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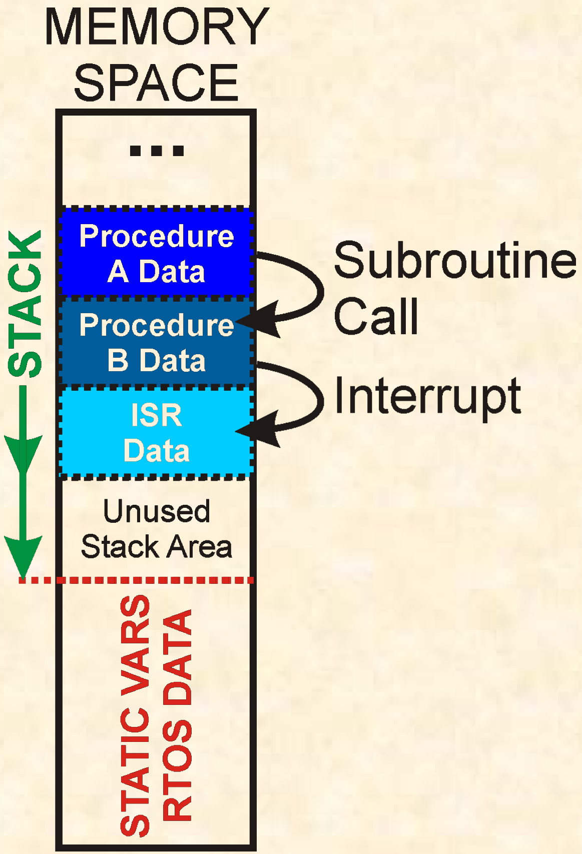
Electrical & Computer ENGINEERING

Stack Overflow

https://goo.gl/YyBvQg

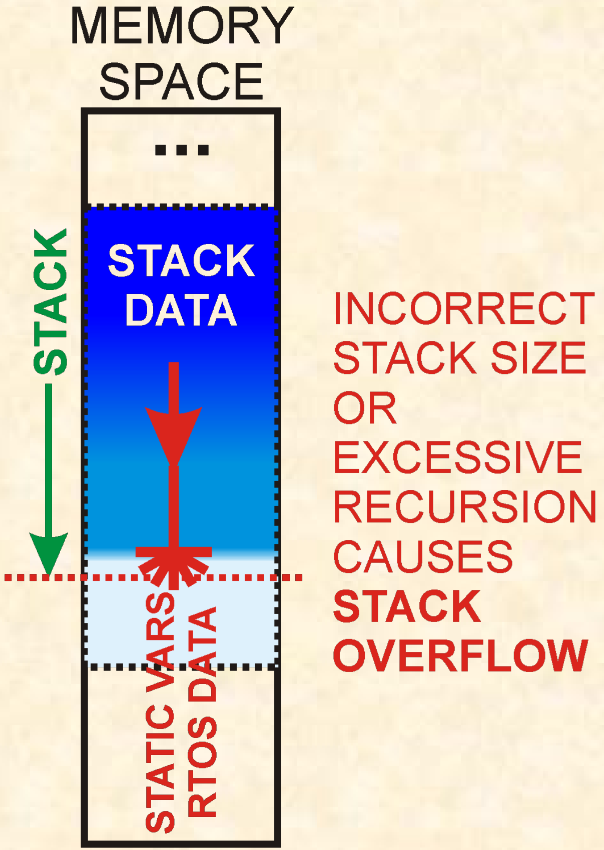
STACK OVERFLOW

- Anti-Patterns:
  - No worst case stack size analysis
  - Use of recursion
  - No memory protection for stack
- The stack stores data for subroutines
  - Automatic (non-static) variables
    - Also, subroutine & interrupt register saves
  - Calls put data on stack
    - Interrupts & RTOS calls put data on stack too
  - But what if the stack overflows?
    - Need to handle worst-case stack size



Stack Overflow Corrupts Memory

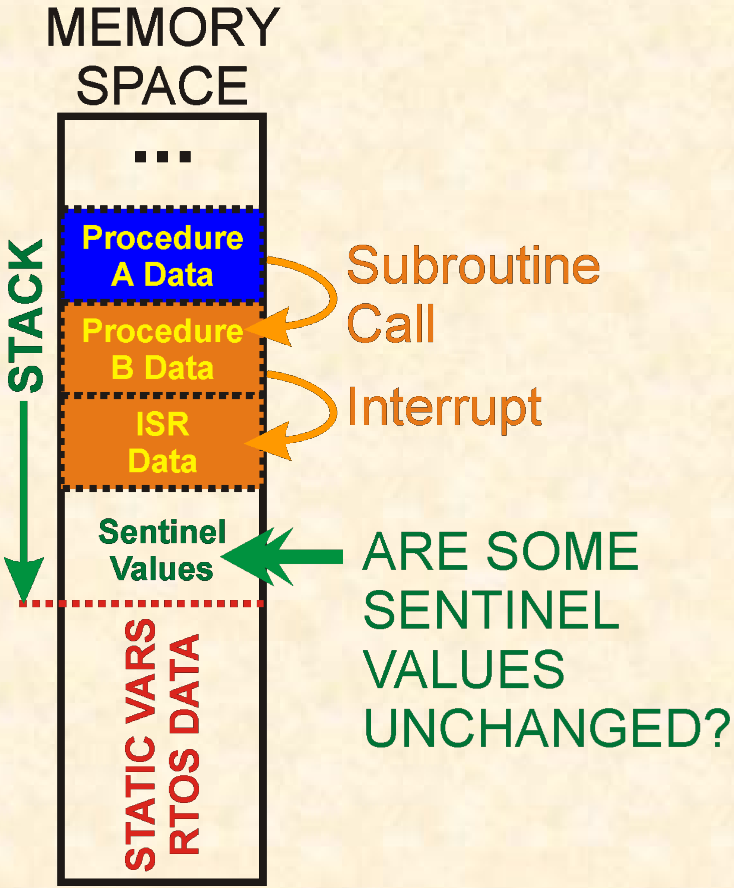
- If stack gets too big, it stomps on other memory: Stack Overflow
  - Can corrupt static variables and globals
  - Can corrupt RTOS data structures
    - System-wide task information corruption
- Can cause system crashes
  - Worse, can cause subtle system corruption
    - Task death, task period alteration
    - Security exploits via access to OS data



INCORRECT STACK SIZE OR EXCESSIVE RECURSION CAUSES **STACK OVERFLOW**

Prevent & Detect Stack Overflow

- Preferred approaches:
  - Static analysis of stack depth
    - Tool can figure out maximum depth
    - MMU hardware memory protection
- At Run-Time: Stack Sentinels
  - At system start, fill stack with a sentinel value (e.g., 0xAA44CC33)
  - Program execution writes to stack
    - Sentinels permanently overwritten
  - Periodically check to see how many sentinels are left (stack size margin)



Best Practices For Avoiding Stack Overflow

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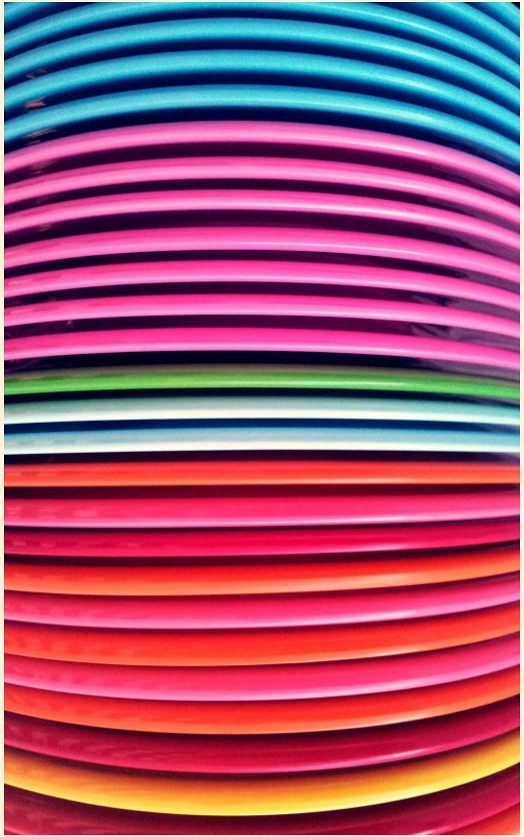
- Determine worst case stack depth
  - Sentinels are a good start
    - But you might not see true worst-case depth in testing
    - Worst-case stack depth for deeply nested calls + safety margin
  - Use a tool if you have one, or use a disassembler
    - PLUS: Biggest interrupt service routine stack use
    - PLUS: RTOS call use of stack (can be significant)
- Protect stack at run time
  - Use MMU hardware protection if you have it
  - Use sentinels & periodic check to detect stack overflow
    - Also helps with experimental confirmation of depth analysis
- Avoid recursion – makes worst case problematic
  - Be mindful that big data structures can make stack big



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https://xkcd.com/303/