Conflicts between Operations on the Proposed H-Block and Existing PCS Receivers

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August 2004

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Executive Summary

Without adequate safeguards, use of the AWS H-block for a PCS-like service would create harmful interference to existing PCS handsets because those handsets were not designed to tolerate transmissions in such nearby spectrum. Quantifying the impact of such interference awaits the outcome of testing. However, analysis based on basic properties of radio components indicates that such interference will occur. Operations on the H-block will also negatively impact future MSS operations in the MSS spectrum adjacent to the upper H-block frequencies.

There is also the threat of significant harmful interference caused by out-of-band emissions ("OOBE") from portable handsets operating in the H-block if the FCC fails to adopt service rules that include OOBE limits as protective as those set forth in industry standards (*i.e.*, -76 dBm/MHz). The industry incentives for mitigating such interference may be much weaker than the corresponding incentives in the PCS industry—incentives that have supplemented the FCC rules and have successfully controlled such interference in the PCS service.

Issue

The FCC has allocated the frequency ranges 1915-1920 MHz and 1995-2000 MHz for use in the advanced wireless service (AWS). These frequencies are often referred to as the H-block—in parallel to the naming of the blocks in the PCS spectrum. However, if the H-block frequencies were to be used for a PCS-like service, the transmissions by portable units operating on the H-block would create interference to PCS receivers. The extent of such interference is unclear and appropriate precautions, such as protective service rules for the H-block, could substantially reduce such interference.

Currently there are about 165 million wireless subscribers in the United States—the majority of whom use portable units that can operate on the PCS band. These portable units, as well as those in the delivery pipeline and in the factories, were designed when there was no need to protect such portables from transmissions in the H-block. Rather, the H-block frequencies were regarded as guard-bands that were essentially empty.

Desensitization

The possibility of interference arises from the fact that neither transmitters nor receivers are ideal systems—transmitters emit radio signals outside their assigned band and receivers respond to radio signals outside the band or channel to which they are tuned. The receivers in existing PCS portables will respond to signals outside PCS band. The nature of that response depends on the strength of the signals, the nature of those signals, and the frequency at which those signals appear. PCS receivers must be able to listen to transmissions from a base station while, at the same time, transmitting back to that base station on a nearby frequency. For example, a PCS portable operating in the PCS A block would listen to transmissions in the range 1930-1945 MHz while, at the same time, transmitting in the range 1850-1865 MHz. The electronics in the PCS handset must protect the handset's receiver from the strong signal transmitted by the handset and from PCS signals, perhaps at 1910 MHz, transmitted by nearby PCS users.

The key building block in PCS handsets that provides this protection is the duplexer filter. Duplexer filters connect a handset's transmitter and receiver to the handset's antenna but isolate the transmitter from the receiver. Typically a duplexer has a filter that passes the PCS base-to-mobile frequencies to the receiver but that blocks PCS mobile-to-base signals from passing to the receiver.

A representative duplexer is Agilent's HPMD-7905 FBAR Duplexer for US PCS Band.[1] Agilent's single unit price for this duplexer is $9.95. Obviously, in large quantities the price would be much lower; however, given that unsubsidized retail prices for basic PCS phones are in the range of $100 to $200, it is clear that the duplexer contributes significantly to the manufacturing cost of a PCS handset.

The duplexers in existing PCS handsets were designed to prevent or block signals in the lower half of the PCS band from flowing to the receiver portion of a handset while

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[1] The datasheet for this device is available at http://we.home.agilent.com/cgi-bin/bvpub/agilent/Product/cp_Product.jsp?COUNTRY_CODE=US&NAV_ID=-536893470.536886300.00&LANGUAGE_CODE=eng.

permitting signals in the upper half of the PCS band to pass to the receiver. Figure 1 shows the PCS band plan. In the 20 MHz of separation between 1910 MHz (the highest transmit frequency for PCS handsets today) and 1930 MHz (the lowest frequency that PCS handsets must receiver) the duplexer's filters must change from blocking signals to passing signals without attenuation. Although 20 MHz may seem like significant frequency separation, one must recall that these filters operate at 1900 MHz, so 20 MHz is only 1% of the center frequency of the filter.

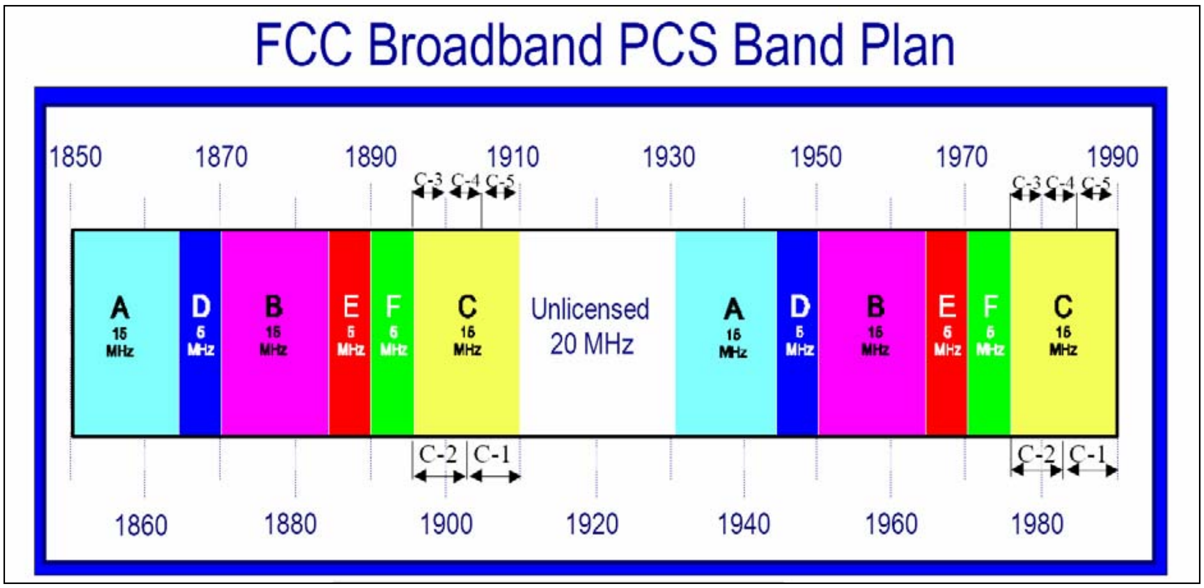

Figure 1 The FCC's PCS Band Plan

As shown in Figure 2, the lower half of the H-block is located in the middle of what today is the transition region for the duplexer filters. The filters in today's PCS receivers were designed to reject strong signals from nearby transmitters in the top of the C-block—just below 1910 MHz and to accept signals at the bottom of the A-block at 1930 MHz; they were not designed to reject strong signals from nearby transmitters in the H-block.

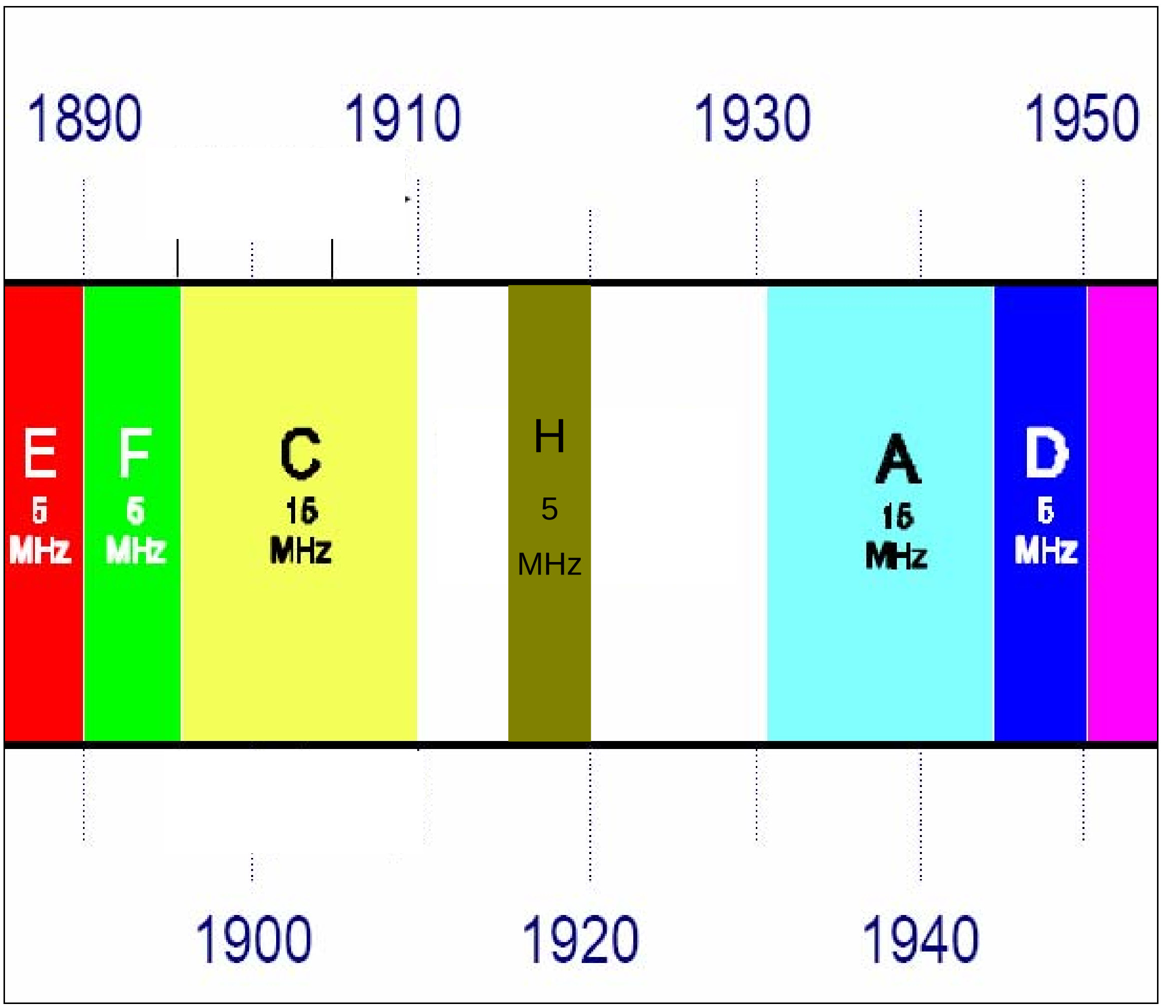

Figure 2 . Location of the lower half of the H-block

The impact of H-block operations on existing PCS handsets can be calculated based on the specified performance of duplexers. Such calculations indicate that a portable operating on the H-block is likely to impair the function of nearby PCS handsets. Such calculations cannot provide any certainty regarding such impacts. Questions regarding the severity of the impairments, the mix of susceptibility and resistance among current handsets, and the separation distance at which H-block operations impose negligible harms can only be answered by testing the impact of H-block transmissions on several real handsets.

Out-of-Band Emissions

A second mechanism whereby H-block operations can harm existing PCS operations is if an H-block portable inadvertently transmitted energy on frequencies outside the H-block. Such transmissions are known as out-of-band emissions and are a natural consequence of the operation of any radio system. The FCC's PCS rules limit out-of-band emissions by PCS handsets.[2] However, PCS industry standards impose far stronger constraints on out-of-band emissions.[3] In order to take advantage of economies of scale in manufacturing and to support roaming, PCS service providers purchase PCS handsets that operate across the entire PCS band. Because of the patchwork nature of PCS band licensing and the need to support roaming, PCS service providers have strong incentives to limit the out-of-band emissions of all handsets used by their subscribers.

However, one can imagine scenarios in which a new entity entered the wireless industry using handsets operating only on the H-block or perhaps on the G-block and the H-block. Such a firm would have no incentive to protect existing PCS handsets from out-of-band emissions beyond the level of protection required by the FCC's rules. Handset filters that would provide sufficient out-of-band attenuation to protect other G-block and H-block handsets could also permit substantial harmful interference in the A, D, B and E PCS blocks—and perhaps even the F-block and the bottom of the C-block.

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[2] *See*, *e.g.*, 47 C.F.R. § 24.238 (-13 dBm/MHz for broadband PCS); 47 C.F.R. § 22.917(a) (-13 dBm/MHz for cellular).

[3] *See* Letter from Paul Garnett, CTIA—The Wireless Association™, to Marlene H. Dortch, FCC, filed July 30, 2004, at 7 (listing OOBE emissions requirements under FCC rules and industry standards).

Given the disparity between the FCC's PCS rules and industry practice, together with the element of moral hazard implicitly created by the incentives associated with higher out-of-band emissions, it is natural that the issue of H-block out-of-band emissions gives significant concern to some in the PCS industry.

MSS Problems

The upper half of the H-block is adjacent to a mobile satellite service (MSS) band. It is hard to imagine any scenario in which H-block operations do not impair or limit future MSS operations. In essence, if the H-block is built out, the MSS industry will have to accept the loss of a few MHz of spectrum as an implicit guardband.

How Bad are the Problems?

This paper does not analyze in any detail the nature of the impairments to the MSS. As indicated above, these problems appear to be substantial.

The problem of out-of-band emissions is technically tractable. But the solution depends on the FCC adopting service rules that reflect current PCS industry practice. Absent such rules out-of-band emissions could significantly impair PCS operations.

The desensitization problem is real although a detailed understanding of the harms awaits the results of testing. However, one can envision scenarios in which this problem creates significant harms. For example, many public safety organizations have chosen to use data services, such as CDPD, provided by wireless carriers rather than build their own networks. Today's wireless data solutions, such as EVDO and EDGE, are substantially superior to the earlier CDPD and it is likely that many public safety agencies, will choose to use these new wireless data solutions to provide data communications capabilities for first responders. Consider an automobile collision in which one driver has a block-H handset. It could easily be the case that calls placed on a block-H handset by an uninjured driver trying to rearrange his or her calendar for the rest of the day would repeatedly interrupt or disconnect data telemetry from an ambulance at the scene. Such interference would clearly be significant to those injured in the accident.

About the Author

Chuck Jackson is an electrical engineer who has worked extensively in telecommunications regulation. He served on the staff of the FCC and of the Commerce Committee of the U.S. House of Representatives. He works as a consultant and is also an adjunct professor of electrical engineering and computer science at George Washington University, where he has taught graduate courses on mobile communications, wireless networks and the Internet. He is a member of the FCC's Technological Advisory Council. Dr. Jackson received his PhD from MIT. A more complete biography is available at www.jacksons.net.