Towards a Robust Exchange of Imperfect Information in Inter-Vehicle Ad-Hoc Networks using Belief Functions

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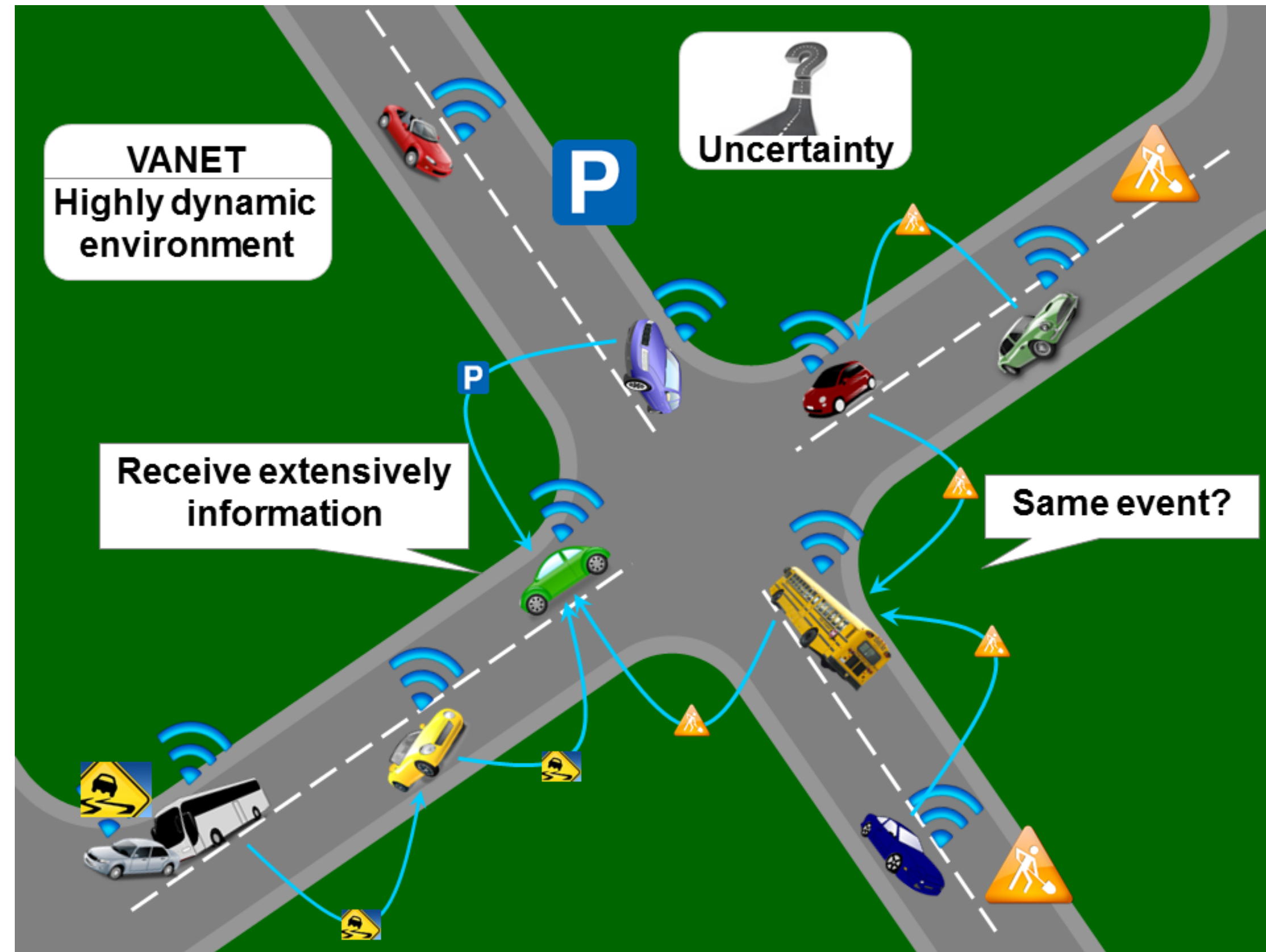
Objective

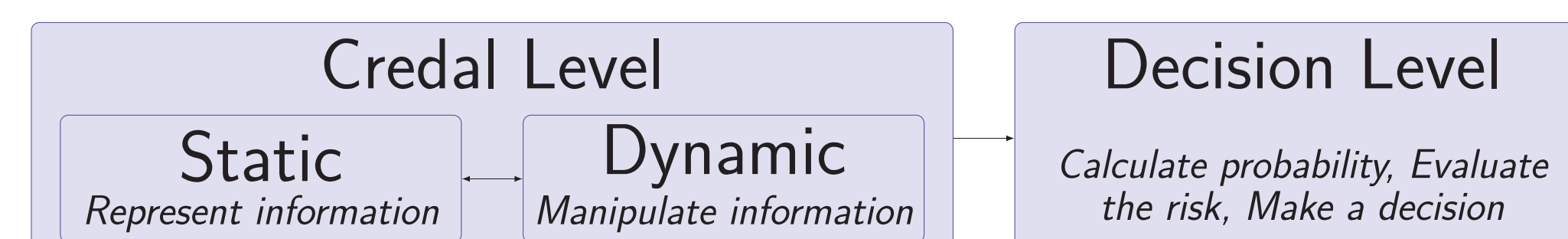**Exchange and manage imperfect information in Inter-Vehicle Communication using belief functions.**

Context

cisit
International Campus on Safety and Intermodality in Transportation

Have intelligent, reliable and clean vehicles.
Lead developed research to industrialization.

VESPA

Share different types of events, and guide drivers to find a parking place or to get traffic information.

Belief Functions

▶ Dempster-Shafer theory (Dempster 1967, Shafer 1976).
▶ Transferable Belief Model (Smets 1994).

Credal Level		Decision Level
Static *Represent information*	Dynamic *Manipulate information*	*Calculate probability, Evaluate the risk, Make a decision*

Static Part: Mass Function Definition

Knowledge regarding the answer to a given question, where:

$$\sum_{A \subseteq \Omega} m_S^\Omega(A) = 1$$

Dynamic Part: Conjunctive Rule of Combination

$$m_{1 \odot 2}(A) = \sum_{B \cap C = A} m_1(B) \cdot m_2(C) \, , \, \forall A \subseteq \Omega$$

m_1 and m_2: obtained from distinct and reliable sources.

Decision Level: Pignistic Probability

$$BetP(\{\omega\}) = \sum_{\{A \subseteq \Omega, \omega \in A\}} \frac{m(A)}{|A| \, (1 - m(\emptyset))} \, , \, \forall \omega \in \Omega$$
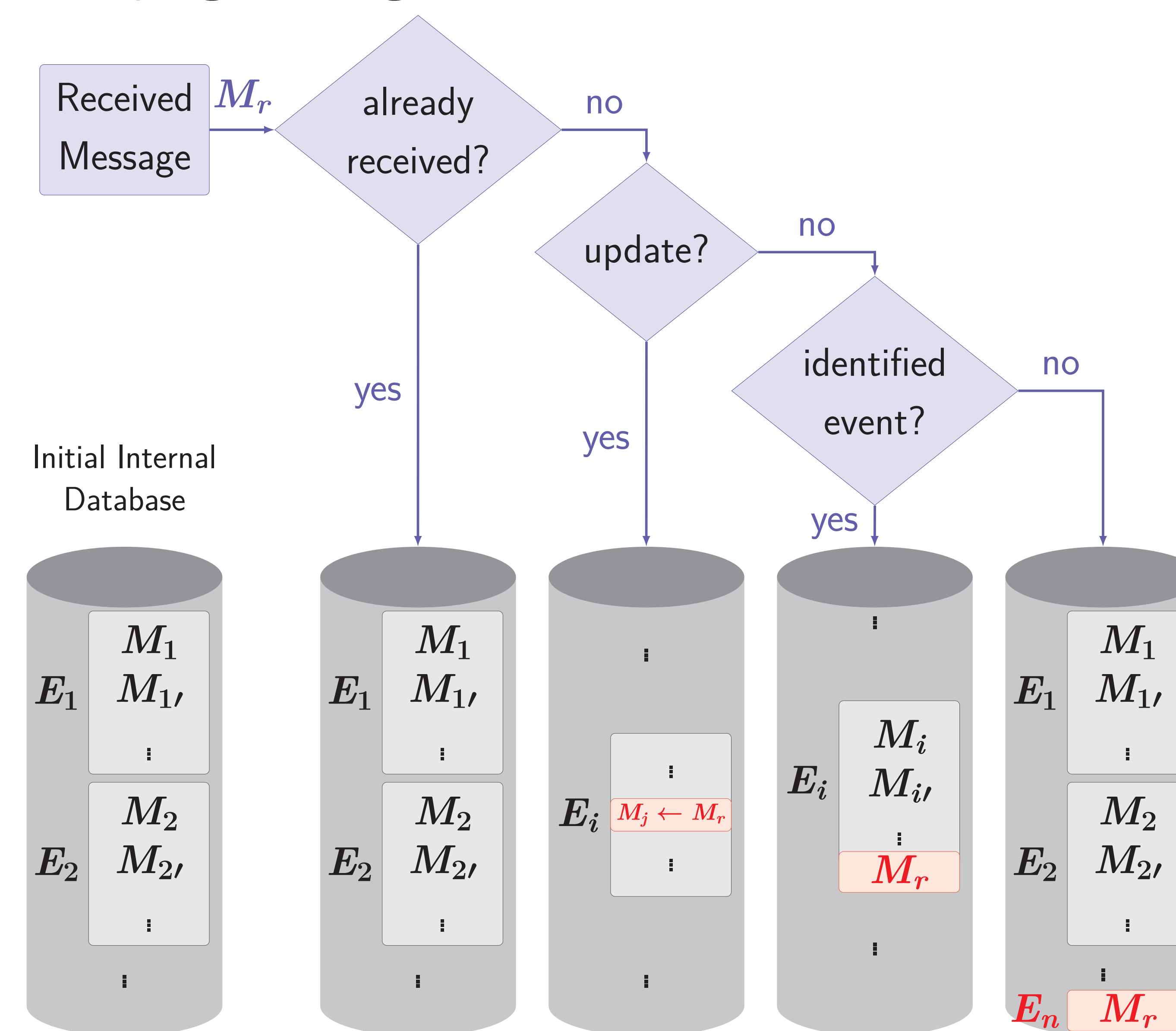
Proposed System Model

Diffused or Received Message Representation

▶ A message (S, t, d, ℓ, m) is perceived by the source S informing about the type t, the date d, the location ℓ and the confidence (mass function m) of an event.
▶ A vehicle can either diffuse a new message or repeat a received message.

Vehicle V_1 — $\dfrac{(V_1, t, d, \ell, m)}{\text{sent}}$ — Vehicle V_2 — $\dfrac{(V_1, t, d, \ell, m)}{\text{repeated}}$ — Vehicle V_3
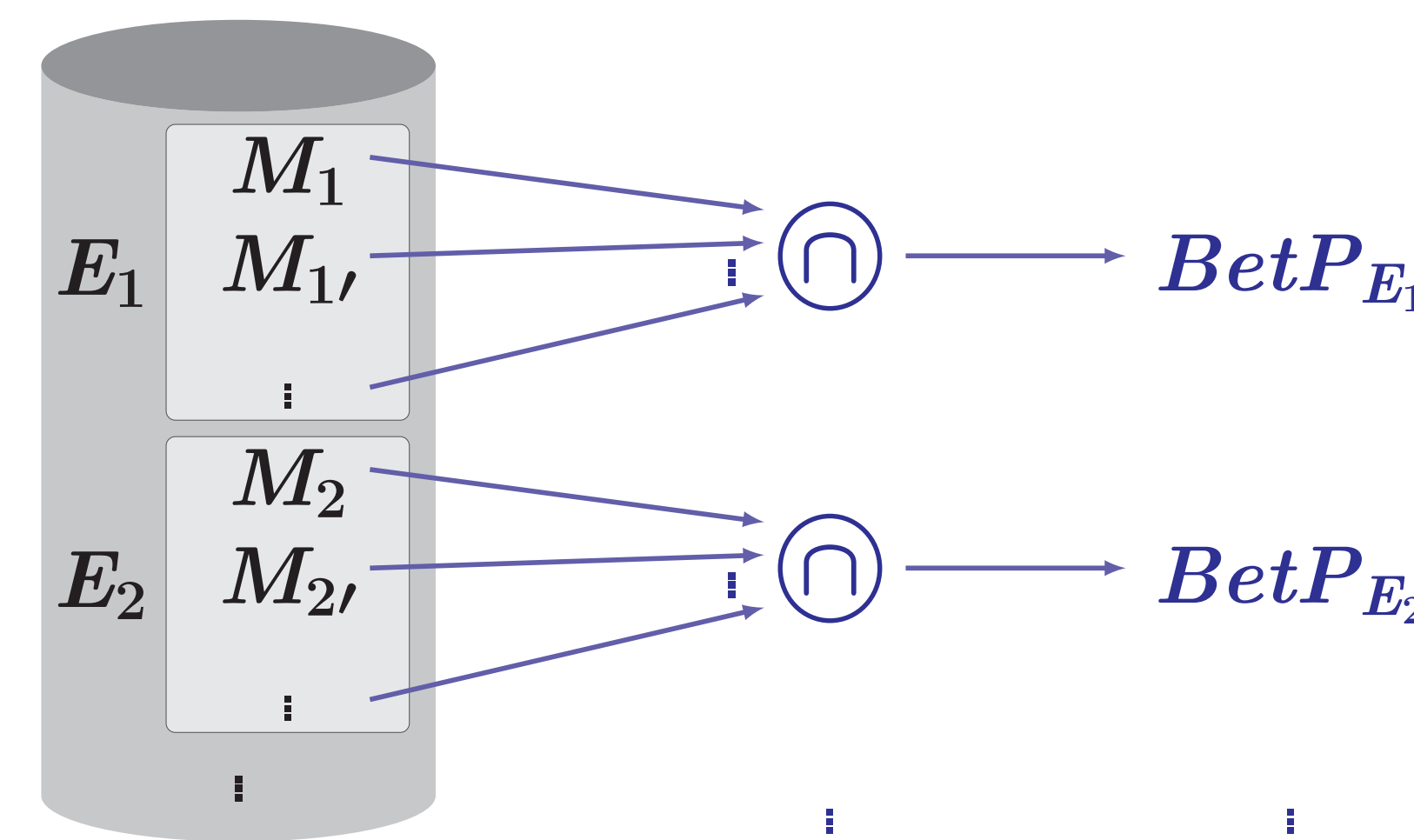
▶ A vehicle receives a summary of the ongoing events on the road. Several messages may inform about the same event.

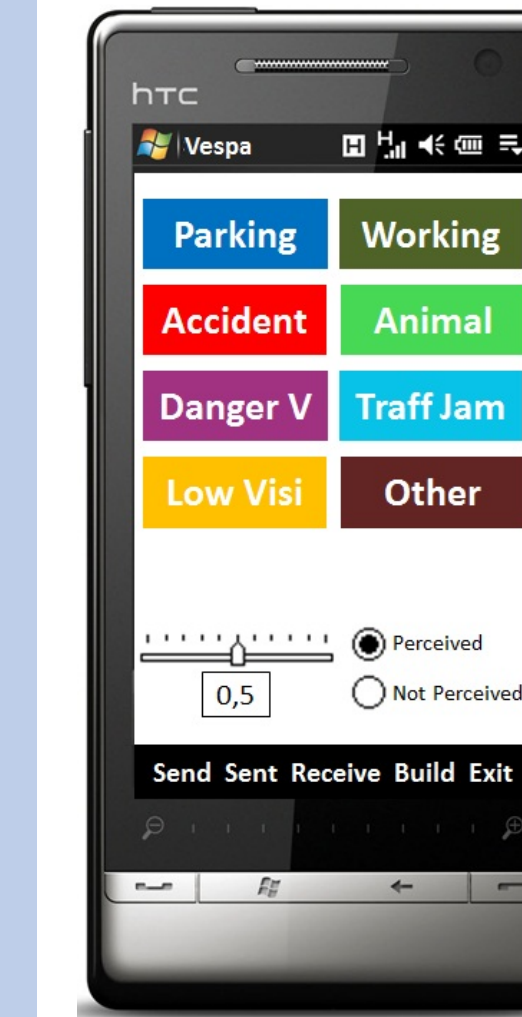### Grouping Messages Associated with the Same Event

Data Fusion

Vehicles do not diffuse the combined information.

Application and Scenario

Embarked in HTC Touch Diamond mobiles: Windows Mobile, Wi-Fi and GPS equipped.
It allows sending messages where:
▶ $m(\{ev\}) = 1 - m(\Omega)$ if user perceived the event ;
▶ $m(\{\neg ev\}) = 1 - m(\Omega)$ ifnot .

Conclusion and Future Work

▶ The method allows the management of uncertain events.
▶ This application is useful also for pedestrians to share other kind of events.
▶ Reflections and Future work:
  ▶ Consider relation between events.
  ▶ Consider more than two states in the frame of discernment.