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## Deployment of caller location services within Sierra Leone's 117 Ebola Response Centre

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### Abstract

The effectiveness of both emergency services and response planning functions in humanitarian response and public health crises are significantly enhanced by the availability of location services in mobile networks. Here we describe how eHealth Africa and Netfuse Telecom are working together to use mobile network location services to improve the operational effectiveness of the 117 Ebola response call centre and support decision making and resource allocation at the National Ebola Response Centre, which is coordinating the response to the Ebola epidemic in Sierra Leone.

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### 1. Introduction

The effectiveness of both emergency services and response planning functions in humanitarian response and public health crisis situations is significantly enhanced by the availability of location services in mobile networks. The value of population mobility information in areas with high mobile phone use was demonstrated by the analysis of mobile phone records following the Haiti Earthquake in 2010 [1]. More recently, Wesolowski et. al. have

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highlighted the potential for mobile phone data to aid in the response to the West African Ebola Virus Disease (Ebola) epidemic [2].

In most developed countries, national regulators mandate that operators provide location data to the emergency services. In humanitarian response contexts there may not be the regulatory precedent, technical capacity, or commercial imperatives that would encourage mobile operators to provide location information for their subscribers. So when location data is most needed, be it for analytical purposes (in the case of mapping) or for operational reasons (in the case of ambulance / health worker dispatch), it is often the hardest to come by. The Groupe Speciale Mobile Association (GSMA - the international mobile operator industry association) has defined privacy guidelines [3] for the use of subscriber data in the Ebola outbreak but these had related to analysis of data by third parties, not the operational, continual usage of location data by the emergency services.

eHealth Africa (eHA) is supporting the government of Sierra Leone to improve the operational capacity of the national 117 Ebola Call Centre, which at peak times has been handling up to 700 calls per hour. Working with Netfuse Telecom (Netfuse), eHA has rapidly developed and deployed location based services supporting on-going reporting for the National Ebola Response Centre (NERC) in Sierra Leone, and the provision of live location information on callers to the 117 Ebola response number, as well as deployed mobile response staff. Without a legal mandate requiring operators to provide location data, and with limited location services infrastructure in networks, a key challenge is in gaining the support of mobile operators and regulators in a way that addresses important privacy concerns, as well as technical and operational limitations.

This paper describes two projects which are running concurrently: the use of cell tower locations provided in call detail records by mobile operators to supplement the information collected by 117 call centre operators and aid in weekly reporting of new trends in call origins; and the rapid deployment of real time location services in mobile operator networks to enable the 117 Ebola response call centre to query the location of subscribers who have called 117 on-going in order to support emergency services dispatch and field operations.

We also describe the authors' experience of the process of gaining access to location data from mobile operators and highlight some of the attendant regulatory, governance and institutional implications of working in rapidly unfolding humanitarian response scenarios.

## **2. Combining mobile network and call centre data to map inbound callers**

The initial objective of the geo-location project has been to deliver useful data for Ebola response planning purposes as quickly as possible using any data that could readily be made available by the mobile operators, in combination with data from the CRM (Customer Relationship Management) software in use at the 117 call centre. The process of engaging the mobile networks and the regulator began in November 2014. The process of mapping data is ongoing.

### *2.1. Regulatory context*

In order to gain access to CDRs (Call Detail Records) relating to inbound calls to the 117 number, a clear description of the data required and how such data would be used was provided by the NERC to the mobile operators, and we engaged directly with the regulator to ensure they were supportive of the project, ensuring that regulatory and privacy concerns were addressed in parallel.

### *2.2. Technical solution*

Data on the cell towers to which inbound callers to 117 are connected is now being provided in CDRs on a daily basis by the 2 largest mobile operators in Sierra Leone, representing more than 95% of mobile subscribers in the country. CRM data collected by the 117 call centre include the caller ID and the call outcome recorded. Recorded call outcomes include "Sick", where a caller is reporting symptoms which are not thought to be Ebola-related; "Suspect" where a caller is suspected of being infected with Ebola; "Quarantine", where a caller is quarantining themselves due to contact with a suspected Ebola case; or "Death", where a body or death has been reported.

Netfuse has provided a custom solution derived from its Synthesis platform, to which CRM and CDR data can be uploaded. Call centre metadata is matched to CDRs, and the resulting combined data is made available via a secure API in JSON or CSV format. This data is then used by the eHA GIS team to generate maps for use in weekly reporting to the NERC. These maps will be used to inform District Ebola Response Centres (DERCs) where there are significant changes in the volume of calls with specific outcomes, enabling them to dispatch District Surveillance Officers to investigate the cause of the change.

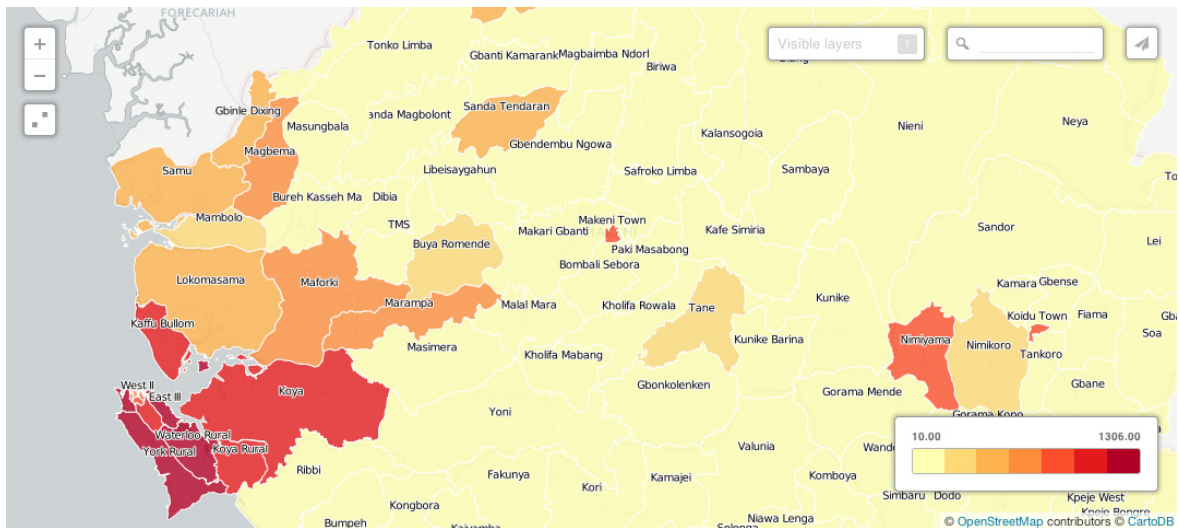


Figure 1. Example map in development showing inbound call origins by chiefdom.

### 2.3. Data Limitations

While these maps help the NERC to focus resources in appropriate areas, the data has a number of limitations. The radius of a mobile cell varies significantly, so the geospatial granularity of the data is variable. 117 is not the only number being publicised as an Ebola response line - local numbers for specific DERCs are also in use, so the data will be skewed by a local population's tendency towards calling the local rather than the national number. Operator error is also an issue, especially in emergency response situations where resource and time pressures make it impossible to provide training to the levels required by traditional emergency services call centres. A key communication challenge has been ensuring that the NERC and DERCs understand the operational implications of the data limitations.

### 3. Capacity building for fine grain, real time location information

Given the limitations on the data available from the mobile operators and the call centre in its current format, and the importance of surveillance and contact tracing for the Ebola response, there are a number of improvements to the location services capabilities of the 117 call centre that could be significant in limiting the spread of Ebola; and in improving emergency services capabilities in a post-Ebola context. Greater accuracy in location data would mean that DERCs and DSOs were better able to identify and investigate new suspected outbreaks. Also, the ability to track any significant movement of a mobile phone user after they have called 117 has the potential to aid in contact tracing. The ability to query a caller's location in real time would significantly improve the speed of response to suspected cases, by enabling the routing of calls to regional answering points where these exist. Tracking DSOs and other health workers in the field would also be of significant benefit to DERC and NERC operations.

### 3.1. Regulatory context

On initial engagement with mobile operators and the national regulator, it was clear that there was no pre-existing legal or operational framework within which live requests for location data could be made. The existing 112 emergency service had no caller location awareness system in place; and beyond knowledge of the cell towers through which calls were being placed as stored in CDRs, there were no enhanced location capabilities within the mobile networks which could easily be used to improve the granularity of location data beyond the cell tower level.

While all stakeholders were committed to aiding the Ebola response, both operators and the national regulator expressed significant concerns over the privacy of subscriber data when presented with the idea of facilitating live location lookups for any subscriber.

eHA and Netfuse are in the process of getting director-level buy-in and mapping technical capacities in mobile networks; identifying location services solutions that would work in each of the two biggest networks; and engaging the national regulator to secure support for the implementation process as it stands and ensuring it is well placed to brief the legislature on any emergency legislation that may be needed.

### 3.2. Technical Solution

The technical solution we have designed involves two different approaches to improving the granularity of location data beyond the cell tower level. One involves placing location servers inside an operator network, while the other provides remote access to a mobile operator network for location lookups.

We have also proposed a software solution to address privacy concerns expressed by the operators and the regulators. The model that we have recommended is a database that sorts callers based on opt-in/opt-out status, combined with full location query audit logs. When a user of the service (i.e. the 117 call centre) requests location data for a subscriber, the location service gatekeeper first checks whether that subscriber is on the opted-in database. This database will have been pre-filled by the emergency teams with staff subscriber numbers. Inbound callers to 117 who have agreed to share their location will be placed on the opted-in whitelist for a period to be agreed in consultation with the regulator and the NERC. The mechanism by which callers agree to being located will also be designed in consultation with the NERC and other stakeholders with an understanding of the prevailing operational requirements and the local context. When any location request is made, the details of that request are stored in an audit log.

If the subscriber being queried is not on the whitelist database, the request is refused. The blacklist database contains any subscribers who have specifically opted-out of the service. This can be used for example for high-profile individuals who do not consent to their location being made available to emergency response teams in any situation, or in the case of a future implementation of opt-out via SMS. The blacklist is provided as a future tool, but at this time there is no proposed active use of it as the opted-in whitelist provides the primary safeguarding role.

### 3.3. Data Limitations

In addition to the issues relating to the existence of regional Ebola response lines and the minimisation of operator error, it is important to note that there are inherent limitations in network-based location lookups. While significantly better than cell tower data, variables like cell size, topography, mobile handset type and network generation (2G, 3G or LTE standards) all have an impact on the accuracy of location lookups.

The accuracy radius of a triangulated cell tower lookup can vary between 50 to 1000 metres depending on these factors, providing a variable degree of usefulness depending on the context in which the information is used. Regardless of the accuracy radius size, there will still be a context for which the information is useful, but ensuring that the data user is aware of the accuracy is vital so that any lack of accuracy is taken into account.

### 3.4. Potential Applications

Given the likely data limitations, eHA are planning a feasibility study that will evaluate the location services solution and determine its operational and analytical value in both humanitarian response and post-Ebola contexts.

Applications under consideration include the automatic routing of calls to regional call centres, which would ensure that inbound callers would be connected to operators with a better understanding of the local context; tracking health worker movements to ensure that resources are being focussed where they are most needed; and more granular mapping for analytical and planning purposes.

#### 4. Conclusions

Location based services in mobile operator networks are traditionally deployed in the context of a set of formal institutions, both legal/regulatory and commercial/contractual that define how the services may be used, how privacy concerns can be addressed, and in the case of location enhanced emergency services (often referred to as E911 or E112), how requests for location information are responded to.

In humanitarian response and public health crisis situations these formal institutions may not exist. Where there is a need for the rapid deployment of location based solutions, organisations working on the response form ad-hoc informal institutions that govern how information and data are shared, who has access to these data, and how data is used in the response. Such organisations may find themselves in the role of self-regulating data controller in a reversal of the traditional legislation-first approach to E911 deployments.

While technical solutions with the potential to significantly enhance the humanitarian response may be available, without an appreciation of the local institutional context and a focus on building local relationships, such solutions may not receive access to the data they need to be effective.

If locations services are to be exploited to their full potential in the earliest stages of humanitarian response situations, there is a clear need not only for technical solutions that meet the unique needs of such situations, but also for standard frameworks that address the privacy and legal concerns of mobile operators and national regulators.

It is also important that the legacy of the Ebola response in Sierra Leone be an improved public health infrastructure. Leaving behind the regulatory framework, privacy protections and technical capacity to deliver granular location support in the Sierra Leonean emergency services must also be a significant consideration in post-emergency planning.

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