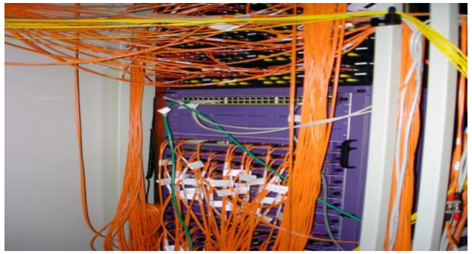


Innovative Standards

TTCN – standardisierte Basis und Motor für Innovatives Testen.

Theo Vassiliou, Axel Rennoch, Ina Schieferdecker
Schloß Steinhöfel Seminar, 26. April 2010

Contents

- **TTCN**
  - Introduction
  - History
- **Status**
  - Concept
  - Applications:
    - Industrial domains, MBT
- **Future**
  - Latest releases, extension packages
  - Outlook: Embedded TTCN-3
- **Conclusion**

Contents

- **TTCN**
  - Introduction
  - History
- **Status**
  - Concept
  - Applications:
    - Industrial domains, MBT
- **Future**
  - Latest releases, extension packages
  - Outlook: Embedded TTCN-3
- **Conclusion**

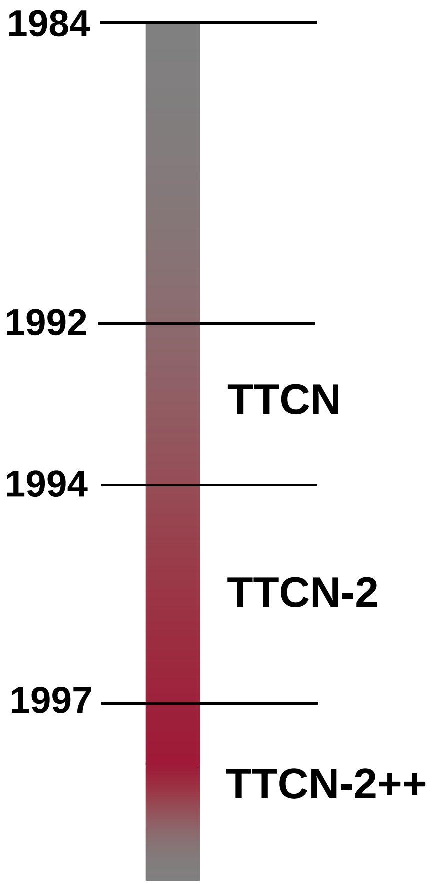
The Testing and Test Control Notation

Idea and 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

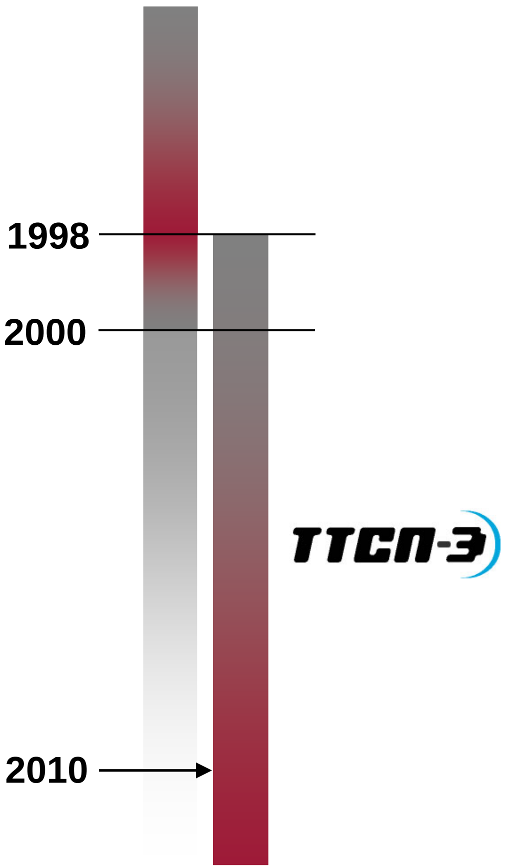
- **Areas of Testing**
  - Regression Testing
  - Conformance and Functionality Testing
  - Interoperability and Integration Testing
  - Load/ Stress Testing

History (1)



- TTCN (1992)
  - Published as an ISO standard
  - Tree and Tabular Combined Notation
  - Used for protocol testing only
    - GSM, N-ISDN, B-ISDN
- TTCN-2/2++ (1997)
  - Concurrent tests
  - Modularization
  - Manipulate external data
  - Rather for conformance testing
  - Developed by ETSI MTS

History (2)



- TTCN-3 (2000)
  - Testing and Test Control Notation
  - Developed by ETSI MTS
  - Proper language
    - Well defined syntax and semantics
  - Enhanced communication, configuration and control
  - Standard test specification
    - SIP, SCTP, HiperLan, HiperAccess, IPv6 ...

TTCN-3 Multipart-Standard

- ETSI ES 201 873-1 TTCN-3 Core Language (CL)
- ETSI ES 201 873-2 TTCN-3 Tabular Presentation Format (TFT)
- ETSI ES 201 873-3 TTCN-3 Graphical Presentation Format (GFT)
- ETSI ES 201 873-4 TTCN-3 Operational Semantics
- ETSI ES 201 873-5 TTCN-3 Runtime Interface (TRI)
- ETSI ES 201 873-6 TTCN-3 Control Interfaces (TCI)
- ETSI ES 201 873-7 Integration of ASN.1
- ETSI ES 201 873-8 Integration of IDL
- ETSI ES 201 873-9 Integration of XML
- ETSI ES 201 873-10 T3Doc

- Standard available for download at http://www.ttcn-3.org
- Also standardized by the ITU-T as ITU-T Z.140

Maintenance of TTCN-3

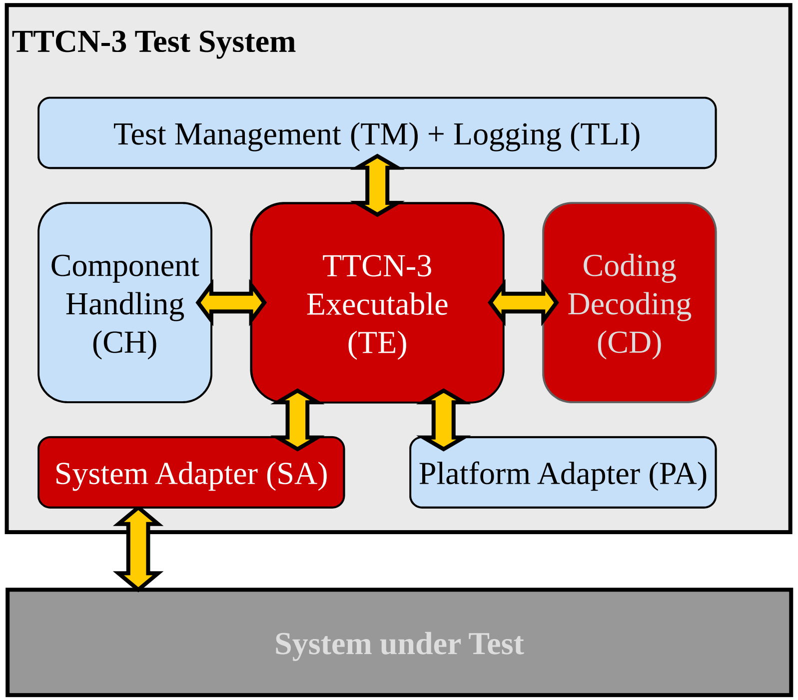
- Standard is constantly maintained
  - Through Change Requests (CRs)
  - Extension proposals
  - Active contributions in the TTCN-3 community
    - TTCN-3 mailing list, TTCN-3 users conference
- ETSI STFs (Specialist Task Force)
- Change requests result in new editions of the standard
  - 2000: Edition 1
  - 2003: Edition 2
  - 2005: Edition 3
  - 2009: Edition 4.1
  - 2010: Edition 4.2

Contents

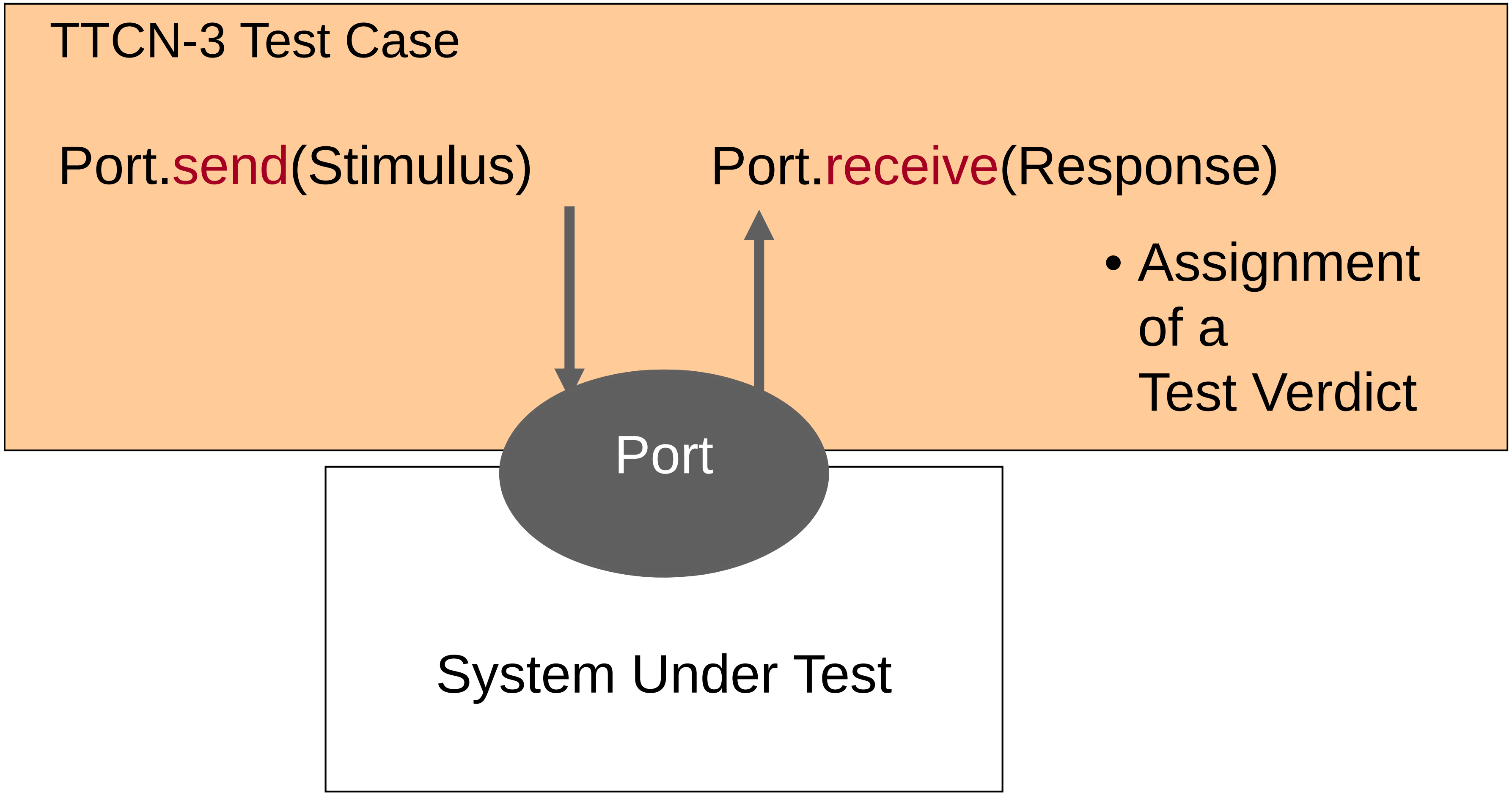
- **TTCN**
  - Introduction
  - History
- **Status**
  - Concept
  - Applications:
    - Industrial domains, MBT
- **Future**
  - latest releases, extension packages
  - Outlook: Embedded TTCN-3
- **Conclusion**

TTCN-3: Testing and Test Control Notation

- A standardized alternative to proprietary test systems
  - Developed by a large group of testing experts
  - Used by a growing community
- Enabling a testing middleware,
  - *unifying* methods, tools, test infrastructure, documentation and training
  - domain-specific extensions
- TTCN-3 is more than a notation: TTCN-3 test system
- The only international standard for
  - Test specification *and* implementation



TTCN-3 is designed for Black-Box Testing

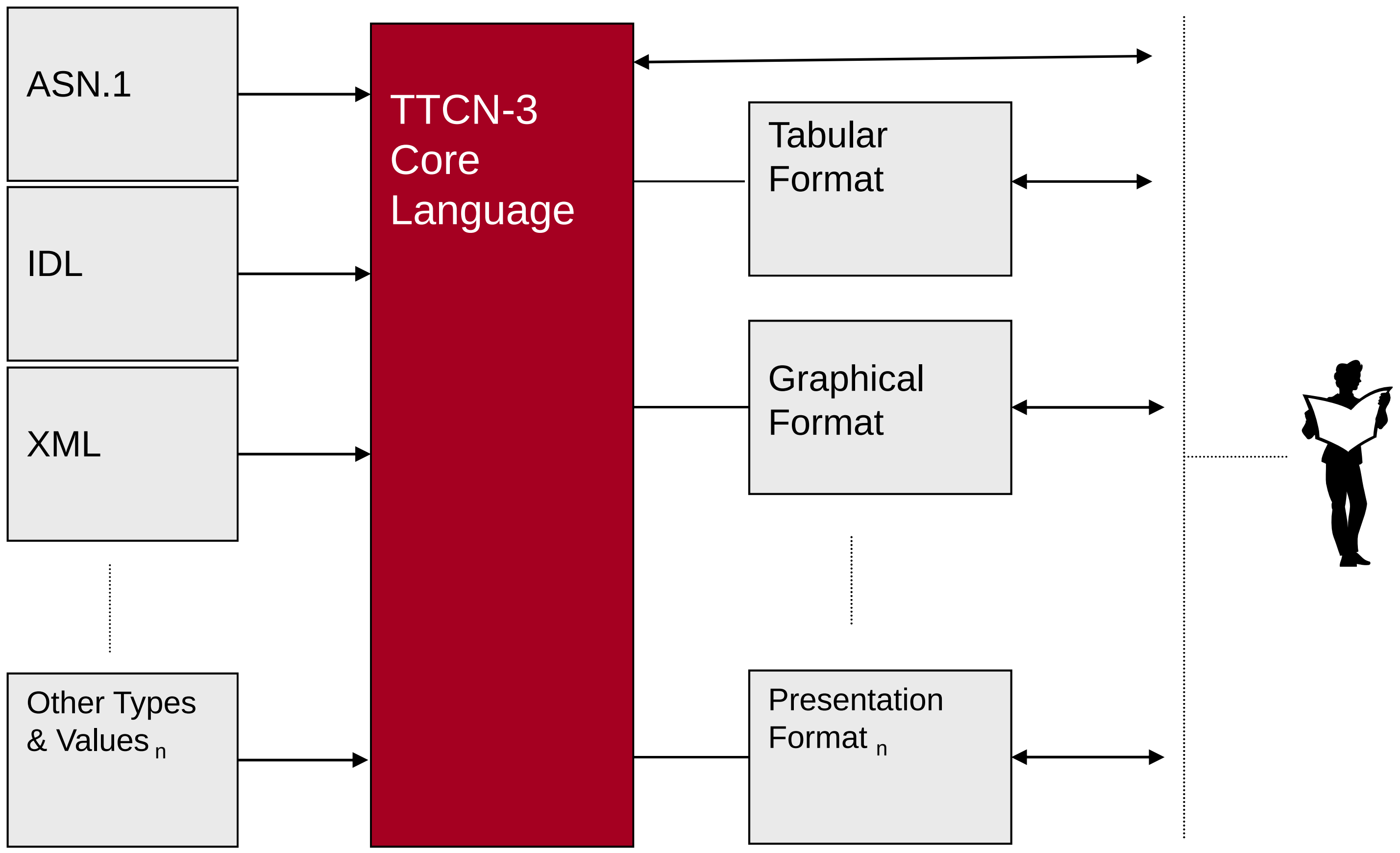


Major language elements of TTCN-3 notation

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/received during test execution (templates, values)
Test Configuration	Definition of the test components and communication ports
Test Behavior	Specification of the dynamic test behavior

TTCN-3 is an „**open**“ standard



Openness for other data types: Example

XML to TTCN-3 Mapping

- Mapping of XML to TTCN-3
  - defined by the ETSI
  - Part 9 of the TTCN-3 multipart-standard
  - restricted to XML data **types** (XSD types) only

- Type import:
  - uses the import mechanism of TTCN-3 for immediate use
  - `import from XSD language "XML1.1" all;`
  - language identifiers:
    - "XML" or "XML1.0" for W3C XML 1.0
    - "XML1.1" for W3C XML 1.1
  - structural information of XML document have no representation in TTCN-3 -> will be converted to encoding instructions

Technical conversion of XSD to TTCN-3

- 16 identifier name conversion rules
- 3 rules to specify the order of mapping

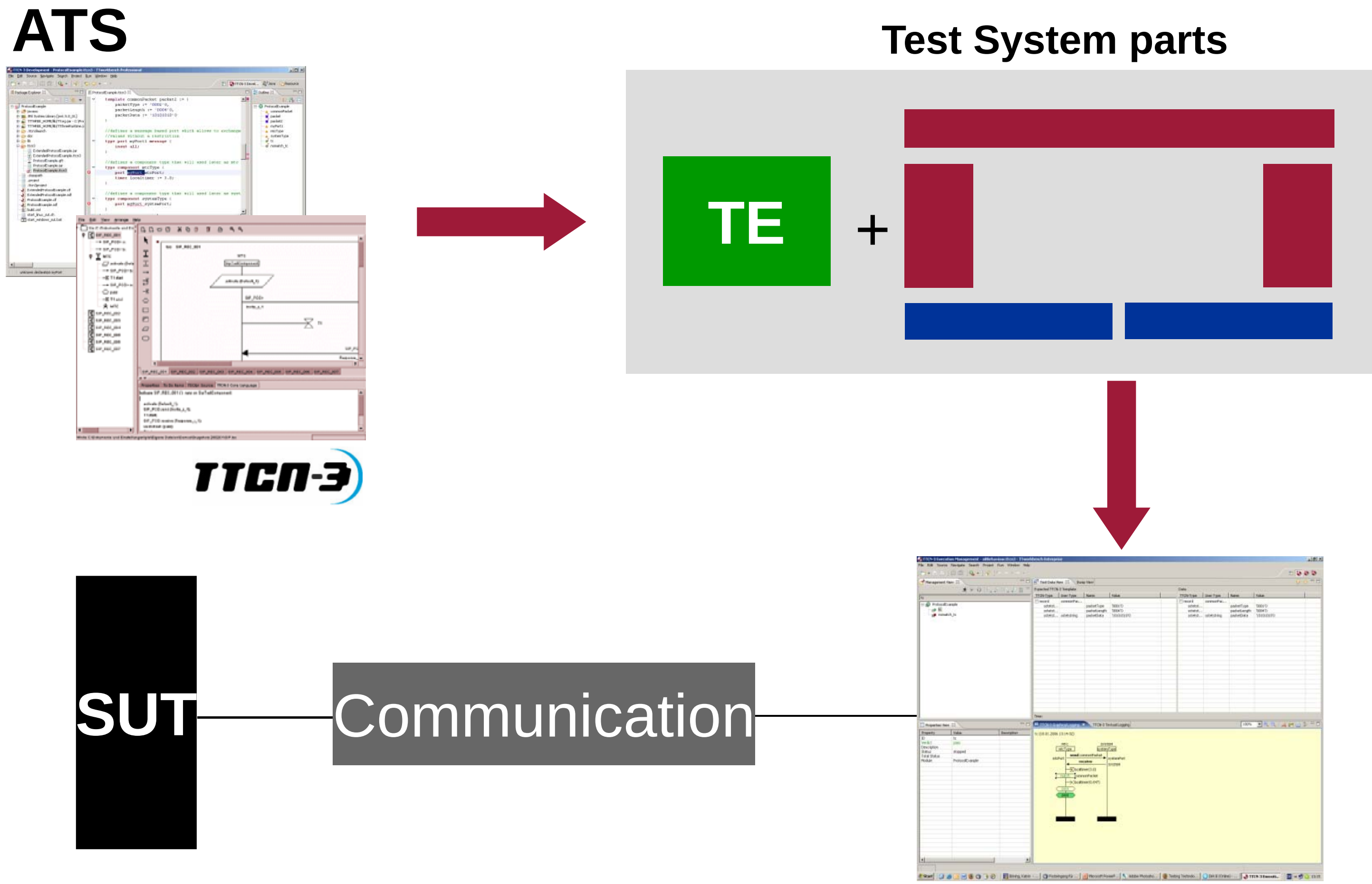
  - **XSD component**

```
<complexType name="e15">
  <sequence minOccurs="5" maxOccurs="10">
    <element name="foo" type="integer"/>
    <element name="bar" type="float"/>
  </sequence>
</complexType>
```

  - **corresponding TTCN-3**

```
type record E15 {
  record length(5 .. 10) of record {
     XSD.Integer foo,
     XSD.Float bar } sequence_list
} with {variant "name as uncapitalized "}
```

More than a notation: Test system implementation

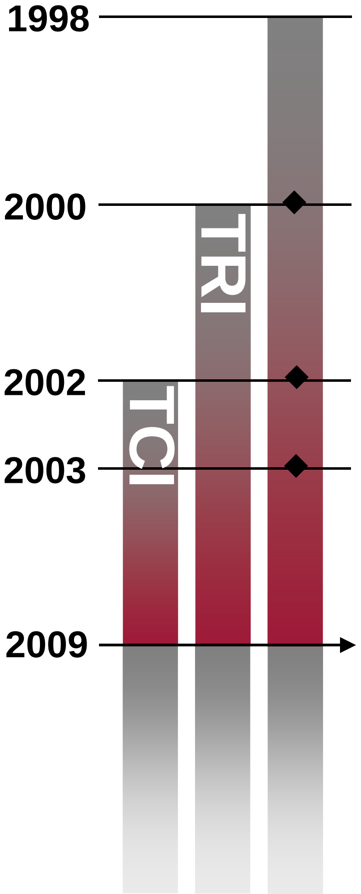


Test Implementation Standards

1.	Core Language	TTCN-3 Concepts and Syntax
2.	Tabular Presentation Format	Presentation Formats
3.	Graphical Presentation Format	
4.	Operational Semantics	Semantics
5.	TTCN-3 Runtime Interfaces (TRI)	Execution Environment
6.	TTCN-3 Control Interfaces (TCI)	
7.	ASN.1 to TTCN-3	Language Mappings
8.	IDL to TTCN-3	
9.	XML to TTCN-3	

10. TTCN-3 Documentation tags

History of TTCN-3



- TTCN-3 was published as ETSI standard in October 2000
- Works on standardizing the runtime interfaces started immediately
- **TRI - TTCN-3 Runtime Interface**
  - First draft released 10/2001
  - First version released 2002
  - Current version v4.1 dated 06/2009
- **TCI – TTCN-3 Control Interfaces**
  - Work for TCI started after v1.0 of TRI
  - v1.0 of TCI released 03/2003
- Ongoing task in the maintenance group

Contents

- **TTCN**
  - Introduction
  - History
- **Status**
  - Concept
  - Applications:
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  - latest releases, Extension packages
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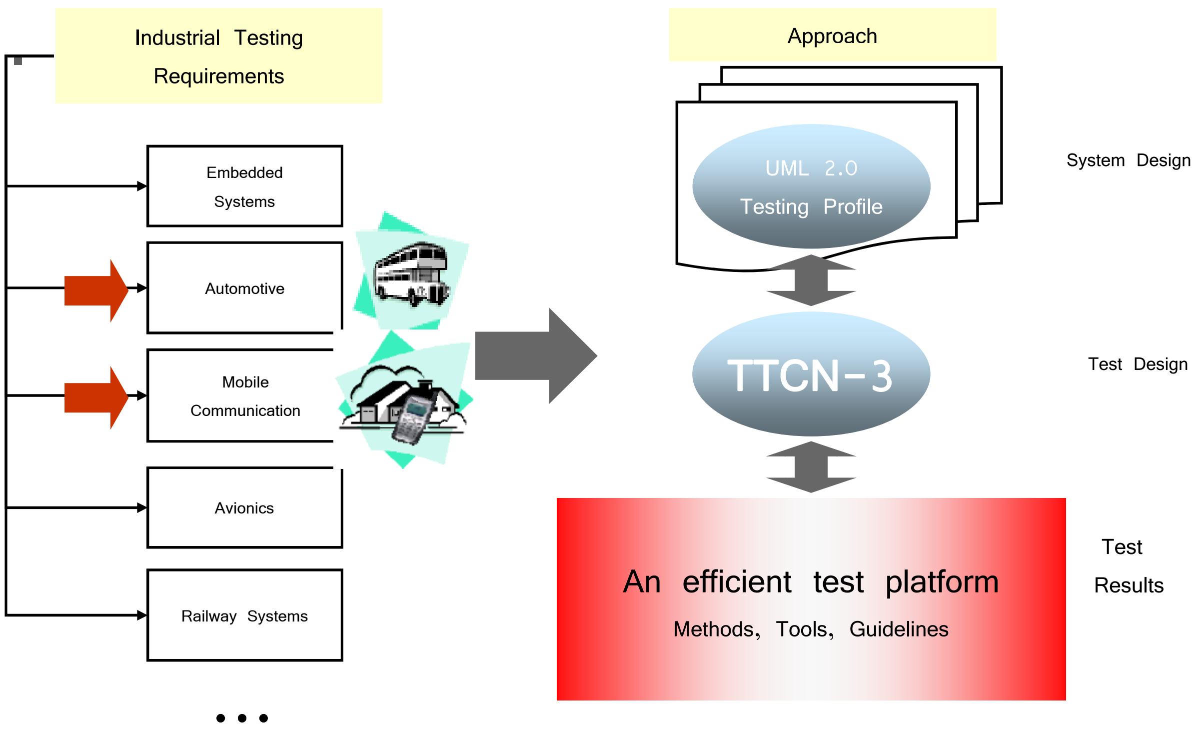
TTCN-3 applications: various industrial applications

Objective:

- To develop an efficient test platform fulfilling **industrial testing requirements**
- To execute high-level test models, e.g. UML2 test profile



TTCN-3 domains: Telecom

- Industrial use
  - Big companies with hundreds of TTCN-3 engineers: Ericson, Nokia, Siemens, Motorola
  - large distribution among SME
- Standardization bodies
  - standardized test suites:
    ETSI / 3GPP / OMA / TETRA and its members
  - IMS performance benchmark project:
    Intel, HP, BT, FOKUS and others
- Test tool manufacturer:
  - Commercial Tektronix, Catapult, Nexus, R&S, …
  - Open source community projects
- Certification program based on TTCN-3: WiMax forum

Telecom example: Performance Benchmarking

Sample: IMS components

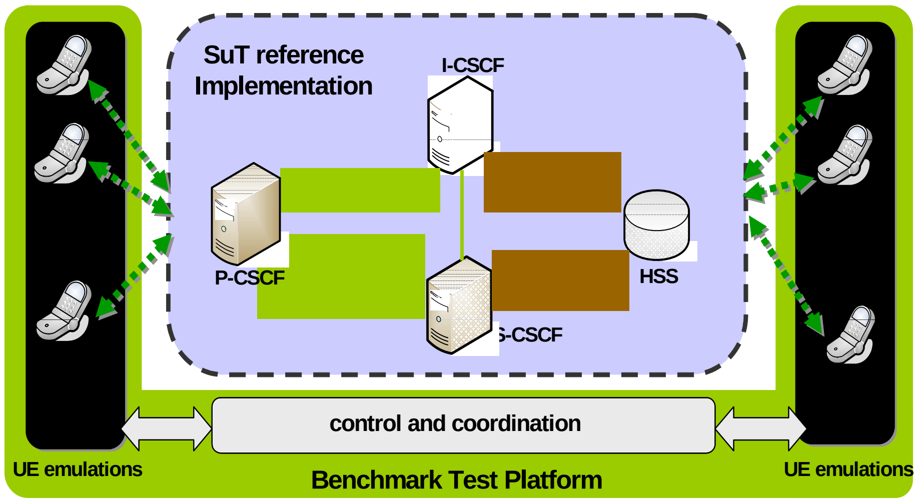
Test IMS components separately and in different configurations

Definitions using TTCN-3:

- standard call scenarios (e.g. voice call, conference call, application call, push-to-talk call)
- traffic set as an aggregation of call scenarios

Performance:

- 5.000 - 10.000 IMS subscribers (per server)
- Up to 250 requests per second (per server)

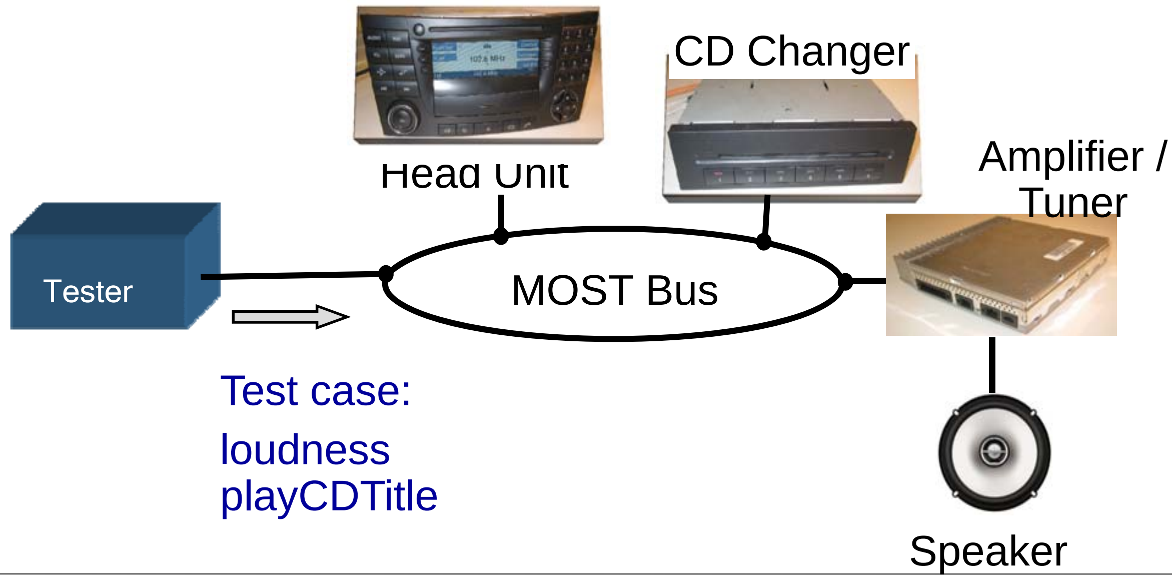


TTCN-3 domains: Automotive

- 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

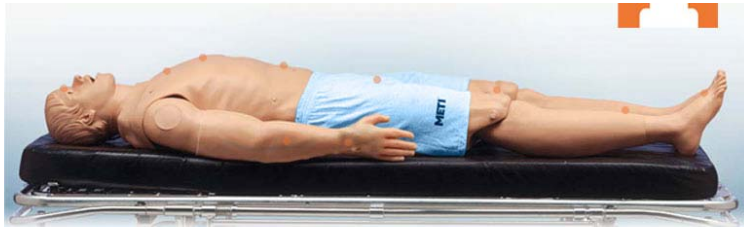
- Audio (CD / Radio), Video
- Telephone, SMS
- Navigation
- Speech recognition
- User interface for body electronic



TTCN-3 domains: other domains

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

- Power transmission and distribution:
  - SiemensPTD (safe and reliable energy system)



- Financial data warehouse:
  - International bank (functional / regression testing)

- Avionics
  - European Space Agency
- Railways
  - Dutch railways (www.tt-medal.org)

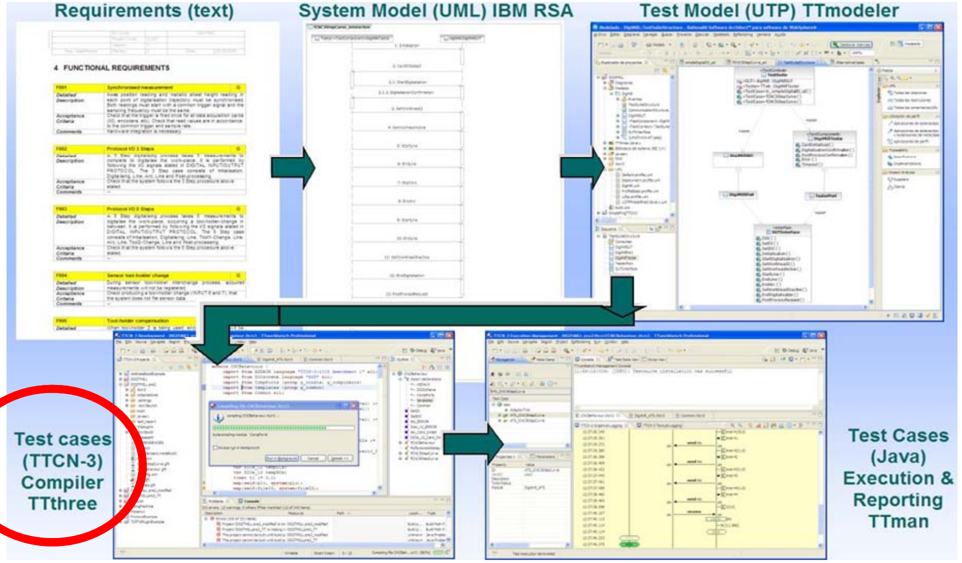
MBT example 1: Trimek/Datapixel production engineering case study

- **SUT: Coordinates Measuring Machines (CMM) control software (CDMS) for controlling a measuring system**

➢ Focus: test case derivation from UML models

- Models in use: *UML class, sequence, state diagrams*

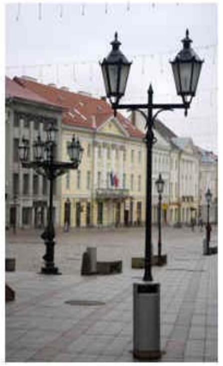
SUT

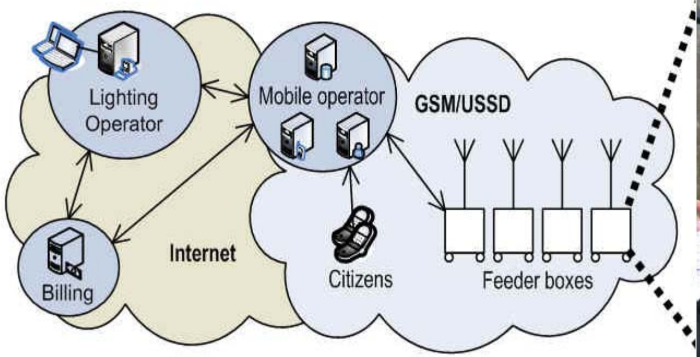


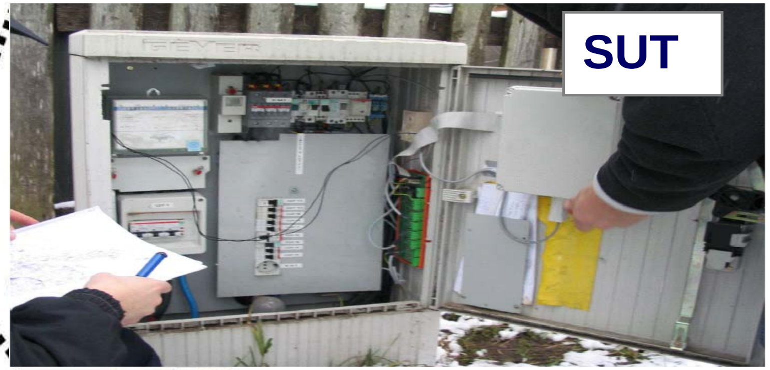
MBT example 2: City street lights case study

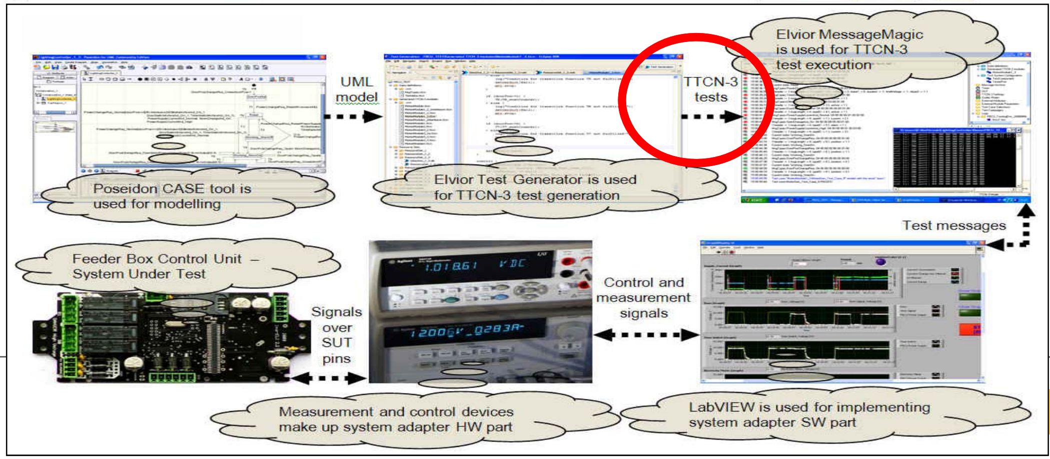
- **SUT: Eliko** ***street lighting control system*** **feeder box control unit (FBCU)**
- Models for the SUT: *UML state charts*, produced with tool Poseidon

➢ Elvior test generator derives *TTCN-3 test cases* from state charts









Further activities

- Establishment of a **TTCN-3 syllabus and certificate**
  - Cooperation of ETSI, GTB and iSQI
  - Two accredited TTCN-3 training providers
  - First exams, lots of certificates issued

- Improvement of **TTCN-3 tool interoperability**
  - Development of a TTCN-3 reference test suite
  - 1st TTCN-3 **Plugtest** test with commercial tools

- TTCN-3 **user conferences**
  - Europe: 2004, 2005, 2006, 2007 (S), 2008 (E), 2009 (F)
  - Asia: 2007 (China), 2009 (India), 2010 (China)

Contents

- **TTCN**
  - Introduction
  - History
- **Status**
  - Concept
  - Applications:
    - Industrial domains, MBT
- **Future**
  - latest releases, Extension packages
  - Outlook: Embedded TTCN-3
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TTCN-3 multipart standard overview: 2010 extensions

Language mappings
- ASN.1
- IDL
- XSD
- …

Extensions
- Documentation t3doc
- Behaviour Types
- Advanced parameteri-zation
- Static configuration
- Real-time

Core language
- TTCN-3 Structuring: Imports, Groups, Attributes
- TTCN-3 Behaviour
- TTCN-3 Data

TRI/TCI mapping
- Java
- C
- C++
- XML
- C#

Extension packages #1: Behaviour types

- **ETSI ES 202 785 V1.1.1** Available since Jan. 2010
- More flexibility: variables may carry “behaviour” (functions/altsteps etc.)
- Effects ES 201 873 parts: -1 (core), -4 (semantics), -6 (TCI), -10 (T3DOC)
- Example:

```
type function MyFuncType ( in integer p1 ); // new type definition (w/o body)
function MyFunc1 ( in integer p1 ) {…}; // concret behaviour
…
var MyFuncType v_func;
v_func := MyFunc1;
apply (v_func(0));
```

Extension packages #2: Advanced Parameterization

- **ETSI ES 202 784 V1.1.1** Available since March 2010
- Formal parameters of kind “type” for: type, template, and behaviour defintions

- Effects ES 201 873 parts: -1 (core), -4 (semantics), -6 (TCI), -7 (ASN1), -10 (T3DOC)

- Examples:

```
type record Data <in type p_PayloadType> {
        Header hdr,
        p_PayloadType payload}


function f_myfunction <in type p_myType >
                        (in MyList<p_myType> p_list, in p_myType p_elem)  return myType
        {return p_list[0] + p_elem)}

f_myfunction <integer> ({1,2,3,4}, 5)
```

Extension packages #3: Configuration and Deployment Support

- **ETSI ES 202781 V1.1.1** release planned for summer 2010
- Introduces predefined static test components/configuration independent of a testcase (save time for testcase setup)
- Effects ES 201 873 parts: -1 (core), -4 (semantics), -5 (TRI), -6 (TCI)

- Example:

```
configuration f_StaticConfig() runs on MyMtcType system MySystemType {
        myComponent := MyPTCType.create static;
        map (myComponent :PCO, system:PCO1) static;…
}

testcase tc_test1 () execute on f_StaticConfig {…}
control {
        var configuration myStaticConfig;
        myStaticConfig := f_StaticConfig();        // configuration setup
        execute(tc_test1);
        myStaticConfig.kill;…
}
```

Extension packages #4: Real time and performance

- **ETSI ES xxxxxx V1.1.1** available in summer 2010

- Introduces **system time progress** (since start of a testcase), **delays and timestamps**
- Effects ES 201 873 parts: -1 (core), -4 (semantics), -5 (TRI)

- Examples:

```
module myModule {...
        type port myPort message [realtime] {...};
        var float v_specified_send_time, v_sendTimePoint, v_myTime;
        ...
        myPort .receive(t)-> timestamp v_myTime;
        …
        wait (v_specified_send_time);
        myPort.send(m);
        v_sendTimePoint:= now;
} with {stepsize “0.001”}; // precision of a milisecond
```

Next future: TTCN-3 embedded

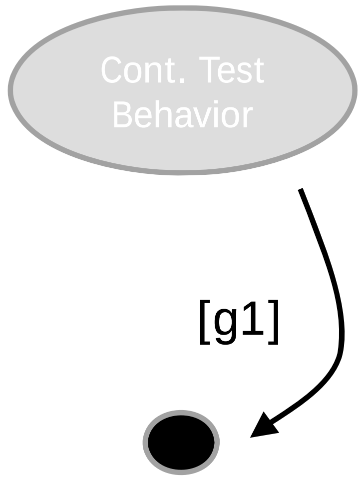
- Extensions for testing
  - real time systems (RT-TTCN-3)
  - continuous systems (Continuous TTCN-3)

- RT TTCN-3 Concepts
  - **clock** as a common basis for time measurement.
  - **timestamp** redirection for exact time measurement of message interaction.

- Continuous TTCN-3 Concepts
  - **sampled clock** as a common basis for discretization and stream definitions.
  - sampled **streams** that provide a data structure to define, access and manipulate discretized signal values and their history in time.
  - **hybrid automata** that provides a control flow structure to enable and control the simultaneous stimulation and evaluation of **stream ports**.

TTCN-3 embedded: Hybrid Behavior Specification

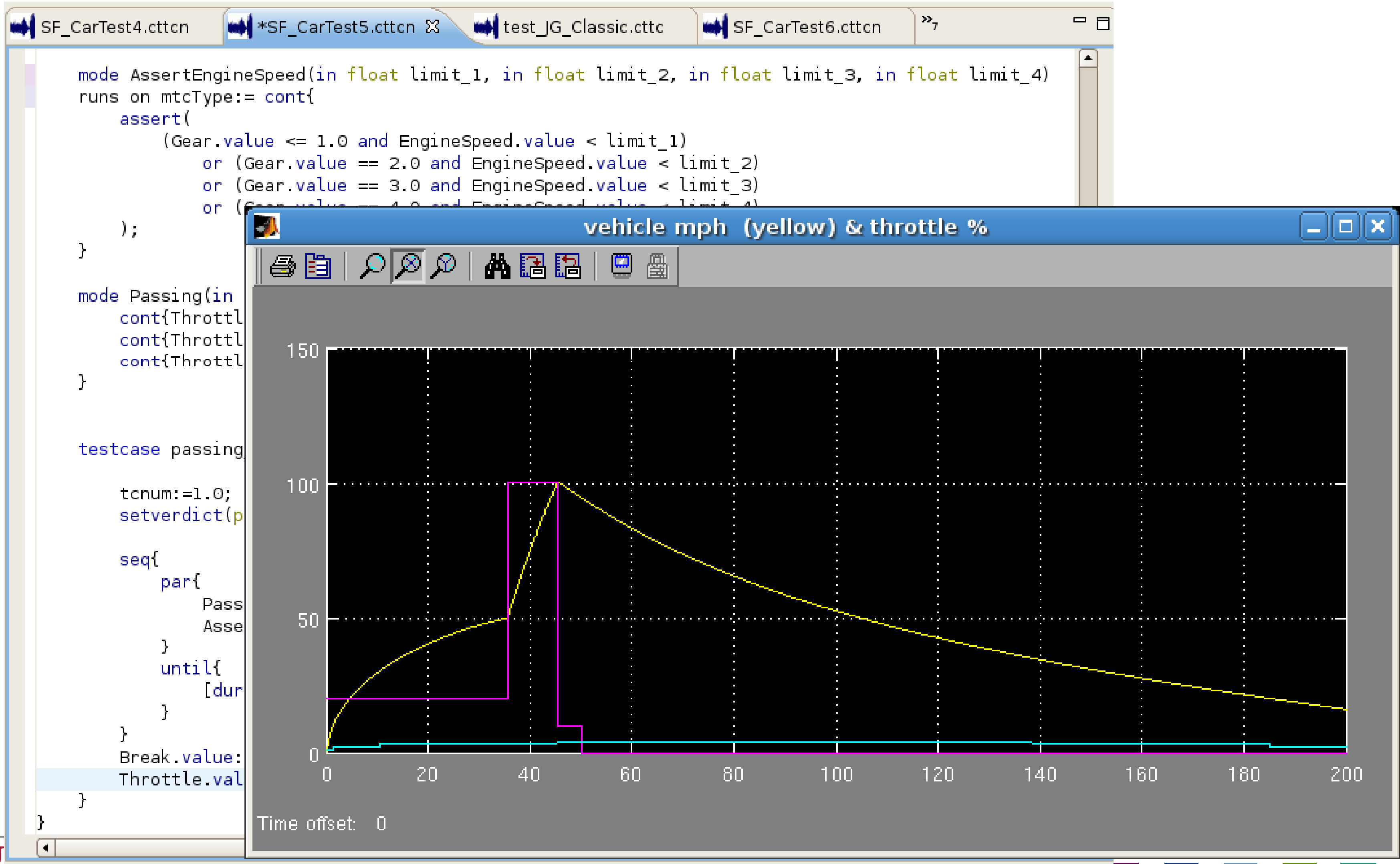
```
cont{
  var integer x :=0;
  onentry{Brake.value := 0.0}
  inv{ Brake.value <= 0.1 }
  Throttle.value := duration * 2.0;
  assert(EngineSpeed.value < 4000.0);
  onexit{Throttle.value := 0.0}
} until (duration >= 10.0)
```



- Modes represent the macro state of the test system
- **Repetitive execution** of the mode's content (micro states)
  - `onentry` and `onexit` are executed **once**
  - `inv`, `until`, `assertions` and `assignments` are executed **continuously**

- Parallel and sequential composition (using *par* and *seq*)

TTCN-3 embedded sample: vehicle passing



Contents

- **TTCN**
  - Introduction
  - History
- **Status**
  - Concept
  - Applications:
    - Industrial domains, MBT
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  - latest releases, extension packages
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Major technical innovations / benefits

- TTCN-3 as standardized test language ***and*** implementation
- Easy (human readable) description of test scenarios
  - free from programming issues,
    (transparent framework for end-customers)
  - platform and tool vendor independence
  - different presentation formats
- Clear separation of testing issues:
  - test configuration, data and behaviour
  - SUT specific adaptation and codec

Conclusions

- 1980s – today, long history and value
- Wide range of applicability
  - different communication paradigms, testing types
  - domains: Telecom, Automotive, Medicine, Finance, Railways,…
  - used in research and industry
- Creates International community, expertise, commercial and open source tools
- TTCN-3 is established and in progress for the future

Thank you!