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/avekshasensys2011.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