

Execution architecture concepts

by *Gerrit Muller* Buskerud University College

e-mail: `gaudisite@gmail.com`

`www.gaudisite.nl`

Abstract

The execution architecture determines largely the realtime and performance behavior of a system. Hard real time is characterized as "missing a deadline" will result in system failure, while soft real time will result "only" in dissatisfaction. An incremental design approach is described. Concepts such as latency, response time and throughput are illustrated. Design considerations and recommendations are given such as separation of concerns, understandability and granularity. The use of budgets for design and feedback is discussed.

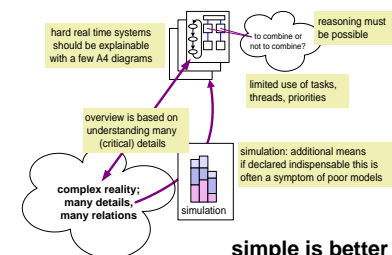
Distribution

This article or presentation is written as part of the Gaudí project. The Gaudí project philosophy is to improve by obtaining frequent feedback. Frequent feedback is pursued by an open creation process. This document is published as intermediate or nearly mature version to get feedback. Further distribution is allowed as long as the document remains complete and unchanged.

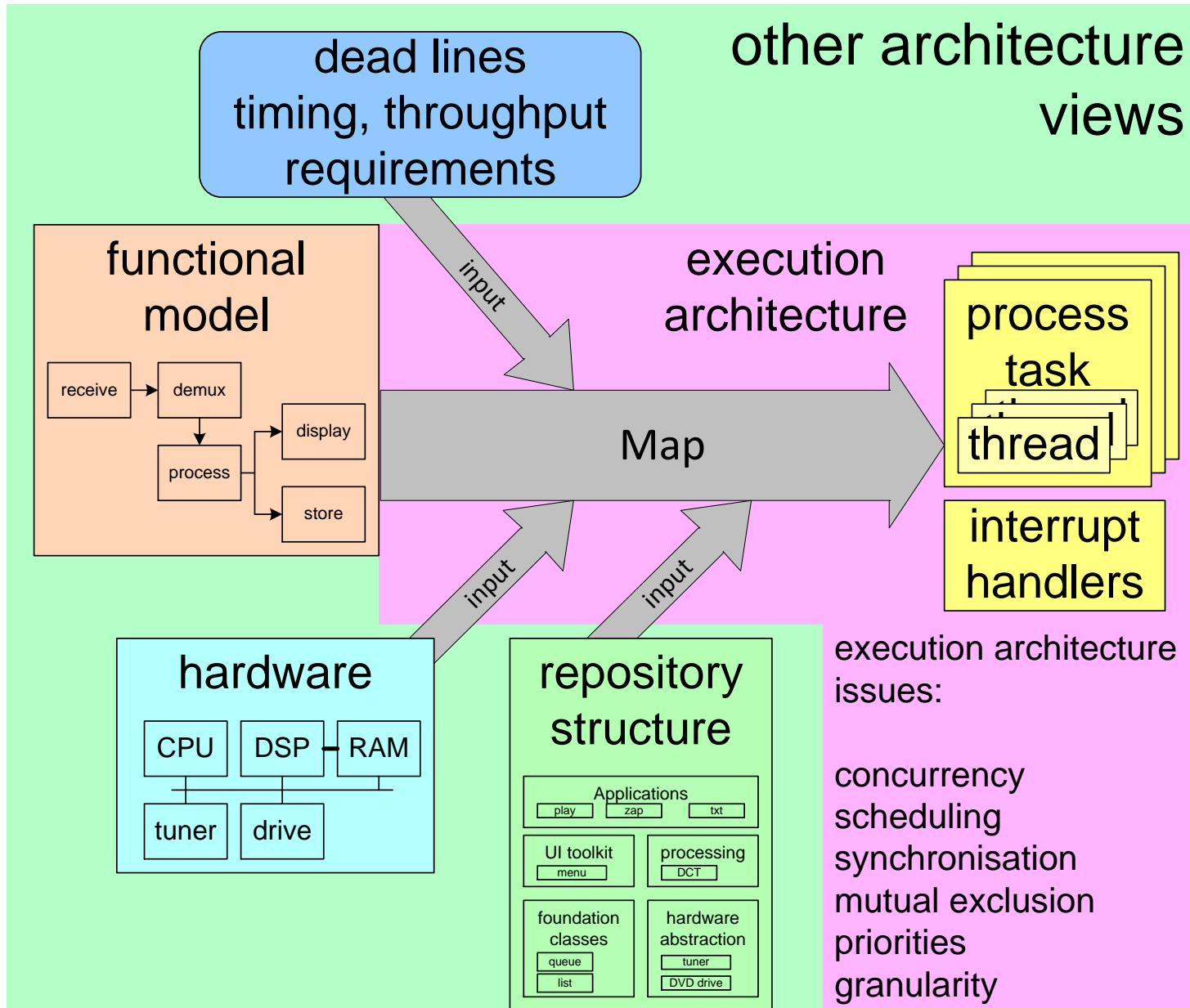
June 23, 2016

status: preliminary
draft

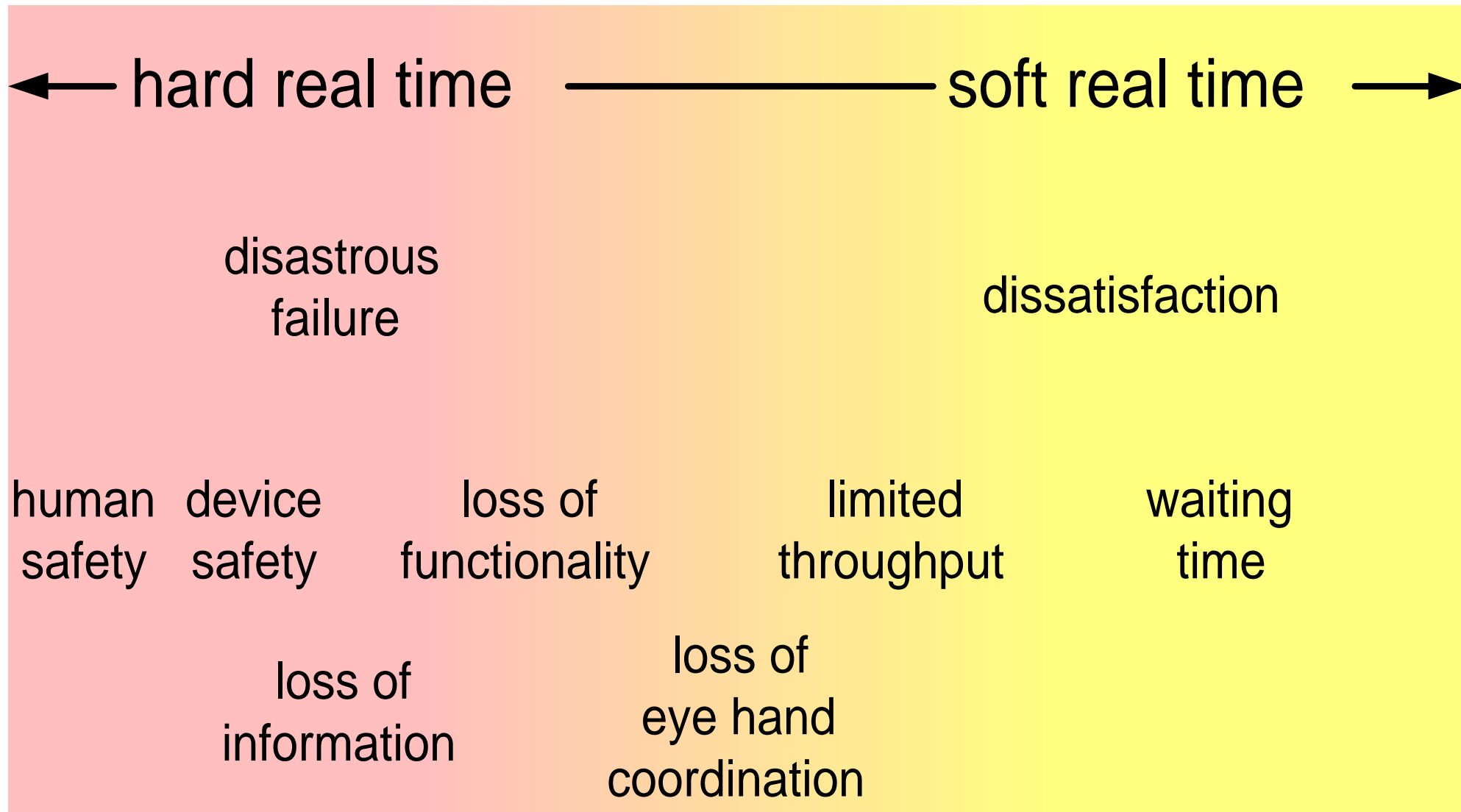
version: 1.1



Execution Architecture

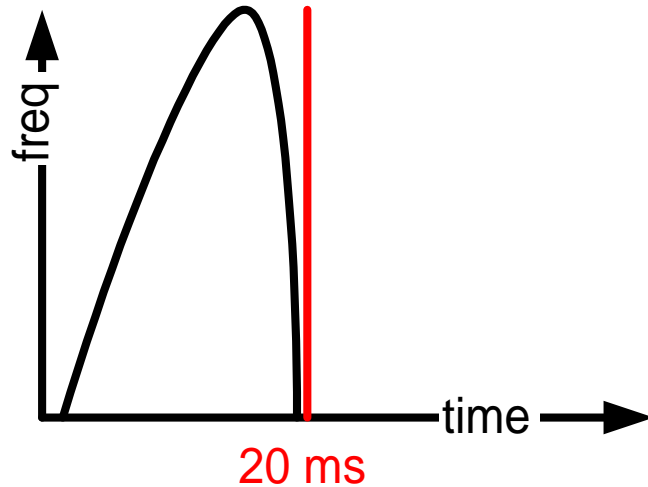


Fuzzy customer view on real time



Smartening requirements

Limited set of hard real time cases

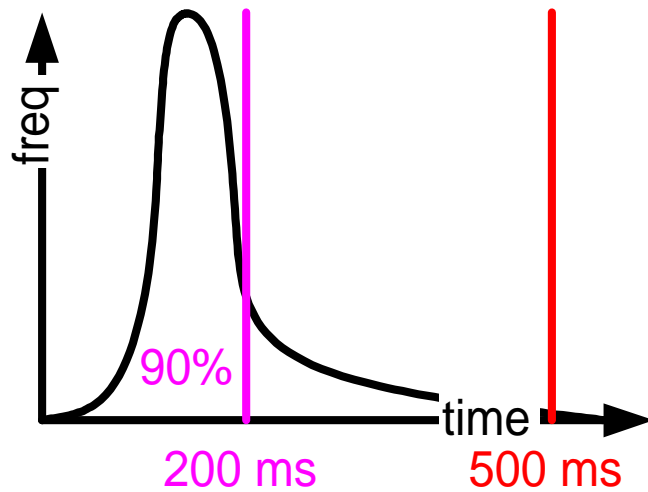


Precise form of the distribution is not important.

Be aware of systematic effects

No exception allowed
Worst case must fit

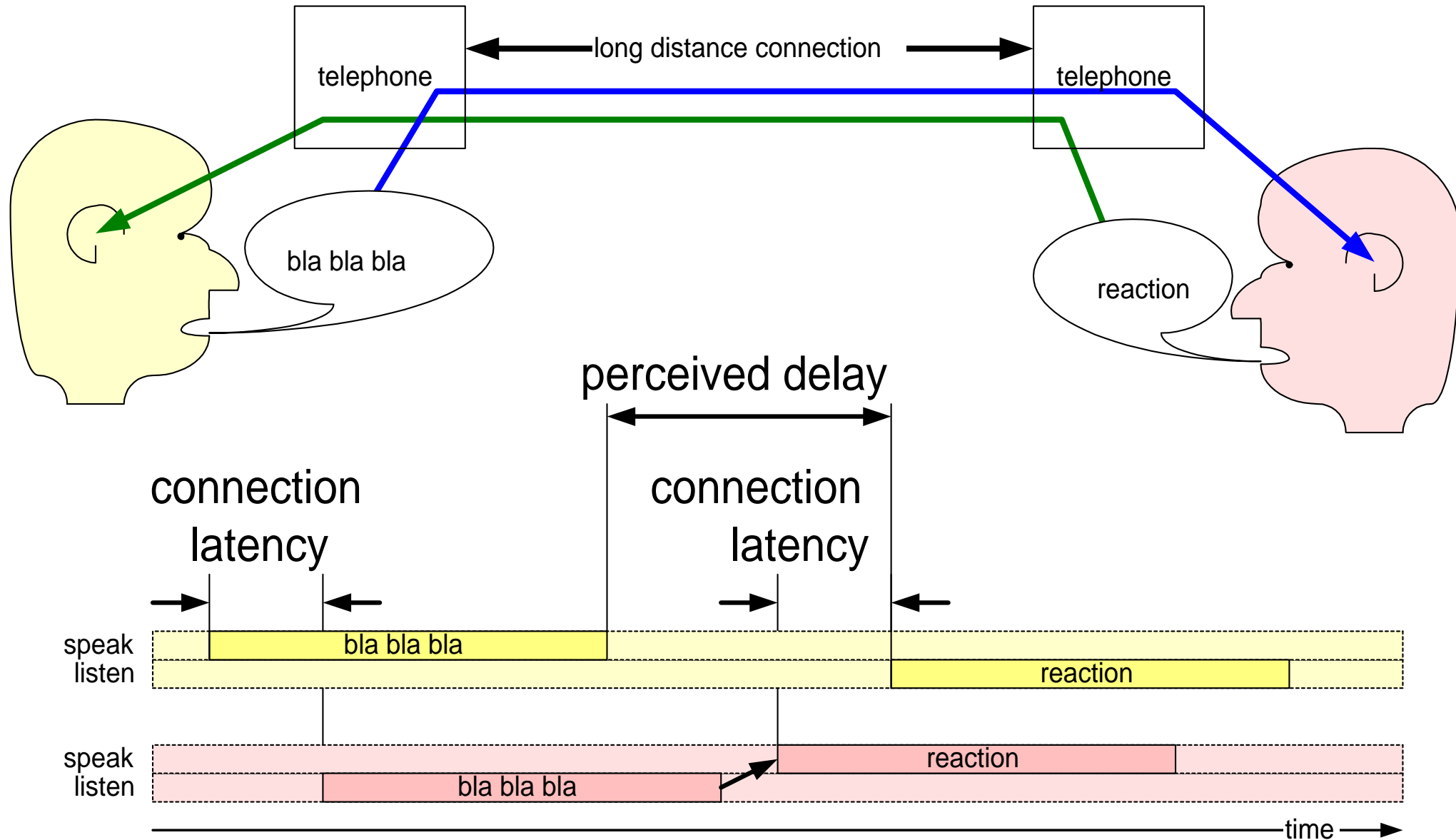
Well defined set of performance critical cases



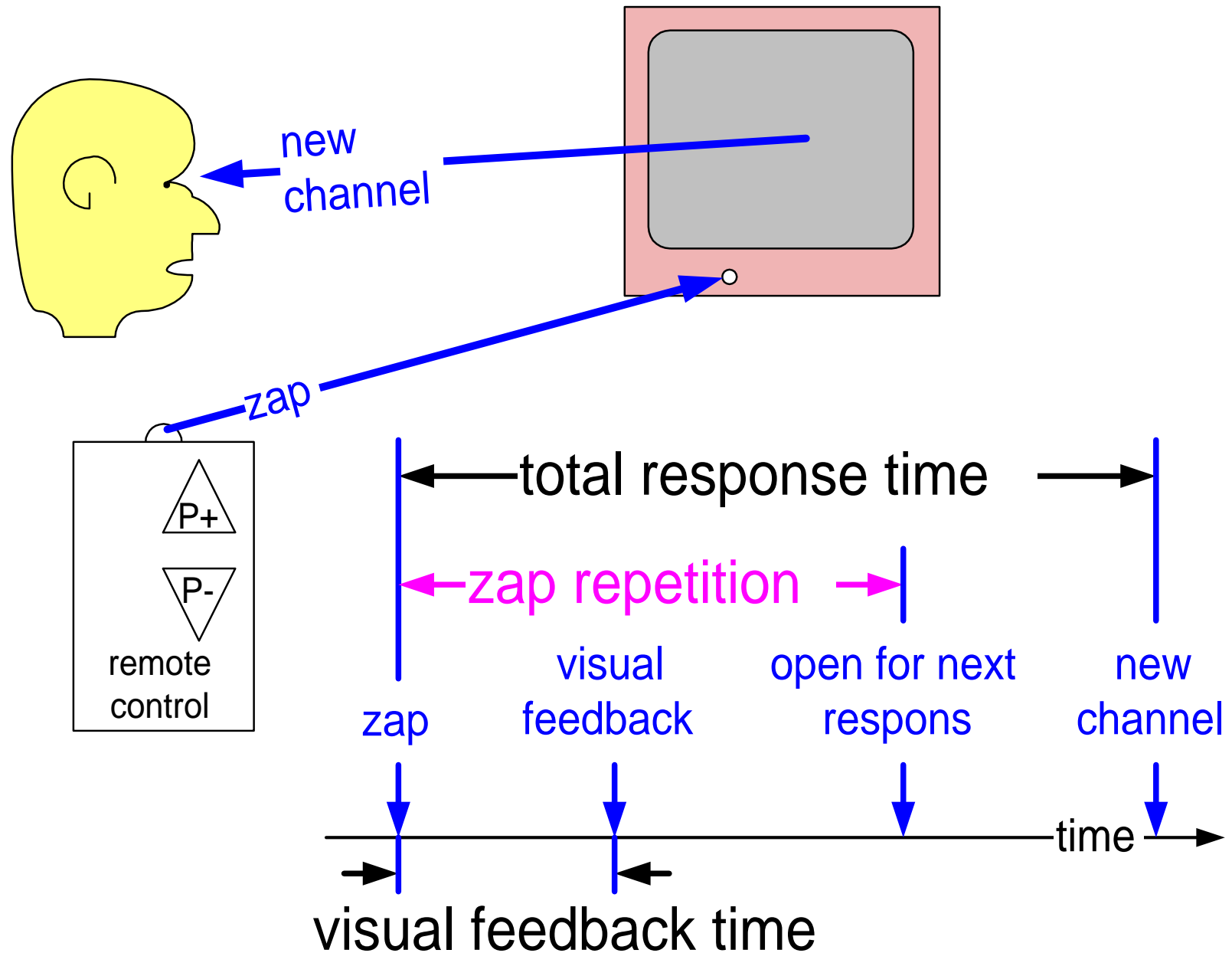
Typical within desired time,
limited exceptions allowed.

Exceptions may not result in
functional failure

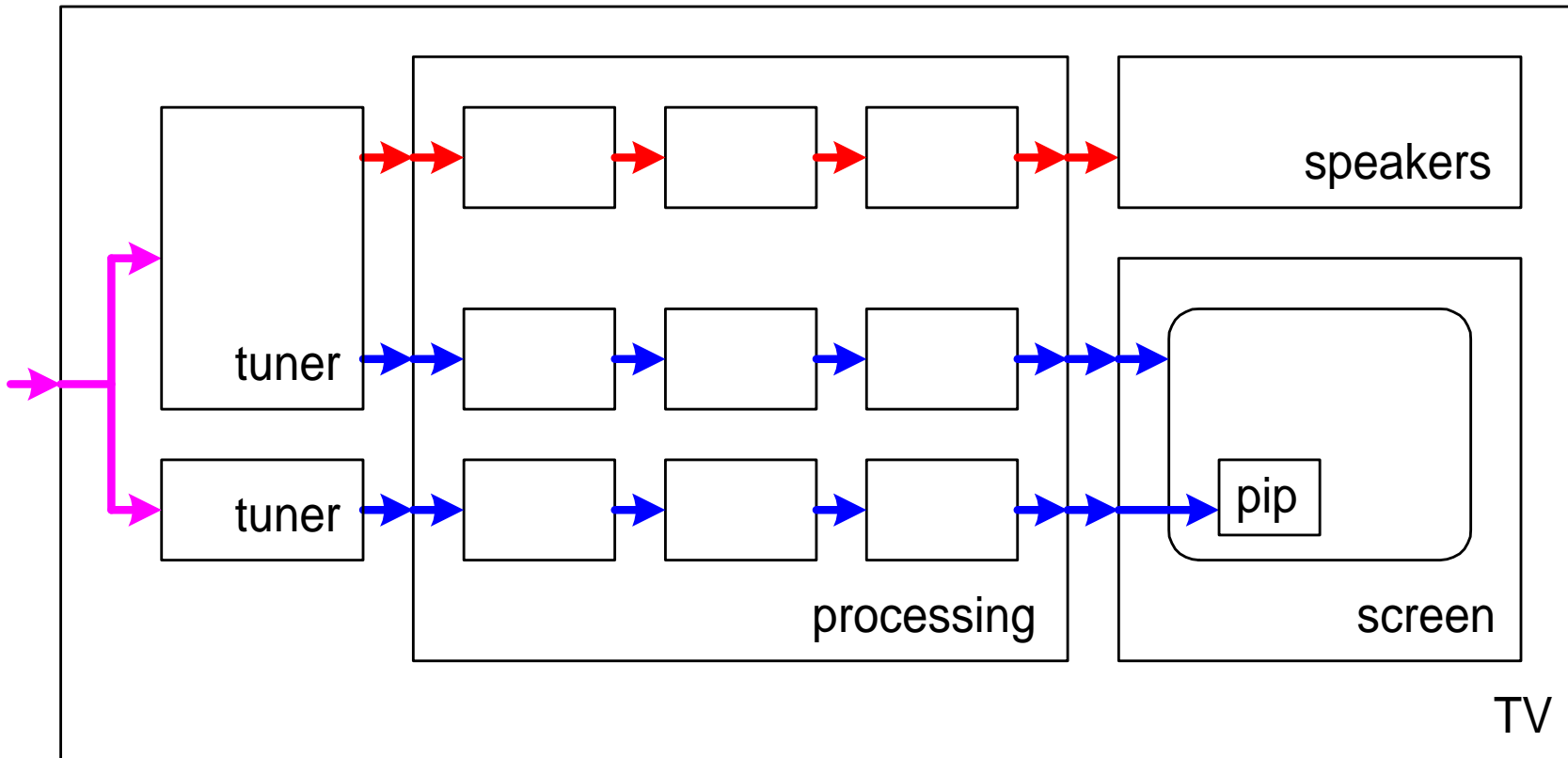
Latency



Response Time



Throughput



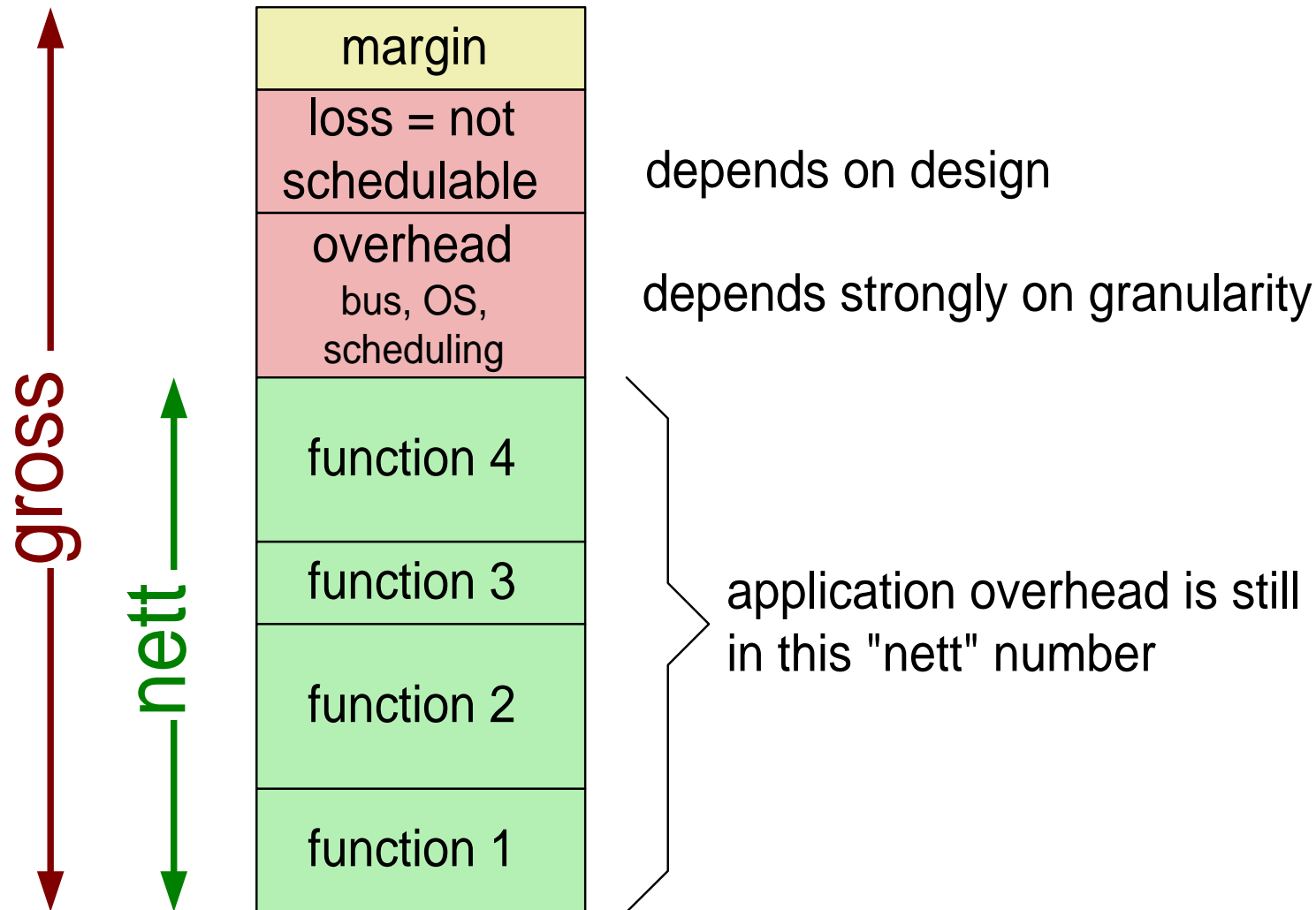
throughput:

- + processing steps/frame
- + frames/second
- + concurrent streams

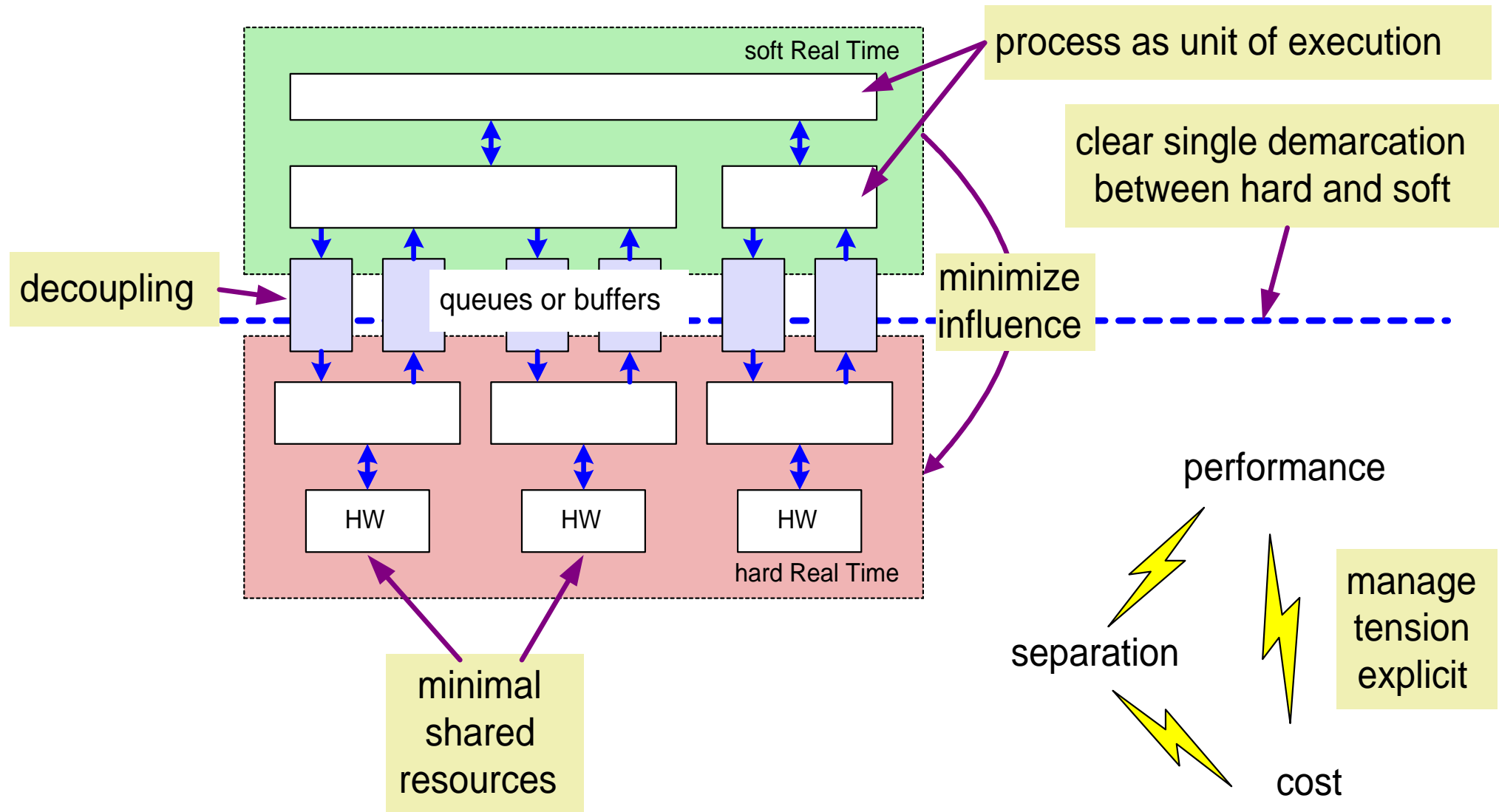
Gross versus Nett

bus bandwidth, processor load [memory usage]

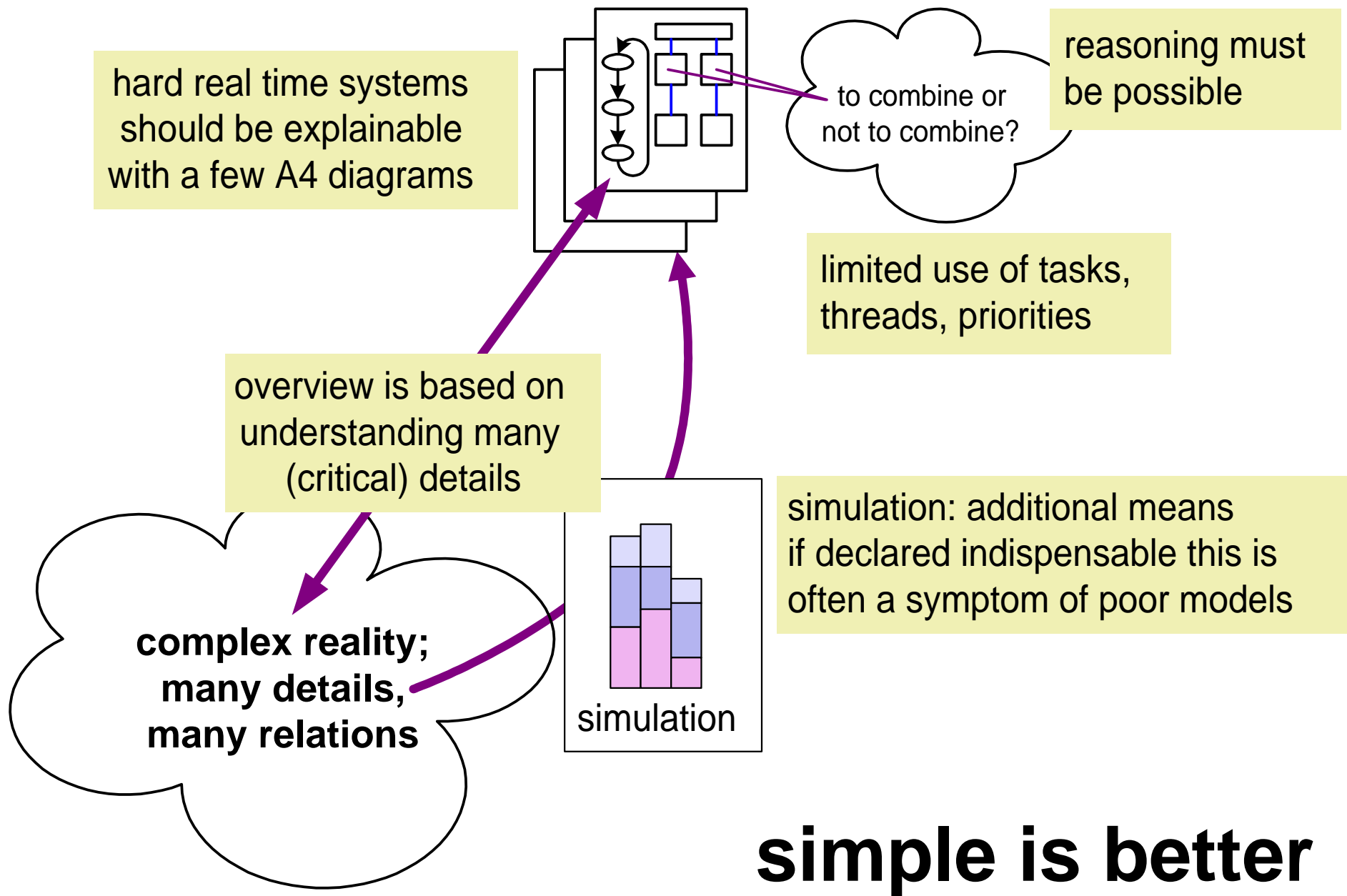
useful macroscopic views, be aware of microscopic behavior



Design recommendations separation of concerns

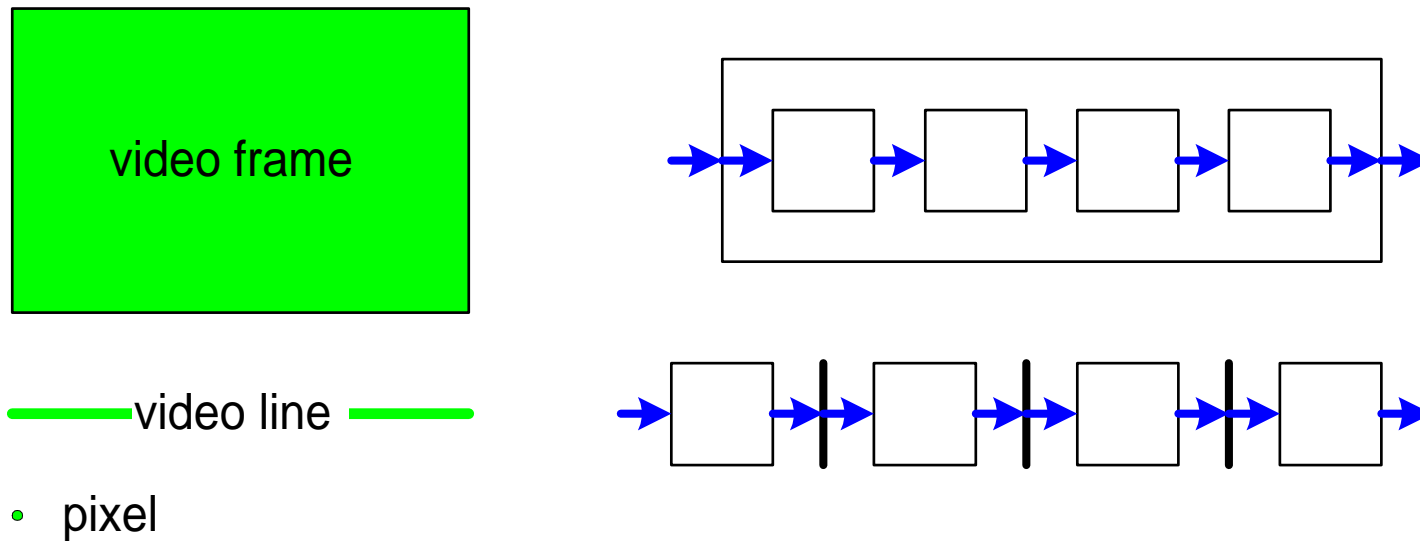


Design recommendations understandability



Granularity considerations

unit of buffering == or <> *unit of synchronization* == or <> *unit of processing* == or <> *unit of I/O*



fine grain:
flexible
high overhead

coarse grain:
rigid
low overhead

Design patterns

synchronous

safety critical, reliable, subsystems

very low overhead
predictable
understandable

works best in total separation
does not work for multiple rhythms

thread based

Asynchronous applications and services

separation of timing concerns
sharing of resources (no wait)

poor understanding of concurrency
danger of high overhead

timer based

regular rhythm;
e.g. monitor HW status, update time,
status display

low "tunable" overhead
understandable

fast rhythms significant overhead

interrupt based

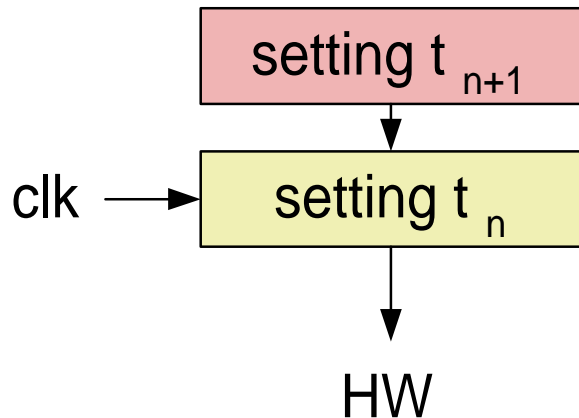
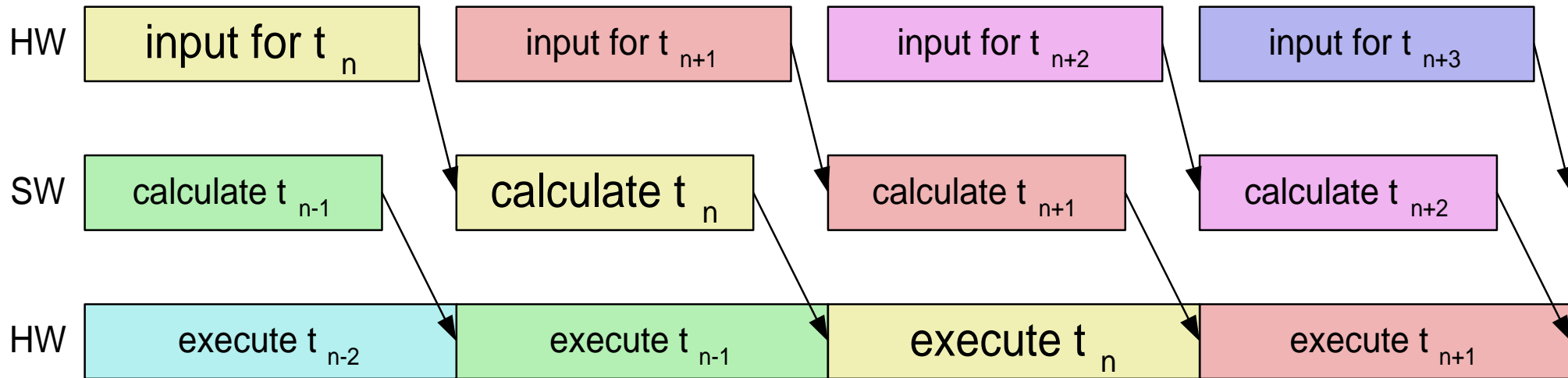
I/O and HW events
data available, display frame sync

separation of timing concerns

definition of interrupts determines:
overhead, understandability

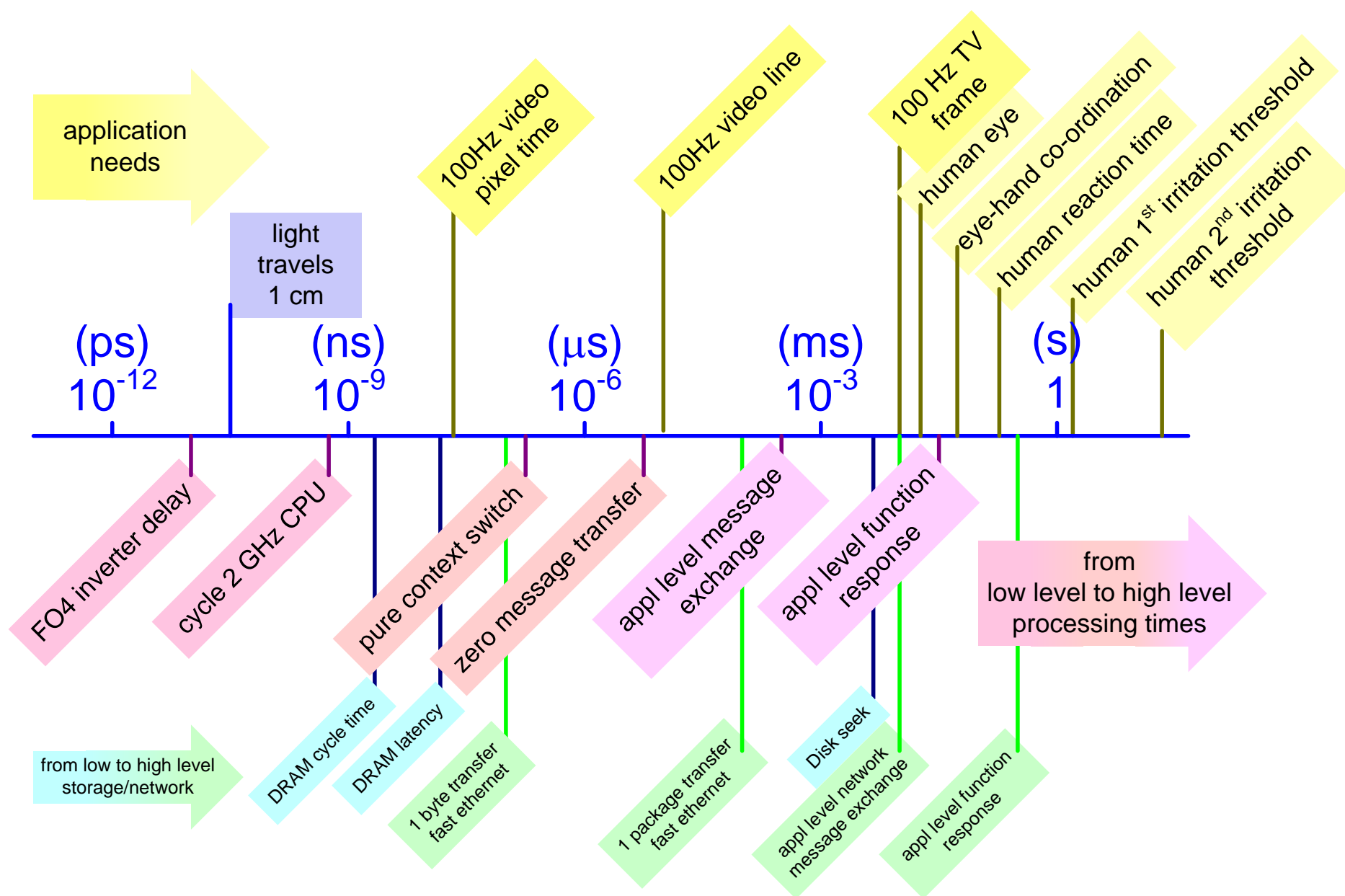


Synchronous design



double buffer:
full decoupling of calculation and execution

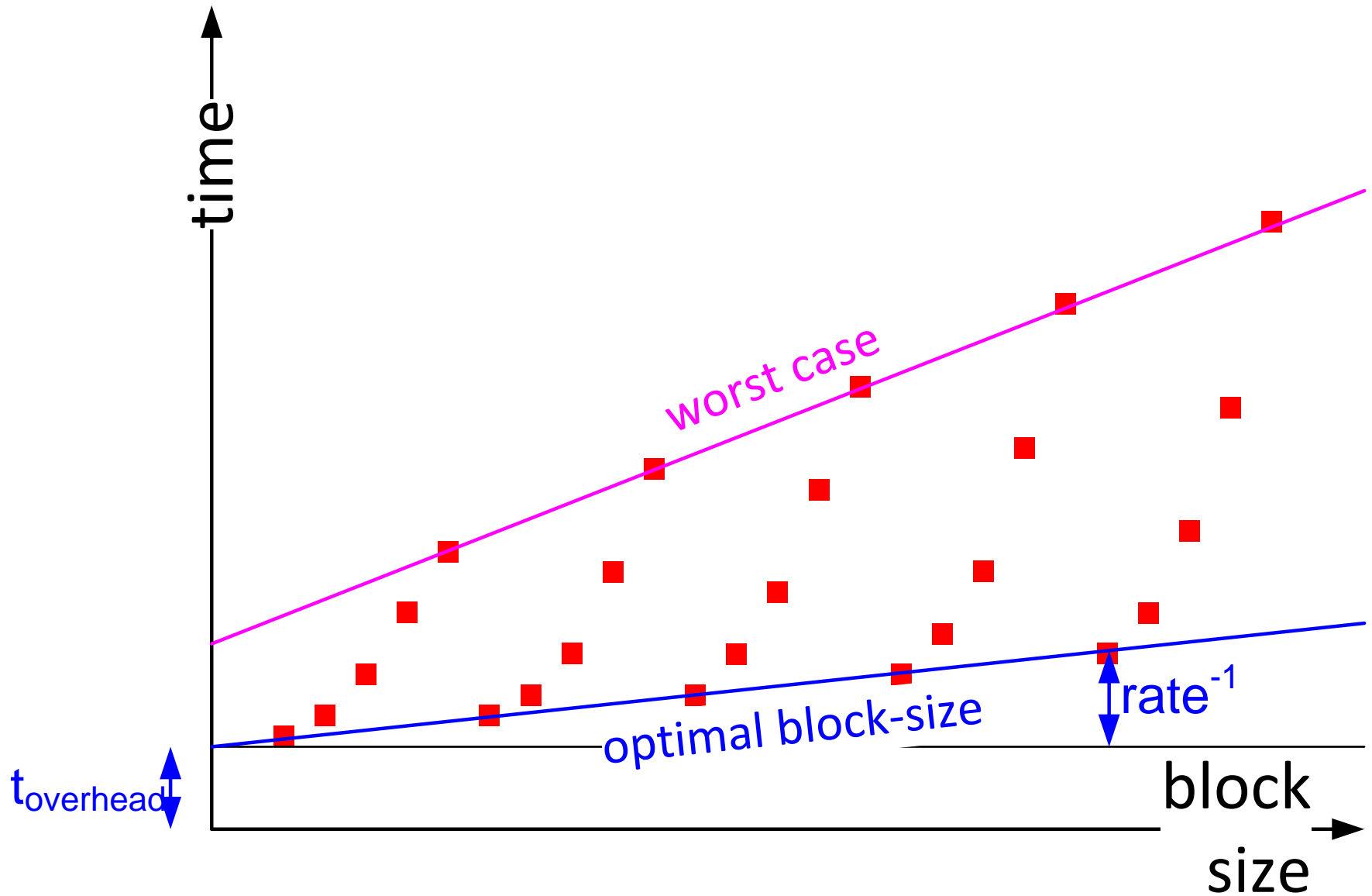
Actual timing on logarithmic scale



Typical micro benchmarks for timing aspects

	<i>infrequent operations, often time-intensive</i>	<i>often repeated operations</i>
<i>database</i>	start session finish session	perform transaction query
<i>network, I/O</i>	open connection close connection	transfer data
<i>high level construction</i>	component creation component destruction	method invocation same scope other context
<i>low level construction</i>	object creation object destruction	method invocation
<i>basic programming</i>	memory allocation memory free	function call loop overhead basic operations (add, mul, load, store)
<i>OS</i>	task, thread creation	task switch interrupt response
<i>HW</i>	power up, power down boot	cache flush low level data transfer

The transfer time as function of blocksize



Example of a memory budget

<i>memory budget in Mbytes</i>	code	obj data	bulk data	total
shared code	11.0			11.0
User Interface process	0.3	3.0	12.0	15.3
database server	0.3	3.2	3.0	6.5
print server	0.3	1.2	9.0	10.5
optical storage server	0.3	2.0	1.0	3.3
communication server	0.3	2.0	4.0	6.3
UNIX commands	0.3	0.2	0	0.5
compute server	0.3	0.5	6.0	6.8
system monitor	0.3	0.5	0	0.8
application SW total	13.4	12.6	35.0	61.0
UNIX Solaris 2.x				10.0
file cache				3.0
total				74.0

Complicating factors and measures

complications

cache

bus allocation

memory management

garbage collection

memory (buffer, storage) fragmentation

non preemptable OS activities

"hidden" dependencies (ie [dead]locks)

systematic "coincidences", avalanche triggers

instable response, performance

measures

considered margin

explicit behavior

architecture rules

monitoring, logging

pool management

feedback to architect

flipover simulation