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**Algorithm 1** A Basic Multiplication Algorithm Based on Classic Decimal Multiplication

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```
for  $i = 0; i < 32; i++$  do  
  if  $multiplier_0 == 1$  then  
     $product \leftarrow product + multiplicand$   
  end if  
   $multiplicand \leftarrow multiplicand \ll 1$   
   $multiplier \leftarrow multiplier \gg 1$   
end for
```

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**Algorithm 2** An Improved Algorithm that Adds to the Left Half of the 64-bit Product Register and Shifts into Place on the Right Half so that a 32-bit ALU Can be Used

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```
for  $i = 0; i < 32; i++$  do  
    if  $multiplier_0 == 1$  then  
         $product_{63:32} \leftarrow product_{63:32} + multiplicand$   
    end if  
     $product \leftarrow product \gg 1$   
     $multiplier \leftarrow multiplier \gg 1$   
end for
```

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**Algorithm 3** A Further Improved Algorithm that Utilizes the Unused Right Half of the 64-bit Product Register (which will be shifted out of the register) as the Multiplier (eliminating a register)

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```

 $product_{31:0} \leftarrow multiplier$ 
for  $i = 0; i < 32; i++$  do
  if  $product_0 == 1$  then
     $product_{63:32} \leftarrow product_{63:32} + multiplicand$ 
  end if
   $product \leftarrow product \gg 1$ 
end for

```

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**Algorithm 4** A Binary Integer Division Algorithm

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```
remainder  $\leftarrow$  dividend  
divisor  $\leftarrow$  divisor  $\ll$  32  
for  $i = 0; i < 33; i++$  do  
    remainder  $\leftarrow$  remainder  $-$  divisor  
    if remainder  $\geq 0$  then  
        quotient  $\leftarrow$  quotient  $\ll$  1  
        quotient0  $\leftarrow$  1  
    else  
        remainder  $\leftarrow$  remainder  $+$  divisor  
        quotient  $\leftarrow$  quotient  $\ll$  1  
        quotient0  $\leftarrow$  0  
    end if  
    divisor  $\leftarrow$  divisor  $\gg$  1  
end for
```

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**Algorithm 5** An Improved Binary Integer Division Algorithm Using a 32-bit ALU and that Uses the Unused Left Half of the Remainder as the Dividend

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```
remainder63:32  $\leftarrow$  dividend  
remainder  $\leftarrow$  remainder  $\ll$  1  
for  $i = 0; i < 32; i++$  do  
  remainder63:32  $\leftarrow$  remainder63:32  $-$  divisor  
  if remainder  $\geq 0$  then  
    remainder  $\leftarrow$  remainder  $\ll$  1  
    remainder0  $\leftarrow$  1  
  else  
    remainder63:32  $\leftarrow$  remainder63:32  $+$  divisor  
    remainder  $\leftarrow$  remainder  $\ll$  1  
    remainder0  $\leftarrow$  0  
  end if  
  remainder63:32  $\leftarrow$  remainder63:32  $\gg$  1  
end for
```

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