Some Ideas for Stack Computer Design

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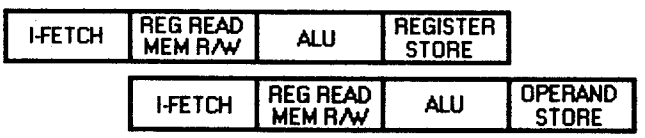
OVERVIEW

- **How to pipeline a stack computer**
  - ° RISC = Pipelined
  - ° Resurrection of the skip Instruction
- **Making the most of on-chip memory**
  - ° Memory hierarchies for real-time control
- **Stack-based execution for C**
  - ° Program size can be smaller

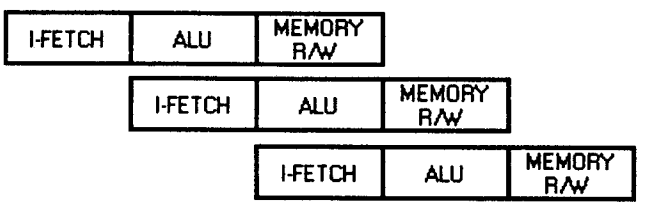
HOW TO PIPELINE A STACK COMPUTER -- 1

- **Traditional pipeline**
  - ° Assumes access into register file takes time
  - ° Assumes writeback of result into register file takes time
  - ° Keeping branch delay to one slot is challenging
  - ° Has a load delay slot



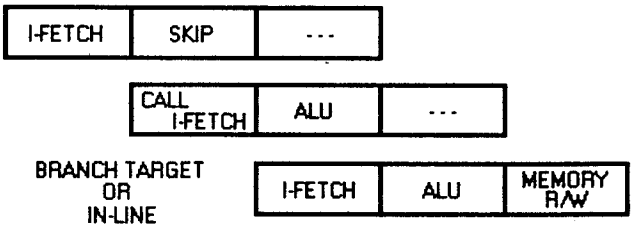
HOW TO PIPELINE A STACK COMPUTER -- 2

- **Proposed stack pipeline**
  - ° Access to TOS is free for read and writes
  - ° Latency of operand access stage avoided
  - ° Can support auto-increment/decrement accesses
  - ° Can exploit two paths to memory
  - ° Has a load delay slot



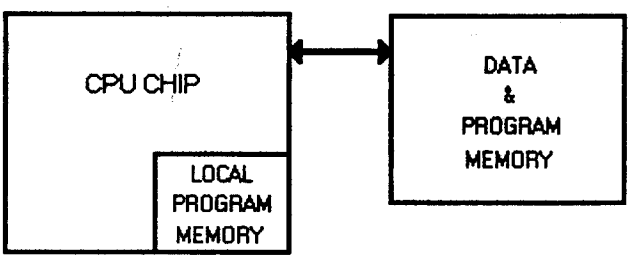
SKIP INSTRUCTIONS

- **Branch delays are a problem with pipelines**
  - ° Delay slot on subroutine call questionable for Forth
  - ° Filling branch delay slot difficult on stack machines
- **Using skip instructions can solve the problem**
  - ° Only branch type is CALL (1 bit controls address generation)
  - ° Conditional branch is a skip over a call instruction -- buries branch delay slot into the skipped instruction



MAKING THE MOST OF ON-CHIP MEMORY (for real-time control)

- **Caches inappropriate for many real-time systems**
- **On-chip memory much faster than off-chip accesses**
- **Use large on-chip memory for user-controlled storage**
  - ° Microcode ROM/RAM
  - ° Instruction ROM/RAM
  - ° Small data memory
- **Idea: on-chip program memory to provide split-bus access without extra pins**



STACK-BASED EXECUTION FOR C

- **IF:**
  - ° Memory space is limited
  - ° Program size matters more than ultimate speed
- **THEN:**
  - ° Stack-relative addressing increases opportunities for code-sharing
  - ° Assignment of registers makes two identical code sequences compile to different binary images
  - ° A compiler can compress code using stack-based execution and shared code sequences
- **A C compiler can produce passable Forth-style code**
  - ° Depends on locality of reference to C variables & coding style