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Customer Success Is Our Mission

Effective use of Automated GUI Interactions on System Verification

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Overview

This presentation seeks to provide an insight to the use of automation of data entry and interaction via a Graphical User Interface (GUI) to provide the input required to conduct integration and verification efforts of a large system.

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Topics

- Why to automate and expected benefits
- How to incorporate automation
- Practical lessons learned from application
- Summary

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Congressional and Customer Desire

- Annually addressed in House Reports for D.O.D. budgets
- Navy NAVSEA Instruction 4215.1 authored in 2010 to provide guidance for implementation for Automated Test and Re-Test (ATRT)

From the House of Representatives Report for National Defense Authorization Act for FY2016

The committee believes that the valuable lessons from such activities as ATRT should be more widely leveraged across the Navy and the rest of the Department of Defense.

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Return on investment

- Return on investment
  - Direct cost savings for test execution
    - Automating an existing test procedure
      - First Procedure – investment resulted in a break even point of 8.6 test executions after automation
      - Subsequent Procedures – investment resulted in a break even point of 6.1 test executions after automation
    - Automating a test without developing a test procedure
      - Automation resulted in 30% increase in development cost and 80% reduction in execution cost
      - Break even point realized in 4 test executions
  - Numerous indirect savings
    - Vary based on test environment, customer relations, etc.

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Technical Benefits (1 of 3)

- Increased test run count provides broader coverage of test objectives
  - Execute automated script hundreds of times in a Monte Carlo approach
  - Allows for wider range of test inputs
  - Provides better opportunity to witness intermittent failures
    - Tool may even help provide characteristics that support debug of the failure

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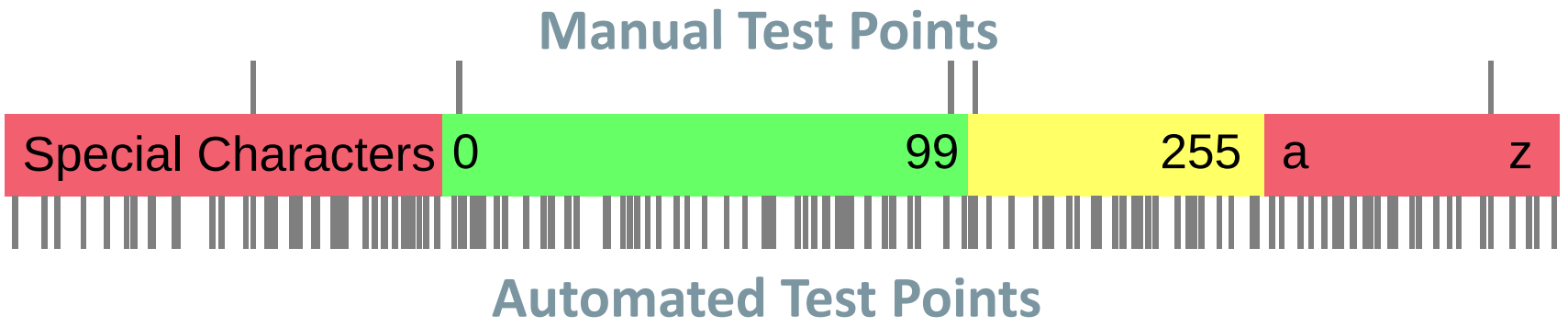
Technical Benefits (2 of 3)

- Broader exercise of operator entered values for data entry points
  - Random selection of enumerations rather than specific entries dictated by test procedure for manual execution
  - Increased breadth of invalid entries to move away from testing boundary conditions



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Technical Benefits (3 of 3)

- Immediate determination of Pass/Fail evaluations rather than post-execution data analysis
- Screen captures of Pass/Fail evaluations
  - Creates evidence of findings for what was typically a Demonstration test procedure
  - Consistent capture points
- Verifying exact measurement that are difficult to conduct in real-time
  - Stringent timing requirements
  - Color mappings to requirements or standards

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Evaluating for Implementation

- Review your Contract and/or Statement of Work
  - Incentives/Contractor Performance Assessment Report
  - May require updates to Master Test Plan and/or Test Procedures which require customer approval
- Dozens of options based on desired approach
  - More than 30 tools have developed in this area and some are already obsolete
  - Wide range of characteristics drive tool selection
  - Understand both your corporate tool providers and the tools available to your customer

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Gaining Customer Acceptance

- Determine if tool selected requires customer certification for use in program qualification
  - Plan for collaboration as automated testing is likely to be new to the customer as well as the contractor
  - Understand limitations of the selected tool

- Issue concerning Method of Verification (MOV)
  - Many tests of an HMI or heavily utilizing an HMI are Demonstration, but automated testing replaces the human witness with a computer witness (i.e., a tool)
  - May have ramifications for an existing specification

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Incorporation into Formal Test Events

- Customer acceptance/reluctance will vary greatly
- One approach that has gained concurrence
  - For converted tests, verify identical execution of an automated test script and paper procedure during the same witnessed test event
    - Identical outcomes allows for future automated execution only
  - For automated only tests, allow the customer to observe the execution of the automated test procedure
    - Demonstrate against specification or approved use case
  - Address use of automation during Test Readiness Review and gain the board's approval to proceed

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Execution Challenges (1 of 2)

- Test automation infrastructure
  - Hardware upgrades
  - Lab support
  - Scripting software and support
  - Documentation
  - Personnel training
  - Security Plans

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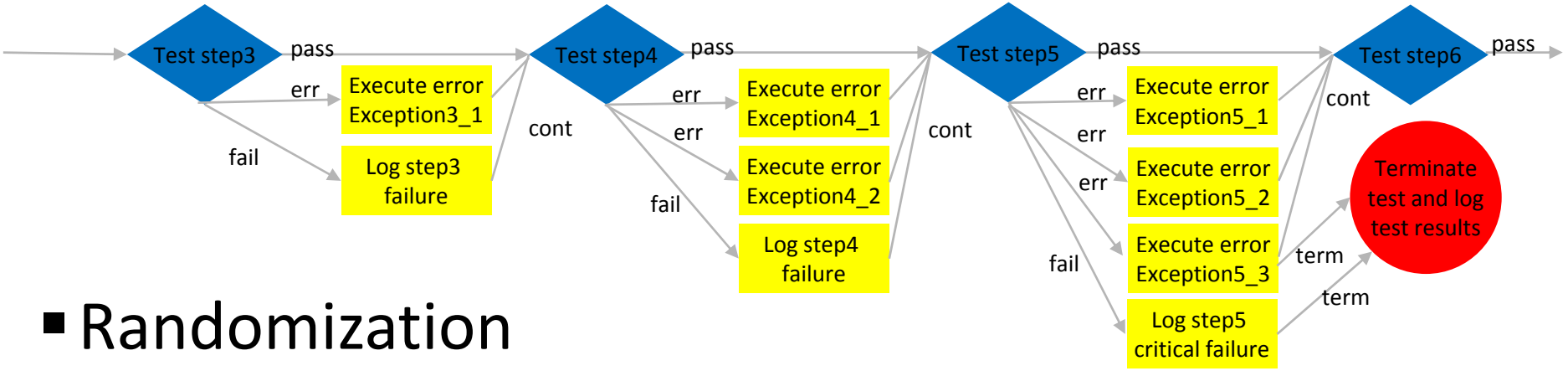
Execution Challenges (2 of 2)

- Test maintenance cost
  - Evolving System Under Test (SUT)
  - Evolving test tool GUIs
  - Evolving lab environment
- Starting the implementation of test automation either too early or too late in the development process
  - Too early: “spinning wheels” during initial development periods reduces ROI
  - Too late: Not enough test execution runs to recoup investment losses (reduced ROI)

Scripting Tradeoffs

- Go path testing vs failure and error handling
  - Challenge of handling test step failure and error exception sprawl
  - Determine the appropriate level of test robustness and reliability for each automation case



- Randomization
  - Human in the loop introduces inherent variability vs scripting introduces repeatability and repetitiveness

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Graphics Comparison and OCR Tuning

- For graphics comparison or Optical Character Recognition (OCR), start with default settings, then depending on test performance tune searches as needed for the specific GUI and test goals

- Tuning can be done for individual searches or globally (all searches)

Click (ImageName: “CloseWindow”, **SearchType: Tolerant**, HotSpot: (45, 15), WaitFor: 10, **Tolerance: 10**, **Discrepancy: 5**, Pulsing: false, SearchRectangle: (180, 250, 240, 300))

ReadText ((300, 200, 350, 220), DPI: 80, **Contrast: true**, **ContrastColor: black**, **ContrastTolerance: 50, ValidCharacters: “A0123456789**”, IgnoreSpaces: true)

*eggPlant code snippets. For eggPlant documentation see http://docs.testplant.com/

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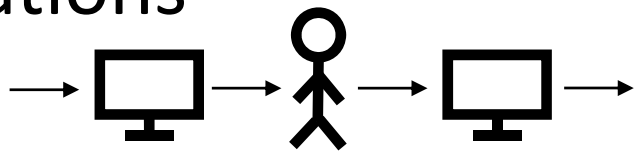
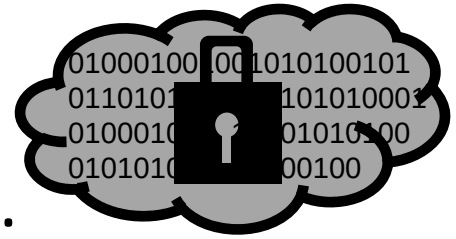
Execution Limitations

- Human-In-The-Loop (HITL) limitations
  - Non-GUI system controls



- Safety limitations
  - Radar ranges
  - High power equipment

- Security limitations
  - Screen locks, Password control, VNC servers
  - Prevention of disclosure of classified capabilities
- Consult SMEs as needed
  - Test Engineers, Lab Manager, Security, etc.



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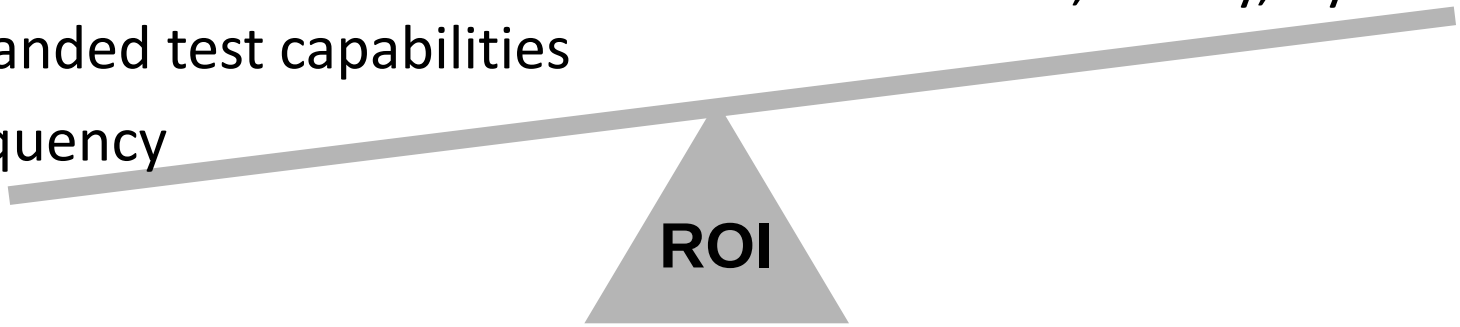
Summary

- Customer Satisfaction
- Value
  - Direct long-term cost savings
  - Indirect efficiencies
- Improved Technical Approach
  - Thoroughness
  - Robustness
  - Expanded test capabilities
  - Frequency
- Infrastructure
  - HW, SW, support, training
- Maintenance
  - SUT, GUIs, lab environment
- Development
  - Scripting, tuning
- Limitations
  - HITL, Safety, Cybersecurity



Consider ALL benefits, costs and drawbacks in the ROI analysis

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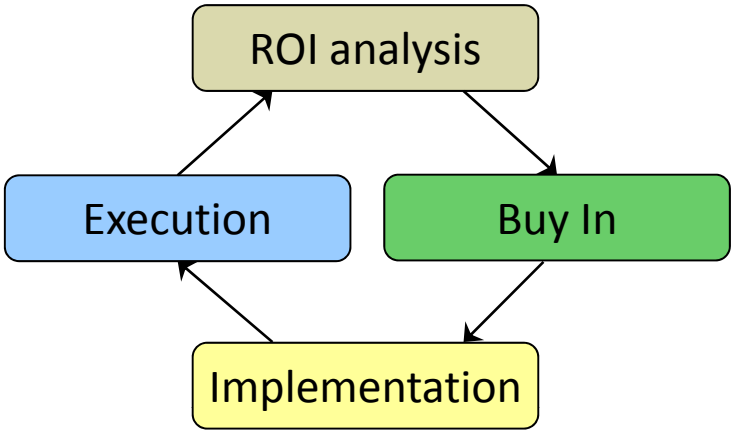
Go Forward Plan

- Start early
  - Use ROI analysis to drive plans
  - Get customer buy-in on approach
- Start conservative
  - Better off with realistic ROI estimate
- Start small
  - Focus on a small set (1-3) of near term test cases
- Start easy
  - Automate the “low hanging fruit”
- Reevaluate



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Biographies

- Mike Mullins is a Senior Principal Systems Engineer at Raytheon Company, Integrated Defense Systems. He has 20+ years of experience in real time communications, networking systems, and track fusion, including algorithm development and IV&V. In his current assignment, Mike is the Integrated Product Team Lead for a Combat System Element. Mike has a Bachelors Degree in Computer Science from Florida State University.
- LeRoy Dunn Jr. is a Principal Systems Engineer at Raytheon Company, Integrated Defense System. He has 10+ years of experience in mechanical design of test equipment and radar electronics, as well as 10+ years of experience in systems requirements development, architecture, IV&V and data analysis. In his current assignment, LeRoy is a data analyst for a Combat System Element. LeRoy has a Bachelor's Degree in Mechanical Engineering from University of Massachusetts at Amherst, a Master's Degree in Mechanical Engineering from Northeastern University, and a Master's Degree in Computer Science from Worcester Polytechnic Institute.