

# *What is Systems Research?*

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# Scientific Research

- Take hypothesis about environment
- Design experiment
- Run experiment and quantify
- Interpret results
- If necessary, create new hypothesis

# Systems Research

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- Run simulation model or measure hardware
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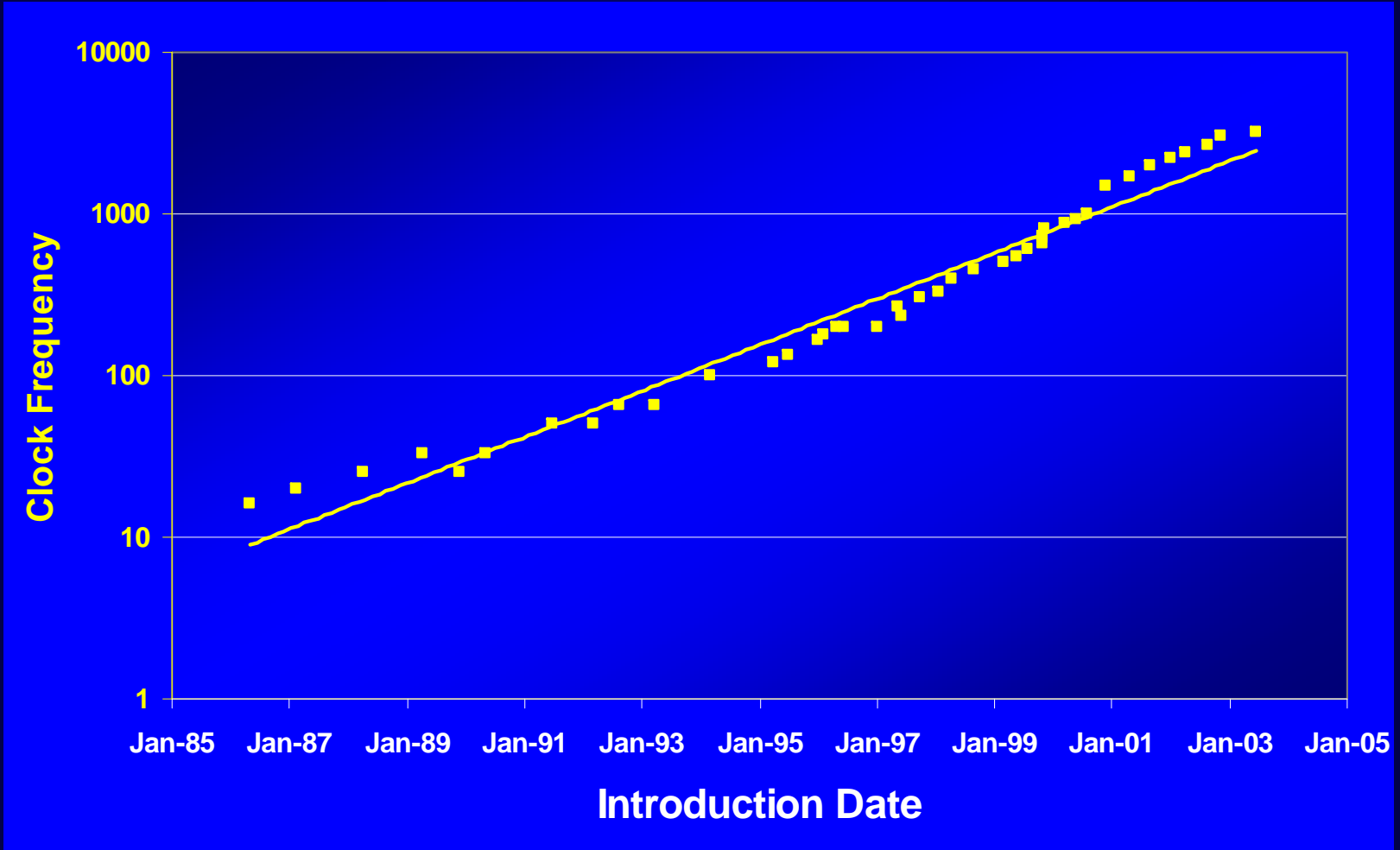
# Systems Research

- Take hypothesis about environment
- Pick baseline design and workload
- Run simulation model or measure hardware
- Interpret results
- If necessary, propose new design

# Creating hypothesis about the future

- Relax a constraint
  - Extrapolate from current trends
  - Throw out standards
  - Use a simpler starting point
  - Abandon conventions
  - Ignore implementation realities
  - Make a radical departure

# Extrapolate from Current Trends



# Extrapolate From Current Trends

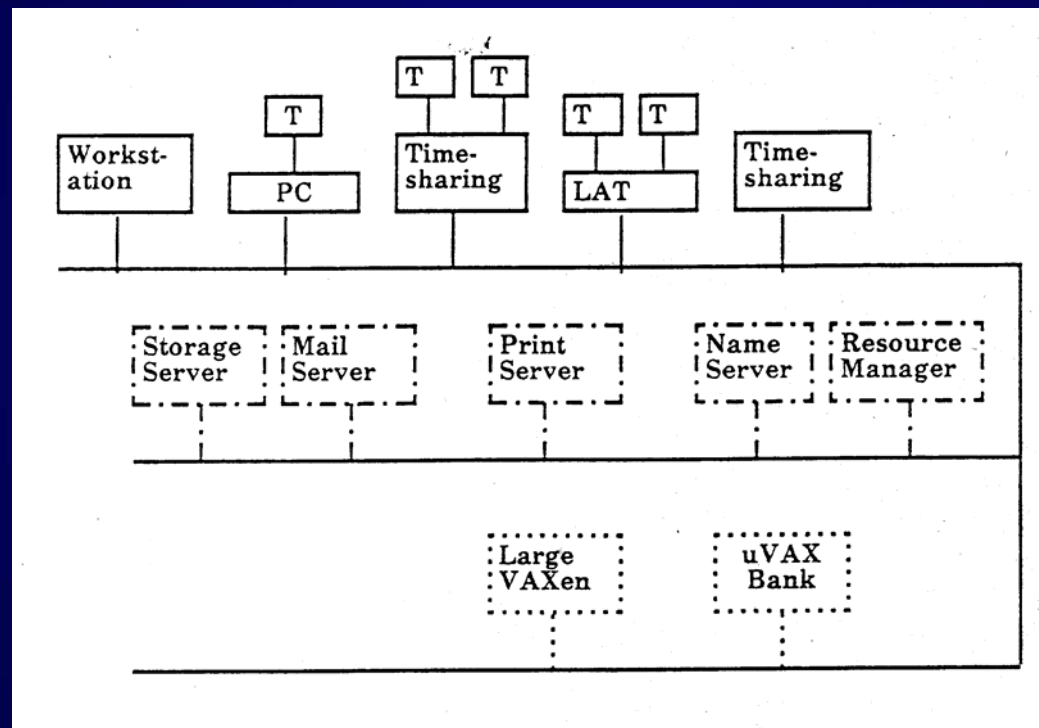
- Personal Workstation – Xerox PARC – late 70's

VAX 11/780	Dorado
5 MHz	15 MHz
512 Kilobytes	8 Megabytes
40+ Users	1 User

- Results
  - Accelerate innovation

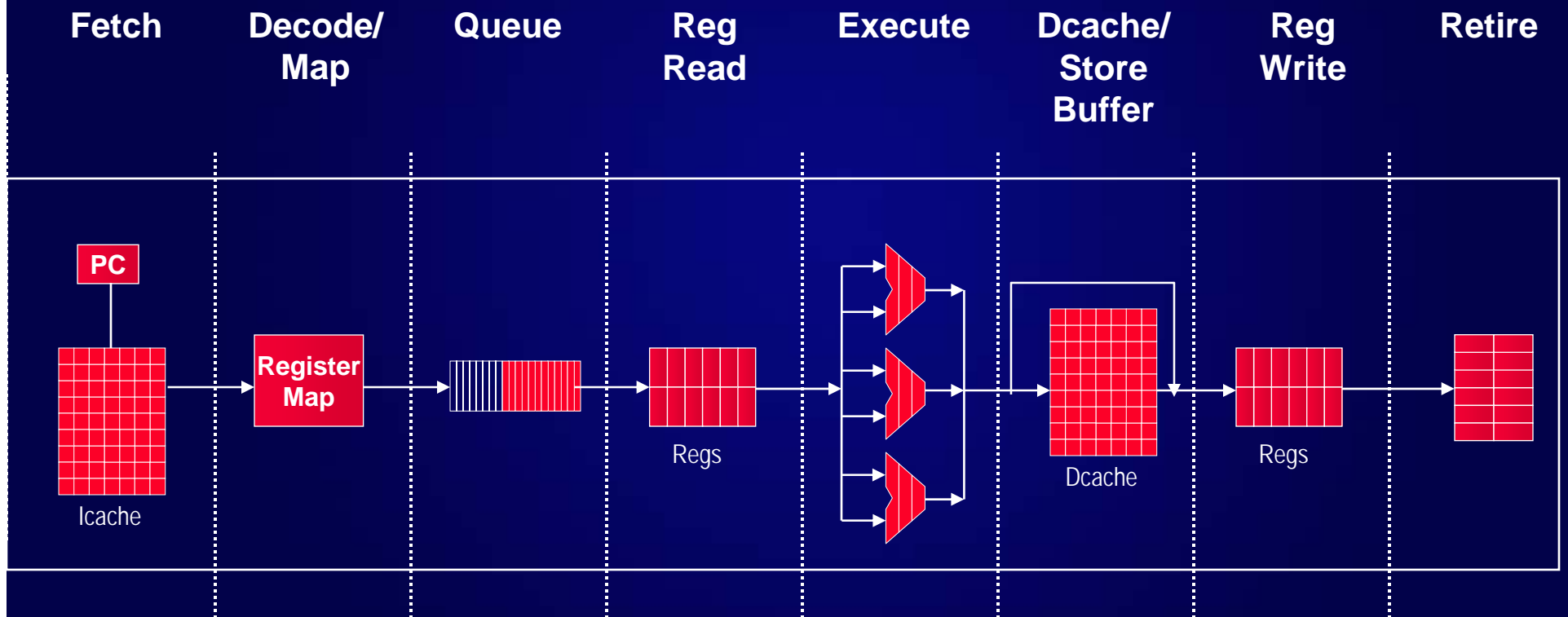
# Throw Out Standards

- Distributed file system - 1985



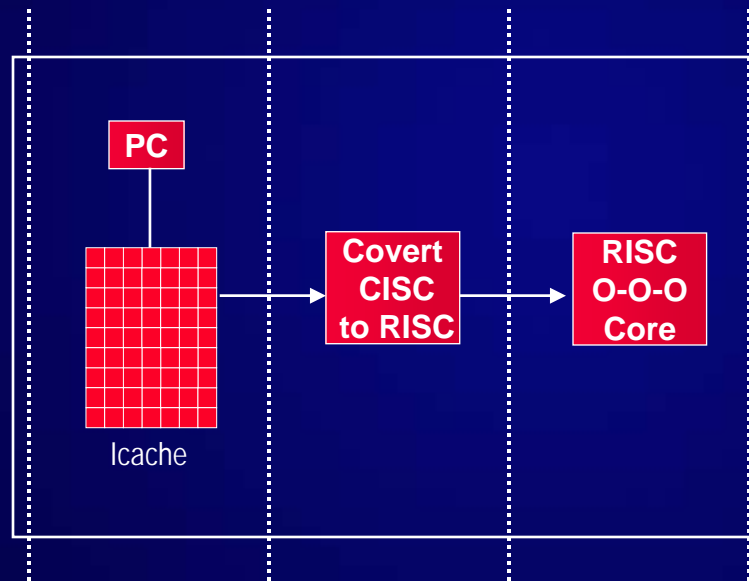
# Use a Simpler Starting Point

## ◆ RISC out-of-order (Johnson, Tourng)



# CISC-based O-O-O

- K6 (Nextgen)
- Pentium Pro (Colwell, Papworth...)



# Abandon conventions

- VLIW (Fisher)
  - Relieve hardware of all dependency responsibility
  - Give that responsibility to compiler
- Expected consequences
  - Much simpler implementation
  - Faster cycle time

# Sometimes not what you expect

- Compiler scheduling for hardware is a great idea
  - For 21064 - narrow in-order
  - For 21164 - wider in-order
  - For 21264 – wider out-of-order

## Important Steps...

- Carefully pick a constraint to relax
- Find contributions without constraint
- Look for benefits even with the constraint

Questions?

Thank you