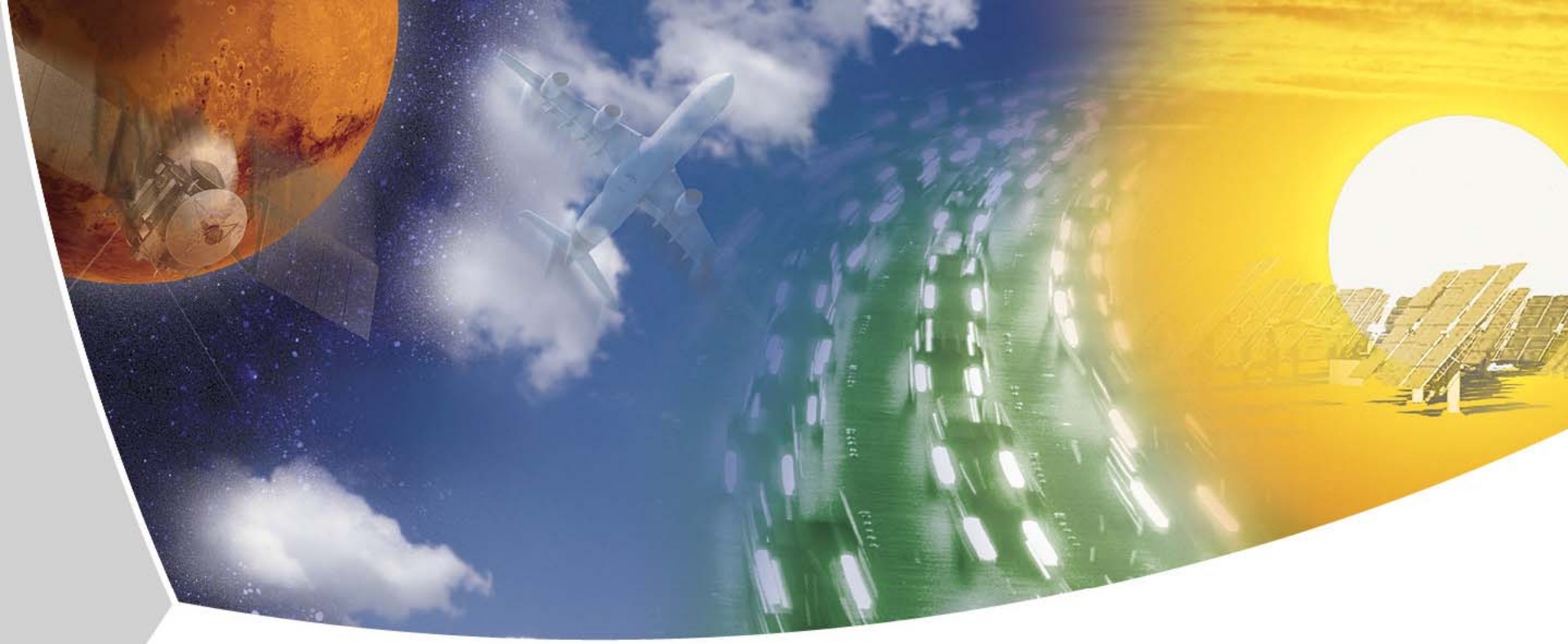

An Architecture for Situation-Aware Driver Assistance Systems

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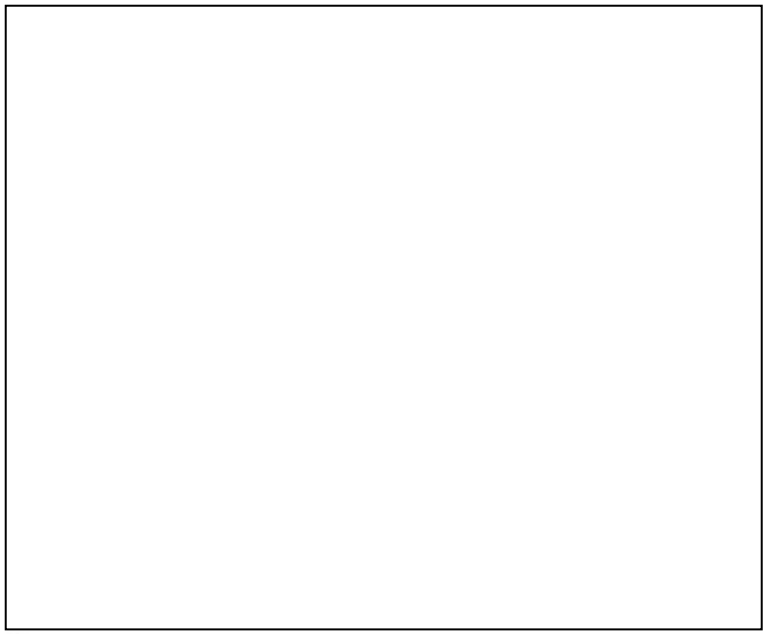
Motivation

- To detect hazardous situations early, precise and reliable, relevant situational information has to be observed and assessed
- Much situational information is already available in current vehicle technology but is not exploited at present



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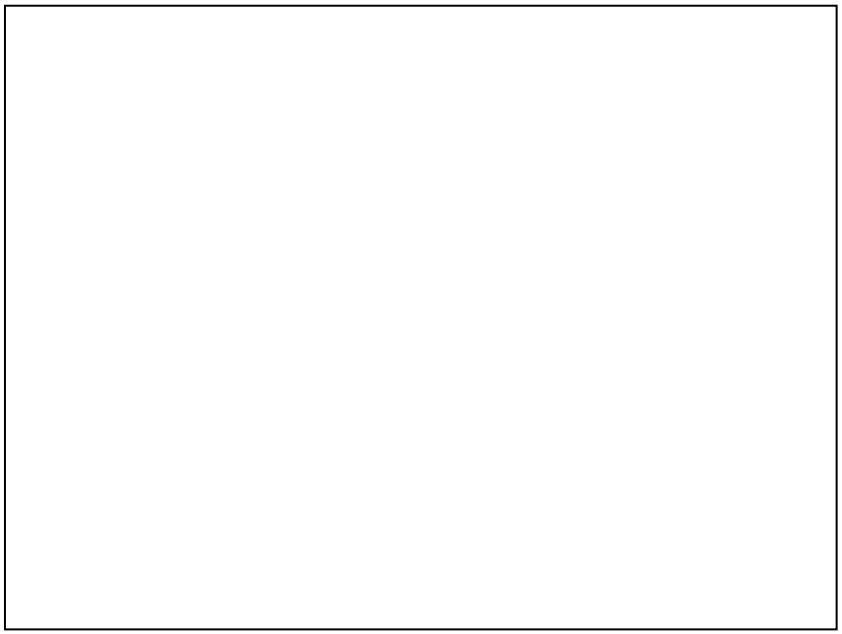

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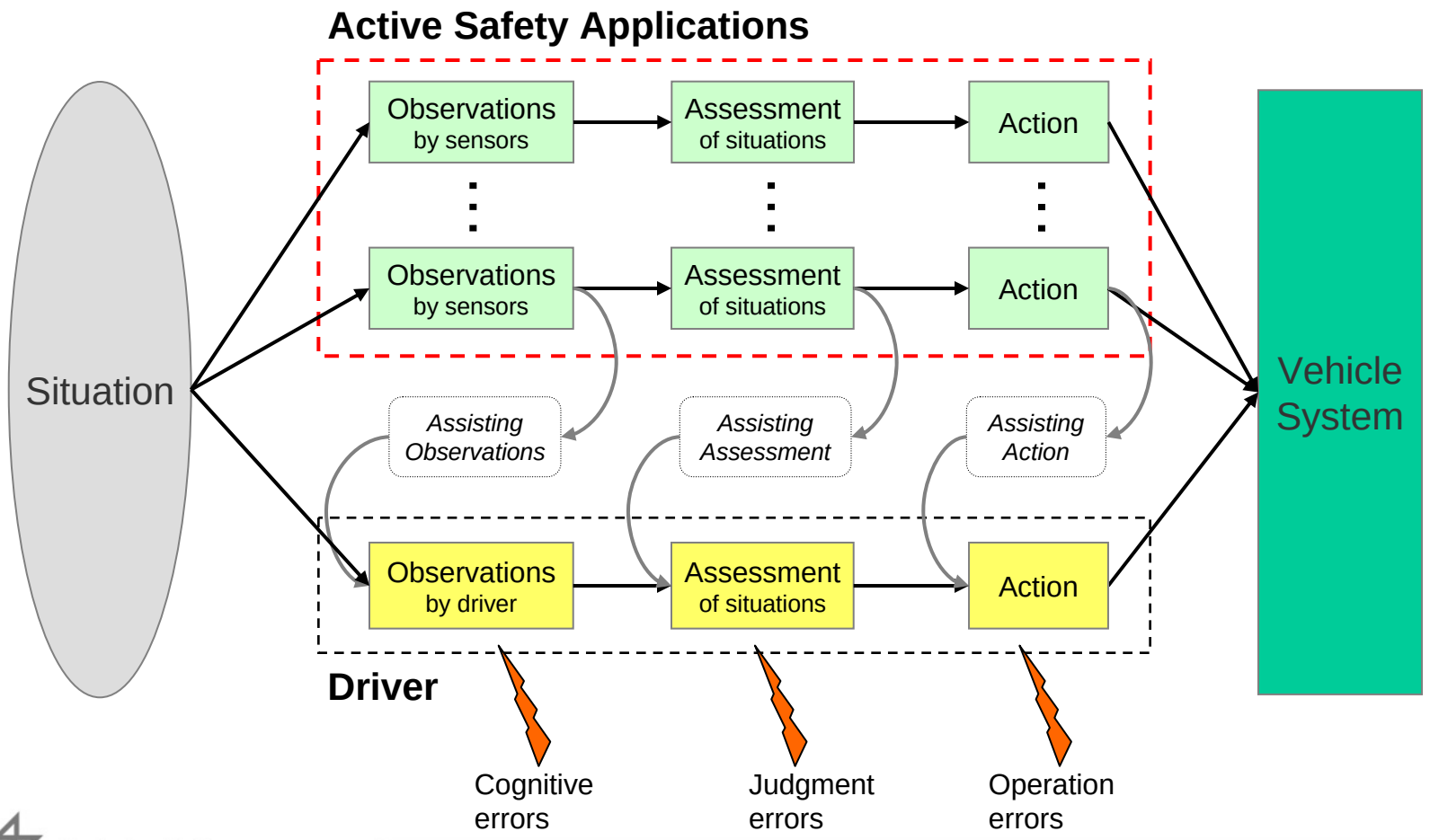
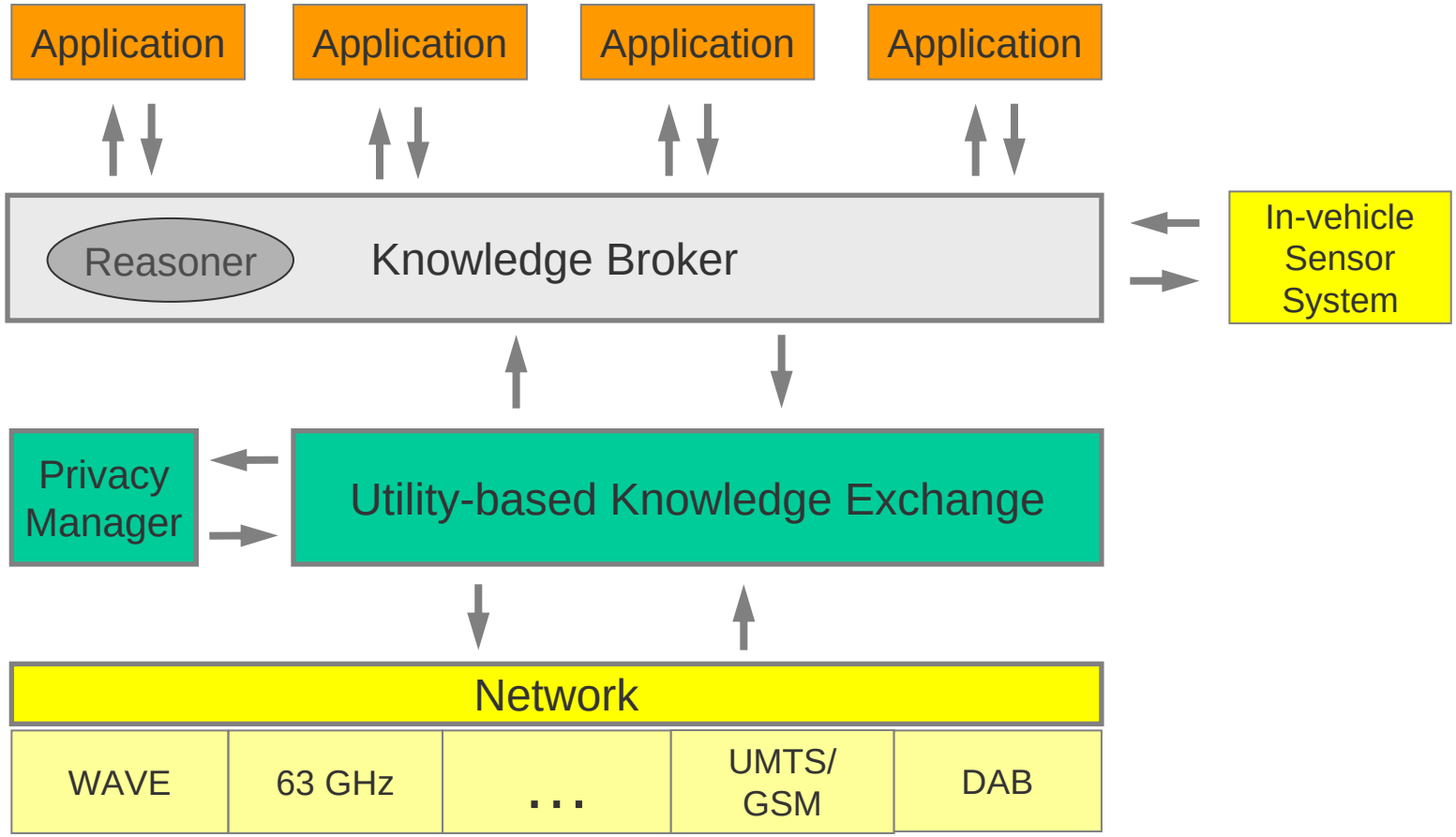
Driver Assistance
Active Safety Applications



Cooperative Active Safety Applications

- *Vehicle-2-X-Communication (V2X)*: Exchange of information between vehicles and between vehicle and infrastructure with wireless vehicular ad-hoc networks (VANET)
- *Cooperation*: Situational information exchange in VANETs to achieve a global utility maximization
- Examples:
  - Lane Change Warning
  - Traffic Jam Ahead Warning
  - Cooperative Merging Assistant
  - Static/Dynamic Black Spot Warning

Architectural Components



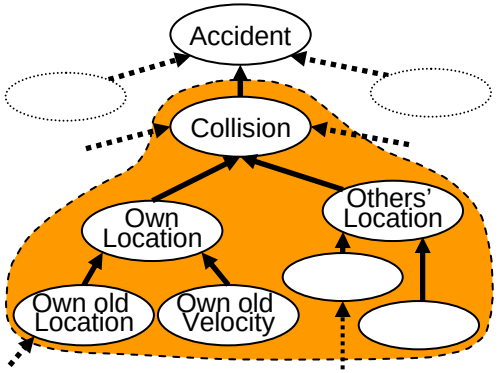
Utility-based Knowledge Exchange

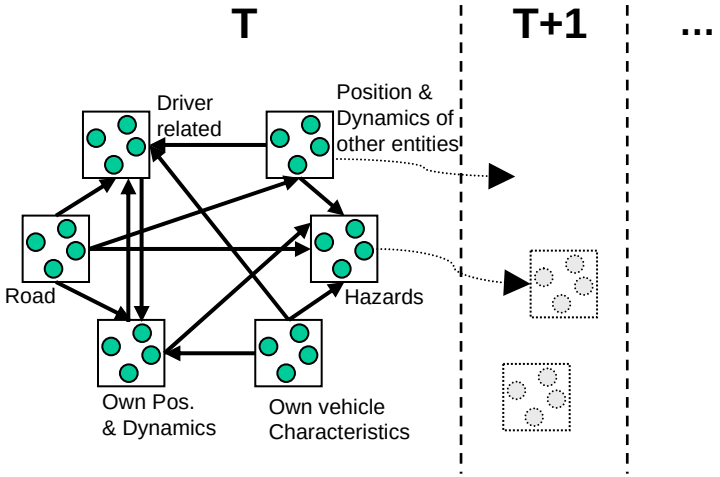
"Catch 22": High situation awareness vs. low channel load

- High situation awareness requires high information exchange, BUT high channel load increases packet drops
- Question: Which information should be sent when, to whom, in which level of inference by consuming which resource?
- Key factors:
  - **Consideration of partner knowledge**: Information selection and prioritisation according to knowledge of the partners
  - **Network selection**: Affiliation of various types of networks (e.g. WAVE, GSM/UMTS, DAB)
  - **Level of inference tradeoff**: Compromise of inference level (from raw sensor information to highly inferred information)
- Nevertheless, privacy constraints (e.g. confidential driver information) have to be considered

Knowledge Broker
Modelling uncertainty and causality

- Situation description is subject to uncertainty due to:
  - Noise in sensor data
  - Insufficient temporal or spatial sensor readings
  - Malfunction of sensors
  - Unreliable wireless data exchange
  - Manipulation by malicious intruders
- Modelling of situations by random variables and their causal relations with (Dynamic) **Bayesian networks**
- Application description as pluggable Bayesian network fragments





Reasoning

- **Hazard Detection**:
  Estimation of the situation according to hazard descriptions
- **Prediction**:
  Estimation of situational information concerning different context (i.e. for future point in time, at remote location, etc)
- **Assessment of partner's knowledge**:
  Estimation of knowledge state of partners (for knowledge dissemination, hazard detection and prediction)
- **Consistency Check**:
  Detection of incorrect information
- **Learning**:
  Definition or update of network structure and conditional probability distributions

Conclusions

- Situation Awareness in vehicular environments will increase safety on the road by laying the foundation for novel and sophisticated applications
- Single middleware connecting applications (information consumers) and sensors (information producers) is required
- Models inherently expressing uncertainty and causality enable *learning*, *hazard detection*, *prediction*, *assessment of partner's knowledge* and *consistency check*
- Information exchange has to incorporate various factors (network availability, partner knowledge, etc) to maximize the global utility

Thank you for your attention!

Questions?

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