The Technical is Political

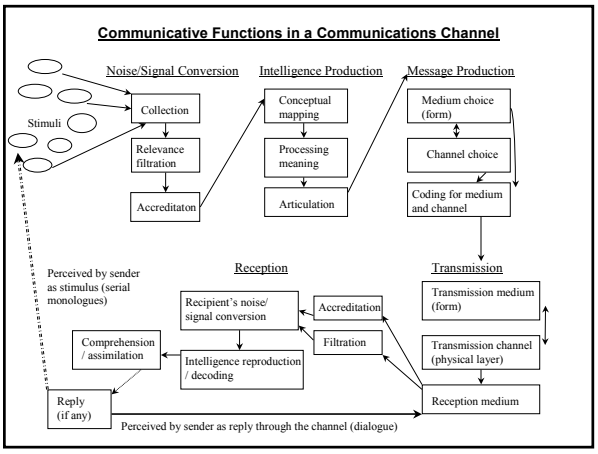
Access to an open Information environment

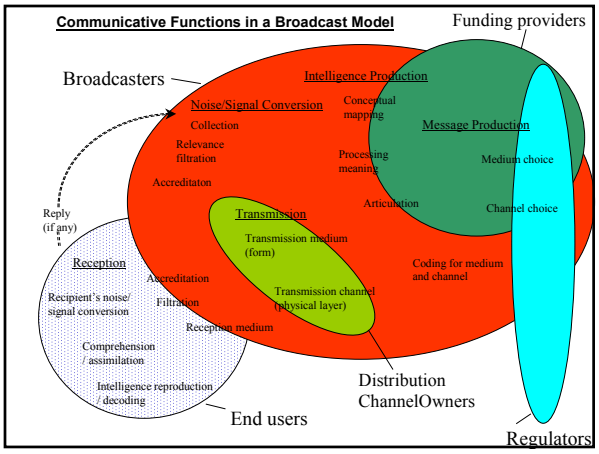
Overview

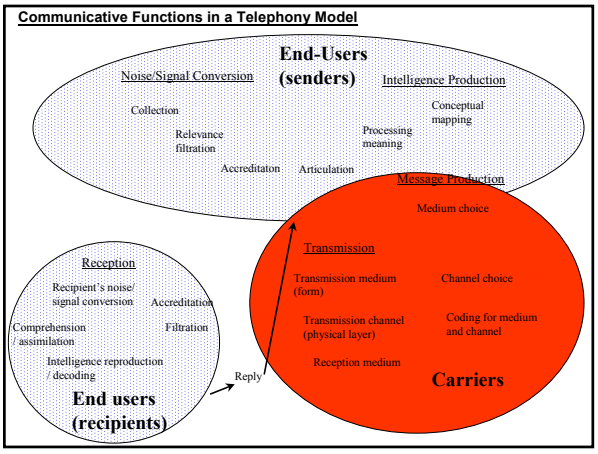
- Models of communication
- The stakes of architecture
  - Political and economic
- State of play at the physical layer
  - Towards a duopoly in wires
  - Open Wireless Networks
- Outline of issues at the logical and content layers

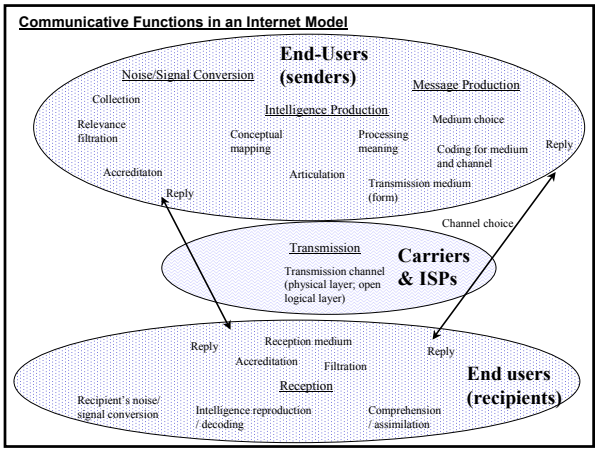
Network Architecture

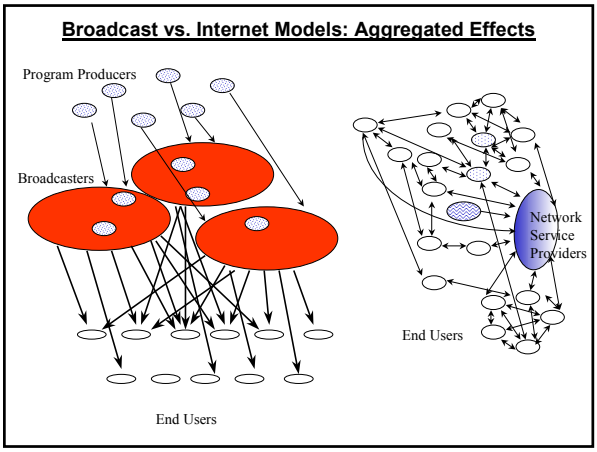
- Models of Communications
  - Broadcast: one-way, controlled infrastructure, intelligent network, simple endpoints. Information flow controlled primarily at the center
  - Telephone: switched, intelligent core, simple endpoints. Information flow end-to-end, but only within parameters tightly controlled by core
  - Internet: Intelligent endpoints, simple network. Content and logic end-to-end











The Stakes

- Democracy
  - Jonas of IDT: "Sure I want to be the biggest telecom company in the world, but it's just a commodity. I want to be able to form opinion. By controlling the pipe, you can eventually get control of the content"
  - Everyone a pamphleteer or printing press
    - Power of media & advertisers
    - Diversity of views and voices

The Stakes

- Democracy
- Autonomy
  - Cisco's QoS control policy routers

"you could restrict the incoming push broadcasts as well as subscribers' outgoing access to the push site to discourage its use. At the same time, you could promote your own or partner's services with full speed features to encourage adoption of your services"

  - Who defines the window through which one trains one's eyes on the prize; whose prize?

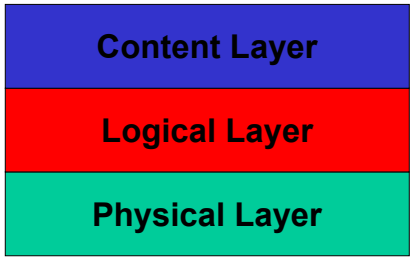
The Stakes

- Democracy
- Autonomy
- Innovation
  - Lessig, Baldwin, Reed
    - E.g., voice/video over IP implemented through desktop software

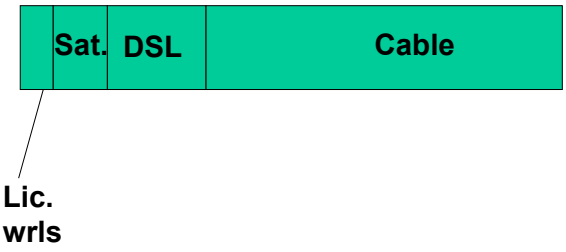
The Stakes

- Democracy
- Autonomy
- Innovation
- Efficiency
  - Where pipeline-type conditions prevail, standard market power issues arise
  - Deferring consumption optimization decisions to the point of consumption
    - Flexibility of using a car, not a train

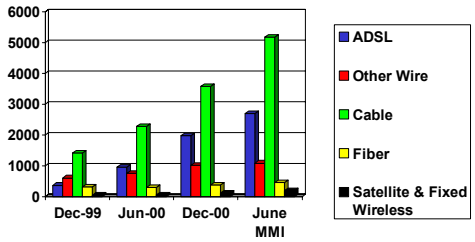
State of Play



Physical Layer

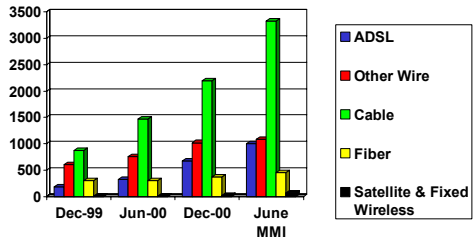


"High Speed"—asymmetric 200 kbps downstream



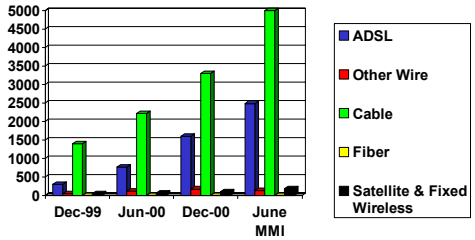
Source: FCC Third 706 Report February 2002

"Advanced Services" at least 200 kbps both ways



Source: FCC Third 706 Report February 2002

"High Speed" to Homes & Small Business



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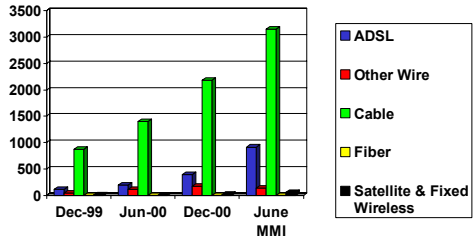
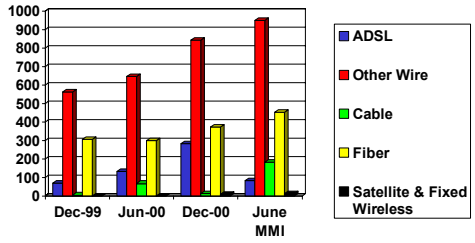


Source: FCC Third 706 Report February 2002

"Advanced Services" (to bigger institutions?)



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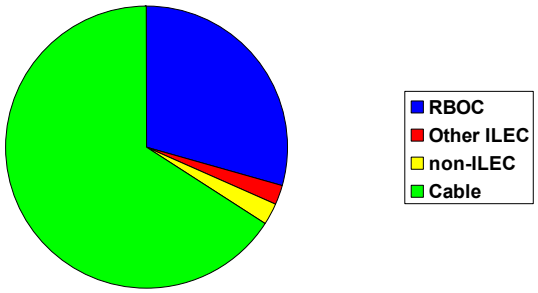
High Speed Lines to Homes & SOHO by Type of Provider



State of Play

- Historically: Natural Monopoly
  - Monopoly more efficient
  - License/franchise plus price & service regulation to prevent abuse

State of Play

- Historically: Natural Monopoly
- 1990s: Multiple wires to the home
  - Contingency
    - Convergence requires upgrade of previous monopoly legacy infrastructures already in most homes
  - Second-best
    - as regulation fails to alleviate monopoly problems, competition becomes preferred second-best

State of Play

- Historically: Natural Monopoly
- 1990s: Multiple wires to the home
- 1996 Act and early implementation
  - Aggressive regulation to required sharing of bottleneck inputs to create intra-modal competition in telcos
  - But forbearance from cable
    - Early local efforts re: cable overturned by courts
    - AOL-Time Warner Merger conditions

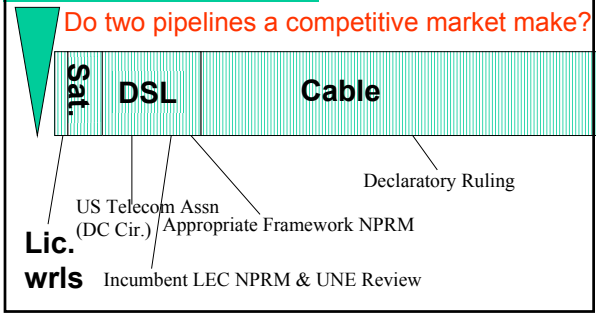
State of Play

- Historically: Natural Monopoly
- 1990s: Multiple wires to the home
- 1996 Act and early implementation
- Last year
  - Drift to sole reliance on intermodal competition, with substantial retreat from access/ unbundling for intramodal competition
  - Slouching towards duopoly?

Physical Layer

Open Wireless Networks

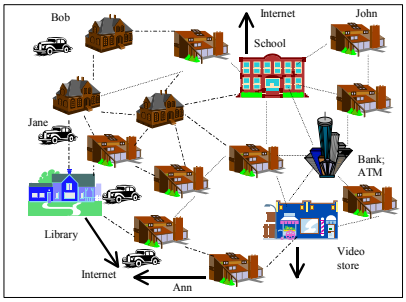
Do two pipelines a competitive market make?



OWL Networks

- Built entirely of end-user devices
- Ad hoc infrastructure
  - Capable of being overlaid with infrastructure-based network
- Scalable from personal and local up to municipal area networks
  - Particularly important not to focus regulation or business plans on one application, like LANs
  - "First mile" applications may drive initial market—need no threshold density
- Mobile & fixed

OWL Networks



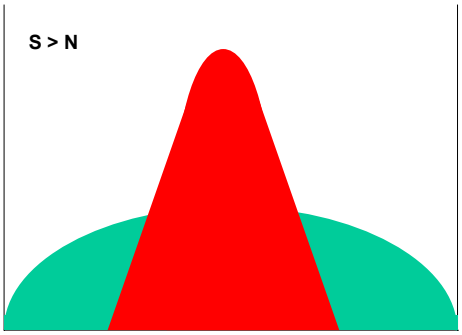
Parameters of Analysis

- Equipment cost
  - Total system cost, not end-user equip. cost
  - No *a-priori* reason to believe that total cost will be greater in OWLs than in proprietary or regulated frameworks
  - Pattern of investment will be different
- Displacement cost
  - Different from traditional interference
  - Intended to measure how many communications, of what value, will be displaced by the communication whose displacement effect is measured
- Transaction/administrative cost

Displacement

- Old model: every communication in a specified narrow band displaced all other communications in that band, "spectrum used" was useful proxy for displacement

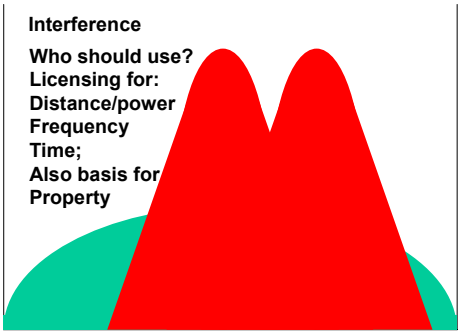
Traditional Approach to Wireless Communications



Traditional Approach to Wireless Communications

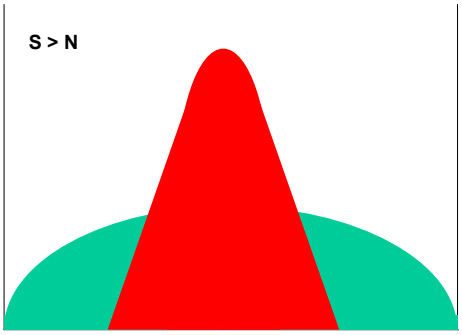
Interference

Who should use?
Licensing for:
Distance/power
Frequency
Time;
Also basis for
Property



Traditional Approach to Wireless Communications

S > N



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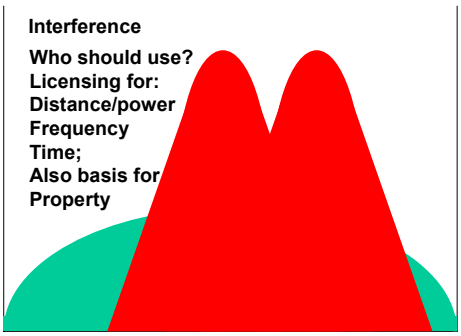
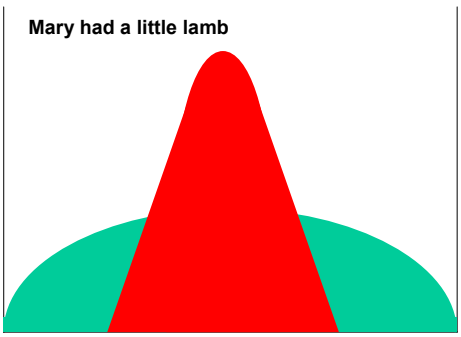


Displacement

- Old model: every communication in a specified narrow band displaced all others
- Destablized by one fact and two theories:
  - Cheap high capacity processing
  - Shannon's information theory
    - Communication as a probability of correct decoding at a distance
    - Cheap computation enables processing gain through wideband communication
  - Multi-user information theory and network architecture concepts from Internet and proprietary wired networks
    - Cooperation/diversity gain attainable

Processing Gain: DSSS Example

Mary had a little lamb

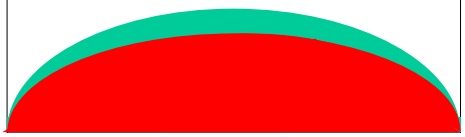


Processing Gain: DSSS Example

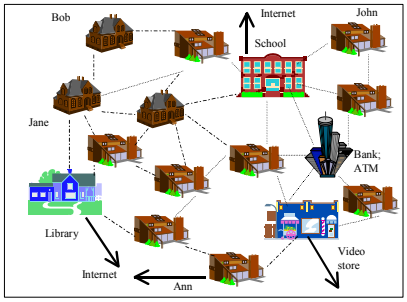
Mary had a little lamb xyz12378965401
20948345987weoirh0120398

Receiver listens for code and
separates S from N by correlating to the code

Processing gain limited by bandwidth usable
and processing power of transmitter & receiver



Cooperation/diversity gain: repeater network example



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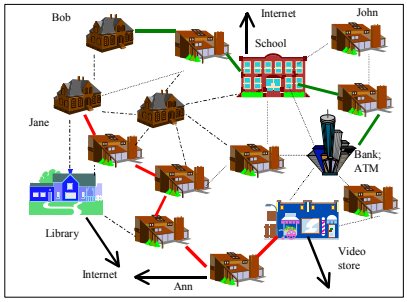
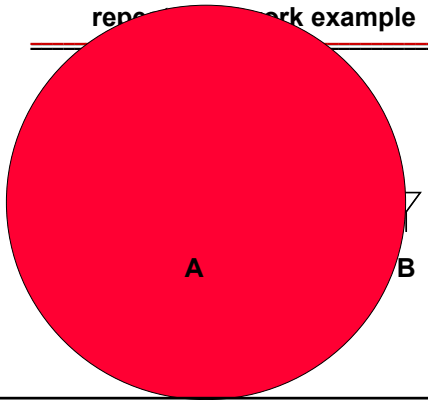
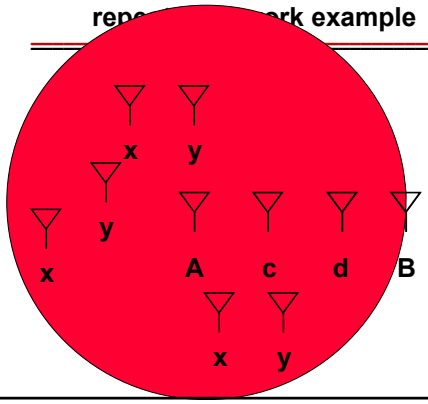


Cooperation/diversity gain: repe rk example



Cooperation/diversity gain: repe rk example



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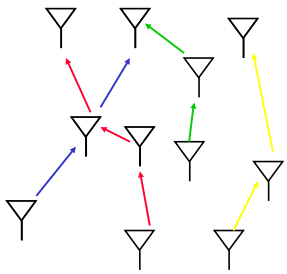
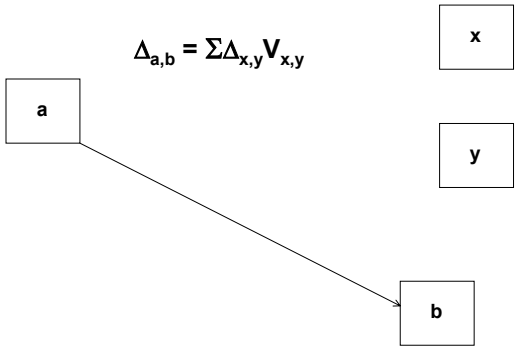


Cooperation/Diversity gain

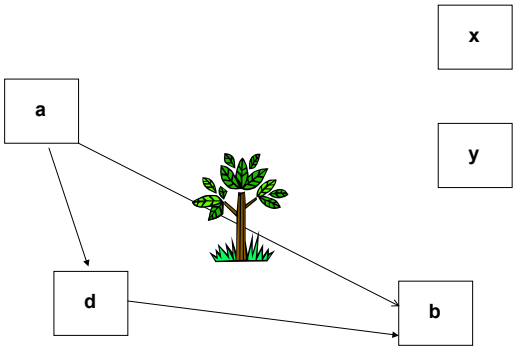
- Repeater networks: intuitively, like adding infrastructure to add capacity—more cells
  - BUT: adding *users* adds capacity
- Multi-user information theory adds other strategies as well
  - Multi-user detection in antenna arrays
  - Spatial diversity utilizing mobility, multipath
  - Sharing information about signal structure to ease filtering

Displacement

$\Delta_{a,b} = \Sigma\Delta_{x,y}V_{x,y}$

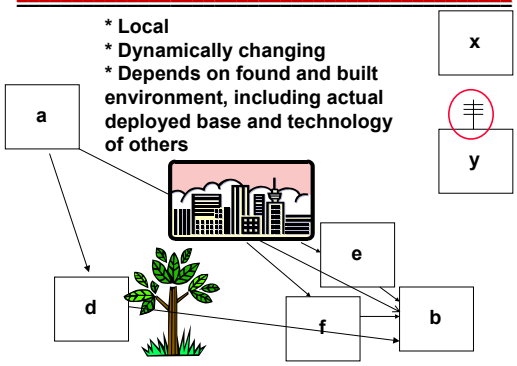


Displacement



Displacement

* Local
* Dynamically changing
* Depends on found and built environment, including actual deployed base and technology of others



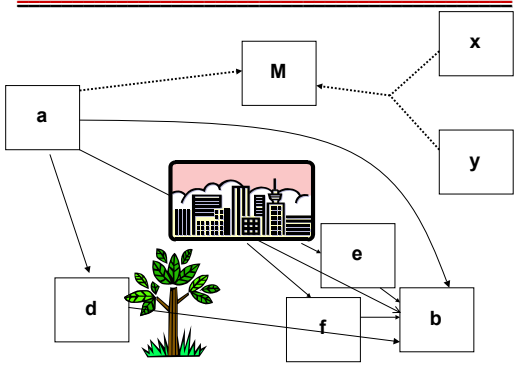
Displacement

- Processing gain + cooperation gain mean that there is no fixed "amount of spectrum" necessary for a communication
- Displacement effect of any communication cannot be defined independently of the configuration of actual devices involved in the communication and actual devices potentially displaced

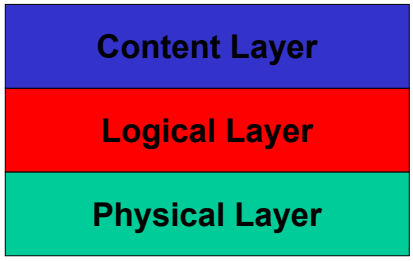
Tradeoff

- For any level of total equipment investment, OWL networks will have a lower $\Delta_{x,y}$
  - For a given investment, OWL networks will carry more communications than property-based networks
- $V_{x,y}$ -- the *value* of communications displaced -- may yet make the total displacement value of a communication between a and b, $\Delta_{a,b}$ (= $\Sigma\Delta_{x,y}V_{x,y}$) higher
- Tradeoff between higher capacity and sensitivity to value of communications

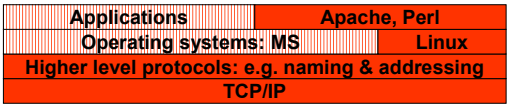
Transaction Costs



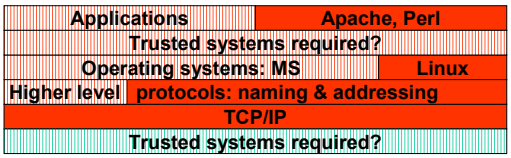
State of Play



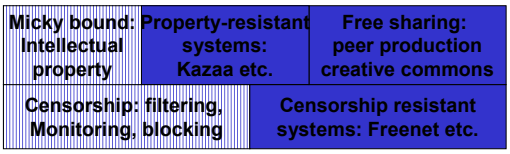
Logical Layer



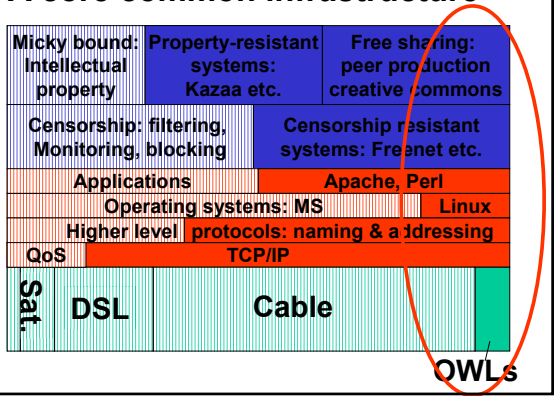
Logical Layer



Content Layer



A core common infrastructure



Wrap up

- The stakes of adhering to an Internet model of communications are both political and economic
- Sustaining that architecture requires openness at all layers of the communications environment
- Government censors and property-based incumbents seek to close the the communications environment
- Will they succeed?