Intro Embedded Operating Systems (Part 2)

1. Design Patterns
   - Modularity
     - Pro
       - Facilitates re-usable code
       - Allows for experimenting with new code
       - Flexibility for application programmers
     - Con
       - Can be complex to know what code is actually being used
       - Module interfaces can suppress useful hardware features
   - Virtualized and Non-Virtualized Resources
     - Pro
       - Direct hardware control reduces uncertainty
       - Flexibility for programmers
     - Con
       - Adds complexity: which to use?
       - Choosing wrong can lead to strange bugs
       - Same or different interfaces?
   - Long Running Operations
     - Pro
       - Some operations are computationally complex
       - Useful to help programmers manage these
     - Con
       - How long is "long"?
       - Overall system timing
   - Event-driven Versus Threading
     - Events
       - Better models hardware
     - Threads
       - Easier to reason about for programmers
     - Difficult to blend them
     - Many ramifications for interface design
2. Debugging
   - Challenges
     - No display
     - Timing overhead
     - Low-level development
     - Toolchain complexity
   - Simple Approaches
     - printf()
     - Turning on/off LED

- Toolchain Help
    - GDB & JTAG
- Hardware Approaches
    - Aveksha, Uses JTAG port: https://engineering.purdue.edu/dcsl/publications/papers/2011/aveksha-sensys2011.pdf
- OS Help
    - Crash logs of MCU state
    - Offline analysis tools
    - Debugging state on demand (e.g. button press)
- Interactive shell
    - Provide inspection capabilities while a device is running
- Profiling
    - Energy use estimations based on activity

3. Services and Shared Libraries
    - Code update
        - Small bootloader manages booting into the correct image
        - "Golden master" for backups
    - Wireless MAC layers
        - Provide low power send and receive
        - Major challenge is to ensure compatibility between devices
    - Wireless routing
        - Multi-hop
        - Star
        - Flooding
    - Filesystem
        - Nonvolatile storage
        - Variety of abstractions
            - Files
            - DB
            - Append only log
            - Key-value
    - Time synchronization

4. Leveraging Available Hardware
    - DMA
        - Reduce CPU time to transfer buffers between components
    - MPU
        - Provide hardware protection for certain memory regions
    - Watchdog
        - Reset MCU if chip in a bad state