

# What is a "packed" structure in C?

Asked 12 years, 5 months ago Modified 5 months ago Viewed 64k times

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I am going though some C code written for the Microchip C30 compiler and I often see structs defined as follows:

```
typedef struct __attribute__((__packed__))
{
    IP_ADDR    MyIPAddr;      // IP address
    IP_ADDR    MyMask;        // Subnet mask
    IP_ADDR    MyGateway;     // Default Gateway
    // etc...
} APP_CONFIG;
```

What does packed mean?

c

microcontroller

packed

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edited Mar 29, 2011 at 13:24

bioffe

6,293

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asked Mar 29, 2011 at 13:21

PlCyourBrain

9,976

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When structures are defined, the compiler is allowed to add paddings (spaces without actual data) so that members fall in address boundaries that are easier to access for the CPU.

For example, on a 32-bit CPU, 32-bit members should start at addresses that are multiple of 4 bytes in order to be efficiently accessed (read and written). The following structure definition adds a 16-bit padding between both members, so that the second member falls in a proper address boundary:

```
struct S {
    int16_t member1;
    int32_t member2;
};
```

The structure in memory of the above structure in a 32-bit architecture is (~ = padding):

```
+-----+
| m1 |----| m2 |
+-----+
```

When a structure is packed, these paddings are not inserted. The compiler has to generate more code (which runs slower) to extract the non-aligned data members, and also to write to them.

The same structure, when packed, will appear in memory as something like:

```
+-----+-----+
| m1 | m2 |----+
+-----+
```

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edited Mar 29, 2011 at 13:30

answered Mar 29, 2011 at 13:24

Juliano

39.2k

13

67

73

2

Tangential question but why would one create a packed structure if it makes things slower? Is it to reduce memory footprint? – [darned](#) Dec 12, 2017 at 6:05

7

One use case: they are used very often for defining and implementing network protocols, binary formats... You usually don't want to add paddings to structures that are going to be stored or sent over the network. – [jmonotes](#) Apr 4, 2018 at 14:25

Considering your example, 16 bits + 32 bits = 48 bits = 12 bytes and that is indeed a multiple of 4 bytes. Why would a compiler then apply padding? – [Jumpman](#) Oct 23, 2018 at 11:19

2

@Maxitj, 48 bits are 6 bytes, not 12. – [Juliano](#) Oct 23, 2018 at 11:50

@Juliano silly me, was rly tired while I was reading this post :) – [Jumpman](#) Oct 29, 2018 at 18:25

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It instructs the compiler to not add any padding between members of the `struct`.

See, for example, [this page](#).

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edited Nov 20, 2011 at 19:22

answered Mar 29, 2011 at 13:24

NPE

487k

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1013

I guess you mean the opposite - packed means to omit any padding and not to add it. – [filo](#) Mar 29, 2011 at 13:26

The link in this answer is broken, any chance of fixing? – [Kev](#) Nov 20, 2011 at 16:41

1

Detail: "not add any padding in select members" is more like to add *minimum* packing. Certain architectures may still oblige some padding in select cases. (e.g. `int` must be on even address boundary to prevent bus fault.) – [chux](#) - [Reinstate Monica](#) Jul 12, 2016 at 17:37

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Let me explain the concept of padding in structures and then packed structures by taking an example.

And then let us see why packing is required.

**Padding:**

```
struct eg_struct
{
    unsigned char abc;
    unsigned int xyz;
};
```

When the structure is declared as above on a 16 bit architecture, the variable `abc` would be assigned some address. The next address is not assigned to variable `xyz`, instead one extra byte is added, and then the next address would be assigned to the variable `xyz`.

In the end, the structure looks something like below:

```
struct eg_struct
{
    unsigned char abc;
    unsigned char paddedbytes[1];
    unsigned int xyz;
};
```

Padding makes addresses of member variables easily accessible to the microcontroller. The disadvantage is extra unnecessary bytes that come into the picture.

**Packing:**

If same structure is declared using the attribute "`packed`", the extra byte will not be added after the variable `abc`.

**Let me give one example where packing is needed:**

Consider a microcontroller interfaced with an EEPROM where some structure is being stored. Imagine a function writing to the EEPROM would look as below:

```
Write_EEPROM(address, Ram address, Byte count);
```

Now if packing is not done, the extra padded bytes would occupy space in the EEPROM, which is of no use.

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edited Apr 28, 2019 at 18:11

answered Apr 28, 2019 at 17:49

Laurenz Albe

210k

17

207

265

Babajan

364

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@laurenz albe Thanks for making my answer more presentable. – [Babajan](#) Apr 28, 2019 at 18:31

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`__attribute__((__packed__))` means (most probably) "do not insert any padding to make things faster" and may also mean "do not insert any alignments to preserve alignment".

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answered Mar 29, 2011 at 13:45

Valine

20.8k

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One thing that has not been explicitly called out is that packing usually is done to match predefined field structures. For example, at the low level layer of a network interface, a series of bytes is exchanged between networked machines. After the data is received, it will need to be mapped to a high level structure so that the data can be manipulated easily. This is when no-padding is usually necessary, so that the structure directly maps to the bytes.

Network data interchange also involves byte endianness issue (i.e. almost all network data uses big endian format regardless the endianness of the source and destination machines).

Furthermore, some machines **cannot** access wide data in non-aligned address, for example, Cortex-M0 cores cannot access 32-bit data in non-32-bit aligned address, so care must be taken on writing networking code in such cases.

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answered Apr 30, 2019 at 19:42

Richard at ImageCraft

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When packed used during structure declaration, compiler will not add any padding to the members of the same structure. Below is the example code and output which is self explanatory.

```
$ cat structure_packed.c
#include <stdio.h>

typedef struct __attribute__((__packed__))
{
    char a;
    int ai;
    char ac;
}A;

struct B
{
    char b;
    int bi;
    char bc;
};

int main()
{
    A a;
    struct B b;
    int c;
    printf("size of struct A: %lu, addr a: %p, addr ai: %p, addr ac: %p\n", si
    printf("size of struct B: %lu, addr b: %p, addr bi: %p, addr bc: %p\n", si
    printf("addr of c: %p\n", &c);
    return 0;
}
```

**Compile**

```
$ gcc structure_packed.c -o structure_packed
```

**Run|Output**

```
$. ./structure_packed
size of struct A: 6, addr a: 0x7ffc6f177ed6, addr ai: 0x7ffc6f177ed7, addr
size of struct B: 12, addr b: 0x7ffc6f177edc, addr bi: 0x7ffc6f177ee0, addr
addr of c: 0x7ffc6f177ed9
```

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edited Apr 14 at 5:53

answered Nov 14, 2022 at 11:20

WicCaesar

15

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Raj

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