



# An Approach to Developing Context-aware Adaptive Vehicle Software Systems

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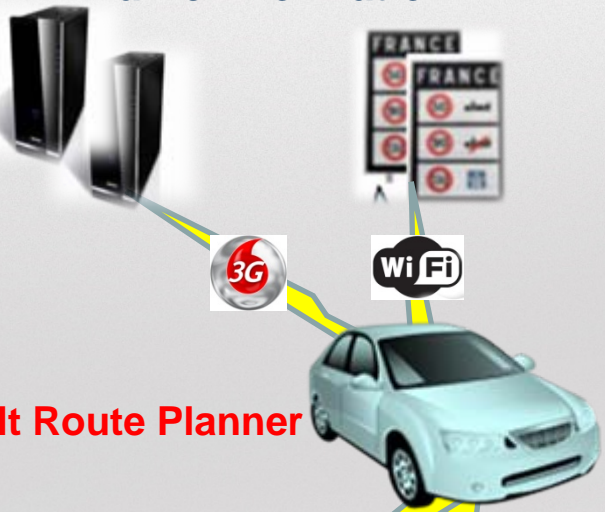
## *Agenda*

- Motivating Scenario
- Research Challenges
- Proposed Approach
- Case Study
- Tool Support
- Conclusions and Future Work



Motivating Scenario: Vehicle Route Planner

Route Planner Two Traffic Information

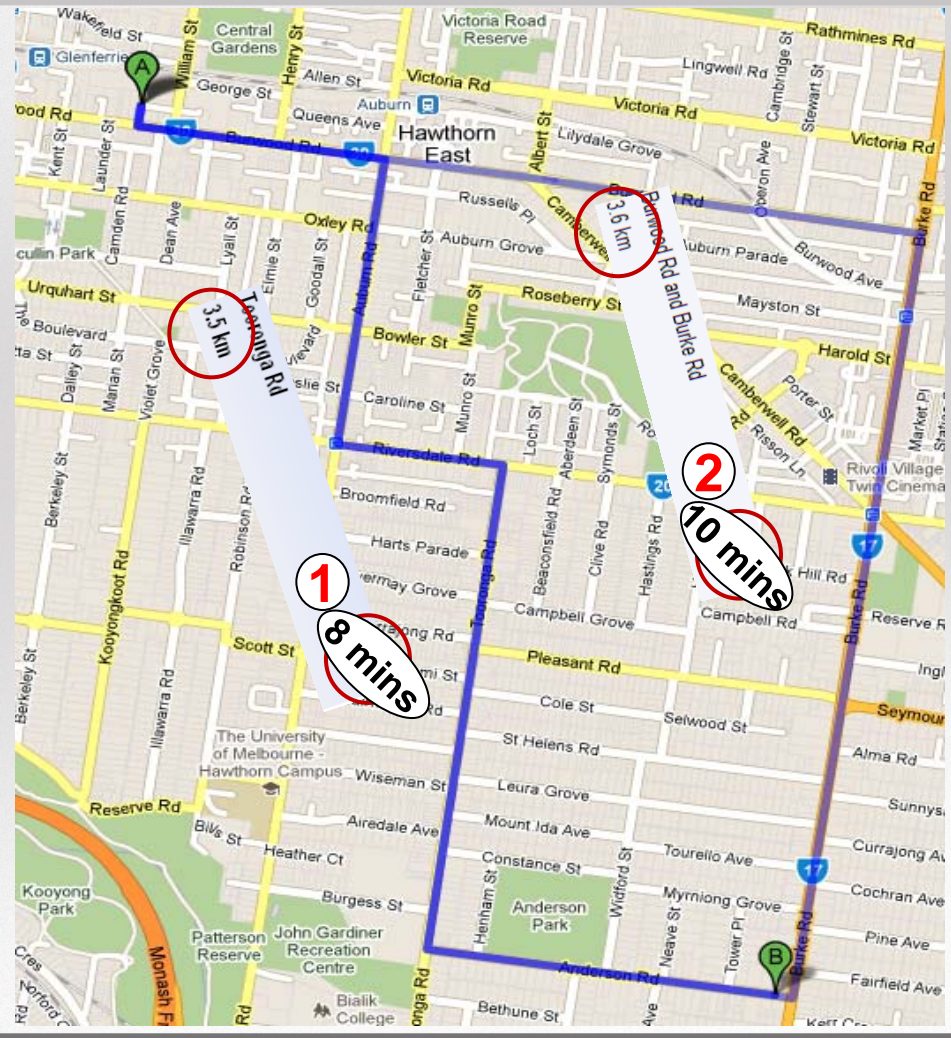


Default Route Planner



Driver Preferences Route Planner One

Route Planner Three



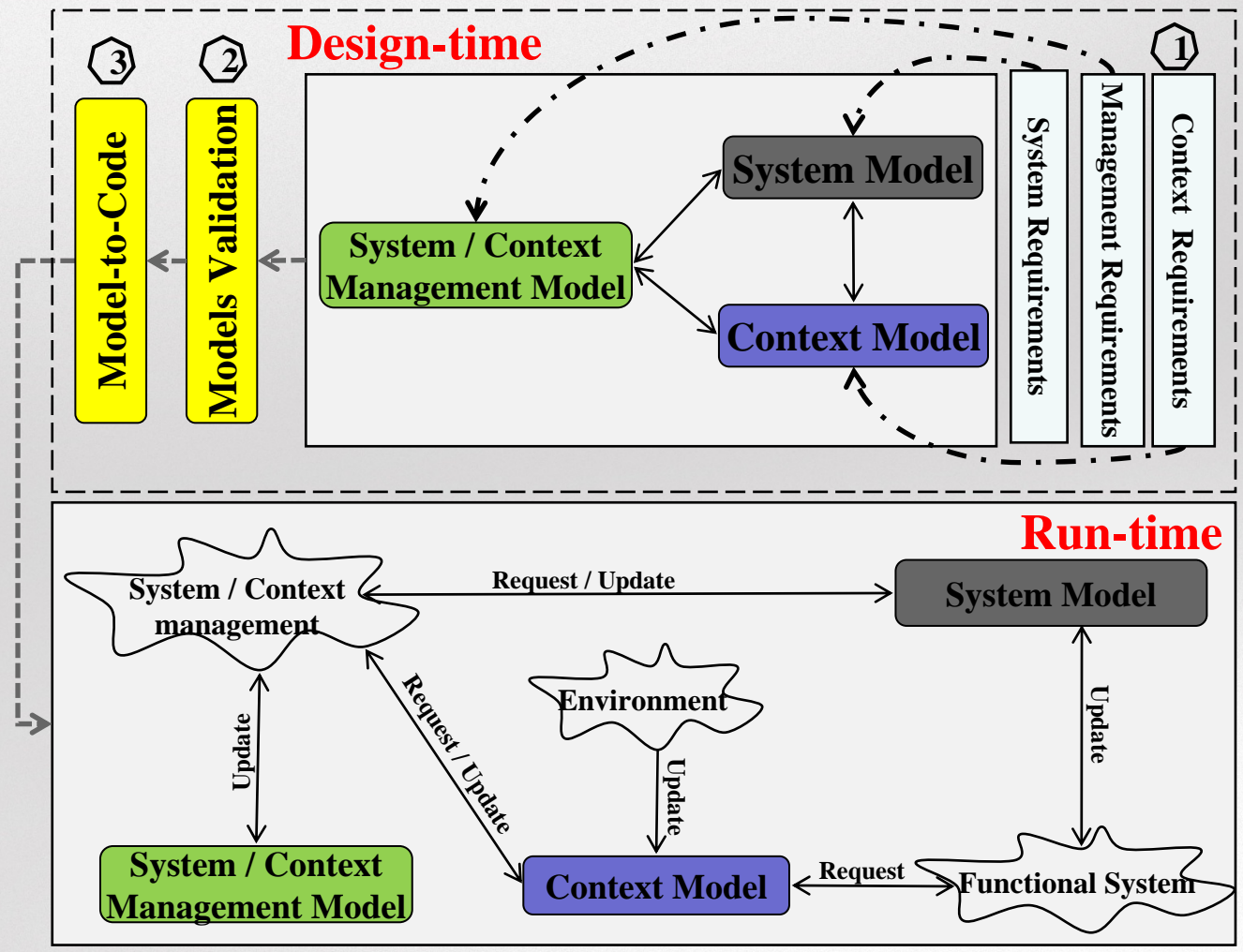


## Research Challenges

- Context Modelling and Management
  - Making the system aware of its context by maintaining a context model at runtime.
  - Enabling the runtime adaptation of the context model.
- System Runtime Adaptability
  - Making the functional system able to change itself in response to context changes.
- Flexible and Managed System-Context Relationships
  - Capturing and managing the system-context *operational* and *management* relationships at runtime.



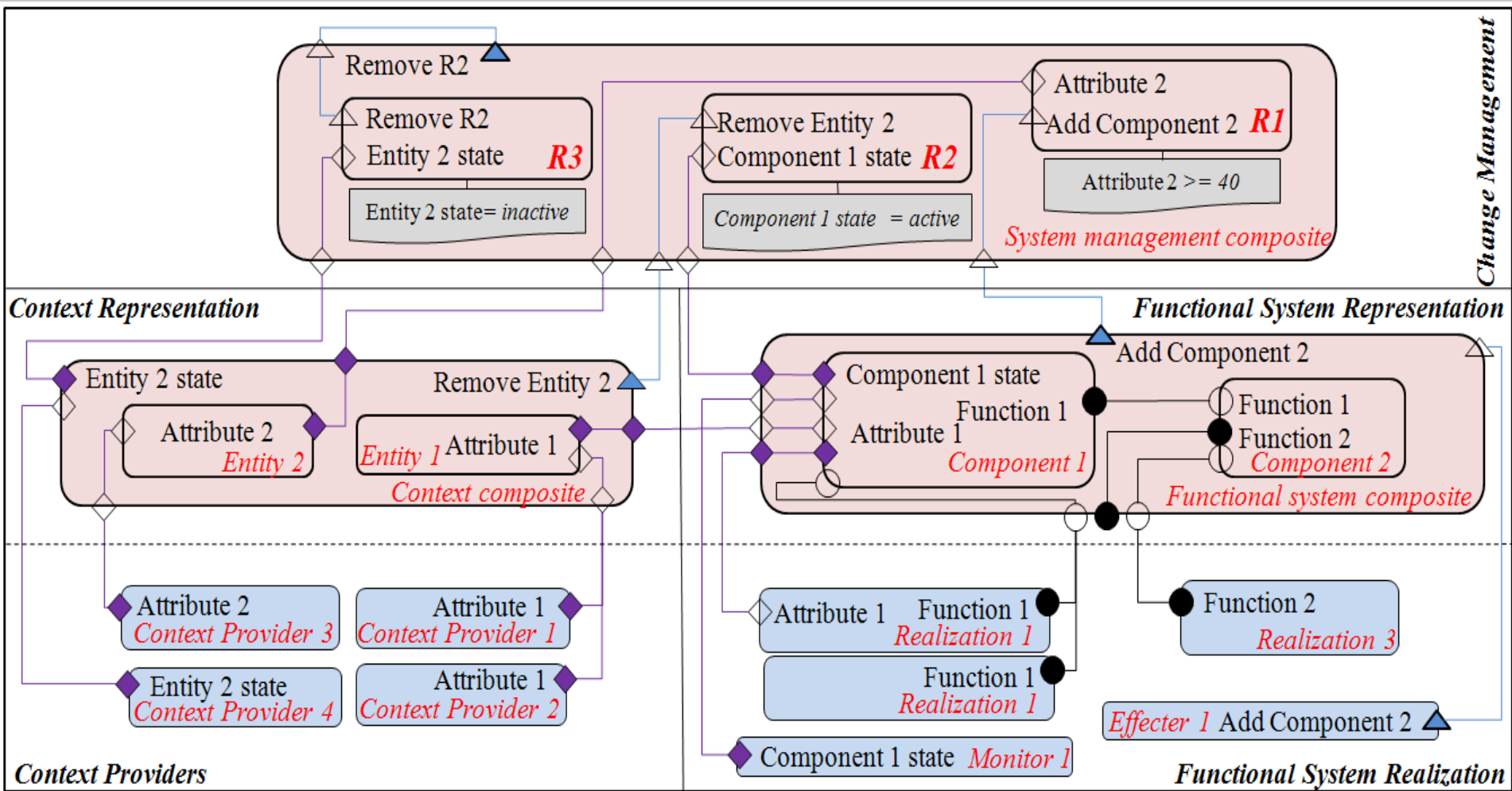
# General Approach: The Development Process\*





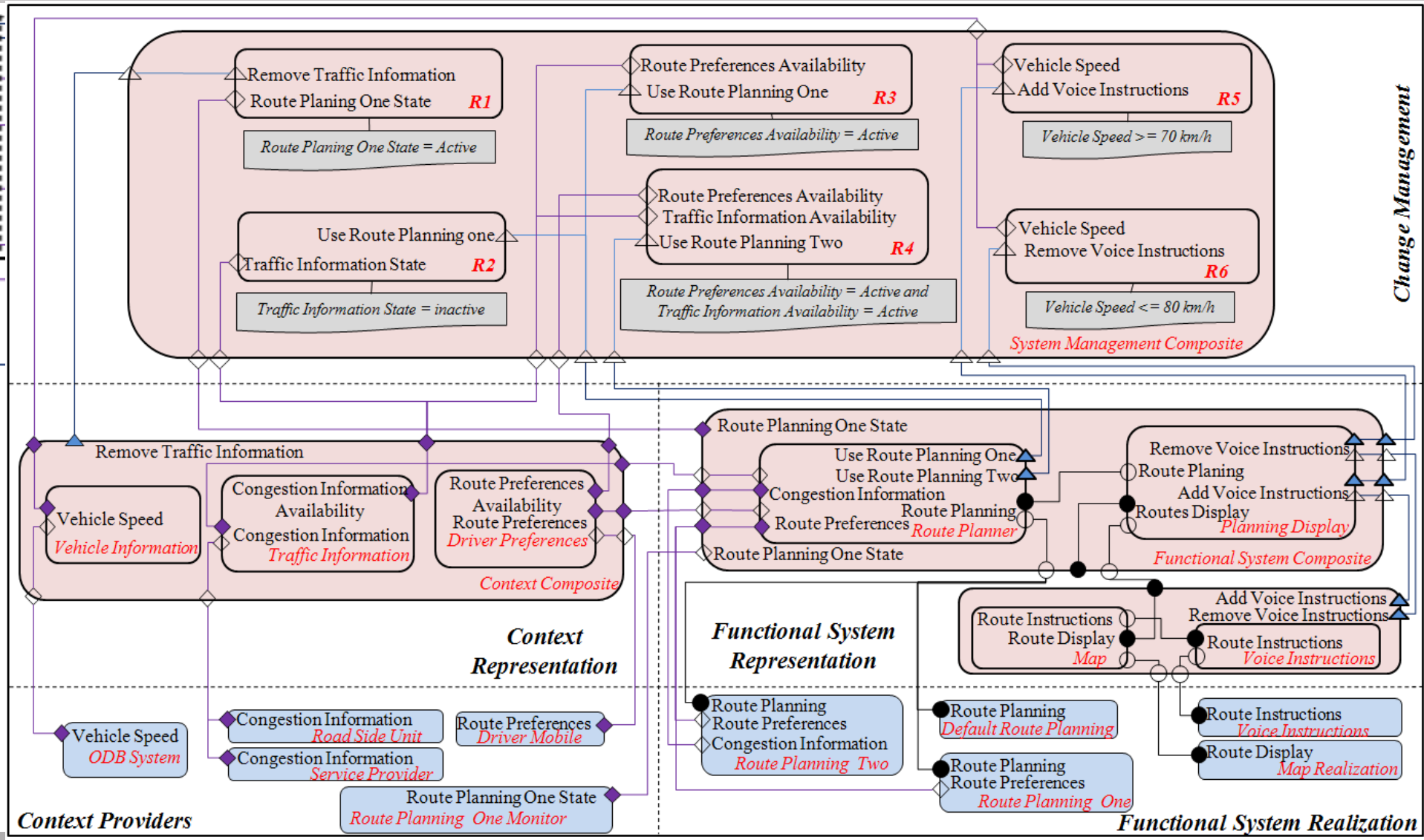


# A Component Model for Representing the System and its Contexts





# A Model for the Context-aware Adaptive Route Planning System





## *Validating the System Adaptive Behaviour*

- The system adaptive behaviour may have errors such as:
  - Inconsistency.
  - Circularity.
  - Redundancy.
  - Incompleteness.
- To validate the system adaptive behaviour:
  - We transform the system adaptive behaviour model to a Petri Net.
  - We represent the possible errors using Timed Computation Tree Logic, and then a model checker is used to check these errors.



# Developed Tool: CAST

The screenshot displays the CAST (Context-aware Adaptive Systems Development Tool) interface, version 3.0. It is divided into several windows:

- Context-aware Adaptive System (Left):** Shows a project tree with files like Context.java, Context\_Pro\_Congestior, and DriverPreferences.java. The 'System Design' tab is active.
- Context-aware Adaptive Systems Development Tool (CAST Ver. 3.0) (Top):** Contains a 'System Design' tab with a 'Generate' button circled in red. A text box below it says 'Generate the Petri Net and Validate the behaviour'. A 'VehicleSpeed' input field is set to '75'.
- Adaptation Rules Faults (Top Right):** A message box states: 'A Conflict Type 1 Error is Detected Between Rules: R5, R6'. It lists 'TYPE 1 ERROR' and 'TYPE 2 ERROR'.
- CAAS RoutePlaning Test (Bottom):** A configuration window for 'Context Information Providers' including ODBII, RSU, and SP. The 'RP1' provider is set to 'active'. A 'DriverMobile' provider is circled in red. A 'Possible System Adaptations' panel on the right shows various system states with checkboxes for FunctionalSystem, RoutePlaning Function Realizations (RP, RP1, RP2), Functional System State (FunctionalSystem, RoutePlaningDisplay, RoutePlaner, Display, Map, VoiceInst), System Management State (R1-R7), and Context Model State (Context, DriverPreferences, TrafficInformation, VehicleInformation).

Red arrows indicate the flow of information: from the 'Generate' button to the Petri Net generation step, from the 'VehicleSpeed' field to the error message, and from the 'DriverMobile' provider to the 'TrafficInformation' checkbox in the adaptation state.



## *Conclusions and Future Work*

- We have proposed an approach to modelling and realizing context-aware adaptive vehicle software systems.
  - It separates context model from system model to clearly capture and manage them and their relationships.
  - It supports the runtime adaptation of the context model, the functional system, and the system-context relationships.
- As future work, our approach can be enhanced in several directions:
  - Making the system able to cope with unanticipated context changes.
  - We will perform more validations to assess the applicability and practicality of our approach.



## *Acknowledgement*

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Thank You

