The Case for Erlang as a Testing Language

Automation and Property Testing

Graham Crowe
Overview

› A broad summary of my experiences:
  – Hardware Development Engineer
  – AXE (Digital Telephone Exchanges)
  – Using Python as testing language
  – Discovering Erlang

› Examples of applying Erlang for testing:
  – Stateless Property Testing
  – Stateful Property Testing
Jindalee Operational Radar Network

**How it Works**

1. **Enemy state fires missile**
2. Jindalee system detects missile passing through ionosphere
3. Signal relayed from Jindalee to defence base near Adelaide and bounced to US spy satellites
4. Satellites and AEGIS radar system aboard air warships detect enemy's two nuclear, chemical or biological warheads
5. Destroyer fires two missiles to intercept the incoming ballistic missile before it re-enters the atmosphere. The impact of missiles colliding at thousands of km/s vapourises any nuclear, chemical or biological warhead.
The AXE 10 Years (1994-2002)

› Structured and consistent
  – blocks, subsystems
› Proprietary language
  – PLEX (PASCAL flavored)
  – ASA (assembler language)
› Execution Model
  – signaling between blocks
  – no shared data between blocks
  – global job buffers for signaling
› Debugging
  – “Test System;”
› Patchable (ASA)
› Forlopp
The Python Years (2002-2005)

› Manual testing laborious and error prone
› Developed a test environment for “black box” testing
  – reduced manual effort but …
  – complete automation not supported
› Concurrency essential for automation
  – multiple interfaces to the “black box” that require coordination
  – Multiple clients to the “black box”
› Added concurrency to the test environment
The Erlang Years (2005-present)

› Easy to grasp its notion of concurrency
  – my PLEX background helped
› Functional programming seemed odd to begin with
  – now feels natural
› High abstraction
  – very easy to design code that does rather complex things
› Introduced to QuickCheck
The case for Erlang as a testing language

- Erlang has a rich tool set for testing systems written in Erlang, ranging from:
  - unit test -> integration test -> system test
- What about testing systems that are not written in Erlang?
- In general unit testing is performed in the native language
  - Exception: Quickcheck has support for unit testing C code compiled with GCC
- Test environments for integration test and system test are often written in other languages
- Why not use Erlang?
- Why use Erlang?
Some Concepts for Grey Box Testing

› We need some enablers in our SUT for communication with the ERTS:

– SEND
  › Send an asynchronous signal to a component

– PEEK
  › Forward a copy of a particular sent or received signal to the requester

– GRAB
  › Redirect a particular sent or received signal (to the requester or discard)
Some Simple Client Server Use Case

```plaintext
some target system

client

"activate_req"

"activate_cfm"

server

"report_ind"

"report_ind"

"report_ind"
```

---

Using Erlang for Testing non-Erlang Products | Public | © Ericsson AB 2011 | 2011-02-28 | Page 9
Applying PEEK, GRAB & SEND

erts

- grab req/cfm “activate_cfm”
- grab req/cfm “report_ind” (discard)
- peek req/cfm “report_ind” (count = 2)
- send req/cfm “activate_req”
- grab ind “activate_cfm”
- peek ind “report_ind”
- peek ind “report_ind”

some target system

client

server

- “activate_cfm”
- “activate_req”
- discard
- “report_ind”
- “report_ind”
- “report_ind”
- “report_ind”
- discard
- SUT

discard
Stateless Test: Hard Real Time Component

some target system

1. Allocation of physical channel(s) per ms

2. Data from antenna(s) per ms

3. Transport channel PDU(s) per ms

4. Feedback per ms

1 ms
Bit Exact Verification

1. Allocation of physical channel(s) per ms
   1a. Physical channel(s) content
2. Data from antenna(s) per ms
   2a. Modeled radio conditions
3. Transport channel PDU(s) per ms
4. Feedback per ms
Stateless Test: Test Data Generation

› Each test case using the bit exact methodology can be described by an Abstract Data Type:
  – Allocation of physical channels (and content) per ms
  – Modeled radio conditions
› The ADT is used to generate the test vectors
  – antenna data (input)
  – feedback & transport channel data (expected output)
› The ADT is used to control the allocation of physical resources on the SUT
› We can then use stateless QuickCheck properties to explore the parameter space of this Hard Real Time component
Stateful Test: Another Simple Client Server

some target system

client

```
"setup service" (configuration)
"activate service"
"service report"
"service report"
"service report"
"deactivate service"
"release service"
```

server

SUT

```
deactive
activate
SUT state machine
```

release
setup
(deactivate
activate

timeout
(send service report)
Stateful Test: Sequence of Events

› We need to test that scalable servers (as depicted) can provide multiple instances of their services in all cases

› We need to generate sequences of events (within the specification) for testing the server

› We need to test that properties of the server hold after each event

An example of a sequence of events in this case

Event1: “setup instance 1”
Event2: “setup instance 2”
Event3: “activate instance 1”
Event4: “release instance 2”
Event5: “setup instance 3”
Event6: “activate instance 3”
Event7: “deactivate instance 1”
Event8: “activate instance 1”
...
EventN

Examples of Properties in this case

Event: “activate instance N”
Test that instance N sends reports periodically

Event: “deactivate instance N”
Test that instance N does not send any reports
Summary

› Given some enablers (such as the PEEK, SEND and GRAB concepts) within a large complex product it is possible to deploy property based testing
  – Stateless and Stateful

› Such enablers are often necessary in any case to assist integration (grey box testing) of large complex products

› When using Erlang as a testing language together with QuickCheck the potential benefits are enormous