BUSKERUD
University College

INCOSE International Symposium
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# System Verification by Automatic Testing

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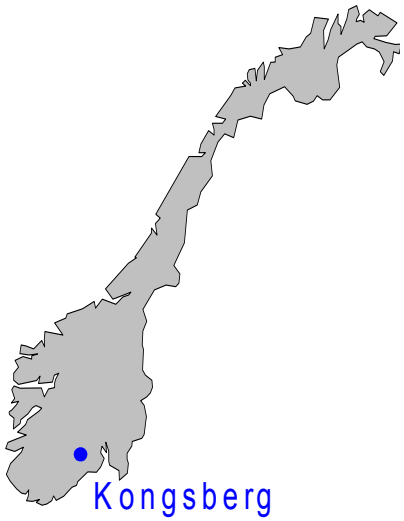
# Technology park Kongsberg






# Research Model Master Students Systems Engineering in Kongsberg, Norway

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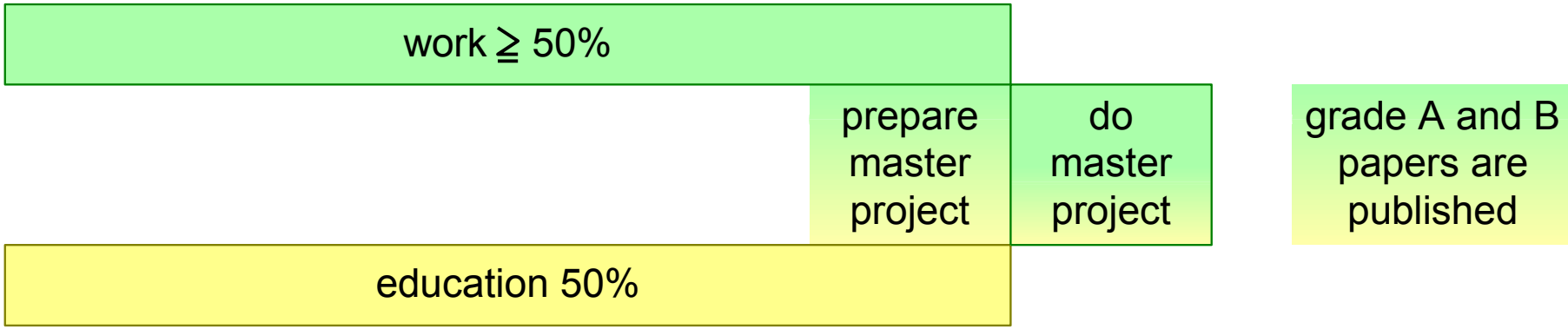
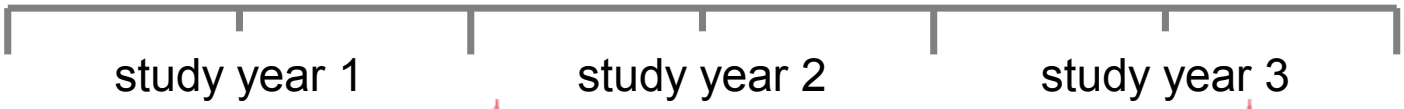
students know:
+ domain
+ SE methods and techniques

students:
+ apply
+ reflect
+ evaluate




# K-Master: System Under Test

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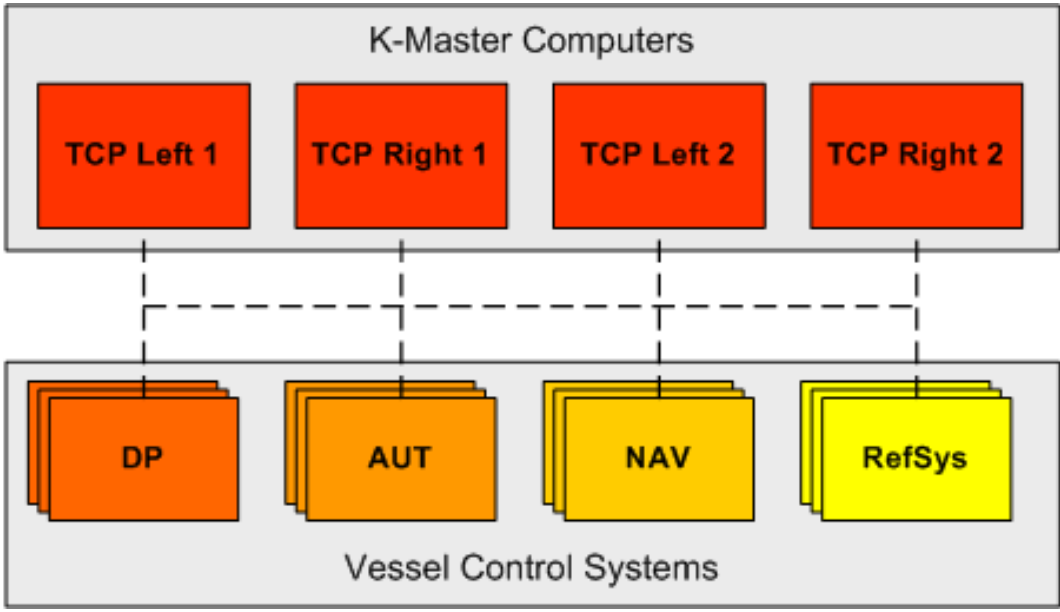



# Current Situation



- Significant manual test effort

→ Limited test frequency

- Expected increase of applications

→ Testing may become bottleneck

Prescribed tool environment:

  - Microsoft Team Foundation Server (TFS).
  - Microsoft Test Manager (MTM)
  - Microsoft Visual Studio (VS)

# Current Situation 2



- 2-3 releases per year
- 2-weekly build cycle
- builds tested on one configuration

→ Testing of ~3 configurations is desirable

- current focus is functional
- non-functional needs maturing

- 1..2 testers need16 days (~=3 weeks) for functional testing
- testing is repetitive

# Literature



Software Test Automation (Graham 1999):

"*At first glance, it seems easy to automate testing: just buy one of the popular test execution tools, record the manual tests, and play them back whenever you want to*."

Experiences of Automation (Graham 2012), Graham and Fewster:

- "*Management support is critical, but expectations must be realistic*"
- "*Automation development requires the same discipline as software development*"
- "*Use a "translation table" for things that may change, so the automation can use a standard constant term*".

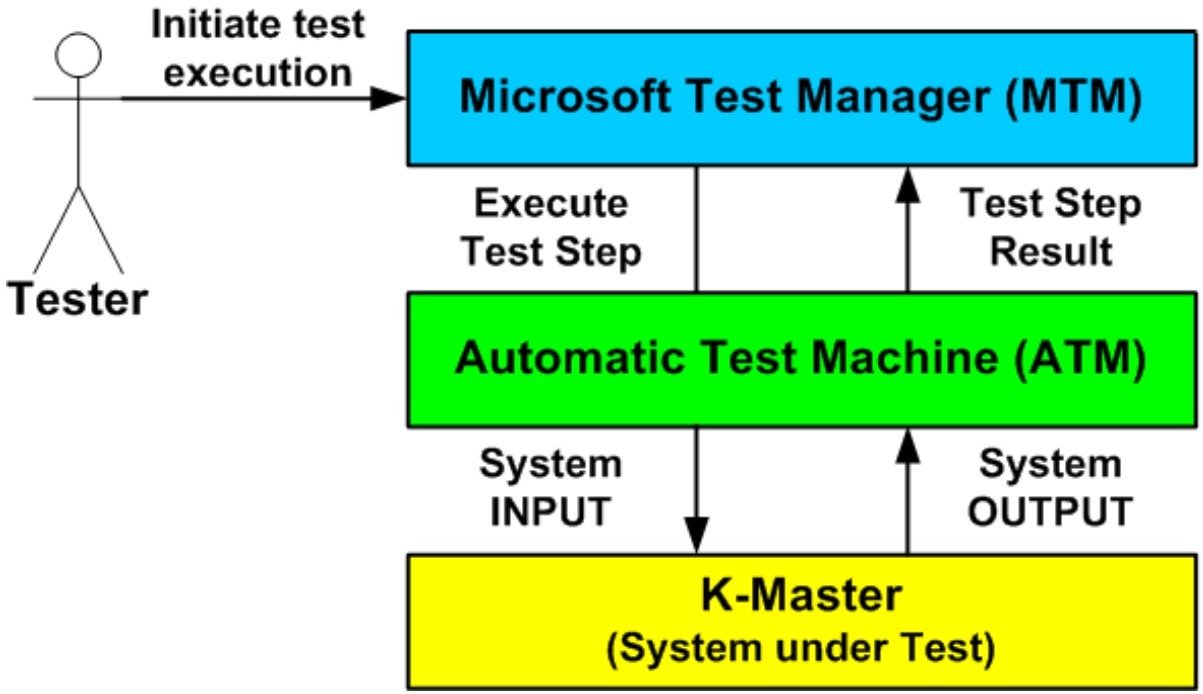
# Objectives



- Significant reduction of testing time, e.g. 90%
- Increase coverage by increasing #test runs

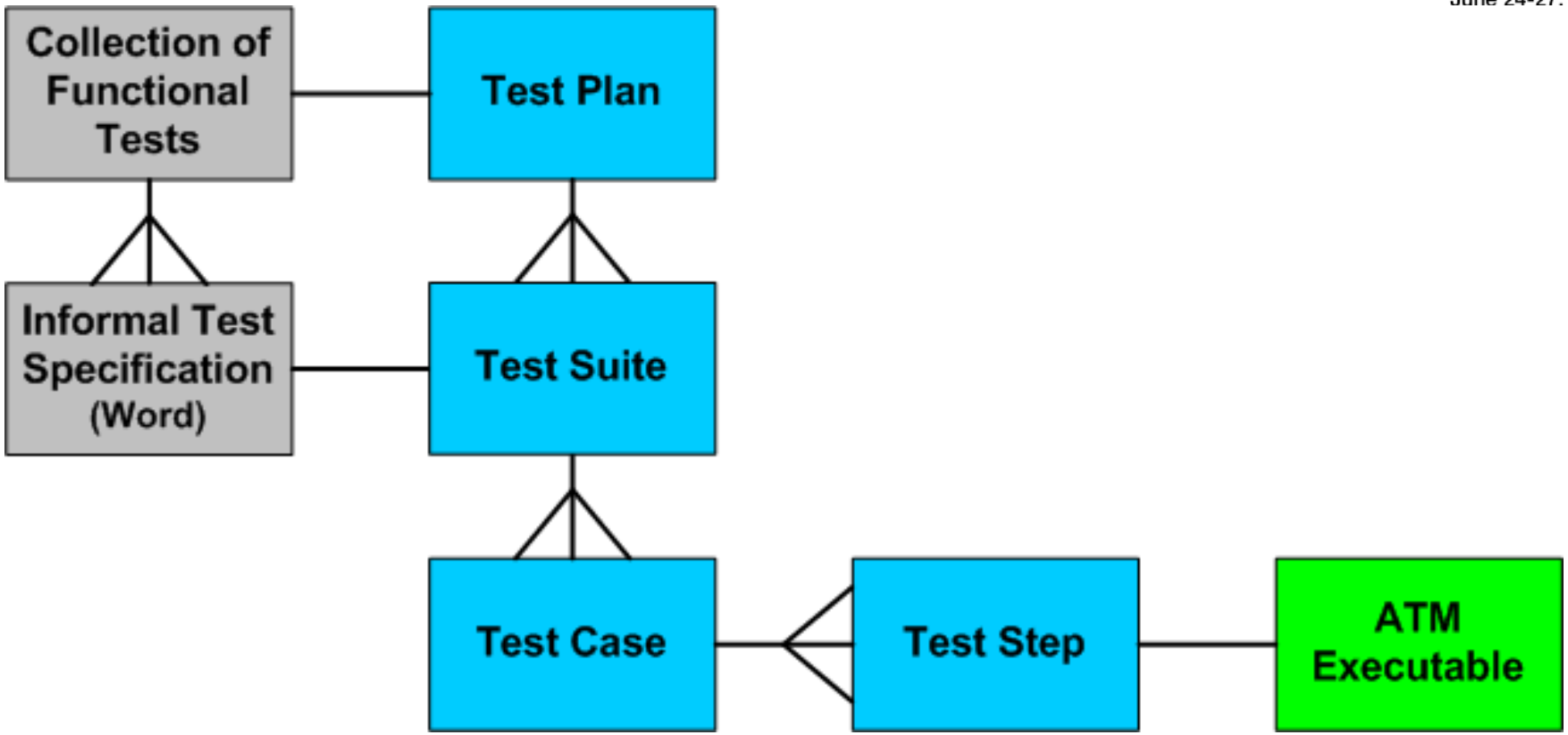
# Design of Test Distribution






# Simple data structure model






# Integral cost model – yearly efforts

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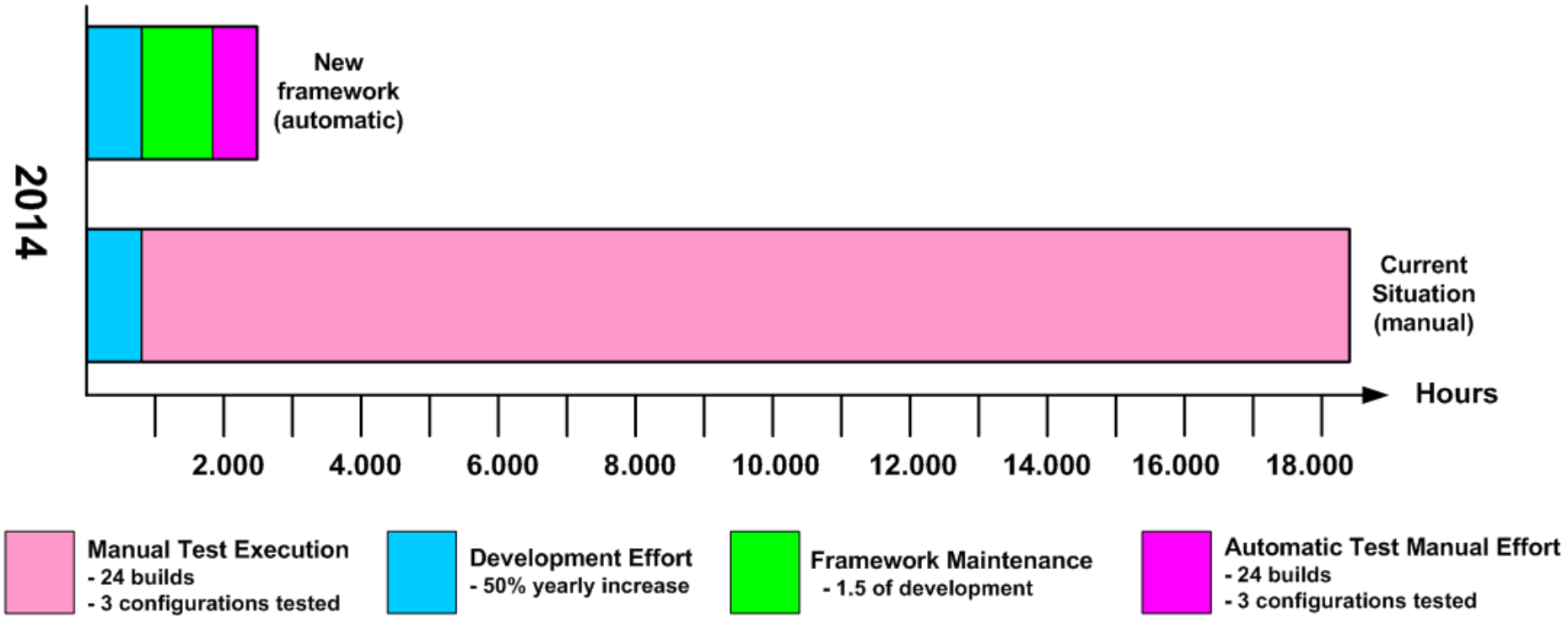


# Automatic test execution effort

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**Pre Execution Effort**
- Preparation
- Reset
- Preconditions
- 10 minutes average per test

→

**Automatic Test Execution**
- All tests run automatically
- No tester interaction required

→

**Post Execution Effort**
- Logs
- Result analysis
- Bitmap comparion
- 5 minutes average per test + 3 seconds average per step

# Simple cost model for nonrecurring engineering costs; wider pink boxes has higher affiliated cost

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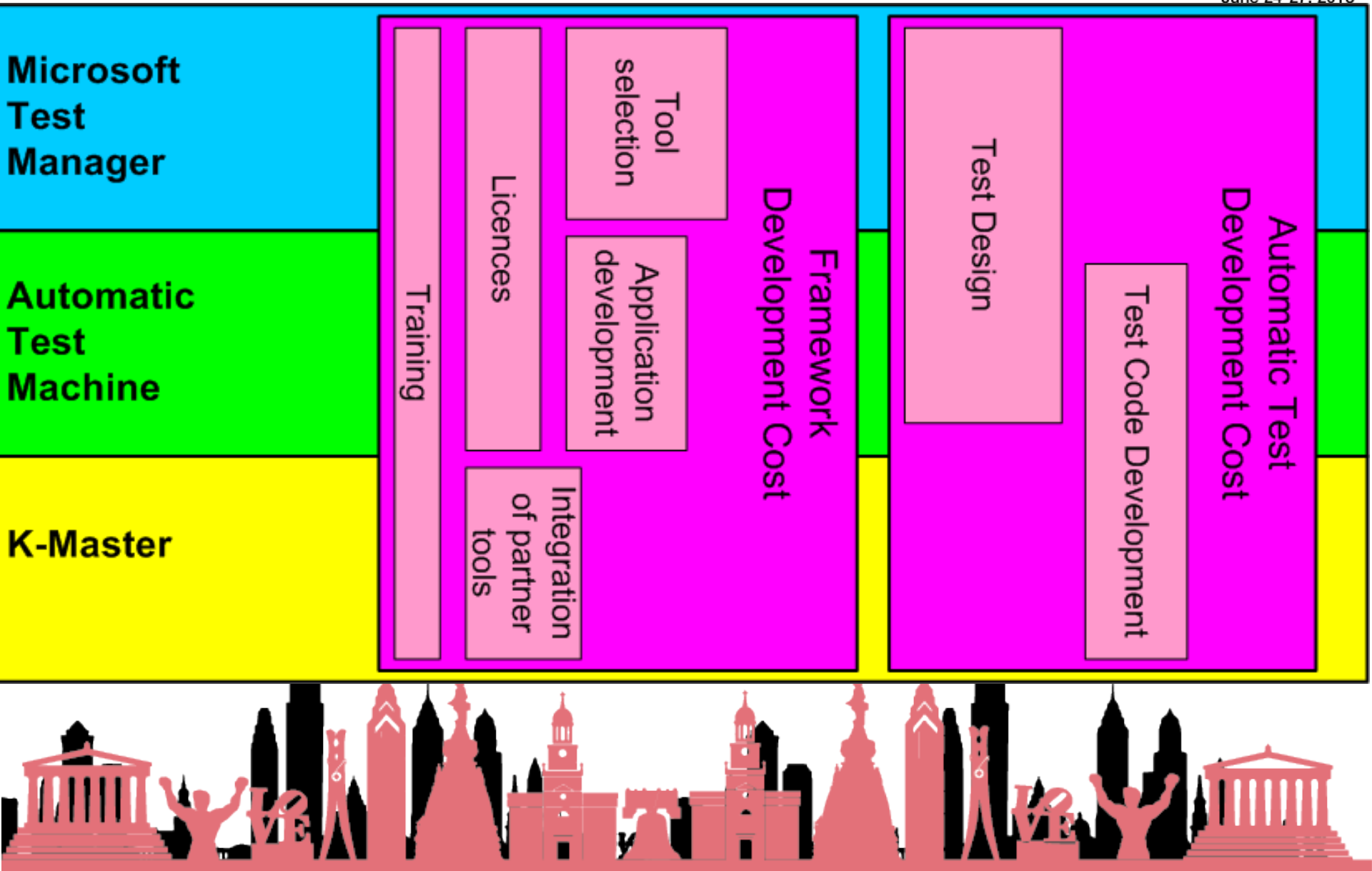

# Test specification overview; we automated the ABCS test

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| Test specification | Test cases | Test steps |
|---|---|---|
| K-Pos Interface Test | 18 | 926 |
| K-Thrust Interface Test | 9 | 1013 |
| **Aft Bridge Control Station Test** | **53** | **426** |
| K-Chief Interface Test | 13 | 159 |
| K-Bridge Interface Test | 30 | 114 |
| system Test | 7 | 80 |
| IJS Control Panel Interface Test | 11 | 48 |

# Estimated development cost per test, using the ABCS test for calibration.

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| Test development cost | |
|---|---|
| K-Thrust Interface Test | 262 hours |
| K-Pos Interface Test | 239 hours |
| **Aft Bridge Control Station Test** | **110 hours** |
| K-Chief Interface Test | 41 hours |
| K-Bridge Interface Test | 29 hours |
| System Test | 21 hours |
| IJS Control Panel Interface Test | 12 hours |
| **Total development cost** | **714 hours** |

# Approximate framework cost pr. layer



| Framework cost pr. layer | |
|---|---|
| Microsoft Test Manager | 513 hours |
| Automatic Test Machine | 342 hours |
| Test Execution Code Framework | 120 hours |
| **Total development cost** | **975 hours** |

# Manual test execution time, and predicted effort for remaining tests

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| Test specification | Test steps | Manual test execution | Automatic test execution | Post & Pre execution effort |
|---|---|---|---|---|
| K-Thrust Interface Test | 1013 | 19 hours | 238 minutes | 104 minutes |
| K-Pos Interface Test | 926 | 23 hours | 217 minutes | 96 minutes |
| **Aft Bridge Control Station Test** | **426** | **16 hours** | **100 minutes** | **52 minutes** |
| K-Chief Interface Test | 159 | 15 hours | 37 minutes | 29 minutes |
| K-Bridge Interface Test | 114 | 15 hours | 27 minutes | 25 minutes |
| System Test | 80 | 13 hours | 19 minutes | 22 minutes |
| IJS Control Panel Interface Test | 48 | 9 hours | 11 minutes | 19 minutes |
| **Sum** | **2766 steps** | **109 hours** | **11 hours** | **6 hours** |

# Simplified function for return on investment, based on desired test frequency; all time numbers in hours

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$$\text{Cycles required to break even} = 18 = \frac{\text{Total investment } 1689}{\text{Manual test execution pr. cycle } 109 - \text{Automatic test preparation and cleanup pr. cycle } 6 - \text{Maintenance pr. cycle } 8}$$

$$\text{Maintenance pr. cycle } 8 = \frac{\text{Yearly maintenance effort } 536}{\text{Test cycles pr. year } 72}$$

$$\text{Test cycles pr. year } 72 = \text{Builds pr. year } 24 \times \text{Configurations to be tested } 3$$

# Estimated future test effort; all time numbers in hours

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**Automatic test effort** = (Current automatic test preparation and cleanup (6) × Increase in functionality (2) × Test cycles pr. year (235)) + Test Design Effort (1428) + Maintenance Effort (2143) = 6.391

**Manual test effort** = (Current manual test execution (109) × Increase in functionality (2) × Test cycles pr. year (235)) + Test Design Effort (1428) = 52.658

Test cycles pr. year (235) = Cycles pr. year (47) × Number of configurations to be tested (5)

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