



Systems & Realtime

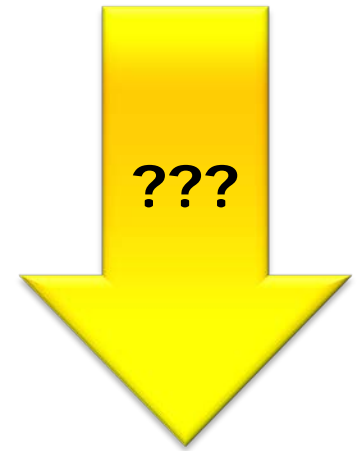
*"Yes, we are going to build a system for our INTRO Demonstrator.
And you bet it has to be real-time too!"*

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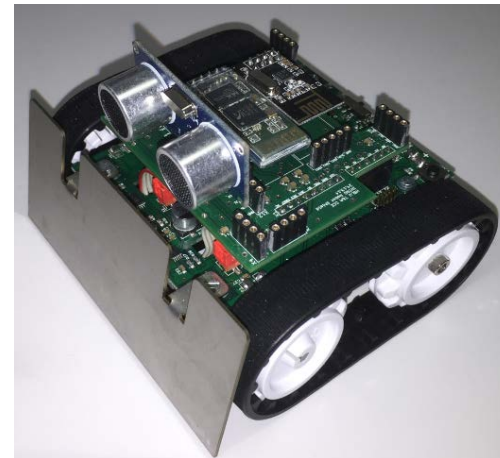
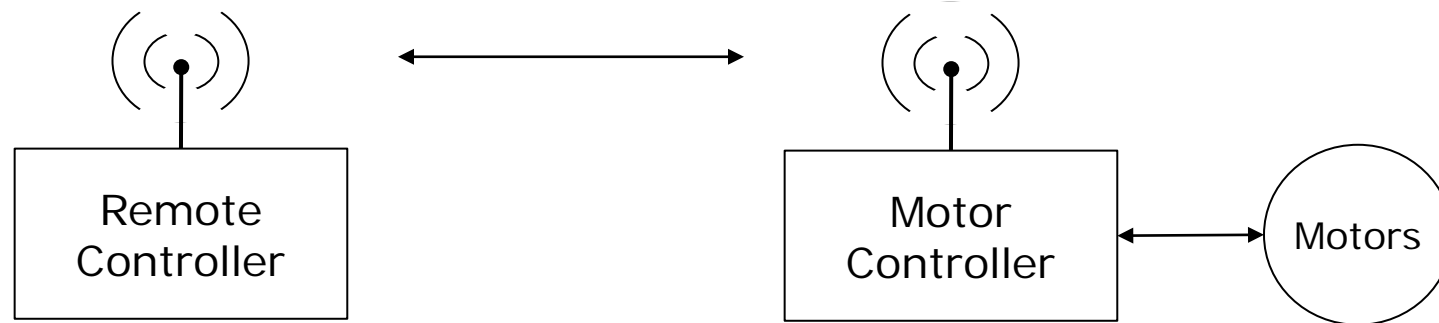
**Scriptum:
Systems, Realtime**

Learning Topics

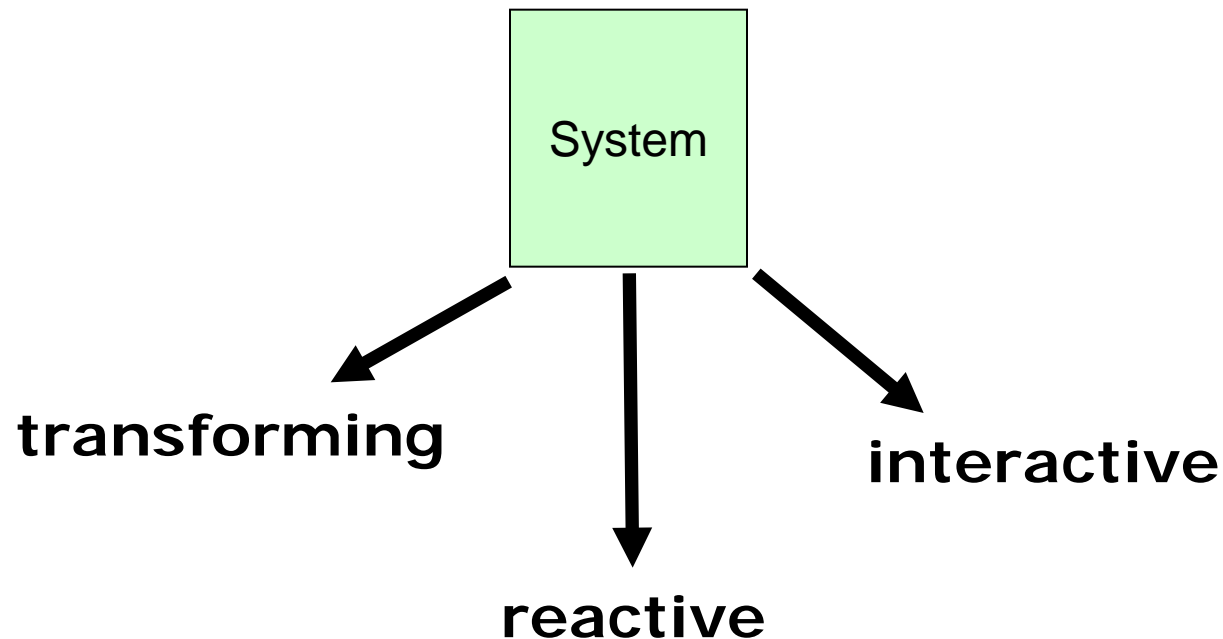
- Problem: Understand and decompose the system
- Systems
- Classification
- Realtime
- Timeliness
- Reaction time



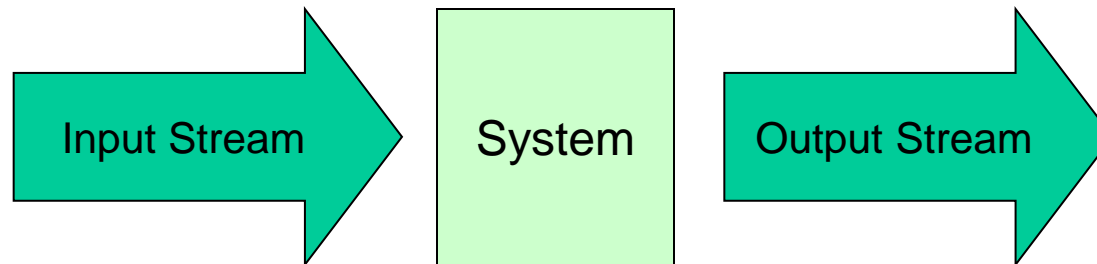
Intro System(s)



Embedded System – System?

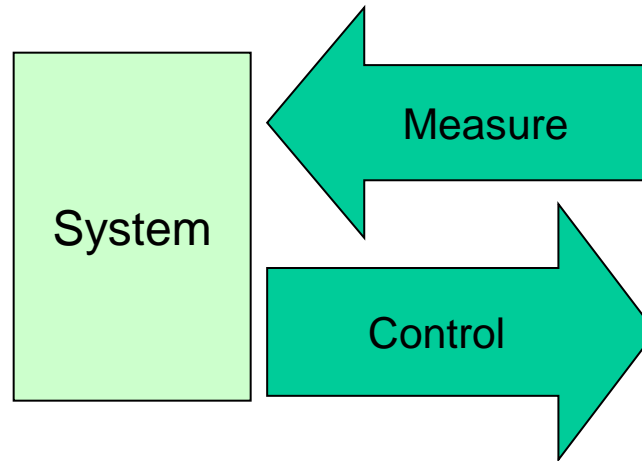


Transforming Systems



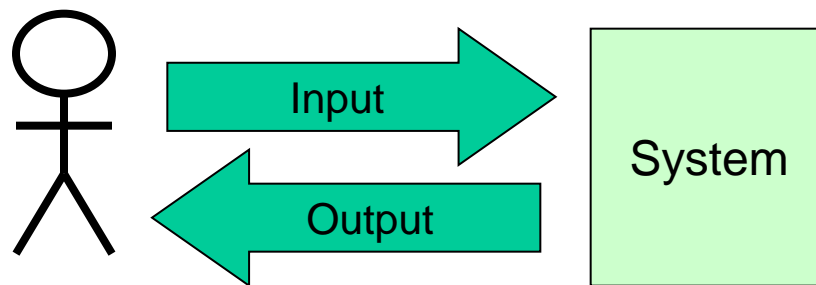
- Typical
 - Data processing quality
 - Throughput
 - Optimized system load
 - Optimized Memory Usage

Reactive Systems



- Typical
 - External events are driving system
 - Guaranteed response time
 - Control loop
 - Realtime

Interactive Systems



- Typical
 - Short response time
 - High system load
 - Human-Machine Interaction (HMI)

Example



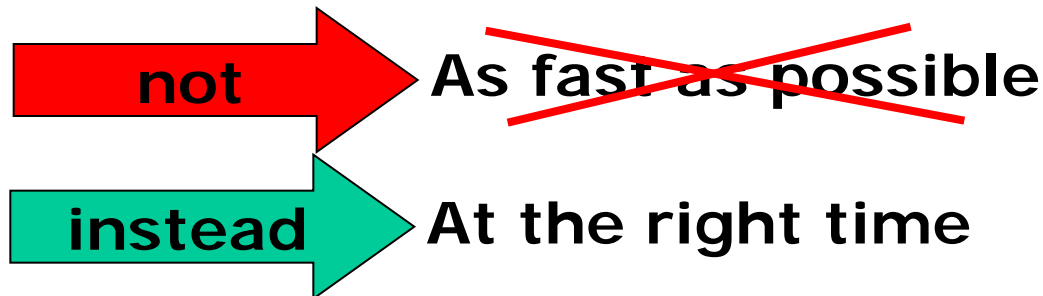
Source: Apple

Trends

Heterogeneous Systems, Multicore

Realtime

- System interaction with the environment
- Different speed domains of events
- System has to deal with the time constraints of the real world (real time)
- Realtime → real time



Realtime Processing

- Systems
 - Transforming
 - Reactive
 - Interactive
- Realtime System Requirements
 - **Correctness**
 - **External** time conditions compliance
- Examples
 - Train system schedule computation
 - Railroad switch

**The correct result at the
correct time**

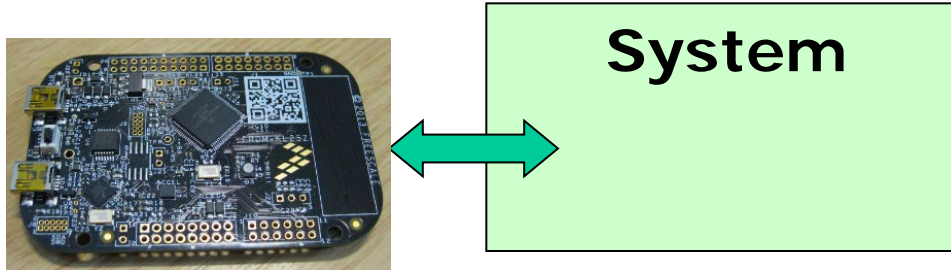


Source: Wikipedia



Source: Wikipedia

Realtime for Computer Systems



- Computer is connected with a system
- Computer has to comply with the real time
 - No time short cut
 - No time expansion
 - Regardless current system load

Realtime

A computer is classified as Realtime if it can react on external events in the real world:

- With the correct result**
- At the correct time**
- Independent of current system load**
- In a deterministic and foreseeable way**

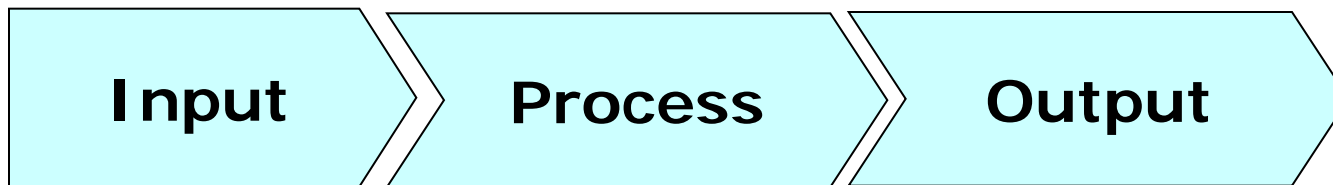


Claims

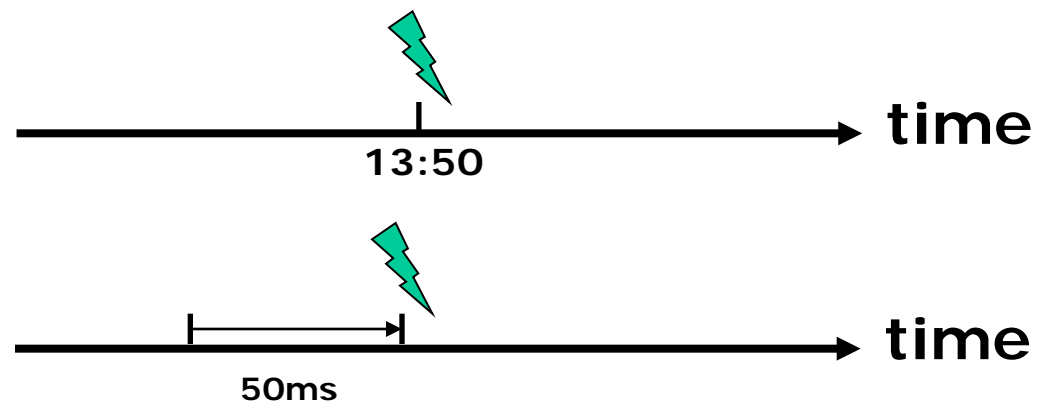
**Timeliness
Concurrency**

Timeliness

- For all processing stages



- Categories
 - absolute
 - relative

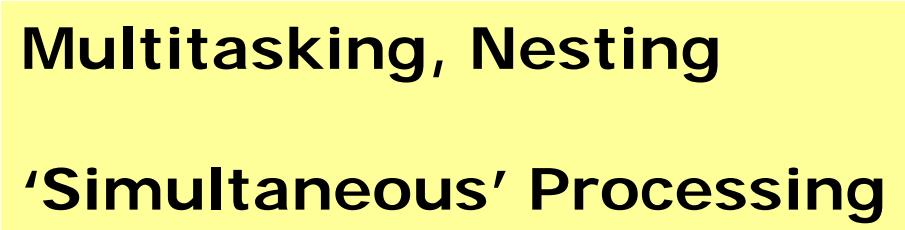


Concurrency

- Real World: is concurrent
- Problem: Computers are sequential



**For slow and
few tasks**



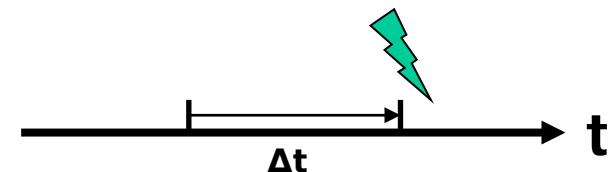
Multitasking, Nesting
'Simultaneous' Processing



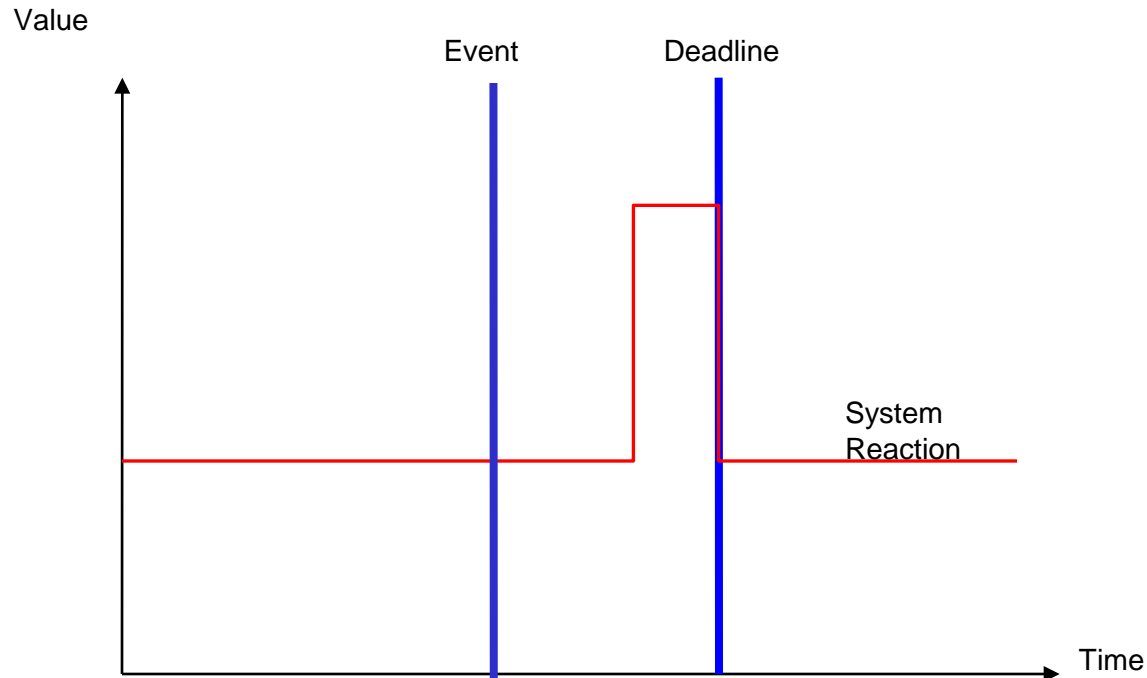
**Does NOT work for many
and fast tasks**

Reaction Time

- Realtime systems require a defined reaction time
 - Absolute
 - Relative
- Interactive Systems
 - seconds
- Reactive & Transitive Systems
 - Milliseconds
 - Microseconds
- System load defined with
 - Number of concurrent events/tasks
 - Interval of events
 - Reaction time for events
 - Processing time for events

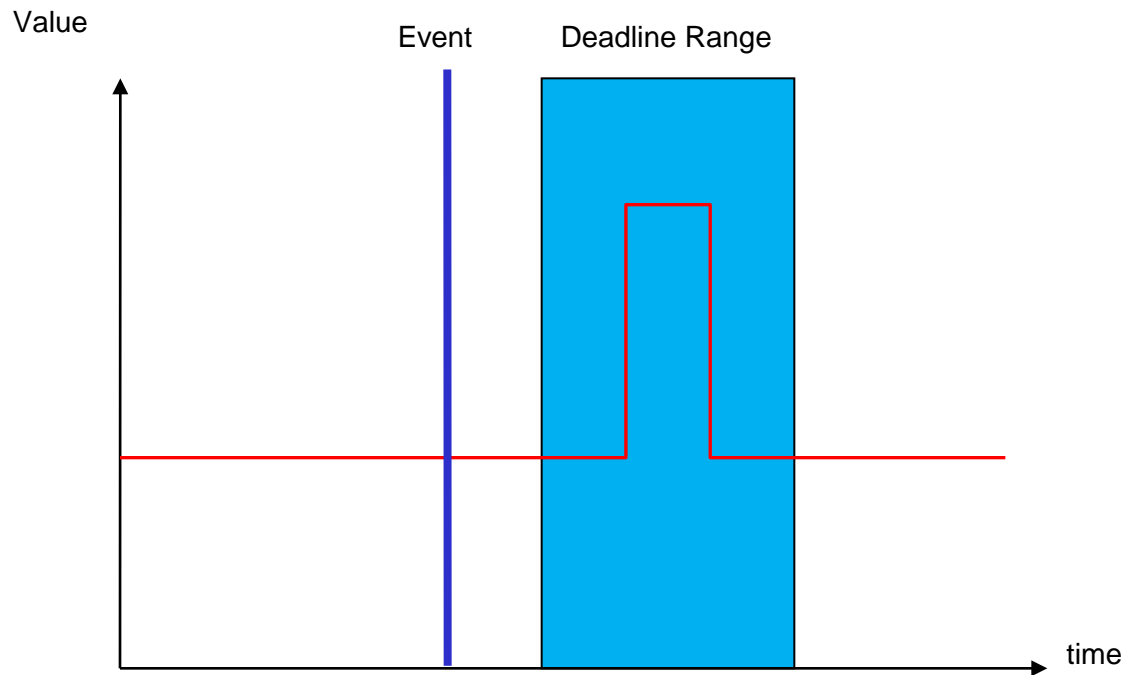


Hard Realtime



- Incorrect if correct result does not meet time conditions

Soft Realtime



- Degradation, if correct result does not meet the time conditions

Summary

- *Problem: Understand and decompose the system*
- Systems
 - Reactive
 - Interactive
 - Transformative
- Realtime: hard & soft
- Characterization of different systems

