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3G or Not 3G: The WiFi Walled Garden*

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1 Introduction

The term "wireless network", as used in common parlance, is much of a misnomer. The word network actually means a system of interconnected relationships. This system derives its functionality from its ability to provide switched connections. However, the term wireless refers to the network's ability to provide mobile connections, though wireless technologies only represent a small portion of the network's elements. The elements of a wireless network include not only the wireless connection, but also switches and landlines. In most wireless networks, the wireless connection only provides the so-called "last mile" connection to the end users and the connection provided by radio is usually not switched at all. The wireless part of the network is the mere tip of the iceberg.

This distinction is more than mere semantics. It is an important fact to remember when analyzing the economics of wireless networks. The fundamental challenge for network operators as they enter the third generation of cellular networks is obtaining strategic control of all parts of the network. There are two entities on either side of its value chain which it must actively cultivate. On the one side are the network's subscribers; on the other, content. To attract subscribers, the network must provide appealing content, and vice versa. A network must reach a critical mass, to sustain itself, otherwise it will not be economically viable. Without the ability to control network access, the carrier lacks the ability to cultivate these two entities.

Carriers need to translate content into services that are not only appealing for customers but also that contribute in making their lives easier and increase the company's revenues. Wireless terminals are moving beyond fancy cordless

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phones, becoming mobile computers, walkmans, and TV sets. Strategy and investment will be reliant on what proved out to temporary and what are permanent changes in technologies, applications, and adoption. Consequently, the deployment of next generation wireless networks has languished.

Further compounding this dilemma is that one of the barriers to entry — the exclusive lock on the spectrum connecting the end user — is falling. The system of spectrum allocation whereby carriers purchase the exclusive right to use spectrum has served as a barrier to entry for new firms. Recently, networks which employ unlicensed spectrum, for which the carrier has not paid for the right to use the frequency, have begun to be used to provide mobile data communications. These "unlicensed" networks are perceived as a threat to the profitability and commercial viability of existing cellular networks and emerging 3G networks. Next generation service providers will have to integrate licensed and unlicensed spectrum in their networks and find means of recreating the barriers to entry of licensing regime with differentiation, externalities, and network investment.

2 The U.S. Wireless Industry

In the United States, wireless communications is very heavily regulated. Nearly every emission of electromagnetic waves is subject to prescription by U.S. statute or Federal regulation. Since the late 1920's, the need to regulate the broadcast of radio signals into the ether has became apparent due to the fact that radio signals cause interference, and at a certain level of interference no one can clearly receive signals. The Federal Communications Commission (FCC) has historically assigned bands of adjacent frequencies to particular applications, then allocates the exclusive right to those frequencies to minimize the problem of interference. The FCC has held various auctions to ensure the economic allocation of this scare resource. Potential wireless providers do not actually bid for spectrum, but rather a license granted by the government for the right to emit electromagnetic waves, into the ether at a given frequency power lever in a specified geographic location. The recipients of licenses in these auctions must then make further capital investments in network infrastructure to provide these services.

There are, however, certain bands for public use. This spectrum does not require a license for use, but the use must conform to FCC rules. These low emission devices, such as remote controllers, wireless LANs, cordless phones, and garage door openers are governed by Part 15 of the FCC's rules. Moreover, the FCC rules previously prohibited transceivers from operating on mul-

tiple frequency bands. Despite the fact that CB radio and marine VHF radio might be similar equipment, the transceivers were required to be in separate boxes. In September of 2001, the FCC changed its rules on Software Defined Radios (SDR), which might now allow radios to operate on multiple standards and services. SDR employs computer processing to enable a single transceiver to provide multiple modes, technologies, platforms, and protocols.

This policy shift reshuffles the spectrum deck for service providers, networks, and equipment suppliers (Bauer et al., 2004). It permits third-party applications and access to other network protocols offered by other types of providers, provided that it conforms to the FCC's software defined radio rules. These three items: Licensed spectrum, unlicensed spectrum, and SDR can be combined to afford a powerful tool for carriers to deploy of advanced, spectrum-hungry 3G services.

3 The Move to 3G

As new wireless products evolve, this market is facing discontinuous change, making it impossible to predict the future. Predictions of consumer demand are virtually useless; a scenarios analysis may prove more reliable and more useful.

3.1 Technological Evolution — Next Generation Networks

Modern mobile wireless networks can trace their origins back to technologies developed at Bell Labs in the late 1940s. Cellular networks are designed to localize the wireless connection and reuse those frequencies in other parts of the network. Cellular networks derive their name from the system of localized, low power base stations that cover a specific area. The base stations are sited to give overlapping coverage, fitting together like cells in a tissue. A set of channels are assigned to each cell. The channels, because they are low power, can then be reutilized in adjacent clusters. This is as opposed to having one centralized, powerful antenna broadcasting over a large area.[1] However, modern cellular networks were not deployed commercially until 1984. This is due to the fact that inexpensive computers were needed to handle the switching and "hand-offs" need by the network.

The original cellular networks of the 1980s, referred to as first-generation (1G) analog networks, were only capable of providing voice communications because they employed analog technologies for the wireless link. In the mid-

1990s, the FCC licensed the PCS bands (Personal Communications Service), which is referred second-generation (2G). It has dedicated channels for both voice channels and optimizes voice traffic. This technology maintains a dedicated channel as long as the call is maintained, regardless of the use. However, PCS uses digital modulated spectrum to provide not only voice, but also limited data communications such as text messaging, email, voicemail, short message service (SMS), and caller ID. Major U.S. carriers use CDMA, TDMA, GSM and PDC to provide 2G networks. 2G users get low transmission rates, usually lower that 9.6 Kb/second per time slot. If new services will focus on data transmission, with this rate of transmission and inefficiency, it will not be possible. Some cell phones are capable of providing limited text browsing of the Internet. This is often referred to as 2.5G.

Cellular networks are now entering what is known as the third-generation or "3G" platform. There is no standard definition of what 3G is, but is generally accepted to mean a wireless network capable of providing high-speed data connectivity which is comparable to current fixed-line communications. 3G is touted as being able to offer broadband services, packet based transmission of text, digitalized voice, video, and multimedia. 3G networks include the capability to support circuit and packet data at high bit rates:

- 144 kilobits/second or higher in high mobility (vehicular) traffic·
- 384 kilobits/second for pedestrian traffic·
- 2 Megabits/second or higher for indoor traffic

Other services and capabilities include:

- Fixed and variable rate bit traffic
- Bandwidth on demand
- Asymmetric data rates in the forward and reverse links
- Multimedia store and forward.

The uptake of 3G has been relatively slow in the U.S. The technology provided by 2.5G is already allowing carriers to deploy a wide variety of features in their wireless network. But, its major limitation is the speed of data transmission. Despite the fact that wireless connection speeds are greater than the wireline speeds of the past, the connection speed of 2.5G networks may be enough to provide voice grade service as well as multimedia content to satisfy customers, obviating their demand for more advanced networks.

Since the wireless network is emerging as an all-purpose, mobile communications network, estimations on total market size will be highly relevant. Next generation technology will provide improved services to the market,

with higher speed connection and increased broadband. Pervasive competition could arise if the vast majority of carriers act aggressively in providing new and targeted services to their customers. Marketing and segmentation tools are extremely important in this strategy. They could deploy a differentiating strategy that consists of targeting a specific market niche. In this practice they will be skimming revenues in the segment of those subscribers that demand data transmission on the go. They should concentrate in launching as many services as they can, collecting the advantages of both skimming practices and being the first in the market.

One emerging trend is carriers offering WiFi instead of traditional cellular. Many service providers offer "franchises" of their network, becoming wireless wholesaler, offering service in chain stores, airports, and other interested companies. However, the lack of barriers to obtaining this unlicensed spectrum and the relative low cost of setting up WiFi hotspots allows customers to use their computers on a variety of networks. This undermines the service provider's ability to institute consumer loyalty, reducing churn and increasing ARPU. One approach is when carriers act as Internet portals to their customers. For example, web portals like Yahoo! have been offering other wireless email option by allowing their customers to access their web site using cellular phones. By doing this, carriers control their customers' Internet access and navigation path.

3.2 Economics

While one may not be able to predict the demand for 3G, its services, or its incarnation, with a basic understanding of network economics, we can start to understand how new networks and wireless applications are likely to be used. Despite the advent of pervasive new technologies, the general rule of wireless will continue to be: plug it in unless it has to move. There are some notable exceptions to this rule.

Even assuming the fixed cost of the radio equipment is similar to the equipment cost of a wireline connection, the increase function of modulating and demodulating radio signals adds delay compared to when those signals are conducted over a conduit. In economic terms, the radio connection lengthens the production process in transmitting and receiving signal, and therefore the average cost of transmission.

In this trade-off, wireless connections should be used when the advantages of radio communication outweighs its additional cost. Such advantages are when the application must be mobile, portable, or wiring is overly cumbersome. An examples of an overly costly wiring installation is when the instal-

lation of conduits requires channeling through walls or digging up streets. A wireless solution such as Bluetooth computer peripheral devices might be used where the wires are overly cumbersome where six USB port connections can be replaced with a single wireless hub. This is similar to ad hoc networks such as a ham radio, which could not be easily formed when a new wire must be used to connect an incremental user. Radio connections also allow for greater shared costs when there is complementary, non-rival use. Sharing of the spectrum is easier than sharing lines, especially for last mile connections.

This wireless-wireline optimization also appears in building a wireless network. The architect of a network has to balance two competing costs: spectrum and network hardware, network architecture balancing cell size and efficient use of spectrum versus the cost of hardware (hubs, routers, etc.), and the cost of wired networking. On the one hand there is the cost of the size of access point and on the other, cost to wire it up. The cost of spectrum places limitations on the size of the cell site. A network provider could use unlicensed spectrum, such as those permitted under Part 15 of the FCC's rules. However, these applications are required to use significantly lower power which implies a much shorter range. In sum, if the network uses unlicensed spectrum, while it does not have to pay for those licenses, it must spend significantly more to wire up much smaller cell sites. Using these tradeoffs, the network engineer can model the cost of spectrum versus the cost of wireline network and optimize that expenditure.

3.3 Network Externalities and Game Theory

An externality is any economic effect that is felt by a third party not part of the original economic transaction. A positive network externality is usually the increase in utility of the network created by the non-rival addition of new subscribers. As the number of users increases, the value of the network to all participants increases exponentially. This is known as Metcalfe Law. A network must reach a critical mass, to sustain itself, otherwise it will not be economically viable. Beyond the critical mass point, the network experiences natural growth as each new user decreases average cost and increases the effect of network externalities.

The effects of network externalities are most apparent in the interconnection of networks. The utility of a network is directly proportional to the number of users. A larger network would not interconnect with a smaller one because the marginal benefit to the smaller network's users would be greater than the benefit to its customers. Networks try to grow their size and exercise market

power to tip the network in its favor. Since the economics of network externalities, tipping, and rules of game economics are relatively well understood by the industry participants, there are a limited number of strategic options and responses. This makes game theory highly relevant and carriers must carefully watch and anticipate the moves and responses of its competitors.

To take advantage of network's externalities, the number of customers should be optimized. To carriers, size and network design is extremely important. This presents a chicken and egg dilemma for the network. To attract subscribers, the network must provide appealing content, and vice versa. A network must reach a critical mass, to sustain itself, otherwise it will not be economically viable. This is most evident in the wide geographic footprint of the network necessary to provide a wide roaming area for mobile users.

4 The WiFi Challenge: 3G and Unlicensed Networks

4.1 The "Free" Spectrum Challenge

The system of licensing whereby carriers obtain the right to use spectrum through auctions has the unintended consequence of serving as a barrier to entry for new firms. Conversely, networks which employ unlicensed spectrum, for which the carrier has not paid for the right to use the frequency, present a threat to the profitability and commercial viability of existing cellular networks and emerging 3G networks. New service providers are beginning to offer portable Internet access for laptops and handheld computers in airports, hotels, cafes, and other public places. Five different hotspot strategies have been identified:

1. Individuals or companies who install in commercial places
2. Aggregators who combine local installations to provide a national foot print
3. Major wireless service provider offerings
4. Computer and electronic manufacturer consortia
5. Grass roots individuals offering free or low-cost access

Most ventures do not rely on a single mode of entry but are pursuing a combination of these strategies.

When a network operator chooses to install hotspots in partnership with another commercial entity, the offering takes advantage of the special expertise derived from each provider in the partnership. One of the early movers

in this arena is T-Mobile, a wireless service provider. T-Mobile made headlines when it purchased a company with contracts to place wireless hotspots in Starbucks coffee shops. Starbucks is offering three subscription plans: a $29.99 per month unlimited plan with a 12 month commitment; a month to month unlimited plan for $39.99; and metered plan for $0.10 per minute with a 60 minute per connection minimum. An organization like Starbucks, clearly not a network operator, finds it more cost effective to outsource Internet access to an organization that specializes in providing network services. Starbucks anticipates that having the Internet access available for its customers will help sell a greater number of $3 cups of coffee. As a PCS operator, T-Mobile can take advantage of its existing mobile service infrastructure to leverage the build-out of more geographically dispersed WiFi services. While T-Mobile does not actually sell access to unlicensed spectrum, as it does with its cellular service, it can offer connectivity to the Internet on a subscription basis using unlicensed spectrum.

An alternative model is the complimentary offering model which McDonald's Restaurants has decided to pursue in 2003. McDonald's Restaurants announced it has selected Cometa Networks to provide WiFi service as it begins to test market wireless Internet service in three U.S. cities. McDonald's recently began offering one hour of free WiFi access to anyone who buys a combination meal in one of ten stores in Manhattan. The company claims that it will extend the service to 300 stores in New York, Chicago, and another city in California. Cometa subsequently filed for bankruptcy protection.

Potentially worse for the prospective 3G network provider, there may be a complete end-run around the commercial wireless provider. A popular activity among computer hobbyists is "warsniffing", traveling around with the goal of gaining "free" Internet access using a legitimate, but unprotected, W-LAN connection. "War-chalking", taking the information learned about open W-LAN connection and creating a map, sometimes leads to the publication of these maps in so-called "weblogs".[2]

It is feared that these "free" spectrum networks could present a threat by cannibalizing their existing businesses. The carriers have paid handsomely for their licenses, and the upstart WiFi carriers do not face that cost structure. The license is generally considered to be a sunk cost and does not effect pricing necessarily competitors do not have that cost. Moreover, since WiFi networking is an open system of protocols the carrier looses the control of attachment of handsets and terminal equipment to its network. This lowers switching costs and lessens ability to charge a premium.

However, this fear may not be as threatening as initially perceived. Any system based on "free" pricing is doomed to fail once scarcity, or rival uses for the finite good, is introduced. The owner of a private hotspot, such as campus

W-LAN or home WiFi access point, will institute access protection as soon as the use of "war-free-riders" start to negatively affect his use. For example, if a "war-sniffing" neighbor has gained access to your home WiFi and is using your cable model or DSL while you are at work, you are not likely to care very much. However, when you return home, you would be unlikely to share your bandwidth with the interloper. Until recently, one of the sharpest criticisms leveled at WiFi is the lack sufficient levels of encryption to prevent the eavesdropping on data and that each employs only rudimentary means to block access by would-be hackers. Implementing security features adds support and configuration costs for both end users and product developers. Nonetheless security features are being incorporated in new products. Furthermore, the WiFi operator cannot guarantee a level of network performance because WiFi is not granted any interference protection under the FCC's rules. Thus, "free" hotspots are likely to disappear relatively quickly.

Moreover, the McDonald's-style model of complementary WiFi is proliferating and may present a serious competitive threat to cellular carriers' efforts to enter this market. However, complementary WiFi may, in fact, prove antithetical to McDonald's fast food business. McDonald's service operations are engineered to get customers in and out of the door; the more and faster, the better. McDonald's stores are also designed with hard plastic seats and other fixtures aimed at getting the customer out of the door in less than 20 minutes. And while most of the McDonald's-going-public is unlikely to bring a laptop to the drive-thru, those who frequent cyber cafés might. A store like Starbucks is very different from McDonald's in that it wants the customer to linger and make repeat purchases.

What is needed is a carrier who can integrate these platforms.

5 Building a WiFi-Proof "Walled Garden"

As we have seen, spectrum-based barriers to entry are insufficient in and of themselves to provide carriers with a sustainable competitive advantage. Differentiation is the name of the game and in this game, free spectrum may in fact help carriers. It creates a new, albeit undifferentiated, product to add to a suite of wireless products. Granted, a network carrier may see some cannibalization of its business from the alternative mode, but these are some non-exclusive, presumably lower quality services. The good news for the carrier is that it now has the ability to varying grades of service quality at corresponding price points. This affords the carrier the ability to price discriminate among its customers. If done right, price discrimination can increase profits signif-

icantly. The dilemma the carrier faces is how to prevent potential customers from making an end-run to other "free" networks.

In creating a walled garden, network providers control access to content, limiting the availability to that which they benefit from the transaction. The openness of a carrier's network ranges from totally proprietary to contract carriage to common carriage. There is an optimal height and number of gates walled garden so as to provide incentives for others come and plant their tulips in it.

5.1 Differentiation and Price Discrimination

To compete effectively, these providers must find ways to differentiate their products. By allowing just any device to attach to its network, a provider can attract more users, but simultaneously runs the risk of turning wireless Internet into a free-for-all. Unlike the cellular network paradigm in which only approved phones are allowed to connect to a network, WiFi service providers currently have far less control over the terminal equipment which can connect to their networks. In an open, competitive environment, there are virtually no impediments to the user switching to another provider since his device can also be used on other (presumably competing or free) networks. To attempt to differentiate themselves, carriers may find some means of offering terminal equipment that is not completely interoperable with the networks and features of other carriers, or at the very least, equipment designed to attach to its primary provider's network first (Noam, 2002). This differentiation will afford the opportunity to price discriminate.

In general, price discrimination improves a firm's financial performance by extracting surplus consumer welfare. However, problems arise in price discrimination. These include when the products are so cheap that a difference in price is hardly noticeable to the consumer, the pricing does not reflect products underlying cost structure, or there is little difference between the competitive products which would afford the ability to discriminate. Another impediment to price discrimination is when the provider cannot differentiate users such as those in a peer to peer network without connection through the network provider's facilities, including both the spectrum and wired portions of the network.

It is possible to make a business selling what is normally a free good. Let me explain in this way. People buy air which has been dehumidified, filtered, and compressed into tanks for SCUBA diving. They will pay for a commodity which has be subject to some sort of differentiation which makes it more useful. The SCUBA diver is paying for the pressurization and not the air. Sim-

ilarly, most people routinely buy bottled water, paying for the convenience of refrigerated water in a container and the perception of purity. This has become a very profitable business since the mark-up on water could be greater than that of Coca-Cola, which requires ingredients other than just water.[3]

Using its exclusive as well as nonexclusive spectrum, a wireless carrier can now discriminate with high- and low-quality products. For example, cell phones which incorporate SDRs which allow them to be used as CB radios[4] or walkie-talkies. This might not be a practical application for business use because of the risk of interference or interception, but it would probably be quite acceptable to more casual users. This is a one-part pricing scheme whereby a cell phone user does not pay to use his phone outside of the initial purchase. This means that once the device is purchased, the consumer does not pay for continued use of the device and there is not necessarily a continued relationship with the vendor or network provider. However, the carrier wants to collect airtime and other service fees. Ultimately, a phone using unlicensed spectrum seem likely to be cheaper to the end user, or at least he avoids reoccurring charges. Carriers can free up the utilization of their licensed bands to provide high quality service while letting other services "ride steerage" with the "unwashed bits" using the unlicensed bands.

5.2 Content and Conduit

To date, cellular carriers in the U.S. have not taken an active interest in pursuing 3G strategies. Cellular offerings are still traditional telecommunications in new packages without wires. Each company has its own proposition to the market, mixing the basic component such as coverage, tariff plans and features. The use of the network is for voice and data transmission of cellular customers. Much of the value created in next generation services will be in content creation and distribution. Many carriers, the progeny of the Bell System, lack understanding of marketing media products which is idiosyncratic. Telecommunications companies have traditionally failed at media offerings and are not likely to reinvent themselves as something they are not. Rather, these carriers should focus on their existing networks, complimenting them with WiFi hotpots. Their principle asset is the local customer. Thus, existing cellular carriers already have advantage of existing network they can leverage to build out and offer WiFi services.

Cable companies are more likely to benefit from the deployment of WiFi hotspots. Growth in the sales of WiFi gear will have positive downstream implications on the demand for complimentary products and services such as high-speed Internet access. WiFi coupled with broadband is generating a pro-

cyclical adoption pattern. Both cable and DSL modems are being sold already equipped for WiFi. Since cable modems have proved to be more successful than DSL, it is likely that cable companies will capture more of the benefit from this increased demand.[5] Moreover, cable companies, often setup more like media firms than network providers, will have an opportunity to distribute news and entertainment offerings through wireless channels. These would be through bundling and cross-marketing of complementary products, which they currently offer to residential subscribers. Cable companies further have the resources to sell advertising or sponsorships used to support the deployment of next generation services. Nonetheless, cable companies face the challenge of creating a national footprint which is an essential asset in offering wireless services.

A few scattered WiFi hotspots alone are not sufficient to create a viable wireless network. A nation-wide, ubiquitous network is necessary. Each hotspot would be useless alone if it were not connected to other networks. From there the connection is made to other cell sites, local and long distance telephone networks, or even the Internet. A wireless network also requires a centralized database in order to keep track of where an individual user is, so that an inbound call can be routed to the cell cite serving the user. Presumably, most users of cellular networks are mobile. When a mobile user travels from one cell site to another, the system provisions service until the customer physically gets under the coverage area of the new cell site.

6 Conclusion

Unlicensed spectrum, such as WiFi lowers the barriers to entry to the market. However not completely open. Those carriers which implement strategies viewing WiFi as a complete threat or a complete means of entry are likely to fail. A system based on the sale of hardware, without services or differentiation is likely to result in a market of commodity products. As a business strategy, it is ultimately indefensible and hence not sustainable against competitive entry. WiFi will be an intrigue part of any network wireless or business strategy. Carriers must have a balanced offering of services within and outside of their networks. In the final analysis, carriers will continue to organize cartels and rely on other barriers such as scale and sunk costs to exclude new entrants. In the world today, oligopoly is a prevalent form of market structure because of its stability. In an oligopolistic market, the offerings oftentimes are not differentiated. In our case, spectrum is spectrum. What would make an oligopoly is if only a few firms had control or possession of most or

all of the available spectrum licenses. As with any oligopoly, a barrier to entry must exist. With a spectrum license, the barrier to entry is that the government can auction only limited amounts. This is a natural barrier to entry, because it is basic to the structure of the telecommunications market in its current state. Furthermore, because the government regulates the availability of spectrum licenses, an incumbent may not even need to initiate strategic actions to deter entry.

Managing a firm in an oligopolistic market structure is complicated, because all decisions, especially pricing and investment decisions, involve important strategic considerations. Because only a few firms are competing, each firm must carefully consider how its actions will affect its rivals, and how its rivals are likely to react. The strategic considerations can be complex. Furthermore, decisions, reactions, reactions to reactions, and so forth are dynamic, evolving over time. When managers evaluate the potential consequences of their decisions, they must assume that their competitors are as rational and intelligent as they are. Then, they must put themselves in their competitor's place and consider how they would react.

WiFi is merely one end user link in a larger, integrated network.

Endnotes

1. The low power has the added advantage of reducing power consumption and potential health risks.
2. This activity has been dubbed "war-sniffing" after the 1983 film War Games. In the movie, Matthew Broderick breaks into a NORAD computer by randomly dialing into computer modems. War-sniffing comes in several different flavors: "war-walking", "war-driving", and even "war-flying", depending on the kind of vehicle one uses. "War-spamming" is the use of an unsecured access point to send spam email on the Internet, and "war-jacking" is a denial-of-service attack that knocks a one hotspot in favor of the hacker's. The FBI has demonstrated a keen interest in many these practices. Since WiFi devices are afforded no interference protection under Part 15 of the FCC's rules, war-sniffing may not be illegal per se, depending on what the would-be hacker does once he has accessed the unprotected access point.
3. Thanks to Robert Pepper for the illustration.
4. Technically, CB radios are licensed by rule and are not unlicensed. For the purpose of this illustration, the distinction is moot, because a CB operator does not have exclusive access to the spectrum.
5. WiFi is a double-edged sword for both cable and telecommunications companies offering broadband products. While it stimulates demand for broadband access, it can also be used to provide an Ethernet for users located in the same building or complex. An Ethernet using WiFi is generally less costly to set up rewiring the

building. The sharing of a single broadband access among these users may reduce the demand for connectivity to the building.

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