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QORVO COMMENTS ON DRAFT OPINION RSPG 16-045:

A Spectrum Roadmap for IoT

DRAFT OPINION ON THE SPECTRUM ASPECTS OF THE INTERNET-OF-THINGS (IOT) INCLUDING M2M

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Qorvo Inc.

Qorvo is a major supplier of RF components and subsystems serving a wide range of markets and users, including mobile, infrastructure and defense using a variety of RF technologies. Qorvo components find application is such diverse products are smartphones, sensors for smart grids, cellular base stations and satellites. Qorvo is a major supplier to the cellular industry as well as to suppliers of license exempt communications technologies. Further information can be found in this products brochure and at www.qorvo.com.

Qorvo concurs with the broadly shared expectations regarding the growth and maturation of the Internet of Things technologies and applications. The comments are motivated by these expectations.

Executive Summary

- The RSPG is to be applauded for addressing this important subject. Industry, providers and users are well served with a long term view of spectrum provisions for this major growth area. It is a necessary basis for continued investments in systems, services and applications.
- The RSPG correctly recognizes that the cellular industry and providers have been served well with a very generous allocations of approximately 1200MHz of licensed spectrum in all segments of the sub-5GHz space. There is ample opportunity for the cellular industry to deploy a variety of IoT oriented products and services aimed at a broad range of IoT applications – covering narrowband, wide area as well as broadband, short range usage.
- The RSPG is not correct in its assessment that there is no shortage of license exempt spectrum for IoT/M2M applications or that such shortage is not likely in the near term. Compared to the 1200MHz cited above, the amount of license exempt spectrum is very limited: 107,5MHz of which 83,5MHz is shared with ISM applications. Developers of large scale IoT applications (e.g. city level management of energy street lighting and parking) have been faced with limited spectrum options in the sub-GHz range.
- SRDs are a very useful type of device for a variety of IoT/M2M applications. Spectrum allocations should take that into consideration.
- The emergence of “verticals” – large scale facilities which need both long range and short range IoT/M2M solutions are faced with limited options to deploy their own solutions tailored to their operating needs – creates another type of spectrum demand that is not easily accommodated by the existing regulations which are focused on “Short Range Devices” (SRDs).
- Innovation and the development of new communications for IoT/M2M applications is well served with a solid prospect of spectrum availability across a variety of frequency bands matched to operational needs. A fixed percentage per frequency range of licensed spectrum dedicated to IoT/M2M use would serve that purpose.

- Given the range of technologies – including ECS technologies as well as bespoke systems – available for IoT/M2M communications, adequate spectrum availability is required to allow users and system designers to choose the technology best suited to their needs.
- Although cognitive radio technology may ease the sharing of spectrum, the role of spectrum management, possibly based on new authorization models, remains important as a potential facilitator for efficient spectrum use.
- Although EU is a large market by any measure, it is just one part of a large world-wide market for IoT technologies and applications. This is exemplified by the emergence of world-wide cooperation on IoT application standards. Therefore, alignment of frequency bands and technical conditions with other regions should be a major consideration in the further development of the Spectrum Roadmap for IoT.

Comments on the text of the draft Opinion

1) pages 2 and 3

Item 2 states that "work is underway to make further spectrum bands accessible for IoT".

Although encouraging, this statement lacks a reference to the actual work being done, the frequencies under consideration and the context in which it is done.

Item 3 states that "spectrum [for IoT applications] is already widely available: bands for Short Range Devices, Mobile bands and those for Wi-Fi (WAS/RLAN)"

Although this is correct it is also true that the bands for Short Range Devices and Wi-Fi below 5GHz are not only heavily used, they are also a small fraction – less than 10% – of the spectrum available for licensed ECS use. The economic impact of this asymmetry is of comparable magnitude: the capacity available for private use is limited which in turn severely limits the options of IoT users to avoid the use of fee-based commercial IoT services.

Item 4 states that "[…the] roadmap could further facilitate these further economies of scale where currently they are only available on a national basis".

This text seems to confuse harmonization of spectrum availability - which, ideally, one should take for granted in the EU perspective – and the specifics of spectrum availability. As noted above it is necessary to designate a variety of spectrum bands for IoT use.

Further Qorvo disagrees with the suggestion that WAS/RLANs should be considered as part of the "IoT space" and with the inclusion of the 5GHz WAS/RLAN bands in the "IoT spectrum (roadmap). In fact, the 5GHz bands are allocated to the Mobile Service and WAS/RLANs have a key role in mobile and local Internet access. The spectrum utilization parameters of WAS/RLANs are very different from and in many case incompatible with those of IoT/M2M access systems.

Item 5 states that "There is no single authorization framework and no single set of technical conditions for access to spectrum which would cater for all possible [IoT] demands."

Qorvo fully agrees with this statement and recommends that a variety of harmonised authorization methods is developed which cover a range of possibilities – from exclusive authorization through registered use only to fully license exempt. Further, new authorization methods may be needed, e.g. a vertical authorization that contains a package of frequency bands dedicated for a given geographical location or campus and including adequate boundary conditions such as Band Edge Masks and geo-boundary RF power limits. A possibly useful model for a flexible authorization regime is the "Citizens Broadband Radio Service" of the FCC (FCC 15-047) which combines an occupancy data base and a number of authorization options.

Item 7 states that "Frequencies allocated or identified for ECS (mobile networks) may be used for emerging IoT applications and services. Following the principle of technology neutrality, it should be ensured that the existing harmonised technical solutions fit with those for IoT."

The reference to "existing harmonised technical solutions " is in direct conflict with the notion of technology neutrality: the existing harmonised solutions are all technology specific: the ENs for ECS frequency bands are based on 3GPP standards. This is not necessarily detrimental; in fact, efficient spectrum usage is served best with a single type of technology. Therefore, adaptation of the current technical conditions for the harmonised ECS bands so as to accommodate other technologies will not provide the benefits expected. Instead, allowing a fraction of an ECS bands to be used by other technologies could be beneficial - given that they comply with certain regulatory criteria such as in-band power limits and Block Edge Masks. This fraction may vary with time to allow adaptation to market developments.

Item 8 states that the RSPG members "….may seek to explain the opportunities for spectrum access for IoT".

Qorvo agrees with this approach and suggests that it be considered to broaden it into a two-way sharing of information that supports the further development of this important subject.

2) Annex

Section 1, Defining IoT

This section concludes with "For the purposes of this overview and taking into account similar recent work in BEREC, it was not considered necessary to determine specific definitions for IoT/M2M. The intention is to take an inclusive view of connected devices and the spectrum they need."

Qorvo concurs with the general idea expressed here but considers the "inclusive" view of IoT/M2M as including all kinds of connected devices as potentially confusing and detrimental to the issue of spectrum for IoT/M2M applications. As noted above we

consider WAS/RLAN devices and applications to be distinct from IoT/M2M in general, mostly because of the type of services that these are used for – private and/or personal broadband communications. This distinction is reflected in tables of Section 2 of the Annex to the draft Opinion.

Section 3, Multiple frequency bands, opportunities for both general and individual authorisation models

Although this section opens with the statement that different authorization models may be needed to service various use cases and operational requirements, it proceeds to discuss only two extreme cases: general authorization based on a small set of technical requirements and individual authorization for a variety of applications. The general authorization is assumed to apply to "consumer IoT", the individual authorization is assumed to apply to professional and commercial communications services.

As noted above, Qorvo sees the need for a broader set of regulatory tools to manage spectrum allocation and use to various types of entity. These tools should take into account that there are many ways to share spectrum – including RF power and duty cycle restrictions but also antenna directivity and contention based access. The usefulness of each depends on geographical scale as well as on application requirements.

In some cases, new authorization methods may be needed, e.g. a vertical authorization that contains a package of frequency bands dedicated for a given geographical location or campus and including adequate boundary conditions such as Band Edge Masks and geo-boundary RF power limits such as used by the FCC for the Citizens Broadband Radio Service (see FCC 15-047). Finally cognitive radio technologies beyond the simple Listen Before Talk currently defined in harmonised standards may enable new approaches to flexible, non-exclusive authorization models.

Section 4: An expected increase in demand for spectrum in the medium and/or long term

Sectorial requests for spectrum authorizations are to be expected but these will not necessarily be requests for exclusive authorizations. For some IoT/M2M applications highly reliable communications will be required but this need not imply a need for full exclusivity in geographical space or at all times.

There are many models of spectrum authorization between the extremes of exclusive licenses and general authorization. As this section notes,

> "*it is essential to focus now on the accessibility of appropriate frequency bands, their efficient management, the capacity of bands under both general and individual authorisation schemes, to cover all expected uses and not hinder the development of the IoT*."

This suggests that frequency managers will select frequency bands and associated authorization models. Qorvo is ready to support such forward looking activities and we assume that applies for the IoT industry in general.

Section 5. Spectrum resources under general authorisation model

The statement "*Bands whose use is under general authorisation model do not seem to be a short-term hindrance to the deployment of IoT because the usable spectrum seems sufficient.*" may be considered true but only for the 2.4GHz ISM band and even that band is heavily used today. The "popularity" of the 863-870MHz band is a clear indication that – contrary to the text of this section – there is a de facto shortage of spectrum suitable for IoT applications which require better propagation conditions than those of the 2.4GHz band. More spectrum with good propagation conditions and a flexible authorization regime is needed to foster the growth of many professional IoT applications.

The listed considerations for work on for spectrum management under a general authorization model certainly point in the right directions but merit a few comments:

- Technology neutrality is a two-edged concept: it avoids top down prescriptions for how spectrum should be used but the freedom of use has the downside that incompatible, mutually destructive technologies could be deployed in the same frequency band. A case in point is the Wi-Fi/LTE incompatibility, which, in the case of the 5GHz WAS/RLAN band, has led to convergence of the medium access methods of the two technologies. There are other examples.
- "Equal opportunity of access to spectrum" is a laudable goal but achieving it is difficult if not impossible because there is no agreement on how to express such equality in general terms. Therefore frequency band specific solutions may have to be found or developed which take into account all three major metrics of spectrum use: Space (i.e. RF power), Time (e.g. duty cycle) and Frequency (i.e. bandwidth).
- New authorization arrangements, possibly frequency band specific, may well benefit from the use of such metrics and so avoid setting technical requirements (in harmonized standards) that de facto freeze the status quo and block innovation.
- Qorvo fully concurs with the need for market surveillance to ensure that spectrum usage remains compliant with the applicable technical requirements.
- The frequency band 1900-1920MHz would be a suitable band for IoT applications that require a more predictable interference environment than that of the 2.4GHz band. Notably Narrow Band IoT (NB-IoT)applications would be suitable for this band. However, the suggested shared use of this band by IoT application, SRDs and DECT needs careful analysis: DECT's TDMA protocol does not accommodate shared spectrum use very well and allowing its use in this band might well reduce the achievable performance benefits of IoT and SRD devices and vice versa.

Section 6. Spectrum resources under [the] individual authorisation model

As the draft Opinion states, the spectrum available under the individual authorization model amounts to some 1200MHz below 5GHz. This spectrum is usually licensed to ECS service providers and it is therefore not available for other types of use by private entities. The implication is market distortion: such private entities have little alternative when negotiating communication fees with service providers. Therefore making some of this spectrum available for non-profit types of use – possibly using ECS technology – warrants consideration.

Mission critical and safety related communications such as used for the management of urban resources, energy distribution, etc, are often associated with spectrum subject to individual authorization. However, there is a broad range of operational requirements that fit between the extremes of mission critical/safety of life and best effort communications. A key example is “business critical” communications which are an integral part of business (or institutional) operations. Such communications may be able to accommodate temporary degradation of service without this causing major losses or threaten lives. Spectrum authorizations for such purposes need not be fully exclusive in space and time and the services offered are likely to be compatible with a License Shared Access regime or a for a flexible authorization regime such as the “Citizens Broadband Radio Service” of the FCC (FCC 15-047) cited above.

Although the draft roadmap is correct in stating that “IoT functionality will be designed into 5G from the start, it must be pointed out that without an available alternative, IoT users will be forced to use ECS based IoT serves and face potentially stiff network fees. There are two basic ways to assure viable alternatives: different exclusive authorization regimes in the same frequency band for commercial and utility operations using ECS technology and, secondly setting aside a subset of an ECS frequency band for non-ECS use under a flexible, technology neutral authorization regime also for utilities.

The 800MHz band is a good candidate for this approach since there is less interest from ECS operators for this band than expected. Given adequate regulatory criteria, “utility” authorizations would allow users to establish business critical or mission critical IoT operations in this band while restricting interference into xDSL and cable infrastructure. A similar authorization regime could be applied in the case of the 400MHz band.