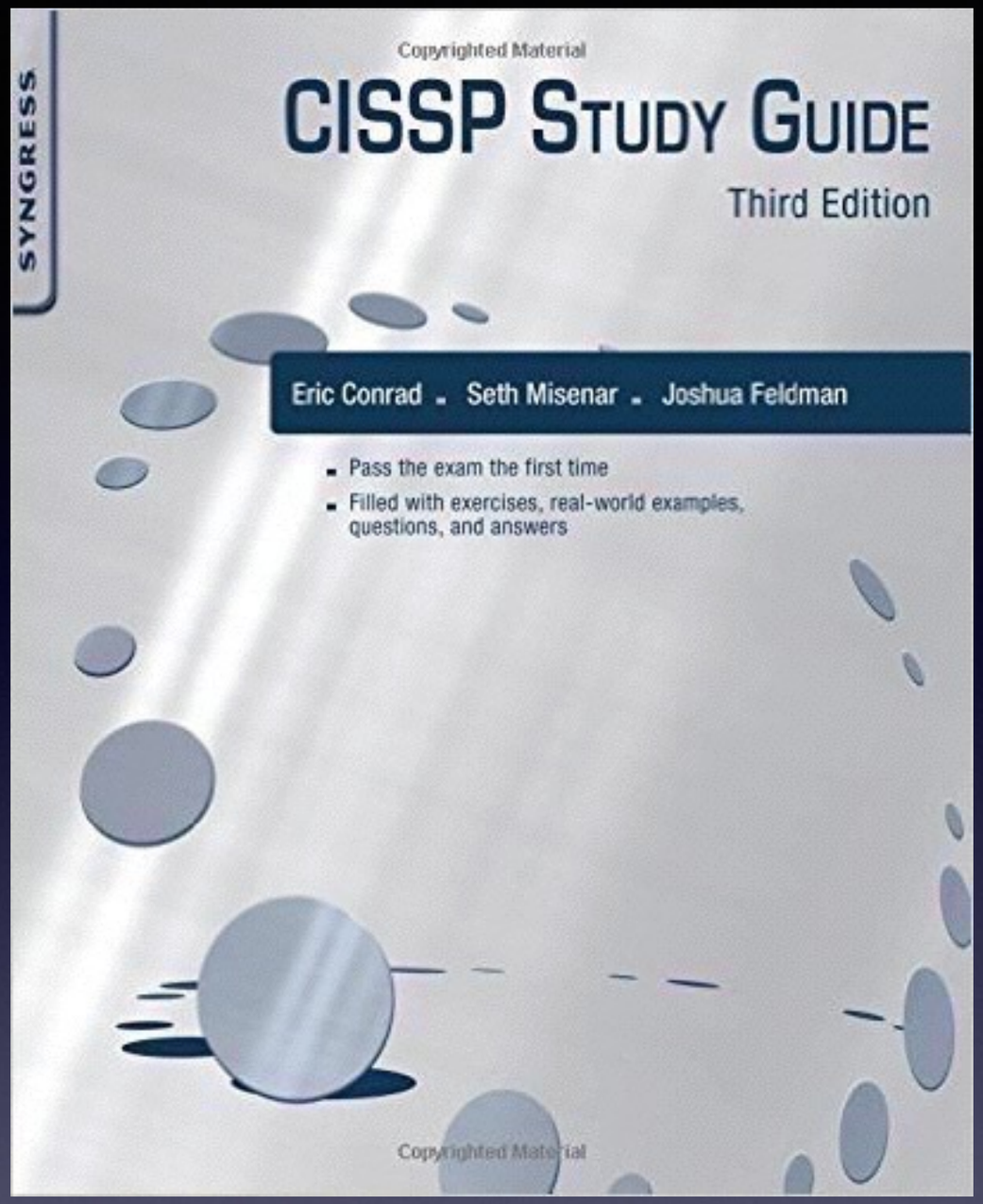
CNIT 125: Information Security Professional (CISSP Preparation)



Ch 8. Security Operations

Administrative Security

Administrative Personnel Controls

- **Least Privilege or Minimum Necessary Access**
- **Need to Know (compartmentalizing)**
- **Separation of Duties**
  - **Multiple people must approve critical transactions**
  - **Requires *collusion* of multiple people to bypass**

Administrative Personnel Controls

- **Rotation of Duties/Job Rotation**
  - **People move from one job to another**
  - **Mitigates fraud**
  - **Can be costly, however**
- **Mandatory Leave/Forced Vacation**
- **Non-Disclosure Agreement (NDA)**
- **Background Checks**

Privilege Monitoring

- **Scrutinize**
  - **Account creation/deletion**
  - **Reboots**
  - **Backup and restore**
  - **Source code access**
  - **Audit log access**

Forensics

Forensics

- **Preserve the "crime scene"**
- **Collect evidence**
- **Antiforensics**
- **Makes forensics difficult or impossible**
- **Malware that is entirely memory-resident**
- **Makes Live Forensics important**
  - **Capturing RAM while system is still on**

Phases of Forensics

- **Identification of potential evidence**
- **Acquisition of evidence**
- **Analysis of evidence**
- **Production of a report**

Forensic Media Analysis

- **Live capture**
- **Binary images of hard disks, USB flash drives, CDs, DVDs, cell phones, MP3 players**
- **Binary image includes deleted files**
  - **More complete than a normal backup**

Four Types of Disk-Based Forensic Data

- **Allocated space (normal files)**
- **Unallocated space (deleted files)**
- **Slack space**
  - **Leftover space at end of clusters**
  - **Contains fragments of old files**
- **Bad bocks/clusters/sectors**
  - **Ignored by operating systems**
  - **May contain hidden data**

Binary Backup Tools

- **Norton Ghost (in forensic mode)**
- **FTK Imager**
- **EnCase**

Network Forensics

- **Legal-focused analysis of traffic**
- **Closely related to Network Intrusion Detection**
  - **Operations-focused analysis**
  - **Emails, Web surfing, IM conversations, and file transfers can be recovered from network captures**

Forensic Software Analysis

- **Investigators have a binary file to analyze**
- **Reverse engineering malware**
- **Uses disassemblers and debuggers**
- **And virtual machines for dynamic analysis**

Embedded Device Forensics

- **SSDs (Solid State Drives)**
- **Handheld devices**

Electronic Discovery
eDiscovery

- **Producing evidence for a lawsuit**
- **Can be difficult**
- **Backups may be inconvenient to access**

Incident Response Management

Incident Response

1. Preparation
2. Detection (aka Identification)
3. Response (aka Containment)
4. Mitigation (aka Eradication)
5. Reporting
6. Recovery
7. Remediation
8. Lessons Learned (aka Post-incident Activity, Post Mortem, or Reporting)

Preparation

- **Training**
- **Writing incident response policies and procedures**
- **Providing tools such as laptops with sniffing softare, crossover cables, original OS media, removable drives, etc.**

Incident Handling Checklist

	Action	Completed
	Detection and Analysis	
1.	Determine whether an incident has occurred	
1.1	Analyze the precursors and indicators	
1.2	Look for correlating information	
1.3	Perform research (e.g., search engines, knowledge base)	
1.4	As soon as the handler believes an incident has occurred, begin documenting the investigation and gathering evidence	
2.	Prioritize handling the incident based on the relevant factors (functional impact, information impact, recoverability effort, etc.)	
3.	Report the incident to the appropriate internal personnel and external organizations	
	Containment, Eradication, and Recovery	
4.	Acquire, preserve, secure, and document evidence	
5.	Contain the incident	
6.	Eradicate the incident	
6.1	Identify and mitigate all vulnerabilities that were exploited	
6.2	Remove malware, inappropriate materials, and other components	
6.3	If more affected hosts are discovered (e.g., new malware infections), repeat the Detection and Analysis steps (1.1, 1.2) to identify all other affected hosts, then contain (5) and eradicate (6) the incident for them	
7.	Recover from the incident	
7.1	Return affected systems to an operationally ready state	
7.2	Confirm that the affected systems are functioning normally	
7.3	If necessary, implement additional monitoring to look for future related activity	
	Post-Incident Activity	
8.	Create a follow-up report	
9.	Hold a lessons learned meeting (mandatory for major incidents, optional otherwise)	

Detection

- **Analyze events to determine whether a security incident has taken place**
- **Requires log files**
- **Many strange events are not security incidents**

Response

- **Also called *Containment***
- **Prevent further damage**
  - **Take systems off the network**
  - **Isolate traffic**
  - **Power off systems**
- **Make binary images of systems involved**
- **Requires management approval: may impact business**

Mitigation

- **Also called *eradication***
- **Determine cause of incident**
- **So systems can be cleaned**
- **Root cause analysis is required**

Reporting

- **Musst begin immediately upon detection of malicious activity**
- **Two types**
  - **Technical**
  - **Non-technical**
    - **Often neglected, but very important**
    - **Non-technical stakeholders include business and mission owners**

Recovery

- **Restoring the affected systems to operation**
- **Monitor systems to see if the infection or attacker returns**

Remediation

- **Removal of the vulnerability that allowed the incident**
  - **Change passwords**
  - **Switch to two-factor authentication**

Lessons Learned

- **Likely to be neglected**
- **Greatest potential to improve security posture**
- **Create a final report to deliver to management**
- **Detail ways the incident could have been detected sooner, response could have been quicker or more effective, and areas for improvement**

Root-Cause Analysis

- **Determine the underlying weakness or vulnerability that allowed the incident**
- **Without this, incident could repeat**

Operational Preventive Detective Controls

IDS & IPS

- **Intrusion Detection System**
  - **Detects malicious actions**
- **Intrusion Prevention System**
  - **Prevents malicious actions**
- **Network-based**
  - **Protects a whole network**
- **Host-based**
  - **Protects only one host**
  - **Ex: Tripwire**

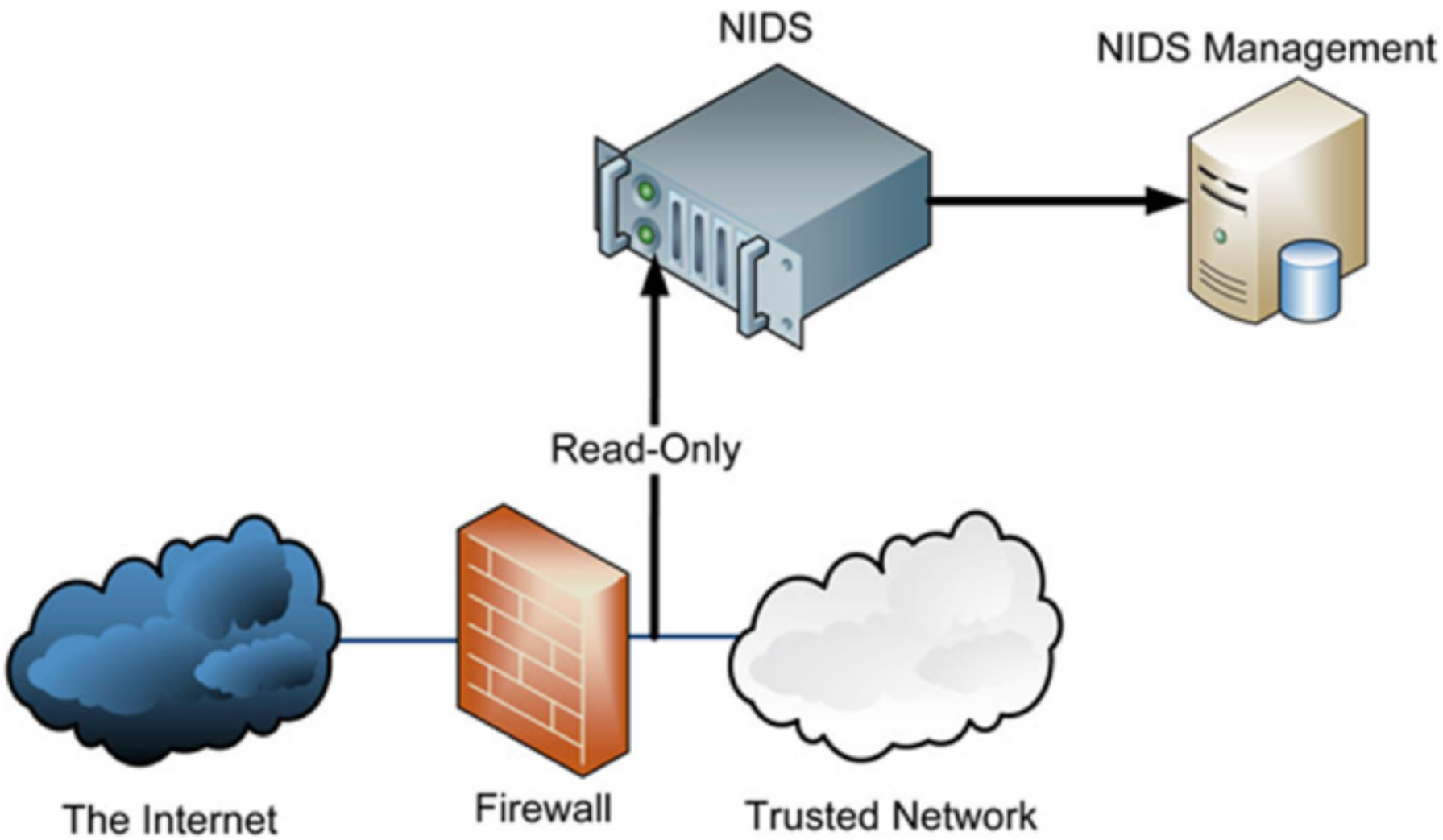


FIGURE 8.5 NIDS Architecture

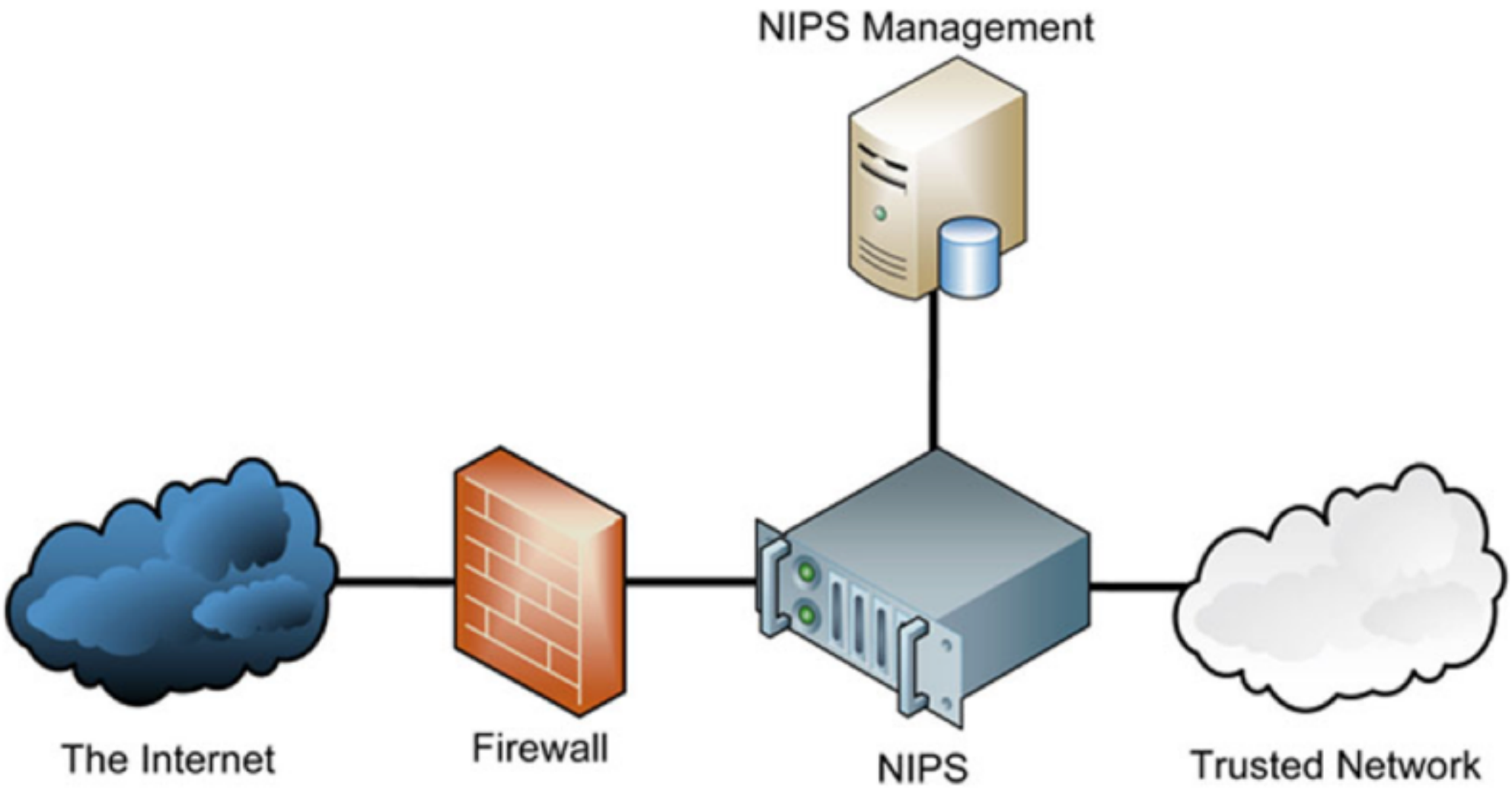


FIGURE 8.6 Inline NIPS Architecture

Types of IDS

- **Pattern matching**
  - **Compares events to static signatures**
- **Protocol behavior**
  - **Detects protocol errors, like SYN/FIN TCP packets**
- **Anomaly detection**
  - **Reports traffic that varies from normal baseline**

Security Information and Event Management (SIEM)

- **Correlates data from many sources**
- **Continuous Monitoring**
  - **Now recommended, replacing the earlier Certification and Accreditation approach of examining a system once every 3 years**

Data Loss Prevention

- **Prevents sensitive data from leaving the network**

Endpoint Security

- **Security suites, including**
  - **Antivirus, application whitelisting, removable media controls, disk encryption, Host Intrusion Prevention Systems, and firewalls**

Antivirus

- **Mostly depend on signature detectio**
  - **Blacklisting**
- **Application whitelisting**
  - **New technique**
  - **Only allow known good software to run**
  - **May use**
    - **File path and name**
    - **Hash**
    - **Code signature**

Removable Media Controls

- **Disable Autorun (default on modern Windows systems)**

Disk Encryption

- **Full Disk Encryption is best**

Honeypots

- System designed to attract attackers
- May have legal risks
  - Attacker may claim they were invited in
- Honey nets
  - Real or simulated network of honeypots

Asset Management

Configuration Management

- **Consistent security configuration**
- **Hardened beyond the defaults**
- **Baselining**
  - **Captures security configuration at a point in time**

Patch Management

- **Must evaluate and test patch**
- **Deploying patches is best done with a management system**

Vulnerability Management

- **Vulnerability scanning finds poor configurations and missing patches**
- **Must remediate the vulnerabilities**
- **Zero Day Vulnerability and Zero Day Exploits**
- **No patch available**

Change Management

- **Change control board oversees and coordinates change control process**
- **Approves or denies changes baed on risk and cost management**

Change Management Steps

- Identifying a change
- Proposing a change
- Assessing the risk associated with the change
- Testing the change
- Scheduling the change
- Notifying impacted parties of the change
- Implementing the change
- Reporting results of the change implementation

Continuity of Operations

Service Level Agreements (SLA)

- **Dictates what is acceptable**
  - **Bandwidth, time to delivery, response times, etc.**
  - **Ex: 99.9% uptime**

Fault Tolerance

- **A device may fail; that is a *fault***
- **If users no longer receive service, that's a *failure***
- **Fault-tolerant systems have redundant systems**
- **So a fault does not lead to a failure**

Backup

- **Full Backup**
- **Incremental backup**
  - **Data changed since last full backup of any kind**
    - **May take several tapes to recover**
- **Differential backup**
  - **Data changed since last full backup**
  - **May take two tapes to recover**

RAID

- **Redundant Array of Inexpensive Disks**

RAID Levels

RAID Level	Description
RAID 0	Striped Set
RAID 1	Mirrored Set
RAID 3	Byte Level Striping with Dedicated Parity
RAID 4	Block Level Striping with Dedicated Parity
RAID 5	Block Level Striping with Distributed Parity
RAID 6	Block Level Striping with Double Distributed Parity

RAID Terms

- **Mirroring**
  - **Duplicating data on another disk**
- **Skipping**
  - **Writing data across many disks**
  - **Improves performance, but does not provide fault tolerance**
- **Parity**
  - **Saves XORed data from other drives**
  - **Provides fault tolerance**

RAID Levels

- **RAID 0: Striped (no fault tolerance)**
- **RAID 1: Mirrored (fault tolerant)**
- **RAID 3: Parity on a single drive (fault tolerant)**
- **RAID 5: Striped set with distributed parity (fault tolerant)**
- **RAID 6: Striped set with dual distributed parity (can recover even if two drives fail)**

RAID Levels

- **RAID 1+0 or RAID 10**
  - **Striped set of mirrors**
  - **Fault tolerant**

System Redundancy

- **Redundant Hardware**
  - **Extra power supplies, NICs, disk controllers**
- **Redundant Systems**
- **High Availability Clusters**
  - **Failover cluster uses another device when the primary one fails**
    - **Called "Active-Passive"**
  - **Active-Active or Load Balancing cluster**
    - **Uses all devices at all times**

BCP and DRP Overview and Process

Business Continuity Planning (BCP)

- **Ensures that business will continue to operate before, throughout, and during a disaster**
- **Ensures that critical services can be carried out**
- **Strategic, long-term: focuses on business as a whole**
- **An umbrella plan that includes multiple plans, most importantly the Disaster Recovery Plan (DLP)**

Disaster Recovery Planning (DRP)

- **Tactical, short-term**
- **Plan to deal with specific disruptions, such as a malware infection**

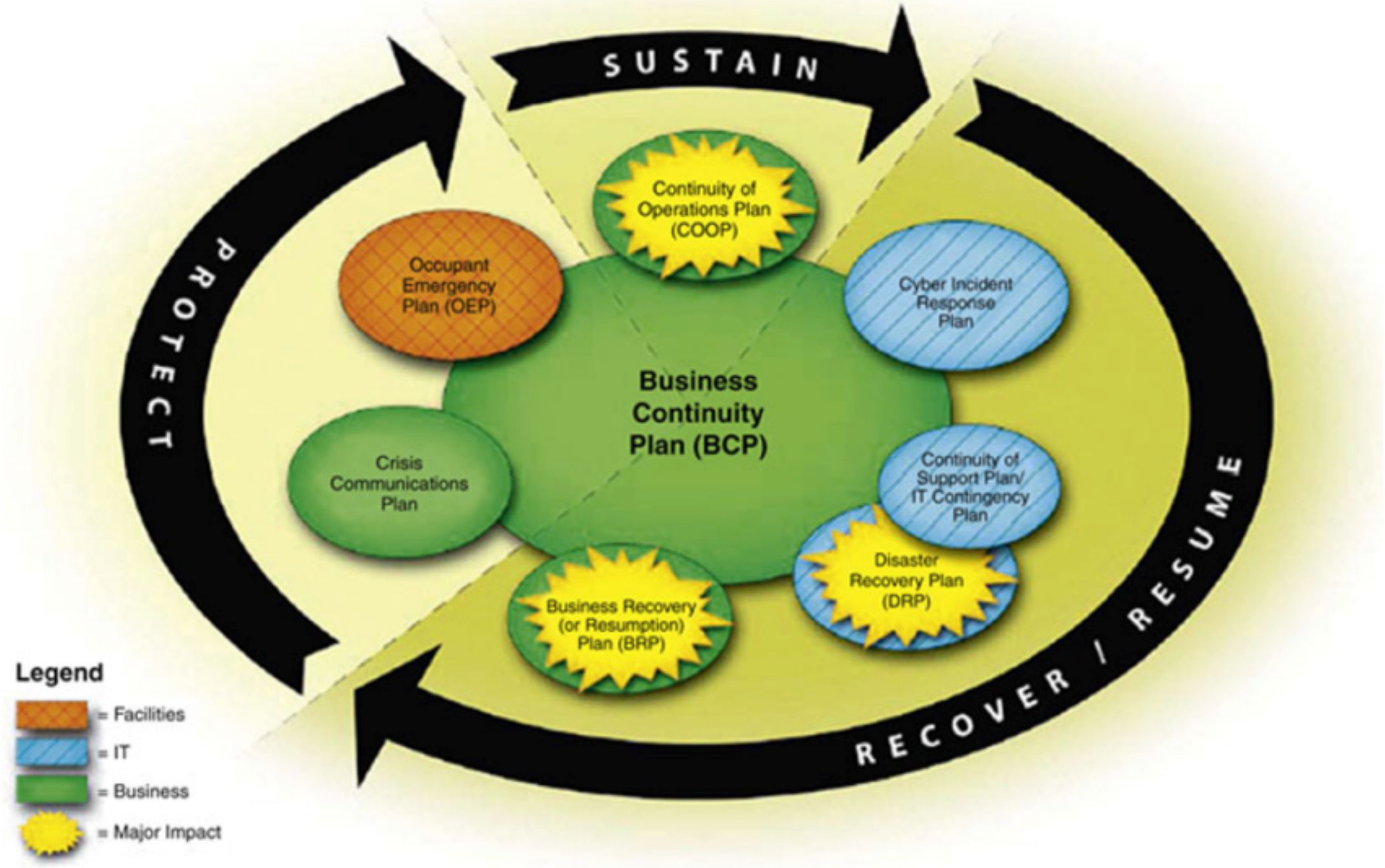


FIGURE 8.11 BCP and Related Plans [9]

Maximum Tolerable Downtime (MTD)

- **Used to determine how to allocate resources for recovery**

Disasters or Disruptive Events

- **By Cause**
  - **Natural (like earthquakes)**
  - **Human**
    - **Intentional like terrorism, rogue insiders, DoS, phishing, etc.**
    - **Inadvertent like errors, laziness, carelessness**
  - **Environmental (like power blackouts, equipment failures, or software flaws)**

Examples of Disruptive Events

Disruptive Event	Type
Earthquake/Tornado/Hurricane/etc.	Natural
Strike	Human (intentional)
Cyber terrorism	Human (intentional)/Technical
Malware	Human (intentional)/Technical
Denial of Service	Human (intentional)/Technical
Errors and Omissions	Human (unintentional)
Electrical Fire	Environmental
Equipment failure	Environmental

Errors and Omissions

- **Most common source of disruptive events**
- **Easily avoided with controls, if they can be identified**

Temperature and Humidity Failures

- **Without proper controls, the Mean Time Between Failures (MTBF) for electrical equipment will decrease**
- **Must test backup power and HVAC**
- **UPS (Uninterruptible Power Supply)**
- **Generators**

Disasters

- **Warfare, terrorism, and sabotage**
- **Financially motivated attackers**
- **Personnel shortages**
  - **Pandemics and disease**
  - **Strikes**
  - **Loss of a critical individual worker**

Communications Failure

- **Physical line breaks**
- **Hurricanes**

The Disaster Recovery Process

- **Respond**
- **Activate Team**
- **Communicate**
- **Assess**
- **Reconstitution**

Respond

- **Initial assessment of damage**
- **Quickly determine if the event is a disaster**
- **Is the facility safe for continued use?**

Activate Team & Communicate

- **Communicating with team may be difficult**
- **Call Trees may help**
- **Timely updates must get back to the central team**
- **Phones may be down**
  - **Organization must be prepared with external communications**

Assess

- **Disaster Recovery team will perform a more detailed and thorough assessment**
- **Determine extent of damage**
- **Proper steps**
- **Consider Maximum Tolerable Downtime (MTD)**
- **Protect safety of personnel**

Reconstitution

- **Recover critical business processes**
- **Either at a primary or secondary site**
- **Salvage team will begin recovery process at primary site**

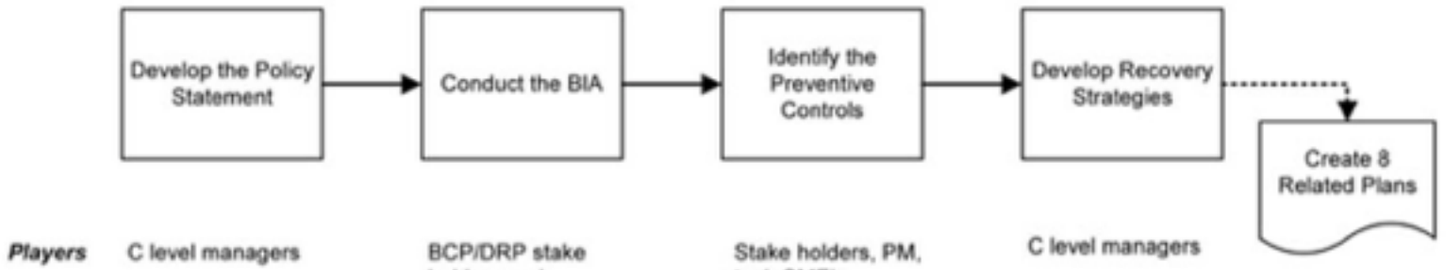
Developing a BCP/DRP

- Project Initiation
- Scope the Project
- Business Impact Analysis
- Identify Preventive Controls
- Recovery Strategy
- Plan Design and Development
- Implementation, Training, and Testing
- BCP/DRP Maintenance [15]

Project Initiation Milestones

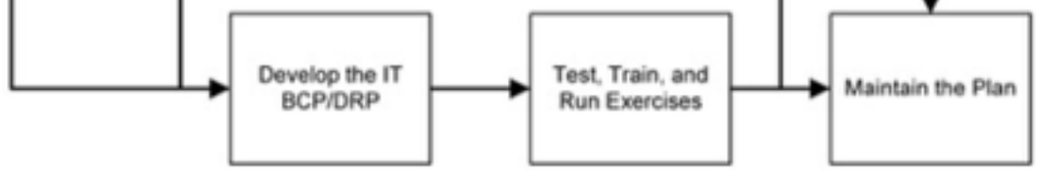
1. **Develop contingency planning policy**
2. **Conduct Business Impact Analysis (BIA) to identify critical systems**
3. **Identify preventive controls**
4. **Develop recovery strategies**
5. **Develop IT contingency plan**
6. **Plan testing, training, and exercises**
7. **Plan maintenance**

Organization BCP/DRP Planning Process



Players	C level managers	BCP/DRP stake holders and project manager (PM)	Stake holders, PM, tech SME's	C level managers
Actions	Org defines guidance for BCP/ DRP that will be followed by all members	Business Impact is measured for all potential organization assets (IT being one of many) IT Specific measurement: Maximum Time Down (MTD)	What controls can reduce risk, prevent damage?	Org defines guidance for BCP/ DRP that will be followed by all members

IT BCP/DRP Components of the Plan



Players	IT PM, IT Staff, User Group	IT PM, IT Staff, User Group, C level managers	IT PM, IT Staff, User Group
Actions	Asses those portions of the BIA that are affected by IT and mitigate	Test, train, and exercise the plan to ensure it meets IT and organizational needs	Keep plan up to date with changes in system and organizational needs.

Management Support

- **"C" level management must support the plan**
- **They can allocate resources**
- **BCP / DRP planning may increase company efficiency even if no disaster occurs**

BCP/DRP Project Manager

- **Key point of contact to ensure that BCP/ DRP plan is completed and tested**
- **Must have good organizational skills**
- **And credibility and authority**
- **Does not need in-depth technical skills**
- **Main skills: negotiation and people skills**

Building the BCP/DRP Team

- **First establish a Continuity Planning Project Team (CPPT) with stakeholders**
  - **Human resources**
  - **Public relations**
  - **IT**
  - **Physical security**
  - **Line managers**
  - **Anyone else responsible for essential functions**

Scoping the Project

- **What assets are protected?**
- **Which emergency events are addressed?**
- **What resources are needed?**

1. Executive management support is needed for initiating the plan.
2. Executive management support is needed for final approval of the plan.
3. Executive management must demonstrate due care and due diligence and be held liable under applicable laws/regulations.

Assessing the Critical State

- **List IT assets, and**
  - **Who uses them**
  - **What business process they support**
- **Business Impact of outage**

Business Impact Analysis (BIA)

- **Determine Maximum Tolerable Downtime (MTD) for specific IT assets**
- **First, identify critical assets**
- **Second, comprehensive risk analysis**
- **Including vulnerability analysis**

Example Risk Assessment for Email

Risk	Vulnerability	BIA	Mitigation
Server room unlocked	Unauthorized personnel may enter	Loss of CIA for system from physical attack	Install locks with PIN and alarm (risk reduced to tolerable level)
Software out of date	Known insecurities, end-of-life	Loss of CIA from cyberattack	Update software (risk eliminated)
No firewall	Added exposure to Internet cyberattacks	Loss of CIA from cyberattack	Move server to managed hosting (transfer risk)

Determine Maximum Tolerable Downtime (MTD)

- **Recovery Point Objective (RPO)**
  - **Amount of data loss an organization can withstand**
- **Recovery Time Objective (RTO)**
  - **Max. time required to recover systems**
- **Work Recovery Time (WRT)**
  - **Time required to configure a recovered system**
- **MTD = RTO + WRT**

MTBF

- **Mean Time Between Failures (MTBF)**
  - **Estimate, systems may fail sooner**
- **Mean Time to Repair (MTTR)**
- **Minimum Operating Requirements**
  - **Minimum environmental and connectivity requirements to operate computer equipment**

Recovery Strategy

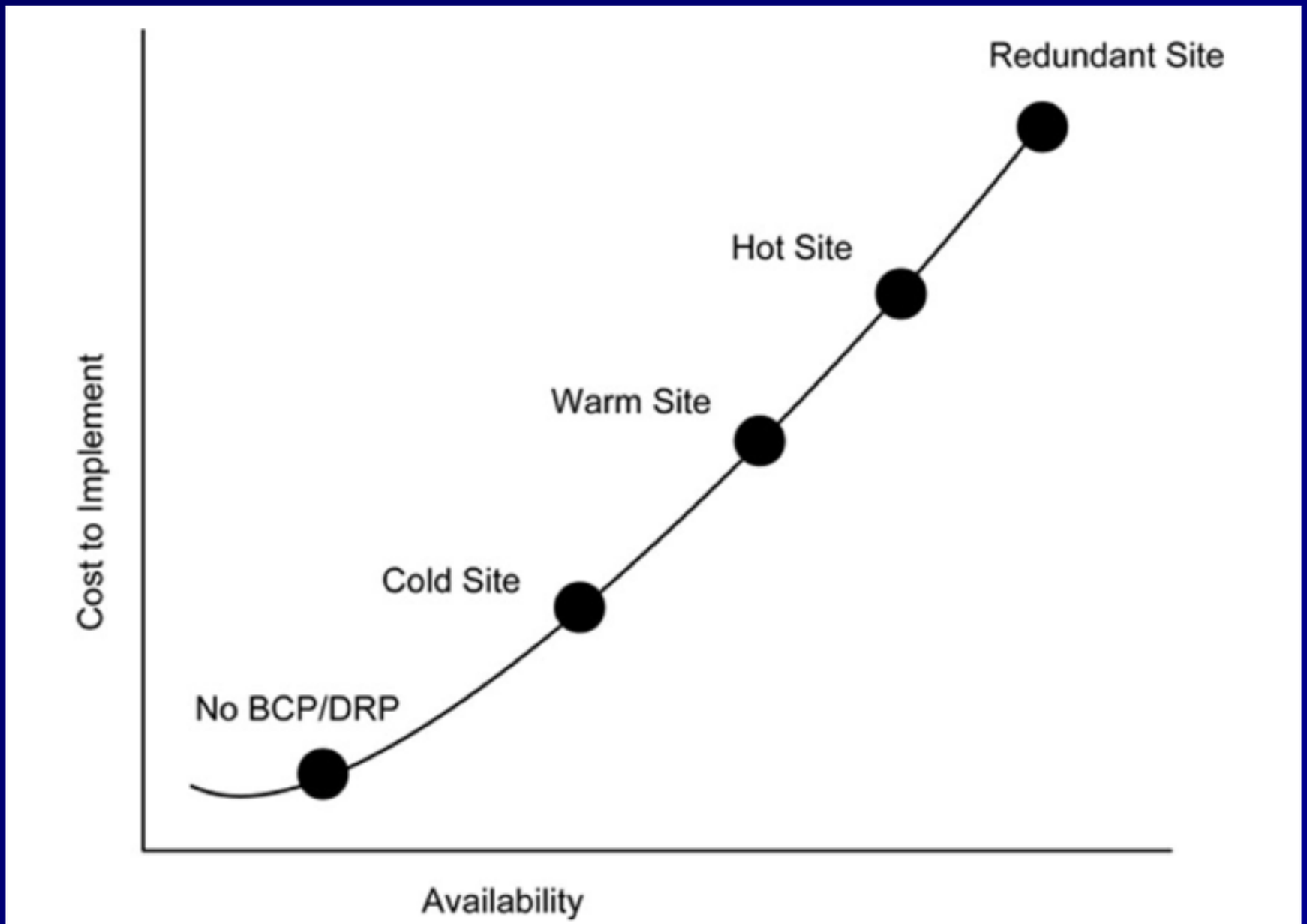


FIGURE 8.13 Recovery Technologies Cost vs. Availability

Supply Chain Management

- **A large disaster may impact your suppliers**
- **Some vendors offer guaranteed replacement insurance**

Telecommunication Management

- **Communication may fail during a disaster**
- **Alternatives**
  - **T1 lines**
  - **Wireless networks**
  - **Satellite phones**

Utility Management

- **Address all required utilities**
  - **Power**
  - **Heating**
  - **Cooling**
  - **Water**

Recovery Options

- **Redundant Site: ready to go, including up-to-date data**
- **Hot Site**
  - **Equipment ready, but may take an hour or so to load data**
- **Warm Site**
  - **Has some equipment, but not exact duplicates; 1-3 days to bring it up**
- **Cold Site**
  - **Datacenter but lacks hardware or data, may take weeks to bring up**

Recovery Options

- **Reciprocal Agreement**
  - **Use another organization's datacenter**
- **Mobile Site**
  - **Datacenter on wheels, drive into disaster area**
- **Subscription services**
  - **Outsource BCP/DRP**
  - **IBM's SunGard**

Plan	Purpose	Scope
Business Continuity Plan (BCP)	Provide procedures for sustaining essential business operations while recovering from a significant disruption	Addresses business processes; IT addressed based only on its support for business process
Business Recovery (or Resumption) Plan (BRP)	Provide procedures for recovering business operations immediately following a disaster	Addresses business processes; not IT-focused; IT addressed based only on its support for business process
Continuity of Operations Plan (COOP)	Provide procedures and capabilities to sustain an organization's essential, strategic functions at an alternate site for up to 30 days	Addresses the subset of an organization's missions that are deemed most critical; usually written at headquarters level; not IT-focused
Continuity of Support Plan/IT Contingency Plan	Provide procedures and capabilities for recovering a major application or general support system	Same as IT contingency plan; addresses IT system disruptions; not business process focused
Crisis Communications Plan	Provides procedures for disseminating status reports to personnel and the public	Addresses communications with personnel and the public; not IT focused
Cyber Incident Response Plan	Provide strategies to detect, respond to, and limit consequences of malicious cyber incident	Focuses on information security responses to incidents affecting systems and/or networks
Disaster Recovery Plan (DRP)	Provide detailed procedures to facilitate recovery of capabilities at an alternate site	Often IT-focused; limited to major disruptions with long-term effects
Occupant Emergency Plan (OEP)	Provide coordinated procedures for minimizing loss of life or injury and protecting property damage in response to a physical threat	Focuses on personnel and property particular to the specific facility; not business process or IT system functionality based

Related Plans

- **Continuity of Operations (COOP)**
  - **Move personnel to alternate site**
- **Business Recovery Plan (BRP)**
  - **After COOP, move back to original site**
- **Continuity of Support Plan**
  - **Covers IT only**
- **Cyber Incident Response Plan**
  - **Viruses, worms, intrusions**

Related Plans

- **Occupant Emergency Plan**
  - **Safety and evacuation of people**
- **Crisis Management Plan (CMP)**
  - **Coordinate managers**

Crisis Management Plan (CMP)

- **Crisis Communications Plan**
  - **Resist rumors by providing the truth**
- **Call Trees**
  - **Employees call a list of other employees**
- **Automated Call Trees**
- **Emergency Operations Center (EOC)**
  - **Command post**
- **Vital Records (stored offsite)**

Executive Succession Planning

- **Some executive should be on-site at all times**

Backups and Availability

Continuous Availability

- **Maximum Tolerable Downtime (MTD)**
  - **Getting shorter**
- **Some systems require Continuous Availability**
  - **MTD of zero**

Hardcopy Data

- **Continue business using paper records during a disaster**

Backups

- **Full backup (all data)**
- **Incremental backup**
  - **All data changed since last full or incremental backup**
  - **May require several tapes to recover**
- **Differential backup**
  - **All data changed since last full backup**
  - **May require two tapes to recover**

Tape Rotation Methods

- **First In First Out (FIFO)**
  - **14 tapes--14 days of backups**
- **Grandfather-Father-Son (GFS)**
  - **7 daily tapes (son)**
  - **4 weekly tapes (father)**
  - **12 monthly tapes (grandfather)**
  - **Once per week a son graduates to a father**
  - **Once a month a father becomes a grandfather**

Electronic Vaulting

- **Transmits backup data over the Internet**
- **Can backup at very short intervals**
- **Should be encrypted in transit**
- **Remote Journaling**
  - **Saves database checkpoints periodically**
- **Database Shadowing**
  - **Maintains two identical databases on different servers, for faster recovery**

HA (High Availability) Options

- **High Availability Cluster**
  - **Active-Active has all systems working**
    - **Also called load balancing**
  - **Active-Passive**
    - **Backup devices come up when main device goes down**

Software Escrow

- **What happens if the company that wrote your mission-critical software goes out of business?**
  - **Source code may be stored at a trusted third party**

DRP Testing, Training and Awareness

DRP Testing

- **DRP Review**
  - **DRP team reads the whole plan to find flaws**
- **Read-Through**
  - **Lists all necessary components**
  - **Ensures they are available**
- **Walkthrough/Tabletop**
  - **Talk through steps**
  - **Find omissions, gaps, erroneous assumptions, etc.**

DRP Testing

- **Simulation Test/Walkthrough Drill**
  - **Teams actually carry out the recovery process**
- **Parallel Processing**
  - **Duplicate real business transactions on backup systems**
- **Partial and Complete Business Interruption**
  - **Stop normal systems**
  - **Can cause a disaster**

Training

- **Starting Emergency Power**
- **Call Tree Training/Test**
- **Awareness**
  - **For employees not directly participating in the DRP**

Continued BCP/DRP Maintenance

Change Management

- **MCP team should be a member of the Change Control board**
- **BCP/DRP Version Control**

Common BCP/DRP mistakes include:

- Lack of management support
- Lack of business unit involvement
- Lack of prioritization among critical staff
- Improper (often overly narrow) scope
- Inadequate telecommunications management
- Inadequate supply chain management
- Incomplete or inadequate crisis management plan
- Lack of testing
- Lack of training and awareness
- Failure to keep the BCP/DRP plan up to date

Specific BCP/DRP Frameworks

Specific BCP/DRP Frameworks

- **NIST SP 800-34**
  - **For US Gov't systems**
- **ISO/IEC-27031**
  - **Part of ISO 27000 series**
- **BS-25999**
  - **British standard**
- **ISO 22301**
  - **Supersedes BS-25999**

BCI

- **Business Continuity Institute**
  - **Six Professional Practices**

- Management Practices
  - PP1 Policy & Program Management
  - PP2 Embedding Business Continuity
- Technical Practices
  - PP3 Analysis
  - PP4 Design
  - PP5 Implementation
  - PP6 Validation [32]