CISSP (8 Domain)
Certified Information Systems Security Professional

Kelly Handerhan, Instructor

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WELCOME TO CISSP BOOTCAMP

CISSP (Certified Information Systems Security Professional)
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THE 8 DOMAINS OF CISSP

CISSP Course Syllabus:

- Chapter 1: Security and Risk Management
- Chapter 2: Asset Security
- Chapter 3: Security Engineering
- Chapter 4: Communications and Network Security
- Chapter 5: Identity and Access Management
- Chapter 6: Security Assessment and Testing
- Chapter 7: Security Operations
- Chapter 8: Software Development Security

EXAM SPECIFICS

- 250 Questions (25 are “beta” and are not graded)
- 6 hours to complete the exam
- You can mark questions for review
- You will be provided with 1“wipe” board 8x11 and a pen. materials. You will also have access to an on-screen calculator.
- Many test centers provide earplugs or noise cancelling head phones. Call your center ahead of time to verify
- Questions are weighted (Remember…security transcends technology)

THE CISSP MINDSET

- Your Role is a Risk Advisor
- Do NOT fix Problems
- Who is responsible for security?
- How much security is enough?
- All decisions start with risk management. Risk management starts with Identifying/Valuating your assets.
- "Security Transcends Technology"
- Physical safety is always the first choice
- Technical Questions are for Managers. Management questions are for technicians
- Incorporate security into the design, as opposed to adding it on later
- Layered Defense!

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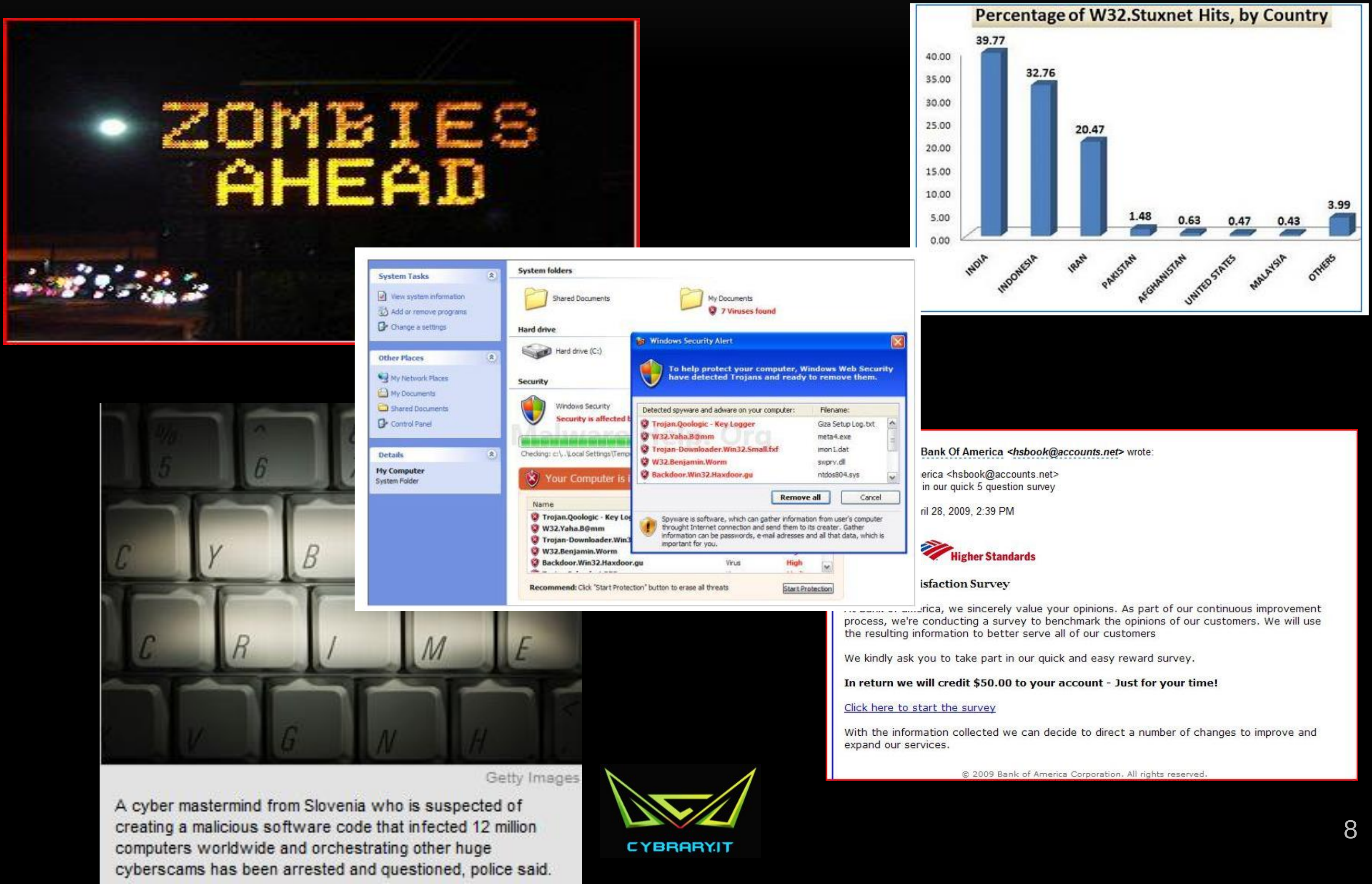
CHAPTER 1

Security and Risk Management

AGENDA

- Confidentiality, integrity, and availability concepts
- IAAA
- Security governance vs. Management
- Compliance
- Legal and regulatory issues
- Professional ethics
- Security policies, standards, procedures and guidelines
- Business Continuity and Disaster Recovery

WELL KNOWN EXPLOITS



To help protect your computer, Windows Web Security have detected Trojans and ready to remove them.

Detected spyware and adware on your computer:	Filename:
Trojan.Qoologic - Key Logger	Giza Setup Log.txt
W32.Yaha.B@mm	meta4.exe
Trojan-Downloader.Win32.Small.fxf	imon1.dat
W32.Benjamin.Worm	swprv.dll
Backdoor.Win32.Haxdoor.gu	ntdos804.sys

Spyware is software, which can gather information from user's computer throught Internet connection and send them to its creater. Gather information can be passwords, e-mail adresses and all that data, which is important for you.

Name		
Trojan.Qoologic - Key Lo		
W32.Yaha.B@mm		
Trojan-Downloader.Win3		
W32.Benjamin.Worm		
Backdoor.Win32.Haxdoor.gu	Virus	High

Recommend: Click "Start Protection" button to erase all threats

Bank Of America <*hsbook@accounts.net*> wrote:

erica <hsbook@accounts.net>
in our quick 5 question survey

ril 28, 2009, 2:39 PM

Higher Standards

isfaction Survey

...erica, we sincerely value your opinions. As part of our continuous improvement process, we're conducting a survey to benchmark the opinions of our customers. We will use the resulting information to better serve all of our customers

We kindly ask you to take part in our quick and easy reward survey.

In return we will credit $50.00 to your account - Just for your time!

Click here to start the survey

With the information collected we can decide to direct a number of changes to improve and expand our services.

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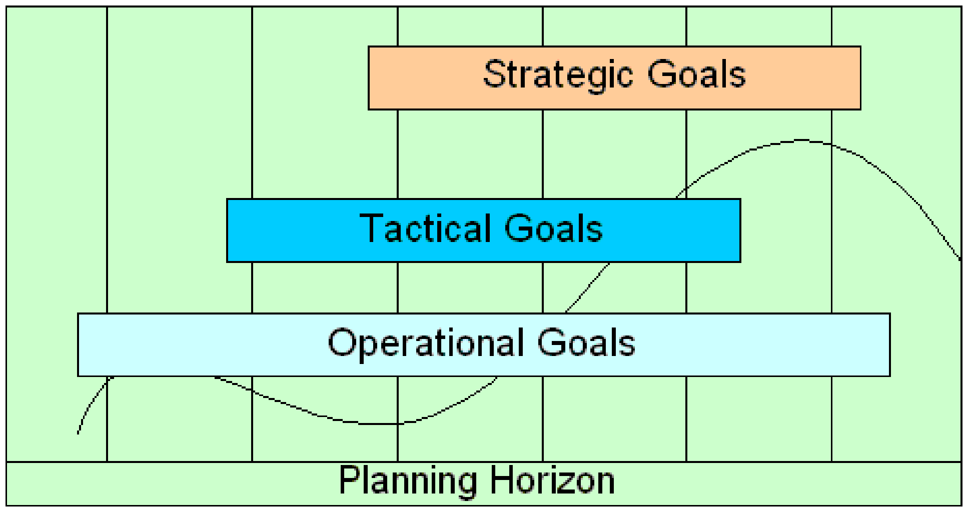
A cyber mastermind from Slovenia who is suspected of creating a malicious software code that infected 12 million computers worldwide and orchestrating other huge cyberscams has been arrested and questioned, police said.

THE ROLE OF INFORMATION SECURITY WITHIN AN ORGANIZATION

- First priority is to support the mission of the organization
- Requires judgment based on risk tolerance of organization, cost and benefit
- Role of the security professional is that of a risk advisor, not a decision maker.

Planning Horizon

- Strategic Goals
  - Over-arching - supported by tactical goals and operational
- Tactical Goals
- Operational Goals



SECURITY FUNDAMENTALS

- **C-I-A Triad**
  - Confidentiality
  - Integrity
  - Availability

CONFIDENTIALITY

- **Prevent unauthorized disclosure**
- **Threats against confidentiality:**
  - Social Engineering
    - Training, Separation of Duties, Enforce Policies and Conduct Vulnerability Assessments
  - Media Reuse
    - Proper Sanitization Strategies
  - Eavesdropping
    - Encrypt
    - Keep sensitive information off the network

INTEGRITY

- **Detect modification of information**
- **Corruption**
- **Intentional or Malicious Modification**
  - Message Digest (Hash)
  - MAC
  - Digital Signatures

AVAILABILITY

- **Provide Timely and reliable access to resources**
  - Redundancy, redundancy, redundancy
  - Prevent single point of failure
  - Comprehensive fault tolerance (Data, Hard Drives, Servers, Network Links, etc..)

BEST PRACTICES (TO PROTECT C-I-A)

- Separation of Duties (SOD)
- Mandatory Vacations
- Job rotation
- Least privilege
- Need to know
- Dual control

DEFENSE IN DEPTH

- **Also Known as layered Defense**
- **No One Device will PREVENT an attacker**
- **Three main types of controls:**
  - Technical (Logical)
  - Administrative
  - Physical

RISK

- Every decision starts with looking at risk
- Determine the value of your assets
- Look to identify the potential for loss
- Find cost effective solution reduce risk to an acceptable level (rarely can we eliminate risk)
- Safeguards are proactive
- Countermeasures are reactive

RISK DEFINITIONS

- **Asset: Anything of Value to the company**
- **Vulnerability: A weakness; the absence of a safeguard**
- **Threat: Something that could pose loss to all or part of an asset**
- **Threat Agent: What carries out the attack**
- **Exploit: An instance of compromise**
- **Risk: The probability of a threat materializing**
- **Controls: Physical, Administrative, and Technical Protections**
  - Safeguards
  - Countermeasure

SOURCES OF RISK

- Weak or non-existing anti-virus software
- Disgruntled employees
- Poor physical security
- Weak access control
- No change management
- No formal process for hardening systems
- Lack of redundancy
- Poorly trained users

RISK MANAGEMENT

- **Processes of identifying, analyzing, assessing, mitigating, or transferring risk. It's main goal is the reduction of probability or impact of a risk.**
- **Summary topic that includes all risk-related actions**
- **Includes Assessment, Analysis, Mitigation, and Ongoing Risk Monitoring**

RISK MANAGEMENT

- **Risk Management**
  - Risk Assessment
    - Identify and Valuate Assets
    - Identify Threats and Vulnerabilities
  - Risk Analysis
    - Qualitative
    - Quantitative
  - Risk Mitigation/Response
    - Reduce /Avoid
    - Transfer
    - Accept /Reject
- **Ongoing Risk Monitoring**

RISK ASSESSMENT

- **Identification and Valuation of Assets is the first step in risk assessment.**
- **What are we protecting and what is it worth**
  - Is it valuable to me? To my competitors?
  - What damage will be caused if it is compromised?
  - How much time was spent in development
  - Are there compliance/legal issues?

RISK ANALYSIS

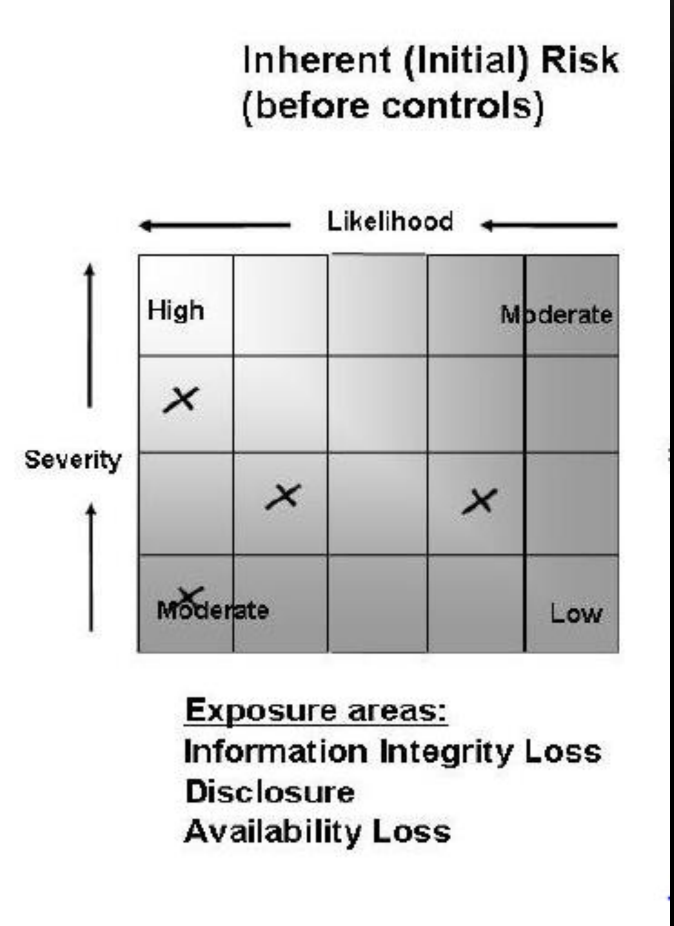
- **Determining a value for a risk**
- **Qualitative vs. Quantitative**
- **Risk Value is Probability * Impact**
- **Probability: How likely is the threat to materialize?**
- **Impact: How much damage will there be if it does?**
    - Could also be referred to as likelihood and severity.

RISK ANALYSIS

- **Qualitative Analysis (subjective, judgment-based)**
  - Probability and Impact Matrix
- **Quantitative Analysis (objective, numbers driven**

QUALITATIVE ANALYSIS

- Subjective in Nature
- Uses words like “high” “medium” “low” to describe likelihood and severity (or probability and impact) of a threat exposing a vulnerability
- Delphi technique is often used to solicit objective opinions



Inherent (Initial) Risk
(before controls)

Exposure areas:
Information Integrity Loss
Disclosure
Availability Loss

QUANTITATIVE ANALYSIS

- More experience required than with Qualitative
- Involves calculations to determine a dollar value associated with each risk event
- Business Decisions are made on this type of analysis
- Goal is to the dollar value of a risk and use that amount to determine what the best control is for a particular asset
- Necessary for a cost/benefit analysis

QUANTITATIVE ANALYSIS

- AV (Asset Value)
- EF (Exposure Factor)
- ARO (Annual Rate of Occurrence)
- SLE (Single Loss Expectancy)=AV * EF
- ALE (Annual Loss Expectancy) SLE*ARO
- Cost of control should be the same or less than the potential for loss

MITIGATING RISK

- **Three Acceptable Risk Responses:**
  - Reduce
  - Transfer
  - Accept
- **Secondary Risks**
- **Residual Risks**
- **Continue to monitor for risks**
- **How we decide to mitigate business risks becomes the basis for Security Governance and Policy**

SECURITY GOVERNANCE

- The IT Governance Institute in its *Board Briefing on IT Governance, 2nd Edition, defines Security governance as follows:*

“Security governance is the set of responsibilities and practices exercised by the board and executive management with the goal of providing strategic direction, ensuring that objectives are achieved, ascertaining that risks are managed appropriately and verifying that the enterprise's resources are used responsibly.”

SECURITY BLUEPRINTS

- For achieving “Security Governance”

- BS 7799, ISO 17799, and 27000 Series
- COBIT and COSO
- OCTAVE
- ITIL

COBIT AND COSO

- COBIT (Control Objectives for Information and related Technology.
- COSO (Committee of Sponsoring Organizations)
- Both of these focus on goals for security

ITIL

- **Information Technology Infrastructure Library (ITIL) is the de facto standard for best practices for IT service management**
- **5 Service Management Publications:**
  - Strategy
  - Design
  - Transition
  - Operation
  - Continual Improvement

****While the Publications of ITIL are not testable, it's purpose and comprehensive approach are testable. It provides best practices for organization and the means in which to implement those practices**

OCTAVE

- Operationally Critical Threat, Asset and Vulnerability Evaluation
- Self Directed risk evaluation developed by Carnegie Mellon. People within an organization are the ones who direct the risk analysis
- A suite of tools, techniques, and methods for risk-based information security strategic assessment and planning.

1. Identify Assets
2. Identify Vulnerabilities
3. Risk Analysis and Mitigation

BS 7799, ISO 17799, 27000 SERIES

- **BS 7799-1, BS 7799-2**
- **Absorbed by ISO 17799**
- **Renamed ISO 27002 to fit into the ISO numbering standard**

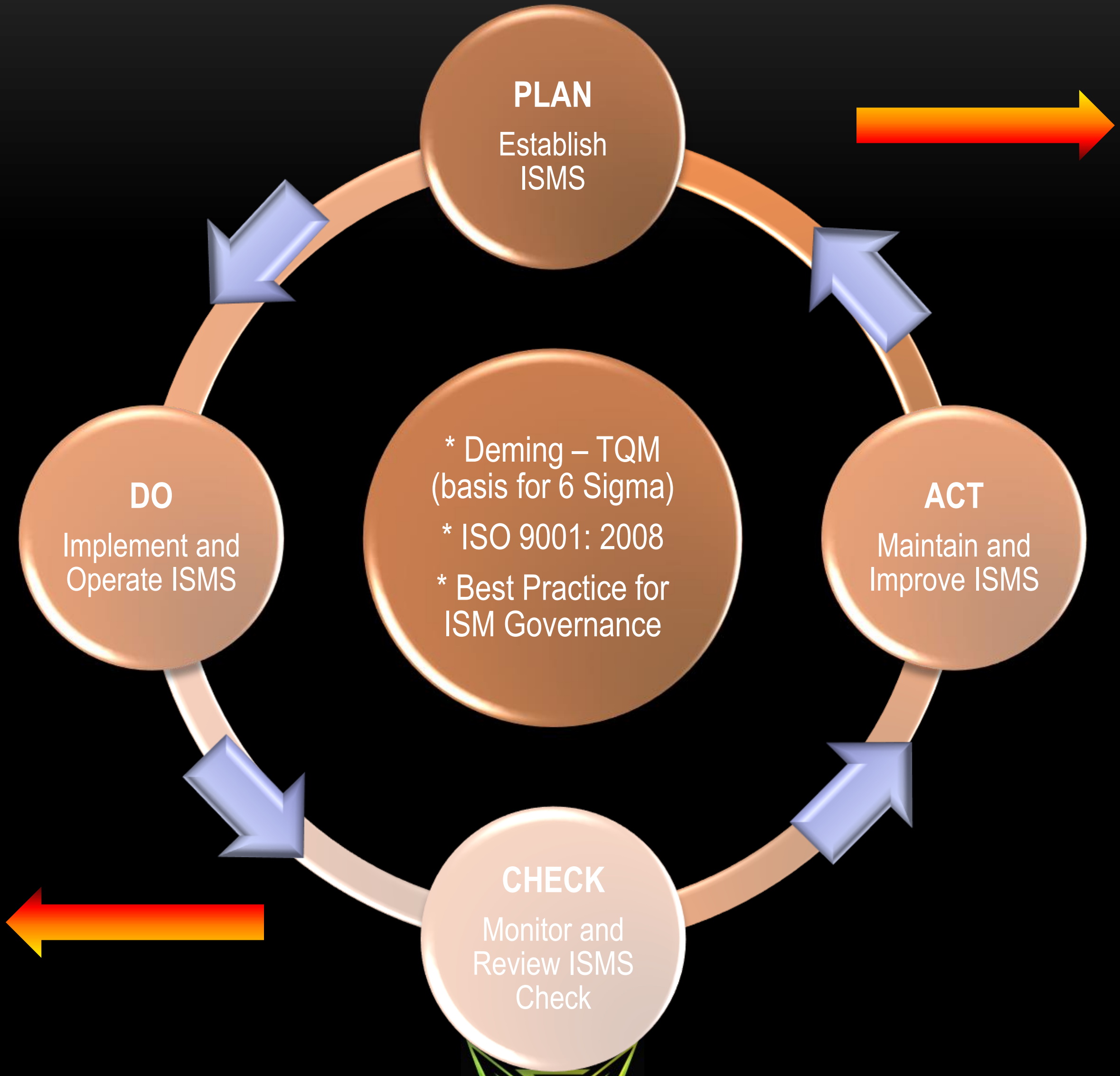
ISO 27000 SERIES

- ISO 27001: Establishment, Implementation, Control and improvement of the ISMS. Follows the PDCA (Plan, Do, Check, Act)
- ISO 27002: Replaced ISO 17799. Provides practical advice for how to implement security controls. Uses 10 domains to address ISMS.
- ISO 27004: Provides Metrics for measuring the success of ISMS
- ISO 27005: A standards based approach to risk management
- ISO 27799: Directives on protecting personal health information

The Plan Do Check Act (PDCA) Model

INTERESTED PARTIES

Information Security Requirements And Expectations



PLAN
Establish ISMS

DO
Implement and Operate ISMS

CHECK
Monitor and Review ISMS Check

ACT
Maintain and Improve ISMS

* Deming – TQM (basis for 6 Sigma)
* ISO 9001: 2008
* Best Practice for ISM Governance

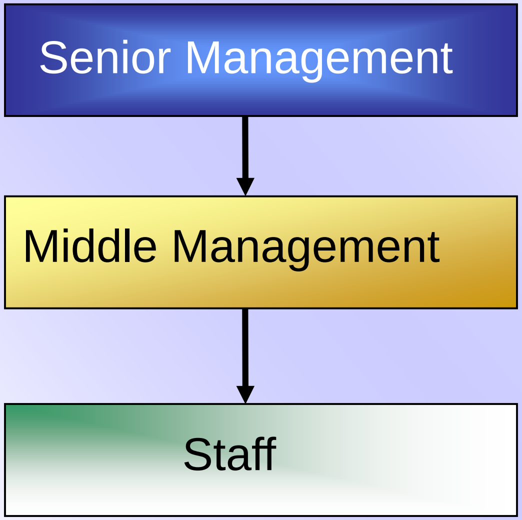
INTERESTED PARTIES

Managed Information Security

MANAGEMENT

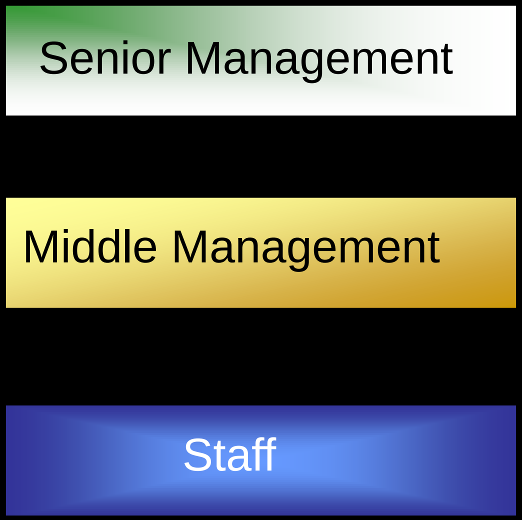
Top-Down Approach

Security practices are directed and supported at the senior management level



Bottom-Up Approach

The IT department tries to implement security



SENIOR MANAGEMENT ROLE

- **CEO, CSO, CIO, etc..**
  - Ultimately responsible for Security within an organization
  - Development and Support of Policies
  - Allocation of Resources
  - Decisions based on Risk
  - Prioritization of business processes

LIABILITIES

- **Legal liability is an important consideration for risk assessment and analysis.**
- **Addresses whether or not a company is responsible for specific actions or inaction.**
- **Who is responsible for the security within an organization?**
  - Senior management
- **Are we liable in the instance of a loss?**
  - Due diligence: Continuously monitoring an organizations practices to ensure they are meeting/exceeding the security requirements.
  - Due care: Ensuring that "best practices" are implemented and followed. Following up Due Diligence with action.
  - Prudent man rule: Acting responsibly and cautiously as a prudent man would
  - Best practices: Organizations are aligned with the favored practices within an industry

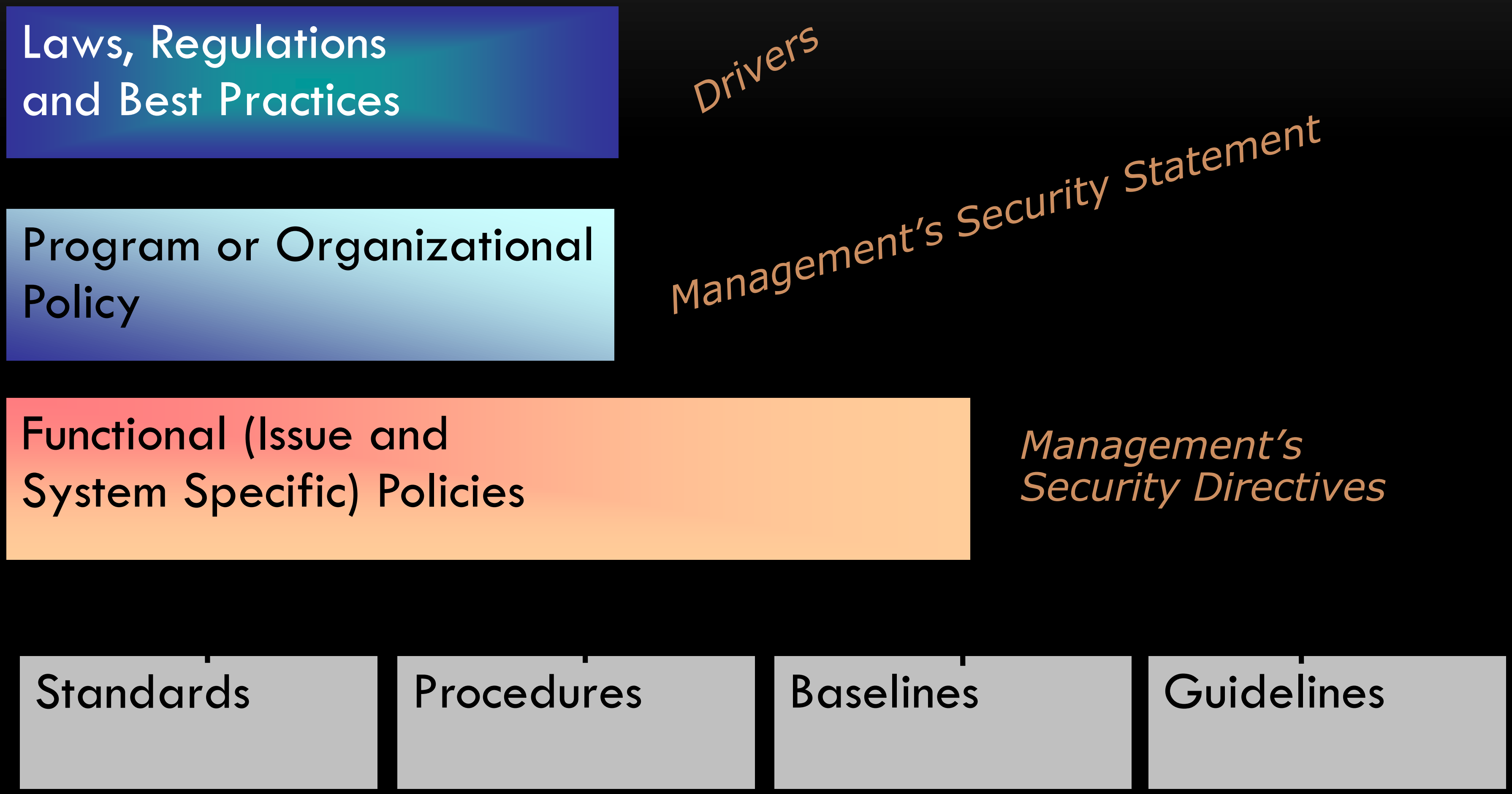
ORGANIZATIONAL SECURITY POLICY

- Also Known as a Program Policy
- Mandatory
- High level statement from management
- Should support strategic goals of an organization
- Explain any legislation or industry specific drivers
- Assigns responsibility
- Should be integrated into all business functions
- Enforcement and Accountability

ISSUE AND SYSTEM SPECIFIC POLICY

- Issue Specific policy, sometimes called Functional Implementation policy would include company's stance on various employee issues. AUP, Email, Privacy would all be covered under issue specific
- System Specific policy is geared toward the use of network and system resources. Approved software lists, use of firewalls, IDS, Scanners, etc.

Security Policy Document Relationships



Laws, Regulations and Best Practices

Drivers

Program or Organizational Policy

Management's Security Statement

Functional (Issue and System Specific) Policies

Management's Security Directives

Standards

Procedures

Baselines

Guidelines

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STANDARDS

- Mandatory
- Created to support policy, while providing more specifics.
- Reinforces policy and provides direction
- Can be internal or external

PROCEDURES

- Mandatory
- Step by step directives on how to accomplish an end-result.
- Detail the “how-to” of meeting the policy, standards and guidelines

GUIDELINES

- Not Mandatory
- Suggestive in Nature
- Recommended actions and guides to users
- “Best Practices”

BASELINES

- Mandatory
- Minimum acceptable security configuration for a system or process
- The purpose of security classification is to determine and assign the necessary baseline configuration to protect the data

PERSONNEL SECURITY POLICIES (EXAMPLES)

- Hiring Practices and Procedures
- Background Checks/Screening
- NDA's
- Employee Handbooks
- Formal Job Descriptions
- Accountability
- Termination

ROLES AND RESPONSIBILITIES

- **Senior/Executive Management**
  - CEO: Chief Decision-Maker
  - CFO: Responsible for budgeting and finances
  - CIO: Ensures technology supports company's objectives
  - ISO: Risk Analysis and Mitigation
- **Steering Committee: Define risks, objectives and approaches**
- **Auditors: Evaluates business processes**
- **Data Owner: Classifies Data**
- **Data Custodian: Day to day maintenance of data**
- **Network Administrator: Ensures availability of network resources**
- **Security Administrator: Responsible for all security-related tasks, focusing on Confidentiality and Integrity**

RESPONSIBILITIES OF THE ISO

- Responsible for providing C-I-A for all information assets.
- Communication of Risks to Senior Management
- Recommend best practices to influence policies, standards, procedures, guidelines
- Establish security measurements
- Ensure compliance with government and industry regulations
- Maintain awareness of emerging threats

LIABILITIES – WHO IS AT FAULT?

- **Failure of management to execute Due Care and/or Due Diligence can be termed negligence**
  - Culpable negligence is often used to prove liability
- **Prudent Man Rule**
  - Perform duties that prudent people would exercise in similar circumstances
  - Example: Due Care: setting a policy; Due Diligence: enforcing that policy
- **Downstream Liabilities**
- **Integrated technology with other companies can extend one's responsibility outside the normal bounds**

LEGAL LIABILITY

- **Legally Recognized Obligation**
  - A standard exists that outlines the conduct expected of a company to protect others from unreasonable risks
- **Proximate Causation**
  - Fault can actually be proven to be a direct result of one’s action or inaction
- **Violation of Law**
  - Regulatory, criminal, or intellectual property
- **Violation of Due Care**
  - Stockholders suits
- **Violation of Privacy**
  - Employee suits

TYPES OF LAWS

- Criminal Law
- Civil Law
- Regulatory
- Intellectual Property

CRIMINAL LAW

- **Beyond a reasonable doubt—can be difficult to meet this burden of proof in computer-related crimes**
- **Penalties: Financial, Jail-time, death**
  - Felonies: More serious of the two. Often penalty results in incarceration of at least a year.
  - Misdemeanors: Normally the less serious of the two with fines or jail-time of less than one year.
- **The Goal of criminal penalties is:**
  - Punishment
  - Deterrence

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CIVIL (TORT) LAW

- **Preponderance of evidence**
- **Damages**
  - Compensatory: Paid for the actual damage which was suffered by a victim, including attorney fees, loss of profits, medical costs, investigative costs, etc…
  - Punitive: Designed as a punishment for the offender
  - Statutory: an amount stipulated within the law rather than calculated based on the degree of harm to the plaintiff. Often, statutory damages are awarded for acts in which it is difficult to determine the value of the harm to the victim.
- **Liability, Due Care, Due Diligence, Prudent Person Rule are all pertinent to civil law , as well as administrative law**

ADMINISTRATIVE (REGULATORY) LAW

- **Defines standards of performance and regulates conduct for specific industries**
  - Banking (Basel II)
  - Energy (EPAct) of 2005
  - Health Care (HIPAA)
- **Burden of Proof is “More likely than not”**
- **Penalties consist of financial or imprisonment**

INTELLECTUAL PROPERTY

- **Intellectual Property Law**
  - Protecting products of the mind
  - Company must take steps to protect resources covered by these laws or these laws may not protect them
- **Main international organization run by the UN is the World Intellectual Property Organization (WIPO)**
- **Licensing is the most prevalent violation, followed by plagiarism, piracy and corporate espionage**

INTELLECTUAL PROPERTY PROTECTION

- **Trade Secret**
  - Resource must provide competitive value
  - Must be reasonably protected from unauthorized use or disclosure
  - Proprietary to a company and important for survival
  - Must be genuine and not obvious

COPYRIGHT

- **Copyright**
  - Copyright protections lasts for the lifetime of the author plus 70 years or 75 years for corporations
  - Work does not need to be registered or published to be protected.
  - Protects expression of ideas rather than the ideas themselves
  - Author to control how work is distributed, reproduced, used
  - Protects the expression of the resource instead of the resource itself
- **Two Limitations on Copyright:**
  - First sale
  - Fair Use

INTELLECTUAL PROPERTY PROTECTION CONTINUED

- **Trademark**
  - Protect word, name, symbol, sound, shape, color or combination used to identify product to distinguish from others
  - Protect from someone stealing another company's "look and feel"
  - Corporate Brands and operating system logos
- **Trademark Law Treaty Implementation Act protects trademarks internationally**

INTELLECTUAL PROPERTY PROTECTION CONTINUED

- **Patent**
  - Originally valid for 17 years, but are now valid for 20 years
  - Protection for those who have legal ownership of an invention
  - Invention must be novel and non-obvious
  - Owner has exclusive control of invention for 20 years
    - Cryptographic algorithm
  - The strongest form of protection
  - Published to stimulate other inventions
  - PCT (Patent Cooperation Treaty) has been adopted by over 130 countries to provide the international protection of patents
  - No organization enforces patents. It is up to the owner to purse the patent rights through the legal system

ATTACKS ON INTELLECTUAL PROPERTY

- Piracy
- Copyright infringement
- Counterfeiting
- Cybersquatting
- Typosquatting

EXPORT/IMPORT RESTRICTIONS

- **Export restriction**
  - WASSENAAR Agreement makes it illegal to export munitions to terrorist sponsored nations
  - Exporting of cryptographic software is allowed to non-government end-users of other countries
  - No exporting of strong encryption software to terrorists states

- **Import restriction**
  - In many countries, the import of cryptographic tools with strong encryption requires a copy of the private keys be provided to law enforcement
  - US Safe Harbor Laws

INTERNATIONAL ISSUES

- **Trans border Issues**
  - Each country treats computer crimes differently
  - Evidence rules differ between legal systems
  - Governments may not assist each other in international cases
  - Jurisdiction issues

PRIVACY ISSUES – EMPLOYEE MONITORING

- **Local labor laws related to privacy cannot be violated**

- **Be mindful of the reasonable expectation of privacy (REP)**
  - Gain an employee waiver by signature on policies, etc…

- **Notify of monitoring that may be used, or do not monitor the employees at all**
  - Banner and security awareness
  - Ensure that monitoring is lawful
  - Do not target individuals in monitoring

- **Monitor work-related events:**
  - Keystroke, Cameras, Badges, Telephone, E-mail

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HIPAA (HEALTH INSURANCE PORTABILITY AND ACCOUNTABILITY ACT)

- **Applies to**
  - Health Insurers
  - Health Providers
  - Health care clearing houses (claim processing agencies)
  - As of 2009, covered entities must disclose security breaches regarding personal information

GRAMM-LEACH-BLILEY FINANCIAL SERVICES MODERNIZATION ACT

- **Known as GLBA**
- **Requires financial agencies to better protect customer's PII (Personally Identifiable Information)**
- **Three Rules:**
    - Financial Privacy rule-Requires financial institutions to provide information to customers regarding how PII is protected
    - Safeguards Rule-Requires each financial institution to have a formal written security plan detailing how customer PII will be safeguarded
    - Pretexting Protection-Addresses social engineering and requires methods be in place to limit information that can be obtained by this type of attack

PCI DSS (PAYMENT CARD INDUSTRY DATA SECURITY STANDARD)

- Not a legal mandate
- Payment Card Industry self-regulates its own security standards
- Applies to any business worldwide that transmits, processes or stores payment card transactions to conduct business with customers
- Compliance is enforced by the payment card vendor (Visa, MasterCard, American Express, etc..)
- Compliance requirements are dictated by the number of transactions, as well as any previous security issues

PCI DSS (PAYMENT CARD INDUSTRY DATA SECURITY STANDARD) CONTINUED

- **Six Core Principles:**
  - Build and maintain a secure network
  - Protect card holder data
  - Maintain a vulnerability management program
  - Implement strong access control measures
  - Regularly monitor and test the networks
  - Maintain an Information security policy

DISCLOSURE

- **Often Organizations prefer not to disclose security breaches**
  - Advertises vulnerabilities
  - Causes loss of customer confidence
  - Liability issues
  - Difficulty of Prosecution
- **Many states have now passed disclosure laws that legally require organizations to publicly disclose security breaches that might compromise personal data**
  - Allow individuals to take corrective action
  - Additional motivation for organizations to protect customer data

AUDITING ROLE

- Objective Evaluation of controls and policies to ensure that they are being implemented and are effective.
- If internal auditing is in place, auditors should not report to the head of a business unit, but rather to legal or human resources--some other entity with out direct stake in result

Knowledge Transfer

Awareness, Training, Education

“People are often the weakest link in securing information. Awareness of the need to protect information, training in the skills needed to operate them securely, and education in security measures and practices are of critical importance for the success of an organization’s security program.”

The Goal of Knowledge Transfer is to modify employee behavior

BEING AWARE OF THE RULES

Security Awareness Training

- Employees cannot and will not follow the directives and procedures, if they do not know about them
- Employees must know expectations and ramifications, if not met
- Employee recognition award program
- Part of due care
- Administrative control

AWARENESS/TRAINING/ EDUCATION BENEFITS

Overriding Benefits:

Modifies employee behavior and improves attitudes towards information security

Increases ability to hold employees accountable for their actions

Raises collective security awareness level of the organization

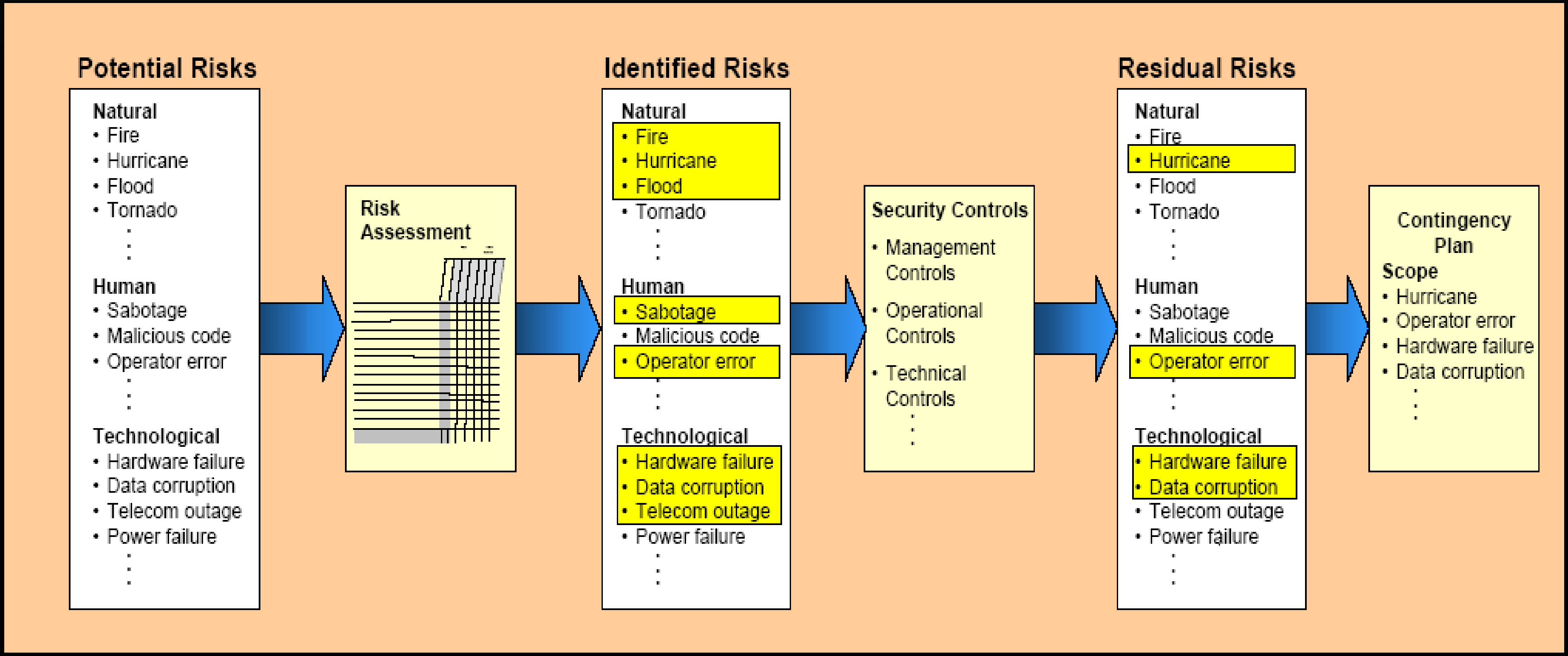
CONTINUITY OF THE ENTERPRISE

Business Continuity and Disaster Recovery Planning

BCP VS. DRP

- Business Continuity Planning: Focuses on sustaining operations and protecting the viability of the business following a disaster, until normal business conditions can be restored. The BCP is an “umbrella” term that includes many other plans including the DRP. Long Term focused
- Disaster Recovery Planning: goal is to minimize the effects of a disaster and to take the necessary steps to ensure that the resources, personnel and business processes are able to resume operations in a timely manner. Deals with the immediate aftermath of the disaster, and is often IT focused. Short Term focused

BCP RELATIONSHIP TO RISK MANAGEMENT



Potential Risks

Natural
- Fire
- Hurricane
- Flood
- Tornado

⋮

Human
- Sabotage
- Malicious code
- Operator error

⋮

Technological
- Hardware failure
- Data corruption
- Telecom outage
- Power failure

⋮

Risk Assessment

Identified Risks

Natural
- Fire
- Hurricane
- Flood
- Tornado

⋮

Human
- Sabotage
- Malicious code
- Operator error

⋮

Technological
- Hardware failure
- Data corruption
- Telecom outage
- Power failure

⋮

Security Controls
- Management Controls
- Operational Controls
- Technical Controls

⋮

Residual Risks

Natural
- Fire
- Hurricane
- Flood
- Tornado

⋮

Human
- Sabotage
- Malicious code
- Operator error

⋮

Technological
- Hardware failure
- Data corruption
- Telecom outage
- Power failure

⋮

Contingency Plan

Scope
- Hurricane
- Operator error
- Hardware failure
- Data corruption

⋮

MITIGATE RISKS

- Reduce negative effects:
- – Life Safety is the number 1 priority!
- – Reputation: Is the second most important asset of an organization. Though specific systems are certainly essential, don’t forget to focus on the big picture—protect the company as a whole

BUSINESS CONTINUITY PLANNING

- **Disaster recovery and continuity planning deal with uncertainty and chance**
  - Must identify **all possible threats** and estimate possible damage
  - Develop viable alternatives
- **Threat Types:**
  - Man-made
    - Strikes, riots, fires, terrorism, hackers, vandals
  - Natural
    - Tornado, flood, earthquake
  - Technical
    - Power outage, device failure, loss of a T1 line

BUSINESS CONTINUITY PLANNING

- **Categories of Disruptions**
  - Non-disaster: Inconvenience. Hard drive failure
    - Disruption of service
    - Device malfunction
  - Emergency/Crisis
    - Urgent, immediate event where there is the potential for loss of life or property
  - Disaster
    - Entire facility unusable for a day or longer
  - Catastrophe
    - Destroys facility
  - A company should understand and be prepared for each category

- **ANYONE CAN DECLARE AN EMERGENCY, ONLY THE BCP COORDINATOR CAN DECLARE A DISASTER (Anyone can pull the fire alarm or trigger an emergency alarm. Only the BCP coordinator or someone specified in the BCP can declare a disaster which will then trigger failover to another facility)**

ISO 27031

- Approved in 2011
- Provides a standard that did not exist previously
- Will solve issues of inconsistency in terms, definitions and documents (so for now, there may be inconsistencies on the exam. Look for concepts more than specific terms)
- Until this ISO standard is included on the test, the following institutes will provide guidance on BCP/DRP:
  - DRII (Disaster Recovery Institute International)
  - NIST 800-34
  - BCI GPG (Business Continuity International Good Practice Guidelines)

BUSINESS CONTINUITY PLAN SUB-PLANS

- **BCP**
- Protect
  - Crisis Communication Plan
  - OEP (Occupant Emergency Plan)
- Recover
  - BRP (Business Recovery Plan)
  - DRP (Disaster Recovery Plan)
  - Continuity of Support Plan/IT Contingency Plan
- Sustain
  - COOP (Continuity of Operations Plan

PROTECT

- **Crisis Communications Plan**

  Purpose: Provides procedures for **disseminating status reports to personnel and the public**
  Scope: Addresses communications with personnel and the public; not IT focused

- **Occupant Emergency Plan (OEP)**

  Purpose: Provide coordinated procedures for **minimizing loss of life or injury and protecting property damage** in response to a physical threat
  Scope: Focuses on **personnel and property** particular to the specific facility; not business process or IT system functionality based. May also be referred to as **Crisis or Incident management** plans. However, the OEP concept should be recognizable as the "**initial response to the emergency event"**

RECOVER

- **Business Recovery (or Resumption) Plan (BRP)**

  Purpose: Provide procedures for recovering business operations immediately following a disaster   Scope: Addresses business processes; not IT-focused; IT addressed based only on its support for business process

- **Continuity of Support Plan/IT Contingency Plan**

  Purpose: Provide procedures and capabilities for recovering a major application or general support system
  Scope: Same as IT contingency plan; addresses IT system disruptions; not business process focused

- **Cyber Incident Response Plan**

  Purpose: Provide strategies to detect, respond to, and limit consequences of malicious cyber incident
  Scope: Focuses on information security responses to incidents affecting systems and/or networks

- **Disaster Recovery Plan (DRP)**

  Purpose: Provide detailed procedures to facilitate recovery of capabilities at an alternate site
  Scope: Often IT-focused; limited to major disruptions with long-term effects

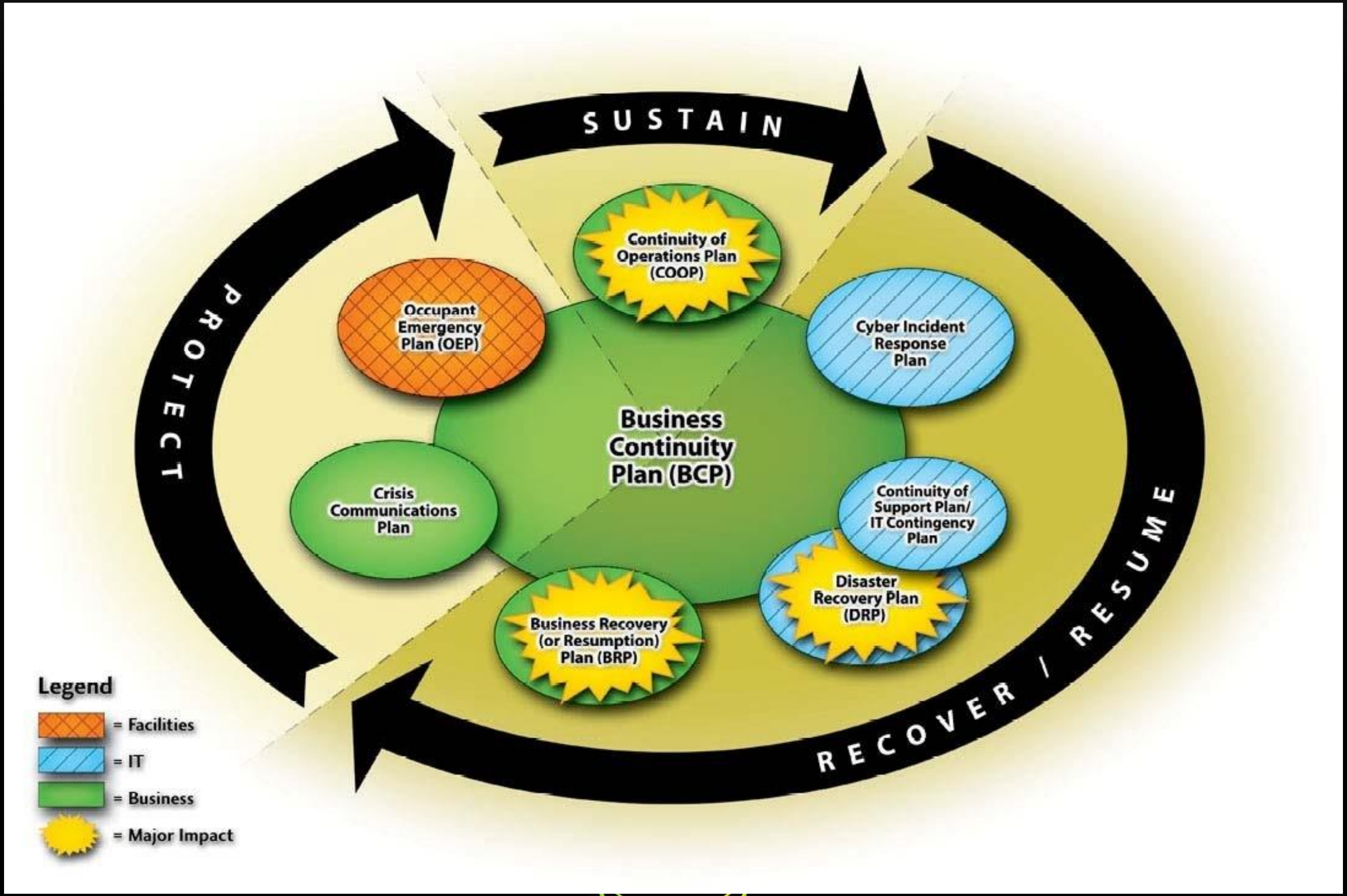
SUSTAIN

Continuity of Operations Plan (COOP)

Purpose: Provide procedures and capabilities to sustain an organization's **essential, strategic functions at an alternate site for up to 30 days.** This term is sometimes used in US Government to refer to the field of Business Continuity Management, but per NIST 800-34, it is a unique sub-plan of the BCP. ****Note, BCP addresses ALL business processes, not just mission critical**.

Scope: Addresses the subset of an organization's missions that are deemed most critical; usually written at headquarters level; not IT-focused

NIST 800-34 INTERRELATIONSHIP OF THE PLANS


SUSTAIN
PROTECT
RECOVER / RESUME
Continuity of Operations Plan (COOP)
Occupant Emergency Plan (OEP)
Cyber Incident Response Plan
Business Continuity Plan (BCP)
Crisis Communications Plan
Continuity of Support Plan/ IT Contingency Plan
Disaster Recovery Plan (DRP)
Business Recovery (or Resumption) Plan (BRP)
Legend
= Facilities
= IT
= Business
= Major Impact

ROLES AND RESPONSIBILITIES

- **Senior Executive Management**
  - Consistent support and final approval of plans
  - Setting the business continuity policy
  - Prioritizing critical business functions
  - Allocating sufficient resources and personnel
  - Providing oversight for and approving the BCP
  - Directing and reviewing test results
  - Ensuring maintenance of a current plan

ROLES AND RESPONSIBILITIES

- **Senior Functional Management**
  - Develop and document maintenance and testing strategy
  - Identify and prioritize mission-critical systems
  - Monitor progress of plan development and execution
  - Ensure periodic tests
  - Create the various teams necessary to execute the plans

ROLES AND RESPONSIBILITIES

- **BCP Steering Committee**
  - Conduct the BIA
  - Coordinate with department representatives
  - Develop analysis group
    - Plan must be developed by those who will carry it out
    - Representatives from critical departments

BCP TEAMS

- **Teams:**
  - Rescue: Responsible for dealing with the immediacy of disaster—employee evacuation, “crashing” the server room, etc..
  - Recovery: Responsible for getting the alternate facility up and running and restoring the most critical services first.
  - Salvage: Responsible for the return of operations to the original or permanent facility (reconstitution)

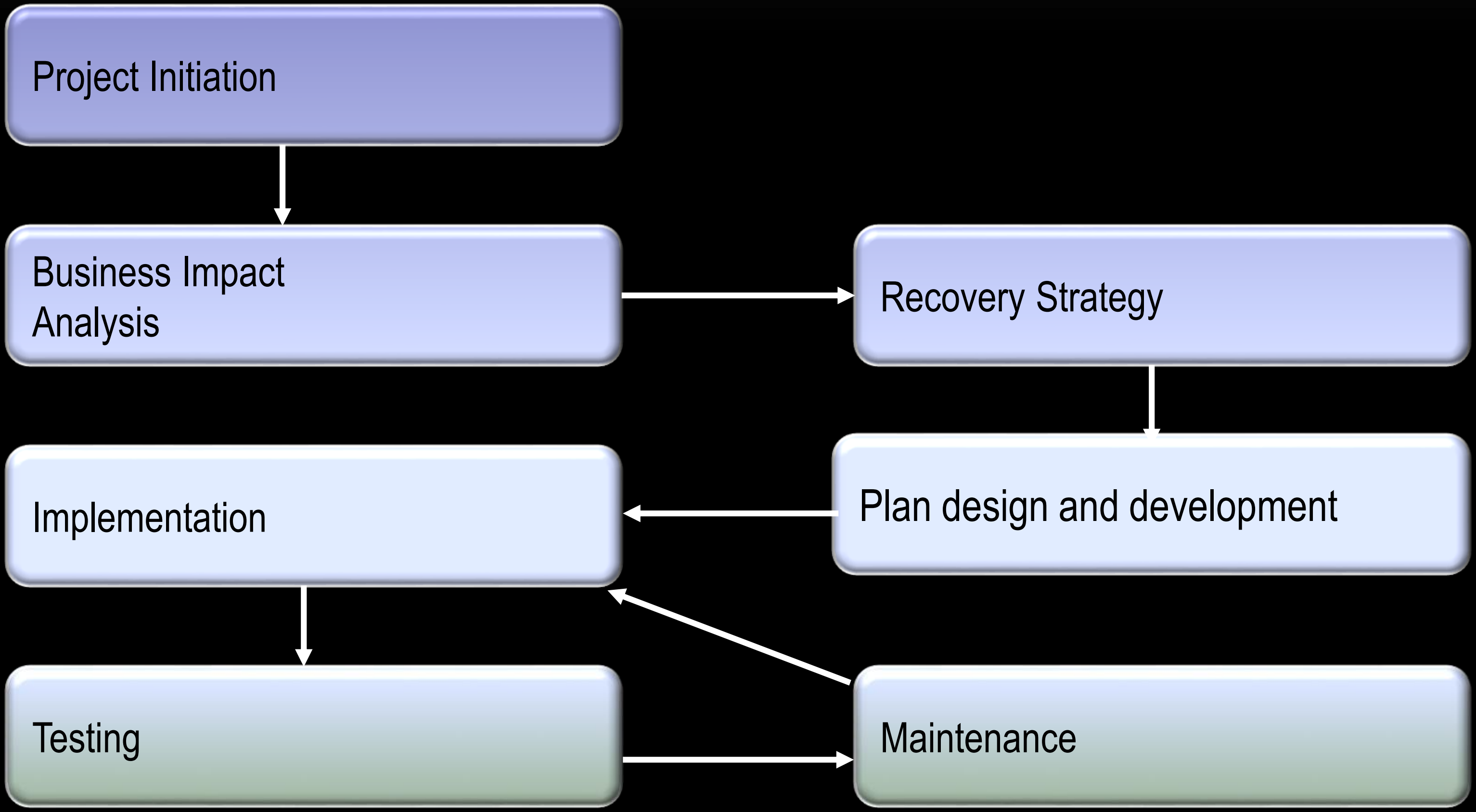
DEVELOPING THE TEAMS

- **Management should appoint members**
- **Each member must understand the goals of the plan and be familiar with the department they are responsible for**
- **Agreed upon prior to the event:**
  - Who will talk to the media, customers, share holders
  - Who will setup alternative communication methods
  - Who will setup the offsite facility
  - Established agreements with off-site facilities should be in place
  - Who will work on the primary facility

7 PHASES OF BUSINESS CONTINUITY PLAN

- Phases of Plan:
  - Project Initiation
  - Business Impact Analysis
  - Recovery Strategy
  - Plan Design and Development
  - Implementation
  - Testing
  - Maintenance

7 PHASES OF BUSINESS CONTINUITY PLAN


Project Initiation

Business Impact Analysis

Recovery Strategy

Plan design and development

Implementation

Testing

Maintenance

PHASES OF THE PLAN: PROJECT INITIATION

- Project Initiation
  - Obtain senior management's support
  - Secure funding and resource allocation
  - Name BCP coordinator/Project Manager
  - Develop Project Charter
  - Determine scope of the plan
  - Select Members of the BCP Team

PHASES OF THE PLAN: BUSINESS IMPACT ANALYSIS

- BIA (Business Impact Analysis)
  - Initiated by BCP Committee
  - Identifies and prioritizes all business processes based on criticality
  - Addresses the impact on the organization in the event of loss of a specific services or process
    - Quantitative: Loss of revenue, loss of capital, loss due to liabilities, penalties and fines, etc..
    - Qualitative: loss of service quality, competitive advantage, market share, reputation, etc..
  - Establishes key metrics for use in determining appropriate counter-measures and recovery strategy
  - IMPORTANCE (relevance) vs. CRITICALITY (downtime)
    - The Auditing Department is certainly important, though not usually critical. THE BIA FOCUSES ON CRITICALITY

PHASES OF THE PLAN:
BUSINESS IMPACT ANALYSIS

- Key Metrics to Establish
    - Service Level Objectives:
    - RPO (Recovery Point Objective):
    - MTD (Maximum Tolerable Downtime)
        - RTO (Recovery Time Objective)
        - WRT (Work Recovery Time)
    - MTBF (Mean Time Between Failures)
      MTTR (Mean Time To Repair)
      MOR (Minimum Operating Requirements)

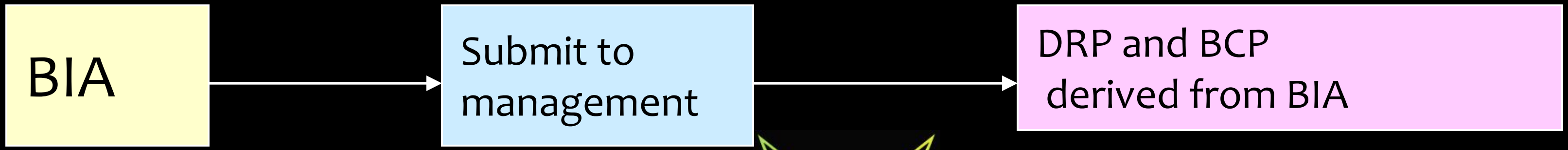
ELEMENTS OF THE PLAN: BUSINESS IMPACT ANALYSIS

- **Management should establish recovery priorities for business processes that identify:**
  - Essential personnel
    - Succession Plans
    - MOAs/MOUs (Memorandums of Agreement/Understanding)
  - Technologies
  - Facilities
  - Communications systems
  - Vital records and data

RESULTS FROM THE BIA

- **Results of Business Impact Analysis contain**
  - Identified ALL business processes and assets, not just those considered critical.
  - Impact company can handle dealing with each risk
  - Outage time that would be critical vs those which would not be critical
  - Preventive Controls

- **Document and present to management for approval**
- **Results are used to create the recovery plans**



PHASES OF THE PLAN:
IDENTIFY RECOVERY STRATEGIES

- **When preventive controls don’t work, recovery strategies are necessary**
  - Facility Recovery
  - Hardware and Software Recovery
  - Personnel recovery
  - Data Recovery

FACILITY RECOVERY

- **Facility Recovery**
  - Subscription Services
    - Hot, warm, cold sites
  - Reciprocal Agreements
  - Others
    - Redundant/Mirrored site (partial or full)
    - Outsourcing
    - Rolling hot site
    - Prefabricated building
  - Offsite Facilities should be no less than 15 miles away for low to medium environments. Critical operations should have an offsite facility 50-200 miles away

FACILITY RECOVERY OPTIONS

Alternative	Time to Occupy	Readiness	Cost
Mirrored Site	Within 24 hours	Fully redundant in every way	Highest
Hot Site	Within 24 hours	Fully configured equipment and communications links; need only load most recent data	High
Rolling Hot Site	Usually 24 hours	Similar to hot site, but supports data center operations only	High
Warm Site	Within a week	Between a hot and cold site. Partially configured equipment and does not contain any live data; some activation activity needed	Medium
Cold Site	Within 30 days	Typically contains the appropriate electrical and heating/air conditioning systems, but does not contain equipment or active communication links	Lowest

FACILITY RECOVERY: RECIPROCAL AGREEMENTS

- **How long will the facility be available to the company in need?**
- **How much assistance will the staff supply in the means of integrating the two environments and ongoing support?**
- **How quickly can the company in need move into the facility?**
- **What are the issues pertaining to interoperability?**
- **How many of the resources will be available to the company in need?**
- **How will differences and conflicts be addressed?**
- **How does change control and configuration management take place?**

HARDWARE RECOVERY

- **Technology Recovery is dependent upon good configuration management documentation**
- **May include**
  - PC's/Servers
  - Network Equipment
  - Supplies
  - Voice and data communications equipment
  - SLA's can play an essential role in hardware recovery—See Below

SOFTWARE RECOVERY

- BIOS Configuration information
- Operating Systems
- Licensing Information
- Configuration Settings
- Applications
- Plans for what to do in the event that the operating system/applications are not longer available to be purchased

PERSONNEL RECOVERY

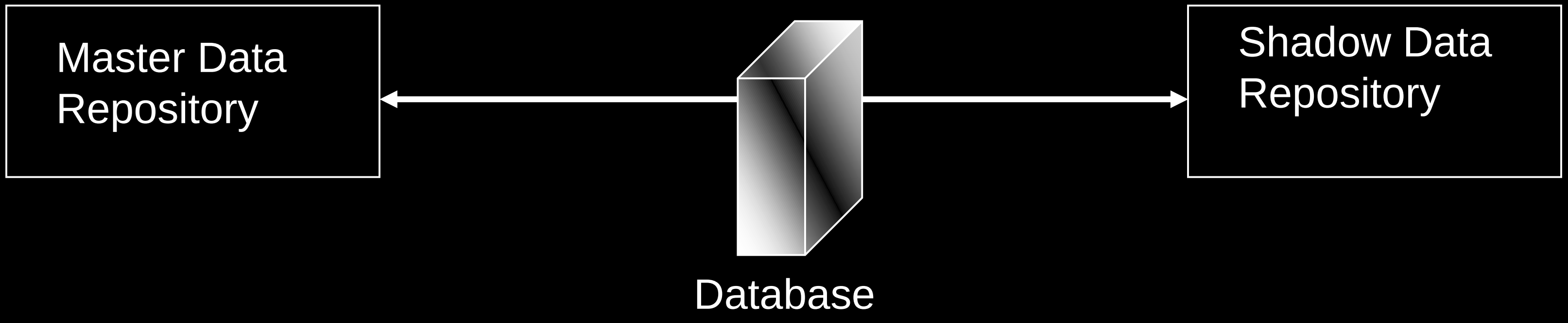
- Identify Essential Personnel—Entire staff is not always necessary to move into recovery operations
- How to handle personnel if the offsite facility is a great distance away
- Eliminate single points of failure in staffing and ensure backups are properly Trained
- Don’t forget payroll!

ADDITIONAL DATA REDUNDANCY

- Database Shadowing
- Remote Journaling
- Electronic Vaulting

DATA RECOVERY CONTINUED

- **Database Backups**
  - Disk-shadowing
    - Mirroring technology
    - Updating one or more copies of data at the same time
    - Data saved to two media types for redundancy



DATA RECOVERY CONTINUED

- **Electronic Vaulting**
  - Copy of modified file is sent to a remote location where an original backup is stored
  - Transfers bulk backup information
  - Batch process of moving data
- **Remote Journaling**
  - Moves the journal or transaction log to a remote location, not the actual files

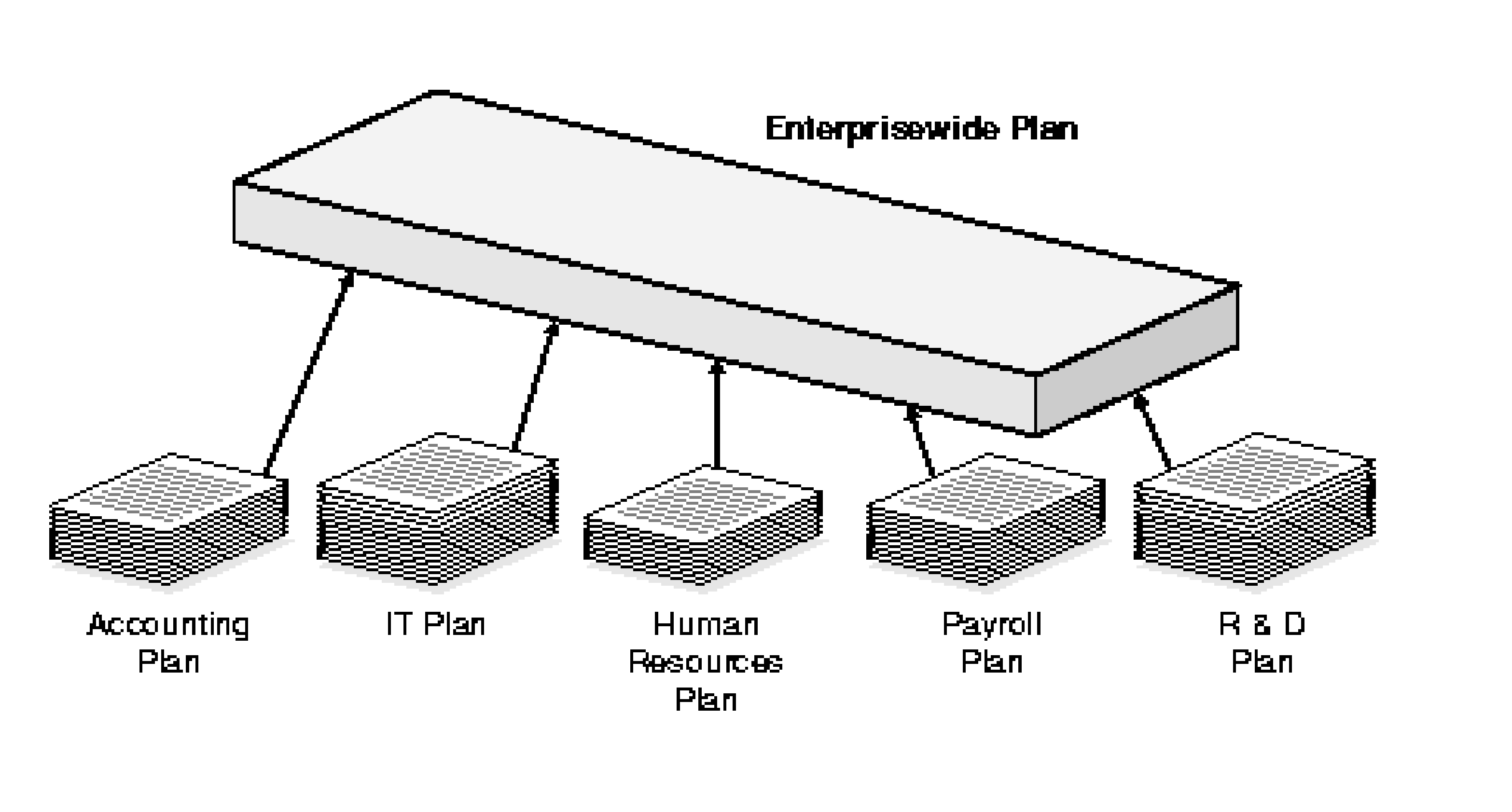
PHASES OF THE PLAN: PLAN AND DESIGN DEVELOPMENT

- **Now that all the research and planning has been done, this phase is where the actual plan is written**
- **Should address**
  - Responsibility
  - Authority
  - Priorities
  - Testing

PHASES OF THE PLAN: IMPLEMENTATION

- Plan is often created for an enterprise with individual functional managers responsible for plans specific to their departments
- Copies of Plan should be kept in multiple locations
- Both Electronic and paper copies should be kept
- Plan should be distributed to those with a need to know. Most employees will only see a small portion of the plan

PHASES OF THE PLAN: IMPLEMENTATION



PHASES OF THE PLAN: IMPLEMENTATION

- **Three Phases Following a Disruption**
  - **Notification/Activation**
    - Notifying recovery personnel
    - Performing a damage assessment
  - Recovery Phase--Failover
    - Actions taken by recovery teams and personnel to restore IT operations at an alternate site or using contingency capabilities—performed by recovery team
  - Reconstitution--Failback
    - Outlines actions taken to return the system to normal operating conditions—performed by Salvage team

PHASES OF THE PLAN: TESTING

- **Should happen once per year, or as the result of a major change (VERY TESTABLE)**
- **The purpose of testing is to improve the response (never to find fault or blame)**
- **The type of testing is based upon the criticality of the organization, resources available and risk tolerance**
  - Testing: Happens before implementation of a plan. The goal is to ensure the accuracy and the effectiveness of the plan
  - Exercises/Drills: Employees walk through step by step. Happens periodically. Main goal is to train employees
  - Auditing: 3rd party observer ensures that components of a plan are being carried out and that they are effective.

TYPES OF TESTS

- **Checklist Test**
  - Copies of plan distributed to different departments
  - Functional managers review

- **Structured Walk-Through (Table Top) Test**
  - Representatives from each department go over the plan

- **Simulation Test**
  - Going through a disaster scenario
  - Continues up to the actual relocation to an offsite facility

TYPES OF TESTS

- **Parallel Test**
  - Systems moved to alternate site, and processing takes place there
- **Full-Interruption Test**
  - Original site shut down
  - All of processing moved to offsite facility

POST-INCIDENT REVIEW

- **After a test or disaster has taken place:**
  - Focus on how to improve
  - What should have happened
  - What should happen next
  - Not who's fault it was; this is not productive

PHASES OF THE PLAN: MAINTENANCE

- **Change Management:**
  - Technical – hardware/software
  - People
  - Environment
  - Laws
- **Large plans can take a lot of work to maintain**
- **Does not have a direct line to profitability**

PHASES OF THE PLAN: MAINTENANCE

- **Keeping plan in date**
  - Make it a part of business meetings and decisions
  - Centralize responsibility for updates
  - Part of job description
  - Personnel evaluations
  - Report regularly
  - Audits
  - As plans get revised, original copies should be retrieved and destroyed

CHAPTER 1: SECURITY AND RISK MANAGEMENT REVIEW

- **Security Basics**
  - Confidentiality, integrity, and availability concepts
  - IAAA
  - Risks
  - Security governance principles
  - Compliance
  - Legal and regulatory issues
  - Professional ethics: download ISC2 code of ethics at

    https://www.isc2.org/uploadedfiles/(isc)2_public_content/code_of_ethics/isc2-code-of-ethics.pdf
- **Business Continuity Planning**
  1. Project Initiation
  2. Business Impact Analysis
  3. Recovery Strategy
  4. Plan Design and Development
  5. Implementation
  6. Testing
  7. Maintenance

CHAPTER 2

Asset Security

CHAPTER 2 ASSET SECURITY AGENDA

- **Roles within an Organization**
- **Classification of Data**
- **System Baselining and Hardening**
- **States of Data**

ROLES AND RESPONSIBILITIES

- **Senior/Executive Management**
  - CEO: Chief Decision-Maker
  - CFO: Responsible for budgeting and finances
  - CIO: Ensures technology supports company's objectives
  - ISO: Risk Analysis and Mitigation
- **Steering Committee: Define risks, objectives and approaches**
- **Auditors: Evaluates business processes**
- **Data Owner: Classifies Data**
- **Data Custodian: Day to day maintenance of data**
- **Network Administrator: Ensures availability of network resources**
- **Security Administrator: Responsible for all security-related tasks, focusing on Confidentiality and Integrity**

AUDITING ROLE

- Objective Evaluation of controls and policies to ensure that they are being implemented and are effective.
- If internal auditing is in place, auditors should not report to the head of a business unit, but rather to legal or human resources--some other entity with out direct stake in result

DATA CLASSIFICATION

- Development of sensitivity labels for data and the assignment of those labels for the purpose of configuring baseline security based on value of data
- Cost: Value of the Data
- Classify: Criteria for Classification
- Controls: Determining the baseline security configuration for each
- Data Owner determines the classification of data
- Data Custodian maintains the data

CONSIDERATIONS FOR ASSET VALUATION

- **What makes up the value of an asset?**
  - Value to the organization
  - Loss if compromised
  - Legislative drivers
  - **Liabilities**
  - Value to competitors
  - Acquisition costs
  - And many others

SENSITIVITY VS. CRITICALITY

- Sensitivity describes the amount of damage that would be done should the information be disclosed
- Criticality describes the time sensitivity of the data. This is usually driven by the understanding of how much revenue a specific asset generates, and without that asset, there will be lost revenue

STATES OF DATA

- **At Rest: File System Encryptions, EFS, TPM**
- **In Process: ?**
- **In Transit: IPSec, SSL/TLS**

SYSTEM HARDENING & BASELINING

- Removing Unnecessary Services
- Installing the latest services packs and patches
- Renaming default accounts
- Changing default settings
- Enabling security configurations like auditing, firewalls, updates, etc..
- ***Don’t forget physical security!***

CONFIGURATION MANAGEMENT

- Defined by ISC2 as "a process of identifying and documenting hardware components, software and the associated settings."
- The goal is to move beyond the original design to a hardened, operationally sound configuration
- Identifying, controlling, accounting for and auditing changes made to the baseline TCB
- These changes come about as we perform system hardening tasks to secure a system.
- **Will control changes and test documentation through the operational life cycle of a system**
- **Implemented hand in hand with change control**
- **ESSENTIAL to Disaster Recovery**

CONFIGURATION MANAGEMENT DOCUMENTATION

- Make
- Model
- MAC address
- Serial number
- Operating System/Firmware version
- Location
- BIOS or other passwords
- Permanent IP if applicable
- Organizational department label

CHANGE MANAGEMENT

- Directive, Administrative Control that should be incorporated into organizational policy.
- The formal review of all proposed changes--no “on-the-fly” changes
- Only approved changes will be implemented
- The ultimate goal is system stability
- Periodic reassessment of the environment to evaluate the need for upgrades/modifications

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THE CHANGE MANAGEMENT PROCESS

- Request Submittal
- Risk/Impact Assessment
- Approval or Rejection of Change
- Testing
- Scheduling/User Notification/Training
- Implementation
- Validation
- Documentation

PATCH MANAGEMENT

- An essential part of Configuration and Change Management
- May come as a result of vendor notification or pen testing
- Cve.mitre.org (Common Vulnerability and Exposures) database provides standard conventions for known vulnerabilities
- Nvd.nist.gov Enables automation of vulnerability management, security measurement, and compliance. NVD includes databases of security checklists, security related software flaws, incorrect configurations, product names, and impact metrics.
- www.cert.gov: Online resource concerning common vulnerabilities and attacks

CHAPTER 2 ASSET SECURITY REVIEW

- Roles within an Organization
- Classification of Data
- System Baselining and Hardening
- States of Data

CHAPTER 3

Security Engineering

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SECURITY ARCHITECTURE & DESIGN OBJECTIVES

- Part I:
- Principles of Secure Design
- Trusted Computer Base Elements
  - Security Perimeter
  - Reference Monitor
  - Security Kernel
- Security Models
- Computer/Security Architecture
- Security Models
- Security Evaluation Criteria
- Part II
  - Cryptography

PRINCIPLES OF SECURE DESIGN

- An information system’s architecture must satisfy the defined business and security requirements.
- Security should be built into an information system by design.
- When designing system architecture, security and business requirements needs to be carefully balanced.
- Tradeoffs are involved in reaching a balance between security and business requirements.
- Security should be integrated into the design, as opposed to added later

PRINCIPLES OF SECURE DESIGN CONTINUED

- The security requirements of an information system are driven by the security policy of the organization that will use the system.
- To incorporate the abstract goals of a security policy into an information system's architecture, you will need to use security models.
- A **security model** lays out the framework and mathematical models that act as security-related specifications for a system architecture.
- The **system architecture**, in turn, is the overall design of the components - such as hardware, operating systems, applications, and networks – of an information system. This design should meet the specifications provided by the security model.

SECURITY ARCHITECTURE

- Security architecture is part of the overall architecture of an information system. It directs how the components included in the system architecture should be organized to ensure that security requirements are met. The security architecture of an information system should include:
  - A description of the locations in the overall architecture where security measures should be placed.
  - A description of how various components of the architecture should interact to ensure security.
  - The security specifications to be followed when designing and developing the system.

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COMPUTER ARCHITECTURE

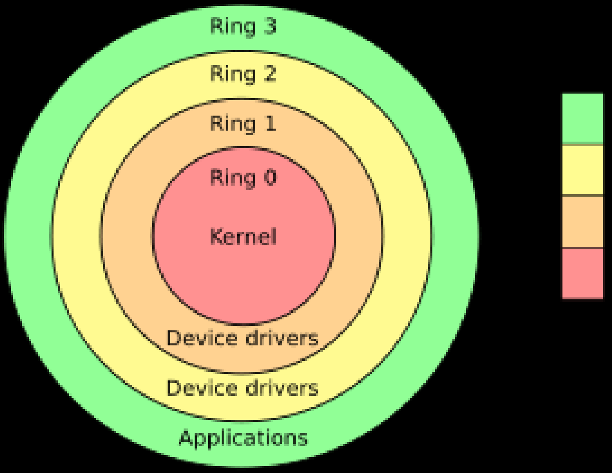
- **The Central Processing Unit (CPU) – Processes the instructions provided by the various applications/programs. To do this the CPU needs to access such instructions from their memory locations.**
- **The CPU can access the memory locations in its cache, along with memory locations in the random access memory (RAM). These types of memory are called primary memory.**
- **The major components.**
  - The Arithmetic Logic Unit (ALU)
  - Control Unit (coordinates instruction execution)
  - Registers that act as temporary memory locations and store the memory addresses of the instructions and data that needs processing by the CPU.

COMPUTER ARCHITECTURE

- Program: An Application
- Process: A program loaded into memory
- Thread: Each individual instruction within a process
- Multiprogramming: no true isolation
- Multiprocessing – more than one CPU
- Multi threading—in the past multiple CPUs were needed. Today multi-core processors provide this.
- Operating System Architecture
- Process Activity
- Memory Management
- Memory Types – RAM, ROM, etc..
- Virtual Memory
- CPU Modes & Protection Rings

CPU MODES & PROTECTION RINGS

- Protection Rings provide a security mechanism for an operating system by creating boundaries between the various processes operating on a system and also ensures that processes do not affect each other or harm critical system components.
- Ring 0 – Operating system kernel (supervisor /privilege mode)
- Ring 1 – Remaining parts of the operating system (OS)
- Ring 2 – Operating system and I/O drivers and OS utilities
- Ring 3 – Applications (Programs) and user activity



SYSTEM ARCHITECTURE

- **Defined Subset of Subjects and Objects**
- **Trusted Computing Base (TCB)**

- **Security Perimeter**
- **Reference Monitor**
- **Security Kernel**
  - The Security kernel enforces the reference monitor concept.
    - Must facilitate isolation of processes
    - Must be invoked at every access attempt.
    - Must be small enough to be tested and verified in a comprehensive manner.
- **Security Policy – a set of rules on how resources are managed within a computer system.**
- **Least Privilege – one process has no more privileges than it needs.**

SECURITY MODELS

- State Machine Models
- **The Bell-LaPadula Model
- **The Biba Model
- **The Clark-Wilson Model**
- **The Brewer & Nash Model**
- The Information Flow Model
- The Non-Interference Model
- The Lattice Model

Security Models

- State Machine Models
  - The state of a system is its snapshot at any one particular moment. The state machine model describes subjects, objects, and sequences in a system. The focus of this model is to capture the system’s state and ensure its security.
  - When an object accepts input, the value of the state variable is modified. For a subject to access this object or modify the object value, the subject should have appropriate access rights.
  - State transitions refer to activities that alter a systems state.

Confidentiality models:
Bell & LaPadula)

- Developed by David Elliot Bell and Len LaPadula
- This model focuses on data confidentiality and access to classified information.
- A Formal Model developed for the DoD multilevel security policy
- This formal model divides entities in an information system into subjects and objects.
- Model is built on the concept of a state machine with different allowable states (i.e. Secure state)

Bell & LaPadula Confidentiality Model

- Has 3 rules:
- Simple Security Property – “no read up”
    - A subject cannot read data from a security level higher than subject’s security level.
- *_Security Property – “no write down”
    - A subject cannot write data to a security level lower than the subject’s security level.
- Strong * Property – “no read/write up or down”.
    - A subject with read/write privilege can perform read/write functions only at the subject’s security levels.

- Integrity models (e.g., Biba, Clark and Wilson)
- Biba Integrity Model
- Developed by Kenneth J. Biba in 1977 based on a set of access control rules designed to ensure data integrity
- No subject can depend on an object of lesser integrity
- Based on a hierarchical lattice of integrity levels
- Authorized users must perform correct and safe procedures to protect data integrity

- Biba Integrity Model
- **The Rules:**
- Simple integrity axiom – “no read down” – A Subject cannot read data from an object of lower integrity level.
- * Integrity axiom – “no write up” – A Subject cannot write data to an object at a higher integrity level.
- Invocation property – A subject cannot invoke (call upon) subjects at a higher integrity level.

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Commercial Models

Integrity models – Clark-Wilson Model

Model Characteristics:

Clark Wilson enforces well-formed transactions through the use of the access triple:

User→Transformation Procedure→CDI (Constrained Data Item)

Deals with all three integrity goals

SEPARATION of DUTIES

- Prevents unauthorized users from making modifications
- Prevents authorized users from making improper modifications
- Maintain internal and external consistency – reinforces separation of duties

Commercial Models – Continued

Brewer-Nash Model – a.k.a. Chinese Wall

Developed to combat conflict of interest in databases housing competitor information

- Publish in 1989 to ensure fair competition
- Defines a wall and a set of rules to ensure that no subject accesses objects on the other side of the wall
- Way of separating competitors data within the same integrated database

Information flow model

- Data is compartmentalized based on classification and the need to know
- Model seeks to eliminate covert channels
- Model ensures that information always flows from a low security level to a higher security level and from a high integrity level to a low integrity level.
- Whatever component directly affects the flow of information must dominate all components involved with the flow of information

Non-interference Model

Model Characteristics:

- Model ensures that actions at a higher security level does not interfere with the actions at a lower security level.
- The goal of this model is to protect the state of an entity at the lower security level by actions at the higher security level so that data does not pass through covert or timing channels.

Lattice Model

Model Characteristics

- Model consists of a set of objects constrained between the least upper bound and the greatest lower bound values.
- The least upper bound is the value that defines the least level of object access rights granted to a subject.
- The greatest lower bound is value that defines the maximum level of object access rights granted to a subject
- The goal of this model is to protect the confidentiality of an object and only allow access by an authorized subject.

Secure Modes of Operation

- Single State
- Multi State
- Compartmented
- Dedicated

See Document entitled Single, Multi, Compartmented Dedicated. *

EVALUATION CRITERIA

Why Evaluate?

  - To carefully examine the security-related components of a system
  - Trust vs. Assurance

- **The Orange Book (TCSEC)**
- **The Orange Book & the Rainbow Series**
- **ITSEC (Information Technology Security Evaluation Criteria)**
- **Common Criteria**

Trusted Computer Security Evaluation Criteria (TCSEC)

- Developed by the National Computer Security Center (NCSC)
- Also known as the Orange Book
- Based on the Bell-LaPadulla model (deals with only confidentiality)
- Uses a hierarchically ordered series of evaluation classes
- Defines Trust and Assurance, but does not allow for them to be evaluated independently

Trusted Computer Security Evaluation Criteria (TCSEC) aka "The Orange Book"

Ratings:

- A1 – Verified Protection
- B1, B2, B3 – Mandatory Protection
- C1, C2 – Discretionary Protection
- D – Minimal Security

Information Tech Security Evaluation Criteria (ITSEC)

- Created by some European nations in 1991 as a standard to evaluate security attributes of computer systems
- The First Criteria to evaluate functionality and assurance separately
- F1 toF10 rates for functionality
- E0 to E6 for assurance

COMMON CRITERIA ISO 15408

- Protection Profile
- Target of evaluation
- Security target
- Evaluation Assurance Level (EAL 1-7)
- Evaluation packages

Common Criteria (CC) Ratings

Rated as Evaluation Assurance Level (EAL) 1 through 7

- EAL 1 – Functionally tested
- EAL 2 – Structurally tested
- EAL 3 – Methodically tested and checked
- EAL 4 – Methodically designed, tested, and reviewed
- EAL 5 – Semi formally designed and tested
- EAL 6 – Semi-formally verified designed and tested
- EAL 7 – Formally verified designed and tested

Certification & Accreditation

- Certification:
  - A process that ensures systems and major applications adhere to formal and established security requirements that are well documented and authorized.
  - It is usually performed by a vendor.
- Accreditation:
  - A formal declaration by a Designated Accrediting Authority (DAA) that information systems are approved to operate at an acceptable level of risk based on the implementation of an approved set of technical, managerial, and procedural safeguards.

TRUSTED RECOVERY

- System reboot, emergency system restart, system cold start
- No compromise of protection mechanisms or possibility of bypassing them
- Preparing system for failure and recovering the system
- Failure of system cannot be used to breach security

MODULE 3 PART II: CRYPTOGRAPHY

- Historical uses of Cryptography
- Security Services provided by cryptography
- Definitions and terms
- Symmetric Cryptography
- Asymmetric Cryptography
- Hybrid Cryptography
- Integrity through Hashing, MACs and Digital Signatures
- Public Key Infrastructure
- IPSec
- Attacks on Cryptography

CRYPTOGRAPHY IN HISTORY

- Caesar Cipher
- Scytale
- Vignere
- Vernam
- Enigma Machine and Purple Machine

CAESAR CIPHER

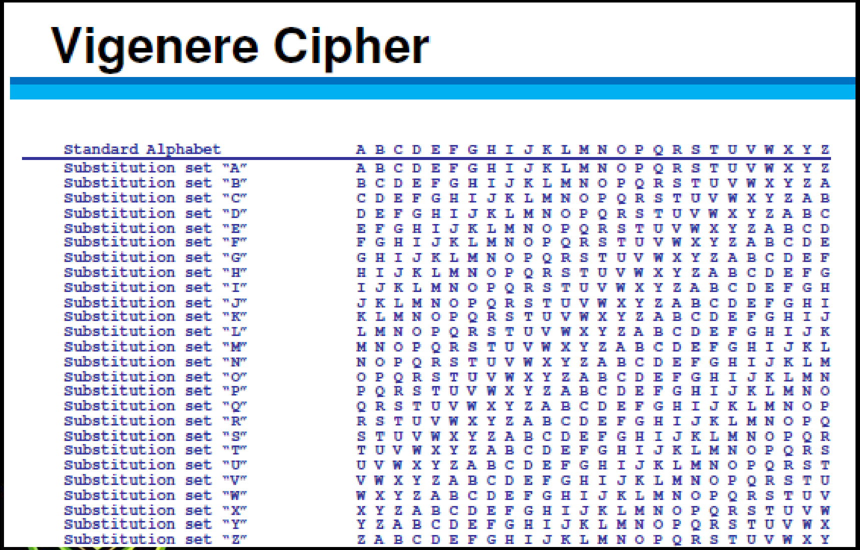
- Simple Substitution
- Shift Characters 3 spaces
- A=D, B=E, C=F, etc..
- Substitution Ciphers are subject to pattern analysis

SCYTALE

- Spartans used this cipher to communicate messages to generals in the field
- Wrapped tape around a rod
- Diameter of the rod is the pre-agreed upon secret (key)

VIGNERE

- First polyalphabetic cipher
- Key word is agreed upon ahead of time
- First letter of the key is matched up against first letter of the message, and so on



Vigenere Cipher

Standard Alphabet	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Substitution set "A"	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Substitution set "B"	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A
Substitution set "C"	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B
Substitution set "D"	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C
Substitution set "E"	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D
Substitution set "F"	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E
Substitution set "G"	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F
Substitution set "H"	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G
Substitution set "I"	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H
Substitution set "J"	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I
Substitution set "K"	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J
Substitution set "L"	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K
Substitution set "M"	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L
Substitution set "N"	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M
Substitution set "O"	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Substitution set "P"	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Substitution set "Q"	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Substitution set "R"	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Substitution set "S"	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Substitution set "T"	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
Substitution set "U"	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Substitution set "V"	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
Substitution set "W"	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
Substitution set "X"	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
Substitution set "Y"	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Substitution set "Z"	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y

CRYPTOGRAPHY IN WARFARE

- Enigma Machine/Purple Machine
- Used by the Germans/Japanese in WWII
- Breaking the cryptography of these devices is credited with reducing the length of the war.

VERNAM CIPHER

- **One Time Pad**
- **Only mathematically unbreakable form of cryptography**
  - Key must be used only once
  - Pad must be at least as long as the message
  - Key pad is statistically unpredictable
  - Key Pad must be delivered and stored securely

SECURITY SERVICES PROVIDED BY CRYPTOGRAPHY

- Privacy: Prevents unauthorized disclosure of information
- Authenticity: Verifies the claimed identity
- Integrity: Detects modification or corruption
- Non-Repudiation: Combines authenticity and integrity. A sender can’t dispute having sent a message, nor its contents.

DEFINITIONS AND CONCEPTS

Plain Text + Initialization Vector + Algorithm (aka Cipher) + Key

=

Cipher Text

INITIALIZATION VECTOR

- **Here are some random numbers (I promise, they're really random!)**

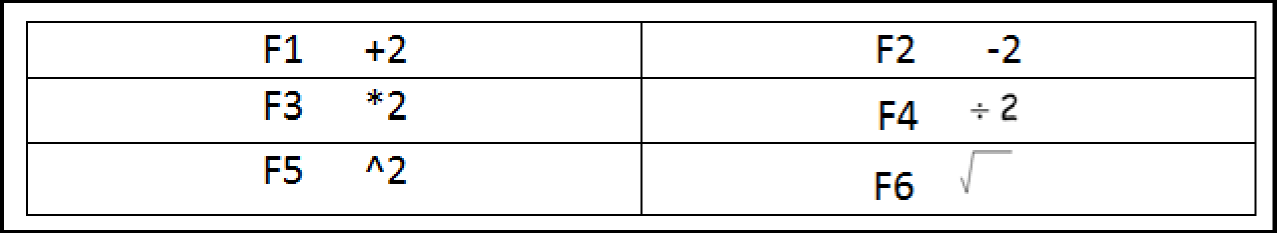
7 5 2 3 4 9 4

If we start at track 0 and +7 +5 – 2 +3 + 4 +9 -4

We still don't have randomness. Vary the starting point and that will make the process more random

Very similar to a "seed" or a "salt"

ALGORITHM



F1 +2	F2 -2
F3 *2	F4 ÷ 2
F5 ^2	F6 √

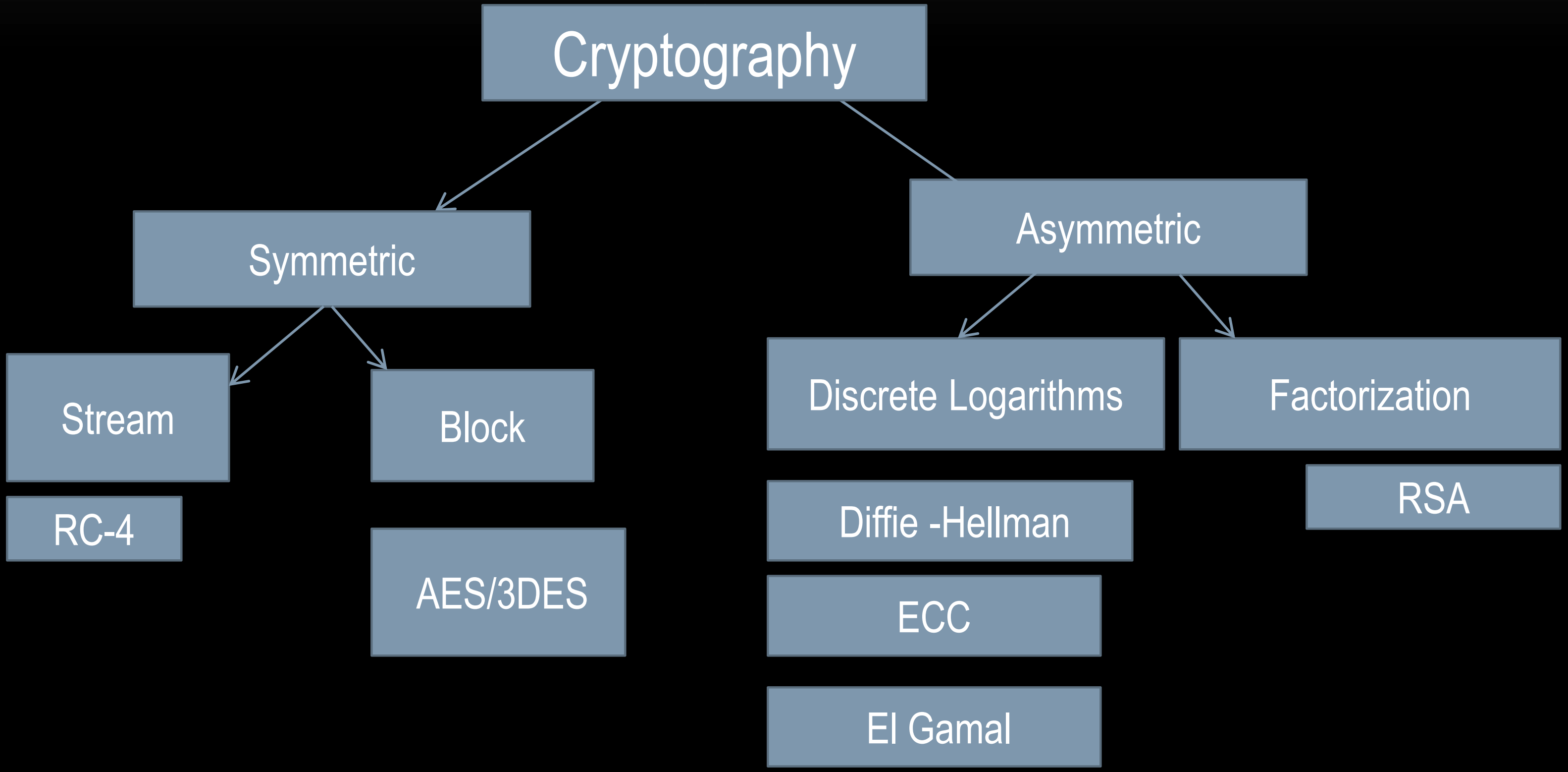
ELEMENTS OF CRYPTOGRAPHY

- **Desirable Qualities of an Algorithm**
  - Confusion
  - Diffusion
  - Avalanche
  - Permutations
  - Open—Kerckhoff’s Principle
- **Desirable Qualities of a Key**
- **Long**
- **Random**
- **Secret**

DEFINITIONS AND CONCEPTS

- Plain text is unencrypted text
- Initialization Vector (IV) adds randomness to the beginning of the process
- Algorithm is the collection of math functions that can be performed
- Key: Instruction set on how to use the algorithm

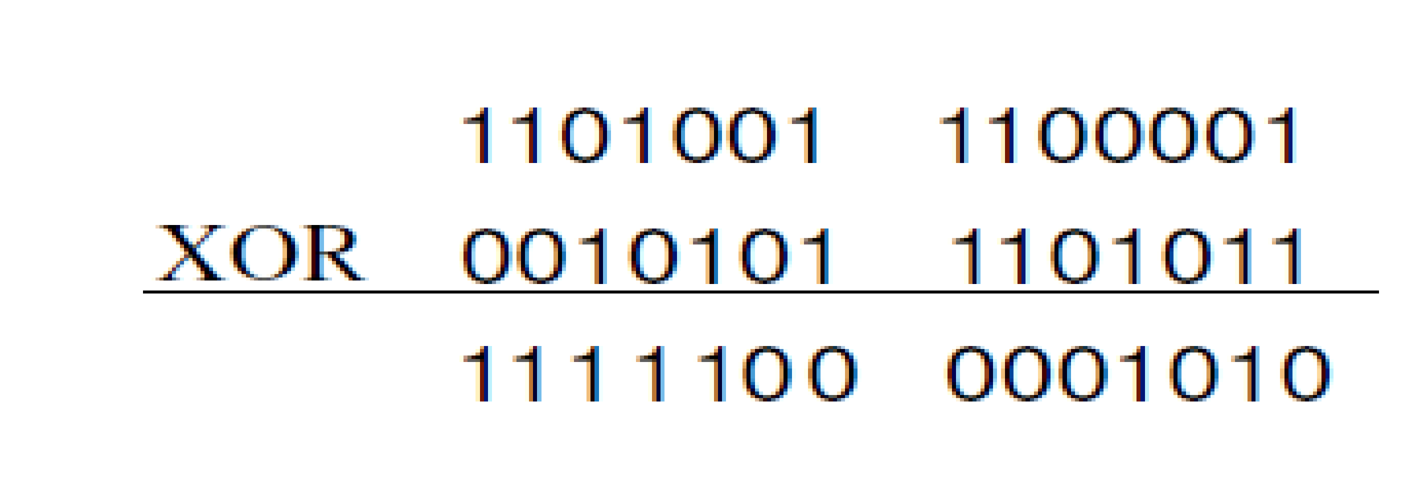
CRYPTOGRAPHY



STREAM CIPHERS XOR

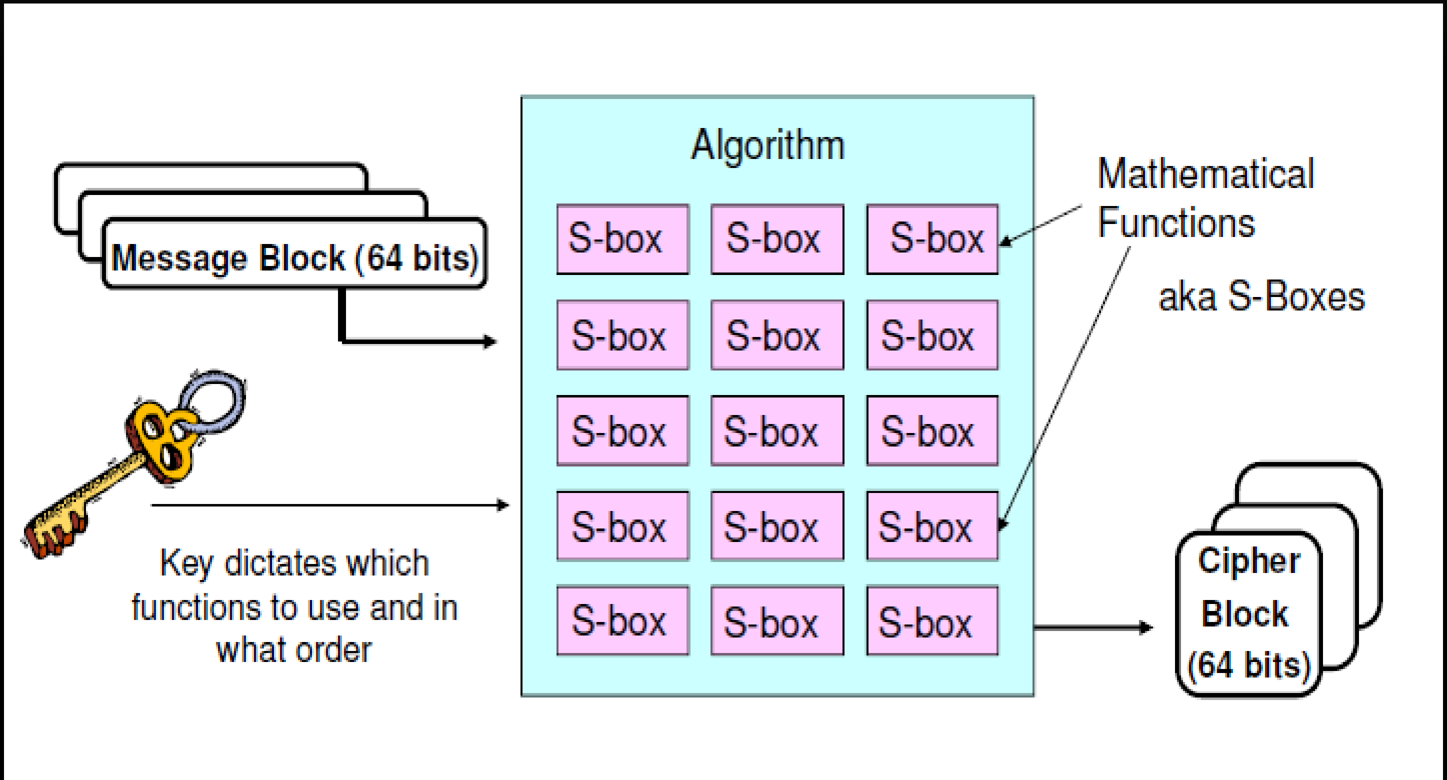
If Values are:

Alike	0
Different	1



	1101001	1100001
XOR	0010101	1101011
	1111100	0001010

BLOCK CIPHERS



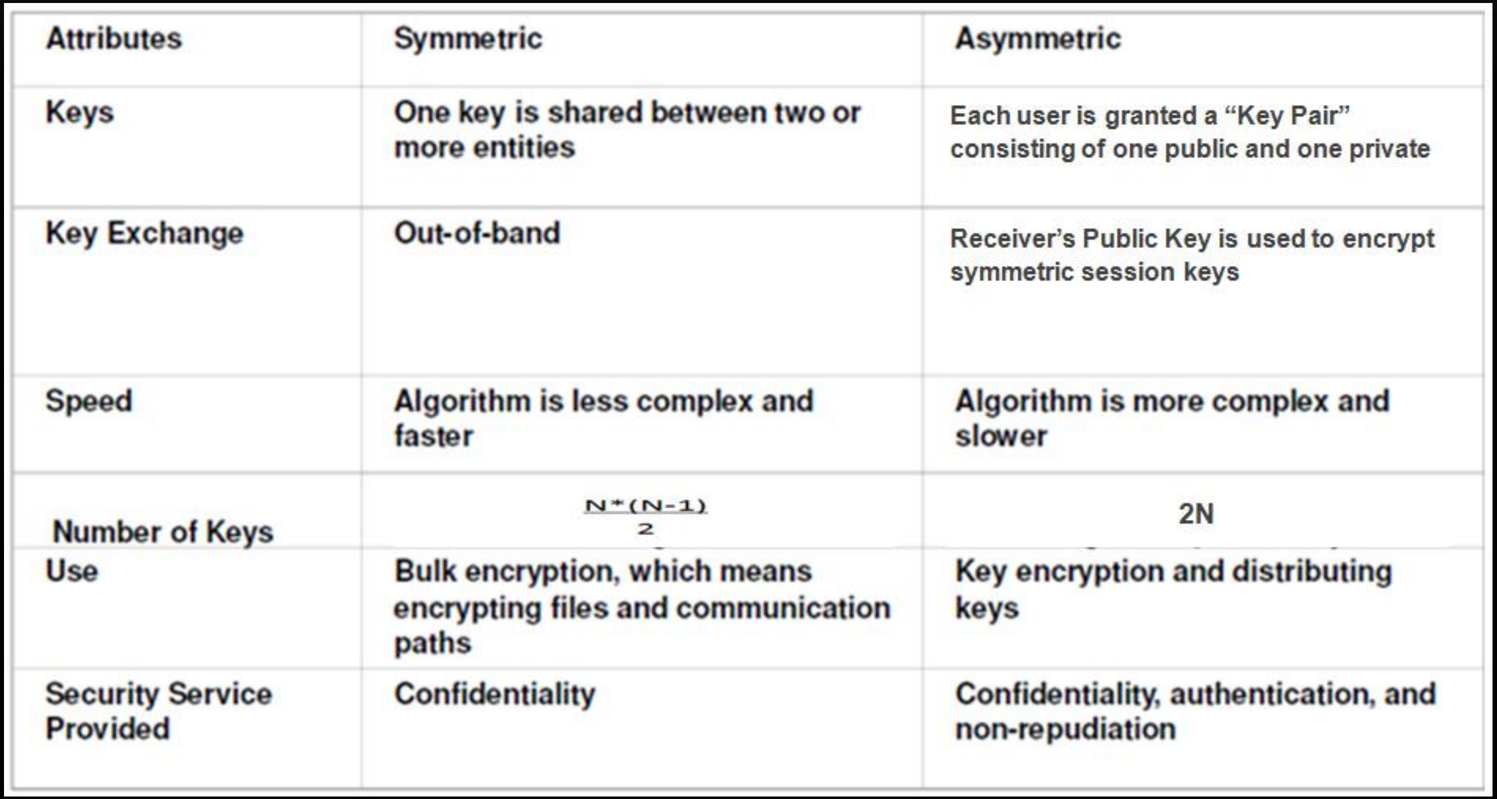
SYMMETRIC CRYPTOGRAPHY

- Symmetric = Same
- In symmetric cryptography the same key is used to both encrypt and decrypt
- Very fast means of encrypting/decrypting with good strength for privacy
- Preferred means of protecting privacy data
- Also can be called “Private Key” “Secret Key” or “Shared Key” Cryptography

STREAM VS. BLOCK

- **Stream Ciphers encrypt one bit (up to one byte) of data at a time.**
  - Transposition, Substitution, XOR
  - Very fast and efficient
  - Not as Secure
  - RC-4 is the only stream cipher necessary for the test
- **Block Ciphers chunk data into blocks. Each chunk goes through a series of math functions called S-boxes**

DRAWBACKS TO SYMMETRIC CRYPTOGRAPHY



Attributes	Symmetric	Asymmetric
Keys	One key is shared between two or more entities	Each user is granted a “Key Pair” consisting of one public and one private
Key Exchange	Out-of-band	Receiver’s Public Key is used to encrypt symmetric session keys
Speed	Algorithm is less complex and faster	Algorithm is more complex and slower
Number of Keys	$\frac{N*(N-1)}{2}$	2N
Use	Bulk encryption, which means encrypting files and communication paths	Key encryption and distributing keys
Security Service Provided	Confidentiality	Confidentiality, authentication, and non-repudiation

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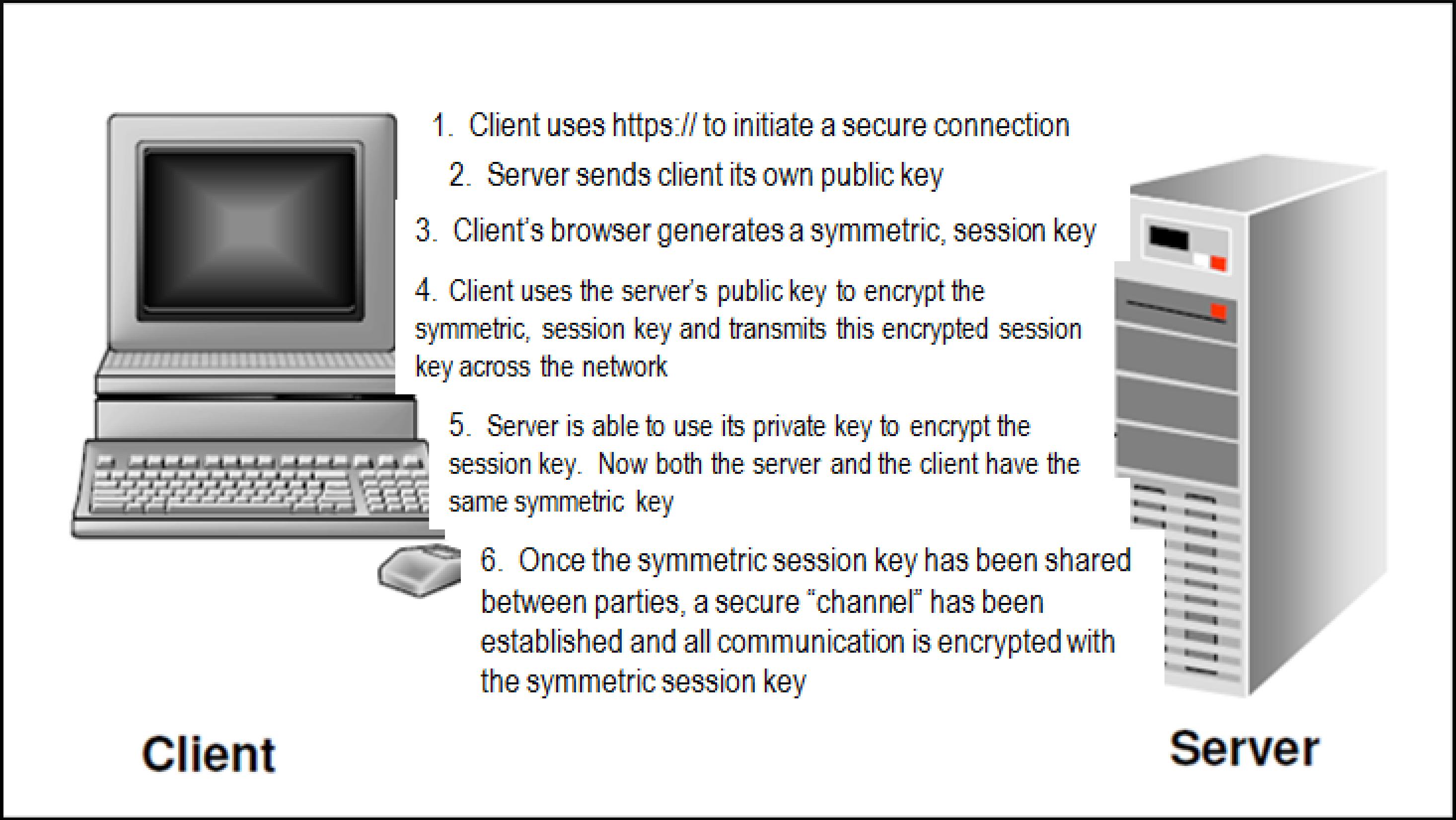
ASYMMETRIC CRYPTOGRAPHY

- **Every user has a key pair.**
  - Public key is made available to anyone who requests it
  - Private key is only available to that user and must not be disclosed or shared
- **The keys are mathematically related so that anything encrypted with one key can only be decrypted by the other.**

P.A.I.N SERVICES THROUGH ASYMMETRIC CRYPTOGRAPHY AND HASHING

- Privacy: Receiver’s Public Key
- Authenticity: Sender’s Private Key
- Integrity (not asymmetric OR symmetric)
- Non-Repudiation: Hash encrypted Sender’s Private Key

SSL/TLS HYBRID CRYPTOGRAPHY



1. Client uses https:// to initiate a secure connection

2. Server sends client its own public key

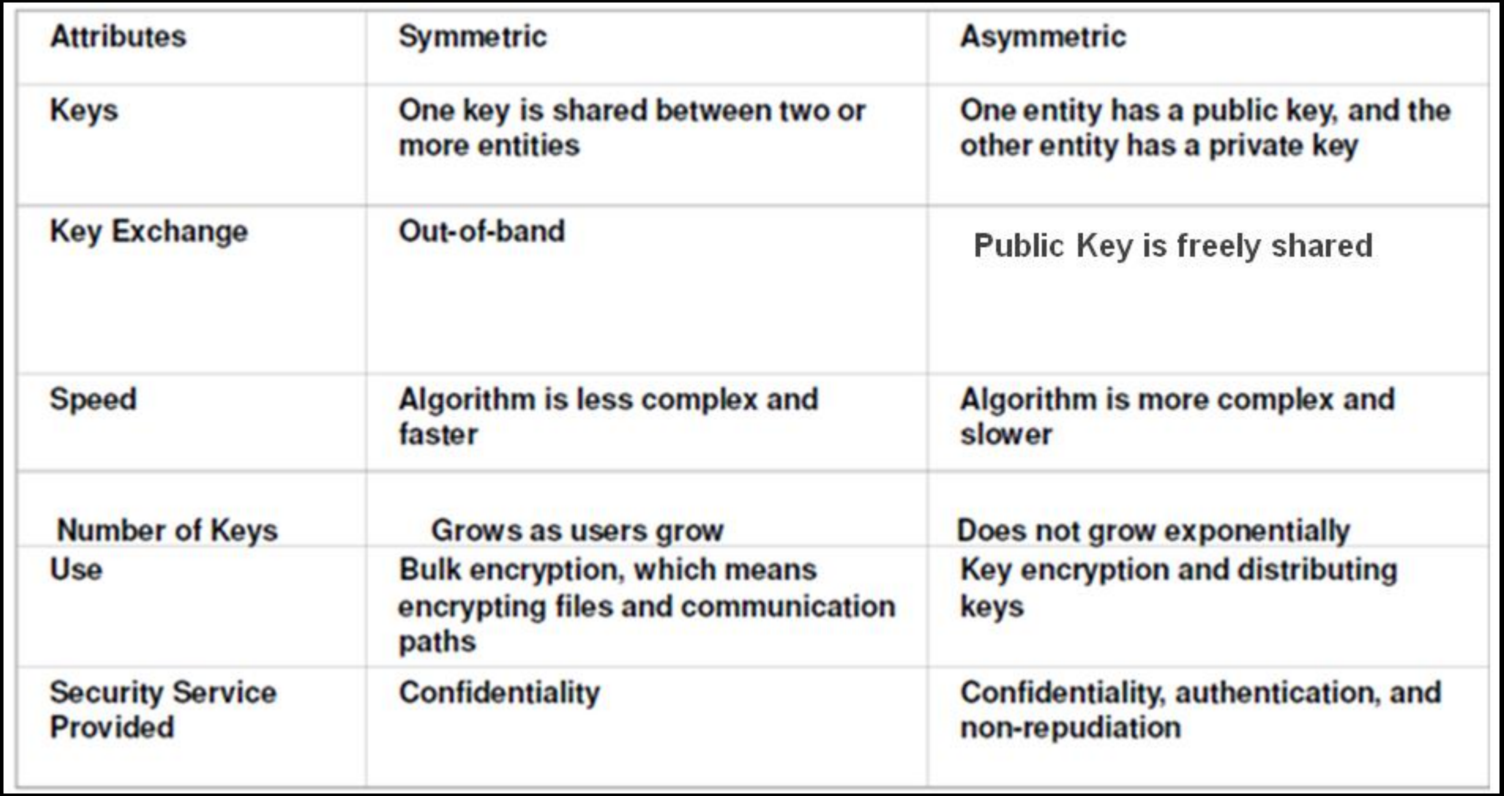
3. Client's browser generates a symmetric, session key

4. Client uses the server's public key to encrypt the symmetric, session key and transmits this encrypted session key across the network

5. Server is able to use its private key to encrypt the session key. Now both the server and the client have the same symmetric key

6. Once the symmetric session key has been shared between parties, a secure "channel" has been established and all communication is encrypted with the symmetric session key

SUMMARY OF SYMMETRIC vs. ASYMMETRIC



Attributes	Symmetric	Asymmetric
Keys	One key is shared between two or more entities	One entity has a public key, and the other entity has a private key
Key Exchange	Out-of-band	Public Key is freely shared
Speed	Algorithm is less complex and faster	Algorithm is more complex and slower
Number of Keys	Grows as users grow	Does not grow exponentially
Use	Bulk encryption, which means encrypting files and communication paths	Key encryption and distributing keys
Security Service Provided	Confidentiality	Confidentiality, authentication, and non-repudiation

COMMON SYMMETRIC ALGORITHM

DES

3DES

AES

RC-4

RC-5

Two Fish

Blowfish

IDEA

CAST

MARS

Skipjack

COMMON ASYMMETRIC ALGORITHMS

- DSA
- RSA
- ECC (Elliptical Curve Cryptography)
- El Gamal
- Diffie Hellman
- Knapsack

THE BUDDY SYSTEM FOR ASYMMETRIC ALGORITHMS

- **RSA and DSA**
- **ECC and El Gamal**
- **DH (Diffie Hellman) and Knapsack**

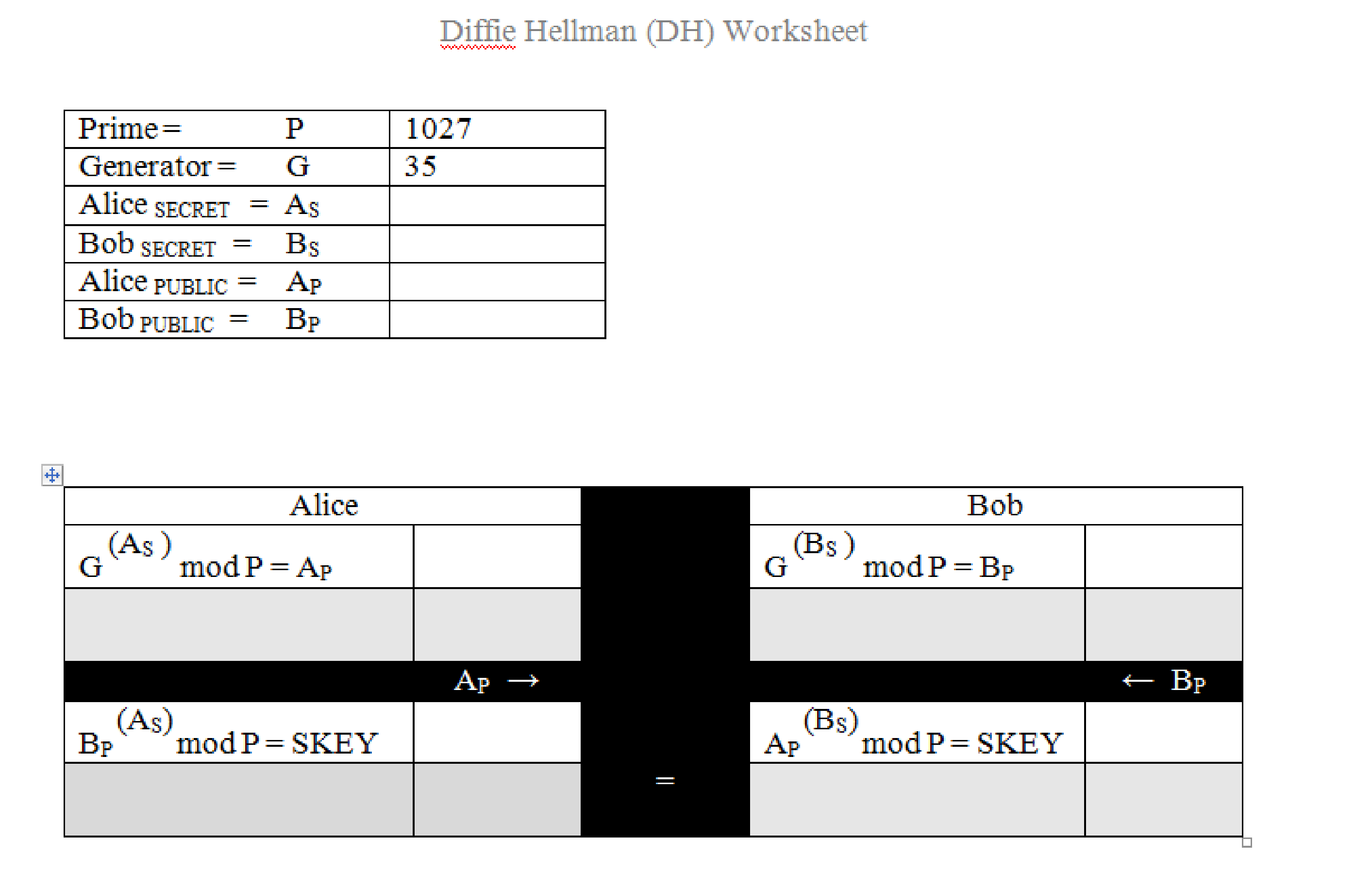
RSA

- Named for Rivest, Shamir, and Adleman, the creator
- Currently the standard for Digital Signatures
- Uses the idea that there is no efficient way to factor the product of large prime numbers
- The math used for RSA is sometimes referred to as a trap-door function
- ****Factorization*****

DIFFIE-HELLMAN

- The first asymmetric algorithm
- Secure key-agreement without pre-shared secrets
- Based on discrete logarithms in a finite field

DIFFIE HELLMAN KEY AGREEMENT



Diffie Hellman (DH) Worksheet

Prime=	P	1027
Generator=	G	35
Alice SECRET =	A_S	
Bob SECRET =	B_S	
Alice PUBLIC =	A_P	
Bob PUBLIC =	B_P	

Alice			Bob	
$G^{(A_S)} \bmod P = A_P$			$G^{(B_S)} \bmod P = B_P$	
	$A_P \rightarrow$			$\leftarrow B_P$
$B_P^{(A_S)} \bmod P = SKEY$			$A_P^{(B_S)} \bmod P = SKEY$	
		=		

ECC (ELLIPTICAL CURVE CRYPTOGRAPHY)

- **Based upon plotting points upon a curve**
- **Very efficient, but only designed to work within certain environments**
- **Frequently used for handheld devices due to their limited processing capability**

REVIEW SYMMETRIC VS. ASYMMETRIC

- **Symmetric**
  - Fast
  - Out of band key exchange
  - No integrity, authenticity or authenticity
  - Not Scalable
- **Asymmetric**
  - Slow
  - Scales to large organizations well
  - Provides non-repudiation
  - Key exchange does not require exchange of any secret information

HYBRID CRYPTOGRAPHY IN SSL/TLS

- Client initiates a secure connection
- Server responds by sending it’s public key to the client
- The client then generates a symmetric session key.
- Client encrypts uses the server’s public key to encrypt the session key.
- Client sends the session key (encrypted with the server’s public key) to the server
- Server uses it’s private key to decrypt the session key
- Now that a symmetric session key has been distributed, both parties have a secure channel across which to communicate.

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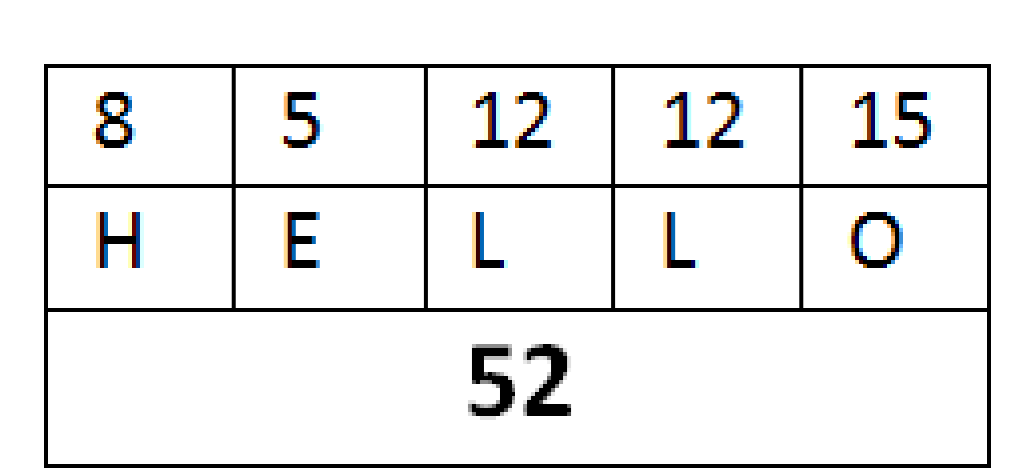
INTEGRITY

- **Data gets modified**
  - Accidentally through corruption
  - Intentionally through malicious alteration
- **Hash: only good for accidental modification**
- **MAC: Provides reasonable authenticity and integrity not strong enough to be non-repudiation (because it uses a symmetric key)**
- **Digital Signatures: Can detect both malicious and accidental modification, but requires an overhead. Provides true non-repudiation**

HASHING



8	5	12	12	15
H	E	L	L	O
52				

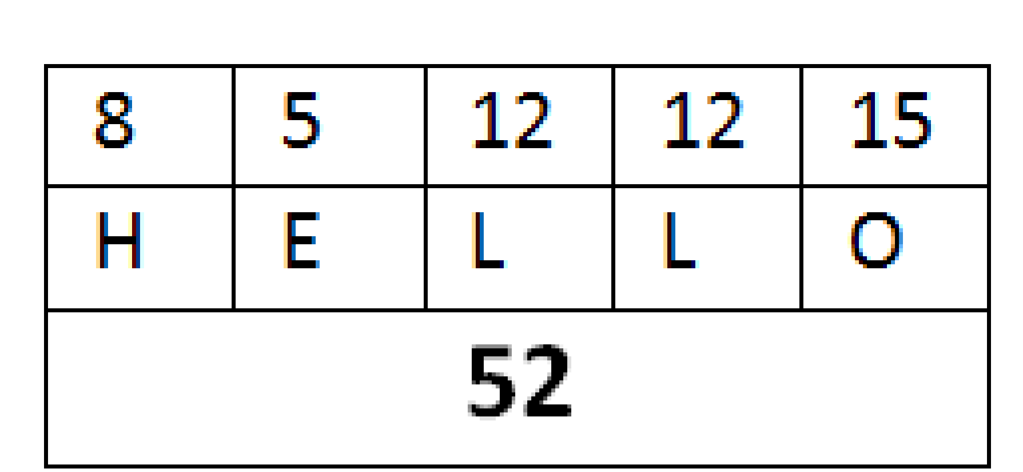
HASHING

- Digital representation of the contents of the file
- If the file changes, the hash will change
- One way math
- When two different documents produce the same hash it is called a collision
- A birthday attack is an attempt to cause collisions. It is based on the idea that it is easier to find two hashes that happen to match than to produce a specific hash.

HASHING ALGORITHMS

- Variable length message, fixed length has
- MD-5 used to be the standard with a 128 bit hash
- SHA-1 160 bit replaced MD-5 for the most part
- SHA-256 is becoming very frequently used
- RipeMD, Tiger, Whirlpool, HAVAL are lesser known hashing algorithms

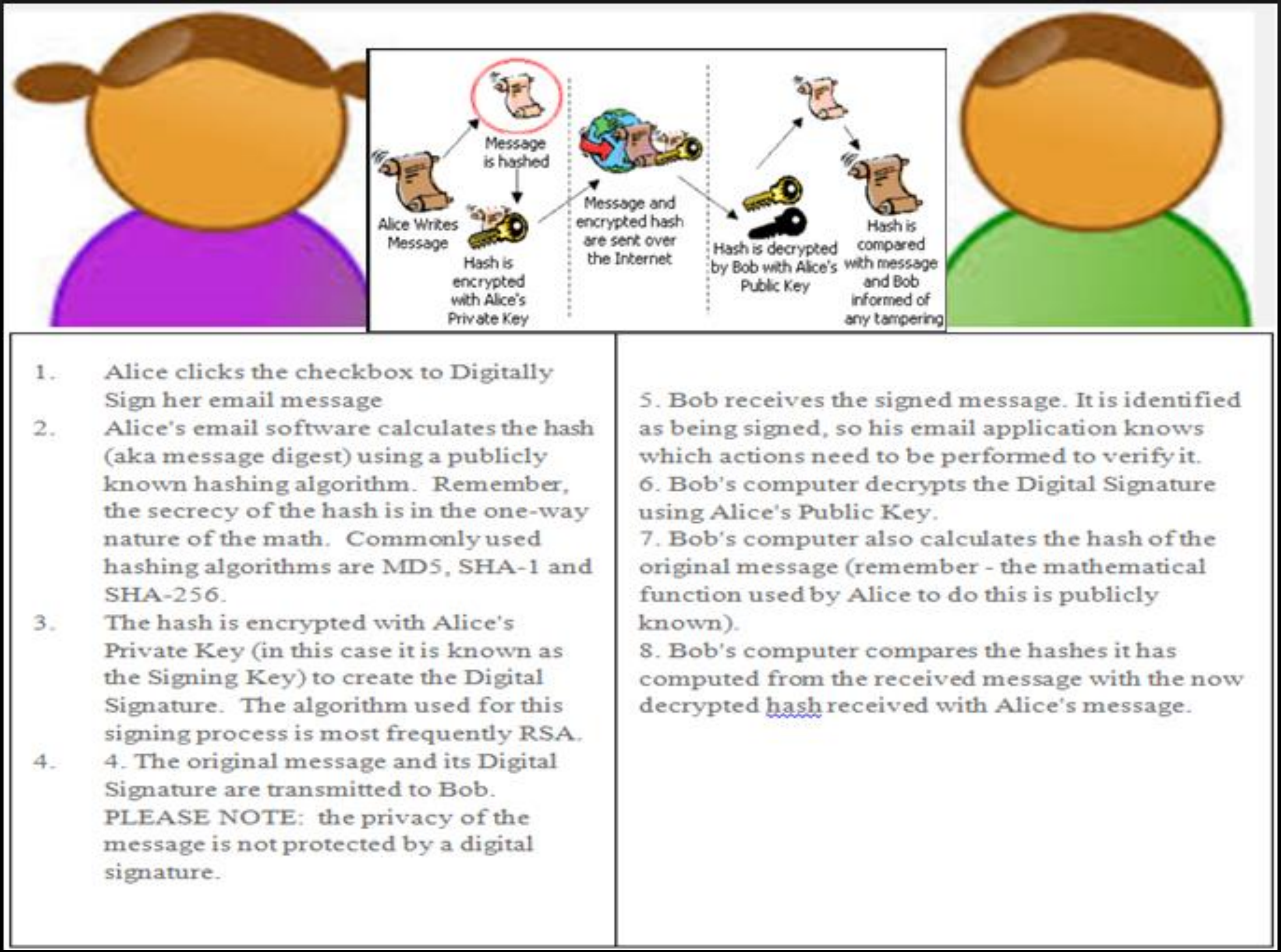
HASHING



8	5	12	12	15
H	E	L	L	O
52				

A hash creates a digital representation of a message. However, there is nothing about a hash that guarantees the origin of the message, or the authenticity of the hash itself. Therefore it is only useful in detecting unintentional modification, like corruption.

DIGITAL SIGNATURE


Alice Writes Message
Message is hashed
Hash is encrypted with Alice's Private Key
Message and encrypted hash are sent over the Internet
Hash is decrypted by Bob with Alice's Public Key
Hash is compared with message and Bob informed of any tampering

1. Alice clicks the checkbox to Digitally Sign her email message
2. Alice's email software calculates the hash (aka message digest) using a publicly known hashing algorithm. Remember, the secrecy of the hash is in the one-way nature of the math. Commonly used hashing algorithms are MD5, SHA-1 and SHA-256.
3. The hash is encrypted with Alice's Private Key (in this case it is known as the Signing Key) to create the Digital Signature. The algorithm used for this signing process is most frequently RSA.
4. 4. The original message and its Digital Signature are transmitted to Bob. PLEASE NOTE: the privacy of the message is not protected by a digital signature.

5. Bob receives the signed message. It is identified as being signed, so his email application knows which actions need to be performed to verify it.
6. Bob's computer decrypts the Digital Signature using Alice's Public Key.
7. Bob's computer also calculates the hash of the original message (remember - the mathematical function used by Alice to do this is publicly known).
8. Bob's computer compares the hashes it has computed from the received message with the now decrypted hash received with Alice's message.

MAC (MESSAGE AUTHENTICATION CODE)

- **Message + Symmetric Number +Hashing algorithm**

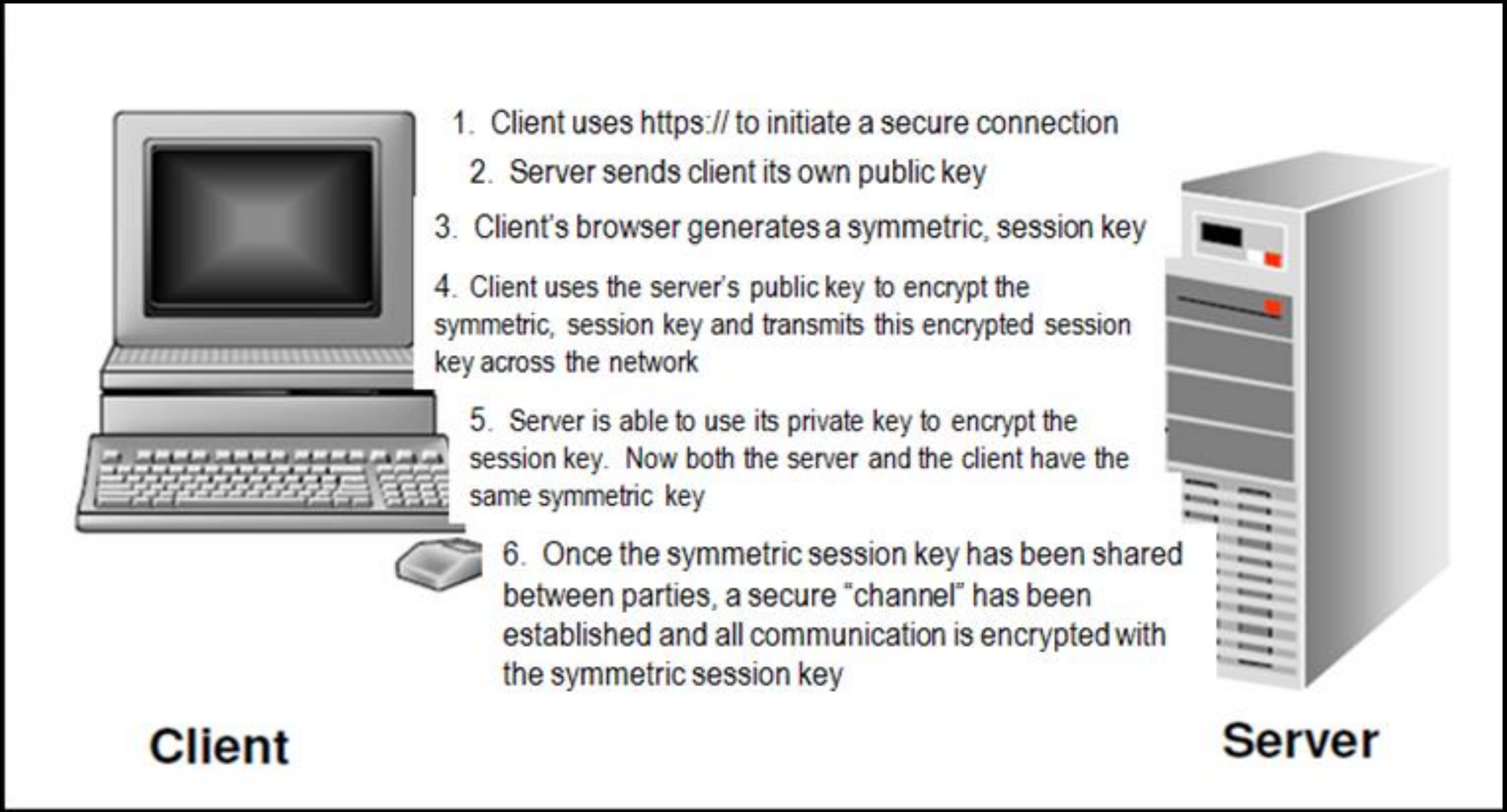
  = HMAC
- **Integrity and (reasonable) authenticity**
- **A MAC does not provide true authenticity (symmetric)**

DIGITAL SIGNATURE

- Message is hashed.
- Hash is encrypted by Sender’s Private Key.
- SHA-1 is generally used for the hash
- RSA is the asymmetric encryption algorithm that encrypts the hash with the sender’s private key.

PKI PUBLIC KEY INFRASTRUCTURES

What’s wrong with this picture?

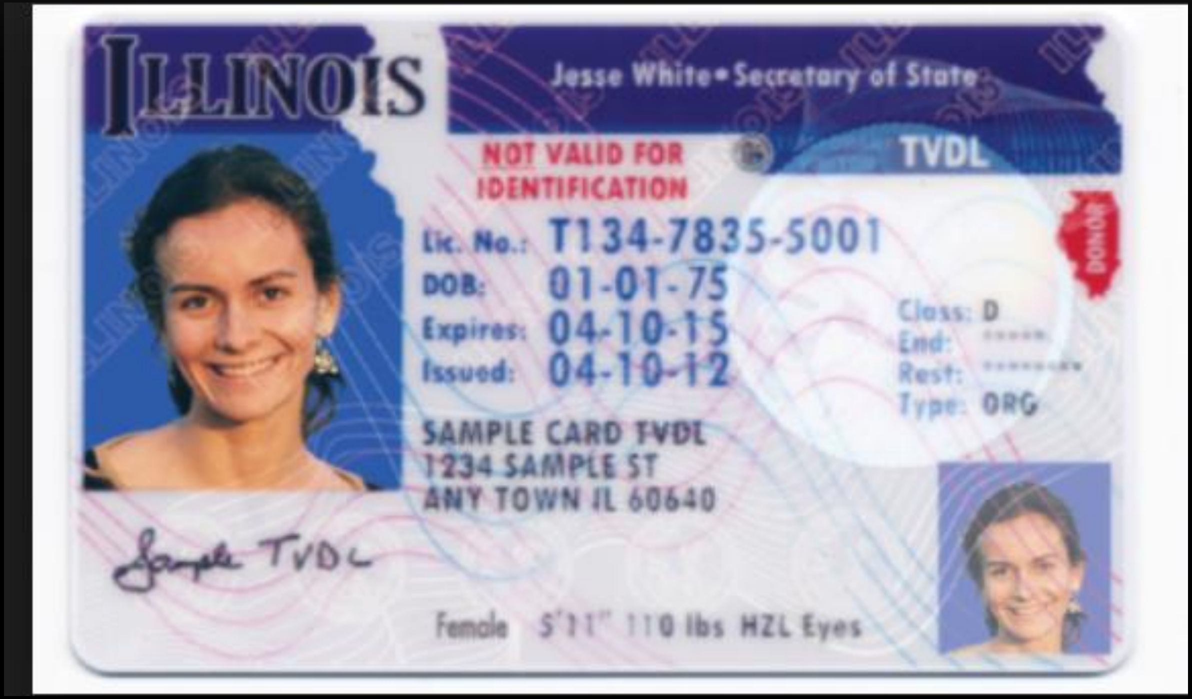


1. Client uses https:// to initiate a secure connection
2. Server sends client its own public key
3. Client’s browser generates a symmetric, session key
4. Client uses the server’s public key to encrypt the symmetric, session key and transmits this encrypted session key across the network
5. Server is able to use its private key to encrypt the session key. Now both the server and the client have the same symmetric key
6. Once the symmetric session key has been shared between parties, a secure “channel” has been established and all communication is encrypted with the symmetric session key

WHAT PREVENTS MITM ATTACKS

- **Authentication**
- **Remember Encryption can NOT thwart a MITM attack**
- **Authentication is what prevents MITM**

HOW DO WE PROVE OUR IDENTITY?



ILLINOIS

Jesse White • Secretary of State

TVDL

NOT VALID FOR IDENTIFICATION

Lic. No.: T134-7835-5001

DOB: 01-01-75

Expires: 04-10-15

Issued: 04-10-12

Class: D

End: *****

Rest: ********

Type: ORG

DONOR

SAMPLE CARD TVDL
1234 SAMPLE ST
ANY TOWN IL 60640

Sample TVDL

Female 5'11" 110 lbs HZL Eyes

Name?

Expiration Date

Class?

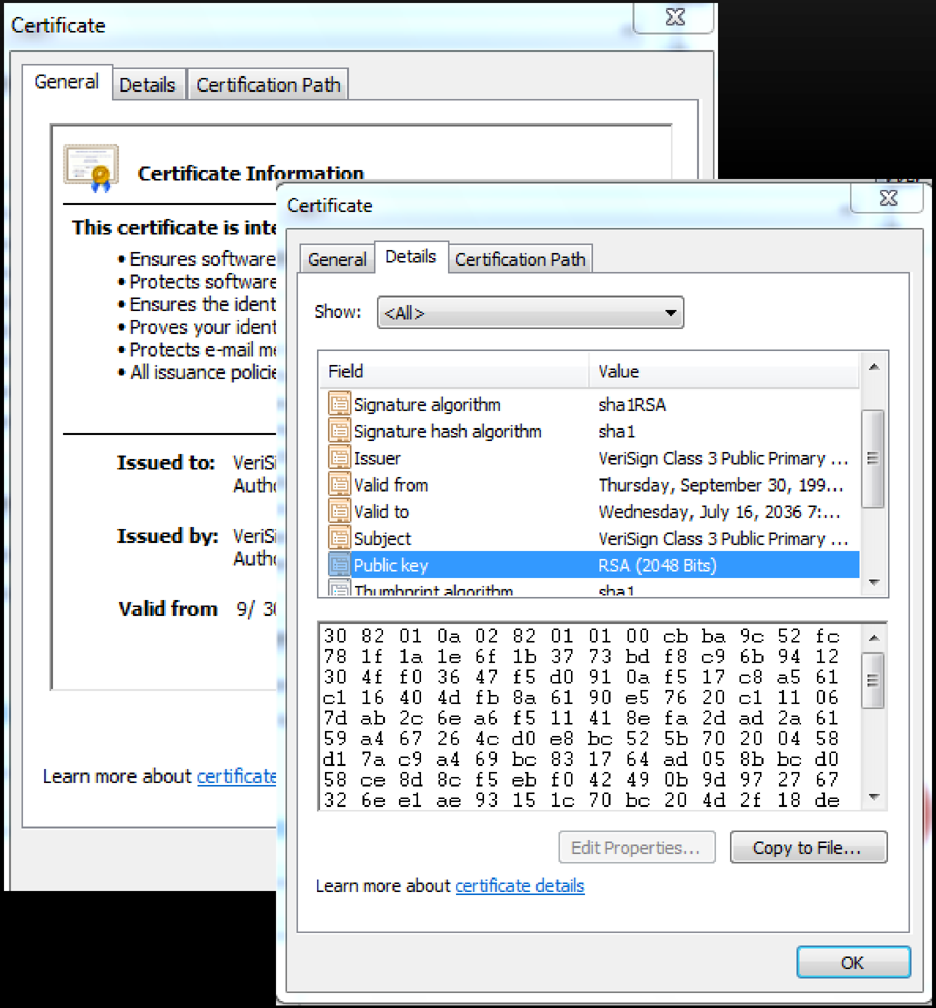
Serial Number?

Is it standardized?

Is it issued by a trusted authority?

CERTIFICATES

- X.509 v.4 standard
- Provides authenticity of a server's public key
- Necessary to avoid MITM attacks with server's using SSL or TLS
- Digitally signed by Certificate Authority



Certificate

General | Details | Certification Path

Certificate Information

This certificate is inte

- Ensures software
- Protects software
- Ensures the ident
- Proves your ident
- Protects e-mail me
- All issuance policie

Issued to: VeriSi Auth

Issued by: VeriSi Auth

Valid from 9/ 3

Learn more about certificate

Certificate

General | Details | Certification Path

Show: <All>

Field	Value
Signature algorithm	sha1RSA
Signature hash algorithm	sha1
Issuer	VeriSign Class 3 Public Primary ...
Valid from	Thursday, September 30, 199...
Valid to	Wednesday, July 16, 2036 7:...
Subject	VeriSign Class 3 Public Primary ...
Public key	RSA (2048 Bits)
Thumbprint algorithm	sha1

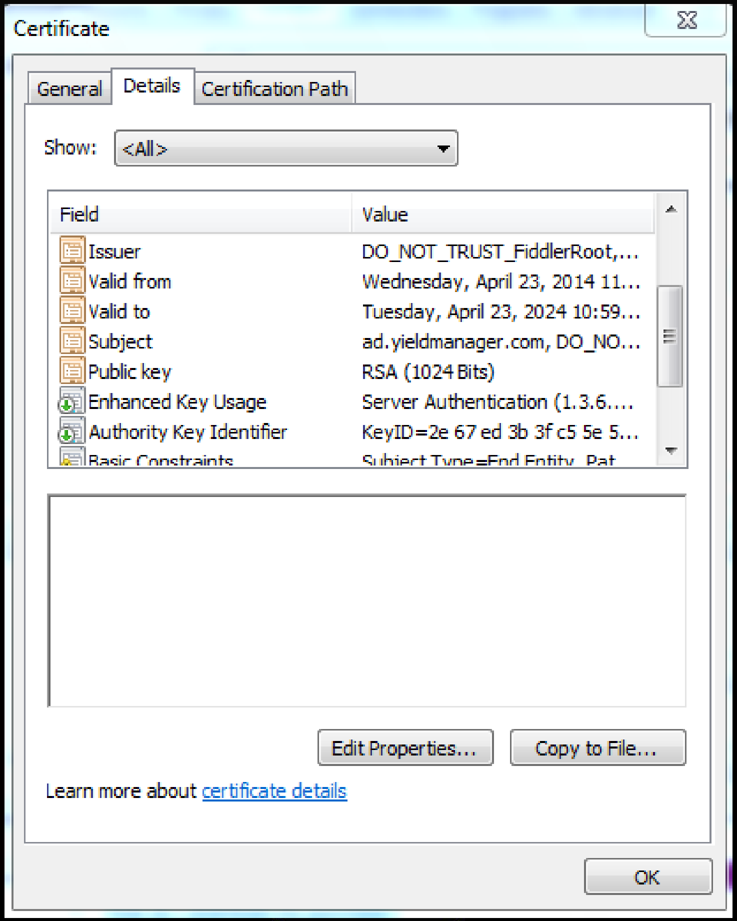
```
30 82 01 0a 02 82 01 01 00 cb ba 9c 52 fc
78 1f 1a 1e 6f 1b 37 73 bd f8 c9 6b 94 12
30 4f f0 36 47 f5 d0 91 0a f5 17 c8 a5 61
c1 16 40 4d fb 8a 61 90 e5 76 20 c1 11 06
7d ab 2c 6e a6 f5 11 41 8e fa 2d ad 2a 61
59 a4 67 26 4c d0 e8 bc 52 5b 70 20 04 58
d1 7a c9 a4 69 bc 83 17 64 ad 05 8b bc d0
58 ce 8d 8c f5 eb f0 42 49 0b 9d 97 27 67
32 6e e1 ae 93 15 1c 70 bc 20 4d 2f 18 de
```

Learn more about certificate details

PKI (PUBLIC KEY INFRASTRUCTURE)

- Certificate Authority (CA)
- Registration Authority (RA)
- Certificate Repository
- Certificate Revocation List

CERTIFICATE CONTENTS



Show: <All>

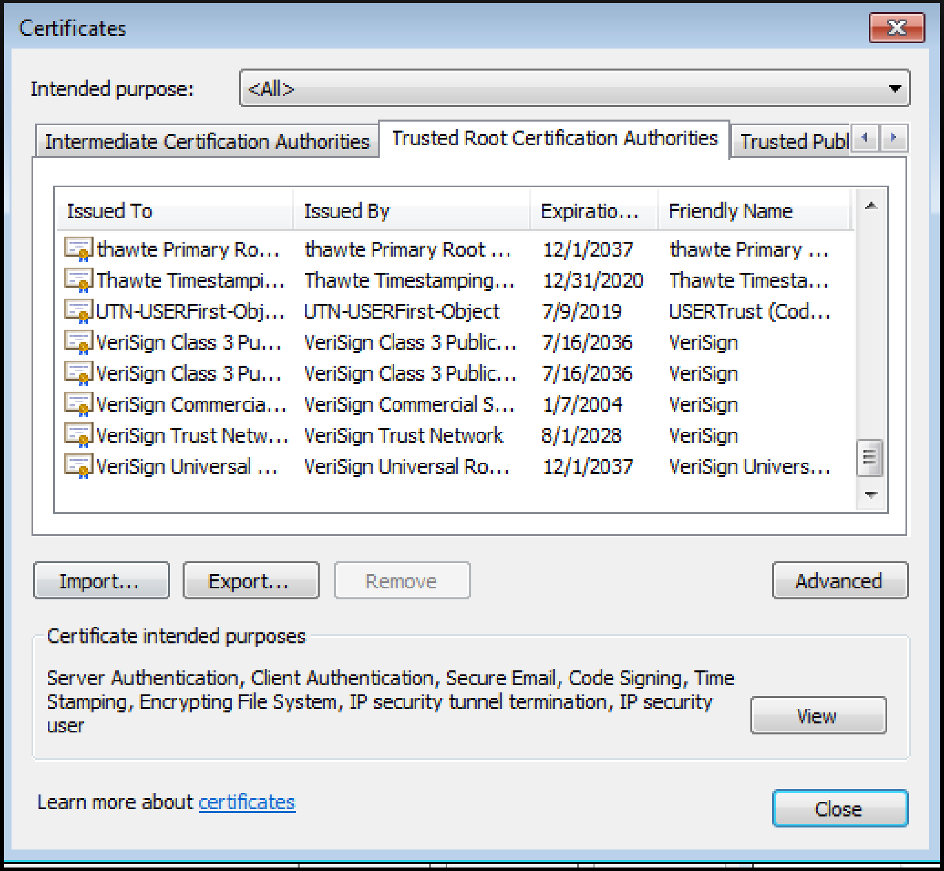
Field	Value
Issuer	DO_NOT_TRUST_FiddlerRoot,...
Valid from	Wednesday, April 23, 2014 11...
Valid to	Tuesday, April 23, 2024 10:59...
Subject	ad.yieldmanager.com, DO_NO...
Public key	RSA (1024 Bits)
Enhanced Key Usage	Server Authentication (1.3.6....
Authority Key Identifier	KeyID=2e 67 ed 3b 3f c5 5e 5...
Basic Constraints	Subject Type=End Entity, Pat

Learn more about certificate details

CERTIFICATE REVOCATION

- **CRL: CA publishes CRL. Client is responsible for downloading to see if a certificate has been revoked.**
- **OCSP (Online Certificate Status Protocol) Streamlines the process of verifying whether or not a certificate has been revoked.**

TRUSTED CERTIFICATE AUTHORITIES


Certificates
Intermediate Certification Authorities
Trusted Root Certification Authorities
Trusted Publ
Import...
Export...
Remove
Advanced
View
Close

Intended purpose: <All>

Issued To	Issued By	Expiratio...	Friendly Name
thawte Primary Ro...	thawte Primary Root ...	12/1/2037	thawte Primary ...
Thawte Timestampi...	Thawte Timestamping...	12/31/2020	Thawte Timesta...
UTN-USERFirst-Obj...	UTN-USERFirst-Object	7/9/2019	USERTrust (Cod...
VeriSign Class 3 Pu...	VeriSign Class 3 Public...	7/16/2036	VeriSign
VeriSign Class 3 Pu...	VeriSign Class 3 Public...	7/16/2036	VeriSign
VeriSign Commercia...	VeriSign Commercial S...	1/7/2004	VeriSign
VeriSign Trust Netw...	VeriSign Trust Network	8/1/2028	VeriSign
VeriSign Universal ...	VeriSign Universal Ro...	12/1/2037	VeriSign Univers...

Certificate intended purposes

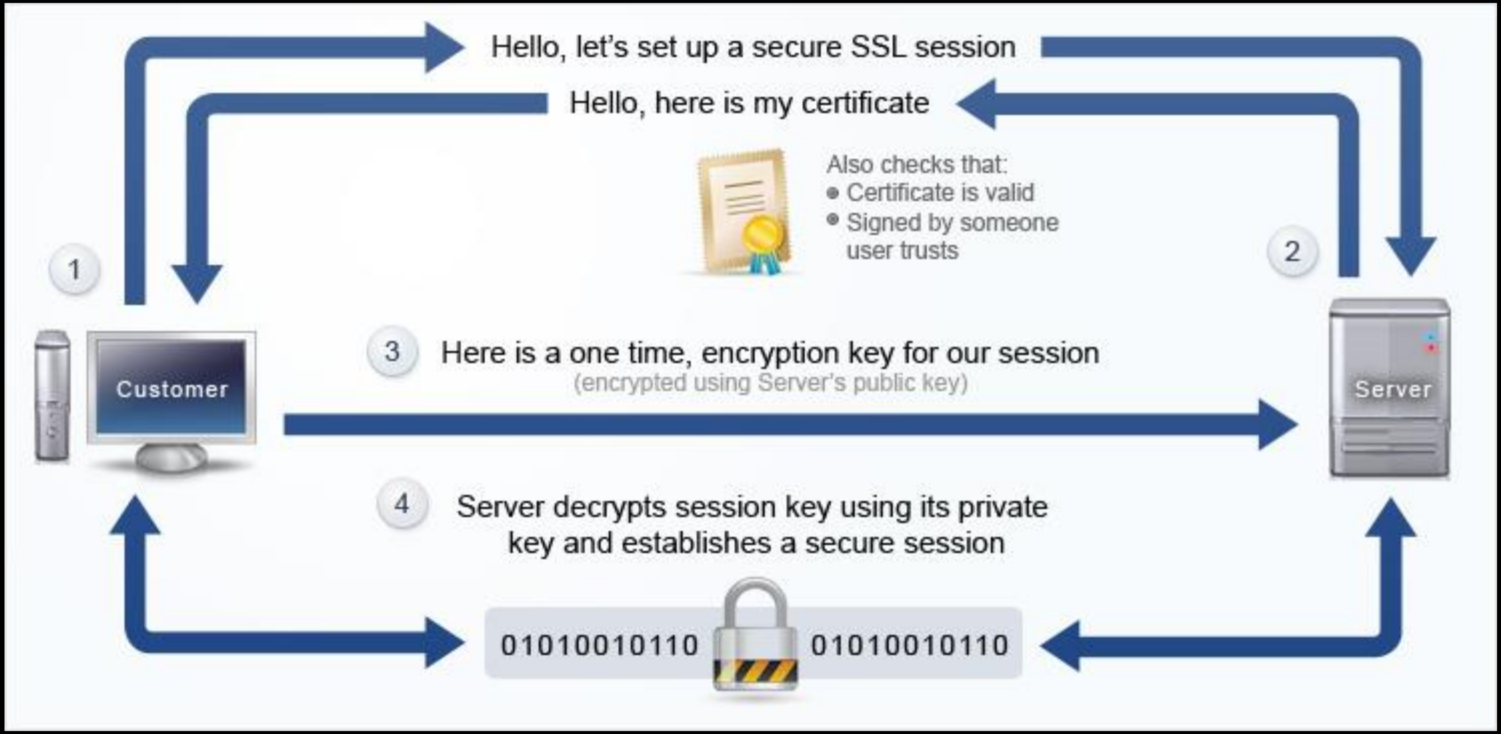
Server Authentication, Client Authentication, Secure Email, Code Signing, Time Stamping, Encrypting File System, IP security tunnel termination, IP security user

Learn more about certificates

ENCRYPTING DATA IN TRANSIT

- **Protect Data as it traverses the network**
- **Most protocols like IP, HTTP FTP are not inherently secure**

ENCRYPTING DATA IN TRANSIT: SSL/TLS

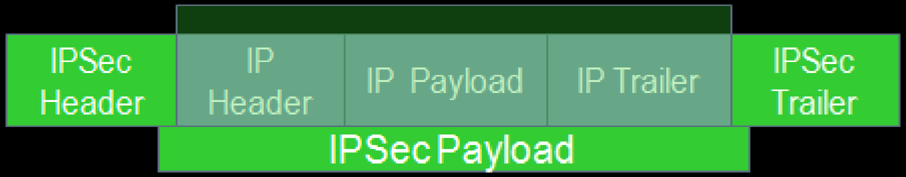


Hello, let's set up a secure SSL session
Hello, here is my certificate
Also checks that:
● Certificate is valid
● Signed by someone user trusts
1
2
Customer
Server
3
Here is a one time, encryption key for our session
(encrypted using Server's public key)
4
Server decrypts session key using its private key and establishes a secure session
01010010110
01010010110

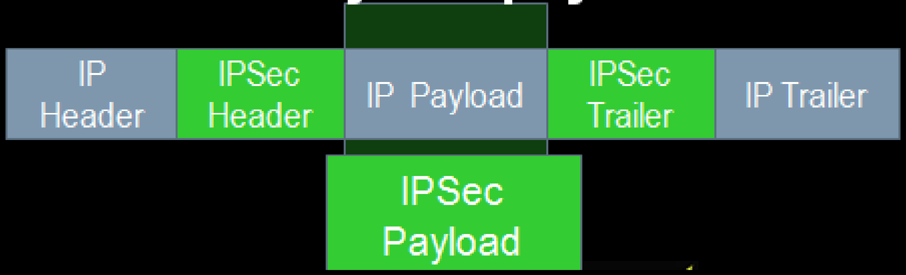
IPSEC

IPSEC is an encapsulation framework. Tunnel vs. Transport mode dictates what portion of the IP Packet is to be encapsulated.

Tunnel Mode: Whole packet is encapsulated



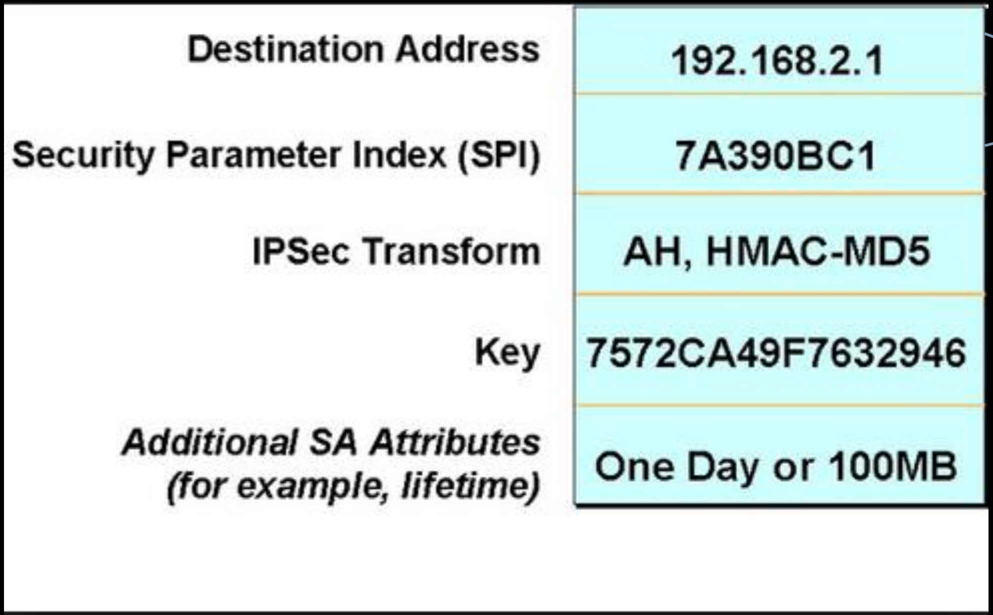
Transport Mode: Only the payload is encapsulated



IPSEC SUB-PROTOCOLS

- **AH (Authentication Header) Provides integrity, authenticity, and non-repudiation through the use of an ICV (Integrity Check Value). The ICV is run on the entire packet (header, data, trailer) except for particular fields in the header that are dynamic (like TTL, etc..). NO CONFIDENTIALITY**
- **ESP (Encapsulating Security Payload) Provides authenticity and integrity through a MAC (no non-repudiation since a MAC is symmetric). The main service provided is ENCRYPTION. ICV is run on payload only.**
- **IKE: Internet Key Exchange---No Security Services. Just management of secure connection**
  - Oakley: Uses Diffie Hellman to agree upon a key
  - ISAKMP (Internet Security Association and Key Management Protocol) Manages Keys, Security Associations (SAs)and Security Parameters Index (SPI)

SECURITY ASSOCIATIONS AND SPIS

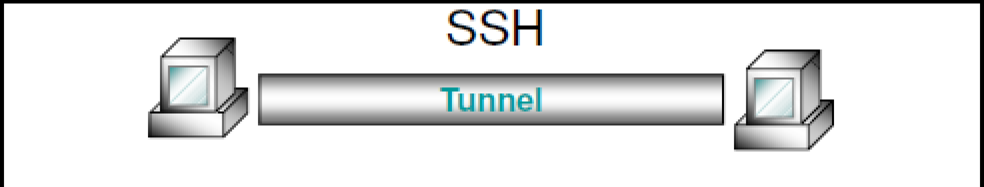


Destination Address	192.168.2.1
Security Parameter Index (SPI)	7A390BC1
IPSec Transform	AH, HMAC-MD5
Key	7572CA49F7632946
Additional SA Attributes (for example, lifetime)	One Day or 100MB

Security Association

SSH (SECURE SHELL)

- Secure alternative to unsecure remote administrative protocols
- Telnet, FTP, R-utilitites (Rlogin, etc..) transmit credentials in clear text
- SSH sets up a secure tunnel



IMPLEMENTATION OF CRYPTOGRAPHY: DIGITAL ENVELOPES IN S/MIME

▣ S/MIME (Secure Multipart Internet Mail Exchange) :

Standards based secure email by creating a digital envelope

Sender functions:

- Calculate hash value on message
- Encrypt message with session key
- Encrypt hash value with private key
- Encrypt session key with receiver’s public key

Receiver functions:

- Decrypt session key with private key
- Decrypt hash value with sender’s public key
- Decrypt message
- Calculate hash value and compare with one sent

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CRYPTOGRAPHY: PGP (PRETTY GOOD PRIVACY)

- Proprietary mail standard from Phil Zimmerman
- Free, but proprietary software must be installed
- Uses Web of Trust
- Passphrases instead of passwords
- Learned keys are stored in a file called the key ring

PROTECTING CONFIDENTIALITY OF DATA REST

- **Data stored on local drives must be protected**
- **Log off of workstations not in use**
- **Use encryption within the operating system (ex: EFS in Windows environment)**
- **Whole Drive Encryption: Protect Hard Drive in the event the disk is stolen**
  - TPM
  - USB
  - Directory Services

ATTACKS ON CRYPTOGRAPHY

- Ciphertext Only: Attacker has captured encrypted text on the network. Usually means all the attacker can do is brute force
- Known Plain Text: The attacker has captured cipher text, but also knows what a portion of the message is in plain text (like an automatic signature)
- Chosen Plaintext: Attacker can see the full text encrypted and decrypted. Usually the attacker has initiated the message
- Chosen Ciphertext: An attacker can see whatever they want in plain or ciphertext. They have compromised a workstation. Sometimes called a lunchtime or midnight attack.

ATTACKS ON CRYPTOGRAPHY CONTINUED

- Meet in the Middle (Not to be confused with Man in the Middle). These attacks are targeted towards algorithms like 3DES where there are multiple key. An attacker tries to learn what each key does individually.

SECURITY ENGINEERING REVIEW

Part I Security Architecture and Design:

- Trusted Computer Base Elements
  - Security Perimeter
  - Reference Monitor
  - Security Kernel
- Security Models
- Computer/Security Architecture
- Security Models
- Security Evaluation Criteria

Part II Cryptography

- Historical uses of Cryptography
- Security Services provided by cryptography
- Definitions and terms
- Symmetric Cryptography
- Asymmetric Cryptography
- Hybrid Cryptography
- Integrity through Hashing, MACs and Digital Signatures
- Public Key Infrastructure
- IPSec
- Attacks on Cryptography

CHAPTER 4

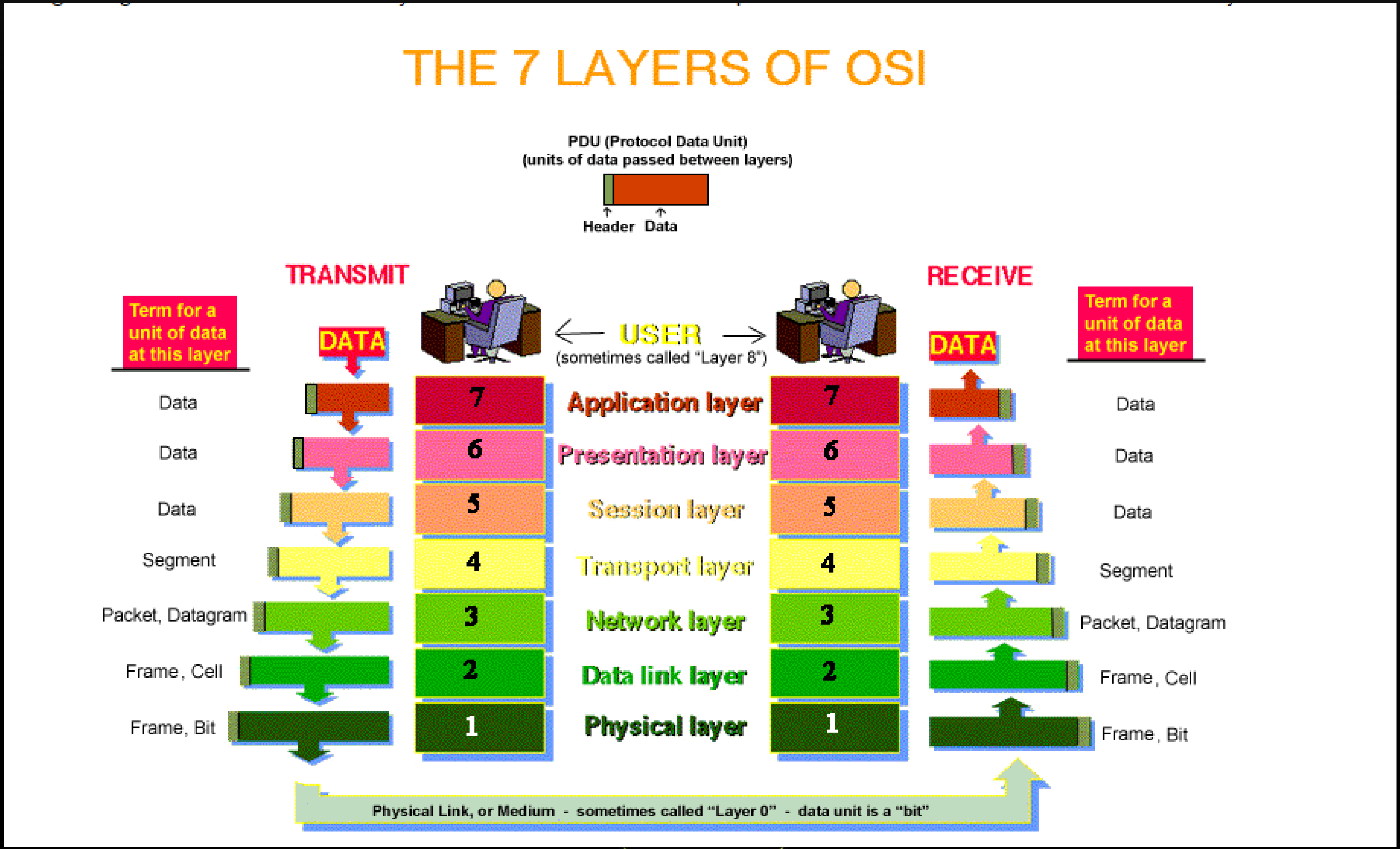
Communications and Network Security

COMMUNICATIONS AND NETWORK SECURITY

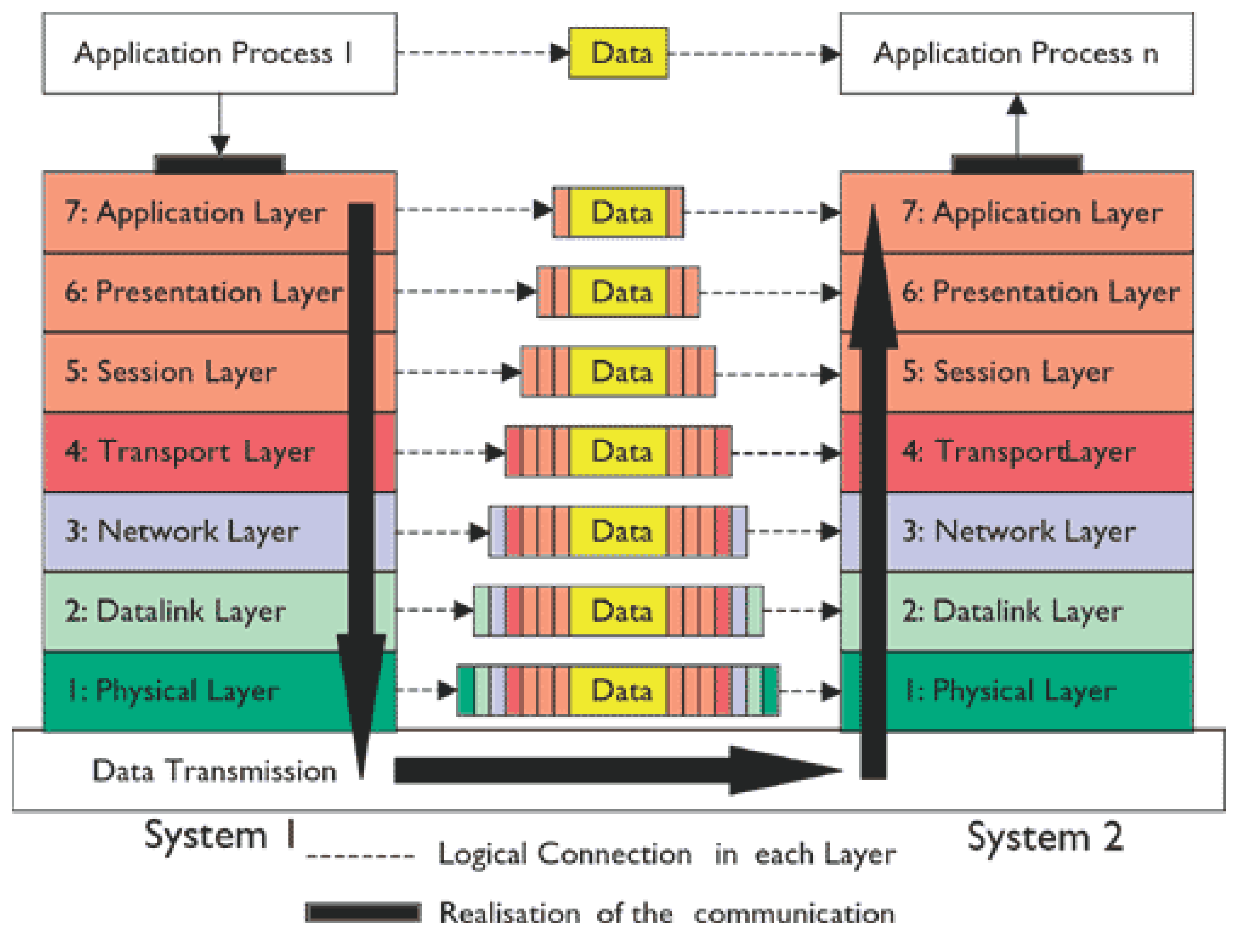
- OSI Reference Model
- Network Protocols
- Network Connectivity Devices
- Threats to Network Security
- Firewalls
- Wireless Communications

OSI REFERENCE MODEL

OSI


THE 7 LAYERS OF OSI
PDU (Protocol Data Unit)
(units of data passed between layers)
Header
Data
TRANSMIT
RECEIVE
Term for a unit of data at this layer
Term for a unit of data at this layer
DATA
DATA
USER
(sometimes called "Layer 8")
Data
Data
Data
Segment
Packet, Datagram
Frame, Cell
Frame, Bit
7
Application layer
7
6
Presentation layer
6
5
Session layer
5
4
Transport layer
4
3
Network layer
3
2
Data link layer
2
1
Physical layer
1
Data
Data
Data
Segment
Packet, Datagram
Frame, Cell
Frame, Bit
Physical Link, or Medium - sometimes called "Layer 0" - data unit is a "bit"

ENCAPSULATION



OSI MODEL

7 layers A P S T N D P… “All People Seem to Need Data Processing”

- Application
- Presentation
- Session
- Transport
- Network
- Data link
  - LLC
  - MAC
- Physical

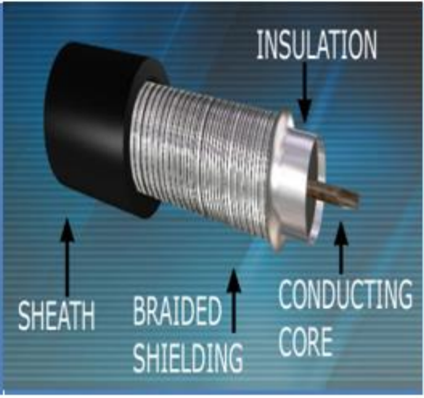
OSI MODEL – LAYER 1 PHYSICAL

Layer 1 Physical – simply put is concerned with physically sending electric signals over a medium. Is concerned with

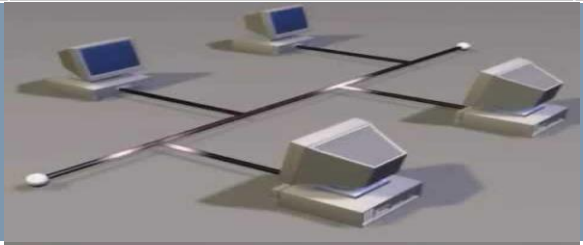
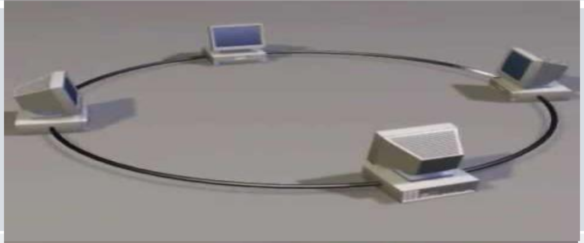
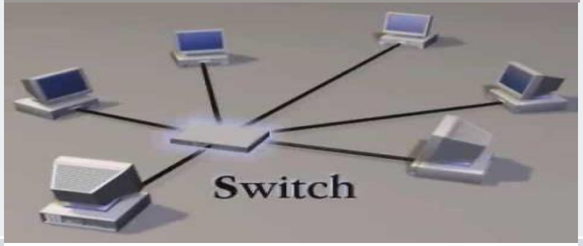
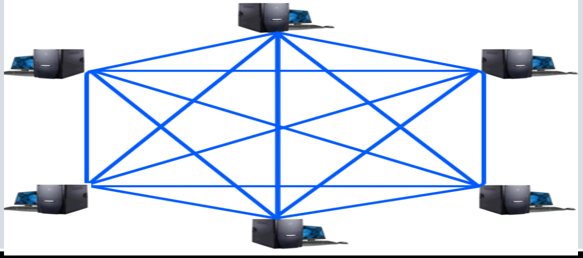
- specific cabling,
- voltages and
- Timings

- **This level actually sends data as electrical signals that other equipment using the same "physical" medium**

OSI REFERENCE MODEL: LAYER 1 (PHYSICAL)
TRANSMISSION MEDIA/CABLING

Coaxial Cable: Not flexible or easy to work with. Speed was originally limited to 10Mbps. More secure that Twisted Pair, but still susceptible to vulnerabilities	 INSULATION SHEATH BRAIDED SHIELDING CONDUCTING CORE	Originally used in LANs: •10Base2 (thinnet) RG-58 •10Base5 (thicknet) RG-8 Now used for WAN Access RG-6 or RG-59
Twisted Pair: Least secure. Easy to tap into, susceptible to **EMI** and **RFI**. **Attenuation** and **cross talk** are other problems Most popular in use: CHEAP and Easy		Shielded and Unshielded CAT3 10 Mbps CAT5 100 Mbps CAT 5e/CAT 6 1000 Mbps
Fiber Optic Cable: Most secure. Signal is sent as pulses of light, so fiber is not susceptible to EMI/RFI. Very difficult to eavesdrop, but also hard to work with (and expensive)		Multi-Mode: Used for short distances Single Mode: Used to cover great distances (in some implementations, hundreds of miles)

OSI REFERENCE MODEL: LAYER 1 (PHYSICAL) TOPOLOGY

Bus		**•No central point of connection** **•Difficult to troubleshoot** **•One break in cable takes down the whole network**
Ring		•No central point of connection •Often implemented with a MAU for fault tolerance
Star		•Switch offers fault tolerance, as individual links no longer affect the network •Switch is still a single point of failure
Mesh		•Most fault tolerant •Fully redundant •Partial Mesh is often used to spare cost

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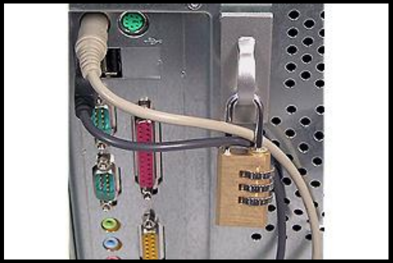
OSI REFERENCE MODEL: LAYER 1 (PHYSICAL) CONNECTIVITY DEVICES

Hub		•Sends all data out all ports •No addressing •Historically a cheap point of central connectivity
Modem		•Modulator/Demodulator •Converts digital signal to analog and back
Wireless Access Point		•Provides wireless devices a point of connection to the wired network.

OSI REFERENCE MODEL: LAYER 1 (PHYSICAL)

Threats:

- Theft
- Unauthorized Access
- Vandalism
- Sniffing
- Interference
- Data Emanation



OSI MODEL – LAYER 2 DATA LINK

- **Data Link Layer**
  - LLC Logical Link Control—error detection
  - MAC Media Access Control—Physical
    - Addressing/Resolution and media access determination
      - ARP (Address Resolution Protocol
      - RARP (Reverse Address Resolution Protocol)
    - Media Access Control
      - CSMA/CD Carrier Sense Multiple Access with Collision Detection (IEEE standard) 802.3 Ethernet
      - CSMA/CA Carrier Sense Multiple Access with Collision Avoidance(IEEE standard) 802.11 Wireless
      - Token Passing: 24 bit control frame passed around the network environment with the purpose of determining which system can transmit data. There is only one token and since a system can't communicate without the token, there are no collisions.

MEDIA ACCESS TECHNOLOGIES

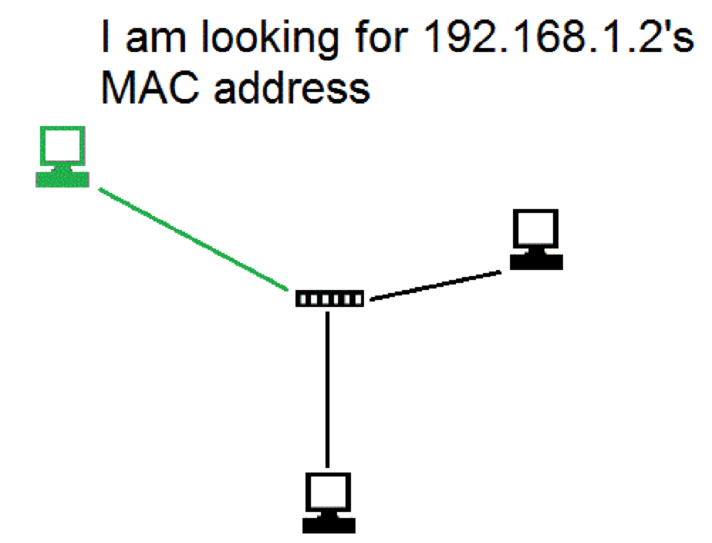
- Token Passing
- CSMA/CD – waits for clear, then starts talking, detect collisions
- CSMA/CA – signals intent to talk

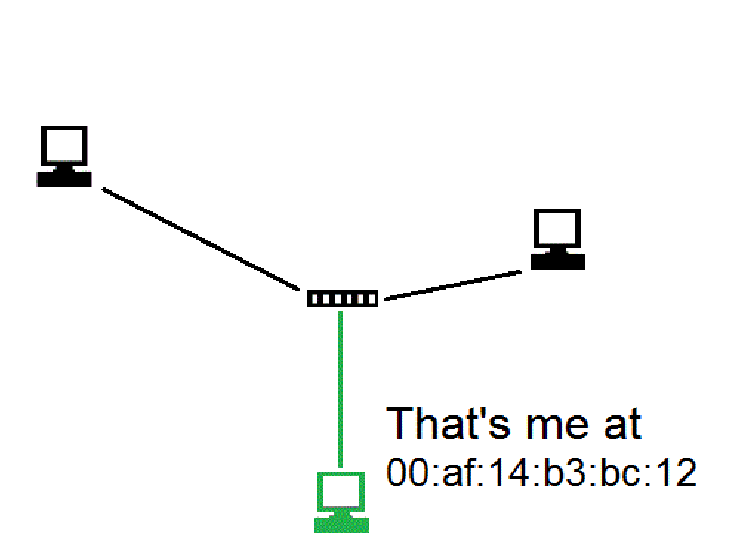
- Collision Domain – where collisions can occur. (i.e. two people try to talk at the same time)
- What is a security impact of collision domains? sniffing, DoS

ETHERNET -

- **Most common form of LAN networking, has the following characteristics**
  - Shares media
  - Broadcast and collision domains (see next slides)
  - CSMA/CD
  - Supports full duplex with a switch
  - Defined by IEEE 802.3

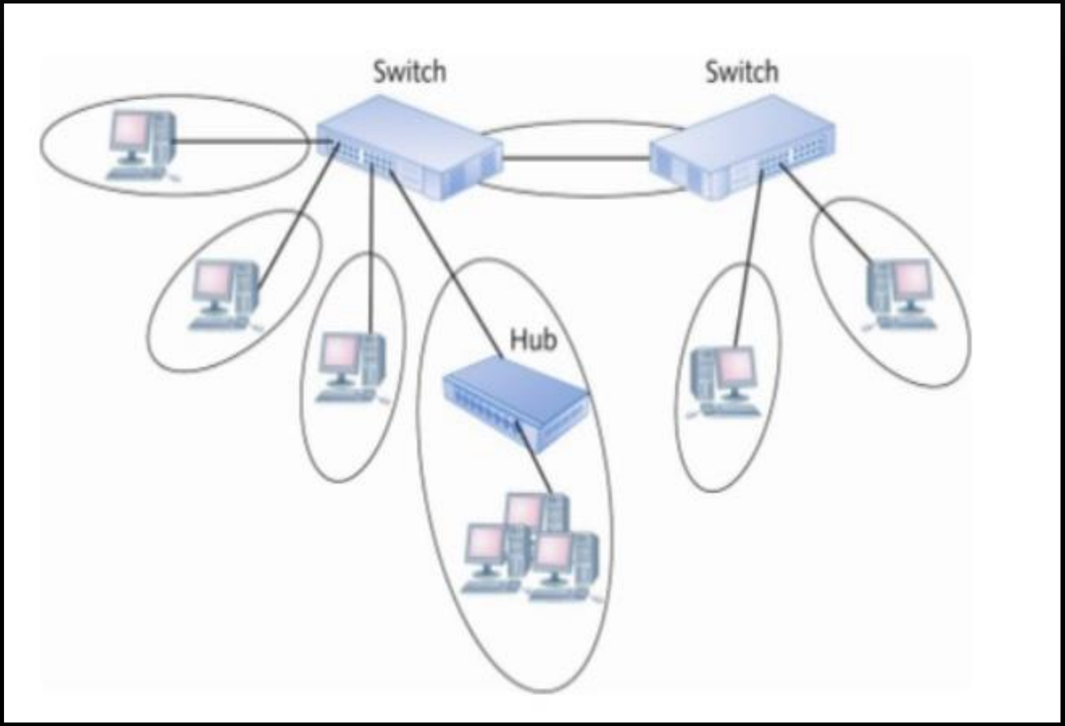
ARP


I am looking for 192.168.1.2's MAC address


That's me at 00:af:14:b3:bc:12

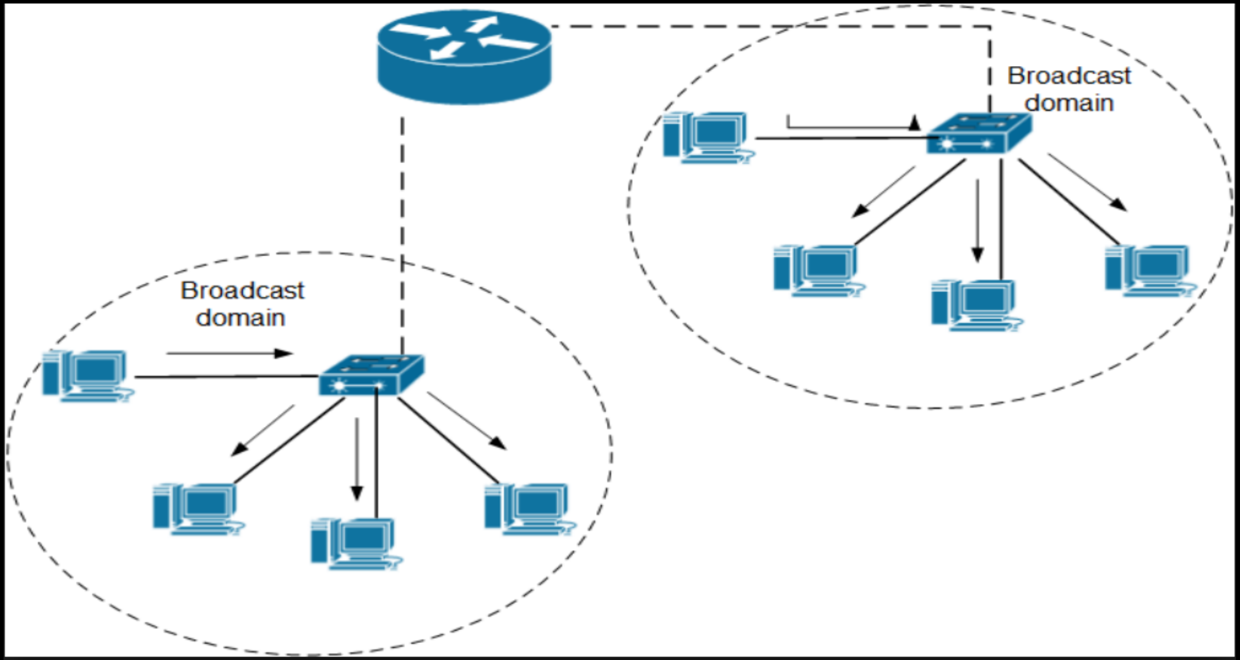
SWITCH

- Layer 2
- Uses MAC addresses to direct traffic
- Isolates traffic into collision domains
- Does NOT isolate broadcasts natively



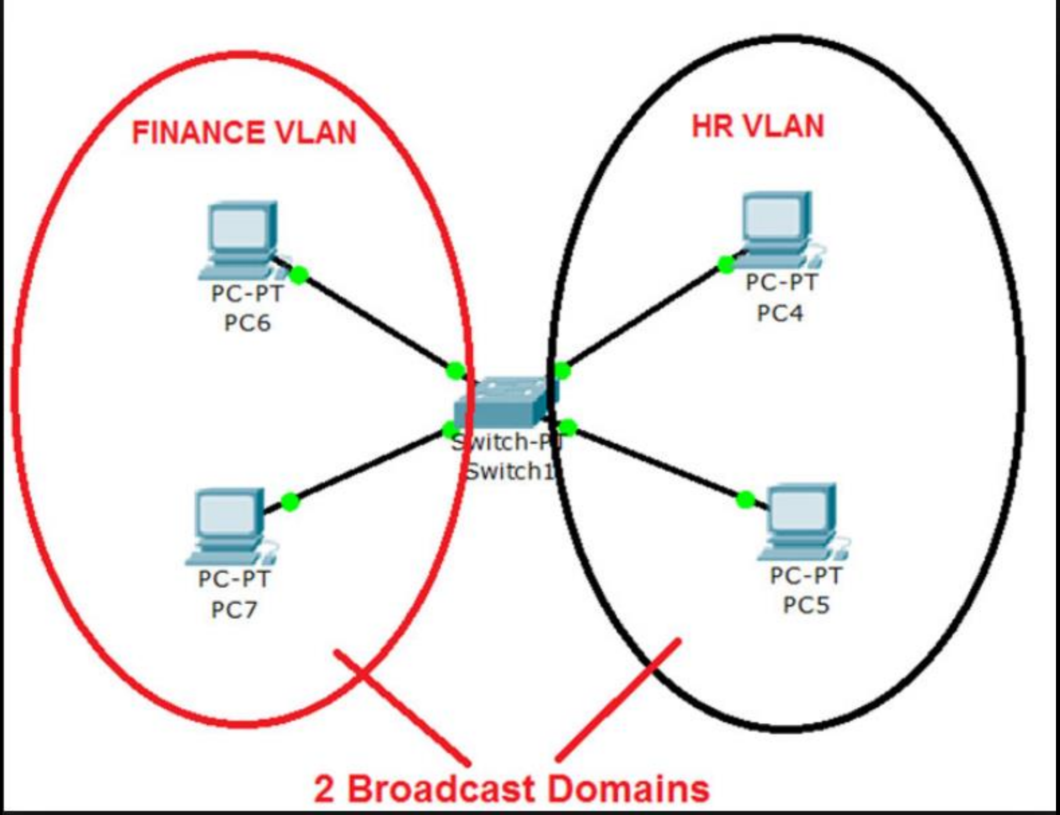
OSI MODEL LAYER 3 NETWORK

- **Routers Isolate traffic into broadcast domains and use IP addressing to direct traffic**



VLANS

- Routers are expensive
- To get broadcast isolation on a switch, a VLAN is necessary
- Not all switches support VLANs
- A Layer 2 switch (even with a VLAN) doesn't truly understand Layer 3 IP Addressing
- A Layer 3 switch is necessary for inter-Vlan Communication



LAYER 3 PROTOCOLS

- All Protocols that start with the letter “I” except IMAP (which is a layer 7 mail protocol)
- IP
- ICMP – IP “helpers” (like ping)
- IGMP – Internet Group Message Protocol
- IGRP
- IPSEC
- IKE
- ISAKMP

ICMP

- **ICMP – “IP helper”**
- **Protocol behind echoing utilities like PING and Traceroute**
- **Frequently exploited**
  - LOKI :sending data in ICMP headers—covert Channel
  - Ping of Death: violates the MTU (maximum transmission unit) size
  - Ping Floods: Lots of ping traffic
  - SMURF: Uses spoofed source address (Target) and directed broadcasts to launch a DDos

OSI MODEL LAYER 4 TRANSPORT

OSI Layer 4 Transport – Provides end-to-end data transport services and establishes a logical connection between 2 computers systems"

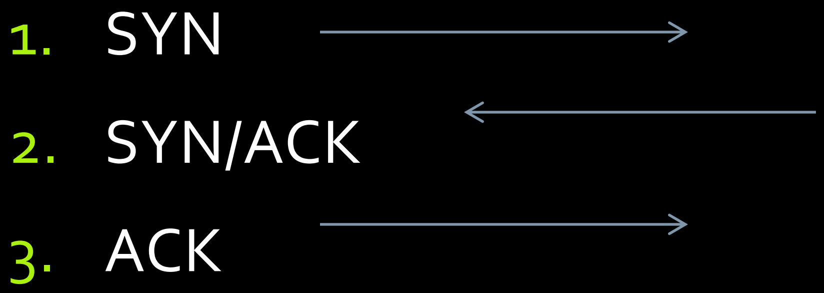
- **The "pony express"**
- **Protocols used at layer 4**
  - SSL/TLS (Discussed in Cryptography Chapter)
  - TCP
  - UDP

TCP (TRANSMISSION CONTROL PROTOCOL)

- **Connection oriented “guaranteed” delivery.**
- **Advantages**
  - Easier to program with
  - Truly implements a session
  - Adds security
- **Disadvantages**
  - More overhead / slower
  - SYN Floods

TCP

- **Reliable connection-oriented protocol**
  - Has a guaranteed delivery based on the handshake process



1. SYN
2. SYN/ACK
3. ACK

UDP (USER DATAGRAM PROTOCOL)

- **Connectionless**
- **Unreliable**
- **No handshaking**
- **Desirable when “real time” transfer is essential**
  - Media Streaming, Gaming, live time chat, etc..
  - FTP uses TCP
  - TFTP uses UDP

OSI MODEL LAYER 5 SESSION

OSI Layer 5 (Session) – responsible for establishing a connection between two APPLICATIONS! (either on the same computer or two different computers)

- ▣ Create connection
- ▣ Transfer data
- ▣ Release connection

- ▣ TCP actually does session oriented services

OSI MODEL LAYER 6 PRESENTATION

OSI Layer 6 – present the data in a format that all computers can understand

This is the only layer of OSI that does NOT have any protocol.

- Concerned with encryption, compression and formatting

- **Making sure data is presented in a universal format**
- **File level encryption**
- **Removing redundancy from files (compression)**

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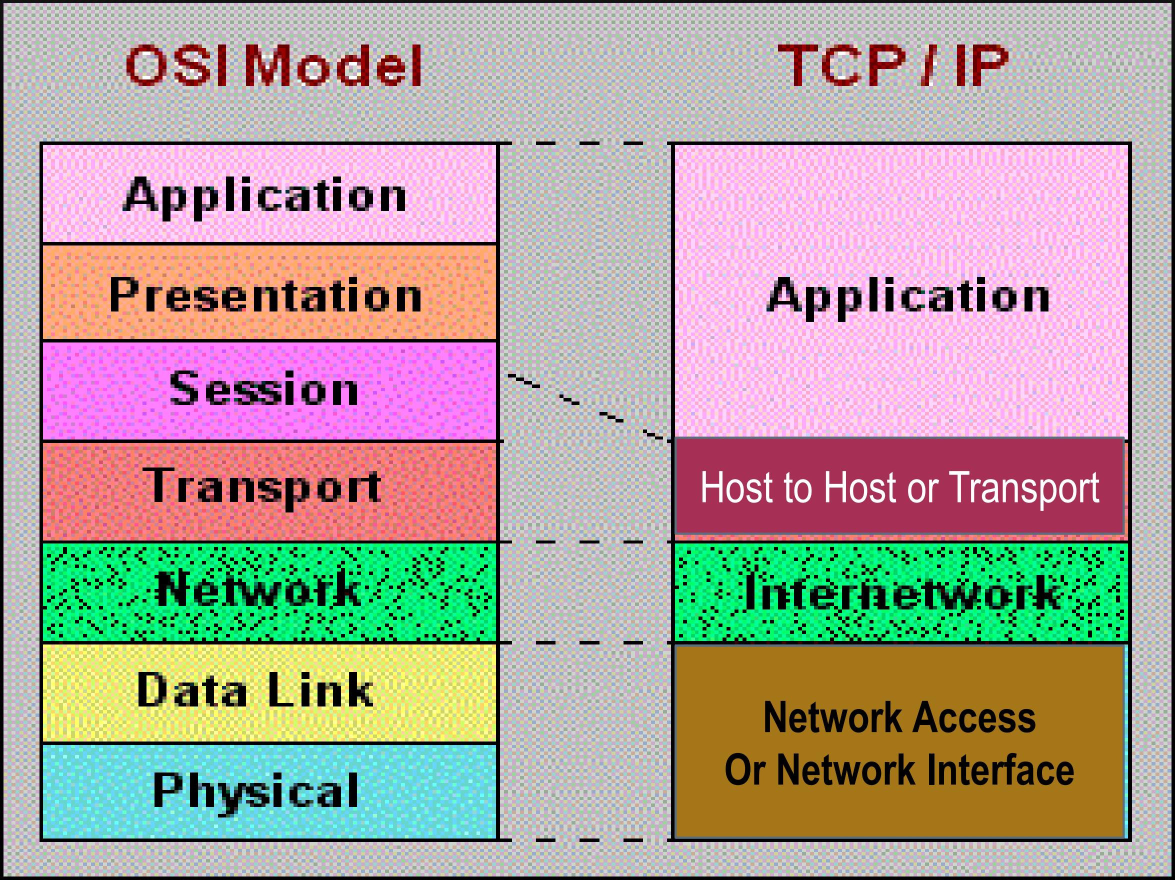
OSI MODEL LAYER 7 – APPLICATION

This defines a protocol (way of sending data) that two different programs or applications understand.

- HTTP, HTTPS, FTP, TFTP, SMTP, SNMP, etc…
- Application Proxies
- Non-Repudiation
- Certificates
- Integration with Directory Services
- Time awareness.

TCP/IP MODEL

OSI VS. TCP/IP MODEL



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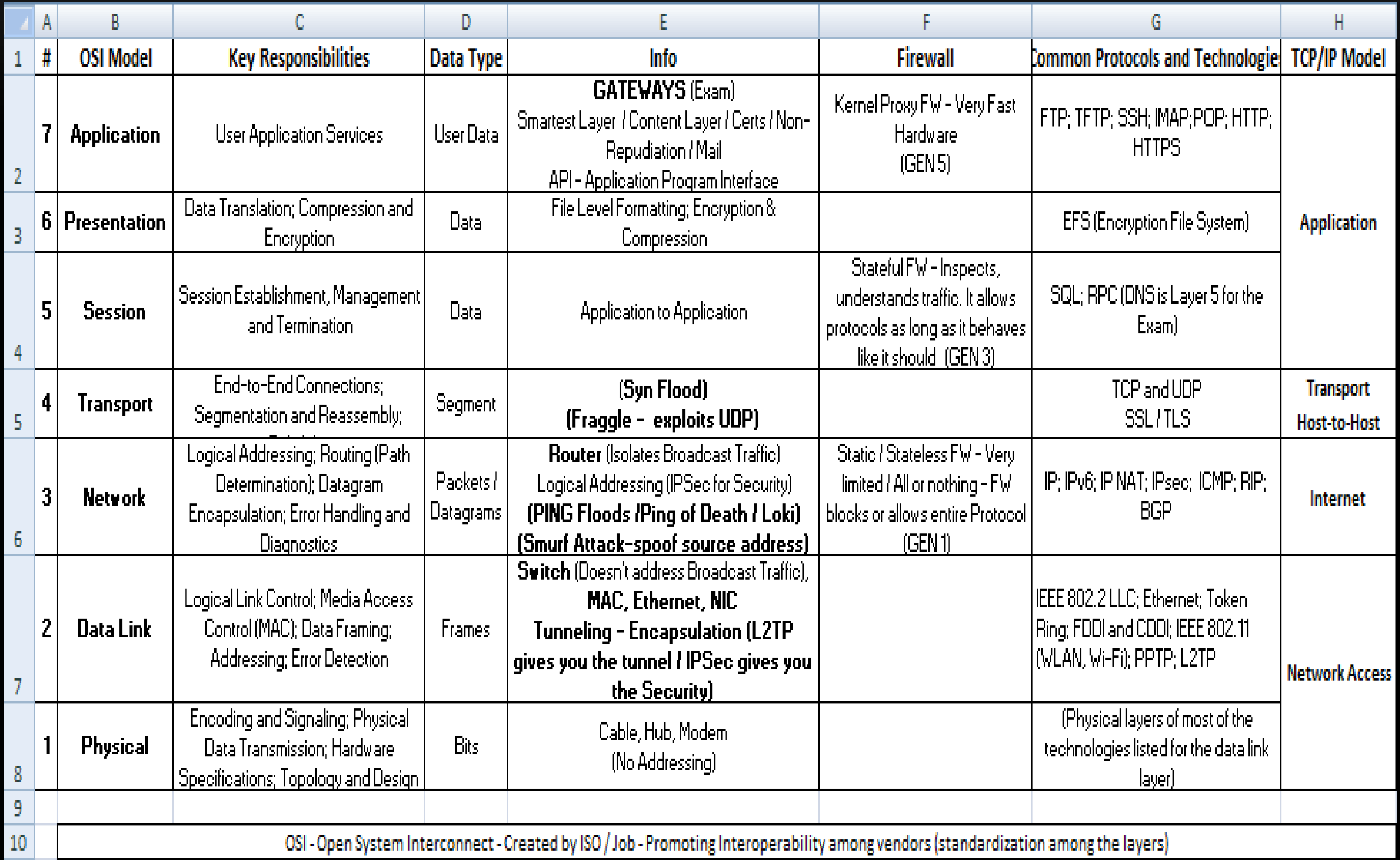
OSI/TCP…WHAT YOU NEED TO KNOW



	A	B	C	D	E	F	G	H
1	#	OSI Model	Key Responsibilities	Data Type	Info	Firewall	Common Protocols and Technologie	TCP/IP Model
2	7	**Application**	User Application Services	User Data	**GATEWAYS** (Exam) Smartest Layer / Content Layer / Certs / Non-Repudiation / Mail API - Application Program Interface	Kernel Proxy FW - Very Fast Hardware (GEN 5)	FTP; TFTP; SSH; IMAP;POP; HTTP; HTTPS	Application
3	6	**Presentation**	Data Translation; Compression and Encryption	Data	File Level Formatting; Encryption & Compression		EFS (Encryption File System)	
4	5	**Session**	Session Establishment, Management and Termination	Data	Application to Application	Stateful FW - Inspects, understands traffic. It allows protocols as long as it behaves like it should (GEN 3)	SQL; RPC (DNS is Layer 5 for the Exam)	
5	4	**Transport**	End-to-End Connections; Segmentation and Reassembly;	Segment	**(Syn Flood)** **(Fraggle - exploits UDP)**		TCP and UDP SSL / TLS	Transport Host-to-Host
6	3	**Network**	Logical Addressing; Routing (Path Determination); Datagram Encapsulation; Error Handling and Diagnostics	Packets / Datagrams	**Router** (Isolates Broadcast Traffic) Logical Addressing (IPSec for Security) **(PING Floods /Ping of Death / Loki)** **(Smurf Attack-spoof source address)**	Static / Stateless FW - Very limited / All or nothing - FW blocks or allows entire Protocol (GEN 1)	IP; IPv6; IP NAT; IPsec; ICMP; RIP; BGP	Internet
7	2	**Data Link**	Logical Link Control; Media Access Control (MAC); Data Framing; Addressing; Error Detection	Frames	**Switch** (Doesn't address Broadcast Traffic), **MAC, Ethernet, NIC** **Tunneling - Encapsulation (L2TP gives you the tunnel / IPSec gives you the Security)**		IEEE 802.2 LLC; Ethernet; Token Ring; FDDI and CDDI; IEEE 802.11 (WLAN, Wi-Fi); PPTP; L2TP	Network Access
8	1	**Physical**	Encoding and Signaling; Physical Data Transmission; Hardware Specifications; Topology and Design	Bits	Cable, Hub, Modem (No Addressing)		(Physical layers of most of the technologies listed for the data link layer)	
9								
10		OSI - Open System Interconnect - Created by ISO / Job - Promoting Interoperability among vendors (standardization among the layers)						

THREATS TO NETWORK SECURITY

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COMMON ATTACKS

- Virus: Virus A piece of malicious code that can take many forms and serve many purposes. Needs a host in which to live, and an action by the user to spread.
- Worm: Similar to a virus, but does not need a host and is self replicating
- Logic Bomb: A type of malicious code that lays dormant until a logical event occurs
- Trojan Horse: One program (usually some type of malicious code) masquerades as another. Common means of distributing Back Door Programs
- Back Door Programs: A Program that allows access (often administrative access) to a system that bypasses normal security controls. Examples are NetBus, Back Orifice, SubSeven

COMMON ATTACKS CONTINUED

- **Salami: Many small attacks add up to equal a large attack**
- **Data Diddling: Altering/Manipulating data, usually before entry**
- **Sniffing: Capturing and Viewing packets through the use of a protocol analyzer. Best defense: Encryption**
- **Session Hijacking: Where an attacker steps in between two hosts and either monitors the exchange, or often disconnects one. Session hijacks are types of Man in the Middle attacks. Encryption prevents sniffing and mutual authentication would prevent a session hijack**
- **Wardialing: An attack on a RAS (Remote Access Server) where the attacker tries to find the phone number that accepts incoming calls. RAS should be set to use caller ID (can be spoofed), callback (best), and configured so that modem does not answer until after 4 calls.**

COMMON ATTACKS CONTINUED

- Dos Denial of Service: The purpose of these attacks is to overwhelm a system and disrupt its availability
- DDoS Distributed Denial of Service: Characterized by the use of Control Machines (Handlers) and Zombies (Bots) An attacker uploads software to the control machines, which in turn commandeer unsuspecting machines to perform an attack on the victim. The idea is that if one machine initiating a denial of service attack, then having many machines perform the attack is better.
- Ping of Death: Sending a Ping Packet that violates the Maximum Transmission Unit (MTU) size—a very large ping packet.
- Ping Flooding: Overwhelming a system with a multitude of pings.

COMMON ATTACKS CONTINUED

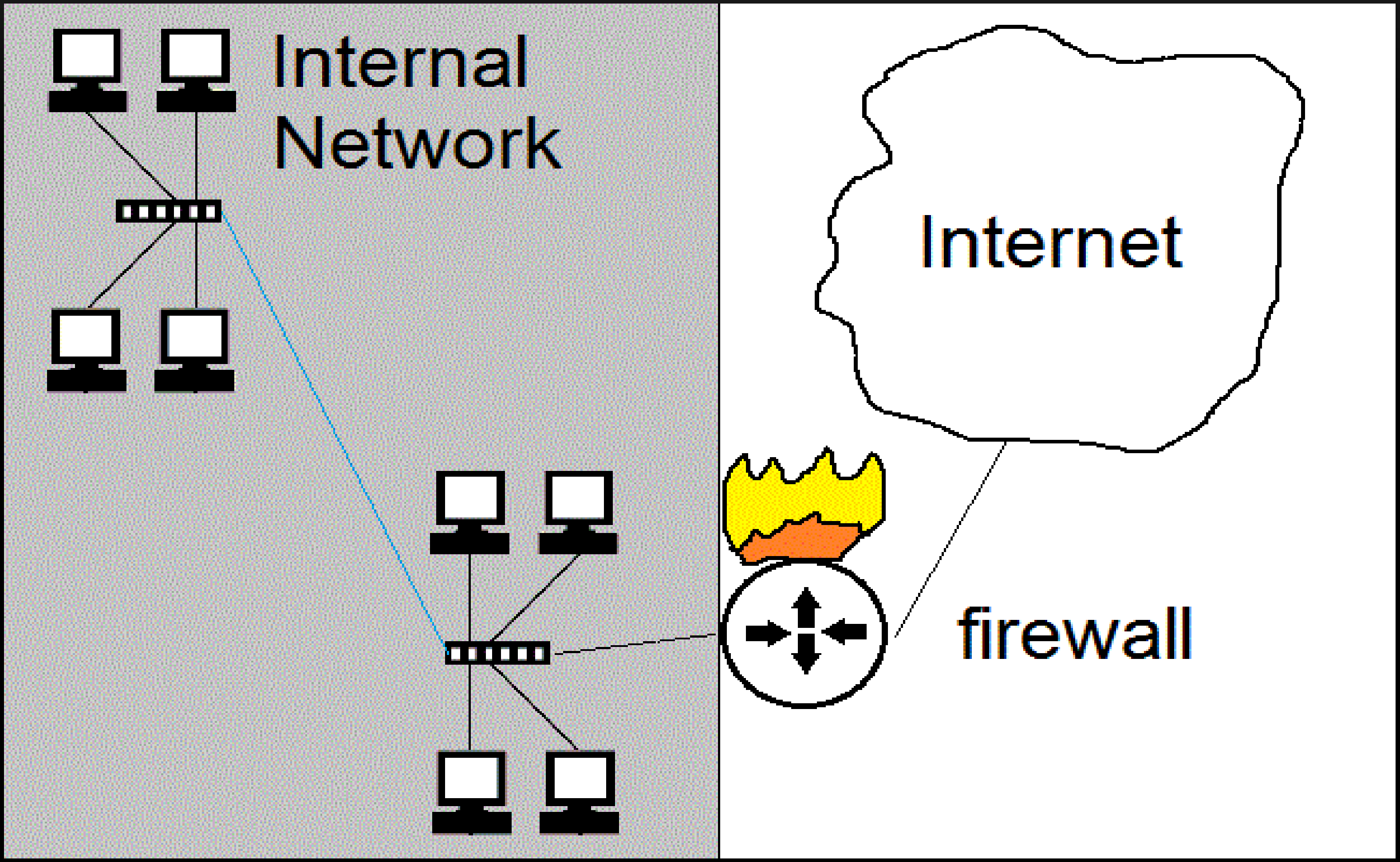
- Tear Drop: Sending Malformed packets which the Operating System does not know how to reassemble. Layer 3 attack
- Buffer Overflow: Attacks that overwhelm a specific type of memory on a system—the buffers. Is best avoided with input validation
- Bonk : Similar to the Teardrop attack. Manipulates how a PC reassembles a packet and allows it to accept a packet much too large.
- Land Attack: Creates a “circular reference” on a machine. Sends a packet where source and destination are the same.
- Syn Flood: Type of attack that exploits the three way handshake of TCP. Layer 4 attack. Stateful firewall is needed to prevent
- Smurf: Uses an ICMP directed broadcast. Layer 3 attack. Block distributed broadcasts on routers
- Fraggle: Similar to Smurf, but uses UDP instead of ICMP. Layer 4 attack. Block distributed broadcasts on routers

FIREWALLS, PROXIES, AND NAT

FIREWALLS AND THE OSI

- Firewalls: Allow/Block traffic
- Rules to Allow or Deny Traffic. Can be HW or SW
- Layer 3: Static Packet Filters: Base decisions on Source/Destination IP Address and Port
- Layer 5 Stateful inspection. Knowledge of who initiated the session. Can block unsolicited replies. Protocol Anomaly firewalls—can block traffic based on syntax being different than the RFC would specify
- Layer 7: Application Proxies/Kernel Proxies: Make decisions on Content, Active Directory Integration, Certificates, Time

FIREWALLS



FIREWALLS -

- **Enforce network policy.**
- **Usually firewalls are put on the perimeter of a network and allow or deny traffic based on company or network policy.**
- **MUST have IP forwarding turned off***
- **Firewalls are often used to create a DMZ.**
- **Generally are *dual/multi homed****
- **Types of firewalls**
  - Packet filtering
  - State full
  - Proxy
  - Dynamic packet filtering

PACKET FILTER -

- **Uses Access control lists (ACLs), which are rules that a firewall applies to each packet it receives.**
- **Not state full, just looks at the network and transport layer packets (IP addresses, ports, and “flags”)**
  - Do not look into the application, cannot block viruses etc…
  - Generally do not support anything advanced or custom

PACKET FILTER

- **Packet filters keep no *state****
  - Each packet is evaluated own it's own without regard to previous traffic
  - Advantages
  - Disadvantages
    - fragments
- **Rule based access control**
- **Packet filters are still used on the edge of the network before a statefull firewall for performance reasons.**

STATE FULL FIREWALL -

- **router keeps track of a connections in a table. It knows which conversations are active, who is involved etc...**
- **It allows return traffic to come back where a packet filter would have to have a specific rule to define returned traffic**
- **More complex, and can launch DoS against by trying to fill up all the entries in the state tables/use up memory.**
- **If rebooted can disrupt conversation that had been occurring.**
- ***Context dependant access control****

DYNAMIC PACKET FILTERING

- I believe the author is confusing about this topic and actually is describing a state full filter in the book. However there are firewalls that do allow “triggers” these could be called dynamic packet filters
- Like a state full firewall but more advanced. Can actually rewrite rules dynamically.
- Some protocols such as FTP have complex communications that require multiple ports and protocols for a specific application, packet and statefull filter cannot handle these easily, however dynamic packet filter can as they can create rules on the fly as needed.

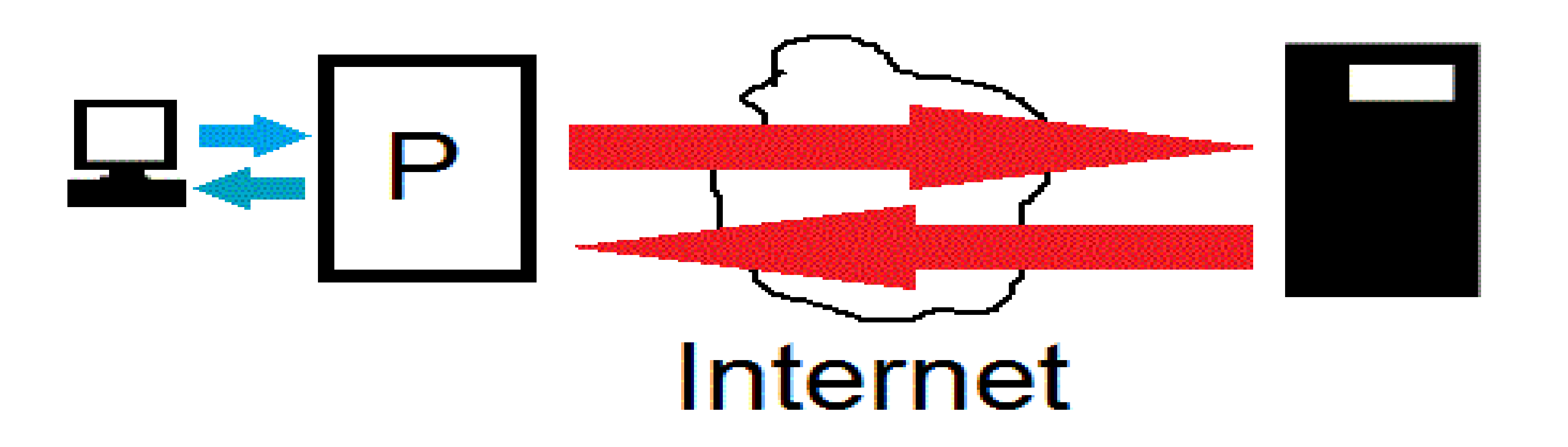
PROXY FIREWALLS

- **Two types of proxies**
  - Circuit level*
  - Application*

- **Both types of Proxies hide the internal hosts/addressing from the outside world.**

- **Talk about each of these on next slides**

APPLICATION PROXIES



- ▣ Like circuit layer proxies, but actually understand the application/protocol they are proxing.
- ▣ This allows for additional security as they can inspect the data for protocol violations or content.

APPLICATION PROXIES

Advantages

- Application proxies understand the protocol, so they can add extra security
- Can have advanced logging/auditing and access control features
  - Ex. Restrict users to only allowed websites
  - Ex. Inspect data for protocol violations
  - Ex. Inspect data for malware (viri etc..)

Disadvantages

- Extra processing requires extra CPU (slower)
- Proxies ONLY understand the protocols they were written to understand. So you generally have a separate application proxy for EACH protocol you want to proxy

APPLICATION PROXIES -

Examples:

- Internet Security and Acceleration Server (MS web proxy)
- SMTP proxies
- FTP proxies

SECURITY ZONES

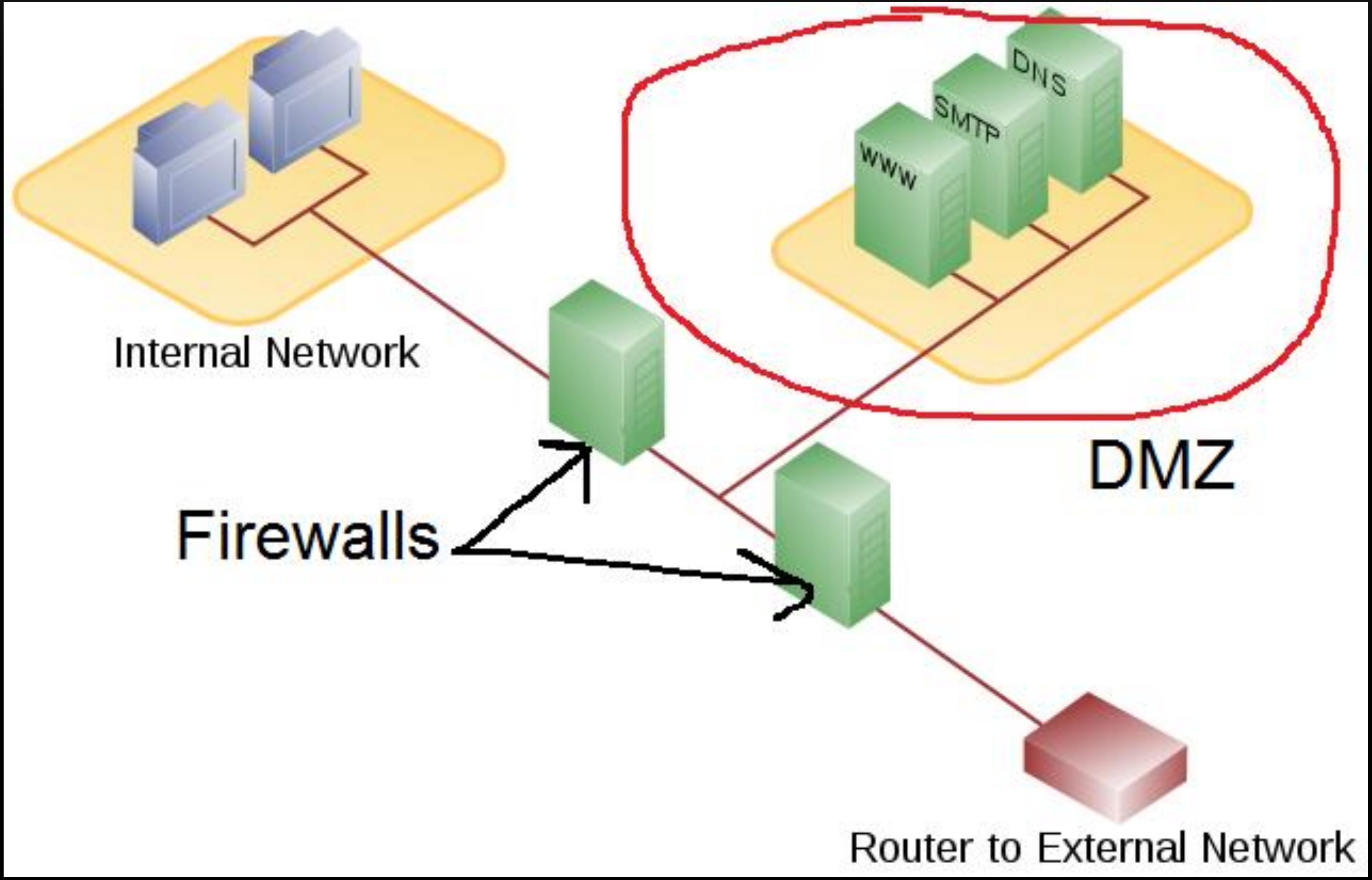
It is common practice in network and physical security to group different security levels into different areas or zones. Each zone is either more or less trusted then the other zones. Interfaces between zones have some type of access control to restrict movement between zones (like biometric and guard stations) or firewalls.) In Network security there is often a median zone between the Internet and internal network called a DMZ.

DMZ

A buffer zone between an unprotected network and a protected network that allows for the monitoring and regulation of traffic between the two.

- Internet accessible servers (*bastion hosts*) are placed in a DMZ between the Internet and Internal network

DMZ


Internal Network
DNS
SMTP
WWW
DMZ
Firewalls
Router to External Network

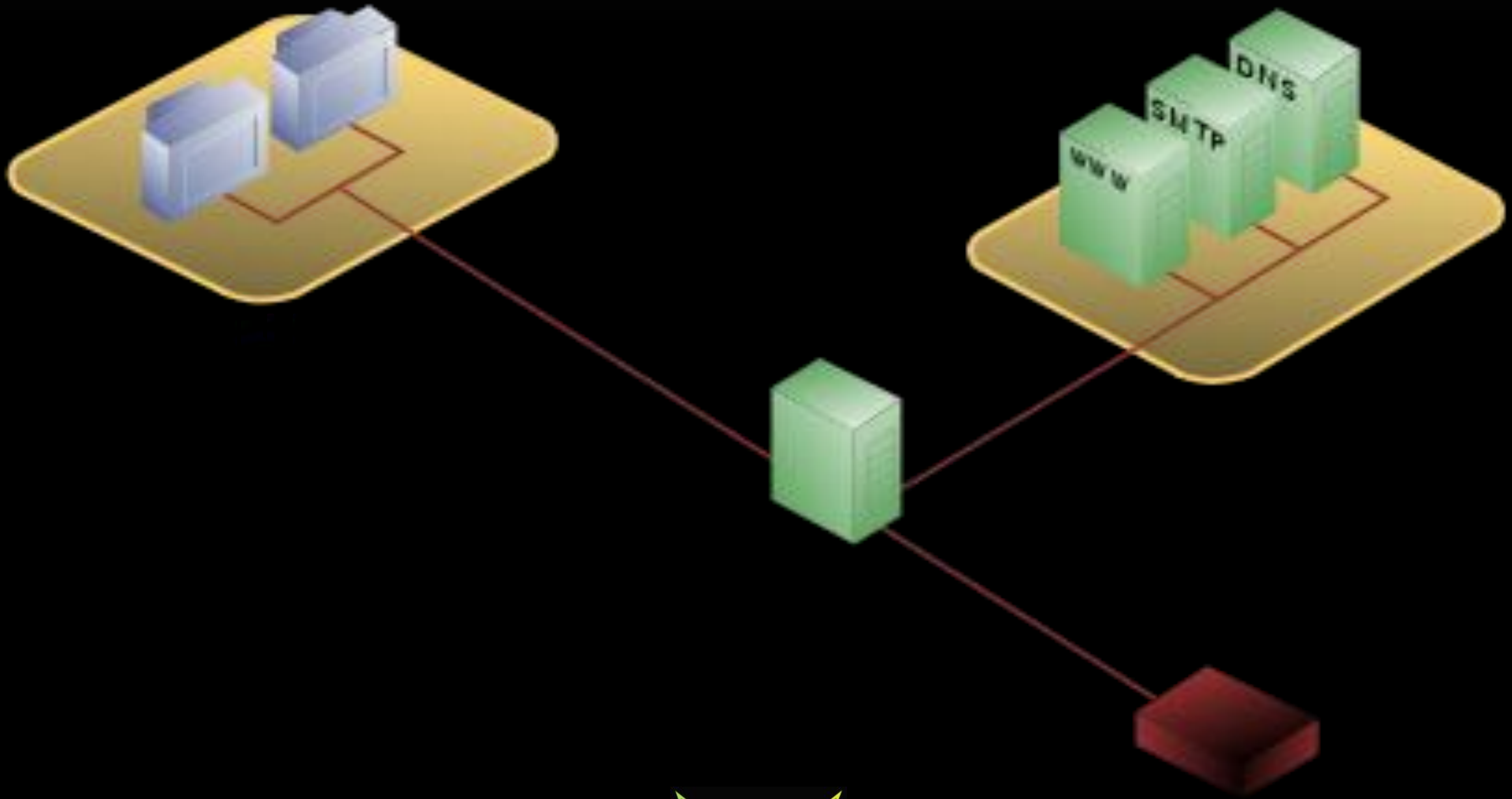
DMZ ARCHITECTURES

- Multi-homed Firewall
- Screened Subnet

MULTI HOMED FIREWALL -

- **Multi-homed firewalls may be used to setup a DMZ with a single firewall. (see next slide)**
- **On any multi-homed machine, *IP forwarding* should be disabled.***

MULTI-HOMED FIREWALL



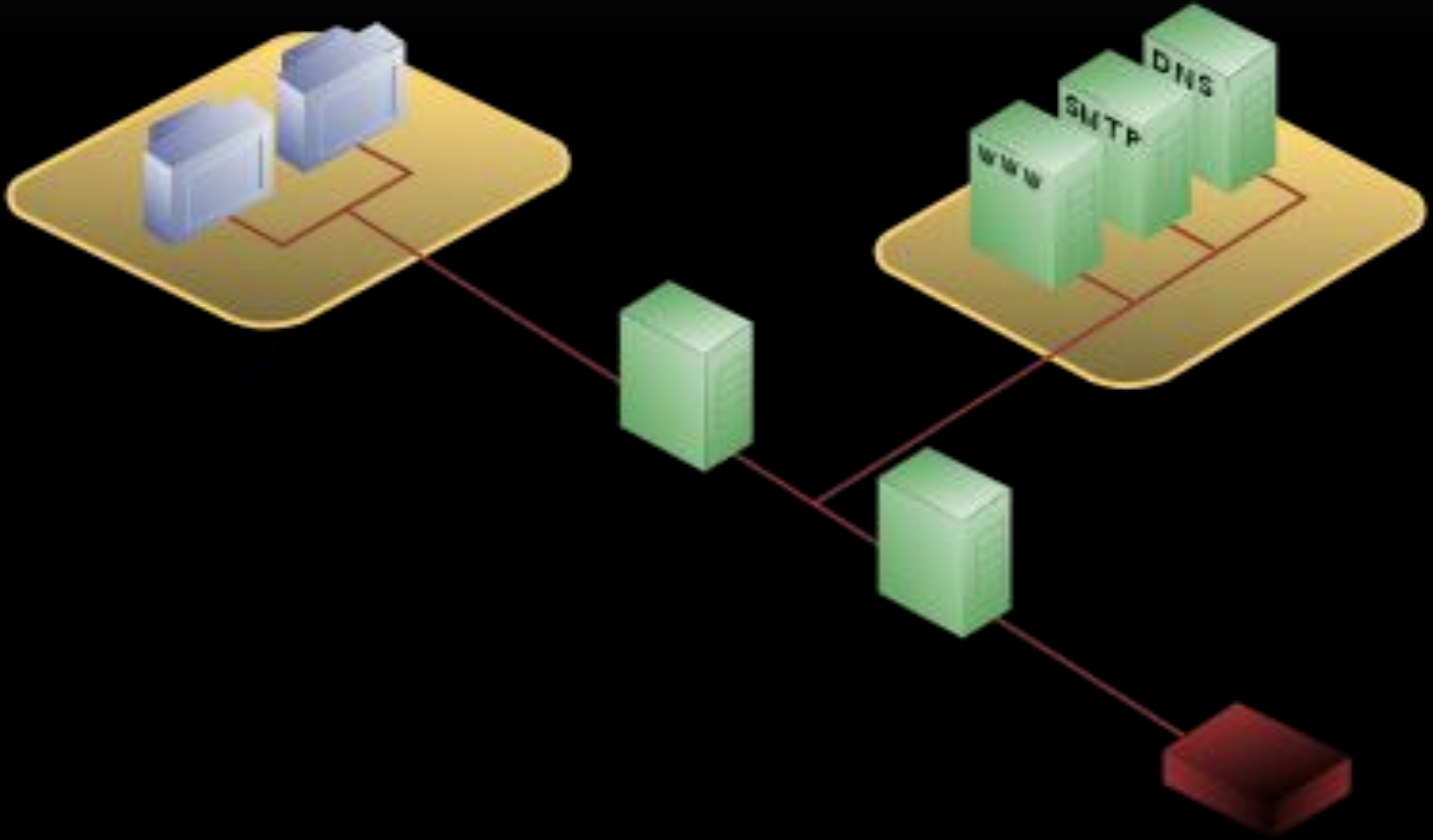
SCREENED SUBNET –

In a screen subnet, there is a separate firewall on both sides of the DMZ.

When using this model it is recommended that each firewall be a different vendor/product.

- *Diversity of defense**

SCREENED SUBNET



NAT/PAT

A proxy that works without special software and is transparent to the end users.

- Remaps IP addresses, allowing you to use *private addresses* internally and map them to *public IP addresses*
- NAT allows a one-to-one mapping of IP addresses
- PAT allows multiple *private address* to share one *public address*

NAT

- Computer 10.0.0.1 sends a packet to 175.56.28.3
- Router grabs packet, notices it is NOT addressed to it. Modifies the src address to one from it's pool (215.37.32.202), then sends the packet on it's way to the destination*
- The end machine accepts the packet as it's addressed to him.
- End machine creates response, src = itself (172.56.28.3) dest = 215.37.32.202
- Router grabs packet, notices the dest address, and looks up in it's NAT table, rewrites the dest to 10.0.0.1 and sends it on its way*
- Originating machine grabs response since it's addressed to him, he processes it.

NAT / PAT

- **Advantages**
  - Allows you to use private addresses Internally, you don’t need to get real public IP addresses for each computer
  - Protects the network by stopping external entities from starting conversations to internal machines
  - Hides internal network structure
  - Transparent, doesn’t require special software
- **Disadvantages**
  - Single Point of Failure / Performance Bottleneck
  - Doesn’t protect from bad content

RFC 1918

- 10.x.x.x
- 172.16.x.x-172.31.x.x
- 192.168.x.x

OVERALL FIREWALL ISSUES

- Potential bottleneck
- Can restrict valid access
- Often mis-configured
- Except for application proxies firewalls generally do not filter out malware or improper content.
- Don’t protect against internal attacks!*

OVERALL FIREWALL BEST PRACTICES

- **Block un-necessary ICMP packets types.**
  - (Be careful though, know your environment)
- **Keep ACLS simple**
- **Use *Implicit deny*****
- **Disallow *source routed packets*****
- **Use *least privilege*****
- **Block *directed IP* broadcasts**
- **Perform *ingress and egress filtering*****
  - **Block traffic leaving the network from a**

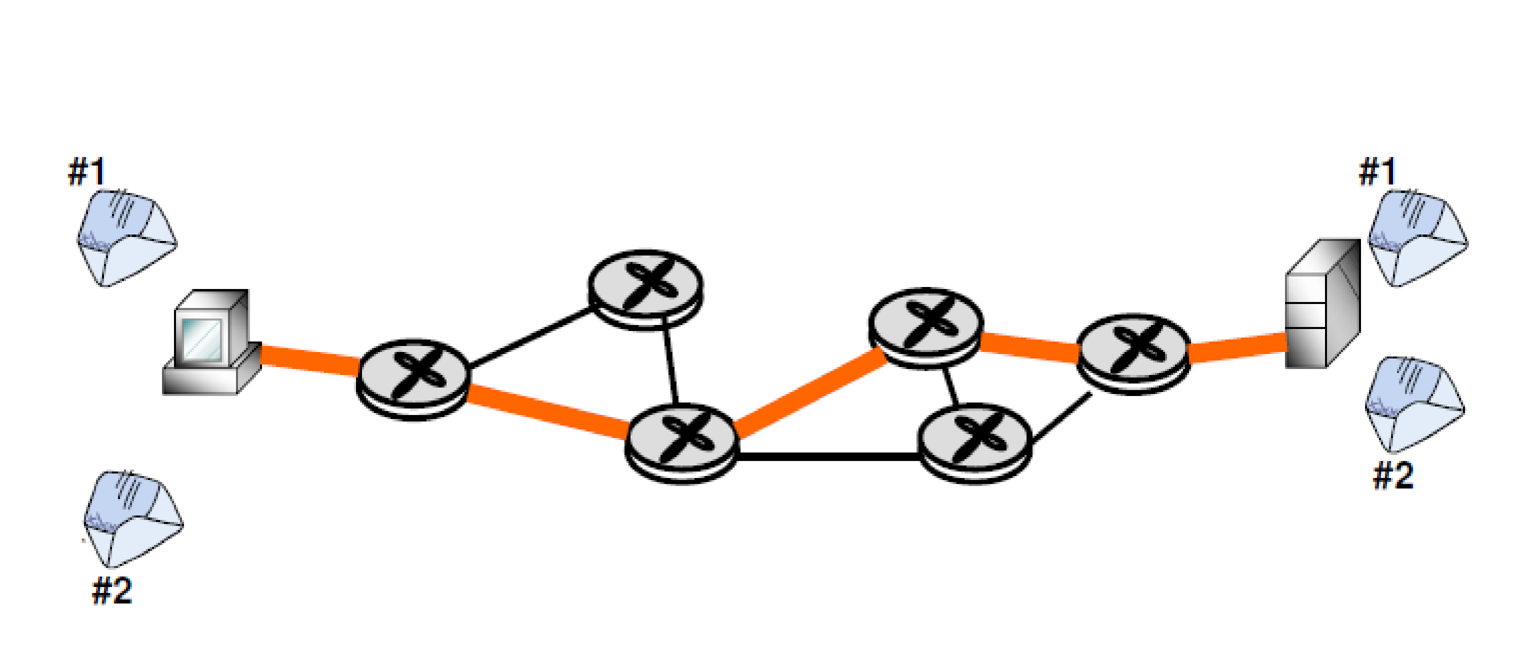
    non-internal address (indicates the network is possibly being used as zombie systems in a possible DDoS attack.
  - **Block all traffic entering the network from an internal address (indicates a potential spoofing attack)**
- **Enable logging**
- **Drop fragments or re-assemble fragments**

WAN TECHNOLOGY

LAN, WAN, MAN

- **LAN – local area network**
  - High speed
  - Small physical area
- **WAN – wide area network**
  - Used to connect LANS
  - Generally slow, using serial links
- **MAN – metropolitan area network**
  - Connect sites together within a medium range area (like a city)

CIRCUIT SWITCHING



CIRCUIT SWITCHING TECHNOLOGIES

- PSTN
- ISDN
- DSL
- T-carriers

DIAL UP (REMOTE ACCESS)

- **Disadvantages**
  - Back door into networks (bypass firewall)
  - Often forgotten about
  - Slow
- **Attacks***
  - War dialing
- **Defenses***
  - Dial Back /
  - Caller ID restrictions
  - Use authentication
  - Answer after 4 or more rings (why/war dialing)
  - Use a different numbering convention for RAS

ISDN

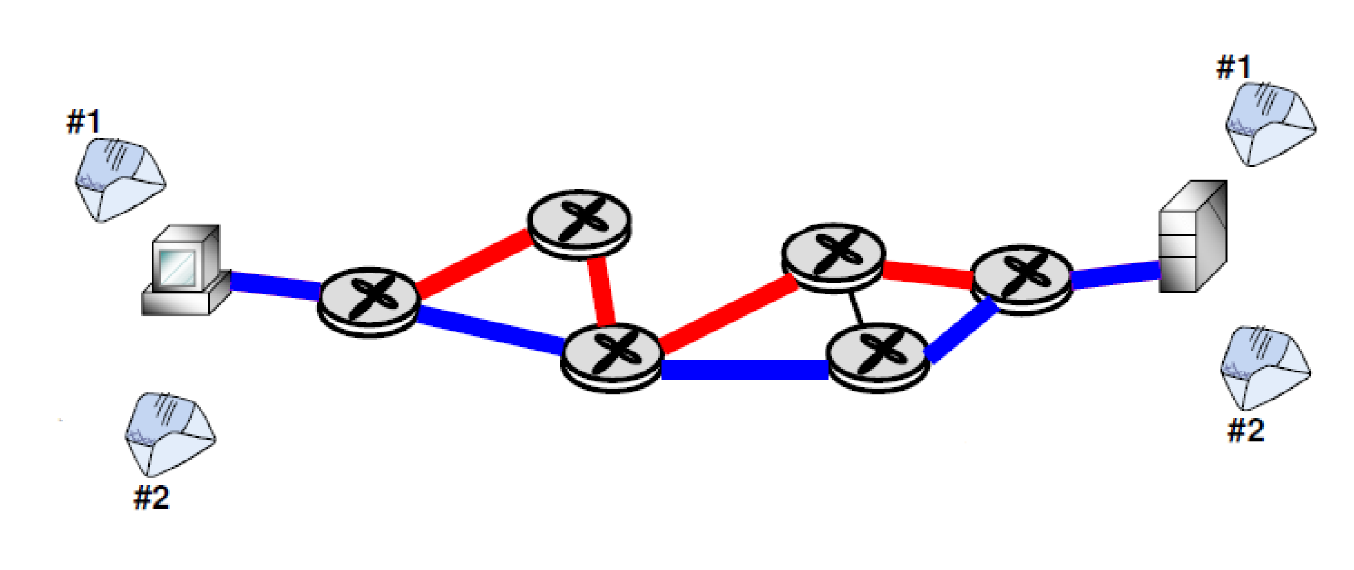
Uses same lines as phone lines, directly dial into company or ISP

- BRI
  - 2 B Channels (64Kbits x 2)
  - 1 D Channel (control channel) Out of Band
- PRI
  - 23 B Channels
  - 1 D Channel
  - Not for personal use

ADSL

- **MUCH faster than IDSN (6-30 times faster)**
- **Must live very close to the DSL equipment**
- **Symmetric and Asymmetric**
- **Always on (security concerns)**

PACKET SWITCHING



PACKET SWITCHING TECHNOLOGIES

- X.25
- Frame Relay
- ATM
- VOIP
- MPLS
- Cable Modems

CABLE MODEM -

High speed access up to 50Mbps via cable TV lines.

- Shared bandwidth
- Always on (security concerns)

MPLS (MULTI PROTOCOL LABELED SWITCHING

- MPLS is used to create cost effective, private Wide Area Networks (WANs) faster and more secure than regular routed “public” IP networks like the internet.
- More secure than the public internet, because a “virtual” private network (end-to-end circuit)can be built just for your organization
- Since it’s a private network, we don’t have to configure and maintain traditional encryption based Virtual Private Networking (VPN) equipment anymore, and can also avoid the latency and delay inherent in this technology.
- Provides QoS for VOIP and other high priority traffic
- Purely Layer 3 technology

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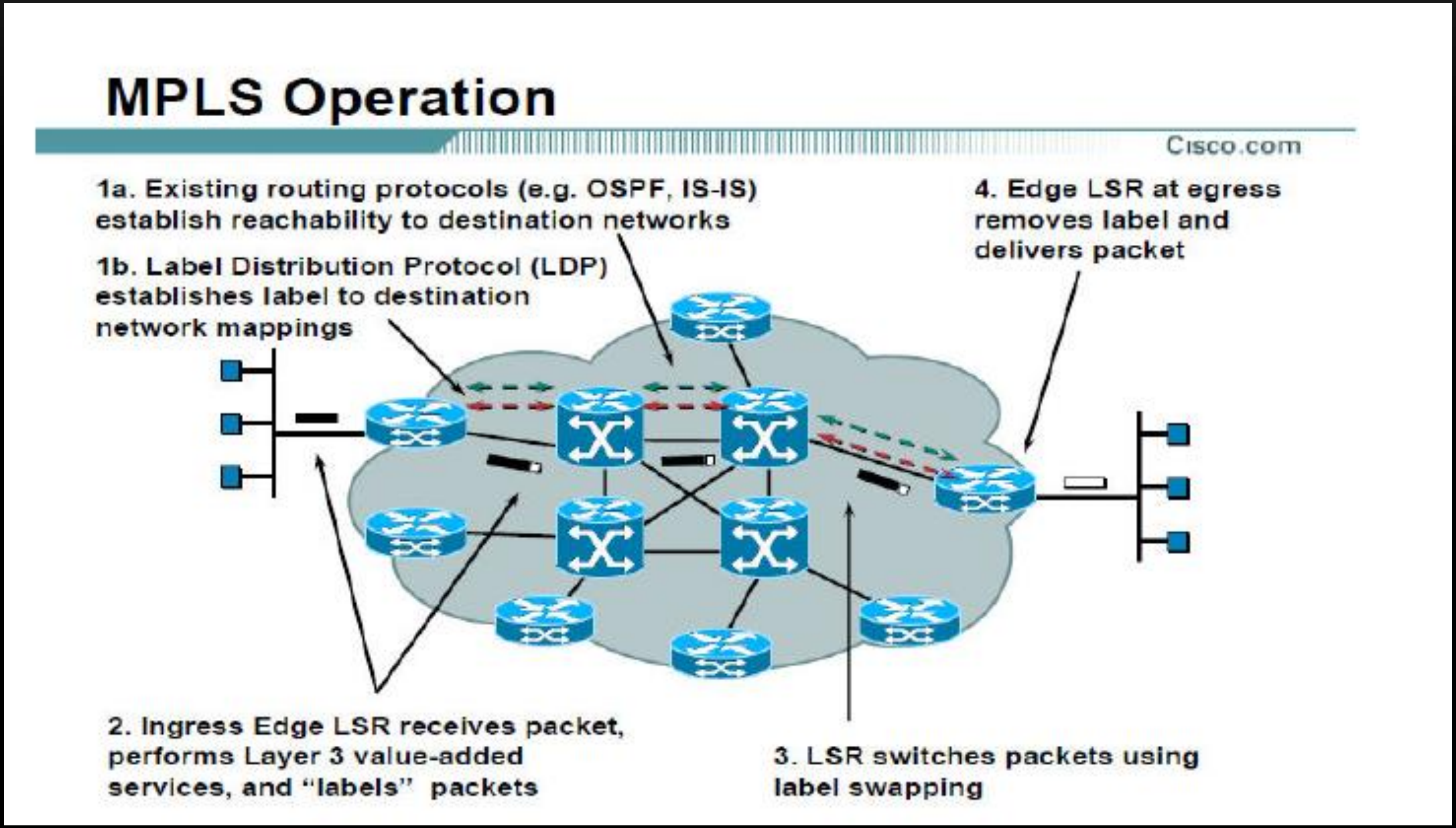
MPLS



MPLS Operation

Cisco.com

1a. Existing routing protocols (e.g. OSPF, IS-IS) establish reachability to destination networks

1b. Label Distribution Protocol (LDP) establishes label to destination network mappings

4. Edge LSR at egress removes label and delivers packet

2. Ingress Edge LSR receives packet, performs Layer 3 value-added services, and "labels" packets

3. LSR switches packets using label swapping

VOIP VOICE OVER IP

- **Converts analog to digital through use of Telephony adapter or smartphone**
- **Data is channeled though gateways (often lacking in authentication mechanisms leading to TOLL FRAUD)**
- **At the end of a VOIP connection the smartphone or TA converts the signal back to**

analog

VOIP SECURITY ISSUES

- Eavesdropping (greatest threat)—Enable S/RTP
- Toll Fraud
- Vishing
- SPIT

Performance Issues

- Latency
- Jittering

REMOTE ACCESS PROTOCOLS

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DIAL-UP

- **PPP Point to Point Protocol: Provides Layer 2 framing for dial-up. Needs other protocols for security**
  - Encryption: MPPE
  - Authentication:
    - PAP (Password Authentication Protocol): Clear Text
    - CHAP (Challenge Handshake Authentication Protocol) Client responds to a challenge from the server. The only way the client can answer correctly is if the correct password had been entered.
    - EAP (Extensible Authentication Protocol) Extends capabilities beyond passwords (smart cards, biometrics, token devices, etc..)

TUNNELING

A function of VPNs - Tunnel encapsulates one protocol within another protocol to create a virtual network.

- Can encrypts original IP headers
- Can encrypts data
- Allows for routing non routable protocols and IP addresses
- Can provide remote/internal IP addresses

VPN PROTOCOLS

Different protocols

- PPTP
- L2TP
- IPSEC

PPTP

Point to Point Tunneling Protocol

Based on PPP (uses MPPE for encryption and PAP, CHAP or EAP for authentication)

- ▣ Lead by Microsoft protocol for a tunneling VPN
- ▣ Only works across IP networks
- ▣ Remote user connects to ISP, gets an Internet Address
- ▣ Establishes VPN connection to work VPN server, get's Internal IP address.
- ▣ Sends private IP packets encrypted within other IP packets.

L2TP

Layer 2 Tunneling Protocol

- Cisco designed L2F to break free of dependence on IP networks, but kept it proprietary.
- L2TP was a combination of L2F and PPTP
- Designed to be implemented in software solutions
- THERE IS NO SECURITY with L2TP. It MUST use IPSec to secure

WIRELESS

WIRELESS COMPONENTS

- Access points are like wireless hubs, they create a *infrastructure* WLAN
- If you use just wireless cards of computers to communicate together that is called an *ad-hoc** network.
- Wireless devices must use the same *channel*
- Devices are configured to use a specific SSID (often broadcasted)

802.11 FAMILY

- **802.11a**
  - 54Mbps
  - 5Ghz
  - 8 channels
- **802.11b**
  - 11Mbs
  - 2.4Ghz (same as other home devices)
- **802.11g**
  - 54Mbs
  - 2.4Ghz
- **802.11i : Wireless with security. First standard to require WPAII**
- **802.11n**
  - 100Mbs
  - 2.4Ghz or 5Ghz

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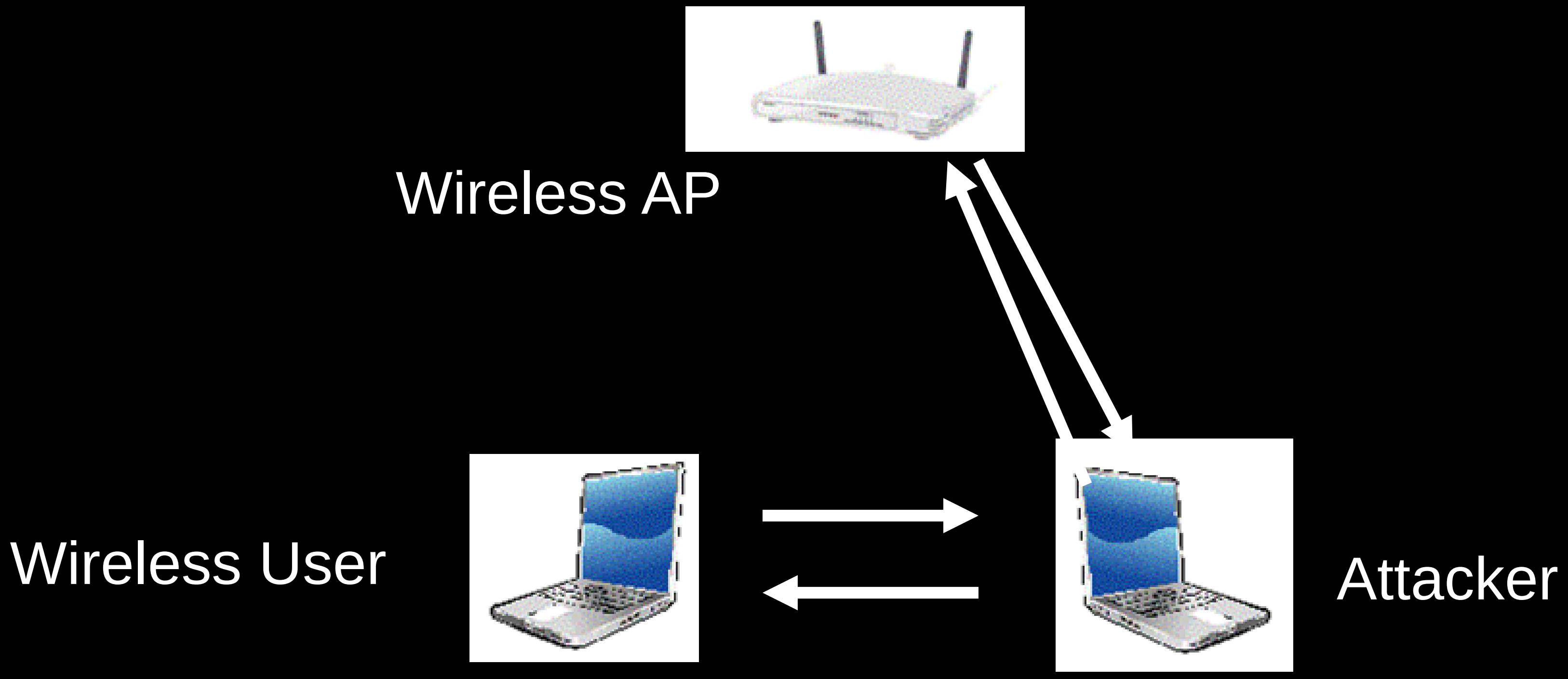
WIRELESS SECURITY PROBLEMS

- Unauthorized access
- sniffing
- War driving
- Unauthorized access points (Man in the middle)

AIRSNARFING (WIRELESS MITM)



TRANSMISSION ENCRYPTION

- **There are many different types of wireless encryption protocols**
- **WEP**
  - Shared authentication passwords
  - Weak IV (24 bits)
  - IV transmitted in clear text
  - RC-4 (stream cipher)
  - Easily crackable
  - Only option for 802.11b
- **WPA**
  - Stronger IV
  - Introduced TKIP
  - Still used RC-4

TRANSMISSION ENCRYPTION

- **WPA2**
  - AES
  - CCMP
  - NOT backwards compatible
- **WPA and WPA2 Enterprise**
  - Uses 802.1X authentication to have individual passwords for individual users
  - RADIUS

BLUETOOTH

Bluetooth is a Personal Area Network protocol designed to free devices from physical wires.

- **Bluetooth Modes**
  - Discovery Mode
  - Automatic Pairing

BLUETOOTH ATTACKS

- **Blue jacking**
  - Sending SPAM to nearby Bluetooth devices
- **Blue Snarfing**
  - Copies information off of remote devices
- **Blue bugging**
  - More serious
  - Allows full use of phone
  - Allows one to make calls
  - Can eavesdrop on calls

BLUETOOTH COUNTERMEASURES

- Disable it if you’re not using it
- Disable auto-discovery
- Disable auto-pairing

WAP

Wireless Application Protocol – a protocol developed mainly to allow wireless devices (cell phones) access to the Internet.

- Requires a Gateway to translate WAP <-> HTML (see visual)
- Uses WTLS to encrypt data (modified version of TLS)
- Uses HMAC for message authentication
- WAP GAP* problem (see visual and explain)
- A lot of wireless devices don’t need WAP anymore.

Cloud Computing

- A new paradigm in computing that involves the provision and hosting of services over the Internet, modeled after a pay-as-you-go approach.
- It allows organizations to extend their existing computing capabilities and also easily scale up.
- As of now three variety of services are provided, namely, Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS).
- There are also four different types of deployment approaches, namely, Private Clouds, Public Clouds, Community Clouds, and Hybrid Clouds.
- Cloud computing can offer useful extensions to enterprise Architectures, on demand without any additional capital investment.
- Many organizations are concerned with security in the cloud and are hesitating going into the cloud.

TELECOMMUNICATIONS AND NETWORK SECURITY OBJECTIVES

- **OSI Reference Model**
- **Network Protocols**
- **Network Connectivity Devices**
- **Threats to Network Security**
- **Firewalls**
- **WAN Technology**
- **Wireless Communications**

REMEMBER…

- Senior management is responsible for the physical safety of their employee
- Focus on prevention, not correction
- Human life should always supersede other assets
- Physical security is the first line of defense in protecting a company's assets

TELECOMMUNICATIONS AND NETWORK SECURITY REVIEW

- OSI Reference Model
- Network Protocols
- Network Connectivity Devices
- Threats to Network Security
- Firewalls
- WAN Technology
- Wireless Communications

CHAPTER 5

Identity and Access Management

IDENTITY AND ACCESS MANAGEMENT

- **Identity Management**
  - Controls the life cycle for all accounts in a system
- **Access Management**
  - Controls the assignment of rights/privileges to those accounts
- **Per ISC2, Identity and Access Management solutions "focus on harmonizing the provisioning of users and managing their access across multiple systems with different native access control systems".**

ACCESS CONTROLS OBJECTIVES

- **IAAA**
  - Identification
  - Authentication
    - Type I (Knowledge)
    - Type II (Possession)
    - Type III (Biometrics)
  - Authorization
  - Accounting
- **Single Sign On**
- **Access Control Models**
- **Access Control Methods**
- **Access Control Administration**
- **Data Emanation**

ACCESS CONTROLS

Access controls are security mechanisms that control how subjects can interact with objects.

Controls should be layered and provide both proactive and reactive protection.

ACCESS

Access is the data flow between an subject and an object.

- Subject is active--a person, process or program
- Object is passive--a resource (file, printer etc..)
- Access controls should support the CIA triad and regulate what a subject can do with an object

ACCESS CONTROLS

Access controls are security features that control how people can interact with systems, and resources.

- Logical
- Physical
- Administrative

IAAA OF ACCESS CONTROL

The components of Access Control that we are about to discuss are:

- Identification:
  - Make a claim (userid etc..)
- Authentication:
  - Provide support (proof) for your claim
- Authorization:
  - What rights and permissions you have
- Auditing:
  - Accountability—matching actions to subjects

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IDENTIFICATION

- Public Information (usually we aren’t concerned with protecting identities)
- Identification **must** be unique for accountability
- Standard naming schemes should be used
- Identifier should not indicate extra information about user (like job position)
  - User ID
  - Account Number
  - RFID
  - IP or MAC address

AUTHENTICATION

Proving your identity

- Type 1: Something you know
- Type 2: Something you have
- Type 3: Something you are

TYPE 1: SOMETHING YOU KNOW

- **Passwords/Passphrases/Cognitive Password**
- **Best practices**
  - No less than 8 characters
  - Change on a regular basis
  - Enforce password history
  - Consider brute force and dictionary attacks
  - Ease of cracking cognitive passwords
  - Graphic Image
  - Enable clipping levels and respond accordingly

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TYPE 2: SOMETHING YOU HAVE

- Token Devices
- Smart Card
- Memory Card
- Hardware Key
- Cryptographic Key
- Certificate
- Cookies

TOKEN DEVICES: ONE TIME PASSWORD GENERATORS

Password that is used only once then no longer valid

- One time password reduces vulnerability associated with sniffing passwords.
- Simple device to implement
- Can be costly
- Users can lose or damage
- Two Types: Synchronous/Asynchronous

SYNCHRONOUS TOKEN DEVICES

•Rely upon synchronizing with authentication server.
Frequently time based, but could be event based
•If damaged, or battery fails, must be re-synchronized
•Authentication server knows what “password” to expect based on time or event.

ASYNCHRONOUS TOKEN DEVICES

Asynchronous/ Challenge Response

- User logs in
- Authentication returns a challenge to the user
- User types challenge string into token device and presses enter.
- Token devices returns a reply
- Only that specific user's token device could respond with the expected reply.
- More Complex than synchronous
- May provide better protection against sniffing

MEMORY CARDS

MEMORY CARDS

- Holds information, does NOT process
- A memory card holds authentication info, usually you'll want to pair this with a PIN… WHY?
- A credit card or ATM card is a type of memory card, so is a key/swipe card
- Usually insecure, easily copied.*

SMART CARD

AVAYA
IPO 500 FEATURE KEY MU-LAW
AVAYA ID
700417470
SN
5100347
46YKY0002UKAB
SN 5100347

SMART CARD (191)

- More secure than memory cards
- Can actually process information
- Includes a microprocessor
- Often integrated with PKI
- Two types
  - Contact
  - Contactless

SMART CARD ATTACKS

There are attacks against smart cards

1. **Fault generation – manipulate environmental controls and measure errors in order to reverse engineer logic**
2. **Side Channel Attacks – Measure the cards while they work**
   - Differential power analysis – measure power emissions
   - Electromagnetic analysis – example frequencies emitted
3. **Micro probing - using needles to vibrations to remove the outer protection on the cards circuits. Then tap into ROMS if possible or "die" ROMS to read data.**

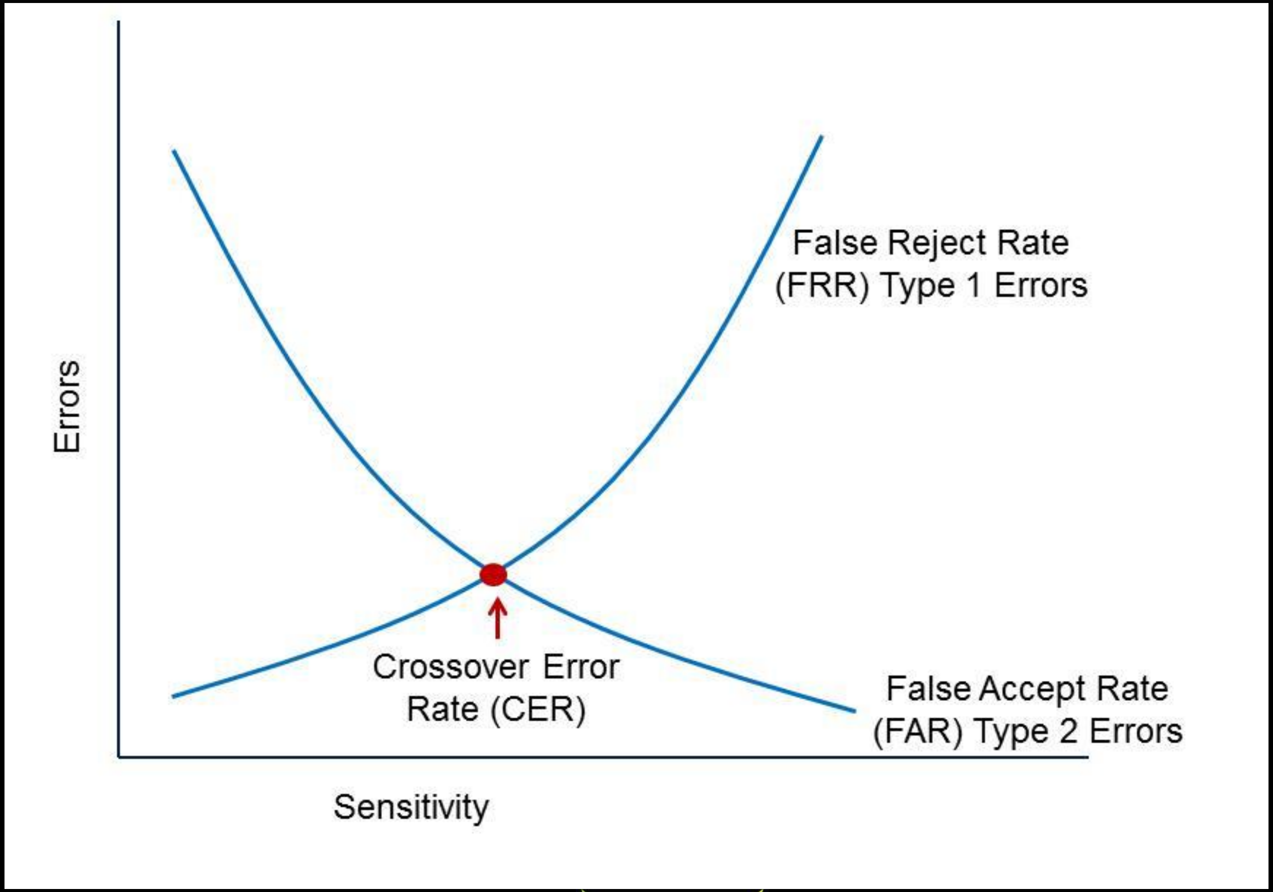
TYPE 3: SOMETHING YOU ARE

- **Biometrics**
  - Static: Should not significantly change over time. Bound to a user’s physiological traits
    - Fingerprint, hand geometry, iris, retina, etc..
  - Dynamic: Based on behavioral traits
    - Voice, gait, signature, keyboard cadence, etc..
    - Even though these can be modified temporarily, they are very difficult to modify for any significant length of time.

BIOMETRIC CONCERNS

- **Accuracy**
  - Type I Error: False Rejection--A legitimate user is barred from access. Is caused when a system identifies too much information. This causes excessive overhead.
  - Type II Error: False Acceptance—An impostor is allowed access. This is a security threat and comes when a system doesn't evaluate enough information
  - As FRR goes down, FAR goes up and vice versa
  - The level at which the two meet is called CER (Crossover Error Rate). The lower the number, the more accurate the system
  - Iris Scans are the most accurate

CROSSOVER ERROR RATE



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BIOMETRIC CONCERNS

- **User Acceptance**
- **Many users feel biometrics are intrusive**
  - Retina scans can reveal health care information
- **Time for enrollment and verification can make user's resistant**
- **Cost/benefit analysis**
- **No way to revoke biometrics**

BIOMETRIC CONCERNS

- Cost
- Biometric systems can be very costly and require unwieldy technology
- Though costs are coming down for means like fingerprint recognition, other technologies still remain prohibitive

STRONG AUTHENTICATION

Strong Authentication is the combination of 2 or more of these and is encouraged!

- Strong Authentication provides a higher level of *assurance**
- Strong Authentication is also called multi-factor *authentication**
- Watch out! Most people want to choose biometrics as the best authentication, but any one source can be compromised. Always look for more than one type!
- Mutual Authentication is beneficial

AUTHORIZATION

The concept of ensuring that someone who is authenticated is allowed access to a resource.

- Authorization is a preventative control
- Race conditions would try to cause authorization to happen before authentication

AUDITING

Logging and reviewing accesses to objects.

- What is the purpose of auditing?
- Auditing is a detective control

AUTHORIZATION

AUTHORIZATION

Now that I proved I am who I say I am, what can I do?

- Both OSes and Applications can provide this functionality.
- Authorization can be provided based on user, groups, roles, rules, physical location, time of day (*temporal isolation*)* or transaction type (example a teller may be able to withdrawal small amounts, but require manager for large withdrawals)

AUTHORIZATION PRINCIPALS

- **Default NO access (*implicit deny*)* - Unless a subject is explicitly given access to an object, then they are implicitly denied access.**
- **Principle of Least Privilege**
- **Need to know**
- **Content-based**

AUTHORIZATION CREEP

As a subject stays in an environment over time, their permissions accumulate even after they are no longer needed.

- Auditing authorization can help mitigate this. SOX requires yearly auditing.

SINGLE SIGN ON

As environments get larger and more complex it becomes harder and harder to manage users accounts securely.

- Multiple users to create/disable
- Passwords to remember, leads to passwords security issues
- Reduces user frustration as well as IT frustration!
- Wastes your IT budget trying to manage disparate accounts.

SINGLE SIGN ON

Single sign on systems try to mitigate this problem. Some SSO systems are.

- Kerberos
- LDAP
- Sesame
- KryptoKnight

SSO SINGLE SIGN-ON PROS AND CONS

- **Pros**
  - Ease of use for end users
  - Centralized Control
  - Ease of administration
- **Cons**
  - Single point of failure
  - Standards necessary
  - Keys to the kingdom

SSO TECHNOLOGIES

- Kerberos
- SESAME
- LDAP
- Microsoft Active Directory*

KERBEROS

- A network authentication protocol designed from MITs project Athena. Kerberos tries to ensure authentication security in an insecure environment
- Used in Windows2000+ and some Unix
- Allows for single sign on
- Never transfers passwords
- Uses Symmetric encryption to verify Identifications
- Avoids replay attacks

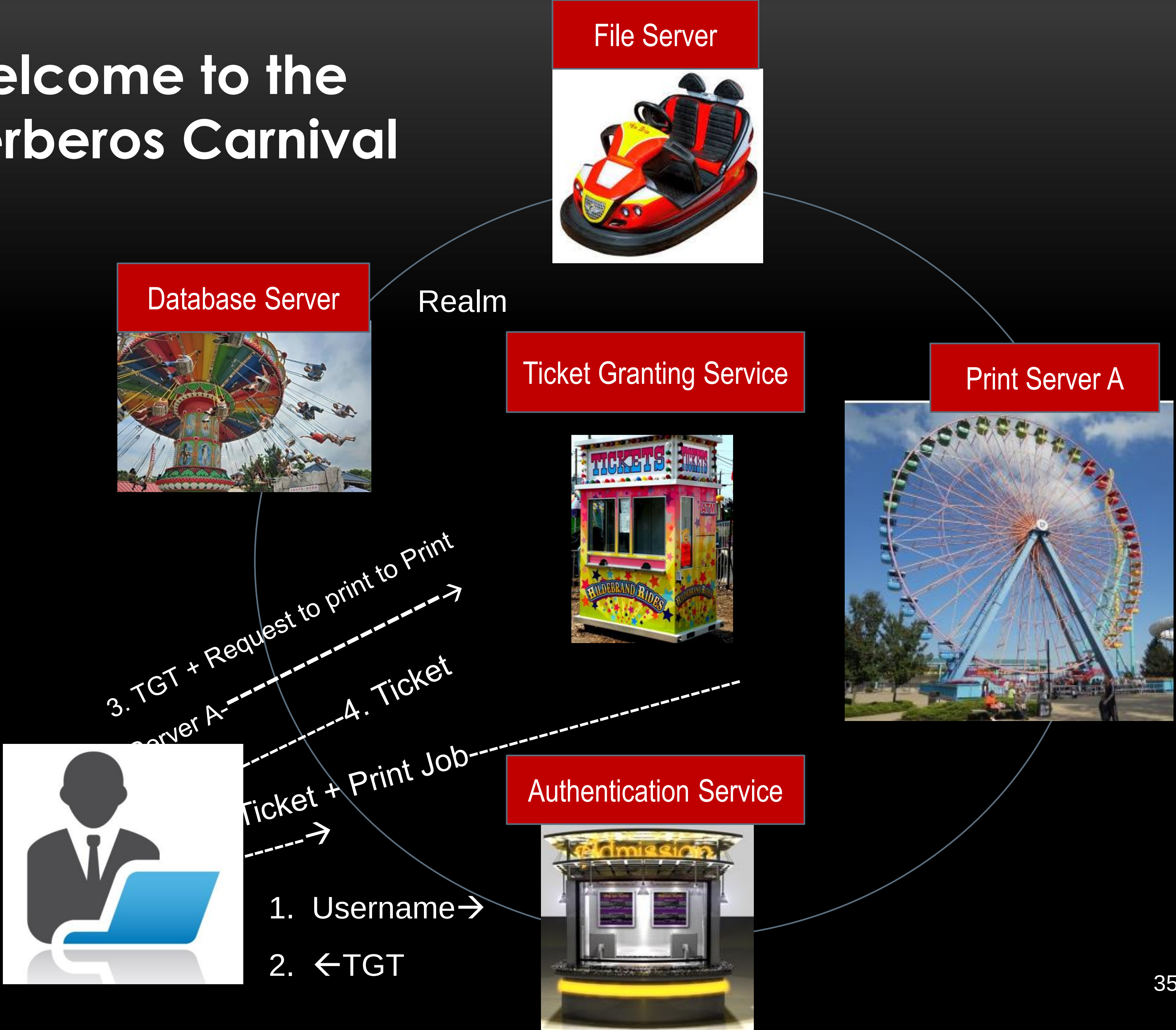
KERBEROS COMPONENTS

- Essential Components:
- AS (Authentication Server): Allows authentication of the user and issues a TGT
- TGS: After receiving the TGT from the user, the TGS issues a ticket for a particular user to access a particular service
  KDC (Key Distribution Center) a system which runs the TGS (Ticket Granting Service) and the AS (Authentication Service)
- Ticket: Means of distributing Session Key
- Principles (users, applications, services)
- Kerberos Software (integrated into most Operating Systems. MS Windows 2000 and up support Kerberos)
- Main Goal: User needs to authenticate himself/herself without sending passwords across the network—needs to prove he/she knows the password without actually sending it across the wire.

Welcome to the Kerberos Carnival

Realm

Welcome to the Kerberos Carnival



KERBEROS CONCERNS

- **Computers must have clocks synchronized within 5 minutes of each other**
- **Tickets are stored on the workstation. If the workstation is compromised your identity can be forged.**
- **If your KDC is hacked, security is lost**
- **A single KDC is a single point of failure and performance bottleneck**
- **Still vulnerable to password guessing attacks**

SESAME

European technology, developed to extend Kerberos and improve on it’s weaknesses

- Sesame uses both symmetric and asymmetric cryptography.
- Uses “Privileged Attribute Certificates” rather than tickets, PACS are digitally signed and contain the subjects identity, access capabilities for the object, access time period and lifetime of the PAC.
- PACS come from the Privileged Attribute Server.

KRYPTOKNIGHT

- **Should only be known as an older obsolete SSO Technology**

SUPER SIGN-ON AND FEDERATED SERVICES

- XML: Universal format for storing information
- SPML: XML based format for exchanging user and resource information and controlling provisioning
- SAML: provides an XML-based framework for exchanging security-related information over networks

ACCESS CONTROL MODELS

ACCESS CONTROL MODELS

A framework that dictates how subjects access objects.

- Uses access control technologies and security mechanisms to enforce the rules
- Supported by Access Control Technologies
- Business goals and culture of the organization will prescribe which model is used
- Every OS has a security kernel/reference monitor (talk about in another chapter) that enforces the access control model.

ACCESS CONTROL MODELS

The models we are about to discuss are

From the TCSEC(Trusted Computer System Evaluation Criteria—Orange Book)

  - DAC (Discretionary Access Control)
  - MAC (Mandatory Access Control)

- **Established Later**
  - RBAC (Role based Access Control)

DAC

Discretionary Access Control

- Security of an object is at the owner's discretion
- Access is granted through an ACL (Access Control List)
- Commonly implemented in commercial products and all client based systems
- Identity Based

MAC

Mandatory Access Control

- Data owners cannot grant access!
- OS makes the decision based on a security label system
- Subject’s label must dominate the object’s label
- Users and Data are given a clearance level (confidential, secret, top secret etc..)*
- Rules for access are configured by the security officer and enforced by the OS.

MAC

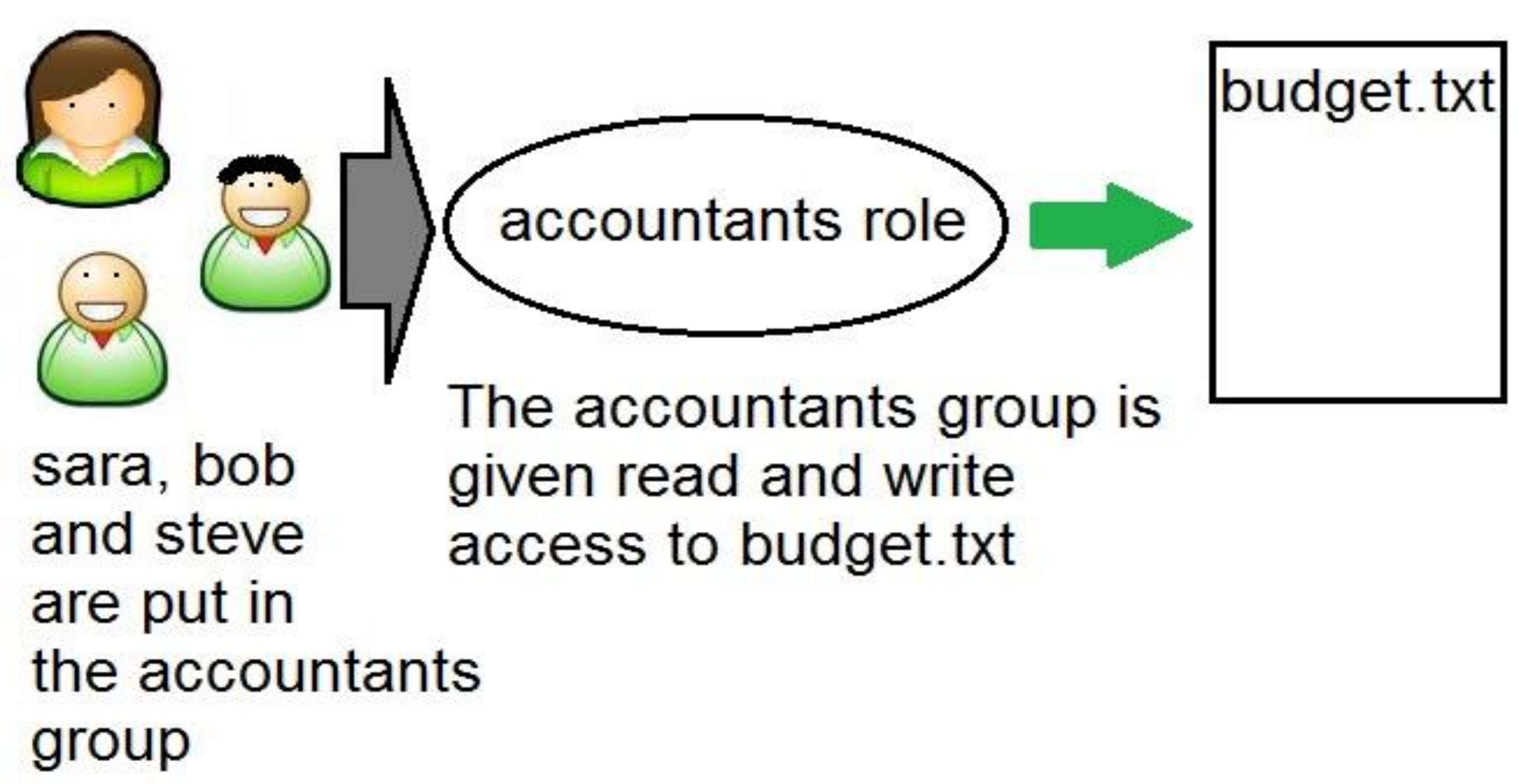
MAC is used where classification and confidentiality is of utmost importance… military.

- **Generally you have to buy a specific MAC system, DAC systems don’t do MAC**
  - SELinux
  - Trusted Solaris (now called Solaris with Trusted Extensions)

MAC SENSITIVITY LABELS

- **All objects in a MAC system have a security label***
- **Security labels can be defined the organization.**
- **They also have categories to support “need to know” at a certain level.**
- **Categories can be defined by the organization**

ROLE BASED ACCESS CONTROL



sara, bob and steve are put in the accountants group

The accountants group is given read and write access to budget.txt

ROLE BASED ACCESS CONTROL

- **Uses a set of controls to determine how subjects and objects interact.**
- **Don’t give rights to users directly. Instead create “roles” which are given rights. Assign users to roles rather than providing users directly with privileges.**

- **Advantages:**
  - This scales better than DAC methods
  - Fights “authorization creep”*

ROLE BASED ACCESS CONTROL

When to use*

- **If you need centralized access**
- **If you DON'T need MAC**
- **If you have high turnover**

THAT SUPPORT ACCESS CONTROL MODELS

We will talk more in depth of each in the next few slides.

▣ Rule-based Access Control

▣ Constrained User Interfaces

▣ Access Control Matrix

▣ Access Control Lists

▣ Content-Dependant Access Control

▣ Context-Dependant Access Control

RULE BASED ACCESS CONTROL

- **Uses specific rules that indicate what can and cannot transpire between subject and object.**
- **Also called non-discretionary.**
- **“if x then y” logic**
- **Before a subject can access and object it must meet a set of predefined rules.**
  - ex. If a user has proper clearance, and it’s between 9AM - 5PM then allow access (Context based access control)
- **However it does NOT have to deal specifically with identity/authorization**
  - Ex. May only accept email attachments 5M or less

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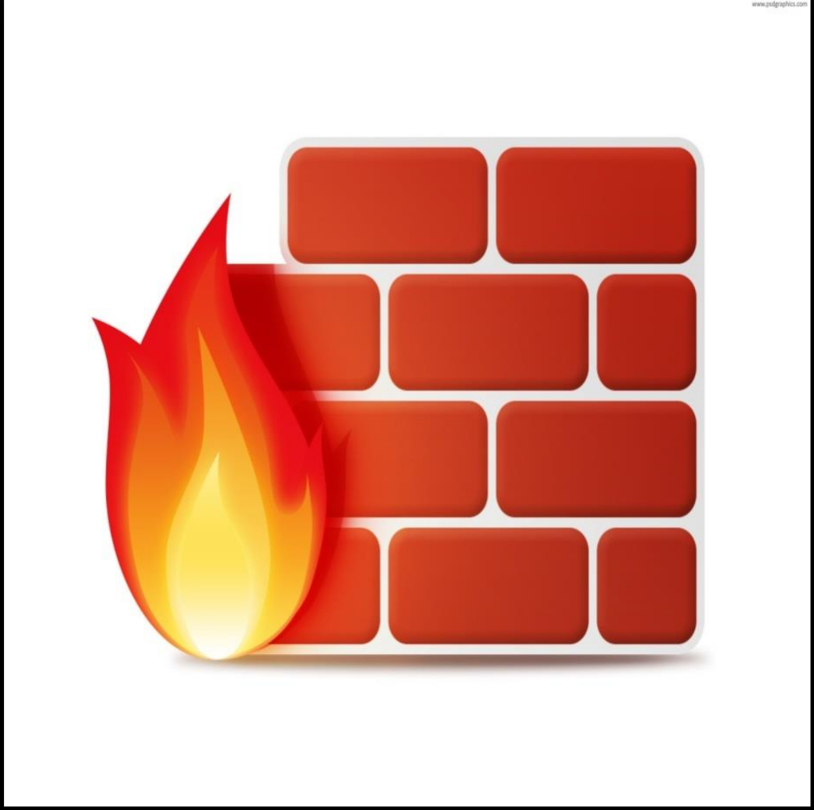
RULES BASED ACCESS CONTROL

- Is considered a "compulsory control" because the rules are strictly enforced and not modifiable by users.
- Routers and firewalls use Rule Based access control*



CONSTRAINED USER INTERFACES

Restrict user access by not allowing them see certain data or have certain functionality (see slides)

- ▣ Views – only allow access to certain data (canned interfaces)
- ▣ Restricted shell – like a real shell but only with certain commands. (like Cisco's non-enable mode)
- ▣ Menu – similar but more “GUI”
- ▣ Physically constrained interface – show only certain keys on a keypad/touch screen. – like an ATM. (a modern type of menu) Difference is you are physically constrained from accessing them.

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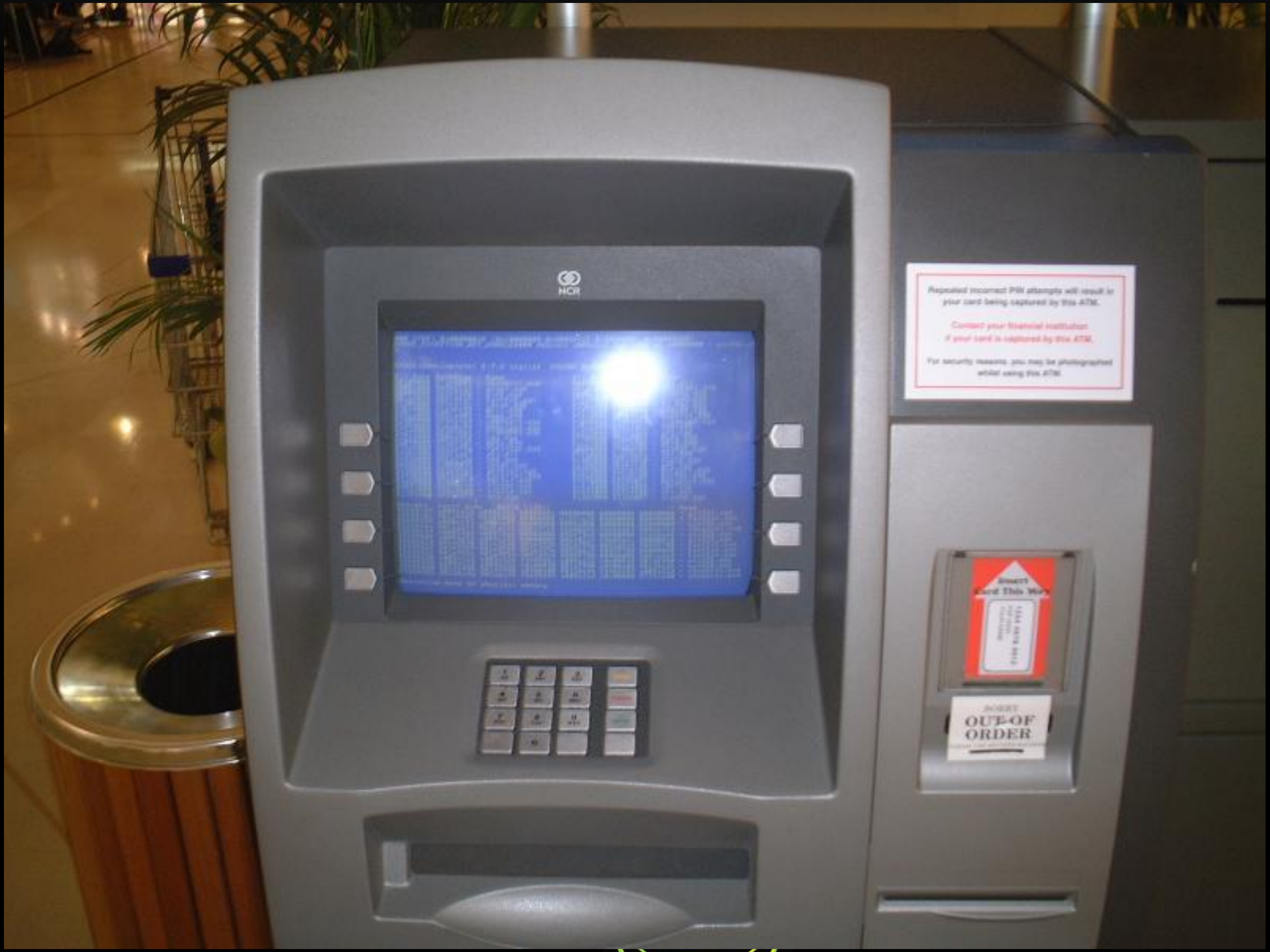
PHYSICALLY CONSTRAINED INTERFACE


NCR
Repeated incorrect PIN attempts will result in your card being captured by this ATM.
Contact your financial institution if your card is captured by this ATM.
For security reasons, you may be photographed whilst using this ATM.
Insert Card This Way
SORRY
OUT OF ORDER

CONTENT DEPENDANT ACCESS CONTROLS

Access is determined by the type of data.

- Example, email filters that look for specific things like “confidential”, “SSN”, images.
- Web Proxy servers may be content based.

CONTEXT DEPENDANT ACCESS CONTROL

System reviews a Situation then makes a decision on access.

- A firewall is a great example of this, if session is established, then allow traffic to proceed.
- In a web proxy, allow access to certain body imagery if previous web sessions are referencing medical data otherwise deny access.

ACCESS CONTROL ADMINISTRATION

CENTRALIZATION VS. DECENTRALIZATION

- **Centralization:**
  - Greater Consistency
  - Ease of Administration
  - Greater Control
  - Usually considered more secure
- **Decentralization**
  - Granularity
  - Flexibility

CENTRALIZED ACCESS CONTROL ADMINISTRATION

- **A centralized place for configuring and managing access control**
- **All the ones we will talk about (next) are "AAA" protocols**
  - Authentication
  - Authorization
  - Auditing

CENTRALIZED ACCESS CONTROL TECHNOLOGIES

We will talk about each of these in the upcoming slides

- **Radius**
- **TACACS, TACACS+**
- **Diameter**

RADIUS

- Remote Authentication Dial-in User Service (RADIUS) is an
- authentication protocol that authenticates and authorizes
- users
- Handshaking protocol that allows the RADIUS server to provide authentication and authorization information to network server (RADIUS client)
- Users usually dial in to an access server (RADIUS client) that
- communicates with the RADIUS server
- RADIUS server usually contains a database of users and
- credentials
- Communication between the RADIUS client and server is
- protected

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RADIUS PROS/CONS

Radius Pros

- It’s been around, a lot of vendor support

Radius Cons

- Radius can share symmetric key between NAS and Radius server, but does not encrypt attribute value pairs, only user info. This could provide info to people doing reconnaissance

TACACS+

- **Provides the same functionality of Radius**
- **TACACS+ uses TCP port 49**
- **TACACS+ can support one time passwords**
- **Encrypts ALL traffic data**
- **TACACS+ separates each AAA function.**
  - For example can use an AD for authentication, and an SQL server for accounting.
- **Has more AVP than Radius… more flexible**

DIAMETER

- DIAMETER is a protocol designed as the next generation RADIUS
- RADIUS is limited to authenticating users via SLIP and
- PPP dial-up modem connections
- – Other device types use different protocol types
- Internet protocol that supports seamless and continuous connectivity for mobile devices - such as PDAs, laptops, or cell phones with Internet data capabilities
- Move between service provider networks and change
- their points of attachment to the Internet
- Including better message transport, proxying, session
- control, and higher security for AAA transactions

CENTRALIZED ACCESS CONTROLS OVERVIEW

- **Idea centralize access control**
- **Radius, TACACS+, diameter**
- **Decentralized is simply maintaining access control on all nodes separately.**

EMANATION SECURITY

EMANATION SECURITY

- All devices give off electrical / magnetic signals.
- A non-obvious example is reading info from a CRT bouncing off something like a pair of sunglasses.
- Tempest is a standard to develop countermeasures to protect against this.

EMANATION COUNTERMEASURES

- **Faraday cage – a metal mesh cage around an object, it negates a lot of electrical/magnetic fields.**
- **White Noise – a device that emits radio frequencies designed to disguise meaningful transmission.**
- **Control Zones – protect sensitive devices in special areas with special walls etc...**

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ACCESS CONTROLS REVIEW

- **IAAA**
  - Identification
  - Authentication
    - Type I (Knowledge)
    - Type II (Possession)
    - Type III (Biometrics)
  - Single Sign On
- **Access Control Models**
- **Access Control Methods**
- **Access Control Administration**
- **Data Emanation**

CHAPTER 6

Security Assessment and Testing

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6 SECURITY ASSESSMENT AND TESTING OBJECTIVES

- Introduction to Security Assessments
- Vulnerability Assessments
- Penetration Testing
- Remediation
- Intrusion Detection
- Audit Logs
- Common Vulnerabilities

VULNERABILITY ASSESSMENTS AND PENETRATION TESTING

- **Vulnerability Assessment**
  - Physical / Administrative/ Logical
  - Identify weaknesses
- **Penetration Testing**
  - Ethical hacking to validate discovered weaknesses
  - Red Teams (Attack)/Blue Teams (Defend)
- NIST SP 800-42 Guideline on Security Testing

DEGREE OF KNOWLEDGE

- **Zero Knowledge (Black Box Testing): Team has no knowledge of the target and must start with only information that is publically available. This simulates an external attack**
- **Partial Knowledge: The team has limited knowledge of the organization**
- **Full Knowledge: This simulates an internal attack. The team has full knowledge of network operations**

VULNERABILITY SCANNING

- **Identifying:**
  - Active hosts on network
  - Active and vulnerable services (ports) on hosts
  - Applications
  - Operating systems
  - Vulnerabilities associated with discovered OS & applications
  - Misconfigured settings
- **Testing compliance with host application usage/security policies**
- **Establishing a foundation for penetration testing**

ATTACK METHODOLOGY

- **Test Attacks 1 of 2**
  1. **Reconnaissance**
  - Who Is Database, Company Website, Job Search Engines, Social Networking
  2. **Footprinting**
     - Mapping the network (Nmap)
     - ICMP ping sweeps
     - DNS zone transfers
  3. **Fingerprinting**
     - Identifying host information
     - Port scanning
  4. **Vulnerability assessment**
     - Identifying weaknesses in system configurations
     - Discovering unpatched software

ATTACK METHODOLOGY CONTINUED

- **Test Attacks 2 of 2**

  5. **The "attack"**

     - Penetration
     - Privilege escalation
       - Run As, SU
     - Root kits
       - Collection of tools to allow continued access. Includes
         - Back Door software
         - Can update the kernel of the operating system
         - Very difficult to detect
     - Cover tracks
       - Trojaned Programs: The Attacker replaces default utilities with ones that masquerade as system utilities that provide normal services, with the exception of helping identify the backdoor software
       - Log Scrubbers

TESTING GUIDELINES

- **Why Test?**
  - Risk analysis
  - Certification
  - Accreditation
  - Security architectures
  - Policy development
- **Develop a cohesive, well-planned, and operational security testing program**

PENETRATION TESTING CONSIDERATIONS

- Three basic requirements:
  - Meet with Senior management to determine the goal of the Assessment
  - Document Rules of Engagement
  - Get sign off from Senior Management
- Issue: it could disrupt productivity and systems
- Overall purpose is to determine subject's ability to withstand an attack and determine effectiveness of current security measures
- Tester should determine effectiveness of safeguards and identify areas of improvement. ****TESTER SHOULD NOT BE THE ONE SUGGESTING REMEDIATION. THIS VIOLATES SEPARATION OF DUTIES*****

RULES OF ENGAGEMENT

- **Specific IP addresses/ranges to be tested**
  - Any restricted hosts
- **A list of acceptable testing techniques**
- **Times when testing is to be conducted**
- **Points of contact for the penetration testing team, the targeted systems, and the networks**
- **Measures to prevent law enforcement being called with false alarms**
- **Handling of information collected by penetration testing team**

TYPES OF PENETRATION TESTS

- **Physical Security**
  - Access into building or department
  - Wiring closets, locked file cabinets, offices, server room, sensitive areas
  - Remove materials from building
- **Administrative Security**
  - Help desk giving out sensitive information, data on disposed disks
- **Logical Security**
  - Attacks on systems, networks, communication

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APPROACHES TO TESTING

- **Do not rely on single method of attack**
  - Get creative

- **Path of least resistance**
  - Start with users—social engineering is often the easiest way to gain access

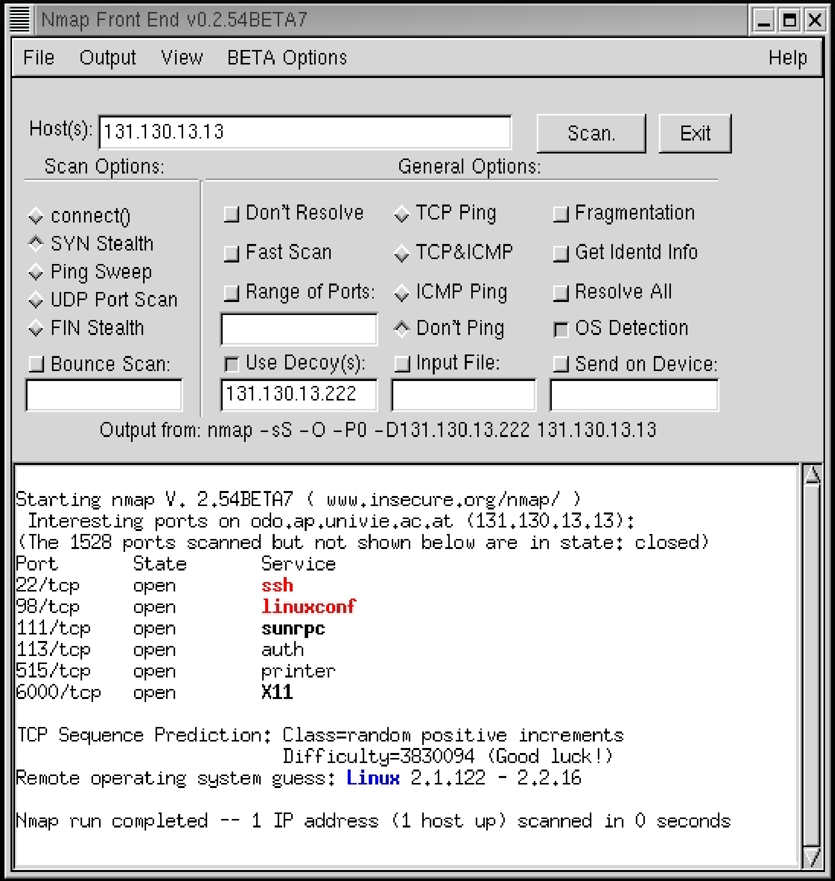
- **Break the rules**
  - Even if a company follows its own policy, standards and procedures, it does not mean that there are not vulnerabilities
  - Attempt things not expected

APPROACHES TO TESTING

- **Do not rely exclusively on high-tech tools**
    - Dumpster diving
- **Stealth methods may be required**
- **Do not damage systems or data**
- **Do not overlook small weakness in search for the big ones**
- **Have a toolkit of techniques**

NETWORK SCANNING

- **List of all active hosts**
- **Network services:**
  - ICMP
  - UDP & TCP
- **Port scanner:**
  - Nmap
  - Finger Printing
  - Banner Grabbing



Host(s): 131.130.13.13

Scan Options:

- ○ connect()
- ● SYN Stealth
- ○ Ping Sweep
- ○ UDP Port Scan
- ○ FIN Stealth
- □ Bounce Scan:

General Options:

- □ Don't Resolve
- □ Fast Scan
- □ Range of Ports:
- ☑ Use Decoy(s): 131.130.13.222
- ○ TCP Ping
- ○ TCP&ICMP
- ○ ICMP Ping
- ● Don't Ping
- □ Input File:
- □ Fragmentation
- □ Get Identd Info
- □ Resolve All
- ☑ OS Detection
- □ Send on Device:

Output from: nmap -sS -O -P0 -D131.130.13.222 131.130.13.13

```
Starting nmap V. 2.54BETA7 ( www.insecure.org/nmap/ )
 Interesting ports on odo.ap.univie.ac.at (131.130.13.13):
(The 1528 ports scanned but not shown below are in state: closed)
Port       State       Service
22/tcp     open        ssh
98/tcp     open        linuxconf
111/tcp    open        sunrpc
113/tcp    open        auth
515/tcp    open        printer
6000/tcp   open        X11

TCP Sequence Prediction: Class=random positive increments
                         Difficulty=3830094 (Good luck!)
Remote operating system guess: Linux 2.1.122 - 2.2.16

Nmap run completed -- 1 IP address (1 host up) scanned in 0 seconds
```

PASSWORD CRACKING

- **Goal is to identify weak passwords**
- **Passwords are generally stored and transmitted in an encrypted form called a hash**
- **Password cracking requires captured password hashes**
  - Hashes can be intercepted
  - Can be retrieved from the targeted system

PASSWORD CRACKING TECHNIQUES

- **Dictionary attack**
- **Brute force**
- **Hybrid attack**
- **LanMan password hashes**
- **Theoretically all passwords are “crackable”**
  - Rainbow tables

ROGUE INFRASTRUCTURES

- Unauthorized DHCP Servers can be used to redirect hosts to rogue DNS servers
- Rogue DNS Servers can direct traffic to spoofed hosts
- DNS zone transfer information contains MUCH information about a network and its configuration
- Secure physical access to the network, require DHCP servers to require authorization, User DHCP reservations and MAC addressing to control assignment of IPs, Secure DNS zone transfers only to specific hosts

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WAR DIALING

- **Goal is to discover unauthorized modems**
  - Provide a means to bypass most or all of the security measures in place
- **Dial large blocks of phone numbers in search of available modems**
  - Should be conducted at least annually
  - Should be performed after-hours
- **Include all numbers that belong to an organization, except those that could be impacted negatively**
- **If removal is not possible, block inbound calls to the modem**

CORRECTIVE ACTIONS – 1 OF 2

- **Investigate and disconnect unauthorized hosts**
- **Disable or remove unnecessary and vulnerable services**
- **Modify vulnerable hosts to restrict access to vulnerable services to a limited number of required hosts**
  - (i.e., host-level firewall or TCP wrappers)
- **Modify enterprise firewalls to restrict outside access to known vulnerable services**
  - Ingress Filtering: No inbound traffic allowed with internal addresses (spoofing)
  - Egress Filtering : No outbound traffic allowed with external addressing (DDoS)

CORRECTIVE ACTIONS – 2 OF 2

- **Upgrade or patch vulnerable systems**
- **Deploy mitigating countermeasures**
- **Improve configuration management program and procedures**
- **Assign a staff member to:**
  - Monitor vulnerability alerts/mailing lists
  - Examine applicability to environment
  - Initiate appropriate system changes
- **Modify the organization's security policies and architecture**
- **All of the above require going through proper change management procedures**

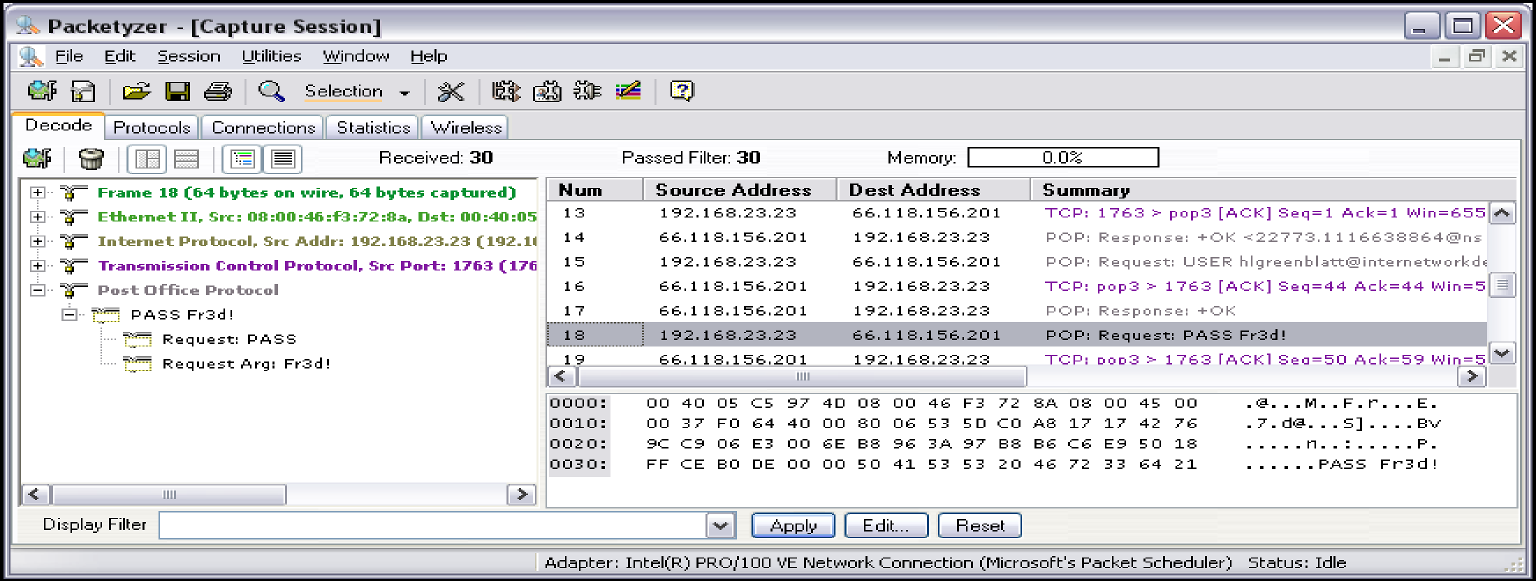
WATCHING NETWORK TRAFFIC

- **Traffic Analysis—Side Channel Analysis**
  - Watching traffic and its patterns to try and determine if something special is taking place. For example:
    - A lot of traffic between two military units may indicate that an attack is being planned
    - Traffic between human resources and headquarters may indicate layoffs are around the corner

- **Traffic Padding**
  - Generating spurious data in traffic to make traffic analysis more difficult
    - Sending out decoy attacks
  - The amount and nature of traffic may be masked
  - Attempt to keep traffic constant so no information can be gained

PROTOCOL ANALYZERS (SNIFFERS) AND PRIVACY

- **Promiscuous mode**
- **Bridging / Switching can affect the Packet Capture**



Packetyzer - [Capture Session]
File Edit Session Utilities Window Help
Selection
Decode Protocols Connections Statistics Wireless
Apply Edit... Reset
Display Filter

Received: 30 Passed Filter: 30 Memory: 0.0%

```
Frame 18 (64 bytes on wire, 64 bytes captured)
Ethernet II, Src: 08:00:46:f3:72:8a, Dst: 00:40:05
Internet Protocol, Src Addr: 192.168.23.23 (192.1
Transmission Control Protocol, Src Port: 1763 (176
Post Office Protocol
    PASS Fr3d!
        Request: PASS
        Request Arg: Fr3d!
```

```
Num   Source Address    Dest Address      Summary
13    192.168.23.23     66.118.156.201    TCP: 1763 > pop3 [ACK] Seq=1 Ack=1 Win=655
14    66.118.156.201    192.168.23.23     POP: Response: +OK <22773.1116638864@ns
15    192.168.23.23     66.118.156.201    POP: Request: USER hlgreenblatt@internetworkde
16    66.118.156.201    192.168.23.23     TCP: pop3 > 1763 [ACK] Seq=44 Ack=44 Win=5
17    66.118.156.201    192.168.23.23     POP: Response: +OK
18    192.168.23.23     66.118.156.201    POP: Request: PASS Fr3d!
19    66.118.156.201    192.168.23.23     TCP: pop3 > 1763 [ACK] Seq=50 Ack=59 Win=5
```

```
0000:   00 40 05 C5 97 4D 08 00 46 F3 72 8A 08 00 45 00    .@...M..F.r...E.
0010:   00 37 F0 64 40 00 80 06 53 5D C0 A8 17 17 42 76    .7.d@...S]....Bv
0020:   9C C9 06 E3 00 6E B8 96 3A 97 B8 B6 C6 E9 50 18    .....n..:.....P.
0030:   FF CE B0 DE 00 00 50 41 53 53 20 46 72 33 64 21    ......PASS Fr3d!
```

Adapter: Intel(R) PRO/100 VE Network Connection (Microsoft's Packet Scheduler) Status: Idle

IDS

IDS are a tool in a layered security model. The purpose of an IDS is to

- identify suspicious activity
- log activity
- Respond (alert people)
- Needs an interface in “Promiscuous” Mode
- Port Mirroring/Span needs to be enabled to view traffic on a switch

IDS CATEGORIES

IDS systems we are about to discuss.

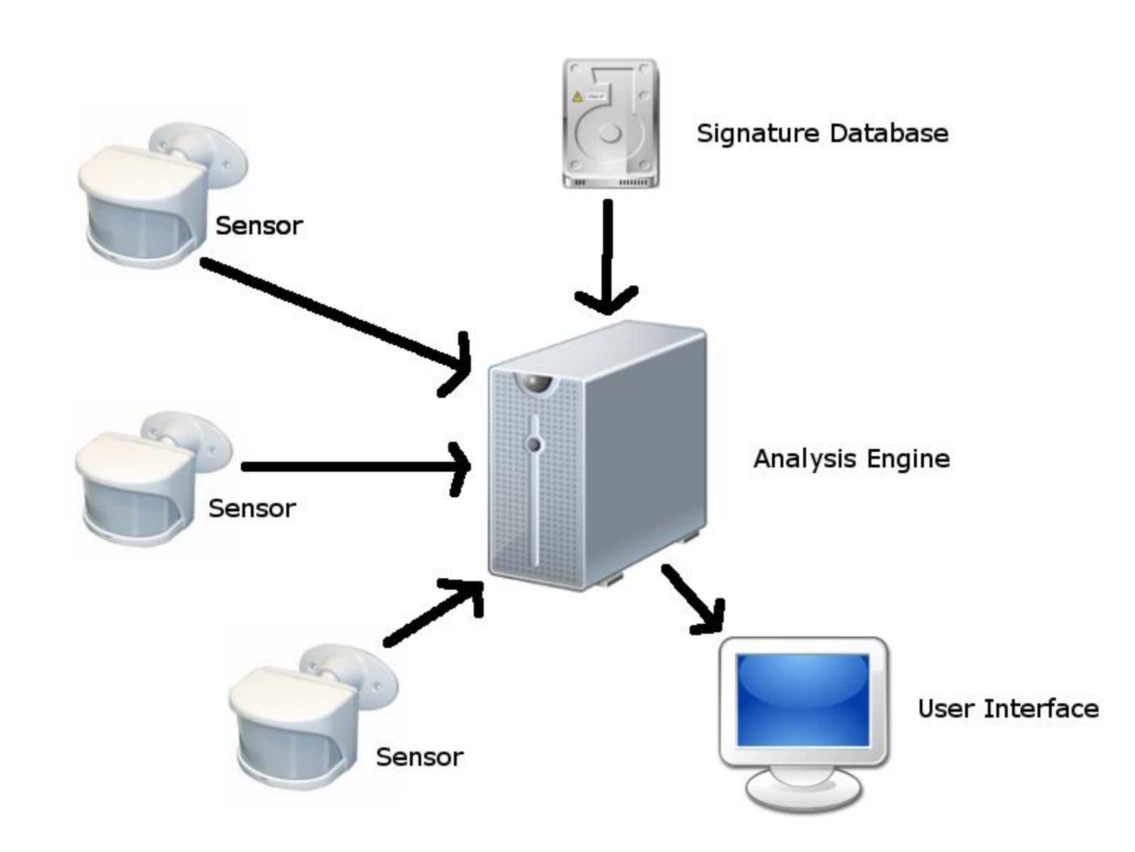
- HIDS – Host Based Intrusion Detection System
- NIDS – Network Intrusion Detection System

IDS COMPONENTS

Both type of IDS have several components that make up the product

- **Sensor – Data Collector**
  - On network segments (NIDS)
  - Or on Hosts (HIDS)
- **Analysis Engine – Analyzes data collected by the sensor, determines if there is suspicious activity**
- **Signature Database – Used by the AE, defines signatures of previously known attacks**
- **User Interface and Reporting – the way the system interacts with users**
- **(visualization next)**

IDS COMPONENTS



HIDS

Hosts Based Intrusion Detection Systems – Examine the operation of a SINGLE system independently to determine of anything “of note” is going on.

Some things a HIDS will looks at

- Logins
- System Log files / audit files
- Application Log Files / audit files
- File Activity / Changes to software
- Configuration Files changes
- Processes being launched or stopped
- Use of certain programs
- CPU usage
- Network Traffic to/from Computer

ADVANTAGES OF HIDS

- **Can be operating system and application specific – might understand the latest attack against a certain service on a host.**

- **They can look at data after it's been decrypted (network traffic is often encrypted)***

DISADVANTAGES OF HIDS

- **Only protect one machine (or must be loaded on every machine you want to protect)**
- **Use local system resources (CPU/memory)**
- **They don't see what's going on, on other machines.**
- **Scalability**
- **The HIDS could be disabled if machine is hacked**

NETWORK BASED IDS

A concept focused on watching an entire network and all associated machines. Focuses specifically on network traffic, in this case the “sensor” is sometimes called a “traffic collector”

Looks at

▣ SRC IP

▣ DEST IP

▣ Protocol

▣ Port Numbers

▣ Data Content

NETWORK BASED IDS

A NIDS system will often look for

- DoS Attacks
- Port Scans
- Malicious content
- Vulnerability tests
- Tunneling
- Brute Force Attacks

NETWORK BASED IDS

In Addition to looking for attacks a NIDS can watch the internal network for policy violations.

Example:

- Detecting Instant Messaging, or streaming video.

NIDS ADVANTAGES

- **A single NIDS sensor can cover a whole network. What happens if I want to cover multiple networks?**
- **Deployment is usually easier**
- **A NIDS can see things that are happening on multiple machine, it gets a bigger picture and may see distributed attacks that a HIDS would miss**

NIDS PROBLEMS

- Data must be UNENCRYPTED for a NIDS to analyze. So many protocols are now encrypted, it’s hard for the NIDS to see what’s going on.*
- Switches cause problems for NIDS—port span should be implemented on the switch port
- If only on the perimeter, it can miss things on the inside.
- It must be able to handle LOTS of data to be effective! (should be able to handle wire speed+)
- It does not see what’s going on a server directly

IDS VS. IPS

An IDS is generally a passive device.

An IPS is an IDS that takes an active approach.

Examples:

- Activate Firewall rules dynamically
- Shuts down TCP traffic

ANALYSIS ENGINES

- **Pattern Matching**
- **Profile Matching**

SIGNATURE BASED (PATTERN MATCHING)

Most network attacks have distinct “signatures” that is data that is passed between attacker and victim. A Signature Based NIDS has a database of known attack signatures, and compares network traffic against this database.

Concerns for Signature Based systems.

- Pay for a signature subscription from vendor*
- Keep signatures updated*
- Does not protect against oday attacks!

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ANOMALY/BEHAVIOR/HEURISTICS (PROFILE MATCHING)

- Anomaly based systems, look for changes in “normal” behavior. To do this generally you let a anomaly based system learn what normal behavior is over a few days or weeks, creating a baseline. The anomaly based system will then look for traffic types and volume that is outside of the normal behavior.

Anomaly/Behavior/Heuristics

Advantages

- Can possibly detect odays*
- Can detect behavioral changes that might not be technical attacks (like employees preparing to commit fraud)*

Disadvantages

- Lots of false positives*
- Often ignored due to reason above
- Requires a much more skilled analyst

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BYPASSING AN IDS

- Evasion Attack “Flying under the RADAR”. Many small attacks from different directions
- Insertion attack (geared toward signature based systems) Adding meaningless information (without modifying the payload) to a known attack

RULES BASED

- Uses expert system/knowledge based systems.
- These use a database of knowledge and an “inference engine”) to try to mimic human knowledge. It’s like of a person was watching data in real time and had knowledge of how attacks work.

Promiscuous mode

- Network interfaces generally only look at packets specifically intended for their MAC address. TO accomplish sniffing, network analysis, or IDS functionality, you have to put network interfaces into promiscuous mode

HONEYPOT

- **Deployment:**
  - Pseudo Flaw: Loophole purposely added to operating system or application to trap intruders
  - Sacrificial lamb system on the network
  - Administrators hope that intruders will attack this system instead of their production systems
  - It is enticing because many ports are open and services are running
- **Be careful of Enticement vs. Entrapment**

PADDED CELL AND VULNERABILITY TOOLS

- **Concept used in software programming where a "safe" environment is created for applications and processes to run in**
  - Similar to a virtual machine
- **Concept used in IDS where identified intruder is moved to a "safe" environment without their knowing**
- **Simulated environment to keep the intruder happy and busy**
  - Hopefully leave production systems alone
- **aka: Self Mutating Honeypot, Tarpit**

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CHAPTER 6 SECURITY ASSESSMENT AND TESTING OBJECTIVES

- Introduction to Security Assessments
- Vulnerability Assessments
- Penetration Testing
- Remediation
- Intrusion Detection

CHAPTER 7

Security Operations

CHAPTER 7 SECURITY OPERATIONS REVIEW

- **Incident Response**
- **Forensics**
  - Evidence Collection
  - Admissibility Issues
  - Types of Evidence
- **Fault tolerance and recovery strategies**

SECURITY INCIDENCE RESPONSE

- **Event: negative occurrence that can be observed, verified and documented**
- **Incident: Series of events that has a negative impact on the company and its security**
- **Incidence response focuses on containing the damage of an attack and restoring normal operations**
- **Investigations focuses on gathering evidence of an attack with the goal of prosecuting the attacker**

SECURITY INCIDENCE RESPONSE CONTINUED

- **Framework should include:**
  - Response Capability
  - Incident Response and handling
  - Recovery and Feedback

RESPONSE CAPABILITY

- **Incident Response**
  - Corporate incidence response polices, procedures and guidelines should be in place
  - Legal, HR, Executive management, and key business units must be involved
  - If handling in-house, an incident response team must be in place
    - Items the Computer Incident Response Team must have at its disposal
      - List of outside agencies and resources to contact or report to
        - Computer Emergency Response Team (CERT)
      - List of computer or forensics experts to contact
      - Steps on how to secure and preserve evidence
      - Steps on how to search for evidence
      - List of items that should be included on the report
      - A list that indicates how the different systems should be treated in this type of situation

INCIDENT RESPONSE AND HANDLING

- **Triage**
  - Detection
  - Identification
  - Notification
- **Investigations**
- **Containment**
- **Analysis and Tracking**

RECOVERY AND FEEDBACK

- Recovery and Repair: restoration of the system to operations. Remember, it does no good to restore to its original status—must provide greater security lest if fall prey to the same attack again

- Provide Feedback: One of the most important (and most overlooked) steps. Document, document, document!

COMPUTER FORENSICS

- **Computer Forensics: The discipline of using proven methods toward the collection, preservation, validation, identification, analysis, interpretation, documentation and presentation of digital evidence.**
- **IOCE and SWGDE are two entities that provide forensics guidelines and principles as follows**
  - All **forensic principles must be applied to digital evidence**
  - Evidence **should not be altered** as a result of collection
  - If a person is to access original digital evidence, that person **must be trained** for such a purpose
  - **All activity** relating to the seizure, access, storage, and transfer of digital evidence **must be fully documented** and available for review
  - **An individual is responsible** for actions affecting digital evidence while that **evidence is in their possession**
  - Any entity responsible for seizing, accessing, storing or transferring digital evidence is **responsible for compliance with these principles**

FIVE RULES OF DIGITAL EVIDENCE

- **Digital Evidence Must:**
  - Be authentic
  - Be accurate
  - Be complete
  - Be convincing
  - Be admissible

THE FORENSICS INVESTIGATION PROCESS

- Identification
- Preservation
- Collection
- Examination
- Analysis
- Presentation
- Decision

THE FORENSICS INVESTIGATION PROCESS

- **Identification**
  - Locard's principle of Exchange: when a crime is committed, the attacker takes something and leaves something behind. What they leave behind can help us identify aspects of the responsible party

THE FORENSICS INVESTIGATION PROCESS

- **Preservation**
  - Chain of Custody **must** be well documented
    - A history of how the evidence was
      - Collected
      - Analyzed
      - Transported
      - Preserved
    - Necessary because digital evidence can be manipulated so easily
  - Hashing Algorithms are used to show the integrity of the evidence has not been modified by the investigation process

THE FORENSICS INVESTIGATION PROCESS

- **Collection**
  - Minimize handling/corruption of evidence
  - Keep detailed logs of your actions
  - Comply with the 5 rules of digital evidence
  - Do not exceed your knowledge
  - Follow organization’s security policy
  - Capture an accurate image of the system
  - Ensure actions are repeatable
  - Work Fast (digital evidence may have a short lifespan)
  - Work from volatile to persistent evidence
  - DO NOT run any programs or open any files on the infected system until a forensic copy of the disk has been made

THE FORENSICS INVESTIGATION PROCESS

- **Collection (Continued)**
- **Steps to evidence collection:**
  - Photograph area, record what is on the screen
  - Dump contents from memory
  - Power down system
  - Photograph inside of system
  - Label each piece of evidence
  - Record who collected what and how
  - Have legal department and possibly human resources involved

THE FORENSICS INVESTIGATION PROCESS

- **Collection (Continued)**
- **The Fourth Amendment protects against illegal search and seizure**
- **Exceptions to previous statement**
  - Private citizen not subject to Fourth Amendment rules unless acting as a police agent
  - Citizen may be subject to restrictions of Electronic Communications Privacy Act
- **Computer evidence can be obtained by law enforcement only through:**
  - Subpoena
  - Search warrant
  - Voluntary consent
  - Exigent Circumstances

THE FORENSICS INVESTIGATION PROCESS

- **Examination**
  - Look for signatures of known attacks
  - Review audit logs
  - Hidden data recovery
- **Analysis**
  - Primary image (original) vs. Working image (copy)
  - Working image should be a bit by bit copy of original
  - Both copies must be hashed and the working copy should be write-protected
  - What is the root cause?
  - What files were altered/installed?
  - What communications channels were opened?

THE FORENSICS INVESTIGATION PROCESS

- **Presentation**
  - Interpreting the results of the investigation and presenting the findings in an appropriate format
  - Documentation
  - Expert Testimony
- **Decision**
  - What is the result of the investigation?
    - Suspects?
    - Corrective Actions?

EVIDENCE LIFE CYCLE

- **Evidence Life Cycle**
  - Collection and identification
  - Analysis
  - Storage, Preservation, Transportation
  - Present in court
  - Return to victim (owner)
- **Integrity and authenticity of evidence must be preserved throughout the life cycle**

CONTROLLING THE CRIME SCENE

- The scene of the crime should be immediately secured with only authorized individuals allowed in
- Document, document, document—the integrity of the evidence could be called in to question if it is not properly documented
  - Who is at the crime scene/who has interaction with the systems and to what degree. Also, any contamination at the crime scene must be documented (contamination does not always negate the evidence)
- Logs should be kept detailing all activities. In most instances, an investigator's notebook is not admissible as evidence, however the investigator can use it to refer to during testimony

EVIDENCE TYPES

- Direct Evidence: Can prove a fact by itself and does not need backup information. Information provided based on the 5 sense of a (reliable) witness.
- Real Evidence: Physical evidence. The objects themselves that are used in a crime.
- Best Evidence: Most reliable—a signed contract

EVIDENCE TYPES

- Secondary: Not strong enough to stand alone, but can support other evidence. Expert Opinion
- Corroborative Evidence: Support evidence. Backs up other information presented. Can’t stand on its own.
- Circumstantial: Proves one fact which can be used to reasonably to suggest another. Again, can’t stand on its own.

EVIDENCE TYPES

- **Hearsay: 2nd hand oral or written. Usually not admissible. "John heard that Bill heard that….." Copies of a document.**
- **Demonstrative: Presentation based. Photos of a crime scene, x-rays, diagrams.**

WHO SHOULD DO THE INVESTIGATION?

- **Law Enforcement**
  - Available skilled resources for this investigation?
  - Fourth amendment, jurisdiction, Miranda, privacy issues
    - More restrictions than private citizen
  - Information dissemination is not controlled

SUSPECT'S ACTIONS AND INTENT

- **Enticement**
  - Tempting a potential criminal
  - Legal and ethical
  - Honeypot

- **Entrapment**
  - Tricking a person into committing a crime
  - Illegal and unethical
  - Pointing user to a site and then saying they trespassed

7 SECURITY OPERATIONS OBJECTIVES

- Evidence Collection and Forensics
- Configuration Management
- Media Management
- Fault tolerance and recovery strategies
- Business Continuity and Disaster Recovery

GENERAL INFORMATION SECURITY PRINCIPLES

- Simplicity
- Fail-Safe
- Complete
- Open Design

- Separation of Privilege
- Psychological Acceptability
- Layered Defense
- Incident Recording

CYBRARY.IT

CONTROL MECHANISMS

- **Control Mechanisms**
  - Protect information and resources from unauthorized disclosure, modification, and destruction
- **Main types of mechanisms**
  - Physical
  - Administrative
  - Technical

GENERAL CONTROL LAYERS

- **Administrative Controls**
  - Development of policies, standards, and procedures
  - Screening personnel, security awareness training, monitoring system and network activity, and change control
- **Technical Controls**
  - Logical mechanisms that provide password and resource management, identification and authentication, and software configurations
- **Physical Controls**
  - Protecting individual systems, the network, employees, and the facility from physical damage

ACCESS CONTROL FUNCTIONS

- **Preventative**
  - Controls used to STOP undesirable events from taking place
- **Detective**
  - Controls used to identify undesirable events that have occurred
- **Corrective**
  - Controls used to correct the effects of undesirable events
- **Deterrent**
  - Controls used to **DISCOURAGE** security violations
- **Recovery**
  - Controls used to restore resources and capabilities
- **Compensation**
  - Controls used to provide alternative solutions

KEY OPERATIONAL PROCEDURES AND CONTROLS

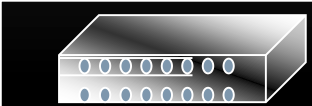
- Fault Management
- Configuration Management
- System Hardening
- Change Control
- Trusted Recovery
- Media Management
- Identity and Access Management
- Monitoring
- Security Auditing and Reviews

FAULT MANAGEMENT

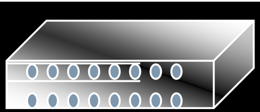
- Spares
- Redundant Servers
- UPS
- Clustering
- RAID
- Shadowing, Remote Journaling, Electronic Vaulting
- Back Ups
- Redundancy of Staff

SPARES

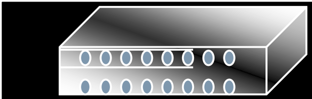
- **Redundant hardware**
- **Available in the event that the primary device becomes unusable**
- **Often associated with hard drives**
- **Hot, warm and cold swappable devices**
- **SLAs**
- **MTBF and MTTR**



Mean time between failure = 785 days; Mean time to repair = 16 Hours



Mean time between failure =650 days; Mean time to repair = 12 Hours



Mean time between failure =652 days; Mean time to repair = 24 Hours

RAID

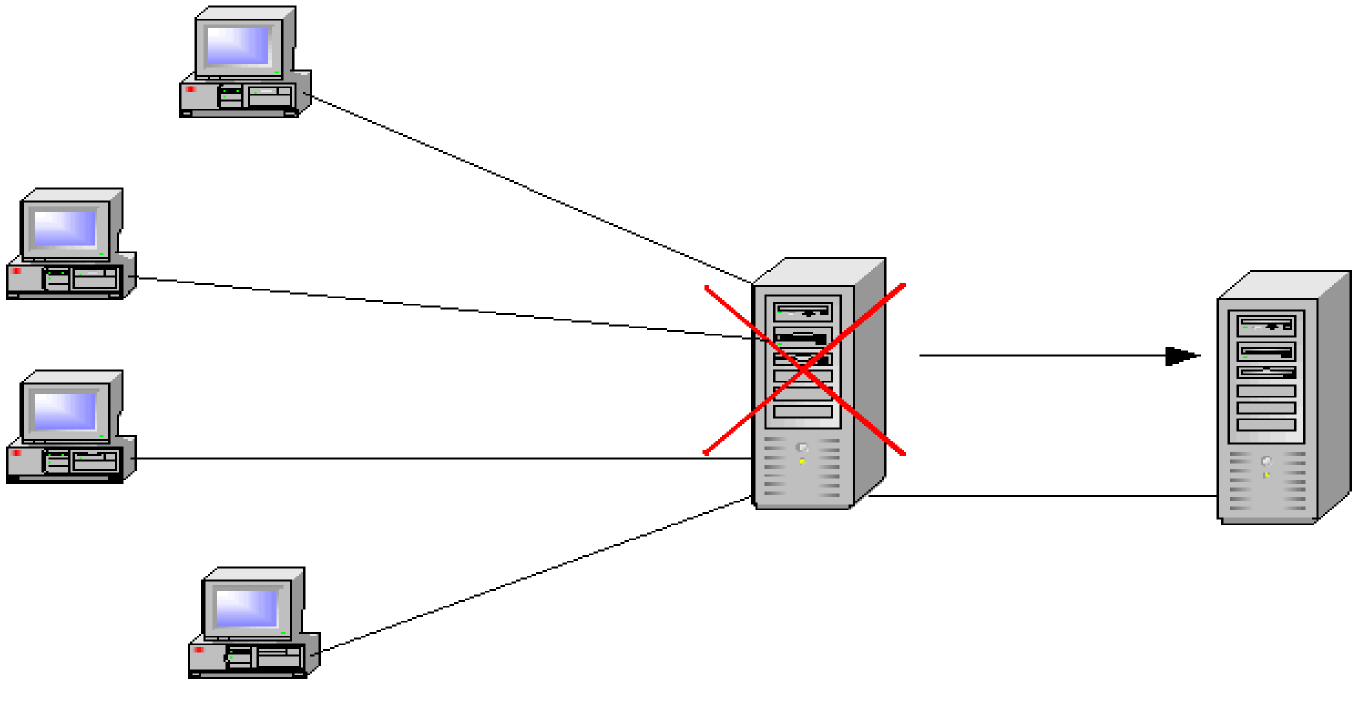
RAID-0 : Disk striping provides no redundancy or fault tolerance but provides performance improvements for read/write functions

RAID-1: Disk Mirroring-Provides redundancy but is often considered to be the least efficient usage of space

RAID-5: Disk Striping with Parity: Fault tolerance + Speed

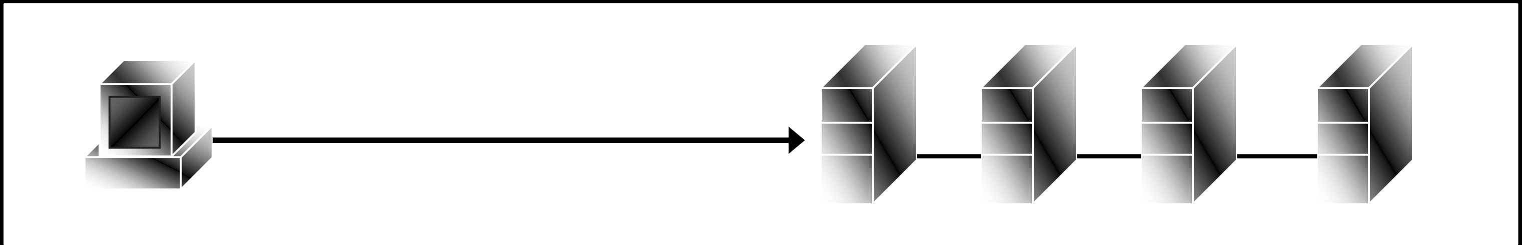
REDUNDANT SERVERS

- **Primary server mirrors data to secondary server**
  - If primary fails it rolls over to secondary
  - Server fault tolerance



CLUSTERING

- **Group of servers that are managed as a single system**
- **Higher availability, greater scalability, easier to manage instead of individual systems**
- **May provide redundancy, load balancing, or both.**
  - Active/Active
  - Active/Passive
- **Cluster looks like a single server to the user**
  - Server farm



UNINTERRUPTIBLE POWER SUPPLY

- **Issues to Consider**
  - Size of load UPS can support
  - How long it can support this load (battery duration)
  - Speed the UPS takes on the load when the primary power source fails
  - Physical space required

- **Desirable Features**
  - Long battery life
  - Remote diagnostic software
  - Surge protection and line conditioning
  - EMI/RFI filters to prevent data errors caused by electrical noise
  - High MTBF values
  - Allow for automatic shutdown of system

BACKUPS

- **Backing up software and having backup hardware is a large part of network availability**
- **It is important to be able to restore data:**
  - If a hard drive fails
  - A disaster takes place
  - Some type of software corruption

BACKUPS

- **Full backup**
  - Archive Bit is reset

- **Incremental backup**
  - Backs up all files that have been modified since last backup
  - Archive Bit is reset

- **Differential backup**
  - Backs up all files that have been modified since last full backup
  - Archive Bit is not reset

- **Copy backup**
  - Same as full backup, but Archive Bit is not reset
  - Use before upgrades, or system maintenance

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BACKUPS

Sunday	Monday	Tuesday	Wednesday	Thursday	Backups needed to recover
Full	Full	Full	Full	Full(w)	
Full	Inc	Inc	Inc	Full(s) + Inc (m,t,w)	
Full	Diff	Diff	Diff	Full(s) + Diff (w)	

Server Crash!!!!!

BACKUP ISSUES

- **Identify what needs to be backed up first**
- **Media Rotation Scheme**
  - Grandfather, Father, Son
  - Tower of Hanoi
- **Backup schedule needs to be developed**
- **If restoring a backup after a compromise, ensure that the backup material does not contain the same vulnerabilities that were exploited**

REDUNDANCY OF STAFF

- Eliminate Single Point of Failure
- Cross Training
- Job Rotation
- Mandatory Vacations
- Training and Education

MEDIA MANAGEMENT

- **Production Libraries**
  - Holds software used in production environment
- **Programmer Libraries**
  - Holds work in progress
- **Source Code Libraries**
  - Holds source code and should be escrowed
- **Media Library**
  - Hardware centrally controlled

CONTROLLING ACCESS TO MEDIA – LIBRARIAN

- **Librarian to control access**
- **Log who takes what materials out and when**
- **Materials should be properly labeled**
- **Media must be properly sanitized when necessary**
  - Zeroization (Previous DoD standards required seven wipes. Currently, only one is required.)
  - Degaussing (Only good for magnetic media)
    - Coercivity: Amount of energy required to reduce the magnetic field to zero
  - Physical destruction (The best means of removing remnants).

7 SECURITY OPERATIONS OBJECTIVES

- Incident Response, Evidence Collection and Forensics
- Fault tolerance and recovery strategies
- Business Continuity and Disaster Recovery

CHAPTER 8
Software Development Security

Objectives

- Software Flaws
- SDLC
- Software Development Methods
- Object Oriented Programming
- Databases
  - Design
  - Vulnerabilities/Threats
- Malicious Code

Software Flaws

Reasons Why Software Lacks Security

- Software vendors rush product to market with much emphasis on functionality not on security
- A majority of software developers are no security professionals and vice versa
- The computing public is used to receiving software with bugs and then apply patches to it
- Software vendors have not been subjected to liability for insecure code/products
- Programmers are not taught secure coding practices in school

TREND:

1. Buggy software is released to the market to beat the competition
2. Hackers find new vulnerabilities in new software
3. Hacker Websites post vulnerabilities and how to exploit them
4. Vendor releases patch to fix vulnerabilities
5. Network administrators and security engineers test and install patches
6. Vendor develops upgrade and organizations follow suit spending lots of money

Software Development Lifecycle

Where to implement Security?

1. Project Initiation
2. Functional Design Analysis and Planning
3. System Design Specifications
4. Software Development
5. Install/Test/Implement
6. Operational/Maintenance
7. Retirement/Disposal

Project Initiation

- Decide on conceptual definition of project
- Identify security requirements
- Perform an initial risk analysis (analyze potential threats)
- Identify security framework
- Determine service level agreements

Functional Design Analysis

- Define security requirements
- Implement security checkpoints in plan
- Develop contingency plans
- Generate preliminary security test plans
- Ensure formal functional baseline includes security requirements

System Design Specification

- Define security specification
- Update test plans involving security
- Security specifications
- System design checklist
- Formal methods developed

Software Development/Programming

- Write programming code to meet specifications
- Implement security within code
- Perform unit test

DOMAIN #4: SOFTWARE DEVELOPMENT SECURITY

Install/Test

- Test system components
- User acceptance testing, data checking, resiliency testing
- Install system
- Create manuals
- Perform acceptance test – i.e. certification and accreditation
- System acceptance

DOMAIN #4: SOFTWARE DEVELOPMENT SECURITY

Operational/Maintenance

- Maintain system through service-level agreement
- After changes, recertification may be necessary
- Audit and test security components periodically

Retirement/Disposal

- Properly dispose of system
- Move data to another system or discard accordingly

Repeat full cycle with a new project initiation

DOMAIN #4: SOFTWARE DEVELOPMENT SECURITY

Object oriented technology

Non-procedural programming where the emphasis is on data objects and their manipulation instead of processes

Benefits:

- Modularity (autonomous objects/modules)
- Reusability

DOMAIN #4: SOFTWARE DEVELOPMENT SECURITY

2. Object oriented technology

- Classes – Define attributes, characteristics, and behaviors
- Attributes-Descriptors for each class
- Objects – collection of attributes for a single instance
- Methods – functionality performed by objects
- Messages – means of communication by objects

2. Object oriented technology

- Inheritance – objects inherit attributes and behaviors from super class
- Polymorphism – capability of different objects to respond differently to same message
- Cohesion –Singleness of purpose
- Coupling – the dependency between modules
- Abstraction - Information hiding

DOMAIN #4: SOFTWARE DEVELOPMENT SECURITY

- **Database Management**
  - Database Management Software
  - Database Models
  - Database programming Interfaces
  - Relational Database Components
  - Database Integrity
  - Database Security Issues
  - Data Warehousing & Data Mining

DOMAIN #4: SOFTWARE DEVELOPMENT SECURITY

Database Models

1. Hierarchical
2. Distributed
3. Object-Oriented
4. Relational

DOMAIN #4: SOFTWARE DEVELOPMENT SECURITY

Database Models

- Describes relationships between data elements
- Used to represent the conceptual organization of data
- Formal methods of representing information

DOMAIN #4: SOFTWARE DEVELOPMENT SECURITY

Columns & Rows

a.k.a. Attributes & Tuples

Name	Address	Phone

Hierarchical

- Stores related information in a tree-like fashion
- Info traced from major group to subgroup
- Predetermined access paths to data
- Data traced through parents (hierarchy)

DOMAIN #4: SOFTWARE DEVELOPMENT SECURITY

Distributed

- Client-server type of DB located on more than one server distributed in several locations
- Synchronization accomplished via a two-phase commit or replication methods
- Data accessible in a single search function despite separate location

DOMAIN #4: SOFTWARE DEVELOPMENT SECURITY

Object-Oriented

- Keeps track of objects and entities that contain both data and action on the data
- Designed for non-text data such as graphics, video and audio clips
- A DB in which the operations carried out on data objects are considered part of their definition

DOMAIN #4: SOFTWARE DEVELOPMENT SECURITY

Relational

- A DB in the form of tables (rows & columns) related to each other
- Stores data in such a way that a data manipulation language can be used independently on data
- Uses a database engine (Oracle, Sybase, etc…)

Definitions

- Primary Key
- Foreign Keys
- Data dictionary
- Metadata (information that describes or augments the main data – it includes details on how to format data for display, processing instructions, or information about how pieces of the data are stored in memory)
- View
- Cell
- Record
- File
- Schema
- Tuple
- Attribute

Databases: Vulnerabilities, Threats and Protections

- Aggregation
- Inference
- Polyinstantiation
- Code Injection
- Input validation

DOES THE DATABASE PASS THE ACID TEST?

- Atomicity
- Consistency
- Isolation
- Durability

Data Warehousing

- Meta Data: “data about data” gives the data its meaning/context
- Data Marts: Often regional collection of information from databases
- Data Warehouse: Collection of information from data marts
- Data mining: Process of pulling information from data warehouse by utilizing meta data

Malicious Software (Malware)

- Adware - Software that automatically displays or downloads advertisements. While not all adware is malicious, many of such are associated with spyware and other types of malicious software (malware).
- Virus - Malicious code that spreads from a computer to computer via attaching itself to other files. The code executes when the attached file is opened.
- Worms - Malicious code that spreads from computer to computer, within a network, on its own. It ultimately consumes network bandwidth.
- Spyware - Is a secretly installed malicious code that is intended to track and report usage of a target system or collect data. Such data may include web browsing history, personal information, user names and passwords, and much more.

MALICIOUS SOFTWARE CONTINUED

- Trojan - Malicious code that masquerades as a harmless file. It usually performs a variety of actions, including key-logging, opening the computer to further attacks, destroying data or files, among others.
- Rootkits - Malicious code that is intended to take full or partial control of a system at the lowest level (core or kernel). They often hide themselves from monitoring or detection and modify system files. Most rootkit infections install back trapdoors, spyware, or other malicious codes once they gain control of the target system.
- Backdoors – Usually created by software developers for an emergency entry into a system. Example may be a hotkey in the event that a password is not available for access. Obviously can be used by anyone with such knowledge to gain access into the system. A trapdoor is rather created via malicious activity.

SEI-CMMI (Software Engineering Institute – Capability Maturity Model Integrated)

- Developed by the Software Engineering Institute of The Carnegie Mellon University in Pittsburgh
- Describes the procedures, principles, and practices in better software development processes. Has five maturity models:
  - Initial
    - Development based on Ad Hoc effort. No procedures in place and there is no assurance of consistency; thereby affecting software quality.
  - Repeatable
    - A formal structure has been developed including quality assurance. However, no formal process models have been defined.
  - Defined
    - Formal procedures and defined processes have been put in place for projects.
  - Managed
    - Formal processes have been put in place to allow for qualitative data analysis. Metrics are defined for process improvement. Quantitative understanding of quality
  - Optimized
    - Integrated plans for continuous process improvement.

8 Software Development Security Review

- Software Flaws
- SDLC
- Software Development Methods
- Object Oriented Programming
- Databases
  - Design
  - Vulnerabilities/Threats
- Malicious Code
- CMMI

THE 8 DOMAINS OF CISSP

CISSP Course Syllabus:

- Chapter 1: Security and Risk Management
- Chapter 2: Asset Security
- Chapter 3: Security Engineering
- Chapter 4: Communications and Network Security
- Chapter 5: Identity and Access Management
- Chapter 6: Security Assessment and Testing
- Chapter 7: Security Operations
- Chapter 8: Software Development Security