Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Waiver of Part 25 Licensing Requirement for	)	IB DOCKET No. 17-16
Receive-Only Earth Stations Operating with the	)	
Galileo Radionavigation-Satellite Service	)	

COMMENTS OF BROADCOM CORPORATION

Broadcom Corporation ("Broadcom") submits these comments in response to the Public Notice issued by the Commission for comments on whether to provide a waiver of Part 25 licensing requirements for receive-only earth stations operating with the Galileo radionavigation-satellite service.[1/] Broadcom strongly believes that modern GPS and Galileo combination receivers are not more susceptible to degradation from adjacent or nearby band operations than GPS-only receivers. In fact, the addition of Galileo potentially provides a large performance advantage.

I. INTRODUCTION

Broadcom is a global leader in wired and wireless communications semiconductors. It ships well over seven million chips on a daily basis, has a meaningful presence in nearly all categories of products that require communications chips, and has one of the broadest portfolios in the industry.

Broadcom's best in class Global Navigation Satellite System (GNSS) chips have been incorporated in market leading flagship smartphones for the last ten years. Over one billion chips have been shipped to date. This success relies on Broadcom's track record of innovation in the mass market GNSS industry, such as being the first manufacturer to produce multiconstellation GNSS chips, and inventing Long Term Orbit (LTO) assistance.

[1/] *See FCC Seeks Comment on Waiver of Part 25 Licensing Requirement for Receive-Only Earth Stations Operating with the Galileo Radionavigation-Satellite Service IB Docket No. 17-16.*

II. ADDING GALILEO MAINTAINS THE SAME LEVEL OF SIGNAL PROTECTION

Historically receivers were GPS-only, designed with the necessary external radio frequency (RF) components - antenna, low noise amplifier (LNA), and bandpass filter. Now, with the recently launched Galileo satellites, manufacturers contemplate making GPS + Galileo combination receivers. A well-designed modern GPS + Galileo receiver in L1 does not need any change in the RF path versus a GPS-only receiver, which simplifies things for manufacturers as well as ensuring that the same level of protection against adjacent or nearby band operations remains after the addition of Galileo.

In the digital domain, the GPS L1 and Galileo E1 signals are different. These signals are routed to different paths to be processed accordingly, which ensures the same level of robustness compared to a GPS-only receiver.

Finally, all the GPS and Galileo measurements are available to the Positioning, Navigation and Timing (PNT) determination algorithm. A well-designed modern GNSS receiver will use them as needed. The protection against poor measurements is both at the GNSS assistance data level, and at the PNT determination level. At the data level, some signals can be flagged as "not to use" if a problem is detected by the system generating the assistance data. At the PNT determination level, a high value residual flag for a particular signal means that it is excluded from the pool of measurements used by the PNT determination algorithm.

III. THERE ARE MULTIPLE MECHANISMS TO FILTER OUT INTERFERENCE IN A WELL-DESIGNED RECEIVER

There are no licensed external signals that cause degradation to well-designed consumer-grade GNSS receivers. Out of band licensed signals are sufficiently filtered in the receiver. Any jamming that does occur is the result of other transmitters within the device or spurious emissions from very local, or even internal, sources. Great care goes into the design of

consumer-grade GNSS receivers to provide the best possible performance in any signal environment.

In well-designed GNSS receivers there are many stages of filtering, each optimized for performance, cost, and power consumption. There is filtering at the antenna, in the RF input path to the receiver chip (usually in the form of a surface acoustic wave (SAW) filter), in the analog radio frequency and intermediate frequency (RF/IF) chain of the receiver, and finally many stages of digital filtering of the receiver. Generally each stage of the system has a progressively narrower passband.

- Antenna –often just very minor filtering of other transmitters within the consumer device.
- RF input path –SAW filters provide significant attenuation of other transmitters within the consumer device. The passband of the SAW is much wider than the main lobe of the GPS signal in order to allow for manufacturing tolerance and variations in desired amount of side lobes to be received.
- Analog RF/IF chain –little filtering is done at the RF stage but a significant amount of filtering is done at the IF stage to isolate the desired signal and reject interference.
- Digital filtering –design decisions will dictate the balance of filtering between the analog RF/IF and digital stages, but the final filtering will occur in the digital domain. This includes precise filtering of close-in jammers. The digital filtering is configurable by the receiver and can adapt to signal conditions.

Since the bandwidth difference between GPS-only and GPS + Galileo is small, all consumer receivers are equally susceptible to degradation of the reception of GPS due to adverse signal conditions whether or not they are capable of receiving Galileo signals.

IV. BENEFITS OF GALILEO

The most critical factor in getting a fix is visibility to the receiver of an adequate number of GNSS satellites. This is difficult in urban conditions where much of the sky may be

blocked. Including Galileo support in the GNSS receiver provides additional spatial diversity to the GPS constellation, providing greater opportunity to get a high-quality fix and increases the ability to get a fix under challenging conditions. In the case of 911 services these factors can have life or death consequences.

V. CONCLUSION

Broadcom strongly believes that a combined GPS + Galileo system will outperform a GPS-only system while not suffering any degradation as a result of the addition of Galileo in receiver designs. The improvement provided by the addition of Galileo is extremely inexpensive to the consumer and has no effect on the level of protection of the GNSS receivers against adjacent or nearby operations.

Broadcom is unaware of any technical concerns that would bar the grant of an FCC waiver for use of Galileo signals and based on the potential benefits, strongly urges the FCC to grant such a waiver.

Respectfully submitted,

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