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

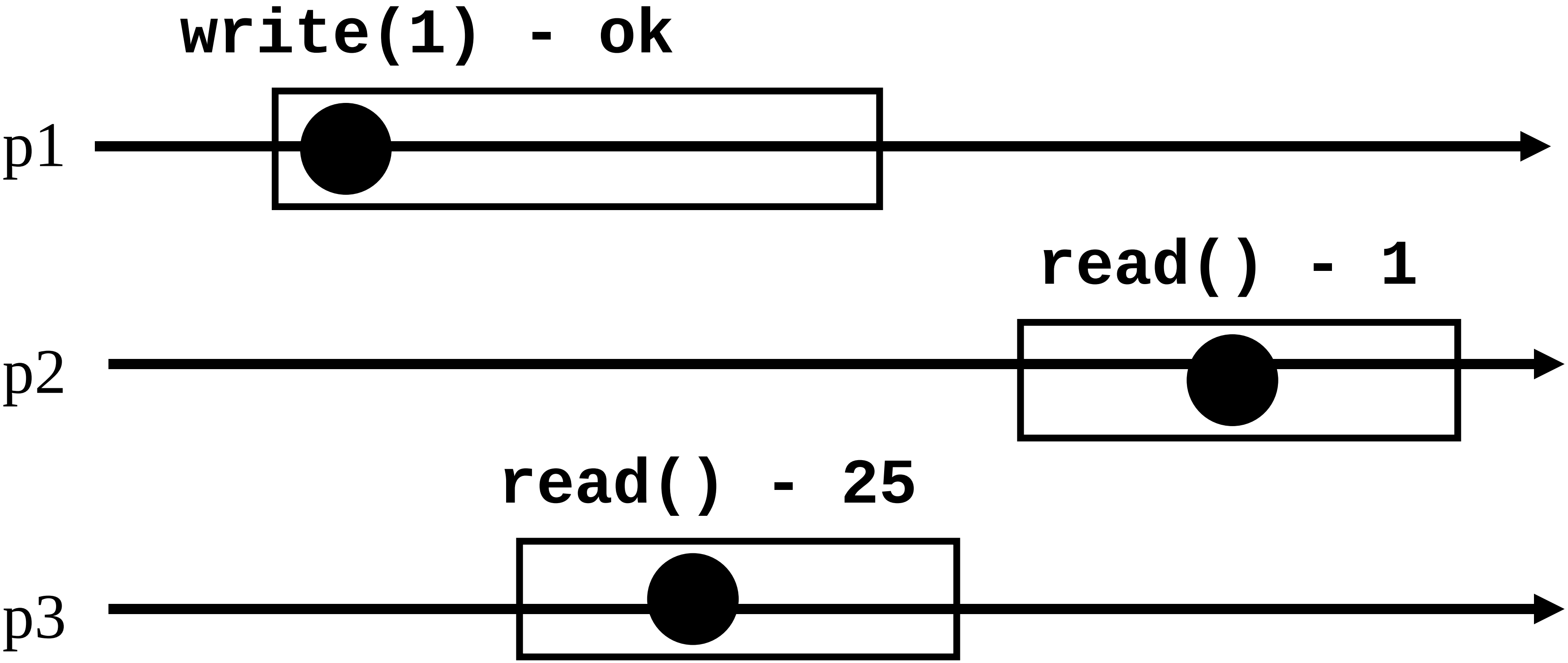
- We assume that ***registers*** contain only integers

- Unless explicitely stated otherwise, ***registers*** are initially supposed to contain 0

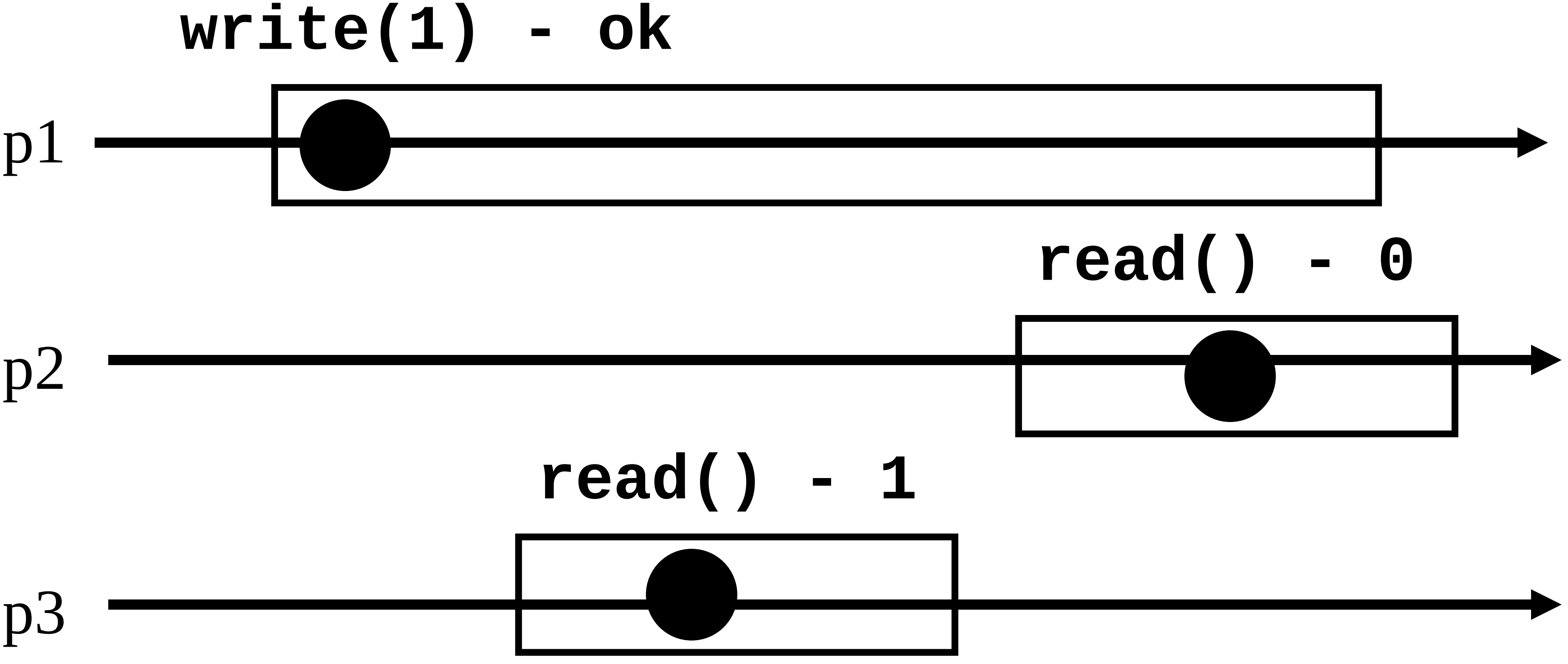
Space of registers

- 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

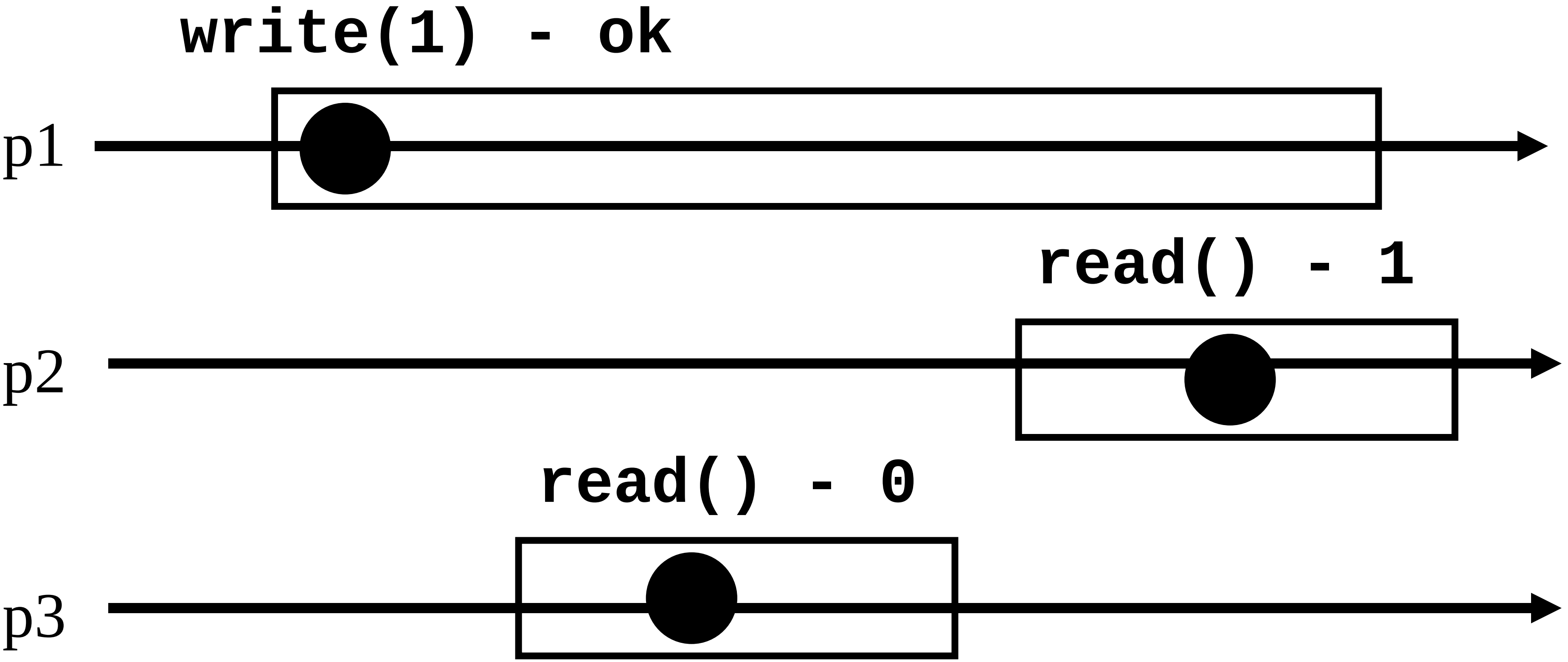
Safe execution



Regular execution



Atomic execution



2 decades of hard work

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

Algorithms

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

Conventions

- 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

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

From Binary MRSW safe to Binary MRSW regular

- We use one MRSW safe register
- **Read()**
  - return(Reg.read());

- **Write(v)**
  - if old $\neq$ 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***

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

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 representing logical time)

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

From SRSW atomic to MRSW atomic (cont'd)

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

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[..]); ← **Value with highest timestamp**
  - for j = 1 to N do
    - RReg[j,i].write(t,x);
  - return(x)

From SRSW atomic to MRSW atomic (cont'd)

- 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)

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);

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)