

# 15-410

*“...#ifndef DSFLK\_FSFDDS\_FSDFDS...”*

#include  
Sep. 18, 2017

**Dave Eckhardt**

**Dave O'Hallaron**

# Outline

**#ifndef DSFLK\_FSFDDS\_FSDFDS**

# What's `_STDIO_H_` anyway?

```
#ifndef _STDIO_H_
#define _STDIO_H_

typedef struct FILE {
    ...
} ...;

#endif /* _STDIO_H_ */
```

# Archaeology

**C is old**

**C doesn't have modules**

**C has *compilation units***

- “Compilation unit” is the secret ANSI code word for “file”
- Compilers sort of know some file types: .c, .s
- Compilers *don't* really know about .h
  - Auxiliary “pre-processor” brain (/lib/cpp) hides them

**People use *conventions* to get module-like C**

- These conventions evolved slowly

# The “.h Responsibility” Dilemma

**Assume: “stdio module”**

**Assume: “network stack module”**

- (Trust us, it's modular!)

**Both need to know**

- What's a `size_t` on this machine, anyway?
- `#include <sys/types.h>`

# Nested Responsibility

## Program 1:

- `#include <stdio.h>`

## Program 2:

- `#include <netinet/tcp_var.h>`

## Assume

- Program 1, 2 don't need `sys/types.h` themselves

## Solution 1

- `stdio.h` and `netinet/tcp_var.h` each include `sys/types.h`

# Too Much

## Program 3:

- `#include <stdio.h>`
- `#include <netinet/tcp_var.h>`

## Problem

- Now we get *two* copies `sys/types.h`
- Lots of whining about redefinitions
- Maybe compilation fails

# Too Much

## Program 3:

- `#include <stdio.h>`
- `#include <netinet/tcp_var.h>`

## Problem

- Now we get *two* copies `sys/types.h`
- Lots of whining about redefinitions
- Maybe compilation fails

## Solution?

- Blame the programmer!



# Passing the Buck

## Solution 2

- Require *main program* to `#include <sys/types.h>`
- Then the other .h files don't have to

## Problem

- Extra work for the programmer
- Modules' needs *change over time*
  - Didn't you know? Since last night xxx needs yyy...

# Solution: Idempotent .h files

## .h responsibility

- Activate only once
- No matter how many times included
- Choose string “unlikely to be used elsewhere”

```
#ifndef _STDIO_H_  
#define _STDIO_H_  
...  
#endif /* _STDIO_H_ */
```

# What *Belongs* in a .h?

**Types (C: *declarations*, not *definitions*)**

**Exported interface routines (“public methods”)**

**Constants (#define or enum)**

**Macros (when *appropriate*)**

**Data items exported by module**

- Try to avoid this
- Same reason as other languages: data != semantics

***No code!***

# But What About...?

## Real modules have multiple .c files

- libx/logging.c, libx/data.c, libx/interface.c
- Who declares *internal* functions?
- Who declares *internal* data structures?
  - “internally exporting” data structures is legitimate: internally, we agree on semantics and can agree on structural changes

# But What About...?

## Real modules have multiple .c files

- libx/logging.c, libx/data.c, libx/interface.c
- Who declares *internal* functions?
- Who declares *internal* data structures?
  - “internally exporting” data structures is legitimate: internally, we agree on semantics and can agree on structural changes

## Not “the” .h file

- We *don't want* to publish internal details

# But What About...?

## Real modules have multiple .c files

- libx/logging.c, libx/data.c, libx/interface.c
- Who declares *internal* functions?
- Who declares *internal* data structures?
  - “internally exporting” data structures is legitimate: internally, we agree on semantics and can agree on structural changes

## Not “the” .h file

- We *don't want* to publish internal details

## Maybe a “.i” file?

- Help?

# Use the *Other* .h File!

## **stdio.h**

- Included by module clients
- Included by module parts
- Available in /usr/include when stdio is installed

## **stdio\_private.h**

- Included only by module parts
- Not made available in a public location (ideally)

**\*\_private.h should be idempotent, too**

# Summary

## **#ifndef DSFLK\_FSFDDS\_FSDFDS**

- Well, use a better string
- Used to make .h files idempotent

## What *should* go here, anyway?

- There are two “here”s here
  - foo.h: public interface, available to public
  - foo\_private.h: internal communication, maybe unpublished