RF compatibility of RS with other MSS

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Purpose:

To discuss RF compatibility requirements for the MMR relay nodes

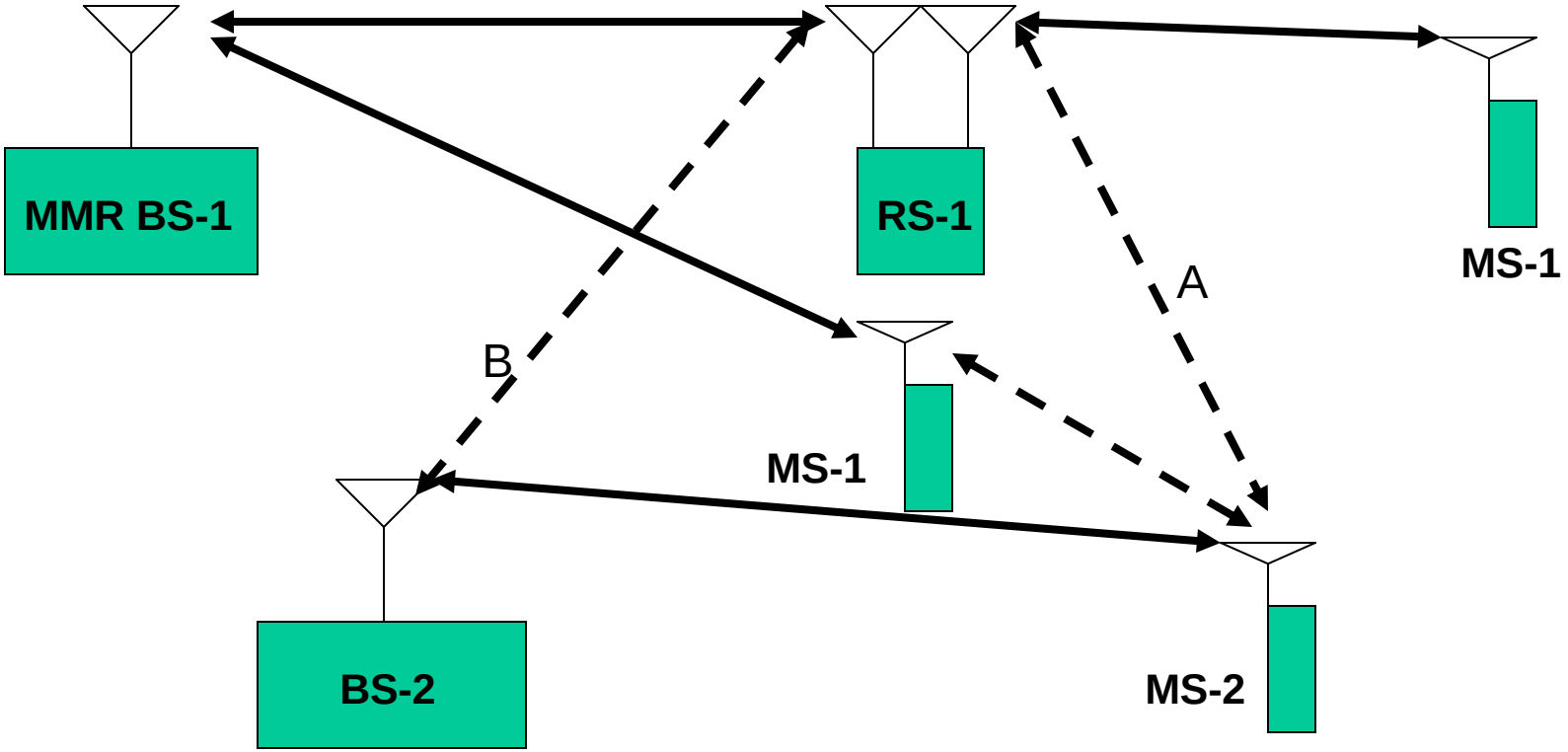
Issues of RS coexist with MS

- This contribution describes some of the scenarios for deploying RS and points out the areas where careful specification for the RS may be required to assure compatibility when RS are intermingled among the MS in the coverage areas and the adjacent channels are used by co-located systems

RF Compatibility – (1)

- Mobile radio access systems, like the 802.16e, typically are designed to operate with a few base station (BS) communicating with a multitude of user stations (mobile stations MS) distributed across a wide area.
- Several different operators may be assigned to adjacent (or nearby) channel sets for operation in co-coverage areas.
- Introducing RS among the field of MS may cause some compatibility problems between transmitters and receivers in adjacent and nearby channels
  - For example, the strong transmitted signal from the RS may block reception at a nearby MS receiving a weak signal on an adjacent channel.
- Some care must be given to the design of the modes of operation and the intentional and unintentional emissions of the radios to assure non-interference and compatibility among systems sharing the bands.

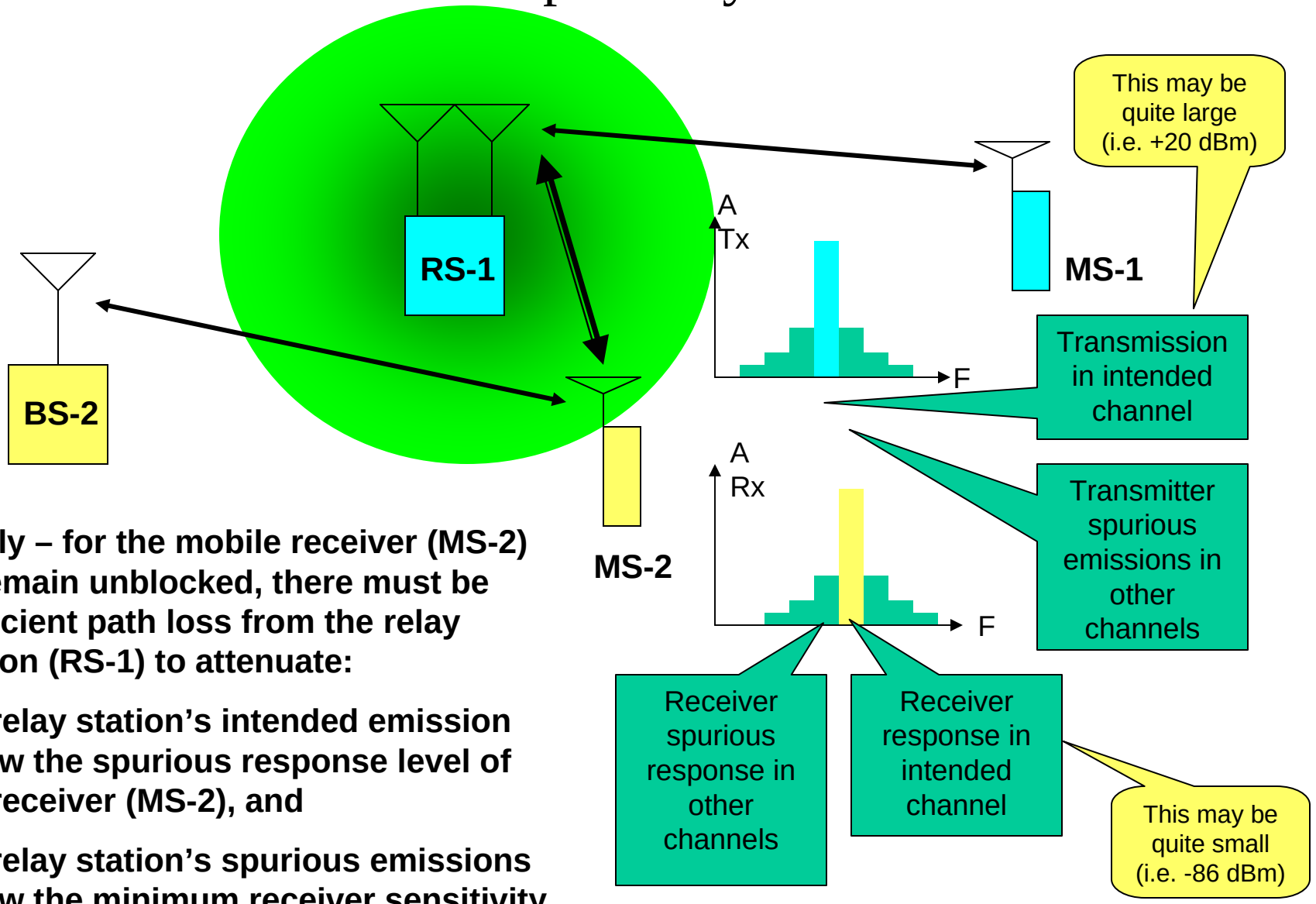
MS blocking due to RS emissions



The transmissions from the RS-1 including its spurious emissions may block the receivers of other stations operating in nearby channels (MS-2, BS-2)

Note that operator (BS-2) may be assigned channels adjacent to those of BS-1

Compatibility



Generally – for the mobile receiver (MS-2) to remain unblocked, there must be sufficient path loss from the relay station (RS-1) to attenuate:

(a) the relay station's intended emission below the spurious response level of the receiver (MS-2), and

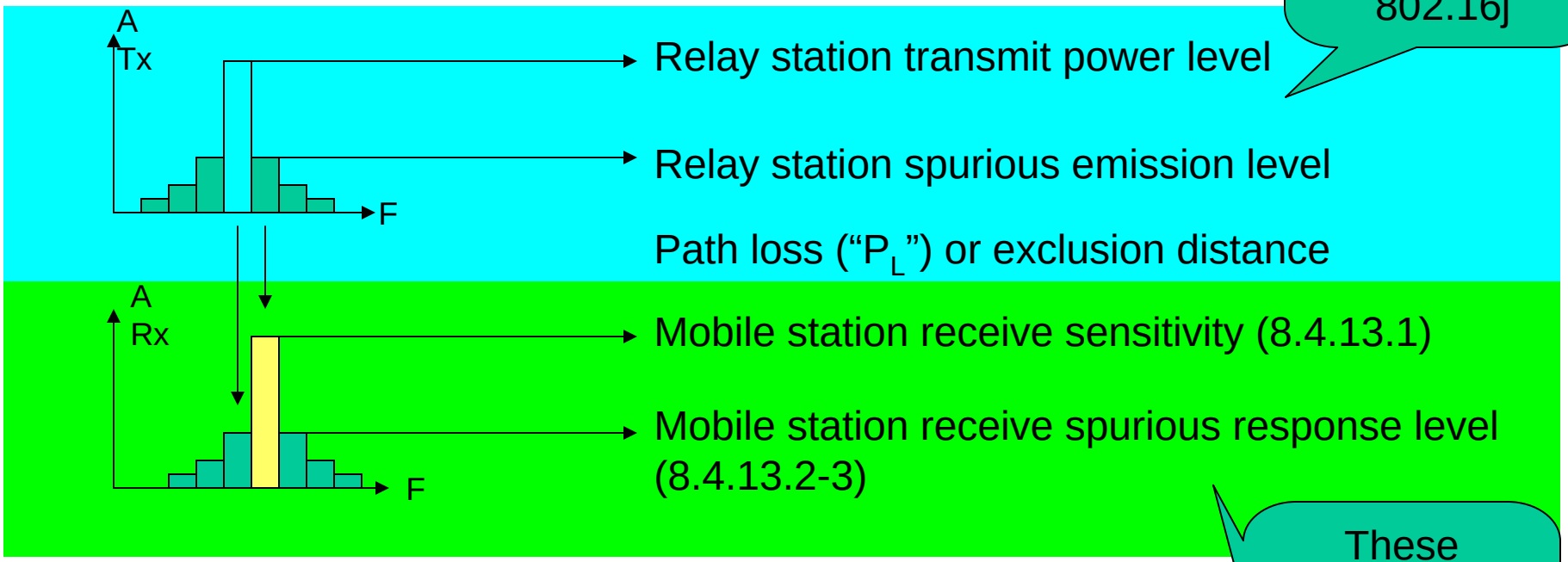
(b) the relay station's spurious emissions below the minimum receiver sensitivity (or received signal level).

RF Compatibility –(2)

- Compatibility in the mixed environment is achieved by assuring the emissions from the relay station do not overpower the receivers of nearby mobiles operating on adjacent channels
- Careful specification is required for:
  - Adjacent channel and spurious emissions* from the relay station
  - Adjacent channel spurious response* for the mobile station receivers

* Here by “spurious emissions” we mean all the emissions from the device that are not in the channel intended for use. Some of these may be due to sidebands from the intended emission and some may be due to other unintended emissions of the device (i.e. digital signals). Similarly, the “spurious response” of the receiver is its response to signals outside its intended channel of reception.

Transmitter and receiver spurious specifications



After choosing a suitable exclusion distance and path loss, then the allowed emissions from the relay station can be calculated from the 802.16 receiver performance requirements

Synchronisation

- If the various systems are using TDD and/or TDM time slots, then there may be a benefit in intersystem synchronisation to avoid Tx/Rx interference

Summary and Recommendations

- Summary
  - RF coexistence and compatibility are discussed
    - Receiver blocking
    - Inter-network synchronization
- Recommendations
  - 802.16j TG need to study the RS emissions limits
    - Minimum separation distance between RS and MS
    - RS Spurious emission specification
    - Maximum RS transmit power level

Appendix

802.16 power class profiles

Example Mobile WiMax System Profile

7. Power Class Profile

The Power Classes listed in following table is developed to cover the complete target range of power levels while different interpretation of applicable modulation levels is addressed through a dual range requirement for QPSK and 16QAM per Power Class.

Table 133. Power Classes

Class Identifier	Transmit Power (dBm) for 16QAM	Transmit Power (dBm) for QPSK	MS
Power Class 1	18 <= PTx,max < 21	20 <= PTx,max < 23	oi
Power Class 2	21 <= PTx,max < 25	23 <= PTx,max < 27	oi
Power Class 3	25 <= PTx,max < 30	27 <= PTx,max < 30	oi
Power Class 4	30 <= PTx,max	30 <= PTx,max	oi

oi Qualified option – for mutually exclusive or selectable options from a set. One or more of the options from the set shall be supported.

Exposure power limits

- In most jurisdictions the RF power that may be radiated by the relay station is limited by regulations for human exposure.
  - In the United States the limits are set by the FCC in FCC parts 1.1310 and 2.1092/1093 as well as OET Bulletin 65.
  - In effect, for uncontrolled environment (i.e. one where the general public is allowed) for frequencies above 1.5 GHz, the limit is 1 milliwatt per square centimetre (see table 1 of 1.1310) averaged over 30 minutes. For a controlled environment this may be as high as 5 milliwatt. This is the allowed peak field strength of all the radio's emissions in the region where people may be exposed (especially things like their eyes).
- Additional guidelines for exposure may be found in ''IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz,'' ANSI/IEEE C95.1.

- Typical radio equipment used in uncontrolled environments operates at levels far below these maximums (i.e. 10 dB lower).
  - As an example: a 100 mW transmitter (i.e.20 dBm) with a (true) omni antenna would have an average field strength of 0.05 mW/sqcm at a distance of ¼ metre.
  - The addition of a 10 dB antenna however, would raise this to 0.5 mW/sqcm in the peak direction. This is close to the regulatory limit, even for such a "low-power" transmitter.

47 CFR Ch. I (§ 1.1310)

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm2)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f2)	6
30–300	61.4	0.163	1.0	6
300–1500			f/300	6
1500–100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f2)	30
30–300	27.5	0.073	0.2	30
300–1500			f/1500	30
1500–100,000			1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.