VTC2007 - Reliable and efficient **Information dissemination** in Intermittently Connected **Vehicular Adhoc Networks**

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Lab Seminar

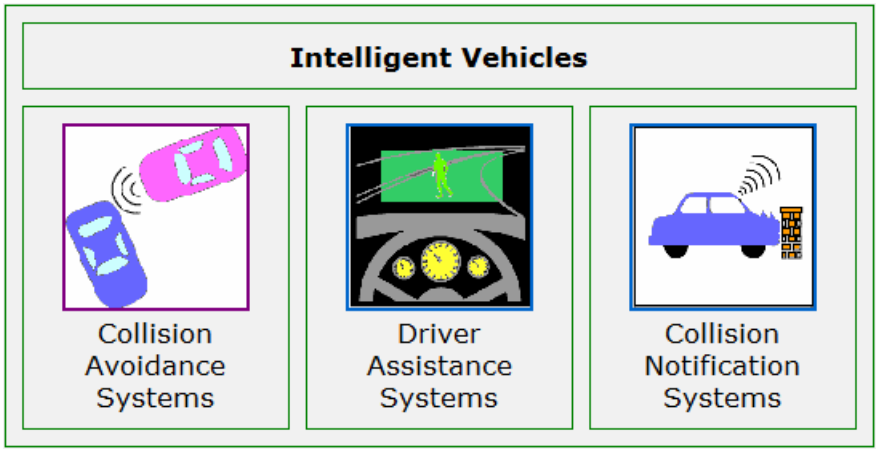
Outline

- Introduction
- Data dissemination
- Edge-aware epidemic protocol
- Simulation results
- Conclusion

Introduction

- **ITS** = Intelligent Transportation System
- **VANET** = Vehicular Adhoc Network

- What is ITS?
  - Infrastructure
  - Vehicle



Intelligent Infrastructure


Arterial Management


Freeway Management


Transit Management


Incident Management

Emergency Management

Electronic Payment and Pricing


Traveler Information

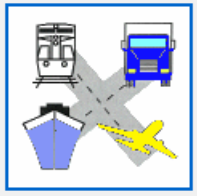

Information Management

Crash Prevention and Safety

Roadway Operations and Maintenance

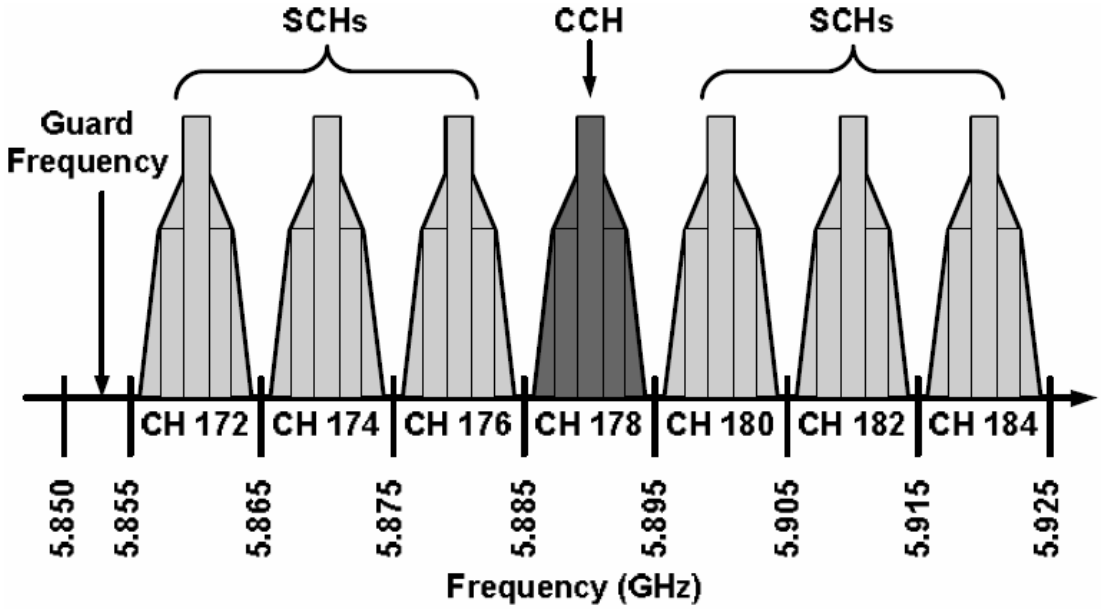

Road Weather Management


Commercial Vehicle Operations


Intermodal Freight

VANET MAC

- **WAVE** = Wireless Access in Vehicular Environments
  - IEEE 802.11p (@5.9 GHz), IEEE P1609.4

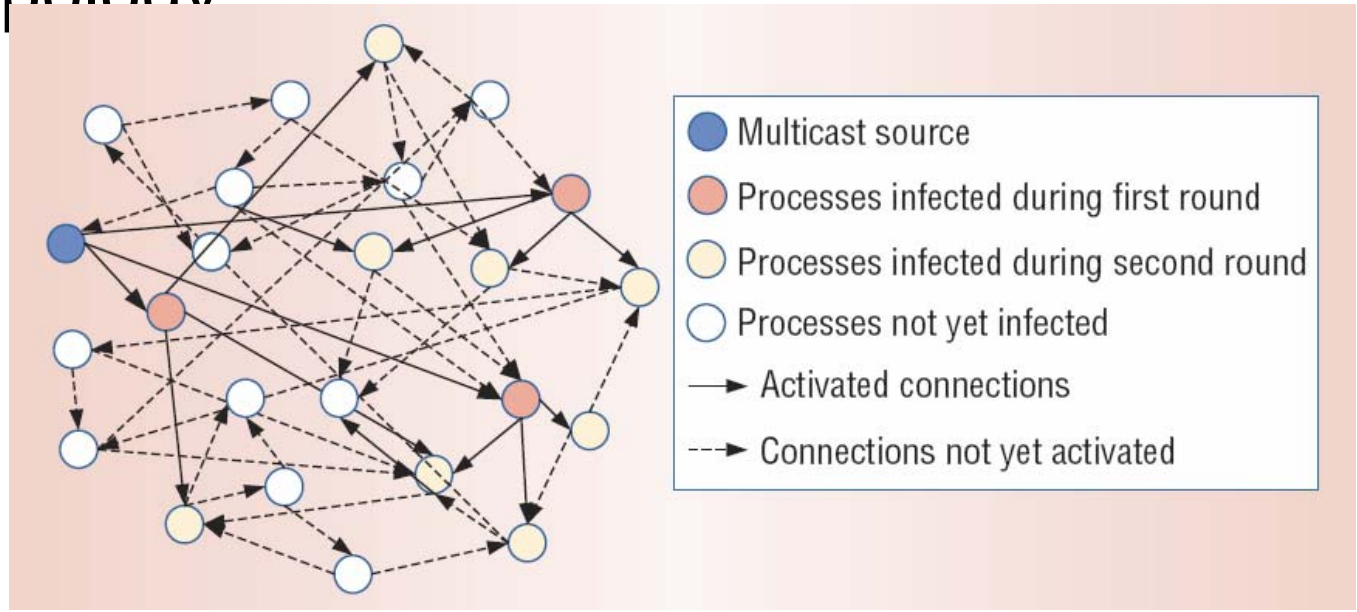


Data Dissemination in ITS

- Existing protocols for multihop wireless adhoc network
  - Static network with E2E connectivity
  - Mobile network where nodes follow random walk or random waypoint
- The highly dynamic nature of VANET results in large variations in node density and frequent fragmentations of disconnected clusters.
- **Reliable and efficient dissemination of data?**

Epidemic protocol for Distributed Computing [18]

- Epidemic protocols are **probabilistic** information dissemination protocols which do not require any knowledge of the local and global network topology



EAEP

- Edge-Aware Epidemic Protocol

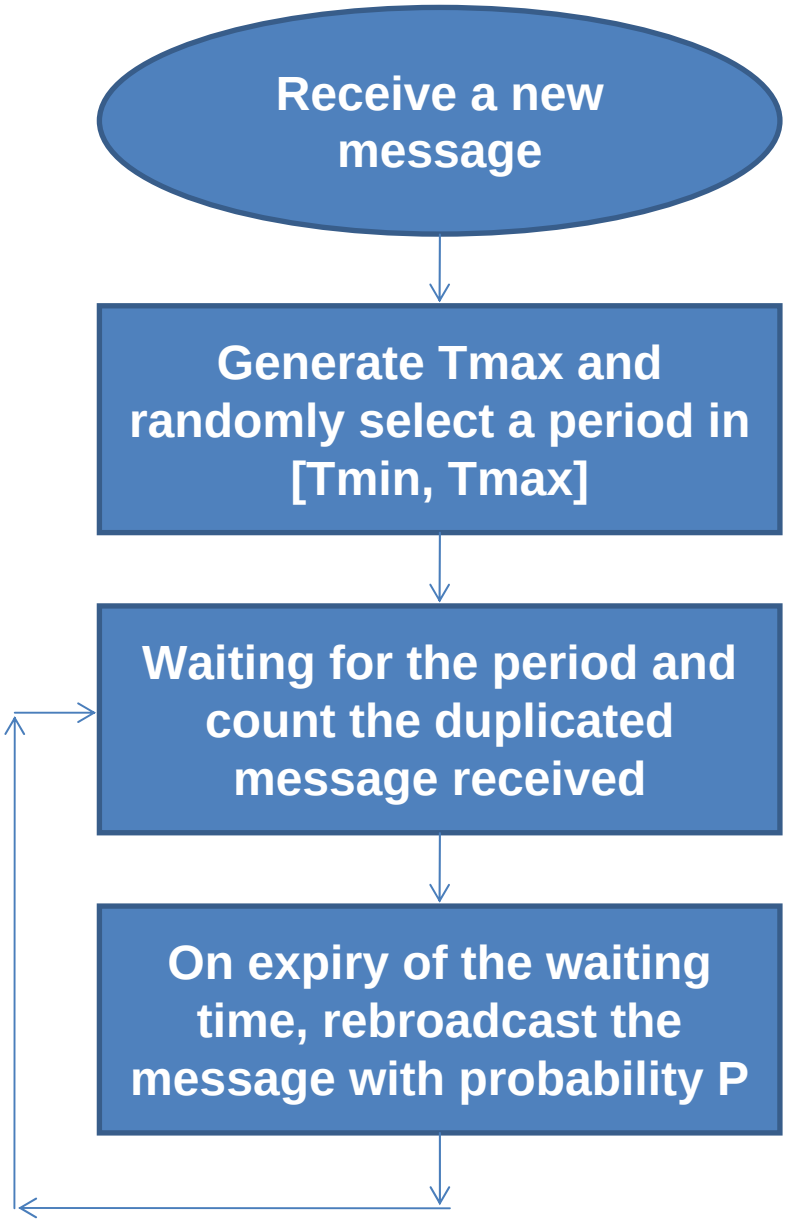
- The proposed scheme releases the requirements for:
  - infrastructure support
  - exchange of “Hello” messages
  - Cluster maintenance

Assumptions

- Each vehicle has knowledge of its own geographical location (by means of GPS)

- Each message contains information of:
  - the position of its source
  - directional or omnidirectional
  - a TTL parameter

The EAEP Algorithm



$$T_{max} = \min \begin{cases} \frac{T_0}{U} \exp\left(\frac{|x_{rec} - x_{sou}|}{L}\right) \\ \\ T_{min} = \frac{T_0}{2U}, \end{cases}$$

$$P = \begin{cases} 1 & \text{if } N_f \text{ or } N_b = 0 \\ \\ 1 - \exp\left(-\alpha \frac{|N_f - N_b|}{N_f + N_b}\right) & \text{otherwise.} \end{cases}$$

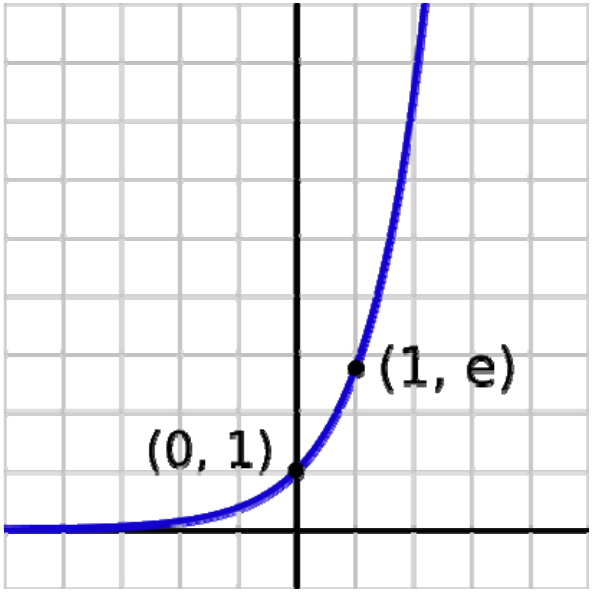
$$P = \begin{cases} 1 & \text{if } N_k = 0 \\ \\ 1 - \exp\left(-\alpha \frac{N_k}{N_k + N_{\bar{k}}}\right) & \text{otherwise,} \end{cases}$$

Tmax

- The waiting time is chosen in a way that it is **exponentially** biased towards vehicles which are further away from the source node.

$$T_{max} = \frac{T_0}{U} \exp\left(\frac{|x_{rec} - x_{sou}|}{L}\right)$$

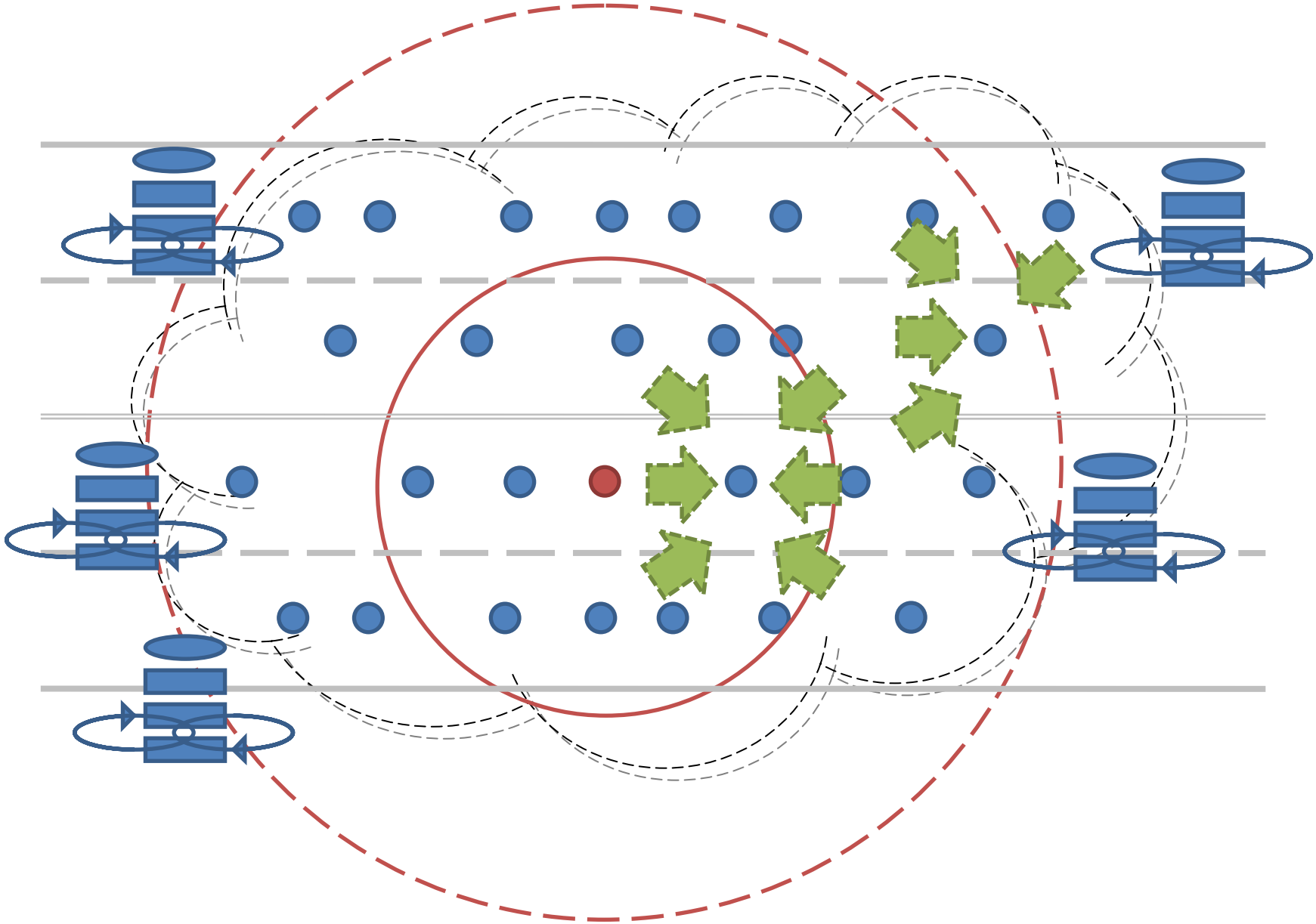
$$T_{min} = \frac{T_0}{2U}$$



The P for Omnidirectional Propagation

- The net effect is that only nodes close to the edge of a cluster (i.e. those with an "**unbalanced**" message count) keep the message alive.

$$P = \begin{cases} 1 & \text{if } N_f \text{ or } N_b = 0 \\ 1 - \exp\left(-\alpha \frac{|N_f - N_b|}{N_f + N_b}\right) & \text{otherwise.} \end{cases}$$



The P for Directional Propagation

- If a message is propagating forward/backward, it is only kept alive by nodes near the head/tail of the cluster.

$$P = \begin{cases} 1 & \text{if } N_k = 0 \\ 1 - \exp\left(-\alpha \frac{N_k}{N_k + N_{\tilde{k}}}\right) & \text{otherwise,} \end{cases}$$

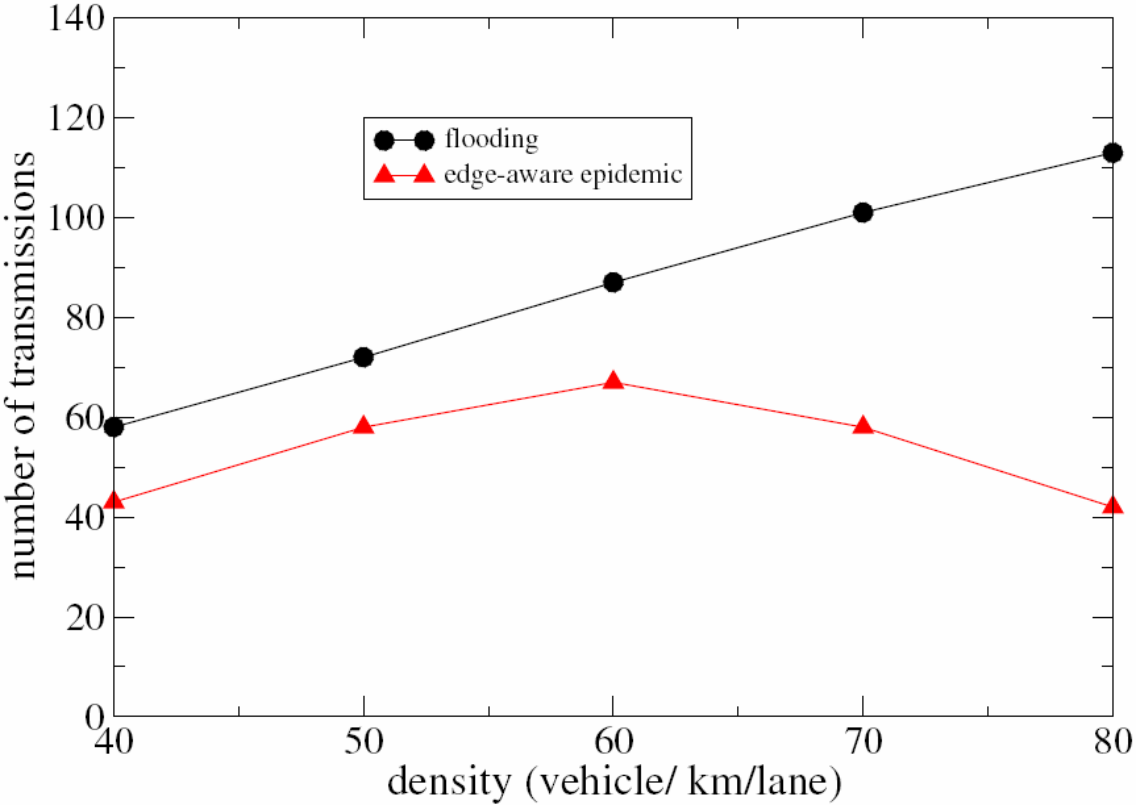
Simulation Setup

- Maximum vehicle speed = 120 km/h
- α (redundant controlling factor) = 1
- L (exp controlling factor) = 1000 m
- T_0 (waiting time parameter) = 2000 timesteps
- U (message Urgency factor) = 1

- Vehicular mobility
  - Macroscopic ($Q = \rho V$)
  - Microscopic (IDM, Intelligent Driver Model) [12]

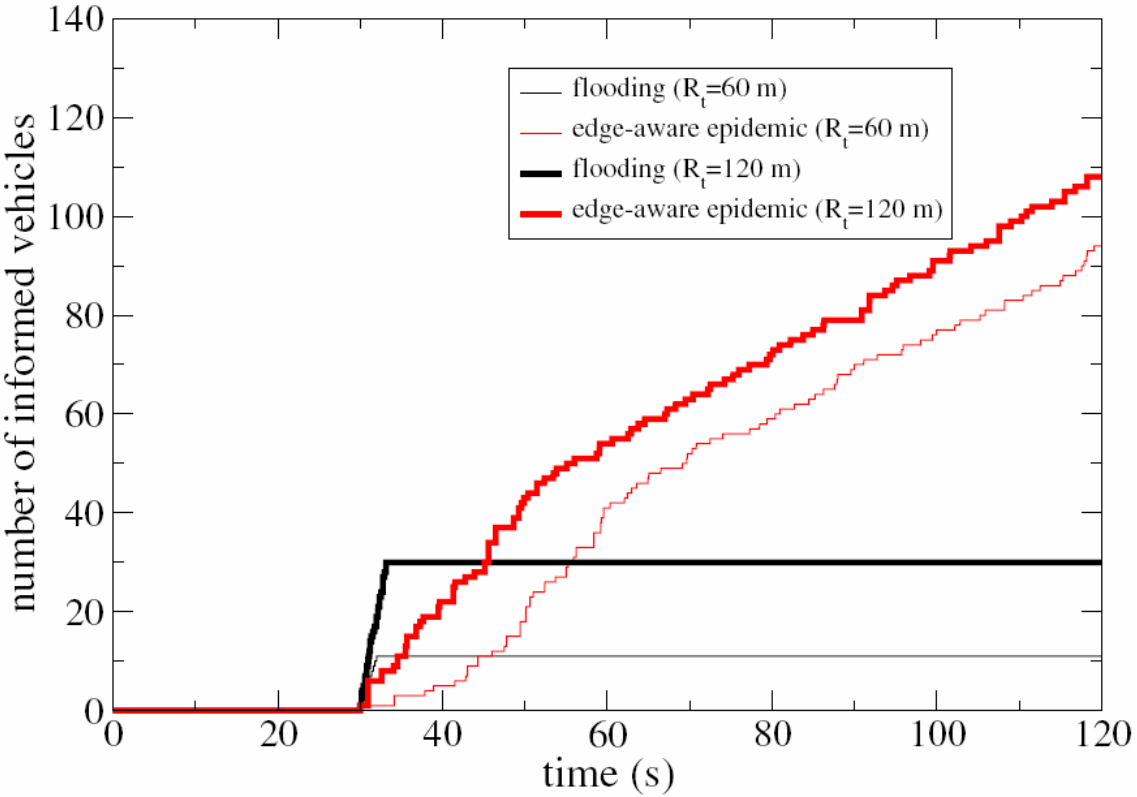
Simulation Result - 1

- VANET w/ continuous E2E connectivity



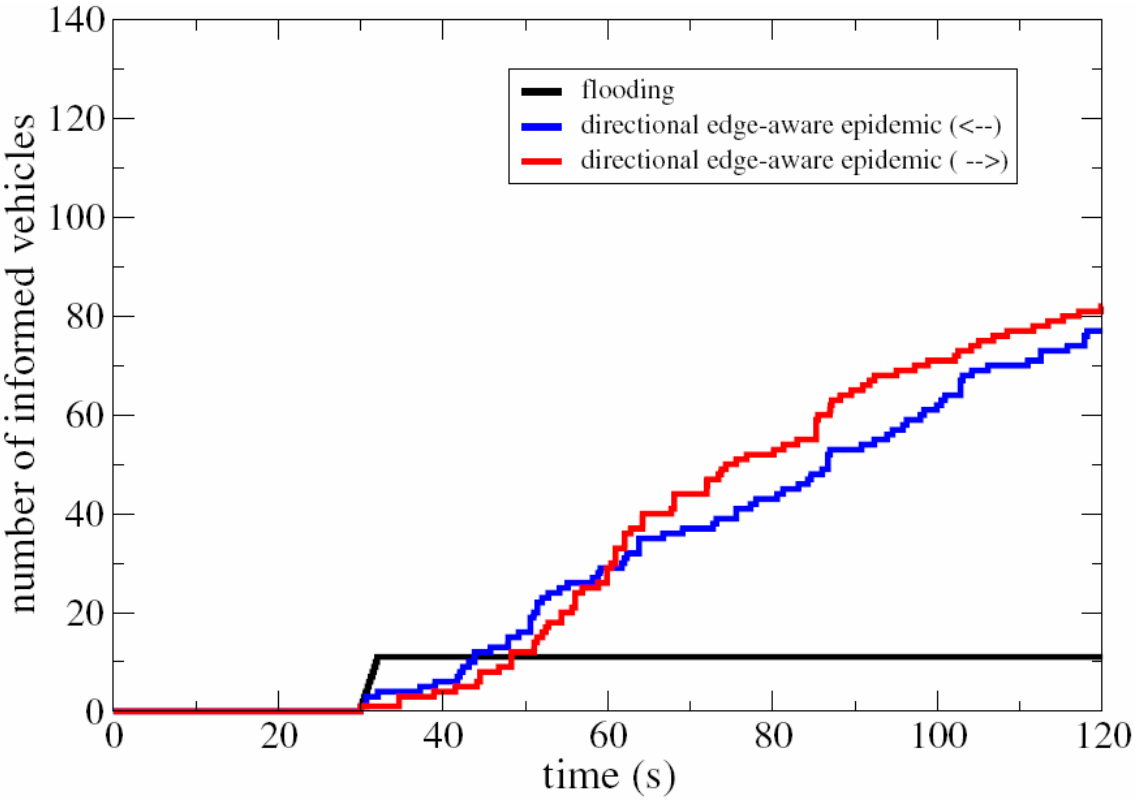
Simulation Result - 2

- Intermittently connected VANET
- Source: a randomly chosen vehicle at 30s
- Omnidirectional case with TTL = ∞



Simulation Result - 3

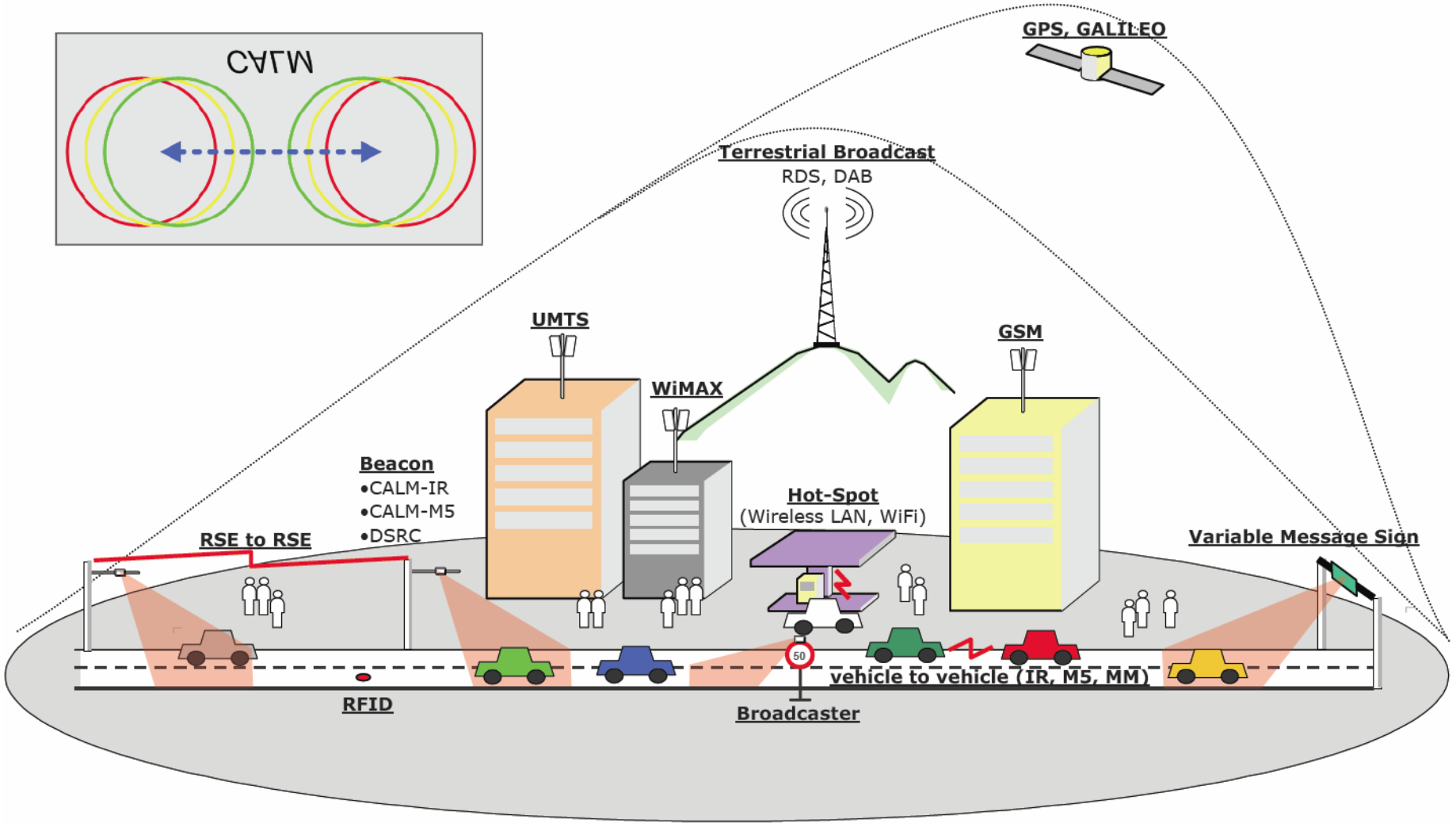
- directional case with TTL = ∞



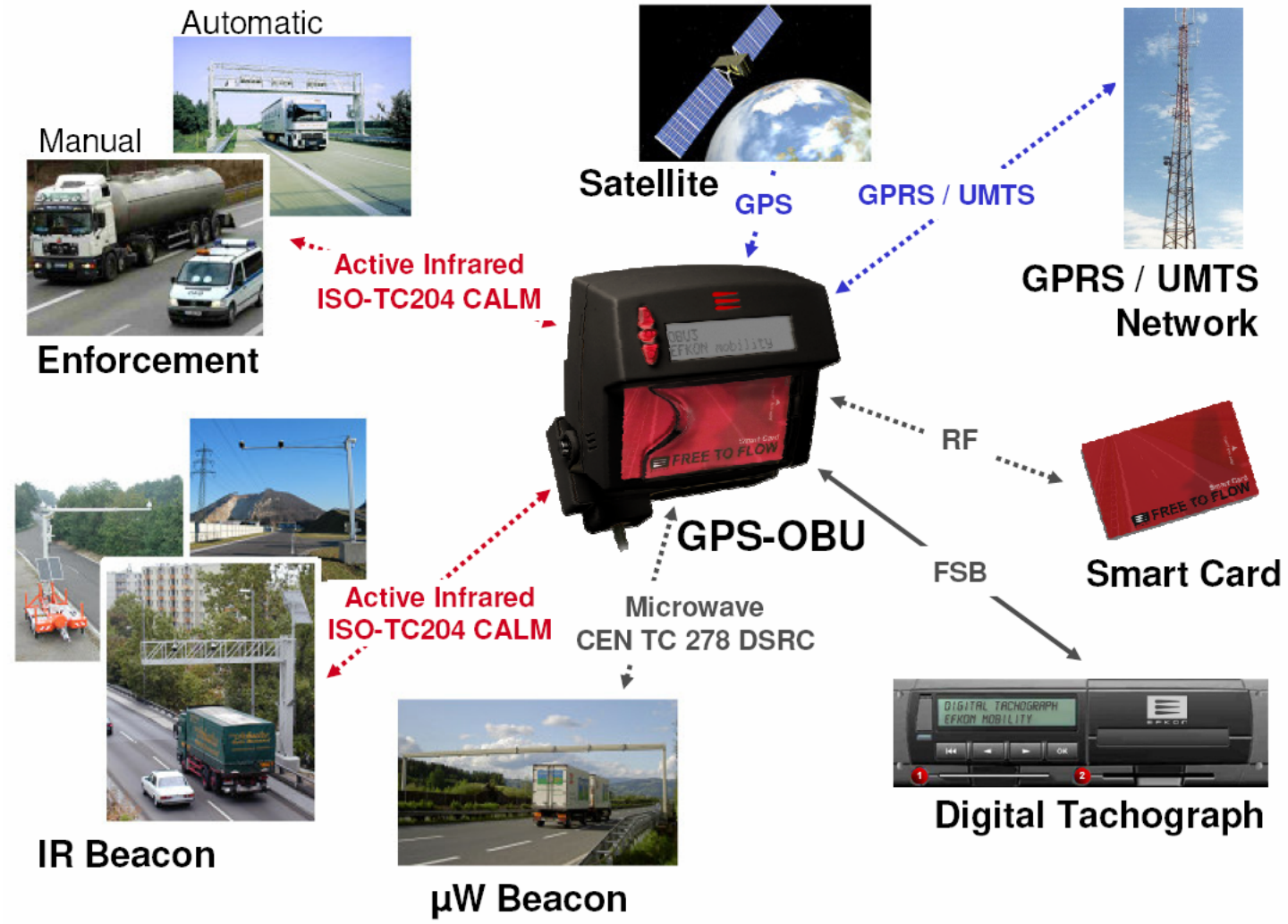
Conclusion

- EAEP employs the **epidemic** protocol, which allows light-weighted algorithms in the field of distributed computing, for the data dissemination in VANET.

- Benefits of EAEP:
  - No need of infrastructure support
  - No need of neighborhood maintenance


GPS, GALILEO
Terrestrial Broadcast
RDS, DAB
UMTS
WiMAX
GSM
Beacon
•CALM-IR
•CALM-M5
•DSRC
Hot-Spot
(Wireless LAN, WiFi)
RSE to RSE
Variable Message Sign
50
vehicle to vehicle (IR, M5, MM)
RFID
Broadcaster

EFKON's Gateway



*Source: A. P. Schalk, its'07

ITS Taiwan

- 先進交通管理系統(Advanced Traffic Management Systems, ATMS)
- 先進旅行者資訊系統（Advanced Traveler Information Systems, ATIS）
- 先進公共運輸系統（Advanced Public Transportation Systems, APTS）
- 先進車輛控制安全系統 (Advanced Vehicle Control and Safety System，AVCSS)
- 商車營運系統（Commercial Vehicle Operations, CVO）
- 緊急事故支援系統 (Emergency Management System，EMS)
- 電子收付費系統 (Electronic Payment System & Electronic Toll Collection，EPS&ETC)
- 資訊管理系統 (Information Management System，IMS)
- 弱勢使用者保護服務 (Vulnerable Individual Protection Services，VIPS)

- 中華智慧型運輸系統協會
- http://www.its-taiwan.org.tw/