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MODULAR CONFINES OF MOBILE NETWORKS: ARE IPHONES IPHONY?

**Thomas W. Hazlett, Professor,
George Mason University School of Law**

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Strategic investments by wireless carriers and others are generating rapid development of the “mobile ecology,” increasing modularity even while embracing and extending vertical controls. Coordination among complementary asset owners and simultaneous rivalry among platforms suggests that the process of creative destruction is robust. Moreover, innovation “at the edge” is vibrant, with smartphone suppliers Research in Motion (Blackberry), Apple (iPhone), Google (gPhone), among others, driving carrier strategies. That vertical network policies help generate welfare gains is apparent via revealed consumer preferences, the advanced state of technology under “strong bundling” in Japan, and the fact that even ostensibly “open” platforms retain an important measure of vertical control, efficiencies yielding value in rivalry against competing platforms.

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¹ Professor of Law & Economics, George Mason University. The author thanks SangHo Yoon and Mitch Calhoun for exceptionally alert research assistance. This is a preliminary draft subject to revision. Comments and criticism welcome.

Introduction

U.S. consumers continue to benefit from effective competition in the CMRS [cellular] marketplace... [W]ith large buckets of inexpensive minutes, the average amount of time U.S. mobile subscribers spend talking on their mobile phones rose to approximately 769 minutes per month in the second half of 2007... more than quadruple the average usage of mobile subscribers in Western Europe and Japan...

Federal Communications Commission²

The wireless industry was once and is still sometimes called a "poster child for competition." That kind of talk needs to end.

Tim Wu, Professor of Law, Columbia University³

Mobile phones are the “killer app” of the Information Age. By year-end 2007, wireless networks enlisted 3.3 billion subscribers globally, more than one-half of every living man, woman and child.⁴ This mass-market success puts mobile penetration far above fixed line telephony, with a mere 1.3 billion subscribers, and fixed line Internet access, with about 1.5 billion subscribers.⁵ Indeed, the most exciting growth opportunities for “online” applications are riding on connectivity via the “wireless web.” Organizations such as the World Bank now look to such emerging markets as driving economic growth. “The cell phone is the single most transformative technology for development,” opines Jeffrey Sachs, Professor of Economics at Columbia University.⁶ And a N.Y. TIMES MAGAZINE queries: “Can the cell phone help cure global poverty?”⁷

For all this excitement, cellular phone networks are being harshly critiqued – as per their structure and performance – in the United States. In early 2007, Columbia University law professor Timothy Wu argued that the U.S. wireless market offered a “mixed picture.”⁸ On the one hand, operators had “succeeded in bringing wireless telephony at competitive prices to the public.”⁹ On the other hand, carriers were “aggressively controlling product design and innovation in the equipment and application

² FCC, *13th Annual CMRS Report* (rel. Jan. 16, 2009), par. 274.

³ Tim Wu, *iSurrender*, SLATE (June 10, 2008); <http://www.slate.com/id/2193293/>.

⁴ International Telecommunications Union (ITU), ICT Global Indicators (Dec. 2007); http://www.itu.int/ITU-D/ict/statistics/ict/graphs/ICT_penetration_2007.jpg.

⁵ Ibid.

⁶ Cindy Shiner, *Cell Phones Could Transform North-South Cooperation*, AllAfrica.com (Feb. 16, 2009); <http://allafrica.com/stories/200902161504.html>.

⁷ Sara Corbett, *Can the Cellphone Help Cure Global Poverty?* N.Y. TIMES MAGAZINE (April 13, 2008).

⁸ Tim Wu, *Wireless Carterfone*, 1 INT’L J OF COMM 389 (2007), 389-426 2007, p. 389).

⁹ Ibid.

markets, to the detriment of consumers.”¹⁰ To counter these asserted inefficiencies, Wu proposed a “Wireless Carterfone” regime:

- bar the “locking” of devices to a single carrier;
- require carriers to allow, as some carriers do now, the attachment of any compatible and non-harmful network device;
- a general ban on the blocking of internet content.¹¹

This agenda springs from a critique of the vertical structure of mobile operators:

The industry should re-evaluate its “walled garden” approach to application development, and work together to create clear and unified standards for developers. Application development for mobile services is stalled, and it is in the carriers’ own interest to try and improve the development environment.¹²

This paper departs from the policy questions raised by Prof. Wu to explore the changing nature of vertical mobile market structure. I argue that *Carterfone* is inaptly applied to wireless markets, and that it would be counter-productive to overrule antitrust rules by categorically banning vertical restraints. Mobile markets have developed complex mechanisms for economic cooperation that involve vertical integration (via contract and ownership) and have intense horizontal platform competition. Professor Wu’s case – targeting an innovative product such as Apple’s iPhone – itself reveals the error of a blanket exclusion of vertical strategies.

I. Vertical Integration in General and in Mobile

The analytical framework developed by Ronald Coase in 1937¹³ models firm scope and structure decisions in a cost-benefit analysis. How much of the final product a firm seeks to create, and what components it purchases from other suppliers, reflect the benefits of scale or scope economies, on the one hand, and specialization, on the other. This choice-making process applies with equal force to contracts that define options for consumers to substitute other components in place of those selected or produced by the firm.¹⁴ There is no categorical efficiency in using “the price system” to purchase inputs from outside suppliers, nor in integrating to supply such products internally. In each instance, firms strive to balance costs against benefits to reach the efficient mode.

Vertical integration facilitates some forms of economic cooperation at the expense of others. The purpose of bringing activities within the scope of the firm is, in fact, to

¹⁰ Ibid.

¹¹ Ibid., p. 390. Wu also recommends disclosure requirements, though such consumer information requirements are already imposed by the Federal Trade Commission.

¹² Ibid.

¹³ R.H. Coase, *The Nature of the Firm*, 4 *ECONOMICA* 16 (Nov. 1937); reprinted in R.H. Coase, *The Firm, the Market and the Law* 33 (Univ. of Chicago Press, 1988).

¹⁴ Stephen N. S. Cheung, *The Contractual Nature of the Firms*, 26 *J LAW & ECON* 1 (Apr., 1983).

bypass arms length transactions at market prices. Some of the avoided transactions may have yielded profitable outcomes for the firm; the wager made in integrating is that the overall strategy pays off. The firm's objective is not a perfect record but a structure and scale that profitably align the incentives of cooperating economic agents – suppliers, partners, investors, and customers. In this pursuit, firms merge or divest, produce or buy, and adopt a range of contractual forms, including those that define the terms of the packages sold to buyers.

Consumers benefit from this process. When the creator of a wireless network invests capital to assemble radio spectrum, base stations, backhaul fiber links, electronic control systems, handsets, and a raft of other inputs to supply mobile communications, multiple opportunities are born. The motivation of the investor is to capture a share of the revenues that will thus be generated, maximizing profit. Coordination of complementary service providers will be achieved implicitly or explicitly. Done well, the emergent “mobile ecosystem” will maximize profits for the network provider.

Maximizing profit does not equate to maximizing profit *share*; hence, the mobile network operator has little economic incentive to “monopolize” the flow of economic gains. To enlist support from a range of firms – technology suppliers, handset makers, infrastructure vendors, application developers – non-carrier profits must be available for appropriation. Dynamically balancing this value-creating profit-chase among producers of complements while simultaneously preserving and protecting its own appropriable profit opportunity is the challenge faced by the network. To characterize vertical integration or restraints as categorically anti-competitive reveals two important errors.

First, it presupposes a well-defined module in which a carrier must efficiently be confined. No such module exists. As Coase found in his near-tautological description of the firm: efficient boundaries are where you find them. Outside of market survivorship, such contours are ill-defined. Second, the coordination across contours, however defined, is efficient across a wide class of phenomenon. This is both because the base platform supplier is able to extract value by pricing platform access (with one-sided or two-sided transactions), and because the platform owner broadly internalizes net gains from organizational investments. This incents the owner to carefully pre-empt various common interest tragedies¹⁵ that would dissipate platform value.

Firms vertically integrate when they expect inputs are more efficiently produced than purchased. At a slightly more nuanced level, firms may seek to mitigate a complement producer's opportunistic behavior either by owning them or by entering into “exclusionary” long-term contracts with them.¹⁶ Alternatively, manufacturers often seek to impose restrictions on downstream retailers of their products, either to keep resale prices higher or lower than otherwise. Either type of restriction has been shown to generally serve consumer interests by protecting against “double marginalization”

¹⁵ Lee Anne Fennell, *Common Interest Tragedies*, 98 NW L R 907 (2004).

¹⁶ Howard P. Marvel, *Exclusive Dealing*, 25 J L & ECON 1 (1982); Benjamin Klein & Kevin M. Murphy, *Vertical Restraints as Contract Enforcement Mechanisms*, 31 J L & ECON 265 (1988).

(monopoly pricing by retailers) or mitigating the incentive to free ride on product service investments made by others.¹⁷

In general, firms have strong incentives to improve the performance of upstream and downstream producers on whom their product sales greatly depend. Platform builders internalize gains from the efficiencies created in ancillary, complementary markets. Conversely, firms that retain key ownership rights may extract the full value of the innovation irrespective of their vertical involvements, the “one monopoly” story.

Nonetheless, anti-competitive outcomes may result from vertical integration. As shown by economic theory, opportunities for output restriction may exist when firms vertically integrate to evade price controls, restrict customer access to nip an emerging horizontal competitor in the bud, or use integration or vertical restraints to engage in price discrimination.¹⁸ The use of integration to escape regulation was of direct concern in *Carterfone*, but not with modern cellular networks, as discussed in the next session.

The remaining anti-competitive stratagems must be evaluated empirically. As noted in a recent review of the literature, however: “empirical analyses of vertical integration and control have failed to find compelling evidence that these practices have harmed competition, and numerous studies find otherwise.”¹⁹ This paper, in examining mobile markets, finds no headline to report that would disrupt that consensus. Wireless carriers have become increasingly modular, not insular, as their markets have matured and their networks have grown. Moreover, increasing use of the mobile ecology to supply network users has also been facilitated with extensive and continuing network management, including exclusive contracts and vertical restraints. These approaches appear to be creating a rich environment for industry growth, consumer welfare generation, and innovation at the edge of the network.

III. *Carterfone* Not

A. The *Carterfone* Analogy is Inapt

AT&T was subject to extensive regulation by the FCC and state public service commissions following the Communications Act of 1934 and for decades thereafter. This regime resulted in a network that was closed, inefficient, and anti-competitive. The FCC determined in the 1950s, for instance, that Hush-a-Phone devices were “deleterious to the telephone system and injures the service rendered by it” and could not be attached

¹⁷ Lester G. Telser, *Why Should Manufacturers Want Fair Trade?*, 3 J L & ECON 86 (1960).

¹⁸ See, e.g., Joseph Farrell & Philip J. Weiser, *Modularity, Vertical Integration, and Open Access Policies: Towards a Convergence of Antitrust and Regulation in the Internet Age*, 17 HARV J L & TECH 85 (Fall 2003).

¹⁹ James C. Cooper, Luke M. Froeb, Dan O’Brien, & Michael G. Vita, *Vertical Antitrust Policy as a Problem of Inference*, 23 INT’L J. INDUS. ORG. 639 (2005). See also, Francine Lafontaine & Margaret Slade, *Empirical Assessment of Exclusive Contracts*, in HANDBOOK OF ANTITRUST ECONOMICS (Paolo Buccirossi, ed., 2008).

to the network.²⁰ This regulatory determination was overturned by the D.C. Circuit Court of Appeals in 1956.

Over a decade later, the FCC, citing *Hush-a-Phone*, overturned regulated tariffs in its *Carterfone* decision.²¹ This policy represented a shift in regulatory strategy. The rationale for requiring that AT&T's telephone customers be permitted to connect to "foreign" devices or networks was based on two primary considerations, each of which was crucial:

- (a) the AT&T network was a monopoly,
- (b) the network was regulated via rate-of-return rules.

Monopoly. Not only did AT&T enjoy market power, it was protected by exclusive franchises. No firm was authorized to offer service in rivalry with AT&T for local or long distance telecommunications. (MCI received limited authority to offer private line long distance services in 1969.²² This authority was subsequently expanded, allowing for competition in long distance markets. The 1996 Telecommunications Act pre-empted state monopoly in local telecommunications service.) A monopolist may have incentives to inefficiently pre-empt independently supplied vertical services which could develop into competitive platforms. Hence, AT&T might have refused to interconnect with wireless phone services (such as Carterfone), to stifle a new communications system that – while complementary at its inception – might burgeon into a substitute over time.

Regulation. Being subject to rate-of-return regulation, AT&T was limited in the prices it charged and the profits it earned by supplying lines. Price controls were set at levels determined by AT&T's costs. A means for AT&T to relax its profit constraint was available via vertical services supplied in unregulated markets. If the firm invested in these services with funds that raised its fixed line costs, regulators would grant a rate increase. While accounting profits in the regulated market would remain constant, economic profits in the unregulated market would increase. This cross-subsidy strategy made AT&T's integration problematic.

Competitive, unregulated markets eliminate the *Carterfone* rationale. An unregulated firm cannot subsidize inefficient vertical integration by increasing costs in other sub-markets. If it attempted to do so, it would simply reduce its profits, dollar for dollar. Not being rate-of-return regulated, it has no opportunity to stick customers with rate increases so as to maintain returns. Vertical integration must pay for itself.

²⁰ *Hush-a-Phone Corporation and Harry C. Tuttle, Petitioners, v. United States of America and Federal Communications Commission, Respondents, American Telephone and Telegraph Company et al., and United States Independent Telephone Association, Intervenors*, 238 F.2d 266 (DC Cir. 1956).

²¹ See Peter W. Huber, Michael K. Kellogg & John Thorne, *Federal Telecommunications Law* (Aspen Law & Bus. 2d ed. 1999 & Supps. 2004 & 2005).

²² IEEE Communications Society, *History of the Technology, 1952-2002* (Chapter 3); http://www.ieee.org/web/aboutus/history_center/conferences/comsoc/chapter3.html.

Hence, vertical integration will generally be efficient, absent regulation. Even when undertaken by a monopolist, inefficient bundling decisions would be constrained by the complementarities between vertical products: firms profit by the availability of desirable complementary products, which raise demand for their goods and services. The notable exception is where the firm sees the complement as a potential competitive threat. That is why antitrust law is sometimes applied to vertical activities by firms with monopoly power.²³ Yet, lacking monopoly power,²⁴ attempts to thwart consumers' use of efficient vertical services will fail, as competitive providers profit from supplying what a firm unreasonably limiting consumers' choices will not.²⁵

In short, profit incentives align with consumers' interests, such that firms are driven to provide packages that feature the efficient level of access to vertical services – or firm scope, in the Coasean analysis. This straightforward logic largely explains why, when the FCC authorized personal communications service (PCS) licenses in 1992, the Commission found regulation inappropriate:

[W]e expect PCS to be a highly competitive service... [R]egardless of whether PCS is determined to be a private or common carrier service, there will be no captive customers who must take the service from a monopoly (or near monopoly) service provider, and government rate and service regulation should not be necessary to protect customers from monopoly abuse.²⁶

Accordingly, the FCC deregulated the service. And, as anticipated, competition developed. For instance, the most recent FCC Commercial Mobile Radio Services (CMRS) Annual Report writes: "U.S. consumers continue to benefit from effective competition in the CMRS [cellular] marketplace... [W]ith large buckets of inexpensive minutes, the average amount of time U.S. mobile subscribers spend talking on their mobile phones rose to approximately 769 minutes per month in the second half of 2007... more than quadruple the average usage of mobile subscribers in Western Europe and Japan..."²⁷

B. The UNE-P Analogy is More Apt²⁸

²³ As in the *U.S. v. Microsoft* case, where Microsoft's tactics in competing with Netscape's browser (a complement to Microsoft's operating system software, Windows) were thought by the government to constitute a strategy to protect the underlying operating system from competition.

²⁴ Horizontal competitors may, at least theoretically, collude to create and share monopoly power. This strategy must overcome prisoners' dilemmas, and is in any event illegal under the antitrust laws.

²⁵ See also, Robert Hahn, Robert Litan, & Hal Singer, *The Economics of "Wireless Net Neutrality,"* 3 J COMP LAW & ECON 399 (2007).

²⁶ *Notice of Proposed Rulemaking and Tentative Decision*, FCC Rcd. 5676 (1992), par. 94.

²⁷ FCC, *13th Annual CMRS Report* (rel. Jan. 16, 2009), par. 274. Schwartz & Mini show how such inter-platform competition resulted in declining costs for U.S. consumers. Marius Schwartz & Frederico Mini, *Hanging Up On Carterfone: The Economic Case Against Access Regulation in Mobile Wireless*, SSRN Working Paper (May 2, 2007); http://papers.ssrn.com/sol3/papers.cfm?abstract_id=984240.

²⁸ UNE-P (unbundled network element – platform) refers to the FCC's program permitting competitive telephone carriers to resale the voice service of the incumbent local exchange carrier, paying sharply discounted wholesale prices. For a description, see Alfred E. Kahn, [Lessons from Deregulation:](#)

How is it, then, that *Hush-a-Phone* and *Carterfone* rules appear to have succeeded in promoting competition, given that they imposed arbitrary regulatory interfaces on the existing fixed-line telephone network? This question has been partly answered by the monopoly and regulatory distinctions discussed above. Another response is to note that the attachment rules were much less than a complete success; the U.S. Government moved to divest AT&T in an antitrust case that ultimately dismembered the monopoly. More pointedly, an answer is supplied by Gerry Faulhaber,²⁹ who has examined episodes in which “open access” requirements appear to have succeeded and those in which they have failed.

He finds “a transaction cost theory of the firm” useful. He observes that “open access” will not likely be successful where “transactions... are best done *within* the firm,”³⁰ writing that, “transaction costs thus help define the optimal boundary of the firm: all complex transactions take place *inside* the boundary and only simple transactions take place *across* that boundary.”³¹ This is consistent with standard industrial organization theory. Carliss Baldwin writes about the natural tendency of markets to separate a chain of production into a network of tasks featuring “thin crossing points (module boundaries) and thick crossing points (module interiors). Although transactions can be placed in both types of locations, transaction costs are lower at module boundaries.”³²

Faulhaber’s policy conclusion for telecoms is that the wall-plug modularity that helped introduce competitive customer premises equipment (CPE) into the AT&T monopoly following *Carterfone* (and other decisions) offered a relatively simple transaction that – by the nature of the network interface – did not need coordination with other users or suppliers of the network.

[A] simple technical specification could enable an existing industry to sell CPE to customers and seamlessly plug into the existing telephone industry, all at very low transactions cost. In other words, the CPE/network interface is a “natural” market boundary, in which transactions cost are very low. The FCC deregulation of CPE thus transformed a somewhat unnatural integration of CPE and the network into the more natural market disintegration at very low cost.³³

But these conditions are not generally present. “The success of CPE deregulation via an FCC administrative fiat was not to be repeated.” In particular, Faulhaber notes the failure of fixed telecommunications network unbundling rules – in the form of the FCC’s

Telecommunications and Airlines after the Crunch (Wash., D.C.: AEI-Brookings Joint Center for Regulatory Studies; 2004).

²⁹ Gerry R. Faulhaber, *Policy-Induced Competition: The Telecommunications Experiments*, 15 INFO ECON & POL’Y 79 (March 2003).

³⁰ Faulhaber, *op. cit.*, p. 77 (emphasis in original).

³¹ Faulhaber, *ibid.*

³² Carliss Baldwin, *Modularity, Transactions, and the Boundary of Firms: A Synthesis*, HBS Working Paper 08-013 (2007), p. 46.

³³ Faulhaber, *op. cit.*, p. 79.

UNE-P resale program -- to induce competitive local exchange service. These network sharing, or “open access” rules, were overturned by federal courts and then abandoned by the FCC, allowing the experiment to be performed in reverse. It was then found that facilities-based competition *accelerated* in the absence of mandatory sharing rules.³⁴

C. Perfectly Apt: The Failure of Unbundling in International Wireless Markets

Timothy Wu objects to the fact that wireless “carriers have [a] strong lock on the retail [market for] mobile wireless devices... “ And he identifies the culprit. “The primary reason is well known, and even beloved by consumers: the practice of subsidizing equipment purchases with subscription fees.”³⁵ Rob Frieden goes further, arguing that “subsidized handsets [help] carriers foreclose subscriber access to services, content and applications [that] possibly compete with services offered by the carrier.”³⁶ Neither considers whether efficiencies are generated by the vertical integration of carriers (by contracting with manufacturers) into handsets.³⁷

Yet, experiments have been performed, both in markets where networks have adopted “strong bundling” strategies, and in markets where regulators have banned the bundling of handsets with mobile network services. The latter episodes are discussed here; the case of DoCoMo i-mode’s “strong bundling” is taken up below.

The first noteworthy aspect of policies to ban handset subsidies, one regulatory approach used to reduce bundling, is that it is explicitly anti-competitive. Carrier subsidies are a source of pro-consumer rivalry, and curtailing the practice directly injures subscribers. In South Korea, regulators have attacked subsidies by going the extra mile and, on a temporary basis, prohibiting mobile carriers “from signing up new subscribers,” a policy “likely to slow down the country’s fiercely competitive wireless market and enable companies to invest in networks and facilities instead of marketing, an official at the Korea Communications Commission said.”³⁸ According to a KCC member, “With handset subsidies, the replacement cycle kicks in too quickly resulting in wasted resources and unfair competition [and] that is why the government bans it.”³⁹

In Japan, a similar protectionist policy has been pursued. “Pushed by the Japanese regulator, Ministry of Internal Affairs and Communications, domestic carriers are going to gradually lessen their dependency on handset subsidies.”⁴⁰ The phase-out is “blamed

³⁴ Thomas W. Hazlett, *Rivalrous Telecommunications Networks With and Without Mandatory Sharing*, 58 FED COMM L J 3 (June 2006).

³⁵ Wu (2007), p. 398.

³⁶ Frieden (2008), p. __.

³⁷ Schwartz & Mini (2007, pp. 17, 18, 21) show that eliminating vertical restrictions would likely raise the overall costs for consumers.

³⁸ *Korean Wireless Market to Slow Down*, TELECOMASIA.NET (June 17, 2004); <http://www.telecomasia.net/article/articleDetail.jsp?id=99163>.

³⁹ Ibid.

⁴⁰ *Dim forecast for Japanese handset market: reduced handset subsidies and longer replacement cycle*, JAPAN’S CELLPHONE EDGE (Feb. 23, 2008); <http://analyticalst.com/analyticalst/2008/02/dim-forecast-for-japanese-handset.html>.

(rightly or wrongly) for declining sales this year.”⁴¹ The result? “DoCoMo (DCM) profits are up on the change, and more consumers have less expensive monthly plans.”⁴² Of course, “less expensive” plans likely deliver less service, and do not constitute, a priori, net gains for customers. The fact that subscribers have older, less functional handsets is a loss for both those subscribers and the network as a whole.

Interestingly, the last two markets in Europe to effectively ban the bundling of handsets with network service have been Finland and Belgium. In Finland, however, slow rates of 3G technology adoption were blamed on the policy; the policy was then eliminated. A recent study notes:

The Finnish Parliament allowed bundling excluding 2nd generation, starting April 2006. In practice this has led to consumers buying subsidized 3G handsets. In Finland 3G has taken off because of bundling. There is a clear cause and effect relationship between allowing bundling and 3G becoming popular in Finland.⁴³

This conclusion is echoed in another paper, which finds that, “In Finland, handset bundling has proved to be an effective driver of 3G adoption. Thus, one could claim that the decision to permit focused 3G subsidization was a successful move. It has opened doors for services markets as many economists anticipated.”⁴⁴

There is a straightforward rationale for this, which goes to the heart of the vertical integration issue. Technologist Charles Jackson emphasizes that “handsets are part of the network,”⁴⁵ and this reality drives economic organization. The customer obtains various benefits from owning a mobile handset, and forms her demand price based on those perceived opportunities. The network owner, on the other hand, values the handset for the same reasons and some additional ones. An example relates to the spectral efficiency of the cell phone. Although airwave emissions reduce other users’ opportunities, it is not a factor for the individual polluter who will have no incentive to spend more money on a better behaving radio. Such “pollution” costs are felt by the network, however, which sees a reduction in revenues as performance declines. Since phones tend to become more spectrally efficient over time, the network has extra incentives to speed the product cycle, with the network’s interest driven by economic efficiency.

There are multiple coordination mechanisms available to properly align incentives. One path is for the network carrier to manage the platform, approving devices and subsidizing more advanced technologies. An alternative is for standards to

⁴¹ Joel West, *U.S. Handset Subsidies to Be Replaced by Something Worse?* SEEKING ALPHA (Dec. 15, 2008); <http://seekingalpha.com/article/110665-u-s-handset-subsidies-to-be-replaced-by-something-worse>.

⁴² Ibid.

⁴³ Ville Saarikoski, *The Odyssey of the Mobile Internet* (2006); http://www.tieke.fi/mp/db/file_library/x/IMG/20156/file/Saarikoskivaitoskirja.pdf.

⁴⁴ Marko Repo, *Regulation of Wireless Stakeholders* (Oct. 2006); http://www.netlab.tkk.fi/opetus/s383042/2006/papers_pdf/B2.pdf. See also, Tallberg, et al., *Impacts of Handset Bundling on Mobile Data Usage: The Case of Finland*, 31 TELECOM POLICY 648 (2007).

⁴⁵ Charles Jackson, *Wireless Handsets are Part of the Network*, CTIA (April 27, 2007).

be set for equipment, by manufacturers and carriers, establishing industry-wide performance criteria and pushing a time path for upgrades. While the mechanisms differ, and are not mutually exclusive, neither allows the consumer to exercise a fully unconstrained handset choice. Certain options are ruled out to protect network functionality. Operators, competing on network quality and handset quality, internalize efficiencies.

Another potential externality involves the creation of critical mass for new mobile applications. With the emergence of 3G data services, network effects are pronounced. An increase in the size of the potential audience drives content developers to invest in new services; this in turn produces new demand to join the 3G network. But there is a “chicken and egg” problem. Being the first consumer to buy an expensive 3G handset is a risky proposition; perhaps it is better to let the applications develop first. By buying expensive handsets for customers, the carrier assists market formation. Content developers thrive and consumers benefit. And the carrier extracts returns through increased subscribership, usage charges and, potentially, a share of application revenues.

This vertical integration enables gains from trade.⁴⁶ In the absence of such economic coordination, common interest tragedies may easily result. As in Belgium, the last E.U. country to ban handset bundling (and subsidies) by network operators, where the iPhone sells for the highest prices in the world:

Mobistar (Belgium): *Ridiculous Unlocked Hardware Prices, With a Contract* Due to Belgian law, all phones must be sold unlocked. That means the iPhone is not eligible for a subsidy, and the 16GB will run you a massive €615 (that's US\$982). You can buy it without activation of a contract, but if you want to actually use the phone in Belgium with Mobistar service, they've still got you for a two-year contract, the most generous of which has a 1GB data cap and 540 minutes for €60 (US\$96)--kind of defeats the purpose of forcing sales of unlocked phones, no?⁴⁷

The backlash over this has led Belgian policy makers to attempt to get the ban overturned by Parliament.⁴⁸

⁴⁶ “Vertical integration can help solve the start-up problem where there are complementary bandwagon effects.” Jeffrey H. Rohlffs, *Bandwagon Effects in High-Technology Industries* (Cambridge, MA: MIT Press; 2001), p. 197. Rohlffs supplies examples: “RCA’s ownership of NBC was a critical factor in starting up original (black-and-white) television and color television. Philips’ partial ownership of Polygram Records helped solved the start-up problem for CD players. On the other hand, the rapid proliferation of independent videocassette rental stores and of manufacturers of television sets show how effective competitive markets can be in meeting consumer needs – *after the user set has become sizable*.” Ibid. (emphasis in original).

⁴⁷ John Mahoney, *Three iPhone Carriers That Make AT&T Look Like a Deal*, GIZMODO (July 16, 2008); http://www.gizmodo.com.au/2008/07/three_iphone_carriers_that_make_att_look_like_a_deal-2.html.

⁴⁸ *International Briefing, Belgium: High iPhone Price Blamed on Subsidy Ban*, WASH POST (July 10, 2008); <http://www.washingtonpost.com/wp-dyn/content/article/2008/07/09/AR2008070902217.html>.

IV. Evolution of Mobile Networks and Handset Platforms in the U.S.

A. Two Views of Industrial Organization

A chasm exists between communications policy and economic analysis. The communications policy approach characterizes the Internet as architecturally designed for freely traveling “end to end” (e2e) traffic flows. Sometimes referenced as the “dumb pipes” model, the vision is that the networks transporting bits indiscriminately accommodate data flows to the edge of the Internet, where end users have access – on non-discriminatory terms and conditions – to all information, applications and transmission services. This structure is said to protect innovation by constraining the discretion of transport network providers (eliminating ‘gatekeepers’), who might otherwise seek to vertically integrate and then exclude competing information services.⁴⁹

This vision clashes with the economic view of the Internet, in which the component parts – at both the transport and content/application layers – are modeled as enterprises that interconnect on negotiated terms that reflect (and drive) underlying efficiencies.⁵⁰ This results in the emergence of layers, as enterprises specialize, but this structure is neither imposed nor rigidly adhered to. The spontaneous evolution of the network of networks reflects a discovery process wherein new business models are explored and tested. In many cases network management – discrimination by transport providers – is efficient.⁵¹ So, too, is price discrimination, which drives backbone providers to increase their size and scope in order to obtain preferred terms.⁵² So, three, is bundling of transport and content.⁵³

Consider America Online’s mid-1990s bundling of dial-up Internet access with proprietary content. Whereas the communications policy reaction condemns AOL’s “walled garden” as inimical to the “open” nature of the Internet, the economic approach cites the aggressive investment that AOL made to enlist new subscribers⁵⁴ as driving the creation of a mass-market in online services. That AOL soon elected to phase out its

⁴⁹ Mark Lemley & Lawrence Lessig, *The End of End-to-End: Preserving the Architecture of the Internet in the Broadband Era*, 48 UCLA L R 925 (2001).

⁵⁰ Thus conflicts frontally with the view that “the core resources of the Internet were left in a ‘commons,’” put forward in Lawrence Lessig, *The Internet Under Seige*, FOR POL’Y (2001); <http://www.lessig.org/content/columns/foreignpolicy1.pdf>.

⁵¹ Robert W. Hahn & Robert E. Litan, *The Myth of Network Neutrality and What We Should Do About It*, 1 INT’L J COMM 595 (2007); <http://ijoc.org/ojs/index.php/ijoc/article/view/161/87>.

⁵² P. Faratin, D. Clark, P. Gilmore, S. Bauer, A. Berger & W. Lehr, *Complexity of Internet Interconnections: Technology, Incentives and Implications for Policy*, Paper for the 35th Telecommunications Policy Research Conference (Sept. 2007).

⁵³ See, generally, Stan J. Liebowitz and Stephen E. Margolis, *Bundles of Joy: The Ubiquity and Efficiency of Bundles in New Technology Markets*, 5 J COMP LAW & ECON 1 (2009).

⁵⁴ Beginning in 1993, AOL undertook “one of the riskiest and most innovative branding campaigns of the digital age – the carpet-bombing of America with free AOL disks. The marketing plan ultimately sent out more than 250 million disks bearing AOL software to the mass market...” Kara Swisher, [AOL.com: How Steve Case Beat bill Gates, Nailed the Netheads, and Made Millions in the War for the Web](#) (New York: Random House; 1998), p. 99.

proprietary content and eliminate “garden walls” confirms the central role of market forces, in the economic view, as opposed to imposed design mechanisms. The communications policy perspective cites the “walled garden” as a danger to innovation. The chasm is seen most sharply in the debate over network neutrality rules. The communications policy approach tends to favor a new layer of Internet-specific regulation,⁵⁵ while the economic view sees vertical restrictions as best governed by existing antitrust law.⁵⁶

The analytical divide extends to the “wireless web.” The communications policy framework characterizes vertical restraints by mobile operators as hostile to innovation by restricting “open architecture.” Under the economic view, however, competition among rival platforms drives innovation, which flourishes as carriers engage in complex network management functions, internalizing complementary efficiencies.

This section attempts to describe the structure of emerging mobile networks. This effort, being a first stab at a moving target, is (at best) just a start. But in outlining the general manner in which markets tend towards modularity, and then applying this pattern to specific institutions developing in mobile markets, a more nuanced understanding of how economic development occurs is possible. Written from the economic perspective described above, it reveals how dynamic competition creates (and destroys) not just products, but modes of organization. The challenge for the policy debate is to square these facts and conclusions with the institutional mechanisms asserted to improve the performance of mobile markets.

B. Modularity and Value Appropriation

Modularity breaks a system into discrete pieces. In markets, modular construction can distribute ownership incentives across a large number of firms coordinated via standardized interfaces. Modularity thus facilitates communication, helping the management of a complex system.⁵⁷ Partitioned pieces, or modules, may be hidden or visible. Where information is encapsulated in the node, the replacement of this so-called hidden module with a superior product does not alter the functioning of the system.⁵⁸ Conversely, a visible module contains design rules that other modules must obey in order to achieve system compatibility.⁵⁹

Modularity simultaneously yields gains from both economies of scale and specialization. When workable interfaces are achievable at low cost, competitive forces are unleashed to create complementary components of a value chain. Modularity eases entry by innovators able to contribute specific inputs in which they exhibit comparative

⁵⁵ Tim Wu, *Network Neutrality, Broadband Discrimination*, 2 J TELECOM & HIGH TECH LAW 141 (2003).

⁵⁶ Alfred E. Kahn, *Network Neutrality*, AEI-Brookings Joint Center for Regulatory Studies Working Paper No. RP07-05 (March 2007); Jonathan Nuechterlein, *Antitrust Oversight of an Antitrust Dispute: An Institutional Perspective on the Net Neutrality Debate*, 7 J TELECOM & HIGH TECH LAW 19 (2009).

⁵⁷ R. N. Langlois, *Modularity in Technology and Organization*, 49 J ECON BEHAVIOR & ORG 19 (2002).

⁵⁸ C.Y. Baldwin & K. Clark, “The option value of modularity in design.” Harvard NOM Research Paper, 02–13 (2002), p. 9.

⁵⁹ Baldwin & Clark (2002), p. 5.

advantage, even when such firms exhibit little or no competence as integrated providers of a larger suite of industry outputs. This does not eliminate the role of organization in creating interfaces and coordinating production. A balancing, between the interests (and returns) of the system architect(s) and those of the satellite (external) suppliers, occurs.

A famous example involves the leadership of IBM in organizing production of the personal computer (PC). This episode is taken to illustrate the possibility of architectural failure, not because the end product was unsuccessful, but because its returns were primarily appropriated by two other contributors, Intel and Microsoft.

As this suggests, there is no categorical path to economic success in the selection of a platform model. IBM, in hindsight, appeared to have crafted too small a module for itself and too many modules for others; in common parlance, the platform was too “open” and IBM was “giving away” the value they were creating. Alternatively, the 1990s collapse in the share price of Apple Computer was widely associated with a decision not to license the Mac OS to other manufacturers of personal computers, retaining a very large and exclusive module for Apple.⁶⁰ This was widely seen as a failure, relative to the overwhelming economic success of Microsoft in pursuing a smaller module focused on operating system software.⁶¹ Farrell & Weiser recall the experience of Palm, a smartphone maker that, learning the lesson of Apple, sought to emulate Microsoft – to its ultimate demise. “Palm lost control of some important aspects of its product deployment,”⁶² and saw its market share fade – losing out most recently, and most ironically, to Apple iPhone.

Innovators must consider the degree to which their economic interest lies in capturing value by vertical integration or by facilitating and nurturing a broader platform. Wealthy maximization governs the choice, but circumstances determine the outcome. Carliss Baldwin and C. Jason Woodward attempt to isolate the key variables.

Outside complementors can be of great value to the system when there is a lot of “option potential” in the complementary modules... Option value is low when consumer tastes are homogeneous and predictable, and designs are on a tightly determined technological trajectory...

Option value is high when consumer tastes are heterogeneous or unpredictable, and technological trajectories are uncertain... Outside complementors will be attracted to the platform if there is option value in the complements, provided the platform owner does not expropriate all the value they create.... [E]ven selfish and fairly myopic platform owners can learn to avoid “overtaxing” their ecosystem members and find a balance

⁶⁰ Jim Carlton, *Apple: The Inside Story of Intrigue, Egomania, and Business Blunders* (New York: Random House; 1997).

⁶¹ Of course, this verdict has changed over time. Apple, surviving its “failure” last century, has emerged with an array of highly profitable proprietary products – including growing sales of its personal computers. This underscores the dynamic nature of business model competition, and the risks inherent in narrowing the scope of market choices.

⁶² Farrell & Weiser (2003), p. 98.

that yields more investment in platforms with higher option value.⁶³

The strategies for appropriating value from options jointly provided are complex, the stuff of which great business fortunes are made. Academic treatments may isolate the key considerations,⁶⁴ but trial and error in the marketplace will produce the outcomes. In practice, pure strategies are all but impossible. The advent of new economic opportunities shifts the efficiency constraints. Platform entrepreneurs are, therefore, constantly attempting to revise structures. The dynamics of creative destruction are such that “the network’s structure and the location of transactions will be ever-changing.”⁶⁵

C. The Mobile Ecology

Cellular networks rely on investment in infrastructure (including base stations and high-capacity backhaul facilities), radio spectrum, and mobile handsets. The evolution of the sector is rapid, exacerbated by its convergence with computing, and involves a high degree of complexity – “including contractors, equipment manufacturers, consumer electronics, platforms, enablers, content aggregators, retailers, network operators and service providers.”⁶⁶

The vertical structure of carriers has been migrating towards greater modularity over time, a trend now decades old. In the earliest (pre-cellular) days of mobile telephony, carriers were highly integrated. They purchased infrastructure and customer equipment from designated vendors, installing network capital and then reselling the mobile radios to subscribers. With the emergence of cellular systems in the 1980s, vertical disintegration set in, and continues through the current migration to 3G and 4G technologies. See Figure 1. This pattern mimics that seen in other markets, such as the computer industry.⁶⁷ While the general formulation is that greater modularity over time is the standard industry pattern,⁶⁸ the reverse trend has also been observed.⁶⁹

Four aspects of industry structure are immediately of interest. First, the modules

⁶³ Carliss Baldwin & C. Jason Woodward, *The Architecture of Platforms: A Unified View*, HBS Working Paper 09-234 (2008), pp. 18-19 (references omitted).

⁶⁴ Joachim Henkel & Carliss Y. Baldwin, *Modularity for Value Appropriation: Drawing the Boundaries of Intellectual Property* (2009).

⁶⁵ Carliss Baldwin, *Modularity, Transactions, and the Boundary of Firms: A Synthesis*, HBS Working Paper 08-013 (2007), p. 49.

⁶⁶ Dan Steinbock, *The Mobile Revolution: The Making of Mobile Services Worldwide* (London: Kogan Page; 2007), p. 13.

⁶⁷ “The computer industry used to be vertically aligned. ... [A] company developed its own chips, its own hardware and its own software, sold and serviced by its own people... Over time, a new horizontal industry emerged. ... A consumer could pick a chip from [one vendor], choose an operating system [from another], grab one of several ready-to-use applications off the shelf ... “ Andrew Grove, *Only the Paranoid Survive* (New York: Doubleday; 1996); pp. 39–42 (quoted in: Baldwin & Woodward 2008; p. 15).

⁶⁸ Timothy F. Bresnahan & Shane Greenstein, *Technological Competition and the Structure of the Computer Industry*, 47 JIND ECON 1 (March 1999).

⁶⁹ “[T]he bicycle drive train industry became more concentrated and vertically integrated following Shimano’s successful introduction of a highly integral (non-modular) product, the Shimano Index System (SIS).” Baldwin & Woodward (2008), p. 16.

that have materialized have assisted the exploitation of global economies of scale in the production of technology, chips, devices, applications, and infrastructure. Hence, chopping the vertical supply chain more finely may result in the increasing dominance of large players. Second, the basic platform – including module boundaries and the links connecting modules -- continues to be coordinated by wireless carriers. Many if not most of the independently supplied contributions enter the production process via actions taken by the network operator. Third, the cellular platform has now evolved into a ‘platform of platforms.’ Complementors to the network, including cell-phone operating system software developers and handset manufacturers, have in turn created their own platforms. These incorporate the work of independent firms; in the case of smartphones, such as RIM’s Blackberry, Apple’s iPhone, or Google’s gPhone, a large part of the competitive effort involves investment in an ecosystem that will attract enterprising applications.

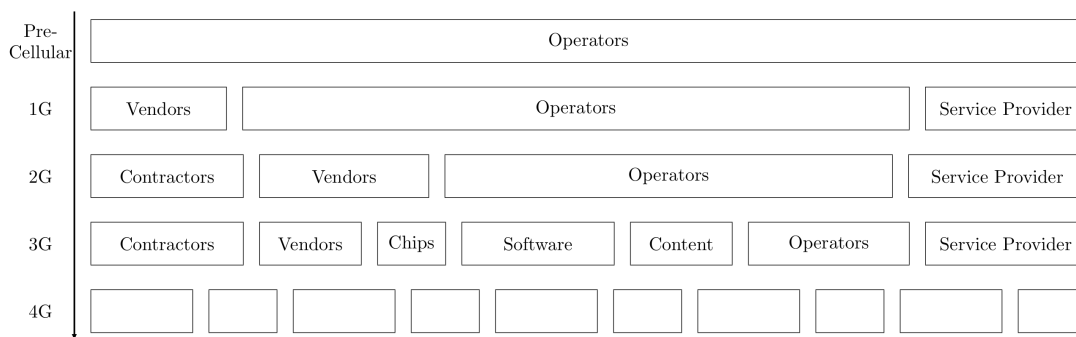


FIG. 1. THE VERTICAL EVOLUTION OF MOBILE NETWORKS⁷⁰

Fourth, “openness” may be increasing or decreasing even as the number of independent firms in the supply chain rises. That is because the terms on which these firms collaborate are constrained, explicitly through contract or implicitly through industry standards or other measures, by platform organizers. The modularization path is multi-dimensional:

The leading cell phone vendors... first... embraced a business model styled after the PC market. Several vendors — including Nokia and Motorola — banded together to create Symbian, a shared operating system that they were all to use. Palm licensed its operating system to a spinout company, PalmSource, and it was adopted by several major vendors including Sony and Samsung. Microsoft focused on licensing its Windows CE operating system to as many companies as possible...

But recently the handset vendors’ OS strategies have become more proprietary. Nokia runs a proprietary software layer, called S60, on top of its Symbian based phones. SonyEricsson runs an incompatible layer called UIQ on its Symbian devices. Palm now has regained rights to its OS, and can make proprietary changes to it. Motorola is a Microsoft and Symbian

⁷⁰ Diagram adapted from Steinbock (2007), p. 13.

licensee, but is investing heavily in its own version of Linux. As of early 2007, the mobile phone market appears to be headed toward a situation where the leading vendors will each have their own incompatible operating software.⁷¹

Observing evolving international markets, Dan Steinbock notes that, “In the past, a single national telecom operator used to dominate the entire mobile value system. Today, the system is specialized and globalized across business and geographic segments.”⁷² Firms iterate across business models, searching for the profit optimum. This discovery process leads to constant exploration and adjustment. The fact that wireless networks are trending in the same general direction suggests that efficiency is driving the migration.⁷³

D. Blackberry

Smartphone competitors are often defined by their operating systems. Based on web usage of devices in March 2009, U.S. market shares are defined as in Figure 2.

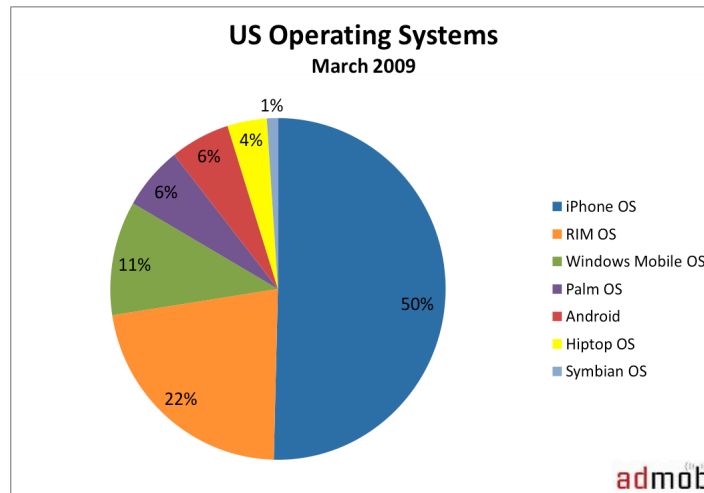


FIGURE 2. U.S. SMARTPHONE COMPETITION BY OS WEB USAGE⁷⁴

The leading OS belongs to iPhone, despite having launched service as recently as late June 2007. In the second position is RIM, maker of the Blackberry family of devices and widely credited with establishing the smartphone category. Originally developed in

⁷¹ West & Mace (2007), pp. 16-17.

⁷² Steinbock (2007), p. 13.

⁷³ Of course, many interesting differences are observed in the mobile markets of, say, Tokyo, Seoul, New York, London, Guatemala City, and New Delhi. In some instances, institutional differences (say, regulatory innovations) or cultural distinctions (say, strong demand for games to play during two hour daily work commutes) will be identified as drivers of these variations. Yet, it seems clear that such cross sectional factors will not eliminate the strong modularization observed across all systems. That is the rebuttable presumption in concluding that economic efficiency is the driver of changing industry structure.

⁷⁴ AdMob Mobile Metrics Report (March 2009), p. 3. Usage is recorded in ad responses, called “requests.” While the number of devices sold influences usage, the market shares recorded here directly reflect data traffic.

the late 1990s as a mobile email client for enterprise employees, handset functionality expanded to include voice and web surfing. The Blackberry has proven to be very popular among web-dependent professionals – a 2003 outage in the Blackberry email network “was especially unwelcome on Wall Street, where the devices have become practically ubiquitous”⁷⁵ – that the term “Crackberry” (coined by Andy Grove, co-founder of Intel⁷⁶) is commonly used to describe dedicated subscribers, including the President of the United States, rumored to be “an addict.”⁷⁷

RIM pioneered cellular data applications as early as 1990. By 1997 it had developed an innovative two-way paging service in the U.S. using a narrowband data network, Mobitex, owned and operated by BellSouth.⁷⁸ The application delivered emails through a corporate server, synced mobile devices with desktops, and prevented missed communications by pushing messages to users in real-time. The Inter@active pager sold for \$249, and subscribers paid \$25 per month for service.⁷⁹ Mobile network access was supplied via a wholesale contract for use of the Mobitex network by BellSouth.⁸⁰ Service coverage was expanded by subsequent deals with Motient (Datatrac), Nextel (iDEN), and numerous GSM providers (using GPRS).⁸¹ The Blackberry was introduced in 1999. By 2002, the Blackberry 5810 delivered voice calls as well as data services, becoming RIM’s first smartphone.⁸² By 2008, the firm served some 21 million subscribers⁸³ and had a market capitalization of about \$40 billion.

Network access solutions have now migrated to 3G technologies, with RIM contracting with wireless carriers. These operators supply mobile access service to RIM’s customers. RIM overlays its data services on these networks, providing software for enterprise servers and maintaining its own network operations center. Most sales are generated by selling wireless handsets to carriers, who resell them to end users. Subscribers are then billed by the carrier, which shares revenues with RIM.

In addition, RIM mobile solutions services are sold directly to enterprises (such as IBM) by RIM and supplied to resellers (such as Vaultus) which then market them to

⁷⁵ Ian Fried, *Outage Leaves Blackberry Users in Dark*, CNET NEWS.COM (Feb. 14, 2003).

⁷⁶ Sofy Carayannopoulos, *Research in Motion: A Small Firm Commercializing a New Technology*, ENTREPRENEURSHIP: THEORY AND PRACTICE (March 2005), p. 225.

⁷⁷ Kermit Pattison, *What Obama’s Blackberry Addiction Says About His Brain*, FAST COMPANY (Nov. 26, 2008); <http://www.fastcompany.com/articles/2008/11/blackberry-addiction-and-obama-brain.html>.

⁷⁸ Sofy Carayannopoulos, *Research in Motion: A Small Firm Commercializing a New Technology*, ENTREPRENEURSHIP: THEORY AND PRACTICE (March 2005).

⁷⁹ Jeff Danielson, *Wireless Security: Research in Motion*, SANS INSTITUTE INFOSEC READING ROOM (Feb. 18, 2002); http://www.sans.org/reading_room/whitepapers/pda/wireless_security_blackberry_by_research_in_motion_258.

⁸⁰ Carayannopoulos (2005), pp. 223-4.

⁸¹ *Research in Motion*, FUNDING UNIVERSE; <http://www.fundinguniverse.com/company-histories/Research-in-Motion-Ltd-Company-History.html>.

⁸² Joel West & Michael Mace, *Entering a Mature Industry Through Innovation: Apple’s iPhone Strategy*, paper delivered to the Druid Summer Conference on Appropriability, Proximity, Routines and Innovation, Copenhagen, CBS, Denmark (June 18-20, 2007); <http://www2.druid.dk/conferences/viewpaper.php?id=1675&cf=9>.

⁸³ http://www.rim.com/investors/pdf/Q3F09_MDA_FS_PR.pdf.

enterprise customers. The company has also partnered with companies such as AOL, building AOL's Instant Messenger service into Blackberrys. Soon after the terrorist attacks on the United States on Sept. 11, 2001, every member of the U.S. House of Representatives was given a Blackberry. In April 2002, RIM made its mobile operating system and hardware designs available for licensing by other equipment makers in response to competitive moves taken by the makers of personal digital assistants (PDAs), as smartphones were then called.⁸⁴

The network is proprietary in a number of key respects. Only Blackberry devices can access RIM's data services. RIM controls and manages device applications, and the operating system used employs software owned exclusively by RIM. RIM exclusively uses the OS in its devices and licenses the software to other vendors. This model proved competitive:

[By] 2007, the most successful converged phones in terms of actual data usage in the US and Europe are the e-mail devices, led by the RIM Blackberry. The Blackberry's basic screen and keyboard layout has been copied by a wide range of competitors, including the Palm Treo, Nokia E-series, Motorola Q, and Samsung Blackjack.⁸⁵

In April 2008, RIM responded to competition from another direction, mimicking iPhone's App Store by opening Blackberry App World. Software developers like Amazon, popular on the iPhone, rushed to sign-up.⁸⁶ RIM manages the applications, but has expanded the platform to more easily integrate third party developers.

E. iPhone

The launch of the iPhone was, by industry consensus, a disruptive innovation.⁸⁷ Eager consumers lined up to buy the high-priced (\$599 for the most popular model, plus a two-year contract on the AT&T network) device. It took just 74 days for Apple to sell one million iPhones,⁸⁸ and less than two years to sell 21 million worldwide.⁸⁹ The iPhone was introduced on a proprietary platform, controlled by Apple and barring third party software, with service offered via an exclusive service agreement with AT&T. In 2008, Apple opened an App Store, creating a platform for independent applications, each approved by Apple and subject to a fee equal to 30% of revenues.

Apple's wireless foray yields benefits directly related to the structure of its platform. By using its proprietary mobile operating system, a modified version of its

⁸⁴ FUNDING UNIVERSE, op cit.

⁸⁵ West & Mace (2007), p. 14.

⁸⁶ *Amazon Seeks to Bear Fruit with a New Blackberry Application*, INTERNET RETAILER (May 2007); <http://www.internetretailer.com/article.asp?id=30277>.

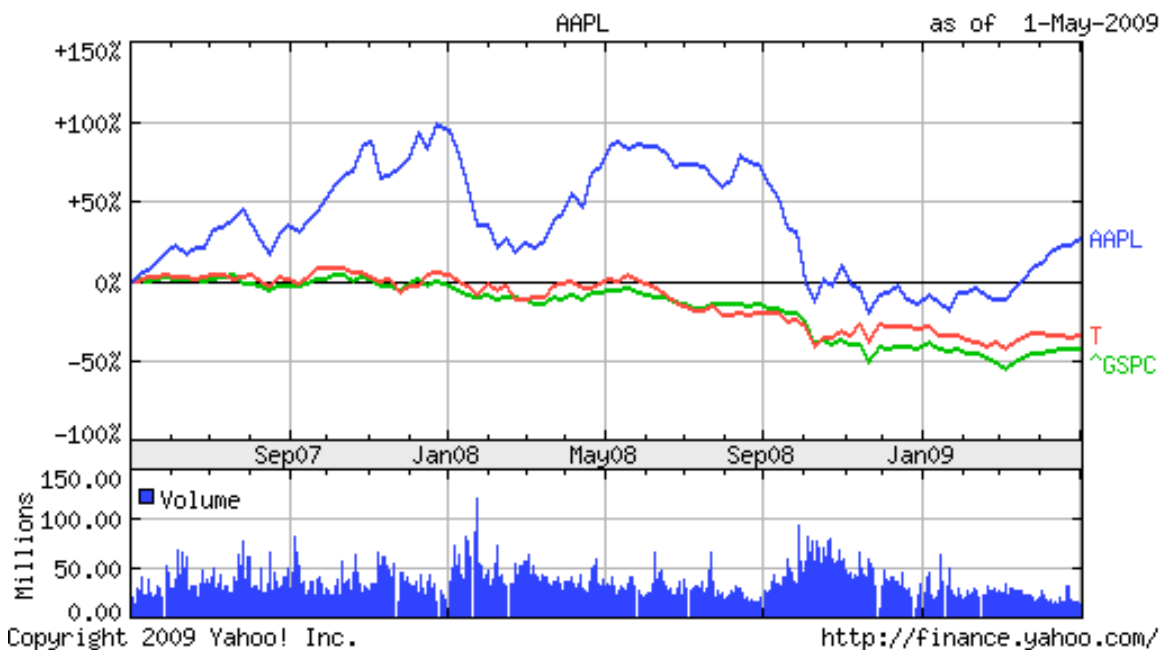
⁸⁷ See, e.g., Om Malik, *5 Ways that iPhone Will Change the Wireless Biz*, GIGA OM (June 12, 2007); <http://gigaom.com/2007/06/12/5-ways-iphone-will-change-the-wireless-biz/>.

⁸⁸ <http://www.apple.com/pr/library/2007/09/10iphone.html>.

⁸⁹ M.G. Siegler, *The State of the iPhone is Strong -- Very Strong*, TECH CRUNCH (April 23, 2009); <http://www.techcrunch.com/2009/04/23/the-state-of-the-iphone-is-strong-very-strong/>.

desktop OS, it offers a desirable product for iPhone users. It also enables this new wireless applications entrant (i.e., Apple) to appropriate the gains from competitive superiority in product design. By filtering applications through the Apple App Store, it both protects its brand and delivers a customer experience that increases demand. And by coordinating the interface both technically and financially, it helps independent developers market and bill for their products while extracting its share of value. Despite the vertical control imposed by the platform owners, software firms have reacted enthusiastically.⁹⁰

The evident market success of this approach suggests underlying efficiencies. Not only has Apple produced strong profit growth in a deep recession,⁹¹ it has triggered a bidding war among cellular carriers to obtain partnership rights. AT&T paid generously to outbid rivals. To the extent that Apple's innovation at the edge is consumer-pleasing, the flow of payments will encourage further edge innovators. By examining share price returns for AT&T and Apple, analysts have come to the conclusion that the iPhone, announced in early 2007, is responsible for a rise in firm capitalization of at least \$25 billion. Alternatively, the effect on AT&T's share price is undetectable. This flows from the observation, seen in Figure 3, that Apple's equity return in the two years from May 1, 2007 was about 25%, during which time the S&P 500 Index fell 40%. Attributing the entire abnormal Apple return to the iPhone – given Apple's \$131 billion market cap as of May 1, 2009 -- would imply an iPhone valuation of over \$65 billion. Over the same interval, AT&T's share returns were roughly equal to the S&P 500.



⁹⁰ Peter Burrows, *The Apple App Monster*, BUS WK (Jan. 15, 2009).

⁹¹ “Of the major companies that announced their earnings yesterday, two of them, AT&T and Apple, beat Wall Street estimates largely thanks to a single product: The iPhone. We’re approaching the two year birthday of the device, and it still remains one of the hottest items out there. Ladies and gentleman, the state of the iPhone is strong.” Siegler (2009). See also, Christian Zibreg, *Apple’s iPhone3G Saves AT&T From Recession*, TG DAILY (Jan. 29, 2009); <http://www.tgdaily.com/content/view/41239/118/>.

FIG. 3. APPLE AND APPLE SHARE PRICES, WITH S&P 500 (5.1.07 – 5.1.09)

Apple’s “closed” applications store, already featuring 37,000 products, generating over \$1 million per day in revenues and having hosted over one billion downloads in its first year of operation,⁹² helps drive these returns. Developers must submit their products to Apple for approval, with the carrier exercising its judgment in accepting or rejecting software. According to one description, Apple is looking to exclude “porn, privacy-breaching tools, bandwidth-hogging apps, and anything illegal,”⁹³ although applications that compete with (duplicate) Apple’s products are also reportedly targeted. Protecting the platform from offensive content and uses that produce negative externalities serves clear efficiency goals, while reducing competition is potentially harmful to consumer interests. Yet, there is a market constraint. If it is damaging, it presents a competitive opportunity for rival platform providers to supply superior, less (or better) filtered access.

Competitive responses are triggered by Apple’s profitability. In any event, rival platforms using diverse models are providing alternative content choices. Rivals are adopting filtering policies of their own, guiding usage towards approved content and imposing certain restrictions, default software applications, and fees. The presence of competitive rivals, the relative success of Apple, and the widespread adoption of their basic business model by entrants presumed not to enjoy market power suggest that iPhone innovation is pro-competitive.

F. gPhone

It was a pretty exciting year for the mobile phone industry in 2008.. [T]he iPhone 3G was released [and] almost every major manufacturer called up their technicians and asked them to come up with the iPhone killer... [A] better alternative to the iPhone which is sweeping the mobile phone market. And so... we’ve witnessed how the industry went gaga in anticipation of... the Blackberry Bold, Sony Ericsson Xperia X1, Samsung Omnia, and of course the much awaited Google-powered HTC-manufactured mobile phone – the G1.⁹⁴

The gPhone’s architect, Google, offers the associated Android operating system as an “open platform.”⁹⁵ It is a module that complements the search engine and online advertisement services that Google currently dominates. “If the only thing Android achieves... is getting more people to spend more time online, then Google still profits.

⁹² Christian Zibreg, *App Store now \$1 million a day business, cloud mobile apps the next big thing*, GEEK.COM (April 24, 2009); <http://www.geek.com/articles/mobile/analysis-app-store-now-1-million-a-day-business-cloud-mobile-apps-the-next-big-thing-20090424/>.

⁹³ Timothy Lee, *Apple’s Walled Garden Will Hurt iPhone Innovation*, TECH DIRT (March 7, 2008); <http://www.techdirt.com/blog.php?tag=walled+gardens>

⁹⁴

⁹⁵ Open Handset Alliance, *Industry Leaders Announce Open Platform for Mobile Devices*, Press Release (2007); http://www.google.com/intl/en/press/pressrel/20071105_mobile_open.html.

More users mean more people viewing pages with Google ads.⁹⁶ Google's share of mobile search traffic was (in March 2009) 97.5%.⁹⁷ Hence, Google stands to capture significant returns to the degree that it maintains high market share in the ancillary application.

Android⁹⁸ contains a proprietary core that can be understood as a hidden module. Android is licensed, without charge, to handset makers. Licenses are available to members of the Open Handset Alliance (OHS), a confederation of firms including Intel, Motorola, Samsung, Qualcomm, Texas Instruments, HTC, Sprint, T-Mobile, and DoCoMo. "Apple's device was an end in itself... Google was never in the hardware business. There would be no iPhone — instead, there would be hundreds of iPhones."⁹⁹ This potentially leaves substantial opportunities for complementors. On the other hand, the Android Application Developer Distribution Agreement mandates a 30% fee (levied on gross sales) from the third-party applications.¹⁰⁰ The Android Market, operated by Google, sells unscreened applications in contrast to Apple Apps certification. By early 2009, a controversy had arisen over suspected malware being posted for download.¹⁰¹

Google's organizational role gives it leverage in Android. Despite the open-source framework, Google products are included as default applications. A tension has arisen that appears to account for the fact that only one handset has been introduced since the Nov. 2007 formation of the OHS. While Samsung has announced that it will be introducing two models in late 2009, it recently revealed that it "drew a distinction between devices built on the Android platform and 'Google Experience' devices, which not only use Android but are also Google-centric, packed with the search giant's own applications."¹⁰²

It is useful to contrast the strategies of Google, Apple, and RIM within the lens of modularity. Google has arguably implemented the greatest degree of vertical disintegration, followed by Apple and RIM, respectively. The diverse strategies reflect their differing economic positions; namely, Google's dominance in the application space

⁹⁶ Daniel Roth, *Google's Open Source Android OS Will Free the Wireless Web*, WIRED (June 23, 2008); http://www.wired.com/techbiz/media/magazine/16-07/ff_android.

⁹⁷ <http://marketshare.hitslink.com/mobile-phones.aspx?qprid=57&sample=32>.

⁹⁸ Android is a mobile OS acquired by Google in 2005 for possibly as much as \$50 million. Developer Andy Rubin is now Google's director of mobile platforms. Android is announced to be a "open platform" as it is distributed for free of charge, its source code is disclosed to the public, and is subject to any modification "as long as the hidden Android DNA is there underneath." Roth (2008).

⁹⁹ Roth (2008).

¹⁰⁰ *Android Market Developer Distribution Agreement* (2009); <http://www.android.com/us/developer-distribution-agreement.html>; *Android Market Help on Transaction Fees* (2009); <http://market.android.com/support/bin/answer.py?answer=112622>.

¹⁰¹ "Android's Market is built on an open model that allows any developers to post any application. That approach can be advantageous in that developers don't have to go through corporate gatekeepers to get their software in customers' hands. By contrast, Apple vets every single iPhone/iPod Touch application before allowing it into its iTunes App Store, a process that can take weeks and prevents certain types of software from appearing at all." Priya Ganapati, *'Rogue' Googlephone App Raises Questions About Android's Open Policy*, WIRED (Jan. 16, 2009).

¹⁰² Elizabeth Woyke, *Samsung's Android Phone Plans*, FORBES (April 2, 2009).

drives it to share more of the platform while leaving handset manufacturing “to the price system.” In addition to lacking such complementary revenue streams, both RIM and Apple have exhibited comparative advantages (core competencies) in innovative handset design and manufacturing, thereby producing iconic devices that other vendors have striven to emulate. Google, with no such capital, loses less by relying on third party providers. Indeed, by supplying only the operating system and not the basic physical platform, Google’s 30% application revenue share may be characterized as an aggressive pricing policy potentially in conflict with the claim of “openness.”

The first Android phone debuted in Oct. 2008. The G1, produced by HTC, operates on the T-Mobile wireless network through an arrangement provided for by terms of the OHS. It includes a Google search button. Reviews have been mostly positive but, as with the iPhone, complaints have been made. *Wired* entitled its article: “T-Mobile's G1 Android Phone: Neither Open nor Exciting.”¹⁰³

Eagerly anticipated... as an open-source alternative to more locked-down handsets... the phone is a bit of a letdown... In terms of its styling and design, G1 does not break new ground. It is thicker and heavier than the Apple's iPhone and lacks some iPhone's features, including video playback... Regular headphones won't work... The G1 is not as "open" as expected, either: Like Apple, T-Mobile will be restricting VoIP.

The G1 has sold well, with a million T-Mobile customers purchasing the devices between its launch in October 2008 and late April 2009.¹⁰⁴ This was a much slower rate of adoption than seen for the iPhone, where one million phones were sold in just 74 days, but a respectable start for the wireless entrant. Some analysts argue that, because G1 users are using their devices for more intensive web browsing, the gPhone start rivals the iPhone start in terms of usage market share.¹⁰⁵ There are also many differences that impact unit sales. At \$179, the G1 is priced far below the (8 MB) iPhone, which was introduced with a \$599 price tag (\$499 for the 4 MB model). Obviously, the T-Mobile network is different than AT&T's; the latter has more spectral capacity, but the ongoing T-Mobile 3G upgrade puts its available speed and coverage close to where the AT&T system was in mid-2007.

G. Summary

Mobile markets are evolving in competitiveness and structure. The production chain reveals a pronounced increase in modularity, driven by technological developments and global economic efficiencies. Greater specialization in the component parts of the service pack are now being captured by the construction of low-cost interfaces that

¹⁰³ Priya Ganapati, *T-Mobile's G1 Android Phone: Neither Open nor Exciting*, WIRED (Sept. 23, 2008); <http://blog.wired.com/gadgets/2008/09/g1-android-phon.html>.

¹⁰⁴ *T-Mobile G1 Android Phone Hits 1 Million*, ZIMBIO.COM (April 24, 2009).

¹⁰⁵ Seth H. Weintraub, *Google's Android's Market Share Compares Well with Apple's iPhone*, COMPUTER WORLD (May 2, 2009); http://blogs.computerworld.com/android_iphone_apple_google_market_share_web_share_safari_chrome.

enable new forms of coordination. This definitional shift to “openness” signals a spontaneous vertical disintegration.

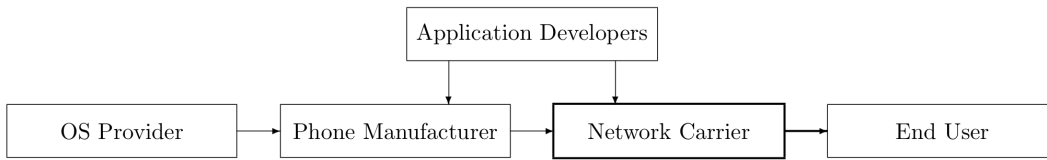


FIG. 4. EARLY STRUCTURE OF THE U.S. CELLULAR INDUSTRY

The early cellular marketplace can be characterized as in Figure 4. Carriers played the central role in organizing spectrum assets, investing and operating network infrastructure, selecting and purchasing handsets, and maintaining customer relationships with end users. Third party developers and technology suppliers could access the production chain through such parties as equipment vendors, but all product developments were monitored by carriers.

As suggested above, in Figure 2, the trend has been strongly towards increased modularity. This structural reformulation is now being driven by smartphone entrants such as Apple and Google, firms possessing no wireless assets. Innovations are accessing the mobile market via unregulated contracts with carriers. Yet, the manner in which industry rents seem to be shifting in favor of such outside innovators – complementors of wireless networks – suggests that, if market power is in evidence, it is generated not by virtue of incumbency in telecommunications network services, but by competitive superiority in the creation of mobile solutions.

This, in turn, suggests market rivalry consistent with Schumpeter’s creative destruction. Entrepreneurial firms are exploiting what they create. Fundamental to this process is competition among organizational forms. As portrayed in Figure 5, which characterizes the Apple iPhone platform, the radio maker moves to a central position in the mobile services production chain. The handset here embeds a more elaborate and complex array of applications, and operates within an expanding ecosystem designed to capture new options over time. This platform augments the carrier’s network, but is owned and managed by Apple, which auctions its affiliation to the highest bidder. This limits the subscriber base of iPhones, and may in the future be abandoned in favor of RIM’s all-carrier model. But it has thus far realized high returns.

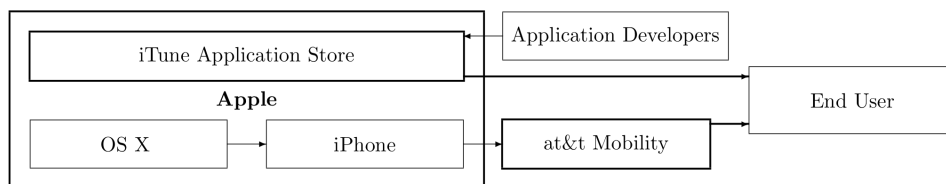


FIG. 5. STYLIZED REPRESENTATION OF APPLE IPHONE’S STRUCTURAL FORM

Google’s mobile platform may be even more ambitious than Apple’s. See Figure 6. Google supplies the mobile operating system, as well as an applications approval

process. It extracts the same fee as in the Apple Apps store – 30% -- but provides no smartphone. It licenses the Android OS to device makers, according to standards laid out by the Open Handset Alliance. This “opens” the structure to the creation of many more modules, and is designed to elicit wide, global support for the platform. Google appropriates value via a share of gross applications revenues, and by driving additional traffic to Google applications, particularly Google Search.

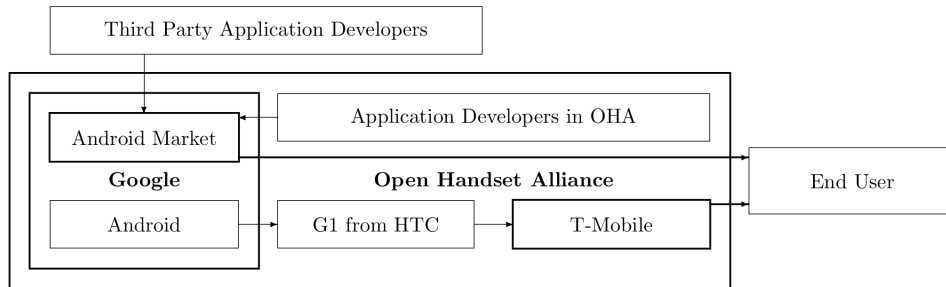


FIG. 6. STYLIZED REPRESENTATION OF ANDROID’S STRUCTURAL FORM

No platform maintains an unambiguously “open” opportunity for third party developers to prosper by providing competitively superior options to customers. Each ecosystem is shaped to provide aggregate growth and capture benefits for the platform developer. This involves a balancing of incentives for both the core investor and the myriad complementors enlisted to cooperate.

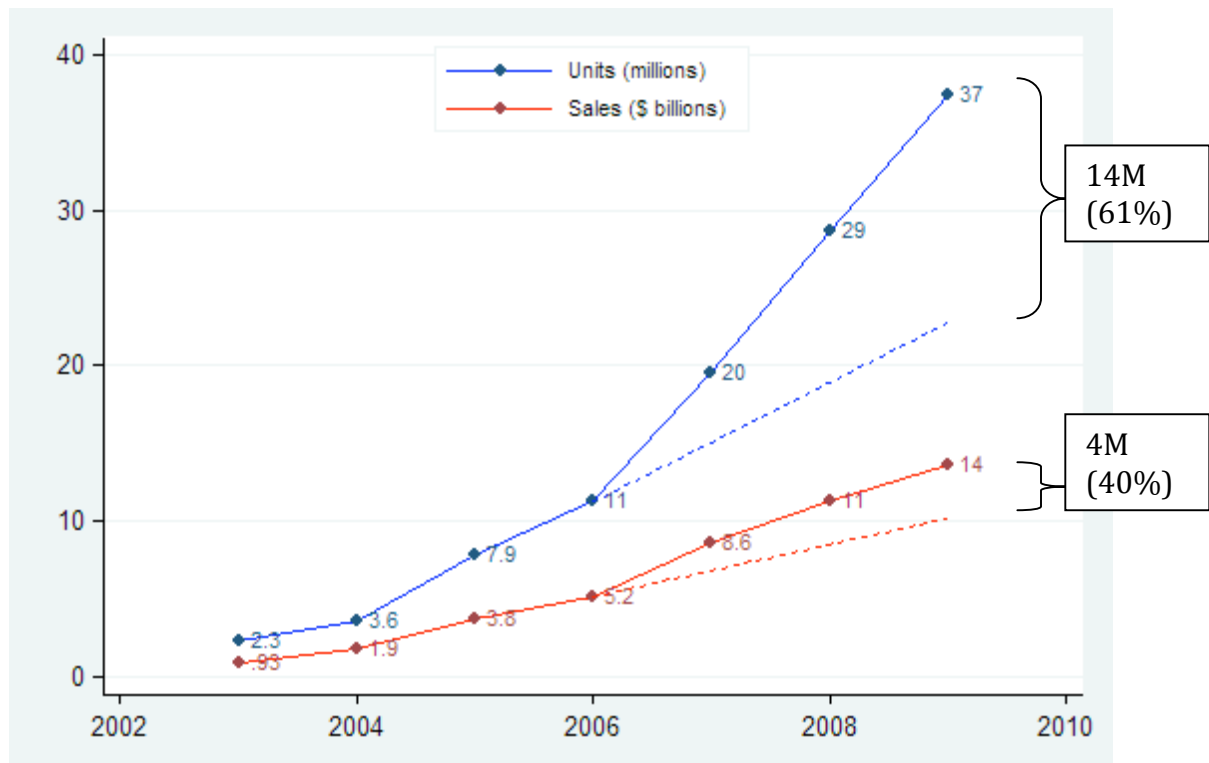


FIG. 7. U.S. SMARTPHONE UNIT SALES AND REVENUES, 2003-09

The macro-level indicators are that the process of innovation is robust in the rivalry witnessed between such products as Blackberry, iPhone and the gPhone. Take, for instance, the notable uptick in smartphone sales in the U.S. since the advent of the iPhone in mid-2007. Were vertical foreclosure to restrict output in the market, it would be reflected in output restriction. A simple test examines the pattern of sales over the 2003-2009 period (via data supplied by the Consumer Electronics Association, tracking smartphone sales since 2003 and providing a 2009 year-end forecast). Despite the beginning of a severe recession in Dec. 2007, smartphone sales demonstrate an upward deviation from trend in 2007-09. See Figure 7. Under a conservative forecast (2004-06 linear trend), the year-end increase in smartphone sales is estimated to total some 14 million units, or an increase over 61% from trend. Output-restriction does not appear to have accompanied the iPhone innovation.

V. DoCoMo i-mode's "Walled Garden"

Data adoption in Finland is growing slowly, but still lags far behind other countries... The main reason for this has probably been the lack of services. Finland [just began to permit] 3G focused bundling, in contrast for instance with Japan, where so called *strong bundling* is prevailing. Strong bundling means that a mobile operator has full control of both handset and service markets.¹⁰⁶

The organization of NTT's DoCoMo, the leading cellular carrier in Japan, displays a structure that looks like the early U.S. cellular market. While executing extensive platform control, DoCoMo has long offered the innovative i-mode service to develop a robust, cutting-edge mobile ecosystem."

The pioneering wireless data system first brought web access to customers in February 1999, before cellular systems were engineered for broadband (3G) applications. NTT DoCoMo¹⁰⁷ launched i-mode as "the first packet-based, always-on, mobile Internet service available anywhere in the world."¹⁰⁸ "Official" i-mode vendors are featured on the phone's menu, enabling customers to easily access their content. Billing is handled exclusively through DoCoMo, which lists transactions on subscribers' monthly statements, and charges content providers nine percent of revenues for the service. DoCoMo also allows "unofficial sites" to be accessed by i-mode users, but such vendors suffer a severe competitive disadvantage.

¹⁰⁶ Marko Repo, *Regulation of Wireless Stakeholders*, Seminar on Networking Business, Helsinki Univ. of Tech (Oct. 2006), p. 3; http://www.netlab.tkk.fi/opetus/s383042/2006/papers_pdf/B2.pdf (emphasis original). Note that Finnish carriers were permitted to bundle handsets with service as of April 2006.

¹⁰⁷ Originally NTT Mobile Communications Network. Renamed NTT DoCoMo in April 2000.

¹⁰⁸ John Ratliff, *DoCoMo as National Champion: I-Mode, W-CDMA and NTT's Role as Japan's Pilot Organization in Global Telecommunications* (Santa Clara, California: Santa Clara University, 2000), p. 12.

DoCoMo erected a “walled garden” which, critics charged, limited customer choice.¹⁰⁹ Yet, i-mode created an innovative hot-house for content. By enabling a platform that encompasses pricing limits and vertical restraints (including payments to the ISP and exclusion for non-compliance with operator-set specifications), content providers have been given more productive opportunities.

At the heart of all this is a paradox: i-mode depends on outside providers for everything from handsets to content, yet it's managed so carefully that nothing is left to chance. Critics see a walled garden, more mobile mall than wireless Web. But in fact, i-mode's success comes less from being walled than from being obsessively tended.¹¹⁰

I-mode has proven exceptionally popular with third party applications developers. Katsumoto Robert Hori, CEO of Cybird, has 23 sites connected to i-mode. “For a company like us,” Hori said, “the i-mode environment has proven very profitable.”¹¹¹ The result has been a steady stream of content innovation.¹¹² DoCoMo’s vertical control has favored certain technologies, formats, or business models. The carrier decided, e.g., to support Linux and Symbian software for i-mode applications, but to exclude Microsoft.¹¹³ Customer acceptance was so pronounced that DoCoMo became Japan’s leading ISP, fixed or mobile. By March 2007, it served 52.6 million cell phone subscribers, of which 47.6 million bought i-mode services.¹¹⁴ This success prompted Japan’s other wireless networks, KDDI and Softbank,¹¹⁵ to each offer competing platform. DoCoMo responded by extending its proprietary platform into e-commerce.¹¹⁶ The upshot is that Japan is noted as the leading wireless data services market globally. See Figure 8.

¹⁰⁹ As reported by Frank Rose, *Pocket Monster*, WIRED (Sept. 2001).

¹¹⁰ *Ibid.*

¹¹¹ *Ibid.*

¹¹² Jack Qiu, *NTT DoCoMo: Review of a Case*, JAPAN MEDIA REVIEW (Oct. 2004); <http://www.ojr.org/japan/research/1097446811.php>.

¹¹³ *Microsoft Excluded from DoCoMo's Ecosystem*, THE REGISTER (Nov. 26, 2004); http://www.theregister.co.uk/2004/11/26/microsoft_excluded_from_docomo/.

¹¹⁴ NTTDoCoMo, <http://www.nttdocomo.co.jp/english/corporate/ir/finance/annual/>.

¹¹⁵ Softbank acquired the assets of Vodafone Japan in 2006. Vodafone purchased J-Phone in 2001.

¹¹⁶ See, e.g., Dan Einhorn, *DoCoMo's "New Business Model"*, BUS WK (April 19, 2004); John Boyd, *Here Comes the Wallet Phone*, IEEE SPECTRUM (Nov. 2005). DoCoMo also created the Mobile Society Research Institute to study how users interact with their mobile phones and to invent applications for making the phones more useful. Stephen McClelland, *Japan: A Future Mobile Society?* TELECOMS MAG (June 7, 2005).

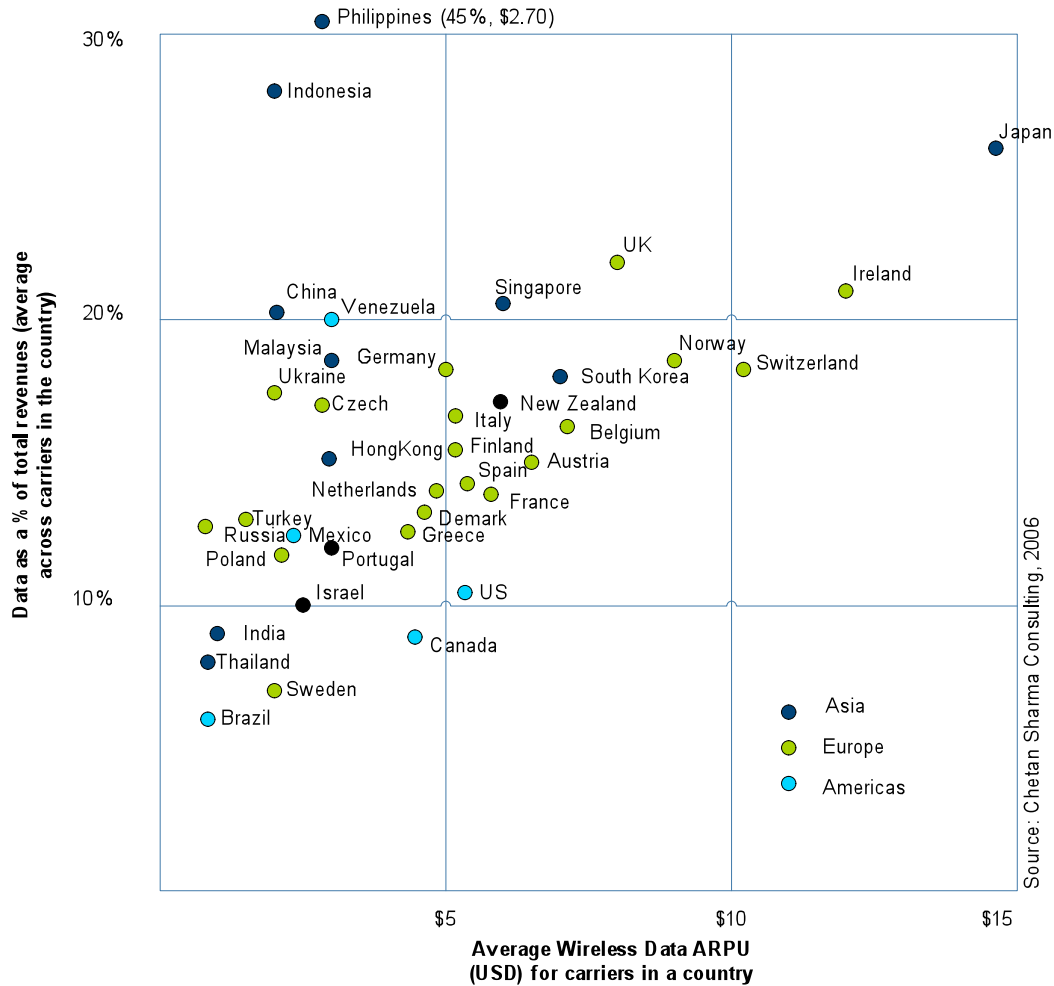


FIG. 8. JAPAN LEADS WIRELESS DATA USAGE (2005 DATA)¹¹⁷

VI. Dynamic Efficiency and Vertical Foreclosure

Recall the premise of Prof. Wu’s call for vertical regulation of mobile networks:

The industry should re-evaluate its “walled garden” approach to application development, and work together to create clear and unified standards for developers. Application development for mobile services is stalled, and it is in the carriers’ own interest to try and improve the development environment.¹¹⁸

The methodology implicit in this passage – not public policy analysis but management consultancy, explaining to wireless carriers what is in their “own interest” – guides the analysis. What Wu sees as anti-consumer – “walled gardens” that manage, to

¹¹⁷ www.chetansharma.com/Worldwide%20Wireless%20Data%20Trends.doc.

¹¹⁸ Ibid.

one degree or another, product menus – are core elements of systems dynamically adjusting to new opportunities and forcing competitive rivalry between integrated platforms. Vertical restraints yield coordinating mechanisms that permit networks to evolve, producing innovation embraced by consumers.

Prof. Wu found Apple iPhone, launched in mid-2007, to be “iPhony.”¹¹⁹ The complaint was directed not at the product but the business model: “If Apple wanted to be ‘revolutionary,’ it would sell an unlocked version of the iPhone that, like a computer, you could bring to the carrier of your choice.”¹²⁰ Apple’s exclusive deal departed from industry practice, but secured higher returns per phone sold, including a unique premium in the form of a share of subscription revenues for iPhone users paid to AT&T.¹²¹ By itself, the exaction moved industry rents away from carriers and towards edge innovators. While Wu asserts that this economic dynamic is central to network development he objects to its realization in the market.

The network edge is a complement to the network core, and the Apple iPhone appears to have fortified competitive forces there as well. Apple’s exclusive drove AT&T to invest aggressively in its wireless network in June 2007 (at iPhone launch), boosting its 2.5 G speeds.¹²² The carrier then rapidly upgraded its system to full 3G capability in time for the iPhone3G launch in June 2008,¹²³ and then to further jump broadband speeds in deploying a Next Generation Network.¹²⁴ This move was part and parcel of an aggressive network improvement project driven in large measure by the demands of Apple and its iPhone customers. The wireless carrier appears to be succeeding in garnering market share,¹²⁵ while a competition between AT&T and rival carrier Verizon appears in play (Apple’s exclusive agreement with AT&T Mobility ends in 2010).¹²⁶

¹¹⁹ Tim Wu, *iPhony - Why Apple’s New Cell Phone Isn’t Really Revolutionary*, SLATE (June 29, 2007); <http://www.slate.com/id/2169352/>.

¹²⁰ Ibid.

¹²¹ Apple reportedly received \$18 per month per iPhone from AT&T. Srimana Mitra, *Wireless Carriers RoundUp* (May 13, 2008); <http://www.sramanamitra.com/2008/05/13/wireless-carriers-roundup/>. This flow then ended with the launch of the iPhone 3G in June 2008, when AT&T ended direct payments to Apple but then began heavily subsidizing iPhone sales, driving Apple revenues in an alternative manner. Srimana Mitra, *3G iPhone Impact on Verizon and AT&T* (June 16, 2008); <http://www.sramanamitra.com/2008/06/16/3g-iphone-impact-on-att-and-verizon/>.

¹²² James Alan Miller, *AT&T Boosting EDGE Data Network for iPhone*, PDA STREET (June 7, 2007); <http://www.pdstreet.com/articles/2007/6/2007-6-7-AT-T-Boosting.html>.

¹²³ Jacqui Cheng, *Just in time for Apple? AT&T wrapping up 3G network upgrade*, ARS TECHNICA (May 22, 2008);

<http://arstechnica.com/apple/news/2008/05/just-in-time-for-apple-att-wrapping-up-3g-network-upgrade.ars>.

¹²⁴ Prince McLean and Kasper Jade, *AT&T hurrying massive network update for new iPhone launch*, *Apple Insider* (April 3, 2009);

http://www.appleinsider.com/articles/09/04/03/att_hurrying_massive_network_update_for_new_iphone_launch.html

¹²⁵ Christian Zibreg, *Apple’s iPhone3G Saves AT&T From Recession*, TG DAILY (Jan. 29, 2009); <http://www.tgdaily.com/content/view/41239/118/>.

¹²⁶ Leslie Cauley, *Apple and Verizon Considering iPhone Deal*, USA TODAY (April 28, 2009); http://www.usatoday.com/tech/wireless/phones/2009-04-26-apple-verizon-iphone_N.htm.

Perhaps the most important market reaction to the Apple-AT&T contract is seen in the competitive motivation it provides to both rival handset makers and wireless networks. The iPhone's splashy introduction,¹²⁷ its embrace by millions of cellular subscribers,¹²⁸ the runaway success of its exclusively tied App Store, and its high profit margins (lifting Apple's share prices substantially) have signaled investors that significant opportunities were emerging in high-quality smartphones.

This has prompted a raft of new alliances and innovative products. The most striking original feature of the iPhone, its touch screen, quickly appeared on new models produced by Samsung, HTC, and Nokia.¹²⁹ RIM opened its own "apps store," inviting third party developers to offer software for Blackberrys. And Google launched its own competing platform, the gPhone, supplying an operating system open to use by handset makers and software developers.

In short, Wu's prediction that the iPhone was a bust due to its exclusive and highly integrated business model, has been rejected by consumers and competitors. The iPhone model has triggered a healthy uptick in the smartphone submarket, invited product imitation, and brought on a new round of business model evolution. The net effect of the platform that Apple has designed is – according to Tim Wu's revealed consumer preference – superior to existing alternatives.¹³⁰

VII. Conclusion

The mobile ecology is mutating, breaking into finer and finer pieces. This fragmentation crafts interfaces that invite innovation in more – and more lucrative – modules, capturing increasing returns from specialization and comparative advantage. Coordination mechanisms, implicit in the hidden modules dominant in an early stage of industry development, become explicit. This visibility leads to policy criticism.

Categorically constraining the competitive process of organizational innovation would, however, stunt the structural evolution of mobile markets. The inapt analogy of Wireless Carterfone would here solve an industrial structure problem that does not exist, and confuse antitrust analysis of anti-competitive outcomes that might develop. At a minimum, the imposition of administratively defined modules would pre-empt the means by which new contours are discovered and innovative models deployed. Because costs and benefits are internalized by the contracting parties, the process tends to efficiency and deserves protecting:

¹²⁷ Tim Krazit, 'Time' Names iPhone 'Invention of the Year,' CNET NEWS.COM (Nov. 1, 2007); http://news.cnet.com/8301-13579_3-9809218-37.html.

¹²⁸ The iPhone sold 17 million units worldwide, as of March 2009. Oliver Garnham, *iPhone Sales Hit 17 Million*, PC WORLD (March 21, 2009); http://www.pcworld.com/businesscenter/article/161725/iphone_sales_hit_17_million.html.

¹²⁹ Richard Wray, *Mobile Phones: Nokia's Smartphone Loses Out to iPhone*, THE GUARDIAN (April 17, 2009).

¹³⁰ Tim Wu, *iSurrender*, SLATE (June 10, 2008).

Modularizations, whatever their stated purpose, create new module boundaries with (relatively) low transaction costs. Modularizations thus make transactions feasible where they were previously impossible or very costly.¹³¹

The result is that mobile markets are being shaken by the inventions of outside innovators. These rivals have created their own platforms, bringing home grown “ecologies” into the mobile marketplace via their control over handset production, mobile operating systems, or both. “Smartphones” are now commonly *defined* as “platforms” rather than devices.¹³²

That non-carriers are revolutionizing the mobile marketplace heralds a tectonic intra-industry movement. In the Apple–AT&T alliance, it seems also to have shifted industry profits. The fact that carriers contractually assist in this transition testifies to the competitive forces in play. The financial implications of this evolution, the organizational nature of the rival business models used to coordinate complex technological change, and empirical analysis of vertical foreclosure are all prime candidates for further research in this dynamically evolving marketplace.

¹³¹ Baldwin (2007), p. 47.

¹³² “A smartphone is a phone that runs complete operating system software providing a standardized interface and platform for application developers” Wikipedia; <http://en.wikipedia.org/wiki/Smartphone>.