TOWARD USING INTELLIGENT AGENTS TO DETECT, ASSESS, AND COUNTER CYBERATTACKS IN A NETWORK-CENTRIC ENVIRONMENT

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Introduction

- “The battlefield is the computer”

- The bad guys have many motivations for attacking computational resources
  - Psychological, military, and financial
- Threat will increase
- So, our primary NCO resource is also a prime target

Introduction (cont.)

- **Network Centric Warfare (NCW) increases effectiveness by information-based empowerment**
- **Increased power from information leads to increasing reliance on information**
  - **Unspoken tenet of NCW is that information is accurate**
  - **The growing threat brings this assumption into question because information will be attacked**
  - **Growing sophistication and effectiveness of cyberbattlespace offensive activity**
  - **Technical sophistication required to manage/conduct defense**
- **State and security of network will be critical to commanders**
- **Speed and complexity of cyberspace indicate that new defense approaches are needed**

Cyber Battlespace Arena

- Events occur at high speed, much faster than human thought processes
- Rapid change in attack vectors
- Need for technical expertise for command and control
- Difficult to develop and maintain situation awareness
- Current lack of metrics to measure defense effectiveness
- Difficult to predict future activity in cyberbattlespace
  - No predictive battlespace awareness
- High degree of vulnerability to intended and serendipitious effects of cyberspace actions

CGFs

- In light of the types of attacks, what response should be made?
  - Preserve integrity/functionality of network
  - Control system use
  - Prevent extraction of software subsets (piracy)
  - Protect data
  - Protect network access
  - Insure correct and accurate software
  - Insure computations are correct and accurate
- Resultant CGF Capability Needs
  - Architecture
  - Distributed system (scale)
  - Knowledge acquisition
  - Cyber sensors
  - Most important task is knowledge acquisition for defense management

Framework for Analysis of Attack

- Goals, effort, vector
  - CGFs must be aware of all three
- Goals of attacks
  - Reverse engineering all or parts of a code
  - Allowing limited or unrestricted execution
  - Tampering with the code
- Type of effort needed for successful attack
  - Human effort (from expert to ordinary skills)
  - Generic tools (COTS, open source)
  - Specialized tools (what is possible by skilled adversaries?)
  - Number of allowed executions
  - Time and availability of code required for attack
- Vector for attack
  - Specific vulnerability exploited; means for delivering attack payload

Attack Identification Methodology

- **Identify each type of attack/exploit category**
  - Web and literature survey
  - Narrative description
- **Convert each narrative into UML threat case and sequence diagrams**
  - Threat case diagrams to document threats
- **Parallel development**
  - Tests, scenarios, and experiments to validate uncovered attacks
- **Testing and analysis of identified attacks and included major and minor threat cases**

Attack Classification

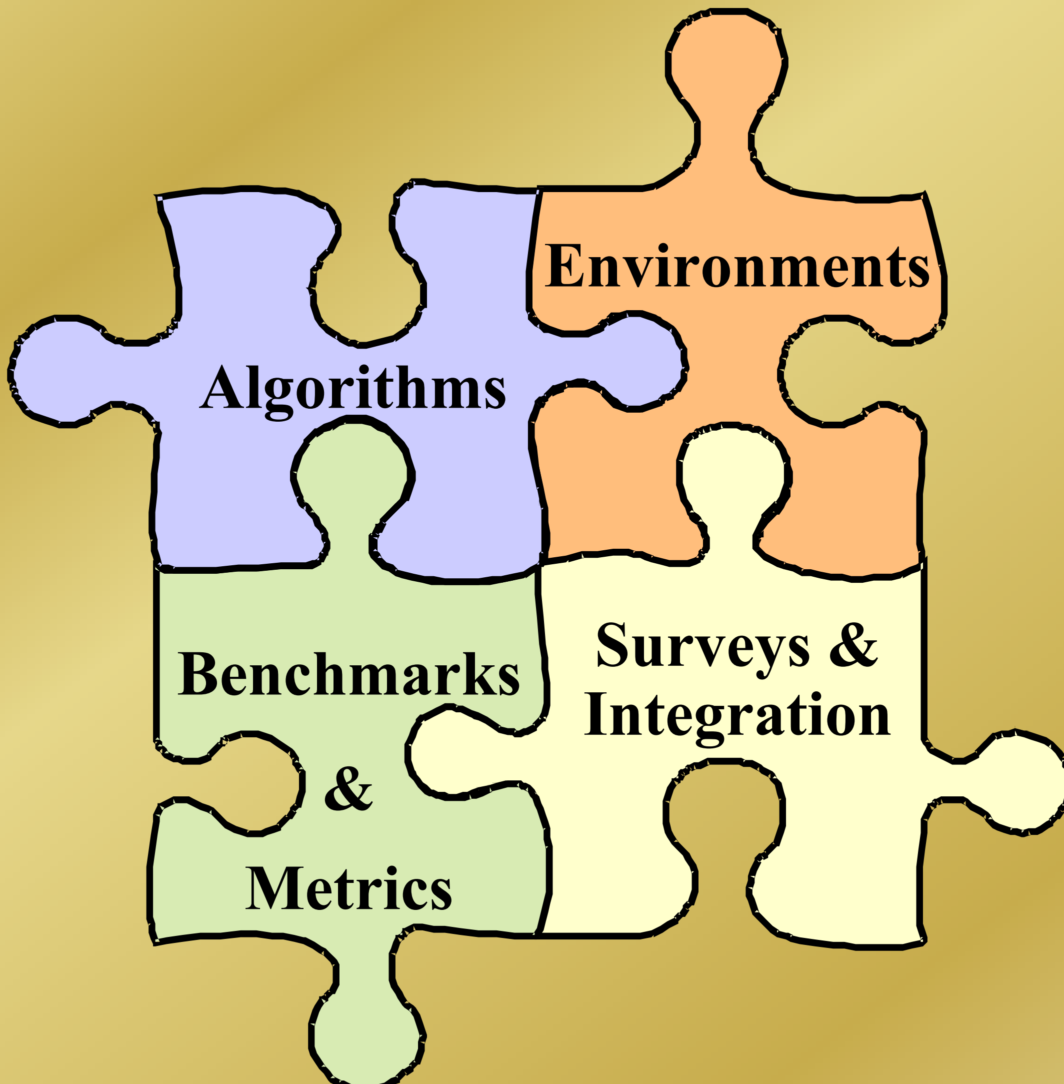
- No generally accepted classification
  - Developed classification based upon extensive research and correlation of literature
- Literature shows it is broad and growing
- Three basic attack strategies
  - Fault injection via environment
  - Fault injection through source
  - Fault injection via errors

Types of Attacks

1- Block Access to Libraries
2- Redirect Access to libraries
3- Manipulate application registry values
4- Force the application to use corrupt files or databases
5- Manipulate and replace files that the application creates, reads, writes, or executes
6- Force the application to operate in low memory, disk-space, and network-availability conditions
7- Overflow input buffers
8- Attack through application switches and options
9- Use escape characters, different character sets, and commands to get malformed input
10- Try common default and test names and passwords
11- Look for and test unprotected application APIs
12- Connect to all ports
13- Fake the data source
14- Create loop conditions in an application that reads script, code or other user supplied macros or logic
15- Look for and use alternative execution routes through an application to accomplish its task(s)
16- Force the application to reset its values
17- Get between time of check of a value and time of use of a value
18- Create fake files with the same name as protected files
19- Force all error messages
20- Look for temporary files for an application and examine their contents for sensitive or exploitable information
21- Force invalid outputs to be generated
22- Attack through shared data

- **Block library access**
- **Overflow input buffers**
- **Connect to all ports**
- **Force error messages**

Basic Research Requirements



CGF Cybersensor Requirements

- **Data acquisition about local attack**
- **Identify type of attack, attack payload, strategy**
- **Attack origination**
- **Must be able to identify an attack and differentiate it from a system failure or fault**
- **Secure transmission of data from sensor to control sensor**
- **Secure migration**
- **Autonomic operation**
- **Exchange data among cybersensors securely**
- **Scan for vulnerabilities and assess risk**

Addressing the Need

- Must develop techniques and environments to assemble the CGF cybersensorss
- Must test the CGFs as well
  - Real world too dangerous
  - Simulation environments provide protection for real-world and required complexity for CGF testing
- Develop application security test suites
- Build testbed for development and evaluation of technologies and CGFs
  - Secure development
  - Benchmarks, metrics, scenarios
  - Integrated cyber defensive techniques for testing and analysis
  - Techniques for testing of methodologies
- Need cost-benefit analysis for different types of security

Conclusions and Future Work

- **Transition to NCW will place a premium on cybersecurity**
- **Speed of activity in cyberspace calls for automated defenses**
- **CGFs will have many functions to perform and much remains to be done before they can be fielded**
  - **Identified requirements and attacks they must be able to manage**
- **Need to refine requirements and develop distributed CGF system**