(Interconnection Module Lectures #2 & #3)

Challenges for Convergence: Interconnection

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Interconnection Lecture Outline

- Examples of interconnection in telecoms
- Why regulate interconnection?
- Basic economics of interconnection
- Goals of interconnection regulation
- Current models for interconnection
  - Cost-based pricing
  - Negotiated pricing (reciprocal compensation)
  - Bill and Keep

Readings

- Sicker, Douglas (2002), "Further Defining a Layered Model for Telecommunications Policy," draft mimeo, October 2002.
- DeGraba, Patrick, “Bill and Keep at the Central Office As the Efficient Interconnection Regime,” OPP Working Paper Series No. 33, Federal Communications Commission, December 2000.
- Kende, Michael “The Digital Handshake: Connecting Internet Backbones,” OPP Working Paper Series No. 32, Federal Communications Commission, 2000.

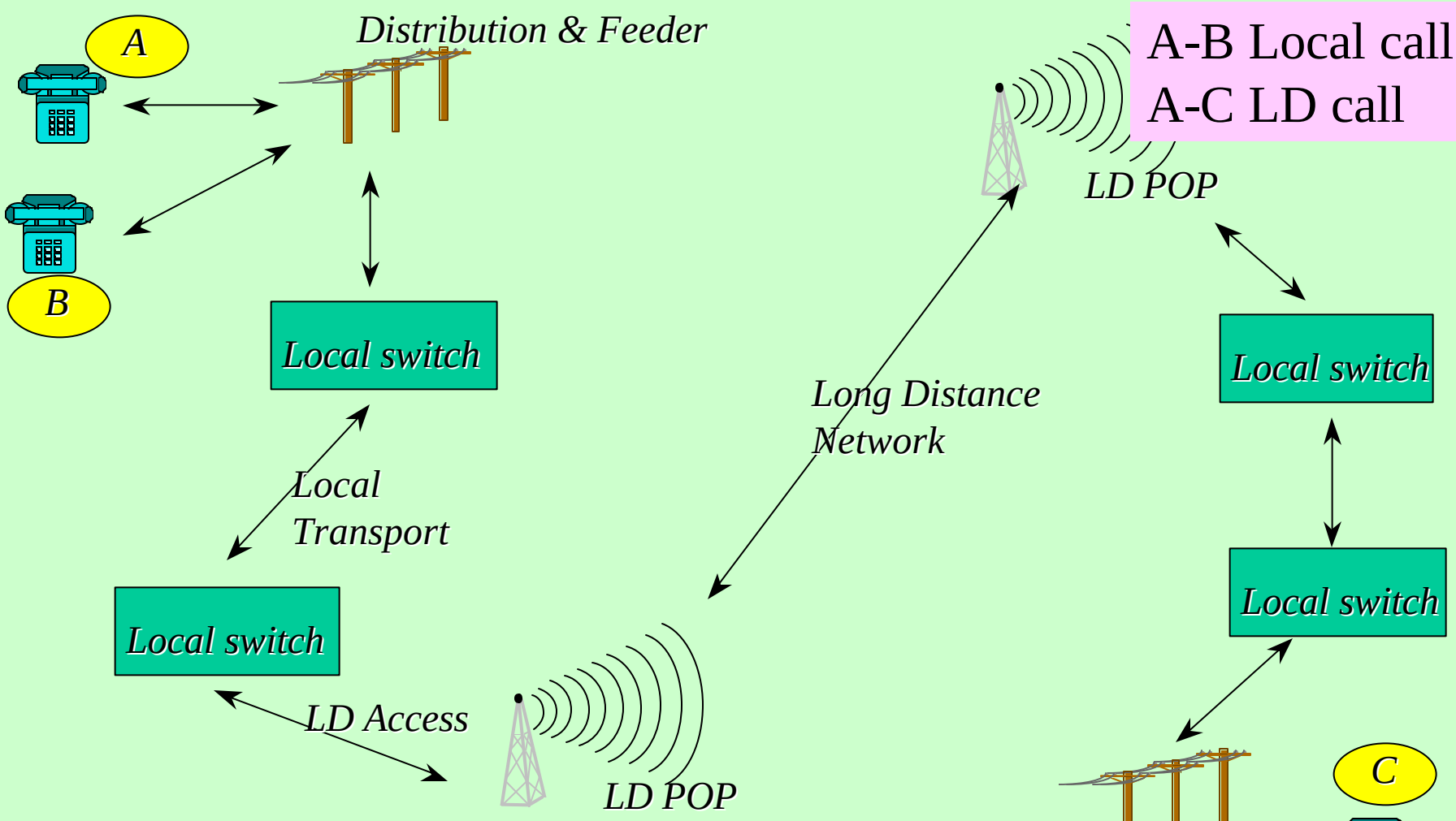
What is interconnection issue?

- Two (or more) networks exchange traffic, they need to be interconnected.
  - Physical point(s) of interconnection
  - Technical/operational issues
  - Commercial relationship: who pays what?
- Why problem for convergence?
  - From silos ➔ platforms
  - Regulation still based on silos

Interconnection & Access Pricing (Theory)

- One way access:
  - Incumbent sells essential input to entrant
  - Incumbent could be vertically integrated or not (does incumbent compete in retail market with entrant?)
  - e.g., Local loop unbundling
- Two way access:
  - Network interconnection problem
  - Reciprocal needs to terminate traffic
  - One or both could have market power
  - e.g., Internet peering or transit, mobile/wireline network interconnection charges, international settlements

Telephone Network: a network of networks



A-B Local call
A-C LD call

Single carrier network or multiple networks?
Which party pays: Calling party or both?

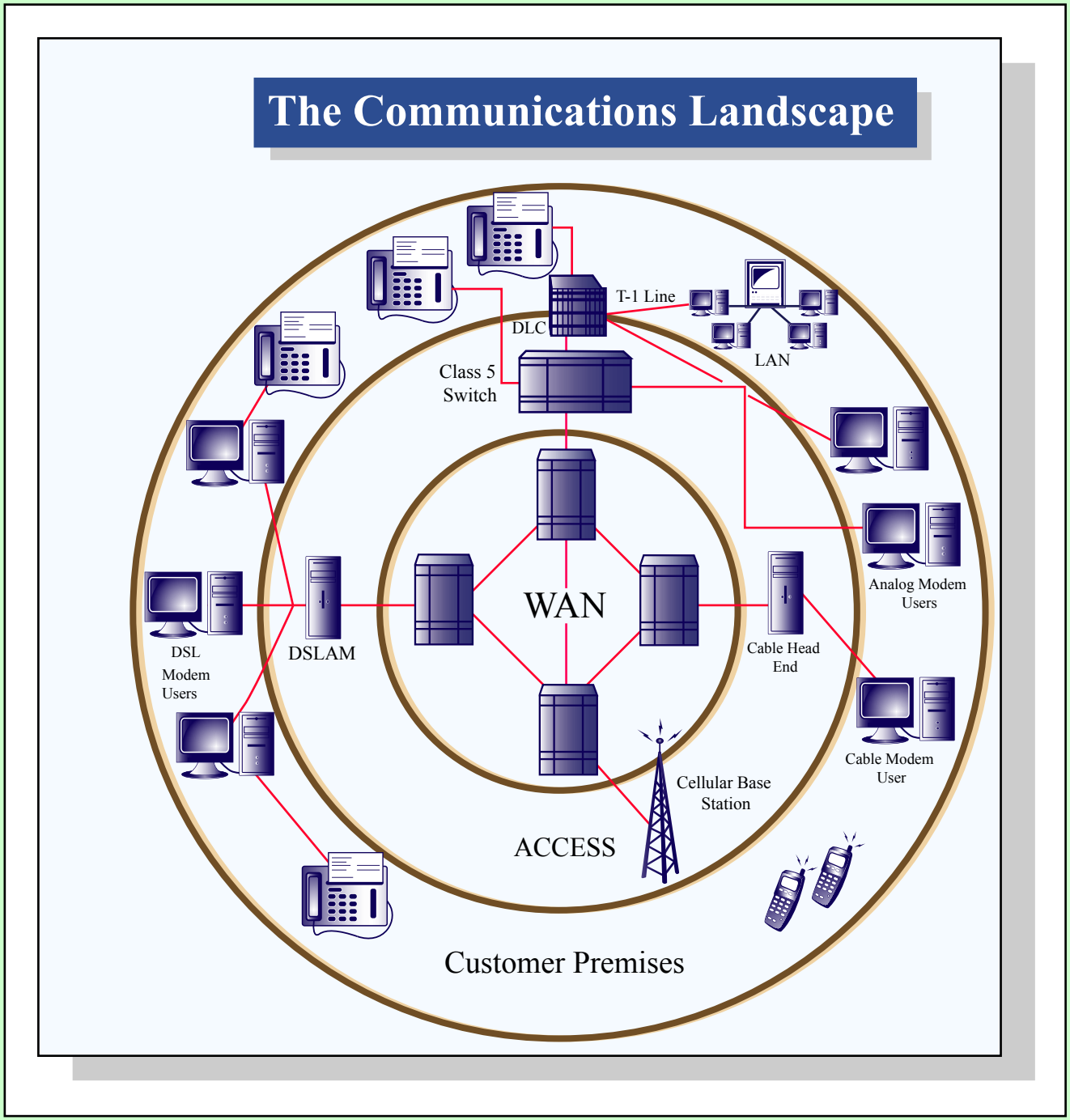
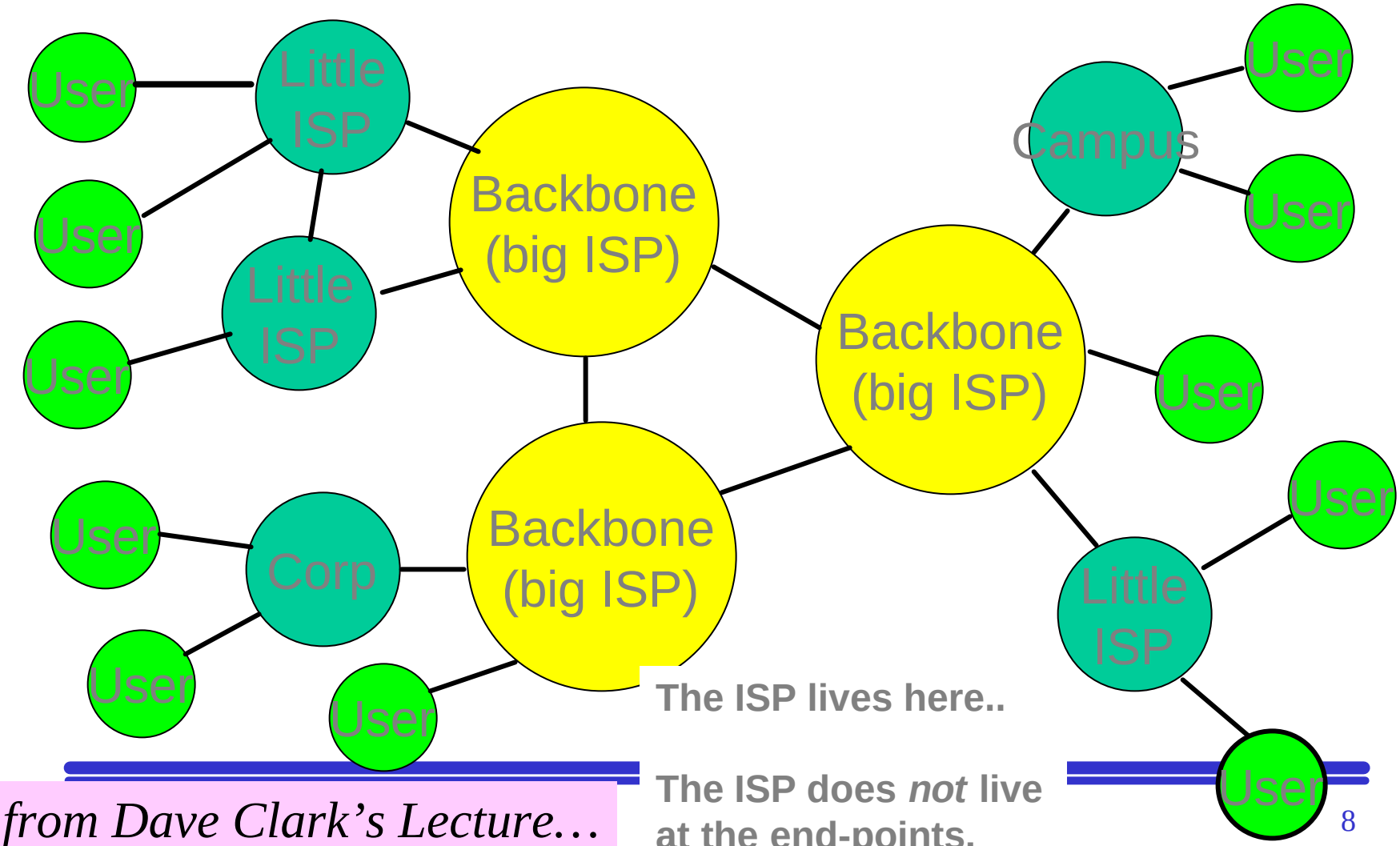


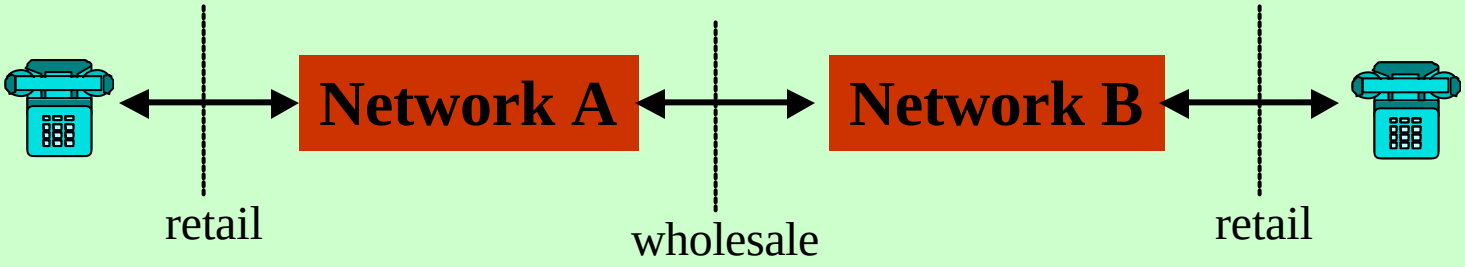
Figure by MIT OCW.

A more realistic picture

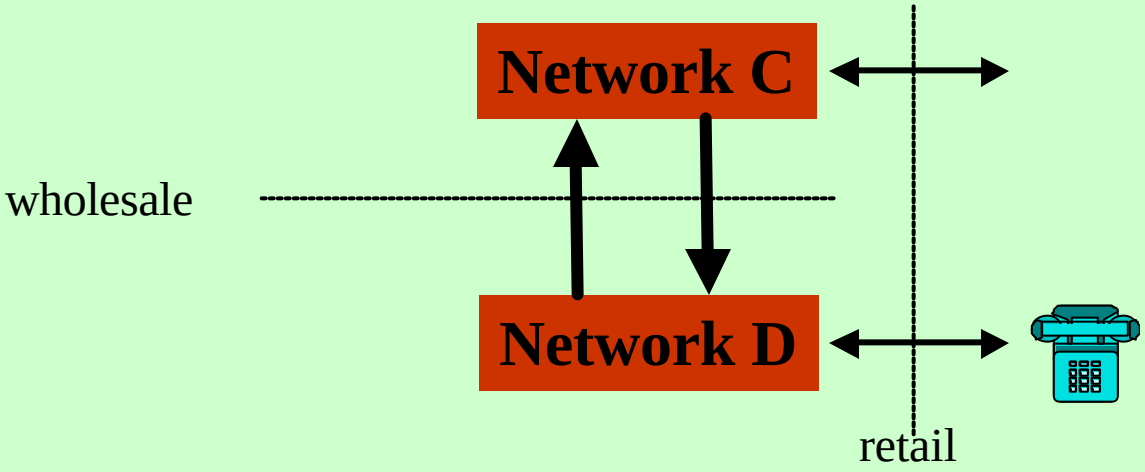


from Dave Clark's Lecture…

Interconnection Models



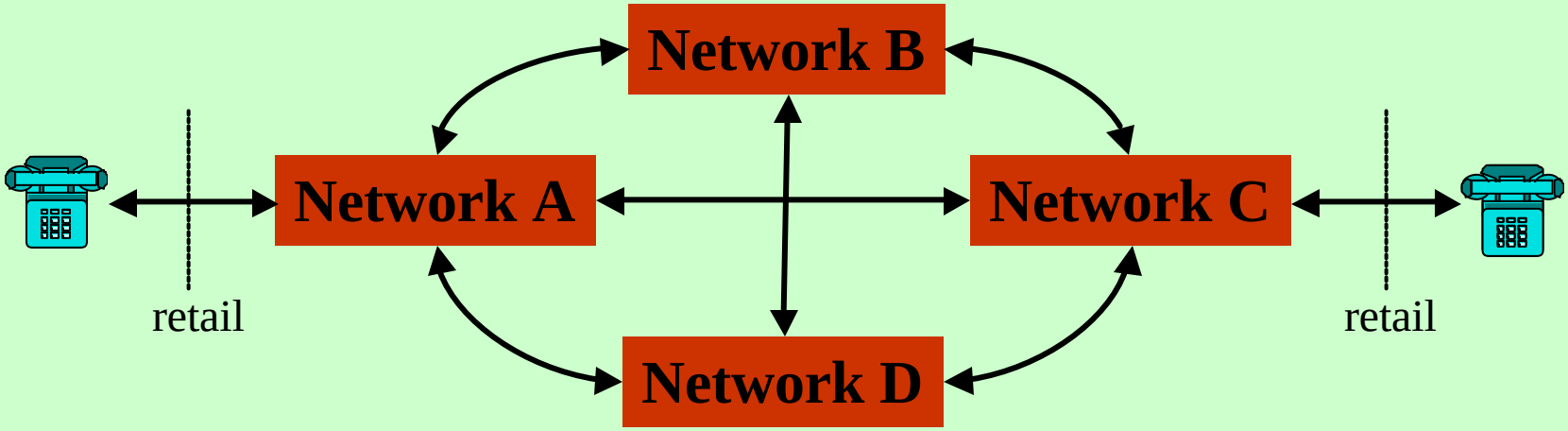
e.g., International LD, Local/LD, Mobile/wireline



e.g., LD/LD, Local/Local, Mobile/mobile, Internet backbone

Interconnection Models

e.g., Multihop routing. B is transit network



e.g., Multilateral peering point

Current models for interconnection

- Examples:
  - International settlements: negotiated rates for terminating calls. May not be symmetric, generally well above costs.
  - Long distance pay per minute access charges for local termination.
  - VoIP calls avoid charges
  - Internet peering using “bill and keep”
- Different prices for similar situations: inefficient pricing

Interconnection Models

- Technology of networks: same or different?
  - Wireline/wireline, wireline/wireless, packet/circuit, etc.
- Type of traffic? (e.g., Web browsing vs. telephone call)
  - Balanced or asymmetric flows?
  - QoS needs: delay sensitivity? BER sensitivity?
- Size of networks: same or different?
- National or international?
- Regulated or negotiated?

Different costs, business relationships, and regulatory treatment. Not a problem when telcos were regulated monopolies…

Elements of Interconnection Agreement

- Scope and Purpose of Interconnection
  - Who are parties?
  - Types of traffic? Networks? Architecture?
  - Points of Interconnection
- Quality of Service and technical specifications
  - Quality of service and performance standards
  - Technical interconnection specs and capacity
  - Infrastructure sharing, collocation
  - Traffic measurement and routing
- Billing and payment terms
  - Pricing
- Enforcement/Dispute Resolution

Why regulate interconnection?

- Promote interconnection: larger networks more valuable
  - Positive network externalities
    - Scale & Scope economies → lower costs
    - Complementary goods → more choice
    - More people to call (subscriber externality)
- Coordinate interoperability → standards
- Control market power
  - Promote competition → facilitate entry
  - Protect consumers from monopoly power

Challenge of Regulating Interconnection

- Promoting "interconnection" → easy when regulated end-to-end monopoly
  - International is negotiated bilateral/multilateral treaty (trade issue)
  - Interconnection rates include implicit subsidies, but lots of other regulatory levers to address distortions
    - Control of "rate base" monitors investment
    - Retail rate regulation protects consumers
  - Silos minimize challenge of cross-platform interconnection
- But, Convergence → Telecom becomes a "network of networks"
  - Traffic passes between networks owned/operated by different carriers, or across regulatory boundaries.
  - Need physical point(s) of interconnection and business rules (pricing, QoS) to exchange traffic.
- And, Competition → Transition to wholesale regulation
  - Interconnection is a "wholesale market"
  - Between carriers, services are ingredient to a retail service

Interconnection and Market power

- Interconnection rates set to exploit/leverage market power
  - Originating monopoly problem
    - Is their competition for subscribers? If so, then competition assures originating carrier cannot extract surplus rents.
      - Switching costs (e.g., incomplete information re: alternatives – pay phones; lack of address portability – email addresses, etc.)
      - International mobile roaming
      - MCI “Friends & Family”: discriminate between on-net and off-net calls
    - No? Then access a bottleneck.
  - Terminating monopoly problem
    - Only one path to terminate
    - Subscribers care more about what they pay than what those who call them pay
    - Incentive for terminating network to set high fees

Interconnection and Market Power

- Incentives to interconnect?
  - Network externalities: larger network more valuable
  - No market power, providers interconnect to increase value of both networks
  - Competition for subscribers (which network to join?)
- If market power, then may seek to abuse interconnection
  - Natural monopoly, scarce resource, or first-mover advantage
  - Incumbent w/ large network has market power relative to smaller (newer) networks
  - Collusion: bilateral setting of high rates (international settlements, mobile roaming)
- Modes of abuse
  - Denial of access: foreclose competition
  - Discriminatory access: inferior access to 3rd parties relative to affiliated subsidiary
  - Monopoly pricing: price access significantly above cost
- Regulatory response
  - Common Carriage → non-discriminatory access and interconnection obligation
  - Mandatory unbundling and interconnection
  - Price and terms of interconnection regulated
  - Line of business restrictions (preclude retail entry)

Regulating Carrier Interconnection

- Regulating both retail *and* wholesale rates problematic
- What price to set for interconnection?
  - Efficiency: P=Incremental cost of termination
    - Economic (forward-looking), not accounting costs.
    - Costs of network "access" recovered on originating end (unbundling)
  - Wholsale rate > cost → arbitrage, inefficient bypass (distort investment)
    - Historically, interconnection prices include subsidies (for universal service, for non-traffic sensitive "access" costs, etc.)
- Who sets rate?
  - Regulators: Expensive proceedings to set cost-based rates
    - Contribution to shared/common costs? Implicit subsidies?
  - Markets: Arbitrage enforces "Law of One Price"
    - International Bypass, Voice-over-IP
  - Negotiated: mandate "reciprocal compensation"
    - OK if costs symmetric, but what if not? Mobile v. Wired. Traffic asymmetric.
- Which party pays?
  - Calling (Sending) party pays: problem of mobile termination
  - "Bill and Keep"

Unified Carrier Compensation Scheme

- Drivers:
  - Convergence: symmetric regulation
  - Liberalization: markets not regulation
  - Globalization: promote free trade (e.g., WTO)
- FCC Unified Intercarrier comp regime (2001): Bill & Keep?
- European Commission: Interconnection directive
  - Competitive markets: allow flexible negotiation
  - When competition lacking, regulators may enforce interconnection, which includes rate setting
  - Symmetric rules
- One size fits all??

Calling party pays

- Calling party pays incremental cost of termination
  - Doesn't address call externality (value called party)
  - Good incentive for quality of service when terminating
  - Vulnerable to terminating monopoly problem
  - Vulnerable to monopoly leveraging if market power
- Reciprocal compensation
  - Technology same
  - Negotiated termination fees, but requirement for reciprocal rates reduces bargaining power of incumbent
  - e.g., debate over ISP Reciprocal Compensation in U.S.
- Incentives to collude? (mobile roaming)
- Implications for retail rate regulation?

Bill and Keep

- Recover all costs from network's own subscribers
  - Wholesale rate for interconnection = 0
  - Carriers each pay own costs for interconnection
- Used in Internet backbone. Could be used more generally.
- Benefits?
  - Simple to implement. No inter-carrier fees paid.
  - Deregulatory: no longer need to set prices for termination.
  - Efficient if:
    - Costs of termination symmetric & traffic balanced → net payment~0 anyway.
    - Costs termination close to zero
- Issues:
  - Hot potato routing
  - Asymmetric costs/values (e.g., mobile/wireline)
  - Asymmetric traffic (Web browsing, streaming media)
  - Incentive to terminate with high quality? (Free riding)

Interconnection Tussle

- Issues/Perspectives
  - Efficient pricing: usage v. flat rate charges, elimination of implicit subsidies
  - Market power? (Terminating or originating monopoly)
  - VoIP?
  - Usage v. Flat rate charges?
  - Jurisdiction?
- Stakeholders:
  - Rural Telcos → high rates, retain subsidies, regulate VoIP
  - ILECs → move usage subsidies into SLC, move to BnK
  - CLECs → competitive neutrality (cost-based), reciprocal comp
  - States → retain state autonomy to set local/intrastate rates
  - FCC → BnK to simplify and increase cross-platform competition

Additional Slides

Costs of terminating traffic

- Economic not accounting (historic)
  - Resources priced at opportunity cost
  - Forward-looking: ignore sunk/history irrelevant
  - Incremental: short-run or long-run?
    - Short-run: take capacity as fixed. Exclude fixed/sunk.
      - Marginal costs = dTC/dq
    - Long-run: investment in capacity.
      - Long-run Incremental Cost (LRIC)
    - Exclude costs already recovered in access (origination)
  - Per minute (switching), per call (set-up), per month (capacity)?
- How to estimate?
  - Market data (comparables?)
  - Engineering cost models
  - Accounting data, adjusted to reflect productivity gains
- Costs variable? e.g., Hot potato routing.

Externalities

- Externality: benefits (or costs) imposed on others as result of individuals actions.
  - Prices which do not reflect all benefits (costs) result in too little (too much) usage
  - Examples: pollution, traffic jams, spectrum interference
- Solution: internalize the externality so individual cost/benefit reflects all impacts
  - Example: pollution fines, road tolls, spectrum fees
- Relevant examples for interconnection
  - Network (“subscriber”) externality (positive)
  - Calling externality (positive)
  - Congestion externality (negative)

Network Externality

- Bigger network more valuable. Impact positive.
  - Direct: expanded connectivity. More options for calling.
  - Indirect: more complementary goods, lower costs
- Subscriber externality
  - Early adopters convey benefit on later (justify penetration pricing?)
  - Diminishing marginal returns
- Examples: Universal service, Microsoft Windows, Internet
- Should small network pay more when connecting to big network?

Calling Party Externality

- Both called and calling party benefit from call
- Typically only calling party pays: makes fewer calls than optimal
- Costs of terminating calls may not be symmetric
  - e.g., Mobile to wireline, Web browsing
  - Origination vs. termination (e.g., switch usage)
  - Not always positive: SPAM
- Solutions:
  - Both parties pay (in US, mobile caller and called party pay)
  - Inter-temporal alternating direction of origination
  - Flat rate billing
- Should called and calling party pay? Metering/privacy?

Congestion externality

- Caller's traffic slows down everyone else's traffic when network congested. Delay imposed on other's is ignored by sender.
- Solutions:
  - Congestion pricing: internalize externality
  - Peak-load pricing: time varying prices (e.g., time of day tariffs)

Arbitrage

- "Law of One Price"
  - Close substitutes ought to have similar prices.
  - Buy one and sell other.
- Examples:
  - Call-back in International Telephone
  - VoIP to avoid telephone charges
  - Reciprocal Comp: ISPs and CLECs in US
- Is it efficient?
  - Forces prices in line with costs (e.g., financial markets)
  - Makes difficult to sustain regulatory subsidies