ideally uses four or more satellites—the more satellites in view, the more accurate the location fix. It should be noted that unless a device already knows its location *and* is programmed to use the current fix rather than start fresh to obtain a new one, obtaining a satellite-based fix in time to route a 9-1-1 call is not feasible as it can take upwards of 30 seconds.

OBSERVED TIME DIFFERENCE OF ARRIVAL (OTDOA)

With the introduction of Long-Term Evolution (LTE) technology, a new location-based service was created, Observed Time Difference of Arrival (OTDOA). OTDOA is based on the mobile device collecting reference signals from a list of cell sites (eNodeBs), measuring the offset between the signals, and providing that information to the network (E-SMLC) to derive a calculated location. OTDOA requires at least three cell sites to derive a location, but more sites can be used to provide increased accuracy. OTDOA provides medium-level accuracy, high availability, low latency and supports dense urban, urban, and suburban morphologies. OTDOA is less reliable in a rural setting where the probability of less than three cell sites increases. Like cell site/sector location methods, OTDOA can work within an indoor environment; however, it cannot provide the accuracy for a dispatchable location or that of a z-axis coordinate.

SMALL CELLS

Perhaps the largest trend in Radio Access Network (RAN) architectures today is the deployment of small cells. Small cells are compact, low-powered base stations and have many names, including femto cells, pico cells, nano cells and metro cells. Small cells can either use 3G or 4G for the radio interface and then backhaul the traffic to a macro cell site or using the customer's broadband network (e.g., cable modem, DSL, corporate LAN, etc.). From a deployment perspective, small cells can be found indoors, outdoors, in someone's house or in an enterprise. They are very flexible and allow wireless carriers to address coverage gaps and provide increased bandwidth in densely populated areas. Small cells are also commonly found in venues with large crowds of people: stadiums, arenas, convention centers, airports, etc. Small cells can propagate a signal anywhere from tens to hundreds of feet, allowing in some case for a dispatchable location to be derived and delivered to a PSAP. Therefore, small cells provide high accuracy, low latency, but they have limited availability and are typically only found in dense urban and urban environments.

NATIONAL EMERGENCY ADDRESS DATABASE (NEAD)

In 2015, the Federal Communications Commission (FCC) released the 4th Report and Order for location accuracy. The FCC's rules envisioned the implementation of a National Emergency Address Database (NEAD). When implemented, the NEAD will house media access control (MAC) addresses of WiFi access points and Bluetooth low energy beacons and their corresponding location. When a 9-1-1 call is made, the carriers would obtain the MAC addresses within the mobile device's range and then cross reference those addresses within the NEAD to receive the location of the device. This platform should provide carriers with a highly accurate, highly available, low-latency solution that works for all morphologies and indoor environments.

DEVICE-BASED HYBRID

Device-based hybrid (DBH) location is a new and exciting location development in 9-1-1. In DBH, logic is placed onto the mobile device that detects when the digits "911" are dialed. Once detected, the logic collects information from the device and sends it to a DBH back-end system that will calculate the location. Many ask, "Why can Uber find me, but 911 cannot?" This is because apps use device-based location while most 9-1-1 calls depend on network-based location. DBH technologies, however, look at both.

The system observes the sensors on the device, "sees" WiFi and Bluetooth low-energy devices, pulls in other location sources like Apple and Google AML/ELS, and uses all this data to calculate a highly accurate location in a very short timeframe. Because DBH leverages many location types when determining its calculated fix, it can provide a highly accurate location in a very ubiquitous manner with very low latency across all morphologies. DBH uses satellite-based location in rural areas where constellations are clearly visible and WiFi access points in densely populated areas where many access points are within range of a mobile device. Because DBH can generate a location so quickly, the 9-1-1 call can be routed based on a more accurate location; in some cases the location may be a dispatchable location and delivered upon call delivery to the PSAP. ●

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With the introduction of new satellite constellations, newer technologies like 4G and 5G providing enhanced methods of obtaining location and the ability to leverage WiFi and Bluetooth low energy devices, more accurate and timely location can be provided to the PSAP. Additionally, companies like Apple, Google, RapidSOS and LaaSer continue to push DBH location methods into public safety. Who knows, maybe someday we will be asking, "Why can't Uber find me like 9-1-1?"

POSITION METHOD	ACCURACY	AVAILABILITY	LATENCY	MORPHOLOGY (DU, U, S, R)	DISPATCHABLE LOCATION POSSIBLE?
AGNSS	HIGH	MEDIUM	HIGH	U, S, R	NO
OTDOA	MEDIUM	HIGH	LOW	DU, U, S	NO
SMALL CELLS	HIGH	LOW	LOW	DU, U	YES
NEAD	HIGH	LOW*	LOW	ALL	YES
DBH	HIGH	HIGH	LOW	ALL	YES

*The NEAD has not yet been deployed. It is anticipated that once it is deployed its availability will increase over time.

Reference: Ryan Jensen, T-Mobile