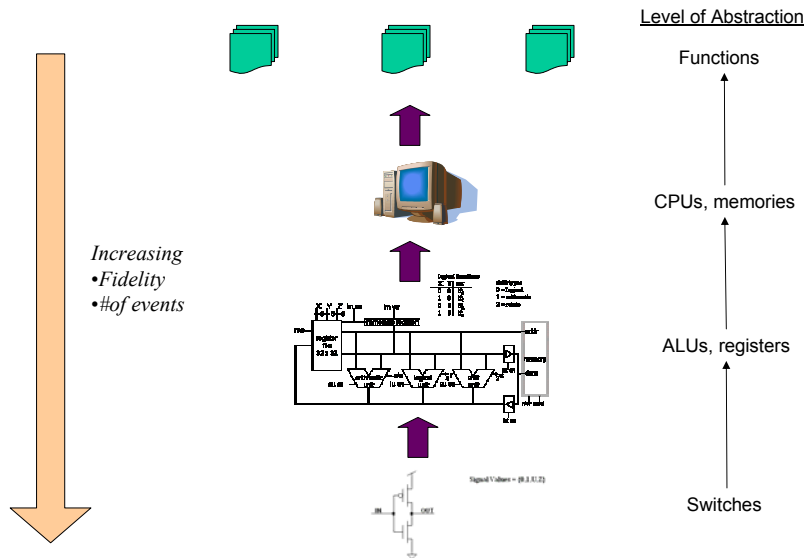
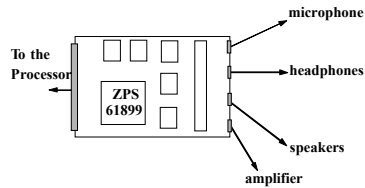


Modeling Digital Systems

Systems Hierarchy





- From Webster's Dictionary:
 - **System:** "An assemblage of objects united by some form of regular interaction or dependence"
- What aspects of a digital system do we want to describe?
 - Interface
 - Function: behavioral and structural

What Elements Should be in a Description?

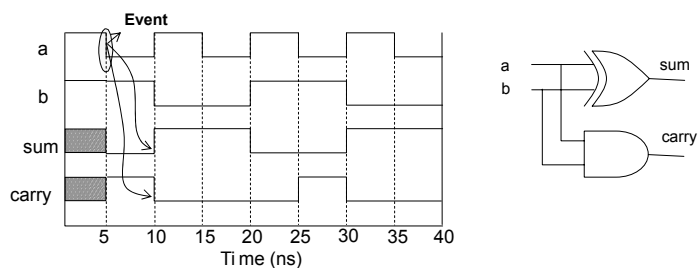
- Descriptions should be at multiple levels of abstraction
 - The descriptive elements must be common to multiple levels of hierarchy
- The elements should enable meaningful and accurate simulation of hardware described using the elements
 - Elements should have attributes of time as well as function
- The elements should enable the generation of hardware elements that realize a correct physical implementation
 - Existence of a mapping from elements to VLSI devices

What Elements Should be in a Description?

- VHDL was conceived for the description of digital systems
 - From switches to networked systems
- Keep in mind the pragmatic issues of design re-use and portability of descriptions
 - Portability across technology generations
 - Portability across a range of cost/performance points
- Attributes of digital systems serve as the starting point
 - Language features designed to capture the key attributes

ECE 4170 (5)

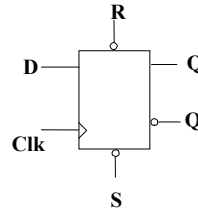
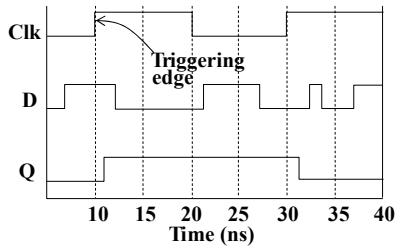
Attributes of Digital Systems



- Digital systems are about *signals* and their *values*
- *Events, propagation delays, concurrency*
 - Signal value changes at specific points in time
- Time ordered sequence of events produces a *waveform*

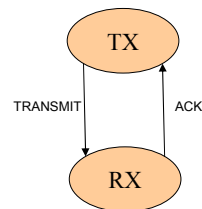
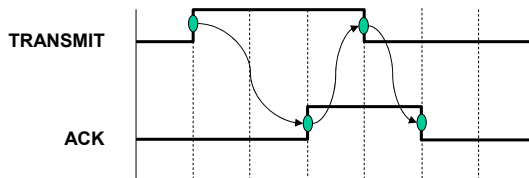
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Attributes of Digital Systems: Timing



- **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

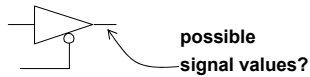
Attributes of Digital Systems: Timing



- Example: Asynchronous communication
- No global clock
- Still need to *wait for* events on specific signals

Attributes of Digital Systems: Signal Values

- We associate logical values with the state of a signal

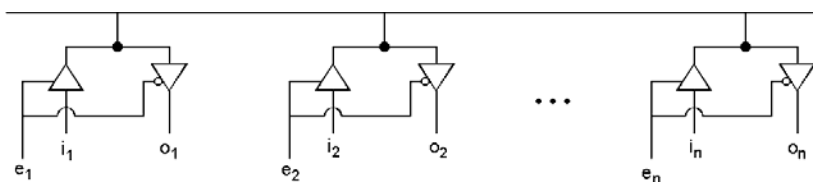


- Signal Values: IEEE 1164 Value System

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

ECE 4170 (9)

Attributes of Digital Systems: Multiple Drivers



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

ECE 4170 (10)

- We seek to describe attributes of digital systems common to multiple levels of abstraction
 - events, propagation delays, concurrency
 - waveforms and timing
 - signal values
 - shared signals
- Hardware description languages must provide constructs for naturally describing these attributes of a specific design
 - simulators use such descriptions for “mimicing” the physical system
 - synthesis compilers use such descriptions for synthesizing manufacturable hardware specifications that conform to this description