LOCATION INFORMATION FOR EMERGENCY CALLS FROM MOBILE PHONES

Call for Input

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NOTICES

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ACRONYMS

Acronym	Definition

Acronym	Definition
TCS	TeleCommunication Systems, Inc.

1. QUESTION 1

1.1. Section 1.1

Is Ofcom correct in focusing its attention on ECLI for mobile emergency calls (as opposed, for example, to fixed-line or VoIP calls) at this time?

TCS Response: TCS agrees that Ofcom's focus should be on providing ECLI for mobile emergency calls. The trend cited by Ofcom in support of this focus area is consistent with our own observations on emergency calling across the world. An increasing number of emergency calls are indeed originating from wireless telephones.

It is TCS' view that wireless emergency calls deserve to be supported with location that is more accurate than just the identification of the base station from which the call originates. Such coarse location may have been a reasonable approach a decade ago when 2G-GSM was still the dominant radio access technology and the available network measurements weren't precise, nor handsets smartphones equipped with GPS capability. However, the situation is different today with most handsets being GPS capable, with 3G-UMTS technology widely deployed and 4G-LTE in the process of being rolled out. The quality and number of measurements available to precisely locate mobiles have increased. Furthermore, precise location is widely used in commercial location based services setting the public's expectation for the same level of precision when it comes to emergency calls as well.

A system for locating fixed (wire-line) emergency calls has been in place for a number of decades and has performed quite satisfactorily. Therefore, we agree with Ofcom's position that immediate attention to this area is not needed.

Voice over IP (VoIP) is the wave of the future. Voice services are poised to move from circuit-switched to packet-switched networks. Broadly, there are two flavors of VoIP; first voice as a service provided by over-the-top providers with no relationship to the access provider (for e.g. Skype providing service over a user's existing Internet service such as DSL, Cable or any wireless broadband technology). Second, voice services provided over IP by the access providers themselves (for e.g. Voice over LTE, where voice services are provided via an IP Multimedia Subsystem by the wireless operator). In the case of the former, the industry still has not resolved the question of who is ultimately responsible for providing location under these circumstances. Nor has it settled on a standardized mechanism for location acquisition and conveyance. In the case of the latter, where both voice and access are provided by a single provider, mechanisms do exist for providing location support.

Irrespective of whether voice is provided over circuit-switched networks or packet-switched networks, devices accessing voice services are increasingly connecting through wireless networks and the problem of determining location of a mobile device remains the same. Hence, Ofcom is right in focusing its attention on mobile emergency calls. As mobile networks move their voice services from circuit-switched networks to packet-switched IMS-based service, the location systems installed for supporting the former can be reused for the latter.

1.2. Section 1.2

Are there, in your view, any concerns associated with the current provision of mobile ECLI in terms of a) accuracy and b) reliability? If so, what are these concerns?

TCS Response: With respect to accuracy, we point out that accuracy is only one aspect of the performance profile of a location technology. Performance characteristics of location technologies are measured in terms of accuracy, yield and latency. Accuracy is the distance between the location of the mobile as determined by the network and the actual location of the mobile computed by independent means known as the "ground truth"– for example, location as computed by a Differential-GPS receiver. Yield is the success rate – i.e. the number of times that a positioning technology successfully returns the target mobile's geodetic coordinates. Latency is the time taken to return a location.

Network topographies impact location technology performance. They are broadly classified into rural, suburban, urban and dense-urban areas. There are no universally established definitions for these terms, nor are they all likely to be present in every network. Nevertheless, they serve to illuminate key factors that impact performance. Broadly, these topographical areas are differentiated by cell spacing/density, multipath and line of sight to signal sources. On one end, rural areas are characterized by cell sites with large ranges; hence there are fewer cell sites that are audible to a mobile and consequently a higher signal-to-noise ratio (SNR) due to low interference from neighbors. Other typical characteristics of this topographical type includes access to open skies (line of sight to satellites), and low multipath (fewer obstructions that deflect signals and distort flight time). On the other end, dense urban areas, typified by city centers such as downtown New York City, have characteristics that include higher cell densities and lower cell ranges, lower SNR, higher multipath, and reduced access to open skies. In between the two ends of this topographical spectrum lie urban and suburban areas with an intermediate mix of characteristics.

The performance of wireless positioning technologies in terms of accuracy, yield and latency vary with network topology. For example, GPS-based technologies may be highly accurate in rural areas with good lines of sight to satellites in the sky as well as low multipath. However, this very same technology suffers from frequent failures and accuracy degradation in dense-urban due to lack of clear lines of sight and high multipath. Conversely, technologies such as Enhanced cell ID or RF Fingerprinting perform poorly in rural areas due to lower cell density and signal variance while performing best in dense-urban areas for precisely the opposite reasons. The variation in performance with topography implies that operators cannot rely on a single location technology to cover their entire network. Operators have to choose a mix of location technologies to suit specific topographies within their networks so that the overall performance of the system is optimized across the entire network.

2. QUESTION 2

Do you agree that network-based approaches could offer solution to tackle the potential issues regarding reliability and accuracy of mobile ECLI?

TCS Response: Yes. Reliability of the location provided in support of emergency calls is an important issue with potentially drastic consequences. Under these circumstances, location provided by the network is less subject to errors.

Consequently, we counsel that location not be procured from over-the-top (OTT) sources as these may not be reliable enough for purposes of serving emergency calls. Consider the following hypothetical example, where a mobile sends a list of all Wi-Fi Access Points (Wi-Fi APs) to an OTT (i.e. network independent) server to secure location. The OTT service provider may have a database of Wi-Fi APs to coarse location that is established via drive-collection or crowd-sourcing. If some of the Wi-Fi APs have moved since the last time the data was collected it is entirely possible that the location may be incorrectly computed. Such a possibility may not be acceptable for emergency services.

Conversely, we are not arguing that location has to be computed only by a server in the network. It is possible that handsets could compute their own location – e.g. handset-based A-GPS where the network supplies assistance data of possible satellites that may be audible to a handset, handset acquires satellite signals and computes its own location. We only point out that, for emergency services, the network must have an opportunity to validate the location of the mobile. The network can validate location using a number of different methods. For example, for a handset computed A-GPS location, the network could determine if the location falls within the range of the cell that is serving the mobile. The range of the serving cell is known to the network from its base station almanac.

3. QUESTION 3

To what extent would the provision of such solutions be reliant on the deployment of LTE networks and what would be the likely timescales for implementing such solutions?

TCS Response: A number of network-based location technology options have existed for 2G-GSM and 3G-UMTS networks. 3GPP has standardized these technologies for a number of years – among others these include A-GPS, Enhanced Cell ID (E-CID based on 2G-TA/RXLEV and 3G-RTT), UTDOA, E-OTD/OTDOA, and RF Fingerprinting. Each of these location technologies have different performance profiles that vary with network topography as well as differing cost profiles.

A combination of one or more of these technologies have been implemented in the United States and Canada for support of emergency calls originating in 2G and 3G networks. A combination of A-GPS and E-CID is the most widely deployed. In the early years, prior to the prevalence of GPS-capable phones, operators deployed U-TDOA in their 2G-networks, albeit at a very high initial overhead needed for installation of specialized location measurement units. For 3G, TCS discusses these cases in the attached white paper which accompanies this response.

With 4G, the basic location technologies defined for 2G and 3G are extended to cover the new LTE access type. The only notable difference is an additional type of location technology based on downlink time difference of arrival called OTDOA that becomes more practical to implement in LTE than in GERAN and UTRAN access types.

Downlink time-difference-of-arrival is based on a mobile making Time-Difference-Of -Arrival (TDOA) measurements of downlink transmissions from serving and neighbor base station. A network server may then use these TDOA measurements along with its knowledge of the base station location to multi-laterate the location of the handset. Although defined by 3GPP for 2G and 3G, downlink time difference of arrival was never implemented widely as the RANs weren't time-synchronized – i.e. because of base station clock drifts the exact time of signal transmission wasn't known. It is expected to be implemented widely for 4G-LTE where the E-UTRAN is expected to be time-synchronized.

The precision of network measurements available in 4G is expected to be greater than in the prior generation of mobile technology. Furthermore, the nature of the LTE transmission (OFDMA) coupled with the signal bandwidth reduce the impact of multipath on location accuracy.

In summation, we opine that operators have access to location technologies for 2G and 3G networks that do not necessarily require LTE as a pre-requisite. Most immediately, operators can deploy a combination of A-GPS and E-CID for 2G/3G networks with modest investment.

4. QUESTION 4

Could these solutions offer the same benefits to Limited Service State ('LSS')37 callers and internationally registered callers as for domestic end-users using their 'home' network?

TCS Response: Yes. LSS callers such as SIM-less mobiles and in-bound roamers can be supported using these technologies.

Per 3GPP standards, the logistics of receiving a location request, gathering measurements from the serving radio node and handsets and computing location resides in the serving radio access network – specifically in a node called the Serving Mobile Location Center (SMLC). Certain technologies such as GPS may require specific handset capabilities. However, these are independent of whether the user belongs to the home network or is an inbound roamer or is a registered user. In other words, the location technologies provided by the SMLC are available to all subscribers who have originated an emergency call from that radio access network.

5. QUESTION 5

5.1. Section 5.1

Do you think that handset based approaches (e.g. Apps) could offer a cost-effective and dependable means to tackle potential problems linked to accuracy and/or reliability in mobile location information? If so, what are the likely costs to all parties involved in the end to end support of handset-based approaches?

TCS Response: TCS does not counsel a handset-based approach for emergency services which are independent of the network.

A handset-based approach, independent of the wireless network presents a number of problems:

a) Location is determined by an unknown/non-trusted source that may not be reliable and the location is not validated by the network
b) May not work uniformly across all devices and OS – e.g. the app may require a smart phone with a certain OS version leaving legacy handsets or those with incompatible OS without support
c) The app may not be able to turn on the GPS capability if the user has disabled it previously
d) Support for in-bound roamers may not be possible as they may not have these apps installed or may not have a smartphone
e) Location support of unregistered/SIMless mobiles may not be possible and
f) SMS transport used to convey location to the PSAP is unreliable as SMS uses a store-and-forward delivery model with no guaranteed delivery times.

5.2. Section 5.2

Do you see solutions such as Apps as a long-term alternative to network-based approaches?

TCS Response: For the reasons mentioned in response to question 5.1, TCS does not see handset-based apps as the solution to location support of emergency calls.

6. QUESTION 6

What are the changes that EAs would suggest in order to address potential issues regarding accuracy and reliability of mobile ECLI?

TCS Response: TCS is a vendor of location systems and is not an Emergency Authority. TCS respectfully refrains from answering this question since it is targeted to EAs.

7. QUESTION 7

What would be the potential costs implications for EAs if such changes were to be implemented?

TCS Response: TCS is a vendor of location systems and is not an Emergency Authority. TCS respectfully refrains from answering this question since it is targeted to EAs.

8. QUESTION 8

Are there ways in which tackling potential issues regarding the accuracy and/or reliability of mobile call ECLI could adversely affect consumers, and could these be mitigated?

TCS Response: As noted in our responses to questions 2 and 5.1, TCS does not encourage the use of handset-based approaches to providing location due to the inherent complications and limitations of this approach.

TCS does note that in the United States and Canada location is computed and validated by the network using measurements from the network and from handsets. In these cases, whenever a mobile makes an emergency call, if a handset has GPS capability it is automatically enabled even if the user had disabled it earlier.

9. QUESTION 9

If Ofcom was to consider setting further criteria for the accuracy and reliability of ECLI, should these be independent of the technology used by a CP?

TCS Response: TCS recommends that Ofcom encourage operators to use A-GPS when a mobile is so equipped. If A-GPS fails, then networks can fall back to E-CID. TCS believes that this is an approach that is both technically and economically feasible. TCS believes that the prevalence of GPS capable handsets coupled with the increasing precision of network measurements does provide good location support immediately. Canada has adopted this approach. Despite the fact that the Canadian regulator (CRTC) did not set any specific targets, network operators in Canada have widely implemented a combination of A-GPS + E-CID.

Setting of location accuracy targets has several downsides. First, is the question of what these targets ought to be? Location technologies in terms of accuracy, yield and latency perform differently in various network topographies. Hence, there can be no uniform application of a single location technology across the entire network. The setting of specific targets may force operators to implement economically infeasible technologies just to meet the target. The contrasting case study of the United States and Canada illustrates this situation.

The United States was among the first countries to require mobile operators to provide location for mobile emergency calls. As early as 1998, the US Federal Communications Commission (FCC) directed operators to implement a phased approach. In the initial phase, wireless network were required to present calling line identification and base station identity for emergency calls. In a subsequent phase, location was to be provided that met certain statistical targets. These targets specified accuracy and yield metrics that operators had to meet over a well-defined coverage area such as a county or PSAP coverage area. Over the years, the FCC has refined these regulations to provide improved accuracy to emergency responders while taking into consideration the practical difficulties that operators face in providing accurate location in certain topographical areas.

The US operator's toolkit to meet the US FCC regulation has changed over time. Initially, when the regulation went into effect, networks were predominantly 2G. In 2G, enhanced cell ID measurements while widely available, were of lower precision (e.g. TA in 2G-GSM has a precision of only approximately 554 meters). Additionally, A-GPS capable handsets were still not prevalent in the marketplace. Due to a variety of technical issues, downlink time-difference-of-arrival technologies such as E-OTD did not meet the mandated target. While RF FP technologies did find favor with a few smaller Tier II and III regional operators, for large U.S. Tier I operators with nation-wide coverage, this wasn't practical due to the periodic requirement to drive-collect calibration data for the entire network. This imposed too great an operational cost. Operators responded by implementing LMU-based technology, the only option that could meet the mandate, albeit with very high initial overhead costs.

Over the last decade, networks in the United States have transitioned from 2G to 3G technology where the precision of network measurements are tighter. Additionally, penetration of GPS-capable handsets in the marketplace has increased. This has enabled operators to cap their investment in the LMU technology and move to a combination of A-GPS and enhanced cell ID techniques to meet the FCC mandate. As of this writing, none of the U.S. tier I 3GPP operators have network-wide commercial deployments of LMU or RF Fingerprinting technologies for 3G to support emergency calls.

The transition to 4G-LTE has begun and voice services will increasingly move from circuit-switched to packet-switched networks. Several new factors have begun to emerge. These include the commoditization of GPS capability as a standard feature of newer handsets, the operational status of additional GNSS systems such as GLONASS, the higher precision of enhanced cell ID network measurements in LTE, and the practical feasibility of additional multi-lateration techniques such as OTDOA due to the expected deployment of a synchronized E-UTRAN,. Collectively these factors indicate that a combination of A-GNSS, OTDOA, and Enhanced cell ID will be the dominant technologies with which operators will meet the US FCC mandate. Other LTE technologies standardized by 3GPP such as LMU-based and RFFP may at best be limited to niche areas where they perform best and no other options are available.

Entering the game much later, the Canadian regulator (CRTC) took a fundamentally different approach to regulation. Unlike the United States, Canada did not mandate specific accuracy targets that operators had to meet. Instead, it was understood that operators would provide a GPS location when the mobile was so equipped. This fitted well with the state of the industry at a time when A-GPS was already widely available and networks in Canada were using 3G technology with availability of more precise network measurements to back up A-GPS. This was further buttressed by consumer expectations, which were already used to GPS for commercial services and expected at least that same level for emergency calls.

Operators in Canada have responded to the CRTC regulations for location support by deploying A-GPS + E-CID. This has been the case for both 2G and 3G. There have been no widespread commercial deployments of LMU or RFFP solutions.

It is interesting to note that despite the differences in regulatory approaches between the United States and Canada, operators in both countries have converged on A-GPS + E-CID as the primary location technologies of choice. Unlike their US counterparts, Canadian operators have been able to take a more economical route to this end point and without having to invest in expensive technologies. As networks transition to 4G, Canadian operators, like their US counterparts, are expected to extend the A-GPS + E-CID approach to cover 4G-VoLTE emergency calls and possibly augment that with deployment of LTE-OTDOA as well.