SCANNING TO SAVE LIVES

THE FORT WORTH POLICE DEPARTMENT IS USING LASER SCANNING TO CAPTURE 3D MODELS OF POTENTIALLY VULNERABLE, HIGH-DENSITY LOCATIONS, ENABLING PRE-EVENT PLANNING FOR FASTER STRATEGIC RESPONSES TO MASS CASUALTY CATASTROPHES. BY **MALGORZATA KROL**

Mass casualty incidents in the United States have consistently risen over the past two decades, leaving members of law enforcement searching for ways to enable faster strategic interventions that save more lives. When arriving at active scenes, first responders and emergency services rely on site information to inform time-critical decisions. However, traditional 2D plans provide limited data, often leaving officers ill-equipped to understand the spatial and structural reality of scenes.

To facilitate better pre-event planning, the Fort Worth Police Department (FWPD) is using 3D laser scanning to capture schools, universities, event venues, and other high-density locations. The 3D plans created from these scans help first responders identify evacuation routes and hazards, define entry points, and more.

Although the system is still in the early stages of implementation, the FWPD envisions that in the near future, these point clouds will connect to officer GPS units and building sensors to create an IoT-activated network of valuable, real-time data.

Officer Christopher Bain and Sergeant Clayton Hayes, with nearly 50 years of combined experience in law enforcement, have led the scanning integration efforts within the FWPD and here share the path from initial adoption to current pre-event planning to projections for a future of blended technology and interactive resources.

Rallying scan support

Garnering support for the use of reality capture technologies in the department began with the integration of laser scanning in crime scene processing in 2016. However, the relatively slow speed of their initial scanner hampered the practicality of crime scene captures amidst capacity limitations and tight timelines, no matter how valuable the data.

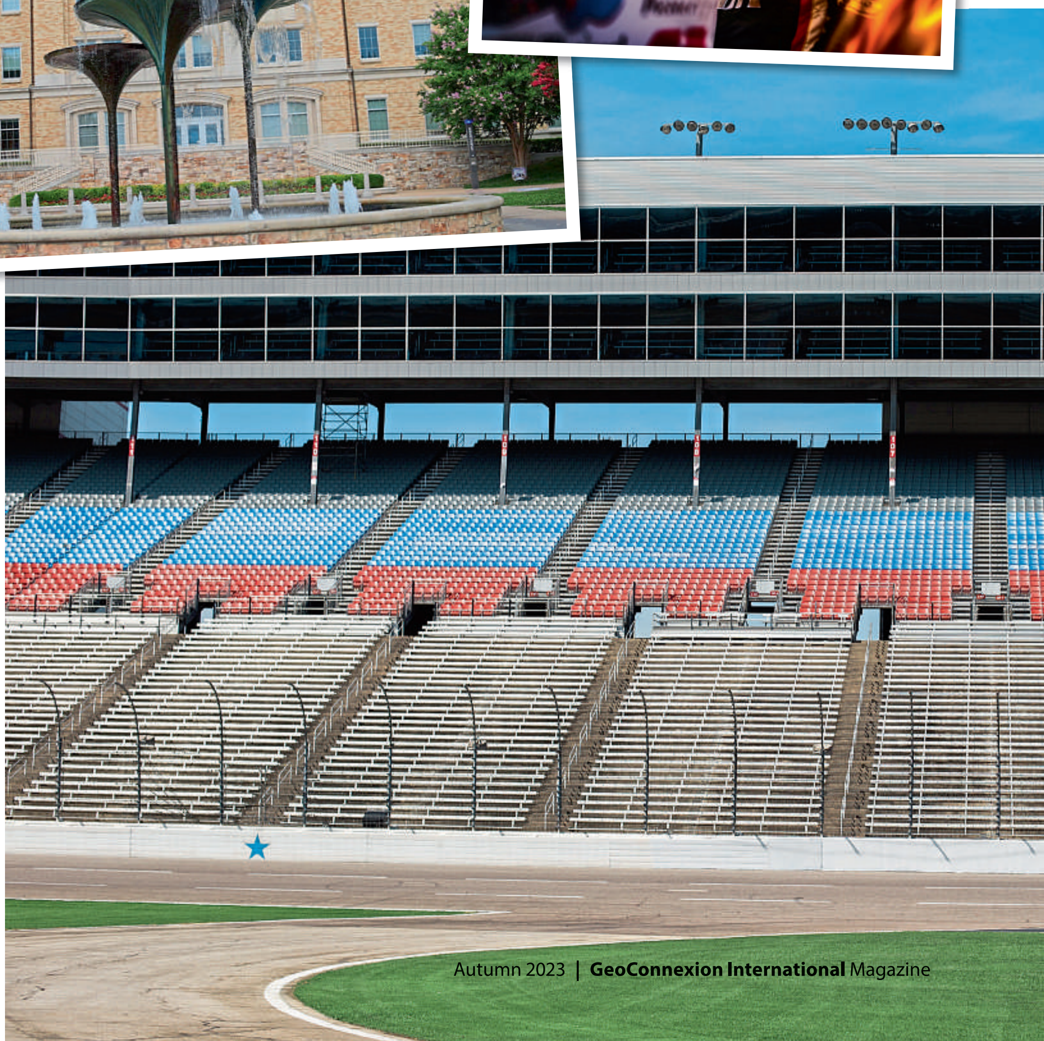
Widespread acceptance of scanning as standard protocol on homicide and major case scenes only occurred after they began using faster terrestrial laser scanners.

"The game changer for our department in moving the scanning projects forward was the RTC360," explains Hayes. "The speed and accuracy of the scanner and ease of registering the scans allows us to go in and scan quickly from station to station. At medium resolution, it takes a minute and a half for one location."

The speed, along with the added value of the data, secured advocates from all levels, including the detectives responsible for cases.

Texas Christian University


NASCAR Driver Texas Motor Speedway



"Scanning barely interrupts crime scene processing. We've had cases where the scan showed the scene so much better than pictures ever could, and now we have the whole unit engaged," recalls Bain.

Pre-event planning

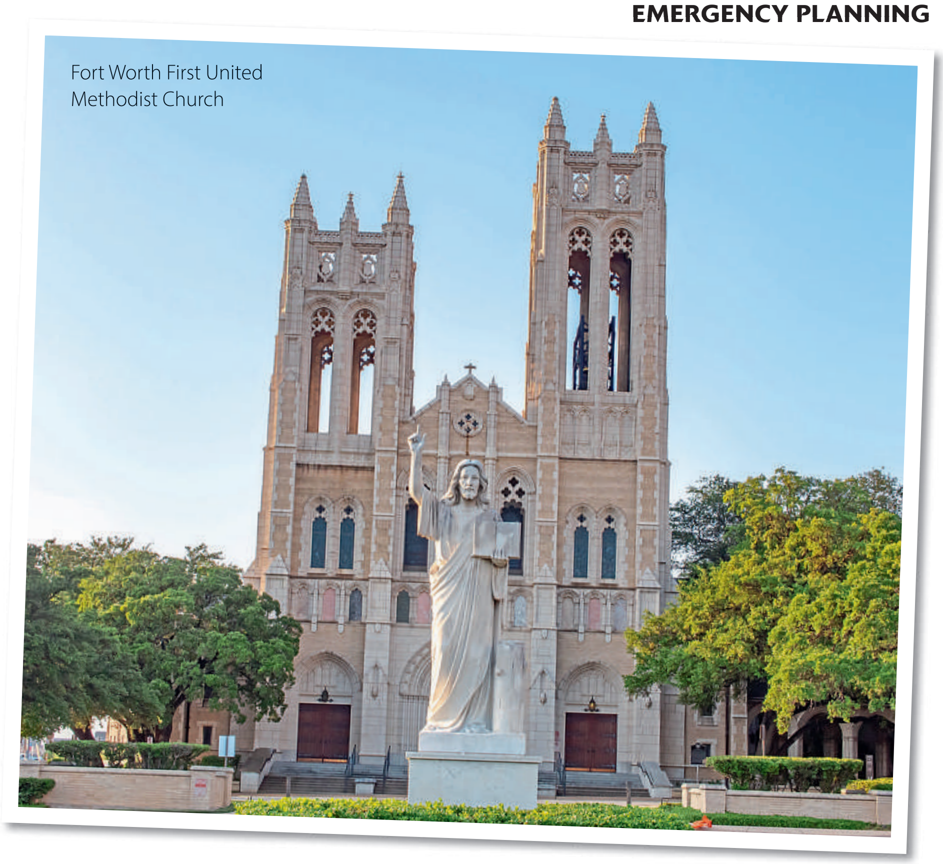
While scanning has enhanced the data for crime scene investigations, Hayes and Bain also saw the potential for scan data to contribute to public safety in an entirely new capacity through pre-event planning.

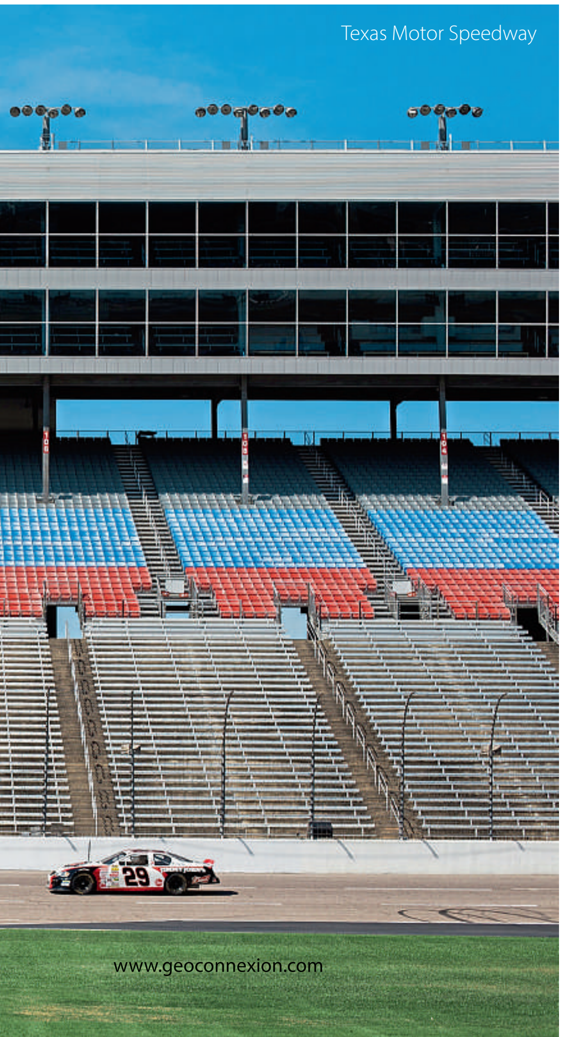
Pre-event planning is an unfortunate but necessary initiative in the wake of ever rising incident rates. Hayes and Bain, however, see the potential for technology to transform the way active shooter scenes are approached in the future, where point clouds and interactive spatial data enable more effective responses that mitigate danger and save more lives.

The FWPD's pre-event planning efforts involve scanning entire buildings and campuses to capture the reality of locations especially vulnerable to mass casualty incidents. Some of their larger captures include parts of the sprawling Texas Christian University campus and the Texas Motor Speedway, which hosts NASCAR events with a capacity of more than 190,000.

"Before, we used two dimensional layouts, and they're hard for people to digest and not always readily available," says Bain. "Having the scans as part of our vehicle for enabling pre-event planning allows officers that have never seen the inside of a site to go quickly to where they're needed and help as many people as possible."

With priority on scanning schools and high-profile venues, the FWPD envisions expanding to collect 3D data of all heavily trafficked sites in their area.


Fort Worth First United Methodist Church


Texas Motor Speedway

Site scanning for planning

Its most recent project, the First United Methodist Church, is a historic house of worship covering 3.5 acres in downtown Fort Worth. With the tragic mass shooting at the First Baptist Church in Sutherland Springs, Texas in 2017, among other recent attacks, documenting places where people gather for religious services is also important for pre-event planning.

Capturing the extensive church property, which offers daily preschool and hosts eight Sunday services with thousands of congregants, was "a daunting task", according to Hayes. "We have a total of 900 scans right now and it's growing – we have about four bundles, possibly five with our drone data."

Despite the size of the capture, they were able to undertake the project with only three officers and two Leica RTC360 scanners, making such pre-event planning efforts viable within departmental resources and capacity.

The connected, integrated future

While 3D models already provide enhanced resources for active incident interventions, Bain and Hayes hope their point clouds can eventually be used within an intuitive 3D interface enabling lifelike representation and visualisation. They also see the potential to better track and guide officers going into active scenes via GPS and internal building sensors.

"That's the ultimate plan," continues Hayes, "especially for police officers – to pull up a 3D view of a school with an active shooter, click on live feeds within the school and track our officers through these point clouds to their destination."

"We've seen the possibilities with interfacing software with hardware, and we're hoping that we could send officers and medical personnel to the right locations without them having to know the structure, divert crowds and even lead the suspect away from other possible victims," elaborates Bain. "We will start to control the situation, create a safe environment faster, and get help there sooner to save lives – that's the main goal."

Malgorzata Krol is the director of marketing communications – global public safety & forensics at Hexagon's geosystems division

THAT'S THE ULTIMATE PLAN, ESPECIALLY FOR POLICE OFFICERS – TO PULL UP A 3D VIEW OF A SCHOOL WITH AN ACTIVE SHOOTER, CLICK ON LIVE FEEDS WITHIN THE SCHOOL AND TRACK OUR OFFICERS THROUGH THESE POINT CLOUDS TO THEIR DESTINATION


At last...
precision for everyone.
Corrected GNSS
Antenna Receiver
✓ < 6-cm accuracy
✓ 60-day PointPerfect corrections
✓ Supporting SDK software
✓ Out-of-the-box operation
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Why should you use a Multi-Frequency, Multi-Constellation Smart GNSS Antenna?

Global Navigation Satellite Systems (GNSS) have grown from GPS only, to now include GLONASS, Galileo, BeiDou, and regional constellations such as Japan's Quazi Zenith Satellite System (QZSS) and India's NavIC, etc. At the same time GNSSs now broadcast two or more signals on different frequencies. The growth of the GNSS constellations and the availability of two or more signals per constellation has enabled unprecedented Position, Navigation and Time (PNT) accuracy and precision.

GNSS receiver and antenna manufacturers have kept pace with affordable receivers that can track all constellations and multiple signals. The combination of very capable receivers, antennas, and inter-operable GNSS constellations has led to widespread adoption over various applications. Figure 1 (1.25m rings) shows the typical accuracy for single (+/- 2.5m), dual (+/- 0.5m), and multi-frequency augmented positioning (30-60mm).

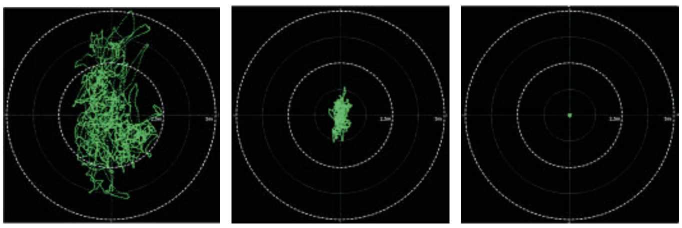

Figure 1: Progression of GNSS precision afforded by single, multi-band signals and PPP-RTK augmentation.

Benefits of Multi-Constellation and Multi-Signal GNSS

The number of GNSS satellites seen and their geometry is dependent upon the user's geographic location. At the equator the satellites seen are evenly distributed above and around the user. At the north and south pole no GNSS (MEO) satellites are seen directly overhead. However, typically there are between 30 and 40 satellites in view. With 30+ satellites in view the satellite geometry should be strong, and the receiver will be able to estimate an accurate position. The key advantages derived from multi-constellation, multi-signal, GNSS are that it enables the estimation of ionospheric and tropospheric errors, more satellites in view typically yields better satellite geometry and a more robust position estimate, it minimizes the effects of multipath, and it provides faster RTK and PPP-RTK convergence, supporting longer RTK baselines and a much more accurate position estimate.

GNSS Corrections: RTK and u-blox PPP-RTK

For this article, we will focus on the concepts of GNSS corrections (augmentation) without delving into the details. All raw GNSS measurements contain errors. These errors originate from satellite orbit and clock variations, atmospheric (ionospheric and tropospheric) effects, receiver errors, and signal multi-path. In this discussion, we will describe two GNSS correction techniques: Real Time Kinematic (RTK) and Precise Point Positioning (PPP)-RTK.

RTK is a relative positioning technique that relies on cancelling or minimizing errors by keeping the distance from the known base station to the rover short and then taking the difference of these measurements to cancel other errors. RTK requires a base station every 30 to 40 km. The base station makes its observations and its coordinates available to the rover. The rover then computes its coordinates. RTK position estimates have a relative accuracy of around 10 mm (short baseline), and the absolute accuracy is based on the accuracy of the base station. RTK solutions converge very quickly when the baseline is short; as the baseline gets long, it takes longer to converge, and the accuracy decreases.

PPP-RTK, on the other hand, is an absolute positioning technique that does not rely on a local base station. PPP-RTK has base stations that are used to track the GNSS satellites. The base station observations are sent to a central processing station, and the GNSS errors are estimated and then sent to the rover. The u-blox PPP-RTK service (PointPerfect) supports a typical accuracy of 20 to 60 mm and a convergence time of approximately 30 to 40 seconds within the service area.

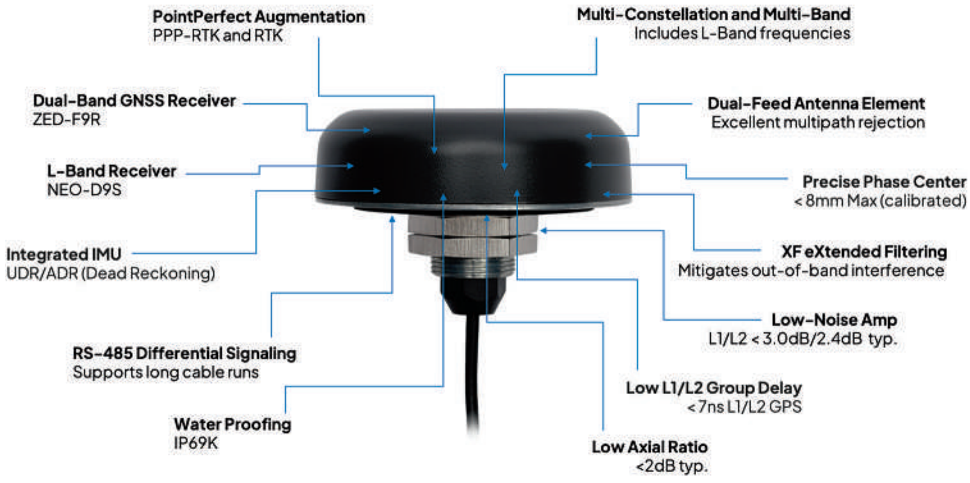

Figure 2 Tallysman's TW5390 Smart Antenna Features

Both RTK and PPP-RTK need a communication system to transmit the correction data to the rover. For example, RTK can use a radio link from the base station to the rover or an Internet Protocol (IP, NTRIP) message over cellular. PPP-RTK augmentation can be delivered using two different technologies: broadcast from a geostationary satellite directly to the TW5390 via L-Band or delivered over an IP link using the MQTT protocol.

Benefits of a *Smart* GNSS Antenna

Traditional GNSS installations placed the GNSS antenna on the roof or a mast and ran a coaxial RF cable to the receiver. This design is suitable for installation where the antenna and antenna cable are not subject to RF noise. Today's installations are increasingly complicated, and often, sensors are collocated; therefore, both the antenna and RF cables are subject to interference from these sensors or vehicle communications (RF Signals).

In a Smart Antenna, the GNSS antenna and receiver are in the same enclosure, often on the same PCB, and are shielded from these other sensors and RF noise. A smart antenna design provides the cleanest and purest signal to the receiver. With a clean and pure signal, the receiver can estimate the most accurate and precise measurements.

Tallysman's TW5390 Smart Antenna Features

Tallysman's TW5390 (See Figure 2) smart GNSS antenna integrates the industry leading TW3972XF, GNSS antenna and the u-blox ZED-F9x family of GNSS receivers. The antenna has many key features such as multi-constellation, multi-band, correction support (including L-Band options), a low axial ratio that provides excellent multi-path mitigation, a precisely calibrated phase center, Tallysman's eXtended Filtering (XF), a low noise amplifier that ensures a low noise figure and strong signal to noise ratio (C/No).

The TW5390 smart antenna is based on the u-blox ZED-F9x module family. The key GNSS features of the smart antenna are that it supports the following: u-blox dual band professional grade ZED-F9R chip, optional u-blox NEO-D9S module (L-Band augmentation), RTK and PPP-RTK, integrated Inertial Measurement Unit (IMU) (F9R), and offers several interface options (RS232, RS485, USB).

Multi-constellation and multi-band GNSS provide several benefits, but primarily, more observation on different frequency bands typically yields a more accurate and robust position estimate. An IMU can bridge short GNSS signal outages, such as when a vehicle passes through a short tunnel or under a bridge. Choosing a receiver family that offers a variety of configuration choices can optimize performance, cost, and flexibility.

Tallysman offers a TW5390 development kit that gives users a tested, robust, out-of-the-box smart GNSS antenna.

TW5390 Applications

Tallysman's TW5390 multi-constellation and multi-band smart GNSS antenna supports RTK and PPP-RTK correction/augmentation technologies. GNSS augmentation technologies enable real-time sub-6 cm positioning accuracy. These features and the features listed in the TW5390 Features section (see Figure 2) make the smart antenna an ideal positioning product for applications such as navigation and positioning for precision agriculture, unmanned aerial vehicles, autonomous vehicles, surveying, and all precision applications.

Contact Tallysman for the latest Smart GNSS antenna news.

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