SIOUX
EMBEDDED SYSTEMS

Design for Testability

QA & Test
2010

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- Scope: integration and system testing

About Bryan Bakker

- Test Architect
- Certifications: ISTQB, TMap, Prince2
- Member of ISTQB Expert Level on Test Automation
- Accredited tutor of ISTQB Foundation
- Domains: medical systems, professional security systems, semi-industry, electron microscopy
- Specialties: test automation, integration testing, design for testability, reliability testing

About Sioux

SIOUX EMBEDDED SYSTEMS

niko Illuminating ideas.

THOMSON images & beyond

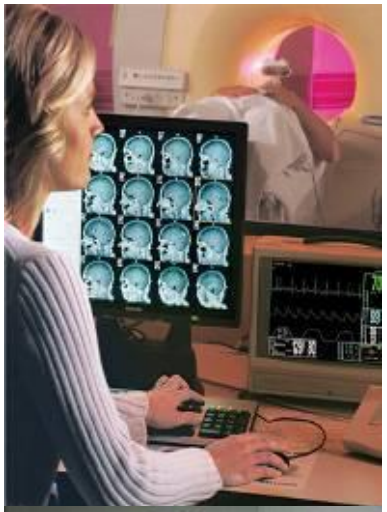
SONY

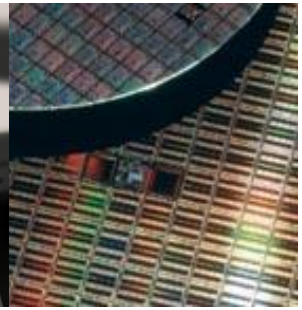
PHILIPS

PUNCH

ICOS

océ





ERICSSON

ASML

TOMTOM

CISCO

BOSCH

SIEMENS VDO Automotive

Sony Ericsson

Intro

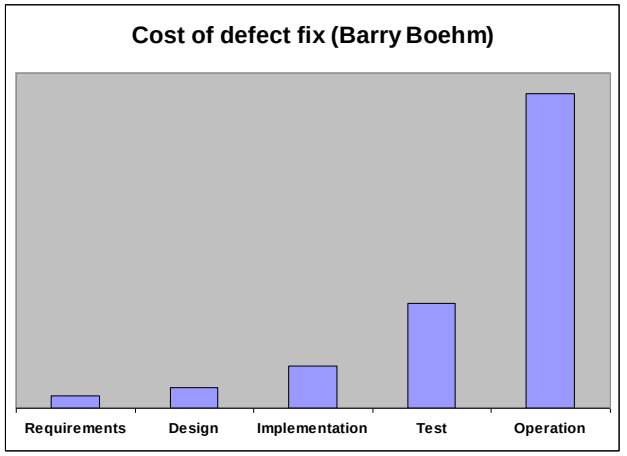
- Device including HDD
- During test phase no serious HDD issues
- After release: HDD failures in field
  →Customers return units (NFF)
  → False alarms!
- SW not robust against HDD imperfections
- Firmware upgrade needed to prevent more returns
- Could this have been prevented?

- Simulate HDD imperfections
  → find defects during development/test
  → more robust SW/System

What is Design for Testability (DfT)?

- Definition:
  Take testing into account during design/architecture definition

- Main goals:
  - More efficient testing (find defects earlier, automation)
  - Increase coverage of testing (manual and automatic, make it possible to detect other problems)
  - Enable automatic testing



Examples

- Think of:
  - Testing without HW (not finished or expensive)
  - Simulate environment (for automatic testing or unfeasible environment)
  - Replace mechanical switches/buttons (test automation)
  - Support for test automation
  - Negative testing (failures from HW or environment)
  - Support for test/sw engineers (diagnosis)
  - Logging/Tracing
  - Test components in isolation (modular architecture)
  - Support for integration testing (test for messages)
  - Test without UI
  - Reliability/Profile testing: record user actions and replay
- By
  - Visibility
  - Control

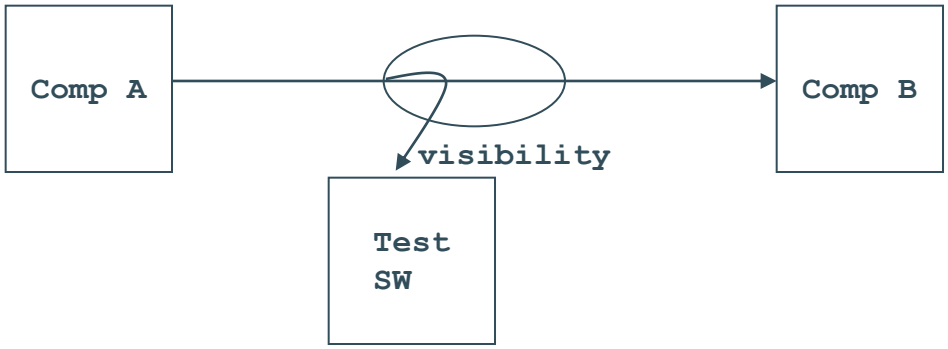
Visibility

- Visibility
  - Usually: subset of system information is shown to end-user
  - DfT: interface defined to extract info from system
  - Also for “hidden” info

Visibility

- Normal transfer of information

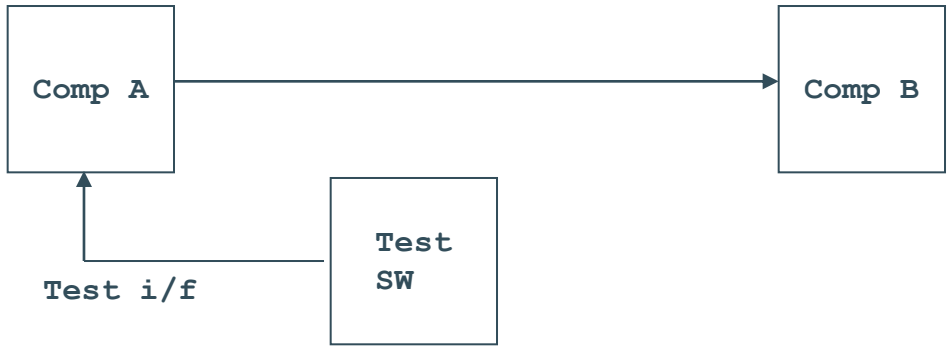
- Offer information to test software:



- Define test interface (test hook) to inspect info from Comp A
- On Comp A or Comp B or in between?

Visibility

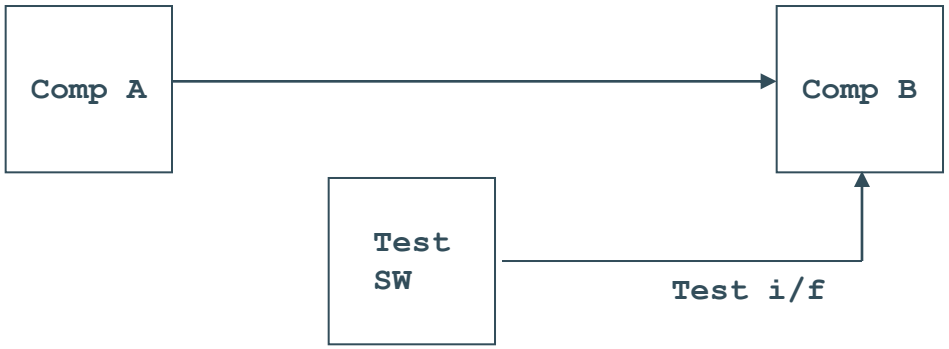
- Test interface on Comp A:



- Comp A is aware of interface

Visibility

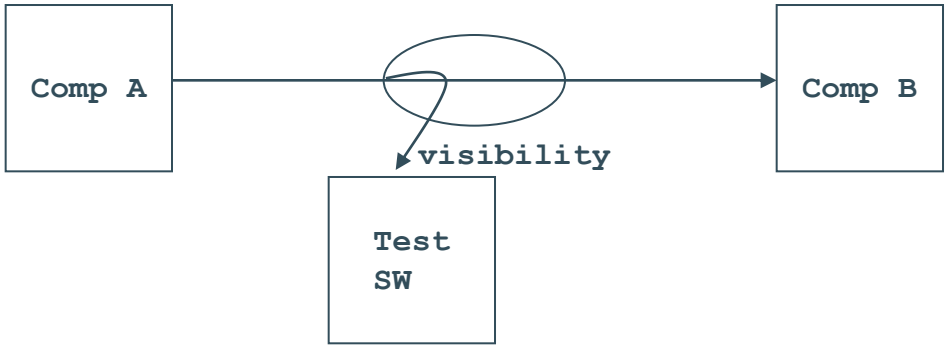
- Test interface on Comp B:



- Comp B is aware of interface

Visibility

- Use wrapper or
  message queue inspector (e.g. VxWorks)



- Comp A and B are unaware of interface
- But not everything is sent to other components…
- Where to interface is design decision

Visibility examples

- Extract all kinds of system information
  - Temperature
  - #Images passing through image chain
  - Recording speed of recorder
  - Mechanical movements verification
  - Inspect messages (for integration tests)
  - State information (of system or components)
  - Logging (better inspection/analysis, tool support)
  - Resource usage (cpu, memory, network)
  - …

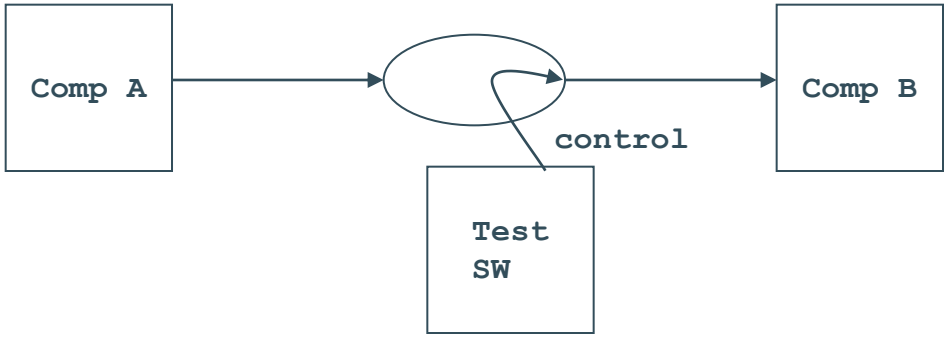
Control

- Control
  - Usually: system controlled by system interfaces like user, environment, network, etc.
  - DfT: interface defined to control the system

Control

- Normal transfer of information

- Information altered by test software:



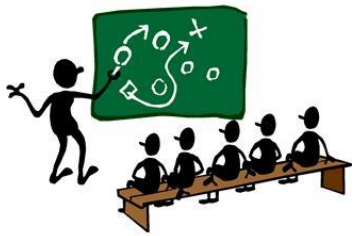
- Define test interface to control Comp B
  - set information
  - ignore control from Comp A (optionally)

Control examples

- Trigger all kinds of system actions
  - Push buttons (UI, mechanical)
  - Set configurations
  - Simulate events (motion events, alarms, hot temps)
  - Mechanical movements
  - Simulate HW failures/imperfections
  - …

Design Rules (examples)

- State visibility:
  - Every component stores state information
  - In one dedicated component
  - Testcases can get this information
  - Possibility: with one key-press → dump the complete system information
    (for defect analysis)
  - Not to be used internally by system (no information hiding)



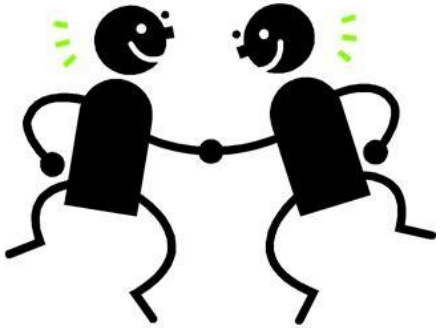
- State machines trace/log state transitions
  - “easily” test the state machines with state-transition testing
  - Determine coverage of testcases (n-switch coverage)

Design Rules (examples)

- Communication between each set of components visible via interfaces (in tracing)
  - Default functionality in VxWorks
  - Communication can also be altered
  - Used for integration testing
- All user actions are logged, and can be “replayed”
  - Input for profile tests (software reliability engineering)
  - Records error-guessing/exploratory tests for reproducibility
- Failures in HW to be simulated via (test i/f in) drivers
- Most projects start with: logging conventions

Pre-requisites

- Early involvement of test discipline
- Influence on architecture/design
  - By (test) architect
  - Architecture must support effective testing
- Test requirements
  - Functionality needed in the product to support testing
  - Real requirements, need priority
  - Implementation available on time
- Test interfaces
  - Are deliverables of project
  - Supported interfaces, thus maintained
  - Used for automatic tests
- Test req/interfaces become part of the product
  - Test functionality grows into supported functionality of the product (Excel, XRays)
- Management commitment (DfT is an investment)



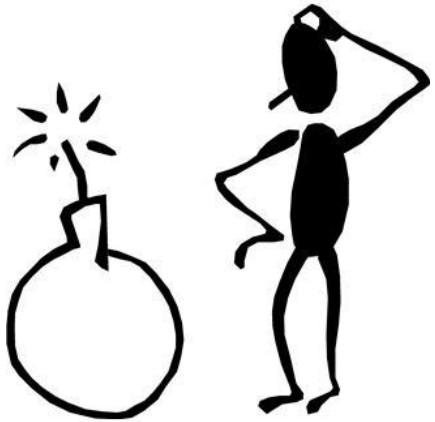
Watch out

1. Disable test functionality in release versions?
   - Like logging, tracing, test functions
   - Different version, will behave differently
     - Performance
     - Issues in release version not reproducible in development version
   - Test functionality may still be needed
     - Service/diagnostics/factory
     - Problem analysis in the field
2. Testing via test interfaces → not the real thing
   - Customer/environment uses different interfaces
   - Decide where to interface (coverage ←→ cost)

Watch out

3. Beware: **Probe Effect**
   - “unintended alteration in system behavior caused by measuring that system” (wikipedia).

Be ware of these effects!



Conclusion

- Design for Testability
  - More efficient testing
  - Increase coverage of testing
  - Enable automatic testing
- Visibility & Control
- Part of design/architecture
- Nothing new! But hardly practiced in a structured way
- Beware: different in real world!

Questions

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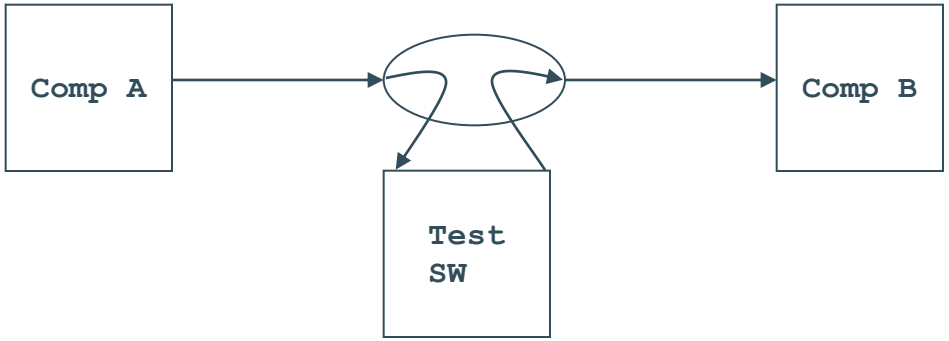
Backup slides

Combined

- Normal transfer of information

- Information retrieved and altered by test software:



- Define get and set test interfaces

Test automation

- Control used to trigger actions
  - Best practice: as “low” as possible in the architecture
    → close to hardware
    → as much coverage as possible
    → trade-off between costs and coverage
  - Possible to test below the UI
    → UI is volatile (except “mechanical UI”)

- Visibility used to verify expected result
  - Best practice: use logfile (also evidence) or internal system information
    → Avoid UI information (volatile)