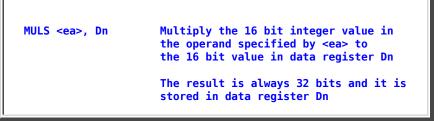
# The MULS instruction - know when to use ext.l to convert into long

### • RECALL: Mulitply instruction in M68000

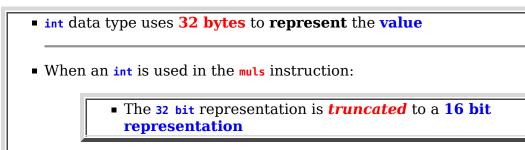
- **M68000** can *only* multiply two **16-bits integers** (due to the technological limitation at the time 1980)
- The syntax of the **multiply** instruction of M68000 is:



• Notice that you do **not** have any choice for operand size.

### • Multiple int data types

#### • Facts:



#### • Example:

int i1, i2, i3; i3 = i1 \* i2; In assembler code: move.l i1,D0 \* get 32 bits value i1 in reg D0 move.l i2,D1 \* get 32 bits value i2 in reg D1 muls D1,D0 \* D0 = D0\*D1 \* We only use 16 bits in D0 and D1 \* So we have converted the int

```
* into a short before we multiply !!
* Note: result is correct as long as
* the values in D0 and D1 is small
move.l D0,i3 * Store i1*i2 to i3
* The product is 32 bits !!!
```

## • Multiply with byte size operands

### • Important fact:

- MULS will *always* use 16 bits operands !!!
- So we must convert a byte (8 bits) representation into a 16 bit representation before we use MULS !!!

#### **Example:**

```
byte b1, b2, b3;
b3 = b1 * b2;
In assembler code:
                 MOVE.B b1, D0
                                   * D0 = b1 (8 bits)
                 EXT.W D0
                                   * D0 now has a 16 bits representation !!
                 MOVE.B b2, D1
                                   * D1 = b2 (8 bits)
                 EXT.W D1
                                   * D1 now has a 16 bits representation !!
                 MULS
                        D1, D0
                                   * D0 = b1 * b2 (32 bits)
                                   * The product is 32 bits !!!
                 MOVE.B D0, b3
                                   * Move byte value to b3
                                    (We have actually converted an int
                                    into a byte !)
```

• Try out this demo program yourself: click here

Some more examples

• More examples:

int a;
short b;

```
byte c;
a = b * c;
                                 (16 bits valid in d0)
               move.w b, d0
               move.b c, d1
                                 (8 bits valid in d1)
               ext.w dl
                                 (16 bits valid in d1)
               * Now have two 16 bits values and can use muls !!
               muls d0, d1
                                 (32 bit result in d1)
               move.l d1, a
                                 (store 32 bits in a)
b = a * c;
               move.l a, d0
                                 (32 bits valid in d0)
                                 (We will only use 16 bits)
               move.b c, d1
                                 (8 bits valid in d1)
               ext.w d1
                                 (16 bits valid in d1)
               * Now have two 16 bits values and can use muls !!
                      d0, d1
                                 (32 bit result in d1)
               muls
                                 (We will only use 16 bits)
               move.w d1, b
                                 (store 16 bits in b)
c = a * b;
               move.l a, d0
                                 (32 bits valid in d0)
                                 (We will only use 16 bits)
                                 (16 bits valid in d1)
               move.w c, d1
               * muls will only use 16 bits from d0
                                 (32 bit result in d1)
               muls
                     d0, d1
                                 (We will only use 8 bits)
               move.b d1, c
                                 (store 8 bits in c)
```