

On Modeling and Testing Components of the ETCS

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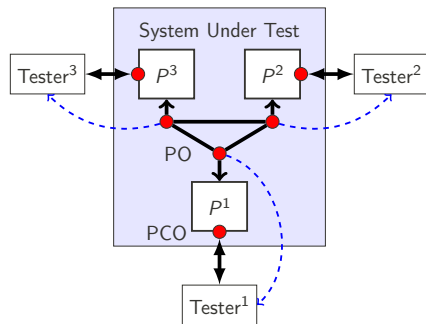
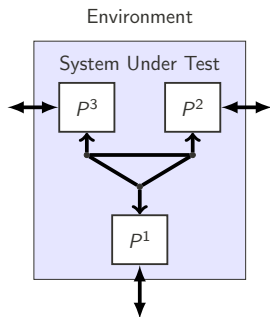
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Outline

- 1 Distributed Testing System
- 2 Case Study: Release Speed Monitoring
- 3 Conclusion

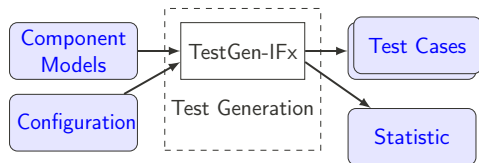
Architectures



Architecture of SUT and the Testing System

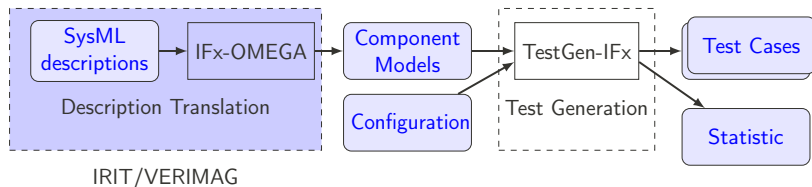
TetGen-IFx tool

- Use IF language to model components: expressiveness, tool support
- Implement four kinds of strategies of exploration: exhaustive (DFS or BFS), interactive, random, coverage
- Complete toolchain



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Local Test Case

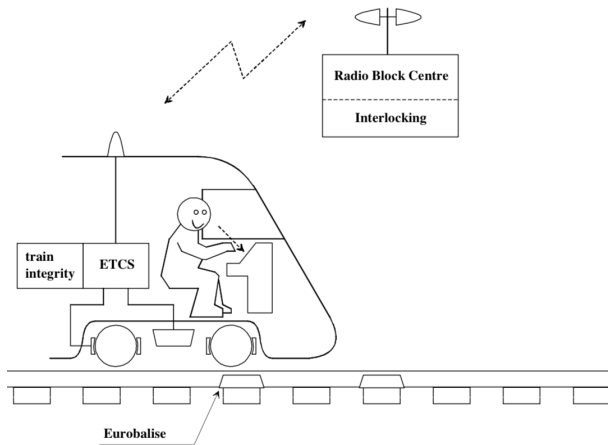
A *local test case* of tester t^k that test the component p^k of SUT is a sequence $\sigma^k = \langle d_1, \alpha_1, d_2, \alpha_2, \dots, \alpha_m \rangle$, where $d_i \in \mathcal{D}$ is a duration, and each α_i is one of the following:

- a sending of a message to its component p^i
- a reception of a message from p^i
- an observation of a sending message of p^i to its component partner p^j , with $i \neq j$
- an observation of a reception message of p^i from its component partner p^j , with $i \neq j$

Outline

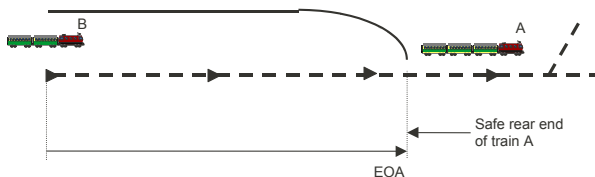
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ETCS level 3



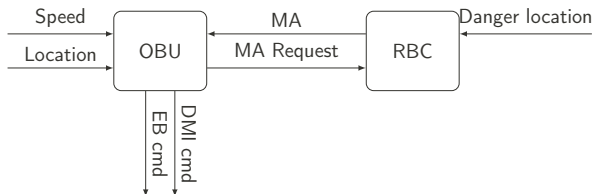
Movement Authority

- A train moves in *virtual moving blocks* defined by its RBC via Movement Authorities
- Movement Authority (MA) gives a permission from RBC to train to run until a location called End Of Authority (EOA)



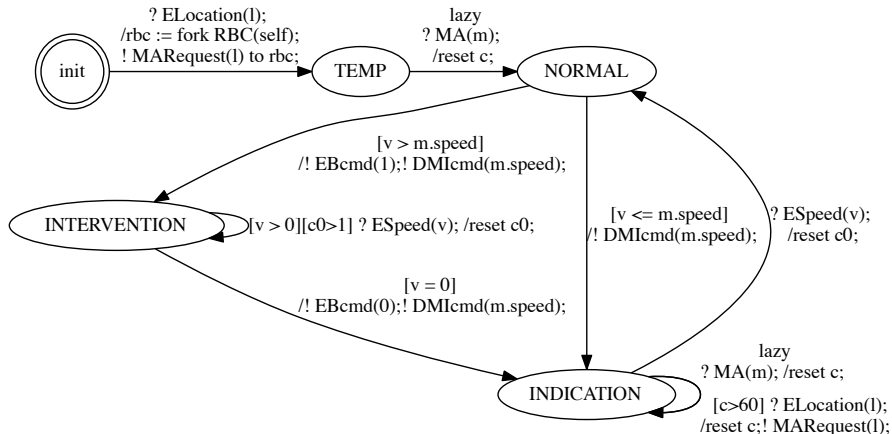
Release Speed Monitoring

- To ensure the train is able to stop at the given EOA, a MA contains also a release speed that is a speed limit under which the train is allowed to run in the vicinity of the EOA.
- Release speed monitoring ensures that the current speed of the train does not overpass the release speed.



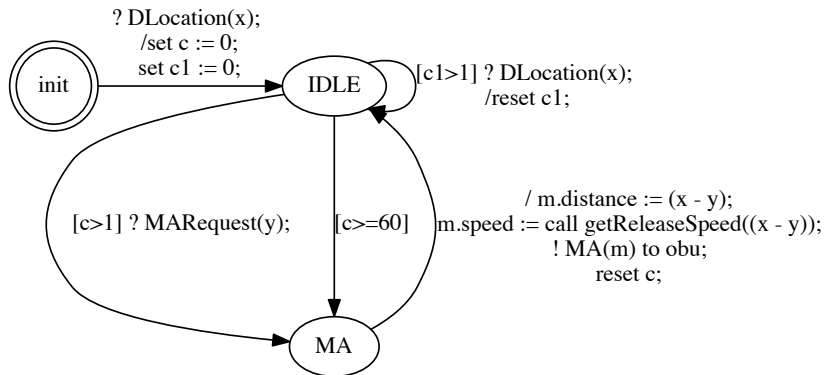
Models

OBU



Models

RBC



BFS Exhaustive Test Generation

Depth	#Test cases	Time(s)	Coverage of variables		
			v	l	x
1	11	0.06		✓	
2	121	0.10		✓	✓
3	121	0.14		✓	✓
4	242	0.35		✓	✓
5	24,563	38.81		✓	✓
6	4,913,084	7792.08	✓	✓	✓

- One may need a big test case rather than a big number of test cases
 \implies use *random*, *interactive* or *coverage* strategies to generate test cases, e.g., a test case of the case study with depth 20 is generated in 0.41s using random strategy.

Test Case

Test objective:

- the train is in the INDICATION state,
- running at 190km/h meanwhile the release speed is 80km/h,

Formulate:

$TP := \{tp_1, tp_2, tp_3, tp_4\}$

$tp_1 = \text{"process : instance = \{OBU\}0"}$

$tp_2 = \text{"state : source = INDICATION"}$

$tp_3 = \text{"variable : v = 190"}$

$tp_4 = \text{"variable : m.speed = 80"}$

Test Case

Test objective:

- the train is in the INDICATION state,
- running at 190km/h meanwhile the release speed is 80km/h,

Test case:

```

1  - Test case of OBU
2  !;  t;          ELocation{p1=3};                {OBU}0
3  !;  {OBU}0;    MAREquest{p1=3};                {RBC}0
4  delay 2
5  ?;  {RBC}0;    MA{p1={distance=3,speed=80}};    {OBU}0
6  !;  {OBU}0;    DMICmd{p1=80};                  t
7  !;  t;          ESpeed{p1=190};                 {OBU}0
8  ?;  {OBU}0;    EBCmd{p1=1};                     t
9  ?;  {OBU}0;    DMICmd{p1=80};                  t
10 - Test case of RBC
11 !;  t;          DLocation{p1=6};                 {RBC}0
12 delay 2
13 ?;  {OBU}0;    MAREquest{p1=3};                {RBC}0
14 !;  {RBC}0;    MA{p1={distance=3,speed=80}};    {OBU}0

```

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Conclusion

- Framework for distributed testing of *timed* composite systems
 - Time, Asynchronous communications
 - No need of communications among testers
 - Test generation tool
 - Applied to ETCS release speed monitoring
- Future work
 - Test executions
 - Clocks drifting

Thank you for your attention!