Exceptional Handling in the Software Lifecycle

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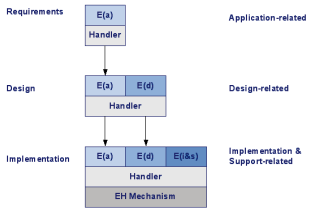
Motivation

A possible cause for the accident of Ariane 5 in its maiden flight has been associated with the mishandling of an abnormal situation (known as an exception) that had occurred in the embedded software of the launcher. That is, after an exception behaviour was detected, the inappropriate corrective action taken by the software made the vehicle to veer off its flight path leading to the structural destruction of the launcher.

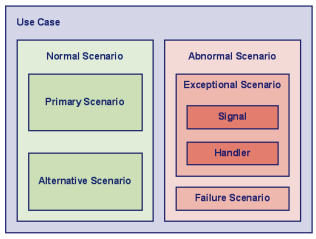
- Exception handling has been associated with design:
  - protect the application software from faults: application, design, implementation and support;
  - consequences:
    - context of error detection and recovery is lost;
    - correlation between exceptions and handlers is lost.
- Proposed approach:
  - specify exceptions, and their respective handlers, in the context where faults occur.



Exception Handling in Software Lifecycle

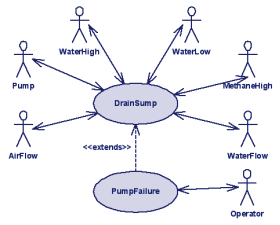
Requirements Phase

- The normal behaviour of a use case is defined by:
  - ***primary scenarios:***
    - capture the basic flow, the minimum number of actions for the specified functionality to be implemented;
  - ***alternative scenarios:***
    - capture the actions that extend the basic flow, mainly to add functionality.
- The abnormal behaviour of a use case is defined by:
  - ***exceptional scenarios:***
    - capture the deviation from normal behaviour when errors are manifested;
      - consist of error detection and recovery;
  - ***failure scenarios:***
    - capture the unacceptable and irrecoverable system behaviour.



Complete Structure of Use Cases

- The three stage approach for modelling and analyse the interdependencies between actors and use cases;
  - describe use cases in the usual manner, but including abnormal behaviour;
  - refine the previous use case description, including:
    - identification of system variables;
    - table of exceptions:
      - causal relation between the abnormal behaviours of actors and use cases;
    - collaboration diagrams for the exception behaviour;
  - formalise use case description for validation;
    - eg, model checking.



Use case DrainSump of a Mining System

Use case DrainSump

Pre-conditions: Pump is off, AirFlow is off, WaterLow is off, WaterHigh is on, WaterFlow is off, MethaneHigh is off

Pump==off and WaterLow==off and WaterHigh==on and WaterFlow ==off and MethaneHigh==off

Primary scenario:

- switch on Pump;

  WaterHigh==on and Pump==off implies Pump:=on
- switch off Pump when WaterLow is on

  WaterLow==on and Pump==on implies Pump:=off

Post-conditions: Pump is off, AirFlow is off, WaterLow is on, WaterHigh is off, WaterFlow is off, MethaneHigh is off

Pump==off and AirFlow==off and WaterLow==on and WaterHigh==off and WaterFlow==off and MethaneHigh==off

Exceptional scenario:

- the pump is on and there is no flow of water;
  - start PumpFailure use case;

    Pump==on and WaterFlow==off implies I_excPumpFailure

  Post-conditions: Pump is off, WaterLow is off, WaterHigh is on, WaterFlow is off

  Pump==off and WaterLow==off and WaterFlow==off
- the pump is off and there is still flow of water;
  - send an alarm to the operator;

    Pump==off and WaterFlow==on implies E_excOperator

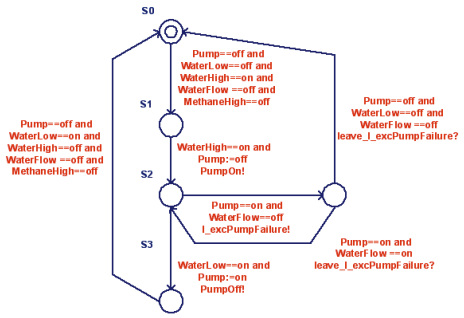
  Post-conditions: Pump is on, WaterLow is on, WaterHigh is off, WaterFlow is on

  Pump==on and WaterLow==on and WaterHigh==off and WaterFlow==on

Failure scenario:

- there is flow of water (the pump is on) and the methane is high,

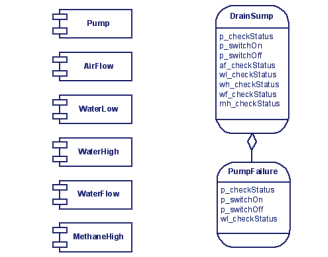
  WaterFlow==on and Pump==on and MethaneHigh==on



Automaton of the primary and exceptional scenarios of DrainSump

Architectural Design

- The exceptional behaviour associated with the actors and use cases should be mapped into the architectural elements of a software architecture.
  - components alone do not provide the appropriate encapsulation to deal with the collaborative behaviour of exception handling;
    - hence the need for a co-operative connector.



Components diagram **Connectors diagram**

Co-operative Architectural Style

For further information

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