openSDN: A Service Delivery Network Architecture for Future Internet Evolution

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Conference Inaugural Speech, IEEE COMNETS conference, Bangalore, January 5, 2011

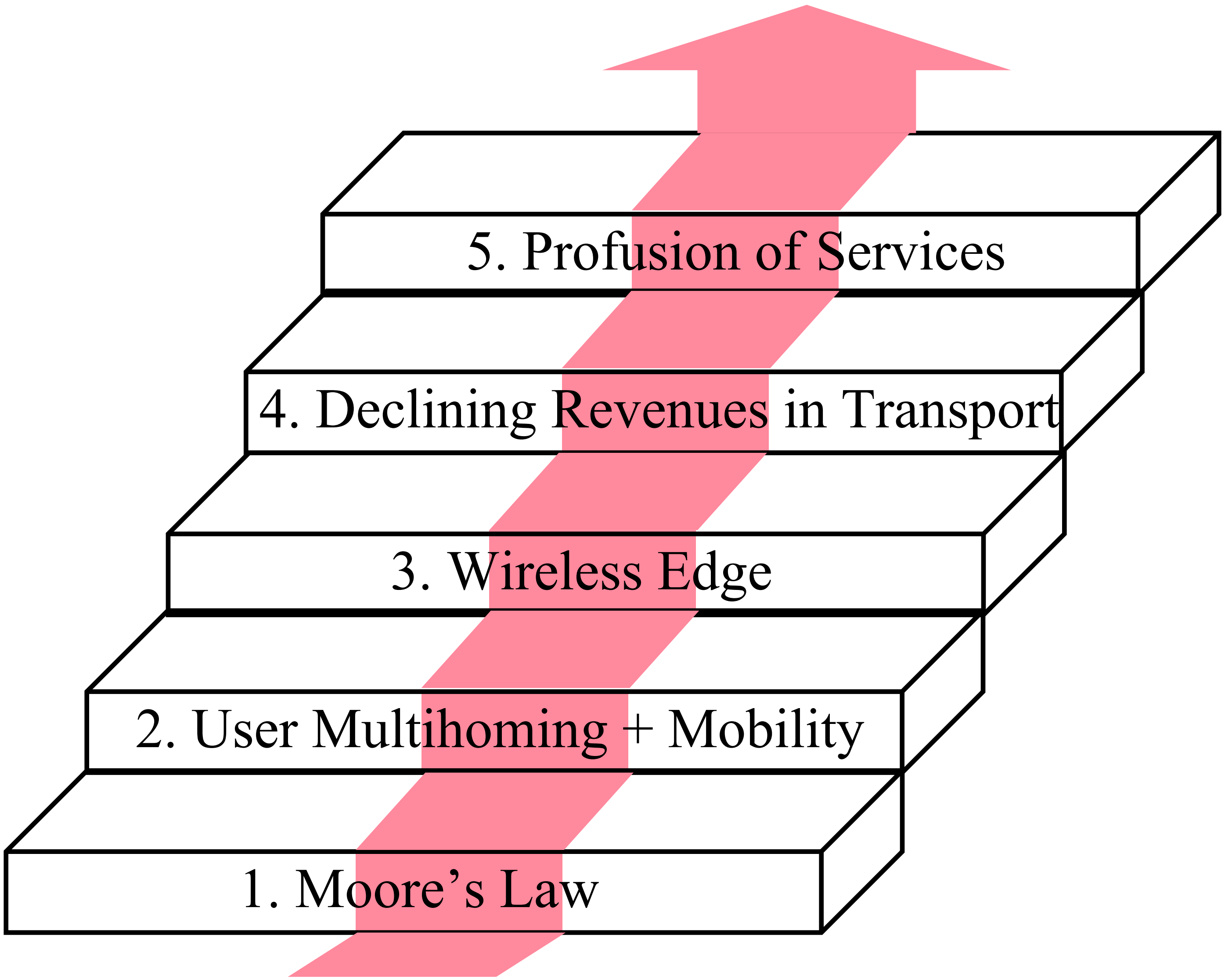
Audio/Video Recordings of this talk are available at http://www.cse.wustl.edu/~jain/talks/comsnets11.htm

1. Five Trends in Networking
2. ~~Five~~ Ten Key Features that Services Need
3. Five Architecture Design Principles for Success
4. Five Key Components of Architecture
5. Five Features of OpenSDN

Why 5?

- It's a Fermat's number, Fibonacci Number, Pell Number, Markov Number, Catalan Number, Smallest twin prime, Safe Prime, Mersenne Prime, Factorial Prime, Eisenstein Prime, Wilson Prime, …
- Don't want to bore you with more than 5 points

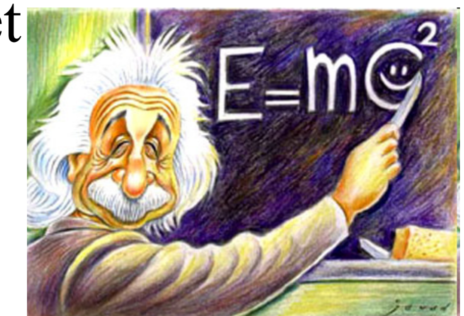
Five Trends in Networking



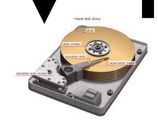
Trend 1: Moore's Law

- Computing Hardware is cheap
- Memory is plenty

⇒ Storage and computing (Intelligence) in the net



- Energy ⟷ Matter
- Space ⟷ Time
- Communication in Space ⟷ Communication in Time



Rural India

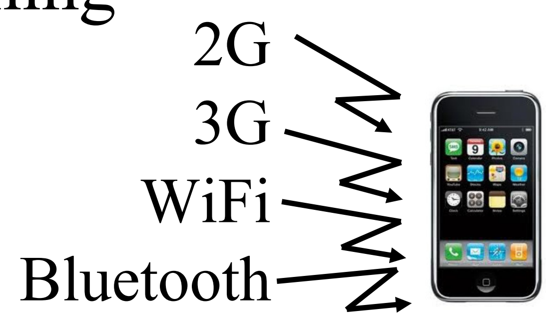
- Link
- Storage (USB, Caching,…)

Next Gen nets will use storage in networks, e.g., DTN, CCN

Trend 2: Multihoming + Mobility

- Centralized storage of info
- Anytime Anywhere computing
- Dynamically changing Locator
- User/Data/Host/Site/AS Multihoming
- User/Data/Host/Site Mobility

⇒ ID/Locator Split



Mobile Telephony already distinguishes ID vs. Locator
We need to bring this technology to IP.

Trend 3: Wireless Edge

1. Billions ⇒ Scalable
2. Heterogeneous ⇒ Customization of content
3. Slow ⇒ Bottleneck ⇒ Receiver Control
   (IP provides sender controls but no receiver controls)

Need to design from receiver's point of view

Trend 4: Declining Revenues in Transport

- Telecom carriers' disappearing revenues in basic transport
- New opportunities in apps and Intelligent transport

2000 FedEx Trucking

2010 FedEx Office
Distribution Centers, Email, …

Future of ISPs is to go beyond best effort trucking services

Trend 5: Profusion of Services

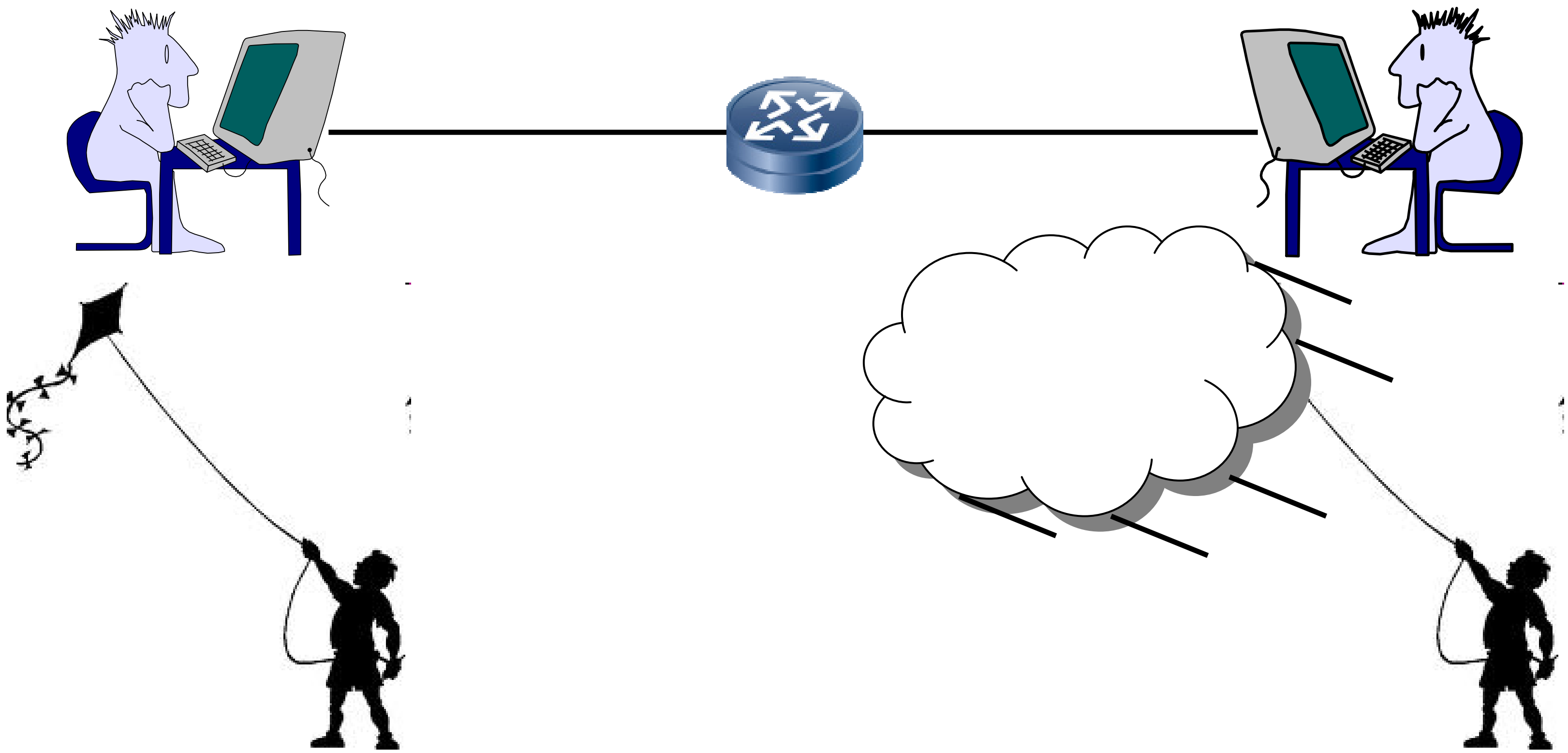
- Almost all top 50 Internet sites are services [Alexa]
- Smart Phones: iPhone, Android Apps
  ⇒ New globally distributed services, Games, …
  ⇒ More clouds, …

Networks need to support efficient service setup and delivery

Ref: Top 500 sites on the web, http://www.alexa.com/topsites

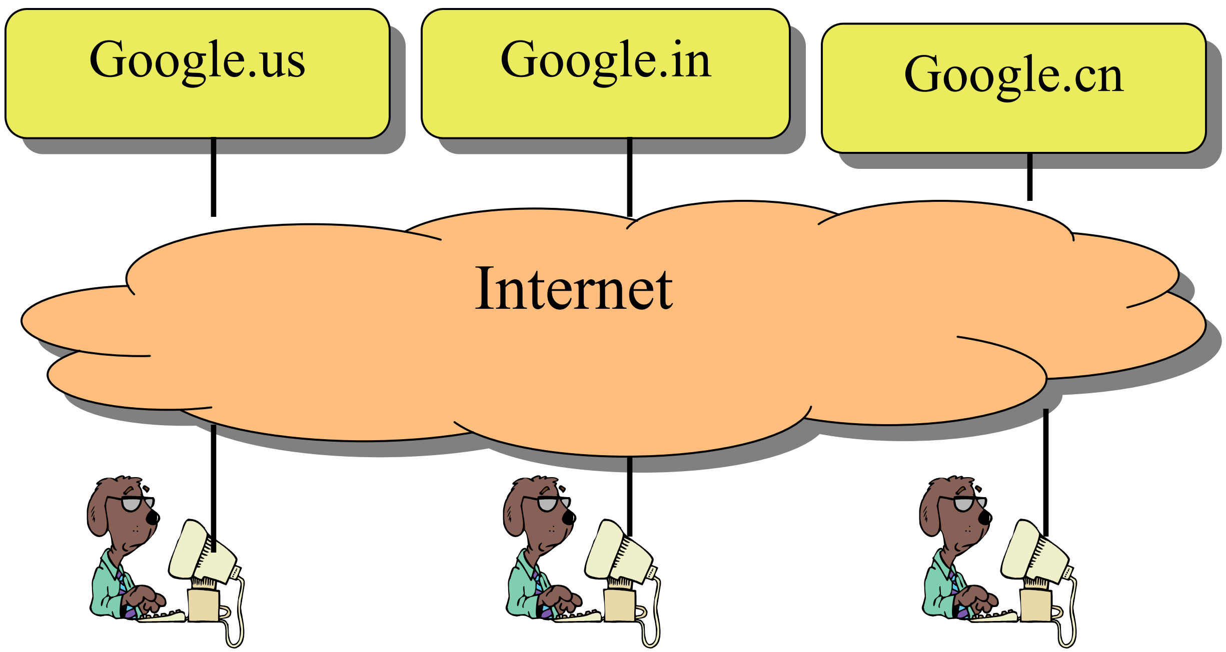
Globally Distributed Services

- Scale ⇒ Global ⇒ Distributed ⇒ Multihomed
- Internet 1.0 is designed for point-to-point communication
- Significant opportunities for improvement for global services



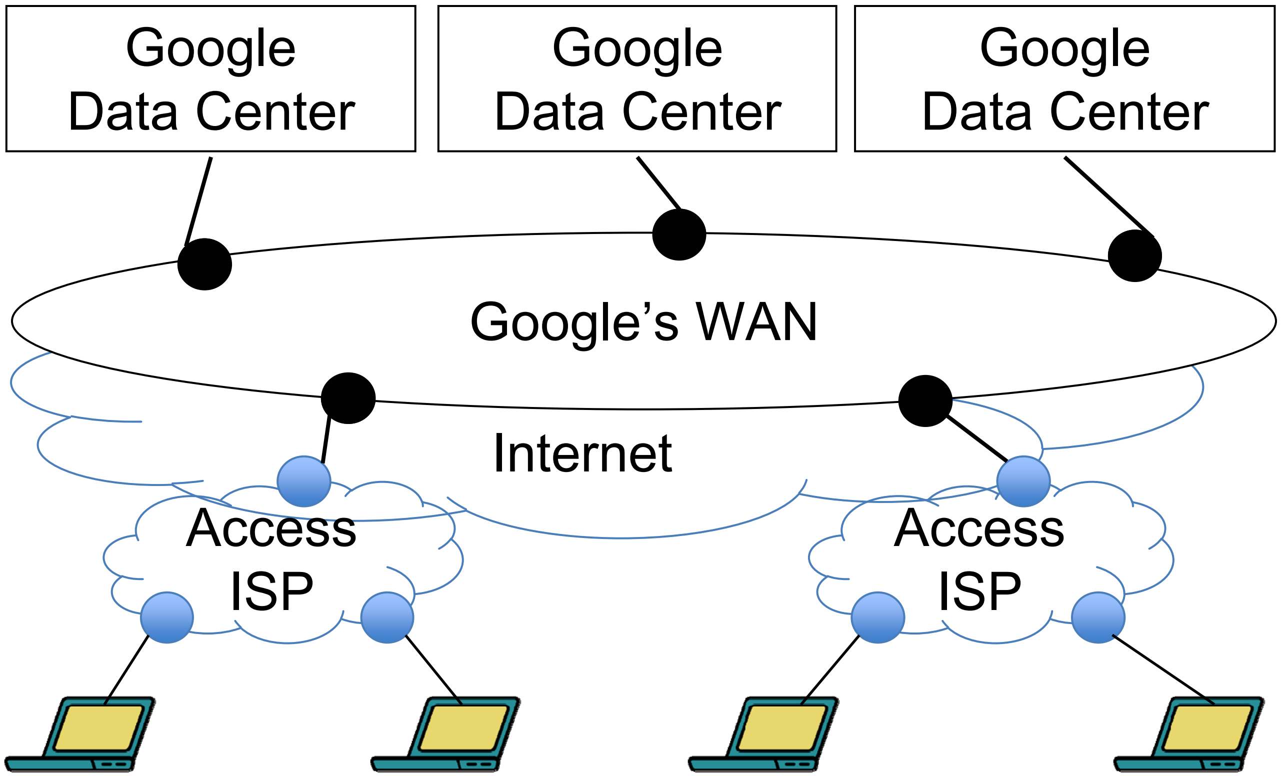
Globally Distributed Services (Cont)

- It's the service responsibility to find the right server for the client



Trend: Private Smart WANs

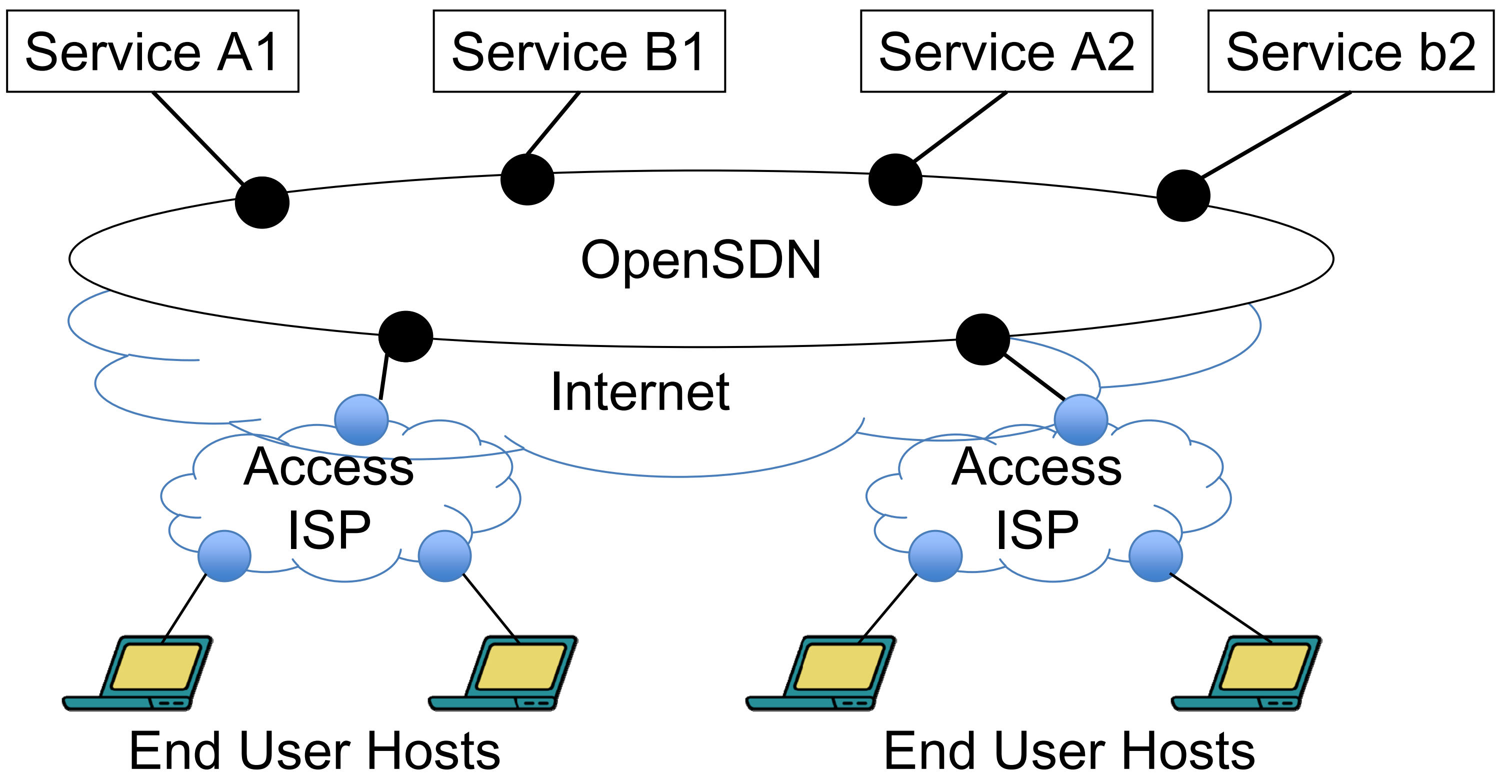
- Services totally avoid the Internet core ⇒ Many private WANs
- Google WAN, Akamai ⇒ Rules about how to connect users



Opportunity for ISPs to offer these types of WAN services

OpenSDN

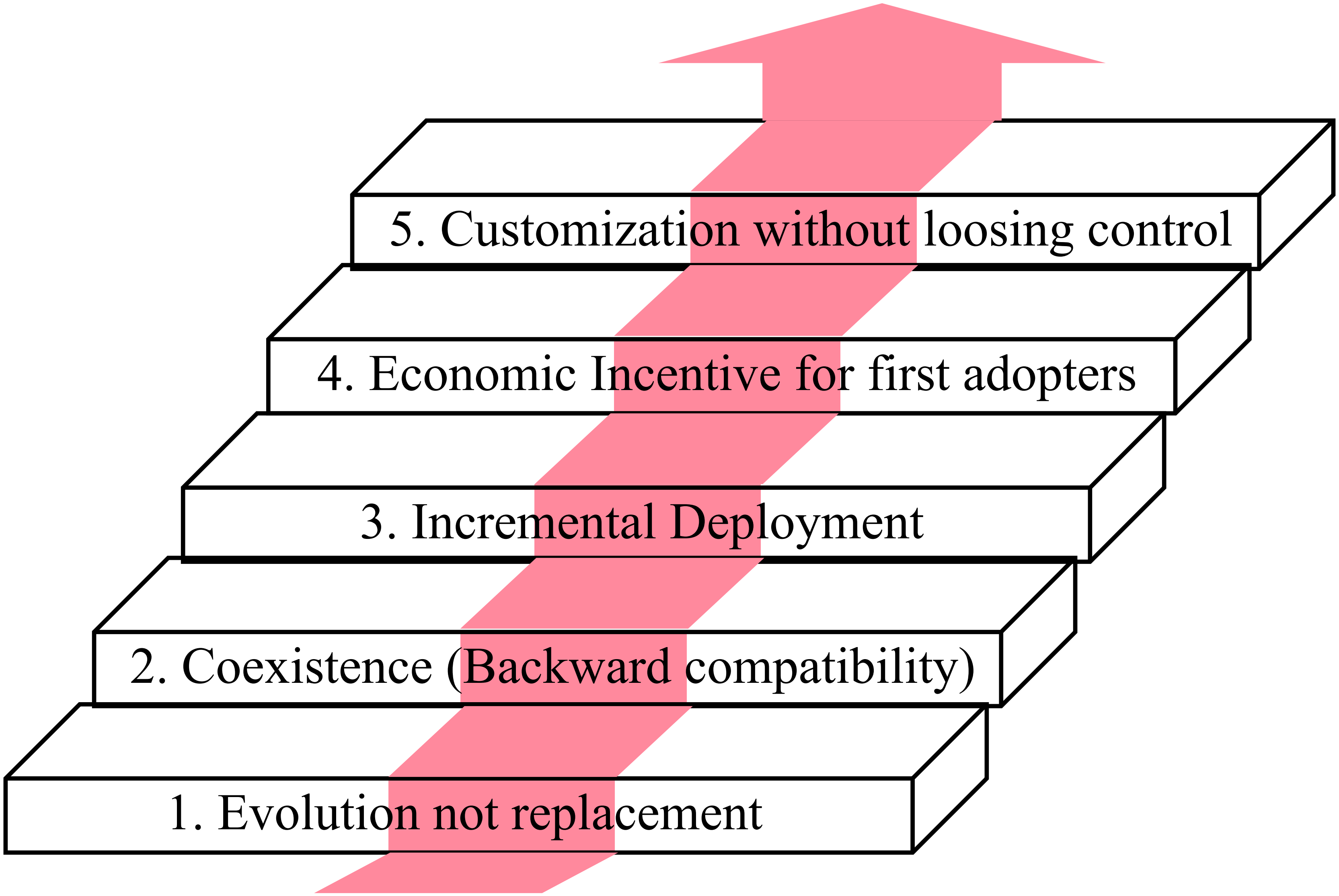
- High-Speed WAN architected for Service Delivery.
- Allows ASPs to quickly setup services



Ten Key Features that Services Need

1. **Replication**: Multiple datacenters appear as one
2. **Fault Tolerance**: Connect to B if A is down
3. **Load Balancing**: 50% to A, 50% to B
4. **Traffic Engineering**: 80% on Path A, 20% on Path B
5. **Flow based forwarding**: Movies, Storage Backup, …
   ATMoMPLS, TDMoMPLS, FRoMPLS, EoMPLS, …
   Packets in Access, Flows in Core
6. **Security**: Provenance, Authentication, Privacy, ...
7. **User Mobility**: Gaming/Video/… should not stop as the user moves
8. **Service composition**: Services using other services
9. **Customization**: Every service has different needs
10. **Dynamic Setup** ⇒ Networking as a Service

Five Arch Design Principles for Success



Networking: Failures vs Successes

- 1986: MAP/TOP (vs Ethernet)
- 1988: OSI (vs TCP/IP)
- 1991: DQDB
- 1994: CMIP (vs SNMP)
- 1995: FDDI (vs Ethernet)
- 1996: 100BASE-VG or AnyLan (vs Ethernet)
- 1997: ATM to Desktop (vs Ethernet)
- 1998: ATM Switches (vs IP routers)
- 1998: MPOA (vs MPLS)
- 1999: Token Rings (vs Ethernet)
- 2003: HomeRF (vs WiFi)
- 2007: Resilient Packet Ring (vs Carrier Ethernet)
- IntServ, DiffServ, …

Technology alone does not mean success.

Five Architecture Design Principles

1. Evolution not replacement.
2. Coexistence (Backward compatibility): Old on New. New on Old
3. Incremental Deployment
4. Economic Incentive for first adopters
5. Customization without loosing control (No active networks)

Most versions of Ethernet followed these principles. Many versions of IP did not.

Five Key Components of Architecture

1. Naming
2. Data Plane (Forwarding)
3. Control Plane (Routing)
4. Management Plane (Monitoring, Fault tolerance, …)
5. Security

OpenSDN Features Overview

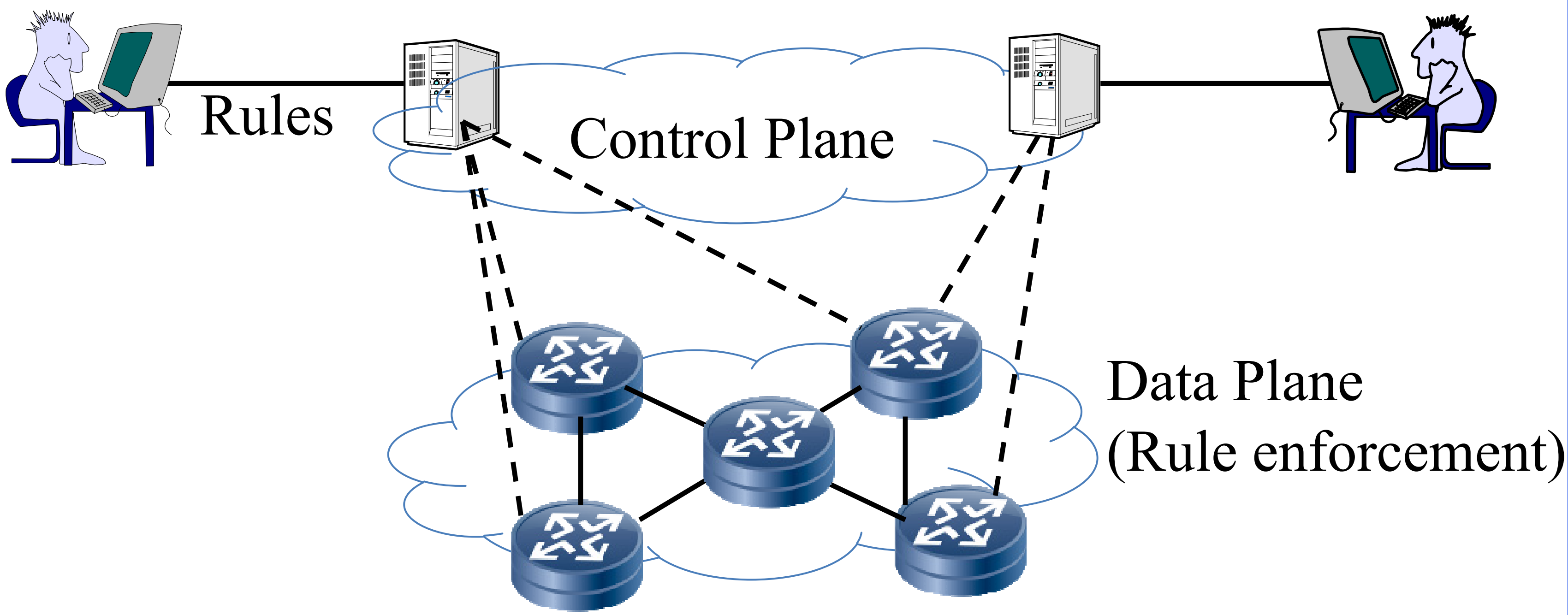
1. Attribute Based Naming
2. Separation of Control and Data Plane
3. Rule based delegation
4. Strong Security
5. Packet and flow based communications

Naming

- Globally unique name with attributes
  ⇒ Attribute based naming
- Attributes: Location, Type
- IDs: Service ID, Host ID, Data ID, User ID, Infrastructure Point-of-Attachment ID (= Locator)
- Applications are bound to IDs
- All IDs are 128-bit
  ⇒ No changes to current applications

Rule Based Delegation

- Control Interface: Registration of Rules
  ⇒ Customization
- Data Interface: Enforcement of Rules

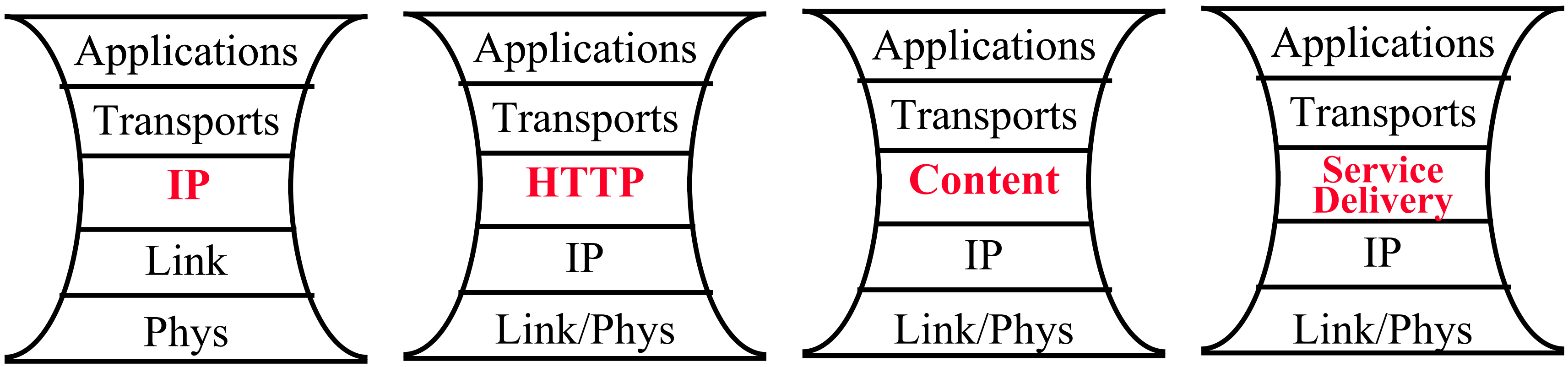


Security

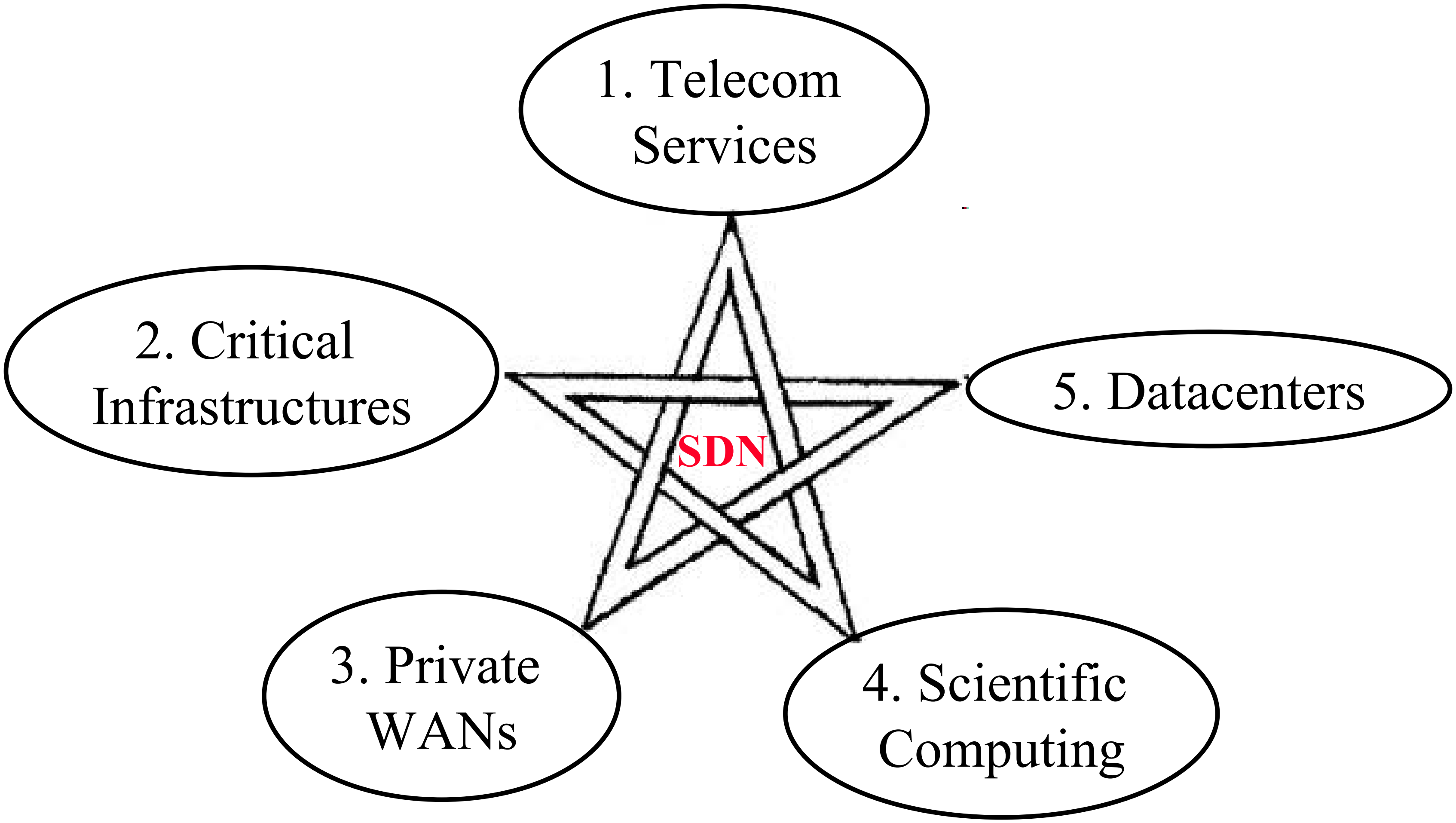
- Control Plane Security:
  Rules Registration, Distribution, Updates
- Data Plane Security: Provenance, Authentication

The Narrow Waist

- Everything as a service over service delivery narrow waist
- IP, HTTP, Content, Service delivery, …

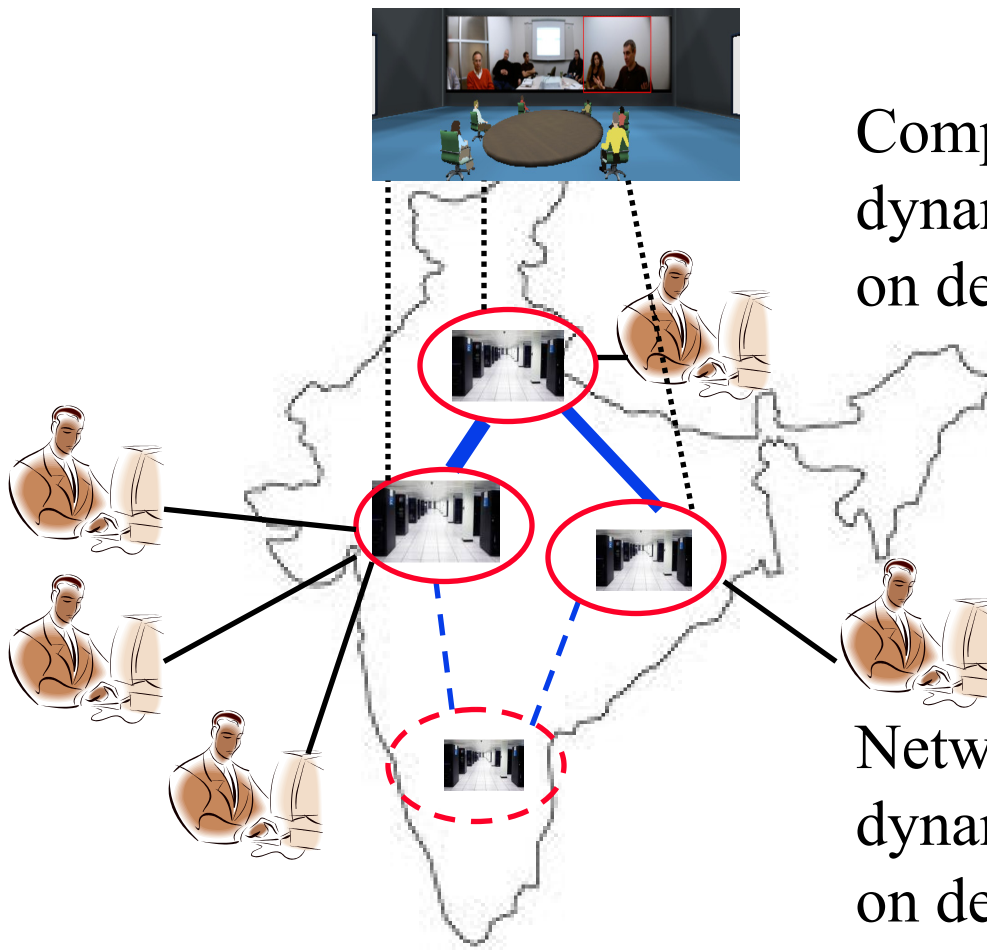


SDN Applications



Application 1: Telecom Services

- IP Multimedia, Video Conferencing, Gaming, …



Computing resources dynamically optimized on demand

Networking resources dynamically optimized on demand

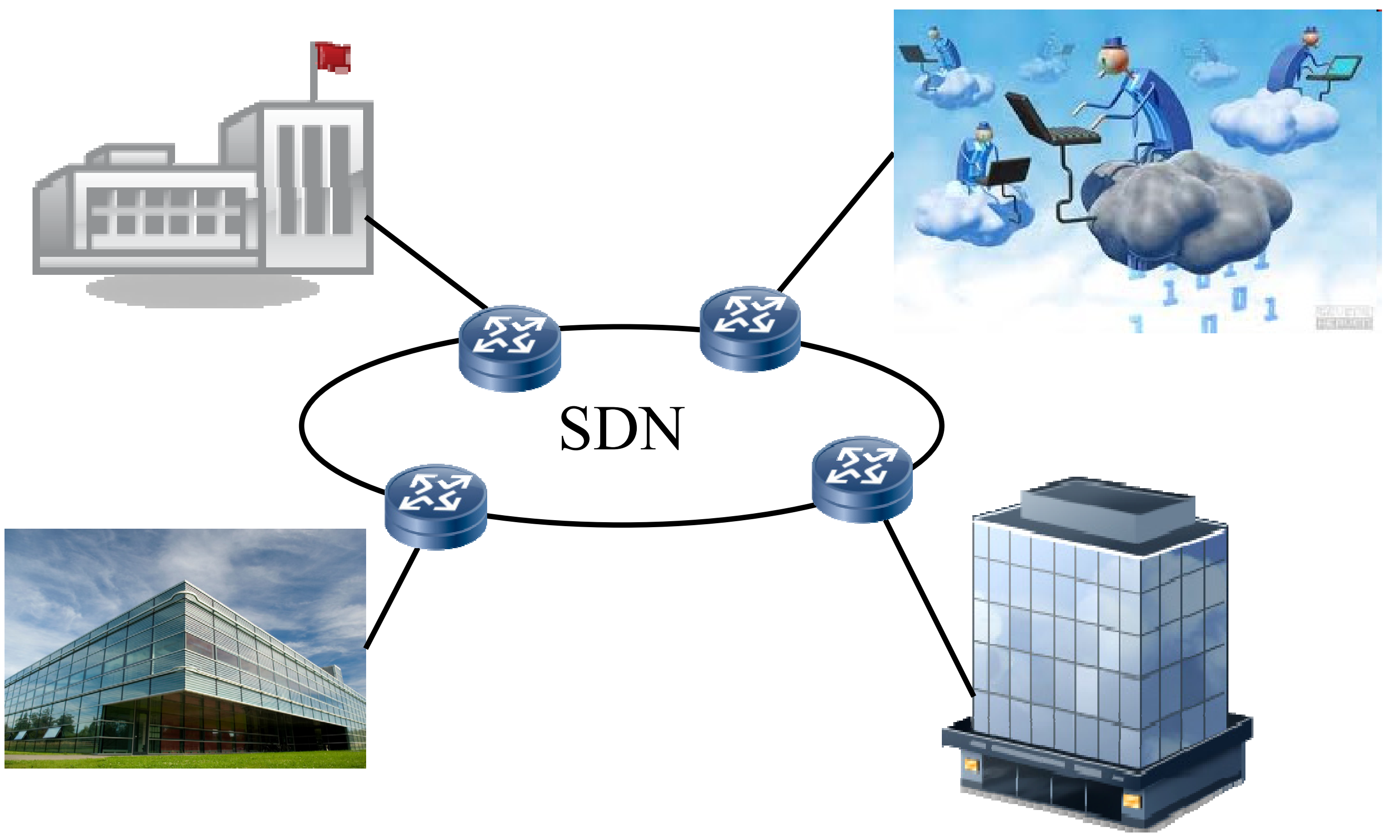
Application 2: Critical Infrastructure

- Defense, Power Grid, Water supply, Gas Supply, …
- Security + Customization
  ⇒ Multiple services can share a single SDN



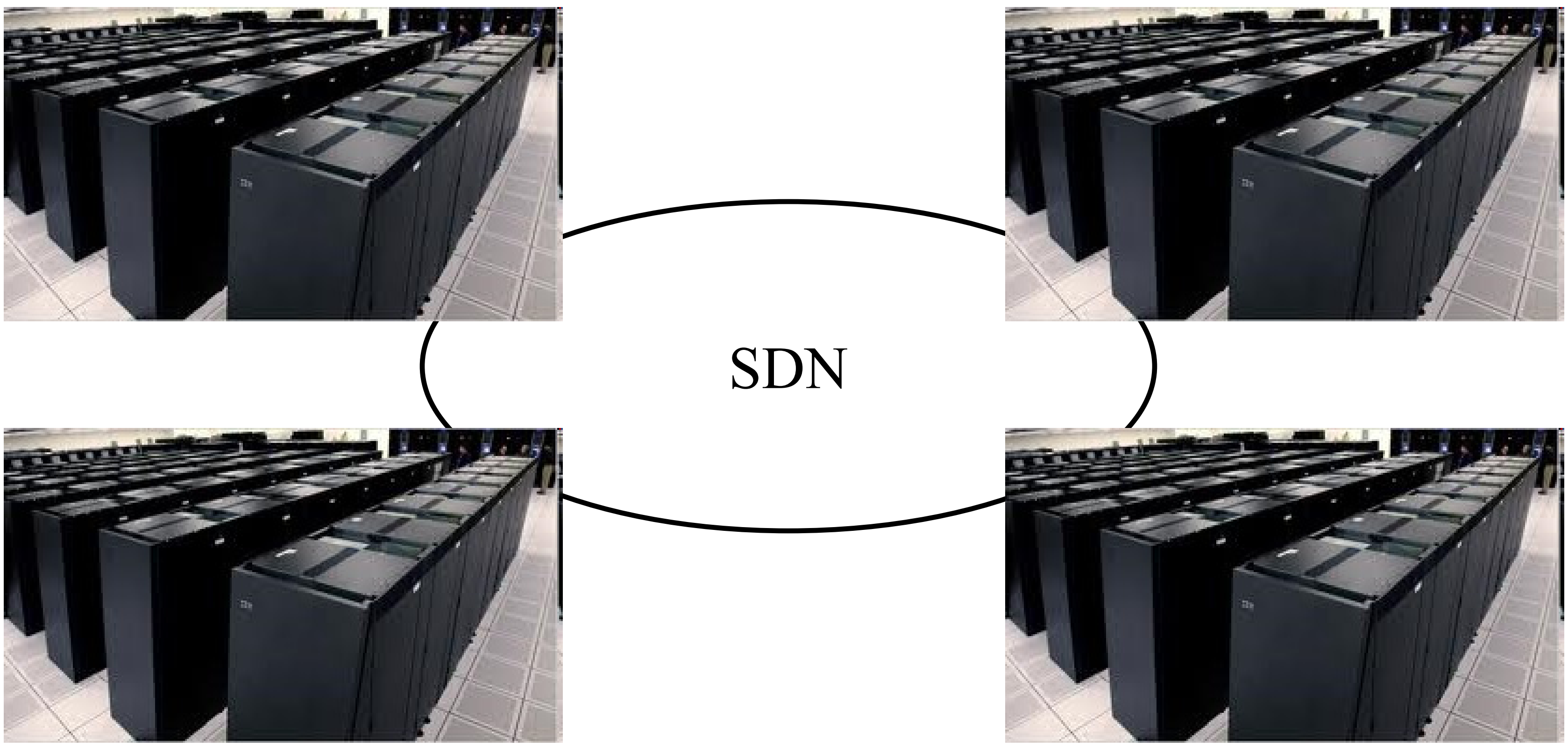

Application 3: Private WANs

- Multiple sites (including cloud computing) with rules for traffic handling



Application 4: Scientific Computing

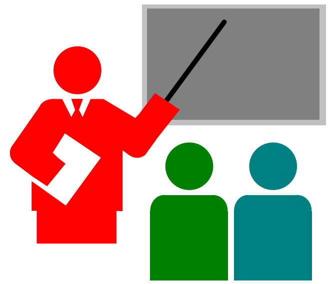
- Distributed computing using high-speed networking,
- National Knowledge Network



Application 5: Datacenter

- Multiple services and clients in a datacenter
- SDN design is good for short distance too

Summary



1. Profusion of services on the Internet
2. OpenSDN is an overlay designed for service delivery
3. New architectures need evolution, backward compatibility, incremental deployment, economic incentives, customization without loosing control for success
4. Services need replication, fault tolerance, traffic engineering, security, …
5. OpenSDN provides these features with rule-based delegation, support for legacy nodes, data-control plane separation

Service Delivery: Opportunity for ISP's and equipment vendors