



Tunnel Radar Solution

ClairWav-U24 Product Presentation

Kevin Gu

2025.07.02

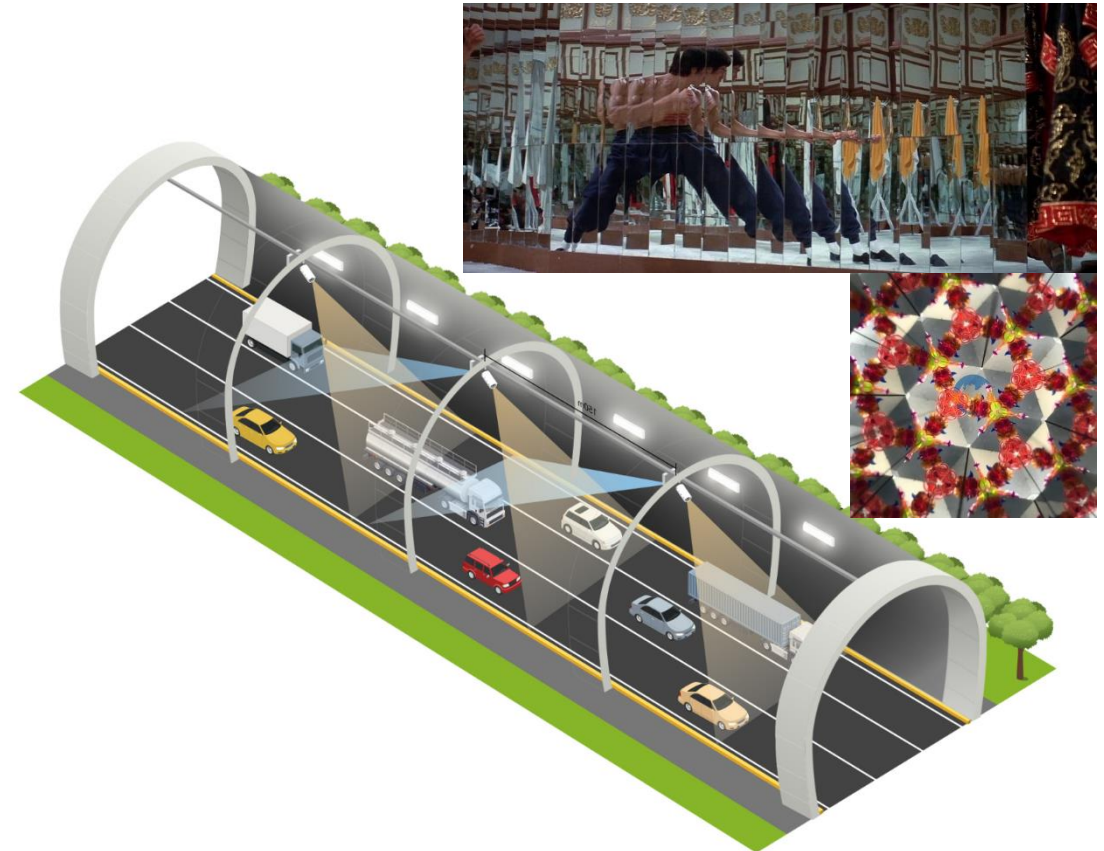
Tunnel Multipath Effect

Causes of Tunnel Multipath Effect

1. Reflection: Signals are repeatedly reflected by surfaces such as tunnel walls, ceilings, and floors, creating multiple propagation paths.
2. Refraction: Signals change direction when passing through different media (e.g., air and walls).
3. Scattering: Signals scatter in multiple directions when encountering irregular surfaces or obstacles.

Impacts of Multipath Effect

1. Signal Attenuation: The superposition of multipath signals may lead to partial signal cancellation, reducing the received signal strength.
2. Signal Distortion: Signals arriving at different times due to varying path lengths can cause inter-symbol interference or signal distortion.
3. Positioning Errors: In radar or positioning systems, the multipath effect may result in incorrect target location calculations.



How does tunnel radar overcome the “tunnel multipath effects”?

To combat these challenges, the ClairWav-U24 employs a combination of advanced technologies:

1. **MIMO Antenna Arrays:** The radar utilizes Multiple Input Multiple Output (MIMO) antenna arrays, which allow for the transmission and reception of multiple signals simultaneously. This technology enhances spatial resolution and improves the radar's ability to distinguish between direct and reflected signals, thereby reducing the impact of multipath interference.
2. **Super-Resolution Angle Estimation Algorithms:** These algorithms enable the radar to achieve highly accurate angle estimation, even in environments with significant signal reflections. By precisely determining the angle of arrival of signals, the radar can better differentiate between true target positions and ghost images created by multipath reflections.
3. **AI Machine Learning Algorithms:** The integration of AI and machine learning algorithms allows the radar to continuously learn and adapt to the specific characteristics of the tunnel environment. These algorithms can identify patterns in the radar data that are indicative of multipath effects and dynamically adjust the radar's processing to mitigate their impact. Over time, the system becomes more adept at filtering out false signals and enhancing the accuracy of target detection.



ClairWav-U24 Tunnel Radar

This radar is specifically customized for highway tunnel environments, with three key advancements to combat multipath interference:

1. MIMO Antenna Design

Employs a MIMO (Multiple-Input Multiple-Output) architecture to extend the effective aperture, improving angular resolution and suppressing multipath effects in tunnels.

2. High-Precision Signal Processing

Incorporates super-resolution angle estimation algorithms in backend processing to further enhance angular measurement accuracy.

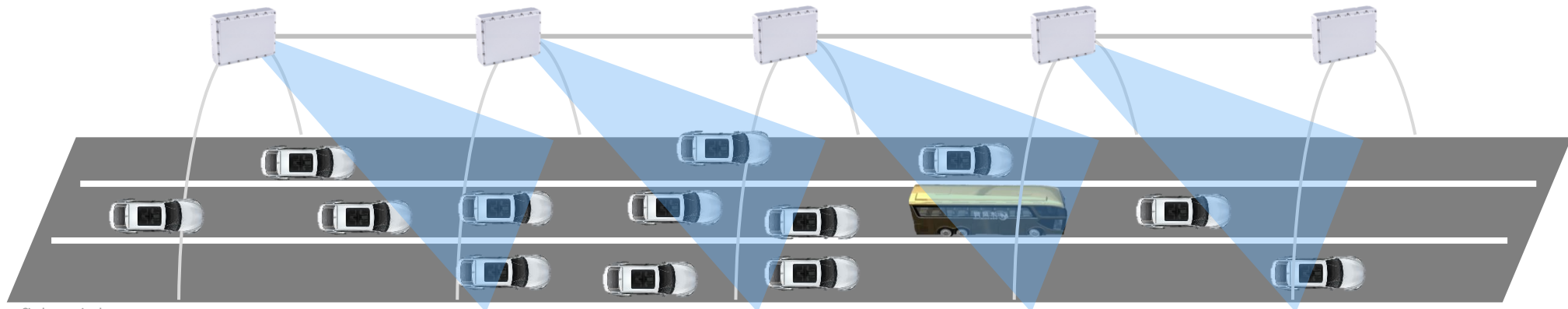
3. AI-Augmented Tracking Algorithm

Combines classical Kalman filtering with AI/machine learning algorithms. After deployment, the system continuously improves detection accuracy through accumulated learning data.

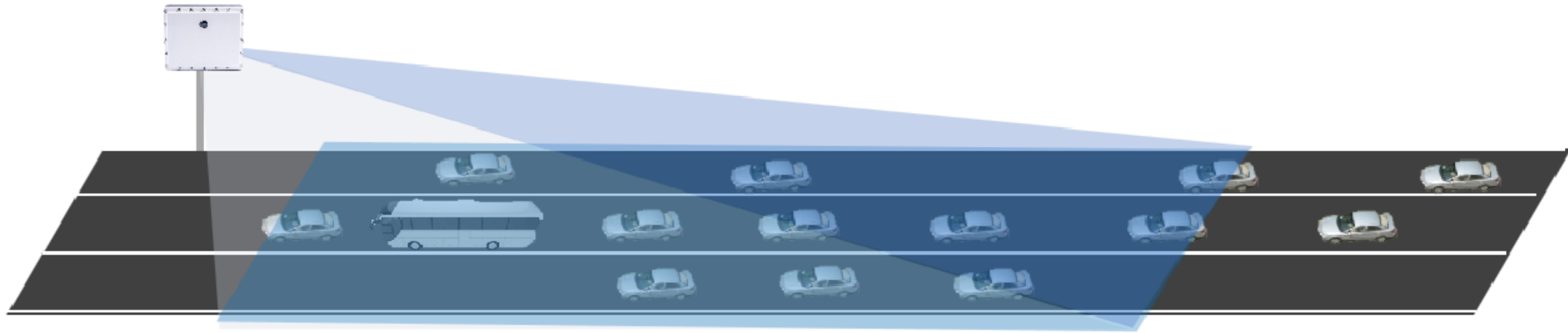


Key Features

- Longitudinal detection distance: 400 m
- Lane positioning distance: 150 m
- Lateral detection range: Full tunnel width (all lanes)
- Detection target capacity: 128 objects
- Detection cross-sections: Up to 64 sections
- Functions: Trajectory tracking, vehicle detection, traffic flow statistics, incident detection, queue length statistics, etc.
- Applications: Highway tunnels, road tunnels



Core Advantages



Wide Coverage & Multi-Target Tracking

- Longitudinal range: 400m
- Full tunnel lane coverage
- Tracks up to 128 targets simultaneously

High-Precision Multi-Parameter Detection

- Position & speed measurement
- Queue length detection
- Incident identification
- Zone-based statistical analysis

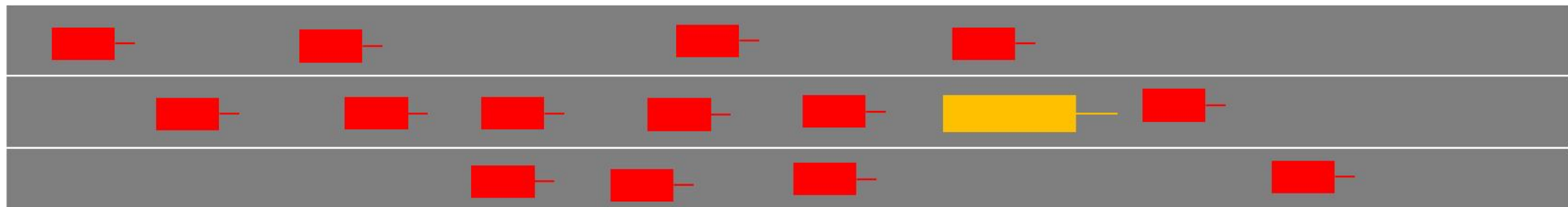
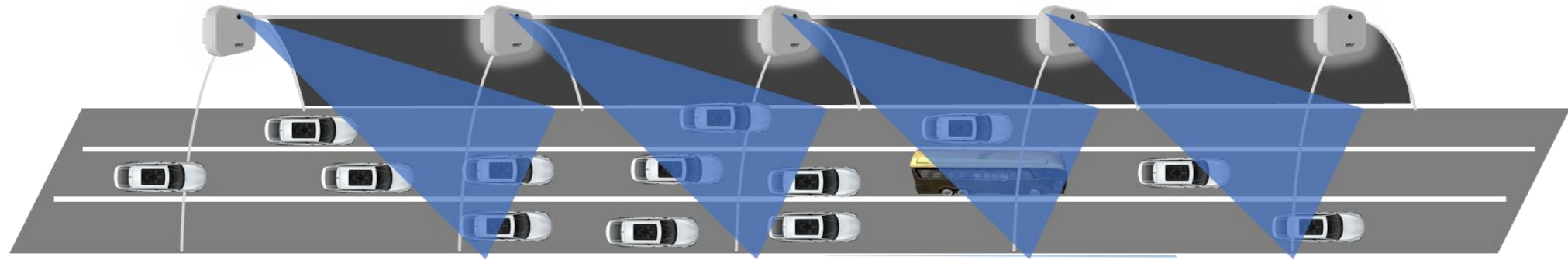
Durability & Maintenance

- Extended service life (>10 years)
- Simplified maintenance design
- Long-term reliability in tunnel environments

All-Weather High-Reliability MIMO Radar

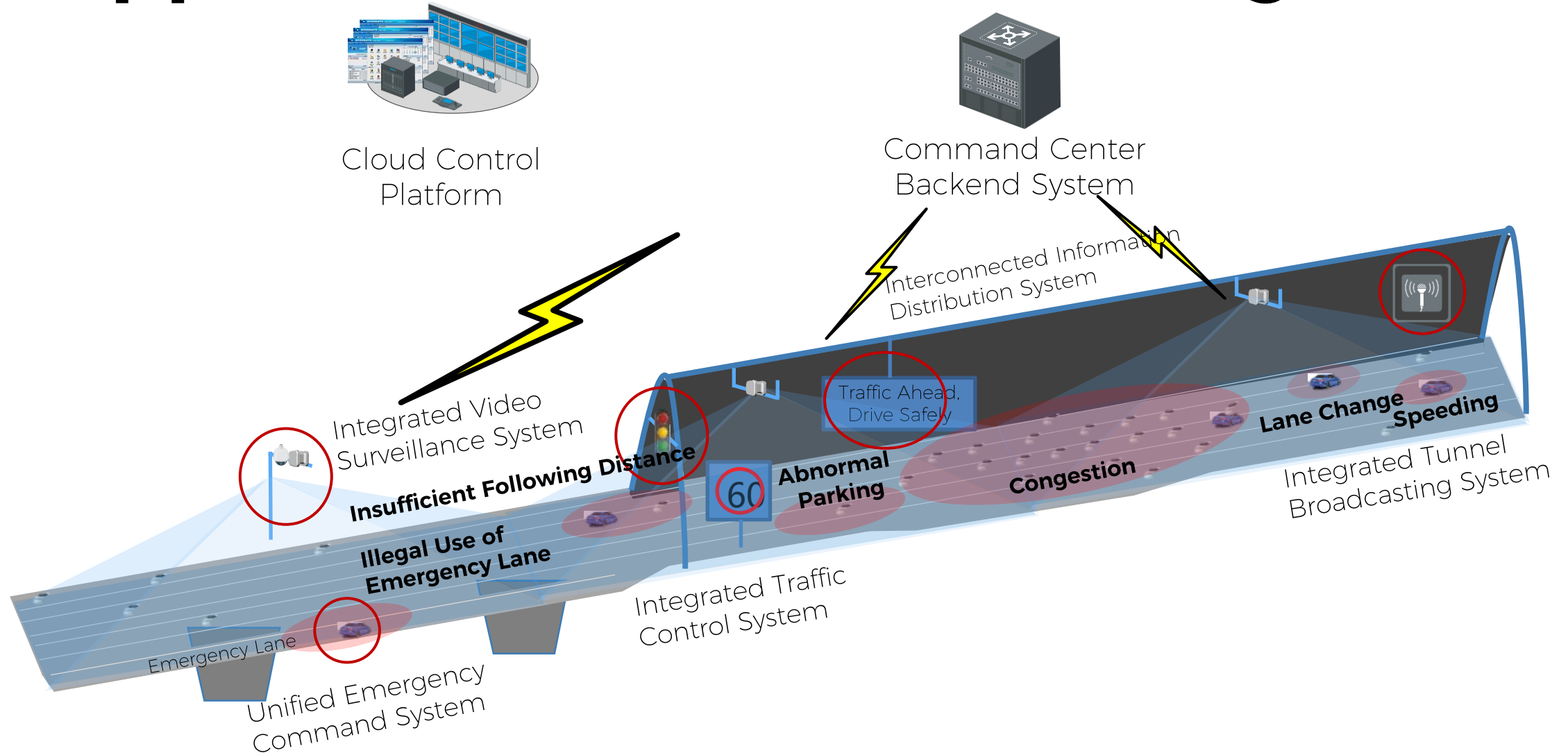
- Immune to tunnel interference
- Unaffected by lighting conditions
- Stable performance in all environments

Application: Tunnel Vehicle Monitoring



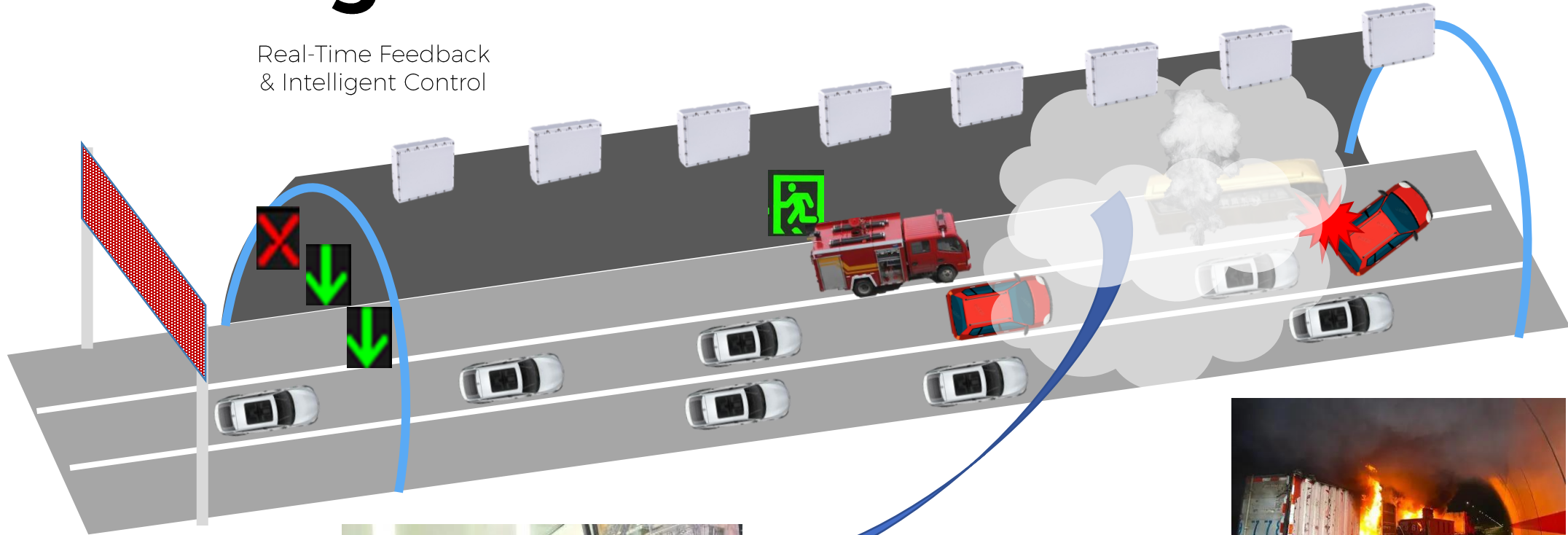
Vehicle Coordinates | Vehicle Classification | Lane Status | Target Velocity | Trajectory Tracking

Application: Event Monitoring



Application: Traffic Accident Management & Rescue

Real-Time Feedback
& Intelligent Control



Second-Level Detection
& Precision Positioning



All-Environment
Perception in Darkness
& Smoke

Case: Key Vehicle Monitoring System



<https://bit.ly/4gDY9uY>

Case: Datong Tunnel Hazardous Materials Monitoring Project



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隧道入口 (超车道)

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隧道入口

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Thanks

