Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of:)
)
E-911 AUTOMATIC LOCATION)
IDENTIFICATION ROUND TABLE)

Commissioners Meeting Room
The Portals
445 12th Street, S.W.
Washington, D.C.

Monday,
June 28, 1999

The parties met, pursuant to notice, at 1:10 p.m.

APPEARANCES:

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Office of Engineering and Technology (OET)

DR. MARK BIRCHLER, Manager
Wireless Access Technology Research
Motorola Labs

DR. OLIVER HILSENRATH, President and CEO
U.S. Wireless Corporation

JOHN MALONEY, Vice President and Chief Scientist
KSI Inc.

DENNIS KAHAN, CEO
SigmaOne Communications

LOU STILP, Executive Vice President
TruePosition, Inc.

WALTER BELL, Vice President of Engineering
SnapTrack, Inc.

KANWAR CHADHA, Founder and VP Marketing
Sirf Technology, Inc.

BETH FRASCO, RF Planning Manager
Aerial Communications, Inc.

APPEARANCES (CONT.):

DAN A. PRESTON, Chief Technology Officer
Integrated Data Communications

TOM SUGRUE, Chief
Wireless Telecommunications Bureau (WTB)

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RON RUDOKAS, Executive Director
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P R O C E E D I N G S

MR. HATFIELD: Okay, if we can get started, please? Is that better? There we go. Good afternoon, I'm Dale Hatfield of the Office of Engineering and Technology and I want to start right out by thanking all of you for coming today.

The purpose of this round table -- well, rectangular table, I guess -- is to discuss together a better understanding of the technologies being proposed to provide wireless Phase II enhanced 911 service to the public.

Our rules require covered wireless carriers to no later than October 1, 2001, deploy automatic location identification technology capable of locating a caller dialing 911 to a given degree of accuracy, namely longitude and latitude within 125 meters, using the RMS methodology, and, to provide that information to public safety answering points or PSAPs.

Currently, our Phase I location rules require location only to the cell side, which, of course, could be from as small as a few blocks to as large as several square miles. We're not, however, going to address any of the issues for deployment concerns regarding Phase I today. Rather, our sole focus here will be on Phase II.

We recognize that our rules were adopted before we

understood that a GPS-based handset solution was an option. The record, unfortunately, is still extremely sparse in terms of technical data on the viability, reliability and accuracy of the various potential Phase II solutions and we hope, of course, to correct that deficiency today.

I also sincerely urge all of you here today and particularly those that we have not been able to accommodate and include on the panel to provide us with information on your proposed solutions, particularly information that answers the type of questions we're posing today. You can do this through our normal ex parte procedures or by filing in response to the June 1, 1999 public notice, copies of which, I believe, have been provided in the rear.

Today's presentations are being carried live on closed circuit TV within the FCC for the benefit of the staff who is not down here in the room. The audio feed is also being carried on the Internet via real audio running off our FCC web page. The audio feed will remain on the home page and a transcript of the hearing will become available on the FCC page in about two weeks.

The addenda that we set forth today starts with a high-level overview of the basic, underlying technologies, both for the network based and the handset based solutions. The overview will be presented by Dr. Mark Birchler, Manager of Wireless Access Technology Research at Motorola Labs.

The slides for the presentation are posted on the web page so that those listening via real audio can follow along.

After the overview, we'll have several proponents of network based solutions and handset based solutions follow-up with brief eight to ten minute presentations that highlight the unique features of their particular solution, provide information about the status of testing of their systems and how they perform in terms of achieving our standards of reliability and accuracy.

I'll let the panelists introduce themselves and identify their companies at the beginning of their respective presentations. One housekeeping matter is that our timekeeper will let you know when you have two minutes, one minute and then no time remaining. In order to keep to the agenda and make sure everybody has a fair shot, I'm going to be very rude and cut you off if you go over the allotted time.

After a short break, then we'll have the representatives of the manufacturers, carriers and public safety join us at the round table and at this point, we'll engage in a question and answer session, moderated by the FCC staff. In selecting the participants for the round table, we tried to provide a balanced group representing both advocates of network based solutions and handset based solutions, manufacturers and so forth. I'm looking forward

to an informative session at the end of today. I hope to have a much better understanding, we hope to have a much better understanding of how these new technical solutions will help address the important objective of insuring our nation's wireless telecommunications system is as safe and reliable for persons needing emergency systems as in our wire line system.

So with that, we'll start with Dr. Mark Birchler.

DR. BIRCHLER: Thank you, good afternoon. Okay, we can flip to the first slide. Okay, the goals of this presentation are fairly modest. I'd like to, at the end of it, have generated a common terminology that we can all refer to as we are moving through our various presentations throughout the afternoon.

I'd also like to describe the basic system types that are available for the E-911 Phase II location solutions and some of the key differentiating features of the various basic system types or technologies that are being developed. On this first slide, I have a short list of acronyms that covers very briefly some of the most important acronyms that we would be using throughout the afternoon. Covered, in alphabetical order, are the various systems, A-GPS for Assisted Global Positioning System, angle of arrival and so on and so forth. I'll let you just take that in yourselves. But you can refer back to this if you have a question about

an acronym throughout the presentation.

Okay, we can move to the next slide. Okay, this slide attempts to show a very high level overview of the basic technologies that are utilized to deliver location. As you can see, we have a handset that we're wondering where it is and we have two basic solution types that meet this desired end.

The first solution type is called network and the other is handset. The key differentiating feature that would make a solution network or handset assisted is where the fundamental information by which the handset is located is collected and generated. For a network solution, that fundamental information is obtained by listening to transmissions on the handset, using equipment at the sites themselves or at other sites.

In a handset solution, the core information required to locate the handset is measured at the handset itself. This doesn't mean that the network plays no part in a handset solution. It simply means that the core information is generated in the handset.

Now, as you can see, there are a number of different solutions in each of these basic solution spaces. I've only attempted to cover the fundamental types of information generation systems in this talk, knowing full well that there are many different permutations of the

various possibilities and some of them are shown on this slide.

But on the network side, you can see that we have three main areas or ways of developing the information required for location. There's a multi-path fingerprint, moving from left to right here, TDOA and AOA, or Time Difference of Arrival and AOA or Angle of Arrival. Then, there are various permutations, combinations of these systems.

On the handset side, there are two main types, the first shown, going, continuing from left to right is EOTD for Enhanced Observed Time Difference, which is a time difference of arrival solution in the handset, and Assisted GPS. So I think we can move onto the next slide.

Okay. Now what I'd like to do is discuss each one of these solution types in a little bit more detail, focusing in on the key differentiating attributes of each type. And I'll be happy, if there's any extra information in the panelists that I've missed in any of these slides, I'll be happy to take those suggestions as I go along.

Each slide is very similar, in that on the left hand side, I have a pictorial view of the system and a couple of comments on the general location solution method. And then, on the right hand side, there's been an attempt made to, at a very high level, explain the various impacts

and systems addressed for each solution.

Now, for the Time Difference of Arrival network based solution, one of the key things to remember is that a minimum of three sites are required to receive the signal, detect its presence and conduct time measurements on the signal in order to arrive at a location solution. And these solutions are based on the apparent differences and times of arrival between pairs of sites. And from there, triangulation technique to be used to estimate the location of the handset. And of course, there's a tremendous amount of intellectual property and good engineering that goes into doing the best job possible of finding the accurate time differences out in the harsh environment.

There are some obviously network impacts for this solution and these are going to be similar for most of the solutions that are network-based, which means that you have to have elements in the network that control the location receivers that are utilized to make the measurements, and you also need -- for digital systems, you may well need to have focused into the operator's network in order to get at the information required to fully obtain all the information you need to locate a specific handset.

At the sites, you're going to need extra location receivers for most of these solutions. The handset impact, there is none, and so therefore, this solution will work for

Legacy handsets and for TDOA, as far as I can tell, all the systems that are out there, first and second generation wireless communication systems are addressed by this technology. So I think we can move onto the next slide.

In an Angle of Arrival solution, you see that we've gone from three cells being shown to two, and the reason for that is that only two cells are needed to find the location of the handset as a minimum. With this type of solution, the apparent Angle of Arrival of the transmissions from the handset are utilized to generate the core information at the site and then, once again, triangulation methods are used to calculate the apparent position of the handset.

This solution has similar network impacts, as did the TDOA solution. On the site impact, in addition to the requirement for location receivers, there is also the additional requirement for antenna rays, which are capable of unambiguously determining the direction of arrival of a signal.

Once again with this solution, there is no handset impact and most of the systems appear to be addressed by this technology, as well. And of course, since there's no necessary changes to the handset, Legacy handsets would be covered by this solution.

The third and last core technology that, on the

network-based side that I'm going to talk about, is multi-path fingerprint technology. This solution is different from the two previous solutions in that it requires a database of tested locations to be available that you can match a fingerprint generated from an unknown location to this database to figure out where the apparent location of signal transmission originated from.

As you can see in this solution, only one site is shown and that's because this solution can locate a handset based on only a single, receiving information only at a single site. The network impacts are the same as the other two. You will need location receivers at the site. The impact on the handset is none. There are no known changes you'd have to make to a handset transmission to make the solution work, and this solution addresses amps, CDMA and, I believe, also, a TDMA system. And of course, Legacy handsets are covered.

Okay. Now, what we have here is the only composite solution that I have in my talk and it's simply to show that there are unique possibilities for creation of hybrid systems that may increase the reliability and accuracy of a location solution. This is by no means the only hybrid approach. QUALCOMM has another CDMA hybrid approach that uses various system elements.

But in this example, we have a situation where we

have enhanced forward link triangulation, where information is generated both at the network and by the handset. And therefore, this solution, if you go back to the original high-level view, spans the network and handset-based sides of the plane. This is a unique CDMA solution. It's network impact is the addition of location, calculation and control elements in the network. You may need to increase the calibration accuracy of the sites to make it work well, but it will work without any handset changes, and it's a CDMA unique solution. So only CDMA is addressed, and Legacy handsets are covered.

Okay, next slide. Now, I'm going to move into the handset assisted area, and there are two primary solutions for this. Although, once again, I should point out that this is not all encompassing. One of the primary handset assisted solution methods is called A-GPS or Assisted GPS. In this system, what's required for minimum requirements for a four-location solution are con activity, datacon activity to at least one site, which would most likely be the serving site, and also, the ability to receive transmissions from three GPS satellites. GPS is Global Positioning System and it's a system of satellites put up by the Department of Defense that is used for military positioning, for high precision use. But also, there's a part of the system that's available for general public use, and this is the

part of the system that's utilized for E-911 location.

In Assisted GPS, the network provides the GPS functionality in the handset, with additional information which allows it to lock on more quickly to the satellites and receive their signals with higher sensitivity. For this type of solution, you will need a GPS assist box in your network. There's a potential for enhancements to the synchronization of systems, in order to support the GPS assist functionality.

With this solution, as with all handset solutions, there are impacts on the handset now, which would include, perhaps, a second GPS antenna, partial or full GPS functionality in the handset. Minimally, a GPS front end and processing. There are memory needs and needs for new software.

I should also point out that you can view a stand alone GPS solution as simply Assisted GPS without the assistance. And I'm aware that there are suggestions that stand alone GPS is a solution to be considered, as well.

The Assisted GPS solution is being standardized for CDMA, for PCS 1900 and GSM. It's under investigation for IDEN and also TDMA, and of course, Legacy handsets are not covered in this solution.

Okay, next slide. The final solution type I'm going to talk about is EOTD or Enhanced Observed Time

Difference. This is a TDOA solution, but the measurements are conducted in the handset by measuring apparent time differences and received time of signals transmitted from the network equipment. Once, as with all TDOA solutions, at least three sites are required in order to come up with a location solution, so the handset must be able to detect and measure time of arrival information from three sites. And once again, the location solution is based on the apparent time differences in transmissions from these three sites.

The network impact, there may be need for location calculation and control. At the sites, we will need either some sort of accurate time synchronization enhancement, because this solution requires that the synchronization characteristics of the supporting infrastructure be either very well controlled or very well known in order for a successful solution, high accuracy solution, or the site air measurements must be calculated and sent to a centralized location that can correct for the synchronization errors at the sites.

For the handset impact, there will be new software required in the handset. In most handsets, no new memory will be required, but it's conceivable in some cases, rare cases, that new memory could be required, if they were operating right up to the edge of their existing memory. But we believe in most cases it would just be a software

upgrade.

The GSM PCS 1900 community are standardizing this solution, and this solution is also under investigation for IDEN. And then, finally, as with all handset-assisted solutions, Legacy handsets are not covered.

Okay, so this is our final slide here and the purpose of this slide is to just point out that there are various combinations of these fundamental location technologies that can be utilized to the advantage of the performance of the system. There are suggestions that Angle of Arrival be combined with receive signal strength to enhance coverage and performance. There are vendors who have a combination of Angle of Arrival plus time difference of arrival, network overlay solutions. There's discussion of combining the two primary handset-assisted solutions, EOTD and Assisted GPS, to approve the efficiency and accuracy of the overall solution.

And then, there is a suggestion of combining in the CDMA system, combining Assisted GPS with E-FLT. And then, in the other column, there's also a QUALCOMM proposal to combine Assisted GPS with round trip time of arrival estimates to improve the performance of that solution. So that concludes my discussion of the various solution types that are out there. I hope it will be helpful in moving this discussion forward and I thank you for your attention.

MR. HATFIELD: And thank you, Dr. Birchler, and thank you also for keeping us on time and on schedule.

We'll shift now to presentations by the proponents of the different ALI technologies and we'll start off to my right with the representative from U.S. Wireless Corporation.

DR. HILSENRATH: Thank you very much, Dale. U.S. Wireless Corporation, I have three colleagues with me here. We're founded and started our activities in 1996. We are concerned by the mandate, with the objective of developing wireless location and with anticipation of the deadline of 2001. Headquartered in the San Francisco Bay area. We're a provider of wireless location information for Emergency 911, and we're anticipating that be the first step in a much bigger industry.

We're a Nasdaq company and in our better days, we're a $100 million market count. The market strategy for U.S. Wireless is to build and operate a nationwide location service bureau, so we're of the opinion that this market requires a leadership in operating these services, in gathering all the moving parts together, and we intend to offer that leadership and set this capability up as a shared platform.

We're very active in the last couple of years of setting off systems in a variety of environments. The main

places where radio camera product is operating is Oakland, which is our home; in Billings, Montana; and in Baltimore. We're expanding a little bit on the Baltimore activity, where Bell Atlantic is our sponsor. It is also a CDMA development group event of one of the network CDMA trials.

The significance of this investment to be made in fairly wide and distributed deployment is to gather a portfolio of a variety of performance environments. As you can see, you have the fairly steep downtown of Baltimore and quite complex downtown of Oakland, but also the very rural environment in Montana. I would expand a little bit on our Montana involvement, in which we're actually very active. Recently, we gathered an entire team of companies that you see on the slide from Western Wireless, who was the carrier, U.S. West, wire line carrier, Zypoint, Nortel, in offering an end-to-end 911 event from the caller all the way to the PSAP, which has operated for the last couple of months on a 211 test basis, in order to avoid obvious liability issues.

So we are looking at this as a miniature of service bureau type scenario. A few words to add to Mark's description about technology. Radio Camera is a location fingerprint strategy. The video camera is located at base stations and extracts complex fingerprints through the existing antennas at the base station, which it then measures against a look up table, which is pretrained in

that environment. That matching results in a preferred location of impingement of that handset and the recognition of its location on the map.

The system is sent to end to end tracking environment, therefore, of course, the tracking of the motion is being taken into account to generate even better performance, as I'll show you in a second.

An important piece of this deployment is what exactly is being stored at the base station? This is a multi-mode radio camera. You can see from the size of it, this is practically the only installation at the base station that uses the existing antennas by the carrier.

To show you just a touch of the many months of field trials, you can see our display of the Oakland area, downtown, as well as suburban, and the Berkeley area, for whoever is familiar. The little circles you see are many times of station recalls that were put from those locations and to flip directly to the summary of the performance, you can see a 67 percent measure with 69 meters. And ours measures at 98 meters. And something that is important to us, also, 90 percent measure at which we're looking, because we're anticipating directions to be given to callers in the future, in which we're assuming that the accuracy requirement might be higher.

Going to a different scenario, which is a motion

mixed highway and the local roads, extensive trial in that same environment would result to 65 meters and 57 meters ours, and it's natural to see a slightly better performance due to the motion involved in the process.

A very interesting document that I just put here just for reference, we were offered a very concise and well-designed audit plan by one of the companies here in the audience, which I would like, with Ron's permission, to submit as a potential way of standardizing trials of location systems. Going through everything which is interesting -- light urban, suburban, in building, near grid, off grid, stationary, in a well organized fashion. You can see pretty much a summary of our performance. We're looking at performance between 40 and 100 meters in all these environments, and one of the interesting capabilities of radio camera is also to operated based on a single site in a remote area, in which, of course, the performance is likely degraded, but it is an interesting solution for the states of rural America.

A touch of CDMA. I'll put the slide up just to remind everybody that CDMA is more complex than anything else we've seen, but these are the famous fingers of CDMA. CDMA has built a reputation of being the toughest mountain to climb for location, and I think that people have forgotten the fact that CDMA is bringing some opportunities

that the other standards don't. So it's band wave and it's a delayed finger strategy by QUALCOMM.

Looking at CDMA radio camera performance, you see quite similar results to what we've seen in amps and, as a matter of fact, due to the multiple fingers arrangement, the 67 percent measures out to much better than the range of 30 meters. Although, RMS tends to be at the same level to what we've seen before.

We believe that CDMA is a major opportunity for network solutions through the richness of its signal, not necessarily a complexity hurdle.

The message with wireless is for anyone to work nationwide, 911 by 2001. The summary, we believe that we have currently a functioning location system all the way from urban, which line of sight is a big issue, to sparse settings. We're looking and required of ourselves a high performance system with anticipation that the public safety community will get even hungrier for performance in the future than the mandate is stipulating.

We're looking at trunking as an opportunity of building additional safety capabilities, as well as additional business. Again, we're applauding the wireless capabilities to a shared platform. We believe that this is going to simplify and going to also, at some extent, focus the deployment of this capability nationwide. And at this

point, in our portfolio, we have amps, TDMA, CDMA and the next system in our first phase, going to the next second phase was richer in standards.

We're planning we'll focus the entire effort of the team, as well as the financial backing of the company, is to make this nationwide capability available by 2001 and we're here to strengthen the FCC's hands in making sure that this capability will be out there for the American public. Thank you.

MR. HATFIELD: Thank you. You didn't identify yourself at the start.

DR. HILSENRATH: Oh, I'm Oliver Hilsenrath, President and CEO, U.S. Wireless.

MR. HATFIELD: Thank you, and thank you again for keeping us on time. Next is our representative from KSI Inc.

MR. MALONEY: My name is John Maloney. I'm vice president and chief scientist at KSI. KSI, as an organization, is built on a core technical staff that's been designing and developing location tracking systems for 25 years or more. We realize the value of doing this in the commercial cellular systems and in 1990, we had it demonstrated already on normal, everyday, unmodified cellular phones involved in normal cellular communications. We described those results to the FCC and were cited in the

NPRN initially published in the docket.

Those results were, of course, amps based and were supported with snapshot locations on control channels and then follow up voice channel continuously updated tracking. With the infusion of capital in '97, we then advanced the results and started demonstrating TDMA results last year, along with the amps results, and right now, we are evaluating a preliminary results from a rural trial. Top management and ownership is from the cellular ranks. The East Coast cellular companies we have had populate our CEO, COB and vice president and COO positions. Next slide.

There's been a lot of misstatements made about infrastructure approaches and hopefully, with a little bit of reality, I can dispel some of the myths. As I mentioned, for a decade now, or in this decade, we have demonstrably had amps availability and we are right now doing digital processing with TDMA signals. We have had early sale agreement with some of our trial equipment, but frankly, production, full scale production will follow on orders, which will be, hopefully, stimulated by disambiguation of the regulatory issues.

The requirements have been met with all the data that we have published throughout the record and in these years and will continue to be met with all future phones. We are currently right now implementing software. Our

operational hardware is in the lab for all the other digital interfaces besides TDMA. Right now, our rural trials have gone through preliminary integration testing. The FCC's requirements have been met and we have, with that system, done end to end real time location based routing among PSAPs with cell spacings of 12 to 20 miles.

The Commission has asked for comments on comparative costs. There are lots of different models. A simple one might ascribe zero cost to the location enablement. The basic phone itself will cost $200 and with 1,000 of them per cell site, the $200,000 would be of the order of ten-fold of what you might estimate for infrastructure equipment.

You could argue that it's $150 a handset. You could argue that there's 1,500 handsets a cell site. You could amortize costs over time, but the basic conclusion is that the handset approach is many more time more costly than the infrastructure.

Locations, I repeat, are not required to be obtained only from three or more sites. We routinely demonstrate two sites and one site location capabilities, and, of course, our location calculations are implemented to optimally exploit whatever information is available. That includes measurements of angles, times, signal strength, from however many sites are available, includes the

collateral information such as road map data. And when area interfaces are modified to support transmission of handset derived location information, our calculations already include the capability to exploit that information in the location calculation. Next slide.

So the TeleSentinel, our system name development, has already demonstrated amps and TDMA. Our hardware in lab revel, is being augmented with the software to support the other interfaces and to be rebanded to the other frequencies. The SMR will be a super modification of the TDMA capability, since it's very similar in band width.

Others of my colleagues here at the table have already achieved the colleagues in other error interfaces that we have not yet. Next.

So the location infrastructure benefits certainly support all phones, all the time, all interfaces, all services, even enhanced communication services, which will benefit 911 also, and provide for security, both at the personal and public level. Next.

Basic issues we think the Commission should look into are how are amps handsets going to be located? We have heard that GPS processing and signals are very similar to those of CDMA signals and can be accommodated with your interface changes to allow for data transmissions. But even a CDMA signal operates as an amps phone in a rural