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**FROM TDL TO TTCN-3: A STEP BY STEP TUTORIAL**

Philip Makedonski, Gusztav Adamis, Martti Käärik, Finn Kristoffersen, György Réthy
Overview

What is TDL?
- Test Description Language
  - Design, documentation, and representation of formalised test descriptions
  - Scenario-based approach
  - Standardised at ETSI by TC MTS
    - STF 454 (2013)
    - STF 476 (2014)
    - STF 492 (2015-2016)
    - STF 522 (2017)

What is TTCN-3?
- Testing and Test Control Notation
  - Specification and implementation of all kinds of black-box tests
  - Platform independent link between modelling and execution
  - Component-based approach
  - Standardised at ETSI

Mapping TDL to TTCN-3
- Establish a connection between TDL and TTCN-3
  - generation of executable tests from test descriptions
  - standardised, ensuring compatibility and consistency
  - re-use existing tools and frameworks for test execution
  - re-use existing TTCN-3 assets (data, behaviour)

Methods for Testing and Specification (MTS); The Test Description Language (TDL); ETSI 873-1

Methods for Testing and Specification (MTS); Part 1: TTCN-3 Core Language; ETSI 873-6

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Steps in technology. That brings challenges but also new opportunities for students and researchers in what is traditionally a research topic. Future developments of deployed solutions is rapid but still offering the diversity common to major technology platform. After years of standardization (also at ETSI) the growth of IoT which has been blurring lines between verticals such as telecom, transport, enterprise IT, automotive and leading to the emergence of a unified platform.

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  - STF 476 (2014)
  - STF 492 (2015-2016)
  - STF 522 (2017)
What is TDL?

- Design, documentation, representation?
  - ease development and review
  - improve productivity and quality
  - both industry and standardisation
  - reduce implementation details
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What is TDL?

- **Scenario-based?**
  - describe interactions with a system
  - attach test objectives to scenarios
  - derive and automate tests
- **Reactive, distributed, real-time**
  - common black-box testing concepts
  - domain adaptation
  - agile development
What is TDL?

- Standardised?
  - canonical reference
  - stable documentation
  - clear semantics
  - interoperability and independence
  - updated with user needs
  - maintenance commitment

ETSi ES 203 119-1 V1.3.1 (2016-09)

Methods for Testing and Specification (MTS);
The Test Description Language (TDL);
Part 1: Abstract Syntax and Associated Semantics
What is TDL?

- Contributions from:
  - Siemens AG, Ericsson Hungary
  - Fraunhofer FOKUS, ETSI CTI
  - CEA, University of Göttingen
  - OU Elvior, Cinderella ApS

- Guidance:
  - Steering Group, TC MTS
What is TDL?

Part 1: MM
Meta-Model and Semantics

Part 2: GR
Graphical Syntax

Part 3: XF
Exchange Format

Part 4: TO
Structured Test Objective Specification
What is TDL?
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About UCAAT

ETSI ES 203 119-1
V1.3.1
(2016-09)
Methods for Testing and Specification (MTS);
The Test Description Language (TDL);
Part 1: Abstract Syntax and Associated Semantics

ETSI ES 203 119-2
V1.2.1
(2016-09)
Methods for Testing and Specification (MTS);
The Test Description Language (TDL);
Part 2: Graphical Syntax

ETSI ES 203 119-3
V1.2.1
(2016-09)
Methods for Testing and Specification (MTS);
The Test Description Language (TDL);
Part 3: Exchange Format

ETSI ES 203 119-4
V1.2.1
(2016-09)
Methods for Testing and Specification (MTS);
The Test Description Language (TDL);
Part 4: Structured Test Objective Specification (Extension)

TDL P1: MM

TDL P2: GR

TDL P3: XF

TDL P4: TO

TDL P5: UD
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### Semantics

A 'GateType' represents a type of communication points, called 'ComponentInstance's. A 'GateType' specifies the 'DataType's that can be exchanged via both directions.

### Generalization

- PackageableElement

### Properties

- dataType: DataType [1..*] {unique}
  The 'DataType's that can be exchanged via 'GateInstance's shall adhere to the 'DataType's that are allowed to be exchanged.

### Constraints

There are no constraints specified.
6.4.2 GateType

Concrete Graphical Notation

- **Extended Name Label**
  - **Data Type:** DATATYPELISTLABEL

Formal Description

- **context** GateType
- GateTypeNameLabel := self.name
- DATATYPELISTLABEL := self.dataType.name->separatortr(',')

Comments

No comments.
What is TDL? Part 1: MM

- TDL main ingredients
  - Test data
  - Test configuration
  - Test behaviour
  - Test objectives
  - Time
What is TDL? Part 1: MM

- TDL main ingredients
- Test data
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What is TDL? Part 1: MM

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What is TDL? Part 1: MM

- TDL main ingredients
  - Test data
  - Test configuration
  - Test behaviour
  - Test objectives
  - Time
What is TDL? Part 1: MM

- Test data
  - data definition and data use
  - abstract types and instances
  - composed by using parameters
  - functions and actions
  - mappable to concrete data
  - variables and special values
What is TDL? Part 1: MM

Type Login;
Login correct;
Login incorrect;

Use "data.ttcn3" as DATA;
Map correct to "johnny_correct" in DATA as correct_ttcn3;
Map incorrect to "johnny_incorrect" in DATA as incorrect_ttcn3;

template Login johnny_correct := {
    user := "johnny",
    password := "apple",
    hint := "seed",
    id := 1000
}
template Login johnny_incorrect := {
    user := "johnny",
    password := "orange",
    hint := "second favourite fruit",
    id := 2000
}
type record Login {
    charstring user,
    charstring password,
    charstring hint,
    integer id
} with {
    encode "xpath=//div[@id='login']";
    encode (user) "relative=/div/dd[3]";
    encode (password) "relative=/div/dd[4]";
};
What is TDL? Part 1: MM

Type Login;
Login correct;
Login incorrect;

Use "data.ttcn3" as DATA ;
Map correct to "johnny_correct" in DATA as correct_ttcn3;
Map incorrect to "johnny_incorrect" in DATA as incorrect_ttcn3;
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About UCAAT
What is TDL? Part 1: MM

- Test configuration
  - typed components and gates
  - timers and variables
  - connections among gates
  - component roles
What is TDL? Part 1: MM

Gate Type gt accepts Login, Response;

Component Type ct having {
    gate g of type gt;
}

Test Configuration tc {
    create Tester tester of type ct;
    create SUT sut of type ct;
    connect tester.g to sut.g;
}
What is TDL? Part 1: MM

- Test behaviour
  - defines expected behaviour
  - failure upon deviations by default
  - actions and interactions
  - alternative, parallel, iterative, conditional
  - defaulting, interrupting, breaking
What is TDL? Part 1: MM

Test Description td (p of type Login) uses configuration tc {
    tester.g sends incorrect to sut.g; alternatively {
        sut.g sends failure to tester.g with {
            test objectives : tp;
        }; set verdict to pass;
    } or {
        sut.g sends success to tester.g; set verdict to fail;
    }
}

or simply (relying on the default semantics):

Test Description td_default (p of type Login) uses configuration tc {
    tester.g sends incorrect to sut.g; sut.g sends failure to tester.g with {
        test objectives : tp;
    };
}
What is TDL? Part 1: MM

- Test objectives
  - may be attached to
    - behaviour (atomic or compound)
    - whole test description
  - contain description and reference
What is TDL? Part 1: MM

Test Objective tp {
    description : "ensure that
        when incorrect login is provided
        a failure response is sent";
}

Test Description td (p of type Login)
uses configuration tc {
    tester.g sends incorrect to sut.g;
    alternatively {
        sut.g sends failure to tester.g with {
            test objectives : tp;
        }
        set verdict to pass;
    } or {
        sut.g sends success to tester.g;
        set verdict to fail;
    }
}
What is TDL? Part 2: GR

- Graphical languages
  - common in (test) modelling
  - ease communication
- TDL Graphical Syntax
  - hybrid graphical language
  - simple shapes, compartments
  - textual visualisation of contents
What is TDL? Part 2: GR

- Aligned with UML
  - distinct where semantics differ
- One diagram to rule them all!
- BNF-like label specification
- Considers both ease of use and implementation
- Prototyped with Sirius
What is TDL? Part 2: GR

**COMPONENTTYPELABEL**

timer: **TIMERLISTLABEL**

**GATELABEL**

context: ComponentType

**COMPONENTTYPELABEL** ::= self.name

**TIMERLISTLABEL** ::= self.timer.name

…

ETSI ES 203 119-2 V1.2.1 (2016-09)

Methods for Testing and Specification (MTS); The Test Description Language (TDL); Part 2: Graphical Syntax
What is TDL? Part 3: XF

- Based on OMG XMI
  - XML: Metadata Interchange
  - Serialisation of MOF models
  - Exchange among MOF tools
- XMI concerns
  - complex, many options
What is TDL? Part 3: XF

- TDL specific XMI structure
- exchange of TDL models
- canonical TDL XMI structure
  - meta-class representations
  - multiplicity, associations, inheritance
- restrict flexibility of XMI
- syntactical validity only!
What is TDL? Part 3: XF

- Syntactical validity only?
  - two-step validation
  - syntax: XMI Schema
  - semantics: MOF model validation
What is TDL? Part 3: XF

```xml
<xsd:complexType name="ComponentInstance">
  <xsd:complexContent>
    <xsd:extension base="tdl:Element">
      <xsd:choice maxOccurs="unbounded" minOccurs="0">
        <xsd:element name="gateInstance" type="tdl:GateInstance"/>
        <xsd:element name="variable" type="tdl:Variable"/>
      </xsd:choice>
      <xsd:attribute name="componentType" type="xsd:anyURI"/>
      <xsd:attribute name="role" type="tdl:ComponentInstanceRole"/>
    </xsd:extension>
  </xsd:complexContent>
</xsd:complexType>
```
What is TDL? Part 3: XF

```xml
<packagedElement xsi:type="tdl:ComponentType" xmi:id="_qKt23asEeWrfP0MdfQNpg" name="ct">
  <gateInstance xmi:id="_qKt24HasEeWrfP0MdfQNpg" name="g" type="_qKt23nasEeWrfP0MdfQNpg"/>
</packagedElement>
```
What is TDL? Part 4: TO

- Based on TPLan
  - refine test objectives
  - formalise specification
  - integrate and unify test description and test purpose specification
What is TDL? Part 4: TO

Base Standard Specification
Identification of Requirements
Creation of ICS/IFS
Definition of TSS
Specification of Test Purposes
Specification of Test Descriptions
Specification of Test Cases
Validation

ETSI ES 203 119-4 V1.2.1 (2016-09)
Methods for Testing and Specification (MTS);
The Test Description Language (TDL);
Part 4: Structured Test Objective Specification (Extension)
What is TDL? Part 4: TO

- Base Standard Specification
- Identification of Requirements
- Creation of ICS/IFS
- Definition of TSS
- Specification of Test Purposes
- Specification of Test Descriptions
- Specification of Test Cases
- Validation
What is TDL? Part 4: TO

- Base Standard Specification
- Identification of Requirements
- Creation of ICS/IFS
- Definition of TSS
- Specification of Test Purposes
- Specification of Test Descriptions
- Specification of Test Cases
- Validation

ETSI ES 203 119-4 V1.2.1 (2016-09)
Methods for Testing and Specification (MTS);
The Test Description Language (TDL);
Part 4: Structured Test Objective Specification (Extension)
What is TDL? Part 4: TO

Test Purpose {
  TP Id "IP/CAM/INA/DOP/BV/02"
  Test objective "Checks that CAM message includes DoorOpen information 30s after closed"
  Reference "TS 102 637-2 [1], clauses 7.1 and 7.2"
  PICS Selection PICS_PUBTRANSVEH
  Initial conditions
  with {
    the IUT entity having reached an initial_state and
    the IUT entity having sent a valid CAM message containing DoorOpen TaggedValue;
  }
  Expected behaviour
  ensure that {
    when {
      the door entity is closed
    }
    then {
      the IUT entity sends a new CAM message containing DoorOpen TaggedValue;
    }
  }
}
What is TDL?
What is new TDL?

- Part 1: New features
  - collections, procedures
  - local ordering option
- Part 5: UML Profile
  - previously included in Part 1
- Part 6: Mapping to TTCN-3
  - coming up next
- Part 7: Extended Configurations
  - instantiate existing configurations
  - reuse and extend
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**What is new TDL?**

<table>
<thead>
<tr>
<th>Test Configuration</th>
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<tbody>
<tr>
<td>compositeTC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>source: defaultTC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TESTER</th>
</tr>
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<tbody>
<tr>
<td>SS: defaultCT</td>
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<table>
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<tr>
<th>SUT</th>
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<tbody>
<tr>
<td>UE: defaultCT</td>
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</table>

<table>
<thead>
<tr>
<th>Test Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>target: defaultTC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TESTER</th>
</tr>
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<tbody>
<tr>
<td>Bridge: defaultCT</td>
</tr>
</tbody>
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<table>
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<tr>
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</table>

---

**Methods for Testing and Specification (MTS); The Test Description Language (TDL):**

- Part 1: Abstract Syntax and Associated Semantics
- Part 2: Graphical Syntax
- Part 3: Exchange Format
- Part 4: Structured Test Objective Specification (Extension)
What is TTCN-3?

- Testing and Test Control Notation
- Specification and implementation of all kinds of black-box tests
- Platform independent link between modelling and execution
- Component-based approach
- Standardised at ETSI by TC MTS
- 15+ years of maintenance work
What is TTCN-3?

- Black-box tests?
  - functional, conformance, interoperability, robustness, load
  - standardisation and certification
- Used in various domains
  - telecommunications
  - automotive
  - railway
  - financial
  - medical
What is TTCN-3?

- Platform independent?
  - standardised core language
  - standardised interfaces
  - not tied to application or interface
  - not tied to tooling

- Requirements
  - test suite
  - compiler / interpreter
  - adapters and codecs
  - execution environment
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Adapted from Grabowski et al., 2014
What is TTCN-3?

- Component-based?
  - describe behaviour of test system
  - one or more test components
  - interconnected among each other
  - mapped to unified SUT interface
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What is TTCN-3?

- Test suite ingredients
  - Data
    - basic, structured, and special types
    - constants, templates, expressions
  - Configuration
    - components, ports, connections
    - dynamic management
  - Behaviour
    - test cases, functions, altsteps
    - defaults and timers
    - optional test execution control
What is TTCN-3?

//enumerated data type
type enumerated MSGKind {question, answer}

//structured data type
type record MSG {
    MSGKind kind,
    charstring content
}

//a question template
template MSG readyQuestion := {
    kind := question,
    content := "Ready?"
}

//a generic question template
//any question is fine
template MSG anyQuestion := {
    kind := question,
    content := ?
}

//a generic answer template
//any content is fine
template MSG anyAnswer := {
    kind := answer,
    content := ?
}
What is TTCN-3?

```plaintext
//simple port
type port MSGPort message {
    inout MSG
    //may also support transmission of other types
}

//simple component
type component Client {
    timer patience;
    port MSGPort clientPort
    //may also define multiple ports, variables, timers
}

//simple test case
testcase TC_isServiceReady() runs on Client {
    clientPort.send(p_Question("Ready?"));
    alt {
        clientPort.receive(p_Answer("Yes!")) {
            setverdict(pass);
        }
        clientPort.receive(p_Answer("No!")) {
            setverdict(fail);
        }
    }
}
```
What is TTCN-3?

//simple timed test case
testcase TC_isTimedServiceReady() runs on Client {
  clientPort.send(p_Question("Ready"));
  patience.start(10.0);
  alt {
    □ clientPort.receive(p_Answer("Yes")) {
      setverdict(pass);
    }
    □ clientPort.receive(p_Answer("No")) {
      setverdict(fail);
    }
    □ patience.timeout {
      setverdict(fail);
    }
  }
  patience.stop;
}
What is TTCN-3?

```c
//simple timed test case for nosy service
testcase TC_isTimedNosyServiceReady() runs on Client {
    clientPort.send(p_Question("Ready?")));
    patience.start(10.0);
    alt {
        □ clientPort.receive(p_Answer("Yes!"))) {
            setverdict(pass);
        }
        □ clientPort.receive(p_Answer("No!"))) {
            setverdict(fail);
        }
        □ clientPort.receive(anyQuestion) {
            clientPort.send(p_Answer("Yes!")));
            repeat;
        }
        □ patience.timeout {
            setverdict(fail);
        }
    }
    patience.stop;
}
What is TTCN-3?

//distributed test case
testcase TC_distributed() runs on Client
  system Service {
    //create components
    var Client client1 := Client.create;
    var Client client2 := Client.create;
    //map / connect components
    map(system:servicePort, client1:clientPort);
    map(system:servicePort, client2:clientPort);
    //start initiate behaviour of components
    client1.start(f_isReady());
    client2.start(f_isReady());
    //wait for components to complete their execution
    all component.done;
  }

//handle timeouts and incoming questions
altstep impatientYesMan() runs on Client {
  [] clientPort.receive(p_Question(?)) {
    clientPort.send(p_Answer("Yes!"))
    repeat;
  }
  [] patience.timeout {
    setverdict(fail);
  }
}

//reusable behaviour
//can be executed multiple times
function f_isReady() runs on Client {
  clientPort.send(p_Question("Ready?"));
  patience.start(10.0);
  activate(impatientYesMan());
  alt {
    [] clientPort.receive(p_Answer("Yes!")) {
      setverdict(pass);
    }
    [] clientPort.receive(p_Answer("No!")) {
      setverdict(fail);
    }
  }
  deactivate(impatientYesMan());
}
Mapping TDL to TTCN-3

- Establish a connection between TDL and TTCN-3
- Generation of executable tests from test descriptions
- Standardised, ensuring compatibility and consistency
- Re-use existing tools and frameworks for test execution
- Re-use existing TTCN-3 assets (data, behaviour)
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Mapping TDL to TTCN-3

- Challenges
  - different levels of abstraction
  - different perspectives
  - different assumptions
    - behaviour
    - configurations
    - data
    - time

Draft ETSI ES 203 119-6 V1.1.1 (2018-04)

Methods for Testing and Specification (MTS);
The Test Description Language (TDL);
Part 6: Mapping to TTCN-3
Mapping TDL to TTCN-3

- Levels of abstraction
  - TTCN-3
    - low - close to implementation
    - sufficient for automated execution
    - still abstracts away some details
  - TDL
    - high - test purposes (TO-extension)
    - medium - test design and description
    - low - some implementation details
    - focus on relevant parts at every level
Mapping TDL to TTCN-3

- Perspectives
  - TTCN-3
    - test-system centric (test system view)
    - test components
    - unified SUT interface (ports)
  - TDL
    - system centric (global view)
    - tester and SUT components (roles)
    - describes entire scenario
Mapping TDL to TTCN-3

- Assumptions: Data
  - TTCN-3
    - comprehensive type system
    - powerful template mechanism
    - extensive matching operators
  - TDL
    - mappable symbolic elements
    - types and instances
    - wildcards
    - limited direct data manipulation
    - nested arguments for data use
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Mapping TDL to TTCN-3

- **Mapping: Data Definition**
  - data mappings within TDL required
  - also for all members
  - substituted by respective targets
  - basic generation in case absent
  - charstrings, records, templates
  - functions for functions and actions
  - annotations override assumptions
  - also for variables and parameters
Mapping TDL to TTCN-3: Data definition

//data types
Type SESSIONS (id1 of type Integer, id2 of type Integer);
Type MSG (ses of type SESSIONS, content of type String);

//data instances
SESSIONS s1(id1 = 1, id2 = 2);
SESSIONS s2(id1 = 11, id2 = 22);
MSG msg1(ses = s1, content = m1);

//value data instances
SESSIONS c_s1(id1 = 1, id2 = 2) with {VALUE;};
MSG c1(ses = s1, content = c1) with {VALUE;};

Component Type ct having {
   //variables
   variable v1 of type MSG with {VALUE;};
   variable v2 of type MSG;
   gate g of type gt;
}

//data types
type record SESSIONS {
   integer id1,
   integer id2
}
type record MSG {
   SESSIONS ses,
   charstring content
}

//templates
template SESSIONS s1 := {id1:=1, id2:=2}
template SESSIONS s2 := {id1:=11, id2:=22}
template MSG msg1 := {ses := s1, content := "m1"}

c_s1 := {id1:=1, id2:=2}
c1 := {ses := c_s1, content := "c1"}

type component ct {
   //variables
   var MSG v1;
   var template MSG v2;
   port gt g;
}
Mapping TDL to TTCN-3

- **Mapping: Data Use**
  - treatment as values or templates
    - temporary templates
    - using valueOf
  - modification for arguments
    - inline for first level
    - iterative for nested arguments
  - special values
    - AnyValue -> ?
    - AnyValueOrOmit -> * (optional), ?
    - OmitValue -> omit
Mapping TDL to TTCN-3: Data use

Test Description \( \text{td} \) uses configuration \( \text{tc} \) {
  //one level arguments
  \( \text{tester.g} \) sends \( \text{msg1}(\text{ses} = \text{s2}) \) to \( \text{sut.g} \);

  //nested arguments
  \( \text{tester.g} \) sends \( \text{msg1}(\text{ses} = \text{s1}(\text{id1} = 111)) \) to \( \text{sut.g} \);

  //nested arguments with value
  \( \text{tester.g} \) sends \( \text{msg1}(\text{ses} = \text{c_s1}(\text{id1} = 111)) \) to \( \text{sut.g} \);
}

function \( \text{td_tester()} \) runs on \( \text{ct} \) {
  //one level arguments
  \( \text{g.send(modifies msg1 := \{ses := s2\}}) \);

  //nested arguments
  template \( \text{SESSIONS t_s1} \) modifies \( \text{s1 := \{id1:=111\}} \);
  \( \text{g.send(modifies msg1 := \{ses := t_s1\}}) \);

  //nested arguments with constants
  template \( \text{SESSIONS t_c_s1 := c_s1} \);
  template \( \text{SESSIONS t_c_s1_m} \) modifies \( \text{t_c_s1 := \{id1:=111\}} \);
  \( \text{g.send(modifies msg1 := \{ses := t_c_s1_m\}}) \);
Mapping TDL to TTCN-3

- Assumptions: Configurations
  - TTCN-3
    - dynamic instantiation / management
    - MTC, PTCs, system interface
    - mapping vs connecting ports
    - connection and mapping restrictions
  - TDL
    - static configuration defined upfront
    - holistic view, multiple SUTs
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Mapping TDL to TTCN-3

- **Mapping: Configurations**
  - port types for each gate type
  - infer unified system interface
  - types for MTC, system components
  - types for tester components
  - creating components
  - map and connect ports
  - respect restrictions in TTCN-3
  - some ports may need to be cloned
Mapping TDL to TTCN-3: Configurations

Gate Type defaultGT accepts
   ACK, PDU, PDCCH, C_RNTI, CONFIGURATION ;

Component Type defaultCT having {
   gate g of type defaultGT;
}

Test Configuration defaultTC {
   create Tester SS of type defaultCT;
   create SUT UE of type defaultCT ;
   connect UE.g to SS.g ;
}

type port defaultGT_to_map message {
   //this is a port type for SUT-Tester connections
   inout charstring, PDCCH /* ACK, PDU, C_RNTI, CONFIGURATION ; */
}

type port defaultGT_to_connect message {
   //this is a port type for Tester-Tester connections
   inout charstring, PDCCH /* ACK, PDU, C_RNTI, CONFIGURATION ; */
}

type component MTC_CT {
   //component type for MTC
   //variable for the PTC(s) --TESTER component(s) in TDL
   var defaultCT TESTER_SS;
}

type component defaultCT {
   port defaultGT_to_map g_to_map;
   port defaultGT_to_connect g_to_connect;
}

function defaultTC() runs on MTC_CT {
   // Test Configuration defaultTC, mappings, connections
   TESTER_SS := defaultCT.create;
   map (TESTER_SS:g_to_map, system:g_to_map);
}
Mapping TDL to TTCN-3

- Assumptions: Behaviour
  - TTCN-3
    - test system view
    - independent concurrent execution
    - explicit synchronisation
    - strictly local behaviours
  - TDL
    - global view
    - global or local ordering
    - implicit or explicit synchronisation
    - global combined behaviours
Mapping TDL to TTCN-3: Views

TTCN-3 view: behaviour defined for a **component and its ports**
Mapping TDL to TTCN-3: View

TDL view: behaviour defined for all components
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Mapping TDL to TTCN-3: Ordering

TTCN-3 assumption: order of sending msg1 and msg2 is undefined
Mapping TDL to TTCN-3: Ordering

TDL global ordering assumption: msg1 always occurs before msg2
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Mapping TDL to TTCN-3: Ordering

In an implementation a global scheduler shall keep everything in order.

GOD\*: Global Order Dispatcher

In an implementation a global scheduler shall keep everything in order.

GOD\*: Global Order Dispatcher
Mapping TDL to TTCN-3: Ordering

TDL local ordering assumption: order of msg1 and msg2 is undefined
Mapping TDL to TTCN-3: Ordering

TDL local ordering assumption: order can be specified explicitly
Mapping TDL to TTCN-3

- Mapping: Behaviour
  - capture tester perspective only
  - only locally ordered so far
  - functions for each component
  - combined behaviours
    - split for each participating component
  - interactions
    - split into test and/or receive
  - deviations from behaviour
    - altsteps activated as defaults
Mapping TDL to TTCN-3: Behaviour

Test Description Implementation TD_7_1_3_1
uses configuration defaultTC {

SS.g sends pdcch (c_rnti=ue) to UE.g;
SS.g sends mac_pdu to UE.g;
UE.g sends harq_ack to SS.g with {
     test objectives : TP1;
};

set verdict to PASS;
SS.g sends pdcch (c_rnti=unknown) to UE.g;
SS.g sends mac_pdu to UE.g;

alternatively {
     UE.g sends harq_ack to SS.g;
     set verdict to FAIL;
} or {
     gate SS.g is quiet for five;
     set verdict to PASS;
} with {
     test objectives : TP2;
}
}

altstep to_handle_deviations_from_TDL_description_AS () {
    [] any port.receive {
        setverdict(fail);
        mtc.stop;
    }
    //if nothing happens, a timer shall be started
    //before every receive instruction
    //and the timer must be here
    //or we can leave the timeout for
    //the execute instruction called with the optional
    //timer parameter - but in this case
    //the final verdict will be 'error'
}

altstep quiescence_handler_AS (timer quiescence) {
    //for all quiescence that is not connected to a gate
    [] any port.receive{
        setverdict(fail);
        mtc.stop;
    }
    [] quiescence.timeout {
        setverdict(pass);
    }
}

Mapping TDL to TTCN-3: Behaviour

Test Description Implementation TD_7_1_3_1 uses configuration defaultCT {

    SS.g sends pdcch (c_rnti=ue) to UE.g;
    SS.g sends mac_pdu to UE.g;
    UE.g sends harq_ack to SS.g with {
        test objectives : TP1 ;
    };

    set verdict to PASS ;
    SS.g sends pdcch (c_rnti=unknown) to UE.g;
    SS.g sends mac_pdu to UE.g;

    alternatively {
        UE.g sends harq_ack to SS.g ;
        set verdict to FAIL ;
    } or {
        gate SS.g is quiet for five ;
        set verdict to PASS ;
    } with {
        test objectives : TP2 ;
    }
}

function behaviourOfTESTER_SS() runs on defaultCT {

    timer quiescence;

    activate(to_handle_deviations_from_TDL_description_AS());
    g_to_map.send(modifies pdcch := {c_rnti := ue})
    g_to_map.send(mac_pdu);
    g_to_map.receive(harq_ack);
    setverdict(pass);
    /*Test Objective Satisfied:  TP2 */

    g_to_map.send(modifies pdcch := {c_rnti := unknown});
    g_to_map.send(mac_pdu);

    quiescence.start(five);
    alt{
        [] g_to_map.receive(harq_ack){
            setverdict(fail);
        }
        [] quiescence_handler_AS(quiescence);
        /*Test Objective Satisfied:  TP2 */
    }
}
Mapping TDL to TTCN-3: Behaviour

Test Description Implementation TD_7_1_3_1

uses configuration defaultTC {

    SS.g sends pdcch (c_rnti=ue) to UE.g;
    SS.g sends mac_pdu to UE.g;
    UE.g sends harq_ack to SS.g with {
        test objectives : TP1;
    };
    set verdict to PASS;
    SS.g sends pdcch (c_rnti=unknown) to UE.g;
    SS.g sends mac_pdu to UE.g;

    alternatively {
        UE.g sends harq_ack to SS.g;
        set verdict to FAIL;
    } or {
        gate SS.g is quiet for five;
        set verdict to PASS;
    } with {
        test objectives : TP2;
    }
}

testcase TD_7_1_3_1() runs on MTC_CT

    system defaultCT
    {
        activate(to_handle_deviations_from_TDL_description_AS());
        defaultTC();
        TESTER_SS.start(behaviourOfTESTER_SS());
        all component.done;
    }
Mapping TDL to TTCN-3

- Assumptions: Time
  - TTCN-3
    - timers and timer operations
    - realtime extension
  - TDL
    - timers and timer operations
    - time operations (wait, quiescence)
    - time labels and time constraints
Mapping TDL to TTCN-3

[Diagram showing a sequence diagram with nodes labeled Tester, SUT, W, Q, and TimerR, connected by messages msg1, msg2, and msg3, and timers labeled with 2.5s and conditions such as @T_sent, @T_received, and [@T_received < T_sent + 3].]
Mapping TDL to TTCN-3

- **Mapping: Time**
  - all concepts expressed by timers
  - local time keeping per component
  - time constraints challenging
Mapping TDL to TTCN-3: Time

function behaviourOfTESTER_tc1() runs on ct {
    timeKeeper.start(forever)
    g.send(msg1);
    //Time label
    var float T_sent := timeKeeper.read;
    g.receive(msg2);
    var float T_received := timeKeeper.read;
    //Time constraint
    if (T_received > T_sent + 3) {
        setverdict(fail);
        mtc.stop;
    }
    //...
}
Mapping TDL to TTCN-3: Time

function behaviourOfTESTER_tc1() runs on ct {
    //...

    //Wait
    timer T1_wait_1;
    var default wh := activate(Wait_handler_AS());
    T1_wait_1.start(2.5);
    T1_wait_1.timeout;
    deactivate(wh);

    g.send(msg3);

    //Quiescence
    timer T1_quiescence_1;
    T1_quiescence_1.start(2.5);
    alt {
        [\] T1_quiescence_1.timeout {setverdict (pass);}
        [\] any port.check(receive) {setverdict (fail);}
    }
}

altstep Wait_handler_AS() {
    //for suppressing handling of unexpected behaviour
    [\] any port.check(receive) {repeat;}
}
Mapping TDL to TTCN-3

- Everything else
  - packages -> modules
  - element imports -> imports
  - annotations ->
    - comments
    - special instructions
    - code (TTCN3Code)
  - test objectives -> comments
  - comments -> comments
Concluding remarks

- New technology, growing rapidly
- Open-source project for essential tool support
  - lower barrier to entry, accelerate adoption
  - commercial tool support not yet available
- Custom tools can be put together in a matter of hours
  - basic yet capable
  - make early adoption easier
- Advanced solutions still require additional effort
  - not immediately necessary to get started with using TDL
Concluding remarks

- Mapping may seem straightforward at first
  - but things can get very complicated the closer one looks
  - both languages have evolved to become rather complex

- Identify assumptions and semantic gaps
  - some restrictions may not be immediately obvious
  - some concepts may not be mappable at all in a useful way
  - adaptations to both languages can make mappings easier
  - some assumptions may need to be challenged

- A standardised mapping defines baseline expectations
  - tool- and user-specific can be optionally applied on top
Concluding remarks

- ES 203 119-6 currently being finalised
  - further refinements and examples
  - locally ordered test descriptions only
  - some mapping-related restrictions
  - ready for approval: January 2018
  - publishing date: April 2018
- Prototypical implementation for validation
  - high-level model-to-model transformation
  - available under the TDL open source project: March 2018
Summary

What is TDL?
- Test Description Language
  - Design, documentation, and representation of formalised test descriptions
  - Scenario-based approach
  - Standardised at ETSI by TC MTS
    - STF 454 (2013)
    - STF 476 (2014)
    - STF 492 (2015-2016)
    - STF 522 (2017)

What is TTCN-3?
- Testing and Test Control Notation
  - Specification and implementation of all kinds of black-box tests
  - Platform independent link between modelling and execution
  - Component-based approach

Mapping TDL to TTCN-3
- Establish a connection between TDL and TTCN-3
  - generation of executable tests from test descriptions
  - standardised, ensuring compatibility and consistency
  - re-use existing tools and frameworks for test execution
  - re-use existing TTCN-3 assets (data, behaviour)

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What would you want to see in TDL?

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From TDL to TTCN-3: A Step By Step Tutorial

Philip Makedonski, Gusztav Adamis, Martti Käärik, Finn Kristoffersen, Gyorgy Rethy