Threat Modeling

SecAppDev 2010

Design flaws are major

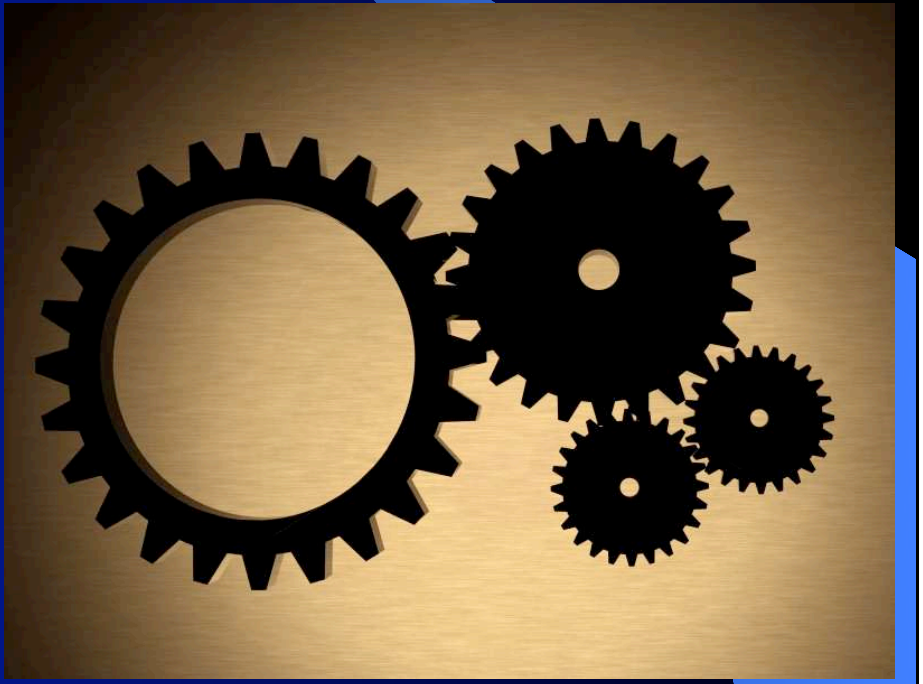
- Difficult and costly to fix post facto
  - Too costly to fix?
- Often made because of false assumptions
  - Trust models
  - Underestimate attackers
  - Naïveté
  - Ignorance

Let’s look at design activities

- Approaches
  - Risk analyses
  - Threat modeling
- Formal vs. ad hoc
  - Same intent
- Find problems before we implement them

Let’s see what the SDLCs offer

- Several to choose from
- Enough good in each to consider all
  - Look carefully at each author’s perspective
- Apply consistently and measure



Who are the players?

- Microsoft
  - Secure Development Lifecycle
  - "The Security Development Lifecycle," Michael Howard and Steve Lipner, Microsoft Press, ISBN 978-0-7356-2214-2
- Cigital
  - "Touchpoint" process
  - "Software Security: Building Security In," Gary McGraw, Addison-Wesley, ISBN 0-321-35670-5
  - http://BuildSecurityIn.US-CERT.gov
- OWASP
  - Comprehensive Lightweight Application Security Process (CLASP)
  - http://www.owasp.org/index.php/OWASP_CLASP_Project

SDL: Product Risk Assessment

- Analyze the product’s functions and their “danger” levels
  - Use their sample questionnaire as a starting point
- Determine the privacy impact
- How much effort should be applied?

SDL: Risk Analysis

This one really comes down to

- Threat modeling
- Using threat model to aid code review
- Using threat model to aid testing
- Determine key success factors and metrics

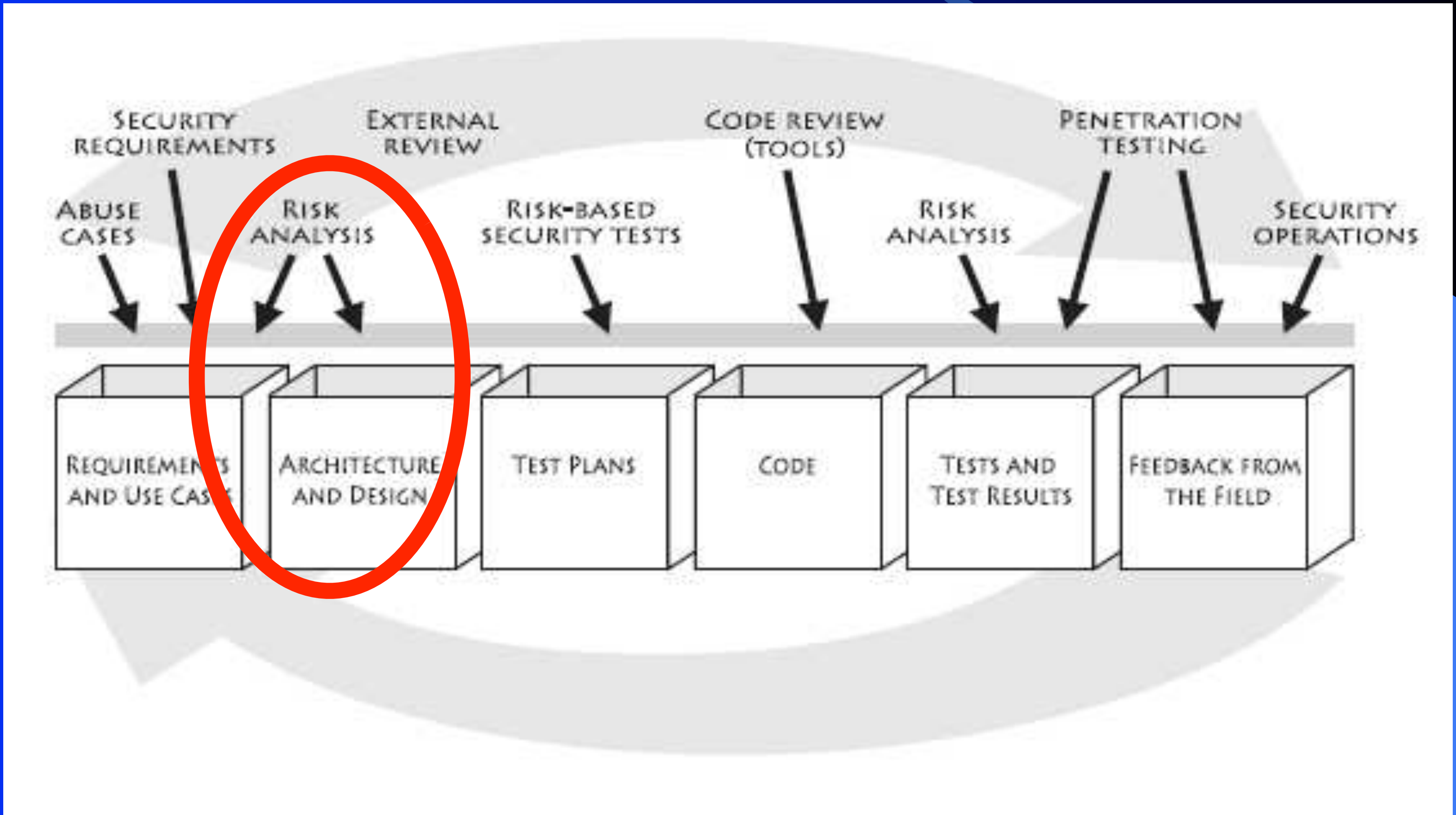
Guided by

- STRIDE (Spoofing, Tampering, Repudiation, Info disclosure, DoS, Elevation)
- DREAD (Damage, Reproducibility, Exploitability, Affected Users, Discoverability)

Cigital's "Touchpoints"

- Built by McGraw et al over time
  - Perspective is consulting services
- Consists of three pillars
  - Risk management
  - Knowledge
  - Touchpoints

The Touchpoints



A risk management framework

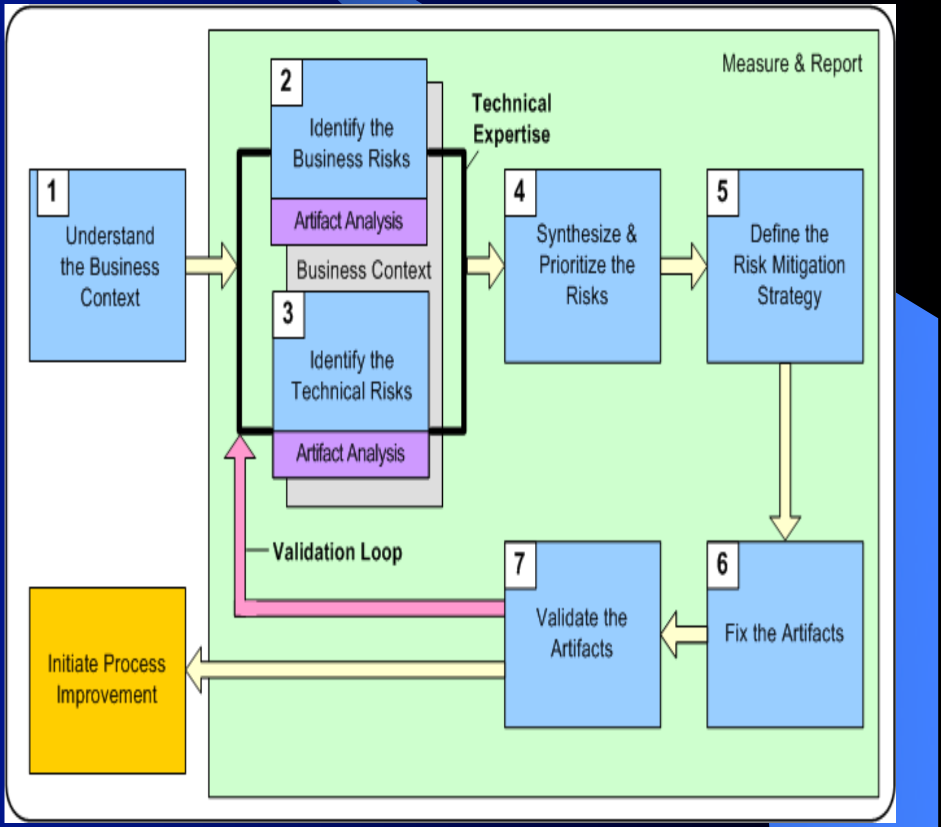
Business goals determine risks

Risks drive methods

Methods yield measurement

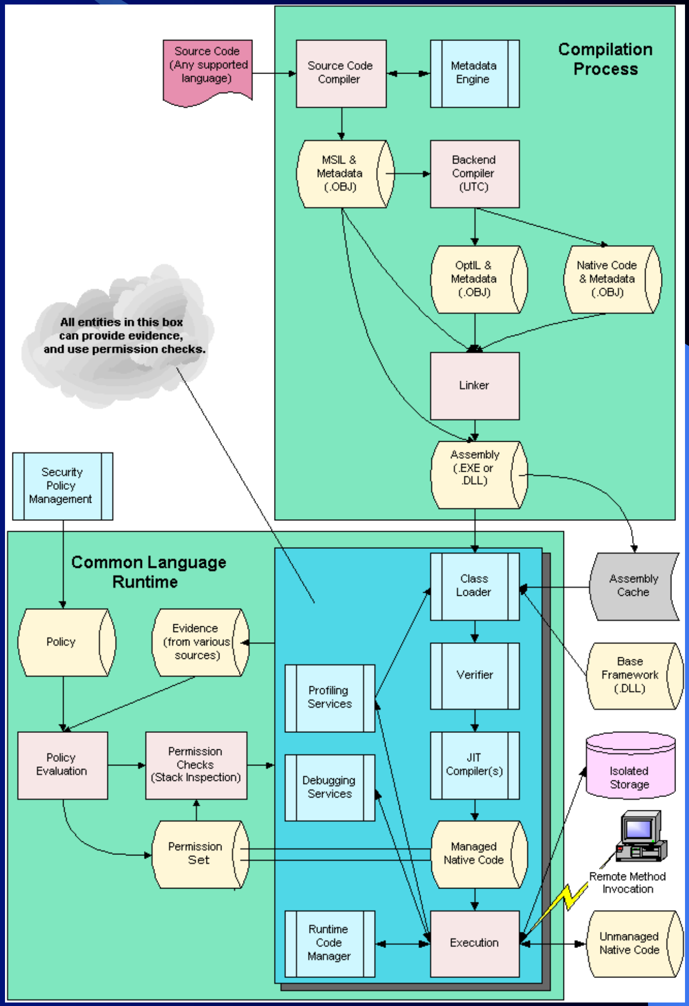
Measurement drives decision support

Decision support drives fix/rework and application quality


Measure & Report
2
Identify the Business Risks
Artifact Analysis
Technical Expertise
1
Understand the Business Context
Business Context
4
Synthesize & Prioritize the Risks
5
Define the Risk Mitigation Strategy
3
Identify the Technical Risks
Artifact Analysis
Validation Loop
7
Validate the Artifacts
6
Fix the Artifacts
Initiate Process Improvement

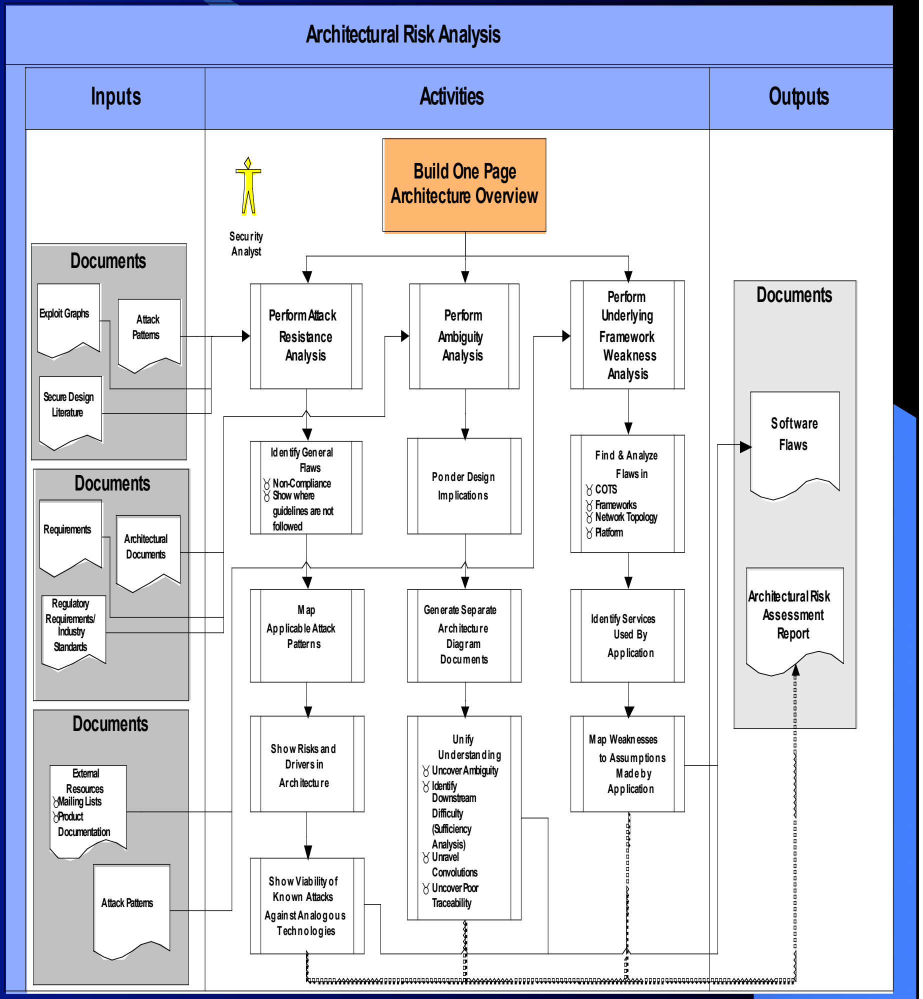
Architectural risk analysis

- Build a one page white board design model
- Use hypothesis testing to categorize risks
  - Threat modeling/Attack patterns
- Rank risks
- Tie to business context
- Suggest fixes
- Repeat



Architectural risk analysis

- Follow a process
- Build an overview (one page)
- Three steps
  - Attack resistance analysis
  - Ambiguity analysis
  - Weakness analysis
- Rank risks
- Build mitigations



Architectural Risk Analysis
Inputs
Activities
Outputs
Security Analyst
Build One Page Architecture Overview
Documents
Exploit Graphs
Attack Patterns
Secure Design Literature
Documents
Requirements
Architectural Documents
Regulatory Requirements/ Industry Standards
Documents
External Resources
• Mailing Lists
• Product Documentation
Attack Patterns
Perform Attack Resistance Analysis
Identify General Flaws
• Non-Compliance
• Show where guidelines are not followed
Map Applicable Attack Patterns
Show Risks and Drivers in Architecture
Show Viability of Known Attacks Against Analogous Technologies
Perform Ambiguity Analysis
Ponder Design Implications
Generate Separate Architecture Diagram Documents
Unify Understanding
• Uncover Ambiguity
• Identify Downstream Difficulty (Sufficiency Analysis)
• Unravel Convolutions
• Uncover Poor Traceability
Perform Underlying Framework Weakness Analysis
Find & Analyze Flaws in
• COTS
• Frameworks
• Network Topology
• Platform
Identify Services Used By Application
Map Weaknesses to Assumptions Made by Application
Documents
Software Flaws
Architectural Risk Assessment Report

Attack resistance

- Identify general flaws
  - Non-compliance
  - Where guidelines are not followed
- Map applicable attack patterns
- Identify risks in architecture
- Consider known attacks against similar technologies

- Attack Patterns
  - Pattern language
  - Database of patterns
  - Actual flaws from clients
- Exploit Graphs
  - Ease mitigation
  - Demonstrate attack paths
- Secure design

Knowledge: Attack patterns

Attack Pattern Schema

Description

General Indication

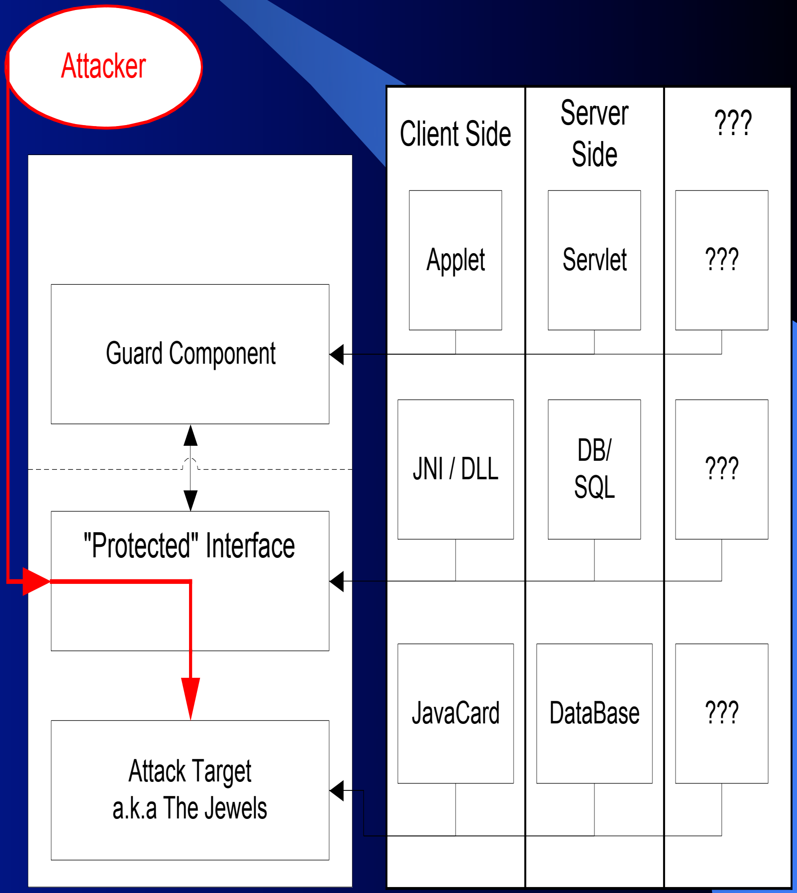
Recipes for exploit

Protection schemes

Indications

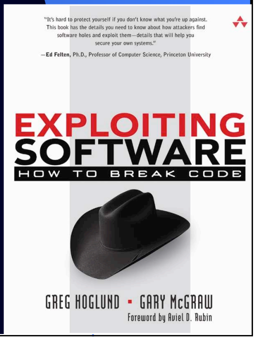
- Signs of weakness
- Specific concrete properties of the software
- Easily detectable

Protection Schemes



Knowledge: 48 attack patterns

- Make the Client Invisible
- Target Programs That Write to Privileged OS Resources
- Use a User-Supplied Configuration File to Run Commands That Elevate Privilege
- Make Use of Configuration File Search Paths
- Direct Access to Executable Files
- Embedding Scripts within Scripts
- Leverage Executable Code in Nonexecutable Files
- Argument Injection
- Command Delimiters
- Multiple Parsers and Double Escapes
- User-Supplied Variable Passed to File System Calls
- Postfix NULL Terminator
- Postfix, Null Terminate, and Backslash
- Relative Path Traversal
- Client-Controlled Environment Variables
- User-Supplied Global Variables (DEBUG=1, PHP Globals, and So Forth)
- Session ID, Resource ID, and Blind Trust
- Analog In-Band Switching Signals (aka “Blue Boxing”)
- Attack Pattern Fragment: Manipulating Terminal Devices
- Simple Script Injection
- Embedding Script in Nonscript Elements
- XSS in HTTP Headers
- HTTP Query Strings
- User-Controlled Filename
- Passing Local Filenames to Functions That Expect a URL
- Meta-characters in E-mail Header
- File System Function Injection, Content Based
- Client-side Injection, Buffer Overflow
- Cause Web Server Misclassification
- Alternate Encoding the Leading Ghost Characters
- Using Slashes in Alternate Encoding
- Using Escaped Slashes in Alternate Encoding
- Unicode Encoding
- UTF-8 Encoding
- URL Encoding
- Alternative IP Addresses
- Slashes and URL Encoding Combined
- Web Logs
- Overflow Binary Resource File
- Overflow Variables and Tags


“It’s hard to protect yourself if you don’t know what you’re up against. This book has the details you need to know about how attackers find software holes and exploit them—details that will help you secure your own systems.”
—Ed Felten, Ph.D., Professor of Computer Science, Princeton University
EXPLOITING
SOFTWARE
HOW TO BREAK CODE
GREG HOGLUND • GARY McGRAW
Foreword by Aviel D. Rubin

Ambiguity analysis

- Consider implications of design
- Generate separate arch. diagrams
- Unify understanding
  - Uncover ambiguity
  - Identify downstream difficulty (traceability)
  - Unravel convolution

- Apprenticeship model
- Use system, technology experts
  - Win32 knowledge
  - JVM/managed code
  - Language/compiler knowledge
- Previous experience

Weakness analysis

- Consider systemic flaws
  - COTS
  - Frameworks
  - Network topology
  - Platform
- Identify services
- Map weaknesses to assumptions
- Experience base
  - Assessments of COTS and platforms
- Attack patterns
- Other resources
  - Mailing lists
  - Product documentation

Enter threat modeling

We seek to enumerate

- Who
- What
- How
- Impact
- Mitigation

Order does not matter

Spreadsheets can help

Who is the threat agent?

Who has access?

What are their motivations?

How resourceful are they?

How knowledgeable?

What is the attack target?

- What is the target of the attack?
  - From high level to low level
- Start with asset inventory
  - Consider business value
  - Technical significance
  - Security dependencies

How will the attack work?

This is the biggie

What kinds of attacks are relevant?

- Available tools to automate
- Manual attacks
- Outside vs. inside
- Authenticated vs. not
- Remote vs. local

What is the impact?

What is the business impact of an attack?

- Direct costs
- Indirect costs
- Reputation impact
- Down time

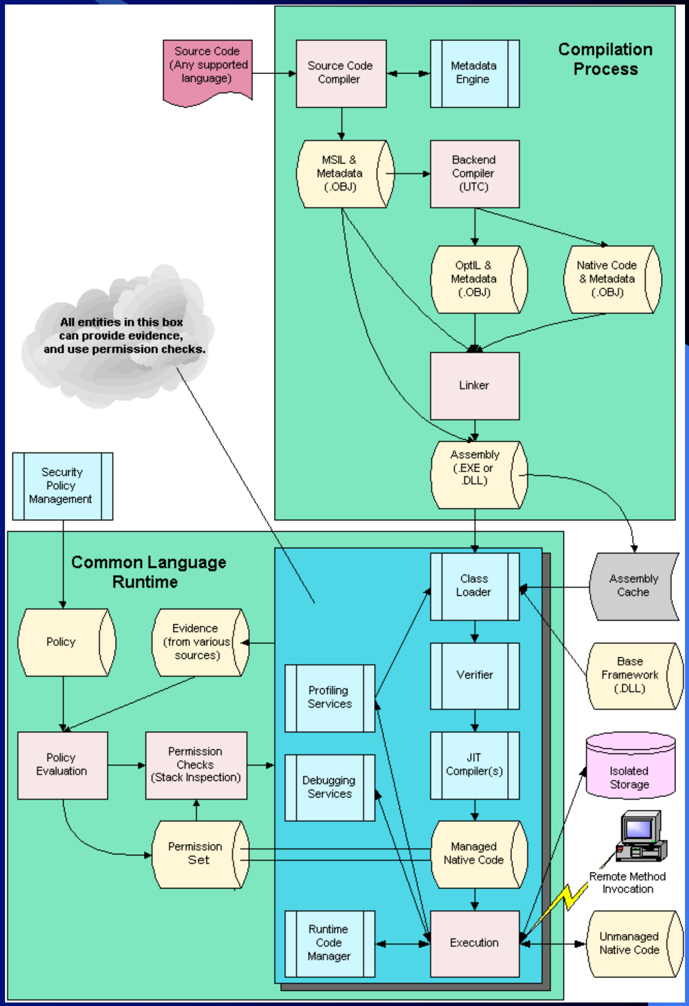
How can it be mitigated?

How can we reduce likelihood of each attack?

- Mechanism
- Costs
- Feasibility
- User acceptance

Start with a diagram

- Top level to visualize functionality
  - Think business, not technology
  - NOT a network diagram
- Identify the assets
- Annotate with design patterns
  - Servlet, thin client, session, MVC, etc.



Attack surface

- Enumerate the entire attack surface
  - Top to bottom
- What interfaces are available, and how?
  - APIs
  - UIs
  - B2B
  - OS
  - Signals
  - Etc

Security zones

Break down architecture into separate zones

- Client (PC) zone
- Middleware zone
- Application zone
- Database zone

Enumerate all

- Components
- Agents

Enumerate attacks

- Attack trees help
  - Start with high value outcome and reverse engineer
    - Dive into fine level of detail
    - List preconditions for each step
- It is OK to fail
- Some attacks may seem extreme and unlikely
- Consider abuse/misuse case attacks too

Include all components

Key security components

- Authenticators
- Access controllers
- Input validators
- Output encoders

Identify security controls explicitly

Consider data flow

Identify and trace key data assets

- Credentials
- Account data
- Customer PII
- Crypto keys

Let's try a simple one

Company background

- Global telecommunications company, USD$20B/yr
- Carrier grade reliability
- "Brick and mortar"
- Very little business on net

Data processing in two groups

- Production data
- Administrative
  - Provisioning
  - Accounting/billing

Provisioning done via legacy mainframe

- MVS/DB2 monster

Your project requirements

- Mobile app for provisioning
  - Connects to DB2 back end
- Functional reqs
  - Field techs securely access provisioning eng
  - View/alter customer acct info
  - All services of DB2 user
  - Only authorized techs may use
  - If device lost, no customer data lost
  - If net not avail, app must cache commands and execute when avail

Business risks

What are the top business risks?

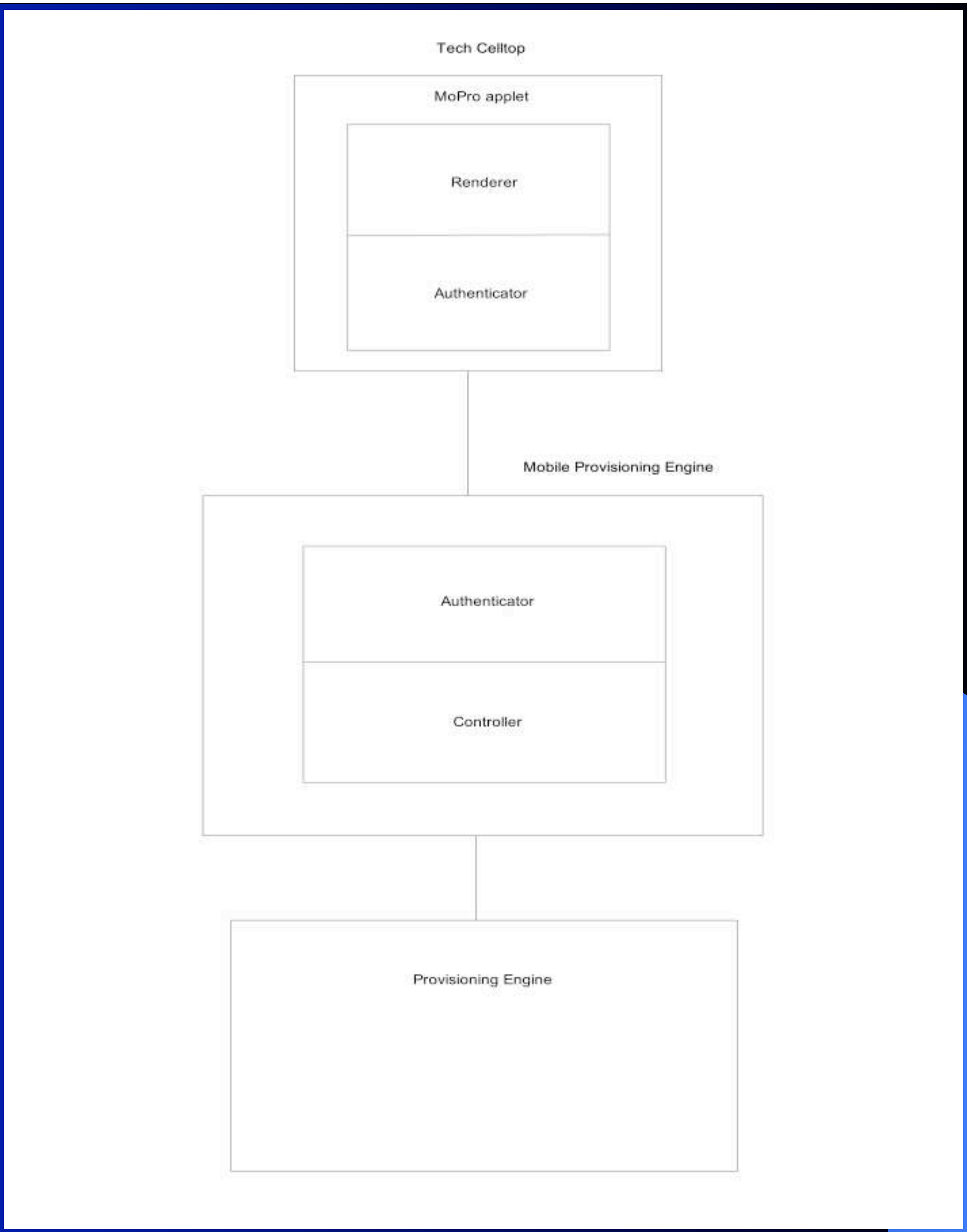
What are the top attack targets?

What abuse cases are likely?

Who are the threat agents?

Design

- Celltop
  - Java app
  - Renderer
  - Authenticator
- Mobile prov engine
  - Authenticator
- Prov engine



Threat analysis

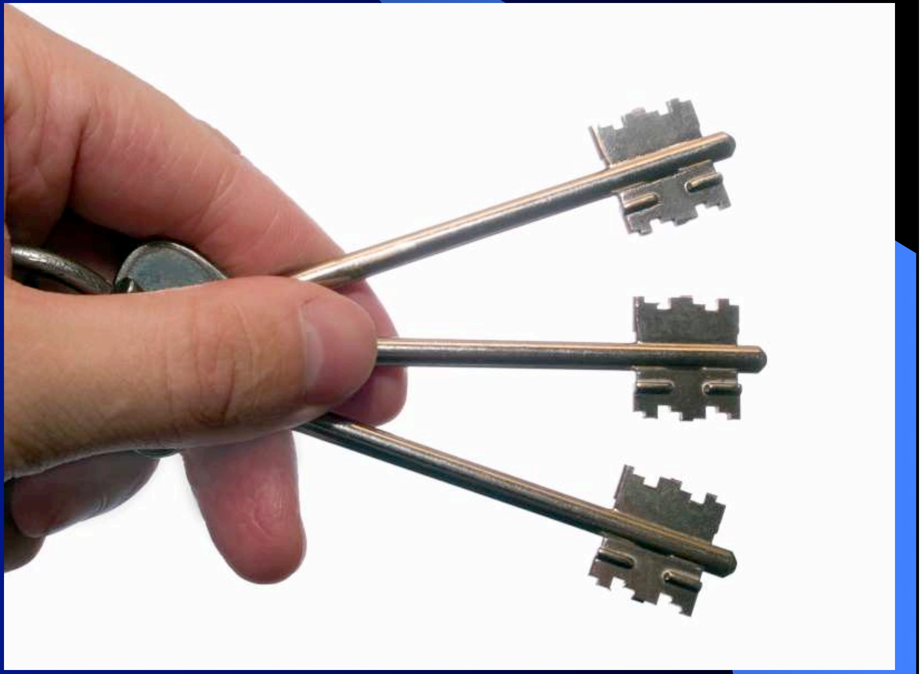
Who	What	How	Impact	Mitigation

What have we learned?

What glaring problems surfaced through this analysis?

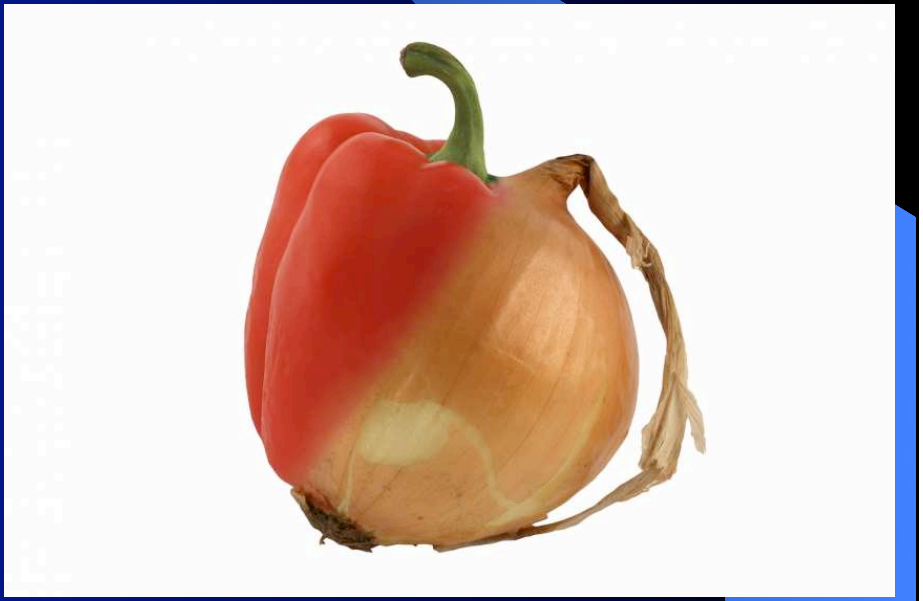
Considerations in Choosing

- One size does NOT fit all
- Cultural issues
  - Dev org size
  - How "process heavy" are you now?
  - Across entire organization



Plan Your Own Hybrid

- Look at each process
- Which components are likely to work best for you?
  - Feasibility is vital
  - Sometimes best isn’t better
- Think things through carefully

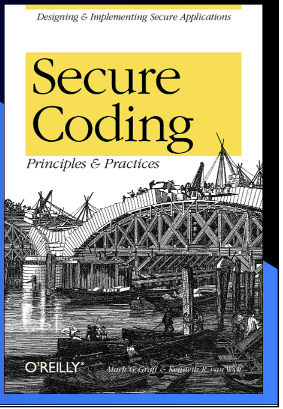


Plan of Action

- What is in place now?
- Target process
- Gap analysis
- Chart a course
  - Small steps
  - Defect data helps to prioritize steps
- Buy-in is essential

Kenneth R. van Wyk
KRvW Associates, LLC

Ken@KRvW.com
http://www.KRvW.com


Designing & Implementing Secure Applications
Secure Coding
Principles & Practices
O'REILLY
Mark G. Graff & Kenneth R. van Wyk