
The Transformation of the Internet



Christopher S. Yoo

University of Pennsylvania Law School

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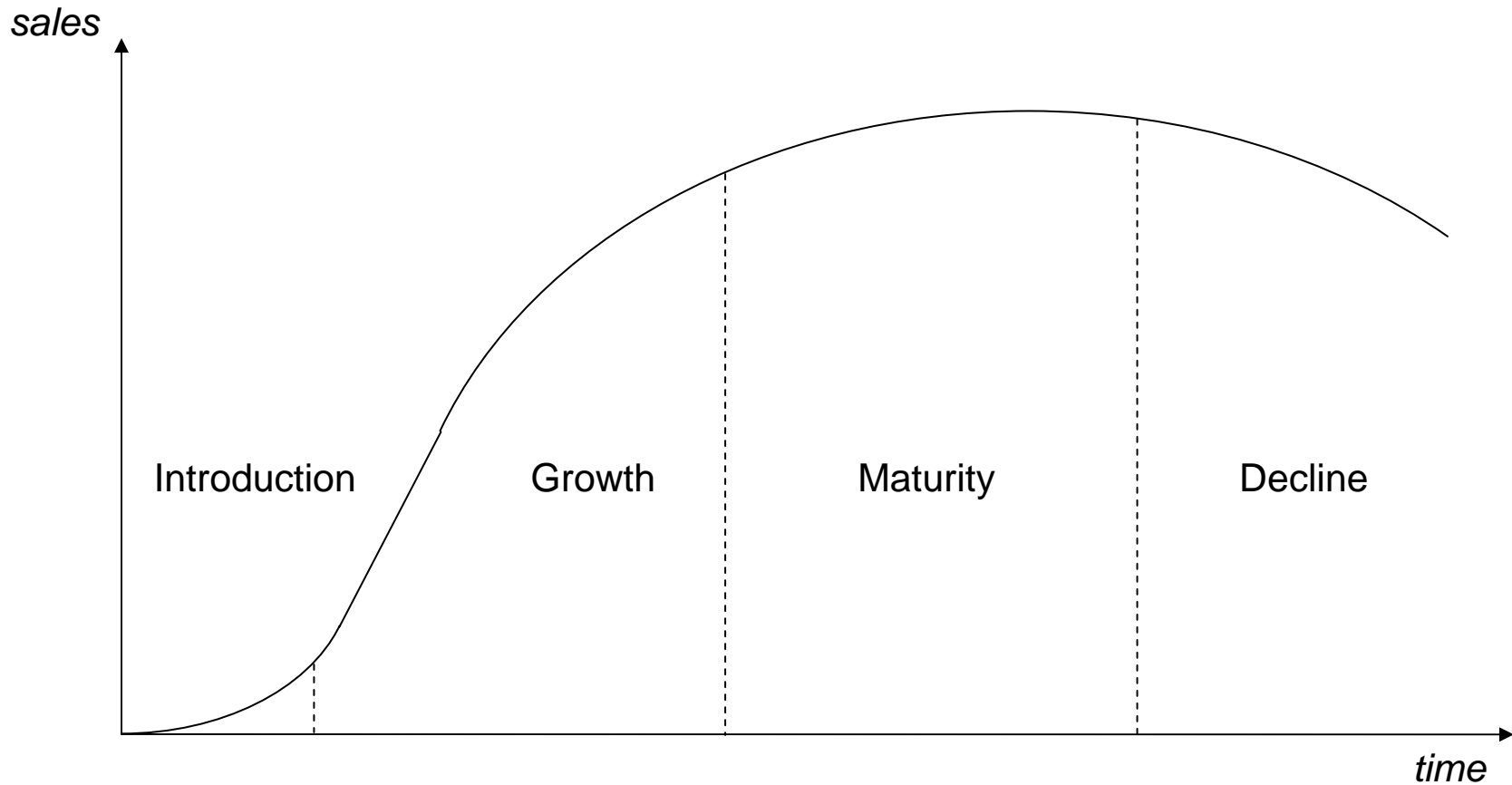
Problems with the Current Debate

- Is framed by a 1990s conception of the Internet
 - Universe of users was relatively small and homogeneous
 - Universe of applications was fairly narrow
 - Networking technologies were dominated by wireline
 - Business relationships fell into a very narrow range
- Overlooks how much the technological and business environment has changed
 - Current architecture may no longer be appropriate
 - Mandating any particular architecture may be harmful

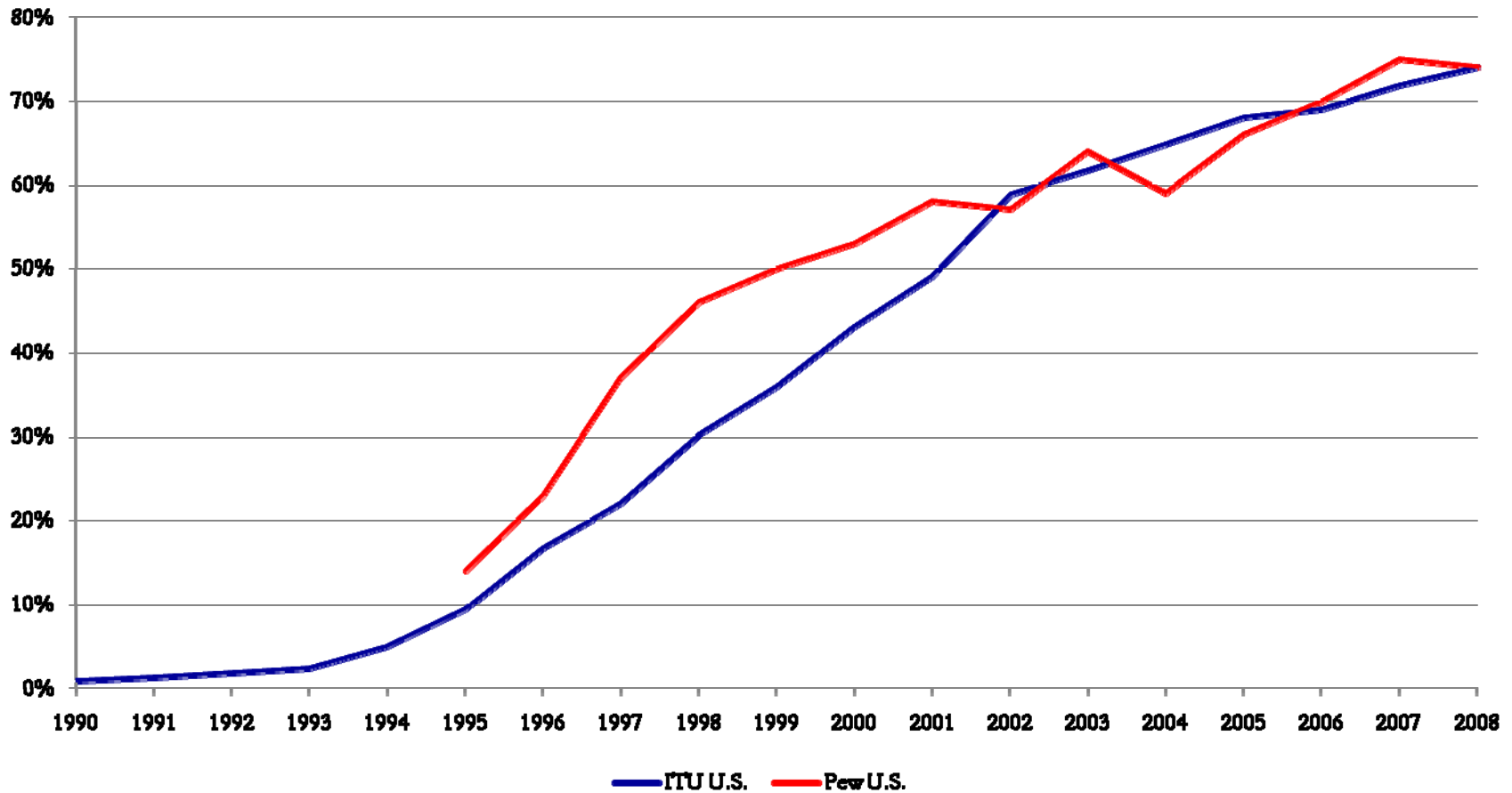
Changes in the User Base

- Is larger and more heterogeneous with less institutional support
 - Makes bargaining more difficult
 - Makes informal governance less effective
 - Favors moving some functions into the network
 - Changes tradeoff between standardization and variety
- May have crossed the inflection point toward market maturity

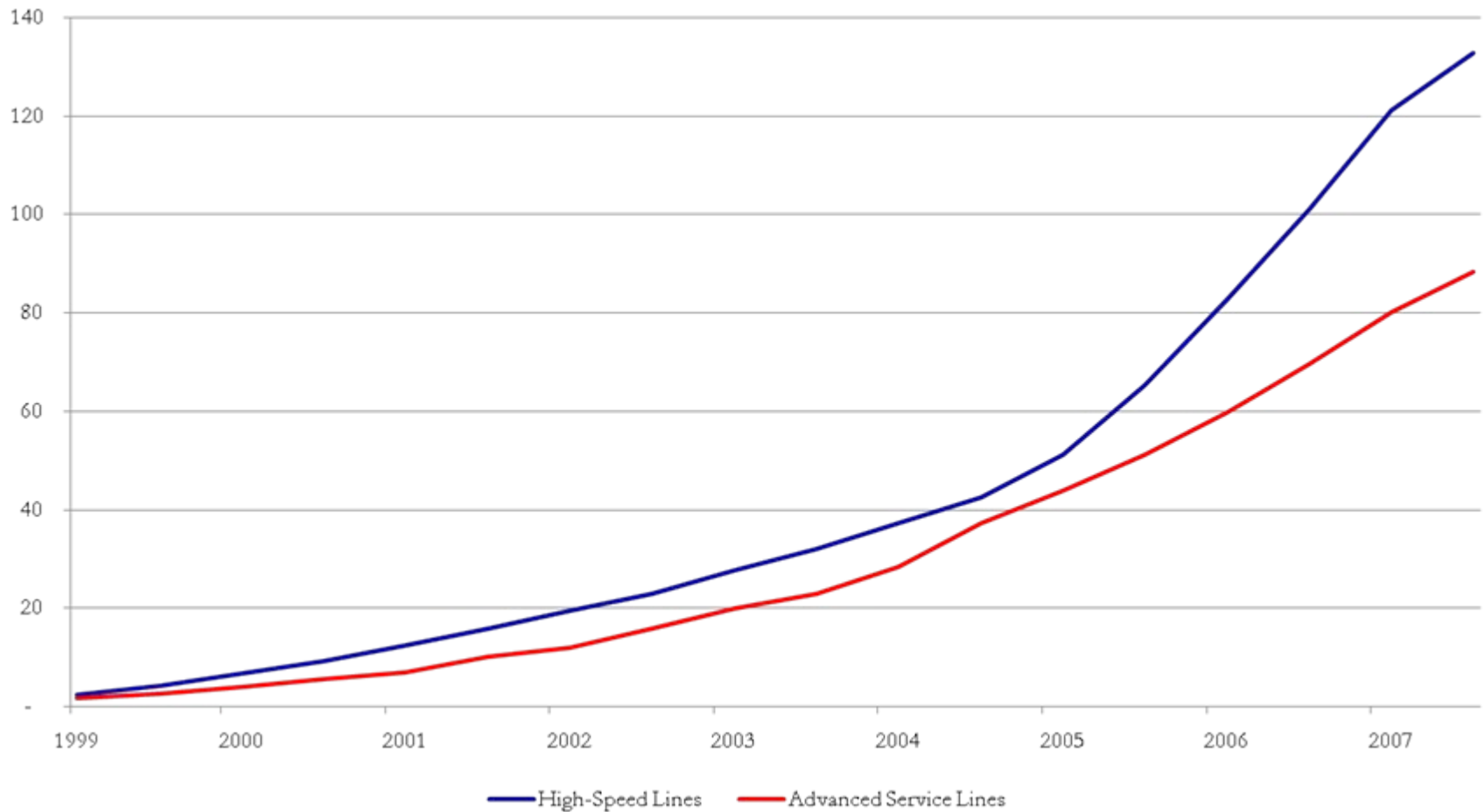
Classic Product Life Cycle



U.S. Penetration of Internet Usage



Broadband Adoption in the U.S. (millions of subscribers)



Impact of Market Maturation

- Nature of competition changes
 - Greater focus on cost reduction & delivering more value
 - Shift toward specialized processes and products
- Markets more likely to become locked in
 - Implicit in network economic effects
 - Especially problematic in design hierarchies
 - Fosters innovation within the hierarchy, but hurts innovation that needs a different hierarchy
 - Many technologists complain the network can't evolve
 - Many initiatives: NewArch, GENI, FIND, Clean Slate

Changes in Applications

- Previous world: downloads (focuses on last packet)
- Current problem: interactive video
 - Is more bandwidth intensive
 - Is more sensitive to delay as well as jitter
 - Based on UDP (needs different congestion control)
- Future world: shift from content to apps
- Prioritization as a longstanding goal
 - In the beginning: ToS, segregation of TCP/UDP from IP
 - Subsequently: IntServ, DiffServ, MPLS, LEBAT

Changes in the Technology

- Growing importance of capital investments
 - Initially leveraged the legacy infrastructure
 - Now must invest in new infrastructure (FiOS, wireless)
 - Looking for ways to rely on OpX rather than CapX
- The emergence of wireless broadband
 - Differences with respect to bandwidth, reliability, local congestion, e2e visibility
 - Use of smart phones instead of PCs
 - Most innovative, most competitive, most uncertain

Broader Implications

- Solutions should vary across technologies and time
 - Regulation should leave open less CapX-intensive solutions
- Current architecture may inhibit certain innovation
- Some problems are best solved at the network level
 - Interactions among users and layers
 - Aggregation of information/lack of coordination
 - Networks' ability to route around
- Technologists' disagreement over prioritization counsels against regulatory intervention