

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

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## Abstract

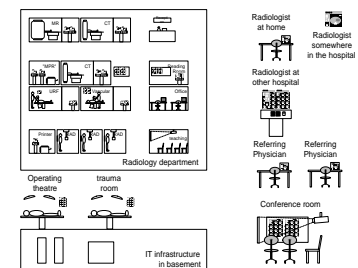
Medical Imaging was an early large scale Object Oriented product. Originally intended to become a re-useable set of toolboxes, it evolved in a family of medical workstations and servers.

This article describes the evolution from different viewpoints, to serve as background material for a number of case studies of the Gaudí project.

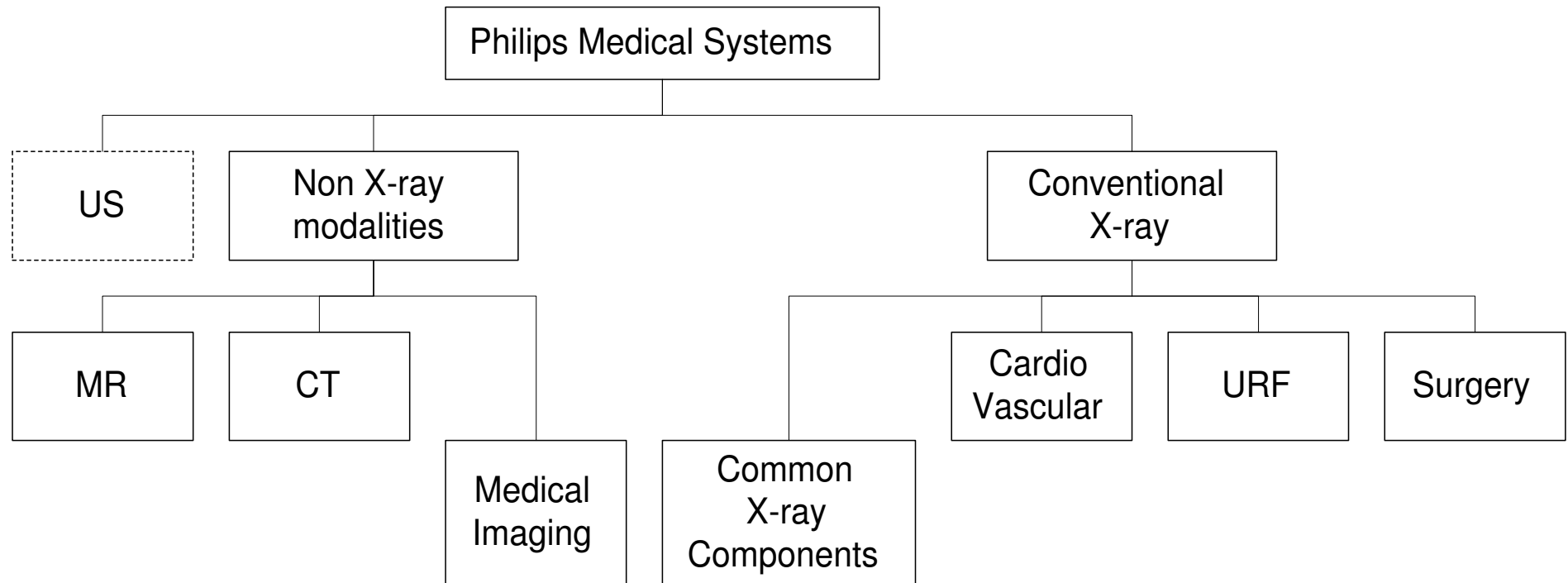
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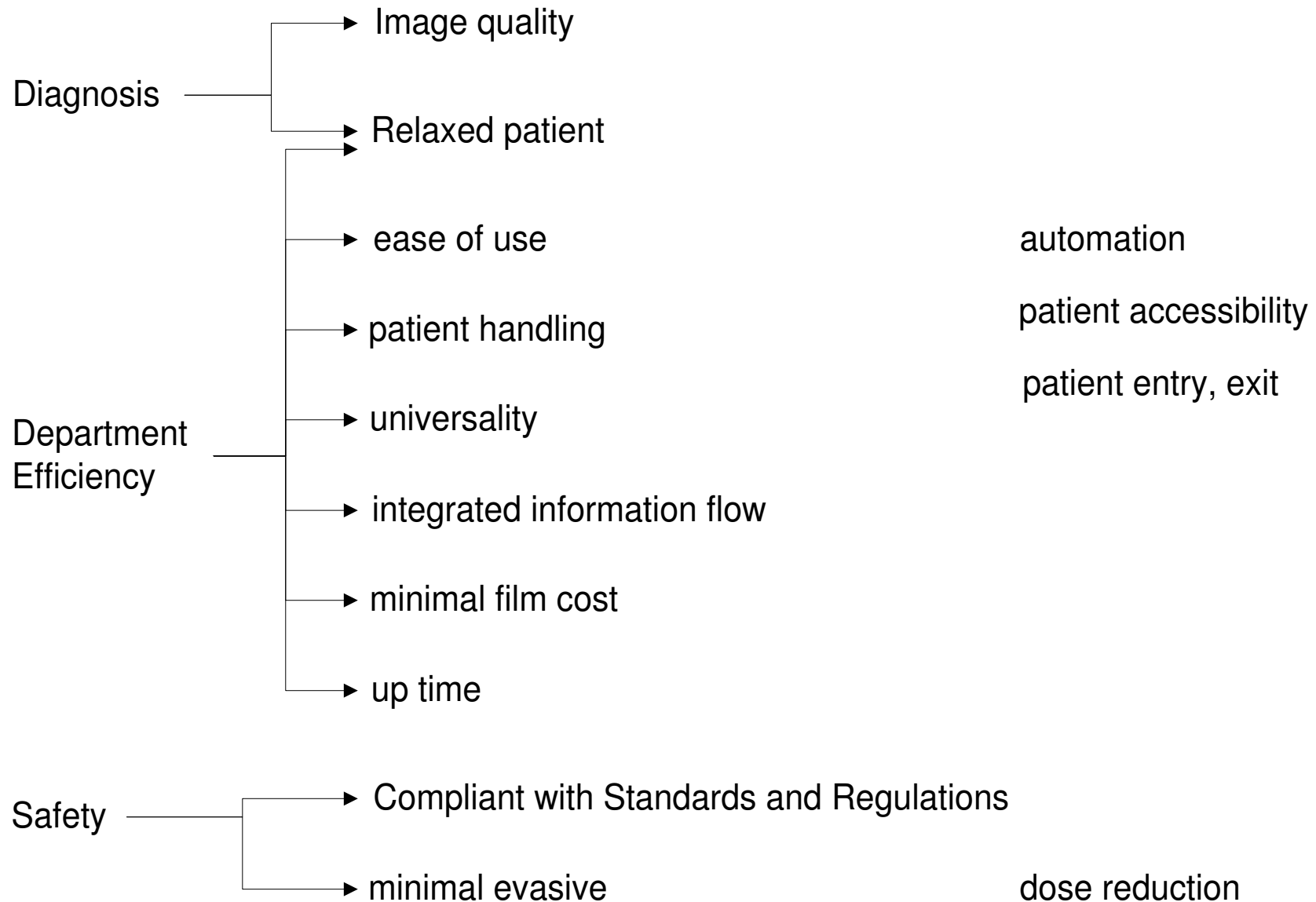
February 10, 2011  
status: preliminary  
draft  
version: 0.4



# Philips Medical Systems, schematic organization



# Generic drivers of Radiology Departments



# Phases of Medical Imaging

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

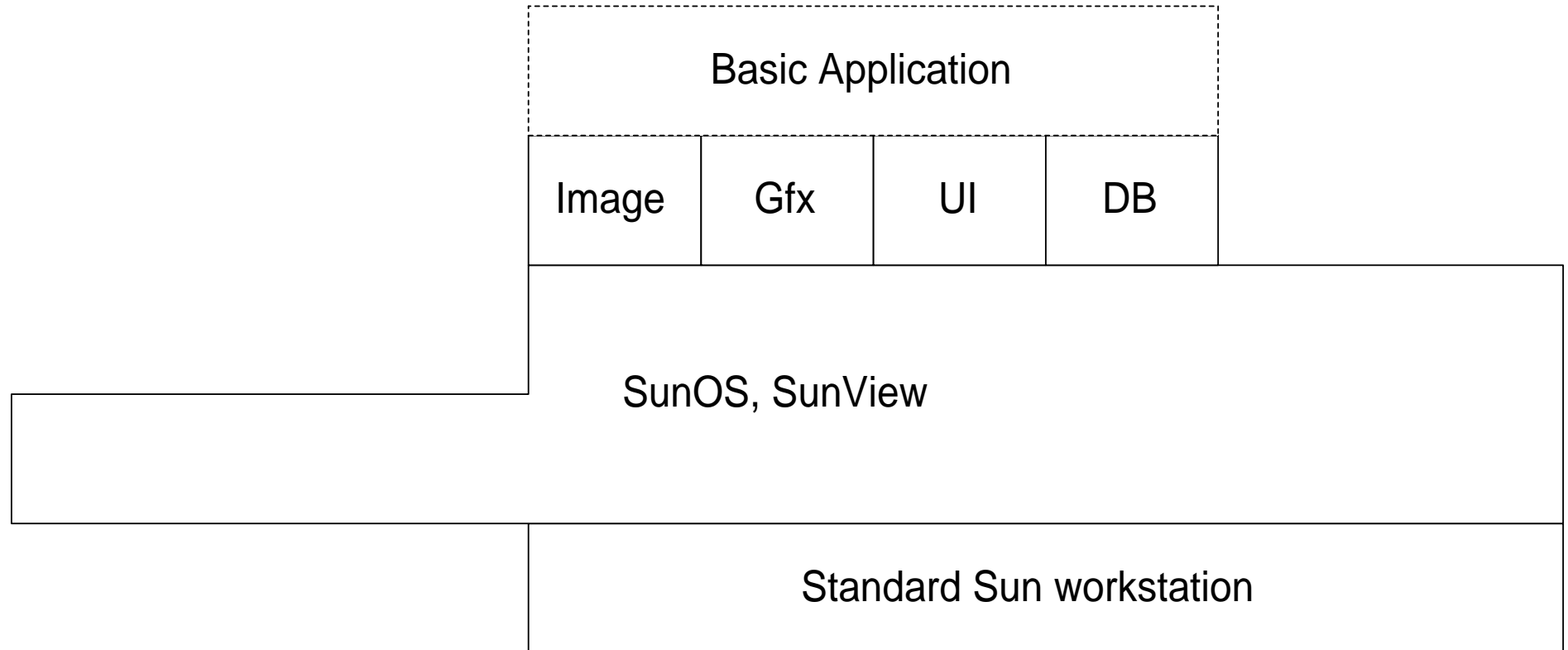
# Technology innovations by Common Viewing

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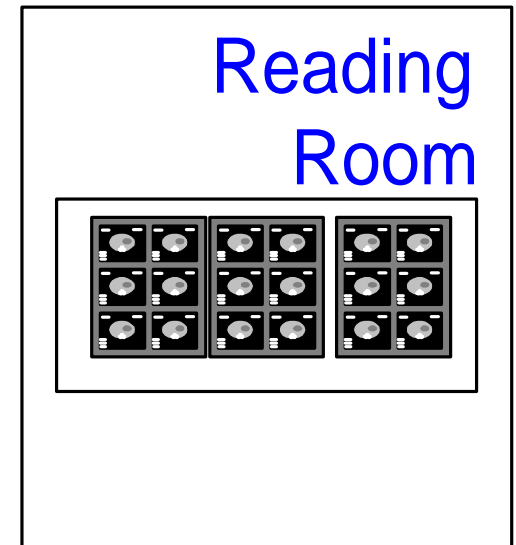
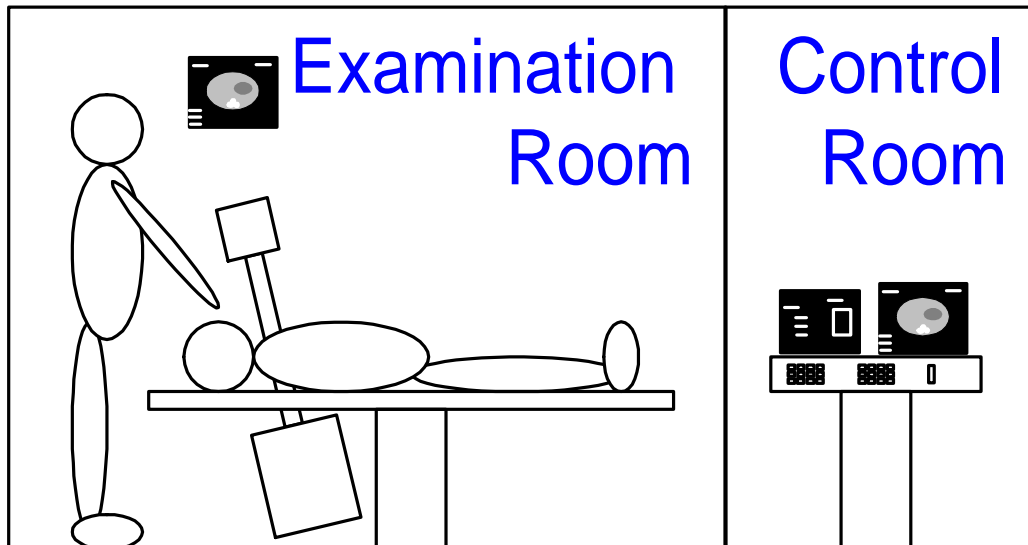
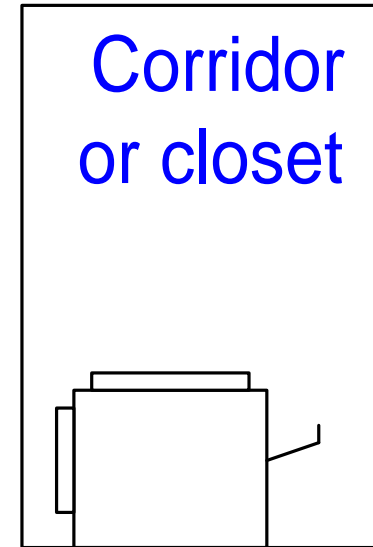
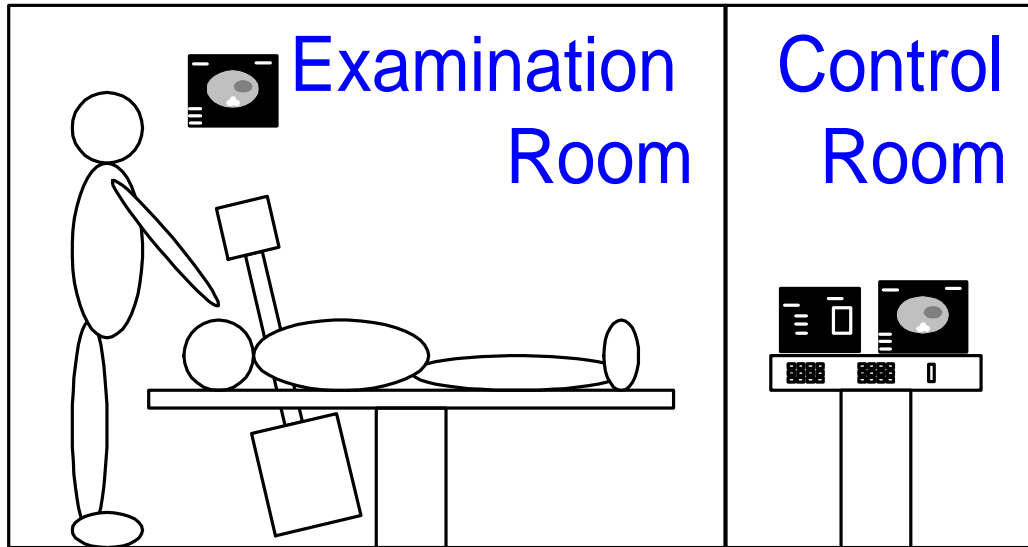
- Standard UNIX based workstation
- Full SW implementation, more flexible
- Object Oriented design and implementation (Objective-C)
- Graphical User Interface, with windows, mouse et cetera
- Call back scheduling, fine-grained notification
- Data base engine, fast, reliable and robust
- Extensive set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

# Idealized layers september 1991

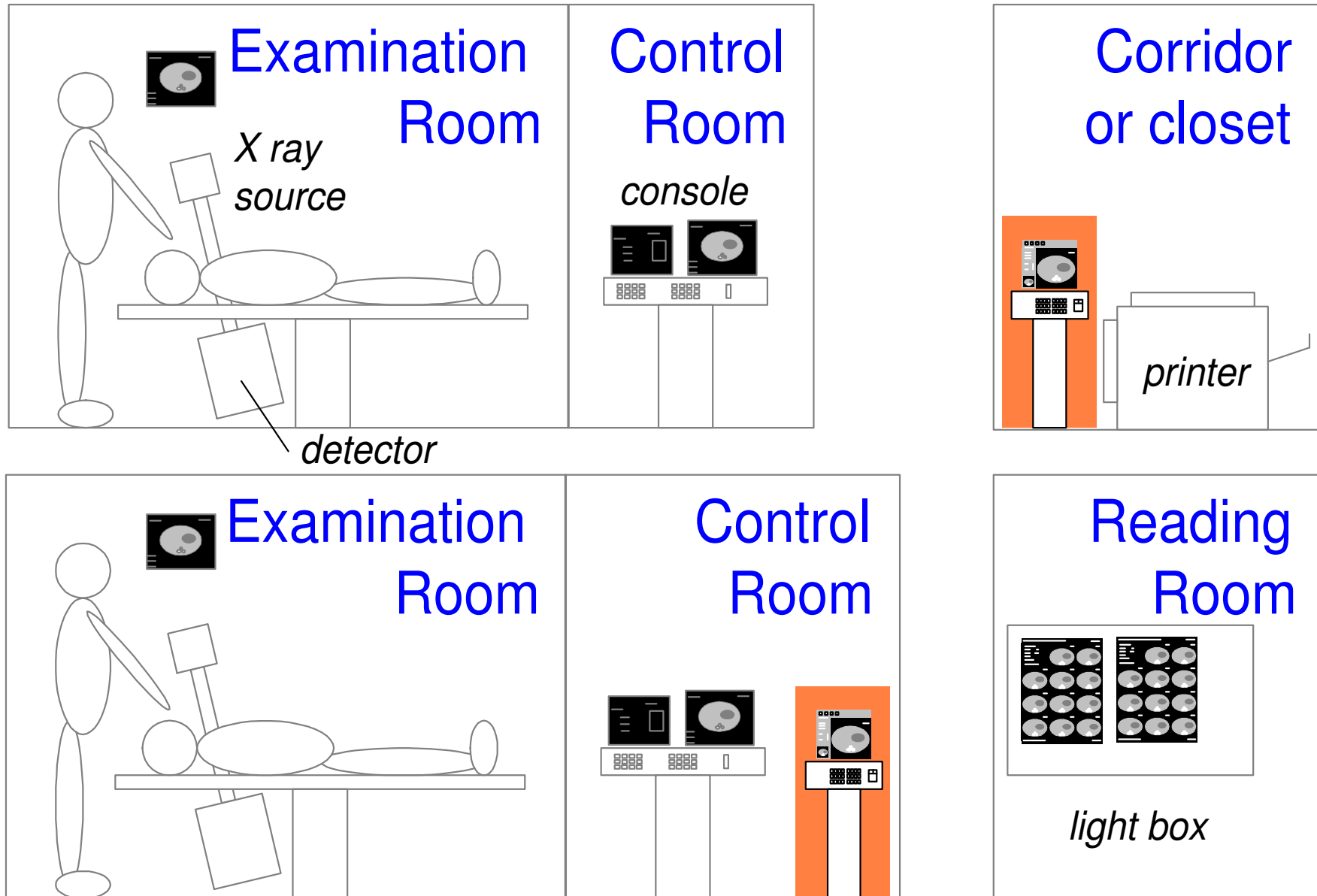
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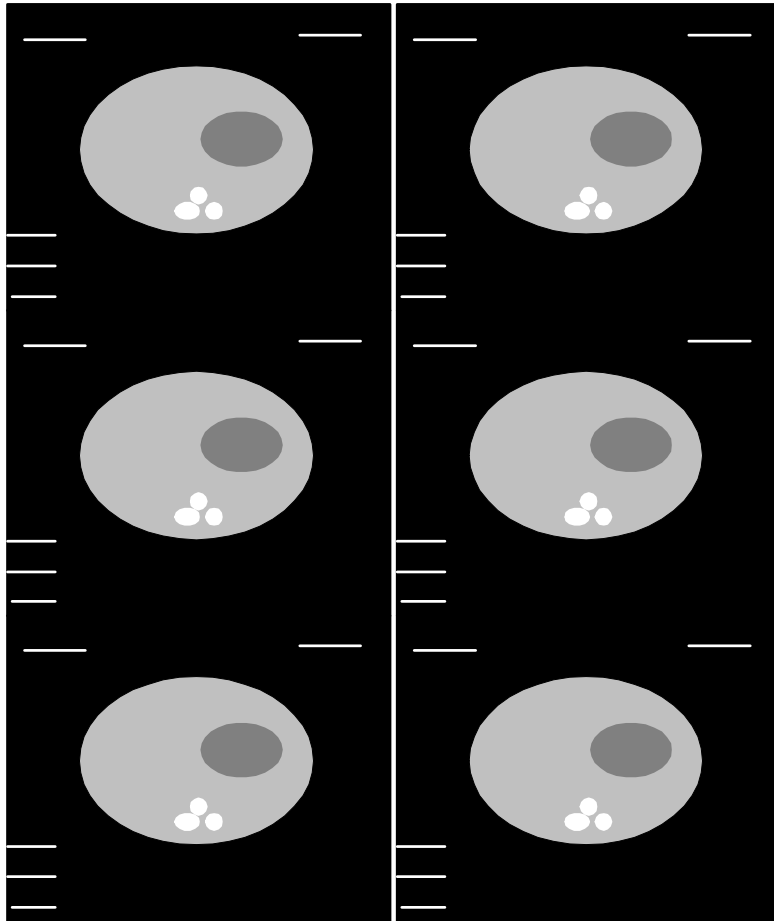
# X-ray rooms from examination to reading around 1990



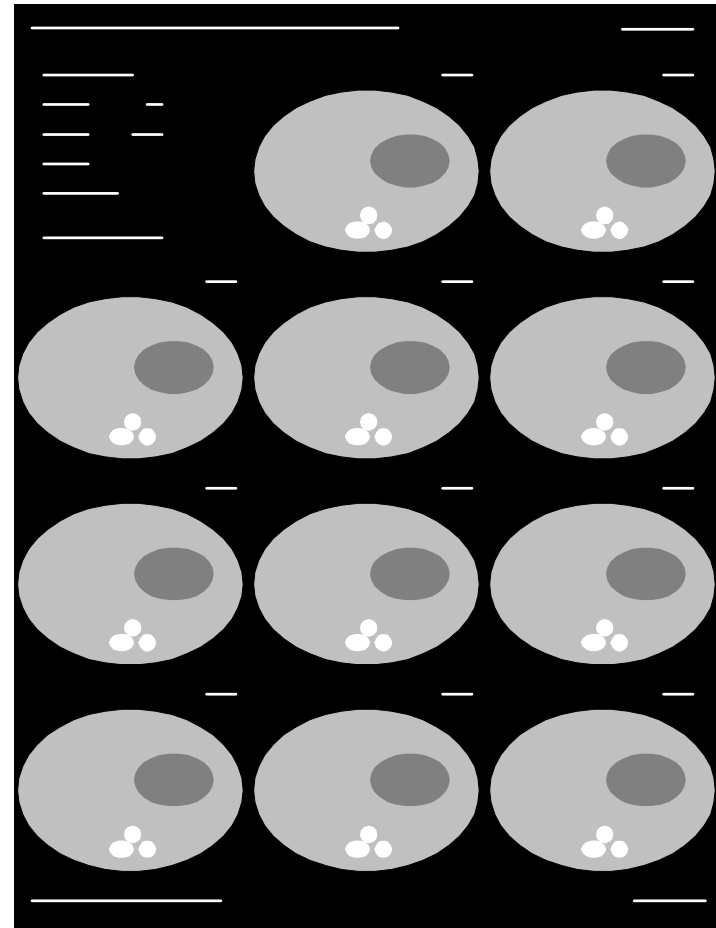
# X-ray rooms with Medical Imaging applied as printserver



# Comparison *screen copy* vs *optimized* film



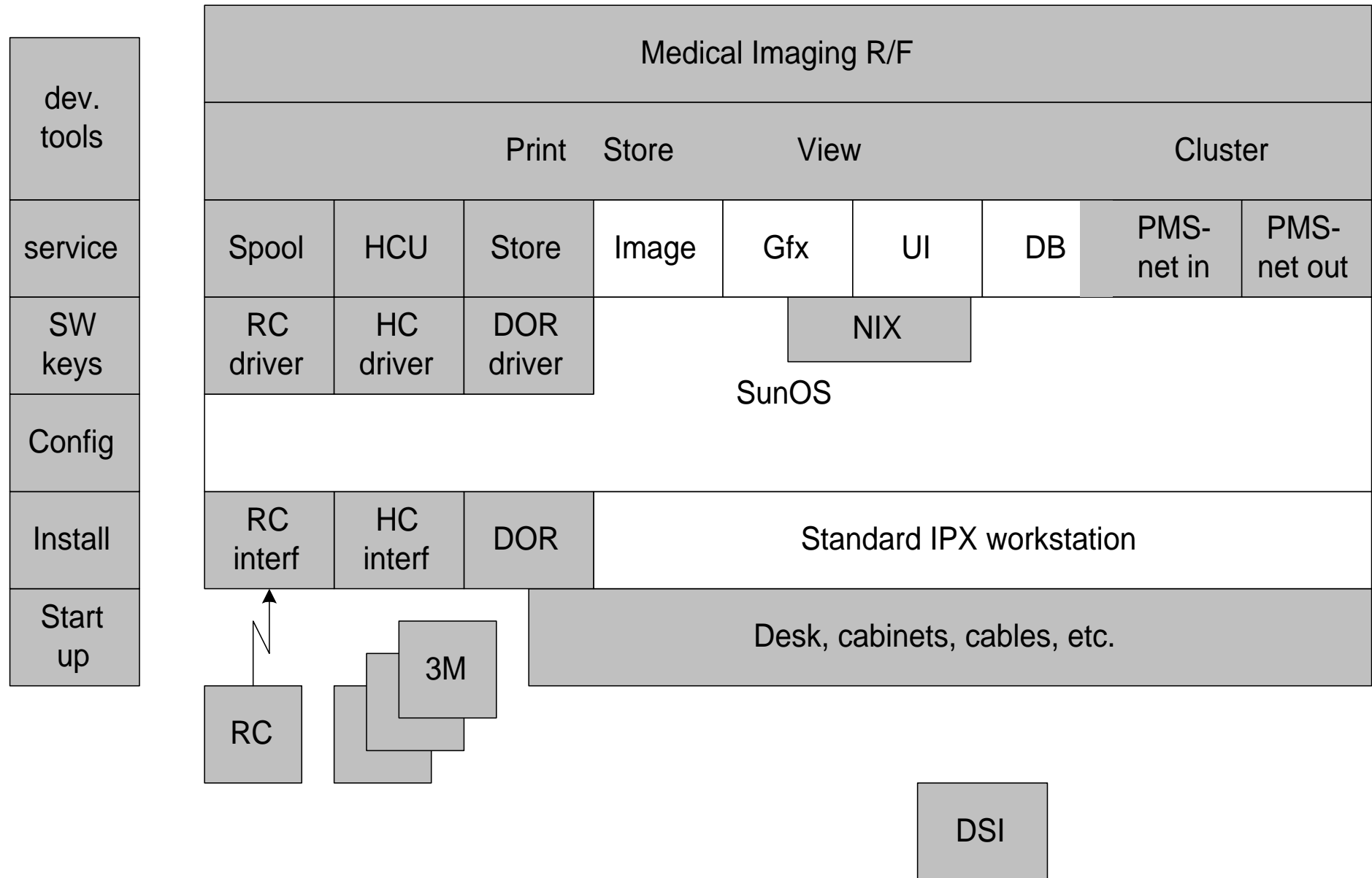
old: screen copy



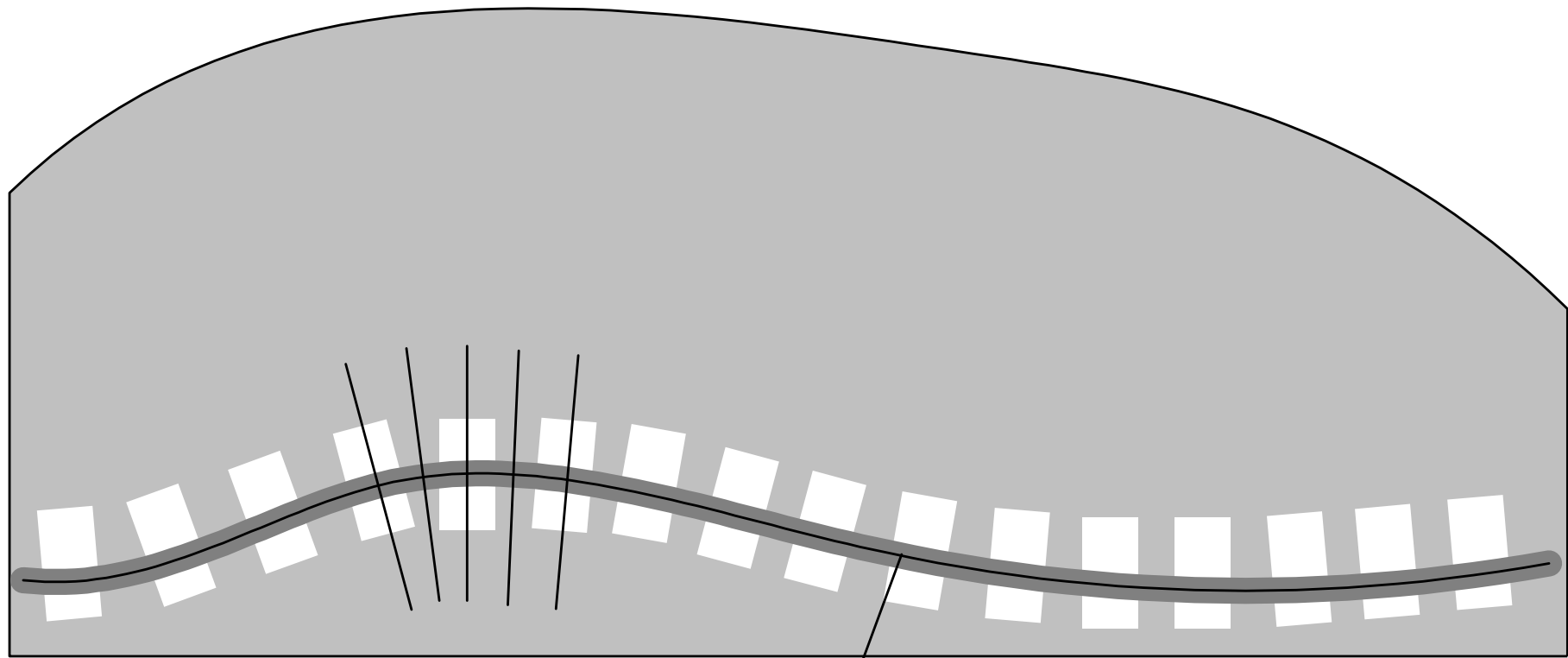
new: SW formatting

20 to 50% less film needed

# Idealized layers september 1992



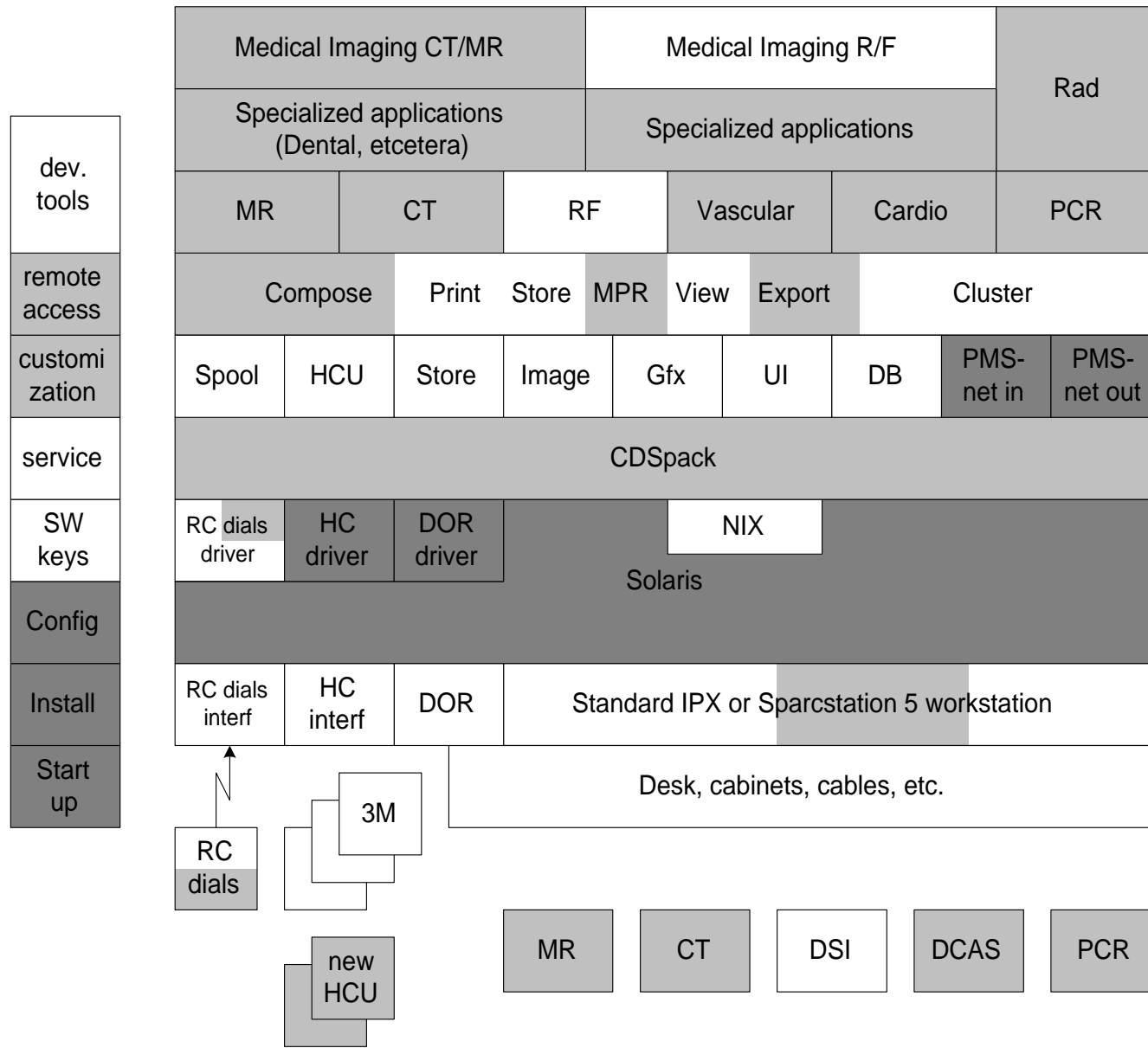
# Example Multi Planar Reconstruction



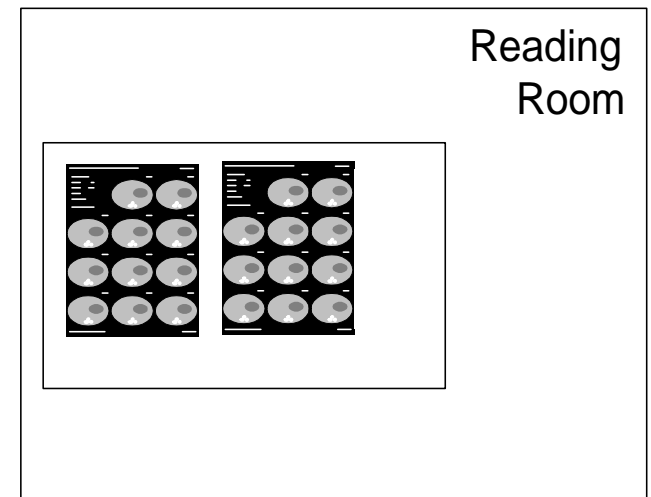
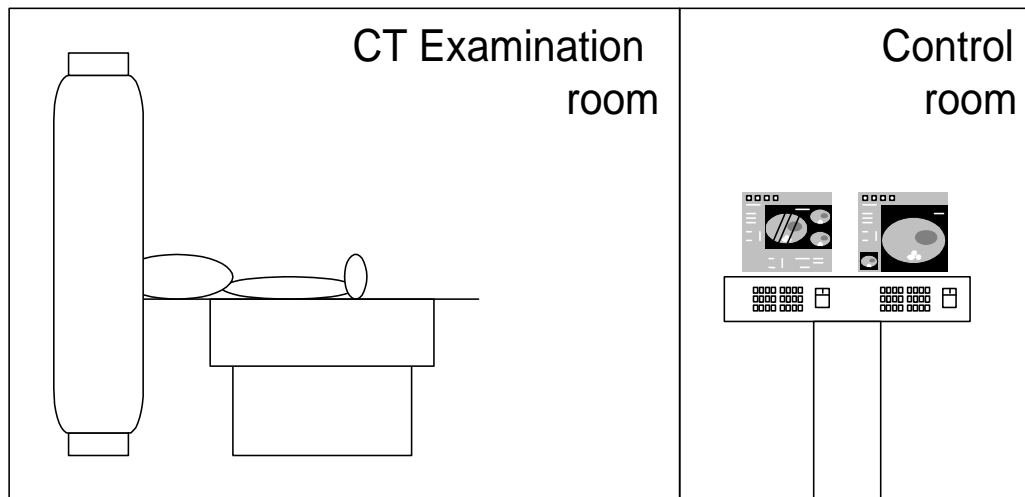
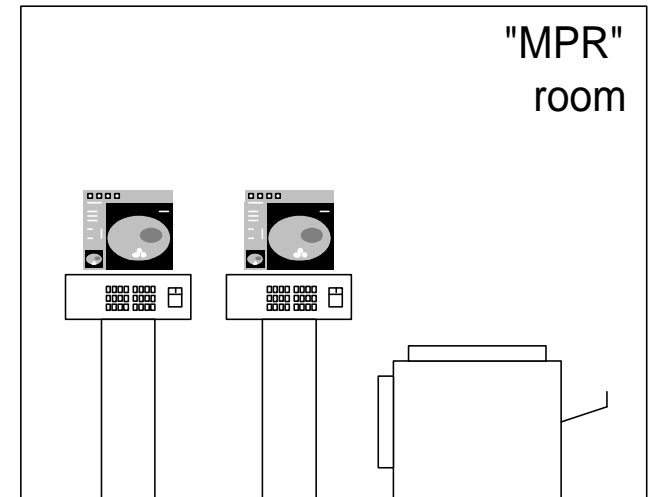
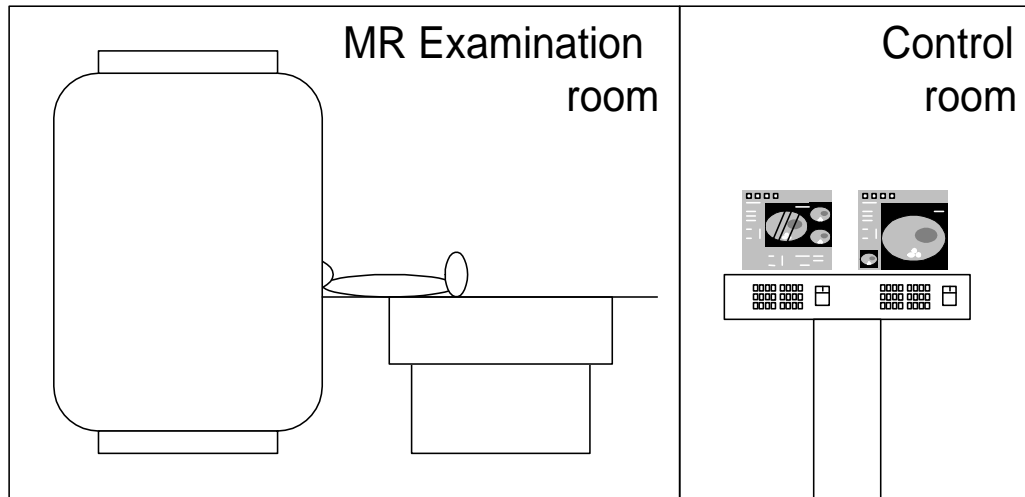
oblique  
slices

curved  
slice

# Idealized layers june 1994



# Example CT/MR department



# Differences between modality images

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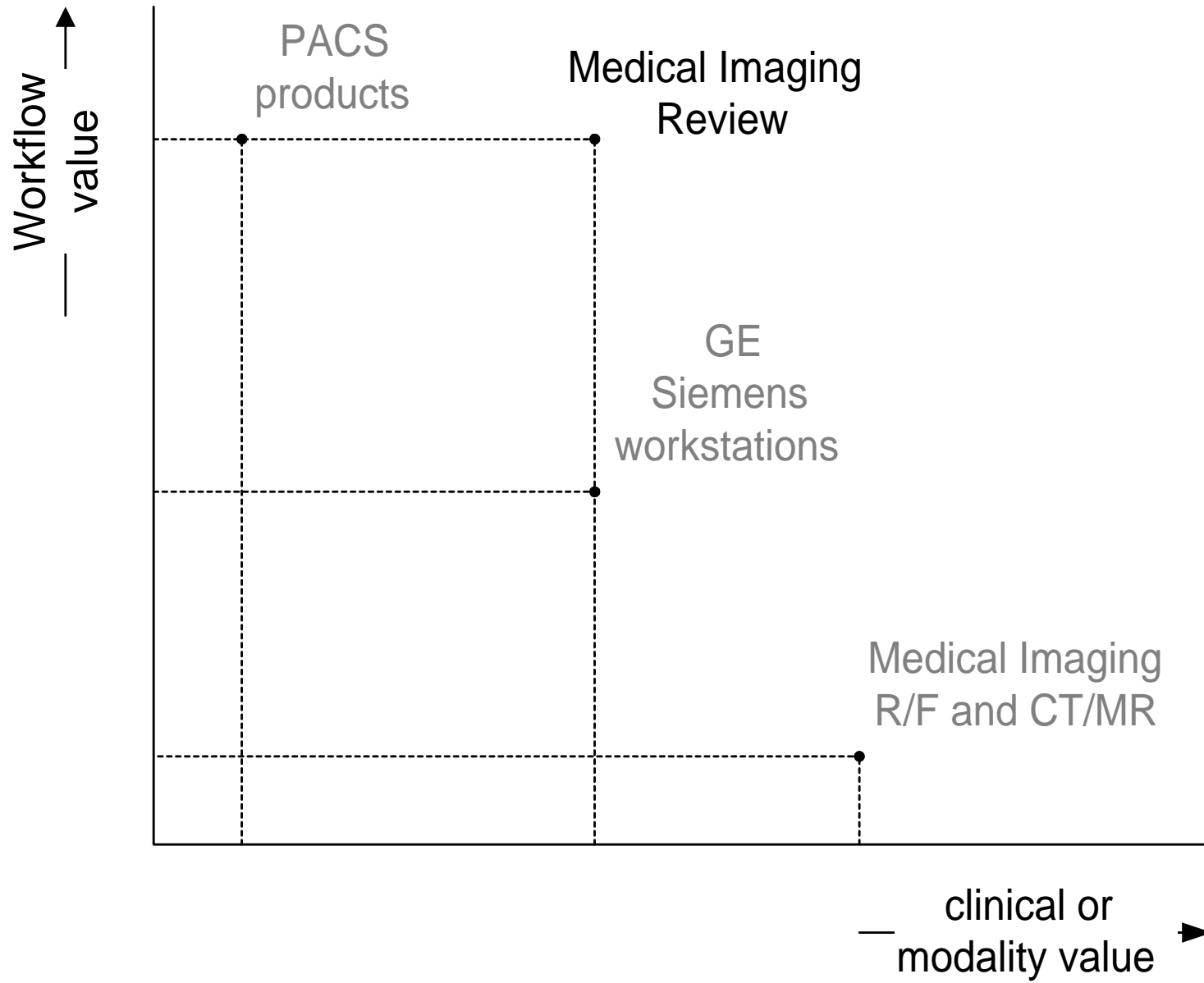
	X-ray	CT	MR
image	projection	slice	slice
structure	single image or time series	stack or volume	stack or more complex
greylevel mapping	contrast brightness	window width window level	window width window level
resolution	1024 <sup>2</sup>	512 <sup>2</sup>	256 <sup>2</sup>
contrast noise ratio	10 bit	12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

# Specification Differences

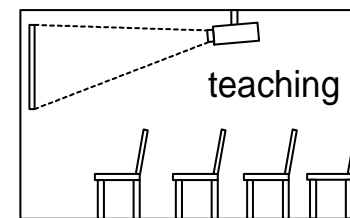
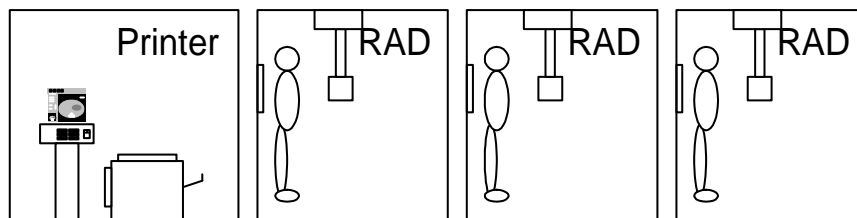
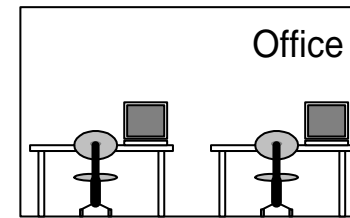
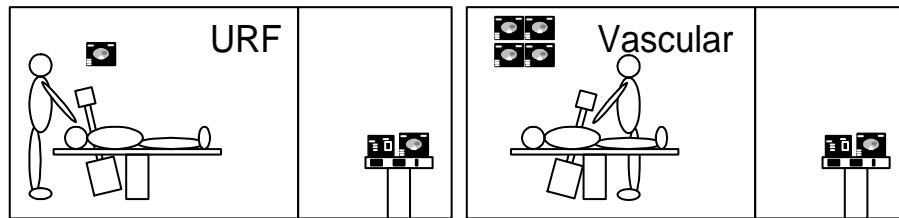
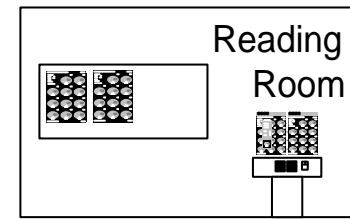
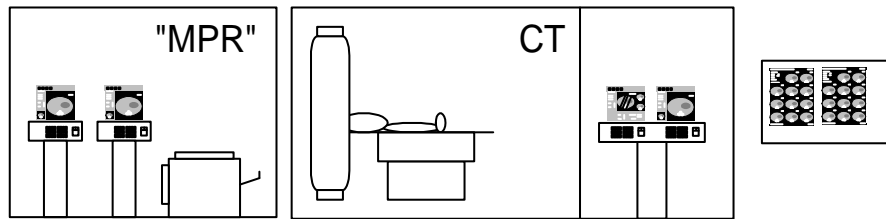
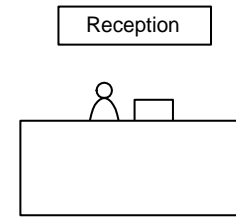
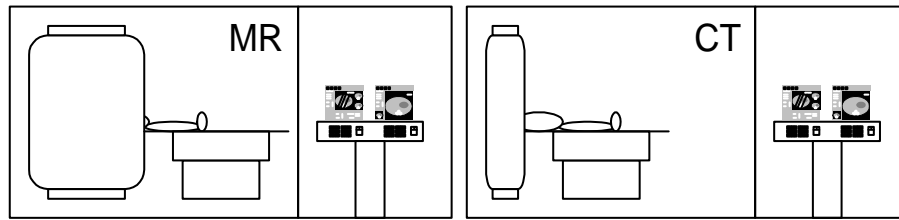
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- viewing and print preparation
  - navigation support
  - multi-image view
  - greylevel control
- specialized clinical functions
  - vascular and cardio analysis (X-ray)
  - dental (CT)
- print protocols
- information model

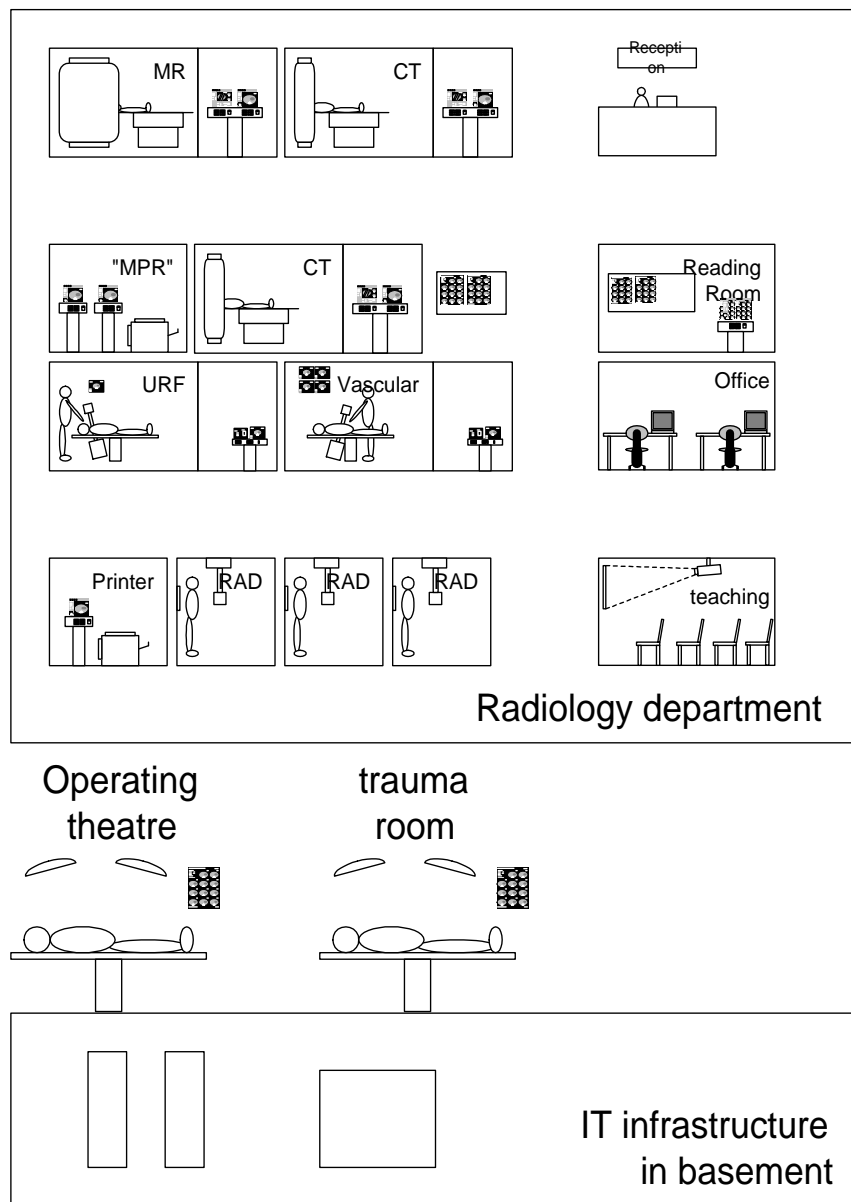
# Medical Imaging Competitive Positioning



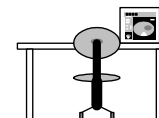
# Radiology Department



# Vision: Medical Imaging in Healthcare

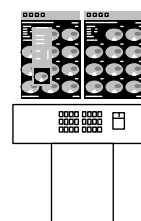


Radiologist at home

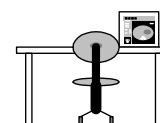


Radiologist somewhere in the hospital

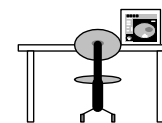
Radiologist at other hospital



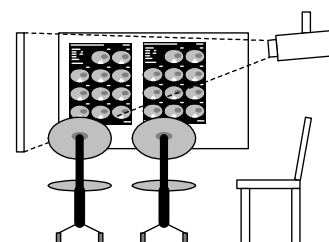
Referring Physician



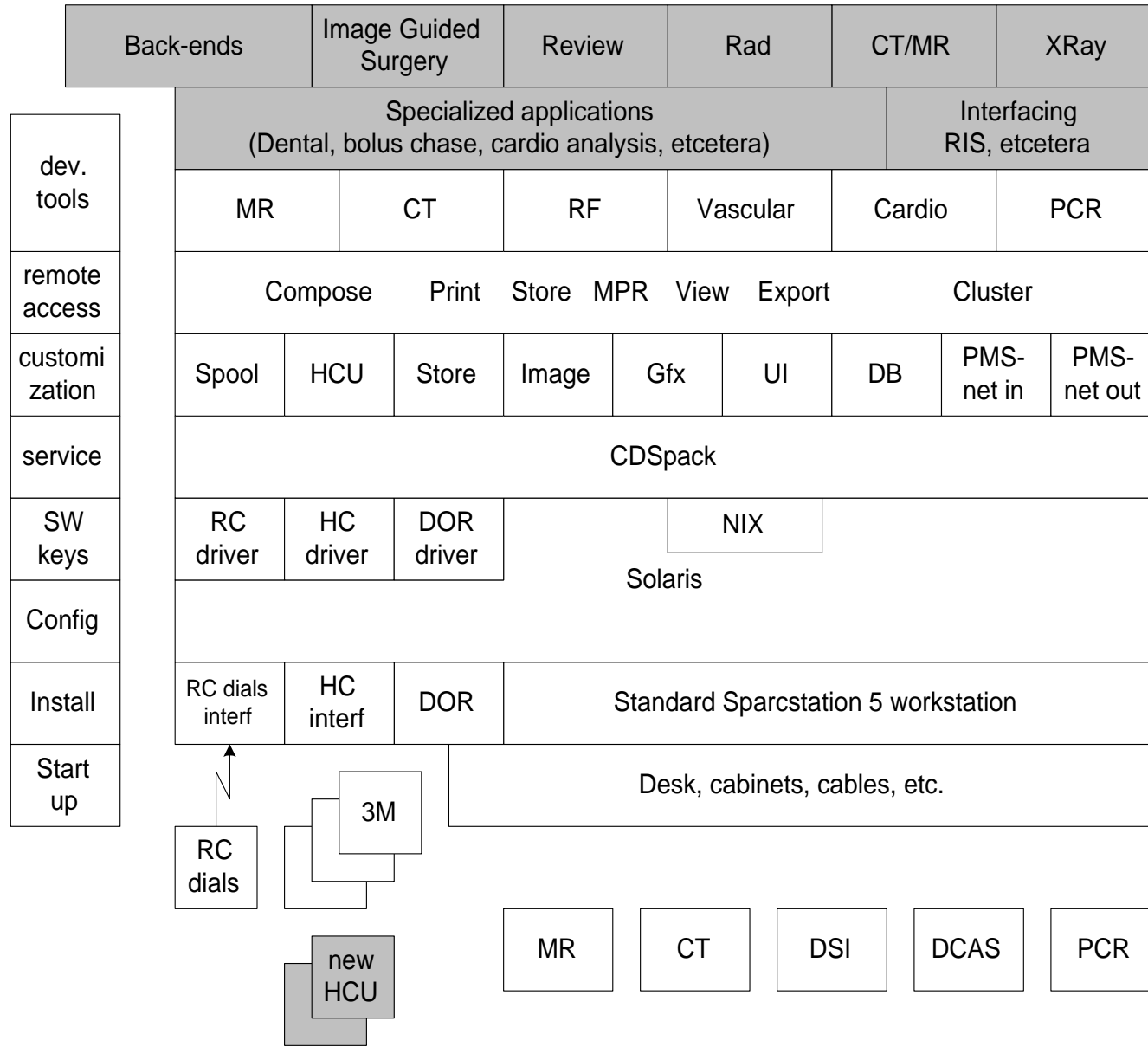
Referring Physician



Conference room



# Idealized layers 1996



# System Level Documents: Root

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

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

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

# Aspect Documents

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- 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

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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