SIOUX
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Insight in Reliability

TEST NET

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TestNet
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Contents

- Reliability
- The need for action
- Reliability Testing
- Reporting on reliability
- Results

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About Bryan Bakker

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

About Sioux

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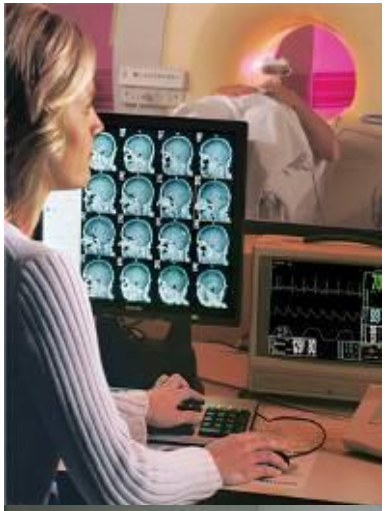

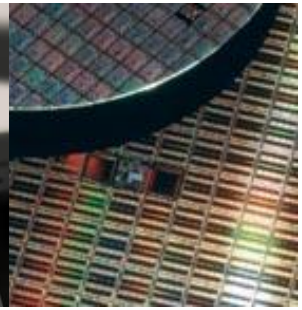

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Reliability

- What is reliability?

Reliability is the probability that a system functions in a specified environment without failure, for a specified time

British Standard BS 4778 and Musa

In short:

- Something can be functional correct
- But is it reliable?

Reliability

- What is reliability?

Reliability is the probability that a system functions in a specified environment without failure, for a specified time

British Standard BS 4778 and Musa

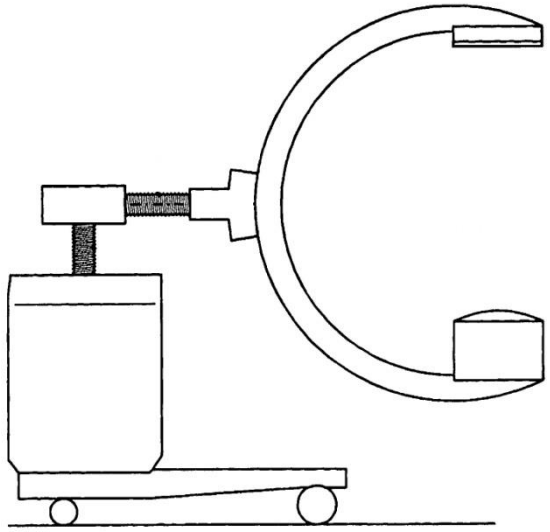
In short:

- Something can be functional correct
- ~~But is it reliable?~~ How reliable is it?

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!

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The need for action

- Reliability issues are nasty to analyse, solve and test
- Fixing defects in field
- Impact on other projects (development + test resources)
- High service costs
- Troublesome system test (up to 15 cycles!!)
- Reliability measurements hampered by software instability
- Major hardware issues in field, but not seen during development phase.

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

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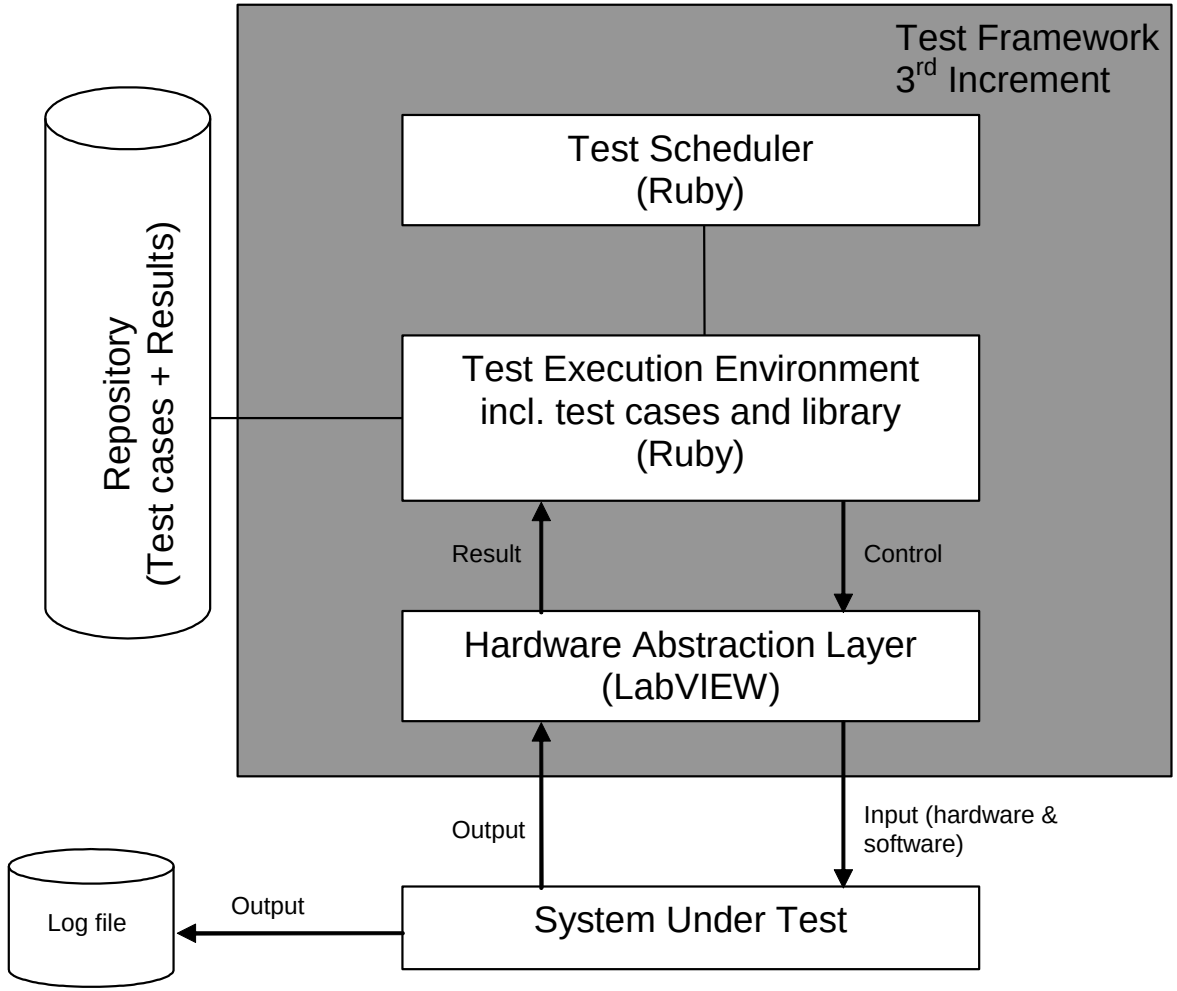
Reliability focus in testing

- Focus on primary functions
- Startup behavior
  - Switch system on (mains)
  - All subsystems successfully started
  - Perform one successful acquisition
- Acquisition
  - No aborted acquisitions
  - No lost images

Test Framework

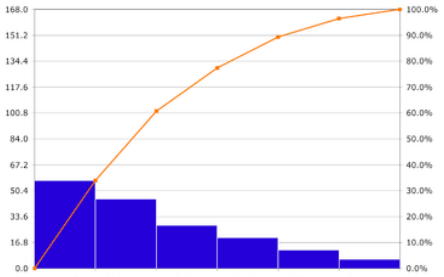


Logfile interpretation

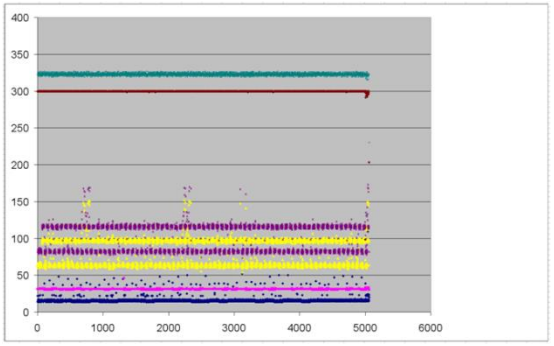
- Logfile scanned during test case execution
- Determine pass/fail criteria
- Detect system states and act upon:
  - Hot generator → extensive acquisition not possible
  - Execute other test cases (e.g. power-cycle), until
  - Generator has cooled down
  - Prevent failures which are in fact machine damage pre-cautions → and thus false alarms
- Logfile can be used to identify (and count) reliability hits

Statistics

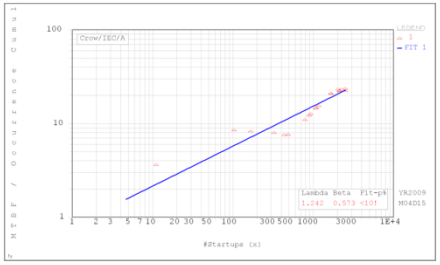
- Pareto charts



- Performance measurements (timing info in logfile)



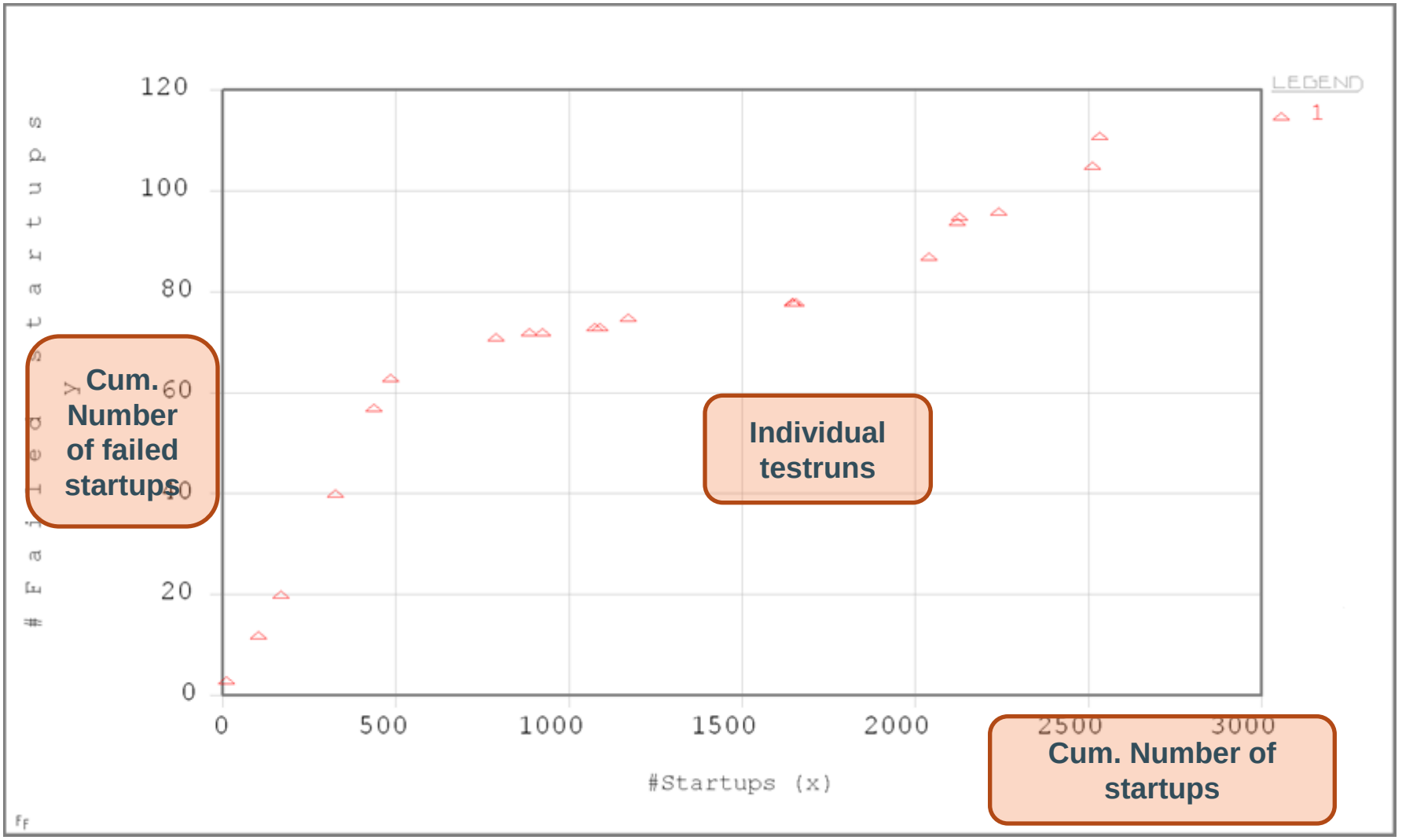
- Crow-AMSAA



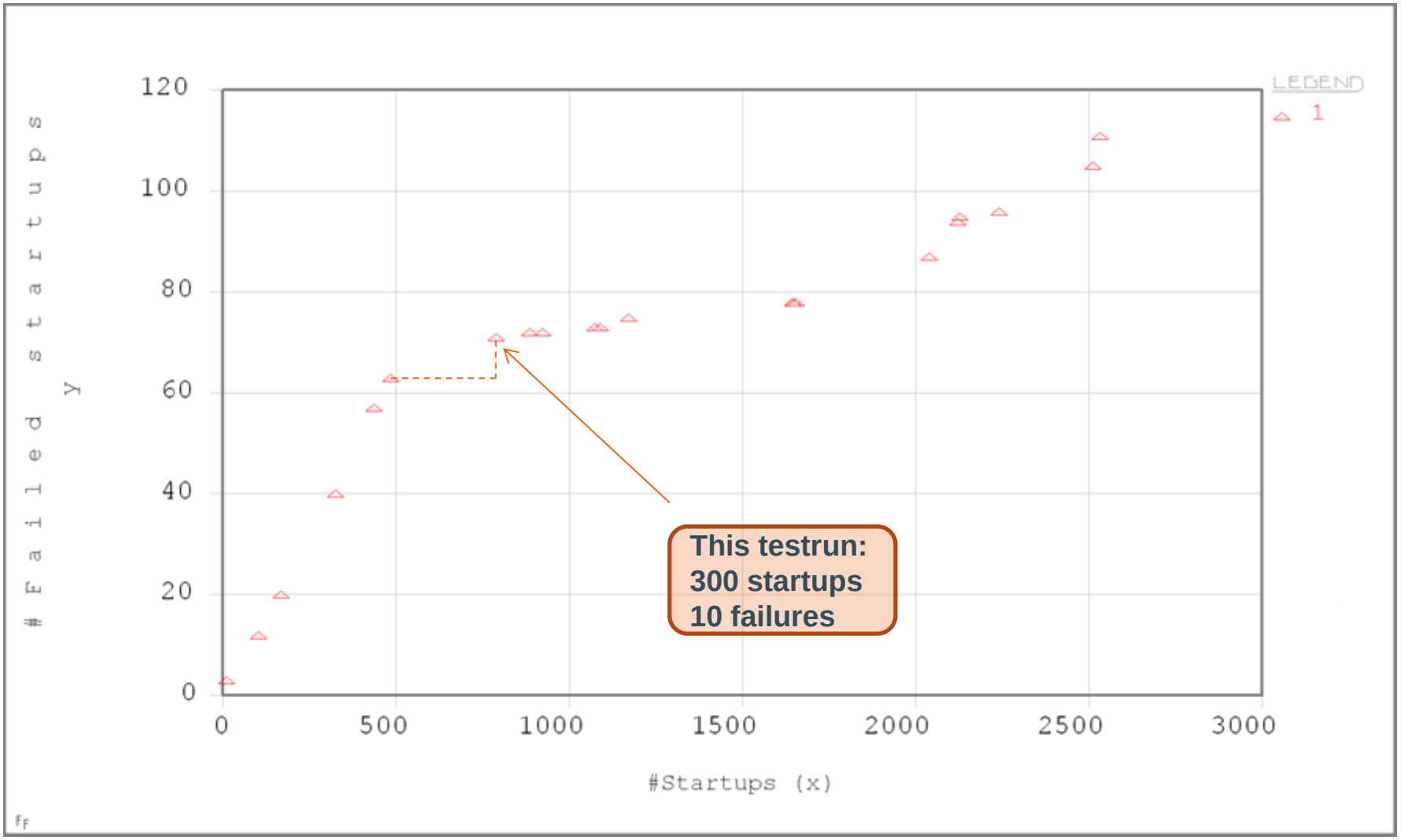
Primary functions and failures

- System statistics extracted from logfile:
  - Number of startups (succeeded and failed)
  - Effective acquisition duration (incl. failures)
- Example: nightly test
  - 12 hours tested
  - Different test cases executed (focus prim. functions)
  - 50 System startups (with 4 failures)
  - In total 1.5 hours effective acquisition
  - 2 Aborts, 4 images lost in 2 runs (4 failures)

Failure Plot Lineair scale



Failure Plot
Lineair scale



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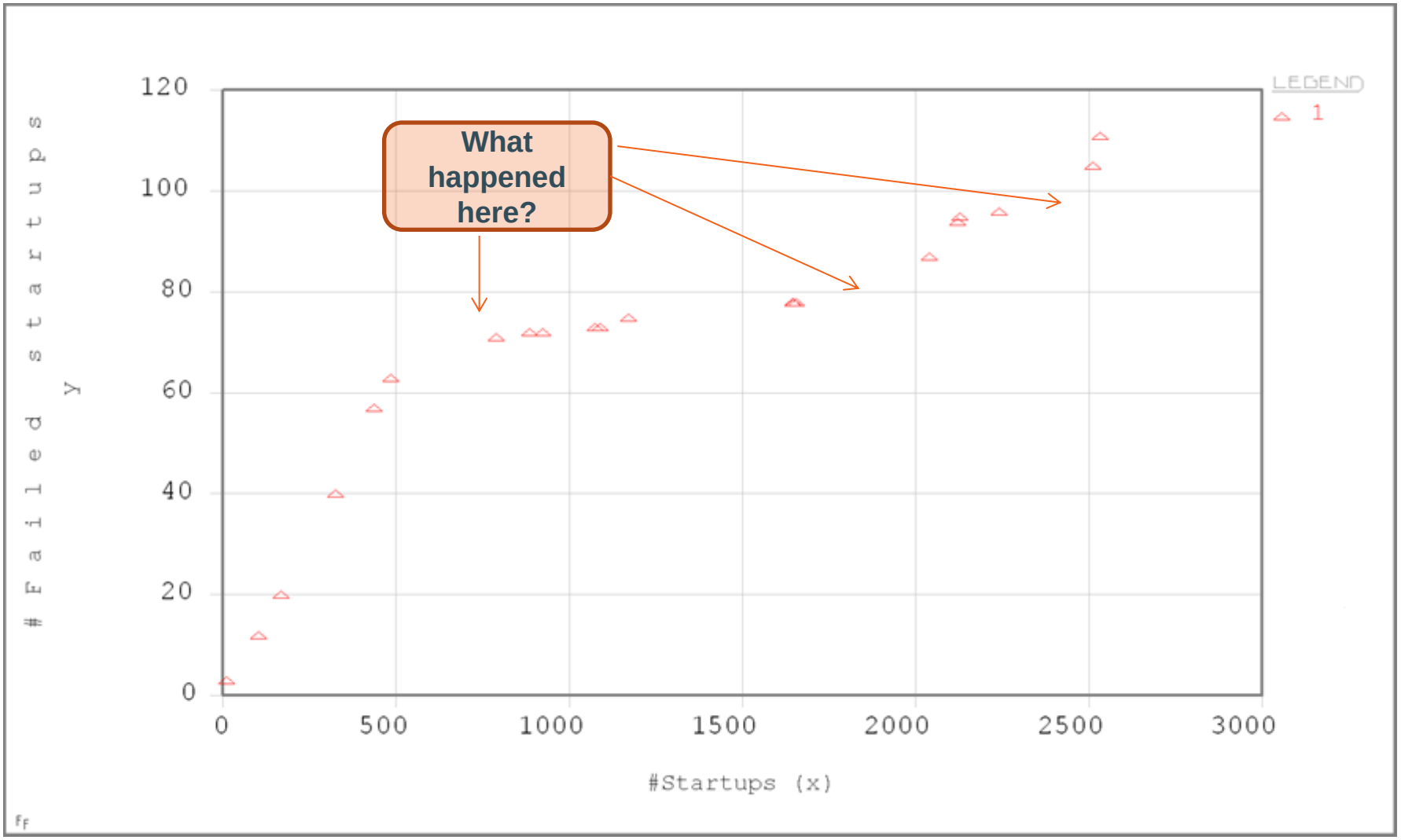
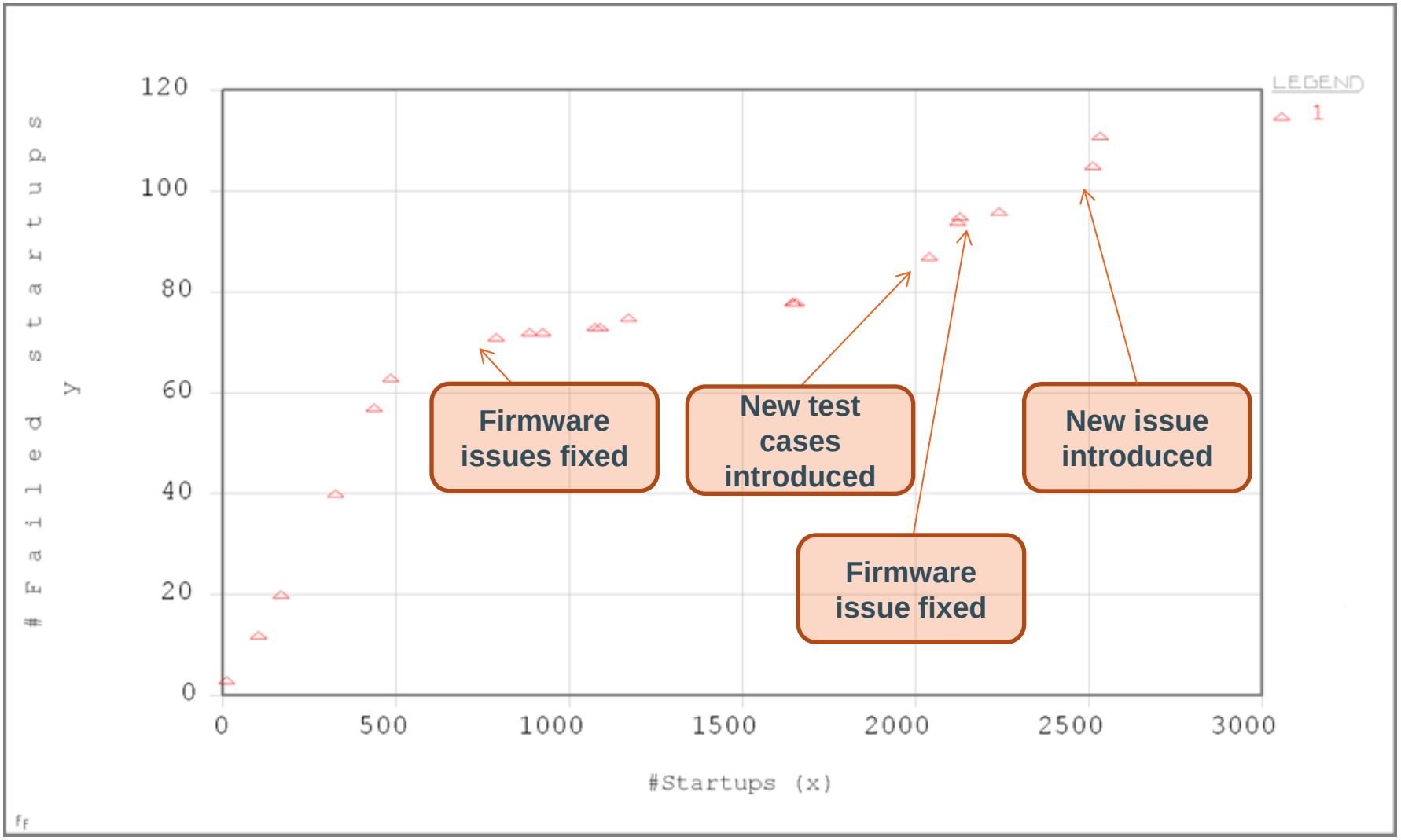
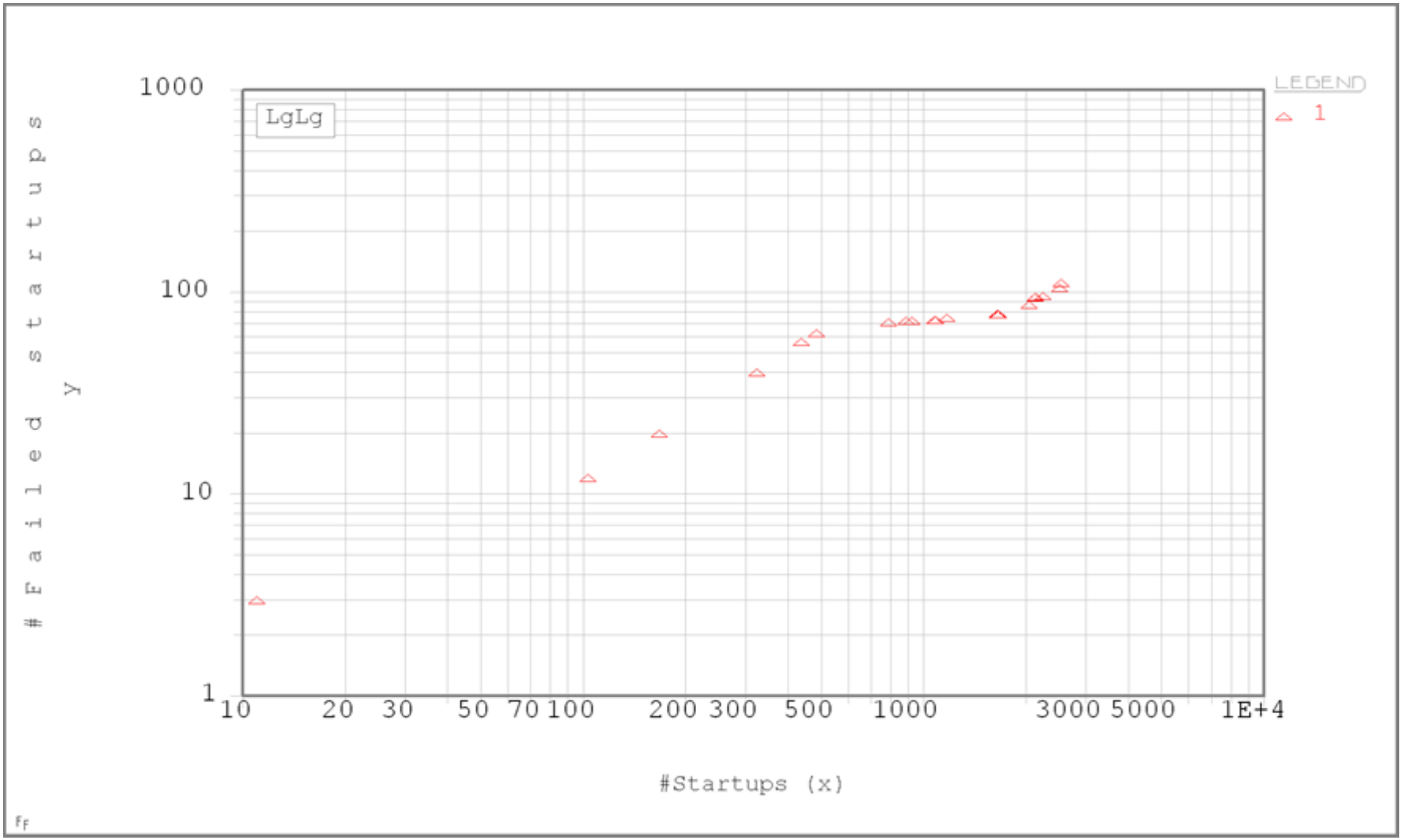


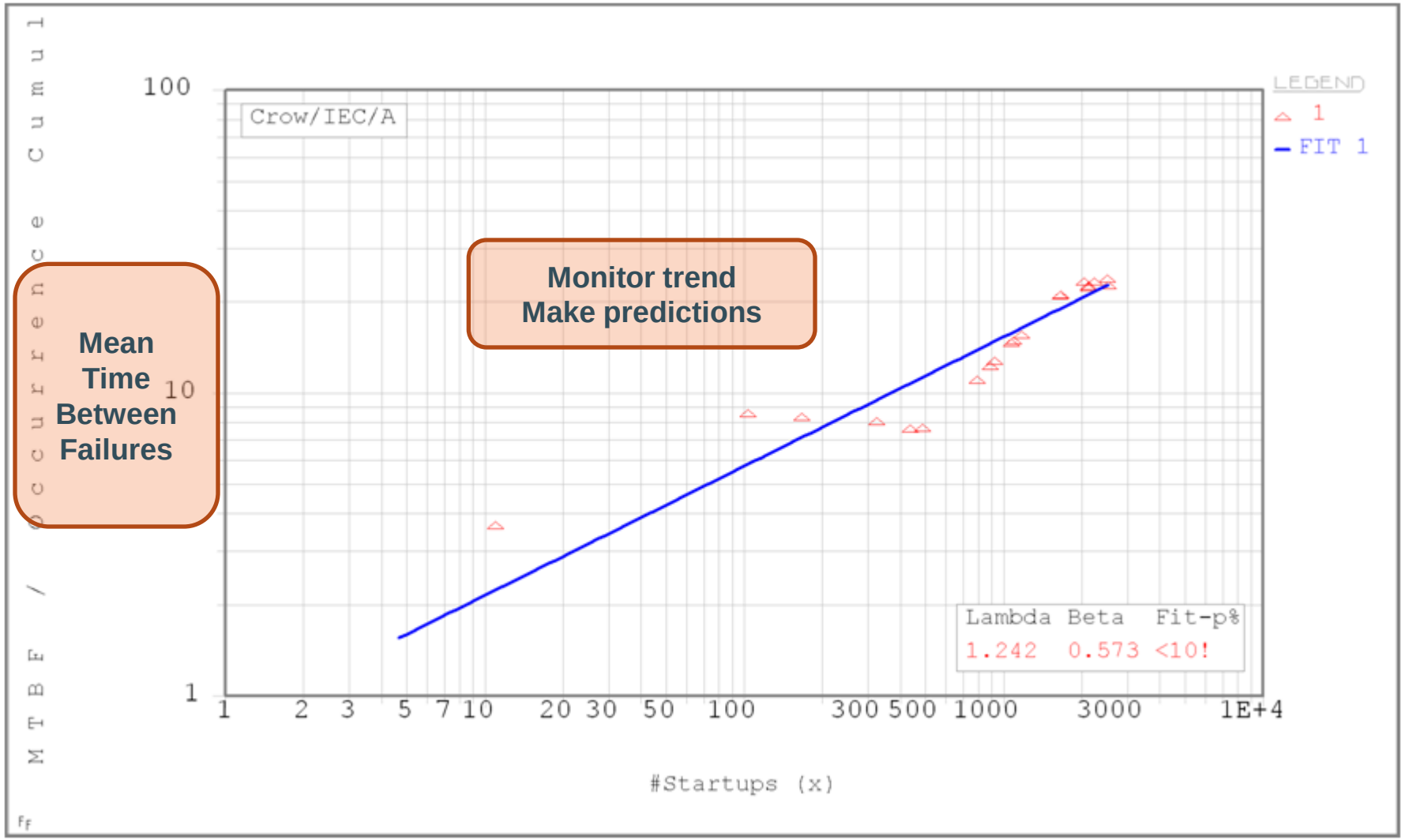
Failure Plot Lineair scale



Failure Plot
LogLog scale



Crow-AMSAA MTBF Plot Example



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Why Crow-AMSAA?

- Multiple not yet known failure modes
- Different software versions
- Different test configurations / test systems
- Different/increasing test sets
  - “Reliability drop” can be caused by new tests
- Single failure mode → e.g. Weibull distribution

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Reliability Growth Curves

- History dragging…. Problems already fixed are still in graph
- Start over now and then
- “Reset history”
- Reset at useful moments in project
  - E.g. when multiple reliability hits have been solved
- Possible to start over at release moment
- The trend is important
  - Are we improving?

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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 complain (and fix would be necessary)

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ROI

- ROI:
  $(8 \times X_1) + (7 \times X_2) - \text{costs} > 0$
- Costs (man-hours + 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

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Results

- Numerous reliability hits identified + solved
- MTBF measured and predicted
- Reporting easy to understand
- 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)

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Questions

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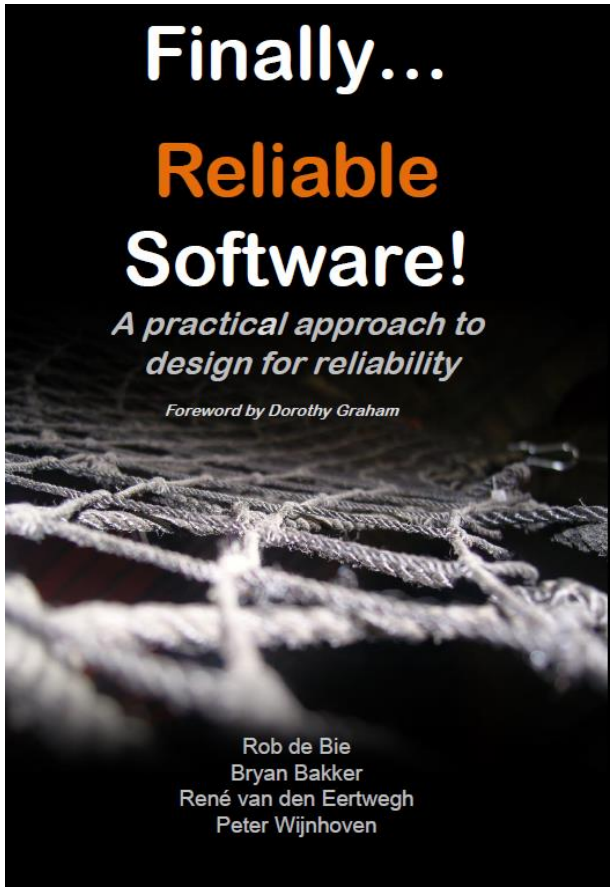

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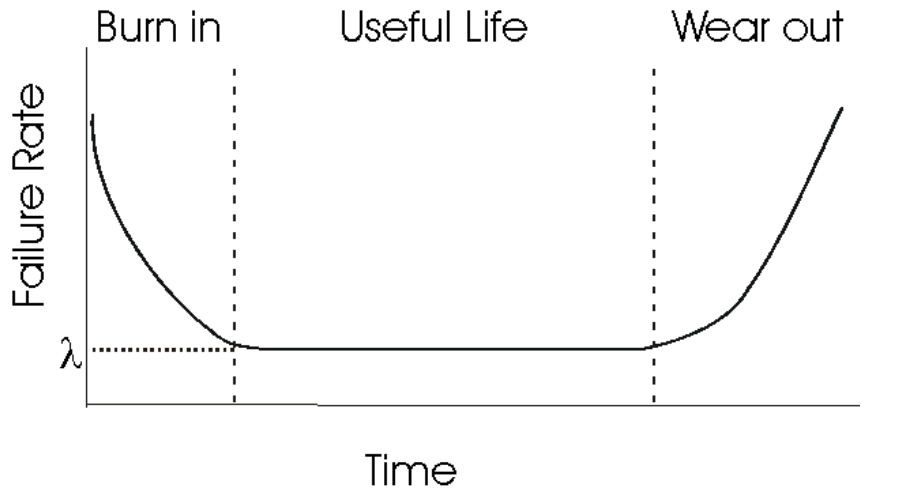
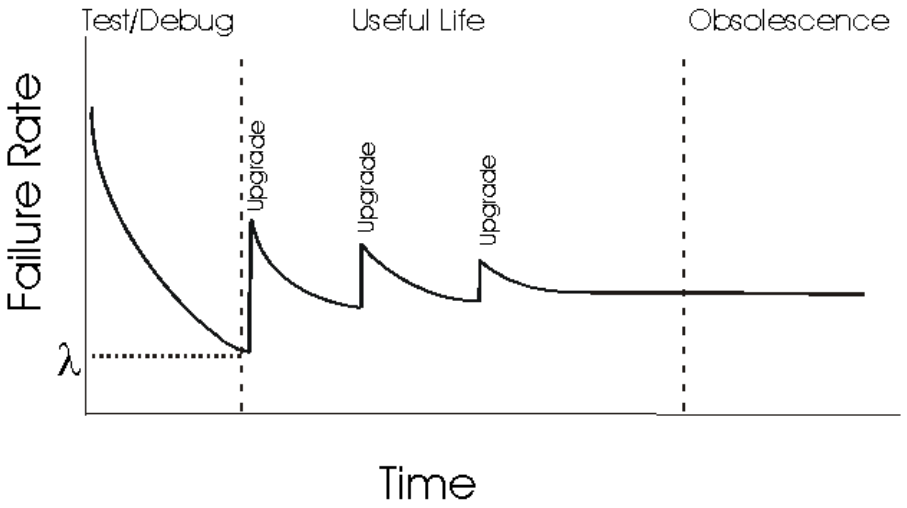
- Backup slides

Reliability Curves

- Bathtub curve
  Hardware Reliability



- Sawtooth curve
  Software Reliability



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