openSDN: A Service Delivery Network Architecture for Future Internet Evolution

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

Internet Evolution to Next Generation

- Intel Science and Technology Centers on:
  - Visual Computing
  - Secure Computing
  - Cloud and Embedded Computing
- Intel is also a networking and communications company: Ethernet, WiFi, WiMAX, …
- Companies that are making money today are all networking companies: Google, Facebook, Apple (Mobile devices), …
- Need an ISTC on Next Generation Networking
- Start a industry collaboration effort on openSDN

Trend: Profusion of Services

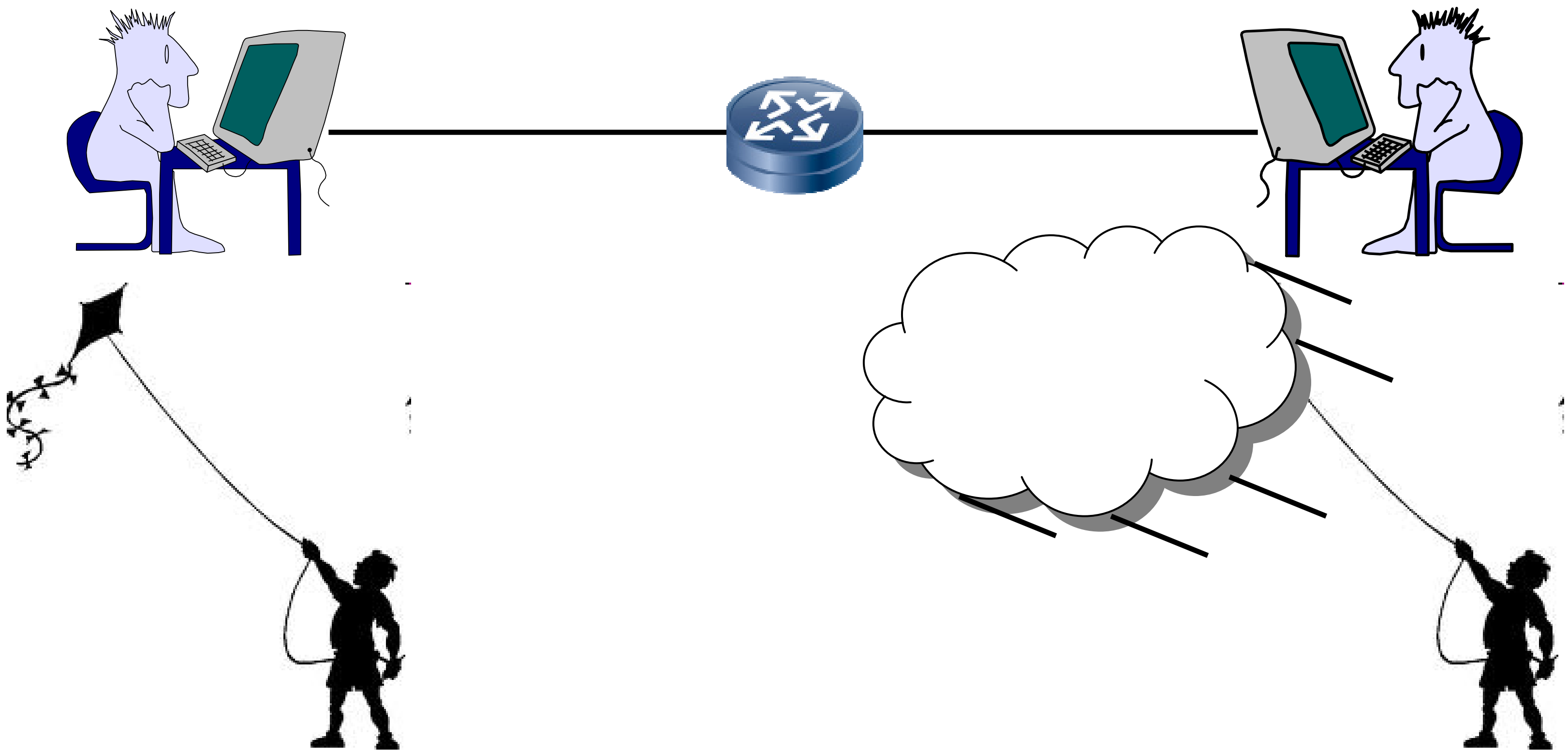
- Almost all top 50 Internet sites are services [Alexa]
- Smart Phones: iPhone, Android Apps
  ⇒ New globally distributed services, Games, …
  ⇒ More clouds, …

Networks need to support efficient service setup and delivery

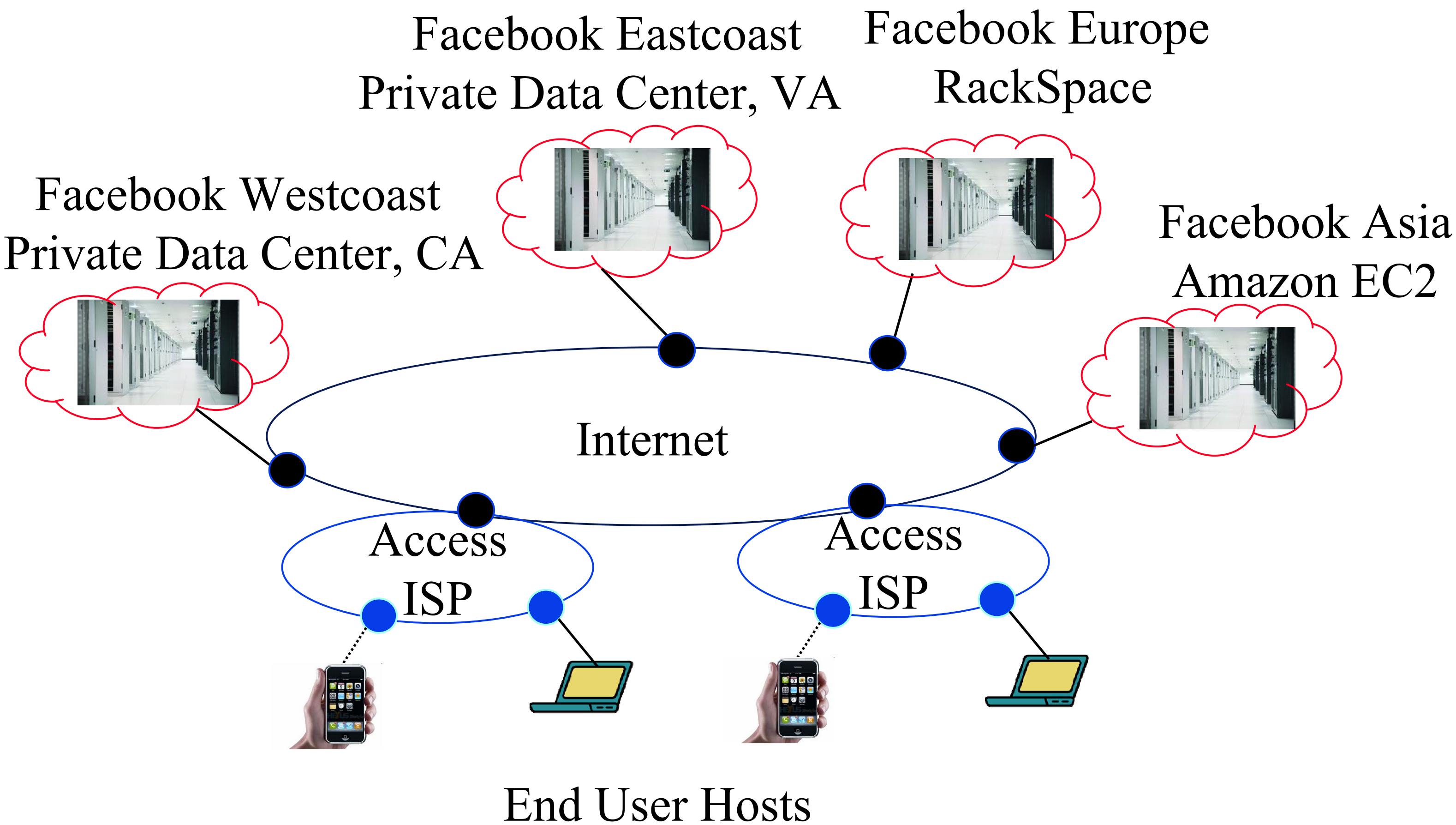
Ref: Top 500 sites on the web, http://www.alexa.com/topsites

Globally Distributed Services

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



Ten Key Features that Services Need



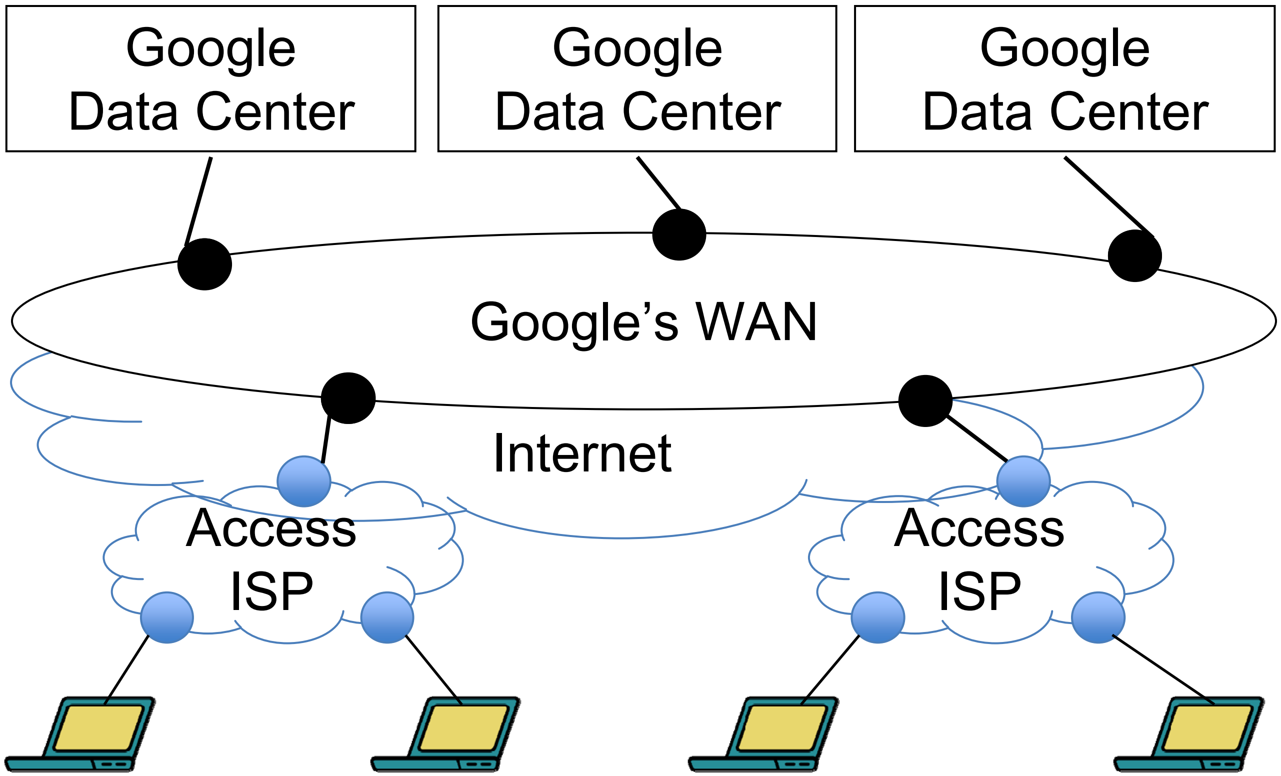
1. **Replication**: Multiple datacenters appear as one
2. **Fault Tolerance**: Connect to B if A is down

Key Features (Cont)

3. **Load Balancing**: 50% to A, 50% to B
4. **Traffic Engineering**: 80% on Path A, 20% on Path B
5. **Server Mobility**: Move service between clouds
   Dynamic Setup ⇒ Networking as a Service
6. **User Mobility**: Gaming/Video/… should not stop as the user moves
7. **Security**: Provenance, Authentication, Privacy, ...
8. **Service composition**: Services using other services
9. **Customization**: Every service has different needs
10. **Flow or Packet based forwarding**: Movies, Storage Backup, …
    ATMoMPLS, TDMoMPLS, FRoMPLS, EoMPLS, …
    Packets in Access, Flows in Core

Trend: Private Smart WANs

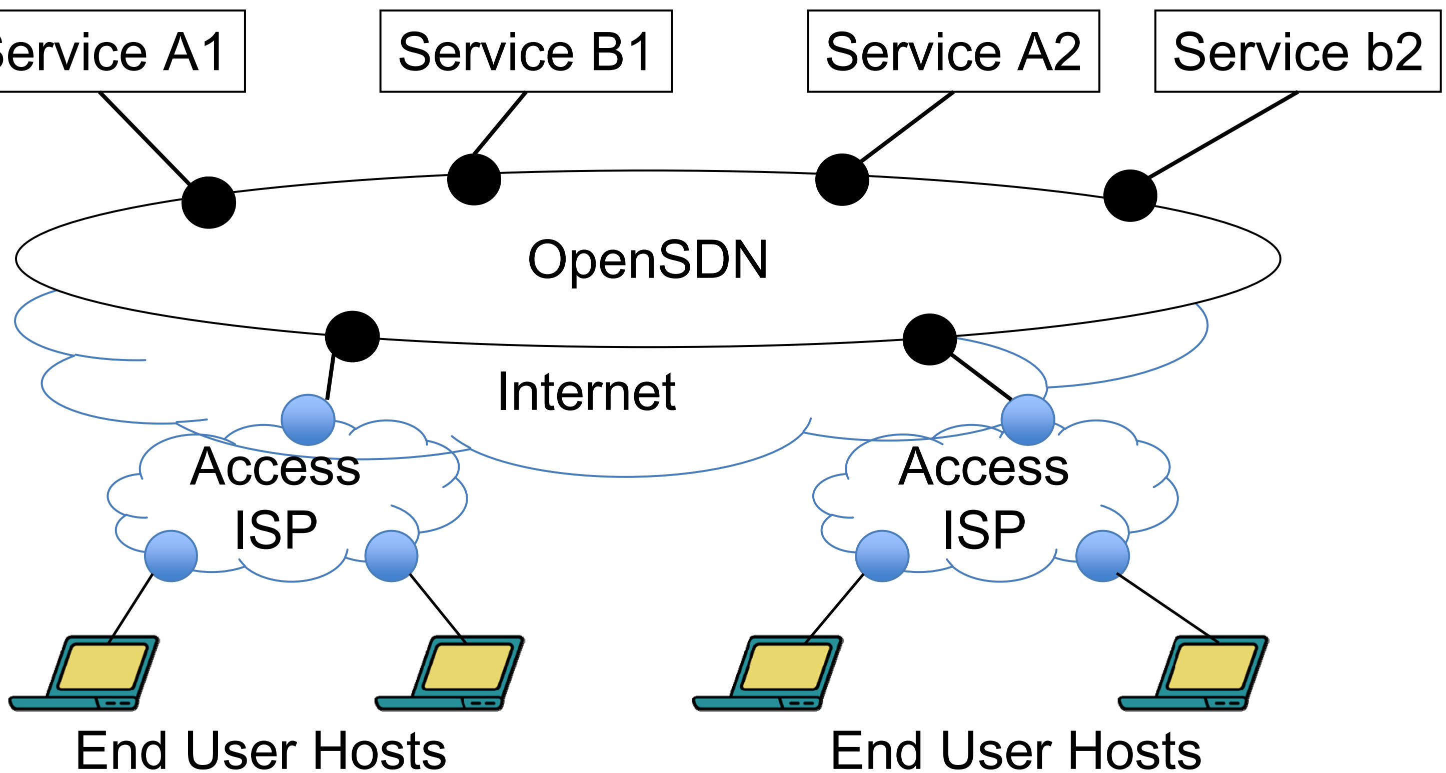
- Services totally avoid the Internet core ⇒ Many private WANs
- Google WAN, Akamai ⇒ Rules about how to connect users



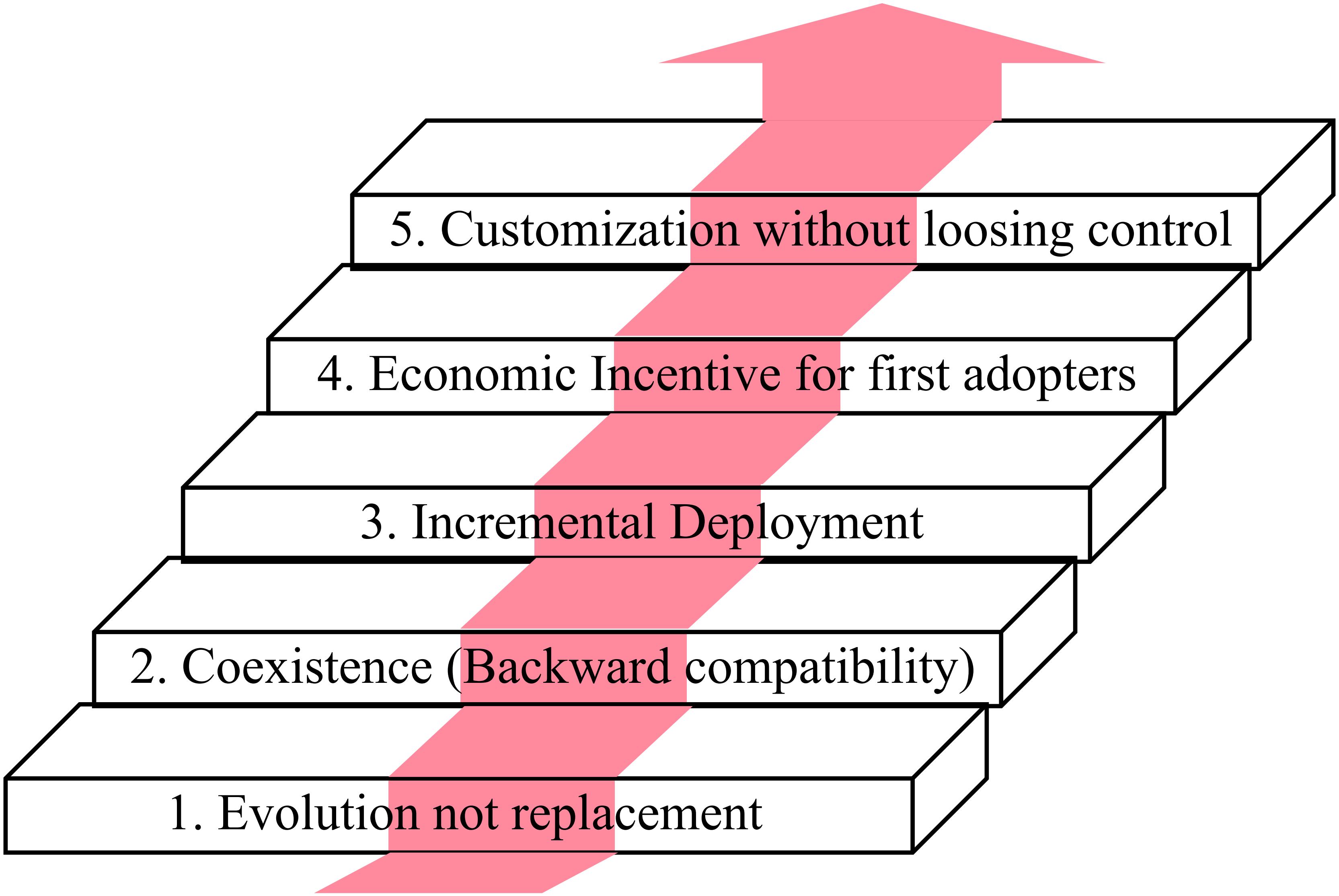
Opportunity for ISPs to offer these types of WAN services

OpenSDN

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



Five Arch Design Principles for Success



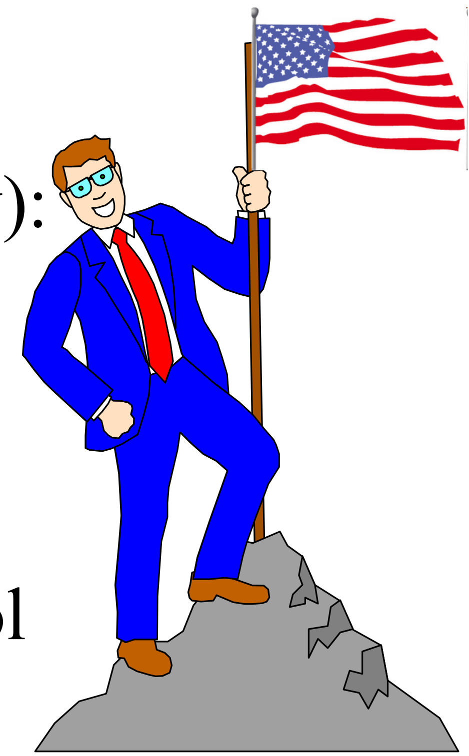
Networking: Failures vs Successes

- 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

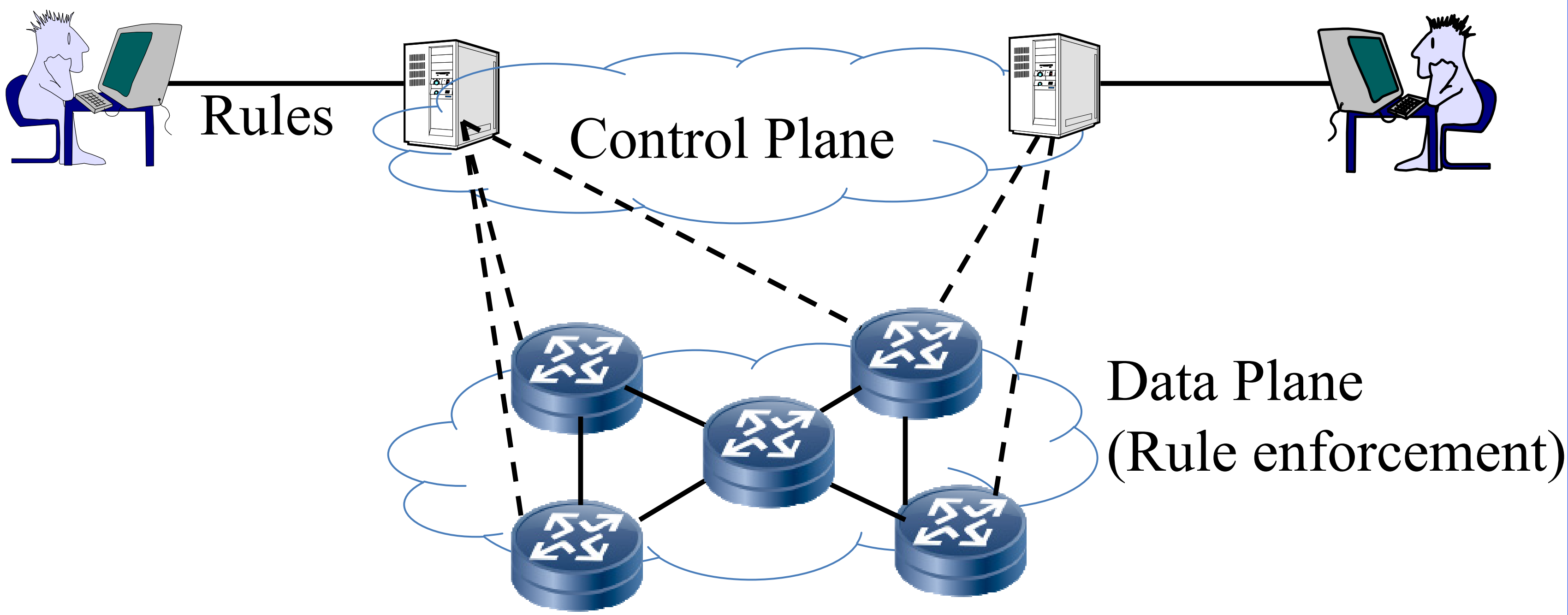
1. Naming
2. Data Plane (Forwarding)
3. Control Plane (Routing)
4. Management Plane (Monitoring, Fault tolerance, …)
5. Security

OpenSDN Features Overview

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

Rule Based Delegation

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



Naming

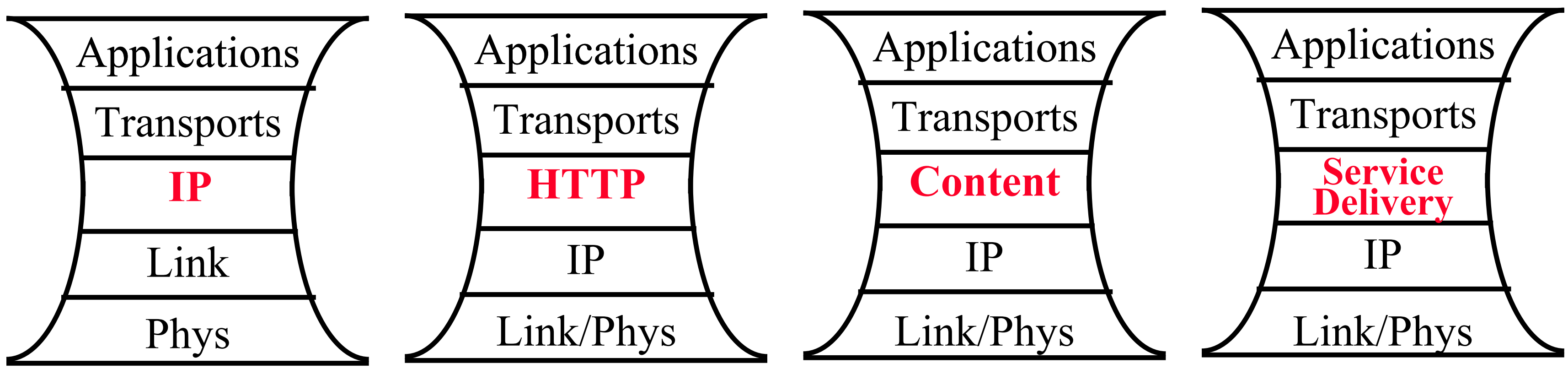
- Globally unique name with attributes
  ⇒ Attribute based naming
- Attributes: Location, Type
- IDs: Service ID, Host ID, Data ID, User ID, Infrastructure Point-of-Attachment ID (= Locator)
- Applications are bound to IDs
- All IDs are 128-bit
  ⇒ No changes to current applications

Security

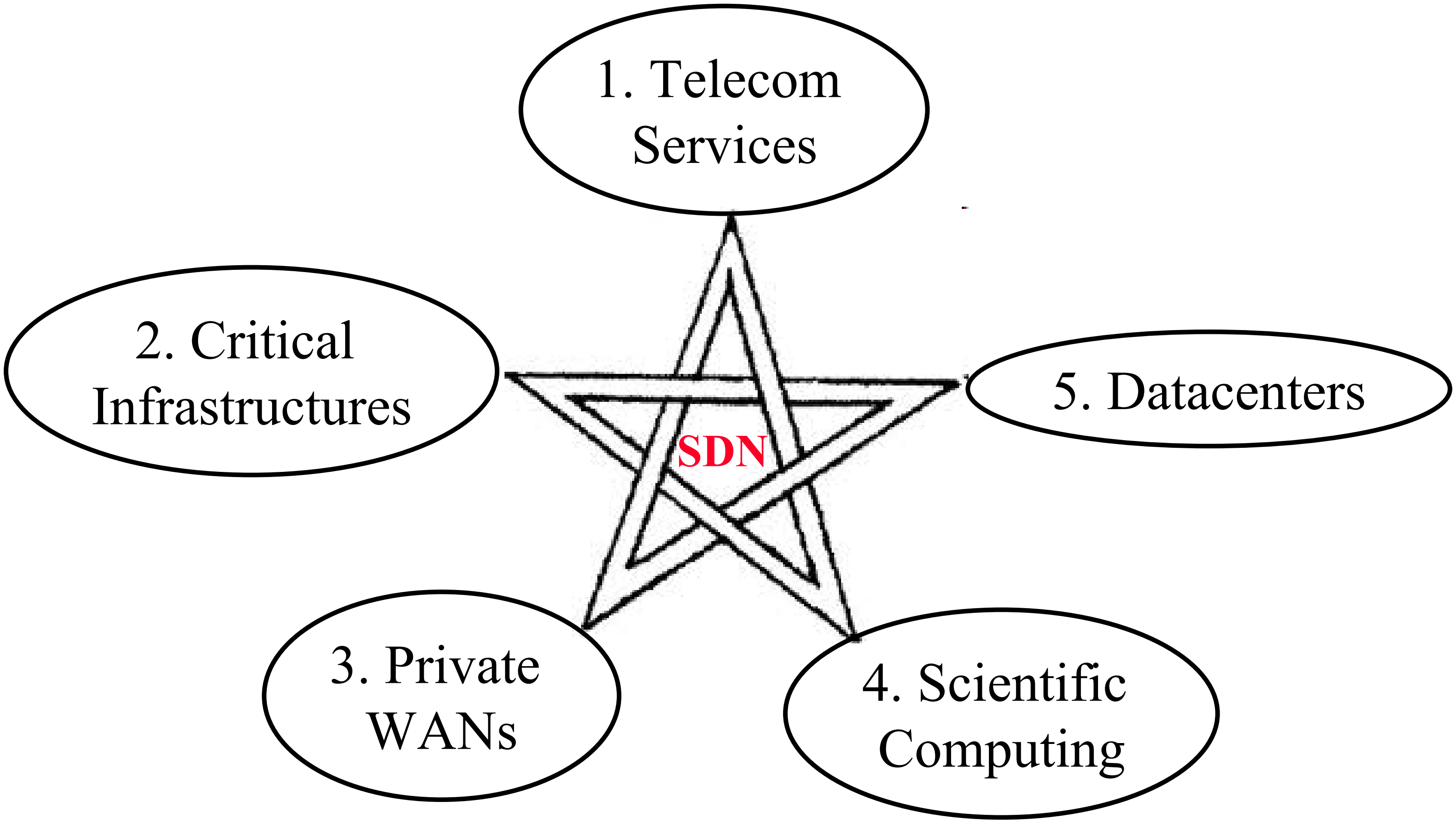
- Control Plane Security:
  Rules Registration, Distribution, Updates
- Data Plane Security: Provenance, Authentication

The Narrow Waist

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

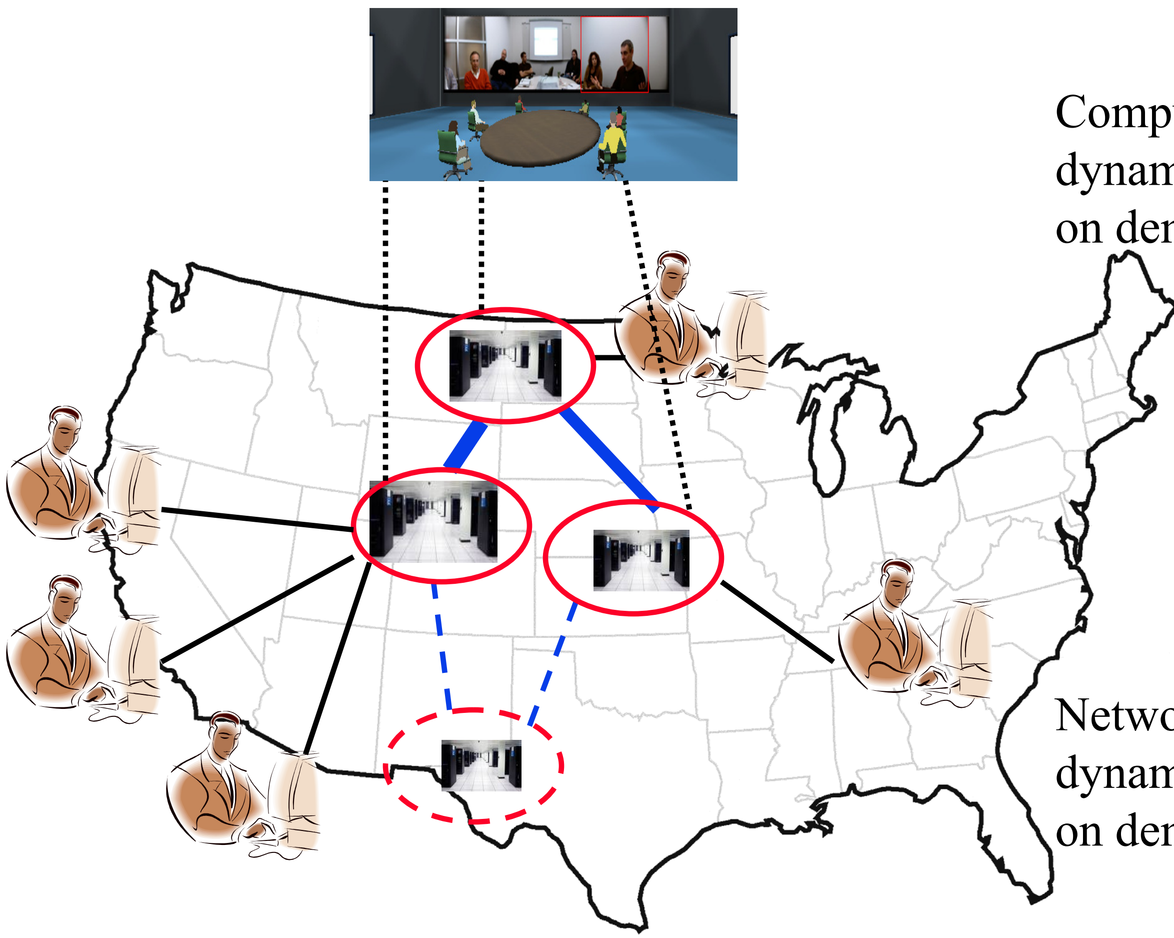


SDN Applications



Application 1: Telecom Services

- IP Multimedia, Video Conferencing, Gaming, …



Computing resources dynamically optimized on demand

Networking resources dynamically optimized on demand

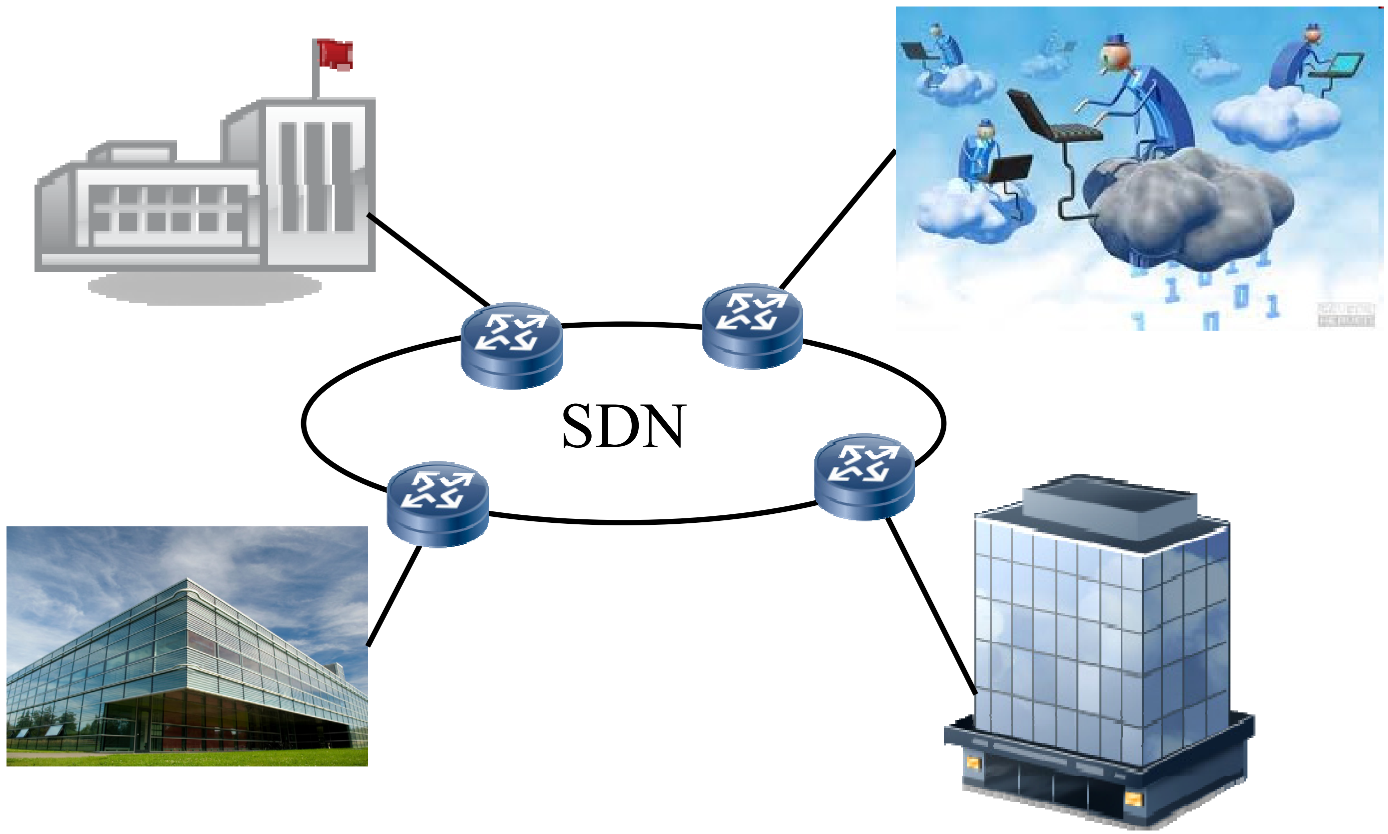
Application 2: Critical Infrastructure

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



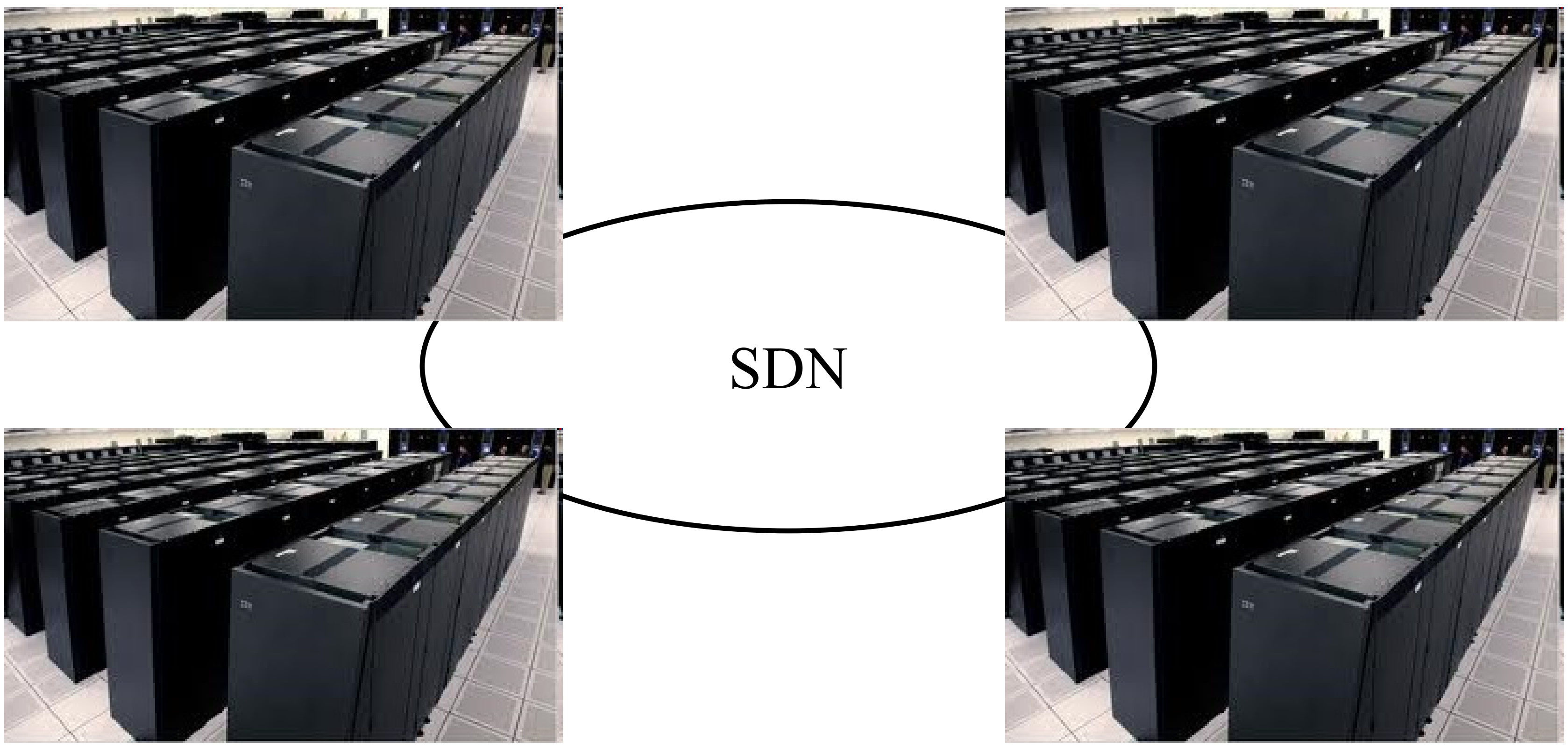

Application 3: Private WANs

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



Application 4: Scientific Computing

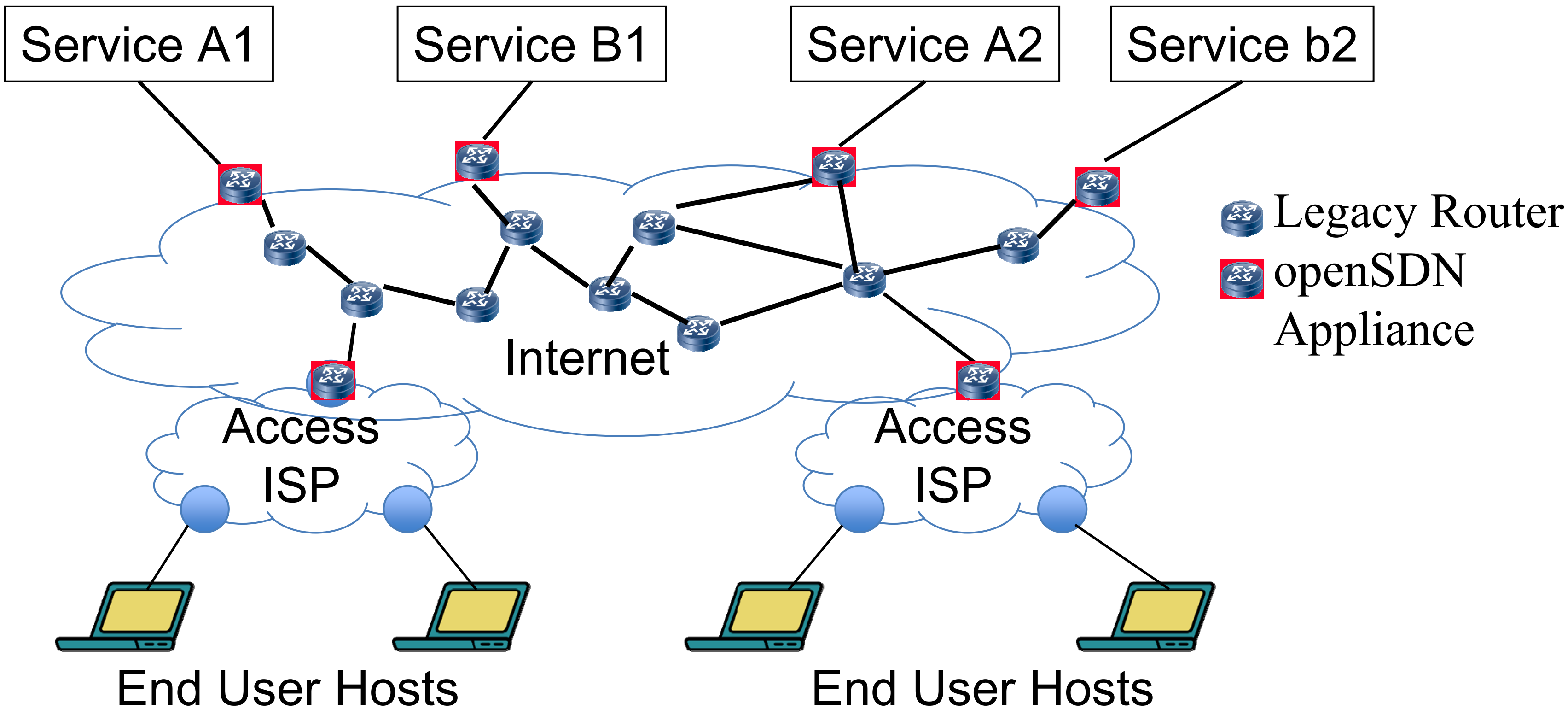
- Distributed computing using high-speed networking,
- National Knowledge Network



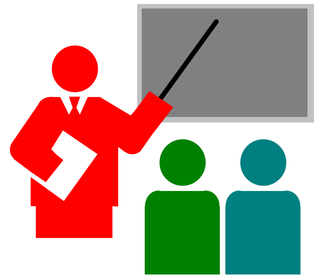
Application 5: Datacenter

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

Implementation: OpenSDN Appliance



Summary



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

Evolution of Internet to the next generation is an important ISTC area