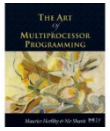
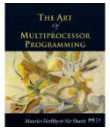
Différentes notions de correction

» Ex linearisabilité (atomicité)
» Autres notions
» Même puissance ?
» Exemple : registres



Toujours

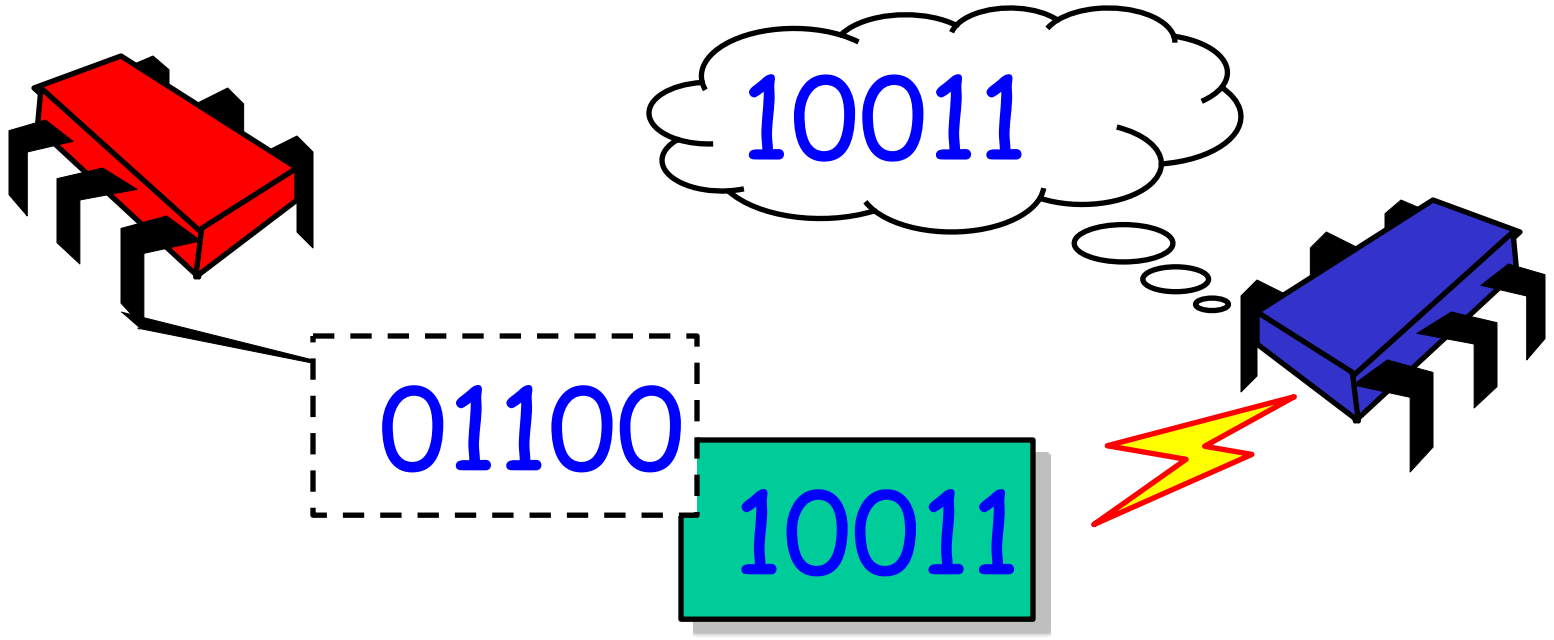
- En cas de non concurrence:
  - Une lecture retourne la dernière valeur écrite ou la valeur initiale si pas df'ecriture avant la lecture



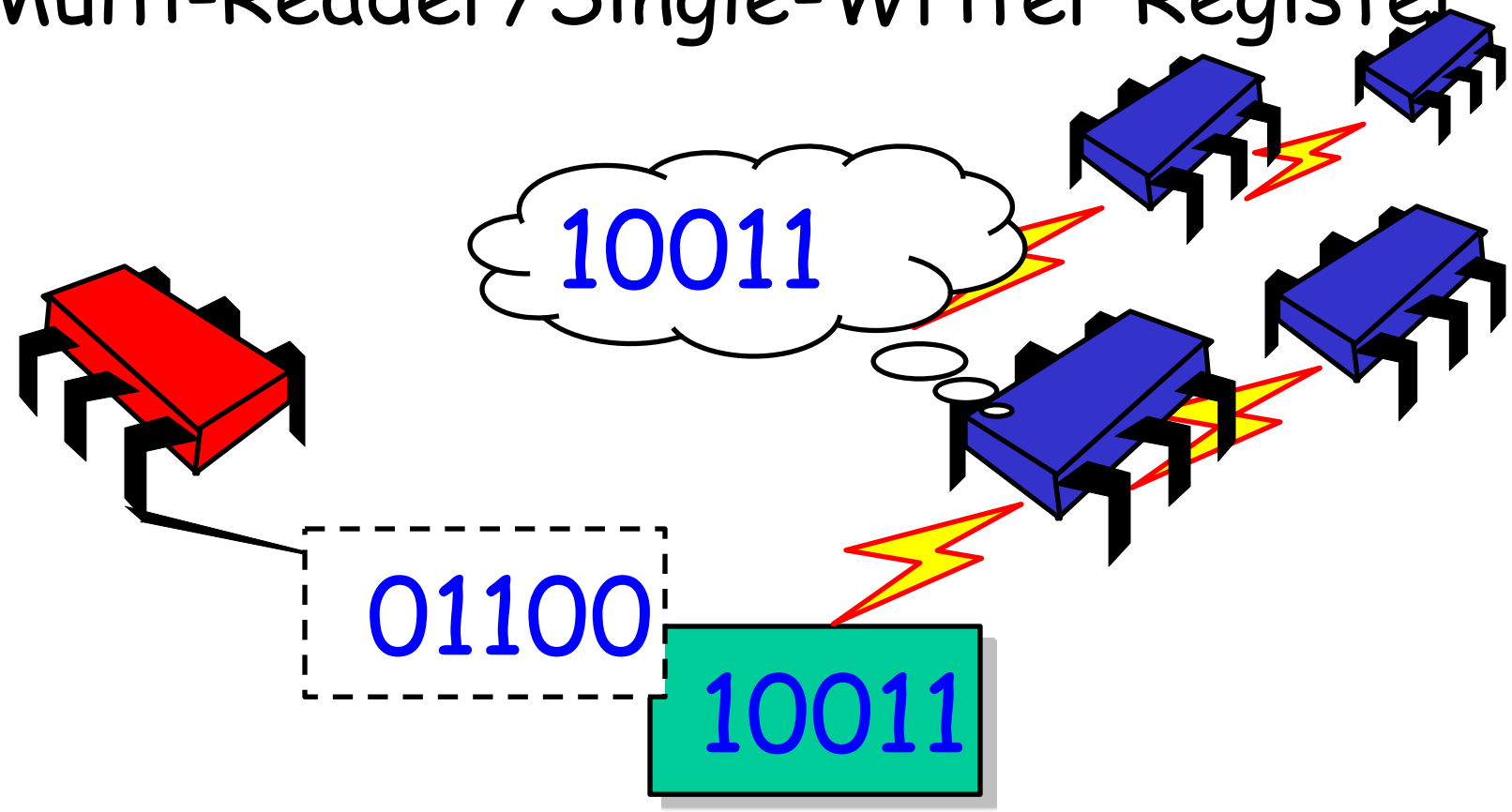
Registres

```
public interface Register<T> {
  public T read();
  public void write(T v);
}
```

Single-Reader/Single-Writer Register



Multi-Reader/Single-Writer Register

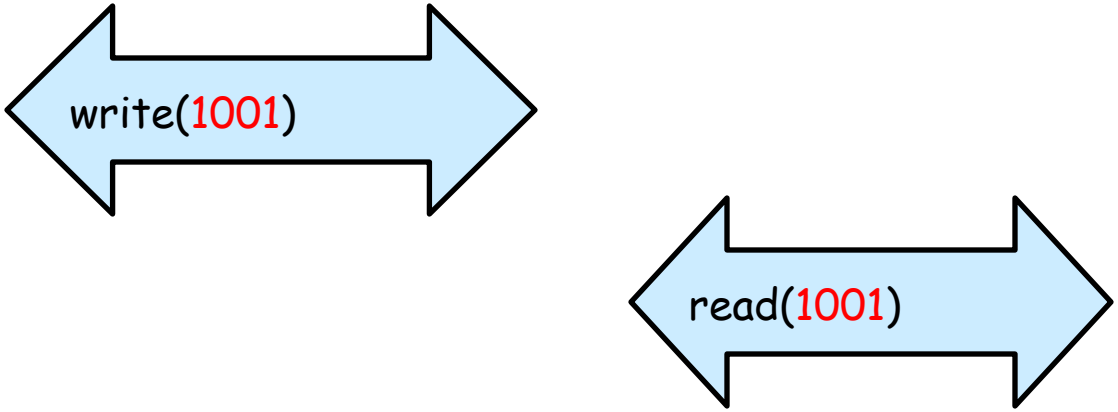


Registres

- SRSW
  - Single-reader single-writer
- MRSW
  - Multi-reader single-writer
- MRMW
  - Multi-reader multi-writer

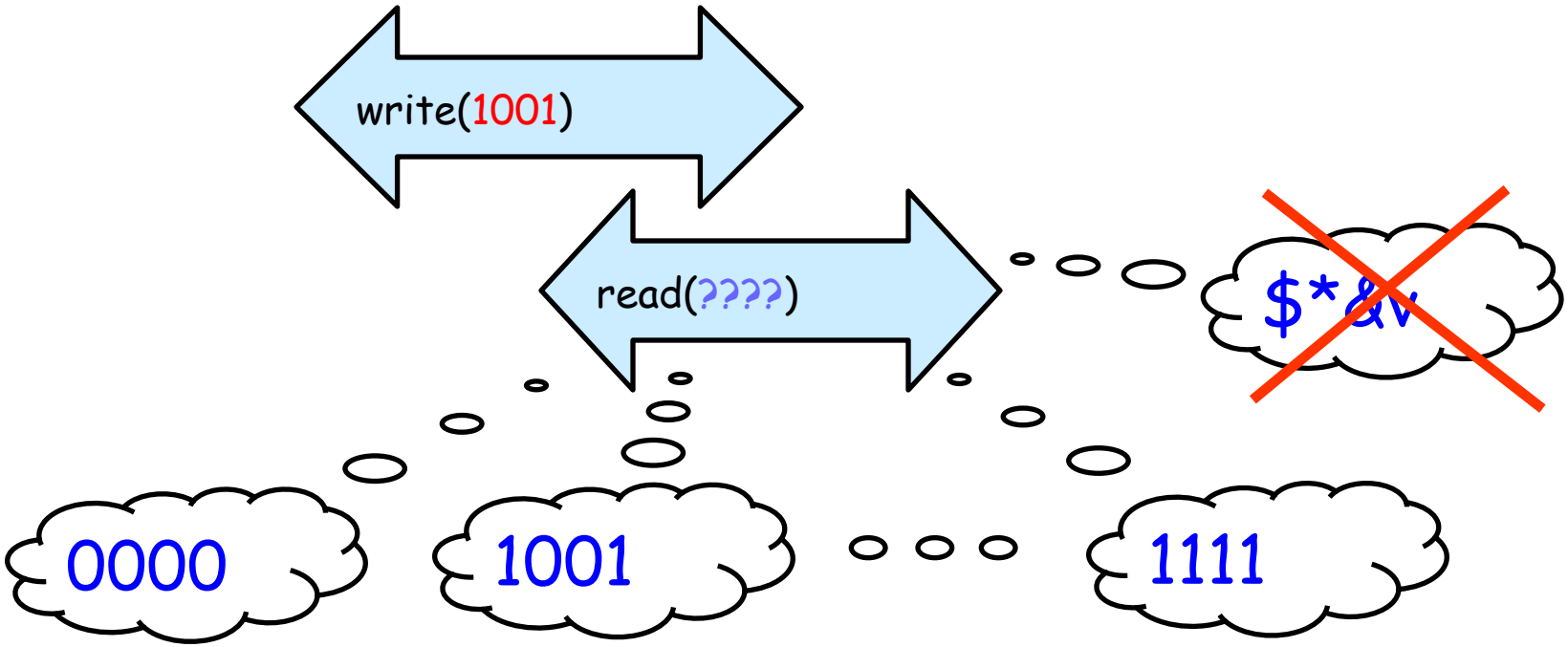
Registre sûr (safe)

OK si non concurrence

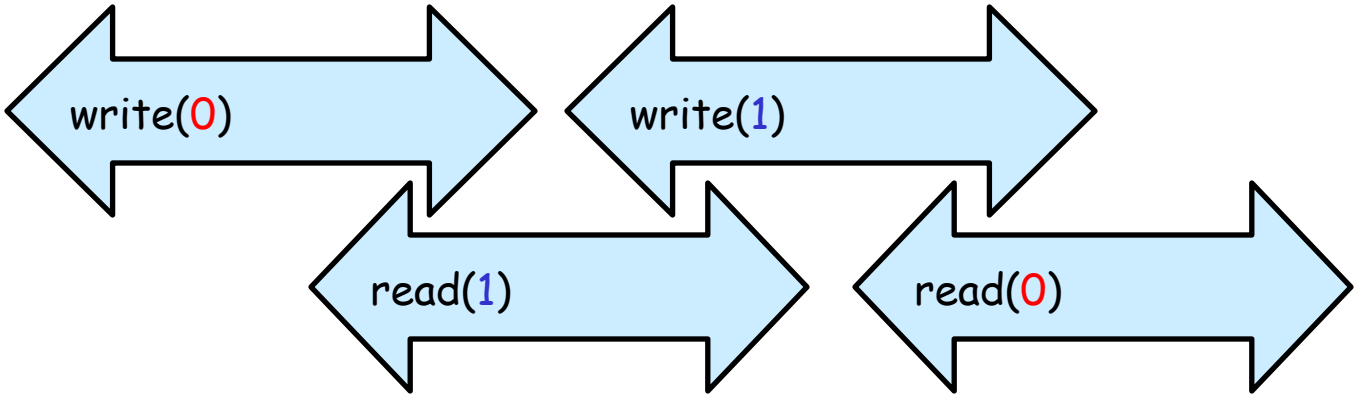


Registre Sûr

Une valeur « légale »
si concurrence

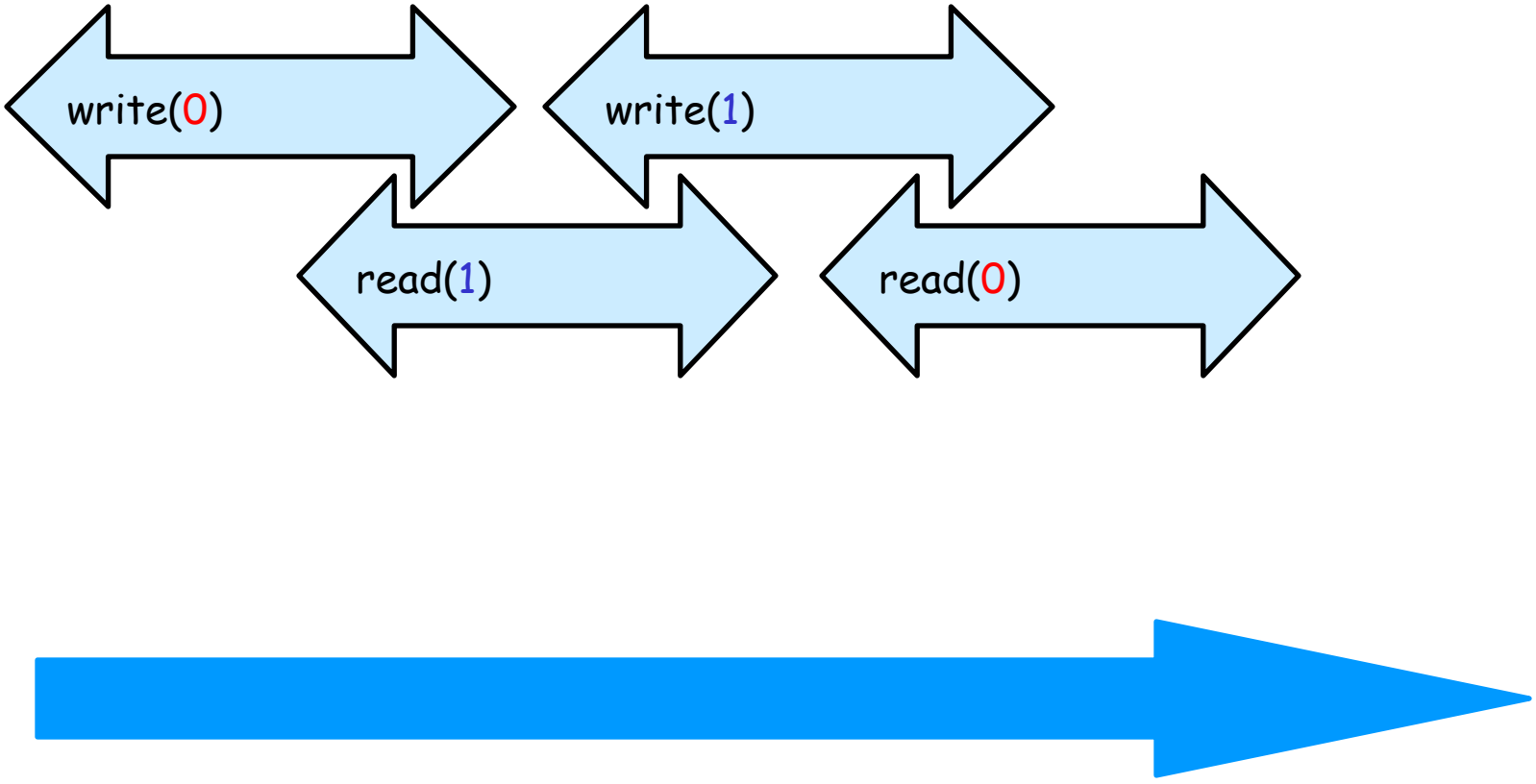


Registre Régulier

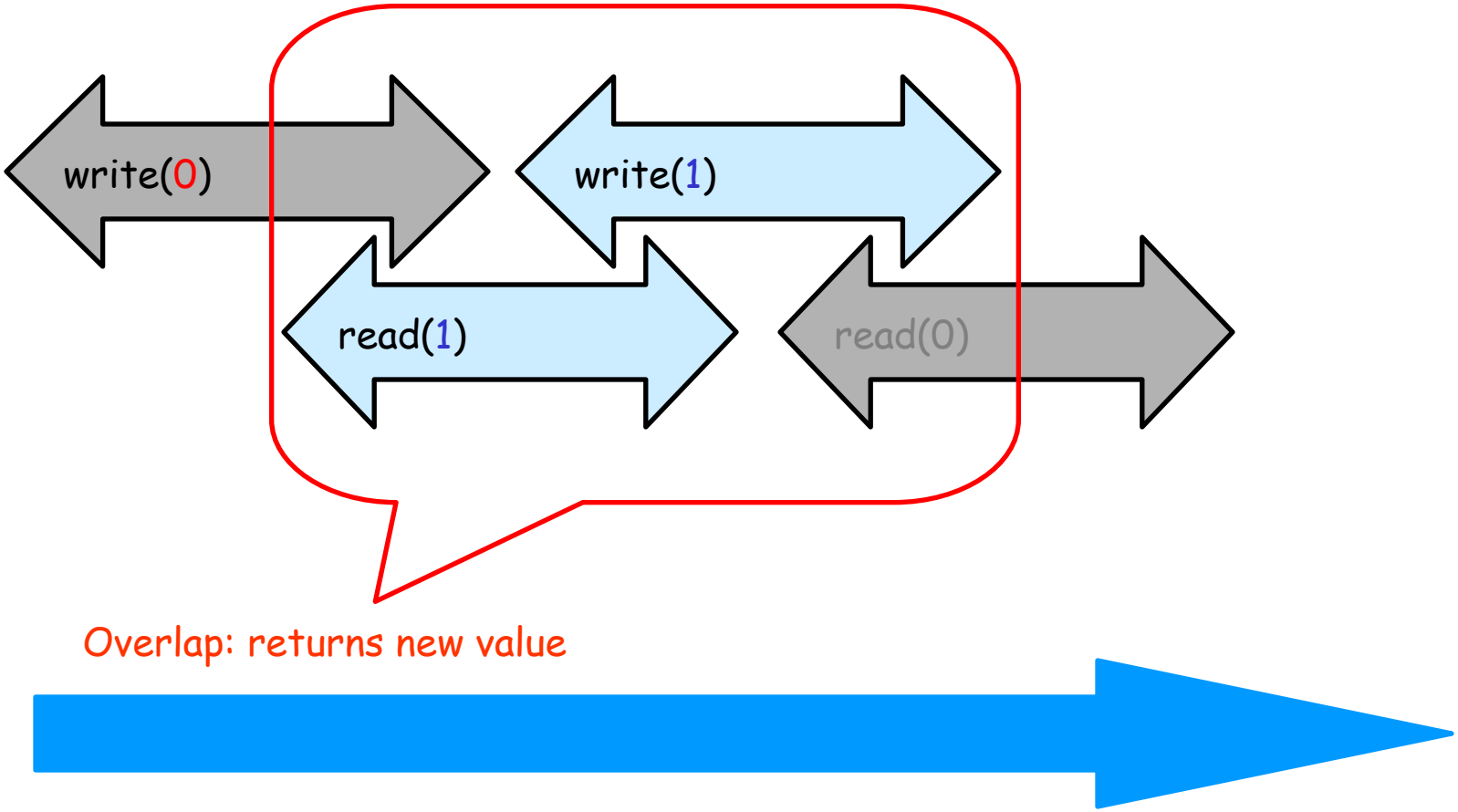


- Single Writer
- Readers:
  - ancienne valeur si non concurrence (sûr)
  - ancienne ou nouvelle si concurrence

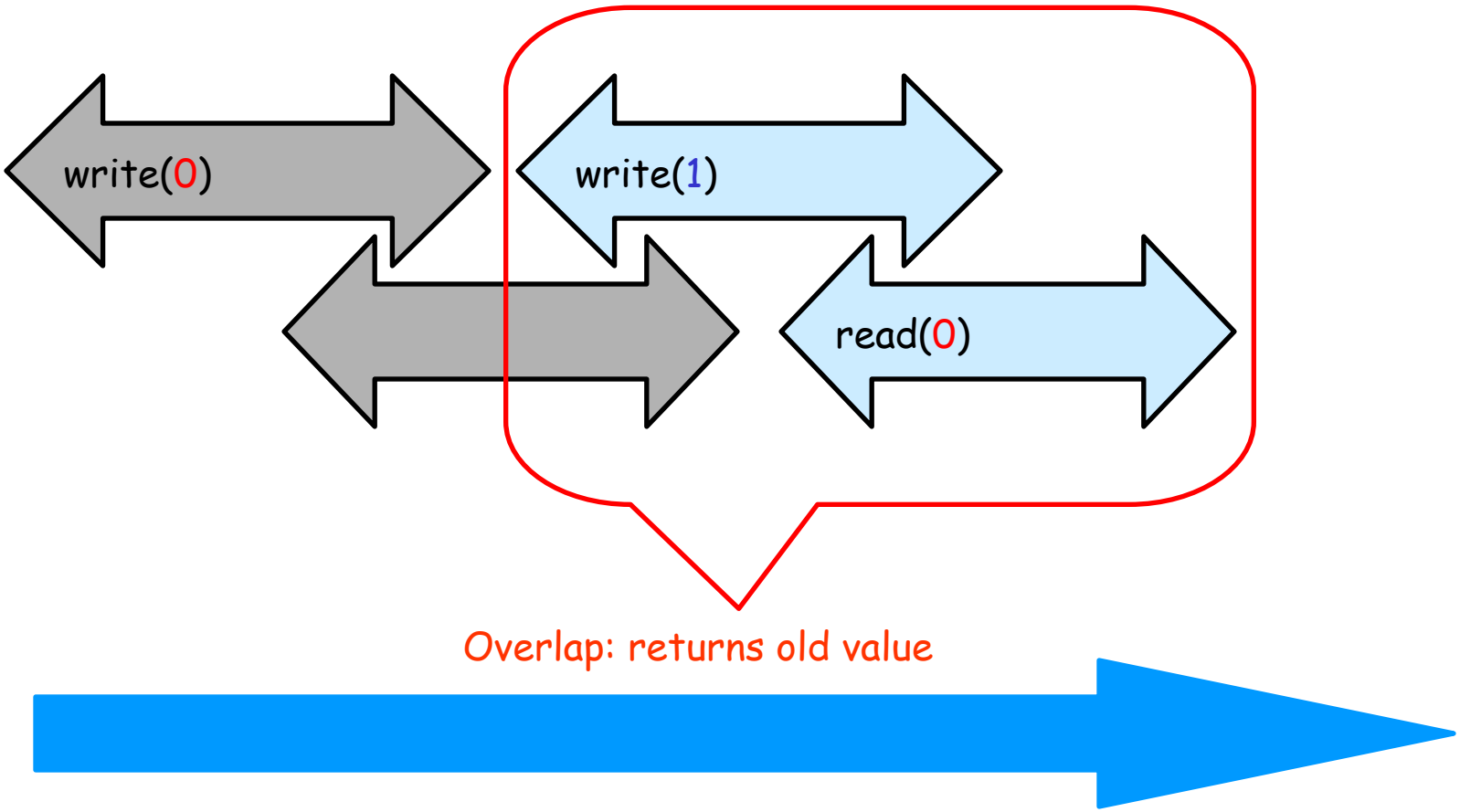
Régulier?



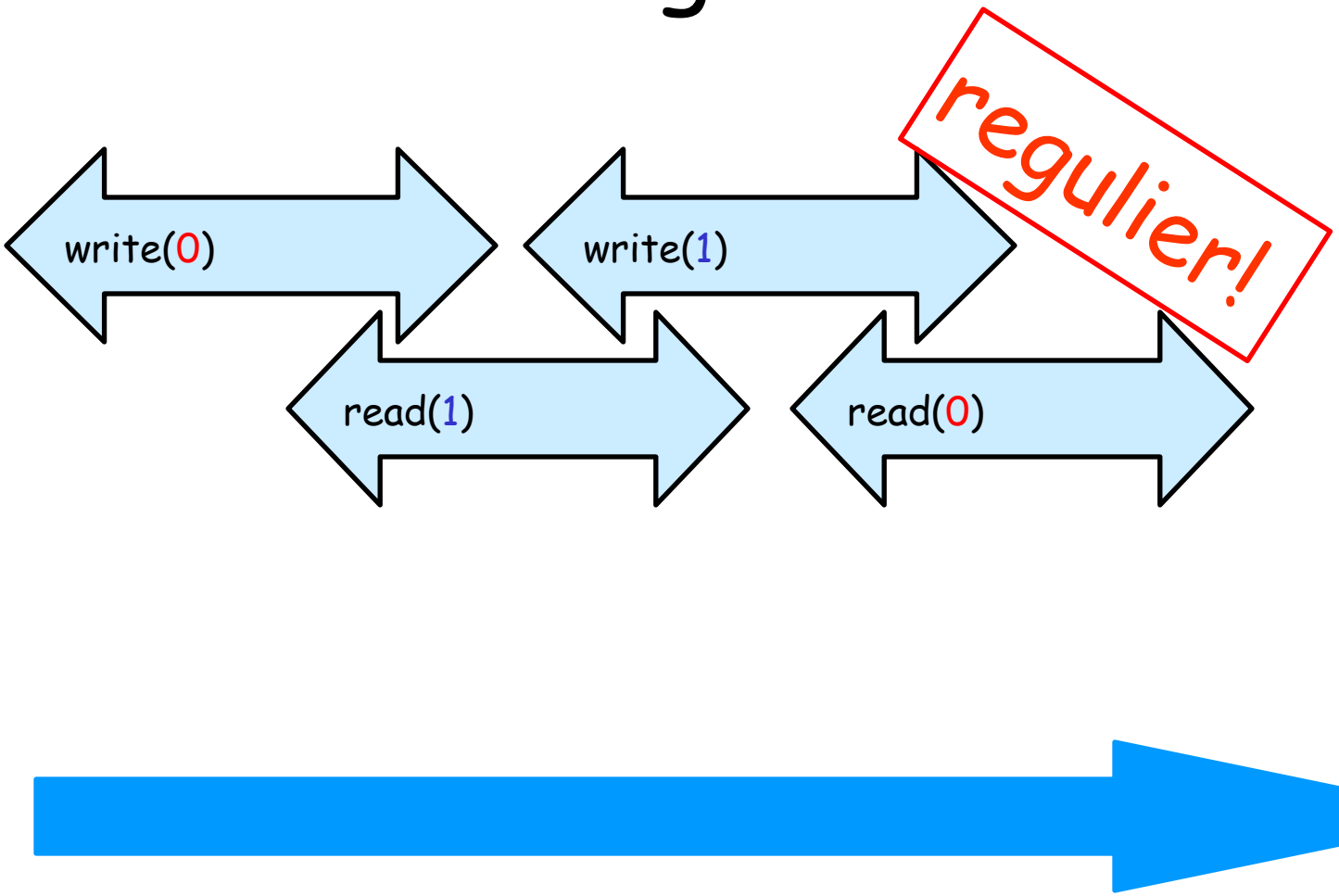
Régulier?


write(0)
write(1)
read(1)
read(0)
Overlap: returns new value
registres

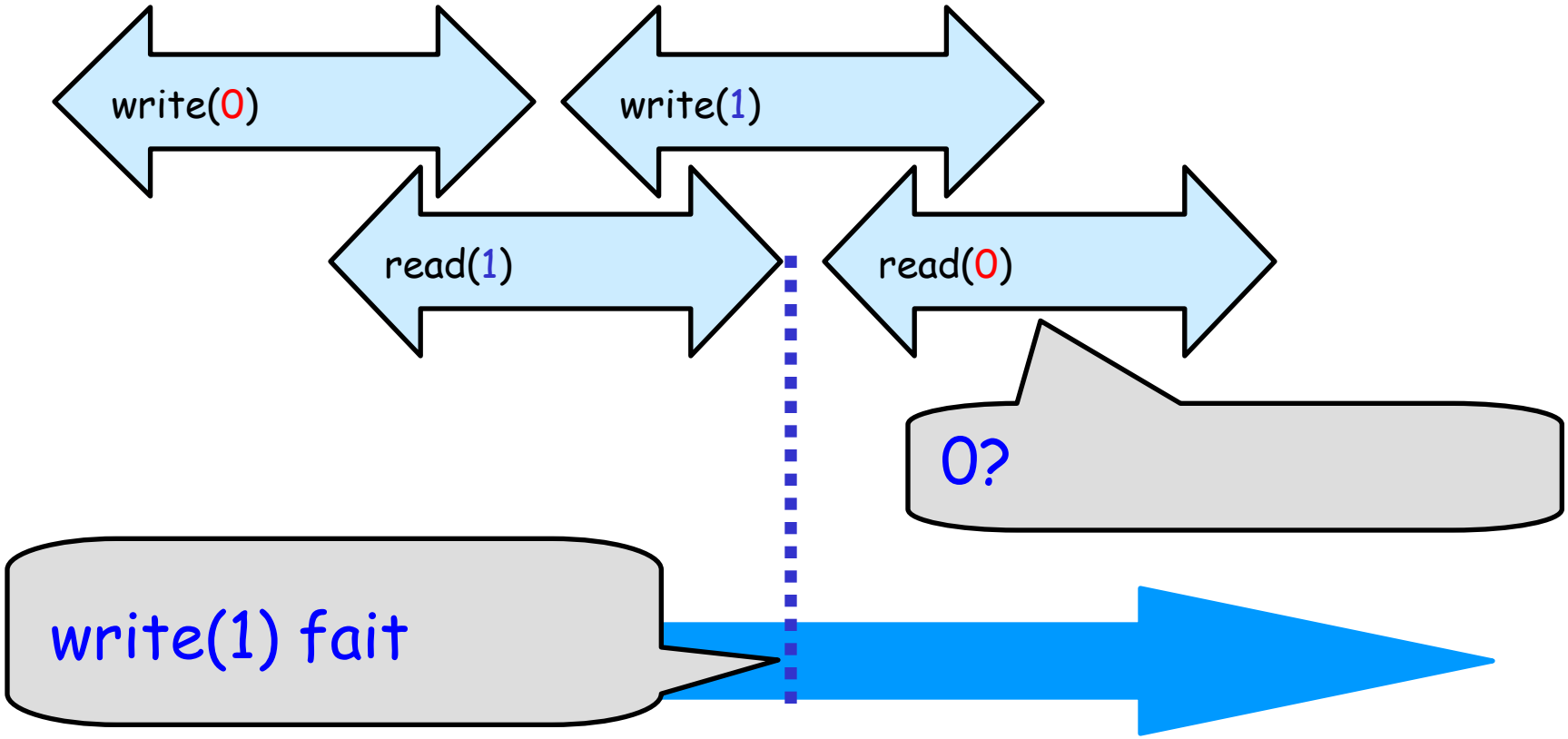
Regulier?



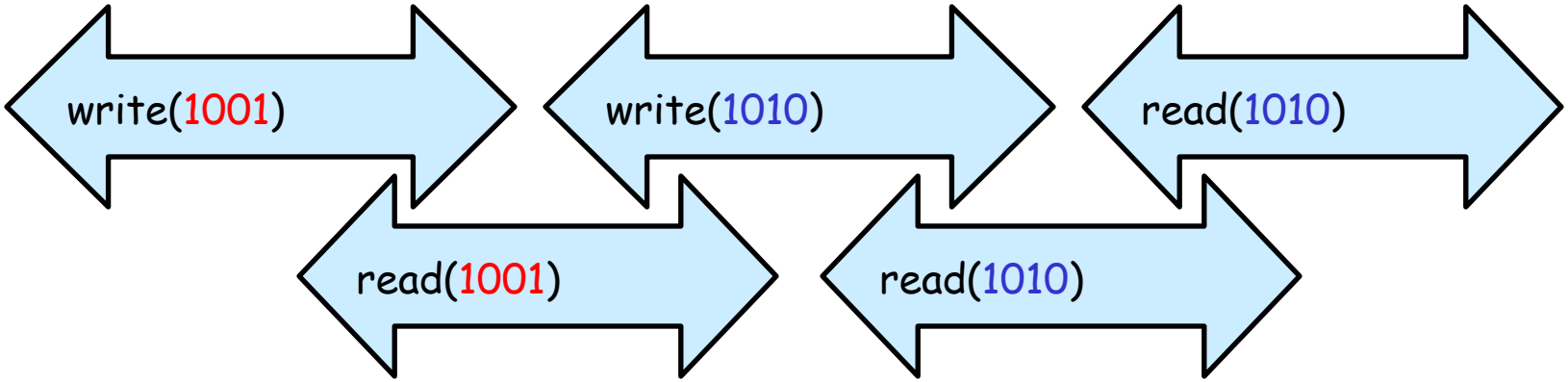
Regulier?



Régulier ≠ Atomique

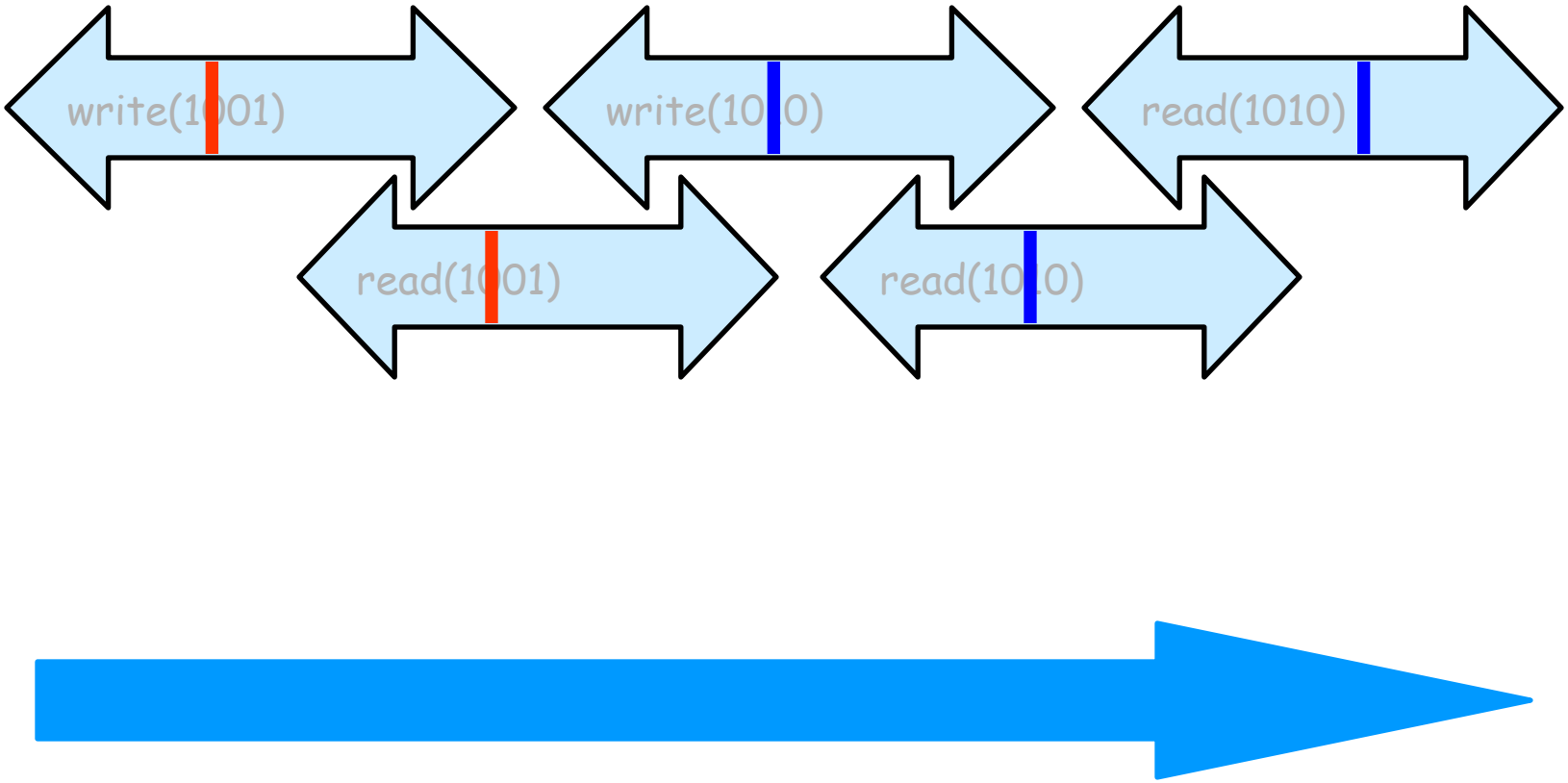


Registre atomique

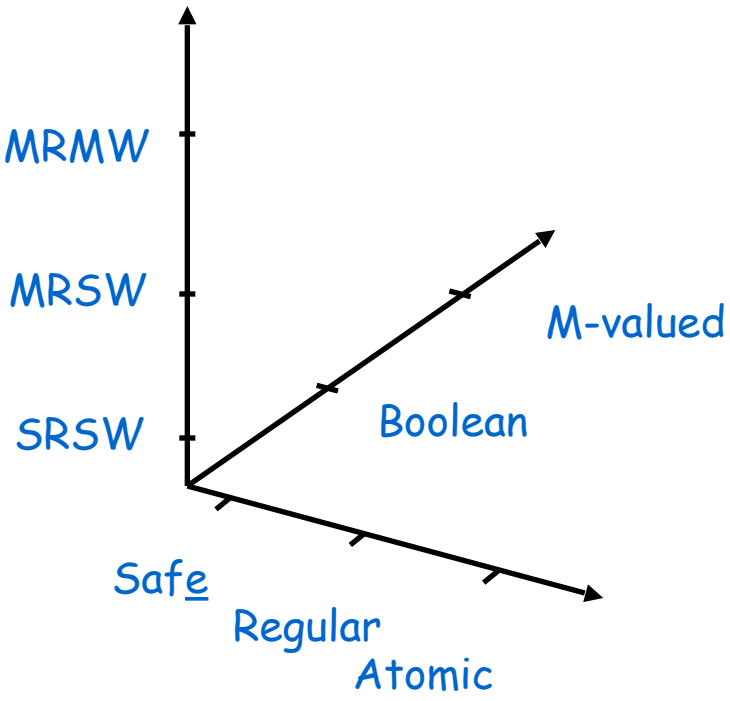


Linéarisable

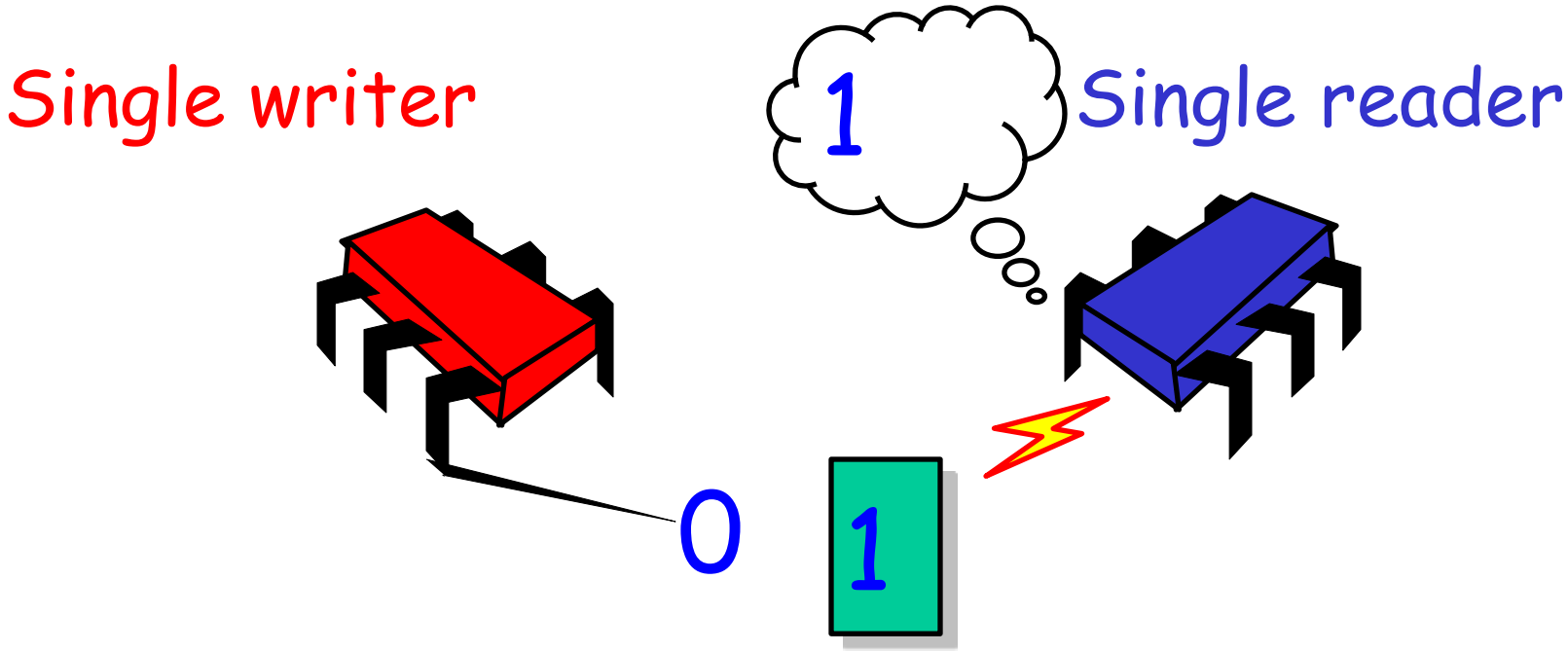
Registre atomique



Registres



le plus faible…



Implementation Wait-Free

Definition: L'implementation d'un objet est **wait-free** si tout appel de méthode de l'objet termine (en un nombre fini de pas)

Pas d'exclusion mutuelle!

- Un Thread peut s'arrêter en section critique!

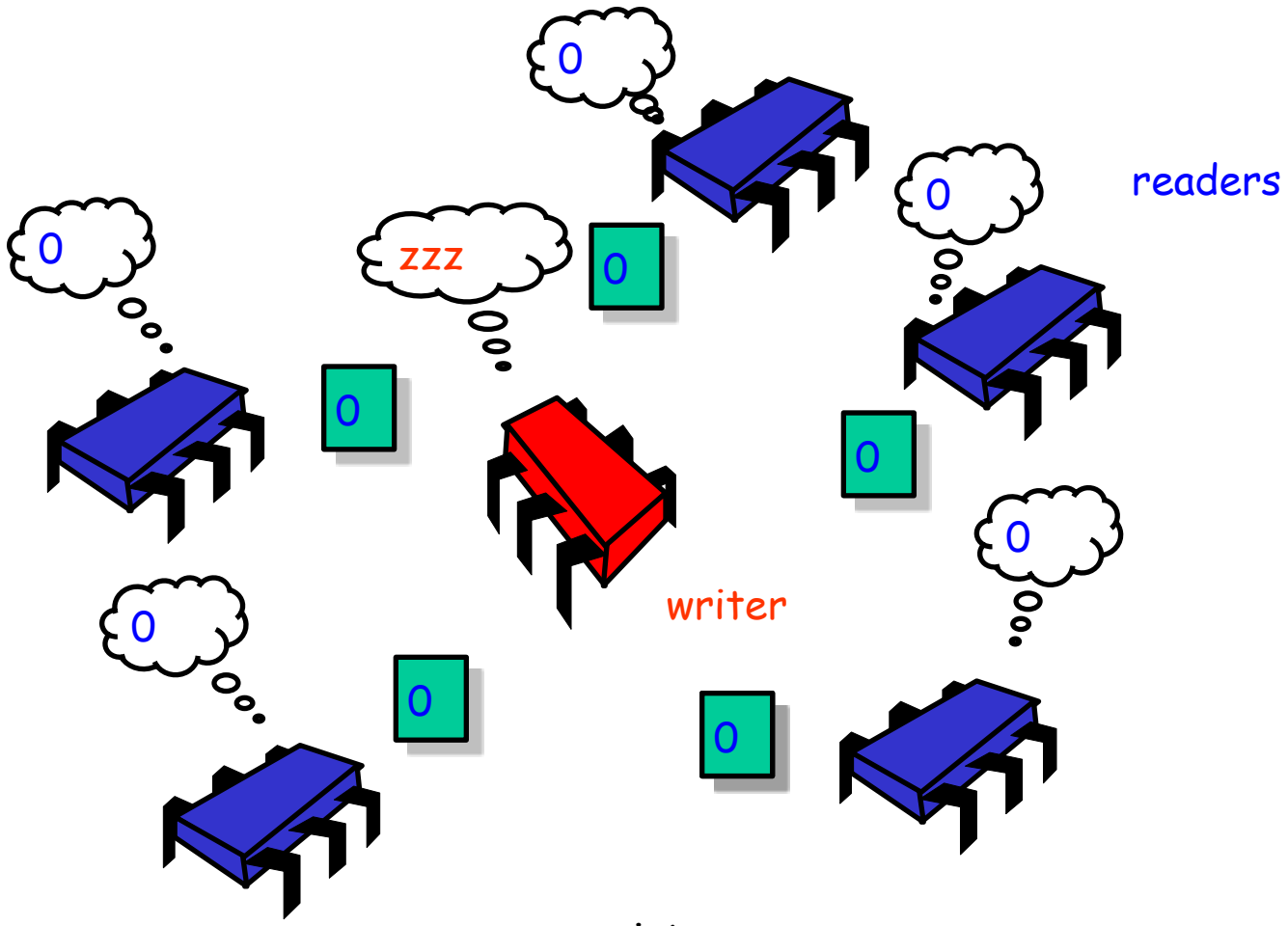
- SRSW Booléen sûr
- MRSW Booléen sûr
- MRSW Booléen régulier
- MRSW regulier
- MRSW atomique
- MRMW atomique

- SRSW Booléen sûr
- MRSW Booléen sûr
- MRSW Booléen régulier
- MRSW regulier
- MRSW atomique
- MRMW atomique

Registres

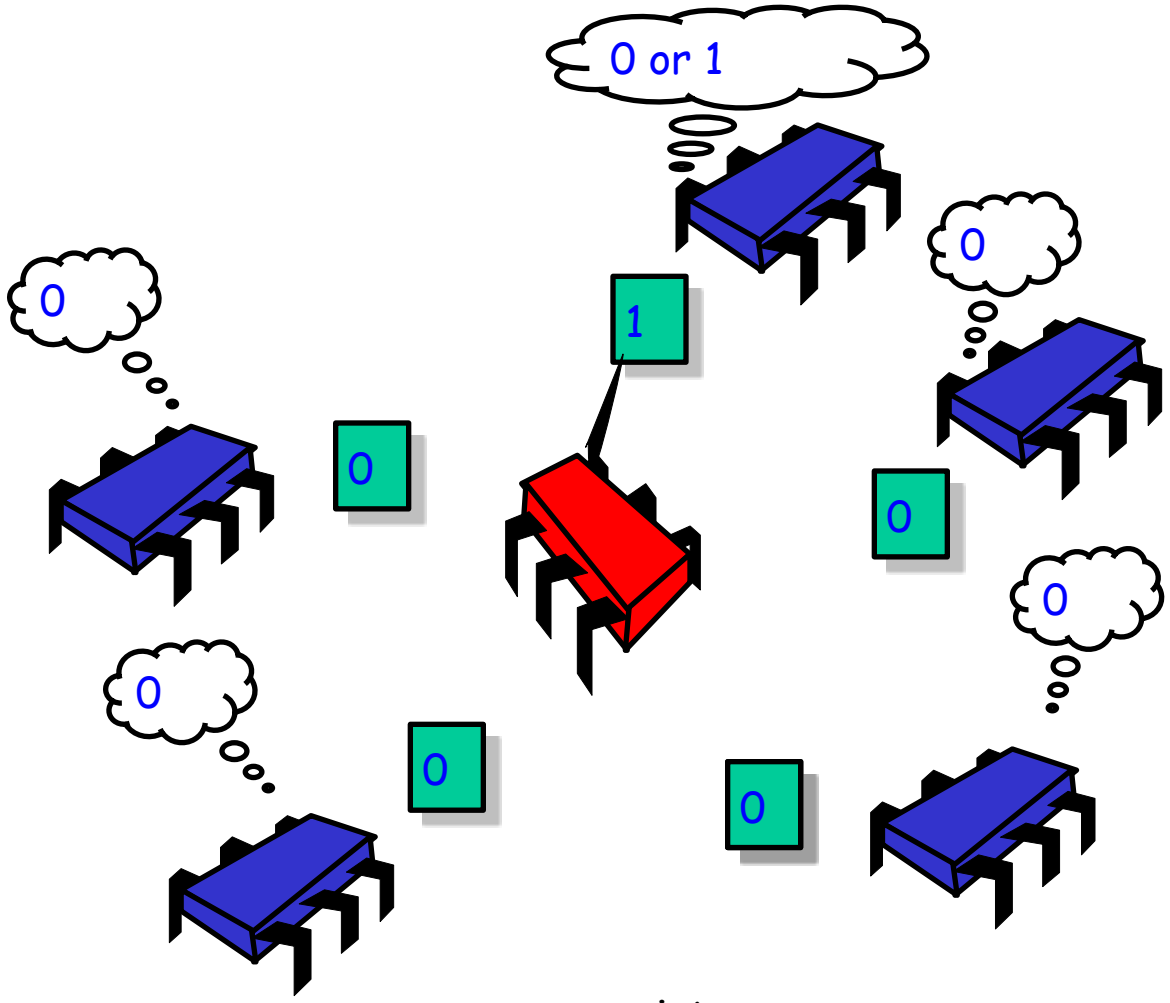
```
public class SafeBoolMRSWRegister
 implements Register<Boolean> {
  public boolean read() { … }
  public void write(boolean x) { … }
}
```

MRSW booléen sûr à partir de SRSW booléen sûr

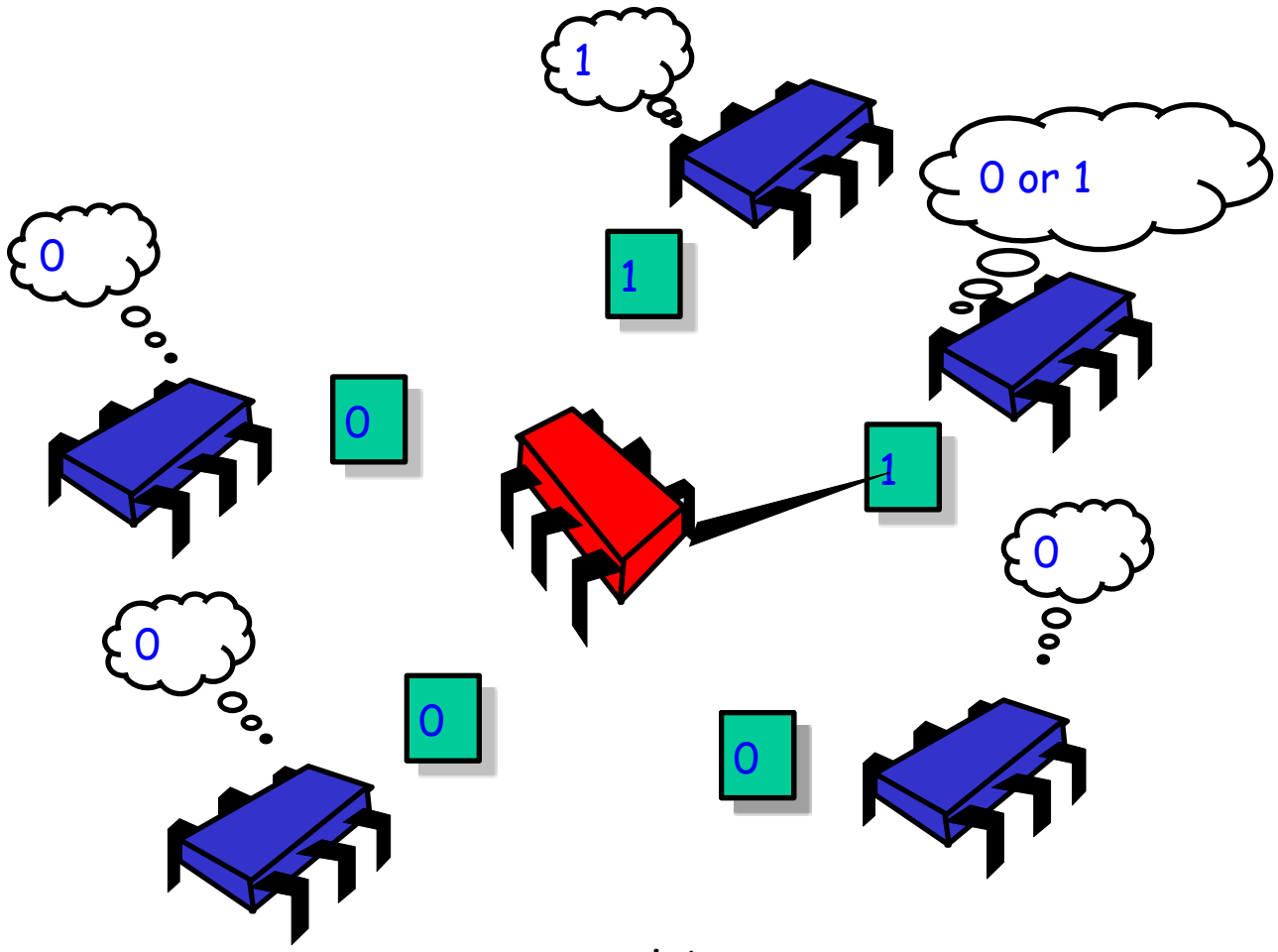


MRSW booléen sûr à partir de SRSW booléen sûr

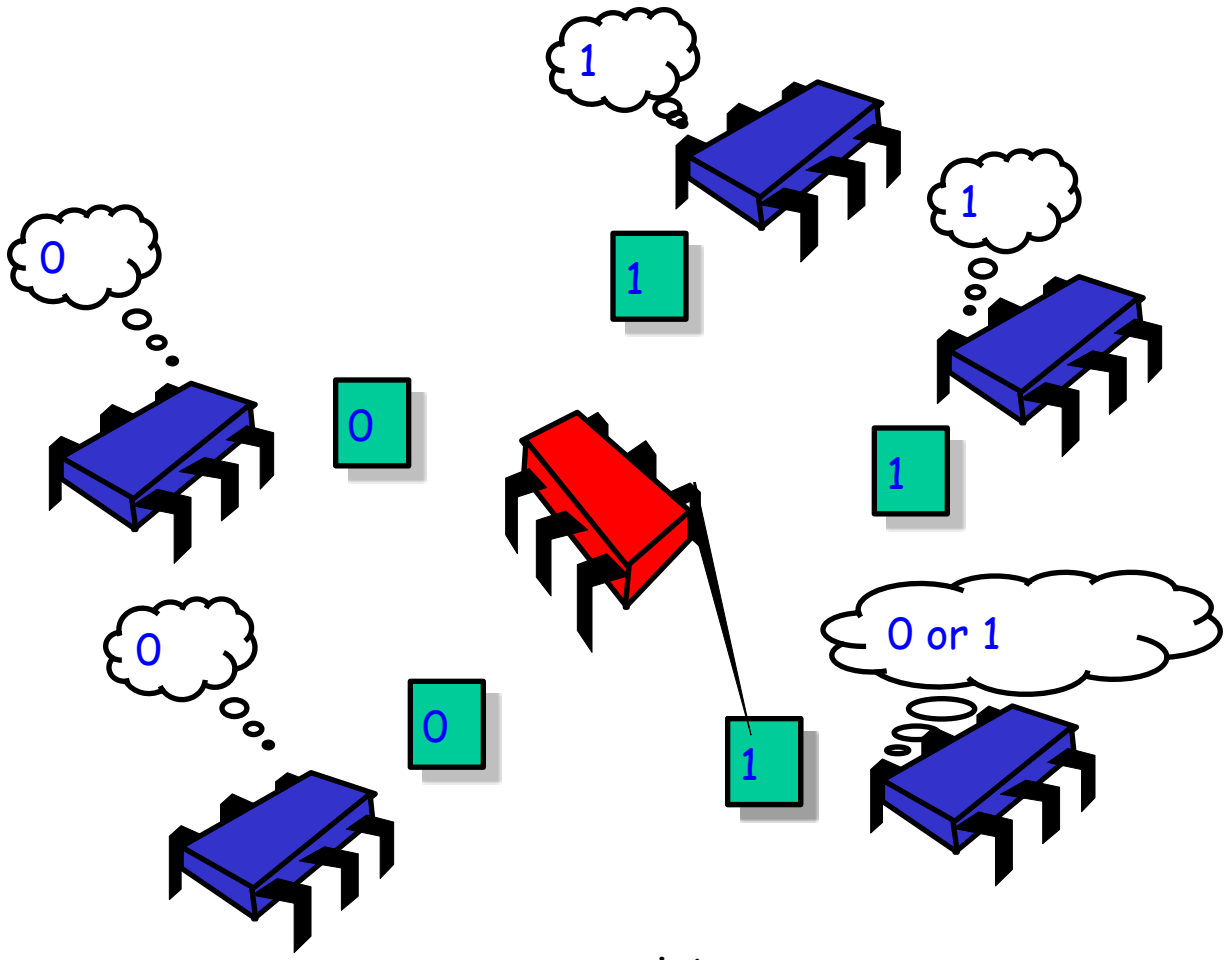
MRSW booléen sûr à partir de SRSW booléen sûr



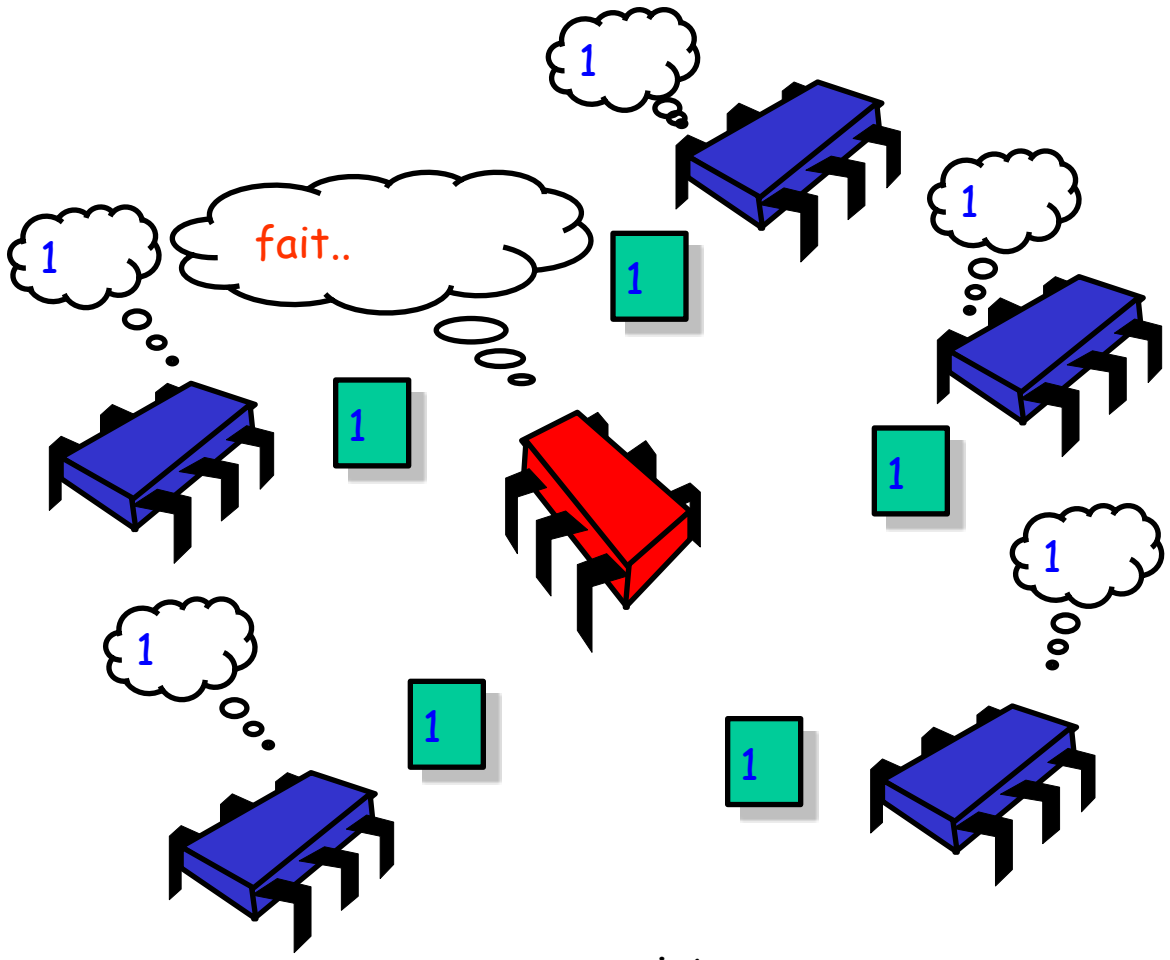
MRSW booléen sûr à partir de SRSW booléen sûr



MRSW booléen sûr à partir de SRSW booléen sûr



MRSW booléen sûr à partir de SRSW booléen sûr



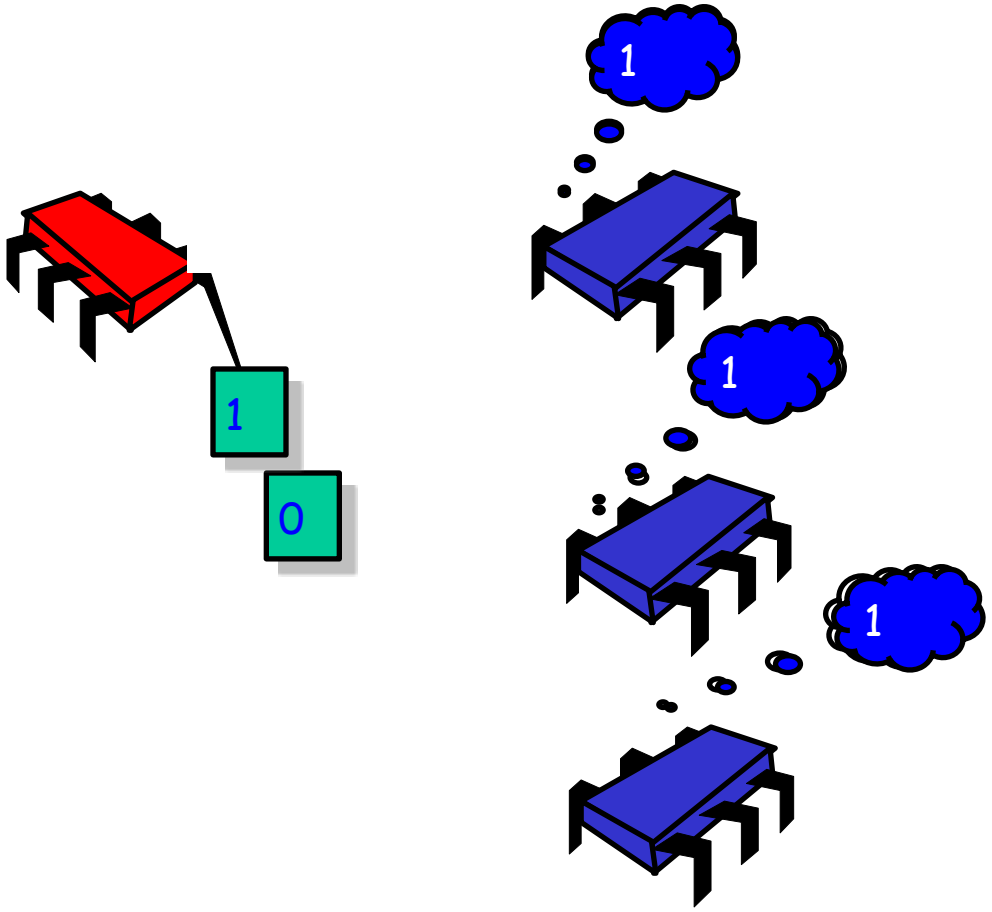
MRSW booléen sûr à partir de SRSW booléen sûr

```
public class SafeBoolMRSWRegister
 implements BooleanRegister {
 private SafeBoolSRSWRegister[] r =
   new SafeBoolSRSWRegister[N];
  public void write(boolean x) {
   for (int j = 0; j < N; j++)
    r[j].write(x);
  }
  public boolean read() {
   int i = ThreadID.get();
   return r[i].read();
  }}
```

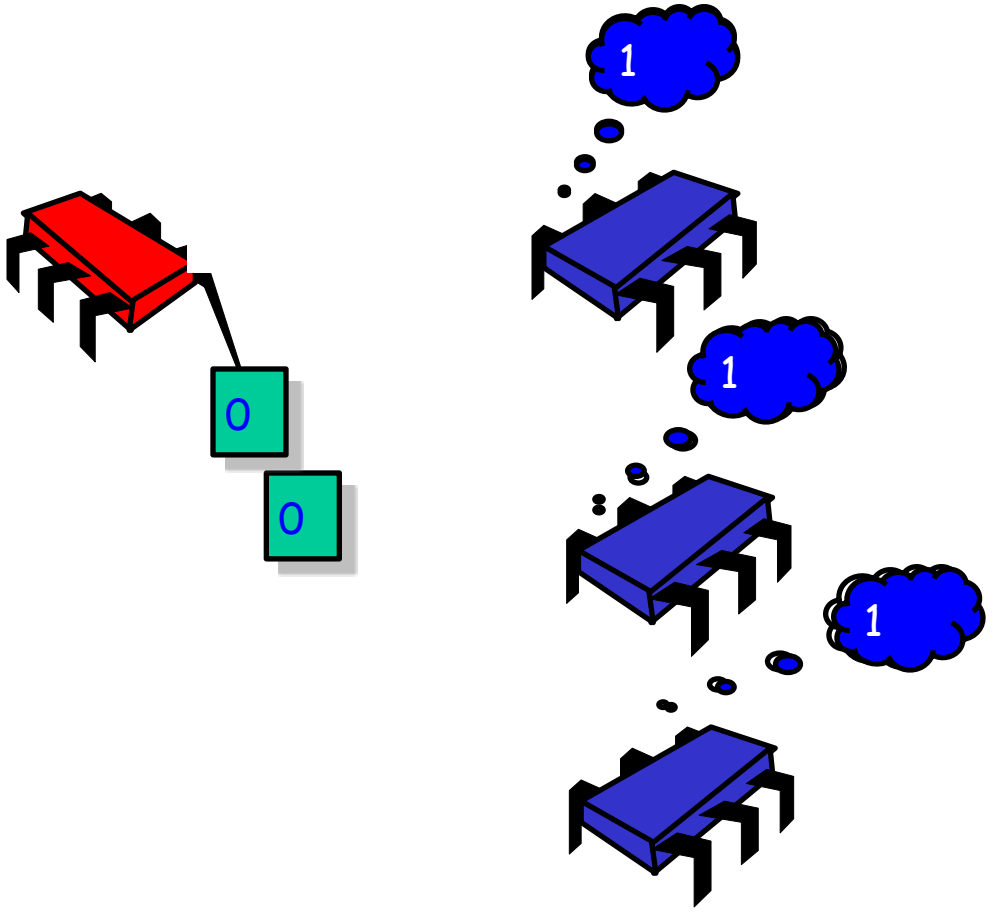
Each thread has own safe SRSW register

- SRSW Booléen sûr
- MRSW Booléen sûr
- MRSW Booléen régulier
- MRSW regulier
- MRSW atomique
- MRMW atomique

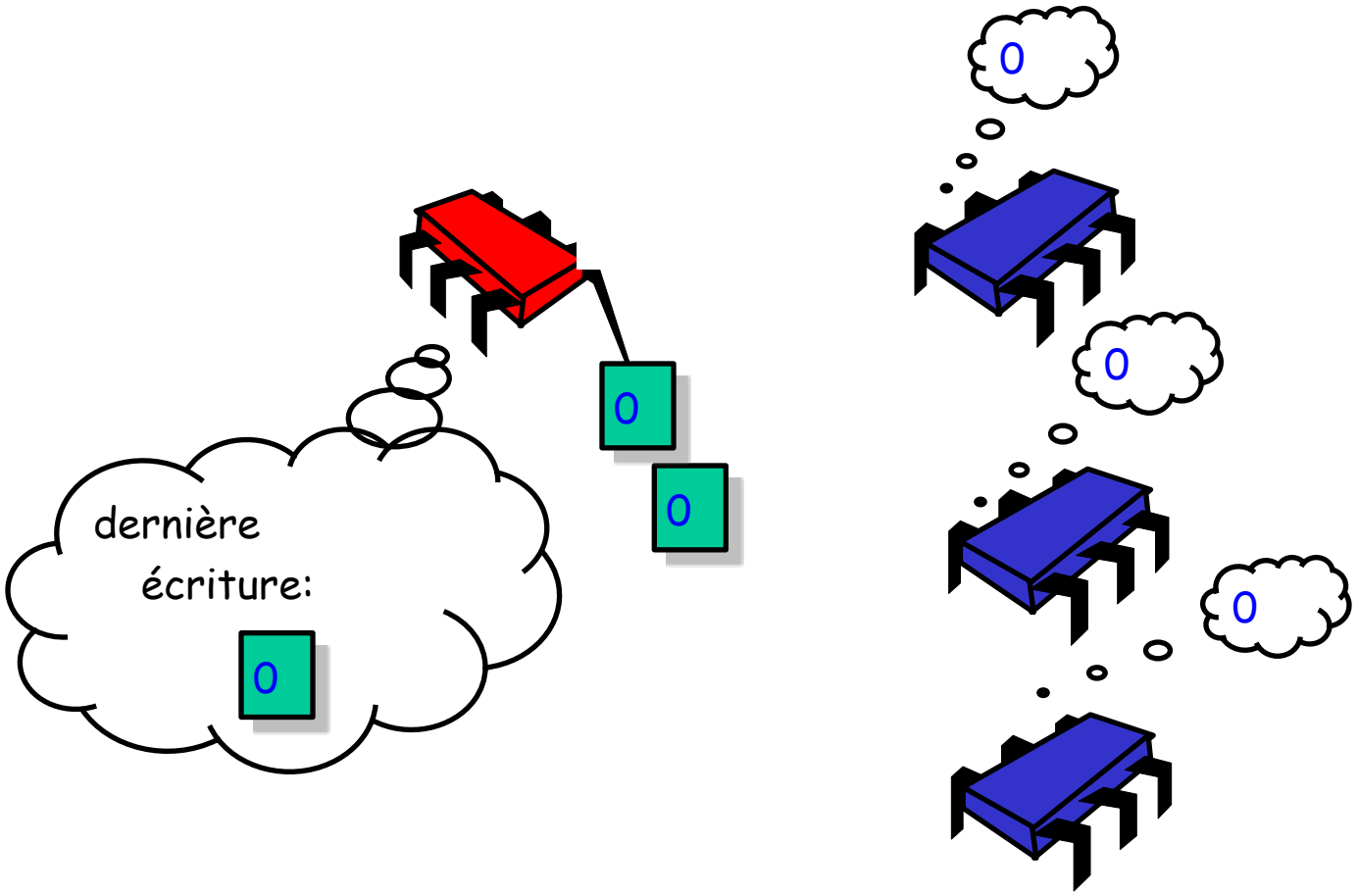
MRSW Booléens Réguliers à partir de MRSW Booléens Sûrs



MRSW Booléens Réguliers à partir de MRSW Booléens Sûrs



MRSW Booléens Réguliers à partir de MRSW Booléens Sûrs

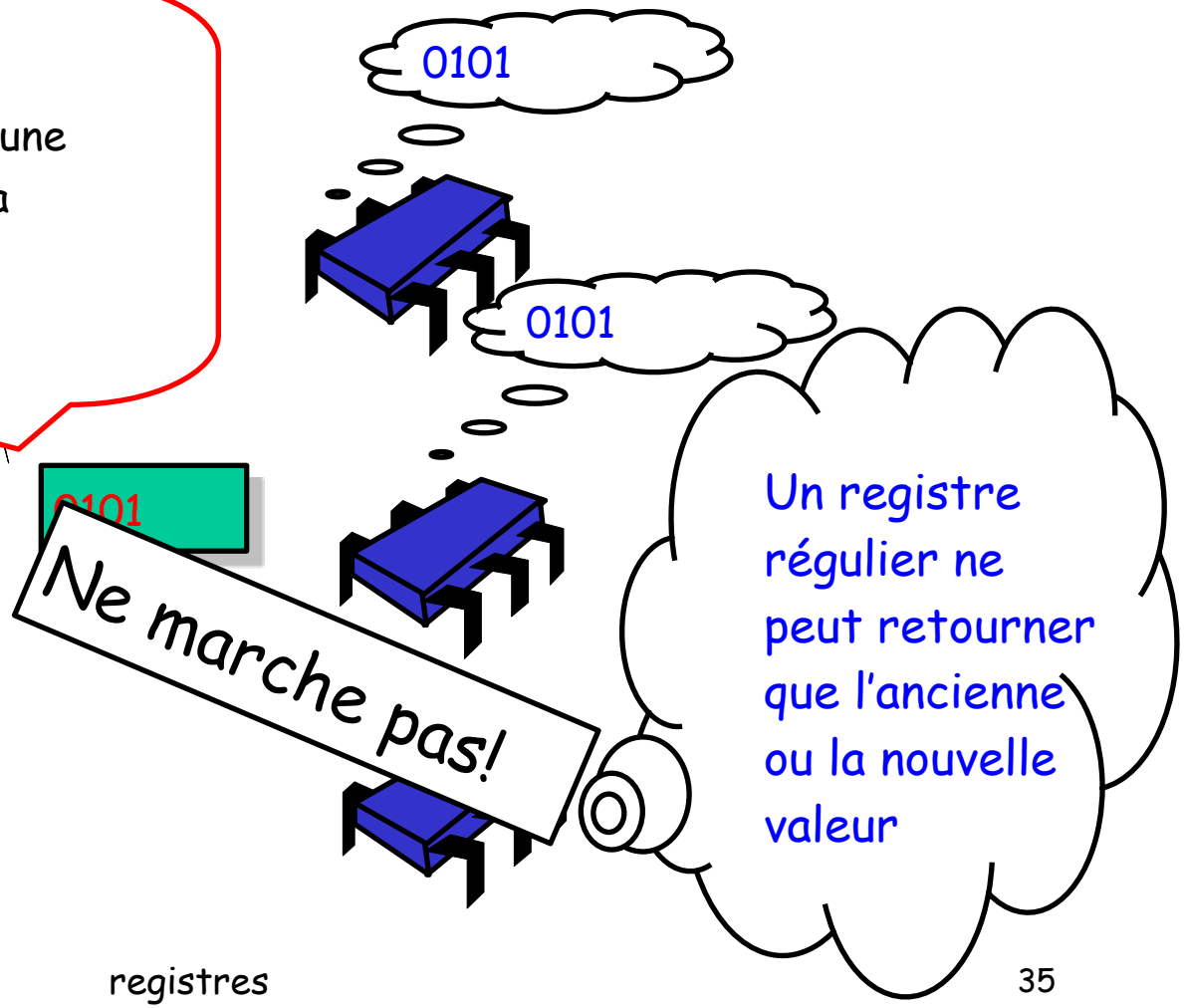


MRSW booléens réguliers à partir MRSW booléens sûrs

```
public class RegBoolMRSWRegister
 implements Register<Boolean> {
  private boolean old;
  private SafeBoolMRSWRegister value;
  public void write(boolean x) {
   if (old != x) {
    value.write(x);
    old = x;
   }}
  public boolean read() {
   return value.read();
  }}
```

et multi-valués?

Un registre sûr peut retourner une valeur qui n'est ni l'ancienne ni la nouvelle.



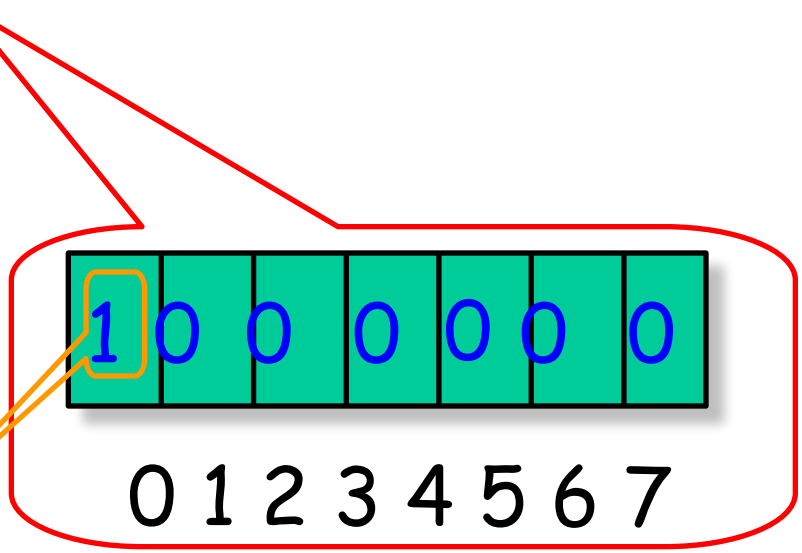
Le programme…

- SRSW Booléen sûr
- MRSW Booléen sûr
- MRSW Booléen régulier
- MRSW regulier
- MRSW atomique
- MRMW atomique

Multi-Valué

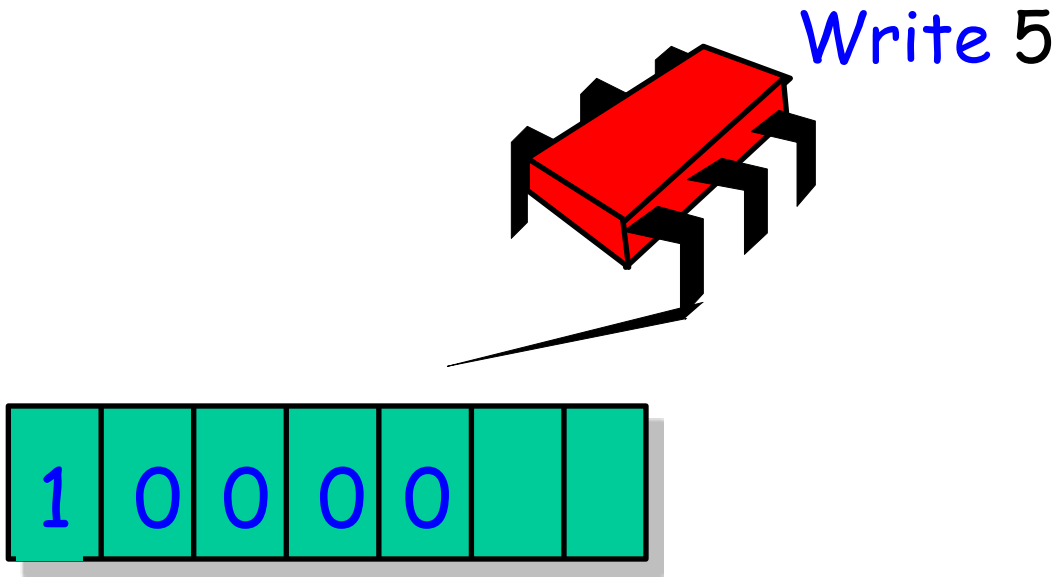
Représentation unaire: bit[i]

-> valeur i



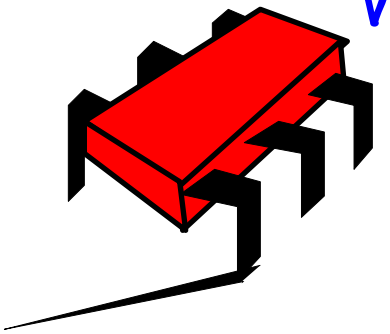
initialement 0

Ecriture

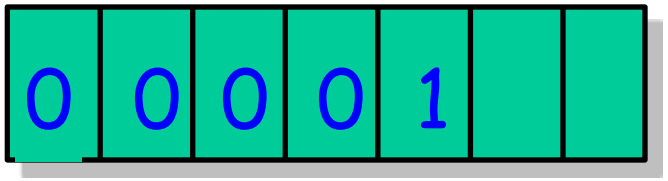


Ecriture

Write 5

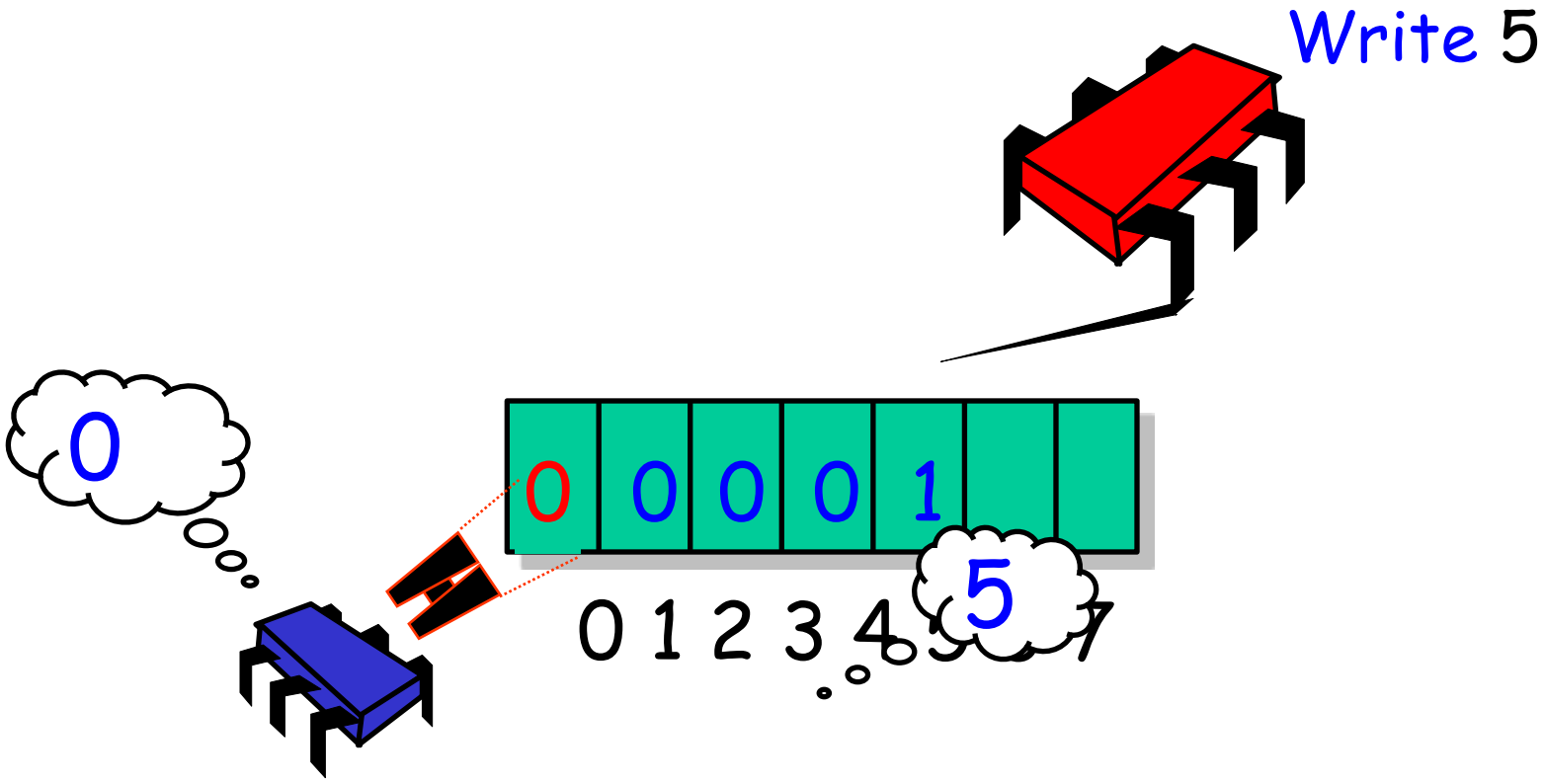


Initialement 0



0 1 2 3 4 5 6 7

Ecriture



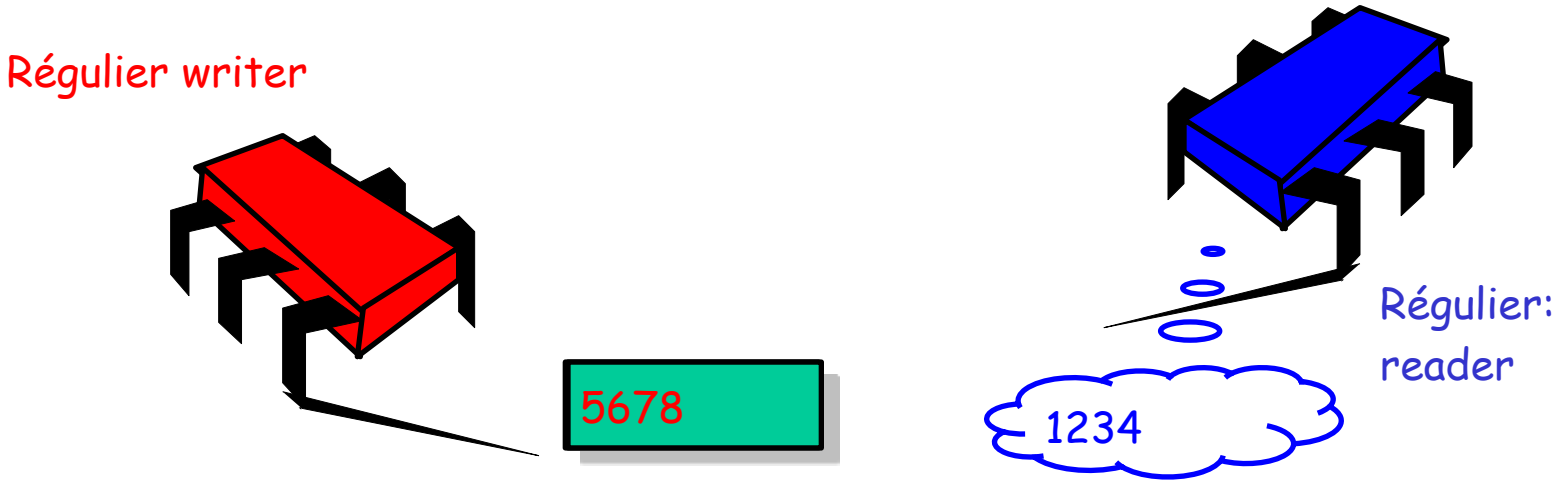
MRSW Régulier Multi-valué à partir de MRSW Booléens Réguliers

```
public class RegMRSWRegister implements Register{
  RegBoolMRSWRegister[M] bit;

  public void write(int x) {
    this.bit[x].write(true);
    for (int i=x-1; i>=0; i--)
      this.bit[i].write(false);
  }

  public int read() {
    for (int i=0; i < M; i++)
      if (this.bit[i].read())
        return i;
   }}
```

- SRSW Booléen sûr
- MRSW Booléen sûr
- MRSW Booléen régulier
- MRSW regulier
- MRSW atomique
- MRMW atomique

SWSR

SRSW Atomique à partir de SRSW Régulier

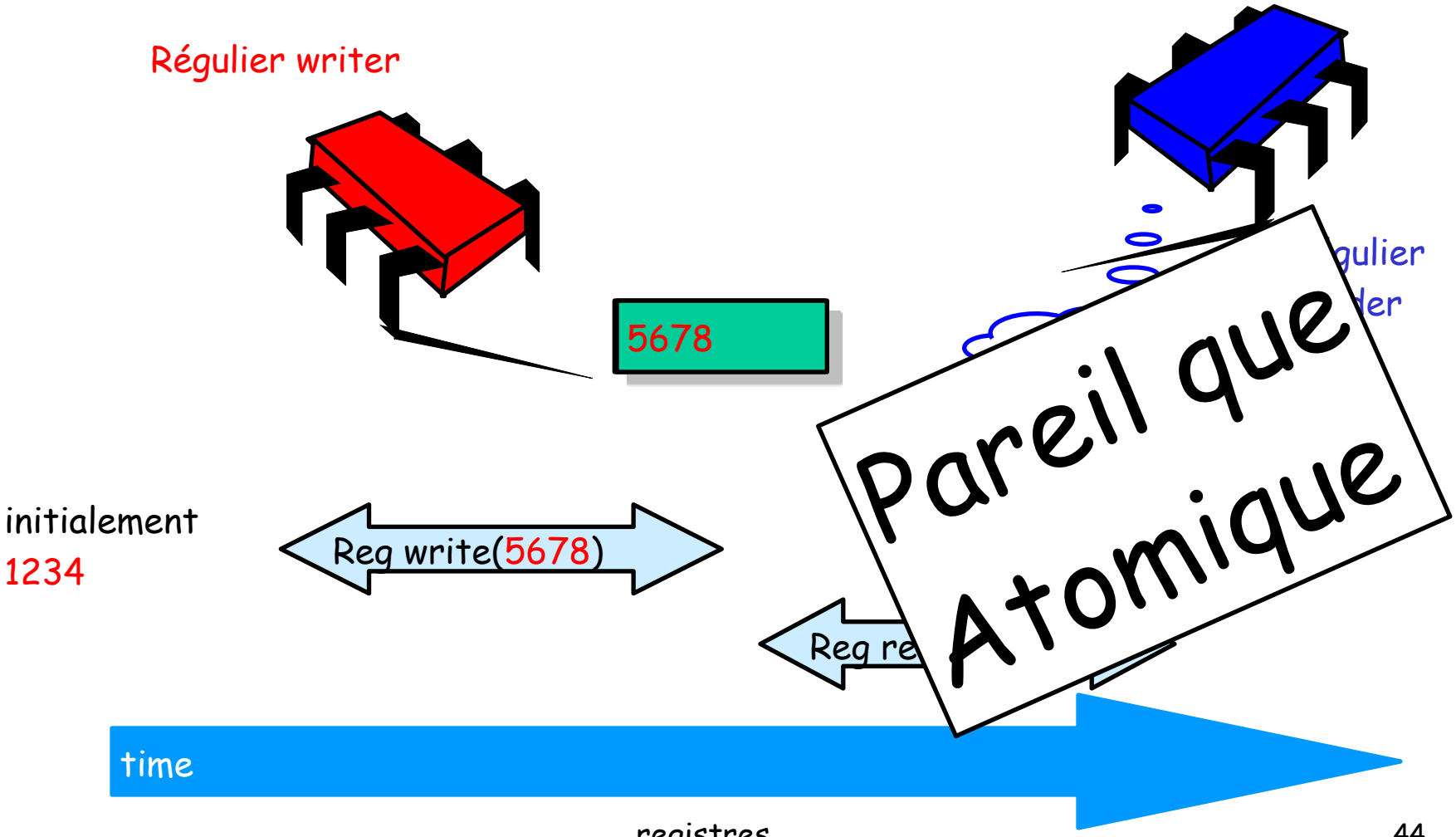


et pas 5678…

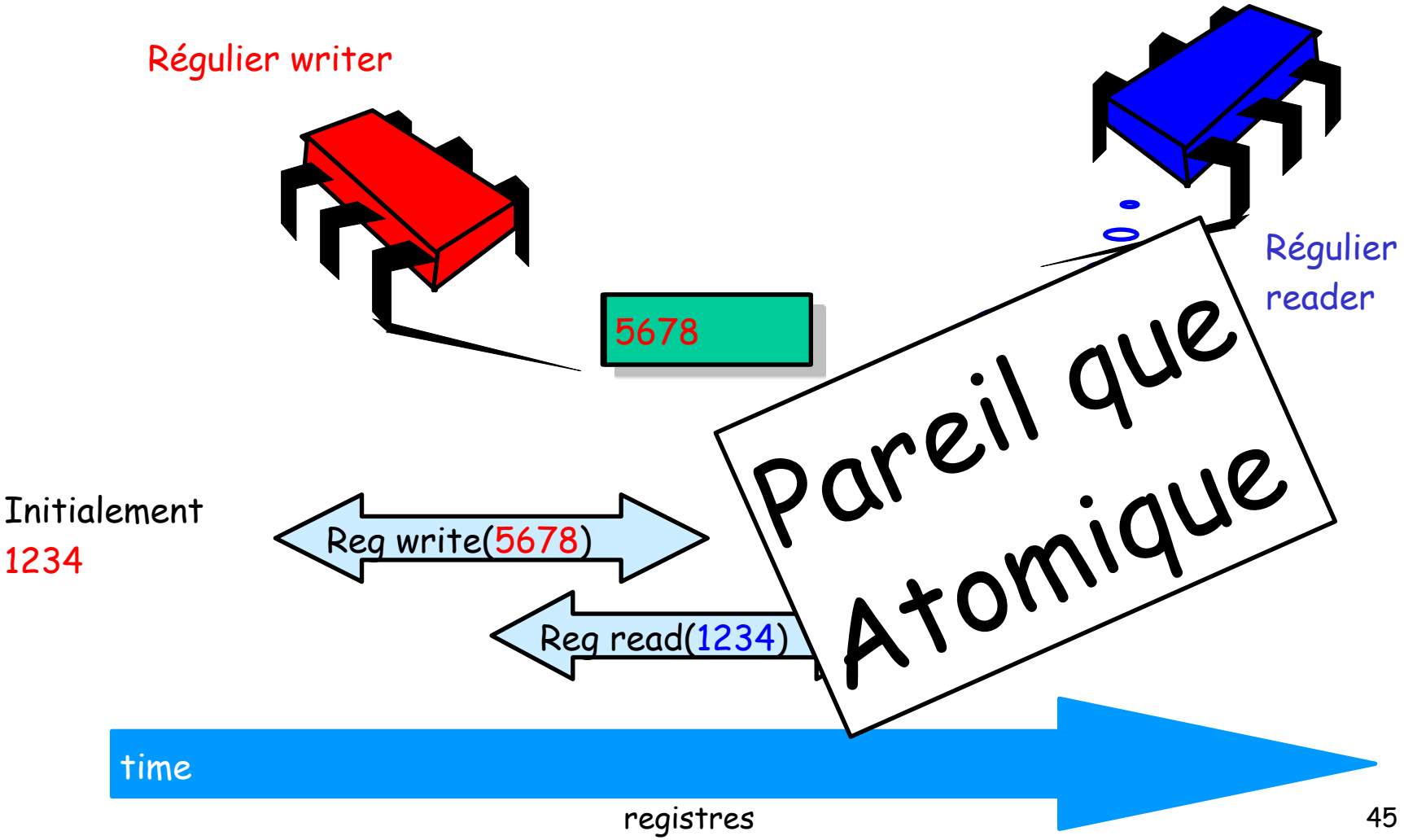
lecture concurrente

Problème?

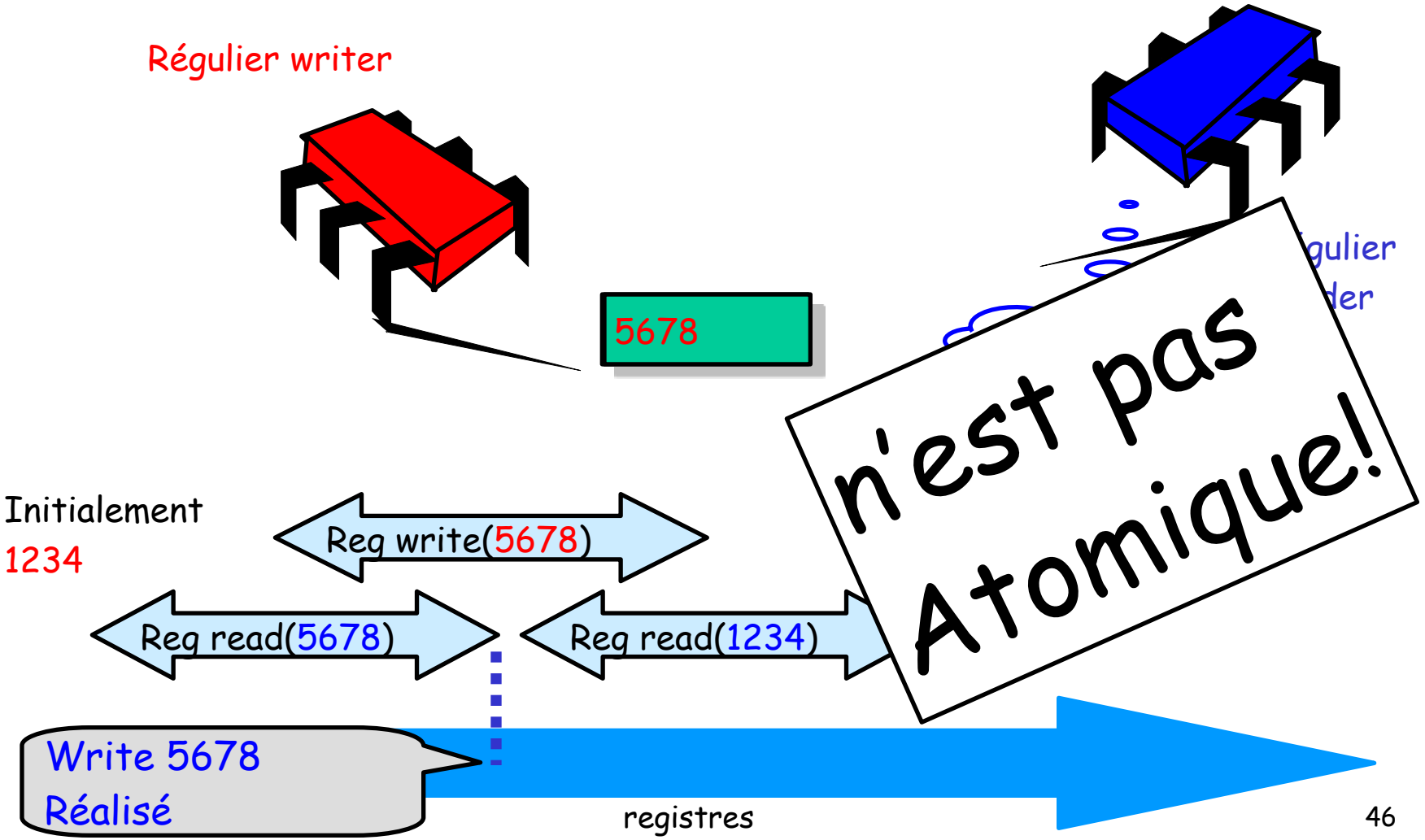
SRSW Atomique à partir de SRSW Régulier



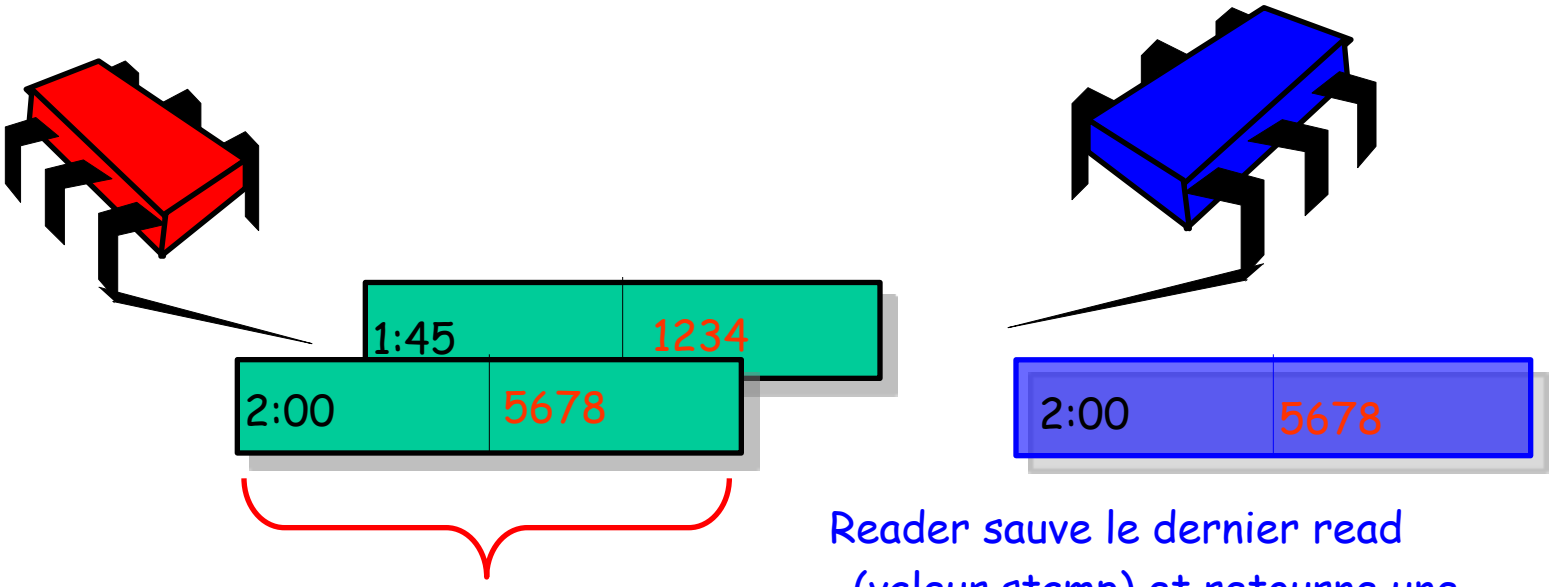
SRSW Atomique à partir de SRSW Régulier



SRSW Atomique à partir de SRSW Régulier



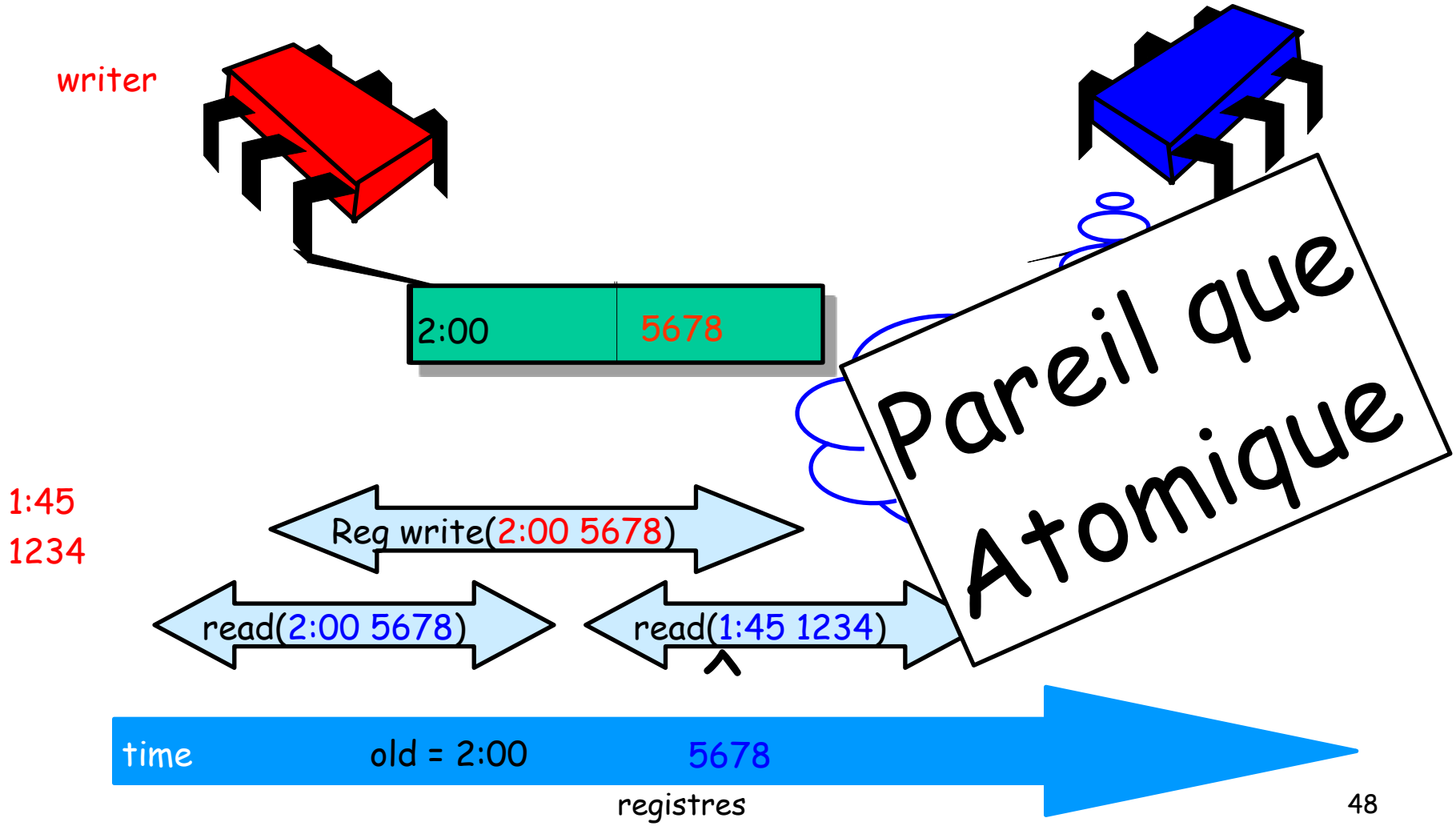
Valeur avec Timestamp



Writer écrit la valeur
et le timestamp

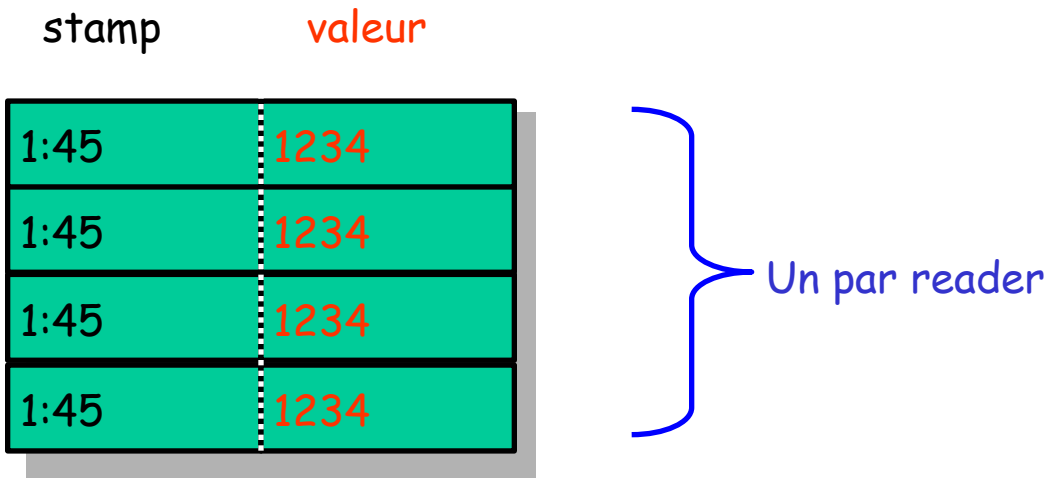
Reader sauve le dernier read (valeur,stamp) et retourne une nouvelle valeur seulement si le timestamp est plus grand

SRSW Atomique à partir de SRSW Régulier

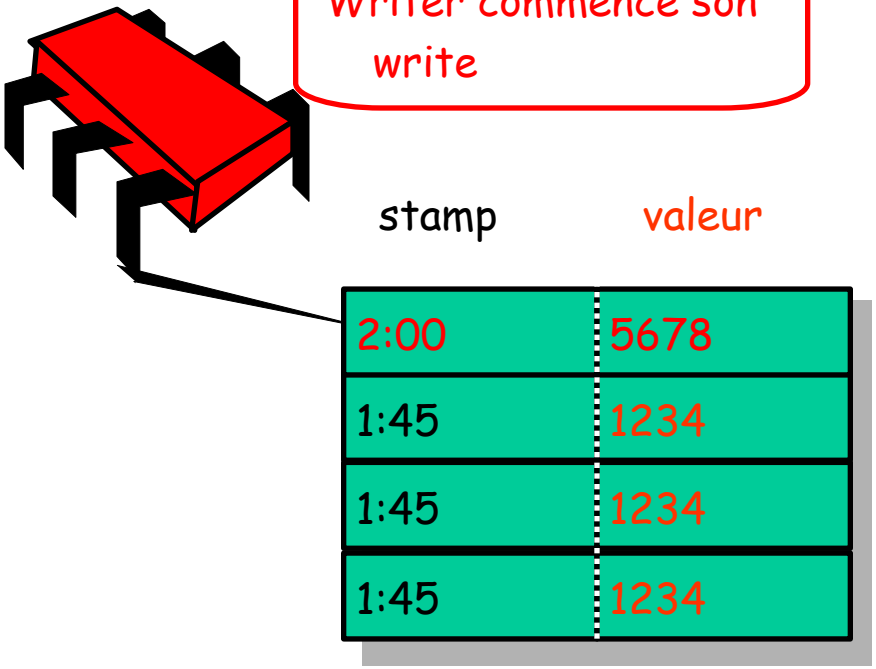


registres

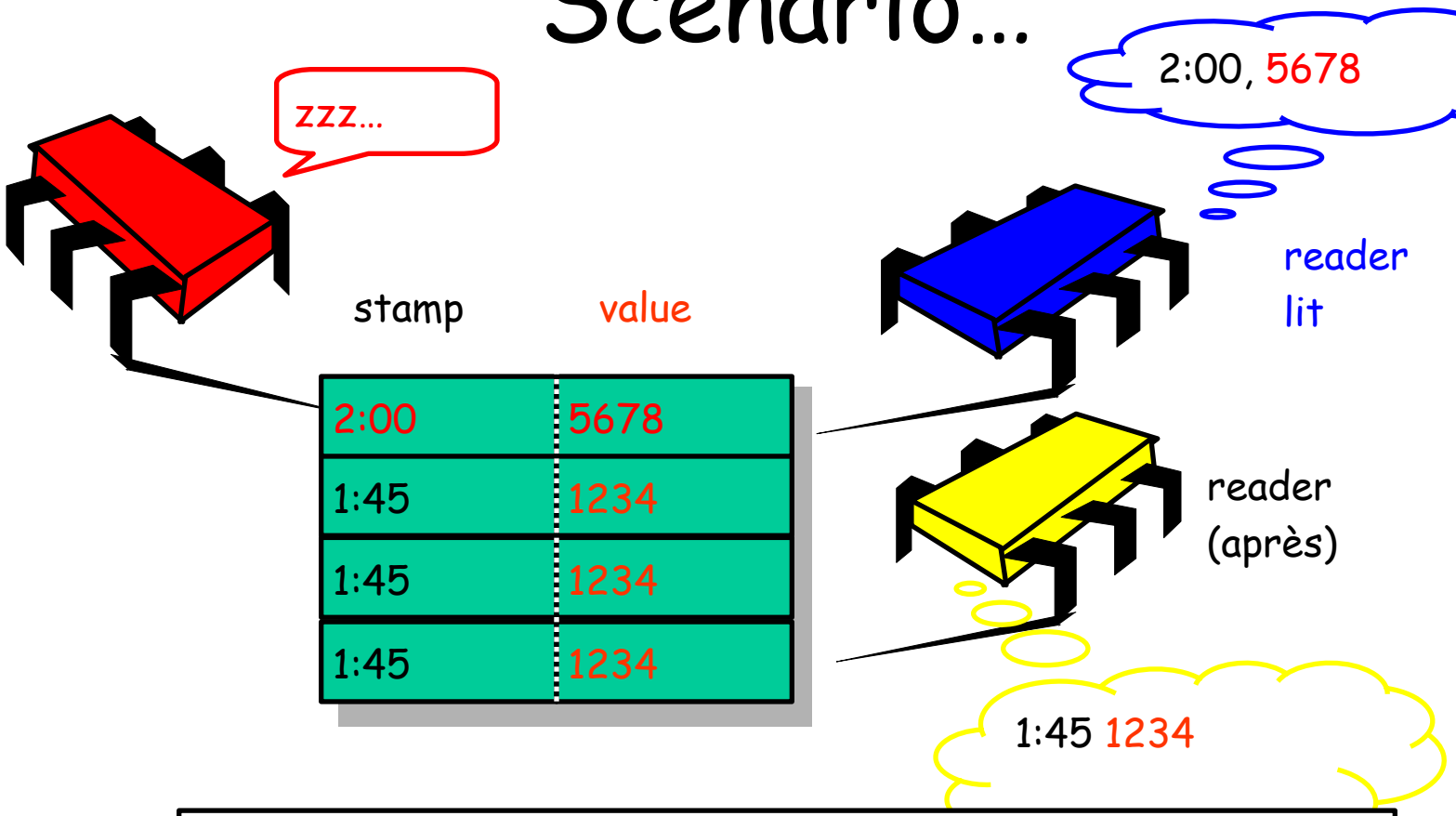
de Single Reader Atomique à Multi-Reader Atomique



Scenario

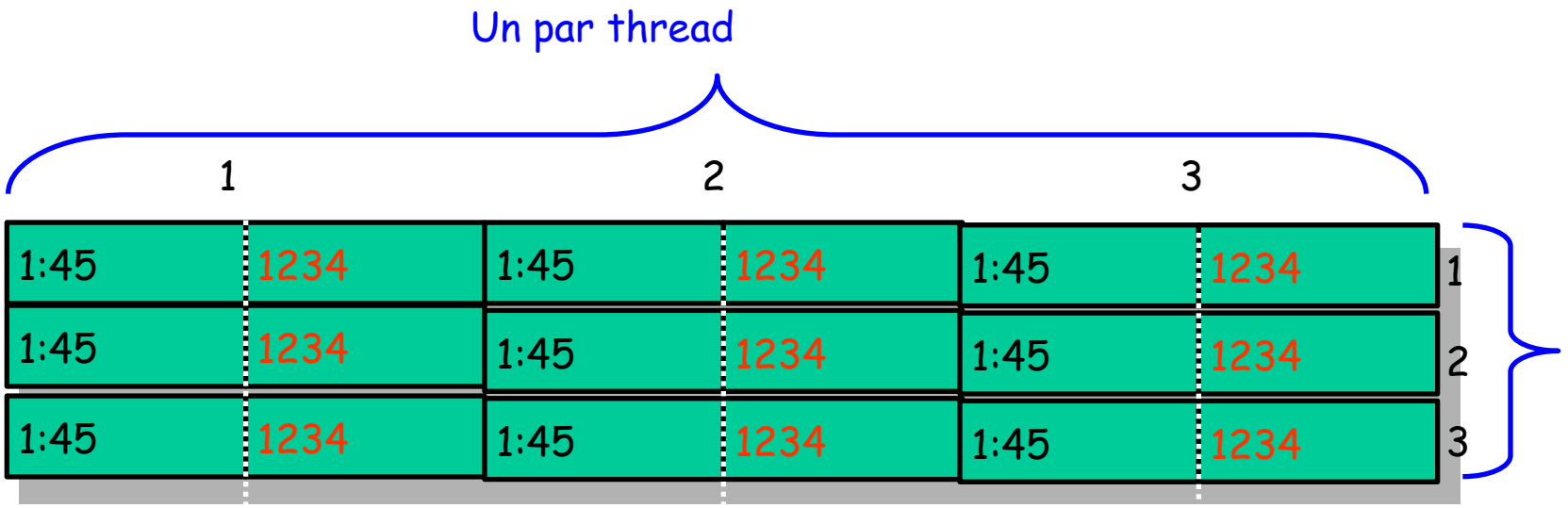

Writer commence son write
stamp
valeur
2:00
5678
1:45
1234
1:45
1234
1:45
1234

Scenario…

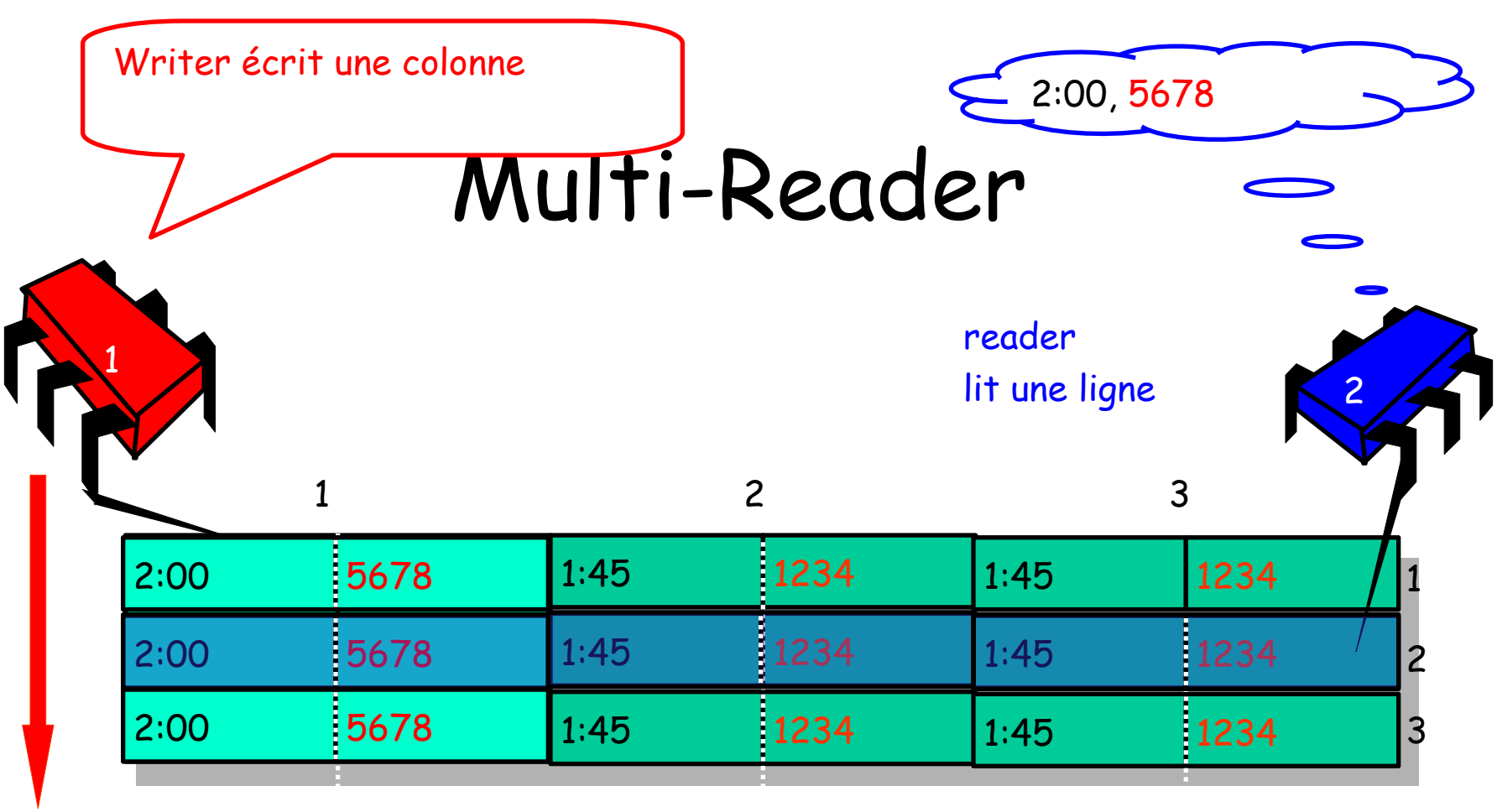


Le Jaune retourne une value antérieure alors qu'il est après Bleu:non linéarisable!

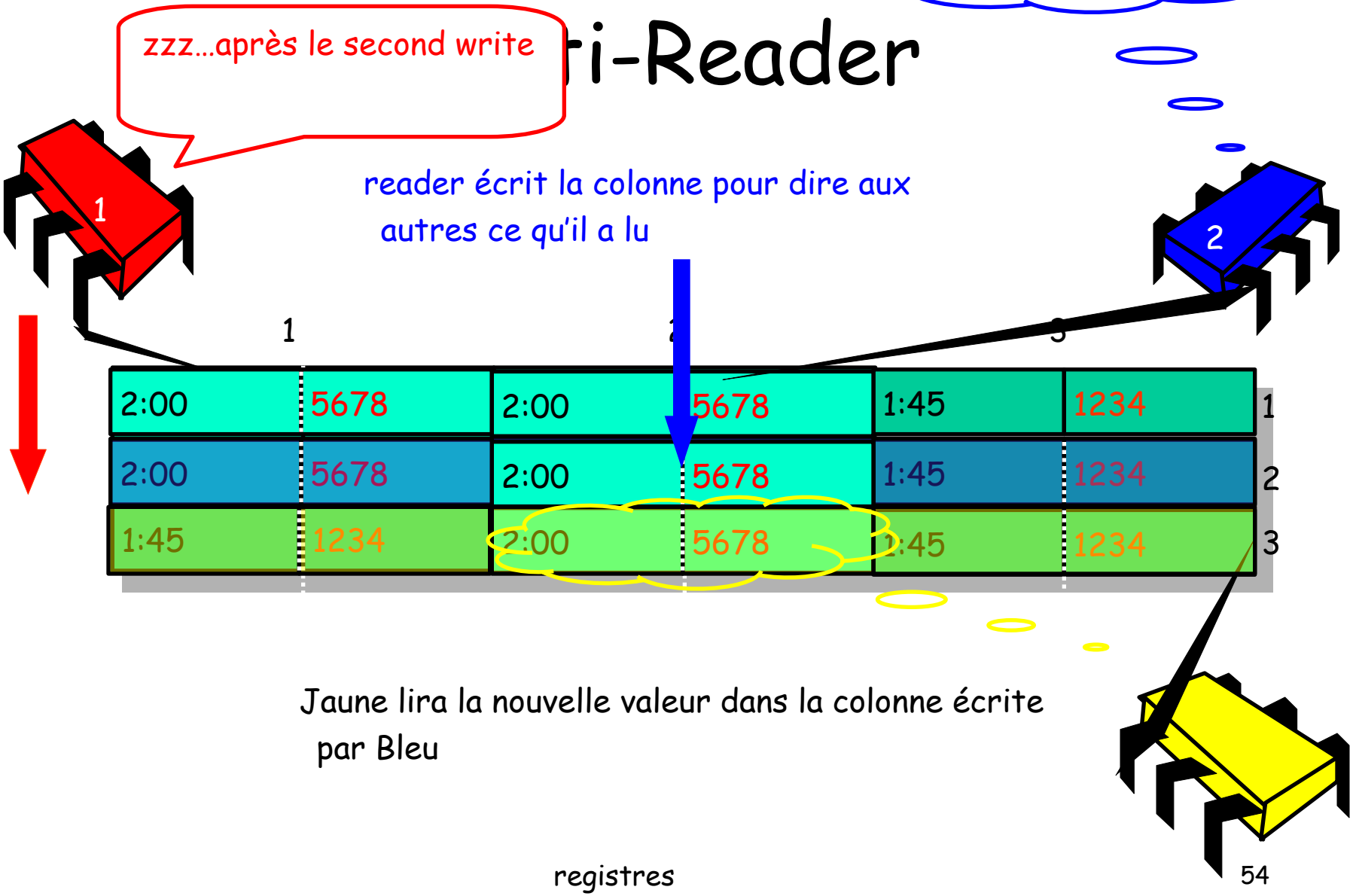
Multi-Reader



Multi-Reader

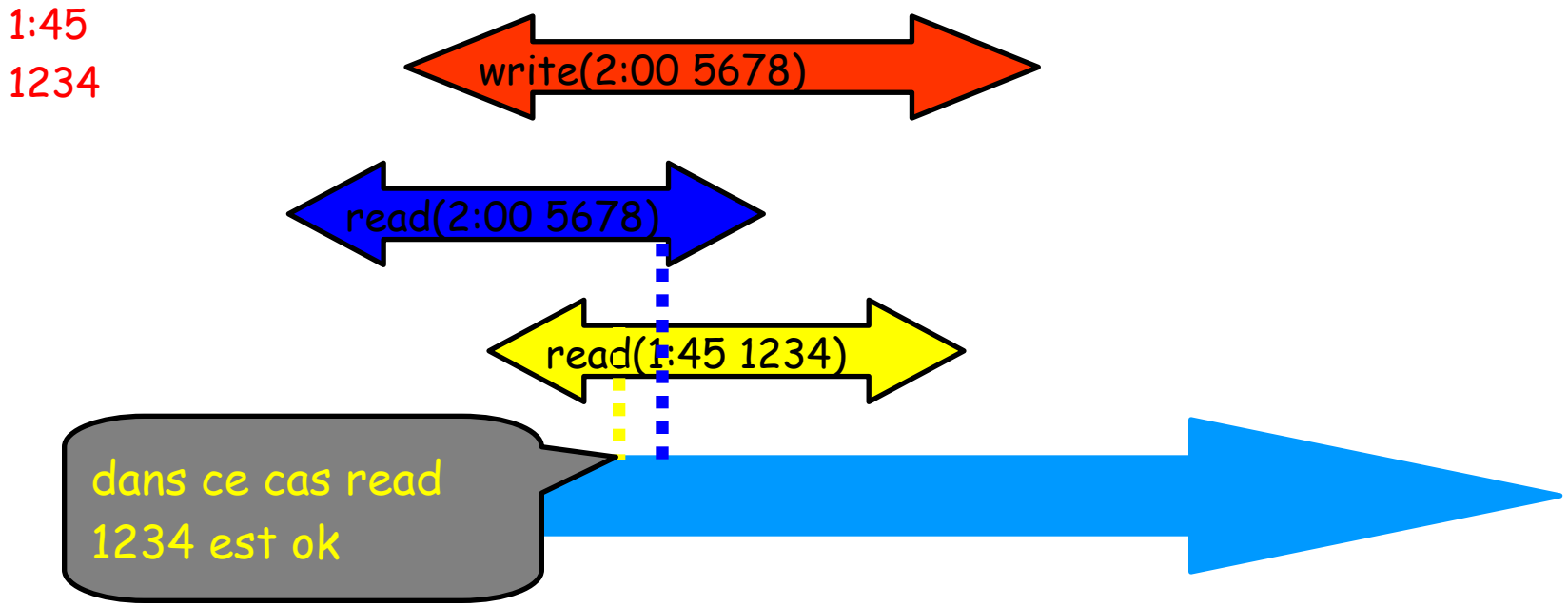


ti-Reader

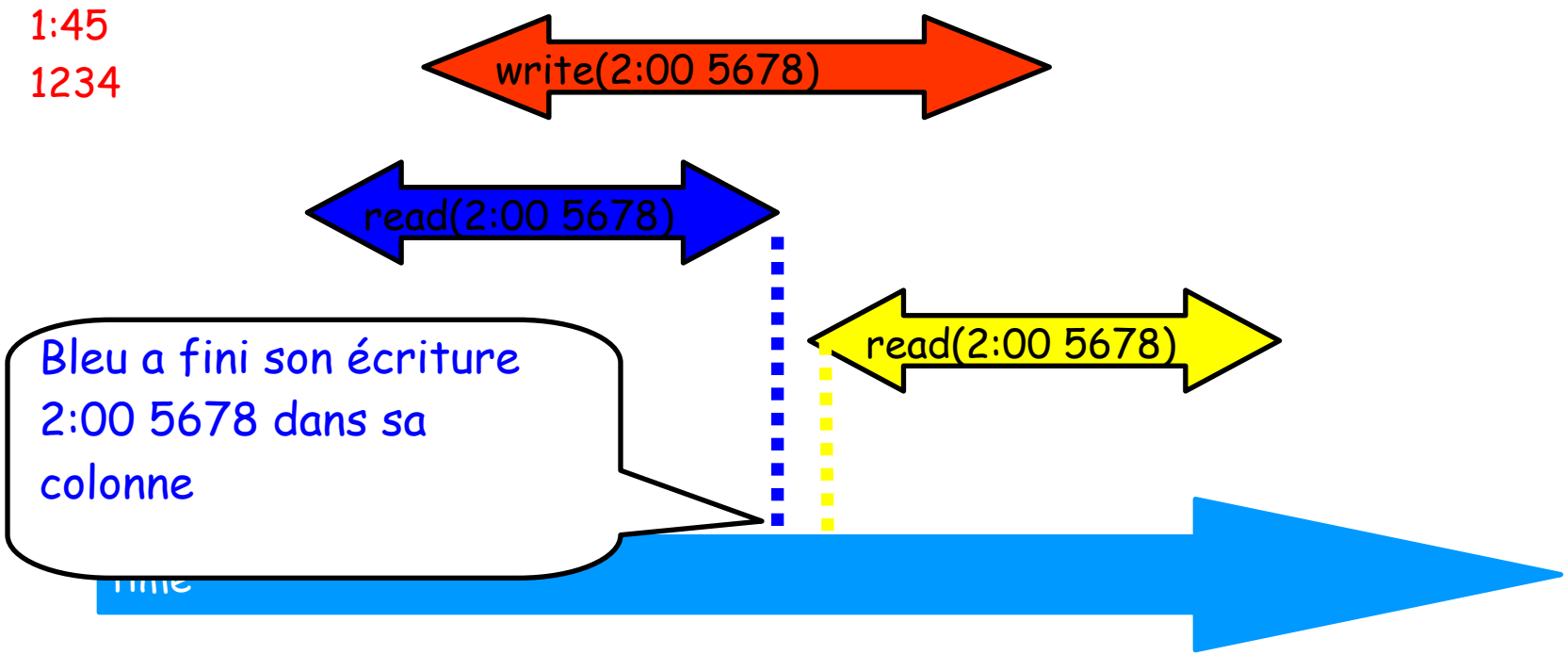


Jaune lira la nouvelle valeur dans la colonne écrite par Bleu

Jaune peut-il rater la mise à jour de Bleu? … seulement en cas de concurrence



Si non concurrence tout va bien!

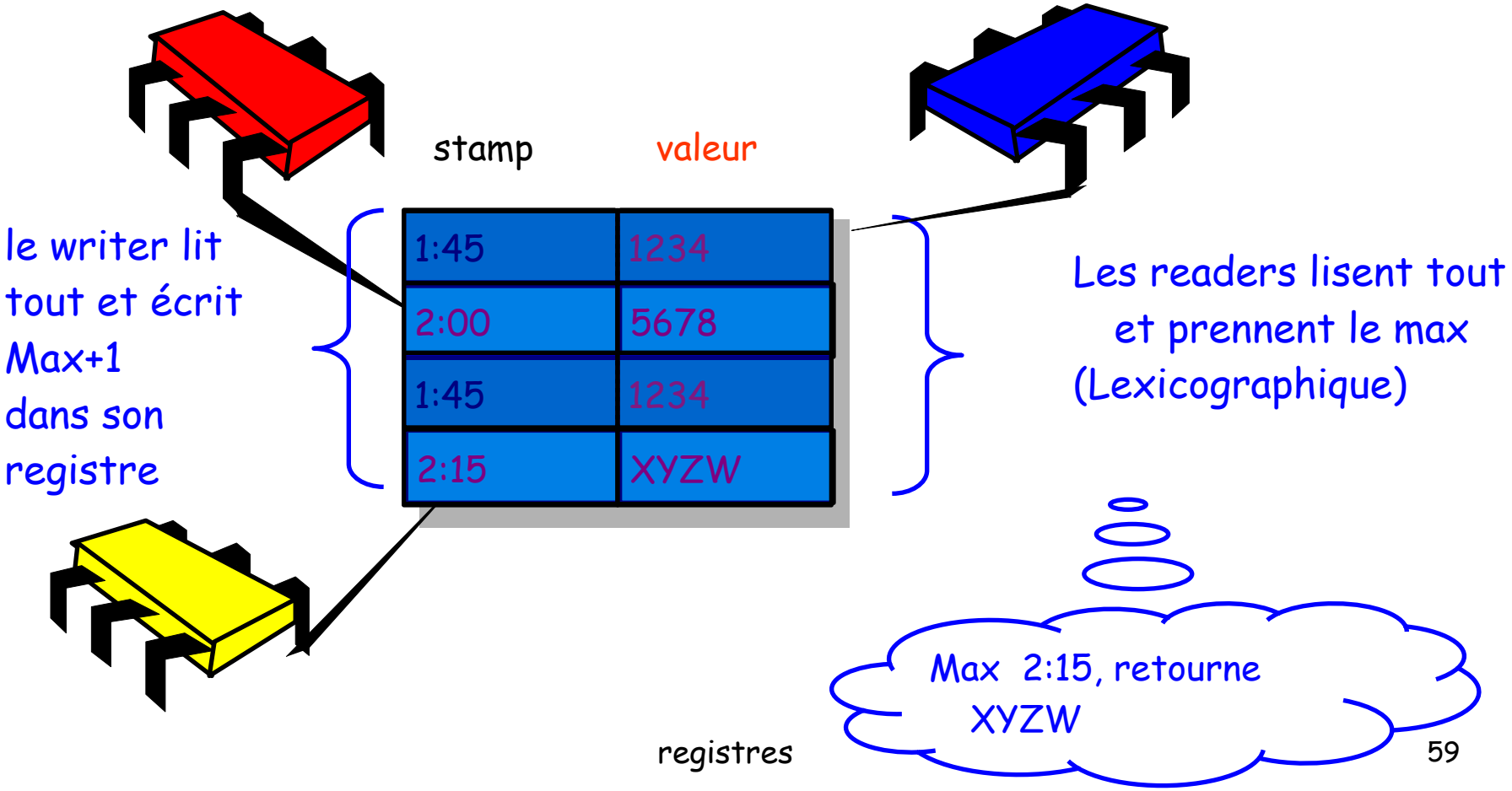


```
1  public class AtomicMRSWRegister<T> implements Register<T> {
2    ThreadLocal<Long> lastStamp;
3    private StampedValue<T>[][] a_table; // each entry is SRSW atomic
4    public AtomicMRSWRegister(T init, int readers) {
5      lastStamp = new ThreadLocal<Long>() {
6         protected Long initialValue() { return 0; };
7      };
8      a_table = (StampedValue<T>[][]) new StampedValue[readers][readers];
9      StampedValue<T> value = new StampedValue<T>(init);
10     for (int i = 0; i < readers; i++) {
11       for (int j = 0; j < readers; j++) {
12         a_table[i][j] = value;
13       }
14     }
15   }
16   public T read() {
17     int me = ThreadID.get();
18     StampedValue<T> value = a_table[me][me];
19     for (int i = 0; i < a_table.length; i++) {
20       value = StampedValue.max(value, a_table[i][me]);
21     }
22     for (int i = 0; i < a_table.length; i++) {
23       a_table[me][i] = value;
24     }
25     return value;
26   }
27   public void write(T v) {
28     long stamp = lastStamp.get() + 1;
29     lastStamp.set(stamp);
30     StampedValue<T> value = new StampedValue<T>(stamp, v);
31     for (int i = 0; i < a_table.length; i++) {
32       a_table[i][i] = value;
33     }
34   }
35 }
```

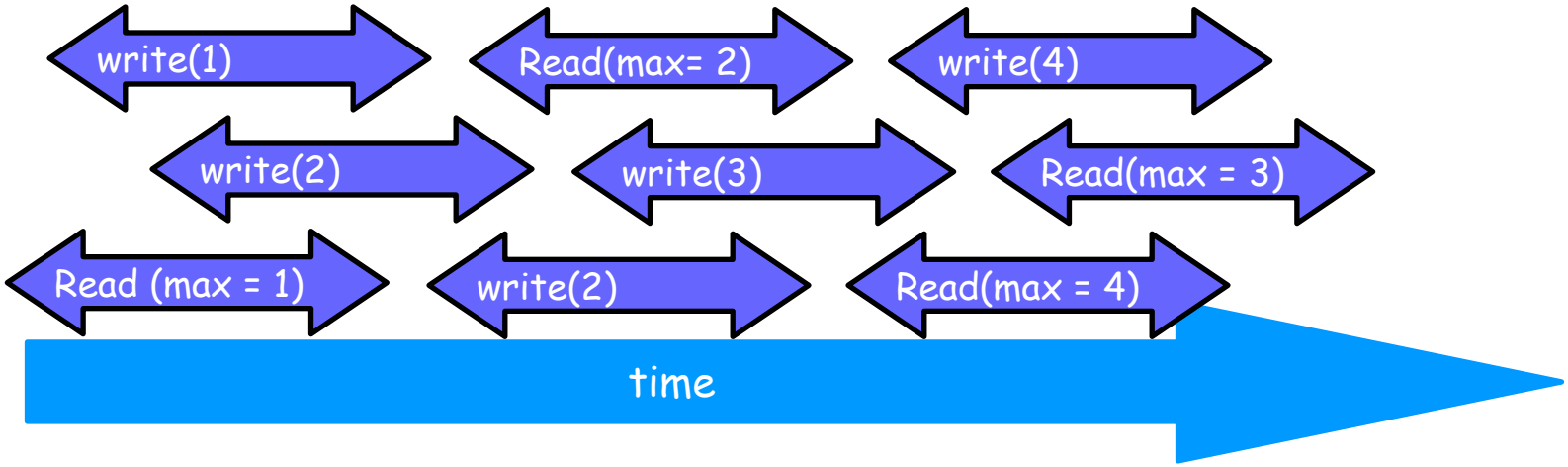
Le programme…

- SRSW Booléen sûr
- MRSW Booléen sûr
- MRSW Booléen régulier
- MRSW regulier
- MRSW atomique
- MRMW atomique

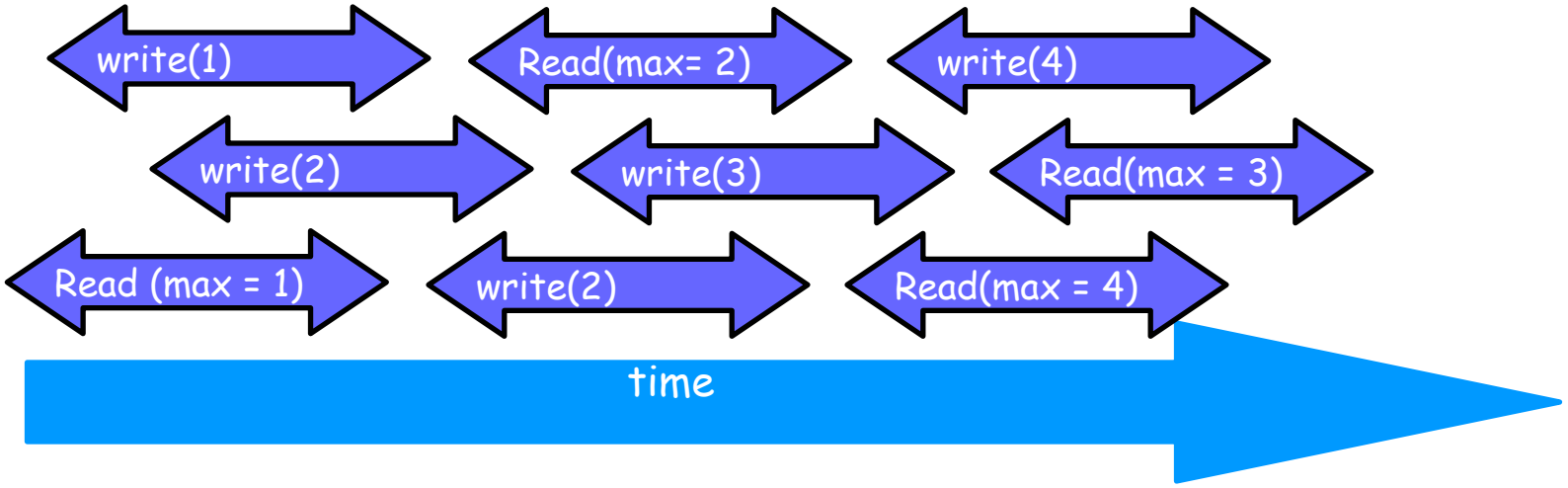
Multi-Writer Atomique à partir de SW-Multi-Reader Atomique



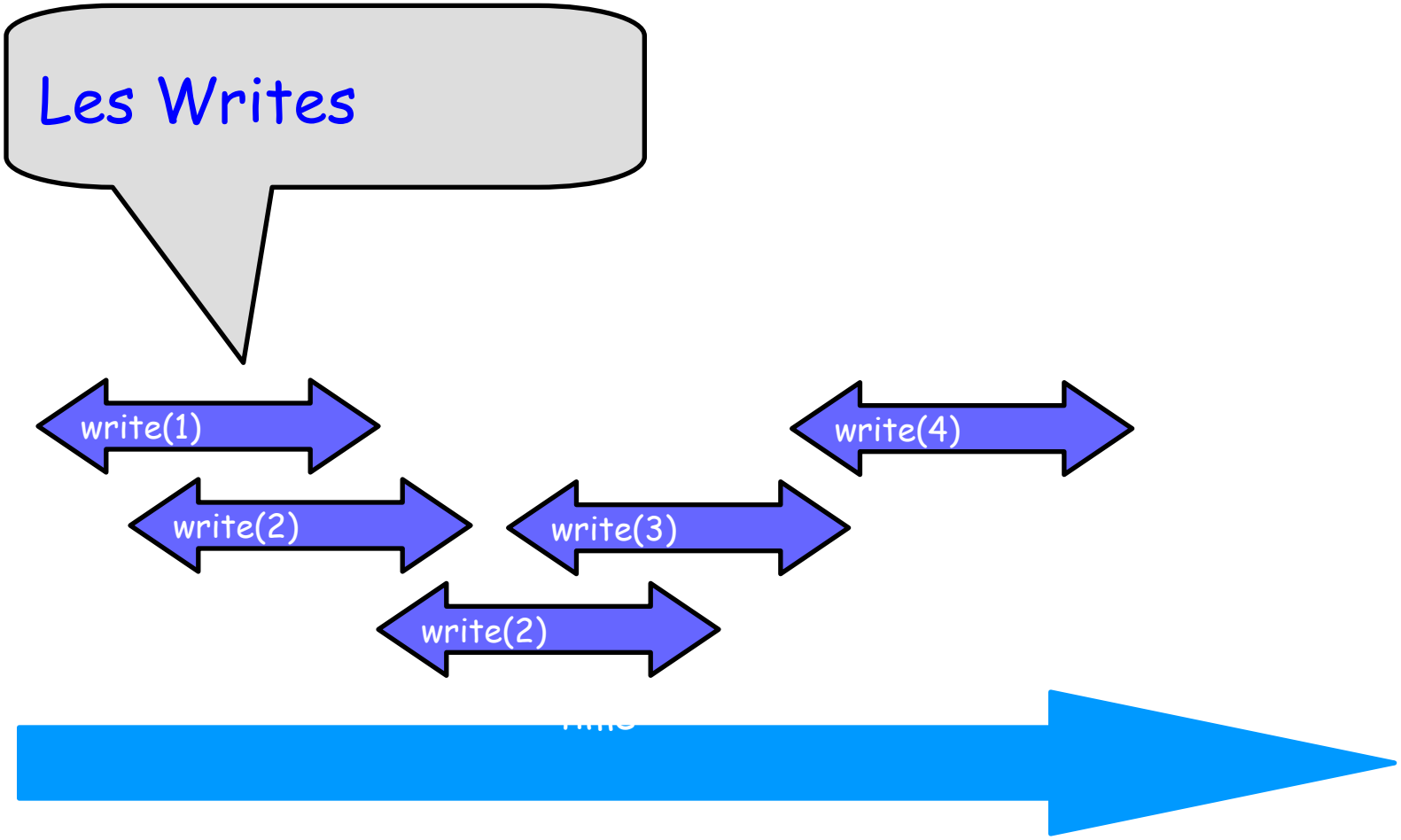
Linearisable



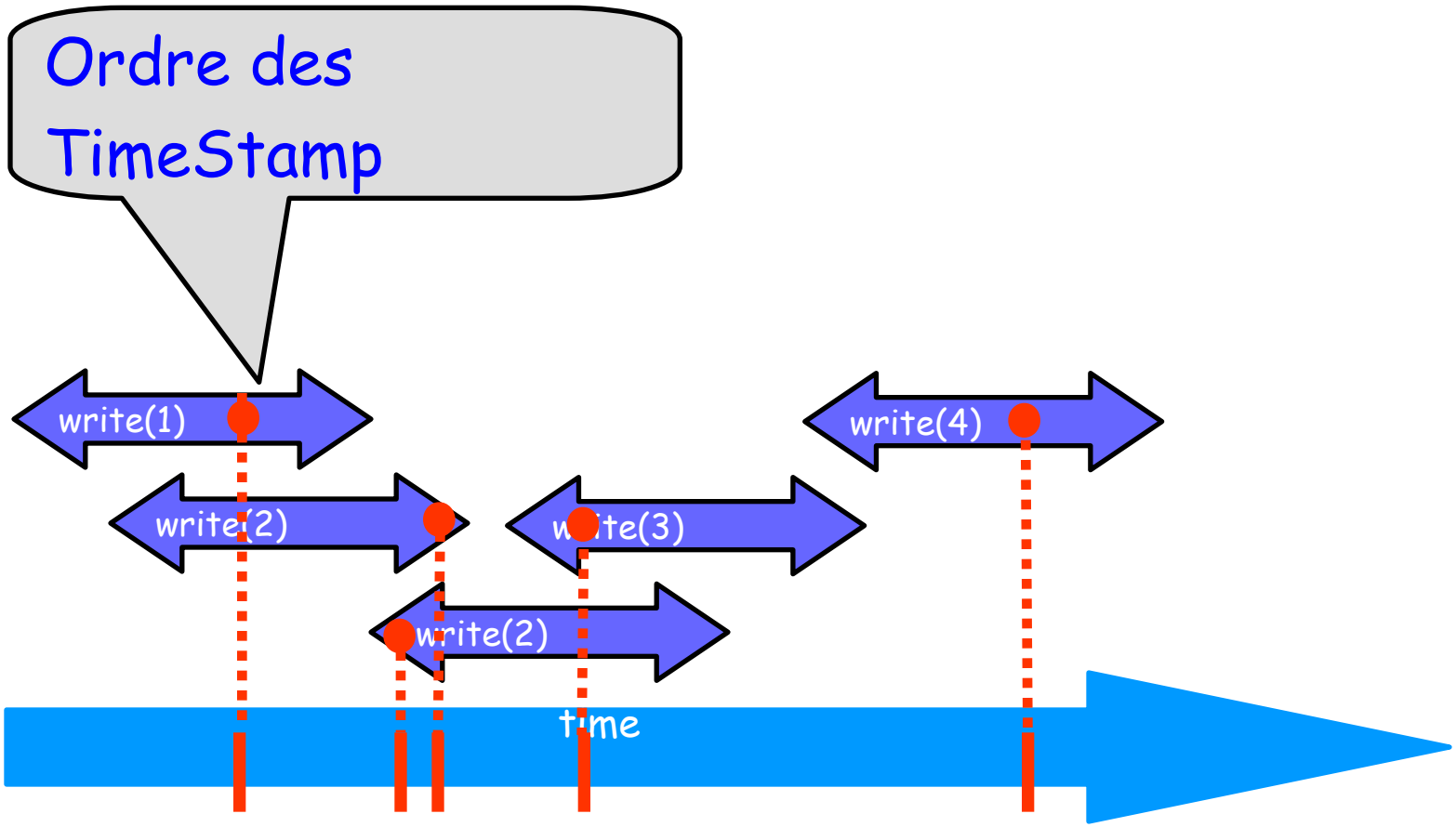
Points de Linéarisation



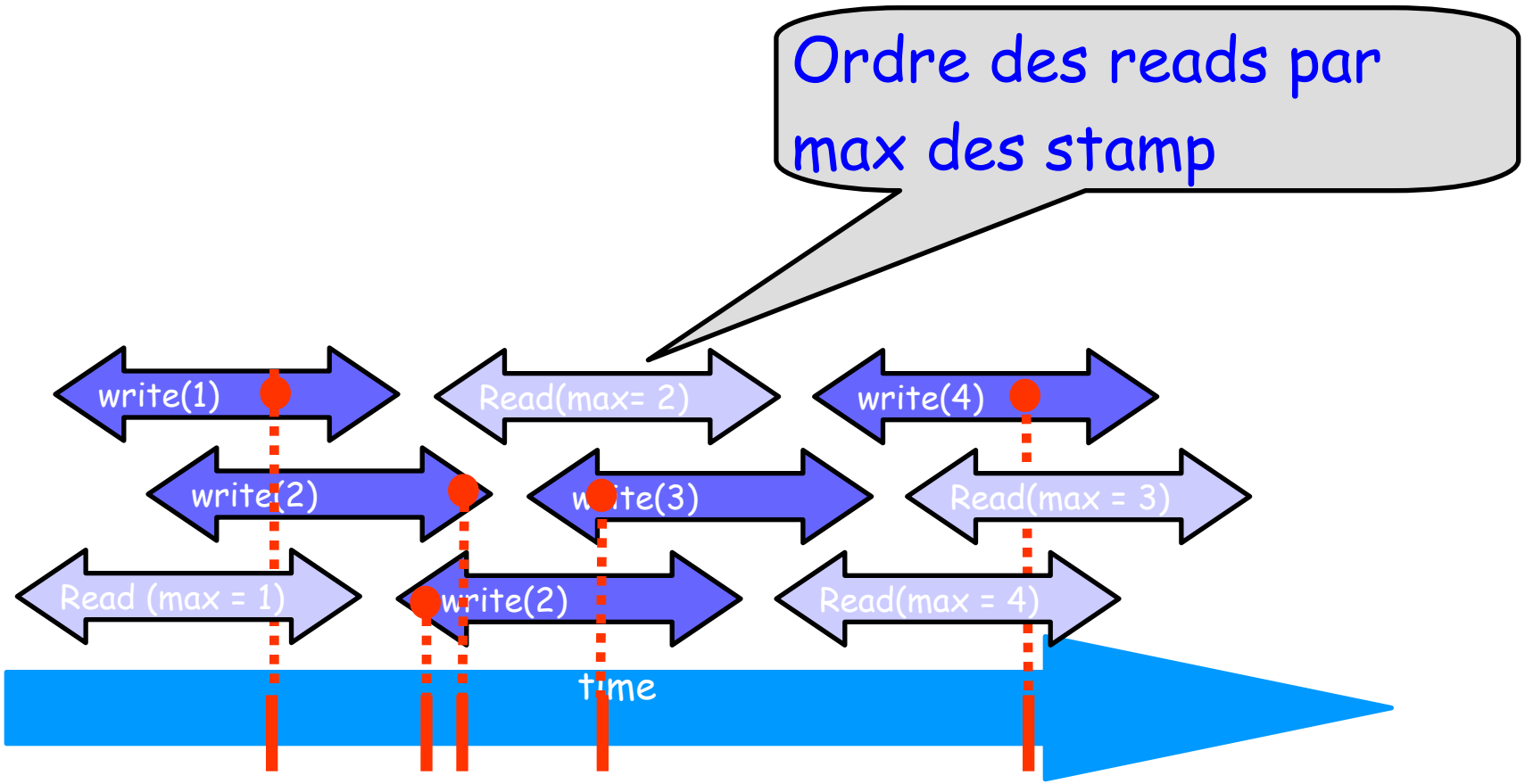
Points de Linéarisation



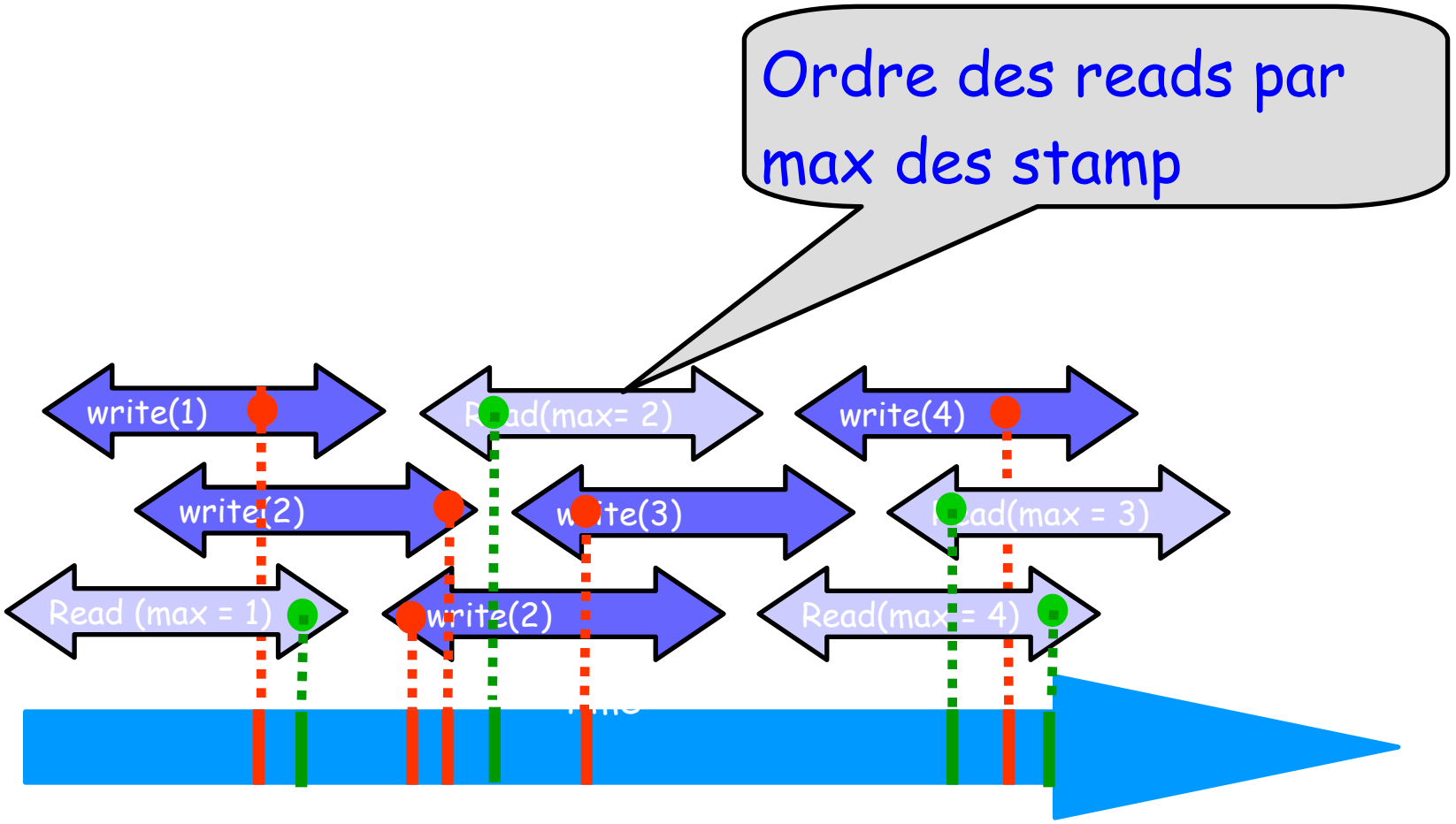
Points de Linéarisation



Points de Linéarisation



Points de Linéarisation



Points de Linéarisation

Le point de linéarisation dépend de l'exécution