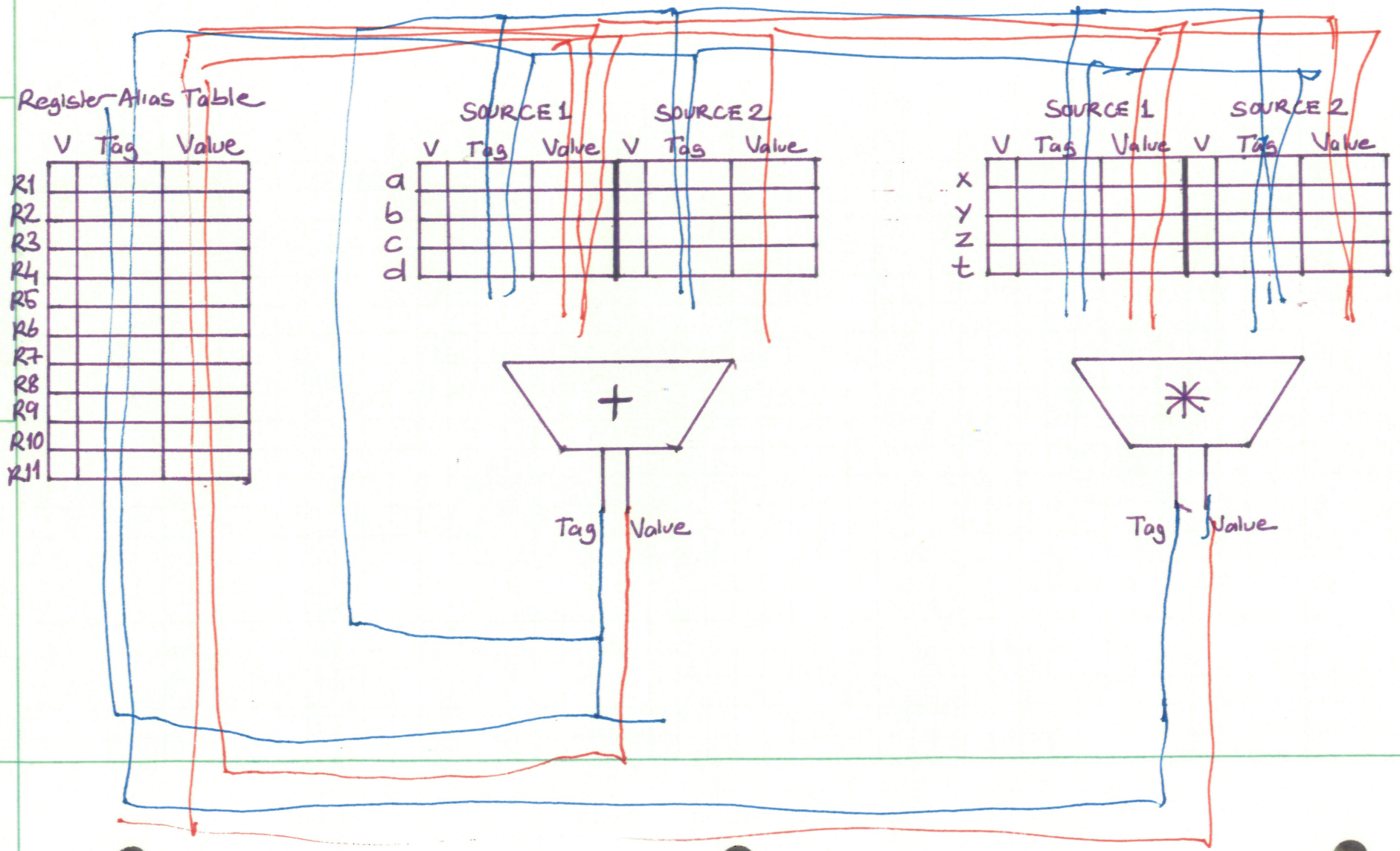
CYCLE ___

MUL R1, R2 → R3
ADD R3, R4 → R5
ADD R2, R6 → R7
ADD R8, R9 → R10
MUL R7, R10 → R11
ADD R5, R11 → R5

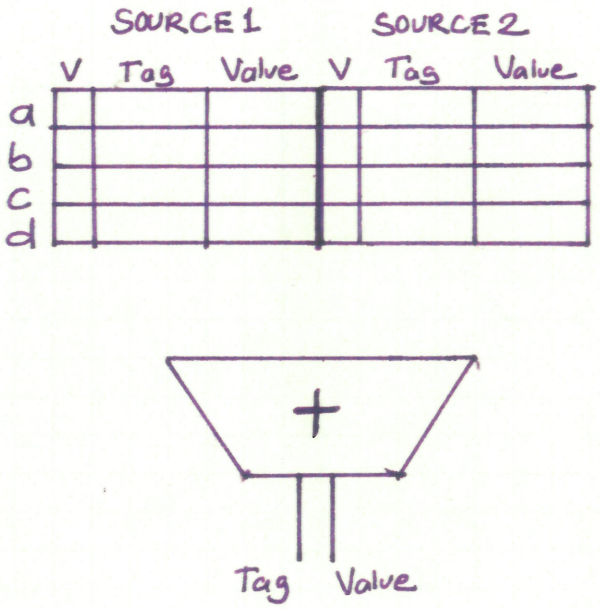


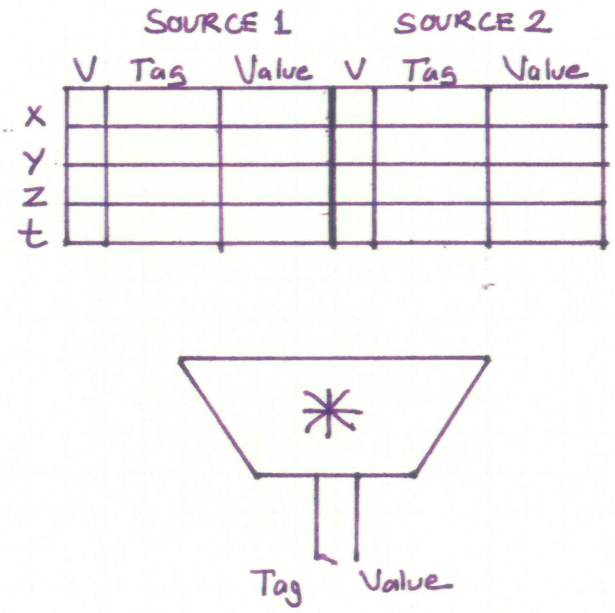
CYCLE 0

MUL R1, R2 → R3
ADD R3, R4 → R5
ADD R2, R6 → R7
ADD R8, R9 → R10
MUL R7, R10 → R11
ADD R5, R11 → R5

Register Alias Table

	V	Tag	Value
R1	1		1
R2	1		2
R3	1		3
R4	1		4
R5	1		5
R6	1		6
R7	1		7
R8	1		8
R9	1		9
R10	1		10
R11	1		11





CYCLE ~~1~~ 2

```
MUL R1, R2 → R3
ADD R3, R4 → R5
ADD R2, R6 → R7
ADD R8, R9 → R10
MUL R7, R10 → R11
ADD R5, R11 → R5
```

Execution Timeline

1 2

F D

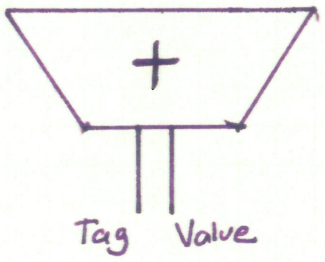
F

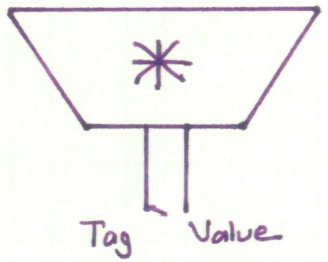
Register Alias Table

	V	Tag	Value
R1	1	~	1
R2	1	~	2
R3	0	X	~~3~~
R4	1		4
R5	1		5
R6	1		6
R7	1		7
R8	1		8
R9	1		9
R10	1		10
R11	1		11

	SOURCE 1			SOURCE 2		
	V	Tag	Value	V	Tag	Value
a						
b						
c						
d						

	SOURCE 1			SOURCE 2		
	V	Tag	Value	V	Tag	Value
x	1	~	1	1	~	2
y						
z						
t						





CYCLE ~~2~~ 3

```
MUL R1, R2 → R3
ADD R3, R4 → R5
ADD R2, R6 → R7
ADD R8, R9 → R10
MUL R7, R10 → R11
ADD R5, R11 → R5
```

Cycle 1 2

F D E_1
F D
F

Allocated?

S1 V
S2 V
E_1 Ready

Register Alias Table

	V	Tag	Value
R1	1		1
R2	1		2
R3	0	PR55	
R4	1		4
R5	0	a	~~5~~
R6	1		6
R7	1		7
R8	1		8
R9	1		9
R10	1		10
R11	1		11

	SOURCE 1			SOURCE 2		
	V	Tag	Value	V	Tag	Value
a	0	PR55	~	1	~	4
b						
c						
d						

	SOURCE 1			SOURCE 2		
	V	Tag	Value	V	Tag	Value
x	1	-	1	1	-	2
y						
z						
t						

Dest tag PR55

+

Tag Value

*

Tag Value

PRF

53

CYCLE ~~3~~ 4

```
MUL R1, R2 → R3
ADD R3, R4 → R5
ADD R2, R6 → R7
ADD R8, R9 → R10
MUL R7, R10 → R11
ADD R5, R11 → R5
```

Cycle 1 2 3 4

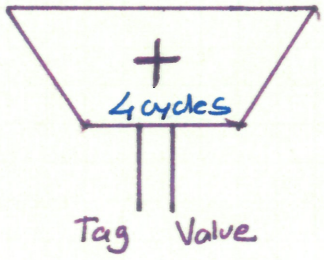
```
F D E1 E2
  F D  —
    F  D
       F
```

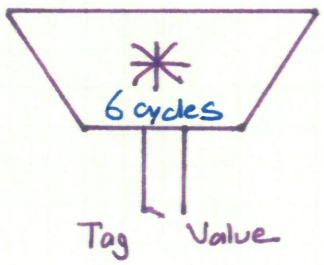
Register Alias Table

	V	Tag	Value
R1	1	–	1
R2	1	–	2
R3	0	x	–
R4	1	–	4
R5	0	a	–
R6	1		6
R7	0	b	~~7~~
R8	1		8
R9	1		9
R10	1		10
R11	1		11

	SOURCE 1			SOURCE 2		
	V	Tag	Value	V	Tag	Value
a	0	x	–	1	–	4
b	1	–	2	1	–	6
c						
d						

	SOURCE 1			SOURCE 2		
	V	Tag	Value	V	Tag	Value
x	1	–	1	1	–	2
y						
z						
t						





Does the tag HAVE TO be the ID of the Reservation Station Entry?

CYCLE ~~4~~ 5

```
MUL R1, R2 → R3
ADD R3, R4 → R5
→ ADD R2, R6 → R7
ADD R8, R9 → R10
MUL R7, R10 → R11
ADD R5, R11 → R5
```

Cycle 1 2 3 4

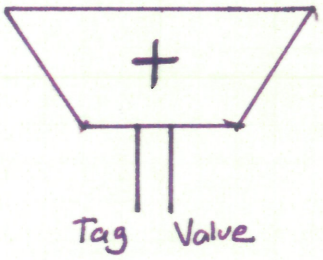
```
F D E1 E2 E3
  F D  -  -
    F D  E1
      F  D
         F
```

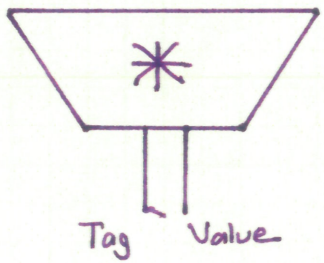
Register Alias Table

	V	Tag	Value
R1	1		1
R2	1		2
R3	0	x	
R4	1		4
R5	0	a	
R6	1		6
R7	0	b	
→ R8	1		8
→ R9	1		9
R10	0	c	~~10~~
R11	1		11

	SOURCE 1			SOURCE 2		
	V	Tag	Value	V	Tag	Value
a	0	x	-	1	-	4
b	1	→	2	1	-	6
c	1	~	8	1	-	9
d						

	SOURCE 1			SOURCE 2		
	V	Tag	Value	V	Tag	Value
x	1	-	1	1	-	2
y						
z						
t						





→ ADD at RS b can execute now (it is READY)

→ Both of its sources are READY
It wakes up & it is selected to be executed
Out of order dispatch into the functional unit

CYCLE 5 6

```
MUL R1, R2 → R3
ADD R3, R4 → R5
ADD R2, R6 → R7   b
ADD R8, R9 → R10  c
MUL R7, R10 → R11
ADD R5, R11 → R5
```

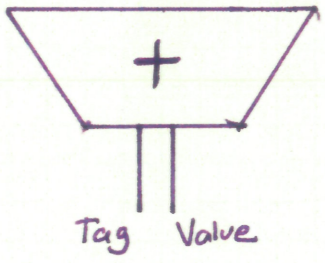
Cycle	1	2	3	4	5
	F	D	E_1	E_2	E_3	E_4
		F	D	-	-	-
			F	D	E_1	E_2
				F	D	E_1
					F	D
						F

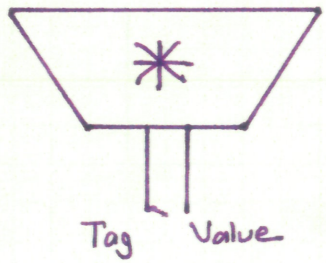
Register Alias Table

	V	Tag	Value
R1	1	-	1
R2	1		2
R3	0	x	
R4	1		4
R5	0	a	
R6	1		6
R7	0	b	
R8	1		8
R9	1		9
R10	0	c	
R11	0	y	

	SOURCE 1			SOURCE 2		
	V	Tag	Value	V	Tag	Value
a	0	x	-	1	-	4
b	1	-	2	1	-	6
c	1	-	8	1	-	9
d						

	SOURCE 1			SOURCE 2		
	V	Tag	Value	V	Tag	Value
x	1	-	1	1	-	2
y	0	b	~~	0	c	~~
z						
t						





ADD at RS c is READY to Execute

CYCLE 6

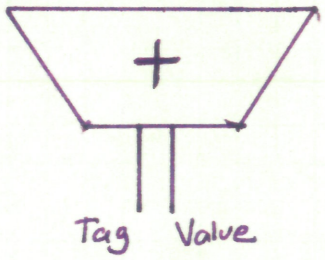
```
MUL R1, R2 → R3
ADD R3, R4 → R5
ADD R2, R6 → R7
ADD R8, R9 → R10
MUL R7, R10 → R11
ADD R5, R11 → R5
```

```
Cycle  1  2  3  4  5  6  7
       F  D  E1 E2 E3 E4 E5
          F  D  -  -  -  -
             F  D  E1 E2 E3
                F  D  E1 E2
                   F  D  -
                      F  D
```

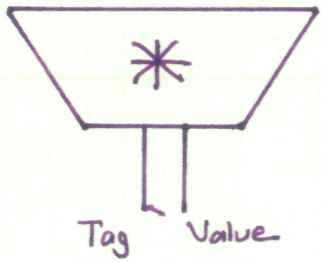
Register Alias Table

	V	Tag	Value
R1	1		1
R2	1		2
R3	0	x	
R4	1		4
R5	0	a	
R6	1		6
R7	0	b	
R8	1		8
R9	1		9
R10	0	c	
R11	0	y	

	SOURCE 1			SOURCE 2		
	V	Tag	Value	V	Tag	Value
a	0	x	–	1	–	4
b	1	–	2	1	–	6
c	1	–	8	1	–	9
d	0	a	~	0	y	~



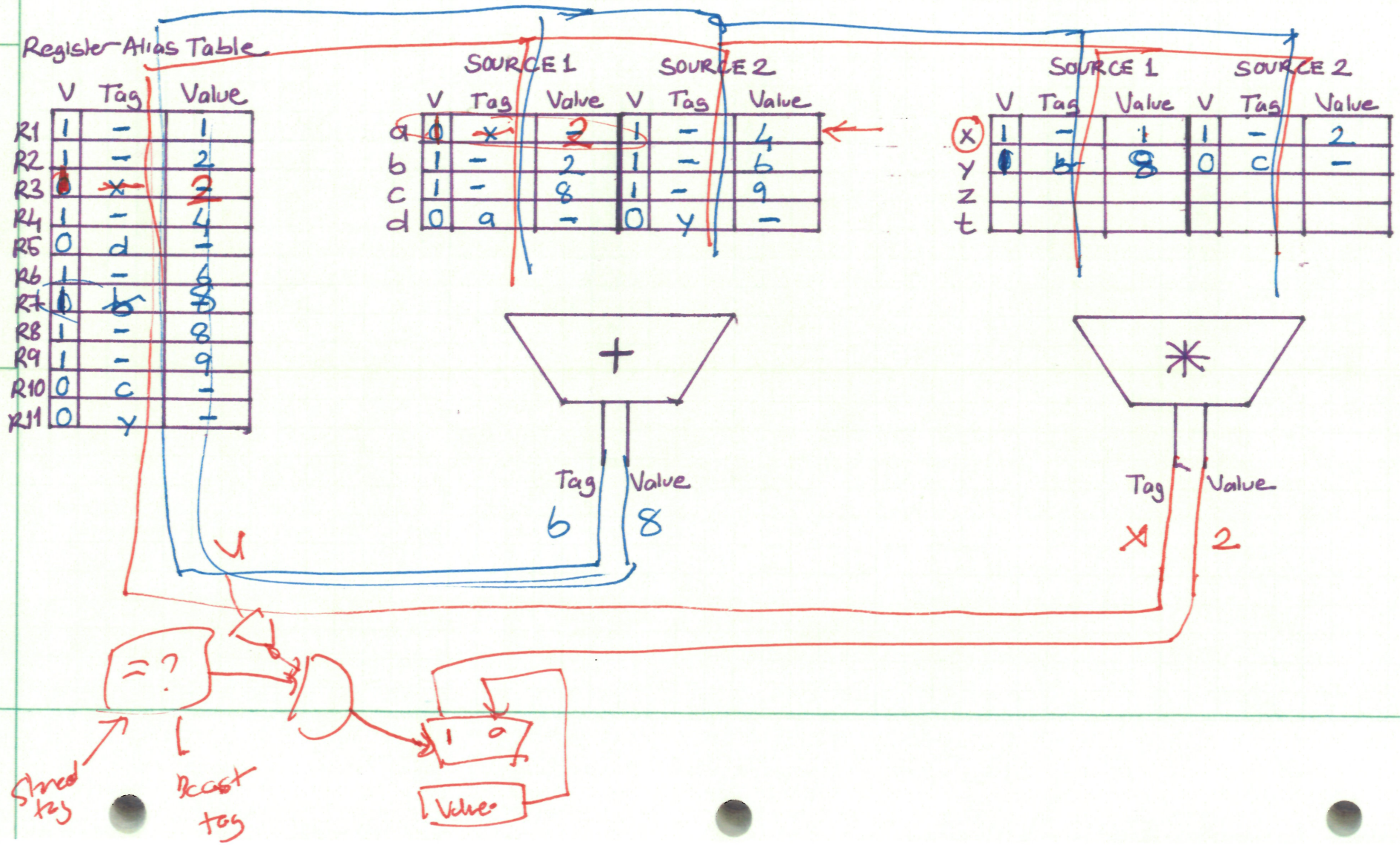
	SOURCE 1			SOURCE 2		
	V	Tag	Value	V	Tag	Value
x	1	–	1	1	–	2
y						
z						
t						



CYCLE ~~7~~ 8

```
MUL R1, R2 → R3
ADD R3, R4 → R5
ADD R2, R6 → R7
ADD R8, R9 → R10
MUL R7, R10 → R11
ADD R5, R11 → R5
```

```
Cycle  1  2  3  4  5  6  7  8
       F  D  E1 E2 E3 E4 E5 E6
          F  D  -  -  -  -  -
             F  D  E1 E2 E3 E4
                F  D  E1 E2 E3
                   F  D  -  -
                      F  D  -
```

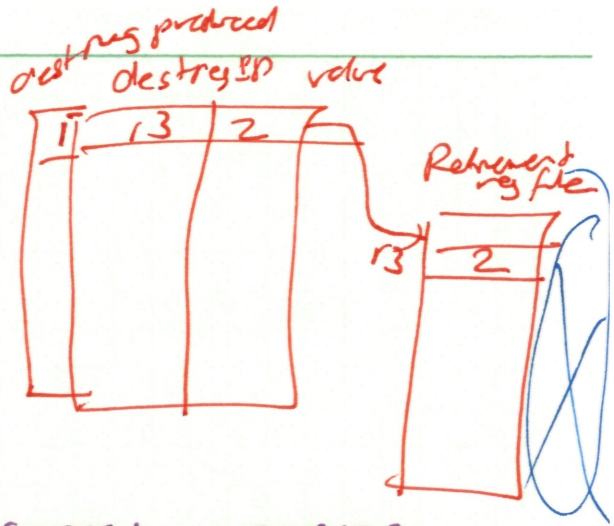


CYCLE 8 9

```
MUL R1, R2 → R3
ADD R3, R4 → R5
ADD R2, R6 → R7
ADD R8, R9 → R10
MUL R7, R10 → R11
ADD R5, R11 → R5
```

```
Cycle  1 2 3 4 5 6 7 8 9
       F D E1 E2 E3 E4 E5 E6 R W
         F D  -  -  -  -  -
            F D E1 E2 E3 E4
               F D E1 E2 E3
                  F D  -  -
                     F D  -
```

Clustering



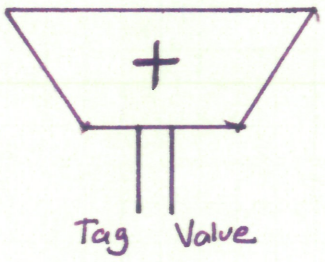
Future

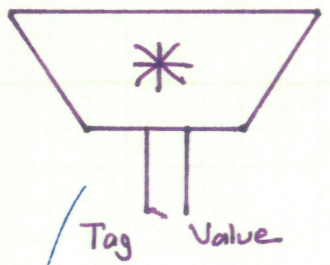
Register Alias Table

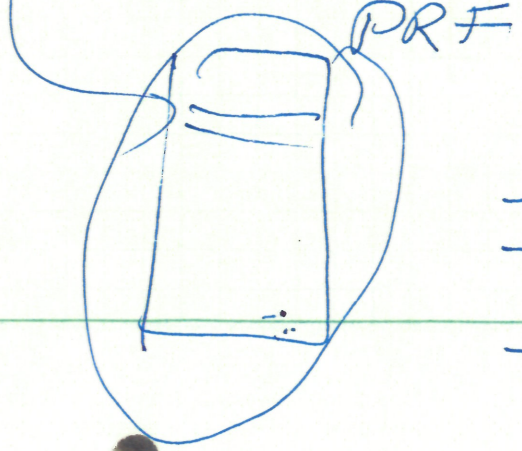
	V	Tag	Value
R1			
R2			
R3	1	x → –	2
R4			
R5			
R6	1	b → –	8
R7			
R8			
R9			
R10			
R11			

	SOURCE 1			SOURCE 2		
	V	Tag	Value	V	Tag	Value
a	1	x → –	2	1	–	4
b	1	–	2	1	–	6
c						
d						

	SOURCE 1			SOURCE 2		
	V	Tag	Value	V	Tag	Value
x	1	–	1	1	–	2
y	1	b → –	8	0	c	–
z						
t						



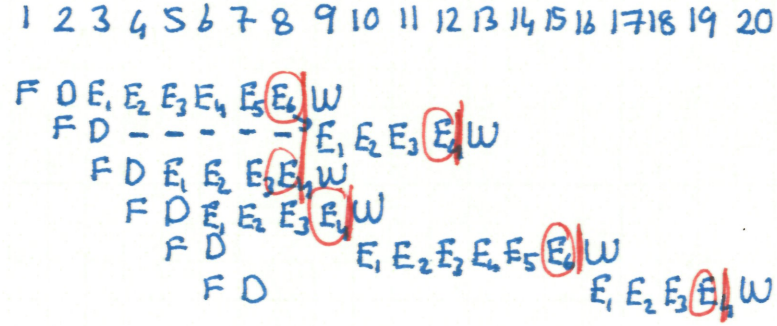




→ MUL at RS x broadcasts its tag & value
→ All RS and RAT entries waiting for the tag capture the value and set their V bits
→ ADD at RS a becomes READY to execute now!

CYCLE 20

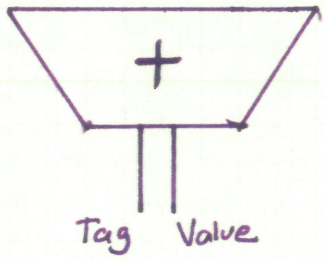
```
MUL R1, R2 → R3
ADD R3, R4 → R5
ADD R2, R6 → R7
ADD R8, R9 → R10
MUL R7, R10 → R11
ADD R5, R11 → R5
```



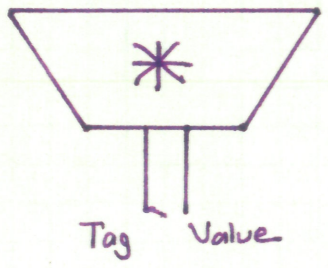
Register Alias Table

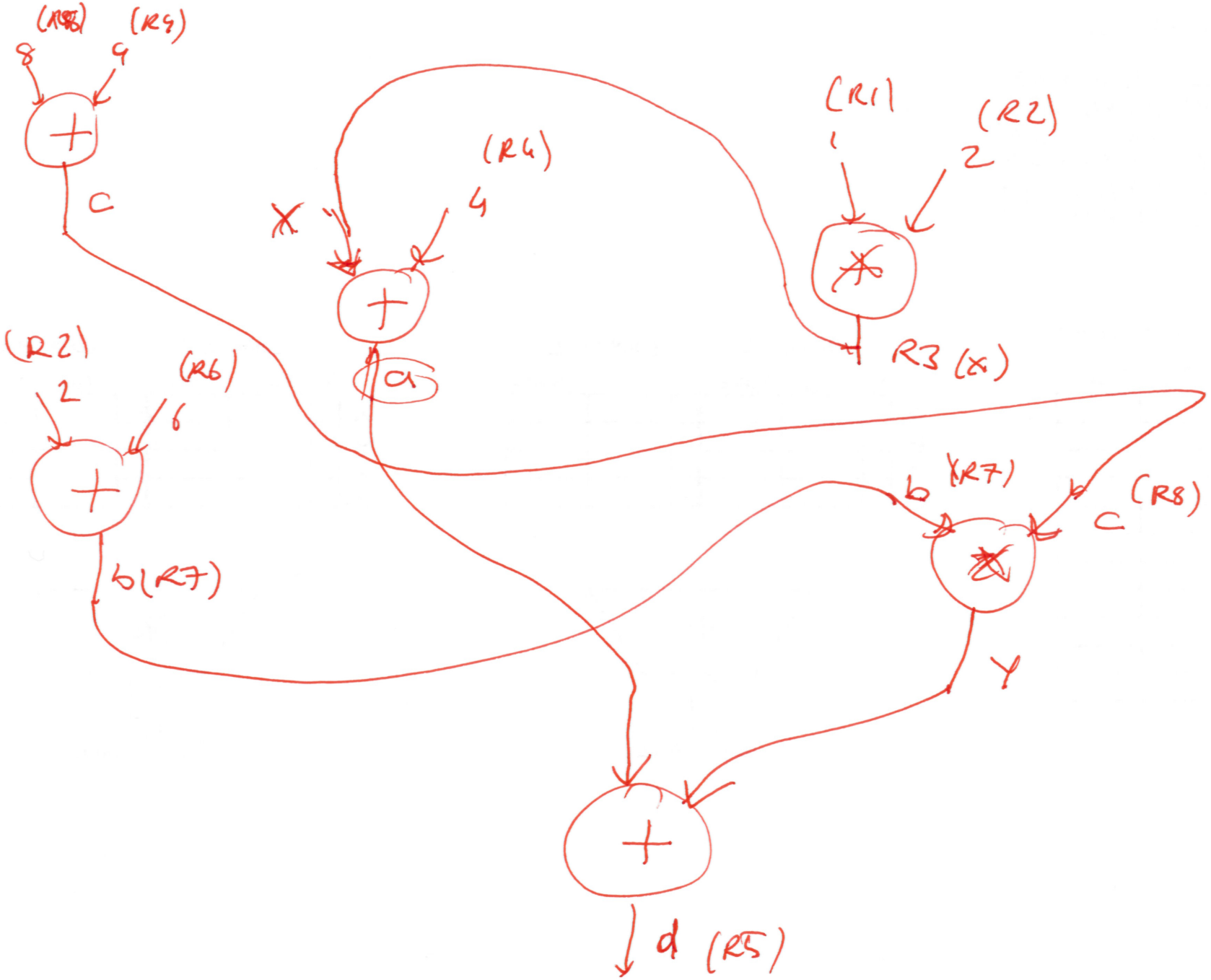
	V	Tag	Value
R1			
R2			
R3			
R4			
R5			
R6			
R7			
R8			
R9			
R10			
R11			

	SOURCE 1			SOURCE 2		
	V	Tag	Value	V	Tag	Value
a						
b						
c						
d						



	SOURCE 1			SOURCE 2		
	V	Tag	Value	V	Tag	Value
x						
y						
z						
t						




(R8)
(R9)
8
9
c
X
(R4)
4
a
(R1)
1
(R2)
2
R3 (x)
(R2)
2
(R6)
6
b(R7)
b
(R7)
c
(R8)
Y
d (R5)