



## Q12/17

### Formal languages for telecommunication software and testing

## Tutorial

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## Motivation

- SG17 addresses confidence and security in the use of information and communication technologies (ICTs)
- Sound engineering practice, founded on formal languages and effective testing is essential to
  - ◆ Provide robust reliable ICT
  - ◆ Prevent vulnerability to failure or attack
- Q12 concerns formal languages for telecommunication software and testing

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## Recommendations

### URN

Z.150,  
Z.151



Z.100, Z.101,  
Z.102, Z.103,  
Z.104, Z.105,  
Z.106, Z.107,  
Z.109



Z.161,  
Z.161.1, Z.161.2,  
Z.161.3, Z.161.4,  
Z.161.5, Z.162, Z.163,  
Z.164, Z.165, Z.165.1,  
Z.166, Z.167, Z.168,  
Z.169, Z.170

Z.110, Z.111,  
Z.119, Z.450,  
Z.500, Z. Sup1

guidance on use and application of the languages

### CHILL

Z.200

### MSC

Z.120,  
Z.121

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## About the Recommendations

- A variety of formal languages
- Guidance on use and application
- Widely used in telecommunications system design and testing
- Supported by commercial tools
- Can be applied collectively or individually
- For specification of standards as well as for realization of products
- Used in industry and by ITU-T

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## Questions

- What maintenance of definitions of existing ITU system design languages adapted to further contemporary user requirements and emerging new architectures and frameworks are needed?
- What new languages are needed for further contemporary user requirements and emerging new architectures and frameworks (such as the Internet of Things) taking into account Recommendation ITU-T Z.110?

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## Tasks

- Maintain Recommendations under responsibility of this Question;
- Provide general advice to users of the language(s), methodology(y/ies), framework(s) for the language(s) covered by the Question study;
- Promote the use of the methodologies, frameworks and languages covered by the Question study within other study groups and external SDOs.

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## Relationships

- X.680/X.690 series (ASN.1);
- ETSI (TC MTS);
- OMG, SDL Forum Society.

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## URN

### User Requirements Notation

- Recommendations Z.150 and Z.151
- URN is the **first** and **currently only** standard which explicitly addresses goals (non-functional requirements) in addition to scenarios (functional requirements) in a **graphical** way in one unified language
- Support for the elicitation, analysis, specification, and validation of requirements

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## URN Background

1990s  
Uni. of  
Ottawa, Uni.  
of Toronto,  
Carleton  
Uni., Nortel,  
Mitel

Use Case Maps, NFR  
Framework, i\*, GRL

2003  
ITU

Z.150

2008  
ITU

Z.151 v1

2012 / 2016  
ITU

Z.151 v2 and v3

Z.150: User Requirements Notation (URN) – Language requirements and framework  
Z.151: User requirements notation (URN) - Language definition

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## URN

### Two Complementary Notations

- Goal-oriented Requirement Language (GRL)
  - ◆ Goal-based modeling
  - ◆ GRL captures stakeholders' business goals, alternative solutions, decisions, and rationales
  - ◆ Solutions in GRL are linked with more detailed models described as scenarios in UCM
- Use Case Maps (UCM)
  - ◆ Workflow/scenario-based modeling
  - ◆ UCM represent visually use cases in terms of causal responsibilities

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## Future of URN

- Support for the definition and analysis of changes to goal-oriented and scenario-oriented requirements over time (e.g., to assess qualities such as sustainability over the lifespan of a project)
- Support for the reuse of goal-oriented and scenario-oriented requirements

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- Recommendation Z.100
- Specification, design, development of real time systems
- In particular, telecommunications systems
- Graphical presentation form
- Formal semantics
- Tool support

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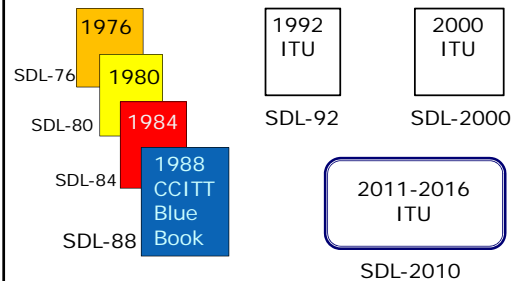
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What makes SDL-2010 different:

- broad spectrum language for state machine models, for use from requirements capture, through detailed design to implementation
- there is no issue of a language paradigm shift when going from an abstract specification to an implementation

## Specification and Description Language History



## SDL present and future

- Ongoing revisions to meet emerging demands
- IoT presents new challenges and opportunities
- SDL provides an ideal basis for developing robust reliable smart things
- plan for further work to be determined at start of next Study Period

## TTCN-3 Testing and Test Control Notation Version 3

- Internationally standardized testing language
  - ◆ Originated at ETSI TC MTS (Methods for Testing and Specification)
- A programming language that has been used for more than 15 years in standardization as well as industry
  - ◆ Specifically designed for black box testing and certification
  - ◆ Constantly developed and maintained at ETSI by a team of leading testing experts from industry, institutes, and academia
- A testing technology that applies to a variety of application domains and types of testing
  - ◆ Knowledge of TTCN-3 is valuable due to its wide applicability
  - ◆ Offers potential for reducing training and test maintenance costs significantly
  - ◆ Proven to work in very large and complex industrial tests, e.g., 3G network elements
  - ◆ Courses, tools, training material, certified TTCN-3 expert

## The TTCN-3 Recommendations

- Z.161: TTCN-3 Core Language
- Z.162: TTCN-3 Tabular Presentation Format (TFT)
- Z.163: TTCN-3 Graphical Presentation Format (GFT)
- Z.164: TTCN-3 Operational Semantics
- Z.165: TTCN-3 Runtime Interface (TRI)
- Z.166: TTCN-3 Control Interfaces (TCI)
- Z.167 and onwards: Using ASN.1, XML, IDL, C/C++ with TTCN-3, documentation comment specification
- + extensions

see also [www.ttcn-3.org](http://www.ttcn-3.org)

Tutorial: <http://www.ttcn-3.org/media/media/images/mime-icon-32/pdf.png>

figures taken from the TTCN-3 Tutorial

## What makes TTCN-3 different ...

From conventional programming or scripting languages?

- Rich type system including native list types and support for subtyping
- Embodies powerful build-in matching mechanism
- Snapshot semantics, i.e., well defined handling of port and timeout queues during their access
- Concept of verdicts and a verdict resolution mechanism
- Support for specification of concurrent test behaviour
- Support for timers
- Allows test configuration at run-time
- Tests focus only on implementation to be tested

## What makes TTCN-3 different ...

From a test tool or vendor proprietary testing language?

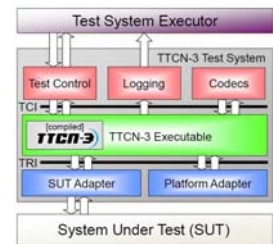
- Not tied to a particular application or its interface(s)
- Not tied to any specific test execution environment, compiler or operation system
- TTCN-3 as such is not executable and requires a compiler/interpreter, adapter as well as codec implementations

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## TTCN-3 test systems in a nutshell

- TTCN-3 specifies a test but a test system is needed for test execution
- TRI and TCI standards define test system architecture
  - ◆ TTCN-3 tools are *required* to support internal interfaces
  - ◆ Allows reuse of test platforms with different tools but also for different SUTs
- A test system requires
  - ◆ A TTCN-3 tool = TTCN-3 compiler and execution environment
  - ◆ A test platform for a specific device under test
- Note: Tools come with default Test Control & Logging



TCI = TTCN-3 Control Interface  
TRI = TTCN-3 Runtime Interface

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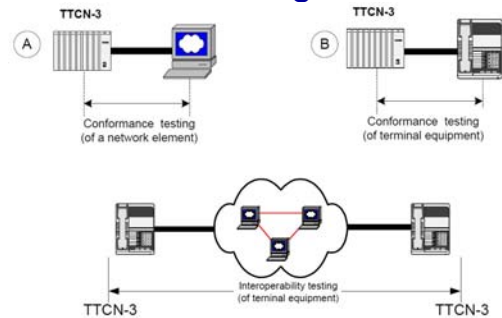
## TTCN-3 Success stories

- TTCN-3 has been used to deploy [SIP](#), [WIMAX](#), and [DSRC](#) test systems.
- a complete and generic [IPv6](#) test suite has been standardized with TTCN-3 for use in 3GPP and other applications
- the tests for the [IETF Diameter](#) protocol is specified in TTCN-3
- the [Open Mobile Alliance](#) adopted a strategy of using TTCN-3 for translating some of the test cases in an enabler test specification into an executable representation
- the [AUTOSAR](#) project promoted the use of TTCN-3 within the automotive industry
- the [3GPP](#) project uses TTCN-3 within the mobile industry, e.g. tests for most of the [IMS](#) interfaces are standardized with TTCN-3
- TTCN-3 is the basis for [handset certification](#)
- TTCN-3 is being used by [ETSI](#) for [smart M2M](#) and considered for the [oneM2M](#) project
- TTCN-3 is being used for [ETSI ITS \(Cooperative Mobile System\)](#)

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## TTCN-3 can automate Conformance and Interoperability Testing



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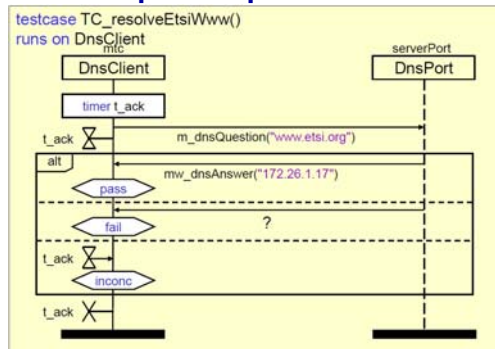
## Example Core (Text) Format

```
testcase TC_resolveEtsiWww() runs on DnsClient
{
  timer t_ack;
  serverPort.send(m_dnsQuestion("www.etsi.org"));
  t_ack.start(1.0);
  alt {
    [] serverPort.receive(mw_dnsAnswer("172.26.1.17")) {
      setverdict(pass);
    }
    [] serverPort.receive { // any other message
      setverdict(fail);
    }
    [] t_ack.timeout {
      setverdict(inconc);
    }
  }
  t_ack.stop;
}
```

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## Example Graphical Format



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### Future of TTCN-3

- Constantly new version of the different parts of the standard are being developed
- ~ new version every 1-3 years per part
- Enhancements are based on change requests from users, systematically managed by the MANTIS system at ETSI

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### Future of Q12/17

- New question text for Study Period 2017-2020 consented in 3/2016
- Draft Question L/17 (TD 2362rev4)
- URN – new features, definition of changes, reuse
- SDL – possibly SDL-2020 to support IoT – decision next Study Period
- New versions of TTCN-3 on the basis of change requests by users
- Maintenance of MSC (Z.120) and CHILL (Z.200)

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**Thank you!**

**Q&A?**

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