Lists in C

Personal Software Engineering

But First - How Much Space Is Needed?

For strings, we can use strlen:

```
char *p_copy = malloc( strlen("Hello")+1 ) ;
```

But what about other types (ints, doubles, structs, etc.)?

This is the purpose of the **`sizeof`** operator!

`sizeof` for basic types

sizeof(*type*) = #bytes needed to hold a type value
sizeof(*variable*) = #bytes needed to hold variable's type.

Examples (current 32 and 64 bit systems):

`sizeof(char)`	= 1
`sizeof(short)`	= 2
`sizeof(int)`	= 4
`sizeof(float)`	= 4
`sizeof(long)`	= 8
`sizeof(double)`	= 8
`sizeof(char *)`	= 4 (32-bit systems) / 8 (64-bit systems)

NOTE: all pointers to *any* type have the same size!

sizeof for array types

```
double sampledata[100] ;
sizeof(sampledata) ;         // = 100 * 8 = 800

char string[81] ;
sizeof(string) ;             // = 81 * 1 = 81
```

BUT

```
void foo(char buffer[81]) { . . . }
sizeof(buffer) ;             // = 8 !!
```

WHY?

Because array arguments are *really* pointers!

The function header above above is equivalent to:

```
void foo(char *buffer) { . . . }
```

`sizeof` for structs

```
typedef struct _node {
    int contents ;
    struct _node *next ;
} node ;
```

`sizeof(node)` == # bytes required to hold the structure.
== **`sizeof(int)`** + **`size(node *)`** + padding

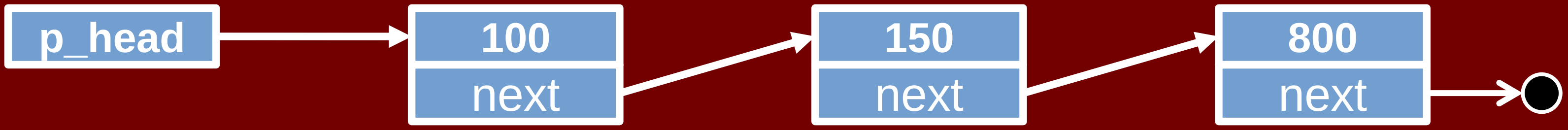
Padding is needed to assure data are aligned on the proper boundary:

ints on 4 byte boundaries
shorts on 2 byte boundaries
doubles and **pointer**s on 8 byte boundaries

Padding is dictated by the way CPU's access memory.

Singly Linked Lists

A *(singly) linked list* comprises a set of *nodes*, each node having a *pointer* to the next node in the list.
We keep a pointer to the first node in a *list head pointer*.



Since lists can grow and shrink dynamically, space for the list nodes is allocated and released dynamically using **malloc** and **free**.

Linked List Example in C

```
typedef struct _node {
    int contents ;
    struct _node *next ;
} node ;

node *p_head = NULL ;
node *np = malloc( sizeof(node) ) ; np->contents = 800 ;
np->next = p_head ; p_head = np ;
np = malloc( sizeof(node) ) ; np->contents = 150 ;
np->next = p_head ; p_head = np ;
np = malloc( sizeof(node) ) ; np->contents = 100 ;
np->next = p_head ; p_head = np ;
```

Linked List Example in C

```c
typedef struct _node {
    int contents ;
    struct _node *next ;
} node ;
```

Definition of the node type with
a field to hold information (contents)
and a pointer to the next node.
NULL will mark the list end.

```c
node *p_head = NULL ;
node *np = malloc( sizeof(node) ) ; np->contents = 800 ;
np->next = p_head ; p_head = np ;
np = malloc( sizeof(node) ) ; np->contents = 150 ;
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np = malloc( sizeof(node) ) ; np->contents = 100 ;
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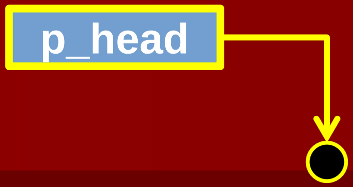
```

Linked List Example in C



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np->next = p_head ; p_head = np ;
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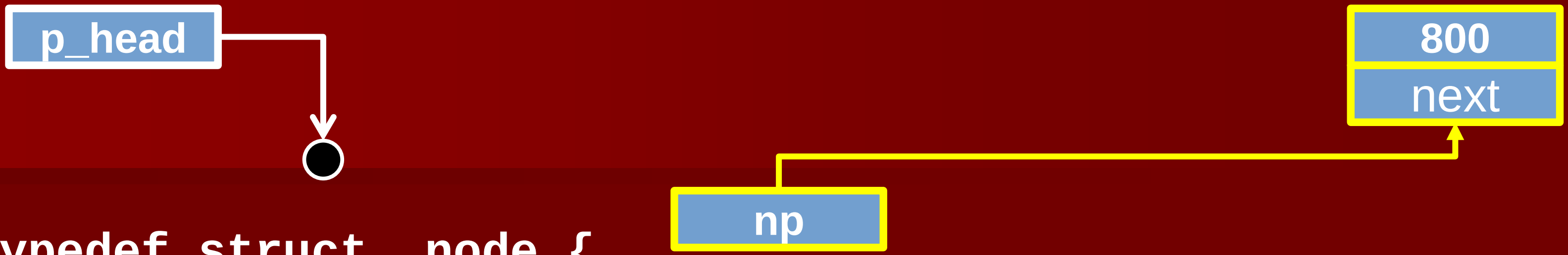
```

p_head = NULL for the initial (empty) list.

Linked List Example in C



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np = malloc( sizeof(node) ) ; np->contents = 100 ;
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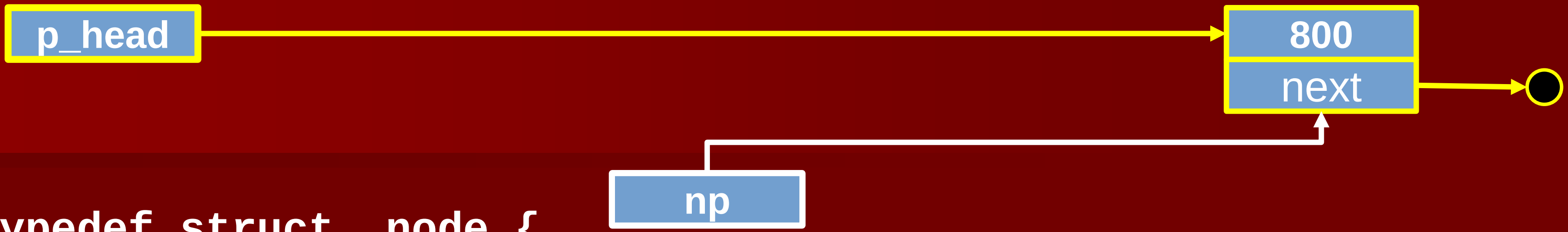
```

Allocate space for a node and
assign the address to np
Set the contents to 800

Linked List Example in C



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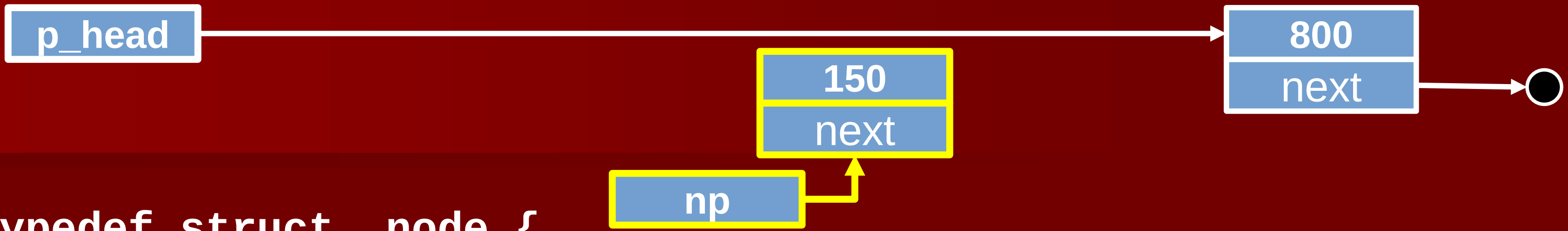
np->next = p_head ; p_head = np ;
np = malloc( sizeof(node) ) ; np->contents = 100 ;
np->next = p_head ; p_head = np ;
```

np's next is copied from p_head
p_head is set to np

Linked List Example in C



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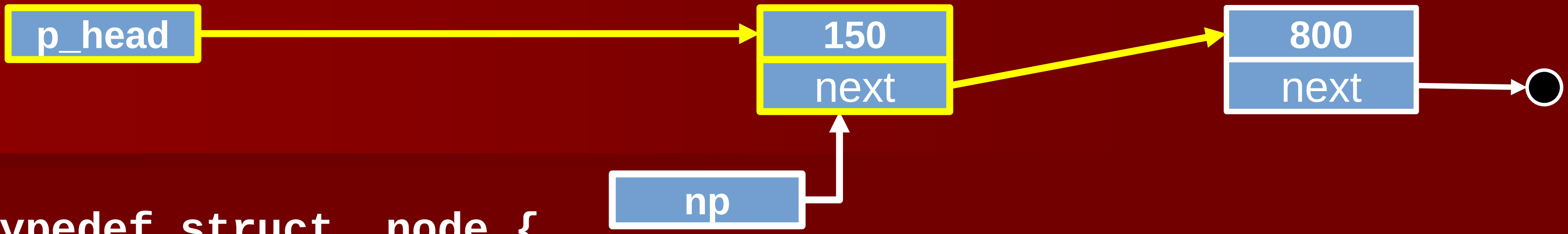
np->next = p_head ; p_head = np ;
np = malloc( sizeof(node) ) ; np->contents = 100 ;
np->next = p_head ; p_head = np ;
```

Allocate space for a node and assign the address to np
Set the contents to 150

Linked List Example in C



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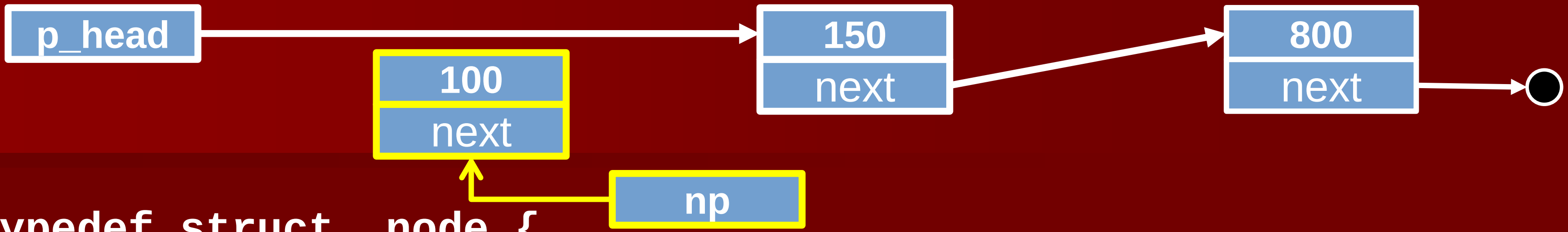

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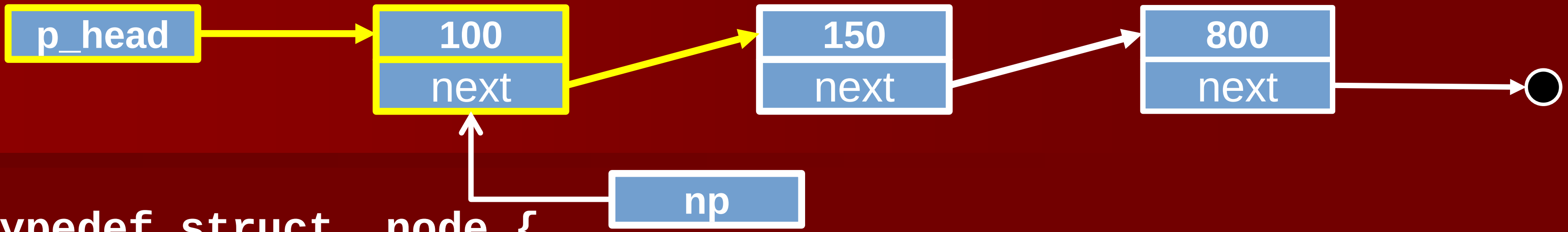
np->next = p_head ; p_head = np ;
np = malloc( sizeof(node) ) ; np->contents = 100 ;
np->next = p_head ; p_head = np ;
```

Allocate space for a node and
assign the address to np
Set the contents to 100

Linked List Example in C



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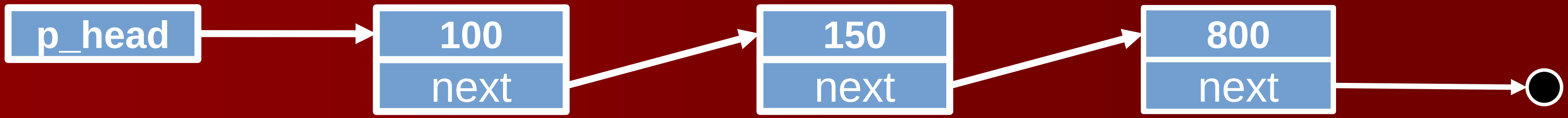
Linked List Example in C



- Some interesting questions:
  - How can we find the length of a list?
  - How can we add a node with the value 999 to the end of the list (rather than the head)?
  - How can we add a node with a new value (say 777) before the node at a given position (say 1)?
  - How can we the position of a node with a desired value?
  - How can we remove a node from the list?