



# Using Automated Testing Tools to Facilitate Affordable Designs

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# DoD Testing

- The testing challenge
- Cheating to find critical faults
- Software and hardware is never finished
- Automated testing can improve affordability
- Testing is a design requirement
- Experiences with automated testing
- Conclusions



# The Test Space is Infinite

- There are hundreds of systems on warships
- All systems must interoperate seamlessly
- The environment is harsh and boundless
- Human factors (faults) must be prevented
- Participants rely on simultaneous correct execution
- Lives are at stake
- Testing is sparse relative to the entire space



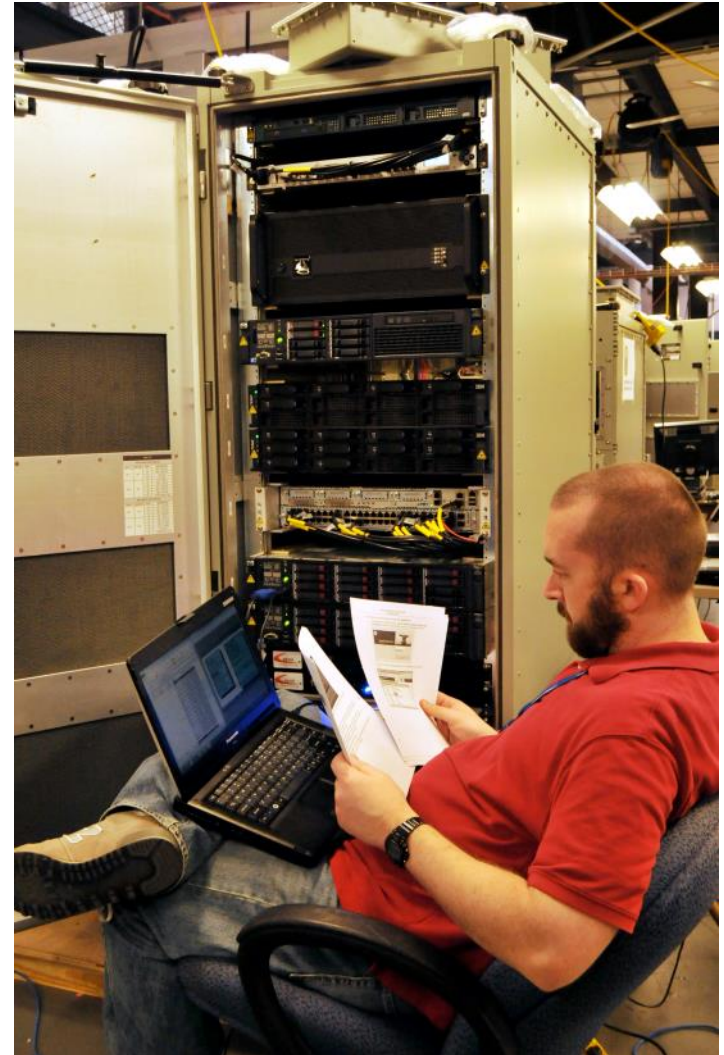
# Critical Faults

- There will be faults left behind
- Some faults are more severe than others
  - Risk
  - Difficulty of detection
  - Probability of occurrence
  - Severity



# Critical Faults

- Finding critical faults may require cheating
  - Statistically invisible = impossible to detect by black box testing
  - Clear box testing can do better
    - Use constraint solvers to synthesize test inputs for majority of cases



# Systems Are Never Finished

- There are always faults to be fixed
- There are always upgrades desired
- Added features create more demand signal



# Automation Can Improve Testing

- Faster development time
- Stable and consistent quality systems
- Lower costs
- Allow fast regression testing
- Changes in approach are required



# Hardware Testing

- Easier than software testing
  - Uniform state representation
  - Known expected outputs
  - Effective error models





# Software Testing

- More complex failure patterns
- Complete test sets not algorithmically computable in the general case



# Testability levels

	Level	Description
0	inadequate	Does not meet requirements for any of the higher levels
1	syntactic	All services and data elements provided by each procurable component have published interfaces/data models that provide names and type signatures.
2	semantic	Published interfaces include precise definitions of the meaning of the services/data, including units, connection to real world objects, and requirements on outputs and final states resulting from all services
3	robust	Published interfaces include all assumptions and restrictions on inputs and states, triggering conditions for all exceptions, and expected results after exceptions
4	observable	All system attributes relevant to checking the requirements are observable either via the published operational interfaces or published augmented testing interfaces
5	measurable	All properties needed to check the requirements have clearly defined measurement and evaluation procedures
6	decidable	Pass/fail decisions for all test cases can be made entirely by automated procedures, without need for subjective human judgment
7	unbounded	Any number of random test inputs can be automatically generated and corresponding test results can be automatically checked for all services

# Agile vs. Waterfall Automated Testing

Agile	Waterfall
Allows for fluid requirements shifts and changes	Does not accommodate changes in requirements easily
Typically requires smaller teams of dedicated developers focused on smaller applications	Typically is based on larger teams working more at the system level
Requires that work be time boxed into Sprints with a working product demonstrable at the end of each time box	Does not have to provide any working components until delivery at the end of the development cycle

# Testing is a Design Requirement

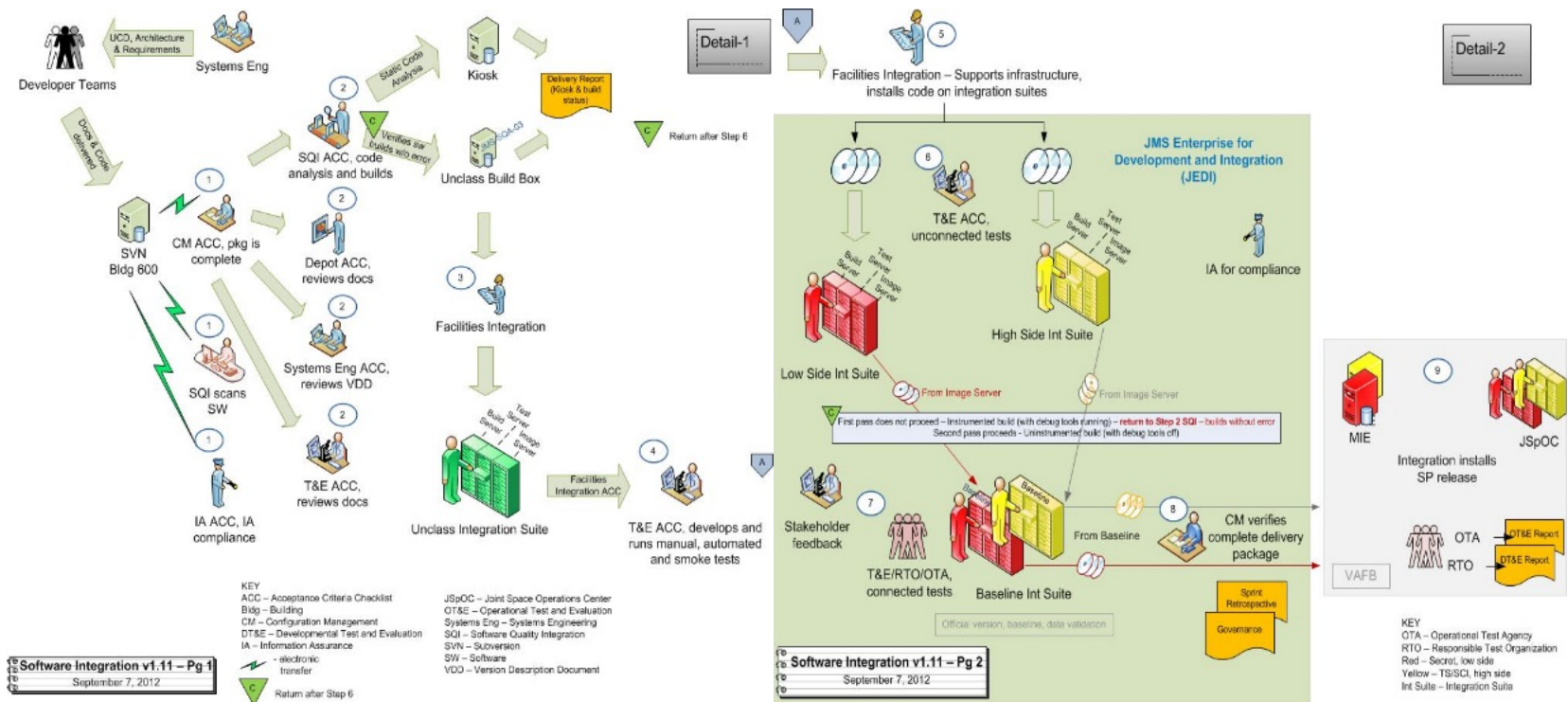
- Programs Approach Testing differently
- Common Instrumentation of SW could allow formalization of Automated Testing
- Using similar Technical Reference Frameworks allows common tools to be utilized
- DoN is considering sponsoring standards for testing

# Experience with Automated Testing

- Rapid Integration and Test Environment (RITE)
  - SPAWAR initiative
  - Fundamental change to DoD integration activities
  - Graduated set of tests
- Focused testing accomplished in three phases is a fundamental aspect
- Continuous integration process



# RITE Continuous Integration Process



# Conclusions

- Automated testing has an important role in achieving affordability
- Depends on valid and sufficiently defined requirements
- Complementary quality assurance processes are needed

