

# An Architecture for Situation-Aware Driver Assistance Systems

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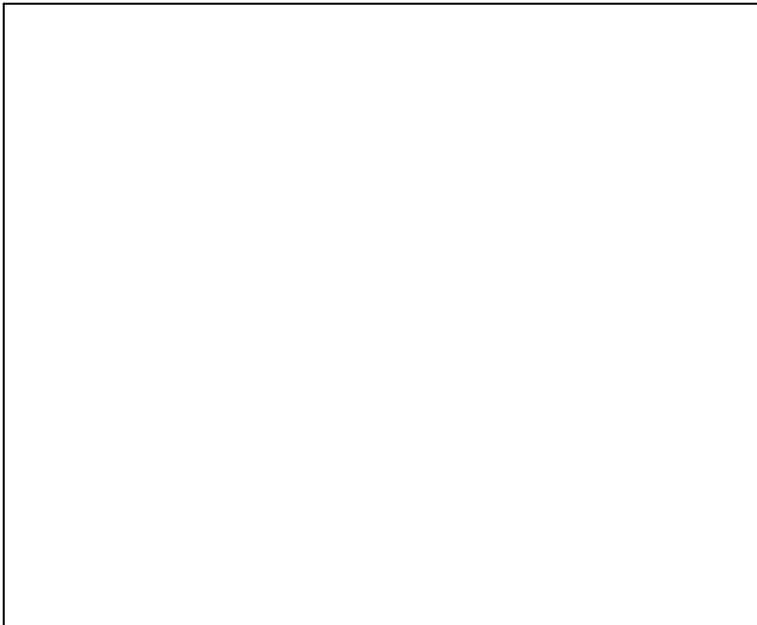


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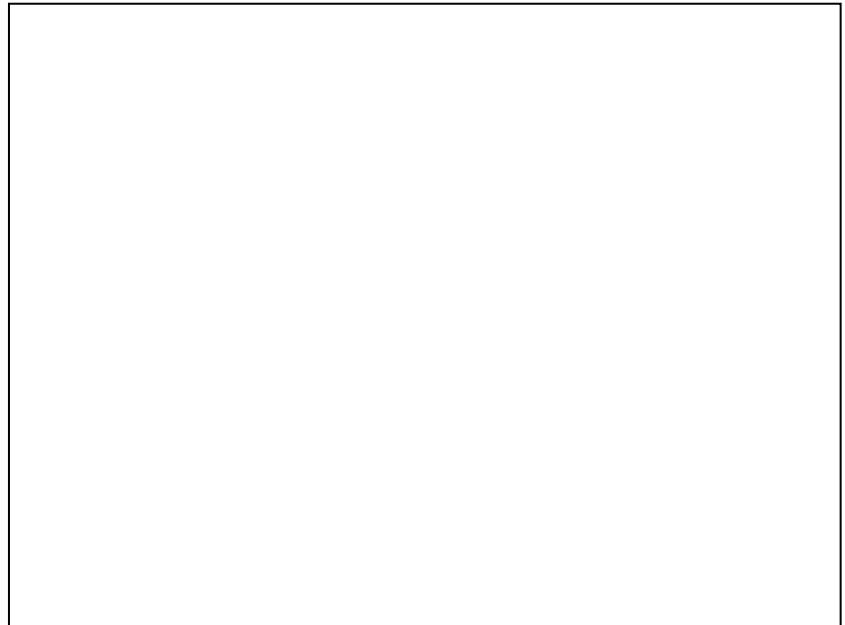


# Motivation

- 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



Source: <http://www.youtube.com/watch?v=CFWhcwtgqQU>

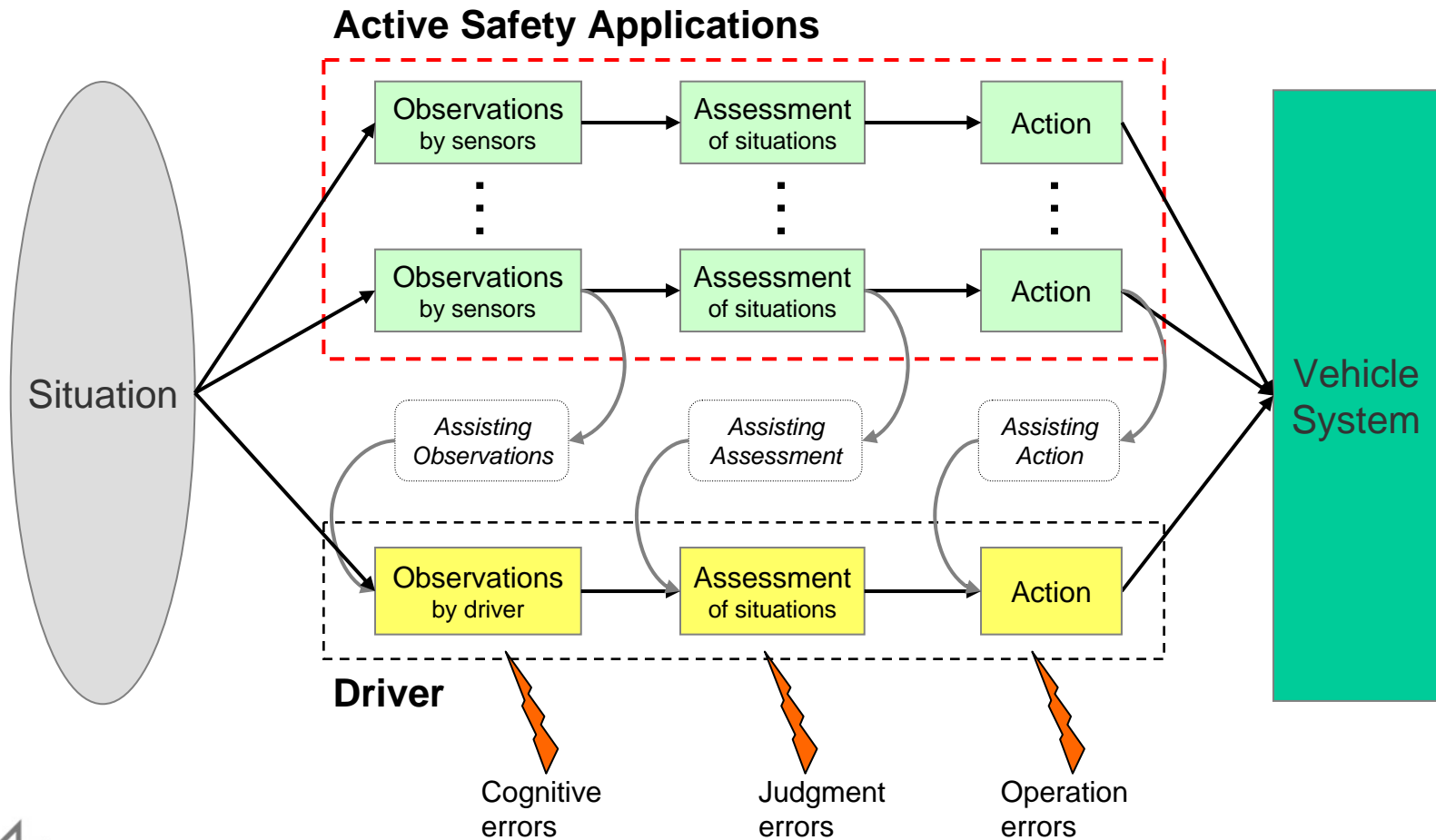


Source: <http://www.youtube.com/watch?v=QKjUz6z8vmA>



# Driver Assistance

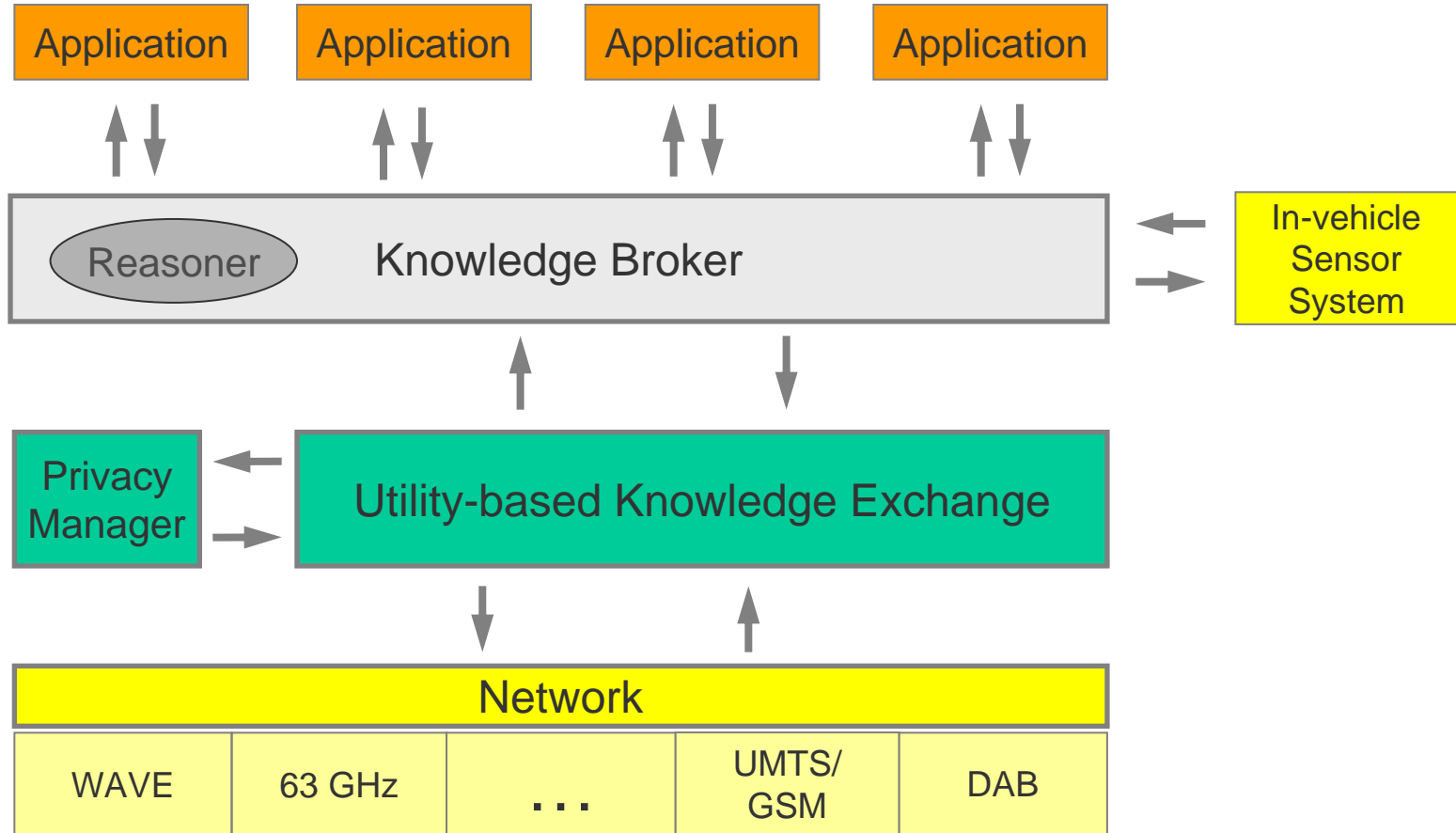
## Active Safety Applications



# 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

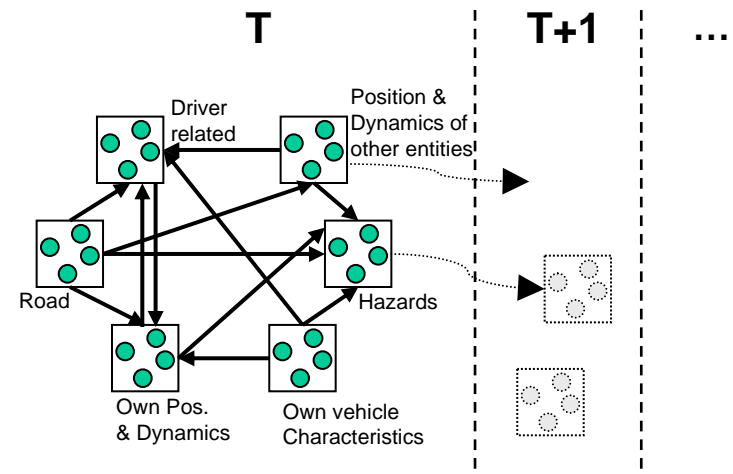
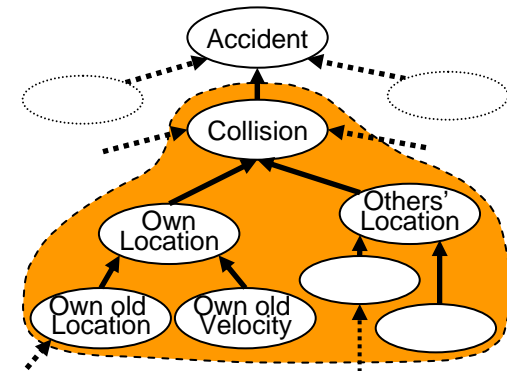
“Catch 22”: High situation awareness vs. low channel load

- 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



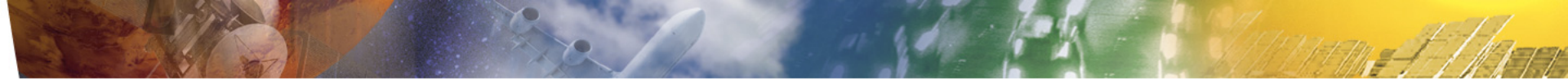
# Thank you for your attention!

## Questions?

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