

The 2.3–2.45 GHz Spectrum in Sweden: Past, Present and Future

Gudmund Wannberg SM2BYA
sm2bya@telia.com

Today, 432 MHz and above EME exists on borrowed time. None of our frequency allocations above 148 MHz is on a primary basis¹ and the commercial demand for more spectrum for broadband wireless access in the 2–10 GHz range is increasing all the time.

This paper presents a brief account of the history of the 13 centimetre band in Sweden, from the early 1990s to today's troubled situation, as documented through the records of the Swedish amateur radio association, SSA, the public archives of the Swedish postal and telecom authority, PTS; and as experienced by myself.

This account is by no means comprehensive – there have undoubtedly been things happening that never made it into the open, but affected the process in decisive ways – but it is believed to be factual and correct as far as it goes. Hopefully, it will also give colleagues from other Region 1 countries an insight into the kind of conflict for spectrum they may soon be faced with, and some hints on how to fight it.

Frequency Administration in Sweden

History pre-Y2K

The PTS was first established (under a slightly different name) in 1992 to take over the spectrum administration and enforcement duties from the old state telecom monopoly, Televerket, which was in the process of being dissolved in order to open up the Swedish telecom market in line with European Union practice.

At the time, the GSM standard for mobile phones had been adopted as a de facto pan-European standard, the first Swedish GSM network had just started up and the new administration was immediately faced with the problem of how to handle the licensing of (potentially) hundreds of thousands of mobile GSM terminals moving about the country in uncontrollable patterns or entering the country from abroad. The obvious solution – but previously untested and unheard-of – was of course to simply exempt all GSM sets from licensing, and this is exactly what the PTS did.

It was quickly realised that this saved the administration a lot of time and money, so PTS also started to exempt other selected type-approved low-power radio systems operating in coordinated frequency bands (e.g. security alarms, wildlife tracking transmitters, PMR etc.). In 1994, this practice was extended to include the amateur service. At the time, this was seen by many amateurs, and also by the SSA, as a good move: there would no longer be annual license fees to be paid, amateurs would be able to keep their calls for life and exams would be conducted by approved volunteers, all of which was expected to make the hobby more attractive. In hindsight, however, it is clear that the transition to license-exempt status also weakened the legal status of the amateur service relative to the PTS, just at the time when it was becoming more and more important to protect our remaining stakes in the UHF and microwave bands.

1. With a very few isolated exceptions that are not coordinated internationally. For instance, in the USA the 2.390 to 2.417 GHz segment is a primary amateur allocation.

The post-Y2K situation

In the pre-2000 Swedish frequency plan, the 2300-2450 MHz band was primarily allocated to *fixed-to-fixed* and *fixed-to-mobile* services, while the *amateur* service had secondary allocation status throughout the band. At the end of the 1990s, the Swedish defence forces started to establish a large number of point-to-point links in the 2300–2400 MHz band segment. These being *fixed-to-fixed* and therefore a *primary service* according to ITU definition, radio amateurs had to accept interference from them and had to yield to them if any interference resulting from amateur transmissions should arise.

In 2000 the PTS lowered the general amateur service power limit across the entire 2.3–2.45 GHz band from 1 kW to, believe it or not, *100 mW*! Ostensibly this was to protect the military links, but primarily it was an effort to protect the almost explosively growing use of 802.11b and 802.11g computer wireless network devices operating in the 2400–2450 MHz ISM segment from a perceived risk of amateur-generated interference (this was later openly admitted in a letter to the SSA VHF Manager). With this action, amateur radio in the 13 centimetre band had suddenly been put on an equal footing with computer wireless networks and ISM devices, making the band essentially useless for all amateur radio work except short- and medium-range data links. For a while, it looked as if 13 cm EME in SM was dead for good.

However, two circumstances worked in our favour. The military was the only *primary* user of the band at the time, so the PTS frequency planners adopted a pragmatic attitude: as long as the military raised no objection, radio amateurs could still be issued high-power (1 kW) permits on a case-by case basis. Then also a strategically placed SSA official who had previously held a high-level management position in the central defence supply authority used his connections to brief the military frequency management office. Following this, the military then became fully supportive of a continued amateur radio presence in the band.

During the 2000–2009 decade, some 20–30 amateurs applied for high-power permits for the 2320–2321 MHz segment. Each individual application was first forwarded to the military for approval, which as far as we know was given in all cases. The PTS then issued a license for 1 kW, valid for one year or until the end of the current calendar year.

Restricting the use of high power to 2320–2321 MHz was a deliberate move, suggested by the SSA, which almost guaranteed approval by the military and also served to align the Swedish high-power allocation with the IARU Region 1 coordinated 13 cm narrow-band allocation already established in many other European countries, e.g. DL and G. Indeed, most high-power permits were used mainly for terrestrial communications with other European countries in contests and tropo openings. Only a relatively small number of licensees already having EME capable dishes like SM2CEW, SM3AKW, SM4DHN and SM4IVE used their high-power permits for EME. I also obtained a high-power permit right away, hoping that I would eventually find the time to build a 2.3 GHz EME rig at my SM3 location – I had an unused Varian 4K3SL 1 kW S-band klystron sitting on the shelf. It is still sitting there...

Another important regulatory event also took place in this decade. On July 25, 2003, the old telecommunications law was repealed and replaced by the Law on Electronic Communications, LEK. The new law is strongly consumer- and market-oriented and governs the whole field of electronic communications in Sweden, both wired and wireless. An important change was that the administration was now given an opening to delegate the responsibility for conducting amateur radio exams and issue calls to an external body. PTS were quick to make use of this and delegated everything to do with exams and callsigns to SSA – but spectrum allocation and management and the enforcement of the radio regulations remained with the administration.

LEK also provided for competitive allocation of spectrum through auctions. This was a clear indication that the government saw a possibility to make money from the public demand for more bandwidth. In response to this, the PTS promptly created a *spectrum market division*.

The amateur high power permits had to be renewed on a yearly basis. Every year in November or December, high-power licensees (including myself) submitted applications for renewal, the PTS made a routine check with the military frequency management office, which raised no objections to a continued sharing of the band, and within a few weeks new permits valid for another year started to appear in the mail. By late 2009, the process had settled down into such a predictable pattern that the SSA proposed to the administration that it could simplify matters for all parties by delegating all aspects of the handling of applications for 2.3 GHz high-power permits, including the necessary contacts to the military, to the SSA.

The 2010 Debacle

But this was not to be. Even before SSA had received an official response to its 2009 proposal, the PTS suddenly started to reject all applications for renewal. Instead of the expected extension, each applicant received an ominous registered letter that he had to personally go down to the post office to collect and sign for. This contained a formal rejection of his application, stating that "the band was now under consideration for re-allocation", supplemented by a copy of the minutes of a formal handling of the application, references to the administration's legal support for its action, and information on how to appeal the rejection to the Stockholm county administrative court.

We should of course have been prepared for something like this, because from 2006 onwards, all high-power permits had had a caveat added at the end: "An extension of this permit beyond its term of validity cannot be guaranteed" – but I guess it is human nature not to take warnings such as these seriously, for as long as everything seems okay.

After some low-key investigating work by the SSA, the background to the abrupt change of policy began to emerge. At WRC-07, the 2300–2400 MHz band was identified as spectrum to be made available for IMT on a worldwide basis. In late 2009 the band was already being widely used for 3G services in Southeast Asia. Figure 1 shows an overview of existing allocations in some Asian countries.

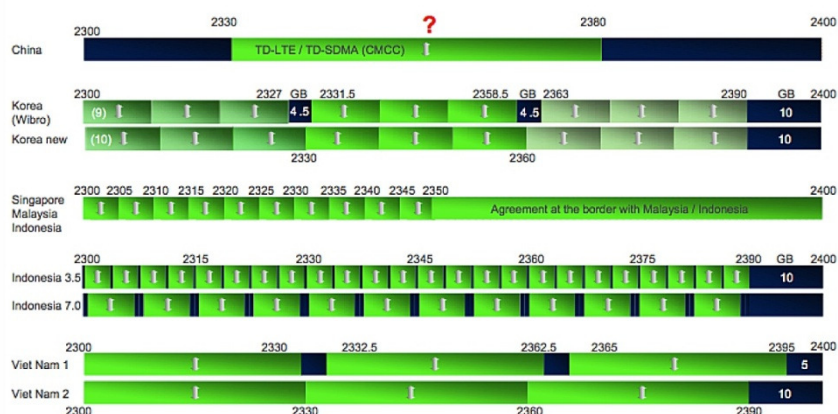


Figure 1: Intensive usage of 2.3–2.4 GHz bands in SE Asia (courtesy: Ericsson)

Swedish telecom industry interests (read: "Ericsson") had for some time been pushing hard to have the band allocated for mobile wireless access also in Europe, as a deci-

sive step towards establishing it as a globally coordinated allocation. The PTS (most likely the spectrum market division) had evidently taken this idea on board and started to clear the band in order to make it available for re-allocation by late 2011. The military, being the only primary user, had already been offered replacement spectrum for their fixed link needs and were expected to start moving out later in the year, but SSA as the formal representative of the amateur use of the band had been given no advance notice. Very little, if anything, of these plans had yet been published.

Somewhat surprisingly, it turned out that the direct reason for the PTS rejecting the amateur high-power applications was not the reallocation scheme as such, but a totally unexpected and different collision of interests. In late 2009, Mediatech, a commercial company providing mobile video link services for TV coverage of conventions, sports events etc. decided to invest in new terminals operating in the 2.3–2.4 GHz band and applied to the PTS for a nationwide licence for these. The company's application was forwarded to the military for approval, and this was given. The administration then issued the company with the requested licence, albeit only until the end of 2012. Unfortunately, the video links being classified as *fixed-to-mobile* made them a *primary* service. Since the first allocated channel, 2301–2321 MHz, overlapped both the 2304–2305 MHz and the 2320–2321 MHz EME spectrum slots, there was now a potential risk of secondary-to-primary-service interference, and so the administration had apparently decided to play it safe by rejecting all amateur (i.e. secondary user) applications for high-power permits to avoid having to investigate the compatibility issue in each individual case.

Reactions in the radio amateur ranks ranged from resignation to anger. Some individuals just sat back, waiting to see what would happen next. There was probably also some operation taking place that never happened officially... SSA went into high gear and started to prepare representations to the PTS. As for myself, I had finally collected all the component parts of a 2.3 GHz EME-capable station; the only thing remaining to be done was the mounting of the 3 m dish. Being so close to my long-term goal, giving up was simply not an option! So after consulting the SSA chairman I agreed to try the legal route to see if that would take the issue forward, and exercised my right of appeal to the Stockholm administrative court. Over the next ten months this cost me a lot of time and produced a lot of acrimonious correspondence between the parties without bringing the matter one step closer to a mutually acceptable solution.

2010: first public consultation

In late 2010, the spectrum market division at PTS finally informed the public about the planned re-allocation of the 2300-2400 MHz band and opened the matter for public consultation. Interested parties were invited to inform the administration about their potential spectrum needs in the band and their views on, for example, what type of licensing they would prefer (regional vs. national), what the minimum allocated spectrum block size should be (5 MHz or more), and perhaps most importantly, by what time they would want access to the band (PTS indicated that allocations could be made by 4Q 2011 at the earliest). While not mentioned outright, it was clear from how the questions were formulated that the intended target group of this consultation was the broadband industry and broadband operators. But others also responded, several of them in support of amateur radio, three of these being SSA, IARU Region 1 and SNRV, the Swedish national URSI committee.

SNRV has a double rôle: it is also an expert subcommittee of KVA, the Royal Swedish Academy of Science. In this capacity, it supports the scientific and educational use of the radio spectrum in Sweden and its opinions in radio-related matters carry considerable weight at the national level, sometimes even at PTS. SNRV now submitted a very concerned response, arguing that amateur radio should be allowed to retain at least a

small slot (500 kHz) for EME and other space work. A discussion of the extremely low cosmic background noise in the 2.3 GHz region, a summary of the international spectrum situation in the band, and brief description of the successful Sirius XM / amateur EME co-existence in the band in the US and Canada were presented. The response highlighted the implied removal of the amateur allocation from the band as an example of how the legitimate needs of ITU-recognised non-profit (e.g. scientific and educational) services were becoming increasingly threatened by commercial interests throughout the UHF and microwave spectrum. It was stressed that the PTS plan, if enacted, might set a precedent that could lead to a situation where amateur radio below some 20 GHz would eventually become impossible; which was seen as unacceptable.

The SSA submitted a response which was much more specific in the matter of frequency allocations, where reference was made to already existing international allocations at 2304 and 2320 MHz. The need for coordination with these was stressed and it was requested that at least 500 kHz be allocated to high power amateur radio at each of them.

Finally, the IARU response stressed the obligation of PTS to honour the ITU regulations and allocations:

"The diverse uses of the 2.3 GHz frequency band and the valuable experience gained by experimenters for the training of technicians in this frequency range call for a continued allocation in the 2.3 GHz band. The fact that the Amateur Radio Service deals with extremely weak signals should also be considered, and therefore any frequency sharing with amateur allocations ought to be restricted to individually licensed services.

We expect that the ITU Regulations be adhered to, and that the presently allocated spectrum remains allocated to the Amateur Radio Service on a world-wide basis."

With all this strong support, we again started feeling hopeful for a continued amateur radio and EME presence in the band – but we were still officially off the air!

2011: Sweden returns to 2.3 GHz EME

In early 2011, the PTS published a commented summary of the responses to the 2010 consultation. This document, advertised by the administration as a roadmap for future work, actually looked quite promising – in its comments, PTS explicitly "*noted the considerable demand for access to the 2.3 GHz band by the amateur radio service*" and stated that "*PTS will review the possibility of reserving spectrum space for this service*".

While all this went on, SSA had been very active behind the scenes. Through informal contacts and meetings with representatives from the spectrum management branch of the PTS, SSA had been able to secure a promise that PTS would again consider issuing temporary high-power permits for EME, if the new operator in the band, Mediatech, would agree to a sharing arrangement. After several rounds of negotiations between SSA and Mediatech, the latter agreed to raise no objections, provided the amateur operations could be terminated immediately in case of interference. This unexpected positive development caused SSA to encourage previous holders of high-power permits to re-apply; so in early 2011 some of us, including myself, successfully did that and were issued new high power permits. PTS was now evidently acting in accordance with its own roadmap!

The new permits were valid only until June 30 2011, but for the first time since 1999 we were again permitted to use high power in both the 2304.1–2304.2 and 2320.0–2320.1 MHz segments, thus making contacts into W/K, VE and VK much more straightforward than earlier. At this point I withdrew my legal appeal against the rejection of my earlier application, which had now been overtaken by events.

It has been said that there is nothing to concentrate the mind like the sight of the gallows. That pretty much summed up my feelings on receiving my new permit in February 2011: if I wanted to get on 2.3 GHz EME from Sweden, it was now or never! So in mid-April I took out four weeks of saved vacation, loaded the rig in my car and set off for my SM3 location in JP81nx, where I proceeded to mount the 3 m dish and set up the rig. I thought I had everything under control in time for the DUBUS contest, but after a sticking coax relay had resulted in four blown HEMTs I had to resign myself to SWLing. This was not all bad, as it gave me a feeling for the band. Two weeks later, with a new relay fitted, I finally made the grade with G3LTF and by the end of June I was up to 26 QSOs, 22 initials, 15 countries (including JA) and all continents except Africa, all in CW. Life was good!

And for a while things have continued to look good – the PTS extended our high-power permits, first until the end of 2011 and again until June 30, 2012, which allowed many of us to operate both in the ARRL microwave EME contest in September and recently in the DUBUS 2.3 GHz and up event in April. At the time of writing I am up to 31 initials and 20 countries and hope to add a few more before the end of June when my present permit elapses.

2012: a new threat

Just when matters appeared at least temporarily under control, PTS launched a seemingly harmless review of all spectrum allocated to licence-exempt radio services. When the results and conclusions were opened for public comment on December 12, 2011, we realised to our dismay that they contained a new proposal to *completely remove the amateur service allocation from the 2.3–2.45 GHz band, not just from 2.3–2.4 GHz but all the way to 2.45 GHz!* (PTSFS 2010:8, Chapter 3 § 117). This was justified in part by the following amazing statement (literal translation): "*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.*" We are still trying to figure out where the PTS got that from!

Even worse, the next paragraph stated that "*the mobile communications industry today has an annual turnover in the tens of billions*" of Swedish Kronor (equivalent to billions of US\$) and described the amateur service allocation 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*".

Since the general impression of the meetings between SSA and the PTS in 2010 and 2011 had been positive, this openly hostile attitude was very surprising; we had expected to see at least a narrow spectrum slot (200–500 kHz) reserved for amateur use somewhere in the band. But it did not stop there, for in January 2012 PTS re-opened the 2.3 GHz public consultation process. The information requested this time around was essentially the same as in the 2010 consultation, but with one important addition: user interest expressed in that round had evidently been large enough to indicate a potential co-existence problem, so PTS now also wanted to have users' views on compatibility problems and mitigation methods. However, none of the inputs to the 2010 consultation would be taken as read, so any party still holding an interest in the band would have to re-submit its comments and requests.

Immediate action was now necessary to protect the amateur service and prevent the total loss of the 13cm allocation. SNRV and SSA joined forces and in early February both entities submitted largely similar responses, first as comments to the frequency allocation revision plan and then also in response to the 2012 consultation. The independent Swedish amateur radio association ESR also submitted a response, addressing the amateur service situation in general. The inputs were based on the respective organisations' responses to the 2010 consultation, but in all cases with wording added

to show that the PTS had no objective justification for removing the amateur allocation in the 2400–2450 MHz band and that this allocation should therefore remain unchanged.

Present status

On April 3, the PTS published a compilation and analysis of the public comments to the planned revision of the frequency allocation table. In Section 4 of that document, the dissenting views of ESR, SSA and SNRV regarding the suggested removal of the 2.3–2.45 GHz allocation are presented and the administration implicitly admits that, as stated in the comments, it has no objective justification for removing the amateur allocation throughout the whole band. *The 2400–2450 MHz amateur service allocation will therefore be retained.*

So this is where the 2300–2400 MHz matter currently stands:

- Swedish amateurs will probably lose 2300–2400 MHz, probably from January 1, 2013.
- 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, we can expect bad interference from IMT base stations in the 2304 and 2320 MHz segments, perhaps so bad that EME reception will become impossible!

However, this may still not be the last word. Although the PTS seems to have taken it for granted that the military would give up all their stakes in the 2.3–2.4 GHz band with no argument, according to unofficial information the Swedish Defence Forces still have equipment that occasionally has to be used in the band in connection with “international cooperation programmes” (read: “NATO”). It will be interesting to see how the administration is going to handle that one, because it may have major implications for the grand scheme and thus possibly also for the amateur service.

The 2.3 GHz IMT–EME Compatibility Issue

Since the probable scenario now unfortunately seems to be one where we will have to learn how to work EME in a band full of strong terrestrial broadband transmissions, let us take a brief look at what we should expect and what can be done.

Our ability to receive weak signals somewhere in the 2.3–2.4 GHz band after the deployment of IMT services will be governed by:

- The IMT base station EIRP levels, spectrum masks and out-of-band emissions
- The possible inclusion of guard bands between IMT channels
- The diversity scheme employed (FDD or TDD).

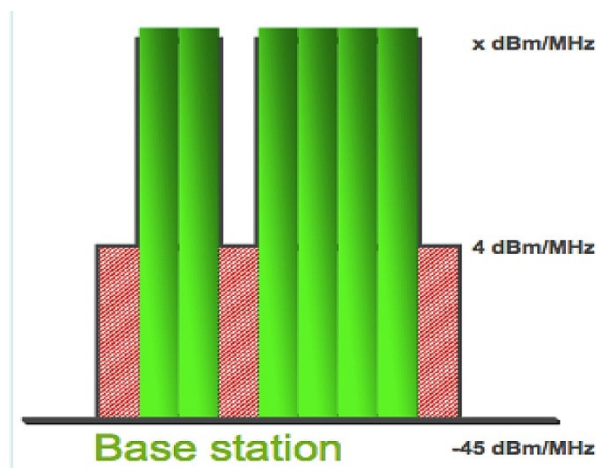


Figure 2: Proposed base station emissions mask. In-channel power density +50 dBm/MHz approx, 1st adjacent channel < +4 dBm/MHz, 2nd adjacent channel < -45 dBm/MHz
(courtesy: Ericsson)

Figure 2 shows a schematic representation of a base station spectrum mask as proposed by Ericsson for TDD LTE. While the base station EIRP and power density are not indicated, they are likely to be in the order of +64 dBm and +50 dBm/MHz respectively; that is, more than 50 dB higher than a typical 802.11 WLAN router. Assuming line-of-sight propagation, a well-designed EME dish located at 1 km distance from an LTE base and pointed such that the base station is in the far sidelobes, would pick up approximately $(+64 - 60 - 12) = -8$ dBm, more than enough to drive a second stage preamplifier into limiting if the LTE signal is allowed that far into the EME receiver. In these conditions, extremely narrowband filtering already after the first stage preamplifier will be required to avoid driving the receiver into saturation.

If overload can be avoided, EME reception may then be possible in IMT guard bands, if any are established, but only when the EME antenna is pointing well away from any nearby base station. If the administration can have things its way, the band will probably be planned for a mixture of WiMAX and LTE and all channels will be 20 MHz wide. This should put the border between the lowest two channels right at 2320 MHz, which *might* result in a guard band being placed there, so opening for some inter-European traffic. To work the US and Canada will probably require our brethren on that side of the Atlantic to transmit as close as possible to the low band edge at 2300 MHz. All of this presumes that the IMT base station out-of-band emissions stay well below the mask levels, which may not always be true in practice. On the other hand, if the band is eventually allocated only to TDD LTE, guard bands may not be possible; in that case, the situation in densely populated areas might become next to hopeless.

If you can, the best solution will of course be to set up your station at a location where there are no IMT bases nearby and where none are likely to be established – that is, in a sparsely populated rural area. Some of us who are currently active on the band, including myself, already enjoy that priceless advantage; but others live in built-up residential neighbourhoods and will probably find themselves in varying degrees of trouble. Only time will tell how things are going to work out.

Summary and Conclusions

In just a decade, the 2.3–2.4 GHz band has been transformed from virtually unoccupied territory into one of the hottest spots in the radio spectrum. The telecom industry is pressing hard to have the WRC-07 decision to allocate the band to IMT enacted worldwide, and developments like the one that recently has been taking place in Sweden

must be expected to soon start also in other ITU Region 1 countries, possibly resulting in the partial or total loss of amateur privileges in the band.

The Swedish EME community is very grateful for the commitment and hard work by the SSA executive and the support received from a number of influential friends of the amateur radio service, like SNRV, ESR and the Swedish defence forces. Thanks to the efforts of these bodies and individuals over the past three years, it was possible to save the Swedish 2400–2450 MHz amateur allocation and the possibility to get high power EME licences; without them, the whole 13 cm allocation would already have been lost. We shall now have to make the best of the new situation.

If some of you should eventually find yourselves in the Swedish situation, do remember that your national amateur radio association usually has one or more frequency managers who enjoy long established connections to your national spectrum administration, and through it possibly all the way to the ITU. Contact them, present the EME case, brief them until they fully understand the EME-specific problems, ask them to inform their counterparts in other national amateur radio associations and the IARU, press them to bring the problem to the attention of your national administration in a concerned but constructive manner, help them with modelling and by all means pitch in as ghost-writers to make sure that your specific points are mentioned.

But PLEASE do not go straight to your national frequency administration; such individual direct action often brings about more harm than good!

And meanwhile: use the 13 cm band while it is there !!!

List of abbreviations

ESR	Experimenterande Svenska Radioamatörer, an independent Swedish national amateur radio society
KVA	Kungliga VetenskapsAkademien, Royal Swedish Academy of Science
PTS	Post- och TeleStyrelsen, the Swedish Postal and Telecommunications authority
SEK	Swedish Kronor (Crowns)
SNRV	Svenska Nationalkommittén för Radiovetenskap, the Swedish National Committee for Radio Science which represents Sweden to URSI
SSA	Series SändarAmatörer, the Swedish Amateur Radio Association which represents Sweden to IARU
URSI	Union Internationale de Radio-Science, the International Union of Radio Science