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A New Method for Interoperability Test Generation

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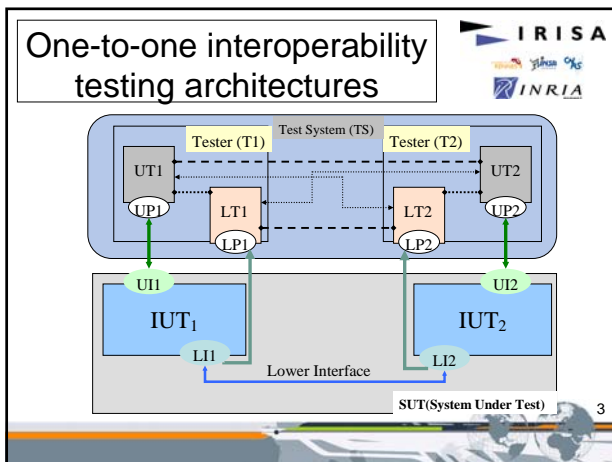*adesmoul@irisa.fr, http://www.irisa.fr*

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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

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One-to-one interoperability testing architectures

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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

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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

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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
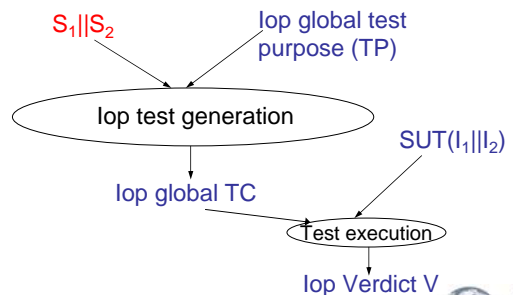
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Interoperability test generation

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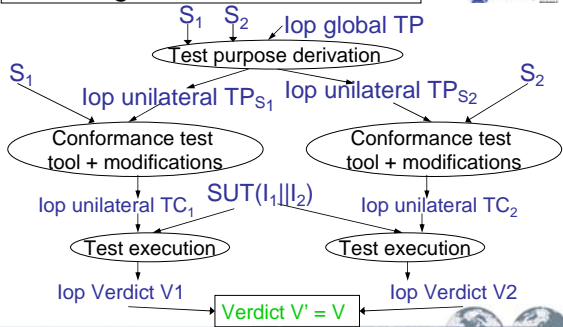- Application to a specification describing a connection request protocol

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Slide 10

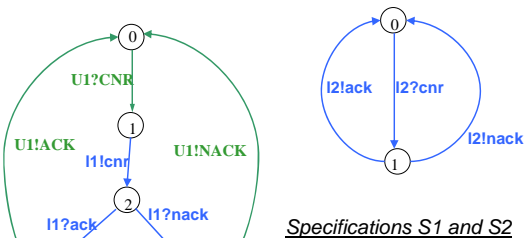### iop_G-based interoperability test generation method

$S_1 \| S_2$ → Iop test generation ← Iop global test purpose (TP)

Iop test generation → Iop global TC

SUT($I_1 \| I_2$) → Test execution

Iop global TC → Test execution

Test execution → Iop Verdict V

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iop_B-based interoperability test generation method

S_1 S_2 → Test purpose derivation ← Iop global TP

Iop unilateral TP_{S_1} Iop unilateral TP_{S_2}

S_1 → Conformance test tool + modifications

S_2 → Conformance test tool + modifications

Iop unilateral TC_1 SUT($I_1 \| I_2$)   Iop unilateral TC_2

Test execution   Test execution

Iop Verdict V1   Iop Verdict V2

Verdict V' = V

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Comparing interoperability test generation methods

U1?CNR
U1!ACK   I1!cnr   U1!NACK
I1?ack   I1?nack

I2!ack   I2?cnr
I2!nack

Specifications S1 and S2

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Slide 13 — Applying iop$_B$-based method

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- *Global TP:*
  TP=
    l2?cnr.U1!ACK
- *Unilateral TPs:*
  TP$_1$:
    l1!cnr.U1!ACK
  TP$_2$:
    l2?cnr.l2!ack

- *Unilateral test cases*

TC$_1$ TC$_2$

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Slide 14 — Applying iop$_G$-based method

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Specifications S1 and S2: global test case

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Slide 15 — Application to another specification

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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

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Slide 16 — Conclusion

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- 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

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