$\boldsymbol{Delete\ Element\ at\ a\ given\ position\ in\ array - Mechanism}$

$\underline{\mathbf{10.}\boldsymbol{Shifting\ of\ Data\ in\ Array}[\boldsymbol{Right\ Shift}]}$.

$\underline{\boldsymbol{Static - Delete\ Element\ At\ Position\ In\ Array}}$

$\mathbf{1}\ \boldsymbol{based\ indexing}(\boldsymbol{logical})$	$\mathbf{0}\ \boldsymbol{based\ indexing}(\boldsymbol{logical})$
$\boldsymbol{a}[\mathbf{1}] = \mathbf{1}$	$\boldsymbol{a}[\mathbf{0}] = \mathbf{1}$
$\boldsymbol{a}[\mathbf{2}] = \mathbf{2}$	$\boldsymbol{a}[\mathbf{1}] = \mathbf{2}$
$\boldsymbol{a}[\mathbf{3}] = \mathbf{3}$	$\boldsymbol{a}[\mathbf{2}] = \mathbf{3}$
$\boldsymbol{a}[\mathbf{4}] = \mathbf{4}$	$\boldsymbol{a}[\mathbf{3}] = \mathbf{4}$
$\boldsymbol{a}[\mathbf{5}] = \mathbf{5}$	$\boldsymbol{a}[\mathbf{4}] = \mathbf{5}$
$\boldsymbol{a}[\mathbf{6}] = \mathbf{6}$	$\boldsymbol{a}[\mathbf{5}] = \mathbf{6}$

$\boldsymbol{If\ this\ is}\ \mathbf{1}\ \boldsymbol{based\ indexing}$:

$$\boldsymbol{Worst\ Case\ Scenario}$$

$$\mathbf{1} - \boldsymbol{based\ indexing - deleting}\ \boldsymbol{a}[\mathbf{1}]$$

$$\boldsymbol{a}[\mathbf{6}] \rightarrow\ \boldsymbol{a}[\mathbf{5}] = \mathbf{6}[\boldsymbol{Left\ to\ right\ shift}] \rightarrow \mathbf{1}\ \boldsymbol{time}$$

$$\boldsymbol{a}[\mathbf{5}] \rightarrow \boldsymbol{a}[\mathbf{4}] = \mathbf{5}[\boldsymbol{Left\ to\ right\ shift}] \rightarrow \mathbf{2}\boldsymbol{nd\ time}$$

$$\boldsymbol{a}[\mathbf{4}] \rightarrow \boldsymbol{a}[\mathbf{3}] = \mathbf{4}[\boldsymbol{Left\ to\ right\ shift}] \rightarrow \mathbf{3}\boldsymbol{rd\ time}$$

$$\boldsymbol{a}[\mathbf{3}] \rightarrow \boldsymbol{a}[\mathbf{2}] = \mathbf{3}[\boldsymbol{Left\ to\ right\ shift}] \rightarrow \mathbf{4}\boldsymbol{rth\ time}$$

$$\boldsymbol{a}[\mathbf{2}] \rightarrow \boldsymbol{a}[\mathbf{1}] = \mathbf{2}[\boldsymbol{Left\ to\ right\ shift}] \rightarrow \mathbf{5}\boldsymbol{th\ time}$$

$$\boldsymbol{Internal\ shifting - deleting}\ \boldsymbol{a}[\mathbf{0}]$$

$$\boldsymbol{a}[\boldsymbol{i} = \mathbf{0}] \rightarrow\ \boldsymbol{a}[\boldsymbol{i} = \mathbf{0} + \mathbf{1}] = \mathbf{2}[\boldsymbol{Left\ to\ right\ shift}] - \mathbf{1}\ \boldsymbol{time}$$

$$\boldsymbol{a}[\boldsymbol{i} = \mathbf{1}] \rightarrow \boldsymbol{a}[\boldsymbol{i} = \mathbf{1} + \mathbf{1} = \mathbf{2}] = \mathbf{3}[\boldsymbol{Left\ to\ right\ shift}] - \mathbf{2}\boldsymbol{nd\ time}$$

$$\boldsymbol{a}[\boldsymbol{i} = \mathbf{2}] \rightarrow \boldsymbol{a}[\boldsymbol{i} = \mathbf{2} + \mathbf{1} = \mathbf{3}] = \mathbf{4}[\boldsymbol{Left\ to\ right\ shift}] - \mathbf{3}\boldsymbol{rd\ time}$$

$$\boldsymbol{a}[\boldsymbol{i} = \mathbf{3}] \rightarrow \boldsymbol{a}[\boldsymbol{i} = \mathbf{3} + \mathbf{1} = \mathbf{4}] = \mathbf{5}[\boldsymbol{Left\ to\ right\ shift}] - \mathbf{4}\boldsymbol{rth\ time}$$

$$\boldsymbol{a}[\boldsymbol{i} = \mathbf{4}] \rightarrow \boldsymbol{a}[\boldsymbol{i} = \mathbf{4} + \mathbf{1} = \mathbf{5}] = \mathbf{6}[\boldsymbol{Left\ to\ right\ shift}] - \mathbf{5}\boldsymbol{th\ time}$$

$$\textbf{\textit{Lower Bound}} : i = pos - 1$$

$$\textbf{\textit{Upper Bound}} : \ i < size - 1$$

$$\textbf{\textit{Operation}} : a[i] = a[i + 1]$$

```
for (int i = pos - 1; i < size - 1; i++)
{
    a[i] = a[i + 1];
}

size = size - 1;

cout << "The array after deletion is: " << endl;

for (int i = 0; i < size; i++)
{
    cout << "a[" << i << "]=" << a[i] << endl;
}
```

6	$0x5014$	$\boldsymbol{a[5]\ or\ a+5}$
5	$0x5010$	$\boldsymbol{a[4]\ or\ a+4}$
4	$0x500C$	$\boldsymbol{a[3]\ or\ a+3}$
3	$0x5008$	$\boldsymbol{a[2]\ or\ a+2}$
2	$0x5004$	$\boldsymbol{a[1]\ or\ a+1}$
1	$0x5000$	$\boldsymbol{a[0]\ or\ a+0}$

If we view it in this way:

6	**5**	**4**	**3**	**2**	**1**
$0x5014$	$0x5010$	$0x500C$	$0x5008$	$0x5004$	$0x5000$
$\boldsymbol{a[5]\ or\ a+5}$	$\boldsymbol{a[4]\ or\ a+4}$	$\boldsymbol{a[3]\ or\ a+3}$	$\boldsymbol{a[2]\ or\ a+2}$	$\boldsymbol{a[1]\ or\ a+1}$	$\boldsymbol{a[0]\ or\ a+0}$
$\boldsymbol{a[6]}$	$\boldsymbol{a[5]}$	$\boldsymbol{a[4]}$	$\boldsymbol{a[3]}$	$\boldsymbol{a[2]}$	$\boldsymbol{a[1]}$

Now we are using $\boldsymbol{1-}$ ***based indexing , lets say we are deleting*** $\boldsymbol{a[1]}$:

$\boldsymbol{i = pos - 1 = 1 - 1 = 0\ and\ i = 0 < size - 1 = 6 - 1 = 5}$:

$$\boldsymbol{a[i = 0] = a[0 + 1 = 1] = 2}$$

$$\boldsymbol{a + 0 = 0x5000 + 0 \times 4\ bytes = 0x5000 + 0_{10} = 0x5000 + 0_{16} = 0x5000}$$

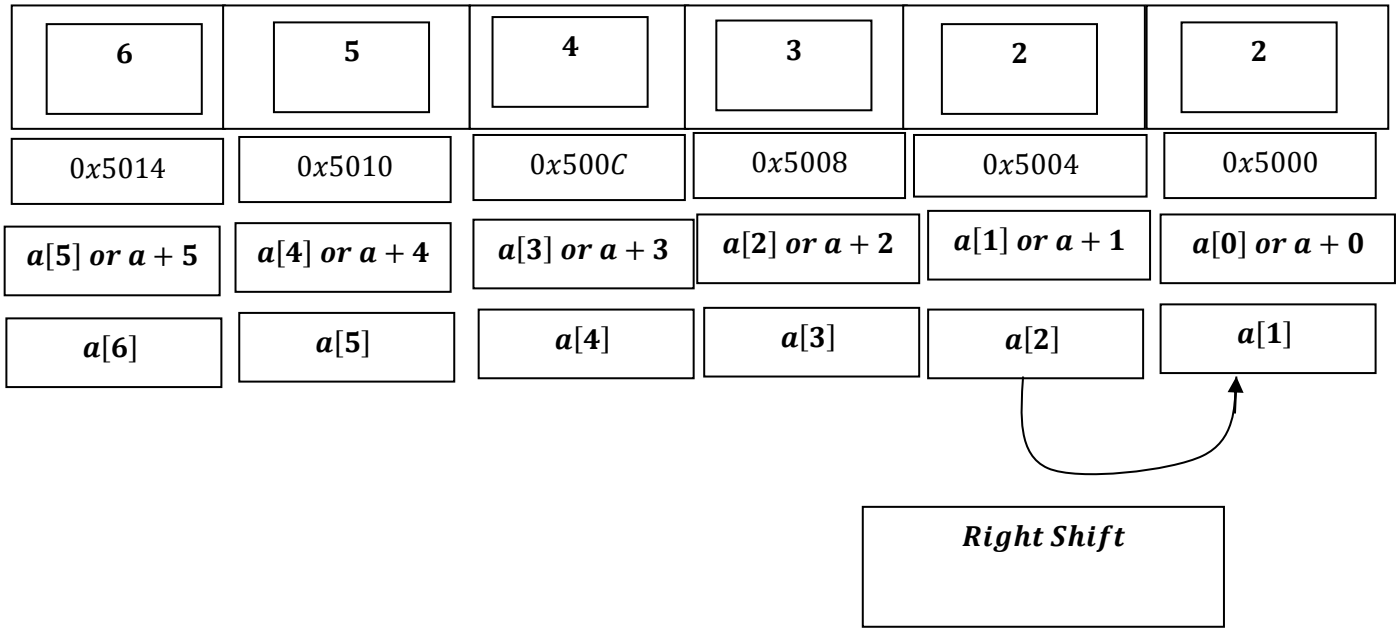
$$=$$

$$\boldsymbol{a + 1 = 0x5000 + 1 \times 4\ bytes = 0x5000 + 4_{10} = 0x5000 + 4_{16} = 0x5004}$$

$$\boldsymbol{= 2}$$

6	$0x5014$	$\boldsymbol{a[5]\ or\ a+5}$
5	$0x5010$	$\boldsymbol{a[4]\ or\ a+4}$
4	$0x500C$	$\boldsymbol{a[3]\ or\ a+3}$
3	$0x5008$	$\boldsymbol{a[2]\ or\ a+2}$
2	$0x5004$	$\boldsymbol{a[1]\ or\ a+1}$
2	$0x5000$	$\boldsymbol{a[0]\ or\ a+0}$

If we view it in this way:



$Now, i++ \Longrightarrow i = i + 1 \Longrightarrow i = 0 + 1 = 1. [Post\ increment]$

$i = 1\ and\ i = 1 < size - 1 = 6 - 1 = 5$:

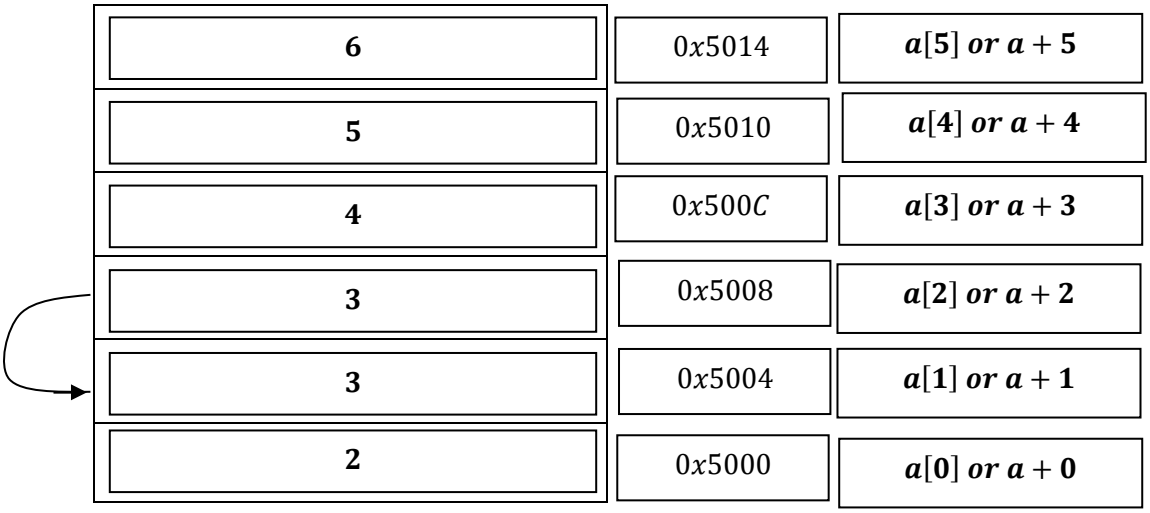
$a[i = 1] = a[1 + 1 = 2] = 3$

$a + 1 = 0x5000 + 1 \times 4\ bytes = 0x5000 + 4_{10} = 0x5000 + 4_{16} = 0x5004$

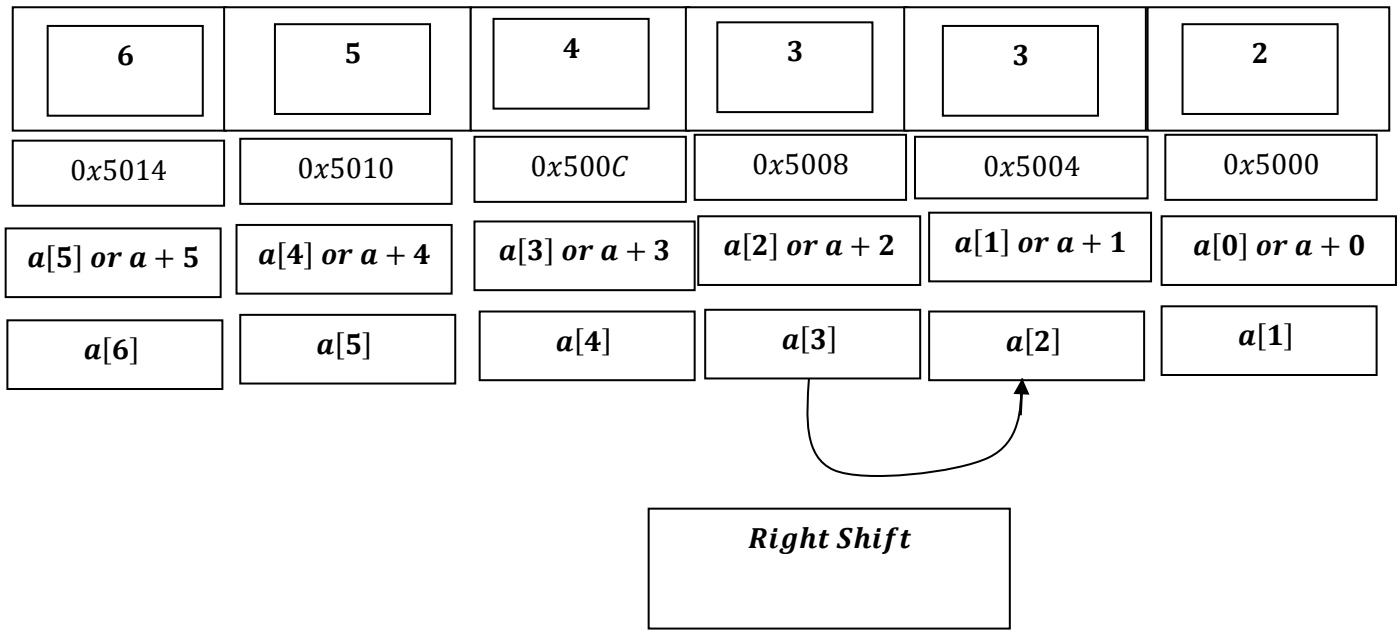
$=$

$a + 2 = 0x5000 + 2 \times 4\ bytes = 0x5000 + 8_{10} = 0x5000 + 8_{16} = 0x5008$

$= 3$



If we view it in this way:



$\boldsymbol{Now, i++ \Rightarrow i = i + 1 \Rightarrow i = 1 + 1 = 2.}$ [***Post increment***]

$\boldsymbol{i = 2\ and\ i = 2 < size - 1 = 6 - 1 = 5}$:

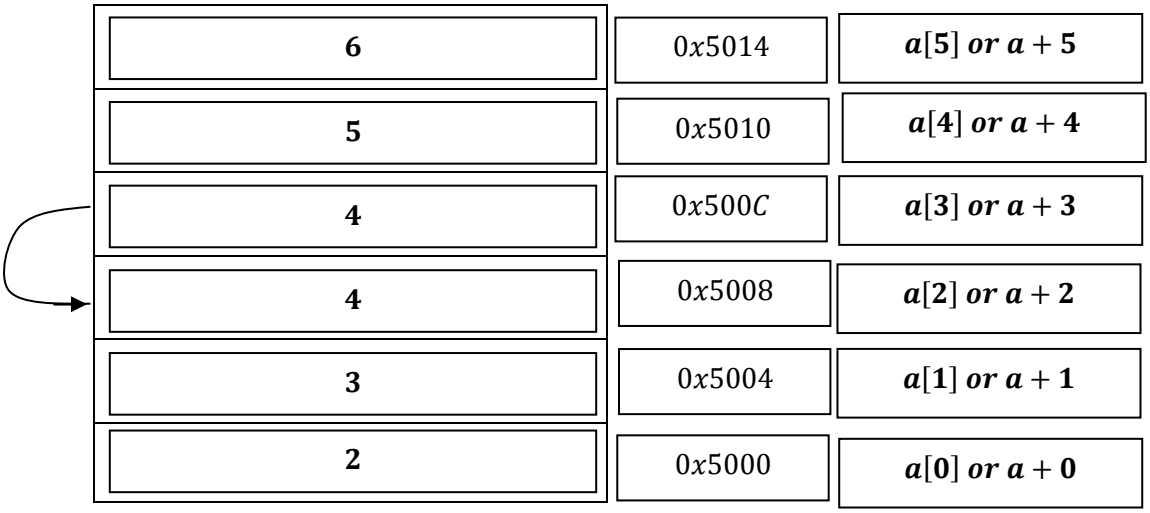
$\boldsymbol{a[i = 2] = a[2 + 1 = 3] = 4}$

$\boldsymbol{a + 2 = 0x5000 + 2 \times 4\ bytes = 0x5000 + 8_{10} = 0x5000 + 8_{16} = 0x5008}$

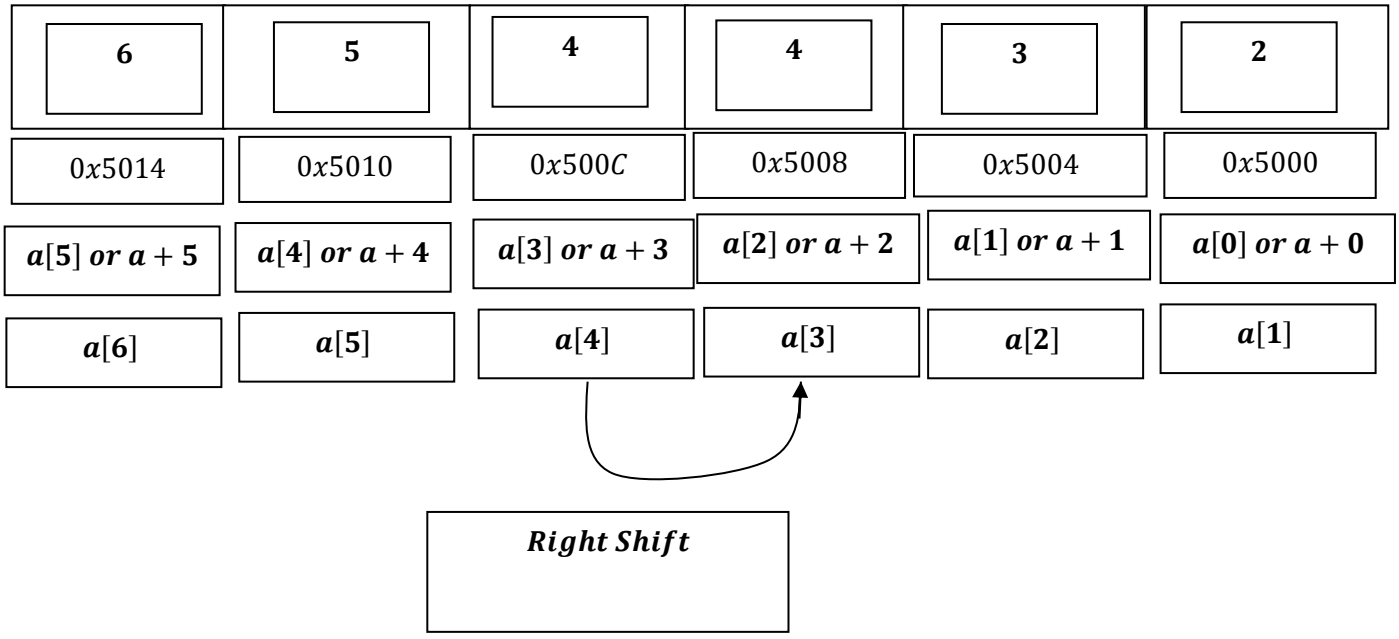
$\boldsymbol{=}$

$\boldsymbol{a + 3 = 0x5000 + 3 \times 4\ bytes = 0x5000 + 12_{10} = 0x5000 + C_{16} = 0x500C}$

$\boldsymbol{= 4}$.



If we view it in this way:



$Now, i++ \Longrightarrow i = i + 1 \Longrightarrow i = 2 + 1 = 3.$ [*Post increment*]

$i = 3$ *and* $i = 3 < size - 1 = 6 - 1 = 5$:

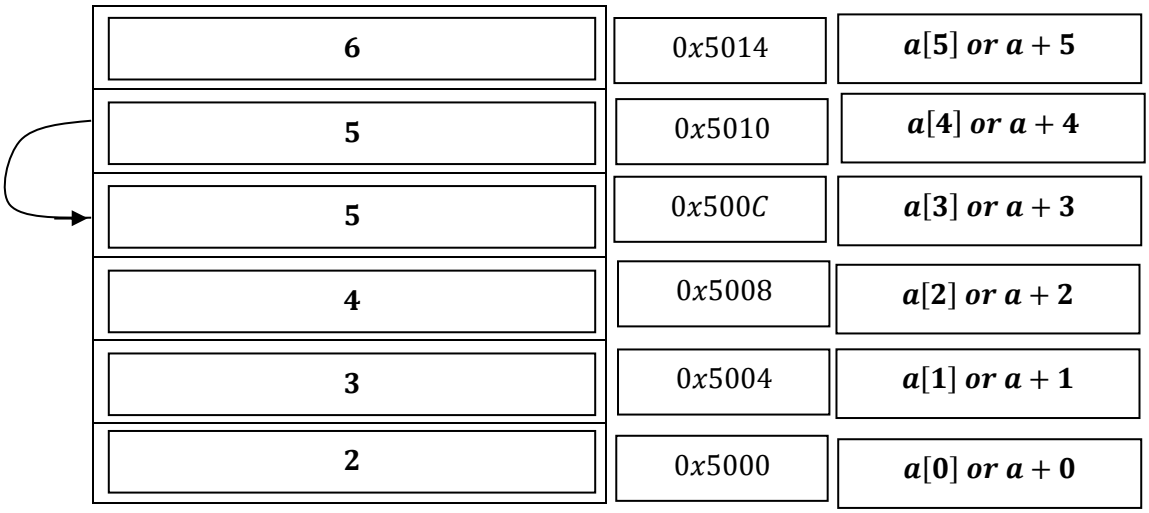
$a[i = 3] = a[3 + 1 = 4] = 5$

$a + 3 = 0x5000 + 3 \times 4\ bytes = 0x5000 + 12_{10} = 0x5000 + C_{16} = 0x500C$

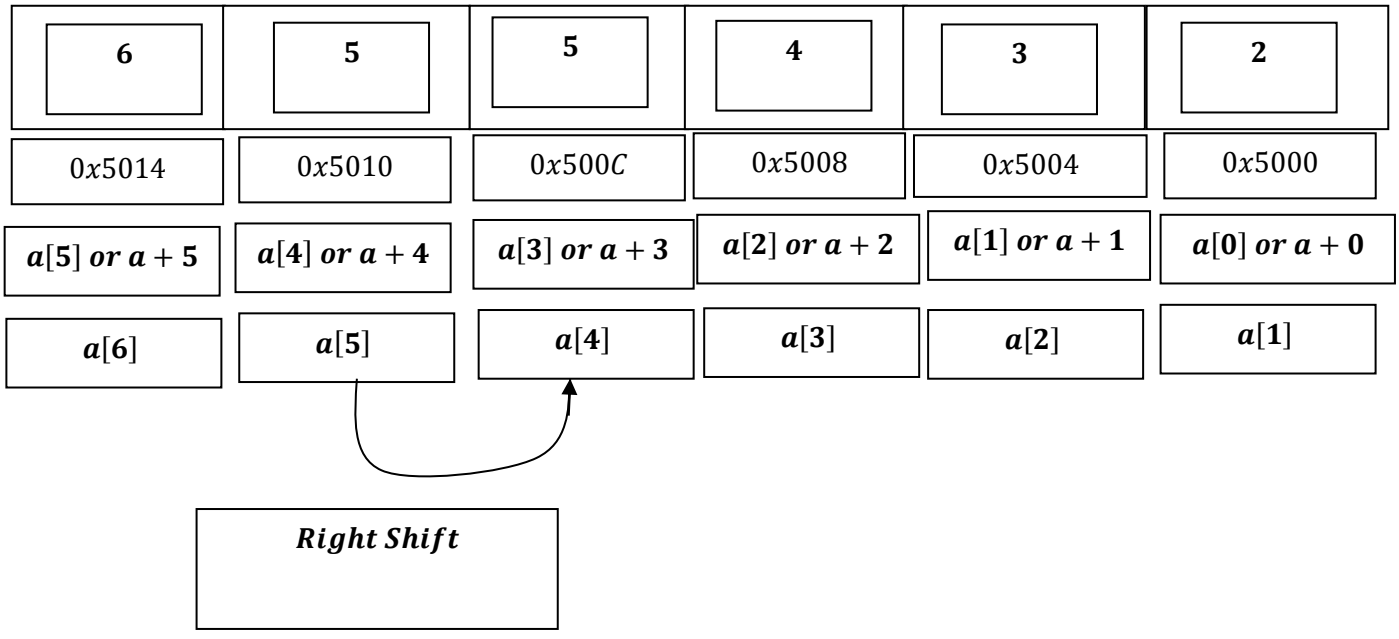
$=$

$a + 4 = 0x5000 + 4 \times 4\ bytes = 0x5000 + 16_{10} = 0x5000 + 10_{16} = 0x5010$

$= 5.$



If we view it in this way:



$Now, i++ \Longrightarrow i = i + 1 \Longrightarrow i = 3 + 1 = 4.$ [*Post increment*]

$i = 4$ *and* $i = 4 < size - 1 = 6 - 1 = 5$:

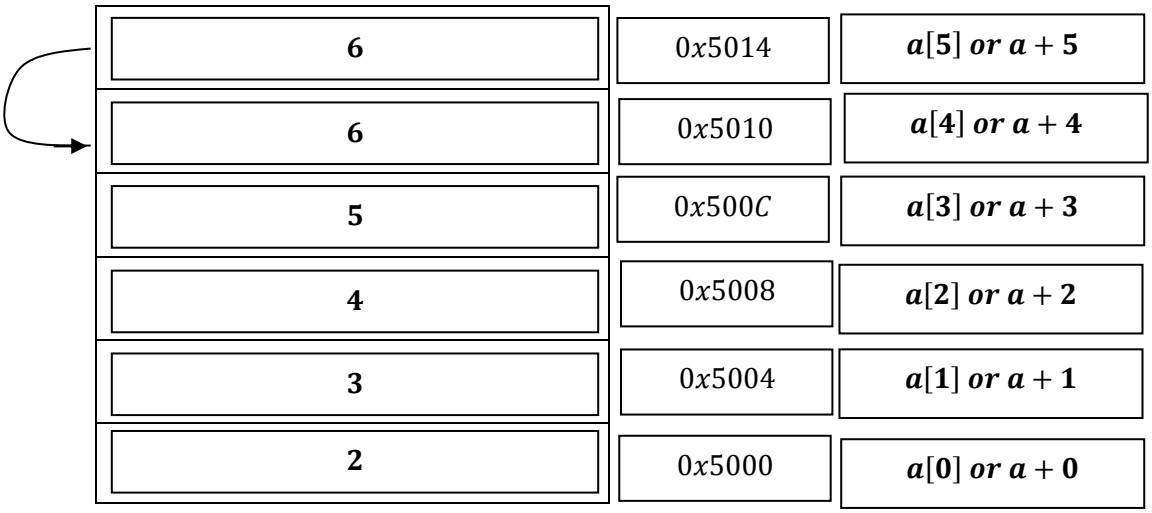
$a[i = 4] = a[4 + 1 = 5] = 6$

$a + 4 = 0x5000 + 4 \times 4\ bytes = 0x5000 + 16_{10} = 0x5000 + 10_{16} = 0x5010$

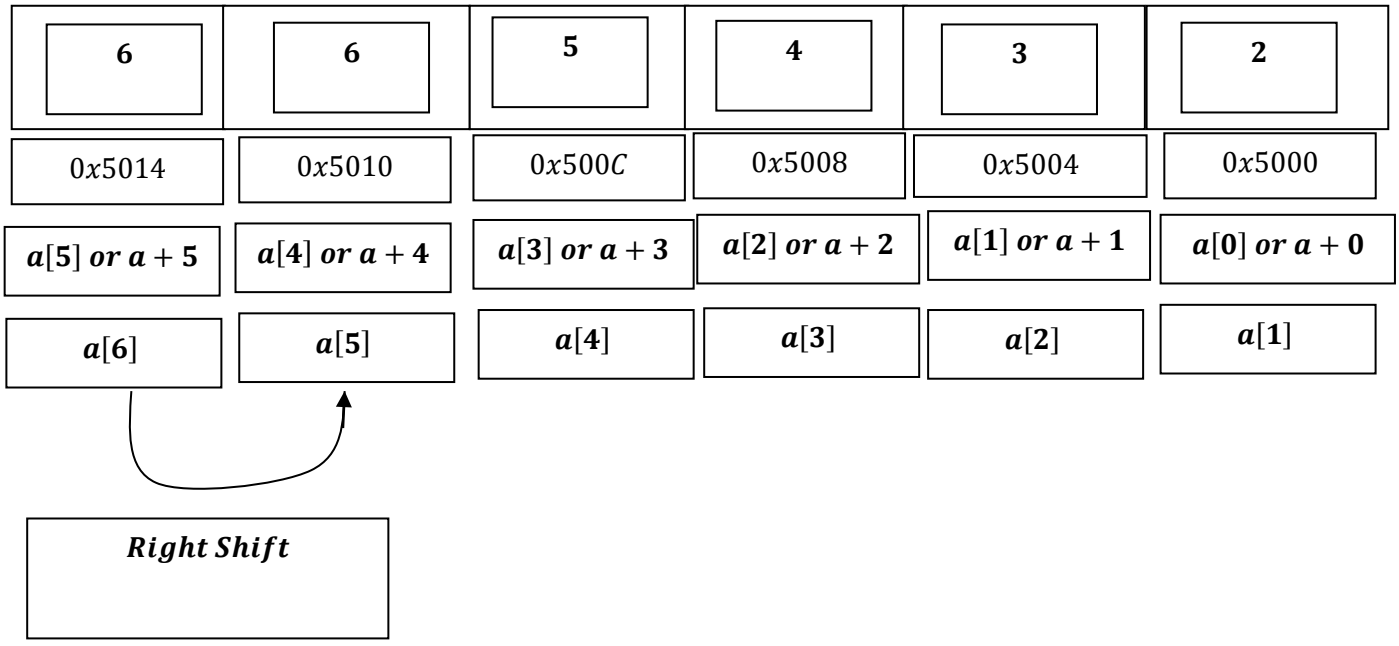
$=$

$a + 5 = 0x5000 + 5 \times 4\ bytes = 0x5000 + 20_{10} = 0x5000 + 14_{16} = 0x5014$

$= 6$.



If we view it in this way:



$Now, i++ \Longrightarrow i = i + 1 \Rightarrow i = 4 + 1 = 5.$ [*Post increment*]

$i = 5$ *and* $i = 5 < size - 1 = 6 - 1 = 5$, *the condition become false , hence loop exits.*

Then:

```
size = size - 1;
```

$size = 6 - 1 = 5$, *it becomes* 5.

```
for (int i = 0; i < size; i++)
{
    cout << "a[" << i << "]=" << a[i] << endl;
}
```

It prints:

$a[0] = 2$

$a[1] = 3$

$a[2] = 4$

$a[3] = 5$

$a[4] = 6$

For $0 -$ *based indexing*

$$a[i = 0] \rightarrow a[i = 0 + 1] = 2[Left\ to\ right\ shift] - 1\ time$$

$$a[i = 1] \rightarrow a[i = 1 + 1 = 2] = 3[Left\ to\ right\ shift] - 2nd\ time$$

$$a[i = 2] \rightarrow a[i = 2 + 1 = 3] = 4[Left\ to\ right\ shift] - 3rd\ time$$

$$a[i = 3] \rightarrow a[i = 3 + 1 = 4] = 5[Left\ to\ right\ shift] - 4rth\ time$$

$$a[i = 4] \rightarrow a[i = 4 + 1 = 5] = 6[Left\ to\ right\ shift] - 5th\ time$$

$$\textbf{Lower Bound} : i = pos$$

$$\textbf{Upper Bound} : \ i < size - 1$$

$$\textbf{Operation} : a[i] = a[i + 1]$$

```
for (int i = pos ; i < size - 1; i++)
{
    a[i] = a[i + 1];
}

size = size - 1;

cout << "The array after deletion is: " << endl;

for (int i = 0; i < size; i++)
{
    cout << "a[" << i << "]=" << a[i] << endl;
}
```

***This also change input validation , for $0-$ based indexing*:**

```
if (pos < 0 || pos > size-1)
{
    cout << "Invalid position";
}
```

***Also , input validation , for $1-$ based indexing*:**

```
if (pos < 1 || pos > size)
{
    cout << "Invalid position";
}
```
