A large, stylized blue wavy line graphic is positioned on the right side of the slide, extending from the top towards the bottom.

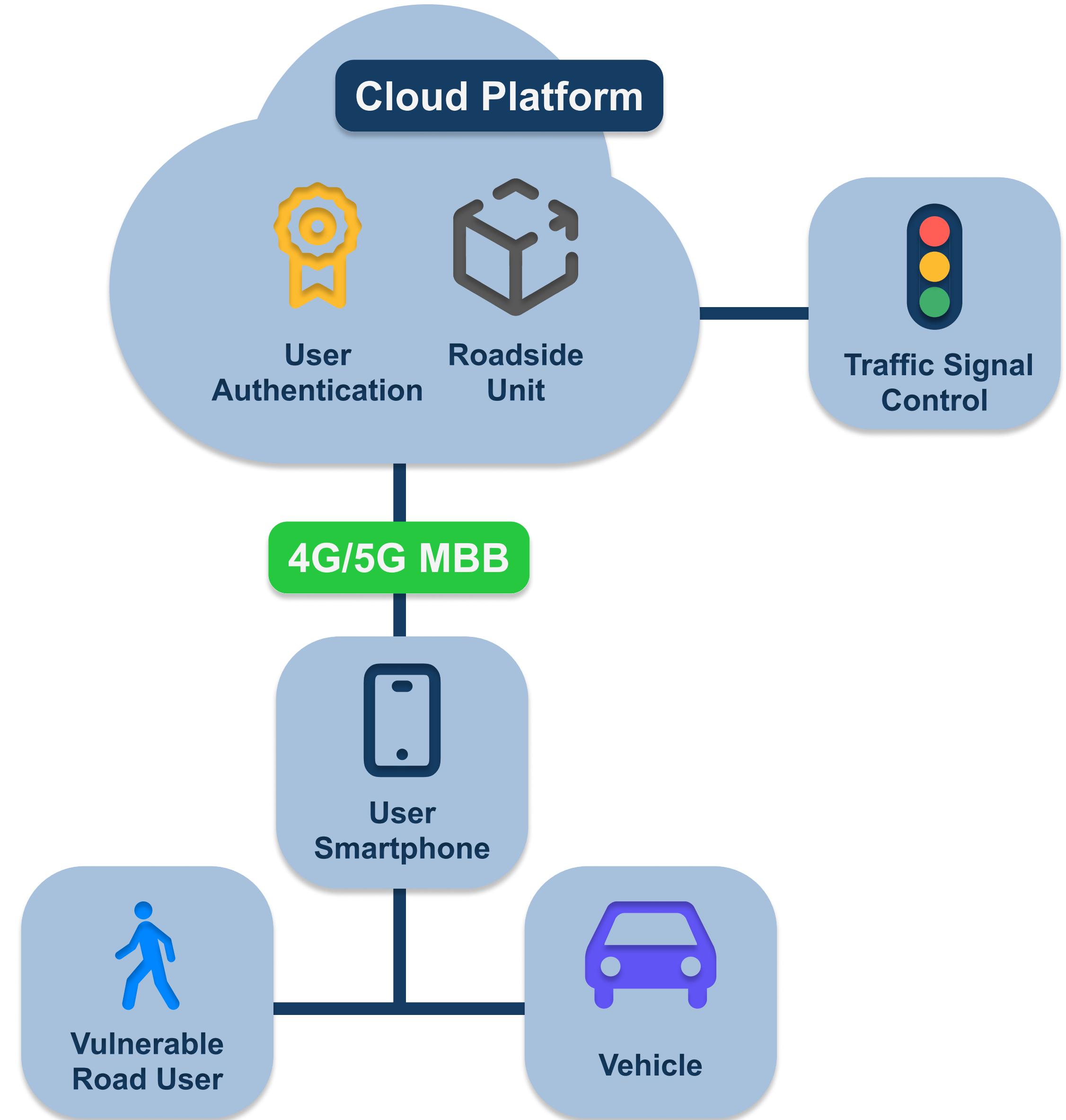
# Smartphone-Based Real-Time V2P Safety System for Signalised Intersections

Jingfei Zheng, Lingfeng Ye

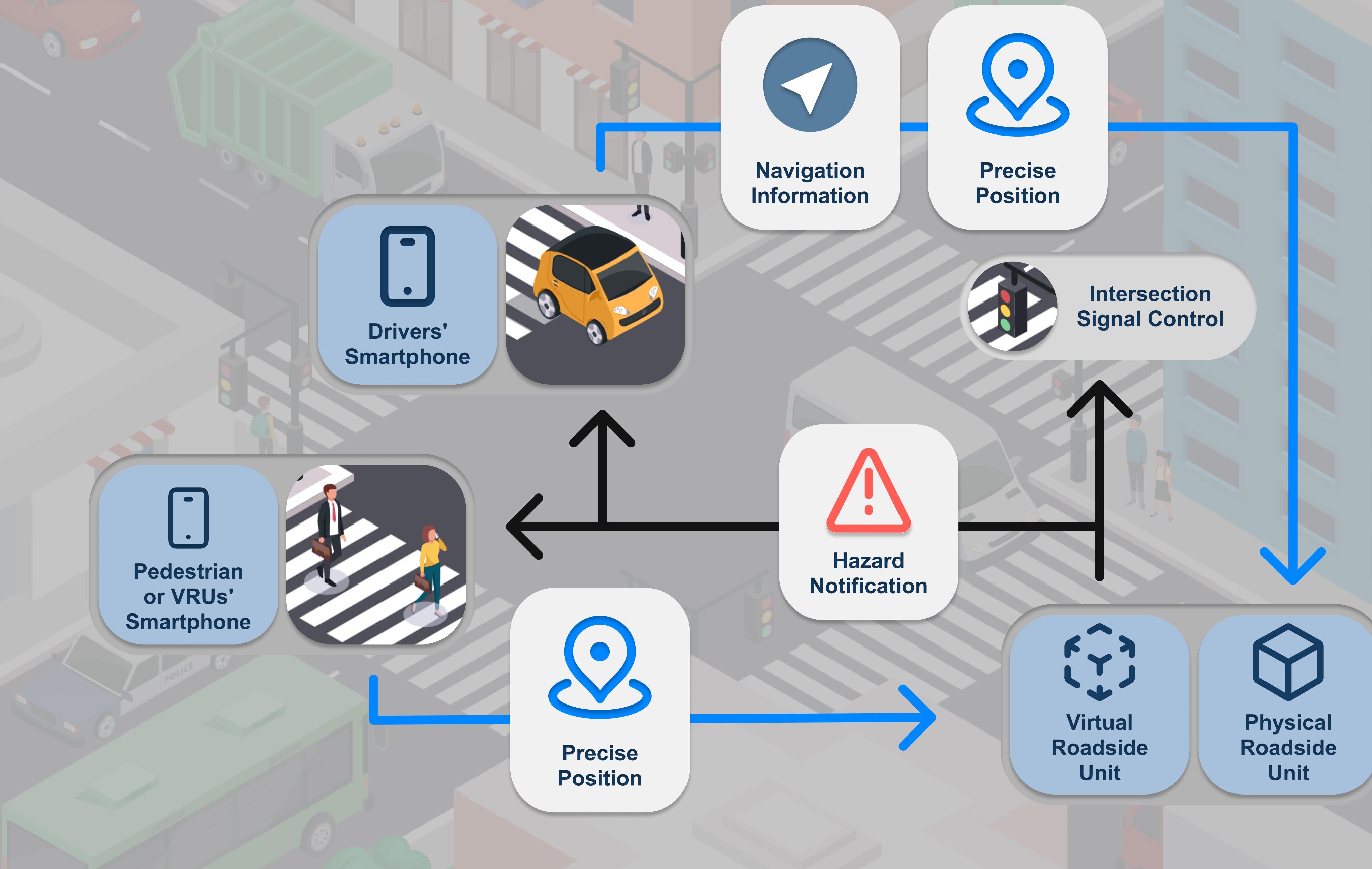
**Supervisor:** Prof. Yanming Feng

# Main idea

Smartphone use 4G/5G + Maps APIs to detect approach to a specific crosswalk, exchange DENM hazard events over MQTT, and show brief on-device cues. This keeps alerts timely, privacy-first, and easily integrated with RSUs/SPaT just like the AoA stream.

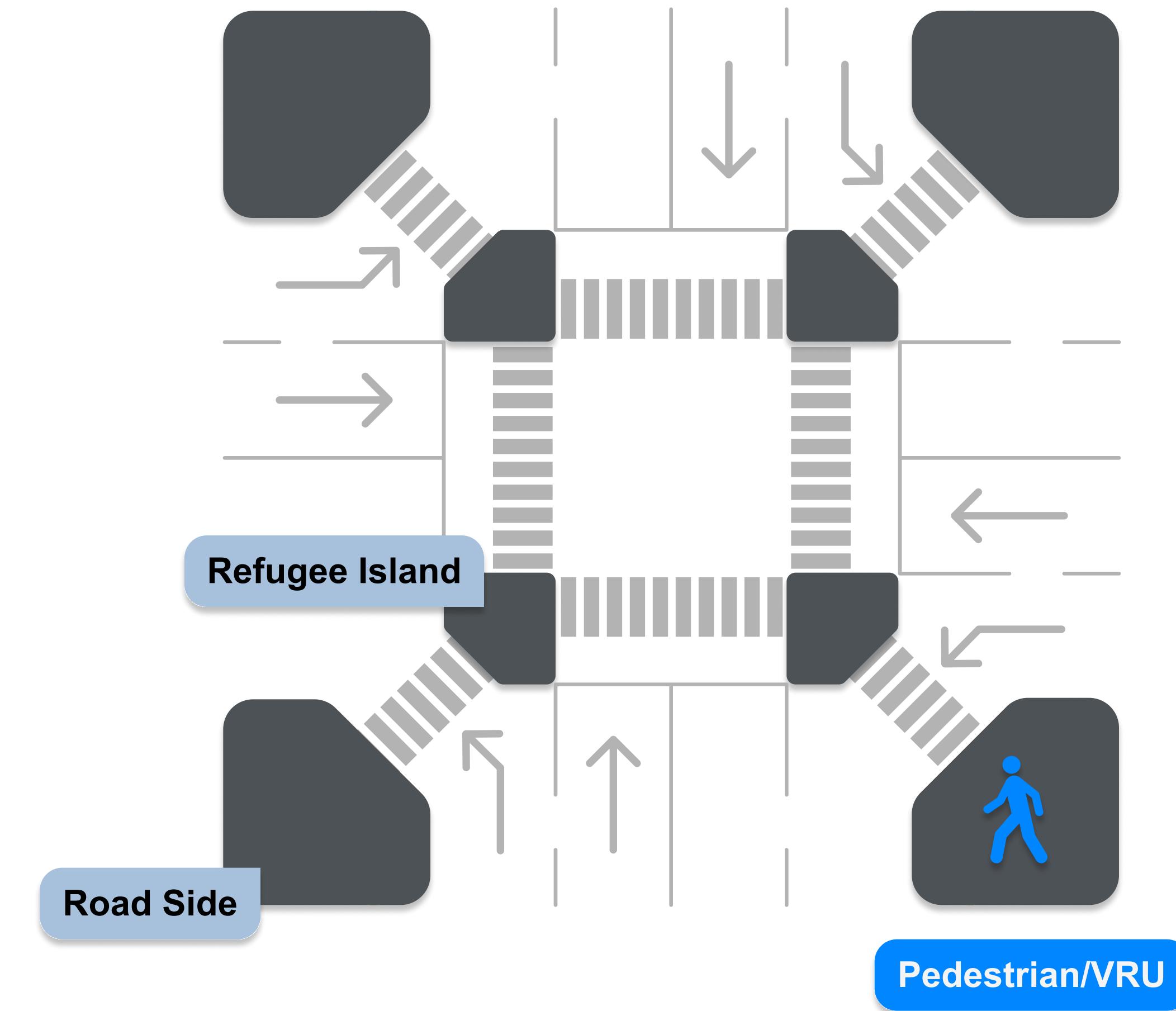


# Road User Interaction



# Pedestrian Time-to-Cross Estimation

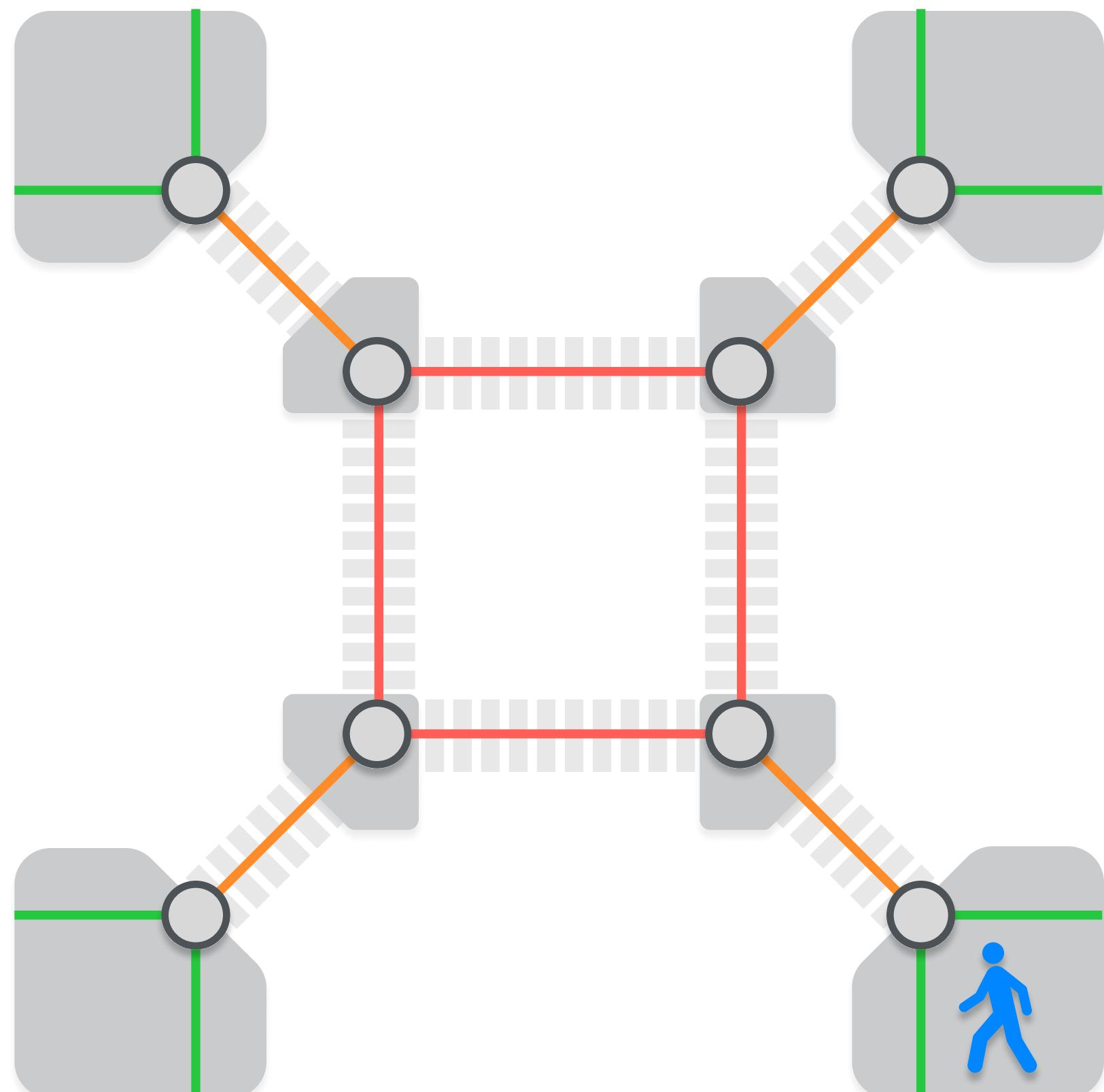
## Typical Intersection



# Pedestrian Time-to-Cross Estimation

## Simplifying Intersection Structure

- Edge (Before Arriving Intersection)
- Edge (Crosswalk across the slip lane)
- Edge (Intersection Crosswalk)
- Nodes (Refugee Island/Road Side)

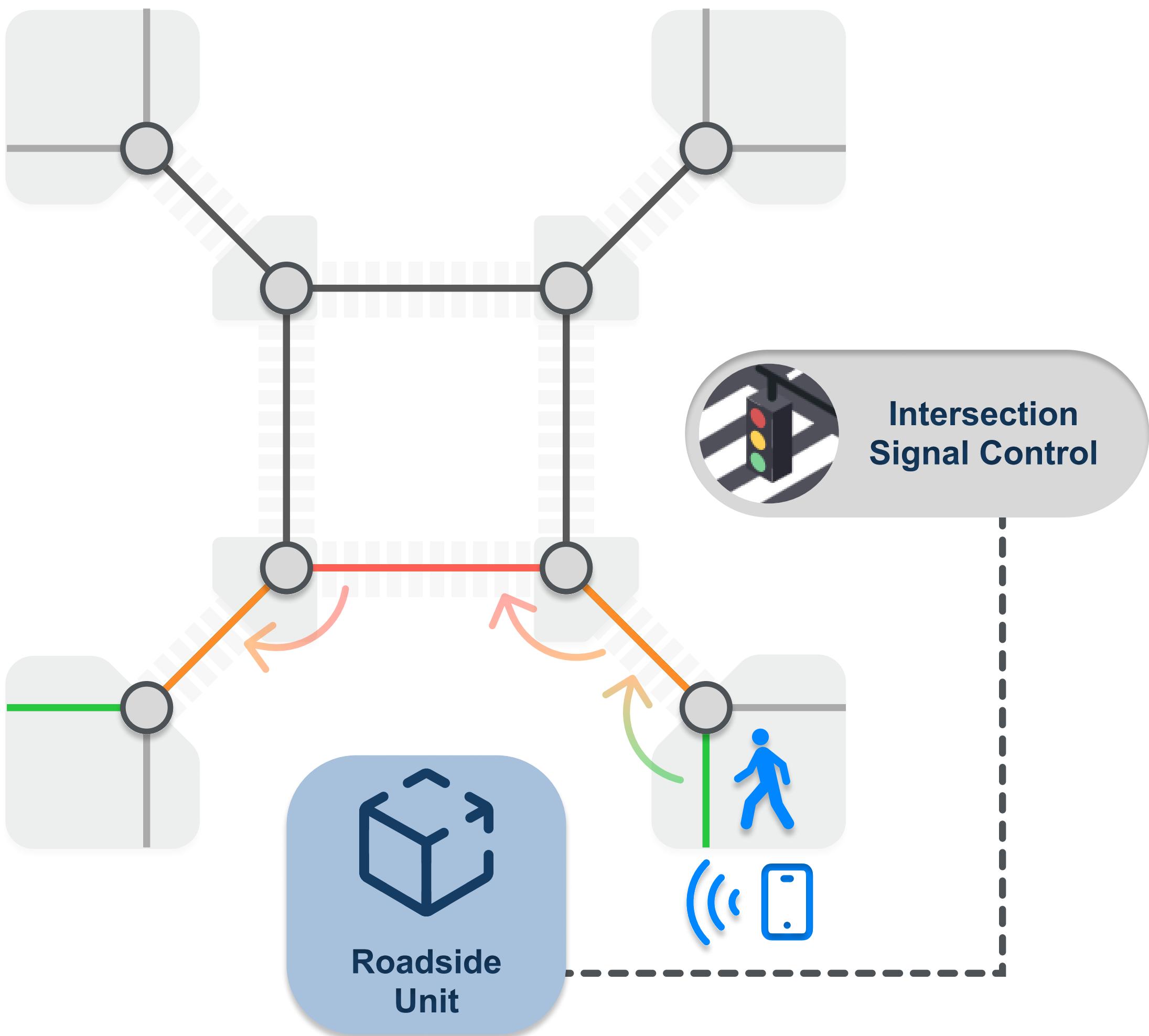


Pedestrian/VRU

# Pedestrian Time-to-Cross Estimation

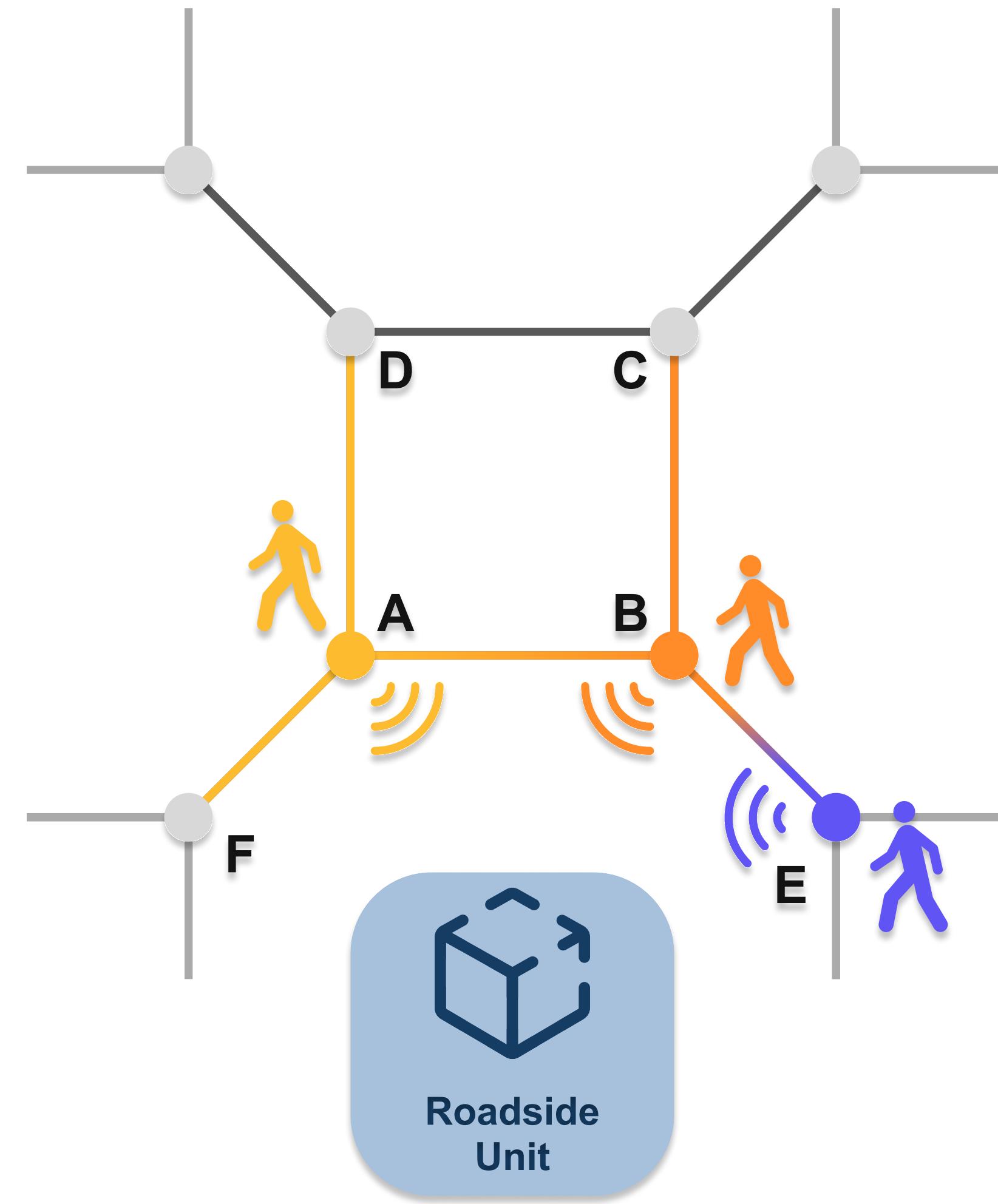
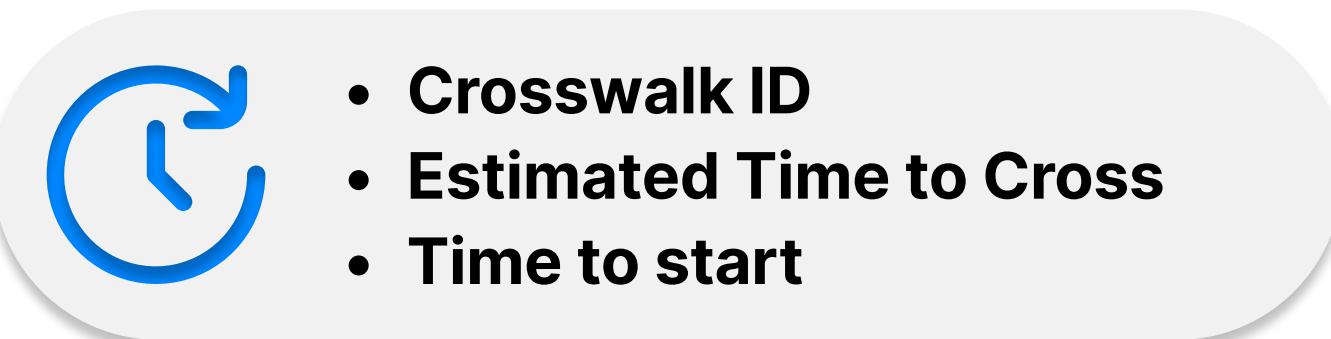
- Edge (Before Arriving Intersection)
- Edge (Crosswalk across the slip lane)
- Edge (Intersection Crosswalk)
- Nodes (Refugee Island/Road Side)

- Start from VRU entering intersection geofence and on the way to intersection, predict the time-to-cross for any crosswalk which VRU may go next.
- VRU smartphone provide crosswalk and time-to-cross to RSU, make sure intersection signal control adjust single timing for VRU's full duration on crosswalks.



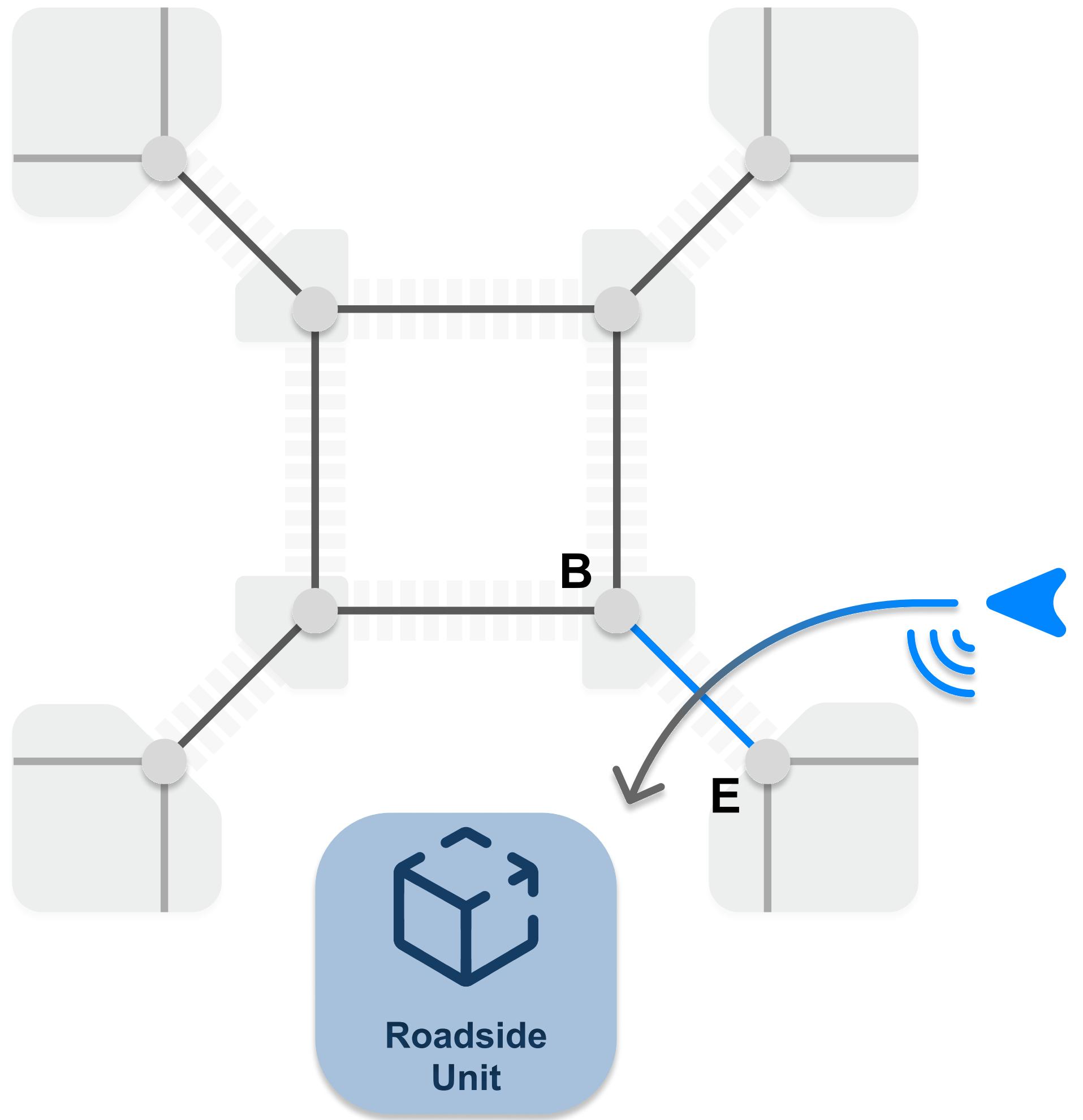
# Pedestrians

- Pedestrian subscribe to event topics for all nearby crosswalks.
-  at A subscribe crosswalks: AB, AD, AF
-  at B subscribe crosswalks: BA, BC, BE
-  at E subscribe crosswalks: BE
- Pedestrians prompt RSU for potential crosswalk heading to and time-to-cross.



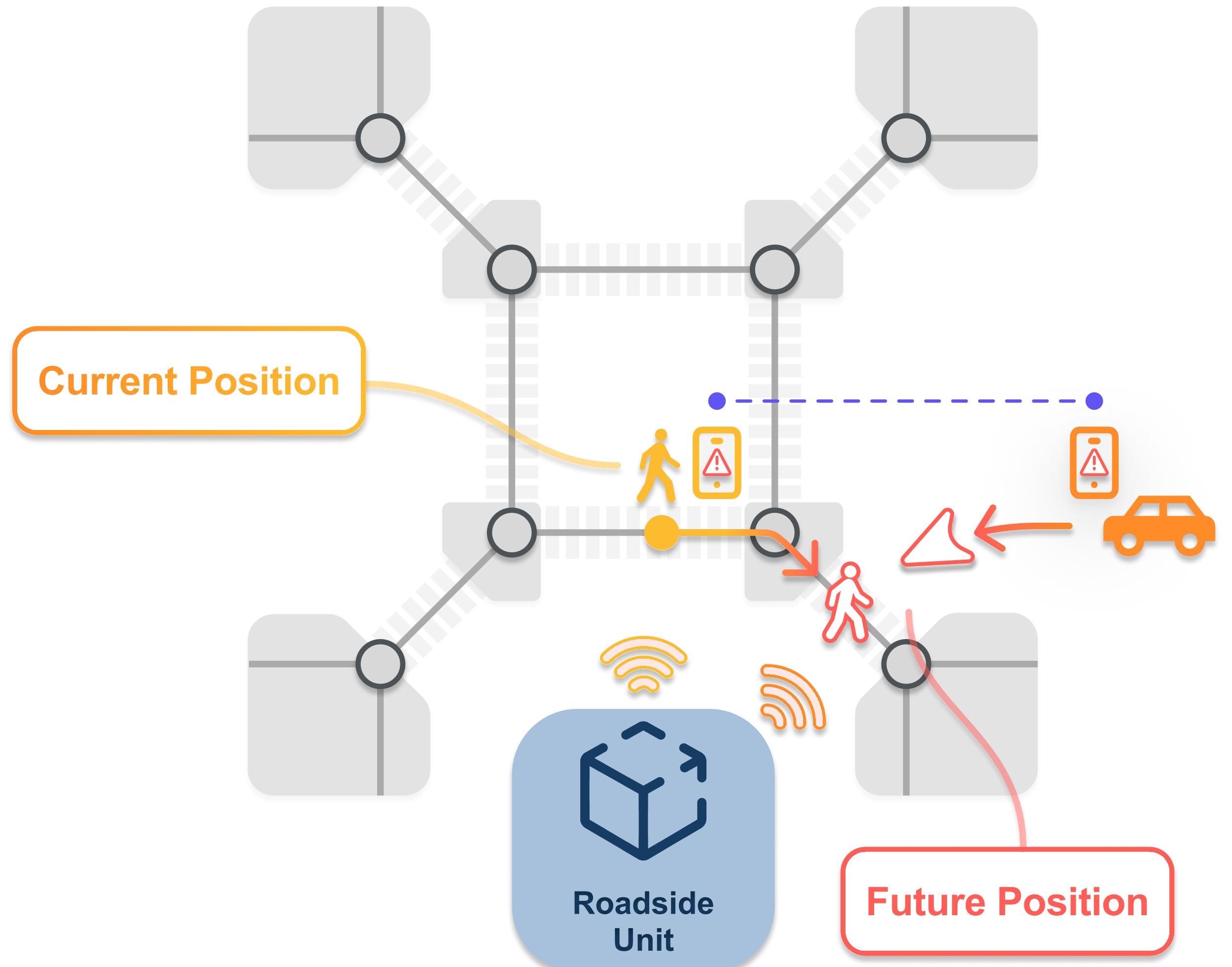
# Vehicle

- Incoming vehicle prompt RSU the crosswalk may pass base on navigation information and provide time of arrival based on speed.
  - Vehicle subscribe to topic of event topic of the crosswalk going to pass.
- Incoming vehicle subscribe to crosswalk BE and provide ETA**



# Hazard Notification

- Pedestrian and incoming vehicle aware of each other.
- VRU help establish link between both road users, precision position and motion data exchange between users allow continues monitoring risk and push hazard notification.



# Event Flow and User Notification

- Approach detected at an intersection crosswalk
- Hazard event created (crosswalk-scoped)
- Routed to nearby users only
- User device decides to shows cue (voice/sound/haptics)
- Symmetric alerts for VRU and vehicle
- Auto clear; no continuous tracking outside defined range.

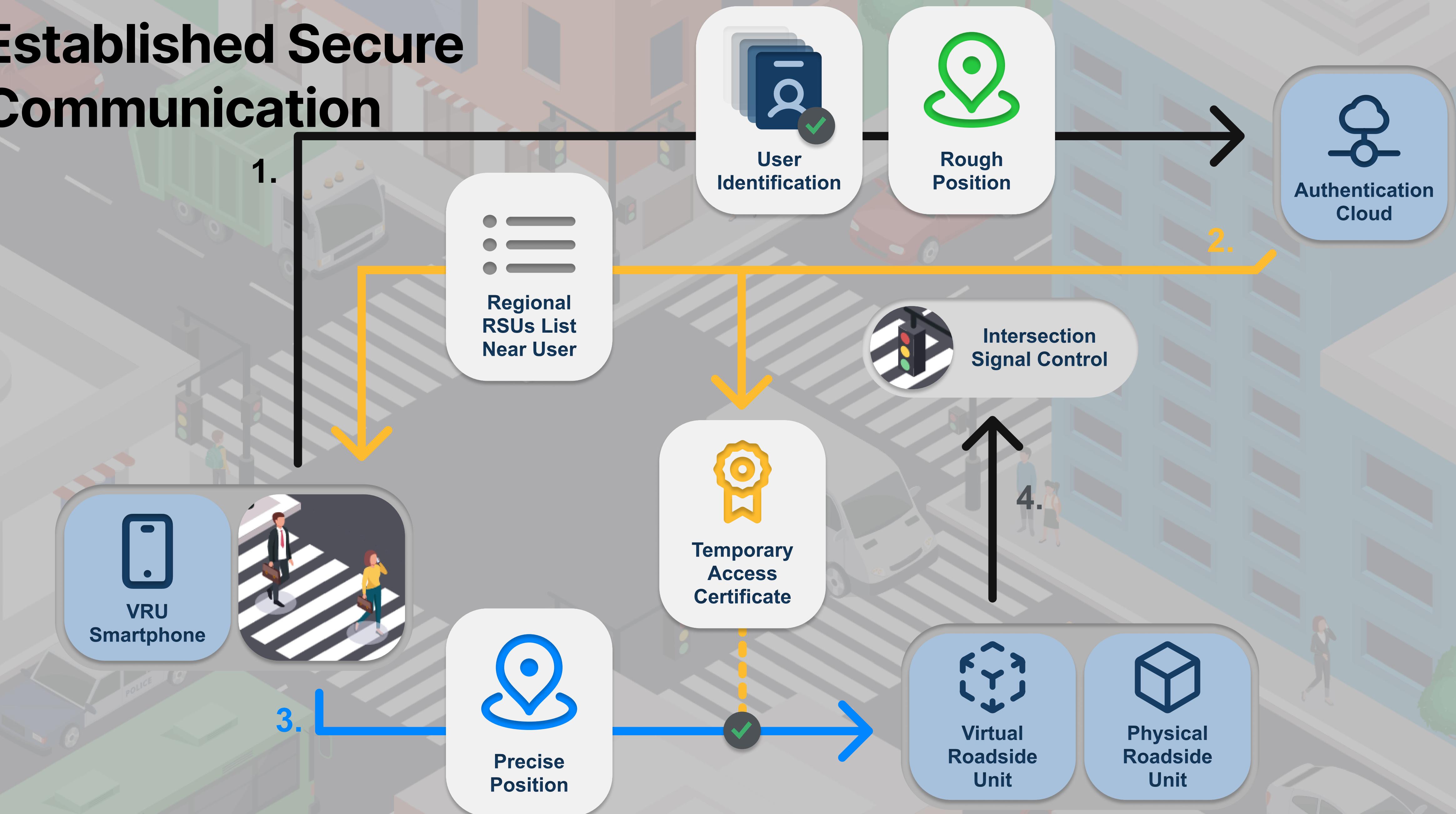


Vehicle Notification



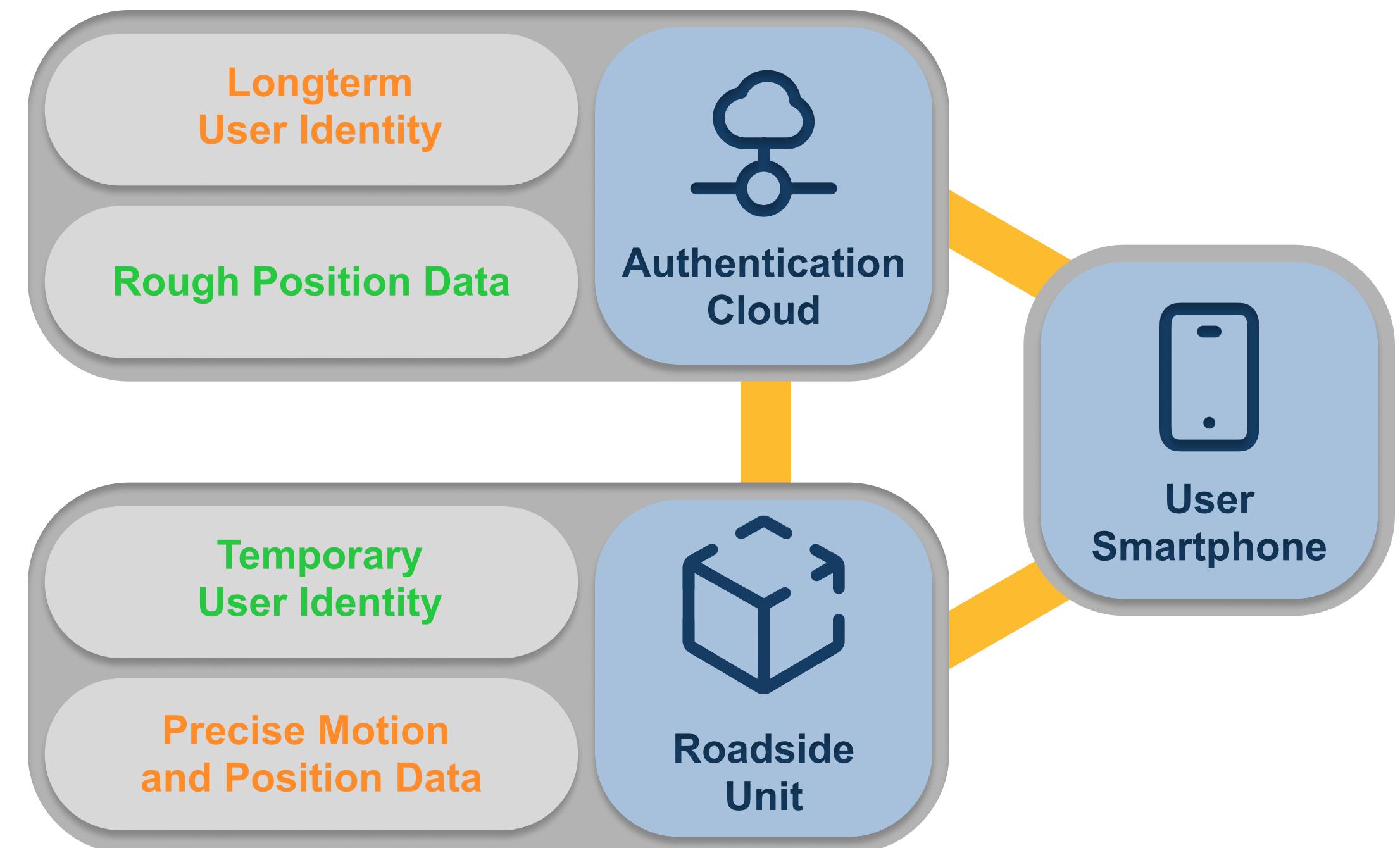
VRU/Predestine Notification

# Established Secure Communication

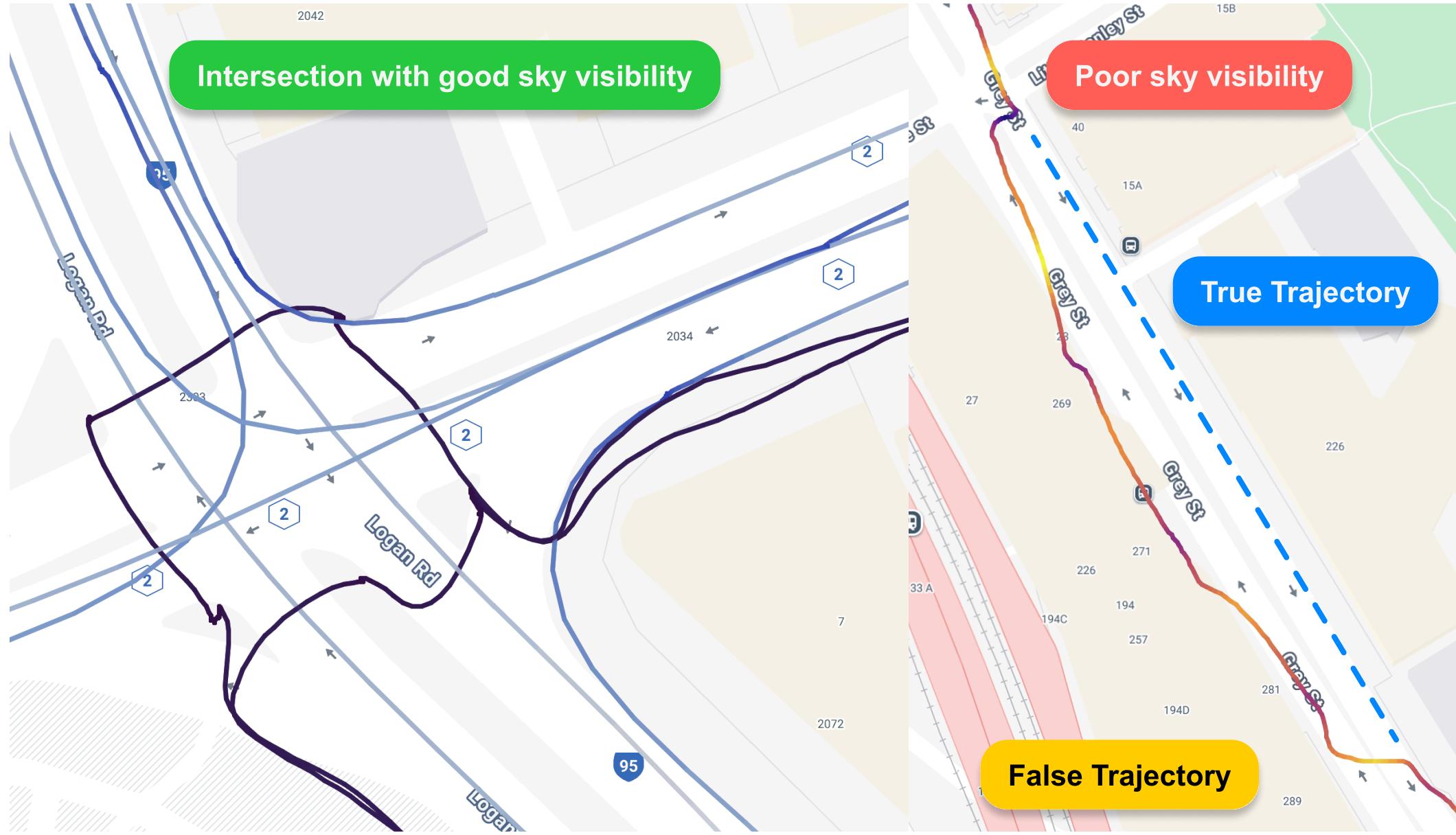


## Privacy Preserved Data Flow

- Exact location is never tied to a real identity
- Cloud allocates temporary IDs to road users
- Devices warn each other directly; roadside stations share map and signal info



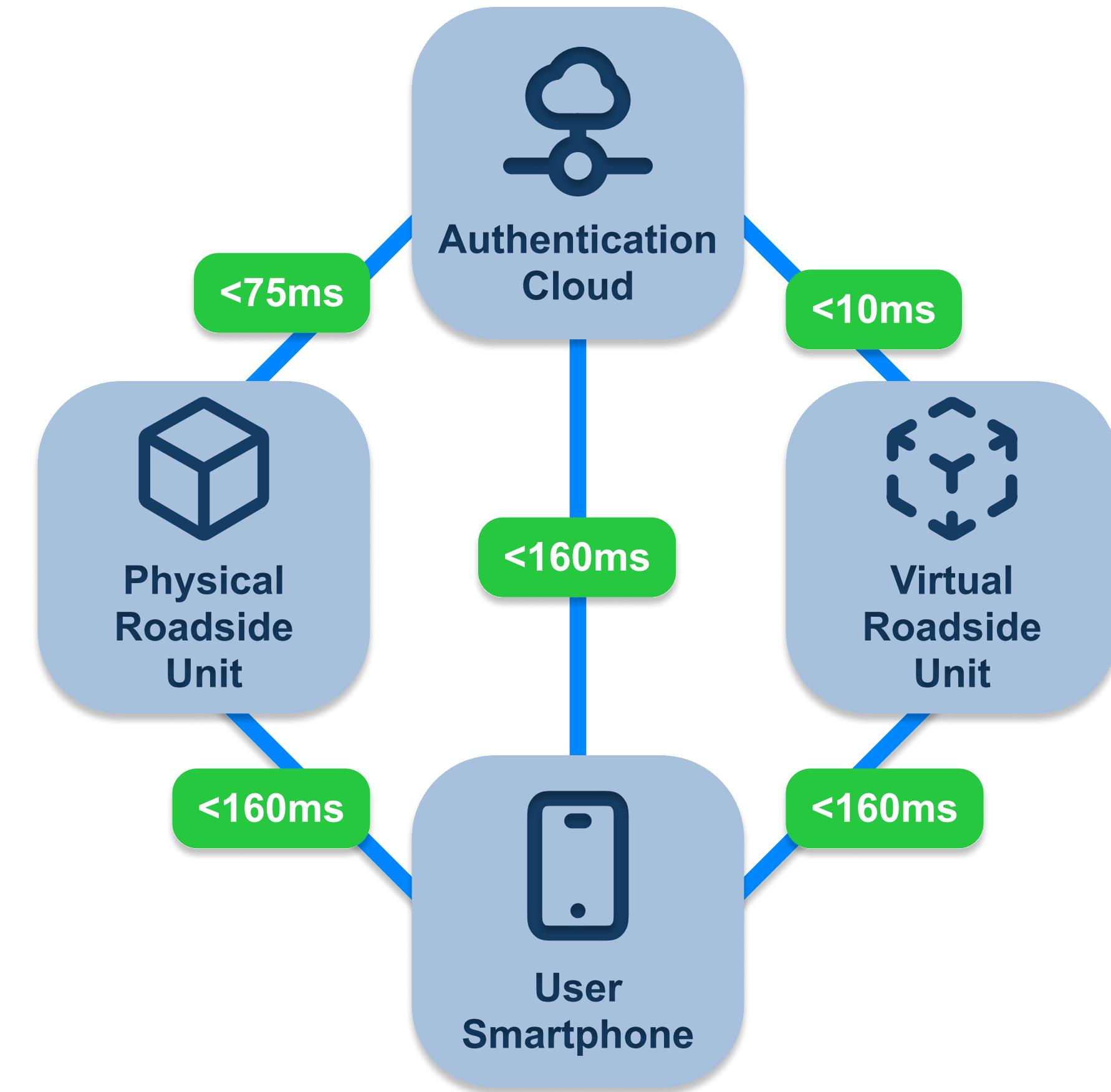
# Feasibility



## Positioning Accuracy

The pedestrian smartphone positioning tests indicate satisfactory accuracy for the V2P application, but require notice the navigation plan for vehicle to determine user's drive intention.

Suffer from low GNSS Availability in urban area without good sky visibility.



## Latency

- 99% package with <160ms latency across different configurations

A detailed 3D isometric illustration of a city street. The scene includes several multi-story buildings with different facades (orange, blue, grey) and windows. On the streets, there are various vehicles: a red car, a green garbage truck, a yellow car, a white van, a yellow taxi, a police car, a green bus, and a red truck. Pedestrians are walking on the sidewalks and crossing the streets at crosswalks. Traffic lights are positioned at intersections. The overall style is clean and modern.

**Thank You**

# Advantages

## **Stand-Alone Rollout**

Works on smartphones over 4G/5G with no new infrastructure, enabling fast, low-cost pilots that perform well even in open areas with modest accuracy.

## **Simple, Symmetric Cues**

Clear, low-distraction alerts (voice/sound/haptics) for both drivers and VRUs, with large banners reserved for imminent risk.

## **Event-Driven Privacy**

Uses DENM hazard events with short TTL and crosswalk scope; on-device decisions avoid continuous tracking and spread of privacy data while preserving timely warnings.

## **Integration Ready (MAPEM/RSU)**

Standards-based (MAPEM for geometry, optional RSU/5G SPaT feeds) so the solution scales across intersections and fleets.