SOFTWARE SECURITY ASSURANCE SUMMIT

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Evolution of Application Security

From Breach to Mobile Applications

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T.E.N. TECH EXEC NETWORKS *presented by* hp HP Enterprise Security

- Who is Heartland Payment Systems?
- Overview of the Breach
- Strategic Asymmetry
- Securing the Application Threat Space
- Securing the Mobile Threat Space
- Partnering for Success

- Publicly traded, NYSE: HPY
- *FORTUNE 1000* company
- Fifth largest processor in the US
- Processes close to 11 million transactions a day
- Serves more than 250,000 businesses nationwide
- More than 2,700 employees
- Ten offices throughout the US and Canada

- Credit/debit/prepaid card processing
- Mobile payments
- E3™ technology
- Payroll services
- Gift marketing and loyalty programs
- Check management
- Online payments
- Give Something Back Network OneCard
- MicroPayments
- K-12 school lunch payments

- Major markets served:
  - Restaurant
  - Lodging
  - Healthcare
  - Retail
  - Petroleum
  - Community Banks

Overview of the Breach

- Very Late 2007 – SQL Injection via a customer-facing web page in our corporate (non-payments) environment. Bad guys were in Heartland’s corporate network.
- Early 2008 – Hired largest approved QSA to perform penetration testing of corporate environment
- Spring 2008 – CEO learned of sniffer attack on Hannaford’s, created a dedicated Chief Security Officer position and filled that position
- April 30, 2008 – Passed sixth consecutive “Annual Review” by largest QSA
- Very Late 2007 – Mid-May 2008 – Unknown period but it is possible that bad guys were studying the corporate network
- Mid-May 2008 – Penetration of Heartland’s payments network

- Late October 2008 – Informed by a card brand that several issuers suspected a potential breach of one or more processors. We received sample fraud transactions to help us determine if there was a problem in our payments network. Many of these transactions never touched our payments network.
- No evidence could be found of an intrusion despite vigorous efforts by Heartland employees and then two forensics companies to find a problem.
- January 9, 2009 – We were told by QIRA that "no problems were found" and that a final report reflecting that opinion would be forthcoming.
- January 12, 2009 – January 20, 2009 – Learned of breach, notified card brands, notified law enforcement and made public announcement.

Strategic Asymmetry

A One-sided Game

- **SQL injection via a customer-facing web page in our corporate (non-payments) environment. Bad guys were in our corporate network**

- Why are applications the targets *du jour*?
    - Network and device security have been focus of vendors and security teams for a number of years
    - Applications are often portals
        - Directly to sensitive data itself, or
        - Unknowingly, to soft underbelly of internal network
- Applications used to be much less of a threat

- This is a classic case of manipulating a strategic asymmetry
  - Strategic use of asymmetric technologies to exploit asymmetric advantages and counter asymmetric weaknesses*
  - Two sides in the battle
    - Corporations, medium-sized enterprises, small businesses, individuals, vs.
    - Professional cybercriminals

- Though not captured in these terms in the past, this is the classic information security struggle – though evolved

*See Nshetri, Kir, The Global Cybercrime Industry, Chapter 6. Springer-Verlag. Pg 119

- Corporations, medium-sized enterprises, small businesses, individuals
  - Large, diverse networks
  - Often multiple hierarchies of responsibility and accountability
  - Constrained by budgets, SLAs, project delivery deadlines and limited human capital

vs.

- Professional cybercriminals who, in almost all cases, are:
  - Very intelligent (at least of their subject matter) and better trained
  - Better financed
  - Better prepared
  - Have a time advantage
  - And … have nation-state protection

- Who are the Bad Actors?
  - Cybercriminals
    - Crime “families” – Russian Business Network
    - Specialists – Bot herders
  - Cyberterrorists
    - Stuxnet
    - Hydraq
  - Hactivists
    - Attacks against military and intelligence organizations
    - Corporations (particularly those who impact their funding model)
- What do each of these have in common?
  - Extensive target research
- Malicious insiders

- Rub of strategic asymmetry
  - Entities least prepared to establish a strong defensive position are least prepared to establish proactive threat modeling
  - With today’s threat space:
    - You cannot fight something if you cannot see it
    - You cannot prevent something if you cannot predict it
    - You cannot secure something that was not built to be secure*
- In our case, the application that was breached was compliant with its functional specifications

*Roger Thornton, CTO & Founder, Fortify Software, Presentation at the 2011 BITS-FS-ISAC Conference, “Increase Your Security Intelligence: Manage Application Security in Context with the Business”.

Securing the Application Threat Space

Where Heartland Found Itself

- Software paradigms have evolved from computer-centric to very distributed models over time
  - Evolving and expanding attack surface
- Another classic example of asymmetry
  - In order to do business, applications and portals have to be:
    - Easily accessible
    - Easy to use
    - Operate transparently to users
  - Expands security scope and oversight
- Adage – "company has to find all security holes in the applications and portals, malicious actors only have to find one"

- You cannot fight something if you cannot see it – visibility
  - First part of the problem for Heartland was two-fold
    - What applications are on our networks?
      - External facing
      - Internal-only
    - Which applications are problematic from security perspective?
  - What access models were being used by various apps?

- Visibility to the application threat space is a critical first step
  - Have to look at all applications
  - Utilities, business intelligence apps, etc.

- How complex is our application security space today?
- Complete a full inventory of application space
  - Internal- vs external-facing applications
  - PC vs mobile platforms
  - Software as a Service
  - Application ownership
  - Authentication mechanisms
  - Account maintenance
- Completely documented data flows
  - Transmission of data
  - Data stores
  - Access to data

- Application Security Framework
  - Developed a baseline of secure coding functionality to be incorporated into coding
  - Requirements grouped by type of application being developed
    - Application Security Baseline – apply to all applications
    - Browser-based Application Baseline – apply to web applications
    - Web Service Application Baseline – apply to all web services
    - Confidential: Restricted Baseline – apply to all applications that store, process, or forward Confidential: Restricted information
  - Trained all developers on the Framework
  - Software leads have first line responsibility that developers adhere to Framework
- Framework a functional part of the SDLC

- You cannot prevent something if you cannot predict it – predictability
  - Look to analytics to increase knowledge of threats
  - Ties threat space to the threats that may impact it

- Number of sources of threat intel
  - Much of information is publicly available (but needs to be current)
  - Threat intel specific to your industry – FS-ISAC is an example
  - Important to develop relationships with local and federal law enforcement
    - Some portion of our personnel need to be cleared for this to be effective
    - No need for attribution

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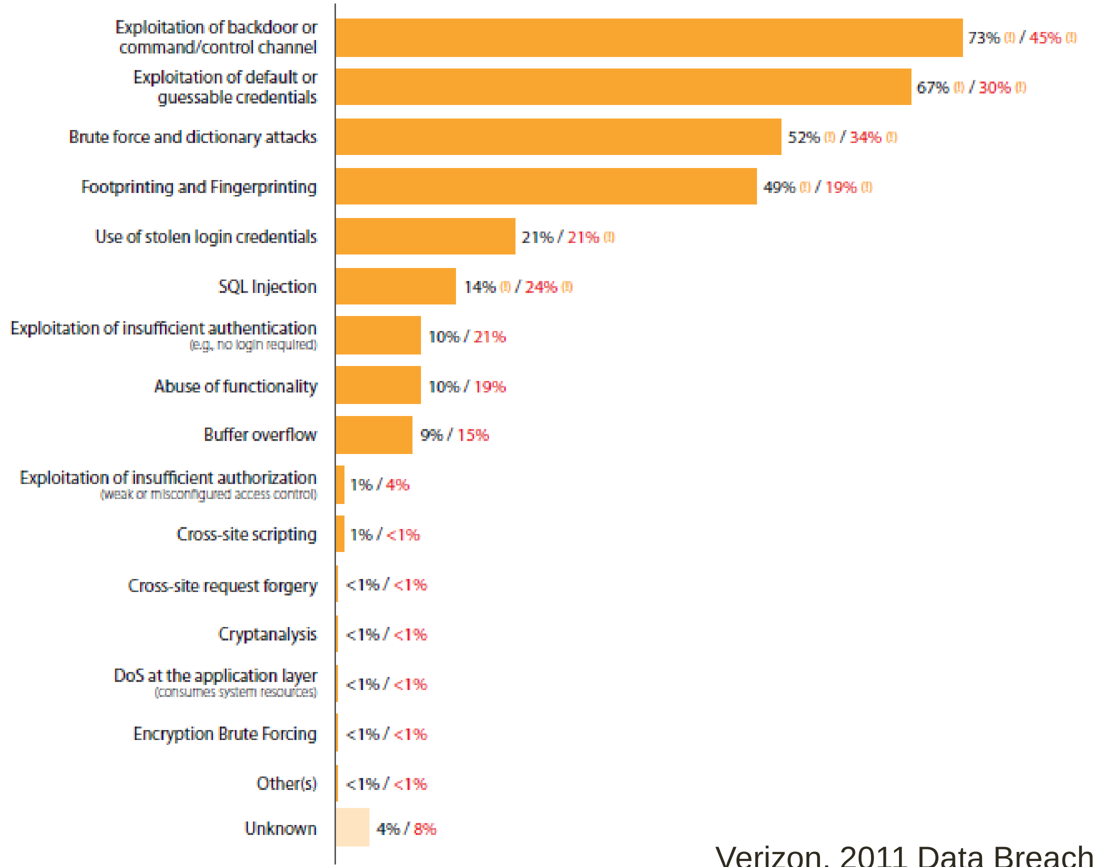
Figure 22. Types of hacking by percent of breaches within Hacking and percent of records



Verizon, 2011 Data Breach Investigations Report, pg 32

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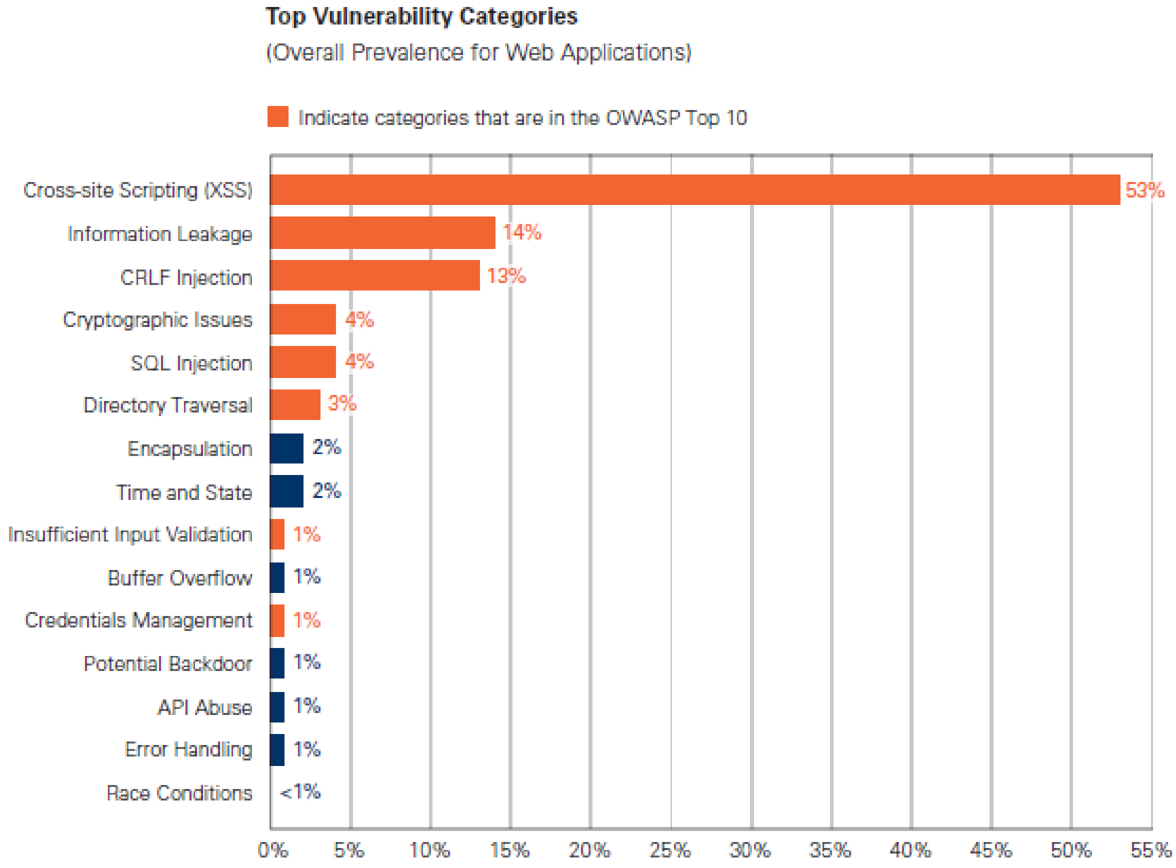
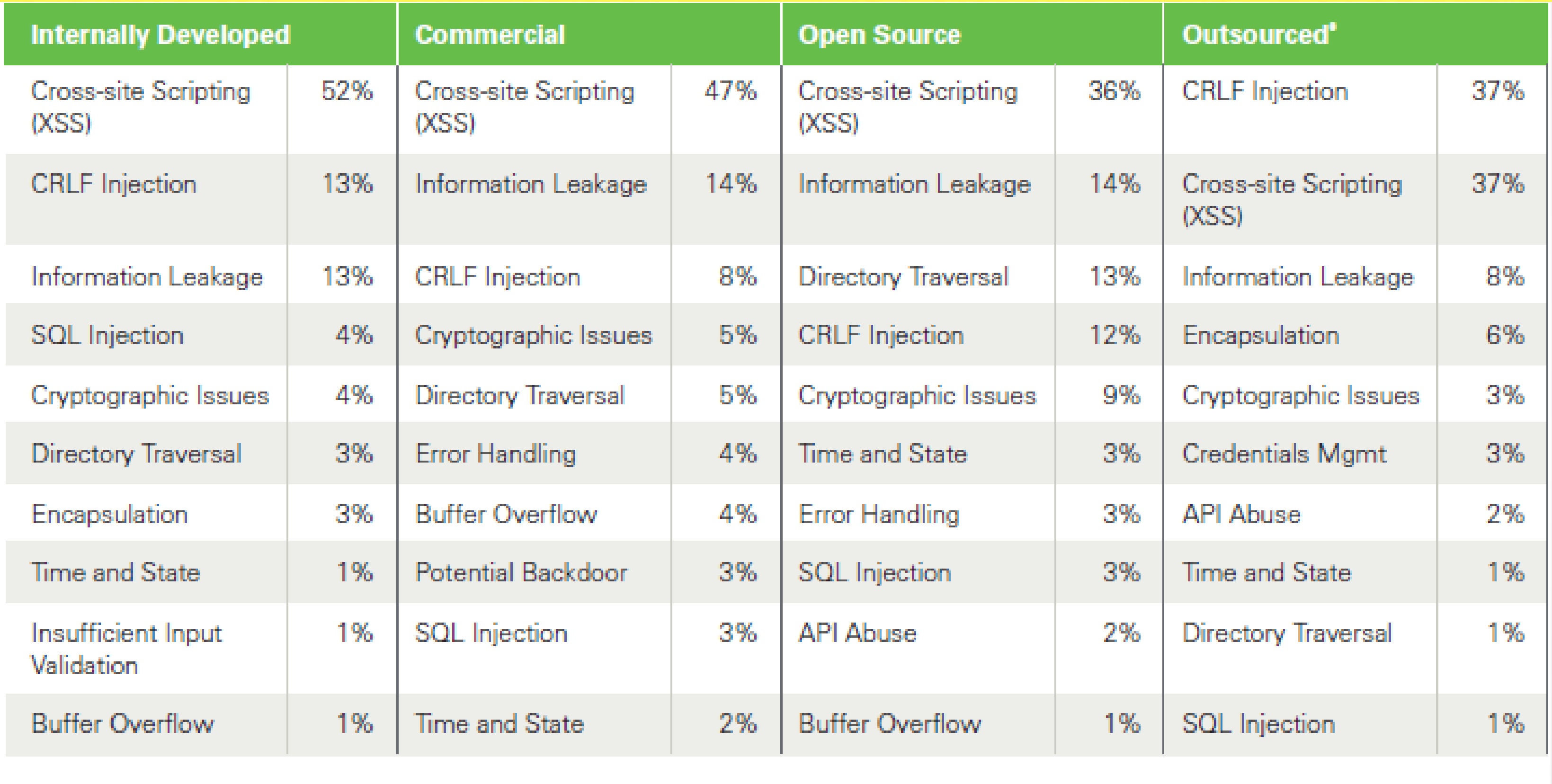


Figure 17: Top Vulnerability Categories (Overall Prevalence for Web Applications)

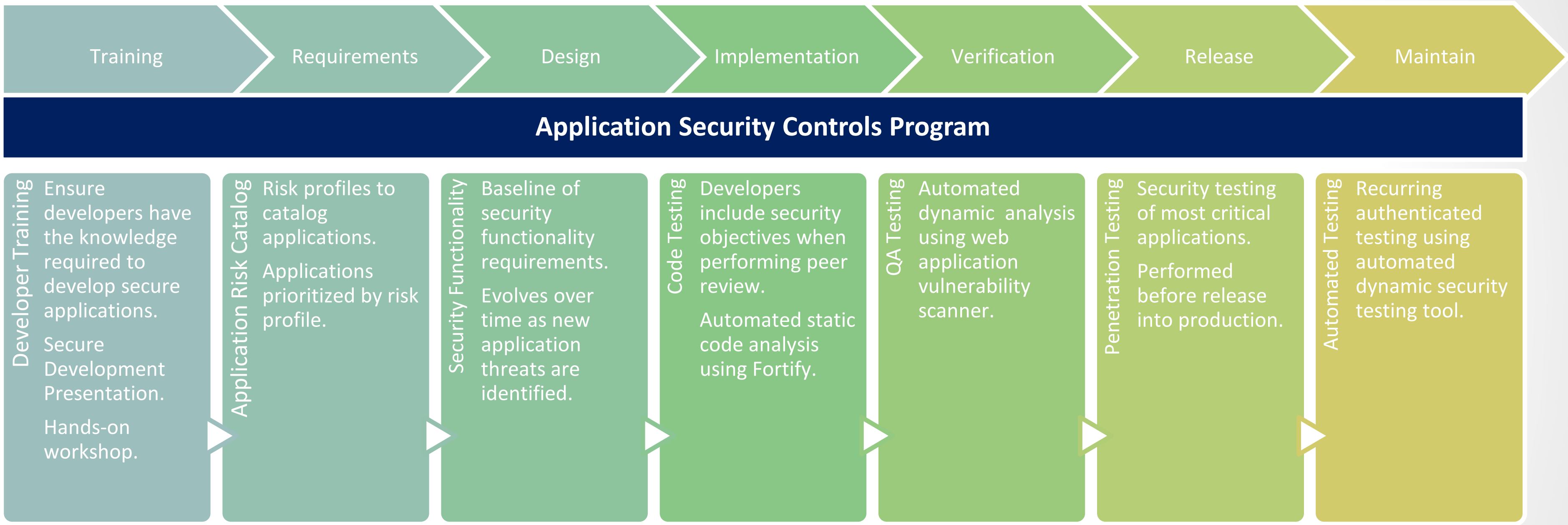
Veracode, State of Software Security Report: The Intractable Problem of Insecure Software, Apr 2011, pg 25



Internally Developed		Commercial		Open Source		Outsourced*	
Cross-site Scripting (XSS)	52%	Cross-site Scripting (XSS)	47%	Cross-site Scripting (XSS)	36%	CRLF Injection	37%
CRLF Injection	13%	Information Leakage	14%	Information Leakage	14%	Cross-site Scripting (XSS)	37%
Information Leakage	13%	CRLF Injection	8%	Directory Traversal	13%	Information Leakage	8%
SQL Injection	4%	Cryptographic Issues	5%	CRLF Injection	12%	Encapsulation	6%
Cryptographic Issues	4%	Directory Traversal	5%	Cryptographic Issues	9%	Cryptographic Issues	3%
Directory Traversal	3%	Error Handling	4%	Time and State	3%	Credentials Mgmt	3%
Encapsulation	3%	Buffer Overflow	4%	Error Handling	3%	API Abuse	2%
Time and State	1%	Potential Backdoor	3%	SQL Injection	3%	Time and State	1%
Insufficient Input Validation	1%	SQL Injection	3%	API Abuse	2%	Directory Traversal	1%
Buffer Overflow	1%	Time and State	2%	Buffer Overflow	1%	SQL Injection	1%

Veracode, State of Software Security Report: The Intractable Problem of Insecure Software, Apr 2011, pg 18

- You cannot secure something that was not built to be secure
  - Static and dynamic code analysis – credentialed and non-credentialed attacks
  - Web application firewalls
- Testing code before it is put into production
  - This can’t be last step before code into production – too late
  - Security testing has to be an integral part of development process



Training → Requirements → Design → Implementation → Verification → Release → Maintain

Application Security Controls Program

Developer Training

- Ensure developers have the knowledge required to develop secure applications.
- Secure Development Presentation.
- Hands-on workshop.

Application Risk Catalog

- Risk profiles to catalog applications.
- Applications prioritized by risk profile.

Security Functionality

- Baseline of security functionality requirements.
- Evolves over time as new application threats are identified.

Code Testing

- Developers include security objectives when performing peer review.
- Automated static code analysis using Fortify.

QA Testing

- Automated dynamic analysis using web application vulnerability scanner.

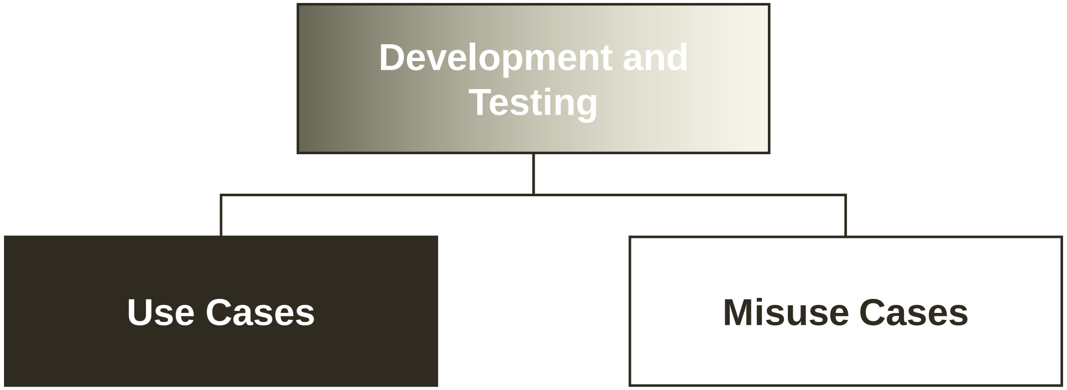
Penetration Testing

- Security testing of most critical applications.
- Performed before release into production.

Automated Testing

- Recurring authenticated testing using automated dynamic security testing tool.

- How does application security fit into the development lifecycle?
  - Functional testing is ensuring that all application functions perform as expected during normal user interaction.
  - Security testing is ensuring that all application functions perform as expected during *abnormal* user interaction.



Securing the Mobile Threat Space

- How complex is the mobile application security space today?
- Looking at this issue from non-applications perspective
  - Physical security – high likelihood of being lost, stolen or co-opted for some other use
  - Data stored on device is more valuable than device itself
- Malware
- Phishing
- Any device driver that has not been secured could be a weakness introduced into architecture of underlying OS
- Application and data isolation – prevent unwanted access to data

- Turn on Transport Layer Security (TLS) or Secure Sockets Layer (SSL)
- Follow secure programming practices
  - Secure coding guidelines (OWASP)
  - Security frameworks
- Validate input
- Leverage the permissions model of underlying OS
  - Permissions models on iPhone and Android generally isolate one app from another
- Store sensitive information properly
  - iPhone and Android have the ability to store sensitive information in non-clear text
- Sign the application code

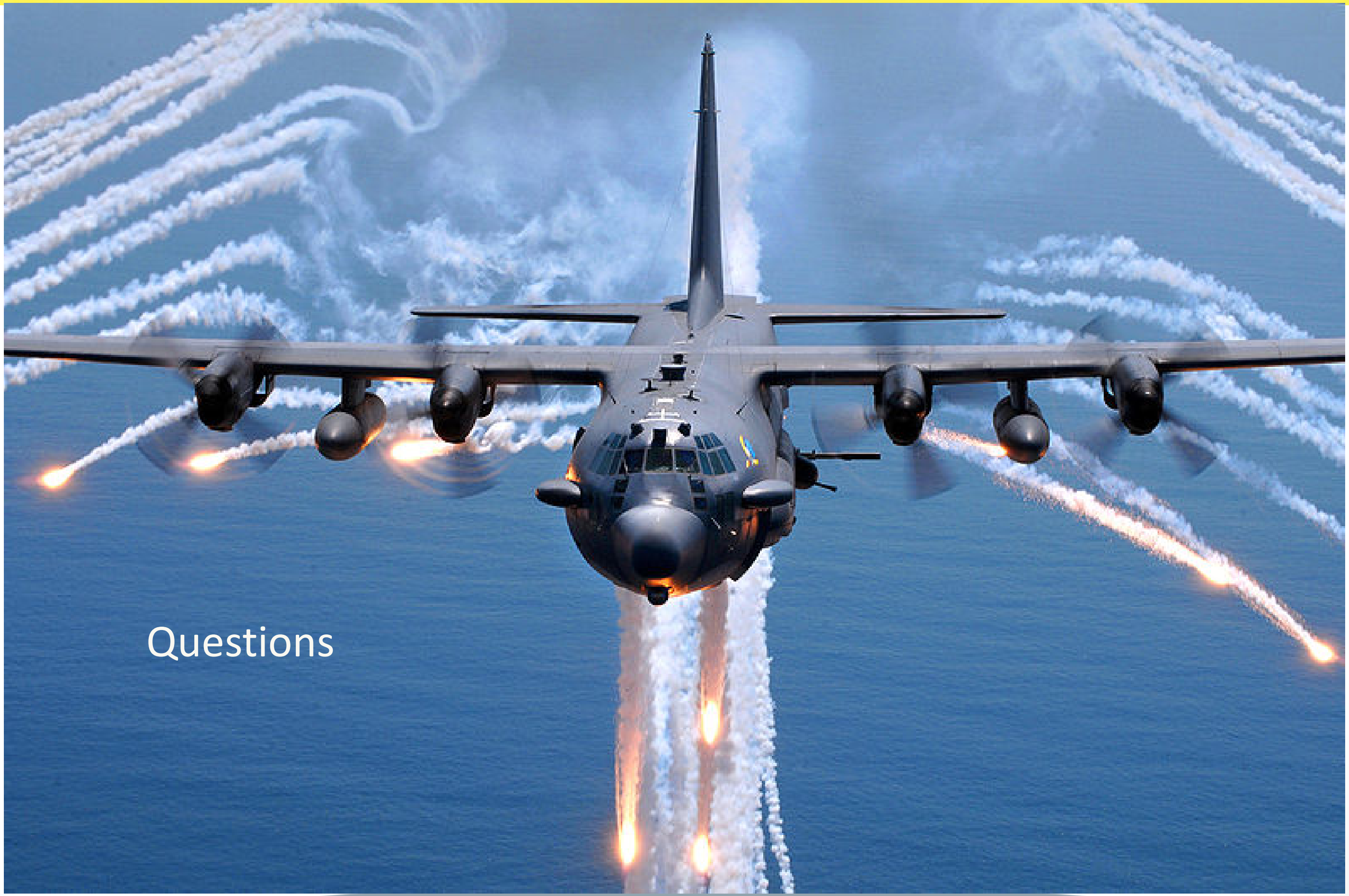
See Dwivedi, H, Clark, C., Thiel, D. Mobile Application Security. McGraw Hill pp 2-13

- Threat modeling for risk reduction
  - Thoroughly vet pros and cons of mobile architectures
    - Security models
    - Weaknesses
    - Securing administrative access
  - Pinpoint all input points in application design
    - Ensure that each of these is included in test plans for input validation
    - Map all data flows
      - Understand where data is stored
      - Understand who has access to data and why
      - Test access and authentication
- Ensure test plans are comprehensive

- Systematic testing
  - Static code analysis
  - Dynamic code analysis
  - Manual review
- Static code analysis can be problematic
  - Android is a Linux-based OS
  - Java-based coding
  - Tools like Fortify work exceptionally well
  - iPhone uses Objective-C coding
  - Most static code analyzers don’t cover this language
    - Flawfinder (www.dwheeler.com/flawfinder)
    - Clang Static Analyzer (clang-analyzer.llvm.org)

- Dynamic code analysis
  - Allows credentialed and non-credentialed testing
  - Very much like the attack might see application
- Manual review
  - Not all problems can be isolated using analyzers
  - Sometimes the best way to look at logic flow is to look at code and programs manually
  - Example: passing of parameters in the URLs
- Distributing the analysis process to development teams

- Conclusions
  - Moving into the mobile application space doesn't inherently mean that we had to change our software development techniques to secure the application
  - Techniques had to morph a bit to meet different threat models
  - Basic SDLC processes are much the same
  - Biggest challenge is in the handling of sensitive data flows when using mobile devices that in themselves have physical and logical security challenges
  - Need specialists who understand the hardware and software architectures of target devices
  - Remain entrepreneurial, but maintain a security focus



Questions

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