PROGRAMMING CONCEPTS AND EMBEDDED PROGRAMMING IN C, C++ and JAVA:

Lesson-4: Data Structures: Stacks

STACK

- A structure with a series of data elements with last sent element waiting for a delete operation.

- Used when an element is not to be accessible by the index with pointer directly, as in an array, but only through LIFO (Last in first out) mode through a stack-top pointer.

Push and Pop onto a STACK

- A data-element can be pushed (inserted) only at the from front (stack-head) in the series of elements waiting for an operation and popped (deleted) also from front (stack-head).

- There is only one pointer, for *deleting* after the read operation from stack-top and other for *inserting* at stack-top. Pointer if increments after a push operation then it decrements after a POP operation.

Standard Functions used in a Stack

1. SELInsert – Pushes a data-element into the stack as pointed by item and increment the item pointer address
2. SELReturn – Pop an element from the stack as pointed by *item and the element deletes from stack on decrement in the item pointer address

3. isSNotEmpty– Return true or false after the check for the stack not empty.

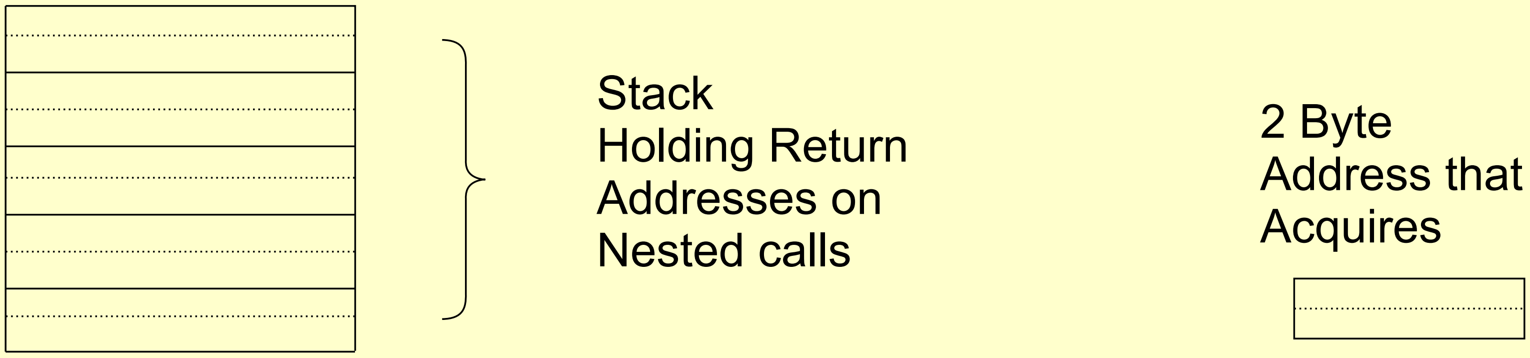
Stack Pointer

- SP (stack pointer): SP is pointer to a memory block dedicated to saving the context on context switch to another ISR or routine.

Stack Pointer

- Each processor has at least one stack pointer so that the instruction stack can be pointed and calling of the routines can be facilitated
- In some processors, RIP (return instruction pointer)— a register for saving the return address of the program counter when a routine calls another routine or ISR.
- RIP is also called link register (LR) in ARM processor

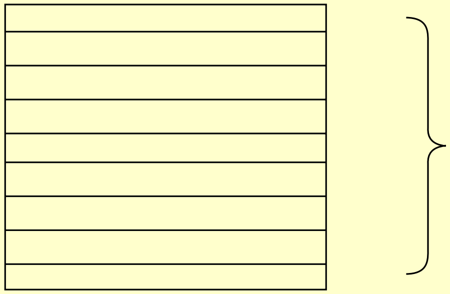
A stack due to nested function calls and pushing of program counters



Stack
Holding Return
Addresses on
Nested calls

2 Byte
Address that PC
Acquires

A program-thread stack having pointers and parameters pushed on to stack before the context switch



Stack
Holding Data
Retrievable in
LIFO Mode

A Memory Block
with Start and End

FP (data frame pointer)

- A pointer to a memory block dedicated to saving the data and local variable values
- FIP in certain processors

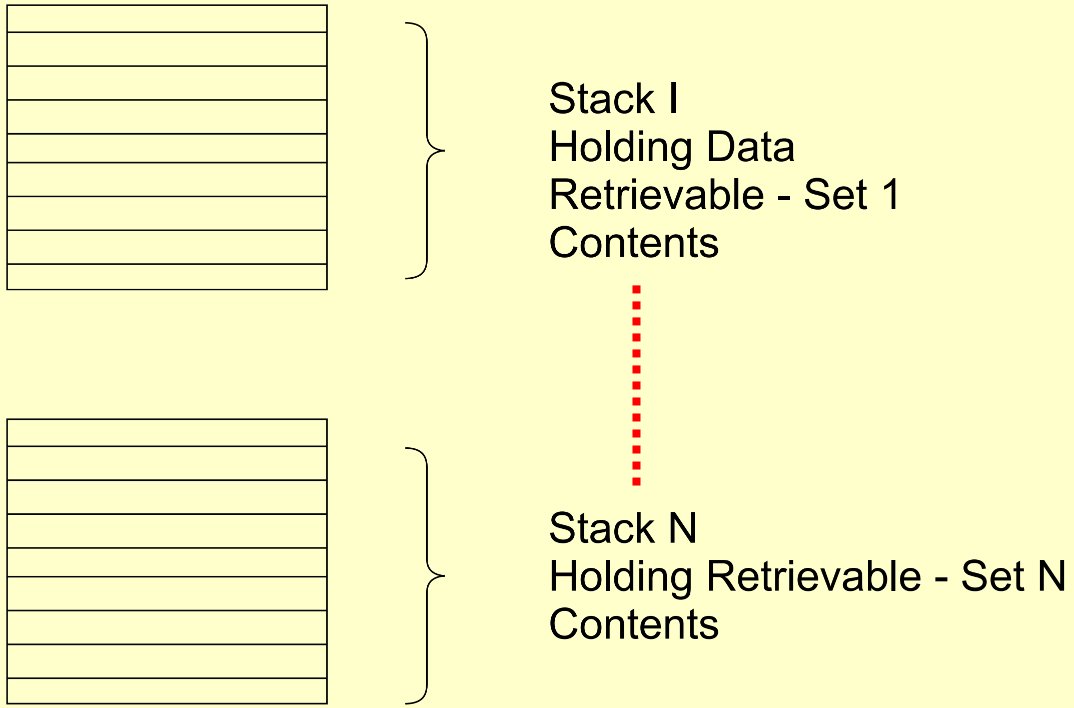
PFP (previous program frame pointer)

- A pointer to a memory block dedicated to saved the program data frame, in certain processors

Multiple stack frames for Multiple Threads

- OS defines processes or threads such that each process or thread is allocated one one task stack pointer or thread stack pointer

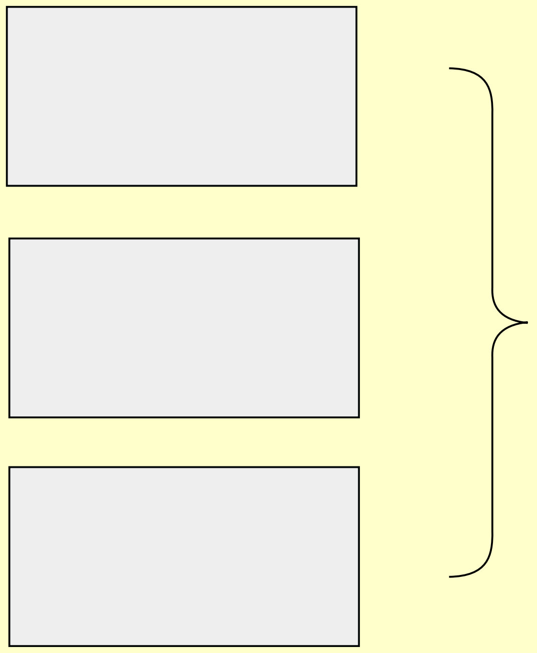
Multiple stacks of multiple tasks or threads pushed on the stacks with each having separate pointer



Stack I
Holding Data
Retrievable - Set 1
Contents

Stack N
Holding Retrievable - Set N
Contents

Multiple stacks of CPU registers for the multiple tasks which are pushed on to stack before context switches



Saved Contexts of the Tasks as the Stacks

Motorola MC68010 processor

- USP (user Stack Pointer) and SSP (Supervisory Stack Pointer).
- Program runs in two modes: user mode and supervisory mode.
- In supervisory mode the operating system functions execute.
- Switch from user mode to supervisory mode after every tick of the system clock

MC68040

- USP (User Stack Pointer), SSP (Supervisory Stack Pointer), (MSP) Memory Stack frames pointers, and Instruction Stack Pointer (ISP).

Application Examples

1. Ease in saving of the data-elements in case of interrupts or function calls
2. Nested set of operations like function calls
3. A program thread, which blocks pushes on the stack and then the last pushed thread pops first.

Summary

We learnt

- Using of *stack* is very helpful for saving the data in case of interrupts or function calls.
- Stack related functions are 'constructing' a stack, 'pushing' an element into it, popping an element from it and 'destruction' of stack.

End of Lesson 4 of Chapter 5