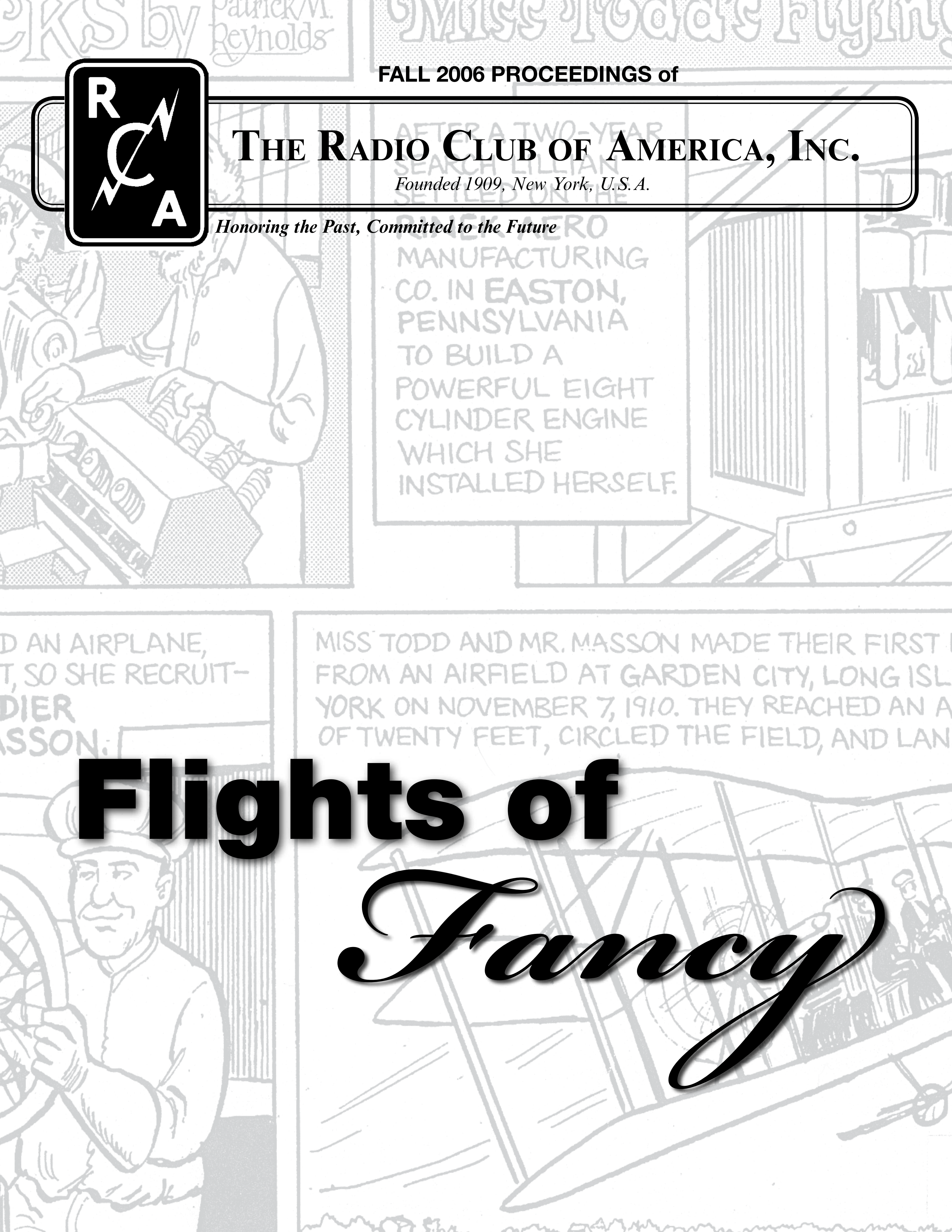
FALL 2006 PROCEEDINGS of

The Radio Club of America, Inc.

Founded 1909, New York, U.S.A.

Honoring the Past, Committed to the Future



Flights of *Fancy*

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A Message From Tony

In the quest for continual improvement or for winning the battle, we sometimes take our eyes off the target and forget all the hard work and effort that goes into supporting and improving The Radio Club of America. This club runs on volunteer power, and sometimes it's hard to maintain that volunteer spirit.

Think about this: Why do we find it easy to be overly critical? Why do we argue over the best way to do things? Why does it seem no one appreciates all the work that goes into running this club? Why do we get an earful every time we try something new? Why does it seem no one else cares about what's important? Why do some members undermine the good we are trying to accomplish? Don't they understand? Sometimes being a volunteer is not easy.

Let me relate two personal stories that may help to put what I am trying to say into a better perspective. A couple of years ago, I was very upset and was yelling at my youngest son for not doing something I had asked him repeatedly to do. He stopped me in my tracks when he asked me, "Dad, would you ever talk that way to someone at your business?"

The light bulb in my head went off.

Of course I wouldn't speak to a co-worker in such a way, so why did I find myself treating my son, whom I dearly love, in a manner that was any less respectful? For some reason, because we were family, the warning flags did not go up in my brain. I really have to thank him for reminding me to always be a little more considerate of the ones we love. After all, the goal is never to hurt them.

The other story comes from when I was an officer in a local volunteer ambulance corps. The corps was trying to decide what type of new ambulance should replace one of our two existing rigs. This was during the period of change, when many of the Cadillac-style ambulances were the norm but when new van-based units were becoming popular. The older corps members were used to the Cadillac style, and they liked the ride. The younger members were supporting change, and they wanted the van that offered much more working room. The two factions were like warring camps over the issue. To make matters worse, the rig committee, in trying to mediate the situation, was recommending an Oldsmobile, which no one wanted!

Volunteers vote with their feet, and there were threats voiced that if one or the other style of ambulance was selected, certain members would resign from the corps. So here we were, putting the corps membership and the citizens of the town at risk over the selection of a vehicle. The membership was fighting over the rig decision but losing sight of the real goal, which was to provide the best service possible to the community.

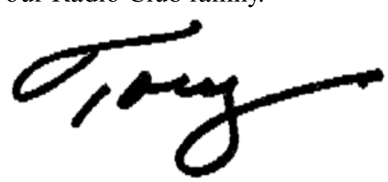
When cooler minds prevailed, everyone finally realized that by keeping one Cadillac in service and purchasing a van-style replacement, the corps would have the best of both worlds. Drivers could then select the vehicle they considered to be the best for the circumstances. Fortunately, the corps didn't lose any of its valuable members over the incident.

So what does this walk down memory lane mean? As president of the Radio Club of America, I can't hire and I can't fire. Sometimes it seems like there is more I can't do than I can do. How do I do my job if I can't make anyone do anything?

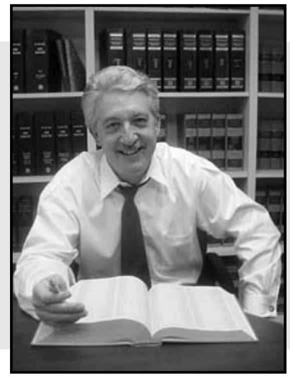
Fortunately, I find myself surrounded by talented people who do a great job at volunteering their time and talents. They are proud of what they do. They love the Radio Club of America. They are motivated by doing the right thing. They are self-starting. They work diligently without supervision. They are there to lend a hand or kind word of support. And they stick by my side when the mud flies.

Many present and former Radio Club officers, directors, committee chairs and members have helped to make my burden a lot lighter. I am proud of the progress and improvements these hard-working volunteers have helped to make happen. It takes a lot of help to head a family that has more than 900 members. I would like to thank everyone who has never taken their eyes off the real target and who has given freely of his or her time, talent and treasure to the Radio Club of America.

This fall, when you cast your ballot for new Radio Club officers and directors, give some serious thought about who should lead our Radio Club family.



Vetting RF Equipment In A Perfect FCC World



— By Robert H. Schwaninger Jr.

Although the Radio Club of America properly lauds the pioneers of radio communications and delivers useful information regarding the latest step forward in the radio art, I have to say that sometimes RF engineers are, well, not as helpful as they might be.

There was the occasion at which I was having a devil of a time getting a device approved by the FCC. The engineers at the FCC labs were tossing out technical questions, and I was trying to keep up while trying to figure out the difference between a surface acoustic wave resonator and a dual barrel carburetor. So, I turned to the client's trusty in-house RF engineer.

Together we went to the FCC labs and attended our meeting with the FCC's testing engineer. The FCC's engineer shot questions to my engineer, and he responded brilliantly for about 20 minutes. Having satisfied the FCC's questions, I sat back in my chair feeling that the long-coveted grant would be forthcoming.

Unfortunately, my engineer also got comfortable – so comfortable, in fact, that he began to explain to the FCC engineer all of the shortcuts in design, the inferior parts and the general chaos he experienced on his job. Despite hard glares from me and an unsuccessful attempt to give him a quick kick under the table, on he went until he had fully apologized to the FCC engineer about the quality of every device his company makes. After that, the grant took a little longer.

Here's the thing: The problem is that RF engineers want to be right, and that's a terrific thing for an engineer. After all, being right produces high-quality devices, systems, networks, and RF infrastructure. It enables our industry to produce ever-better-quality goods and services. And I appreciate the desire to always be better and to make better radios. But I am an attorney. Being right is good. Winning is better.

The radio-communications industry is highly competitive and highly regulated. Although research and design is important, at the end of the day, RF engineers have to make money on their designs. This means they have to get their ideas off the drawing board, out of the clean room, past production, through testing for FCC compliance and into a vicious marketplace. Those same engineers have to tailor their efforts to federal regulation that, in some cases, lags a few decades behind.

If you want to watch the production of frustration, listen to a telecommunications lawyer talk to a RF engineer about a FCC rule that does not make sense from a RF design point of view. The RF engineer will say something like, "Well, that rule is ridiculous. It presumes masking that is unworkable or insufficient filtering or it presumes a perfect RF world. The FCC must have meant something different."

Then I reply, "No, the FCC did not mean something different. The FCC meant to write a rule pursuant to a rulemaking that had a bunch of comments filed to it by persons who were not motivated by science and getting it right. The commenters (read *lobbyists*) were interested in winning, aka making money."

"But it's wrong," answers the RF engineer.

"That doesn't matter," say I, trying to keep from saying in a singsong voice that it ain't a perfect world.

"Sure it matters," says the RF engineer. "We have to make the device (system, whatever) operate properly, and the way the rule reads, we can't."

At this juncture, the conversation kind of goes down hill fast and usually lands in the one area that is the last

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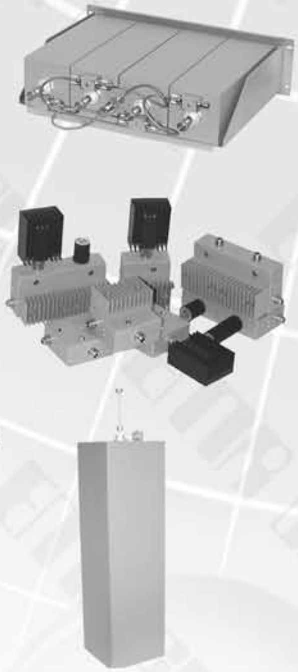


bastion for the frustrated RF engineer: the rule waiver. The RF engineer sincerely believes that once the FCC is presented with a logically supported, technically correct vision of the RF world, the FCC will quickly move to accommodate the waiver and the brilliant efforts of the enterprising RF engineer. And if I were any kind of a lawyer, I would whip up a waiver request that would knock the socks off the FCC staff, and the grant would be in the bag.

Remember that this is the same FCC staff that thought its rules for broadband over power lines (BPL), ultra-narrowband VHF, ACSB, Line A, digital AM, forbidden bands, the microwave clearinghouse, IVDS, avian mortality issues, family radio and the legislative volcano known as the "Wardrobe Malfunction" were all just peachy. Thus, I have little faith in the FCC's innate ability to discern good engineering design and to reward same.

This is not to say that the FCC will not accommodate a better RF design. It will – over the passage of time…lots of time. But to illustrate the difficulties, you may wish to ponder the fact the FCC does not have a formal process for rule waivers when the rules apply to equipment authorizations. So if you build a better mousetrap, there is every reason to believe that the mouse may die of old age before the FCC rules are changed to accommodate it.

To my Radio Club colleagues who are far better at figuring out phase nulls and Raleigh factors than this physics-challenged lawyer, I say: Remember that while you are battling throughput and are wrestling electromagnetic energy, one wave at a time, have a little sympathy and understanding for the lawyer. You're just battling physics. We're battling politics. And the FCC is not keen on reverse-engineering its rules to fit your newest device.

This does not mean that RF engineers and system designers should stop trying to improve radio communications. To the contrary, this effort is the all-important energy that drives our industry. What it means is that part of the design function should include an examination of the present state of federal regulation, and the design cycle should include (when possible) a recognition of the challenges of bringing the device to the marketplace when regulation does not presently accommodate your device.

Having now written this piece of advice to my fellow Radio Club members for consumption by the core of the RF engineering world represented by our notable gathering, I will no longer have to worry about trying to shoehorn another new device into the FCC's regulatory parameters, right?

E. Lillian Todd, The Radio Club Of America's First Honorary President

— Text by Don Bishop (F)
— Comic strip by Patrick M. Reynolds

*(**A note from Don Bishop:** I saw Lillian Todd's name in the Radio Club of America's historical documents many years ago and, ever since, I wondered who she was. In June, I uncovered biographical information about her along with some photographs. During a telephone conversation on July 22, Gil Houck mentioned noticing the historical comic strip, and Lillian emerged from the shadows.)*

Who was E. Lillian Todd?

E. Lillian Todd was the first woman to design and build an airplane, and she also was one of the adult charter members of the Radio Club of America. Two adults were absolutely key to the founding of the Radio Club, and Lillian was one of those two. Without them, the club would not have started.

At an uncertain date, Lillian was reported as "the first person to induce the State of New York to accept an airplane as a gift." She relocated to Corona del Mar in Orange County, Calif. The report of her relocating was published in August 1936 but there is no other information about her life after she left New York, and neither her date birth nor her date of death can be verified.

A clipping from the *New York Herald*, dated Nov. 8, 1910, reads as follows:

Miss E. L. Todd Sees in Trial Flight Biplane She Built Herself

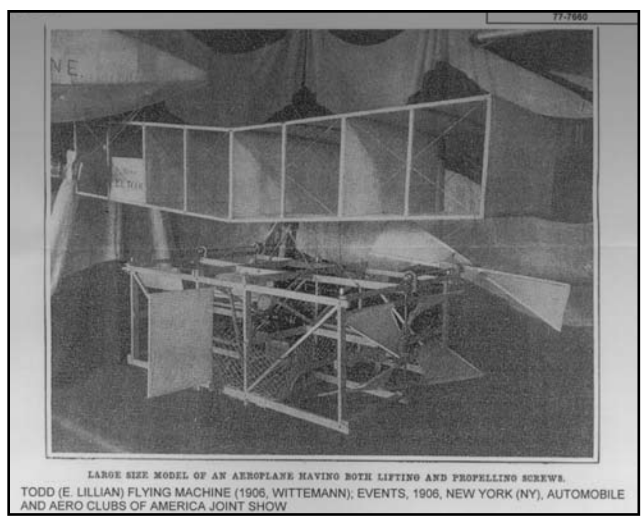
New York Woman's Years of Effort Are at Last Crowned with Success

After years of effort, Miss E. Lillian Todd, of No. 131 West Twenty-third Street, realized her ambition yesterday, when she had the pleasure of seeing a biplane, the work of her hands and brain, fly across the Garden City aviation field.

After having the machine built numerous times, Miss Todd, about four months ago, announced that she had a biplane which she thought would fly. She then tried to get an engine, but met with repeated defeat, as the engines which she tried were not suitable. Finally a modified Rinek motor was declared satisfactory.

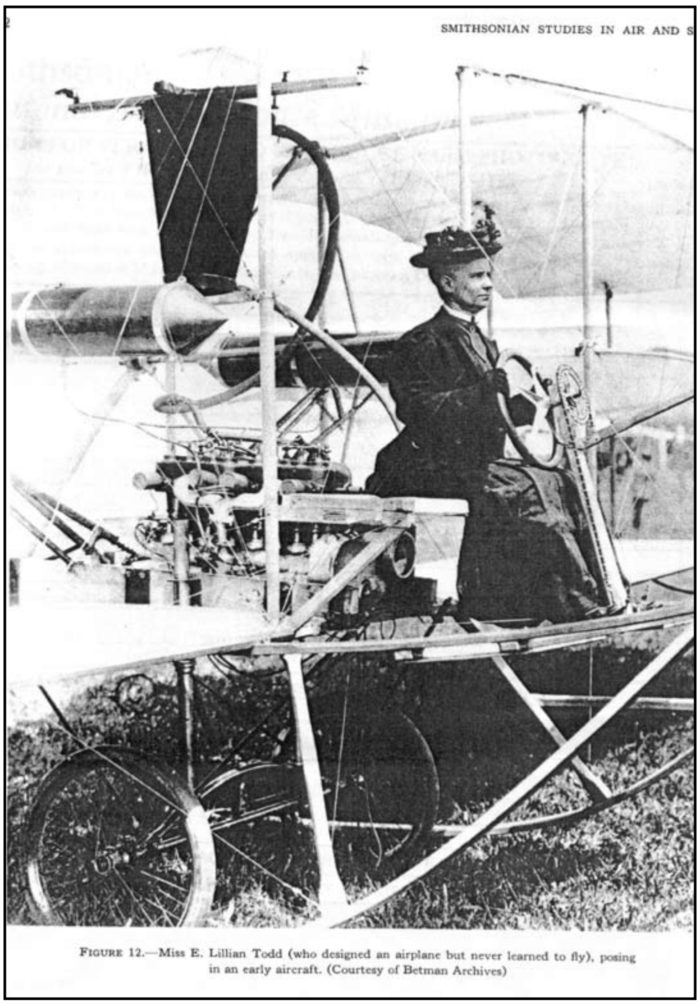
A good sized crowd was on hand to witness the first attempt to fly the biplane. Mr. Didier Masson was the aviator. He ran the machine across the ground, then went to the air for twenty feet and made a turn at the far end, returning to the starting place, where he was enthusiastically received by Miss Todd and the crowd.

The upper planes of the biplane are shaped somewhat like a bird's wings when in flight, while the lower planes are level. The chassis is about five feet high.



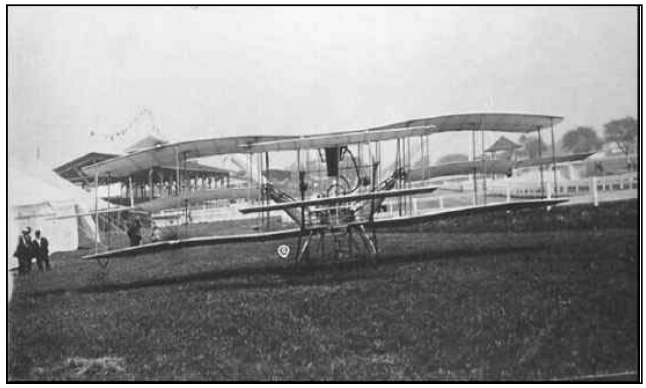
This is a photograph of the airplane Lillian displayed in 1906. It did not fly and, with the hindsight of 100 years of aviation, you probably wouldn't expect it to. The description of the photograph is as follows: "Three-quarter left front view of flying machine designed by E. Lillian Todd and constructed by Wittemann Brothers, on display at the exhibition of the Aero Club of America, December 1906. Titled: LARGE SIZE MODEL OF AN AEROPLANE HAVING BOTH LIFTING AND PROPELLING SCREWS. Note sign affixed to model at upper left reading, 'Miss E. L. Todd.' "

In his historical comic strip, Patrick M. Reynolds depicts Lillian riding with her pilot, Didier Masson, during the first flight of her airplane on Nov. 7, 1910, but it is inaccurate to say that she rode with the pilot. This photograph taken on that day shows the airplane at rest with Lillian seated between Masson and another man -- and we don't know which man is which.



This picture shows Lillian posing at the controls of her airplane. All sources seem to be in agreement: She never learned to fly. One source said she was the first woman to apply for a pilot's license, at that time issued by the Aero Club of America.

Photo credits: *Women in Aviation International; National Air and Space Museum, Smithsonian Institution; Smithsonian Studies in Air and Space; the collection of Dean Unger*



Here is one last look at Lillian's airplane. What a difference between the 1906 airplane and the 1910 airplane!

An E. Lillian Todd Timeline

Summer 1905 — Five men, four of them from New York, founded the Aero Club of America, which in 1922 evolved into and was incorporated as the National Aeronautic Association.

December 1906 — Lillian displayed the airplane she designed and built — an early version that was not flown — at the Second Annual Exhibit of the Aero Club of America, held in conjunction with the American Automobile Association. The public display of her work may help to explain why she has been credited as the first woman to design and build an airplane.

1908 — Lillian organized the Junior Aero Club of the United States. While she continued redesigning and rebuilding her airplane, seeking a version that would fly, she helped teenagers to build model airplanes that also were supposed to fly. "Of course, the science of flying was in its infancy at that time and, although their tests were not particularly successful, they were none the less commendable," said George Burghard, a member of the Radio Club of America in 1911. He described the results of the teenagers' model airplane projects that way in a history of the Radio Club of America that was published in 1934.

Summer 1908 — Electrician and Mechanic magazine started a national society for wireless telegraphy enthusiasts called the Wireless Club, and it counted 114 members as of Aug. 1, 1908.

Jan. 2, 1909 — By this time, the interest of at least three members of the Junior Aero Club had shifted from aviation to wireless telegraphy. They had become the "wireless division" of the Junior Aero Club. They built wireless apparatus at Lillian's studio in New York and displayed it at a public exhibition. Their activities drew the interest of two additional teenagers. The five teenagers and the two adults, including Lillian, had a meeting Jan. 2, 1909, at which time Lillian transferred the teenagers' memberships and their dues payments from the Junior Aero Club to the

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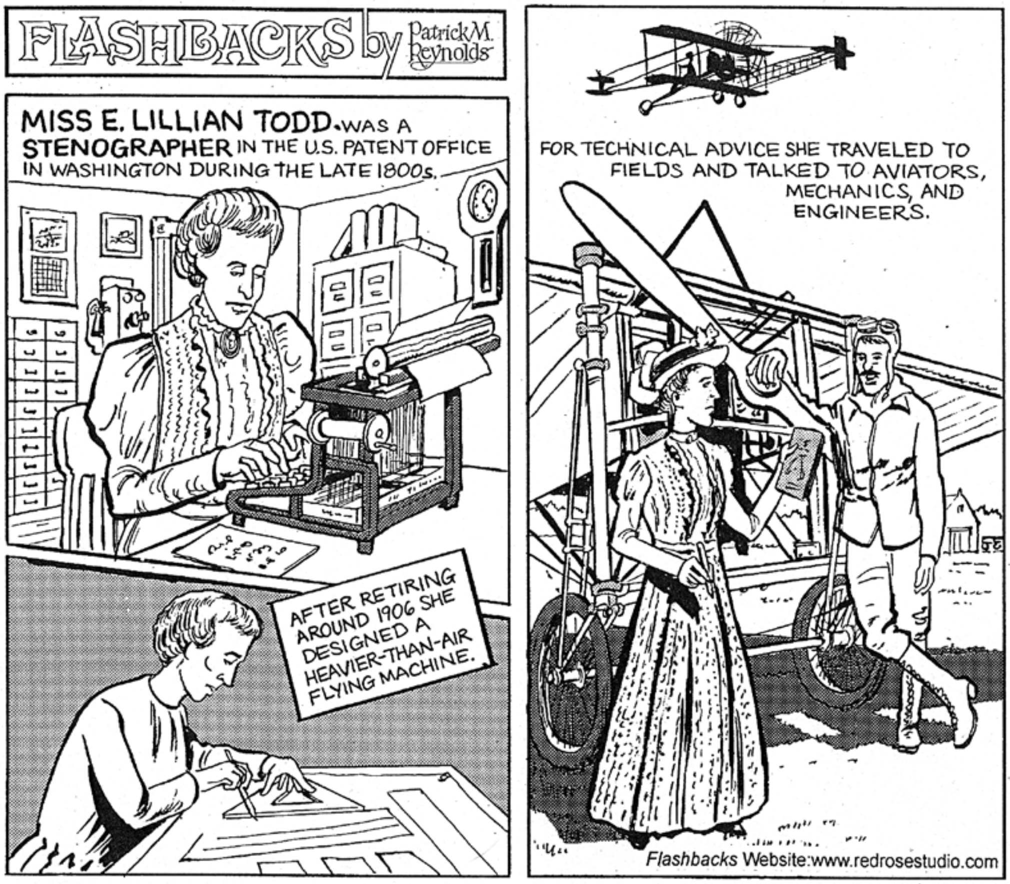
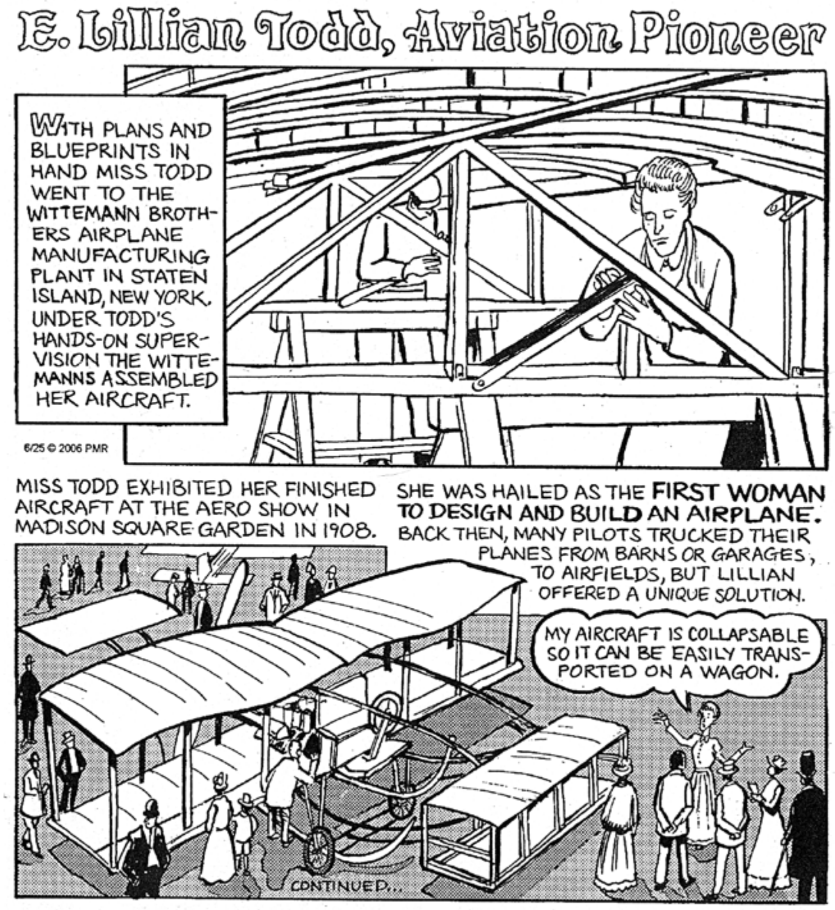




An E. Lillian Todd Timeline

(Continued from p. 11)

newly formed Junior Wireless Club Limited. Lillian was among those designated as charter members of the Junior Wireless Club, and she was elected as an officer: Honorary President.

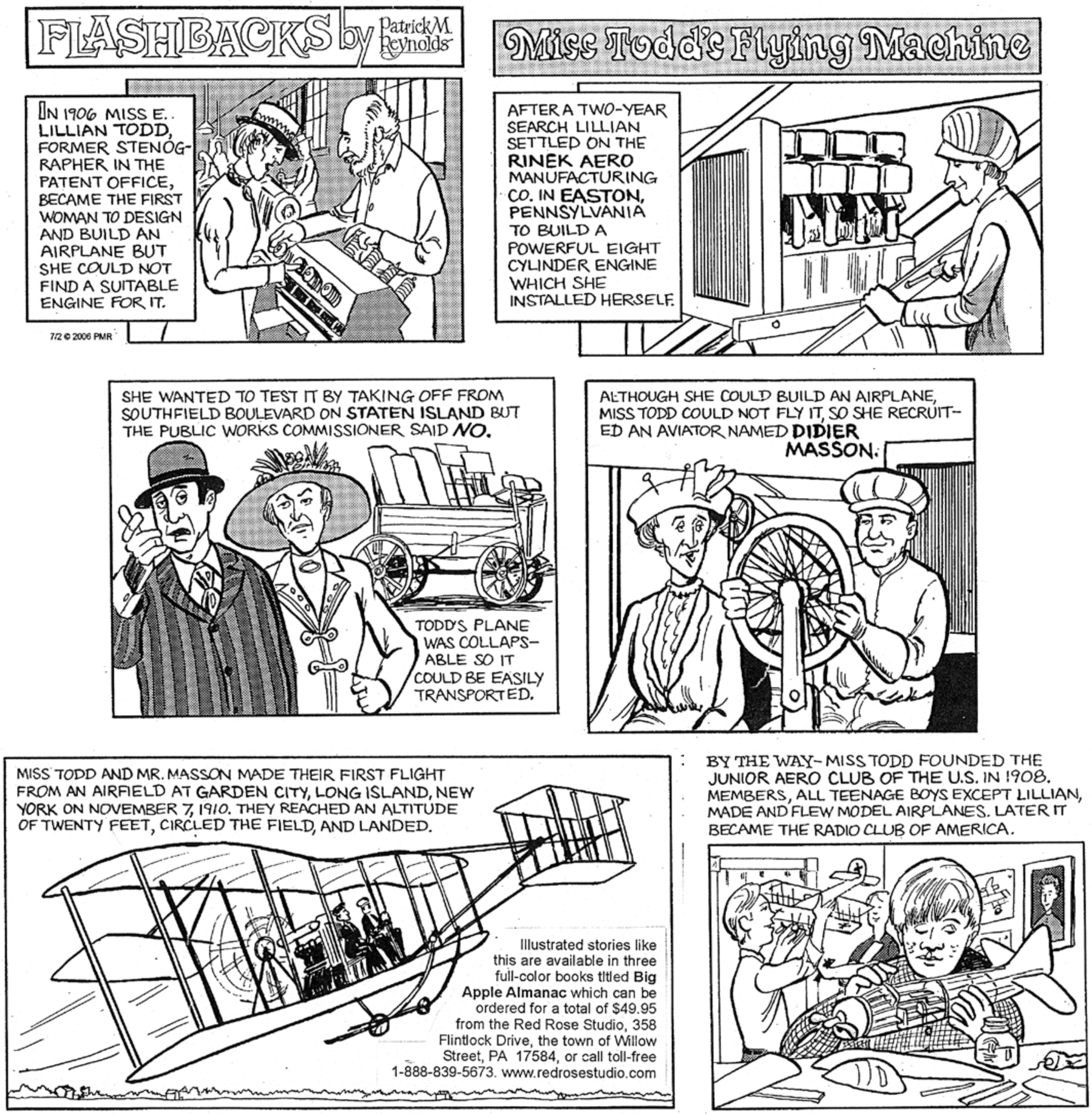
Oct. 21, 1911 — The teenagers had grown older, with most of them 20 or 21 years old by the end of 1911. It was time to shed the word "Junior" from the Club's name, but the name "Wireless Club" was in use by others nationally and locally. The Junior Wireless Club of America (the way the name appeared in the record of the Oct. 21, 1911, meeting) changed its name to The Radio Club of America. Of the nine individuals named at the Jan. 2, 1909, meeting, only the five who were teenagers at the time remained with the Club. None of the four adults from 1909 was a member when the Club's name changed, not even Lillian. Four individuals from 1909 had exited, and eight had joined, giving the Club 13 members when the name changed. By the end of 1911, nine weeks later, membership numbered 24. In the span of three years, the aging of the original teenaged members and the age of new members then joining the Radio Club converted the Radio Club of America into a society with mostly adult members. And so it remained. In 2006, the Club has only one or two teenaged members.

Corrections:

In the Spring 2006 Radio Club of America Proceedings, the caption on page 8 should read:

Boeing Employees Amateur Radio Society (BEARS) members, and their CIE and CRSA friends talk for the first time from China's Great Wall on September 10, 1988. Left to right: Miss. Lou, Chinese interpreter; the late Dick Mehnert, BEARS president; Pat West, W7EA; Zhou Mengqi, CIE; Ning Yunhi, CRSA; Mike Norin, NS7O; and Bill Showers, KC7CF (1988 photo).

In addition, Russ Kroeker's amateur radio call sign is K7HGE.



Women And The Radio Club Of America

1909	**E. Lillian Todd**	First woman member. First woman officer. Only woman elected as honorary president. As a charter member, she did not join the Radio Club, but she did co-found it.
1973	**Vivian A. Carr**	Vivian A. Carr. First woman to join the Radio Club of America as a member. Elected a director in 1974.
1981	**June Poppele**	First woman Honorary Member (designated by board of directors).
1982	**Vivian A. Carr** **Connie M. Conte** **Louise Ramsey Moreau**	First women to receive Radio Club of America awards.
1999	**Mercy S. Contreras**	First women to be elected Vice President. First woman to become Executive Vice President (2001). First woman to become President by succession (2003). First woman to become President Emeritus (2005).

Spread Spectrum Is Good — But It Does Not Obsolete *NBC v. U.S.*!

— By Charles Jackson (M), Raymond Pickholtz and Dale Hatfield (F)

Have new technologies like spread spectrum eliminated the problem of radio interference? According to three experts, while spread spectrum is a great technology, it does not eliminate the problem of interference. Similarly, although some have asserted otherwise, signals below the noise floor can create interference.

A word from the authors: We first show that a number of authors have embraced these misconceptions in works addressing public policy—unfortunately, we are not attacking a straw man. Simplifying these authors' views somewhat, they argue technology has eliminated the problem of interference; therefore, the legal rationale for radio regulation under the Communications Act of 1934, affirmed in the 1943 *NBC* case[1] must be reconsidered. On such reconsideration, the First Amendment trumps an obsolete theory of interference; therefore, the fundamental structure of the Communications Act of 1934 is invalid.

We then provide a nonrigorous (no equations!) explanation of the nature of interference created by spread spectrum signals or by signals below the noise floor. We also offer a few pointers to the technical literature for those who wish to understand these issues in more depth.

Scientific discoveries and technologies sometimes gain a cachet out of proportion to their value. Their names become buzzwords — they are called on to explain problems far beyond their reach. Google the phrase "chaos theory" together with the word "politics" or Google the terms "quantum" and "finance," and you will find a host of articles and Web pages that stretch the fabric of science far beyond its elastic limit.[2] Some authors merely use the science as simile, but others claim that the relevant science supports their analysis of politics, finance or movie criticism.

A recent example of this phenomenon has occurred in telecommunications policy discussions in which analysts claim that new technology has solved the problems of radio interference.[3] Such claims have appeared in both the popular press and in academic journals.[4] The purpose of this article is to examine two such claims and to match those claims with what we understand to be the capabilities of the technology. It is not our purpose here to engage in a discussion of spectrum policy — we (the Authors, collectively and individually) may agree with some of the policies advanced by these authors and disagree with others — rather, our purpose is to examine assertions regarding technology and to put those assertions into perspective.[5]

These technological claims are then used as the basis for arguing that the policy goals and legal basis of the Communications Act of 1934 are no longer valid.[6] For example, Benkler and Lessig state:

> "If the engineers are right — if the efficiency of an architecture of spread-spectrum wireless technology were even roughly equivalent to the architecture of allocated spectrum — then much of the present broadcasting architecture would be rendered unconstitutional. If shared spectrum is possible, in other words, then the First Amendment would mean that allocated spectrum — whether licensed or auctioned — must go."[7]

(Continued on p. 16)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The Communications Act of 1934[8] incorporates large parts of the Radio Act of 1927[9] and, albeit amended many times, still governs use of the radio spectrum in the United States. The Supreme Court upheld the constitutionality of the Communications Act in *NBC*.[10] Justice Frankfurter, writing for the majority, upheld the challenged regulations and noted that interference justified regulation,"[u]nlike other modes of expression, radio inherently is not available to all. That is its unique characteristic, and that is why, unlike other modes of expression, it is subject to governmental regulation. Because it cannot be used by all, some who wish to use it must be denied."[11] In dissent, Justice Murphy agreed with Justice Frankfurter on interference as the justification for regulation, "[o]wing to its physical characteristics radio, unlike the other methods of conveying information, must be regulated and rationed by the government. Otherwise there would be chaos, and radio's usefulness would be largely destroyed."[12]

Both the majority and the dissent in *NBC* accepted interference as the justification for regulation—that was not in debate. But if spread spectrum eliminates interference, then that predicate is wrong.

We note that we hold in high regard many of the authors whose works are considered below and, if it were possible, would omit their names from our analysis. Unfortunately, it is hard to cite an article properly without using the author's name.

We use the following approach. We state a proposition and follow that proposition with quotations from multiple sources showing how individual authors have expressed and accepted that proposition. We then analyze that proposition from the point of view of communications engineering. Our analysis is intended to be accessible — not mathematical. There are no equations, and mathematical jargon has been relegated to the footnotes.

The Analysis

A. Assertion One: Spread Spectrum Eliminates Interference

This assertion appears in various forms in many publications. Below are several instances of this assertion.

- CDMA [a spread spectrum technology] modulation schemes allow you to use spectrum without interfering with others.[13]

- A variety of techniques, some dating back to the 1940s, allow two or more transmitters to coexist on the same frequency. The best-known of these is spread spectrum… The practical consequence is that no government regulator or property owner need decide which signal is entitled to use the frequency; both of them can use it simultaneously.[14]

- [N]ew technological developments, such as spread spectrum and ultra-wideband radio, make it possible for many users to use the same broad swath of spectrum simultaneously without interference.[15]

- The spread-spectrum transmissions of multiple users occupy the same frequency band, but are treated by each other as manageable noise, not as interference that causes degradation of reception.[16]

- But the most important implication of spread-spectrum technology for regulatory purposes is that it allows many users to use the same band of frequencies simultaneously. Because every signal is noise-like, the signal of each user is, to all the others, just part of the background noise. The receiver ignores all signals but the one chosen for reception, and "receives" — translates into humanly intelligible form — only those noise-like transmissions that carry the intended signal.[17]

- Using a variety of strategies, mostly known as spread spectrum, researchers in wireless technology have begun to demonstrate the viability of systems that allow many users to share the same slice of spectrum without interfering with one another.[18]

- The problem of interference, as real and serious as it was, like the problem of recouping the non-zero marginal cost of the book, went away.[19]

- With spread spectrum, a transmission is disassembled and sent out over a variety of frequencies, without causing interference to whatever else might be operating within those frequencies, and is reassembled on the other end…[20]

- With spread-spectrum technologies, spectrum would not need to be allocated, in the sense of giving one person an exclusive right to the detriment of all others. With spread spectrum, broad swaths of the radio spectrum could be available for any to use, so long as they were using an approved broadcasting device. Spectrum would become a commons, and its use would be limited to those who had the proper, or licensed, equipment.[21]

These quotations came from *Forbes*, *Columbia Journalism Review*, *The New Republic*, three law-review articles and speeches by the authors. Those authors include professors at Stanford, New York University, Columbia and the University of Pennsylvania. Another author is a practicing attorney who was a member of the *Harvard Law Review* and clerked for two federal circuit-court judges.

Unfortunately, the fundamental assertion is incorrect. Actually, spread spectrum does not eliminate interference; rather, it changes the nature of interference.

Aquinas regarded arguments based on authority as the weakest form of proof.[22] Nevertheless, arguments regarding spread spectrum put forth by engineering experts would seem to carry more weight than those of the legal experts cited above. The reader can judge whether our contention that spread spectrum does not eliminate interference carries any weight. Others with substantial credentials support that same view. Consider Professor Andrew Viterbi, the Presidential Chair Professor in the Electrical Engineering Department at the University of Southern California, and a member of both the National Academy of Engineering and the National Academy of Science. Viterbi explains the effect of spread spectrum on interference, saying: "[T]he main thrust of spread-spectrum CDMA is to render the interference from all users and all cells, sharing the same spectrum, as benign as possible."[23]

Professor James Spilker, Jr., Consulting Professor in the Electrical Engineering and Aeronautics and Astronautics Departments at Stanford University and a member of the National Academy of Engineering, summarizes spread spectrum well, saying:

> "It is often desired to provide a method by which multiple signals can simultaneously access exactly the same frequency channel with minimal interference between them. Spread-spectrum signaling has the capability to provide a form of multiple access signaling called code division multiple access (CDMA) wherein multiple signals can be transmitted in exactly the same frequency channel with limited interference between users, if the total number of user signals M is not too large."[24]

(Continued on p. 18)

Let us back up a little, provide some background and explain why spread spectrum does not eliminate interference. Spread spectrum is the name for a class of methods for impressing or modulating information on radio signals.[25] Spread spectrum has many advantages over earlier methods for transmitting information over radio, such as AM and FM. A key advantage is that, in many circumstances, it is better at resisting interference than systems using most other radio modulation technologies. Depending on the circumstances, spread-spectrum transmissions may generate either more or less interference to other communications systems than would modulation methods, such as AM or FM.

An example may illustrate some of these properties. Consider a simplified world of radio communications in which there is a block of spectrum divided into 10 radio channels. The radio channels are used for one-way communications from multiple groups of climbers communicating with their base camps in the valley below as illustrated in *Figure 1*. This example is constructed to remove some technical complications — *e.g.*, all the transmitters are roughly equidistant from all the receivers. One can think of these radio channels as being 25 kHz blocks of spectrum. Communication using multiple individual frequency channels is defined as Frequency-Division Multiplexing (FDM),[26] and the process of accessing these channels is called Frequency-Division Multiple Access (FDMA).[27] An ideal frequency division multiplex system would permit a user to operate on any one of the 10 channels without causing interference to users on the other nine channels. But if two users tried to use a specific channel at the same time, the receivers in the valley would not be able to separate one signal from the other, and interference would result.[28]

Figure 1: **The Hypothetical Communications World**

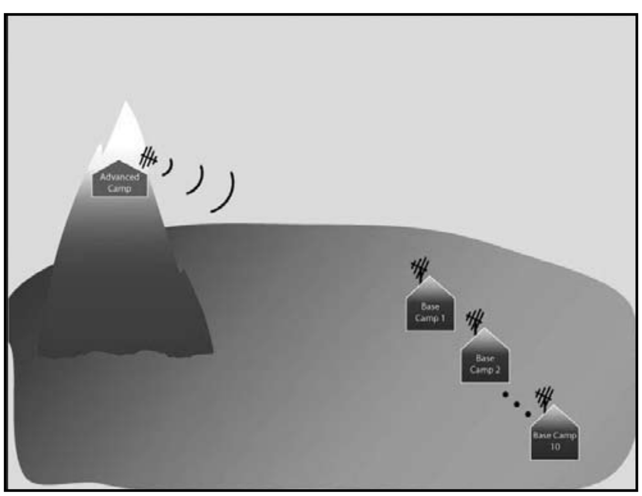


Figure 2: **Ten Separate Frequency Division Channels**

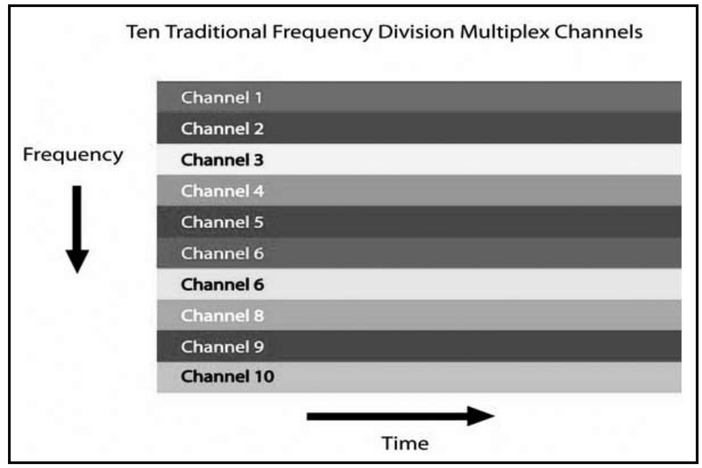
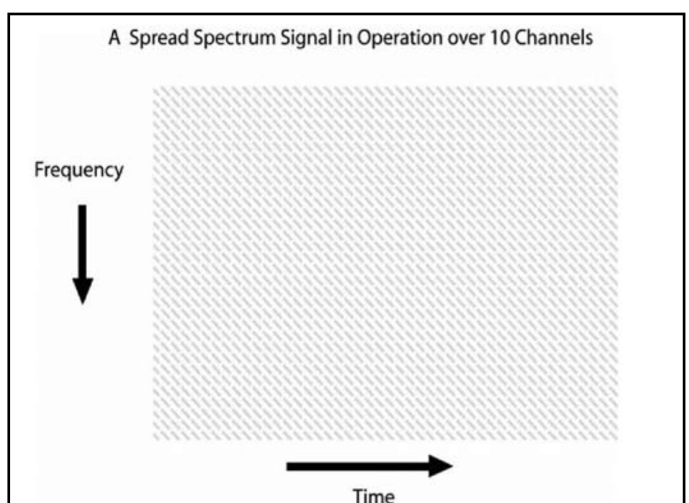


Figure 2 shows the 10 channels as a region or range of frequencies devoted to one use over time. Channel 1 is shown by the bar across the top of the figure.

In this technology, signals are not spread — rather, each signal occupies just the bandwidth it needs. Interference is a purely zero-one affair. If two users try to transmit on the same channel at the same time, each receives interference that makes the channel unusable. If two users transmit on different channels at the same time, there is no interference. *Figure 3* illustrates a hypothetical spread-spectrum signal corresponding to the Channel 1 signal of the *Figure 2* above. The intense signal that filled Channel 1 is now a weaker signal that covers all 10 channels. The transmitted energy is scattered in both time and frequency in what appears to be a random fashion in accordance with what is called a spreading code. The process of multiplexing many signals on the same block of radio spectrum by using separate spreading codes for each user is called Code-Division Multiple Access (CDMA).

Figure 3: **A Representation of a Spread Spectrum Signal**



(Continued on p. 20)

Figure 4: **Representation of a Second Spread Spectrum Signal**

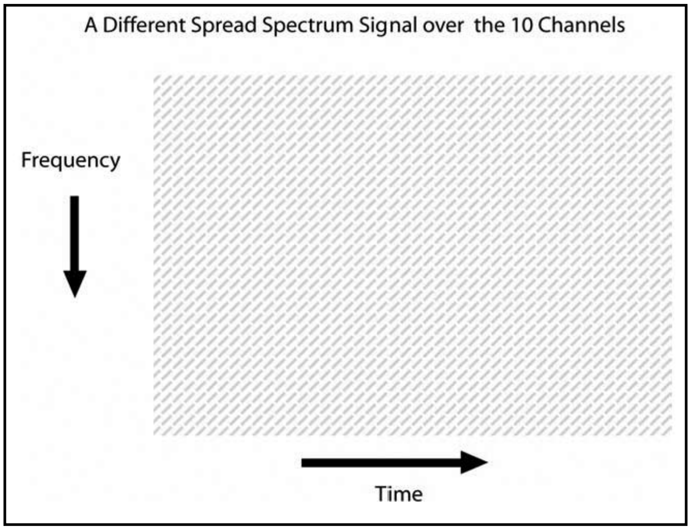


Figure 4 illustrates a different spread spectrum signal occupying all 10 channels.

Figure 5: **Representation of Two Spread Spectrum Signals**

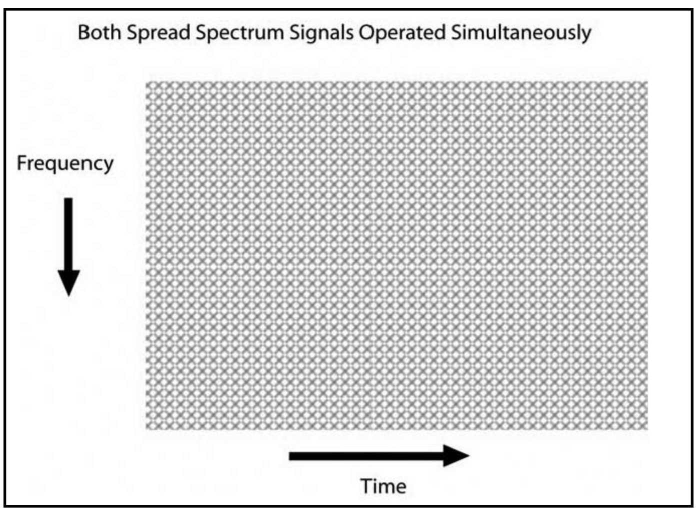


Figure 5 illustrates the operation of both spread spectrum signals simultaneously. Those signals overlap in time and space. If one examines any small range of frequencies over a short period of time, one will find parts of both spread-spectrum signals. However, the proper receiver can distinguish one spread-spectrum signal from the other sufficiently well, making effective communication possible. Unlike the case with the earlier frequency-division channels, the receiver for one spread spectrum signal responds slightly to the other spread spectrum signal.[29] So, a spread-spectrum system such as this could work acceptably if two or three users were operating.

But each additional user would increase the interference to all other active users. At some point, perhaps at about four to six users, interference would become so great that all users would lose service.

At this point, the non-engineering reader is probably willing to throw up his or her hands and ask, "What is the point of all this? You started with an ideal system that had no interference and replaced it with a system that has inescapable interference and supports fewer communications than were possible before!" The answer is that the utility of spread spectrum depends on the problem one is trying to solve. Assume that there are 20 groups of climbers on the mountain — more climbers than channels. Assume also that the climbers cannot coordinate channel use with one another or determine when another climbing party is using a channel, and only need to send requests back to their base camp occasionally — an average of two minutes per hour for each party. In the world with 10 channels with zero-one interference, a climbing party would have to pick one of the 10 channels, transmit their message and hope that no other party was using that channel.

In the spread-spectrum world, there is an alternative solution. Each of the 20 climbing parties could be given a different spreading code and would use their individual code when transmitting. As long as no more than four or five climbing parties transmit at the same time, the mutual interference is low, and all the messages are received. But under these assumptions, it is highly unlikely that more than four climbing parties will choose to transmit at the same time. This spread-spectrum system provides efficient distributed access to a range of frequencies.[30] In the real world, with pools of thousands of channels and millions of occasional users, the benefits of such distributed access would be even greater.

Of course, this example is an oversimplification — real-world applications include many other factors. One important factor is distance separation. In this example, the climbing parties were all roughly equidistant from the base camps. But if one user were substantially closer to the base camps than were the others, that user's signal would be substantially stronger. Consequently that user's signal would create more interference to other users. In a situation in which such near-far problems abound, the older separate channel system may be a preferable technology.[31]

In some circumstances, spread spectrum systems can share radio channels with older technologies without receiving or causing harmful interference. But such sharing does not happen automatically. Rather, one must analyze the systems involved, calculate the performance impairments and determine the highest power level at which the spread-spectrum system can operate without creating unacceptable impairments. In 1991, Schilling and his co-authors provided an example of such a calculation and measurements.[32] They showed that a personal radio service, similar to today's Personal Communications Service (PCS) that used wideband spread spectrum, could share spectrum with the microwave radio systems that were then in the 2 GHz band.[33]

But this showing was conditional on the spread-spectrum handsets not transmitting at powers above one thousandth of a watt and the acceptance of the authors' definition of impairment.[34] Alternatively, one could say that they showed that a PCS with handset power above one thousandth of a watt would create interference. They also calculated total system capacity (the number of mobile units that could be supported in a given region), taking into account the mutual interference of each mobile unit with all the others.[35] The system had a finite system capacity — albeit a capacity about three times larger than the capacity calculated for non-spread-spectrum designs.

There is also substantial empirical evidence of interference to spread spectrum signals. One example is the strong protest that users of the GPS satellite signal (a spread-spectrum system) raised against interference to the GPS signal from proposed ultra-wideband (UWB) systems.[36] Another example is the purchase of additional spectrum by the wireless carriers that use spread spectrum.[37] Relatedly, those wireless carriers using spread spectrum require their equipment suppliers to reduce the interference one handset generates to nearby handsets to a level a million times lower than that permitted by the Federal Communications Commission (FCC).[38] It is hard to understand why these firms would spend money to reduce interfering signals unless those signals were harmful.

CDMA has built into it extensive capabilities for managing the power of signals transmitted from handsets so that those signals will all arrive at the cell tower at the same strength, thereby avoiding the near-far problem discussed earlier. If spread spectrum really eliminated interference, these capabilities would be unnecessary.

The unlicensed community is pressing for the release of more spectrum for unlicensed applications.[39] However, were interference not a problem, the current several hundred megahertz of spectrum available for

(Continued on p. 23)

unlicensed systems would be sufficient to carry more data than any person would need.[40]

Spread spectrum is a great technology. When used in personal wireless systems, such as cellular and PCS, it increases capacity by a factor of two to 10 over the earlier Time Division Multiple Access (TDMA) and FDMA technologies.[41] Used in the GPS system, it permits the efficient sharing of the satellite-to-earth radio channel.[42] Manufacturers and service providers have converged on the use of spread spectrum for third-generation wireless systems.[43] But as good as spread spectrum is, it is not good enough to make the problem of interference go away.

B. Assertion Two: Signals Below The Noise Floor Are Harmless

- Spectrum below the noise floor is therefore not scarce, at least from the perspective of high-power systems above it, because these systems ignore radiation at that level.[44]

- For example, low-power UWB would be covered by this easement, to the extent that it operates under the noise floor and creates no interference.[45] An underlay easement would allow secondary unlicensed users to share licensed spectrum as long as they remain below the noise floor established by the license.[46]

The radio noise floor is the level of unavoidable radio static in the environment.[47] Such noise arises from different causes in different regions of the spectrum. In the AM band, the primary source of radio noise is either distant lightning (for someone on a rural road far from town) or nearby electrical equipment (for someone in town).[48] In the cellular and PCS bands, noise comes from the thermal microwave radiation in the environment, electronic equipment such as personal computers, and the out-of-band emissions of radio transmitters.[49] Satellite-TV receivers see primarily the thermal microwave radiation from space and, because space is cold, this noise is lower than the noise seen by PCS receivers.[50]

When an external source adds noise to the environment, the total noise rises. Adding noise to the environment might be analogized to pouring more water in a bathtub — the level of the water in the bathtub rises. In contrast, if one pours more water into a river, the level of the water in the river stays the same.[51] *Figure 6*, taken from a presentation given by Kevin Werbach, illustrates this fallacy.[52] It shows a desired signal, the noise floor and a signal below the noise floor (an underlay signal). As illustrated, there appears to be no problem.

Figure 6: **Illustration of Underlay Signal**

However, the drawing does not represent the physics observed in the real world. The proper illustration is shown in *Figure 7*.

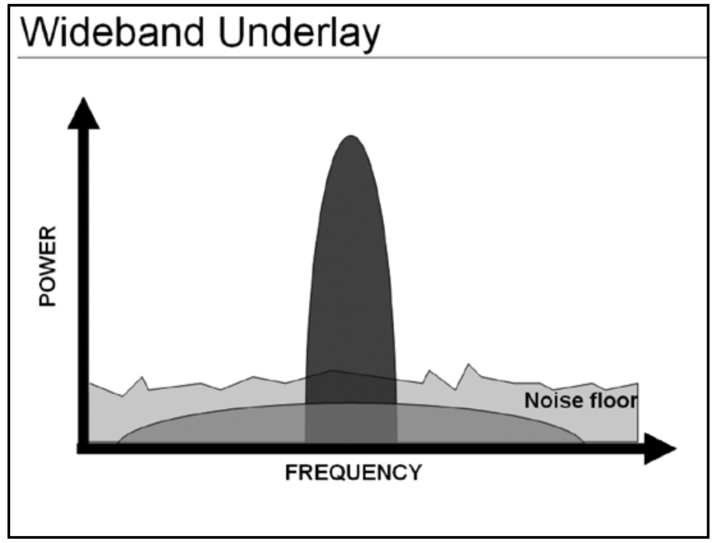
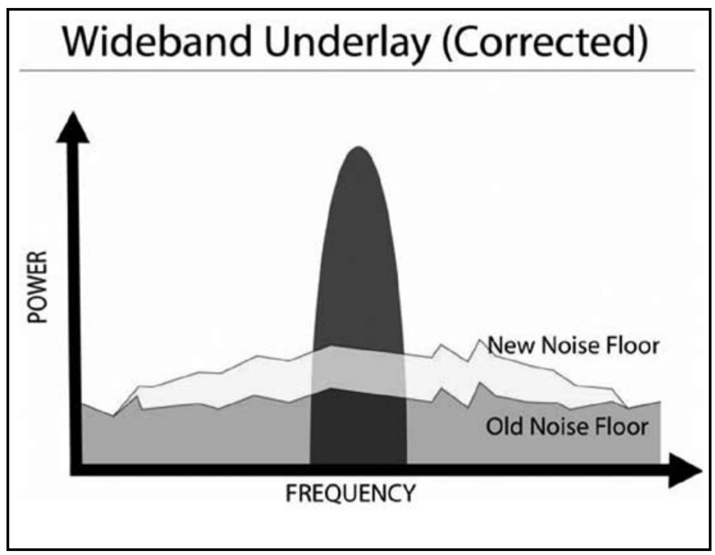


Figure 7: **Proper Illustration of Underlay Effects**

The contrast is clear. In Werbach's diagram, the added noise or interference does not affect the total noise. In



the revised diagram, the added noise or interference increases the total noise. That is how real-world systems work — akin to more water in a tub, not to more water in a river. An interfering signal reduces the margin against noise and interference.

This issue is not merely theoretical. Some modern radio systems can operate at signal levels sufficiently low that added noise or interference — even if below the noise floor — will noticeably degrade the performance of these systems.[53] For example, Superconductor Technologies sells cryogenically cooled ultra-low noise amplifiers for use in cellular and PCS systems.[54] These amplifiers increase cell coverage by permitting the base station to hear signals that are too weak to hear with more conventional gear. Noise or interference at half the level of the noise floor would impair systems using such receivers.

Conclusion

Radio interference remains a genuine problem, and neither using spread spectrum nor keeping the potentially interfering signal below the noise floor eliminates interference. We have tried to explain why interference remains a problem. We have also pointed to the behavior of spectrum users — users who could save billions if spread spectrum truly eliminated interference — as further evidence that our point is correct.

Although our purpose in this paper is to throw cold water on some unjustifiably optimistic views of radio technology, we conclude by noting that there is substantial cause for optimism regarding future use of the radio spectrum. Emerging technologies, such as Multiple-Input Multiple-Output (MIMO) and Multi-User Detection (MUD), will expand spectrum capacity several times over. Unfortunately, these technologies cannot be used in every radio application, and they may impose costs such as shorter battery life or higher prices. Technology has not eliminated interference, but the future for wireless communications is bright.[55]

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Footnotes:

1. NBC v. United States, 319 U.S. 190 (1943).

2. We note that such overreaching papers are sometimes written by engineers. Back when information theory was a hot new topic, a famous editorial by Peter Elias lamented the repeated appearance of the generic paper Information Theory, Photosynthesis, and Religion, which "discusses the surprisingly close relationship between the vocabulary and conceptual framework of information theory and that of psychology (or genetics, or linguistics, or psychiatry, or business organization)" and suggested that the authors "give up larceny for a life of honest toil." Peter Elias, Two Famous Papers, 4 IRE TRANSACTIONS ON INFO. THEORY 99, 99 (1958).

3. Succinctly stated, interference occurs when one radio transmission impairs the reception of a second transmission. Properly defining interference and harmful interference can be a difficult task—one as rooted in economics and tort law as engineering. For the purposes of this Article, we assume that the reader will follow Justice Stewart's approach to definitional issues and supply the definition he or she finds appropriate. Cf. Jacobellis v. Ohio, 378 U.S. 184, 197 (1963) (Stewart, J., concurring) (noting that despite the near impossible task of defining "hard-core pornography" he "[knew] it when [he] [saw] it"). For a discussion of interference, see generally R. Paul Margie, Can You Hear Me Now?, 2003 STAN. TECH. L. REV. 5, http://stlr.stanford.edu/STLR/Articles/03_STLR_5/article_pdf.pdf.

4. See infra Parts III.A and III.B.

5. Although we argue that some policy recommendations are based on reasoning from faulty premises, we acknowledge that those recommendations may, nonetheless, be valid.

6. Of course, there are attacks on the viability of NBC based on theories other than spread spectrum is like a magic pixie dust. See, e.g., Stuart Benjamin, The Logic of Scarcity: Idle Spectrum as a First Amendment Violation, 52 DUKE L.J. 1 (2002).

7. Yochai Benkler & Lawrence Lessig, Net Gains: Will Technology Make CBS Unconstitutional?,THE NEW REPUBLIC, Dec. 14, 1998 at 12, 14.

8. Communications Act of 1934, ch. 652, 48 Stat. 1064 (1934) (codified as amended in various sections of 47 U.S.C.).

9. Radio Act of 1927, ch. 169, 44 Stat. 1162 (1927), repealed by Communications Act of 1934, ch. 652, § 602(a), 48 Stat. 1064, 1102 (1934).

10. 319 U.S. 190.

11. Id. at 226.

12. Id. at 228 (Murphy, J., dissenting).

13. George Gilder, Telecosm: "Auctioning the Airwaves," FORBES ASAP, Apr. 11, 1994, at 99, 112 (emphasis added).

14. Kevin Werbach, Supercommons: Toward a Unified Theory of Communications, 82 TEX. L. REV. 863, 874 (2004) (emphasis added).

15. Stuart Buck, Replacing Spectrum Auctions with a Spectrum Commons, 2002 STAN. TECH. L. REV. 2, ¶ 6, http://stlr.stanford.edu/STLR/Articles/02_STLR_2/article_pdf.pdf (emphasis added).

16. Yochai Benkler, Overcoming Agoraphobia: Building the Commons of the Digitally Networked Environment, 11 HARV. J.L. & TECH. 287, 324 (1997) (emphasis added).

17. Id. at 396 (emphasis added).

18. Benkler & Lessig, supra note 7, at 14 (emphasis added).

19. Eben Moglen, Freeing the Mind: Free Software and the Death of Proprietary Culture, Keynote Address at the University of Maine Law School's Fourth Annual Technology and Law Conference, 13 (June 29, 2003), http://moglen.law.columbia.edu/ publications/maine-speech.pdf (emphasis added).

20. Jesse Sunenblick, Into the Great Wide Open, COLUM. JOURNALISM REV. Mar.–Apr. 2005, at 44, 46 (emphasis added).

21. Lawrence Lessig, Code and the Commons, Keynote Address at Fordham Law School: Media Convergence, 7 (Feb. 9, 1999), http://www.lessig.org/content/articles/ works/Fordham.pdf (emphasis added).

22. "Nam, locus ab auctoritate est infirmissimus." THOMAS AQUINAS, SUMMA THEOLOGIAE, Iª Q. 1, 8, available at http://www.corpusthomisticum.org/sth1001.html.

23. Andrew J. Viterbi, The Orthogonal-Random Waveform Dichotomy for Digital Mobile Personal Communications, IEEE PERS. COMM., First Qtr. 1994, at 18.

24. 1 GLOBAL POSITIONING SYSTEM: THEORY AND APPLICATIONS 62 (Bradford W. Parkinson & James J. Spilker Jr., eds., 1996).

25. For an older, but still excellent, introduction to spread spectrum see Raymond L. Pickholtz, Donald L. Schilling & Laurence B. Milstein, Theory of Spread-Spectrum Communications—A Tutorial, 30 IEEE TRANS. ON COMM. 855 (1982), http://mail.com.nthu. edu.tw/~jmwu/com5195/ Schilling-DSSS-tutorial.pdf.

26. ATIS Committee T1A1, ATIS Telecom Dictionary, frequency-division multiplexing (FDM)), http://www.atis.org/tg2k/ (scroll to frequency-division multiplexing (FDM), http://www. networkdictionary.com/telecom/fdm.php (last visited Mar. 23, 2006).

27. ATIS Committee T1A1, ATIS Telecom Dictionary, frequency-division multiple access (FDMA), http://www.atis.org/tg2k/ (scroll to frequency-division multiple access (FDMA)), http://www. networkdictionary.com/telecom/fdm.php (last visited Mar. 23, 2006).

28. Recall that this is an idealized system. In the real world, the use of adjacent FDM channels often causes interference because real-world receivers cannot perfectly reject signals in adjacent channels.

29. Two caveats should be added here. First, recall that the perfect rejection of the adjacent channel signals in FDMA depended upon an ideal system. However, even in an ideal CDMA system, a receiver for one spreading code will respond (slightly) to a signal sent with a different spreading code. Second, there are some CDMA systems in which a receiver can perfectly separate two signals—such CDMA signals are as separate as the ten frequency-division multiplex channels considered above. But, there is no free lunch. If there is space for only ten frequency-division channels, there will be space for only ten perfectly separate CDMA signals with the same capacity. The sampling theorem shows that a waveform of bandwidth W and duration T has only 2WT degrees of freedom. A system that uses ten orthogonal wideband spread spectrum signals puts one tenth of these degrees of freedom into each spreading code. See JOHN G. PROAKIS, DIGITAL COMMUNICATIONS 160–68 (4th ed. 2001).

30. A rough calculation shows that in this example interference is approximately 100 times less likely with the CDMA system than with the traditional FDMA channels. This example parallels the data link in the Global Positioning System ("GPS") navigational satellite system in which each satellite uses a different spreading code to transmit its signal. The GPS data link works well with a dozen satellites in view by a receiver at any one time. But, the data link would fail if there were 200 satellites in view—mutual interference would overwhelm the desired signals. An excellent explanation of the GPS signaling system is the two-volume text (roughly 1400 pages) edited by Parkinson and Spikler. GLOBAL POSITIONING SYSTEM, supra note 24.

31. Real-world FDMA systems also suffer from this near-far problem—though usually not as severely as do CDMA systems. FDMA may be considered as an orthogonal multiple access technique for stationary communications so that, in theory, there is no interference (cross correlation is zero). The same can be said with orthogonal, direct sequence spread spectrum (e.g., Walsh codes) CDMA when there is no multipath (echoes or ghosts on the radio path). Multipath will deorthogonalize Walsh (or other orthogonal sequences), and Doppler spread will deorthogonalize FDMA signals. Doppler spread occurs when transmitters and receivers move relative to one another thereby shifting the received frequency slightly from the transmitted frequency. The two schemes are mathematical duals—by dual we refer to mathematical systems with symmetries that permit substituting one variable for another. See the discussion in the reference by Viterbi, supra note 23. For a discussion of time-frequency dualities, see Phillip Bello, Time-frequency duality, 10 IEEE TRANS. ON INF. THEORY 18–33 (1964). That is why, for highly time dispersive (e.g., multipath) channels with little or no Doppler spread, Orthogonal Frequency Division Multiplexing ("OFDM") performs well (the new IEEE 802.11g wireless Local Access Network ("LAN") standard takes advantage of this property). The tradeoff is that narrow subbands make multipath effects and InterSymbol Interference ("ISI") negligible. But, if the subbands are too narrow, Doppler spread deorthogonalizes the subbands and you get the dual of ISI—adjacent channel interference. Some respectable people now assert that they can get substantial capacity increases using coded OFDM. When one looks at it this way, there is both mutual Multiple Access Interference ("MAI") and Gaussian noise. Traditional thinking was that we want to eliminate MAI by first othogonalizing and

then working just above the noise floor (strictly speaking, at the lowest ratio of energy-per-bit to the noise density [E_b/N_0] as allowed by coding) in each "channel." This is the case in FDMA—a subdivision of spectrum so that each user gets a piece of "private" spectrum, if only for the allocation period. First generation IS-95 CDMA took a different philosophy by operating at the lowest $E_b/(N_0 + M*I_0)$, where I_0 is the MAI power density per user and M is the number of active, equally power-controlled users. As M gets large, N_0 is no longer the floor; so first-generation CDMA is best thought of as an interference-sharing scheme. For larger spreading, I_0 is reduced and you can allow more users—but you need more bandwidth to accommodate the increased spreading. CDMA also easily takes advantage of voice activity and actually uses the multipath to improve the Signal-to-Noise Ratio ("SNR") by diversity combining. Modern, 3G CDMA (e.g., cdma2000) uses more sophisticated coding but also allows for interference cancellation, i.e., MAI or Multi-User Detection ("MUD"), or space-time coding, each of which reduces the effective I_0.

32. Donald L. Schilling et al., Broadband CDMA for Personal Communications Systems, IEEE COMM. MAG., Nov. 1991, at 86–93.

33. Id. at 86, 87, 92 n.5.

34. Id. at 92.

35. Id. at 90, 92.

36. See DAVID S. ANDERSON ET AL., U.S. DEP'T OF COMMERCE, ASSESSMENT OF COMPATIBILITY BETWEEN ULTRAWIDEBAND (UWB) SYSTEMS AND GLOBAL POSITIONING SYSTEMS (GPS) (2001), http://www.ntia.doc.gov/osmhome/reports/uwbgps/NTIASP_01 _45.pdf. See also Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, First Report and Order, 17 F.C.C.R. 7435 (2002), http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-02-48A1.pdf.

37. See, e.g., Verizon Wireless Buys All NextWave for USD 3B, MOBILE MONDAY, Nov. 5, 2004, http://www.mobilemonday.net/mm/story.php?id=3893.

38. See 3rd Generation Partnership Project 2, Recommended Minimum Performance Standards for cdma2000 Spread Spectrum Mobile Stations Release B, 3-113 (Dec. 13, 2002), http://www.3gpp2.org/public_html/specs/cs0011-B_V1.0.pdf (setting the industry limit of -76 dBm on such emissions); see also 47 C.F.R. § 24.238(a) (2004) (limiting the existing PCS bands to -13 dBm). The CFR requires out-of-band emissions to be attenuated below the transmitting power by a factor of 43 + 10 log(P). This is analogous to a speed limit sign that stated "slow down by (your current speed) – 35 miles/hour" So, if you are going 40 mph, you would slow down by 5 MPH (40 – 35) to 35 miles/hour. See id. The 63 dBm difference between the FCC permitted level and the industry standard is a factor of two million.

39. See Broadcast to Broadband: Completing the Digital Television Transition Can Jumpstart Affordable Wireless Broadband: Hearing Before the S. Comm. on Commerce, Science, & Transportation, 109th Cong. (2005) (testimony of Michael Calabrese, Vice President and Director, Wireless Future Program, New America Foundation), http://www.newamerica.net/Download_Docs/pdfs/Doc_File_2460_1.pdf. In his testimony, Mr. Calabrese states, "we also strongly recommend that roughly one-third (20 MHz) of the TV band spectrum reallocated for wireless services be reserved for shared, unlicensed wireless broadband . . . ." Id.

40. Cf. The Future of Spectrum Policy and the FCC Spectrum Policy Task Force Report: Hearing Before the S. Comm. on Commerce, Science, & Transportation, 108th Cong. (2003) (tesimony of Michael Calabrese, Director, Spectrum Policy Program, New America Foundation), http://www.newamerica.net/Download_Docs/pdfs/Pub_File_1165_ 1.pdf (noting the abundance of spectrum available to the public when regulations eliminate interference).

41. See CDMA Development Group, Technology, 2G - cdmaOne, http://www.cdg.org/ technology/2g.asp (last visited Mar. 23, 2006).

42. See 1 Global Positioning System, supra note 24.

43. See CDMA Development Group, Technology, 3G-CDMA2000, http://www.cdg.org /technology/3g.asp (last visited Mar. 23, 2006).

44. Werbach, supra note 14, at 960.

45. Gerald Faulhaber, The Question of Spectrum: Technology, Management, and Regime Change 11 (2005) (paper presented at the Economics, Technology, and Policy of Unlicensed Spectrum Conference, Michigan State University), http://quello.msu.edu/ conferences/spectrum/papers/faulhaber.pdf (last visited Feb. 28, 2006). UWB radios spread their signals out over an enormous range of frequencies with little energy in any small range of frequencies.

46. William Lehr, Dedicated Lower-Frequency Unlicensed Spectrum: The Economic Case for Dedicated Unlicensed Spectrum Below 3 GHz 18 (New Am. Found., Spectrum Series Working Paper No. 9, 2004), available at http://www.newamerica.net/Download_ Docs/pdfs/Doc_File_1548_1.pdf.

47. See Rudholf F. Graf, Modern Dictionary of Electronics 505 (7th ed. 1999).

48. A. D. Spaulding & R. T. Disney, U.S. Dep't of Commerce, Man-Made Radio Noise: Part I: Estimates for Business, Residential, and Rural Areas 10–11 (1974), available at http://www.its.bldrdoc.gov/pub/ot/ot-74-38/Ch1-3.pdf.

49. Id.

50. See GARY D. GORDON & WALTER L. MORGAN, PRINCIPLES OF COMMUNICATIONS SATELLITES 202–04, 220–21 (1993).

51. We ignore the transient rise in the river level while the added water works its way downstream.

52. Kevin Werbach, The Open Spectrum Revolution, Presentation to the Wireless Future Conference 9 (Mar. 23, 2004), http://werbach.com/docs/wireless_future.ppt.

53. A short calculation shows why this is so. The Superconductor Technologies' SuperLink Rx 1900 has a noise figure of 1 dB. Thus, in an environment with an external noise temperature of 290 K, use of this device yields a system with total noise temperature of 365 K (1 dB higher). Adding noise power at a level of one half the noise floor (140 K) increases system noise temperature to 505 K. Thus, noise well below the noise floor increases system noise temperature by a factor of 505/365 = 1.38 or 1.4 dB. Such a 1.4 dB increase in noise will degrade the performance of modern wireless systems or will require compensating adjustments, such as a 38% increase in transmitted power.

54. See Superconductor Technologies Datasheet for SuperLink Rx 1900, http://www.suptech.com/pdf/SuperLinkRx1900_web.pdf (last visited Mar. 23, 2006).

55. Technically speaking and in the interests of completeness, we note that MUD works by eliminating interference. Unfortunately, it can only eliminate some kinds of interference and, even then, is not perfect.

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Email: *Lincoln.ravntech@verizon.net*

CREATING SOLUTIONS

Advertiser Index

The Radio Club of America, Inc.
Awards Committee

Major Award Nomination Form

The Club annually grants each of several major awards to members and non-members in recognition of outstanding achievement, and to provide inspiration for many people, both currently and in the future. As a member of the Club, your help in nominating and sponsoring candidates is appreciated. This form is provided to assist you in this process. In order to complete the grant process in time for the annual Awards Banquet in November, the Awards Committee prefers to receive nominations prior to April of the year of the proposed grant.

For each major award, the Awards Committee collects and evaluates all nominations then submits its recommendation to the Board of Directors for final approval by a majority of the Board.

To nominate someone for an award, please **legibly provide the information below** to the Club's Awards Committee in care of the Club's Executive Secretary in any of the following ways:

Fax:	(732) 219-1938
E-mail:	ExSec@Radio-Club-of-America.org
U.S.P.S. mail:	10 Drs James Parker Blvd – Ste 103, Red Bank, NJ 07701-1500

A. Name of RCA award:____

B. Is Club membership required for this award?__________________________

C. Full name of candidate:______________________________________

D. Is candidate a member of the Club?_______________________________

E. Proposed citation (between 5 and 25 words), based on why it is felt that this candidate should be considered: (to be published and announced at the presentation of the award)

____

____

____

F. Attach supporting material such as an expanded explanation, a biography, a resume, and any significant published articles: (please list your attachments below)

____

____

____

Sponsor submitting this nomination:

Full name:__________________________ **Phone number:**________________

E-mail address:________________________ **Fax number:**__________________

U.S.P.S. mailing address:_______________________________________

Date submitted:________________________


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2809 Emerywood Parkway • Suite 505
Richmond, VA 23220
Phone: 804-353-0300 • Fax: 804-353-8059
www.rcc.com • info@rcc.com
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The Radio Club of America, Inc.
Awards Committee
Fellow Nomination Form

The Club annually elevates worthy Club members to the grade of Fellow in recognition of outstanding achievement, and to provide inspiration for many people, both currently and in the future. As a member of the Club, your help in nominating and sponsoring candidates is appreciated. This form is provided to assist you in this process. In order to complete the elevation process in time for the annual Awards Banquet in November, the Awards Committee prefers to receive nominations prior to April of the year of the proposed elevation.

Article I of the Club's By-Laws states the following:

Section 6: Elevation or transfer to the grade of Fellow shall be by a majority vote of the Board of Directors.

Section 7: A Fellow shall have been a member of the Club for at least five (5) years and/or a Senior Member for at least two (2) years and one whose contributions have been outstanding with extraordinary qualifications in the art and science of radio and electronics. The five and two years referenced above may be waived by a majority vote of the Board of Directors.

Section 8: Elevation to the status of Fellow is by invitation only. If such person is not a Senior Member, his/her sponsor must submit a Senior Member form to the Executive Committee for recommendation to the Board of Directors

To nominate an RCA member, please **legibly provide the information below** to the Club's Awards Committee in care of the Club's Executive Secretary in any of the following ways:

Fax: (732) 219-1938
E-mail: ExSec@Radio-Club-of-America.org
U.S.P.S. mail: 10 Drs James Parker Blvd – Ste 103, Red Bank, NJ 07701-1500

A. Full name of candidate:______________________________

B. Proposed citation (between 5 and 25 words), based on why it is felt that this candidate should be considered: (to be announced at the presentation of the award)

____

____

____

C. Attach supporting material such as an expanded explanation, a biography, a resume, and any significant published articles: (please list your attachments below)

____

____

Sponsor submitting this nomination:

Full name:______________________ **Phone number:**______________

E-mail address:______________________ **Fax number:**______________

U.S.P.S. mailing address:______________________________

Date submitted:______________________

The Radio Club of America, Inc.

Founded 1909, New York, U.S.A.
WORLD'S FIRST RADIO COMMUNICATION SOCIETY

The mission of The Radio Club of America is to provide a forum for the exchange of knowledge, recognize outstanding achievement, provide financial assistance to deserving students and preserve the history of wireless communications.

APPLICATION FOR MEMBERSHIP

TO: **THE EXECUTIVE COMMITTEE**
I hereby apply for ☐ Regular ☐ Retired ☐ Student (*please check one*) membership in THE RADIO CLUB OF AMERICA and certify that I meet the requirement for the grade selected. I further agree that, if elected, I will be governed by the Club's Constitution and By-Laws as long as I continue to be a Member.

Date: ______________________ Signature: ______________________

Full Name: ____
(FIRST) (MIDDLE INITIAL) (LAST) (CURRENT AMATEUR CALL)

Home: ____
(STREET) (The above information is used for mailings and your membership directory listing)

____
(CITY) (STATE) (ZIP CODE)

____
(PHONE) (FAX) (EMAIL)

Please complete REVERSE SIDE as well.

ENTRANCE FEE AND DUES

REGULAR ....$185 .... includes $135 for 3 years of dues (required at initiation) + a $50 initiation fee
[After your initial 3 years, you will have the option to pay the annual dues rate (currently $50) or a discounted 3-year dues rate (currently $135).

RETIRED ....$100 .... includes $75 for 3 years of dues (required at initiation) + a $25 initiation fee
QUALIFICATION: At least 65 years of age and fully retired.
[After your initial 3 years, you will have the option to pay the annual dues rate (currently $32) or a discounted 3-year dues rate (currently $75).

STUDENT ....$30 .... includes $20 for 1 year of dues + a $10 initiation fee
QUALIFICATION: A full-time student at an accredited academic institution.

***For Non-U.S. Mailing Address**
REGULAR & RETIRED: Please add $45 surcharge ($15 per year of dues) **STUDENT:** Please add $15.

☐ Check enclosed ☐ International Money Order enclosed ☐ Traveler's Check enclosed ☐ Credit Card

Visa M/C Amex Card number ______________________ Exp. date __________ Amt. $__________

Cardholder Name ______________________ Signature ______________________ Date __________

Billing address for credit card ____

***PLEASE NOTE**: The charge will appear on your statement as "Meredith & Hopkins."*

All monies to be issued in U.S. funds, drawn on an U.S. bank. International money orders and traveler's checks are accepted in U.S. funds, payable in the U.S. Checks should be made payable to **The Radio Club of America, Inc.**

Mail this application with the applicable ENTRANCE FEE (as indicated above) to:
The Radio Club of America, 10 Drs James Parker Blvd — Ste 103, Red Bank, NJ 07701-1500
732-842-5070 • Fax 732-219-1938 • Emails: exsec@radioclubofamerica.org [or] info@ radioclubofamerica.org • Website: www.radioclubofamerica.org

The Radio Club of America was founded in 1909 by a group of the industry's pioneers, and is the first active electronics organization in the world. Its roster of members is a worldwide Who's Who that includes many who founded and built the radio industry.

The Club's objectives include promoting cooperation among individuals interested in electronic communications and in preserving its history. The Club administers its own Scholarship Fund to provide educational scholarships from tax-deductible contributions of the Club's members and business organizations.

The Club publishes and distributes its *PROCEEDINGS* twice a year.

Business: ______________________________
(ORGANIZATION) (DIVISION)

____
(STREET) (CITY) (STATE) (ZIP CODE)

____
(PHONE) (EXT.) (FAX) (EMAIL)

IF APPLYING FOR STUDENT MEMBERSHIP: School ______________________ Graduation Year ______

Birthplace: ______________________ Date of Birth: ______________________

Education and memberships in other clubs and societies: ______________________

____

Present occupation ______________________________

Previous experience, indicate approximate dates (a current resume may be attached to the application):

____

____

____

In what particular branch of the communications art are you most interested? ______________________

In what year did you become interested in electronic communications? ______________________

SPONSOR (optional) Please list the name of a member to whom you are personally known: ______________________

Recommendation of sponsor: (optional)

____

____

____

____

____

Sponsor Signature: ______________________

Date: ______________________

REV-121505

The Radio Club of America, Inc.

Founded 1909

WORLD'S FIRST RADIO COMMUNICATION SOCIETY

APPLICATION FOR SENIOR GRADE MEMBERSHIP

Date: ___________________________

To: THE EXECUTIVE COMMITTEE

I hereby apply for the Grade of Senior Member of THE RADIO CLUB OF AMERICA, INC. and agree, if advanced to this level, that I will be governed by the Club's Constitution and By-Laws.

Full Signature_____________________________________

Full Name:____

(LAST) (FIRST) (INITIAL)

Home Address: ____

(STREET)

____

(CITY) (STATE) (ZIP CODE)

____

(PHONE) (FAX) (EMAIL)

PRESENT OCCUPATION

____

(Company or organization name) (Title or Position)

____

(STREET) (CITY) (STATE) (ZIP CODE)

____

(Phone) (EXT.) (Fax) (Email)

Sponsors

Letters of recommendation are required from two or more members (any grade) for sponsorship of Grade of Senior Member. Letters must be sent by each sponsor directly to The Radio Club Of America, Inc., 10 Drs James Parker Blvd — Ste 103, Red Bank, NJ 07701-1500. List Sponsors below:

1. ______________________________ 4. ______________________________

2. ______________________________ 5. ______________________________

3. ______________________________ 6. ______________________________

Mail this application with the $40 initiation fee to cover the cost of the Senior Grade Certificate and Pin (which will be mailed to the address indicated above).

❏ Check Enclosed ❏ International Money Order enclosed ❏ Traveler's Check enclosed ❏ Credit Card

❏ Visa ❏ M/C ❏ Amex Card number ______________________ Exp. date________ Amt. $ __________

Signature ______________________ Billing address for credit card______________________

____

(The charge will appear on your statement as Meredith & Hopkins.)

All monies to be issued in the U.S. funds, drawn on a U.S. bank. International money orders and traveler's cheks are accepted in U.S. funds, payable in the U.S. checks should be made payable to The Radio Club of America, Inc.

(more) ➡

EDUCATION

Institution | Level Achieved | Date | Field

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PUBLICATIONS OF SCIENTIFIC OR PROFESSIONAL PAPERS, BOOKS OR ARTICLES RELATING TO ELECTRONIC COMMUNICATIONS

OTHER BACKGROUND RELATING TO ELECTRONIC COMMUNICATIONS

Professional Awards: ____________________

Professional Engineer's License(s) ____________________

Other Professional Society Affliations & Grade of Membership ____________________

Current Amateur Radio Call Sign ____________________

Other FCC Licenses Now or Previously Held ____________________

FOR OFFICIAL USE

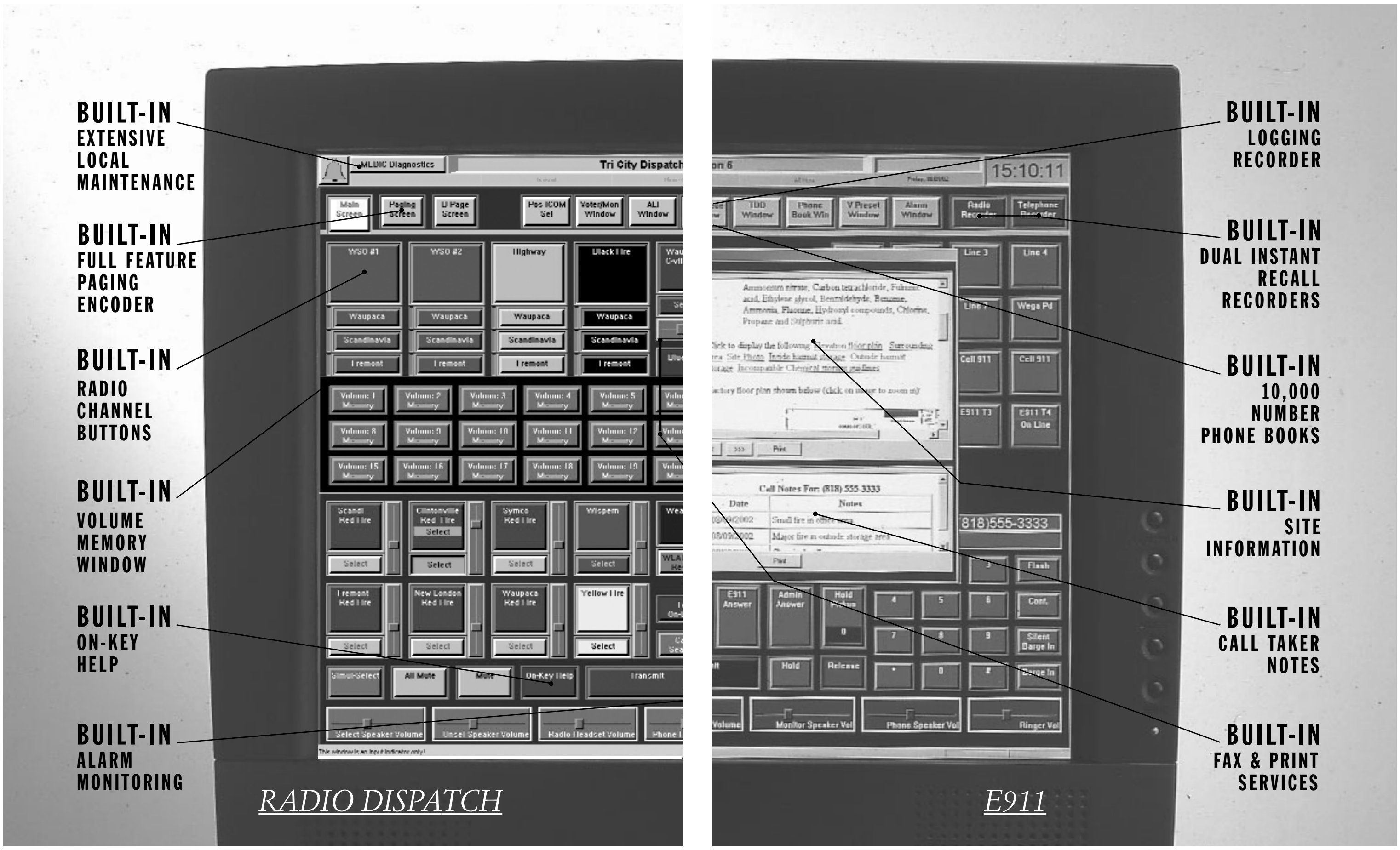
REV-010104

Date Application received: ____________________

Amount of Fee Received: ____________________

Date Approved by Board: ____________________

Certificate & Pin issued on: ____________________



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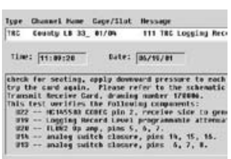

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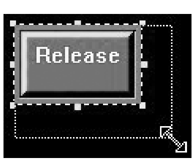

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