# Porting Applications to IRIX

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## Porting Issues

*Porting applications is usually very easy, but in some cases changes need to be made to the code.*

- IRIX 6.x is a 64–bit operating system
- Virtual *user* address space is now 40 bytes (= 1 TByte)
- This means that addresses are no longer 32 bit!
- Most data types remain the same (i.e. REAL is 32 bit)
- There is still the possibility to stay with the old 32 bit compilers:

  % setenv SGI_ABI [–32|–64]

- Compilers support a 32 bit addressing environment as well through the –n32 option or using:

  % setenv SGI_ABI –n32





## Porting Issues

| *C type* | *32–bit* | *64–bit* | *F77 type* |
|---|---|---|---|
| char | 8 | 8 | character |
| short int | 16 | 16 | integer*2 |
| int | 32 | 32 | integer |
| long int | 32 | 64 | --- |
| long long int | 64 | 64 | integer*8 |
| pointer | 32 | 64 | pointer |
| float | 32 | 32 | real |
| double | 64 | 64 | real*8 |
| long double | 64 | 128 | real*16 |

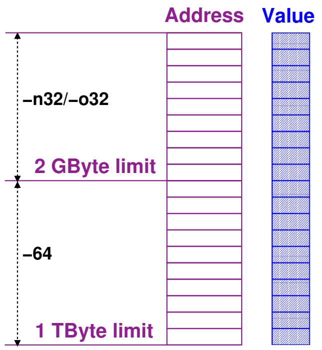
red = Potential cause of porting problems





## Memory – Byte addressable

*Do not confuse address and value*




Increment in addresses is one byte or more:

| | |
|---|---|
| char | 1 byte |
| short int | 2 bytes |
| int | 4 bytes |
| long int | 4 bytes (–n32) |
| | 8 bytes (–64) |
| float | 4 bytes |
| double | 8 bytes |

= 32 bit or 64 bit

= byte (8 bits)

# Porting Issues

Datatypes start on their "natural" boundary in memory:

| C | Fortran | Boundary |
|---|---|---|
| char | character | 8 bit |
| int | integer | 32 bit |
| float | real | 32 bit |
| double | double precision | 64 bit |

Things to watch out for:

- Single datatype big common block in Fortran
- Structures and unions in C

In general (!) a C-program has more potential porting pitfals than a Fortran program





# Porting Issues – Fortran Example/1

```
COMMON /WORK/ IARRAY(8)
CALL SUBA(IARRAY(2))

        SUBROUTINE SUBA(X)
        DOUBLE PRECISION X(2)
```

Array X is expected to start on a *64 bit* boundary

However, it is on a 32 bit boundary => bus error

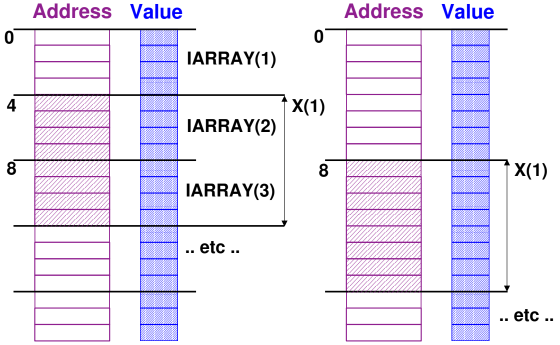




# Porting Issues – Fortran Example/2

Intended in calling program

Expected within the subroutine



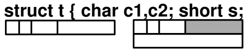





# The LP64 model

*Things to watch out for:*

*padding:* struct t { char c1,c2; short s; long l;}



*%loc – %val:* these return 64 bit values now (parm. passing)

*sizeof:*
sizeof(long) != 4
sizeof(void *) != 4
sizeof(int) != sizeof(long)
sizeof(long) != sizeof(float)

*pointer:*
int *p,i;
i = (int) p; /* truncation */
p = (int *) i; /* extension */

*constant:* 0xffffffff = 0x00000000ffffffff = 4294967295 != –1

# Example Program/1

```
program lp64
implicit none

integer offset, j6
integer ivar
integer ia(10)

ia(5) = -1
ia(6) = 12345
ia(7) = 2

print *,'%loc(ia(1))=',%loc(ia(1))

offset = %loc(ia(1))
j6 = offset + 4*(6-1)

ivar = -1957
call getval (ivar, j6)

print *,'After getval: ivar=',ivar

stop
end
```

```
void getval_ (int *item,
              int *addr)
{
    int *index;

    index = (int *) *addr;

    *item = *index;
}
```

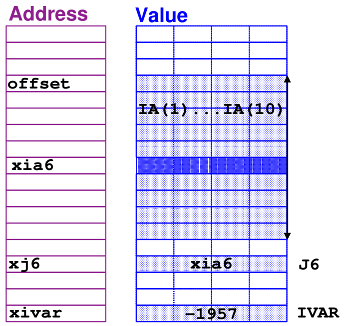
***The code will run compiled with –n32, but crash when compiled with –64***

Why?





# Example Program/2




call getval(ivar, j6) :

```
void getval_ (int *ivar, int *j6)
{
    int *index;
    index   =  (int *) *j6;
    *ivar   =  *index;
}
```

Note that:

- Arguments are pointers to ints
- index is a *pointer* to an int variable
- *index = the contents of this pointer

=> Effect of this call:

index = pointer to *contents* of j6 = xia6
*ivar = *index = ia(6) = 12345





# Example Program/3

```
        cc -c -n32 funcs.c
        f77 -c -n32 lp64.f
        f77 -o lp64 -n32 funcs.o lp64.o
        ./lp64
 Addresses of IA array:
 address IA( 1)=  2147429976 value is           0
 address IA( 2)=  2147429980 value is   263582800
 address IA( 3)=  2147429984 value is           0
 address IA( 4)=  2147429988 value is           1
 address IA( 5)=  2147429992 value is          -1
 address IA( 6)=  2147429996 value is       12345
 address IA( 7)=  2147430000 value is           2
 address IA( 8)=  2147430004 value is           0
 address IA( 9)=  2147430008 value is           0
 address IA( 10)=  2147430012 value is          0
 Address pointer j6 =  2147429996
 Before getval: ivar=       -1957
 After  getval: ivar=       12345
```





# Example Program/4

```
        cc -c -64 funcs.c
        f77 -c -64 lp64.f
"lp64.f", line 9: warning(1412): destination type of cast is too small to
hold all pointers: truncation possible
        offset = %loc(ia(1))
                 ^
        f77 -o lp64 -64 funcs.o lp64.o
        ./lp64
 Addresses of IA array:
 address IA( 1)=   1099511606648 value is          255
 address IA( 2)=   1099511606652 value is       -21088
 address IA( 3)=   1099511606656 value is            0
 address IA( 4)=   1099511606660 value is           15
 address IA( 5)=   1099511606664 value is           -1
 address IA( 6)=   1099511606668 value is        12345
 address IA( 7)=   1099511606672 value is            2
 address IA( 8)=   1099511606676 value is    263606220
 address IA( 9)=   1099511606680 value is          255
 address IA(10)=   1099511606684 value is       -20840
 Address pointer j6 =       -21108
 Before getval: ivar=       -1957
Bus error (core dumped)
```

# Example Program/5

Why ?

*The new code will run compiled –64 and crash compiled with –n32*

```
program lp64
implicit none

integer*8 offset, j6
integer   ivar
integer   ia(10)

ia(5) = -1
ia(6) = 12345
ia(7) = 2

print *,'%loc(ia(1))=',%loc(ia(1))

offset = %loc(ia(1))
j6 = offset + 4*(6-1)

ivar = -1957
call getval (ivar, j6)

print *,'After getval: ivar=',ivar

stop
end
```

```
void getval_ (int *item,
              long int *addr)
{
    int *index;

    index = (int *) *addr;

    *item = *index;
}
```





# Example Program/6

```
        cc -c -64 funcs.c
        f77 -c -64 lp64.f
        f77 -o lp64 -64 funcs.o lp64.o
        ./lp64
Addresses of IA array:
address IA( 1)=  1099511606632 value is           0
address IA( 2)=  1099511606636 value is           0
address IA( 3)=  1099511606640 value is           0
address IA( 4)=  1099511606644 value is   229914144
address IA( 5)=  1099511606648 value is          -1
address IA( 6)=  1099511606652 value is       12345
address IA( 7)=  1099511606656 value is           2
address IA( 8)=  1099511606660 value is          15
address IA( 9)=  1099511606664 value is           0
address IA(10)=  1099511606668 value is   229914144
Address pointer j6 =   1099511606652
Before getval: ivar=    -1957
After  getval: ivar=    12345
```





# Example Program/7

```
        cc -c -n32 funcs.c
     f77 -c -n32 lp64.f
     f77 -o lp64 -n32 funcs.o lp64.o
     ./lp64
Addresses of IA array:
address IA( 1)=  2147429976 value is           0
address IA( 2)=  2147429980 value is   263582800
address IA( 3)=  2147429984 value is           0
address IA( 4)=  2147429988 value is           1
address IA( 5)=  2147429992 value is          -1
address IA( 6)=  2147429996 value is       12345
address IA( 7)=  2147430000 value is           2
address IA( 8)=  2147430004 value is           0
address IA( 9)=  2147430008 value is           0
address IA(10)=  2147430012 value is           0
Address pointer j6 =           2147429996
Before getval: ivar=        -1957
*item = -1957
*addr = 0
index  = 0
Segmentation fault (core dumped)
```

*Argument j6 is integer*8*
*With –n32, a long int is 32 bit ...*

0





# Macros

Note that certain macros are set. For example:

| Macro | 32–bit | 64–bit |
|---|---|---|
| –MIPS_SZINT | 32 | 32 |
| –MIPS_SZLONG | 32 | 64 |
| –MIPS_SZPTR | 32 | 64 |

**For much more information:** `% man abi`

# Summary 32–64 bit

- *64–bit addressing and full performance*

  *use –64 –mips4*

- *32–bit addressing and full performance*

  *use –n32 –mips4*

- *32–bit addressing and less performance*

  *use –o32*





# Static versus automatic storage

*What should be the printed value of abc in the second call?*

*Static storage:* *1*
*Local variables maintain values between the calls*

*Automatic storage:* *undetermined*
*Local variables do not maintain values between the calls*

```
program test

call suba(1)
call suba(2)

stop
end

subroutine suba(i)

integer i, abc

print *,'abc = ',abc
abc = i
return
end
```



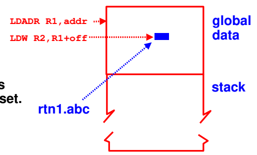


# Static versus automatic storage

*Static*

* As offsets to pointers are limited to 64KB, first load a register with a base address then load the data with an offset.

* Permanent storage of local (temporary) variables





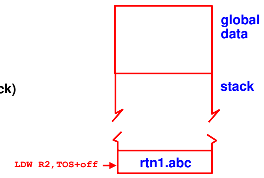



# Static versus automatic storage

*Automatic*

* One operation to fetch a word of memory using the TOS (Top Of Stack) pointer

* Temporary storage of local (temporary) variables



# Floating Point Exceptions

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