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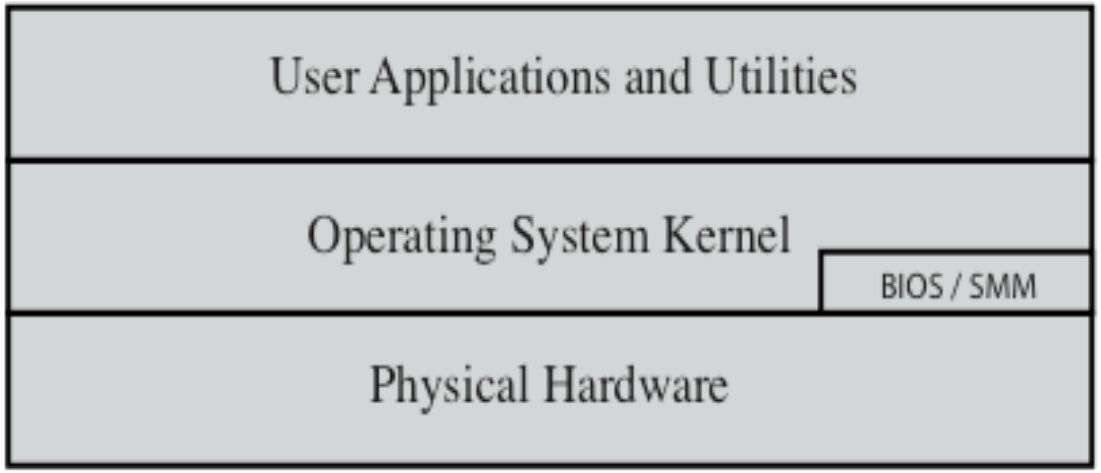
Chapter 7
Operating System Security

Book Reading: Computer Security Principles and Practice (3ed), 2015, p.416-432

OS Security Layers

- Each layer is vulnerable to attack from below if the lower layers are not secured appropriately



OS Hardening Measures

- The 2010 Australian Defense Signals Directorate (DSD) list the "Top 35 Mitigation Strategies"
- Over 70% of the targeted cyber intrusions investigated by DSD in 2009 could have been prevented the top four measures
- The top four measures for prevention are:
  - white-list approved applications
  - patch third-party applications and OS vulnerabilities
  - restrict admin privileges to users who need them
  - create a defense-in-depth

DSD list similar to NSA top 20

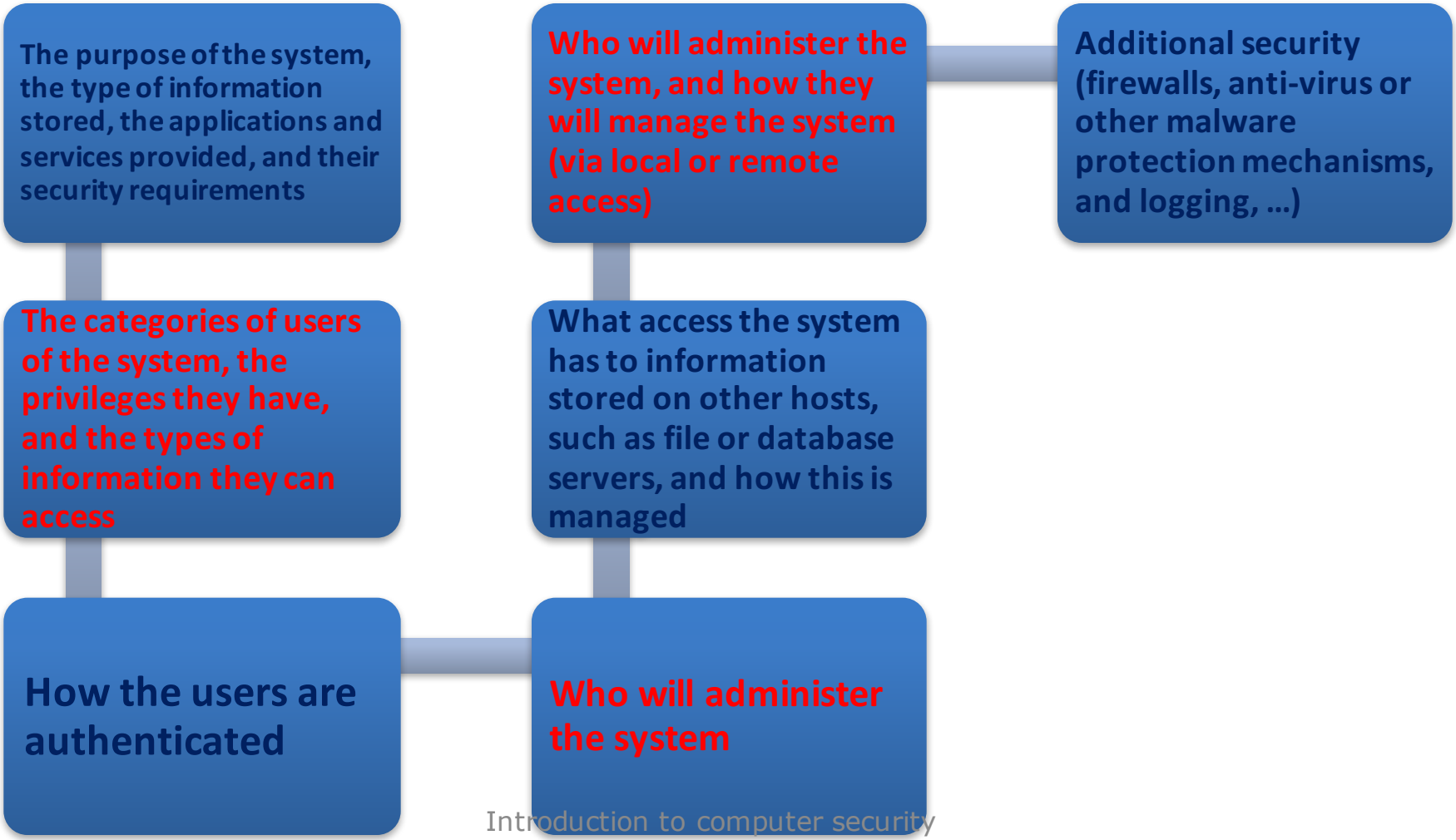
Operating System Security

- Possible for a system to be compromised during the installation process before it can install the latest patches
- Building and deploying a system should be a planned process designed to counter this threat
- Process must:
  - assess risks and plan the system deployment
  - secure the underlying operating system and then the key applications
  - ensure any critical content is secured
  - ensure appropriate network protection mechanisms are used
  - ensure appropriate processes are used to maintain security

System Security Planning

- The first step in deploying a new system is planning
  - Plan needs to identify appropriate personnel and training to install and manage the system
  - Planning process needs to determine security requirements for the system, applications, data, and users
- Aim: maximize security while minimizing costs

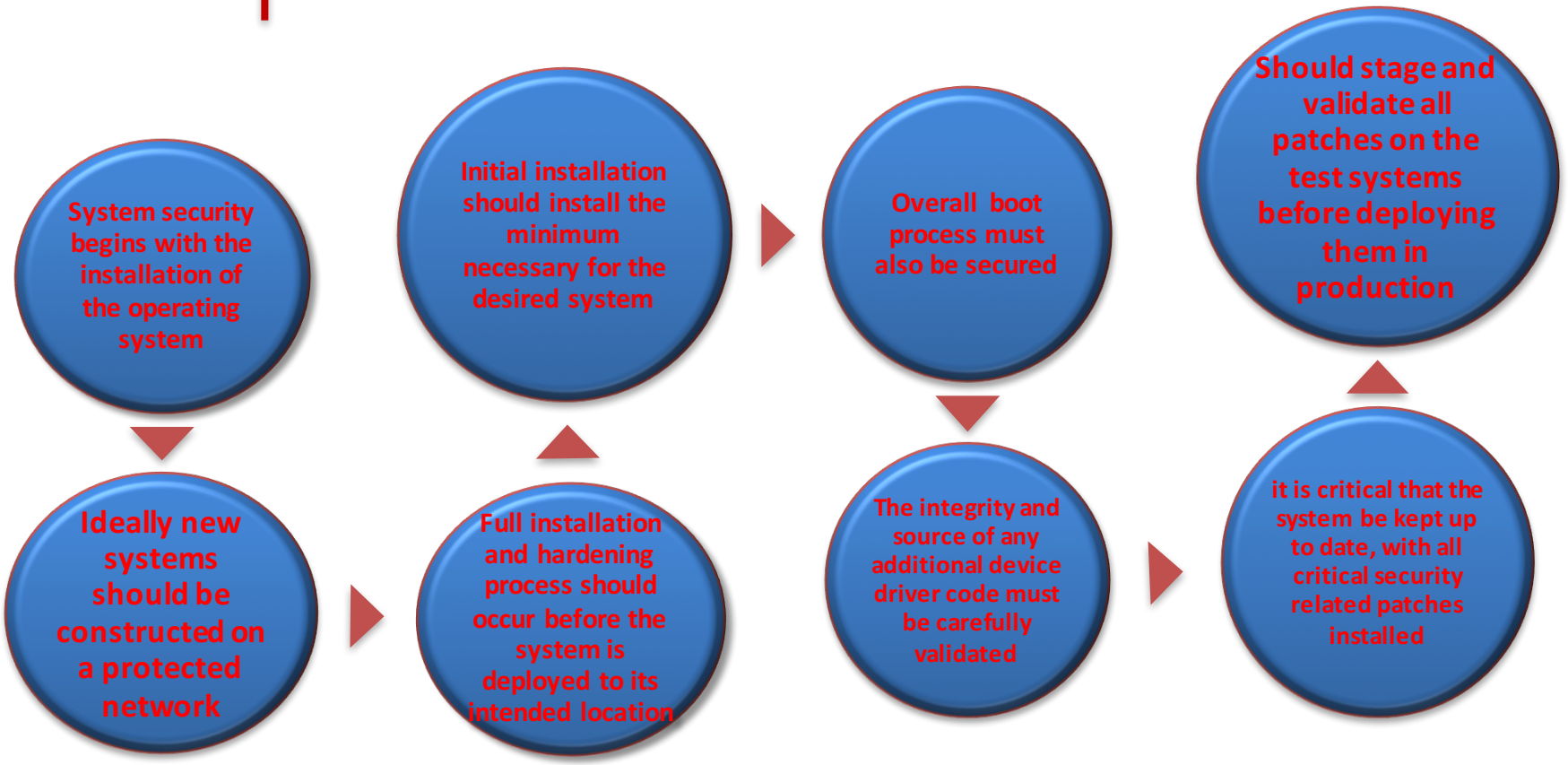
System Security Planning Process



Operating Systems Hardening

- First critical step in securing a system is to secure the base operating system
- Basic steps
  - Install and patch the operating system
  - Harden and configure the operating system to adequately address the identified security needs of the system
  - Install and configure additional security controls, such as anti-virus, host-based firewalls, and intrusion detection system (IDS)
  - Test the security of the basic operating system to ensure that the steps taken adequately address its security needs

Initial Setup and Patching



Remove Unnecessary Services

- if fewer software packages are available to run the risk is reduced
- system planning process should identify what is actually required for a given system

- when performing the initial installation the supplied defaults should not be used
  - default configuration is set to maximize ease of use and functionality rather than security
  - if additional packages are needed later they can be installed when they are required

Configure Users and Privileges

- Not all users with access to a system will have the same access to all data and resources on that system
- Elevated privileges should be restricted to only those users that require them, and then only when they are needed to perform a task

- System planning process should consider:
  - categories of users on the system
  - privileges they have
  - types of information they can access
- Default accounts included as part of the system installation should be secured
  - those that are not required should be either removed or disabled
  - policies that apply to authentication credentials configured

Configure Resource Controls

- Once the users and groups are defined, appropriate permissions can be set on data and resources
- Many of the security hardening guides provide lists of recommended changes to the default access configuration
- Further security possible by installing and configuring additional security tools:
  - Anti-virus software
  - Host-based firewalls
  - IDS or IPS software
  - Application white-listing

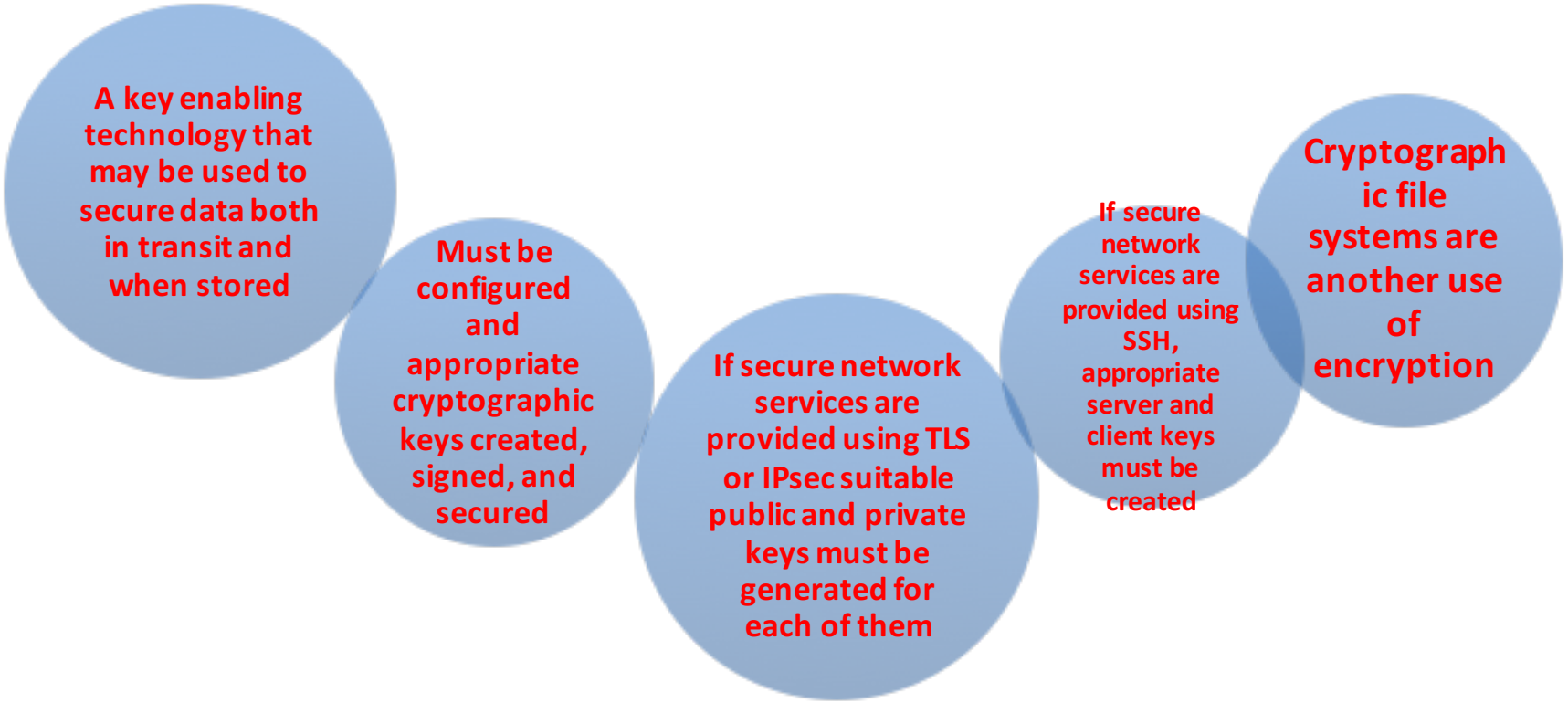
System Testing

- Final step in the process of initially securing the base operating system is security testing
  - Goal: Ensure the previous security configuration steps are correctly implemented
- Checklists are included in security hardening guides
- There are programs specifically designed to:
  - Review a system to ensure that a system meets the basic security requirements
  - Scan for known vulnerabilities and poor configuration practices

Application Configuration

- May include:
  - Creating and specifying appropriate data storage areas for application
  - Making appropriate changes to the application or service default configuration details
- Some applications or services may include:
  - Default data, scripts, user accounts
- Of particular concern with remotely accessed services such as Web and file transfer services
  - Risk from this form of attack is reduced by ensuring that most of the files can only be read, but not written, by the server

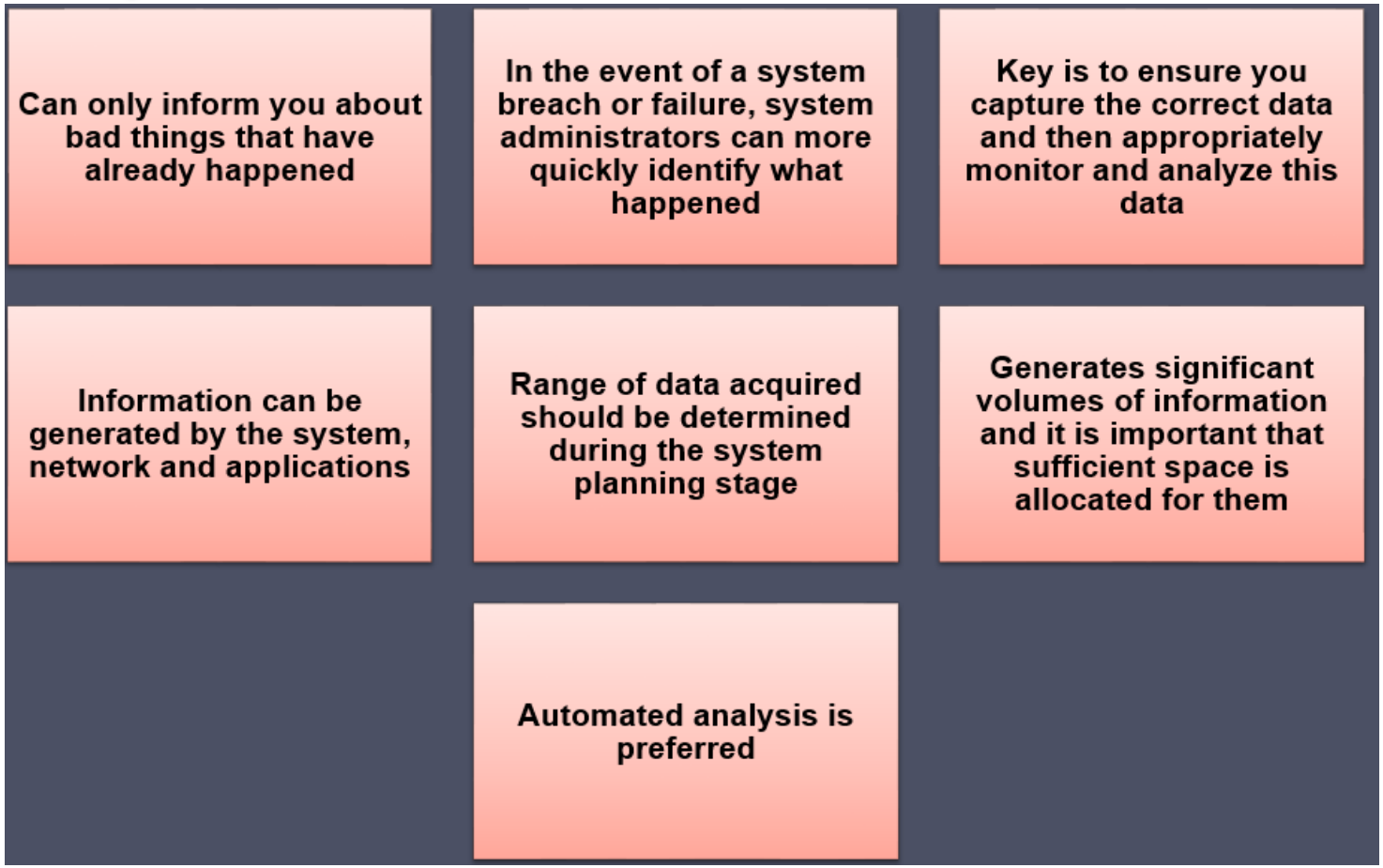
Encryption Technology



Security Maintenance

- Process of maintaining security is continuous
- Security maintenance includes:
  - Monitoring and analyzing logging information
  - Performing regular backups
  - Recovering from security compromises
  - Regularly testing system security
  - Using appropriate software maintenance processes to patch and update all critical software, and to monitor and revise configuration as needed

Logging


Can only inform you about bad things that have already happened
In the event of a system breach or failure, system administrators can more quickly identify what happened
Key is to ensure you capture the correct data and then appropriately monitor and analyze this data
Information can be generated by the system, network and applications
Range of data acquired should be determined during the system planning stage
Generates significant volumes of information and it is important that sufficient space is allocated for them
Automated analysis is preferred

Data Backup and Archive

Performing regular backups of data is a critical control that assists with maintaining the integrity of the system and user data

Backup

Archive

The process of retaining copies of data over extended periods of time in order to meet legal and operational requirements to access past data

Needs and policy relating to backup and archive should be determined during the system planning stage

Kept online or offline

Stored locally or transported to a remote site

- Trade-offs include ease of implementation and cost versus greater security and robustness against different threats

Linux/Unix Security: Patch/Configs

- Patch management
  - keeping security patches up to date is a widely recognized and critical control for maintaining security
  - application and service configuration
  - most commonly implemented using separate text files for each application and service
  - generally located either in the /etc directory or in the installation tree for a specific application
  - individual user configurations that can override the system defaults are located in hidden “dot” files in each user’s home directory
  - most important changes needed to improve system security are to disable services and applications that are not required

Linux/Unix Security

- Users, groups, and permissions
  - access is specified as granting read, write, and execute permissions to each of owner, group, and others for each resource
  - guides recommend changing the access permissions for critical directories and files
  - local exploit
    - software vulnerability that can be exploited by an attacker to gain elevated privileges
  - remote exploit
    - software vulnerability in a network server that could be triggered by a remote attacker

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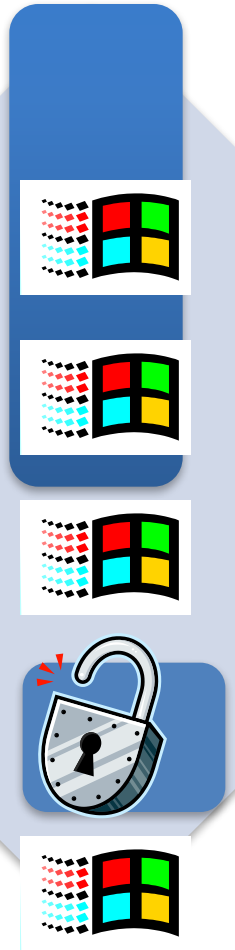
Linux/Unix Security

- Chroot jail
  - restricts the server's view of the file system to just a specified portion
  - uses chroot system call to confine a process by mapping the root of the filesystem to some other directory
  - file directories outside the chroot jail aren't visible or reachable
  - main disadvantage is added complexity

Windows Security

Patch management

- "Windows Update" and "Windows Server Update Service" assist with regular maintenance and should be used
- third party applications also provide automatic update support



Users administration and access controls

- systems implement discretionary access controls resources
- Vista and later systems include mandatory integrity controls
- objects are labeled as being of low, medium, high, or system integrity level
- system ensures the subject's integrity is equal or higher than the object's level
- implements a form of the Biba Integrity model

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Windows Security

Much of the configuration information is centralized in the Registry

- Forms a database of keys and values that may be queried and interpreted by applications
- Registry keys can be directly modified using the "Registry Editor"
  - more useful for making bulk changes

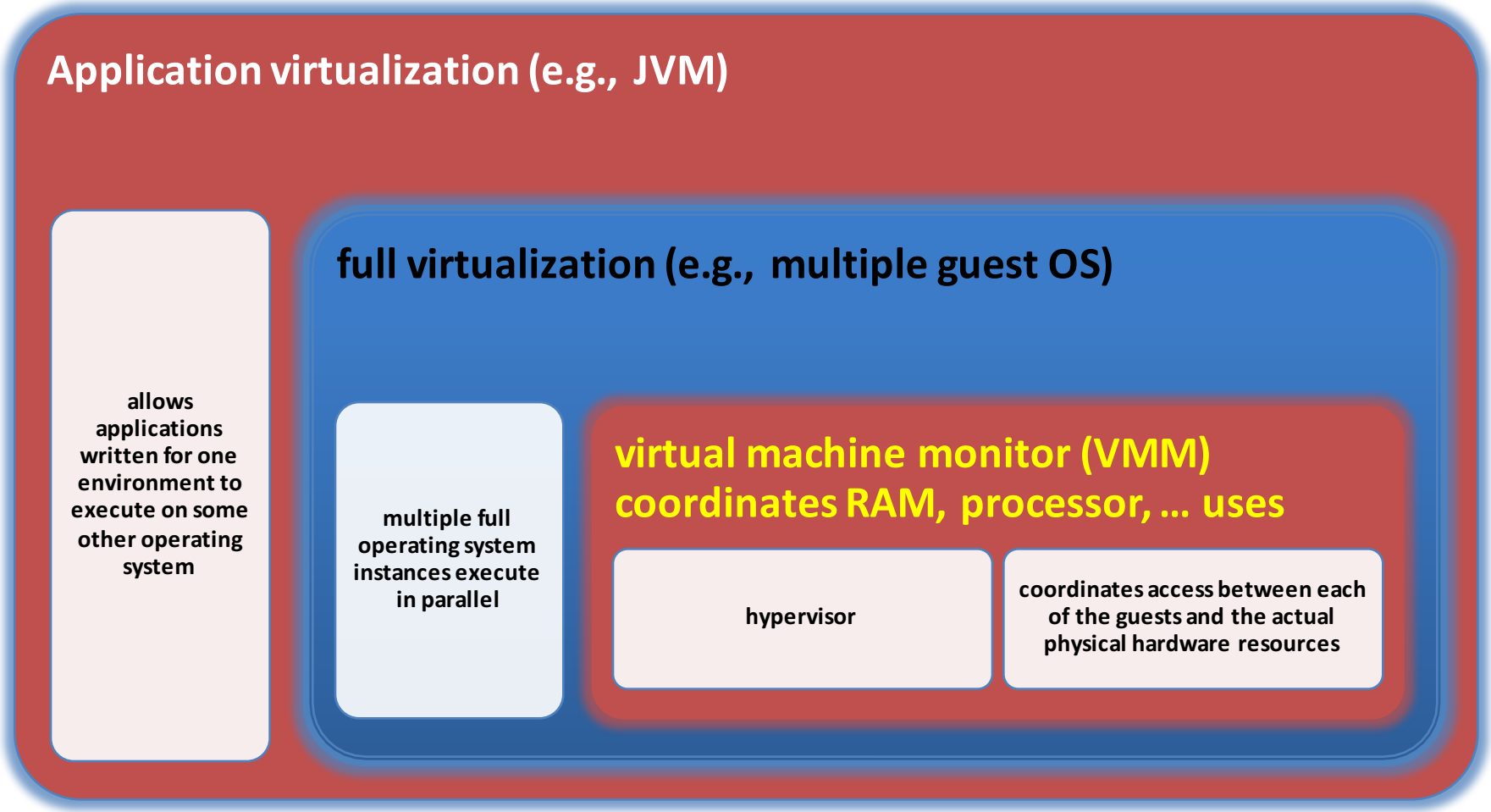
Windows Security

- Other security controls
- Essential that anti-virus, anti-spyware, personal firewall, and other malware and attack detection and handling software packages are installed and configured
- Current generation Windows systems include basic firewall and malware countermeasure capabilities
- Important to ensure the set of products in use are compatible
- Windows systems also support a range of cryptographic functions:
- Encrypting files and directories using the Encrypting File System (EFS)
- Full-disk encryption with AES using BitLocker
- “Microsoft Baseline Security Analyzer”
- Free, easy to use tool that checks for compliance with Microsoft’s security recommendations

Virtualization

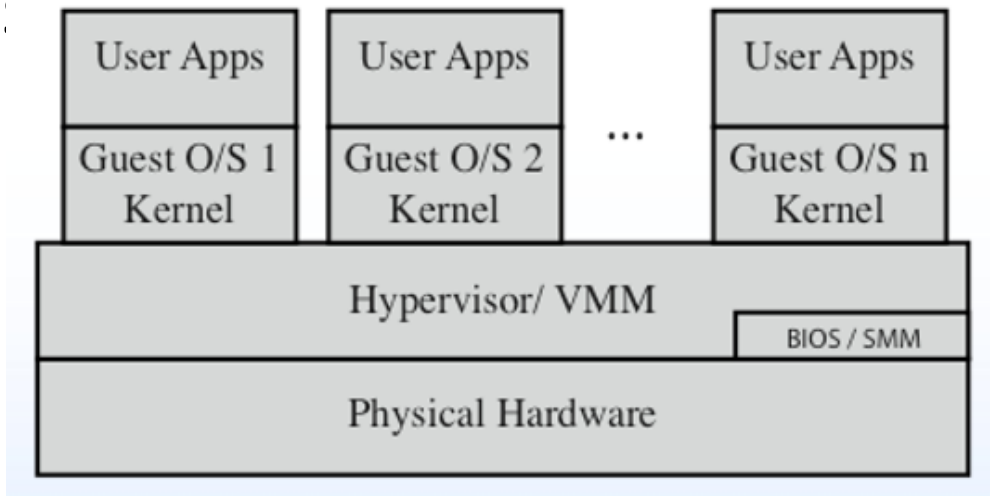
- A technology that provides an abstraction of the resources used by some software which runs in a simulated environment called a virtual machine (VM)
- Benefits include better efficiency in the use of the physical system resources
- Provides support for multiple distinct operating systems and associated applications on one physical system
- Raises additional security concerns

Virtualization Alternatives



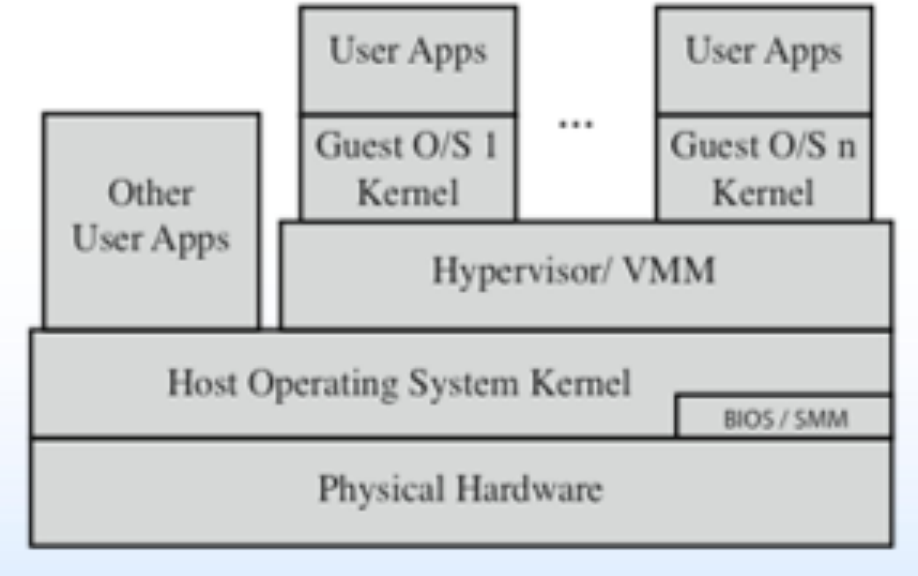
Full Virtualization Variations

- **Native virtualization**: the hypervisor executes directly on the underlying hardware
- Hosted OS is just another app
- More



Full Virtualization Variations

- **Hosted virtualization**: Hosted OS run along other apps
- Adds additional layers, increased security concerr



Virtualization Security Issues

- Security concerns include:
  - **Guest OS isolation**: ensuring that programs executing within a guest OS may only access and use the resources allocated to it
  - Guest OS monitoring by the **hypervisor**: has privileged access to the programs and data in each guest OS and ***must be trust***
  - Virtualized environment security: particularly **image** and **snapshot management** which attackers may attempt to view or modify

Hypervisor Security

- Should be
  - secured using a process similar to securing an operating system
  - installed in an isolated environment
  - configured so that it is updated automatically
  - monitored for any signs of compromise
  - accessed only by authorized administration
- May support both local and remote administration so must be configured appropriately
- Remote administration access should be considered and secured in the design of any network firewall and IDS capability in use

Summary

- System security planning
- operating systems hardening
  - initial setup and patching
  - remove unnecessary services
  - configure users and groups
  - test system security
- Application security
  - application configuration
  - encryption technology
  - security maintenance
  - data backup
  - virtualization security
    - virtualization alternatives
- Linux/Unix security
  - patch management
  - application configuration
  - users, groups, permissions
  - remote access
  - security testing
- Windows security
  - patch management
  - users administration and access controls
  - application and service configuration
  - security testing