



Adaptive Context-aware Automotive Software Systems

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Outlines

- Background
- Motivating Scenario
- Research Gaps
- Basic Approach and Strategies
- Design and Implementation
- Summary



Background

- **Pervasive Computing** (early 1990s)
 - Envisions environments where people are assisted in their everyday tasks by technologies – being *invisible* yet significantly helpful

- **Context-awareness** (in 1994)
 - **Context** – any information that characterize the situation of an entity
 - **Context-awareness** – ability to use context information to provide services (present, recommend, trigger,...)



Background (cont..)

❑ Pervasive Social Computing

- ❑ Aims to take advantage of human social relationships to enable the fulfillment of *users' task* on the move
- ❑ Computer mediated means of social interaction by recognizing *social context...*

❑ Social Interaction

- ❑ Sequence of social action between individuals by considering their relationships



Background (cont..)

Research Trend (in general)

- Modeling, Reasoning and Managing context information
- Developing context-aware applications
- Architecture and framework for context-aware systems

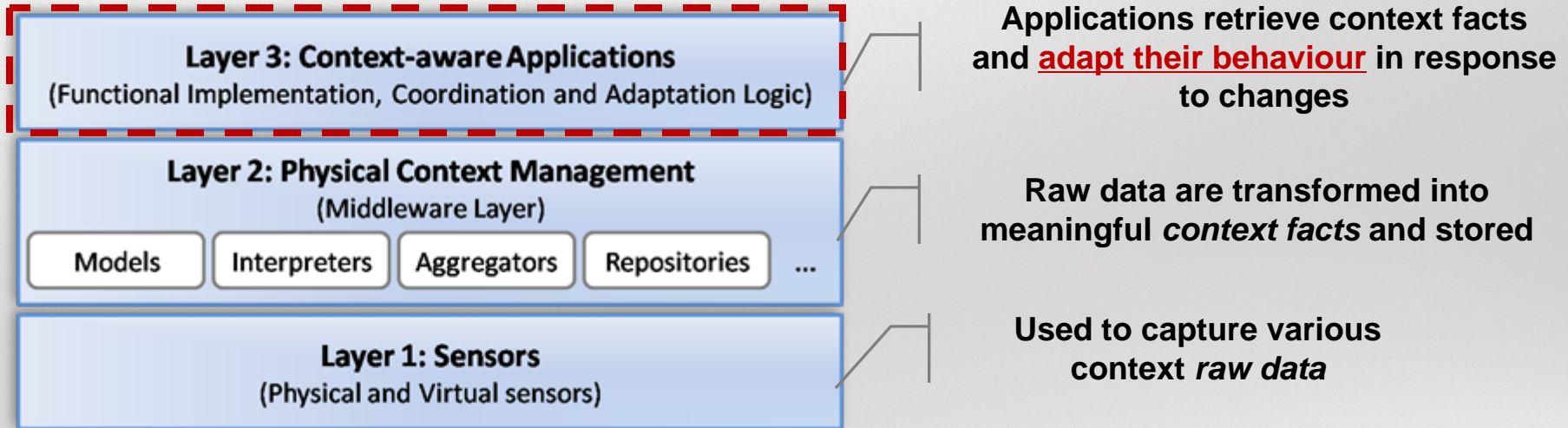
Examples of Context-aware relevant projects

- | | |
|--------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| <input type="checkbox"/> EasyLiving (Microsoft) | <input type="checkbox"/> Conference assistant (CMU) |
| <input type="checkbox"/> Active space (UIUC) | <input type="checkbox"/> Smart Vehicle space (Zhejiang University) |
| <input type="checkbox"/> iRoom (Stanford) | <input type="checkbox"/> ContextServ - Attraction searching service (University of Adelaide) |
| <input type="checkbox"/> Assist elderly person in smart home (University of Florida) | <input type="checkbox"/> ... |
| <input type="checkbox"/> Smart home (NUS) | |



Research Gaps

Architecture of Context-aware Systems



Limitations

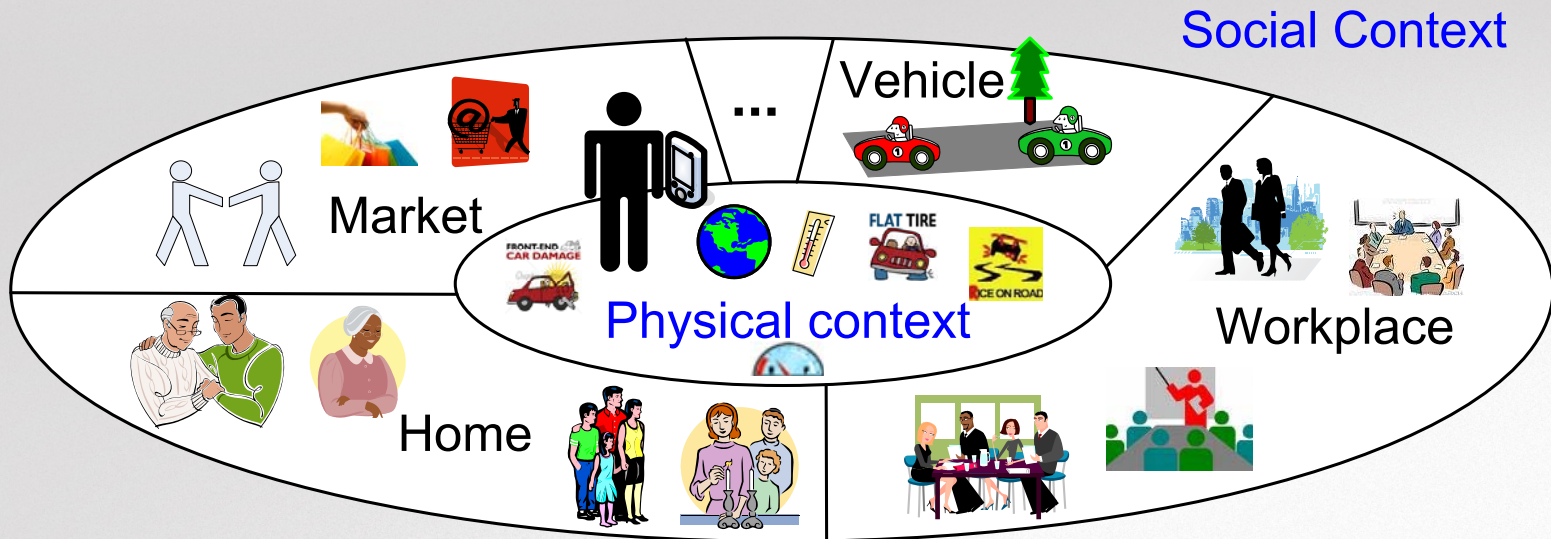
- ❑ *Fail to separate* the implementation of actors (agents, people or services) from the *management* of their *relationships* and *adaptive behavior*
- ❑ The constructed relationships between actors, their interaction constraints, and the coordination logic are *not modeled explicitly*



Physical and Social Contexts

Two Types of Contexts

- Physical context – properties of the actor and its operative environment
- Social context – set of norms, rules and obligations that defines the *relationship* between actors





Basic Approach and Strategies

- ❑ Role based approach
 - ❑ Very useful in modeling entities, their relationships and interactions

- ❑ Organizational concept
 - ❑ Composition structure of dynamic relationships between roles

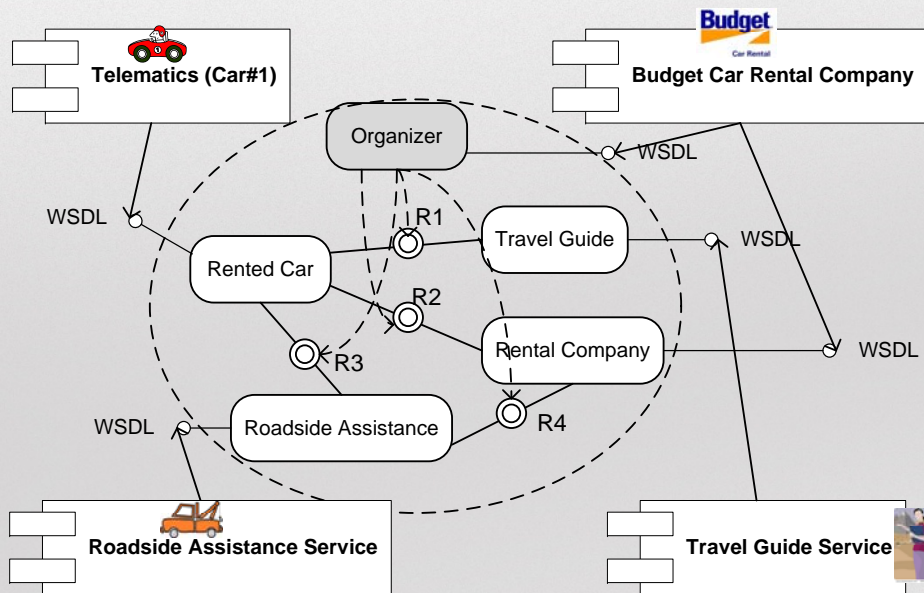
- ❑ Domain-centric perspective – captures the *relationships* among roles associated with a particular domain or environment (e.g., Home, office, and so on)

- ❑ Player-centric perspective – provides *overall view* of all the relationships of an individual (across different domains) and allows *coordination* among its interactions

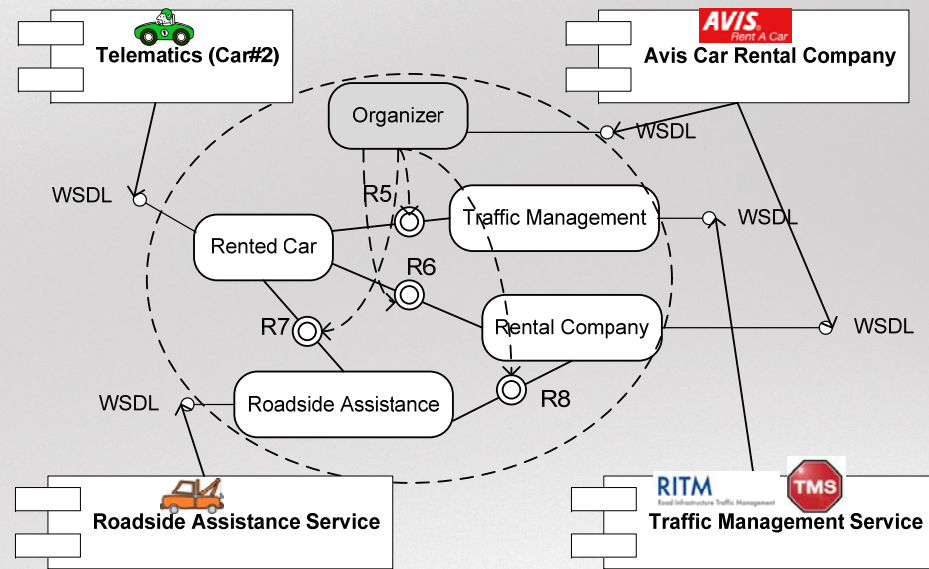


CAT: Cooperative Convoy

□ DSCM for Budget and AVIS car rental companies



DSCM for Budget car rental company

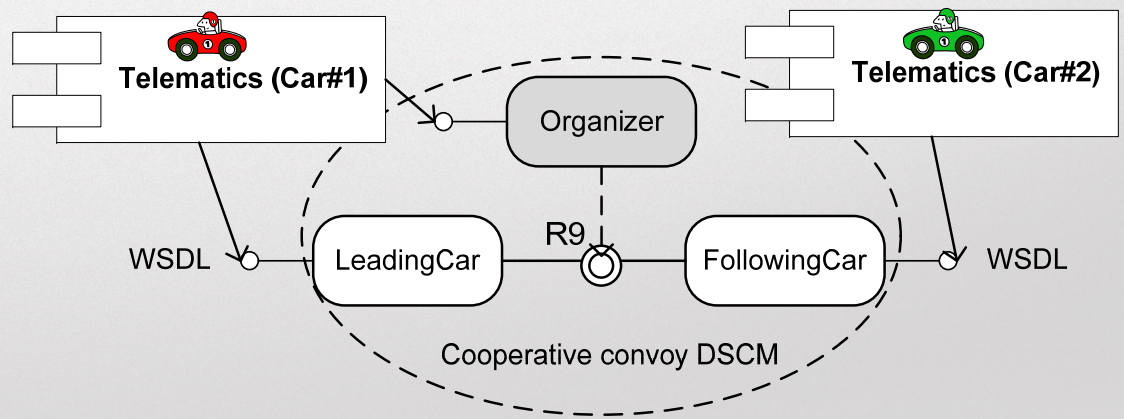


DSCM for AVIS car rental company

The most challenging issue is how to leverage the two cars' own domain specific interactions states into their cooperative convoy (as agreed by their drivers) and incorporate this capability into their telematics systems



CAT: Cooperative Convoy

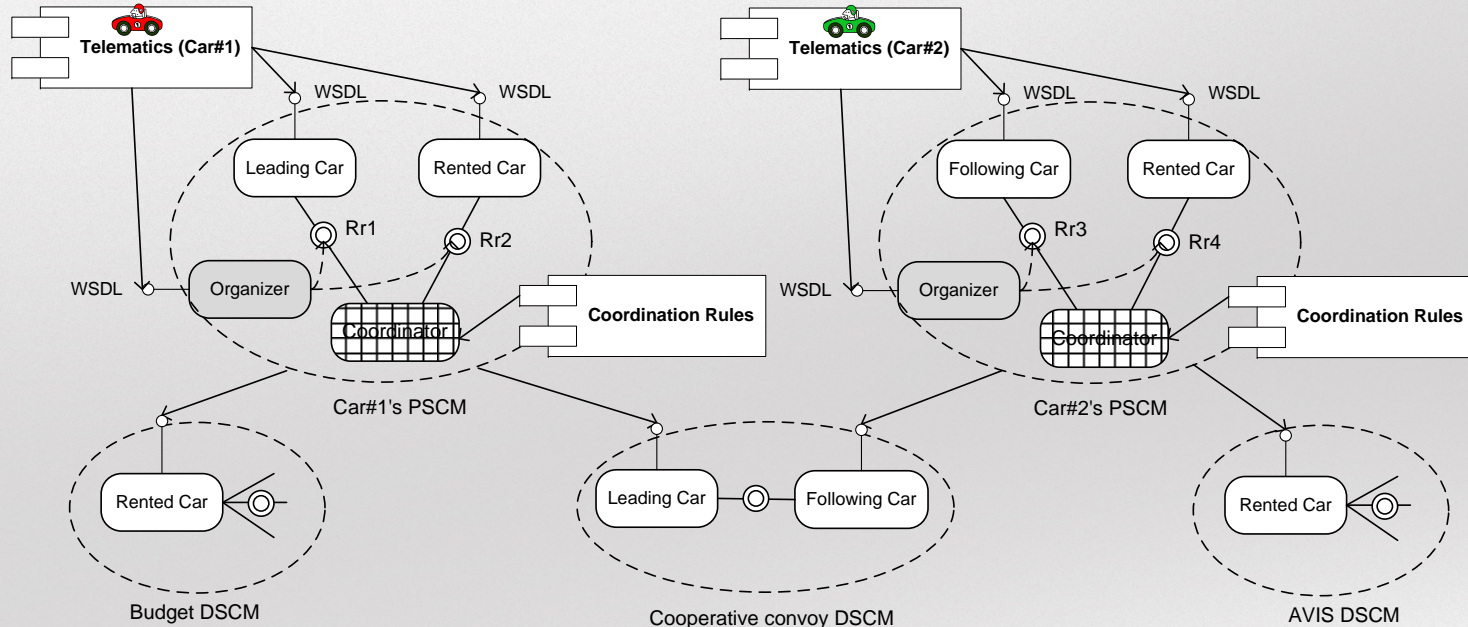


Specification from scenario	Representation
Following car will send ahead road blocked condition to the leading car (if any)	i7: {notifyRoadBlock, FC to LC}
Leading car will update the travel plan to the following car	i8: {routeUpdate, LC to FC}
Following car should send a distance update to the leading car every 10 seconds	i9: {notifyPosition, FC to LC} c1: {i3, Timer, periodic, =, 10, seconds}
If either vehicle has mechanical issue (e.g., flat tire, engine issue, etc) it needs to notify the other vehicle	i10: {notifyMechanicalIssue}
Either vehicle may leave the convoy	i11: {leaveConvoy}
Leading car may change the maximum desire distance between two cars, say from 300m to 100m when the road is wet	i12: {changeMaxDistance, LC to FC}
Maximum desired distance is 300m	p1: maxDesiredDistance = 300;

Leading Car (LC), Following Car (FC), Interaction (i), Conversation (c), Operational parameter (p)



CAT: Cooperative Convoy



	Specification from scenario	Coordination Rule
Coordination rule for Car#1	after getting update route information from the Travel service guide notify that to the Following Car	Rule: { notifying route update: <i>when</i> i1.OnNotificationReceived; <i>if</i> ?convoy.state = ACTIVE && ?receivedNotification = sendingRoute <i>do</i> LC.routeUpdate} //i8
Coordination rule for Car#2	after receiving the road block information from the road side assistance service immediately send it to the Leading Car	Rule: { notifying Road block information: <i>when</i> i6.OnNotificationReceived; <i>if</i> ?convoy.state = ACTIVE && ?receivedNotification = notifyRoadBlock <i>do</i> FC.notifyRoadBlock} //i7



CAT: Cooperative Convoy

Supporting Adaptation

Structural adaptation

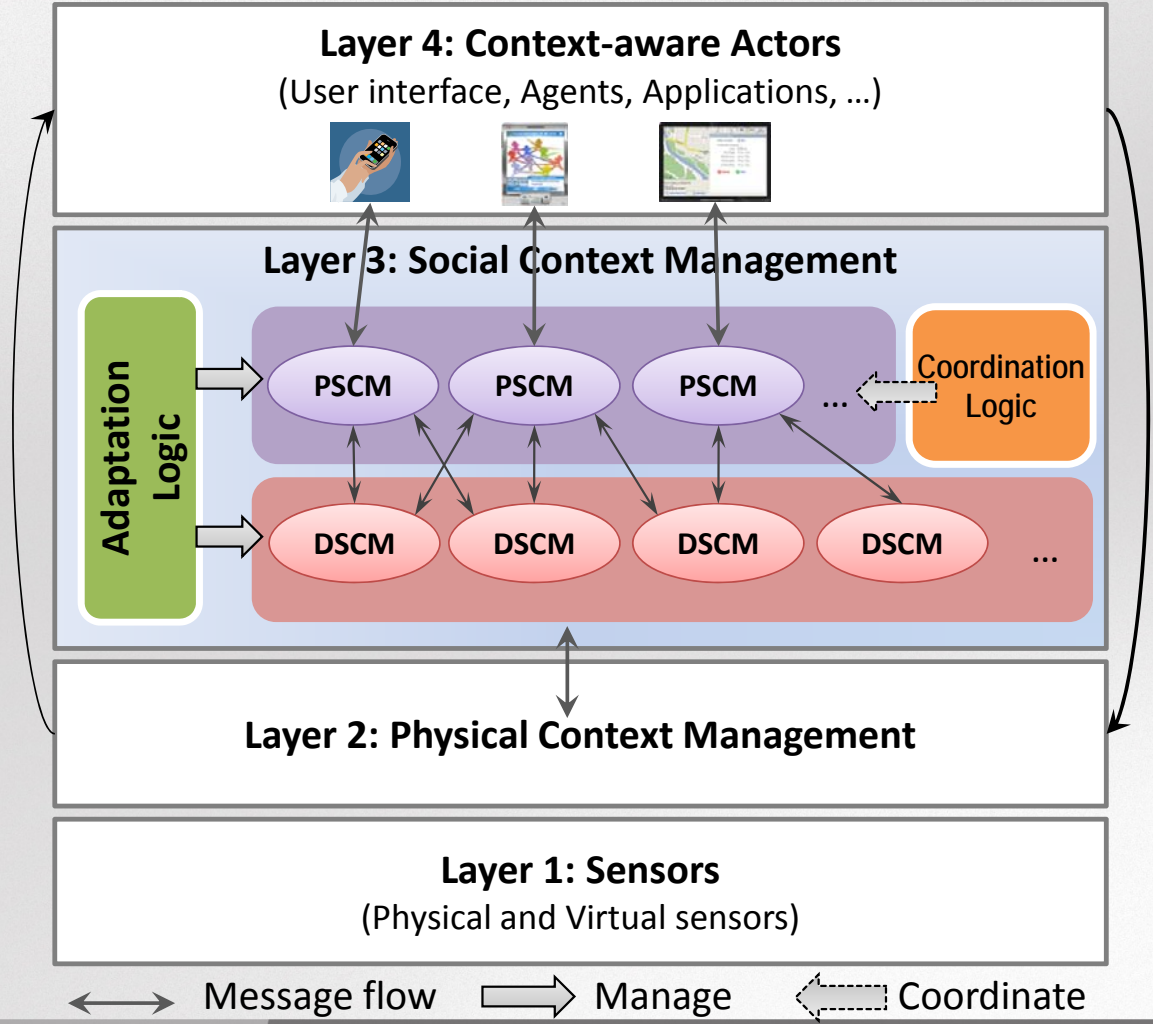
- Changes of Topology** – third vehicle could join or a break down of vehicle might leave the convoy
- Changes of binding between roles and players** – traffic management role could be played by different traffic management system as the vehicle moves from one jurisdiction to another

Behavioral adaptation

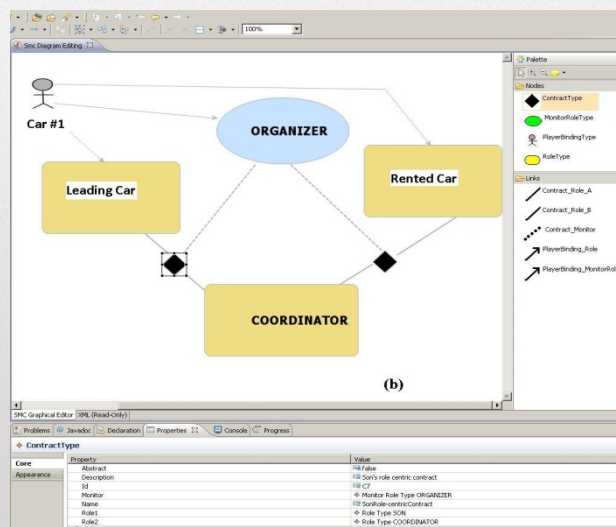
- Changes of operational parameters** – desired distance between two cars needs to reduce, say from 300m to 100m when the road is wet



Extended Context-aware Systems Architecture



Tool Support and Deployment



```

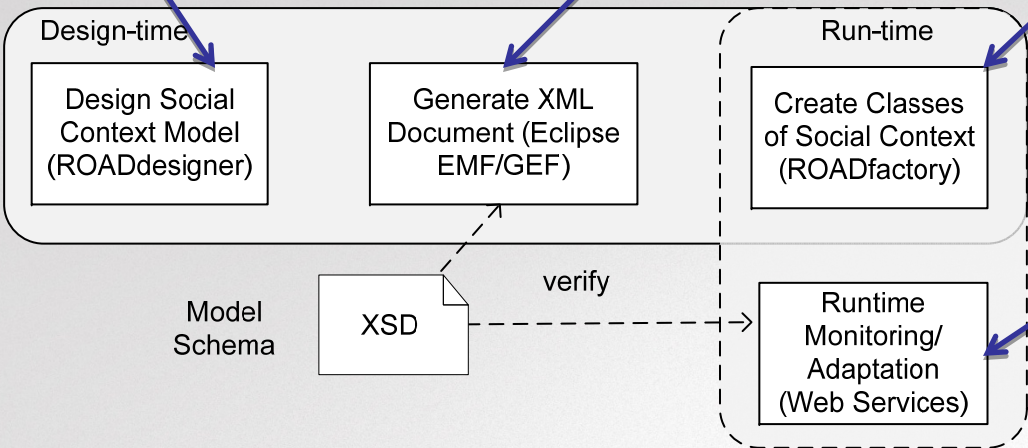
<?xml version="1.0" encoding="UTF-8" ?>
<tns:DSCM xmlns:tns="http://www.swin.edu.au/ict/road/mc" name="HomeDSCM">
  <SocialRoles>
    <Role id="EM">ElderlyMother</Role>
    <Role id="SM">Son</Role>
  </SocialRoles>
  <OrganizerRole id="OG">Organizer</OrganizerRole>
  <Contract>
    <Contract id="EM-SM" name="ElderlyMother_Son">
      <InteractionClauses>
        <Interaction id="EM-SM-12">
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          <Direction>SonToElderlyMother</Direction>
          <Return>
            <Operation name="situationAnswering">
              <Parameters>
                <Type>String</Type>
                <Name>situation</Name>
              </Parameters>
            </Operation>
          </Return>
        </Interaction>
        <Interaction id="EM-SM-11">
          ...
        </Interaction>
      </InteractionClauses>
      <ConversationClauses>
        ...
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        <OperationalParameter>
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          <Name>plyConstCheckDuration</Name>
          <Value>2</Value>
          <Unit>NAME</Unit>
        </OperationalParameter>
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    </Contract>
  </Contract>
</tns:DSCM>
  
```



Middleware

Modeling Tool

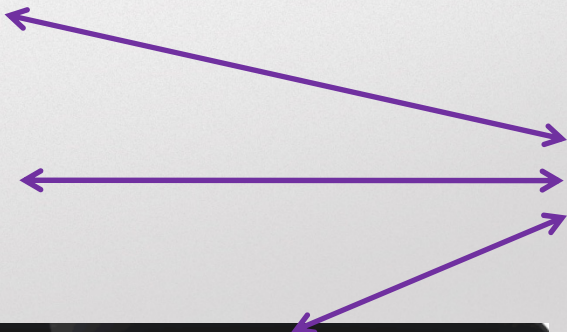
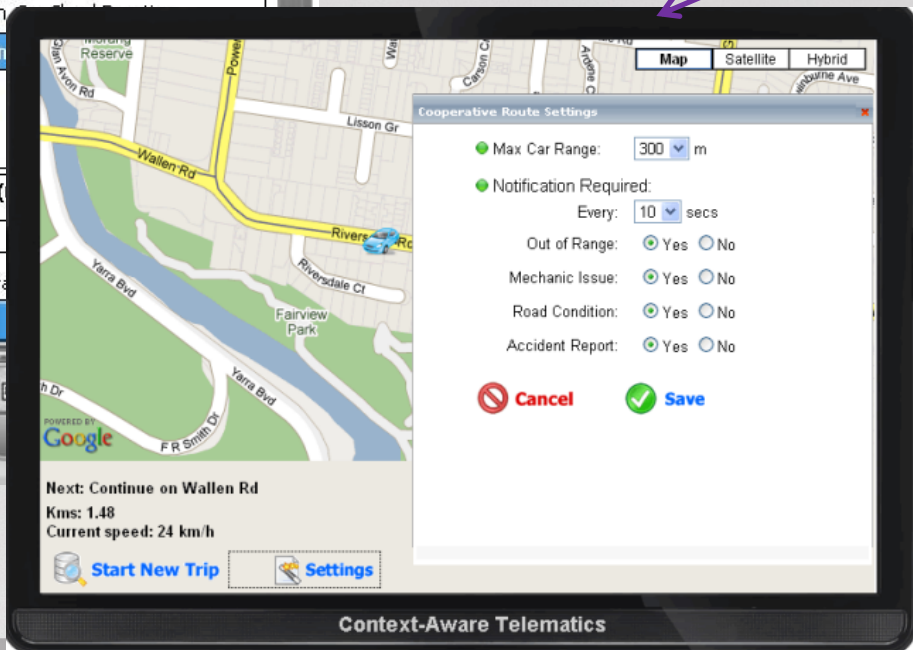
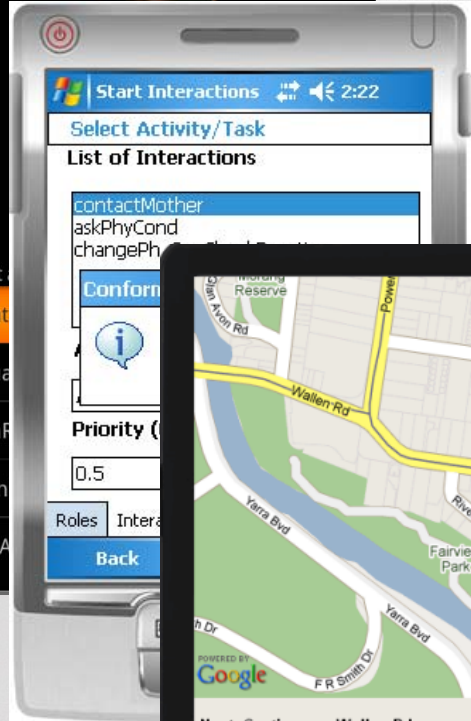
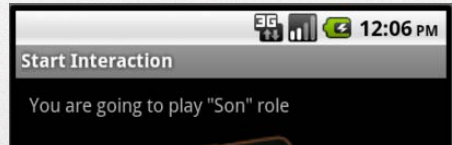
XML representation of DSCM/PSCM



Interaction terms are exposed as Web service methods



Prototype Implementation



Middleware

Applications

Context-Aware Telematics



Publications

- ❑ A. Kabir et al., “**Modeling and Coordinating Social Interactions in Pervasive Environments**”, *16th IEEE International Conference on Engineering of Complex Computer Systems (ICECCS 2011)*, Las Vegas, USA, April 27-29, 2011 (ERA rank: A)

- ❑ A. Kabir et al., “**Modelling and Managing Social Context to Support Coordinated Interactions in Pervasive Environments**”, *The Computer Journal*, Oxford University Press (Under review) (ERA rank: A*)



Summary and Forward Plan

□ Summary

- Explore the concept of *social context* to represent dynamic relationships
 - Model it from both *domain-* and *player-*perspectives
- Present the dynamic nature of social context and propose *structural* and *behavioral* adaptations to manage that
- Propose an approach to coordinate interactions
- Demonstrate its applicability using CAT prototype

□ Plan towards PhD Completion

- Social Context Management issues
- Enhance the Prototype
- Evaluation and Validation



Thank you!

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