

**2499-19**

**International Training Workshop on FPGA Design for Scientific  
Instrumentation and Computing**

*11 - 22 November 2013*

**Digital CMOS Design  
Arithmetic Operators  
Register Files**

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# Outline

- Digital CMOS Design

- Arithmetic Operators

- Sequential Blocs

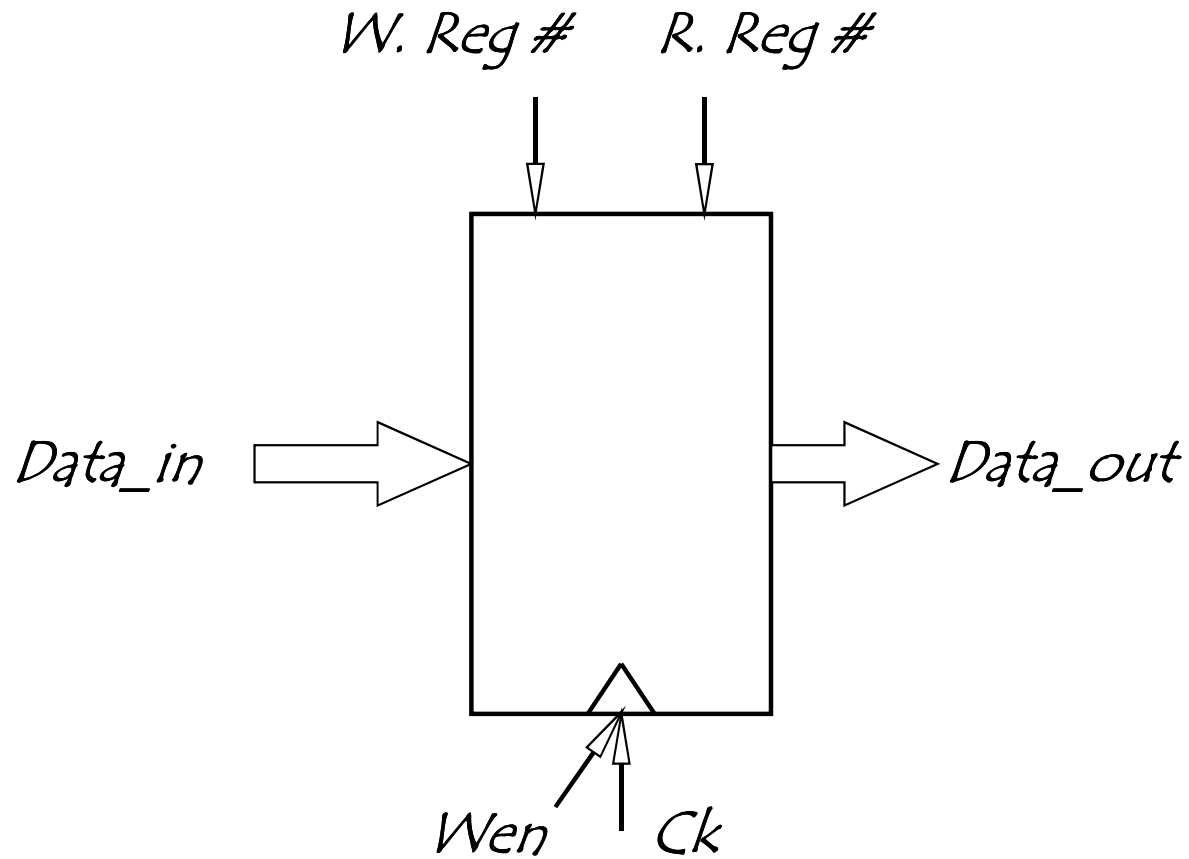
  - Register Files

  - Fifos

# Register files

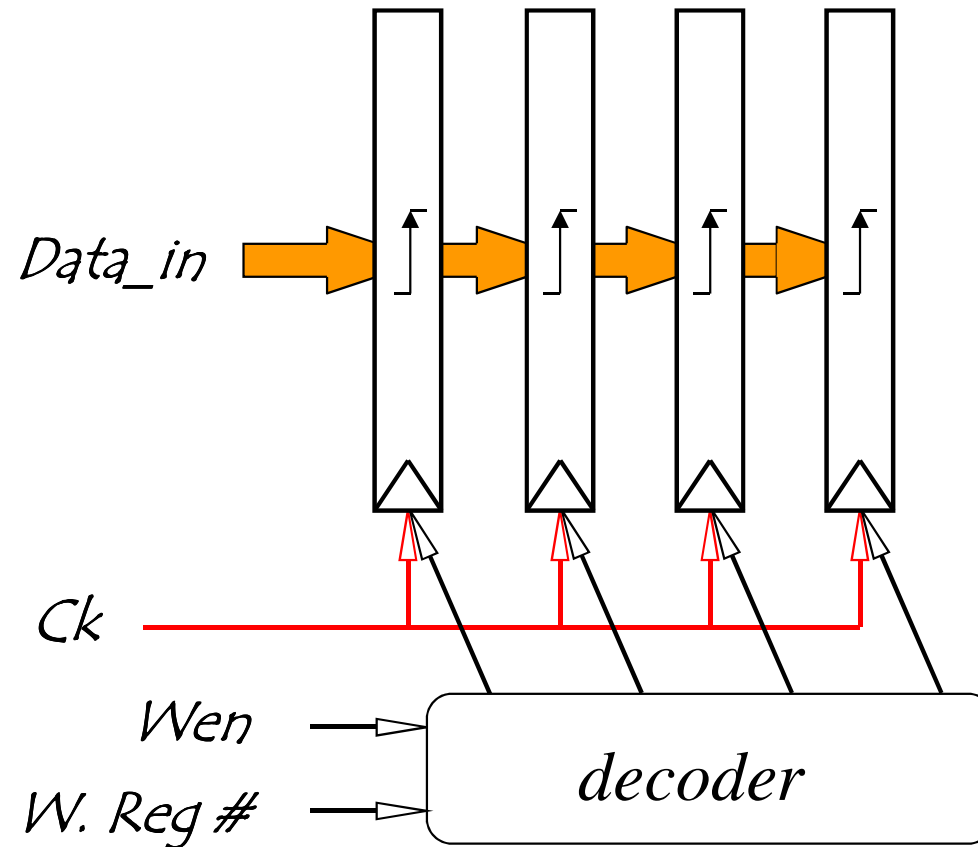
- A set of registers with the same size  $n$ -bit
- At each cycle a data can be written into one register
- At each cycle a data can be read from one register

# Register files



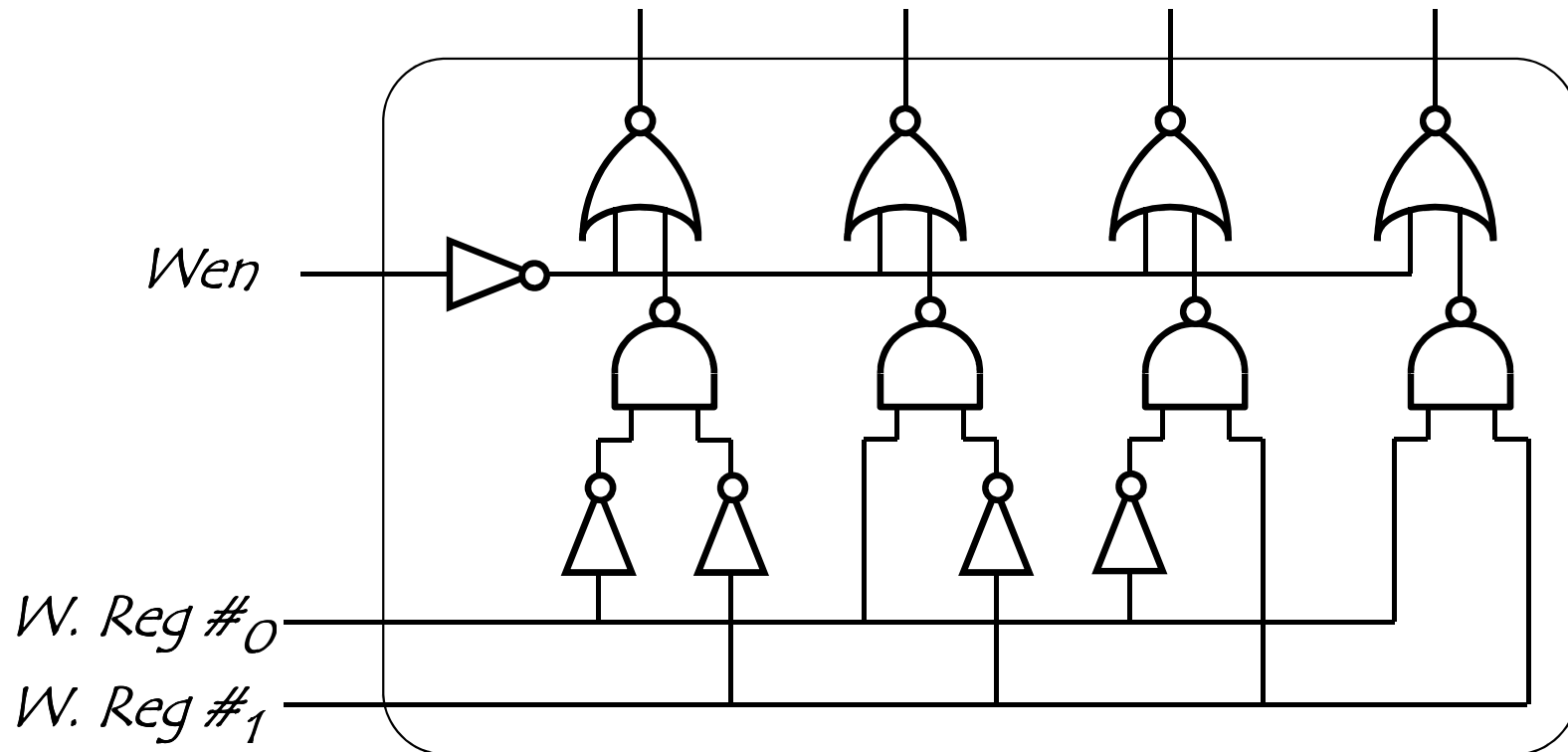
# Register files

## Write function



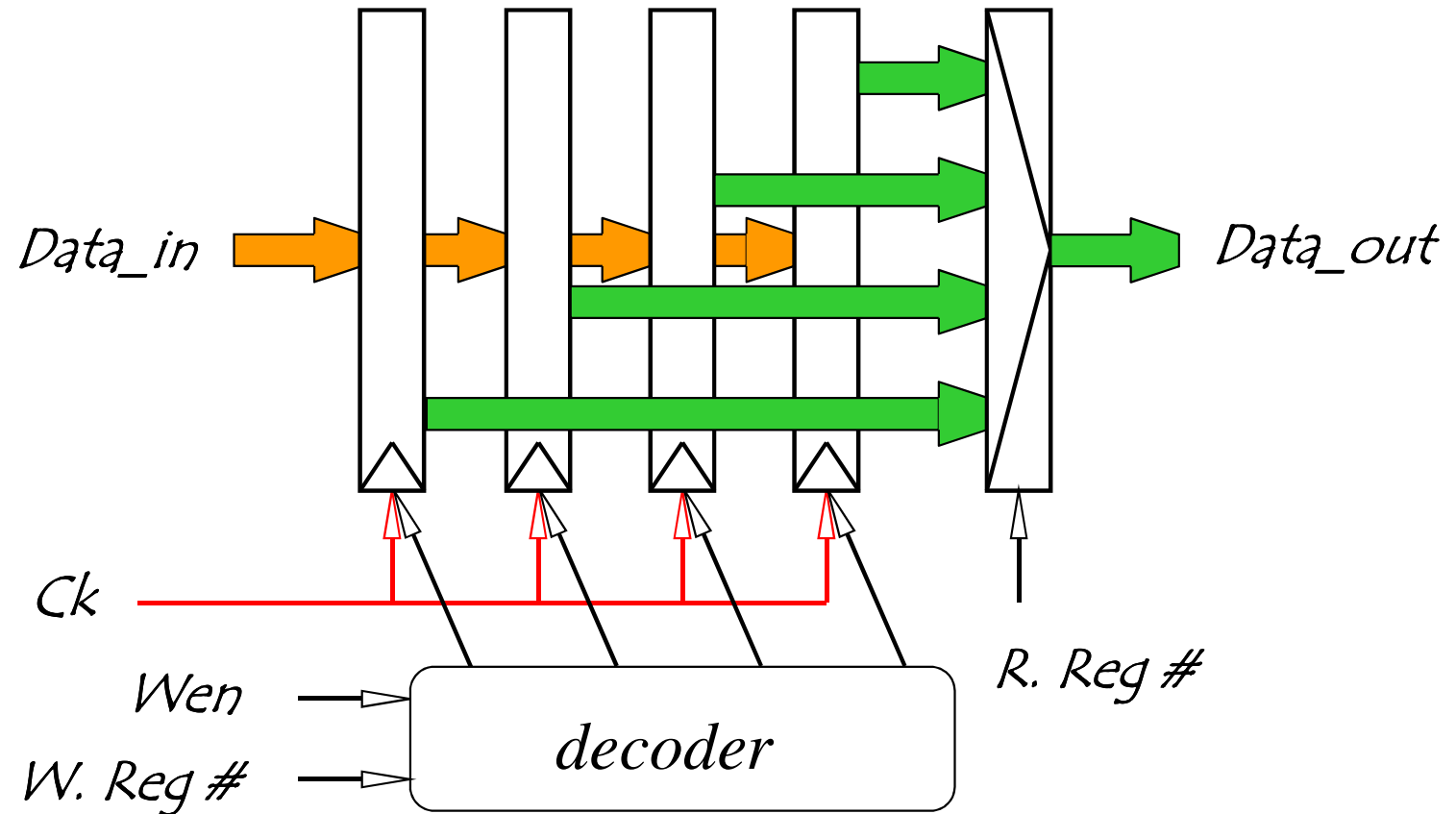
# Register files

## Write function



# Register files

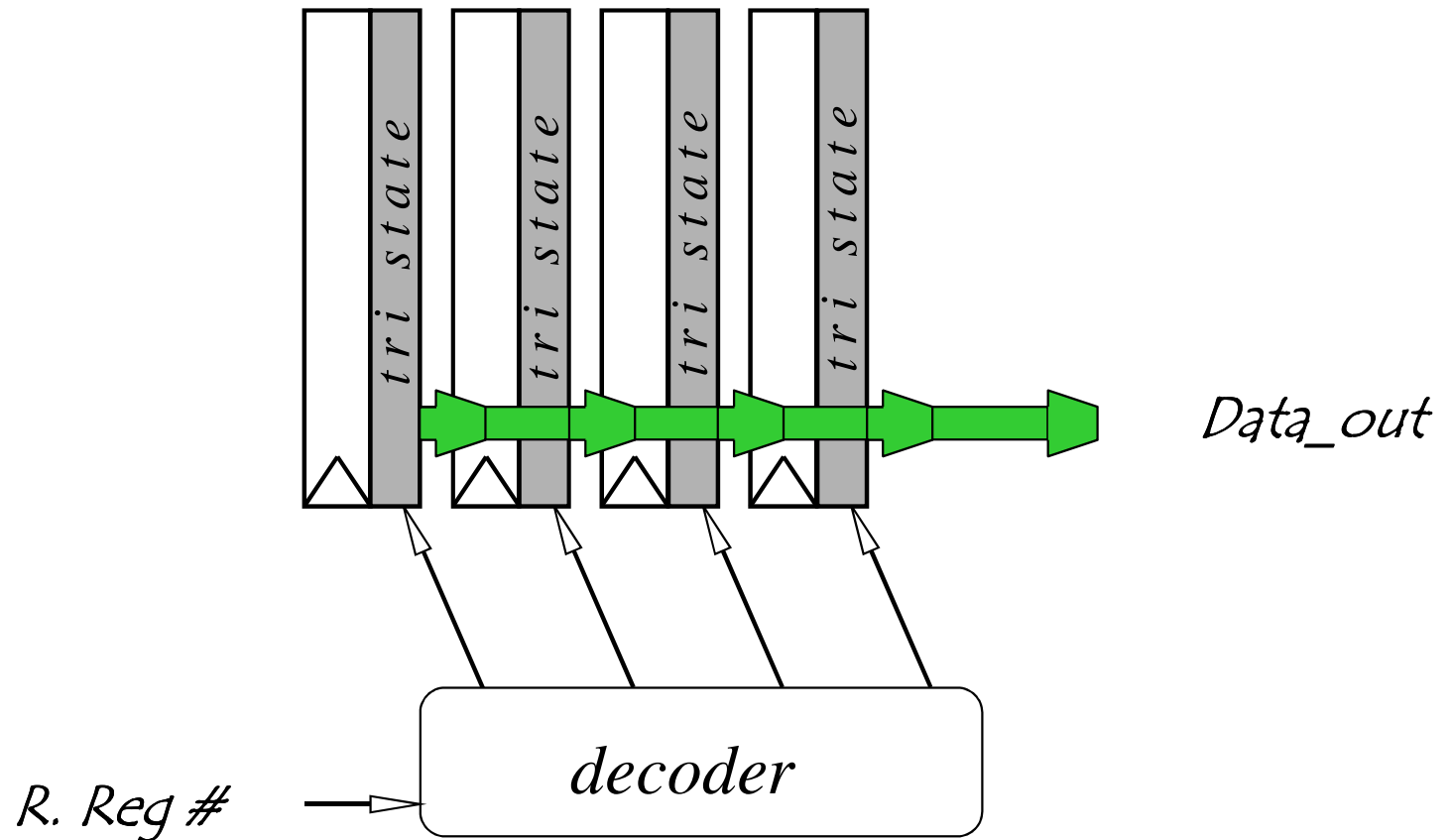
## Read function



Hardware implementation

# Register files

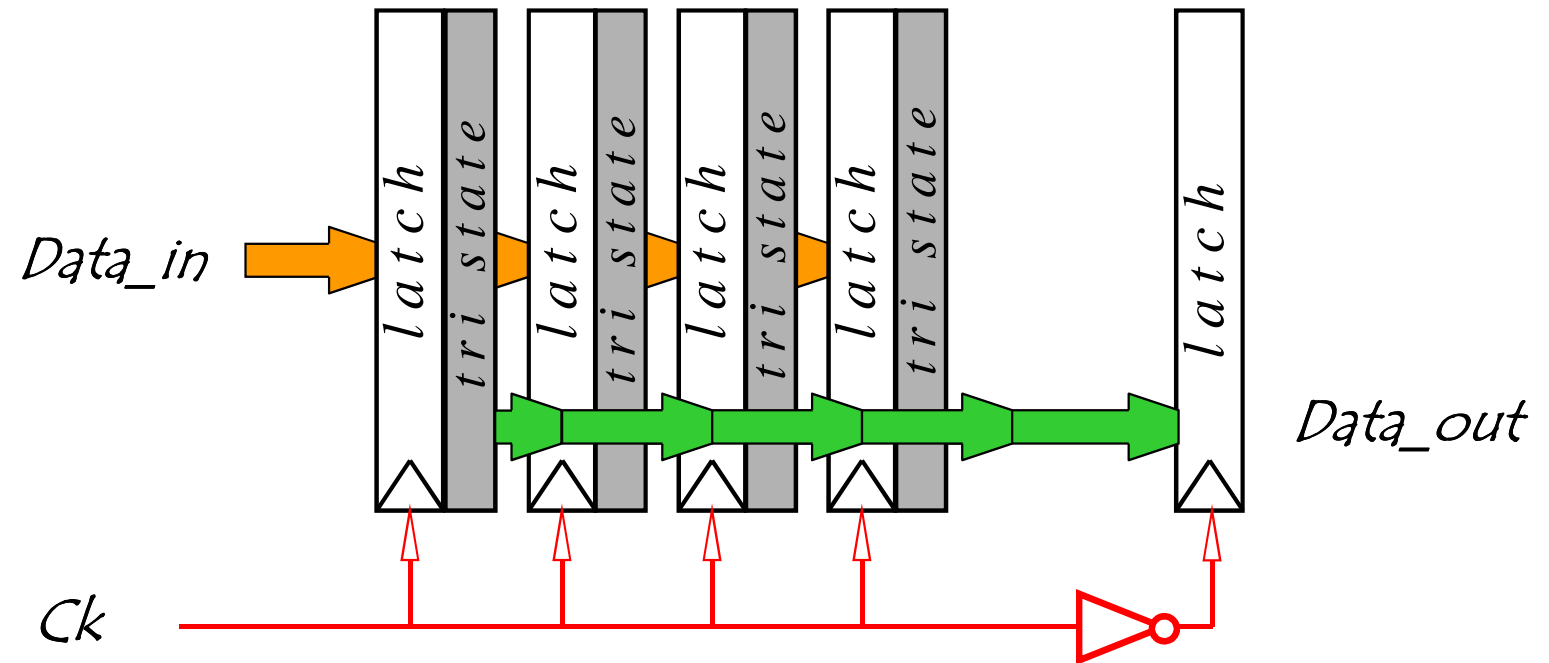
Read function





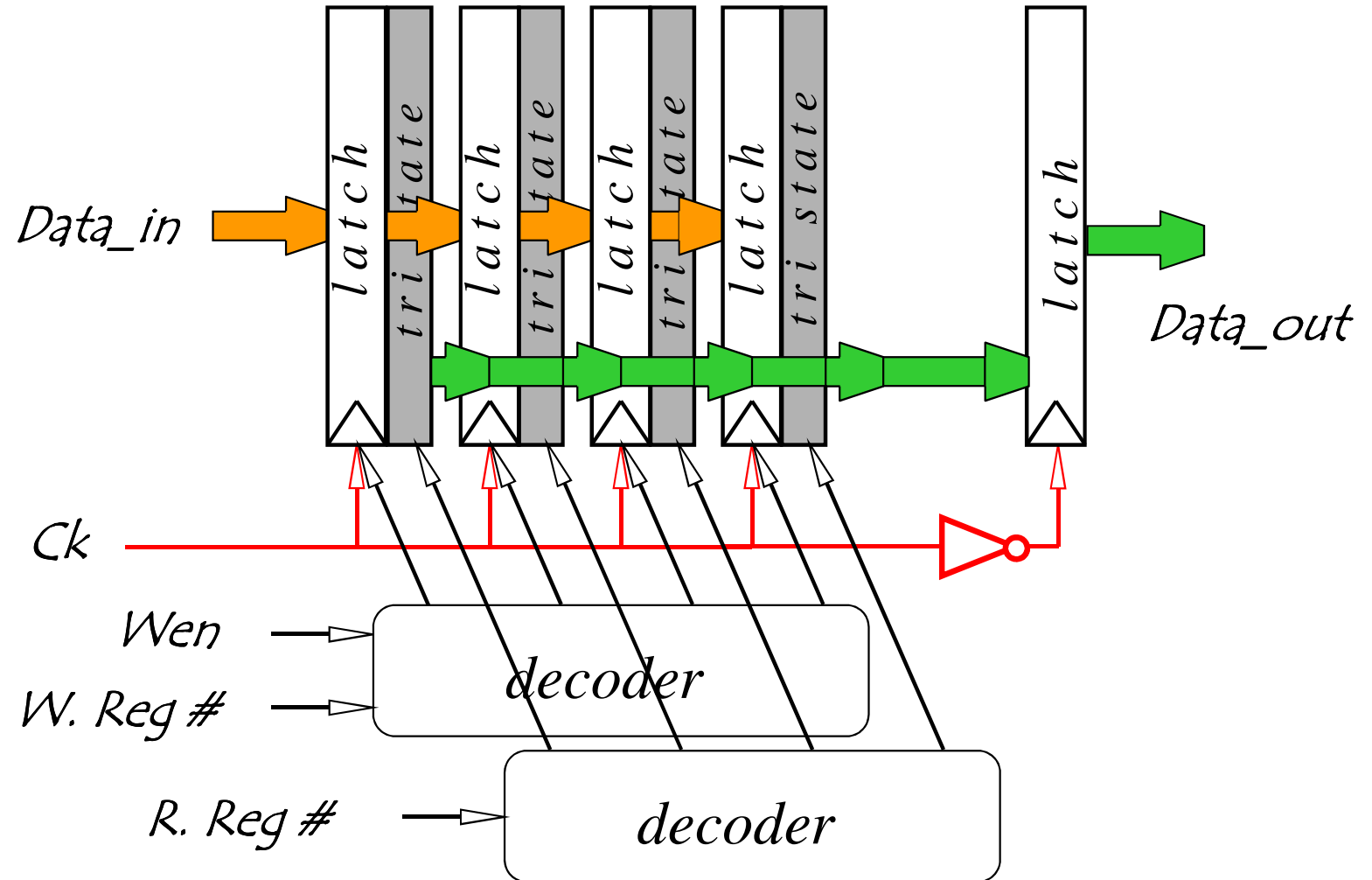
# Register files

There is no move of data inside the register file



# Register files

Putting all together



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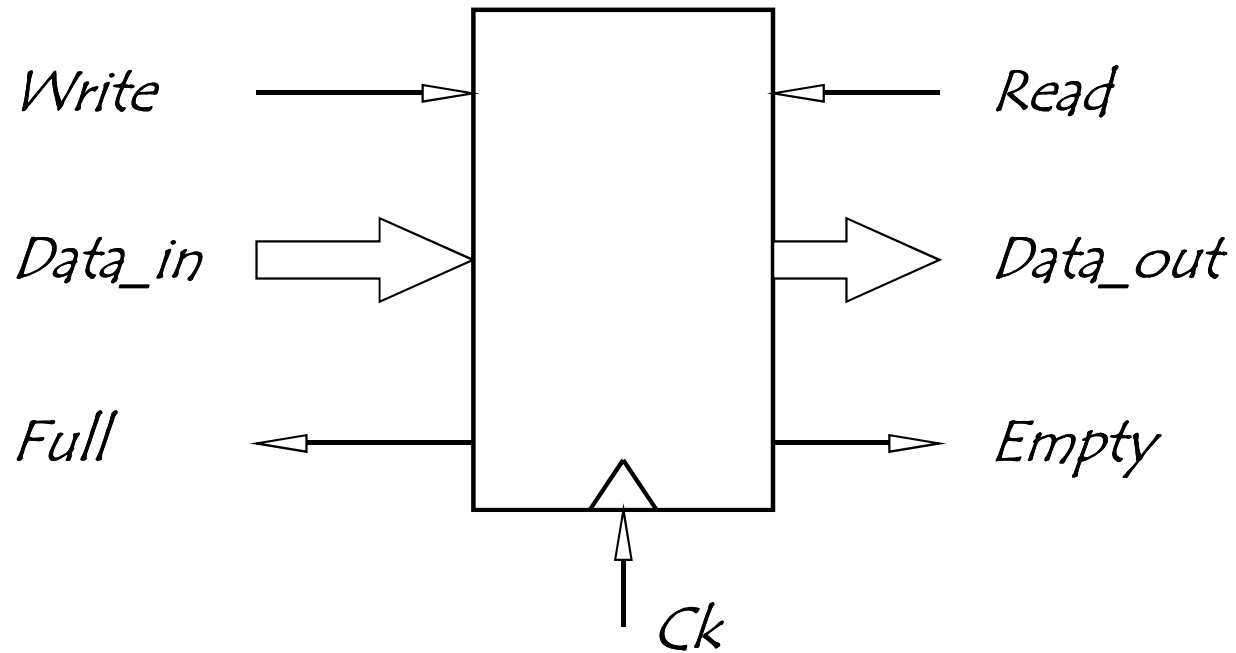
  - Fifos



# FiFos

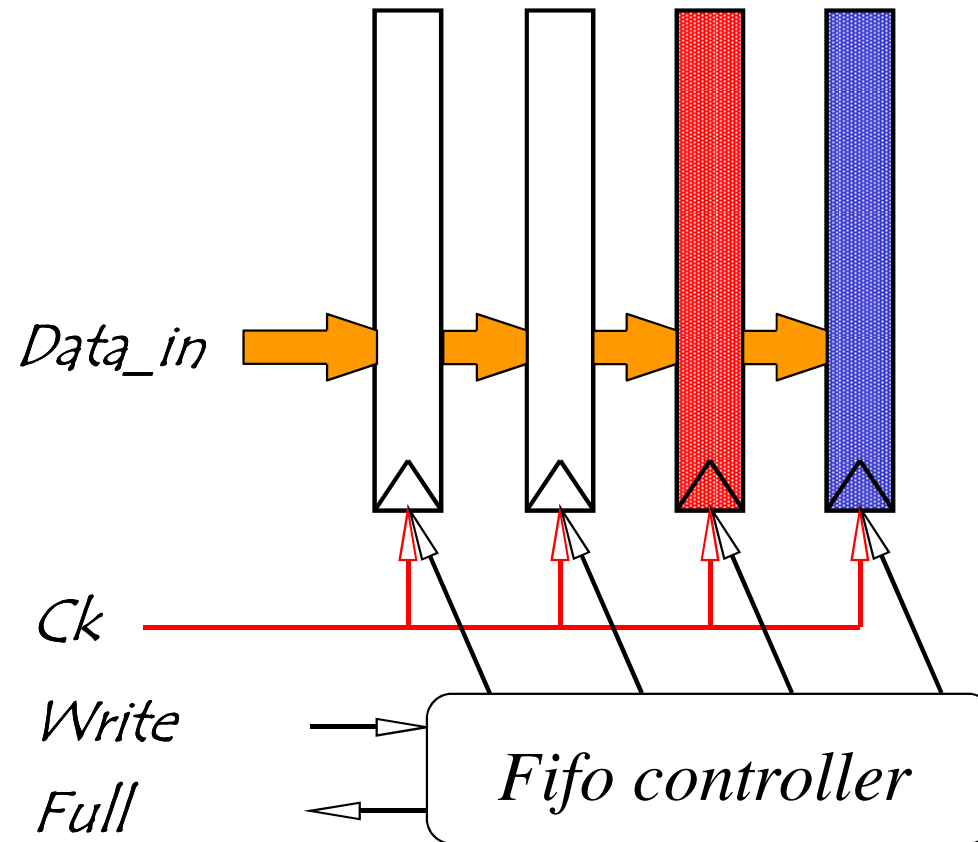
- A set of registers with the same size n-bit
- At each cycle a data can be written into the Fifo
- At each cycle a data can be read from the Fifo
- Data are read in the same order as they are written

# Fifos



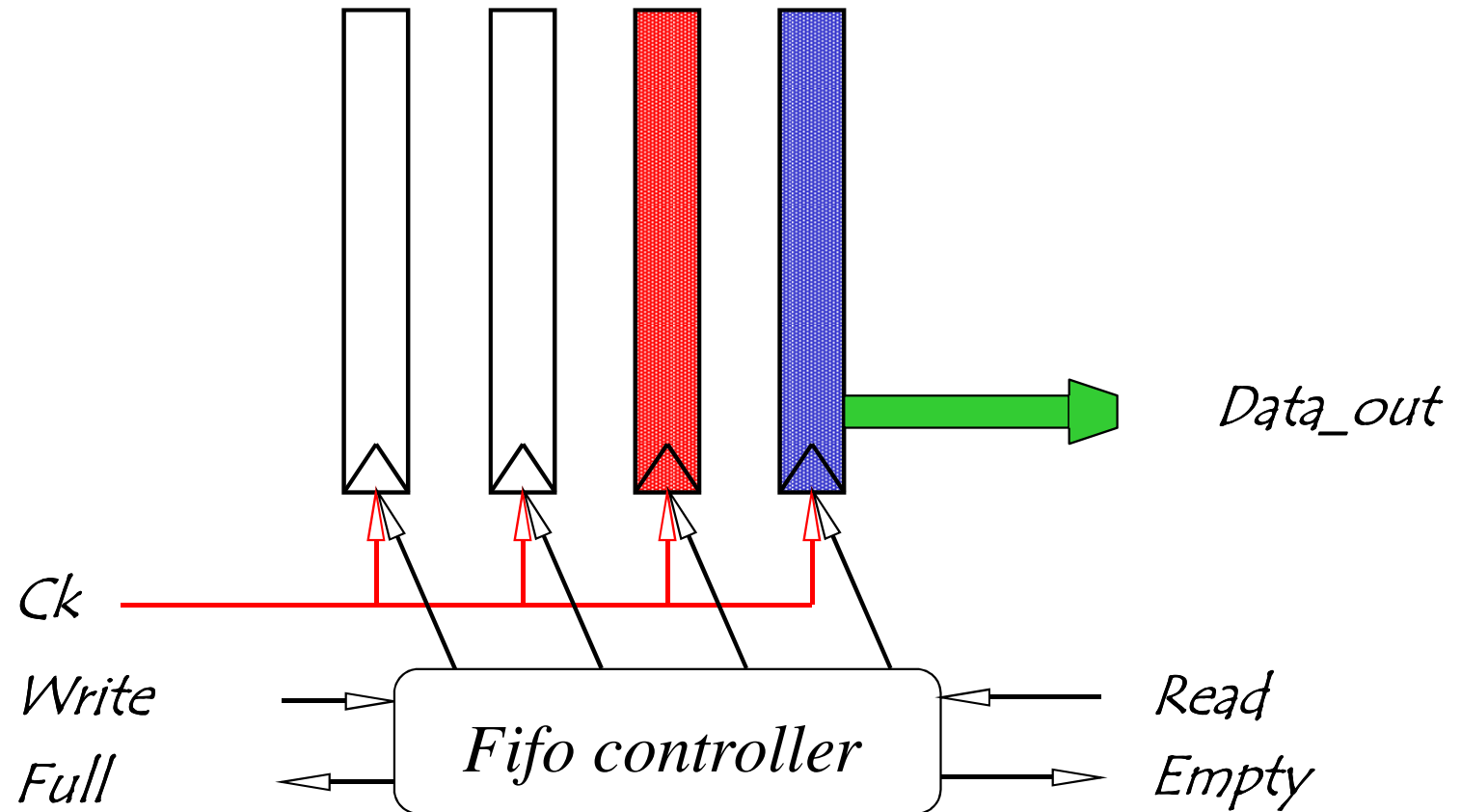
# Fifos

## Write function



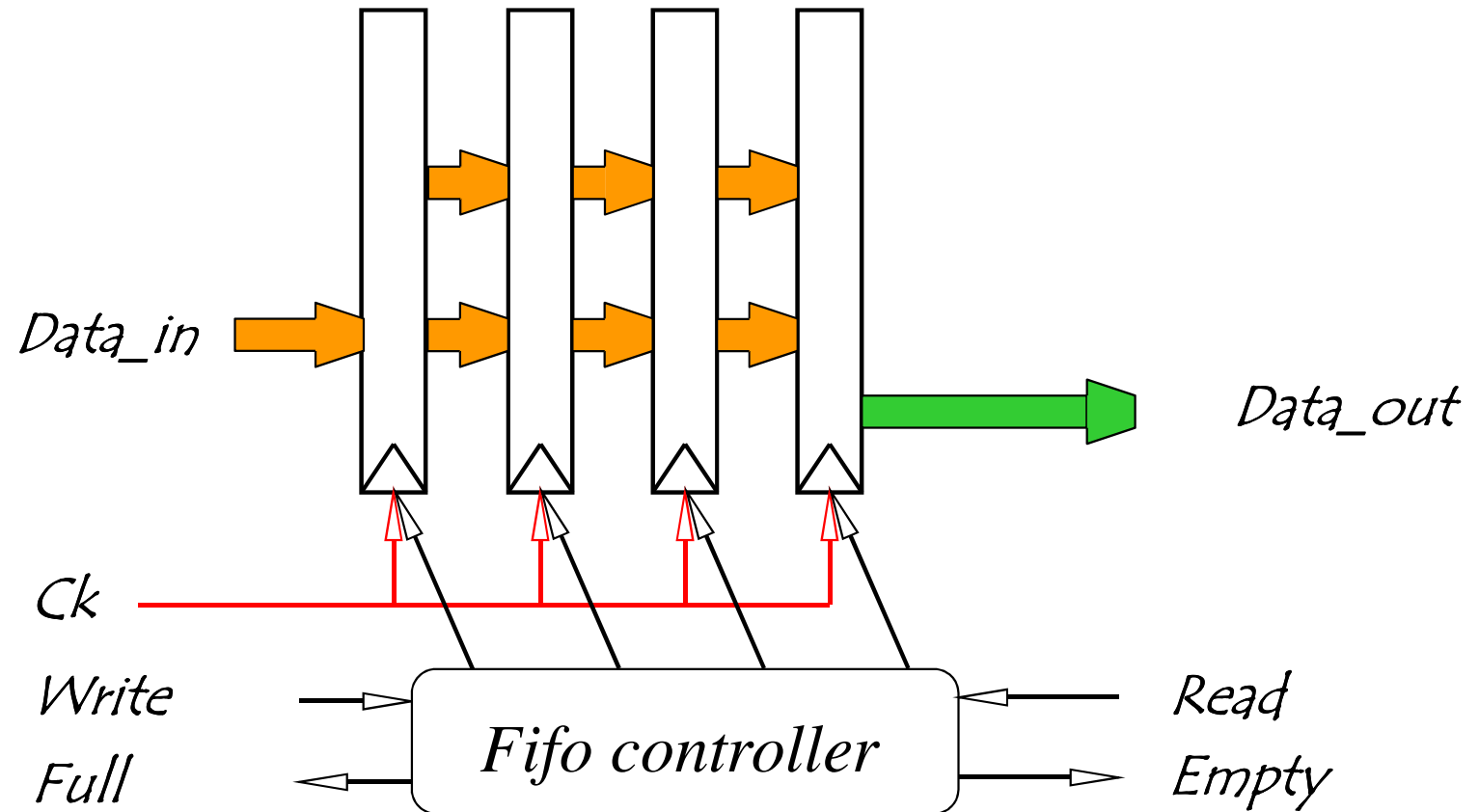
# Fifos

## Read function



# Fifos

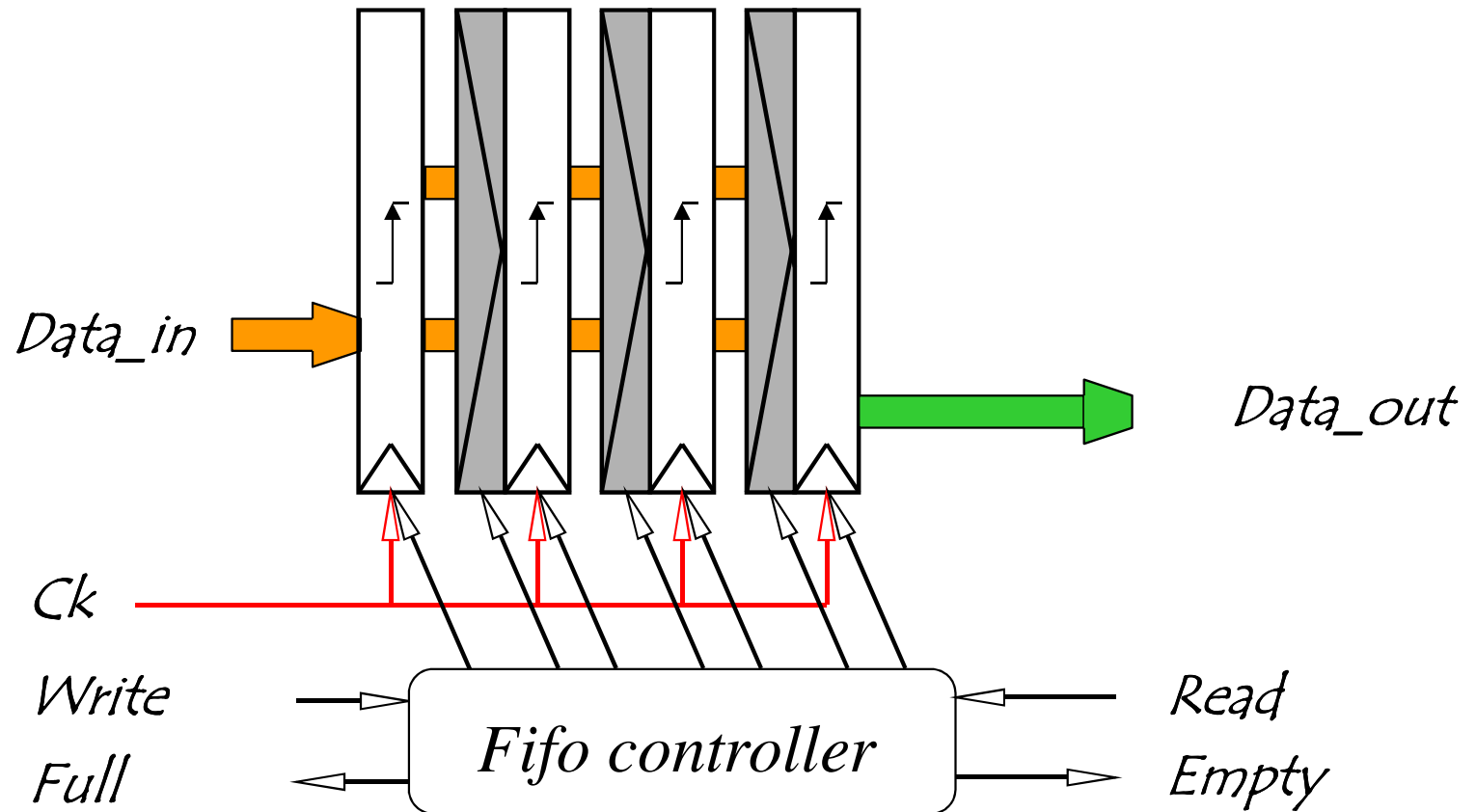
## Read function





# Fifos

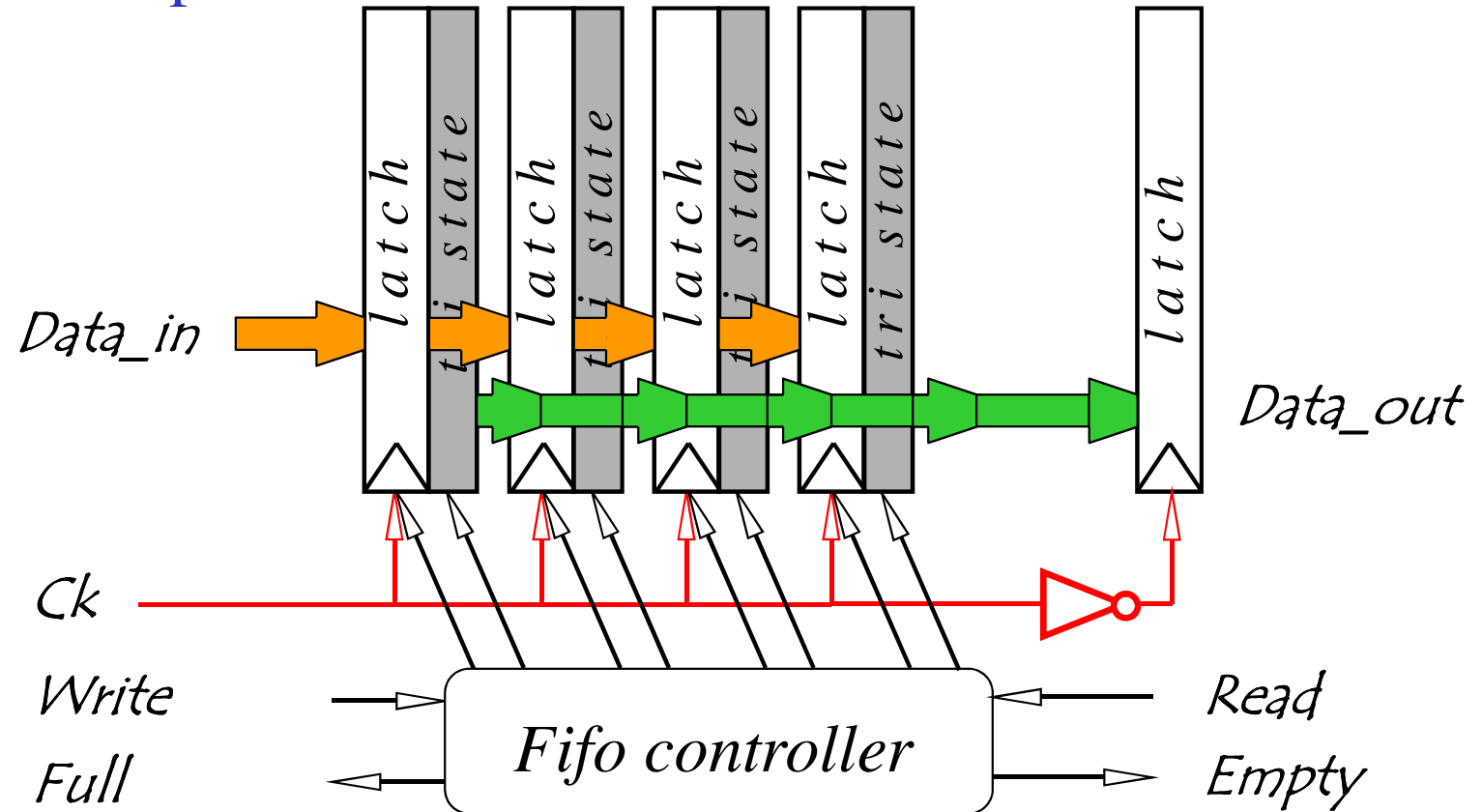
## Read function



Data are moved inside the Fifo

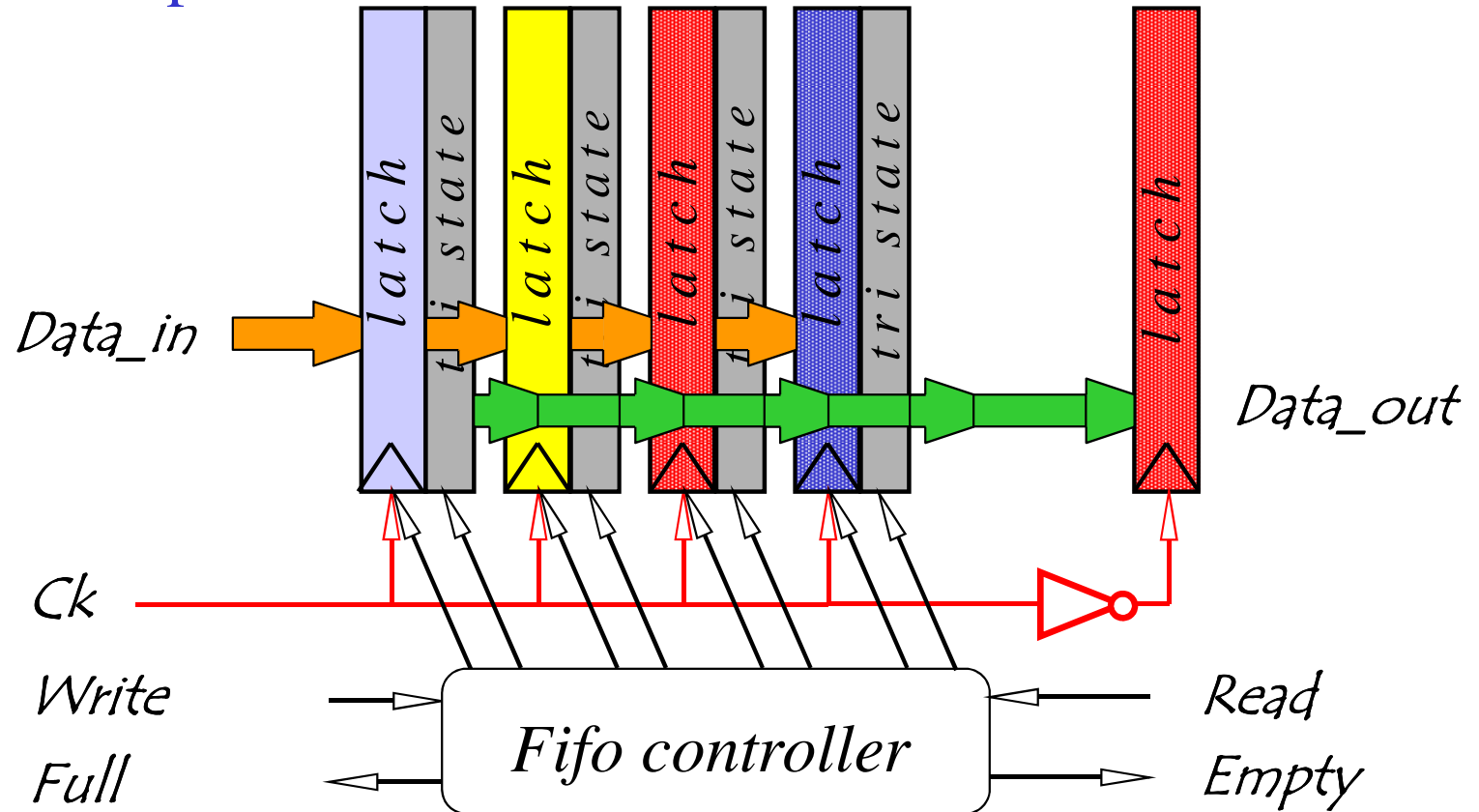
# Fifos

## Improved implementation



# Fifos

## Improved implementation

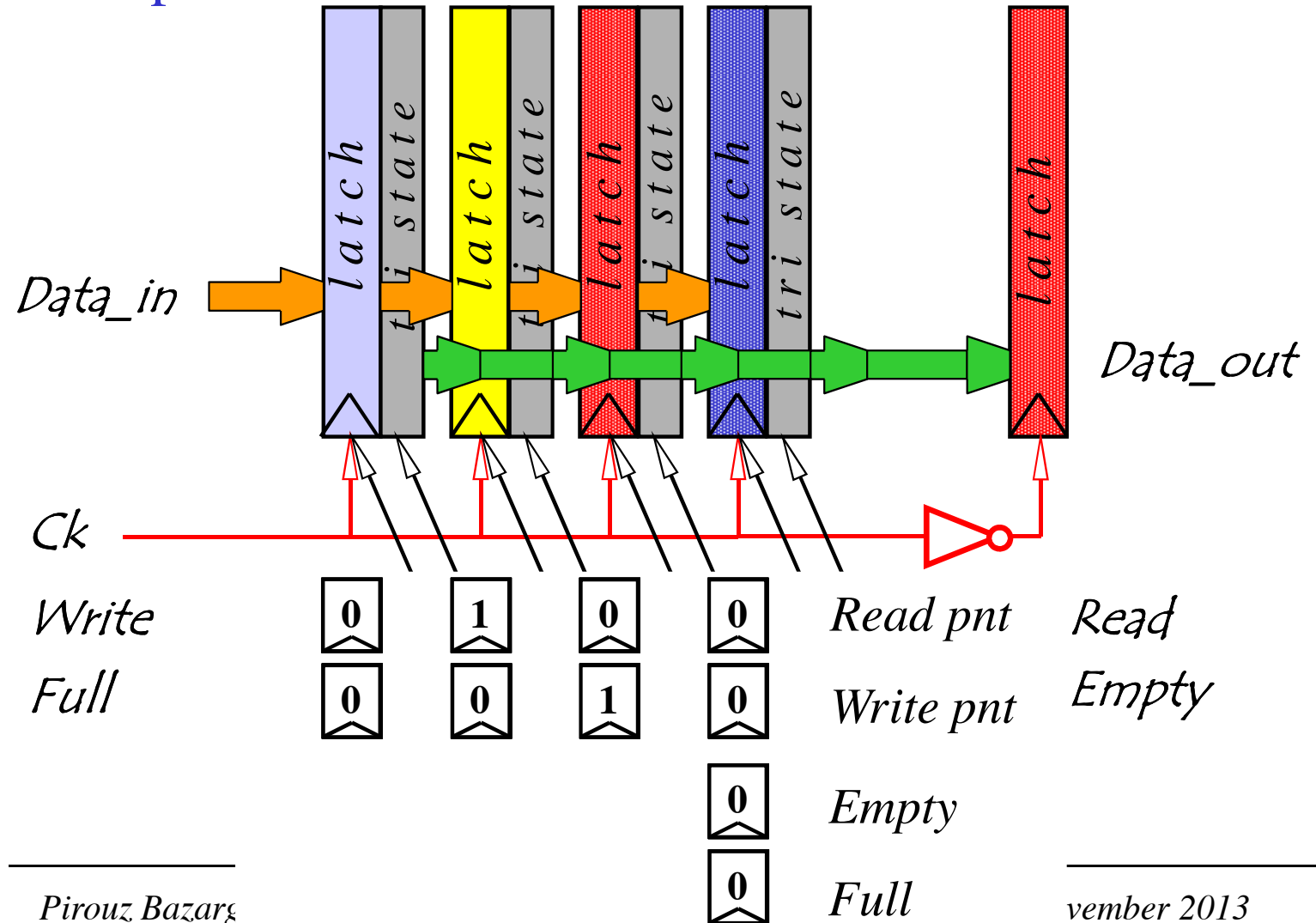


## Circular Fifo



# Fifos

## Improved implementation



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  - Register Files

  - Fifos

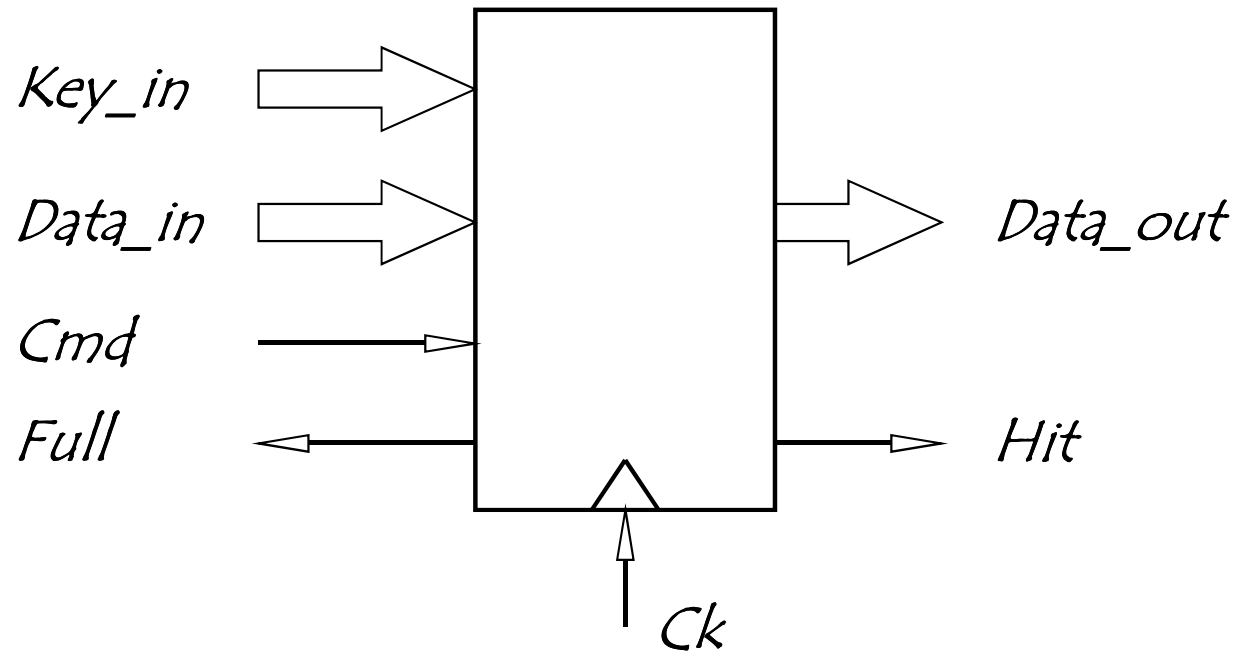
  - Associative tables



# Associative table

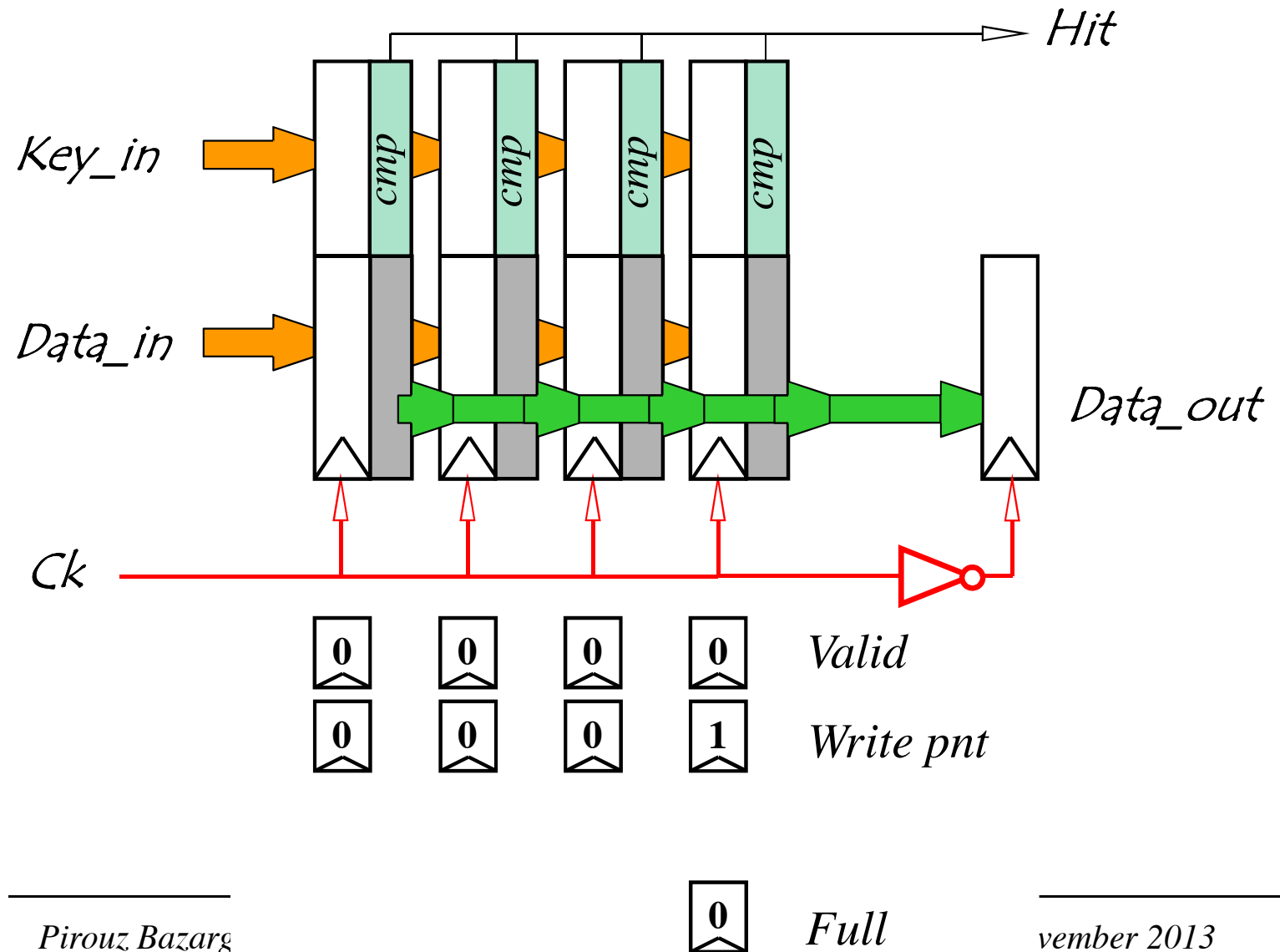
- A set of registers with the same size n-bit
- Each data is associated with a key
- At each cycle a data can be written into the table or read/removed from the table
- The read/removed data is selected by giving the corresponding key

# Associative table



*Cmd : Write , Read , Remove*

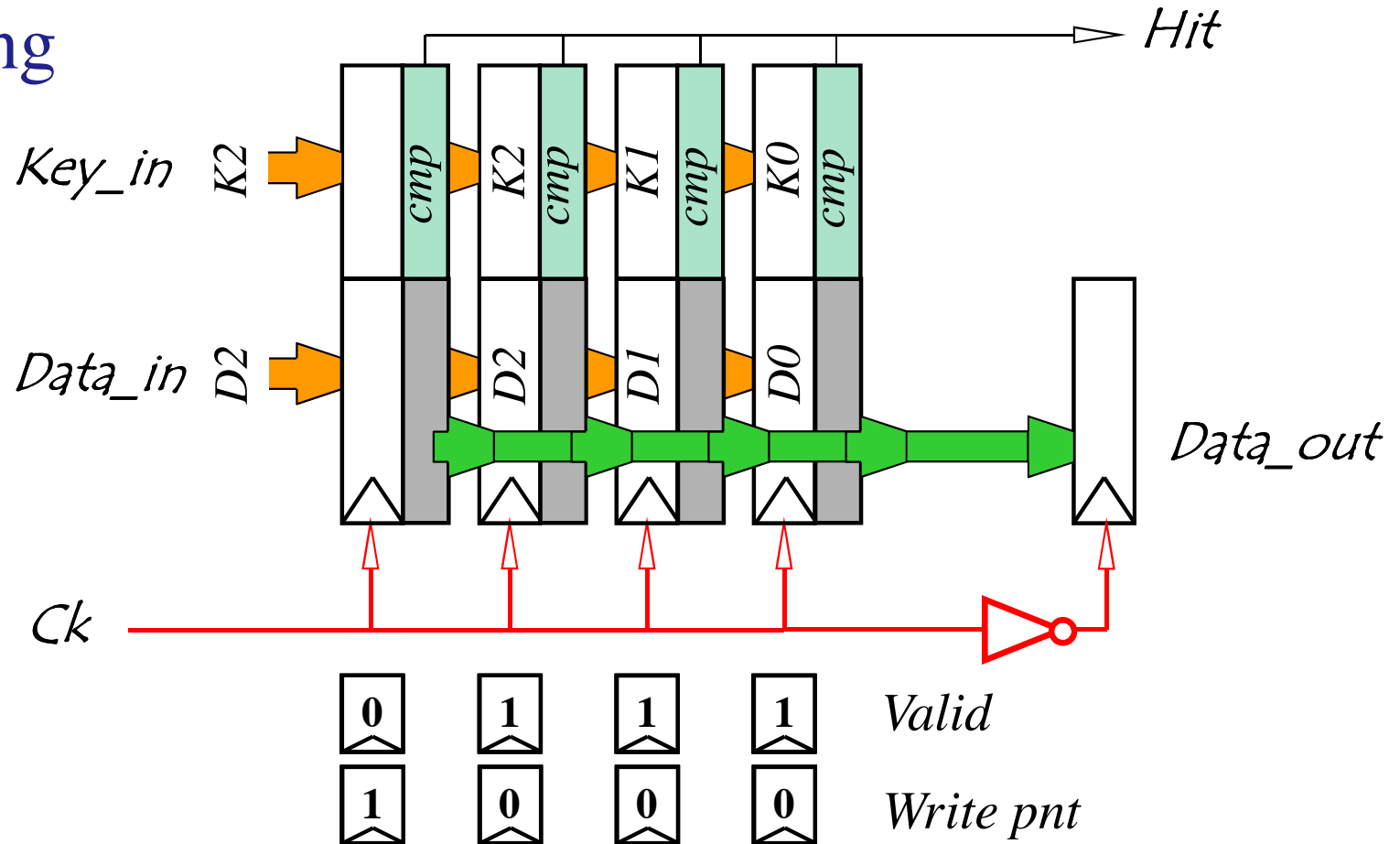
# Associative Table





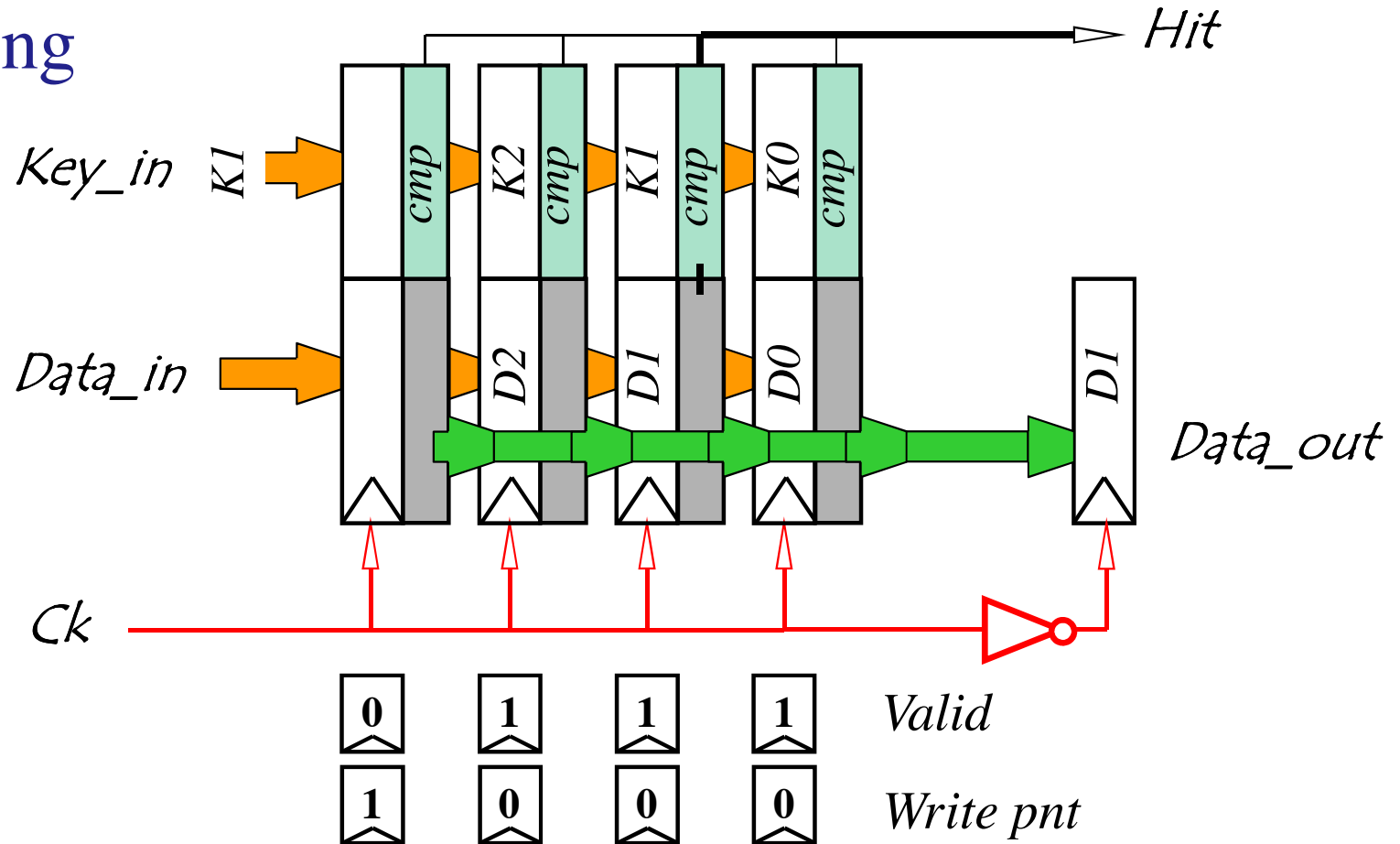
# Associative Table

Writing



# Associative Table

Reading



# Associative Table

Removing

