Automated Reliability Testing via hardware interfaces

TestNet Najaarsevenement

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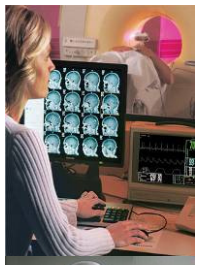
About Bryan Bakker

- Test Expert
- 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

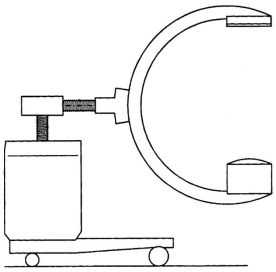
About Sioux



Intro – The need for action

Medical Surgery Device:

- X-ray exposure + acquisition during surgery activities
- Real-time image chain
- Mobile device (frequently off/on)
- Quality and testing considered important in organization

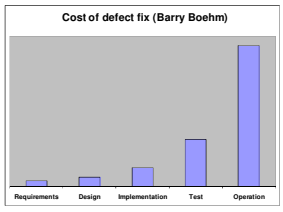


Reliability was an issue:

- “Frequent” startup failures
- Aborted acquisitions
- Always safe… but not reliable!

The need for action

- Reliability issues are nasty to analyse, solve and test
- Fixing defects in field (remember Boehm)
- Impact on other projects (development + test resources)
- High service costs
- Troublesome system test (up to 15 cycles!!)



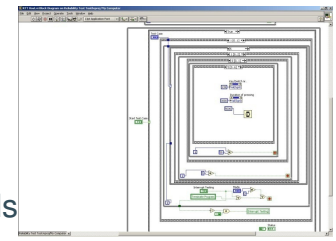
The need for action

- Start with automated reliability tests (simple, short)
- Quick and dirty at first
- No SW resources available
  - To help with automation
  - Implementing test interfaces

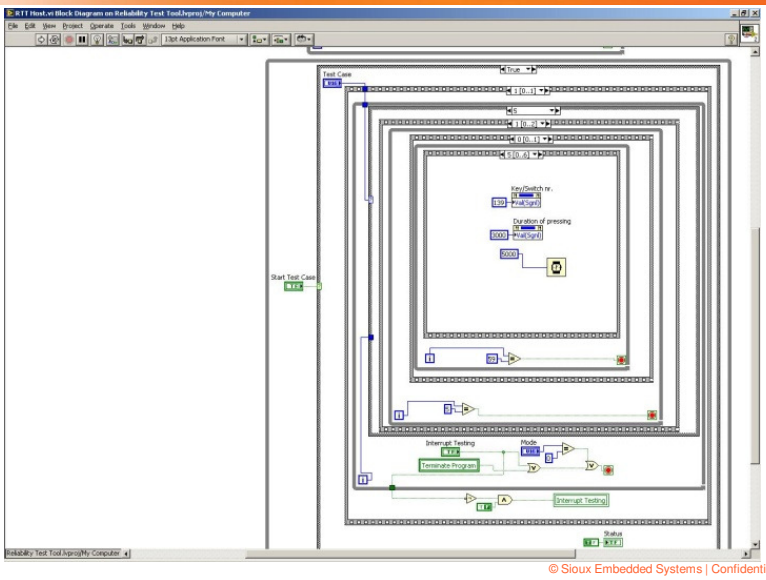
- Goal: show (quick) that reliability issues can be reproduced
- Expectation: … then attention and funding would increase

Increment 1 – First success

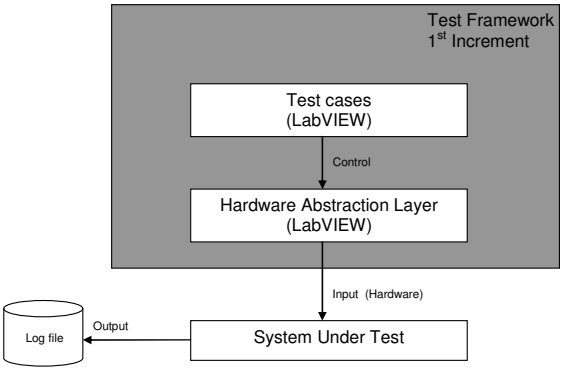
- Hardware interfaces used to invoke actions on SUT
  - Buttons on different keyboards
  - Handswitches
  - Footswitches
  - Different power-switches
- LabVIEW generates hardware signals
- Test cases defined in LabVIEW
- Only logfiles stored, no other verification performed
- No software changes needed for this approach



Increment 1 – First success



Increment 1 – First success



- Simple, but quick first results
- Multiple reliability issues found
- Work to do for the developers

Management buy-in

- Several defects found were already known:
  - Customer issues
  - Not reproducible -> no solution
  - Now: developers could work on them
  - And fix could be tested as well
- Several presentations given explaining the approach
- And… get clear what we are looking for!
- Primary functions should work reliable

Definition of Reliability Hit

1 Primary failure **Problem in PF**	2 Secondary failure **Problem outside PF, but impact on PF**	3 Tertiary failure **No direct impact on PF**
PF fails Reset during PF	PF cannot be started Reset outside PF	Functional failures

Reliability Hits

Also important but not for reliability

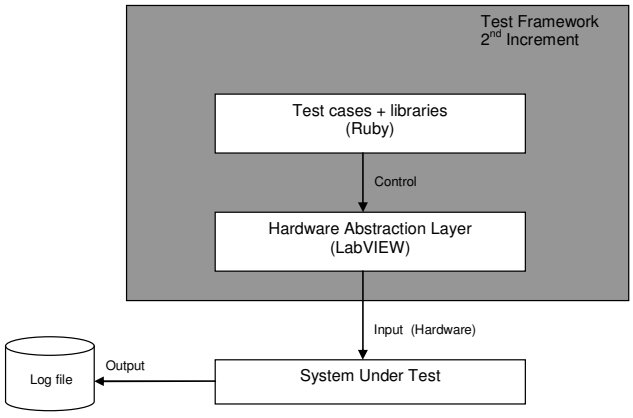
PF = Primary Function
Primary function: e.g. startup, acquisition
Non-primary function: e.g. printing, post-viewing

Increment 2
A language for the testers

- LabVIEW is not that easy
- Provide general scripting language (Ruby)
- Ruby interfacing with LabVIEW via abstraction layer

- Development of test libraries was started
- Still only control, no verification
- Log file analysis after test (tools were used)

Increment 2
A language for the testers

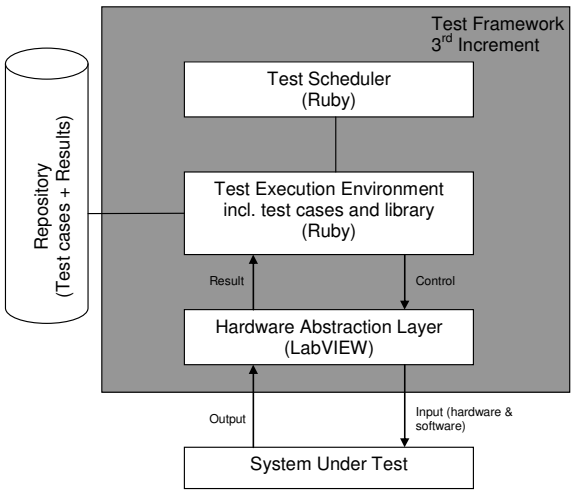


Increment 3
Logfile interpretation

- Logfile scanned during test case execution
- Determine pass/fail criteria
- Detect system states and act upon:
  - Hot generator → extensive acquisition not possible
  - Execute other test cases (e.g. power-cycle), until
  - Generator has cooled down

- Log file analysis after test was still performed
- Still no software changes in the SUT, but existing interfaces were available now

Increment 3
Logfile interpretation

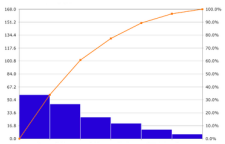


Increment 3
Logfile interpretation

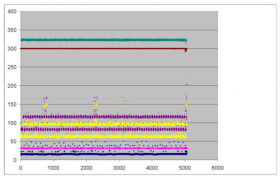
- Best practise:
  - Test actions by external interfaces
  - Test verification by log file and internal state information
- System statistics extracted from logfile:
  - Number of startups (succeeded and failed)
  - Number of acquisitions (succeeded and failed)

Statistics

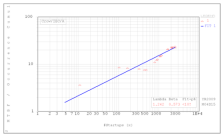
- Reliability hits could be identified from logfile (semi-automatic)
- Pareto charts



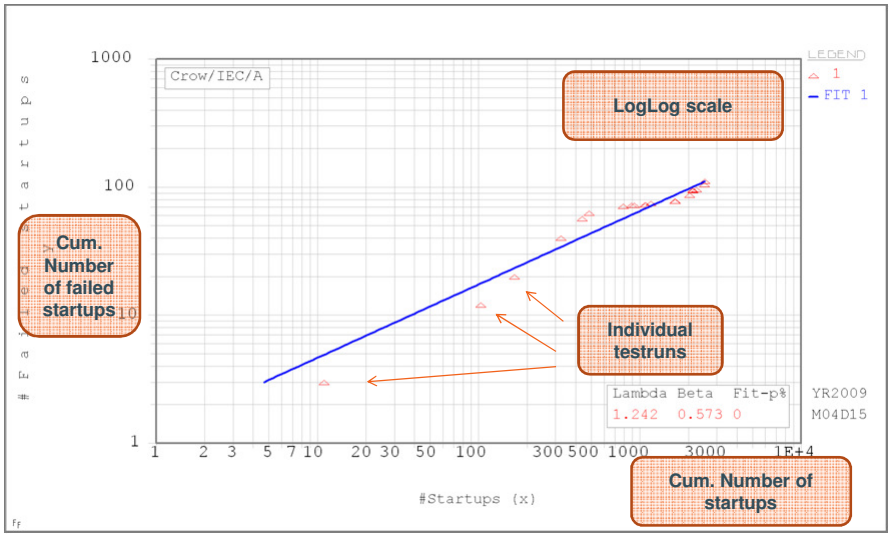
- Performance measurements (timing info in logfile)



- Crow-AMSAA



Crow-AMSAA Failure Plot Example



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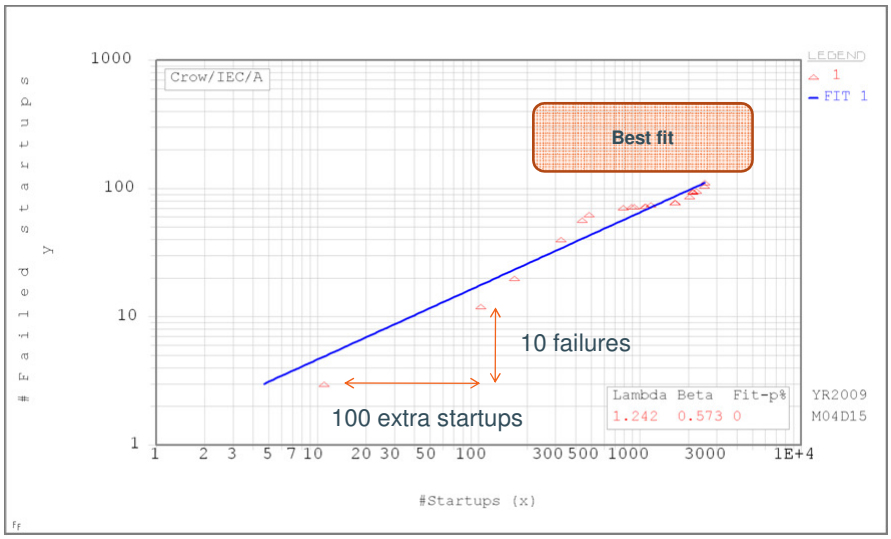
Crow-AMSAA Failure Plot Example



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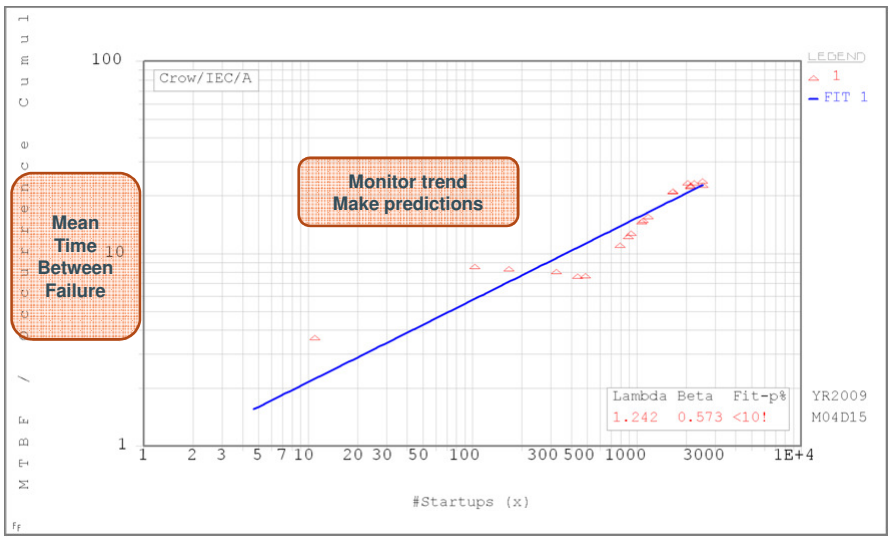
Crow-AMSAA MTBF Plot Example



ROI

- >100 reliability hits identified
  - Which ones would have slipped through other tests?
  - Which ones would the customer complain about?
- “Independent” analysis of hits:
  - 8 would have been in system test, but not earlier
  - 7 would not have been found, but customer would compain (and fix would be necessary)

ROI

- ROI:
  $(8 \times X_1) + (7 \times X_2) - \text{costs} > 0$
- Costs (manhours + material) = 200K Euro
- X_1: costs of defect found in system test: 10K Euro
- X_2: costs of field defect: 200K Euro

- 80K + 1.4M – 200K → **1.2M Euro saved**

- More money and time became available…
  →Implementing/executing more tests
  →More projects/products

Results

- Numerous reliability hits identified + solved
- MTBF measured and predicted
- Startup MTBF increased by factor 7.6
- Acquisition MTBF incr. by factor 18
- More testing hours on systems
- Customer satisfaction
- More projects wanted this approach
- Only 5 system test cycles remaining (was 15)

Key success factors

- Choose right project at the right time
- Incremental development (early visible benefit)
- Communication / ROI
- Clear and simple reporting (Crow-AMSAA)
- Hardware interfaces
  - →Low probe effect (not a single false alarm)
  - →Easy ported to different products

Questions

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