Registers

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Register

- A ***register*** has two operations: ***read()*** and ***write()***
- Sequential specification
- - ***read()***
    - return(x)
  - ***write(v)***
    - x <- v; return(ok)

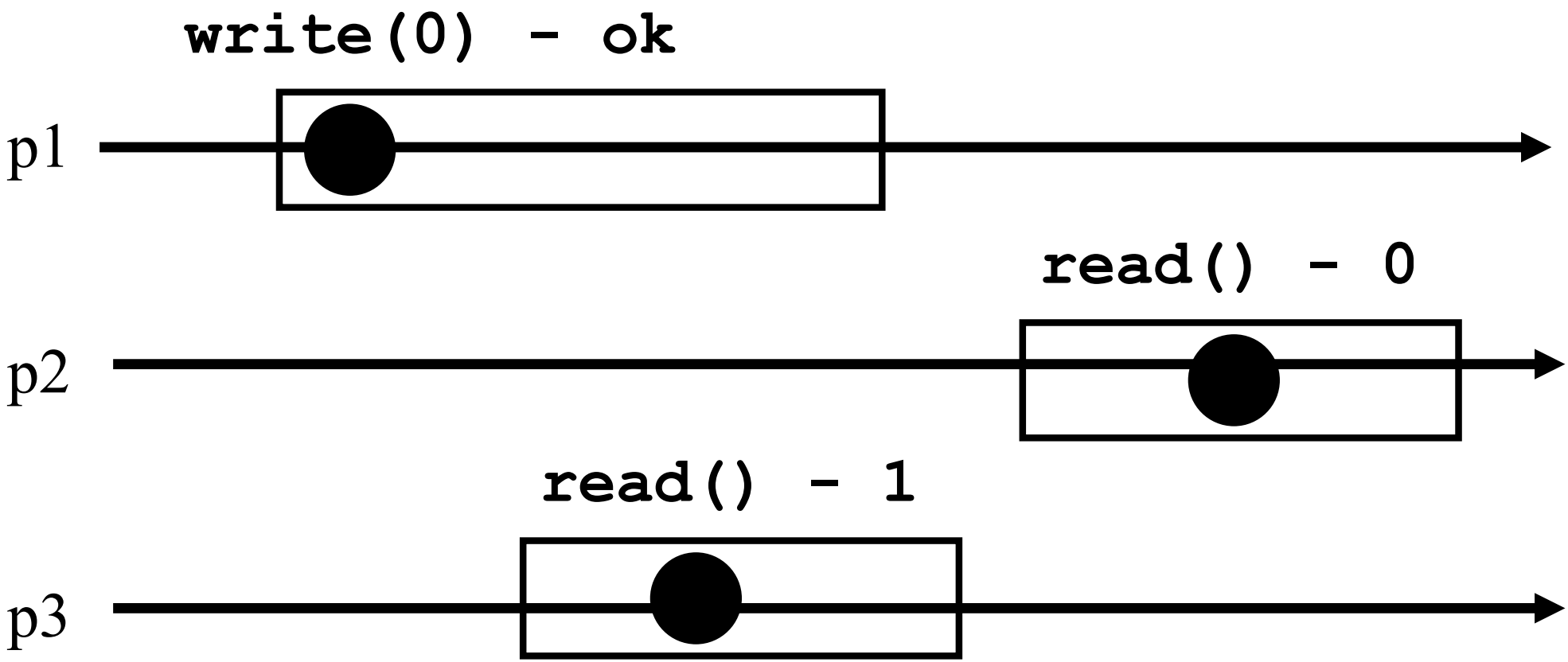
Simplifications

- We assume that ***registers*** contain only integers
- Unless explicitly stated otherwise, ***registers*** are initially supposed to contain 0

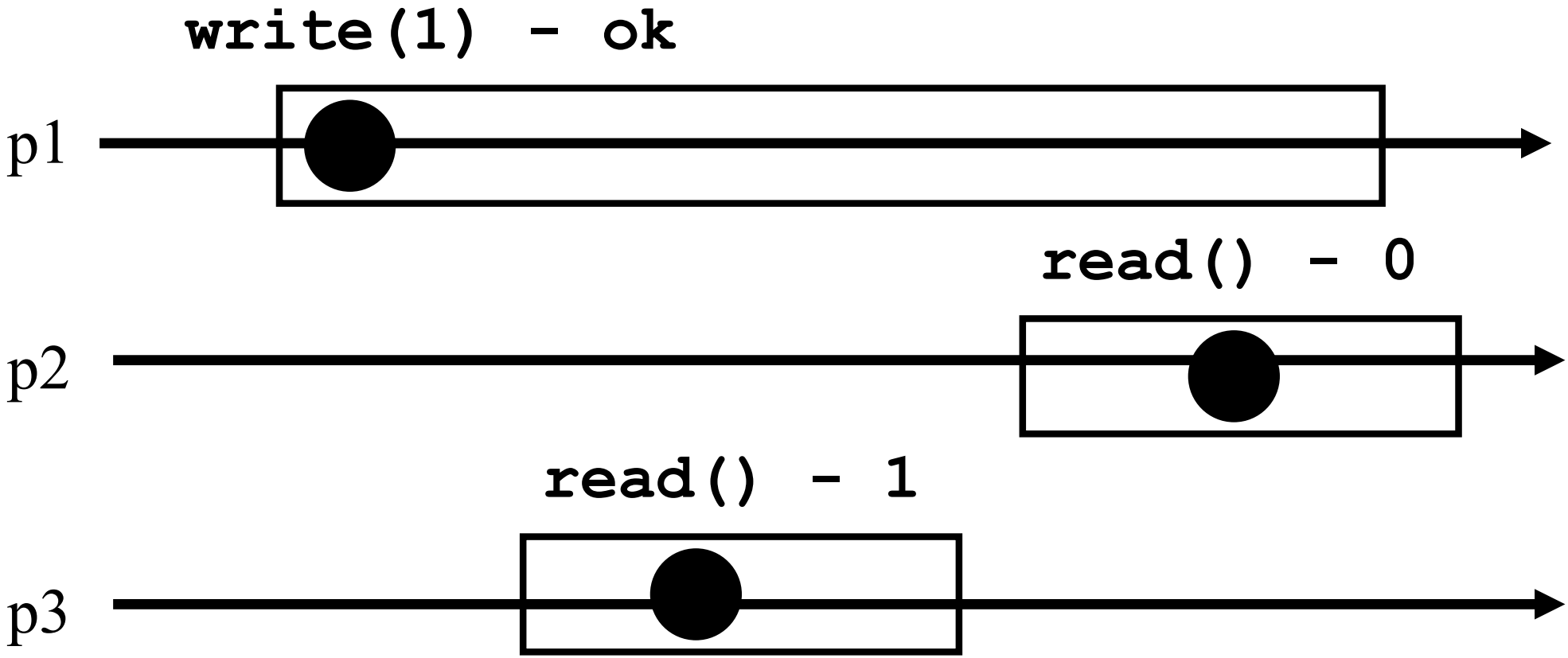
Dimensions

- Dimension 1: binary (boolean) – multivalued
- Dimension 2:
  - SRSW (single reader, single writer)
  - MRSW (multiple reader, single writer)
  - MRMW (multiple reader, multiple writer)
- Dimension 3: safe – regular – atomic

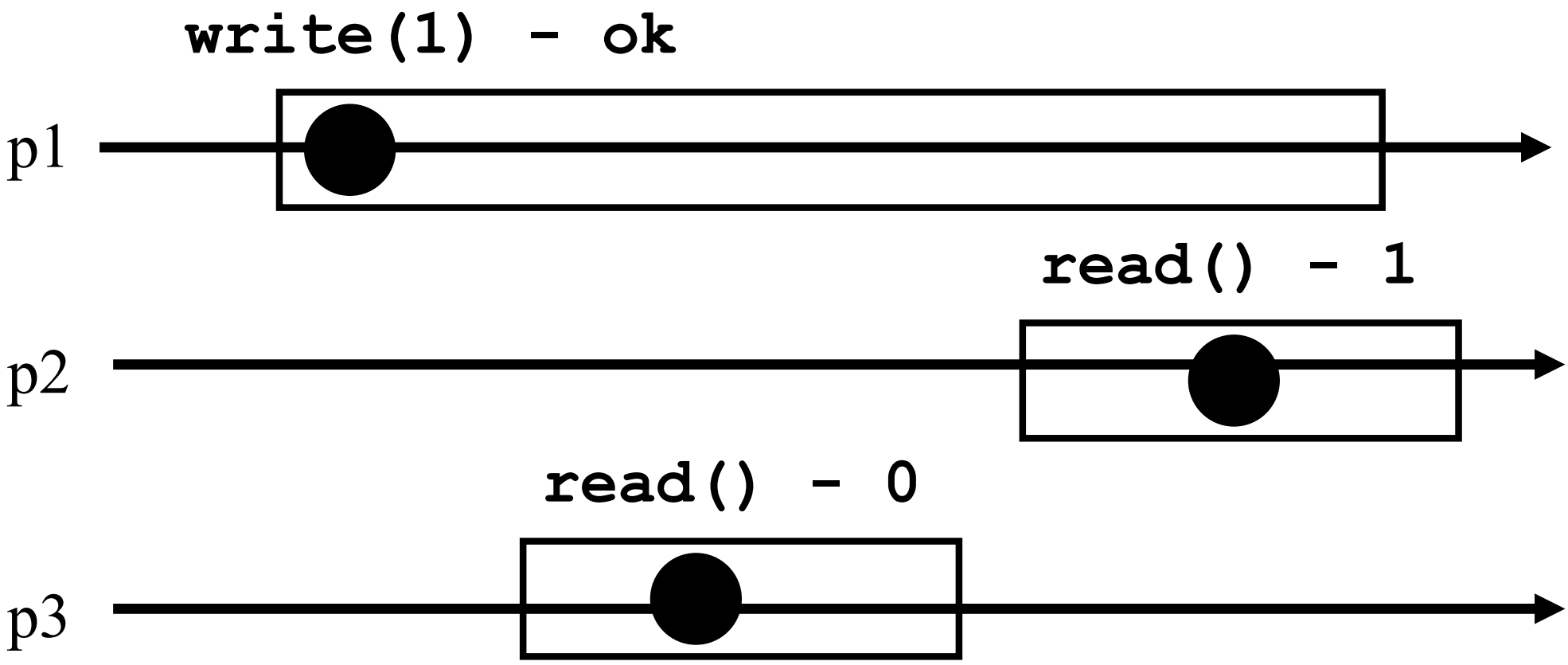
Safe execution



Regular execution



Atomic execution



2 decades of hard work

- Theorem: A multivalued MRMW atomic ***register*** can be implemented with binary SRSW safe ***registers***

Conventions (1)

- The process executing the code is implicitly assumed to be pi
- We assume a system of N processes
- NB. We distinguish base and high-level registers

Conventions (2)

- The operations to be implemented are denoted ***Read()*** and ***Write()***
- Those of the base registers are denoted ***read()*** and ***write()***

- We omit the ***return(ok)*** instruction at the end of ***Write()*** implementations

(1) From (binary) SRSW safe to (binary) MRSW safe

- We use an array of SRSW ***registers*** Reg[1,..,N]
- **Read()**
  - return (Reg[i].read());
- **Write(v)**
  - for j = 1 to N
    - Reg[j].write(v);

From (binary) SRSW safe to (binary) MRSW safe

- The transformation works also for multi-valued registers and regular ones

- It does not however work for atomic registers

(2) From binary MRSW safe to binary MRSW regular

- We use one MRSW safe register
- **Read()**
  - return(Reg.read());
- **Write(v)**
  - if old ≠ v then
    - Reg.write(v);
    - old := v;

From binary MRSW safe to binary MRSW regular

- The transformation works for single reader ***registers***
- It does not work for multi-valued ***registers***
- It does not work for atomic ***registers***

(3) From binary to M-Valued MRSW regular

- We use an array of MRSW registers Reg[0,1,..,M] init to [1,0,..,0]

- **Read()**
  - for j = 0 to M
    - if Reg[j].read() = 1 then return(j)
- **Write(v)**
  - Reg[v].write(1);
  - for j = v-1 downto 0
    - Reg[j].write(0);

From binary to M-Valued MRSW regular

- The transformation would not work if the Write() would first write 0s and then 1

- The transformation works for regular but NOT for atomic registers

(4) From SRSW regular to SRSW atomic

- We use one SRSW register Reg and two local variables t and x

- **Read()**
  - (t′,x′) = Reg.read();
  - if t′ > t then t:=t′; x:=x′;
  - return(x)
- **Write(v)**
  - t := t+1;
  - Reg.write(v,t);

From SRSW regular to SRSW atomic

- The transformation would not work for multiple readers

- The transformation would not work without timestamps

(variable t represents logical time, i.e., timestamp)

(5) From SRSW atomic to MRSW atomic

- We use N*N SRSW atomic registers RReg[(1,1),(1,2),..,(k,j),..(N,N)] to communicate among the readers
  - In RReg[(k,j)] the reader is pk and the writer is pj
- We also use N SRSW atomic ***registers*** WReg[1,..,N] to store new values
  - the writer in all these is p1
  - the reader in WReg[k] is pk

(5) From SRSW atomic to MRSW atomic (cont'd)

- **Write(v)**
  - t1 := t1+1;
  - for j = 1 to N
    - WReg.write(v,t1);

(5) From SRSW atomic to MRSW atomic (cont'd)

- **Read()**
  - for j = 1 to N do
    - (t[j],x[j]) = RReg[i,j].read();
  - (t[0],x[0]) = WReg[i].read();
  - (t,x) := highest(t[..],x[..]);
  - for j = 1 to N do
    - RReg[j,i].write(t,x);
  - return(x)

Value with highest timestamp

From SRSW atomic to MRSW atomic

- The transformation would not work for multiple writers

- The transformation would not work if the readers do not communicate (i.e., if a reader does not write)

(6) From MRSW atomic to MRMW atomic

- We use N MRSW atomic registers Reg[1,..,N]; the writer of Reg[j] is pj

- **Write(v)**
  - for j = 1 to N do
    - (t[j],x[j]) = Reg[j].read();
  - (t,x) := highest(t[..],x[..]);
  - t := t+1;
  - Reg[i].write(t,v);

(6) From MRSW atomic to MRMW atomic (cont'd)

- **Read()**
  - for j = 1 to N do
    - (t[j],x[j]) = Reg[j].read();
  - (t,x) := highest(t[..],x[..]);
  - return(x)