SECURE SMART MOTORWAYS BY
UTILIZING EXISTING FIXED
INFRASTRUCTURE AS ACCESS POINTS

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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
VANETs or Intelligent VANETs (InVANETs) are a form of Mobile Adhoc Network (MANET).
UNCONVENTIONAL DATA NETWORKS

- PSTN Telephone Box
- Digital Speed Camera
- Centrally managed traffic control
- CCTV Street Cabinet
- Digital Advertising Hoarding
- Digital Public Notice Board
- Digital Road Signage
- Emergency Roadside Telephony
- ANPR
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
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
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

1. RSU-1
   ( ( ( )) )

RSU-1
   ( ( ( )) )

RSU-2
   ( ( ( )) )

2. A → B

3. B → A
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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TEAM
Tomorrow’s Elastic Adaptive Mobility
THANK YOU! ANY QUESTIONS?

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