downlink

| Test Environment | ITU Requirement | | Source 1 | Source 2 | Source 3 | Source 5 | Average |
|---|---|---|---|---|---|---|---|
| Indoor (InH) | Cell | 3.0 | 6.85 | 5.81 | | 6.89 | 6.517 |
| | Cell-Edge User | 0.10 | 0.239 | 0.118 | | 0.266 | 0.208 |
| | | | | | | | |
| Microcellular (UMi) | Cell | 2.6 | 3.57 | 3.56 | 3.41 | 3.14 | 3.420 |
| | Cell-Edge User | 0.075 | 0.090 | 0.103 | 0.109 | 0.108 | 0.103 |
| | | | | | | | |
| Base Coverage Urban (UMa) | Cell | 2.2 | 2.63 | 2.63 | 2.61 | 2.30 | 2.543 |
| | Cell-Edge User | 0.06 | 0.069 | 0.069 | 0.091 | 0.063 | 0.073 |
| | | | | | | | |
| High Speed (RMa) | Cell | 1.1 | 3.58 | 2.72 | | 2.72 | 3.007 |
| | Cell-Edge User | 0.04 | 0.095 | 0.076 | | 0.087 | 0.086 |

# Updated Simulation Results

### Cell/cell-edge user spectral efficiency in the FDD uplink

| Test Environment | ITU Requirement | | Source 1 | Source 2 | Source 3 | Source 5 | Average |
|---|---|---|---|---|---|---|---|
| Indoor (InH) | Cell | 2.25 | 5.40 | 5.49 | | 7.05 | 5.980 |
| | Cell-Edge User | 0.07 | 0.377 | 0.184 | | 0.511 | 0.357 |
| | | | | | | | |
| Microcellular (UMi) | Cell | 1.8 | 2.66 | 2.97 | 2.75 | 2.73 | 2.778 |
| | Cell-Edge User | 0.05 | 0.141 | 0.110 | 0.107 | 0.110 | 0.117 |
| | | | | | | | |
| Base Coverage Urban (UMa) | Cell | 1.4 | 2.38 | 2.35 | 2.66 | 2.86 | 2.563 |
| | Cell-Edge User | 0.03 | 0.113 | 0.096 | 0.097 | 0.123 | 0.107 |
| | | | | | | | |
| High Speed (RMa) | Cell | 0.7 | 2.45 | 2.05 | | 2.99 | 2.497 |
| | Cell-Edge User | 0.015 | 0.130 | 0.063 | | 0.118 | 0.104 |



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# Updated Simulation Results

VoIP capacity results for TDD

| Test Environment | | Source 1 | Source 3 | Source 5 | Average |
|---|---|---|---|---|---|
| Indoor (InH) | UL | 154 | | 176 | 165 |
| | DL | 146 | | 135 | |
| | Min of UL and DL | 146 | | 135 | 140 |
| | ITU Requirement | 50 | 50 | 50 | 50 |
| | | | | | |
| Microcellular (UMi) | UL | 99 | | 110 | 104 |
| | DL | 84 | 86 | 77 | 82 |
| | Min of UL and DL | 84 | 86 | 77 | 82 |
| | ITU Requirement | 40 | 40 | 40 | 40 |
| | | | | | |
| Base Coverage Urban (UMa) | UL | 93 | | 98 | 95 |
| | DL | 78 | 78 | 68 | 74 |
| | Min of UL and DL | 78 | 78 | 68 | 74 |
| | ITU Requirement | 40 | 40 | 40 | 40 |
| | | | | | |
| High Speed | UL | 101 | | 106 | 103 |
| | DL | 99 | | 80 | 89 |
| | Min of UL and DL | 99 | | 80 | 89 |
| | ITU Requirement | 30 | 30 | 30 | 30 |

# Updated Simulation Results

VoIP capacity results for FDD

| Test Environment | | Source 1 | Source 3 | Source 5 | Average |
|---|---|---|---|---|---|
| Indoor (InH) | UL | 156 | | 176 | 166 |
| | DL | 144 | | 134 | 139 |
| | Min of UL and DL | 144 | | 134 | 139 |
| | ITU Requirement | 50 | 50 | 50 | 50 |
| | | | | | |
| Microcellular (UMi) | UL | 100 | | 104 | 102 |
| | DL | 80 | 84 | 68 | 77 |
| | Min of UL and DL | 80 | 84 | 68 | 77 |
| | ITU Requirement | 40 | 40 | 40 | 40 |
| | | | | | |
| Base Coverage Urban (UMa) | UL | 94 | | 96 | 95 |
| | DL | 74 | 80 | 64 | 72 |
| | Min of UL and DL | 74 | 80 | 64 | 72 |
| | ITU Requirement | 40 | 40 | 40 | 40 |
| | | | | | |
| High Speed | UL | 102 | | 100 | 101 |
| | DL | 96 | | 84 | 90 |
| | Min of UL and DL | 96 | | 84 | 90 |
| | ITU Requirement | 30 | 30 | 30 | 30 |

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# Updated Simulation Results

Evaluating the mobility requirement for TDD

| Test Environment | | Source 1 | Source 2 | Source 3 | Source 5 | Average |
|---|---|---|---|---|---|---|
| Indoor (InH) | LOS | 3.51 | 4.02 | | 4.00 | 3.843 |
| | NLOS | 3.41 | 3.67 | | | 3.540 |
| | ITU Requirement | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| | | | | | | |
| Microcellular (UMi) | LOS | 1.64 | 1.80 | | 1.98 | 1.807 |
| | NLOS | 1.33 | 1.55 | 1.66 | | 1.513 |
| | ITU Requirement | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 |
| | | | | | | |
| Base Coverage Urban (UMa) | LOS | 1.58 | 1.59 | | 1.85 | 1.673 |
| | NLOS | 1.26 | 1.28 | 1.33 | | 1.290 |
| | ITU Requirement | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 |
| | | | | | | |
| High Speed | LOS | 1.54 | 1.74 | | 1.85 | 1.71 |
| | NLOS | 1.23 | 1.58 | | | 1.405 |
| | ITU Requirement | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |

# Updated Simulation Results

Evaluating the mobility requirement for FDD

| Test Environment | | Source 1 | Source 2 | Source 3 | Source 5 | Average |
|---|---|---|---|---|---|---|
| Indoor (InH) | LOS | 3.64 | 4.16 | | 4.08 | 3.960 |
| | NLOS | 3.56 | 3.65 | | | 3.605 |
| | ITU Requirement | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| | | | | | | |
| Microcellular (UMi) | LOS | 1.70 | 1.79 | | 1.74 | 1.743 |
| | NLOS | 1.41 | 1.55 | 1.60 | | 1.520 |
| | ITU Requirement | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 |
| | | | | | | |
| Base Coverage Urban (UMa) | LOS | 1.66 | 1.60 | | 1.60 | 1.62 |
| | NLOS | 1.30 | 1.24 | 1.38 | | 1.307 |
| | ITU Requirement | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 |
| | | | | | | |
| High Speed (RMa) | LOS | 1.61 | 1.71 | | 1.60 | 1.640 |
| | NLOS | 1.27 | 1.55 | | | 1.410 |
| | ITU Requirement | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |



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# Comments on IEEE’s RIT Proposal

- Comments on LBT

  Comments:

  – No differentiation between the bandwidth of UL control channel and UL data channel

  Observation:

  – According to IEEE’s RIT proposal, the UL control channel (i.e. Ranging channel) will only occupy a portion of the bandwidth.
  – The parameter in LBT does not reflect this characteristic, which will result in incorrect UL LBT calculation and worse UL coverage.

  Recommendation:

  – Agree with IEEE’s self-evaluation results. Suggest to further update the UL LBT to differentiate the channel bandwidth of UL control and UL data channel.

# Comments on IEEE's RIT Proposal

- Bandwidth of UL control channel in P802.16m/D5

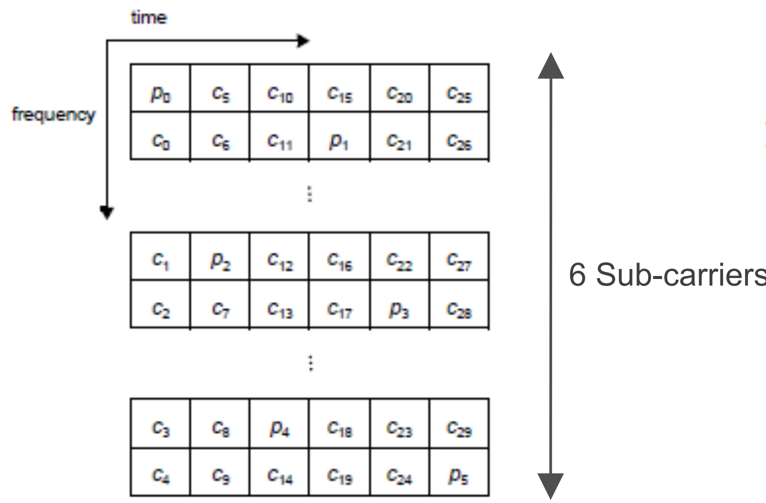


Figure 557—SFBCH comprising of three distributed 2x6 UL FMTs

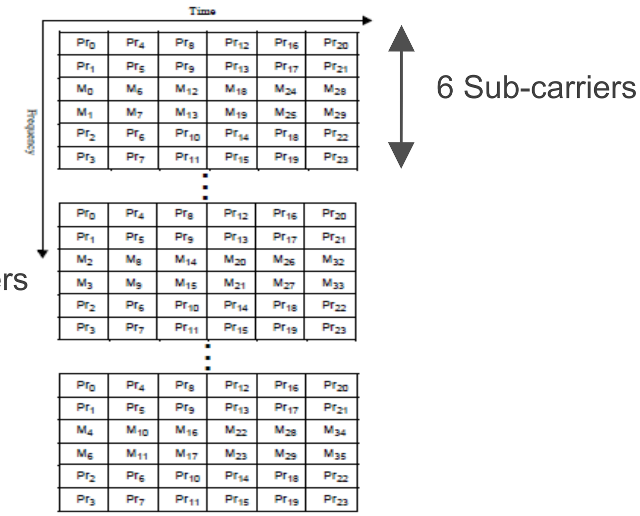


Figure 560—6x6 BR Tile Structure in the Advance Air Interface

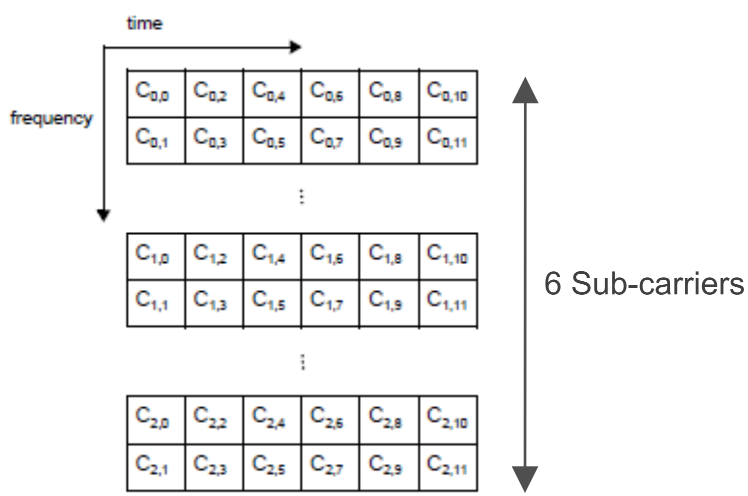


Figure 555—PFBCH comprised of three distributed 2x6 UL FMTs

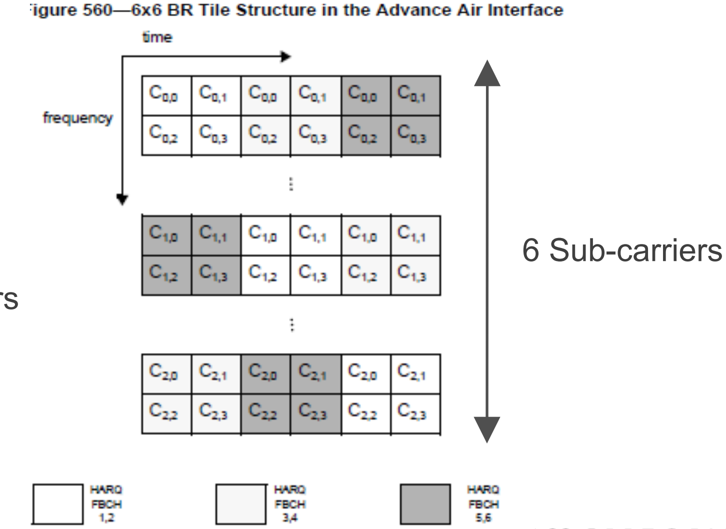


Figure 558—2x2 HMT structure

# Comments on IEEE's RIT Proposal

- Comments on DL peak spectral efficiency

  Comments:

  – The overhead due to mid-amble was not included in the calculation of the DL peak spectral efficiency

  Observation:

  – According to IEEE self-evaluation result, overhead from MIMO mid-amble seems not considered in DL peak spectral efficiency calculation, which will result in slightly difference on the calculation result.

  Recommendation:

  – Agree with IEEE's self-evaluation results. Suggest to further update the DL peak spectral efficiency values in section 7.2.4 and section 8.2 of IEEE's RIT proposal with inclusion of MIMO mid-amble overhead

# Comments on IEEE's RIT Proposal

- **Possible update on L1/L2 Overhead for DL peak spectral efficiency**

| Assumption | Overhead | Minimum Fraction of Radio Frame Resources | Maximum Fraction of Radio Frame Resources |
|---|---|---|---|
| 10 MHz Bandwidth<br>CP = 1/8<br>DL 2×2 Antenna Configuration | L1 Overhead | 0.3104 | 0.3104 |
| | Total Overhead (L1/L2) | 0.3532 | 0.4380 |
| 20 MHz Bandwidth<br>CP = 1/16<br>DL 4×2 Antenna Configuration | L1 overhead | 0.2824 | 0.2824 |
| | Total overhead (L1/L2) | 0.3029 | 0.3441 |

# Comments on IEEE's RIT Proposal

- Comments on control plane latency

  Comments:

  – The assumption on super frame header (SFH) sub-packet (SP) #1 and #2 transmission periodicity should be reduced

  Observation:

  – In the updated IEEE 802.16m draft standard received from IEEE, the value of the SFH SP1 and SP2 transmission frequency seems to be different than the original value in IEEE's RIT proposal
  – The updated value is 40ms, where the original value is 50ms.

  Recommendation:

  – Agree with IEEE's self-evaluation results. Suggest to further correct the control plane latency calculation to reflect a lower value in updated IEEE 802.16m draft standard

# Comments on IEEE's RIT Proposal

- Possible update on control plane latency calculation

| | | | |
|---|---|---|---|
| 0 | AMS wakeup time | Implementation dependent | Implementation dependent |
| 1 | DL scanning and synchronization + Acquisition of the broadcast channel (system configuration information) for network re-entry initial system entry | 40 ms ~~< 50 ms~~<br>Assuming that S-SFH SP12 that contains network re-entry information is transmitted every ~~50~~ 40 ms. ~~This could further reduce if SP2 is transmitted more frequently~~ | 40 ms ~~< 50 ms~~<br>Assuming that S-SFH SP12 that contains network re-entry information is transmitted every ~~50~~ 40 ms. ~~This could further reduce if SP2 is transmitted more frequently~~ |
| 2 | Random access procedure (UL CDMA Code + ABS Processing + DL CDMA_ALLOC_IE) | 5 ms | 5 ms |
| 3 | Initial ranging (RNG-REQ + ABS processing + RNG-RSP)<br>+ HARQ retransmission of one message at 10% or 30%, only first-order estimation | HARQ case: 1 frame * 0.9*0.9 + 2 frame * 2*0.1*0.9 + 3 frame * 0.1*0.1 = 1.2 frame = 6 ms<br>The assumption is the message will either succeed in #1 transmission with probability=0.9 or succeed in #2 transmission with probability=0.1 | HARQ case: 1 frame * 0.7*0.7 + 2 frame * 2*0.3*0.7 + 3 frame * 0.3*0.3 = 1.6 frame = 8 ms<br>The assumption is the message will either succeed in #1 transmission with probability=0.7 or succeed in #2 transmission with probability=0.3 |
| 4 | Capability negotiation (SBC-REQ + ABS processing + SBC-RSP) + HARQ retransmission | < 5 ms<br>(0.1 * 5 ms for HARQ ReTX) | < 5 ms<br>(0.3 * 5 ms for HARQ ReTX) |
| 5 | Authorization and authentication/key exchange (PKM-REQ + ABS processing + PKM-RSP + ...) +HARQ retransmission | < 5 ms<br>(0.1 * 5 ms for HARQ ReTX) | < 5 ms<br>(0.3 * 5 ms for HARQ ReTX) |
| 6 | Registration (REG-REQ + ABS/ASN-GW processing + REG-RSP) + HARQ retransmission | < 5 ms<br>(0.1 * 5 ms for HARQ ReTX) | < 5 ms<br>(0.3 * 5 ms for HARQ ReTX) |
| 7 | RRC connection establishment (DSA-REQ + ABS processing + DSA-RSP + DSA-ACK) + HARQ retransmission | < 5 ms<br>(0.1 * 5 ms for HARQ ReTX) | < 5 ms<br>(0.3 * 5 ms for HARQ ReTX) |
| | Total C-plane connection establishment delay | < 31 ms | < 33 ms |
| | Total IDLE_STATE –> ACTIVE_ACTIVE delay | < 71 ~~81~~ ms | < 73 ~~83~~ ms |

# Conclusion

- WFEG will submit final report to ITU-R WP5D Meeting in June 2010
  - Base on the preliminary report to ITU-R WP5D submitted in Feb. 2010
  - Including the updated simulation results on IEEE's RIT proposal from WFEG members
  - Quantitative assessment shows that IEEE's RIT proposal satisfies all the requirements per ITU-R M.2133 Section 4.2.4
  - Several comments on IEEE's self-evaluation results are identified
    - Regarding to link budget, peak spectral efficiency and control plan latency
  - WFEG has not received the evaluation results on 3GPP's RIT proposal from WFEG members