Case Study: Medical Imaging; From Toolbox to Product to Platform

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Abstract

Medical Imaging was an early large scale Object Oriented product. Originally intended to become a re-useable set of toolboxes, it evolved in a family of medical workstations and servers.
This article describes the evolution from different viewpoints, to serve as background material for a number of case studies of the Gaudí project.

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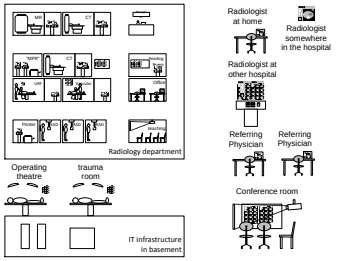
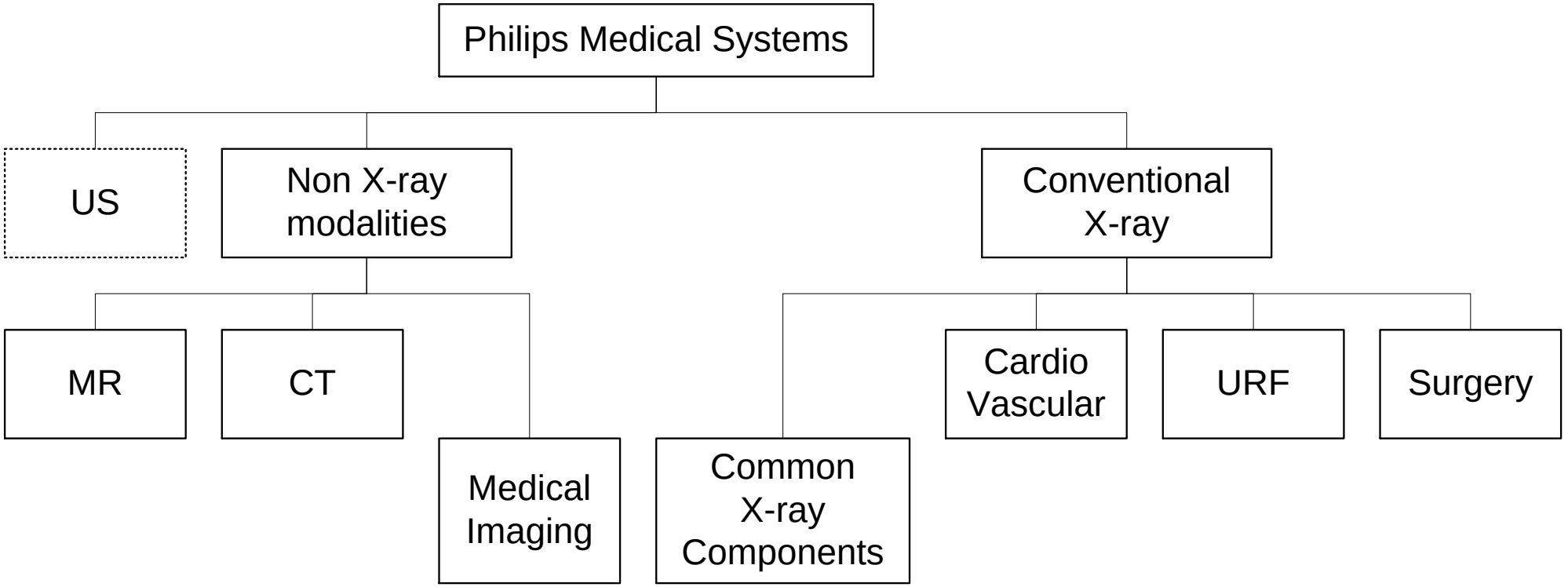
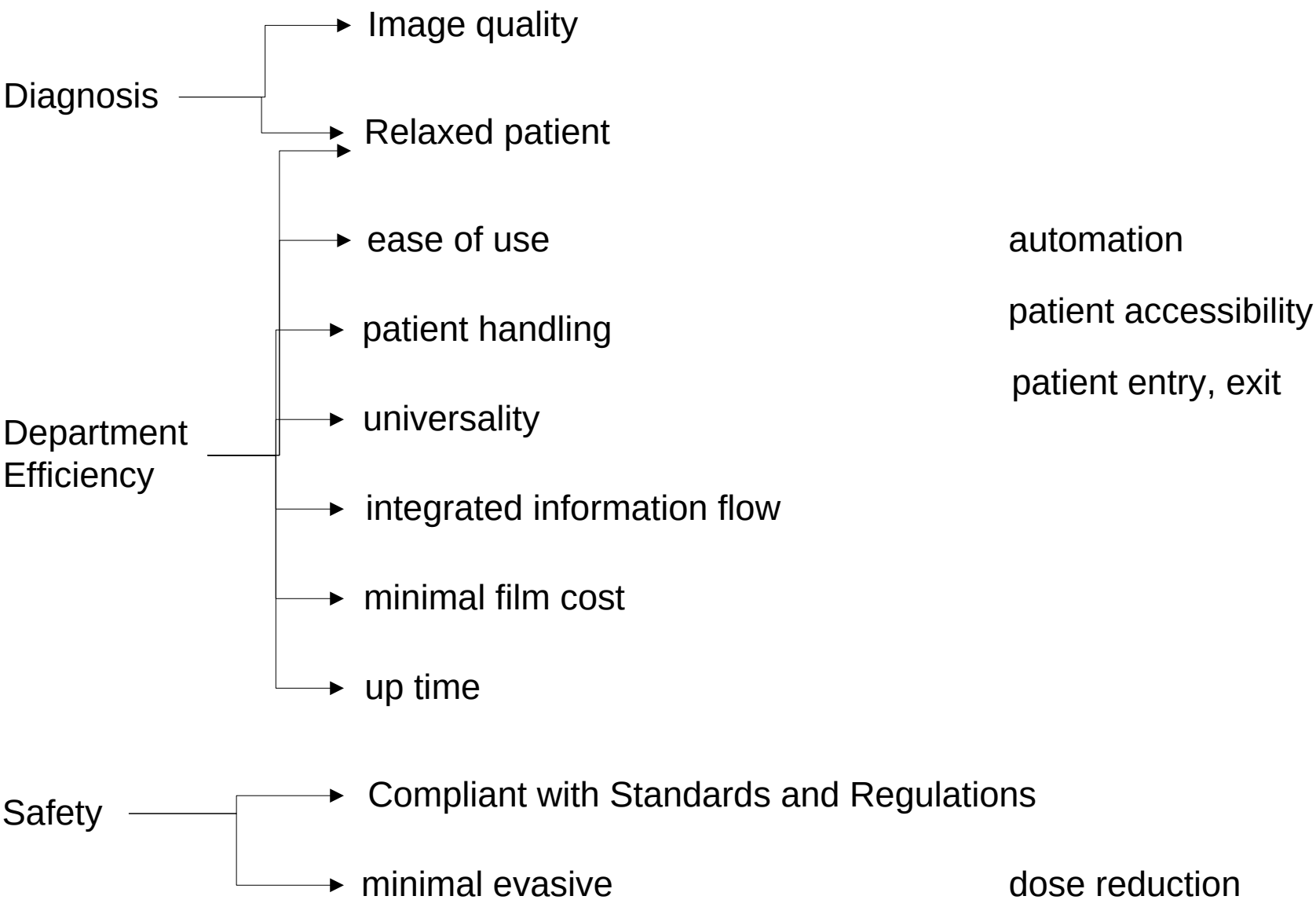


Philips Medical Systems, schematic organization



Generic drivers of Radiology Departments



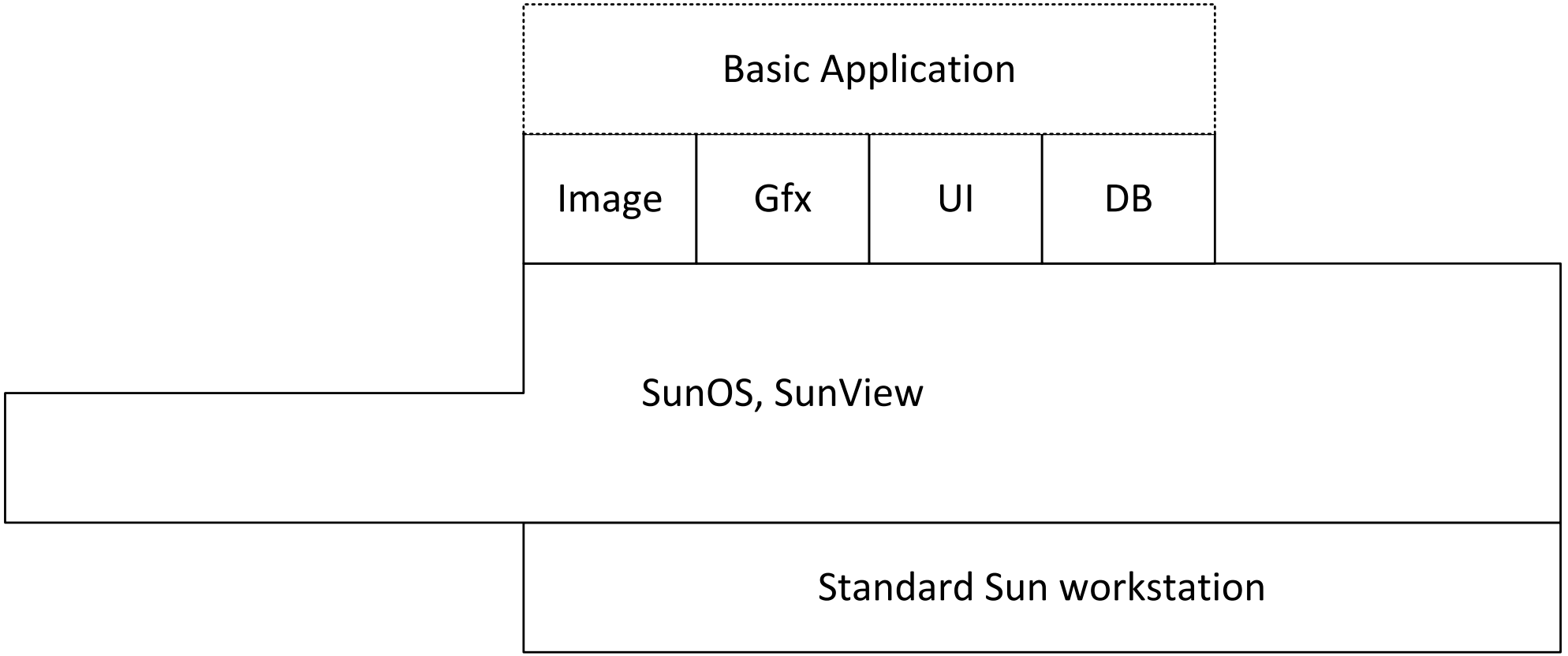
Phases of Medical Imaging

- 1987-1991 Advanced Development (”Common Viewing”), result: Basic Application plus toolboxes
- 1991-1992 Development of 1^{st}product: Medical Imaging R/F
- 1992-1994 Parallel Development of 2^{nd} product: Medical Imaging CT/MR
- 1994-1997 Family Development
- 1997-2000 Transformation in re-useable components

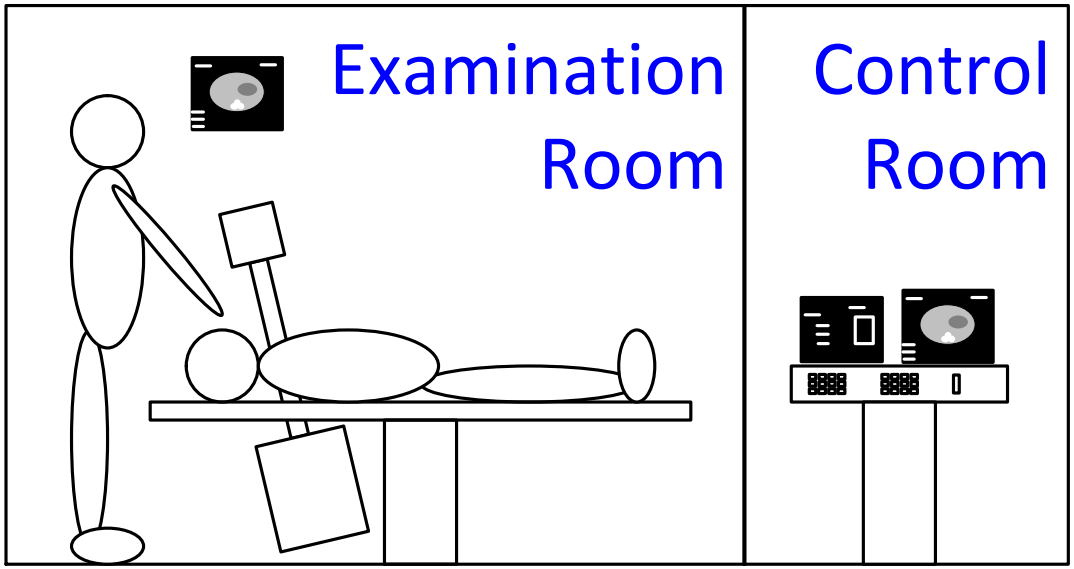
Technology innovations by Common Viewing

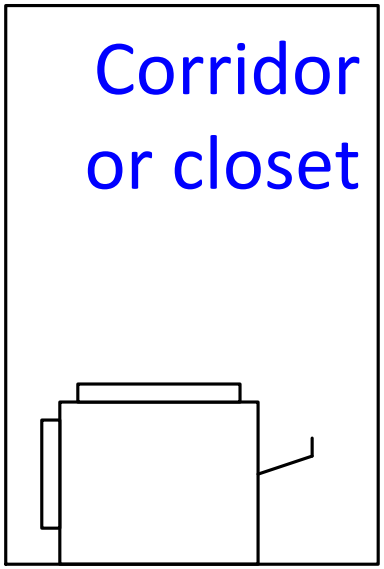
- Standard UNIX based workstation
- Full SW implementation, more flexible
- Object Oriented design and implementation (Objective-C)
- Graphical User Interface, with windows, mouse et cetera
- Call back scheduling, fine-grained notification
- Data base engine, fast, reliable and robust
- Extensive set of toolboxes
- Property based configuration
- Multiple coordinate spaces

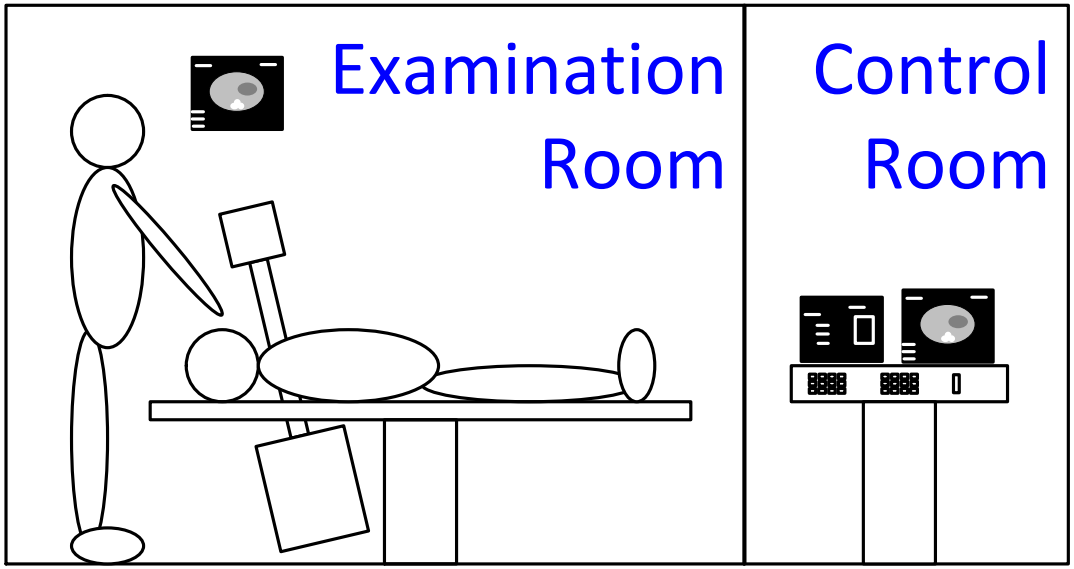
Idealized layers september 1991

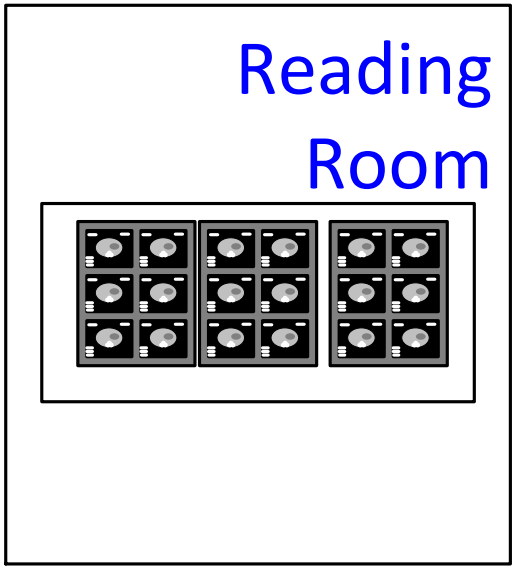


X-ray rooms from examination to reading around 1990

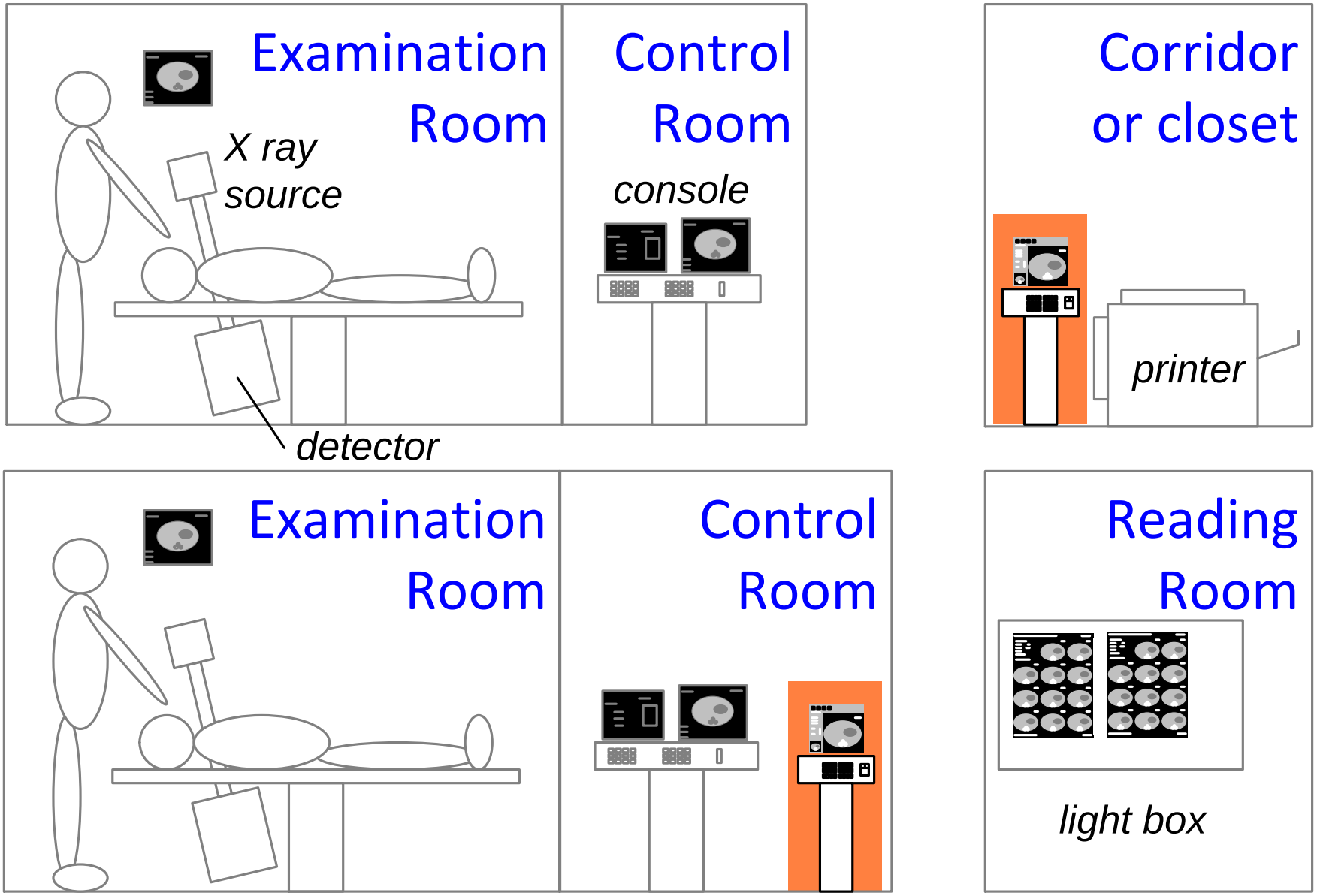




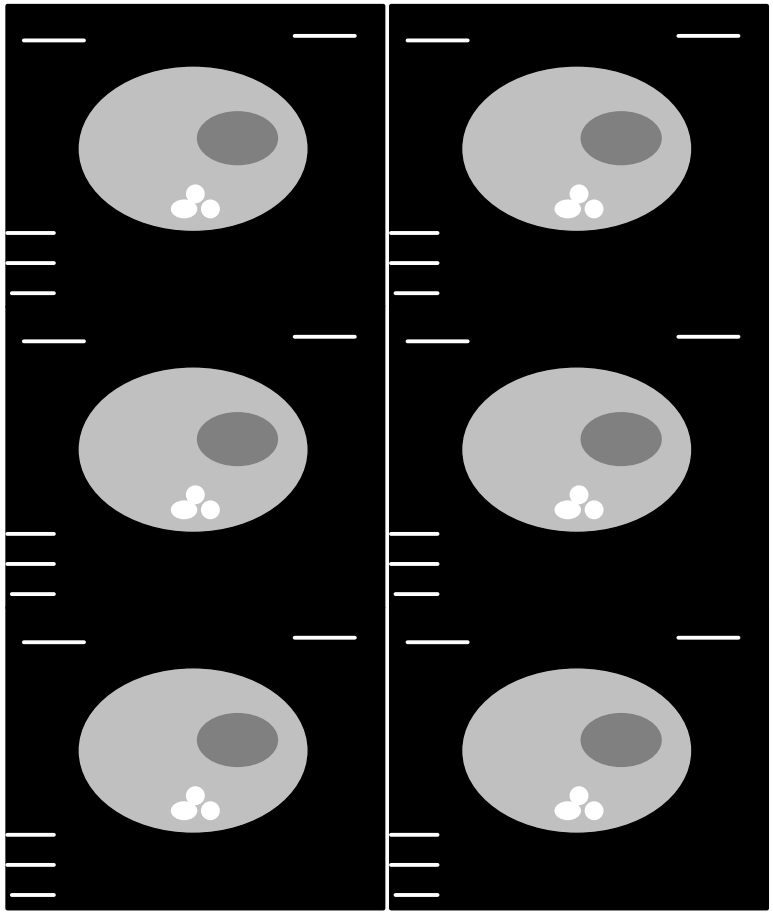




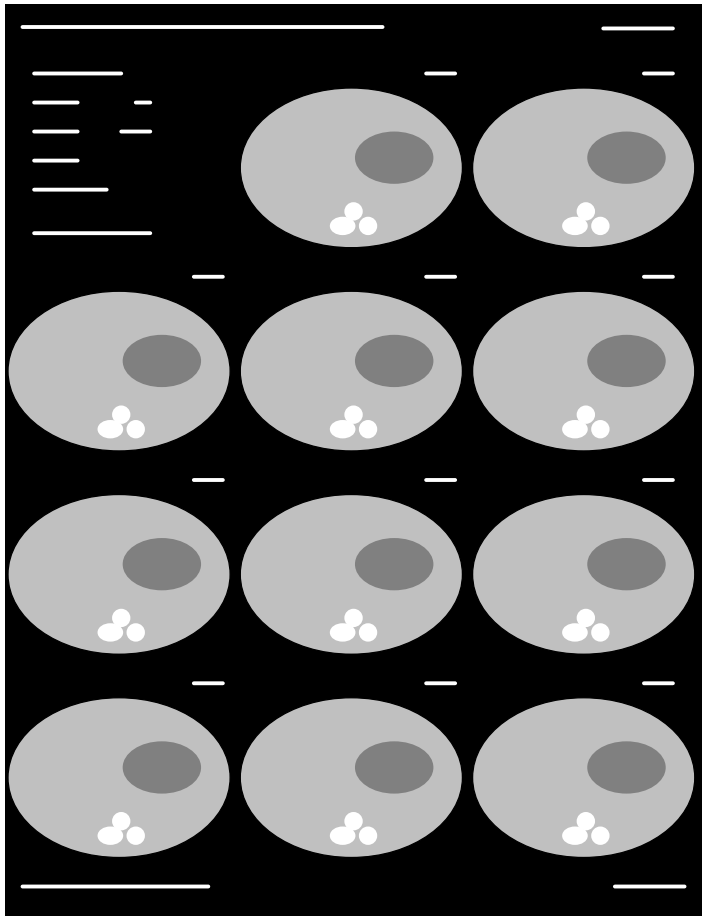
X-ray rooms with Medical Imaging applied as printserver



Comparison *screen copy* vs *optimized* film



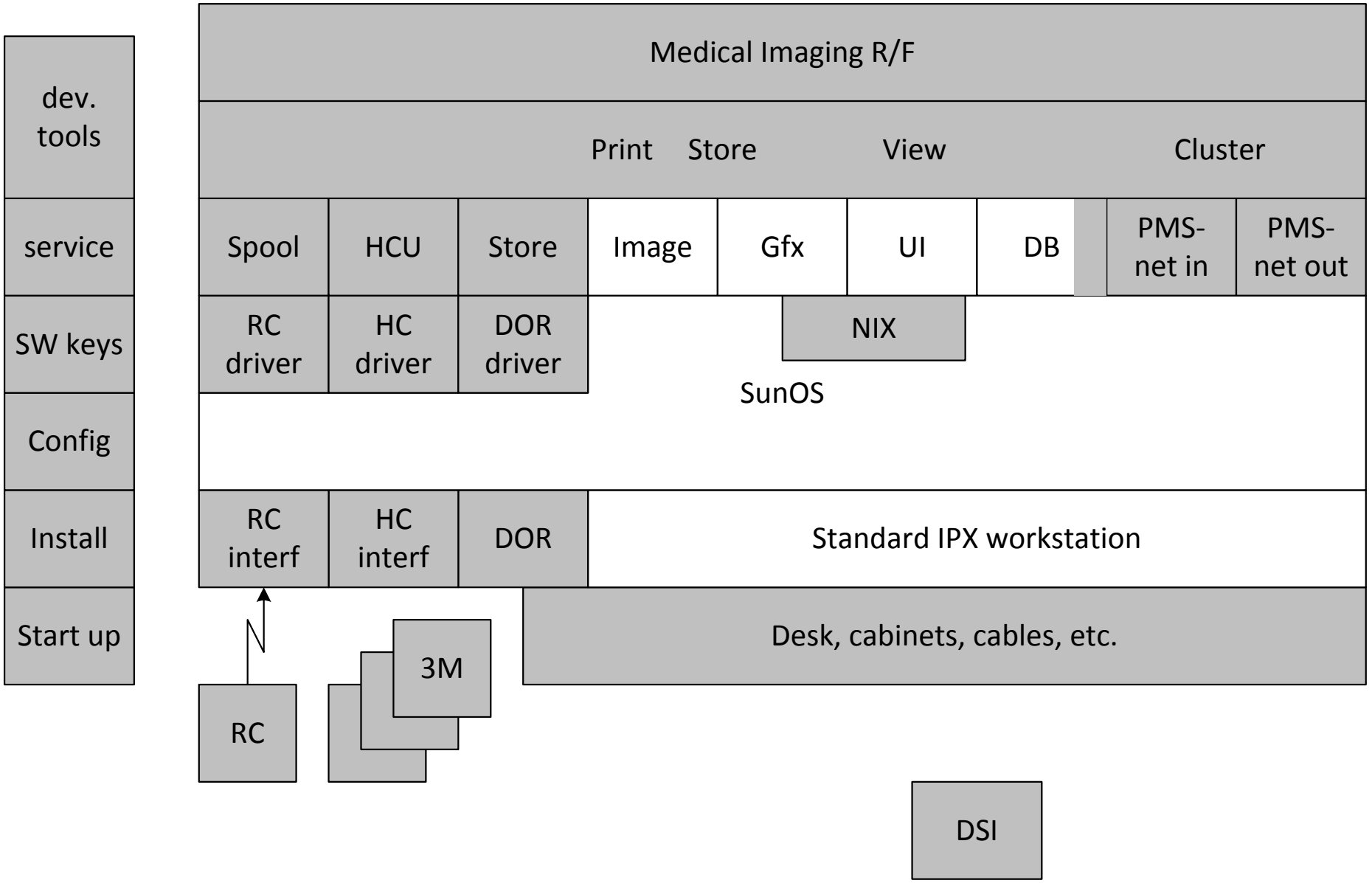
old: screen copy



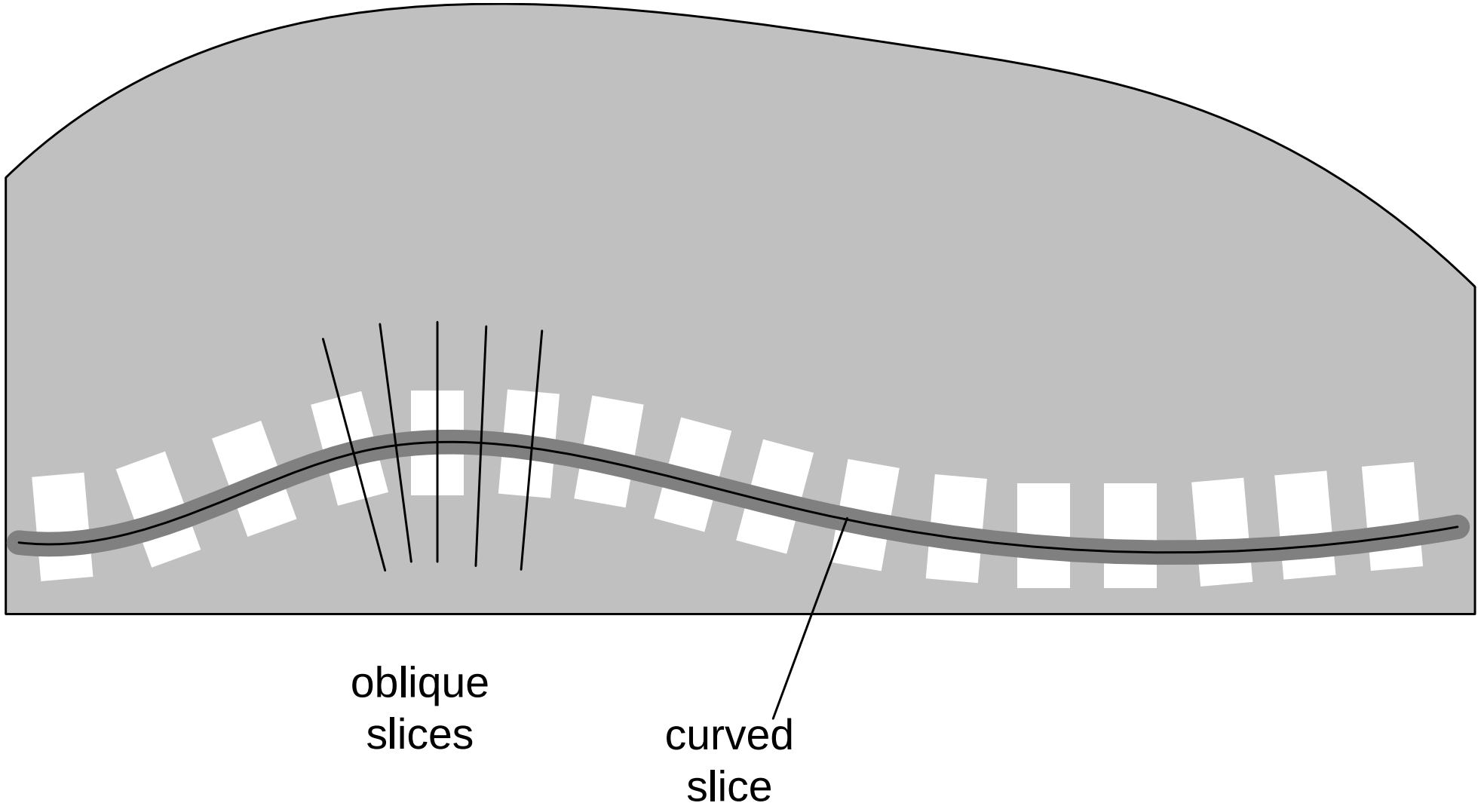
new: SW formatting

20 to 50% less film needed

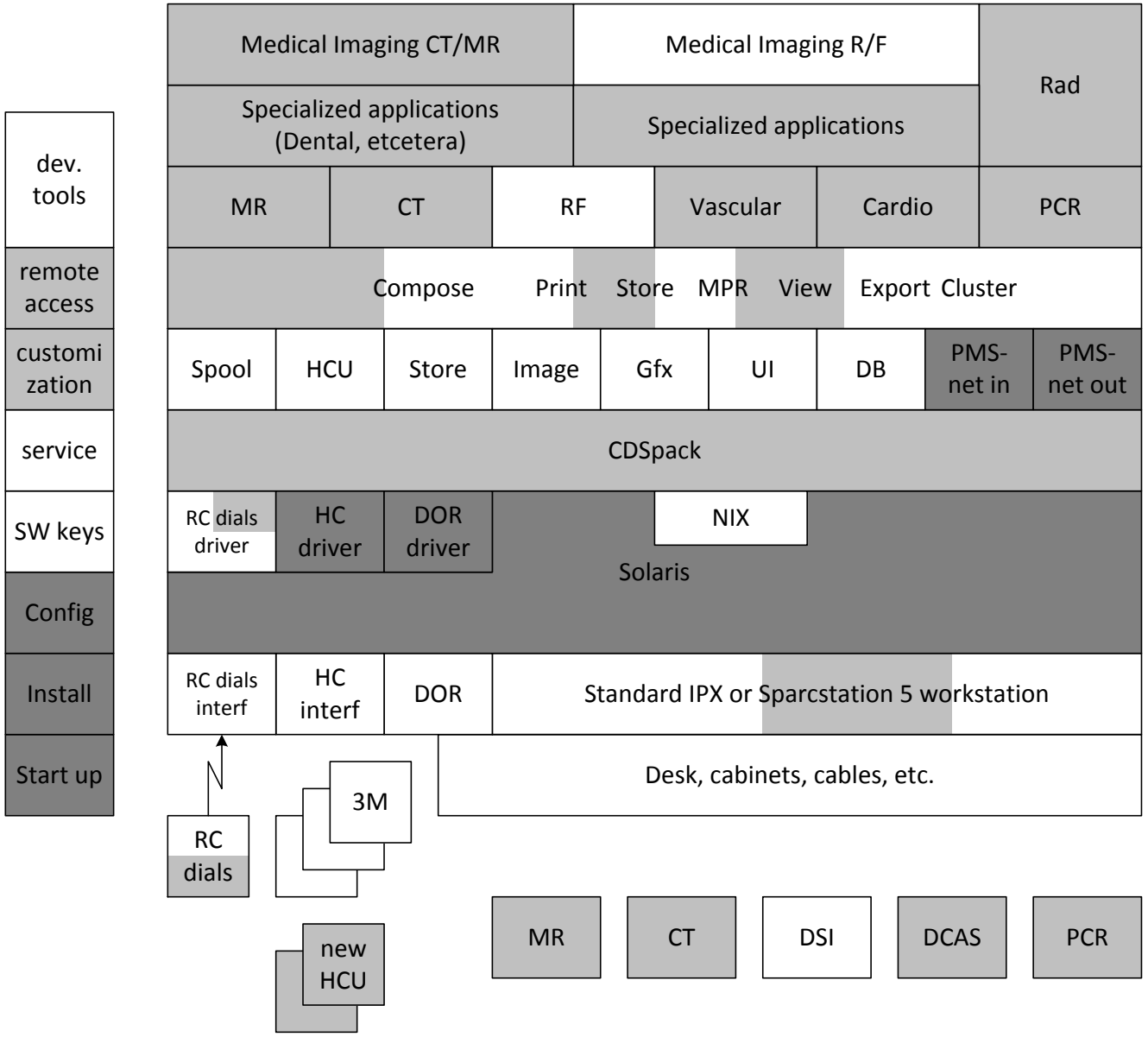
Idealized layers september 1992



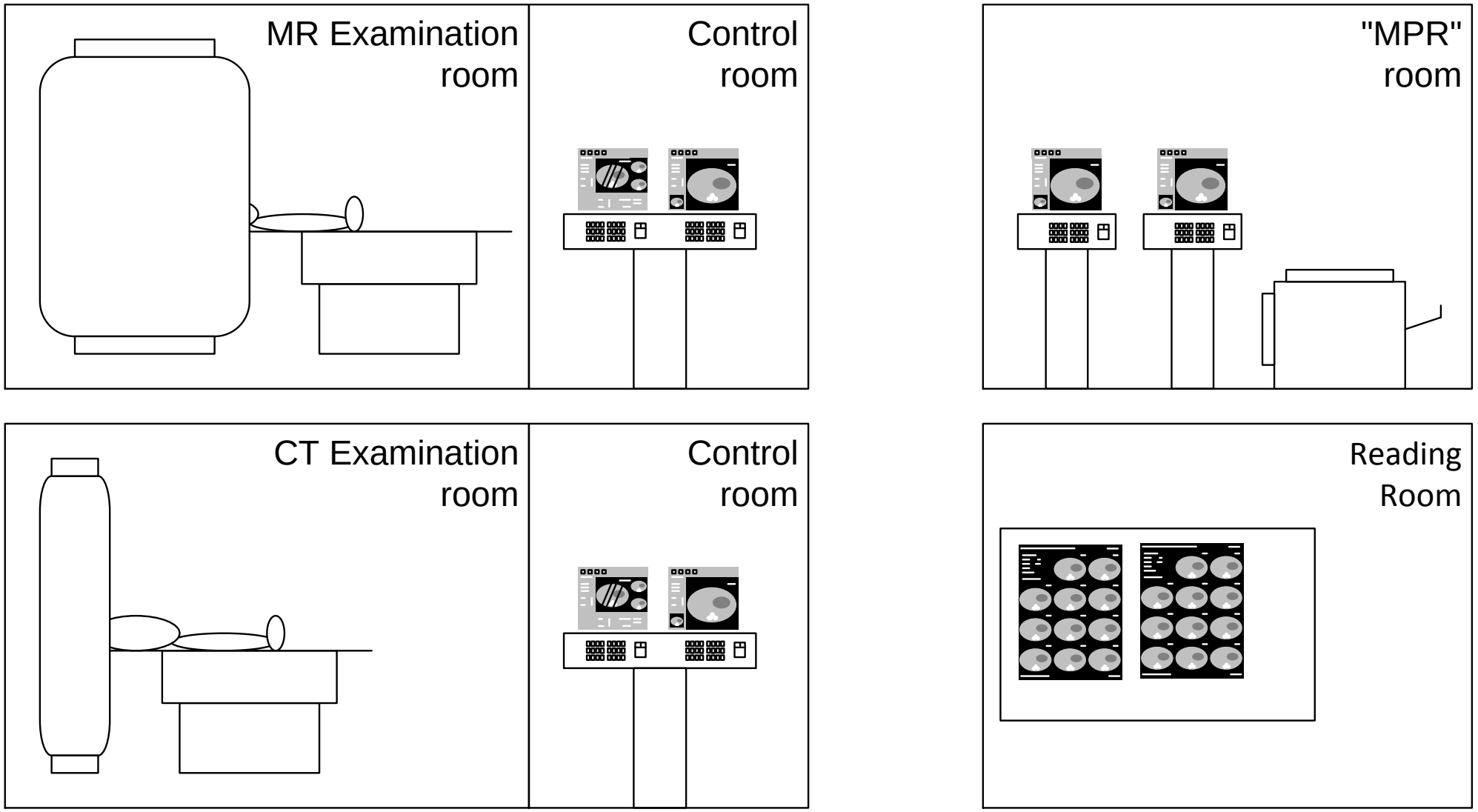
Example Multi Planar Reconstruction



Idealized layers june 1994



Example CT/MR department



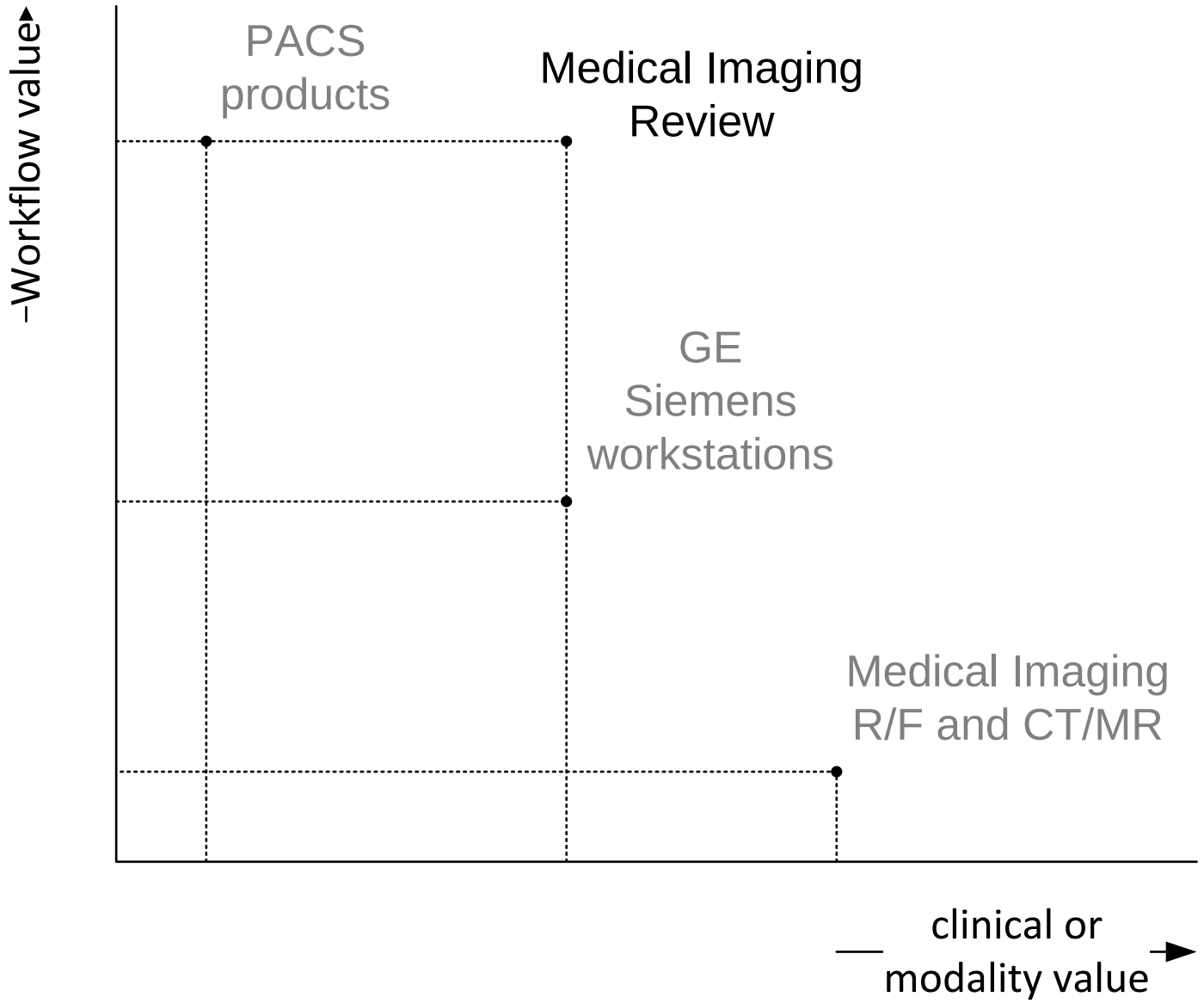
Differences between modality images

	X-ray	CT	MR
image	projection	slice	slice
structure	single image	stack	stack
	or time series	or volume	or more complex
greylevel mapping	contrast	window width	window width
	brightness	window level	window level
resolution	1024^2	512^2	256^2
contrast noise ratio	10 bit	12 bit	8 bit
value		absolute	acquisition dependent

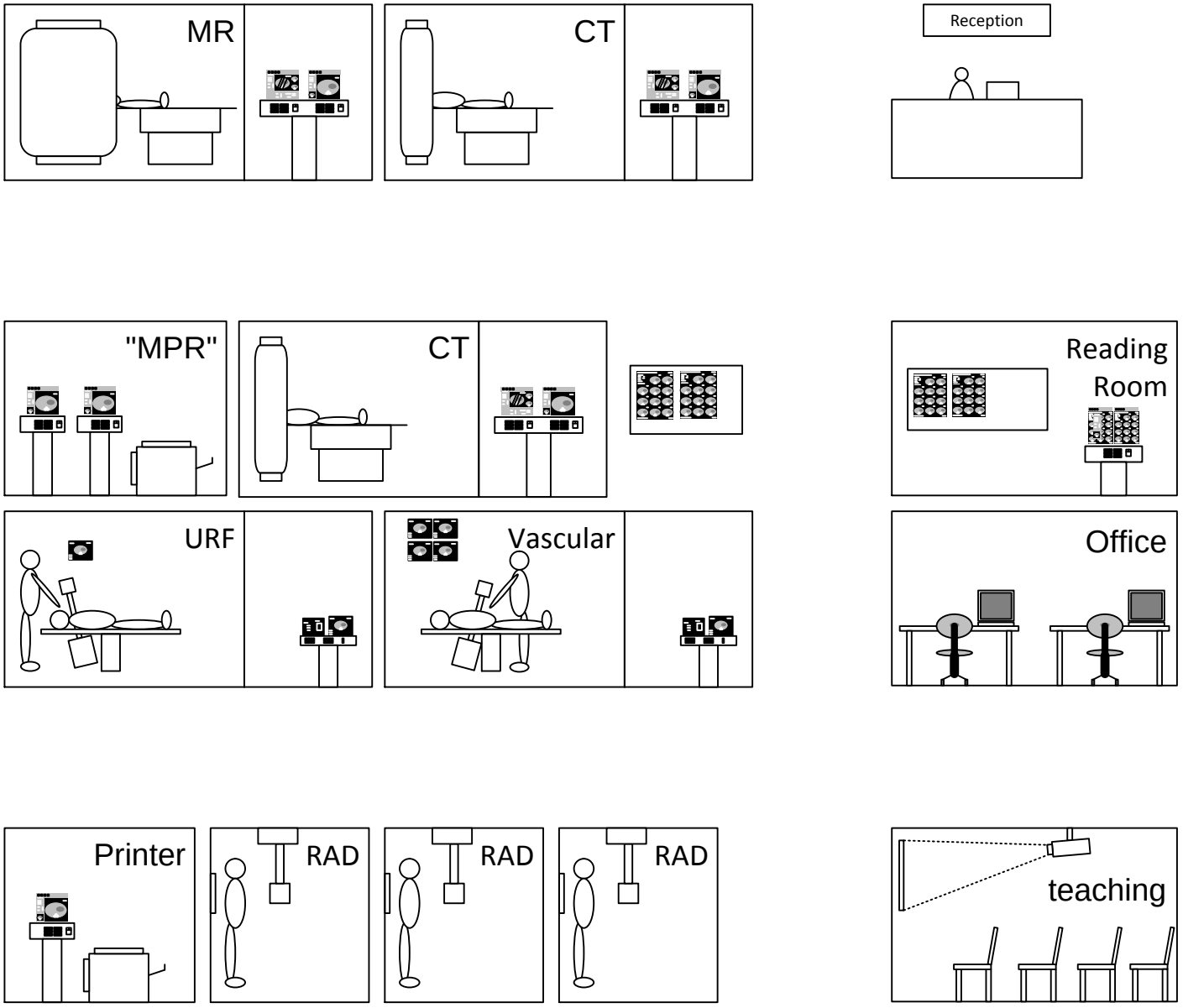
Specification Differences

- viewing and print preparation
  - navigation support
  - multi-image view
  - greylevel control
- specialized clinical functions
  - vascular and cardio analysis (X-ray)
  - dental (CT)
- print protocols
- information model

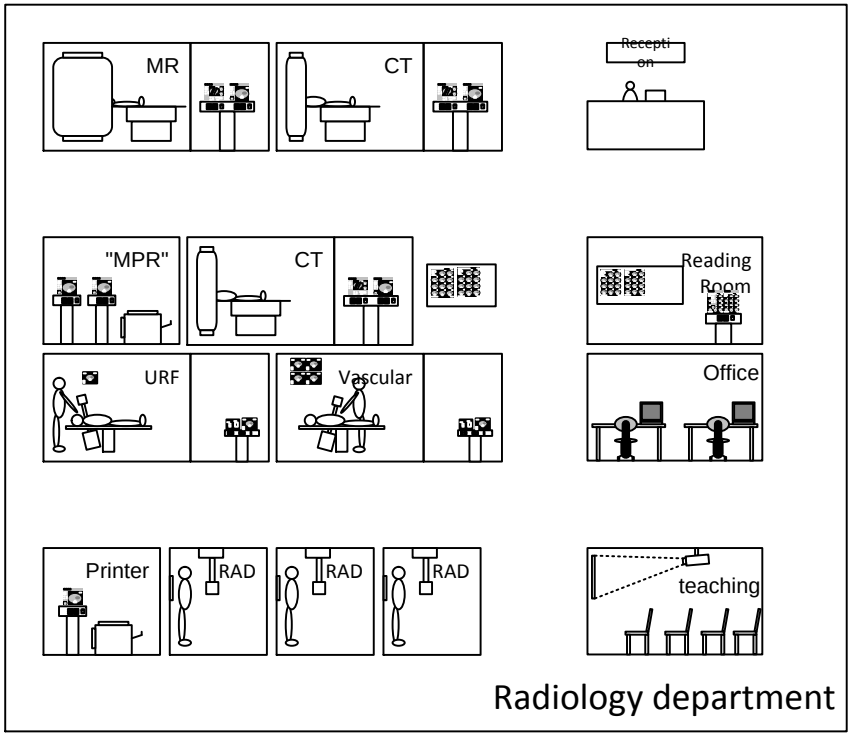
Medical Imaging Competitive Positioning



Radiology Department

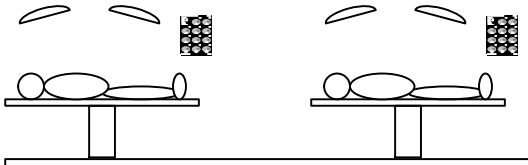


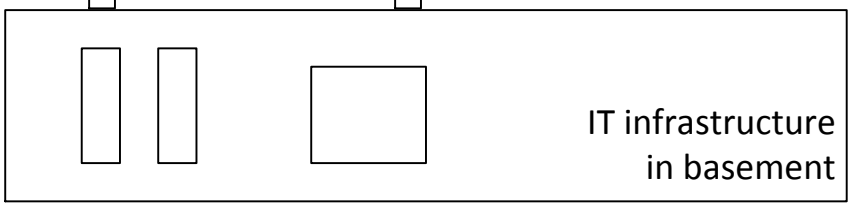
Vision: Medical Imaging in Healthcare



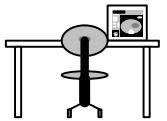
Operating theatre

trauma room



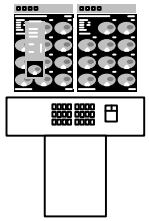


Radiologist at home

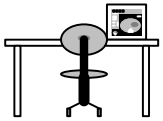


Radiologist somewhere in the hospital

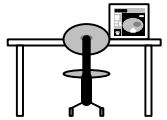
Radiologist at other hospital



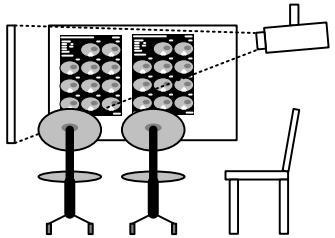
Referring Physician



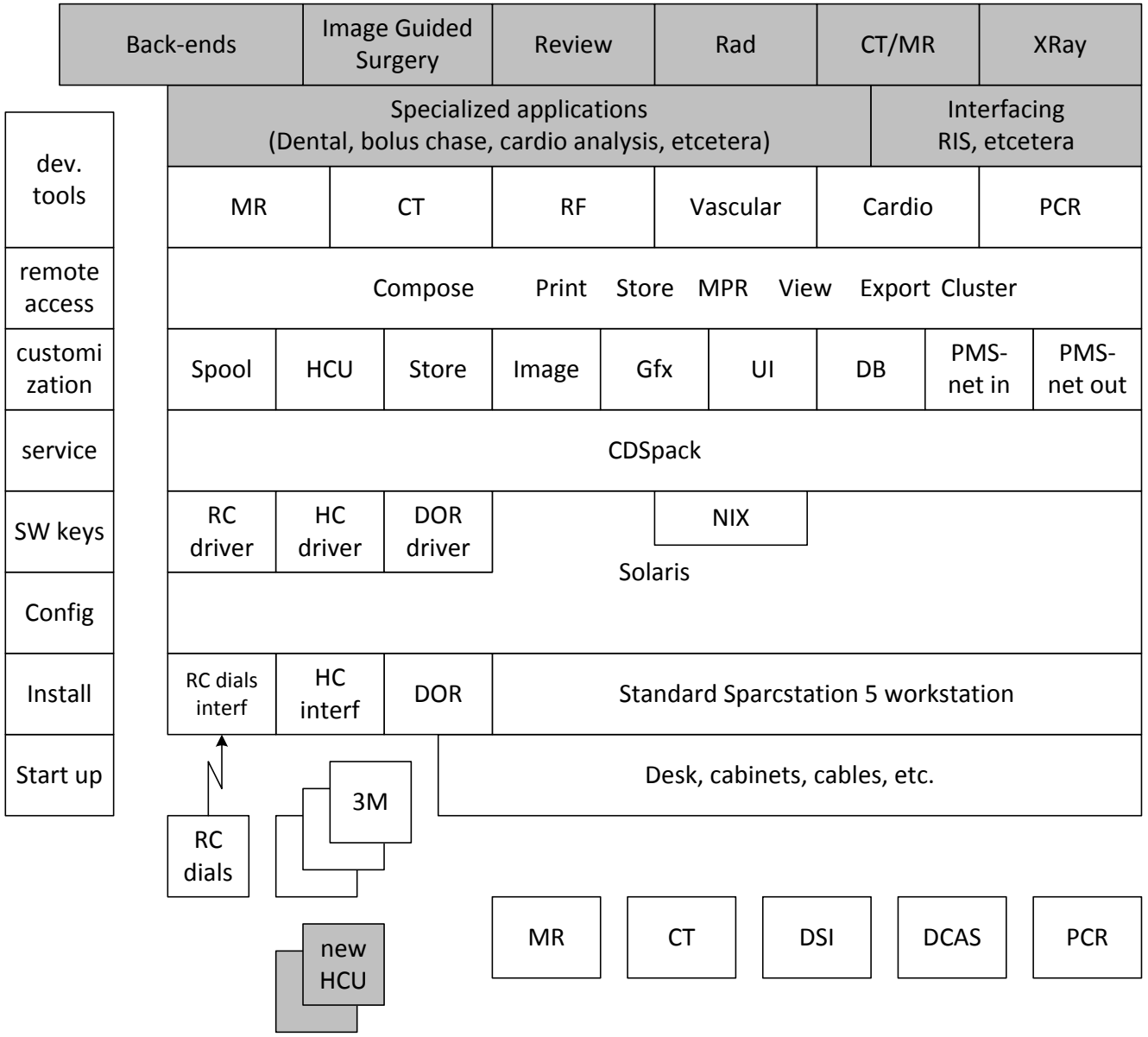
Referring Physician



Conference room



Idealized layers 1996



System Level Documents: Root

- List of system level document lists
- System level requirements, specification and design documents
- System aspect documents
- Feasibility reports

Lists

- Cluster, interoperability documents
- Functional Specifications X-ray
- Functional Specifications CT/MR
- Application SW design
- System Software design
- Hardware documents

Documents

- Product Structure
- System Engineering requirements
- Design overview
- Hazard analysis
- Verification specification X-ray
- Verification specification CT/MR

Aspect Documents

- Cluster design
- HW Configuration
- CPU resource usage
- Disk resource usage
- Memory resource usage
- Requirements system monitor
- Safety
- Security
- SW process structure
- Testability and Service tools
- Installation, Configuration and Start-up design
- CT/MR image quality
- R/F image quality
- CT/MR typical load
- R/F typical load

Example Memory Budget

budget in MBytes	X-ray	CT/MR
code	14	14
non bulk data	14	18
bulk data	36	88
Unix	13	13
total used	77	133
physical memory	64	128