

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:

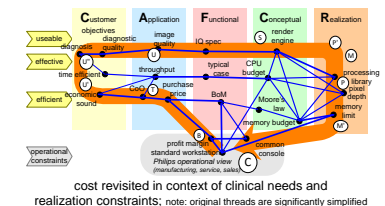
- the CAFCR viewpoints
- qualities as integrating needles
- story telling
- threads of reasoning

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

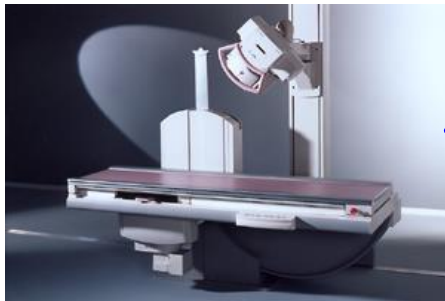
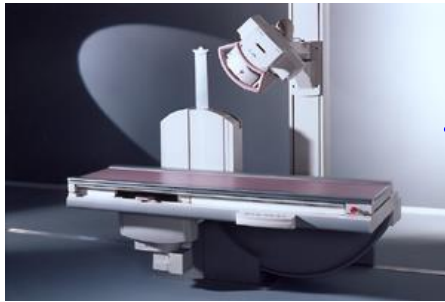
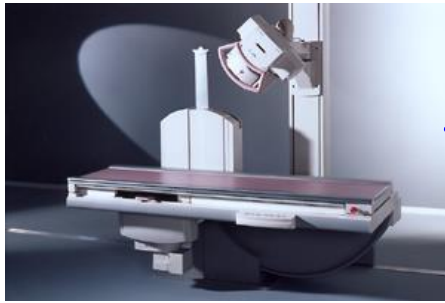
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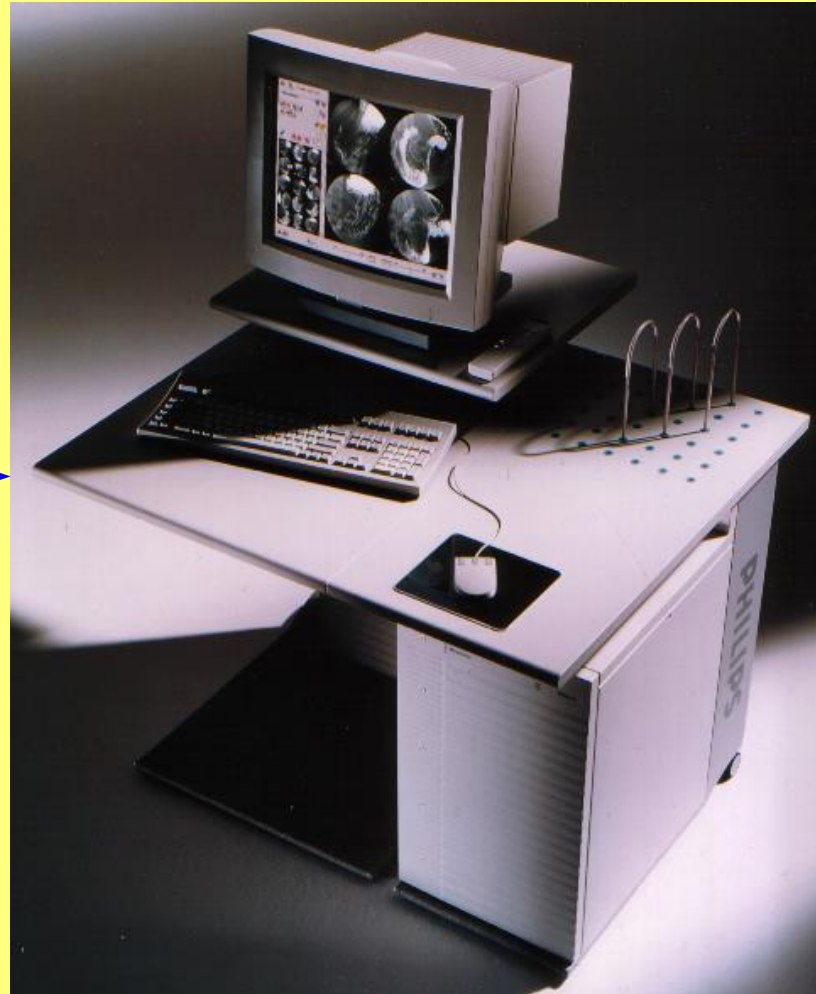
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status: preliminary
draft
version: 0



Easyvision serving three URF examination rooms



URF-systems

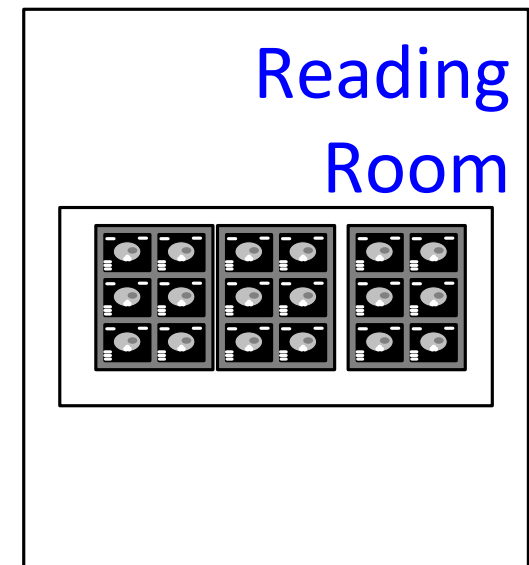
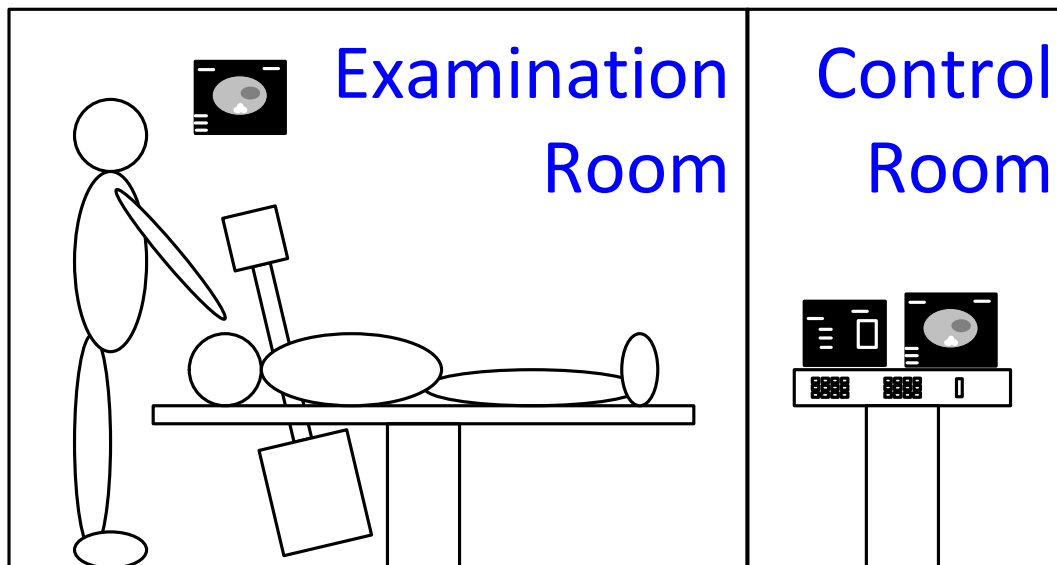
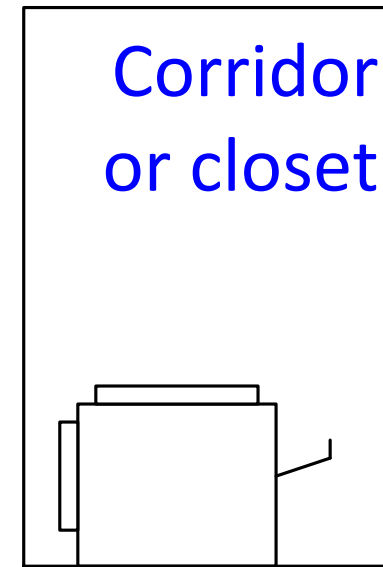
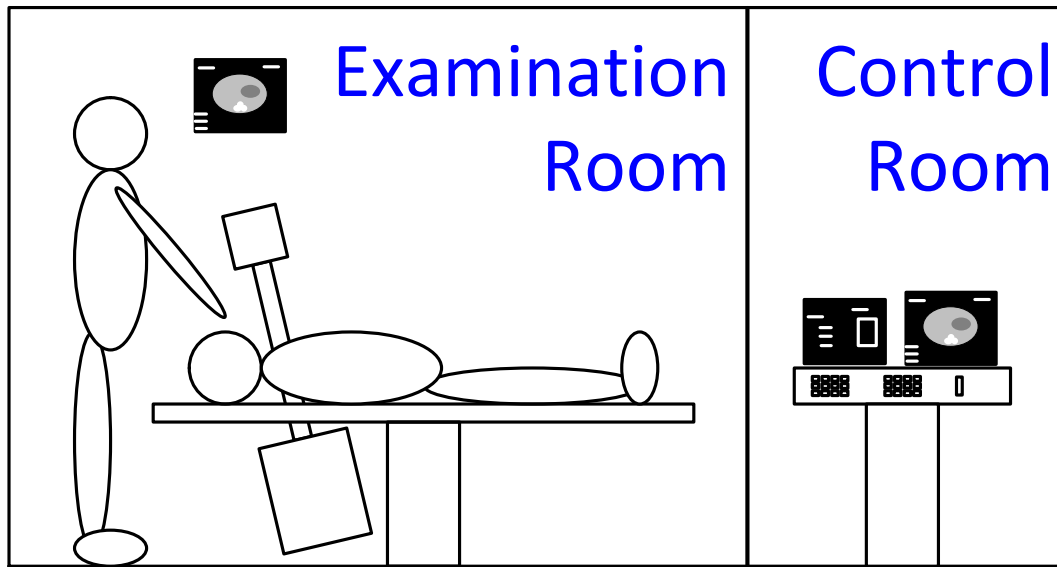


EasyVision: Medical Imaging Workstation

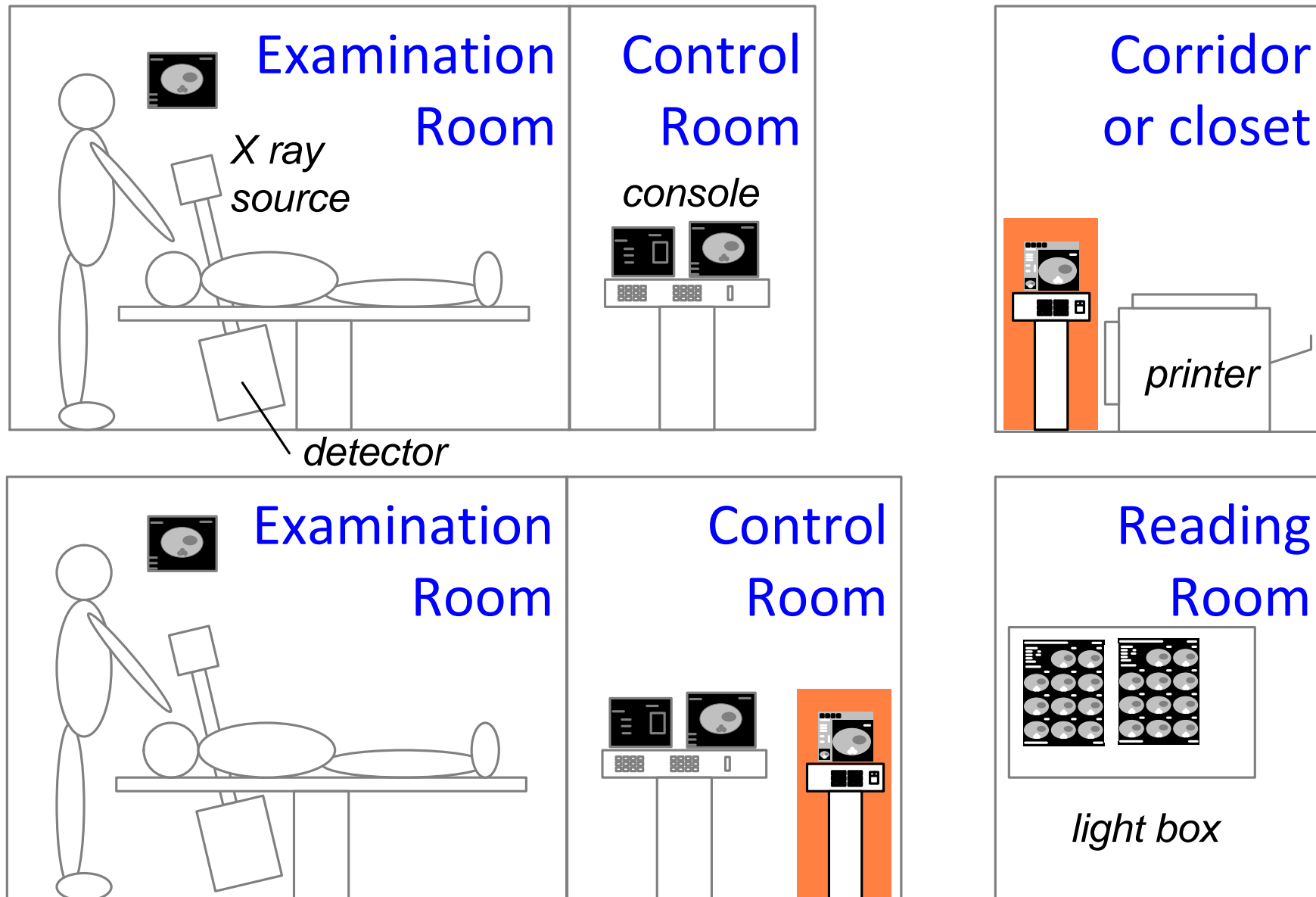


typical clinical
image (intestines)

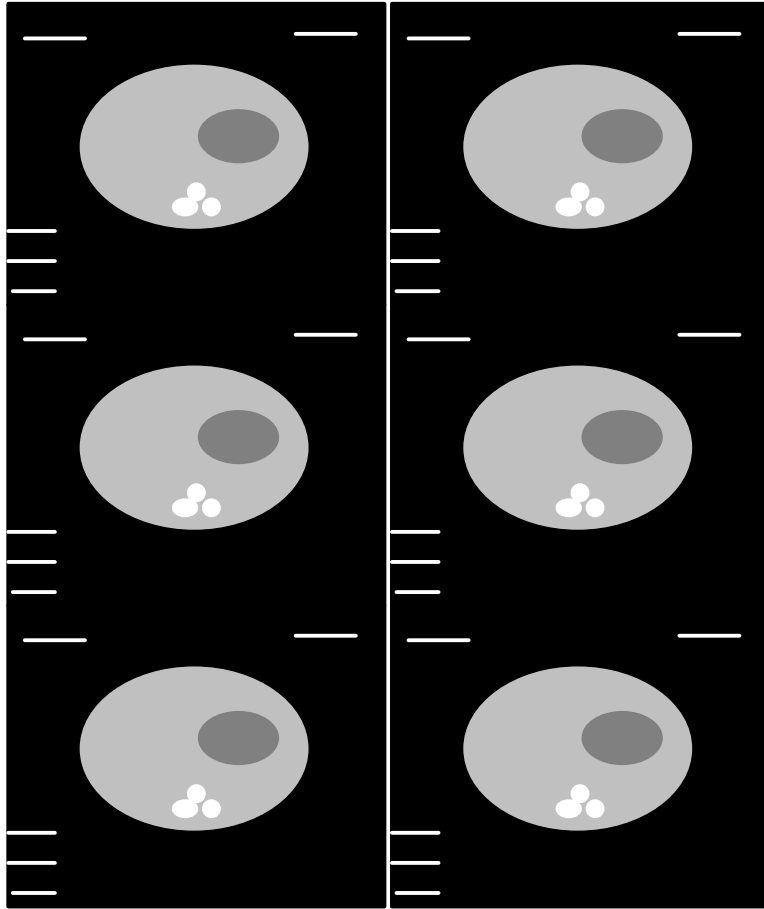
X-ray rooms from examination to reading around 1990



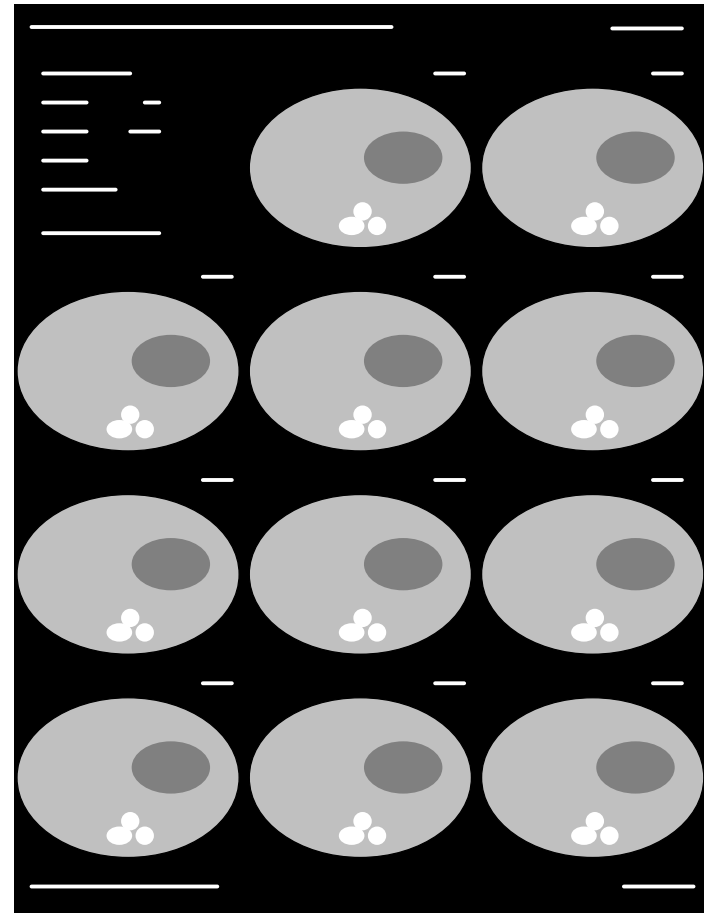
X-ray rooms with Easyvision applied as printserver



Comparison screen copy versus optimized film



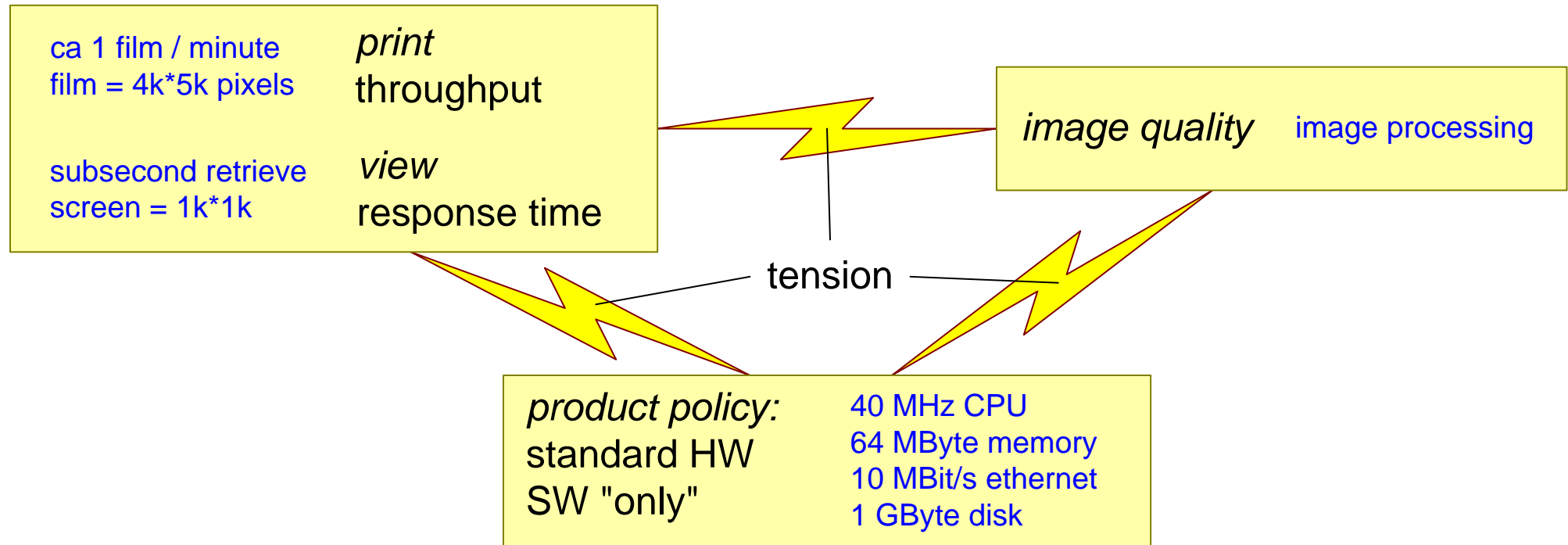
old: screen copy



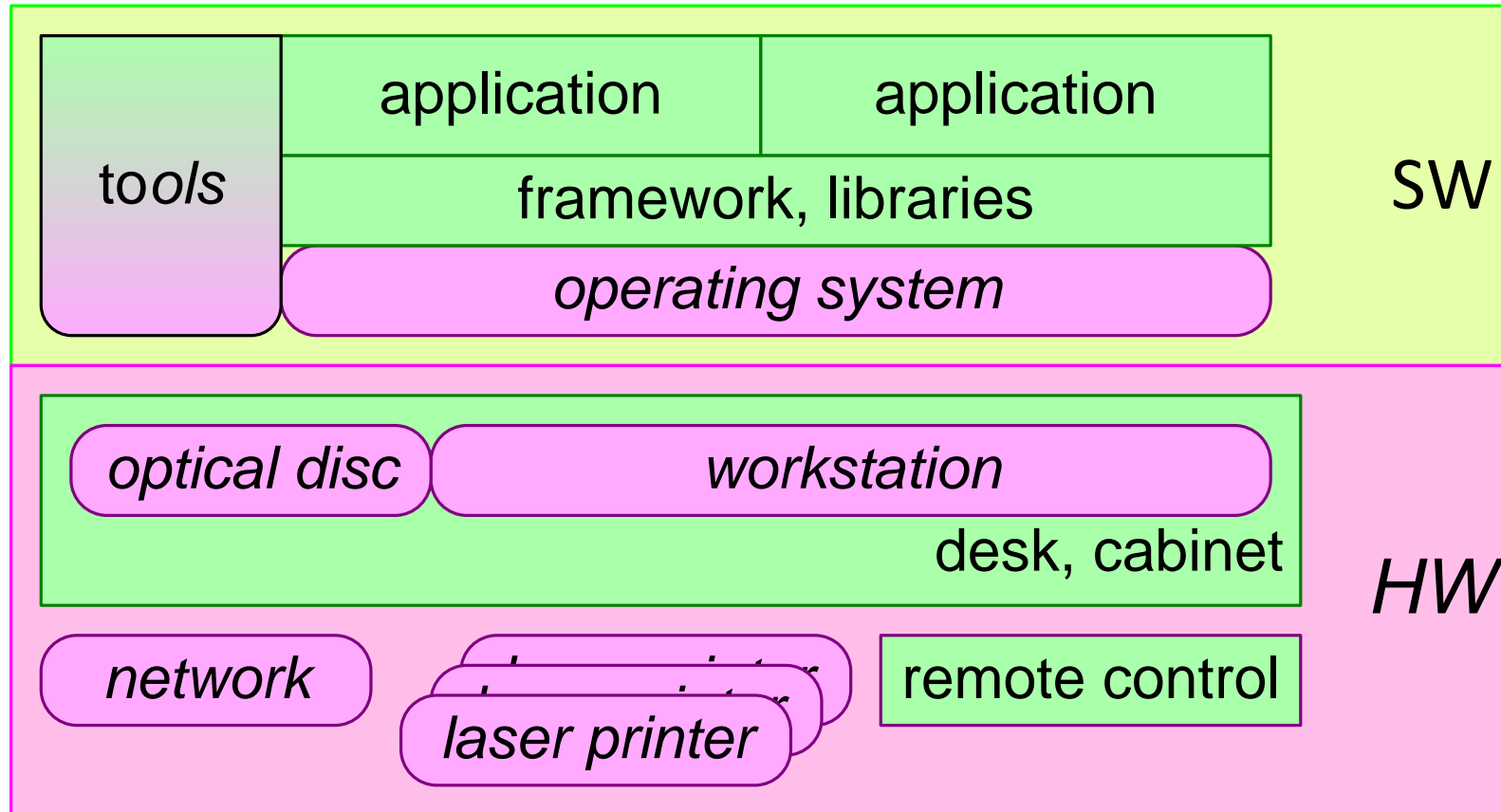
new: SW formatting

20 to 50% less film needed

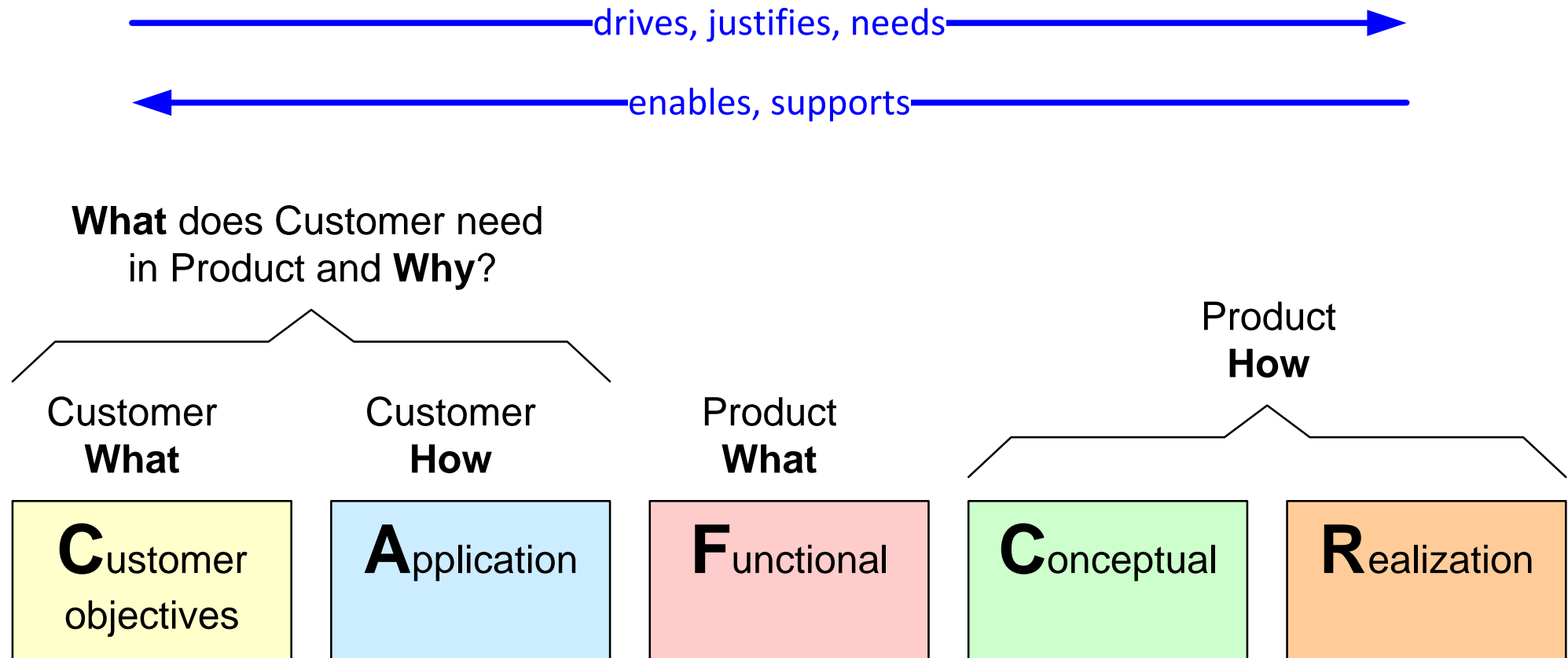
Challenges for product creation



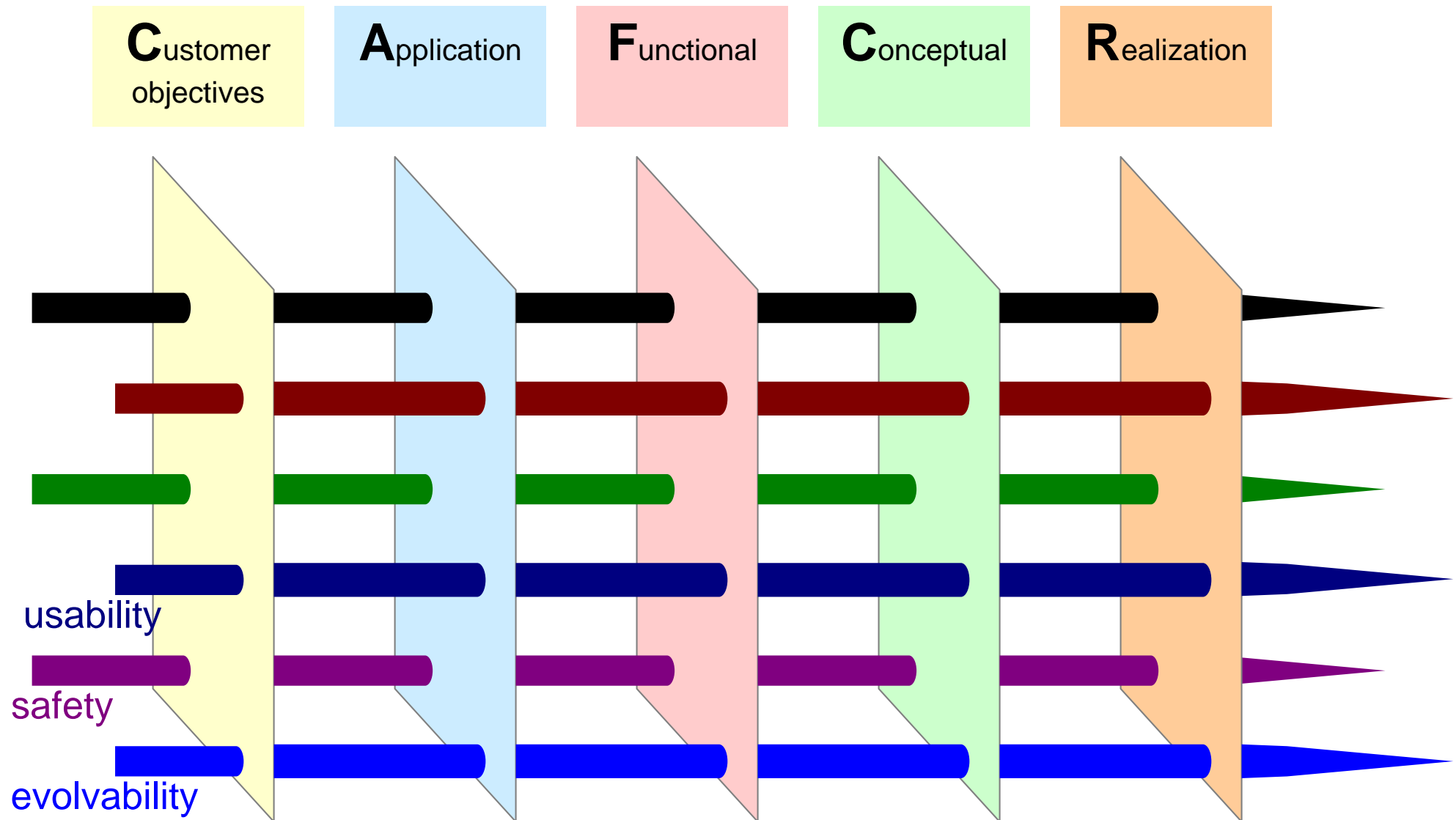
Top level decomposition



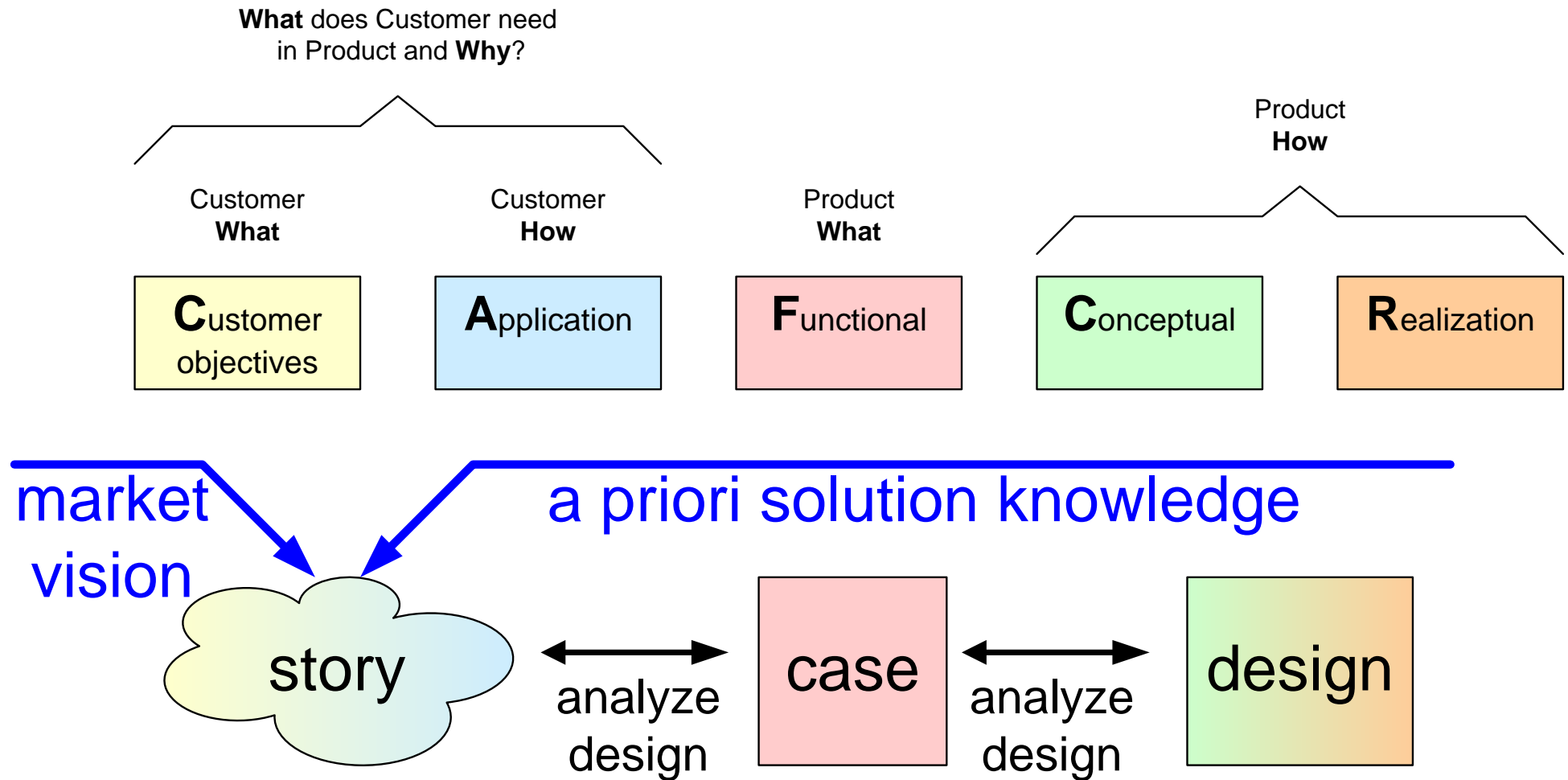
CAFCR viewpoints



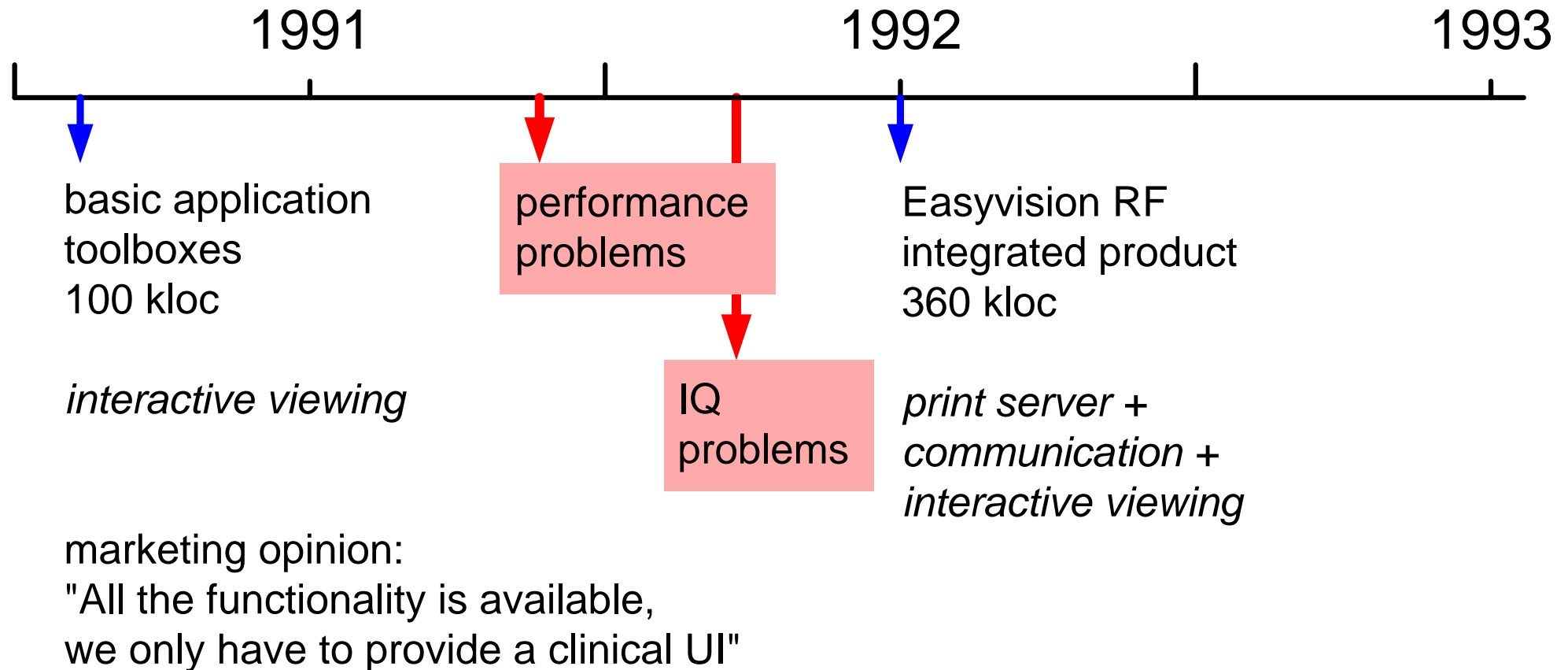
Quality needles as generic integrating concepts



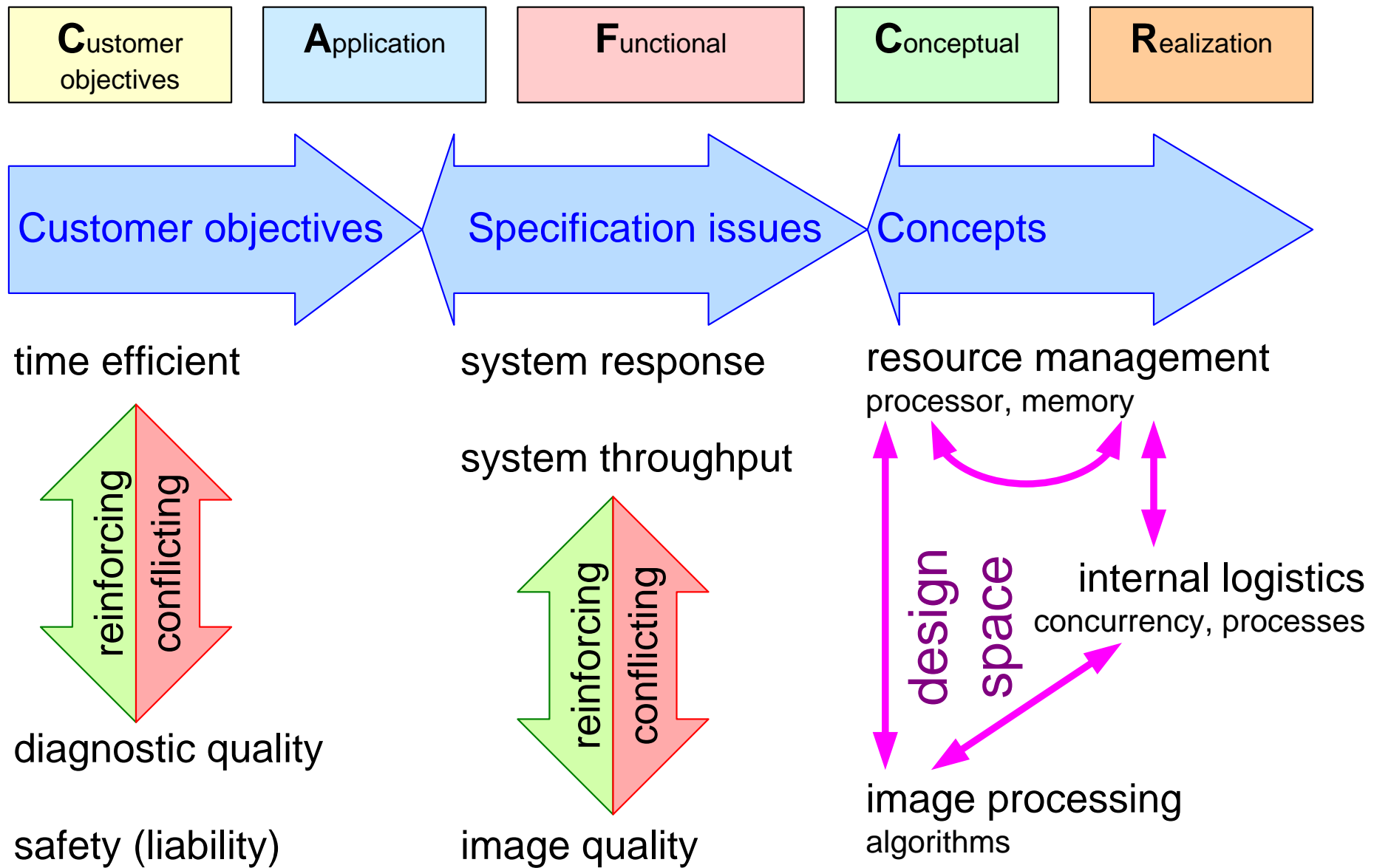
From story to design



Chronology of Easyvision RF R1 development



Thread of reasoning based on efficiency-quality tension



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

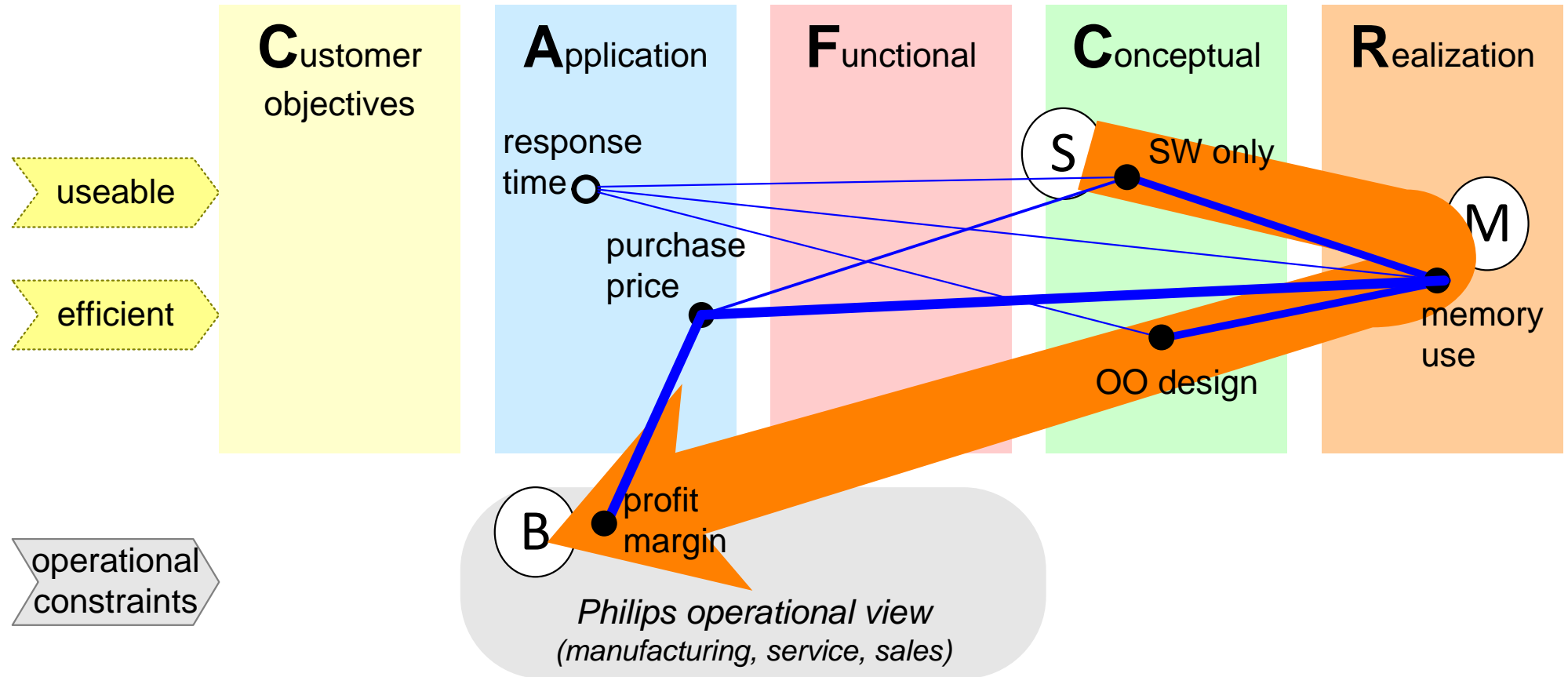
data base engine, fast, reliable and robust

extensive set of toolboxes

property based configuration

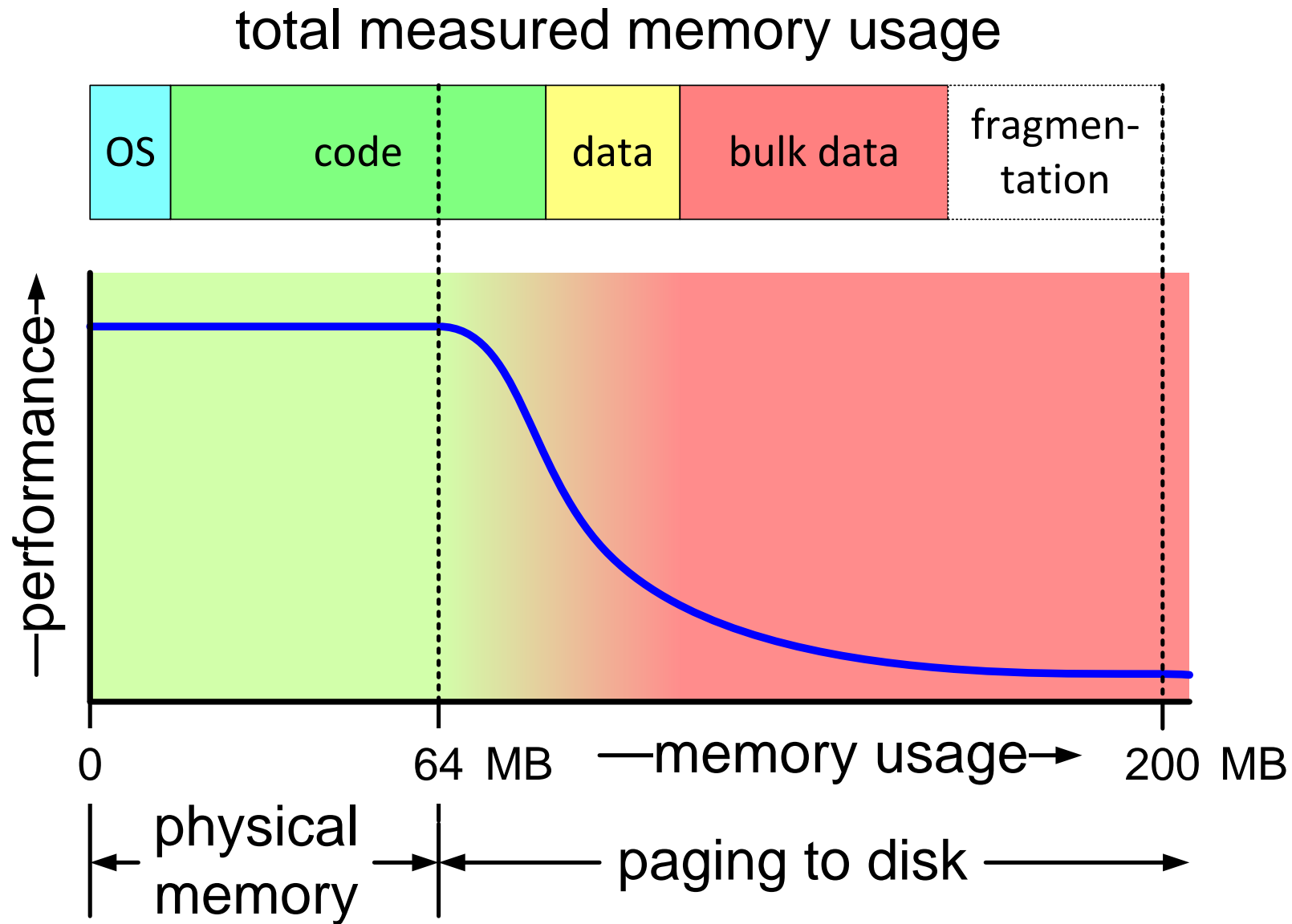
multiple coordinate spaces

Thread of reasoning; introvert phase

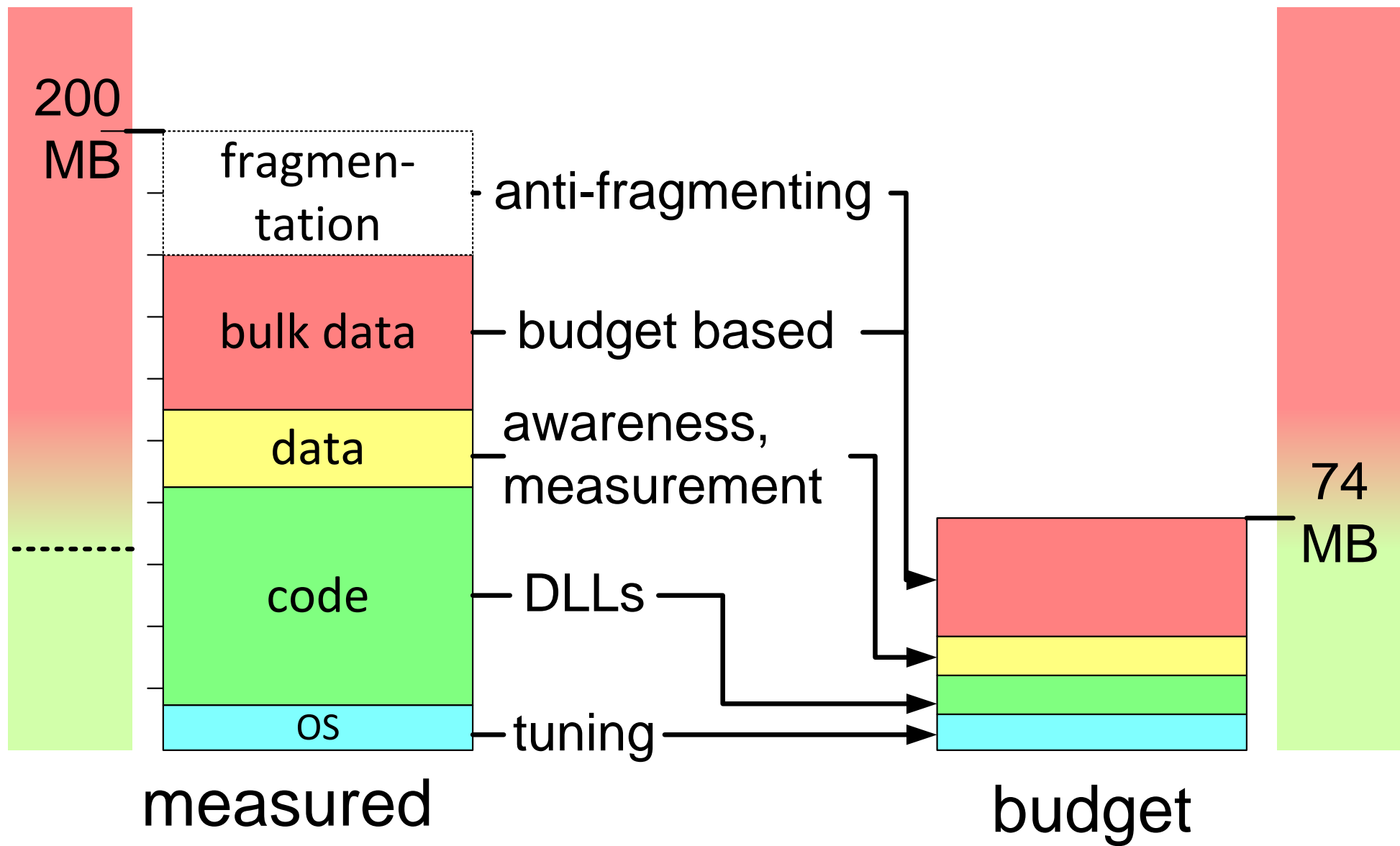


Introvert view: cost and impact of new technologies

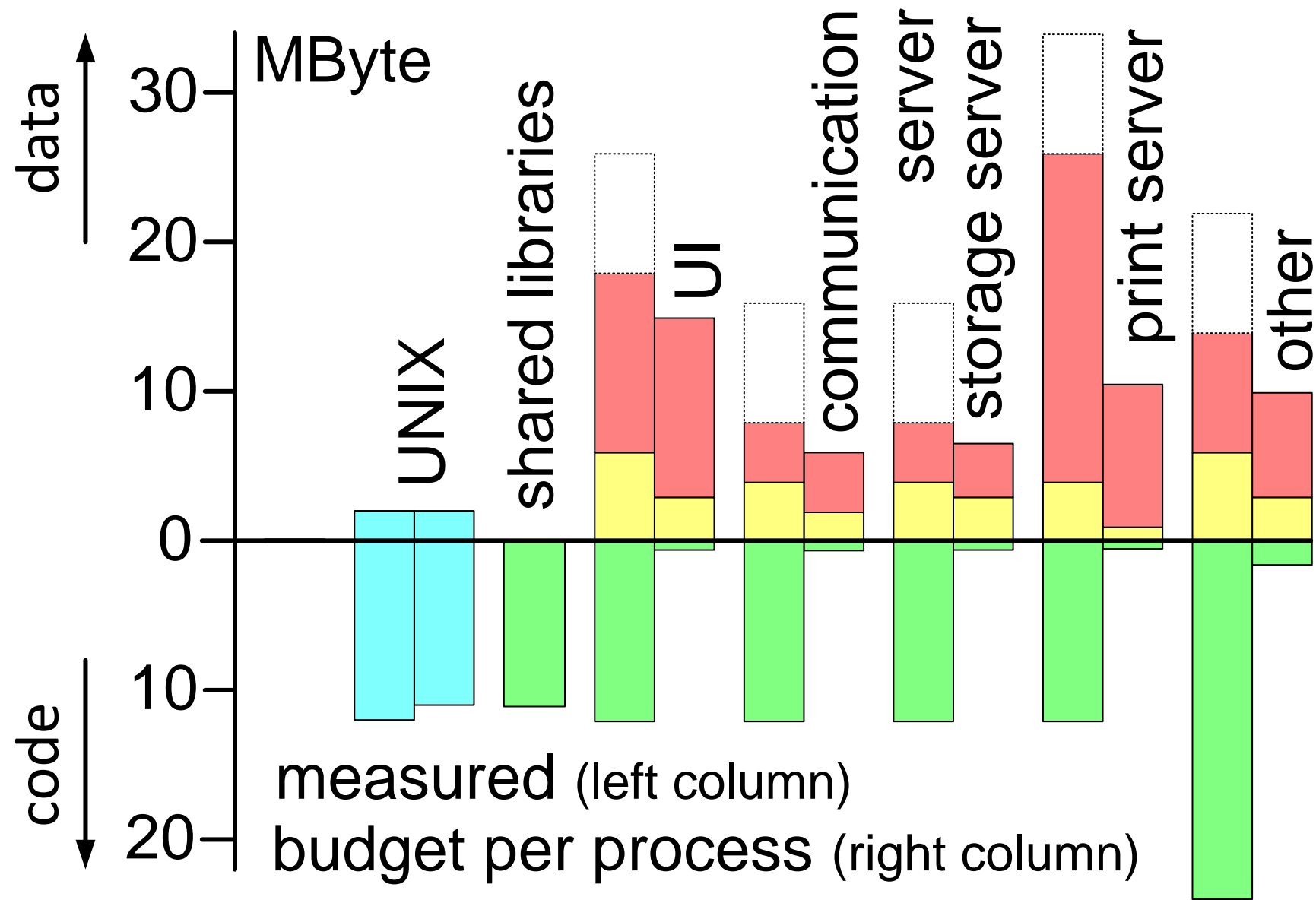
Memory usage half way R1



Solution of memory performance problem



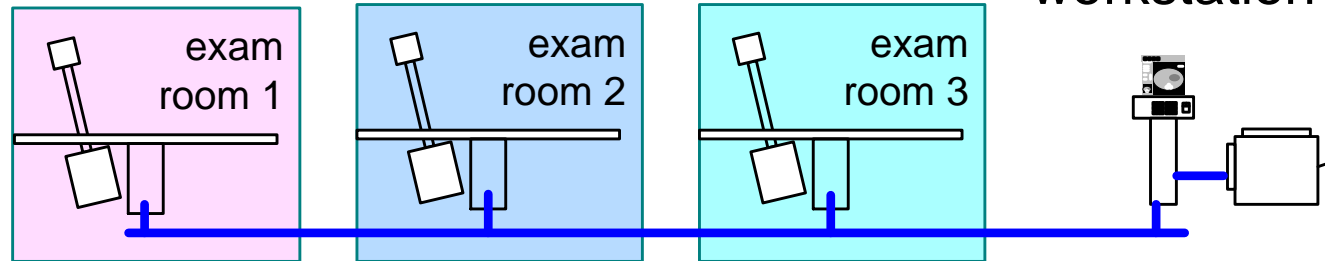
Visualization memory use per process



Typical case URF examination

3 examination rooms connected to

1 medical imaging
workstation + printer

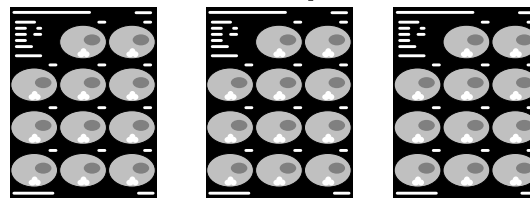


examination room: average 4 interleaved examinations / hour

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

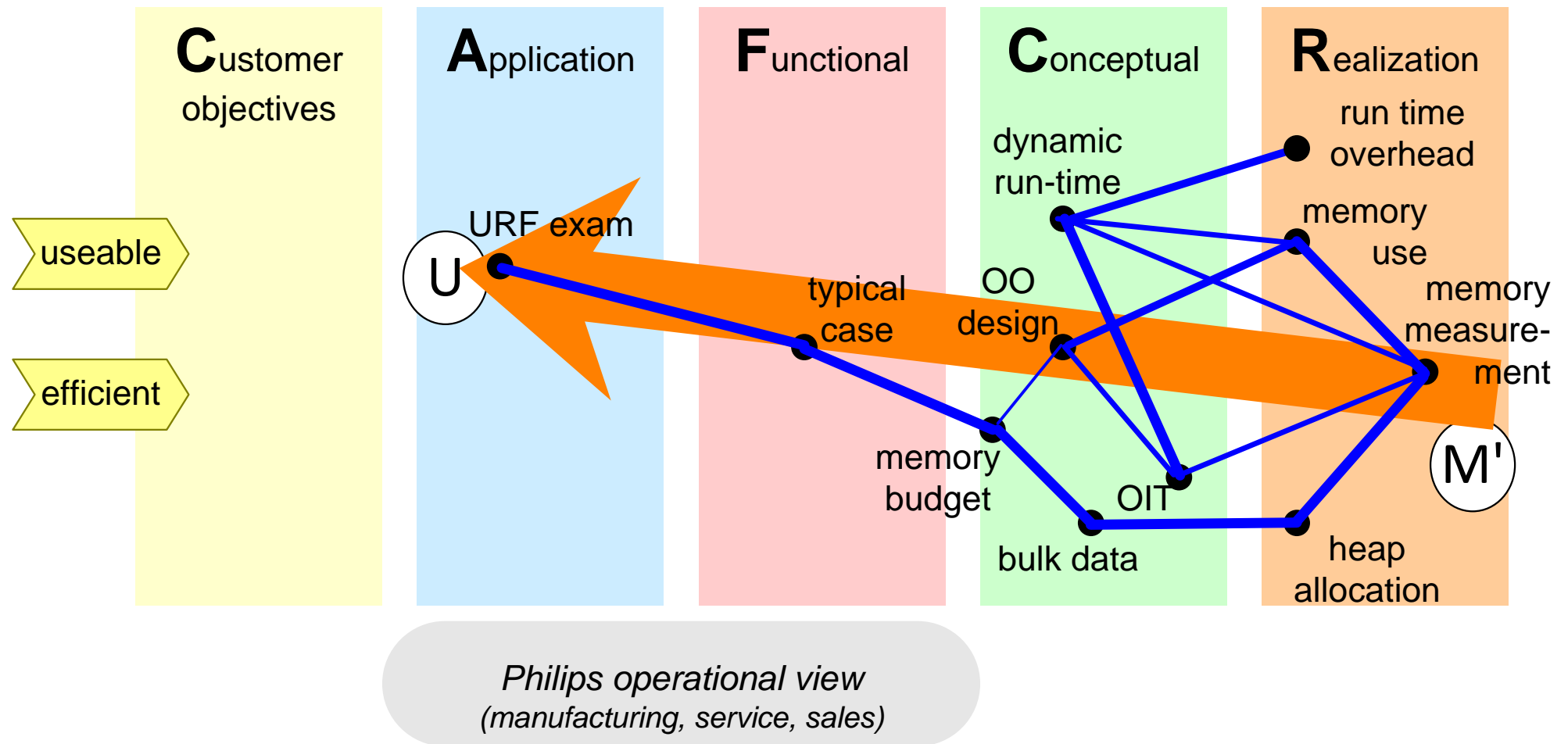


film production: 3 films of 4k*5k pixels each



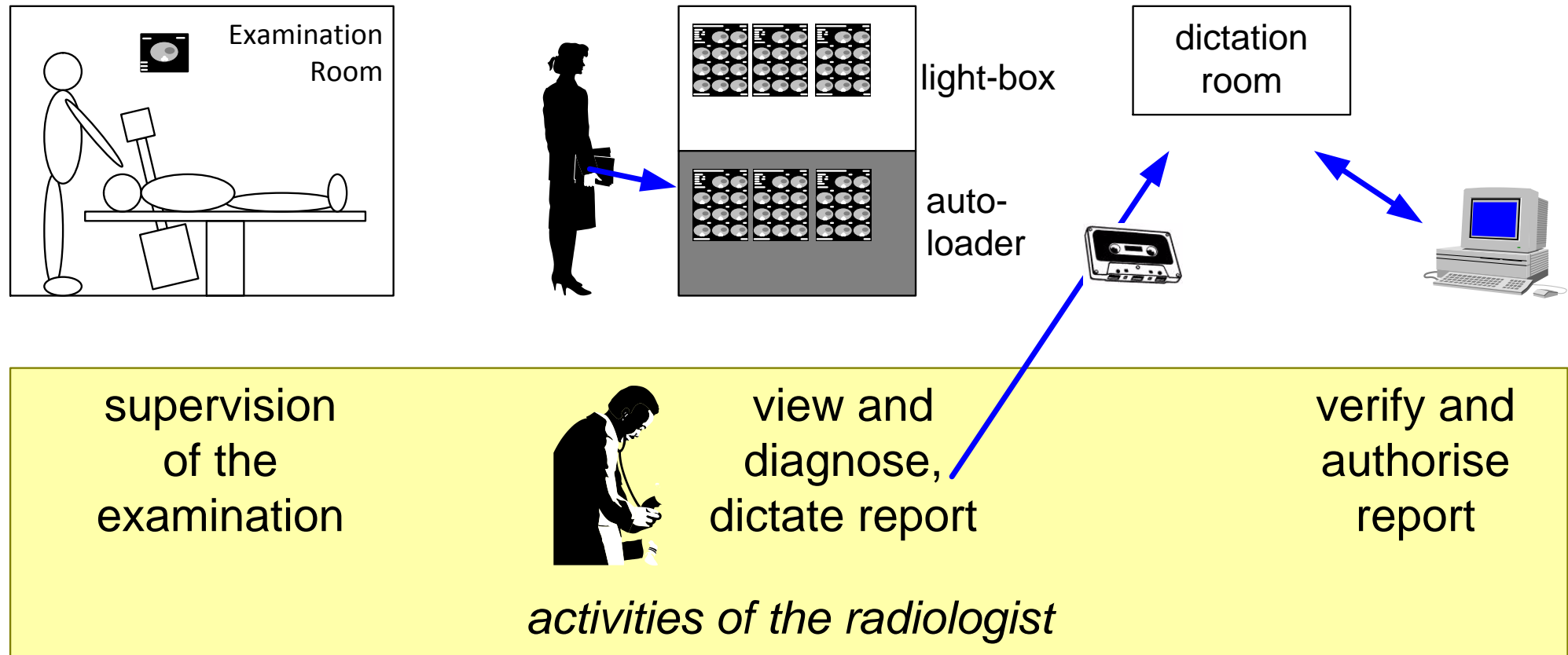
high quality output
(bi-cubic interpolation)

Thread of reasoning; phase 2

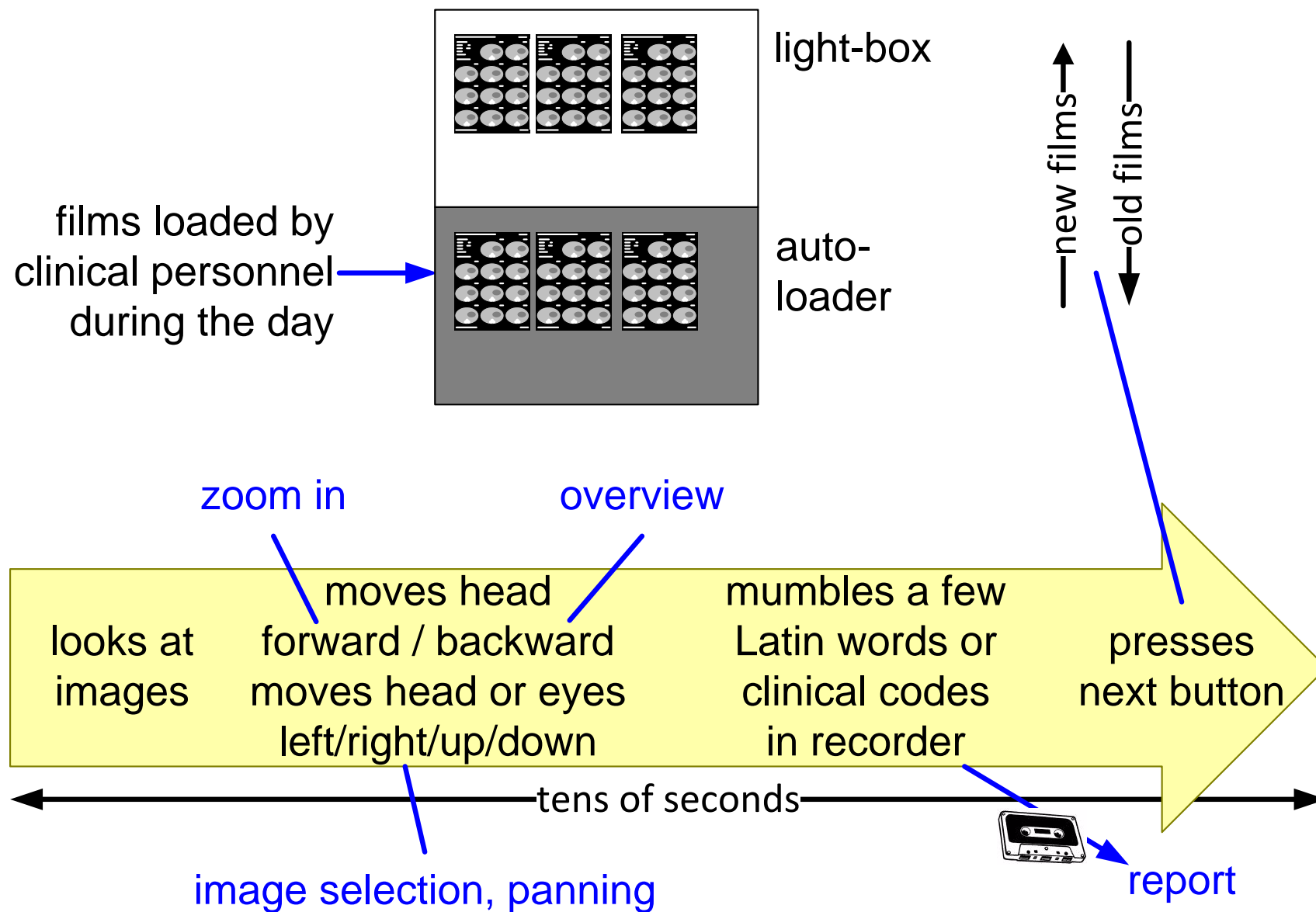


How to measure memory, how much is needed?
from introvert to extrovert

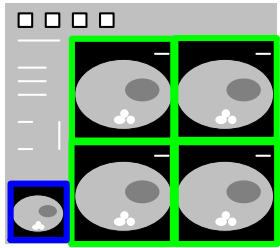
Radiologist workspots and activities



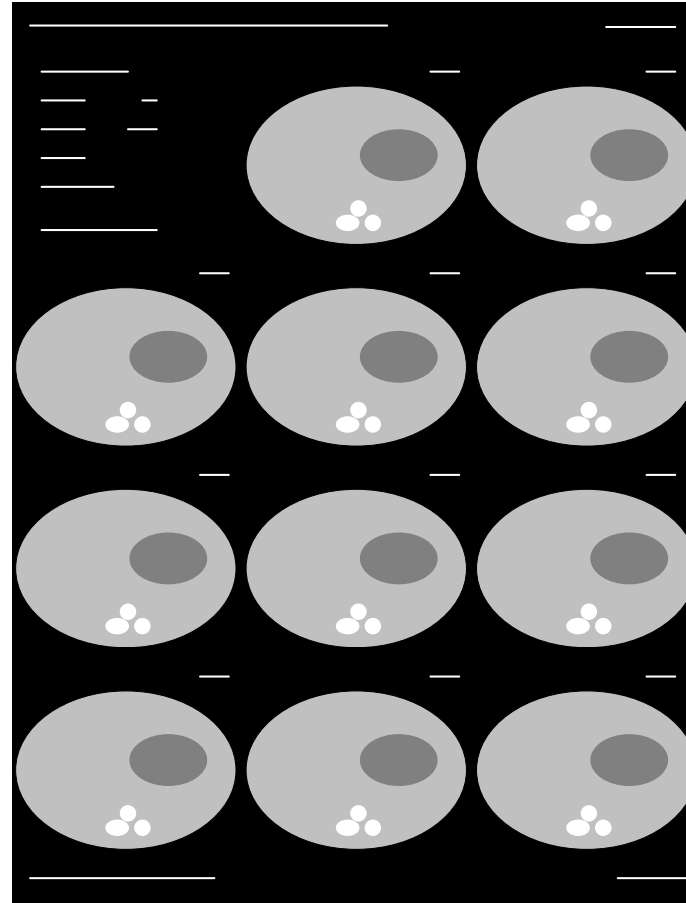
Diagnosis in tens of seconds



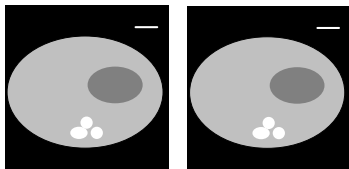
Rendered images at different destinations



Screen:
low resolution
fast response

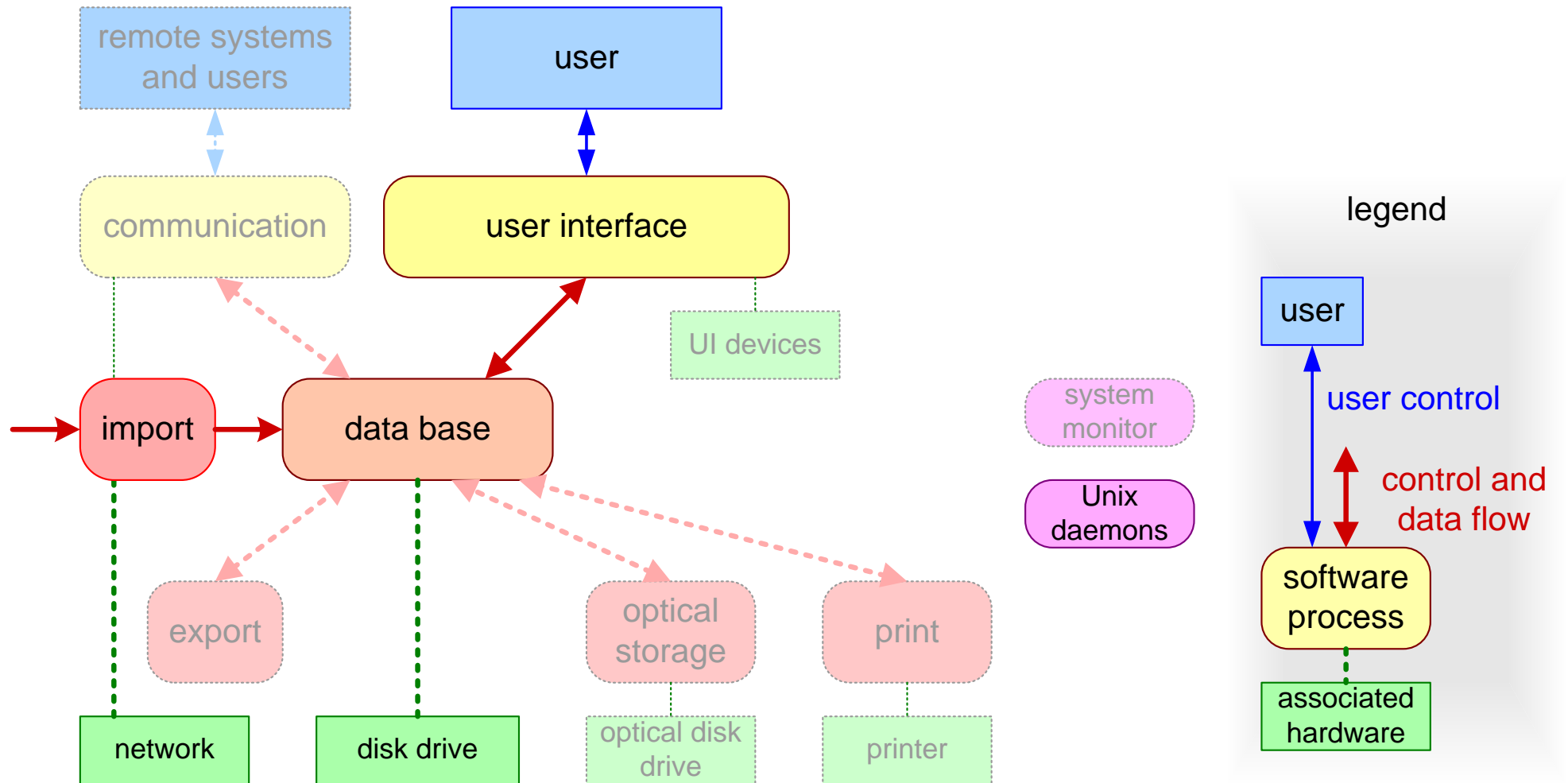


Film:
high resolution
high throughput

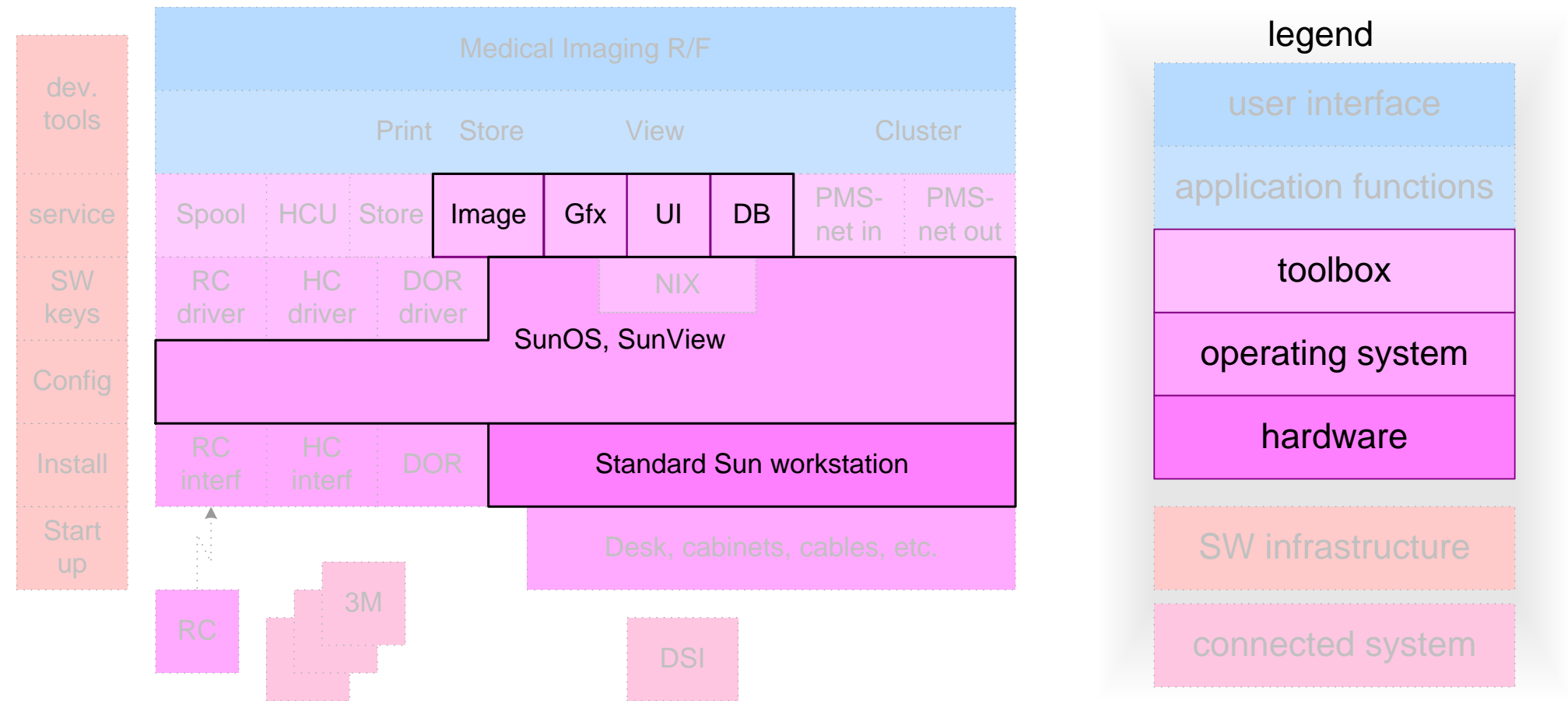


Network:
medium resolution
high throughput

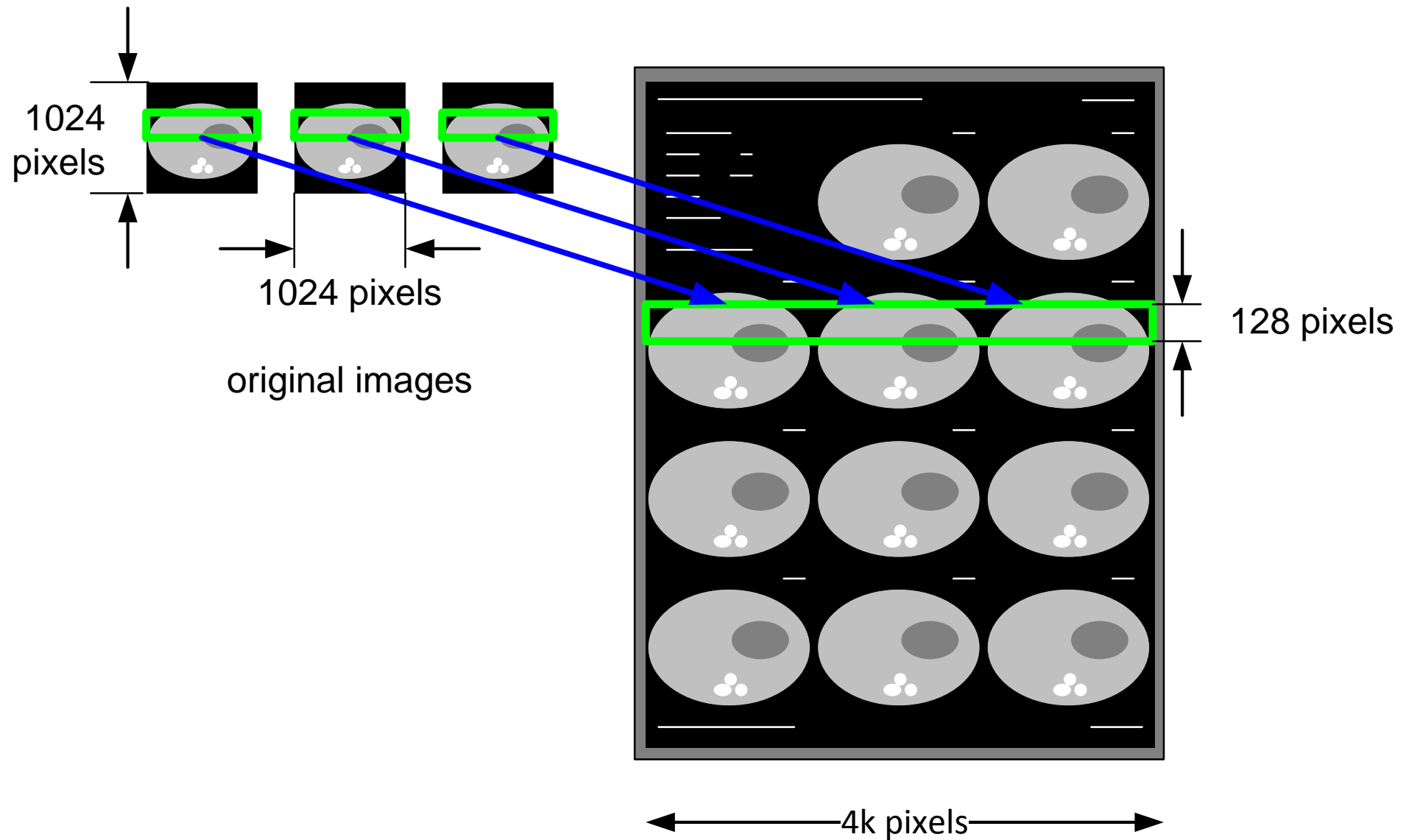
SW Process structure 1991



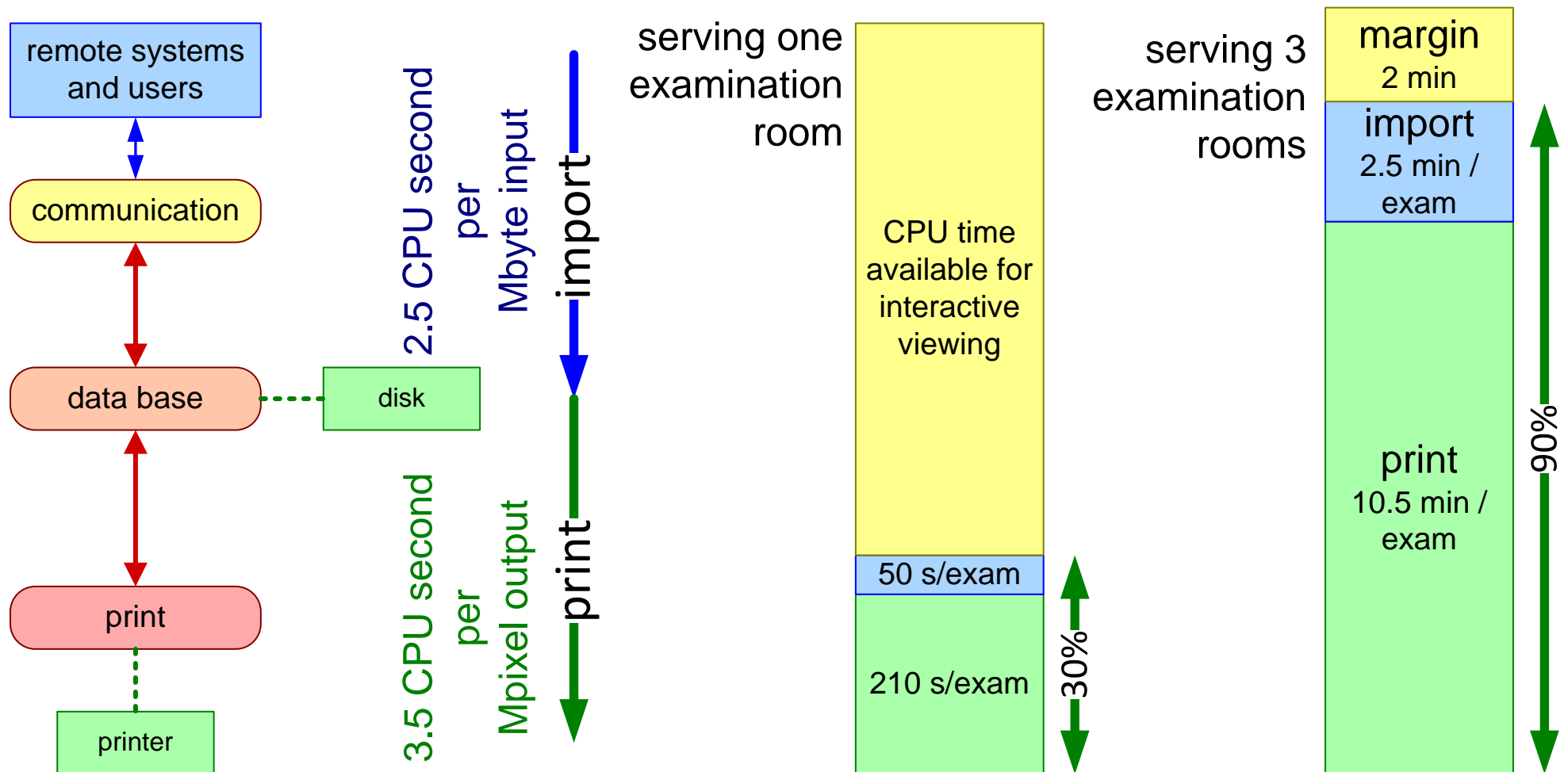
SW layers 1991



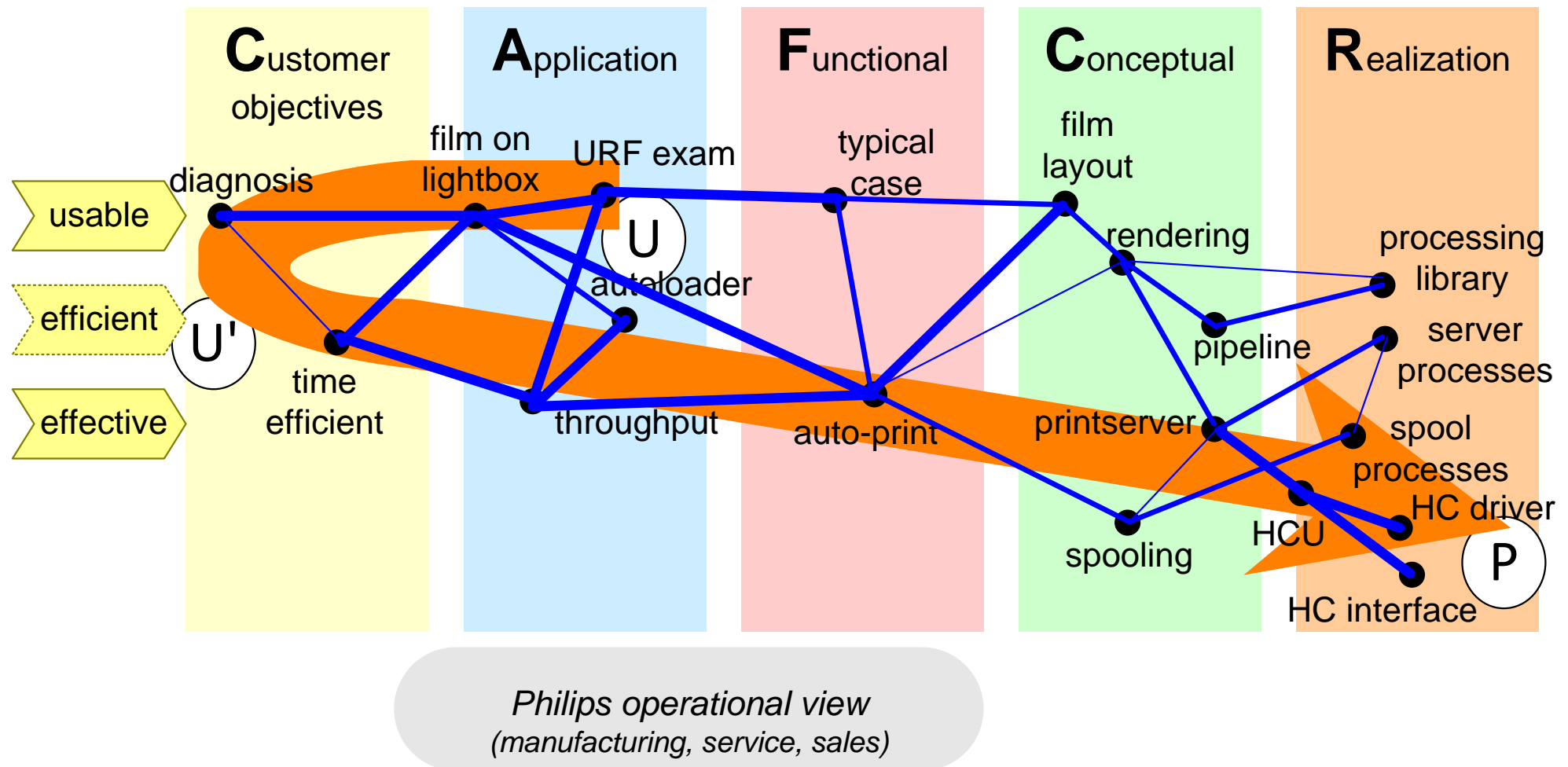
Print server is based on banding



Server CPU load

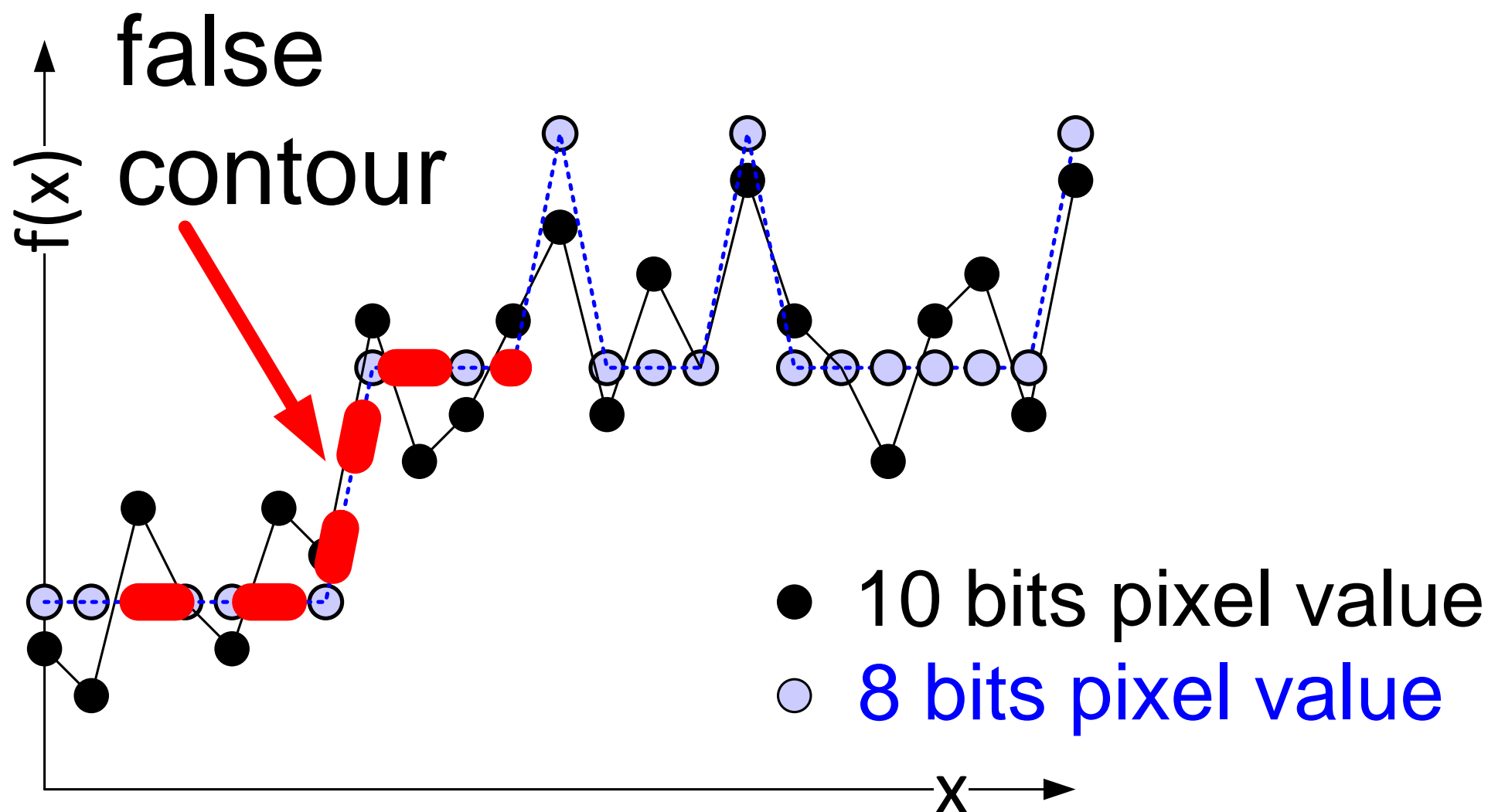


Thread of reasoning; phase 3



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

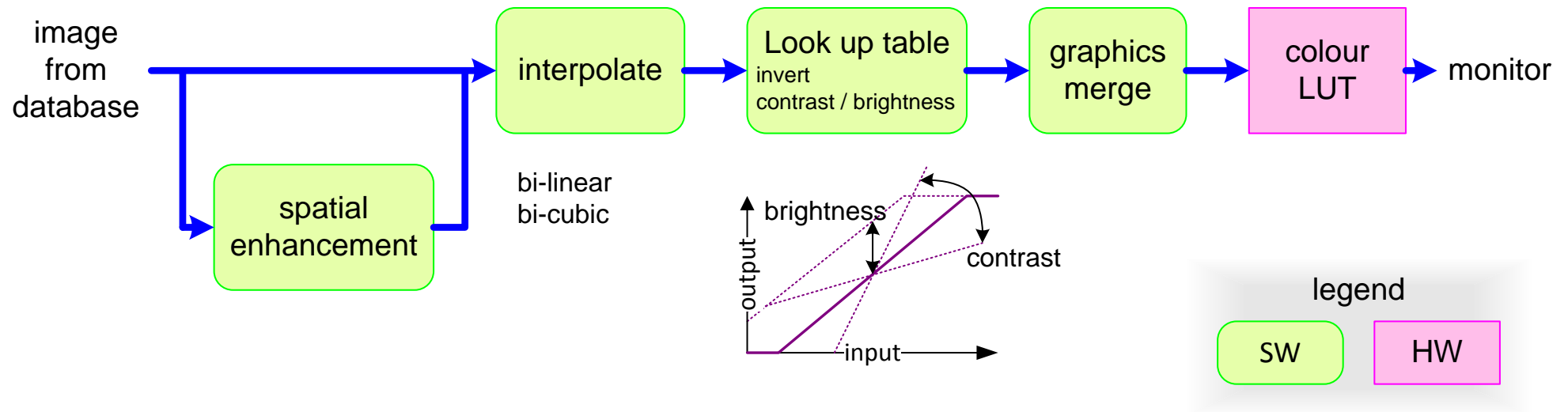
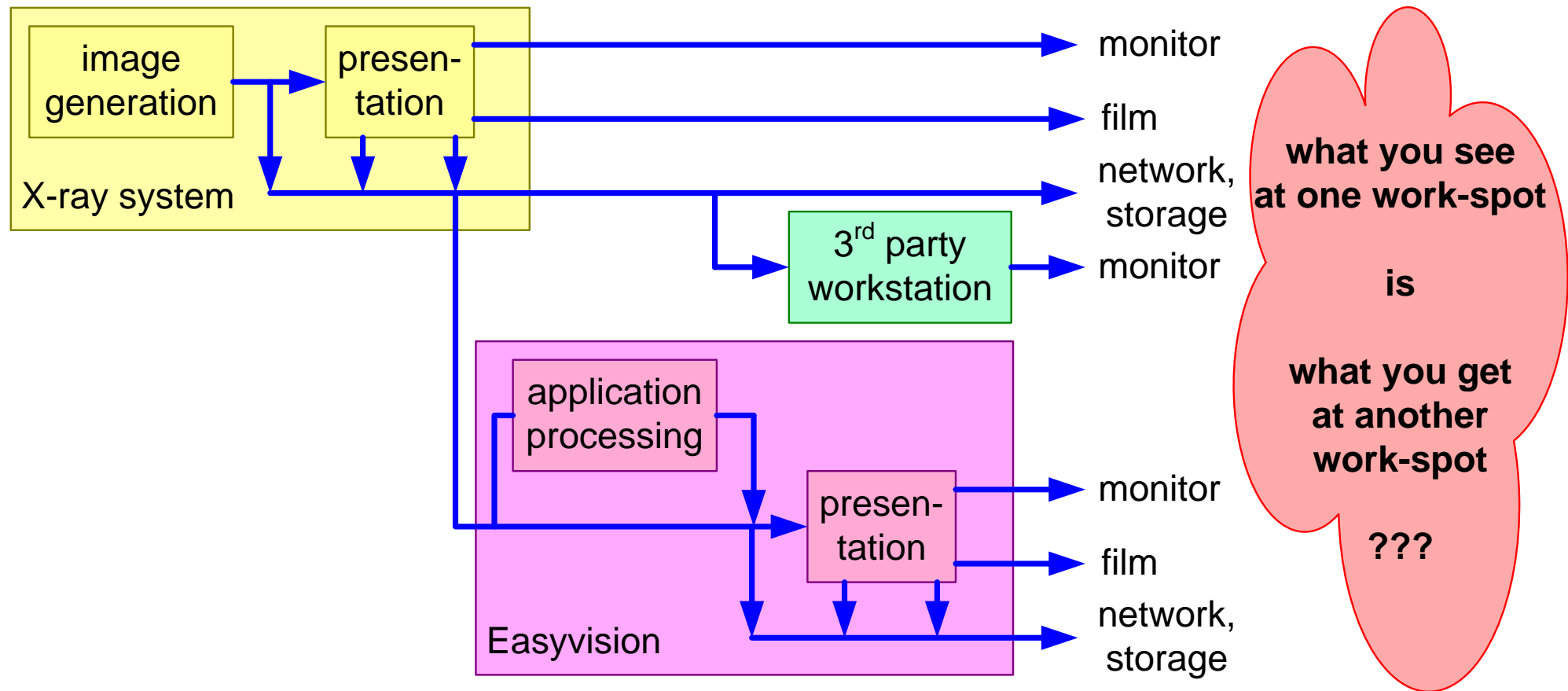
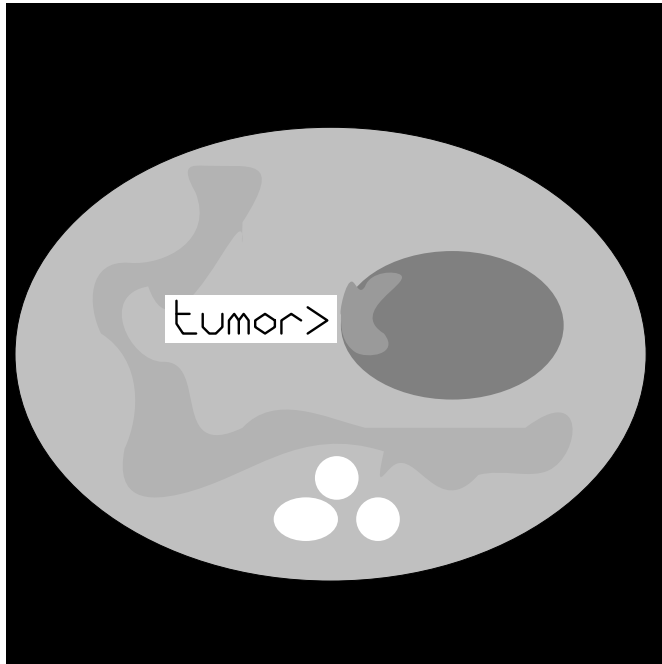


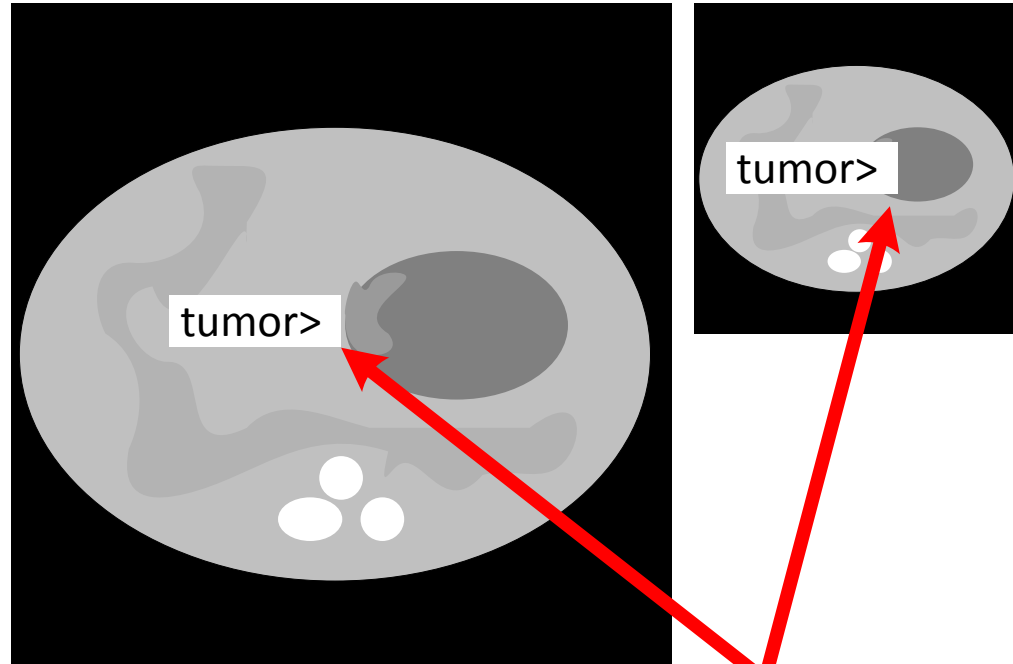
Image Quality expectation WYSIWYG



Safety problem



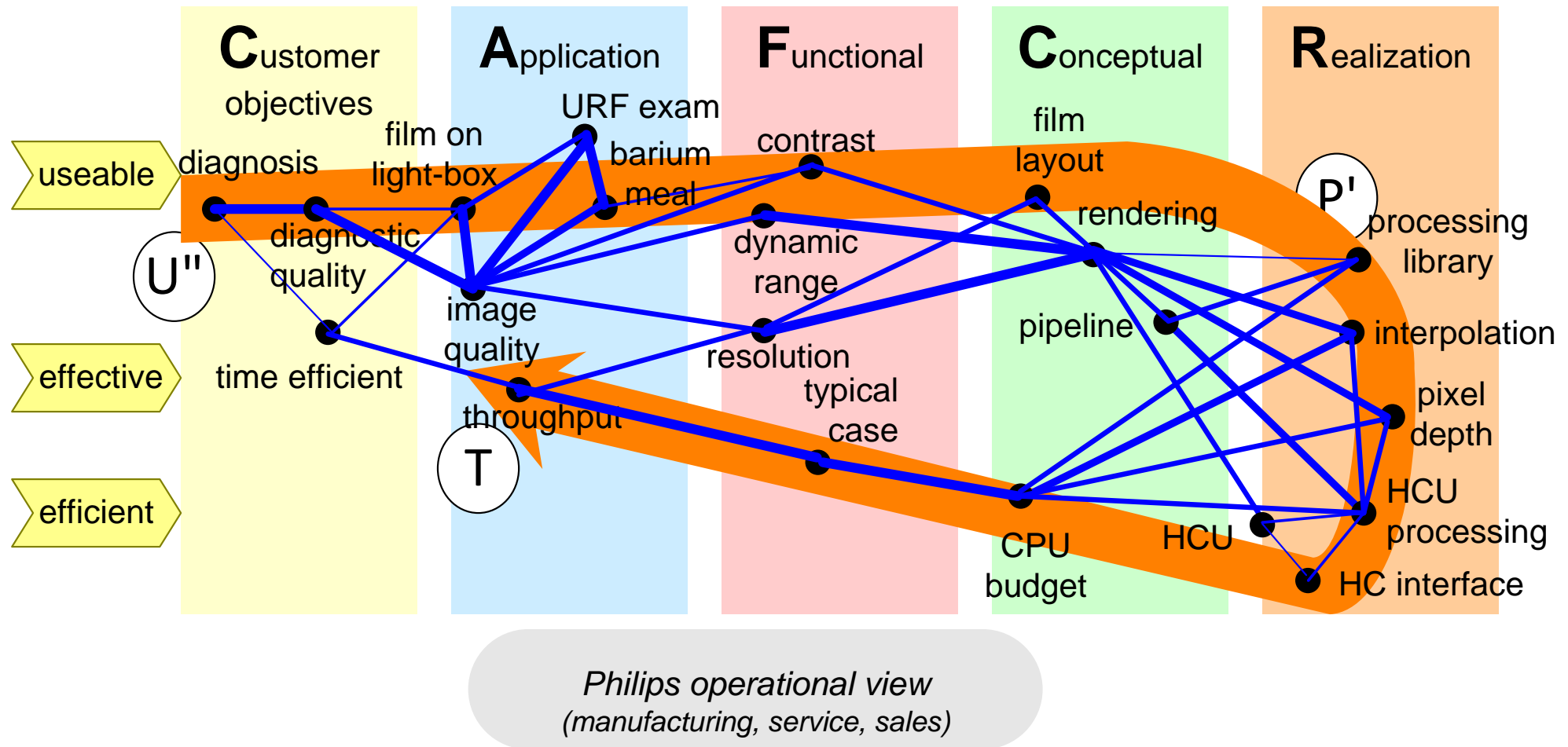
URF monitor output:
fixed size letters at fixed grid



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

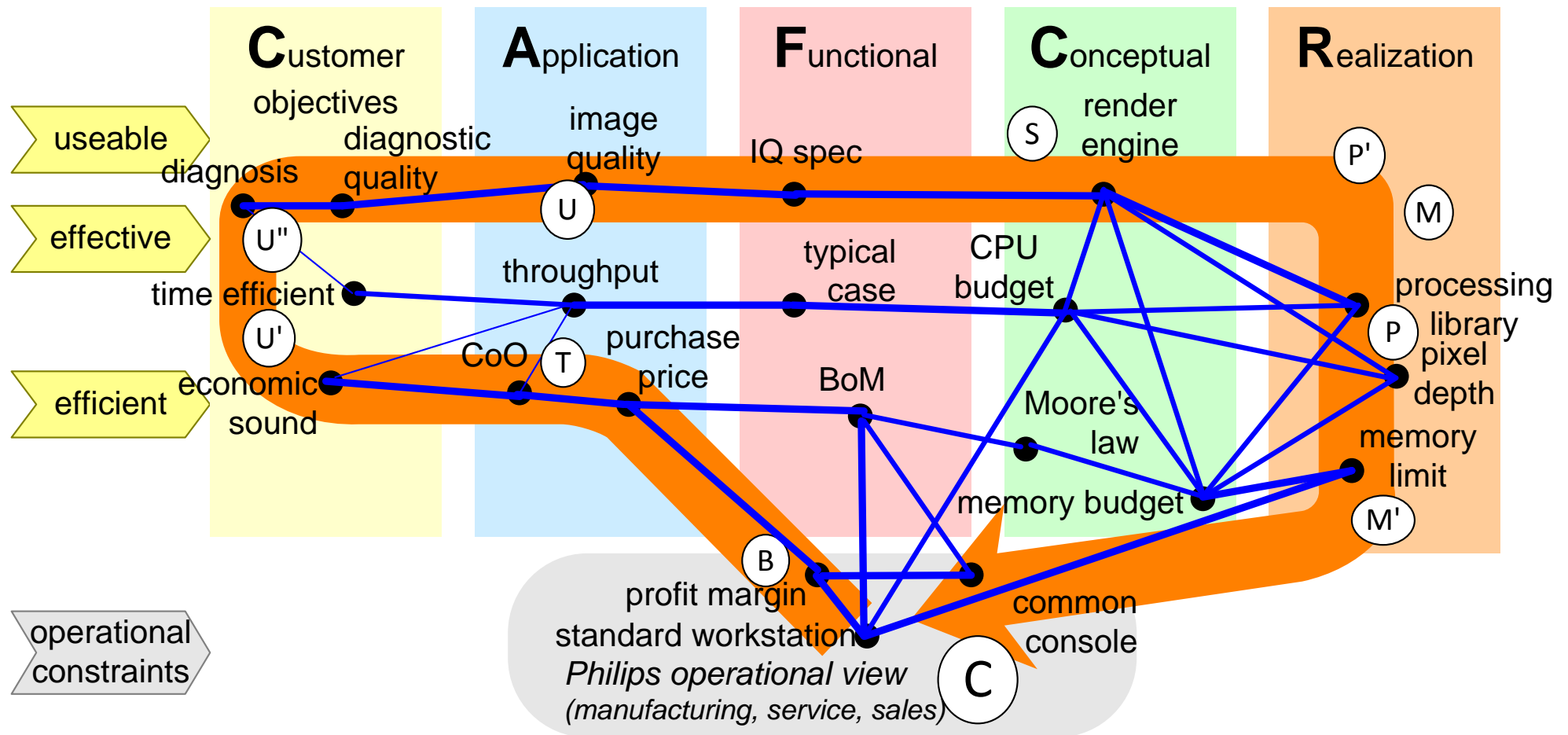
EV output: scaleable fonts in graphics overlay

Thread of reasoning; phase 4



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

Thread of reasoning; phase 5



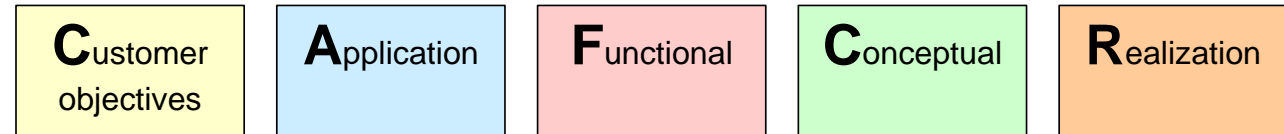
cost revisited in context of clinical needs and realization constraints; note: original threads are significantly simplified

Overview of architecting method

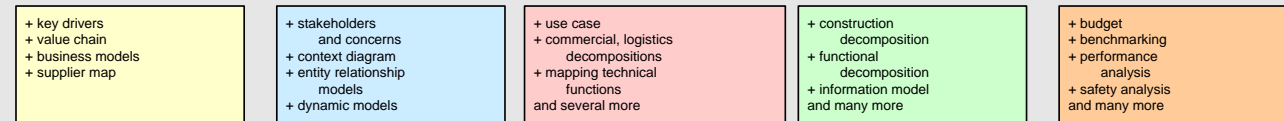
method outline

method visualization

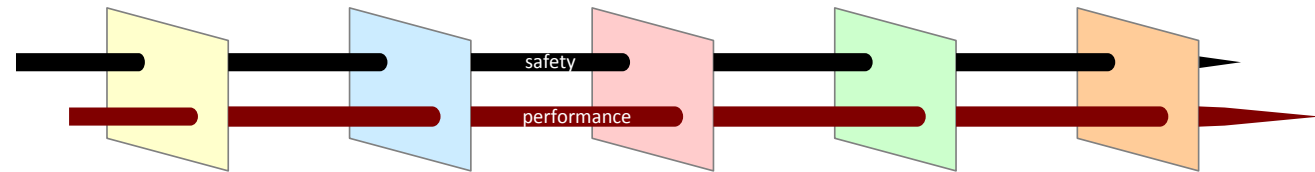
framework



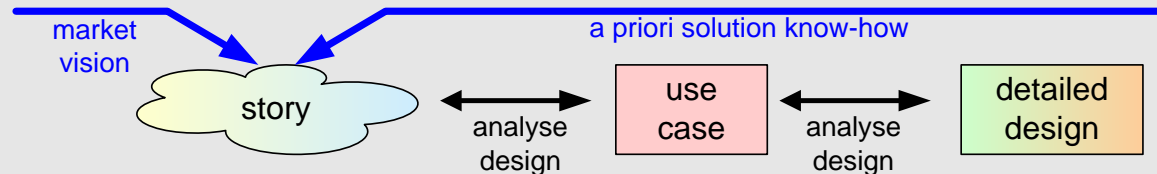
submethods



integration via qualities



explore specific details



reasoning

