DOCKET FILE COPY ORIGINAL

EX PARTE OR LATE FILED

Building The Wireless Future™

June 4, 1998

CTIA
Cellular Telecommunications Industry Association
1250 Connecticut Avenue, N.W.
Suite 200
Washington, D.C. 20036
202-785-0081 Telephone
202-785-0721 Fax

RECEIVED
JUN - 4 1998
FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Ms. Magalie R. Salas
Secretary
Federal Communications Commission
1919 M Street, NW Room 222
Washington DC 20554

Re: Ex Parte Presentation
CC Docket # 94-102 (E9-1-1/Strongest Signal)

Dear Ms. Salas:

On Wednesday, June 3, 1998, Brian Fontes, Senior Vice President, Policy and Administration, of the Cellular Telecommunications Industry Association ("CTIA"), delivered a copy of the following letter and its attachments to Chairman William Kennard. The letter references the above-captioned proceeding and emphasizes the efforts of the wireless industry to provide customers with reliable access to 9-1-1 services.

On Thursday, June 4, 1998, copies of Mr. Fontes' letter and attachments were delivered to the following:

Commissioner Harold Furchtgott-Roth	Commissioner Susan Ness
Commissioner Michael Powell	Commissioner Gloria Tristani
Paul Misener	David Siddall
Peter Tenhula	Karen Gulick
Daniel Phythyon	Rosalind Allen
John Cimko	Ron Netro

Pursuant to Section 1.1206 of the Commission's Rules, an original and one copy of this letter and its attachments are being filed with your office. If you have any questions concerning this submission, please contact the undersigned.

Sincerely,

Cleveland Lawrence III

No. of Copies rec'd 0+1
List A B C D E

WOW-COM™ the World of Wireless Communications on the Internet at www.wow-com.com™

Make it a daily habit.

Building The
Wireless Future™

CTIA

Cellular
Telecommunications
Industry Association
1250 Connecticut
Avenue, N.W.
Suite 200
Washington, D.C. 20036
202-785-0081 Telephone
202-466-7289 Fax
202-736-3216 Direct Dial

Brian F. Fontes
Senior Vice President for
Policy and Administration

June 3, 1998

William E. Kennard, Chairman
Federal Communications Commission
1919 M Street, N.W.
Washington, D.C. 20554

CC Docket 94-102

Dear Chairman Kennard:

Today, CTIA submitted a Standards Requirements Document (SRD) to the Telecommunications Industry Association (TIA) seeking a review of possible enhancements to the public safety capabilities of wireless phones, including the ability of wireless callers to reach 9-1-1 in emergencies. Specifically, CTIA is asking the standards setting body to investigate possible enhancements to assure the most effective and efficient completion of 9-1-1 calls.

In a separate, but related, submission to TIA, CTIA provided new information on the "strongest signal" proposal being advanced by the Ad Hoc Alliance for Public Access to 9-1-1. The Alliance has proposed that all 9-1-1 calls automatically go to the strongest control channel signal available. The CTIA submission explains that the Alliance's proposal could actually cripple emergency response. CTIA's filing provides technical support for the position taken by the public safety community in opposition to the Alliance's proposal.

Finally, you will find a copy of a letter from Mr. Paul Wilkinson, Vice President Cellular Engineering and Service, with Audiovox Communications Group to Mr. Jonathon D. Linkous of the Ad Hoc Alliance for Public Access to 9-1-1. Mr. Wilkinson's letter corrects the assertion made by the Ad Hoc Alliance that the Audiovox cellular phone selects the strongest signal.

Mr. Chairman, each day more than 83,000 wireless phone calls are made to 9-1-1 and other public safety operators. The documents submitted to TIA further demonstrate the wireless industry's commitment to provide customers reliable access to 9-1-1 services.

Sincerely,

Brian F. Fontes

TIA Committee TR45

Hyatt Regency
Oak Brook, IL
June 3-4, 1998

TITLE: **CTIA Documents Addressing 9-1-1 Call Completion**

SOURCE: **Cellular Telecommunication Industry Association (CTIA)**

DISTRIBUTION: ANSI Accredited Engineering Committee TR45 and appropriate sub-committees

CONTACT: Ed Hall, CTIA 202/736-3259
Ehall@ctia.org

ABSTRACT: This contribution contains various documents and technical reviews, commissioned by CTIA, to analyze and comment on the numerous technical claims presented by Trott Engineering Group on behalf of the Ad Hoc Alliance for Public Access to 9-1-1. These commentaries are provided for consideration while reviewing the CTIA SRD on 9-1-1 Call Completion. Contained are:

1. Audiovox operational review of the MVX505 wireless phone
2. *"CTIA: A Study of 911 Call Originating Policies in Cellular and PCS"*
3. *"CTIA: Strongest Signal Impact on Call Setup Time"*
4. Appendix A to the WEIAD Annual Report to the FCC
5. eXpert Wireless Solution, Inc. *Analysis of the "Strongest Signal" Proposal for Handling Cellular 911 Calls*

NOTICE: This contributor grants a free, irrevocable license to The Telecommunications Industry Association (TIA) to incorporate text contained in this contribution and any modification thereof in the creation of a TIA publication; to copyright in the name of TIA and any TIA publication even though it may include portions of this contribution; and at the sole discretion of TIA to permit others to reproduce in whole or in part the resulting TIA publication. This contribution has been prepared by the Cellular Telecommunications Industry Association (CTIA), as a basis for discussion to assist the TIA technical subcommittee. This document shall not be considered a binding proposal. Specifically, CTIA reserves the right to modify, amend, or withdraw this contribution.

Copyright: Permission is granted to TIA participants to copy any portion of this document for the legitimate purposes of TIA. Copying for monetary gain or other non-TIA related purposes is prohibited.

AUDIOVOX
COMMUNICATIONS CORP.

An Audiovox MVX505 can have 2 different setup conditions based on the programming of the phone, with 5 distinct cases associated with each. Each of the 2 setups will cause the receive function of the phone to behave differently in what it is capable of receiving. They are listed below along with a background description of how a 911 call would be placed during each condition (and if possible).

SID management turned off

1.) No ROAM indication with signal strength:

The phone is operating in the "HOME" system signal area. If 911 is called, the call will be placed through the "HOME" system cellsite. The "HOME" system is always preferred over other service providers when placing calls.

2.) ROAM indication with signal strength:

The phone is using a preferred "ROAM" service provider. If a call is placed other than 911, the phone will rescan to look for a "HOME" service provider. If it finds the "HOME" service it will place the call on it. If not, it places the call on the "ROAM" service. If a 911 call is placed, the phone does not rescan. It will place the call on the "ROAM" service.

3.) FLASHING ROAM indication with signal strength:

The phone is using a non-preferred "ROAM" service provider. If a call is placed other than 911, the phone will rescan to look for a "HOME" service provider. If it finds the "HOME" service provider, it will place the call on it. If not, it places the call on the non-preferred "ROAM" service. If a 911 call is placed, the phone does not rescan. It will place the call on the non-preferred "ROAM" service.

4.) FLASHING NO SVC with signal strength:

Flashing no service indicates service is available but the phone's preferences are set in such a way that it is not allowing that service to be used for placing calls. If a 911 call is placed, the phone disregards the set preferences of the phone and rescans for ANY available service to place the call.

(continued on next page)

555 Wireless Blvd., P.O. Box 18034, Hauppauge, NY 11788 • Phone (516) 233-3300 Fax (516) 233-3437

5.) **CONSTANT NO SVC with no signal strength:**

There is no service provider in the area and the cellular phone is not detecting ANY available service. A 911 call cannot be placed since there is no service provider to place the call with.

SID management turned on

1.) **NO ROAM indication with signal strength:**

The phone is operating in the "HOME" or "BROTHER/SISTER" system signal area. If 911 is called, the call will be placed through the "HOME" service provider. The "HOME" system is always preferred over other service providers when placing calls.

2.) **ROAM indication with signal strength:**

The phone is using a "COUSIN" service provider. If a call is placed other than 911, the phone will rescan to look for a "HOME" service provider. If it finds the "HOME" service it will place the call on it. If not it places the call on the "COUSIN" service. If a 911 call is placed, the phone does not rescan. It will place the call on the "COUSIN" service.

3.) **FLASHING ROAM** indication with signal strength:

The phone is using a non-preferred "ROAM" service provider which is not part of the SID family management list. If a call is placed other than 911, the phone will rescan to look for a "HOME" service provider 1st, a "BROTHER/SISTER" service provider 2nd and then a "COUSIN" 3rd. If it finds either of those 3 services available, the call will be placed on that available service. If not, it places the call on the non-preferred "ROAM" service. If a 911 call is placed, the phone does not rescan. It will place the call on the non-preferred "ROAM" service.

4.) **FLASHING NO SVC with signal strength:**

Flashing no service cannot happen with SID family management active. It will show up as a flashing roam if service is available but is not listed within the "HOME", BROTHER/SISTER or "COUSIN" SID lists. It would act as if #3 above.

(continued on next page)

5.) **CONSTANT NO SVC** with no signal strength:

There is no service provider in the area and the cellular phone is not detecting **ANY**. A 911 call cannot be placed because there is no service provider to place the call.

These are all the conditions available at the phone. The phone works as one would reasonably except under a "flashing no svc" condition. This one condition bypasses the normal operation of the phone and places the 911 call on **ANY** available service provider.

CTIA

A Study of 911 Call Origination Policies in Cellular and PCS Systems

INTRODUCTION

With the importance of 911 emergency calls today, the reliable support of 911 emergency calls in cellular and PCS systems is essential. Due to the critical nature of 911 calls, the success rate of call origination becomes an important issue. A proposal was made that 911 calls shall always be originated using the strongest RF signal regardless of the default band (A or B), system, or operator. The objective of this paper is to examine the effectiveness of this proposal, and to compare this proposal with alternatives.

SUMMARY and CONCLUSIONS

When a 911 call needs to be made, the call origination should not use RF signal strength as the sole guide. In fact, the analysis of this paper shows that this policy improves the call origination success rate only slightly under light call traffic condition. When the call traffic is beyond a moderate level, this policy is more likely to hurt the call origination success rate than improving it. When the call traffic is heavy or when many 911 calls need to be made due to the large scale of an emergency incident, this policy may even lead to catastrophe with an unacceptably high level of blocking rate. This catastrophe is mainly caused by the fact that most of the 911 calls originated around the same incident location will likely to lock into the same cell closest them. This tends to make the available channels in the cell the dominate factor relative to the coverage hole factor.

Beyond the call origination policies studied in this paper, the call origination success rate can improve significantly when handset is allowed to originate calls in the second cell when its origination in the first cell fails. Even in this situation, the first call origination is recommended to use the handset default system to guarantee even call distribution and to avoid potential call collision.

I. SYSTEM MODEL

In general, the success of a call origination is a function of the following parameters:

1. the signal strength;
2. the designed blocking rate of the system;
3. the available channels of the system during the time of the call;

Since the time of the call depends on the time of the incidence, and is not a controllable parameter, we shall focus on the first two parameters in this study.

Currently in the United States, there are two frequency bands (A and B) in the cellular frequencies, and more than three frequency bands (A, B and C) in the PCS frequencies. Since the PCS systems using band C and others are not yet widely deployed, we shall assume the general availability of only four frequency bands (or operators) for both cellular and PCS in this study. We shall also study the case in which there are only two bands available (cellular only or PCS only cases).

For any given frequency band, we further make the following assumptions based on typical cell site settings of the current cellular and PCS service providers:

1. the coverage of each cell is 90%;
2. the call blocking probability is 2% in the coverage area;
3. the emergency location can be anywhere in the cell with identical probability;
4. probabilities that a call belonging to one of the four frequency bands is identical;
5. normal calls and 911 calls arrive according to a Poisson process with a constant call arrival rate λ;
6. call lengths are statistically independent and follow exponential distribution.

Let us consider two polices for call origination when an emergency situation occurs. In the first case, a call is originated using the strongest detected signal regardless the default band, system (if the phone is at least dual mode) and operator. In the second case, a call is originated using the default band and operator.

Based on the current statistics, 911 calls are usually originated in clusters in both time and space. This is because that calls are usually made around the time and place of an incidence. For a particular incident, usually more than one 911 calls are made depending on the size of the incident and number of people involved. For this reason, we shall study the case in which all 911 calls will be made within one cell. Here we use the word cell as a generic term that means a cell site when the cell site is omni-directional and a sector when the cell site has more than one sector.

To study the call origination success rate, we shall adopt the Erlang-B queueing model. Assume that the call arrival rate is λ, the call duration is $1/\mu$, and the number of channels in the cell is m, the probability of a call being blocked is given by[1]:

$$p = \frac{(\lambda / \mu)^m / m!}{\sum_{k=0}^{m} (\lambda / \mu)^k / k!} \tag{1}$$

Denote p_1 as the probability that a call is in the coverage area. Clearly, the probability of a successful call origination in a given cell P is the product of the probability that the call is in the coverage area and the probability that the call is not being blocked due to lack of any channel, given by:

$$P = (1 - p) p_1 \tag{2}$$

II. CALL ORIGINATION ANALYSIS

Given the mathematical model as described in the last section, we shall examine the call origination success rate using some typical numbers so that certain typical trends can be identified.

First let us consider the cell site coverage issue. When there is only one cell, the coverage is assumed to be 90% as given in the last section. When there are two frequency bands covering the

[1] Leonard Kleinrock, Queueing System, Vol. I., pp. 106, John Wiley & Sons, 1975.

same area, the coverage clearly improves because the cell sites may not be in the exactly the same location. However in this case, we cannot assume that the two cell coverage areas are statistically independent. Cell location selection is clearly a complex problem and a detailed study of this problem is out of the scope of this paper. However, it is important for us to observe that:

1. cell sites are selected to cover residents, business and traffic roads;
2. different operators of different frequency bands usually target the same set of customers;
3. many coverage holes are due to particular terrain structure that may affect coverage of all operators.

To circumvent the above complex problem, we shall adopt the following simple mathematical model. As shown in the following figure, there are two cells located along the x axis with a distance x_1 between them. The coverage of the two cells are the two circles as shown with the same radius r=1. When x_1=0, the two cells are at the exactly the same location and the two coverage areas completely overlap. When one of the cell moves to the edge of another cell, x_1=1, the overlap areas decrease to the minimum. When the cell center moves outside the coverage area of the given cell, we assume that it belongs to another cell and it shall overlap with an adjacent cell of a different service provider. Therefore, the range of x_1 is between 0 and 1.

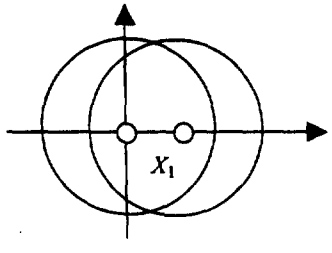

Figure 1. Two cell sites at different locations with common and separate coverage areas

With the help of the above figure, we shall try to identify the percentage of the overlap area of the two cells and to determine the percentage improvement of the coverage when a location is covered by two cells.

From the above figure, the overlap area can be computed from the following equation.

$$\begin{aligned} A &= \int_{x_1-1}^{1-x_1/2} dx \int_{-\sqrt{1-(x-x_1)^2}}^{\sqrt{1-(x-x_1)^2}} dy + \int_{1-x_1/2}^{1} dx \int_{-\sqrt{1-x^2}}^{\sqrt{1-x^2}} dy \\ &= \frac{\pi}{2} + (1-1.5x_1)\sqrt{1-(1-1.5x_1)^2} + \arcsin(1-1.5x_1) \\ &\quad + \frac{\pi}{2} - (1-x_1/2)\sqrt{1-(1-x_1/2)^2} + \arcsin(1-x_1/2) \end{aligned} \tag{3}$$

By substituting x_1=1, and x_1=0 into the equation, we observe that the overlapping areas for the two cells are 40% and 100% respectively.

To determine the coverage improvement due to two overlapping cells covering the same location, we need to know the average of the overlapping with x_1 as a variable. We further assume that x_1 follows a linear distribution with the maximum at x_1=0 and zero at x_1=1. This assumption is included to account for the observation that different operators usually target the same set of

2

customers. Therefore the cell locations may more likely to be close than to be apart. Under all these conditions, the average of the overlapping area for the two cells is computed to be about 85% relative to the whole cell area.

Now let us calculate the probability that a call is in the coverage area with two operators. It is:

$$p_2 = 0.85p_1 + 0.15(1-(1-p_1^2)) = 0.9135$$

The above number is calculated assuming p_1=0.9. With similar argument, we can also calculate the probability that a call is in the coverage area with four operators:

$$p_4 = 0.85p_2 + 0.15(1-(1-p_2^2)) = 0.925$$

From the above analysis, the average of the coverage improvement is about 2.5% under the assumption that different operators target similar set of customers.

As for other parameters, we shall assume that the average number of channels in a cell is m=20. The average call duration is $(1/\mu)$=2.5 minutes as published by CTIA[2]. Under all the above assumptions, the blocking probability for a call that always select the strongest signal of two cellular or PCS operators regardless the handset default is

$$P_s = 1-(1-p)p_2 = 1-p_2\left(1-\frac{(\lambda/\mu)^m/m!}{\sum_{k=0}^{m}(\lambda/\mu)^k/m!}\right) \tag{4}$$

Note that in this case all calls will select the same cell for call origination because this cell is supposedly closest to the incident site and has the strongest detected signal. The blocking probability for a call that always select the strongest signal of four cellular and PCS operators regardless the handset default is

$$P_s = 1-(1-p)p_4 = 1-p_4\left(1-\frac{(\lambda/\mu)^m/m!}{\sum_{k=0}^{m}(\lambda/\mu)^k/m!}\right) \tag{5}$$

Note again that in this case all calls will select the same cell for call origination because this cell is supposedly closest to the incident site and has the strongest detected signal. When a call is made using the handset default setting, the blocking probability can be determined from:

$$P_d = 1-(1-p)p_1 = 1-p_1\left(1-\frac{(\lambda/\mu)^m/m!}{\sum_{k=0}^{m}(\lambda/\mu)^k/m!}\right) \tag{6}$$

In this case calls will be uniformly distributed in two or four cells belonging to two or four different operators. Since calls are not originated using different operators, the number of channels available for a call remains to be m=20 rather than 40 or 80. No further queueing

[2]Survey Result Table in Wireless Reference Desk at CTIA Website

2

efficiency can be obtained. However, the Erlangs value (λ/μ) does increase by two or four times. Or equivalently, $\lambda_d=2\lambda$ or $\lambda_d=4\lambda$ for a given μ.

Substituting all the numbers in the above three equations, the call blocking probabilities for the above four cases can be computed with respect to the supportable call arrival rate per minutes as shown in the following figure.

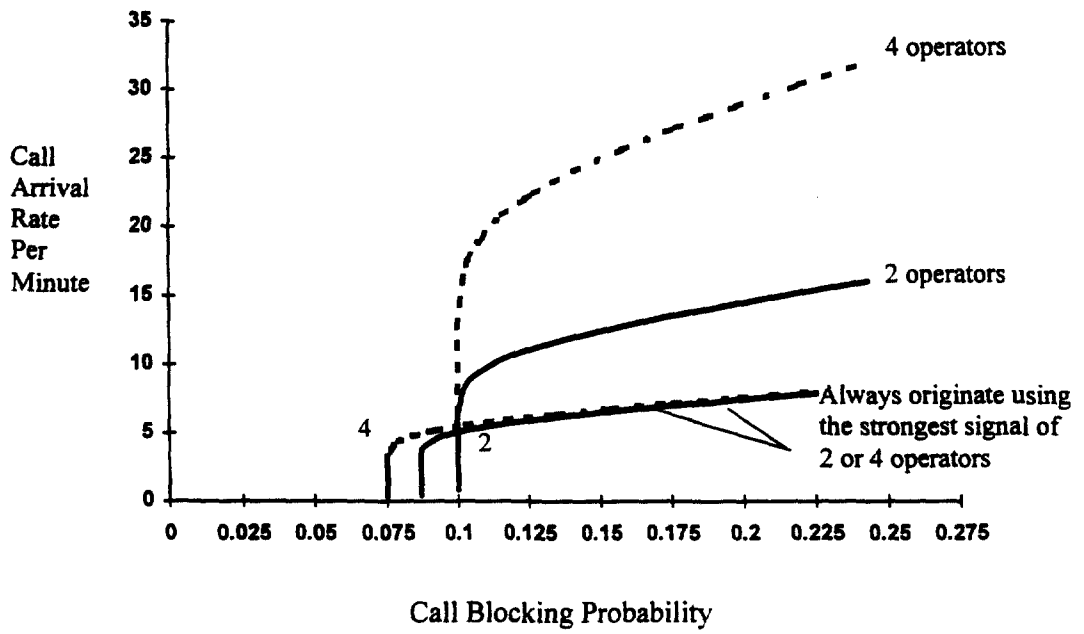

Figure 2. Supportable call arrival rate as a function of call blocking probability

From the above figure, the following observations can be made:

1. When the system is not busy, and calls arrive at the cell site at a rate less than 5 calls per minute, call origination using the strongest signal has 1.4% or 2.5% less chance to be blocked depending on whether 2 or 4 operators are available.
2. When the system is busy with more than 5 calls per minute, call origination using the handset default system performs much better because it has much less chance to be blocked by other calls.
3. The above figure is obtained assuming the system is empty with no calls. When there are existing customers, the supportable call arrival rate will decrease linearly according to the load.

III. FURTHER DISCUSSIONS

From the analysis of the previous sections, the success rate of the 911 call origination depends on both signal strength and call volumes. When call volumes is low, the origination scheme based on signal strength is superior. When call volumes is high, the performance curves cross cover and the origination scheme based on handset default setting is better. While these results are obtained based on certain specific parameter assumptions that are subject to change, this cross-over trend nevertheless appears to be general.

2

While so far we only studied cases in which calls are always originated in a particular cell, the results can also apply to the cases in which calls are allowed to be originated in another cell when origination in one cell fails. In this case, the results can be interpreted as the success rate of the first attempt of call origination.

2.

CTIA

"Strongest Signal Impact on Call Setup Time"

Call setup times for 9-1-1 calls will be significantly longer when the call is processed for registration and authentication by the accessed system. This is because half of the time, the mobile station will access a system that it has not been registered to previously (i.e., the "non-preferred system").[1]

The registration cycle for IS-41-based network signaling requires an authentication message exchange and a registration message exchange. The authentication message exchange proves the phone is who it says that it is and the registration message exchange retrieves the profile of the mobile station, including the mobile directory number. Once this information is obtained the call can be allowed to proceed with the callback number. Authentication Requests may take up to 6 seconds and Registration Notification may take up to 12 seconds for a total of 18 seconds (according to the IS-41 standards). These numbers are worst case numbers with nominal delays expected to be around 4 to 6 seconds for each registration attempt. Thus, if a phone is registered on the A carrier, scans A-B and then selects the B carrier when 9-1-1 is called, re-registration on the B carrier could take an additional 4 to 18 seconds. These delays are on top of any delays caused by the mobile station performing rescan or any call setup.

To implement this callback capability using the "strongest signal" concept, roamer agreements would have to be supported between all service providers. In addition, for this to work, IS-41 network signaling protocols would have to be modified to support such emergency service roaming agreements. This protocol development would take time and investment to standardize, develop, and deploy.

In should also be noted that registering on the subscriber's non-preferred system may result in a loss of the ability to support the subscriber's chosen location service. A service provider may elect to offer mobile assisted location services that may not be supported by other service providers. When the subscriber-scans to the non-preferred service provider, the ability to precisely locate the mobile station may be lost. For example if Carrier A elects to use GPS units built into the consumer's handset, location will not be possible for Carrier B's customers that end up on Carrier A's network because of the "strongest signal concept".

[1] Note that registration is required for mobiles to obtain their mobile directory number, since the mobile directory number and mobile identification number will no longer be tied together in order to support local number portability and NPA splits. The serving system uses the mobile directory number as the callback number when it passes the 9-1-1 call to the emergency services network.

APPENDIX A

(excerpted from January 30, 1998 WEIAD[1] Annual Report to the FCC)

WEIAD SUMMARY DISCUSSION ON STRONGEST SIGNAL

Coverage "holes" will always exist in one form or another due to the very nature of radio communications. A wireless telephone user who is located in such a hole may find that there is no signal or insufficient signal to establish and maintain adequate communications over the wireless system accessed by the handset. There is agreement that in these instances, a user should be able to attempt access to an alternate, technically compatible, system for 9-1-1 calls.

In the case of no signal from the preferred system, there is agreement that programming a purely analog handset to use A over B or B over A may alleviate the problem. Two proposals were considered. The first is based on the premise that the user should always be able to access the strongest channel when placing a 9-1-1 call. The second proposal is that all handsets be programmed to use A over B or B over A logic when 9-1-1 is dialed, at a minimum. Among the proposals presented but not fully explored was establishing minimum signal strength levels as a trigger for the handset to switch systems.

The Strongest Signal and A over B proposals are not mutually exclusive. It was agreed that the user should always be given the choice between viable alternatives. There was concern by some participants that the Strongest Signal proposal, favored by the Alliance, may not be desirable, technically feasible, or sufficient. The Alliance position is that more than significant opportunity has been afforded through the FCC comment period for such objections to be stated and supported.

The WEIAD desires the best means to ensure the completion of 9-1-1 calls. As one avenue of exploration, Public Safety and the Wireless Industry suggested that the WEIAD request the appropriate Standards Development Organization (SDO) to expeditiously consider the Alliance proposal. The Alliance does not believe that such a reference is appropriate because it maintains that its petition does not seek a change in the existing standard, or in the interoperability "standards" or "common air Interfaces" that have been established. The other parties disagreed with this position and maintained that the SDO itself should determine if the Alliance proposal requires a change in an existing standard or the establishment of a new standard.

A two track approach which contemplated endorsement of prompt consideration of the Alliance proposal by the FCC and the SDO was not acceptable. However,

[1] WEIAD - Wireless E911 Implementation ADHOC (a group comprised of industry, public safety, and consumer representatives that was formed at the request of the FCC)

the Wireless Industry and the Public Safety organizations agreed to assist the Alliance in expediting the SDO process in order to reduce the time for the SDO to consider the Alliance proposal. The WEIAD recognizes the Alliance will continue to urge the FCC to rule on its petition. The Alliance agrees that it will take under advisement the suggestion that it submit its proposal to the appropriate SDO for consideration.

I. The WEIAD-3 recommends that the wireless industry promptly begin to undertake to educate users of purely analog phones manufactured or provisioned prior to mm/dd/yy(earliest practical) on the capabilities of those phones to be programmed, where capable, to use A over B or B over A logic as prescribed by EIA/TIA 553* for 9-1-1 calls.**

II. The WEIAD-3 recommends that all purely analog phones manufactured or provisioned after mm/dd/yy(earliest practical) be programmed, where capable, to use A over B or B over A logic as prescribed in EIA/TIA 553* for 9-1-1 calls, at a minimum; with the proviso that users can elect to stay on their preferred carrier.

* Paragraph 26.1.1.2
**Implementing this logic will apply to all calls

Recommendation III represents the consensus of the WEIAD. The Alliance does not concur with this recommendation.

III. The WEIAD desires the best means to ensure the completion of 9-1-1 calls. As one avenue of exploration, the WEIAD remands to the appropriate SDO[2], for expeditious consideration, the AD HOC Alliance proposal that all purely analog phones manufactured or provisioned after (earliest possible date) be programmed, where capable, to scan all of the forward control channels assigned to both system A and system B and select and use the channel with the strongest compatible signal whenever a 9-1-1 call is placed, with the provision that the user be able to disable this feature.

[2] In the event that a problem is identified but no solution is known or available to be offered for review, a mechanism exists in the form of a Standards Requirements Document (SRD). This document describes the problem and defines the elements required to address the problem. It is submitted to the appropriate Standards Development Organization (SDOs) and contributions are made by the members in an effort to craft solutions.

When a proposed solution exists, the process has long been established to review the technical validity and merit of any party's proposal. In this case, the proposal would accompany the SRD. The submission of an SRD is the first rung of the ladder.

Public Safety Organizations (PSOs) offered to assist the wireless industry to help shepherd the Alliance's proposal through an SDO process. Additionally, the PSOs and the wireless industry helped draft such a document for the Alliance. A draft SRD was offered to the Alliance for submission to the SDO process.

To advance the achievement of this capability, the Wireless Industry and Public Safety organizations agree to assist the Alliance in creating a requirements document for consideration by the appropriate SDO.

Analysis of the "Strongest Signal" Proposal for Handling Cellular 911 Calls

Prepared for:

CTIA

By:

eXpert
Wireless Solutions, Inc.

2050 Center Ave., Suite 120
Fort Lee, NJ 07024
(T) (201) 944-7780
(F) (201) 944-6619

8221 Old Courthouse Road, Suite 200
Vienna, VA 22182
(T) (703) 760-9180
(F) (703) 760-9182

June 1, 1998

5

Table of Contents

1.0 Executive Summary 1

2.0 Background and Analysis Scope 1

3.0 Review of TROTT Report 2

3.1 August 27, 1996 TROTT Report 2

3.2 October 18 1996 TROTT Cellular System Survey Results 2

3.3 January, 27 1998 TROTT Report 3

4.0 eWS Analysis of the "Strongest Signal" Proposal 4

4.1 Equating Signal Level with Coverage 4

4.2 Recognizing an Emergency Call 4

4.3 Network Diversity 5

4.4 Coverage Hole Argument 5

4.5 Network Support 5

5.0 Recommendations on How to Proceed 6

1.0 Executive Summary

eXpert Wireless Solutions ("eWS") has been asked by the CTIA to perform a technical analysis of the proposal by Ad Hoc Alliance for Public Access to 911 ("Alliance") to improve 911 emergency access to the cellular networks (commonly referred to "Strongest Signal" proposal).

It is eWS' conclusion that the underlying assumption (upon which the "Strongest Signal" proposal is constructed) is to equate coverage or network access with control channel signal strength. This is not a valid assumption for many realistic cases. In addition to equating signal strength with increased probability of network access, "Strongest Signal" proposal treats such important issues as recognition of an emergency call by the handset, network diversity and reasons behind existing coverage holes using what we believe to be an over simplified approach with very limited engineering data to support it.

2.0 Background and Analysis Scope

For background, eWS is one of the leading independent providers of RF engineering and network design services to the wireless telecommunications industry. The company has provided these services to operators and manufacturers in more than 40 wireless markets in 8 countries. With offices in the US, Asia, Europe and South America, eXpert Wireless Solutions has a worldwide presence providing expert engineering solutions to the wireless operators in all major wireless technologies available today (e.g., CDMA, TDMA, GSM, DCS, IS-136, iDEN, AMPS and ETACS).

CTIA has requested that eWS provide a technical analysis of the "Strongest Signal" proposal by Ad Hoc Alliance for Public Access to 911 ("Alliance") to improve 911 emergency access to the cellular networks. The scope of our analysis was focused on the following :

- A technical review of the TROTT report dated August 27, 1996 and the subsequent response dated October 18, 1996 and January 27, 1998 all submitted by TROTT COMMUNICATIONS GROUP..
- A general analysis of any other technical issues relating to the "Stronger Signal" proposal that may not have been addressed or accessed by the above report including many points raised in the report titled "Public Safety Response to the Trott Reported" dated February 23, 1998 submitted by Donelan, Cleary, Wood and Maser, P.C.

In preparing this report, it has been our intention to analyze any claims of improvements or problems related to this proposal through a scientific approach where any claim is supported with statistically valid engineering data. Additionally, since cellular RF environments and networks are highly complex phenomenon that are driven by a multitude of random factors and stochastic events, eWS has put a lot of emphasis on

quantifying any claims using statistically valid facts and figures. Where such data is not presented, eWS has suggested what data needs to be collected to validate such claims.

It must be noted that our subsequent analysis is based on the limited information provided by the reports mentioned above, our interaction with CTIA and our knowledge of the cellular technologies in general. eWS has not had access to any other publications, reports, supporting material or interactions that may exist on this issue.

3.0 Review of TROTT Report

In this section, a review of two reports provided by TROTT COMMUNICATIONS GROUP are presented. The following is what eWS considers as claims that need further clarifications or engineering data to be statistically valid:

3.1 August 27, 1996 TROTT Report

Under "Proposed Change to the Process" on Page 4, the report claims that "*This Change will ensure the MS access to the best communication path ...*" The report is claiming that the best signal strength on the forward link of an access channel automatically ensures not only the best reception at the cell site on the reverse link, but also the best assignment of a voice channel. This is only correct under certain conditions, and not statistically correct for all cases. A strong signal on the forward link is no guarantee that the mobile will be received at acceptable levels at the BS. Existence of interference on the reverse link (an event that MS has no knowledge of) only makes this problem worse. In fact one of the most challenging problems for optimization engineers is balancing of the forward and reverse channels during access and voice channel assignment.

In the same paragraph, the report also claims "*more accurately report the true location of the MS*". Their claim is not substantiated. In fact, the exact opposite might be true in many cases. The 911 call might be handled from a "non-preferred" more distant cell site that has a "stronger forward control channel signal" thereby reducing the precision for locating the caller. The report further claims minimizing the requirement for call back to a PSAP. We can not identify a logical argument based on which this conclusion was reached and again their claim is not substantiated.

3.2 October 18 1996 TROTT Cellular System Survey Results

In the Alliance response dated October 18, 1996, a series of signal strength measurements on the access channels of the A-band and B-band systems in two cellular markets (Atlanta and Dallas) are presented. The data appears to be signal levels measured at fixed locations. By analyzing the data that iis submitted in this report, we could only reach the following conclusions:

- In this limited test which we believe has no statistical significance due to its very small sample points, there are places within the surveyed A-band or B-band markets where signal levels on access channels are below acceptable thresholds. No indication was provided by this report on whether access to the network (i.e., making a successful call) was possible at locations where signal levels were recorded as insufficient. Also, given the nature of the fading in cellular environment, it is very likely that by moving the receiving antenna few inches, the signal levels could increase significantly to pass acceptable signal thresholds

- At some locations, the signal level of one carrier is stronger then the other carrier. . No indication was provided by this report on whether access to the network (i.e., making a successful call) was possible on a carrier with the weaker signal level. Also, given the nature of the fading in cellular environment, it very likely that by moving the receiving antenna few inches, the situation could be reversed (i.e., the stronger carrier becomes the weaker) and the difference between them change significantly as well. The point is that with such a small sample points and statistics, one can not draw such far reaching conclusions to say that " ***differential between systems in some markets averages 20 dB and in many locations this differential was measured as high as 50 dB***".

- Assuming that signal levels can be an indicator of access to the network (i.e., making a successful call), an assumption that the Alliance has consistently relied on, a phone that is programmed for preferred A/B or B/A would be able to access the system in all locations tested.

3.3 January, 27 1998 TROTT Report

The Alliance has consistently used the RSSI measurement (e.g., signal level) of the forward control channel as the measurement of reliable access. Since no other detail is provided in the report, one can assume that this was the criteria used by Alliance engineers in their testing. It is our belief that this method is not a reliable method to assess accessibility to any cellular network especially in case of an emergency. Cellular optimization engineers have been using many more sophisticated methods and equipment to make such assessments for many years.

Further on Page 3 under "A/B or B/A System Select Criteria", the report refers to additional tests performed to make the assessment that "total absence of the preferred signal was not an issue in the metropolitan areas tested". Once again, no additional details on how this assessment was made is presented.

On Page 4 under "Control Channel signal Strength. ...", the report makes the statement that "*the design of cellular systems mandates that control channel signal strength will be less than or equal to the associated voice channel signal strength from that cell site*". This statement suffers from a typical misrepresentation of equating coverage with signal strength. It is true that the design of cellular systems mandates that control channel

5

coverage will be less than or equal to the associated voice channel coverage from that cell site, but this is not correlated with signal level in all cases. In fact, the AMPS control channel can provide the same coverage as a voice channel using lower transmit power at the base station. This is the result of fundamental differences between control and voice channels in AMPS. The AMPS control channel is based on a different format with digital modulation and redundancy to make the control channel a more robust channel that can operate under either lower signal levels or more severe interference conditions.

On page 5, right before the section entitled "Customer Choice", the report mentions more tests that prove in rural areas, signal superiority of one carrier over the other is evenly distributed. We stipulate that this means there are as many areas where A is superior to B versus B superior to A. This is a critical statement, and eWS recommends that details on which such determination was made be shared with CTIA.

4.0 eWS Analysis of the "Strongest Signal" Proposal

Based on a technical and logistical analysis, and considering some of consequences of the "Strongest Signal" proposal by the Alliance, eWS has formulated the following important elements, in no particular order, that must be considered in evaluating the merit of this proposal.

4.1 Equating Signal Level with Coverage

We believe that the underlying assumption upon which the "Strongest Signal" proposal is constructed is not valid for many realistic cases. Strongest signal level on the forward link does not always ensure increased probability of access to the system and assignment of a voice channel. The particulars of the AMPS air interface, the randomness of cellular environment, its dependence on random events such as interference and resource availability of cellular networks are only a few factors that make equating signal level and coverage impossible. That is why almost all of the new generation digital technologies use other criteria such as Bit Error Rate (BER) and Frame Erasure Rate (FER) to characterize coverage and not signal strength.

The question then becomes: if the carriers were to rely on the "Strongest Signal" proposal, what portion of the users would benefit? This is a very complex question, and could only be answered by performing more sophisticated tests in representative markets to obtain statistically valid samples on how signal strength and access to the cellular networks correlate. The Trott Reports fail to address these very important issues.

4.2 Recognizing an Emergency Call

Based on the information obtained from the CTIA, there are some markets in the US where symbols other than 911 such as *77 (or #77 or *FHP or #HP etc.) must be dialed to

make an emergency call from a cellular phone. Depending on how many such emergency symbols exist, and their uniqueness, this ambiguity may create substantial issues for the subscriber unit manufacturers and carriers alike. In essence, any new phone equipped with "Strongest Signal" feature must also be able to recognize any of these patterns to perform its A and B band scans.

4.3 Network Diversity

As indicated in the report titled "Public Safety Response to the Trott Report" dated February 23, 1998 submitted by Donelan, Cleary, Wood and Maser, P.C., a "Strongest Signal" scheme for cellular 911 calls could potentially route many 911 calls on one carrier's network in the scenario where both carriers offer acceptable levels of service, but one carrier happens to have stronger signals on the ground. In this case, the subscriber does not gain anything by using the "hotter" carrier. At the same time, more stress is placed on the "hotter" carrier network, and the emergency resources (dedicated voice channels and 911 trunks) of the other carrier is underutilized. Such loss in network diversity at no gain will be tremendous and unwarranted.

4.4 Coverage Hole Argument

The TROTT report makes the claim that the "Strongest Signal" proposal allows the emergency calls to be handled by the non-preferred carrier where the preferred carrier has coverage holes, and that there are many markets such that a non-preferred carrier can fill in the coverage holes of the preferred carrier. eWS believes that claims with such far reaching consequences must be verified with extensive testing. Such tests must be comparing coverage in terms of access to the network and not signal strength. Until such data is available to prove otherwise, it is our contention that the occurrence of such cases does not constitute a majority.

In most metropolitan markets where competitive market forces dictate substantial coverage in the entire area, it is very rare to see large regions where only one carrier has dominant coverage. Most coverage holes exist as a result of the inability of both carriers to provide coverage caused by regional zoning restrictions (e.g., antenna sites). In more rural areas, finding coverage dominance is more likely, but still rare. Again, additional testing must be performed to quantify such statements. With the advent of PCS and creation of new local carriers concentrating on rural communities, cellular carriers have accelerated their efforts to provide coverage in rural areas, and such cases will even be more rare in the coming years.

4.5 Network Support

Although the TROTT report briefly explores the impact of the required changes to the MS to support "Strongest Signal" proposal, it hardly looks beyond the simple call processing to see the requirements on the network side to accommodate this scheme.

Consider the case where a cellular subscriber is to have access to its non-preferred carrier for an emergency call in the subscriber's home market.

Under the "strongest signal" proposal 50% of 9-1-1 calls will go to the non-preferred carrier and the non-preferred carrier at best can deliver the call to a designated PSAP. Without the proper subscriber validations and access to necessary records, many of the e-911 Phase 1 and Phase 2 mandated services may not be either properly or efficiently delivered by the serving carrier.

5.0 Recommendations on How to Proceed

As emphasized throughout this report, it is necessary to properly analyze the effectiveness of the "Strongest Signal" proposal. It is clear to us that the "Strongest Signal" proposal has a limited potential to provide emergency services to callers under very special circumstances. It is also clear to us that to warrant the implementation of some of the major changes needed to support this proposal on the network side (that will be consistent with the Phase 1 and Phase 2 requirements), it must be shown by use of statistically valid technical analysis and call access data that these special circumstances occur often. When these tests are performed, they must use successful access on a statistical sense as the measurement criteria, and not signal strength. The Trott Reports fail to substantiate any of their claims using statistically valid data or analysis. Therefore, this analysis needs to be done by Subject Matter Experts such as exist within the wireless industry and members of the Telecommunications Industry Association's TR45 Standards Committee.

END OF REPORT

TIA Committee TR45

Hyatt Regency
Oak Brook, IL
June 3-4, 1998

TITLE: **9-1-1 Call Completion**

SOURCE: **Cellular Telecommunication Industry Association (CTIA)**

DISTRIBUTION: ANSI Accredited Engineering Committee TR45 and appropriate sub-committees

CONTACT: Ed Hall, CTIA 202/736-3259
Ehall@ctia.org

ABSTRACT: This contribution contains a SRD seeking a possible improvement of call completion rate when attempting access to *9-1-1* when such a call is originated by a wireless user. The SRD is applicable to all air interface technologies currently employed by CMRS providers in the United States.

NOTICE: This contributor grants a free, irrevocable license to The Telecommunications Industry Association (TIA) to incorporate text contained in this contribution and any modification thereof in the creation of a TIA publication; to copyright in the name of TIA and any TIA publication even though it may include portions of this contribution; and at the sole discretion of TIA to permit others to reproduce in whole or in part the resulting TIA publication. This contribution has been prepared by the Cellular Telecommunications Industry Association (CTIA), as a basis for discussion to assist the TIA technical subcommittee. This document shall not be considered a binding proposal. Specifically, CTIA reserves the right to modify, amend, or withdraw this contribution.

Copyright: Permission is granted to TIA participants to copy any portion of this document for the legitimate purposes of TIA. Copying for monetary gain or other non-TIA related purposes is prohibited.