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The Prospects for Computing- Communications Convergence

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What is convergence?

- Industries and/or technologies that were largely independent become
 - competitive, or
 - complementary, or both
- Accompanied by reorganization of industry to adapt to changing realities

2

Outline

- What new applications are enabled by convergence?
- What is the best way to identify new applications?
- How is the infrastructure supporting applications changing?
- What are the appropriate industry roles?

3

Technological basis



Scientific and
technical
computing



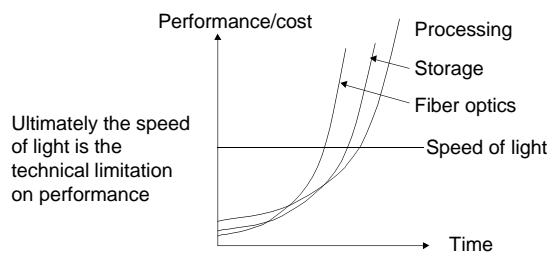
Databases
and
transactions



Communications

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Performance advances



5


A good assumption

Ample and affordable processing, storage, and bandwidth whenever and wherever we need them, including portable devices

6

The new emphasis

The rapidly advancing technology enables a wider set of applications, shifting the emphasis

- 
- **How** to design high performance or low cost systems
 - **What** to do with our impressive set of technologies

7

The “what” question

What new applications will be enabled by convergence?

8

Technical contributions

Modify information



Communicate information across time



Communicate information across distance

9

Three existing application traditions

Algorithmic



Document



Collaboration

10

Examples

- **Algorithmic:**
 - financial engineering, data mining, scientific computing
- **Document:**
 - scholarship, knowledge, entertainment, commerce
- **Collaboration:**
 - organization, design, socialization

11

Prediction

Most major applications will integrate traditional computing (algorithmic and document) and communications (collaboration and coordination) features

12

Example application

- Global automotive design
 - Document: plans, specifications, design database, manufacturing database
 - Collaboration: planning meetings, brainstorming sessions
 - Coordination: concurrent design
 - Algorithmic: design modeling and simulation
- Benefits to integration, process could change significantly₁₃

Sociotechnical applications

- A sociotechnical system is an integration of
 - information technology
 - people and organizations
 - information and knowledge
 - paper, material, finished goods, etc
- Sociotechnical applications are an opportunity for computer/communication convergence

14

Assertion

- There are a large number of specialized convergence applications serving particular groups or organizations
- There are few generic applications of broad interest

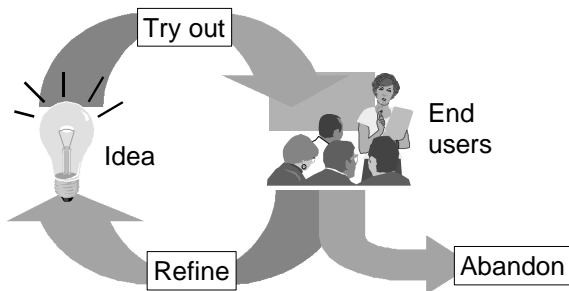
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Question

What is the most effective way to identify and develop new applications?

17

Let a thousand ideas bloom



18

Division of effort

Universities and startup companies	Identify and refine applications by trying a thousand ideas
Big companies	Design, deploy, operate, service customers
Standards bodies	Coordinate necessary interoperability in the infrastructure

19

Application vs. infrastructure

Applications	• End-user specific functionality
Infrastructure	• Everything supporting all applications

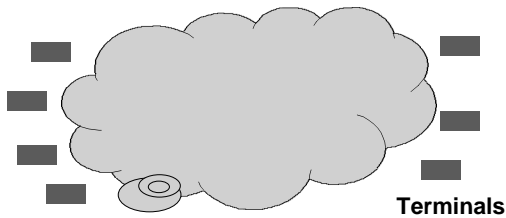
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Question

How does the infrastructure change with convergence?

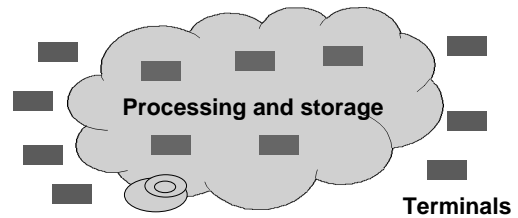
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The present infrastructure



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The future infrastructure



23

Why processing and storage?

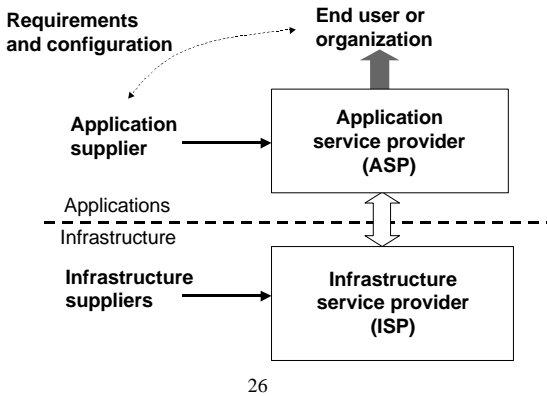
- Application service provider (ASP) model makes processing available to applications
- Value-added infrastructure
- Minimize or eliminate the role of standardization in applications

24

Application service provider

Provide an application as a service from the network (rather than as a shrink-wrap software product)

25



Examples of ASP model

- Telephony
- Web-based information access and commerce
- Yahoo: Web-based calendar
- Hotmail: Web-based email
- Schwab: Web-based stock trading
- SUN: StarOffice

27

ASP model

Advantageous to user

- Proven way to reduce installation, integration, and maintenance costs
- Contractual obligation for availability and quality
- Quality improved by more controlled environment
- Location independence

28

ASP model (con't)

Advantages to supplier

- Ongoing revenue stream supporting upgrade and maintenance
- Usage-based revenue better aligned with user's value proposition
- Opportunity for price discrimination, advertising revenue, etc.
- Renders personal computer operating system less important

29

Value-added infrastructure

Many opportunities for value-added infrastructure making it easier for users and/or applications:

- example: information brokerage
- middleware services
- compensation for poor connectivity (e.g. caching and compression)

30

Assertion

Standardization in applications should be avoided to encourage experimentation, lower barriers and encourage application diversity, increase flexibility

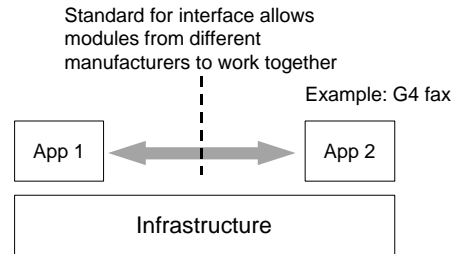
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Two opportunities to avoid standardization in applications

- Mobile code allows compatible interoperable software-defined application modules to be deployed dynamically
- Metastandards focus on how to describe things, rather than fixing those things directly

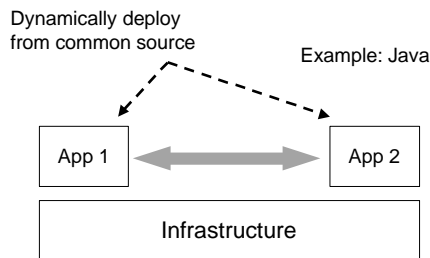
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Standardization approach



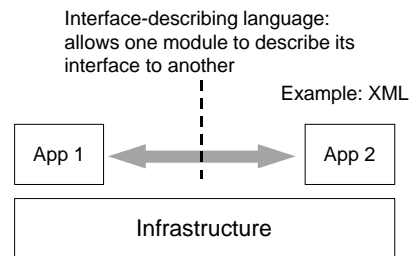
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Mobile code approach



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Metastandard approach



35

Reminder

These all require processing and storage in the infrastructure:

- ASP
- Value-added infrastructure
- Standardization

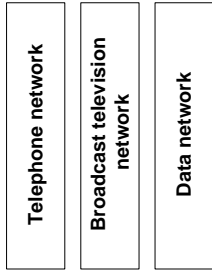
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Question

- How will the architecture of the future infrastructure (offering processing, storage, and connectivity) differ from today's?
- Answer is important because architecture defines the boundaries of competition in the supplier and service provider industries

37

Past: stovepipe



- Application and infrastructure are integral, not separated
- Each new application requires major investment in infrastructure

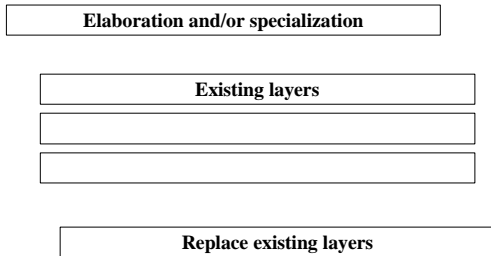
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Application diversity

- Requires the separation of applications from infrastructure
- Test: Can applications be deployed without knowledge of infrastructure service provider?

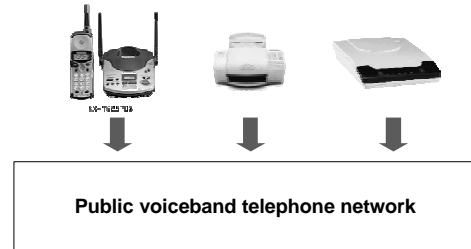
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Future: layering



41

Familiar examples of layering

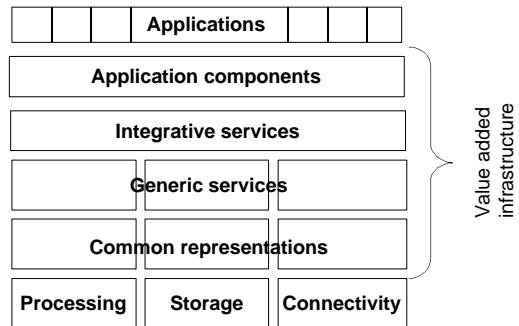


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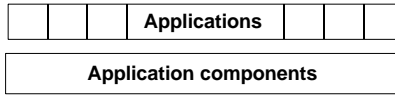
Layering and separation

Applications	• Layering separates application from infrastructure
Infrastructure	• The infrastructure will be internally layered

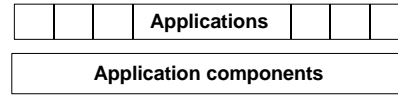
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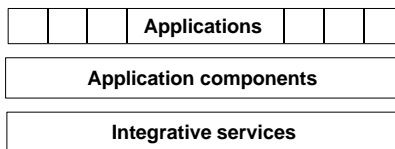


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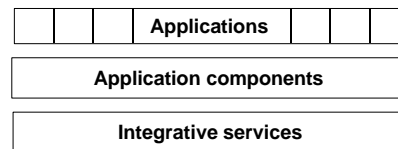


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- Provides common functionality useful to a variety of applications

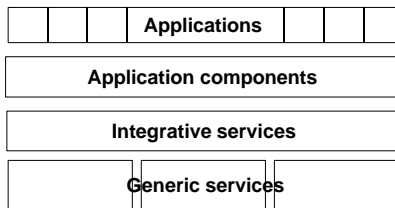


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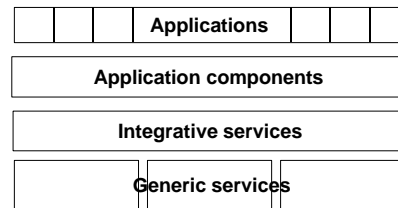


48

- Integrate processing, storage, and connectivity in ways useful to applications

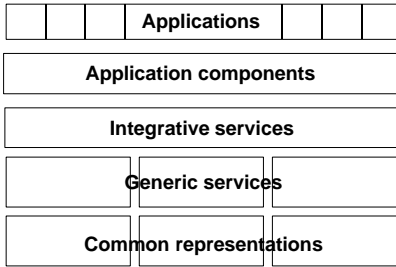


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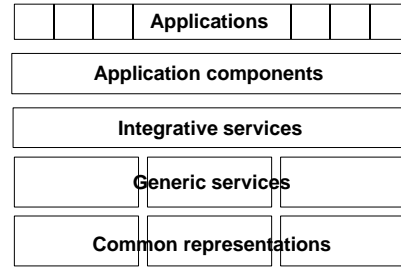


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- Provides abstract and structured services for processing, storage, and connectivity separately

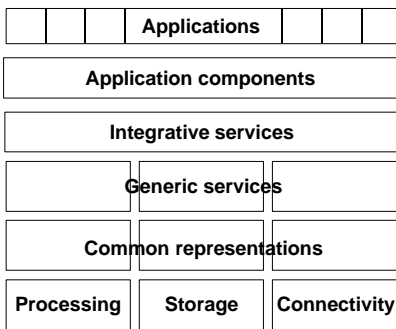


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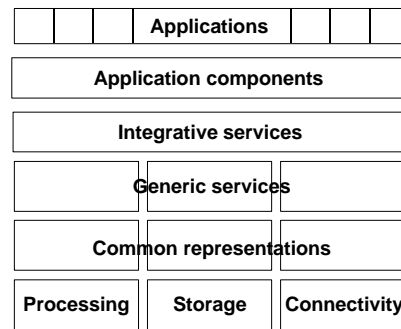


- Provides abstract and structured representations of raw processing, storage, and connectivity common across technologies

52



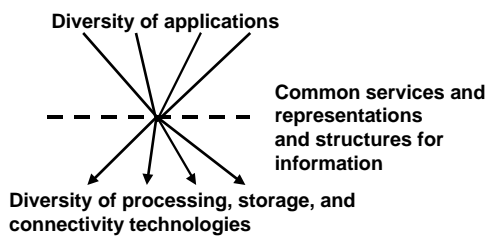
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- Accommodate different technologies

54

The basic idea in retrospect



55

Networked externalities

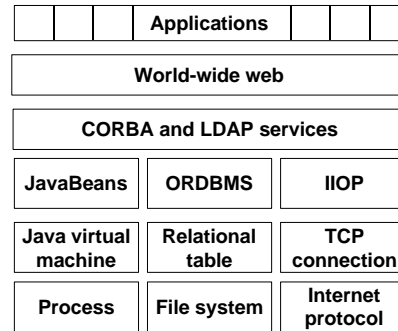
- In a networked environment, widely adopted infrastructure solutions offer much greater value to users and applications
- Standards are thus advantageous in the infrastructure

56

Ways to arrive at a standard

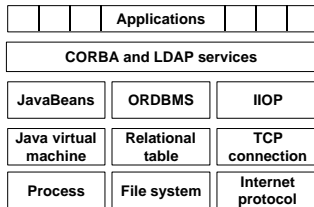
- Top-down standardization process
 - solve the entire problem, all at once
- De facto standardization
 - winner-take-all market forces
 - can be accelerated by industry alliances

57



58

Supplier industry implications of layering



- Industry becomes more fragmented
- Complementors become as important as competitors

59

Assertion

The Internet will provide the dominant connectivity services in the converged and layered computer/communications infrastructure

- shortcomings, but can be upgraded

60

Success factors

Why has the Internet marginalized some competing solutions (e.g. ISO, ATM)?

61

Internet technology advantages

- First mover advantage
 - “embrace and interconnect” previous networks
- Separation of infrastructure from application
 - let those thousand ideas bloom
 - embrace application diversity
- Bottom line: there first with adopters and compelling applications

62

Internet process advantages

- Continuous improvement and experimental approach, continuous user feedback
- Mostly a target for research rather than standardization
- Informal standards process open to all ideas

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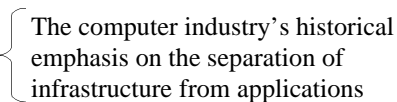
Assertion

As illustrated by the Internet, there will be increasing reliance on de facto standardization and market forces

- adapt to a rapidly changing world
- broader participation by universities and small companies

64

Observation

- The software industry is now solidly entrenched as the developer of both applications and the higher layers of the supporting infrastructure
- Why?  The computer industry's historical emphasis on the separation of infrastructure from applications

65

Another observation

Major attempts by the telecommunications industry to define new applications have met with failure

- in the U.S., videophone, videotex, and video-on-demand
- (also many successes, such as extending the telephony franchise and Minitel)

66

Why this lack of success?

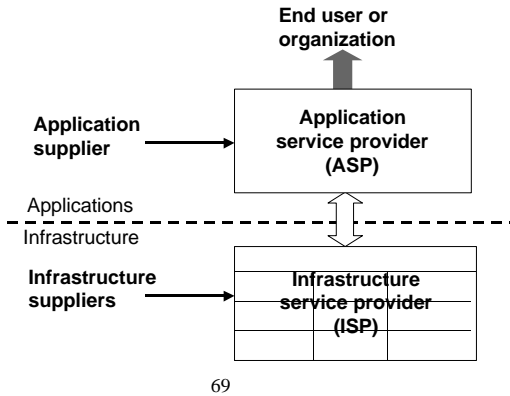
- Few applications with a huge enough market to justify a new infrastructure
- Difficult to define and deploy new applications without user-based experimentation and refinement
- Not enough research on applications

67

Question

- Is the telecommunications industry marginalized by the software industry's success in defining both infrastructure technology and applications?
- No! Not if it builds on core competencies

68



69

What are core competencies?

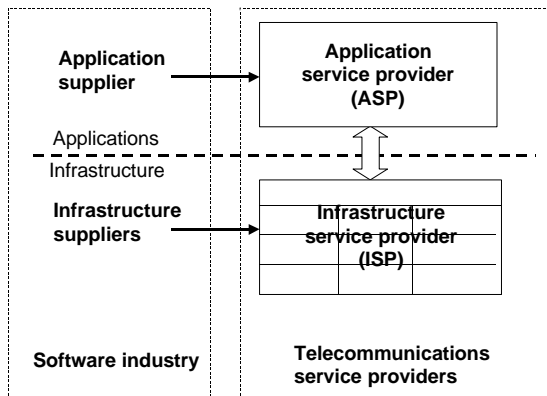
Telecommunications operators:

- provisioning and operations of an infrastructure
- reliability and availability
- customer service and billing

• Software suppliers:

- application requirements
- application development

70



71

Assertion

- The core competencies of the telecommunications and software industries are complementary, not competitive
- The strength of one is the weakness of the other

72

Advice

What advice can we give to Germany?

73

Success in applications

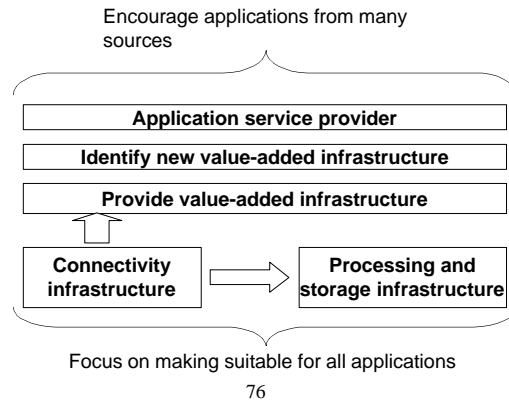
- Support experimentation and research in applications, including in universities
 - interdisciplinary approach
- Encourage startup companies
 - access to infrastructure for experimentation and commercialization

74

Advice

What advice can we give to telecommunications firms?

75



76

Summary of key points

- Convergence enables a rich set of applications that integrate the collaboration, document, and algorithmic traditions
- The numerous specialized applications are best identified and developed by experimentation involving end users

77

Key points (con't)

- The needed diversity of applications requires
 - separation of application from infrastructure
 - limited role for standardization in applications
- Expanding role for service providers
 - includes processing and storage made available directly to applications
 - ASP and ISP
- Software industry will be the main source of applications, and the Internet the bottom layer of infrastructure

78

Key points (con't)

- Success in applications:
 - encourage startup companies
 - support research on applications
- Opportunities for service providers:
 - horizontal: add processing and storage
 - vertical: value-added infrastructure and ASP
 - be open to applications from many sources

79