M2M INNOVATION WORLD CONGRESS

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SECURE SMART MOTORWAYS BY UTILIZING EXISTING FIXED INFRASTRUCTURE AS ACCESS POINTS

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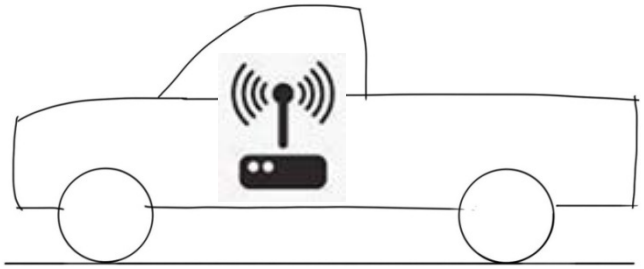
TEAM Tomorrow's Elastic Adaptive Mobility

ABSTRACT

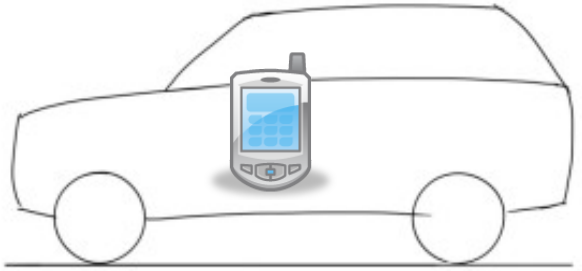
- **The connected car is placing increasing demands on mobile access networks**
- **The current mobile access networks are constrained by:**
  - Bandwidth
  - Latency
  - Coverage
- **Likely uptake constraints:**
  - Cost of service subscriptions
  - Data charges
  - Quality of service/connectivity
- **Mobile Operators need to invest in network capacity, but:**
  - Deployment cost vs. falling ARPU
  - How do they monetise value?
  - Availability of frequencies?
- **Dedicated vehicular adhoc networks (VANETs) are an alternative**
  - Significant deployment costs
  - Long-term programme
- **We propose to increase coverage and bandwidth by using unconventional data networks to provide the data backbone for a new distributed VANET**
  - This will enable a more rapid expansion of coverage
  - Use of existing infrastructure will reduce costs significantly
  - In time changes to the backhaul of the host networks will increase OTA bandwidth and therefore services
- **Further we propose new a mechanism to reduce handover latency as fast moving vehicles move through network "cells"**
  - Our proposed mechanism utilises the Doppler Effect to improve predictions of vehicle speed and ingress/egress of "cells"
  - Packets can be pre-emptively re-routed and cached in advance of a handover to reduce the effect of latency

Data Links in the Connected Car Today

- GSM module based
  - GSM/GPRS/EDGE
    - Low data rates
    - kbps up to 10s of kbps
    - Unsuitable for data intensive applications
      - e.g., streaming
    - Large cells and almost universal coverage

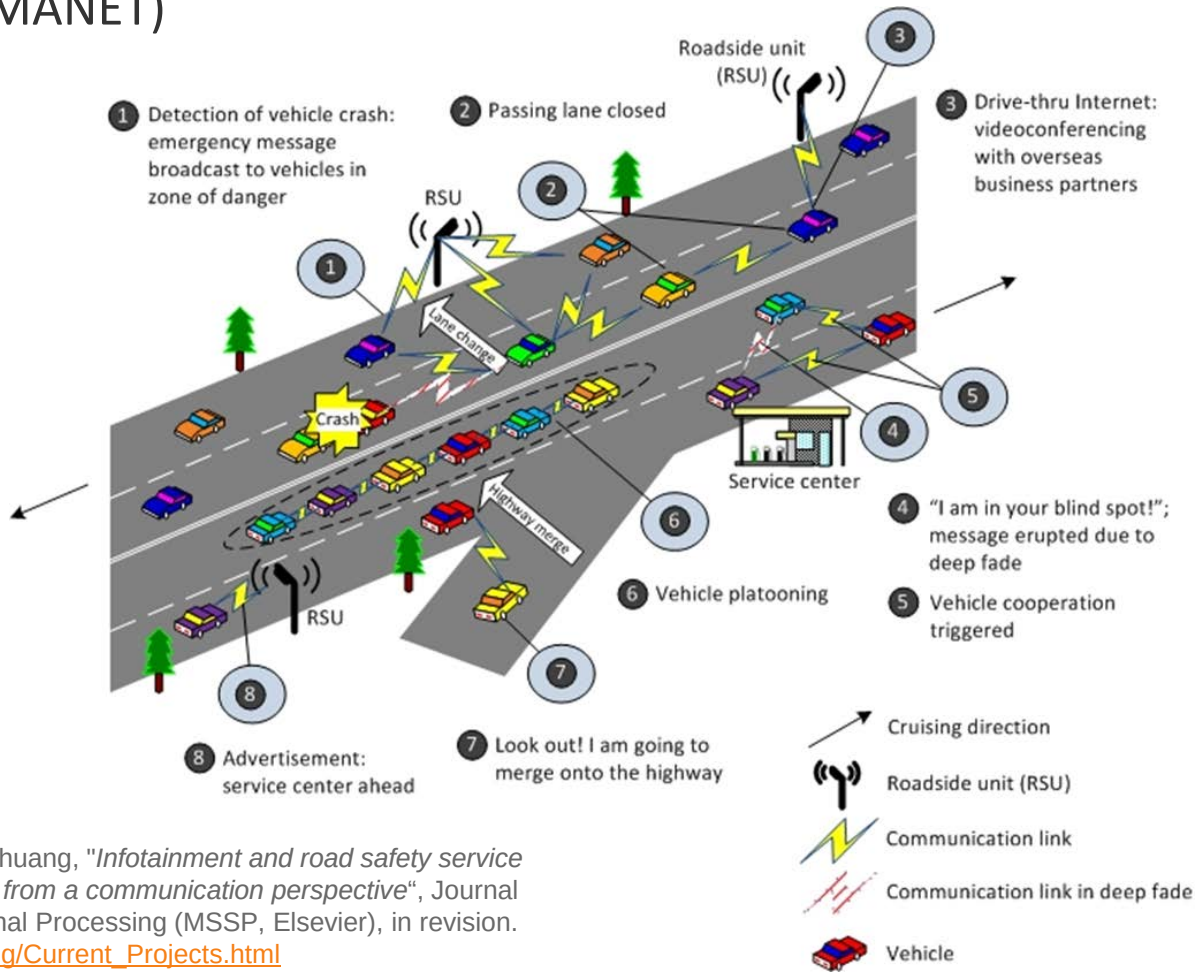


- Tethered smartphone
  - 3G/HSPA/4G
    - High potential data rates
    - 100s of kbps to 10s of Mbps
    - Support streaming services
    - Cell size, handovers & contention reduce rates
    - Coverage not ubiquitous
    - Investment in network
    - Device power consumption is high



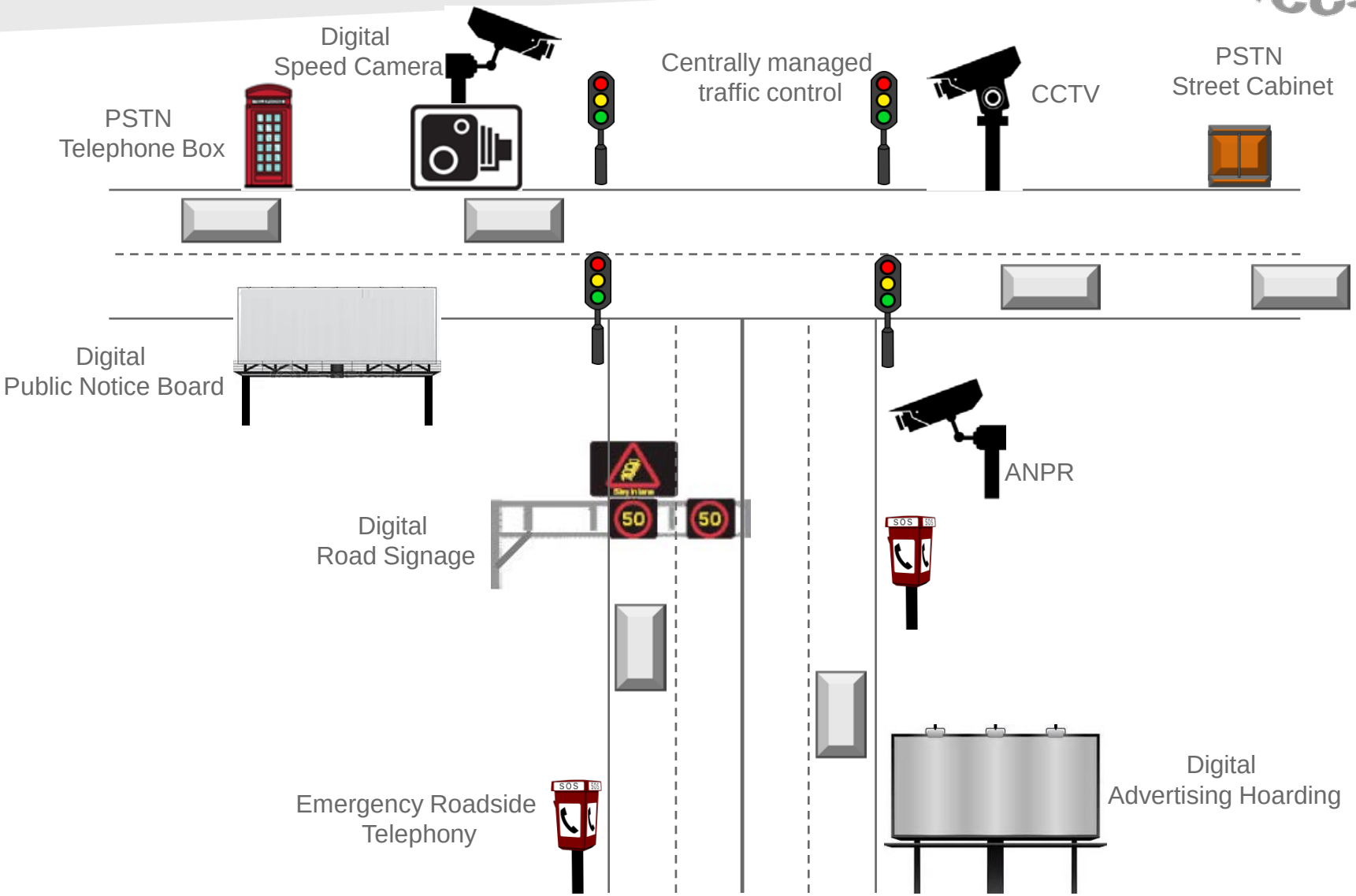
Near-Future: Vehicular Adhoc Networks (VANETs)

- VANETs or Intelligent VANETs (InVANETs) are a form of Mobile Adhoc Network (MANET)



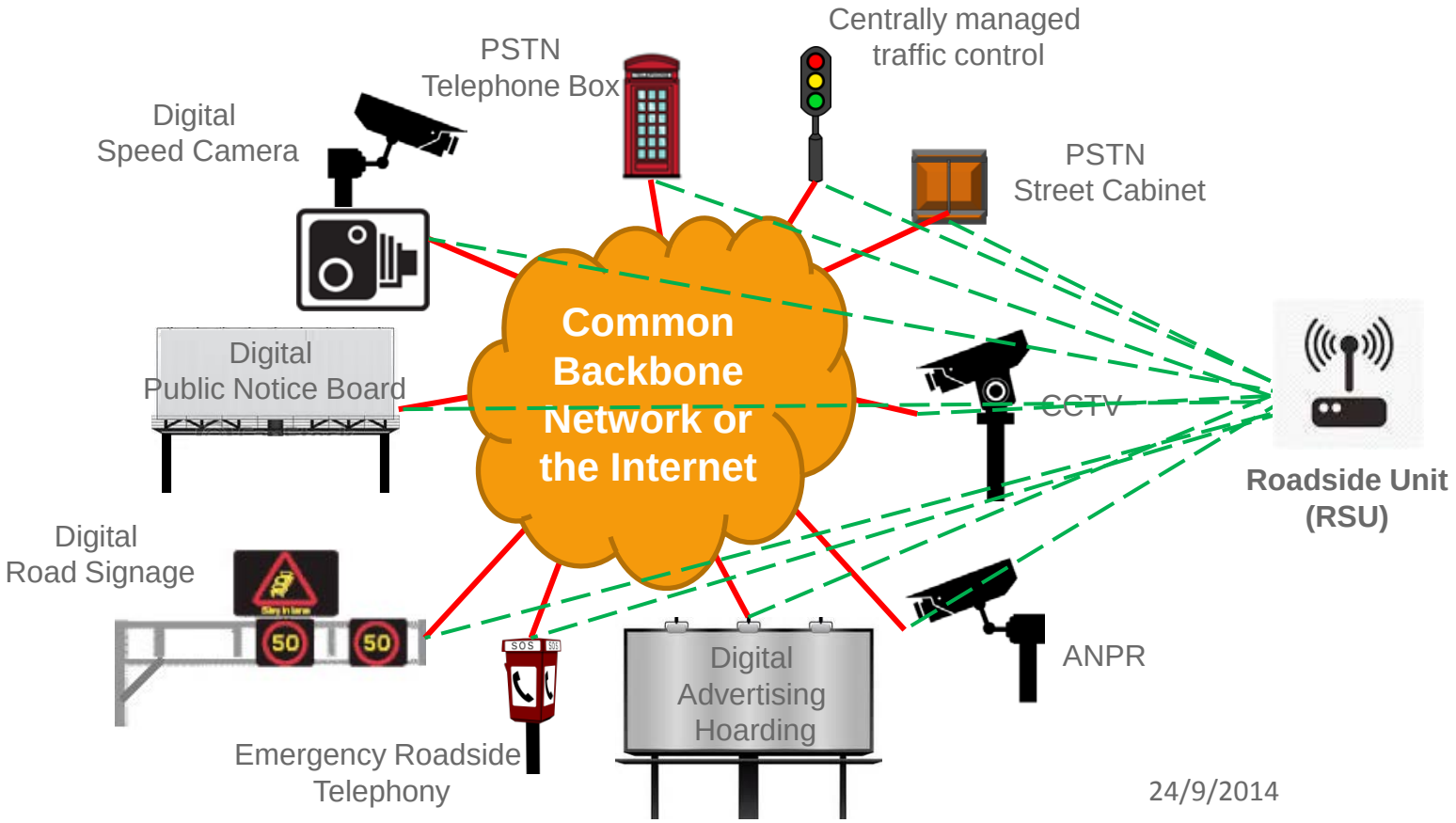
H. T. Cheng, H. Shan, and W. Zhuang, "*Infotainment and road safety service support in vehicular networking: from a communication perspective*", Journal of Mechanical Systems and Signal Processing (MSSP, Elsevier), in revision. http://bbcr.uwaterloo.ca/~htcheng/Current_Projects.html

UNCONVENTIONAL DATA NETWORKS



Using Unconventional Data Networks

- Allow Roadside Units (RSUs) to share the backhaul links
  - Then connect all these disparate data networks to a common data backbone or indeed the internet



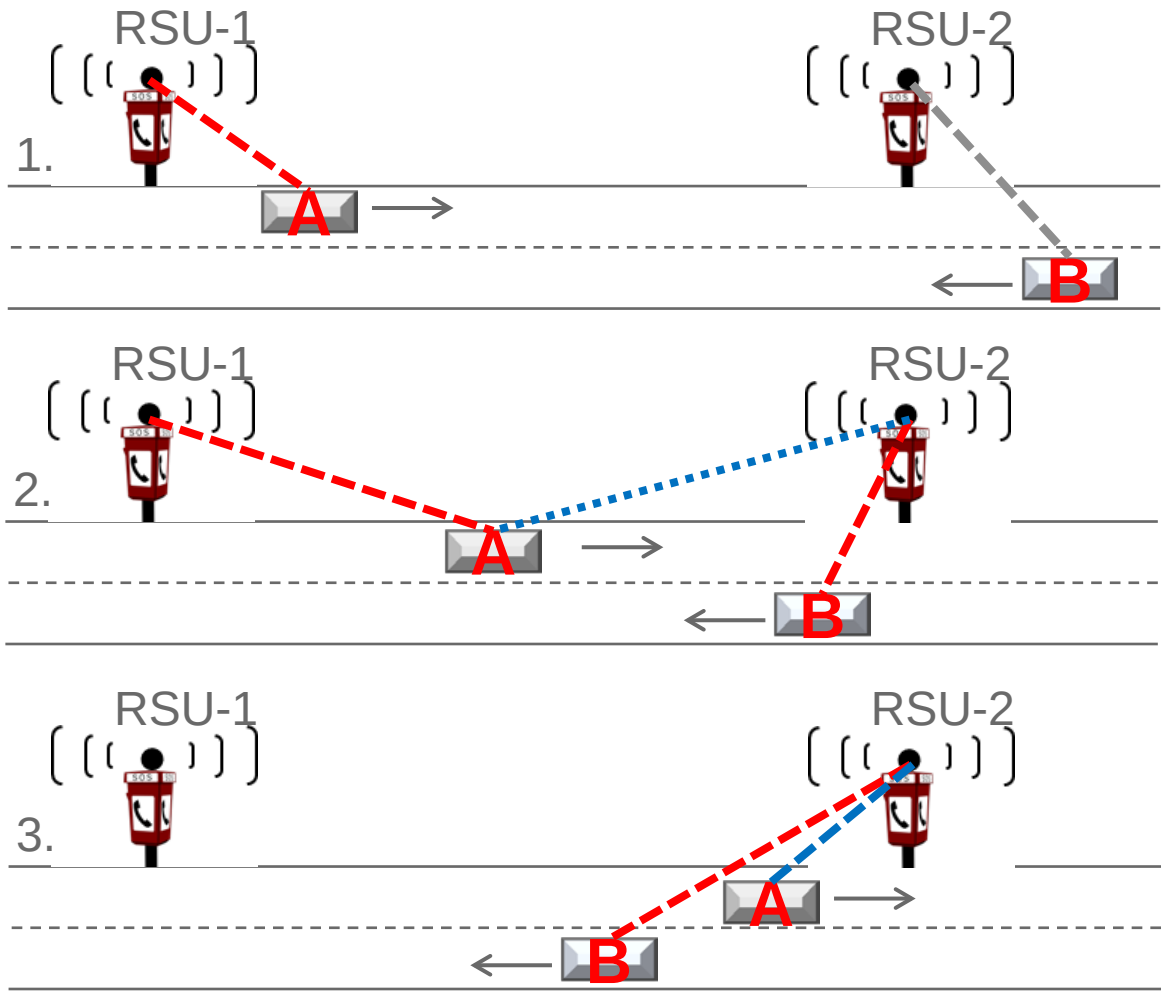
Common Unconventional Data Network

- Issues for further consideration:
  - Legal and contractual around sharing infrastructure
    - Public interest
    - Revenue sharing
  - Some of these data networks are dedicated, closed networks
    - Gateways will be required to allow connectivity “off-the-grid”
    - Segregation and traffic shaping
  - The existing cabling and gateways may need upgrading for more traffic
  - Security
    - Security of the host networks, e.g., Police operated CCTV networks
    - Security of user data, i.e., “over-the-air” & across the host networks
  - Latency
    - Short cell dwell times and frequent cell handovers
    - Fast or pre-emptive routing mechanisms required

Doppler Effect Handover Management

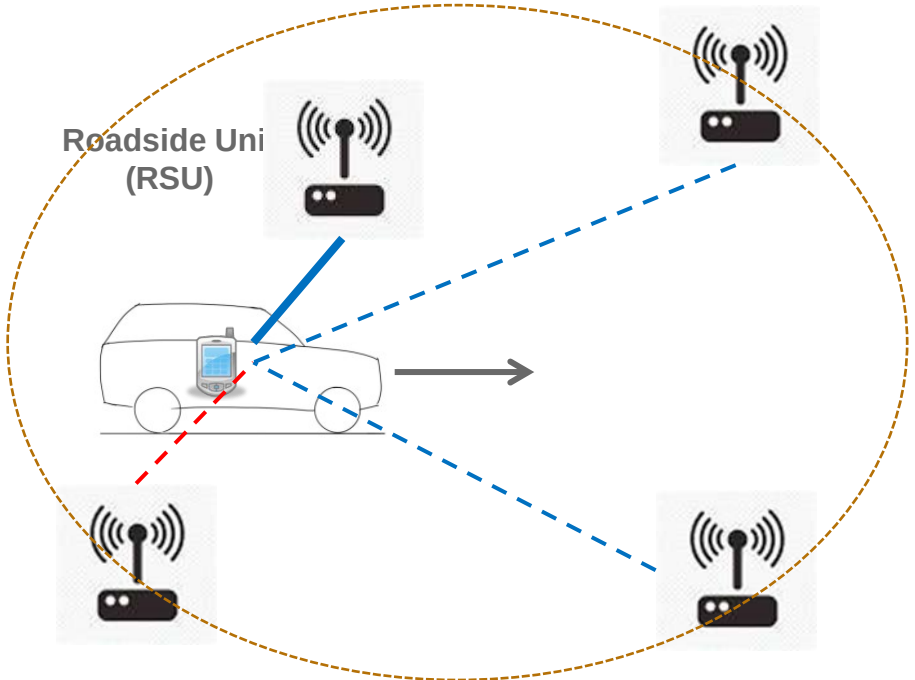
- If a vehicle broadcasts an identification signal:
  - Doppler shifts in the frequency will let an RSU know:
    - If vehicle is approaching
      - Get ready to takeover/takeover
      - Maintain link
    - If the vehicle is moving away
      - Get ready to handover
      - Send “re-route data packets to next RSU” message to main switch
        - Reduces latency, but packets may be lost
      - Alternatively send “start caching duplicate packets to next RSU in readiness for handover” message to the main switch
        - Eliminates latency at handover but decreases network efficiency
    - At what speed
      - Used in the handover algorithm to predict cell exit
      - Used to throttle data to reduce packet loss

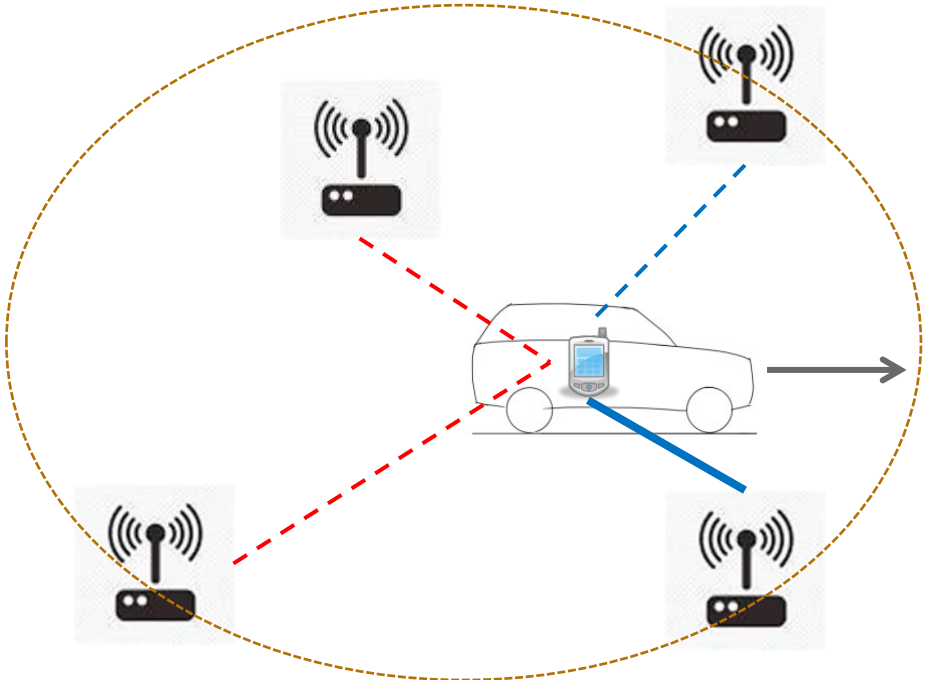
Example of Doppler Handover Management



Doppler Effect Handover Management

- Issues for further consideration:
  - In a linear environment the handover algorithm is straightforward
    - In an urban environment, where roads intersect, run in parallel and at angles to one-another, the handover calculation will be more complex.
      - Several RSUs may be “handshaking” the vehicle at any one time.
    - It may be necessary to devolve some handover intelligence to the vehicle.





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THANK YOU!
ANY QUESTIONS?

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