



A photograph showing the back of a person's head as they work at a complex control console. The console is filled with numerous knobs, buttons, and screens. One large screen displays a video feed of another person speaking into a microphone. Another screen shows a list of items or tasks. To the right, there are two more monitors displaying various software interfaces. The overall environment suggests a professional broadcast or monitoring facility.

Professor Messer's **CompTIA A+**

CORE 2 220-1102
Course Notes

James "Professor" Messer

Professor Messer's

CompTIA 220-1102 Core 2

A+ Course Notes

James "Professor" Messer



Professor Messer's CompTIA 220-1102 Core 2 A+ Course Notes

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Introduction

The CompTIA A+ certification requires a broad set of knowledge, and it covers more topics than many industry certifications. It's no surprise that the A+ certification has become one of the most sought-after industry certifications by both aspiring technologists and employers.

I hope this book helps you with your “last mile” of studies before taking your exam. There’s a lot to remember, and perhaps some of the information in this book will help jog your memory while you’re sitting in the exam room. Best of luck with your studies!

- Professor Messer

The CompTIA A+ Certification

CompTIA’s A+ certification is considered to be the starting point for information technology professionals. Earning the A+ certification requires the completion of two exams and covers a broad range of technology topics. After completing the CompTIA A+ certification, an A+ certified professional will have an understanding of computer hardware, mobile devices, networking, operating systems, security techniques, and much more.

The current series of the A+ certification is based on the successful completion of the 220-1101 and the 220-1102 exams. You must pass both exams to earn your CompTIA A+ certification. This book provides a set of notes for the 220-1102 Core 2 exam.

The 220-1102 Core 2 exam

The 220-1102 exam objectives are focused on operating systems, with over half of the exam detailing operating systems and the troubleshooting of software.

Here’s the breakdown of the four 220-1102 exam domains:

Domain 1.0 - Operating Systems - 31%

Domain 2.0 - Security - 25%

Domain 3.0 - Software Troubleshooting - 22%

Domain 4.0 - Operational Procedures - 22%

Study Tips

Exam Preparation

- Download the exam objectives, and use them as a master checklist: <http://www.ProfessorMesser.com/objectives>
- Use as many training materials as possible. Books, videos, and Q&A guides can all provide a different perspective of the same information.
- It's useful to have as much hands-on as possible, especially with network troubleshooting and operating system command prompts.

Taking the Exam

- Use your time wisely. You've got 90 minutes to get through everything.
- Choose your exam location carefully. Some sites are better than others.
- Get there early. Don't stress the journey.
- Manage your time wisely. You've got 90 minutes to get through everything.
- Wrong answers aren't counted against you. Don't leave any blanks!
- Mark difficult questions and come back later. You can answer the questions in any order.



1.1 - An Overview of Windows

Windows on the Core 2 exam

- 220-1102 exam released in January 2022
 - Two Windows versions available
 - Windows 10 and Windows 11
- CompTIA considers all in-support Windows versions to be in scope for the exam
 - Mainstream support is 5 years after release
- Windows versions are listed in the objectives
 - Everything else includes both Windows 10 and 11
- Fortunately, these are remarkably similar
 - Once you know one, you effectively know the other!

Windows 10

- Released on July 29, 2015 - We skipped Windows 9
- A single platform
 - Desktops, laptops, tablets, phones, all-in-one devices
- Ongoing updates
 - More than twelve different released versions
 - November 2021 (Version 21H2)

Windows 10 Home

- Home user - Retail sales
- Integration with Microsoft account
 - Microsoft OneDrive backup
- Windows Defender
 - Anti-virus and anti-malware
- Cortana - Talk to your operating system

Windows 10 Pro

- The business version of Windows
 - Additional management features
- Remote Desktop host
 - Remote control each computer
- BitLocker - Full disk encryption (FDE)
- Join a Windows domain
 - Group Policy management

Windows 10 Pro for Workstations

- An edition for high-end desktops
 - Enhanced performance and storage options
- More physical CPUs - Up to four
- High maximum RAM - Supports up to 6 TB
- Support for ReFS - Resilient File System
 - Same as Windows Server

Windows 10 Enterprise

- Built for large implementations
 - Volume licensing
- AppLocker - Control what applications can run
- BranchCache - Remote site file caching
- Granular User Experience (UX) control
 - Define the user environment
 - Useful for kiosk and workstation customization

	Windows 10 Minimum Requirements (x86)	Windows 10 Minimum Requirements (x64)
Processor / CPU	1 GHz processor or faster	
Memory	1 GB RAM	2 GB RAM
Free disk space	32 GB or larger	
Video	Microsoft DirectX 9 graphics device with WDDM driver, minimum of 800 x 600	

Windows 10 Edition	Domain Access	BitLocker	Remote Desktop	Group Policy Management	Max x86 RAM	Max x64 RAM
Home	✗	✗	Client only	✗	4 GB	128 GB
Pro	✓	✓	Client and Host	✓	4 GB	2 TB
Pro for Workstations	✓	✓	Client and Host	✓	4 GB	6 TB
Enterprise	✓	✓	Client and Host	✓	4 GB	6 TB

1.1 - Windows Features

Windows at work

- Large-scale support
 - Thousands of devices
- Security concerns
 - Mobile devices with important data
 - Local file shares
- Working on a spreadsheet
 - Watching a movie
- Geographical sprawl - Cache data between sites

Domain Services

- Active Directory Domain Services
 - Large database of your network
- Everything documented in one place
 - User accounts, servers, volumes, printers
- Distributed architecture
 - Many servers - Not suitable for home use
- Many different uses
 - Authentication, centralized management

1.1 - Windows Features (continued)

Organizing network devices

- Windows Workgroups
 - Logical groups of network devices
 - Each device is a standalone system, everyone is a peer
- Windows Domain
 - Business network
 - Centralized authentication and device access
 - Supports thousands of devices across many networks

Desktop styles

- Your computer has many different uses
 - Those change depending on where you are
- Work
 - Standard desktop
 - Common user interface
 - Customization very limited
 - You can work at any computer
- Home
 - Complete flexibility
 - Background photos, colors, UI sizing
 - Centralized authentication and device access
 - Supports thousands of devices across many networks

Availability of RDP

- Remote Desktop Protocol
 - View and control the desktop of a remote device
- RDP client
 - Connects to a Remote Desktop Service
 - Clients available for almost any operating system
- Remote Desktop Service
 - Provides access for the RDP client
 - Available in Windows 10 Pro and Enterprise
 - Not available in Windows 10 Home

RAM support limitations

- RAM support varies between editions
 - More advanced editions allow additional RAM

BitLocker and EFS

- Data confidentiality
 - Encrypt important information
- Encrypting File System
 - Protect individual files and folders
 - Built-in to the NTFS file system
- BitLocker
 - Full Disk Encryption (FDE)
 - Everything on the drive is encrypted
 - Even the operating system
- Home and business use
 - Especially on mobile devices

Group Policy editor

- Centrally manage users and systems
 - Policies can be part of Active Directory or a local system
- Local Group Policy
 - Manages the local device
 - `gpedit.msc`
- Group Policy Management Console
 - Integrated with Active Directory
 - Powerful system management
 - `gpmc.msc`

1.1 - Windows Upgrades

Why upgrade?

- Upgrade vs. Install
 - Upgrade - Keep files in place
 - Install - Start over completely fresh
- Maintain consistency
 - Customized configurations
 - Multiple local user accounts
- Upgrades save hours of time
 - Avoid application reinstall
 - Keep user data intact
 - Get up and running quickly

Upgrade methods

- In-place
 - Upgrade the existing OS
 - Keeps all applications, documents, and settings
 - Start the setup from inside the existing OS

- Clean install
 - Wipe everything and reload
 - Backup your files
 - Start the setup by booting from the installation media

Upgrading Windows

- Upgrade from the Windows installation media
 - Downloadable versions are available from Microsoft
 - Includes a media creation tool
- You cannot upgrade x86 to x64
 - Or x64 to x86
 - Applies to all Windows versions
 - You'll have to migrate instead

1.1 - Windows Upgrades (continued)

Upgrade paths

- Many upgrades are between similar editions
 - Or higher-level Windows editions
- In-place upgrade paths to Windows 10
 - Windows 7, Windows 8.1 (not Windows 8.0)
- In-place upgrade paths to Windows 11
 - Windows 10

Post-installation

- Does it work?
 - If it doesn't boot, there are bigger problems
- Some testing is useful for unknown hardware configurations
 - Start > Settings > System > Recovery > Go back
- Additional installations
 - Service packs, security patches, security applications, driver updates, application updates

1.2 - Windows Command Line Tools

Privileges

- Not all users can run all commands
 - Some tasks are for the administrator only
- Standard privileges
 - Run applications as normal user
 - This works fine for many commands
- Administrative/elevated privileges
 - You must be a member of the Administrators group
 - Right-click Command Prompt, choose *Run as Administrator*
 - **cmd**, **Ctrl+Shift+Enter**

Command line troubleshooting

- Use “**help**” if you’re not sure
 - > **help dir**
 - > **help chkdsk**
- Also use:
 - [**command**] /?
 - Close the prompt with **exit**

File management

- **dir**
 - List files and directories
- **cd / chdir**
 - Change working directory
 - Use backslash \ to specify volume or folder name
- **..**
 - Two dots/periods
 - The folder above the current folder
- **md / mkdir**
 - Make a directory
- **rd / rmdir**
 - Remove directory

Drive letters

- Each partitions is assigned a letter
 - Primary storage drive is usually C
- Reference the drive with the letter and a colon
 - C:
- Combine with the folder
 - Folder names are separated with backslashes
 - C:\Users\professor

hostname

- View the name of the device
 - This is very useful when there are 10 different terminal screen tabs in use
- This is the Windows Device name
 - Name can be changed in the System settings

format

- Formats a disk for use with Windows
- **BE CAREFUL - YOU CAN LOSE DATA**
 - **format c:**

copy (/v, /y)

- Copy files from one location to another
 - /v - Verifies that new files are written correctly
 - /y - Suppresses prompting to confirm you want to overwrite an existing destination file

xcopy

- Copies files and directory trees
 - xcopy /s Documents m:\backups**

Robust Copy

- **robocopy**
 - A better Xcopy
 - Included with Windows 10 and 11

Managing Group Policy

- Group Policy
 - Manage computers in an Active Directory Domain
 - Group Policy is usually updated at login
- **gpupdate**
 - Force a Group Policy update
 - gpupdate /target:{computer|user} /force**
 - gpupdate /target:user /force**
- **gpresult**
 - Verify policy settings for a computer or user
 - gpresult /r**
 - gpresult /user sgc/professor /v**

1.2 - Windows Command Line Tools (continued)

shutdown

- Shutdown a computer
 - And optionally restart
- **shutdown /s /t nn**
 - Wait nn seconds, then shutdown
- **shutdown /r /t nn**
 - Shutdown and restart after nn seconds
- **shutdown /a**
 - Abort the countdown!

sfc

- System File Checker
 - Scan integrity of all protected system files
- **sfc /scannow**

Check Disk

- **chkdsk /f**
 - Fixes logical file system errors on the disk
- **chkdsk /r**
 - Locates bad sectors and recovers readable information
 - Implies **/f**
- If volume is locked, run during startup

DiskPart

- Manage disk configurations
- BE CAREFUL - YOU CAN LOSE DATA
 - **diskpart** - start the DiskPart command interpreter

winver

- View the About Windows dialog
 - A quick check
- Useful when troubleshooting
 - Are you running the latest version?

1.2 - The Windows Network Command Line

ipconfig

- Most of your troubleshooting starts with your IP address
 - Ping your local router/gateway
- Determine TCP/IP and network adapter information
 - And some additional IP details
- View additional configuration details
 - DNS servers, DHCP server, etc.

ping

- Test reachability
 - Determine round-trip time
 - Uses Internet Control Message Protocol (ICMP)
- One of your primary troubleshooting tools
 - Can you ping the host?

netstat

- Network statistics
 - Many different operating systems
- **netstat -a**
 - Show all active connections
- **netstat -b**
 - Show binaries (Windows)
- **netstat -n**
 - Do not resolve names

nslookup

- Lookup information from DNS servers
 - Canonical names, IP addresses, cache timers, etc.
- Lookup names and IP addresses
 - Many different options

net

- Windows network commands
- View network resources
 - **net view \\<servername>**
 - **net view /workgroup:<workgroupname>**
- Map a network share to a drive letter
 - **net use h: \\<servername>\<sharename>**
- View user account information and reset passwords
 - **net user <username>**
 - **net user <username> * /domain**

tracert

- Determine the route a packet takes to a destination
 - Map the entire path
- Takes advantage of ICMP Time to Live Exceeded message
 - The time in TTL refers to hops, not seconds or minutes
 - TTL=1 is the first router, TTL=2 is the second router, etc.
- Not all devices will reply with ICMP Time Exceeded
 - Some firewalls filter ICMP
 - ICMP is low-priority for many devices

Flavors of traceroute

- Not all traceroutes are the same
 - Minor differences in the transmitted payload
- Windows commonly sends ICMP echo requests
 - Receives ICMP time exceeded messages
 - And an ICMP echo reply from the final/destination device
 - Unfortunately, outgoing ICMP is commonly filtered

1.2 - The Windows Network Command Line (continued)

- Some operating systems allow you to specify the protocol Linux, Unix, macOS, etc.
- IOS devices send UDP datagrams over port 33434
 - The port number can be changed with extended options
 - The mechanics of traceroute

pathping

- Combine ping and traceroute
 - Included with Windows NT and later
- First phase runs a traceroute
 - Build a map
- Second phase
 - Measure round trip time and packet loss at each hop

1.3 - Task Manager

Task Manager

- Real-time system statistics
 - CPU, memory, disk access, etc.
- Starting the Task Manager
 - *Ctrl-Alt-Del*, select Task Manager
 - Right mouse click the taskbar and select Task Manager
 - *Ctrl-Shift-Esc*

Services

- Non-interactive applications
 - Hundreds of background processes
- Manage from one screen
 - Start, stop, restart

Startup

- Manage which programs start with a Windows login
 - Easily toggle on and off
- Multiple reboots
 - Enable and disable
 - You'll find it

Processes

- View all running processes
 - Interactive and system tray apps
 - View processes from other accounts
- Manage the view
 - Move columns, add metrics
- Combine all apps, processes, and services into a single tab
 - Easy to view and sort

Performance

- What's happening? - CPU, memory, etc.
- Statistical views - Historical, real-time
- Current versions include CPU, memory, disk, Bluetooth, and network in the Performance tab

Networking

- Network performance
 - Integrated into the Performance tab
- View utilization, link speeds, and interface connection state

Users

- Who is connected? What are they doing?
- Other options
 - Disconnect a user, manage user accounts

1.3 - The Microsoft Management Console

Task Manager

- Build your own console
 - `mmc.exe`
- A handy starting point
 - Event Viewer
 - Local Users and Groups
 - Disk management
 - Task Scheduler
 - And more!

Event Viewer

- Central event consolidation
 - What happened?
- Application, Security, Setup, System
- Information, Warning, Error, Critical, Successful Audit, Failure Audit
- `eventvwr.msc`

Disk Management

- Manage disk operations
 - Individual computers and file servers
- `diskmgmt.msc`
- **WARNING**
 - YOU CAN ERASE DATA
 - ALWAYS HAVE A BACKUP

Task Scheduler

- Schedule an application or script
 - Plan your future
- Includes predefined schedules
 - Click and go
- Organize
 - Manage with folders
- `taskschd.msc`

1.3 - The Microsoft Management Console (continued)

Device Manager

- The OS doesn't know how to talk directly to most hardware
- Device drivers are hardware specific and operating system specific
 - Older device drivers may not necessarily work in Windows 10 or 11

• **devmgmt.msc**

Certificate Manager

- View user and trusted certs
 - Add and remove

• **certmgr.msc**

Local users and groups

- Users
 - Administrator - the Windows super-user
 - Guest - Limited access
 - “Regular” Users
- Groups
 - Administrators, Users, Backup Operators, Power Users, etc.

• **lusrmgr.msc**

Performance Monitor

- Gather long-term statistics
 - **perfmon.msc**
- OS metrics
 - Disk, memory, CPU, etc.
- Set alerts and automated actions
 - Monitor and act
- Store statistics
 - Analyze long-term trends
- Built-in reports
 - View the data

Group Policy Editor

- Centrally manage users and systems
 - Policies can be part of Active Directory or a local system
- Local Group Policy Editor
 - Manages the local device
 - **gpedit.msc**
- Group Policy Management Console
 - Integrated with Active Directory
 - Powerful system management
 - **gpmc.msc**

1.3 - Additional Windows Tools

System Information

- System overview
 - **msinfo32.exe**
- Hardware Resources
 - Memory, DMA, IRQs, conflicts
- Components
 - Multimedia, display, input, network
- Software Environment
 - Drivers, print jobs, running tasks

Resource Monitor

- Detailed real-time view of performance
 - Separated by category
- Categories
 - Overview, CPU, Memory,
 - Disk, and Network

• **resmon.exe**

System Configuration

- Manage boot processes, startup, services, etc.
 - One-stop shop
- **msconfig.exe**

Disk Cleanup

- Find unused or unneeded files
 - A quick way to free up space
- Select the categories
 - Click the button

• **cleanmgr.exe**

defrag

- Disk defragmentation
 - Moves file fragments so they are contiguous
 - Improves read and write time
- Not necessary for solid state drives
 - Windows won't defrag an SSD
- Graphical version in the drive properties
- Requires elevated permissions
 - Command line:
 - **defrag <volume>**
 - **defrag C:**

regedit.exe

- The Windows Registry Editor
 - The big huge master database
 - Hierarchical structure
- Used by almost everything
 - Kernel, Device drivers
 - Services
 - Security Account Manager (SAM)
 - User Interface, Applications
- Backup your registry!
 - Built into regedit

1.4 - The Windows Control Panel

Internet Options

- General - Basic display
- Security - Different access based on site location
- Privacy - Cookies, pop-up blocker, InPrivate browsing
- Content - Certificates and auto-complete
- Connections - VPN and proxy settings
- Programs - Default browser, plugins, etc.
- Advanced - Detailed configuration options (and reset!)

Devices and Printers

- Everything on the network
 - Desktops, laptops, printers, multimedia devices, storage
- Quick and easy access
 - Much less complex than Device Manager
 - Properties, device configurations

Programs and Features

- Installed applications - Uninstall, size, version
- Windows features - Enable and disable

Network and Sharing Center

- All network adapters - Wired, wireless, etc.
- All network configs
 - Adapter settings, network addressing

System

- Computer information - Including version and edition
- Performance - Virtual memory
- Remote settings
- System protection

Windows Defender Firewall

- Protect from attacks - Scans, malicious software
- Integrated into the operating system
- Control Panel > Windows Firewall

Mail

- Icon does not appear unless a mail client, e.g., Outlook, is installed
 - Otherwise not an option
- Access to local mail configuration
 - Account information, data files

Sound

- Output options - Multiple sound devices may be available
- Set levels for output and input
 - Speakers and microphone

User Accounts

- Local user accounts
 - Domains accounts are stored elsewhere
- Account name and type
- Change password
- Change picture
- Certificate information

Device Manager

- The OS doesn't know how to talk directly to most hardware - You need drivers
- Manage devices - Add, remove, disable
- First place to go when hardware isn't working
 - Instant feedback

Indexing Options

- Speed up the search process
 - Constantly updates an index
- Searches browser history and user folders
 - Good default options
- Add other locations
 - Modify to include other folders

File Explorer Options

- Manage File Explorer - Many options
- General - Windows, expand folders
- View - View hidden files, hide extensions
- Search
 - Disable index searches, search non-indexed areas

Administrative Tools

- Not commonly used utilities
 - Used for system administration
- Useful system tools
 - Often used options for system administrators and technicians

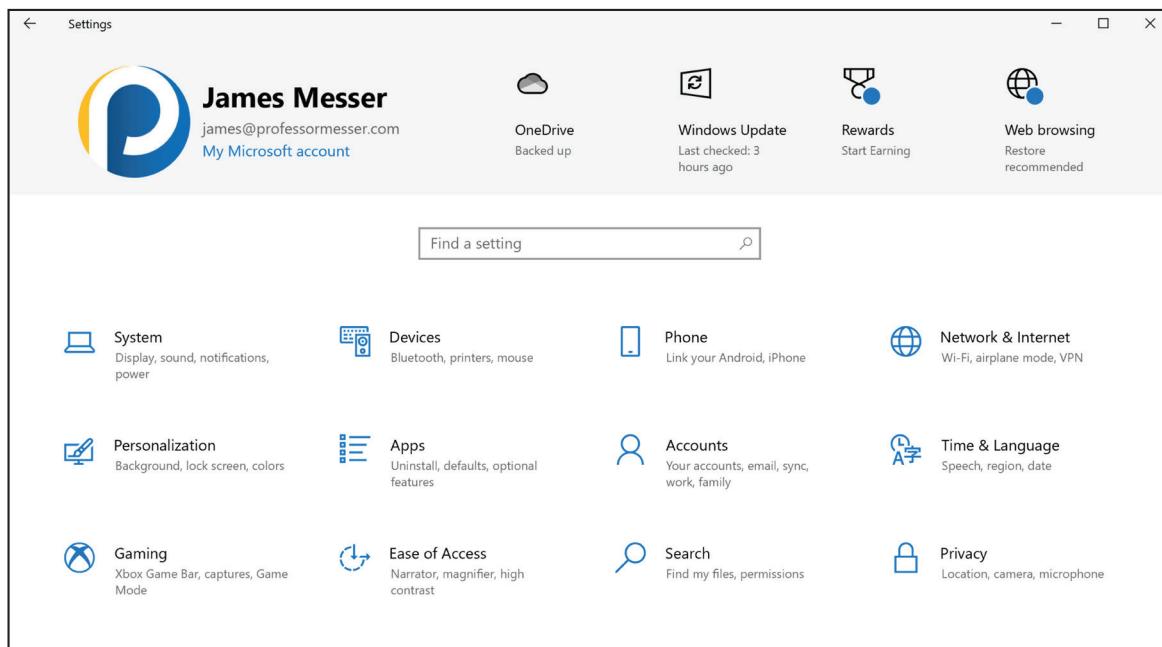
Power Options

- Hibernate
 - Open docs and apps are saved to disk
 - Common on laptops - Used by Fast Startup
- Sleep (standby)
 - Open apps are stored in memory
 - Save power, startup quickly
 - Switches to hibernate if power is low
- Power plans
 - Customize power usage
- Choose what closing the lid does
 - Useful for docking stations
- USB selective suspend
 - Disable individual USB devices
 - Save power
 - Fingerprint readers, biometrics
- Fast startup
 - Enable or disable - Useful for troubleshooting

Ease of Access Center

- Usability enhancements - Useful for everyone
- Change display, keyboard, mouse, and other input/output options
 - Use Windows without a display
 - Change the mouse pointers

1.5 - Windows Settings



Settings

- An updated interface
 - A migration from the Control Panel
- One place for most configuration settings
 - A common UI
- Search for “Settings”, Or scroll down to “S”

Time and Language

- Windows can automatically set the time
 - Active Domain is very sensitive to synchronized clocks
 - Five minutes of tolerance by default
- Windows can speak many different languages
 - Change or add a language

Update and Security

- Keep your OS up to date - Security patches, bug fixes
- Automatic installation - Updates are always installed
- Active hours - You control the update time

Personalization

- Change the way Windows looks and feels
 - Colors, wallpaper, lock screen
- Extensive customization - Make Windows your own

Apps

- Manage installed applications
 - Uninstall or modify an existing app
- Add Windows features
 - Fonts for other languages
 - OpenSSH Server
 - SNMP support

Privacy

- Share app activity - Customized advertising
- Share your language - Website content
- Speech recognition - Sends audio to an online service

System

- Change display settings
 - Night light, scaling, resolution
- Audio settings
 - Input and output
- Notifications
 - Enable/disable
 - Show on lock screen

Devices

- Manage devices
 - Bluetooth, printers, etc.
- Mouse settings
 - Button and wheel options
- Typing and writing
 - Keyboard and pen

Network and Internet

- Network settings
 - Internet connectivity
- View Internet status
 - Up or down?
- Change IP settings
 - Modify address information

Gaming

- Xbox Game Bar - Xbox gaming network
- Chat, join games - Look for friends

Accounts

- Manage login account information
 - Microsoft account or local account
- Email configuration - Specify an email app
- Sign-in options - PIN, password, security key, etc.

1.6 - Windows Network Technologies

Shared resources

- Make a folder or printer available on the network
 - “Share” with others, view in File Explorer
- Assign (map) a drive letter to a share
 - Access a file server
 - Reconnect automatically
- Shares ending with a dollar sign (\$) are “hidden”
 - Not a security feature
- Administrative Tools > Computer Management

Mapping drives

- Access a share
 - This PC / Map network drive
- Local drive letter and share name
 - May require additional authentication
- Or use the command line:
`net use h: "\\\Daedalus\Gate Room"`

Sharing printers

- Similar to sharing a folder
 - But it's a printer instead
- Printer Properties
 - Access through File Explorer, the Settings app, or any other Printer Properties
 - Share an existing printer

Using a shared printer

- Similar to sharing a folder
 - But it's a printer instead
- Add a printer
 - File Explorer
 - Settings app

Proxy Settings

- Change the traffic flow
 - An Internet go-between
- Settings > Network and Internet
 - Or use Control Panel > Internet Options > Connections > LAN settings
- Define address and exceptions
 - Proxies don't work for everything

Network locations

- Private
 - Share and connect to devices
 - Home or work network
- Public
 - No sharing or connectivity
 - Public Wi-Fi
- Customize security settings
 - Profile is determined automatically
 - Change the settings at any time

Network paths

- View network paths in File Explorer
 - Server and share name
- Map network drive
 - Add a drive letter
- Disconnect
 - Toolbar - Right-click the drive

Metered connections

- Reduce data usage
 - Slow network links
 - Limited bandwidth
 - Usage-based billing
- Can modify application communication
 - Windows Updates
 - OneDrive sync

1.6 - Configuring Windows Firewall

Windows Defender Firewall

- Your firewall should always be enabled
 - Sometimes you need to troubleshoot
- Temporarily disable from the main screen
 - Turn Windows Firewall on or off
 - Requires elevated permissions
- Different settings for each network type
 - Public / Private

Windows Firewall configuration

- Block all incoming connections
 - Ignores your exception list
 - Useful when you need the most security
- Modify notification
 - App blocking

Creating a firewall exception

- Allow an app or feature through Windows Firewall
 - The more secure exception
- Port number
 - Block or allow
- Predefined exceptions
 - List of common exceptions
- Custom rule
 - Every firewall option

1.6 - Windows IP Address Configuration

How Windows gets an IP address

- DHCP (Dynamic Host Configuration Protocol)
 - Automatic IP addressing
 - This is the default
- APIPA (Automatic Private IP Addressing)
 - There's no static address or DHCP server
 - Communicate locally (link-local address)
 - Assigns 169.254.1.0 to 169.254.254.255
 - No Internet connectivity
- Static address
 - Assign all IP address parameters manually
 - You need to know very specific details

TCP/IP host addresses

- IP Address – Unique identifier
- Subnet mask – Identifies the subnet
- Gateway – The route off the subnet to the rest of the world

- DNS – Domain Name Services
 - Converts domain names to IP addresses
- DHCP – Dynamic Host Configuration Protocol
 - Automates the IP address configuration process
- Loopback address - 127.0.0.1 - It's always there!

A backup for the DHCP server

- Multiple DHCP servers should be installed for redundancy
 - There will always be one available
- If a DHCP server isn't available, Windows uses the Alternate Configuration
 - The default is APIPA addressing
- You can also configure a static IP address
 - Keep working normally

1.6 - Windows Network Connections

Network setup

- Control Panel
 - Network and Sharing Center
 - Set up a new connection or network
- Step-by-step wizard
 - Confirmation during the process
- Many different connections
 - Direct, VPN, dial-up, etc.

VPN connections

- Built-in VPN client
 - Included with Windows
 - Connect to a workplace
- Integrate a smart card
 - Multi-factor authentication
 - Something you know
 - Something you have
 - Something you are
- Connect from the network status icon
 - Click and provide credentials

Wireless connections

- Network name - SSID (Service Set Identification)
- Security type - Encryption method
- Encryption type - TKIP, AES
- Security key
 - WPA2-Personal - Pre-shared key
 - WPA2-Enterprise - 802.1X authentication

Wired connections

- Ethernet cable - Direct connection
- Fastest connection is the default - Ethernet, Wireless, WWAN
- Alternate configurations - When DHCP isn't available

WWAN connections

- Wireless Wide Area Network
 - Built-in mobile technology
- Hardware adapter - Antenna connections
- USB connected or 802.11 wireless - Tether or hotspot
- Requires third-party software - Each provider is different

1.7 - Installing Applications

Installing applications

- Extend the functionality of your operating system
 - Specialized applications
- Available everywhere
 - Find the application you need
 - Install on your operating system
- Not every computer can run every application
 - Some simple checks can help manage your desktop

Operating system platform

- 32-bit vs. 64-bit
 - Processor specific
- 32-bit processors can store $2^{32} = 4,294,967,296$ values
- 64-bit processors can store $2^{64} = 18,446,744,073,709,551,616$ values
 - 4 GB vs. 17 billion GB
 - The OS has a maximum supported value
- Hardware drivers are specific to the OS version
 - 32-bit (x86), 64-bit (x64)

1.7 - Installing Applications (continued)

- 32-bit OS cannot run 64-bit apps
 - But 64-bit OS can run 32-bit apps
- Apps in a 64-bit Windows OS
 - 32-bit apps: \Program Files (x86)
 - 64-bit apps: \Program Files

Graphics requirements

- Integrated graphics
 - CPU and GPU are the same chip
 - Uses system memory for graphics
 - Common in laptops
- Dedicated graphics card
 - Also called a discrete graphics card
 - Uses its own VRAM (Video RAM)
 - High-end graphics requirements
- Check the application
 - Integrated or dedicated
 - VRAM requirements

RAM requirements

- Random Access Memory
 - Memory modules
- A critical specification
 - Application may perform poorly
 - Or not at all
- This would be above and beyond the OS requirements
 - Dependent on the application
 - Consider all of the other running applications

CPU requirements

- Central Processing Unit
 - Processing speed
 - Usually measured in gigahertz (GHz)
- A broad measurement
 - Higher numbers are faster CPUs
- Application requirements vary
 - Word processing vs. video editing

External hardware tokens

- Manage application usage
 - Limit access to authorized users
- Application will only operate with the hardware token connected
 - Commonly a USB device
 - Can be a challenge to manage
- Often used with high-end software
 - High per-seat licensing costs

Storage requirements

- Drive space concerns
 - Initial installation space requirement
 - Application use requirement
- Some applications use a LOT of storage space after installation
 - The initial install requirements may not be the most important specification

Distribution methods

- Downloadable
 - Direct from the manufacturer
 - Centralized app store
 - Avoid 3rd-party downloads
- Physical media
 - Optical media, USB drive, etc.
 - Increasingly rare

ISO files

- Optical disk image
 - A single ISO file / ISO image
 - Files and folders
- Sector by sector copy of the data on an optical disc
 - ISO 9660 file system
 - International Organization for Standardization
- Mount in the OS
 - Appears as a separate drive

Installation considerations

- There's a reason we are careful when installing applications
 - Applications have the same rights and permissions as the user
 - An unknown application can cause significant issues
- Impact to device
 - Application upgrade stops working
 - Slowdowns
 - Deleted files
- Impact to network
 - Access to internal services
 - Rights and permissions to file shares
- Impact to operation
 - Many jobs are time-sensitive
 - An updated application may require a change to the workflow
 - Or may not work at all
- Impact to the business
 - Critical processes are sensitive to downtime and outages
 - A change to an application can create significant issues
 - Other parts of the business rely on your results

1.8 - Operating System Overview

Why do you need an OS?

- Control interaction between components
 - Memory, hard drives, keyboard, CPU
- A common platform for applications
 - You're going to do some work, right?
- Humans need a way to interact with the machine
 - The “user interface” - Hardware can't do everything!

Standard OS features

- File management
 - Add, delete, rename
- Application support
 - Memory management, swap file management
- Input and Output support
 - Printers, keyboards, storage drives, USB drives
- Operating system configuration and management tools

Microsoft Windows

- Major market presence
 - Many different versions
 - Windows 10, Windows 11, Windows Server
- Advantages
 - Large industry support
 - Broad selection of OS options
 - Wide variety of software support
- Disadvantages
 - Large install base provides a big target for security exploitation
 - Large hardware support can create challenging integration exercises

Linux

- Free Unix-compatible software system
 - Unix-like, but not Unix
- Many (many) different distributions
 - Ubuntu, Debian, Red Hat / Fedora
- Advantages
 - Cost. Free!
 - Works on wide variety of hardware
 - Passionate and active user community
- Disadvantages
 - Limited driver support, especially with laptops
 - Limited support options

Apple macOS

- macOS - Desktop OS running on Apple hardware
- Advantages
 - Easy to use
 - Extremely compatible
 - Relatively fewer security concerns
- Disadvantages
 - Requires Apple hardware
 - Less industry support than the PC platform
 - Higher initial hardware cost

Chrome OS

- Google's operating system
 - Based on the Linux kernel
- Centers around Chrome web browser
 - Most apps are web-based
- Many different manufacturers
 - Relatively less expensive
- Relies on the cloud - Connect to the Internet

Apple iPadOS

- Operating system for Apple's iPad tablets
 - A variant of Apple's phone iOS
- Tablet features
 - Desktop browser (Safari)
 - Second monitor (Sidecar)
 - Keyboard support
 - Multitasking

Apple iOS

- Apple iOS
 - Apple iPhones
 - Based on Unix
 - Closed-source - No access to source code
 - Exclusive to Apple products
- iOS Apps
 - Apps are developed with iOS SDK on macOS
 - Apps must be approved by Apple before release
 - Apps are available to users in the Apple App Store

Google Android

- Google Android
 - Open Handset Alliance
 - Open-source OS, based on Linux
 - Supported on many different manufacturer's devices
- Android Apps
 - Apps are developed on Windows, macOS, and Linux with the Android SDK
 - Apps available from Google Play
 - Apps also available from third-party sites (i.e., Amazon Appstore)

Vendor-specific limitations

- End-of-life
 - Different companies set their own EOL policies
- Updating
 - iOS, Android, and Windows check and prompt for updates
 - Chrome OS will update automatically
- Compatibility between operating systems
 - Some movies and music can be shared
- Almost no direct application compatibility
 - Fortunately, many apps have been built to run on different OSes
 - Some data files can be moved across systems
 - Web-based apps have potential

1.8 - Filesystems

File systems

- Before data can be written to the partition, it must be formatted
 - Build the foundation
- Operating systems expect data to be written in a particular format
 - FAT32 and NTFS are popular
- Many operating systems can read (and perhaps write) multiple file system types
 - FAT, FAT32, NTFS, exFAT, etc.

FAT

- FAT - File Allocation Table
 - One of the first PC-based file systems (circa 1980)
- FAT32 - File Allocation Table
 - Larger (2 terabyte) volume sizes
 - Maximum file size of 4 gigabytes
- exFAT - Extended File Allocation Table
 - Microsoft flash drive file system
 - Files can be larger than 4 gigabytes
 - Compatible across many operating systems
 - Windows, Linux, macOS

NTFS

- NTFS – NT File System
 - Extensive improvements over FAT32
 - Quotas, file compression, encryption, symbolic links, large file support, security, recoverability
- Not very compatible across operating systems
 - Many OSes will read NTFS (but not write)
 - Some have limited write functionality to an NTFS file system

Other file systems

- ext3 - Third extended file system
 - Commonly used by the Linux OS
- ext4 - Fourth extended file system
 - An update to ext3
 - Commonly seen in Linux and Android OS

APFS

- Apple File System (APFS)
 - Added to macOS High Sierra (10.12.4)
 - Also included with iOS and iPadOS
- Optimized for solid-state storage
 - Encryption, snapshots, increased data integrity

1.9 - Installing Operating Systems

Boot methods

- USB storage
 - USB must be bootable
 - Computer must support booting from USB
- Optical media
 - CD-ROM and DVD-ROM
- PXE (“Pixie”) - Preboot eXecution Environment
 - Perform a remote network installation
 - Computer must support booting with PXE
- Solid state drives / hard drives
 - Store many OS installation files
- Internet-based
 - Linux distributions, macOS Recovery installation, Windows updates
- External / hot swappable drive
 - Some external drives can mount an ISO image (optical drive image)
 - Boot from USB
- Internal hard drive
 - Install and boot from separate drive
 - Create and boot from new partition

Types of installations

- In-place upgrade - Maintain existing applications and data
- Recovery partition
 - Hidden partition with installation files
- Clean install
 - Wipe the slate clean and reinstall
 - Migration tool can help
- Image deployment
 - Deploy a clone on every computer
 - Relatively quick
 - Can be completely automated
- Repair installation
 - Fix problems with the Windows OS
 - Does not modify user files
- Remote network installation
 - Local server or shared drive
 - Install across the Internet
- Load alternate third party drivers when necessary
 - Disk controller drivers, etc.

The disk partition

- Separates the physical drive into logical pieces
 - Useful to keep data separated
 - Multiple partitions are not always necessary
- Useful for maintaining separate operating systems
 - Windows, Linux, etc.
- Formatted partitions are called volumes
 - Microsoft’s nomenclature

1.9 - Installing Operating Systems (continued)

GPT partition style

- GPT (GUID Partition Table)
 - Globally Unique Identifier
 - The latest partition format standard
- Requires a UEFI BIOS
 - Can have up to 128 partitions
 - Maximum partition size is over 9 billion TB
 - Windows max partition is currently 256 TB
- No need for extended partitions or logical drives

MBR partition style

- MBR (Master Boot Record)
 - The old standby, with all of the old limitations
 - Maximum partition size of 2 TB
- Primary
 - Bootable partitions
 - Maximum of four primary partitions per hard disk
 - One of the primary partitions can be marked as Active
- Extended
 - Used for extending the maximum number of partitions
 - One extended partition per hard disk (optional)
 - Contains additional logical partitions
 - Logical partitions inside an extended partition are not bootable

Disk partitioning

- The first step when preparing disks
 - May already be partitioned
 - Existing partitions may not always be compatible with your new operating system
- An MBR-style hard disk can have up to four partitions
- GUID partition tables support up to 128 partitions
 - Requires UEFI BIOS or BIOS-compatibility mode
 - BIOS-compatibility mode disables UEFI SecureBoot

• BE CAREFUL!

- Serious potential for data loss
- This is not an everyday occurrence

Quick format vs. full format

- Quick format
 - Creates a new file table
 - Looks like data is erased, but it's not
 - No additional checks
- Quick format the default during installation in Windows 10 and 11
 - Use `diskpart` for a full format
- Full format
 - Writes zeros to the whole disk
 - Your data is unrecoverable
 - Checks the disk for bad sectors (time consuming)

1.9 - Upgrading Windows

Why upgrade?

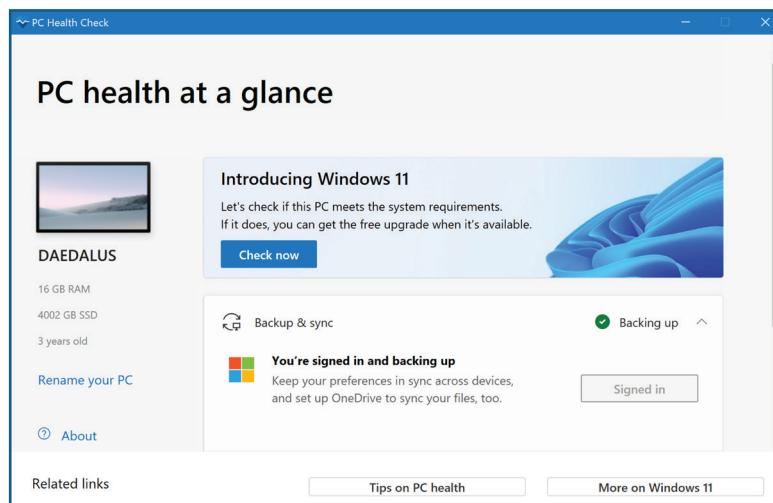
- Upgrade vs. Install
 - Upgrade - Keep files in place
 - Install - Start over completely fresh
- Maintain consistency
 - Customized configurations
 - Multiple local user accounts
- Upgrades save hours of time
 - Avoid application reinstall
 - Keep user data intact
 - Keep user settings
 - Get up and running quickly

Upgrade methods

- In-place upgrade
 - Upgrade the existing OS
 - Keeps all applications, documents, and settings
 - Start the setup from inside the existing OS
- Clean install
 - Wipe everything and reload
 - Backup your files
 - Start the setup by booting from the installation media

Prepare the boot drive

- Know your drive
 - Is data on the drive?
 - Has the drive been formatted?
 - What partitions are on the drive?
- Backup any old data
 - You may need that data again someday
 - Save user preferences
- Most partitioning and formatting can be completed during the installation
 - Clear the drive and start fresh



1.9 - Upgrading Windows (continued)

Before the installation

- Check minimum OS requirements
 - Memory, disk space, etc.
 - And the recommended requirements
- Run a hardware compatibility check
 - Runs when you perform an upgrade
 - Run manually from the Windows setup screen
 - Windows 10 Upgrade Checker,
PC Health Check for Windows 11
- Plan for installation questions
 - Drive/partition configuration, license keys, etc.
- Application and driver compatibility
 - Check with the app developer and hardware manufacturer

Windows product life cycle

- Quality updates
 - Monthly security updates and bug fixes
- Feature updates
 - Annual update with new features
 - Used to occur every three to five years
- Support is provided after the release
 - 18 to 36 months
 - Dependent on the Windows version and edition
- Also called the Modern Lifecycle Policy
 - For continuously supported products

1.10 - macOS Overview

File types

- .dmg
 - Apple Disk Image
 - Mountable as a drive in Finder
- .pkg
 - Installer Package
 - Used to distribute software
 - Runs through an installer script
- .app
 - Application bundle
 - Contains the necessary files to use the application
 - “View Package Contents” from the Finder

App store

- Centralized updates and patches
 - For both OS and apps
- App Store application
 - The “Updates” option
- Automatic updates
 - Or manual install
- Patch management
 - Install and view previous updates

Uninstallation process

- Move the .app file to the Trash
- The .app package contains all of the application files
- Quick and easy
- Some applications include a separate uninstall program
 - Usually included in the Application folder

Apple ID and corporate restrictions

- Personal Apple products use a personal Apple ID
 - Associated with personal data and digital purchases
- Companies use Managed Apple IDs using Apple Business Manager
 - Integrate with Active Directory
 - Connect with an existing MDM (Mobile Device Manager)
 - Assign and move apps and digital content to selected users

Backups

- Time Machine - Included with macOS
- Hourly backups - The past 24 hours
- Daily backups - The past month
- Weekly backups - All previous months
- Starts deleting oldest information when disk is full

Anti-virus

- macOS does not include anti-virus
 - Or anti-malware
- Many 3rd-party options
 - From the usual companies
- An emerging threat
 - Still doesn't approach Windows
 - It's all about the number of desktops
- Automate your signature updates
 - New updates every hour / day

Name	Size	Date Modified	Kind
Logitech Gaming Software.app	--	October 24, 2017 at 6:35 AM	Application
Uninstaller.app	--	October 24, 2017 at 6:35 AM	Application
FWUpdate	--	February 12, 2018 at 10:24 PM	Folder
LGS	--	February 12, 2018 at 10:20 PM	Folder

1.10 - macOS System Preferences

System Preferences

- The macOS version of the Windows Control Panel
 - A close comparison
- Access to most customization and personalization options
 - Includes important configuration utilities
- A good place to start
 - It's probably in here

Displays

- Configure the location of multiple displays
 - Side by side, top to bottom
- Menu can be moved to any display
 - Doesn't have to be the primary
- Modify individual display settings
 - Resolution, brightness, colors

Network

- Configure network interfaces - Wired, wireless
- IPv4 and IPv6 - Manual and automatic (DHCP)
- Detailed network settings - IP, DNS, 802.1X, etc.

Printers & Scanners

- Add and remove printers and scanners
 - Configure individual settings
- Share printers and scanners
 - Configure rights and permissions
- View status - Ink and toner levels, scanning status

Privacy

- Limit application access to private data
 - Location services, photos, calendars
- Control access to cameras and microphones
 - Enable on a per-app basis
- Unauthorized apps can't view your private data
 - Malware, other apps

Accessibility

- Allow apps to use system input
 - Keyboard, mouse, audio, video
- Scripting and automation
 - Requires access for input
- Limits third-party applications
 - Can't take over the keyboard

Time Machine

- Automated backups
 - Included with macOS
- Hourly backups
 - The past 24 hours
- Daily backups
 - The past month
- Weekly backups
 - All previous months
- Starts deleting oldest information when disk is full

1.10 - macOS Features

Mission Control and Spaces

- Quickly view everything that's running
 - Spread out the desktop into a viewable area
 - Swipe upwards with three fingers or
 - Control-Up arrow
- Spaces
 - Multiple desktops
 - Add Spaces inside of
 - Mission Control

Keychain

- Password management
 - Passwords, notes, certificates, etc.
- Integrated into the OS - Keychain Access
- Passwords and Secure Notes are encrypted
 - Login password is the key

Spotlight

- Find files, apps, images, etc.
 - Similar to Windows search
- Magnifying glass in upper right
- Or press Command-Space
- Type anything in - See what you find
- Define search categories in System Preferences / Spotlight
 - Enable/disable categories

iCloud

- Integrates Apple technologies
 - macOS, iOS, iPadOS
- Share across systems
 - Calendars, photos, documents, contacts, etc.
- Backup iOS devices
 - Never lose data again
- Store files in an iCloud drive
 - Similar to Google Drive, Dropbox
 - Integrated into the operating systems

Gestures

- You can do more than just point and click
 - Extend the capabilities of your trackpad
- Use one, two, three fingers
 - Swipe, pinch, click
- Customization
 - Enable/disable
 - System Preferences / Trackpad

1.10 - macos Features (continued)

Finder

- The central OS file manager - Compare with File Explorer
- File management - Launch, delete, rename, etc.
- Integrated access to other devices
 - File servers, remote storage, screen sharing

Remote Disc

- Use an optical drive from another computer
 - Has become more important over time
 - Designed for copying files
 - Will not work with audio CDs or video DVDs
- Set up sharing in System Preferences
 - Sharing options - Appears in the Finder

Dock

- Fast access to apps - Quickly launch programs
- View running applications - Dot underneath the icon
- Keep folders in the dock - Easy access to files
- Move to different sides of the screen
 - Auto-hide or always display

Disk Utility

- Manage disks and images - Resolve issues
- File system utilities
 - Verify and repair file systems, modify partition details, erase disks

- Create, convert, and restore images

– Manage disk images

FileVault

- Full Disk Encryption (FDE) for macOS
 - Decryption uses a local key or iCloud authentication
- Proper authentication is required before macOS can start
 - Data is unavailable to others
- Available in System Preferences
 - Security & Privacy > FileVault

Terminal

- Command line access to the operating system
 - Manage the OS without a graphical interface
- OS access
 - Run scripts, manage files
 - Configure OS and application settings

Force Quit

- Stop an application from executing
 - Some applications are badly written
- Command-Option-Escape - List application to quit
- Hold the option key when right-clicking the app icon in the dock
 - Choose Force Quit

1.11 - Linux Commands

Linux commands

- The command line - Terminal, XTerm, or similar
- Commands are similar in both Linux and macOS
 - Mac OS derived from BSD (Berkeley Software Distribution) Unix
 - This section is specific to Linux
- Download a Live CD or install a virtual machine
 - Many pre-made Linux distributions are available
- Use the `man` command for help - An online manual
 - > `man grep`

ls

- List directory contents
 - Similar to the dir command in Windows
- Lists files, directories
 - May support color coding;
 - Blue is a directory, red is an archive file, etc.
- For long output, pipe through more:
 - > `ls -l | more`
 - (use `q` or `Ctrl-c` to exit)

pwd

- Print Working Directory
 - Displays the current working directory path
 - Useful when changing directories often

mv

- Move a file or rename a file

• `mv SOURCE DEST`
> `mv first.txt second.txt`

cp

- Copy a file - Duplicate files or directories

• `cp SOURCE DEST`
> `cp first.txt second.txt`

rm

- Remove files or directories - Deletes the files
- Does not remove directories by default
 - Directories must be empty to be removed or must be removed with `-r`

chown

- Change file owner and group - Modify file settings

• `sudo chown [OWNER:GROUP] file`
> `sudo chown professor script.sh`

su / sudo

- Some commands require elevated rights

sudo

- Execute a command as the super user or user ID
- Only that command executes as the super user

su

- Become super user or change to a different user
- You continue to be that user until you exit

1.11 - Linux Commands (continued)

chmod

- Change mode of a file system object
 - r=read, w=write, x=execute
 - Can also use octal notation
 - Set for the file owner (u), the group(g), others(o), or all(a)
- **chmod mode FILE**
 > **chmod 744 script.sh**
- **chmod 744 first.txt**
 - User; read, write, execute
 - Group; read only
 - Other; read only
- **chmod a-w first.txt**
 - All users, no writing to first.txt

#	Permission	r	w	x
7	Read, Write, and Execute	r	w	x
6	Read and Write	r	w	-
5	Read and Execute	r	-	x
4	Read only	r	-	-
3	Write and Execute	-	w	x
2	Write only	-	w	-
1	Execute only	-	-	x
0	none	-	-	-

chmod u+x script.sh

- The owner of script.sh can execute the file

apt-get

- Advanced Packaging Tool
 - Handles the management of application packages
 - Applications and utilities
- Install, update, remove
 > **sudo apt-get install wireshark**

yum

- Yellowdog Updater, Modified (yum) -
 - Install, delete, update
- Manages RPM packages
 - Red Hat Package Manager - RPM Package Manager
 - A Linux distribution will commonly use either **yum** or **apt-get**

ip

- Manage the network interfaces
 - Enable, disable, configure addresses, manage routes, ARP cache, etc.
- **ip address**
 - View interface addresses
- **ip route**
 - View the IP routing table
- **sudo ip address add 192.168.121.241/24 dev eth0**
 - Configure the IP address of an interface

df

- Disk Free - View file systems and free space
- **df**
 - View number of blocks
- **df -h**
 - View human-readable sizes

grep

- Find text in a file
 - Search through many files at a time
- **grep PATTERN [FILE]**
 > **grep failed auth.log**

ps

- View the current processes
 - And the process ID (PID)
 - Similar to the Windows Task Manager
- View user processes
 ps
- View all processes
 ps -e | more

top

- View CPU, RAM, and resource utilizations
 - The “Task Manager” for Linux
- Process information
 - Easy to find the highly utilized applications
- Summary of overall load
 - One, five, and fifteen minutes
- Many different options
 - Check the man page for startup options and keys

find

- Find a file by name or extension
 - Search through any or all directories
- Find files with a specific extension
 > **find . -name "*.txt"**

dig

- Lookup information from DNS servers
 - Canonical names, IP addresses, cache timers, etc.
- **dig** (Domain Information Groper)
 - Detailed domain information

cat

- Concatenate - Link together in a series
- Copy a file/files to the screen
 cat file1.txt file2.txt
- Copy a file/files to another file
 cat file1.txt file2.txt > both.txt

nano

- Full-screen text editor - Easy to edit
- Included with many Linux distributions - Easy to install
- Select, mark, copy/cut, and paste text
 - Similar features to graphical-based editors

1.11 - Linux Features

Backups

- Many options
 - Command line and graphical
 - May be included with the distribution

• tar

- Tape Archive
- Easy to script into
- a backup schedule

• rsync

- Sync files between storage devices
- Instant synchronization or scheduled

• Command line tools

apt-get, yum

- Graphical update managers
 - Software updater
- Patch management
 - Updates can be scheduled
- Software center
 - The Linux “App Store”

Anti-Virus / Anti-malware

- Relatively few viruses and malware for Linux
 - Still important to keep updated
- Clam Antivirus
 - Open source antivirus engine
- Same best practice as any other OS
 - Always update signature database
 - Always use real-time scanning

Shell/Terminal

- Command line access to the operating system
 - Common to manage in Linux
- OS maintenance
 - Run scripts, manage files
 - Configure OS and application settings

Samba

- Add SMB (Server Message Block) to Linux
 - File and print sharing
 - Active Directory integration
- Integrate Linux into a Windows environment
 - Linux becomes a Windows file server

2.1 - Physical Security

Access control vestibule

- All doors normally unlocked
 - Opening one door causes others to lock
- All doors normally locked
 - Unlocking one door prevents others from being unlocked
- One door open / other locked
 - When one is open, the other cannot be unlocked
- One at a time, controlled groups
 - Managed control through an area

Badge reader

- Magnetic swipe, RFID, or NFC
 - Many different identification methods
- Different applications
 - Time clocks
 - Security guard patrols
 - Door access

Video surveillance

- CCTV (Closed circuit television)
 - Can replace physical guards
- Camera features are important
 - Object detection can identify a license plate or person's face
- Often many different cameras
 - Networked together and recorded over time
- Motion detection
 - Radio reflection or passive infrared
 - Useful in areas not often in use

Alarm systems

- Circuit-based
 - Circuit is opened or closed
 - Door, window, fence
 - Useful on the perimeter
- Motion detection
 - Identify motion without a camera
- Duress
 - Triggered by a person
 - The big red button

Door locks

- Conventional - Lock and key
- Deadbolt - Physical bolt
- Electronic - Keyless, PIN
- Token-based - RFID badge, magnetic swipe card, or key fob
- Biometric - Hand, fingers or retina
- Multi-factor - Smart card and PIN

Equipment locks

- Data center hardware is usually managed by different groups
 - Responsibility lies with the owner
- Racks can be installed together
 - Side-to-side
- Enclosed cabinets with locks
 - Ventilation on front, back, top, and bottom

2.1 - Physical Security (continued)

Guards and access lists

- Security guard
 - Physical protection at the reception area of a facility
 - Validates identification of existing employees
 - Provides guest access
- ID badge
 - Picture, name, other details
 - Must be worn at all times
- Access list
 - Physical list of names
 - Enforced by security guard
- Maintains a visitor log

Barricades / bollards

- Prevent access
 - There are limits to the prevention
- Channel people through a specific access point
 - And keep out other things
 - Allow people, prevent cars and trucks
- Identify safety concerns
 - And prevent injuries
- Can be used to an extreme
 - Concrete barriers / bollards
 - Moats

Fences

- Build a perimeter
 - Usually very obvious
 - May not be what you're looking for
- Transparent or opaque
 - See through the fence (or not)
- Robust
 - Difficult to cut the fence
- Prevent climbing
 - Razor wire
 - Build it high



2.1 - Physical Security for Staff

Key fobs

- Small RFID key
 - Add to physical keychain
- Replaces a physical key
 - Commonly used for door locks
 - Proximity operation and contactless

Smart cards

- Certificate-based authentication
 - Something you have
 - Usually requires additional factors
- Integrated card reader
 - Built into the laptop
- External reader
 - USB connected

Keys

- Some doors may not have an electronic lock
 - Rarely used
 - Standalone locks
 - Safe, storage bin, cabinet
- Use a key cabinet
 - Formal check in/check out
 - Well-defined storage location
 - Allows for auditing and timestamps

Biometrics

- Biometric authentication
 - Usually stores a mathematical representation of your biometric
 - Your actual fingerprint isn't usually saved
- Difficult to change
 - You can change your password
 - You can't change your fingerprint
- Used in very specific situations
 - Not foolproof

Biometric factors

- Retina scanner
 - Unique capillary structure in the back of the eye
- Fingerprint scanner - Phones, laptops, door access
- Palmprint scanner - Shape of the hand and fingers

Lighting

- More light means more security
 - Attackers avoid the light
 - Easier to see when lit
 - Non IR cameras can see better
- Specialized design
 - Consider overall light levels
 - Lighting angles may be important
 - Facial recognition
 - Avoid shadows and glare

2.1 - Physical Security for Staff (continued)

Magnetometers

- Passive scanning - Detect metal objects
- Not useful for non-metal objectives
 - Won't identify ceramic or plastic



Mobile Device Management (MDM)

- Manage company-owned and user-owned mobile devices
 - BYOD - Bring Your Own Device
- Centralized management of the mobile devices
 - Specialized functionality
- Set policies on apps, data, camera, etc.
 - Control the remote device
 - The entire device or a "partition"
- Manage access control
 - Force screen locks and PINs on these single user devices

2.1 - Logical Security

Least privilege

- Rights and permissions should be set to the bare minimum
 - You only get exactly what's needed to complete your objective
- All user accounts must be limited
 - Applications should run with minimal privileges
- Don't allow users to run with administrative privileges
 - Limits the scope of malicious behavior

Access Control Lists (ACLs)

- Used to allow or deny traffic
 - Also used for NAT, QoS, etc.
 - Commonly used on the ingress or egress of a router interface
- ACLs evaluate on certain criteria
 - Source IP, Destination IP,
 - TCP port numbers, UDP port numbers, ICMP
- Deny or permit
 - What happens when an ACL matches the traffic?
- Also used in operating systems
 - Allow or deny access to the filesystem

Multi-factor authentication

- More than one factor
 - Something you are, something you have, something you know, somewhere you are, something you do
- Can be expensive
 - Separate hardware tokens

Software tokens

- Authenticator application
 - Pseudo-random number generator
 - Can't guess it
 - Changes constantly

- Saves money
 - Free smartphone applications
 - No separate device to lose

Short message service (SMS)

- Text messaging
 - Includes more than text these days
- Login factor can be sent via SMS to a predefined phone number
 - Provide username and password
 - Phone receives an SMS
 - Input the SMS code into the login form
- Security issues exist
 - Phone number can be reassigned to a different phone
 - SMS messages can be intercepted
 - SMS spoofing

Voice call

- A phone call provides the token
 - The computer is talking to you
 - "Your code is 1-6-2-5-1-7."
- Similar disadvantages to SMS
 - Phone call can be intercepted or forwarded
 - Phone number can be added to another phone

Email filtering

- Unsolicited email
 - Stop it at the gateway before it reaches the user
 - On-site or cloud-based
- Scan and block malicious software
 - Executables, known vulnerabilities
 - Phishing attempts
 - Other unwanted content

2.1 - Active Directory

Active Directory

- A database of everything on the network
 - Computers, user accounts, file shares, printers, groups, and more
- Manage authentication
 - Users login using their AD credentials
- Centralized access control
 - Determine which users can access resources
- Commonly used by the help desk
 - Reset passwords
 - Add and remove accounts

Domain

- The name associated with this related group of users, computers, and resources
 - Each domain has a name
- Domain controllers store this central domain database
 - Active Directory is the service that manages this directory
- Often referenced when troubleshooting
 - Is this computer on the domain?
 - Can you reset the domain password?

Organizational units (OU)

- Keep the (very large) database organized
 - Users, Computers
- Create your own hierarchy
 - Countries, states, buildings, departments, etc.
- Apply policies to an OU
 - Can be very large:
 - Domain Users
 - Can be for a specific group:
 - Marketing, North America,
 - Pegasus galaxy

Login script

- Automate a series of tasks during login
 - Assign a script to a specific user, group, or OU
- Associate the script with a Group Policy
 - User Configuration > Policies >
 - Windows Settings > Scripts
- Create different login scripts for different OUs
 - Customize based on your needs

Group Policy/updates

- Manage the computers or users with Group Policies
 - Local and Domain policies
 - Group Policy Management Editor
 - A central console
 - Login scripts
 - Network configurations (QoS)
 - Security parameters
- Update a client with the **gpupdate** utility:
> **gpupdate /force**

Home folder

- Assign a user Home folder to a network folder
 - Manage and backup files from the network
 - Avoid storing files on the local computer
- When added to the user profile, the directories are automatically created
 - And proper permissions are assigned
- Requires some training
 - Encourage users to store files on the network Home folder

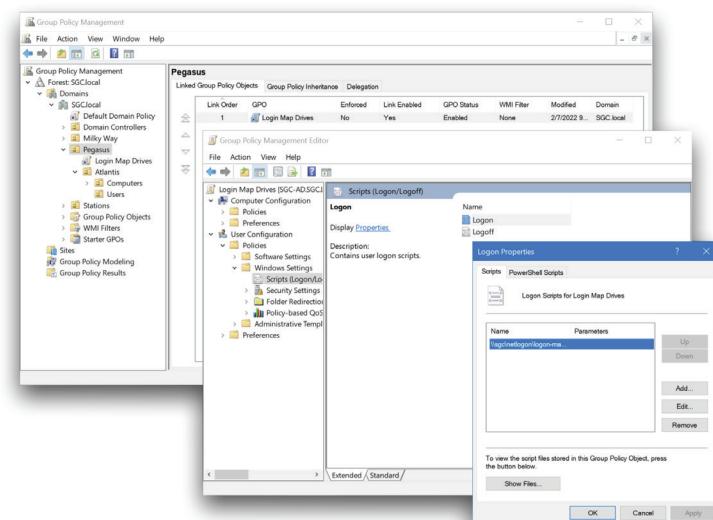
Folder redirection

- Some users and applications use the Windows Library folders
 - Desktop, Downloads,
 - Music, Documents, etc.
- Redirect the folders to a network share
 - Group Policy > User Configuration >
 - Windows settings > Folder Redirection
- This is often paired with the Offline Files feature
 - You're not always connected

Security groups

- Create a group
 - Assign permissions to the group
- Set the rights and permissions to the group
 - Add users to the group
- Some built-in groups
 - Users, guests
 - Remote management users
 - Event Log Readers
- Save time
 - Avoid confusion and mistakes

Group Policy and login scripts



2.2 - Wireless Encryption

Securing a wireless network

- An organization's wireless network can contain confidential information
 - Not everyone is allowed access
- Authenticate the users before granting access
 - Who gets access to the wireless network?
 - Username, password, multi-factor authentication
- Ensure that all communication is confidential
 - Encrypt the wireless data
- Verify the integrity of all communication
 - The received data should be identical to the original sent data
 - A message integrity check (MIC)

WPA (Wi-Fi Protected Access)

- 2002: WPA was the replacement for serious cryptographic weaknesses in WEP (Wired Equivalent Privacy)
 - **Don't use WEP**
- Needed a short-term bridge between WEP and whatever would be the successor
 - Run on existing hardware

Wireless encryption

- All wireless computers are radio transmitters and receivers
 - Anyone can listen in
- Solution: Encrypt the data
 - Everyone has an encryption key
- Only people with the right key can transmit and listen
 - WPA2 and WPA3

WPA2 and CCMP

- Wi-Fi Protected Access II (WPA2)
 - WPA2 certification began in 2004
- CCMP block cipher mode
 - Counter Mode with Cipher Block Chaining Message Authentication Code Protocol, or Counter/CBC-MAC Protocol
- CCMP security services
 - Data confidentiality with AES encryption
 - Message Integrity Check (MIC) with CBC-MAC

WPA3 and GCMP

- Wi-Fi Protected Access 3 (WPA3)
 - Introduced in 2018
- GCMP block cipher mode
 - Galois/Counter Mode Protocol
 - A stronger encryption than WPA2
- GCMP security services
 - Data confidentiality with AES
 - Message Integrity Check (MIC) with
 - Galois Message Authentication Code (GMAC)

The WPA2 PSK problem

- WPA2 has a PSK brute-force problem
 - Listen to the four-way handshake
 - Some methods can derive the PSK hash without the handshake
 - Capture the hash
- With the hash, attackers can brute force the pre-shared key (PSK)
- This has become easier as technology improves
 - A weak PSK is easier to brute force
 - GPU processing speeds
 - Cloud-based password cracking
- Once you have the PSK, you have everyone's wireless key

SAE

- WPA3 changes the PSK authentication process
 - Includes mutual authentication
 - Creates a shared session key without sending that key across the network
 - No more four-way handshakes, no hashes, no brute force attacks
- Simultaneous Authentication of Equals (SAE)
 - A Diffie-Hellman derived key exchange with an authentication component
 - Everyone uses a different session key, even with the same PSK
 - An IEEE standard - the dragonfly handshake

Wireless security modes

- Configure the authentication on your wireless access point / wireless router
- Open System
 - No authentication password is required
- WPA/2/3-Personal / WPA/2/3-PSK
 - WPA2 or WPA3 with a pre-shared key
 - Everyone uses the same 256-bit key
- WPA/2/3-Enterprise / WPA/2/3-802.1X
 - Authenticates users individually with an authentication server (i.e., RADIUS)

2.2 - Authentication Methods

RADIUS (Remote Authentication Dial-in User Service)

- One of the more common AAA protocols
 - Supported on a wide variety of platforms and devices
 - Not just for dial-in
- Centralize authentication for users
 - Routers, switches, firewalls
 - Server authentication
 - Remote VPN access
 - 802.1X network access
- RADIUS services available on almost any server operating system

TACACS

- Terminal Access Controller
 - Access-Control System
 - Remote authentication protocol
 - Created to control access to dial-up lines to ARPANET
- TACACS+
 - The latest version of TACACS
 - More authentication requests and response codes
 - Released as an open standard in 1993

Kerberos

- Network authentication protocol
 - Authenticate once, trusted by the system
 - No need to re-authenticate to everything
 - Mutual authentication - the client and the server
 - Protect against on-path or replay attacks
- Standard since the 1980s
 - Developed by the Massachusetts Institute of Technology (MIT)
- Microsoft starting using Kerberos in Windows 2000
 - Based on Kerberos 5.0 open standard
 - Compatible with other operating systems and devices

SSO with Kerberos

- Authenticate one time
 - Lots of backend ticketing
 - Cryptographic tickets
- No constant username and password input!
 - Save time
- Only works with Kerberos
 - Not everything is Kerberos-friendly
- There are many other SSO methods
 - Smart-cards, SAML, etc.

Which method to use?

- Many different ways to communicate to an authentication server
 - More than a simple login process
- Often determined by what is at hand
 - VPN concentrator can talk to a RADIUS server
 - We have a RADIUS server
- TACACS+
 - Probably a Cisco device
- Kerberos - Probably a Microsoft network

Multi-factor authentication

- More than one factor
 - Something you are
 - Something you have
 - Something you know
 - Somewhere you are
 - Something you do
- Can be expensive
 - Separate hardware tokens
 - Specialized scanning equipment
- Can be inexpensive - Free smartphone applications

2.3 - Malware

Malware

- Malicious software - These can be very bad
- Gather information - Keystrokes
- Participate in a group - Controlled over the 'net
- Show you advertising - Big money
- Viruses and worms
 - Encrypt your data and ruin your day

Malware types and methods

- Trojan Horse
- Rootkit
- Viruses
- Spyware
- Ransomware
- Keylogger
- Boot sector virus
- Cryptominers

How you get malware

- These all work together
 - Malicious software takes advantage of a vulnerability
 - Installs malware that includes a remote access backdoor
 - Bot may be installed later
- Your computer must run a program
 - Email link - Don't click links
 - Web page pop-up
 - Drive-by download
 - Worm
- Your computer is vulnerable
 - Operating system - Keep your OS updated!
 - Applications - Check with the publisher

2.3 - Malware (continued)

Trojan horse

- Used by the Greeks to capture Troy from the Trojans
 - A digital wooden horse
- Software that pretends to be something else
 - So it can conquer your computer
 - Doesn't really care much about replicating
- Circumvents your existing security
 - Anti-virus may catch it when it runs
 - The better Trojans are built to avoid and disable AV
- Once it's inside it has free reign
 - And it may open the gates for other programs

Rootkits

- Originally a Unix technique
 - The “root” in rootkit
- Modifies core system files
 - Part of the kernel
- Can be invisible to the operating system
 - Won't see it in Task Manager
- Also invisible to traditional anti-virus utilities
 - If you can't see it, you can't stop it
 - Finding and removing rootkits
- Look for the unusual
 - Anti-malware scans
- Use a remover specific to the rootkit
 - Usually built after the rootkit is discovered
- Secure boot with UEFI
 - Security in the BIOS

Virus

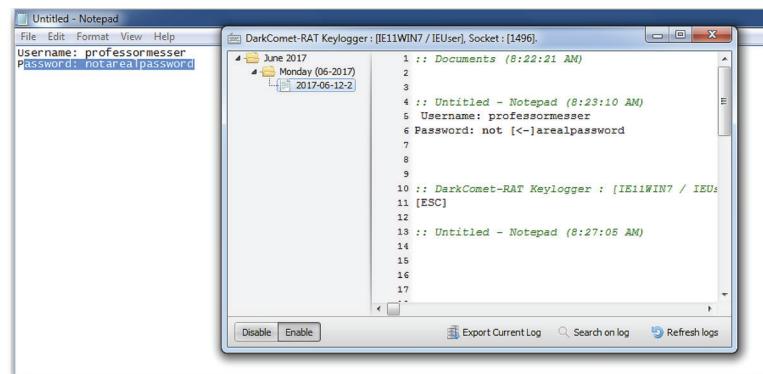
- Malware that can reproduce itself
 - It needs you to execute a program
- Reproduces through file systems or the network
 - Just running a program can spread a virus
- May or may not cause problems
 - Some viruses are invisible, some are annoying
- Anti-virus is very common
 - Thousands of new viruses every week
 - Is your signature file updated?
 - Boot sector virus
- Most viruses run after the OS is loaded
 - Like most applications
- Some boot loaders can be modified to run malware
 - Runs every time you start your computer
- Modern UEFI BIOS includes Secure Boot
 - Prevent unsigned software from running during the boot process

Spyware

- Malware that spies on you
 - Advertising, identity theft, affiliate fraud
- Can trick you into installing
 - Peer to peer, fake security software
- Browser monitoring - Capture surfing habits
- Keyloggers
 - Capture every keystroke
 - Send it back to the mother ship

Keyloggers

- Your keystrokes contain valuable information
 - Web site login URLs, passwords, email messages
- Save all of your input
 - Send it to the bad guys
- Circumvents encryption protections
 - Your keystrokes are in the clear
- Other data logging
 - Clipboard logging, screen logging, instant messaging, search engine queries



Ransomware

- A particularly nasty malware
 - Your data is unavailable until you provide cash
- Malware encrypts your data files
 - Pictures, documents, music, movies, etc.
 - Your OS remains available
 - They want you running, but not working
- You must pay the bad guys to obtain the decryption key
 - Untraceable payment system
 - An unfortunate use of public-key cryptography

Cryptominers

- Some cryptocurrency mining requires “proof of work”
 - Usually consists of a difficult math problem
 - Answer the problem and earn some currency
- This requires extensive CPU processing
 - One CPU isn't enough
 - Attackers want to use your CPU
- May appear in different ways
 - Visit a website and CPU utilization spikes
 - Malware is installed and mining is always occurring

2.3 - Anti-Malware Tools

Windows Recovery Environment

- Very powerful
- **Very dangerous**
 - Last resort
- Complete control
 - Fix your problems before the system starts
 - Remove malicious software
- Requires additional information
 - Use, copy, rename, or replace operating system files and folders
 - Enable or disable service or device startup
 - Repair the file system boot sector or the master boot record (MBR)

Starting the console

- All Windows versions
 - Hold Shift key while clicking Restart
 - Or boot from installation media
- Windows 10
 - Settings > Update and Security > Recovery > Advanced startup
- Windows 11
 - System > Recovery > Advanced startup > Restart now
- After rebooting
 - Troubleshoot > Advanced Options > Command Prompt

Anti-virus and anti-malware

- You need both
 - Often included together
- Real-time options
 - Not just an on-demand scan
- Modern anti-malware recognizes malicious activity
 - Doesn't require a specific set of signatures

Software firewalls

- Monitor the local computer
 - Alert on unknown or unauthorized network communication

- Prevent malware communication
 - Downloads after infection
 - Botnet communication
- Use Microsoft Defender Firewall - At a minimum
- Runs by default
 - Constantly monitoring
 - Any network connection

Anti-phishing training

- No single technology can stop social engineering
 - Don't give away private information
 - The user is the best anti-phishing
- Extensive training - Avoid becoming a victim
- Test the users
 - Send a phishing email
 - Find out who clicks and gives up information
- Train again

End user education

- One on one - Personal training
- Posters and signs - High visibility
- Message board posting - The real kind
- Login message - These become invisible
- Intranet page - Always available

OS reinstallation

- Only one way to guarantee malware removal
 - Delete everything
 - Install from scratch
- Restore from backup (fast)
 - As long as the backup is not also infected
- Manual installation (slowest)
 - Backup data files
 - Install Windows from installation media
- Image the system (fastest)
 - User's data files are on a network share
 - Recover from a prebuilt image

2.4 - Social Engineering

Effective social engineering

- Constantly changing - You never know what they'll use next
- May involve multiple people
 - And multiple organizations
 - There are ties connecting many organizations
- May be in person or electronic
 - Phone calls from aggressive "customers"
 - Emailed funeral notifications of a friend or associate

Phishing

- Social engineering with a touch of spoofing
 - Often delivered by email, text, etc.
- Don't be fooled - Check the URL
- Usually there's something not quite right
 - Spelling, fonts, graphics
- Vishing (Voice phishing) is done over the phone or voicemail
 - Caller ID spoofing is common
 - Fake security checks or bank updates

2.4 - Social Engineering (continued)

Shoulder surfing

- You have access to important information
 - Many people want to see
 - Curiosity, industrial espionage, competitive advantage
- This is surprisingly easy
 - Airports / Flights, hallway-facing monitors, or coffee shops
- Surf from afar
 - Binoculars / Telescopes (easy in the big city)
 - Webcam monitoring

Preventing shoulder surfing

- Control your input
 - Be aware of your surroundings
- Use privacy filters
 - It's amazing how well they work
- Keep your monitor out of sight
 - Away from windows and hallways
- Don't sit in front of me on your flight
 - I can't help myself

Spear phishing

- Targeted phishing with inside information
 - Makes the attack more believable
- Spear phishing the CEO is "whaling"
 - Targeted phishing with the possibility of a large catch
 - The CFO (Chief Financial Officer) is commonly speared
- These executives have direct access to the corporate bank account
 - The attackers would love to have those credentials

Tailgating and piggybacking

- Tailgating uses an authorized person to gain unauthorized access to a building
 - The attacker does not have consent
 - Sneaks through when nobody is looking
- Piggybacking follows the same process, but the authorized person is giving consent
 - Hold the door, my hands are full of donut boxes
 - Sometimes you shouldn't be polite
- Once inside, there's little to stop you
 - Most security stops at the border

Watching for tailgating

- Policy for visitors - You should be able to identify anyone
- One scan, one person
 - A matter of policy or mechanically required
- Access Control Vestibule / Airlock
 - You don't have a choice
- Don't be afraid to ask
 - Who are you and why are you here?

Impersonation

- Pretend to be someone you aren't
 - Halloween for the fraudsters
- Use some of those details you got from the dumpster
 - You can trust me, I'm with your help desk
- Attack the victim as someone higher in rank
 - Office of the Vice President for Scamming
- Throw tons of technical details around
 - Catastrophic feedback due to the depolarization of the differential magnetometer
- Be a buddy
 - How about those Cubs?

Dumpster diving

- Mobile garbage bin
 - United States brand name "Dumpster"
 - Similar to a rubbish skip
- Important information thrown out with the trash
 - Thanks for bagging your garbage for me!
- Gather details that can be used for a different attack
 - Impersonate names, use phone numbers
- Timing is important
 - Just after end of month, end of quarter
 - Based on pickup schedule

Wireless evil twins

- Looks legitimate, but actually malicious
 - The wireless version of phishing
- Configure an access point to look like an existing network
 - Same (or similar) SSID and security settings/captive portal
- Overpower the existing access points
 - May not require the same physical location
- WiFi hotspots (and users) are easy to fool
 - And they're wide open
- You encrypt your communication, right?
 - Use HTTPS **and** a VPN

2.4 - Denial of Service

Denial of service

- Force a service to fail
 - Overload the service
- Take advantage of a design failure or vulnerability
 - Keep your systems patched!
- Cause a system to be unavailable
 - Competitive advantage
- Create a smokescreen for some other exploit
 - Precursor to a DNS spoofing attack
- Doesn't have to be complicated
 - Turn off the power

A "friendly" DoS

- Unintentional DoSing
 - It's not always a ne'er-do-well
- Network DoS
 - Layer 2 loop without STP
- Bandwidth DoS
 - Downloading multi-gigabyte Linux distributions over a DSL line
- The water line breaks
 - Get a good shop vacuum

Distributed Denial of Service (DDoS)

- Launch an army of computers to bring down a service
 - Use all the bandwidth or resources - traffic spike
- This is why the bad guys have botnets
 - Thousands or millions of computers at your command
 - At its peak, Zeus botnet infected over 3.6 million PCs
 - Coordinated attack
- The attackers are zombies
 - Many people have no idea they are participating in a botnet

Mitigating DDoS attacks

- May be able to filter out traffic patterns
 - Stop the traffic at your firewall
- Internet service provider may have anti-DDoS systems
 - These can help "turn down" the DDoS volume
- Third-party technologies
 - CloudFlare, etc.

2.4 - Zero-Day Attacks

Zero-day attacks

- Many applications have vulnerabilities
 - We've just not found them yet
- Someone is working hard to find the next big vulnerability
 - The good guys share these with developers
- Attackers keep these yet-to-be-discovered holes to themselves
 - They want to use these vulnerabilities for personal gain
- Zero-day
 - The vulnerability has not been detected or published
 - Zero-day exploits are increasingly common
- Common Vulnerabilities and Exposures (CVE)
 - <https://cve.mitre.org/>

Zero-day vulnerabilities

- December 9, 2021 - Log4j remote code execution
 - Java-based logging utility provided as an Apache service
 - Installed on millions of servers
 - Vulnerability introduced on September 14th, 2013
- December 14th - Fix is released
 - Extensive patching
- December 17th -
 - Two new issues fixed
 - Everyone is looking for bugs

2.4 - On-Path Attacks

On-path network attack

- How can an attacker watch without you knowing?
 - Formerly known as man-in-the-middle
- Redirects your traffic
 - Then passes it on to the destination
 - You never know your traffic was redirected
- ARP poisoning
 - On-path attack on the local IP subnet
 - ARP has no security
 - ARP poisoning (spoofing)

On-path browser attack

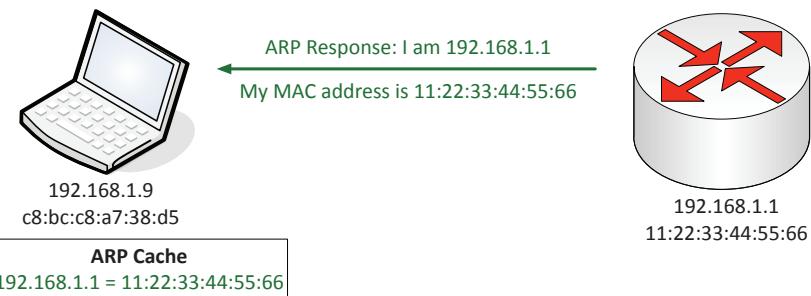
- What if the middleman was on the same computer as the victim?
 - Malware/Trojan does all of the proxy work
 - Formerly known as man-in-the-browser
- Huge advantages for the attackers
 - Relatively easy to proxy encrypted traffic
 - Everything looks normal to the victim
- The malware in your browser waits for you to login to your bank
 - And cleans you out

2.4 - On-Path Attacks (continued)

ARP poisoning (spoofing)

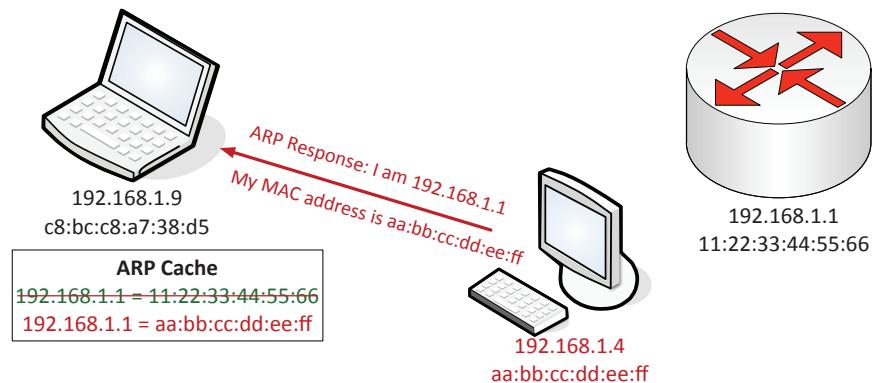
1

A legitimate response to an ARP request is received from the default gateway.



2

An attacker sends an ARP response that spoofs the IP address of the router and includes the attacker's MAC address.



2.4 - Password Attacks

Plaintext / unencrypted passwords

- Some applications store passwords “in the clear”
 - No encryption. You can read the stored password.
 - This is rare, thankfully
- Do not store passwords as plaintext
 - Anyone with access to the password file or database has every credential
- What to do if your application saves passwords as plaintext:
 - Get a better application

Hashing a password

- Hashes represent data as a fixed-length string of text
 - A message digest, or “fingerprint”
- Will not have a collision (hopefully)
 - Different inputs will not have the same hash
- One-way trip
 - Impossible to recover the original message from the digest
 - A common way to store passwords

The password file

- Different across operating systems and applications
 - Different hash algorithms

Brute force

- Try every possible password combination until the hash is matched
- This might take some time
 - A strong hashing algorithm slows things down
- Brute force attacks - Online
 - Keep trying the login process
 - Very slow
 - Most accounts will lockout after a number of failed attempts
- Brute force the hash - Offline
 - Obtain the list of users and hashes
 - Calculate a password hash, compare it to a stored hash
 - Large computational resource requirement

Dictionary attacks

- Use a dictionary to find common words
 - Passwords are created by humans
- Many common wordlists available on the ‘net
 - Some are customized by language or line of work
- The password crackers can substitute letters
 - p&ssw0rd
- This takes time
 - Distributed cracking and GPU cracking is common
- Discover passwords for common words
 - This won’t discover random character passwords

2.4 - Insider Threats

Insider threats

- More than just passwords on sticky notes
 - Some insiders are out for no good
- Sophistication may not be advanced, but the insider has institutional knowledge
 - Attacks can be directed at vulnerable systems
 - The insider knows what to hit
- Extensive resources
 - Eating away from the inside

Recruiting insiders

- We're getting better with protecting the network perimeter
 - It's an ongoing race
- Ransomware actors are targeting insiders
 - Offering Bitcoin in exchange for access
 - One ransomware infection can earn millions for an attacker
- Keep aware
 - Maintain good security fundamentals
 - Always have backups

2.4 - SQL Injection

Code injection

- Code injection
 - Adding your own information into a data stream
- Enabled because of bad programming
 - The application should properly handle input and output
- So many different data types
 - HTML, SQL, XML, LDAP, etc.

SQL injection

- SQL - Structured Query Language
 - The most common relational database management system language
- SQL Injection
 - Modify SQL requests (Your application shouldn't allow this)
- If you can manipulate the database, then you control the application
 - A significant vulnerability

2.4 - Cross-site Scripting

Cross-site scripting

- XSS
 - Cascading Style Sheets (CSS) are something else entirely
- Originally called cross-site because of browser security flaws
 - Information from one site could be shared with another
- One of the most common web application development errors
 - Takes advantage of the trust a user has for a site
 - Complex and varied
- Malware that uses JavaScript
 - Do you allow scripts? Me too.

Persistent (stored) XSS attack

- Attacker posts a message to a social network
 - Includes the malicious payload
- It's now "persistent"- Everyone gets the payload
- No specific target - All viewers to the page
- For social networking, this can spread quickly
 - Everyone who views the message can have it posted to their page
 - Where someone else can view it and propagate it further...

Hacking a Subaru

- June 2017, Aaron Guzman - Security researcher
- When authenticating with Subaru, users get a token
 - This token never expires (bad!)
- A valid token allowed any service request
 - Even adding your email address to someone else's account
 - Now you have full access to someone else's car
- Web front-end included an XSS vulnerability
 - A user clicks a malicious link, and you have their token

Protecting against XSS

- Be careful when clicking untrusted links
 - Never blindly click in your email inbox. Never.
- Consider disabling JavaScript
 - Or control with an extension
 - This offers limited protection
- Keep your browser and applications updated
 - Avoid the nasty browser vulnerabilities
- Validate input
 - Don't allow users to add their own scripts to an input field

2.4 - Security Vulnerabilities

Non-compliant systems

- A constant challenge
 - There are always changes and updates
- Standard operating environments (SOE)
 - A set of tested and approved hardware/software systems
 - Often a standard operating system image
- Operating system and application updates
 - Must have patches to be in compliance
 - OS updates, anti-virus signatures
 - Can be checked and verified before access is given

Protecting against non-compliant systems

- Operating system control
 - Apply policies that will prevent non-compliant software
- Monitor the network for application traffic
 - Next-generation firewalls with application visibility
- Perform periodic scans
 - Login systems can scan for non-compliance
 - Require correction before the system is given access

Unpatched systems

- Microsoft Patch Tuesday
 - Second Tuesday of each month (10:00 AM PST)
- Suddenly, systems are vulnerable to security flaws
 - Patch the operating system and applications
- An organization might have thousands of systems
 - Some of those are major services
- One forgotten system may be the weakest link
 - This happens quite a bit
- Patch management is a critical practice
 - Test, prioritize, and deploy

Unprotected systems

- Security issues are often roadblocks
 - Applications may not work properly without additional configurations
- Some troubleshooting tasks can be insecure
 - Disable antivirus and try again
 - Disable the firewall and try again
- Permanently disabling security isn't the answer
 - You don't fix a bad door lock by removing the door
 - Become an expert in application troubleshooting

Product support lifetime

- End of life (EOL) operating systems
 - Manufacturer stops selling an OS
 - May continue supporting the OS
 - Important for security patches and updates
- End of service life (EOSL)
 - Manufacturer stops selling an OS
 - Support is no longer available
 - No ongoing security patches or updates
 - May have a premium-cost support option
- Technology EOSL is a significant concern
 - Security patches are part of normal operation

BYOD

- Bring Your Own Device / Bring Your Own Technology
- Employee owns the device
 - Need to meet the company's requirements
- Difficult to secure
 - It's both a home device and a work device
 - How is data protected?
 - What happens to the data when a device is sold or traded in?
 - An infected device could disclose proprietary company information

2.5 - Defender Antivirus

Microsoft Defender Antivirus

- Built-in antivirus for Windows 10 and 11
 - No additional third-party products required
- Included in the Windows Security app
 - Virus & threat protection
- May not specifically display "Defender Antivirus"
 - The name has changed over time
 - Windows Defender
 - Microsoft Defender Antivirus

Activate or deactivate

- Don't disable your security protection
 - This is for temporary troubleshooting
 - This will increase risk
 - Make sure you know what you're doing

- Defender Antivirus operates in real-time
 - Enable or disable this feature
- Windows Security app
 - Virus & threat protection settings >
 - Manage settings > Real-time protection

Updated definitions

- Antivirus is only as good as the latest signatures
 - It's important to stay up to date
- Virus & threat protection updates
 - Check for updates
- Click the "Check for updates" button
 - Automatic updates are normally configured

2.5 - Windows Firewall

Enabling and disabling Windows Firewall

- Your firewall should always be enabled
 - Sometimes you need to troubleshoot
- Temporarily disable from the Control Panel or from Windows Security
 - Turn Windows Firewall on or off
 - Requires elevated permissions
- Different settings for each network type
 - Public / Private

Windows Firewall configuration

- Block all incoming connections
 - Ignores your exception list
 - Useful when you need security
- Modify notification - App blocking

Creating a firewall exception

- Allow an app or feature through Windows Firewall
 - The more secure exception
- Port number
 - Block or allow
- Predefined exceptions
 - List of common exceptions
 - Custom rule
 - Every firewall option

2.5 - Windows Security Settings

Windows authentication

- Login to the Windows desktop
 - And access network resources
- Local accounts
 - Only associated with a specific Windows device
- Microsoft accounts
 - Sync settings between devices, integrate applications (Skype, Office) with OneDrive, and more
- Windows Domain accounts
 - Centrally managed from Active Directory

Users and groups

- Users
 - Administrator
 - The Windows super-user
 - Guest (Limited access)
 - Standard Users
- Groups
 - Power Users
 - Not much more control than a regular user
 - Permissions removed in Windows Vista and later

Login options

- Username / password
 - Common authentication credentials
- Personal Identification Number (PIN)
 - A local access code
- Biometrics
 - Fingerprint, facial recognition
- Single sign-on (SSO)
 - Windows Domain credentials
 - Sign in one time

NTFS vs. Share permissions

- NTFS permissions apply from local and network connections
- Share permissions only apply to connections over the network
 - A “network share”
- The most restrictive setting wins
 - Deny beats allow
- NTFS permissions are inherited from the parent object
 - Unless you move to a different folder on the same volume

Explicit and inherited permissions

- Explicit permissions
 - Set default permissions for a share
- Inherited permissions
 - Propagated from the parent object to the child object
 - Set a permission once, it applies to everything underneath
- Explicit permissions take precedence over inherited permissions
 - Even inherited deny permissions

Run as administrator

- Administrators have special rights and permissions
 - Editing system files, installing services
- Use rights and permissions of the administrator
 - You don't get these by default, even if you're in the Administrators group
- Right-click the application
 - Run as administrator
 - Or search and click “Run as administrator”

2.5 - Windows Security Settings (continued)

UAC (User Account Control)

- Limit software access - Protect your computer
- Standard users
 - Use the network or change your password
- Administrators
 - Install applications or configure Remote Desktop
- Secure Desktop - Limits automated access

BitLocker

- Encrypt an entire volume
 - Protects all of your data, including the OS
 - Support for all Windows editions except Home
- Lose your laptop? - Doesn't matter without the password
- Data is always protected
 - Even if the physical drive is moved to another computer
- BitLocker To Go - Encrypt removable USB flash drives

EFS

- Encrypting File System
 - Encrypt at the file system level
 - Requires the NTFS file system
- OS support
 - Support for all Windows editions except Home
- Uses password and username to encrypt the key
 - Administrative resets will cause EFS files to be inaccessible

2.6 - Security Best Practices

Data encryption

- Full-disk encryption
 - Encrypt data-at-rest
- File system encryption
 - Individual files and folders
- Removable media
 - Protect those USB flash drives
- Key backups are critical
 - You always need to have a copy
 - This may be integrated into Active Directory
 - You'll want to keep the key handy

Password complexity and length

- Make your password strong
 - Resist guessing or brute-force attack
- Increase password entropy
 - No single words, no obvious passwords
 - Mix upper and lower case and use special characters
- Stronger passwords are at least 8 characters
 - Consider a phrase or set of words

Password expiration and recovery

- All passwords should expire
 - Change every 30 days, 60 days, 90 days
 - System remembers password history, requires unique passwords
- Critical systems might change more frequently
 - Every 15 days or every week
- The recovery process should not be trivial!
 - Some organizations have a very formal process

Password best practices

- Changing default usernames/passwords
 - All devices have defaults
 - There are many web sites that document these

• BIOS/UEFI passwords

- Supervisor/Administrator password:
 - Prevent BIOS changes
 - User password: Prevent booting
- Requiring passwords
 - Always require passwords
 - No blank passwords
 - No automated logins

End-user best practices

- Require a screensaver password
 - Integrate with login credentials
 - Can be administratively enforced
- Does not require user intervention
 - Automatically locks after non-use or timeout
- Secure critical hardware
 - Laptops can easily walk away -
 - Lock them down

Securing PII and passwords

- Personally identifiable information
 - Name, address, social security number, etc.
- Control your input
 - Be aware of your surroundings
- Use privacy filters
 - It's amazing how well they work
- Keep your monitor out of sight
 - Away from windows and hallways

2.6 - Security Best Practices (continued)

Account management

- User permissions
 - Everyone isn't an Administrator
 - Assign proper rights and permissions
 - This may be an involved audit
- Assign rights based on groups
 - More difficult to manage per-user rights
 - Becomes more useful as you grow
- Login time restrictions
 - Only login during working hours
 - Restrict after-hours activities

Disabling unnecessary accounts

- All operating systems include other accounts
 - Guest, root, mail, etc.
- Not all accounts are necessary
 - Disable/remove the unnecessary
 - Disable the guest account
- Disable interactive logins
 - Not all accounts need to login
- Change the default usernames
 - User:admin Password:admin
 - Helps with brute-force attacks

Locking the desktop

- Failed password attempts
 - Should lock the account and/or reboot after a certain threshold
 - Prevents online brute force attacks
- Automatically lock the system
 - After a certain amount of inactivity
 - Or when you walk away

AutoRun and AutoPlay

- Disable AutoRun on older OSes
 - autorun.inf in Vista
 - No Autorun in Windows 7, 8/8.1, 10, or 11
 - Disabled through the registry
- Disable AutoPlay
 - Configure in Settings > Bluetooth & devices > AutoPlay
- Get the latest security patches
 - Updates to autorun.inf and AutoPlay

2.7 - Mobile Device Security

Screen locks

- Restrict access to the device
 - You're going to leave it somewhere
- Facial recognition
 - Unlock with your face
- PIN
 - Choose a personal identification number
- Fingerprint
 - Built-in fingerprint reader
- Swipe
 - Choose a pattern
- Failed attempts
 - iOS: Erase everything after 10 failed attempts
 - Android: Lock the device and require a Google login or wipe the device

Locator applications and remote wipe

- Built-in GPS
 - And location "helpers"
- Find your phone
 - On a map.
- Control from afar
 - Make a sound
 - Display a message
- Wipe everything
 - At least your data is safe

Patching/OS updates

- All devices need updates - Even mobile devices
- Device patches - Security updates
- Operating system updates
 - New features, bug fixes
- Don't get behind!
 - Avoid security problems

Full device encryption

- Encrypt all device data
 - Phone keeps the key
- iOS 8 and later
 - Personal data is encrypted with your passcode
- Android
 - Version 5.0 and later is probably already encrypted

Remote backup

- Difficult to backup something that's always moving
 - Backup to the cloud
- Constant backup
 - No manual process
- Backup without wires
 - Use the existing network
- Restore with one click
 - Restores everything
 - Authenticate and wait

2.7 - Mobile Device Security (continued)

Anti-virus and anti-malware

- Apple iOS
 - Closed environment, tightly regulated
 - Malware has to find a vulnerability
- Android
 - More open, apps can be installed from anywhere
 - Easier for malware to find its way in
- Apps run in a “sandbox”
 - You control what data an app can view
- Third-party virus and malware protection
 - Available from the usual providers

Firewalls

- Mobile phones don't include a firewall
 - Most activity initiates outbound, not inbound
- Some mobile firewall apps are available
 - Most for Android
 - None seem to be widely used
- Enterprise environments can control mobile apps
 - Firewalls can allow or disallow access

Policies and procedures

- Manage company-owned and user-owned mobile devices
 - BYOD - Bring Your Own Device
- Centralized management of the mobile devices
 - Specialized functionality / Mobile Device Manager (MDM)
- Set policies on apps, data, camera, etc.
 - Control the remote device
 - The entire device or a “partition”
- Manage access control
 - Force screen locks and PINs on these single user devices

IoT (Internet of Things)

- Sensors - Heating and cooling, lighting
- Smart devices - Home automation, video doorbells
- Wearable technology - Watches, health monitors
- Facility automation - Temperature, air quality, lighting
- Weak defaults
 - IoT manufacturers are not security professionals
 - Consider isolating IoT devices on their own network

2.8 - Data Destruction

Physical destruction

- Shredder
 - Heavy machinery - complete destruction
- Drill / Hammer
 - Quick and easy - Platters, all the way through
- Electromagnetic (degaussing)
 - Remove the magnetic field
 - Destroys the drive data and the electronics
- Incineration - Fire hot.

Certificate of destruction

- Destruction is often done by a 3rd party
 - How many drills and degaussers do you have?
- Need confirmation that your data is destroyed
 - Service should include a certificate
- A paper trail of broken data
 - You know exactly what happened

Disk formatting

- Low-level formatting
 - Provided at the factory
 - Not recommended for the user
- Standard formatting / Quick format
 - Sets up the file system, installs a boot sector
 - Clears the master file table but not the data
 - Can be recovered with the right software
- Standard formatting / Regular format
 - Overwrites every sector with zeros
 - Default for Windows Vista and later
 - Can't recover the data

Erasing data

- File level overwriting
 - Sdelete – Windows Sysinternals
 - Remaining files are still available
- Whole drive wipe secure data removal
 - DBAN - Darik's Boot and Nuke
 - Removes all data on the drive
 - Use the drive again
- Physical drive destruction
 - One-off or industrial removal and destroy
 - Drive is no longer usable

Hard drive security

- 2019 study from Blancco and Ontrack
 - 159 storage drives from eBay
 - 42% of the used drives contain sensitive data
- Different data types
 - 66 drives had data, 25 drives with PII
- Varied data sources
 - Travel company email archive
 - Freight company shipping details
 - University student papers
 - Audio, video, and other personal files

2.9 - Securing a SOHO Network

Change default passwords

- All access points have default usernames and passwords
 - Change yours!
- The right credentials provide full control
 - Administrator access
- Very easy to find the defaults for your access point or router
 - <https://www.routerpasswords.com>

Firmware updates

- Small office / home office appliances
 - Appliance are usually a closed architecture
 - Updates are provided by the manufacturer
- Updates may address different requirements
 - Bug fixes
 - New features
 - Security patches
- Install the latest software
 - Update and upgrade the firmware
 - Firewalls, routers, switches, etc.

IP address filtering

- Content filtering, IP address ranges
 - Or a combination
- Allow list
 - Nothing pass through the firewall unless it's approved
 - Very restrictive
- Deny list
 - Nothing on the “bad list” is allowed
 - Specific URLs
 - Domains
 - IP addresses

Content filtering

- Control traffic based on data within the content
 - URL filtering, website category filtering
- Corporate control of outbound and inbound data
 - Sensitive materials
- Control of inappropriate content
 - Not safe for work
 - Parental controls
- Protection against evil
 - Anti-virus, anti-malware

Physical placement

- Often a single device
 - Router, switch, access point, firewall, etc.
- Location may be restricted to a secure room
 - Prevent access to servers and network devices
 - For wireless, location becomes more important
 - Above ceiling tiles or another high point
 - This may cause problems for power cycling
- Plan before the installation
 - May require additional setup time

IP addressing

- DHCP (automatic) IP addressing vs. manual IP addressing
- IP addresses are easy to see in an unencrypted network
- If the encryption is broken, the IP addresses will be obvious
- Configuring a static IP address is not a security technique
 - Security through obscurity

DHCP reservations

- Address reservation
 - Administratively configured
- Table of MAC addresses
 - Each MAC address has a matching IP address
- Other names
 - Static DHCP Assignment
 - Static DHCP
 - Static Assignment
 - IP Reservation

Static WAN IP

- Wide area network / Internet link
 - External IP address
- Many ISPs dynamically allocate WAN addresses
 - The default for most ISPs
- It's easier to manage if the IP address is static
 - The IT team always knows the IP address
 - A SOHO might provide a service
- This may be an additional cost
 - Contact the ISP for options

UPnP (Universal Plug and Play)

- Allows network devices to automatically configure and find other network devices
 - Zero-configuration
- Applications on the internal network can open inbound ports using UPnP
 - No approval needed
 - Used for many peer-to-peer (P2P) applications
- Best practice would be to disable UPnP
 - Only enable if the application requires it
 - And maybe not even then

Screened subnet

- Previously known as the demilitarized zone (DMZ)
 - An additional layer of security between the Internet and you
 - Public access to public resources

2.9 - Securing a SOHO Network (continued)

SSID management

- Service Set Identifier
 - Name of the wireless network
 - LINKSYS, DEFAULT, NETGEAR
- Change the SSID to something not-so obvious
- Disable SSID broadcasting?
 - SSID is easily determined through wireless network analysis
 - Security through obscurity

Wireless channels and encryption

- Open System
 - No authentication password is required
- WPA/2/3-Personal / WPA/2/3-PSK
 - WPA2 or WPA3 with a pre-shared key
 - Everyone uses the same 256-bit key
- WPA/2/3-Enterprise / WPA/2/3-802.1X
 - Authenticates users individually with an authentication server (i.e., RADIUS, LDAP, etc.)
- Use an open frequency
 - Some access points will automatically find good frequencies

Disable guest networks

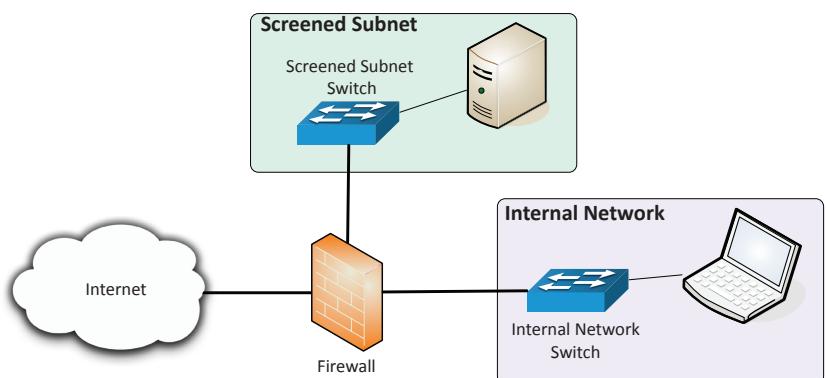
- Limit access to outsiders
 - Guest networks are often enabled by default
- Some guest networks can be used for other connections
 - Internet of Things
 - Lab networks
- Don't enable without security
 - WPA2 or WPA3

Disabling ports

- Enabled physical ports
 - Conference rooms
 - Break rooms
- Administratively disable unused ports
 - More to maintain, but more secure
- Network Access Control (NAC)
 - 802.1X controls
 - You can't communicate unless you are authenticated

Port forwarding

- 24x7 access to a service hosted internally
 - Web server, gaming server, security system, etc.
- External IP/port number maps to an internal IP/port
 - Does not have to be the same port number
- Also called Destination NAT or Static NAT
 - Destination address is translated from a public IP to a private IP
 - Does not expire or timeout



2.10 - Browser Security

Browser download and installation

- Always use trusted sources
 - Attackers want you to install the malware for them
 - No fancy exploit required
- Avoid untrusted third-party sites
 - Don't click links in emails
 - Don't follow links from other websites
 - Always visit a browser site directly
- Use hashes to verify the download
 - Confirm the downloaded file matches the version on the server

Hash verification

- Install a hash checking application
 - Available for command line and GUI
 - Options available in the Microsoft Store
- Hash values may be available on the download site
 - Usually includes a digital signature for verification
- Verify the downloaded file
 - Compare the downloaded file hash with the posted hash value

Extensions and plug-ins

- Trusted sources
 - Official browser extension library
 - Chrome Web Store
 - Microsoft Store
 - Known-good websites
- Untrusted sources
 - Random or unfamiliar websites
 - Installed by malware
- This is a significant attack vector
 - Almost everything we do is in our browser

Malicious browser extensions

- March 2021
 - More than 24 malicious
 - Google Chrome extensions identified
 - Includes 40 malicious domains
 - Not identified by security technologies

2.10 - Browser Security (continued)

- Malicious activity identified
 - Credential theft
 - Screenshots and keylogging
 - Data exfiltration
- Don't trust any software - Always have backups

Password managers

- Password vaults
 - All passwords in one location
 - A database of credentials
- Secure storage
 - All credentials are encrypted
 - Cloud-based synchronization options
- Create unique passwords
 - Passwords are not the same across sites
- Personal and enterprise options
 - Corporate access

Secure connections

- Security alerts and invalid certificates
 - Something isn't quite right
 - Should raise your interest
- Look at the certificate details
 - May be expired or the wrong domain name
 - The certificate may not be properly signed (untrusted certificate authority)
 - Correct time and date is important

Enable pop-up blockers

- Pop-up blocker
 - Prevent unwanted notification windows
- Enable or disable
 - Should usually be enabled
 - Disable temporarily when troubleshooting
- Block and allow
 - Control pop-up blocking on certain websites

Clearing private data

- Clear browsing data
 - History
 - Saved passwords
 - List of downloaded files
- Clear cache
 - Parts of a website are stored locally
 - Remove all local data

Private browsing mode

- Don't store information from a browsing session
 - Good for privacy
 - Useful when testing or troubleshooting
- Removes the information when the browser is closed
 - No history tracking
 - No download file list
 - Cached information is deleted

Browser data synchronization

- Share browsing data across multiple systems
 - Sign in to the browser
- Use with other computers, tablets, and mobile devices
 - Browsing history
 - Favorites
 - Installed extensions
 - Other settings

Ad blockers

- Some browsers can block advertising
 - This isn't always an option
- Many sites will track visits
 - And recognize a return visit
- Difficult to always recognize an advertisement
 - You can control the security level

3.1 - Troubleshooting Windows

Bluescreens and frequent shutdowns

- **Startup and shutdown BSOD**
 - Bad hardware, bad drivers, bad application
- **Use Last Known Good, System Restore, or Rollback Driver**
 - Try Safe mode
- **Reseat or remove the hardware**
 - If possible
- **Run hardware diagnostics**
 - Provided by the manufacturer
 - BIOS may have hardware diagnostics

Sluggish performance

- Task Manager
 - Check for high CPU utilization and I/O
- Windows Update - Latest patches and drivers

- Disk space - Check for available space and defrag

- Laptops may be using power-saving mode
 - Throttles the CPU

- Anti-virus and anti-malware - Scan for attackers

Boot errors

- **Can't find operating system**
 - "Operating system not found", "Missing operating system"
- **Boot loader replaced or changed**
 - Multiple operating systems installed
- **Check boot drives** - Remove any media
- **Startup Repair**
- **Modify the Windows Boot Configuration Database (BCD)**
 - Formerly boot.ini
 - Recovery Console: **bootrec /rebuildbcd**

3.1 - Troubleshooting Windows (continued)

Startup Repair

- **Missing NTLDR**

- The main Windows boot loader is missing
- Run **Startup Repair** or replace manually and reboot
- Disconnect removable media

- **Missing operating system**

- Boot Configuration Data may be incorrect
- Run **Startup Repair** or manually configure BCD store

- **Boots to Safe Mode**

- Windows is not starting normally
- Run **Startup Repair**

Starting the system

- **Device not starting**

- Check Device Manager and Event Viewer
- Often a bad driver
- **Remove or replace driver**

- **“One or more services failed to start”**

- Bad/incorrect driver, bad hardware
- Try starting manually
- Check account permissions
- Confirm service dependencies
- Windows service; check system files
- Application service; reinstall application

Applications crashing

- **Application stops working**

- May provide an error message
- May just disappear

- **Check the Event Log**

- Often includes useful reconnaissance

- **Check the Reliability Monitor**

- A history of application problems
- Checks for resolutions

- **Reinstall the application**

- Contact application support

Low memory warnings

- **Your computer is low on memory**

- Applications need RAM to run
- More applications need more RAM

- **Close large-memory processes**

- Check Task Manager

- **Increase virtual memory**

- More room for swapping applications
- System > About > Advanced system settings > Performance > Settings > Virtual memory

USB controller resource warnings

- USB devices contain buffers called “endpoints”
 - Different USB controllers support a different number of endpoints
 - (96 endpoints, 254 endpoints, etc.)
- Different devices require a different number of endpoints
 - Exceed the number of endpoints and you run out of resources
 - It’s difficult to determine the number of endpoints used by a device
- **The controller does not have enough resources for this device.**
 - The endpoints are these resources
- **Move the device to a different USB interface**
 - USB 2.0 interfaces might support a larger number of endpoints
- **Match the USB interface to the device capabilities**
 - USB 2.X devices or USB 3.X devices
 - More endpoints for all devices

System instability

- **General system failures**

- Software errors, system hangs, application failures

- **Time for a full diagnostic** - This could be anything

- **Hardware diagnostic**

- Most systems include manufacturer diagnostics
- Also run storage and memory checks

- **Check the operating system**

- Run SFC (System File Checker)
- Perform an anti-malware scan

Slow profile load

- Roaming user profile

- Your desktop follows you to any computer
- Changes are synchronized

- Network latency to the domain controller

- Slows login script transfers
- Slow to apply computer and user policies

- May require many hundreds (or thousands) of LDAP queries

- Client workstation picks a remote domain controller instead of local DC

- Problems with local infrastructure

Time drift

- **A computer’s internal clock will drift over time**

- Computers aren’t great timekeepers

- The solution is to fix the symptom

- Fixing the problem would require changing the design of every computer

- **Enable automatic time setting**

- Settings > Time & language > Date & time
- Time zone may need to be configured manually if privacy settings are enabled

3.1 - Troubleshooting Solutions

Reboot

- Have you tried turning it off and on again?
 - There's a reason it works
- Bug in your router software - Reboot the router
- Application is using too many resources
 - Stops the app
- Memory leak slowly consumes all available RAM
 - Clears the RAM and starts again

Restart services

- Services
 - Applications that run in the background
 - No user interaction
- Similar issues as a normal process
 - Resource utilization
 - Memory leaks
 - Crashes
- View status in Task Manager
 - Services tab
 - Right-click to start, stop, or restart

Uninstall/reinstall/update applications

- Application issues
 - Problems with the application files or configurations
- Settings > Apps > Apps & features
 - Repair, reset, or uninstall
- Some options in the Control Panel
 - Programs and Features
- Run the application setup again
 - Other options may be available from the setup program
- Repair
 - Install missing files
 - Replace corrupted files
 - Fix application shortcuts
 - Repair registry entries
 - Update or reconfigure drivers
- Reset
 - Remove all application data
 - A factory reset / original install
- Uninstall - Remove the application

Verify requirements

- Every operating system and application publishes a set of requirements
 - These are commonly the bare minimums
- Check with the manufacturer
 - Get the official requirements
- Hardware and software resources
 - CPU speed, total RAM, video options, device drivers, runtime libraries
- Use System Information
 - View the current configuration

Add resources

- Check resource utilization
 - Task Manager
- Consider a long-term analysis
 - Performance Monitor
- Compare existing resources with manufacturer requirements
 - Add or replace hardware (CPU, SSD, RAM)
- Free drive space
 - Disk Cleanup

System file checker

- Verify the integrity of the operating system
 - Check every important system file with **sfc**

Startup Repair

- Start from Settings
 - Settings > System > Recovery
- Also available from the
 - Advanced Boot Options
 - Repair Windows

Windows Restore

- Start the System Restore application
 - System > About > System Protection
 - This assumes you've not disabled restore points
- Pick a restore point and let the system reboot
 - The operating system configuration will revert to the previous date and time
 - User data will not be modified

Reimage or reload OS

- Windows is big
 - And complex
- Spend time trying to find the needle
 - Or simply build a new haystack
- Many organizations have prebuilt images
 - Don't waste time researching issues
- Windows includes a reset option
 - Windows 10: Settings > Update & Security > Recovery
 - Windows 11: Settings > System > Recovery

Update and patch

- Windows Update
 - Centralized OS and driver updates
- Lots of flexibility
 - Change active hours
 - Manage metered connections
- Applications must be patched
 - Security issues don't stop at the OS
 - Download from the publisher

3.1 - Troubleshooting Solutions (continued)

Roll back updates

- Updates are installed automatically by default
 - Important security patches
- View the history
 - Windows 10:
 - Settings > Update & Security >
 - Windows Update
 - Windows 11:
 - Settings > Windows Update

Rebuild Windows profiles

- Profiles can become corrupted
 - The User Profile Service failed the logon.
 - User Profile cannot be loaded.
 - User documents may be “missing”
- If a profile doesn’t exist, it’s recreated
 - We’re going to delete the profile and force the rebuilding process

Deleting Windows profiles

- Login to the computer with Domain Administrator rights
- Rename the \Users\name folder - This will save important files
- Backup the user’s registry
 - HKLM\SOFTWARE\Microsoft\Windows NT\CurrentVersion\ProfileList
 - Right-click / Export
- Delete the registry entry
 - You have a backup - Restart the computer

Reconstructing Windows profiles

- Login to the computer with the user account
 - The profile will be rebuilt
 - This will recreate the \Users\name folder
- Login as Domain Administrator
 - Copy over any important files from the old profile
- Do not copy the entire profile
 - Corrupted files might exist in the old profile
- Logout as Domain Administrator, login with the user account

3.2 - Troubleshooting Security Issues

Unable to access the network

- Slow performance, lock-up
 - Malware isn’t the best written code
- Internet connectivity issues
 - Malware likes to control everything
 - You go where it wants you to go
 - You can’t protect yourself if you can’t download
- OS updates failures
 - Malware keeps you vulnerable
 - Some malware uses multiple communication paths
- Reload or clean
 - Malware cleaner or recover from known good backup

Desktop alerts

- Browser push notification messages
 - Pretends to be a malware infection
 - Actual notifications come from your antivirus utility
- Disable browser notifications
 - Create an allow list of legit sites
- Scan for malware
 - Consider a cleaning
 - Rebuild from scratch or known good backup to guarantee removal

False antivirus alerts

- False antivirus message
- May include recognizable logos and language
 - May require money to “unlock” your PC
 - Or to “subscribe” to their service
- Often requires a specific anti-malware removal utility or technique
 - The attackers are very, very good

Altered system or personal files

- Renamed system files - Won’t need that anymore
- Files disappearing - Or encrypted
- File permission changes - Protections are modified
- Access denied
 - Malware locks itself away
 - It doesn’t leave easily
- Use a malware cleaner or restore from known good backup
 - Some malware is exceptionally difficult to remove

Browser security alerts

- Security alerts and invalid certificates
 - Something isn’t quite right
 - Should raise your interest
- Look at the certificate details
 - Click the lock icon
 - May be expired or the wrong domain name
 - The certificate may not be properly signed (untrusted certificate authority)
 - Correct time and date is important

Browser redirection

- Instead of your Google result, your browser goes somewhere else
 - This shouldn’t ever happen
- Malware is the most common cause
 - Makes money for the bad guys
- Use an anti-malware/anti-virus cleaner
 - This is not the best option
- Restore from a good known backup
 - The only way to guarantee removal

3.3 - Removing Malware

Malware removal

- This is almost never the best practice
 - It's impossible to know if all of the malware has been removed
- Ideally, you should delete everything and start over
 - Restore from a known-good backup
 - Install from the original media
- There are reasons to remediate
 - Important user documents may need to be recovered
 - Get the system running well enough to backup certain files

1. Verify malware symptoms

- Odd error messages
 - Application failures, security alerts
- System performance issues
 - Slow boot, slow applications
- Research the malware
 - Know what you're dealing with

2. Quarantine infected systems

- Disconnect from the network
 - Keep it contained
- Isolate all removable media
 - Everything should be contained
- Prevent the spread
 - Don't transfer files, don't try to backup
 - That ship sailed

3. Disable System Restore

- Restore points make it easy to rewind
 - Malware infects restore points
- Disable System Protection
 - No reason to save an infected config
- Delete all restore points
 - Remove all infection locations

4a. Remediate: Update anti-virus

- Signature and engine updates
 - The active anti-virus engine
 - Signature updates
 - A very, very tiny shelf life
- Automatic vs. manual
 - Manual updates are almost pointless
- Your malware may prevent the update process
 - Copy from another computer

4b. Remediate: Scan and remove

- Microsoft and others - The big anti-virus apps
- Malware-specific -
 - Scan and remove difficult malware
- Stand-alone removal apps
 - Check with your anti-virus company
- There's really no way to know if it's really gone
 - Delete and rebuild

4b. Remediate: Scan and remove

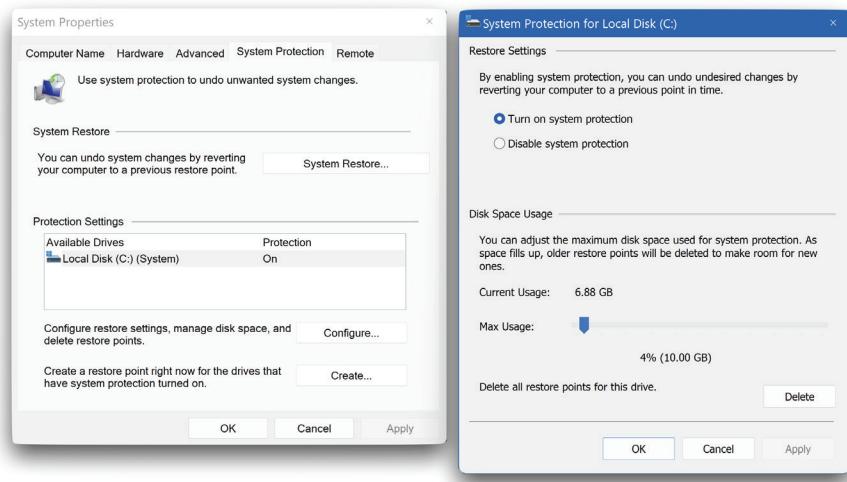
- Safe mode
 - Load the bare minimum operating system
 - Just enough to get the OS running
 - Can also prevent the bad stuff from running
- Pre-installation environment (WinPE)
 - Recovery Console, bootable CD/DVDs/USBs
 - Build your own from the Windows
 - Assessment and Deployment Kit (ADK)
- May require the repair of boot records and sectors

5. Schedule scans and run updates

- Built into the antivirus software
 - Automated signature updates and scans
- Task scheduler
 - Run any task
- Operating system updates
 - Make sure its enabled and working

6. Enable System Protection

- Now you're clean
 - Put things as they were
- Create a restore point
 - Start populating again



7. Educate the end user

- One on one
 - Personal training
- Posters and signs
 - High visibility
- Message board posting
 - The real kind
- Login message
 - These become invisible
- Intranet page
 - Always available

3.4 - Troubleshooting Mobile Devices

App issues

- Problematic apps
 - Apps not loading
 - Slow app performance
- Restart the phone
 - Hold power button, power off
- Stop the app and restart
 - iPhone: Double-tap home|slide up, slide app up
 - Android: Settings/Apps, select app, Force stop
- Update the app - Get the latest version

App fails to close or crashes

- App hangs
 - But other apps are still working
- App crashes
 - May provide an error message, or just disappear
- Restart the device
 - Clear the slate, try the app again
- Update the app
 - A bug fix might resolve the issue
- Delete and reinstall the app
 - Be careful not to remove important app data

App fails to update

- App does not update to a new version
 - But other apps are still working
- Check the Store to manually upgrade
 - Force the upgrade process
 - Some stores require a valid method of payment on file
- Restart the device
 - Try the update process again

OS fails to update

- Device operating system will not update
 - New features, bug fixes, security updates
- Check available storage
 - Remove unused documents and apps
- Check download bandwidth
 - Connect to Wi-Fi
- Try a different network connection
 - Update server may not be accessible
- Reboot - Always a good idea

Battery life issues

- Bad reception
 - Always searching for signal
 - Airplane mode on the ground
- Aging battery
 - There's only so many recharges
- Disable unnecessary features
 - 802.11 wireless, Bluetooth, GPS
- Check application battery usage
 - iOS/iPadOS: Settings/Battery
 - Android: Settings/Battery

Random reboots

- A device reboots during normal operation
 - May occur randomly
- Check the OS and app versions
 - Keep everything up to date
- Perform a hardware check
 - Check the battery health
 - Not many diagnostics options
- Contact Tech Support for options
 - Crash logs should be on the device

Connectivity issues

- Intermittent connectivity
 - Move closer to access point
 - Try a different access point
- No WiFi connectivity
 - Check/Enable WiFi
 - Check security key configuration
 - Hard reset can restart wireless subsystem
- No Bluetooth connectivity
 - Check/Enable Bluetooth
 - Check/Pair Bluetooth component
 - Hard reset to restart Bluetooth subsystem
- NFC not working
 - Limited troubleshooting options
 - Device may allow disable/enable of NFC
 - Reset the device
 - If payment related, remove and add the card again
- AirDrop not working
 - Distance between devices < 30 feet
 - Turn on Wi-Fi and Bluetooth
 - Check AirDrop discovery options
 - “Allow me to be discovered by”

Screen does not autorotate

- Turning the device doesn't rotate the view
 - It should know which way is up
- Disable rotation lock
 - Prevents autorotation when enabled
- Restart the app
 - The device might be working properly
- Restart the device
 - Perhaps the device isn't working properly
- Contact device support
 - If nothing rotates, you could have a sensor issue

3.5 - Troubleshooting Mobile Device Security

Android package source

- Once malware is on a phone, it has a huge amount of access
 - Don't install APK (Android Package Kit) files from an untrusted source
- iOS - All apps are curated by Apple
- Android
 - Apps can be downloaded from Google Play or a trusted app store
 - Sideloaded is where problems can occur

Developer mode

- Enables developer-specific settings
 - USB debugging
 - Memory statistics
 - Demo mode settings
- iOS and iPadOS
 - Enable using Xcode - Must use macOS
- Android
 - Enabled from Settings > About Phone
 - Tap the build number seven times

Root access/jailbreaking

- Mobile devices are purpose-built systems
 - You don't need direct access to the operating system
- Gaining access
 - Android - Rooting
 - Apple iOS - Jailbreaking
- Install custom firmware
 - Replaces the existing operating system
- Uncontrolled access
 - Circumvent security features, sideload apps without using an app store
 - The MDM becomes relatively useless

Application spoofing

- Install what appears to be a legitimate app
 - Actually a bootleg or malicious application
- Google removed 150 apps from the store in 2021
 - Photo editing, camera filters, games, QR code scanners
 - UltimaSMS app tried to subscribe users to \$40/month SMS service
- Infect the application used to build the apps
 - A malicious version of Xcode: XcodeGhost malware
- Always check the source of a download
 - And the legitimacy of the app
 - You are giving this app permissions and control

High network traffic

- Higher than normal network use
 - May indicate installed malware
 - Command & control
 - Proxy network use
- Check built-in data use reports
 - Some of these are quite detailed

- Use a third-party reporting app
 - Use a trusted source

- Run a malware scan
 - Always a good precaution

Data-usage limit notification

- Built-in Android feature
 - Not native in iOS
- Set a warning and limit
 - Get notification when traffic is excessive
- Can indicate a malware infection
 - Drill-down on individual app usage
- Run a malware scan
 - Find the problem app

Sluggish response time

- Running slowly
 - Screen lags, poor input response time
- Restart
 - Clear the slate
- Check for OS and app updates
 - Fix the buggy code
- Close apps that are not in use
 - Less resources to manage
- Factory reset
 - A last chance to resolve the problem

Limited or no Internet connectivity

- Malware doesn't want to be removed
 - It will prevent access to network resources
- Disable and enable Wi-Fi
 - Or enable/disable airplane mode
- Restart the device
 - Clear memory and reload drivers
- Perform a malware scan
 - Find and remove

High number of ads

- Malware wants to show you advertising
 - Revenue for each view and click
- May be difficult to find
 - 2019: Ads Blocker for Android promised to remove ads
 - Actually did the opposite
 - Once installed, wasn't listed in available apps
 - FakeAdsBlock malware strain
- Run anti-malware utility
 - Remove the adware

3.5 - Troubleshooting Mobile Device Security (continued)

Fake security warnings

- The easiest way to get on a phone
 - Have the user install their own malware
- The warnings seem legitimate
 - They are not actual security issues
 - Do not install any software
- Malware can directly access user data
 - Steals credit card details, stored passwords, browsing history, text messages
- Don't click - If you click, run a malware removal tool

Unexpected application behavior

- Apps unexpectedly close - Or have excessive delays
- App doesn't seem to have all of the normal features
 - Or included features are not working
- High battery utilization
 - Only when this application is running
- Update the app - Get the latest version

Leaked personal files

- Unauthorized account access
 - Unauthorized root access
 - Leaked personal files and data
- Determine cause of data breach
 - Perform an app scan, run anti-malware scan
- Factory reset and clean install
 - This is obviously a huge issue
- Check online data sources
 - Apple iCloud/Apple Configurator, Google Workspace, Microsoft OneDrive
 - Change passwords

4.1 - Ticketing Systems

Ticketing systems

- The best way to manage support requests
 - Document, assign, resolve, report
- Usually a responsibility of the help desk
 - Take the calls and triage
- Determine the best next step
 - Assign the ticket and monitor
- There are many different ticketing systems
 - They're all very similar in function

Managing a support ticket

- Information gathering
 - User and device information
 - Problem description
- Applying context
 - Categorization of the problem
 - Assign severity
 - Determine if escalation is required
- Clear and concise communication
 - Problem description, progress notes, resolution details

User information

- You can't address a person's problem unless you know who has the issue
 - Add the name of the person reporting the problem
- Usually integrated into a name service
 - Active Directory or similar
- May be added automatically
 - Many issues arrive from a portal or email gateway
- Always confirm the contact information
 - The database may not be up to date

Device and description

- Device information
 - Laptop, printer, conference room projector, etc.
- Description
 - One of the most important fields in the ticket
 - Make the description clear and concise
- The description determines the next step
 - Call back for more information
 - Associate with another event
 - Assign to another person

Categorization and escalation

- Categories
 - Broad description
 - Change request, hardware request, problem investigation, hardware failure, onboarding/offboarding, etc.
- Severity
 - Often an established set of standards
 - Low, medium, high, critical
- Escalation levels
 - Difficult problems can be handled by a specialist
 - Escalate to a new tier or to a specific group

Resolving the issue

- Progress notes
 - Many people may read and/or work on a single ticket
 - Keep the progress information concise
 - Document any changes or additional information
- Problem resolution
 - Document the solution
 - May be referenced later by others with the same problem
 - A "live" knowledgebase of issues and resolutions

4.1 - Asset Management

Asset management

- A record of every asset
 - Laptops, desktops, servers, routers, switches, cables, fiber modules, tablets, etc.
- Associate a support ticket with a device make and model
 - Can be more detailed than a user's description
- Financial records, audits, depreciation
 - Make/model, configuration, purchase date, location, etc.
- Add an asset tag
 - Barcode, RFID, visible tracking number, organization name

Asset database

- A central asset tracking system
 - Used by different parts of the organization
- Assigned users
 - Associate a person with an asset
 - Useful for tracking a system

Warranty

- A different process if out of warranty

Licensing

- Software costs
- Ongoing renewal deadlines

Procurement life cycle

- The purchasing process
 - Multi-step process for requesting and obtaining goods and services
- Start with a request from the user
 - Usually includes budgeting information and formal approvals
- Negotiate with suppliers
 - Terms and conditions
 - Purchase, invoice, and payment
 - The money part

4.1 - Document Types

Acceptable use policies (AUP)

- What is acceptable use of company assets?
 - Detailed documentation
 - May be documented in the Rules of Behavior
- Covers many topics
 - Internet use, telephones, computers, mobile devices, etc.
- Used by an organization to limit legal liability
 - If someone is dismissed, these are the well-documented reasons why

Incident reports

- Security policy
 - An ongoing challenge
 - Documentation must be available
 - No questions
- Incidents are ongoing
 - Organizations have formal incident plans
- Reports and documentation
 - Details of any security incident
 - Create a reference for future incidents

Standard operating procedures

- Organizations have different business objectives
 - Processes and procedures
- Operational procedures
 - Downtime notifications, facilities issues
- Software installation and upgrades
 - Custom installation of a software package
 - Testing, change control
- Documentation is the key
 - Everyone can review and understand the policies

On-boarding

- Bring a new person into the organization
 - New user setup checklist
- IT agreements need to be signed
 - May be part of the employee handbook or a separate AUP
- Create accounts
 - Associate the user with groups and departments
- Provide required IT hardware
 - Laptops, tablets, etc.
 - Preconfigured and ready to go

4.1 - Document Types (continued)

Off-boarding

- All good things...
 - End-user termination checklist
- This process should be predefined
 - You don't want to decide how to do things at this point
- What happens to the hardware?
- What happens to the data?
- Account information is usually deactivated
 - But not always deleted

Knowledge base and articles

- External sources
 - Manufacturer knowledge base
 - Internet communities
- Internal documentation
 - Institutional knowledge
 - Usually part of help desk software
- Find the solution quickly
 - Searchable archive
 - Automatic searches with helpdesk ticket keywords

4.2 - Change Management

Change management

- How to make a change
 - Upgrade software, patch an application, change firewall configuration, modify switch ports
- One of the most common risks in the enterprise
 - Occurs very frequently
- Often overlooked or ignored
 - Did you feel that bite?
- Have clear policies
 - Frequency, duration, installation process, rollback procedures
- Sometimes extremely difficult to implement
 - It's hard to change corporate culture

Rollback plan

- The change will work perfectly and nothing will ever go bad
 - Of course it will
- You should always have a way to revert your changes
 - Prepare for the worst, hope for the best
- This isn't as easy as it sounds
 - Some changes are difficult to revert
- Always have backups

Sandbox testing

- Isolated testing environment
 - No connection to the real world or production system
 - A technological safe space
- Use before making a change to production
 - Try the upgrade, apply the patch
 - Test and confirm before deployment
- Confirm the rollback plan
 - Move everything back to the original
 - A sandbox can't consider every possibility

Responsible staff members

- A team effort - Many different parts of the organization
- IT team - Implements the change
- Business customer - The user of the technology or software
- Organization sponsor
 - Someone's budget is responsible for the process
 - Or responsible for the profit

Change management process

- A formal process for managing change
 - Avoid downtime, confusion, and mistakes
- Nothing changes without the process
 - Complete the request forms
 - Determine the purpose of the change
 - Identify the scope of the change
 - Schedule a date and time of the change
 - Determine affected systems and the impact
 - Analyze the risk associated with the change
 - Get approval from the change control board
 - Get end-user acceptance after the change is complete

Change request forms

- A formal process always seems to include a bit of paperwork
 - This is usually an online system
- Nothing gets missed
 - Easy to manage
 - Create detailed reports and statistics
- Usually a transparent process
 - Many different groups and people are usually involved

Purpose of the change

- Why are we doing this?
 - There needs to be a compelling reason
- Application upgrades
 - New features
 - Bug fixes
 - Performance enhancements
- Security fixes
 - Monthly patches and vulnerability fixes
- There needs to be a good reason
 - Changes are costly

4.2 - Change Management (continued)

Scope of the change

- Determine the effect of the change
 - May be limited to a single server
 - Or an entire site
- A single change can be far reaching
 - Multiple applications, Internet connectivity, remote site access, external customer access
- How long will this take?
 - Specific date and time for the change
 - May have no impact, could have hours of downtime

Risk analysis

- Determine a risk value - i.e., high, medium, low
- The risks can be minor or far-reaching
 - The “fix” doesn’t actually fix anything
 - The fix breaks something else
 - Operating system failures
 - Data corruption
- What’s the risk with NOT making the change?
 - Security or application vulnerability
 - Unexpected downtime to other services

Change board and approvals

- Go or no go
 - Lots of discussion
- All important parts of the organization are represented
 - Potential changes can affect the entire company
- Some changes have priority
 - The change board makes the schedule
 - Some changes happen quickly, some take time
- This is the last step
 - The actual work comes next

End-user acceptance

- Nothing happens without a sign-off
 - The end users of the application / network
- One of your jobs is to make them successful
 - They ultimately decide if a change is worth it to them
- Ideally, this is a formality
 - Of course, they have been involved throughout this entire process
 - There’s constant communication before and after

4.3 - Managing Backups

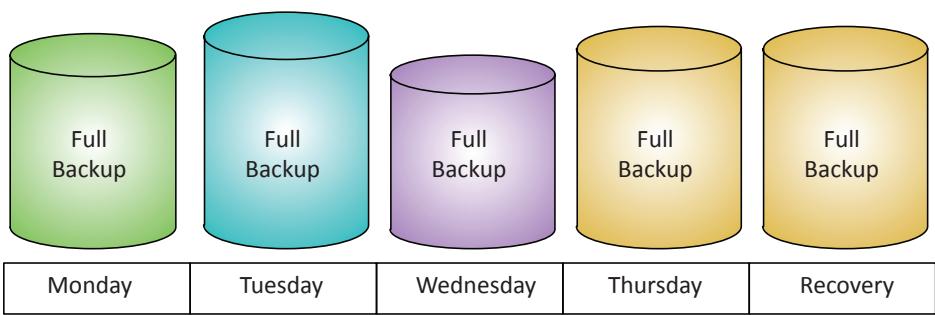
Backups

- Incredibly important
 - Recover important and valuable data
 - Plan for disaster

- Many different implementations
 - Total amount of data
 - Type of backup
 - Backup media
 - Storage location
 - Backup and recovery software
 - Day of the week

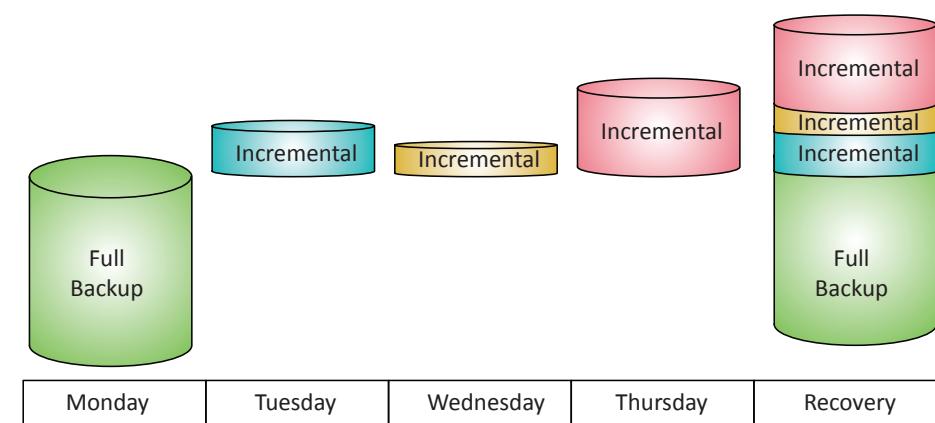
Full Backup

- Backup everything
 - All operating system and user files
- This is usually the longest backup process
 - It’s everything in one backup
- Might be impractical every day
 - Long backup times
 - Lots of storage space



Incremental Backup

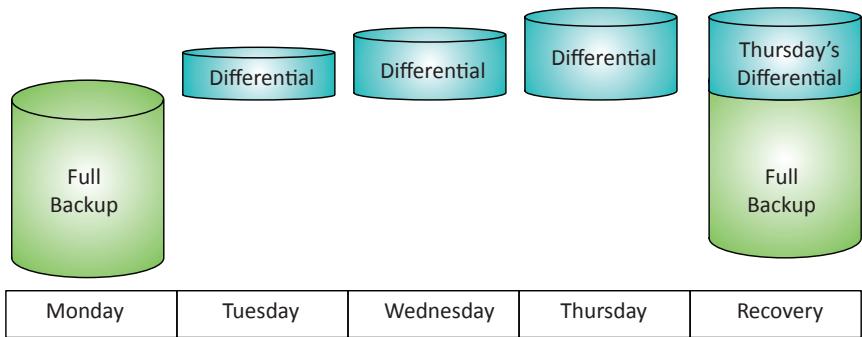
- A full backup is taken first
- Subsequent backups contain data changed since the last full backup and last incremental backup
 - These are usually smaller than the full backup
- A restoration requires the full backup and all of the incremental backups



4.3 - Managing Backups (continued)

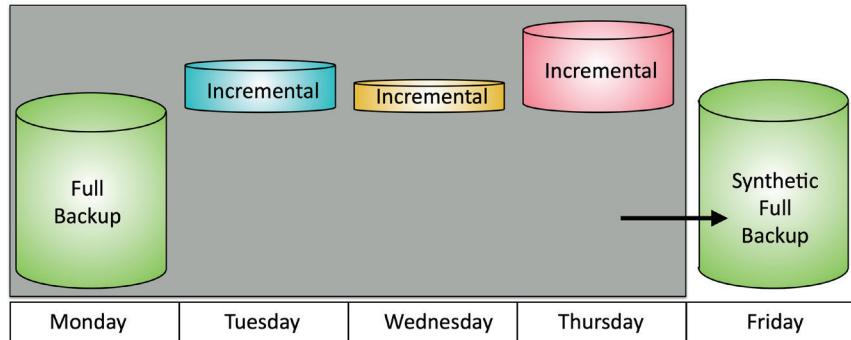
Differential backup

- A full backup is taken first
 - Subsequent backups contain data changed since the last full backup
 - These usually grow larger as data is changed
- A restoration requires the full backup and the last differential backup



Synthetic backup

- Create a full backup
 - Without actually performing a full backup
- Synthetic backup
 - The first full backup copies every file
 - Subsequent full backups are created from previous backups
- Can be faster and less bandwidth intensive
 - The advantage of a full backup
 - The efficiency of an incremental backup



Backup testing

- It's not enough to perform the backup
 - You have to be able to restore
- Disaster recovery testing
 - Simulate a disaster situation
 - Restore from backup
- Confirm the restoration
 - Test the restored application and data
- Perform periodic audits
 - Always have a good backup
 - Weekly, monthly, quarterly checks

On site vs. off site backups

- On site backups
 - No Internet link required
 - Data is immediately available
 - Generally less expensive than off site
- Off site backups
 - Transfer data over Internet or WAN link
 - Data is available after a disaster
 - Restoration can be performed from anywhere
- Organizations often use both
 - More copies of the data
 - More options when restoring

Grandfather-father-son (GFS)

- Three separate backup rotations
 - Monthly, weekly, daily
- Twelve monthly full backups (grandfather)
 - A good choice for offsite storage
- Four (or five) weekly full backups (father)
 - Depends on which day of the month is selected
- Thirty-one daily incremental or differential backups (son)
 - Backup any daily changes

GFS backup schedule

- Choose a rotation
 - Every organization is different
- Grandfather
 - Last day of every month
- Father
 - Every Monday
- Son
 - Monday through Friday

3-2-1 backup rule

- A popular and effective backup strategy
 - For business or home use
- 3 copies of data should always be available
 - One primary copy and two backups
- 2 different types of media should be used
 - Local drive, tape backup, NAS
- 1 copy of the backup should be offsite
 - Offsite storage, cloud backup

4.4 - Managing Electrostatic Discharge

What is electrostatic discharge?

- Static electricity
 - Electricity that doesn't move
- Static electricity isn't harmful to computers
 - It's the discharge that gets them
- ESD can be very damaging to computer components
 - Silicon is very sensitive to high voltages
- Feel static discharge: ~3,500 volts
 - Damage an electronic component: 100 volts or less

Controlling ESD

- Humidity over 60% helps control ESD
 - Won't prevent all possible ESD
 - Keeping an air conditioned room at 60% humidity isn't very practical
- Use your hand to "self-ground"
 - Touch the exposed metal chassis before touching a component
 - You'll want to unplug the power connection
 - Always. Really.
- **Do not connect yourself to the ground of an electrical system!**

Preventing static discharge

- Anti-static strap
 - Connect your wrist to a metal part of the computer
- Anti-static pad
 - A workspace for the computer
- Anti-static mat
 - A mat for standing or sitting
- Anti-static bag
 - Safely move or ship components

Component handling and storage

- Try not to touch components directly
 - Card edges only
- Store in an HVAC regulated environment
 - Between 50 and 80 degrees Fahrenheit or 10 to 27 degrees Celsius
- Avoid high humidity
 - Silica gel packets can help control humidity
- Store in the original padded box
 - Bubble wrap can be a good alternative

4.4 - Safety Procedures

WARNING

- Power is dangerous
- **Remove all power sources before working**
- Don't touch **ANYTHING** if you aren't sure
- Replace entire power supply units
 - Don't repair internal components
- High voltage
 - Power supplies, displays, laser printers

Equipment grounding

- Most computer products connect to ground
 - Divert any electrical faults away from people
- Also applies to equipment racks
 - Large ground wire
- Don't remove the ground connection
 - It's there to protect you
- **Never connect yourself to the ground of an electrical system**
 - This is not a way to prevent ESD

Personal safety

- Lifting technique
 - Lift with your legs, keep your back straight
 - Don't carry overweight items
 - You can get equipment to lift
- Electrical fire safety
 - Don't use water or foam
 - Use carbon dioxide, FM-200, or other dry chemicals
 - Remove the power source
- Safety goggles
 - Useful when working with chemicals
 - Printer repair, toner, batteries
- Air filter mask
 - Dusty computers
 - Printer toner

Local government regulations

- Health and safety laws
 - Vary widely depending on your location
 - Keep the workplace hazard-free
- Building codes
 - Fire prevention, electrical codes
- Environmental regulation
 - High-tech waste disposal

4.5 - Environmental Impacts

Disposal procedures

- Read your Material Safety Data Sheets (MSDS)
 - United States Department of Labor,
 - Occupational Safety and Health Administration (OSHA)
 - <https://www.osha.gov>, Index page
- Provides information for all hazardous chemicals
 - Batteries, display devices / CRTs, chemical solvents and cans, toner and ink cartridges
- Sometimes abbreviated as Safety Data Sheet (SDS)
 - Different names in each country

MSDS info

- Product and company information
- Composition / ingredients
- Hazard information
- First aid measures
- Fire-fighting measures
- Accidental release / leaking
- Handling and Storage
- Much more

Handling toxic waste

- Batteries
 - Uninterruptible Power Supplies
 - Dispose at your local hazardous waste facility
- Toner
 - Recycle and reuse
 - Many printer manufacturers provide a return box
 - Some office supply companies will provide a discount for each cartridge
- Other devices and assets
 - Refer to the MSDS
 - Don't throw out without clear directions

Room control

- Temperature
 - Devices need constant cooling
 - So do humans

- Humidity level
 - High humidity promotes condensation
 - Low humidity promotes static discharges
 - 50% is a good number

Proper ventilation

- Computers generate heat
- Don't put everything in a closet

Battery backup

- Uninterruptible Power Supply
 - Backup power
 - Power failures, under-voltage events, surges
- UPS types
 - Standby UPS
 - Line-interactive UPS
 - On-line UPS
- Features
 - Auto shutdown, battery capacity, outlets, phone line suppression

Surge suppressor

- Not all power is "clean"
 - Self-inflicted power spikes and noise
 - Storms, power grid changes
- Spikes are diverted to ground
- Noise filters remove line noise
 - Decibel (Db) levels at a specified frequency
 - Higher Db is better

Surge suppressor specs

- Joule ratings
 - Surge absorption
 - 200=good, 400=better
 - Look for over 600 joules of protection
- Surge amp ratings
 - Higher is better
- UL 1449 voltage let-through ratings
 - Ratings at 500, 400, and 330 volts
 - Lower is better

4.6 - Privacy, Licensing, and Policies

Incident response: Chain of custody

- Control evidence - Maintain integrity
- Everyone who contacts the evidence
 - Avoid tampering, use hashes
- Label and catalog everything
 - Seal, store, and protect - Use digital signatures

Incident response: First response

- Identify the issue - Logs, in person, monitoring data
- Report to proper channels
 - Don't delay
 - May include internal management and law enforcement
- Collect and protect information relating to an event
 - Many different data sources and protection mechanisms

Incident response: Copy of drive

- Copy the contents of a disk
 - Bit-for-bit, byte-for-byte
- Remove the physical drive
 - Use a hardware write-blocker
 - Preserve the data
- Software imaging tools
 - Use a bootable device
- Use hashes for data integrity
 - Drive image is hashed to ensure that data has not been modified

4.6 - Privacy, Licensing, and Policies (continued)

Incident response: Documentation

- Document the findings
 - For Internal use, legal proceedings, etc.
- Summary information
 - Overview of the security event
- Detailed explanation of data acquisition
 - Step-by-step method of the process
- The findings - An analysis of the data
- Conclusion - Professional results, given the analysis

Software licenses

- Most software includes a license
 - Terms and conditions
 - Overall use, number of copies, and backup options
- Valid licenses
 - Per-seat or concurrent
- Non-expired licenses
 - Ongoing Subscriptions
 - Annual, three-year, etc.
 - Use the software until the expiration date

Licenses

- Personal license
 - Designed for the home user
 - Usually associated with a single device
 - Or small group of devices owned by the same person
 - Perpetual (one time) purchase
- Corporate use license
 - Per-seat purchase / Site license
 - The software may be installed everywhere
 - Annual renewals

Open source license

- Free and Open Source (FOSS)
 - Source code is freely available
 - End user can compile their own executable
- Closed source / Commercial
 - Source code is private
 - End user gets compiled executable
- End User Licensing Agreement (EULA)
 - Determines how the software can be used

Regulating credit card data

- Payment Card Industry
 - Data Security Standard (PCI DSS)
 - A standard for protecting credit cards
- Six control objectives
 - Build and Maintain a Secure Network and Systems
 - Protect Cardholder Data
 - Maintain a Vulnerability Management Program
 - Implement Strong Access Control Measures
 - Regularly Monitor and Test Networks
 - Maintain an Information Security Policy

Personal government-issued information

- Used for government services and documentation
 - Social security number, driver license
- There may be restrictions on collecting or storing government information - Check your local regulations
- U.S. Office of Personnel Management (OPM)
 - Compromised personal identifiable information
 - Personnel file information; name, SSN, date of birth, job assignments, etc.
- July 2015 - Affected ~21.5 million people

PII - Personally identifiable information

- Any data that can identify an individual
 - Part of your privacy policy - How will you handle PII?
- Not everyone realizes the importance of this data
 - It becomes a “normal” part of the day
 - It can be easy to forget its importance
- Attackers use PII to gain access or impersonate
 - Bank account information
 - Answer badly-written password-reset questions

GDPR - General Data Protection Regulation

- European Union regulation
 - Data protection and privacy for individuals in the EU
 - Name, address, photo, email address, bank details, posts on social networking websites, medical information, a computer’s IP address, etc.
- Controls export of personal data
 - Users can decide where their data goes
- Gives individuals control of their personal data
 - A right to be forgotten, right of erasure
- Site privacy policy
 - Details all of the privacy rights for a user

PHI - Protected Health Information

- Health information associated with an individual
 - Health status, health care records, payments for health care, and much more
- Data between providers
 - Must maintain similar security requirements
- HIPAA regulations
 - Health Insurance Portability and Accountability Act of 1996

Data retention requirements

- Keep files that change frequently for version control
 - Files change often - Keep at least a week, perhaps more
- Recover from virus infection
 - Infection may not be identified immediately
 - May need to retain 30 days of backups
- Often legal requirements for data retention
 - Email storage may be required over years
 - Some industries must legally store certain data types
 - Different data types have different storage requirements
 - Corporate tax information, customer PII, tape backups, etc.

4.7 - Communication

Communication skills

- One of the most useful skills for the troubleshooter
- One of the most difficult skills to master
- A skilled communicator is incredibly marketable

Avoid jargon

- Abbreviations and TLAs
 - Three Letter Acronyms
- Avoid acronyms and slang
 - Be the translator
- Communicate in terms that everyone can understand
 - Normal conversation puts everyone at ease
 - Decisions are based on what you say
- These are the easiest problems to avoid

Maintain a positive attitude

- Positive tone of voice
 - Partner with your customer
 - Project confidence
- Problems can't always be fixed
 - Do your best
 - Provide helpful options
- Your attitude has a direct impact on the overall customer experience

Avoid interrupting

- But I know the answer!
- Why do we interrupt?
 - We want to solve problems quickly
 - We want to show how smart we are

- Actively listen, take notes
 - Build a relationship with the customer
 - They'll need help again someday
 - Don't miss a key piece of information
 - Especially useful on the phone
- This skill takes time to perfect
 - The better you are, the more time you'll save later

Clarify customer statements

- Ask pertinent questions
 - Drill-down into the details
 - Avoid an argument
 - Avoid being judgmental
- Repeat your understanding of the problem back to the customer
 - Did I understand you correctly?
- Keep an open mind
 - Ask clarifying questions, even if the issue seems obvious
 - Never make assumptions

Setting expectations

- Offer different options
 - Repair or replace
- Document everything
 - No room for questions
- Keep everyone informed
 - Even if the status is unchanged
- Follow up afterwards
 - Verify satisfaction

4.7 - Professionalism

Professional appearance

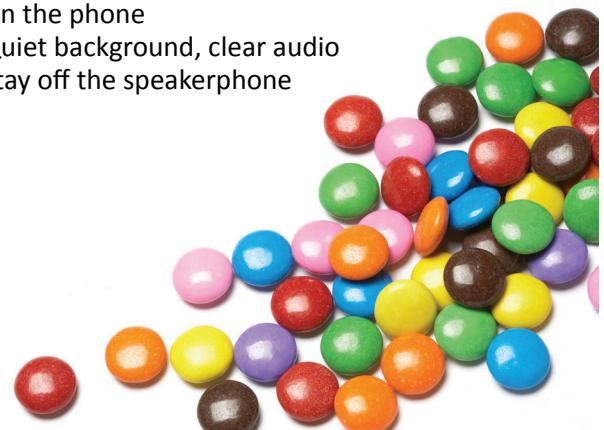
- Match the attire of the current environment
 - Everyone should feel comfortable about their dress
- Formal
 - Some organizations have specific requirements
- Business casual
 - A more relaxed style
- Find the right balance
 - Follow the organization's lead

Avoid being judgmental

- Cultural sensitivity
 - Use appropriate professional titles
- You're the teacher
 - Not the warden
 - Leave insults on the playground
- Make people smarter
 - They'll be better technologists
- You're going to make some BIG mistakes
 - Remember them.

Be on time and avoid distractions

- Don't allow interruptions
 - No personal calls, no texting, no Twitter
 - Don't talk to co-workers
- Apologize for delays and unintended distractions
 - Create an environment for conversation
 - In person
- Open and inviting
 - Candy bowl can be magical
 - On the phone
 - Quiet background, clear audio
 - Stay off the speakerphone



4.7 - Professionalism (continued)

Difficult situations

- Technical problems can be stressful
- Don't argue or be defensive
 - Don't dismiss
 - Don't contradict
- Diffuse a difficult situation with listening and questions
 - Relationship-building
- Communicate
 - Even if there's no update
- Never take the situation to social media

Maintain confidentiality

- Privacy concerns
 - Sensitive information
 - Both professional and private
 - On the computer, desktop, or printer
- Professional responsibilities
 - IT professionals have access to a lot of corporate data
- Personal respect
 - Treat people as you would want to be treated

4.8 - Scripting Languages

Scripting languages

- Automate with the right tools
 - The script should match the requirement
- May be specific to a task or operating system
 - Your choices may already be limited
- You will probably learn more than one of these
 - An important skill for any technician

Batch files

- .bat file extension
 - Scripting for Windows at the command line
 - Legacy goes back to DOS and OS/2

Windows PowerShell

- Command line for system administrators
 - .ps1 file extension
 - Included with Windows 10 and 11
- Extend command-line functions
 - Uses cmdlets (command-lets)
 - PowerShell scripts and functions
 - Standalone executables
- Automate and integrate
 - System administration
 - Active Domain administration

Microsoft Visual Basic Scripting Edition

- VBScript
 - .vbs file extension
- General purpose scripting in Windows
 - Back-end web server scripting
 - Scripting on the Windows desktop
 - Scripting inside of
 - Microsoft Office applications

Shell script

- Scripting the Unix/Linux shell
 - Automate and extend the command line
- Starts with a shebang or hash-bang #!
 - Often has a .sh file extension

JavaScript

- Scripting inside of your browser
 - .js file extension
- Adds interactivity to HTML and CSS
 - Used on almost every web site
- JavaScript is not Java
 - Different developers and origins
 - Very different use and implementation

Python

- General-purpose scripting language
 - .py file extension
- Popular in many technologies
 - Broad appeal and support

```
#!/bin/sh
// Add the first input string
INPUT_STRING=hello
// Keep looping if the string isn't equal to bye
while [ "$INPUT_STRING" != "bye" ]
do
    echo "Please type something in (bye to quit)"
    read INPUT_STRING
    echo "You typed: $INPUT_STRING"
done
```

4.8 - Scripting Use Cases

Basic automation

- Automate tasks
 - You don't have to be there
 - Solve problems in your sleep
 - Monitor and resolve problems before they happen
- The need for speed
 - The script is as fast as the computer
 - No typing or delays
 - No human error
- Automate mundane tasks
 - You can do something more creative

Restarting machines

- Turning it off and back on again
 - An important task
- Application updates
 - Some apps require a system restart
- Security patches
 - Deploy overnight and reboot the system
- Troubleshooting
 - The once-a-day restart
 - You may not have physical access

Remapping network drives

- Shared network drives
 - The link between the user and their data
- A common task during startup
 - Login scripts provide the connection
- Automate software changes
 - Map a drive to the repository
- Add or move user data
 - Automate the process

Application installations

- Install applications automatically
 - Don't walk a flash drive to every computer
 - Many applications have an automated installation process
 - Scripting can turn this into a hands-off process
- On-demand or automatic installation scripts
 - Map the application installation drive
 - Install the application without user prompts
 - Disconnect the drive
 - Restart the system

Automated backups

- Usually performed at night or during off-hours
 - Get a copy of all important data
- Time consuming
 - File systems, network connections
- Script an automated backup process
 - Works while you sleep
 - Don't have to think about it

Information gathering

- Get specific information from a remote device
 - Monitoring and reporting
- Performance monitoring
 - Confirm proper operation of a device
- Inventory management
 - Check the hardware or software configuration
- Security and vulnerability checks
 - Check for certain application or library versions
 - Plan for the latest patches

Initiating updates

- Nothing ever stays the same
 - Constant changes and updates
- Operating systems
 - New features
 - Security patches
- Device drivers
 - Bug fixes
 - New hardware or OS support
- Applications
 - New version rollouts

Other scripting considerations

- Unintentionally introducing malware
 - Make sure you know what you're installing
- Inadvertently changing system settings
 - Test all updates
 - Track the file and registry changes
- Browser or system crashes
 - Mishandling of resources
 - A single character in a script can have unintended consequences
 - Always have a backup
 - Always test before deployment



4.9 - Remote Access

Remote desktop connections

- Share a desktop from a remote location
 - It's like you're right there
- RDP (Microsoft Remote Desktop Protocol)
 - Clients for Mac OS, Linux, and others as well
- VNC (Virtual Network Computing)
 - Remote Frame Buffer (RFB) protocol
 - Clients for many operating systems
 - Many are open source
- Commonly used for technical support
 - And for scammers

Remote desktop security

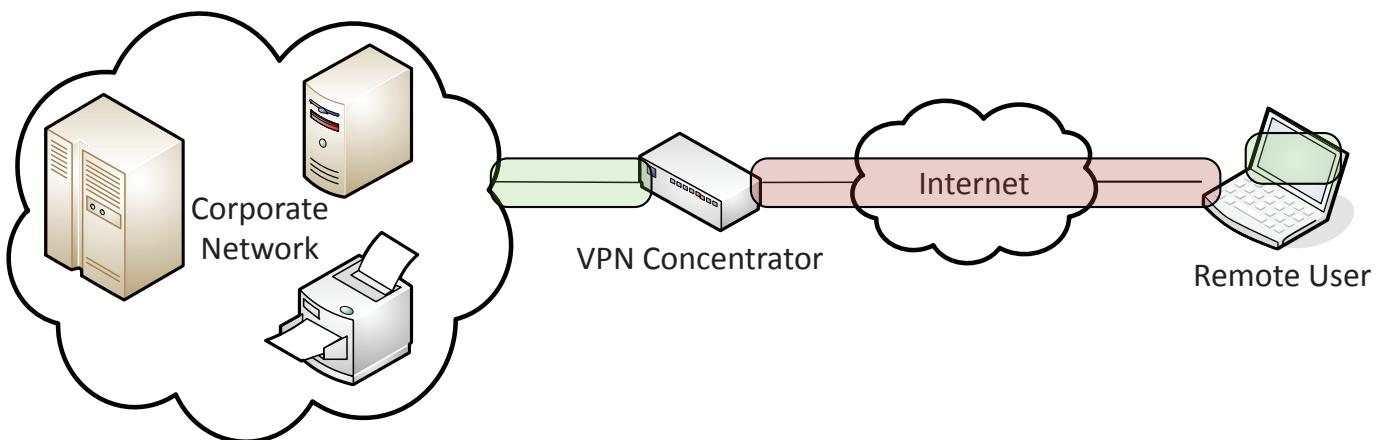
- Microsoft Remote Desktop
 - An open port of tcp/3389 is a big tell
 - Brute force attack is common
- Third-party remote desktops
 - Often secured with just a username and password
 - There's a LOT of username/password re-use
- Once you're in, you're in
 - The desktop is all yours
 - Easy to jump to other systems
 - Obtain personal information, bank details
 - Make purchases from the user's browser

VPNs

- Virtual Private Networks
 - Encrypted (private) data traversing a public network
- Concentrator
 - Encryption/decryption access device
 - Often integrated into a firewall
- Many deployment options
 - Specialized cryptographic hardware
 - Software-based options available
- Used with client software
 - Sometimes built into the OS

Client-to-site VPN

- On-demand access from a remote device
 - Software connects to a VPN concentrator
- Some software can be configured as always-on



VPN security

- VPN data on the network is very secure
 - The best encryption technologies
- Authentication is critical
 - An attacker with the right credentials can gain access
- Almost always includes multi-factor authentication (MFA)
 - Require more than just a username and password

SSH (Secure Shell)

- Encrypted console communication - tcp/22
- Looks and acts the same as Telnet - tcp/23

SSH security

- The network traffic is encrypted
 - Nothing to see in the packets
- Authentication is a concern
 - SSH supports public/private key pair authentication
- Certain accounts should be disabled in SSH
 - For example, root
 - Consider removing all password-based authentication
- Limit access to SSH by IP address
 - Configure a local firewall or network filter

RMM

- Managed Service Providers (MSP)
 - Many customers and systems to monitor
 - Many different service levels
- Remote Monitoring and Management (RMM)
 - Manage a system from a remote location
- Many features
 - Patch operating systems
 - Remote login
 - Anomaly monitoring
 - Hardware/software inventory

4.9 - Remote Access (continued)

RMM security

- A popular attack point
- The RMM has a great deal of information and control
- Access should be limited
 - Don't allow everyone to connect to the RMM service
- Auditing is important
 - Know who's connecting to which devices and what they're doing

Microsoft Remote Assistance (MSRA)

- Get access to a remote user's desktop
 - No firewall configurations or port forwarding required
- User makes a request
 - Sends an invitation with the details
- Technician connects
 - Uses the password in the request
- Replaced by Quick Assist in Windows 10 and Windows 11
 - The latest version of MSRA

MSRA/Quick Assist security

- No ongoing Remote Desktop service required
 - Avoids unintended access
 - No port forwarding
- Email with invitation details is always a concern
 - Consider using voice communication
- Perhaps a bit too easy to use
 - Social engineering can be an issue

Third-party tools

- Screen-sharing
 - See and control a remote device
 - GoToMyPC, TeamViewer
- Video-conferencing
 - Multi-user meetings with video and audio
 - Zoom, WebEx
- File transfer
 - Store and share documents in the cloud
 - Dropbox, Box.com, Google Drive
- Desktop management
 - Manage end-user devices and operating systems
 - Citrix Endpoint Management, ManageEngine Desktop Central

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