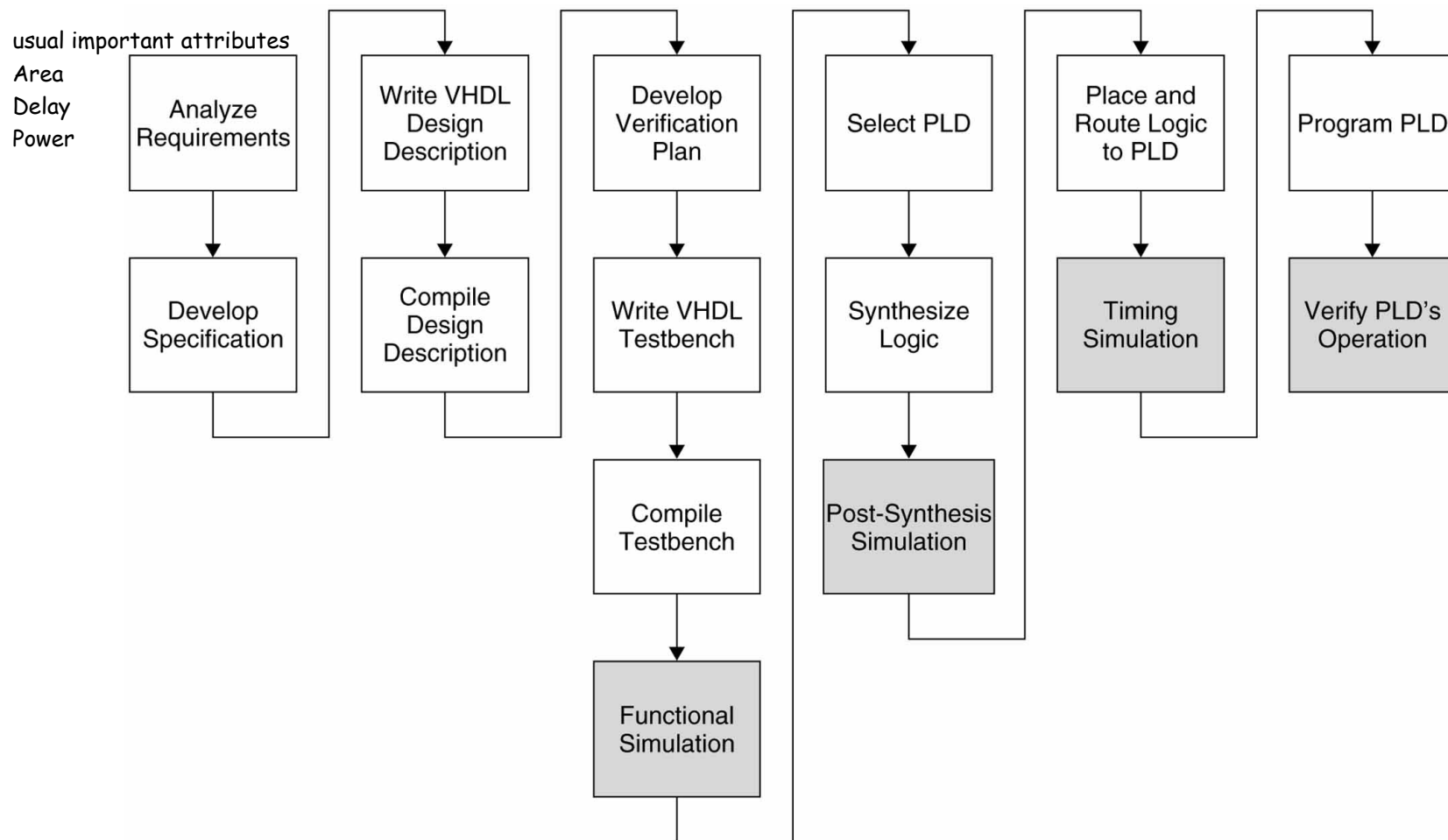
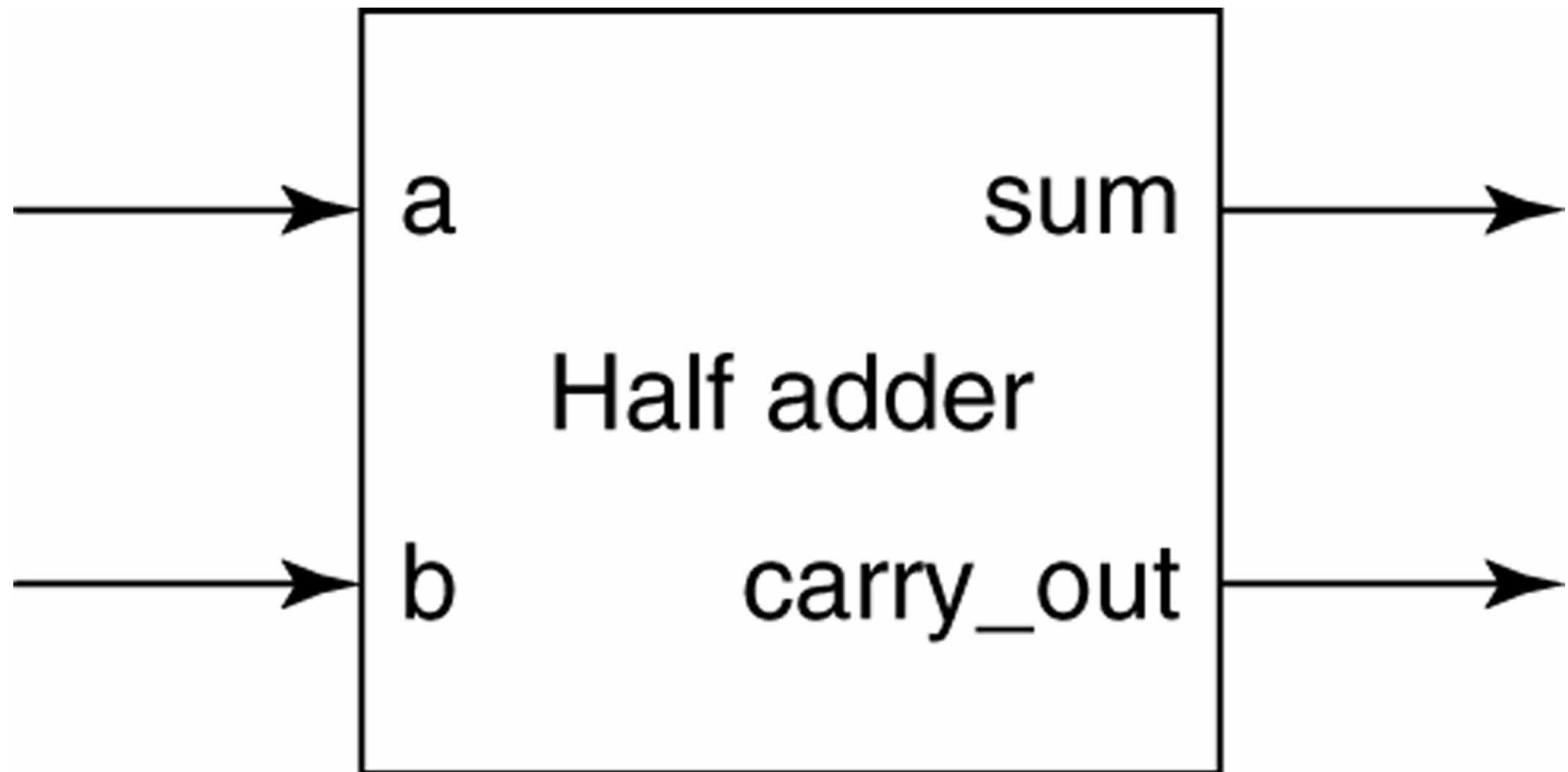


Chapter 1

Digital Design Using VHDL and PLDs



Design flow for the VHDL/PLD design Methodology

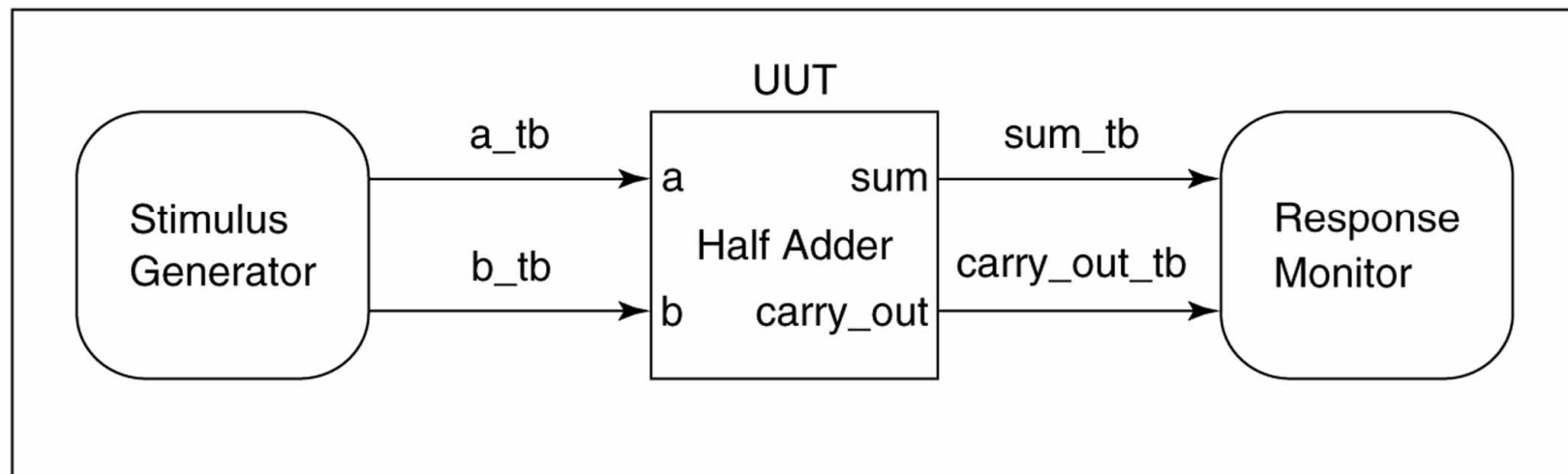


Block diagram of a half adder

Table 1.3.1*Half-adder truth table and minterms.*

a	b	sum	carry_out	sum minterms	carry_out minterms
0	0	0	0		
0	1	1	0	$\bar{a}b$	
1	0	1	0	$a\bar{b}$	
1	1	0	1		ab

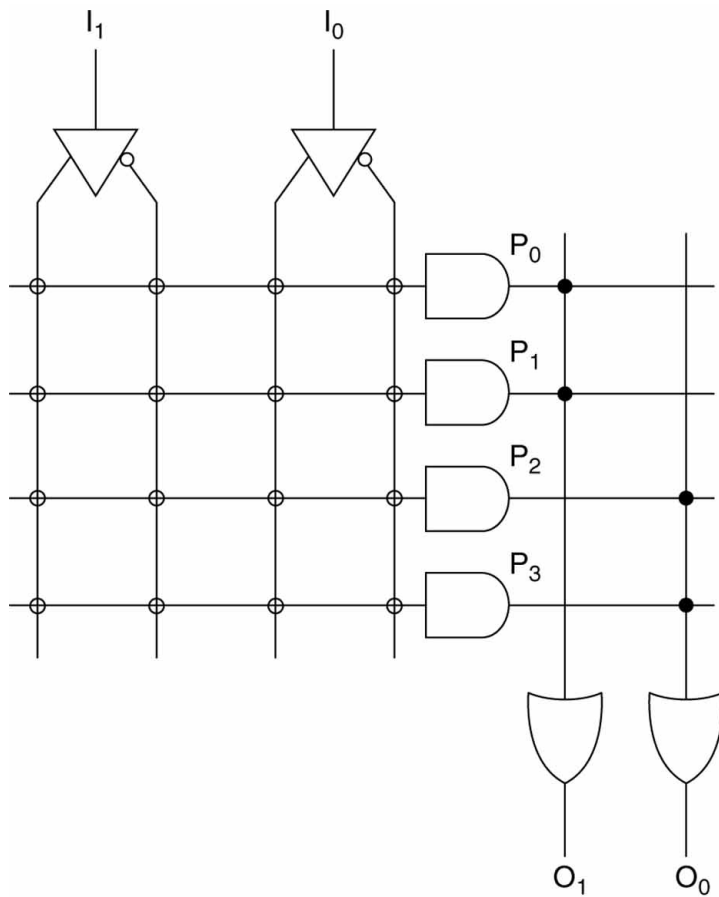
Testbench



Half-adder to its testbench

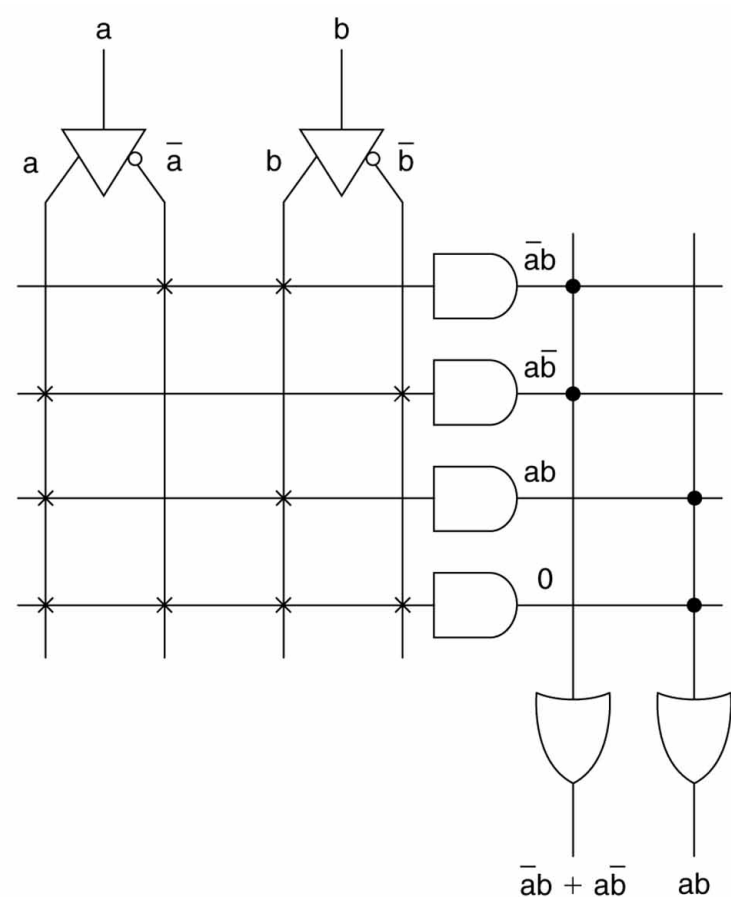
Name	0	20	40	60	80
$\text{nr } a_tb$	0	0	1	1	1
$\text{nr } b_tb$	0	1	1	0	1
$\text{nr } sum_tb$	0	1	0	1	0
$\text{nr } carry_out_tb$	0	0	1	1	0

Functional simulation of half-adder



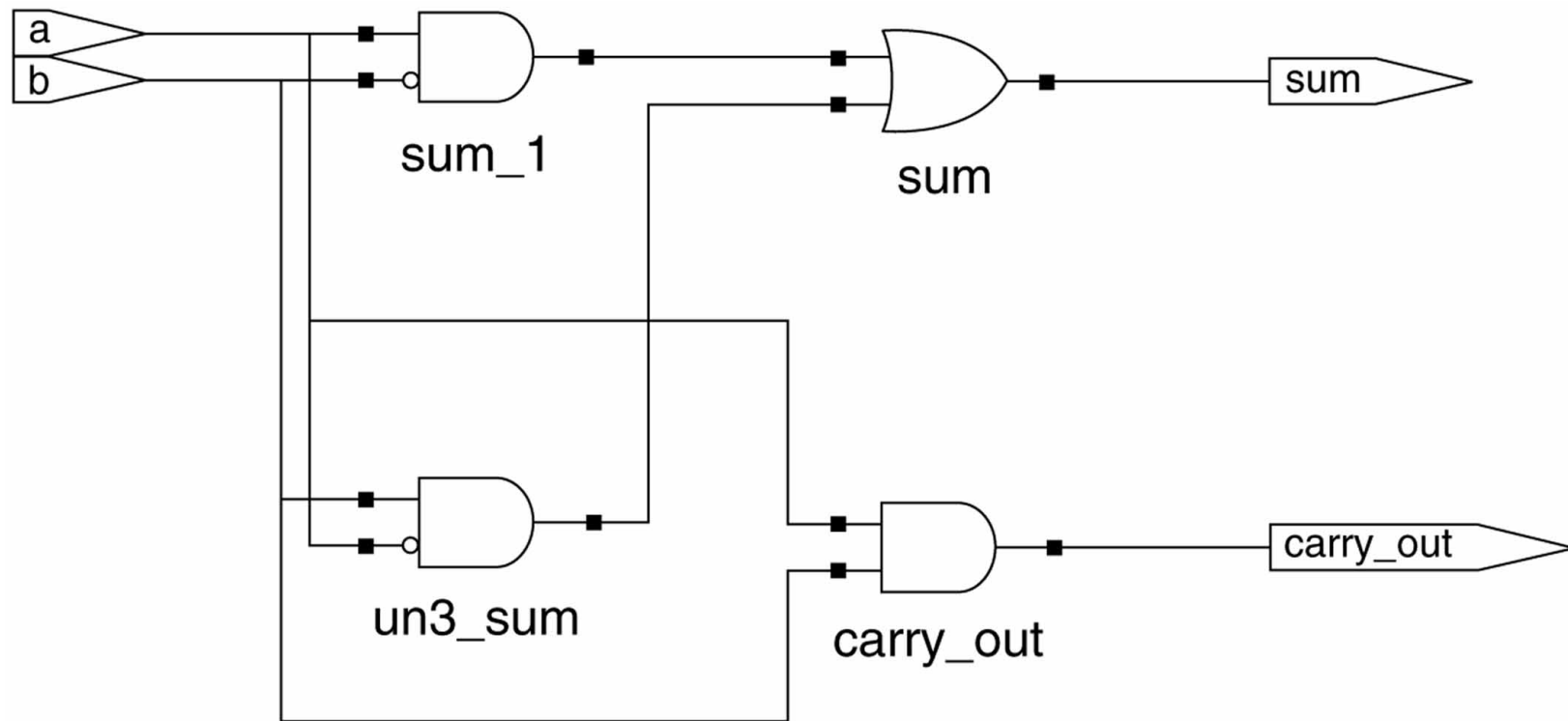
(a)

PLD (unprogrammed)

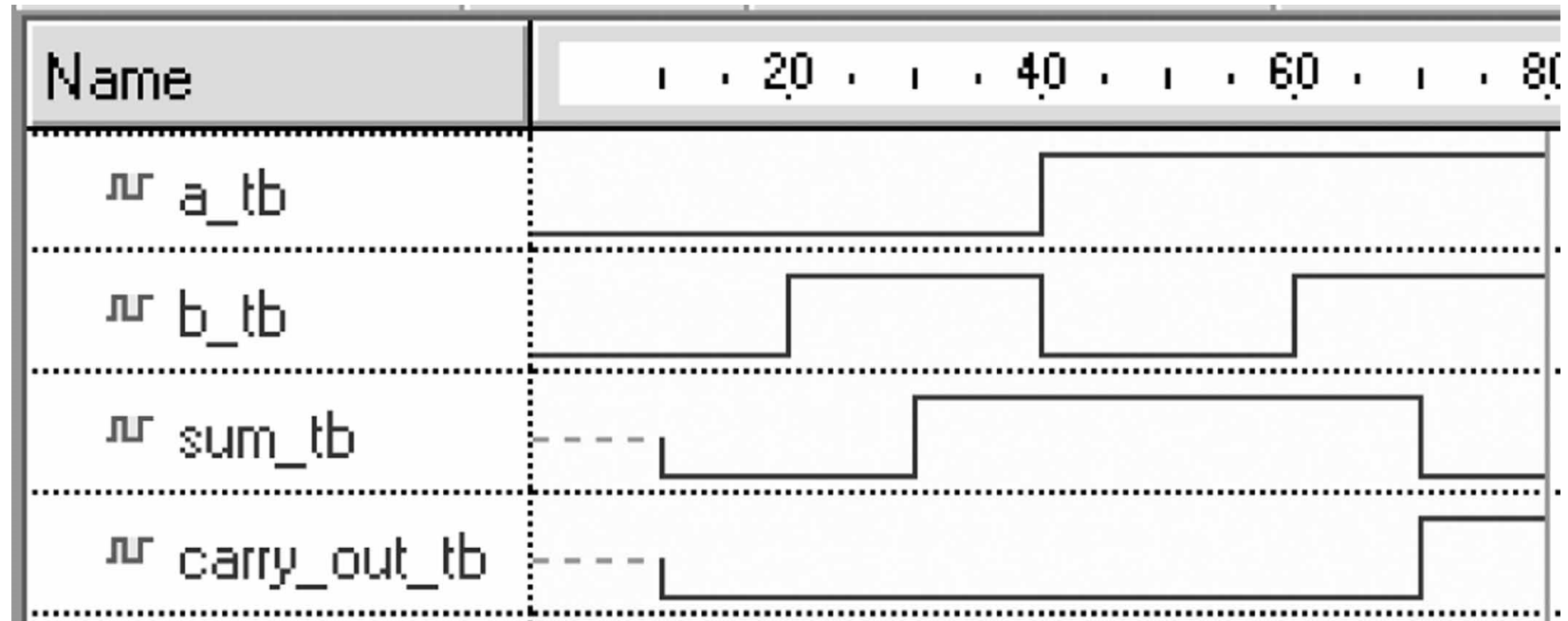


(b)

Programmed for half-adder

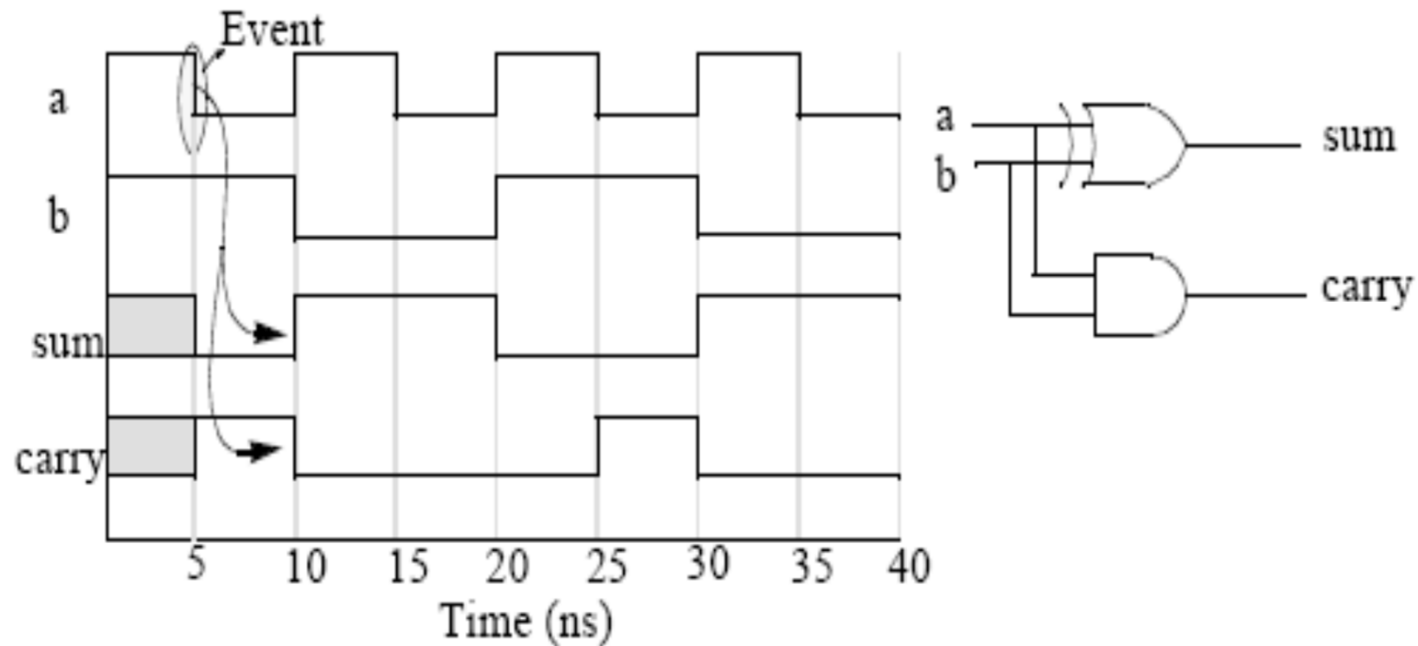


Technology independent view of RTL half-adder synthesized from Boolean equations



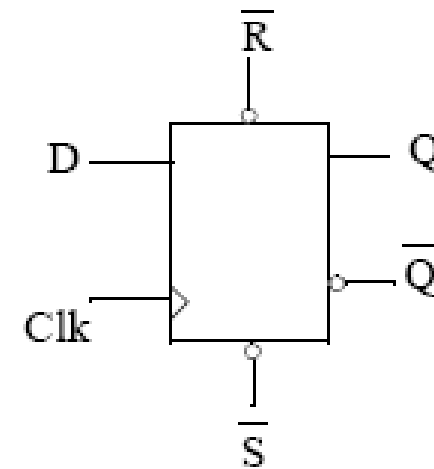
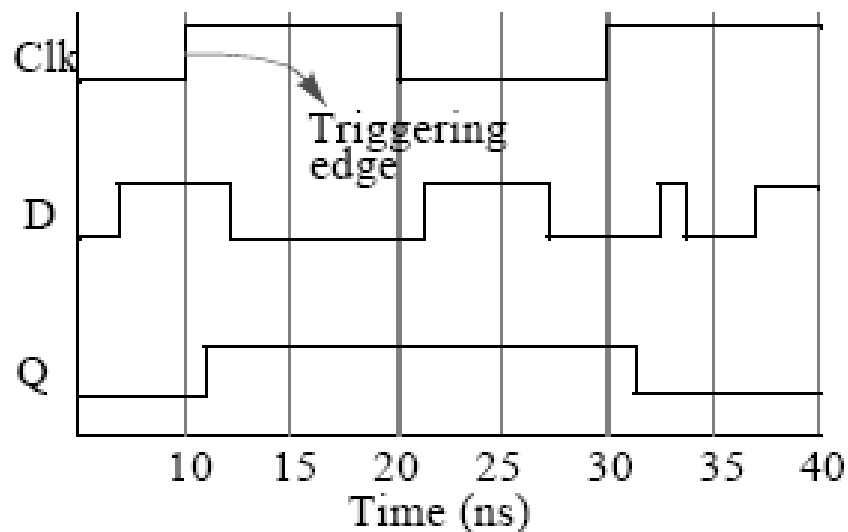
Timing simulation output of half-adder

Attributes of Digital Systems



- Digital systems are about *signals* and their *values*
- *Events*, *propagation delays*, *concurrency*
- Time ordered sequence of events produces a *waveform*

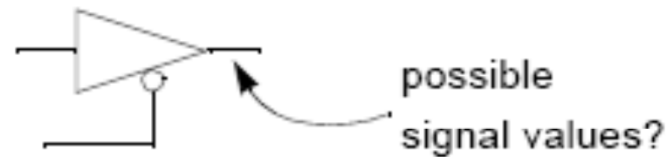
Attributes of Digital Systems: Timing



- *Timing*: computation of events takes place at specific points in time
- Need to “wait for” an event: in this case the clock
- Timing is an attribute of both synchronous and asynchronous systems

Attributes of Digital Systems: Signal Values

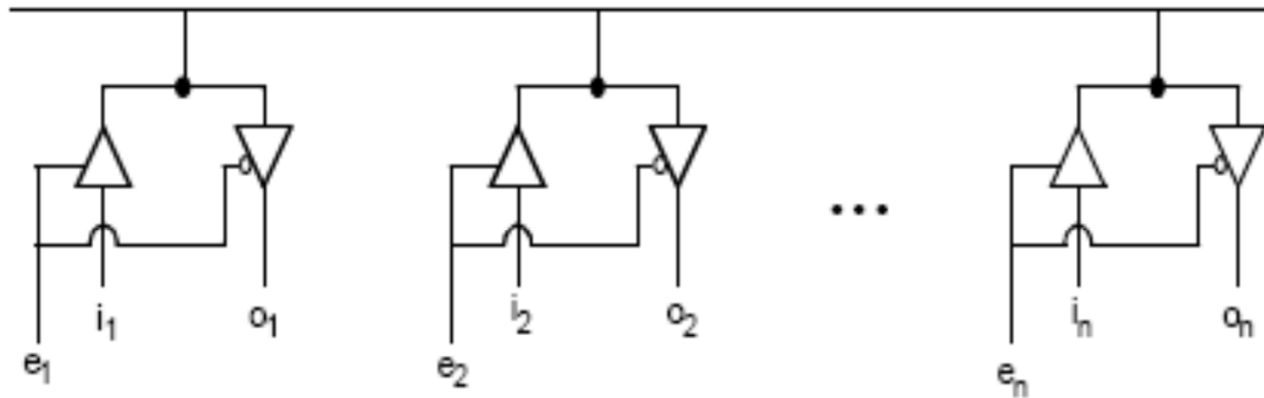
- We associate logical values with the state of a signal



- Signal Values: IEEE 1164 Value System

Value	Interpretation
U	Uninitialized
X	Forcing Unknown
0	Forcing 0
1	Forcing 1
Z	High Impedance
W	Weak Unknown
L	Weak 0
H	Weak 1
-	Don't Care

Attributes of Digital Systems: Shared Signals

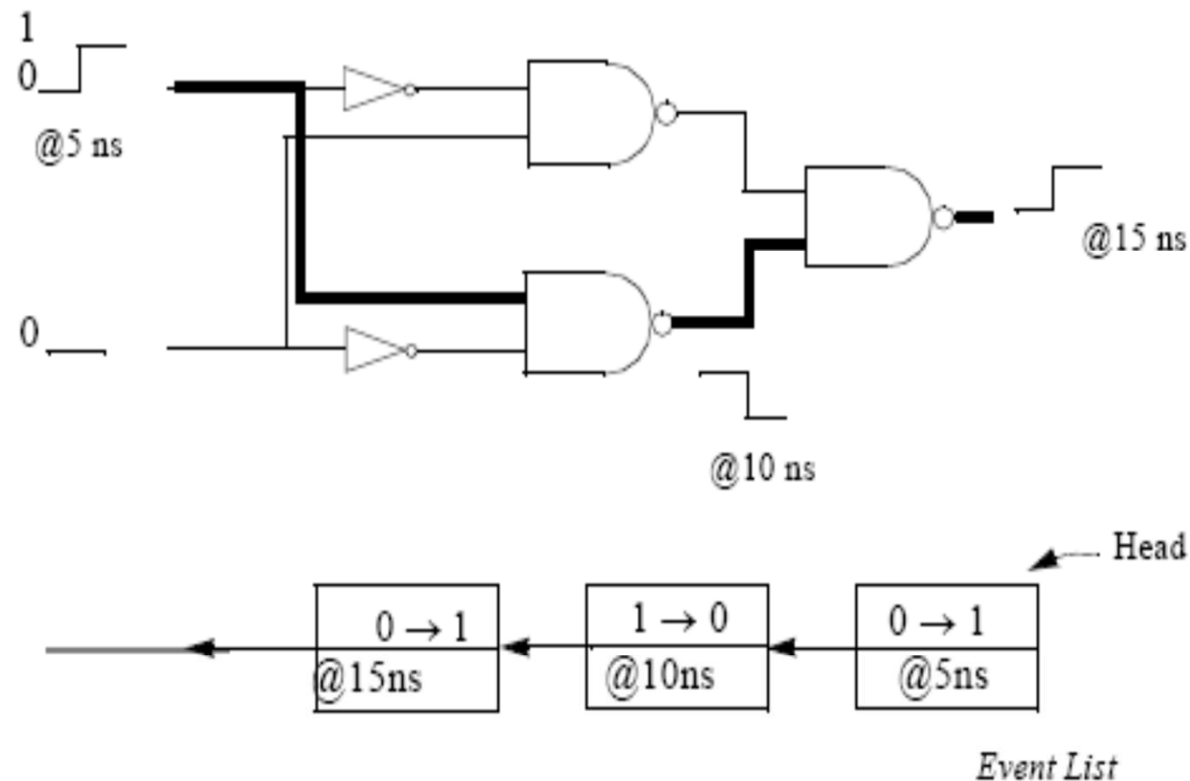


- Shared Signals
 - multiple drivers
- How is the value of the signal determined?
 - arbitration protocols
 - wired logic

Execution Models for VHDL Programs

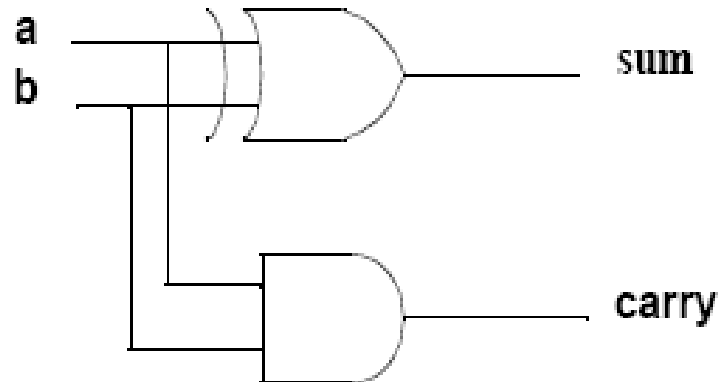
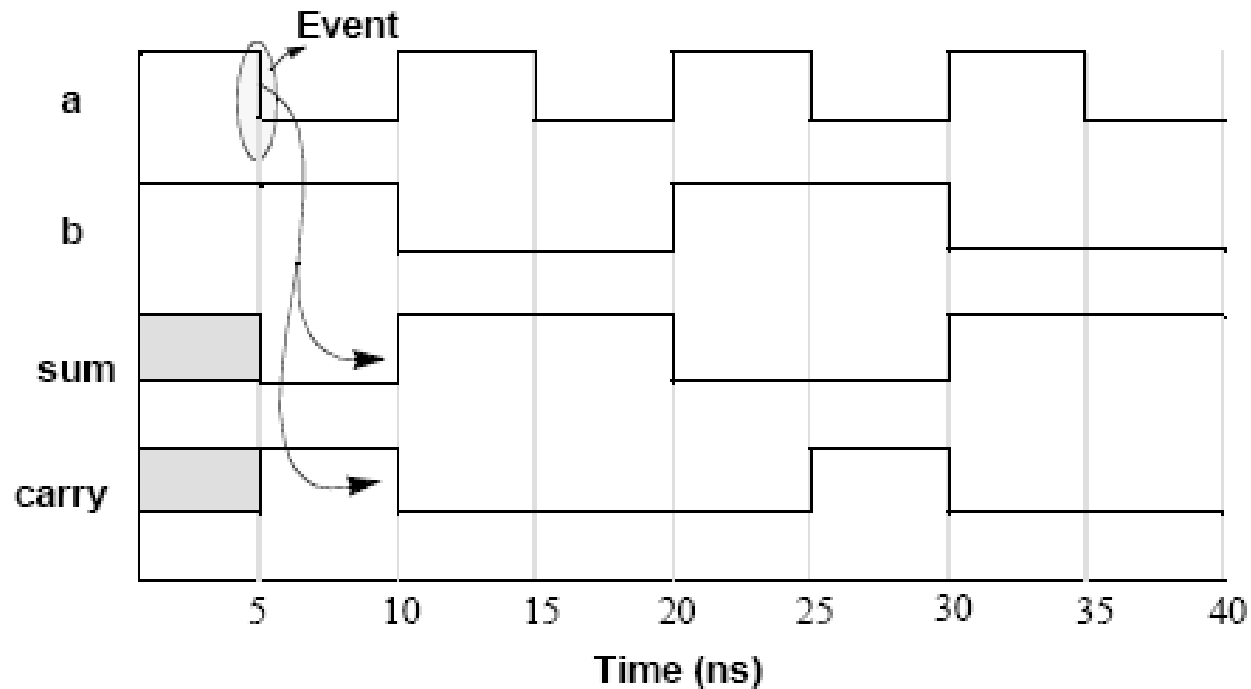
- Two classes of execution models govern the application of VHDL programs
- Simulation
 - discrete event simulation
 - understanding is invaluable in debugging programs
- Synthesis
 - inference of hardware
 - a function of the building blocks used for implementation

Simulation of Digital Systems

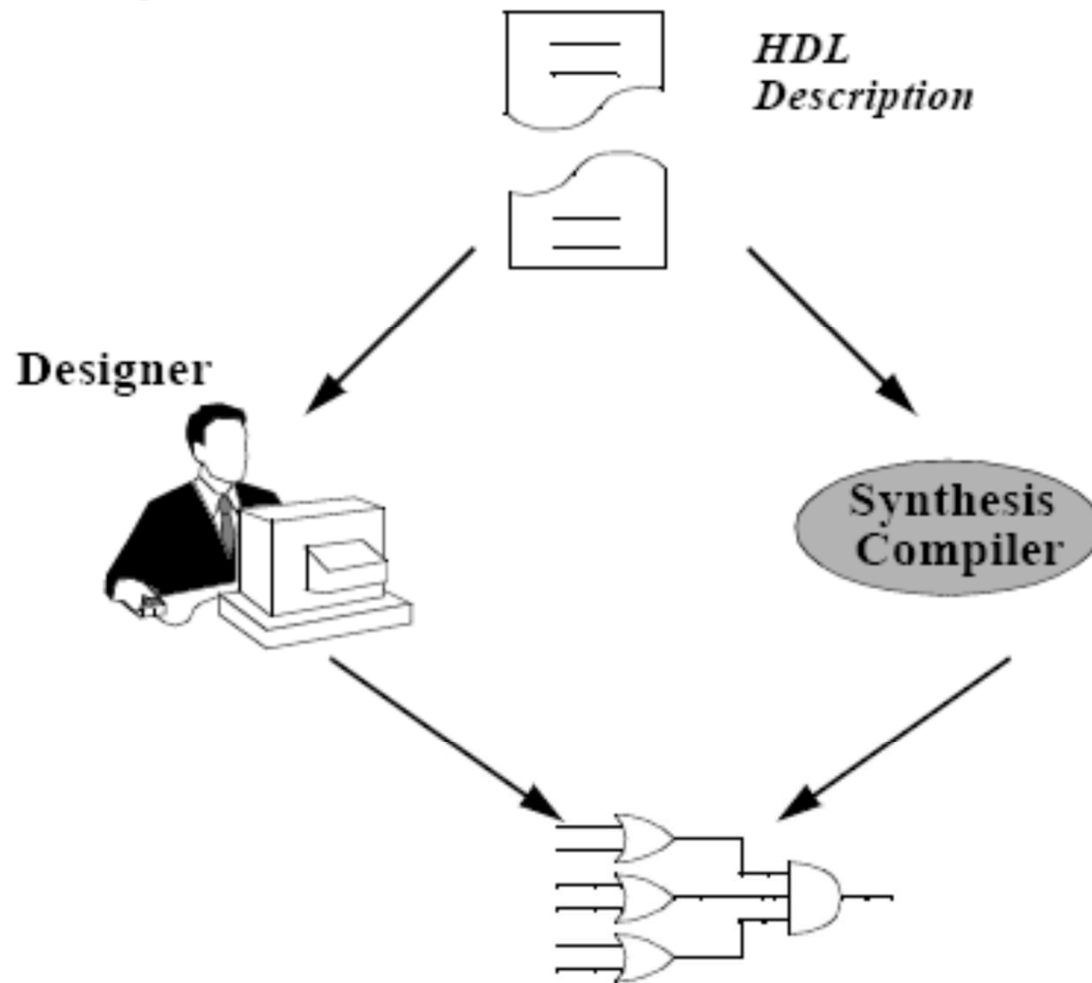


- Digital systems propagate events
- Discrete event simulations manage the generation and recording of events

Discrete Event Simulation: An Example



Synthesis and Hardware Inference



- Both processes can produce very different results!