Internet Ecosystems and Virtualization Issues

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Demands for Future Internet

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Internet

- Not Considered When Designed
  - Mobility
  - Security
  - QoS/QoE
  - Economic Incentives
  - ...

➔ More and more demands are emerging with various applications/services

What Future Internet Services Look Like?

- User-Centric
  → Customized Service
- Context-Aware
  → Intelligent Service
- Data-Centric
  → Fast, Easy, and Exact Service
- Hard Realtime
  → Social Infrastructure Service

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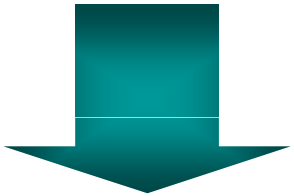
Paradigm Shift

A single infrastructure provides a **single** service



A single infrastructure provides **multiple** services

Paradigm Shift Availability

- Moore's Law
  - Every 18 months,

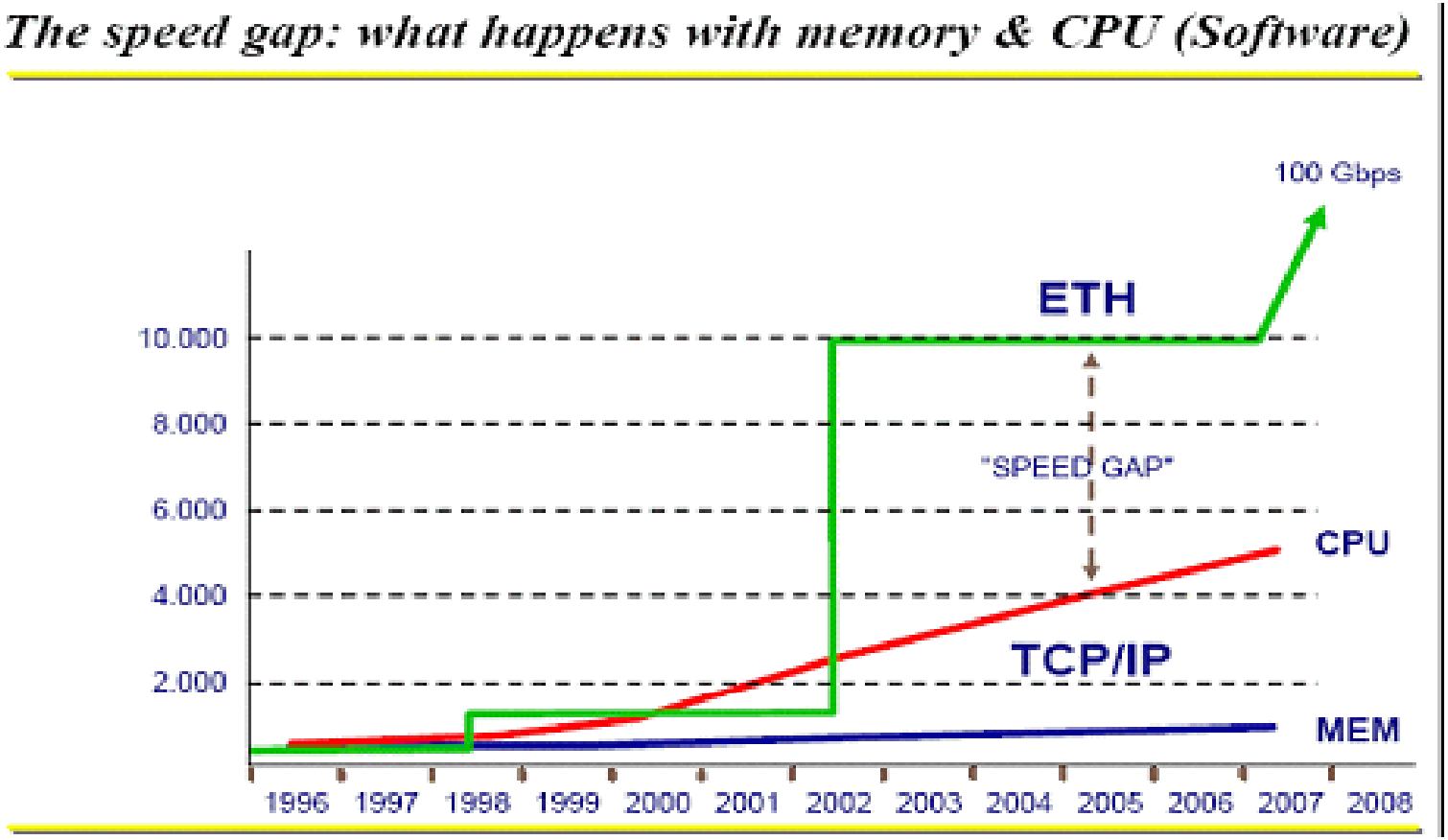
    Computing power doubles while the cost remains the same
- Hwang's Law
  - Every 12 months,

    Semiconductor memory capacity doubles
- Gilder's Law
  - Every 12 months,

    Optical fiber bandwidth triples

➔Reversing the role of Computers and Networks

Speed Gap Between Computers and Networks



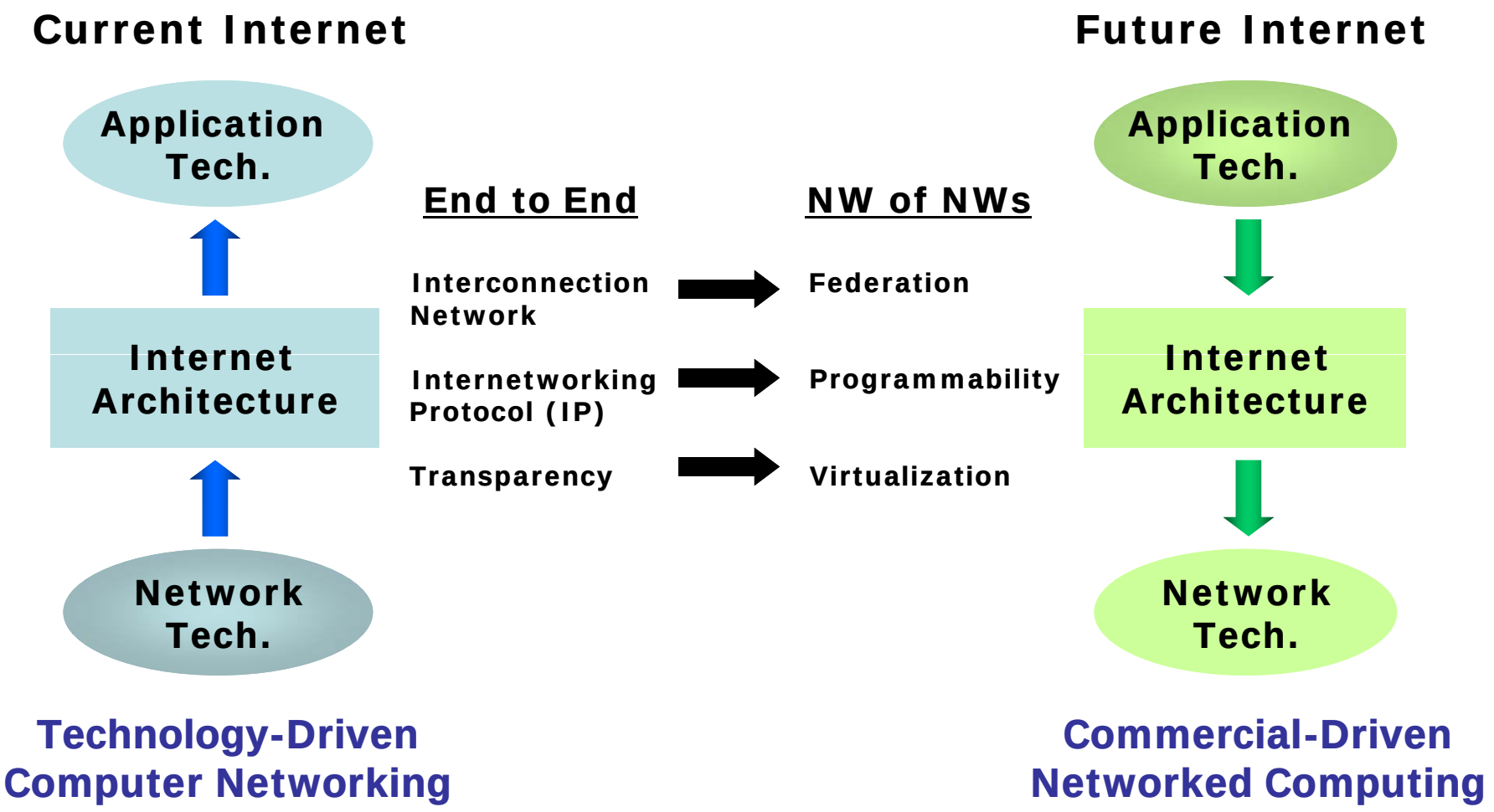
Source: J. Barroso (2006)

Reversing the role of Computers and Networks

Computer Networking

Networked Computing

Current Internet vs. Future Internet



Commercial-Driven Approach for Future Internet

- User-Centric Services
  - ➔ Customize Cost, Bandwidth, Speed, …
- Context-Aware Services
  - ➔ Take in Location, Mobility, Time, Harm/Safety, …
- Data-Centric Services
  - ➔ Fast/Easy/Exact Identification, Fetch, …
- Hard Realtime Service
  - ➔ Reduce Transmission latency, Processing delay, …

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Demands for Future Internet

- Diverse Transfer Modes
  - Packet mode, Circuit mode, ...
- Precise Identification of
  - Time and Location
- Prompt Response Time

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Internet Ecosystems of the Future

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Four Views of Future Internet

- Social View
- Commercial View
- Technical View
- Operational View

Social View of Future Internet

- Future Social Infrastructure that enables Social Growth

➔ Need to Support Public/Private Services

(e.g., Collaborations, Transportation, Health-care, Education, etc.)

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Commercial View of Future Internet

- Each part of the Internet vies/competes in favour of their own particular interests
  - Users
  - Commercial ISPs
  - Content/High-Level-Service Providers
  - Intellectual Property Right (IPR) Holders
  - Governments

→Demands are often contradictory between the players on the ground of the Internet

➔Need for Ecosystem

Technical View of Future Internet

- Different Service networks are demanded by diverse services/users

➔Need for Programmable network architecture that can implement any service network

→Defined by Networked Computing Technical Standards

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Operational View of Future Internet

- Ecosystem with Autonomic Management

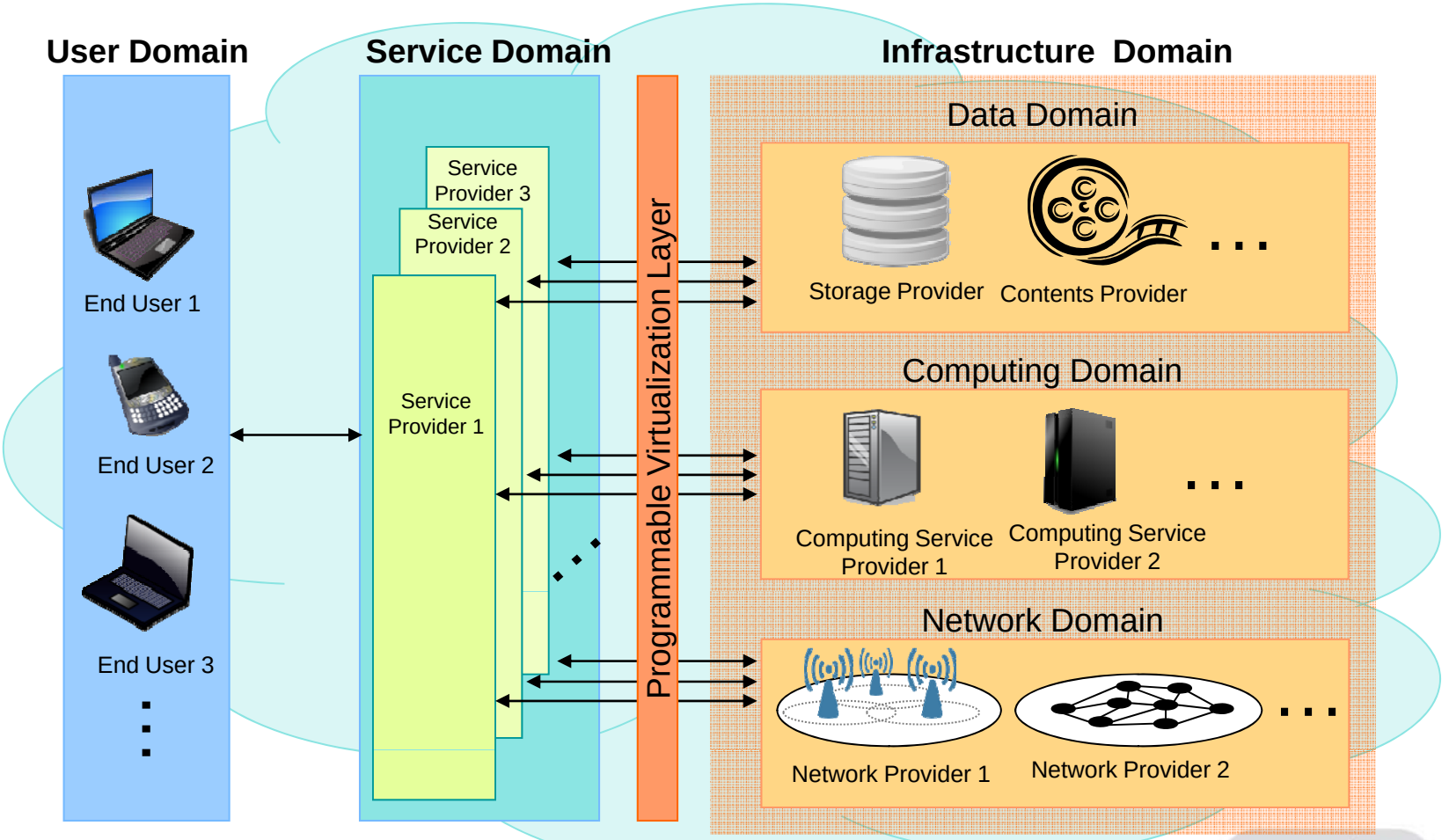
➔Need for Operation and Management

  – User/Application-Side Operation/Management

  – Network-Side Operation/Management

Internet Ecosystem

- Future Internet as the solution for the tussles over the Internet
  - Technically guarantees proper economic incentives according to their contribution



Network Virtualization Issues

Network Virtualization Issues

- Physical/Virtualized Resource Management
- Virtualized Network Isolation
- Wireless Virtualization
- Scope of Programmability
- Scalability and Performance
- Virtualization Policy
- Virtualized Network Provision

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Physical/Virtualized Resource Management

- Resource Identification
- Resource Location
- Resource Discovery
- Resource Availability
- Resource Monitoring
- Autonomic Management for Resources
  - Self-Healing
  - Self-Configuration
  - Self-Optimization

Virtualized Network Isolation

- Level of Isolation Between Virtualized Networks to Achieve
  - QoS/QoE
  - Security
  - ...

Wireless Virtualization

- Need Different Considerations
  - Different Characteristics (Dynamic/Ad-hoc) and Capacity (Bandwidth, CPU, etc.)
- Isolation and Spectrum characteristics
- Non-identical Nodes and Node-specific Properties
- End-to-end slicing through wired and wireless networks

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Scope of Programmability

- Software Level
- Hardware Level

Scalability and Performance

- Number of Users
- Number of Virtualized Networks
- Performance Measurement/ Evaluation Metric

➔ Critical for Commercial Deployment

Virtualization Policy

- Federation
- Admission
- Resource Allocation
- Economic Incentives

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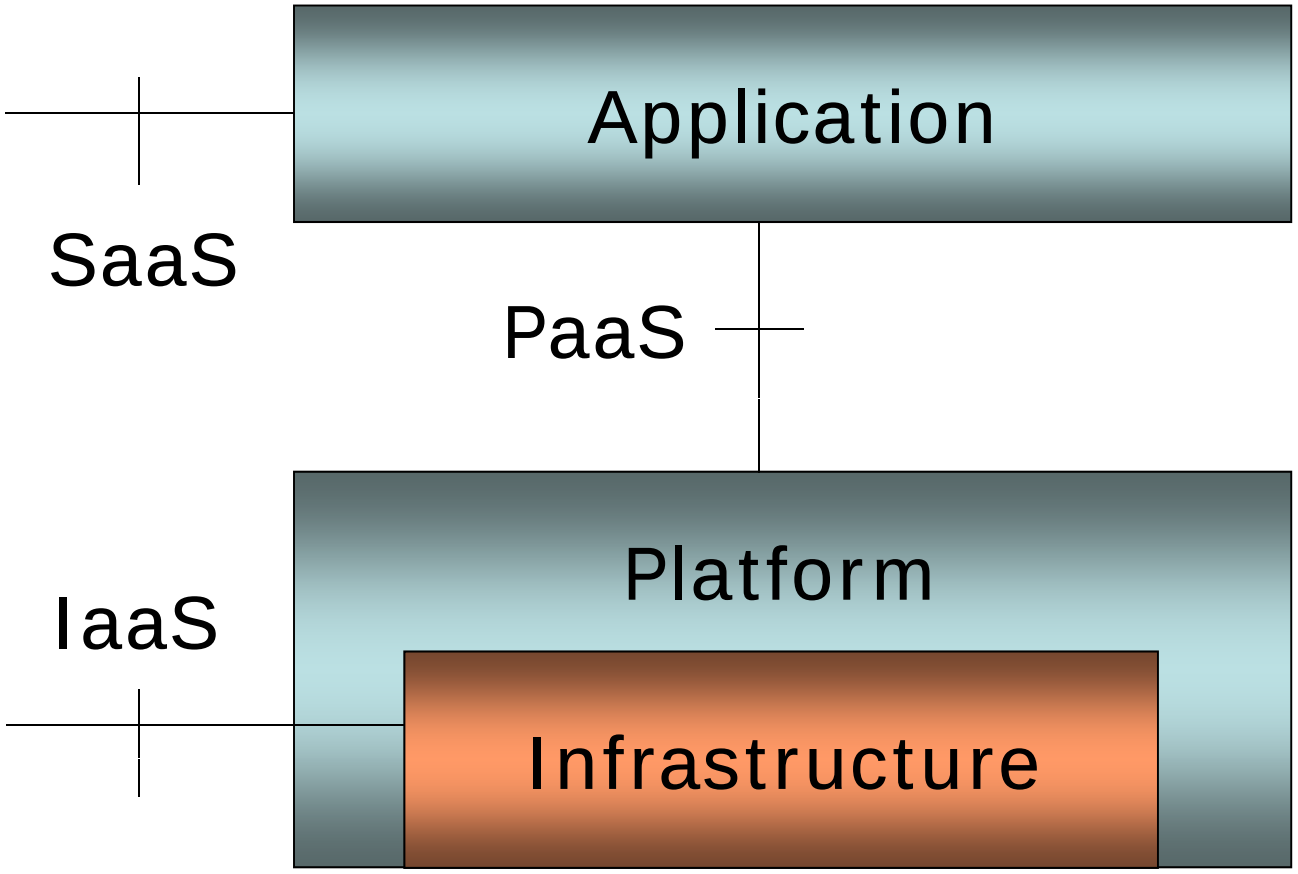
Virtualized Network Provision



Conclusion and Open Discussion

Future Internet

- Technically
  - Future Society Infrastructure, over which any network service that users want is available by Networked Computing paradigm

    ➔ Programmable Network Architecting is available
- Socially
  - Future Society Infrastructure, over which political, economical, social, and/or cultural activities of new paradigm are supported

Future Internet Features

- Programmable Infrastructure
  - QoS, Security, Multicast, …
- Autonomic Management
- Synchronous & Hard Real-Time
- Theory of Networked Computing
- Network Science for Social Value

Internet Ecosystems and Virtualization Open Discussion

- Economic incentives are important for the Internet ecosystem
- Will virtualization play a key role of paradigm shift and change the rule of game ?
- Is Network virtualization performance enough for commercial deployment?

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Contact

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