02/01/2016: This document is not subject to further review or revision, but is available as a reference for MF signaling when needed to support other NENA documents.

NENA Standard for the Implementation of Enhanced MF Signaling, E9-1-1 Tandem to PSAP

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TABLE OF CONTENTS

1 Executive Overview

1.1 Purpose and Scope of Document

This NENA Standard defines the use of a Feature Group D like signaling protocol between the E9-1-1 selective routing tandem and E9-1-1 customer premises equipment (CPE) which is called "Enhanced MF Signaling". This document does not suggest the implementation of Feature Group D trunking - there are tariff issues associated with FGD that do not apply to 91-1. Rather, it recommends borrowing the "off the shelf" MF signaling protocol from Feature Group D in order to facilitate the delivery of one or two ten-digit ANI's to the PSAP over existing facilities, without creating an entirely new protocol.

1.2 Reason to Implement

The purpose of utilizing Enhanced MF Signaling is to facilitate the delivery of one or two ten-digit ANI transmissions to the PSAP. The protocol supports both.

1.3 Benefits

This document is a guide for designers and manufacturers of selective routing tandems and PSAP CPE. It may also be of value to purchasers, maintainers, and users of such equipment.

This document describes the use of Enhanced MF Signaling in place of the protocol described in Bellcore Technical Reference TR-TSY-000350. It does not recommend any changes to, or the replacement of, in-place multi-frequency (MF) signaling used between the E9-1-1 selective routing tandem and the E9-1-1 PSAP CPE, nor does this document recommend any other modifications to selective routing tandems or CPE, beyond those necessary to implement Enhanced MF Signaling.

The existing protocol, as described in Bellcore TR-TSY-000350, limits the PSAP to receiving 9-1-1 calls from callers in up to four area codes only. The implementation of Enhanced MF Signaling removes that limitation by delivering all ten digits of the caller's telephone number.

1.4 Operational Impacts Summary

Enhanced MF Signaling also provides for the delivery of two ten-digit numbers to the PSAP. This capability can be used to implement Phase 1 and Phase 2 of FCC Report and Order 96-264 (also commonly known as FCC Docket 94-102), the delivery of a wireless 9-1-1 caller's ten digit callback number plus a ten digit number that identifies the cell/sector through which the call originated.

1.5 Document Terminology

The terms "shall", "must" and "required" are used throughout this document to indicate required parameters and to differentiate from those parameters that are recommendations. Recommendations are identified by the words "desirable" or "preferably".

1.6 Reason for Issue

This document is reissued to correct a misstatement in the Operational Impact Summary and to make a few minor grammatical changes. The grammatical changes do not, in any way, change the meaning of the document content.

This document is also reissued to add Section 1.13, which explains that the deployment of Enhanced MF Signaling is not tied to any particular wireless 9-1-1 architecture. This interface supports all current wireless 9-1-1 implementations. It further explains that Enhanced MF Signaling is not limited to wireless. It can be used to support 10-digit wireline ANI delivery, or it can also carry 20 digits associated with wireline PBX or Voice over IP network calls.

1.7 Reason for Reissue

NENA reserves the right to modify this document. Upon revision, the reason(s) will be provided in the table below.

Version	Date	Reason For Changes
Original	06/15/2006	Initial Document
2	10/20/2006	Revision to update Sections 1.3, 1.7 and footer with Issue # and date of final approval.
3	01/17/2007	Correct misstatement in section 1.4, minor grammatical changes and update to current template formatting.

1.8 Date Compliance

All systems that are associated with the 9-1-1 process shall be designed and engineered to ensure that no detrimental, or other noticeable impact of any kind, will occur as a result of a date/time change up to 30 years subsequent to the manufacture of the system. This shall include embedded application, computer based or any other type application.

To ensure true compliance, the manufacturer shall upon request, provide verifiable test results to an industry acceptable test plan such as Telcordia GR-2945 or equivalent.

1.9 Anticipated Timeline

The Anticipated Timeline section does not apply to this issue of the Standard. Enhanced MF Signaling has been deployed for several years.

1.10 Costs Factors

There are no cost factors associated with this issue of the Standard.

1.11 Cost Recovery Considerations

There are no Cost Recovery Considerations associated with this issue of the Standard.

1.12 Acronyms/Abbreviations/Definitions

This is not a glossary! See NENA 00-001 - NENA Master Glossary of 9-1-1 Terminology located on the NENA web site for a complete listing of terms used in NENA documents.

The following Acronyms are used in this document:	
ALI	Automatic Location Identification
ANI	Automatic Number Identification
CBN	Callback Number
CPE	Customer Premises Equipment
ESCO	Emergency Services Central Office
KP	Key Pulse
MF	Multi-frequency
MPC	Mobile Positioning Center
ms	Milliseconds
MSC	Mobile Switching Center
NPA	Number Plan Area
NXX	Telephone exchange code
ST	Start
STP	Start Prime

1.13 Intellectual Property Rights Policy

1.13.1 General Policy Statement

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1.14 Application of Wireless ANI Terminology

This document uses the term “pseudo ANI” (pANI) to describe a ten-digit number used to identify the cell site and sector from which the call originated, or a specific call sent to a specific destination

PSAP. Depending upon the overall network implementation, a pANI may represent either Emergency Services Routing Digits (ESRD) or an Emergency Services Routing Key (ESRK). Enhanced MF Signaling supports the delivery of one or two ten-digit numbers, therefore it can be employed to support any Wireless 9-1-1 implementation, including but not limited to:

- Phase I CAS (Delivery of CBN and ESRD)
- Phase I NCAS (Delivery of ESRK)
    - Phase I NCAS, 20-digit variant (Delivery of CBN and ESRK)
- Phase II NCAS (Delivery of CBN and ESRD)
- Phase II Wireline Compatibility Mode (Delivery of ESRK)
    - Phase II Wireline Compatibility Mode, 20-digit variant (Delivery of CBN and ESRK)

In the future it is recognized that Enhanced MF Signaling could also support other situations, such as PBXs or Voice over IP networks that may use a ten-digit number to identify the location from which the call originated. The specific term attributed to such a number in that case is Emergency Location Identification Number (ELIN), but for the purposes of this document it too can be considered to be a pANI. It is presumed that such situations would mimic the wireless scenarios shown above, in that the PBX or VoIP network may send one or two 10 digit numbers into the local E9-1-1 network for delivery to the PSAP using Enhanced MF Signaling.

1.15 Wireless 9-1-1 Variation Terminology

If you send in voice path:	The J-STD-036 Term is:		It is Commonly Called:	
	Phase I	Phase II	Phase I	Phase II
ESRK	NCAS	WCM	NCAS	
ESRK and CBN			NCAS 20D	WCM 20D
ESRD and CBN	CAS	NCAS	CAS	Hybrid CAS

NCAS 20D – Non-Callpath Associated Signaling Mode, 20-Digit Variation
WCM – Wireline Compatibility Mode
WCM 20D – Wireline Compatibility Mode, 20-Digit Variation
"ESRK and CBN" is not defined in J-STD-036-A.

2 Technical Description

2.1 Call Progress Signals

2.1.1 E9-1-1 PSAP to Tandem with 10/20 Digit ANI via Enhanced MF Signaling

MF outpulsing is required to send ANI to the E9-1-1 PSAP. An idle 9-1-1 trunk to the PSAP is seized and an attempt is made to seize and connect an idle MF transmitter to the outgoing 9-1-1

trunk. When an MF transmitter is available, it is seized and connected to an E9-1-1 outgoing trunk to the PSAP. Standard, start-dial timing is done for receipt of the ANI start signal (approximately 250 +50 ms wink signal) from the PSAP CPE. There are several failure modes that can occur after the E9-1-1 tandem seizes a dedicated E9-1-1 outgoing trunk and connects an MF transmitter.

The normal sequence of events that occurs after a 9-1-1 trunk seizure is described below. Failure modes are discussed as they are applicable to a particular sequence.

(Sections 1-3 following are reprinted verbatim from NENA Standard NENA-04-001, Generic Standards for E9-1-1 PSAP Equipment, dated March 2001. Sections 4 and 5 have been taken from NENA-04-001 but modified to address the differences and requirements of the FGD type protocol.)

1. The E9-1-1 tandem office sends an off-hook signal to the PSAP indicating 9-1-1 trunk seizure.

2. The E9-1-1 tandem office waits 4 to 20 seconds for receipt of the ANI start pulsing wink signal from the PSAP. The normal call sequence continues if the PSAP returns the start pulsing wink signal. If the start pulsing wink signal is not received within 4 to 20 seconds, the E9-11 tandem office puts the trunk on the trunk maintenance list and makes one retry on a different E9-1-1 trunk to the PSAP. In this case, the trunk hunting and the connection phase begin again.

3. When the PSAP recognizes the E9-1-1 trunk seizure, it shall return an ANI start pulsing wink signal (250+50 ms Line Reversal) to the E9-1-1 tandem within 4 seconds. After sending the start pulsing wink signal, if the MF pulses are not received within 6 seconds (NOTE: This is increased from 4 seconds in the eight-digit protocol.), or garbled pulses are received, the PSAP completes the call as if an ANI failure has occurred. That is, the PSAP CPE shall immediately signal the attendant(s) and return audible ringing to the calling station via the E9-1-1 network. In this case, when the attendant answers, all zeros are displayed on the ANI display. Otherwise, receipt of the start pulsing wink signal typically causes the E91-1 tandem office to start MF outpulsing.

4. The MF outpulsing consists of a stream of MF tone pulses, 53 ms to 65 ms duration, separated by silent intervals of 55 ms to 65 ms. The ANI II and DN digits are preceded by a KP digit of 115 ms to 125 ms duration and followed by an STP digit of 55 to 65 ms duration when a single, ten digit ANI is transmitted, or an ST digit of 55 to 65 ms duration when two ten digit numbers are transmitted. (The KP, ST and STP digits are within the family of MF signals.) For transmission of a single, ten digit ANI, the E9-1-1 tandem begins MF outpulsing the ANI information to the PSAP in the form KP II NPA NXX YYYY STP. For transmission of two, ten digit numbers, MF outpulsing begins in the form KP II NPA NXX YYYY (calling party's number) ST KP NPA NXX YYYY (dialed number or pseudo ANI) ST.

The "II" represents encoded information indicating whether the calling line display device (ANI display) should remain steady or flash, or if the call is a test call. II digits will be used as follows:

II Digit	Meaning
40	Steady ANI display
44	Flashing ANI display
48	Test call

ANI Failures

If a valid ANI is not available at the E9-1-1 tandem office, a fictitious NPA-NXX-YYYY ANI is sent to the PSAP as either 000-911-0000 or 000-911-0TTT. The digits TTT indicate the E91-1 tandem switch Central Office number (also known as ESCO code) associated with the originating office.

000-911-0TTT may be sent due to ANI failures, multi-party or QZ billing lines, and possibly a 9-1-1 call received via a message trunk.

Where trunks that deliver two telephone numbers (calling party's number and pseudo ANI) are implemented between the Mobile Switching Office (MSC) and the 9-1-1 tandem office, it is conceivable that an ANI failure may occur in the transmission of either or both numbers. In that event, the failure(s) shall be indicated to the PSAP as follows:

If the pseudo ANI fails, but the CPN is received intact, the tandem will transmit the CPN as normal and substitute 000-911-0TTT for the pseudo ANI, where 0TTT represents the ESCO code for the MSC from which the call originated.

If the pseudo ANI is received intact, but the CPN fails, the tandem will transmit the pseudo ANI as received and substitute 000-911-0TTT for the CPN, where OTTT represents the ESCO code for the MSC from which the call originated.

If both numbers fail, the tandem will transmit 000-911-0TTT in both the CPN and pseudo ANI fields.

If, for some reason, only one ANI is transmitted by the MSC and it fails, the tandem should transmit a dual ANI failure to the PSAP (as described above), if possible. If that is not possible, 000-911-0TTT shall be transmitted to the PSAP.

Implementation Options:

1. If the originating end office serves a single NPA, it may be possible to send NPA-9110TTT.

2. The 9-1-1 Service Provider may chose, or be forced, to expand ESCO codes from three to four digits. In that case, ANI transmission for an ANI failure may be sent as 000-911TTTT or NPA-911-TTTT.

000-911-0000 is sent when an anonymous call is made to a PSAP. An anonymous call is a 7 or 10-digit call (non 9-1-1) to the DN of the PSAP (where applicable).

Note: If an ANI failure occurs between the E9-1-1 tandem office and the PSAP, the digits that may be displayed are 000-000-0000.

5. Upon receipt of the complete ANI information, the PSAP shall signal the attendant(s) and return audible ringing to the calling party. When the call is answered, the PSAP shall disconnect audible ringing, connect the call to the answering attendant, display the calling party's number on the ANI display, and return an off-hook signal to the E9-1-1 tandem office, indicating that the call has been answered.

If a single, ten digit ANI has been delivered with the call, the E9-1-1 PSAP CPE will display the number on the ANI display and use that number to query the ALI database.

In Phase 1 wireless implementations, when two, ten digit numbers have been delivered, the PSAP CPE will display the calling party's number on the ANI display, but use the pseudo ANI to query the ALI database.

In Phase 2 wireless implementations, the calling party's number may be used to query the ALI database, depending upon the configuration of the Mobile Position Center (MPC) interface. In this instance, the pseudo ANI would only be used to query the ALI database in the event the calling party's number was garbled or not received.

Calls originated from non-service-initialized wireless telephones may not have a calling party number to display. It is also conceivable that multiple calls from non-service-initialized wireless telephones could be received at the PSAP simultaneously. In this event, a "surrogate CBN" may be assigned by the MSC.

J-STD-036-A, Annex-C prescribes that calls originated from non-service-initialized mobile telephones may be sent with a CBN of 911-XXX-XXXX, where XXX-XXXX is based upon the unit's Electronic Serial Number (ESN), or International Mobile Equipment Identity (IMEI) number. This 911-XXX-XXXX number cannot be used for callback purposes, but will identify any and all calls made by that mobile unit. Due to its inherent syntax it will serve as an immediate visual indicator to the calltaker that the number cannot be called back. Also inherent in the syntax is that, in most cases, it should equate to a uniquely identifiable number that may assist in resolving prank or annoying calls to the PSAP.

6. After the answer is detected, the E9-1-1 tandem office supervises the call for disconnect and a PSAP transfer request.

2.2 Trunk Maintenance Test Calls

For a PSAP equipped with CPE for ANI display, test calls can be made from the E9-1-1 tandem office using encoded ANI. The PSAP CPE should decode the special ANI as a test call and connect the trunk under test to a test termination facility in the PSAP CPE. Specifically, when KP 48 STP is outpulsed to the PSAP, the E9-1-1 trunk under test should be connected to a permanent busy circuit without answer supervision (no battery reversal) in the PSAP CPE. This allows the E9-1-1 tandem office to verify the integrity of the circuit using the trunk diagnostic program. The test call sequence is listed in the following three steps:

1. After seizing the selected idle trunk and receiving the wink start signal prior to time-out, the E9-1-1 tandem office outpulses KP 48 STP to the PSAP.

2. The PSAP should interpret the digits 4 and 8 as a maintenance test call and connect the incoming E9-1-1 trunk to a permanent busy tone (continuous 60-ipm, tone) without answer supervision (normal battery polarity). The tone should be returned to the E9-1-1 tandem office within 20 seconds after receipt of the wink start pulse, otherwise, the E9-1-1 tandem office would consider the trunk test a failure.

3. Approximately 5 seconds after receiving the 60-ipm tone, the E9-1-1 tandem office disconnects and idles the trunk under test. It is not necessary for the PSAP to do any timing for a maintenance call, but merely react to the seizure and disconnect from the E9-1-1 tandem office.

2.3 Database Query Protocol

2.3.1 Change to Query Protocol

The change to the ANI delivery protocol will necessitate a corresponding change in the ALI database query protocol. In short, the NPD digit will be replaced by the three-digit NPA. No other modifications are envisioned at this time.

The resulting protocol will be as follows:

Query:

Old protocol: NPD-NXX-YYYY-POS-TRNK-CHECK-CARRIAGE RETURN
New Protocol: NPA-NXX-YYYY-POS-TRNK-CHECK-CARRIAGE RETURN

No modifications are required for ACK's, NAK's, heartbeats or ALI text messages sent from the ALI/DMS to the PSAP.

3 Technical References

Document Number	Description	Issue date
TR-TSY-000350	Telcordia. E9-1-1 Public Safety Answering Point: Interface Between a 1/1AESS Switch and Customer Premise Equipment	Issue 1. 1987
GR-2953-CORE	Telcordia. Enhanced MF Signaling: E9-1-1 Tandem to PSAP Interface (Intended to be used in conjunction with TR-TSY-000350)	Issue 1. March 1997
NENA-04-001 (2001)	NENA Generic Standards for E9-1-1 PSAP	Issue 2.
N/A	E9-1-1 ALI Multiplexer System (ALI/DMS) PSAP -Node Interface Specification (AT&T)	1988
J-Standard 036-A	TIA/ATIS Committee TR 45.2. Enhanced Wireless E9-1-1	June 2002