Introduction to the TEMA Toolset

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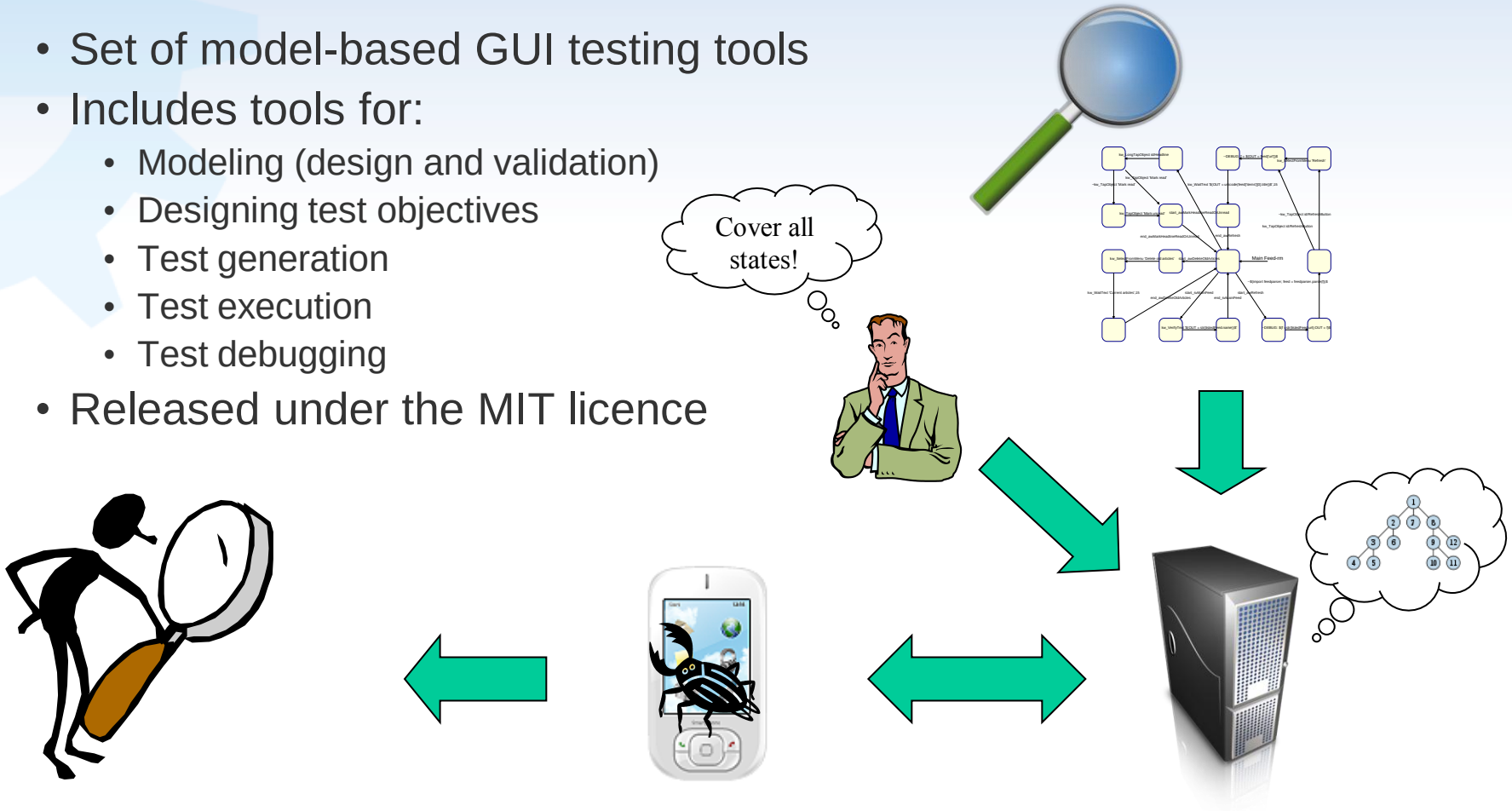
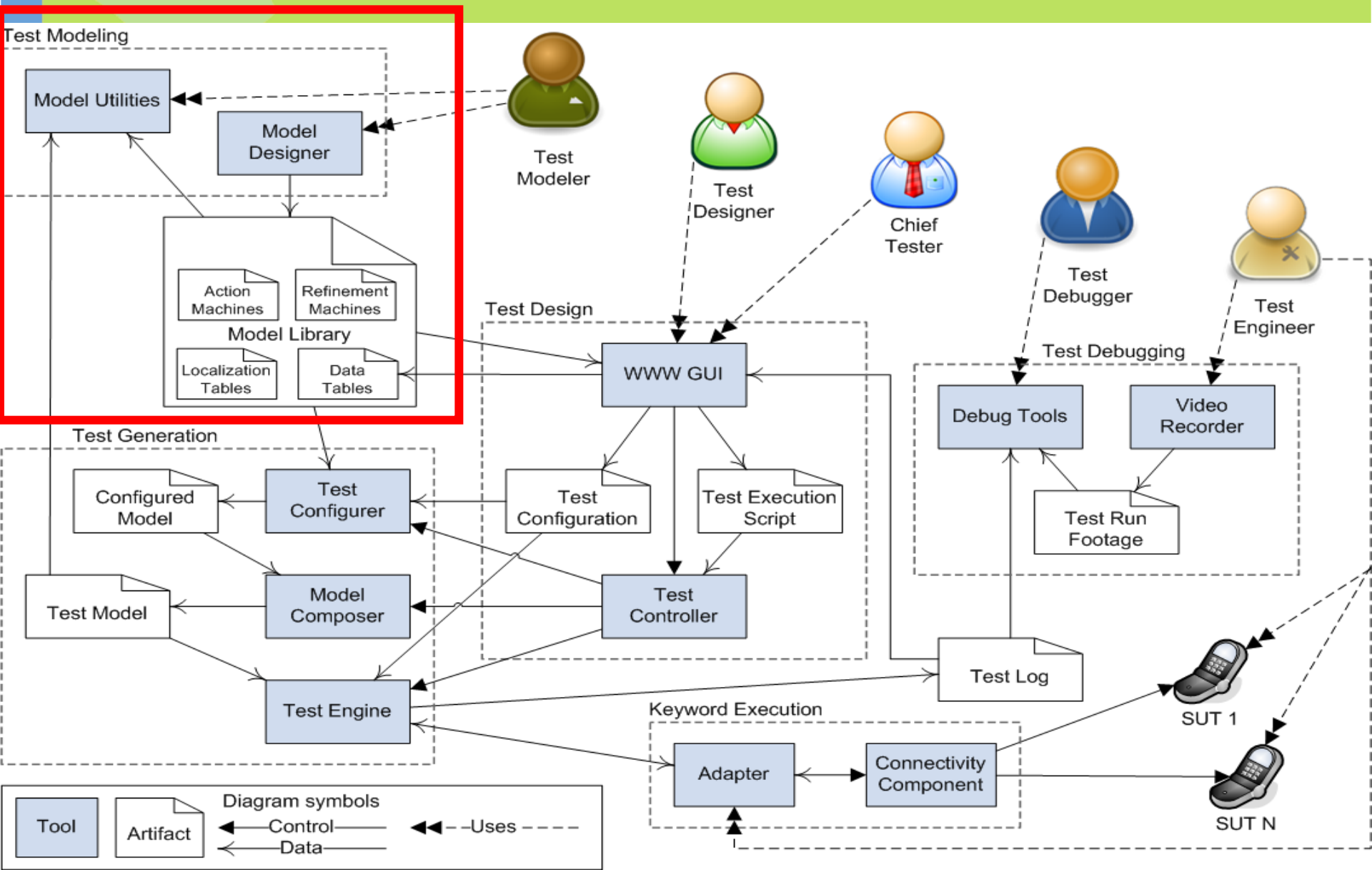
What is the TEMA Toolset?

- Set of model-based GUI testing tools
- Includes tools for:
  - Modeling (design and validation)
  - Designing test objectives
  - Test generation
  - Test execution
  - Test debugging
- Released under the MIT licence



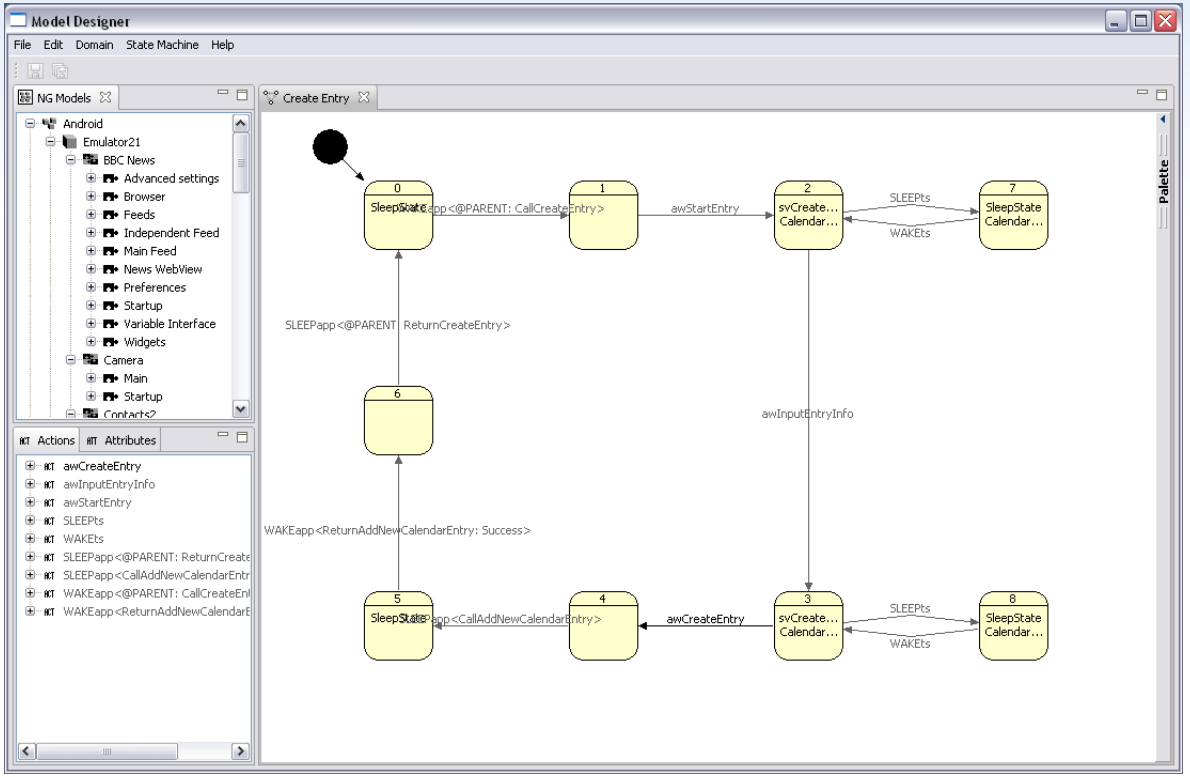
Test Modeling



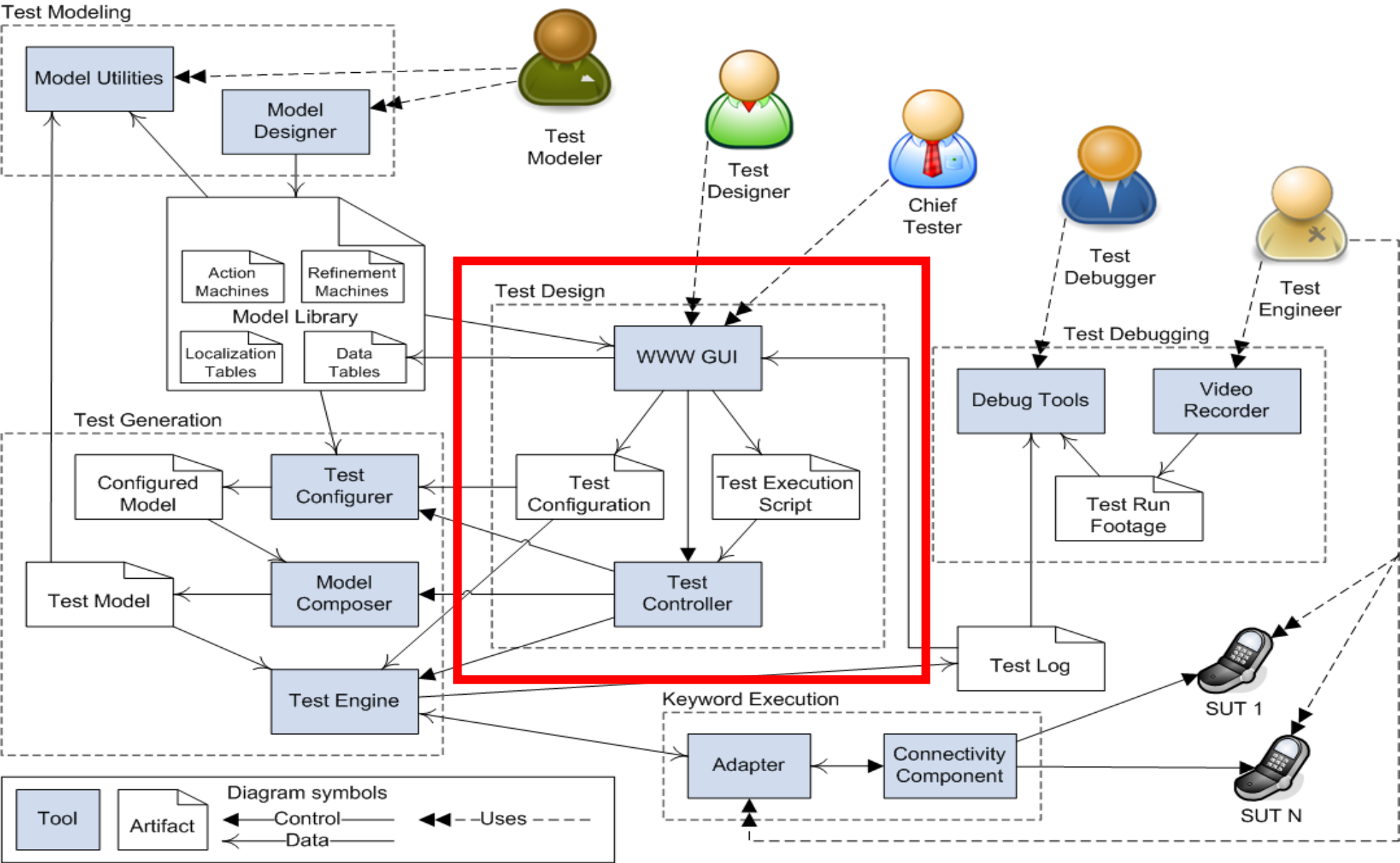
Test Modeling

Includes:

- Model Designer for developing state machine models
- TEMA Model features:
  - Division to small components
  - Two-level models
  - Concurrency
  - Embedded Python code
- Model simulation and validation tools for ensuring model correctness
- Conversion tools between model-formalisms



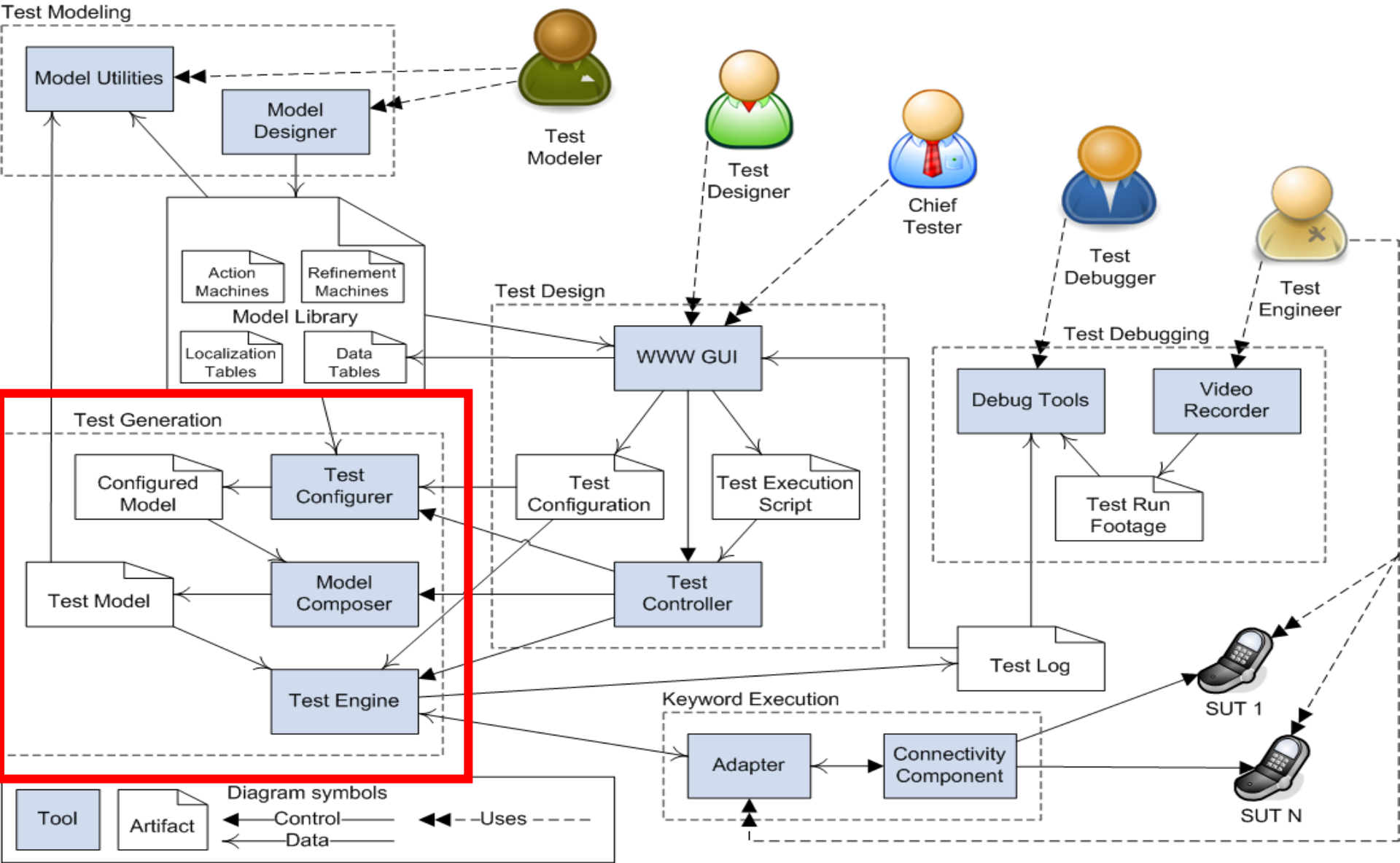
Test Design


Test Modeling
Model Utilities
Model Designer
Test Modeler
Test Designer
Chief Tester
Test Debugger
Test Engineer
Action Machines
Refinement Machines
Model Library
Localization Tables
Data Tables
Test Design
WWW GUI
Test Debugging
Debug Tools
Video Recorder
Test Generation
Configured Model
Test Configurer
Test Configuration
Test Execution Script
Test Run Footage
Test Model
Model Composer
Test Controller
Test Log
Test Engine
Keyword Execution
Adapter
Connectivity Component
SUT 1
SUT N
Diagram symbols
Tool
Artifact
Control
Data
Uses

Test Design

- Since testers don't want to directly deal with models or test generation algorithms, we have abstracted them out in our web GUI
- TEMA web GUI is a testers' interface with the test server, used for designing and managing test configurations, running and tracking actual tests, and managing test model packages
- The test generation is abstracted behind different testing modes:
  - Bug-hunting test
  - Use case test
  - Smoke test
  - Basic coverage test
- This all boils down to allowing testers to just choose what they want to test and what physical device they want to run their tests on

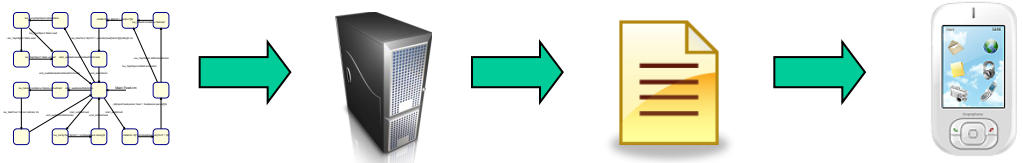
Test Generation



Test Generation

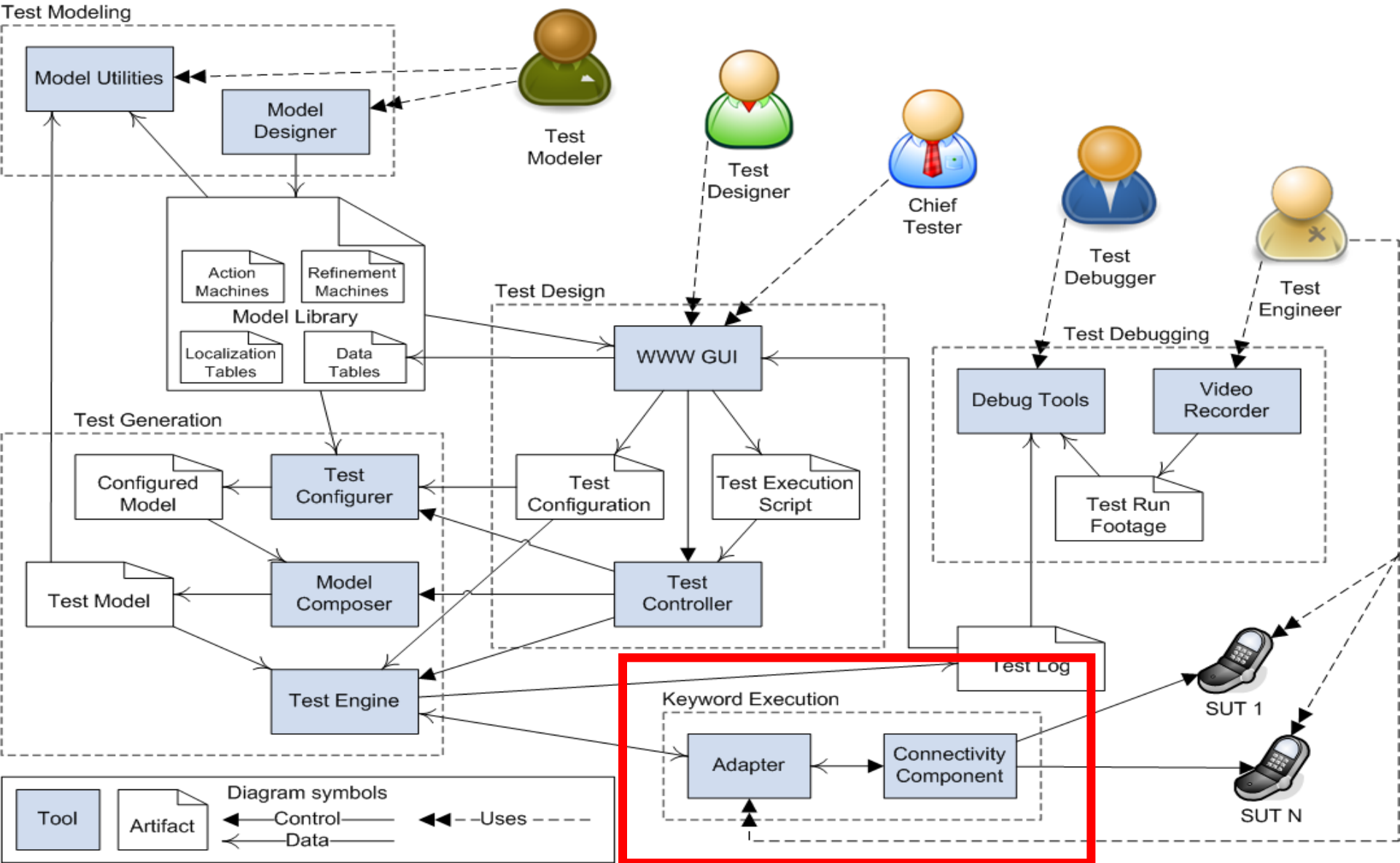
- Composes a full test model from the model components on the fly during execution
- We use various graph search algorithms, such as random and interaction-based algorithms
- The end user is only concerned with Web GUI modes and their parameters
- The Web GUI is not mandatory, advanced users can use the test generation engine with a command line interface
  - Convenient for scripting purposes
- Test generation is based on the **online** approach:

Offline:



Online:

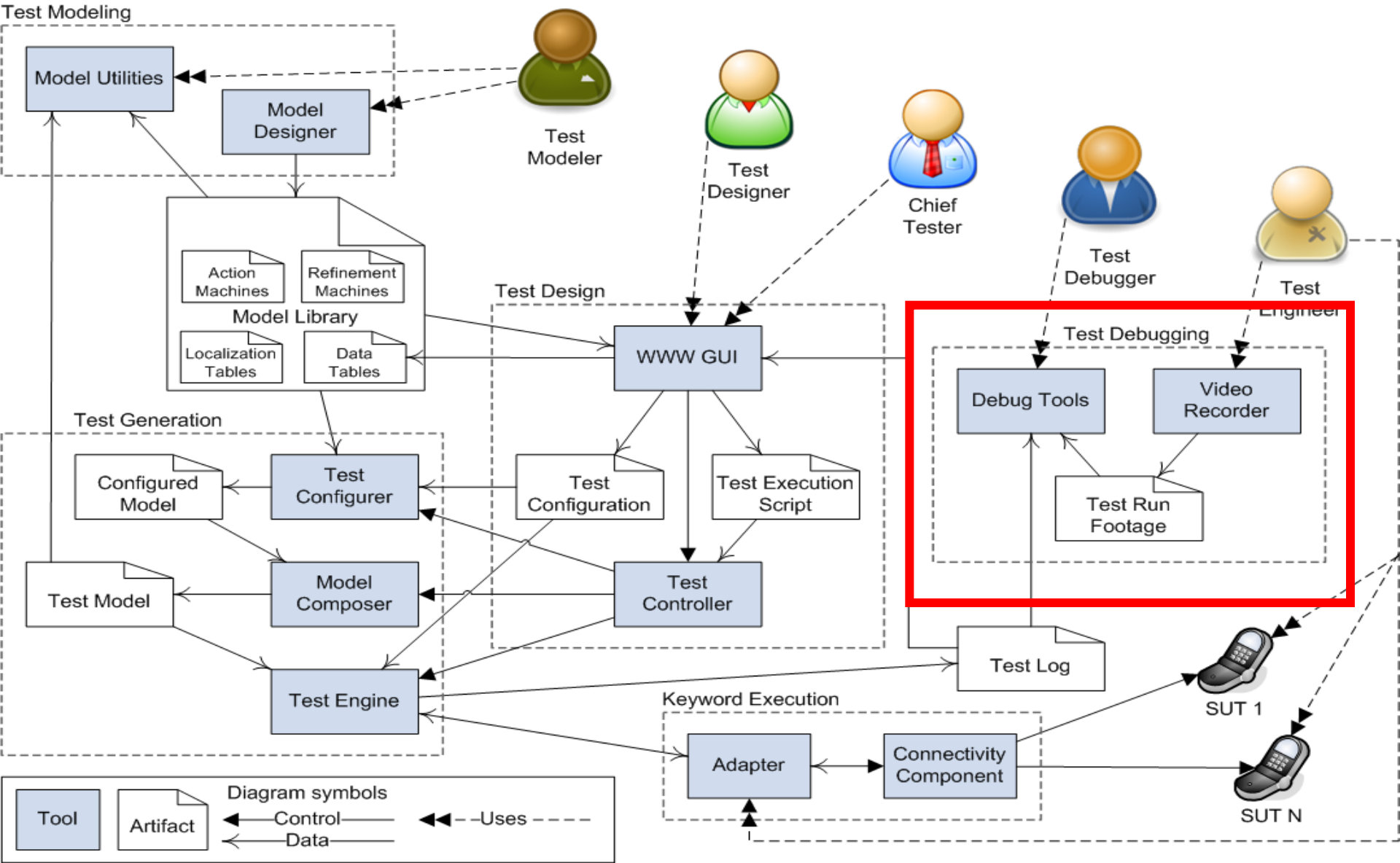
Keyword Execution



Keyword execution

- Test engine provides a socket interface for test automation clients.
- Test execution is based on keywords
  - PressKey, TypeText, ClickObject, VerifyText, …
- After each keyword has been executed, the test execution provides the result (true/false) back to the test engine, following the online approach
- Existing public test automation support for the Android emulator, Linux (Gnome), QT and Robot framework libraries (Java Swing, Selenium)

Test Debugging



Test Debugging

- In long-period random testing, it can be hard to interpret what exactly causes a bug to occur.
- Video recorder and subtitle generation from test log
- Tools for searching a minimized sequence of actions that causes the bug
  - For example, a test run about 1850 keywords long that found a bug was shortened to about 100 keywords long

Domains Conquered

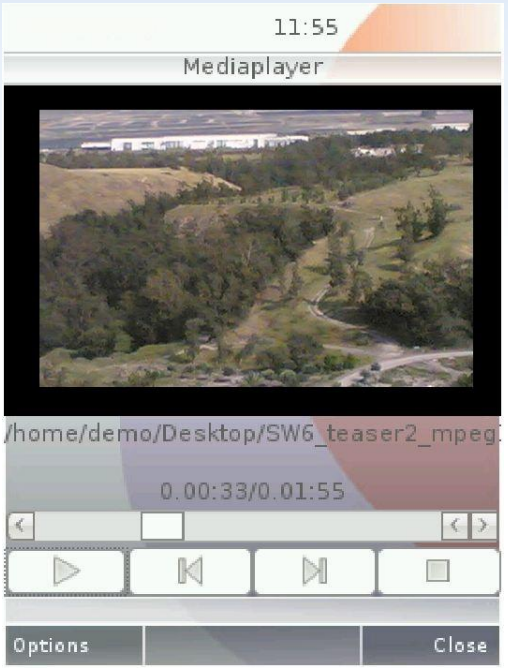
- We have been primarily focusing on mobile platforms, but our approach is also suited to desktop applications
- Our model library presently holds models for the following domains:
  - S60 (No public test automation support)
  - Mobile Linux
  - Android
  - Java Swing
- In addition, public test automation support is available for QT and Robot framework libraries.

Case: S60 (Project Starting Point)

- Built-in applications in S60 smartphones, such as Gallery, Music Player, Flash Player, Notes, Voice Recorder, Contacts and Messaging
- Keyword execution using proprietary and commercial test automation tools
  - Optical character recognition was used for verifications, which caused some reliability and maintenance issues
- 21 defects of different severities and priorities were found
  - Some of these defects existed in more than one smartphone model
  - The most severe of the defects caused the phone to hang with “System error” message on the display
  - About two thirds of the defects were discovered while modeling (reverse engineering), and the remaining third by execution (dynamic testing)
  - Most of the defects had already been previously found in traditional testing (both manual and automatic test execution), but they had not been fixed for some reason
    - However, there were also some that were totally new
  - Many of the defects were related to **concurrency issues**: performing some multimedia-related functionality in one application and then switching to another application caused unexpected behavior in some circumstances
  - In addition to defects found in applications, some were found in test automation tools, which was considered rather surprising, as these tools were quite mature

Case: Mobile Linux

- Media player application by Ixonos
  - New modeling challenge: real-time requirements
    - Playing videos, fast-forwarding, rewinding, pausing…
    - Although it was difficult, real-time support was eventually accomplished
- Keyword execution using Linux accessibility features
  - API access to GUI components
  - Easier and more reliable than in S60 case
  - Works on the GTK enviroment (Gnome)
- Some minor bugs were found (both during modeling and execution)



Case: Android Phone

- Messaging, Contacts and Calendar applications
  - High-level models created for S60 were reused
  - Calendar was modeled with ATS4 AppModel and converted to TEMA models with an automatic converter
- Keyword execution was based on A-Tool by Symbio
- Optical character recognition was implemented with MS Office Imaging, which could have been more reliable
- Some bugs were found (both during modeling and execution)

Case: Android revisited

- BBC News application
  - RSS reader optimized for BBC news feeds
  - About 300 000 users (downloads)
- Self-made test automation for the emulator
  - Based on API access -> improved reliability
- Defects found so far:
  - 14 in total
  - 8 found during modeling
  - 6 found during execution
  - 2 of the bugs cause the application to crash
- Some Android base applications were also modeled: Gallery, Camera

Lessons learned

- Modeling typically uncovers more bugs and quirks than test execution itself
  - Reverse-engineering vs. use of system models
  - Lack of precise enough GUI specifications
    - Agile trend hasn't made matters easier….
- It is possible to find bugs in already well-tested applications
  - Mostly minor or cosmetic, but also serious (system errors, crashes etc.)
  - Otherwise hard-to-find concurrency-related bugs have been found (major upside of our approach)
- A talented student was able to create the first version of the S60 model library in 2 months (+1 month for debugging & maintenance)
- Automatic GUI testing requires mature test automation support from the domain

DEMO

Thank you!

TEMA TOOLSET NOW AVAILABLE!

http://tema.cs.tut.fi/

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