Multi-Layer Faults in the Architectures of Mobile, Context-Aware Adaptive Applications: A Position Paper

Michele Sama
and
David S. Rosenblum

Dept. of Computer Science
University College London
London UK

m.sama@cs.ucl.ac.uk
d.rosenblum@cs.ucl.ac.uk

Zhimin Wang
and
Sebastian Elbaum

Dept. of Computer Science and Engineering
University of Nebraska – Lincoln
Lincoln, NE, USA

zwang@cse.unl.edu
elbaum@cse.unl.edu
A common layered architecture for CAAAs

- **Context Manager** collects and maintains context raw data from sensors.
- **Adaptation Manager** queries and processes context values, then triggers the wanted behaviour of the CAAA.
Multiple coexistent views on context

- **Sensed**: discretization of continuous physical values read from sensors at different times.
  - “BT 00:01:A6:23:FD paired”
- **Inferred**: predicate-oriented evaluation of Sensed Context.
  - “Car hands-free paired = true”
- **Presumed**: application-oriented representation applied to the CAAA to trigger an adaptation.
  - “The user is driving”
From context inconsistencies... 
...to adaptation faults

Unfortunately:

- **Sensed**: contains discrepancies in read discrete values:
  - Inconsistent from each other.
  - Different from the physical ones.

- **Inferred**: incorrect if evaluated in the wrong moment:
  - When a value is updating.
  - Before an update.

- **Presumed**: certain adaptation have not been modelled in the CAAA.
Faults in PhoneAdapter (1)
Nondeterministic adaptation

- **Physical**: at home with home pc and office laptop.
- **Sensed**: GPS = N/A, both home and office pc found.
- **Inferred**: @home = true or/and @office = true, depending from the implementation.
- **Presumed**: nondeterministic.
Faults in PhoneAdapter (2)
Hazard (Adaptation Race)

- **Physical**: the user is outside and starts driving.
- **Sensed**: GPS speed increasing, BT discovering.
- **Inferred**: handsfree = false, medium_speed = true.
- **Presumed**: Jogging.
  - Driving cannot be applied from Jogging.
Faults in PhoneAdapter (3)
Slow adaptation

- **Physical**: the user starts driving fast and receives a call.
- **Sensed**: GPS is reacting slowly, BT car_handsfree.
- **Inferred**: handsfree = true, high_speed = false -> true.
- **Presumed**: Driving, the phone allows the incoming call, then Driving Fast and ringing.
Faults in PhoneAdapter (4)
Metastability (Adaptation Loop)

- **Physical**: the user is in the office after a scheduled meeting.
- **Sensed**: time = 16:40.
- From Office:
  - **Inferred**: meeting_start = true.
  - **Presumed**: Meeting.
- From Meeting:
  - **Inferred**: meeting_over = true.
  - **Presumed**: Office.
Conclusion and future works

• How these faults can be Predicted.
  – A model based approach.
• How these faults can be Prevented.
  – Predictive architectures.
• How the correctness of a CAAA can be Verified.
  – Context emulation.