TITAN TTCN-3 TEST EXECUTOR

INTRODUCTION

TEST COMPETENCE CENTER
ERICSSON HUNGARY

http://ttcn.ericsson.se/

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All link starts a standalone presentation ("custom shows") which returns to this page.

I. TITAN TTCN-3 TEST EXECUTOR: INTRODUCTION

WHAT IS TITAN?
HISTORY
BLOCK DIAGRAM
FEATURES

CONTENTS

WHAT IS TITAN?

TTCN-3 Test Executor

- Compile Abstract Test Suites written TTCN-3, ASN.1 to C++
- Generate code skeleton and provide API for developing protocol adaptation
- Control hardware test tools that have well-defined API
- Execute the compiled Executable Test Suites

Runs on multiple platforms

- Platform independent source written in C/C++
- TITAN can be built on any platform with a decent C++ compiler (Currently available for: Solaris, Linux, FreeBSD, Windows+cygwin at http://ttcn.ericsson.se ➔ TITAN DOWNLOADS)

Optimized for performance testing

API: Application Programming Interface

HISTORY OF TITAN

2000: M.Sc. thesis work
- Goal: performance test tool
- version 1.0 single mode, Test Port API, no semantic analysis

2001-2002: Research prototype
- Application driven development
- version 1.1 parallel & distributed execution
- version 1.2 ASN.1 support, RAW & BER encoding

2003: Productification
- Candidate as official TTCN-3 tool within Ericsson
- version 1.4 full ASN.1 support
- version 1.5 TTCN-3 semantic analysis (static parts)

2004-2008: Official Ericsson TTCN-3 tool
- Version 1.5pl6 Graphical User Interface
- Version 1.6pl0 Full semantic analysis
- Version 1.7pl0 TTCN-3 edition 3

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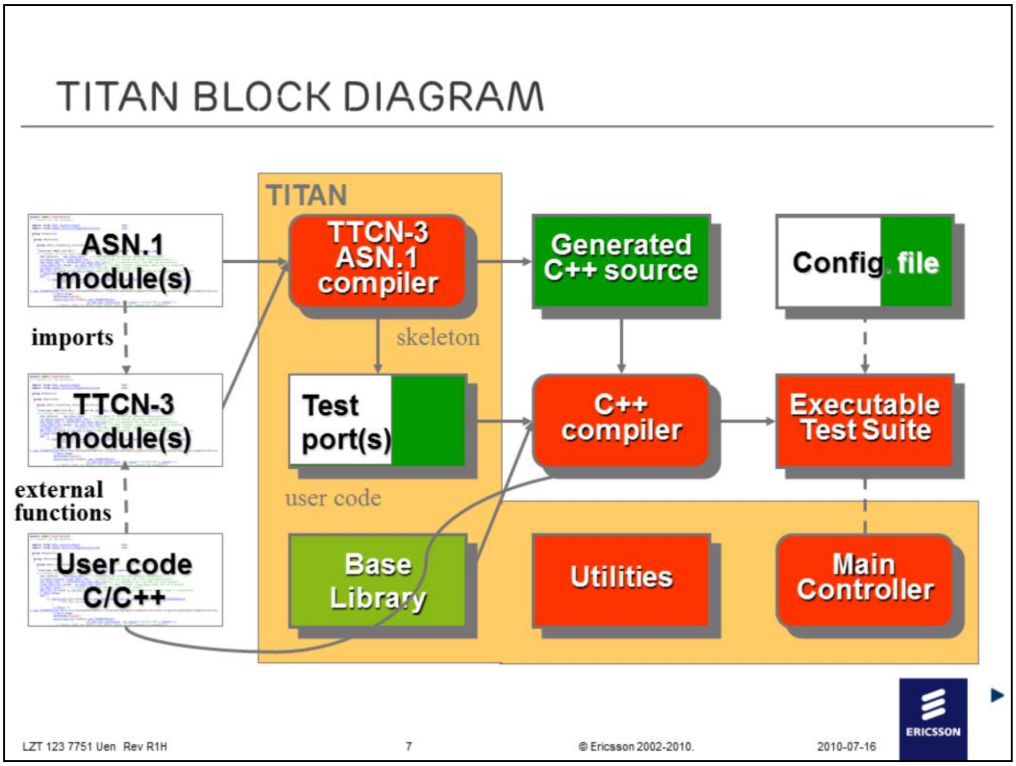
BER: Basic Encoding Rule

ASN.1 Abstract Syntax Notation One


TITAN BLOCK DIAGRAM
TITAN
ASN.1 module(s)
TTCN-3 ASN.1 compiler
Generated C++ source
Config file
imports
skeleton
TTCN-3 module(s)
Test port(s)
C++ compiler
Executable Test Suite
external functions
user code
User code C/C++
Base Library
Utilities
Main Controller
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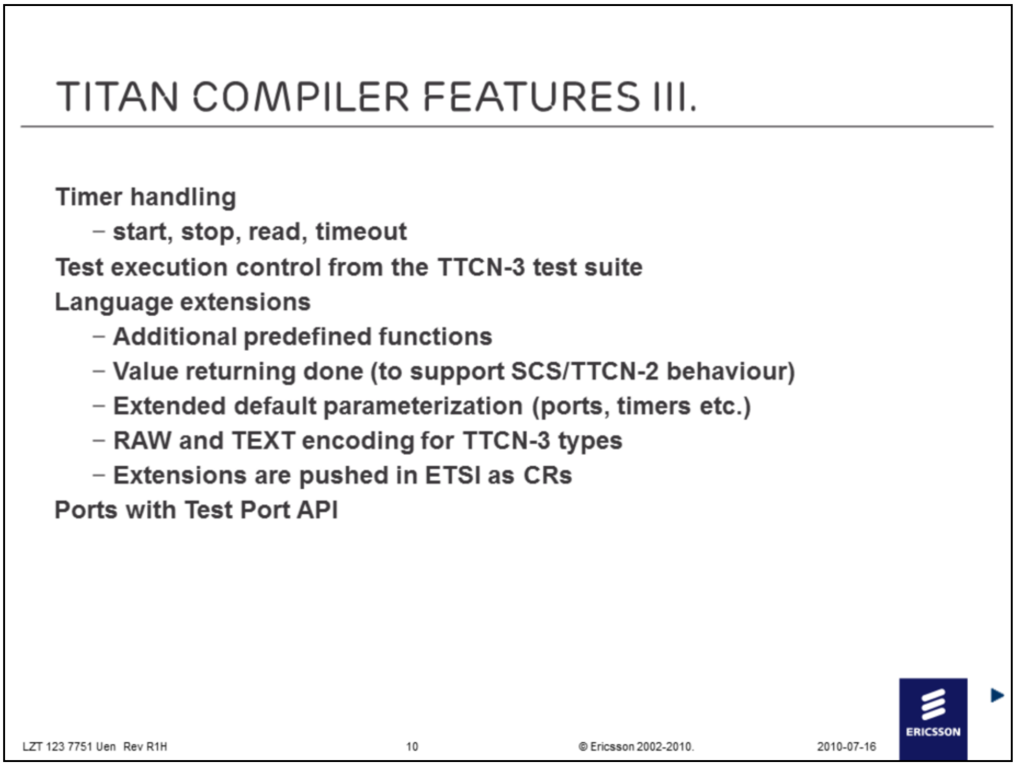
TITAN COMPILER FEATURES I.

- Supports modularity
- Supports TTCN-3 types:
  - All data types
  - All test configuration & default types (port, component, address & default)
  - Sub-typing (type constraints)
  - Semantic check for all supported TTCN-3 types
  - RAW, TEXT encoding (TITAN specific, because no standard exists)
- ASN.1 support:
  - X.680, X.681, X.682, X.683 version 2002
  - Full semantic check of ASN.1 types and values
  - XML related ASN.1 language elements are not supported
  - ASN.1 encodings: BER (direct), PER & (E)XER (using 3rd party SW)

TITAN COMPILER FEATURES II.

- Supports TTCN-3 data
  - Constants and run-time parameterization (module parameters)
  - Templates (simple~, compound~, parameterized~, modified ~, in-line ~)
  - Semantic check for all static data constructs
- Support of message based communication
  - sending & receiving messages with template matching etc.
- Support of procedure based communication (API testing)
- Dynamic behaviours
  - Dynamic test configuration and port/connection handling
  - Sequential and alternative behaviours
  - Default behaviour handling
  - All functional elements of dynamic behaviour supported: testcases, functions, structured alternative behaviour (altsteps)
  - All operations and control constructs supported (interleave since 1.6.pl3/R6D)



CR: Change Request

II. SETTING UP TITAN

CONTENTS

PREREQUISITES

The following tools need to be installed for using TITAN:

The same GCC C/C++ version shall be installed which the given TITAN distribution was built with (with using `as` and `ld` from GNU binutils)

- `setenv GCC_DIR` to your GCC installation
- add `$GCC_DIR/bin` to your `PATH`
- add `$GCC_DIR/lib` to your `LD_LIBRARY_PATH`

`makedepend` utility shall be available

`make` (or `gmake`) shall be available

- using GNU `make` (gmake) is recommended

NEdit (>5.4) or XEmacs with TTCN-3 and ASN.1 language mode is recommended

SETTING UP THE ERICSSON TTCN-3 ENVIRONMENT

The following environment variables need to be set for using TITAN:

`$TTCN3_DIR` shall point to the base directory of the installation

Add `$TTCN3_DIR/bin` to `PATH` and `$TTCN3_DIR/lib` to `LD_LIBRARY_PATH`

Set `$TTCN3_LICENSE_FILE` to the full path and name of your license file

The next environment variables are used only for using TITAN GUI:

Set `$TTCN3_BROWSER` to your browser to be used by TITAN GUI (default browser: `netscape`)

Set `$TTCN3_LOGBROWSER_EDITOR` to your favorite editor (`nedit` or `xemacs` suggested)

CONTENTS OF THE ERICSSON TTCN-3 ENVIRONMENT

- `$TTCN3_DIR/bin` – TTCN-3/ASN.1 compiler binaries, log tools, etc.
- `$TTCN3_DIR/etc`
  - `gui/` contains icon images for GUI;
  - `nedit/` contains the NEdit support package (e.g. syntax highlighting);
  - `xemacs/` contains the xemacs TTCN-3 and ASN.1 language mode support;
  - `skeleton/` holds the TTCN-3 code skeletons;
  - `license/` a demo license key
- `$TTCN3_DIR/include` – include files required for translated modules and Test Ports
- `$TTCN3_DIR/lib` – TTCN-3 and ASN.1 base libraries
- `$TTCN3_DIR/man` – manual pages for some binaries
- `$TTCN3_DIR/doc` – PDF and/or PS version of TITAN documentation
- `$TTCN3_DIR/demo` – simple “Hello World!” application demo

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LICENSING

You need a license to use TITAN!

Order your license at:

http://ttcn.ericsson.se → License ordering

Copy your license file to your home:

```
cp license_<number>.dat ${HOME}/
```

Set your TTCN3_LICENSE_FILE environment variable:

```
setenv TTCN3_LICENSE_FILE
  ${HOME}/license_<number>.dat
```

Once your system-related environment variables are set, you can check the validity of the license:

- from the shell command line: `compiler -v`

III. GRAPHICAL USER INTERFACE

FUNCTIONALITY
SCREEN SHOTS
DETAILED DESCRIPTION

CONTENTS

ECLIPSE

"Eclipse is a multi-language software development environment comprising an IDE and a plug-in system to extend it. It is written primarily in Java and can be used to develop applications in Java and, by means of the various plug-ins, in other languages as well, including C, C++, COBOL, Python, Perl, PHP, and others. The IDE is often called Eclipse ADT for Ada, Eclipse CDT for C, Eclipse JDT for Java and Eclipse PDT for PHP. " WIKIPEDIA

Available at

- http://www.eclipse.org/downloads/

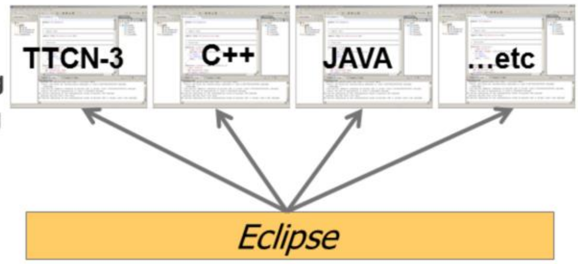
The Ericsson customized version

Eclipse4Ericsson (E4E)

ECLIPSE AS A PLATFORM

Platform
- **Provides a platform to support various programming languages**
- **Supports TTCN3/C++/JAVA/Tcl/Tk/XML/…etc**

Common way of working
- **Common shortcuts**
- **Common windows**
- **Common concept**
- **Common way of compiling**
- **Common way of executing**



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ECLIPSE TERMS: EDITOR

Editors

- appear in workbench editor area

Functionality

- Open, edit, save, close lifecycle
- Open editors are stacked

Extension point for contributing new types of editors

Example

- JDT provides Java source file editor
- TTCN-3 perspective provides TTCN-3 editor

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ECLIPSE TERMS: VIEWS

Views provide information on some object

Views augment editors
- Example: Outline view summarizes content

Views augment other views
- Example: Properties view describes selection

Eclipse Platform includes many standard views
- Resource Navigator, Outline, Properties, Tasks, Search…etc

View API and framework
- Views can be implemented with JFace viewers

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ECLIPSE TERMS: PERSPECTIVES

Perspectives are arrangements of views and editors
- Different perspectives suited for different user tasks
- Users can quickly switch between perspectives

Task orientation limits visible views, actions
- Scales to large numbers of installed tools

Perspectives control
- View visibility
- View and editor layout
- Action visibility

Extension point for new perspectives

Eclipse Platform includes standard perspectives
- Resource, Debug, …

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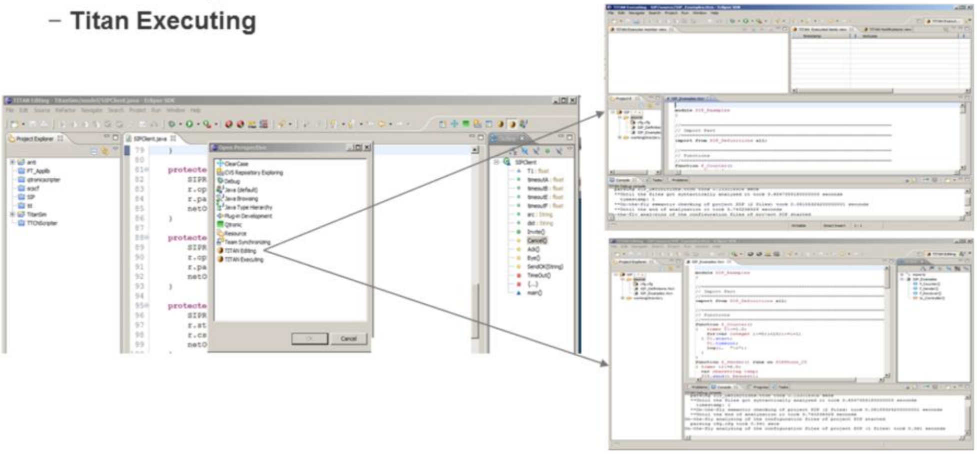
WAY OF WORKING WITH ECLIPSE

TCC provides 2 plugins → 2 perspectives for eclipse

- **Titan Editing**
- **Titan Executing**



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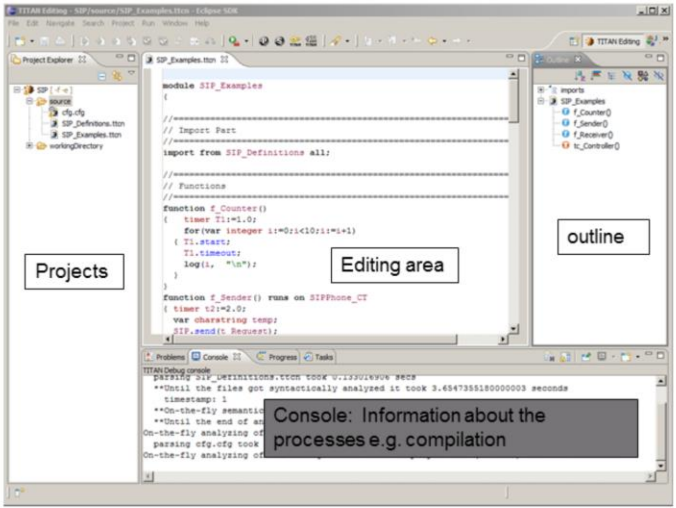
WAY OF WORKING WITH ECLIPSE

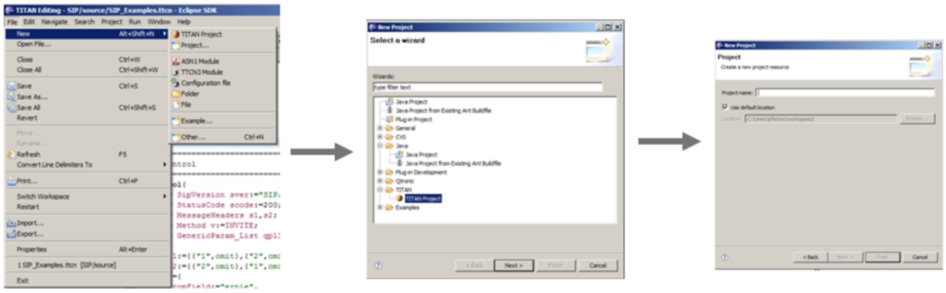
The TTCN Editing perspective



WOW:CREATE NEW…

File menu

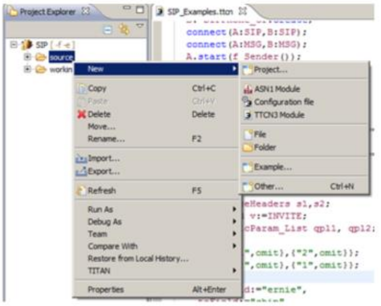
- **New**
  - **Titan Project/TTCN-3 Module/Cfg File**



OR SIMPLY RIGHT CLICK…

To create new element:

- **Either File menu → New → Select the type of the file to be created → select the target folder & assign a name to it.**
- **Or Select the target folder right click to it → new → select the type of the file to be created → assign a name to it.**



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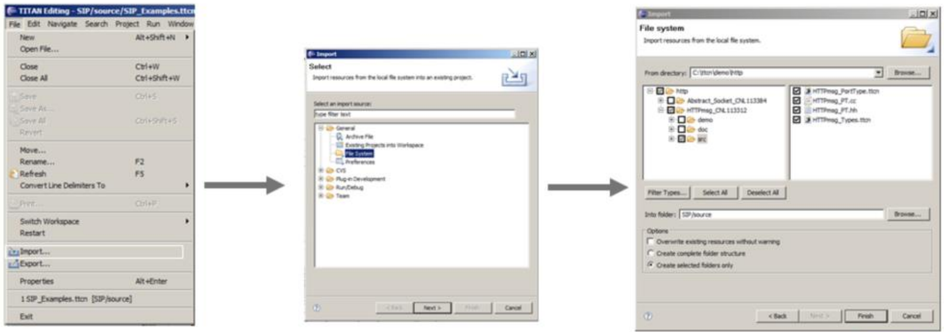
WOW: ADD FILES TO THE PROJECT

By local copy

- **File Menu → import →**
  - **Select the type to be imported (to import ordinary files select the General File System) → Next → Browse for the target directory (that contains the file, the file will be in grey) → press ok → Thick the files to be imported (You can add more than open file..)**



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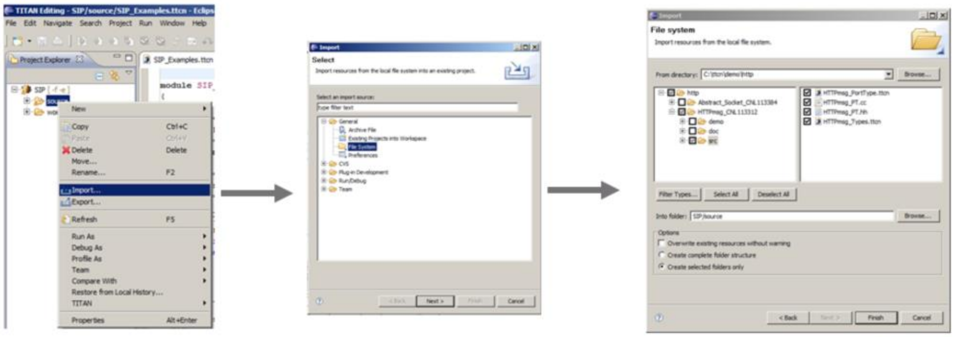
WOW: ADD FILES TO THE PROJECT

Or…

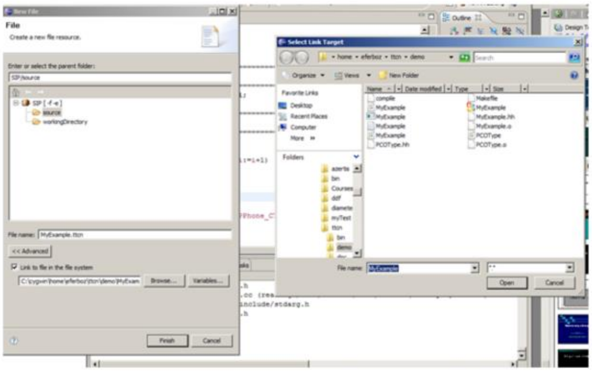
- **Right click to the folder you would like to import**
  - **import → Select the type to be imported (to import ordinary files select the General File System)→ Next → Browse for the target directory (that contains the file, the file will be in grey) → press ok → thick the files to be imported**



WOW: ADD FILES TO THE PROJECT

As link (By references similar to symlinks)

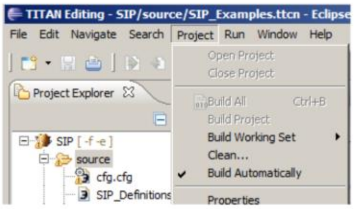
- File menu
  - New → File or Folder
    - → thick the advanced box → thick the *Link to file* in the file system → browse for the target file select the file.

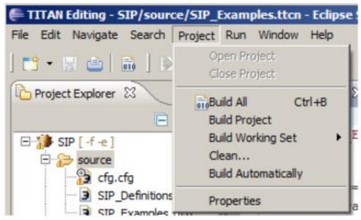


WOW: BUILD THE PROJECT

Build automatically

- **Project menu Build Automatically**
- **After each and every save the code is compiled automatically**
- **The build option at the context menu turns to grey**





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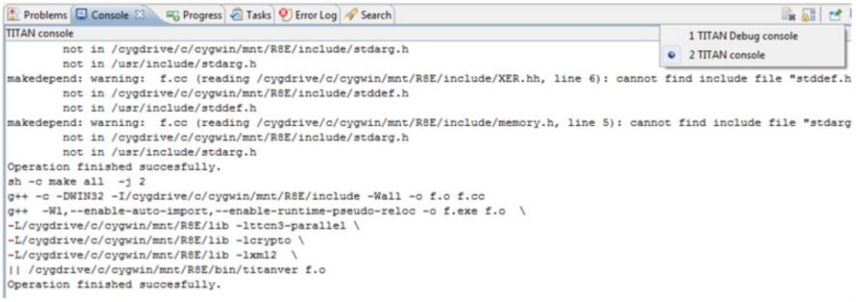
WOW: BUILD THE PROJECT

Build manually

- Project menu ➔ Build Project
  - Builds the project
- Project menu ➔ Build All
  - Builds all the opened projects within the workspace
- Check the result of the process at the TITAN console



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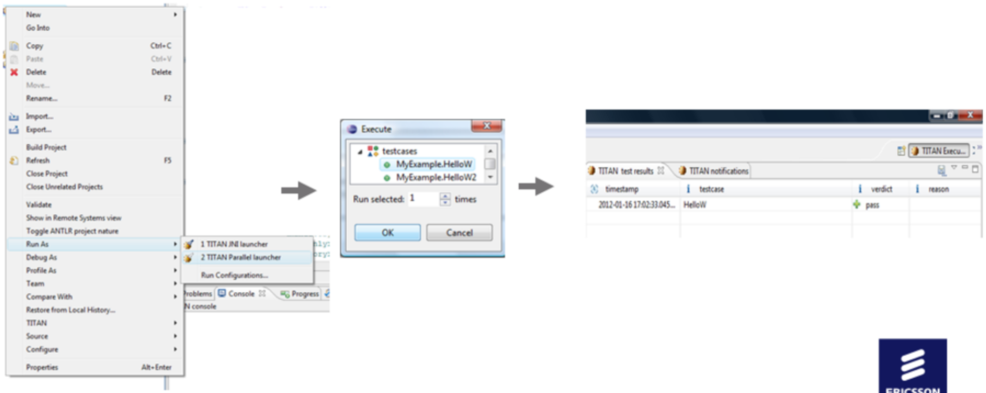
WOW: RUN THE PROJECT

- **Right click to the project**
  - **Run As..**
    - **TITAN Parallel launcher**
  - **Select the testcase/control part to be executed**
- **Check the result at the Titan test result view (TITAN EXECUTOR perspective)**



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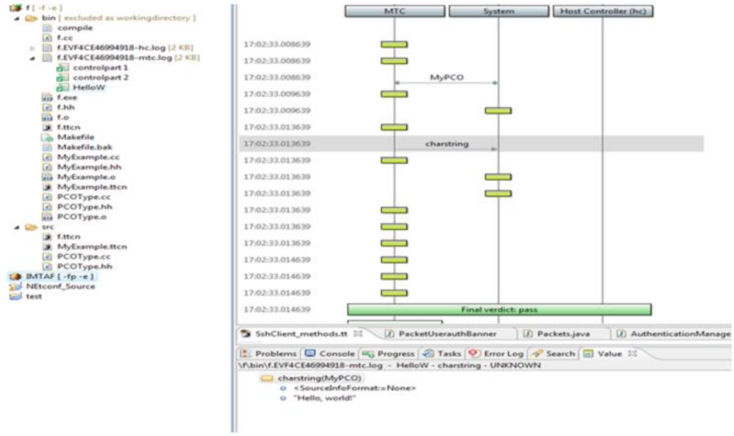
WOW: OPEN THE LOG FILE

Locate the log files (files with .log extension)

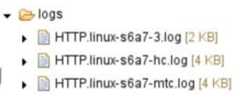
- **Double click to the testcase…**

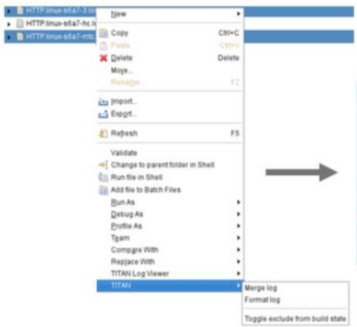


LOGVIEWER PLUGIN

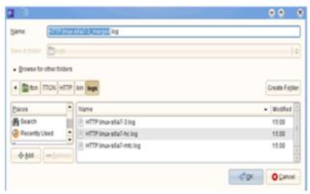
Locate the log files (files with .log extension)

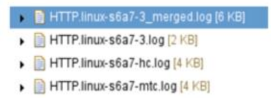
- Each and every test component by default has its own log file
- The information is distributed among the testcases, therefore these log files should be merged first
- Select the log files → right click → Titan Menu Merg





Name the merged log file





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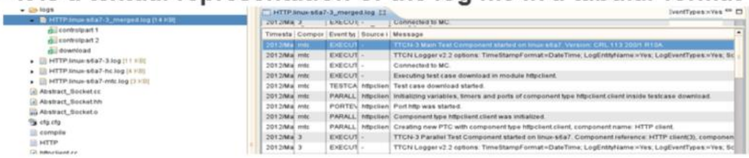
LOGVIEWER PLUGIN

Open the merged log file

- By a double click to the name, the table view will be opened
  - It is a textual representation of the log file in a tabular format



- By a double click to the testcase name (e.g. “download” in the screenshot) the MSC view will be opened

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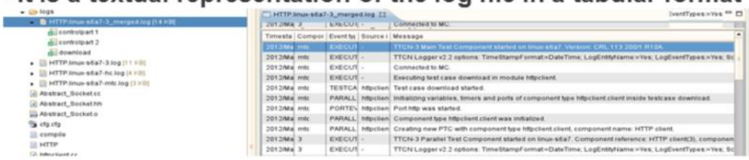
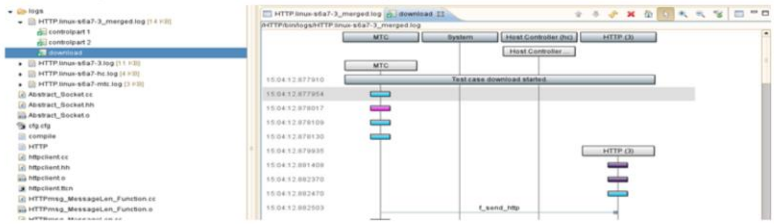
LOGVIEWER PLUGIN

Open the merged log file

- By a double click the name, the table view will be opened
  - It is a textual representation of the log file in a tabular format



- By a double click to the testcase name (e.g. “download” in the screenshot) the MSC view will be opened



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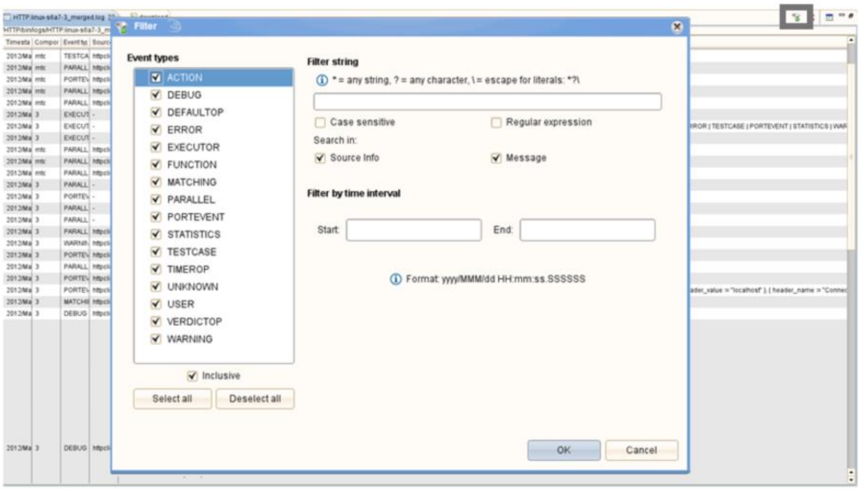
LOGVIEWER PLUGIN

Table view

Filter



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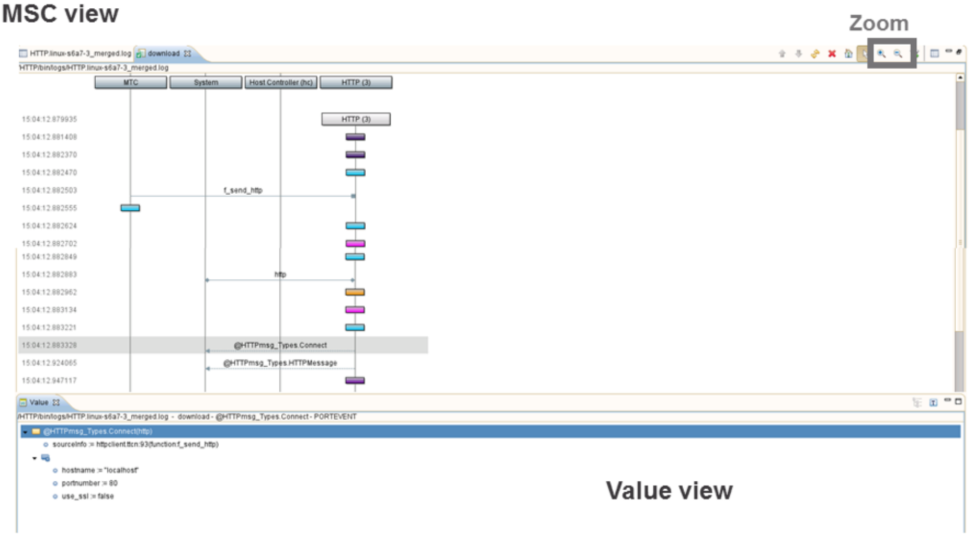
LOGVIEWER PLUGIN

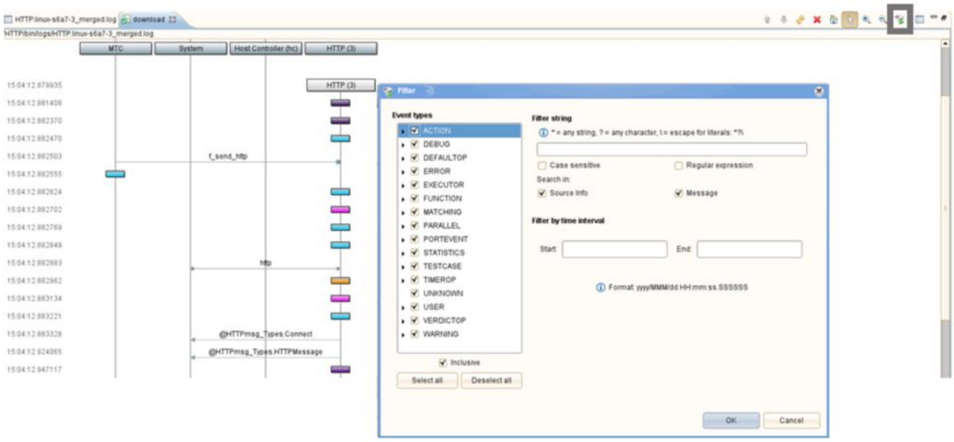
MSC view



LOGVIEWER PLUGIN

MSC view

filter



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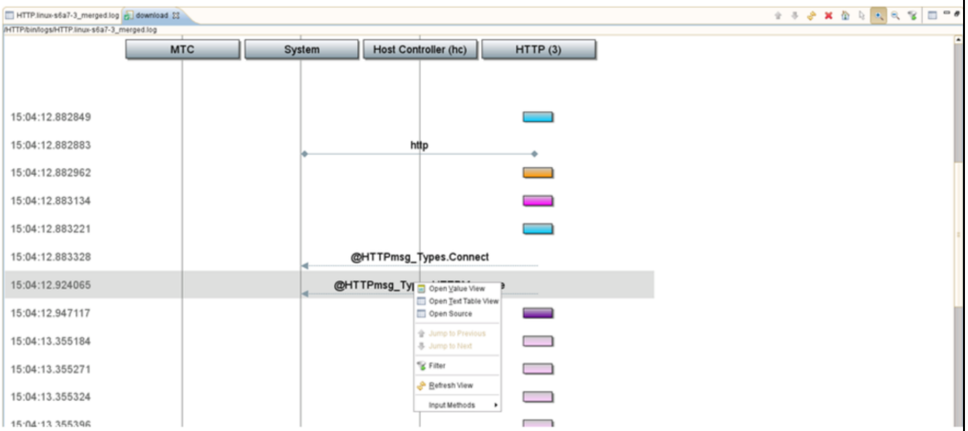
LOGVIEWER PLUGIN

Switch between views: right click to an event



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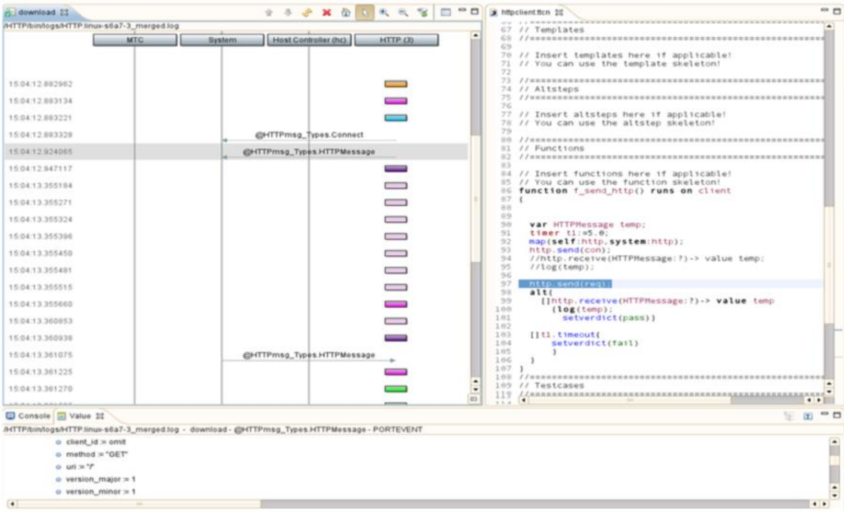
LOGVIEWER PLUGIN

Follow in source: if the cfg file is configured to use source info, the log events are traceable in the source file
A convenient development environment could contain the MSC + Source + Value views



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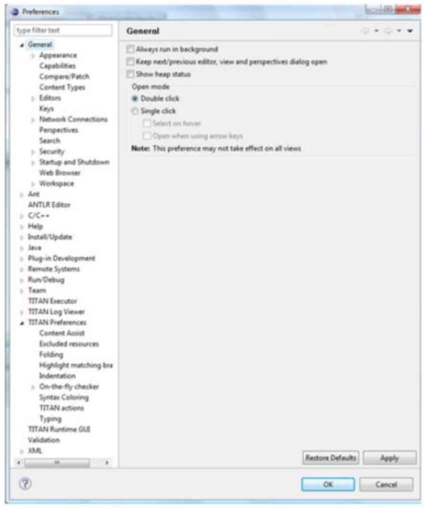
WOW: SET THE PREFERENCES

Window menu ➔ Preferences



<u>GENERAL</u>

Editor Font size:

- **Appearance Colors and Fonts**
- **Basic → Text Font**
- **click edit to set the font size**

<u>TITAN Preferences</u>

- **Content assistant settings**
- **On-the-fly analyzer settings**
- **To tweak the '}', '"' ')' auto insertion Typing**

VII THE TITAN CONFIGURATION FILE

CONFIGURATION FILE STRUCTURE
SECTIONS

CONTENTS

THE RUN-TIME CONFIGURATION FILE

- **Sets important parameters required for test execution**
- **Can be created/edited from GUI or with any text editor**
- **The parameters are subdivided into sections:**
  - **[MODULE_PARAMETERS], [LOGGING], [TESTPORT_PARAMETERS], [EXTERNAL_COMMANDS], [EXECUTE], [GROUPS], [COMPONENTS], [MAIN_CONTROLLER]**
- **The format for predefined and/or user-defined parameters is: <*parameter name*> [:= <*parameter value*> [, <*parameter value*> [...]]]**
- **The permitted parameter names and type of parameter values are section dependent**

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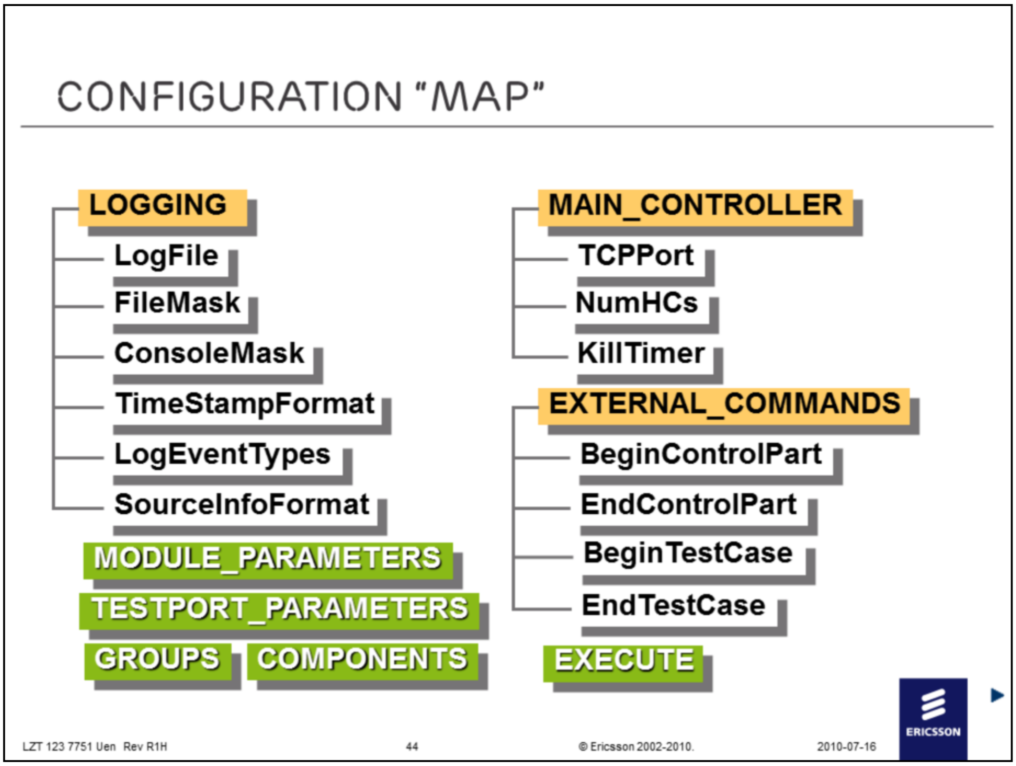
The usual suffix of configuration files is .cfg.



MODULE_PARAMETERS

This section shall contain the values of all parameters that are defined in your TTCN–3 modules.

LOGGING

In this section you can specify the name of the log file and the classes of events you want to log into the file or display on console (standard error).

TESTPORT_PARAMETERS

In this section you can specify parameters that are passed to Test Ports.

EXTERNAL_COMMANDS

This section can define external commands (shell scripts) to be executed by the ETS whenever a control part or test case is started or terminated.

EXECUTE

In this section you have to specify what parts of your test suite you want to execute.

GROUPS (used in parallel mode)

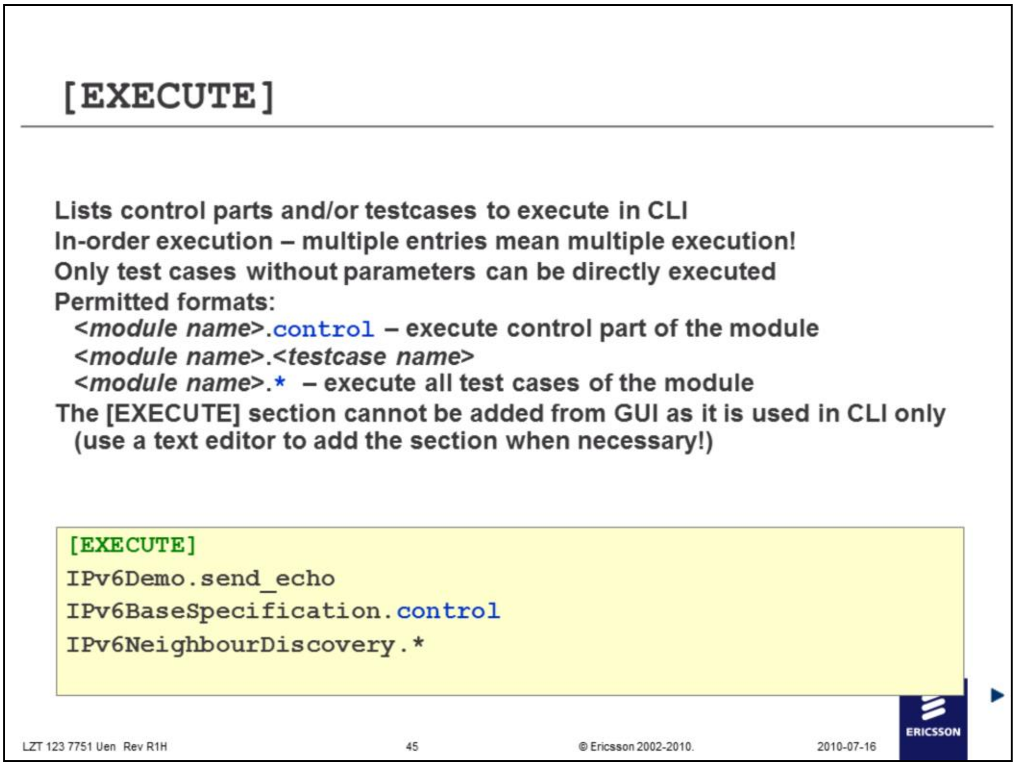
In this section you can specify groups of hosts which can be used to restrict the creation of certain PTCs to a given set of hosts.

COMPONENTS (used in parallel mode)

This section consists of rules restricting the location of created PTCs.

MAIN_CONTROLLER (used in parallel mode)

The variables herein control the behavior of MC.



In single mode the configuration file is useless without this section.

In parallel mode the section is optional.

[LOGGING]

- *LogFile* – name of log file (use in single mode only!)
- *FileMask* – enlists events to be logged to *LogFile*; default: `LOG_ALL`
- *ConsoleMask* – specifies events to be logged to Console; defaults to:
  `TTCN_ERROR | TTCN_WARNING | TTCN_ACTION | TTCN_TESTCASE | TTCN_STATISTICS`
- *AppendFile* –should the old log be overwritten? `Yes`, `No` (default)
- *TimeStampFormat* – `Time` (default), `DateTime` or `Seconds`
- *LogEventTypes* – include symbolic event type in each log entry
  `Yes`, `No` (default)
- *SourceInfoFormat* – insert reference to TTCN-3 line number into log event
  (requires `–L` compiler option!) `Single`, `Stack`, `None` (default)
- *LogEntityName* – `Yes`, `No`: prints the function, test case, etc. that the source line belongs to.

The executable test program produces a log file during its run. The log file contains the important events of the test execution with time stamps. In this section you can specify the name of the log file and the classes of events you want to log into the file or display on console (standard error).

LogFile: To make the names of the log file of the components unique, the string should contain special metacharacters, which are substituted dynamically during test execution. (See Table 8.1 of TITAN User Guide).

FileMask resp. **ConsoleMask** may contain symbolic constants enumerated in table 8.2. of TITAN User Guide

AppendFile controls whether the run-time environment shall keep the contents of existing log files when starting execution.

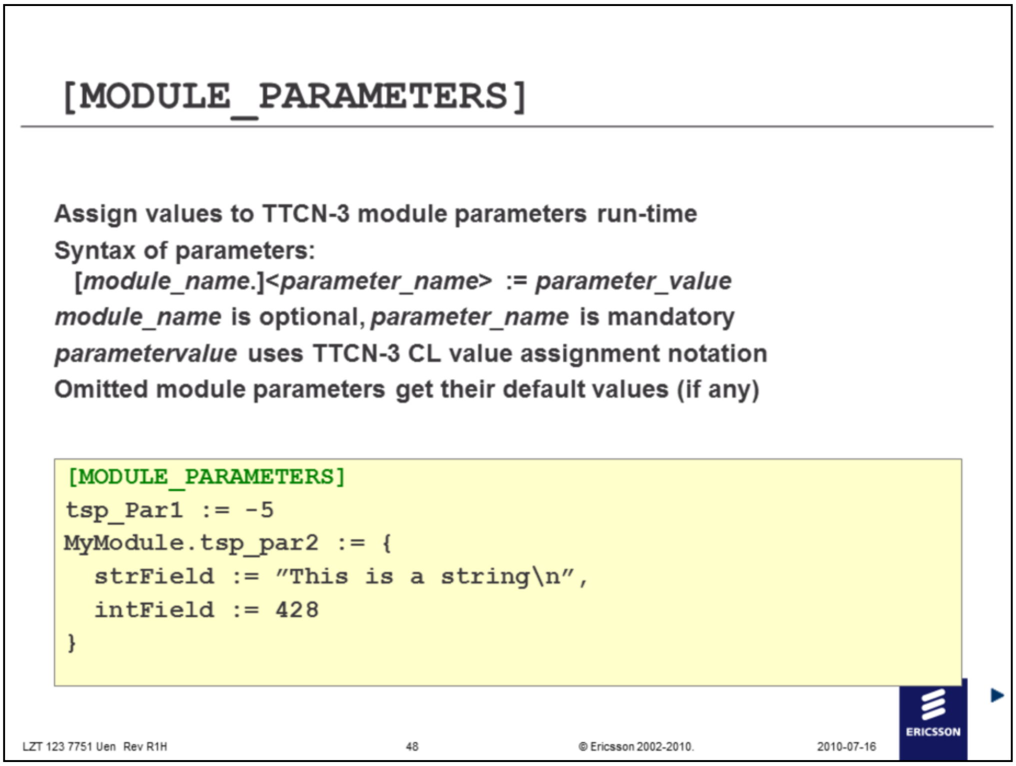
TimeStampFormat: has three possibilities:Time stands for the format hh:mm:ss.microsec. DateTime results in yyyy/Mon/dd hh:mm:ss.microsec. Seconds produces relative timestamps in format s.microsec. (Zero time is at the starting of the test component or test execution). The default value is Time.

LogEventType indicates whether to include the symbolic event type (without the TTCN prefix) in each logged event immediately after the timestamp. The event types are listed in Table 8.2. of TITAN User Guide

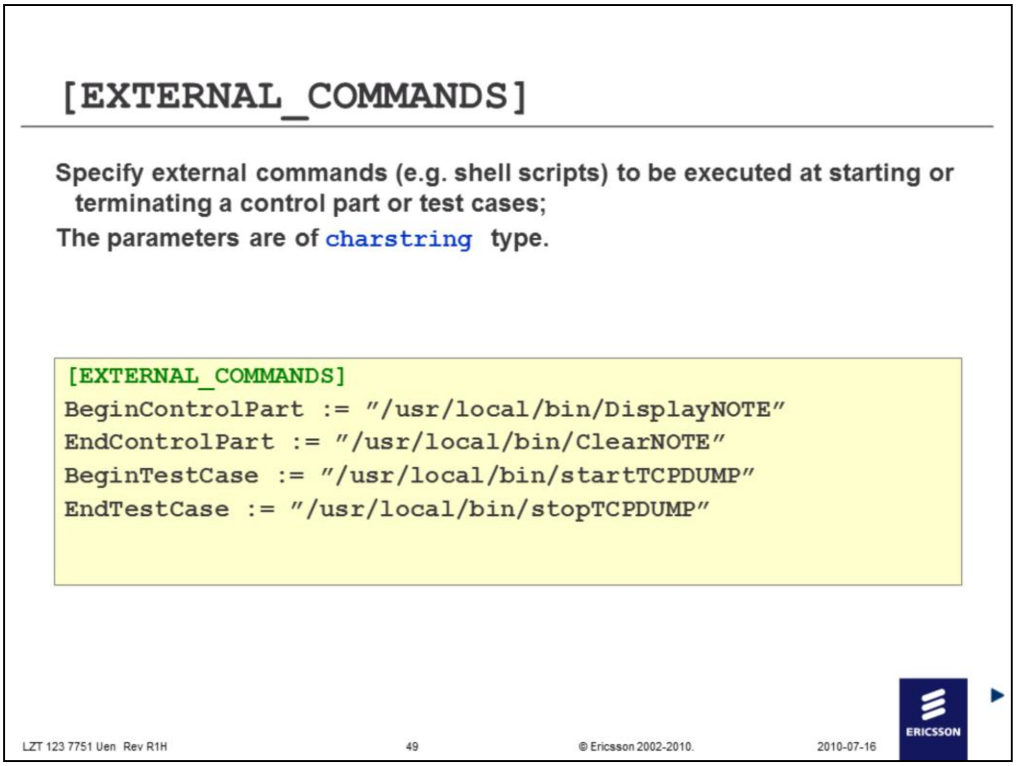
ELEMENTS OF BITMASK (USED IN FILE & CONSOLE MASK)

Identifier in BITMASK	Description of events logged when corresponding event identifier appears in BITMASK
TTCN_ERROR	Dynamic Test Case errors (e.g. snapshot matching failure)
TTCN_WARNING	Run-time warnings (e.g. stopping a not running timer)
TTCN_PORTEVENT	Port events (e.g. send, receive including logging of messages themselves)
TTCN_TIMEROP	Timer operations (start, stop, read, timeout)
TTCN_VERDICTOP	Verdict operations (getverdict, setverdict)
TTCN_DEFAULTOP	Default operations (activate, deactivate)
TTCN_FUNCTION	Function calls
TTCN_TESTCASE	Start, end and final verdict of Test Cases
TTCN_USER	User log() statements
TTCN_STATISTICS	Statistics of verdicts at the end of test execution
TTCN_PARALLEL	Parallel test execution related operations (e.g. create, done)
TTCN_MATCHING	Analysis of template matching failures in receiving operations
TTCN_DEBUG	Debug messages in Test Ports and External Functions
LOG_ALL	Bitwise or of everything except TTCN_MATCHING and TTCN_DEBUG
LOG_NOTHING	Nothing to be logged

The table lists the symbolic constants referring to bit masks used for filtering the events to be written to the log file or the console, respectively.



This section contains the values of all parameters that are defined in your TTCN–3 modules.



This section defines external commands (shell scripts) to be executed by the ETS whenever a control part or test case is started or terminated.

In case of parallel mode, the external command is executed on the host where the MTC runs.

[MAIN_CONTROLLER]

Parameters controlling Main Controller (mctr) behaviour:

TCPPort – specifies the MC server's TCP port number; otherwise the mctr application will choose an ephemeral port to listen on at every invocation; accepts and `integer` value

NumHCs – controls batch mode execution: mctr expects this many HC connections before starting to execute contents of the EXECUTE section; accepts an `integer` value

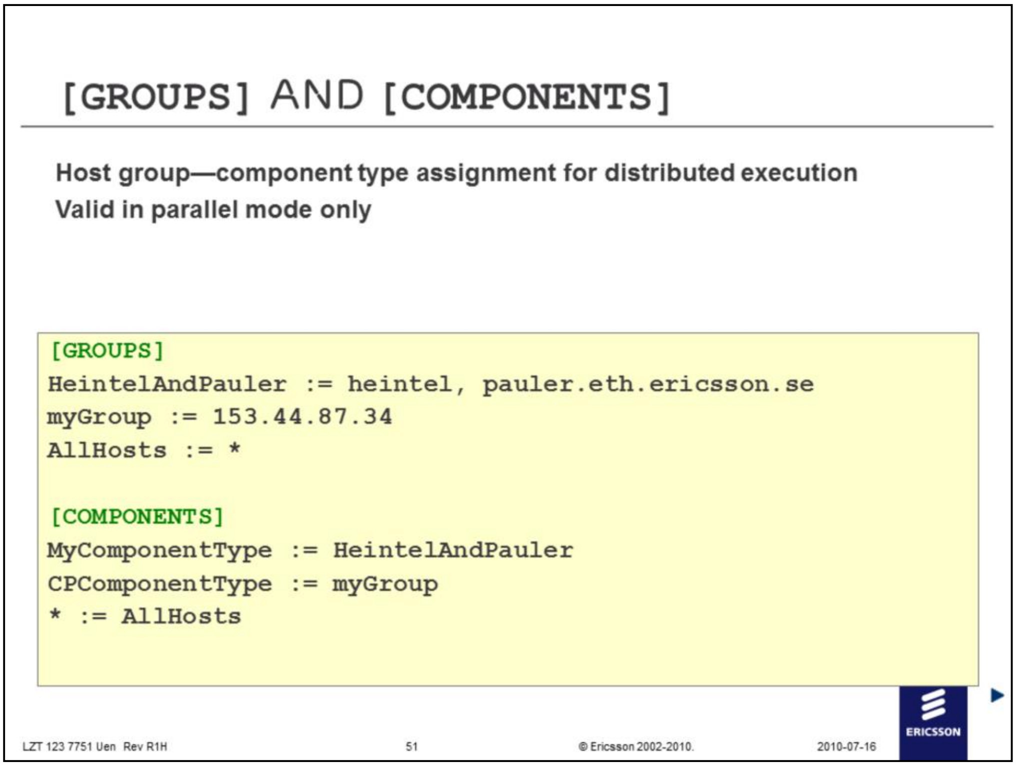
KillTimer – forces PTC termination after stop; requires a `float` value in [s]

```
[MAIN_CONTROLLER]
TCPPort := 9034
NumHCs := 3
KillTimer := 4.5
```


The [MAIN CONTROLLER] section controls the behavior of MC and includes three variables. Variable TCPPort determines the TCP port on which the MC application will listen for incoming HC connections. Use a port number greater than 1024 if you don't have root privileges! The recommended port number is 9034.

The optional NumHCs variable provides support for automated (batch) execution of distributed tests. When the specified number of HCs are connected, the MC automatically creates MTC and executes all items of the [EXECUTE] section.

The KillTimer variable tells the MC to wait some seconds for a busy PTC to terminate when it was stopped. The purpose of this function is to prevent the test system from deadlocks.



Groups of hosts specified in the section [GROUPS] can be used in the [COMPONENTS] section to restrict the creation of certain PTCs to a given set of hosts.

VIII. TITAN INTERNALS

BASIC OVERVIEW OF COMPILATION PROCESS
SYNTACTIC/SEMANTIC ANALYSIS
CODE GENERATION
BUILDING/EXECUTING ETS
THE PARALLEL DISTRIBUTED ARCHITECTURE

CONTENTS

TITAN COMPILATION PROCESS

The compilation of TTCN-3 and ASN.1 modules comprises:

Parsing the input TTCN-3 and ASN.1 files (stops at first error)

Semantic analysis of input TTCN-3 and ASN.1 modules:

- report all errors and warnings appearing in input;
- continue only if no errors are found

Code generation for input modules

Invoking the C++ compiler to compile generated files

Linking the modules with Test Ports, external functions and the proper version of TTCN-3 and ASN.1 base libraries

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SYNTACTIC AND SEMANTIC ANALYSIS

Syntactic analysis:

- Reports “typographic” errors (e.g. mistyped keywords, missing braces)
- Both erroneous and expected token are displayed
- No error recovery: Parse errors brake compilation process (work in progress)

Semantic analysis:

- Detect semantic errors (e.g. type mismatch, formal-actual parameter mismatch, incorrect references) in input
- Full semantic analysis for TTCN-3 and ASN.1 modules since 1.6.pl0
- Supports ambiguous language constructs (e.g. start)
- Error recovery: detects all errors in one run w/o avalanche effect
- Basis for code optimization (in future)

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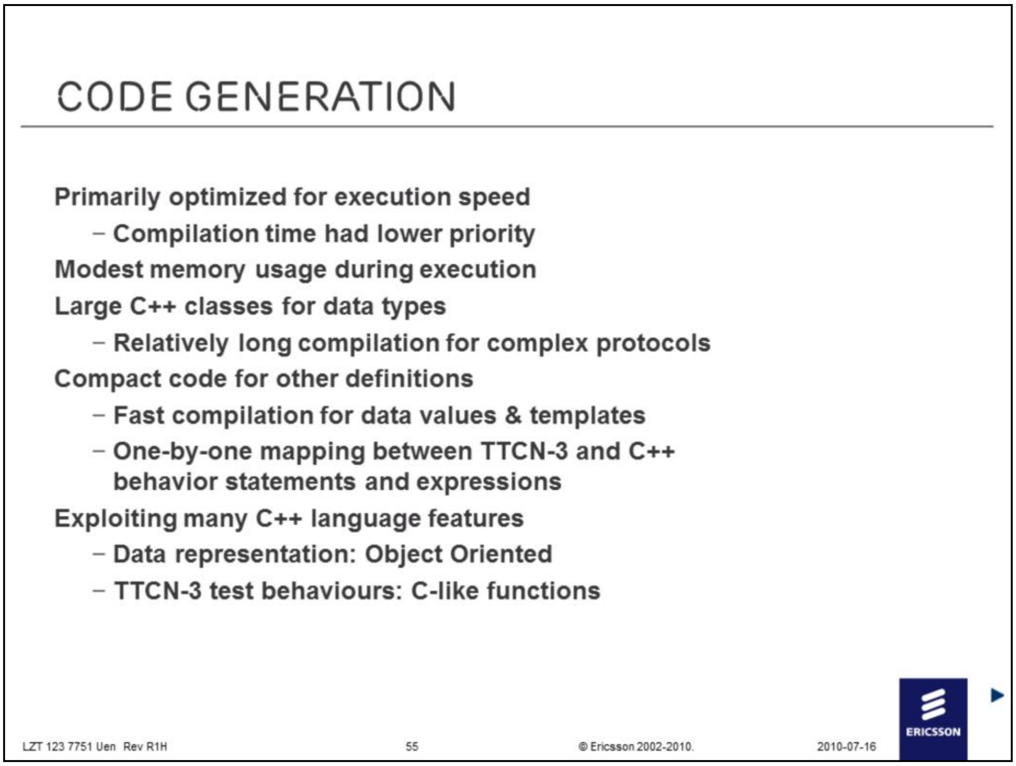
CODE GENERATION
Primarily optimized for execution speed
– Compilation time had lower priority
Modest memory usage during execution
Large C++ classes for data types
– Relatively long compilation for complex protocols
Compact code for other definitions
– Fast compilation for data values & templates
– One-by-one mapping between TTCN-3 and C++ behavior statements and expressions
Exploiting many C++ language features
– Data representation: Object Oriented
– TTCN-3 test behaviours: C-like functions
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BUILDING EXECUTABLE TESTS

- Parts of the executable:
  - C++ code generated from TTCN-3 and ASN.1 modules
  - Test Ports and external functions (user code)
  - Base Library (part of TITAN)
- Fully automated build process using standard tools such as make, makedepend, C++ compiler (GCC)
- Incremental builds are possible
  - Type definitions change seldom
  - Optimal TTCN-3 module structure is important to keep compilation time low
- Makefile generation from “project”
- Clean API for external functions and libraries

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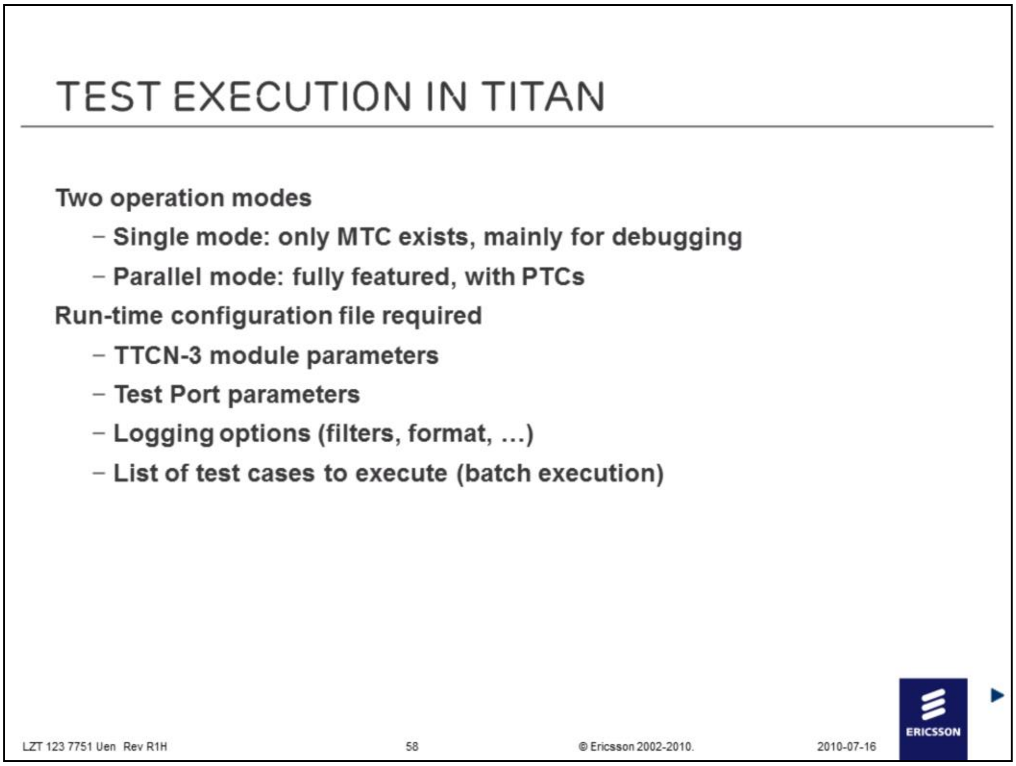
IMPORTANT NOTES

- Platform independent source but *platform-dependent binaries*
- TITAN version, C++ compiler version, module object version, test port version *MUST* be synchronized!
- When change to another TITAN version, you should *make clean*, and rebuild all files.
- Important to have correct build hierarchy – *use Makefile* and always update module *dependency list* if import structure changes!
- Always *read the limitations* section of the user guide!



MTC: Main Test Component

PTC: Parallel Test Component

DEBUGGING AND TEST RESULT ANALYSIS

Debugging capabilities:
- No source level TTCN-3 debugger
- Precise, self-explanatory error messages from semantic analyzer and RTE
- Console logging and configuration monitoring
- C++ debuggers (GDB) are usable for Test Ports in single mode

Logging:
- Configurable, detailed logging to console and file
- Log entries contain timestamp, reference to source file and line number, etc.
- Separate log file (with configurable name) for each test component
- Almost “everything” can be logged explicitly from TTCN-3 using `log`
- Logging of template matching failures in alternatives (TTCN_MATCHING)
- Post-processing (merging, filtering, pretty-printing) of log files

LOG FILE PROCESSING UTILITIES

`ttcn3_logformat [-i n] [-o outfile] [-s] {input.log}`

- Pretty-prints contents of file.log or stdin
- Result is saved into outfile or written stdout
- `n` defines indentation depth
- `-s` places each test case log into a separate file

`ttcn3_logmerge [-o outfile] {input.log}`

- Merges the content of all argument files into a single log file sorted by increasing timestamp. Results go into `outfile` or `stdout`.
- Only files using the same timestamp format (`Time, DateTime`) are merged (`Seconds` not implemented)!

`ttcn3_logfilter [-o outfile] {eventtype+|-} [input.log]`

- Filters events specified on argument list from input.log or stdin.

PARALLEL DISTRIBUTED TEST EXECUTION – FEATURES

Execution environment

- Distributed parallel test execution
- Can work on heterogeneous environment (over a TCP/IP network)
- Scalability, load balancing between group of hosts
- Dynamic component creation and run-time test reconfiguration (controlled from the TTCN-3 code)
- Transparent internal communication (between connected test components)
- Configurable automatic test execution (mixed list of module control parts & test cases)

High execution performance

- Applicable for load testing (traffic generation) as well
- Message sending takes 0.1…0.2 ms (highly depends on machine performance and test port code efficiency)

COMPONENTS OF PARALLEL DISTRIBUTED TEST ARCHITECTURE

Main Controller (MC)
- Central test campaign management, configuration and log monitoring
- Embedded GUI or standalone CLI version
- Maintains direct control connection with all components

Host Controller (HC)
- An instance of the executable program
- Exactly one HC on each computer taking part in distributed execution
- Creates a new test component by duplicating itself

Main Test Component (MTC)
- Special test component that created first at test case execution
- Only one MTC in the Test System but it can change its component type
- Can execute the control part of a TTCN-3 module

Parallel Test Component (PTC)
- Created by HC upon request from MC
- Executes TTCN-3 function

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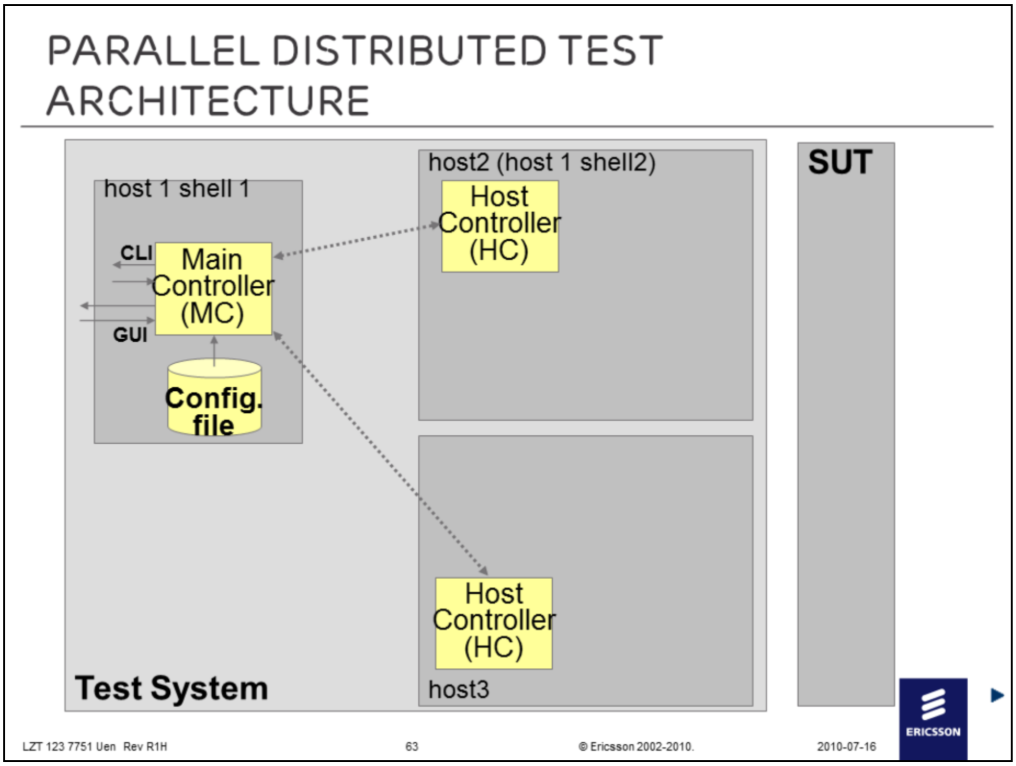
PARALLEL DISTRIBUTED TEST ARCHITECTURE
host 1 shell 1
CLI
GUI
Main Controller (MC)
Config. file
host2 (host 1 shell2)
Host Controller (HC)
Host Controller (HC)
host3
Test System
SUT
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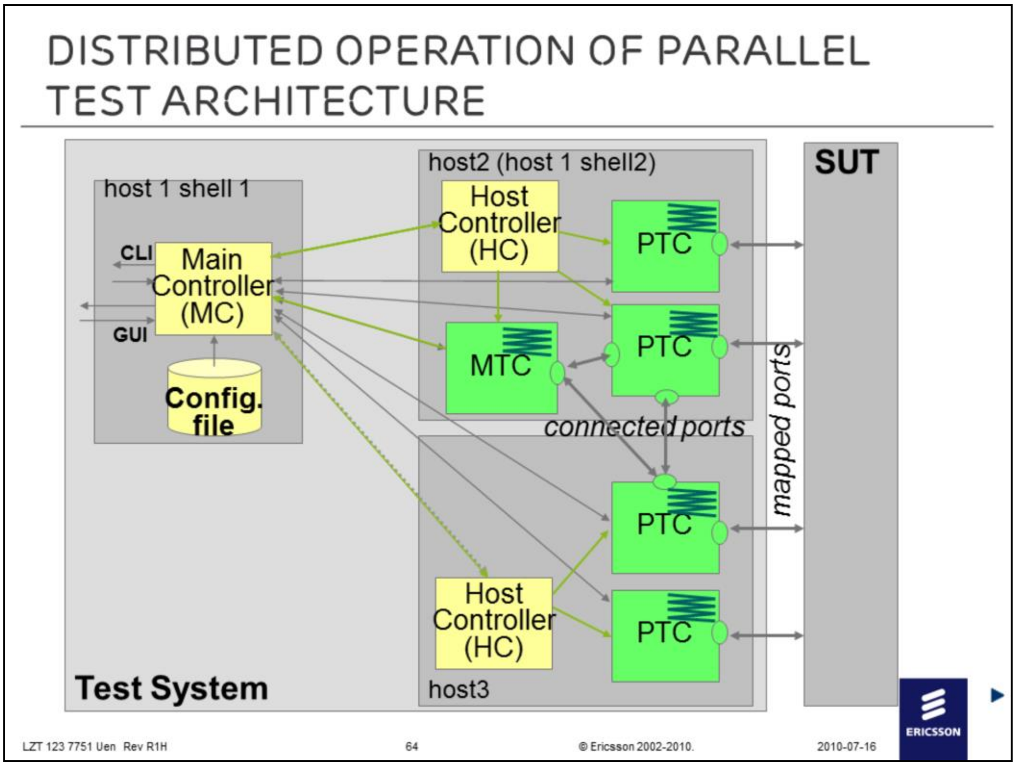
DISTRIBUTED OPERATION OF PARALLEL TEST ARCHITECTURE
host 1 shell 1
CLI
Main Controller (MC)
GUI
Config. file
host2 (host 1 shell2)
Host Controller (HC)
PTC
PTC
MTC
connected ports
mapped ports
SUT
PTC
PTC
Host Controller (HC)
host3
Test System
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THE CONTROL PROTOCOL BEHIND THE PARALLEL ARCHITECTURE

Purpose of communication
- PTC creation / termination
- Establishing / destroying port connections and mappings
- Transport of internal TTCN-3 messages between PTCs
- Test campaign management

Messages are sent over a reliable transport channel

Platform independent abstract messages

Verified with SPIN model checker

Around 50 different PDUs

Possible bottleneck: MC
- Used for test setup only, inactive during load generation

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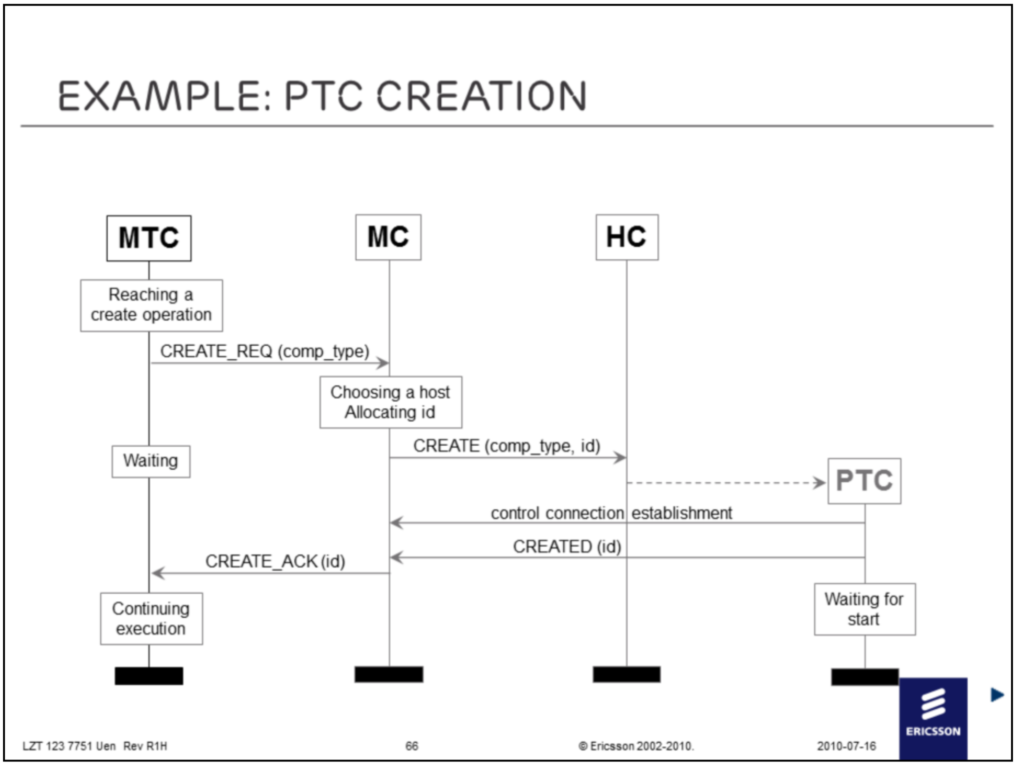
EXAMPLE: PTC CREATION
MTC
MC
HC
Reaching a create operation
CREATE_REQ (comp_type)
Choosing a host Allocating id
CREATE (comp_type, id)
Waiting
PTC
control connection establishment
CREATED (id)
CREATE_ACK (id)
Continuing execution
Waiting for start
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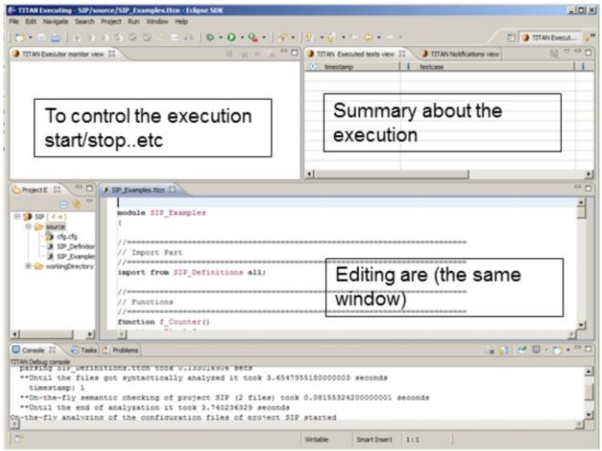
ECLIPSE EXECUTOR PLUGIN

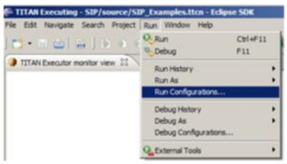
The TTCN executor perspective

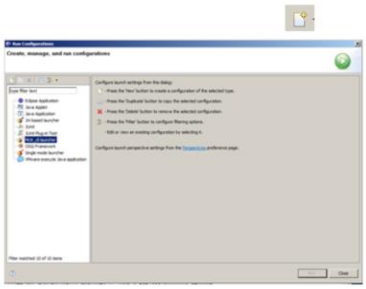


ECLIPSE EXECUTOR PLUGIN

The executor plugin provides a GUI interface to set all the required parameters

- **Run menu..**
  - **Run Configuration…**
- **Create new Parallel Launcher (or edit an existing one)**
  - **Set the MC options**
  - **Set the HC options**
- **Launch the code**

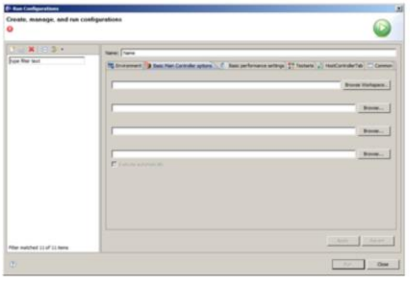


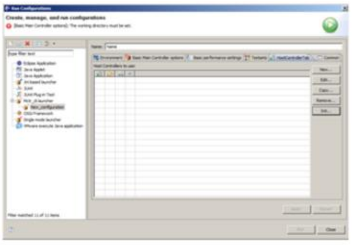


WAY OF WORKING WITH ECLIPSE PLATFORM

- Basic Main controller options
  - Browse for the project to be executed
  - The three records below will be filled up automatically
  - Browse for the cfg file if there is any
- Host Controller tab
  - Press the init button it will initialize all the required field

Press Run





IX. BUILDING EXECUTABLE TEST SUITES FROM COMMAND LINE (W/O GUI)

COMPILING MANUALLY
BUILDING EXECUTABLE TEST SUITES
AUTOMATIC BUILD USING MAKE

CONTENTS

BUILDING THE ETS MANUALLY

Translate your TTCN-3 core language module into C++:

```
$TTCN3_DIR/bin/compiler modulename.ttcn
```

Results: `modulename.hh, modulename.cc` (provided the module has the same identifier as the file's name!)

Compile the generated C++ code:

```
g++ -c -I$TTCN3_DIR/include modulename.cc -o modulename.o
```

Link the object with the TTCN-3 base library and OpenSSL code library:

```
g++ -o modulename modulename.o -L$TTCN3_DIR/lib
-lttcn3 -lcrypto
```

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BUILDING THE EXECUTABLE TEST SUITE

Generate makefile:

```
ttcn3_makefilegen {module}* {testport}* {other}*
  -e PROJECTNAME
```

Edit the generated makefile:

- Set the `TTCN3_DIR` to the base directory of installation
- Assure that `TTCN3_LIB` contains the desired TTCN-3 base library (`ttcn3` for single mode, `ttcn3-parallel` for parallel mode)
- Ensure that `CXX` points to the appropriate C++ compiler version
- Optionally add new switches to `CPPFLAGS`, `CXXFLAGS` and `LDFLAGS`
- You SHOULD NOT modify the rest of the generated makefile – regenerate it when new modules are added!

Resolve import dependencies – `make dep`

Build the ETS – `make`

EXTRA FEATURES IN MAKEFILE

- Perform syntactic and semantic analysis only `make check`
- Clean all generated files using `make clean`
- Make an archive of all sources under directory `ARCHIVE_DIR` using `make archive`
- More advanced features of GNU make are utilized when generating Makefile with `-g` flag

X. EXECUTING THE EXECUTABLE TEST SUITE FROM COMMAND LINE (W/O GUI)

EXECUTION IN SINGLE MODE
PARALLEL MODE TEST EXECUTION

CONTENTS

EXECUTING THE ETS IN SINGLE MODE

The ETS generated during the build process can be executed without the need for any other application when the ETS was built in *single* mode

The generated output file will be the ETS itself

ETS takes one mandatory parameter for its execution: the *configuration file*

Optional parameters of the ETS:

`-v` prints tool version, license information, compilation time and checksum of the participating modules

`-l` lists the names of all control parts and test cases in the ETS

EXECUTING THE ETS IN PARALLEL MODE

- The execution in parallel mode requires the Main Controller (MC)
- Two kinds of MC: GUI version (see GUI pres.) and CLI version
- The CLI version of MC can be started with:

  ```
  mctr_cli [module-cfg-file]
  ```

  where `module-cfg-file` is the run-time configuration file
- In addition to the ETS itself, the target file generated during build process contains some static code, the Host Controller (HC)
- The HC can be started from a shell; it requires the hostname (or IP address) and TCP port number of the MC in order to connect to it:

  ```
  modulename <MC-hostname> <MC-port>
  ```
- The parallel architecture is based on client-server mode operation between MC (TCP server) and some HCs (TCP clients)

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MAIN CONTROLLER COMMANDS IN CLI MODE

MC commands available in CLI:

- `help` **[*command*]: display help overview or specific help on *command***
- `cmtc`**: create Main Test Component (1st step of test execution)**
- `smtc` **[*something-to-execute*]: start *something-to-execute* or contents of the [EXECUTE] section of the run-time configuration file on MTC**
- `emtc`**: terminate Main Test Component**
- `quit`, `exit`**: terminate MC and quit to shell**
- `stop`**: stop test execution at next appropriate state**
- `pause` **[** `on` **|** `off` **]: toggle interrupt after test case execution**
- `continue`**: resume interrupted test execution**
- `info`**: display information on current status of test configuration**
- **!*command*: execute *command* in underlying shell**

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EXAMPLE EXECUTION WITH SINGLE HC

Start the MC in shell 1:
`mctr_cli Test.cfg`

`TCPPort := 9999` is set in [MAIN_CONTROLLER] section

<MC gives prompt and waits for HC connections>

Start a HC in shell 2:
`Test mc-host 9999`
<Terminal is blocked>

<HC connection is accepted>

<No more HC is expected>

Create MTC: `cmtc`

Execute control part of module Test: `smtc Test.control`

<Wait for execution to finish>

Shut down the MTC: `emtc`

Quit MC: `quit`

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XI. TITAN TEST PORTS

TEST PORT BASICS
TEST PORT API
PROGRAMMING A TEST PORT

CONTENTS

WHAT IS A TEST PORT (TP)

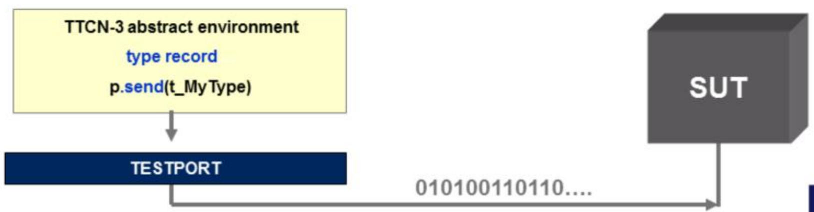
Ericsson proprietary communication interface between TITAN and SUT (i.e. abstract TTCN-3 test configuration and real world)

Translate abstract TTCN-3 messages into real-world messages

It contains:

- Formal Data Type Definitions
- Encoder/Decoder Functions
- (Utility Functions)
- Transport

Test System Architecture



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TEST PORT CONCEPT

Ericsson proprietary communication interface between TITAN and SUT (i.e. abstract TTCN-3 test configuration and real world)

Translate abstract TTCN-3 messages into real-world messages:

- Directly or using some 3rd party HW or SW (e.g. EIN protocol stack, UNIX OS)
- Protocol specific encoding and decoding

Consequently:

- Different protocols need different Test Ports
- Alternative applications of the same protocol may need different Test Ports

Test Ports written by TCC are PRODUCTs related to TITAN, therefore:

- come with full documentation (User Guide, Function Specification, PRI)
- include maintenance (Trouble Reporting in MHWEB)

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SUT: System Under Test

TCC: Test Competence Center

TEST PORT PROPERTIES AS SEEN FROM TTCN-3

- Test Ports are transparent in TTCN-3
- Test Ports are associated to communication ports of components
  - except ports used solely for internal communication i.e. declared using `with { extension "internal" }` attribute
- Link between TTCN-3 port type definition and TITAN Test Port is their identifier:
  - TTCN-3 port type: `type port MyPort message { ... };`
  - is for instance implemented in C++ as: `class MyPort;`
- Single Test Port instance is used for each TTCN-3 port
- Test Ports are created and started together with the TTCN-3 ports automatically at component instantiation

TEST PORT CONTENTS

Test Ports can be obtained from TCC's ClearCase VOB
- usually mounted under `/vobs/ttcn/TCC_Releases/TestPorts`
- refer to TCC's FAQ pages on intranet or contact your ClearCase administrator otherwise!

Test Ports contain
- TTCN-3 source file with port type definitions of the Test Port
- Optional additional TTCN-3 source file containing additional definitions
- A pair of C++ header and source files containing the Test Port implementation
- Extensive documentation
- Optional unofficial demo or test modules in TTCN-3

USING TEST PORTS

- Always read Test Port's User Guide first
- Required Test Ports must be added to TITAN Project
  - including all source files (e.g.: *.ttcn, *.cc, *.hh) and optional dependencies
    (e.g.: Abstract Socket)
- TTCN-3 module of selected Test Port containing the port type definition MUST be imported into your module
- TTCN-3 and/or ASN.1 module(s) of selected Test Port containing the protocol type definitions MUST be imported into your module
- Test Ports can accept run-time parameters
  - depending on particular Test Port product
  - documented in Test Port's User Guide
  - can be set in `[TESTPORT_PARAMETERS]` section of configuration file

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[TESTPORT_PARAMETERS]

Specify parameters to be passed to Test Ports when started

Syntax:

<component_name>.<port_name>.<parameter_name> := *<parameter_value>*

component_name – component reference (`integer` value), `mtc`, `system` or `*` (all components)

- `system` refers to Test System Interface, passed at mapping of system ports

port_name – port identifier, including optional array reference; or `*` (all ports of the given component)

parameter_name – depends on the test port used

parameter_value – only `charstring` values permitted

In this section you can specify parameters that are passed to Test Ports.

PROGRAMMING A TEST PORT

- Test Port skeleton can be generated from port type definition
  - Port type definitions of a Test Port reside in a separate TTCN-3 module that has to be imported in all TTCN-3 modules, which use this Test Port
  - When generating test port skeleton a pair of .hh and .cc files are created
- Protocol-dependent parts written by the user:
  - C++ functions generated for messages declared `out` are invoked when the particular message is sent in TTCN-3; these functions are responsible for message encoding
  - The generated event handler function gets triggered by state change of designated file descriptors or at regular time interval
  - The event handler implementation is responsible for decoding and forwarding incoming messages to the TTCN-3 Run-Time Environment
- Test Port functions MUST be non-blocking

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EXAMPLE

```
// TestPortTypeDef.ttcn
// TTCN-3 module containing Test Port's port type definition
module TestPortTypeDef {
  type port PortTypeDef message {
      inout charstring;
  }
}
```

```
// C++ class implementing the Test Port resides in:
// PortTypeDef.hh, PortTypeDef.cc
```

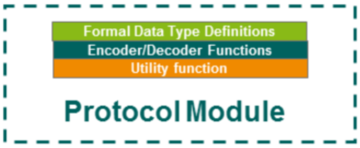
```
// Using the Test Port defined in module TestPortTypeDef
module ExampleUsesTestPortTypeDef {
  import from TestPortTypeDef all;
}
```

WHAT IS A PROTOCOL MODULE (PM)

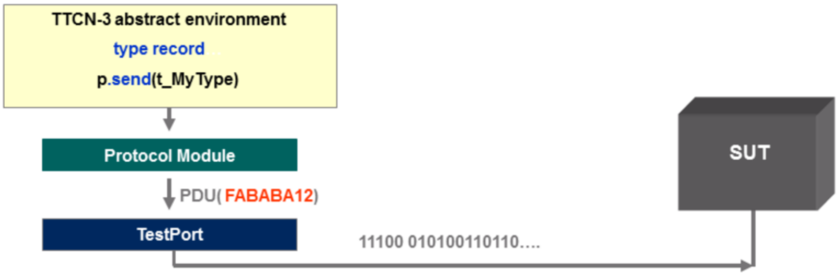
Protocol modules implement the message structure of the related protocol in a formalized way, using the standard specification language TTCN-3.

It contains:

- Formal Data Type Definitions
- [Encoder/Decoder Functions]
- [Utility Functions]



Test System Architecture



EXAMPLE

```
module Demo {
 import from GTCP_Types all;
 import from UDPPortTypeDef all;

type component GTP_CT { port UDPPortType UDP_PCO ;}
testcase tc() runs on..
{…
var PDU_GTCP v_gtcp_pdu:={
   pn_bit:='0'B,
   s_bit:='1'B,
   e_bit:='1'B,
   spare:='0'B,
   pt:='1'B,
   version:='100'B,
   messageType:='0A'O,
   lengthf:=0,
   teid:='01020304'O
   opt_part:=omit,
   gtcp_pdu:={echoRequest:={private_extension_gtpc:=omit}}
}
…
var ASP_UDP_message v_udp_asp;
  v_udp_asp:={
    data := enc_GTPC_PDU(v_gtpc_pdu),
    addressf := "",
    portf := 0,
    id:=omit }
UDP_PCO.send(v_udp_asp);}
```

Message type of the PM

```
type record PDU_GTPC {
BIT1                         pn_bit,
BIT1                         s_bit,
BIT1                         e_bit,
BIT1                         spare,
BIT1                         pt,
BIT3                         version,
OCT1                         messageType,
LIN2_BO_LAST                 lengthf,
OCT4                         teid,
GTPC_Header_optional_part opt_part optional,
GTPC_PDUs                    gtpc_pdu
```

Encoding function of the PM

Message type of the TP

```
type record ASP_UDP_message{
 PDU_UDP              data,
 AddressType          remote_addr optional
 PortType             remote_port optional,
 integer              id optional  }
```

```
// C++ class implementing the Protocol Module's encoding function
// TCP_EncDec.cc
```

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