Femtocell and UMA TID

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TECHNICAL INFORMATION DOCUMENT

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Acknowledgments:

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1. Executive Overview

1.1. **Purpose and Scope of Document**

The purpose of this "Femtocel/UMA Technical Information Document" is to describe in technical as well as operational terms the current state of femtocell and UMA deployments with respect to call processing of E9-1-1 calls, and to identify the impacts to Public Safety Answering Points (PSAPs) of receiving and processing calls from femtocells. This TID also describes the current 9-1-1 infrastructure, next generation emergency networks, and discusses integration of femtocells and UMA technologies into those networks. This TID will provide information to allow the National Emergency Number Association (NENA) and other interested parties to develop new communications methodologies, standards, and protocols to facilitate emergency communications between users of femtocells/UMA and PSAPs.

This document also addresses situations in which a femtocell/UMA device offers POTS type service as an additional a feature, since this information is also relevant to public safety agency handling of calls from these devices.

Implementation-specific details pertaining to current deployments have been included in this TID to convey the current state of affairs. Inclusion of this detail does not imply that the deployment is correct and acceptable to PSAPs. The working group expects that information contained within this document may be used to generate future recommendations or standards.

1.2. **Femtocell and UMA**

By definition, a femtocell is a cell that operates in the geographic area of a carrier's licensed footprint. Femtocells communicate with mobile devices using the carrier's licensed spectrum of the carrier's network and interconnect to the carrier's' network using a broadband connection. Depending upon the carriers' product specification, a femtocell may accept new call originations, process hand-offs between the femtocell and to the macro network, and process hand-offs between the macro network and the femtocell. A femtocell typically extends cellular communications service by providing base station capability in a small unit located at the customer's home or small business premises, providing enhanced mobile coverage. In addition, depending upon the carriers' architecture and product specification, the femtocell may provide an interface for landline wired phones, facilitate E9-1-1call completion, and may provide service for NSI (non service initialized phones, and allow both registered users of the associated service and / or registered users of the femtocell access to the wireless network). Depending upon the carrier's architecture, calls may be delivered to the E911 service provider's selective router over the same trunks as the macro network, or possibly over different trunks.

A UMA (Universal Mobile Access) base station is stand-alone unit that acts as a WiFi "hot-spot" and is typically deployed in a building such as a home or small business.

Both types of devices connect to the carrier's mobile network through a customer-supplied broadband connection.

Since a femtocell uses a carrier's licensed frequencies, it allows the customer to use existing handsets to take advantage of the service. Thus, femtocells are usually backwards-compatible with deployed handsets, although they may also offer enhanced functionality to newer handsets.

To use the a UMA base station, a customer needs a handset that can operate both on a cellular network and over WiFI, providing voice calls in the VoIP mode as well as over traditional cellular. However, UMA handsets may often also be able to operate outside the customer's premise, by accessing WiFI "hotspots" in other locations.

Today, processing of E9-1-1 calls from femtocells and UMA devices presents challenges to both PSAPs and to carriers. PSAPs and carriers want to provide the PSAP with enough detail so they can process the call and dispatch in a timely and accurate manner. Due to the lack of defined standards for femtocell deployment relative to E9-1-1, each carrier may populate ALI data fields differently when an emergency call originates on a femtocell. This TID was prepared to reduce any cause confusion at the PSAP which could impact emergency response time.

2. Introduction

2.1. **Operational Impacts Summary**

How a carrier implements their architecture to support femtocells will determine how the PSAP recognizes and processes E9-1-1 calls.

This document compares differences among the various solutions that have been deployed or which carriers expect to be deployed.

2.2. **Security Impacts Summary**

No security risks have been identified.

2.3. **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".

2.4. **Reason for Issue/Reissue**

This is the initial issue of this document. It is intended to provide public safety with information on how femtocells and UMA Access Points will service emergency calls to 9-1-1, and what ALI information will be available for these calls.

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	Xx/xx/xxxx	Initial Document Submitted to NTC for review and approval.

2.5. **Recommendation for Additional Development Work**

None identified.

2.6. **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.

2.7. **Anticipated Timeline**

Application of the recommendation in this TID would follow current business practices.

2.8. **Costs Factors**

The working group did not consider any costs associated with this analysis.

2.9. **Future Path Plan Criteria for Technical Evolution**

In present and future applications of all technologies used for 9-1-1 call and data delivery, it is a requirement to maintain the same level or improve on the reliability and service characteristics inherent in present 9-1-1 system design.

New methods or solutions for current and future service needs and options should meet the criteria below. This inherently requires knowledge of current 9-1-1 system design factors and concepts, in order to evaluate new proposed methods or solutions against the Path Plan criteria.

Criteria to meet the Definition/Requirement:

1. Reliability/dependability as governed by NENA's technical standards and other generally accepted base characteristics of E9-1-1 service

2. Service parity for all potential 9-1-1 callers

3. Least complicated system design that results in fewest components to achieve needs (simplicity, maintainable)

4. Maximum probabilities for call and data delivery with least cost approach

5. Documented procedures, practices, and processes to ensure adequate implementation and ongoing maintenance for 9-1-1 systems

This basic technical policy is a guideline to focus technical development work on maintaining fundamental characteristics of E9-1-1 service by anyone providing equipment, software, or services.

2.10. Cost Recovery Considerations

Normal business practices shall be assumed to be the cost recovery mechanism.

Additional Impacts (non cost related)
The information or requirements contained in this NENA document are not expected to have significant technical or operational impacts, based on the analysis of the authoring group.

2.11. Intellectual Property Rights Policy

NENA takes no position regarding the validity or scope of any Intellectual Property Rights or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; nor does it represent that it has made any independent effort to identify any such rights.

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2.12. **Acronyms/Abbreviations/Definitions**

This is not a glossary! See 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:		
Acronym	***Description***	***** (N)ew (U)pdate***
ALI	Automatic Location Identification	
ANI	Automatic Number Identification	
ATM	Asynchronous Transfer Mode	
ATIS	Alliance for Telecommunications Industry Solutions	
CAMA	Centralized Automatic Message Accounting	
CAS	Call path Associated Signaling	
CBN	Call Back Number	
CdPN	Called Party Number	
CGL	Calling Geodetic Location parameter	
CHGN	Charge Number parameter	
COS	Class of Service	
CpCAT	Calling party CATegory	
CPE	Customer Premises Equipment	
CPN	Calling Party Number parameter	
E9-1-1	Enhanced 9-1-1	
ESN	Emergency Service Number	
ESP	Emergency Service Protocol	
ESRN	Emergency Service Routing Number	
ESQK	Emergency Service Query Key	
ESGW	Emergency Services Gateway	
FCC	Federal Communications Commission	

The following Acronyms are used in this document:		
Femtocell		
FG-D	Feature Group D	
GDP	Generic Digit Parameter	
IAM	Initial Address Message	
ISDN	Integrated Services Digital Network	
ISUP	ISDN User Part	
LEC	Local Exchange Carrier	
MF	Multi-Frequency	
MSC	Mobile Switching Center	
MTP	Message Transfer Part	
NCAS	Non-Callpath Associated Signaling	
NPA	Numbering Plan Area	
NSI	Non-Service Initiated - A NSI handset is a handset that is not registered with a carriers' network. Under FCC rules, carriers are obligated to allow emergency calls from NSI handsets on any network with a compatible air interface.	
OLI	Originating Line Identification parameter	
PAM	PSAP to ALI Message specification	
PSAP	Public Safety Answering Point	
PSTN	Public Switched Telephone Network	
RNA	Routing Number Authority	
SIF	Signaling Information Field	
SIO	Service Information Octet	
SS7	Signaling System Number 7	
TIA	Telecommunications Industry Association	
TID	Technical Information Document	
UMA	Unlicensed Mobile Access (Point)	
VSP	VoIP Service Provider	

****** Required entry of New or Update. Any change made to an existing Acronym, Abbreviation or Definition constitutes an Update.

3. Technical Description

3.1. **UMA / Femtocell Similarities and Differences**

This TID includes information obtained from the four largest nationwide (Tier I) wireless carriers. It was based on a series of questions submitted by public safety regarding the nature of the information which would be displayed on a PSAP ALI screen during calls originated over a Femtocell of a UMA Access Point. Some of these questions appear as the headers for individual sections of this document. Primary emphasis was on noting similarities and differences between these calls and those originating on the macro wireless network.

One carrier surveyed is providing service over UMA Access Points, and three others are deploying Femtocells. While all four carriers participated in the preparation of this document, the description of UMA service includes additional information from public documents.

Please note that in addition to the discussion by topic in the body of the TID, Appendix A contains a matrix which provides a " quick reference " of the responses.

BACKGROUND

UMA uses 802.11 (unlicensed) frequencies to communicate to the UMA base station. In UMA access, the handset may use any 802.11 access point that is in proximity and is accessible. This may be a router in the home which is connected to a broadband connection or a WiFi "hot spot." In the UMA system, handsets are configured to place emergency calls over the macrocell, and to use the UMA AP (VoIP) as a last resort if the macrocell network is not available. Customers of this system must obtain from the carrier a dual mode handset that can operate on cellular and unlicensed frequencies.

Femtocells share frequencies that are licensed to the carrier by the FCC. The Femtocell connects to the carrier network, typically using a customer provided broadband connection, and must be used within the carriers' licensed geographic area. In these cases, there may or may not be a macro-cell in close proximity to the femtocell. Customers of these systems use the same handset on the Femtocell that they use on the carriers' macro networks.

3.2. **Information sent in ALI record from Carriers using UMA / Femtocell.**

3.2.1 Class of Service

Today there are no unique classes of service assigned for calls originating on Femtocells or UMA APs.

3.2.2 Company ID

At least one carrier is displaying a different NENA Company ID for femtocell originated calls. Other carriers deploying Femtocells and UMA Access Points are using the same Company ID that is used for wireless calls on their macro networks.

3.2.3 Address Field Information

The carrier deploying UMA Access Points attempts to direct the handset in all cases to the macro network for an emergency call. Address information would be the same as for a Phase I or Phase II call on the macro network. This carrier says that over 99.5% of all 9-1-1 calls end up being processed on the macro network.

Carriers deploying Femtocells are using two different addressing plans: Two carriers are providing the cell and sector information for the nearest macro cell site. One of those carriers creates a virtual cell in areas where there is no overlying cellular coverage. In either case, the ALI display for the site will be the same as that provided for a macro cellular call.

The third carrier using Femtocells requires the customer to enter the address of the femtocell, and this address is MSAG validated. It is the MSAG validated address of the femtocell that appears in the ALI record. If a customer entered address cannot be immediately validated, the customer entered address temporarily populates the ALI record, until the MSAG validation is completed.

3.2.4 Latitude and Longitude

In a PhaseII environment, all carriers surveyed send the geographic coordinates of the femtocell receiver as the location estimate when the call is originated via the femtocell. The geographic coordinates of the Femtocells are measured by an internal GPS unit at the time of setup. Therefore, it may not be necessary for a PSAP operator to rebid to receive coordinate data, as it will probably be available at the time of call setup and routing.

As noted in 3.2.3, the carrier providing UMA Access Points directs an emergency call whenever possible to the macro network, and the PSAP experience will be the same as for any wireless Phase 2 call, including the need to rebid.

All carriers confirmed that in the above scenarios, the class of service of WPH2 is provided when the latitude and longitude are sent.

3.2.5 Customer Name

All carriers surveyed indicate they will provide a different carrier name in the customer name field, to indicate that the call was placed from a femtocell or UMA Access Point. This name incorporates the carrier name and some indicator that a Femtocell or UMA Access Point handled the call. Some carriers are accomplishing this with pANI ranges unique to Femtocell or UMA Access Points. As noted above in 3.2.2, one carrier also provides a different Company ID for this purpose.

3.2.6 pANIs (ESRK / ESQK)

Most, but not all, carriers surveyed are utilizing unique pANI ranges to indicate that the call originated on the femtocell. Unique pANIs can enable an ALI record to contain unique company names and/or unique Company IDs.

3.3. **Class of Service and Location within Macro Network**

Upon initialization, femtocells from two carriers obtain their location using a GPS receiver. When communicating to a Phase 2 PSAP, these carriers send the latitude and longitude of the femtocell, and the address information indicates the closest macro cell. When the latitude and longitude is that of the femtocell, the class of services is WPH2.

One carrier deploying Femtocells obtains the Femtocell's geographic coordinates, but sends the MSAG validated address of the femtocell as the address information. This carrier also sends the latitude and longitude of the Femtocell, with a Class of Service of WPH2.

The carrier using UMA Access Points directs the 9-1-1 call to the macro network whenever possible. Therefore, it is processed like a standard E9-1-1 call from their macro network, with the appropriate wireless Class of Service indicators.

If this cannot be accomplished, the call will be routed in the manner of a VoIP call with a customer entered address. If that option is not available, the call goes to a dedicated response center for forwarding to the appropriate PSAP.
The carrier states that failure of the call to route over the macro cellular network only occurs on less than one half of one percent of all 9-1-1 calls. As a future enhancement, this carrier stated it is seeking arrangements to MSAG validate customer entered addresses.

3.4. **Class of Service and Location – Outside Macro Network**

Carriers do not offer a femtocell product in areas where they do not have a macro license to operate. If they do have a license, but there is not a macrocell in the area, one carrier creates a virtual cell and populates the address field with this information. The latitude and longitude of the Femtocell are provided.

Since a UMA Access Point does not require licensed spectrum, there is no restriction that prohibits carriers from implementing an access point in an area where they are not licensed. The address of the UMA access point will be sent to the PSAP with the class of service of WPH2. This may be a customer's premises or a WiFI "hot spot."

3.5. **Femtocell versus Handset Location**

Unless the E9-1-1 call is on the macro network (or forced onto the macro network), all carriers employing femtocells provide the latitude and longitude of the femtocell. The latitude and longitude of the fermtocell is obtained at femtocell initialization using its own GPS receiver.

Customer provided location varies between each carriers' implementation. One carrier uses the address of the closest macro cell (if the femtocell is in the carrier's service footprint, and if a macro

cell overlays the Femtocell). Another carrier may use the address of a virtual cell that is configured by the carrier to be in close proximity to the Femtocell, in cases where the carrier is licensed but there is no macro cellular coverage. And one carrier sends the customer provided MSAG validated address of the service location of the femtocell.

3.6. **Address questions**

The "format" of the address field in the ALI record is consistent with the requirements of the PSAP. During Phase I and Phase II deployment, PSAPs usually specify the address and format to be used for a macro cellular site. Carriers that provide this in the address portion of the ALI record use this format. The carrier using the MSAG validated address of the femtocell is providing the address in the format consistent with the MSAG.

Carriers that are using either a macrocell or the address of a virtual cell intend to deliver the address in the format that is accepted by the local PSAP. In cases where the carrier is providing the femtocell address, it is entered by the customer during provisioning and MSAG validated by the carrier.

If a PSAP observes a discrepancy in an address, the address is modified by the carrier.

While carriers are using a variation of their company name to uniquely identify calls from Femtocells or UMA Access Points, there is no current method to differentiate between the address of a macro cellular site used in the ALI record by two carriers, and the femtocell address provided by the third Femtocell carrier. However, since the Femtocell is uniquely identified, PSAPs can be certain that the geographic Phase 2 coordinates being provided are for the femtocell's location, even though the address may not be.

3.7. **Rebidding / Address and Location**

If the call was received with a Class of Service of WPH2, the PSAP is viewing the GPS determined latitude and longitude of the Femtocell. A rebid will make no change in this information, unless the handset has moved out of the Femtocell coverage area and onto the macro cellular network. In that case, a rebid will provide the handset's estimated location, as determined by the network's Phase II solution.

3.8. **Routing of Calls**

One carrier uses the MSAG validated address of the femtocell, and determines call routing by overlaying the geocoded coordinates of this address on a shape file of the jurisdictional boundary. Carriers which display the macro cell site (or virtual site) address in the ALI record will use call routing consistent with that of the macro cell.

3.9. **Service Restrictions and Non Service Initiated Calls**

Most carriers, with some limitations, report that emergency calls including NSI calls are completed via their femtocell product.

One carrier's femtocells will not process NSI calls, unless the macro network is not available; then the femtocell will process the call.

For NSI calls, the CBN is 911+the last 7 digits of the IMEI / ESN. This will usually be presented to the PSAP.

If a carrier lets the NSI call go through, the display at the PSAP would be the same as a NSI call on the macro network. As mentioned earlier, there may be an identifier to show the call originated on the femtocell.

3.10. Handoffs – Femtocell to Macrocell

All carriers support hand-offs from the Femtocell to the macro cellular network. Mid call location updates are supported to allow the latitude and longitude to be updated.

3.11. Handoffs – Macrocell to Femtocell

No carriers support this form of hand-off.

3.12. Portability of Femtocell

When a customer moves a femtocell, its' GPS receiver will determine the new location and it will be used to decide if the device is within the carriers licensed area. If so, the activation process will be similar to the initial activation process. If the device is outside the carriers' licensed area, the carrier will not allow the Femtocell to activate.

When a customer moves a UMA AP, it can be re-activated with a customer entered address.

The address information will follow the guidelines presented in this document (section 3.6).

3.13. Callback to Phone on a Femtocell

All carriers support callback using the mobile number of the phone. In the case of an NSI phone, callback is not supported since the callback number supplied to the PSAP is a non-dialable number.

3.14. Phase 1 PSAPs

Using femtocells, as mentioned in section 3.4, some carriers use the address of the macrocell in the area. If a carrier does not have a close macro-cell, one carrier creates a virtual cell to provide a text address.

Using femtocells, one carrier accepts and MSAG validates a customer provided address. This address is displayed in the address field of the ALI record.

Using UMA AP implementations, a user provided address is sent to the PSAP as the text location.

3.15. Ability at Femtocells to connect to wired device (i.e. RJ-11 jack)

None of the carriers offering femtocells provide this capability as this TID was being prepared.

The carrier that offers a RJ-11 port at the UMA AP assigns a unique phone number to it.

3.16. Trunks to PSAP Selective Routers Supporting Calls from Femtocells

Some carriers use the existing wireless trunks serving the macro network to deliver calls that originate on the femtocell to the selective router.

Some carriers use a totally different network (peering network, using VoIP technology) to route calls.

Regardless of what trunks are used to route calls to the selective router, the carrier is responsible to insure that the call is delivered to the correct selective router (and PSAP).

3.17. RJ-11 Jack and unique phone numbers Class of Service.

For the carrier that incorporates the RJ-11 jack into their product, a unique phone number is assigned to the RF-11 port. Class of Service is wireless, but is being transitioned to VoIP.

3.18. Confidence and Uncertainty.

The carriers operating femtocells will provide confidence and uncertainty for inclusion in a Phase II ALI record. The ability of a PSAP to receive and display this information varies, but the experience will be the same for a given PSAP as it is for regular wireless calls. The confidence and uncertainty may be hard coded values.

3.19. ELT or English Language Translation fields

Since carriers are classifying Femtocell based calls as wireless, the ELT fields will be populated in the same way as a wireless call.

3.20. Network considerations

Network technologies have and are advancing at a rapid pace and that their implementation will impact solutions proposed for femtocell/UMA communications

Internet Networks: Rapid and successful growth of the Internet has dramatically demonstrated the capabilities of new network technologies to connect 9-1-1 and other emergency agencies to external data sources. Internet protocol (IP) technologies need to be applied to emergency voice and data traffic as rapidly as possible, using backbone networks, secure servers, gateways and other infrastructure have been installed to accomplish the needs of today's emergency agencies

4. NENA NG9-1-1

Any communications standards or protocols developed as a result of this TID should fall within the guidelines developed by NENA for technical development in 9-1-1. Several years ago, NENA developed a Future Path Plan. This outlined the criteria any proposed technology should meet to be considered as viable for incorporation into the national emergency networks. The five criteria expressed in this plan were:

NENA Future Path Plan Criteria
1 – Reliability/dependability as governed by NENA's technical standards, and other generally accepted base characteristics of E9-1-1 service
2 – Service parity for all potential 9-1-1 callers
3 – Least complicated system design that results in fewest components to achieve needs
4 – Maximum probabilities for call and data delivery with least cost approach
5 – Documented procedures, practices, and processes to insure adequate implementation and ongoing maintenance for 9-1-1 systems.

More recently, NENA and a diverse group of partners are developing the Next Generation architecture for emergency communications. See http://www.nena.org.

5. Exhibits

None

6. References

APPENDIX A

This is a spreadsheet, which summarizes the information above, organized by carrier name, solution and implementation features.