The macOS Boot Process

Objectives:

At the end of this episode, I will be able to:

1. Describe the five phases of the macOS boot process.
2. Select the appropriate troubleshooting method based on the phase where a system stops responding properly.

> Additional resources used during the episode can be obtained using the download link on the overview episode.

- macOS Boot Phases
    1. Firmware
    2. Booter
        - File Vault
    3. Kernel
    4. System *launchd*
    5. Login
- STEP 1: **Firmware** (BootROM)
    - Stored in hardware
    - Power On Self Test (POST)
    - Extensible Firmware Interface (EFI)
    - Mac chime plays
    - Power light flashes
    - Appears as an Apple logo on the screen
    - If everything passes, moves on to boot selection
    - Allows the user to select which drive to boot
    - Uses *Startup Disk* system preference by default
    - If FileVault is enabled, it boots from Recovery to unlock the disk
    - Executes the Booter
    - Troubleshooting
        - Audible beep codes
        - Power light flashing patterns
        - Apple Hardware Diagnostics
            - Hold **D** while booting to access diagnostics
        - Generally hardware issues requiring maintenance
        - If no booter is found, a folder with a "?" is displayed
        - Startup disk could be incorrectly set
            - `System Preferences -> Startup Disk`
            - Can be set from Recovery also
        - Boot to recovery and use Disk Utility to repair the disk
- STEP 2: **Booter**
    - `/System/Library/CoreServices/boot.efi`
    - Loads the kernel and initial extensions
    - Basic extensions are cached by default
    - Booting in safe mode flushes the cache
    - Appears as a spinning wheel on the screen
    - When booting from Internet Recovery it displays as a globe
    - Turns over control to Kernel

    - Troubleshooting
        - Attempt Safe Boot to flush the KEXT cache
- STEP 3: **Kernel**
    - Loads additional extensions as necessary
    - Starts underlying core (BSD)
    - Executes *launchd*
    - Troubleshooting
        - Attempt Safe Boot to flush the KEXT cache
        - Boot in verbose mode to see where the boot process halts
        - Use target mode to remove newly added extensions
- STEP 4: **System** *launchd*
    - `/sbin/launchd`
    - Process ID #1
    - Executes remaining system processes
        - `/System/Library/LaunchDaemons`
        - `/Library/LaunchDaemons`
        - `/System/Library/StartupItems`
        - `/Library/StartupItems`
    - Displays login window
    - *loginwindow* process is owned by root at this stage
    - Troubleshooting
        - Boot into Safe Mode
        - Clear out caches in /Library/Caches
        - Clear out preferences
          - `/Library/Preferences`
          - `/Library/Preferences/SystemConfiguration`
- STEP 5: **Login**
    - *loginwindow* process prompts for credentials
    - User provides credentials
    - *loginwindow* transitions to the user's credentials
    - *launchd* is executed on behalf of the user
    - Builds user interface
    - Executes launch agents
        - `/System/Library/LaunchAgents`
        - `/Library/LaunchAgents`
        - `/Users/username/Library/LaunchAgents`
    - Finally, executes *Login Items*
        - `System Preferences -> Users & Groups -> Select User -> Login Items`
    - Troubleshooting
        - Perform *Safe Mode* login
            - Hold **Shift** while logging in
        - Check/Remove Launch Agents and login items
            - `/Users/username/Library/Preferences/loginwindow.plist`