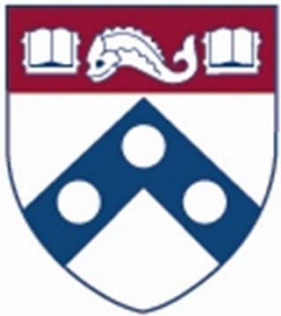

Cloud Computing: Architectural and Policy Implications



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Overview

- Introduction to key cloud computing concepts
- The economics of cloud computing
- Architectural implications
 - Access networking
 - Core networking/data center connectivity
- Policy implications
- Overview of NSF Project (time permitting)

Key Cloud Computing Concepts

- Service oriented architecture/thin clients
- Virtualization
- Delivery models
 - Software as a Service (SaaS)
 - Platform as a Service (Paas)
 - Infrastructure as a Service (IaaS)
- Public vs. private clouds

Economics of Cloud Computing

- Operating cost reductions
- Amortization of fixed costs
- The transformation of CapEx into OpEx
- Reduction in peak variability
- Improved reliability and latency
- Other benefits (mobility, collaboration, information aggregation)

Implications for Access Networking

- Ubiquity
- Capacity
- Reliability
- Quality of service
- Privacy/security

Implications for Core Networking

- Capacity
- Reliability
- Privacy/security
- End user control over routing policies
- Standardization
- Coordination/integration across data centers
- Metering and payment

Implications for Industry Structure

- Looser integration of devices and operating systems
- Tighter integration of end user software
- Market concentration in access networking
- Economies of scope in data center operations
- Growing importance of key middleware (e.g., hypervisors) and equipment
- Importance of lowering switching costs (e.g., data portability)

Policy Implications

- Potential benefits of standardization
- Threat of public utility regulation
- Restrictions on quality-based price differentials
- Potential revisions to data privacy restrictions

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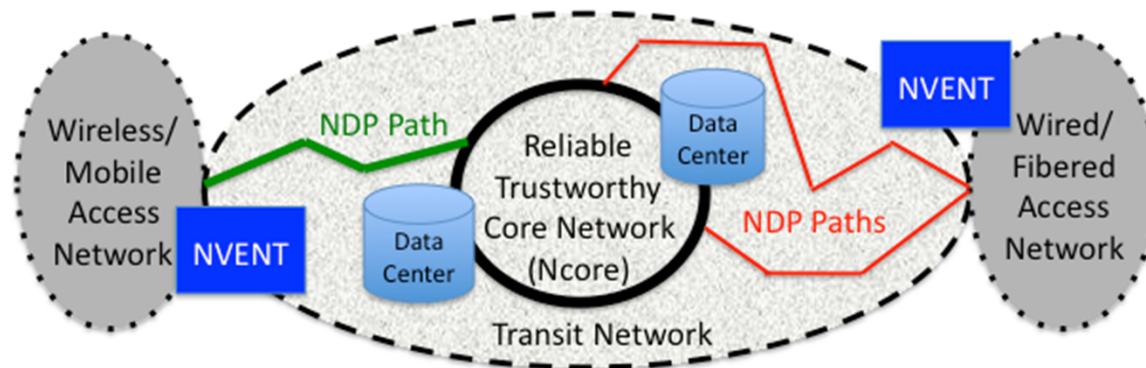
- NEBULA – three elements
 - NEBULA Virtual and Extensible Networking Technologies (NVENT)
 - NVENT discovers paths and negotiates consent
 - Negotiated path information incorporated into NDP
 - NEBULA Data Plane (NDP)
 - Rewrite network layer header to include path information
 - For each hop, include Proof of Consent (PoC) and Proof of Provenance (PoP)
 - NDP provides sufficient primitives to support a variety of policies

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- NEBULA – three elements

- NEBULA Core (NCore)

- BGP is slow, bad at parallel paths, bad at updates
 - NCore focuses on faster *intra-router*, not *inter-* or *intra-domain*
 - NCore supports redundant connections, fast transfer in case of failure, dynamic updating of router software



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■ Benefits of NEBULA

- End-user ability to specify paths through software (security and ability to implement routing policies)
- Ability to ensure availability and quality of service (through access controls)
- Ability to verify/enforce paths (security and privacy)
- Ability to support multiple parallel paths (reliability)
- Flexibility to support a wide variety of routing policies