

Cycle 0

```
LOOP: subi r1, r1, 1
muld f0, f1, f1
addd f0, f2, f2
bne r1, r0, LOOP
addd f1, f2, f3
```

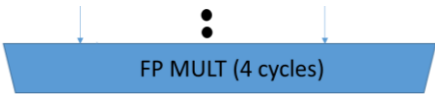
	Tag	Value	Valid
f0		0	1
f1		1	1
f2		2	1
f3		3	1

	Tag	Value	Valid
r0		0	1
r1		2	1

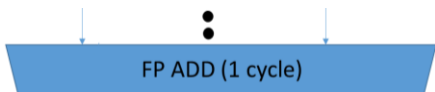
	Inst	Reg	Value	Valid
A	-	-	-	0
B	-	-	-	0
C	-	-	-	0
D	-	-	-	0
E	-	-	-	0

...
ROB

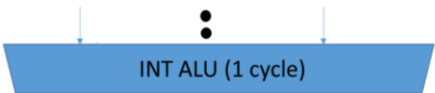
Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Cycle 1

```
LOOP: subi r1, r1, 1    Dispatch
      muld f0, f1, f1    Fetch
      addd f0, f2, f2
      bne r1, r0, LOOP
      addd f1, f2, f3
```

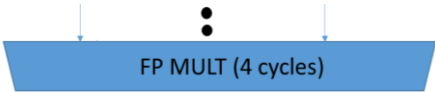
	Tag	Value	Valid
f0		0	1
f1		1	1
f2		2	1
f3		3	1

	Tag	Value	Valid
r0		0	1
r1	A	2	0

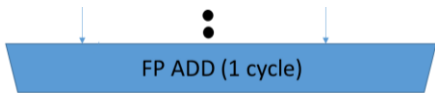
	Inst	Reg	Value	Valid
A	subi	r1	-	0
B	-	-	-	0
C	-	-	-	0
D	-	-	-	0
E	-	-	-	0

...
ROB

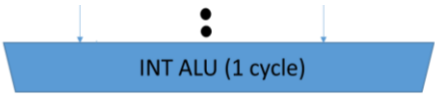
Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	2	1	-	-	0	A
-	-	0	-	-	0	-



Cycle 2

```
LOOP: subi r1, r1, 1    Issue (E1)
      muld f0, f1, f1    Dispatch
      addd f0, f2, f2    Fetch
      bne r1, r0, LOOP
      addd f1, f2, f3
```

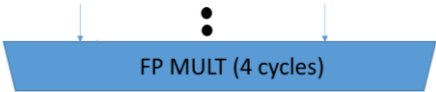
	Tag	Value	Valid
f0		0	1
f1	B	1	0
f2		2	1
f3		3	1

	Tag	Value	Valid
r0		0	1
r1	A	2	0

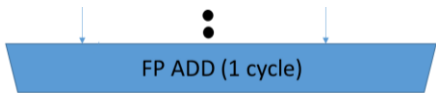
	Inst	Reg	Value	Valid
A	subi	r1	-	0
B	muld	f1	-	0
C	-	-	-	0
D	-	-	-	0
E	-	-	-	0

...
ROB

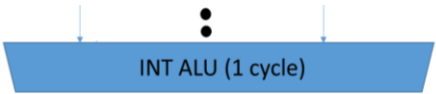
Tag	Value	Valid	Tag	Value	Valid	ROB
-	0	1	-	1	1	B
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	2	1	-	-	0	A
-	-	0	-	-	0	-



Cycle 3

```
LOOP: subi r1, r1, 1    WB
      muld f0, f1, f1    Issue (E1)
      addd f0, f2, f2    Dispatch
      bne r1, r0, LOOP   Fetch (and predict as Taken)
      addd f1, f2, f3
```

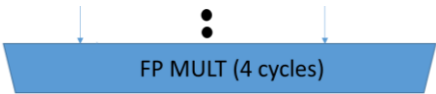
	Tag	Value	Valid
f0		0	1
f1	B	1	0
f2	C	2	0
f3		3	1

	Tag	Value	Valid
r0		0	1
r1	A	2	0

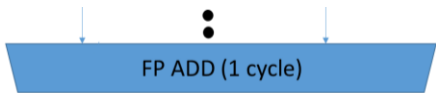
	Inst	Reg	Value	Valid
A	subi	r1	1	1
B	muld	f1	-	0
C	addd	f2	-	0
D	-	-	-	0
E	-	-	-	0

...
ROB

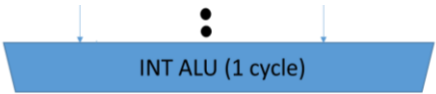
Tag	Value	Valid	Tag	Value	Valid	ROB
-	0	1	-	1	1	B
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	0	1	-	2	1	C
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Cycle 4

LOOP: subi r1, r1, 1 Commit
muld f0, f1, f1 Issue (E2)
addd f0, f2, f2 Issue (E1)
bne r1, r0, LOOP Dispatch
LOOP: subi r1, r1, 1 Fetch

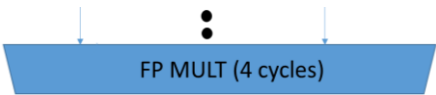
	Tag	Value	Valid
f0		0	1
f1	B	1	0
f2	C	2	0
f3		3	1

	Tag	Value	Valid
r0		0	1
r1	-	1	1

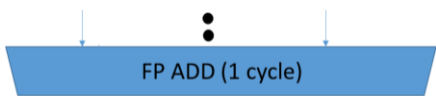
	Inst	Reg	Value	Valid	T/NT
A	-	-	-	0	0
B	muld	f1	-	0	0
C	addd	f2	-	0	0
D	bne	-	-	0	T
E	-	-	-	0	

...
ROB

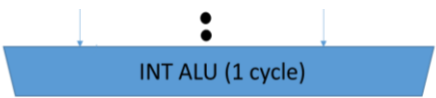
Tag	Value	Valid	Tag	Value	Valid	ROB
-	0	1	-	1	1	B
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	0	1	-	2	1	C
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	1	1	-	0	1	D
-	-	0	-	-	0	-



Cycle 5

```
LOOP: subi r1, r1, 1
muld f0, f1, f1      Issue (E3)
addd f0, f2, f2      WB
bne r1, r0, LOOP     Issue (E1)
LOOP: subi r1, r1, 1 Dispatch
muld f0, f1, f1      Fetch
```

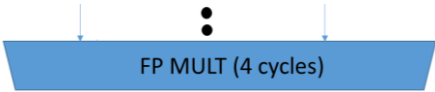
	Tag	Value	Valid
f0		0	1
f1	B	1	0
f2	C	2	0
f3		3	1

	Tag	Value	Valid
r0		0	1
r1	E	1	0

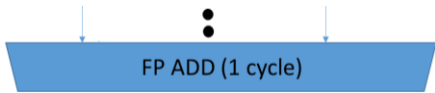
	Inst	Reg	Value	Valid	T/NT
A	-	-	-	0	0
B	muld	f1	-	0	0
C	addd	f2	2	1	0
D	bne	-	-	0	T
E	subi	r1	-	0	0

...
ROB

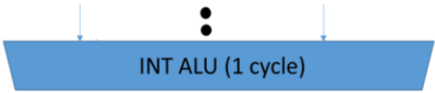
Tag	Value	Valid	Tag	Value	Valid	ROB
-	0	1	-	1	1	B
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	1	1	-	0	1	D
-	1	1	-	-	0	E



Cycle 6

```
LOOP: subi r1, r1, 1
muld f0, f1, f1      Issue (E4)
addd f0, f2, f2      Waiting
bne r1, r0, LOOP     WB(Taken)
LOOP: subi r1, r1, 1  Issue (E1)
muld f0, f1, f1      Dispatch
addd f0, f2, f2      Fetch
```

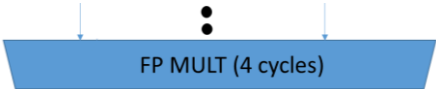
	Tag	Value	Valid
f0		0	1
f1	F	1	0
f2	C	2	0
f3		3	1

	Tag	Value	Valid
r0		0	1
r1	E	1	0

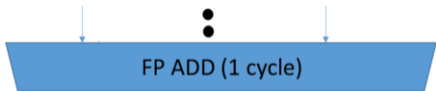
	Inst	Reg	Value	Valid	T/NT
A	-	-	-	0	0
B	muld	f1	-	0	0
C	addd	f2	2	1	0
D	bne	-	-	1	T
E	subi	r1	-	0	0
F	muld	f1	-	0	0

...
ROB

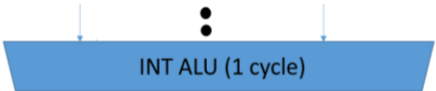
Tag	Value	Valid	Tag	Value	Valid	ROB
-	0	1	-	1	1	B
-	0	1	B	-	0	F



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	1	1	-	-	0	E



Cycle 7

```
LOOP: subi r1, r1, 1
muld f0, f1, f1      WB
addd f0, f2, f2      Waiting
bne r1, r0, LOOP     Waiting
LOOP: subi r1, r1, 1  WB
muld f0, f1, f1      Waiting
addd f0, f2, f2      Dispatch
bne r1, r0, LOOP     Fetch (and predict as taken)
```

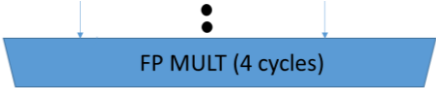
	Tag	Value	Valid
f0		0	1
f1	F	1	0
f2	G	2	0
f3		3	1

	Tag	Value	Valid
r0		0	1
r1	E	1	0

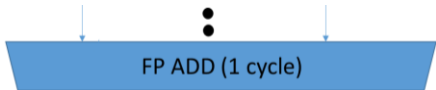
	Inst	Reg	Value	Valid	T/NT
A	-	-	-	0	0
B	muld	f1	0	1	0
C	addd	f2	2	1	0
D	bne	-	-	1	T
E	subi	r1	0	1	0
F	muld	f1	-	0	0
G	addd	f2	-	0	0

...
ROB

Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	0	1	-	0	1	F



Tag	Value	Valid	Tag	Value	Valid	ROB
-	0	1	-	2	1	G
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Cycle 8

```
LOOP: subi r1, r1, 1
muld f0, f1, f1      Commit
addd f0, f2, f2      Waiting
bne r1, r0, LOOP      Waiting
LOOP: subi r1, r1, 1  Waiting
muld f0, f1, f1      Issue(E1)
addd f0, f2, f2      Issue(E1)
bne r1, r0, LOOP      Dispatch
LOOP: subi r1, r1, 1  Fetch
```

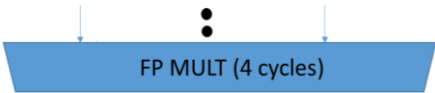
	Tag	Value	Valid
f0		0	1
f1	F	0	0
f2	G	2	0
f3		3	1

	Tag	Value	Valid
r0		0	1
r1	E	1	0

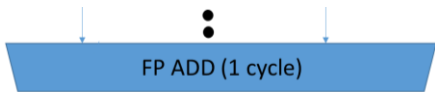
	Inst	Reg	Value	Valid	T/NT
A	-	-	-	0	0
B	-	-	-	0	0
C	addd	f2	2	1	0
D	bne	-	-	1	T
E	subi	r1	0	1	0
F	muld	f1	-	0	0
G	addd	f2	-	0	0
H	bne	-	-	0	T

...
ROB

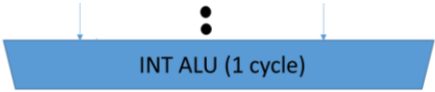
Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	0	1	-	0	1	F



Tag	Value	Valid	Tag	Value	Valid	ROB
-	0	1	-	2	1	G
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	0	1	-	0	1	H
-	-	0	-	-	0	-



Cycle 9

```
LOOP: subi r1, r1, 1
muld f0, f1, f1
addd f0, f2, f2      Commit
bne r1, r0, LOOP     Waiting
LOOP: subi r1, r1, 1  Waiting
muld f0, f1, f1      Issue(E2)
addd f0, f2, f2      WB
bne r1, r0, LOOP     Issue(E1)
LOOP: subi r1, r1, 1  Dispatch
muld f0, f1, f1      Fetch
```

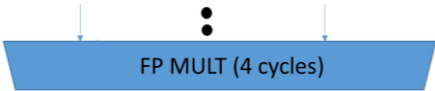
	Tag	Value	Valid
f0		0	1
f1	F	0	0
f2	G	2	0
f3		3	1

	Tag	Value	Valid
r0		0	1
r1	I	1	0

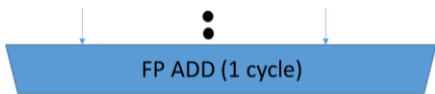
	Inst	Reg	Value	Valid	T/NT
A	-	-	-	0	0
B	-	-	-	0	0
C	-	-	-	0	0
D	bne	-	-	1	T
E	subi	r1	0	1	0
F	muld	f1	-	0	0
G	addd	f2	2	1	0
H	bne	-	-	0	T
I	subi	r1	-	0	0

...
ROB

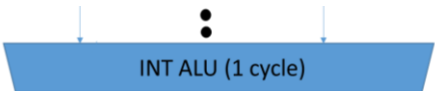
Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	0	1	-	0	1	F



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	0	1	-	0	1	H
-	0	1	-	-	0	I



Cycle 10

```
LOOP: subi r1, r1, 1
muld f0, f1, f1
addd f0, f2, f2
bne r1, r0, LOOP
LOOP: subi r1, r1, 1
muld f0, f1, f1
addd f0, f2, f2
bne r1, r0, LOOP
LOOP: subi r1, r1, 1
muld f0, f1, f1
addd f0, f2, f2
```

Commit
Waiting
Issue(E3)
Waiting
WB (not taken!)
Issue(E1)
Dispatch
Fetch

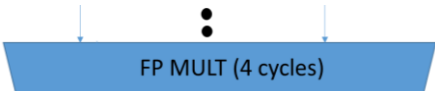
	Tag	Value	Valid
f0		0	1
f1	J	0	0
f2	G	2	0
f3		3	1

	Tag	Value	Valid
r0		0	1
r1	I	1	0

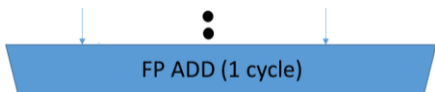
	Inst	Reg	Value	Valid	T/NT
A	-	-	-	0	0
B	-	-	-	0	0
C	-	-	-	0	0
D	-	-	-	0	0
E	subi	r1	0	1	0
F	muld	f1	-	0	0
G	addd	f2	2	1	0
H	bne	-	-	1	NT
I	subi	r1	-	0	0
J	muld	f1	-	0	0

...
ROB

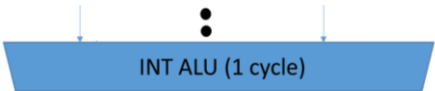
Tag	Value	Valid	Tag	Value	Valid	ROB
-	0	1	F	-	0	J
-	0	1	-	0	1	F



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	0	1	-	-	0	I



Cycle 11 (Frozen for recovery)

```
LOOP: subi r1, r1, 1
muld f0, f1, f1
addd f0, f2, f2
bne r1, r0, LOOP
LOOP: subi r1, r1, 1
muld f0, f1, f1
addd f0, f2, f2
```

Waiting
Issue(E3)
Waiting
WB (not taken!)

	Tag	Value	Valid
f0		0	1
f1	F	0	0
f2	G	2	0
f3		3	1

	Tag	Value	Valid
r0		0	1
r1	E	1	0

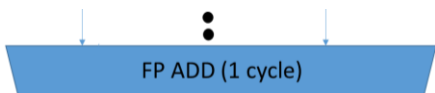
	Inst	Reg	Value	Valid	T/NT
A	-	-	-	0	0
B	-	-	-	0	0
C	-	-	-	0	0
D	-	-	-	0	0
E	subi	r1	0	1	0
F	muld	f1	-	0	0
G	addd	f2	2	1	0
H	bne	-	-	1	NT
I	-	-	-	0	0
J	-	-	-	0	0

...
ROB

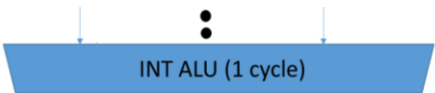
Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	0	1	-	0	1	F



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Cycle 12

```
LOOP: subi r1, r1, 1
muld f0, f1, f1
addd f0, f2, f2
bne r1, r0, LOOP
LOOP: subi r1, r1, 1
muld f0, f1, f1
addd f0, f2, f2
bne r1, r0, LOOP
addd f1, f2, f3
```

Commit

Issue(E4)

Waiting

Waiting

Fetch

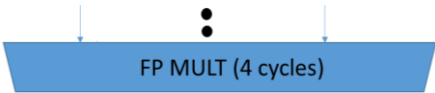
	Tag	Value	Valid
f0		0	1
f1	F	0	0
f2	G	2	0
f3		3	1

	Tag	Value	Valid
r0		0	1
r1		0	1

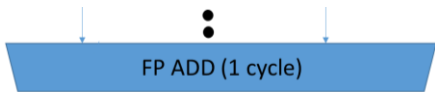
	Inst	Reg	Value	Valid	T/NT
A	-	-	-	0	0
B	-	-	-	0	0
C	-	-	-	0	0
D	-	-	-	0	0
E	-	-	-	0	0
F	muld	f1	-	0	0
G	addd	f2	2	1	0
H	bne	-	-	1	NT
I	-	-	-	0	0
J	-	-	-	0	0

...
ROB

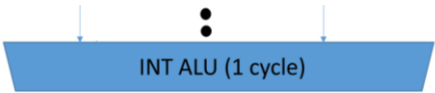
Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	0	1	-	0	1	F



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Cycle 13

```
LOOP: subi r1, r1, 1
muld f0, f1, f1
addd f0, f2, f2
bne r1, r0, LOOP
LOOP: subi r1, r1, 1
muld f0, f1, f1
addd f0, f2, f2
bne r1, r0, LOOP
addd f1, f2, f3
```

WB
Waiting
Waiting
Dispatch

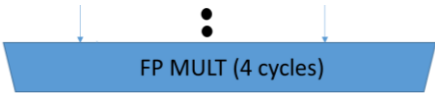
	Tag	Value	Valid
f0		0	1
f1	F	0	0
f2	G	2	0
f3	I	3	0

	Tag	Value	Valid
r0		0	1
r1		0	1

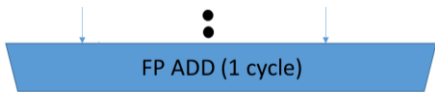
	Inst	Reg	Value	Valid	T/NT
A	-	-	-	0	0
B	-	-	-	0	0
C	-	-	-	0	0
D	-	-	-	0	0
E	-	-	-	0	0
F	muld	f1	0	1	0
G	addd	f2	2	1	0
H	bne	-	-	1	NT
I	addd	f3	-	0	0
J	-	-	-	0	0

...
ROB

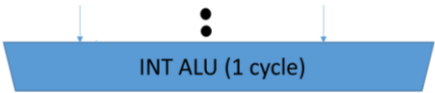
Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	0	1	-	2	1	I
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Cycle 14

```
LOOP: subi r1, r1, 1
muld f0, f1, f1
addd f0, f2, f2
bne r1, r0, LOOP
LOOP: subi r1, r1, 1
muld f0, f1, f1
addd f0, f2, f2
bne r1, r0, LOOP
addd f1, f2, f3
```

Commit

Waiting

Waiting

Issue(E1)

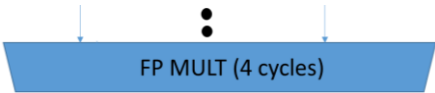
	Tag	Value	Valid
f0		0	1
f1		0	1
f2	G	2	0
f3	I	3	0

	Tag	Value	Valid
r0		0	1
r1		0	1

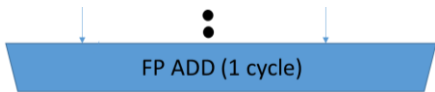
	Inst	Reg	Value	Valid	T/NT
A	-	-	-	0	0
B	-	-	-	0	0
C	-	-	-	0	0
D	-	-	-	0	0
E	-	-	-	0	0
F	-	-	-	0	0
G	addd	f2	2	1	0
H	bne	-	-	1	NT
I	addd	f3	-	0	0
J	-	-	-	0	0

...
ROB

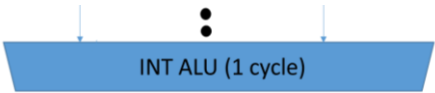
Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	0	1	-	2	1	I
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Cycle 15

```
LOOP: subi r1, r1, 1
muld f0, f1, f1
addd f0, f2, f2
bne r1, r0, LOOP
LOOP: subi r1, r1, 1
muld f0, f1, f1
addd f0, f2, f2      Commit
bne r1, r0, LOOP      Waiting
addd f1, f2, f3      WB
```

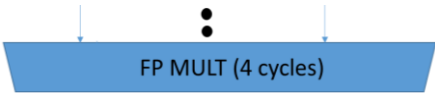
	Tag	Value	Valid
f0		0	1
f1		0	1
f2		2	1
f3	I	3	0

	Tag	Value	Valid
r0		0	1
r1		0	1

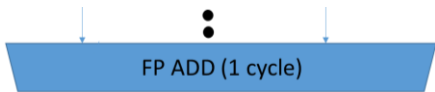
	Inst	Reg	Value	Valid	T/NT
A	-	-	-	0	0
B	-	-	-	0	0
C	-	-	-	0	0
D	-	-	-	0	0
E	-	-	-	0	0
F	-	-	-	0	0
G	-	-	-	0	0
H	bne	-	-	1	NT
I	addd	f3	2	1	0
J	-	-	-	0	0

...
ROB

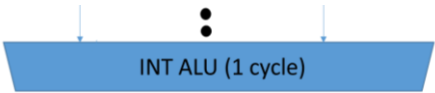
Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Cycle 16

```
LOOP: subi r1, r1, 1
muld f0, f1, f1
addd f0, f2, f2
bne r1, r0, LOOP
LOOP: subi r1, r1, 1
muld f0, f1, f1
addd f0, f2, f2
bne r1, r0, LOOP
add f1, f2, f3
```

Commit

Waiting

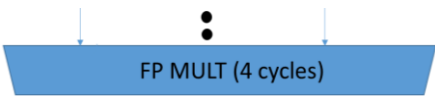
	Tag	Value	Valid
f0		0	1
f1		0	1
f2		2	1
f3	I	3	0

	Tag	Value	Valid
r0		0	1
r1		0	1

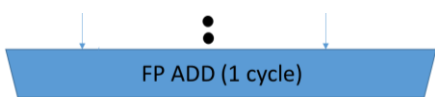
	Inst	Reg	Value	Valid	T/NT
A	-	-	-	0	0
B	-	-	-	0	0
C	-	-	-	0	0
D	-	-	-	0	0
E	-	-	-	0	0
F	-	-	-	0	0
G	-	-	-	0	0
H	-	-	-	0	0
I	addd	f3	2	1	0
J	-	-	-	0	0

...
ROB

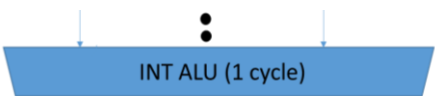
Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Cycle 17

```
LOOP: subi r1, r1, 1
muld f0, f1, f1
addd f0, f2, f2
bne r1, r0, LOOP
LOOP: subi r1, r1, 1
muld f0, f1, f1
addd f0, f2, f2
bne r1, r0, LOOP
addd f1, f2, f3
```

Commit

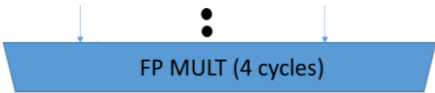
	Tag	Value	Valid
f0		0	1
f1		0	1
f2		2	1
f3		2	0

	Tag	Value	Valid
r0		0	1
r1		0	1

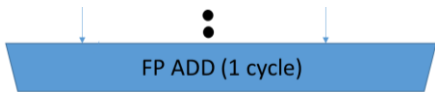
	Inst	Reg	Value	Valid	T/NT
A	-	-	-	0	0
B	-	-	-	0	0
C	-	-	-	0	0
D	-	-	-	0	0
E	-	-	-	0	0
F	-	-	-	0	0
G	-	-	-	0	0
H	-	-	-	0	0
I	-	-	-	0	0
J	-	-	-	0	0

...
ROB

Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-



Tag	Value	Valid	Tag	Value	Valid	ROB
-	-	0	-	-	0	-
-	-	0	-	-	0	-

