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Technology and the Demand for Commercial Real Estate

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Technology and the Demand for Commercial Real Estate

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I. Executive Summary

Technology has a pervasive influence on real estate demand because it affects where and how people live (residential); work (office, industrial); buy (retail) and recreate (hospitality).

Technology has been a key driver of the U.S. economy historically, and will be so in the future. Accordingly, while many new technologies appear in isolation to reduce real estate demand, the net effect of technology on economic growth—and real estate demand—is positive.

Technology and Commercial Real Estate Demand

While scores of technology changes affect real estate, broadband, wireless, and the Internet will have the largest and most far-reaching influence of those technologies known today. The communications revolution ignited by these technologies influences the demand for specific properties directly through "intelligent" building technology as well as through the overall demand for real estate.

To date, quantitative analyses demonstrating that "intelligent" building technologies provide economic benefits over and above their cost are nearly non-existent. Tenant demand for "intelligent" building technologies, other than demand for broadband and telecommunications, has not become a widespread factor in decision-making. However, better, cheaper technology and increased tenant demand will enable more rapid adoption of "intelligent" building technologies in the future.

Investors have not focused on "intelligent" building technologies. Significant opportunity exists for those investors who consider technological issues.

Technology and Office Property Demand

On balance, technology should generate a net positive effect on office employment growth in the future. The structural shift to knowledge workers, the United State's leadership in many technology markets, and the increasing profitability of businesses due to technology should be more powerful positive stimuli than global outsourcing, telecommuting and increased productivity. However, while in the longer run the effect of technology on office space demand should be a net positive, current trends towards globalization and corporate space downsizing suggest a difficult transition period in the next few years.

While broad macro economic trends will determine the overall magnitude of office space demand, and which regions win and lose, technology also affects tenant demand for specific buildings within a market.

The demand for "intelligent" building technologies by office tenants is still in its infancy. Regardless of the type or size of tenant, the key issues driving tenant office leasing decisions are cost, proximity to the boss's residence, access to current and potential employees, proximity to customers or clients, and proximity to restaurants and retail locations.

Perhaps the most important influence of technology on office space demand relates to interior office design. An office building today is not fully "intelligent" if it cannot cost effectively adapt its internal space to meet changing business needs.

Technology and Industrial Property Demand

Technology, in concert with the trend to consolidate warehouse and distribution facilities into fewer locations, has increased the demand for larger and more sophisticated warehouse, distribution and manufacturing facilities. Due primarily to the potential decline in warehouse space due to radio frequency identification and improved inventory management, the overall demand for unsophisticated industrial properties is expected to decline as a result of technology change.

The demand for "intelligent" building technologies by industrial tenants is strong for the new, larger distribution facilities, but still fairly limited throughout the marketplace. Perhaps the most important attribute is the need for adaptability. The industry trend is towards fewer locations and larger facilities. However, consolidation into larger facilities has risks, and those risks are being mitigated by tenant demands for flexibility.

Few industrial property owners are interested in "intelligent" building technology. Owners are focused on providing the shell and backbone infrastructure to enable the widest range of tenants to be accommodated in their space.

Technology and Retail Property Demand

Despite doomsday forecasts that the Internet would eliminate the middleman—retail properties—from the retailing equation, technology has had a surprisingly limited impact on the overall volume of retail sales in stores. However, Internet retail sales have had a dramatic impact on retail properties by reinforcing the trend towards entertainment and convenience oriented tenants, and enabling retailers to expand into multi-channel distribution systems incorporating Internet sites and "land based" stores.

Fortunately, through continuing innovations, adapting tenant mixes, and capital investment, retail property owners can mitigate many potential declines in retail demand from consumers. Longer term, rent pressure is expected as the Internet "distribution channel" grows.

While telecommunications and adaptability of space are the most important "intelligent" building technologies to tenants as they adjust to a multi-channel retail sales strategy, "intelligent" building technologies that address energy efficiency, security, air quality, lighting and other expense related issues can also reduce owner expenses as well as the substantial common area maintenance charges which are typically passed on to tenants.

Technology and Multifamily Demand

Technology has not fundamentally altered the total magnitude of multifamily tenant demand like it has for other property types. However, technology innovation continues to be key to job and income growth resulting in a strong net positive to multifamily demand. With new development continuing and little evidence of job growth, property market fundamentals in the U.S. apartment market are expected to remain weak until job growth increases.

By far the most important "intelligent" building attribute to multi-family tenants is high-speed Internet. While estimates vary, there are still surprisingly large numbers of apartments that do not have access to broadband Internet (speed of at least 200 Kbps). For many older buildings, new wireless technology may be the best alternative because it saves the cost of pulling cable for extensive wiring. For larger properties, the cost-benefit tradeoff between wireless installation or a structured wiring system is still being debated.

The demand for multifamily "intelligent" building technologies, with the exception of Internet access, is still relatively low. Energy efficiency is the most important factor influencing the selection of a new apartment, with 94% of respondents identifying energy efficiency as an important issue, far outdistancing issues such as the size of the unit, noise level, and crime.

Technology and Hotel Demand

Technology has had limited effect on the overall magnitude of demand for hotel properties. Slight declines in demand due to teleconferencing, reduction in the number of sales meetings, and enhanced communication technology have been offset by the broad economic growth benefits derived from technology based on productivity and profit increases. However, particularly in down markets, room rates have been negatively affected by comparative shopping made possible by the Internet.

The evidence for tenant demand, as indicated by occupancy and rent premiums, has not yet been established for many of these technology enhancements. The good news is that it is not typically difficult, or too expensive, to “wire” a hotel room. Category 5 cable, which is sufficient for most uses, is below $0.10 a foot while hardware can be as low as $10 and certainly not above $50 for the most expensive.

Geographic Differences in “Intelligent” Building Demand

Tenant demand for “intelligent” buildings varies by metropolitan area. It is not hard to understand that tenants for any type of property in San Jose are likely to place a greater priority on “intelligent” building technologies than tenants in most other metropolitan areas. However, with over 300 metropolitan statistical areas, (MSAs), geographic differences are not always so obvious, but can be important.

Conclusion

Technology is so pervasive in our society that it is difficult to isolate and evaluate its influence on real estate demand. Technology’s influence on demand is generally positive given its fundamental importance to economic growth. However, technology will significantly reduce demand in some areas and increase demand in others, making winners or losers out of certain properties or geographic markets. Investors and other real estate professionals who maintain vigilance concerning technology change will outperform their competitors.

II. Introduction

Technology has a pervasive influence on real estate demand because it affects where and how people live (residential); work (office, industrial); buy (retail) and recreate (hospitality).

In this report, we evaluate how technology affects commercial real estate demand in three primary ways:

- **Technology's effect on the overall magnitude of tenant demand by property type**;
- **Technology's effect on tenant demand for specific buildings; and,**
- **Technology's effect on investor demand.**

That technology influences property demand is no secret, but how it affects demand is not well understood. To unlock the secrets of this relationship, we first identify the key technologies influencing real estate demand in Chapter III. Next, in Chapters IV through VIII, we examine how technology influences the demand for each of the major property types: office, industrial, retail, multifamily and hotels. Finally, in Chapter IX we examine geographic differences in the demand for "intelligent" buildings. Technology terms throughout the report are clearly defined in the Technology Glossary in Appendix 1.

This report focuses on technology's influence on properties, not companies. While property assets managed by top managers with efficient and effective technology tools can increase the value of the asset to that manager, the purpose of this report is to isolate technology's impact at the property level.

The findings and conclusions of this report are based upon scores of interviews and review of hundreds of articles, reports, and databases addressing technology change and real estate demand. Due to the breadth of the topic covered, the purpose of the report is to provide an overview of key ideas and issues on the topic of technology and real estate demand to guide further investigation and study.

This report is designed to provide general, and not exhaustive, information regarding technology's impact on commercial real estate demand and does not constitute investment advice. The information, analysis or conclusions found in this report should not be used for the purposes of specific investment decisions without independent due diligence, further investigation and consultation with a professional investment advisor.

The National Association of REALTORS® neither endorses the conclusions of this report nor makes any representation that the information and analysis in this report are accurate, complete, or timely.

A. Recent History of Demand Forecasts

In the late 1990s, concern over rapid Internet and telecommunications advances led industry forecasters to project dramatic declines in office workers due to telecommuting, hoteling, and other changes. They also projected a decline in the need for retail space due to Internet shopping, and dramatic changes to industrial property demand due to improved inventory management technologies.

In 1999 and 2000, tremendous economic growth and the over-expansion of technology companies resulted in numerous, well-recognized industry forecasters challenging earlier concerns and predicting that technology changes would have a net positive impact on the demand for real estate.

Today, with the cooling of the overheated technology employment markets, and better information about telecommuting, Internet retail sales, and technology trends, it is a good time to reassess how technology influences real estate demand.

Additionally, beyond broad macroeconomic trends, technology can also directly influence a tenant's decision to lease space in a specific building and the price they are willing to pay for space in that building. For the purposes of this report, these building-specific technology attributes will be referred to as "Intelligent" Building Technologies.

B. Technology's Prominence in Driving Economic Growth

Technology has been a key driver of the U.S. economy historically, and will be so in the future. Accordingly, while many new technologies appear in isolation to reduce real estate demand, the net effect of technology on economic growth—and real estate demand—is positive.

Technology is often credited with the dramatic economic growth the U.S. has experienced in the last 50 years. Since the turn of the century, the U.S. economy has grown at a compound annual rate of 3.3%. However, prior to World War II, economic growth was around 2.7% per year. Since that time, the economy has accelerated at a compound annual rate of 3.8%. The principal catalyst for this enhanced economic performance was the dramatic increase in research spending by the federal government during World War II and after. Between 1938 and the mid-1960s, the federal government's share of all expenditures for research and development increased from 13% to 70%.[1]

Office space forecasting provides a good illustration of the complexity of evaluating technology effects on demand. As will be discussed in the next section, global job outsourcing and reductions in the space per office worker, fueled by technology change, appear to have significant potential to reduce the demand for office space in the United States. In isolation, this conclusion might be true. However, if the corporations that reduce costs and increase profits through using less office space and global job outsourcing reinvest and expand in other businesses, net office space demand could actually increase. It is because of these economic inter-relationships that one must be careful in drawing conclusions, in isolation, about a particular technology's effect on demand.

With these caveats and fundamentals in mind, in the rest of this section we look more closely at the effect of technology change on tenant demand for office, industrial, retail, multifamily, and hotel properties.

III. Technology and Commercial Real Estate Demand

Technology innovations like fiber optics, chip technology and advances in materials have led to some very critical technology applications such as broadband, the Internet, biotechnology, electro-magnetic trains, and solar energy as shown in Exhibit III-1. In turn, these technology applications significantly influence real estate property demand.

While scores of technology changes affect real estate, broadband, wireless, and the Internet will have the largest and most far-reaching influence of those technologies known today. The communications revolution ignited by these technologies influences the demand for specific properties directly through "intelligent" building technology as well as through the overall demand for real estate through changes such as Internet shopping, telecommuting, improved inventory management and other changes in the way people use space.

In the first half of this chapter we define "intelligent" buildings and address some key building technology issues influencing all property types. In the second section, we evaluate six other intriguing technologies with significant long-term potential to change the world.

A. "Intelligent" Buildings

"Intelligent" building technology began with electronically enhanced heating ventilation and air conditioning (HVAC) systems in the 1970s. The first stories on "intelligent buildings" began showing up in trade magazines in the early 1980s. The focus in the early 1980s through the early 1990s was in the automation of occupant safety, security and lighting systems. Today, with the dramatic growth in the Internet and fiber-optic cabling since 1998, and the more recent improvements in wireless technology, the capabilities of a fully "intelligent" building have grown dramatically, increasing their importance to tenants and owners.

1. Definition of an "Intelligent" Building

If you are confused about what an "intelligent" building is, you are not alone. Between rapidly changing technologies, often-conflicting definitions by competing vendors of "intelligent" building technologies, and the proliferation of new technologies, a clear and stable definition of what an "intelligent" building is has yet to evolve. While the classic definition of an "intelligent" building— "*any building that is fully leased*"—has some validity and intuitive appeal, a good working definition adapted from work done by the Continental Automated Building Association is:

> *The use of integrated technological building systems, communications, and controls to create a building, and its infrastructure, which provides the owner, operator and occupant with an environment that is flexible, effective, comfortable and secure.*[2]

Important points to highlight in the definition are the issues of system integration and building adaptability/flexibility. While historically, many "intelligent" attributes were available on a piece-meal basis—heightened security and/or automated lighting for example—the key thrust moving into the future is to utilize the new power of the Internet and enhanced broadband capabilities to put all of the building systems on a unified platform that can be easily managed and controlled in real time over the Internet using a standard web browser. An integrated "open platform" will enable the use of existing and newly developed building technologies while allowing tenant customization and control of their own environments.

Equally important is the issue of building adaptability and flexibility. Given rapid technological change, an "intelligent" building must be able to cost-effectively adapt to new technologies and tenant needs. Substantial risks have been taken on and real estate losses sustained by developers of telecom hotels and biotechnology buildings due to both high initial development costs and costly adaptation to alternative uses. Accordingly, for some types of buildings that may appear on the face of it to be "intelligent, " a lack of adaptability may disqualify them as "intelligent buildings," using a more practical definition of the term.

2. "Intelligent" Building Attributes

A building's "intelligence" is best understood by evaluating the number and quality of "intelligent" building technologies in the building as well as the integration of its technologies into a common management platform. Twelve key attributes of an "intelligent" building are described in Exhibit III-2. The most important attribute is the voice and data communications infrastructure.

The amount of bandwidth, wireless capabilities, and other telecommunications offerings have become critical to many tenant leasing decisions.

Many tenants are also attracted to a more efficiently run building with superior landlord communications and the ability to customize their environment. Certainly, for those tenants that pay their own energy costs, an efficient energy management system is also highly desirable.

While the physical characteristics of an "intelligent" building differ by property type, some of the key characteristics investors should consider include:

- Redundant access to multi-megawatts of electric power, with backup batteries and generators to ensure continuity of power;
- High-capacity risers that permit optical fiber runs by multiple carriers from redundant sources;
- Adequate rooftop space, with convenient access to in-building fiber or other communications circuits, for wireless local loop, conventional cellular and satellite antennas;
- Heavy-duty HVAC systems;
- Higher ceilings to allow for raised floors;
- Industrial-grade flooring able to support heavy equipment loads; and
- Physically and economically adaptable interior spaces.

The specific requirements for a building will vary by the size of the building and its targeted tenants, but these issues are important to assess in evaluating future capital expenditure requirements and the implications on building competitiveness. When evaluating possible "intelligent" Building redevelopment, it is also important to check local building departments because codes are often not as technology friendly as might be expected, increasing the cost and time required for redevelopment.

3. Costs and Benefits of "Intelligent" Buildings

To date, quantitative analyses demonstrating that "intelligent" building technologies provide economic benefits over and above their cost are nearly non-existent. Tenant demand for "intelligent" building technologies, other than demand for broadband and telecommunications, has not become a widespread factor in decision-making.

The cost of "intelligent" building technologies has also been high, and new technologies continue to be developed at a rapid pace, increasing the risk of obsolescence for technology investment that building owners must amortize over many years. Accordingly, many building owners, confronted with high costs, uncertain and changing technology, and lackluster tenant demand have chosen to ignore "intelligent" building technologies.

The cost/benefit relationship of "intelligent" buildings is improving as tenant demand increases and owner interest grows. Tenants are becoming more aware of "intelligent" building technologies, particularly those that reduce energy costs or improve their telecommunications. Demand is likely to accelerate in the future as more people access high speed broadband in their homes, and gain further experience with "intelligent" building technologies in many aspects of their lives. Many office tenants, primarily driven by corporate real estate facilities directors, are starting to be able to demonstrate cost savings through more efficient use of space through implementation of "intelligent" building technologies and flexible open office systems that decrease the amount of office space they need.

Owners have the most to gain through "intelligent" building technologies and are now beginning to take notice. Proponents of "intelligent" building technologies promote the opportunity for significantly higher rents, higher occupancies, and lower operating expenses. While rent increases sufficient to cover capital expenditures have been hard to demonstrate, anecdotal evidence suggests that "intelligent" building technologies can improve occupancies and, particularly through energy savings, lower operating expenses. As the hardware and the software to integrate "intelligent" building technologies improves, technology costs decline, and owners become more educated, the implementation of "intelligent" building technologies will increase.

In summary, better, cheaper technology and increased tenant demand will enable more rapid adoption of "intelligent" building technologies in the future.

4. Understanding Broadband

A straightforward definition of broadband is an Internet connection that is on 24/7 and delivers Internet service dramatically faster than the speediest dial-up modem. Broadband is widely defined as the ability to support data transfer speeds of at least 200 kilobytes per seconds (Kbps) in both directions. Three primary methods, and one emerging method, for delivering broadband are discussed below. A Table describing the relative data flow speed of each option is presented in Exhibit III-3.

a. Fixed Wire

DSL, or Digital Subscriber Lines, is a digital connection over existing telephone lines. DSL speed varies tremendously depending upon how far the customer is from the phone company central office and the sophistication of the office's digital switch. T1 and T3 lines are two variations of DSL broadband connections primarily in use by businesses and service carriers. T1 lines (or fractional T1 lines) provide connectivity at rates of up to 1.5 Mbps. T3, a variant of T1, can transfer data at speeds as fast as 45 Mbps. While T1 and T3 have historically been available at a cost range of $1,000 to $2,000 per month per service, this price has declined significantly in many areas.

Larger companies can access broadband speeds of up to 100 Mbps through Category 5 UTP copper wiring. Category 5 copper wiring is commonly used for data transfers within a local area network (LAN) and across the building cabling backbone. Many businesses today are beginning to demand even higher bandwidth applications. The copper cabling industry is working to meet these demands through delivery of Category 6 and Category 7 wiring.[3]

Fiber optic cables provide the highest bandwidth currently available. Multi-mode fiber is also used for cabling backbones due to its high bandwidth of up to 1 gigabyte (1,000 Mbps), its increased protection against tapping, and its ability to provide clearer, less distorted signals over long distances. Fiber optic cables are now comparable in price to UTP copper wiring, making them competitive for horizontal distribution, although the expense of terminating the fiber at each computer is still high.

b. Cable Systems

Cable offers a good solution for home-based businesses to access high-speed Internet service. However, except for select office buildings that are already wired for cable, cable is not a good solution for small businesses, but can be a strong alternative for multifamily properties.

c. Wireless

Wireless technology, as demonstrated by cellular telephones, is a practical technology with broad implications for real estate and society. While mobile wireless service has been available for many years, it is the more recent innovations and growth of Wifi, or wireless broadband, that has attracted strong interest from building owners.

Wireless broadband (or WiFi) is going to become more important in the future. While wireless speeds were around 15 Kbps or less a few years ago, today, speeds ranging from 11 Mbps for the widely adopted 802.11b technology to 54 Mbps for 802.11a are available. A 54-Mbps wireless system is nearly 1,000 times faster than a 56 kbps modem, more than enough speed and capacity for most users. In contrast, the latest 3G (third generation) mobile technology supports data rates of only 100 kbps. While WiFi appears to be the more important application for "intelligent" buildings, a full comparison of WiFi and 3G technologies can be found in a recent paper by William Lehr and Lee McKnight of MIT.[4]

The concept of an 802.11 wireless (WiFi) office is simple. It is a wireless local area network (LAN) that allows individuals to be connected to each other—and the Internet—at very fast speeds without the need for wiring. With an 802.11 wireless access point and wireless cards in all the devices, hard wiring is no longer required.[5] WiFi began as a way for businesses to set up office networks without running Ethernet cables all over the building, but once people discovered how easy it was to use WiFi to access the Internet wirelessly, WiFi has taken off around the world.[6]

Wireless technology cannot serve the full needs of many larger corporate businesses who need UTP copper (100 Mbps) or fiber optic (1,000 Mbps) capacity. However, wireless can be complimentary to the high bandwidth copper or fiber optic cables that run vertically through a building. Wireless, with a range of approximately 300 feet from Wire Access Points (WAPs), can significantly reduce the cost of wiring a specific tenant's space and add significant flexibility to the space. More importantly, for the millions of existing older buildings where raised floors are not feasible, wireless eliminates the need for such requirements. For major corporate users, wireless technology also provides a redundancy to fiber optics that increases the security of an "intelligent" building.

d. Power Line Communications

Technological advances that enable uninterrupted transmission of voice, video and data over electric power lines are anticipated to expand Internet service to large underserved areas in the United States and around the world.

Many of the nation's largest power companies are conducting field trials and a cost effective alternative to cable TV and phone lines is expected to be available in many areas in the near future. Power-line Internet is faster than dial-up, but not as fast as cable or DSL, and will be priced at around $30 per month.[7]

5. Energy Technologies

Building owners can earn substantial energy savings through tenant sub-metering, proximity controlled lighting, automated heat and lighting, and improved energy management. For new buildings, substantial energy efficiencies can be obtained by maximizing the use of daylight, external glazing and sophisticated HVAC design. Additionally, through the result of recent technological advances in electrical energy generation systems, building owners can build new independent systems, which are commonly referred to as distributed generation (DG) and combined heat and power (CHP).

DG/CHP systems can economically deliver electric power to large commercial properties on a more fuel-efficient, environmentally friendly basis. A typical DG/CHP system involves the installation of small micro plants located at or near the property that produce some or all of the electrical energy required by that property. The system is typically anchored by a generator that uses natural gas for its fuel. The systems typically occupy 800 to 1,600 sq.ft. of otherwise unused space – typically the rooftop, equipment room, garage or underused outdoor areas. The electricity generated by the systems flows into the building in parallel with the local utility grid's electricity, reducing, but not eliminating, the demand from the grid.[8]

To implement and operate a DG/CHP system, an owner must install, own and operate their own system or outsource to a third party that is engaged in such a business. In either case, with the tremendous increase in building technology, owners that can offer tenants redundant power economically will be significantly better off.

6. Investor Demand for "Intelligent" Buildings

Investors do not focus on "intelligent" building technologies. Limited tenant demand or focus on technology has kept investor interest low. Significant opportunity exists for those investors who consider technological issues. Through identifying potentially obsolete properties, or profitable capital expenditures, investors can profit from understanding changing tenant demands for "intelligent" buildings.

Based on our survey of acquisition officers, technology seldom even has a place on acquisition due diligence checklists. Market factors, leases, environmental issues, and building electrical and mechanical systems are the focus. The basic premise is that if tenants are leasing the building, then it shows empirical evidence of demand.

7. Future Directions for "Intelligent" Buildings

"Intelligent" building technologies and their role in the real estate industry will change dramatically in the future. The Internet has experienced unprecedented growth in the last few years and will continue to grow. The Internet is expected to become as dominant a technology as the computer or telephone. It took the Internet only nine years from its commercial introduction to penetrate 60% of households. This compares to 22 years for personal computers, 31 years for television, 37 years for radio, 42 years for electric light, and 53 years for the telephone to reach a similar market penetration.[9]

As access to broadband increases—the majority of people are still connected by 56K modems—the power and value of Internet access, and changes in the way people live their lives, will lead building owners and tenants towards greater adoption of "intelligent" building technologies.

Some observations about the future of "intelligent" building technology include:

- Office working environments will continue to become more flexible, with wireless networking and Internet access the norm for many small to mid-size buildings and businesses.

- Large public and private companies that have been leaders in leveraging technology in their businesses will also be leaders pushing the development and adoption of "intelligent" building technologies.

- More buildings will adopt "intelligent" technologies as positive cost benefit ratios emerge in more buildings due to increases in tenant demand and building technology cost reductions.

- Security applications will become more sophisticated including the use of biometric techniques to insure that recognition is unassailable, e.g., retinal scans, voice patterns, fingerprints, etc.

- Customization will become common, with software and interfaced devices allowing individual end users to control their personal environments to achieve a comfortable and effective work or living space.

- Energy systems will become more sophisticated. Indexing of employees' identification badges to heating and cooling systems, copiers or other office appliances so that the appliance will only operate when they sense they are approaching, will be commonplace having been demonstrated to reduce energy consumption by 45% in a test at Xerox.[10]

B. Six Other Intriguing Technologies

The six technologies described below have the potential to generate significant economic growth and determine which regions win and lose in their attempt to capture economic growth in the future:

- **Nanotechnology** has the potential to fuel U.S. economic growth in the future, providing the next wave—in concert with biotechnology—of technology-induced economic growth.

- **Biotechnology**, as with nanotechnology, will affect real estate primarily through promoting economic growth, but also in the attributes of properties required.

- **Cold Fusion's** influences on real estate could be significant if the cost of energy declines, increasing the value of property in areas that cannot be economically served by water and electrical power today, and potentially changing the relative value of areas where coal, oil, and natural gas are economic drivers.

- **Electromagnetic Train's** most important economic influence would be to reduce the cost of travel between markets within 1,000 miles of each other, enabling continued diversification of employment centers. Overall economic implications are uncertain as increasing train employment may come as a result of reduced air transportation employment.

- **Hydrogen Car's** economic impacts could be substantial as new automobiles and systems are put in place and we transition from an oil-based transportation economy to one based on hydrogen.

- **Saltwater conversion** has the potential to increase the value of land and property in arid regions, enabling continued development of markets that already have many natural growth attributes.

  While all the technologies identified have potential practical applications, the timing and potential for change varies dramatically. The broader implications of advanced nanotechnology may be five or more years out, while biotechnology is already driving economic growth in some regions. Cold fusion is still fighting its way through the scientific community and real progress is probably 10 or more years out. Electromagnetic trains are a technology here today in a number of countries, but the political and economic will to move the industry forward, given huge up front costs, has yet to materialize, making timing projections difficult. Hydrogen cars are at least 10 years from having a significant impact, and saltwater desalinization will be most important when water prices rise in the future.

  Each of the six technologies is discussed in more detail below.

1. Nanotechnology

Nanotechnology is not just technology reserved for Star Trek conventions, but a real new technology built upon our improving fundamental understanding of the physical structure of matter that will have vast ramifications on our lives in the future. Nanotechnology is typically referred to in two distinct ways:

- **Near-term nanotechnology:** this term covers almost any technology significantly smaller than micro-technology, e.g., nanoparticles. These new products will have both positive and negative health and environmental effects, but the effects will be modest compared to the later stages of the technology.

- **Advanced nanotechnology:** technology enabling broad control at the level of individual atoms. The essence of nanotechnology is the ability to work at the molecular level—to create large structures with fundamentally new molecular organization. It is this stage of nanotechnology that will have major societal impact.

Advanced nanotechnology, known as molecular manufacturing, will enable construction of a wide range of large objects inexpensively and with atomic precision. It will take us beyond materials and devices to complex systems of molecular machines, inspired by—but in some ways superior to—those found in nature. While scientists have not overcome the technical challenges of such complex systems, ongoing research is building the needed technology base, and will eventually place enormous payoffs within reach.[11]

The key applications of advanced nanotechnology driving growth that will have significant implications on real estate include:

- **Medical Uses:** molecular machine systems will be able to sense and rearrange patterns of molecules in the human body, providing tools needed to bring about a state of health, regardless of the cause of the disease;

- **Environmental Applications:** using molecular manufacturing techniques, it will be possible to construct products with zero chemical pollution, recycling leftover molecules. Environmental restoration could be carried out at the molecular level, detecting and inactivating unwanted chemicals;

- **Raising Sustainable Living Standards:** molecular manufacturing will be able to cleanly and inexpensively produce high quality products using common materials (especially carbon, which is in excess in the atmosphere in the form of carbon dioxide) and solar energy;

- **Lower Cost to Access Space:** the strong, lightweight materials enabled by molecular manufacturing will greatly lower the cost of accessing space and space resources, making their active use affordable for the first time.

Clearly, the ethical, economic and political ramifications of such wide-ranging applications will be immense and nanotechnology is clearly a technology to be watched[12].

2. Biotechnology

Bread, cheese, vinegar, marinades, wine and beer (biotechnology products) have been made using fermentation by microbes for thousands of years. Since 1953, when James Watson and Francis Crick described the double helix of DNA, progress has moved steadily. In 1982, the first genetically engineered product was approved for use by diabetics, human insulin, which was produced by Eli Lily & Company using E-Coli bacteria. With the completion of the "working draft" of a human genome in June 2000, the level of information and potential applications has grown dramatically. In combination with advances in data storage and computer technology, biotechnology will continue to be an important technology.[13]

Biotechnology's most well known applications are in pharmaceuticals and food production. The tremendous potential economic benefits to private sector businesses in both these areas has fueled tremendous research and many practical applications. Other biotechnology applications include:

- **Fuel:** using yeast and bacteria in the production of ethanol, methane, and crops for bio-renewable fuel;

- **Diagnostics:** using biotechnology to speed diagnosis of genetic disorders or infectious diseases and early detection of pregnancy;

- **Bioplastics:** instead of petroleum, biorenewable material, such as starch from corn or whey from cheese-making, can be used to make plastics;

- **Genetic Counseling and Gene Therapy:** prospective or current parents can learn about diagnosing and treating inherited diseases and whether their children may inherit such diseases; and,

- **Biopulping:** use of a fungus to convert wood chips to paper pulp while reducing energy use and pollutants.[14]

3. Cold Fusion

The collection of phenomena that has come to be called "cold fusion" was discovered by Professors Martin Fleischmann and Stanley Pons in the mid-1980s, and announced at a press conference of March 23, 1989 at the University of Utah. The phenomena reported by Fleischmann and Pons defied the then current understandings of how nuclear reactions could occur – they were never thought to be able to happen under such modest temperature conditions. This "cold fusion" reaction was obtained by splitting heavy hydrogen from oxygen in the molecules of the heavy water solution. Thus, the concept of nuclear energy from water at lower heat and more manageable waste products was born. This area of physics and energy research is still hotly debated.

Although cold fusion and other low energy nuclear reactions (LENR) appear promising, with technology and political debates continuing, and the high level of investment necessary to push cold fusion technology forward, practical applications will not be available for some time.[15]

4. Electromagnetic Trains

Electromagnetic (maglev) trains currently exist, but are not in commercial operation. The big difference between a maglev and a conventional train is that maglev trains do not have an engine—at least not the kind of engine used to pull typical train cars along steel tracks. The engine for a maglev train is the magnetic field created by the electrified coils in the guideway walls and tracks, which combine to propel the train.

Maglev trains, which can reach speeds of more than 310 miles per hour, would compete with the commercial airline industry. For comparison, a Boeing 777 commercial airplane used for long-range flights can reach a top speed of about 490 miles per hour versus the 310 miles per hour for maglev trains.

The first commercial maglev train made its test debut in Shanghai, China in 2002. Germany and Japan are both developing maglev train technology, and are currently testing prototypes. The influence of maglev trains in the United States is unlikely to be important for at least a number of decades. Estimated cost for building a maglev system in the United States range from $10 million to $30 million per mile. However, the development of room temperature super conducting super magnets could lower the cost of such a system, and the technology should be watched in the future.[16]

5. Hydrogen Fuel Cars

Hydrogen fueled cars are not expected to be viable for at least 15 years, and are not as clear a solution to energy and environmental concerns as might be popularly believed. In the short term, it is much less expensive to increase fuel energy standards in conventional automobiles and explore ethanol or other alternative fuels than it is to develop hydrogen-fueled cars. One of the key problems is producing the hydrogen. Current methods of producing hydrogen from oil and coal result in substantial carbon dioxide and require significant amounts of electricity, possibly eliminating many of the potential benefits of reducing greenhouse gases. Additionally, some estimates show that setting up a completely new infrastructure to distribute hydrogen would cost at least $5,000 per vehicle. Finally, billions of dollars in additional research is needed to develop hydrogen fuel cells that can match the performance of today's gasoline engines.[17]

Despite concerns, hydrogen cars have become a political favorite with President Bush's announced $1.2 billion in research spending in his January 2002 State of the Union address. Several oil companies, including BP and Shell, are exploring hydrogen production and distribution, and other groups have been organized to promote the fledgling industry. Perhaps most promising, some observers suggest hydrogen can be generated at home with steam and natural gas and several companies are developing such technologies.[18]

6. Saltwater Conversion

The conversion of saltwater, either brackish water or seawater, is a technological reality today. A handful of saltwater conversion plants are operational in Southern California producing water for more than 100,000 residents. The desalination plants in Southern California produce water for approximately $800 per acre-foot of water—enough water to meet the annual needs of two typical households—compared with $430 to bring in the same amount of water from the Colorado River. Accordingly, as the availability of alternative water sources declines, and water costs increase, desalinization could take on a much bigger role in many parts of the country. One water manager in Southern California estimates that as much as 20% to 25% of the water supply will be provided by desalinization in 2020 in Southern California.[19]

Exhibit III-1
Linking Technology Change and Real Estate

Technology Innovations	Technology Applications	Real Estate Property Implications
	Communications:	
• Fiber Optics	• Broadband	• Reduced/Modified Space Demand
• Chip Technology	• Wireless Communication	• Real-Time Customization of Space Use
• Materials Advances	• Internet	• Speed of Business/Product Change
• Micro-electronics	• Communications Software	• Global Job Outsourcing
• Programming Languages	• Network Integration	• Internet Shopping
• Genetics Advances	• Radio Frequency Tracking	• Telecommuting
• Photovoltaic Cells	• Automated Language Translation	• Improved Inventory Management
• Lasers		• Intelligent Buildings
• Electro Magnetic Power	**Other:**	• Energy Options/Efficiency
• Cold Fusion	• Nanotechnology	• Geographic Area Winners and Losers
	• Biotechnology	
	• Hydrogen Cars	
	• Saltwater Conversion	
	• Solar/Nuclear Energy	
	• Electromagnetic Trains/Travel	

Source: The Muldavin Company, Inc.

Exhibit III-2
Intelligent Building Attributes

	Basic Building Systems	*Widespread use of computer-based processing enables the automation of all basic building systems. Increased use of "Open Protocol" platforms enables more systems to be integrated, increasing the value achieved from intelligent building investment. Definitions for each system follow.*
1.	**Voice and Data Communications**	DSL, cable, UTP copper cable; fiber optic cabling and/or wireless infrastructure. Telephones, voicemail, intercoms, paging, elevator music and kiosks; video and audio conferencing, email, Internet access, database access, remote building services access, television; enhanced in-building cellular.
2.	**Digital Amenities**	Digital signage; web-based tenant communication and information systems for interactive property management and community building (procurement, building maintenance, community portal), business center, electronic funds transfer to pay bills.
3.	**Lighting**	Auto on/off; adjust lighting levels through photochronomic windows or PC/phone; centralized control, manage energy consumption by room; occupancy detection.
4.	**HVAC and Air Quality**	Permit individual occupants to adjust workspace temperatures, monitor temperatures, introduce aromas, adjust usage profile, adjust indoor air quality based on room occupancy and, adjust humidity, temperature and air flow speeds.
5.	**Energy Efficiency and Management**	Ensure maximum efficiency and lowest operating cost. Reduce heat gain in the summer and heat loss in the winter. Purchase of electricity in real-time for cost savings, combining various energy sources to create more efficient utilization and pricing. Submetering for apartments and/or tenant offices or retail spaces.
6.	**Security**	Access control; intrusion and surveillance integrated via access cards; elevator and door interfaces; intrusion detection; video cameras, sensor detection, guard tours and parking controls.

Exhibit III-2
Intelligent Building Attributes

7.	**Elevators and Escalators**	Efficiency of use. Some elevators may be shut down during part of the day; communications within the elevator for voice and advertising/information; controlled floor access; passengers grouped by floor designation.
8.	**Life Safety**	Fire and police communication; doors release per code constraints under emergency conditions; HVAC systems extract smoke, pressurize stairwells, and recall elevators; lighting is turned on in key areas of the building; exact location of fire is communicated to fire personnel; emergency broadcast systems automatically initiated.
9.	**Building Condition Monitoring**	Counteract vibrating floors, measure snow-loads on roofs, moisture detection in subsurfaces, fault detection, monitor strain on key structural elements from wind and earthquake loads, electrical flow monitoring to identify potential hazards; monitor conductivity of lubricating oil to detect excess metal wear.
10.	**Parking Communications**	Automated parking attendants; parking management that integrates a building's internal car parking system within the framework of a citywide car park management system.
11.	**Smart Construction Materials**	Active noise insulation using piezo-electric actuators, anti-phase cancellation and masking noise generators. Active sound absorption using dynamic change of surface acoustics, audience size adaptability and distinction between music and speech types, along with dynamic sound control. Photovoltaic systems (PV's), are used with solar cells.
12.	**Adaptability**	Open floors; wireless access; zonal distribution and control of lighting, and thermal controls; standardized interior building components; sophisticated acoustical controls and planning.

Source: The Muldavin Company, Inc.

Exhibit III-3
Relative Speed of Telecommunication Options

Option	Speeds	Relative Speed
1. Initial Wireless Speed	15 Kbps	¼ speed of 56 Kbps modem.
2. Standard Telephone Modem	56 Kbps	Typical speed of 56 Kbps dial-up modem.
3. Typical Home or Small Business DSL/Cable Broadband	350 Kbps	***6 times faster*** than 56 Kbps modem.
4. DSL T-1 Line	1.5 Mbps (1,500 Kbps)	***26 times faster*** than 56 Kbps modem.
5. Mid-Size Business Fixed Copper Wire Broadband; 802.11b Wireless	11 Mbps (11,000 Kbps)	***196 times faster*** than 56 Kbps modem.
6. Large Business Fixed Copper Wire; 802.11a Wireless	54 Mbps (54,000 Kbps)	***964 times faster*** than 56 Kbps modem.
7. Large Business Fixed Copper Wire Broadband	100 Mbps (100,000 Kbps)	***1,785 times faster*** than 56 Kbps modem.
8. Fiber-Optic Fixed Wireless	1,000 Mbps (1 Gigabit) (1,000,000 Kbps)	***17,857 times faster*** than 56 Kbps modem.

Source: The Muldavin Company, Inc.

IV. Technology and Office Property Demand

A. Overall Demand for Office Space

On balance, technology should generate a net positive effect on office employment growth in the future. The structural shift to knowledge workers, the United State's leadership in many technology markets, and the increasing profitability of businesses due to technology should be more powerful positive stimuli than global outsourcing, telecommuting and increased productivity. However, while in the longer run the effect of technology on office space demand should be a net positive, current trends towards globalization and corporate space downsizing suggest a difficult transition period in the next few years.

Evaluating the influence of technology on demand for office space has been difficult during the last few years. In 1998 and 1999, increasing productivity and telecommunications innovations led forecasters to predict that technology might reduce office space demand, all other things being equal. In late 1999 and 2000, the dramatic growth in technology companies, primarily related to telecommunications and the Internet, increased office demand in certain markets to unprecedented levels. As is often the case, the answer about how technology will affect real estate demand lies somewhere in the middle.

We have identified eight key trends that are critical to understanding the effect of technology on office demand:

- Telecommuting
- Global outsourcing
- Changing tenant use of space
- Increased productivity
- Structural shift to knowledge workers
- Productivity and profit increases
- Projected labor shortages

- Biotechnology and nanotechnology

These trends are described and evaluated in Exhibit IV-1 found at the end of this chapter.

To most accurately evaluate the overall net influence of technology on office space demand, economists need to refine their economic forecasting models to fully consider the trends identified above. The positive job effects of global outsourcing, productivity, and other trends are subtle and complex, making it easy for investors and other observers to gravitate to broad negative conclusions about the markets, as has recently been the case with Outsourcing in the media. Based on discussions with economists and real estate demand forecasters, they are beginning to pay more attention to how some of the trends identified in this section influence future job growth, and continued vigilance in reviewing forthcoming forecasts can yield important insights.

B. Tenant Demand for Specific Office Buildings

While broad macro economic trends will determine the overall magnitude of office space demand, and which regions win and lose, technology also affects tenant demand for specific buildings within a market.

1. Attributes of "Intelligent" Office Buildings

All of the 12 key "intelligent" building attributes described in Exhibit III-2 are applicable to office buildings. Enhanced voice and data communications is the most important attribute, now a commodity requirement for many tenants.

Enhanced broadband capabilities are becoming more common. While in the past, many companies would run their network communications and Internet access for their employees on a 1.5 Mbps T1 connection, many large and small companies are opting for 10 Mbps, 100 Mbps, and in some cases, even giga Ethernet (1,000 Mbps) solutions. Owners of larger new buildings that appeal to more sophisticated corporate tenants need to carefully consider installation of the full suite of high quality integrated systems outlined in Exhibit III-2 if they want to ensure the longer term positioning, and pricing, of their property as a Class A asset.

While larger Class A office properties in the future will need to employ a majority of the 12 "intelligent" building attributes in Exhibit III-2 to stay at the forefront of the market, most Class B, Class C, and many existing Class A buildings need only focus on enhanced broadband and wireless capabilities. A solid broadband and wireless capability will enable most existing office buildings to meet their target tenant needs and enable some level of security and energy technology enhancement to occur. Importantly, with the dramatic improvements in wireless capability, many older office buildings that were becoming technologically obsolete due to their inability to cost-effectively provide raised floors for cabling have received a new lease on life.

Cisco Systems provides a good example of cutting-edge "intelligent" building technology applications for office buildings. Cisco has design guidelines and standards that highlight the technology required in their buildings. A summary of the basic structure of an "intelligent" building for Cisco Systems is as follows:

- Fiber optics between buildings;

- Category 6 wiring from the fiber optics to wireless hub boxes in the building;

- Wireless transmission from the wireless hubs to desktops systems. Their system is the backbone for card access, security and video surveillance, batch data processing, voice and data;

- Building automated systems, such as HVAC and lighting, are switching from a direct digital control (DDC) format to an Internet protocol port connecting all of the internal operating systems; and

- Raised floors are required in R & D labs, but not in office administration buildings.

2. Evidence of Tenant Demand For "Intelligent" Office Buildings

The demand for "intelligent" building technologies by office tenants is still in its infancy. Regardless of the type or size of tenant, the key issues driving tenant office leasing decisions are cost, proximity to the boss's residence, access to current and potential employees, proximity to customers or clients, and proximity to restaurants and retail locations.

To a large degree, due to proliferation of high-speed broadband that can be delivered through telephone lines at speeds of up to 45 Mbps, the majority of tenants view a quality telecommunications service package as a minimum requirement. Accordingly, if your particular building does not have access to broadband – with speeds of a minimum of 200 Kbps – or has some other limitation to high speed Internet due to its remote location, cost, or other issues, the building may become functionally obsolete, or not perform to historic levels.

a. Technology Not Ranked as Key Issue

The tension between tenant demand for more sophisticated telecommunications services and cost were clearly reflected in a recent survey of 21 tenants in a Class B office building in Chicago. In this survey, mostly of tenants of 8,000 sq. ft. or less, only three of the tenants were willing to pay the additional costs to get a more comprehensive, higher speed telecommunications package. Since building tenants already had access to 1.5 Mbps DSL broadband, very few were willing to pay the incremental dollars to add the technology.

The sentiment demonstrated by tenants in Chicago is reflected in building owners' and managers' opinions, as shown by a 2002 Building and Owner Management Association (BOMA) survey presented in Exhibit IV-2. In a survey of BOMA members, technology was ranked 7th out of 9 operational issues in the short-term. Looking at the same 9 operational issues over the longer term, building owners and managers continued to rank it 7th. Leasing and marketing, tenant retention, and operations and maintenance issues ranked 1, 2 and 3 respectively.

Perhaps most interesting, our research indicates that little published work has been done recently on tenant demand for technology related building attributes. Even corporate real estate groups, whose members tend to be some of the most sophisticated office space tenants, have not focused on technology's role in office buildings. Despite limited research, technology is clearly becoming more important to tenants, and owners and tenants should see increased benefits from technology investments, so more research can be expected. However, given rapid technology change, solid studies demonstrating economic benefits will continue to be difficult to complete.

b. Key Technology Attributes

While "intelligent" building technologies may always be less important than location and cost, for some tenants "intelligent" building technologies are critical. Some of the key technology related attributes demanded by tenants include:

- Redundancy/back-up power source;
- Above standard electrical (up to 12 watts per sq.ft. of power);
- Fiber optic capability;
- Improved security and 24/7 access;
- Minimum of T1 and T3 lines;
- Automated building management systems (HVAC, etc.); and
- Access to satellite dish.[20]

c. Adaptable Offices

Perhaps the most important influence of technology on the type of office buildings tenants want relates to interior office design. An office building today is not fully "intelligent" if it cannot cost effectively adapt its internal space to meet changing business needs. Technology change, shorter product lifecycles, employee churn rates of 40% to 100%[21] and ongoing mergers and acquisitions make frequent change the norm.

An adaptable office must respond to changes in demand in four important ways:

- The adaptable workplace must adapt quickly with minimum downtime;
- Reconfigurations or renovations must be executed easily, with minimal need for construction trades or specialists;
- The space should perform economically, with minimal cost or expense; and,
- The space must perform responsibly with minimal waste of resources.[22]

Law offices in some markets, which once averaged 1,400 sq.ft. per attorney, now average less than 700 sq. ft., due partially to technological advances. Lexus Nexus' databases have replaced space-consuming law libraries, and computer savvy attorneys do a lot of work that previously was assigned to assistants; thus several attorneys share one assistant. Meeting rooms, break rooms, conference rooms, centralized support services and other design changes have also changed office interiors, as well as the overall demand for office space.[23]

Exhibit IV-1
Technology's Influence on Office Demands

Trends	Facts/Observations	Demand Effect
1. Telecommuting	Latest U.S. Bureau of Labor statistics data from 2001 show 19.8 million people (15% of workforce) do some work at home. Only 539,000, less than 0.5%, are fulltime wage earners. Importantly, the absolute number of workers working at home has gone down 8% since 1997, reversing the upward trend from earlier years.[1] Growing broadband accessibility and growing self- and part-time employment should slowly increase this number.	Marginally reduce demand; enables decrease in space/worker.
2. Global Outsourcing	Forrester Research estimates 3.3 million jobs, and $136 billion in wages, will be lost in next 13 years. If even half these jobs use office space at an average of 220 sq. ft. per worker, this would equate to an annual decline of nearly 28 million square feet. Average annual forecasted absorption by PP&R for the top 54 markets for the next four years is 92 million, which, to some degree, incorporates economists' estimate of the negative impact of global outsourcing. The loss of 3.3 million workers in isolation, would result in less than a 1% drop in GDP.[2]	Significant reduction in demand; biggest impact likely in secondary and tertiary U.S. cities that historically have served as call centers and/or administrative and technology back-office.
3. Tenant Use of Space	Telecommunications innovations and rapid product life cycles, as well as cost cutting, encourage more group workspace, smaller offices, more open flexible space, hoteling, and other space reducing actions. One major corporation who is moving to what they call a "Net Office" environment has demonstrated reductions in space per worker from 220 sq. ft. to 120 sq. ft. in select office buildings. Despite such examples, space per worker trends have not declined significantly and some predict continuing slow increases in space per worker.[3]	Decline in space required per worker.

Source: The Muldavin Company, Inc.

Exhibit IV-1
Technology's Influence on Office Demands

Trends	Facts/Observations	Demand Effect
4. Worker Productivity	Technology related productivity gains have contributed to the current U.S. "jobless" recovery. Federal Reserve economists report that 2.7 million jobs lost since 2001 unlikely to come back. Due to productivity gains, unemployment rate could stay above 6%, with little employment gain, even with GDP growth of 3% and 4% in the next two years.[4]	Reduce space demand; shorter-term vs. longer-term problem.
5. Structural Shift to Knowledge Workers	The U.S. economy continues its long-term shift from an agrarian and manufacturing economy to a knowledge-based economy emphasizing office jobs. U.S. companies dominate the TR Patent Scorecard in 2003, a leading index of the world's 750 most innovative technology companies, capturing all the top rankings and over 80% of all spots. The index serves as a means of identifying technologies with commercial potential.[5]	Significant demand increase.
6. Productivity and Profit Increases	Technology has been a key contributor to economic and job growth historically. Recent productivity and profit gains due to global outsourcing, reductions in costs, and worker productivity will result in investment and innovation in other areas that will improve job growth.	Moderate demand increase.
7. Projected Labor Shortages	By 2010, the U.S. economy will require 168 million jobs, but only 158 million people will be able to fill them according to the Bureau of Labor Statistics. Future corporate profits will be driven by investments in human capital. "Very likely, workers will not only demand the flexibility to work from home, for example, but will also expect employers to provide personal (not shared) space at the company office and more amenities. On a relative basis, the potential cost of losing employees to competitors will far exceed the cost of continuing to provide 200 square feet per worker".[6]	Help to maintain space per worker ratios; significant long-term concern for office absorption if fewer workers are coming into the workforce.

Source: The Muldavin Company, Inc.

Exhibit IV-1
Technology's Influence on Office Demands

Trends	Facts/Observations	Demand Effect
8. New Technologies	Nanotechnology, biotechnology and other of the six key technologies identified in Chapter III have significant potential to drive office space demand. Biotech is big, but obsolescence and oversupply (over 28 states have at least one publically supported financial source for biotechnology) are a cause for concern.[7]	Increase in demand; clustering in select regions likely.

Net Impact on Office Demand: Office using employment growth net positive; short-term declines, balance in longer run; declines in space per worker. Globalization trend bears watching; U.S. needs to find new and exploit old strengths in world economy.

[1] U.S. Bureau of Labor Statistics, *News*, Work at Home in 2001, March 1, 2002; Telecommuting; The Real Story, *Torto Wheaton Research*, January 1999.
[2] 3.3 Million US Service Jobs to go Offshore, *Tech Strategy Research Brief*, November 11, 2002; The Outsourcing Solution, *Business 2.0*, September 2003; Overseas Job Shift Could Displace 50 million SF of U.S. Office Space Per Year, *Globestreet*, August 19, 2003; Globalization Heat Wave: Outsourcing White Collar Jobs, *Trend Letter*, May 26, 2003; Property and Portfolio Research, 2Q 2003 *PPR Fundamentals*.
[3] Real Estate at Cisco; Presentation at Senior Executive Strategic Issues Forum of The National Association of Real Estate Investment Managers, June 24, 2003.
[4] TWR Viewpoint; Extended Jobless Recovery Goes Mainstream; *Torto Wheaton Research*, Fall 2003; Federal Reserve Bank Study; Erica Groshon and Simon Potter, September 2003.
[5] The TR Patent Scorecard 2003, *MIT Enterprise Technology Review*, 2003.
[6] Gain a Competitive Edge with a Well Trained Workforce, *Trend Letter*, May 23, 2003, Conjectures on the Impact of Technology on Real Estate, Prudential Real Estate Investors, *Real Estate Finance*, Summer 2000.
[7] Incubate This, Warren Lutz, *Urban Land*, March 2003.

Source: The Muldavin Company, Inc.

Exhibit IV-2
Key Property Operational Issues[1]
Office Properties

Operational Issues	Rank	Short-Term Score	Rank	Long-Term Score
Leasing/Marketing	1	8.34	1	6.89
Tenant Retention	2	7.55	2	6.77
Operations/Maintenance	3	3.24	4	3.23
Aging Equipment/Building	4	2.30	3	6.02
Space Remodel/Tenant Improvement	5	1.88	8	1.33
Budgeting	6	1.76	6	1.49
Technology	7	1.65	7	1.44
Energy Management	8	1.53	9	1.15
Staffing/Personnel	8	1.53	5	1.50

[1] Based on Survey of Building Owner and Management Association (BOMA) members. The higher the score, the more interest in the issue by BOMA members. Any issue with score of 5 or above should warrant high attention; a score below 2 reflects less than 1 in 7 respondents listed it a top issue, and therefore it should not be considered a priority.

Source: BOMA International Research Department, *BOMA Pulse*; May 2002; The Muldavin Company, Inc.

V. Technology and Industrial Property Demand

A. Overall Demand for Industrial Space

Technology, in concert with the trend to consolidate warehouse and distribution facilities into fewer locations, has increased the demand for larger and more sophisticated warehouse, distribution and manufacturing facilities. Due primarily to the potential decline in warehouse space due to radio frequency identification and improved inventory management, the overall demand for unsophisticated industrial properties is expected to decline as a result of technology change.

Industrial properties will benefit, like office properties, from the general increase in the profits and productivity of U.S. companies as a result of technology. A summary assessment of eight key technology trends and their effect on industrial property demand is presented in Exhibit V-1.

An important new technology, Radio Frequency Identification (RFID) has received a lot of attention recently, with the *Trend Letter* predicting in their June 9, 2003 newsletter that applications of this technology would reduce warehouse inventories by 50%.[24]

RFID tags are miniscule microchips, which already have shrunk to half the size of a grain of sand. They listen for a radio query and respond by transmitting their unique ID code. Most RFID tags have no batteries, using the power from the initial radio signal to transmit their response. RFID provides near perfect visibility of the supply chain, enabling real time tracking of what and where inventory is available. Unlike bar codes, which must be read one by one, RFID chips enable all items on a pallet to be read at once, reducing a 20-minute task to a matter of seconds.[25]

As to the *Trend Letter's* estimate of a 50% decline in warehouse inventory, it does not appear reasonable. However, a marginal decline of 10% or more in warehouse space demand in the coming years is possible. Reductions in warehouse space demand would come from a reduction in the volume of goods needed in inventory. If a supplier had near perfect inventory information, the extra "contingency" volume of inventory could be reduced. Wal-Mart has already announced that its top 100 vendors must employ RFID by 2005, and other vendors by 2006. Wal-Mart expects savings—due to theft control, inventory efficiencies, etc.—of 6-8% of its supply chain costs, which are estimated to be approximately 10% of revenues.[26]

While Wal-Mart is leading the way, privacy, performance and other issues will moderate the speed and breadth of adoption. One huge issue limiting adoption is the systems and software costs to collect, integrate and use the data, which can sometimes exceed the hardware costs by an order of magnitude.[27]

B. Tenant Demand for Specific Industrial Buildings

1. Attributes of "Intelligent" Industrial Buildings

Of the 12 key "intelligent" building attributes identified in Exhibit III-2, the most important for industrial buildings are voice and data communications, energy efficiency, life safety, and adaptability. Unlike office buildings, where high quality voice and data communications are a minimum standard, there are numerous types of storage and manufacturing properties where sophisticated telecommunications are not important. However, for higher quality warehouse and distribution facilities, high-speed telecommunications bandwidth has become critical.

Energy efficiency and fire safety are also critical concerns, and technology that assists in providing these benefits can be important. Redundant fiber and power service for financial institutions and other types of tenants with "mission-critical" responsibilities are also important attributes.

Perhaps the most important attribute is the need for adaptability. Technology-induced changes in inventory management, customer requirements for 24-hour turnaround and "just in time" distribution, and changes in logistics for e-commerce companies have forced property owners to focus on adaptability and service. Many companies are moving to consolidate major manufacturing and distribution operations. The industry trend is towards fewer locations and larger facilities. However, consolidation into larger facilities has risks, and those risks are being mitigated by tenant demands for flexibility.

In some cases, flexibility is sought through shorter leases, five year out clauses, and expansion options in leases. Physical requirements can also enable flexibility. Adequate parking for potential changes in use, portable mezzanines that don't require major retrofit when leases expire, more onsite trailer/container parking, storage to handle increased product turnover, space to accommodate additional staging options, and built-in expansion space for the future are a few of such physical requirements.[28]

The proliferation of e-commerce companies led by Amazon.com, eBay and others is further pushing the change in industrial property as shown in Exhibit V-2. Where traditional logistics typically involved the movement of bulk goods in large quantities to a more limited number of destinations, today's e-commerce logistics require much smaller orders to customers all over the country in highly dispersed locations. The result of this change is that the demand for larger distribution-orientated properties is growing while the demand for more traditional storage-orientated facilities is declining. Certainly, for many potential tenants, an old-style warehouse will continue to make sense, but industrial buildings with an old-style warehouse and distribution configuration may have more trouble attracting tenants in the future in certain markets.

2. Evidence of Tenant Demand for Industrial Buildings

The demand for "intelligent" building technologies by industrial tenants is strong for the new, larger distribution facilities, but still fairly limited throughout the marketplace. As shown in Exhibit V-3, availability of telecommunications services was ranked 11th of the 25 most important site selection factors of manufacturing and distribution companies.[29] The availability of skilled labor, labor costs, tax exemptions, state and local incentives, and highway accessibility were the most important factors identified by industrial property users. The availability of broadband telecom services ranked even lower at 15th. On the other hand, the availability of telecommunications services ranked significantly above raw materials availability, availability of unskilled labor, and proximity to suppliers, key historically important site selection factors.

Those corporations who want to maximize the efficiency of their industrial properties, and build an infrastructure that supports future growth, are focusing on the following property attributes:

- Flexible configurations;
- High speed telecommunications bandwidth;
- Two sources of fiber optic cable access;
- Extra conduit duct banks for future telecom facilities growth;
- Giga-speed copper based capability;

- Wireless local area network capability to support remote warehouses and access facilities;
- Minimum of T1 lines;
- Redundant fiber and power service providers;
- Added clear height and accommodation of narrow aisle racking systems;
- Large number of truck doors, cross dock configurations, and internal staging areas;
- Larger truck courts and/or excess land for staging/expansion; and,
- Energy and fire safety efficient systems.[30]

Few industrial property owners are interested in "intelligent" building technology. In some cases, this is due to the triple net structure that is common with many industrial facilities. Owners are focused on providing the shell and backbone infrastructure to enable the widest range of tenants to be accommodated in their space. Cost issues, which are much more critical to evaluate on a payback basis in office properties, are less an issue for industrial property owners due to tenant responsibility for much of the build-out in industrial properties.

Exhibit V-1
Technology's Influence on Industrial Demand

Trends	Facts/Observations	Demand Effect
1. Radio Frequency Identification	Radio frequency identification technology—known as RFID, or smart tags—has been around for decades, but is now becoming more cost effective. According to IBM Research and other industry specialists, companies using smart tags can potentially shrink their inventories by 5% to 25%. Market research firm Frost & Sullivan predicts that RFID chips and related software will be a $7.5 billion industry by 2008[1]. Editors of the *Trend Letter* predict that it will be twice that, if not more. They also project that RFID systems will cut in half the amount of warehouse inventory While editors of the *Trend Letter* project that RFID systems may eventually reduce warehouse demand in half, this estimate appears unsupportable. Many companies, such as Wal-Mart, Department of Defense vendors, Benetton, and AMEX have initiated adoption of the technology over the next few years, but privacy concerns, cost (averaging 40¢ to 50¢ or more per chip depending on volume), lack of definitive standards, performance and functionality concerns, and systems integration issues will continue to moderate absorption for a number of years.[2] Additionally, inventory management techniques have already improved efficiency, reducing the magnitude of additional efficiency enhancements.	Moderate longer-term reduction in warehouse and distribution property demand; demand reductions not projected across all industrial property types.

Source: The Muldavin Company, Inc.

Exhibit V-1
Technology's Influence on Industrial Demand

Trends	Facts/Observations	Demand Effect
2. E-Commerce Retailing	Internet retailers demand different fulfillment practices, inventory controls, and distribution systems. Several logistical models for Internet sellers have emerged, including in-house distribution and warehouse development (e.g., Amazon); outsourcing all logistical operations (e.g., Wal-Mart); outsourcing the distribution function (e.g., Dell Computers); or combining both physical store and regional warehouse (e.g., Gateway, Macys).[3]	Increase in demand for sophisticated automated distribution properties; decrease in demand for other industrial property types.
3. Improved Inventory Management	Technology innovations in telecommunications and logistics planning software have enabled corporations to improve inventory management to address "just in time" and related customer demands.	Decline in industrial space demand.
4. Mass Customization	Communications technologies have enabled business and home consumers to customize the way they relate to products. This trend is expected to grow as both consumers and businesses become more comfortable with technology and more individualized marketing programs are created.	Increased demand for more sophisticated distribution facilities with the flexibility to provide greater value added services at the distribution level. Merging of manufacturing and distribution facilities in some situations.

Source: The Muldavin Company, Inc.

Exhibit V-1
Technology's Influence on Industrial Demand

Trends	Facts/Observations	Demand Effect
5. Structural Shift to Knowledge Workers	The United States has been transforming from a manufacturing economy to a knowledge and services economy for many years. In 1950, manufacturing accounted for 33.7% of all non-farm jobs. By 2000, the proportion had dropped to 14%. Not only has the percentage dropped, but since 1980 the total number of manufacturing jobs has decreased by 1.8 million.[4]	Significant decline in manufacturing employment and demand for industrial space.
6. Productivity & Profit Increases	Technology has been a key contributor to economic and job growth historically. Recent productivity and profit gains due to global outsourcing, reductions in costs, and worker productivity will result in investment and innovation in other areas that will improve job growth.	Moderate increase in industrial demand due to overall economic growth.
7. Projected Labor Shortages	Labor shortages projected by the Bureau of Labor Statistics to arrive later this decade will have a significant influence on industrial property. Today, the availability of skilled labor is already the most important site selection factor of 25 factors cited by manufacturers.[5]	Increased importance of quality of life variables in site selection; encourage current trend towards higher quality and more attractive industrial facilities.
8 New Technologies	Nanotechnology, biotechnology and other of the six technologies identified in Chapter 3 have potential to drive industrial space demand.	Limited increase in warehouse and distribution demand; strong demand increase in R&D and specialized manufacturing facilities.

Source: The Muldavin Company, Inc.

Exhibit V-1
Technology's Influence on Industrial Demand

Net Impact on Industrial Demand: Increase in demand for more sophisticated warehouse, distribution and manufacturing facilities; potential declines and functional obsolescence for many properties.

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[1] Bye-Bye Bar Codes," *Trend Letter*, June 9, 2003.
[2] RFID Tags: Big Brother in Small Packages, *Perspectives*, CNETNews.com, January 13, 2003; More Companies Eye RFID Technology's Potential, *Computer World*, July 28, 2003; RFID Technology, *Silicon Investor*, September 25, 2003; Clothier Benetton Adopts Phillips RFID Technology, *EE Times*, March 12, 2003; interview with Ian McPherson, The Wireless Data Research Group, October 2003.
[3] "E-Commerce and Real Estate: Threat or Opportunity?" *PREA Quarterly*, Winter 2000.
[4] U.S. Department of Labor
[5] 17th Annual 2002 Corporate Survey, Area Development, December 2002; U.S. Census Bureau.

Source: The Muldavin Company, Inc.

Exhibit V-2
Traditional vs. E-Commerce Site Logistics Comparison

	Traditional Logistics	E-commerce Logistics
Shipment type	Bulk	Parcel
Customer	Strategic	Unknown
Demand style	Push	Pull
Inventory/order flow	Unidirectional	Bidirectional
Average order amount	More than $1,000	Less than $100
Destinations	Concentrated	Highly dispersed
Demand	Stable, consistent	Highly seasonal, fragmented
Accountability	One link	Through the entire supply chain

Source: James McWalters, PMRealty Advisors; Technology & Warehouse Real Estate; REIP 2000, February 8, 2000; The Muldavin Company, Inc.

Exhibit V-3
Key Site Selection Factors[1]

Ranking	Site Selection Factors	2002
1.	Availability of skilled labor	90.9%
2.	Labor costs	89.9%
3.	Tax exemptions	88.2%
4.	State and local incentives	88.0%
5.	Highway accessibility	86.6%
6.	Corporate tax rate	84.6%
7.	Proximity to major markets	83.7%
8.	Occupancy or construction costs	82.4%
9.	Energy availability and costs	80.9%
10.	Environmental regulations	76.7%
11.	**Availability of telecommunications services**	**76.1%**
12.	Availability of land	75.2%
13.	Cost of land	74.0%
14.	Low union profile	69.4%
15.	**Availability of broadband telecom services**	**66.7%**
16.	Proximity to suppliers	61.8%
17.	Availability of long-term financing	60.0%
18.	Right-to-work state	58.0%
19.	Raw materials availability	56.0%
20.	Availability of unskilled labor	55.1%
21.	Accessibility to major airport	54.0%
22.	Training programs	44.7%
23.	Proximity to technical university	33.4%
24.	Railroad service	22.6%
25.	Waterway or ocean port accessibility	19.3%

[1] 81% of survey respondents are in manufacturing or distribution. All figures are percentages and are the total of "very important" and "important" ratings of the Area Development Corporate Survey.

Source: 17th Annual Corporate Survey, Area Development, December 2002.

VI. Technology and Retail Property Demand

A. Overall Demand for Retail Space

Despite doomsday forecasts that the Internet would eliminate the middleman—retail properties—from the retailing equation, technology has had a surprisingly limited impact on the overall volume of retail sales in stores. However, Internet retail sales have had a dramatic impact on retail properties by reinforcing the trend towards entertainment and convenience oriented tenants, and enabling retailers to expand into multi-channel distribution systems incorporating Internet sites and "land based" stores.

Internet driven companies such as Dell Computers, Sharper Image, and Coldwater Creek have significantly increased demand for retail properties. Finally, while Internet retail sales have had a limited impact on the total volume of retail sales in stores, they have had a greater impact on rental price declines due to comparative shopping and their negative effect on property owners achieving percentage rents.

While the Internet competes with the traditional mall as an alternative distribution channel, it does not fundamentally change the key factors that have made retail properties successful. These factors include the economies to consumers of stores in close proximity to each other, single ownership of a diverse shopping area, shared expenses, reinforcing tenant mixes, and innovative lease structures (percentage rents).[31]

Retail properties have been largely successful at transforming themselves to reflect changing consumer demands. As the Internet captures a growing percentage of book, music, software, and clothing sales, retailers have responded with increasing numbers of restaurants, entertainment venues and community service tenants. Some industry observers visualize the shopping center of 2013 like an old fashioned Main Street, in form if not function. "Consumers will be able to visit the grocery or post office, keep appointments with doctors and dentists, relax with a workout or facial, take in a movie, enjoy a gourmet meal or hang out with neighbors at an outdoor concert." Interestingly, this sounds very similar to the vision laid out by architect Victor Gruen, the father of the enclosed mall, 50 years ago: "…by affording opportunities for social life and recreation in a protected pedestrian environment, and by incorporating civic and educational facilities, shopping centers can fill an existing void."[32]

Internet retail sales have increased 70%, from $28 billion in 2000 to nearly $50 billion for the four quarters ending in the 2nd quarter 2003, as shown in Exhibit VI-1.[33] However, e-commerce as a percent of total sales has only increased from 1.1% of total sales at the end of 2000 to 1.5% of total sales in the 2nd quarter of 2003. During the last 3 quarters ending 2nd quarter 2003, e-commerce as a percent of total sales actually declined.

Internet retail sales are projected to increase both in absolute volume as well as a percent of total sales. This will occur due to the expanding access of consumers to high-speed broadband connections as well as to the expanding "multi-channel" sales efforts of traditional e-retailers like Amazon.com and traditional store retailers like Sears. For example, when Sears Roebuck allowed in-store pick-up of its retail Internet sales, 40% of purchasers went to the store to pick up their sale, indicating significant buyer concern about shipping costs. Importantly, approximately 20% of these web customers say they bought additional merchandise when they went to the store to pick up those purchases.[34] This kind of result from multi-channel sales efforts will force many traditional retailers more aggressively into the Internet space.

The expansion of Internet retailing, and the already strong penetration of books, music and clothes on the Internet, suggest that future tenant mix and retail demand will change, moving away from those types of goods that can be effectively sold and distributed over the Internet. Interestingly, the profile of the "Net" shopper is changing from mostly men to mostly women and instead of being monopolized by teenagers, seniors are now the fastest growing cohort in cyberspace.[35]

Perhaps e-retailing's biggest impact will be on its potential to reduce tenant rents. While market penetration of 1% to 2% does not seem threatening, if this number moves up in the future as projected, these marginal sales losses could significantly lower percentage rent payments, an important component of retail lease structures that has strongly contributed to the success of retail properties. More fundamentally, as the overall value of retail properties as a distribution channel is threatened by a successful alternative distribution channel—the Internet—it will eventually have a negative impact on the rents that owners can charge tenants.

Fortunately, through continuing innovations, adapting tenant mixes, and capital investment, retail property owners can mitigate many potential declines in retail demand from consumers.

Some of the key trends influencing retail space demand are summarized and presented in Exhibit VI-2.

B. Tenant Demand for Specific Retail Properties

1. Attributes of "Intelligent" Retail Properties

All of the 12 key "intelligent" building attributes identified in Exhibit III-2 are applicable to retail malls, but have more limited applicability to power centers, community and neighborhood shopping centers, and other retail venues.

While telecommunications and adaptability of space are the most important "intelligent" building technologies to tenants as they adjust to a multi-channel retail sales strategy, "intelligent" building technologies that address energy efficiency, security, air quality, lighting and other expense related issues can also reduce owner expenses as well as the substantial common area maintenance charges which are typically passed on to tenants.

Voice and data communications, primarily focused on high-speed telecommunication capabilities, will grow in importance to all retail venues with the exception of strip retail and neighborhood shopping centers. More sophisticated telecommunications are important to allow kiosks, wireless hot spots and high speed Internet access for employees who need to be able to access product information at least as easily as their customers, who increasingly are doing their comparative shopping on the Internet. Additionally, as more stores allow Internet shoppers to pick up merchandise at their store, a higher quality communications between the retail store and external distribution and back office functions will be critical.

2. Evidence of Tenant Demand for "Intelligent" Retail Buildings

Based on our review of information and interviews, there are no published surveys identifying the demand for "intelligent" building technology in retail properties. The International Council of Shopping Centers and other retail research firms occasionally address changing technology needs of retailers, but focus mostly on the influence of technology on the retail business, not retail properties.

Exhibit VI-1
Internet Retail Sales - 1999 to 2003

Time Period	Retail Sales[1] ($ in Millions)		E-Commerce % of Total Sales
	Total	E-Commerce[2]	
1999 4th Quarter	787,362	5,393	0.7
2000 1st Quarter	715,102	5,772	0.8
2nd Quarter	775,364	6,250	0.8
3rd Quarter	768,559	7,079	0.9
4th Quarter	812,667	9,248	1.1
2001 1st Quarter	723,710	8,009	1.1
2nd Quarter	801,115	7,904	1.0
3rd Quarter	777,882	7,894	1.0
4th Quarter	850,608	10,788	1.3
2002 1st Quarter	740,020	9,470	1.3
2nd Quarter	818,609	9,761	1.2
3rd Quarter	822,125	10,465	1.3
4th Quarter	864,653	13,770	1.6
2003 1st Quarter	772,185	11,928	1.5
2nd Quarter	858,787	12,477	1.5

[1] Does not include Food Services.
[2] E-commerce sales are sales of goods and services where an order is placed by the buyer or price and terms of sale are negotiated over an internet, extranet, Electronic Data Interchange (EDI) network, electronic mail, or other online system. Payment may or may not be made online.

Source: United State Department of Commerce, September 2003; The Muldavin Company, Inc.

Exhibit VI-2
Technology's Influence on Retail Demand

Trends	Facts/Observations	Demand Effect
1. Internet Retail Sales	Internet retail sales increased 70% from $28 billion in 2000 to nearly $50 billion during the four quarters ending in the 2nd quarter of 2003. However, Internet sales as a percent of total sales have never exceeded 1.6%, and actually declined during the 3 quarters ending 2nd quarter of 2003. Expansion of broadband to more consumers and aggressive expansion of multi-channel sales strategies by many retailers suggest that Internet retailing will grow significantly in the future. Forrester Research, in an August 2002 report, projected that an additional 26.4 million U.S. households are expected to join the 36.5 million that already shop online. As a result of the swell in Internet users, Internet retail sales are projected to increase from $72.1 billion in 2002 to $217.8 billion in 2007, accounting for 8% of total retail sales.[1]	The demand by retail tenants has remained steady due to owners attracting new types of tenants, increased demand by Internet retailers for stores, and strong retail sales growth in recent years. Longer-term negative effect on the level of tenant rents, rent growth, and percentage rents expected.
2. Tenant Use of Space	Internet competition is likely to reduce foot traffic putting a premium on merchandise presentation, merchandise mix (want to display goods that are not easily purchased over the Internet), and inventory. Retailers must ensure that popular merchandise is always in stock so as not to alienate consumers and push them online.[2]	No significant effect on overall magnitude of demand, priority on sufficient storage and inventory space and flexibility of interior space to cost effectively adjust presentation of selling floor.

Source: The Muldavin Company, Inc.

Exhibit VI-2
Technology's Influence on Retail Demand

Trends	Facts/Observations	Demand Effect
3. Productivity and Profit Increases	Technology has been a key contributor to economic and job growth historically. Recent productivity and profit gains due to global outsourcing, reductions in costs, and worker productivity will result in investment and innovation in other areas.	Significant demand increase.
4. Cart Escalator	While not a new technology, recent implementation of escalator technology to handle large carts (more space and power required) will impact the nature of retail demand, while not necessarily the magnitude of sales.	Big box retailers move into cities, taking traditional anchor space; increased competition in dense urban areas for traditional retailers.

Net Impact on Retail Demand: Limited influence in the short term; tenant rents may decline as alternative distribution channel (the Internet) gains favor; important benefits of percentage rents may be negatively affected by marginal move to Internet sales and challenges of on-line purchases being picked up at stores; problems with percentage rents may be mitigated by more sophisticated lease structures and attracting new types of tenants.

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[1] Multi-Channel Challenge, Retailers Explore New Ways to Harness the Internet, *Shopping Center Today*, International Council of Shopping Centers, November 2002; Internet Retail Sales, United States Department of Commerce..

[2] Reinventing Marketing and Merchandising in the Multichannel World, *Retail News*, Spring 2000

Source: The Muldavin Company, Inc.

VII. Technology and Multifamily Demand

A. The Overall Demand for Multifamily Space

Technology has not fundamentally altered the total magnitude of multifamily tenant demand like it has for other property types. However, technology innovation continues to be key to job and income growth resulting in a strong net positive to multifamily demand.

Multifamily property demand is driven by household and income growth, which in turn are driven by population, employment and economic growth. As stated above, technology's strong role and driving income and employment growth makes it a direct positive contributor to multifamily demand.

Other key factors influencing multifamily demand that are not significantly influenced by technology include the decision to rent or buy, which is largely influenced by interest rates, and demographic changes. The highest proportion of multifamily demand comes from people in the 18-34 year old age group. Significant demographic changes, such as the growth in echo baby boomers, are expected to drive multifamily demand forward in the coming years, but are not really influenced by technology.

Our assessment of four key trends influencing multifamily demand is presented in Exhibit VII-1:

- Telecommuting;
- Worker productivity;
- Productivity and profit increases; and
- New technologies.

In summary, with new development continuing and little evidence of job growth, property market fundamentals in the U.S. apartment market will remain weak until job growth increases. However, as discussed above, technology's role in these short-term changes and longer-term demographic changes affecting multifamily demand are very limited with the exception of technology's fundamental positive influence on productivity and job growth.

B. Tenant Demand for Specific Multifamily Buildings

1. Attributes of "Intelligent" Apartment Buildings

Of the 12 key "intelligent" building attributes identified in Exhibit III-2, the most applicable to apartments are voice and data communication, energy efficiency, life safety, and building condition monitoring. While it is possible to apply the other "intelligent" building attributes to apartment properties, they don't typically make sense economically.

By far the most important benefit to tenants is high-speed Internet. While estimates vary, there are still surprisingly large numbers of apartments that do not have access to broadband Internet (speed of at least 200 Kbps). However, due to the rapid expansion of DSL and cable modem service being pushed by major telecommunications providers, and the potential for power line Internet from utility companies, the accessibility of high-speed broadband will grow significantly. For many older buildings, new wireless technology may be the best alternative because it saves the cost of pulling cable for extensive wiring. For larger properties, the cost-benefit tradeoff between wireless installation or a structured wiring system is still being debated.[36]

Another interesting technology that is gaining interest is submetering of sewer and water costs. According to statistics from the National Sub-Metering and Utility Allocation Association, only approximately 2 million of the 10 million investment grade multifamily properties across the country currently sub-meter or allocate water and sewer costs to their residents.

The primary benefit of submetering is reduction in water use and water costs. Submetering also enables landlords to pass on costs to their tenants. An independent study conducted for the National Apartment Association and National Multi-Housing Council concluded that water consumption was significantly lower in properties that allocated water and sewer charges to tenants than in properties that did not. The study estimated that submetering reduced water and sewer use between 18% and 39%.[37] A 25% reduction in resident water use equates to approximately $4-$5 per unit per month in reduced water cost. While the amount of money is not large, payback times can be relatively short compared to most capital expenditures.

Online reservation systems can have a significant impact on the demand for a specific multifamily property. Online reservations systems are still in their infancy—only 500 of 21,000 apartment projects on Apartmentguide.com showed online availability in mid 2003. However, the trend towards online reservations is growing. For example, Apartmentguide.com estimates that 1,000 apartment properties will be online by year end, and 5,000 or more by 2005. As more tenants search for property online, property that is well presented will be able to attract marginally more tenants. While use of the Internet to market properties will be a strong benefit, tenant demand will increase even more when tenants can view available inventory online and reserve a specific unit, which they will then visit within a certain time period. Eventually, lease execution may even be able to be done online. As online reservations expand, real time information will be the key and perhaps the biggest challenge.[38]

A list of some of the technologies that will be important to apartments is presented below:

- High speed Internet access;
- Cables/satellite dish;
- Enhanced security features;
- Digital advertising;
- Sewer and water submetering;
- Online reservation systems;
- Community web sites, onsite kiosks and miscellaneous luxury attributes; and
- Business office facilities, media room, and other "intelligent" building technologies for those tenants who are willing to pay for them.

2. Evidence of Tenant Demand for "Intelligent" Multifamily Buildings

The demand for multifamily "intelligent" building technologies, with the exception of Internet access, is still relatively low. As shown in Exhibit VII-2, of 22 apartment products or amenities cited, Internet access ranked fifth, with high-speed Internet access ranking 11th. This result, based on a comprehensive survey by the National Association of Home Builders (NAHB) in late 2002, suggests that 56k modem access maybe sufficient for many tenants today.

Parking, garage, storage and cable systems still ranked higher than Internet access. However, Internet access ranked higher than 24-hour security, outdoor swimming pools, fitness facilities, and most other recreational or service amenities. Clearly, for any multifamily property that doesn't have Internet access, it is a clear, relatively low cost, way to satisfy tenants compared to many of the other more capital-intensive alternatives shown in Exhibit VII-2.[39]

The NAHB Survey is their most comprehensive since 1992. Their survey covered 2,000 renters, balanced across the U.S. by many different market segments. A little more than half of the respondents to the 2002 survey live in garden apartments, 12% live in high- or mid-rise apartments, 6% live in single-family detached rental homes and 13% reside in town homes.

Energy efficiency was the most important factor influencing the selection of a new apartment based on the 2002 National Association of Home Builders Survey. With 94% of the people identifying energy efficiency as an important issue, it far outdistanced issues such as the size of the unit, noise level, and crime in its importance. While building technologies were not cited directly by any of the respondents, more luxury features were cited by 34% as being important, ranking 7th of the 12 key factors renters identified as important in selecting apartments.

Exhibit VII-1
Technology's Influence on Multi-Family Demand

Trends	Facts/Observations	Demand Effect
1. Telecommuting	Latest U.S. Bureau of Labor statistics data from 2001 show 19.8 million people (15% of workforce) do some work at home.[1] Growing broadband accessibility and self-employment should slowly increase this number.	No increase in overall demand; increased demand for high-speed broadband connections in units.
2. Worker Productivity	Technology related productivity gains have contributed to the current U.S. "jobless" recovery. Federal Reserve economists report that 2.7 million jobs lost since 2001 unlikely to come back. Due to productivity gains, unemployment rate could stay above 6%, with little employment gain, even with GDP growth of 3% and 4% in the next two years.[2]	Reduce space demand; shorter-term vs. longer-term problem.
3. Productivity and Profit Increases	Technology has been a key contributor to economic and job growth historically. Recent productivity and profit gains due to global outsourcing, reductions in costs, and worker productivity will result in investment and innovation in other areas that will improve job growth.	Significant long-term demand increase; increase tenant incomes
4. New Technologies	Nanotechnology, biotechnology and other of the six key technologies identified in Chapter III have significant potential to drive office multi-family demand.	No increase in demand; clustering of employment in select regions likely driving regional differences in multi-family demand.

Net Impact on Multifamily Demand: Technology innovation key to job and income growth; strong indirect net positive to multi-family demand through job and income growth.

[1] U.S. Bureau of Labor Statistics, *News*, Work at Home in 2001, March 1, 2002; Telecommuting, The Real Story, *Torto Wheaton Research*, January 1999.
[2] TWR Viewpoint; Extended Jobless Recovery Goes Mainstream; *Torto Wheaton Research*, Fall 2003; Federal Reserve Bank Study; Erica Groshon and Simon Potter, September 2003.

Source: The Muldavin Company, Inc.

Exhibit VII-2
Importance of In-Apartment Products/Amenities

Rank		
1.	Parking	3.7
2.	Cable/satellite/dish network	2.8
3.	Garage	2.8
4.	Storage room	2.8
5.	**Internet access**	**2.4**
6.	24-hour security personnel	2.2
7.	Outdoor swimming pool	2.1
8.	Fitness facilities	2.1
9.	Convenience store	2.0
10.	Indoor swimming pool	1.9
11.	**High-speed internet access**	**1.7**
12.	Telephone answering service	1.7
13.	Party room	1.7
14.	Media room	1.6
15.	Doorman	1.5
16.	Tennis courts	1.5
17.	Racquetball court	1.5
18.	Business office facilities	1.4
19.	Roof garden	1.4
20.	Concierge services	1.3
21.	Valet facilities	1.3
22.	Other	1.7

Note: Based on response to question: Please rate the products/amenities in your apartment complex (on a scale of 1 to 5, 1 = not at all important, 5 = very important); mean rating reported.

Source: National Association of Homebuilders, Inc.

VIII. Technology and Hotel Demand

A. Overall Demand for Hotel Space

Technology has had limited effect on the overall magnitude of demand for hotel properties. Slight declines in demand due to teleconferencing, reduction in the number of sales meetings, and enhanced communication technology have been offset by the broad economic growth benefits derived from technology based on productivity and profit increases.

Technology has had a significant influence on hotel room rates due to price transparency and the commoditization of hotel properties on the Internet. While significant price declines brought about by comparison shopping on the Internet are most pronounced during periods when the markets are down, as in the last three years, price transparency is here to stay and will negatively influence hotel pricing and revenues in the future.

High-speed Internet access has also become critical to hotels with a substantial business base. High-speed access is now becoming a minimum commodity for a significant percentage of business travelers. In response, many hotels, across all price categories, are investing in high-speed Internet access.

The influence of technology on hotel demand has been particularly difficult to ascertain given the economic slowdown that started in 2000 and the dramatic upheaval in the hotel industry brought on by the terrorist attacks on September 11, 2001. Hotel demand is generally broken up into three categories: business travelers, leisure, and group meetings. One would expect that the influence of technology would be most felt by business travelers, but most hotel companies do not have the systems or technology in place to determine which type of travelers are purchasing over the Internet, making it difficult to draw data-based conclusions (many hotel companies assume that all Internet sales are leisure).

Our assessment of some of the key technology trends and their influence on hotel demand are presented in Exhibit VIII-1.

B. Tenant Demand for Specific Hotel Properties

1. Attributes of "Intelligent" Hotel Properties

All 12 of the key "intelligent" building attributes described in Exhibit III-2 are applicable to hotel buildings. High-speed Internet access is the most important attribute, but particularly in new properties, all 12 of the "intelligent" building technologies have applicability.

Some of the specific attributes of an "intelligent" hotel building include:

- Wireless and high speed Internet access;
- Interactive keyboard communication with management;
- Wireless credit card check-in by bellman;
- Digitally driven movies with stop, fast forward, pause and rewind capabilities;
- Fully networked computer systems enabling efficient inventory controls and tracking of customer background and preferences;
- Easy access community portal offering information on local restaurant menus, entertainment, and other hotel and neighborhood specific information; and,
- Sophisticated business center facilities.

2. Evidence of Tenant Demand for Technology

The evidence for tenant demand, as indicated by occupancy and rent premiums, has not yet been established for many of these technology enhancements. One area with growing demand is the requirement for high-speed Internet access. While in certain technology markets, business hotels without Internet access could not survive, as of early 2003, paid access was still below 10% and free access was only attracting 20% or so of guests. Again, while this may not seem like a significant number, it is growing rapidly and a marginal increase or decrease of 10% to 20% occupancy can make or break most hotels.

The good news is that it is not typically difficult, or too expensive, to "wire" a hotel room. Category 5 cable, which is sufficient for most uses, is below $0.10 a foot while hardware can be as low as $10 and certainly not above $50 for the most expensive. That brings material cost per room from $25 to perhaps $100.[40] While the cost to wire hotel properties is not excessive, there are numerous choices to make today between wireless or wired technologies, and the type of wire and/or system components that you need. While it is important to consider wireless, particularly for common areas, most guests still do not have wireless capabilities, so a wireless-only solution would exclude numerous guests, and is not currently being contemplated by most owners.

Marriot International has focused their expansion of free high-speed Internet access through the wiring of their rooms. Marriot also has 400 hotels with wireless access, but they view wireless access as a complement to wired access. At the company's higher-end hotels, Marriott and Renaissance, they continue to offer "Wired for Business" packages that provide unlimited local and long distance calls within the United States with in-room broadband for $9.95/day.

Marriot is not the only one making such technology investments, as Starwood Hotels and Resorts, Fairfield, and many others are moving forward with similar plans.[41]

Exhibit VIII-1
Technology's Influence on Hotel Demand

Trends	Facts/Observations	Demand Effect
1. Teleconferencing	Video teleconferencing, once seen as a major threat to the hotel business, has not had a significant influence on hotel demand. While teleconferencing is used by some businesses, it is still relatively expensive to set up and maintain and has not significantly limited the need for face-to-face meetings.	Marginal reduction in hotel demand.
2. Business to Business Internet Sales	The business-to-business Internet sales market has expanded rapidly, much more so than the business to consumer market. As more businesses expand their business-to-business sales, a reduction in sales meetings is anticipated. Given the quantity and quality of information that can now be communicated electronically, the number of sales meetings required to close a deal is expected to decline. Sales meetings will not go away, but fewer meetings with clients and potential clients are expected.	Reduction in the business component of hotel demand.
3. Enhanced Communication Tools	Improvements in the speed, quality, and interactive nature of Internet communications makes it easier to conduct more value added telephone conferences with interactive computer presentations.	Marginal reduction in the business component of hotel demand.
4. Internet Reservations	A substantial volume of hotel reservations are made through the Internet. Most hotels have Internet sites and online reservations, but the bulk of actual purchases occur through third-party travel services. These third-party travel services enable instant price and value comparisons, and tend to push demand towards the lowest cost providers.	Significant reduction in average room prices; no significant change in overall magnitude of demand.

Source: The Muldavin Company, Inc.

Exhibit VIII-1
Technology's Influence on Hotel Demand

Trends	Facts/Observations	Demand Effect
5. Geographically Expanded Communities	The expansion of Internet communities based on hobbies and interests has enabled people from disparate geographic regions to communicate at low cost over the Internet. New hotel business is projected from individuals and group meetings.	Moderate increase in demand.
6. Productivity and Profit Increases	Technology has been a key contributor to economic and job growth historically. Recent productivity and profit gains due to global outsourcing, reductions in costs, and worker productivity will result in investment and innovation in other areas that will improve job growth.	Significant demand increase.
7. New Technologies	Nanotechnology, biotechnology and other of the six key technologies identified in Chapter III have significant potential to drive hotel demand.	Increase in demand; clustering of demand in select regions likely.

Net Impact on Hotel Demand: Limited impact on the overall magnitude of hotel demand; significant reductions in average price per room, particularly in down market periods such as we have today.

Source: The Muldavin Company, Inc.

IX. Geographic Differences in "Intelligent" Building Demand

Tenant demand for "intelligent" buildings varies by metropolitan area. It is not hard to understand that tenants for any type of property in San Jose are likely to place a greater priority on "intelligent" building technologies than tenants in most other metropolitan areas. However, with over 300 metropolitan statistical areas, (MSAs), geographic differences are not always so obvious, but can be important.

A. "Intelligent" Building Demand Index

We have created the Intelligent Building Demand Index to measure and rank metropolitan areas by the level of expected demand by tenants for "intelligent" buildings. A full description of our data, methodology and calculations is presented in Appendix 2.

The Index is based on our hypothesis that, if the metropolitan area's economy is heavily reliant upon technology and the workforce is well compensated more and newer technologies will be demanded, and adopted faster, in that metropolitan area.

The purpose of this section is to identify where tenants are more likely to demand "intelligent" buildings to provide commercial brokers, owners and investors guidance in estimating likely tenant demand for "intelligent" building technologies in their markets. This information can help in determining the emphasis of technology in capital expenditure programs, property valuations, and leasing and sales strategies.

B. The Technologically Sophisticated Metropolitan Area

Demand for technology will permeate business and personal use. For example, if you spend a day in a metropolitan area that has a high-technology culture you may be able to easily and inexpensively take the following scenario for granted because technology is a significant part of the culture. You can read your e-mails on the way to work. Once you get to work you can use a high-speed wireless Internet connection to videoconference with your close-working colleagues in Singapore (your virtual company). For lunch, you visit your office building's community portal to see lunch specials at nearby restaurants and make reservations for a business meeting. While walking through a retail area to get to the restaurant you see digital advertisements that have been changed to advertise for the time of day. While in the restaurant you check e-mails on your PDA by using the free WiFi in the restaurant and throughout the retail area. Before you return home for the day you go online to check brokerage accounts, adjust the temperature in your home, and start the dishwasher you forgot to start this morning. Once you walk through the door, lights in your house automatically turn on and adjust their brightness to include the natural light in the home, by zone. After dinner, you log into your office Intranet via your high-speed broadband wireless connection from the back porch while you watch your kids playing. You feel at ease from having been able to be more productive during the day, connect with more people, attain better balance in your life and save money along the way.

C. Metro Ranking Results

Each metro's rank is based upon its index score. We further characterize each metropolitan area as being small, medium or large based upon second quarter 2003 population counts. Small metros have populations below 250,000, medium-sized metro areas have populations from 250,000 to 1,000,000 and large metro areas have populations over 1,000,000.

The top 30 metros with the highest demand for "intelligent" building technologies are shown in Exhibit IX-1. The top 30 metros represent the top 10 percent of the 300 metros ranked. The top 30 are dominated by the larger metros, which comprise 17 out of the 30. Not surprisingly, San Jose is ranked number one with an index score or 98.4 out of a possible 100. Cedar Rapids, with a population of only 196,000, is number two, with a score of 85.2.

The top 20 ranked metro areas for large, medium-sized and smaller metro markets are presented in Exhibits IX-2, IX-3 and IX-4, respectively. Metro size appears to matter in terms of "intelligent" building demand only for the smaller metros. The top 20 smaller metros have an average score of only 31.0, while the top 20 large and medium-sized metros have average scores of 47.7 and 44.4, respectively.

Exhibit IX-1
Intelligent Building Demand Index
Top 30 Metros

Rank	Metropolitan Area	Intelligent Building Index Value	Metro Size [1]
1	San Jose, CA	98.4	Large
2	Cedar Rapids, IA	85.2	Small
3	Boulder-Longmont, CO	76.4	Medium
4	Albuquerque, NM	63.6	Medium
5	Raleigh-Durham-Chapel Hill, NC	59.9	Large
6	Melbourne-Titusville-Palm Bay, FL	58.3	Medium
7	Seattle-Bellevue-Everett, WA	57.7	Large
8	Middlesex-Somerset-Hunterdon, NJ	57.1	Large
9	Huntsville, AL	55.8	Medium
10	Dutchess County, NY	54.5	Medium
11	Portland-Vancouver, OR-WA	53.7	Medium
12	Wichita, KS	53.0	Medium
13	Ventura, CA	52.4	Medium
14	Newark, NJ	49.5	Large
15	San Francisco, CA	48.7	Large
16	Dallas, TX	48.2	Large
17	Washington, DC-MD-VA-WV	47.5	Large
18	Denver, CO	47.1	Large
19	Austin-San Marcos, TX	46.2	Large
20	Kansas City, MO-KS	42.4	Large
21	Colorado Springs, CO	42.2	Medium
22	Greenville, NC	42.0	Small
23	Indianapolis, IN	41.1	Large
24	Phoenix-Mesa, AZ	40.6	Large
25	Monmouth-Ocean, NJ	40.2	Large
26	Oakland, CA	39.9	Large
27	Boise City, ID	39.6	Medium
28	Atlanta, GA	39.5	Large
29	Tucson, AZ	39.4	Medium
30	Boston, MA	39.2	Large

1. Small metros have populations below 250,000, medium-sized metro areas have populations from 250,000 to 1,000,000 and large metro areas have populations over 1,000,000. (Source: The Muldavin Company, Inc.; see also Appendix 2.)

Exhibit IX-2
Intelligent Building Demand Index
Top 20 Large Metro Areas (1)
Population Over 1,000,000

Rank	Metropolitan Statistical Area	Index Value
1	San Jose, CA	98.4
2	Raleigh-Durham-Chapel Hill, NC	59.9
3	Seattle-Bellevue-Everett, WA	57.7
4	Middlesex-Somerset-Hunterdon, NJ	57.1
5	Newark, NJ	49.5
6	San Francisco, CA	48.7
7	Dallas, TX	48.2
8	Washington, DC-MD-VA-WV	47.5
9	Denver, CO	47.1
10	Austin-San Marcos, TX	46.2
11	Kansas City, MO-KS	42.4
12	Indianapolis, IN	41.1
13	Phoenix-Mesa, AZ	40.6
14	Monmouth-Ocean, NJ	40.2
15	Oakland, CA	39.9
16	Atlanta, GA	39.5
17	Boston, MA	39.2
18	Rochester, MN	37.5
19	San Diego, CA	37.4
20	Rochester, NY	36.6

(1) The survey does not include all metropolitan areas in the U.S. due to lack of complete data for some of them. For an explanation of the index and its methodology, See Appendix 2 and the notes to Appendix 3.

Source: The Muldavin Company, Inc.

Exhibit IX-3
Intelligent Building Demand Index
Top 20 Medium-sized Metro Areas (1)
Population 250,000 to 1,000,000

Rank	Metropolitan Statistical Area	Index Value
1	Boulder-Longmont, CO	76.4
2	Albuquerque, NM	63.6
3	Melbourne-Titusville-Palm Bay, FL	58.3
4	Huntsville, AL	55.8
5	Dutchess County, NY	54.5
6	Portland-Vancouver, OR-WA	53.7
7	Wichita, KS	53.0
8	Ventura, CA	52.4
9	Colorado Springs, CO	42.2
10	Boise City, ID	39.6
11	Tucson, AZ	39.4
12	Binghamton, NY	39.2
13	Lincoln, NE	37.3
14	Trenton, NJ	36.0
15	Kalamazoo-Battle Creek, MI	34.3
16	Little Rock-North Little Rock, AR	31.3
17	Omaha, NE-IA	31.1
18	Provo-Orem, UT	30.7
19	Lafayette, IN	30.1
20	Spokane, WA	29.9

(1) The survey does not include all metropolitan areas in the U.S. due to lack of complete data for some of them. For an explanation of the index and its methodology, See Appendix 2 and the notes to Appendix 3.

Source: The Muldavin Company, Inc.

Exhibit IX-4
Intelligent Building Demand Index
Top 20 Smaller Metro Areas (1)
Population Under 250,000

Rank	Metropolitan Statistical Area	Index Value
1	Cedar Rapids, IA	85.2
2	Greenville, NC	42.0
3	Lynchburg, VA	38.7
4	Pocatello, ID	33.6
5	Sherman-Denison, TX	32.6
6	Richland-Kennewick-Pasco, WA	31.8
7	San Angelo, TX	31.3
8	Cheyenne, WY	28.7
9	Jackson, MS	28.2
10	Roanoke, VA	27.3
11	Elmira, NY	27.1
12	Lawrence, KS	26.9
13	Monroe, LA	26.2
14	State College, PA	25.6
15	Greensboro-Winston Salem, NC	24.2
16	Charleston, WV	23.1
17	Waco, TX	22.8
18	Asheville, NC	21.8
19	Santa Fe, NM	21.4
20	Lubbock, TX	21.1

(1) The survey does not include all metropolitan areas in the U.S. due to lack of complete data for some of them. For an explanation of the index and its methodology, See Appendix 2 and the notes to Appendix 3.

Source: The Muldavin Company, Inc.

X. Conclusion

Technology is so pervasive in our society that it is difficult to isolate and evaluate its influence on real estate demand. Technology's influence on demand is generally positive given its fundamental importance to economic growth. However, technology will significantly reduce demand in some areas and increase demand in others, making winners or losers out of certain properties or geographic markets. Investors and other real estate professionals who maintain vigilance concerning technology change will outperform their competitors.

XI. Author Biography and Acknowledgements

A. Acknowledgements

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B. Author's Biography

For over 20 years, Scott Muldavin has advised the nation's leading real estate companies on how changing trends in the investment environment impact their assets and businesses.

Mr. Muldavin's broad experience in real estate transaction structuring, underwriting, due diligence, and valuation — gained through work on over 300 assignments for his clients — provide him with a unique perspective to interpret the practical effects of technology changes on real estate.

Scott Muldavin is President of The Muldavin Company, a real estate finance and investment consulting firm. Prior to starting his firm, he was Partner in Charge of the West Coast Real Estate Consulting Practice of Deloitte & Touche. Mr. Muldavin also serves on the investment committee of Guggenheim Real Estate *PLUS*, an actively managed, open-end real estate investment fund investing in a diversified portfolio of direct properties, REITs, private open-end funds, high yield debt, and partnership units purchased on the secondary market. In addition to serving on the investment committee, Mr. Muldavin has direct responsibility for investment and capital formation activities in the Western region.

Select clients Mr. Muldavin has advised include the State Teachers Retirement System of Ohio, the Government of Singapore Investment Corporation, Hunt

Realty, Catellus, Bank of America, CalPERS, Universal Studios, Amstar, RREEF, Standard Insurance, Morgan Stanley, Freddie-Mac, and Prudential Real Estate.

Mr. Muldavin has published over 225 articles on real estate finance, investment, and economics. He has achieved professional certification from the top management consulting (CMC) and top real estate consulting (CRE) professional organizations and has a Masters in City and Regional Planning from Harvard University and an Undergraduate Degree in Environmental Studies from the University of California at Berkeley.

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Appendix 1
Real Estate Technology Glossary

3G Technology: Refers to third generation technology for mobile service providers. Mobile service providers sell subscription services and offer coverage over large geographic areas.

Backbone Cabling: The interbuilding and intrabuilding cable connections between entrance facilities, equipment rooms and the telecommunications closets. It consists of the transmission media, main and intermediate cross-connects and terminations at these locations.

Broadband (Wiring for high-speed networks): This term is commonly used to refer to communications lines or services at T1 rates and above. However, the actual threshold of broadband is very subjective and may be below or well above T1, depending on the situation. In every case however, it implies transmitting at higher speeds than what has been common for some time.

Building Automation and Control Networks (BACnet): BACnet is one of the two major open protocols developed by the American Society of Heating, Refrigerating, and Air-conditioning Engineers. While the BACnet system focuses on energy management functions, it does include capabilities for communications with other systems.

Building Automation Systems (BAS): In a smart building, the BAS uses microprocessor-based controls to monitor each building zone, transfer information through cabling, and provide the sensory functions, signal processing and control responses that lead to smart-building operation. A smart building BAS typically relies on full DDC systems as opposed to pneumatic or combined pneumatic and digital component systems.

Cold Fusion: "Cold fusion" is obtained by splitting heavy hydrogen from oxygen in the molecules of the heavy water solution. Thus, the concept of nuclear energy from water at lower heat and more manageable waste products was born. This area of physics and energy research is still hotly debated.

Demarcation Point: The physical point dividing "inside wire" from outside telecommunications facilities. The determination of who controls the location of this point is set by federal and state regulatory bodies.

Digital Subscriber Line (DSL): A technology that dramatically increases the digital capacity of ordinary telephone lines into the home or office. DSL speeds are tied to the distance between the customer and the Telco central office. DSL is always "on" as opposed to ISDN, which is also digital, but travels through the switched telephone network. ADSL: Asymmetric DSL – shares same line as telephone.

Symmetrical DSL (SDSLN) are DSL lines that send and receive data at the same speed, like a home DSL line. Asymmetrical DSL (ADSL), typically receive data at a much greater speed than they provided.

Direct Digital Controls (DDCs): DDC's are microprocessor-based controllers whose control logic is performed by software. Full DDC's systems consist of digital controllers that work in conjunction with electronic and ancillary devices (i.e., sensors and actuators) to control building systems.

Electromagnetic Trains: electromagnetic (maglev) trains currently exist, but are not in commercial operation. The big difference between a maglev and a conventional train is that maglev trains do not have an engine—at least not the kind of engine used to pull typical train cars along steel tracks. The engine for a maglev train is the magnetic field created by the electrified coils in the guideway walls and tracks, which combine to propel the train.

Fiber Optics: Communications systems that use optical fibers for transmission. Information is transmitted in the form of light. Eventually, all transmission systems may become fiber-optic based. Fiber optics is the primary source of transmission for long distance carriers.

Gigabits (Gbps): One billion bits of data are transferred every second. One billion bits of data is approximately the size of a large software program.

Hoteling: Using office space on an as needed basis like a hotel. (e.g., traveling employees will reserve working space before arriving in a certain office).

Integrated Services Digital Network (ISDN): An international telecommunications standard for transmitting voice, video and data over digital lines running at 64 Kbps. The telephone companies commonly use a 64 Kbps channel for digitized, two-way voice conversations. ISDN service is available in most parts of the U.S.

Internet Service Provider (ISP): An organization that provides access to the Internet. Small Internet service providers (ISPs) provide service via modem and ISDN while the larger ones also offer private line hookups (T1, fractional T1, etc). Customers are generally billed a fixed rate per month, but other charges may apply. For a fee, a web site can be created and maintained on the ISP's server, allowing the smaller organization to have a presence on the web with its own domain name.

Kilobits Per Second (Kbps): One thousand bits of data are transferred every second. A measure of bandwidth (total information flow over a given time).

LonWorks: Is a second major open protocol developed for the purpose of integrating all building control systems.

Long Range Ethernet (LRE): LRE is Cisco's version of DSL. LRE and DSL use special equipment that compresses Ethernet signals to allow a single pair of phone wires to carry data, even with a simultaneous voice conversation over the same wires.

Megabits Per Second (Mbps): One million bits of data are transferred every second. One million bits is approximately the size of a ten-page text file.

Multi-Channel Retailing: Refers to the trend of internet retailers opening land based stores and traditional land based retailers aggressively expanding their internet accessibility. The concept of multi-channel retailing involves not just having both stores and the internet, but reorganizing both sales channels to reinforce each other in an integrated fashion.

OSI Seven Layer Communication Model: The open system interconnection (OSI) model is a widely recognized generic standard for communications that defines network in terms of seven layers. This standard was developed in and supported by the International Standards Organization (ISO).

Protocol Requirements For Building Automation Systems: Many buildings, even modern buildings, use proprietary communication protocols within each building system making it difficult to share data. Recently, open protocol languages have allowed free information flow between systems. An open protocol is a standard of communication that is made available to the industry. Components that use an open protocol are capable of exchanging information with other components using the same protocol, regardless of who manufactures the components.

Radio Frequency Identification (RFID): RFID technology is used to mark, identify and track individual objects as they move from the manufacturing floor through the supply chain and into the hands of the buyer or consumer. As the objects move through the supply chain, wireless RFID readers can communicate with an RFID tag on the object, collect information about the object (such as a unique number), and match that number in a database to access a complete record about the object.

Redundancy: Refers to peripherals, computer systems and network devices that take on the processing or transmission load when other units fail; also referred to in relationship to a secondary electrical power source.

Riser: Pathway for indoor cables that pass vertically between floors.

Synchronized Supply Chain (SSC): Technology advances have enabled manufacturers, distributors, and retailers to create "synergized" supply chains based on collaboration, interdependence, and task sharing between that creates a trading network with competitive edge.

Smart Metering: Metering technologies that record real time energy data electronically and make the data available through a software interface; also being applied to sewer and water metering.

T1 – T2 – T3: A point-to-point dedicated, digital circuit provided by the telephone companies. Monthly cost typically based on distance. T1 lines are widely used for private networks as well as interconnections between an organization's PBX or LAN and the Telco. T1 = 1.544 Mbps. T2=6.312 Mbps. T3=44.736 Mbps. Uses two wires, one to send and one to receive.

TCPIP: A third open protocol standard competing with LonWorks and BACnet.

Telco Hotel: Buildings where telecommunications carriers congregate to connect their networks and pass traffic back and forth. Although building specifications are more stringent, these hotels lower the cost and improve the reliability of communications.

Vertical and Horizontal Distributing Cable: Buildings typically have a vertical cable, which is typically fiber in a smart building and a horizontal cabling system to the spaces within each floor. The horizontal distributing cable is typically a Category 5 unshielded twisted pair (UTP) copper wiring capable of transferring information at speeds of up to 100 megabytes per second.

Virtual Private Network (VPN): Virtual private network is a technology that provides security through enabling a private network to be carried on an external network.

WiFi: WiFi is short for wireless fidelity, an international standard of communication that lets computers and networks connect to each other wirelessly. 802.11b enables speeds of up to 11 megabytes per second, a hundred times faster than the typical than the 56k modem. Today with 802.11a ,and 802.11g, this technology now enables wireless capacity up to 54 Mbps, more speed than the average user would ever use.

Appendix 2
"Intelligent Building" Demand Index
Methodology

We ranked 296 Metropolitan Statistical Areas (MSAs) based upon their respective High-Tech Location Quotient and Per Capita Personal Income. The ranking is based upon an index. The index is calculated by:

- Normalizing each data measure (High-Tech Location Quotient and Per Capita Personal Income) by metro. Normalized scoring is based on a top score of 100 and low score of zero for each respective data measure.
- The next step is to weight, and then multiply, the data measures by metro. The weights were 85% for High-Tech Location Quotient and 15% for Per Capita Personal Income.
- The composite score for each market becomes the index. The index is then ranked. If two metros have the same index score they receive the same ranking.

The High-Tech Location Quotient (LQ) is a measure of high-tech concentration in a metropolitan area as compared to the nation as a whole (U.S. = 1.0). This measure indicates a metropolitan area's participation in the knowledge-based economy. A metropolitan area with an LQ higher than 1.0 is said to be more concentrated than the United States and vice versa. The LQ uses Gross Domestic Product and Gross Metro Product for this calculation. Each measures the economic output for a geographic area.

The Per Capita Personal Income is the income that is received by persons from participation in production, from both government and business transfer payments, and from government interest (which is treated like a transfer payment). It is calculated as the sum of wage and salary disbursements, other labor income, proprietors' income with inventory valuation and capital consumption adjustments, rental income of persons with capital consumption adjustment, personal dividend income, personal interest income, and transfer payments to persons, less personal contributions for social insurance.

This measure of income is calculated as the personal income of the residents of a given area divided by the resident population of the area. In computing per capita personal income, Bureau of Economic Analysis (BEA) uses the Census Bureau's annual midyear population estimates. All state and local area dollar estimates are in current dollars (not adjusted for inflation).

Appendix 2

Intelligent Building Demand Index
Methodology

There are a total of 318 MSAs (including PMSAs or NECMAs) in the United States. The 22 MSAs we did not rank, due to insufficient data, follow (in alpha order).

Auburn-Opelika, AL (MSA)
Bangor, ME (NECMA)
Barnstable-Yarmouth, MA (NECMA)
Burlington, VT (NECMA)
Corvallis, OR (MSA)
Flagstaff, AZ-UT (MSA)
Fort Pierce-Port St. Lucie, FL (MSA)
Hagerstown, MD (PMSA)
Hartford, CT (NECMA)
Hattiesburg, MS (MSA)
Jackson, TN (MSA)
Jamestown, NY (MSA)
Jonesboro, AR (MSA)
Lewiston-Auburn, ME (NECMA)
Missoula, MT (MSA)
New Haven-Bridgprt-Stamfrd-Danbry-Wtrbry, CT (PMSA)
New London-Norwich, CT (NECMA)
Pittsfield, MA (NECMA)
Portland, ME (NECMA)
Providence-Warwick-Pawtucket, RI (NECMA)
Rocky Mount, NC (MSA)
Springfield, MA (NECMA)

Appendix 3

Intelligent Building Demand Index

Rank	Metropolitan Area	Metro Size (1) 2002 Value	High-Tech GDP LQ (2) 2001 Value	High-Tech GDP LQ Index	Per Capita Personal Income (3) 2001 Value	Per Capita Personal Income Index	Intelligent Building Index Value
		Weighting ->	85%	Best = High	15%	Best = High	Best = High
1	San Jose, CA	Large	3.710	100.0	$51,579	89.4	98.4
2	Cedar Rapids, IA	Large	3.350	90.3	$32,391	56.1	85.2
3	Boulder-Longmont, CO	Large	2.870	77.4	$40,840	70.8	76.4
4	Albuquerque, NM	Large	2.470	66.6	$27,030	46.8	63.6
5	Raleigh-Durham-Chapel Hill, NC	Large	2.240	60.4	$32,998	57.2	59.9
6	Melbourne-Titusville-Palm Bay, FL	Large	2.240	60.4	$26,888	46.6	58.3
7	Seattle-Bellevue-Everett, WA	Large	2.050	55.3	$41,229	71.4	57.7
8	Middlesex-Somerset-Hunterdon, NJ	Large	2.000	53.9	$43,292	75.0	57.1
9	Huntsville, AL	Large	2.110	56.9	$28,684	49.7	55.8
10	Dutchess County, NY	Large	2.010	54.2	$32,349	56.1	54.5
11	Portland-Vancouver, OR-WA	Large	1.980	53.4	$31,971	55.4	53.7
12	Wichita, KS	Large	2.020	54.4	$25,716	44.6	53.0
13	Ventura, CA	Large	1.920	51.8	$32,232	55.8	52.4
14	Newark, NJ	Large	1.680	45.3	$42,550	73.7	49.5
15	San Francisco, CA	Large	1.470	39.6	$57,714	100.0	48.7
16	Dallas, TX	Large	1.710	46.1	$34,697	60.1	48.2
17	Washington, DC-MD-VA-WV	Large	1.600	43.1	$41,754	72.3	47.5
18	Denver, CO	Large	1.620	43.7	$38,513	66.7	47.1
19	Austin-San Marcos, TX	Large	1.660	44.7	$31,511	54.6	46.2
20	Kansas City, MO-KS	Large	1.480	39.9	$32,693	56.6	42.4
21	Colorado Springs, CO	Large	1.510	40.7	$29,280	50.7	42.2
22	Greenville, NC	Small	1.550	41.8	$24,854	43.1	42.0
23	Indianapolis, IN	Large	1.430	38.5	$31,960	55.4	41.1
24	Phoenix-Mesa, AZ	Large	1.450	39.1	$28,337	49.1	40.6
25	Monmouth-Ocean, NJ	Large	1.340	36.1	$36,543	63.3	40.2
26	Oakland, CA	Large	1.290	34.8	$39,963	69.2	39.9
27	Boise City, ID	Large	1.400	37.7	$29,109	50.4	39.6
28	Atlanta, GA	Large	1.340	36.1	$33,769	58.5	39.5
29	Tucson, AZ	Large	1.440	38.8	$24,767	42.9	39.4
30	Boston, MA	Large	1.260	34.0	$39,873	69.1	39.2
31	Binghamton, NY	Large	1.420	38.3	$25,669	44.5	39.2
32	Lynchburg, VA	Large	1.410	38.0	$24,665	42.7	38.7
33	Rochester, MN	Small	1.240	33.4	$35,110	60.8	37.5
34	San Diego, CA	Large	1.250	33.7	$33,883	58.7	37.4
35	Lincoln, NE	Large	1.280	34.5	$30,872	53.5	37.3
36	Rochester, NY	Large	1.260	34.0	$29,870	51.8	36.6
37	Trenton, NJ	Large	1.090	29.4	$42,317	73.3	36.0
38	Kalamazoo-Battle Creek, MI	Large	1.200	32.3	$26,207	45.4	34.3
39	Pocatello, ID	Small	1.220	32.9	$21,780	37.7	33.6
40	Sherman-Denison, TX	Small	1.160	31.3	$23,366	40.5	32.6
41	Fort Worth-Arlington, TX	Large	1.080	29.1	$30,230	52.4	32.6
42	West Palm Beach-Boca Raton, FL	Large	0.920	24.8	$43,626	75.6	32.4
43	Philadelphia, PA-NJ	Large	1.010	27.2	$35,192	61.0	32.3
44	Richland-Kennewick-Pasco, WA	Large	1.100	29.6	$25,259	43.8	31.8
45	San Antonio, TX	Large	1.080	29.1	$26,887	46.6	31.7
46	Nassau-Suffolk, NY	Large	0.910	24.5	$41,559	72.0	31.7
47	Houston, TX	Large	0.970	26.1	$35,872	62.2	31.5
48	Little Rock-North Little Rock, AR	Large	1.040	28.0	$28,845	50.0	31.3
49	San Angelo, TX	Small	1.080	29.1	$25,104	43.5	31.3
50	Omaha, NE-IA	Large	0.980	26.4	$33,249	57.6	31.1
51	Provo-Orem, UT	Large	1.120	30.2	$19,271	33.4	30.7
52	Orange County, CA	Large	0.920	24.8	$36,647	63.5	30.6
53	Los Angeles-Long Beach, CA	Large	0.980	26.4	$30,611	53.0	30.4
54	Chicago, IL	Large	0.910	24.5	$36,624	63.5	30.4
55	Lafayette, IN	Small	1.030	27.8	$25,141	43.6	30.1
56	Spokane, WA	Large	1.010	27.2	$26,107	45.2	29.9
57	Pittsburgh, PA	Large	0.920	24.8	$32,626	56.5	29.6
58	Birmingham, AL	Large	0.940	25.3	$30,620	53.1	29.5
59	Minneapolis-St. Paul, MN-WI	Large	0.850	22.9	$38,131	66.1	29.4
60	Sacramento, CA	Large	0.930	25.1	$30,906	53.6	29.3
61	Santa Cruz-Watsonville, CA	Large	0.840	22.6	$36,865	63.9	28.8

Appendix 3

Intelligent Building Demand Index

Rank	Metropolitan Area	Metro Size (1) 2002 Value	High-Tech GDP LQ (2) 2001 Value	High-Tech GDP LQ Index	Per Capita Personal Income (3) 2001 Value	Per Capita Personal Income Index	Intelligent Building Index Value
		Weighting ->	85%	Best = High	15%	Best = High	Best = High
62	Cheyenne, WY	Small	0.910	24.5	$30,074	52.1	28.7
63	Jackson, MS	Large	0.920	24.8	$27,428	47.5	28.2
64	St. Louis, MO-IL	Large	0.860	23.2	$32,666	56.6	28.2
65	Brownsville-Harlingen-San Benito, TX	Large	1.050	28.3	$15,334	26.6	28.0
66	South Bend, IN	Large	0.900	24.3	$28,098	48.7	27.9
67	Ann Arbor, MI	Large	0.820	22.1	$33,965	58.9	27.6
68	Roanoke, VA	Large	0.850	22.9	$30,249	52.4	27.3
69	Cincinnati, OH-KY-IN	Large	0.830	22.4	$31,967	55.4	27.3
70	Fort Collins-Loveland, CO	Large	0.850	22.9	$30,198	52.3	27.3
71	Bergen-Passaic, NJ	Large	0.690	18.6	$43,856	76.0	27.2
72	Lancaster, PA	Large	0.860	23.2	$28,863	50.0	27.2
73	Elmira, NY	Small	0.890	24.0	$25,638	44.4	27.1
74	Lawrence, KS	Small	0.900	24.3	$24,129	41.8	26.9
75	Columbus, OH	Large	0.810	21.8	$31,343	54.3	26.7
76	Eugene-Springfield, OR	Large	0.870	23.5	$25,963	45.0	26.7
77	Tampa-St. Petersburg-Clearwater, FL	Large	0.830	22.4	$29,379	50.9	26.7
78	Albany-Schenectady-Troy, NY	Large	0.800	21.6	$31,789	55.1	26.6
79	San Luis Obispo-Atascadero, CA	Large	0.840	22.6	$27,917	48.4	26.5
80	Santa Rosa, CA	Large	0.760	20.5	$34,671	60.1	26.4
81	Wilmington-Newark, DE-MD	Large	0.740	19.9	$35,638	61.7	26.2
82	Monroe, LA	Small	0.870	23.5	$24,171	41.9	26.2
83	Columbus, GA-AL	Large	0.850	22.9	$25,909	44.9	26.2
84	Madison, WI	Large	0.730	19.7	$36,201	62.7	26.1
85	State College, PA	Small	0.820	22.1	$26,396	45.7	25.6
86	Salem, OR	Large	0.840	22.6	$24,402	42.3	25.6
87	Detroit, MI	Large	0.720	19.4	$34,035	59.0	25.3
88	Allentown-Bethlehem-Easton, PA	Large	0.760	20.5	$30,317	52.5	25.3
89	Salt Lake City-Ogden, UT	Large	0.800	21.6	$26,780	46.4	25.3
90	Anchorage, AK	Large	0.680	18.3	$36,949	64.0	25.2
91	Orlando, FL	Large	0.790	21.3	$27,003	46.8	25.1
92	Fort Lauderdale, FL	Large	0.730	19.7	$30,702	53.2	24.7
93	Tulsa, OK	Large	0.710	19.1	$30,650	53.1	24.2
94	Greensboro-Winston Salem, NC	Large	0.730	19.7	$28,774	49.9	24.2
95	Dayton-Springfield, OH	Large	0.700	18.9	$29,340	50.8	23.7
96	Santa Barbara-Santa Maria-Lompoc, CA	Large	0.630	17.0	$33,739	58.5	23.2
97	Charleston, WV	Large	0.720	19.4	$25,543	44.3	23.1
98	Syracuse, NY	Large	0.700	18.9	$27,021	46.8	23.1
99	Springfield, IL	Large	0.650	17.5	$31,037	53.8	23.0
100	Nashville, TN	Large	0.630	17.0	$32,338	56.0	22.8
101	Fort Wayne, IN	Large	0.680	18.3	$27,819	48.2	22.8
102	Waco, TX	Large	0.730	19.7	$23,302	40.4	22.8
103	Tallahassee, FL	Large	0.690	18.6	$26,127	45.3	22.6
104	Milwaukee-Waukesha, WI	Large	0.600	16.2	$33,780	58.5	22.5
105	Baltimore, MD	Large	0.570	15.4	$34,039	59.0	21.9
106	Richmond-Petersburg, VA	Large	0.590	15.9	$32,268	55.9	21.9
107	Asheville, NC	Large	0.640	17.3	$27,378	47.4	21.8
108	Charlotte-Gastonia-Rock Hill, NC-SC	Large	0.590	15.9	$31,526	54.6	21.7
109	Columbia, SC	Large	0.620	16.7	$28,578	49.5	21.6
110	Wilmington, NC	Large	0.630	17.0	$27,081	46.9	21.5
111	Buffalo-Niagara Falls, NY	Large	0.620	16.7	$27,852	48.3	21.4
112	Flint, MI	Large	0.650	17.5	$25,105	43.5	21.4
113	Santa Fe, NM	Small	0.560	15.1	$32,920	57.0	21.4
114	Brazoria, TX	Large	0.640	17.3	$25,695	44.5	21.3
115	Harrisburg-Lebanon-Carlisle, PA	Large	0.580	15.6	$30,829	53.4	21.3
116	Lubbock, TX	Large	0.640	17.3	$24,788	42.9	21.1
117	Billings, MT	Small	0.600	16.2	$27,891	48.3	21.0
118	Fort Myers-Cape Coral, FL	Large	0.580	15.6	$29,540	51.2	21.0
119	La Crosse, WI-MN	Small	0.600	16.2	$27,626	47.9	20.9
120	Knoxville, TN	Large	0.600	16.2	$27,330	47.4	20.8
121	Glens Falls, NY	Small	0.620	16.7	$23,952	41.5	20.4
122	Johnson City-Kingsport, TN-VA	Large	0.620	16.7	$23,473	40.7	20.3

Appendix 3
Intelligent Building Demand Index

Rank	Metropolitan Area	Metro Size (1) 2002 Value	High-Tech GDP LQ (2) 2001 Value	High-Tech GDP LQ Index	Per Capita Personal Income (3) 2001 Value	Per Capita Personal Income Index	Intelligent Building Index Value
		Weighting ->	85%	Best = High	15%	Best = High	Best = High
123	Abilene, TX	Small	0.610	16.4	$24,304	42.1	20.3
124	Greenville-Spartanburg-Anderson, SC	Large	0.590	15.9	$25,818	44.7	20.2
125	Reno, NV	Large	0.460	12.4	$36,988	64.1	20.2
126	Lexington, KY	Large	0.550	14.8	$28,849	50.0	20.1
127	New York-Newark, NY-NJ-PA	Large	0.410	11.1	$40,450	70.1	19.9
128	Tyler, TX	Small	0.540	14.6	$28,824	49.9	19.9
129	Cleveland-Lorain-Elyria, OH	Large	0.500	13.5	$31,807	55.1	19.7
130	Des Moines, IA	Large	0.480	12.9	$32,991	57.2	19.6
131	Fort Walton Beach, FL	Small	0.540	14.6	$27,674	48.0	19.6
132	Charleston-North Charleston, SC	Large	0.510	13.7	$29,847	51.7	19.4
133	Vineland-Millville-Bridgeton, NJ	Small	0.580	15.6	$23,616	40.9	19.4
134	Montgomery, AL	Large	0.540	14.6	$26,830	46.5	19.3
135	Wichita Falls, TX	Small	0.510	13.7	$29,386	50.9	19.3
136	Grand Rapids-Muskegon-Holland, MI	Large	0.520	14.0	$28,471	49.3	19.3
137	Topeka, KS	Small	0.510	13.7	$29,144	50.5	19.3
138	Oklahoma City, OK	Large	0.530	14.3	$26,970	46.7	19.2
139	Dubuque, IA	Small	0.530	14.3	$26,889	46.6	19.1
140	Louisville, KY-IN	Large	0.480	12.9	$31,251	54.1	19.1
141	Savannah, GA	Large	0.510	13.7	$28,422	49.2	19.1
142	Olympia, WA	Large	0.510	13.7	$28,266	49.0	19.0
143	Longview-Marshall, TX	Large	0.540	14.6	$25,439	44.1	19.0
144	Macon, GA	Large	0.530	14.3	$26,265	45.5	19.0
145	Reading, PA	Large	0.500	13.5	$28,835	50.0	18.9
146	Mobile, AL	Large	0.560	15.1	$23,400	40.5	18.9
147	Iowa City, IA	Small	0.470	12.7	$31,203	54.1	18.9
148	Bryan-College Station, TX	Small	0.580	15.6	$21,028	36.4	18.8
149	Las Vegas, NV-AZ	Large	0.500	13.5	$27,916	48.4	18.7
150	Jacksonville, FL	Large	0.480	12.9	$29,625	51.3	18.7
151	Dothan, AL	Small	0.540	14.6	$24,030	41.6	18.6
152	Norfolk-Virginia Beach, VA-NC	Large	0.500	13.5	$27,452	47.6	18.6
153	Scranton-Wilkes Barre-Hazelton, PA	Large	0.510	13.7	$26,439	45.8	18.6
154	Springfield, MO	Large	0.510	13.7	$25,756	44.6	18.4
155	Evansville-Henderson, IN-KY	Large	0.470	12.7	$29,185	50.6	18.4
156	Utica-Rome, NY	Large	0.520	14.0	$24,452	42.4	18.3
157	New Orleans, LA	Large	0.470	12.7	$28,048	48.6	18.1
158	Albany, GA	Small	0.520	14.0	$23,275	40.3	18.0
159	Sarasota-Bradenton, FL	Large	0.360	9.7	$37,212	64.5	17.9
160	Chico-Paradise, CA	Large	0.520	14.0	$22,818	39.5	17.8
161	Elkhart-Goshen, IN	Small	0.480	12.9	$26,050	45.1	17.8
162	Las Cruces, NM	Small	0.570	15.4	$17,984	31.2	17.7
163	Myrtle Beach, SC	Large	0.500	13.5	$24,021	41.6	17.7
164	Memphis, TN-AR-MS	Large	0.420	11.3	$30,559	52.9	17.6
165	Baton Rouge, LA	Large	0.470	12.7	$26,032	45.1	17.5
166	Lansing-East Lansing, MI	Large	0.440	11.9	$27,253	47.2	17.2
167	Charlottesville, VA	Small	0.390	10.5	$31,657	54.9	17.2
168	Waterloo-Cedar Falls, IA	Small	0.450	12.1	$25,826	44.7	17.0
169	Shreveport-Bossier City, LA	Large	0.460	12.4	$24,812	43.0	17.0
170	Jersey City, NJ	Large	0.410	11.1	$28,584	49.5	16.8
171	Fargo-Moorhead, ND-MN	Small	0.410	11.1	$28,372	49.2	16.8
172	Akron, OH	Large	0.390	10.5	$29,953	51.9	16.7
173	Atlantic-Cape May, NJ	Large	0.370	10.0	$31,511	54.6	16.7
174	Terre Haute, IN	Small	0.460	12.4	$23,493	40.7	16.6
175	Hickory-Morganton, NC	Large	0.440	11.9	$24,988	43.3	16.6
176	Mansfield, OH	Small	0.450	12.1	$23,989	41.6	16.5
177	Miami, FL	Large	0.420	11.3	$26,594	46.1	16.5
178	Fayetteville-Springdale-Rogers, AR	Large	0.440	11.9	$24,585	42.6	16.5
179	Odessa-Midland, TX	Large	0.400	10.8	$27,920	48.4	16.4
180	Corpus Christi, TX	Large	0.440	11.9	$24,280	42.1	16.4
181	Honolulu, HI	Large	0.360	9.7	$31,115	53.9	16.3
182	Peoria-Pekin, IL	Large	0.380	10.2	$29,139	50.5	16.3
183	Tacoma, WA	Large	0.400	10.8	$26,601	46.1	16.1

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Intelligent Building Demand Index

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		Weighting ->	85%	Best = High	15%	Best = High	Best = High
184	Bismarck, ND	Small	0.390	10.5	$27,461	47.6	16.1
185	Eau Claire, WI	Small	0.400	10.8	$25,899	44.9	15.9
186	Johnstown, PA	Large	0.430	11.6	$23,141	40.1	15.9
187	Gainesville, FL	Large	0.400	10.8	$25,572	44.3	15.8
188	Appleton-Oshkosh-Neenah, WI	Large	0.350	9.4	$29,579	51.3	15.7
189	Benton Harbor, MI	Small	0.390	10.5	$25,826	44.7	15.6
190	Greeley, CO	Large	0.420	11.3	$22,469	38.9	15.5
191	Toledo, OH	Large	0.350	9.4	$28,098	48.7	15.3
192	Bloomington, IN	Small	0.380	10.2	$25,302	43.8	15.3
193	Saginaw-Bay City-Midland, MI	Large	0.360	9.7	$26,749	46.3	15.2
194	Athens, GA	Small	0.390	10.5	$24,085	41.7	15.2
195	Decatur, IL	Small	0.330	8.9	$28,417	49.2	14.9
196	Augusta-Aiken, GA-SC	Large	0.370	10.0	$24,721	42.8	14.9
197	Newburgh, NY-PA	Large	0.340	9.2	$27,343	47.4	14.9
198	Rockford, IL	Large	0.350	9.4	$26,335	45.6	14.9
199	Columbia, MO	Small	0.330	8.9	$28,020	48.5	14.8
200	Amarillo, TX	Large	0.370	10.0	$24,365	42.2	14.8
201	Beaumont-Port Arthur, TX	Large	0.370	10.0	$24,296	42.1	14.8
202	Canton-Massillon, OH	Large	0.340	9.2	$26,620	46.1	14.7
203	Dover, DE	Small	0.370	10.0	$23,940	41.5	14.7
204	Bremerton, WA	Large	0.330	8.9	$27,427	47.5	14.7
205	Erie, PA	Large	0.350	9.4	$25,495	44.2	14.6
206	Davenport-Moline-Rock Island, IA-IL	Large	0.320	8.6	$27,879	48.3	14.6
207	Sheboygan, WI	Small	0.300	8.1	$29,409	51.0	14.5
208	Daytona Beach, FL	Large	0.360	9.7	$23,827	41.3	14.4
209	Naples, FL	Large	0.160	4.3	$41,269	71.5	14.4
210	Green Bay, WI	Large	0.280	7.5	$30,535	52.9	14.4
211	Salinas, CA	Large	0.280	7.5	$29,901	51.8	14.2
212	Sioux Falls, SD	Small	0.250	6.7	$32,154	55.7	14.1
213	St. Joseph. MO	Small	0.330	8.9	$24,799	43.0	14.0
214	Lafayette, LA	Large	0.330	8.9	$23,881	41.4	13.8
215	Decatur, AL	Small	0.310	8.4	$25,233	43.7	13.7
216	Pensacola, FL	Large	0.320	8.6	$24,140	41.8	13.6
217	Rapid City, SD	Small	0.280	7.5	$27,181	47.1	13.5
218	Kokomo, IN	Small	0.270	7.3	$28,038	48.6	13.5
219	Yolo, CA	Small	0.270	7.3	$27,332	47.4	13.3
220	Bakersfield, CA	Large	0.340	9.2	$21,021	36.4	13.3
221	Riverside-San Bernardino, CA	Large	0.300	8.1	$23,840	41.3	13.1
222	Altoona, PA	Small	0.290	7.8	$24,682	42.8	13.1
223	Medford-Ashland, OR	Small	0.280	7.5	$25,505	44.2	13.0
224	Galveston-Texas City, TX	Large	0.250	6.7	$27,786	48.1	12.9
225	Fort Smith, AR-OK	Large	0.300	8.1	$23,048	39.9	12.9
226	York, PA	Large	0.250	6.7	$27,365	47.4	12.8
227	Chattanooga, TN-GA	Large	0.250	6.7	$27,213	47.2	12.8
228	Sumter, SC	Small	0.320	8.6	$21,009	36.4	12.8
229	El Paso, TX	Large	0.340	9.2	$19,186	33.2	12.8
230	Champaign-Urbana, IL	Small	0.250	6.7	$26,808	46.4	12.7
231	Punta Gorda, FL	Small	0.260	7.0	$25,800	44.7	12.7
232	Vallejo-Fairfield-Napa, CA	Large	0.220	5.9	$29,289	50.7	12.7
233	Great Falls, MT	Small	0.250	6.7	$26,016	45.1	12.5
234	Duluth-Superior, MN-WI	Large	0.240	6.5	$26,873	46.6	12.5
235	Fresno, CA	Large	0.300	8.1	$21,463	37.2	12.5
236	Kankakee, IL	Small	0.260	7.0	$24,749	42.9	12.4
237	Biloxi-Gulfport-Pascagoula, MS	Large	0.270	7.3	$23,679	41.0	12.3
238	Grand Forks, ND-MN	Small	0.250	6.7	$25,351	43.9	12.3
239	Racine, WI	Large	0.200	5.4	$29,550	51.2	12.3
240	Kenosha, WI	Small	0.220	5.9	$27,217	47.2	12.1
241	Bellingham, WA	Small	0.250	6.7	$24,564	42.6	12.1
242	Gadsden, AL	Small	0.280	7.5	$21,865	37.9	12.1
243	Panama City, FL	Small	0.240	6.5	$24,575	42.6	11.9
244	Williamsport, PA	Small	0.240	6.5	$24,344	42.2	11.8

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Rank	Metropolitan Area	Metro Size (1) 2002 Value	High-Tech GDP LQ (2) 2001 Value	High-Tech GDP LQ Index	Per Capita Personal Income (3) 2001 Value	Per Capita Personal Income Index	Intelligent Building Index Value
		Weighting ->	85%	Best = High	15%	Best = High	Best = High
245	Redding, CA	Small	0.230	6.2	$25,175	43.6	11.8
246	Stockton-Lodi, CA	Large	0.250	6.7	$23,155	40.1	11.7
247	Lake Charles, LA	Small	0.240	6.5	$23,935	41.5	11.7
248	Muncie, IN	Small	0.220	5.9	$25,493	44.2	11.7
249	Casper, WY	Small	0.130	3.5	$33,274	57.7	11.6
250	Alexandria, LA	Small	0.210	5.7	$26,053	45.1	11.6
251	Sioux City, IA-NE	Small	0.210	5.7	$25,768	44.6	11.5
252	Lakeland-Winter Haven, FL	Large	0.230	6.2	$23,991	41.6	11.5
253	St. Cloud, MN	Small	0.220	5.9	$24,802	43.0	11.5
254	Huntington-Ashland, WV-KY-OH	Large	0.250	6.7	$21,793	37.8	11.4
255	Houma, LA	Large	0.230	6.2	$23,540	40.8	11.4
256	Joplin, MO	Small	0.230	6.2	$23,019	39.9	11.3
257	Pueblo, CO	Small	0.230	6.2	$22,954	39.8	11.2
258	Gary, IN	Large	0.170	4.6	$28,094	48.7	11.2
259	Modesto, CA	Large	0.230	6.2	$22,677	39.3	11.2
260	McAllen-Edinburg-Mission, TX	Large	0.330	8.9	$13,788	23.9	11.1
261	Youngstown-Warren, OH	Large	0.210	5.7	$24,322	42.1	11.1
262	Florence, AL	Small	0.230	6.2	$22,037	38.2	11.0
263	Bloomington-Normal, IL	Small	0.130	3.5	$30,761	53.3	11.0
264	Parkersburg-Marietta, WV-OH	Small	0.200	5.4	$24,055	41.7	10.8
265	Texarkana, TX-Texarkana, AR	Small	0.220	5.9	$22,150	38.4	10.8
266	Sharon, PA	Small	0.200	5.4	$23,512	40.7	10.7
267	Laredo, TX	Large	0.290	7.8	$15,508	26.9	10.7
268	Hamilton-Middletown, OH	Large	0.140	3.8	$28,718	49.8	10.7
269	Killeen-Temple, TX	Large	0.200	5.4	$23,415	40.6	10.7
270	Clarksville-Hopkinsville, TN-KY	Large	0.200	5.4	$23,017	39.9	10.6
271	Wheeling, WV-OH	Small	0.190	5.1	$23,783	41.2	10.5
272	Victoria, TX	Small	0.150	4.0	$27,158	47.1	10.5
273	Lima, OH	Small	0.170	4.6	$25,353	43.9	10.5
274	Owensboro, KY	Small	0.170	4.6	$25,095	43.5	10.4
275	Yakima, WA	Large	0.190	5.1	$22,872	39.6	10.3
276	Enid, OK	Small	0.160	4.3	$24,780	42.9	10.1
277	Yuma, AZ	Small	0.250	6.7	$16,839	29.2	10.1
278	Wausau, WI	Small	0.120	3.2	$28,274	49.0	10.1
279	Cumberland, MD-WV	Small	0.190	5.1	$21,694	37.6	10.0
280	Florence, SC	Small	0.140	3.8	$25,742	44.6	9.9
281	Fayetteville, NC	Large	0.140	3.8	$25,729	44.6	9.9
282	Jacksonville, NC	Small	0.160	4.3	$23,945	41.5	9.9
283	Lawton, OK	Small	0.170	4.6	$22,672	39.3	9.8
284	Grand Junction, CO	Small	0.130	3.5	$25,366	44.0	9.6
285	Ocala, FL	Large	0.150	4.0	$22,910	39.7	9.4
286	Pine Bluff, AR	Small	0.170	4.6	$20,387	35.3	9.2
287	Merced, CA	Large	0.190	5.1	$18,461	32.0	9.2
288	Tuscaloosa, AL	Small	0.110	3.0	$25,041	43.4	9.0
289	Jackson, MI	Small	0.110	3.0	$24,415	42.3	8.9
290	Danville, VA	Small	0.140	3.8	$21,280	36.9	8.7
291	Janesville-Beloit, WI	Small	0.080	2.2	$25,908	44.9	8.6
292	Anniston, AL	Small	0.110	3.0	$22,035	38.2	8.2
293	Goldsboro, NC	Small	0.110	3.0	$21,738	37.7	8.2
294	Yuba City, CA	Small	0.100	2.7	$21,983	38.1	8.0
295	Steubenville-Weirton, OH-WV	Small	0.060	1.6	$22,876	39.6	7.3
296	Visalia-Tulare-Porterville, CA	Large	0.080	2.2	$20,166	34.9	7.1
296	Maximum		3.710	100.0	$57,714	100.0	98.4
1	Minimum		0.060	1.6	$13,788	23.9	7.1
295	Range		3.650	98.4	$43,926	76.1	91.3

Appendix 3
Intelligent Building Demand Index

Rank	Metropolitan Area	Metro Size (1) 2002 Value	High-Tech GDP LQ (2) 2001 Value	High-Tech GDP LQ Index	Per Capita Personal Income (3) 2001 Value	Per Capita Personal Income Index	Intelligent Building Index Value
		Weighting ->	85%	Best = High	15%	Best = High	Best = High

Notes:
The survey does not include all metropolitan areas in the U.S. due to lack of complete data for some of them.

(1) Of the small metros, the population ranges from 57,000 to 185,000 people (average of 133,000 people). Of the Large metros, the population ranges from 190,000 to 9,637,000 people (average of 1,046,000). Source: The Muldavin Company, Inc.

(2) High-Tech GDP LQ; Milken Institute
Combined Metropolitan area high tech location quotient during 2001. Location Quotient (LQ) is a measure of high tech concentration (U.S. = 1.0). A metro with an LQ higher than 1.0 is said to be more concentrated than the United States and vice versa.

(3) Per Capita Personal Income; Bureau of Economic Analysis, an agency of the U.S. Department of Commerce
Personal income is the income that is received by persons from participation in production, from both government and business transfer payments, and from government interest (which is treated like a transfer payment). It is calculated as the sum of wage and salary disbursements, other labor income, proprietors' income with inventory valuation and capital consumption adjustments, rental income of persons with capital consumption adjustment, personal dividend income, personal interest income, and transfer payments to persons, less personal contributions for social insurance.

This measure of income is calculated as the personal income of the residents of a given area divided by the resident population of the area. In computing per capita personal income, BEA uses the Census Bureau's annual midyear population estimates.

All state and local area dollar estimates are in current dollars (not adjusted for inflation).

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