Zebra DevCon 2023

ZEBRA

Locate What Matters

Carl Mower
Sr. Director, Engineering
Advanced Locating Technologies

Locate What Matters

Agenda

Zebra DevCon 2023

- Base principles
- Examples:
  - NFL NextGen Stats
  - Equipment tracking
  - Boeing worker safety
  - Crowd-sourced locate
  - Locating tractor-trailers
  - Using a drone to “read” warehouse inventory

Zebra DevCon 2023

Base Principles

ZEBRA TECHNOLOGIES

Locate What Matters

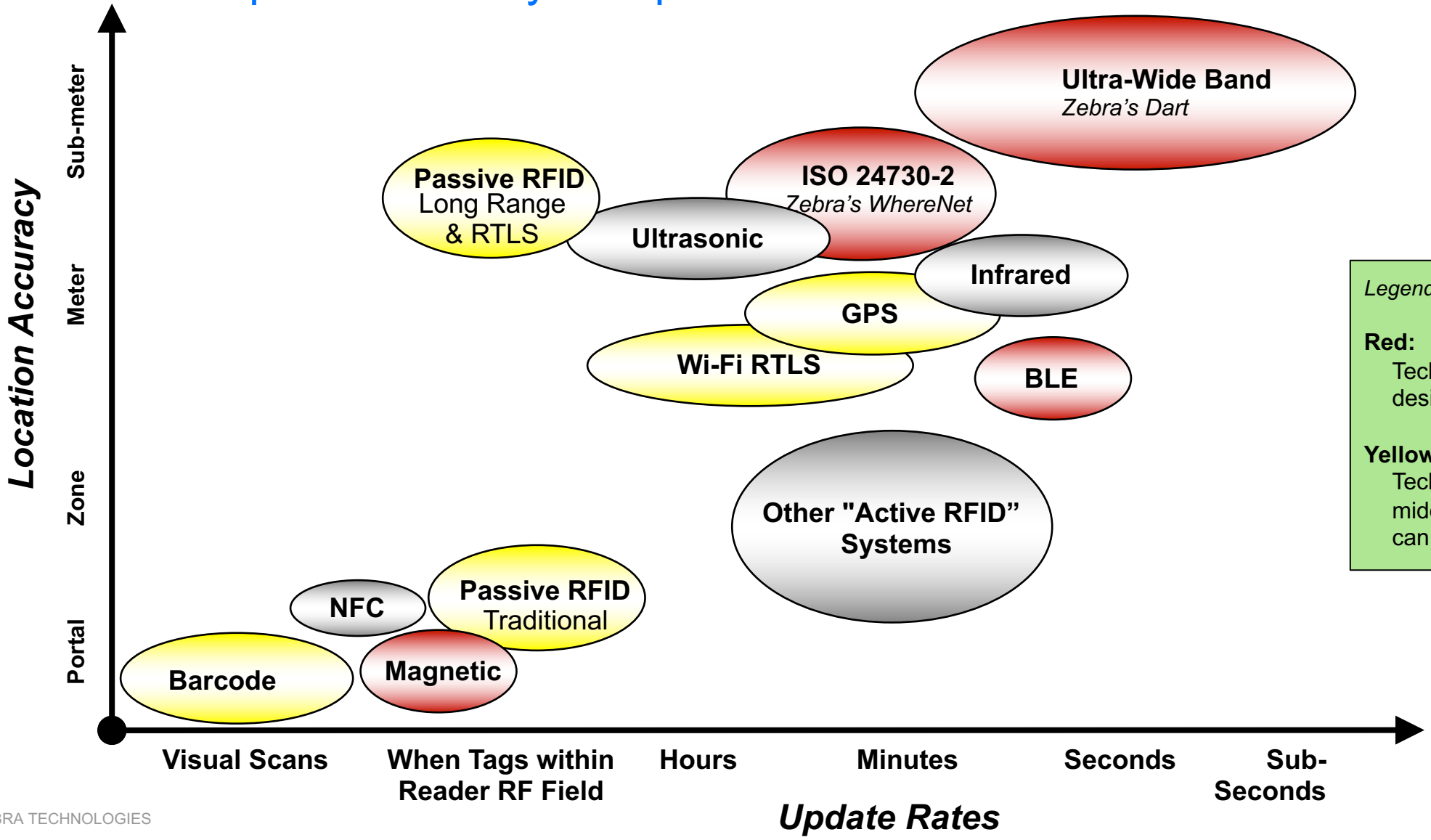
Base Principles: Taxonomy of Locate Solutions

Zebra DevCon 2023

- **Range** – Global vs 1km vs 200m vs 10m vs 4m
- **Accuracy** – subject to reflection/interference, time/angle/signal, and size of common error
- **Precision** – 7m vs 2.5m vs 1m vs 25cm
- **Determinacy** – know every second, every 5 minutes, every time someone checks
- **Infrastructure** – existing (Wi-Fi), externalized (satellite/cellular), simple, complex
- **Deployment** – traditional cabling , receivers and antennas vs stick-up tags and an app
- **Battery Life** – recharge daily, replace batteries yearly, replace tags every 5-10 years
- **Interoperability** – at the tags, at the reader/receiver, at the locate engine, above the middleware
- **Cost** – of the tag, of the infrastructure, of the deployment, of the maintenance

Locate What Matters

Base Principles: Accuracy vs Update Rates



Legend

Red:
Technologies Zebra designs & builds

Yellow:
Technologies Zebra middleware software can consume.

Locate What Matters

Base Principles: Methods of Locating & Unavoidable Truths

Zebra DevCon 2023

Different ways to locate…

Calculation

- Includes trilateration based on time-difference of arrival (TDOA), angle of arrival, signal strengths. Typically, surround the area to locate objects in with infrastructure.
- DART, WhereNet, GPS, WiFi (gen-2)
- Typically, tightly coordinated clocks

Presence – portal entry/exit, beacons

- Locate to nearest beacon (or extrapolate between two)
- WiFi (today), passive RFID, Magnetic

Crowd-sourced – sniffers are roaming

- Apple Tags

Hybrid – combinations of the above

All solutions have these pieces…

Somebody "chirping" (often the target, but not always)

- GPS: satellites
- UWB, WhereNet: player tags
- BLE: cheap beacon stuck to IV-pump
- WiFi: the AP –or– the laptop/client

Somebody "listening" (often infrastructure, but not always)

- GPS: the handheld
- UWB, WhereNet: fixed infrastructure receivers
- BLE: Zebra mobile computer or dedicated badge
- WiFi: the AP –or– the laptop/client

Typ. one end "pays the price" (cost, complexity, battery…)

- GPS: expensive satellites
- UWB, WhereNet: receivers much more expensive than tags
- BLE: the mobile computer (tags relatively cheap & simple)
- WiFi: both sides are expensive (exception to the rule)

Zebra DevCon 2023

NFL NextGen Stats

ZEBRA TECHNOLOGIES

Locate What Matters

NFL NextGen Stats: Tracking every player, every venue

Zebra DevCon 2023

- Every player
- Every venue
- Every week for 8+ years
- Every football
- Every referee

Locate What Matters

NFL NextGen Stats: How viewers experience the data

Zebra DevCon 2023

Locate What Matters

NFL NextGen Stats: Venue infrastructure

Zebra DevCon 2023

Zebra Sports GameDay Tracking Solution

TWO NICKEL-SIZED SENSORS THAT EMIT UNIQUE RADIO FREQUENCIES 25 TIMES PER SECOND

20 RECEIVERS MOUNTED BETWEEN UPPER & LOWER DECKS COLLECT DATA IN REAL-TIME

ALGORITHMS AGGREGATE PLAYERS' STATS AND DISPLAY IT ON ANALYTICS SOFTWARE IN REAL-TIME

CREATION OF MOST ROBUST DATABASE IN SPORTS FOR REAL-TIME USE BY MEDIA PRODUCERS

Locate What Matters

NFL NextGen Stats: Player & Ball tags

Zebra DevCon 2023

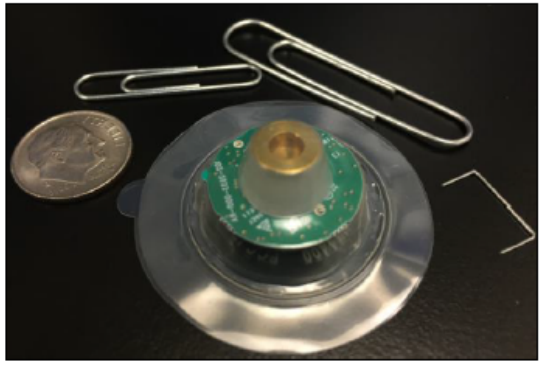
Zebra Sports Player and Ball Tracking

ZEBRA PLAYER TAGS

Size: Diameter < 1” **Weight:** 6.7 grams

Smallest Form Factor In The Marketplace
Low Touch Factor: Battery Lasts Entire Season
Impact And Water Resistant

ZEBRA INSTRUMENTED FOOTBALL



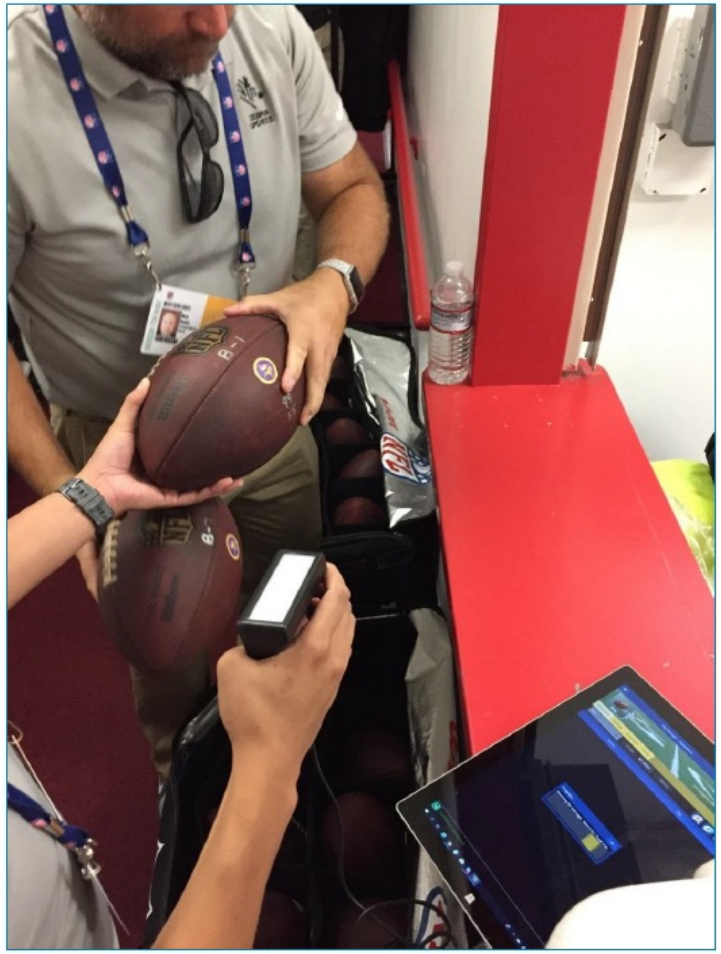
Locate What Matters

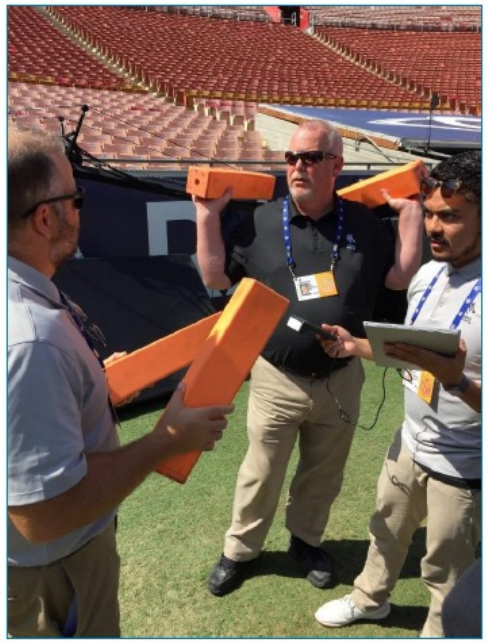
NFL NextGen Stats: Installing tags under pads

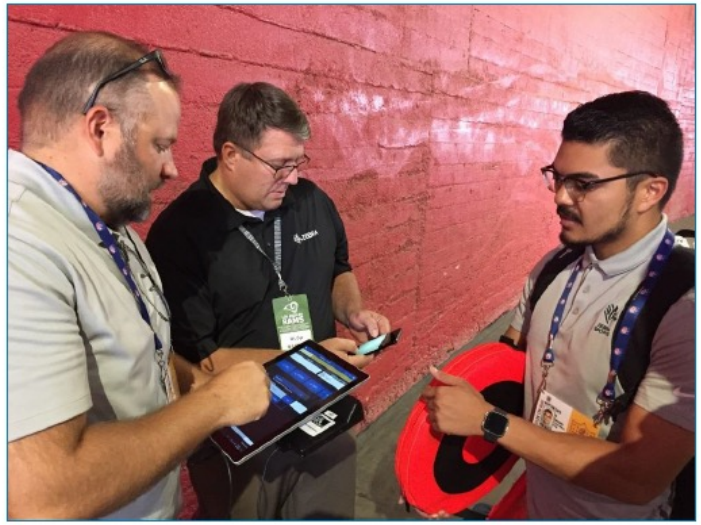
Locate What Matters

NFL NextGen Stats: Activating footballs & equipment

Zebra DevCon 2023



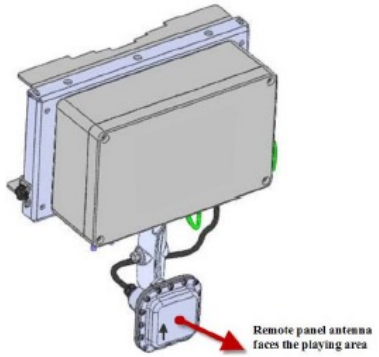


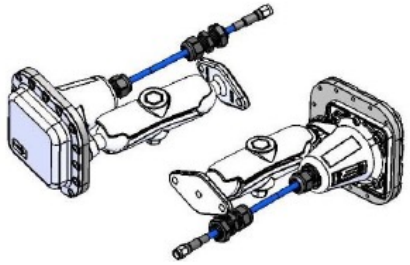


Locate What Matters

NFL NextGen Stats: Infrastructure (receivers)

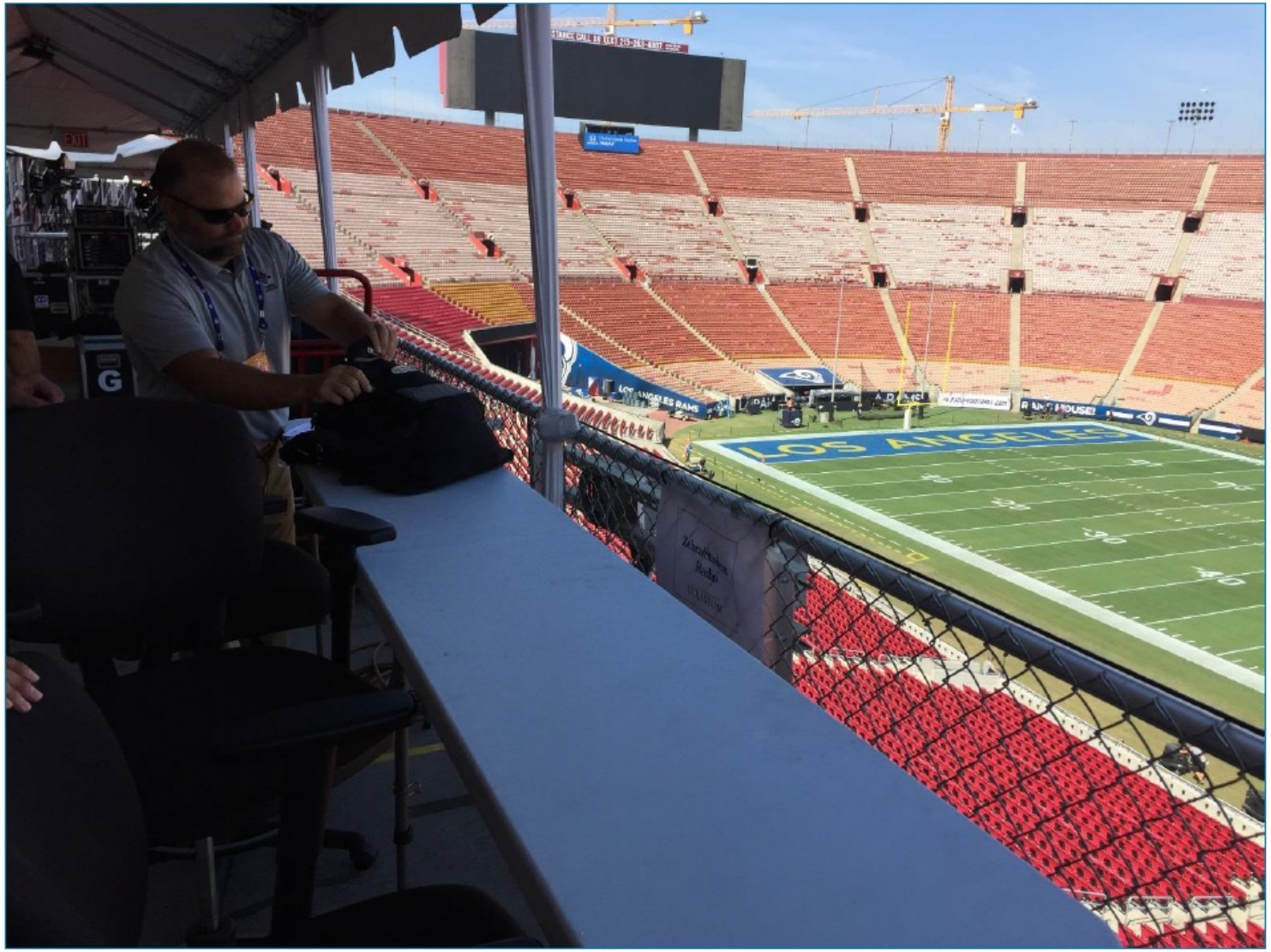
Zebra DevCon 2023



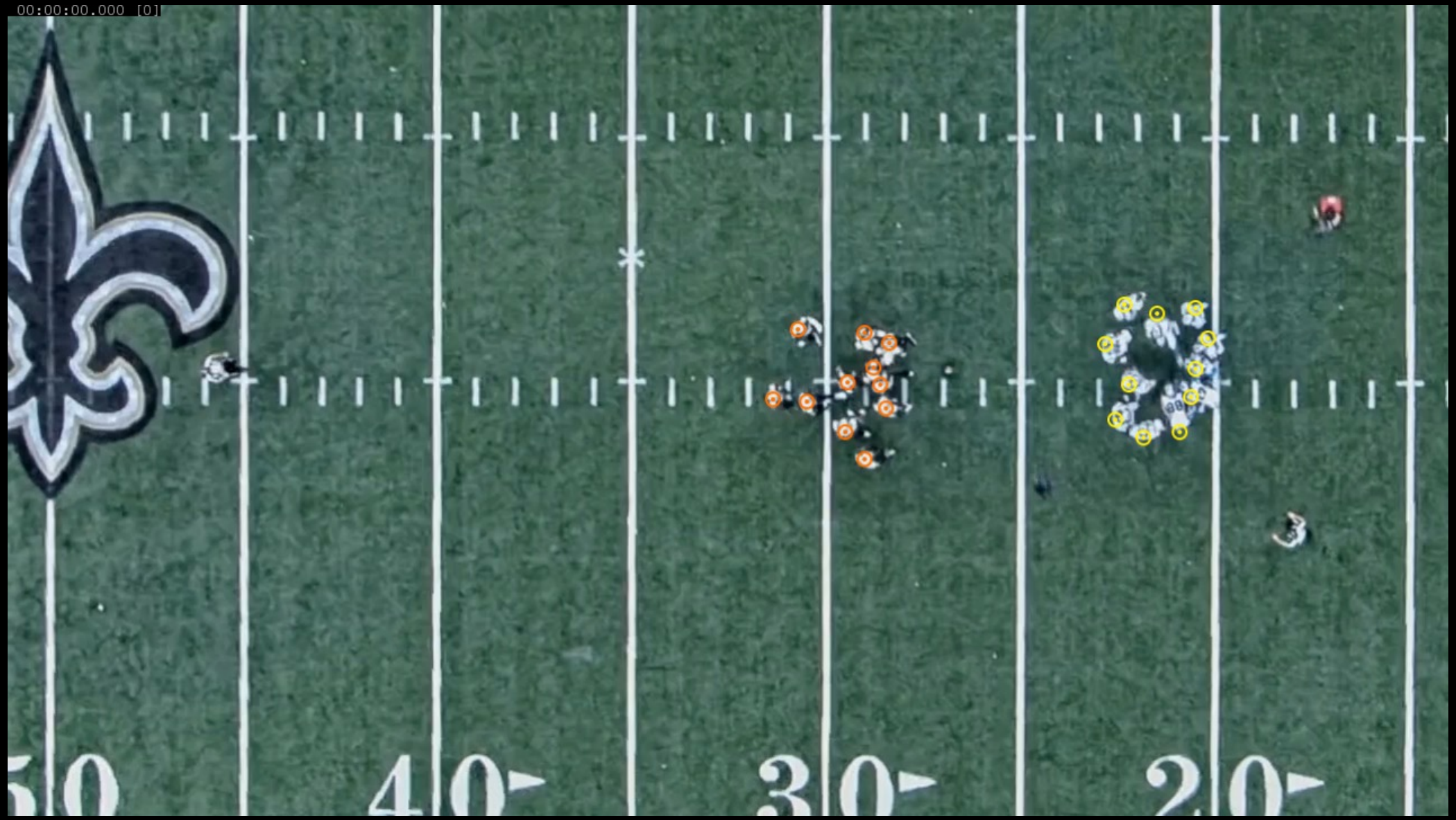


Locate What Matters

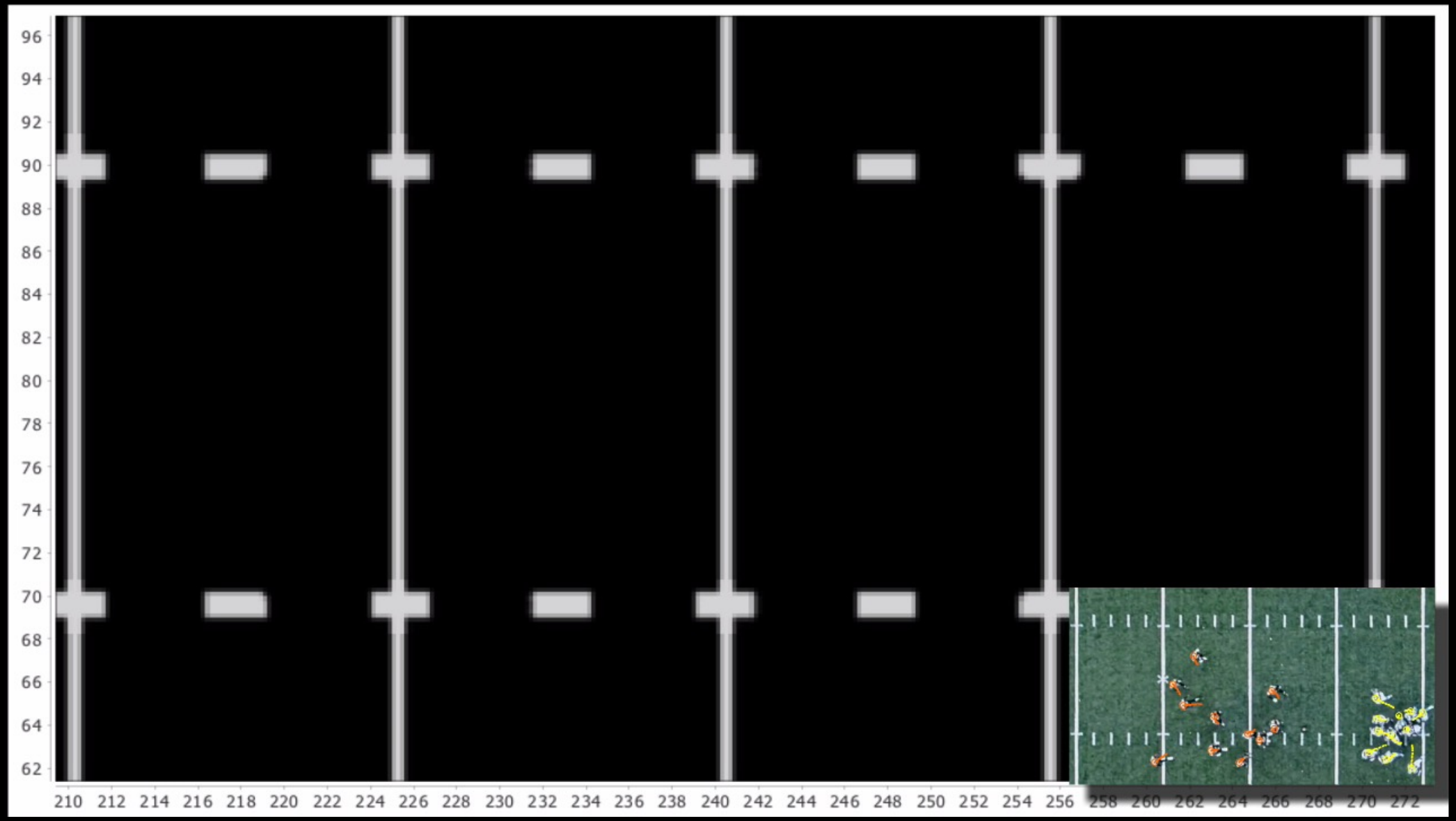
NFL NextGen Stats: Where operators sit



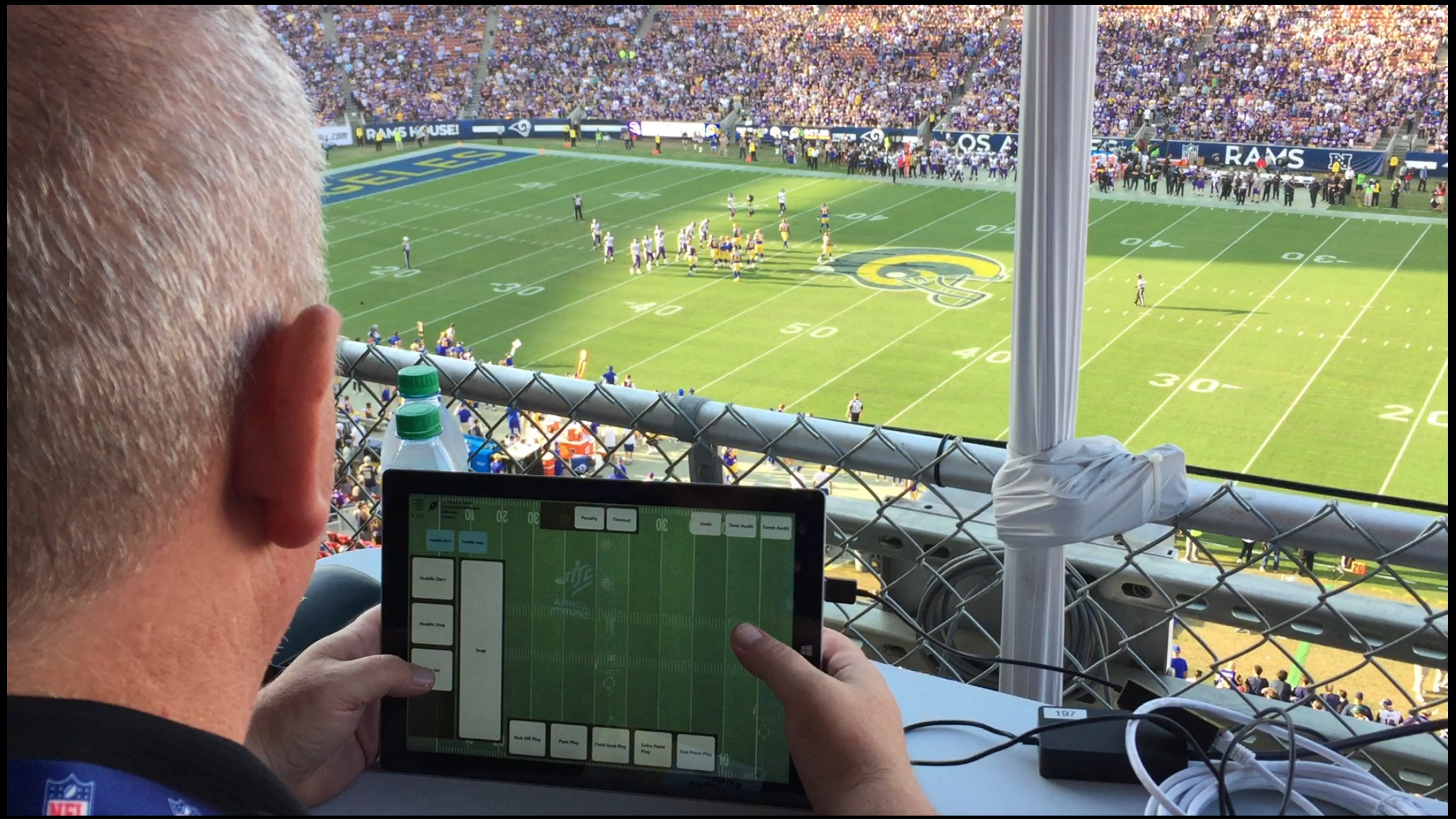
Kalman Filtered Output (30sec)



Raw Hub Output (30sec)

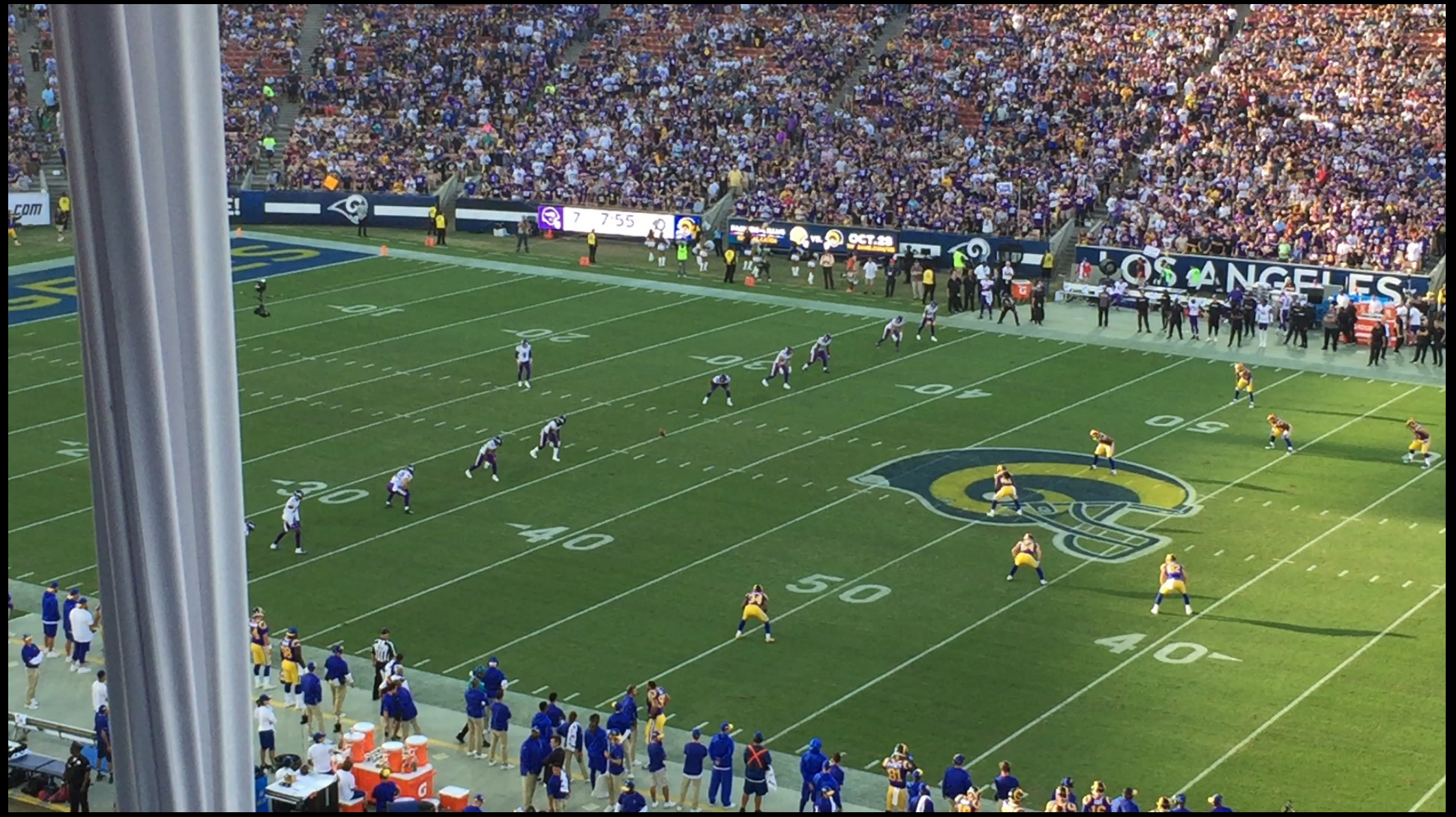


Play Logger (19sec)



Play Editor (9sec)

The End-to-End (16sec)



Zebra DevCon 2023

Equipment Tracking

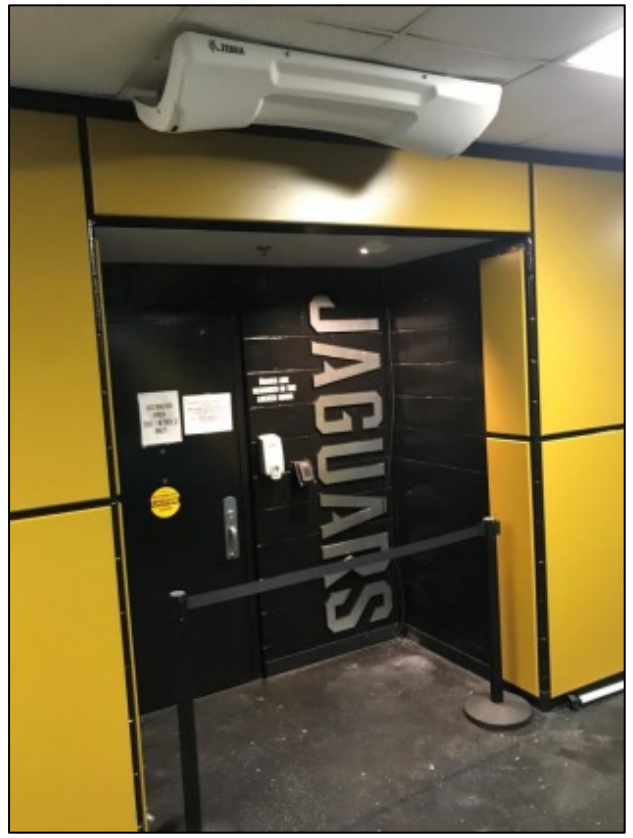
ZEBRA TECHNOLOGIES

Locate What Matters

Equipment Tracking: Using RFID Reads at a Point-in-Time

Zebra DevCon 2023

- Even a short-range RFID read is a “locate”
- The target was at that reader at that time

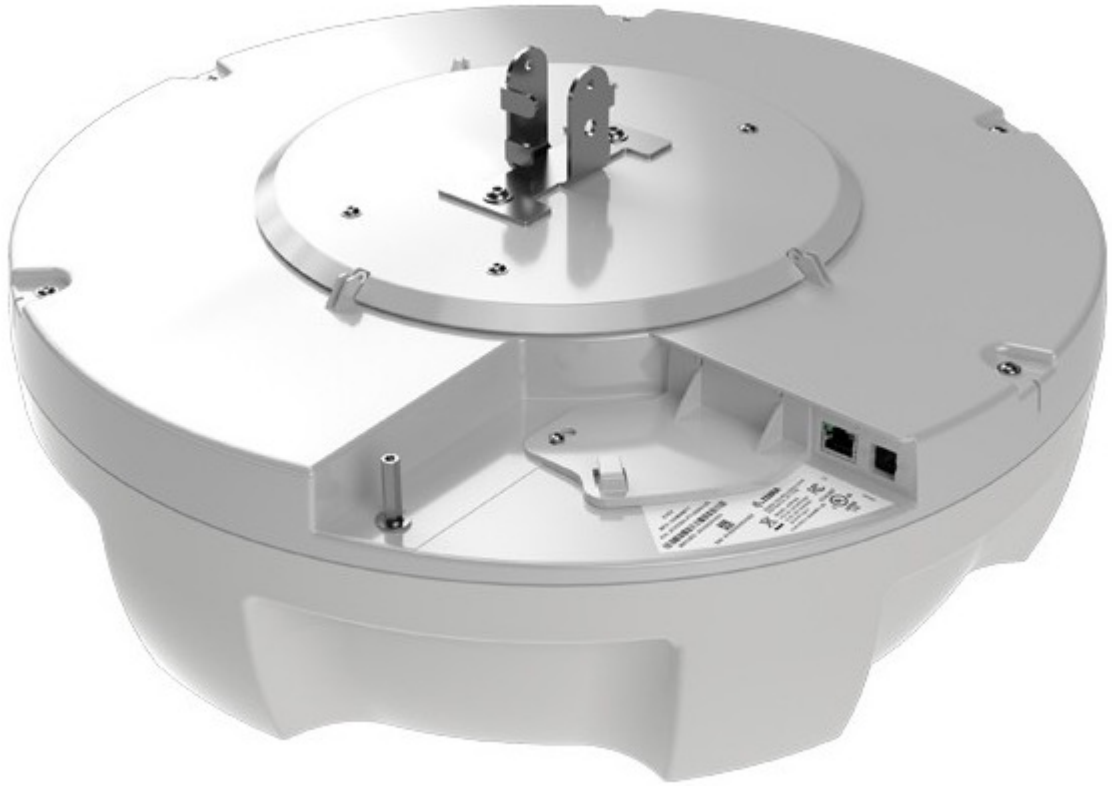


Locate What Matters

Equipment Tracking: Using ATR to literally tri-angulate

Zebra DevCon 2023

- Phased-array can create narrow virtual read beams
- A checker-board of ATRs can tri-angulate to less than a meter
- All with inexpensive passive RFID tags



Zebra DevCon 2023

Boeing: Worker Safety

ZEBRA TECHNOLOGIES

Boeing Supplier of the Year (safety)

Boeing Fall Protection Solution

BENEFITS TO CUSTOMERS

- Non-Invasive solution to challenging safety/protection environments.
- Improved protection versus human safety spotters.
- Cost savings versus human safety spotters.
- Reduction of on-site system maintenance/support footprint as compared to offering as a collection of customer-managed components.
- Rewarded Zebra as Supplier of the Year – Safety!

Boeing: Platforms hanging from ceiling

Boeing Overview – platforms (24 sec)

Boeing: Ensuring workers “clip in”

Boeing Overview – painting (13 sec)

Zebra DevCon 2023

Crowd-sourced locate

ZEBRA TECHNOLOGIES

Locate What Matters

Crowd-Sourced Locate: Using the many to find the target

Zebra DevCon 2023

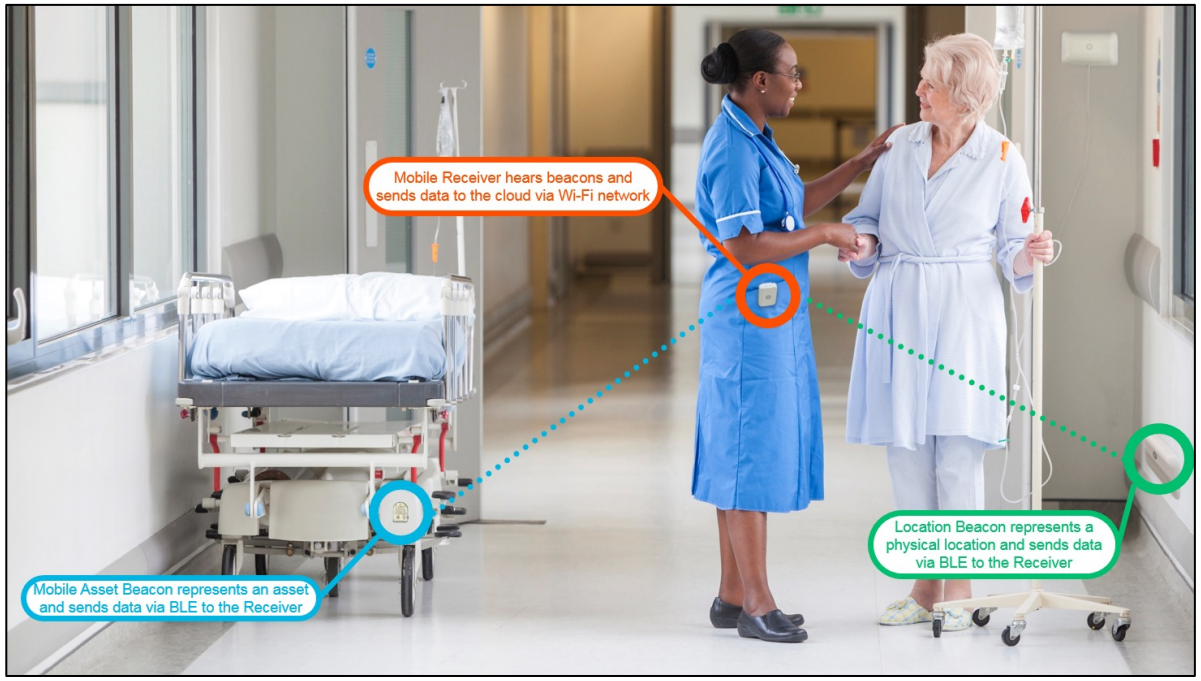
Staff moving around the hospital, “bump into” the IV pumps trying to locate

Use cases:

- Where are my IV pumps (assets)?

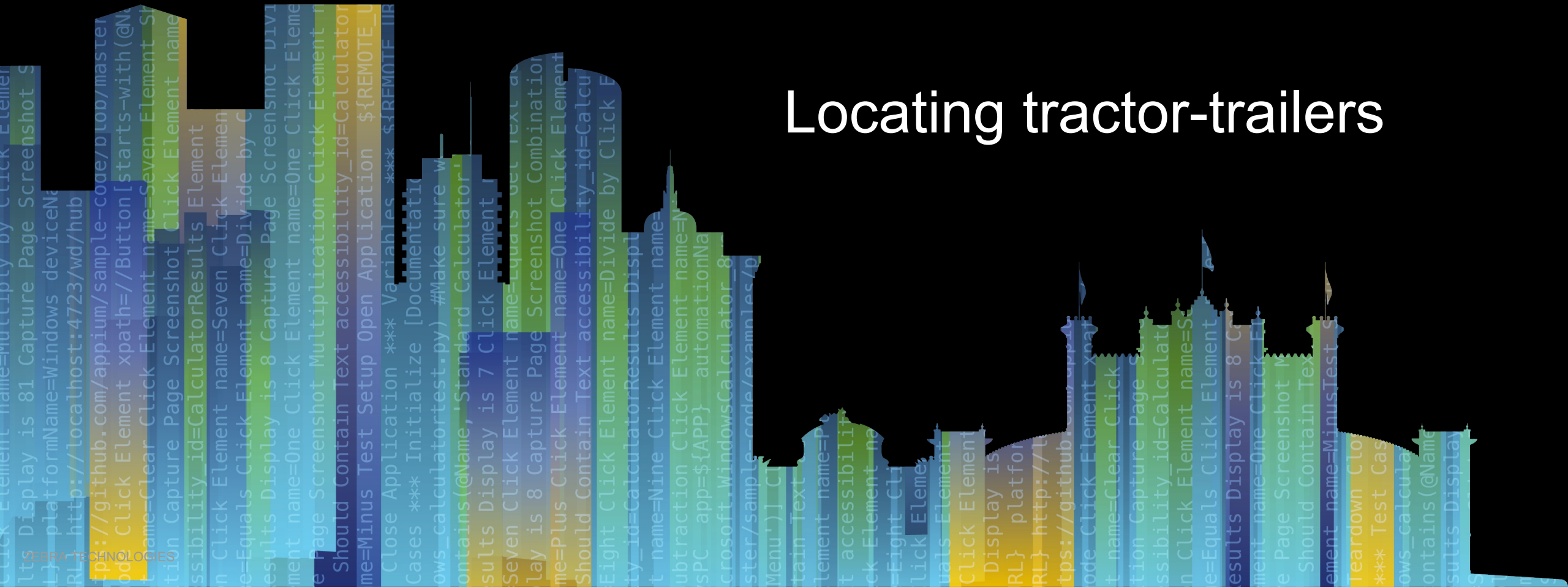
Solution components:

- Assets wear beacons
- Rooms have location beacons
- Staff wears mobile receiver
- Storage rooms have fixed receivers
- Uses Hospital’s existing WiFi



Any staff that roams the hospital is suitable

Zebra DevCon 2023



Locating tractor-trailers

ZEBRA TECHNOLOGIES

Locate What Matters

Locating Tractor Trailers: 1m accuracy over 1km territory

Zebra DevCon 2023

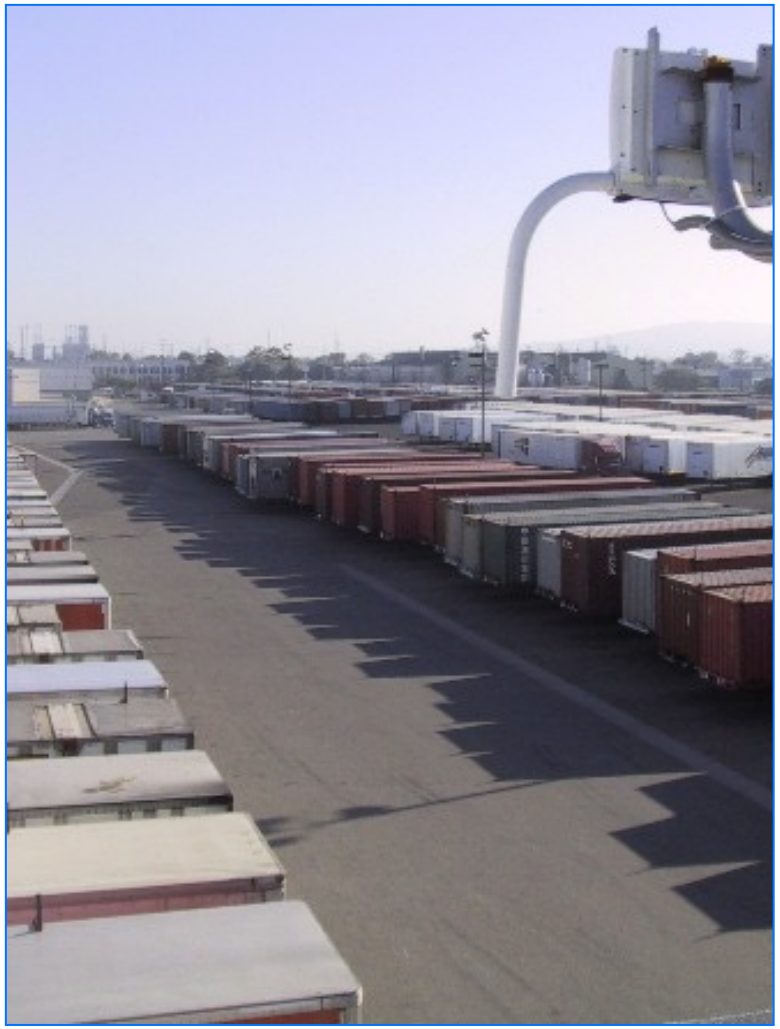
T&L: Yard Management

Managing trailer traffic from gate to yard to door and back out again.

Use cases:

- Where is trailer #123 ?

A “gate” with WhereNet readers



A typical “yard” with WhereNet reader

Zebra DevCon 2023

Drone “reading” warehouse

ZEBRA TECHNOLOGIES

Locate What Matters

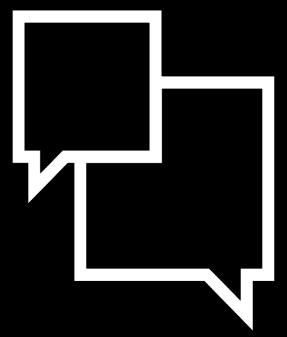
Drone “reading” Warehouse: Moving the reader

Zebra DevCon 2023

Locate the reader

- GPS does not work indoors
- Use UWB to precisely locate/fly the drone
- Drone has a barcode reader

“System of record .vs. System of reality”

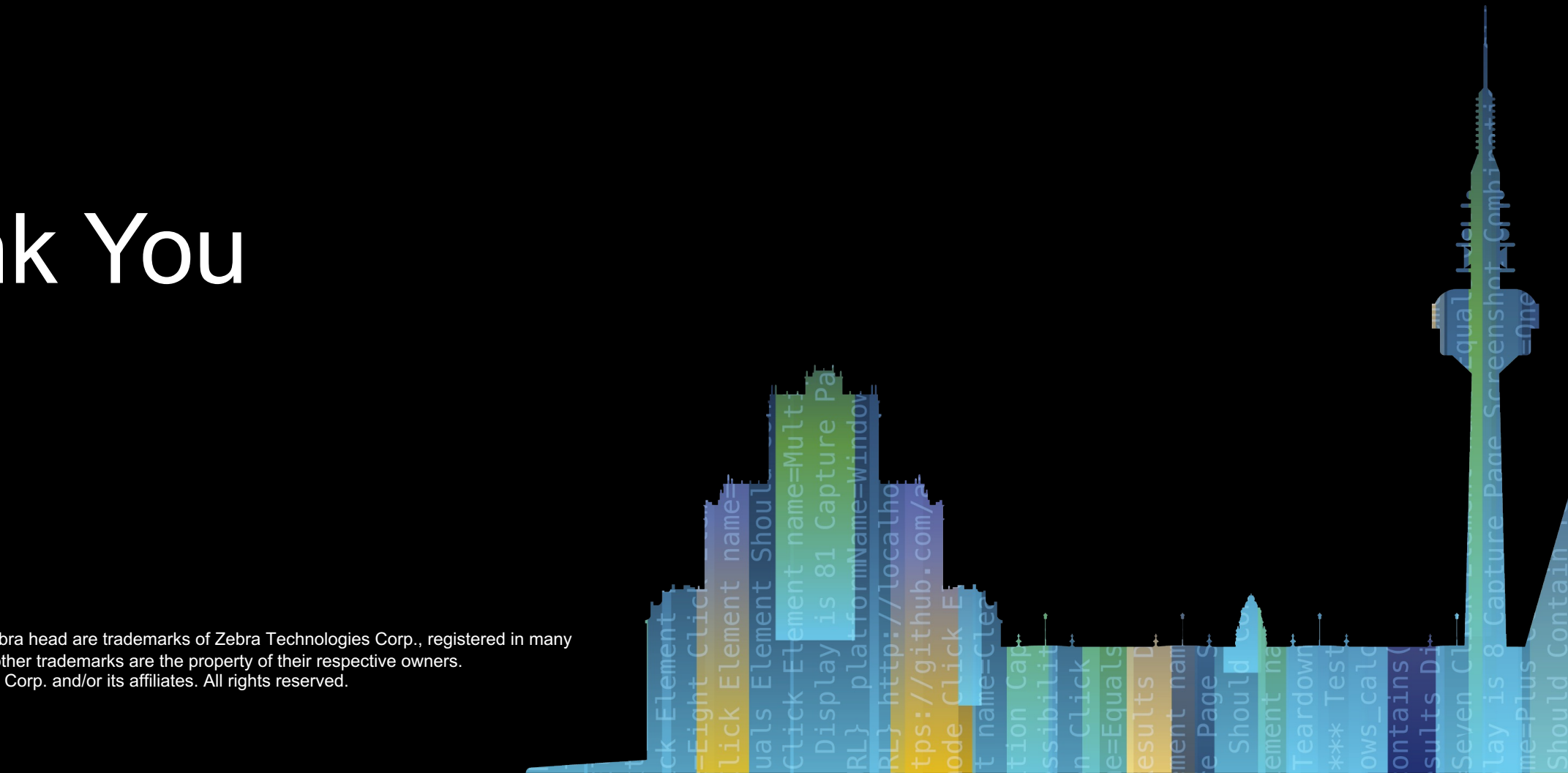


Questions

Zebra DevCon 2023

ZEBRA

Thank You



ZEBRA and the stylized Zebra head are trademarks of Zebra Technologies Corp., registered in many jurisdictions worldwide.All other trademarks are the property of their respective owners.
©2023 Zebra Technologies Corp. and/or its affiliates. All rights reserved.