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Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of	)	
	)	ET Docket No. 00-47
Inquiry Regarding Software Defined Radios	)	

REPLY COMMENTS OF
SBC WIRELESS INC.

SBC Wireless Inc. is excited about the prospects of Software Defined Radio (SDR) technology and is encouraged to see a large response to the FCC's Notice of Inquiry (NOI)[1] on SDR from all sectors of the telecommunications industry. In these reply comments, SBC Wireless points out some common issues that have been highlighted in the initial Comments, and raises some concerns that the FCC should consider while evaluating these Comments.

1. SDR Technology

The Comments received by the FCC indicate that the telecommunications industry sees definite benefits deriving from SDR technology. SDR technology allows more efficient implementation of multi-band and multi-mode radios, and when combined with wideband radio technology, SDR technology enables the efficient implementation of advanced spectral efficiency techniques such as fully adaptive smart antennas. SDR technology results in great flexibility such as allowing radio equipment to be re-

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programmed across the entire protocol stack with software downloads after the date of manufacture. This flexibility of re-programming a radio with software downloads allows software bugs to be fixed, or upgrades to be implemented, without requiring the end user to bring in their handset or a truck roll to a base station. It allows a radio to upgrade itself to the latest version of a particular air interface standard, or even to support a completely different air interface. Thus, SDR is an implementation technology that primarily gives benefits in terms of implementation efficiency, the economically viable implementation of new techniques, and the flexibility of post-manufacture re-configuration.

The Comments filed by Motorola give an excellent account of the capabilities and limitations of SDR technology.[2] SBC Wireless strongly agrees with the key messages of Motorola's Comments. Likewise, the Comments filed by the SDR Forum[3] also gives a good overview of some of the capabilities and limitations of SDR technology.

Even though significant advances have been made in component technology, there are still many challenges to be overcome, a point reiterated in many of the Comments filed. Motorola provides a detailed account of the technical challenges facing commercial implementation of SDR technology.[4] Other wireless manufacturers and vendors concur. Ericsson agrees that SDR technology is not ready for commercial implementation.[5] Lucent Technologies likewise states that given the nascency of SDR technology and the sufficiency of the current rules, Lucent recommends that the FCC continue to monitor the development of SDR technology and allow it to develop further

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[1] In the Matter of Inquiry Regarding Software Defined Radio, *Notice of Inquiry*, Released March 21, 2000.
[2] Comments of Motorola, In the Matter of Inquiry Regarding Software Defined Radio, ET Docket 00-47, pages 3-16 ("Motorola Comments").
[3] Comments of the SDR Forum, In the Matter of Inquiry Regarding Software Defined Radio, ET Docket 00-47, pages 6-12 ("SDR Forum Comments").
[4] Motorola Comments, pages 9-15.

before considering adopting additional SDR-specific regulations or requirements.[6] Nortel Networks echoes a similar caution to the FCC.[7] Nokia notes that equipment capable of handling a dynamic radio environment and a wide spectrum range would require components that have yet to be developed.[8] SBC Wireless acknowledges these challenges and agrees that any rule changes would be premature.

The FCC also needs to be leery of sweeping statements made regarding a particular component technology's ability to dramatically improve the development timeline of SDR technology. For example, Comments submitted by Hypres Inc. discuss a superconductive analog-to-digital converter (ADC) technology and claim that this core technology may allow software radios to be developed much sooner than anticipated (in the near-term rather than the long-term).[9] It is encouraging to see that a promising new ADC technology is being researched. Currently, ADC technology is one of the challenges limiting the implementation of wideband SDR-based systems, so any breakthrough in this field is very welcome. However, superconductive ADC technology is a research topic and is still in its development phase. Moreover, advances in ADC technology are not the only challenges facing the commercial development of SDR technology. As stated in SBC Wireless's Comments to the NOI, there are many other technical challenges to be overcome before widespread commercial deployment of SDR-based systems is

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[5] Comments of Ericsson Inc., In the Matter of Inquiry Regarding Software Defined Radio, ET Docket 00-47, page 1 ("Ericsson Comments").
[6] Comments of Lucent Technlogies, Inc., In the Matter of Inquiry Regarding Software Defined Radio, ET Docket 00-47, pages 1 and 2.
[7] Comments of Nortel Networks Inc.,In the Matter of Inquiry Regarding Software Defined Radio, ET Docket 00-47, pages 3 and 4.
[8] Comments of Nokia Inc., In the Matter of Inquiry Regarding Software Defined Radio, ET Docket 00-47, pages 3 and 4 ("Nokia Comments").
[9] Comments of Hypres Inc., In the Matter of Inquiry Regarding Software Defined Radio, ET Docket 00-47, page 2.

possible.[10] Hence, it would be premature to state that, based on the potential performance of superconductive ADC technology or any other singular component, the development timeline of SDR technology may change from long-term to near-term.

Comments submitted by Airnet describe an SDR-based system that has been commercially deployed for commercial PCS systems.[11] Airnet has been one of the early adopters of SDR technology and an innovator in this field. But while Airnet's system is operational in the commercial world, it is important to note that the radio system described in Airnet's Comments digitizes only 5 MHz of spectrum. SBC Wireless believes that to attain all the desired benefits, a wideband SDR-based PCS base station operating in the 1900 MHz band needs to digitize 15 MHz of spectrum, while still meeting stringent dynamic range performance specifications set by the appropriate air interface standard. ADC technology has barely reached the ability to meet these specifications in the 1900 MHz band. ADC technology is just now approaching the performance levels required to meet the more stringent dynamic range specifications for operation in 900 MHz band GSM systems. While SBC Wireless appreciates the efforts and progress made by AirNet in this arena, such systems are not nearly ready to implement the types of capabilities envisioned by the FCC in this NOI.

2. Spectrum Management

The resounding conclusion to be drawn from the Comments submitted is that it is premature to make any rule changes regarding the FCC's spectrum management policy.

[10] Comments of SBC Wireless Inc., In the Matter of Inquiry Regarding Software Defined Radio, ET Docket 00-47, pages 6-8.
[11] Comments of Airnet Communications Corporation, In the Matter of Inquiry Regarding Software Defined Radio, Docket ET 00-47, page 2.

As noted in its initial Comments, SBC Wireless agrees and recommends to the FCC to leave the current spectrum management rules unchanged in this docket.

SDR is an implementation technology[12]; it is not a panacea to alleviate spectrum shortage. Nor will SDR be able to replace the need for additional spectrum for new and existing wireless systems[13]. Since SDR technology is an implementation technology, it does not directly determine the spectral efficiency of a wireless system. This is determined by the air interface and system deployment standards. These thoughts have been indicated in the Comments of Nokia, Motorola, and Ericsson.[14] Motorola has a good summary of spectrum related issues in Section 4 of their Comments.[15] SBC Wireless strongly agrees with Motorola's assessment of these issues.

A number of Comments submitted discuss dynamic sharing and auctioning of spectrum.[16] SBC Wireless would caution the FCC that there are very difficult technical, business, customer service, and human factors problems related to operating such systems in the commercial wireless world. For example, the Comments of Red Bat Communications propose a system where spectrum is dynamically auctioned when users want a service as simple as making a phone call.[17] There are major problems with this proposal. When wireless users want to make a phone call, they do not want to negotiate in an auction to determine the rate of the phone call. Especially in today's world where flat rates for wireless calls anywhere in the country have become quite common, such a system is commercially unacceptable.

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[12] SDR Forum Comments, pages 21 and 32; Ericsson Comments, pages 2 and 3.
[13] Nokia Comments, page 7.
[14] Nokia Comments, page 7; Motorola Comments, page 27; Ericsson Comments, page 3.
[15] Motorola Comments, pages 27-31.
[16] Comments of Red Bat Communications and Comments of the Dandin Group, In the Matter of Inquiry Regarding Software Defined Radio, Docket ET 00-47.

The dynamic auction system has an even bigger issue of quality of service. When the wireless system operates on the basis of a dynamic auction, how does the user get a guaranteed quality of service? Today's wireless carriers take pride in the quality of service with which they engineer their networks. It assures customers that they will get a certain level of service from a particular operator's network. There are many technical issues also. For example, can a dynamic auctioning system guarantee that in spite of the negotiations related to auctioning, the call set up delay will be comparable to the call set up delay in current cellular and PCS networks? Today's cellular and PCS networks are finely engineered to control the amount of co-channel interference experienced by a wireless user. How does one control the amount of co-channel interference in a wireless network where channels are being assigned to users on an ad-hoc dynamic basis through this auction? These are just a few issues. But it is quite clear that the dynamic auctioning system is currently impractical.

The Comments of Red Bat Communications also propose that the FCC should allocate a separate frequency for a standard control channel to support real time auctions and bandwidth exchange.[18] Besides the apparent flaws in the approach, SBC Wireless believes that this would be a waste of valuable spectrum. Current cellular and PCS systems already have standard control channels that broadcast information specific to the wireless network. By reading this control information, wireless devices become aware of their whereabouts and of the network's capabilities before initiating a wireless call. These standard control channels are crucial elements of today's cellular and PCS systems and wireless operator's specifically engineer these control channels with great care. Red Bat

[17] Comments of Red Bat Communications, In the Matter of Inquiry Regarding Software Defined Radio, Docket ET 00-47, page 3 ("Red Bat Comments").

suggests that if spare frequencies are not available, "the unused capacity of a cellular control channel" should be used.[19] Contrary to what the FCC might be led to believe, today's cellular control channels do not have large amounts of unused capacity. In fact, with the large growth in wireless users, control channel capacities are being challenged and wireless operators must constantly assess their control channel capacities to avoid congestion.

The Comments submitted by the Dandin Group[20] discuss self-regulating wireless networks based on SDR. Nokia has presented an excellent discussion of problems related to dynamic sharing of spectrum in Section 4 of their Comments. They rightly state that "Spectrum use through dynamic spectrum assignments for different services would significantly increase system complexity." And that "Given the increased complexity, Nokia views these solutions as viable only in the longer term."[21]

Contrary to some assertions, a system that dynamically allocates and de-allocates spectrum on an ad-hoc basis, based on demand, is not necessarily more spectrum efficient. Today's cellular and PCS networks are precisely engineered to control the amount of interference in the system. Techniques such as dynamic channel allocation (DCA) allow the wireless network to move frequencies from a relatively idle cell to a busy cell to be able to support more users in the busy cell. These DCA techniques increase the spectrum efficiency of the network and can be implemented today without SDR technology. With the advent of SDR technology it will become commercially feasible to implement spectrally efficient techniques such as fully adaptive smart

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[18] Red Bat Comments, page 13.
[19] Red Bat Comments., page 13.
[20] Comments of the Dandin Group, In the Matter of Inquiry Regarding Software Defined Radio, Docket ET 00-47, page 3.

antennas and enhanced interference cancellation techniques. These techniques will lead to much more efficient use of spectrum. When compared to such a finely tuned cellular or PCS system, ad-hoc dynamic sharing of spectrum adds complexity without necessarily enhancing spectrum efficiency, and may lead to a particular network serving the customer of another provider, possibly to the detriment of its own customers.

3. Equipment Approval

An important issue brought up by Commissioner Ness[22] in the separate statement issued with the FCC NOI on SDR is that "protection of other spectrum licensees from interference resulting from SDR devices is paramount." SBC Wireless shares this concern and so do other organizations in the telecommunications industry. The Comments submitted by the Association of Public-Safety Communications Officers-International Inc. (APCO)[23], American Petroleum Institute (API)[24] and Industrial Telecommunications Association (ITA)[25] caution the FCC about the possibility of disruption of public safety and other critical communications through intentional or unintentional misuse. This is one reason why SBC Wireless believes that the FCC should distinguish between the software that may affect the RF emissions of a SDR device and the software that may in no way affect the RF emissions of a SDR device. SBC Wireless believes that SDR equipment manufacturers should not allow third party access to the

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[21] Comments of Nokia Inc., In the Matter of Inquiry Regarding Software Defined Radio, page 8, June 14, 2000

[22] Separate Statement of Commissioner Susan Ness, In the Matter of Inquiry Regarding Software Defined Radio, *Notice of Inquiry*, Released March 21, 2000

[23] Comments of APCO, In the Matter of Inquiry Regarding Software Defined Radio, Docket ET 00-47, pages 2 and 3.

[24] Comments of the American Petroleum Institute, In the Matter of Inquiry Regarding Software Defined Radio, Docket ET 00-47, page 3.

[25] Comments of Industrial Telecommunications Association, Inc., In the Matter of Inquiry Regarding Software Defined Radio, Docket ET 00-47, page 4.

software that may affect the RF emissions of SDR equipment. Motorola rightly states in their Comments that equipment manufacturers should control software interfaces that affect emissions and safety[26].

Conclusion

In conclusion, SBC Wireless is excited about the capability of SDR technology to increase flexibility, improve equipment manufacturing cost and efficiency, and allow commercially feasible implementation of spectrally efficient techniques such as adaptive antennas. SBC Wireless believes that SDR technology can bring benefits to equipment manufacturers, wireless operators, and users alike. However, SDR is an implementation technology and not the panacea to spectrum shortages. There are many pitfalls in implementing a system that performs ad-hoc dynamic spectrum allocation. Moreover, such a system may not necessarily be more efficient in the use of spectrum than finely engineered cellular and PCS systems of the future. SBC Wireless applauds the FCC's effort to better understand SDR technology and recommends that the FCC should first watch how this technology develops before considering any rule changes.

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[26] Motorola Comments, page 1.

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