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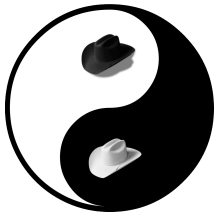
Bug Parade, Zombies and the BSIMM:
A Decade of Software Security



Gary McGraw, Ph.D.
Chief Technology Officer

Cigital

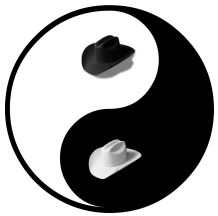
Providing software security professional services since 1992

World's premiere software security consulting firm

- 230 professional consultants
- Washington, NY, Santa Clara, Bloomington, Amsterdam, London

Recognized experts in software security

- Widely published in books, white papers, and articles
- Industry thought leaders



In the beginning

Software industry blooms in the 1970s

- IBM unbundles software and services from hardware in late 1960s
- Unbundling created inequality in system security
- Security shifts from consumers to producers

who should DO software security?

← Network security ops guys

NOBODY IN THE MIDDLE

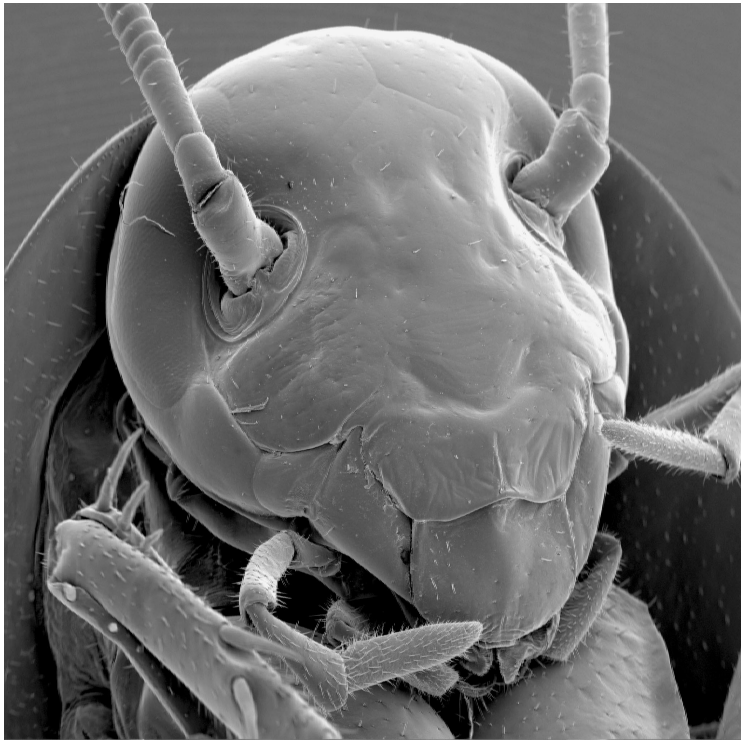
Super rad developer dudes →

The bug parade

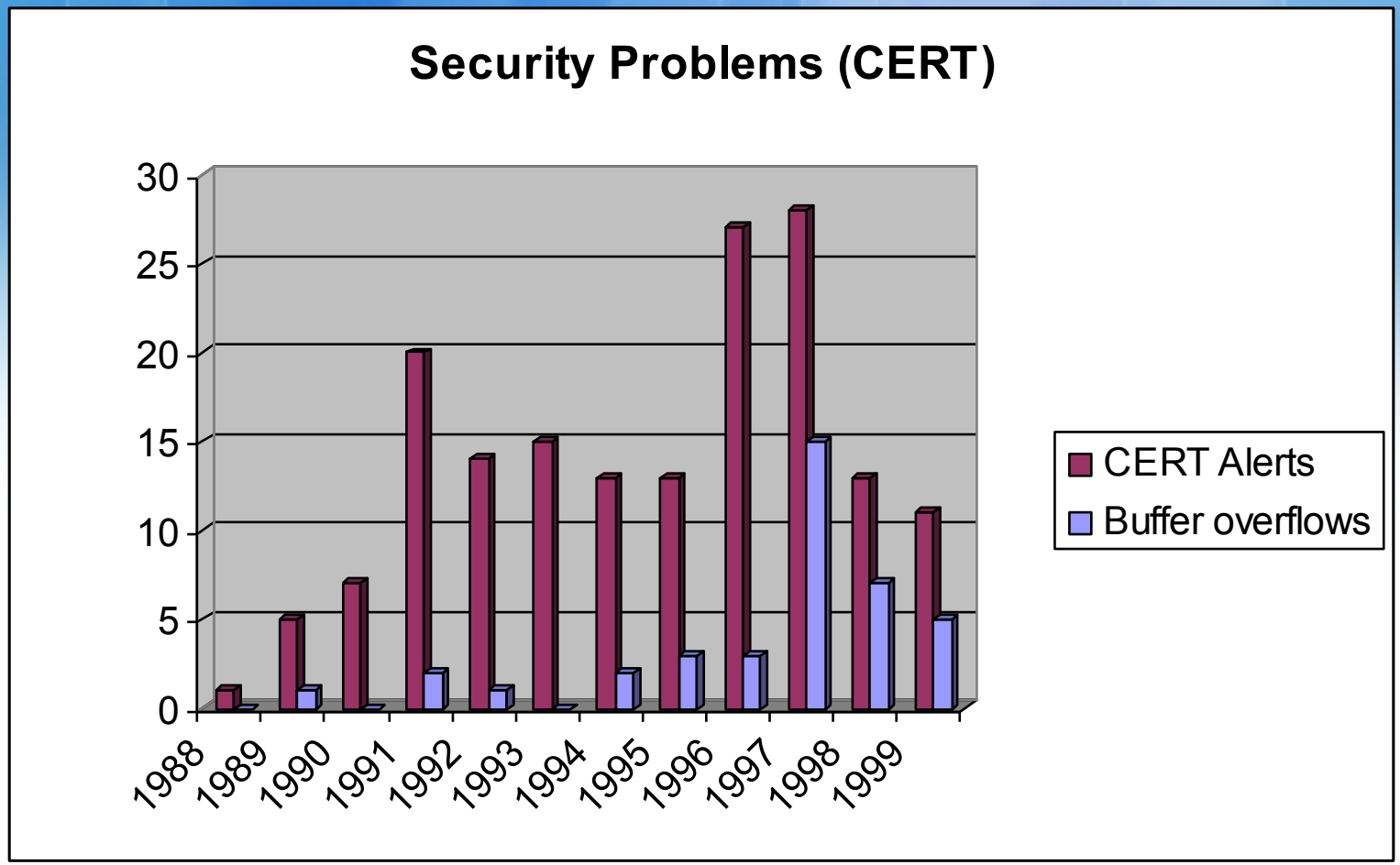
Bug: the dreaded buffer overflow

- Overwriting the bounds of data objects
- Allocate some bytes, but the language doesn't care if you try to use more
- char x[12]; x[12] = '\0'
- Why was this done? Efficiency!
- (remember in the 70's when code had to be tight?)

- The most pervasive security problem today in terms of reported bugs in the '90s



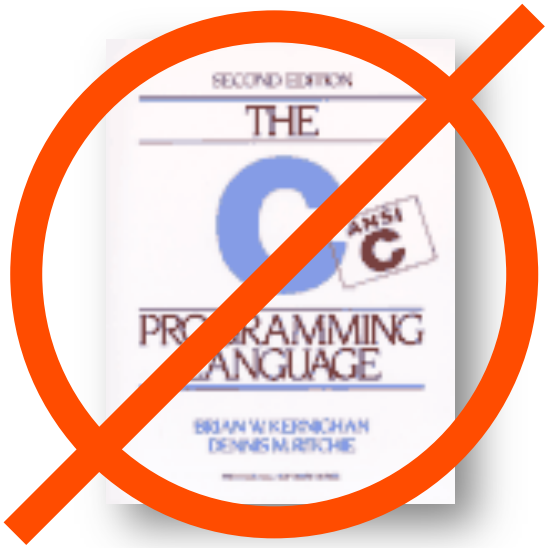
eleven years of CERT data



A classic error in C

```
void main() {
        char buf[1024];
        gets(buf);
}
```

- How not to get input
  - Attacker can send an infinite string!
  - Chapter 7 of K&R (page 164)



calls to avoid in C

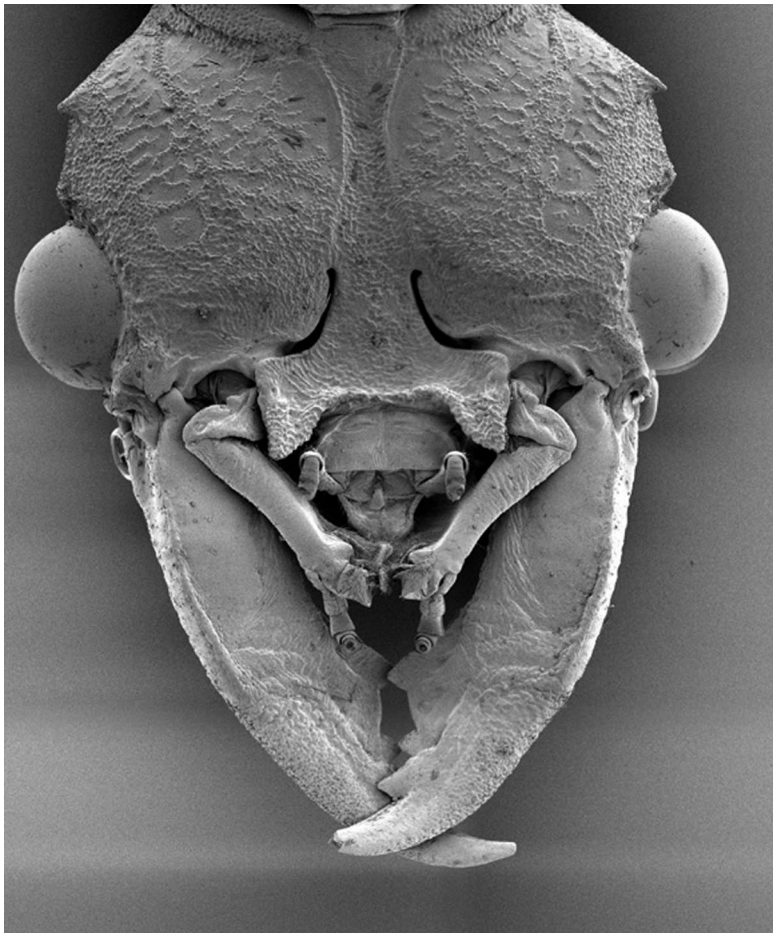
- Very risky:
  - gets,strcpy,strcat,sprintf,scanf, sscanf,fscanf,vfscanf,vsprintf,vscanf, vsscanf,streadd,strecpy,realpath,syslog, getopt,getopt_long,getpass
- Risky:
  - strtrns,getchar,fgetc,getc,read
- Be wary:
  - bcopy,fgets,memcpy,snprintf, strccpy,strcadd,strncpy,vsnprintf

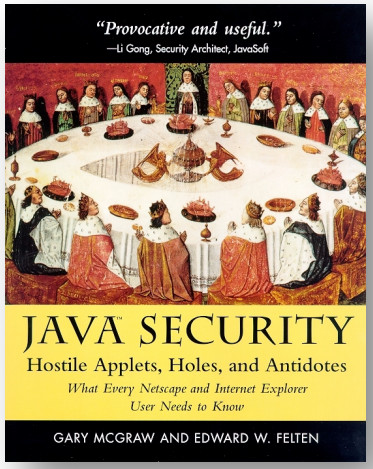
Big 1999 idea: Why not make a tool to find these for you??!

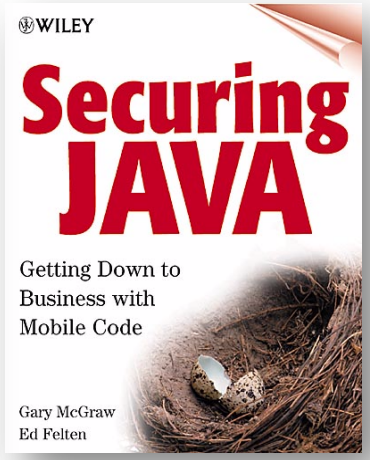
Bug: race condition

- Time makes all the difference
- Atomic operations that are not atomic

Bug: Java security







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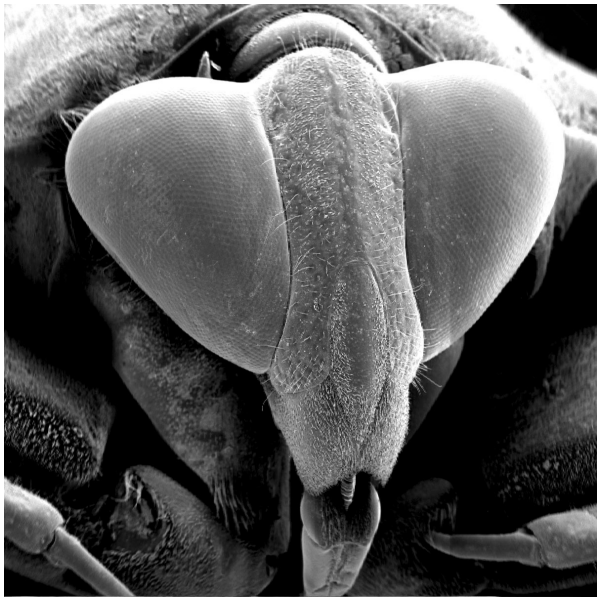
A Chronology of Java attack applets

- February 96: DNS flaw in JDK 1.0.1
- March 96: Path name bug
- March 96: Princeton Class Loader bug
- May 96: type casting attack
- June 96: Array type implementation error
- July 96: More type casting problems
- August 96:Flaw in Microsoft's Java VM
- February 97: Invasion of Privacy attack applets
- March 97: JVM hole
- April 97: Code signing flaw
- May 97: Verifier problems discovered in many VMs
- July 97: Vacuum bug
- August 97: redirect bug
- July 98: ClassLoader bug
- March 99: Verifier hole
- August 99: Race condition
- October 99: Verifier hole 2
- August 2000: Brown Orifice
- October 2000: ActiveX/Java

All of these bugs have been fixed (but they're back)

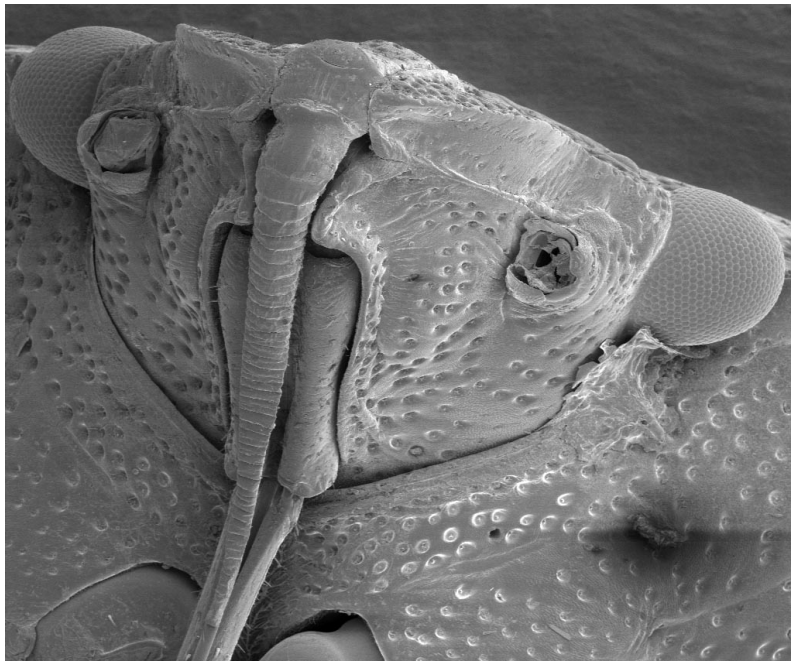
Bug: SQL injection

- Enables an attacker to execute arbitrary SQL commands on back-end database
- Example:
- PHP code inputs USERNAME and PASSWORD and passes to MySQL back-end
- USERNAME is entered as bob
- PASSWORD is entered as ' or USERNAME='bob
- Back-end executes Select ID from USERS where USERNAME='bob' and PASSWORD='' or USERNAME='bob'
- Instead of Select ID from USERS where USERNAME='bob' and PASSWORD='password'



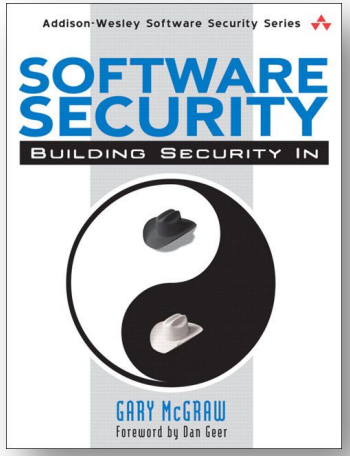
Bug: XSS

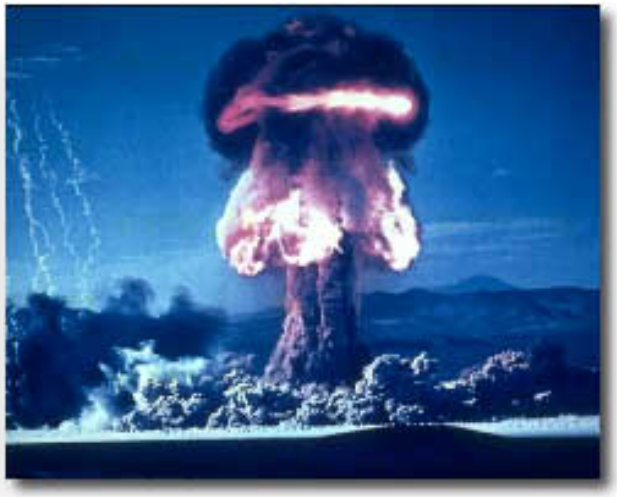
- Unaltered user-controlled content in a Web server response gives an attacker the opportunity to insert HTML and scripts
- This code gets rendered in a victim's browser
  - Reflected (malicious links)
  - Stored (by website)
- OWASP top ten bug



Seven pernicious kingdoms (of bugs)

- Input validation and representation
- API abuse
- Security features
- Time and state
- Error handling
- Code quality
- Encapsulation
- Environment





Bug parade FAIL

IMPLEMENTATION BUGS

- Buffer overflow
  - String format
  - One-stage attacks
- Race conditions
  - TOCTOU (time of check to time of use)
- Unsafe environment variables
- Unsafe system calls
  - System()
- Untrusted input problems

50%

ARCHITECTURAL FLAWS

- Misuse of cryptography
- Compartmentalization problems in design
- Privileged block protection failure (DoPrivilege())
- Catastrophic security failure (fragility)
- Type safety confusion error
- Insecure auditing
- Broken or illogical access control (RBAC over tiers)
- Method over-riding problems (subclass issues)
- Signing too much code

50%

Software security zombies

Zombie ideas need repeating

- Software security seems obvious to us, but it is still catching on
- The middle market is just beginning to emerge
- Time to scale!

ZOMBIE

- Network security FAIL
- More code more bugs
- SDLC integration
- Bugs and flaws
- Badness-ometers

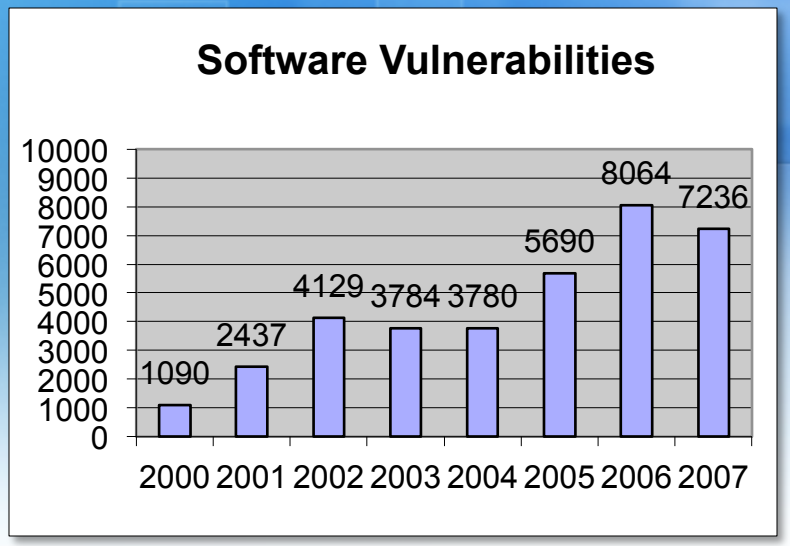
Experts in software security take things for granted. That's OK, but don't forget how far behind some firms are.

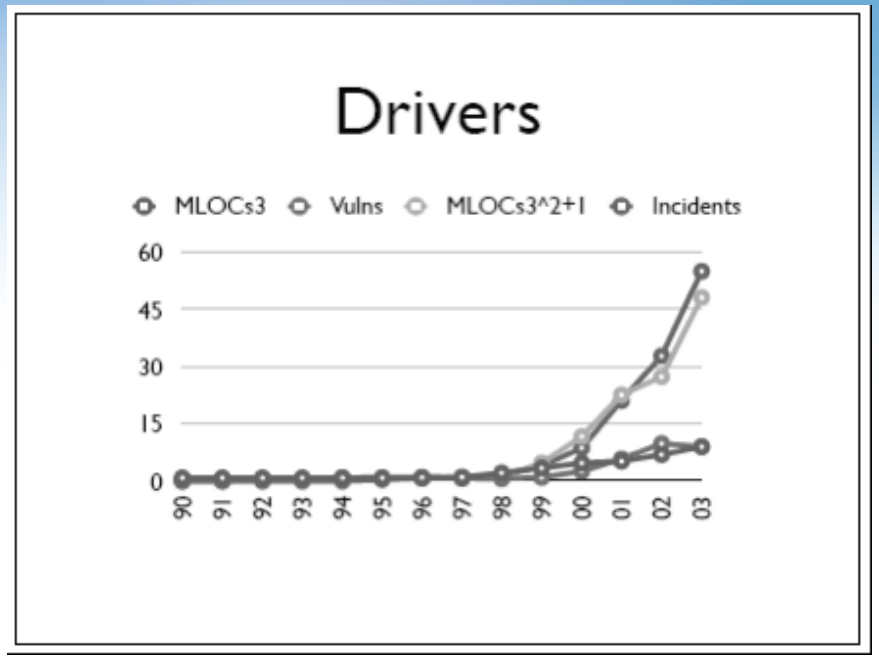
Zombie: old school security is reactive

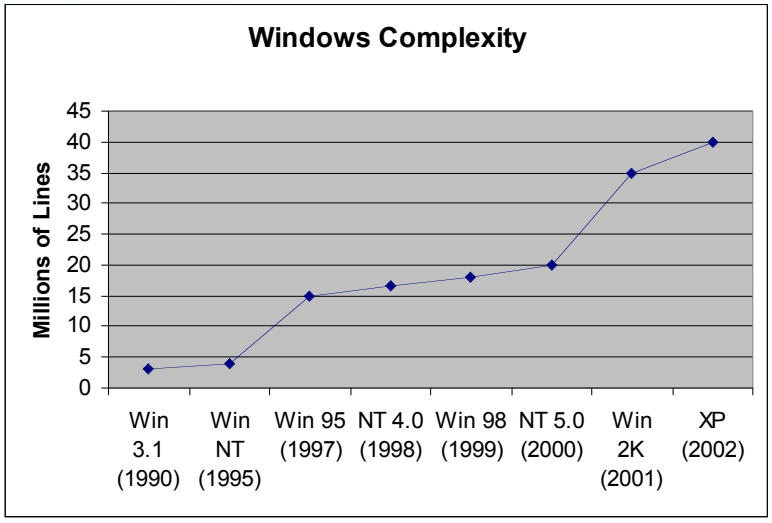
- Defend the "perimeter" with a firewall
  - To keep stuff out
- Promulgate "penetrate and patch"
- "Review" products when they're complete
  - Throw it over the wall testing
  - Too much weight on penetration testing
- Over-rely on security functions
  - "We use SSL"

The "network guy with keys" does not really understand software testing. Builders are only recently getting involved in security.

Zombie: more code, more bugs







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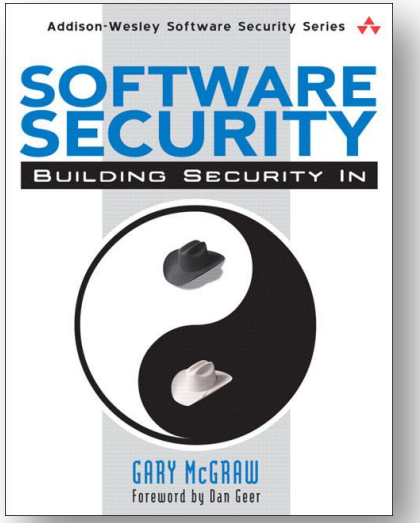
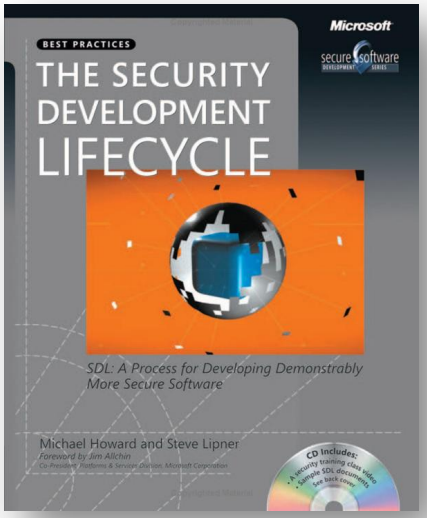
Zombie: SDLC integration

- Integrating best practices into large organizations
- Microsoft's SDL
- Cigital's touchpoints
- OWASP CLASP/SAMM





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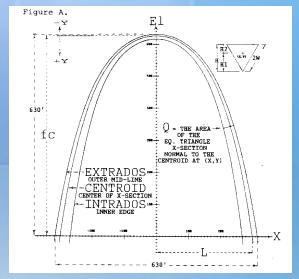
Zombie: bugs AND flaws



`gets()`

`attacker in the middle`

BUGS — FLAWS

- Architectural risk analysis
- Customized static rules (Fidelity)
- Commercial SCA tools: Fortify, Ounce Labs, Coverity

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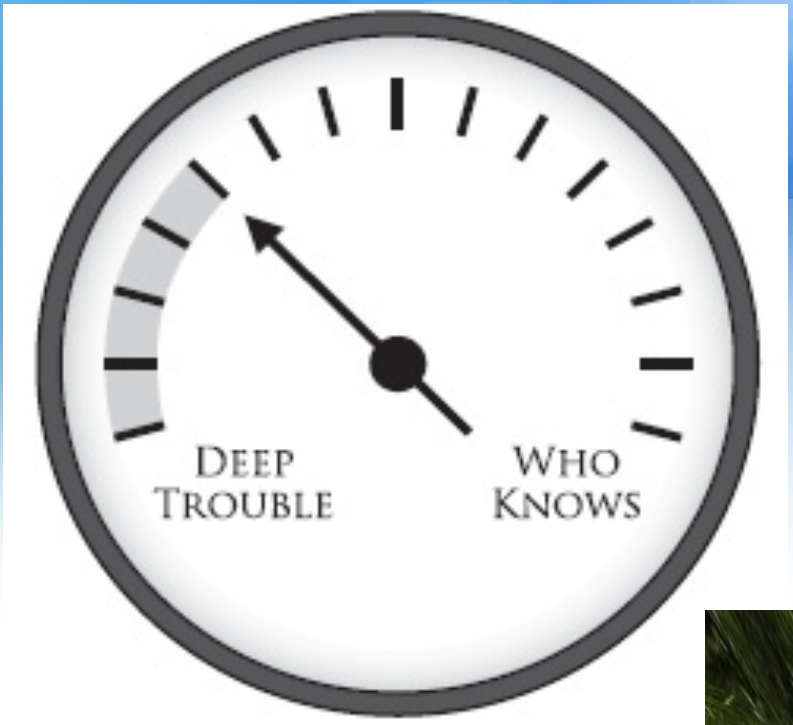
Zombie: badness-ometer



badness-ometer

Zombie baby: fix the dang software

- Software security and application security today are about finding bugs
- The time has come to stop looking for new bugs to add to the list
- Which bugs in this pile should I fix?

Software security touchpoints

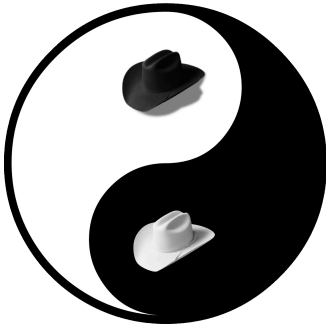
The rise of the software security group (SSG)

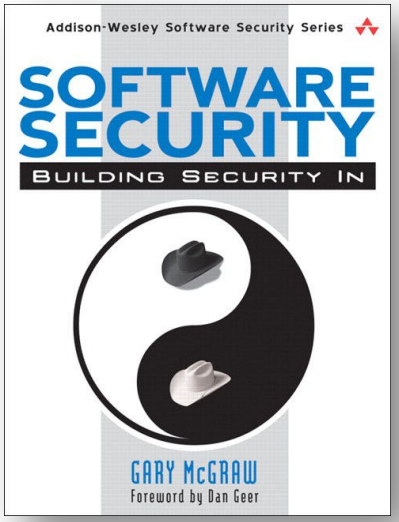
- Cigital SSG turned fifteen in 2012
- Microsoft adopts the Secure Development Lifecycle
- Most firms have a group devoted to software security

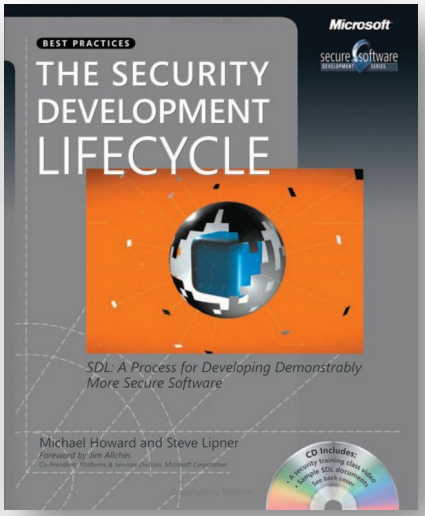
- microsoft
- dtcc
- emc
- fidelity
- adobe
- wells fargo
- goldman sachs
- google
- qualcomm
- morgan stanley
- usaf
- dell
- pershing
- the hartford
- barclays capital
- bank of tokyo
- ups
- bank of montreal
- sterling commerce
- time warner
- cisco
- bank of america
- walmart
- finra
- vanguard
- college board
- oracle
- state street
- omgeo
- motorola
- general electric
- lockheed martin
- intuit
- vmware
- amex
- bank of ny mellon
- harris bank
- paypal
- symantec
- visa europe
- thomson/reuters
- BP
- SAP
- nokia
- ebay
- mckesson
- ABN/amro
- ING
- telecom italia
- swift
- standard life
- cigna
- AON
- coke
- mastercard
- apple
- AOL
- CA

2006: a shift from philosophy to HOW TO

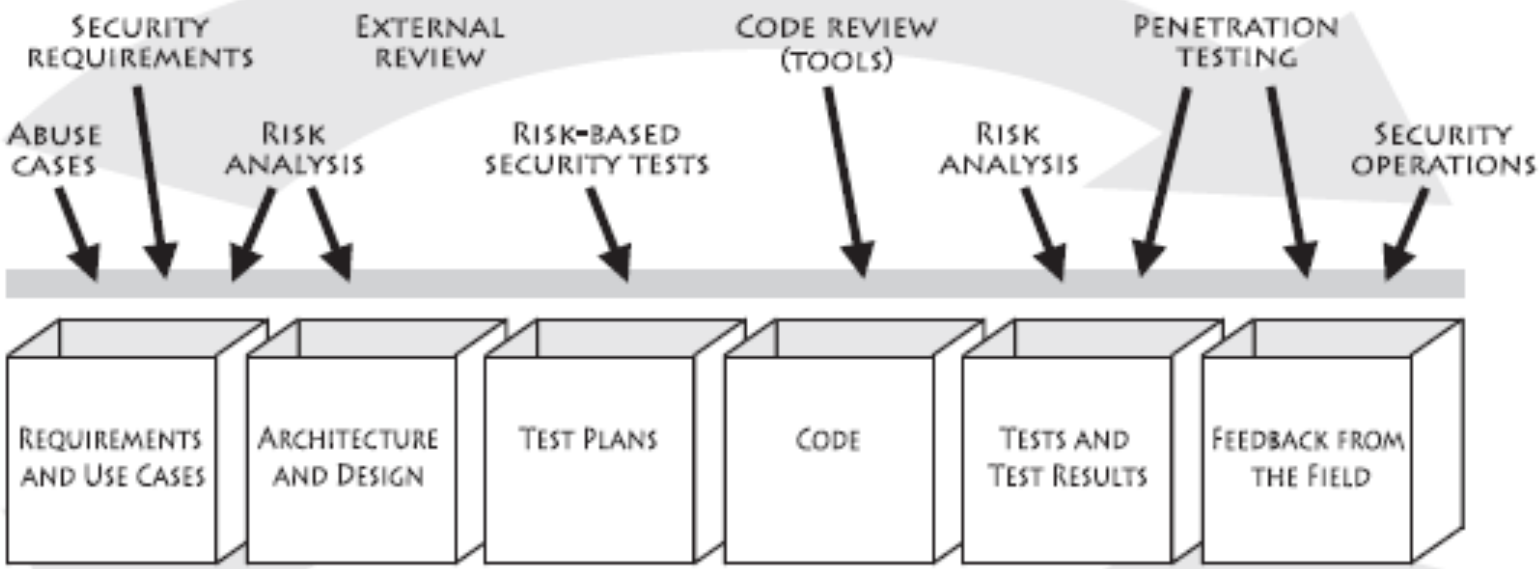
- Integrating best practices into large organizations' SDLC (that is, an SSDL)
  - Microsoft's SDL
  - Cigital's Touchpoints
  - OWASP CLASP







Software security touchpoints



The BSIMM

BSIMM: software security measurement

- Real data from (51) real initiatives
- 95 measurements
- 13 over time
- McGraw, Migues, & West

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FORTIFY An HP Company

PlexLogic

Minded security

VIRTUALFORGE we harden your software

51 firms in the BSIMM community

Plus 17 firms that remain anonymous

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Monkeys eat bananas

- BSIMM is not about good or bad ways to eat bananas or banana best practices
- BSIMM is about observations
- BSIMM is descriptive, not prescriptive
- BSIMM describes and measures multiple prescriptive approaches

A software security framework

The Software Security Framework (SSF)			
Governance	**Intelligence**	**SSDL Touchpoints**	**Deployment**
Strategy and Metrics	Attack Models	Architecture Analysis	Penetration Testing
Compliance and Policy	Security Features and Design	Code Review	Software Environment
Training	Standards and Requirements	Security Testing	Configuration Management and Vulnerability Manage-ment

- Four domains
- Twelve practices
- See informIT article on BSIMM website http://bsimm.com

Architecture Analysis practice skeleton

SSDL TOUCHPOINTS: ARCHITECTURE ANALYSIS

Capturing software architecture diagrams, applying lists of risks and threats, adopting a process for review, building an assessment and remediation plan.

	Objective	Activity	Level
[AA1.1]	get started with AA	perform security feature review	1
[AA1.2]	demonstrate value of AA with real data	perform design review for high-risk applications	
[AA1.3]	build internal capability on security architecture	have SSG lead review efforts	
[AA1.4]	have a lightweight approach to risk classification and prioritization	use risk questionnaire to rank apps	
[AA2.1]	model objects	define/use AA process	2
[AA2.2]	promote a common language for describing architecture	standardize architectural descriptions (include data flow)	
[AA2.3]	build capability organization-wide	make SSG available as AA resource/mentor	
[AA3.1]	build capabilities organization-wide	have software architects lead review efforts	3
[AA3.2]	build proactive security architecture	drive analysis results into standard architectural patterns (T: sec features/design)	

Example activity

[AA1.2] **Perform design review for high-risk applications.** The organization learns about the benefits of architecture analysis by seeing real results for a few high-risk, high-profile applications. If the software security group (SSG) is not yet equipped to perform an in-depth architecture analysis, it uses consultants to do this work. Ad hoc review paradigms that rely heavily on expertise may be used here, though in the long run they do not scale.

Real-world data (51 firms)

- Initiative age
  - Average: 5.5 years
  - Newest: 0
  - Oldest: 17
  - Median: 4
- SSG size
  - Average: 19.48
  - Smallest: 1
  - Largest: 100
  - Median: 7.5
- Satellite size
  - Average: 40.77
  - Smallest: 0
  - Largest: 350
  - Median: 6
- Dev size
  - Average: 4455
  - Smallest: 11
  - Largest: 30,000
  - Median: 1500

Average SSG size: 1.95% of dev group size

BSIMM4 Scorecard

Governance		Intelligence		SSDL Touchpoints		Deployment	
Activity	Observed	Activity	Observed	Activity	Observed	Activity	Observed
[SM1.1]	35	[AM1.1]	15	[AA1.1]	39	[PT1.1]	47
[SM1.2]	30	[AM1.2]	31	[AA1.2]	35	[PT1.2]	40
[SM1.3]	33	[AM1.3]	25	[AA1.3]	27	[PT1.3]	35
[SM1.4]	44	[AM1.4]	13	[AA1.4]	32	[PT2.2]	20
[SM1.6]	35	[AM1.5]	32	[AA2.1]	10	[PT2.3]	24
[SM2.1]	21	[AM1.6]	17	[AA2.2]	7	[PT3.1]	11
[SM2.2]	26	[AM2.1]	12	[AA2.3]	17	[PT3.2]	8
[SM2.3]	26	[AM2.2]	13	[AA3.1]	9		
[SM2.5]	22	[AM3.1]	3	[AA3.2]	4		
[SM3.1]	15	[AM3.2]	5				
[SM3.2]	6						
[CP1.1]	40	[SFD1.1]	44	[CR1.1]	23	[SE1.1]	21
[CP1.2]	45	[SFD1.2]	37	[CR1.2]	20	[SE1.2]	47
[CP1.3]	36	[SFD2.1]	25	[CR1.4]	33	[SE2.2]	21
[CP2.1]	21	[SFD2.2]	19	[CR1.5]	22	[SE2.4]	23
[CP2.2]	28	[SFD2.3]	15	[CR1.6]	21	[SE3.2]	11
[CP2.3]	25	[SFD3.1]	8	[CR2.2]	13	[SE3.3]	7
[CP2.4]	22	[SFD3.2]	9	[CR2.5]	12		
[CP2.5]	31			[CR3.1]	13		
[CP3.1]	7			[CR3.2]	3		
[CP3.2]	12			[CR3.3]	4		
[CP3.3]	8						
[T1.1]	38	[SR1.1]	38	[ST1.1]	38	[CMVM1.1]	40
[T1.5]	19	[SR1.2]	27	[ST1.3]	37	[CMVM1.2]	44
[T1.6]	21	[SR1.3]	34	[ST2.1]	24	[CMVM2.1]	37
[T1.7]	23	[SR1.4]	21	[ST2.3]	8	[CMVM2.2]	31
[T2.5]	10	[SR2.1]	12	[ST2.4]	12	[CMVM2.3]	23
[T2.6]	12	[SR2.2]	20	[ST3.1]	9	[CMVM3.1]	5
[T2.7]	11	[SR2.3]	18	[ST3.2]	11	[CMVM3.2]	6
[T3.1]	5	[SR2.4]	19	[ST3.3]	5		
[T3.2]	5	[SR2.5]	21	[ST3.4]	6		
[T3.3]	8	[SR3.1]	8				
[T3.4]	6						
[T3.5]	6						

- 109 Activities
- 3 levels
- Top 12 activities
  - 69% cutoff
  - 31 of 51 firms
- Comparing scorecards between releases is interesting

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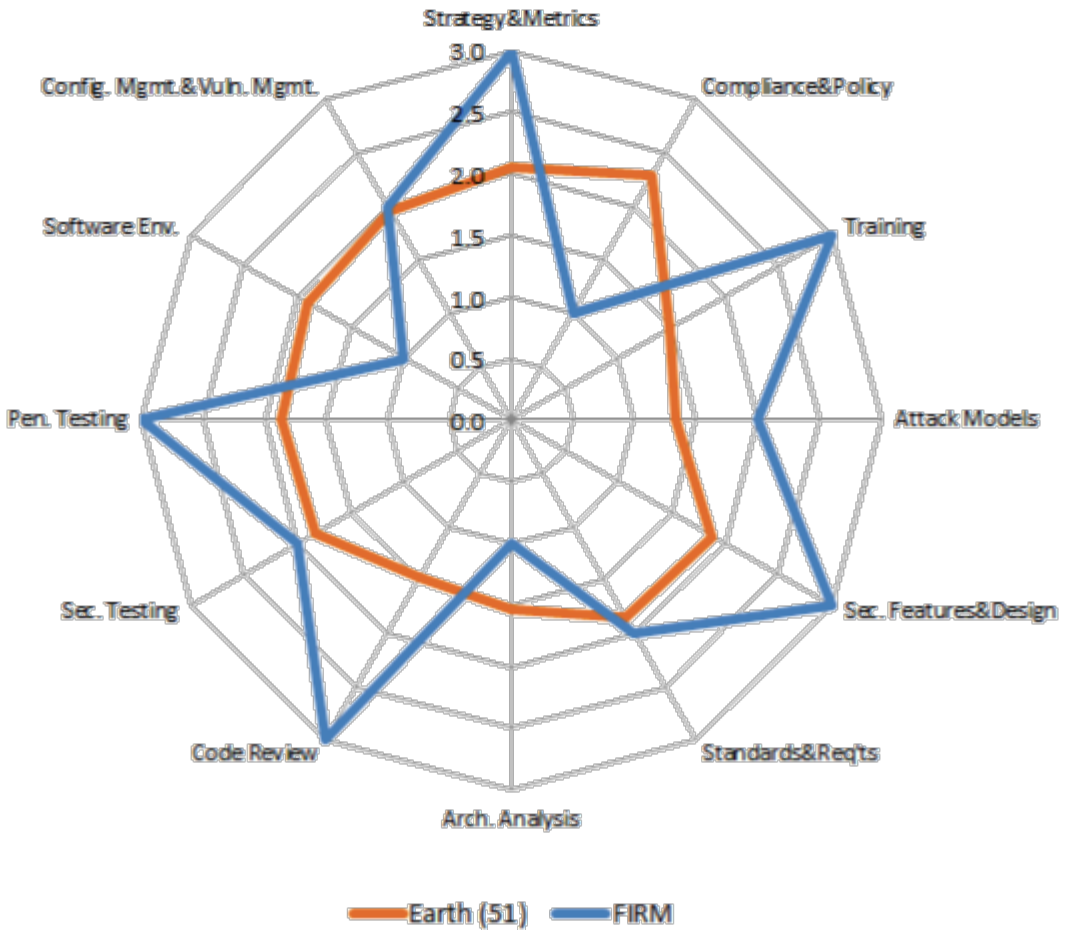
BSIMM4 as a Measuring Stick

- Compare a firm with peers using the high water mark view
- Compare business units
- Chart an SSI over time



BSIMM4 scorecard with FAKE firm data

BSIMM4 Scorecard for: FIRM — Raw Score: 41

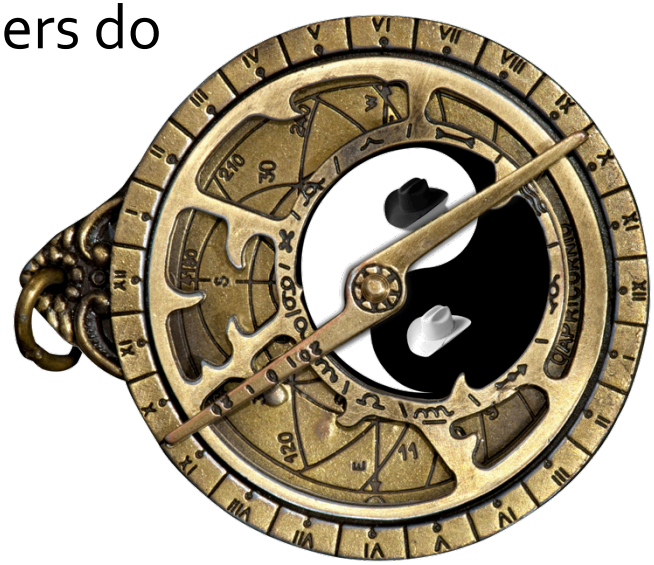
Governance			Intelligence			SSDL Touchpoints			Deployment		
Activity	BSIMM Firms	FIRM	Activity	BSIMM Firms	FIRM	Activity	BSIMM Firms	FIRM	Activity	BSIMM Firms	FIRM
[SM1.1]	35	1	[AM1.1]	15	1	[AA1.1]	39		[PT1.1]	47	1
[SM1.2]	30		[AM1.2]	31		[AA1.2]	35	1	[PT1.2]	40	1
[SM1.3]	33		[AM1.3]	25		[AA1.3]	27	1	[PT1.3]	35	
[SM1.4]	44	1	[AM1.4]	13	1	[AA1.4]	32		[PT2.2]	20	
[SM1.6]	35		[AM1.5]	32	1	[AA2.1]	10		[PT2.3]	24	1
[SM2.1]	21		[AM1.6]	17	1	[AA2.2]	7		[PT3.1]	11	
[SM2.2]	26		[AM2.1]	12		[AA2.3]	17		[PT3.2]	8	
[SM2.3]	26		[AM2.2]	13		[AA3.1]	9				
[SM2.5]	22	1	[AM3.1]	3		[AA3.2]	4				
[SM3.1]	15	1	[AM3.2]	5							
[SM3.2]	6										
[CP1.1]	40	1	[SFD1.1]	44	1	[CR1.1]	23	1	[SE1.1]	21	1
[CP1.2]	45		[SFD1.2]	37	1	[CR1.2]	20	1	[SE1.2]	47	
[CP1.3]	36	1	[SFD2.1]	25		[CR1.4]	33	1	[SE2.2]	21	
[CP2.1]	21		[SFD2.2]	19		[CR1.5]	22		[SE2.4]	23	
[CP2.2]	28		[SFD2.3]	15	1	[CR1.6]	21		[SE3.2]	11	
[CP2.3]	25		[SFD3.1]	8	1	[CR2.2]	13		[SE3.3]	7	1
[CP2.4]	22		[SFD3.2]	9		[CR2.5]	12				
[CP2.5]	31					[CR3.1]	13	1			
[CP3.1]	7					[CR3.2]	3				
[CP3.2]	12					[CR3.3]	4	1			
[CP3.3]	8					[CR3.4]	TBD				
[T1.1]	38		[SR1.1]	38	1	[ST1.1]	38	1	[CMVM1.1]	40	1
[T1.5]	19	1	[SR1.2]	27		[ST1.3]	37	1	[CMVM1.2]	44	1
[T1.6]	21	1	[SR1.3]	34	1	[ST2.1]	24	1	[CMVM2.1]	37	1
[T1.7]	23		[SR1.4]	21		[ST2.3]	8		[CMVM2.2]	31	
[T2.5]	10		[SR2.1]	12	1	[ST2.4]	12		[CMVM2.3]	23	1
[T2.6]	12	1	[SR2.2]	20		[ST3.1]	9		[CMVM3.1]	5	
[T2.7]	11		[SR2.3]	18		[ST3.2]	11		[CMVM3.2]	6	
[T3.1]	5	1	[SR2.4]	19		[ST3.3]	5		[CMVM3.3]	TBD	
[T3.2]	5		[SR2.5]	21	1	[ST3.4]	6				
[T3.3]	8		[SR3.1]	8							
[T3.4]	6										
[T3.5]	6										

Legend:
- Activity — 111 BSIMM4 activities, shown in 4 domains and 12 practices
- BSIMM Firms — count of firms (out of 51) observed performing each activity
- the most common activity within a practice
- a most common activity not observed in this assessment
- a most common activity observed in this assessment
- a practice where the firm's high-water mark score is below the average of the 51 firms

- Top 12 activities
  - purple = good?
  - red = bad?
- "Blue shift" practices to emphasize

BSIMM4 to BSIMM-V

- BSIMM4 released September 2012 under creative commons
  - http://bsimm.com
  - Italian and German translations available, Spanish soon
- BSIMM is a yardstick
  - Use it to see where you stand
  - Use it to figure out what your peers do
- BSIMM4→BSIMM-V
  - BSIMM is growing
  - Target of 70 firms



Where to learn more

SearchSecurity + Justice League

TechTarget

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www.searchsecurity.com

No-nonsense monthly security column by Gary McGraw

www.cigital.com/~gem/writing

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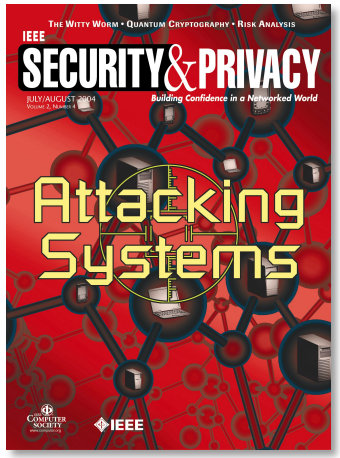
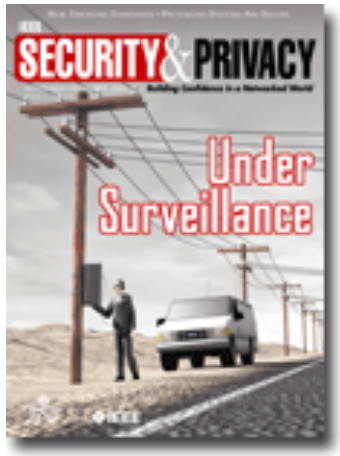
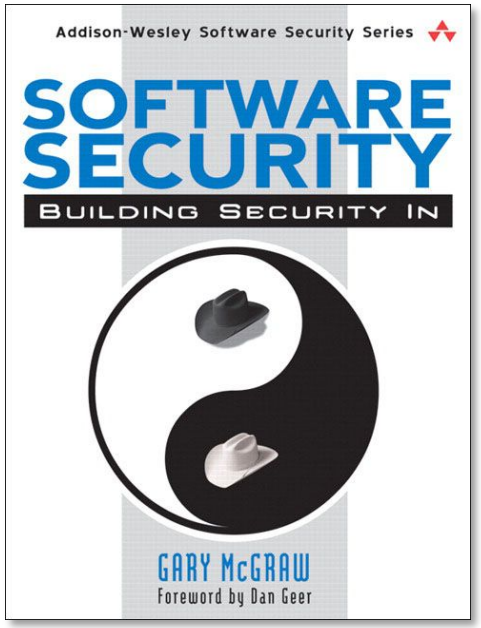




The book



How to DO software security

- Best practices
- Tools
- Knowledge

Cornerstone of the Addison-Wesley Software Security Series

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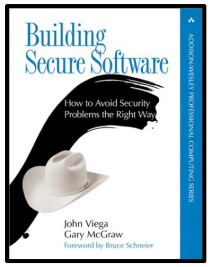

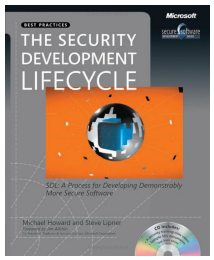

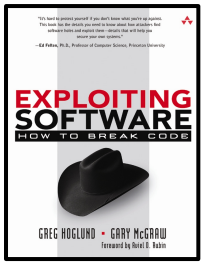

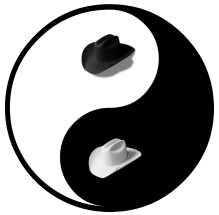

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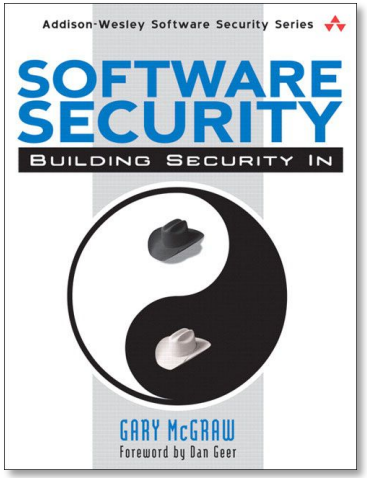

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