

Northeastern University - Seattle



CS6650 Building Scalable Distributed Systems
Professor Ian Gorton

Building Scalable Distributed Systems

Week 1 – Introduction to Scalable Systems

Introductions

- Before we begin let's quickly introduce ourselves
- Can you briefly indicate:
 - Write your name and
 - a hint on how to pronounce it (be creative!!)
 - Something about you that no one else in class knows

Outline of Week 1

- Internet Scale Systems - History
- Modern Web Sites and Scale
- What is Scalability?
- Course Overview

Learning objectives

1

Describe the evolution of software systems to achieve web scale

2

Explain the difficulties inherent in achieving linear scalability

3

Explain performance, availability and scalability

4

Lab: Get up and running on AWS

(Part 1)
Internet Scale Systems –
Some History

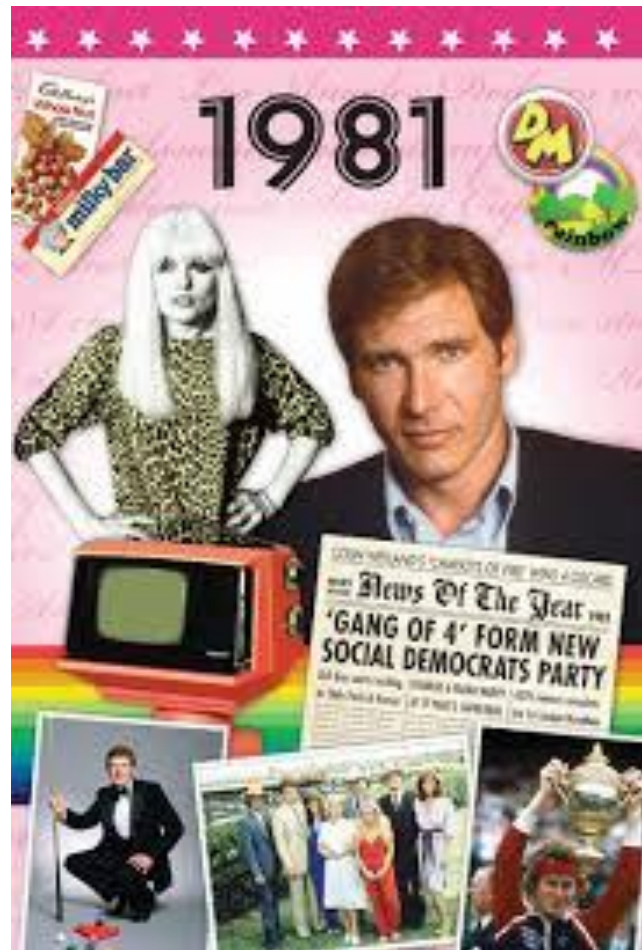
The first
computer I
used
(similar anyway)





coupe-jarretti. Mandarine collier; drap-
 ond front buttoning. French Fast. (3) Bagnoli
 costume velvet evening jacket
 worn with black sand-cuffed pants.
 Michel Robichaud for Barthelemy Chiffons.
 (4) Royal purple jumpsuit with white
 floral pattern in velvet texture. Alice la-
 duchesse. (5) Purple/black acetate/ter-
 celine slims and black acetate pants.
 Michel Robichaud for French Fast.
 (6) Black polyester jumpsuit with dou-
 ble spaghetti straps and multi-colored
 polyester jacket. Etc. ... Stanley Nider.
 De gauche à droite: (1) Jaquette de
 tricoterie à carreaux non-superposées
 portée sur une combinaison-pantalon
 fausse soie en acétate/tercélène. Etc.
 (2) Combinaison-pantalon en tricot
 de cretonne orange et blanc, col et man-
 ches en satin. (3) Veste habillée en so-
 leuse de satin. (4) Pantalon de soie à
 revers. Michel Robichaud pour Barthelemy Chiffons. (5)
 Combinaison-pantalon pourge en
 tissu à motif floral. (6) Jaquette de
 tricoterie à carreaux non-superposées
 portée sur une combinaison-pantalon
 fausse soie en acétate/tercélène. Etc.
 Stanley Nider.









Cheshire County Council IT Department 1984



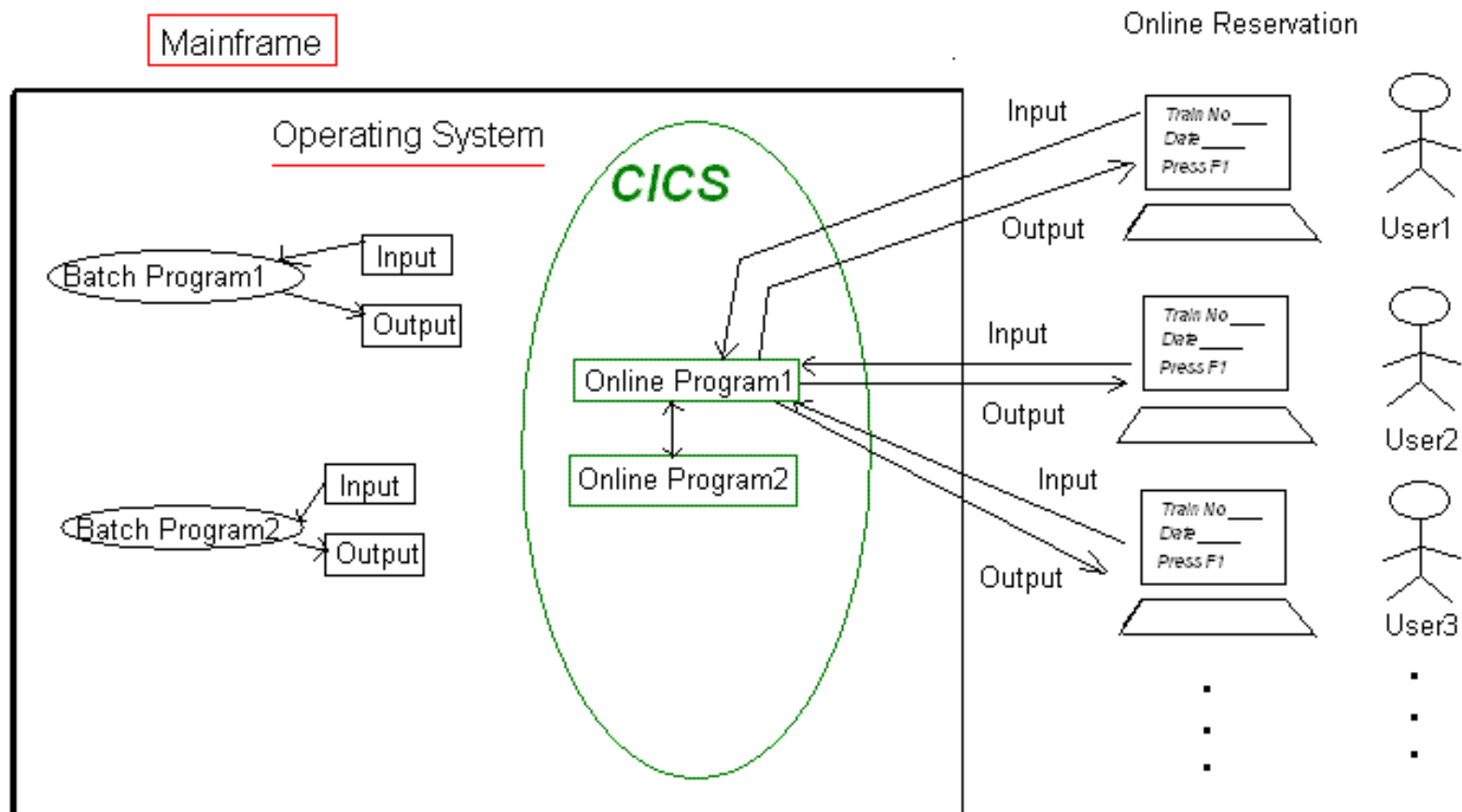
```
SV          MSS-21 Management of Sales and Service  Production Files
          Clear Communications

          Service Management
1. Job Ticket Entry/Update      16. Recurring Scheduling History
2. Job Ticket Parts/Labor      17. Weekly Calendar
3. Job Ticket Ready to Price   18. Quick Parts Scan
4. Job Ticket Ready to Invoice  19. Invoice Number Inquiry
5. Job Ticket Inquiry          20. Customer Service Inquiry
6. Job Ticket Profit Analysis  21. Item Inquiry
7. Scheduling                  22. Serial Number Inquiry
8. Job Ticket Release from Crd Hold  23. Serial Num Inq By Sys/Dec/Hex Id
9. Tech Hours Worked Inquiry    24. Summary Sales Analysis
10. Hours Worked Inquiry        25. Customer Maintenance
11. Contract Management Menu    26. Ship To Maintenance
12. Tech Scheduling            27. Item Maintenance
13. Job Ticket Invoicing        28. Technician Maintenance
14. Recurring Scheduling        29. Sales Order Management Menu
15.                            More...

Selection or command
==>
F3=Exit  F4=Prompt  F6=Messages  F9=Retrieve  F10=Goto Menu  F12=Previous
          F16=Spool Files  F21=Search Menu  F22=Initial Menu
                      (C) copyright systems implementation, inc., 2009
```



Mainframe



```

DEF PROG(PGM1) GROUP(GRP12)
OVERTYPE TO MODIFY
CEDA DEFINE PROGRAM( PGM1      )
  PROGRAM      : PGM1
  Group        : GRP12
  Description   ==> -
  Language      ==> CObol | Assembler | Le370 | C | Pli
  REload        ==> No | Yes
  RESident      ==> No | Yes
  USAge         ==> Normal | Transient
  USElpacopy    ==> No | Yes
  Status        ==> Enabled | Disabled
  RSL           : 00
  CEdf          ==> Yes | No
  DAtalocation  ==> Below | Any
  EXECKey       ==> User | Cics
  COncurrency   ==> Quasirent | Threadsafe
  REMOTE ATTRIBUTES
  DYnamic       ==> No | Yes
+ REMOTESystem ==>
I New group GRP12 created.

  DEFINE SUCCESSFUL
                                SYSID=CICS APPLID=CICS
                                TIME: 05.57.10 DATE: 11.280
PF 1 HELP 2 COM 3 END          6 CRSR 7 SBH 8 SFH 9 MSG 10 SB 11 SF 12 CNCL

```




IBM

Cloud Enabling IBM CICS

Seznam firm in goštev: [klikni tukaj](#)

The 1994 program is being prepared and will be announced September.

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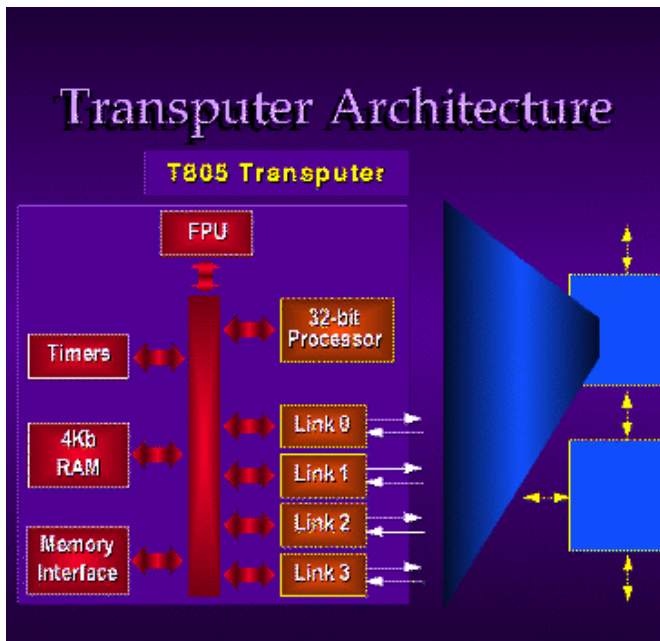
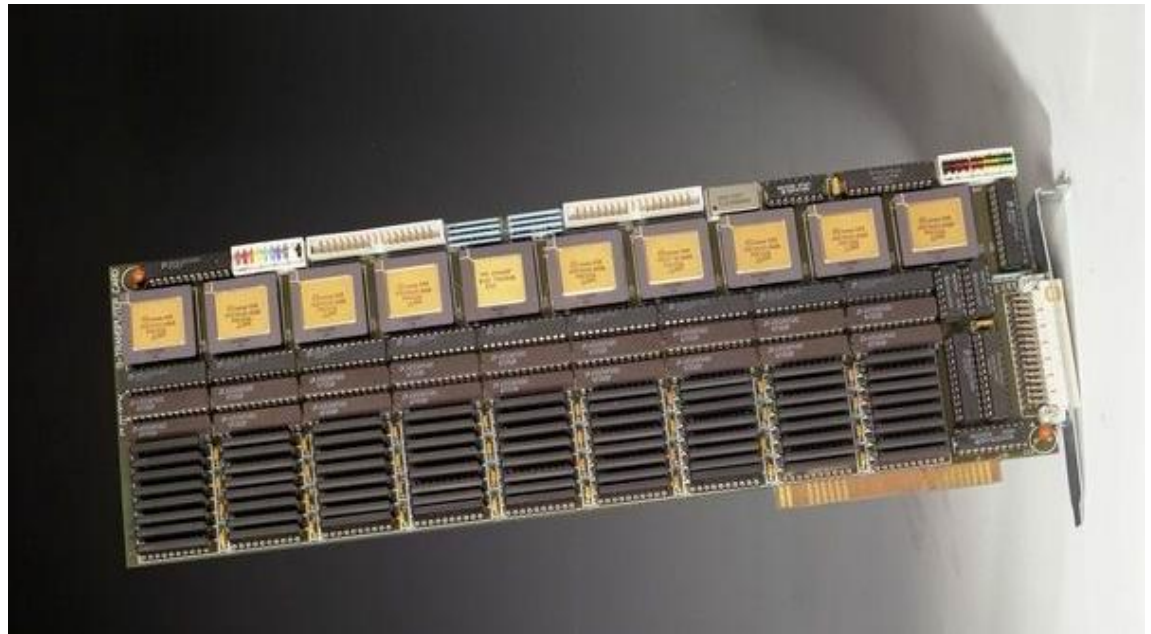
- **Business Goals**
- **Business Objectives**
- **Business Strategy**
- **Business Plan**
- **Business Model**
- **Business Process**
- **Business Structure**
- **Business System**
- **Business Environment**
- **Business Culture**
- **Business Ethics**
- **Business Law**
- **Business Finance**
- **Business Marketing**
- **Business Management**
- **Business Information Systems**
- **Business Analytics**
- **Business Innovation**
- **Business Sustainability**
- **Business Social Responsibility**
- **Business Governance**
- **Business Compliance**
- **Business Risk Management**
- **Business Quality Management**
- **Business Human Resources Management**
- **Business Operations Management**
- **Business Logistics Management**
- **Business Procurement Management**
- **Business Production Management**
- **Business Distribution Management**
- **Business Customer Relationship Management**
- **Business Supplier Relationship Management**
- **Business Partner Relationship Management**
- **Business Government Relationship Management**
- **Business Community Relationship Management**
- **Business Environmental Relationship Management**
- **Business Stakeholder Relationship Management**
- **Business Interest Group Relationship Management**
- **Business Pressure Group Relationship Management**

Webmaster's Note:

Redbooks

A man with a beard and short brown hair, wearing a light blue button-down shirt, is sitting at a desk. He has a bored or frustrated expression, with his right hand pressed against his forehead. In front of him is a silver laptop, a white mug, and some papers. The background is a plain, light-colored wall.

Boredom!

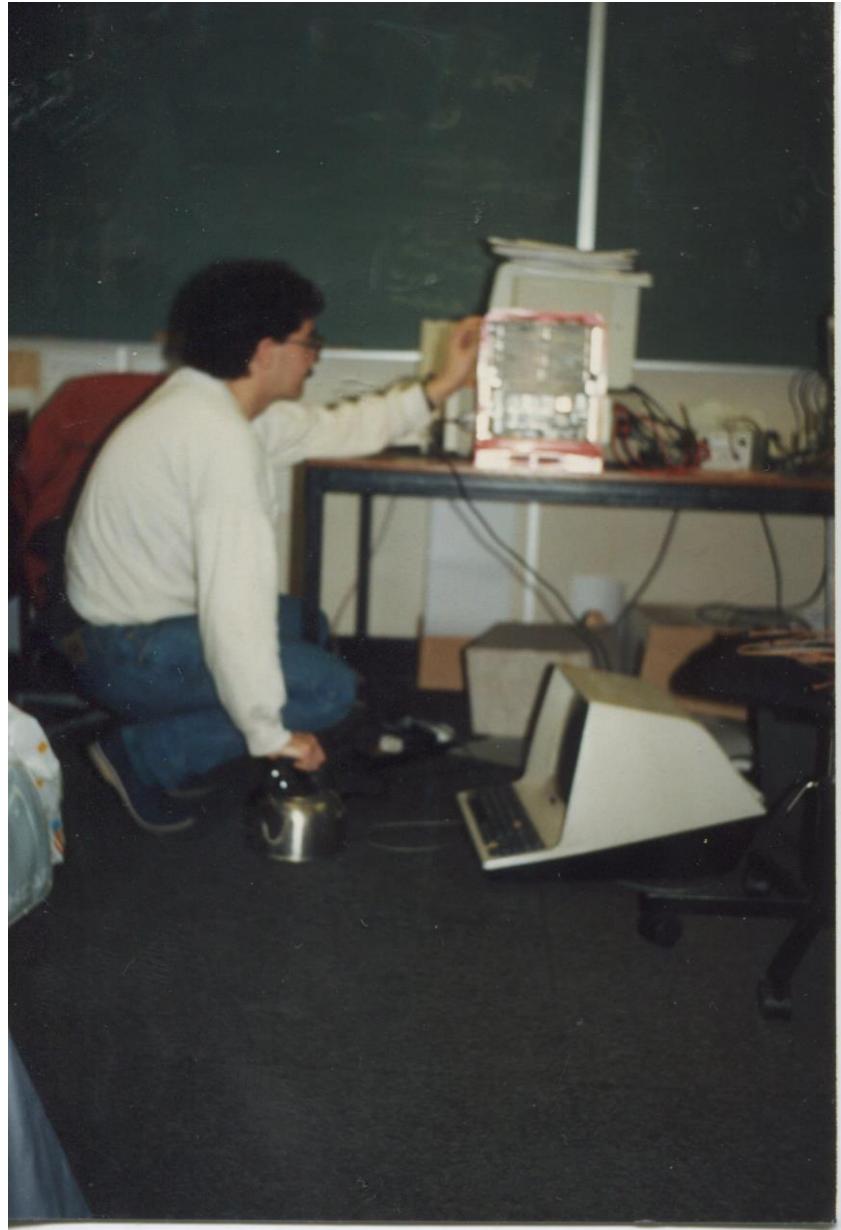


Grad School!!

Multiprocessor Transputer Systems

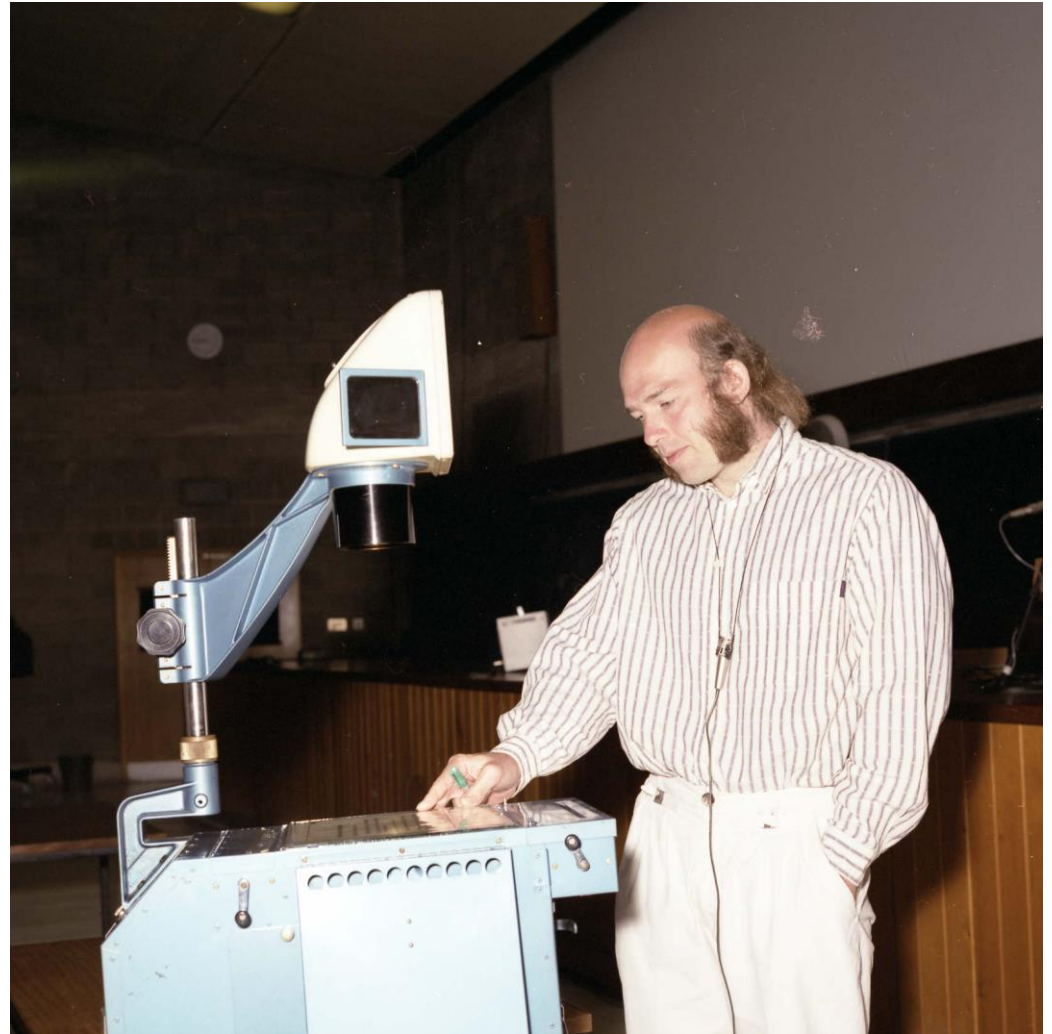


It really is
me!





David May,
Inmos
Chief
Scientist
and Occam
guru





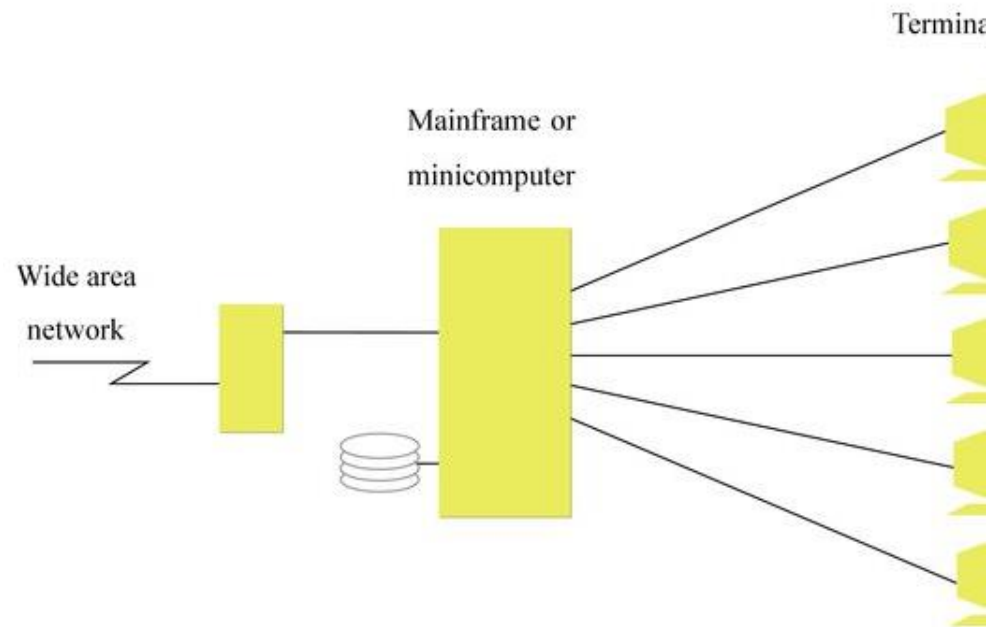
Next Stop – Australia!

1990

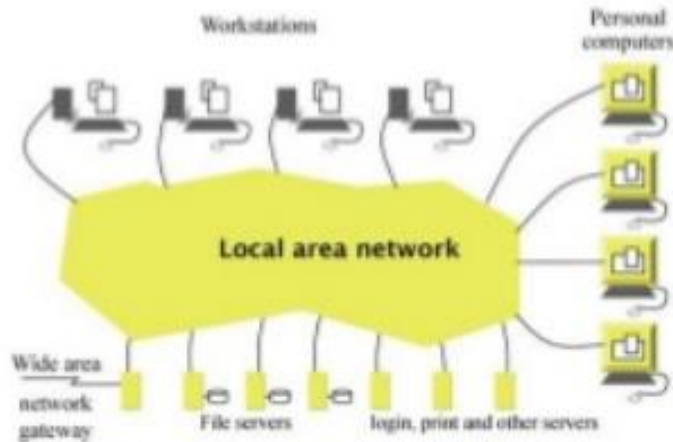
What about distributed systems?

- Rare until basically early 1990s ...
- Networks slow ...
- Protocols slow
- Computers slow 😊

A Centralized Multi-user System

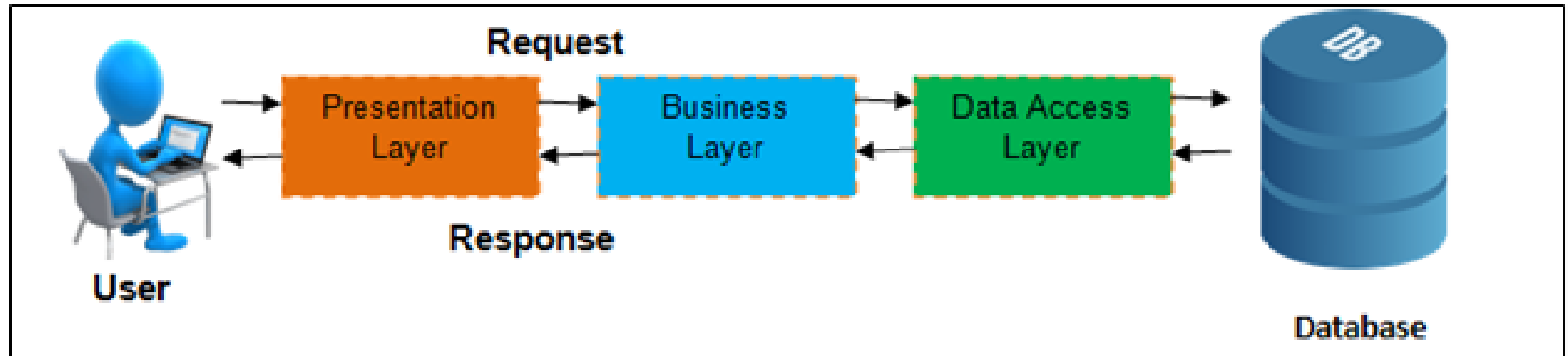


A Distributed System



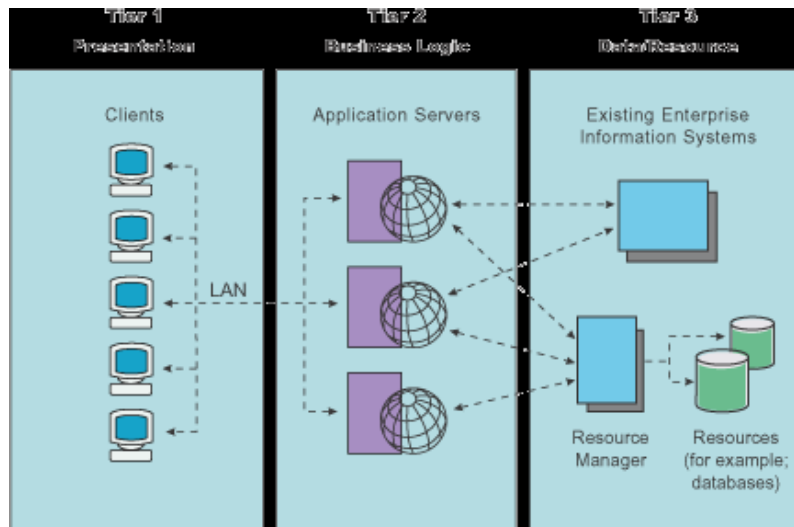
Early 1990s - the
internet went
mainstream-ish

- PCs and work stations become connected
 - LANs
 - WANs
- Global internet backbone
 - Corporate networks
 - Dial up at home
- Client software
 - Program
 - Browsers very simple static content serving



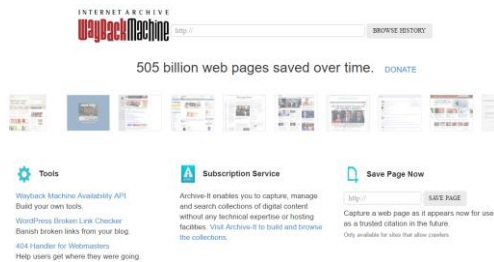
Three tier system becomes common

As the internet grew (mid 1990s onwards)



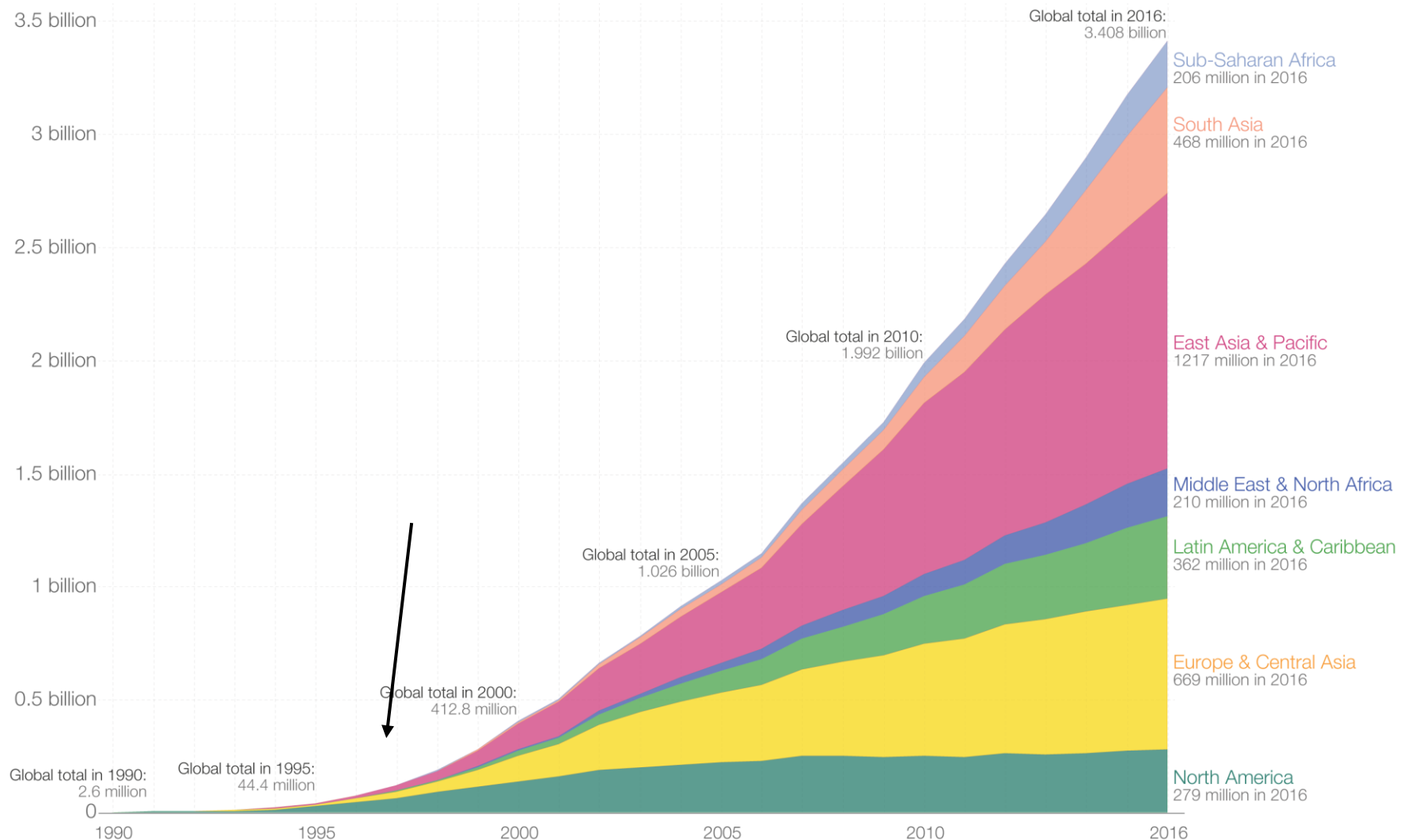
- Step change – business systems opened up to the internet
 - Eg internet banking
- Scalability achieved by
 - replication at middle tier (scale out)
 - Stateless services
 - Scaling up at database tier

What Led to Growth?



- The advent of the WWW was the backbone for the growth
- It allowed for access by an increasing number of users
 - Potentially every person in the world can see a Web app
- It also allowed for a new service model for:
 - Enterprises
 - Consumer products
 - eGovernment
- Poke around the Wayback Machine to see the Web-past
 - <https://archive.org/web/>

Internet users by world region since 1990



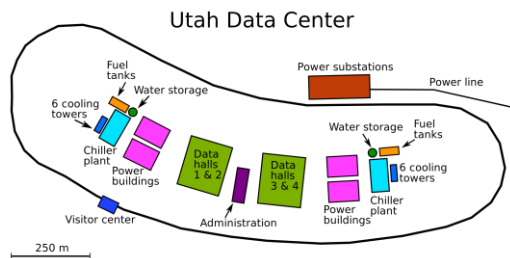
Data source: Based on data from the World Bank and data from the International Telecommunications Union. Internet users are people with access to the worldwide network.

The interactive data visualization is available at [OurWorldinData.org](https://ourworldindata.org). There you find the raw data and more visualizations on this topic.

Licensed under CC-BY-SA by the author Max Roser.

The Google logo is displayed in its characteristic multi-colored font (blue, red, yellow, blue, green, red) on a white background. The logo is slightly tilted and appears to be on a piece of paper with a subtle shadow and a diagonal crease.The Amazon logo features the word "amazon" in a bold, black, lowercase sans-serif font. Below the text is a curved orange arrow pointing from the letter 'a' to the letter 'z'.The eBay logo is shown in its signature multi-colored font (red, blue, yellow, green) on a white background.

Unprecedented Data Collection and Distribution



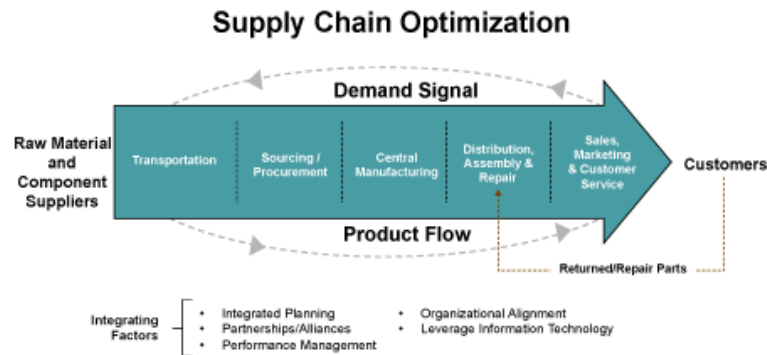
- New service models allow for collection of data that wasn't previously available
- This knowledge can provide competitive advantage
 - If they can manage and analyze the data effectively
 - The realm of data sciences
 -



Wal-Mart

- Wal-Mart knows what will happen when we have inclement weather
- What items do you think are impacted by an impending hurricane?
 - Certainly water and flashlights
 - The sales of Strawberry Pop Tarts increases seven fold
 - The largest selling item, however, is beer ...
- What does knowing this allow Wal-Mart to do?

Knowledge is Profit



- Predict sales
- This allows them to have sufficient stock on hand
 - Otherwise they could sell out of items
- It also allows them to minimize the surplus stock that they need
 - Thus reducing the overhead by adopting a “leaner” *just in time* approach

Significant Competitive Advantage



- Wal-Mart uses this data to its advantage
- 20 years ago Wal-Mart trailed K-Mart
 - K-Mart had more collective bargaining power and was able to negotiate a lower wholesale price
- Wal-Mart used data to streamline operations
 - They were able to reduce the percentage of the store that was used to stock surplus from the normal 25% to 10%
 - They are able to better coordinate with suppliers (resulting in more efficient production runs)
- Wal-Mart is now the largest retailer in the world

Distributed frameworks

- [Sockets – Berkeley, 1983](#) (earlier implementations existed), became POSIX implementation
- [ONC/Sun RPC](#) – 1984-onwards
- [OSF DCE](#) – 1989-onwards
- [CORBA](#) – early 1990s-onwards
- Java RMI mid 1990-s onwards
- XML Web Services – SOAP 2000-ish
- HTTP – REST – Fielding thesis 2000
- [WebSockets](#) - 2001



Next ...

Let's look at contemporary
Internet systems

