WHITE PAPER

Accurate Mobile Positioning Using a Single LTE Macro Cell

PoLTE Corporation[1] is a company that is revolutionizing the market for location-based data services. PoLTE have teamed with Applied Computer Solutions (ACS) and Intel to develop Positioning over LTE (PoLTE) Macro, a solution specifically for Mobile Network Operators (MNOs). In a highly fragmented location data market, PoLTE Macro enables MNOs to deliver immediate value in the form of highly accurate location data to customers whether they are indoors or outdoors. This paper describes the PoLTE Macro solution and the test results from field trials using Long Term Evolution (LTE) macro cells.

Access and control of location information

Accurate network-based location information is becoming a core need for MNO. The location information crosses a multitude of highly valuable and critical markets, including network performance, public safety, retail, data analytics, enterprise, and the Internet of Things (IoT). Currently, obtaining location data is highly fragmented for the end user, the venue owner, and the MNO. Typically, network-based solutions do not meet the accuracy requirements, and local solutions are stand-alone products that require significant investment in infrastructure equipment and operate independently from or in competition with the MNO.

The most challenging aspects of providing location services is the ability to provide a seamless experience for the customer and a complete location dataset as the user moves between indoor and outdoor environments. MNOs are uniquely positioned to solve these issues by exploiting the dense macro cell deployments used to maintain subscriber voice and data services.

PoLTE is transforming the market for location-based data services by leveraging the carrier's vast terrestrial LTE networks to accurately locate user devices in the network both indoors and outdoors. PoLTE has developed technology called positioning over LTE (PoLTE) that provides a universally available, integrated global platform that helps ensure user privacy. This solution, PoLTE Macro, achieves a high level of precision by leveraging the Sounding Reference Signals (SRS) that are embedded in an LTE user's transmissions. PoLTE Macro uses the SRS in the LTE uplink signal, and converts it into a probe signal by adapting radar location techniques. This approach enables the location of the user devices to be determined to a level of accuracy not previously achieved with LTE, TDMA or CDMA-based technologies.

Leveraging PoLTE Macro, MNOs can become leaders in providing the end-to-end location information. This unique approach and solution enables the MNO to monetize their existing LTE infrastructure deployment and provide next generation location services.

Location accuracy within 6 meters

A critical consideration when selecting a location solution is the location Quality of Service (QoS), such as positioning accuracy and location response time. Today, access to location information that the user device generates is subject to interruption. PoLTE Macro allows MNOs to provide consistent and reliable positioning across their LTE macro, micro and small cell deployments, independent of whether the user device is using the Apple iOS* or Google Android* operating system or if it is an LTE-enabled IoT device. Other location solutions, such as Wi-Fi and Bluetooth beacons, can be implemented to complement the core PoLTE Macro deployment, but they are not required.

Traditional macro cell location methods require at least three towers to see the user device in order to locate the device with precision. Historically, single tower

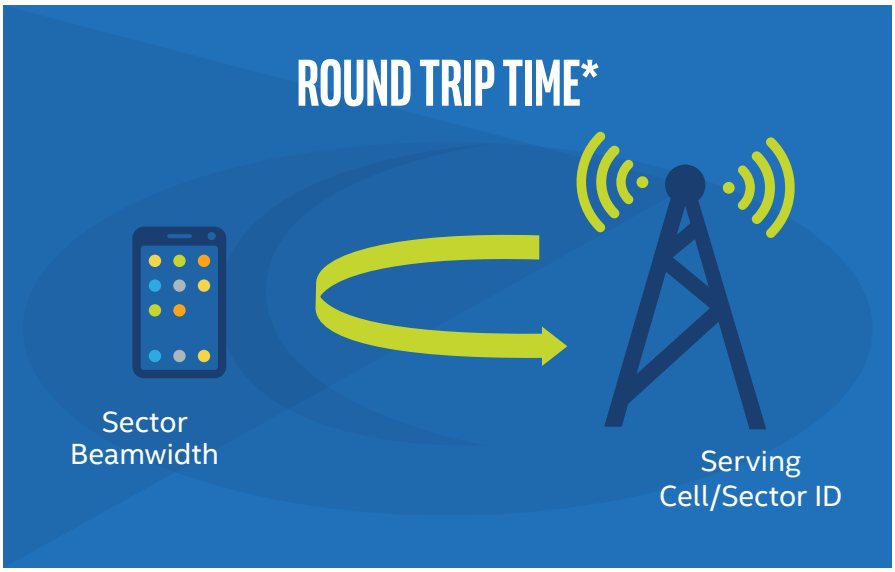

Figure 1: Historical single cell solutions.

deployments as shown in Figure 1 were limited in accuracy to the width of the sector created by the 120-degree antenna that was serving the user device. For example, at a distance of 1.5 kilometers from a base station, the cross range precision would be 4000 meters.

PoLTE Macro can improve the precision to less than 2 meters. Table 1 provides a snapshot of the location measurements attained during intensive field-testing of the PoLTE Macro solution[2].

Consistency across indoor and outdoor environments

Subscribers have shown interest in additional location services such as improved interactive gaming experience, new social networking opportunities, and localized relevant information. However, variations among user device capabilities, and the need to connect to different networks can cause subscriber frustration. The PoLTE Macro solution seamlessly tracks the location of the user device as it moves among different networks, including Wi-Fi, and legacy cellular networks. It provides a consistent service as the subscriber moves between their home, office, stores, and other public locations.

For complicated indoor environments such as multi-story office buildings, where the outdoor macro signal does not penetrate, there is a complementary solution called PoLTE Indoors. PoLTE Indoors can provide greater location accuracy than Wi-Fi and Bluetooth dependent solutions by using existing indoor network infrastructure.

Even though the PoLTE Macro solution works across all LTE network infrastructures, initial MNO interest is focused on the macro cell. Russ Markhovsky, CEO at PoLTE Corporation, explained, "In our conversations with MNOs, they see significant value in reusing existing infrastructure to provide a universal and highly accurate location solution. MNOs see the greatest near-term opportunity to monetize location services at the macro cell."

Monetizing accuracy location metadata

The utilization of PoLTE Macro can be further enhanced by processing the location calculations at the edge of the network. This capability is provided by two PoLTE partners, ACS and Intel. ACS offers a Mobile-Edge Computing (MEC) appliance that allows the location metadata to be immediately utilized by other applications and services running at the network edge. Intel provides the MEC compliant architecture that helps maximize the performance of PoLTE software.

The ACS MEC appliance runs on the same Intel general purpose platform that MNOs have implemented in their data center. The Intel® Network Edge Vitalization SDK (Intel® NEV SDK real-time virtualization platform and developer's environment enables the MNO to leverage the same architecture and mechanisms that they use in their data centers. This allows the PoLTE Macro location metadata to be seamlessly integrated with other third-party applications at the network edge.

Presence-based applications that utilize contextual location information are significantly more valuable as the level of accuracy and ubiquity increases. MEC enables a new suite of real-time location services to be envisioned and allows the existing location services to be reinvented. Potential services include targeted advertising, location analytics to determine what is trending locally, public safety services such as crowd and situation monitoring, and emergency and disaster response logistical services. Example use cases are provided in Table 2.

Propagation environments	Antenna configuration	No. of sectors used	Location accuracy at up to 3 km distance
Light industrial (indoors and out), dense tree coverage, and non-line of sight.	• Three 120° sectors – 2m separation • 2x2 MIMO • Antenna height 9m	1	Better than 6m
		2	Better than 2m

Table 1: PoLTE Macro test results.

Use case	Description
Public Safety	Provides law enforcement, security, and emergency services with accurate tracking information on user locations in real-time or post-event.
Retail	MNOs will have an ability to combine crowd tracking with data-analytics to provide retailers and advertisers with accurate customer traffic pattern information, in real-time or post-event. Applications can also offer navigation and highly accurate presence-based triggers that lead to additional carrier monetization opportunities and consumer benefits.
Enterprise	Several industry verticals like healthcare and government institutions can benefit from precise location information for tracking employees, assets, or customers both outdoors across enterprise campuses, and indoors.
IoT	With the proliferation of network based connected devices, such as watches, tablets, asset tags, and connected cars, a network-wide always-on location service enhances the utility of such devices.

Table 2: Use cases that require accurate location information.

Ease of implementation

PoLTE's key differentiation is the ability to provide accuracy and seamless positioning information between outdoor and indoor environments. Powered by Intel® architecture, PoLTE Macro puts the potential of monetizing location metadata and controlling the user experience back in the hands of the MNO. It expands the overall location eco-system and provides the MNO with the ability to develop or enhance use cases across a wide selection of industry verticals.

PoLTE Macro requires a minor firmware upgrade to allow access to the signals that arrive at the tower's MIMO antennas. It does not require any changes to the LTE network equipment or tower site. As it does not require changes to the user device, once implemented, PoLTE immediately starts reporting user device locations. PoLTE Macro is currently being integrated into several leading LTE infrastructure vendor products.

To learn more about the team that enabled PoLTE Macro, visit:

- **http://www.polte.com** to learn more about Position over LTE (PoLTE) solutions.
- **https://networkbuilders.intel.com/intel-technologies/nev** for more information on Intel® Network Edge Virtualization (NEV) and Software Developer's Kit (SDK) with MEC reference libraries.
- **http://www.acsacs.com/service-providers** to learn about how ACS helps service providers integrate and deploy MEC.

Footnote:
[1] To better represent the mission of the Company, InvisiTrack is changing the name of the company to PoLTE Corporation.

[2] PoLTE conducted these tests in the 700 MHz band using a 10 MHz LTE channel. Contact PoLTE for additional details on the test environment.

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