POINTERS & MODULARITY

17TH LECTURE SUPPLEMENT

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Pointer

- Pointer Operators
  - **&**: 'Address of' Operator
    - Get the address of the variable
  - *: 'Indirect' Operator
    - Get the value at the address

```
p=&var;
*p = 3;
```

- Result

Pointer Example

```
int i, j, *p1, *p2;
i = 7;
p1 = &i;
printf("%d \ n",*p1);
printf("%d \ n",*&i);
j = 10;
p2 = &j;
*p1 = 3;
*p2 = *p1;
printf("%d, %d \ n", i, j);
printf("%x, %x \ n", &i, p1);
```

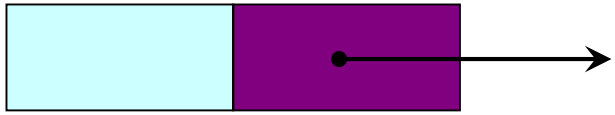
- Result

```
7
7
3, 3
bffffc98, bffffc98
```

Self-Referential Structure

- Structure w/ a Pointer Pointing to a Structure of the Same Type

```
struct node {
    int data;
    struct node *next;
};
```



- Example

```
struct node a, b;
a.data = 1;
b.data = 2;
a.next = b.next = NULL;  /* Pointing to nothing */
a.next = &b;
printf("%d \ n", a.next->data);
```

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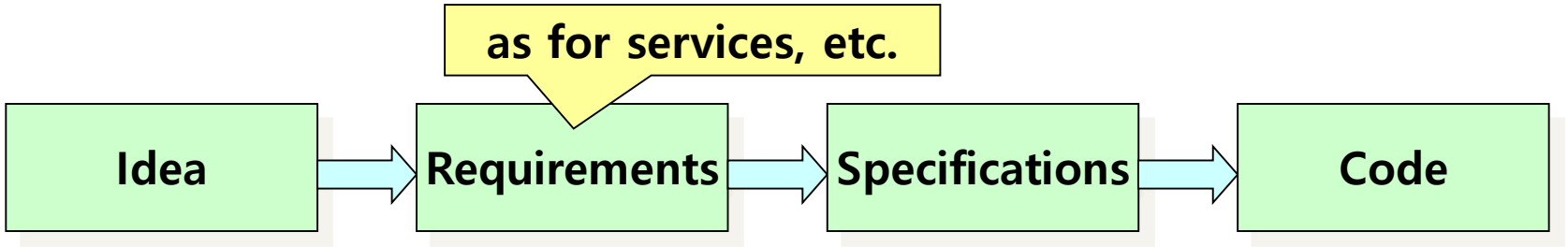
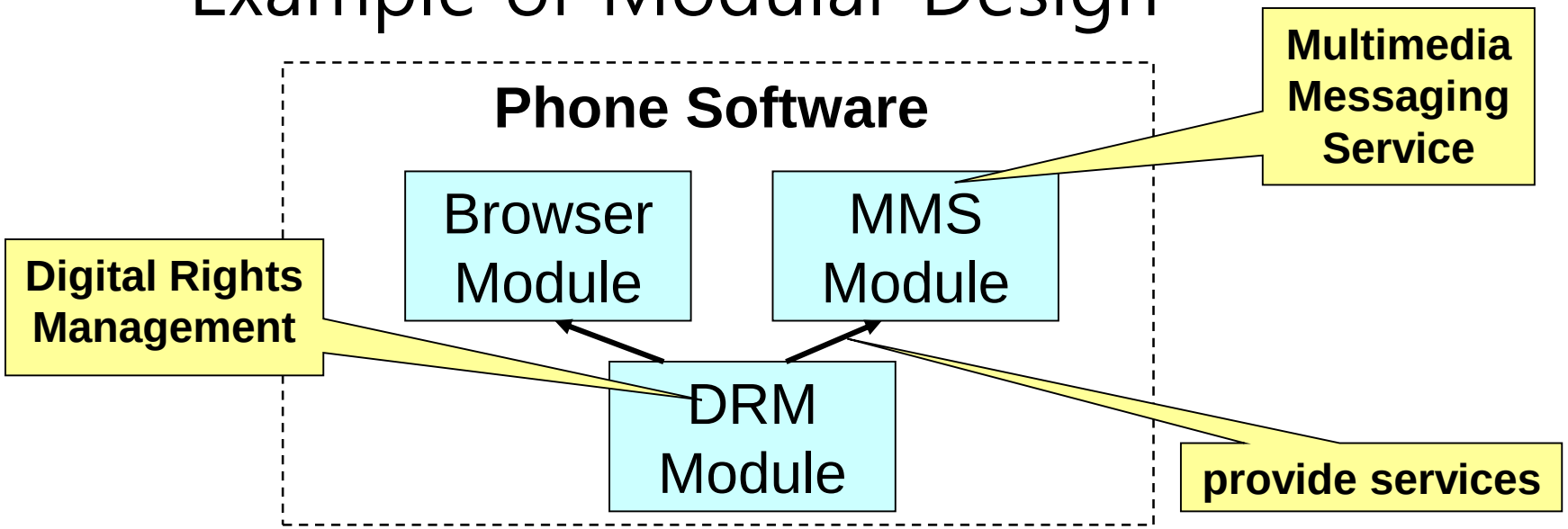
Modular Software Design

- Standardized Software Design & Development

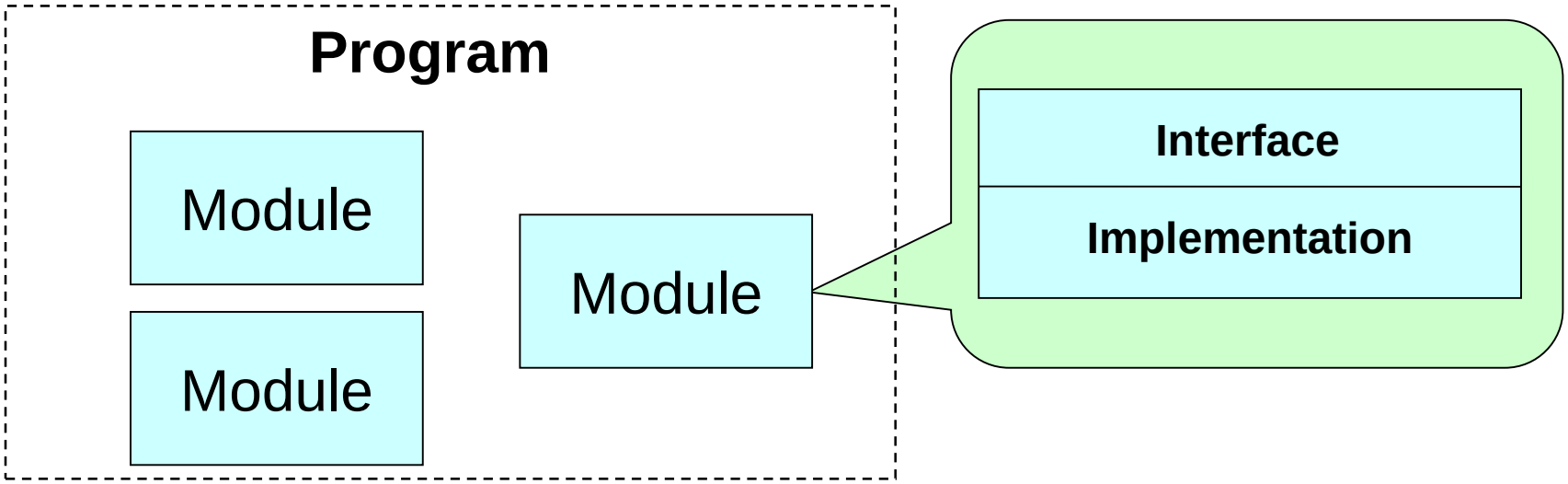


- Example of Modular Design



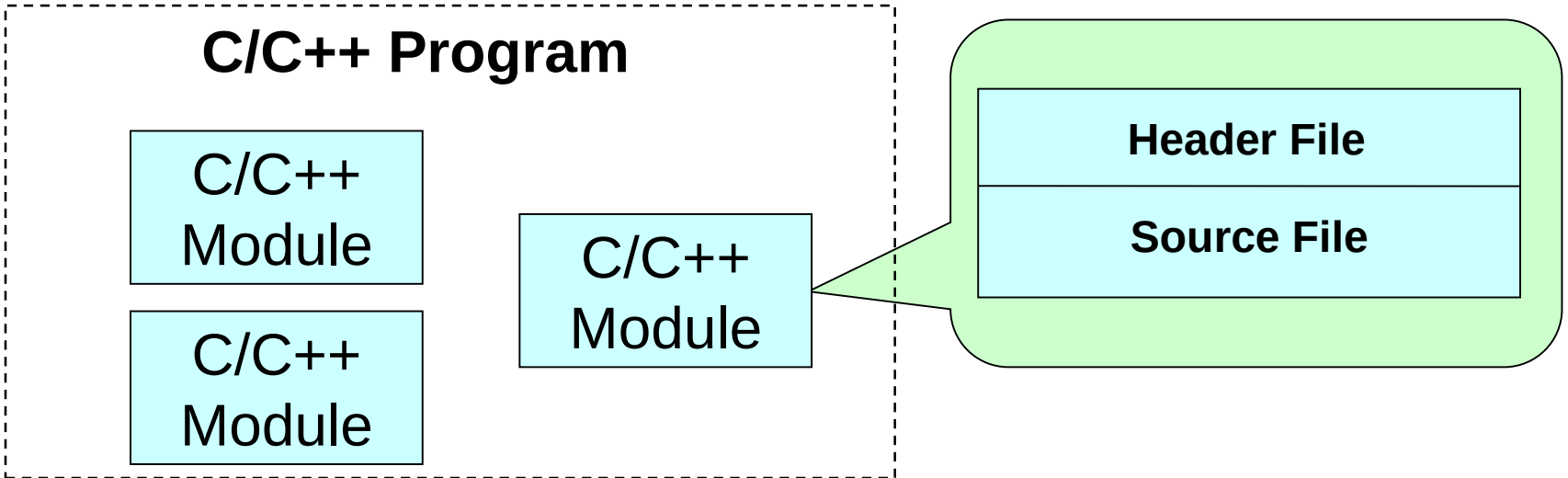
Modules

- Program
  - Independent Modules
- Module
  - Collection of Services
    - Interface: description of available services
    - Implementation: detailed definitions of services

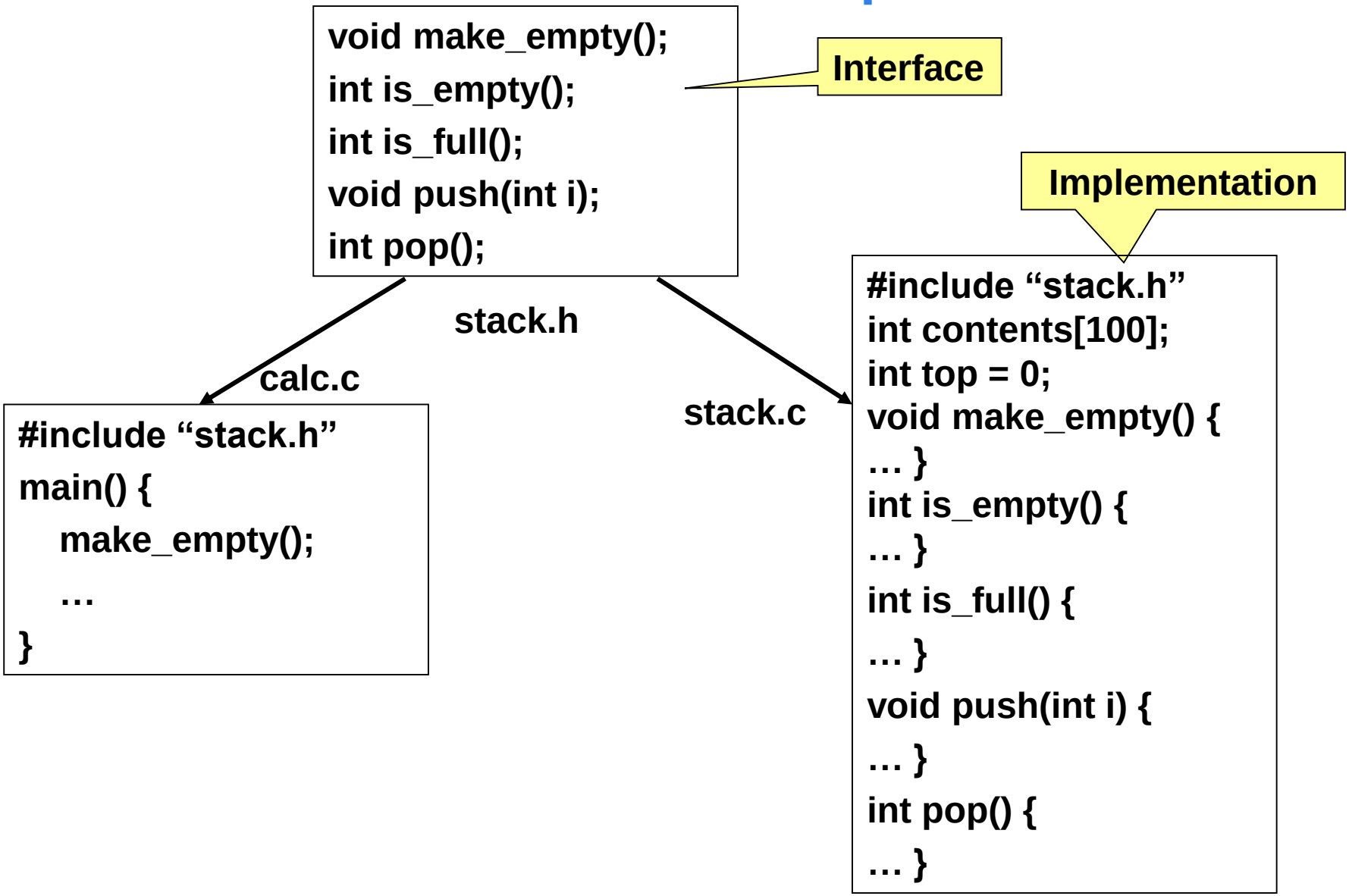


C/C++ Modules

- C/C++ Program
  - Independent C/C++ Modules
- C/C++ Module
  - Collection of Functions
    - Interface: a header file containing prototypes
    - Implementation: a source file containing definitions



Module Example



Dividing a Program into Modules

- Advantages
  - Abstraction
    - What they do; interface
  - Reusability
    - Reusable services
  - Maintainability
    - Module-wise maintenance
- Considerations
  - High Cohesion
    - Cooperating towards a common goal
  - Low Coupling
    - Independence

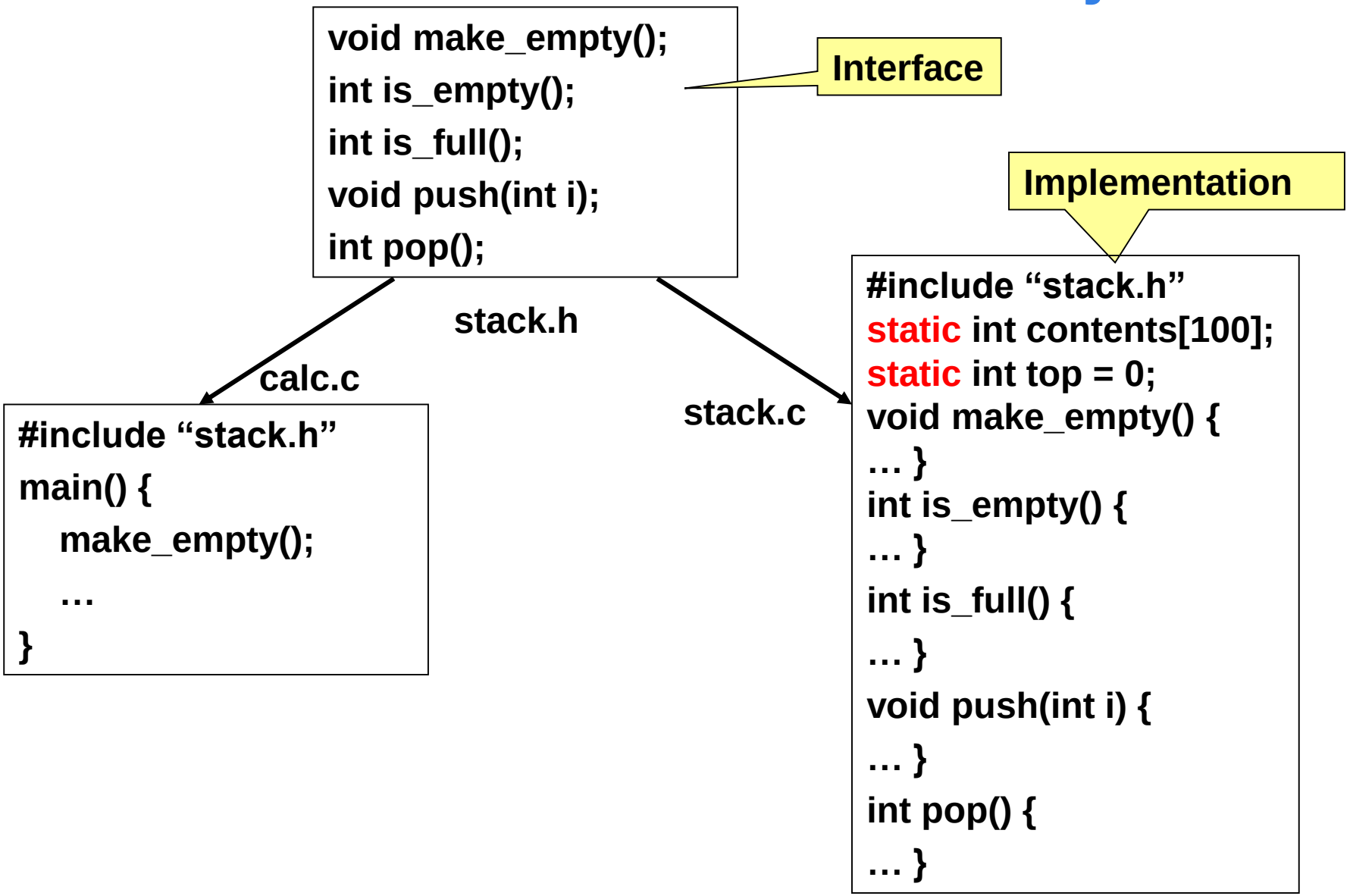
Module Types

- Data Pool
  - Collection of Related Variables and/or Constants
    - e.g., <limits.h>
- Library
  - Collection of Related Functions
    - e.g., <string.h>
- Abstract Object
  - Collection of Functions That Operate on a *Hidden* Data Structure
    - e.g., stack module
- Abstract Data Type (ADT)
  - Type with Its Representation *Hidden*

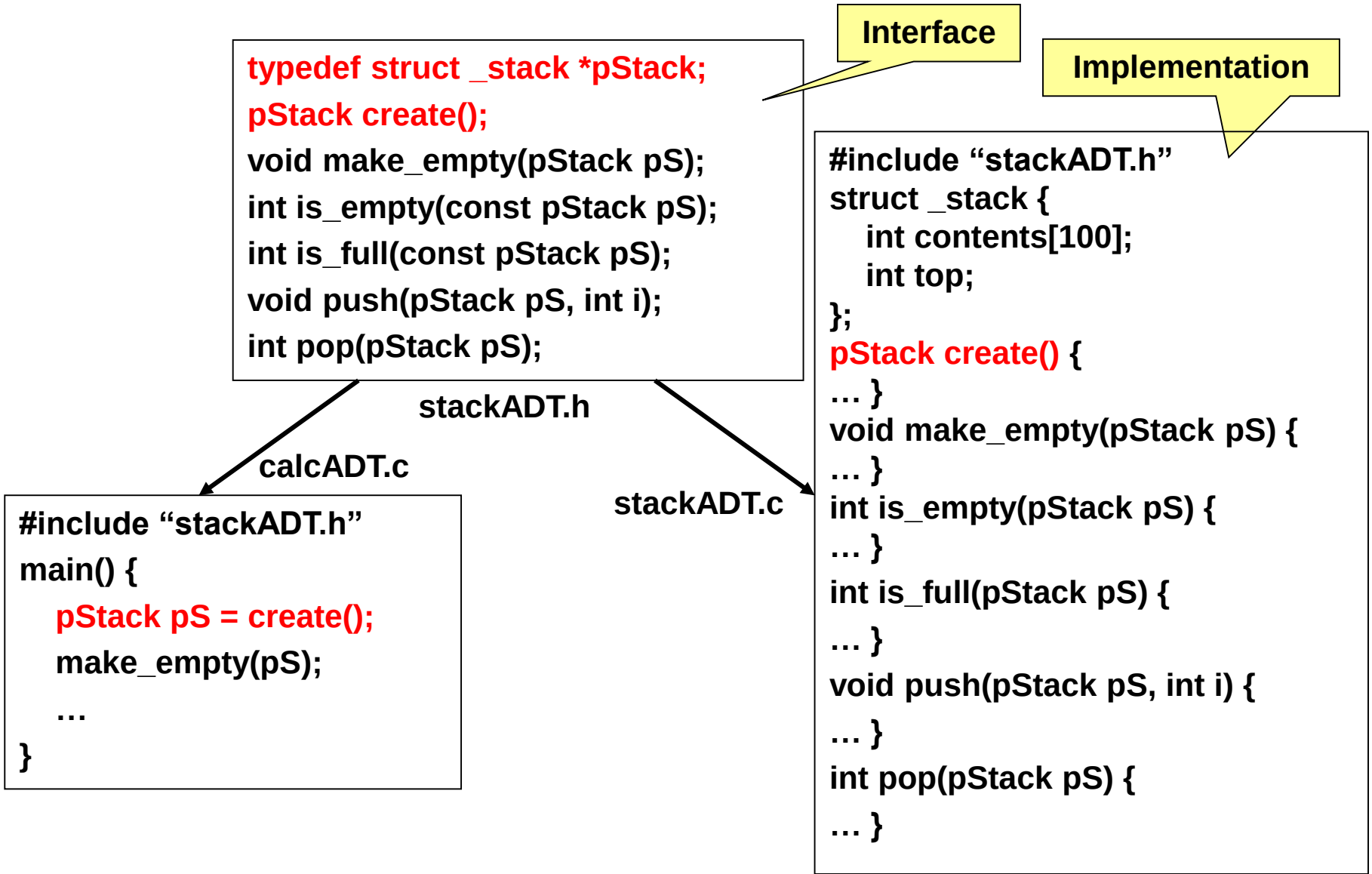
Information Hiding

- Advantages
  - Security
    - Only access to public information possible
  - Flexibility (Due to Abstraction)
    - Separation of interface from implementation
- C/C++ Tool
  - **Static**
    - Static functions callable within the file
    - Static variable accessible within the file/function

Module as an Abstract Object



Module as an ADT



Abstraction

- Definition
  - Process of Separating the Qualities of Something from the Object That They Belong to
    - Separation of *what* from *how*
      - e.g., C/C++ variables
- Major Types
  - Procedural Abstraction
    - Separation of *what* a function does from *how*
      - e.g., function outline & algorithm
  - Data Abstraction
    - Separation of *what* is stored (data object and its operators) from *how*
      - e.g., C/C++ data types

Abstraction Cont'd

- Advantages
  - Reduced Complexity
    - Information Hiding
  - Flexibility
  - Reusability
- Level
  - How to Determine It?