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OPTIMAL BUILDINGS THROUGH AUTOMATION TECHNOLOGY: TOWARD SYSTEMS UNIFICATION FOR SECURE, INTELLIGENT, GREEN, AND IMMUNE BUILDINGS

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INTELLIGENT AND SECURE BUILDINGS

Intelligent Building and construction automation in one form or another have been in existence for decades. Open source communication protocol standards such as BACnet have been instrumental in the profilation of intelligent building technologies while yielding many benefits.

Most notably, Intelligent Building Automation Systems (IBASs) can have a direct effect on the energy profile of a building. In addition, they can promote residential quality of life through refined lighting and automated environmental controls. Large complexes can utilize intelligent building infrastructure to lower energy costs and increase quality of life through air monitoring. The optimal amount of external (fresh) air is introduced into a building as needed. This regulated introduction not only saves energy, but also assures a habitable and productive work environment for occupants.

Secure buildings utilize intelligent building technologies for provisioning of localized access control within buildings or complexes. This access control typically includes biometrics, or RFID access cards. In addition, access control can be fully regulated and automatically changed as needed. This location information provides the intelligent system and thus first responders with valuable and accurate personal location information.

GREEN BUILDINGS

The Concept of a Green Building is truly holistic since it is not only concerned with lifecycle energy savings but also construction, O&M (Operations and Maintenance), and demolition/removal.

One of the more commonly accepted rating standards is *Leadership in Energy and Environmental Design* (LEED) developed by the U.S. *Green Building Council* (USGBC). This standard and accreditation exam is now utilized in more then 30 countries around the world, so it is truly international. Since LEED utilizes a common standard of measure, buildings can now be rated for their relative level of "green compliance" and can be rated as "certified" 26–32 points, through "platinum" 52–69 points

which represent the highest level of compliance. LEED-NC 3.0 (new construction) will likely contain a provision for carbon foot printing. This quantative capability can be directly applied to the emerging economy of carbon trading. Efficient, accurate and verifiable carbon trading policies and practices require a unified inter- and intra- building information exchange and monitoring architecture.

IMMUNE BUILDINGS

Current practices related to building immunization relate primarily to design and analysis for protecting traditional buildings against airborne disease transmission, mold contamination, nosocomial infections, and the threat of biological weapon agents (see *www.immunebuildingsys tems.com*).

Immune building concepts have gained additional focus from the government due to the 9/11 attacks. Until those events, the public viewed a building scale biochemical attack as possible, but not probable. This extreme example of stateless asymmetric warfare sparked a renewed focus in homeland protection, which in turn resulted in increased funding for immune building technology.

Immune building technology is intended to protect building inhabitants form biological or chemical attack/exposure. Building occupants could be exposed to external or internal agents. However, due to proximity and concentration, the internal exposure threat is more likely to cause harm or death. The goal of immune building technology is to remove the "soft-target" characteristics inherent to traditional buildings.

However, infrastructure and system costs are typically too high for the low-level risk associated with typical government or civilian buildings. Consequently, deployment of immune building technology has been limited. A view toward infrastructure and total systems sharing with Intelligent/Green building technology is a viable solution to mitigate the added cost of immune building infrastructure.

FUTURE RESEARCH ISSUES

For the most part, immune building projects have been designed around the specific needs of the federal government and not industry. The principal reasons for this are the lack of distributed system scalability, and an unfavorable cost vs. risk relationship. The government must and can protect some secure facilities with immune building technology because there is a greater risk of attack vs. a civilian target. Widespread government and industrial adaptation of immune building technology has been further mitigated by the high cost of system procurement, O&M, and the absence of effective system integration coupled with a less favorable cost vs. risk relationship.

Disconnected buildings lack automated control and notification systems that can trigger a campus or city wide alert system in the event of an attack or emergency. This creates inefficiencies that can result in many unnecessary casualties during an emergency [1–4].

BENEFITS OF INTELLIGENT, GREEN, SECURE AND IMMUNE BUILDINGS

There is a pressing need to develop a systems unification concept that will include the implementation of cross-functional sensor and control systems. These cross-threaded systems will utilize "multi-purpose" components and adaptive technologies that will reduce implementation, operation, and maintenance costs while increasing system efficacy and scalability. These multiuse components will be further enhanced by integration in a unified system architecture (Figure 1).

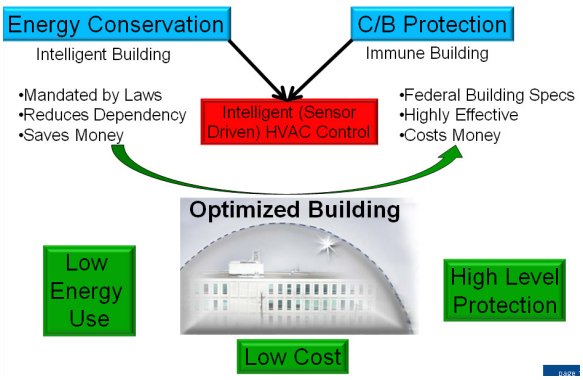

Figure 1. The Optimized Building Concept

Intelligent, green, secure and immune buildings which share a unified architecture can benefit from live information sharing and analytical analysis which provides constant omnipresent situational awareness. Unification will also facilitate instant application of changes if security posture of the building owner were to change. A city operating under *optimal energy* and *normal access* conditions can instantly change to adapt to modifications in threat levels. These changes can be stimulated by the combination of sensor triggering and analytical analysis of this sensor information. Buildings can be automatically or manually locked-down and/or evacuated based on this live situational awareness information [5–7].

There is great anticipation for growth in the market of carbon gas emissions trading throughout the world based on the conclusions of the Kyoto Protocol signed in 1997 and entered into force in 2005. Highly connected intelligent buildings will have the capability of reporting carbon gas emissions in real time and thus enabling continuous commodity trading process. Leaders in this market possess advanced building automation expertise and are currently creating command and control centers managing large portfolios of commercial buildings throughout the world (see Pacific Control Systems LLC of Dubai, UAE www.pacificcontrols.net and Middle East Centre for Sustainable Development www.mecsd.com) [8–9].

Other cost benefits will not only be realized through efficient force protection re-posturing but through energy savings since buildings will collaborate via the unified system to provide the highest state of energy efficiency. Some experts expect energy costs to increase up to tenfold over the next few years, profoundly changing the way business and society operate. Thus, the added benefit of Immune Building technology can easily be offset by efficient systems integration and energy savings from Intelligent/Green Building technology. In addition, intangible benefits will be realized through a safer, more productive work environment and the overall satisfaction of owners and tenants.

The e-Construction Group at the University of Maryland is working to develop a consensus Functional Requirements Document that will capture building system unification requirements. The aim of this research is to define a unifying systems architecture that encompasses Intelligent/Green Buildings and Immune buildings. This architecture will overcome limitations, such as increased cost and reduced functionality of large scale distributed building concepts.Researchers prepare to conduct a modeling and systems analysis study of the cost and benefit of merging intelligent/green building technology with Immune building technology. The effort must also explore the possibility for the need of a new system wide communication and information protocol to increase security and efficiency. This concept model should consider technology enhancements and limitations through simulation of unified system architecture on both an urban and individual facility scale. Maximum consideration will also be given to multiuse: sensor, control, and communication compilations. The model will not only consider the potential benefits of systems unification, but also the potential increased IT security risks associated with unification.

CONCLUDING REMARKS

The author has been in attendance at all but two of the annual proceedings of the International Symposia on Automation and Robotics in Construction held annually throughout the world since 1984 [10]. The evolution of construction and building automation concepts leads him to believe that the time has come to unify the various automation and robotic technology concepts presented at these symposia and employ them in the service of designing and producing optimized buildings encompassing the objectives of intelligent, green, secure and immune performance in response to the needs of the first half of this 21st century.

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