THE FULLY NETWORKED CAR

Solutions for Active Safety with vehicular communications

Dr. Massimiliano LENARDI

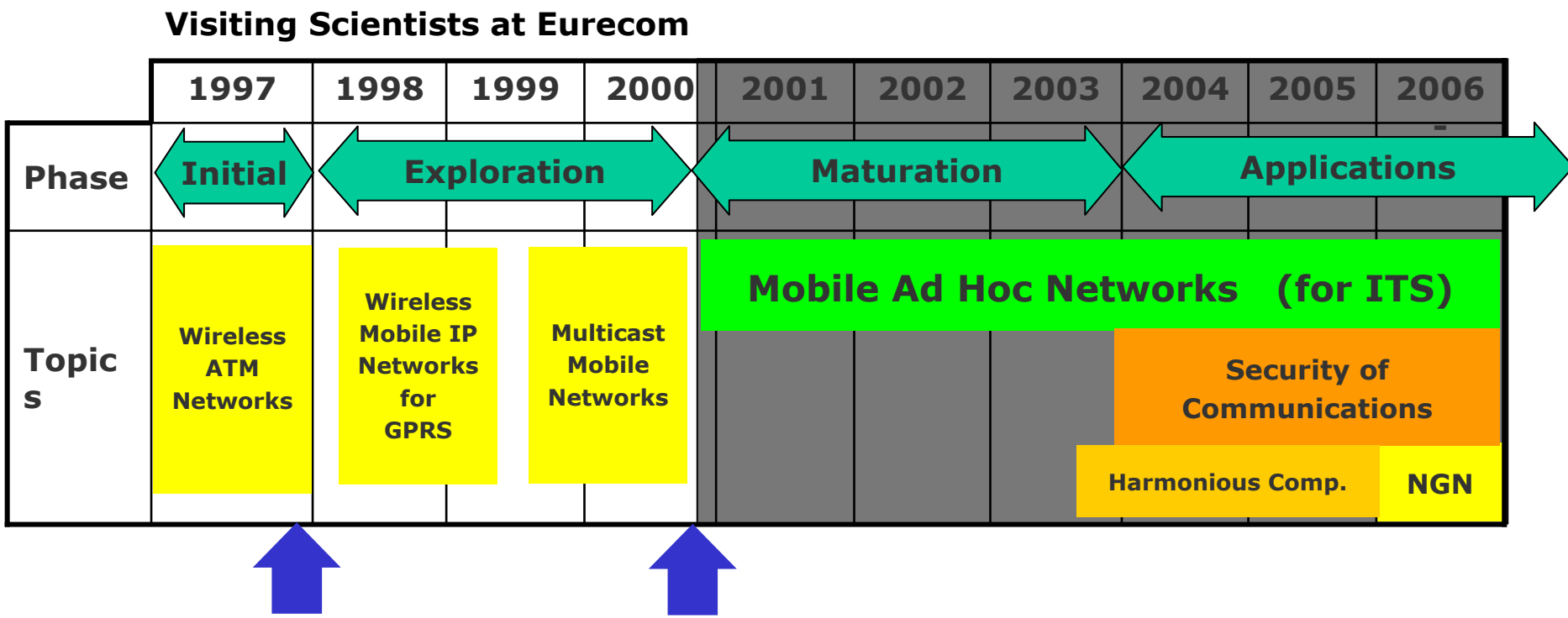
HITACHI
Inspire the Next

Geneva, 7-9 March 2007

Outline

- Hitachi Sophia Antipolis Lab (HSAL) R&D areas
- HSAL ITS-related activities
- 2 research examples
- Open ITS C2X communications issues

HSAL : R&D closer and closer to business



HSAL actual ITS staff:
5 people (2 researchers, 2 PhDs, 1 Internship)

HITACHI
Inspire the Next

ISO IEC ITU International Telecommunication Union

Ongoing and Future Ad Hoc / ITS R&D issues:

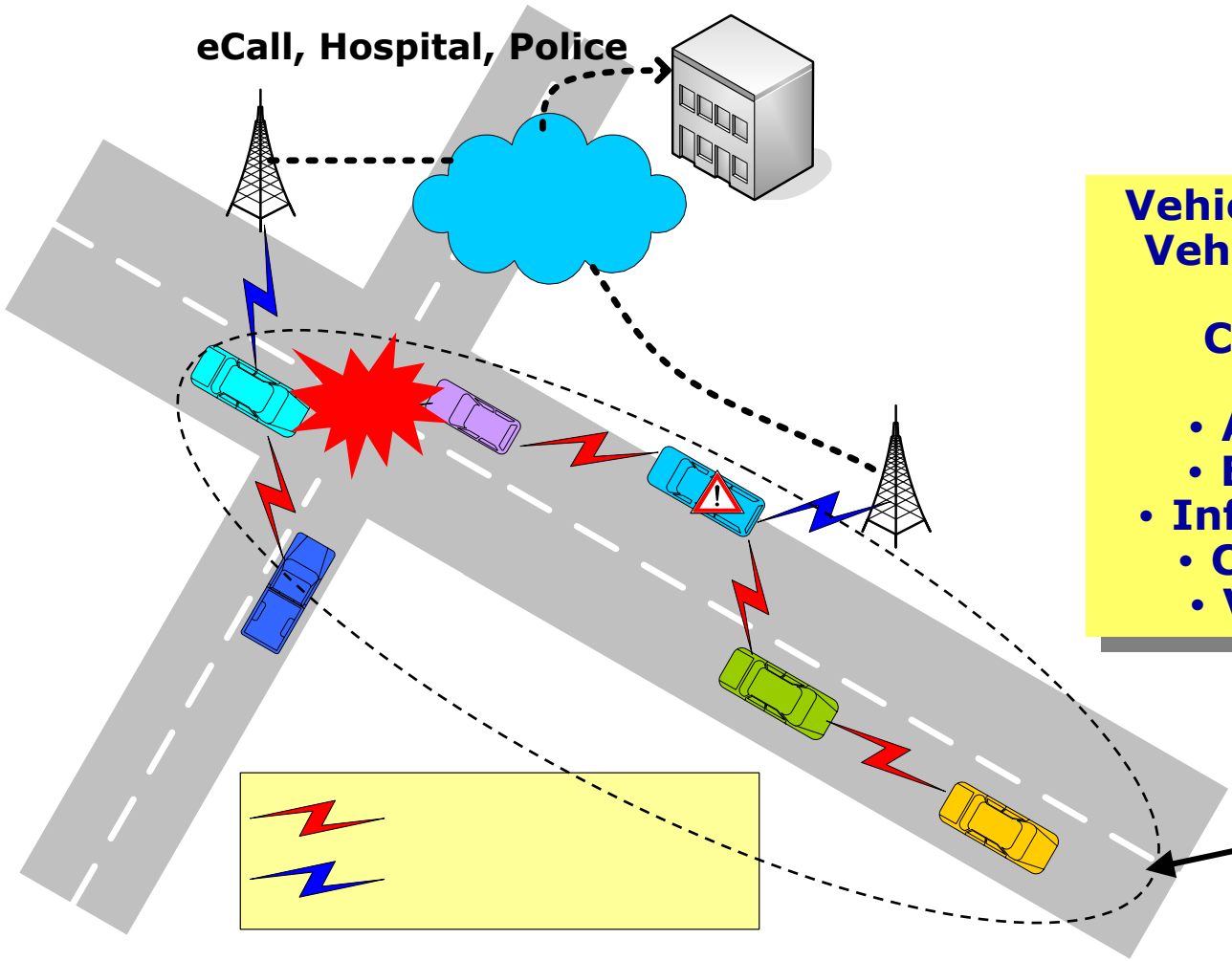
- **Routing protocols (unicast, multicast, "georouting", cross-layer protocols, etc.)**
- **(IPv6 and) Autoconfiguration**
- **Reliability and High-Speed Mobility**
- **Scalability**

- **Security**
- **QoS**
- **Service-related unicast protocols**
- **Ad hoc network management schemes**
- **Multi-interface devices**
- **Service Announcement and Discovery**
- **Active Networking**
- **...**

in particular within the

Intelligent Transport Systems (ITS) context ...

Potential Applications by V2V and V2I



Vehicle-to-Vehicle (V2V) & Vehicle-to-Infrastructure (V2I) Communications for

- **Accident Prevention**
- **Emergency Warning**
- **Infrastructure Warnings**
- **Comfort Applications**
- **V2I warnings/signs**

1st R&D example:
Multi-Hop Vehicular Beacon Broadcast (MHVBB)

In **high speed scenarios**, periodic beacons with vehicles' movement information need to be broadcasted over longer distances and received within short intervals; this would be helpful for emergency applications (traffic jam, accident ahead, ambulance approaching…) and thus ensure high levels of Active Safety.

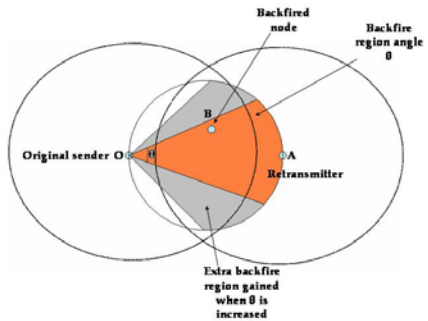
➔ need for an efficient dissemination protocol : **MHVBB**

"Save NET resources"

- by **decentralized traffic jam detection**
- by Transmission Interval Control (**TIC**, dynamic beaconing period)

"Efficient next forwarder selection"

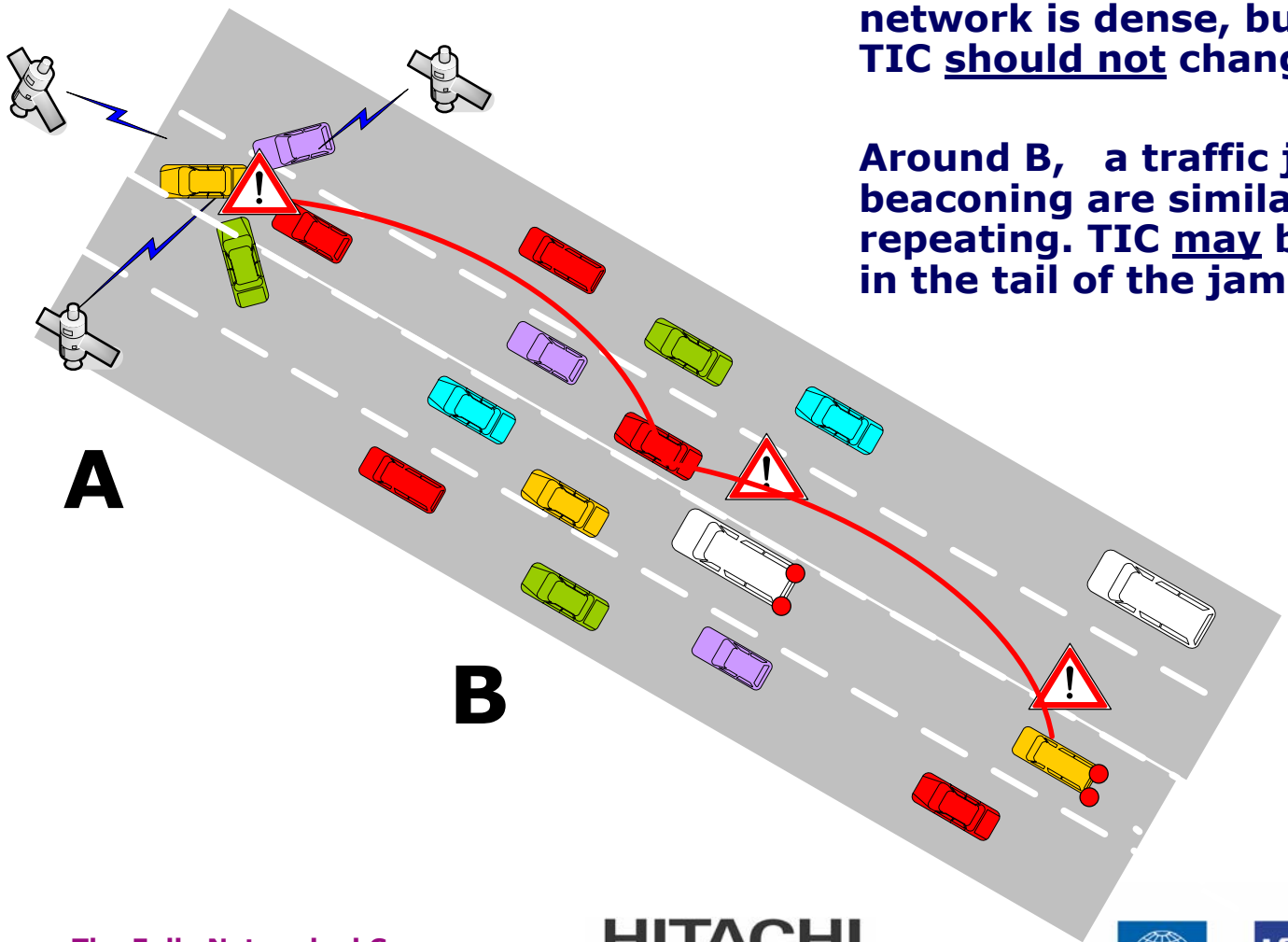
- within the backfire area
  "**sectoral** instead of circular"
- retransmission time
  "**Dynamic Scheduling** dep. on distance"



HITACHI
Inspire the Next

ISO IEC ITU International Telecommunication Union

Motivations for different TX intervals in MHVBB



Around A, an accident happens, the network is dense, but the beaconing TIC should not change.

Around B, a traffic jam is formed, beaconing are similar and repeating. TIC may be changed BUT in the tail of the jam …

2nd R&D example:
Movement Prediction-based Unicast Routing (MOPR) Protocols

Existing MANETs topology-based unicast routing protocols are
not suitable, as they are, for VANETs

Movement prediction seems helpful in improving them

MOPR proposes to select the most stable routing route based on vehicles movement

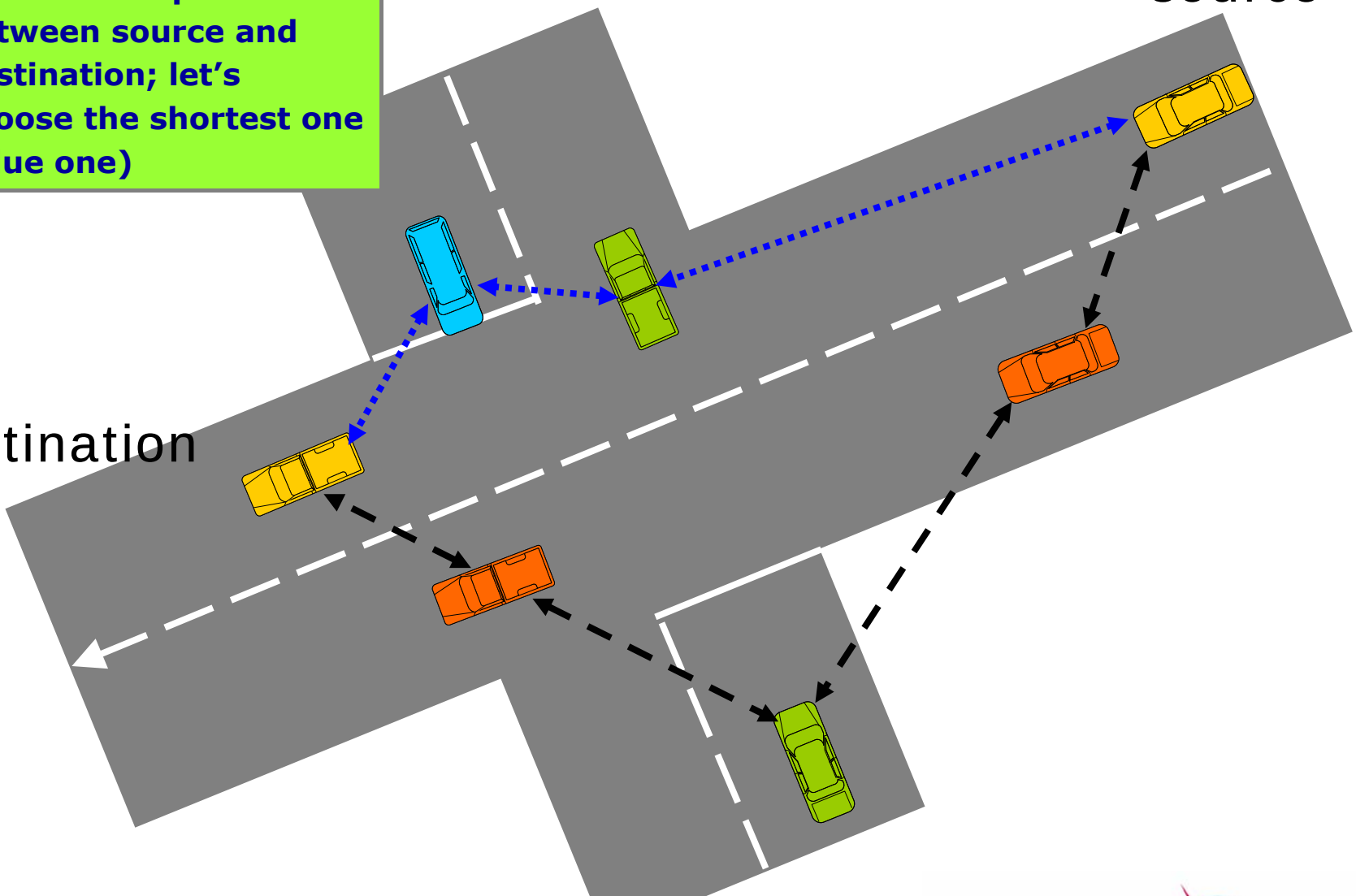
"Animation" in next slide

At $t = t_0$

2 routes are possible between source and destination; let's choose the shortest one (blue one)

source

destination



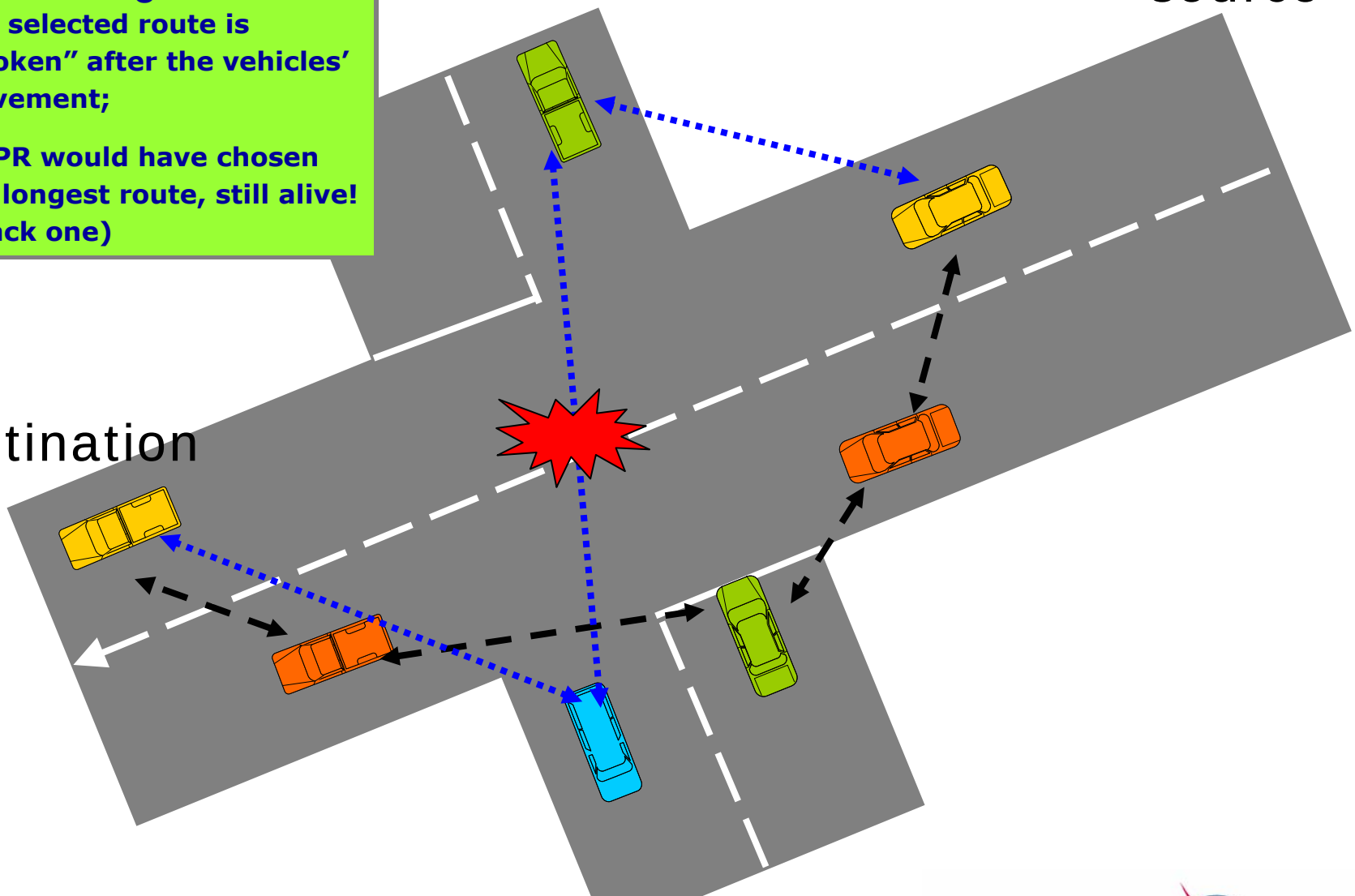
At $t = t_0 + T$

The selected route is "broken" after the vehicles' movement;

MOPR would have chosen the longest route, still alive! (black one)

source

destination



MOPR versions

- **Preliminary version of MOPR**

Each node in the network, adds its movement information into the routing control packet before sending/forwarding it.

That increases too much the routing overhead !

- **New version of MOPR**

We suppose that each node knows the movement information of all nodes in 1hop/2hop neighborhood.

That can be provided by some lower layer like some periodic beaconing system

MOPR implementations' overview

MOPR can be applied on reactive and proactive topology-based routing protocols and on position-based protocols

reactive routing

MOPR-based AODV √

georouting

GEOMOPR √

proactive routing

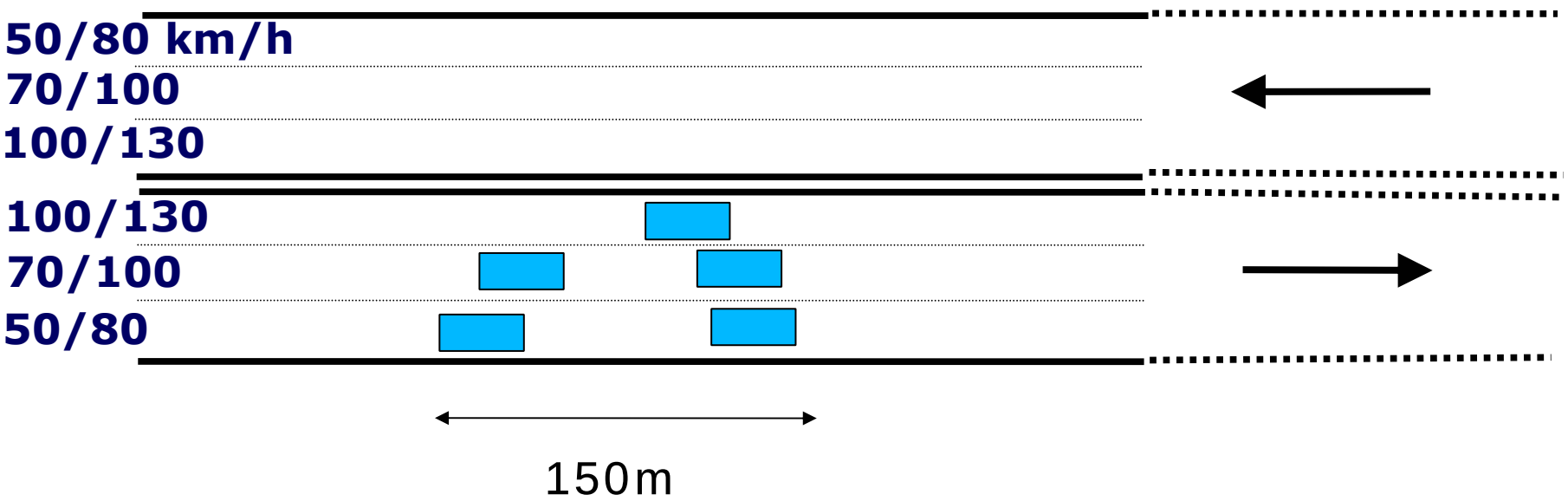
MOPR-based OLSR

1. MPR 2-hop
   MPR nodes are selected based on 2-hop neighbours' movement information
2. **MPR 2-hop_Rt**
   same like in MPR 2-hop, with MOPR-based routing routes selection

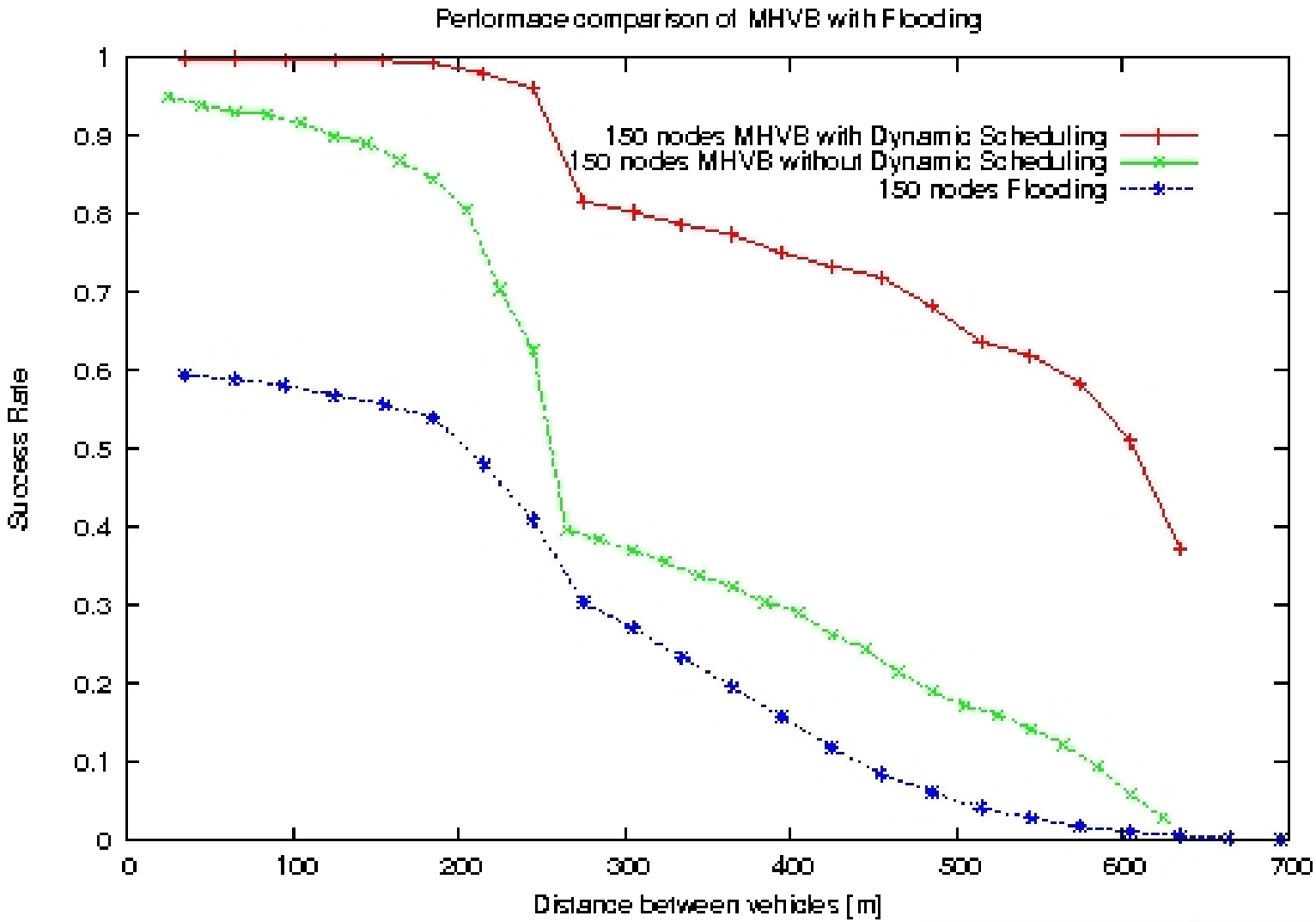
√

Simulations' settings

- Simulator: ns2.28
- Scenario: Highway scenario (3 lanes in each direction for 5000m)
- Traffic type: CBR (for MOPR)
- Radio propagation: 250m
- Density: 5 vehicles every 150m



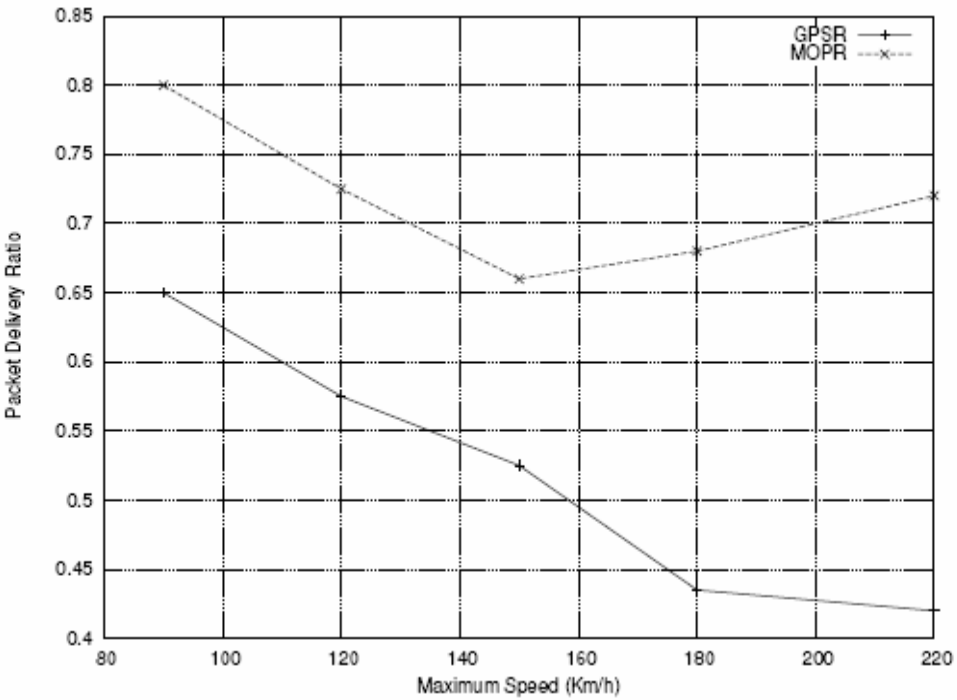
Comparison of MHVBB and pure flooding Highway model

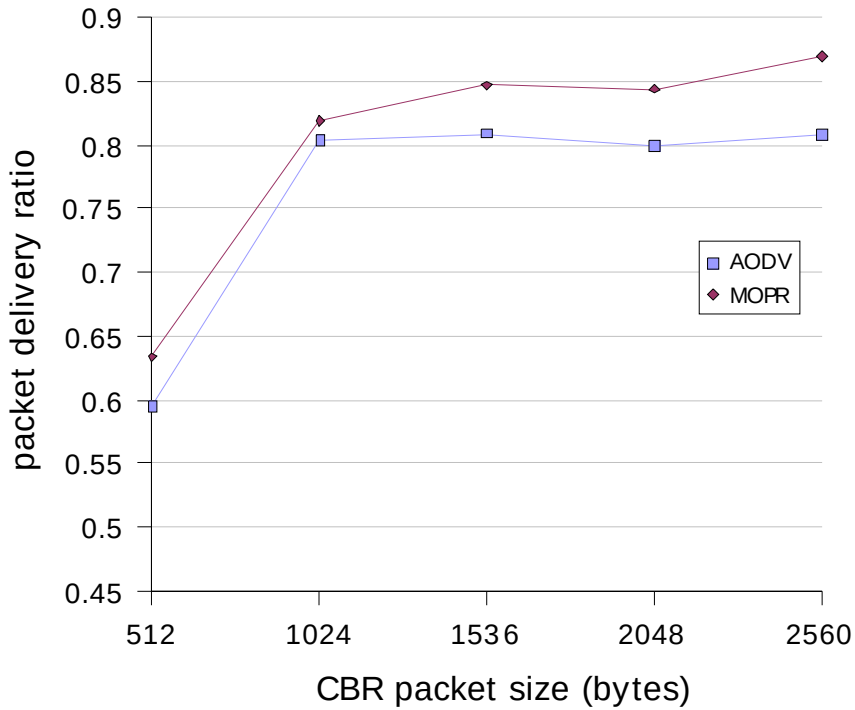


Simulations' Results: GEOMOPR and MOPR-AODV

Comparison of GEOMOPR and GPSR

Highway model





Comparison of AODV and MOPR-AODV

Highway model

Open issues

- **System deployment** (penetration) and **ITS infrastructures** (in EU nobody seems ready to assume the responsibility of the infrastructure! … and : "Operated Network", "ITS extension" or "Value-added" infrastructures ?)
- **Security** (not only data integrity, but also data trustiness, privacy, traceability, threats, etc.)
- Not only vehicles on the roads! **Pedestrians ? Bicycles ?**
- **Legal issues** (insurances almost never involved in R&D …)
- **"New" biz models ?** (are we sure people wants to pay for active *safety* on the roads via communications? Perhaps only for Traffic/Infotainment…)
- **ITS network scalability and self-organization** (MobileIPv6, MANEMO, x.yG…)

Future Events

ITST 2007

6 – 8 June 2007

Sophia Antipolis

http://www.itst2007.eurecom.fr