



CTIA

Building The Wireless Future
Cellular Telecommunications Industry Association

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August 5, 1998

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FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, DC 20541

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 (TTY Compatability)

Dear Ms. Salas:

On Tuesday, August 4, 1998, the Cellular Telecommunications Industry Association ("CTIA"), represented by Andrea Williams, Assistant General Counsel, met with Dale Hatfield, Chief, Bruce Franca, Deputy Chief, and Martin Liebman, Staff Engineer, of the Office of Engineering and Technology, regarding the above-referenced proceeding.

The parties discussed the Wireless TTY Forum, and Mr. Hatfield was asked to review and opine on the test results and findings of that forum. Additionally, copies of the Quarterly Status Reports from April 10, 1998 and July 10, 1998, which have already been filed in the docket, were left with the Commission staff in attendance.

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

Attachments (2)

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April 10, 1998

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Mr. Dan Phythyon
Chief, Wireless Telecommunications
Bureau
2025 M Street, N.W., 5th Floor
Washington, DC 20554

CTIA

Cellular
Telecommunications
Industry Association
1250 Connecticut
Avenue, N.W.
Suite 200
Washington, D.C. 20036
202-785-0081 Telephone
202-785-8203 Fax
202-736-3215 Direct Dial

Dear Mr. Phythyon:

Andrea D. Williams
Assistant General
Counsel

In accordance with the Commission's rules governing TTY/E9-1-1 compatibility requirements, CTIA is filing the attached Quarterly Status Report of the Wireless TTY Forum in CC Docket No. 94-10 on behalf of the Signatories of the TTY Consensus Agreement.¹ The Signatories of the TTY Consensus Agreement include the following organizations: Cellular Telecommunications Industry Association, Personal Communications Industry Association, National Association of the Deaf, Telecommunications for the Deaf, Inc., Gallaudet University, and Consumer Action Network.

If you should have any questions concerning this filing, please contact me at (202) 736-3215.

Sincerely,


Andrea D. Williams

¹ See In the Matter of Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems, CC Docket No. 94-102, Consensus of The Cellular Telecommunications Industry Association, Personal Communications Industry Association, National Association of the Deaf, Telecommunications for the Deaf, Inc., Gallaudet University, Consumer Action Network ("TTY Consensus Agreement"), filed November 20, 1997.



WIRELESS TTY FORUM

*Seeking Solutions to TTY Through Wireless
Digital Systems*

QUARTERLY STATUS REPORT

Submitted by:

**The Cellular Telecommunications Industry Association (CTIA)
Consumer Action Network (CAN)
Gallaudet University
National Association of the Deaf (NAD)
Personal Communications Industry Association (PCIA)
Telecommunications for the Deaf, Inc. (TDI)**

April 10, 1998

Introduction

The purpose of the TTY Forum is to seek and develop technical solutions to support TTY technology over digital wireless systems. The TTY Forum includes representatives from the four interest groups that have a significant stake in providing TTY users access to 9-1-1 over digital wireless systems: wireless telecommunications industry (wireless carriers and phone manufacturers), manufacturers of TTY equipment, emergency and relay service providers (9-1-1 and TRS), and consumer organizations that represent individuals who are deaf and hard of hearing ("Stakeholders"). The Stakeholders acknowledge that intensive collaborative efforts are necessary in order to support TTY signaling over digital wireless systems, and that carriers, equipment vendors (wireless phones and TTY equipment), emergency and relay service providers, and consumer organizations should participate in these collaborative efforts.¹ The TTY Forum strives for consensus among the Stakeholders regarding the most appropriate technical solutions for providing TTY access to 9-1-1 over digital wireless systems.

The TTY Forum commenced in September 1997 and has held subsequent meetings to continue its efforts to provide viable solutions for TTY access to 9-1-1 over digital wireless systems.² The Forum has reached consensus on several issues that will facilitate progress.³ While the Working Groups have provided several demonstrations, proposed test procedures and presented preliminary test results, much work remains to be done. In an effort to focus research efforts and resources to meet the Federal Communications Commission's ("FCC") October 1, 1998, compliance date, the Forum's immediate focus is to provide an acceptable short-term solution while work continues to develop long-term solutions for TTY users to access 9-1-1 over digital wireless systems. In an effort to assist wireless carriers with the FCC's notification requirements, the TTY Forum has developed notification text and strategy targeted at current and potential subscribers.

¹ The Consumer Organizations formally agreed to support the efforts of the TTY Forum by providing representatives with appropriate technical expertise to the Working Groups. The TTY Forum agreed to coordinate efforts with and receive technical input on user requirements from the Consumer Organizations to achieve TTY Access. See In the Matter of Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems, CC Docket No. 94-102, Consensus of The Cellular Telecommunications Industry Association, Personal Communications Industry Association, National Association of the Deaf, Telecommunications for the Deaf, Inc., Gallaudet University, Consumer Action Network ("TTY Consensus Agreement"), filed November 20, 1997.

² The TTY Forum Meetings were held on the following dates: September 17-19, 1997; December 11-12, 1997; February 11-12, 1998; and April 1-2, 1998. Subsequent meetings are scheduled for May 20-21, 1998, June 16, 1998 (Signatories, TTY Forum Steering Committee and Working Group Chairpersons), and July 21-22, 1998 (tentative) in Washington, DC. See Appendix F, attached hereto, for TTY Forum Reports.

³ See Appendix A, attached hereto.

This quarterly status report provides the FCC with information on the problems associated with TTY access to 9-1-1 over digital wireless systems, the TTY Forum's proposed technical solutions, steps taken to achieve proposed technical solutions, steps taken to notify current and potential subscribers, and a summary of the TTY Forum's forthcoming workplans. The quarterly status report includes several appendices that provide supporting data on the progress and efforts of the TTY Forum and its Working Groups.

I. Problems Associated With TTY Access to 9-1-1 Over Digital Wireless Systems

(A) Passing TTY signals through the voice channel (vocoder)

The TTY Forum has identified several technical challenges associated with providing reliable TTY access to 9-1-1 over digital wireless systems. Digital wireless systems use vocoders that represent a mathematical model of the human voice tract to efficiently reproduce the speech it produces. Signals or tones other than human speech such as ambient noise, progress tones, and music-on-hold can impact the quality and accuracy of the voice or data transmission. Since TTY signaling tones are not sounds typically produced by the human voice tract, some vocoders do not accurately reproduce such tones into coherent messages.⁴

(B) Technical difficulty of using Baudot due to obsolescence

With respect to connectivity and compatibility, the challenge is developing an interface between new digital wireless technology⁵ and older TTY technology, such as the 45.45 baud Baudot signaling, that will allow the Baudot tones to pass successfully over digital wireless systems. The Baudot signaling is an analog protocol that has virtually remained unchanged for over 30 years. The majority of TTY users, however, still rely on TTY machines equipped with 45.45 baud Baudot signaling as their primary mode of communication. Many technical experts at the TTY Forum consider the Baudot signaling obsolete — vulnerable to error, slow, and incompatible with today's advanced telecommunications technology. They would prefer to provide advanced telecommunications data services to people who currently use TTYs. Until TTY users transition from the embedded base of Baudot TTY machines to more current telecommunications data services, the TTY Forum will focus research efforts and resources on backward compatibility solutions, particularly if carriers are to meet the FCC's October 1, 1998, compliance date.

(C) Possible interference between TTYs and digital wireless phones

TTYs working with some digital wireless phones may experience interference. Problem has not been verified, and no findings have been presented during the TTY Forum.

(D) Connecting a TTY and a digital wireless phone

Digital wireless phones and TTYs do not have a common interface for coupling. Acoustic coupling by physically placing a digital wireless phone on a TTY's cups is not effective due to the size and shape of phones and ambient noise, *i.e.*, noise from the surrounding environment.

⁴ Baudot is a varying transmission. While a vocoder anticipates and predicts the next tones, Baudot signaling is not predictable. Running at full speed the character bits in Baudot can be dropped. Digital vocoders have different error corrections and prediction methods. Thus, the various types of digital vocoders should be tested to determine tolerable error rate.

⁵ For purposes of the TTY Forum, digital wireless technology includes CDMA 800 MHz, CDMA 1900 MHz, PCS 1900 (GSM), TDMA, and iDEN.

E) Developing user requirements

Another challenge is defining appropriate user requirements with respect to coupling, error rate, and portability. With respect to specifying a tolerable error rate, TTY manufacturers should provide the error rate experienced on wireline connections. Human error rate on the part of the TTY user and the 9-1-1 calltaker must also be factored into the equation along with the error rate via transmission over digital wireless systems.

II. Proposed Technical Solutions

The TTY Forum has reached consensus on the need for backward compatibility, and therefore has focused primarily on sending Baudot signals through the voice channel of digital wireless systems for TTY access to 9-1-1. This is not to preclude supporting other types of TTY protocols, but Baudot must be one of them. Possible solutions in support of this approach are referred to as short-term solutions.

The TTY Forum has also discussed the possibility of adding Baudot protocol into the modem pools of digital wireless networks, and bypassing the voice channel, *i.e.*, V.18 standard or equivalent. The user would not use a TTY, but a commercial device such as a personal digital assistant. This approach is referred to as a long-term solution.

A. Short-Term Solutions

(A) Passing TTY signals through the voice channel (vocoder)

While preliminary laboratory tests, demonstrations and informal tests have been provided to the TTY Forum, the extent of the problem has yet to be measured. Several Working Groups have not provided the necessary data in order for the TTY Forum to reach a consensus on appropriate solutions.⁶

(B) Technical difficulty of using Baudot due to obsolescence

The TTY Forum believes there are no short-term solutions to this issue, particularly in view of the October 1, 1998, compliance date. This problem will require long-term solutions, *i.e.*, after October 1, 1998.

(C) Possible interference between TTYs and digital wireless phones

While no findings have been presented during the TTY Forum concerning electromagnetic interference between TTYs and some digital wireless phones, there is an independent research center specifically dedicated to the investigation of issues related to electromagnetic compatibility of electronic equipment with wireless devices, *i.e.*, the Center for the Study of Wireless Electromagnetic Compatibility at the University of Oklahoma ("EMC Center"). The EMC Center already has a program in place whereby TTY and equipment manufacturers may submit their devices to the EMC Center for device interaction testing.

⁶ See infra p. 9.

(D) Connecting a TTY and a digital wireless phone

In order to pass Baudot signal through the voice channel, there must be a direct connection between the digital wireless phone and the TTY. Wireless telephones and TTYs, however, use different types of connectors. The 2.5mm audio jack provided on wireless phone handsets (or via a manufacturer-supplied adapter for hands-free operation) is a logical solution. However, TTYs do not have audio jacks and would need to be changed in design or retrofitted. Conversely, many TTYs have RJ-11 connections, but these are not included in digital wireless telephones. An adapter to interface these two types of connections would render the device less portable and would require a separate power source (battery).

Wireless equipment manufacturers need the cooperation of TTY manufacturers to provide input and output specifications for several types of TTY including other relevant information such as voltage, ring, *etc.*, in order to pass the audio directly to the TTY device. It appears that no technical standard exists to accommodate this coupling solution. Accordingly, the TTY Forum anticipates that this solution will require producing a Standards Requirement Document (SRD) for the 2.5mm jack and submission of the SRD to the appropriate standards-setting body. According to TTY Forum Members who have expertise in the standards-setting process, the TTY Forum can anticipate twelve to eighteen months for this process.

Another proposed solution involves having the user carry a wireline telephone handset, coupled to the digital wireless telephone. The user would then take this handset and place it on the cups of the TTY. It was noted that while this solution may be a "stop gap" measure for coupling, it may be cumbersome for the TTY user.

(E) Developing user requirements

The TTY Forum recommended that the Consumer Organizations provide a list of user requirements. The Consumer Organizations will draft a user requirements document for consideration by the TTY Forum. Discussion and research among the Consumer Organizations are taking place. The document will be an agenda item for discussion at the May 20-21, 1998 Forum Meeting.

(F) One phone model for each digital technology that CMRS provider offers

At the February 1998 Forum Meeting, the wireless industry asked whether the FCC and TTY Forum members, particularly the Consumer Organizations represented at the TTY Forum⁷, would accept as a short-term solution at least one phone model for each digital technology, *i.e.*, CDMA (800 MHz & 1900 MHz), TDMA, PCS-1900, and iDEN, in order to meet the FCC's October 1, 1998, compliance date. The TTY Forum deferred discussion of this issue until the April 1998 Forum Meeting in order to seek guidance from the FCC and to provide Consumer Organizations with an opportunity to discuss privately their position on this issue. In preparation of the April 1998 Forum Meeting, CTIA, on behalf of the TTY Forum, met with Dan Phythyon,

⁷ The following consumer advocacy groups are actively participating in the TTY Forum: Consumer Action Network, Gallaudet University, National Association of the Deaf, Telecommunications for the Deaf, Inc., Self Help for the Hard-of-Hearing ("Consumer Organizations").

Chief, Wireless Telecommunications Bureau, FCC, and his staff to discuss the progress of the TTY Forum Working Groups, and their need for FCC guidance on several issues.

Specifically, CTIA asked if the FCC would accept, as a short-term solution, CMRS carriers' ability to provide TTY users with one (or more) model of TTY-compatible digital wireless phones by October 1, 1998. Mr. Phythyon stated that in his view, carriers who can offer TTY users at least one digital phone model at a reasonable price by October 1, 1998, would be considered in compliance with the E9-1-1/TTY compatibility requirements. Mr. Phythyon also noted that manufacturers of CMRS equipment have their own obligation under Section 255 of the Communications Act with respect to the accessibility or compatibility of their products for TTY users.⁸ CTIA provided this information to the TTY Forum at its April 1998 Meeting in order to facilitate discussion on developing a consensus on this short-term solution.

CTIA clarified that the recommended short-term solution is that each CMRS provider would provide at least one compliant phone model for each digital technology that the service provider offers, *i.e.*, CDMA, TDMA, PCS-1900(GSM), and iDEN. The Consumer Organizations stated that the significant factor is that each service provider must support TTY on its selected digital technology. They stated that it is not acceptable to send a TTY user to another provider using that same technology.

During the discussion of the "one phone model" short-term solution, the Consumer Organizations requested clarification on several issues. They wanted to know what happens after October 1, 1998. Once the short term solution is in place, what time frames exist to ensure that long-term solutions are met? While CTIA and PCIA emphasized their commitment to working with the TTY Forum until the work is completed, the Consumer Organizations recommended that the TTY Forum seek a consensus on benchmarks. Such consensus should include a workplan and discussion with the FCC as to what can be accomplished within the specific time frames and benchmarks.

The Consumer Organizations also expressed their concern that the "one phone model" solution may require their constituents to purchase a phone with inadequate features and functionalities and that only the highest priced models would be made available. Several Forum Members suggested that the Consumer Organizations compile a list of the features and functionalities that the one phone model must have to meet their needs, *e.g.*, vibrator, portability, error rate, and provide that list to the TTY Forum. The Consumer Organizations also stated their concerns regarding the availability of the "one phone model" at the point of sale, *i.e.*, whether the TTY-compatible digital phone would be a "special" product that would take weeks to "special order." Several members of the TTY Forum clarified that a customer who wanted the TTY-

⁸ Mr. Phythyon also indicated that the quarterly status reports submitted to the FCC would be an appropriate mechanism to inform the FCC of the TTY Forum's activities and to seek FCC guidance on regulatory issues that may arise during future meetings. CTIA also asked that an FCC representative attend TTY Forum Meetings as an observer. See Ex Parte Letter from Andrea Williams, Assistant General Counsel, CTIA to Ms. Magalie Salas, Secretary, Federal Communications Commission, dated March 26, 1998, filed in CC Docket No. 94-102.

compatible digital phone model would be treated in the same manner as other customers. If the TTY-compatible digital phone model was out of stock, it would be ordered and delivered to the customer promptly just as any other out of stock phone model would be ordered and delivered promptly to a customer. The Consumer Organizations requested clarification on the connector between the phone and the TTY. For example, would the user obtain the connector from the wireless equipment manufacturer, the carrier, or the TTY manufacturer? Who would pay for the connector?

Several TTY Forum Members acknowledged that the test results and reports from the Working Groups were key to this discussion. The Consumer Organizations expressed their concern that it was futile to discuss this issue at the April 1998 Forum Meeting without information from the Working Groups. Accordingly, the TTY Forum agreed to table this discussion until the May 1998 Forum Meeting.

B. Long-term Solutions

The TTY Forum has identified several long-term solutions that provide for future advancements in technology by looking at solutions beyond 45.45 baud, Baudot signaling. One solution is to develop a method whereby the Baudot signal bypasses the vocoder. Another long-term solution is defining a new service whereby a deaf or hard of hearing person uses a Personal Digital Assistant (PDA) device with a digital interface to connect directly with the digital wireless phone. The TTY Forum also identified data services as a long-term solution.⁹ Although the Stakeholders have different interpretations as to whether the FCC E9-1-1 rules require VCO/HCO access to 9-1-1 over digital wireless systems, it is the consensus of the TTY Forum that Working Group #2 will examine VCO/HCO issues under long-term solutions.

III. Steps Taken To Achieve Proposed Technical Solutions

A. Working Groups Established

At the September 1997 Forum Meeting, the TTY Forum established three Working Groups to address short-term and long-term solutions for TTY access to 9-1-1 over digital wireless systems. The TTY Forum directed Working Group #1 to address the performance of TTY Signals over voice service and Working Group #2 to address the performance of TTY signals over data service ("long-term solutions"). The Forum also directed Working Group #3 to address coupling as a short-term solutions. The TTY Forum agreed on the scope of the work for each Working Group and anticipated that the Working Groups would work concurrently to develop appropriate test standards, conduct tests, evaluate test results, and specify requirements to achieve TTY access to 9-1-1 through digital voice services, data services, coupling and direct connection.¹⁰

⁹ With respect to data services, the TTY Forum envisions a solution that will provide two-way, real-time, open network data capability, *e.g.*, Internet chat room, rather than two-way, delayed text messaging, *e.g.*, electronic mail via Internet.

¹⁰ See Resolution Document from Wireless TTY Forum - 1 in Appendix D, attached hereto.

Based on the impending October 1, 1998, compliance date, the TTY Forum reorganized the efforts of the Working Groups. The TTY Forum agreed to combine Working Groups #1 and 3 and develop a new set of deliverables based on the FCC's October 1, 1998, compliance date. The Forum concluded that in order to meet the compliance date, Working Group #3 would focus on developing interface specifications for acoustic coupling and direct connection. Working Group #3 noted that digital technology currently exists that can operate a modem via an RJ-11 interface, but it is bulky and expensive. The trade-off is that it is readily available, off-the-shelf. A refined handset design, portability, and reasonable cost, however, will not be commercially available by October 1, 1998. Working Group #1 will use the interface specifications developed by Working Group #3 to pass the signal through the vocoder so that it interprets the Baudot tones as if they were voice tones. Working Group #1 will also evaluate the performance of TTY signals over voice sent via acoustic coupling (connection with 2.5mm jack and RJ-11 interface and handset directly placed on TTYs cups). The TTY Forum also redefined the scope of Working Group #2 to deliver a written report by October 1998 which outlines specifications for agreed upon long-term solutions. It was noted that Working Group #2 may have to provide a technical proposal in order to determine the workability of the long-term solutions

B. Short-term Solutions

Several wireless phone manufacturers indicate that they are in the process of testing the performance of TTY signals over voice services via acoustic coupling and direct connection. However, only one manufacturer to date has demonstrated and shared preliminary results with the TTY Forum on the technical feasibility of these short-term solutions.¹¹

The preliminary results from the demonstrations indicate that in a laboratory, TTY signals may be sent with relatively few errors over an analog wireless system and over a PCS 1900 (GSM) wireless system using acoustic coupling via placing the handset in the TTY cups or via a connection with a 2.5mm jack to a RJ-11 interface. The manufacturer noted that this potential short-term solution has its drawbacks. For example, the TTY device may need design modifications. Another coupler that provides an RJ-11 interface is commercially available but it requires an external power supply. The manufacturer also indicated that while this solution may be technically feasible, it may not support user portability requirements since the handset needs to be streamlined. While it appears technically feasible for the resistors and capacitors to be on the connecting cables, the connection is not simple. The manufacturer indicated that a "middleware" is needed rather than making changes to all existing TTY devices.

The manufacturer's initial findings suggest that standardization of the connection must be undertaken to allow for a variety of TTY devices to interconnect efficiently and effectively with

The Resolution Document describes the scope of the work and the charge to each Working Group.

¹¹ See Appendix B, attached hereto, for preliminary test results submitted by Ericsson. See also Appendix F, TTY Forum - 2 Report, 10-11.

a variety of digital wireless phones. Based on information provided by Gallaudet University's technical expert, such standards for digital cellular exist, *i.e.*, TR45.2.xxx and TIA Standard 688. Working Group #3 polled manufacturers, and they agreed that the 2.5mm jack and short cable could provide a retrofit to support TTY devices with wireless equipment. Based on the preliminary findings of Working Group #3 and the consensus of the TTY Forum, the Chairperson of Working Group #3 will circulate to the manufacturers a formal document with the proposed technical requirements for coupling devices. Manufacturers will have 30 days to provide feedback to Working Group #3.

Gallaudet University also has conducted informal field tests using a dual-mode CDMA phone (800 MHz) and shared its test results with the TTY Forum. Gallaudet's preliminary results demonstrated that the TTY calls sent using the analog mode of the dual-mode handset were relatively clear. However, when switched to the digital mode, the Baudot tones were garbled. According to Gallaudet's technical expert, results were much better for ASCII at 300 bps (Bell 103) digital transmission.¹²

The combined Working Group #1/#3 has developed an objective test procedure that is designed to evaluate the "throughput" error rate of 45.45 baud Baudot TTY devices over cellular telephone links ("Throughput Test"). The objective of the Throughput Test is to provide manufacturers with a standard test that will provide a reliable measure of error rate in transmission over an air interface. Character error is the dependent variable in this test. Manufacturers will use the real life test pattern provided to the TTY Forum as Contribution TTY/98.02.11.10 and add scenario-based modifications. The TTY Forum reached a consensus at the February 1998 Forum Meeting that phone manufacturers would use the Throughput Test to benchmark TTY signal performance over digital capabilities in order to determine the success rate for transport, and report test results at the April 1998 Forum Meeting.

At the April 1998 Forum Meeting, TTY Forum Members expressed their frustration and concern at the lack of progress and participation by the phone manufacturers in completing the throughput testing. Several TTY Forum Members expressed their dissatisfaction with the lack of progress on testing. They want to review test results in a timely manner so that wireless carriers can provide solutions for TTY users to access 9-1-1 on digital systems by the October 1, 1998, compliance date. The TTY Forum reached a consensus that phone manufacturers need to conduct the tests and report the test results by the next meeting scheduled for May 20-21, 1998. The TTY Forum agreed to send a letter from the TTY Forum with CTIA's and PCIA's endorsement urging strong support and effort from phone manufacturers to complete the testing by the next meeting. During the April 1998 Forum Meeting, the TTY Forum developed a Testing Matrix to facilitate manufacturers' completion of the tests and reporting test results in a timely manner.¹³ The TTY Forum agreed that the Testing Matrix should go to every wireless and wireline phone manufacturer listed at CTIA.

¹² See Appendix F, TTY Forum - 2 Report, 10-11. See also Appendix B, attached hereto, for preliminary test results submitted by Gallaudet University.

¹³ See Appendix C, attached hereto, Testing Matrix.

The TTY Forum formed another working group to develop a test to arrive at benchmarks for a maximum tolerable character error rate. The measurement will probably involve live conversations through a simulator that generates various character error rates. Emergency scenarios will be used for the conversations. The test will determine the error rate at which communication breaks down or requires otherwise unnecessary clarifications.

There was a consensus that field testing would be conducted by Gallaudet University to verify that laboratory throughput results bear a strong relationship to error rates in field conditions. For example, the throughput test uses TTY computer modems and not portable TTYs. The effect of using TTYs and working within a live system need to be examined. Gallaudet University has agreed to provide service to the TTY Forum in field testing, as its resources permit. The TTY Forum agreed that TTY and wireless equipment manufacturers will provide equipment support for the field testing, and carriers will support the phones used in the field testing.¹⁴

At the April 1998 Forum Meeting, Gallaudet University demonstrated the effects on live conversation of a 5% bit error rate within a TTY context: 20-character display, *etc.* Gallaudet also produced TTY conversations edited to introduce random character errors at 1%, 3%, and 5% error-rates. These scripts are being used by the Consumer Organizations as one piece of input to their consideration of maximum tolerable error rate and by other Forum participants to have a clearer understanding of the effect of various error rates. Gallaudet is working on refining instrumentation for purposes of data collection on live conversations with various character error rates introduced into the conversation.

C. Long-Term Solutions

Working Group #2 is investigating the technical feasibility of future technology such as Personal Digital Assistant devices to allow TTY users to take advantage of innovations in technology. Initial findings indicate that PDA devices can now do both voice and digital two-way text over wireless technology. It appears that this solution will require a simple, additional feature that will provide an automated formatting interface and allow two-way, real-time communications in Baudot. The PDA solution would not rely on modem pooling but would rely on a vigorous digital wireless infrastructure.

¹⁴ According to Gallaudet University, TTY and wireless equipment manufacturers will need to work together to provide the digital wireless phones and the TTYs so that they are coupled for the field testing. Gallaudet University also noted that in order for the field testing to be completed in a timely manner, service providers must be willing to support the digital wireless phones coupled with the TTY device on their respective systems during the field testing. While Gallaudet explained that it is willing to conduct the field tests, it has very limited funding and resources. Gallaudet specifically noted that it does not have funding to support service subscriptions for the field testing and asked the relevant service providers to consider this fact when providing service support to this field testing.

The TTY Forum directed Working Group #2 to begin work on a User Requirements Document with the caveat that they produce a more detailed description of their efforts by the April 1998 Forum Meeting. Working Group #2 needs more participation from TTY Forum members representing consumer organizations to assist in the development of the User Requirements Document. Working Group #2 Chairperson was unavailable for the April 1998 Meeting. Consequently, no status report was provided at the April 1998 Meeting. The Co-chairpersons of the TTY Forum will follow up with the chairperson of Working Group #2.

With respect to VCO/HCO issues, Gallaudet University and the TTY Forum Members representing the consumer advocacy groups agreed to provide consumer requirements for wireless 9-1-1 calling. The PSAP needs to know where the VCO/HCO caller is located and the type of emergency. The standard PSAP can do Baudot or voice, but not simultaneously.

At the April 1998 meeting, it was noted that Working Groups #2 will need to increase its efforts in order to meet the objectives of the TTY Forum. The following issues will need to be addressed:

- (1) What are the specific user issues that will arise with this approach? What are the user requirements?
- (2) What are the Stage 0 - building requirements?
- (3) What will be the digital protocol?
- (4) Can simultaneous or switchable voice and data be handled for VCO using this approach?
- (5) Can Working Group #2 produce for the TTY Forum a proof-of-concept prototype using V.18 or TTY-modems in digital wireless networks?

III. Steps Taken To Notify Current and Potential Subscribers

The TTY Forum has provided wireless carriers and the other Stakeholders with recommended text and notification strategy to assist carriers in notifying current and potential subscribers that they will not be able use TTYs to call 9-1-1 with digital wireless devices and services until October 1, 1998. With the increasing popularity of over-the-air activation and the use of indirect retail distributors to provide wireless services and equipment, several members of the TTY Forum expressed the need for multiple channels to distribute the message to subscribers. While the FCC has placed the obligation of notification upon the wireless carrier, many members of the TTY Forum acknowledged that cooperation among all the Stakeholders is necessary to reach the TTY user community. Each Stakeholder will assist wireless carriers in their notification efforts.

A. Notification Text

At the February 1998 Forum Meeting, the TTY Forum established an ad hoc working group, The Customer Awareness Team ("T-CAT"), to develop a recommended text that provides a clear, consistent and comprehensible message to subscribers concerning TTY access to 9-1-1 through analog and digital wireless systems. The text can be used in all communication pieces

regardless of the type of media.¹⁵

T-CAT included representatives of the wireless industry and Consumer Organizations. Upon the consensus of the TTY Forum, CTIA and PCIA immediately provided their members with the notification text via access to their respective websites, facsimile, and e-mail. While CTIA and PCIA encouraged their members to use the recommended notification text via multiple channels, wireless carriers will determine how to incorporate the recommended text in their notification efforts and the appropriate method of notifying their current and potential subscribers. The TTY Forum anticipates that as solutions become available, T-CAT will update the notification text and send it to the appropriate channels for distribution.

At the April 1998 TTY Forum Meeting, CTIA and PCIA indicated that they have received positive feedback from several members concerning the recommended text and appreciated the TTY Forum's timely response to their members' request.

B. Notification Strategy

At the February 1998 TTY Forum Meeting, the TTY Forum agreed to provide a notification strategy that includes all Stakeholders cooperating in the effort to provide the appropriate message to consumers. T-CAT believes that multiple channels of notification are imperative to reaching all current and potential subscribers. Attached as Appendix E is the recommended notification strategy that was sent to CTIA and PCIA members as well as to other members of the TTY Forum.

Several Stakeholders have started implementing a notification process based on the TTY Forum's recommended notification strategy. For example, AT&T Wireless will have the appropriate text printed on all bills sent to customers during the April billing cycle. BellSouth Mobility is sending the appropriate message in condensed form for inclusion in all subscriber bills. GTE Wireless has placed placards with the appropriate notification text in its retail sales offices in order to reach the largest number of potential subscribers as possible. In addition, CTIA and PCIA have received feedback from several carriers who plan to use billing inserts as the channel for notification. The target dates for these efforts coincide with the carrier's billing cycle for March or April 1998.

Many TTY Forum Members plan to use their Internet websites as a channel of notification. For example, UltraTec, the only TTY manufacturer that has consistently participated to date in the TTY Forum, provides a discussion of the TTY/E9-1-1 compatibility issues under the EasyLink page of its website, <http://www.ultratec.com>, to inform its customers, *i.e.*, TTY users. UltraTec also provides hyperlinks to Gallaudet University's website and CTIA's WOW-COM website for additional information. CTIA, Gallaudet University, and PCIA will also provide notification and information to current and potential subscribers at their respective websites.¹⁶

¹⁵ See Appendix E, attached hereto, for the Recommended Notification Text and Strategy.

¹⁶ Several carriers have indicated that they will post the notification at their website. For

Wireless carriers represented at the TTY Forum have also encouraged TTY manufacturers and wireless equipment manufacturers to provide the recommended notification text in or on the box of their products and in their operation manuals. However, TTY and wireless equipment manufacturers have not supported the use of the recommended text in this channel of notification.¹⁷ Further discussion with TTY and wireless equipment manufacturers is necessary to clarify their reluctance to support the recommended notification text in this channel of notification.

The TTY Forum anticipates an article in the next newsletter of the Maryland Relay Services containing the TTY Forum's recommended notification text. At the April 1998 TTY Forum Meeting, the TTY Forum agreed that CTIA and PCIA will send a letter to consumer organizations requesting their assistance in notifying their members. The letter will provide a copy of the recommended notification text and offer an electronic version from CTIA's and PCIA's respective websites. The letter will also provide a copy of an article written by Judy Harkins. CTIA and PCIA will meet with Judy Harkins to establish the appropriate terms and conditions to allow consumer organizations to reprint the article in their publications. CTIA and PCIA will suggest that consumer organizations provide their members with this information via e-mail, articles in their publications, websites, and facsimile. While CTIA and PCIA will encourage consumer organizations to use multiple channels of notification, consumer organizations will determine the most appropriate method of notifying their members. CTIA and PCIA anticipates that this letter will be sent before the TTY Forum reconvenes for its May 1998 meeting.

Recommendation 1: *The Signatories of the TTY Consensus Agreement recommend that the Steering Committee of the TTY Forum include an agenda item at the May 1998 TTY Forum Meeting concerning clarification of wireless equipment and TTY manufacturers' reluctance to support insertion of recommended notification text inside or outside the separate boxes containing digital wireless phone and TTY devices.*

Recommendation 2: *The Signatories of the TTY Consensus Agreement recommend that the TTY Forum encourage the FCC and the Architectural and Transportation Barriers Compliance Board to include the recommended notification text at their respective websites and provide hyperlinks to appropriate websites that provide information on this issue.*

V. FCC Guidance

At the April 1998 Forum Meeting, questions were raised concerning whether the FCC's E9-1-1/TTY compatibility requirements require a carrier to provide VCO/HCO access to 9-1-1 over digital wireless systems. It would be helpful if the FCC could provide guidance on this issue so that a determination can be made whether VCO/HCO access is a long-term or short-term

example, AT&T Wireless has already posted the notification on its website.

¹⁷ At the April 1998 Meeting, UltraTec provided a copy of the type of information they provide in the boxes of their EZcom Pro TTY device. See Appendix G, attached hereto, for brochure titled *Cellular TTY Calling*.

solution for TTY users to access 9-1-1 over digital wireless systems.

VI. Summary

The TTY Forum - 5 Meeting is scheduled for May 20-21, 1998 at Gallaudet University Kellogg Conference Center. The following is a summary of the TTY Forum's workplans until the next scheduled TTY Forum Meeting, *i.e.*, May 20-21, 1998.

- **Objective test (Throughput Test)** - Developed. Will be sent to manufacturers and carriers with a testing matrix to record testing completion dates and documentation.
- **Testing Matrix** - Developed. Will be sent to every wireless equipment manufacturer listed at CTIA as well as wireless and wireline carriers. All inclusive, not just those participating in the TTY Forum.
- **Subjective test (End User Test)** - Development to be finalized by next TTY Forum Meeting. Testing will be conducted by Gallaudet University. CTIA and PCIA will sponsor letter from TTY Forum requesting equipment support for Field Testing from wireless manufacturers and TTY manufacturers. Test will replicate authentic 9-1-1 calls between a deaf or hard of hearing caller and a trained 9-1-1 calltaker.
- **Letter to Manufacturers** - CTIA and PCIA will sponsor letter from TTY Forum to wireless equipment manufacturers concerning the lack of test results and inform them of the urgency and critical need to respond expeditiously to the Testing Matrix.
- **Analog Phones Compatible with TTY Devices** - CTIA External Relations Department (Eileen Duff) will coordinate the development of a list for inclusion in the notification efforts.
- **End User Requirements** - Gallaudet University and the other Consumer Organizations will draft end-user requirements for the Field Tests.
- **Coupling** - Doug Neeley will provide formal document that will include technical requirements for proposed coupling solutions. Document to be circulated to equipment manufacturers for comment within 30 days.
- **Standard Requirements Document** - Work will begin on producing Standards Requirements Documents for V.18 and the 2.5 mm jack.
- **Consensus Agreement** - Forum will work to develop a consensus on whether it is an acceptable short-term solution that by October 1, 1998, each CMRS provider would provide at least one compliant phone model for each digital technology that the CMRS provider offers, *i.e.*, CDMA, TDMA, PCS-1900(GSM), and iDEN. (Based on preliminary discussions with Consumer Organizations, acceptance of such solution may be contingent upon additional terms and conditions to be discussed at the May 1998 Forum Meeting.)

Appendix A

TTY Forum Agreements

APPENDIX A

AGREEMENTS REACHED AT TTY FORUM - 1

- "Solve for 45.45 Baudot, not to preclude looking for other solutions."
- Look for near term and long term solutions.
- Near term - send through vocoder
- Long term - circumvent vocoder, enhance quality and connectivity
- Provide for the analog function of wireless phones.
- The only body that can change the agreements reached is this body. All agreements remain intact until/unless action is taken in this forum.

AGREEMENTS REACHED AT TTY FORUM - 2

- Combine Working Group #1 and Working Group #3. Develop new set of deliverables based on the October 1, 1998, deadline.
- Short term solution: solve for backward compatibility.
- Develop Standard Test to measure error rate of TTY over digital.

AGREEMENTS REACHED AT TTY FORUM - 3

- Established six sponsored spots for identified consumer groups, relinquished (but subject to reinstatement by a consensus of the Forum) if member group misses two consecutive meetings.
- Accept modified "readability test" to be used by phone manufacturers to benchmark TTY over digital capabilities, to determine success rate for transport. (See Contribution TTY/98.02.11.06) Two tests: Manufacturers Readability Test, End User Test
- Error rate is defined as "character" not "bit" for the purpose of this forum. (Shift error rate of ratio 1/8 (*i.e.*, 1 shift error causes up to eight text errors and will be counted as such) to be determined)
- Develop User Requirements Document. The outcome of Working Group #2. Represents the effort to provide for future advancements in technology by looking at solutions beyond 45.45 baud, Baudot.
- Define process to update Customer Notification Document: refer updated information to CTIA to be distributed to The Consumer Awareness Team (T-CAT).

AGREEMENTS REACHED AT TTY FORUM - 4

- Coupling and Direction Connection
- CTIA and PCIA to sponsor letter from TTY Forum requesting manufacturers to cooperate more fully with the Forum's efforts to fulfill the FCC's TTY/E9-1-1 compatibility requirements.
- Develop SRD for 2.5 mm interface
- Consensus: Doug Neeley, Chairperson of Working Group #3, to provide manufacturers with a formal document of technical requirements for coupling solutions. Provide 30 days for feedback.
- Objective Tests

- **Throughput Test to be used as objective test for equipment manufacturers and carriers. TTY Forum to provide manufacturers with Test Matrix to complete tests and documentation. Results to be logged on Test Matrix.**
- **CTIA and PCIA to sponsor a letter from the TTY Forum to the wireless switch and equipment manufacturers requesting their vigorous support and participation to accomplish throughput testing and to record on Test Matrix. Copies to be sent to the FCC**
- **Subjective Tests**
- **Test to be determined. Gallaudet University to conduct user research to attempt to identify a benchmark for maximum tolerable error rate. Gallaudet to receive units for field testing; to verify that lab test results will hold up in the field; and to identify any remaining user issues that may have been missed through the TTY Forum dialogue. This will be done to the extent that Gallaudet's time and resources permit.**
- **CTIA and PCIA to sponsor a letter from the TTY Forum requesting phone manufacturers to provide handsets to Gallaudet University for the Field Tests with additional support from UltraTec and other TTY manufacturers.**
- **Consumer Requirements - consumer groups with Gallaudet using equipment supplied by Wireless and TTY Manufacturers to do end user testing**
- **List of Analog Phones Compatible with TTY and Consumer Requirements**
- **Eileen Duff, CTIA's Manager for External Relations to coordinate efforts to provide a list of analog phones that are TTY compatible.**
- **Develop SRD for V.18 standard.**
- **Explore testing to quantify and qualify, if any, electromagnetic interference between digital wireless phones and TTY devices.**

Appendix B

Documentation of Preliminary and Informal Tests Proposed Test Procedures for Throughput Test

E911, TDD Compatibility to GSM

1 Introduction

1.1 Scope

The FCC requires that the Telecommunication Devices for the Deaf (TDD) be supported for E911 in all wireless networks by October 1997 [1]. The coded character set used in TDD/TTY signals is identified as the International Telegraph Alphabet Number 2 (ITA No.2) or Baudot code (in U.S.).

GSM-North America (GSM-NA) would like to determine if a TDD/TTY has any inherent limitations when being used with a GSM based system in the North American market. Ericsson Inc. has performed investigation to determine these limits and based on the completion of internal test execution, this report documents the usability of TDD/TTY under various radio conditions and listed BSS features.

1.2 Terms and Concepts

Baudot code - a code character set in which five bits represent one character.

CCN - a Coaxial Cable Network is used to create various radio conditions in a controlled lab environment.

DTX - Discontinuous Transmission is a technique of saving MS battery by turning on/off the transmitter when no activity detected.

EFR - Enhanced Full Rate transcoders, note recommendation GSM 06.55.

FR - Full Rate transcoders, note recommendation GSM 06.10.

RXQuality - a measure of the Bit Error Rates (BER) on the air interface, (receive quality) in recommendation GSM 05.08.

RXQuality 0 = average BER 0.14%

RXQuality 1 = average BER 0.28%

RXQuality 2 = average BER 0.57%

RXQuality 3 = average BER 1.13%

RXQuality 4 = average BER 2.26%

RXQuality 5 = average BER 4.53%

RXQuality 6 = average BER 9.05%

RXQuality 7 = average BER 18.10%

TDD/TTY - communication devices used in the hard-of-hearing and deaf communities.

2 Configuration

2.1 Main cases tested

A pre-recorded "canned" test message consisting of 61 characters, "THE QUICK BROWN FOX JUMPED OVER THE LAZY DOGS BACK 1234567890" was sent and received by the TDD/TTY. Some test were repeated with the manual typed string, "QWERTY 123456". Both of these text strings are considered one sample and the tables below show the percent of errors.

These BSS conditions were tested:

Ericsson MS to Ultratec TDD/TTY with connector modifications
Full Rate (FR) and Enhanced Full Rate (EFR) transcoders
Various radio conditions (RXQuality)
Discontinuous Transmission (DTX)
Frequency Hopping
Handovers

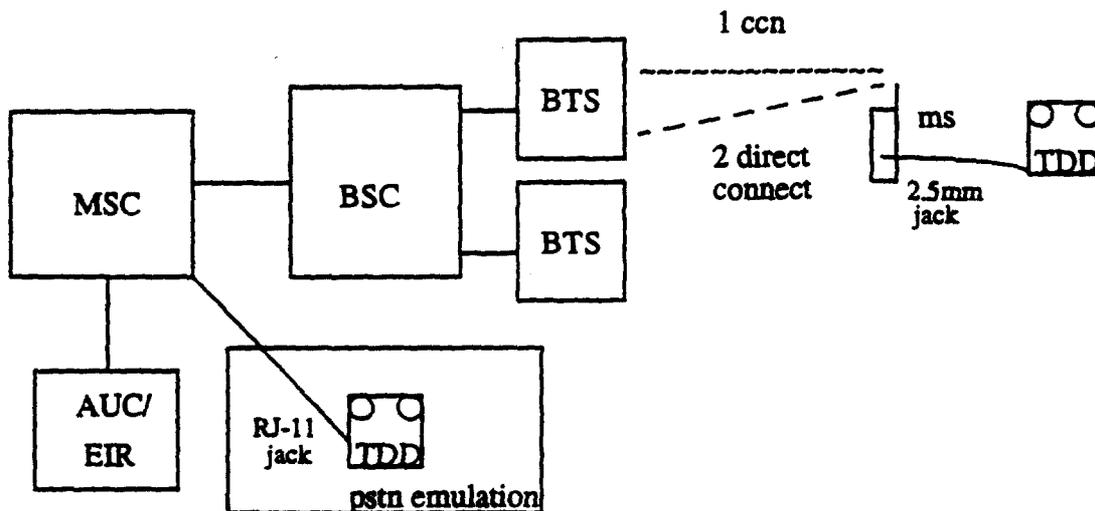
2.2 Test Environment

These tests were done with the ULTRATEC 4425 TDD with direct 2.5mm audio connection to the Ericsson CF388 via it's standard hands-free adaptor.

Ericsson's PCS-1900 system that was used is a full GSM lab system in Richardson Texas, which includes a MSC (with echo cancellers), AUC/EIR, BSC, BTS.

To simulate the various radio conditions on the air interface (RXQuality and Handovers) the MS was connect to the BTS via a Coaxial Cable Network (CCN), but in all other cases the MS was directly connected to the BTS (as figure 1 shows).

Figure 1: LAB NETWORK CONFIGURATION



3

Testing Results

Ericsson's testing results has shown that all BSS features (including FR and EFR) support the use of TDD in a typically engineered PCS-1900 system. FR and DTX affected the Baudot signal a little, but is still very usable.

The need for the space-bar to fix a missing "case-switch" is counted as one corrupted character. Note that this type of missing "case-switch" is also experienced in the TDD/TTY's original design domain (PSTN) and is attributed to the non robust protocol, Baudot. The use of the space-bar is the manufacturers recommendation to fix this problem in real time.

Test summaries are given in tables below.

3.1 EFR Transcoder devices

The following tests were executed with EFR transcoder devices

TABLE 1: Percent Error per sample

Transmit Direction	No. of samples	Total Errors	Percent Errors	RXQual	Ciphering	DTX	Freq Hop
MS-PSTN	20	31	2.46%	0 to 1	YES	NO	NO
PSTN-MS	40	10	0.41%	0 to 1	YES	NO	NO
MS-PSTN	20	2	0.16%	0 to 1	YES	NO	YES
PSTN-MS	25	5	0.33%	0 to 1	YES	NO	YES
MS-PSTN	18	31	2.78%	0 to 1	YES	YES	NO
PSTN-MS *	20	68	5.57%	0 to 1	YES	YES	NO
MS-PSTN	20	2	0.16%	0 to 1	YES	YES	YES
PSTN-MS	20	3	0.25%	0 to 1	YES	YES	YES
MS-PSTN	**	**	**	various	YES	YES	NO

The test case marked with an * may be corrupt data, because its outside of a standard deviation. Note standard deviation data below.

**More testing was done to vary the RXQuality (increase BER) and these test showed that the TDD/TTY was stable from RXQuality 0 to 4. The amount of character errors on the TDD/TTY did not show any significant increase until RXQuality = 5, then at this point it became unusable and in extreme BER cases the call was dropped.