Input on Research and Development Priorities for Desirable Features of a Nationwide Public Safety Broadband Network

For:

DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
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1 Introduction

IPWireless appreciates the opportunity to provide input to NIST on research and development priorities for public safety mobile broadband. Our company has 12 years of experience in this field, including being the first company to launch 3GPP Mobile Broadband solutions in 2002, and having made over 1650 contributions to the 3GPP standards process. In addition, IPWireless has a joint R&D venture with Sony, focusing on new features and capabilities for LTE Advanced.

We have analyzed the requirements outlined in the Notice and Request for Comment published in the Federal Register, and distilled these down to define key areas where we believe further R&D is essential to meeting the objectives outline for Public Safety Broadband Networks.

In defining R&D project areas, we have focused on those:

- Where it is clear from our involvement in the 3GPP standards process that little or no activity is taking place or likely to in the near term
- Public safety requires capabilities which are not a high priority for commercial carriers who are focused on the consumer market.
- Where IPWireless has specific expertise and experience

The suggested R&D focus areas are described in the following sections, together with analysis of the alignment with public safety broadband network needs, and the 3GPP standards context.

2 Mobile LTE Relay, with Self-Organizing Network Capabilities

In the long term, public safety networks may be built out for a high degree of indoor coverage, however initial deployments are generally built for street level in-vehicle coverage due to funding constraints. This is understood to be the case with most networks being built under Waivers.

To provide high quality indoor coverage at incident scenes, LTE Relay can be a practical option, but requires specific development to meet the unique requirements of public safety, particularly addressing relay mobility aspects.

LTE Relay nodes are envisaged to be installed on emergency vehicles such as fire trucks and mobile command center vehicles, relaying traffic between the donor LTE eNodeB and first responders in adjacent buildings or outdoor areas nearby with poor coverage from fixed sites.

In 3GPP, LTE Relay is in development, with basic fixed relay functionality having been completed in Rel-10. However, RF core requirements, RF performance requirements, and enhancements to fixed relay functionality will be addressed in Rel-11, due for completion in June 2012. Study on Mobile Relays is also planned to be performed in Rel-11 timescale, due for completion March 2012.

Even with the planned Mobile Relay functionality in Rel-11, there are many additional aspects that need to be addressed to meet the specific needs of Public Safety. LTE Relay work in 3GPP is currently focused on fixed relay as would be used by commercial cellular operators, with support of mobile relay only in a limited context, for example for special events. In the Public Safety environment, LTE Relay must work in dynamic, itinerant situations without any advance planning. Items that need to be addressed for Relay to be an effective tool for Public Safety include the following. These assume that no additional spectrum is available for relay, and therefore that the relay techniques must be in-band.

- Antenna isolation on vehicles (e.g. fire trucks) for in-band full-duplex relay
- Relay backhaul enhancements, to allow for mobile relay stations that may not be in advantageous coverage from the donor cell. Including addressing of backhaul link reliability, handover of backhaul link
- Self Organizing Networks (SON) implementation in conjunction with LTE relay, to allow for multiple itinerant mobile nodes without impairment of the donor network
- Management of multiple relay nodes at an incident including load balancing between donor cells where feasible.
- Dynamic resource management between donor and relay nodes, to allow for widely varying incident capacity requirements
- Interference management, including study of intra-relay node interference mitigation, and management of interference between nearby macrocells and relay nodes
- Security aspects – to ensure public safety LTE security is not impaired by the introduction of relay

While not in the normal context of LTE Relay, relay of emergency calls by adjacent UEs (Collaborative communication) should be considered separately in conjunction with work on direct UE – UE communication ("Talkaround").

3 Higher Power UE

Public Safety networks are likely to continue to be capital constrained, limiting both in-building coverage and the extent of rural coverage, creating a clear requirement for UEs supporting higher transmit power than the standard 23 dBm (~200 mW) of LTE Power Class 3 UEs. The 3GPP standards do not support any higher power classes, and there are no current study items or work items on this topic to our knowledge.

As well as extending coverage and increasing coverage reliability, higher transmit power will allow UE's at the cell edge or deep inside buildings to achieve higher modulation and coding levels, benefitting both user performance and sector throughput.

Increased UE power is also likely to be a requirement for direct UE – UE communications (this requires study of the tradeoffs on increased power versus other techniques to improve the link budget, such as processing gain).

Commercial networks do not have a need for higher power UEs, due to the denser cell grid that is typically used, and the consumer demand for small handsets with long battery life, such that the development and standardization of such devices would be specific to Public Safety. Aspects that need to be addressed in the design and standardization of higher power UEs include:

- Study of the appropriate tradeoff between higher power UE, network costs and usability aspects (such as size and battery life), to determine the maximum power level to be targeted
- Coexistence aspects, especially management of interference with adjacent cells, adjacent spectrum allocations (public safety narrowband, C and D blocks) and increased UE – UE interference given the relatively narrow duplex gap in band 14
- Related to coexistence, power control and interference mitigation enhancements
- Techniques for higher efficiency UE power amplifiers
- Techniques for variable transmitter power output based on sensing of available DC power supply. For example the same device would vary its transmitter power between operating on battery, and operating within a vehicle where power is available.

4 Machine Type Communications (MTC) UE

In the absence of unlimited federal funding, the economics of building private LTE networks are likely to dictate the support of a wider range of government agencies and government-owned utilities as well as the traditional public safety users.

With such a wider range of users comes a wider range of applications, including many machine-to-machine applications. In 3GPP, the term "Machine Type Communications" (MTC) is used to describe machine-to-machine. Examples of these are:

- Radiation, biological, chemical and gunshot sensors
- Automatic vehicle location (AVL) and fleet management
- Vehicle performance and "health" monitoring
- Clandestine tracking of vehicles of interest
- Traffic light management and sequencing
- Telemetry / SCADA for city/county owned utilities, such as water, sewage, gas and electricity
- Automatic license plate recognition
- Ambulance patient vital signs monitoring
- Automated utility meter reading AMR (where applicable with Government-owned utilities)
- Asset tracking
- Parking meters
- Flood, tsumani and other early warning detectors

The low traffic nature of these machine-to-machine applications allows them to share a network with traditional first-responder applications, where they contribute to the economics and utility of the network without significant impact on capacity for public safety. In addition, QOS can be applied to ensure that there is no undesirable impact to the latter.

Effective support of large numbers of MTC devices on a network shared with first responders requires the following development and standardization work:

- Mechanisms to support large numbers of MTC UE's connected to a sector (hundreds, or potentially thousands longer term) without significant impact to normal broadband data services.
- EPC modifications to avoid congestion with large numbers of MTC UEs
- Low cost MTC UEs
- MTC UEs with low DC power consumption, and very low standby power consumption
- Network techniques to support lower power MTC UE's or UE's deep within buildings. Examples are LTE relay and Cooperative Multipoint (CoMP) optimized for MTC
- QOS specific to MTC, to minimize impact on mission critical broadband applications
- Address management – to conserve both MSISDN and IP address space

Work has started on MTC in 3GPP, with most work slated for Rel-11 in 2012, but without specific consideration of public safety or other government requirements. Through the proposed R&D program, there is an opportunity to ensure that MTC is developed to meet public safety needs, and furthermore to make MTC available as early as possible.

5 QOS - With Optimized "Tier of Service" Implementation for Public Safety

Unlike previous 3GPP and 3GPP2 standards, LTE provides a range of capabilities for managing quality of service in terms of priority by traffic type and by user session. This provides the framework to implement QOS, but without attention to the unique requirements of public safety.

The IPWireless implementation of Rel-7 TD-CDMA used by the New York City 'NYCWin" network provides user level priority known as "Tier of Service" (TOS), and then application/ traffic type prioritization between users in the same tier (QOS). These operate dynamically on every scheduler cycle, to ensure that the changing user demands on the network are continuously tracked and to ensure efficient use of capacity. These provide the ideal mechanism for public safety / government networks, allowing first responders to get priority over other non-critical government applications, while still gaining the economic benefits of a multi-agency network

There is an opportunity to develop similar TOS/QOS mechanisms for public safety LTE, using the existing standards framework. Areas that require further development to meet public safety / government network requirements include:

- Definition of typical user tiers required. From experience, the number of tiers needs to be limited to ensure adequate differentiation between tiers.
- Tier of Service implementation using the existing QCI and ARP mechanisms in the Rel-8 standards
- QOS implementation within each tier, using stateful packet inspection in the UE for the uplink and the EPC for the downlink
- Mapping of ToS and QoS definitions between LTE and existing public safety data networks where applicable
- Mechanisms to dynamically control / change priorities by event and by location in major incident / disaster situations
- QOS specific to push-to-talk group call services, with appropriate prioritization relative to other mission critical applications
- Application of QOS to encrypted / VPN packets, where stateful inspection cannot view the packet contents.
- Extensions to techniques for the management of Access Class Barring definitions for Public Safety user groups in critical situations where access of specific groups of users must be barred to manage network access congestion at the control plane level, to ensure first responders get the access and service they need.
- Policy control and governance mechanisms

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