Project	**IEEE 802.16 Broadband Wireless Access Working Group**
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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
Purpose	For information of IEEE 802.16 members.
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IMT-2000 Standardization

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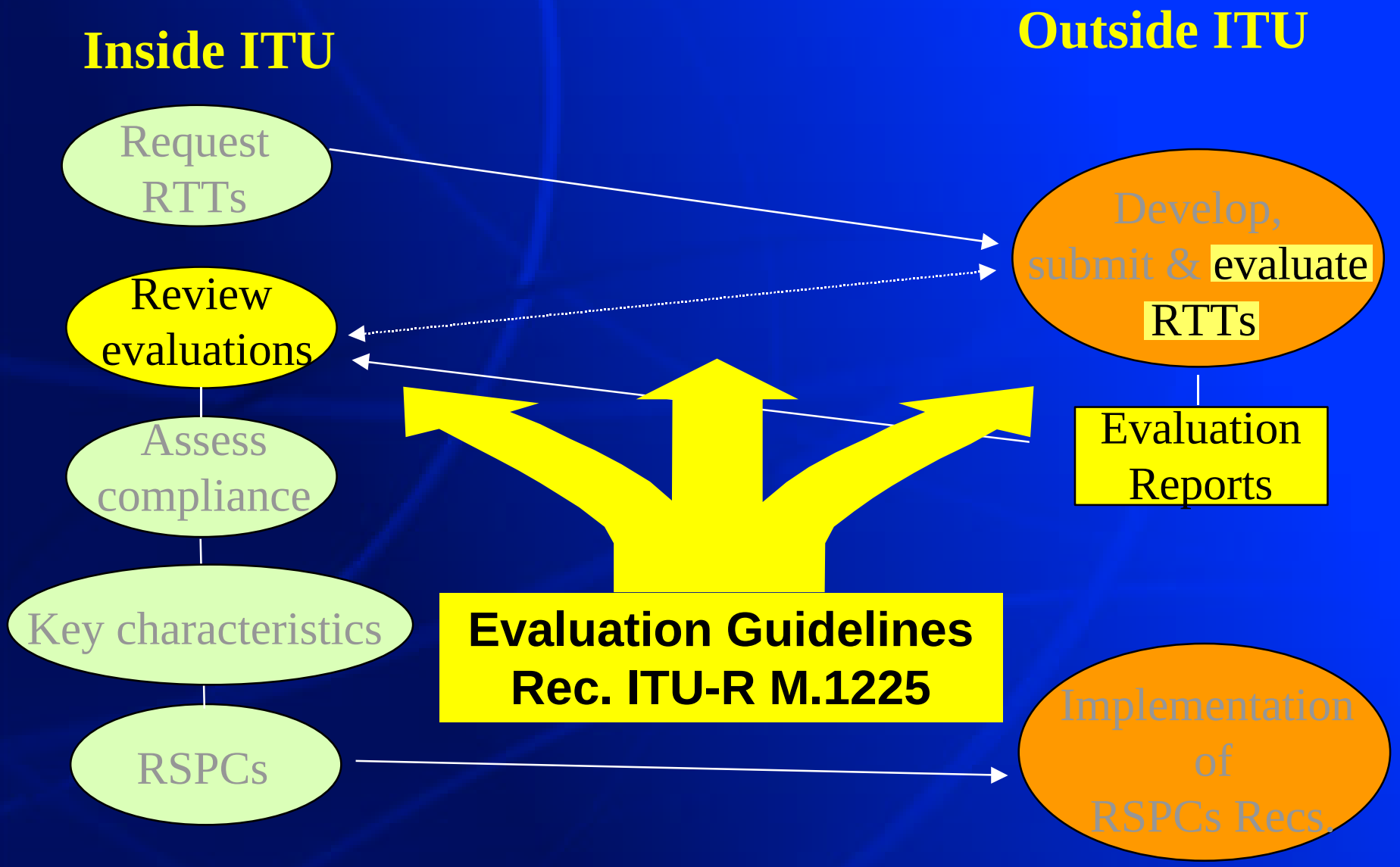
15 September 1999

IMT-2000 RADIO INTERFACE DEVELOPMENT PROCESS

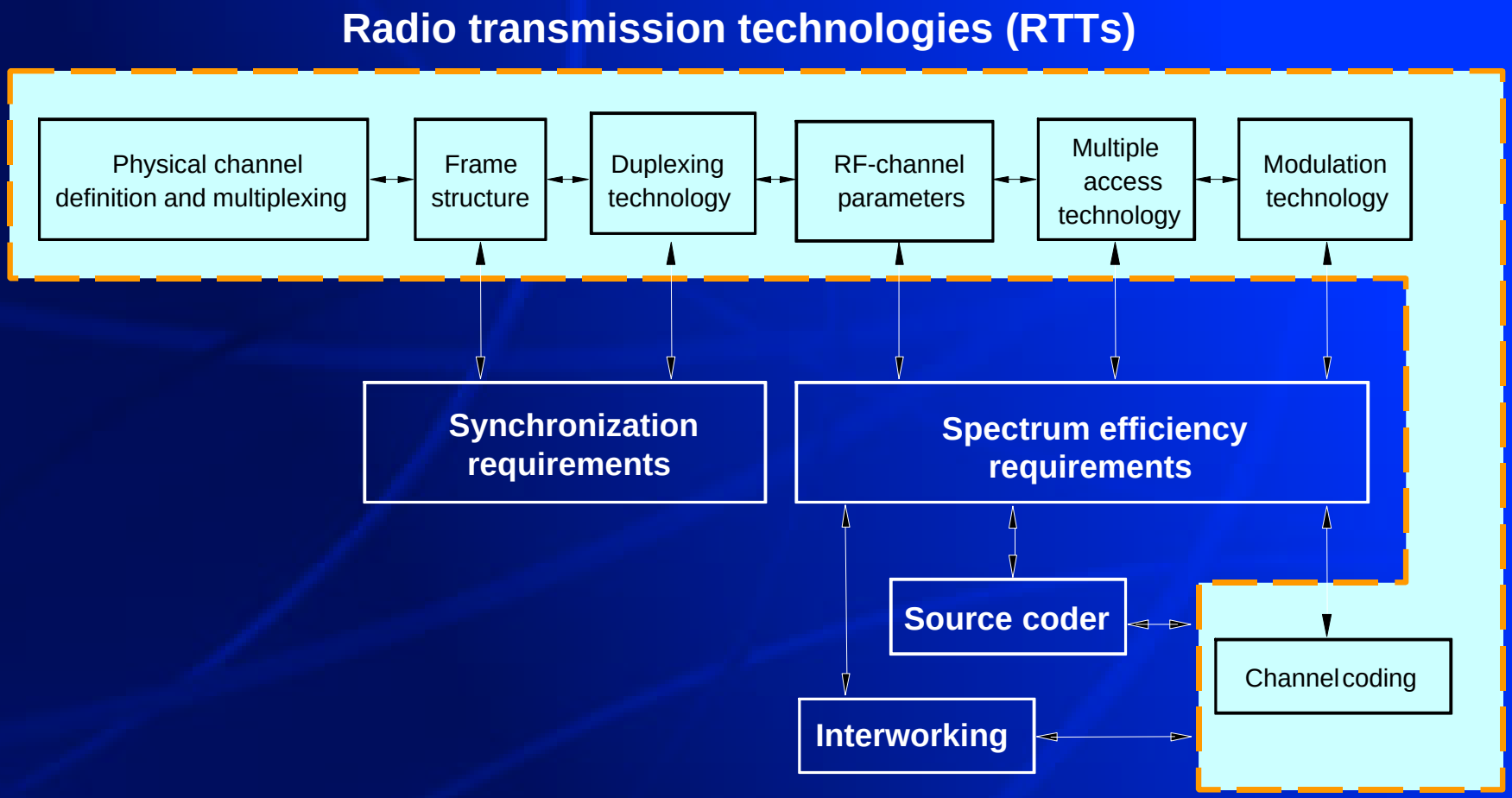


Guidelines for the Evaluation of Radio Transmission Technologies (RTTs) for IMT-2000: M.1225

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



Criteria for evaluation

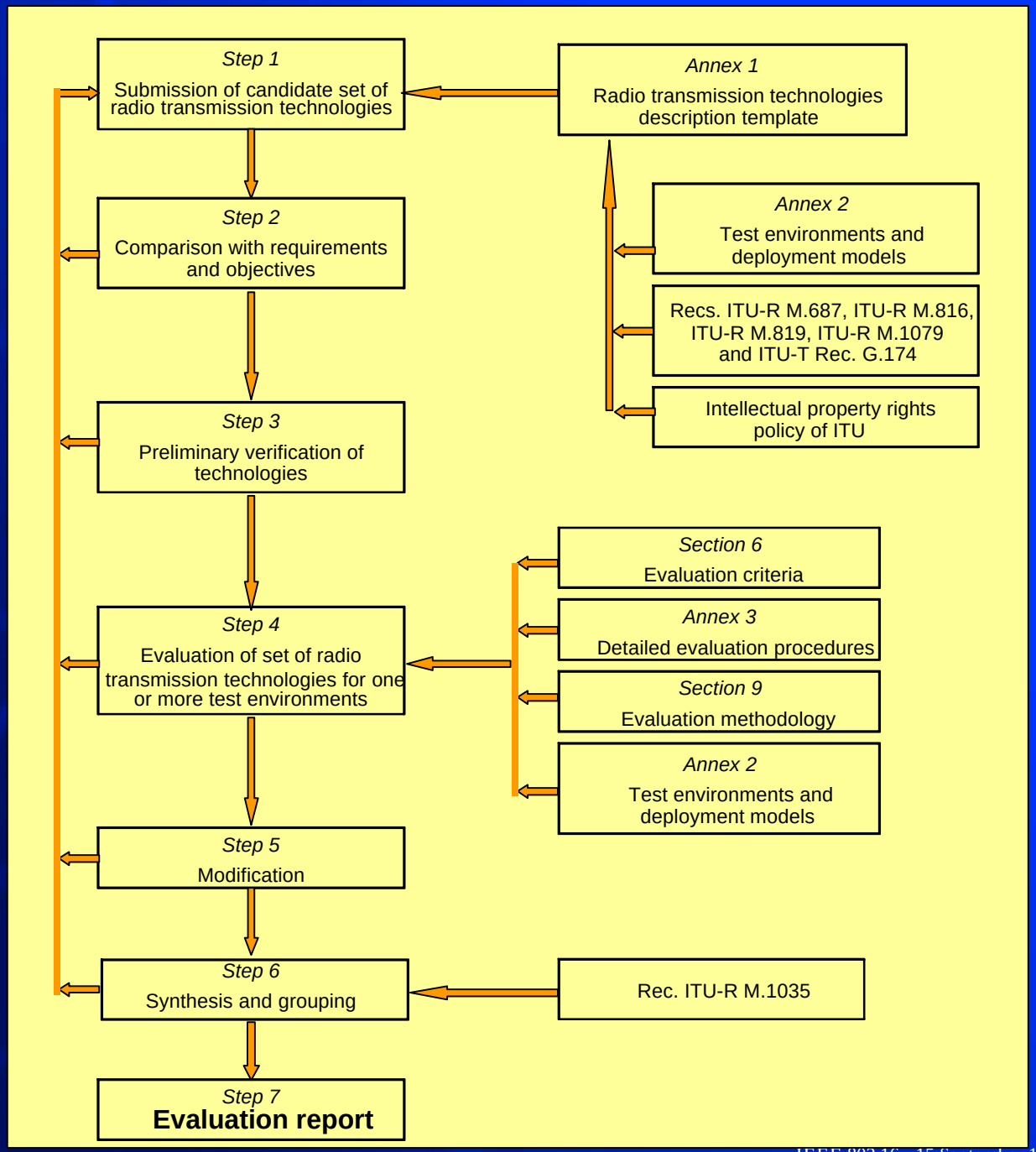
- Spectrum efficiency*
- Technology complexity – Effect on cost of installation and operation
- Quality
- Flexibility of radio technologies
- Implication on network interfaces
- Handportable performance optimization capability
- Coverage/power efficiency*

* Objective Criteria

Test Environments

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

Evaluation procedure



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

Number	Categories	Attributes (examples)
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

Number	Criteria	Most Important Technical Attributes (G1)
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?

Region	*Total* Terrestrial Mobile Spectrum Requirement (2010) (MHz)*	Identified Total Terrestrial Mobile Spectrum (including RR S5.388 IMT-2000 Spectrum) (MHz)	Forecasted *Additional* IMT-2000 Terrestrial Component Spectrum Requirement (2010) (MHz)
Region 1	555	395	160
Region 2	390	230	160
Region 3	480	320	160

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

Reference: IMT-2000 text for CPM report to WRC-2000, Task Group 8/1, March 1999.

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)

Mobility	In-building	Pedestrian	Vehicular
Density			
Dense Urban (CBD)			
Urban			
Suburban			
Rural			

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/km^2)
  - 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

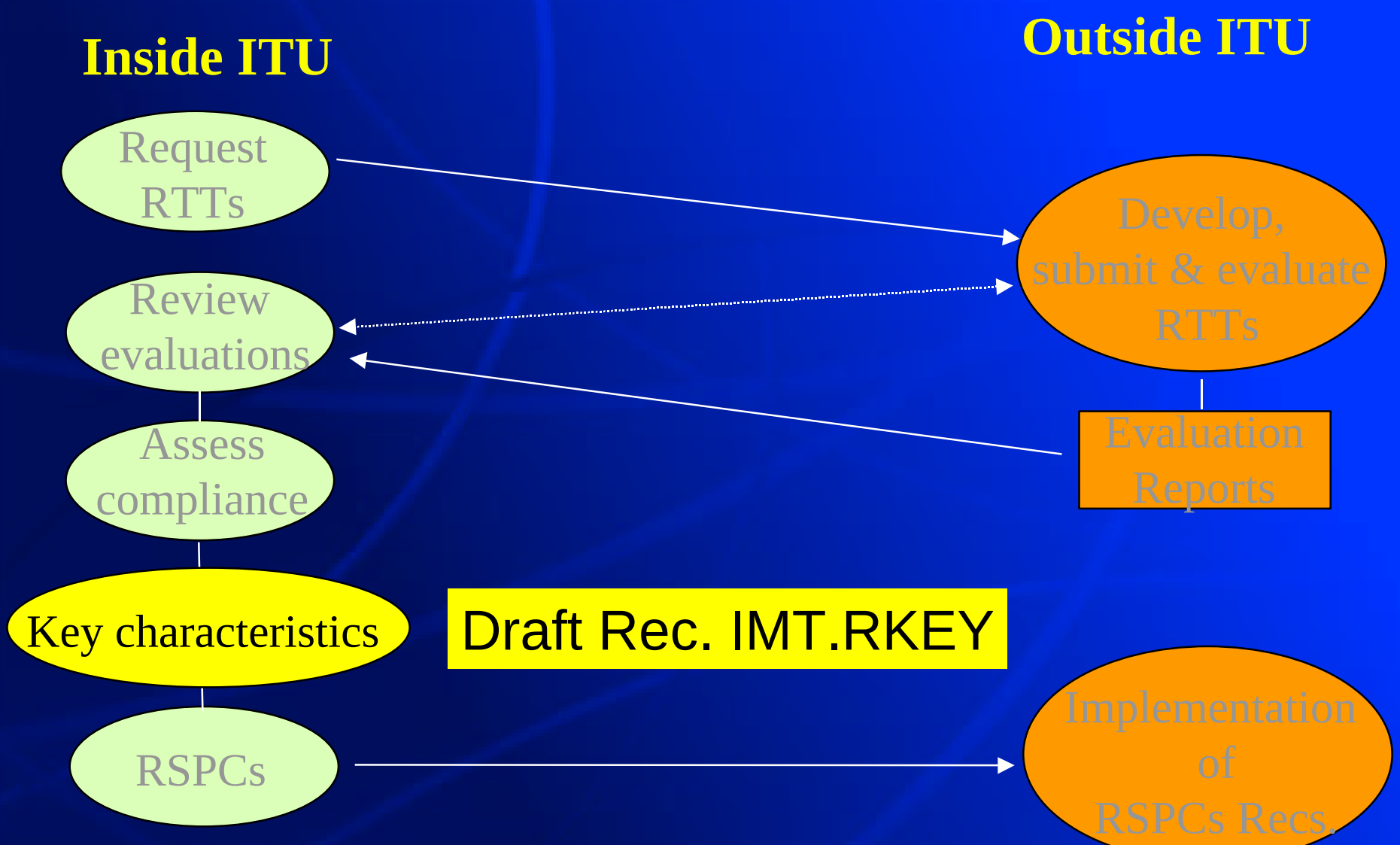
IMT-2000 Spectrum Requirement Methodology (M.1390)

- **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)

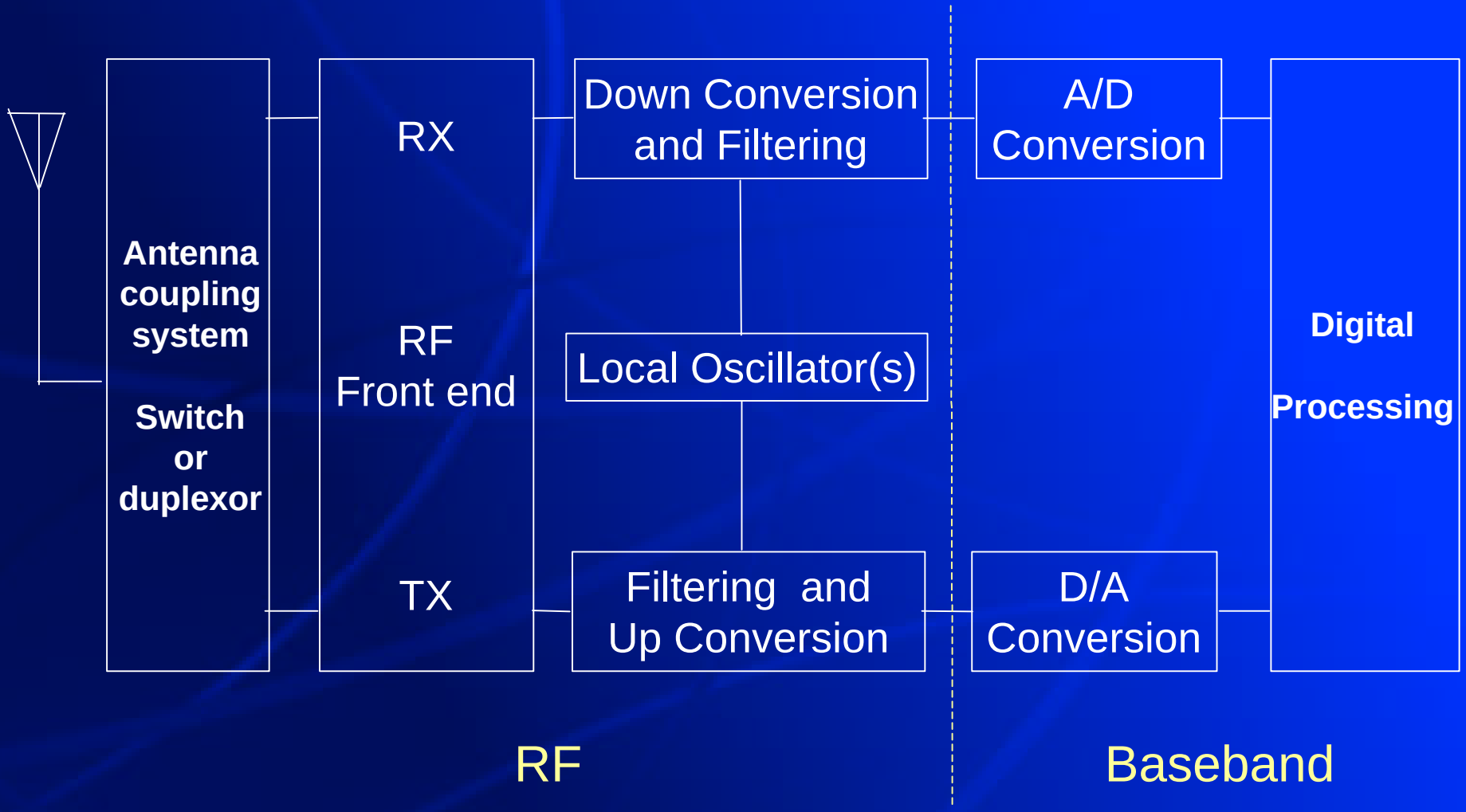
IMT-2000 RADIO INTERFACE DEVELOPMENT PROCESS



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



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