World Class Standards

LTE test suites for UE conformance

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Session 1: June 4th 11:15
- MCC TF160 – 3GPP LTE/SAE UE Conformance Test
- UE Conformance Testing: Test Suite Design
- Coding Style and Template Restrictions
- Conclusions
What is 3GPP?

- A collaborative standardization activity between:
  - ARIB (Japan-radio)
  - ATIS (North America)
  - CCSA (Peoples Republic of China)
  - ETSI (Europe)
  - TTA (Republic of Korea)
  - TTC (Japan-core network)

- Founded in December 1998

- Prepares complete sets of specifications for mobile radio systems; GSM, GPRS, EDGE, W-CDMA, HSPA, LTE and LTE-Advanced
3GPP Family Evolution

Standards availability

- **EDGE**
  - 384Kb/s

- **EDGE+**
  - 1Mb/s

- **UMTS**
  - 384Kb/s

- **HSPA**
  - 18Mb/s

- **HSPA+**
  - 42Mb/s

- **LTE**
  - 100Mb/s

- **LTE-Advanced**
  - 1000Mb/s

Timeline:
- 2000
- 2009
MCC TF160 - General

- **Task Force** – Mobile Competence Centre: Project Group at ETSI
  - Pool of TTCN expertise used by 3GPP

- **3GPP: 3rd Generation Partnership Project**  [http://www.3gpp.org](http://www.3gpp.org)
  - Telecommunication Standardisation Bodies
  - TSG RAN: Radio Access Network
  - WG RAN5: Mobile terminal conformance testing

- **Conformance Tests**
  - Specification (Prose): RAN5
  - Implementation (TTCN): MCC TF160
  - Validation: Test Industry

- **MCC TF160:** Signalling Conformance Tests for 3GPP (RAN5: Testing)
  - Task: Develop Conformance Test Suites for UE world-wide certification
  - since 2000: Conformance Tests for UMTS Signalling (TTCN-2)
    - since 2006: Conformance Tests for IMS (TTCN-3)
    - 2007..2008: Pre-evaluation of TTCN-3 for LTE Signalling
    - 2008..now: 3GPP LTE/SAE UE Conformance Test
MCC TF160 – LTE/SAE Project (1)

- **Size:** 18 experts all over the world
- **Duration:** more than 5 years
- **Test cases:** ~ 100 implemented; 450 planned
- **Code size:**
  - Modules: more than 90 (more than 120 expected)
    - 60 000 lines of code (TTCN-3)
    - 250 000 words
    - 2 800 000 bytes
  - Type Definitions: 15 TTCN-3 modules, 3 ASN.1 modules
    - 12 000 lines of code (TTCN-3)
    - 26 000 lines of code (ASN.1)
- **Tools:**
  - 6 different compilers (all available at ETSI)
  - quality checks (naming conventions, template restrictions etc.)
  - code generation (top-level test case definitions, parameters, etc.)
MCC TF160 – LTE/SAE Project (2)

- General Requirements and Challenges
  - Ensuring all test equipment has similar behaviour at any time
  - Different data types: TTCN-3, ASN.1, XML …
  - Test suite life cycle > 8 years
  - Backward compatibility and extendibility towards LTE- Advanced
  - Continuous maintenance and deliveries (every 3 – 4 weeks)
  - Verification and Validation of the test suite

- Technical Requirements
  - Real-time behaviour
  - Test Model
    - Control and Configuration of Test Equipment
    - Agreed by 3GPP (TS 36.523-3)
MCC TF160 – LTE/SAE Project (3)

- **Quality Requirements**
  - Tool-independent implementation
  - Delivered TTCN-3 test cases can only be verified by 3GPP test industry
    - Runtime Errors very costly
    - Change Request Process

- **Readability**
  - Code needs to be readable by 3GPP test industry, not only test case writers

- **Impact on Implementation**
  - Tools for Quality Assurance (e.g. to avoid runtime errors)
  - Change Request necessary for Changes in approved Objects (even on Name Changes)
MCC TF160 – Cooperation with other ETSI Projects

- STF343 – TTCN-3 Tool Assurance
  - Test Suite for Tool Compatibility based on MCC TF160’s Pre-evaluation Result

- STF349/380 - TTCN-3 extension and maintenance
  - Input for clarifications on TCCN-3 core spec.
  - Handling of local timers ("any timer.timeout", "all timer.stop")
  - Template restrictions
  - encvalue/decvalue functions
  - Pre-processing macros
  - etc.

- Quality Assurance for TTCN-3 Test Specifications
  (ETSI, University of Göttingen)
  - Usage of the Tool
  - Feedback
  - Additional Requirements

- Knowledge Exchange and Support with other ETSI Projects and Groups
  - WiMax Test Project
  - MTS (ETSI Body: Methods for Testing & Specification)
MCC TF160 – 3GPP LTE/SAE UE Conformance Test

UE Conformance Testing: Test Suite Design

Coding Style and Template Restrictions

Conclusions
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Test Suite Design: UE Conformance Testing

- **ASPs**: Layer-to-Layer (acc. to the test model)
  - Control ASPs: Configuration and Control of the Test Equipment
  - Data ASPs: Carrying PDUs and Control Information (Timing, Routing, ...)

- **PDUs**: Peer-to-Peer (acc. to the protocol standards)
Test Suite Design: Design Considerations

- **Timers**
  - only local timers are used

- **Global Variables**
  - grouped into component specific structures
  - Accessed by wrapper functions ("set", "get")

- **Verdict Assignment**
  - Immediate test case termination after FAIL or INCONC

- **Test Cases**
  - Top-level test case definition generated by Tools

- **Modular Structure**
  - Separation of components into different Radio Access Technologies (these use different type definitions)
  - Common Modules + Test case specific modules
**World Class Standards**

**PTC Model**

- **MTC**
  - Control of PTCs
  - Upper Tester (AT/MMI interface to UE)

- **PTCs**:
  - per Radio Access Technology
  - LTE-only
  - LTE + UMTS
  - LTE + GSM/GPRS
  - etc.

- **L3-PDU Handler**
  - coding and encryption
  - no verdict assignment etc.

- **UE Control**: AT/MMI Commands
  - Routed through MTC
  - Only one System Port

- **Coordination ASPs**
  - PTC to PTC
  - InterRAT Handover

- **TTCN-3 Component Control**
  - TTCN-3 Build-in Mechanism
  - (Create, Start, Kill, Done, Killed, etc.)
MCC TF160 – 3GPP LTE/SAE UE Conformance Test

UE Conformance Testing: Test Suite Design

Coding Style and Template Restrictions

Conclusions
Coding Style

- **Project specific Naming Conventions**
  - ETSI Generic Naming Conventions
  - Project Specific Requirements
  - 3GPP LTE/SAE UE Conformance Test Suite Specific Naming Conventions

- **Different Approaches for Templates**
  1. Classification into Templates with and without Matching Pattern
     - Templates with matching pattern shall be used in receive statements only
     - Templates without matching pattern may be used in receive or send statements
  2. Classification into Templates for Sending and for Receiving
     - Templates for sending are exclusively used in send statements
     - Templates for receiving are exclusively used in receive statements
     - MCC TF160 applies 2nd Approach

- **Project Specific Conventions for LTE/SAE Conformance Tests**
  - Same prefixes as for templates in TTCN-2
    - same people are working on/with TTCN-2 and TTCN-3 test cases
  - Templates distinguished for Sending and Receiving
    - Simple checks for template parameters (see next slides)
    - Improved quality check capabilities for template restrictions

→ [http://www.ttcn-3.org/NamingConventions.htm](http://www.ttcn-3.org/NamingConventions.htm)
Naming Conventions: Example "Baseline Moving"

- **Old Type Definition**
  
  ```
  cr_Message := {
    field1 := value1,
    field2 := value2
  }
  
  ⇒ the template does not contain matching pattern
  ```

- **Extended Type Definition**
  
  ```
  cr_Message := {
    field1 := value1,
    field2 := value2,
    newField := * // any-or-omit for backward compatibility }
  
  ⇒ now the template contains matching pattern
  ```

⇒ Classification into send and receive templates does not cause problems with baseline moving
Template Restrictions (Release 3.4.1)

- **Motivation**
  - Runtime errors may be caused by matching pattern used
    - in send statements
    - as parameters of "valueof"
  - Due to parameterisation of templates compiler cannot find all of these errors

- **Rules**
  - **Send Templates**
    - Prefix: cs_, cas_, cds_, etc. (acc. to naming conventions)
    - Template itself: "template (value)"
    - Template Parameters: "template (omit)" (optional field)
    - Template Parameters: "template (value)" (mandatory field)
  - **Receive Templates**
    - Prefix: cr_, car_, cdr_, etc. (acc. to naming conventions)
    - Template itself (no restriction)
    - Template parameters: "template" (optional field)
    - Template parameters: "template (present)" (mandatory field)

- **Checks**
  - Rules can be checked by appropriate tool ("restrictions fitting to prefix")
  - Correct parameterisation can be checked by compilers
    (parameter handed over shall follow restriction of formal parameter)

⇒ Template Restrictions + Naming Conventions = Better Quality
Template Restrictions: Examples

Correct Implementation

\[
\text{template (value) PDU\_Type cs\_SendTemplate(}
\begin{array}{l}
\text{integer p\_Value,} \\
\text{template (value) IE1\_Type p\_Mandatory,} \\
\text{template (omit) IE1\_Type p\_Optional)}
\end{array}
\]

\[:= \{ \ldots \} \]

Wrong Implementation

\[
\text{template PDU\_Type cs\_SendTemplate(}
\begin{array}{l}
\text{integer p\_Value,} \\
\text{template (value) IE1\_Type p\_Mandatory,} \\
\text{template (omit) IE1\_Type p\_Optional)}
\end{array}
\]

\[:= \{ \ldots \} \quad // \text{missing restriction for template}\]

\[
\text{template (value) PDU\_Type cs\_SendTemplate(}
\begin{array}{l}
\text{integer p\_Value,} \\
\text{template (present) IE1\_Type p\_Mandatory,} \\
\text{template IE1\_Type p\_Optional)}
\end{array}
\]

\[:= \{ \ldots \} \quad // \text{missing or wrong restrictions for parameters}\]
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Conclusions
Conclusions

- 3GPP conformance testing moved from TTCN-2 to TTCN-3 for LTE

- The LTE test suite
  - Aims to be tool independent
  - Is visible to the whole of 3GPP
  - Has a long project lifespan
  - Is extendable (LTE \(\Rightarrow\) LTE-Advanced \(\Rightarrow\) ???)

- MCC TF160 gives feedback to and receives support from
  - TTCN-3 Standardisation Group
  - TTCN-3 Quality Check Projects
  - TTCN-3 Tool Vendors

- MCC TF160 wants to encourage the close co-operation with the above parties to continue to improve the quality of TTCN-3.