TDD is Better Than FDD for Sharing

Another of Qualcomm's claims which reflects a lack of knowledge regarding the existing OFS users within the 1850-1990 MHz band is Qualcomm's assertion that FDD actually helps by 3 dB in sharing with OFS[18]. However, Qualcomm's FDD system will need to find two frequencies.whereas Omnipoint's TDD system will need to find only one non-interfering frequency at a given location. Exacerbating this disadvantage of FDD is the fact that OFS licensees follow 80 MHz pair spacing only some of the time; actual pairings range from 40 to 120 MHz within the OFS band. In high OFS density regions, non-standard OFS duplex spacings approach 50% in many MSAs. Consequently, FDD air interfaces will be forced to use variable duplex spacing in order to coexist in these areas, and still may not avoid the OFS receivers depending on the geographic pattern of the OFS frequencies. Variable duplex spacing would necessitate extremely complex hardware architectures in contrast with a TDD air interface.

In figure 1 we plot the probability that a PCS operator can find suitable frequencies to commence operations as a function of a single frequency OFS necessitated exclusion probability using a Bernoulli trial analysis for any given $2x10 = 20$ MHz block. Even with only 50% of the frequencies occupied by OFS at any given cell site, the FDD system is unable to begin operation in 75% of the geographic areas while the TDD system is excluded less than 25% of the time. Stated another way; even with a random distribution of OFS the TDD PCS system is 3 times more likely to find a frequency allocation compared with an FDD system.

To gain some understanding of the magnitude of the initial sharing problem; COMSEARCH performed a study of the Detroit MSA (32 microwave paths) and presented these results to Telocator on April 13, 1993[19]. In their study, COMSEARCH assumed a TDD PCS system and

[18]page 4/5 of Appendix A: "... the difference between duty cycles improves (for Qualcomm) from 14 dB to 17 dB because the Qualcomm system uses frequency division duplexing (FDD)."

[19]"Spectrum Allocations and Their Impact on Microwave User Relocations: A Case Study.", COMSEARCH, March 12, 1993, Telocator Doc. Number TE/93-4-13/239

still found a requirement to relocate as many as nine OFS operators within the initial PCS deployment time frame assuming even a 30 MHz allocation. Imagine how much worse the situation would be with an FDD air interface.

The Proof is In The Experimental Reports

Omnipoint's approach to OFS sharing has been the subject of hundreds of pages of experimental data. Omnipoint's techniques have been tested or studied specifically for their sharing capabilities by many companies including:

- Southwestern Bell
- McCaw
- Oracle
- APCN
- LCC
- Alcatel
- Westinghouse

In every case, Omnipoint's system was verified to perform as predicted in its pioneer's preference claims.

In contrast, Qualcomm's sharing claims are based on a few paragraphs of a relatively simplistic analysis. Further, the only experiment we are aware of is the January 1993 APC test.

In Omnipoint's last experimental reports (attached to its reply comments dated March 1, 1993) we pointed out that while APC is developing methodologies for avoiding OFS frequencies in use in a given area, the tests of Qualcomm's system shows substantial interference to OFS receiving equipment from Qualcomm upbanded basestations operating at normal radiated power levels of 4.1 to 6.6 Watts. Using the clearly labeled data tables in APC's report, we simply plotted the data to show that upwards of 25 dB of degradation was occurring to the OFS receiver. Qualcomm has

objected to the interpretation of these findings by implying that 5 watts is not their normal transmit power, even though this is the number given for their coverage/capacity numbers.

However, consider the effects of turning down Qualcomm's power. In APC's experimental program they reduced Qualcomm ERP until interference effects became relatively benign in accordance with TSB-10E definitions. Specifically, APC found that when received Qualcomm signal strength is -101 dBm into the OFS receiver, it does not cause harmful interference[20]. However, Qualcomm never states what the EIRP must be when it finally becomes benign under the same test conditions.

In APC's test program, the victim OFS receiving antenna (Garfield) is at 480' AMSL[21] while the Qualcomm base station sites are located between 150' and 495' AMSL. Exhibits 3 and 4 in APC's report show unobstructed line of sight paths between the Garfield site and Qualcomm basestations designated DC1 and VA1. Exhibit 2 shows a 25' obstruction near the DC2 site location. For all intents, we can assume free space propagation exists between the Qualcomm sites and the victim OFS receiver. Measured interference power going into the victim OFS receiver is described by:

$$\mathbf{P_{received} = EIRP + G_r - PL}$$

where:

$P_{received}$ = Receive Power Level (dBm)
EIRP = Transmitted Isotropic Power Level (dBmi)

[20] 45-th page of Appendix V in APC report.

[21] Above Mean Sea Level

G_r = OFS Receiving Antenna Gain in Direction of Interfering Transmitter (dBi)
PL = Propagation Path Loss (dB)

At 1970 MHz, free space propagation path loss is described by:

PL = 102.46 + 20 log R

where:

R is slant range (miles)

Solving for EIRP and assuming -5 dBi OFS antenna gain in the direction of the Qualcomm site we obtain Table 1.

Table 1: Allowable Qualcomm Basestation EIRP to meet Interference Objective

Site Name	Range to Victim OFS Receiver	Allowable Basestation Transmit EIRP to Generate −101 dBm Into -5 dBi OFS Receiver
DC2	0.45 Miles	1.39 milliWatts
DC1	2.61 Miles	30.16 milliWatts
VA1	4.56 Miles	92.08 milliWatts

Qualcomm base stations do not provide significant coverage at these power levels because of their CDMA nature. In fact, in APC's coverage testing, actual base station pilot power levels alone were 1.53 Watts, 1.85 Watts, and 2.15 Watts[22]. This is the transmitted power level in the absence of traffic. APC indicates that the base station will need to transmit an additional 0.198 to 0.226 Watts per user in order to carry traffic[23]. Base station transmitted powers of 4 to 6 Watts are typical in the APC configuration. In both their March and July 1993 reports, APC notes that the base stations transmit 5 Watts.

[22]Page 8 of APC report.

[23]Pages 9 and 10 of the APC report.

For example, in their July 27, 1993 filing, APC confirms this in describing some of their microcell testing in the Washington D.C. area:

> *"This microcell employs a 5 watt power amplifier, which is the same power as the base stations."*[24]

Thus the APC tables used in demonstrating 25 dB of OFS degradation due to Qualcomm basestation interference are representative of typical Qualcomm operating conditions.

Note that 5 Watt power levels are not particularly high for the Qualcomm system. In Qualcomm's November 4, 1992 filing with the FCC, they indicate a base station ERP of 100 Watts for their 800 MHz testing and 39.7 Watts for their 1700 MHz testing. Also see MCI's July 1993 report which describes the two base station transmit powers as being 20 Watts and 16 Watts.

In conclusion the experimental evidence stands on its own.

[24]Re: American Personal Communications KC2XDM, FCC File No. 2056-EX-R-92, Twelfth Progress Report. dated July 27,1993.

Time Division Duplex Helps Ensure Ability to Find a Frequency in Each Geographic Location

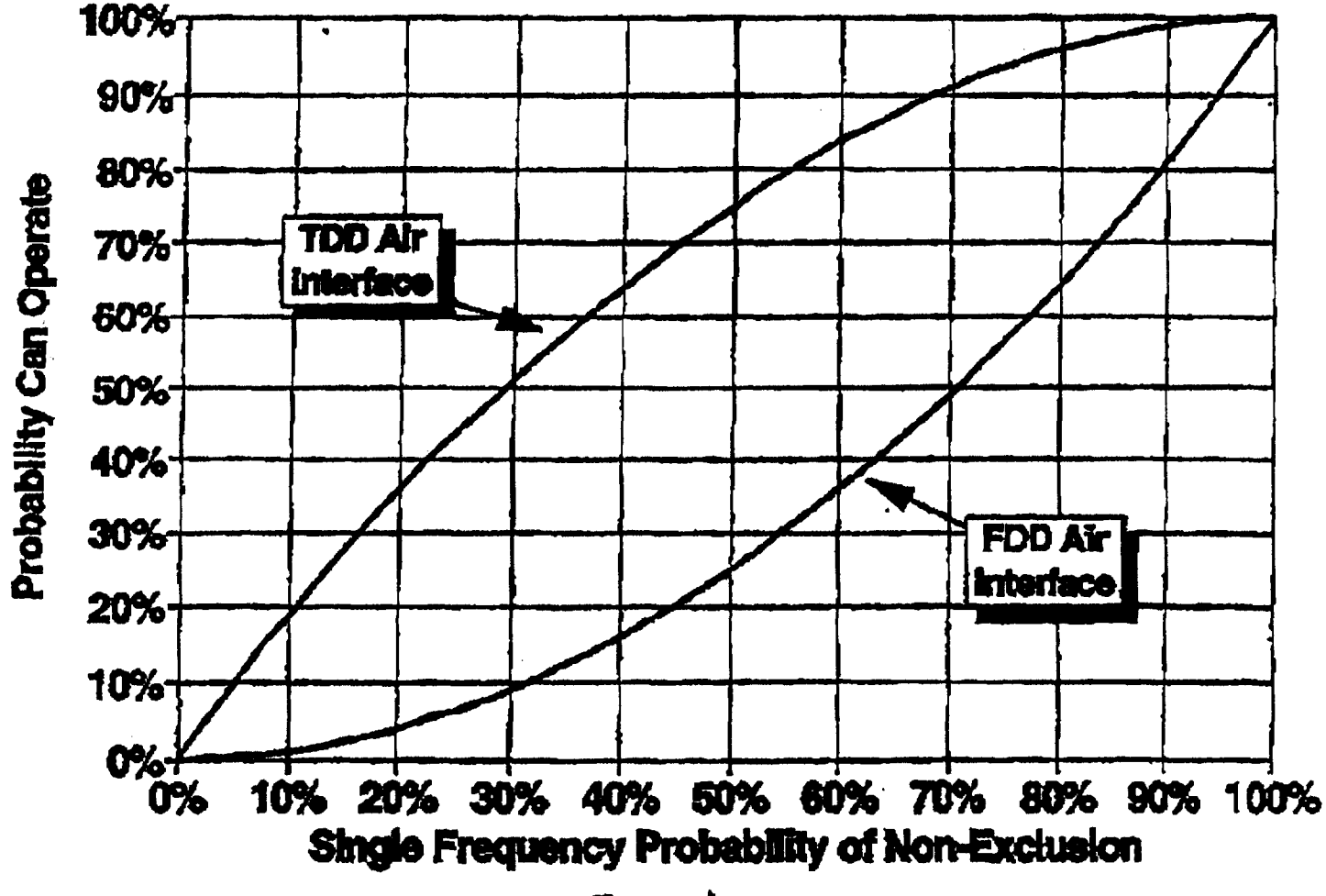

Figure 1