Threads of reasoning illustrated by medical imaging case

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Abstract

The medical imaging workstation case is introduced. An architecting method based on the CAFCR viewpoints is explained, consisting of 4 elements:

- the CAFCR viewpoints
- qualities as integrating needles
- story telling
- threads of reasoning

A thread of reasoning is build up in steps, based on this case. The underlying reasoning is explained.

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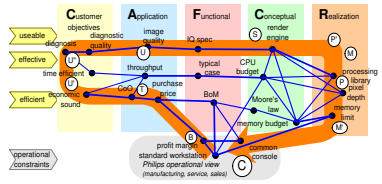
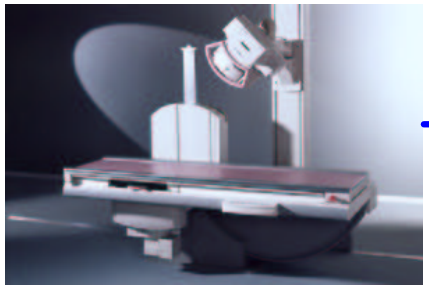
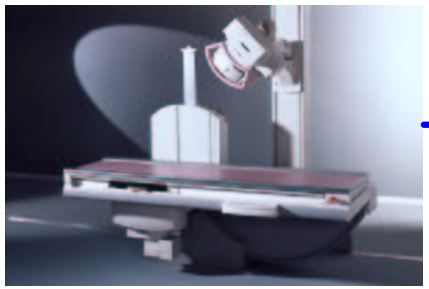
status: preliminary draft
version: 0

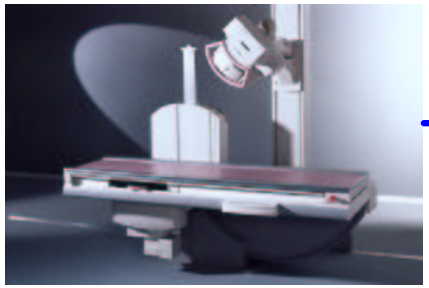


cost revisited in context of clinical needs and realization constraints; note: original threads are significantly simplified

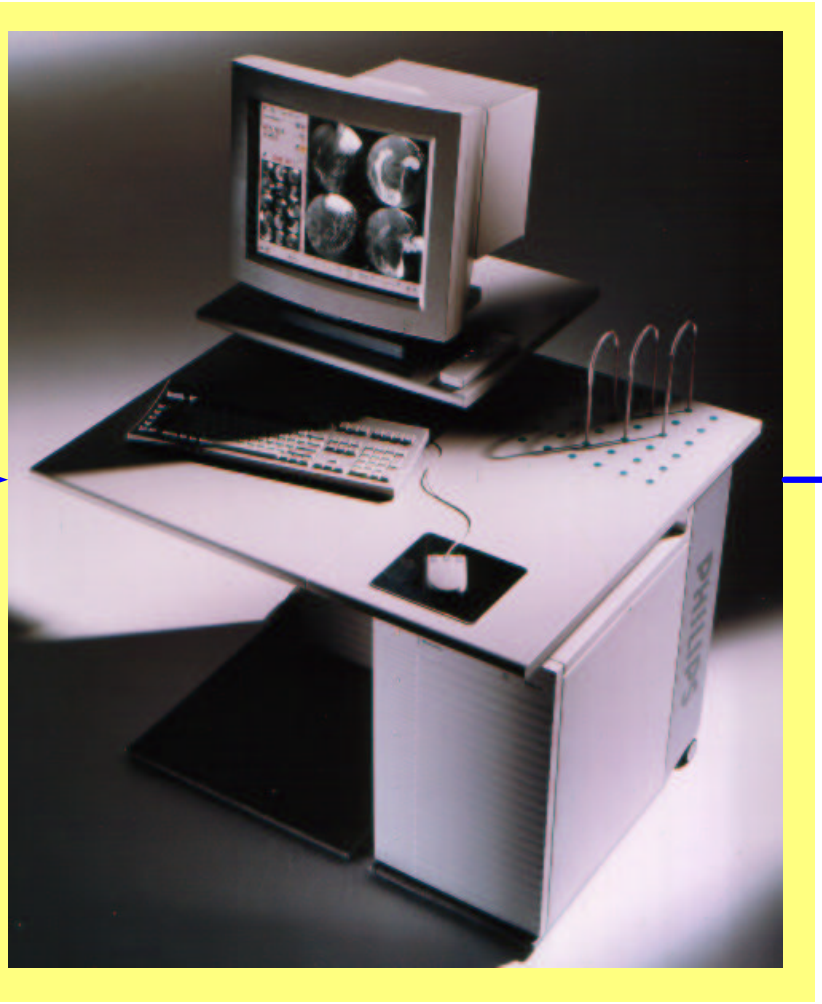
Easyvision serving three URF examination rooms







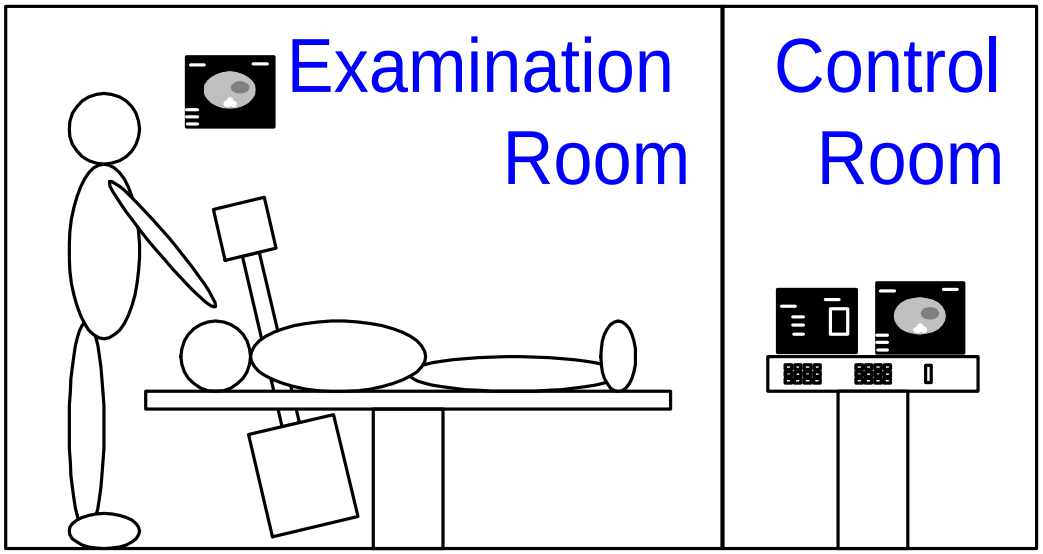
URF-systems

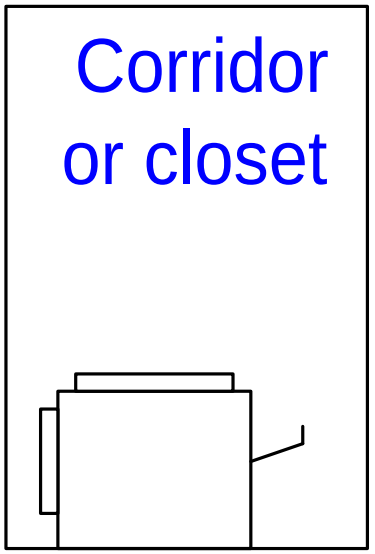


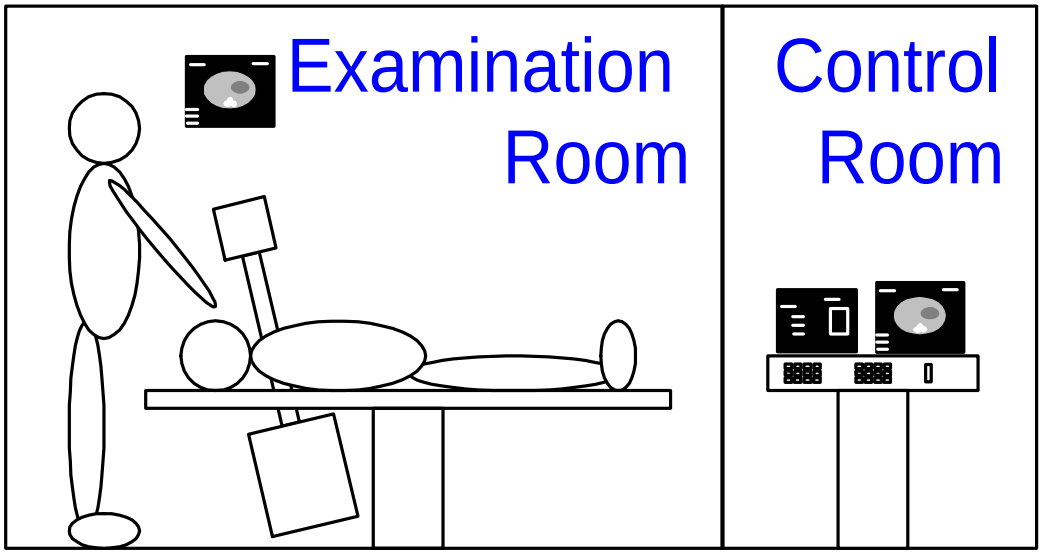
EasyVision: Medical Imaging Workstation

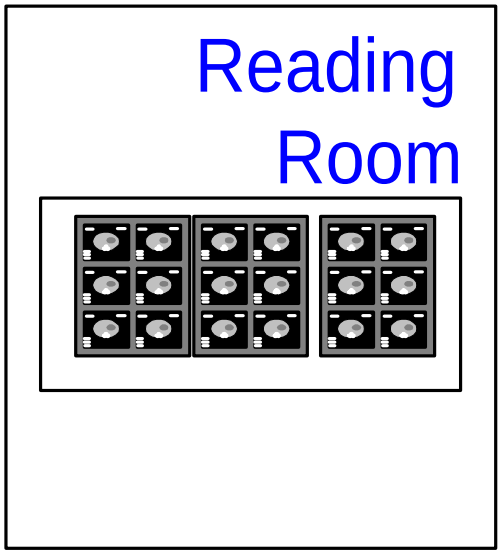
typical clinical image (intestines)

X-ray rooms from examination to reading around 1990

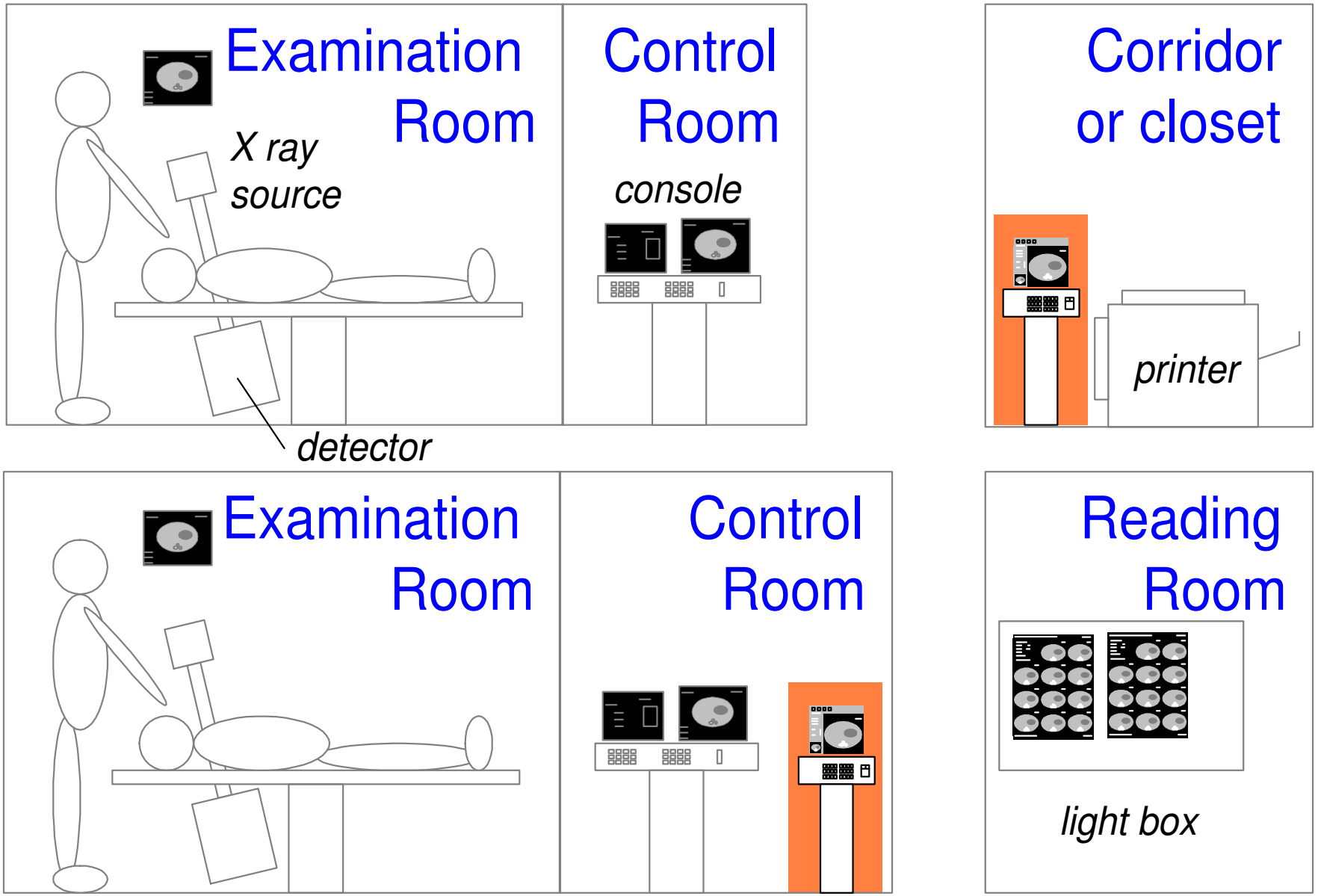




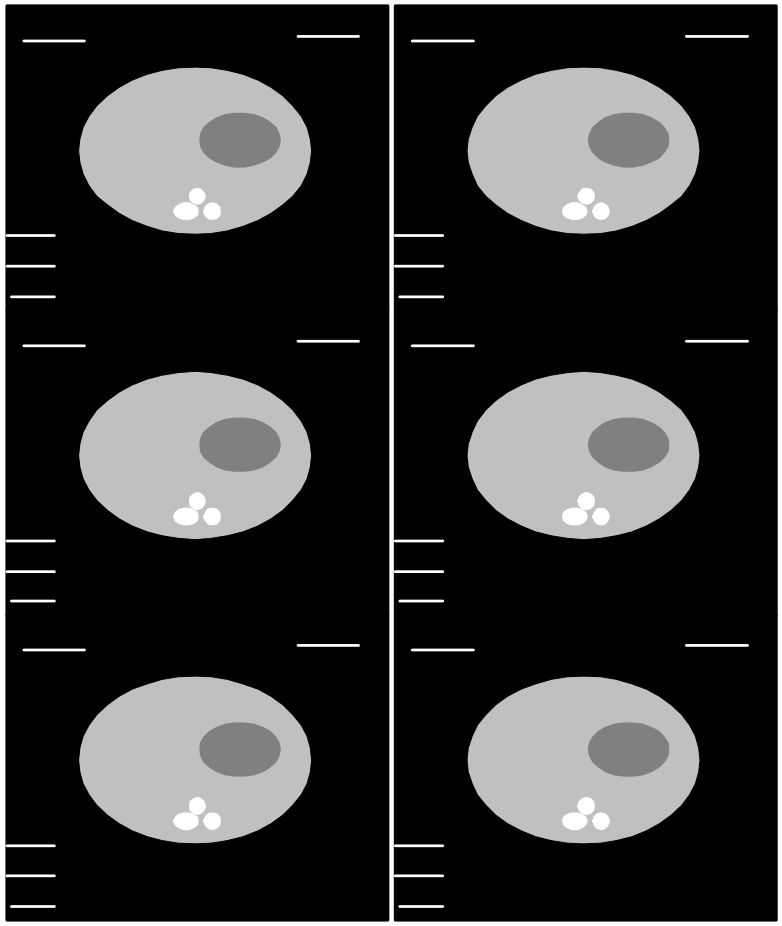




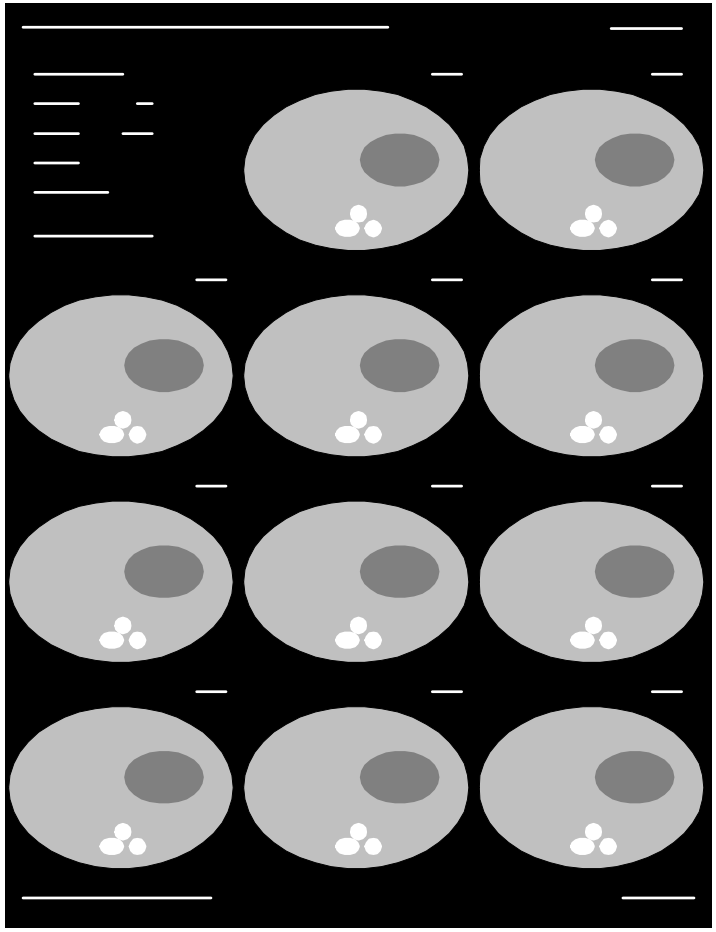
X-ray rooms with Easyvision applied as printserver



Comparison screen copy versus optimized film



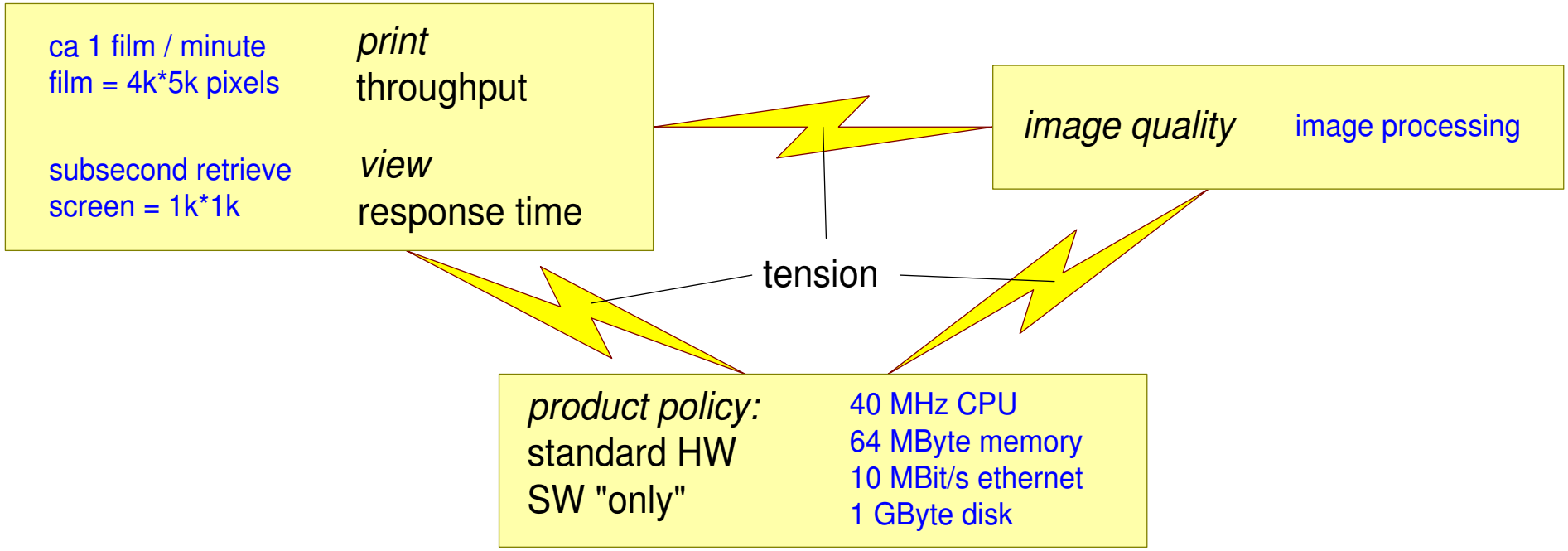
old: screen copy



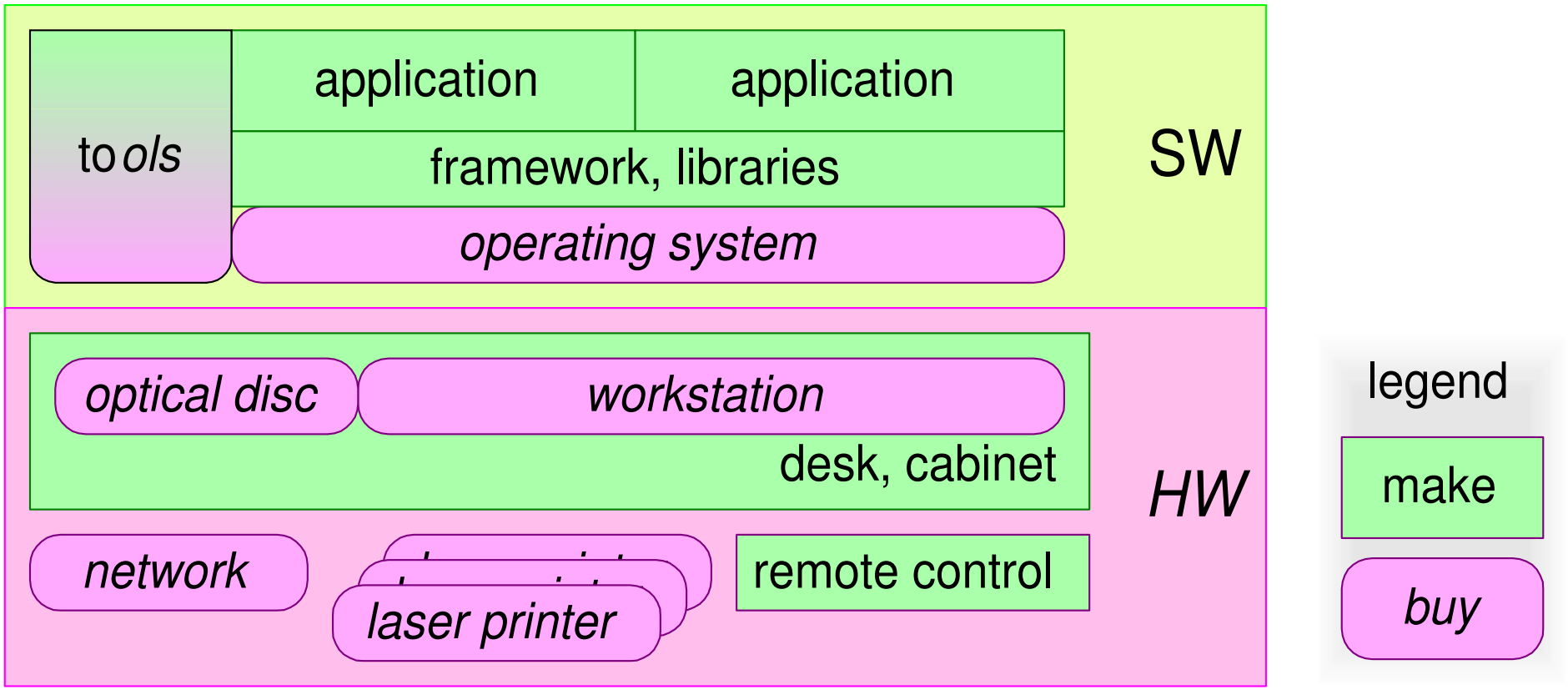
new: SW formatting

20 to 50% less film needed

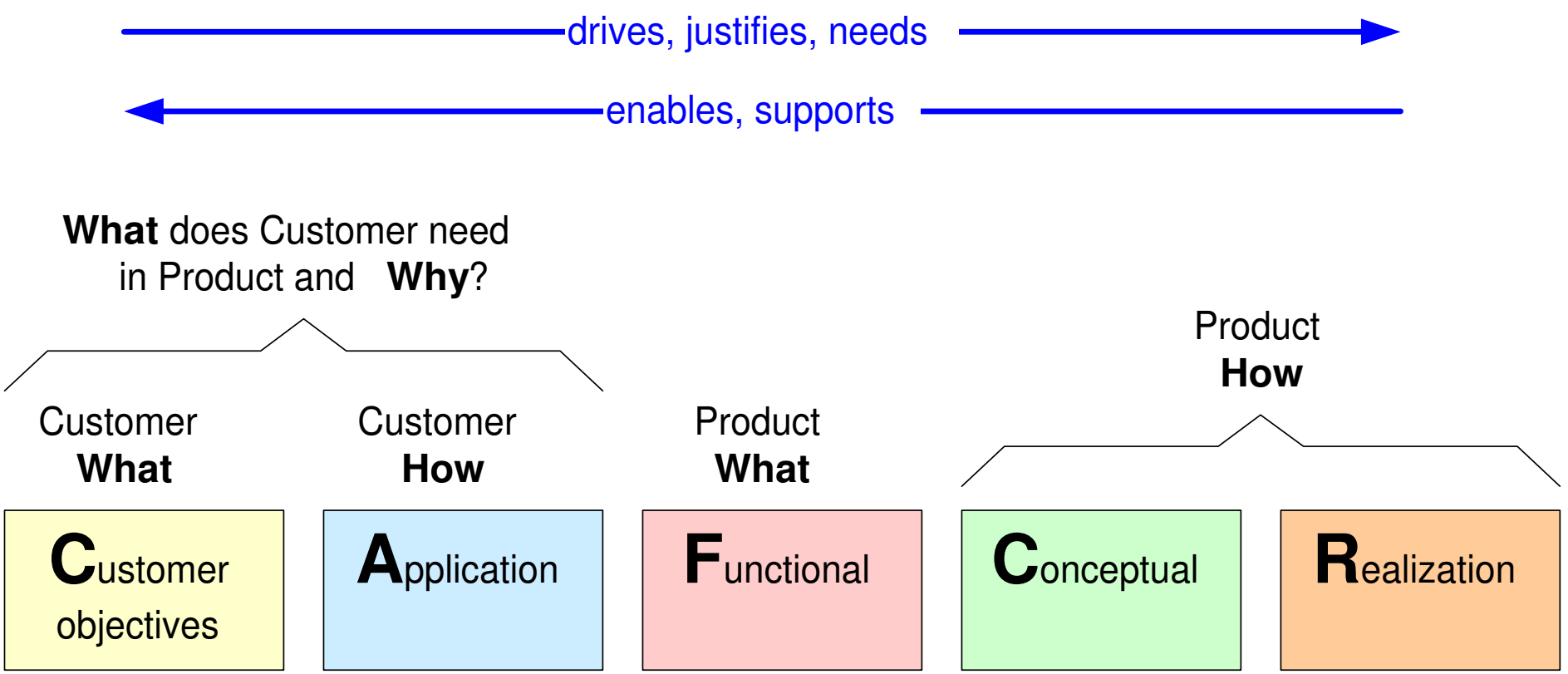
Challenges for product creation



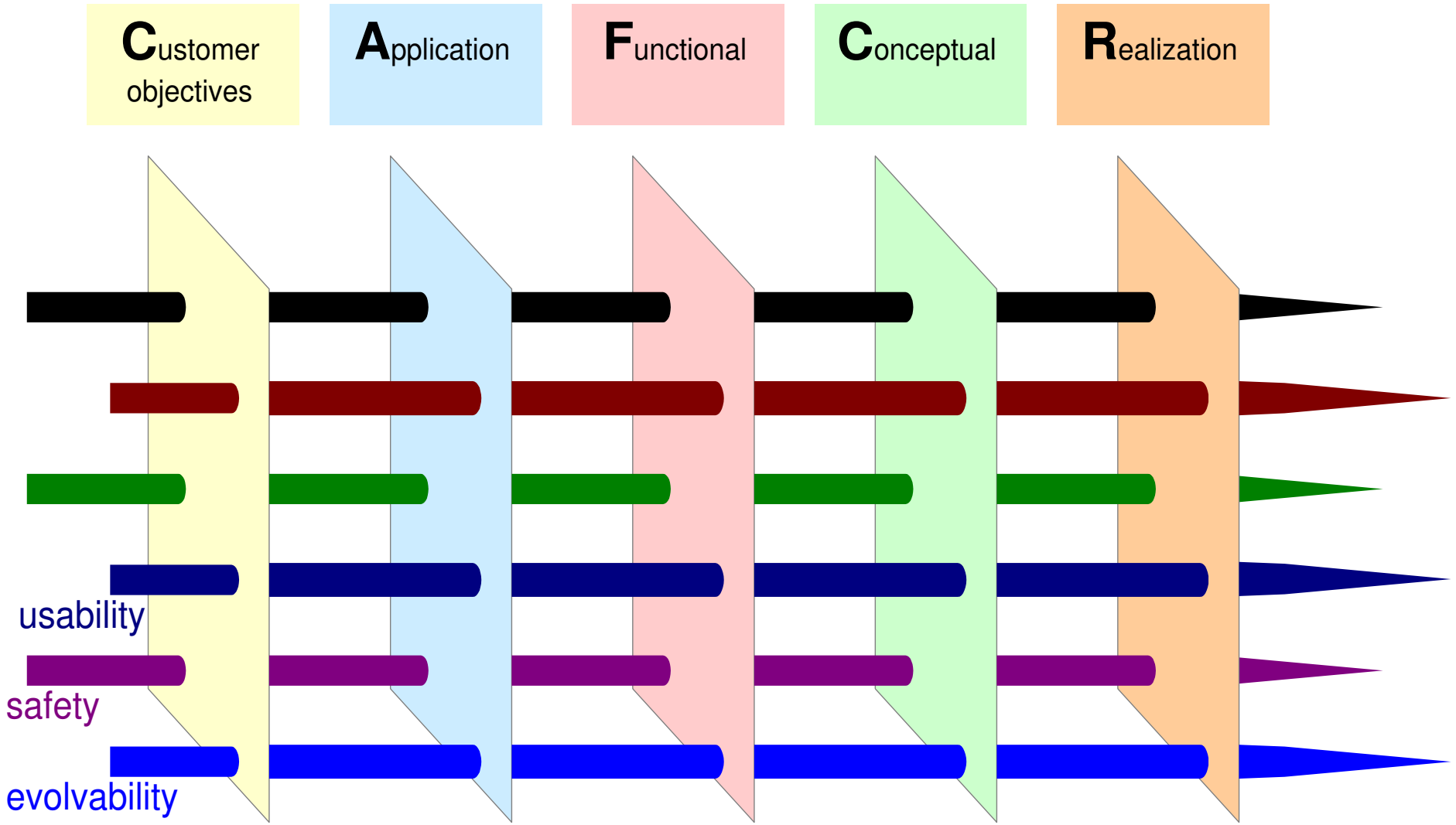
Top level decomposition



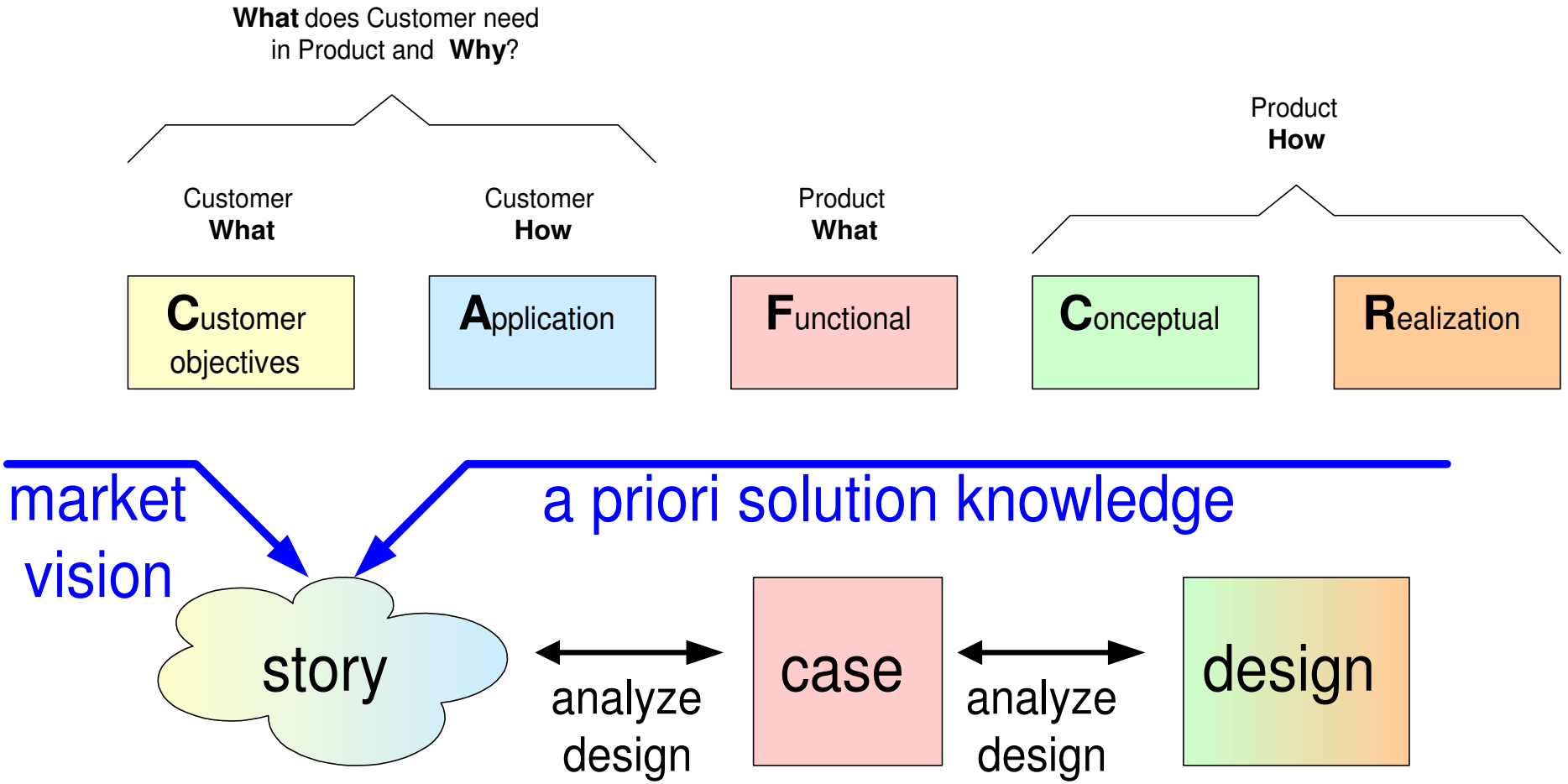
CAFCR viewpoints



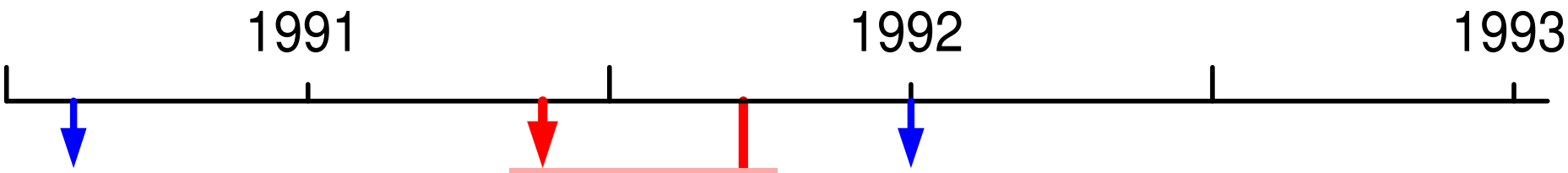
Quality needles as generic integrating concepts



From story to design



Chronology of Easyvision RF R1 development



basic application
toolboxes
100 kloc

interactive viewing

performance
problems

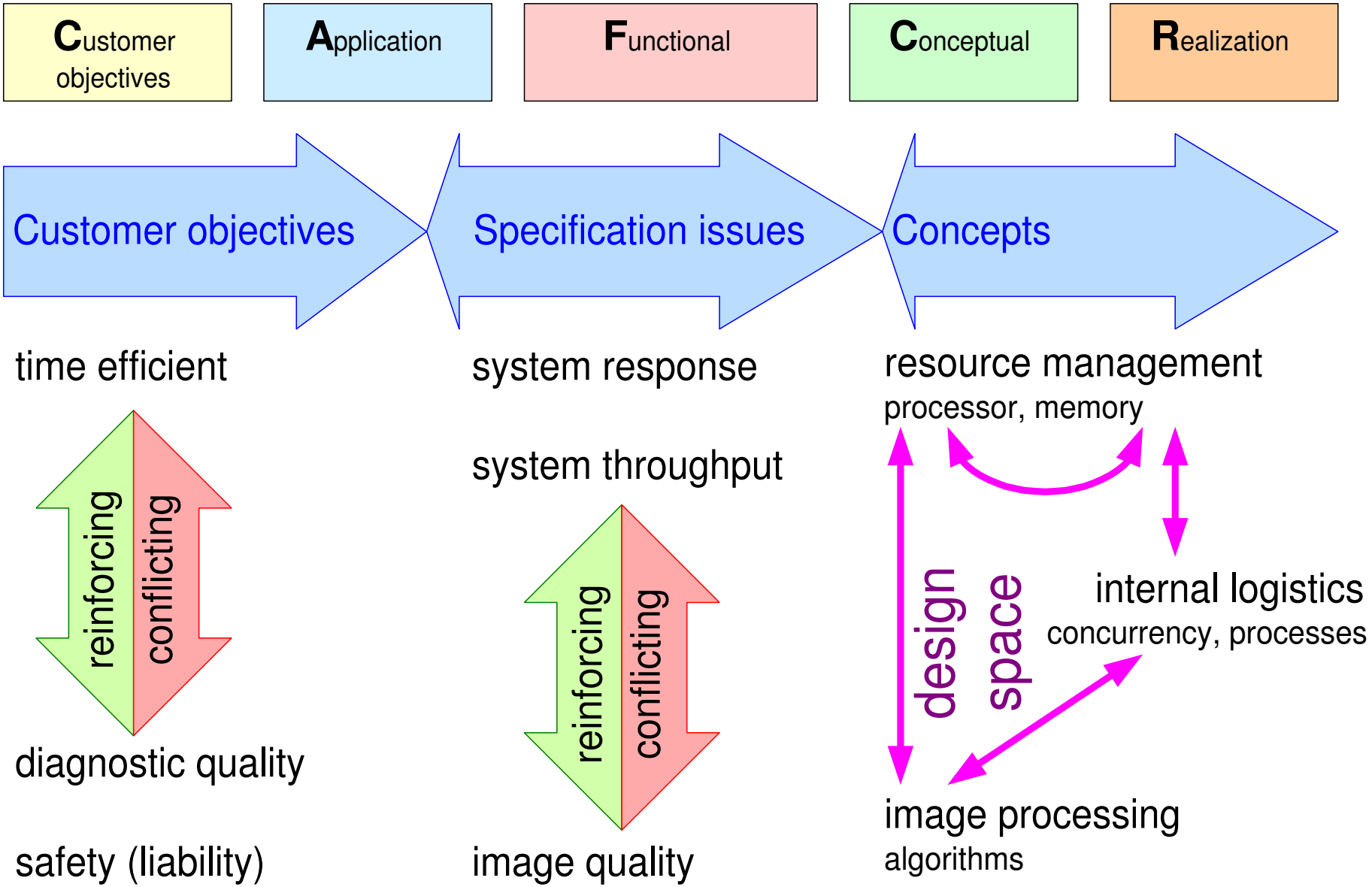
IQ
problems

Easyvision RF
integrated product
360 kloc

print server +
communication +
interactive viewing

marketing opinion:
"All the functionality is available,
we only have to provide a clinical UI"

Thread of reasoning based on efficiency-quality tension



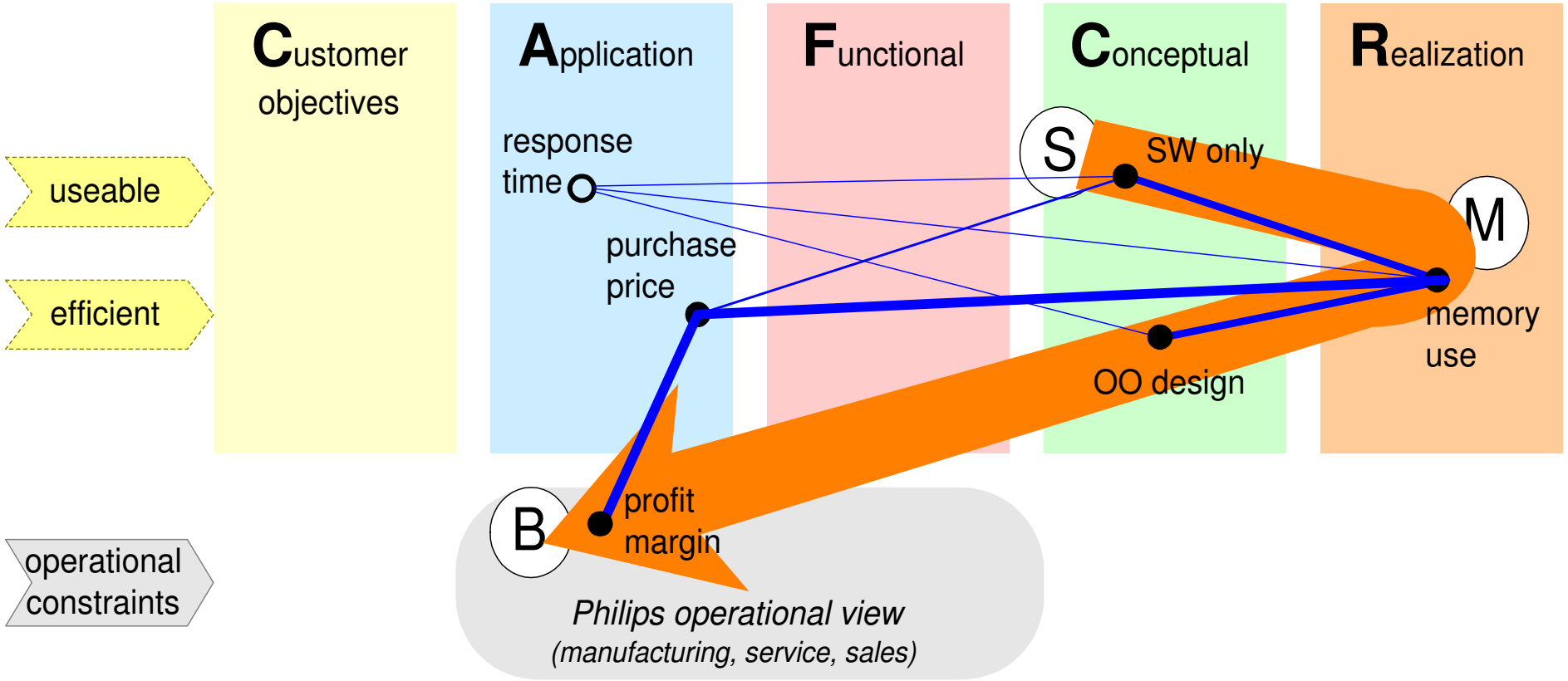
Technology innovations

performance

cost

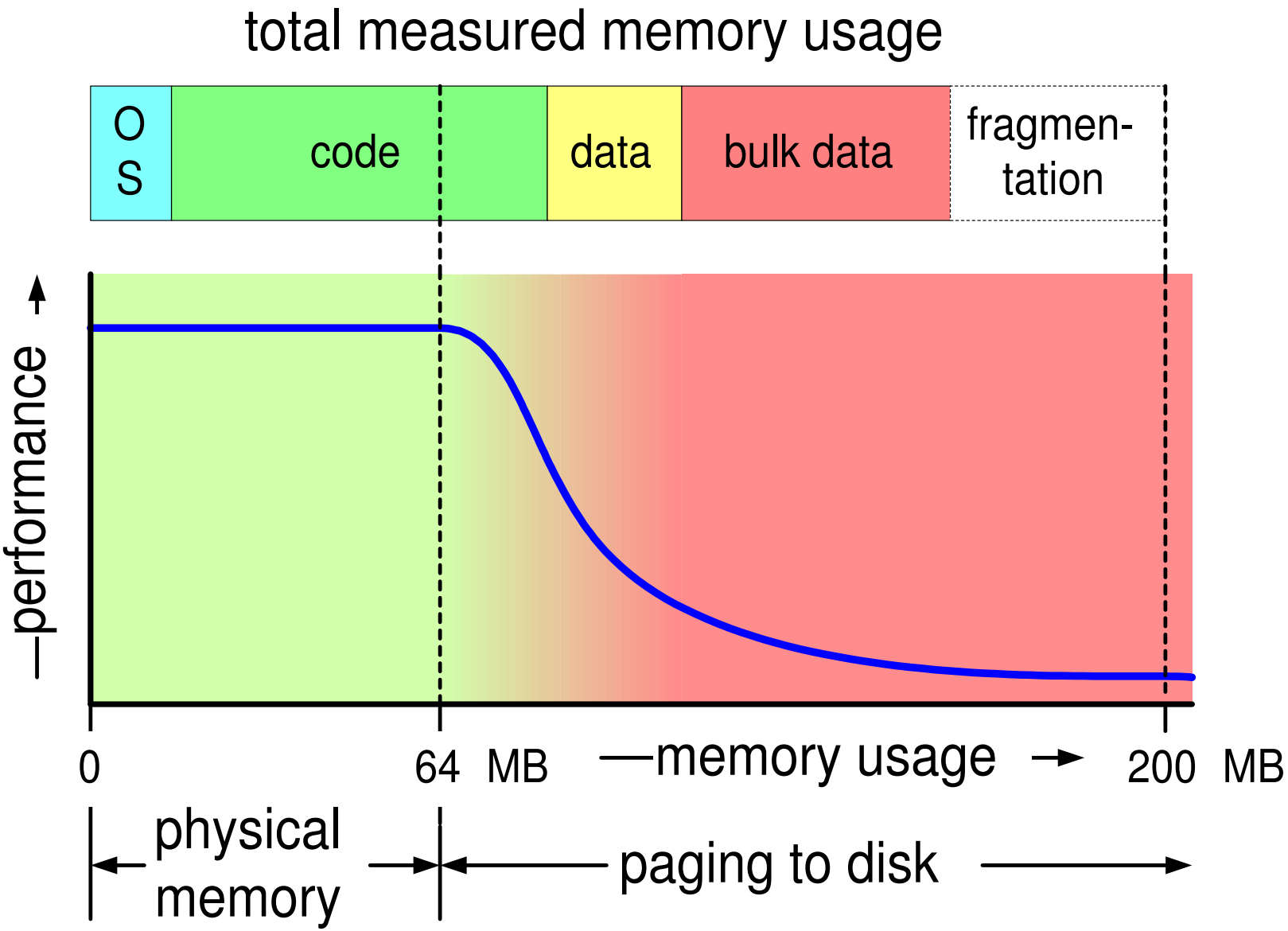
- standard UNIX based workstation
- full SW implementation, more flexible
- object oriented design and implementation (Objective-C)
- graphical User Interface, with windows, mouse etcetera
- call back scheduling, fine-grained notification
- data base engine, fast, reliable and robust
- extensive set of toolboxes
- property based configuration
- multiple coordinate spaces

Thread of reasoning; introvert phase

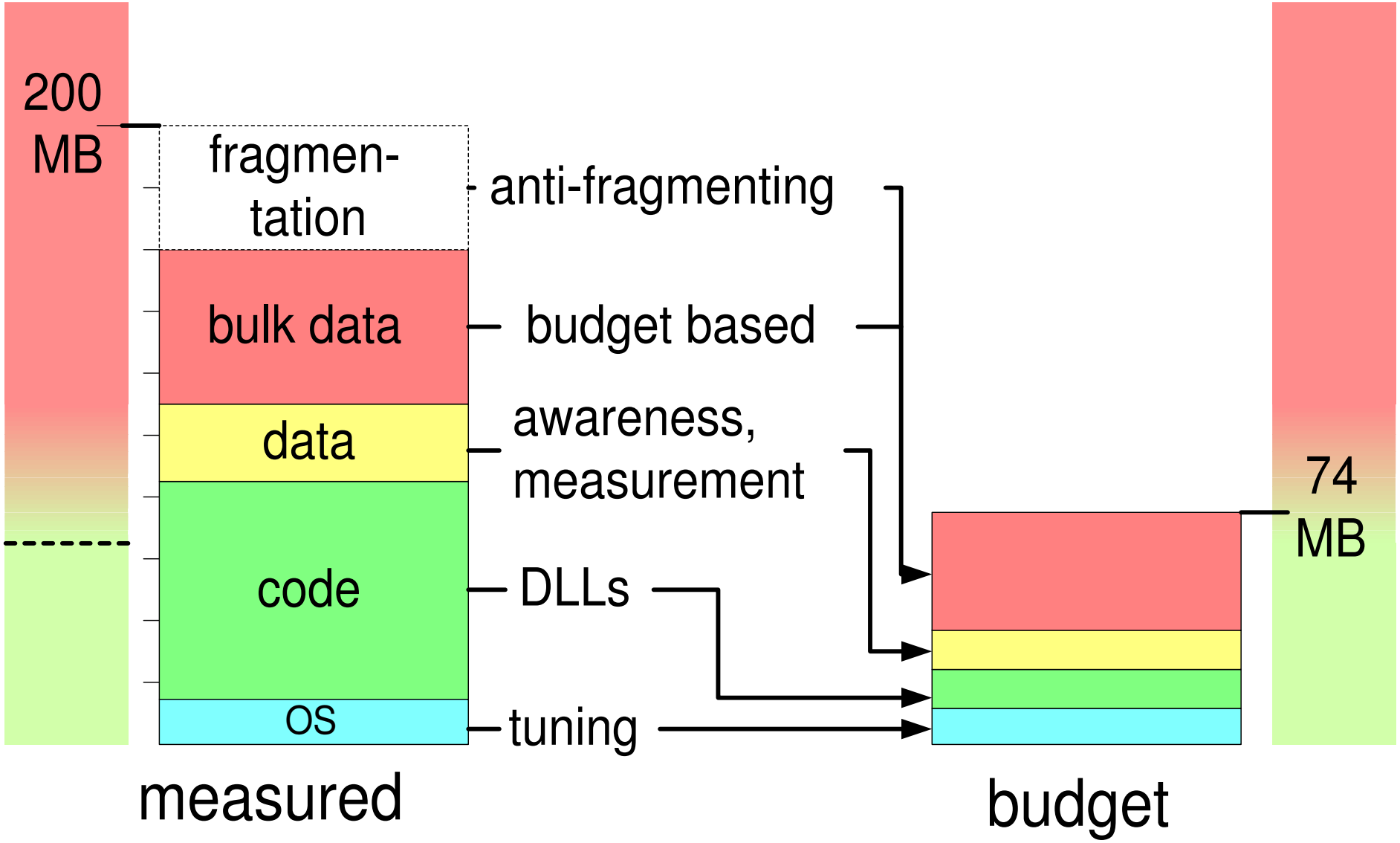


Introvert view: cost and impact of new technologies

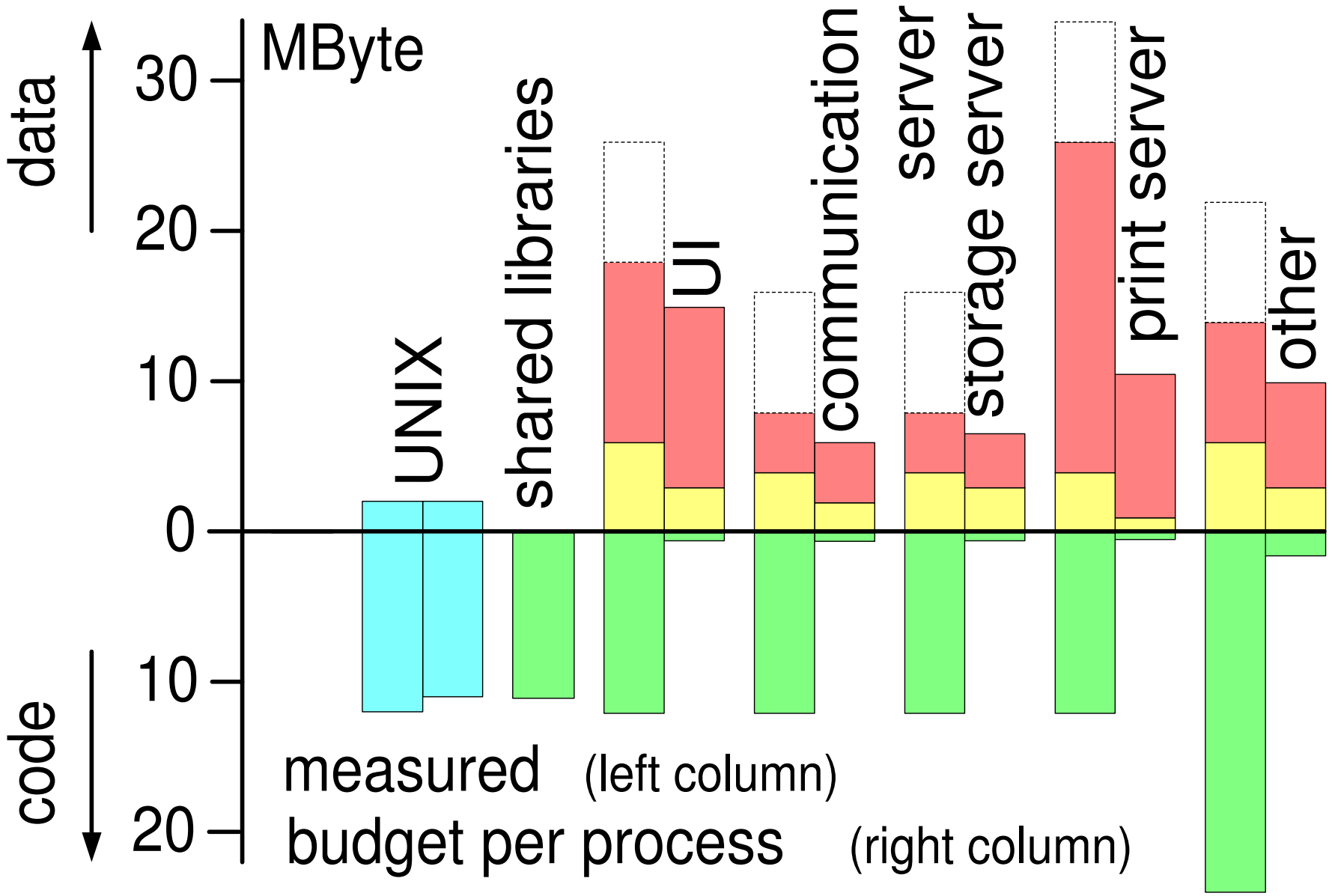
Memory usage half way R1



Solution of memory performance problem

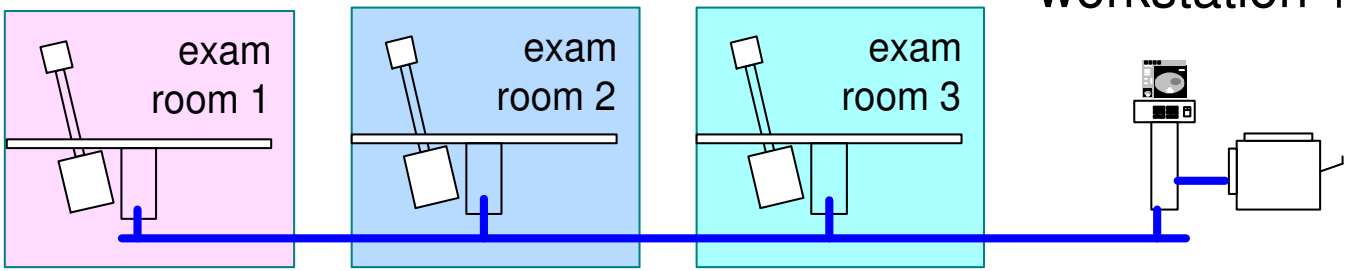


Visualization memory use per process



Typical case URF examination

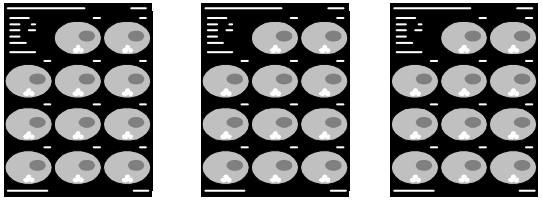
3 examination rooms connected to 1 medical imaging workstation + printer



examination room: average 4 interleaved examinations / hour

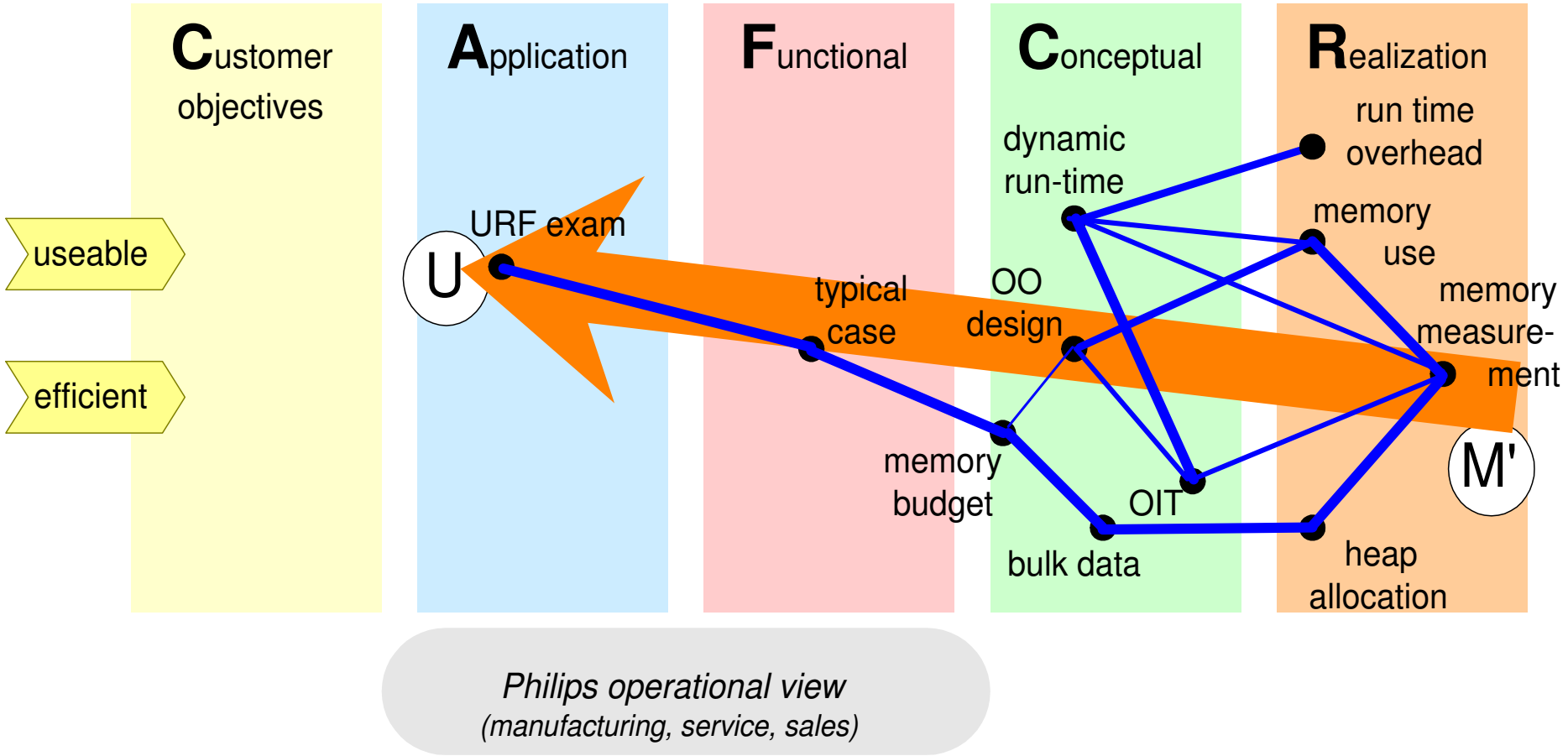
image production: 20 1024^2 8 bit images per examination

film production: 3 films of 4k*5k pixels each



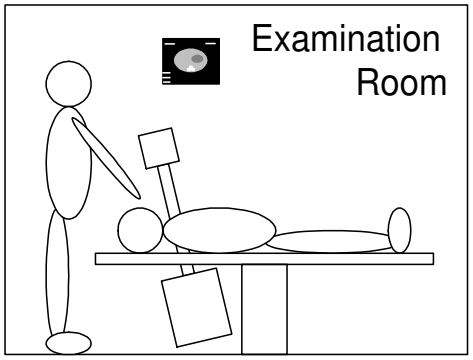
high quality output
(bi-cubic interpolation)

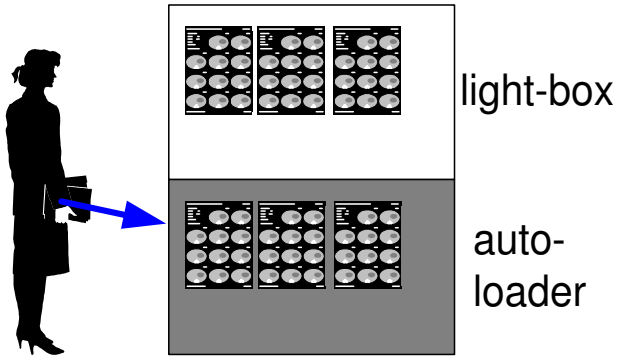
Thread of reasoning; phase 2

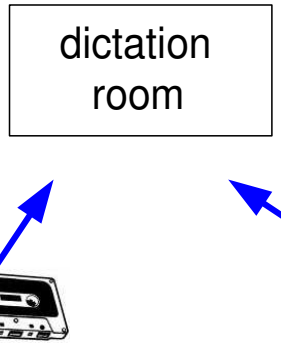


How to measure memory, how much is needed?
from introvert to extrovert

Radiologist workspots and activities







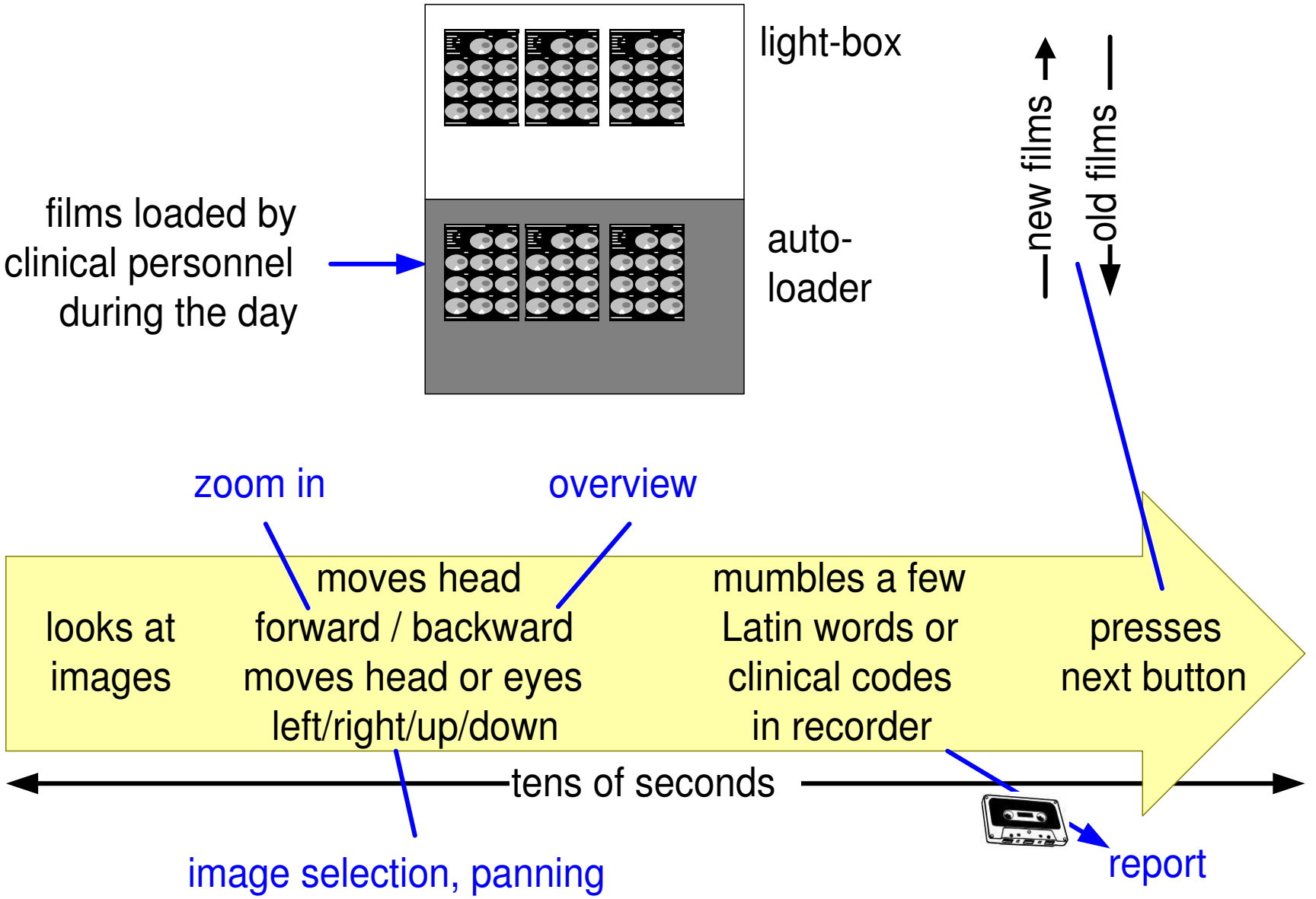
supervision of the examination

view and diagnose, dictate report

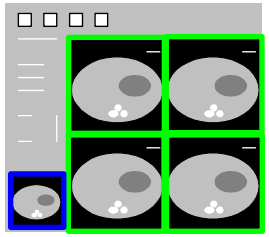
verify and authorise report

activities of the radiologist

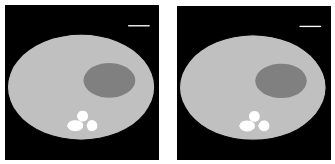
Diagnosis in tens of seconds



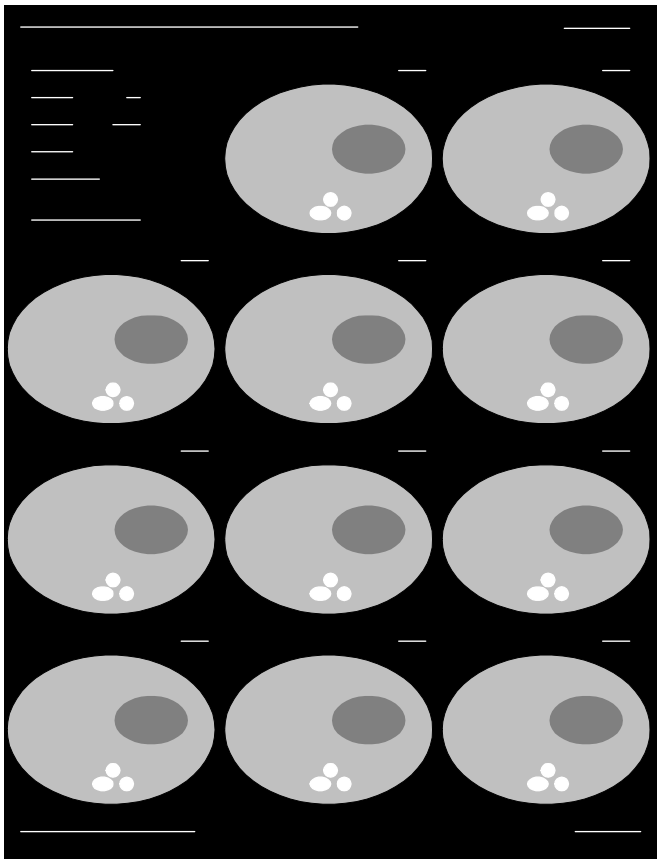
Rendered images at different destinations



Screen:
low resolution
fast response

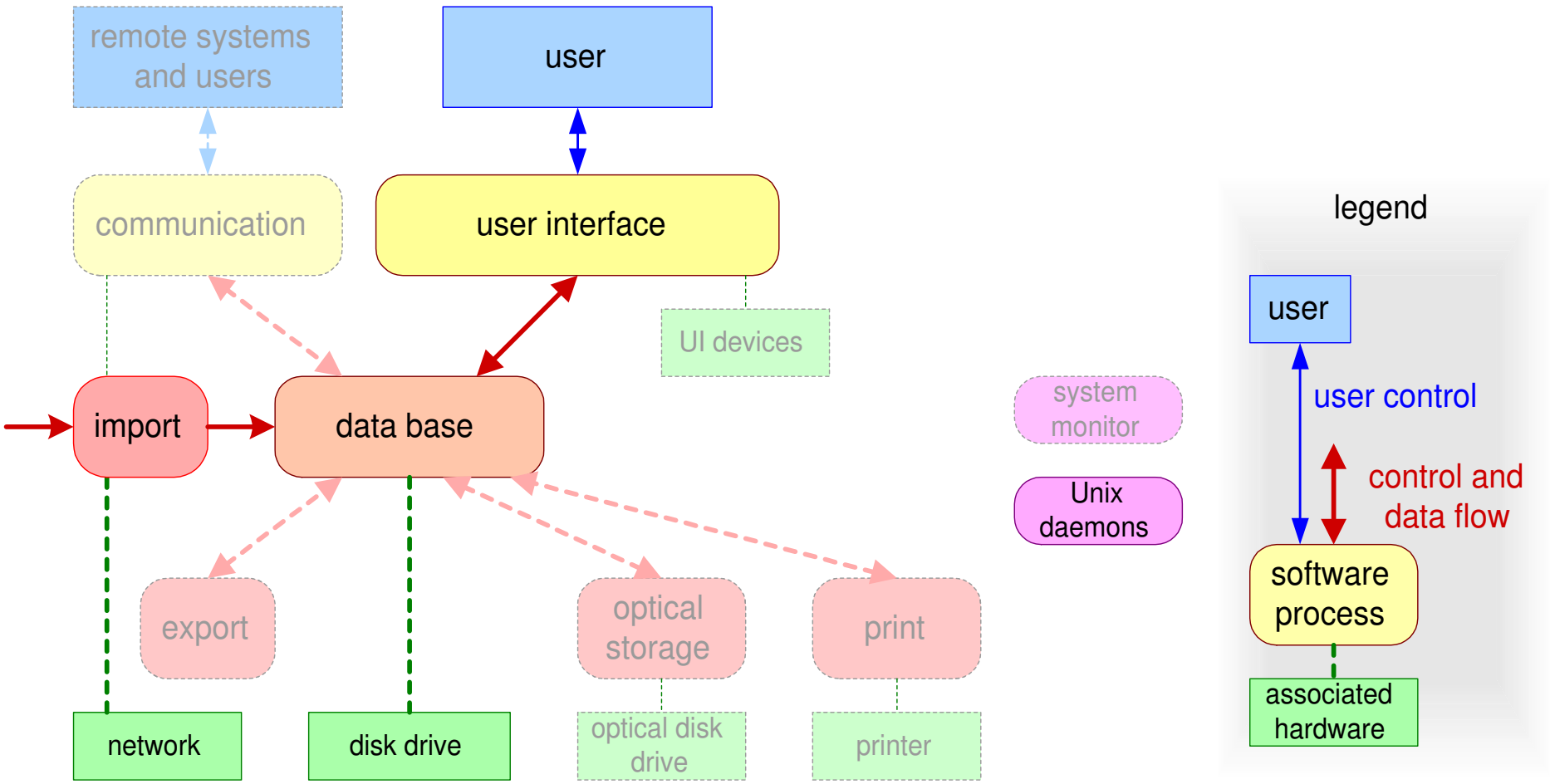


Network:
medium resolution
high throughput

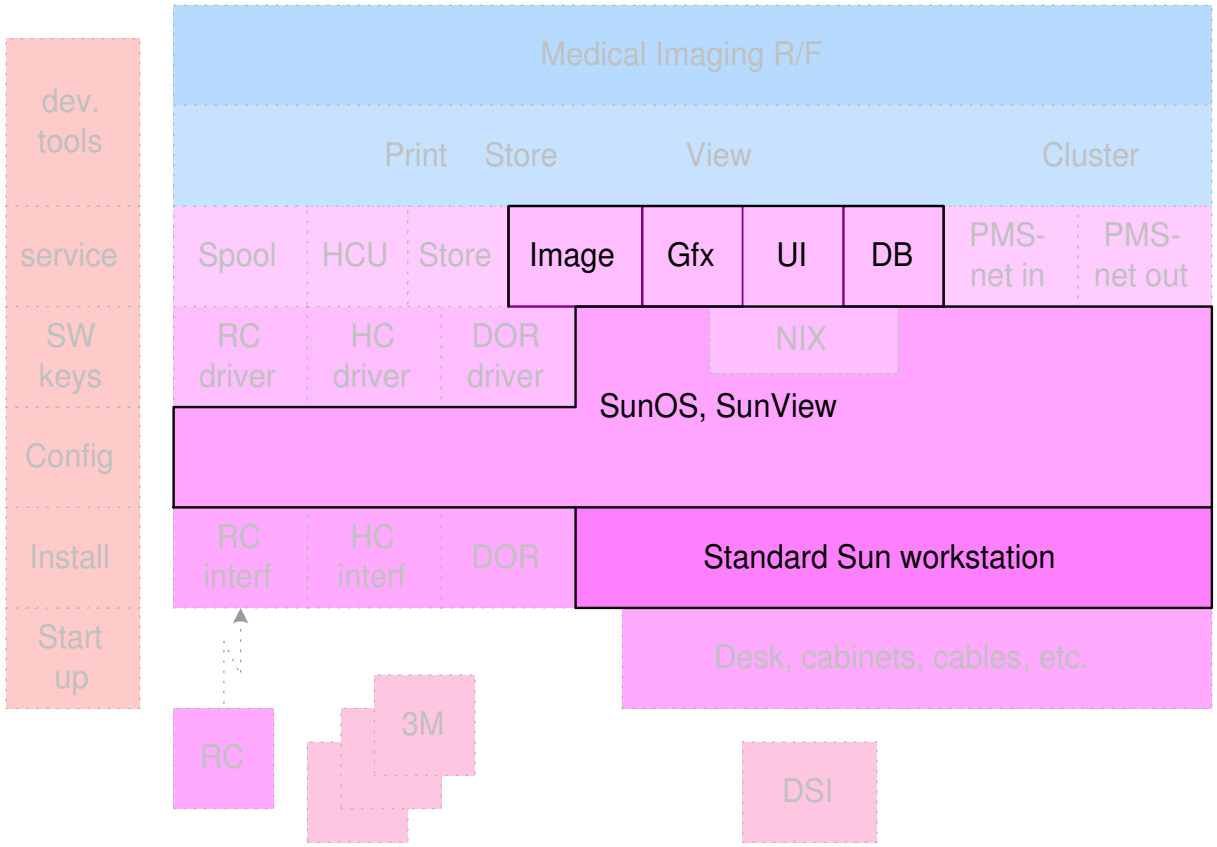


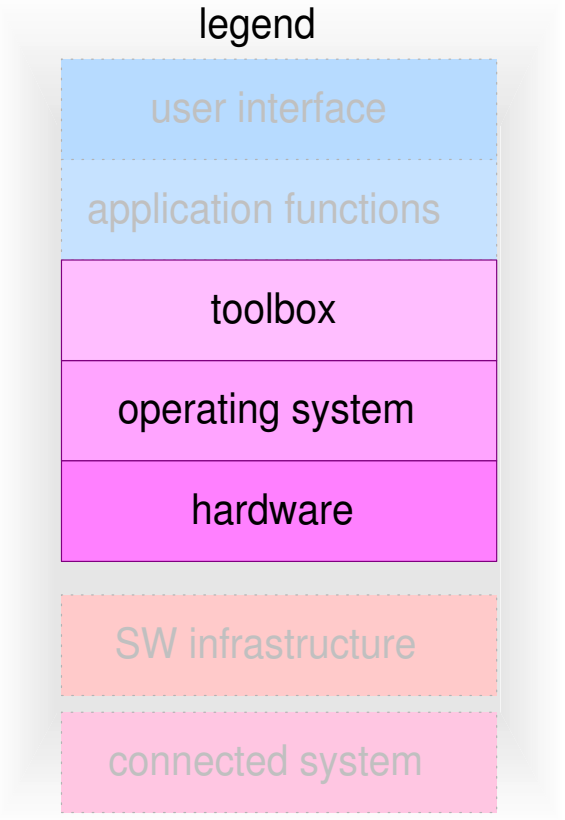
Film:
high resolution
high throughput

SW Process structure 1991

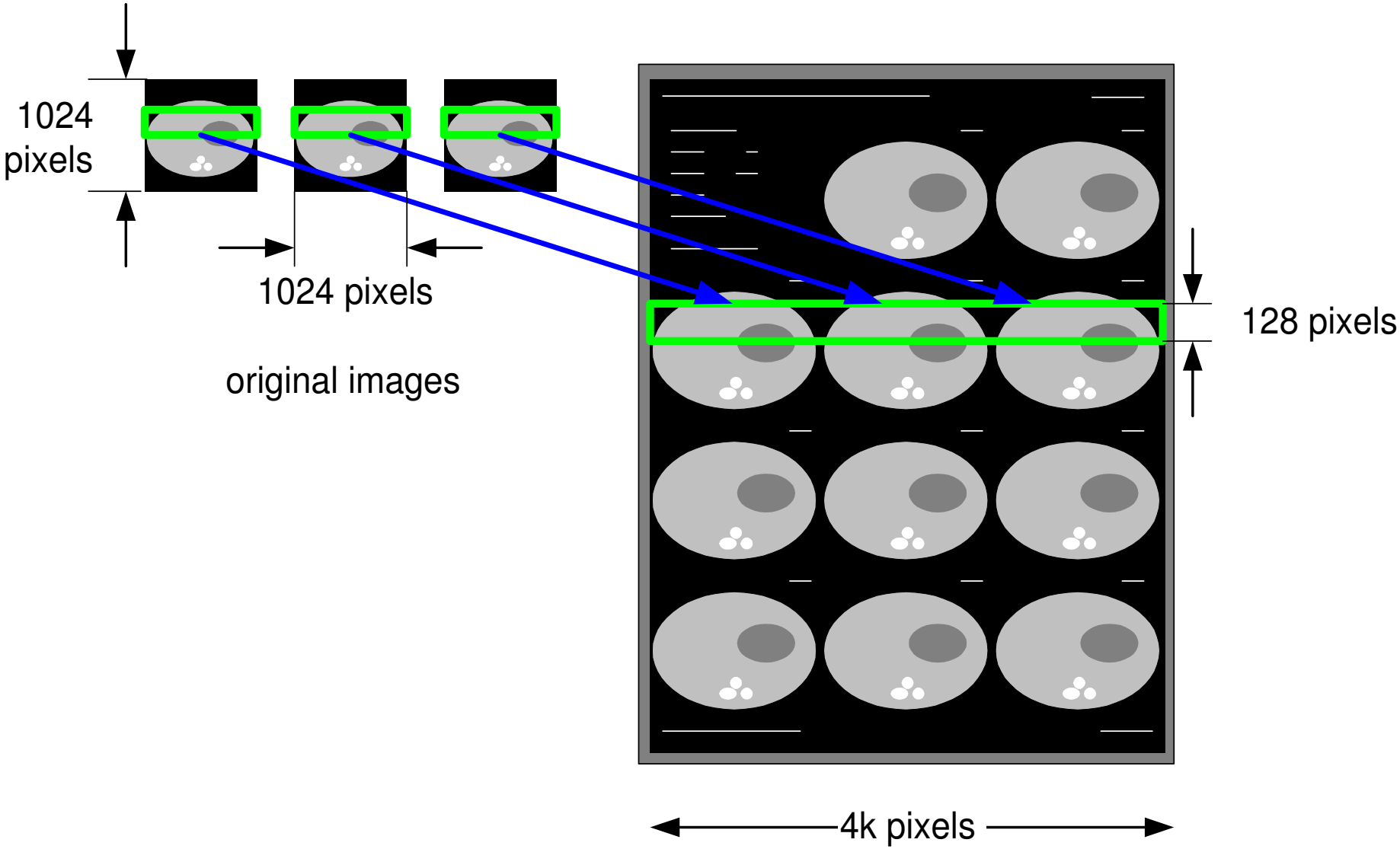


SW layers 1991

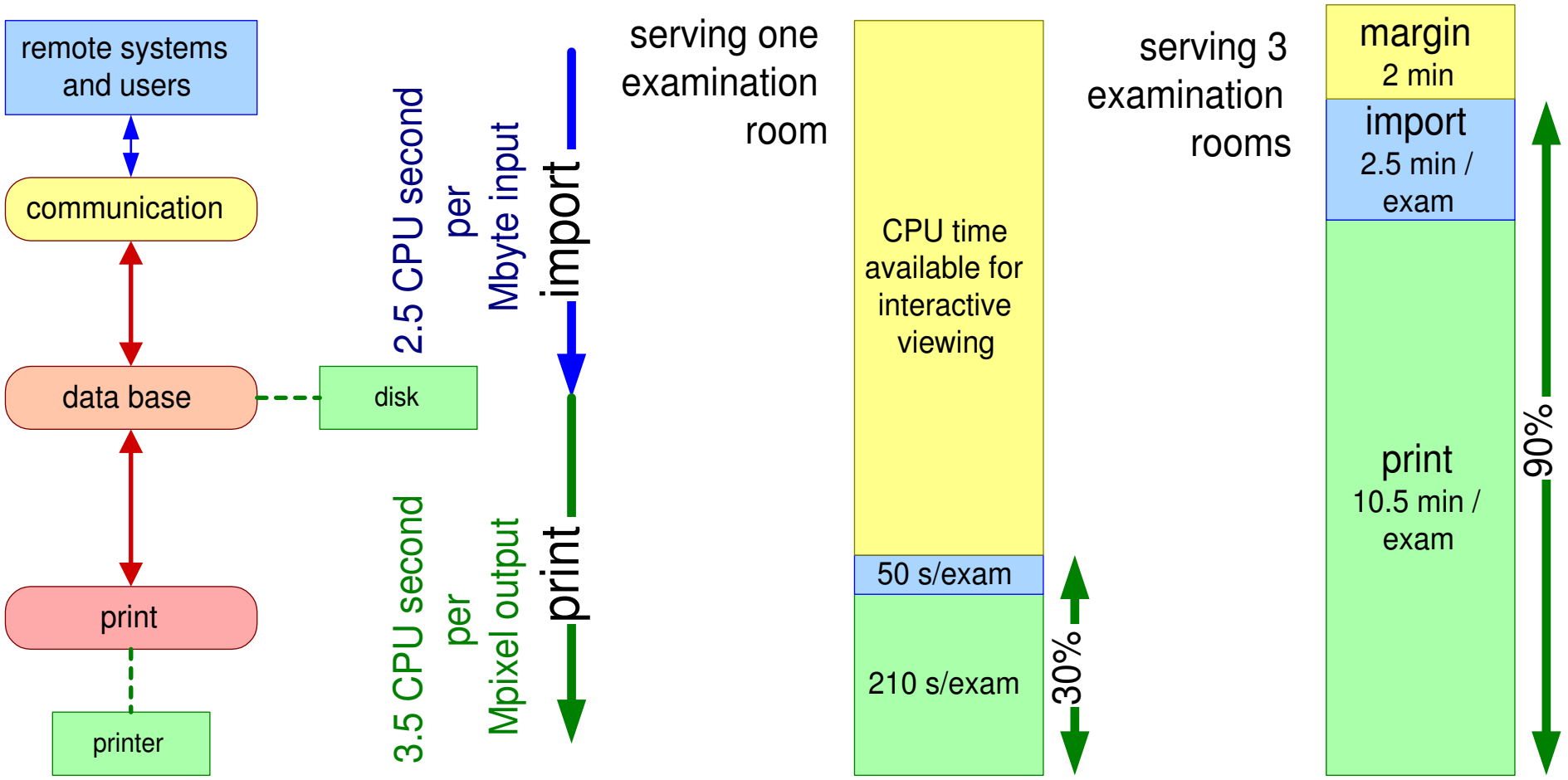




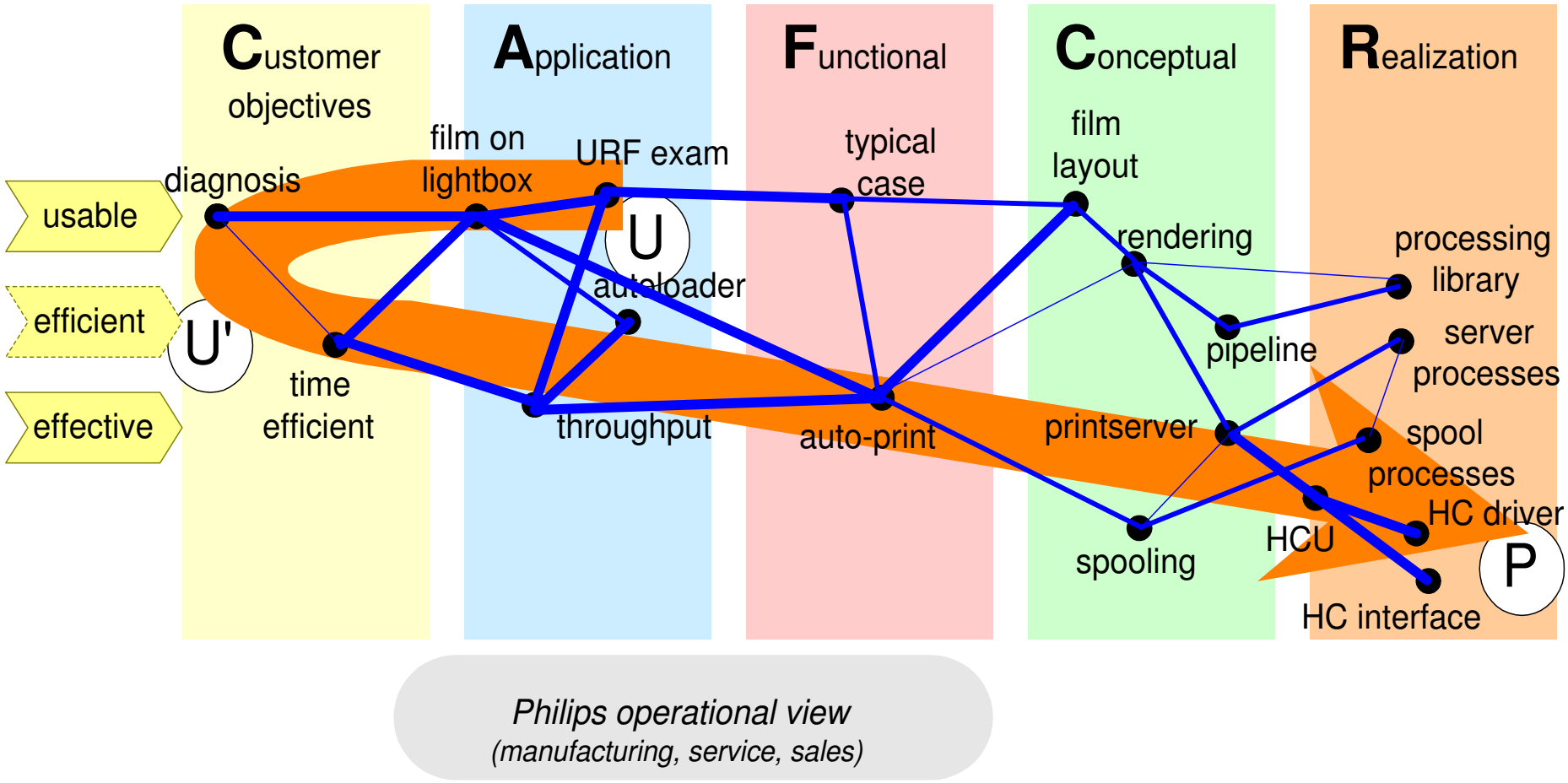
Print server is based on banding



Server CPU load

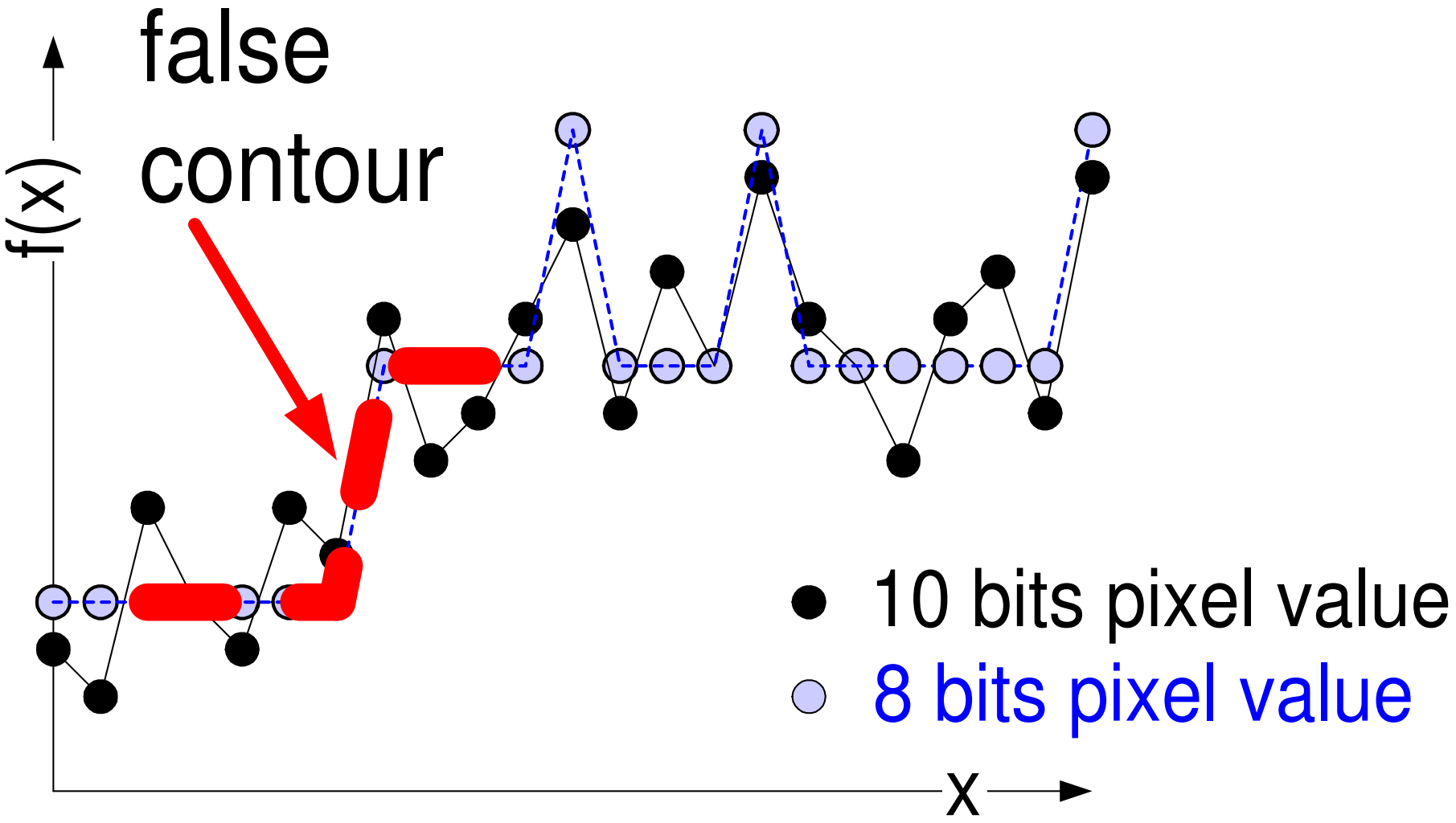


Thread of reasoning; phase 3



Radiologists diagnose from film, throughput is important
Extrovert view shows conceptual and realization gaps!

Image quality and safety problem



Presentation pipeline for X-ray images

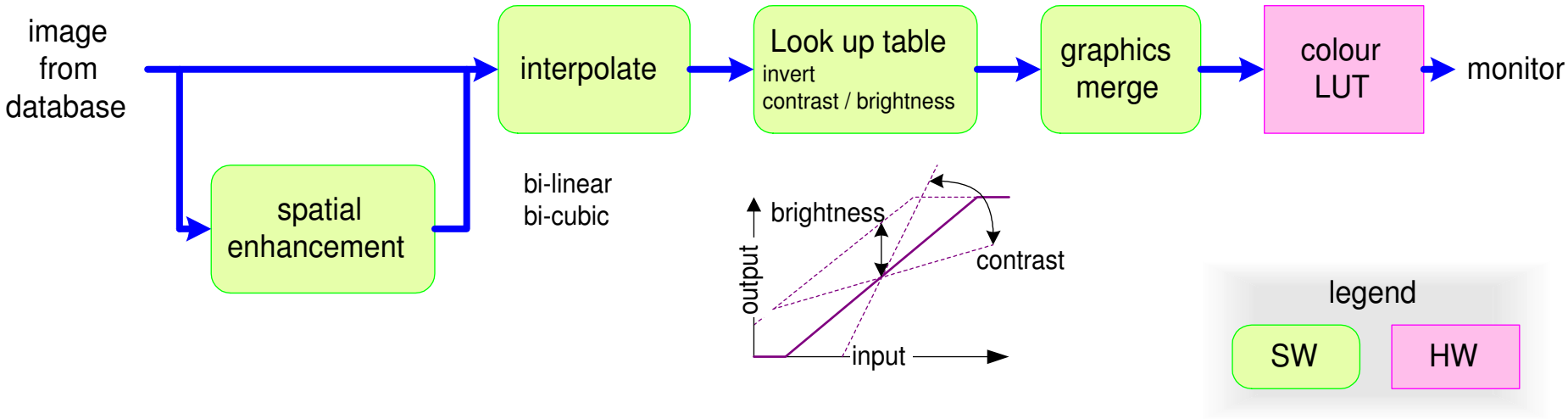
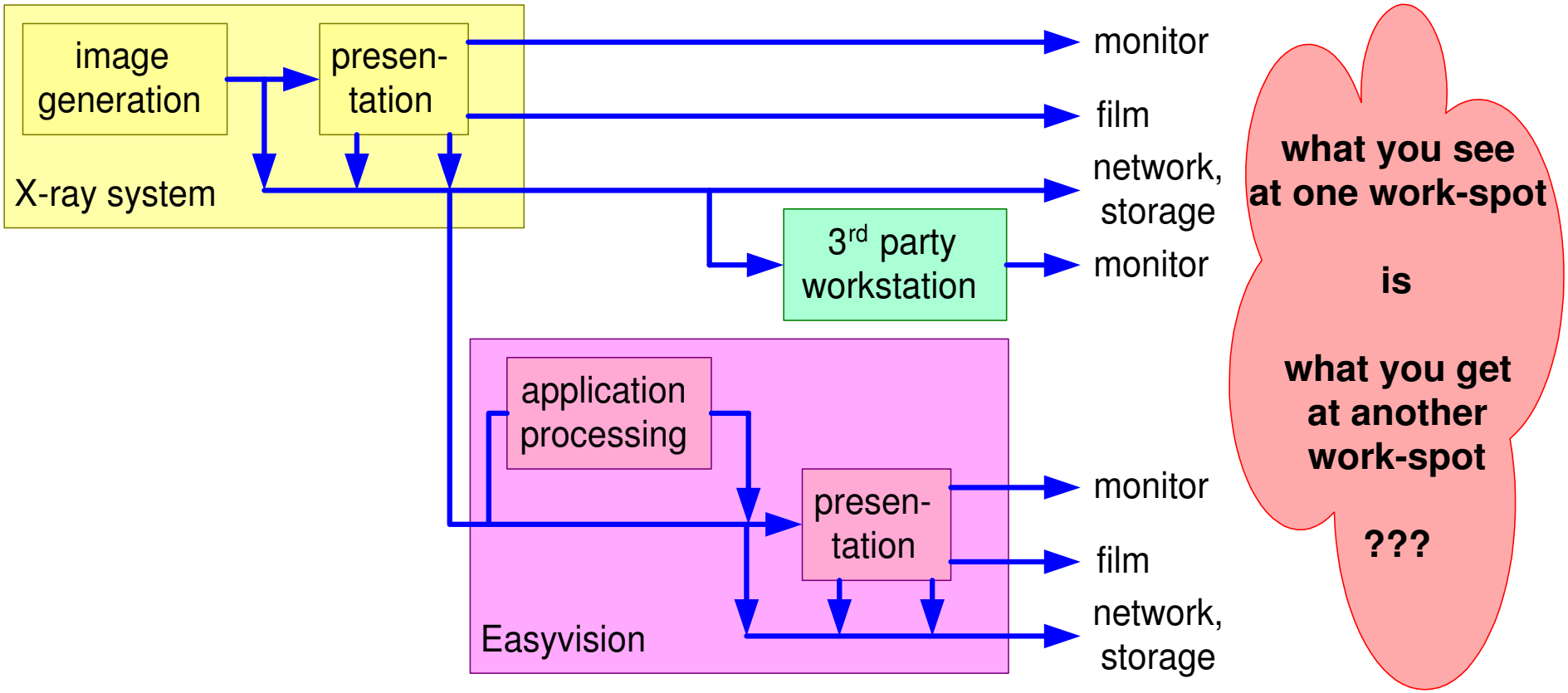
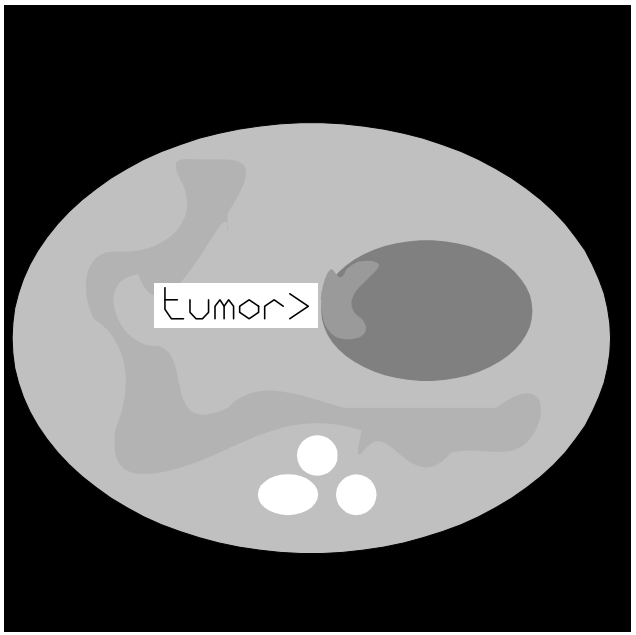


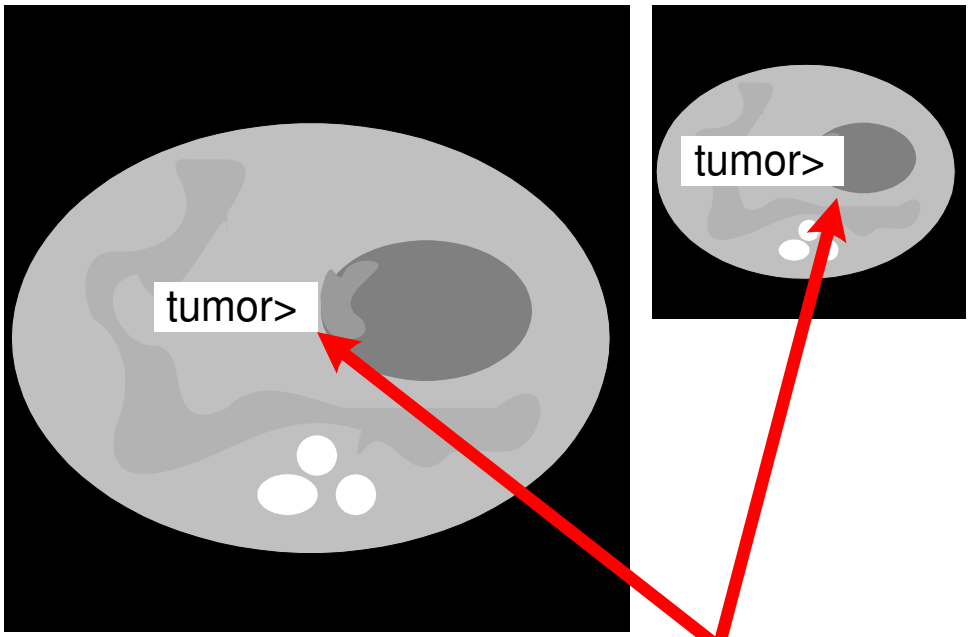
Image Quality expectation WYSIWYG



Safety problem



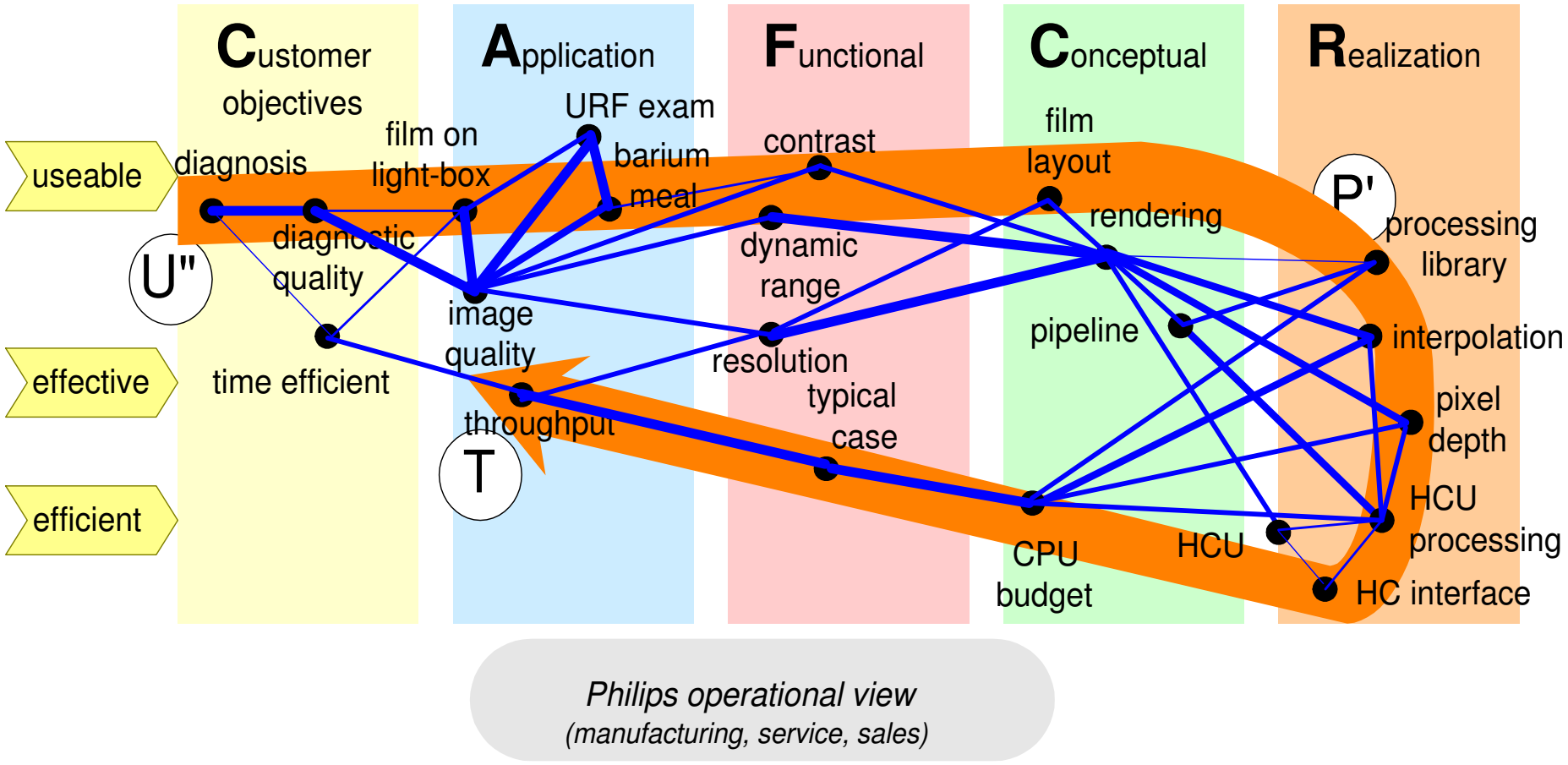
URF monitor output:
fixed size letters at fixed grid



for user readability the font-size was determined "intelligently"; causing a dangerous mismatch between text and image

EV output: scaleable fonts in graphics overlay

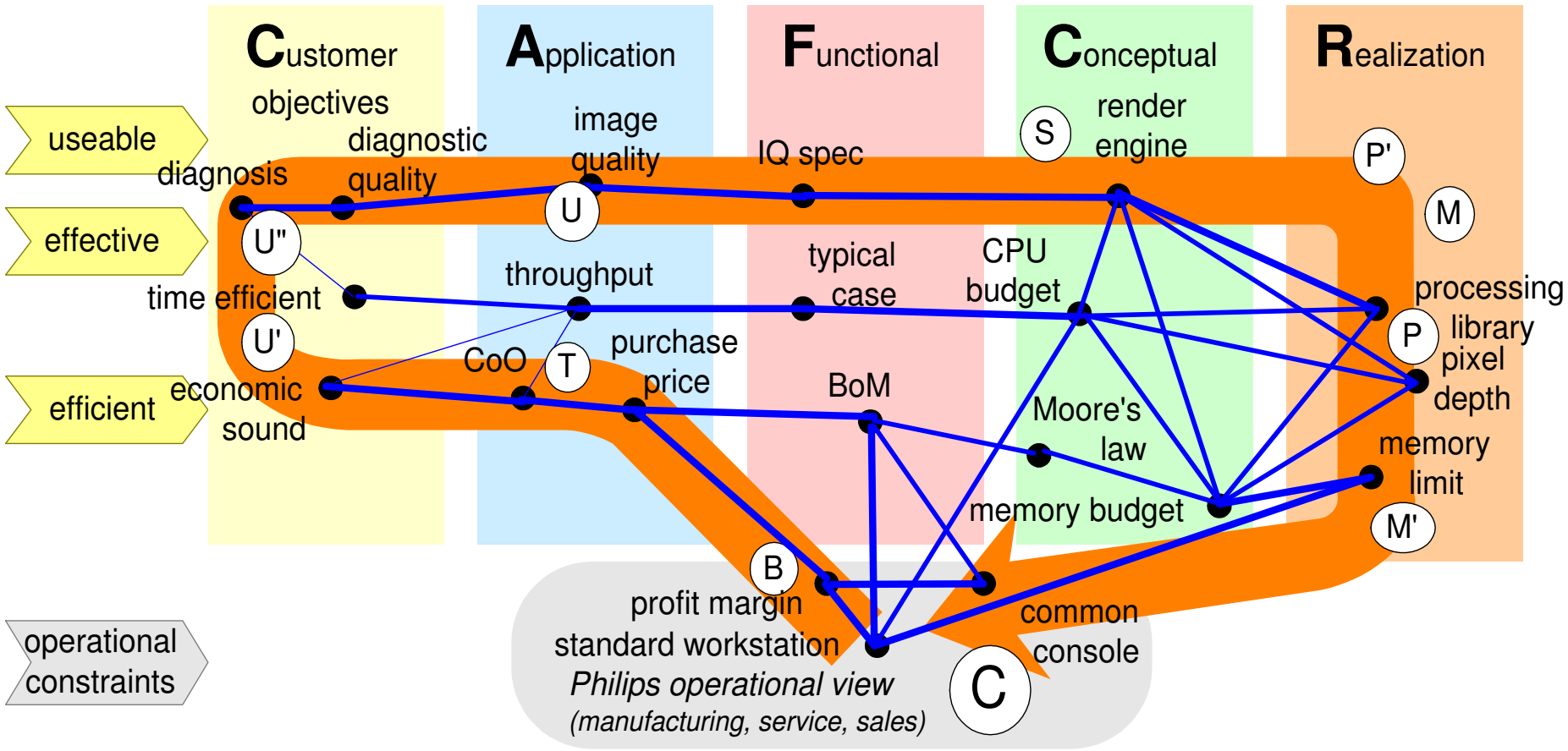
Thread of reasoning; phase 4



Philips operational view
(manufacturing, service, sales)

from extrovert diagnostic quality, via image quality, algorithms and load, to extrovert throughput

Thread of reasoning; phase 5



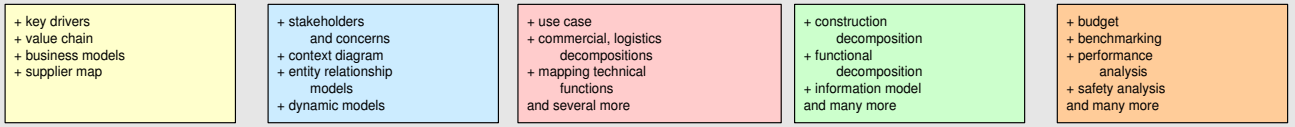
cost revisited in context of clinical needs and realization constraints; note: original threads are significantly simplified

Overview of architecting method

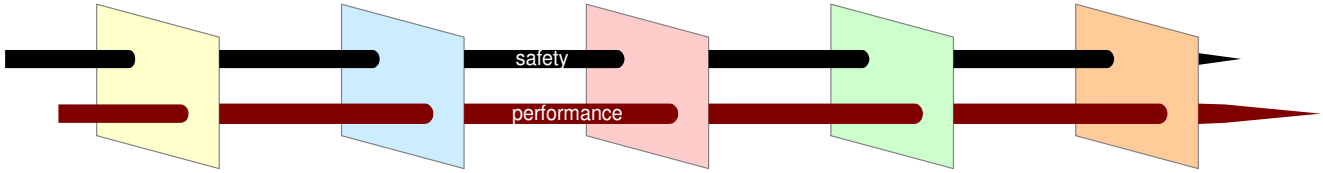
method outline *method visualization*

framework

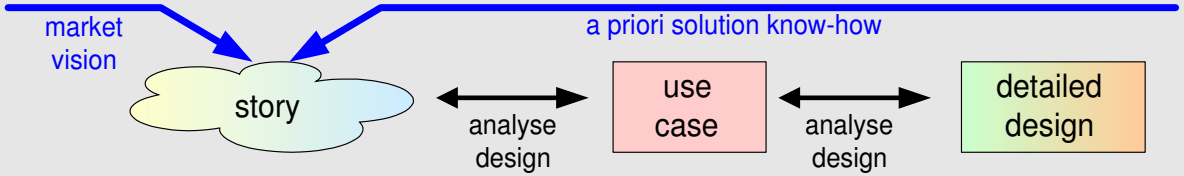
submethods



integration via qualities



explore specific details



reasoning