Welcome to the World of Standards

ETSI World Class Standards

TOWARDS THE USAGE OF MODEL BASED TESTING IN THE STANDARDIZATION OF TELECOMMUNICATION SYSTEMS

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Agenda

- Introduction
  - Motivation
  - STF 442
- Case Studies
  - Overview
  - GeoNetworking Case Study
    - Modeling
    - Test Generation
  - Evaluation
- Methodology
  - Outline
  - MBT Process for Test Standardization
- Conclusions

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Motivation

- MBT has matured into an industrial technology
  - Successfully used in a wide range of application areas
- Enable MBT technology at ETSI
  - ETSI Standard on model-based testing
  - ETSI MBT User Conference
  - Next Step: applying MBT in standardized test development
- Goals
  - Assess feasibility
  - Feedback on current MBT standard
  - Create a methodology and process
  - Determine next steps in MBT standardization

STF 442

- Specialist Task Force initiated by ETSI MTS
- Manpower
  - 4 persons with 30 days each (120 working days total)
- Duration
  - February 2012 – December 2012
- Expected Results
  - Case Study Report
    - Experiments with state of the art MBT tools
    - Evaluation: MBT and ETSI test development
  - ETSI MBT Methodology Guidelines
    - Tool independent
    - Outlining the usage of MBT at ETSI

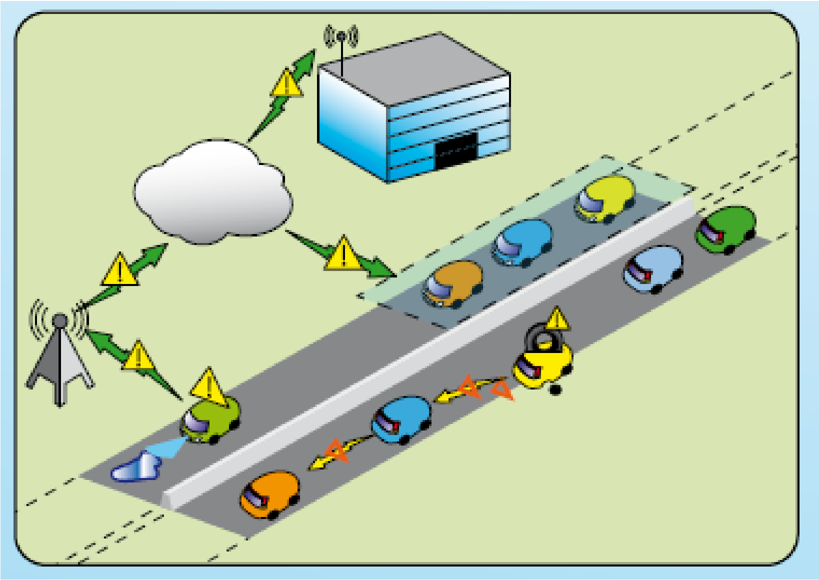
Overview of the Case Studies

- Tools
  - Fraunhofer MDTester (academic)
  - Conformiq Designer
  - Microsoft SpecExplorer
  - Sepp.med MBTsuite
- Case Studies
  - Academic Example
    - Automated Teller Machine (ATM)
  - GeoNetworking Protocol (ETSI TS 102 636)
    - Intelligent Transportation Systems (ITS)
    - Location service functionality of the GeoNetworking protocol
    - Packet routing in ad-hoc networks, packet distribution in a geographical area
  - Diameter Protocol (ETSI TS 129 214)
    - UMTS, LTE, Rx interface
    - Conveys session information and policy/charging rules between the Application Function (AF) and the Policy/Charging Rules Function (PCRF)

GeoNetworking Protocol Overview

- Vehicles exchange information with
  - other vehicles,
  - road infrastructure and
  - Internet peers.

- Example usages
  - Locating free parking lots
  - Instant notifications
    - Braking actions
    - Road hazards
    - Traffic conditions



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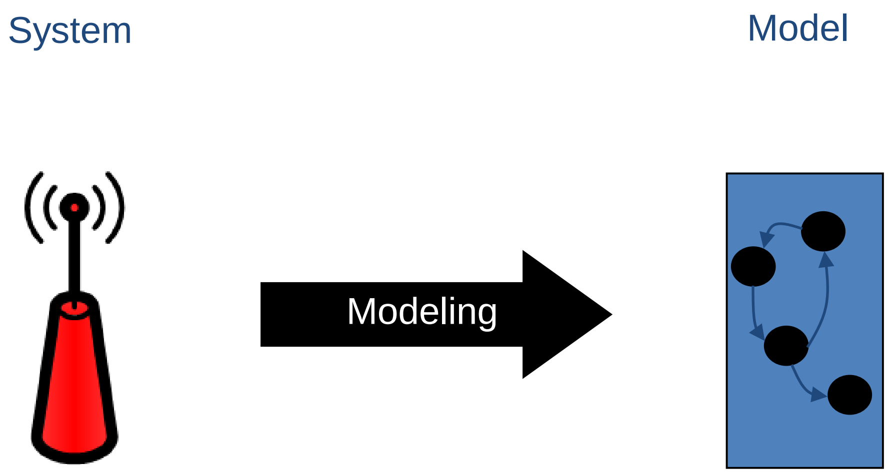
Modeling (1/3)

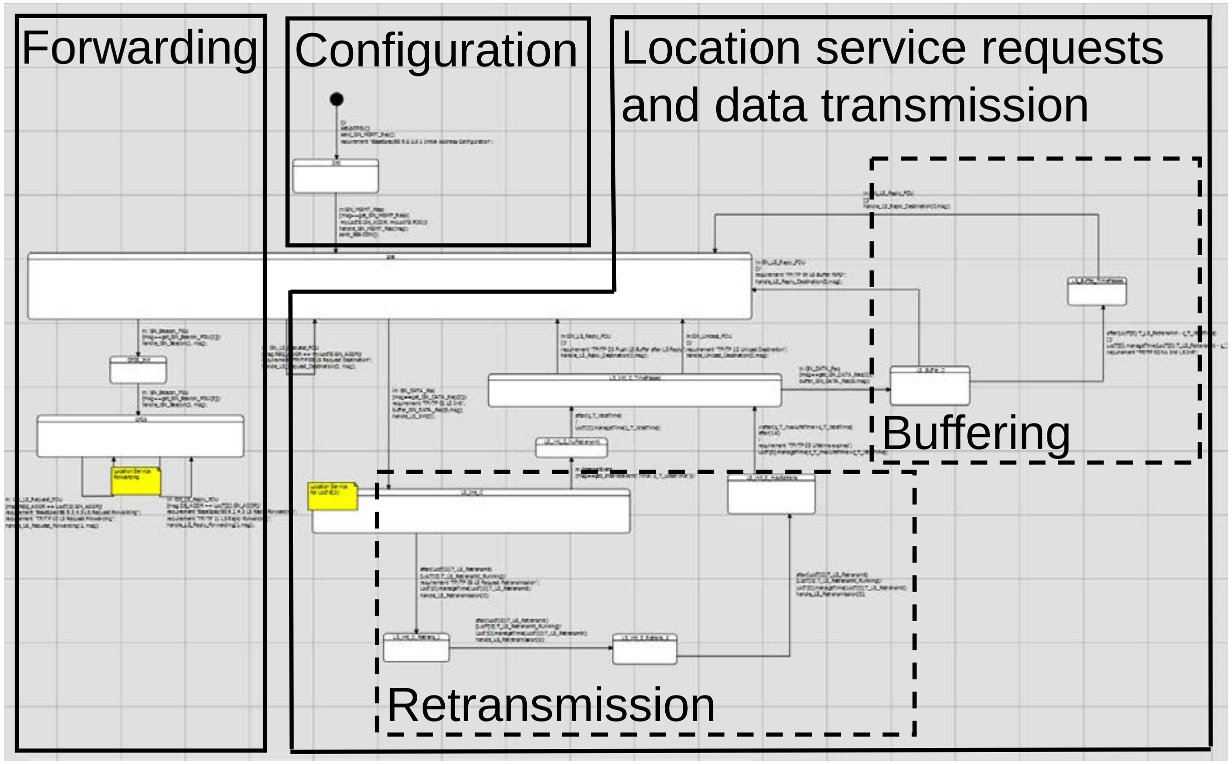
- What is modeling?
  - A sometimes simplified "mathematical description of a system or process, used to assist calculations and predictions". – Oxford Dictionary



Modeling (2/3)

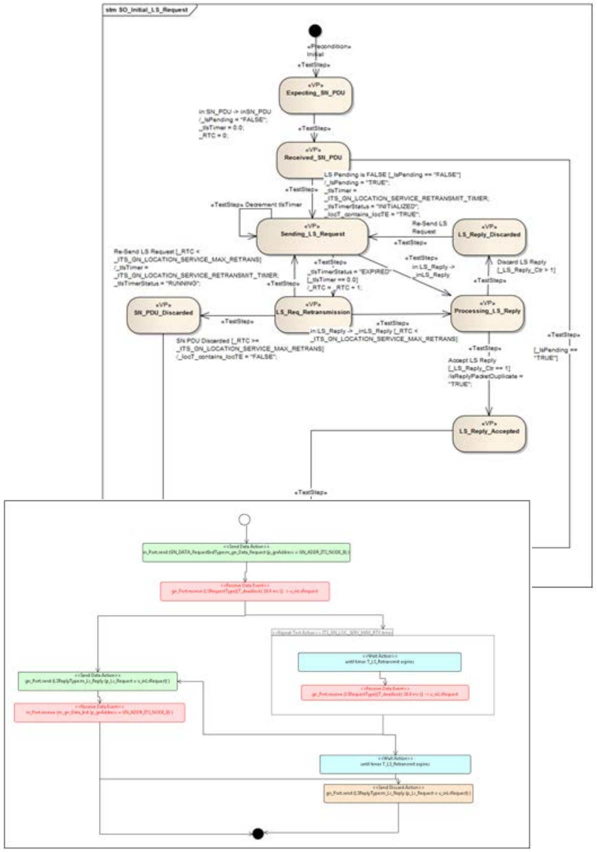
- GeoNetworking Model Example (Conformiq Designer)

- Model consists of
  - Graphical part
    - FSM
  - Code part
    - Message handling
    - Internal data
    - Generating response data
    - Guard conditions



Modeling (3/3)

- Challenges
  - Expertise in protocol, tool and testing
  - Choosing the right level of abstraction
  - Dealing with complexity
- Models for GeoNetworking Case Study
  - SpecExplorer
    - C# code is mapped to an extended state machine
    - Lower abstraction level than the Test Purposes
    - Complete modeling, slicing
  - Conformiq, MBTsuite, MD Tester
    - Extended State Machines (Conformiq)
    - Annotated UML State and Activity Diagrams (MBTsuite, MD Tester)
    - Abstraction level of the Test Purposes
    - Simplified modeling using Test Configurations

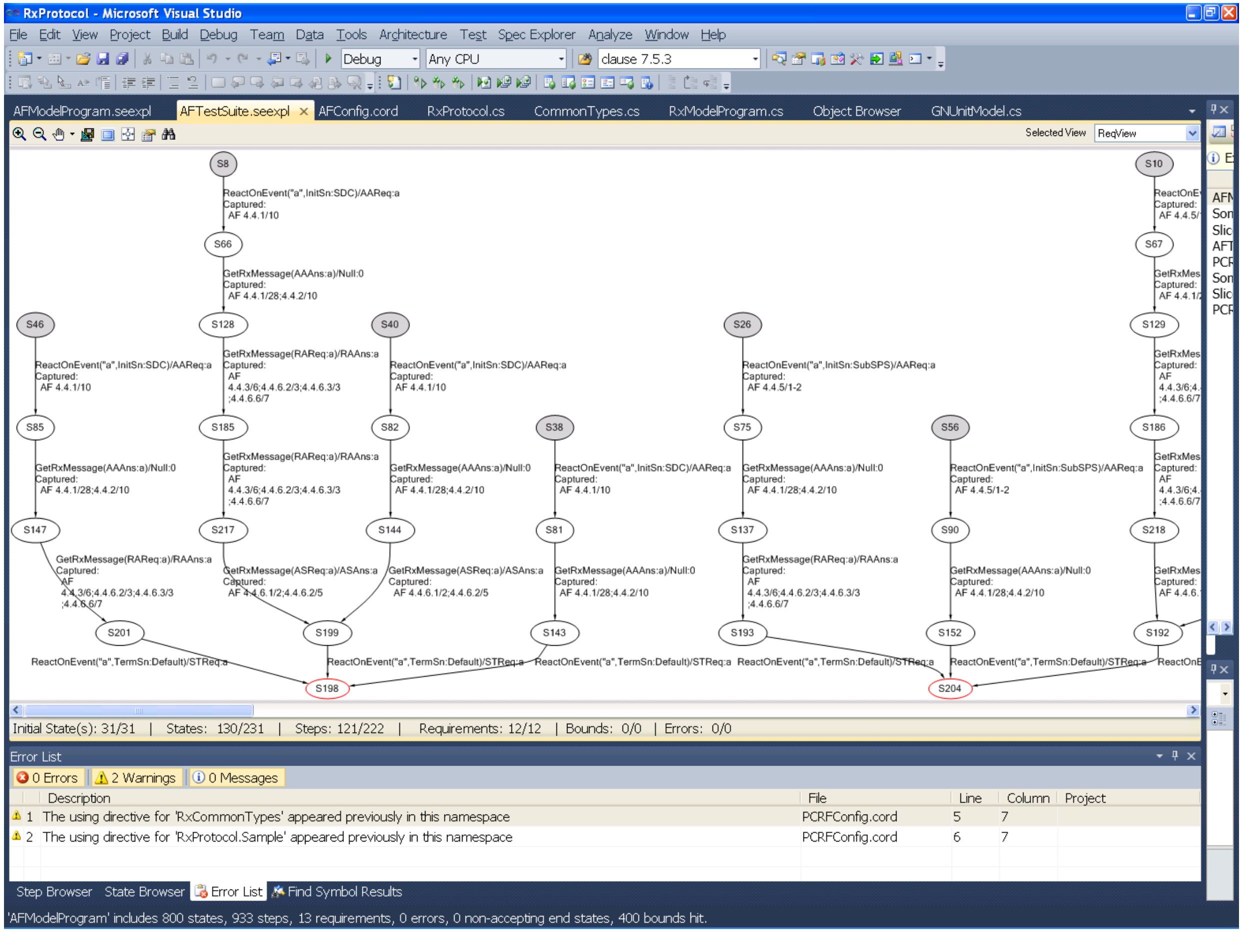


Test Generation (1/2)

- Influencing Test Generation
  - Different modeling approaches lead to different test suites
  - Each tool has different means to control test generation
- Generating Tests for GeoNetworking Case Study
  - SpecExplorer
    - Coverage goals were selected requirements extracted from standard
  - Conformiq Designer, MBTsuite, MDTester
    - Coverage goals were based on standardized test purposes

Test Generation (2/2)

- Example for generated tests in SpecExplorer



Evaluation of Generated Tests

- Test Purposes (TP) were used for comparison
- The manually created TPs could be covered in all case studies
- Tools have also means to go beyond the TPs
- The generated test cases were at least on the same level of abstraction as the TPs

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
TP 01 LS Init								X		X	X	X	X	X	X	X	X	X
TP 02 No 2nd LS Init															X			
TP 03 Flush LS Buffer after LS Reply														X				X
TP 04 LS Buffer FIFO																	X	
TP 05 Lifetime expired																		X
TP 06 LS Request Retransmission																		
TP 07 LS Retransmission maxRetransTimes																		
TP 08 LS Request Destination				X		X												
TP 09 LS Request is the same from an other node						X												
TP 10 LS Request Frowarding																		
TP 11 LS Reply Forwarding																		
TP 12 Unicast Destination																		

Prerequisite / Dependent	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Method main()		↵	↵	↵	↵	↵	↵	↵	↵	↵	↵	↵	↵	↵	↵	↵	↵	↵
Method get_GN_MGMT_Resp(String,String)			↵	↵	↵	↵	↵	↵	↵	↵	↵	↵	↵	↵	↵	↵	↵	↵
Method GeoNetworking.get_GN_Beacon_PDU(int)					↵		↵		↵									
TP 08 LS Request Destination						↵												
Move from GeoNetworking.CF03_Init to GeoNetworking.CF03							↵		↵									
TP 09 LS Request is the same from an other node																		
TP 10 LS Request Frowarding																		
TP 01 LS Init										↵	↵	↵	↵	↵	↵	↵	↵	↵
TP 11 LS Reply Forwarding																		
Method get_InternalEvent(String)												↵		↵	↵	↵	↵	
TP 06 LS Request Retransmission													↵					↵
GeoNetworking.LS_Init_0_TimePassed to G~.LS_Buffer_0															↵		↵	
GeoNetworking.LS_init_0_Retrans_1 to G~.LS_init_0_Retrans_2																		↵
TP 03 Flush LS Buffer after LS Reply																		↵
GeoNetworking.LS_Buffer_TimePasses to GeoNetworking.Idle																		↵
TP 12 Unicast Destination																		
TP 04 LS Buffer FIFO																		
Use Case: TP: maxRetrans																		

TP 06 LS Request Retransmission

Adaptation to Test Environment

- Support of Test Execution
  - Possible to generate executable test cases with all tools
  - 3 out of 4 tools have TTCN-3 support
- Test Harness
  - Adaptation to the target test system
  - Adding of data not specified in the model, because it does not influence the test generation
  - Parallelization
- Improving Maintainability
  - Parameterization
  - Renaming of test cases, messages, variables etc.
  - Re-structuring of test behaviour (e.g. preamble, test body, postamble)

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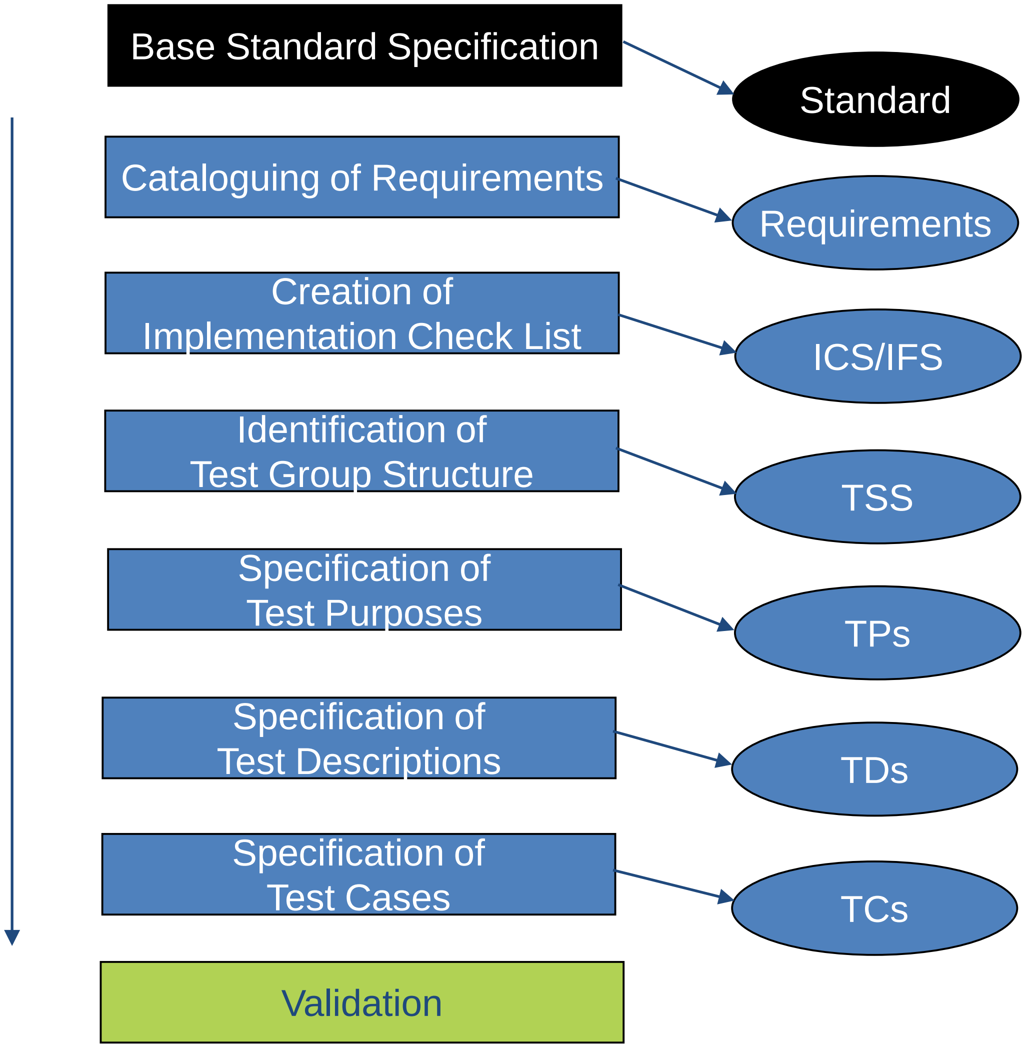
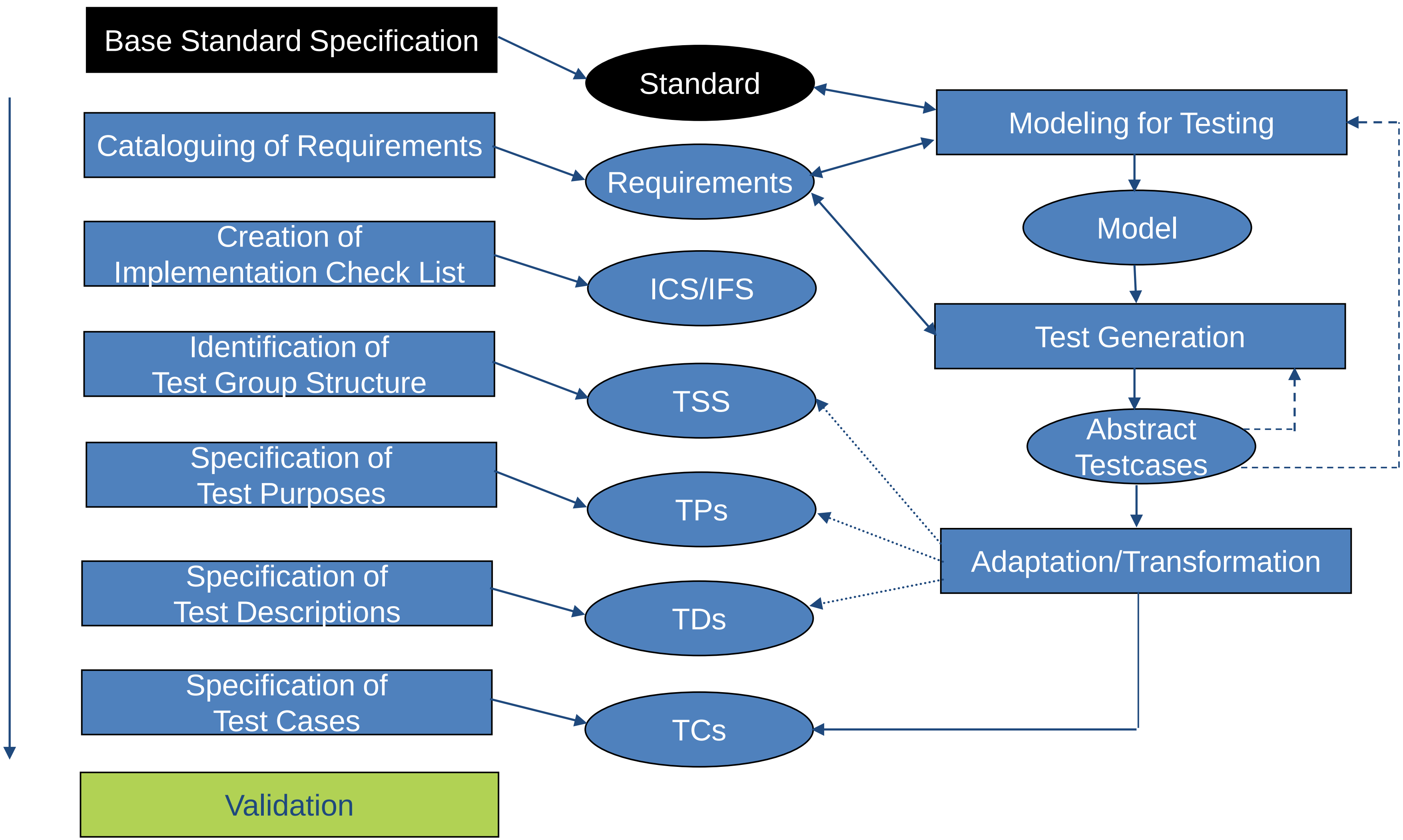
Methodology Outline

- Modeling
  - Identification of requirements
  - Identification of modeling strategy
  - Annotating models with references for requirements
  - Modeling guidelines
  - Model quality
- Automatic test generation
  - Defining test coverage
  - Generating test cases
  - Quality of generated test cases
- Transformation and adaptation of generated test cases
  - Transformation and adaptation steps
  - Quality of adapted test suite

MBT Process for Test Standardization Outline



MBT Process for Test Standardization Outline



Conclusions

- Case studies were successful with all tools
  - All case studies have been modeled
  - Abstract test cases were successfully generated
  - Test coverage comparable with the manually designed test suite
- MBT can be applied in standardized test development
  - Additional validation of base standards and requirements
  - MBT allows better control of test coverage
- Challenges
  - Gather expertise in base standard, testing and modeling
  - Abstraction gap between generated and manually written test cases
  - Maintenance of test suite vs. maintenance of test model

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ETSI and ETSI Specialist Task Forces

- *About ETSI:*
  - *ETSI produces globally-applicable standards for Information and Communications Technologies (ICT), including fixed, mobile, radio, converged, broadcast and internet technologies and is officially recognized by the European Commission as a European Standards Organization. ETSI is a not-for-profit organization whose 700 ETSI member organizations benefit from direct participation and are drawn from 60 countries worldwide. For more information, please visit: www.etsi.org*

- *About ETSI Specialist Task Forces (STF):*
  - *STFs are teams of highly-skilled experts working together over a pre-defined period to draft an ETSI standard under the technical guidance of an ETSI Technical Body and with the support of the ETSI Secretariat. The task of the STFs is to accelerate the standardization process in areas of strategic importance and in response to urgent market needs. For more information, please visit: http://portal.etsi.org/stfs/process/home.asp*

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