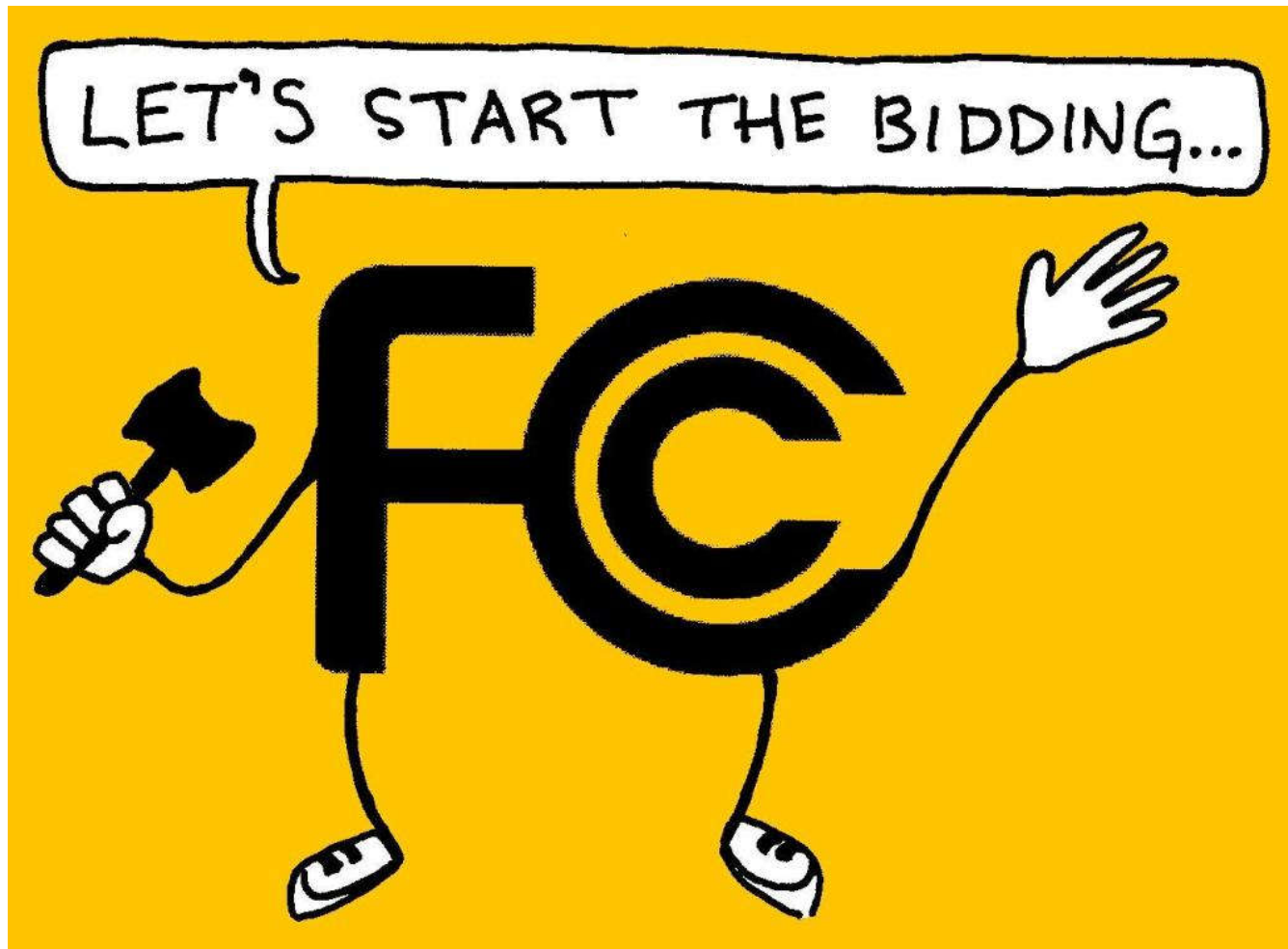


## —RAKO STUDIOS—

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### Old-FCC\_New-FCC

The old FCC cared about interference. The new FCC cares about money.



Take any cell phone and place it on the package tray of your car, the tray right next to your radio. You can tune the radio to any station on the Am or FM band. As you drive your car you will hear horrible interference on the radio caused by your cell phone. Oft times the interference will be so severe that the music from the radio will be completely obliterated.

Indeed, interference from cell phones is so commonplace than many engineers take it for

granted. Francis Lau is an engineer at Arielle, a company that makes FM transmitters that allow your MP3 player or iPod to play over your car radio. He reports: "When I was in college at UCLA I could always tell when the cell phone was going to ring. I would hear the interference caused by the phone in my home stereo." Before any cell phone rings there is an exchange of radio transmissions between the phone and the nearest base station. During this time the phone often ratchets up its power

in order to provide a good connection. It was this pre-ring negotiation between the cell phone and the base station that engineer Lau heard as interference on his home stereo just prior to his phone ringing.

Many engineers may be astonished by the severity and how commonplace cell phone interference is. After all, most of us assume the FCC exists in order to insure that radio communications are free from interference. Actually the FCC charter says nothing about interference (See sidebar--"the FCC is born"). Therein lies a grievous problem for the American people. Certainly the FCC used to be concerned about interference. This is the FCC best called the Old FCC. In contrast the New FCC seems far more concerned with revenue generation, both for itself and for businesses it chooses to favor.

The diving line between the old FCC that worried about interference and the new FCC that worries about money was the analog cell phone auctions of the 1980s and early 90s. George Gilder, noted telecom guru points out that the analog cell phone companies have made more money off their tiny slice of radio spectrum these last two decades than all the advertising revenue created by the broadcast TV networks in their entire history.

It could be argued that when analog cell phones came out, the FCC felt the interference was an acceptable tradeoff to the public good created by conveniently mobile communication. By the time newer the newer digital cell phones standards were promulgated by the FCC it is obvious they just didn't care about interference. By 1992 when the FCC had to bless the digital cell standards there was big money, with big lobbyists and big politics and big egos involved in the industry.

It should be stated in no uncertain terms that no one thinks the FCC took bribes or payola or did anything unseemly or against the law. Indeed there was a spirited discussion between the old and new factions insider the FCC. The old faction worried about interference and quality of communication, the new faction worried about potential business opportunities and providing competition to the existing land-line phone companies. What must be understood is the dynamics of big-money politics. When the FCC's primary focus was preventing interference between broadcasters they were on the periphery of the revenue streams of the companies being regulated. Now that the new FCC has taken upon itself to auction off spectrum and approving new transmission protocols, they are smack-dab in the middle of companies revenue streams.

If certain companies can get the spectrum and transmission protocols approved then those companies can make billions of dollars. If the FCC does not go along, well then those same companies make nothing. As you can imagine, this has caused a string of well-dressed corporate lobbyists showing up at the FCC headquarters. The people that don't have the time or money to fly to Washington include Francis Lau and the millions of Americans that have to suffer with horrible interference, all seemingly sanctioned by the FCC.

### **Case in Point: BOP**

The new FCC's preference for money and business overriding concerns about interference has continued beyond the cell phone radio spectrum. Another very troubling technology to those concerned with interference is broadband over power lines (BOP). This technology uses your house's 120 volt wall socket wiring to transmit internet and other network traffic. By the criteria of the New FCC this is a great

technology. It can be seen as encouraging competition since it empowers a whole new industry to bring networking to your home. With BOP, the electric utility companies would connect your home to the internet, in cooperation with the phone companies DSL, the cable company's cable modems and the satellite companies dish modems. The new FCC would be providing revenue to another industry as well as having an entirely new regulatory regime to oversee.

All this sounds great until you examine the horrible radio interference caused by BOP. The only reason BOP has not swept across the country is due to the concerted efforts of the ham radio community. Time after time a small startup company installs a trial system and each time the ham radio operators have proven that the system causes horrible interference. Dennis Monticelli, a Fellow at National Semiconductor and avid ham radio enthusiast says he doesn't blame the electric utilities. "What is happening is a series of small startups are all approaching the electric utility companies and telling them that they can get a whole new source of revenue. In addition, the startups can point out that the FCC has approved these new technologies. The electric utilities think that if the FCC has said it is OK then the technology must work but that is not the case."

### **Public choice theory**

The FCC's approval of such a marginal technology is a case exercise in what Nobel winning economist James Buchanan has dubbed public choice theory. This theory posits that since the government can hand out valuable benefits to specific people, those people dominate the voices heard by policymakers. The benefits are concentrated to one company or industry whereas the costs are spread over the entire population. The concept of concentrated benefits and diffuse costs

animates much governmental regulatory behavior. Public Choice theory is why the dairy industry has won price supports for milk. The added revenue to dairy farmers is a concentrated benefit that makes lobbying and political involvement worthwhile to them. The added cost of milk is spread out through millions of consumers. When the cost is artificially raised by a quarter, no one bothers to write their congressman or march on Washington. Meanwhile a dairy farmer will receive tens or hundreds of thousands of dollars of additional revenue. The dynamics of BOP is similar. The founder of a small BOP startup stands to get very rich. The electric utility can get a small but helpful revenue stream. These are the same concentrated benefits enjoyed by dairy farmers. The difference with BOP is with the diffuse costs. The cost to society is not monetary; it is increased interference to all the broadcasters including ham radio operators. Before you trivialize the concerns of ham radio operators please remember that after hurricane Katrina all the land lines and cell phone towers were down. As in so many other natural and terrorist disasters in our history, it was the ham radio operators that provided critical communications to the rescuers and the nation at large.

### **Picking winners, but not picking winners**

The political stance of the new FCC has only made interference issues worse. The new FCC is more than willing to empower new industries, yet it takes great pains to not favor any specific company. This can have terrible consequences. For instance, digital phones can operate with two different modulation schemes. The common scheme is TDMA (time division multiple access). This is the scheme that is causing so many interference problems. As the name implies, TDMA defines short time slots

that allow multiple phones to use the same radio frequency. Each phone transmits a short pulse but only when it is that phone's turn. This means no two phones in a cell ever transmit at the same time. Although the phone transmission frequency is 900 MHz or 1900 MHz, the pulses of these high frequencies occur at 200 Hz intervals [see sidebar "cell phone modulation schemes"]. It is this 200 cycle per second pulsing that you hear in your car radio or home stereo. There is a different modulation scheme called CDMA (code division multiple access). This scheme has the phone transmitting continually at a lower power with the frequency is being spread over a wide bandwidth. Multiple phones can share the same band because each phone is being swept across the band in a different pattern or code. The receiver at the cell phone base station locks onto the phone transmissions and can use signal processing techniques to extract each phone's transmission since the receiver presupposes the unique pattern each phone is using.

Since CDMA phones broadcast continuously over a wider band at lower effective radiated power, they cause much less interference in consumer electronics, ham radios and the military bands. The reason the FCC does not mandate CDMA phones is because the CDMA scheme is patented by one company, Qualcomm of San Diego. This brings out an interesting contrast in government regulation. The Patent Officer is more than willing to pick an exclusive winner in a government enforced monopoly for 17 years. The FCC is loath to select any one company as an exclusive winner for any slice of the radio spectrum.

### **The 2.4 GHz mess**

The FCC's reluctance to endorse any specific modulation scheme has caused problems in more than the cell phone bands. The FCC has

caused an interference mess in the 2.4 GHz ISM (industrial scientific and medical) band. This band, 83 MHz wide, is recognized as an unlicensed band by the FCC. This came about because microwave ovens use 2.4 GHz. Ovens use this frequency because it is absorbed by food and water causing it to heat up. Now realize, unlicensed does not mean unregulated. The FCC will not let you broadcast 50,000 watts at 2.4 GHz. What unlicensed means is that you the consumer do not need to apply to the FCC for permission to use equipment that broadcasts at 2.4 GHz. The equipment itself is strictly regulated but only for the effective radiated power that it can broadcast. But the FCC does not feel it is within its purview to specify a particular modulation scheme for this band (reference Paul Rako wireless article). Portable phones use several modulation schemes with no standard across companies or even different models of phones. Wireless LANs use DSSS (digital sequence spread spectrum). Bluetooth uses FHSS (frequency hopping spread spectrum). Zigbee uses DSSS but it is purposely a different code and incompatible with the DSSS used by wireless LANs. Other companies are considering broadcasting FM base-band at 2.4 GHz. All these schemes are legal as long as the transmitters are below specified FCC power limits. The problem is that all these different modulation schemes interfere with each other. Indeed wireless LANs even interfere with themselves. Although the standard for 2.4 GHz wireless LANs defines 11 channels only three of those channels do not overlap frequencies and interfere with one another. Three wireless LANs operating on channels 1, 6 and 11 will not interfere. If the LANs are set to channels 1, 2 and 3 for instance, none of the LANs will be able to provide the full bit rate since they will all be interfering with one another.

## Man down! Hello? Hello?

The FCC's tacit endorsement of the monetization of the radio spectrum is causing more than irritation and inconvenience. It is putting the lives of American firefighters in jeopardy. This has been demonstrated by the experience of the San Francisco fire department. The fire department used to have radios that operated much like walkie talkies. Each radio would broadcast on a permitted frequency and any radio nearby could receive that frequency and listen to the transmission. The radios communicate directly between each other. The high value of radio spectrum and the need to sell "better" radios to firefighters caused Motorola to convince the FCC that a new scheme should be adopted. These new radios would connect with a base station and then the call would be pouted to the appropriate receiving radio, much the way a cell phone works. Because the radios could use a digital packer oriented modulation scheme it was felt that more radios could operate on a given band. No doubt this is how Motorola convinced the FCC to allow the use of this scheme on the public safety bands.

Once San Francisco bought the radios and put them in service the fundamental problem with the scheme became apparent. Since the new radios had to transmit for mile to a base station, and then oft times the same distance back to the same fire location there was often interference and lost reception. In contrast the old analog radios would broadcast directly between two firefighters, often inside a building that had a steel structure that would block any radio transmissions to a base station. In an episode of political courage that rivaled the physical courage of his men, the San Francisco fire Chief ordered his men to abandon the new radios and go back to the older analog radios.

You can see the lure of centralized communication to the radio vendor. Like cell phone companies a centralized system can charge by the call. Cell phone companies would not have made billions of dollars if all they did was sell radios that talked amongst themselves like a walkie talkie. The concept of base stations was sensible because the mobile phones needed to tie into the land lines, but charging by the minute has been a revenue goldmine for the cell phone industry.

The existence of base station technology made it an irresistible temptation for Motorola to adopt and promote this method for firefighters. Experience in San Francisco shows that sometimes the existing technology is more suited to the job. With human life on the line it behooves the FCC to allocate whatever bandwidth is needed for public safety and to not promote schemes that are good for revenue at the expense of interference.

This issue will be critical in the coming years. The lack of coordinated comthe 9-11 tragedy has caused a call for radio interoperability among various public safety agencies. If this interoperability is achieved by radios that can operate over many bands and modulation schemes this will be a public benefit. If interoperability means all radios will communicate with a base station then this will put the lives of American firefighters and police at risk because it simply does not work.

## WiMAX and 700 MHz: future follies

The new FCC's love of business at the cost of inference has serious future implications. One area of concern is twith the upcoming WiMax munications during rollout. WiMax is a wireless system like your wireless LAN that operates over miles instead of meters. WiMax operates above 3 GHz. All the radio spectrum

used by WiMax was already allocated by the FCC for other uses. What the companies promoting WiMax have done is convince the FCC that the by using UWB (ultra wideband modulation) they can broadcast over existing bands without interference. The issue is how serious the interference will be. After all, two transmitters cannot operate over the same frequency without interference. The proponents of WiMax, including industry giants Intel and Google have assured the public and the FCC that the interference problems will be minimal. One dire concern is that these new WiMax schemes broadcast over hundreds of megahertz instead of say, the kilohertz modulation of an FM radio broadcast. Once the WiMax transmitters are deployed it will be politically impossible to take them off the market. This means that huge swaths of the radio spectrum above 2.5 GHz may be irredeemably compromised by a scheme that is more concerned with creating a revenue stream as opposed to being a good radio spectrum citizen. Only time will tell if the UWB will really cause problematical interference.

### **700 MHz good business but bad for the public**

The damage that the New FCC has caused to the public trust pales in comparison to the potential damage caused by the allocation of new spectrum. In 2009 the analog TV bands will taken from the broadcast industry and auctioned off. Even the most generous observer of American politics must admit that the primary goal of this auction is government revenue, not public good. When the FCC deposits billions of dollars in spectrum auction proceeds into the US treasury you can be sure they will get bigger budgets, more personnel and more attention from congress. With this, in addition to the steady stream of K-Street lobbyists prancing through the FCC

headquarters it is no wonder the public good gets left behind.

We have already examined how Public Choice Theory animates the behavior of the regulatory process. The fact that the 700 MHz band auction will make billions for the US treasury insures an even more perverse set of incentives. Now, for most goods and services the market process works perfectly. The fact that the old analog cell phone bands made more money for the cell phone companies than all the TV advertising in history tells us that the public puts tremendous value on cell phone service. It is not necessarily a bad thing that the cell phone spectrum made billions for the American business. These billions were made providing a highly desired service to the American people. But it must be observed that the auction for those analog cell phone frequencies in 1985 marked the delineation between the old FCC and the new FCC. Once there was big money involved, it assured that the lobbyists would descend on the FCC like locusts on fresh crops.

When the big money became available to the FCC directly via spectrum auctions, the public interest got left behind. The market distortion caused and encouraged by the FCC works like this: It is a given that the FCC will only entertain spectrum uses that make the most money via auction. This forces business and technologists to come up with usage schemes that cost the people the most money in order to pay for the huge cost of the auctioned spectrum.

Remember the story of the San Francisco fire chief and how the new radios did not work? That episode contains an instructive lesson. It is obvious cell phone companies love base-station technology since that allows them to charge by the minute. Samsung and Nokia would be perfectly happy to sell you a phone that would work like a walkie talkie or the old

fireman's radios. These phones could use modern modulation schemes like FHSS and DSSS and communicate with digital technology that provides encryption and prevents eavesdropping. Like the old firefighter's radios these phones could communicate directly between each other with no need for base stations. You could talk to anyone with the same type of phone over a distance of a few miles. This allows you to stay in touch with the friends and family and conduct most of your local business, all for no monthly charge. When the person you are calling is close the fidelity and purity of the call could rival that of a land line. But this direct radio scheme does not use a base station. This means it would be difficult if not impossible to charge you by the minute and maximize the revenue to the company.

Samsung is in Korea and Nokia is in Finland. Neither has very much traction with US politicians and regulatory officials. Cell phone carriers and the phone company and American giants like Intel and Google are quite familiar with convincing US politicians and regulators to encourage schemes that benefit business and government at the expense of the American people.

You can rest assured that none of the uses considered for the 700 MHz bands will allow you to pay 20 dollars extra for a cell phone that allows you call anyone in a 5 mile radius for free. Furthermore there will be no one to blame or point a finger at. The businesses will rightly note the huge cost of the spectrum auction they need to recover and the FCC will point out that anyone is allowed to bid for the bandwidth, so what could be more fair? The only loser will be the American public. The auction of bandwidth to the highest bidder insures that Americans will forever be saddled with the highest cost of personal communications as opposed to the lowest cost. Markets are not meant to promote

waste and inefficiency, but that is exactly what happens when the government goes into the bandwidth business.

The FCC's encouraging revenue generation at the expense of the public good should concern us all. The FCC needs to pay more attention to the ham radio and broadcast engineering communities. Interference is becoming more and more of a problem. Paul Grohe, a Silicon Valley electrical engineer relates that every time an airplane lands at San Jose airport, his broadcast digital TV signal breaks up and takes seconds to recover. It makes his digital over the air broadcast TV essentially unusable. Other users report HD public TV broadcasts where the audio drops out every few seconds. The complete mess in the 2.4 GHz ISM band is a warning to us all of the consequences of too light a regulatory hand.

Poor cell phone reception and dropped calls seem to be an accepted part of life. Cell phone users just seem to accept that their calls will occasionally be garbled and unintelligible. Many seem to accept that the call simply terminates without warning.

The sideband interference from all these new radio schemes like WiMax and whatever ends up on 700 MHz insures that cell phones will only work even less acceptably in the future. Even of more concern to all of us should be the effect of the monetization of radio spectrum encouraged by the new FCC. This virtually guarantees that American will have the most expensive radio communication system, not the best.

Despite the vagaries of the FCC charter we all can agree that the public good is the primary responsibility of the FCC. Perhaps with the power of the internet the voice of the public and technical community will cause the FCC to

consider factors other than revenue when it formulated the use of the 700 MHz band. Reducing interference and serving the public good might be a great place to start.

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Tailpiece