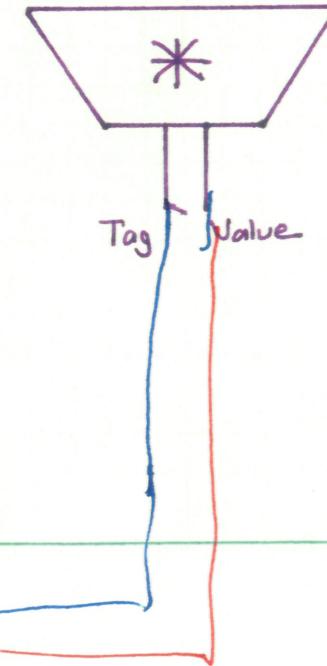
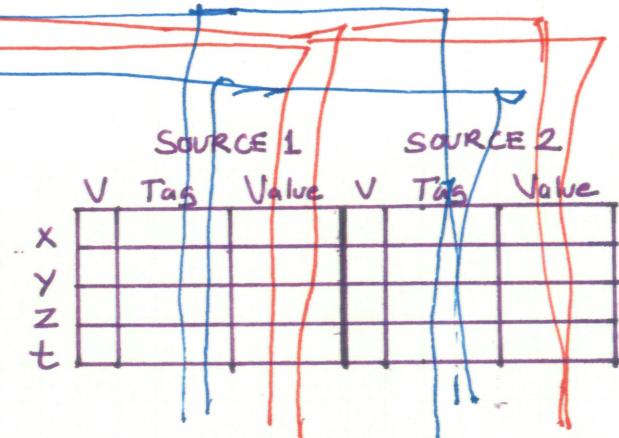
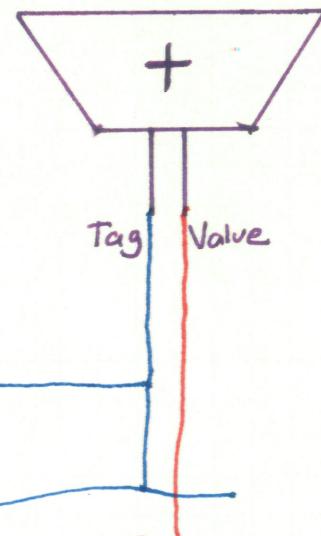
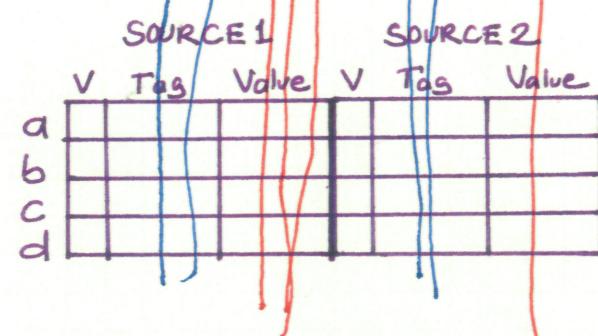


## CYCLE —

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

Register Alias Table

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



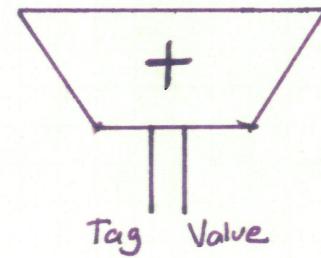
## CYCLE 0

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

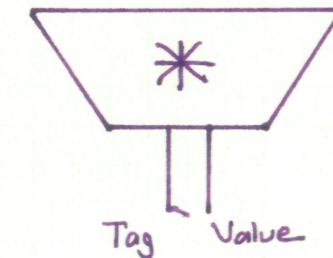
Register Alias Table

	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

	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						



CYCLE  $\xleftarrow{2}$

MUL R1, R2  $\rightarrow$  R3  
ADD R3, R4  $\rightarrow$  R5  
ADD R2, R6  $\rightarrow$  R7  
ADD R8, R9  $\rightarrow$  R10  
MUL R7, R10  $\rightarrow$  R11  
ADD R5, R11  $\rightarrow$  R5

Execution Timeline

I 2  
F D  
F

Register Alias Table

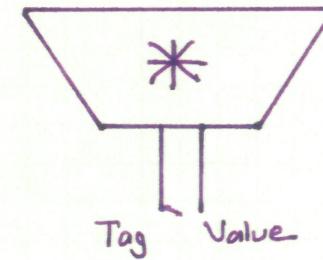
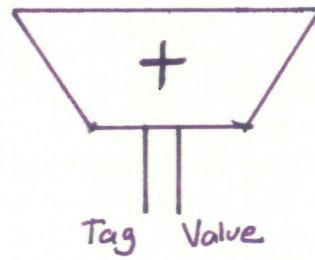
	V	Tag	Value
R1	I	~	1
R2	I	~	2
R3	0	X	3
R4	I		4
R5	I		5
R6	I		6
R7	I		7
R8	I		8
R9	I		9
R10	I		10
R11	I		11

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	I	~	1	I	~	2
y						
z						
t						

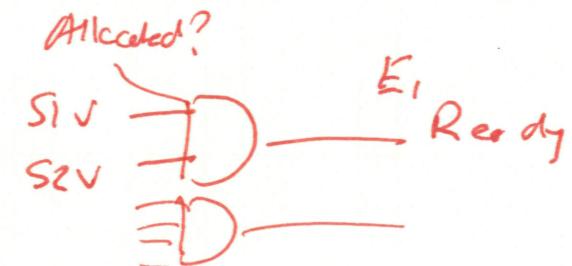


CYCLE ~~2~~<sup>3</sup>

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~~

~~F D E<sub>1</sub>~~  
~~F D~~  
~~F~~

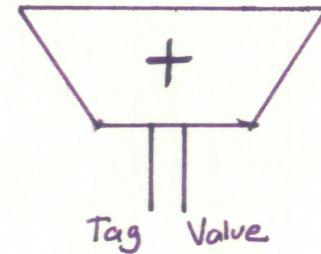


Register Alias Table

	V	Tag	Value
R1	1	1	
R2	1	2	
R3	0	0	<del>PRSS</del>
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

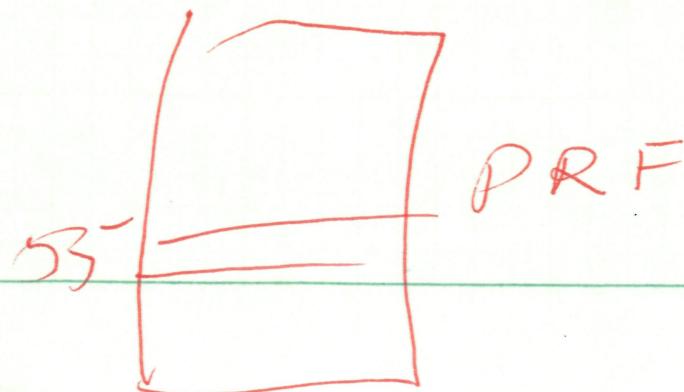
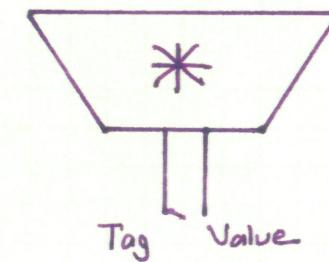
	V	Tag	Value	V	Tag	Value
a	0	PRSS	~	1	~	4
b						
c						
d						



SOURCE 1

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

Dest tag PRSS



CYCLE 3 <sup>4</sup>

Cycle 1 2 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

F D E, E<sub>2</sub>  
F D  
F D  
F

Register Alias Table

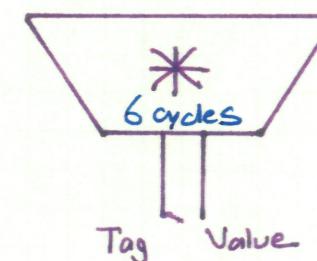
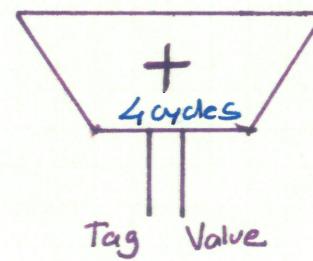
	V	Tag	Value
R1	1	-	1
R2	1	-	2
R3	0	X	-
R4	1	-	4
R5	0	a	-
R6	1	-	6
R7	0	b	7
R8	1	-	8
R9	1	-	9
R10	1	-	10
R11	1	-	11

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<sup>5</sup>

Cycle 1 2 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 → RS

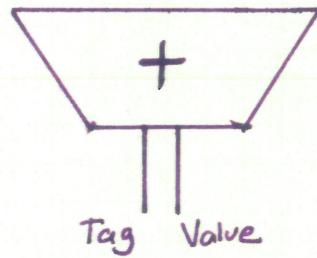
F D E<sub>1</sub> E<sub>2</sub> E<sub>3</sub>  
 F D - -  
 F D E<sub>1</sub> -  
 F D  
 F

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

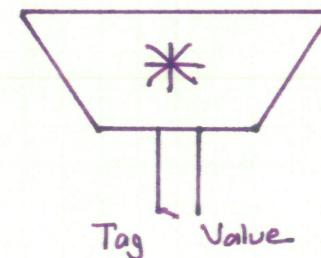
SOURCE 1      SOURCE 2

	V	Tag	Value	V	Tag	Value
a	0	x	-	1	-	4
b	1	-	2	1	-	6
c	0	~	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 <sup>6</sup>

Cycle 1 2 3 4 5

MUL R1, R2 → R3  
 ADD R3, R4 → R5  
 ADD R2, R6 → R7 <sup>a</sup>  
 ADD R8, R9 → R10 <sup>c</sup>  
 MUL R7, R10 → R11 <sup>b</sup>  
 ADD R5, R11 → R5

F D E<sub>1</sub> E<sub>2</sub> E<sub>3</sub> E<sub>4</sub>  
 F D - - -  
 F D E<sub>1</sub> E<sub>2</sub>  
 F D E<sub>1</sub>  
 F D  
 F

Register Alias Table

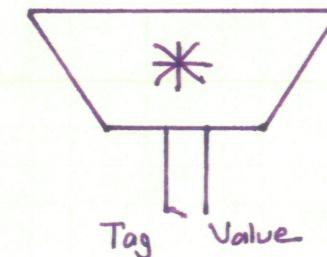
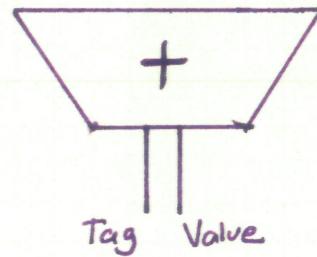
V	Tag	Value
R1	1	1
R2	1	2
R3	0	x
R4	1	4
R5	0	a
R6	1	6
R7	0	b
R8	1	8
R9	1	9
R10	0	c
R11	0	y

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	-	r	1	-
y	0	b	o	e	-
z					
t					



ADD at RSC c is READY to Execute

CYCLE 6

Cycle 1 2 3 4 5 6 7

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

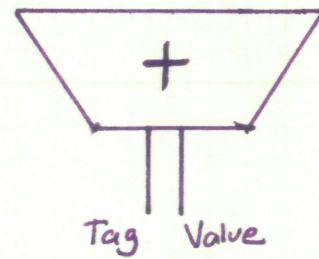
F D E<sub>1</sub> E<sub>2</sub> E<sub>3</sub> E<sub>4</sub> E<sub>5</sub>  
 FD - - -  
 F D E<sub>1</sub> E<sub>2</sub> E<sub>3</sub>  
 F D E<sub>1</sub> E<sub>2</sub>  
 FD -  
 FD

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	e	10
R11	0	y	-

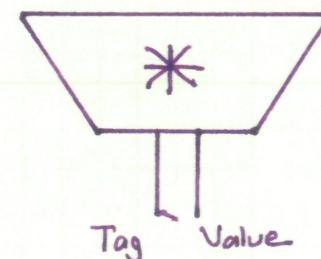
SOURCE 1      SOURCE 2

	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

Cycle 1 2 3 4 5 6 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

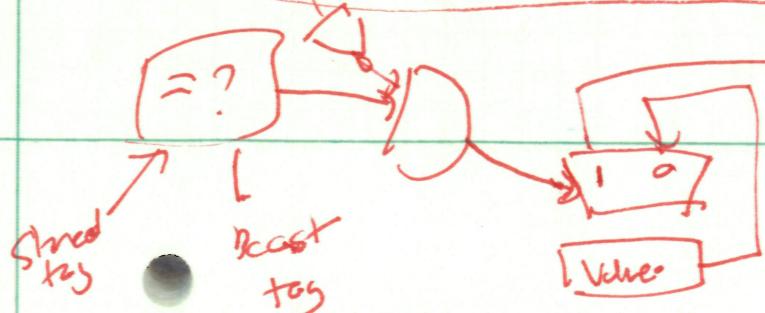
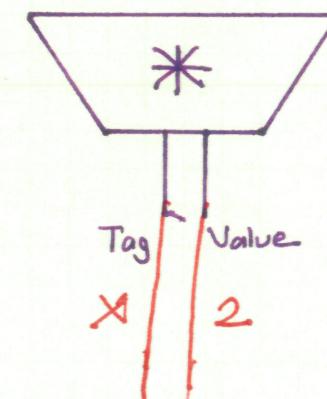
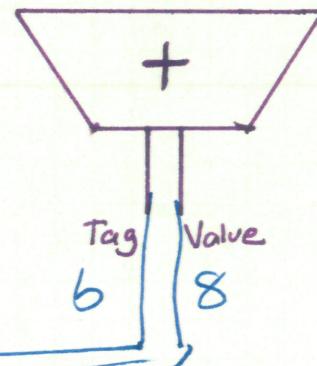
F D E<sub>1</sub> E<sub>2</sub> E<sub>3</sub> E<sub>4</sub> E<sub>5</sub> E<sub>6</sub> I  
 F D - - - - -  
 F D E<sub>1</sub> E<sub>2</sub> E<sub>3</sub> E<sub>4</sub> I  
 F D E<sub>1</sub> E<sub>2</sub> E<sub>3</sub> I  
 F D - - -  
 F D - - -

Register Alias Table

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

	SOURCE 1		SOURCE 2			
	V	Tag	Value	V	Tag	Value
a	0	X	2	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	0	b	8	0	c	-
z	-	-	-	-	-	-
t	-	-	-	-	-	-



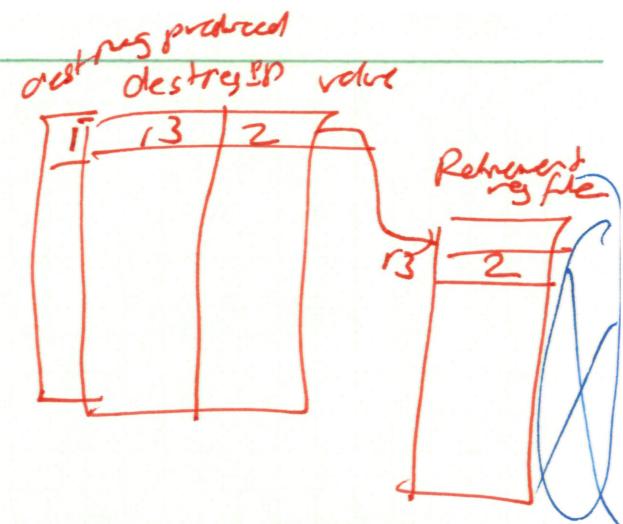
CYCLE 8 <sup>9</sup>

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 E, E<sub>2</sub> E<sub>3</sub> E<sub>4</sub> E<sub>5</sub> E<sub>6</sub> ~~W~~ W  
 FD - - - - -  
 F D E, E<sub>2</sub> E<sub>3</sub> E<sub>4</sub> ~~E<sub>5</sub>~~  
 F D E<sub>1</sub> E<sub>2</sub> E<sub>3</sub>  
 FD - -  
 FD -

Clustering



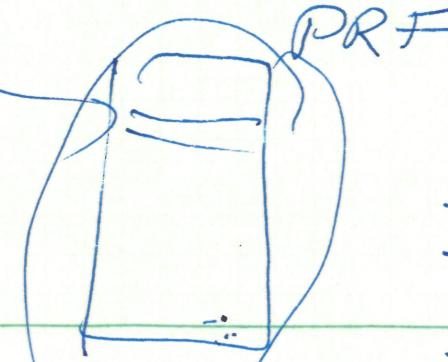
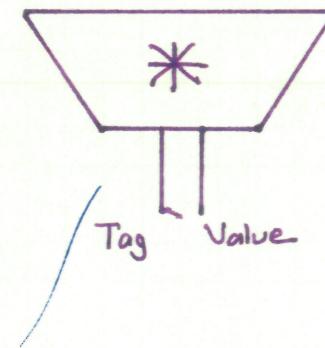
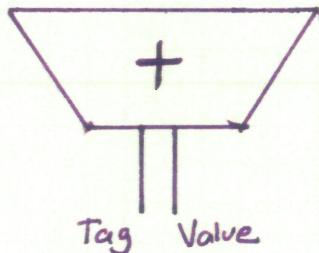
Future

Register Alias Table

	V	Tag	Value
R1			
R2			
<u>R3</u>	1	$x \rightarrow -$	2
R4			
R5			
R6	1	$b \rightarrow -$	8
R7			
R8			
R9			
R10			
R11			

	SOURCE 1			SOURCE 2		
	V	Tag	Value	V	Tag	Value
a	1	$x \rightarrow -$	2	1	-	4
b	1	-	$x \rightarrow -$	1	-	6
c						
d						

	SOURCE 1			SOURCE 2		
	V	Tag	Value	V	Tag	Value
x	1	-	1	1	-	2
y	1	$b \rightarrow -$	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

Cycle 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 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

F D E, E<sub>2</sub> E<sub>3</sub> E<sub>4</sub> E<sub>5</sub> E<sub>6</sub> W  
 F D E, E<sub>2</sub> E<sub>3</sub> E<sub>4</sub> W

### 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						

