

Herding cats III

Jade Alglave

Arm and University College London

March 2019

Remember our pony



Message passing

initially $x=y=0$

P_0	P_1
(a) $x \leftarrow 1$	(c) $r3 \leftarrow y$
(b) $y \leftarrow 1$	(d) $r4 \leftarrow x$

$r3=1$ and $r4=0$ allowed?

iy: $W_y=0$ ix: $W_x=0$

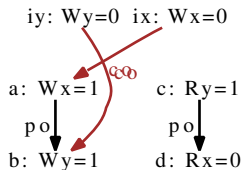
a: $W_x=1$	c: $R_y=?$
\downarrow	\downarrow
po	po
b: $W_y=1$	d: $R_x=?$

Message passing

initially $x=y=0$

P_0	P_1
(a) $x \leftarrow 1$	(c) $r3 \leftarrow y$
(b) $y \leftarrow 1$	(d) $r4 \leftarrow x$

$r3=1$ and $r4=0$ allowed?

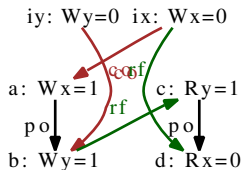


Message passing

initially $x=y=0$

P_0	P_1
(a) $x \leftarrow 1$	(c) $r3 \leftarrow y$
(b) $y \leftarrow 1$	(d) $r4 \leftarrow x$

$r3=1$ and $r4=0$ allowed?

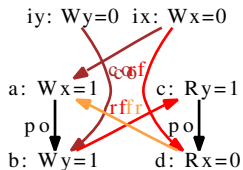


Message passing

initially $x=y=0$

P_0	P_1
(a) $x \leftarrow 1$	(c) $r3 \leftarrow y$
(b) $y \leftarrow 1$	(d) $r4 \leftarrow x$

r3=1 and r4=0 allowed?

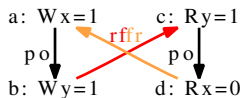


Message passing

initially $x=y=0$

P_0	P_1
(a) $x \leftarrow 1$	(c) $r3 \leftarrow y$
(b) $y \leftarrow 1$	(d) $r4 \leftarrow x$

$r3=1$ and $r4=0$ allowed?



Let's try it out

initially $x=y=0$

P_0	P_1
(a) $x \leftarrow 1$	(c) $r3 \leftarrow y$
(b) $y \leftarrow 1$	(d) $r4 \leftarrow x$

r3=1 and r4=0 allowed?

- ▶ on Intel x86
- ▶ on Armv8

- ▶ x86 implements a Total Store Order (TSO) model
- ▶ This can be modelled as two axioms:
 - ▶ SC per location
 - ▶ Total Store Order

Armv8

- ▶ Armv8 implements a multi-copy-atomic model
- ▶ It has two axioms:
 - ▶ SC per location (called Internal visibility by Arm)
 - ▶ External visibility

x86: Total Store Order

```
let obs = rfe | coe | fre
let ppo-tso = po & (W*W) | po & (R*M)
let ob = obs | ppo-tso | mfence
acyclic ob as tso
```

See also: [herdtools7/herd/libdir/x86tso.cat](#)

Armv8: External visibility

```
let dob = ... (*dependencies*)
let bob = ... (*fences, release/acquire*)
let aob = ... (*read-modify-writes, atomics*)
let rec ob = obs | dob | bob | aob | ob; ob
irreflexive ob as external-visibility
```

See also: [herdtools7/herd/libdir/aarch64.cat](#)

That's it for today!

