Perception at the edge to heal the HERE HD Live Map

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Edge Perception

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HERE in numbers

200
Countries mapped

9,000+
Employees in 56 countries focused on delivering the world's best map and location technologies

30+
Years of experience transforming location technology

4 of 5
In-car navigation systems in Europe and North America use HERE maps

400+
HERE cars collecting data for maps

HERE Maps on board of
100M
vehicles and counting

28
TB map data collected per day

700,000
3D data points per second per car

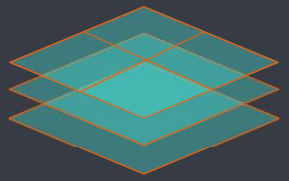
HD Live Map covering
555k+ km
for Autonomous Driving

Key building blocks for autonomous driving

HD maps are essential in autonomous solutions

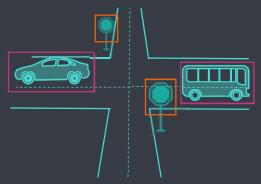
Sensors

Intelligent sensors to see, feel and sense surroundings



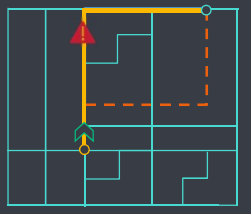
HD Maps

Highly detailed, helping pinpoint a car's location and understand its surroundings



Perception Stack

Real-time information for localization and path planning



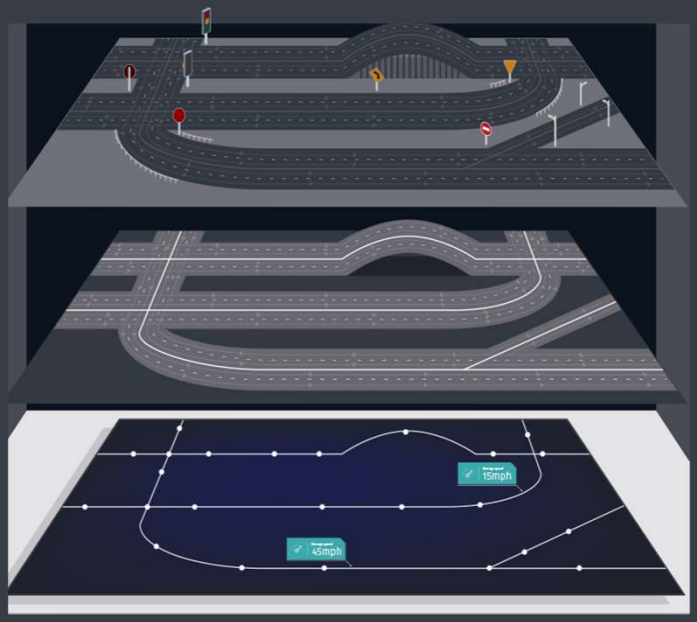
Decision Making

Deep learning and sensor fusion for decision making

HERE HD Live Map

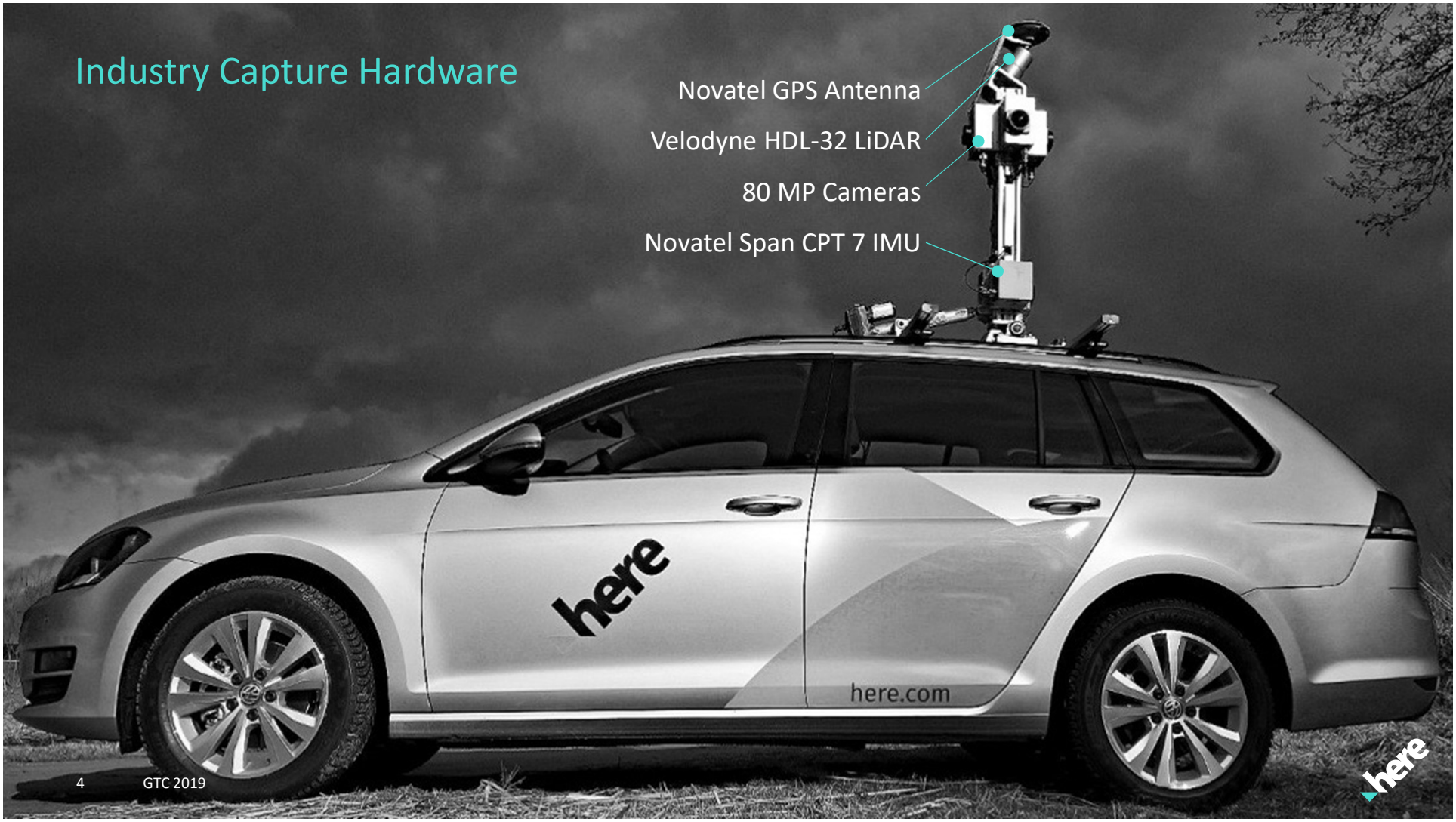
Data layers providing key benefits

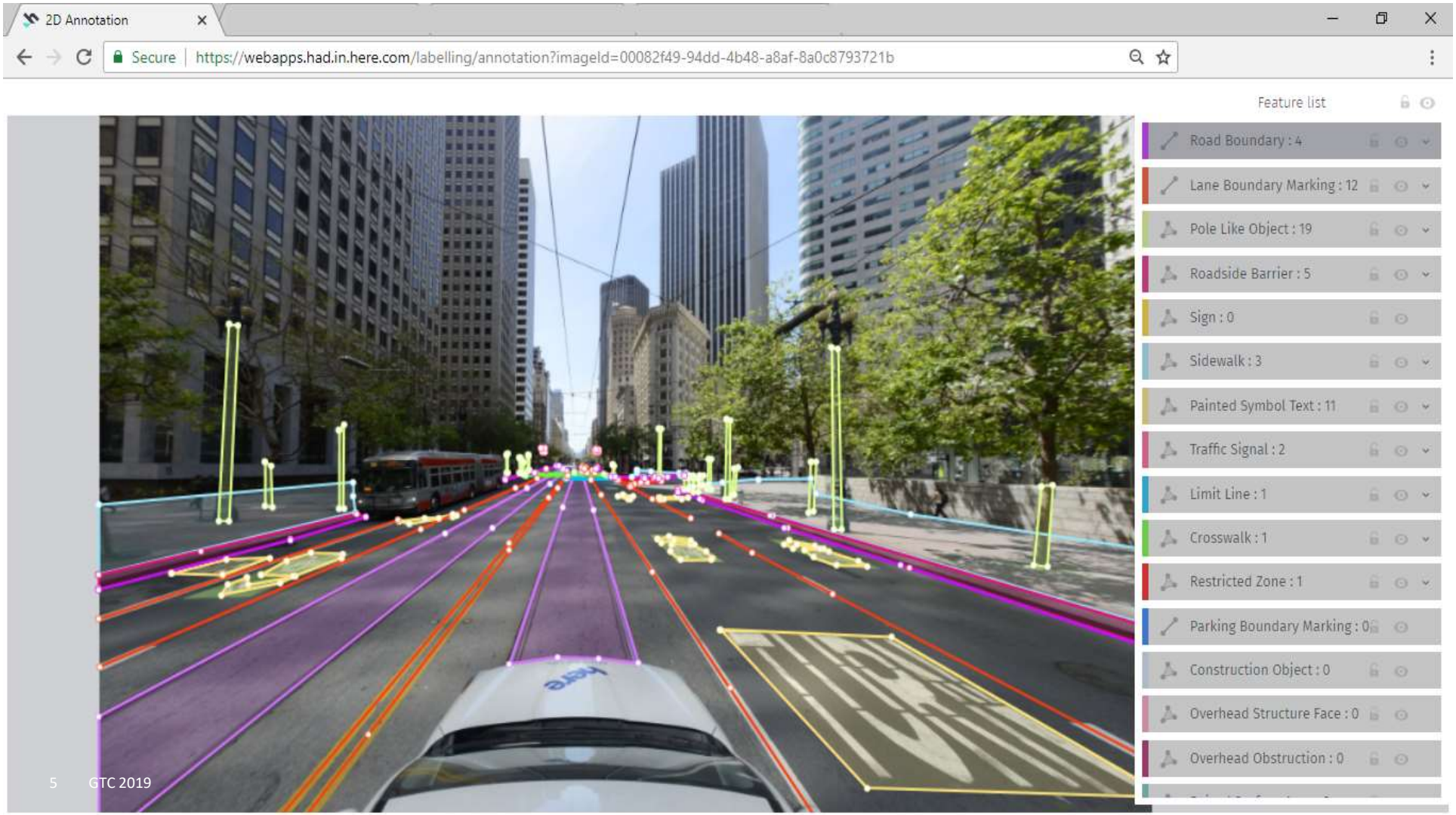
Published in NDS and Protobuf formats

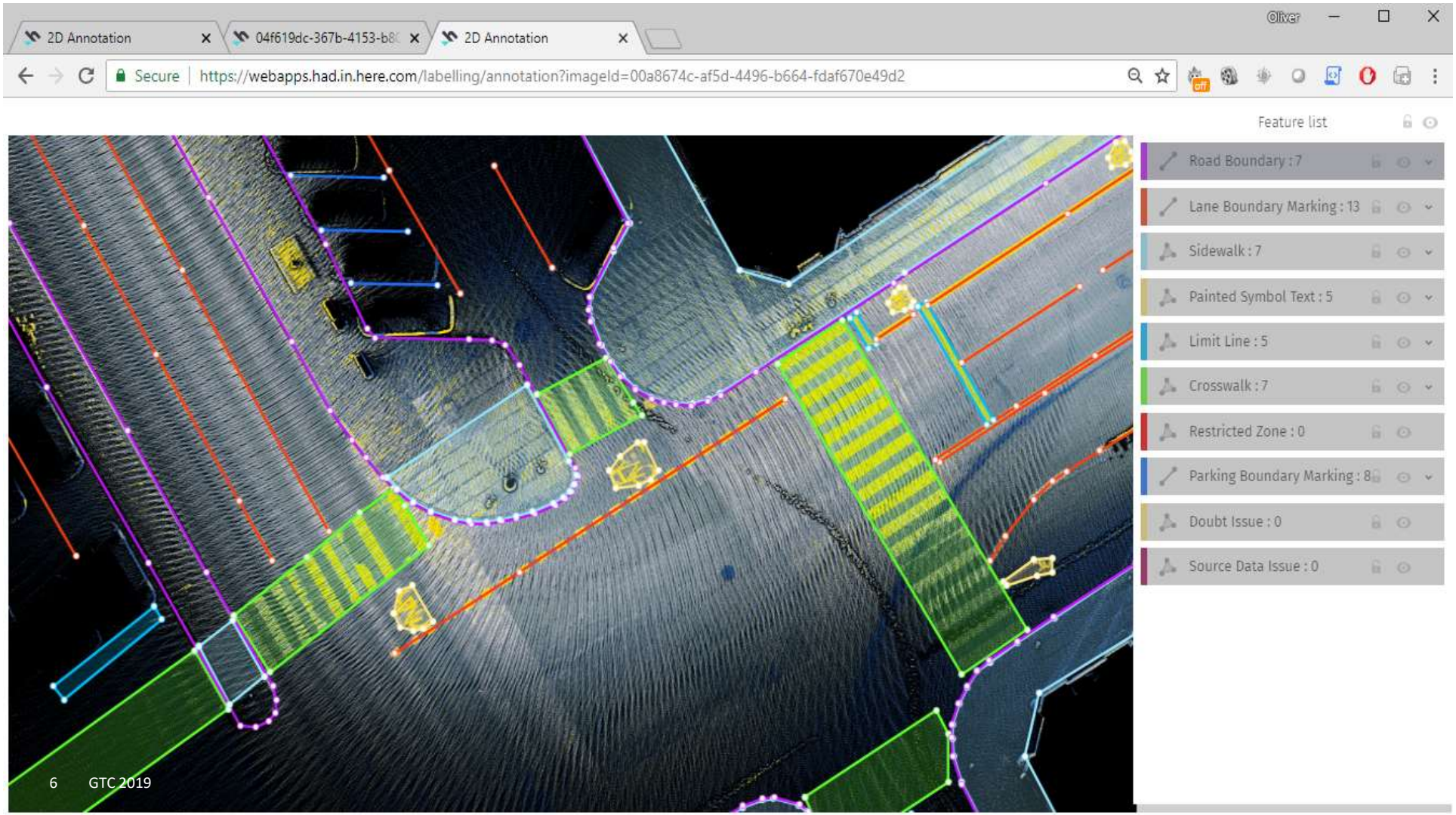


Layer	Data	Benefits
HD Localization Model	Road side objects (furniture) Ex: road signs, barriers	Localization Enhanced sensor functionality
HD Lane Model	Lane level features Ex: Lane lines, lane widths, lane markings, etc.	Localization Route planning Rules of the road Enhanced sensor functionality
Road Model	HERE's Standard Definition (Infotainment) map with ADAS attributes Ex: Road topology, direction of travel, elevation, slop, etc.	Route planning Rules of the road Enhanced sensor functionality

Industry Capture Hardware




2D Annotation
Secure
https://webapps.had.in.here.com/labelling/annotation?imageId=00082f49-94dd-4b48-a8af-8a0c8793721b
Feature list
Road Boundary : 4
Lane Boundary Marking : 12
Pole Like Object : 19
Roadside Barrier : 5
Sign : 0
Sidewalk : 3
Painted Symbol Text : 11
Traffic Signal : 2
Limit Line : 1
Crosswalk : 1
Restricted Zone : 1
Parking Boundary Marking : 0
Construction Object : 0
Overhead Structure Face : 0
Overhead Obstruction : 0


2D Annotation
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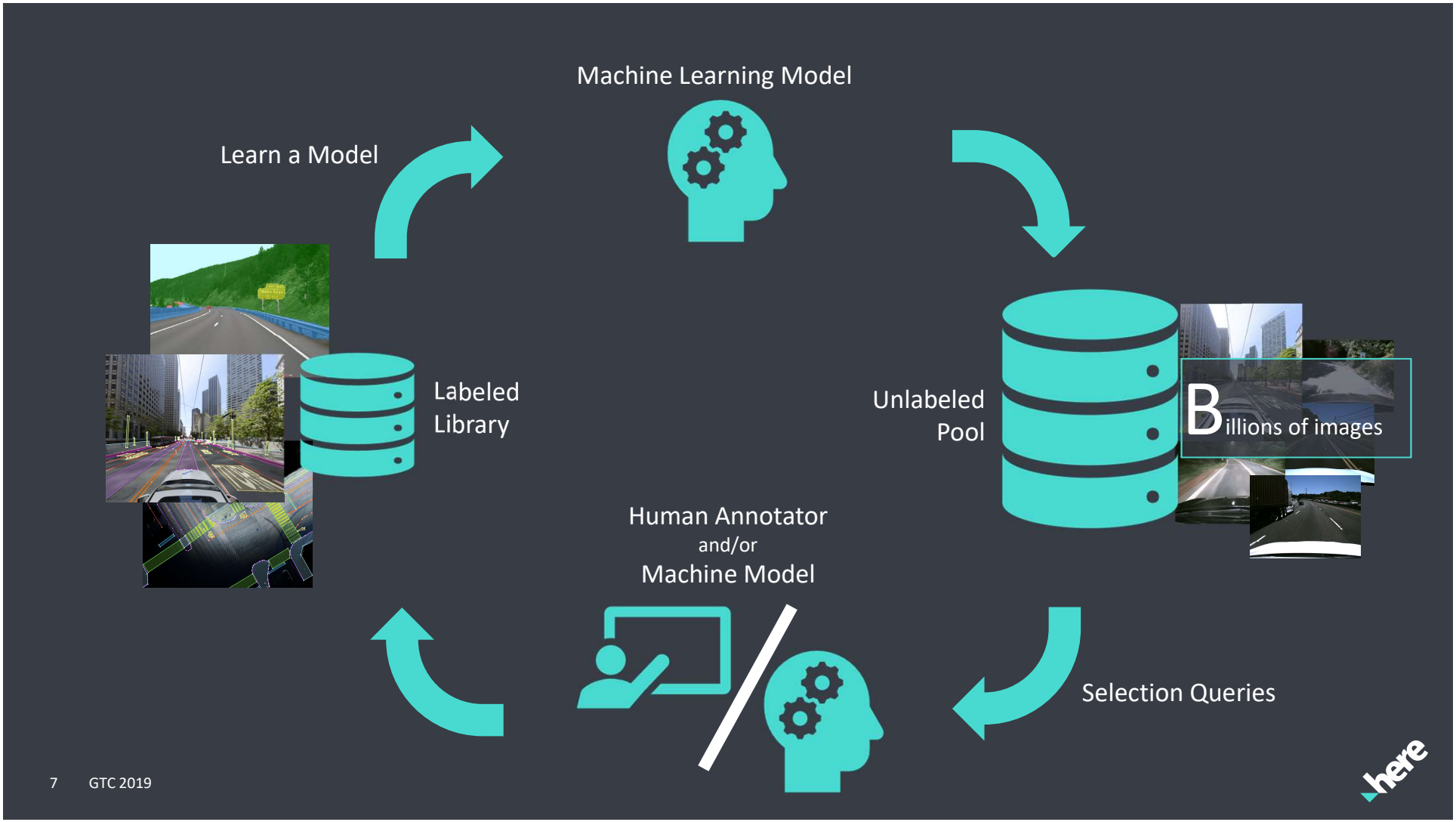
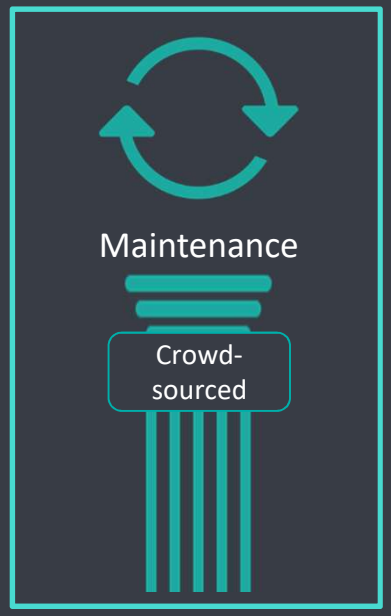
2D Annotation
Oliver
Secure
https://webapps.had.in.here.com/labelling/annotation?imageId=00a8674c-af5d-4496-b664-fdaf670e49d2
Feature list
Road Boundary : 7
Lane Boundary Marking : 13
Sidewalk : 7
Painted Symbol Text : 5
Limit Line : 5
Crosswalk : 7
Restricted Zone : 0
Parking Boundary Marking : 8
Doubt Issue : 0
Source Data Issue : 0


Machine Learning Model
Learn a Model
Labeled
Library
Unlabeled
Pool
Billions of images
Human Annotator
and/or
Machine Model
Selection Queries

HERE's Maintenance Strategy to HD Maps



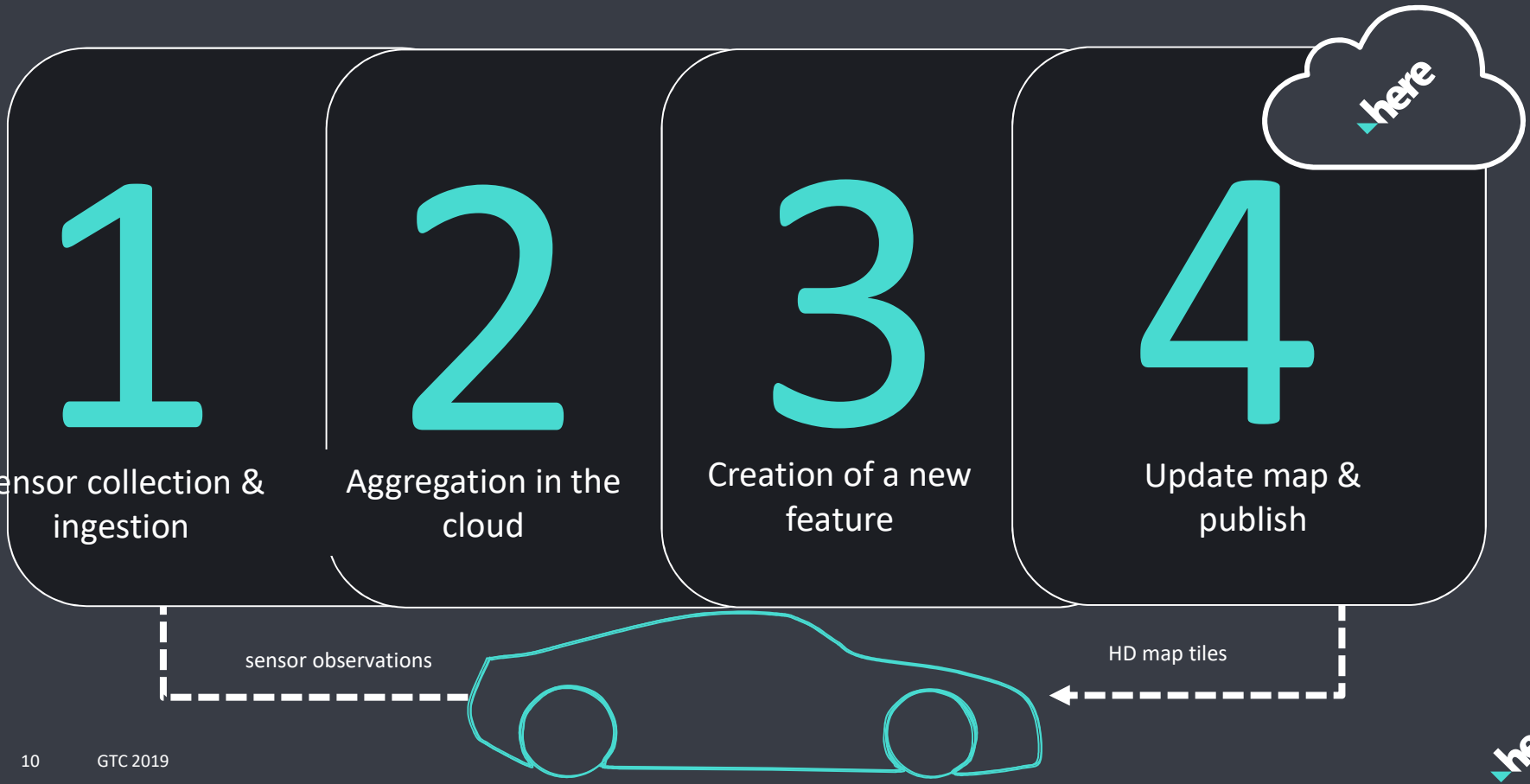
- The world isn't static, it's constantly shifting and evolving
- Mapping systems that support autonomous driving functionalities require rapid map updates to reflect real-world changes
- Freshness can only be achieved through a constant and broad flow of sensor data
- Map maintenance is transitioning from a systematic industrial capture (HERE True) mapping model to a self-healing crowd-source model

A high definition, continuously updated map requires the crowd

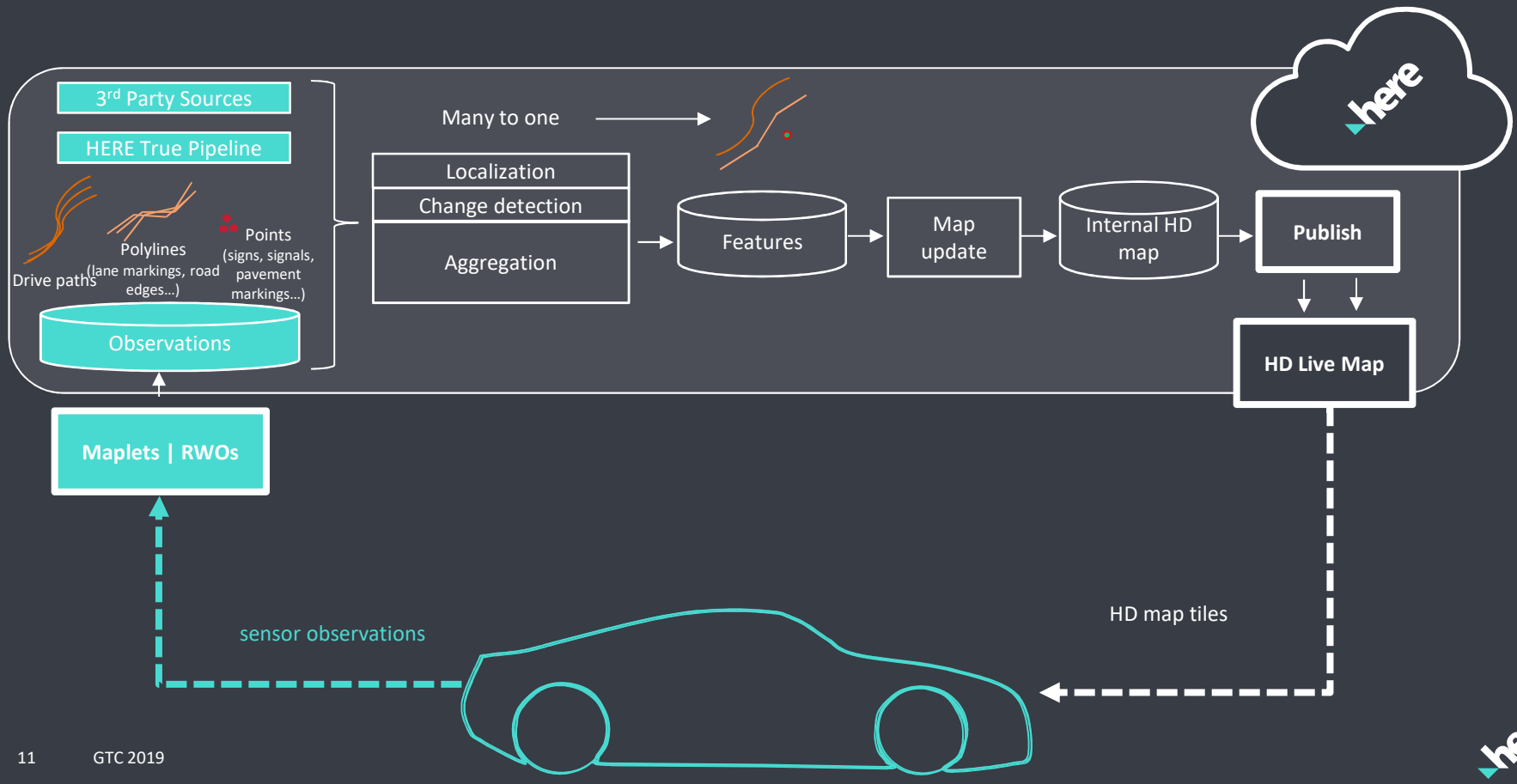
Harness crowdsourced sensor data…

…for near real-time updates

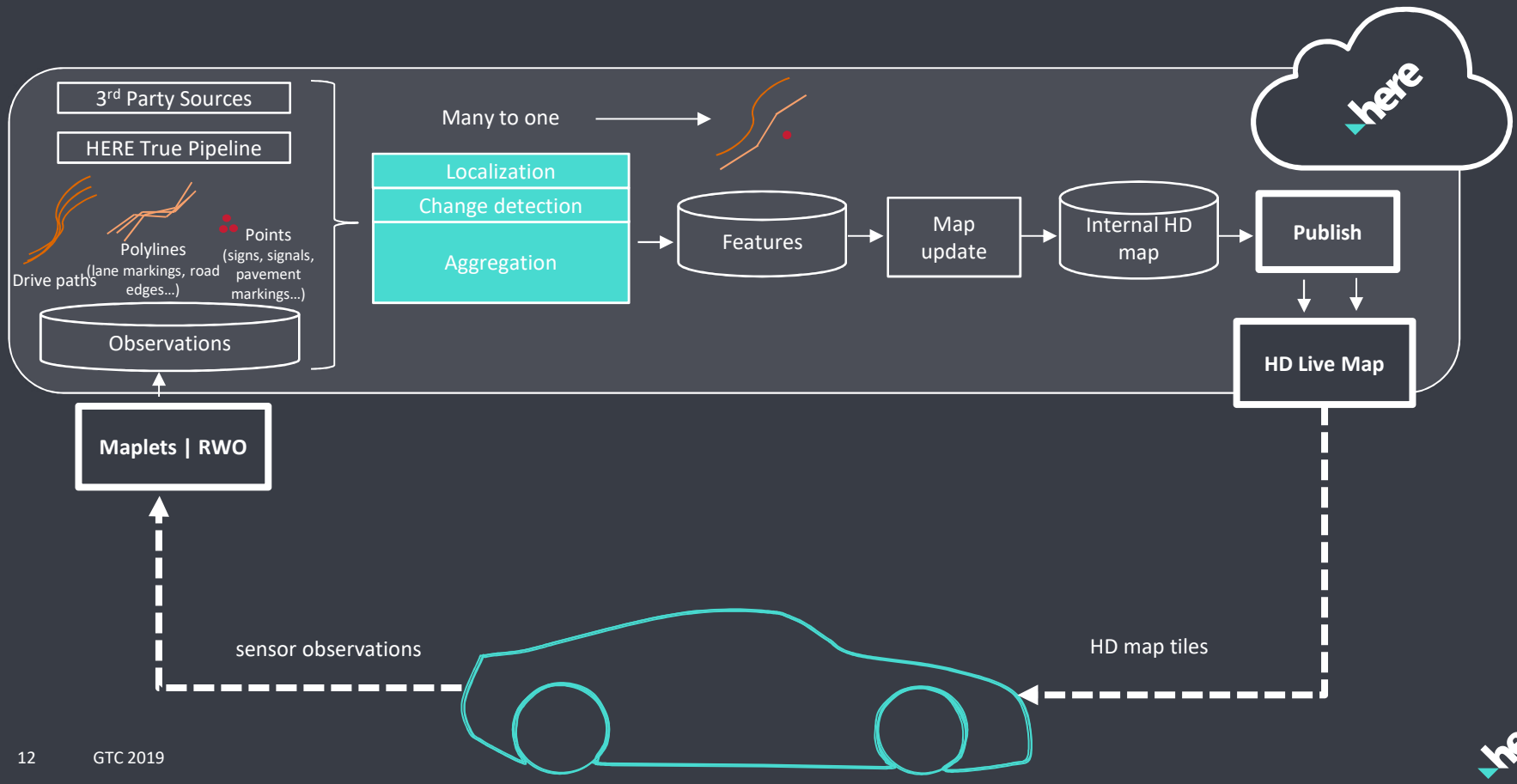
HERE's self-healing map process



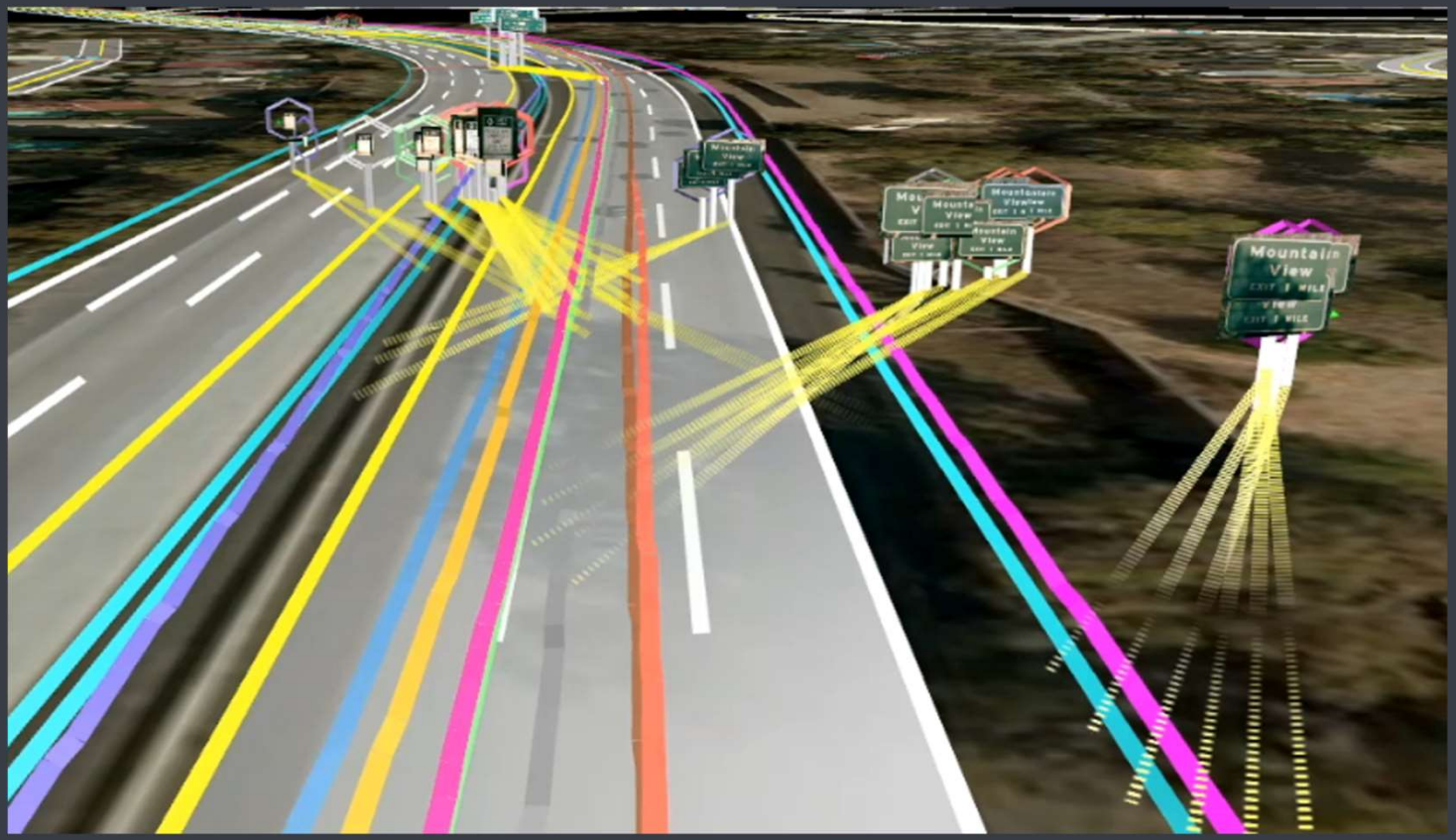
HERE's self-healing map process



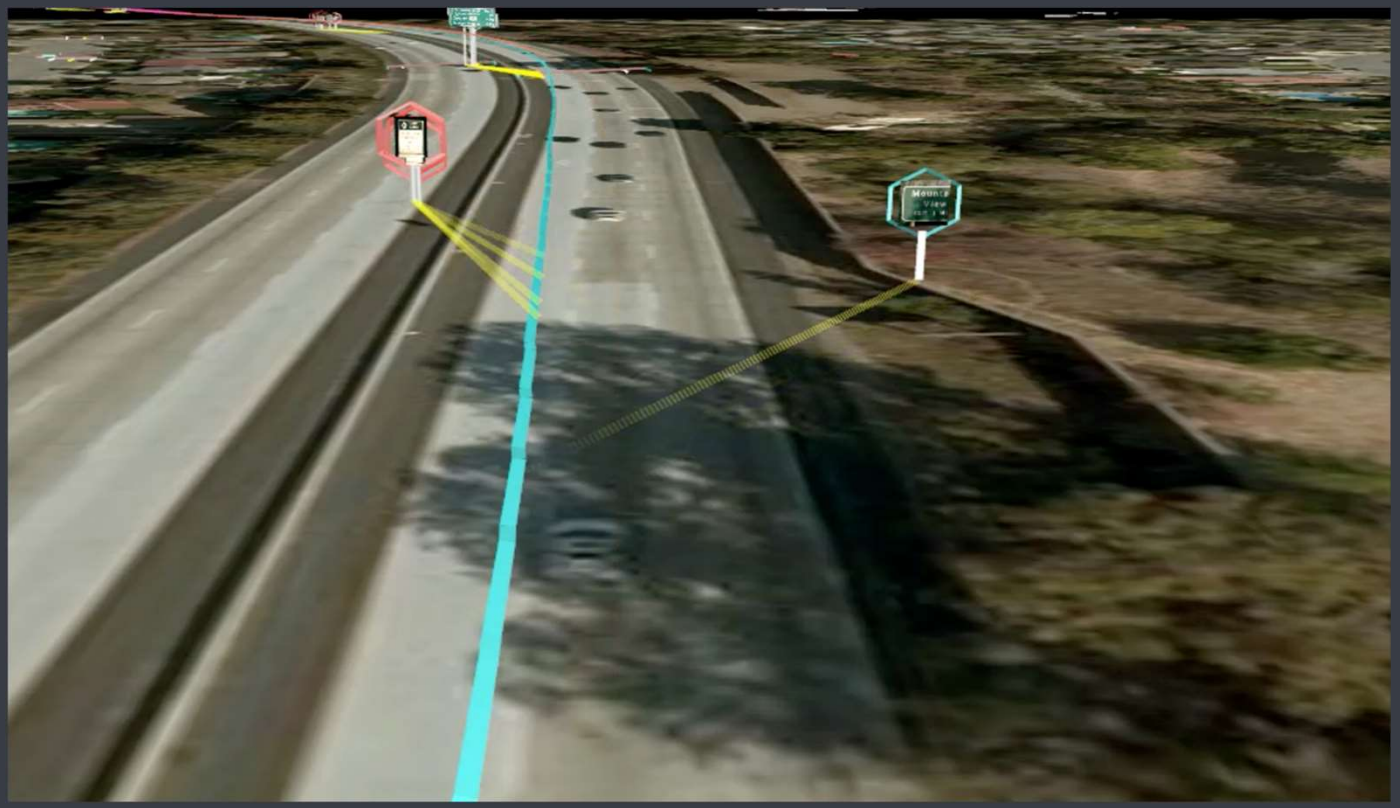
HERE's self-healing map process



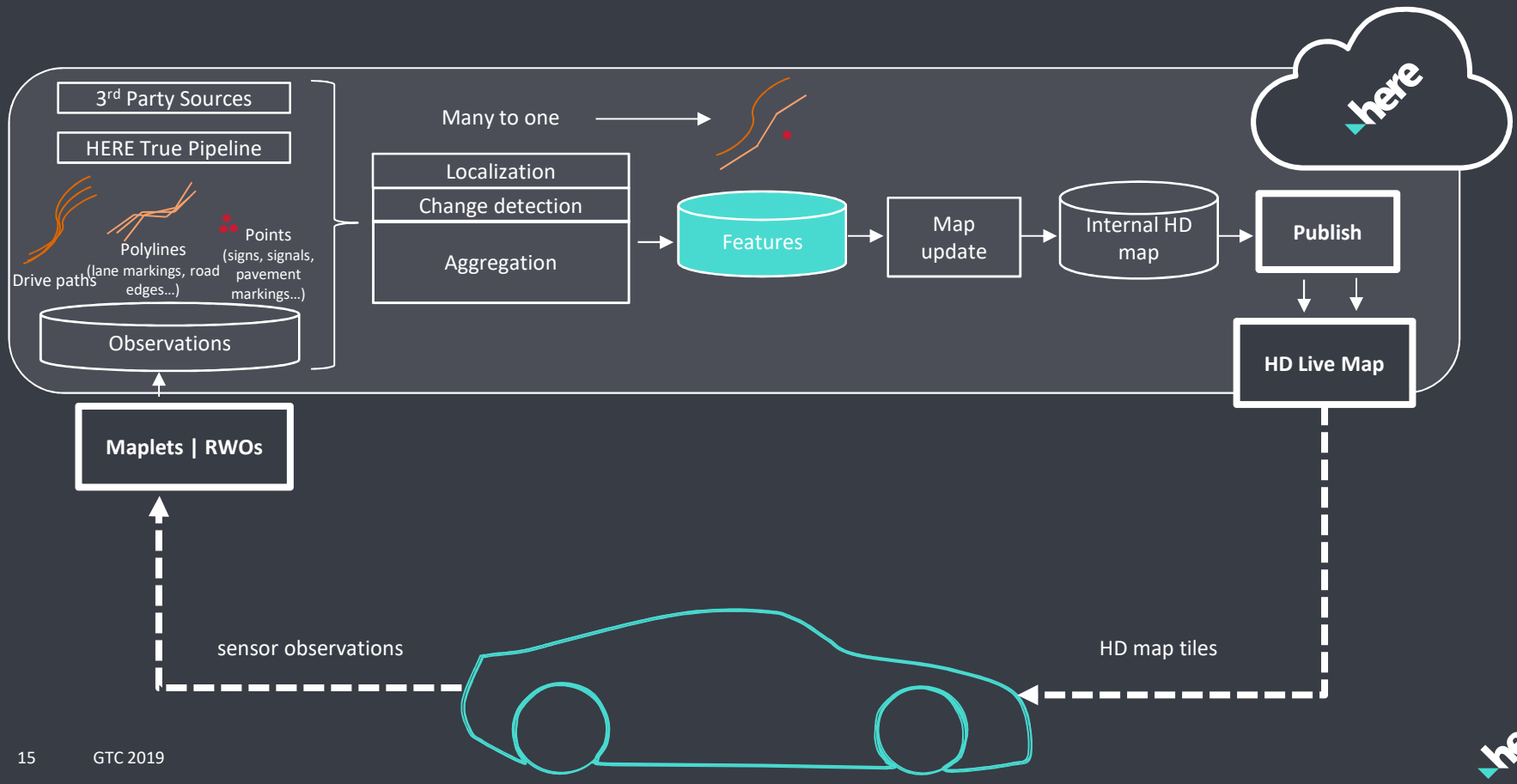
Aggregation



Aggregation



HERE' self-healing map process



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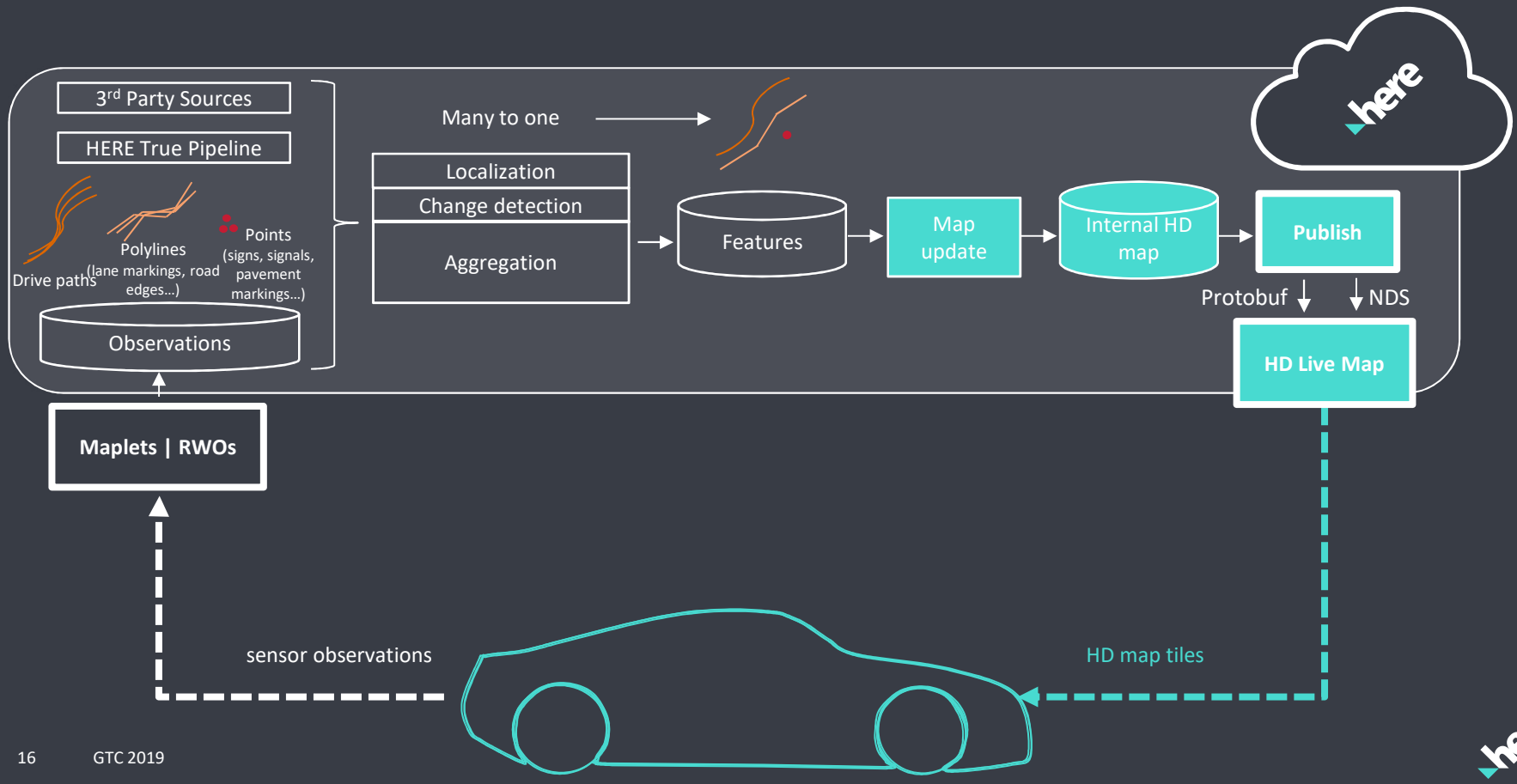
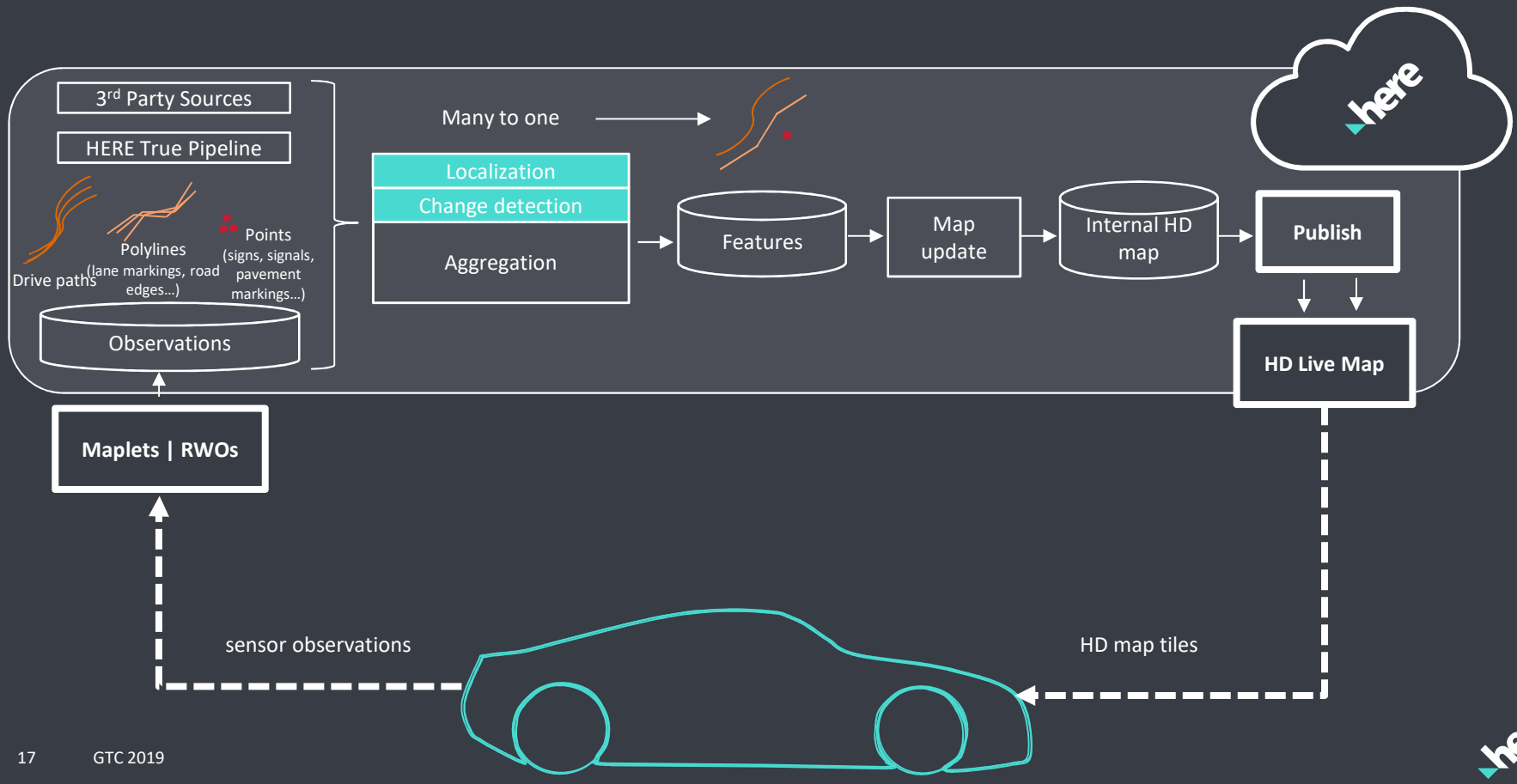
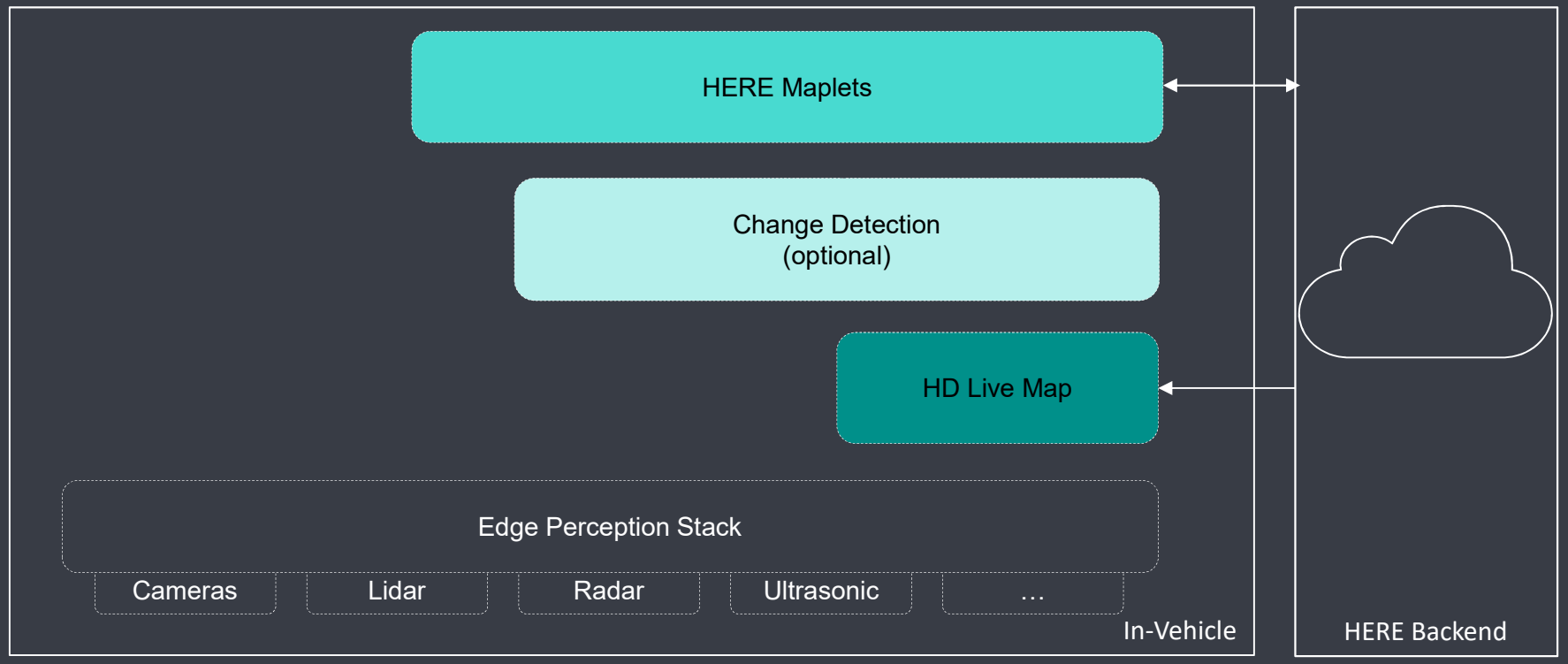


Cloud and edge analytics: What to do where, best?



In-Vehicle Processing



Cyclops

Off the Shelf, At the Edge, In the Vehicle

Cyclops

Off the Shelf, At the Edge, In the Vehicle

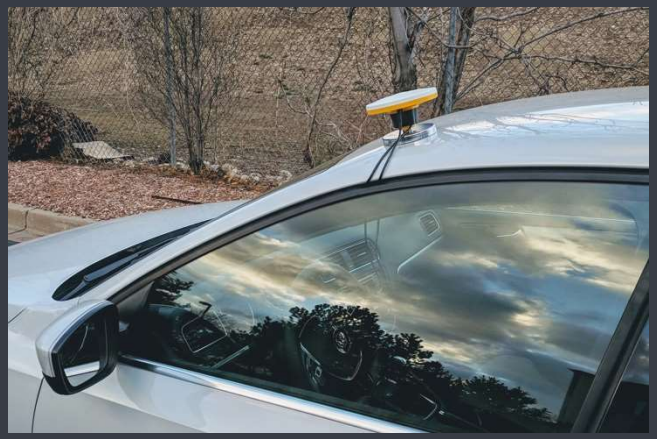
Standard Configuration

- Android smartphone
  - Imagery at 30 Hz
  - Android Fused GPS positions at 1 Hz
  - MEMS readings at 50 Hz
  - Efficiently packed
  - Wireless stream
- NVIDIA GPU compute

Cyclops: RTK GNSS

Optional configuration: positioning via RTK

- Lightweight digital antenna
- Connects directly to an Android phone via USB
- Greatly improved GNSS accuracy
- 10Hz position update



Real-Time Perception Architecture

Sensor stream: smartphone

Compute: Jetson AGX Xavier

Optional Laptop: visualization

- Peer-to-peer set of decentralized microservices
- Nodes run stand-alone or deployed as a set of services
- Wireless: UDP, TCP and HTTP

Cyclops: Maplets

Sensoris: *Sensor Interface Specification*

- International, standardized interface for exchange
- Within the vehicle
- Vehicle to Cloud
- Cloud to Cloud
- Is at the core of HERE Maplets

Maplets:

- Structurally combines in-vehicle observations and related accuracy requirements
- Sensor-agnostic, low data footprint for instant data transmission
- Populate into SENSORIS
- Python and C++ implementations available

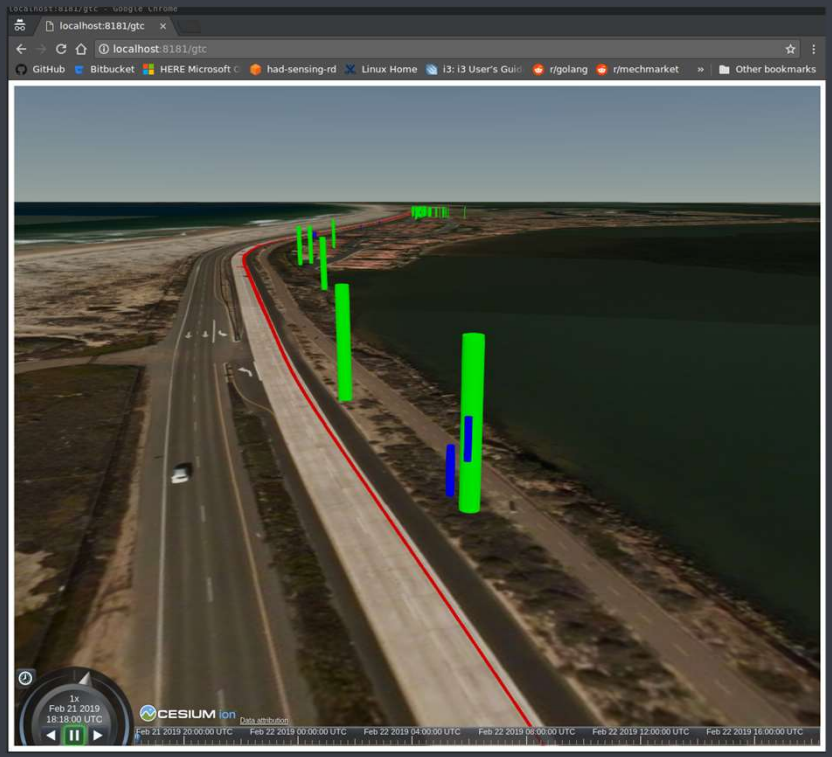
Cyclops: Demonstration Setup

Sensor stream and visualization

- Xiaomi Mi 8: sensor stream and wifi network
- RTK GNSS positioning
- Optional laptop: monitoring and visualization

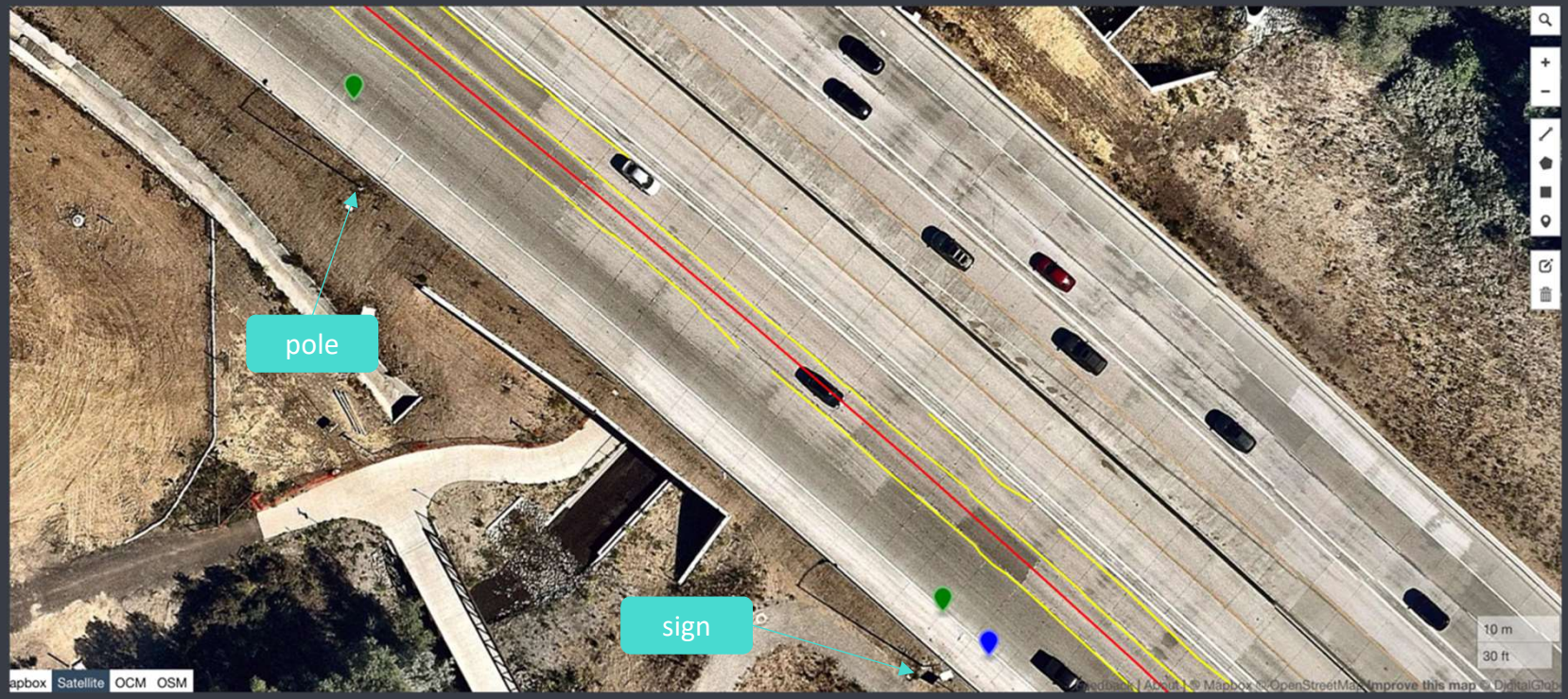
Xavier in-vehicle

- Power via USB Type-C (cigarette-lighter adapter)
- Headless via an Intel 8265 wifi chip, antennas
- Edge Perception software stack



Cyclops: Demonstration

Cyclops: Assessment



Stronger with our partners