



# Policy Implications of Network Management

CYBR 4400 / 5400: Principles of Internet Policy, Lecture 3-3

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# Today's Lecture

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- ✿ Finish Restoring Internet Freedom Lecture
- ✿ Network Management Technologies Applied to Net Neutrality Lecture

# Reaction to Rules

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- ✿ Fight to Save Net Neutrality
- ✿ Burger King on Net Neutrality!?!?
- ✿ Broadband Providers Are Quietly Taking Advantage of an Internet Without Net Neutrality Protections
- ✿ How to tell if your provider is throttling your internet



# DC Court of Appeals Reaction... Generally Upholding Order

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- ✿ FCC could change classification of BIAS from common carrier to information service based largely on Brand X US Supreme Court decision in 2005
- ✿ Rejected most claims that FCC did not correctly decide factual and policy questions, except requiring the FCC to review the following issues
  - ✿ impact of the decision on public safety
  - ✿ how the decision would affect the rates paid by ISPs to attach their transmission facilities to utility poles
  - ✿ impact of the decision on the FCC's Lifeline program,
- ✿ Overturned portion of FCC decision that widely prohibited state and local regulation of BIAS, concluding that prohibition not supported by any legal authority
  - ✿ FCC could address potential conflicts with Restoring Internet Freedom decision on case-by-case basis.

# Timeline Summary

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- ❖ Computer Inquiry II established 2 service types
  - ❖ Basic (subject to Title II common carrier regulation of 1934 Act) or Enhanced (ill-defined Title 1 rules) services
- ❖ Telecom Act of 1996 defined two entities
  - ❖ Telecommunications carriers (Title II) or Information service providers (Title I unregulated)
- ❖ FCC classified DSL as a telecommunications service (1998)
- ❖ FCC classified cable broadband as an information service (2002)

# Timeline Summary (cont'd)

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- ❖ FCC classified DSL (2005) and wireless (2007) broadband as information services
- ❖ FCC ordered Comcast to new network management approach and transparency based on “ancillary jurisdiction” (2008)
  - ❖ Vacated because FCC failed to identify statutory authority that was reasonable ancillary
- ❖ FCC's Preserving the Open Internet rules based upon same theory of ancillary jurisdiction (2010)

# Timeline Summary (cont'd)

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- ❖ FCC sought comment on reclassification of broadband Internet services in 2010, but adopted Open Internet rules instead
- ❖ Also in 2010, FCC concluded “broadband deployment to all Americans is not reasonable and timely” in Sixth Broadband Deployment Report
- ❖ U.S Court of Appeals rules in Verizon v. FCC (2014) vacates portions of Open Internet Order (2010) that could only be applied to common carriers
- ❖ FCC's Protecting and Promoting the Open Internet rules based upon Title II statutory authority (2015)

# Timeline Summary (cont'd)

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- ✿ FCC's Restoring Internet Freedom rules eliminating Title II statutory authority and reclassifying BIAS as information service (2018)
- ✿ US Court of Appeals for District of Columbia affirms most of FCC decision (2019)

# Group Discussion

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- Eliminating the Internet conduct standard
  - ✿ “We believe that eliminating the Internet conduct standard will promote network investment and service-related innovation by eliminating the uncertainty caused by vague and undefined regulation.”
  - ✿ Do you agree?

# Group Discussion

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- The need for “bright line” rules of 2015
  - ✿ Is there any evidence of market failure, or is there likely to be, sufficient to warrant these rules?
- The need for no-blocking rule
  - ✿ Prior to 2015, many large ISPs voluntarily abided by the 2010 no-blocking rule in the absence of a regulatory obligation to do so. Do we have evidence that providers are blocking today given the elimination of the no-blocking rule?

# Group Discussion

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- Need for no-prioritization rule of 2015
  - ✿ What are the trade-offs in banning business models dependent on paid prioritization versus allowing them to occur when overseen by a regulator or industry actors?
- Need for the transparency rule in 2018
  - ✿ Is the “effective disclosure of Internet service providers’ network management practices, performance, and commercial terms of service” the best way to accomplish the goals of competition, innovation, investment, end-user choice, and broadband adoption?

# Group Discussion

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The “no-throttling” rule in 2015 banned impairment or degradation of lawful Internet traffic or use of a non-harmful device, subject to reasonable network management practices

- ✿ When is “throttling” harmful to consumers?

Does the 2018 rule allow providers to offer BIAS with differentiated prioritization that benefits consumers?

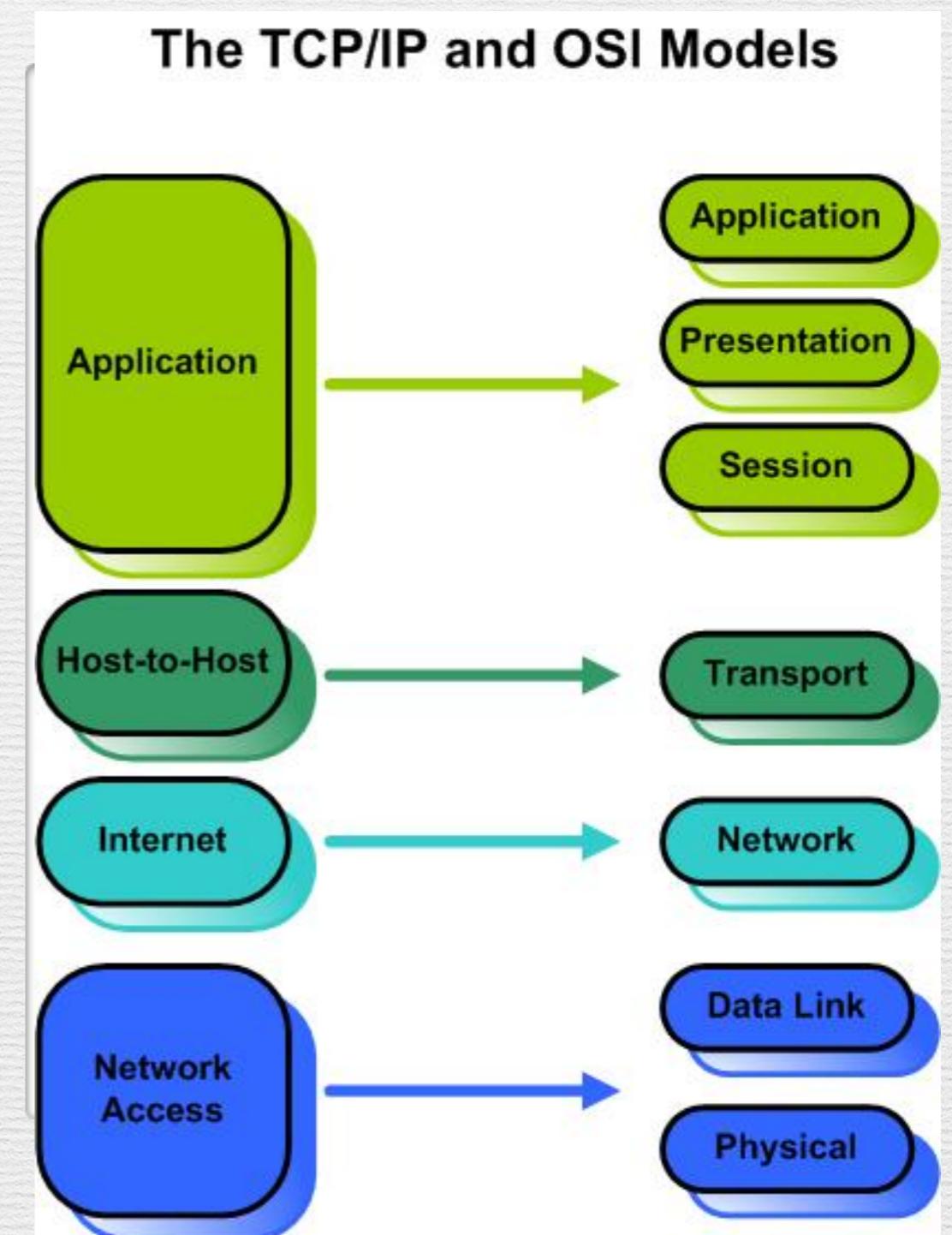
- ✿ What differentiates reasonable network management?

# Network Management Technologies Applied to Net Neutrality

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# Layered Internet Model

- Modularity – mutually independent functional layers
- Firms compete independently at each layer without having to enter market for services at other layers
- Openness – nobody owns core protocols
- Stimulates entry and disaggregated competition at each layer
- Mix and match best technologies at each layer



# Net Neutrality

- Recall Internet policy challenge: when is government intervention needed to prevent dominant provider at one layer from stifling competition at another?
- Net neutrality transferred the debate from open access for ISPs to access for applications and content providers
- Based on end-to-end design principle and the equal opportunity it engenders

# End-to-End Design Principle\*

- Key question: What NOT to design into the “core” of a system (or the Internet)?
- Original formulation:

“In a system  $S$  including a shared communications subsystem  $C$ , App. function  $F$  might be specified to be implemented either in  $C$ , or in the endpoints using  $S$ , or both.  $F$  can only be completely and correctly implemented at the endpoints. Therefore providing  $F$  in  $C$  is not possible.”

- Key Insight: resisting function inclusion into the core was often the correct design choice

\*Source: Saltzer, J. H., D. P. Reed, and D. D. Clark (1981) "End-to-End Arguments in System Design". Proceedings of the Second International Conference on Distributed Computing Systems, Paris, France. April 8–10, 1981. IEEE Computer Society, pp. 509-512.

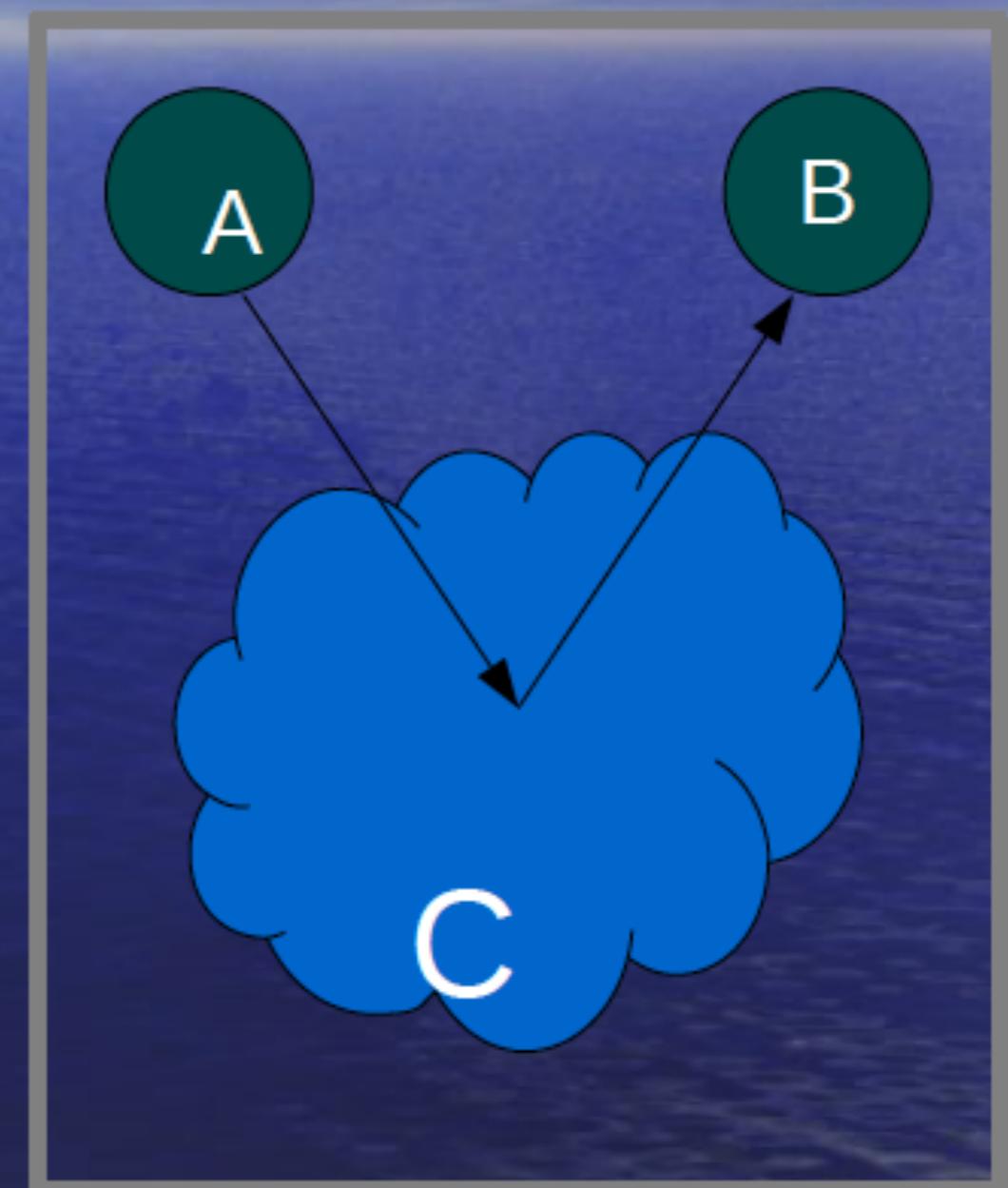
# What They Meant

*F: Secure Message Delivery: only B can see contents*

Using Internet - complete and correct SMD can only be ensured by end-to-end encryption

Therefore providing F in C is not possible. (an incomplete F' in C may be useful for optimization).

In End-to-end argument



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# End-to-End Functions

## End-to-End Examples

Secure message delivery  
Reliable delivery  
Duplicate suppression  
Authentication/  
Accountability

## Non-Examples

Traffic management  
Capacity reservation  
Multicast routing  
Packet fragmentation  
and reassembly

Cloud computing? “Amazon EC2/S3 is not ‘in the communications system’ - it's an end” – Reed (no relation)

# Evolution in Thought

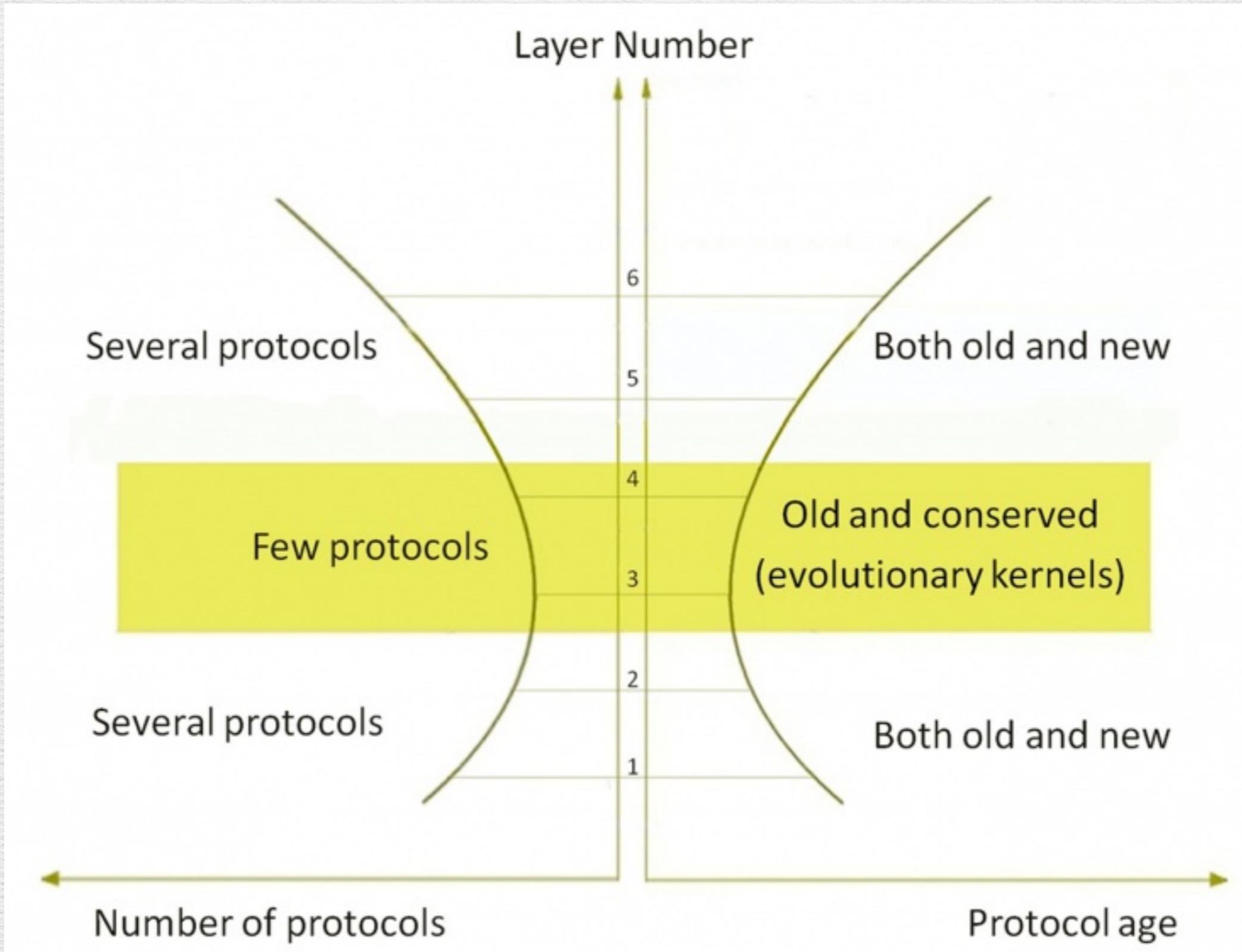
2000 The New Republic (Lessig):

“...intelligence should lie in the applications, or ‘ends’. This design principle has a consequence: It embeds a type of neutrality. Because the network is ‘simple’, it is not in a position to discriminate against new applications or new content.”

Saltzer:

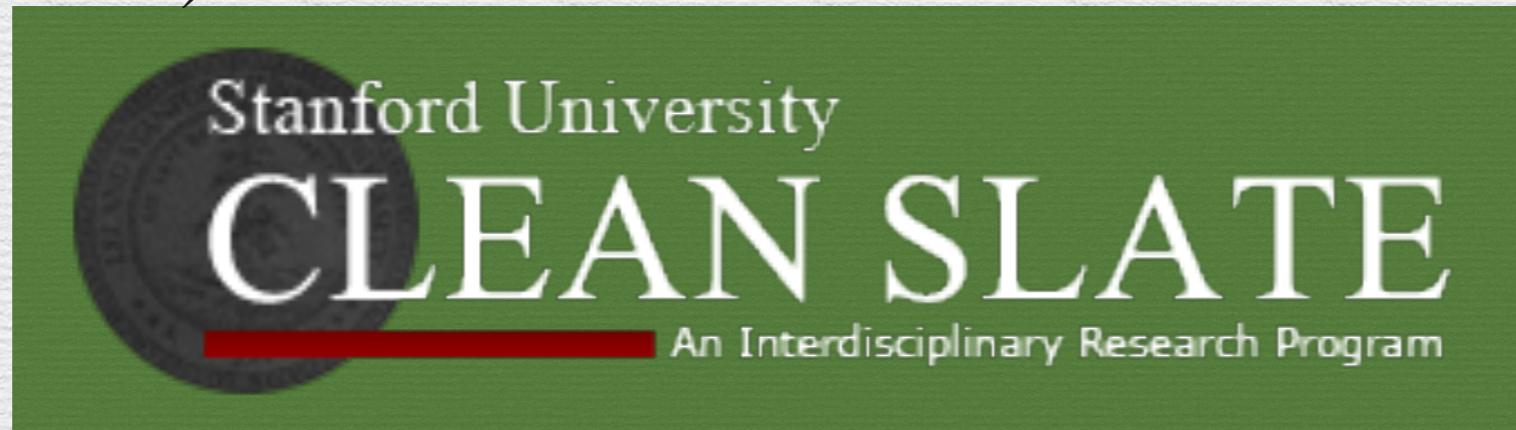
“...you should be very conservative about embedding function in the lower layers because if you embed a function down there, everybody up there above you has to live with it and has to work with it... You should keep the bottom layers as general and straightforward as possible.”

# Explanation of Hourglass Model



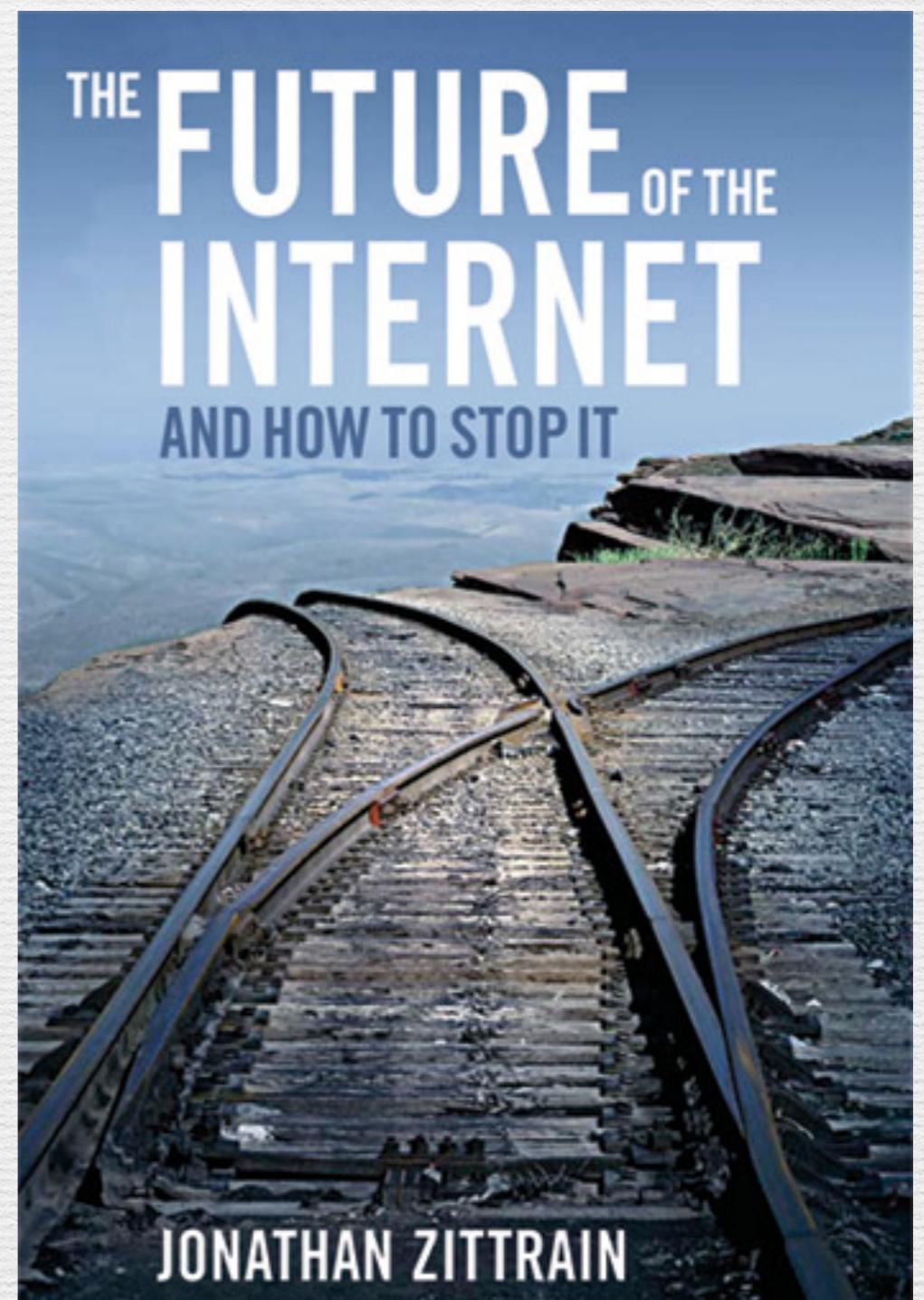
# Internet Architecture Requirements

- Network security and safety require abandoning end-to-end arguments
- Internet requirements are changing (rise of ISPs, unsophisticated users)
- Internet Design Principles are/at near some limit (clean slate)



# Issues of Concern (Zittrain, 2008)

- Internet architecture insecure
  - Puts users in control of computers, therefore in control of network ... free to cause harm
- Locked down edges (for perfect enforcement) incent functions “in network”
- Cloud/SaaS: freedom to lose independence (leads to dependency risk)
- Privacy 2.0: “the challenges to personal and social privacy arising from pervasive real-time sensing, data capture, permanent logging, inference, and dissemination.”



# Returning to Net Neutrality Rules and “Reasonable” Network Management

- Judging this standard requires regulators to “second-guess” network engineers cross-layer traffic management
  - Is “Just Add Capacity” a recipe for an expensive Internet?
- Proposal to use self-regulatory organizations (SROs) to provide engineering community’s perspective on disputed practices
  - Broadband Internet Technical Advisory Group (BITAG) charter: “bringing transparency and clarity to network management processes”



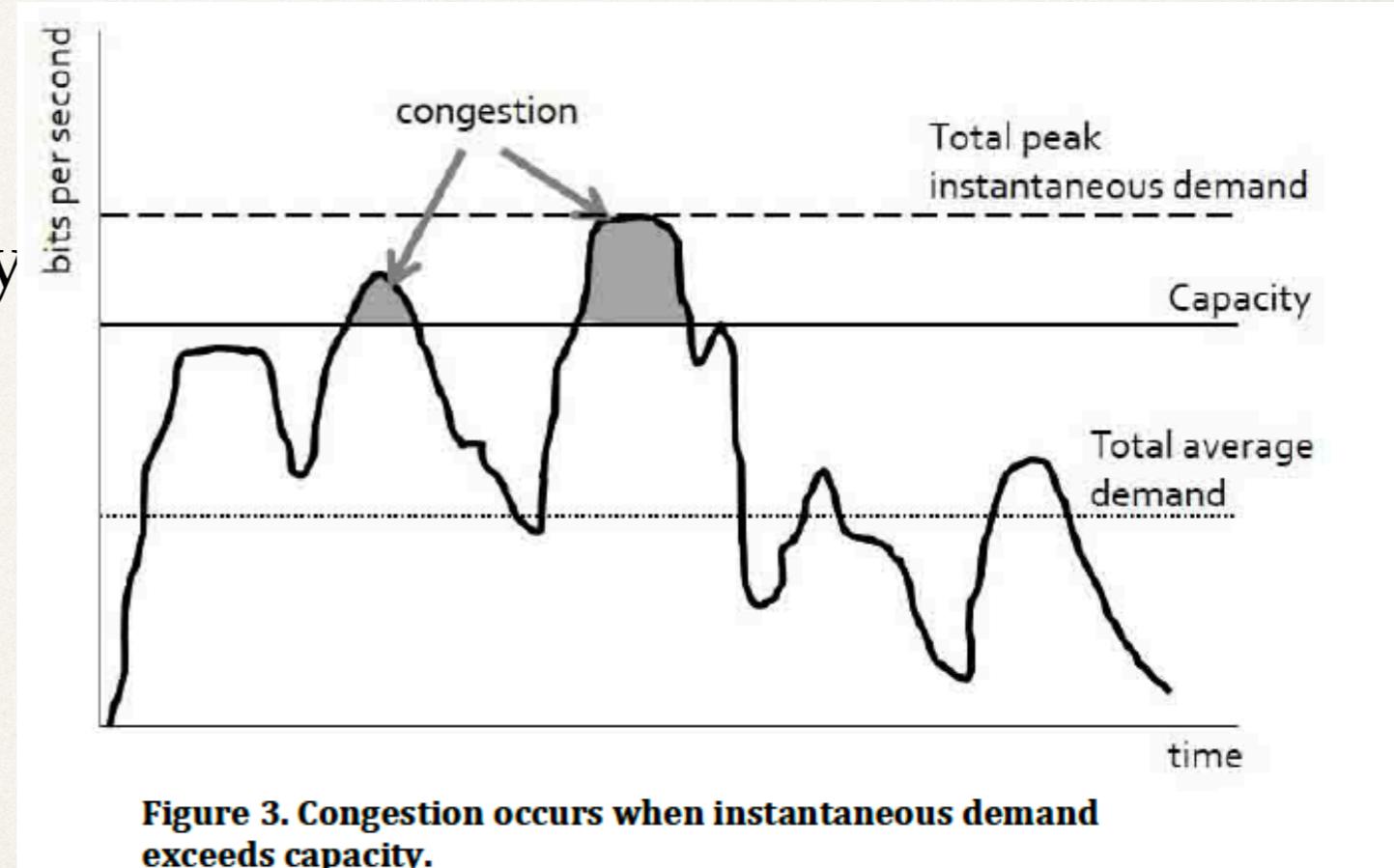
# BITAG Report

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- ✿ Excellent primer on network congestion
  - ✿ Definition of congestion
  - ✿ Occurrence and duration of congestion
  - ✿ Location of congestion

# Definition of Congestion

- ❖ Effect upon network performance during times when demand exceeds capacity
- ❖ Problem when duration is disruptive to applications
- ❖ Fix by increasing capacity or decreasing demand



**Figure 3. Congestion occurs when instantaneous demand exceeds capacity.**

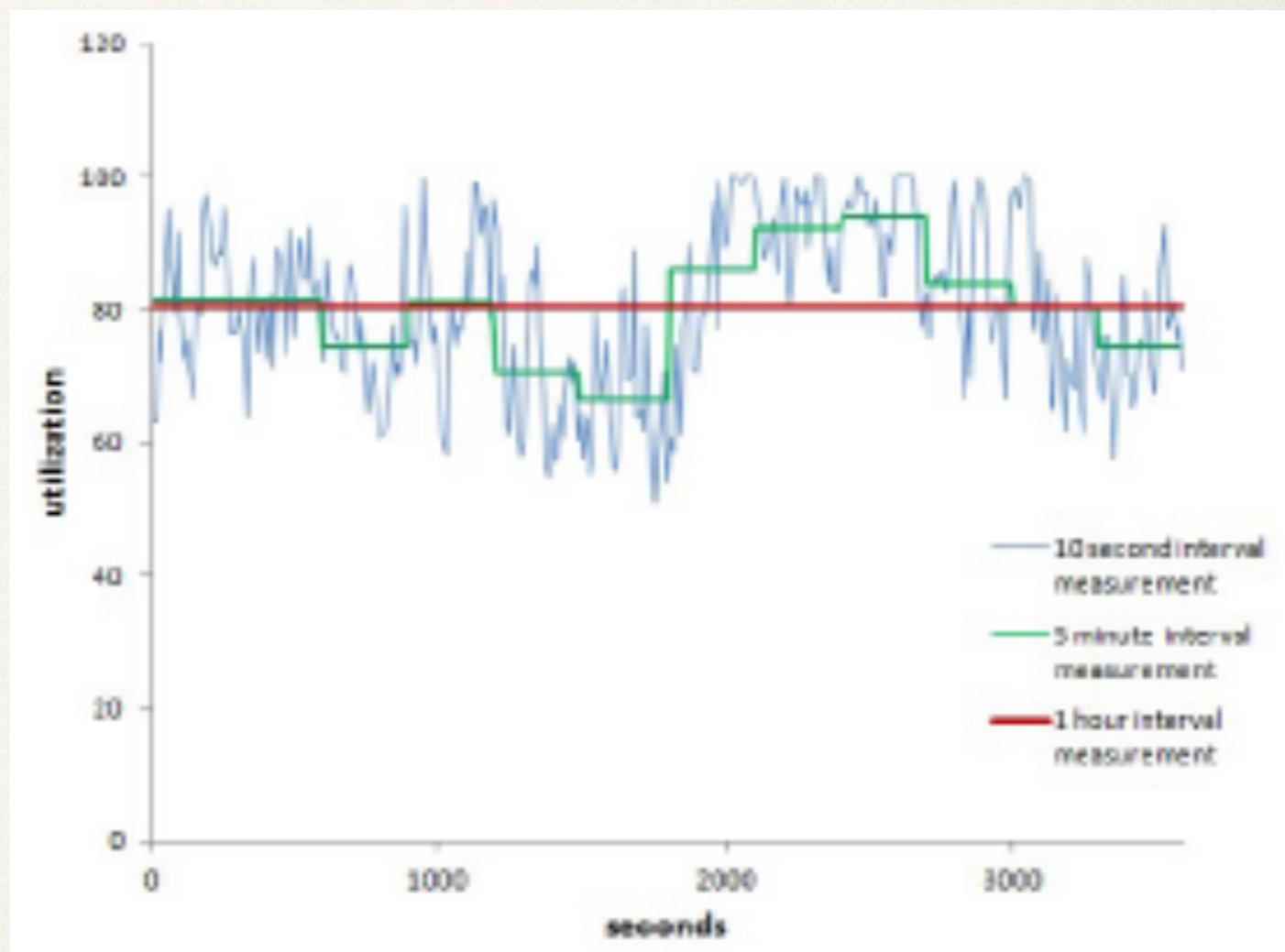
# Occurrence and Duration of Congestion and Its Location

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- ✿ Recurrent congestion
- ✿ Predictable events
- ✿ Unpredictable events
- ✿ Random congestion
- ✿ Bottlenecks usually in low-bandwidth network segments (e.g., access networks) not high (e.g., core ISP networks and networks of ASPs)

# Indicators of Congestion

- ✿ Link utilization or load (ratio of demand to capacity)
- ✿ QoS metrics
  - ✿ End-to-end packet delay / packet loss / throughput and jitter
- ✿ QoE - satisfaction of user with performance



# Examples of Congestion Management

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- ✿ TCP connection termination practices to control P2P traffic
- ✿ Traffic shaping practices (per flow capacity limits)
- ✿ Traffic prioritization (packet queuing and scheduling)
- ✿ Transcoding (per flow re-encoding)
- ✿ Resource reservation to improve performance of applications needing minimum bandwidth
- ✿ Preferential treatment to improve the performance of delay- and loss-intolerant applications

# Group Discussion

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# Reasonable Network Management (2010)

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- ❖ Legitimate reasons:
  - ❖ Ensuring network security and integrity (including addressing traffic harmful to the network)
  - ❖ Addressing traffic unwanted by end users (e.g., parental controls)
  - ❖ Mitigating network congestion

“A network management practice is reasonable if it is appropriate and tailored to achieving a legitimate network management purpose, taking into account the particular network architecture and technology of the broadband Internet access service.”

# Current Network Management Practices

Let's Take a Look!

<http://www.comcast.com/policies/>

[https://www.spectrum.com/policies/terms-of-  
service.html](https://www.spectrum.com/policies/terms-of-service.html)