Risk Analysis

CS498IA – Information Assurance

Spring 2007

Overview

- Definition and Purpose Of Risk Analysis
  - Elements of Risk Analysis
  - Quantitative vs Qualitative Analysis
- Quantitative Example
- Qualitative Example

Reading Material

- *Part of Chapter 1 from Secrets of Computer Espionage, by Joel McNamara*
- *Information Security Risk Analysis*, by Thomas R. Peltier
  - Soon to be on reserve at the library
  - Identifies basic elements of risk analysis and reviews several variants of qualitative approaches
- "Information Security Risk Assessment: Practices of Leading organizations", By GAO
  - http://www.gao.gov/special.pubs/ai99139.pdf
  - Case studies of risk analysis procedures for four companies
- "Risk Management Guide for Information Technology Systems", NIST
  - http://csrc.nist.gov/publications/nistpubs/800-30/sp800-30.pdf
  - Outlines steps for risk assessment

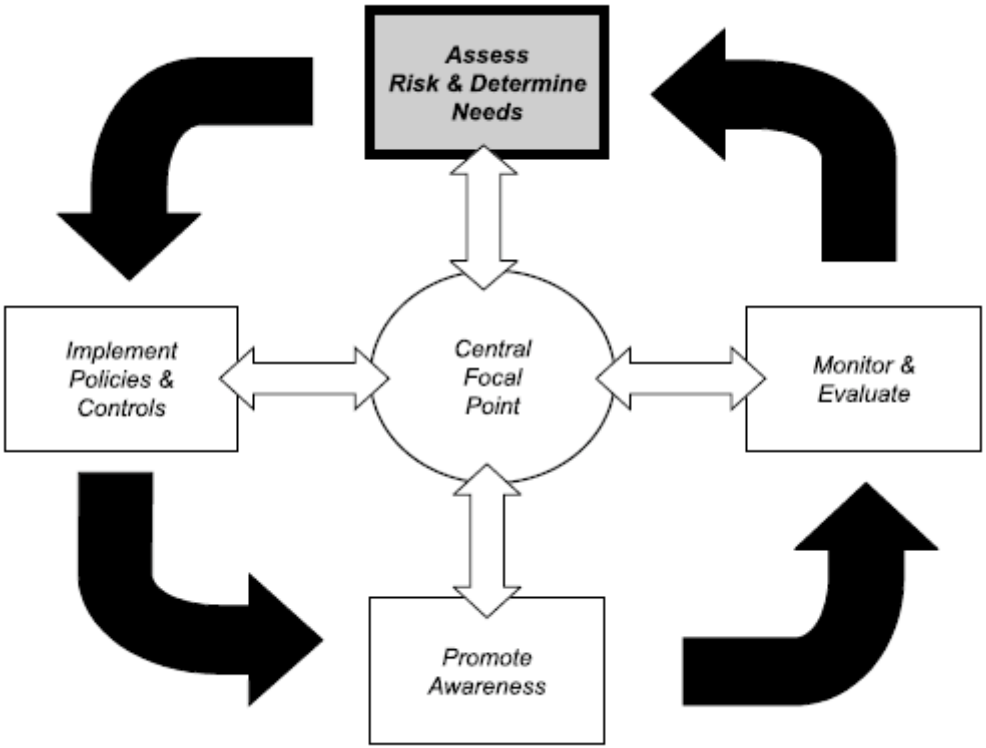
Goal of Risk Analysis

- "If you know the enemy and know yourself, you need not fear the result of a hundred battles."
  - Sun Tzu, Art of War

What is Risk?

- The probability that a particular threat will exploit a particular vulnerability
- Need to systematically understand risks to a system and decide how to control them.

Risk Management Cycle



From GAO/AIMD-99-139

What is Risk Analysis?

- The process of identifying, assessing, and reducing risks to an acceptable level
  - Defines and controls threats and vulnerabilities
  - Implements risk reduction measures
- An analytic discipline with three parts:
  - Risk assessment: determine what the risks are
  - Risk management: evaluating alternatives for mitigating the risk
  - Risk communication: presenting this material in an understandable way to decision makers and/or the public

Benefits of Risk Analysis

- Assurance that greatest risks have been identified and addressed
- Increased understanding of risks
- Mechanism for reaching consensus
- Support for needed controls
- Means for communicating results

Basic Risk Analysis Structure

- Evaluate
  - Value of computing and information assets
  - Vulnerabilities of the system
  - Threats from inside and outside
  - Risk priorities
- Examine
  - Availability of security countermeasures
  - Effectiveness of countermeasures
  - Costs (installation, operation, etc.) of countermeasures
- Implement and Monitor

Who should be Involved?

- Security Experts
- Internal domain experts
  - Knows best how things really work
- Managers responsible for implementing controls

Identify Assets

- Asset – Anything of value
- Physical Assets
  - Buildings, computers
- Logical Assets
  - Intellectual property, reputation

Example Critical Assets

- People and skills
- Goodwill
- Hardware/Software
- Data
- Documentation
- Supplies
- Physical plant
- Money

Threats

- An expression of intention to inflict evil injury or damage
- Attacks against key security services
  - Confidentiality, integrity, availability

Example Threat List

- **T01 Access (Unauthorized to System - logical)**
- **T02 Access (Unauthorized to Area - physical)**
- **T03 Airborne Particles (Dust)**
- **T04 Air Conditioning Failure**
- **T05 Application Program Change (Unauthorized)**
- **T06 Bomb Threat**
- **T07 Chemical Spill**
- **T08 Civil Disturbance**
- **T09 Communications Failure**
- **T10 Data Alteration (Error)**
- **T11 Data Alteration (Deliberate)**
- **T12 Data Destruction (Error)**
- **T13 Data Destruction (Deliberate)**
- **T14 Data Disclosure (Unauthorized)**
- **T15 Disgruntled Employee**
- **T16 Earthquakes**
- **T17 Errors (All Types)**
- **T18 Electro-Magnetic Interference**
- **T19 Emanations Detection**
- **T20 Explosion (Internal)**
- **T21 Fire, Catastrophic**
- **T22 Fire, Major**
- **T23 Fire, Minor**
- **T24 Floods/Water Damage**
- **T25 Fraud/Embezzlement**
- **T26 Hardware Failure/Malfunction**
- **T27 Hurricanes**
- **T28 Injury/Illness (Personal)**
- **T29 Lightning Storm**
- **T30 Liquid Leaking (Any)**
- **T31 Loss of Data/Software**
- **T32 Marking of Data/Media Improperly**
- **T33 Misuse of Computer/Resource**
- **T34 Nuclear Mishap**
- **T35 Operating System Penetration/Alteration**
- **T36 Operator Error**
- **T37 Power Fluctuation (Brown/Transients)**
- **T38 Power Loss**
- **T39 Programming Error/Bug**
- **T40 Sabotage**
- **T41 Static Electricity**
- **T42 Storms (Snow/Ice/Wind)**
- **T43 System Software Alteration**
- **T44 Terrorist Actions**
- **T45 Theft (Data/Hardware/Software)**
- **T46 Tornado**
- **T47 Tsunami (Pacific area only)**
- **T48 Vandalism**
- **T49 Virus/Worm (Computer)**
- **T50 Volcanic Eruption**

Characterize Threat-Sources

Threat-source	Motivation	Threat Actions
Hacker	Challenge, ego, rebellion	Hacking Social engineering System intrusion Unauthorized access
Terrorist	Blackmail, Destruction, Revenge	Information warfare System attack System tampering
Insider	Ego, Revenge, Monetary gain	Blackmail Malicious code Input of falsified data System bugs

Vulnerabilities

- Flaw or weakness in system that can be exploited to violate system integrity.
  - Security Procedures
  - Design
  - Implementation
- Threats trigger vulnerabilities
  - Accidental
  - Malicious

Example Vulnerabilities

- *Physical*
- *V01 Susceptible to unauthorized building access*
- *V02 Computer Room susceptible to unauthorized access*
- *V03 Media Library susceptible to unauthorized access*
- *V04 Inadequate visitor control procedures*
- *(and 36 more)*
- *Administrative*
- *V41 Lack of management support for security*
- *V42 No separation of duties policy*
- *V43 Inadequate/no computer security plan policy*
- *V47 Inadequate/no emergency action plan*
- *(and 7 more)*
- *Personnel*
- *V56 Inadequate personnel screening*
- *V57 Personnel not adequately trained in job*
- *...*
- *Software*
- *V62 Inadequate/missing audit trail capability*
- *V63 Audit trail log not reviewed weekly*
- *V64 Inadequate control over application/program changes*
- *Communications*
- *V87 Inadequate communications system*
- *V88 Lack of encryption*
- *V89 Potential for disruptions*
- *...*
- *Hardware*
- *V92 Lack of hardware inventory*
- *V93 Inadequate monitoring of maintenance personnel*
- *V94 No preventive maintenance program*
- *...*
- *V100 Susceptible to electronic emanations*

Controls/Countermeasures

- Mechanisms or procedures for mitigating vulnerabilities
  - Prevent
  - Detect
  - Recover
- Understand cost and coverage of control
- Controls follow vulnerability and threat analysis

Example Controls

- **C01 Access control devices - physical**
- **C02 Access control lists - physical**
- **C03 Access control - software**
- **C04 Assign ADP security and assistant in writing**
- **C05 Install-/review audit trails**
- **C06 Conduct risk analysis**
- **C07Develop backup plan**
- **C08 Develop emergency action plan**
- **C09 Develop disaster recovery plan**
- **...**
- **C21 Install walls from true floor to true ceiling**
- **C22 Develop visitor sip-in/escort procedures**
- **C23 Investigate backgrounds of new employees**
- **C24 Restrict numbers of privileged users**
- **C25 Develop separation of duties policy**
- **C26 Require use of unique passwords for logon**
- **C27 Make password changes mandatory**
- **C28 Encrypt password file**
- **C29 Encrypt data/files**
- **C30 Hardware/software training for personnel**
- **C31Prohibit outside software on system**
- **...**
- **C47 Develop software life cycle development program**
- **C48 Conduct hardware/software inventory**
- **C49 Designate critical programs/files**
- **C50 Lock PCs/terminals to desks**
- **C51 Update communications system/hardware**
- **C52 Monitor maintenance personnel**
- **C53 Shield equipment from electromagnetic interference/emanations**
- **C54Identify terminals**

Risk/Control Trade Offs

- Only Safe Asset is a Dead Asset
  - Asset that is completely locked away is safe, but useless
  - Trade-off between safety and availablity
- Do not waste effort on efforts with low loss value
  - Don’t spend resources to protect garbage
- Control only has to be good enough, not absolute
  - Make it tough enough to discourage enemy

Example Scenarios

- E4bics – VoIP startup
- No More Violence – tracking clients
- Common Questions
  - What are the assets?
  - What are the vulnerabilities?
  - What are the threat-sources?
  - What are possible controls?

Types of Risk Analysis

- Quantitative
  - Assigns real numbers to costs of safeguards and damage
  - Annual loss exposure (ALE)
  - Probability of event occurring
  - Can be unreliable/inaccurate
- Qualitative
  - Judges an organization's risk to threats
  - Based on judgment, intuition, and experience
  - Ranks the seriousness of the threats for the sensitivity of the asserts
  - Subjective, lacks hard numbers to justify return on investment

Quantitative Analysis Outline

1. Identify and value assets
2. Determine vulnerabilities and impact
3. Estimate likelihood of exploitation
4. Compute Annual Loss Exposure (ALE)
5. Survey applicable controls and their costs
6. Project annual savings from control

Quantitative (2)

- Risk = Risk-impact x Risk-Probability
  - Loss of car: risk-impact is cost to replace car, e.g. $10,000
  - Probability of car loss: 0.10
  - Risk = 10,000 x 0.10 = 1,000
- General measured per year
  - Annual Loss Exposure (ALE)

Qualitative Risk Analysis

- Generally used in Information Security
  - Hard to make meaningful valuations and meaningful probabilities
  - Relative ordering is faster and more important
- Many approaches to performing qualitative risk analysis
- Same basic steps as quantitative analysis
  - Still identifying asserts, threats, vulnerabilities, and controls
  - Just evaluating importance differently

Example 10 Step QRA

- Step 1: Identify Scope
  - Bound the problem
- Step 2: Assemble team
  - Include subject matter experts, management in charge of implementing, users
- Step 3: Identify Threats
  - Pick from lists of known threats
  - Brainstorm new threats
  - Mixing threats and vulnerabilities here...

Step 4: Threat prioritization

- Prioritize threats for each assert
  - Likelihood of occurrence
- Define a fixed threat rating
  - E.g., Low(1) … High(5)
- Associate a rating with each threat
- Approximation to the risk probability in quantitative approach

Step 5: Loss Impact

- With each threat determine loss impact
- Define a fixed ranking
  - E.g., Low(1) … High(5)
- Used to prioritize damage to asset from threat

Step 6: Total impact

- Sum of threat priority and impact priority

Threat	Threat Priority	Impact Priority	Risk Factor
Fire	3	5	8
Water	2	5	7
Theft	2	3	5

Step 7: Identify Controls/Safeguards

- Potentially come into the analysis with an initial set of possible controls
- Associate controls with each threat
- Starting with high priority risks
  - Do cost-benefits and coverage analysis (Step 8)
  - Rank controls (Step 9)

Safeguard Evaluation

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Threat	Risk Factor	Possible Safeguard	Safeguard cost
Fire	8	Fire supression system	$15,000.00
Tornado	8	Business Continuity Plan	$75,000.00
Water Damage	7	Business Continuity Plan	$75,000.00
Theft	5		

Step 10: Communicate Results

- Most risk analysis projects result in a written report
  - Generally not read
  - Make a good executive summary
  - Beneficial to track decisions.
- Real communication done in meetings an presentations

Key Points

- Key Elements of Risk Analysis
  - Assets, Threats, Vulnerabilities, and Controls
- Most security risk analysis uses qualitative analysis
- Not a scientific process
  - Companies will develop their own procedure
  - Still a good framework for better understanding of system security