Automatic Interoperability Test Case Generation based on Formal Definitions

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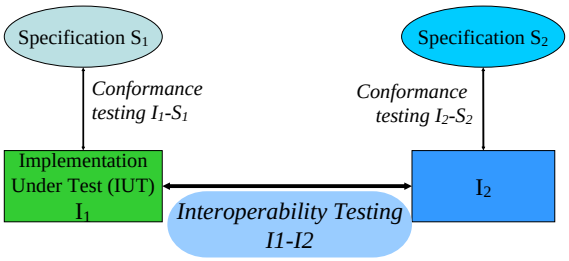
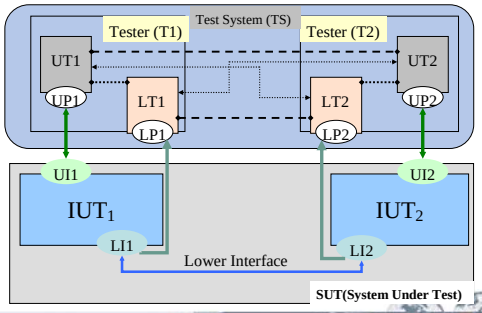
Context



Introduction

- Interoperability Testing: verifying that the implementations communicate properly while providing the expected services
- Objectives of this study:
  - Interoperability formal definitions
  - A method for automatic test generation
  - Focusing on one-to-one interoperability context

One-to-one interoperability testing architectures



Interoperability testing

- Verification of both interaction between the implementations and provided service
  - ⇒Service: verification of outputs on upper interfaces
  - ⇒Interaction: verification of both outputs and inputs on lower interfaces

Input's observation issues

- Output verification: comparison between observations and specification
- Input verification:
  - Problem: Inputs are not observable
  - The idea: searching *outputs* that can be observed if and only if the considered *input* was actually received.
    - Method: Calculating *causal dependencies* between the considered input and the possible outputs to conclude on the execution of the input
      - ✓ Algorithm: based on a breadth-first search algorithm

Global iop criterion iop_G

Two conditions in the criterion:

- C1: *after a trace of the interaction of the specifications, all outputs observed during the interaction of the implementations must be foreseen in the specification interaction*
- C2: *inputs corresponding to messages sent by one IUT must be effectively received by the other*

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Bilateral iop criterion iop_B

Conditions describing the bilateral iop criterion:

- C1a: *after a trace of S_1 observed during the asynchronous interaction of the implementations, all outputs and quiescence observed in I_1 must be foreseen in S_1*
- C1b: *same as C1a in the point of view of I_2 / S_2*
- C2: *inputs corresponding to messages sent by the other IUT must be effectively received and vice-versa*

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Comparison between global and bilateral iop criteria

- ✓ $iop_B \equiv iop_G$: same power of non-interoperability detection
- ✓ $S_1||S_2$ is calculated in test generation methods derived from global criterion iop_G, not in methods using bilateral criterion iop_B

  ⇒The idea: interoperability test generation based on bilateral criterion avoiding state-space explosion

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Interoperability test generation

- Presented approaches
  - Classical approach (based on iop_G)
  - New method: bilateral approach based on iop_B
- Application to a specification describing a connection request protocol

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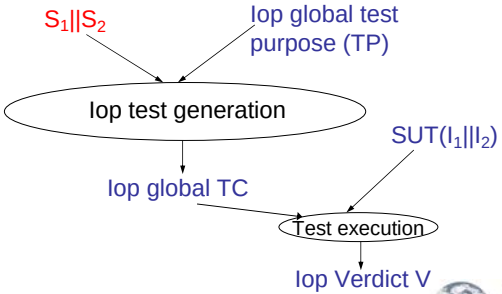
iop_G-based interoperability test generation method



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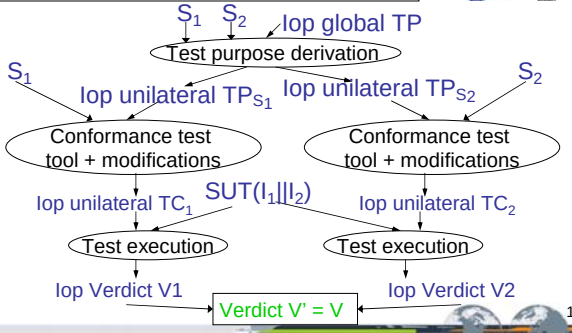
iop_B-based interoperability test generation method



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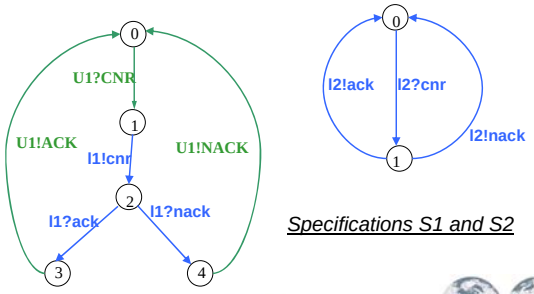
Comparing interoperability test generation methods



Specifications S1 and S2

Applying iop_B-based method

- *Global TP:*

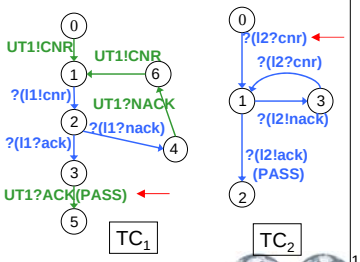
TP= !2?cnr.U1!ACK

- *Unilateral TPs:*

TP_1: !1!cnr.U1!ACK

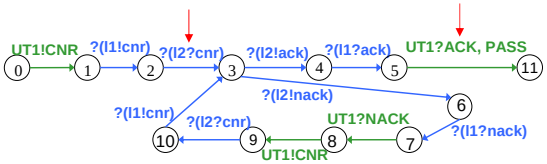
TP_2: !2?cnr.!2!ack

- *Unilateral test cases*



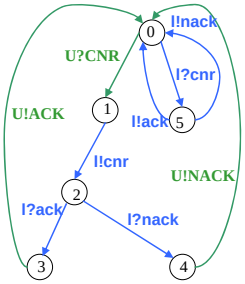
Applying iop_G-based method

Specifications S1 and S2: global test case



Application to another specification

Specification S



With iop_B-based method :

Same TP, TP_1 and TP_2

TC1: 9 states/17 transitions

TC2: 12 states/22 transitions

With classical method:

- Interaction S||S: 47.546 states/114.158 transitions
- Global TC: 54.456 states/120.443 transitions

Conclusion

- Equivalence between global and bilateral methods based on global iop criterion and bilateral iop criterion
- Equivalence confirmed by experimentations
- Bilateral method avoids state-space explosion problem
- Future work: generalization to a context with N interacting implementations