

**ΟΙΚΟΝΟΜΙΚΟ  
ΠΑΝΕΠΙΣΤΗΜΙΟ  
ΑΘΗΝΩΝ**



**ATHENS UNIVERSITY  
OF ECONOMICS  
AND BUSINESS**

# Information-Centric Networks

**Section # 2.2: Internet Evolution**

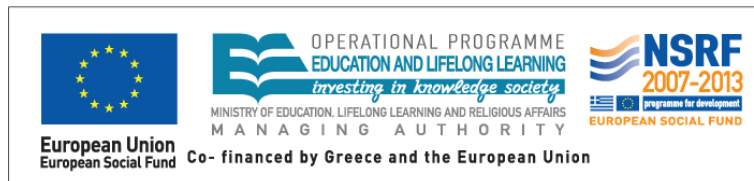
**Instructor: George Xylomenos**

**Department: Informatics**



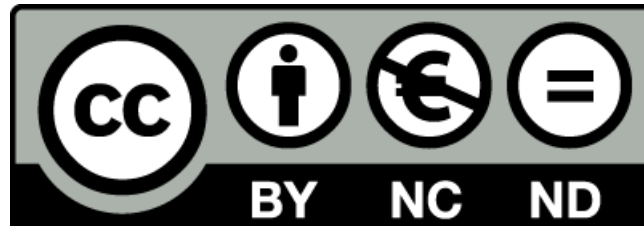
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# Week 2 / Paper 2

- Tussle in Cyberspace: Defining Tommorow's Internet
  - David D. Clark, John Wroclawski, Karen R. Sollins and Robert Braden
  - ACM SIGCOMM, 2002
- Main point
  - The current Internet has grown well beyond its intended use
  - Different stakeholders have conflicting interests
    - This is the “tussle in cyberspace”
  - How can Internet evolution accommodate this tussle?

# Introduction

- In the original Internet everyone had a common goal
  - Interconnect all the computers in the world
- This common goal no longer exists
  - Important and powerful players are at odds with each other
- Examples abound
  - Music exchange
  - Private communications
  - ISPs must compete and co-operate
- The Internet architecture must meet new requirements
  - This implies new design strategies
  - Handling tussles is a critical issue

# Internet and society

- The Internet is an engineering artifact
  - It was designed to meet specific goals
- Societies are not engineered
  - They reflect conflicting interests
- The Internet needs to reflect society
  - Its technical architecture must reflect the tussles of society
- Stakeholders (good and bad)
  - Users running applications
  - Commercial ISPs
  - Private network providers
  - Governments and regulators
  - Intellectual property rights holders
  - Content providers

# Principles

- The generic principle
  - Design for variation of outcome
    - The tussle should take place within the design
    - The design should not dictate the outcome
- Two more specific principles
  - Modularize along tussle boundaries
    - Functions within a tussle space should be isolated
    - Counter-example: use of copyrighted names in DNS
    - Example: use of ToS bits for QoS instead of ports
  - Design for choice
    - All parties should be able to express choices
    - Example: choosing an SMTP server
    - Choice requires configuration

# Implications

- Choice often requires open interfaces
- Tussles often happen across interfaces
  - Tussle interfaces are not only about interoperability
- It matters if the consequences of choice is visible
  - Choices made in public may be different than secret choices
- Tussles have different flavors
  - The type of conflict may vary
- Tussles evolve over time
  - They are multi-round processes
- There is no such thing as value-neutral design
  - Tussles are shaped by designs
- Don't assume that you design the answer!



# Tussle spaces: Economics

- Economics
  - Provider vs. provider and provider vs. consumer
  - The drivers of investment are greed and fear
    - Greed is obvious, fear is less so
- Specific examples of economic tussles
  - How can the design promote competition?
- Provider lock-in from IP addressing
  - A consumer should be able to easily move to another ISP
  - Addresses should not be confused with identities
- Value pricing
  - ISPs charge business and residential consumers differently
  - Should a residential customer hide a server behind a tunnel?

# Tussle spaces: Economics

- Residential broadband access
  - Broadband access requires low level access to the cables
  - Open access forces telcos to open their networks
  - But then who would invest in optical fiber? Municipalities?
  - Optical fiber systems should be design for open access
- Competitive wide area access
  - Customers cannot choose their wide area providers
    - They have to live with the choices of their ISPs
  - The Internet should support source routing at the provider level
  - But payments must also be considered in the design
  - Overlays may have role to play there

# Tussle spaces: Trust

- Internet uses do not trust each other (with good reason!)
  - This has led to a proliferation of firewalls
    - Whatever is not permitted, gets dropped
  - Firewalls violate the architecture and inhibit innovation
    - But they respond to a genuine user need
  - Users should be able to indicate their control choices
  - Endpoints should not invest effort before verification
  - Third parties are also needed in many cases
    - Banks, credit card companies, certificate agencies
  - Users should be able to explicitly select third party mediators
  - What about identities on the Internet?
    - Probably no single solution is perfect
    - Many users also value anonymity

# Tussle spaces: Openness

- The open nature of the Internet has many benefits
  - Users can freely select servers and services
  - New application and uses spring up all the time
- But openness is not good for everyone
  - Openness means competition (fear!)
    - Entrenched providers prefer closed systems
  - Vertical integration does not prevent openness
    - A provider may have cables, access routers and services
    - This does not require proprietary interfaces
- The critical issue is to allow innovation
  - We need transparent packet carriage
  - New protocols can evolve over this basic service

# The future of the E2E arguments

- The E2E argument
  - The network should not do what can be done at the endpoints
  - Innovation: the network can work with many applications
  - Reliability: there are no scattered points of failure
- The Internet E2E principles are eroding
  - Loss of trust (firewalls)
  - ISP desire for control (application filtering)
  - Third party data capture (wiretapping)
  - Web optimizations (caches)
- There is simple way out of this
  - Accept that these things will happen
  - Think of how the design can accommodate them

# Separation of policy and mechanism

- A good design should be policy-free
  - Provide mechanisms upon which policies can be built
  - Maybe too simplistic: are there value-neutral designs?
    - The range of mechanisms available limits feasible policies!
  - Try to discover the value-neutral parts
- Lessons for designers
  - Many good ideas have failed (multicast, explicit QoS)
  - Remember that you need business drivers (greed and fear!)
    - Greed: providers should get something out of their investment
    - Fear: users should be able to choose a provider that made it
  - One should analyze and manage the tussles of a design
- Primary lesson: the Internet is part of our society
  - Its evolution requires also thinking about society

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# End of Section # 2.2

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