Testimony of
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Chairman Inouye, members of the Committee on Commerce, Science, and Transportation, and congressional staff, I am pleased and honored to appear before you today to testify on important national issues associated with Voice over Internet Protocol ("VoIP") and the Future of 9-1-1 Services. My name is Dale Hatfield and I am currently an independent consultant and adjunct professor at the University of Colorado at Boulder. In the interest of full disclosure, I should mention that I am also on the board of directors of Crown Castle International, a major operator of radio towers for the wireless industry here in the United States and Australia. In addition, along with two colleagues of mine at the University of Colorado, I was recently engaged by an industry group to study certain funding issues associated with the continued rollout of wireless E-9-1-1 services in the U.S. However, today I am testifying before you on my own behalf as a private citizen.

In today's testimony, I will emphasize how our E-9-1-1 policy should be responsive to a changed telecommunications landscape. The way we use our phones is markedly different than just a decade ago. People increasingly rely upon VoIP or cellular phones for voice communication, sometimes fully substituting such services in lieu of traditional wireline services. Moreover, VoIP and cellular calls are commonly made from indoor locations which present challenges relating to in-building location abilities. Today's changed telecommunications landscape makes the topic of E-9-1-1 particularly important and I commend this Committee for its attention to the topic.

Specifically, I would today like to explore three perspectives concerning the Future of 9-1-1 Services. *First*, to provide some background context on the issue, I'll quickly provide a high-level overview of the results of an independent inquiry that I conducted for the Federal Communications Commission ("FCC or "the Commission") in 2002. *Second*, I'll discuss my current observations on the topic, many of which stem from a subsequent investigation commissioned by the FCC in 2005, which requested that I update portions of my prior report. As some of you may know, the FCC stopped my work on this second report in the spring of last year. Accordingly, *third*, I will conclude by sharing some of the recommendations which I was contemplating when my work was terminated. As I will explain, I think it is important that the Commission take appropriate steps to encourage stakeholders to agree on a common testing methodology (or to at least reduce the differences and ambiguities associated with existing methodologies) for assessing location accuracy involved in finding 9-1-1 callers. Moreover, this revised methodology should take into account increased indoor usage of wireless devices.

My involvement in 9-1-1 issues goes back to the late 1990s when I was Chief of the Office of Engineering and Technology at the Federal Communications Commission ("FCC or "the Commission"). I retired from government service in the year 2000 and about a year later – in November of 2001 – the Commission asked me to conduct an independent inquiry into the technical and operational issues associated with wireless E-9-1-1. Early in the following year – 2002 – the agency announced the details of the inquiry whose purpose was – and I am essentially quoting from the Commission's formal notice –

to obtain an expert, informed, unbiased assessment of the technical and operational issues that impact wireless E911 deployment including any obstacles to deployment and steps that might be taken to overcome or minimize them. My independent inquiry got started in earnest in April 2002 and the final report was submitted to the agency in October of that same year.

While I do not intend to go back and review the findings and recommendations of that report in any detail in this testimony, certain aspects of the findings are still relevant today. In the report, I high-lighted three over-arching findings:

First, I stressed the importance of E-9-1-1 in general and wireless E-9-1-1 in particular to the safety of life and property and to homeland security. I noted that Congress had acknowledged this importance with the passage of the Wireless Communications and Public Safety Act of 1999. I also noted how the continued growth in wireless – cellular phone – networks and the public's dependency upon them had further underscored the importance of wireless E-9-1-1. If I were writing that passage today I would point out that the importance and dependency has further increased as a rising percentage of all E-9-1-1 calls are made from wireless devices and some subscribers even give up their landline service and rely solely upon their cellular phones for basic voice services.

Second, in 2002, I pointed out that in the preceding years the center of attention of the industry had clearly shifted from discovering, developing, evaluating and selecting the ways of locating mobile units in wireless systems to integrating the location information into the existing E-9-1-1 system. I regarded that as good news at the time because it indicated that there was no longer any real disagreement regarding the technical feasibility of providing wireless E-9-1-1 to the then approximately 130 million wireless subscribers in the United States. I went on to argue that the challenge at that point was to successfully complete the implementation of wireless E-9-1-1 – a process that was still in its early stages at that point. The report also noted that the shift in emphasis to actual deployment of the technology had surfaced other issues and challenges that needed to be overcome to facilitate the timely rollout of wireless E-9-1-1 – issues and challenges that I addressed in the main body of the report.

Viewed from today's perspective – nearly five years later – I would note that we have fallen short in terms of implementation because, as recently reported by National Emergency Number Association – NENA – "…only fifty-four percent of Public Safety Answering Points ("PSAPs") covering two-thirds of the population have the necessary technology to locate wireless 9-1-1 callers." I would also note that – besides the emergence of VoIP which has created an additional set of challenges – the increased use of wireless devices inside buildings presents formidable challenges, a topic that I will address in more depth later in my testimony.

In the **third** initial finding in my report in 2002, I raised concerns about the technical limitations associated with the existing wireline E-9-1-1 network infrastructure. Namely, the existing infrastructure was largely built upon outdated analog technology in an increasingly digital world. I concluded that while the wireline E-9-1-1 network was generally recognized as being reliable, it was also recognized that it had serious limitations in terms of speed, scalability, and adaptability – limitations that not only burdened the development of wireless E-9-1-1 at the time but also constrained our ability to extend E-9-1-1 access to a myriad of emerging non-traditional devices and networks. While those limitations were understood to a certain extent in 2002, they are even more apparent today. For example, with the camera phone that I have in my pocket, in calling E-9-1-1, I could send a picture of a suspect's car speeding away from a crime scene because modern, all-digital packet switched networks based upon the Internet Protocol suite are perfectly capable of conveying voice, data, image and even video traffic. The challenges to that vision

include not only the still-remaining limitations of the existing wireline E-9-1-1 infrastructure but also the ability of the PSAP to receive, process, and display such information.

While I have not studied in great detail S. 428, the bill known as the "IP-Enabled Voice Communications and Public Safety Act of 2007," I was gratified to find that it requires the National E-9-1-1 Implementation Coordination Office "to develop and report to Congress on a national plan for migrating to a national IP-enabled emergency network capable of receiving and responding to all citizen activated emergency communications…" Such a network would not only facilitate wireless E-9-1-1 calling but also the handling of VoIP calls made over broadband wired networks.

With that background on my first report done on behalf of the FCC, I would now like to turn to some more recent efforts – and some of the tentative findings and recommendations that stem from that work. The FCC came back to me in 2005 – about three years after the completion of my first report – and asked me to update it. At the time, they were unable to fund a comprehensive update and, consequently, we negotiated and settled on a statement of work that encompassed three areas:

- Providing an independent view of the current state-of-the-art in location technologies that were currently deployed

- Reviewing the technical and other interrelationships between Wireless E911 and nomadic VoIP issues

- Evaluating the technical and other challenges faced by smaller carriers/telecommunications providers in deploying Phase II services

My proposed methodology for the update was the same as I used in my original report. Namely, I would conduct interviews with stakeholders and other technical experts, study peer-reviewed technical journal articles, review industry produced whitepapers, evaluate anecdotal evidence, etc. One hope was that stakeholders would be a little more open with me than they might be when dealing with other stakeholders or with the Commission itself. Additionally, in the spirit of achieving open communications with stakeholders, it was agreed early-on that I would focus my attention on longer range issues and not on the really contentious issues of the moment. For example, at that time, one of the really hot issues was the question of how big an area the wireless carriers should be allowed to average over in carrying out the accuracy measurements to demonstrate that they were in compliance with the Commission's rules and regulations. That is, the issue was whether the averaging should be done on a PSAP-by-PSAP basis or, alternatively, over a statewide or other larger area. While I had identified this issue in my earlier study, it had become so charged and contentious by the time of my second report that to address the issue would risk overshadowing the remainder of the study. Accordingly, this issue was left outside the scope of my second inquiry.

With regard to the first question I was to address in the second study – the state of the art in location technology – I would like to offer the initial comment that I think it is an extremely important topic. We – including the general public – need to know how well the E-9-1-1 systems are doing in terms of the overall accuracy with which they are locating wireless callers. Specifically, it is important to know how well they are actually performing in operational systems in the field rather than in laboratory or other, more controlled settings. As the old management adage says, "You can't manage what you don't measure." Without information from measurements on operational systems, how can we tell whether

things are improving and how, as consumers, can we make informed purchasing decisions? If, as has been reported, the FCC takes action to require wireless providers to improve accuracy, how will public safety officials and the public know that improvements are actually being achieved in the field?

Going directly to this point, when I began the second study, I quickly discovered that, in terms of the overall performance of currently deployed wireless E9-1-1 systems, there was very little in the way of publicly available information upon which to ascertain the actual state-of-the-art in location technologies. However, by signing Non-Disclosure Agreements – NDAs – I was able to gain access to some actual performance information – routine measurements made on working systems. And, as it turned out, APCO, under its project LOCATE, had recently completed a series of accuracy measurements of their own in several markets with different topological and other characteristics. By signing an NDA, APCO very graciously made that information available to me; unfortunately, however, I was unable to fully absorb it before the FCC stopped my work in the spring of last year. Because of the NDAs I signed, I cannot talk now about that aspect of my work – the actual accuracy results being obtained – and will not do so.

Rather, what I would like to do in the remainder of my testimony here this afternoon is to give you a flavor of my tentative conclusions regarding other aspects of the study – conclusions relating to issues other than the one dealing with the actual position accuracies being obtained in the field. First, with regard to the overall problem of measuring location accuracy, I found that even when public or non-public measurement results were available, differences in testing methodology make it extremely difficult to interpret the results and compare the overall location accuracies obtained. That is, it is extremely difficult to make "apples to apples" comparisons across carriers, location technologies, types of geographic areas – urban, suburban and rural – and over time. Such differences in methodologies are primarily the result of the flexibility in test procedures permitted under the FCC's rules and the test procedures recommended by industry groups. These procedures – such as the ones addressed in Office of Engineering and Technology Bulletin 71 ("OET-71") – do not specify a detailed testing methodology; rather they provide what amounts to as guidance for the carriers and their vendors in creating such a detailed test methodology or plan.

From a regulatory perspective, there are some good reasons to provide such flexibility so that changes in technology, for example, do not require time consuming regulatory proceedings to change the agency's rules. Clearly such flexibility has advantages to the wireless carriers. But I found that such flexibility produces the difficulties in making valid comparisons as I touched upon a moment ago. More specifically, I observed that a major factor producing differing – or hard to compare – test results is how the locations for making the required test calls are determined.

Although not as important a factor, differences in the way handset- and network-based solutions work add an additional level of complexity in terms of comparing the performance of different location technologies. This is because, within the two basic technological approaches, there are significant tradeoffs among yield, time-to-first-fix and accuracy that have not been fully explored. For example, one technology (or one implementation of a technology) may produce a less accurate position location but produce it very quickly while another technology or implementation may produce a more accurate estimation of the location but at the cost of some delay. In that case, is the more accurate fix always to be preferred? Now that the location technologies are more mature, it may be time to investigate these tradeoffs in more detail.

Now otherwise legitimate differences in test methodologies – e.g., how test calls are distributed geographically – or system implementations can result in potentially serious disagreements in terms of regulatory compliance and, for the purposes of the study I was conducting, in terms of ascertaining the current state-of-the-art and the associated trends. Having observed this, I felt strongly – and still feel strongly – that serious repercussions could result if these and other differences in methodology (e.g., between public safety entity sponsored accuracy testing and carrier sponsored testing) are left unresolved.

A critical example of the importance of location weighting is what percentage of the test calls are made from inside buildings as opposed to out in the open. For reasons that I will expand upon in a moment, this is especially true of handset based solutions which depend upon the reception of Global Positioning System ("GPS") satellite signals to function properly. The fact that the GPS signals come from far out in space means that they are typically much weaker than the signal arriving at the handset from a nearby cellular tower. The result is that a cellular subscriber may be able to successfully complete a 9-1-1 call from within the building while, in contrast, the satellite signals are too few or too weak to allow an accurate position fix to be obtained. That is, you can complete the call but you cannot be automatically located. If it is true that as many as many as 40 – 60 percent of all cellular calls are made indoors – from an office, home, sports arena, restaurant, airport or whatever, then it follows that a corresponding percentage of test calls should be made from such locations. I do not believe that is the case today.

Still another factor that bears heavily upon this issue is the phenomenon that younger people – such as college students – and other people in our society are increasingly giving up their landline telephone and relying entirely upon their cellular phone for traditional voice communications. This continuing trend, known as wireless for wireline substitution, clearly compounds the problem of in-building accuracy performance. I should also mention that various devices and systems – such as bi-directional amplifiers ("BDAs"), distributed antenna systems, "leaky-coax systems," and pico-cells – have been developed and deployed to enhance in-building cellular coverage without a corresponding "boost" in GPS signals. While these systems may have important consumer benefits in terms of better coverage, they may exacerbate the problem of accurately locating in-building E-9-1-1 callers. Moreover, even network based location systems may suffer in terms of location accuracy due to the weakening of the additional terrestrial signals needed for triangulation.

Since this issue of in-building coverage is perhaps the most important finding that emerged from my study, I would like to say a few more words about it. One thing I want to make clear is that, in raising this in-building coverage issue, I am not being critical of past efforts to develop and deploy wireless E-9-1-1 location systems. When we embarked upon this program of locating wireless E-9-1-1 callers well over a decade ago – cellular phones were still rather clunky devices and the cost of cellular service was still relatively high compared to landline calling. At that time, few could have fully appreciated the increasing percentage of calls that would be made from inside buildings and the technological advances that would facilitate such calling. The systems that have been developed have, in many ways, been truly amazing and we should all be thankful for them. But the fact of the matter is, people are making more indoor calls and, with existing technology, we may have trouble locating them there. Hence, it doesn't make sense to me – and it is potentially misleading to consumers – to have test methodologies that require placing only a small fraction of the test calls from inside buildings when it is likely that a significantly greater fraction of cellular calls are made from such locations.

Turning now to another part of my second study, the interrelationship between wireless E-9-1-1 and nomadic VoIP, a major challenge for nomadic VoIP services is the lack of a system for automatically

entering or confirming the location of VoIP phone or other end user device. Requiring customers to manually enter their location information when movement is not infrequent is fraught with problems. When a VoIP user moves his or her device from a certain location and fails to update his or her new location information, then a call to 9-1-1 may not be properly routed. For example, if a VoIP user moves from a home or office location in Washington, DC to a rented beach house in Rehobeth, Maryland and fails to update his or her location information, then a call to 9-1-1 may be answered in Washington rather than Rehobeth with potentially disastrous results. Moreover, and not surprising, since nomadic VoIP calls require a broadband connection for good performance, they are more apt to be made from indoors. This means that wireless and VoIP E-9-1-1 systems share a common need for an automatic location system that works well from within buildings. Thus in considering the interrelationship between wireless and VoIP E-9-1-1 requirements, it is quite possible that there could be substantial benefits from developing an automatic location system that would serve both needs.

I will come back to this issue in a moment but, before I do, let me add just a few words about the rural issue. Rural carriers using network-based terrestrial solutions face legitimate problems in meeting accuracy requirements where there are not enough antenna sites or the sites are geographically distributed in such a way that reliable triangulation among them is not possible. An extreme example of this would be a small and rural community served by a single cellular base station antenna site. Under these circumstances, network-based terrestrial triangulation will not work in the absence of additional cellular base station antenna sites. Ultimately, technology may produce a solution to this rural problem through the use of "hybrid" or blended solutions that combine handset (GPS satellite) based solutions, which tend to work best outdoors and in less congested areas, and network (terrestrial triangulation) based solutions which tend to work best in more congested urban areas where the cellular base station antenna sites are more densely packed and evenly distributed. However, even a hybrid solution could leave <u>in-building</u> coverage problems for wireless E-9-1-1 and for nomadic VoIP providers who might try to solve their automatic location problem using the same blended approach.

With that background, I would like to conclude by suggesting to you some of the recommendations that I was contemplating at the time my work was terminated last year:

Ø *First*, that the Commission take appropriate steps to encourage the stakeholders to agree on a common testing methodology (or to at least reduce the differences and ambiguities associated with existing methodologies) for assessing location accuracy. Moreover; the revised methodology should take into account increased indoor usage of wireless devices

Ø *Second*, that the Commission arrange for the filing of aggregated accuracy measurement data using the common or more standardized methodology. This aggregated data could, in turn, be used by the Commission (or by a third-party with appropriate protection of proprietary data) to ascertain and track the current state-of-the-art in location based technologies in various environments – e.g., urban, suburban and rural. It may also be appropriate to report the state-of-art to the Congress on a regular basis as well

Ø *Third*, that the Commission take appropriate steps to encourage the development of hybrid or combined technologies that would solve the rural location problem I described earlier

Ø *Fourth*, that the Commission, through an appropriate forum such as its own Technological Advisory Counsel ("TAC") or the National Academy of Engineering, and, perhaps, in conjunction with other governmental agencies such as the Department of Homeland Security and the National Telecommunications and Information Administration of the Department of Commerce, investigate the

broad issue of in-building location taking into account wireless and perhaps nomadic VoIP requirements as well

Ø *Fifth*, that the Commission work with the wireless carriers to ensure that customers understand the limitations of location technologies as compared to the wireline system when they call 9-1-1.

That concludes my testimony and I would be happy to entertain any questions that you might have.