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Model-based testing for LTE Radio Base Station

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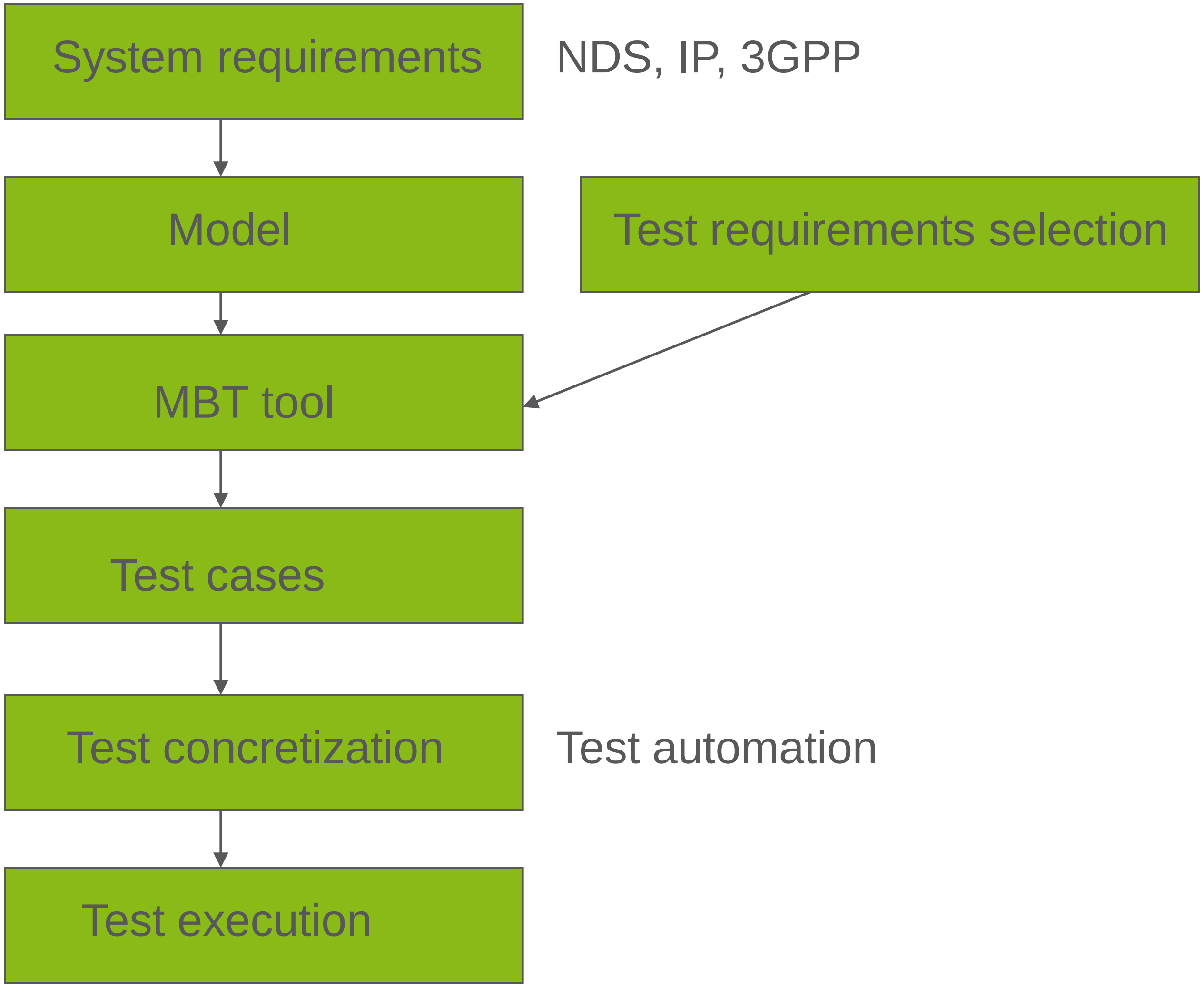
Overview

- Model based testing was applied to LTE Radio Base Station
- We present results of testing Public Warning System using MBT
- We describe our experience with using Spec Explorer for modeling and test generation

Model-based testing



System requirements

NDS, IP, 3GPP

Model

Test requirements selection

MBT tool

Test cases

Test concretization

Test automation

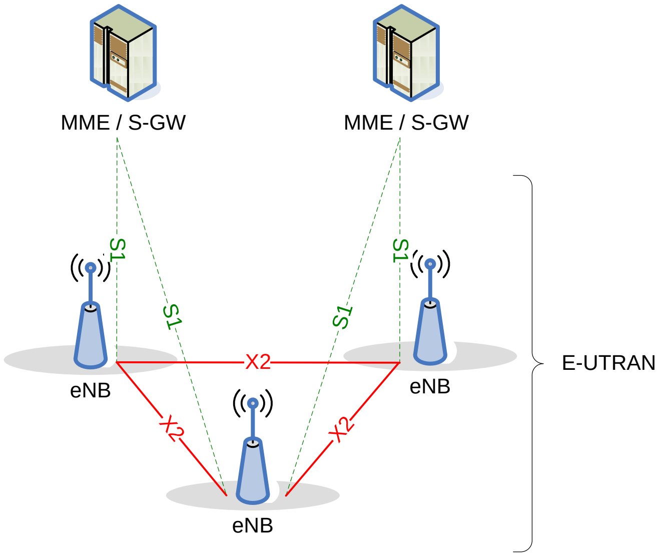
Test execution

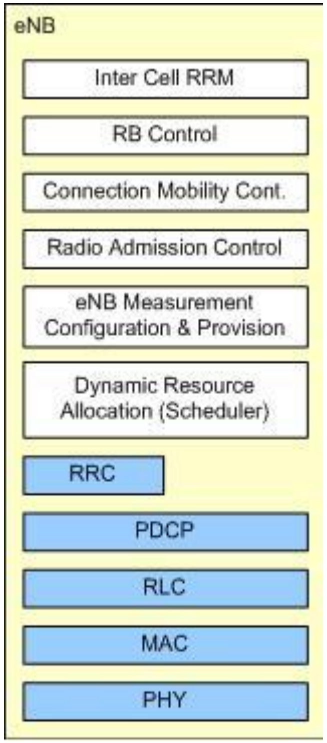
LTE Radio Base Station (eNodeB)

LTE Radio Access Network consists of LTE Radio Base Station (RBS), which supports the LTE air interface and performs radio resource management.

LTE RBSes are interconnected with each other by means of the X2 interfaces.

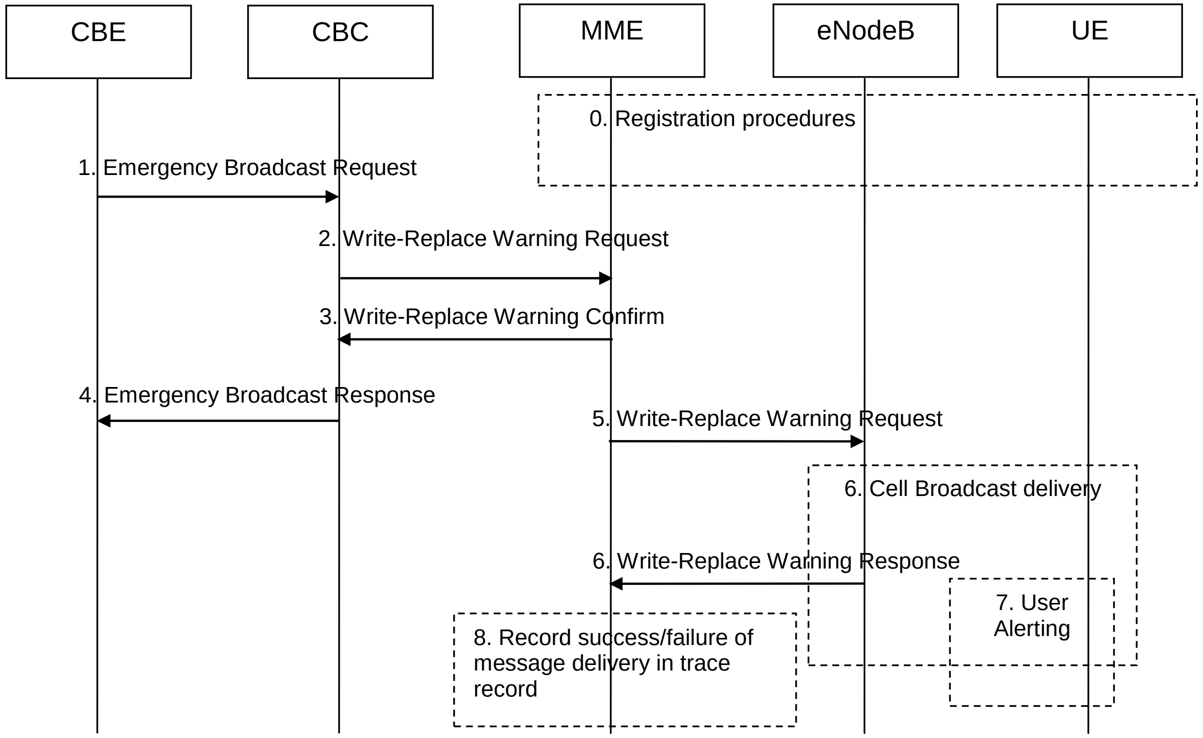
LTE RBSes are also connected by means of the S1 interface to the Evolved Packet Core.




eNB
Inter Cell RRM
RB Control
Connection Mobility Cont.
Radio Admission Control
eNB Measurement Configuration & Provision
Dynamic Resource Allocation (Scheduler)
RRC
PDCP
RLC
MAC
PHY

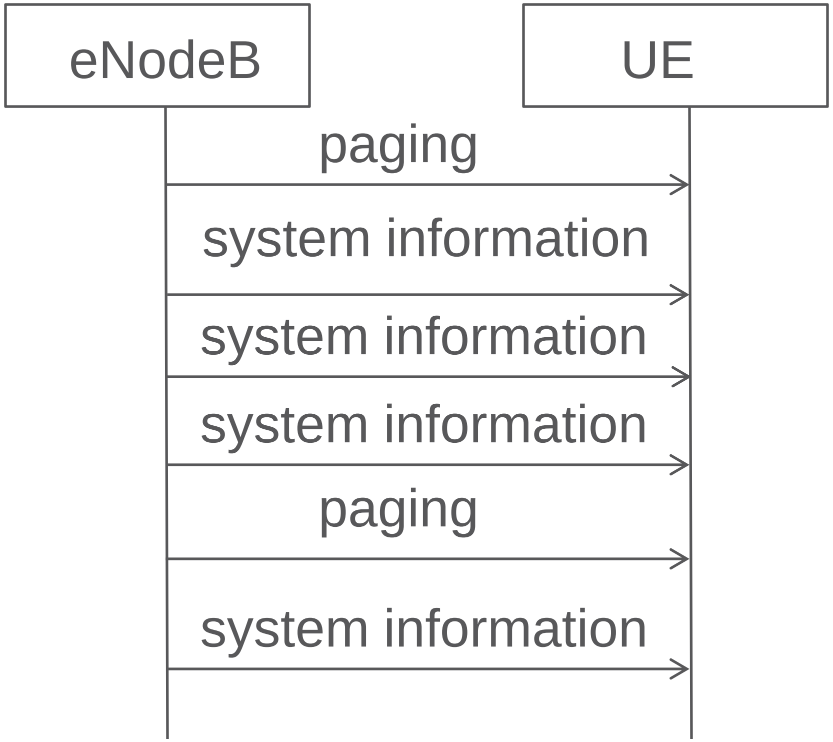
3GPP TS 36.300

Public Warning System


CBE
CBC
MME
eNodeB
UE
0. Registration procedures
1. Emergency Broadcast Request
2. Write-Replace Warning Request
3. Write-Replace Warning Confirm
4. Emergency Broadcast Response
5. Write-Replace Warning Request
6. Cell Broadcast delivery
6. Write-Replace Warning Response
7. User Alerting
8. Record success/failure of message delivery in trace record

3GPP TS 23.041

Public Warning System



eNodeB sends different types of system information messages.

There are time constraints.

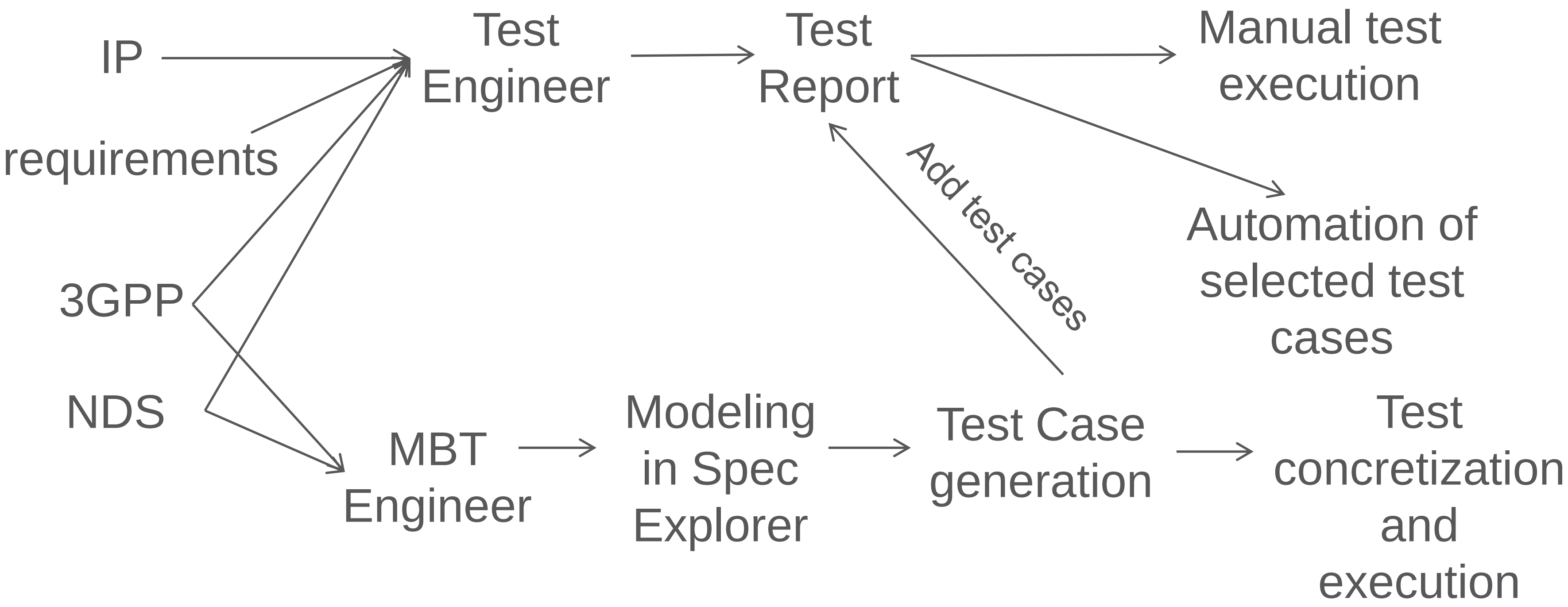
Spec Explorer

- Tool for model-based specification and testing
- Produced by the Software Engineering group in Microsoft Research
- Spec Explorer 2010 uses C# as a modeling language
- Spec Explorer 2010 requires Microsoft Visual Studio

Spec Explorer

- Modeling in Spec Explorer
  - writing rules in C#
  - writing Cord script which defines configurations, parameter values and scenarios
- Requirement coverage is supported
- Combinatorial testing is supported
- Test scripts in C#

MBT project



IP

requirements

3GPP

NDS

Test Engineer

Test Report

Manual test execution

Automation of selected test cases

Add test cases

MBT Engineer

Modeling in Spec Explorer

Test Case generation

Test concretization and execution

Modeling

- 21 parameters
- Some parameters are symbolic
- Several models created. One model to test only RBS log.
- Combination.Isolated, Combination.Interaction, Condition.In, Condition.IsTrue, Combination.Seeded
- Some parameters appear in several Combination.Interaction()
- Pairwise testing is not enough
- Test generation took seconds.
- Test case minimization in Spec Explorer

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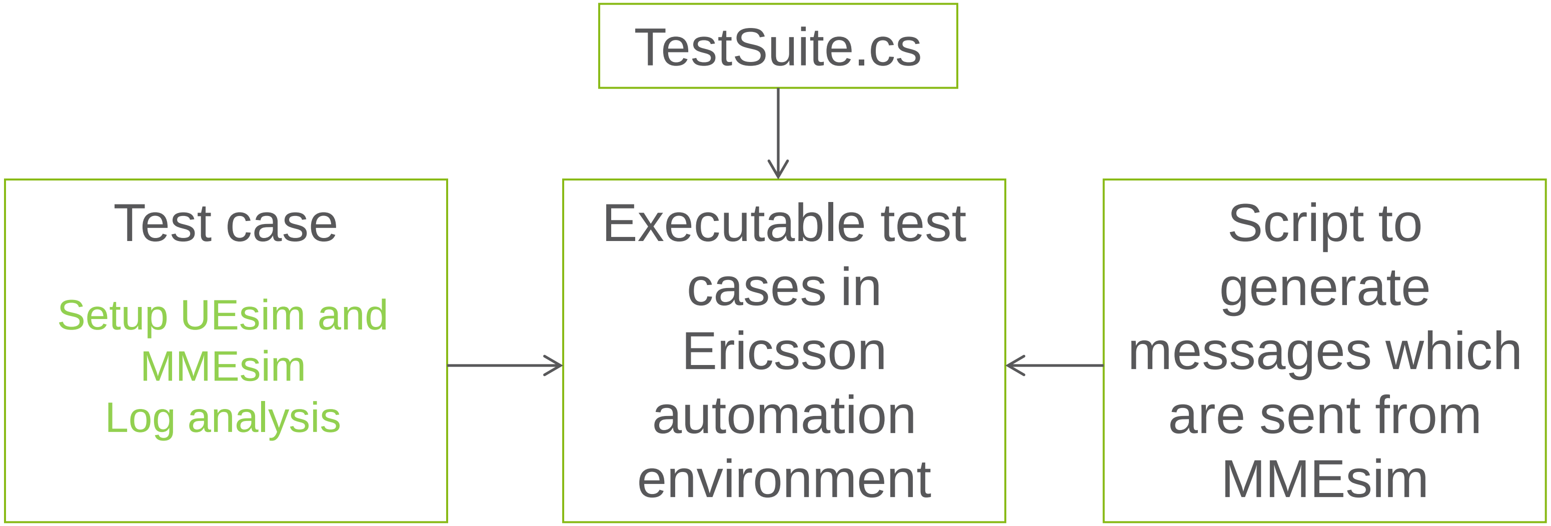
  ```
  if (x!=0 & y!=0)
          Combination.Interaction(x,y,z);
  ```
  cannot be used

Test concretization



TestSuite.cs

Test case

Setup UEsim and MMEsim
Log analysis

Executable test cases in Ericsson automation environment

Script to generate messages which are sent from MMEsim

Test concretization and execution

- Log analysis is difficult, a lot of information to check in logs
- Unstable environment, test cases should be rerun
- Manual execution is required to understand what is needed for concretization
- Testing of executable test cases is needed
- It takes time to analyze failed tests (model, SUT, concretization).

Conclusion

- Good collaboration between Test Engineers and System Engineer
- It takes time to find MBT tool suitable for modeling of functionality
- MBT generates complex test cases, test automation is more difficult
- MBT is time consuming, but

  faults were found during test execution

  missing requirements were found

  contradiction between two 3GPP standards was discovered

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