

# Find how much RF interference is in your coverage area..... before and after rebanding!

***The experts say that it's not possible, it takes too long, it costs too much, it just can't be done! We say, "That's not true!"***

*"In the field, we knew where deadspots exist, where our mobile radios don't work. When we had to pull someone over, we'd follow him until we were in an area where we knew our radios would work!" says a former Illinois State Police officer.*

*"I would throw away my mobile phone, there are so many times when needed to make a call, and I was not able to use it" says an Elk Grove, IL police officer.*

*I can tell you exactly where the deadspots are between Route 83 and Route 53 along Thorndale Road. I drive it every day, and I know when and where I can't use my phone!" says the President of a Bensenville, IL company.*

Dear Reader,

Public safety officers know they exist. Commuters who travel the same route daily know they exist. Business people using their cell phones have lost their connection in the middle of an important call. Dropped calls, garbled voices, and poor connections are common problems. When a mobile radio or handset becomes suddenly unusable, the person's probably in a deadspot! These problems are all symptoms of RF interference, but it happens so often that many people have begun to accept them as a part of wireless communications instead of a problem that should be fixed!

***Somebody should do something about this!***

The plan is in place! To quickly recap what the Federal Communications Commission (FCC) has put together:

July 8, 2004, Washington D.C.

The Federal Communications Commission adopts the Report and Order "Improving Public Safety Communications in the 800 MHz band", a highly anticipated action that took four years of deliberation, research and debate from the public safety, wireless providers, and the engineering, economic, legal and policy communities.

*"In this Report and Order, we adopt a two-prong solution to the public safety interference problem in the 800 MHz band, with each prong having several components. First, to more adequately respond to individual interference events immediately, we establish an objective standard for defining "unacceptable interference" to 800 MHz non-cellular systems, establish rules and procedures for the expeditious implementation and enforcement of this standard, and endorse a variety of technical solutions and mechanisms, defined as "Enhanced Best Practices" to address interference abatement in*

*the short term. Second, to provide a better spectrum environment for public safety in the long term, we adopt a plan for reconfiguration of the 800 MHz band and provide a thirty-six month transition by incumbent licensees from their current frequency assignments to new frequency assignments in the band.”<sup>1</sup>*

The Rule & Order is a great achievement by the FCC. It is a major step towards providing a better spectral environment. A standard for unacceptable interference is now established.

Three steps make up the first part of the Rule & Order, which took effect on January 21, 2005.

*“We adopt a new, objective definition of “unacceptable interference” to determine when public safety and other non-cellular 800 MHz band licensees are entitled to interference protection”*

*“We assign strict responsibility for eliminating unacceptable interference to the ESMR or cellular telephone operator(s) implicated in the interference occurrence, and assign joint responsibility to all involved commercial operators if unacceptable interference results from a combination of signals from multiple systems.”*

*“We require ESMR and cellular telephone licensees, on request, to notify public safety and CII licensees prior to activating new or modified cells, and require public safety and CII licensees receiving such information to notify ESMR and cellular telephone licenses of changes in system parameters.”<sup>2</sup>*

The second part of the ruling involves the reconfiguration of the 800 MHz band to separate public safety, critical infrastructure industries (CII), and other non-cellular systems on one hand, and ESMR systems, such as Nextel’s, on the other. This too, will move forward, with Nextel’s acceptance of the terms of the plan on Monday, February 7, 2005.

*“The method of interference abatement we adopt herein leaves to the involved parties...the choice of how to best ensure that their systems do not cause unacceptable interference.....to the extent that interference results from the combination of signals from multiple transmitters, and potentially multiple licensees, we place joint responsibility on such CMRS licensees to eliminate unacceptable interference using the remedies of their choice.”<sup>3</sup>*

Our past experience in interference analysis shows that the problem is not always caused by Nextel. Now that interference reporting will require a response, proper analysis will tell us who needs to take action. Wireless providers are on notice to keep from interfering with the networks used by Public Safety and the Critical Infrastructure Industries.

The Transition Administrator is moving ahead with their plans. The first wave of reconfigurations will start June 27, 2005. Over the next three years, the entire process of rebanding should finish by 2008, if everything goes smoothly!

Just one question left.....

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<sup>1</sup> Section II, Executive Summary, Rule & Order (WT Docket 02-55)

<sup>2</sup> Section II, Executive Summary, Rule & Order (WT Docket 02-55)

<sup>3</sup> Section III-B.20 Major Findings and Decisions, Rule & Order (WT Docket 02-55).

## *Just how much interference is out there?*

That's a big question! Finding and resolving interference is now a high priority, a mandatory action for certain parties. Interference abatement has moved to the forefront of regulatory attention. Effective methodologies and tools to deal with the problem need to be put into use now!

A "field trial" or a "drive test" can help locate deadspots. For some engineers, this means going out with a handset and making a series of calls while driving down the highway. The engineer logs when a call can or can't be made. The report is very basic. A list is compiled with street or highway intersections, the time of day, and whether the call is complete or incomplete. It is systematic in its process, and used by Department of Transportation engineers in different states.

On a more advanced level, a scanner is used on the drive test. The scanner detects what signals exist in the environment. This captures each signal's "measured" field strength, which is the basis for determining unacceptable interference as specified in the 800 MHz Rule & Order. The scanner creates a text file that contains information about those signals and that file can be transferred to a PC or laptop. The data needed for an interference analysis is transferred to a Microsoft Excel spreadsheet using a manual "copy and paste" operation. That spreadsheet contains the formulas of calculating interference, and uses the data from the scanner to solve for interference. It's a proven method for mathematically calculating interference.

If a few channels are analyzed, the calculation time to do the study can be quick. When hundreds of channels are involved, solving the equations could take a while; perhaps hours or even all weekend. Sometimes it never finishes because the computer ran out of memory. Seeing the infamous "blue screen of death" on the computer monitor on Monday morning is not an uncommon occurrence!

*The limitation of this method is the computing performance of Microsoft Excel or of the computer, not the methodology!*

## *Can the performance barrier be broken?*

We did a drive test of 26 miles of highway in Chicago. At 5:00pm on a busy Friday afternoon, we loaded up our equipment, an Andrew scanner, with 800 MHz receivers, a GPS antenna and AIM software on a laptop. We started in Hoffman Estates by Barrington Road and I-90. We drove east towards downtown Chicago, through busy Schaumburg rush hour traffic, through Arlington Heights, past O'Hare airport near Rosemont and Des Plaines, south on I-94 through the heart of the downtown Chicago and back west on I-290. We got back at 8:00 pm.

By the end of the drive, we had collected 40 MB of data and more than 120,000 GPS records. As we drove, the scanner recorded what frequencies were in the environment. It captured the corresponding signal strength and the latitude and longitude for that spot. We captured every frequency in the 800MHz range. The 800 MHz Rule & Order specifies a minimum measurement area of 300 ft. x 300 ft. To meet that requirement, we'll do an interference study every 300 feet along that 26 mile route.

*How many studies is that?* A quick bit of math tells us that (26 miles x 5,280 feet) / 300 feet/mile = 461 studies!

## What did the drive test tell us?

We picked out seven frequencies belonging to an Illinois Public Safety agency as an example. We wanted to see how the mobile radios for this Public Safety agency would be affected along this 26 mile stretch of highway. We did an interference study for the seven frequencies against all of the other 800 MHz frequencies that the scanner had detected, every 300 feet.

*For those seven frequencies, we found 61 interference points in 13 unique locations along that 26 mile route. Sixty one incidents where the interference level (C/I) was less than 20db!*

At these locations, officers in the field would be unable to use their mobile radios, to receive a call or make one. That is an average of one location every 2 miles! Not an acceptable situation for a public safety official! Look at Figure 1 for the results of the analysis.

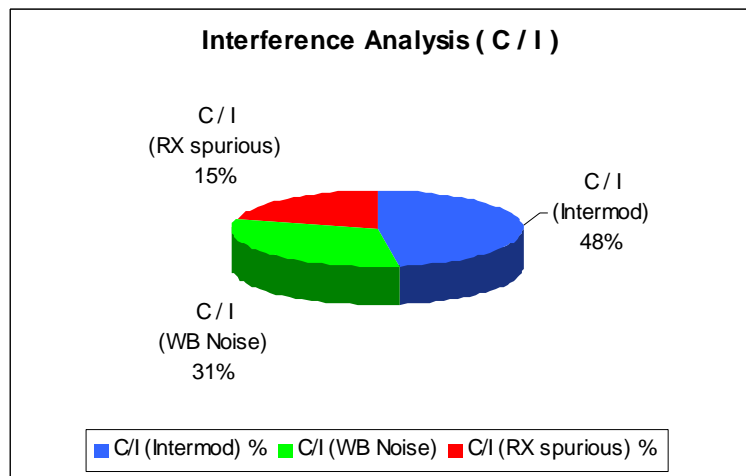
**Drive Route**                                **26 mi**  
**Segment Length**                        **300 ft**  
**# of Segments analyzed**                **461**  
**Receiver Power**                         **-75 dBm**

Interference type	Intermodulation		Wideband / TX noise		RX Spurious noise		Interference points	
	C/I < 20 dB	C/I %	C/I < 20 dB	C/I %	C/I < 20 dB	C/I %	Total	Total (%)
866.xxxx	4	0.9%	2	0.4%	2	0.4%	8	1.74%
866.xxxx	4	0.9%	3	0.7%	2	0.4%	9	1.95%
866.xxxx	4	0.9%	2	0.4%	2	0.4%	8	1.74%
866.xxxx	5	1.1%	3	0.7%	2	0.4%	10	2.17%
867.xxxx	4	0.9%	2	0.4%	2	0.4%	8	1.74%
867.xxxx	4	0.9%	4	0.9%	1	0.2%	9	1.95%
868.xxxx	4	0.9%	3	0.7%	2	0.4%	9	1.95%
<b>Total</b>	<b>29</b>	<b>6.3%</b>	<b>19</b>	<b>4.1%</b>	<b>13</b>	<b>2.8%</b>	<b>61</b>	<b>13.2%</b>

**Figure 1. Summary of interference analysis**

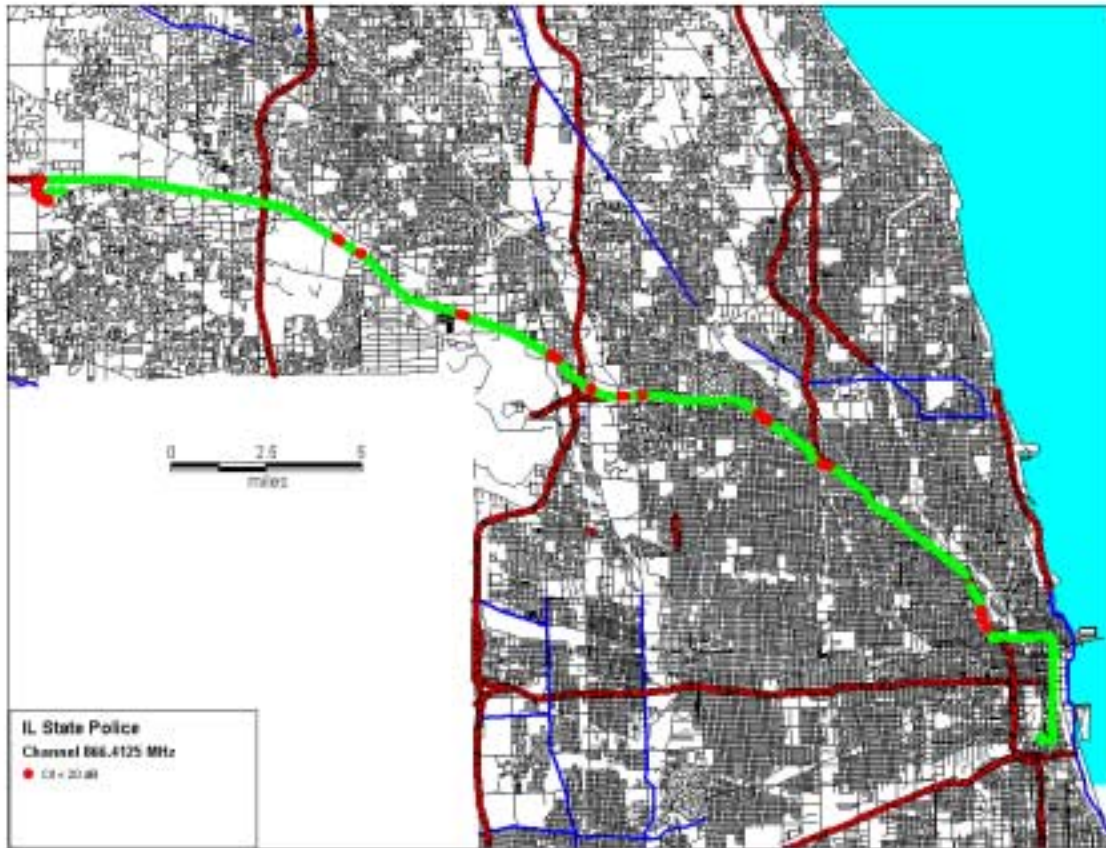
Numbers can be hard to visualize, especially if you're not an RF engineer. A graph of these results is shown in Figure 2. It shows the relative percentage of the different types of interference found for those frequencies on Chicago's highways.

In this case, of the 78 interference points found, 48% were intermodulation, 31% were wideband noise, and the remaining 15% were receiver noise.



**Figure 2. Intermodulation, wideband and receiver noise**

Since we have the latitude and longitude from the drive test, we can easily plot these on a map of Chicago.



**Map 1. Interference points in Chicago**

Now we have a visual reference of where interference exists in our world, or more specifically, on a busy rush hour evening in the city of Chicago.

Our next step is to analyze these locations to see who is causing the interference. In this case, we can tell you that interference is being caused by certain Cellular A and Cellular B channels, and which ones were caused by Nextel's signals!

We've purposely not named the Public Safety entity, for obvious reasons. We will have presented the data to them by the time you get this letter, because it is important for them to know. In this test run, it looks like there is a lot of interference in their network! We do need to know how they are using these channels to get a better idea of what's going on at that location.

***But now we know where to look, and where to start resolving interference problems!***

Four hundred and sixty one studies were processed and analyzed. Using traditional tools, if each one took an hour, 461 studies would take 19 days, working day and night! *We didn't stay up that long!*

*“Four hundred and sixty one interference studies were processed and analyzed in two hours!”.....We broke the performance barrier!*

Actually we broke two performance barriers! First, we broke the performance barrier for the time to process a single study. In processing the data from the Chicago drive test, we were able to do 461 studies in less than two hours. Our high performance interference analysis engine can take a complex study of 1,000 channels and finish it in seconds!

Secondly, we automated the processing of sequential studies. When hundreds, or thousands, of studies need to be done to assess the interference impact on an area, automation is the only way to finish the job. Instead of manually processing each study; manually moving text into an Excel spreadsheet, running the study (for how many hours?), and then starting all over again for the next study, we transfer the data directly into our software and begin processing all of the studies with minimal effort.

Breaking the speed limit for each step is an achievement in itself, but together, the resulting speed brings new dimensions to interference analysis! We can take a year of work and do it in one week on a single laptop! Use a multiprocessor server and you could process the job in even less time! Blazing speed, no matter how complex the environment you need to analyze!

*Finally, an RF engineer can gather data in the environment, compute a mathematically accurate picture of interference in the environment, and determine who is causing the problems in the field, without limitation!*

*Speed enables new capabilities!*

Let's examine the possibilities. What we can do with the data? What does the data reveal? How do we use it? What can we extrapolate and predict from this information? And finally how can we use this data to make sound decisions?

In the environment there are thousands of antennas transmitting and receiving data. At any one point in time, for a single location in space, there may be a hundred channels at different signal strengths, coming from different directions, from different sources.

A scanner collects data about each of these signals and provides a digital output file for further analysis. The digital output that is essential to an interference analysis includes the GPS time, latitude, longitude, frequency, a signal strength level called RSSI (Receive Signal Strength Indicator) and a marker. With this information we can calculate different types of interference, including intermodulation, transmitter noise, receiver desensitization, transmitter harmonics and transmitter spurious output, simultaneously, in one pass.

Not only can we calculate that interference will occur, but we can also determine what signals are creating the interference problem.

*Why is it important to scan the area?*

If you have data at hand about your own transmission equipment, you can calculate internal interference caused by your own equipment. This is the easiest interference to predict and analyze. Co-channel and adjacent-channel interference in your own network are interference analysis problems that are easy to solve.

Intermodulation is the most likely cause for interference problems that cause RF engineers to scratch their heads. Intermodulation is caused when external signals mix together with your channels in a particular way to form new signals that disrupt communications. Interference can be mathematically calculated and predicted if you have the right information. If you don't have that information, it is impossible to calculate. The computing effort for hundreds of channels can be significant, billions of calculations!

In an open environment, you don't know and can't control the incoming signals from other sources. If they cause intermodulation products with your channels, it becomes apparent when someone can't make a call with his mobile radio. But the person has to be standing there to find out. The information from the scanner in a drive test allows you to mathematically create a simulated model where interference caused by intermodulation can be precisely identified and located.

The Illinois State police officer mentioned earlier knows where those locations are based on personal field experience. They know when not to use their radio when they are in certain locations. But you and I know that he should be able to make a call whenever and wherever he is. His life or someone's life may depend on it!

If you're installing a new system, tweaking an existing system, changing or adding frequencies, it is possible that some of your channels may experience interference caused by external signals. You may be creating interference problems for others!

*Without scanning the area, it's not possible to properly troubleshoot interference problems!*

Fixing interference problems without knowing who else is in the area is like trying to find enemy land mines without a metal detector. Sending in your troops without a scan of the area will give them plenty of field experience to draw upon!

This is precisely the problem that Public Safety and Critical Infrastructure Industries are having with wireless providers in the field. Interference problems are reported by those who happen across locations where they are having problems. Many problems have been reported, but how many haven't been reported because they haven't been found? Can you really judge how much interference is in an area based on random reports?

*By collecting all of the data in the field, it is possible to study the effect of all of the other frequencies on a specific channel or group of channels.*

It is that simple! Everything you need to know is collected in a text file. Now all of the possible creators of interference can be found and investigated!

- You can identify the frequency, and the identity of the source causing interference to your channels!
- You can determine what other channels should be used at that location for interference free operation!
- Most importantly, you can simulate what the effect would be if you made changes to the frequency assignments. You can determine what interference would be caused those new channel assignments!

Each Public Safety entity, each Critical Infrastructure company, and each commercial radio service provider using the airwaves wants to know that his channels are clear and interference free. Any number of users out there may be keeping you from that goal!

### *What will it take to do a whole city?*

The city of Chicago occupies approximately 234 square miles. A grid with a density of 300 feet would give us 72,500 locations to study. There would be approximately 4,000 miles of roadway. How long would it take to collect and analyze the data?

The drive test for 4,000 miles would take about 180 hours. That would be about eighteen ten hour days. That's the easy part. The bulk of the work comes when the data needs to be processed and analyzed. Sampling at 300 feet provides 72,500 locations. Pity the poor RF engineer who is assigned the task of doing 72,500 interference studies, copying and pasting numbers into an Excel spreadsheet! Using traditional methods, even at one hour per study, it would take 3,020 days (working day and night) or 8 years! No wonder why drive testing is not a preferred tool interference analysis!

But using our methodologies and our software tools on a laptop, 72,500 studies could be processed in 200 hours! In a little over a week, after collecting the data, we can tell you where interference exists in a metropolitan city and who's causing it. Now we can experiment with different frequencies to see what life would be like post-reconfiguration!

### *What is very clear?*

The 800 MHz Rule & Order is very clear on its goal:

- The limits for unacceptable interference have been established.
- The party who is causing interference is responsible for fixing it (within 48 hours, if it is affecting a Public Safety network).
- If you make changes in your system, you must tell everyone whom you may affect.

### *What is unclear.....*

- How do you know if you have interference in your network?
- How do you know that it is “unacceptable interference”?
- How do you know that all the interference locations in my network can be identified?
- How many of my frequencies are affected by others?
- Who is affecting my frequencies? By how much?
- Who do I need to notify when I make changes to my network?
- How do I know that rebanding doesn't make things worse for me?
- Will I get comparable facilities with the new frequencies?
- How do I certify that my environment after rebanding is interference free?
- How do I know that future changes in my network won't adversely affect others?
- How do my changes affect the border countries, before during and after reconfiguration?

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<sup>4</sup> Section II, Executive Summary, Rule & Order (WT Docket 02-55)

<sup>5</sup> Section II, Executive Summary, Rule & Order (WT Docket 02-55)

<sup>6</sup> Section III-B.20 Major Findings and Decisions, Rule & Order (WT Docket 02-55).

An inoperable mobile radio may be a good indication of interference at a location, but you cannot depend upon random interference reports to tell you how much interference you have in your network. That information is not very complete.

- A field trial can give you a systematic method of identifying deadspots. As our trial in Chicago shows, the amount of interference can be very significant!
- Using proper tools in the drive test, significant and re-usable data is collected for analysis and processing.
- The technologies currently used by RF engineers depend on manual transfer of data, and the processing speed of existing programs are much too slow to meet the response times demanded in the 800 MHz Rule & Order.
- When the 800 MHz Rule & Order was written, methodologies and the technologies to deliver an analysis in a practical timeframe did not exist!

The technological demands that the 800 MHz Rule & Order requires to deliver on its promise are immense! The Rule & Order needs a technology breakthrough. Breakthrough technology is defined as “a technology that makes it possible to exceed existing performance limitations”. The interference analysis engine behind our products is not just faster, but several orders of magnitude faster. The limitations that keep drive tests from being a practical engineering tool are now gone.

InterMod60™, IMOptimizer™ and IMPowerDrive™ are products which represent breakthrough technology. New technology, developed in time to help resolve a very complex, difficult and thorny issue, “*Improving Public Safety Communication in the 800 MHz Band*”.

With these products, interference detection, abatement efforts and reconfiguration activities can occur with the following benefits:

- Accurate, complete and comprehensive interference detection.
- Better information for decision making.
- Certification that an interference free environment has been created.

### *What can you do?*

Give us a call, or send us an e-mail. We would be happy to discuss your current needs related to the 800 MHz Rule and Order. We realize that each person has a unique situation.

It’s essential to resolve the 800 MHz problems quickly and efficiently. A lot of time and money is going into this effort. No one wants to be sitting around three years later deciding on Plan “B”. The clock has already started to click! Act now to stay ahead of the crowd, and to do it right the first time!

Call 888-868-6365 toll free for more information, email us at [info@aimws.com](mailto:info@aimws.com), or email myself, Ahmad Malkawi, at [amalkawi1@aimws.com](mailto:amalkawi1@aimws.com) or Phil Moy, Director of Sales at [pmoy@aimws.com](mailto:pmoy@aimws.com). We would be happy to tell you more about our comprehensive solutions for achieving an interference free environment!

Look forward to hearing from you!

Sincerely,

**Ahmad Malkawi**

President and Director of Engineering  
AIM Wireless Solutions

**AIM Wireless**

*"Enabling a wireless world"*

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P.S. Find out who is implementing drive test methods to get a true picture of interference in their network! Call us at 1-888-868-6365, toll-free!

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