The 2.3-2.45 GHz Spectrum: past, present and future in Sweden

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The 2.3-2.45 GHz Spectrum

- The 2300 – 2400 MHz band is designated by the ITU as a *primary* band for the *Fixed* and *Mobile* Services,
- *Military* use of the 2300 – 2400 MHz sub-band is widespread (e.g. in SM),
- In the US, part of the band has also been allocated to *satellite broadcasting,* (Sirius XM at 2310 – 2390 MHz),
- 2400 – 2450 MHz is full of licence-exempt devices (802.11 b/g and ISM),
- In many countries, all or part of the band is also allocated to the *Amateur Service* on a *secondary* basis (with some isolated exceptions),
- But the Amateur high-power allocations suitable for EME are unfortunately not coordinated between ITU Regions (nor internally in Reg 1):

2.3 – 2.45 GHz in Sweden, 2000 - 2009

- Before Y2K, the whole 2.3 – 2.45 GHz band was open for unrestricted amateur use with a 1 kW output power limit.
- In 2000, PTS lowered the general power limit to 100 mW !

  (For the background story please refer to my article in the Proceedings)

- From 2000 to 2008, the PTS issued high-power permits to individual amateurs on a case-by-case basis after approval by the Swedish Defence forces. These permits were for 1 kW at 2320 – 2321 MHz and had to be renewed every two years.

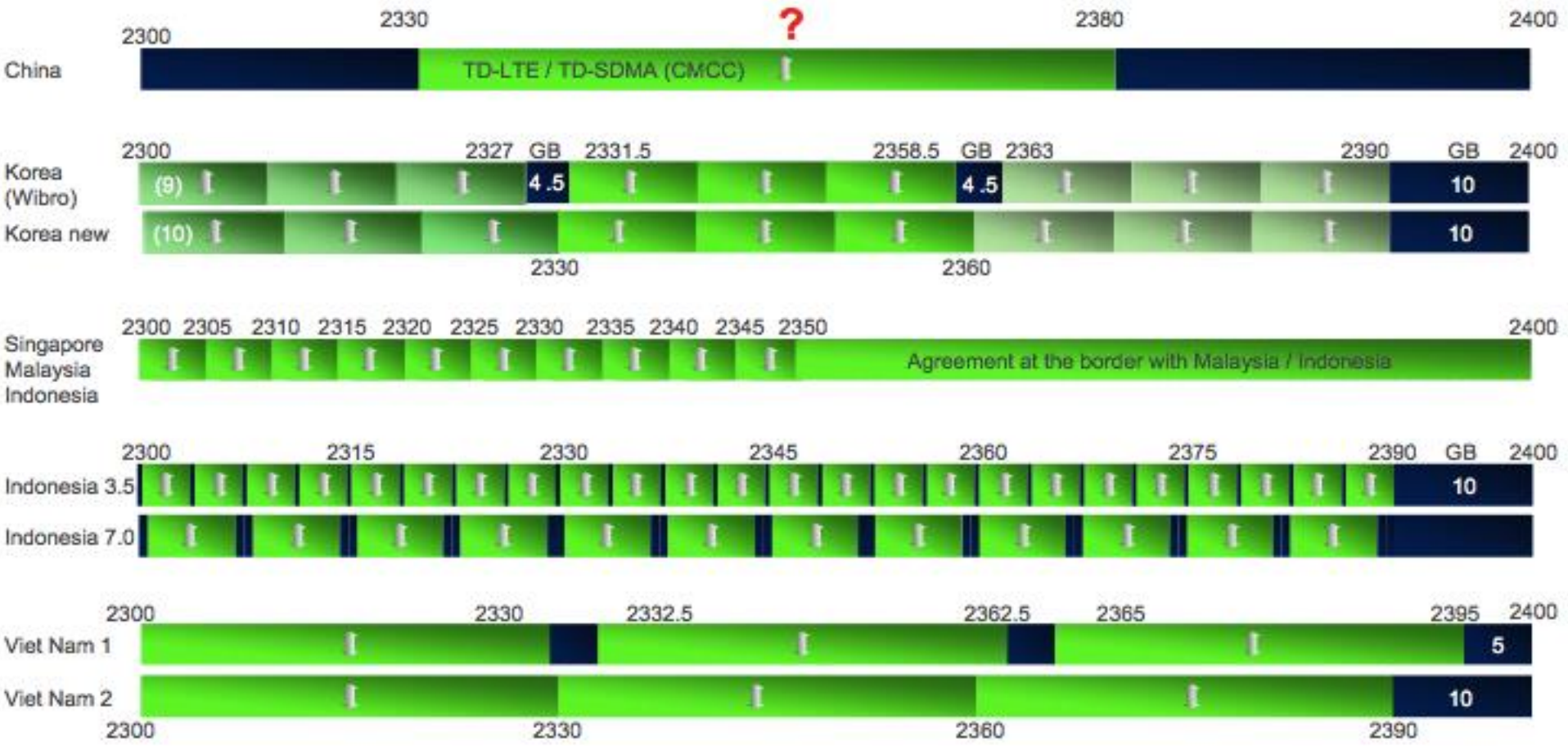
  (SM3BYA held such a permit throughout this period)

- In 2009 the national Swedish radio amateur association, SSA, proposed to the PTS that it could take over the administration of the 2.3 GHz high-power permits...

The 2010 debacle

- In 2010, the PTS suddenly started to reject all applications for prolongation of our 2320 - 2321 MHz high-power permits.
- The reason given was that “the band was under consideration for re-allocation”.
- It turned out that also the incumbent primary user (the military) had been told to move its fixed links out of the band!
- Later in the year, it became clear that these actions had probably been precipitated by pressure from industry to have PTS implement the decision taken at WRC-07 *to make the 2300 – 2400 MHz band available for IMT, eventually worldwide.* PTS was now clearing the band in preparation for auctioning out spectrum and licences in 2011,
- However, the direct reason for PTS refusing to issue high-power EME permits was found to be that, in the midst of all this, a video link operator had been given temporary access to the low end of 2.3 GHz, recognised as a Primary Service and issued with a nationwide licence!

The 2300 – 2400 MHz band has already been allocated for IMT in many countries in Southeast Asia



Each country has opted for different standards and channel widths; in some cases guard bands have been set up...

Developments in 2010 and 2011

- 2010-11-11: PTS goes public with its plan to re-allocate and sell the 2.3 GHz band, opens the issue for public consultation and comments,
- Strong comments supporting a continued Amateur allocation in the band submitted by
  - SSA, the national Swedish radio amateur association,
  - SNRV, the Swedish national URSI committee (also affiliated with the Royal Swedish Academy of Science, KVA),
  - IARU Reg 1
- Intermediate-level contacts between SSA, PTS and the video link company lead to an understanding whereby PTS is again willing to consider issuing temporary EME high power permits, subject to the case-by-case agreement from the video people,
- In early 2011, several SM EMEers re-apply and are issued with high-power permits for both 2304 and 2320 MHz, valid for six months; these are later extended until 2011-12-31. SM3BYA finally becomes QRV...

Developments in 2011 and 2012

- 2011-12-12: PTS publishes a suggested revision of the table of frequency allocations, and opens the document for public comment,
- It is proposed that the entire 2.3 – 2.45 GHz Amateur allocation be removed: *"According to information from radio amateurs, the band is hardly used at all today because of the low power limit, thus the administration evaluates the effects of removing the amateur service allocation as minor"*.
- The Amateur service in the band is described as: *"an obstacle to the future allocation of the band to mobile broadband services, needed in order to improve the competition in the marketplace for the benefit of the consumer"*!
- Early 2012: Crash action by SSA and SNRV to prevent the total loss of the 13 cm band. In detailed responses to the document, it is shown that *PTS has shown no objective justification for removing the 2400 – 2450 MHz allocation; this should therefore be retained*,
- Similar response submitted by the independent association ESR

2.3 – 2.45 GHz in Sweden, 2013 -

On April 3, 2012, PTS publishes its evaluation of the public comments to the suggested revision of the frequency table:

- Swedish amateurs will lose 2300–2400 MHz to IMT, probably from January 1, 2013,
- PTS admits to having no objective reason for withdrawing the whole band; we will retain 2400–2450 MHz, but still only with a general 100 mW power limit,
- It may still be possible to get high-power permits on a case-by-case basis, but the exact conditions will be known only after the 2.3–2.4 GHz band has been allocated. Thus we cannot yet say where in the band future SM EME transmissions may be,
- But worse, in the 2304 and 2320 MHz segments we can expect bad interference from IMT base stations, perhaps so bad that EME reception will become impossible!

If EME must coexist with IMT, will we be able to hear anything at all ?

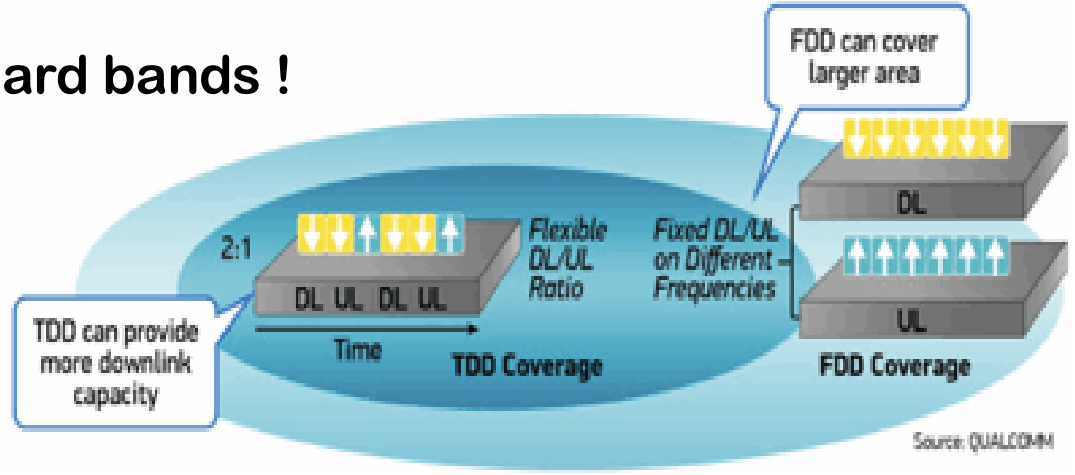
- That depends on, among other things,
  - The IMT base station EIRP levels, spectrum masks and out-of-band emission levels,
  - The possible inclusion of guard bands between IMT channels,
  - The diversity scheme employed (FDD or TDD).
- If the PTS can have things its way, the band may be allocated to a mix of Wimax and LTE (this is called “technology-neutral”). In this case, channels will probably be 20 MHz wide and there will be guard bands inserted, possibly even right at 2320 MHz,
- OTOH, if the industry view will prevail, the whole band may be allocated to TDD LTE – and then we may be in for real trouble...

TDD LTE

What is TDD?
There are two modes of operation for LTE technology: FDD and TDD, which are technically very similar and part of the same radio access specification. LTE FDD and TDD were both defined and introduced as part of the 3GPP specification in 2009 to make efficient use of paired and unpaired spectrum allocations over a common, core network architecture. The main differences are around the duplex method used.

In both LTE FDD and LTE TDD, the transmitted signal is organized into subframes of one millisecond (ms) duration and 10 subframes constitute a radio frame. Each subframe normally consists of 14 orthogonal frequency division multiplexing (OFDM) symbols (12 OFDM symbols in an extended cyclic prefix). Although the frame structure is, in most respects, the same for LTE FDD and LTE TDD, there are some differences between the two—most notably the use of special subframes in TDD. The subframes in TDD are allocated either for uplink (UL) or downlink (DL) transmission.

TDD <=> no guard bands !



In the case of FDD operation, there are two carrier frequencies, one for UL transmission and one for DL transmission. During each frame, there are consequently 10 UL subframes and 10 DL subframes, and UL and DL transmission can occur simultaneously within a cell.

In TDD operation, there is only a single carrier frequency, and UL and DL transmissions in the cell are always separated in time. As the same carrier frequency is used for UL and DL transmission, both the base station and the mobile terminals must switch from transmission to reception and vice versa. Thus, as a subframe is either a UL subframe or DL subframe, the number of subframes per radio frame in each direction is less than 10.

Minimum requirements for successful EME / TDD LTE coexistence:

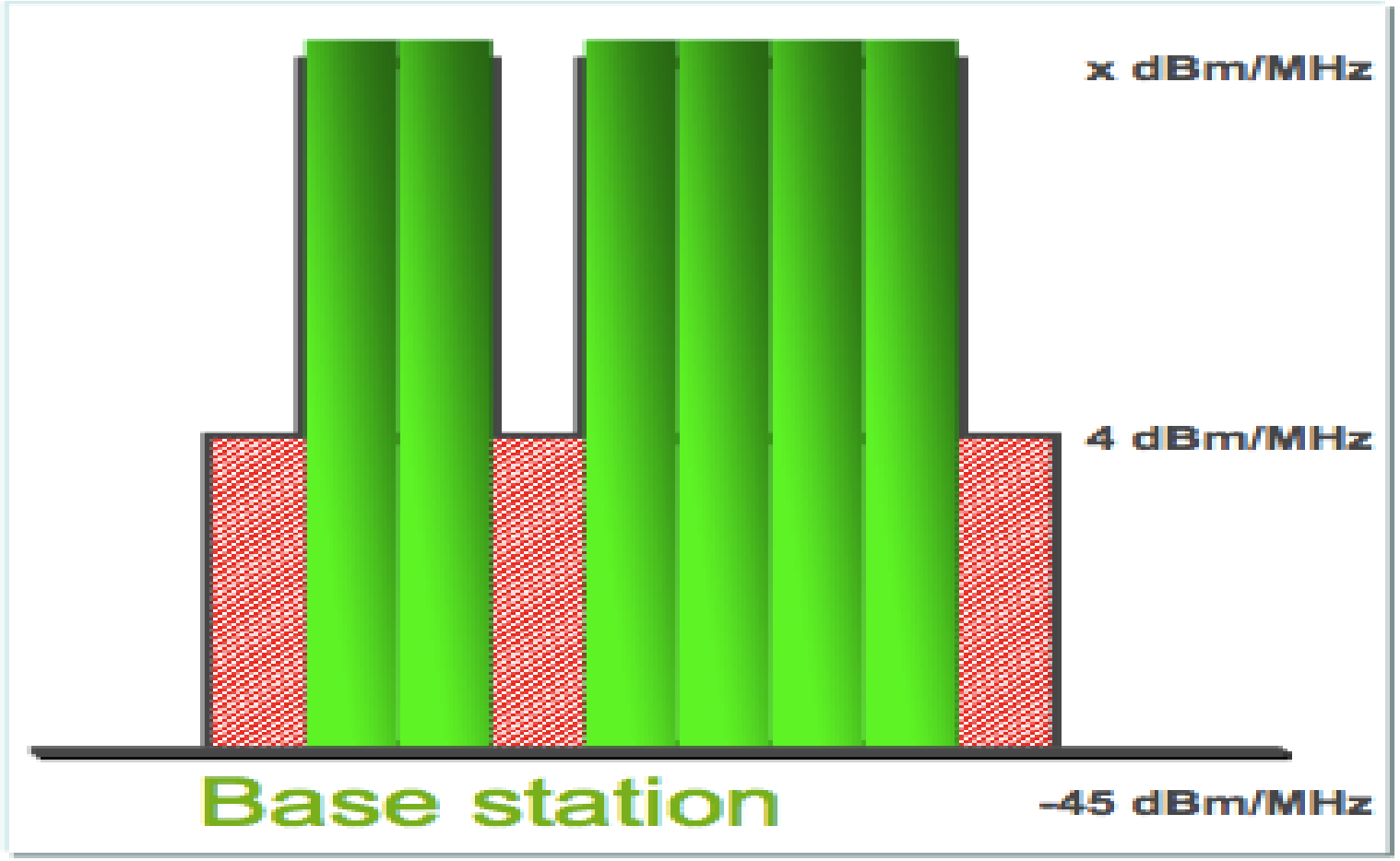
- Sufficiently high LTE base <=> EME system attenuation to avoid driving the respective receivers into non-linearity,

- LTE off-channel emissions, as seen by the EME system, at or below the EME receiver noise floor,

And, very important,

- LTE channels overlapping the EME band(s) must not be active!

LTE TDD spectrum mask as proposed by Ericsson



Power spectral density:

In-channel	≈ +50 dBm/MHz
1st adjacent channel	< +4 dBm/MHz
2nd adjacent channel	< - 45 dBm/MHz

In-channel peak power: ≈ +64 dBm

Example calculation

- Using the Ericsson numbers and further assuming:
  - LTE base – EME station separation = 1 km,
  - EME dish gain in the far sidelobes ~ (0...+10) dBi,
  - Unobstructed line-of-sight LTE base – EME station path,

the worst-case LTE power picked up by the EME antenna is

$P_{LTE=>EME}$ = (+64 -2 -70) dBm = - 8 dBm !

- This will drive the 2nd stage EME LNA into nonlinearity
- Extremely sharp filters will be required to prevent saturation
- Off-channel LTE emissions will be seen at -177 dBm/Hz
  - This is equivalent to an additional T_N = 145 Kelvin !

Summary and conclusions

- Swedish amateurs will lose 2300 – 2400 MHz in 2013,
- Thanks to dedicated work by the SSA excecutive and strong support from SNRV, ESR and IARU we will be able to keep 2400 -2450 MHz, albeit still only with a 100 mW power limit,
- It may be possible to obtain high power permits for EME also in the future, but the conditions for this will not be known until the 2.3-2.4 GHz band has been allocated to IMT and taken in use,
- Once IMT networks start to be deployed, EME reception in the 2301-2305 and 2320-2321 MHz segments may or may not be possible, depending on location and which mix of standards and channel widths is finally chosen,
- TDD LTE will be a very difficult case; a minimum geographic separation between LTE base and EME station of > 5 km will probably be required for successful continued EME work.

What to do if you should find yourselves in the Swedish situation:

- Work through your national amateur association and its frequency managers -
  - These have long established connections to your national spectrum administration, through it all the way to the ITU, and enjoy credibility,
  - They also have the right connections to IARU,
- Present the EME case and brief them until they understand the EME-specific problems,
- Ask them to bring the problem to the attention of your administration in a concerned but constructive manner,
- Help out with modelling, pitch in as ghostwriters if necessary -
- BUT DO NOT GO STRAIGHT TO YOUR ADMINISTRATION, such individual direct action often brings more harm than good!


Meanwhile:
Use the 13-cm band !
Thank you for your attention!
SM2BYA EME2012