APPENDIX A

ECONOMIC NEED FOR A NATIONAL LICENSE IN THE 1670-75 MHZ BAND

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1. SUMMARY

In managing spectrum resources, the Commission seeks to enhance competition, to encourage the development of emerging telecommunications technologies, to allow licensees to respond efficiently to market demands, and to promote greater efficiency in spectrum markets. In the case of the 1670-75 MHz band, each of these goals would be furthered by the Commission's defining operating rights to permit delivery of an innovative new TDD broadband service on a nationally ubiquitous basis. At the same time, failure to afford the opportunity for widespread geographic service penetration will likely impose a number of economically significant obstacles to competition and service innovation. In particular, a new entrant will confront significant economic barriers to entry resulting from the need to incur extra expenses, its inability to realize economies of scale that incumbents with large service footprints are able to exploit and the need to overcome incumbent service providers' "first-mover" advantages. "Piecemeal" entry also suffers a number of strategic "disabilities" likely to undermine and ultimately forestall successful service

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innovation—notably, exposure to "copy-cat" service duplication before the critical mass necessary for competitive effectiveness and enterprise viability can be achieved.

2. LICENSING ENVIRONMENT AND GOALS OF PUBLIC POLICY

The most valuable application for much of the spectrum that the government will allocate over the next few years, including the 1670-75 block, is likely to be wireless Internet access. The U.S. is under considerable pressure to "catch up" to the Europeans and Japanese who are widely perceived to be well ahead in terms of developing new wireless Internet access applications (most notably, 3G). With a packet-based protocol, wireless can provide a convenient and economical way to use the Internet. It offers the benefits of always-on capability, together with portability. Wireless would be expensive for persistently transmission-intensive applications, such as streaming video. But for most Internet applications, which typically involve sending and receiving relatively few packets per hour of usage, the cost of wireless would be competitive.

Within the category of wireless Internet access, potential spectrum users can be divided into two categories: 1) those that plan to offer wireless carriage on a common-carrier basis; and 2) those that plan to develop specialized applications including portable Internet access. The latter might, for example, involve the use of proprietary hardware and/or software.

Wireless common carriage can often be conducted at a local or regional level. For example, common carriers for mobile telephony or wireless Internet access could operate in a single locality or a single region. There are significant scale economies to broader geographic coverage (and there has been significant industry consolidation), but the spectrum has considerable value in these applications, even if the common carrier has limited geographic coverage.

In sharp contrast, near nationwide coverage may be required for a specialized application to be viable at all. An expensive nationwide advertising campaign is often the only cost-effective way to introduce such a service to the public. Furthermore, the proprietor could lose out to "copy-cat" competition in the areas that it was unable to serve, because it could not get the spectrum it needed.

For these reasons, regional (or *a fortiori*, local) licenses may have virtually no value in use to the proprietor of such a service. If the proprietor were (inadvertently) to win such a license in an auction, the best course of action would be to try quickly to sell

the license to someone else. And there is no certainty that the proprietor, who would be in an obvious distress situation, would be able to sell the spectrum for as much as he/she paid for it.[1]

3. ACHIEVING AN ECONOMICALLY EFFICIENT SCALE OF OPERATIONS

A prospective entrant undertaking to supply a new wireless service in competition with the set of incumbent wireless service providers[2] confronts two types of economic hurdles: (1) the incumbents possess formidable "first-mover" advantages that need somehow to be neutralized; and (2) the enterprise needs to achieve output rates that lower unit costs through the realization of scale economies sufficiently to ensure competitive costs. Unless an entrant enterprise can overcome both of these challenges, it will not be successful—in which case neither its capital investors nor the consumers who would otherwise derive utility from consumption of its services will reap any economic benefits.

It is thus important in defining spectrum resource rights to take account of the economically significant effects rights definition has on the ability of entrepreneurs to bring desired new services to market successfully. The FCC should seek to delineate spectrum resource rights in such a way as to facilitate rather than frustrate successful new service innovations. In particular, the Commission should ideally define the geographic scope of operating rights in the 1670-75 MHz band on a national basis to permit full realization of a variety of important economies of scale and scope that can be explicitly identified and are elaborated herein.[3]

3.1. OVERCOMING "FIRST-MOVER" ADVANTAGES

As the rubric implies, "first-mover" advantages are competitive "edges" that market incumbents possess as a result of their incumbency. Incumbents, almost by definition, have an established market presence, usually some considerable brand recognition and on-going relationships (including contractual, credit and billing) with

[1] This is called the "exposure problem" in the literature. It results from the risk of winning only some of a set of desired licenses (*e.g.*, for nationwide service) and paying more than the bidder values those licenses individually (*i.e.,* without the complementary licenses).

[2] Wireless service also, of course, competes with wireline service to a significant extent for many types of communications demands.

[3] Relatedly, it is important that the Commission permit maximum exploitation of this band's limited potential information "carrying capacity" and, in particular, not degrade its productive potential by subdividing the band. Taking into account the need to avoid adjacent channel interference and given technical and economic operating requirements, five MHz is the minimum amount of bandwidth necessary to provide the kind of specialized broadband service applications contemplated by the ArrayComm partners using their innovative TDD technology.

the relevant customer base (as well as financial and governmental bodies). Their market presence is frequently geographically widespread with synergistic service benefits for customers, and may benefit as well from synergistic connections to related product and service lines.

To neutralize or offset these incumbent advantages, a new entrant will usually need to invest significant capital resources to establish its own market presence, brand identification, reputation for fair dealing and other aspects of customer/investor good will (*viz.*, *e.g.*, links to its own or partners' products and services). The need to sink these kinds of investments can create a difficult-to-surmount, if not insurmountable barrier to competitive entry and the benefits associated therewith—notably, new products and services with lower costs and improved performance characteristics plus more competitive pricing discipline.

In economic terms, a barrier to entry may be defined as a cost of production an entrant must bear that an incumbent does not.[4] The need to establish customer goodwill toward an established brand name may entail just this kind of cost differential: The first firm to introduce a new product may incur lower investment costs to create a product identification with consumers simply because it faces no rivals; later entrants may need to incur higher investment costs to neutralize their incumbent rivals' efforts.[5] Indeed, incumbents may well possess powerful "strategic" incentives to expand their marketing efforts precisely to "raise the ante" their prospective rivals must be willing to sink to establish an effective market presence in order to compete successfully.[6]

These competitive considerations have an obvious and important implication for defining the economically optimal geographic scope of operating rights in the 1670-75 MHz band.

There are, in general, very substantial economies of scale associated with spreading the fixed costs and maximizing the effective productivity of capital investments in advertising, marketing programs and billing systems. These types of economies

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[4] *See* George J. Stigler, "Barriers to Entry, Economies of Scale, and Firm Size," in *The Organization of Industry* (1968), pp. 67-70.

[5] As Professors Carlton and Perloff observe in their industrial organization text: "If the presence of the incumbent raises the marketing costs of the second firm to enter, then the first firm has a permanent advantage—a long-run barrier to entry—and can maintain high prices. For example, because the product of the first firm in the market is familiar to customers, they may be reluctant to switch to a new brand." *See Modern Industrial Organization* (1994), p.113.

[6] *See* Steven Salop, "Strategic Entry Deterrence," *American Economic Review* (1979), Vol. 69, pp. 335-8; Steven Salop and David T. Scheffman "Cost-Raising Strategies," *Journal of Industrial Economics* (1987), Vol. 36, pp. 19-34; F.M Scherer, "The Welfare Economics of Product Variety: An Application to the Ready-to-Eat Cereals Industry," *Journal of Industrial Economics*, (1979), Vol. 28, pp. 113-34; Richard Schmalensee, "Entry Deterrence in the Ready-to-Eat Cereals Industry," *Bell Journal of Economics* (1978), Vol. 9, pp. 305-327; and Richard Schmalensee, "Product Differentiation Advantages of Pioneering Brands," *American Economic Review*, (1982), Vol. 72, pp. 349-65.

typify both the design and execution/operation phases of such systems resources: The costs of the design artists and copywriters who create an advertising campaign and the production costs of the advertisements themselves are fixed costs in economic terms that do not vary with respect to the size of the audience to which they are exposed. Similarly, the design and hardware/software costs of billing systems do not vary greatly with the size of the relevant customer base.[7]

National advertising campaigns are less costly to implement on a per-exposure basis and are much more transactionally convenient to organize (*i.e.*, entail lower resource expenditures). For new product introductions, "bandwagon" effects are also often extremely important—one person's purchase may prompt another person's purchase.[8] This type of effect typifies new product adoptions in high-technology industries especially where there are significant network externalities.[9] Thus, to "get (and keep) the bandwagon rolling" and, thereby, to enable the successful innovation of a new service capability, it is important that operating rights be defined sufficiently broadly so as to permit substantial realization of available marketing economies.

Failure to afford a new entrant the means to exploit marketing economies will multiply the barriers to entry that need to be overcome. Maximizing the payoff to marketing investments is necessary to overcome incumbents' "first-mover" advantages—the need to sink *greater* investments in capital resources to offset incumbents' brand identification and market presence—but if the geographic scope of an entrant's scale of operations is constrained by limitations on relevant spectrum operating rights, this task will likely prove even more difficult. Not only will incumbents have the advantages of incumbency, they will often, as a result of their own geographically ubiquitous operations, be well-positioned to realize economies of scale in marketing, billing, brand identification, *etc.* that entrants, the geographic scope of whose operations are constrained, are not able to realize. Thus, "first-mover" barriers to innovation may also translate into competitive barriers along other important dimensions as well: If the geographic scope of the entrant's operations are constrained by inadequate spectrum operating rights, the incumbent will pay less for more effective advertising than the entrant—a classic "Stiglerian" entry barrier.[10]

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[7] Additions to data processing capacity may be necessary, but likely do not loom largely in terms of overall budget impact in relation to the costs of defining the basic design parameters of a particular program.

[8] "Word-of-mouth" advertising prompted by "paid-for" advertising can lead demands to spread rapidly, but effective exploitation of this effect requires adequate productive capacity to meet demand and effectively "internalize" the bandwagon externalities.

[9] *See* Jeffrey H. Rohlfs, *Bandwagon Effects in High Technology Industries* (MIT Press, Forthcoming). When the value of a network depends on the number (and/or specific identity) of the people on it, growth in subscribership may itself promote additional growth—*assuming* such growth is feasible and not constrained by, for example, spectrum-derived limits on availability in some geographic regions.

[10] Economic Nobelist, George J. Stigler was the first to operationalize the definition of "entry barriers" in terms of cost differentials. *See op. cit.*

The products and services against which the ArrayComm partners will be competing have established national (and, in some cases, global) footprints as a result of their ability to aggregate large economically and technically complementary sets of spectrum resource rights. The large geographic scope of such operations not only conveys significant advantages in terms of the ability to deliver service offerings that are valued, in part, precisely because of their geographical ubiquity, but also enables these enterprises to realize tremendous economies of scale and scope in production and design. We now address the economic significance of these latter types of economies.

3.2. OTHER ECONOMIES OF SCALE

Wireless communications networks are *very* complex systems. Most of the complexity is manifest in the network and component design and software that runs the systems. These are quintessentially "intellectual capital" resources and they constitute "fixed" costs (*i.e.*, they are largely invariant to output) in economic terms. Conception, development and maintenance of these essential intellectual inputs require very substantial financial capital investments.[11] It pays to spread these fixed-cost investments over as many customers as is economically and technically feasible. Fixed costs of network and component design and software development may amount to a relatively modest portion of the sales price when, say, ten million customers are effectively sharing those costs, but a substantially larger portion when costs are spread over, say, one million customers. These kinds of differences in per-unit costs can easily spell the difference between success and failure in terms of introduction of a new service.

Again, the definition of spectrum resource rights has obviously important implications for the ability of firms to realize these significant economies of scale that are of critical importance to enterprise viability. The larger the authorized geographic scope of system operations, the larger the potential and, hopefully, actual body of customers over which these design and product development costs can be spread. In addition, there are also important advantages to be derived from the absence of signal interference problems at the geographic borders of service areas owned by the same producer. With a national footprint, there are no (internal) "borders" and, as a result, technically effective systems can be deployed at lower costs with few coverage losses produced by the operation of interfering systems.[12]

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[11] For example, "Developing and maintaining the software embodied in a state-of-the-art electronic switch product line is a billion-dollar-a-year proposition." *See* Ronald A. Cass and John Haring, *International Trade in Telecommunincations* (AEI/MIT Press, 1998), p. 243.

[12] There will remain certain other authorized operations within the band in certain geographic areas whose effectiveness needs to be protected.

Other important advantages of entry on a large (geographically ubiquitous) scale include lower per-unit costs of entry. Consider, for example, that all of the fixed costs associated with participation in an FCC spectrum auction can be spread over larger output volumes the larger the geographic coverage with which the target license is endowed. It is also likely that costs of preparing bid valuations will be lower and less complex were a license to afford broad geographic coverage.

The existence of significant economies of scale and scope in providing mobile communications services is widely recognized. For example, in gauging the economic efficiency of the FCC's spectrum auctions, the Congressional Budget Office specifically adverts to the successful aggregation of spectrum licenses sufficient to permit nationwide footprints, thereby enabling the realization of cost advantages derived "from spreading the fixed cost of new systems over a larger customer base" or from avoidance of "problems with signal interference at the geographic borders of service areas owned by the same producer."[13]

Similar kinds of economies have been identified in mass media communications. The FCC, in justifying its allocation of a very substantial chunk of spectrum for provision of satellite DARS, pointed to the potential ability (and explicit promises) of DARS operators to aggregate minority audiences on a national scale and thus to economically rationalize provision of otherwise (allegedly) uneconomic minority programming, thus fostering greater programming diversity.[14] The analogy to the design and development costs to which we previously referred is quite close: programming has significant fixed "first-copy" costs and then very low marginal costs for delivery to additional consumers. If a programmer can reach a large audience, it can effectively spread production costs and recover its costs with only minimal fixed-cost burdens.

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[13] *See* Congressional Budget Office, *Where Do We Go From Here? The FCC Auctions and the Future of Radio Spectrum Management* (April 1997). "The *strongest indicator* of the auction's success was the ability of three large bidders to win the licenses *necessary to provide mobile telephone service nearly nationwide.*" (p. 18, emphasis added).

[14] *See* FCC, *In the Matter of Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band,* Report and Order dtd. March 3, 1997. "Moreover satellite DARS can provide new services that local radio inherently cannot provide. With its national reach, satellite DARS could provide continuous radio service to the long-distance motoring public, persons living in remote areas, and may offer new forms of emergency services. Satellite DARS may also be able to foster niche programming because it can aggregate small, nationally dispersed listener groups that local radio could not profitably serve." We believe virtually the same arguments apply to the kind of interactive service ArrayComm plans to supply using the 1670-75 MHz frequency band (*viz.*, niche applications for a variety of special/unique-interest personal tastes and preferences).

4. CONCLUSION

Economically successful innovation of a new specialized wireless Internet application in the 1670-75 MHz band would likely be impossible/extremely difficult without a national license.

APPENDIX B

Recommendation ITU-R RA.769-1: Protection Criteria Used for Radioastronomical Measurements

Recommendation ITU-R SA.509-2: Generalized Space Research Earth Station and Radio Astronomy Antenna Radiation Pattern for Use in Interference Calculations Including Coordination Procedures