

AN INTRODUCTION TO TTCN-3

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TestingStage, Kiev, April 14, 2018



BERLIN CENTER FOR DIGITAL TRANSFORMATION

Digital Transformation from A to Z



AGENDA

- Introduction
- Language concepts
- Application domains
- Summary and outlook

INTRODUCTION

TESTING TODAY

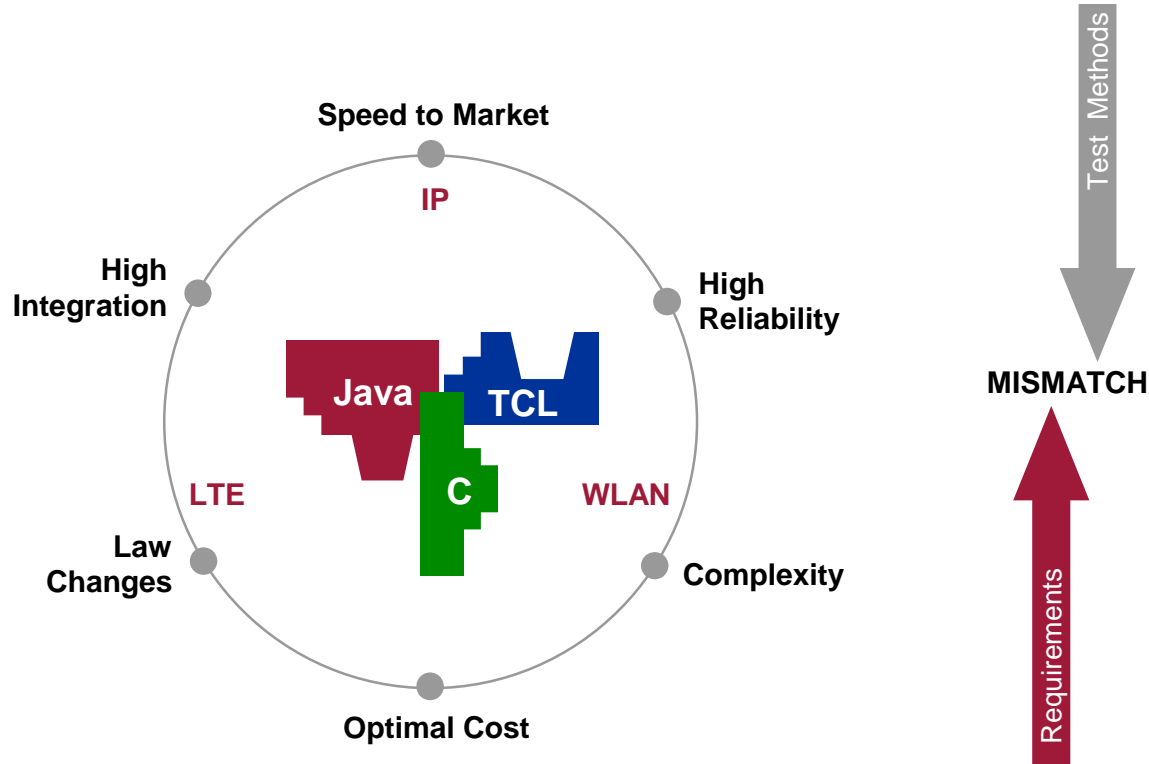
Is

- Important for QA
- Expensive (costs!)
- Time critical

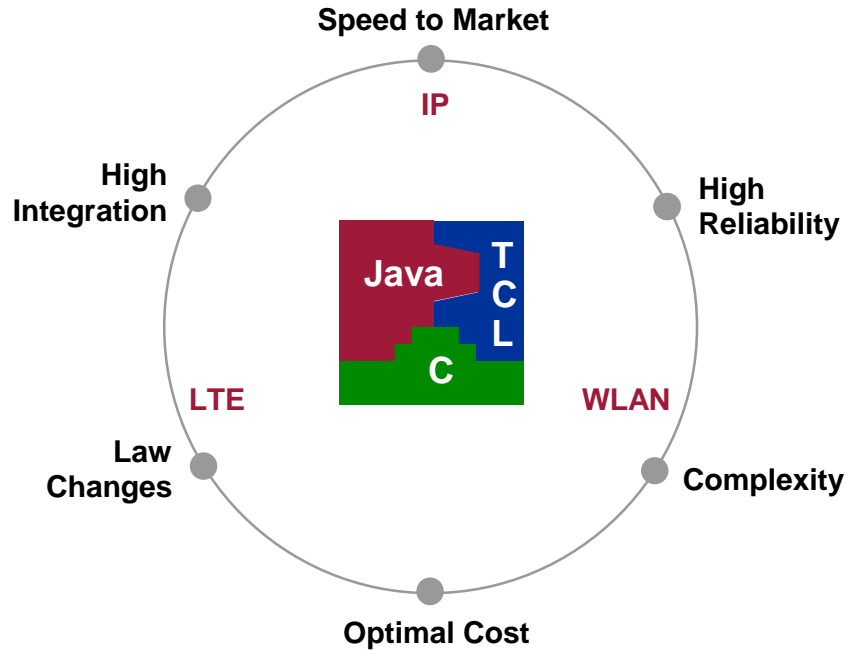
But

- Only rarely practiced
- Unsystematic
- Performed by hand
- Error-prone
- Uncool (*„If you are a bad programmer you might be a tester.“*)
- Destructive

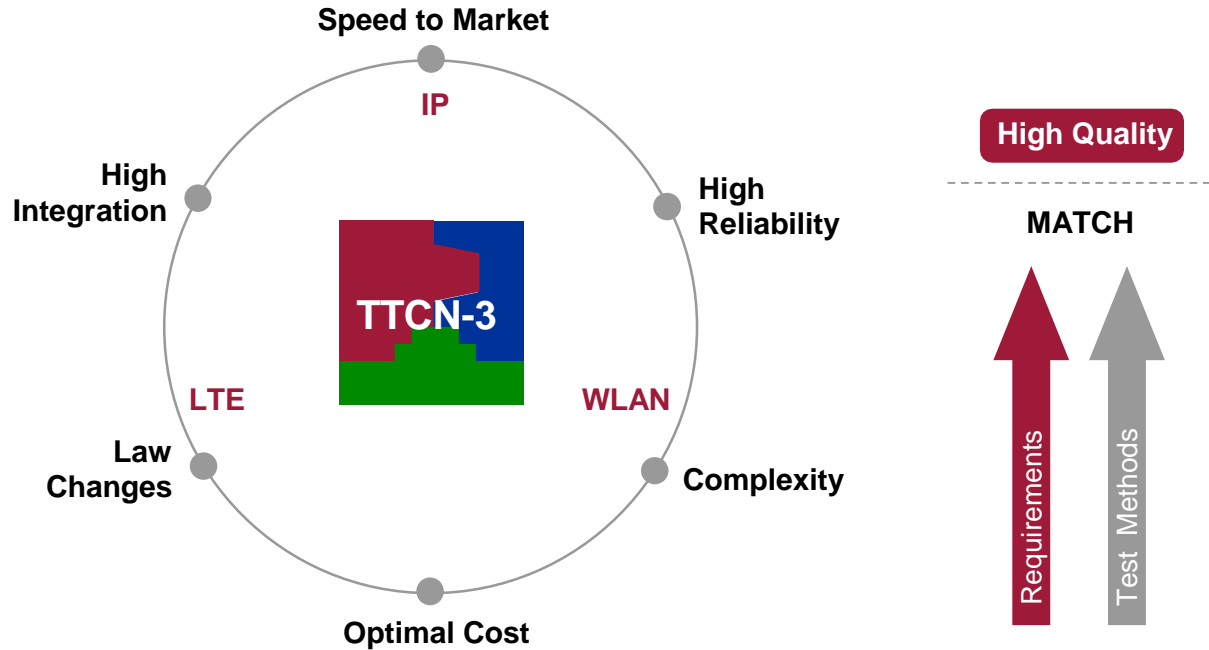
WHY USING TTCN-3



WHY USING TTCN-3



WHY USING TTCN-3



THE INTERNATIONAL TEST LANGUAGE

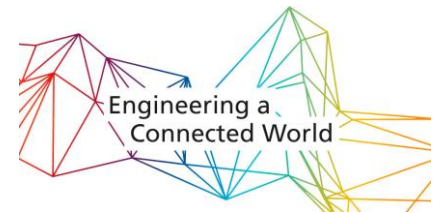
Did you know that **YOUR PHONE...**

...has been
tested using



specifications
written in
TCN-3 ?

What do we use?



CHALLENGE TEST AUTOMATION

- TTCN-3 is the **Testing and Test Control Notation**
- **Internationally standardized** testing language for formally defining test scenarios.
- Designed **purely for testing**



TESTING OF COMMUNICATION SCENARIOS



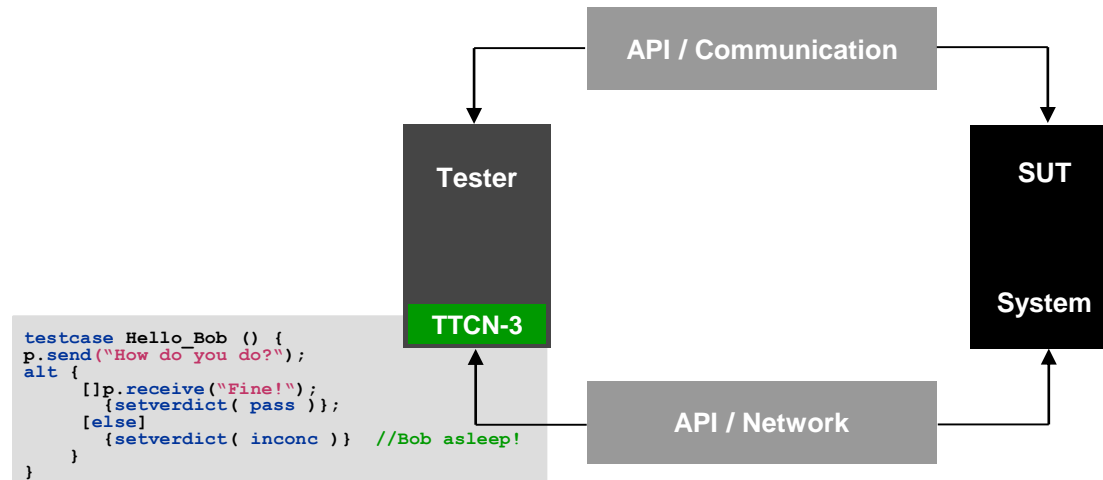
TESTING OF COMMUNICATION SCENARIOS



```
testcase Hello_Bob () {  
    p.send("How do you do?");  
    alt {  
        [p.receive("Fine!");  
            {setverdict( pass )};  
        [else]  
            {setverdict( inconc )} //Bob asleep!  
    }  
}
```

TESTING AND TEST CONTROL NOTATION (TTCN-3)

- **Distributed testing**
- **Automatic** execution (TTCN-3 -> Java/C++) and logging
- Import and use of **external data types** (ASN.1, IDL, XML, JSON)



DESIGN PRINCIPLES OF TTCN-3

- **One test technology for different tests**

- Distributed, platform-independent testing
- Integrated graphical test development, documentation and analysis
- Adaptable, open test environment



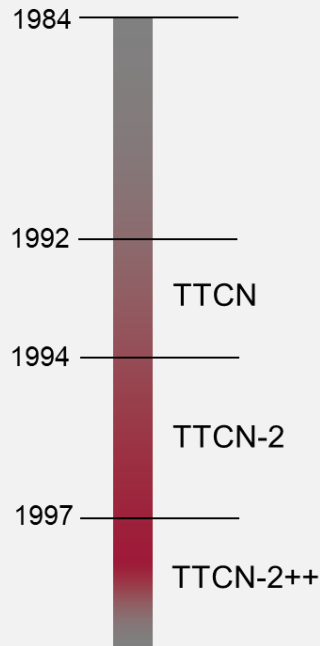
- **Areas of Testing**

- *Conformance and functional* testing
- *Interoperability and integration* testing
- *Real-time, performance, load and stress* testing
- *Security* testing
- *Regression* testing



- Used for *system and product qualification and certification* (e.g. **handset** certification)

TTCN-3 HISTORY



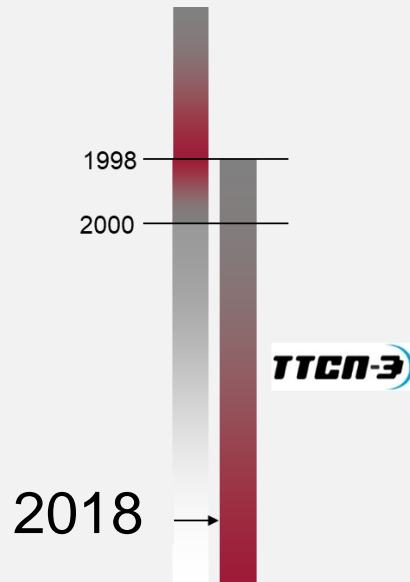
TTCN (1992)

- published as ISO standard
- **Tree and Tabular Combined Notation**
- used for protocol tests:
GSM, N-ISDN, B-ISDN

TTCN-2/2++ (1997)

- enhancements by ETSI MTS
- module concept, concurrency
- used for conformance tests

TTCN-3 HISTORY (CONT.)



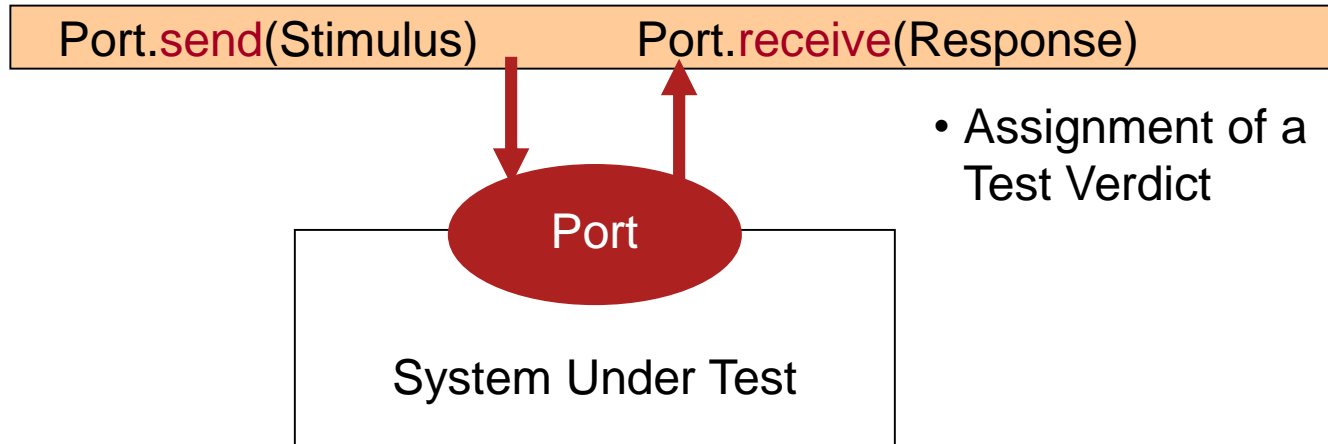
TTCN-3 (2000)

- Further development by ETSI MTS
- **Testing and Test Control Notation**
- Standardised test specifications:
 - SIP, SCTP, M3UA, IPv6
 - HiperLan, HiperAccess, WiMAX
 - 3GPP **UMTS, LTE, NB-IoT, 5G**
 - OMA
 - TETRA
 - MOST, AUTOSAR
 - EUROCONTROL
 - **oneM2M**

LANGUAGE CONCEPTS

TTCN-3 IS DESIGNED FOR DYNAMIC TESTING

TTCN-3 Test Case



- Assignment of a Test Verdict

MAJOR LANGUAGE ELEMENTS OF TTCN-3 NOTATION

module definitions	
Imports	Importing definitions from other modules defined in TTCN-3 or other languages
Data Types	User defined data types (messages, PDUs, information elements, ...)
Test Data	Test data transmitted/expected during test execution (templates, values)
Test Configuration	Definition of the test components and communication ports
Test Behavior	Specification of the dynamic test behavior

IMPLEMENTATION

Type definitions: boolean, integer, float, bitstring, charstring, octectstring, hexstring, record, set, enumeration, union

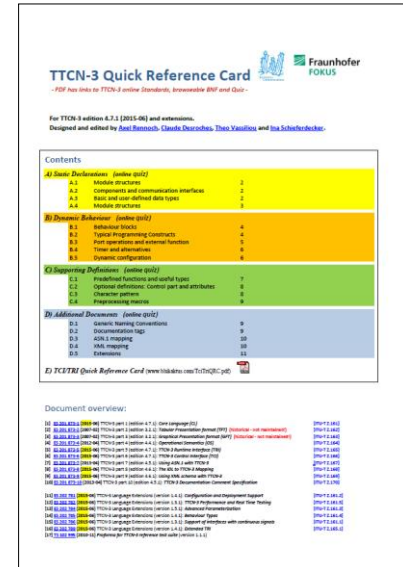
Programming constructs:


- *message*: send/receive
- *procedure*: call/getcall, reply/getreply, raise/catch
- if-then-else, loops: for, while, do-while, functions, alternatives
- component/port/timer control

Predefined functions:

type conversion, lengthof (string), sizeof (records), ...

Overview: e.g. TTCN-3 Quick Reference Card



TTCN-3 Quick Reference Card 

For TTCN-3 edition 4.2.1 (2015-06) and extensions.
Designed and edited by [Josef Roth](#), [Claudia Dierkes](#), [Thies Vautz](#) and [Iris Schuberth](#).

Contents

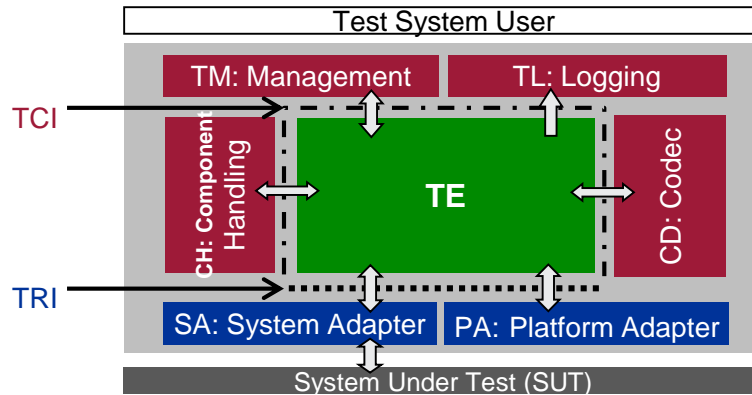
A) Basic Declarations (index.pdf)	
A.1	Module structures
A.2	Constants and communication interfaces
A.3	Basic and user-defined data types
A.4	Module structure
B) Dynamic Behaviour (index.pdf)	
B.1	Behaviour blocks
B.2	Typed Programming Constructs
B.3	Port operators and external functions
B.4	Timeout and alternatives
B.5	System configuration
C) Supporting Definitions (index.pdf)	
C.1	Predefined functions and useful types
C.2	Operator definitions, control part and attributes
C.3	Character patterns
C.4	Stringing syntax
D) Additional Discussions (index.pdf)	
D.1	Generic Naming Conventions
D.2	Documentation tags
D.3	ASN.1 mapping
D.4	XML mapping
D.5	Extensions

D) FC2871 Quick Reference Card (www.ttcn3.com/Tools/FC2871.pdf)

Document overview:

FC_00_01_01_0001	FC2871 part 1 (index 4.1) (one language)	FC2871-001
FC_00_01_01_0002	FC2871 part 2 (index 4.2) (one language)	FC2871-002
FC_00_01_01_0003	FC2871 part 3 (index 4.3) (one language)	FC2871-003
FC_00_01_01_0004	FC2871 part 4 (index 4.4) (one language)	FC2871-004
FC_00_01_01_0005	FC2871 part 5 (index 4.5) (one language)	FC2871-005
FC_00_01_01_0006	FC2871 part 6 (index 4.6) (one language)	FC2871-006
FC_00_01_01_0007	FC2871 part 7 (index 4.7) (one language)	FC2871-007
FC_00_01_01_0008	FC2871 part 8 (index 4.8) (one language)	FC2871-008
FC_00_01_01_0009	FC2871 part 9 (index 4.9) (one language)	FC2871-009
FC_00_01_01_0010	FC2871 part 10 (index 4.10) (one language)	FC2871-010
FC_00_01_01_0011	FC2871 part 11 (index 4.11) (one language)	FC2871-011
FC_00_01_01_0012	FC2871 part 12 (index 4.12) (one language)	FC2871-012
FC_00_01_01_0013	FC2871 part 13 (index 4.13) (one language)	FC2871-013
FC_00_01_01_0014	FC2871 part 14 (index 4.14) (one language)	FC2871-014
FC_00_01_01_0015	FC2871 part 15 (index 4.15) (one language)	FC2871-015
FC_00_01_01_0016	FC2871 part 16 (index 4.16) (one language)	FC2871-016
FC_00_01_01_0017	FC2871 part 17 (index 4.17) (one language)	FC2871-017
FC_00_01_01_0018	FC2871 part 18 (index 4.18) (one language)	FC2871-018
FC_00_01_01_0019	FC2871 part 19 (index 4.19) (one language)	FC2871-019
FC_00_01_01_0020	FC2871 part 20 (index 4.20) (one language)	FC2871-020
FC_00_01_01_0021	FC2871 part 21 (index 4.21) (one language)	FC2871-021
FC_00_01_01_0022	FC2871 part 22 (index 4.22) (one language)	FC2871-022
FC_00_01_01_0023	FC2871 part 23 (index 4.23) (one language)	FC2871-023
FC_00_01_01_0024	FC2871 part 24 (index 4.24) (one language)	FC2871-024
FC_00_01_01_0025	FC2871 part 25 (index 4.25) (one language)	FC2871-025
FC_00_01_01_0026	FC2871 part 26 (index 4.26) (one language)	FC2871-026
FC_00_01_01_0027	FC2871 part 27 (index 4.27) (one language)	FC2871-027
FC_00_01_01_0028	FC2871 part 28 (index 4.28) (one language)	FC2871-028
FC_00_01_01_0029	FC2871 part 29 (index 4.29) (one language)	FC2871-029
FC_00_01_01_0030	FC2871 part 30 (index 4.30) (one language)	FC2871-030
FC_00_01_01_0031	FC2871 part 31 (index 4.31) (one language)	FC2871-031
FC_00_01_01_0032	FC2871 part 32 (index 4.32) (one language)	FC2871-032
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FC_00_01_01_0055	FC2871 part 55 (index 4.55) (one language)	FC2871-055
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FC_00_01_01_0063	FC2871 part 63 (index 4.63) (one language)	FC2871-063
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FC_00_01_01_0065	FC2871 part 65 (index 4.65) (one language)	FC2871-065
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FC_00_01_01_0069	FC2871 part 69 (index 4.69) (one language)	FC2871-069
FC_00_01_01_0070	FC2871 part 70 (index 4.70) (one language)	FC2871-070
FC_00_01_01_0071	FC2871 part 71 (index 4.71) (one language)	FC2871-071
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FC_00_01_01_0074	FC2871 part 74 (index 4.74) (one language)	FC2871-074
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FC_00_01_01_0076	FC2871 part 76 (index 4.76) (one language)	FC2871-076
FC_00_01_01_0077	FC2871 part 77 (index 4.77) (one language)	FC2871-077
FC_00_01_01_0078	FC2871 part 78 (index 4.78) (one language)	FC2871-078
FC_00_01_01_0079	FC2871 part 79 (index 4.79) (one language)	FC2871-079
FC_00_01_01_0080	FC2871 part 80 (index 4.80) (one language)	FC2871-080
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FC_00_01_01_0085	FC2871 part 85 (index 4.85) (one language)	FC2871-085
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FC_00_01_01_0097	FC2871 part 97 (index 4.97) (one language)	FC2871-097
FC_00_01_01_0098	FC2871 part 98 (index 4.98) (one language)	FC2871-098
FC_00_01_01_0099	FC2871 part 99 (index 4.99) (one language)	FC2871-099
FC_00_01_01_0100	FC2871 part 100 (index 4.100) (one language)	FC2871-100

A TTCN-3 TEST SYSTEM



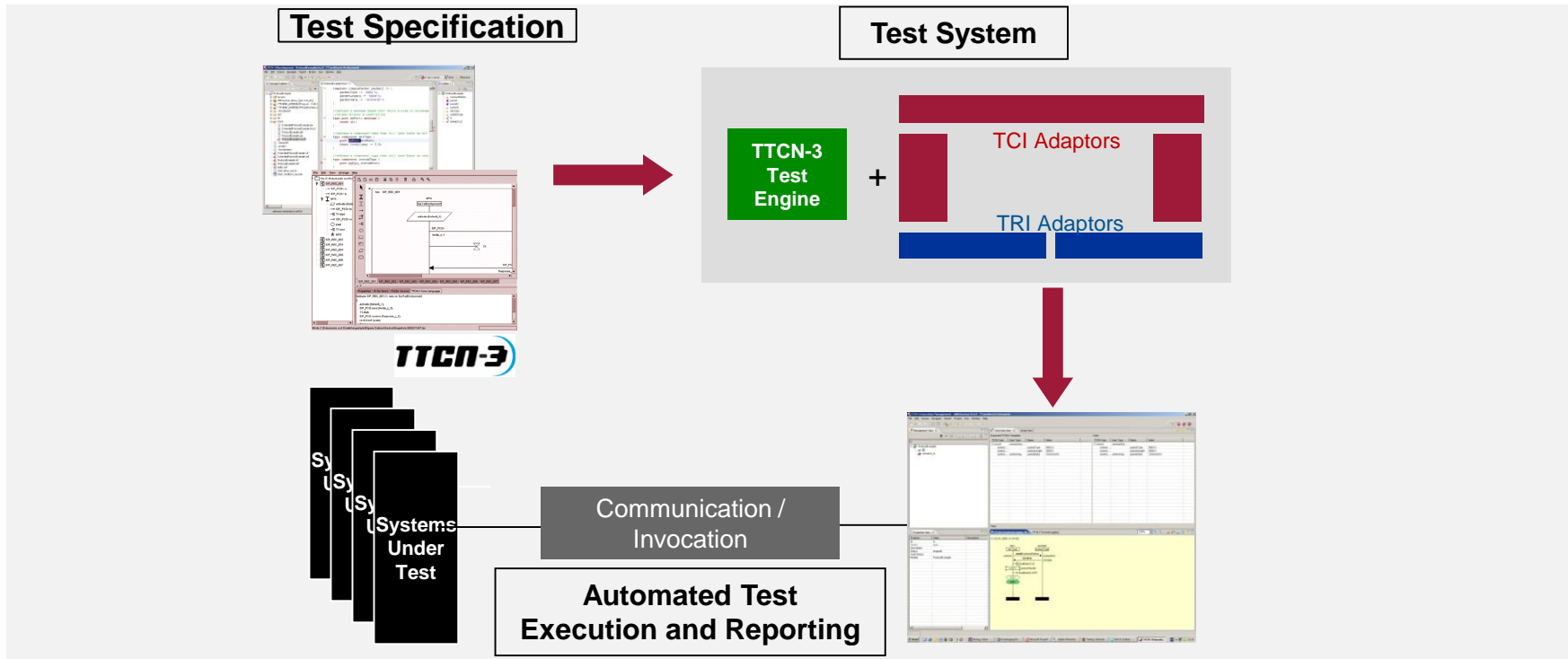
- TE – TTCN-3 Executable
- TM – Test Management
- TL – Test Logging
- CD – Codec
- CH – Component Handling
- SA – System Adapter
- PA – Platform Adapter
- SUT – System Under Test

ETSI ES 201 873-1 TTCN-3 Core Language (CL)

ETSI ES 201 873-5 TTCN-3 Runtime Interface (TRI)

ETSI ES 201 873-6 TTCN-3 Control Interfaces (TCI)

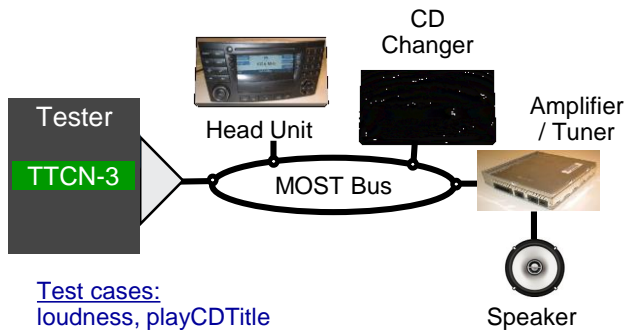
IMPLEMENTATION



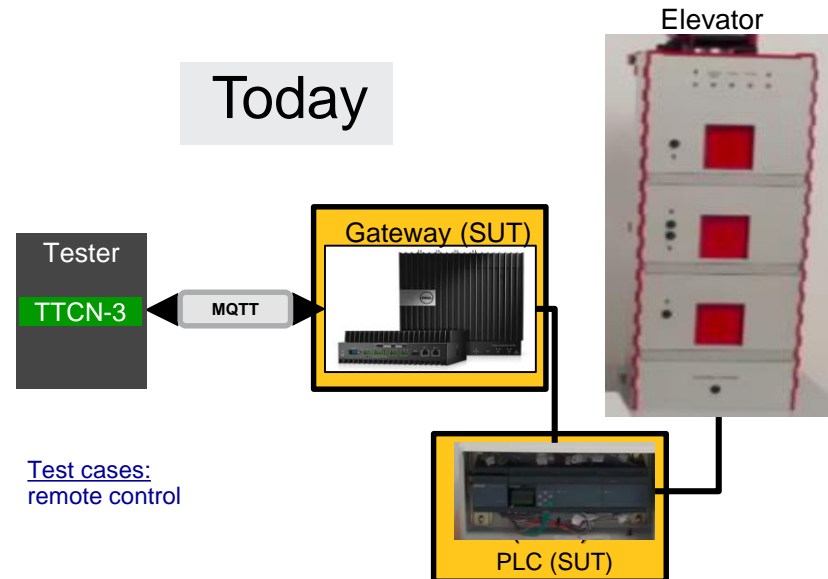
TTCN-3 FOR MULTIPLE PURPOSES

- Test technology address **various protocols** and **interfaces**
- Control of *real* and/or *virtual devices*
(special hardware-interfaces, simulators)

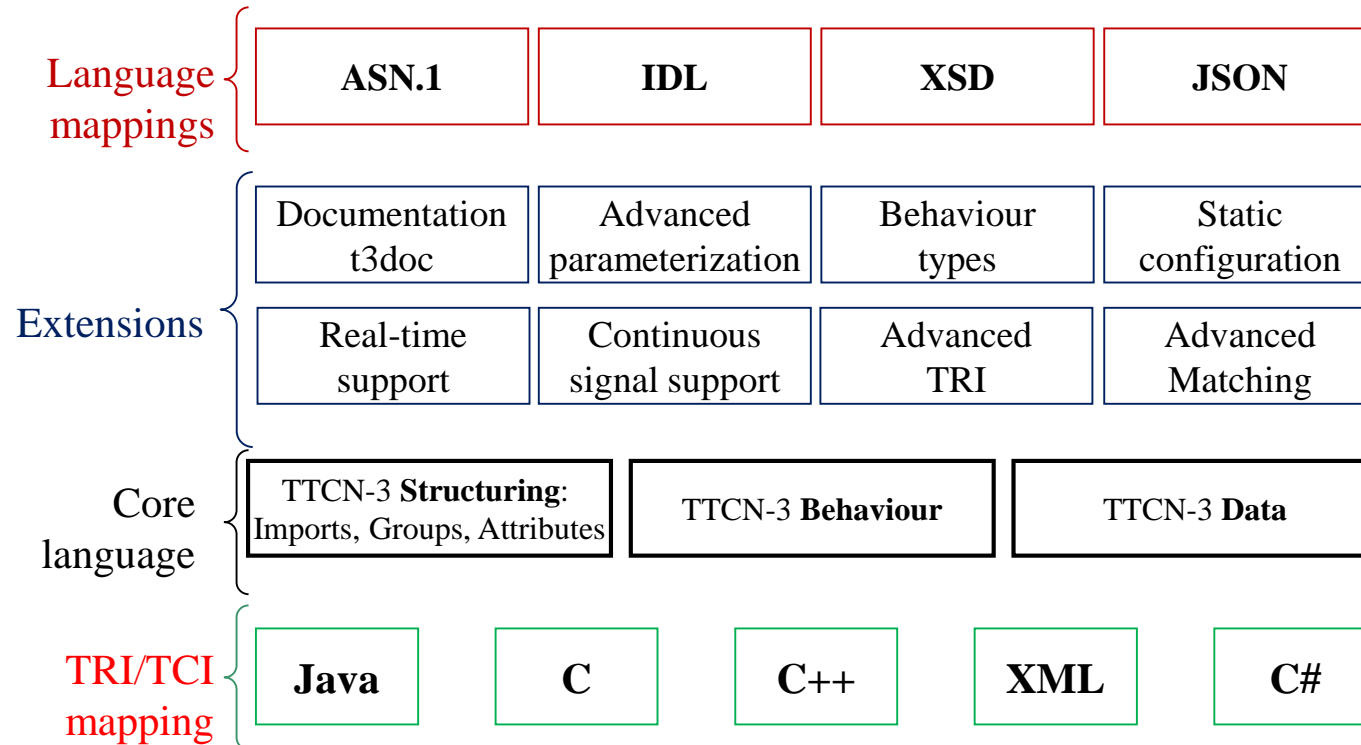
Earlier days



Today



TTCN-3 STANDARDS OVERVIEW



COMMERCIAL TTCN-3 TOOLS (SOURCE: WWW.TTCN-3.ORG)

TTCN-3 Compilers and Interpreters

- [Exhaustif/TTCN](#): compiler (C++) produced by [Métodos y Tecnología \(MTP\)](#), Spain.
- [OpenTTCN](#): interpreter (C, Java, C# interfaces) produced by [OpenTTCN Ltd](#), Finland.
- [MessageMagic](#): compiler (C/C++, Java, C#) produced by [ELVIOR](#), Estonia.
- [Real Time Developer Studio](#): modelling tool including TTCN-3 compiler by [PragmaDev](#), France.
- [TAU Tester](#): compiler (C) by [IBM](#).
- [TTCN-3 toolbox](#): compiler (C) by [Devoteam](#), Germany.
- [TTCN-3 Express](#): compiler (C#) by [Fraunhofer FIRST](#) and [Metarga GmbH](#), Germany.
- [TTworkbench](#): compiler (C, Java) by [Spirent](#), USA/Germany.

TTCN-3 Generators

- [Qtronic](#) by [Conformiq OY](#), Finland. generate complete TTCN-3 test suites from e.g., UML, Java, or C# models.
- [MaTeLo](#) by [All4Tec](#), France (TTCN-3 test suites from usage models specified using Markov chains).
- [MOTES](#) by [ELVIOR](#), Estonia (from the state model of the SUT)

OPEN SOURCE TTCN-3 TOOLS (SOURCE: WWW.TTCN-3.ORG)

- **LoongTesting** testing platform including TTCN-3 **compiler** and **integrated development environment** by Information Processing Center of USTC, China.
- **BBT** TTCN-3 **Compiler**, by **BroadBit**, Hungary.
- **TRex**: by University of Göttingen to provide **IDE** functionality for TTCN-3 core notation, and to support assessment and automatic restructuring of TTCN-3 test suites. (open-source Eclipse plug-in).
- **T3doc** by Federico Engler and further developed by ETSI. for generating HTML **documentation** via tagged TTCN-3 comments.
- **Codec generator** by IRISA as part of T3DevKit. It automatically **generates a codec** based on TTCN-3 type module(s), C++ codec functions.
- **T3DevLib** by IRISA as part of T3DevKit. It allows the development or **integration of Codec, SUT and Platform Adapter** implementations written in C++.
- **NEW TITAN** by Ericsson: <https://projects.eclipse.org/projects/tools.titan> !

... and more academic prototype/research tools
(guideline checking, quality analysis, ...)

APPLICATION DOMAINS

What else?



TTCN-3 DOMAINS: TELECOM

✓ Industrial use

- Big companies with hundreds of TTCN-3 engineers: Ericsson, Nokia, Siemens, Motorola
- large distribution among SME

✓ Standardization bodies

- standardized test suites:
ETSI / 3GPP (**LTE!**)/ OMA / TETRA / oneM2M / **5G** (*in preparation*)
- IMS performance benchmark project:
Intel, HP, BT, FOKUS and others

✓ Test tool manufacturer

- Commercial Tektronix, Catapult, Nexus, R&S, Spirent, ...

✓ Certification programs based on TTCN-3: e.g. WiMax forum, **oneM2M**

TTCN-3 DOMAINS: AUTOMOTIVE

✓ Car communication systems

- Daimler, Volkswagen, SiemensVDO
- edutainment bus system (test suite)

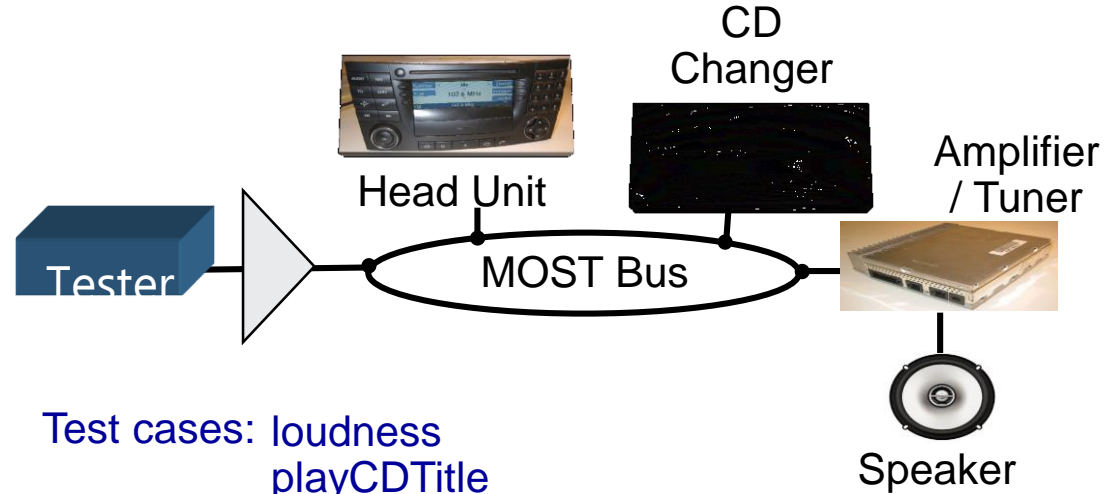
✓ Standardization groups

- AUTOSAR consortium
- MOST cooperation

✓ Car-to-car communication

Telematics Applications in the Cockpit

- Audio (CD / Radio), Video
- Telephone, SMS
- Navigation
- Speech recognition
- User interface for body electronic



TTCN-3 DOMAINS: MEDICINE

Medicine

- SiemensMED (image processing)
- HL7 eHealth protocols (Interoperability)



Upcoming E-Health infrastructure for Germany

- High security requirements (e.g. certificates, cryptography)
- Multiple heterogenous interfaces:
 - cardterminals, card simulations,
 - Webservices, OCSP server etc.



IOT-TESTWARE



GETTING STARTED MEMBERS PROJECTS MORE ▾

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HOME / PROJECTS / TECHNOLOGY PROJECT / ECLIPSE IOT-TESTWARE / ECLIPSE IOT-TESTWARE

This proposal has been approved and the **Eclipse IoT-Testware** project has been created.

Eclipse IoT-Testware

BASICS

This proposal is in the Project Proposal Phase (as defined in the **Eclipse Development Process**) and is written to declare its intent and scope. We solicit additional participation and input from the community. Please login and add your feedback in the comments section.

Parent Project:
Technology Project



THE TEST EXECUTION TOOL

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★ DONATE

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Eclipse Titan

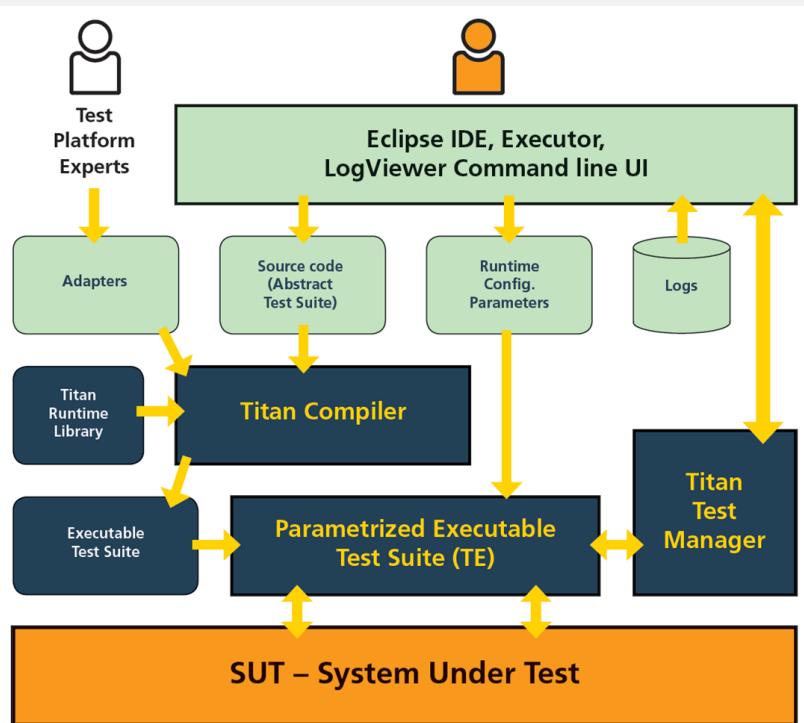
Overview Downloads Who's Involved Developer Resources Governance Contact Us

Titan is a TTCN-3 compilation and execution environment with an Eclipse-based IDE. TTCN-3 is a modular language specifically designed for testing (the acronym itself stands for Test and Test Conformance Notation), standardized by ETSI (see www.ttcn-3.org) and endorsed by ITU. The user of the tool can develop test cases, test execution logic and build the executable test suite for several platforms. Titan consists of a core part, executing in a Unix/Linux-like environment and a set of Eclipse plug-ins.

Titan



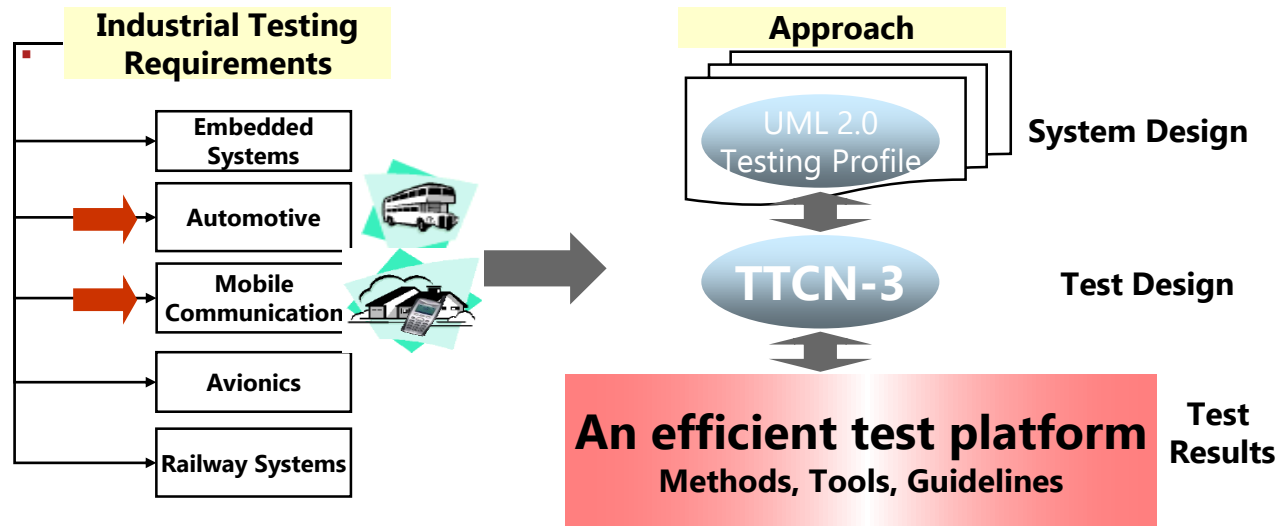
ECLIPSE TITAN PROJECT



TTCN-3 LINK TO MBT

Objective:

- To develop an efficient **test platform** fulfilling **industrial testing requirements**
- To **execute high-level test models**, e.g. UML testing profile



...

SUMMARY AND OUTLOOK

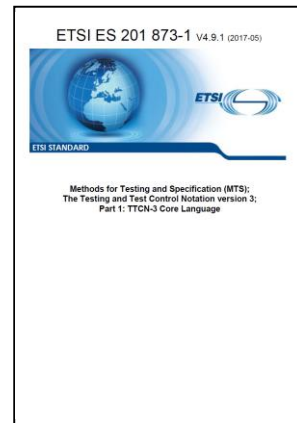
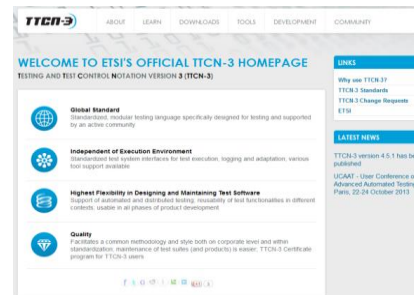
GOOD REASONS FOR STANDARDIZED TEST LANGUAGES

- They significantly increases your system quality.
- You can focus on what to test, not on how.
- They reduce costs and efforts in test system maintenance.
- They are independent of access technology, operating system and implementation domain.

- They support communication between system development and test department.
- You can count on available, trained and certified experts

TTCN-3 SOURCES

- Online information
→ www.ttcn-3.org
- TTCN-3 User Conference
→ 2018 in Paris, France
- TTCN-3 Standards, Papers, Book
→ <http://www.ttcn.de/>
- Quick Reference
→ <http://www.blukaktus.com/>
- Exercises and Tooling
→ research licenses



TTCN-3 Quick Reference Card

For TTCN-3 version 4.1.1 (2017-05) and extensions.

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ETSI TTCN-3 Quick Reference Card www.ttcn.de/blukaktus.com/TTCN3qr.pdf

CONTACTS

Thank you for your attention!

<https://www.fokus.fraunhofer.de/sqc>

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