

Automated Cyber-Readiness Evaluation (ACE)

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DoD Challenge Problem

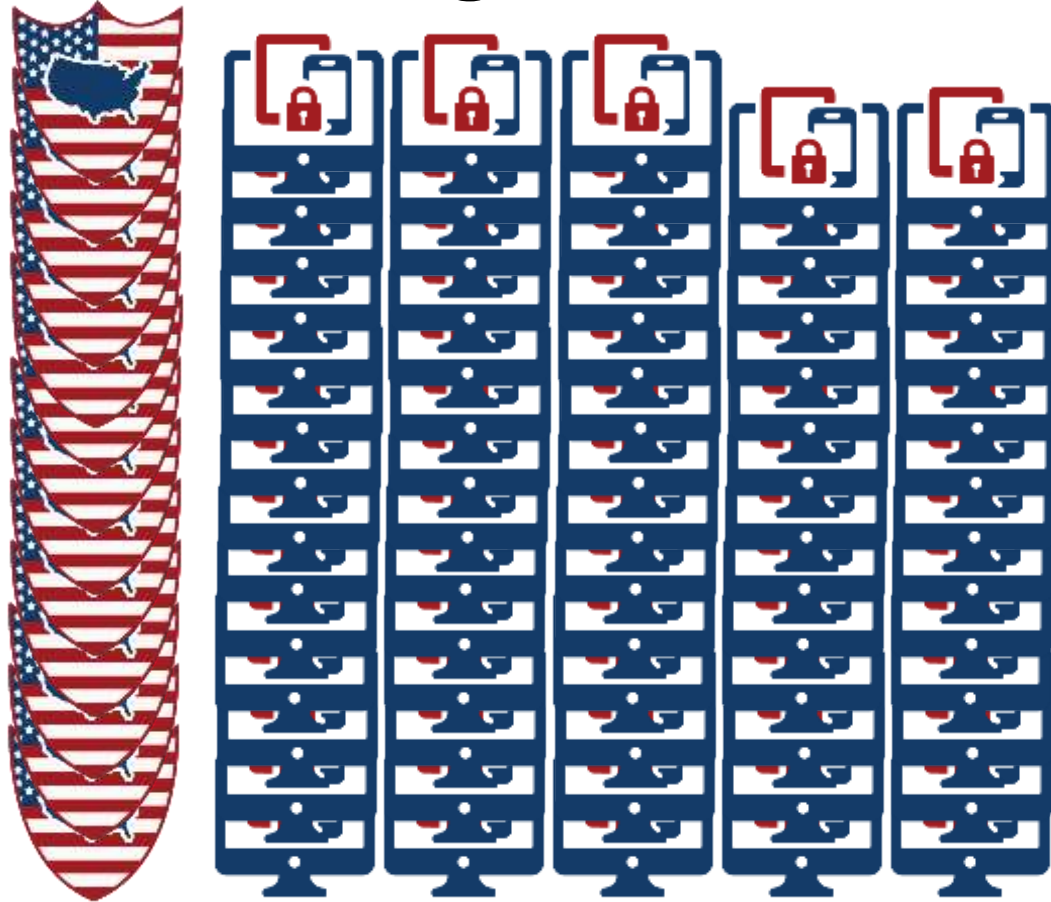


**13 National Mission Teams
(Defend the Nation)**

Evaluating Mission-Readiness for Cyber Operators at Scale

- **Scalable**
- **Objective**
- **Reliable**
- **Valid**

DoD Challenge Problem

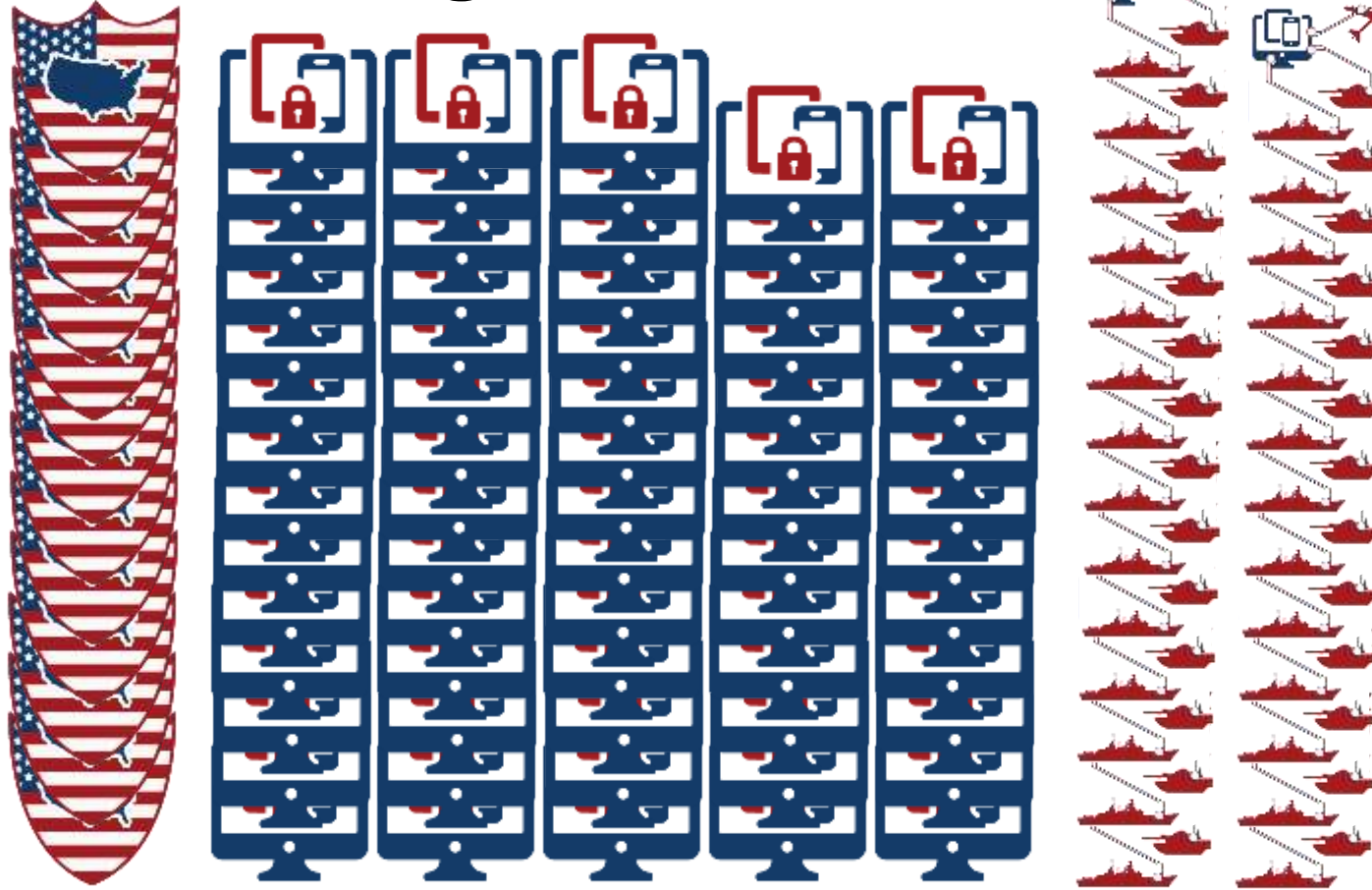


**68 Cyber Protection Teams
(Defend DoD Networks)**

Evaluating Mission-Readiness for Cyber Operators at Scale

- Scalable
- Objective
- Reliable
- Valid

DoD Challenge Problem



**27 Combat Mission Teams
(Support Combatant Commands)**

Evaluating Mission-Readiness for Cyber Operators at Scale

- **Scalable**
- **Objective**
- **Reliable**
- **Valid**

DoD Challenge Problem



+25 Support Teams

Evaluating Mission-Readiness for Cyber Operators at Scale

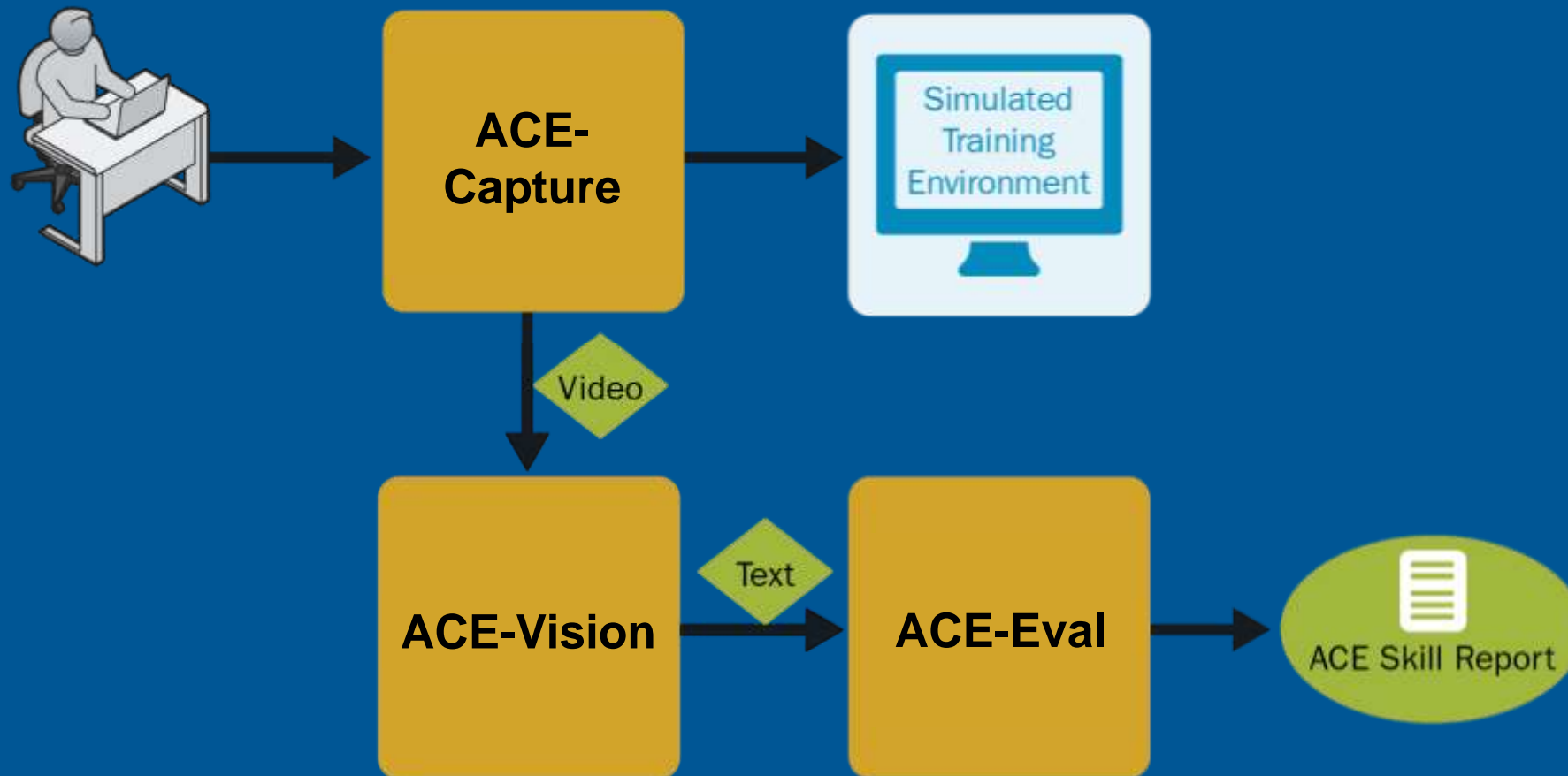
- Scalable
- Objective
- Reliable
- Valid

ACE Philosophy



- **Train as you fight?**
- **Evaluate as you fight!**
 - Place cyber operators in familiar environment
 - Task cyber operators with realistic mission
 - Understand actions taken within scenario
 - Verifiably assess mission-readiness based on actions taken
- **Benefits**
 - Automated analysis
 - Specific deficiencies isolated
 - Automated remediation plans
 - Recording available for future review

ACE Architecture Overview



Role Choice



**Joint Cyberspace Training &
Certification Standards (JCT&CS)**

Forensic Analyst

- 2 Hours
- Existing DoD Standard*
- Self-Contained

* During the course of the project more specific readiness criteria became available

Scenario Development



Scenario I

- **Missing Person**
 - Apartment Searched
 - Laptop Drive Recovered
 - Foul Play Suspected

Scenario II

- **Classified* Documents Exfiltrated**
 - Documents In Enemy Hands
 - Source Organization Drives Imaged
 - Multiple Layers
 - APT1
 - USB
 - Personal Email

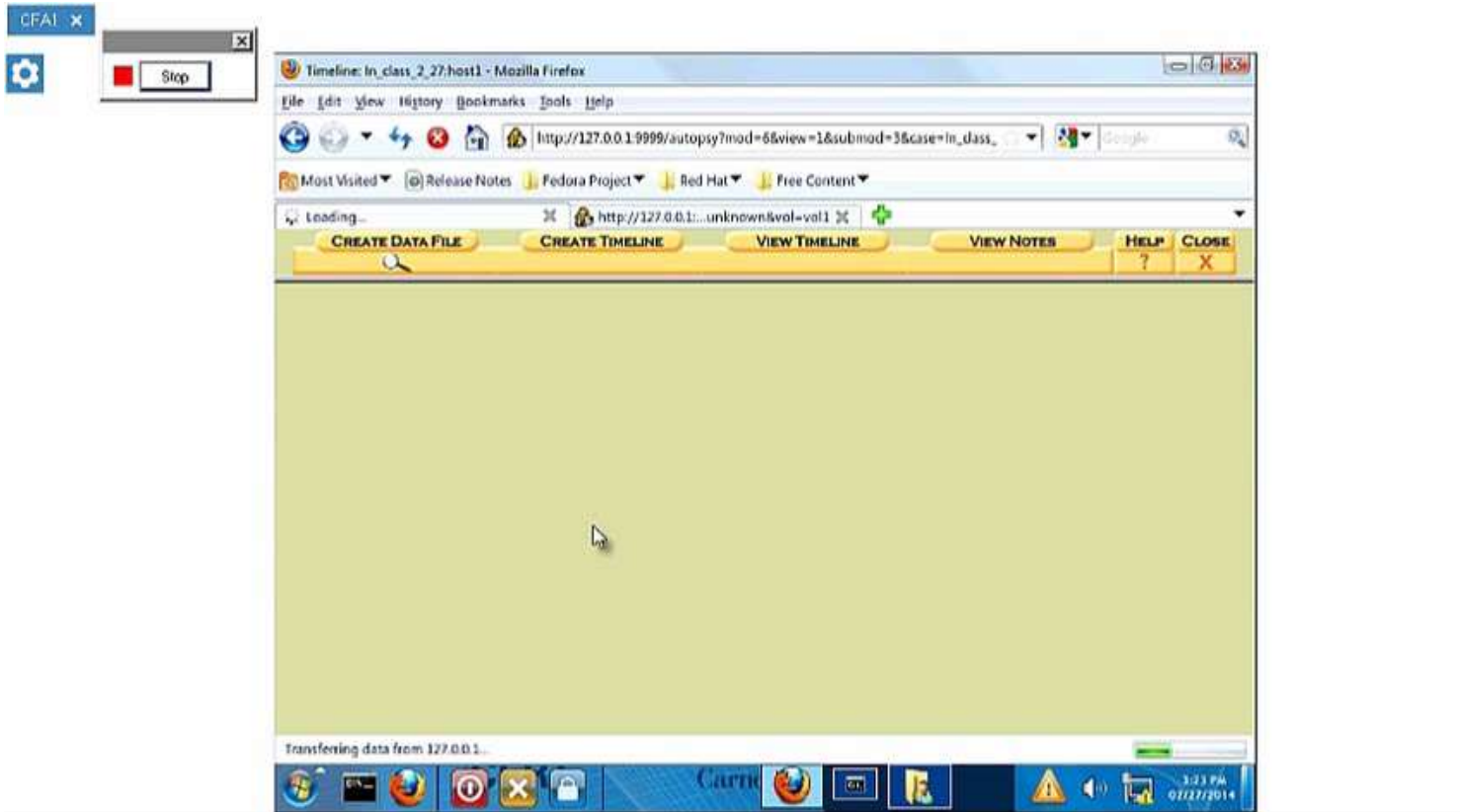
* Classified for evaluation use – not actual classified information.

Data Collection Capability



- Background Data Collection
- Restricted to Environment
- Scalable

Data Collection Capability



Multiple Sources (Increase Dataset Robustness)

- CERT Staff
- CMU Graduate Students
- DoD Personnel
 - Multiple Collections
- NCFTA Personnel



Primary Collaborator:
Professor Yaser Sheik

CMU Robotics Institute, Graphics Lab

Custom Detection System

Designed for massive parallelization

Optimized for use case:

- Maximize pre-process capability
- Minimize duplicate calculations

- Original: $O(nN)$
 - Infeasible for our problem set.
- Optimized: $O(N\log N)$ time.
 - Implemented on GPU array.

Note: Our data set uses high resolution images and so $n \gg \log N$

ACE-Vision - Results



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Custom Detection System

Custom system running on octoputer hardware

- Faster-than-realtime analysis
- May allow for streaming analysis (not in scope)

ACE-Eval



Primary Collaborator:
Professor Geoffrey Gordon
CMU Machine Learning Department

Development

- Requires Categorized Data
 - Evaluator driven categorization (Training data)
 - Hybrid solution required
 - Differing KSA Complexity
 - Simple Binary Detection
 - Path Analysis
 - Hidden Markov Models
 - Frequency Analysis
 - Automated Anomaly Detection
 - Human Intervention

ACE-Eval



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Development

- Data Tagging system
 - Allow subject matter experts (SME) to categorize data
- Several iterations of machine learning solutions
 - Revealed problems in dataset

ACE-Eval



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Challenges

- Signal to noise ratio in data is much lower than expected
 - Need larger dataset
- Available personnel are very limited
 - Order of magnitude difference

ACE-Eval



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Adaptation



Changing Problem

- Better standards definitions available
 - 1000/2000 Level tasks
 - Specific skills and activities isolated
- Gate-Based assessment possible
 - ML solution no longer required

Adaptation



Gate-Based Assessment

- Custom Web-app created
 - Allow capture of KSA / Level tasks
 - Nested abilities
 - Linked by Job Role
 - Reusable Templates
 - Bulk Import/Export
 - Designed for merging into evaluation pipeline

Automated Cyber-Readiness Future Work

Future Work



Transition to CPT evaluation

- Compatible for gate-based assessment
- Part of ongoing PWP work
- Job role transition simplified with specific tasking

Future Work



Stand-Alone utility

- Vision system
 - Insider threat detection
 - Analyst Support
 - Dynamic workstation thresholding
 - User study data collection
 - Experimental tool
- User friendly template generation wizard created
 - Requires no domain specific knowledge
 - Simple screen capture will do!