The Survivable Network Analysis Method:
Assessing Survivability of Critical Systems

CERT/Coordination Center
Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA 15213

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Mission Survivability
Changing Environment

- System Evolution
  - expanding network boundaries
  - additional participants with varying levels of trust
  - numerous point solutions: Public Key Infrastructure, Virtual Private Networks, Firewalls
  - blurring of Intranet and Extranet boundaries
  - new technologies -- directory services, XML

- The impact of attacks is on organizations, and hence on the applications which support the organization’s mission
Impact on Analysis

• Lack of complete information
  – physical and logical perimeters
  – participants, untrusted insiders
  – software components --- COTS Java, etc.
• Mix of central and local administrative control
• Critical components more exposed
• An attack could impact essential business services
Survivability Defined

*Survivability* is the ability of a system to fulfill its mission, in a timely manner, in the presence of attacks, failures, or accidents.
Key properties

• Mission Focus
  – Identification of risks and trade-offs
  – Alternative means to meet mission
• Assume imperfect defenses
The “Three Rs”

- **Resistance**
  - Capability to deter attacks

- **Recognition**
  - Capability to recognize attacks and extent of damage

- **Recovery**
  - Capability to provide essential services/assets during attack and recover full services after attack
Techniques and Methods

• **Traditional Security**
  – fortress model: firewalls, protection, security policy
  – insider trust
  – encryption, authentication, passwords
  – resistance and recognition with recovery secondary

• **Survivability is enhanced by**
  – security techniques where applicable
  – redundancy, diversity, general trust validation, etc
  – automated recovery support
Example

- **E-mail**
  - E-mail content tunnels through firewalls
  - Always time lag between initial discovery and upgraded virus signatures required for scans
  - Enhanced e-mail functionality
    - Attachments (Word macros)
    - Rich content such as HTML, Javascript
  - Significant impact on services other than e-mail.
The Survivable Network Analysis Method

• Focus
  – early phase of life cycle
  – applications as well as system infrastructure
  – tailorable depending on stage of development.

• Three options for SNA analysis
  – survivability architecture
  – survivability requirements
  – mission lifecycle
Architectural Focus

• Capture assumptions such as boundaries and users
• Support system evolution as requirements and technologies change
  – evolving functional requirements
  – trend to loosely coupled
  – requirements for integration across diverse systems
• Assist with product selection and integration with respect to rapidly changing security product world
General Method

- Identify essential services with normal usage.
- Generate intrusion scenarios which are use cases for intruder.
- Evaluate system in terms of response to scenarios:
  - Requirements: propose response to intrusions
  - Architecture: evaluate system and operational behavior
- Mission impact:
  - Applications as well as system components
  - Stakeholders input essential
Survivability Architecture

• Make recommendations for survivability improvements
• Identify decision and tradeoff points - areas of high risk
• Identify trade-offs with other software quality attributes – safety, reliability, performance, usability
The Survivable Network Analysis Method

STEP 1
SYSTEM DEFINITION
• Mission requirements definition
• Architecture definition and elicitation

STEP 2
ESSENTIAL CAPABILITY DEFINITION
• Essential service/asset selection/scenarios
• Essential component identification

STEP 3
COMPROMISABLE CAPABILITY DEF’N
• Intrusion selection/scenarios
• Compromisable component identification

STEP 4
SURVIVABILITY ANALYSIS
• Softspot component (essential & compromisable) identification
• Resistance, recognition, and recovery analysis
• Survivability Map development
Determining Survivability Strategies
# Survivability Map

<table>
<thead>
<tr>
<th>Intrusion Scenario</th>
<th>Softspot Effects</th>
<th>Architecture Strategies for</th>
<th>Resistance</th>
<th>Recognition</th>
<th>Recovery</th>
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<td>Current</td>
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- Roadmap for management evaluation and action
Option: Survivability Requirements

- Identify requirements for mission-critical **functionality**
  - minimum essential services
  - graceful degradation of services
  - restoration of full services

- Identify explicit requirements for
  - recovery
  - recognition
  - resistance
Option: Mission Lifecycle

- Factor survivability into the development and operational lifecycle

- Capture security and survivability assumptions
  - boundaries, users

- Identify survivability decision points
  - impact of changes on recovery, intrusion detection, etc.
Benefits of the SNA

- Clarified requirements
- Documented basis for system decisions
- Basis to evaluate changes in architecture
- Early problem identification
- Increased stakeholder communication
Additional Information

- SNA Case Study: The Vigilant Healthcare System
  - IEEE Software: July/August 1999
- Survivability: Protection Your Critical Systems
  - IEEE Internet Computing: Nov/December 1999
- Web site: IEEE article and other reports
  www.sei.cmu.edu/organization/programs/nss/surv-net-tech.html