Economic Principles for *Ex Ante* Rules for Radio

Position Paper for the conference on

"The Unfinished Radio Revolution: New Approaches to Handling Wireless Interference"

Washington, DC, November 12, 2010

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In September, 2009, Silicon Flatirons hosted a conference featuring a number of recent case studies of radio regulation and interference. The studies highlighted substantial disputes about rights and responsibilities of radio operation in various bands despite apparently detailed *ex ante* rules by the Federal Communications Commission regarding interference.[3] In each case the parties disagreed about whether the transmitter or the receiver "caused" the interference and if so, whether that party was operating within its rights as defined by the FCC.

In each case, the FCC had set rules on factors such as transmission power in order to control emissions, but circumstances changed so that those rules no longer prevented "harmful interference." Unable to reach mutually beneficial agreements given changing supply and demand conditions under the existing rules, some of the parties came to the FCC to resolve the dispute, in part, by amending its rules (possibly to the benefit of some parties relative to others).

These case studies highlight the importance of a regulatory framework that facilitates efficient transactions between licensees and minimizes transactions costs to achieve efficient solutions. Such a regulatory framework would start with clear rules and allow parties to negotiate efficiency-enhancing changes to those rules.

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[3] The bands in the case studies included 800 MHz, AWS-BAS, AWS-3 and WCS/DARS.

Well-Defined Rights and/or Rules

The FCC must ensure that licensees and other spectrum users know the rules and that those rules be clearly defined. Spectrum users are more likely to invest if they understand their and others' rights well enough to be reasonably sure their long-lived investments will continue to work without harmful interference from other users, and that their transmissions will not be shut down because they interfere with other users' transmissions.

For example, the FCC should clearly spell out rules regarding emissions into a band on the basis of emitted power, protection from emitted power or other well-defined technical metrics, yet also allow—and probably encourage—parties to work out solutions to violations of these standards, or to adapt the standards to other levels or even other metrics on their own.

Focusing on emissions into other bands—the actual cause of harm to adjacent licensees—rather than on transmission power—which is but one potential cause of harm—should create more, though by no means perfect, certainty and align incentives with minimizing the transaction costs of adapting behavior.

For example, consider a licensee with the right to emit a certain level of radiation into an adjacent band. If those emissions interfere with an adjacent licensee's transmissions several solutions that do not involve the FCC become possible that are not possible, or at least not likely today. The licensee could continue to operate in the same way while the adjacent licensee installs receiver filters to ensure its transmissions still work. Alternatively, if the receiver technology is expensive relative to emitting less from the transmitter, the adjacent licensee could negotiate with the transmitter to change its technology. Today, such an outcome is not likely because of the reliance on the FCC to change its rules in favor of one party or another, and the difficulty in coming to complete agreements when the FCC stands in the background.

This simple example illustrates some the potential inefficiencies due to bargaining and diffusion of rights. The well-known Coase Theorem implies that if transaction costs are zero the two parties will agree to an efficient solution for solving the interference problem. In our example, the transmitter would simply agree to pay to replace the receiver since that is mutually beneficial. The real world, however, is rife with transactions costs. For example, suppose the example involved a large number of parties with receivers. Some might hold out on the agreement, preventing the neat solution. In fact, in the relocation of microwave incumbents from the PCS band, many incumbents apparently asked for substantial premiums to their actual costs of moving.

With these types of licenses and flexibility, licensees that desire to make trades with neighbors can adapt or make trades to allow for different standards that then become part of their new operating rights. For example, if a new 5G technology had different operating characteristics that roll off more to adjacent bands, existing cellular and PCS licensees could negotiate a solution—even one that involved rule changes—without a rule-making by the FCC. However,

to facilitate these transactions, the rules need to be set and the FCC must credibly commit not to change its rules in response to political or other pressure. Setting a firm stance might be difficult in the face of pressure from groups like public safety who might argue that they cannot afford to get to pay others to move to the efficient solution and there may be other reasons that it would be difficult for a public agency to commit, but when firms make long-lived investments, they tend to get more court protection against *ex post* rule changes.

Well-defined rules are important for licensed and unlicensed bands as well as for device-type acceptance. Unlicensed bands may, however, require stricter rules because trades of the sort described above could be prohibitively costly. That is, the ability to make trades is not as important for unlicensed bands as it will be more difficult or impossible to organize such a complete change in rights with a diffuse and amorphous group of rights holders.

Because trading of rights and adaptation is more difficult with unlicensed bands, setting up a rational and clear set of rules in advance is more important for unlicensed bands than for licensed bands.

Application to the case studies

One key problem with the historic method of command and control radio regulation based on transmitter power has been its inability to deal with technological change. Technological change is crucial for increasing the standard of living as it allows more productive use of scarce resources. However, changing technology can cause conflict with rules written for then-current or only foreseen technology.

The dispute between Nextel and the public safety community over the 800 MHz transmissions exemplifies how the current system is ill-equipped to deal with technological change. The initial 800 MHz private radio rules were written when the FCC expected that spectrum to be used for "high-tower, high-power" sites. Based on this expectation, the FCC set maximum power limits for transmission, and allocated channels in an interleaved pattern. (At the same time, adjacent spectrum was allocated in large blocks to the two cellular providers).

Nextel (then FleetCall) realized that the spectrum allocated to "private radio" was nearly identical in its physical properties to the spectrum allocated to the two cellular providers and began to acquire licenses. After substantial work Nextel convinced the FCC to change the private radio rules so that Nextel could function as a CMRS provider and use "low-tower, low-power" cellular architecture. The low power sites obviously did not exceed the power limits of the high power high tower sites, but they did interfere with the public safety receivers operating on adjacent (and interleaved) channels.

The rules for 800 MHz transmission could have minimized interference between CMRS providers and public safety providers by requiring Nextel to continue to only use high-tower, high-power sites. But that would have disallowed the technological advances of cellular architecture and digital transmission and prevented much more efficient use of the spectrum.

The FCC could also have allowed the new technology but only if the CMRS licensees negotiated with the public safety entities for the right to operate their systems in a new manner. By clearly defining the rights upfront, but allowing for changes to the rights upon agreement, the flexibility could have led to a mutually agreeable situation.

Finally, and perhaps best, would have been to define initially the rights of 800 MHz licensees differently. Rather than designating technology or transmission power, the rights could have explicitly established a maximum level of emissions into adjacent channels. The emission rate would have been known to both the private radio licensees (and Nextel when it bought those rights) and the public safety entities when they began to construct their adjacent systems and acquire their radios. If Nextel had then decided to use a technology that increased emissions into the adjacent channels, it would have realized that it would have to negotiate with the public safety agencies if its new transmission method did not comply with the emission limits. If Nextel's new technology did comply with the emissions rules, then the public safety agencies would either have to adapt their receivers or negotiate with Nextel. In both cases, the efficient reducer of interference would be selected by negotiation between the parties. Of course, this in part depends on the ability to strike a deal with one or a small number of parties on each side – transactions cost increase with the number of parties needed to reach agreement.