<table>
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<tr>
<th><strong>Project</strong></th>
<th><strong>IEEE 802.16 Broadband Wireless Access Working Group</strong></th>
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<tbody>
<tr>
<td><strong>Title</strong></td>
<td>IMT-2000 Standardization</td>
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<tr>
<td><strong>Date Submitted</strong></td>
<td>1999-09-16</td>
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</tbody>
</table>
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| **Re:**    | Selection Criteria for Radio Transmission Technologies |
| **Abstract** | This contribution provides an overview of ITU-R Recommendations and draft Recommendations on IMT-2000 dealing with the evaluation and characterization of radio transmission technologies. Although these Recommendations were developed for mobile applications, such as IMT-2000, it is expected that many of the technical principles may readily be adapted for fixed broadband wireless access. The full text of the Recommendations is available from the ITU web site at [http://www.itu.int](http://www.itu.int) |
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IMT-2000 Standardization

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15 September 1999
IMT-2000 RADIO INTERFACE DEVELOPMENT PROCESS

Inside ITU
- Request RTTs
- Review evaluations
- Assess compliance
- Key characteristics
- RSPCs

Outside ITU
- Develop, submit & evaluate RTTs
- Evaluation Reports
- Implementation of RSPCs Recs

Evaluation Guidelines Rec. ITU-R M.1225
Guidelines for the Evaluation of Radio Transmission Technologies (RTTs) for IMT-2000: M.1225

Scope of Recommendation ITU-R M.1225

• Radio transmission technology (RTT) considerations
• Technical evaluation criteria and attributes
• Test environments
• Evaluation procedure
• Summary evaluation methodology
• RTT description template
• Detailed evaluation procedures
RTT Considerations

Radio transmission technologies (RTTs)

Physical channel definition and multiplexing
Frame structure
Duplexing technology
RF-channel parameters
Multiple access technology
Modulation technology

Synchronization requirements
Spectrum efficiency requirements

Source coder
Interworking
Channel coding
Criteria for evaluation

- Spectrum efficiency*
- Technology complexity – Effect on cost of installation and operation
- Quality
- Flexibility of radio technologies
- Implication on network interfaces
- Handportable performance optimization capability
- Coverage/power efficiency*

* Objective Criteria
Test Environments

- Indoor Office
- Outdoor to indoor and pedestrian
- Vehicular
- Mixed-cell pedestrian/vehicular
- Satellite
Evaluation procedure

Step 1: Submission of candidate set of radio transmission technologies

Step 2: Comparison with requirements and objectives

Step 3: Preliminary verification of technologies

Step 4: Evaluation of set of radio transmission technologies for one or more test environments

Step 5: Modification

Step 6: Synthesis and grouping

Step 7: Evaluation report

Annex 1: Radio transmission technologies description template

Annex 2: Test environments and deployment models


Intellectual property rights policy of ITU

Section 6: Evaluation criteria

Annex 3: Detailed evaluation procedures

Section 9: Evaluation methodology

Annex 2: Test environments and deployment models

Rec. ITU-R M.1035

Radio transmission technologies description template

Test environments and deployment models


Intellectual property rights policy of ITU

Evaluation criteria

Detailed evaluation procedures

Evaluation methodology

Test environments and deployment models
Summary Evaluation Methodology

• An evaluation summary is required from each evaluation group, but Rec. M.1225 does not specify any methodology to determine evaluation summaries.

• The evaluation summary methodology may be numerical (e.g., using weights and scores) or non-numerical (e.g., using performance classifications).

• Each evaluation group can define each own methodology.
## RTT Description Template

<table>
<thead>
<tr>
<th>Number</th>
<th>Categories</th>
<th>Attributes (examples)</th>
</tr>
</thead>
</table>
| A1.1   | Test Environment Support                    | - What test environments does the RTT supports?  
- Support for FWA                        |
| A1.2   | Technical parameters                        | - Physical channel definition and multiplexing  
- Frame structure  
- Duplexing technology  
- RF channel parameters  
- Multiple access technology  
- Modulation technology  
- Channel coding and bit interleaving  
- Power classes and power control  
- Variable bit rate capabilities and asymmetry  
- Handover and dynamic channel allocation |
| A1.3   | Expected performances                       | - Maximum user bit rates, BER, capacities  
- Coverage efficiencies  
- Delay                               |
| A1.4   | Technology design constraints               | - Out-of-band and spurious emissions  
- Synchronization requirements         |
| A1.5   | Information required for terrestrial link budget template | - Link Budget template (Table 6)  
- Noise figures, antenna gains, losses |
| A1.6   | Satellite system configuration              | - Configuration of satellite constellation  
- Configuration of spot beams cell layout pattern  
- Feeder link information               |
### Detailed Evaluation Procedures

<table>
<thead>
<tr>
<th>Number</th>
<th>Criteria</th>
<th>Most Important Technical Attributes (G1)</th>
</tr>
</thead>
</table>
| A3.1   | Spectrum efficiency | - Voice traffic capacity (E/MHz/cell)  
|        |          | - Information capacity (Mbit/s/MHz/cell) |
| A3.2   | Technology complexity – Effect on cost of installation and operation | - Peak transmitter/carrier (Pb) power  
|        |          | - Broadband power amplifier (PA)  
|        |          | - Number of users per RF carrier/frequency channel  
|        |          | - Base site implementation/installation requirements  
|        |          | - Handover complexity |
| A3.3   | Quality | - Maximum user bit rate for data (bit/s)  
|        |          | - Voice quality |
| A3.4   | Flexibility of radio technologies | - Multimedia capabilities  
|        |          | - Flexibility in the use of the frequency band  
|        |          | - Minimum frequency band required to operate  
|        |          | - Frequency management between different layers  
|        |          | - Existing system migration capability |
| A3.5   | Implication on network interfaces | - Examine the network modifications required for the RTT to pass the standard set of ISDN bearer services |
| A3.6   | Handportable performance optimization capability | - Peak transmission power  
|        |          | - Diversity schemes  
|        |          | - The number of antennas  
|        |          | - The number of receivers  
|        |          | - The ratio of “off(sleep)” time to “on” time  
|        |          | - Digital signal processing requirements |
| A3.7   | Coverage/power efficiency | - Base site coverage efficiency  
|        |          | - Method to increase the coverage efficiency |
How to Calculate Spectrum Requirements?

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Region 1</td>
<td>555</td>
<td>395</td>
<td>160</td>
</tr>
<tr>
<td>Region 2</td>
<td>390</td>
<td>230</td>
<td>160</td>
</tr>
<tr>
<td>Region 3</td>
<td>480</td>
<td>320</td>
<td>160</td>
</tr>
</tbody>
</table>

There is a forecasted need for 160 MHz of additional spectrum for terrestrial IMT-2000; beyond that identified in RR S5.388, for consideration at WRC-2000

IMT-2000 Spectrum Requirement Methodology (M.1390)

• A Geographic Considerations
• B Market and Traffic Considerations
• C Technical and System Considerations
• D Spectrum Results Considerations
IMT-2000 Spectrum Requirement Methodology (M.1390)

- A. Geographic Considerations
  - Select Environment Type: User Density and Mobility
  - Select Direction: Uplink or Downlink
  - Establish representative cell area and geometry
  - Calculate cell area \((km^2)\)

<table>
<thead>
<tr>
<th>Mobility</th>
<th>In-building</th>
<th>Pedestrian</th>
<th>Vehicular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dense Urban (CBD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Suburban</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
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</table>
IMT-2000 Spectrum Requirement Methodology (M.1390)

• B Market and Traffic Considerations
  B1 Select Service Type and Net-User-Bit-Rate
  B2 Establish population density (potential users/km²)
  B3 Establish penetration rate (%)
  B4 Calculate users/cell
  B5 Establish Traffic Parameters: Busy hour call attempts, effective call duration, activity factor.
  B6 Calculate traffic/user (call-seconds)
  B7 Calculate offered traffic/cell (call-seconds/cell)
  B8 Establish Quality-of-Service-Function Parameters
IMT-2000 Spectrum Requirement Methodology (M.1390)

• C Technical and System Considerations
  C1 Calculate number of Service-Channels/Cell required to carry Offered-Traffic/Cell
  C2 Determine Service-Channel-Bit-rates needed to carry Net-User-Bit-Rate
  C3 Calculate Traffic (Mbit/s/cell)
  C4 Determine Net-System-Capability (a function of the spectral efficiency; coding factor; overhead factor; deployment model and other factors)
  C5 Calculate Net-System-Capability (Mbit/s/MHz/cell)
IMT-2000 Spectrum Requirement Methodology (M.1390)

- **D** Spectrum Results Considerations
  
  D1. Calculate component spectrum requirement in one direction for one service in one environment (MHz)
  
  D2. Repeat process for calculation of other direction (either downlink or uplink as appropriate)
  
  D3. Calculate component spectrum requirement in both directions
  
  D4. Repeat process for all desired services and environments
  
  D5. Determine weighting factor applicable to each individual component (e.g., to adjust for overlapping environments or to correct for non-simultaneous busy hour traffic requirements)
  
  D6. Determine Adjustment Factor(s) (e.g., number of operators, sharing issues, guard bands, and technology modularity)
  
  D7. Calculate Final Total Spectrum Value (MHz)
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**Draft Rec. IMT.RKEY**
Draft New Recommendation M.[IMT.RKEY]:
Key characteristics for the IMT-2000 radio interfaces

• Reflects the agreements reached so far within Task Group 8/1 towards the goal of minimizing the number of different radio interfaces and maximizing their commonality.

• To be used in the subsequent detailed specification of the IMT-2000 radio interfaces.

• The key characteristics by themselves do not constitute an implementable specification.

• The key characteristics are grouped into radio frequency (RF) and baseband key characteristics: facilitates the use of software defined radios, leading ultimately to software radios.
General block diagram of an IMT-2000 device: RF and Baseband Groupings

RX
- RF Front end
- Down Conversion and Filtering
- Local Oscillator(s)
- Filtering and Up Conversion

TX
- A/D Conversion
- D/A Conversion

RF
- Antenna coupling system
- Switch or duplexor

Baseband

Digital Processing
RF Key Characteristics

Transmitter characteristics:
Transmit power
• Power classes
• Dynamic range
• Power control steps
• Frequency stability
Output RF spectrum emissions
• 3 dB Bandwidth
• Adjacent channel leakage power ratio
• Out of band and spurious emissions
• Transmit linearity requirements
• Standby RF output power

Receiver characteristics:
• Receiver sensitivity
• Receiver dynamic range
• Intermodulation sensitivity
• Spurious response and blocking
• Adjacent channel selectivity

Other characteristics:
• Diversity techniques
• Smart antennas
• Minimum operating bandwidth
Baseband Key Characteristics

- Multiple access technique
- Multi-carrier
- Duplexing scheme
- Modulation
- Channelization code
- Scrambling code
- Pilot structure
- Detection
- Channel coding and interleaving
- Variable data rate
- Chip rate
- Frame structure

- Variable length spreading factor
- Random access
- Inter base station asynchronous/synchronous operation
- Absolute up-link chip code synchronization
- Handover
- Power control
- Diversity
- Adaptive equalizer
- Dynamic Channel Allocation