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TECHNICAL REPORT

Smart Building
Volume 1- Executive Summary

March 2006

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13. ABSTRACT (Maximum 200 words)
The Defense Threat Reduction Agency conducted a technology demonstration called the "Smart Building" Program in support of the 2002 Winter Olympics. It showed that a facility could be protected from chemical and biological warfare agents, and radiological particulates using commercial off-the-shelf hardware. The facility selected was the Social Hall Plaza building in Salt Lake City, Utah. The key elements of the Smart Building system were infrastructure protection and consequence assessment.

The infrastructure protection team developed a comprehensive, automated, modular, transportable CBR protection system and integrated it into the Social Hall Plaza. The system provided positive pressure collective protection, chemical, biological and radiological detectors, automated HVAC response, notification procedures, emergency decontamination provision, and physical security to regulate vehicle and pedestrian traffic.

The consequence management team provided the capability to assess the potential or actual impact of a threat event through the use of hazard modeling software tools at a Consequence Assessment Center, using E-Team ® incident management system. Developing the CAC involved the use of Geo-spatial Information System, population database development and the linking of the Olympic Coordination Center to first responders, and remote sites to the incident management system.

This executive summary is Volume 1 of six volumes that each addresses a particular aspect of the program.

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Conversion Factors for U.S. Customary to metric (SI) units of measurement.

MULTIPLY → BY → TO GET
TO GET ← BY ← DIVIDE

angstrom	1.000 000 x E -10	meters (m)
atmosphere (normal)	1.013 25 x E +2	kilo pascal (kPa)
bar	1.000 000 x E +2	kilo pascal (kPa)
barn	1.000 000 x E -28	meter^2 (m^2)
British thermal unit (thermochemical)	1.054 350 x E +3	joule (J)
calorie (thermochemical)	4.184 000	joule (J)
cal (thermochemical/cm^2)	4.184 000 x E -2	mega joule/m^2 (MJ/m^2)
curie	3.700 000 x E +1	*giga bacquerel (GBq)
degree (angle)	1.745 329 x E -2	radian (rad)
degree Fahrenheit	$t_k = (t^o f + 459.67)/1.8$	degree kelvin (K)
electron volt	1.602 19 x E -19	joule (J)
erg	1.000 000 x E -7	joule (J)
erg/second	1.000 000 x E -7	watt (W)
foot	3.048 000 x E -1	meter (m)
foot-pound-force	1.355 818	joule (J)
gallon (U.S. liquid)	3.785 412 x E -3	meter^3 (m^3)
inch	2.540 000 x E -2	meter (m)
jerk	1.000 000 x E +9	joule (J)
joule/kilogram (J/kg) radiation dose absorbed	1.000 000	Gray (Gy)
kilotons	4.183	terajoules
kip (1000 lbf)	4.448 222 x E +3	newton (N)
kip/inch^2 (ksi)	6.894 757 x E +3	kilo pascal (kPa)
ktap	1.000 000 x E +2	newton-second/m^2 ($N\text{-}s/m^2$)
micron	1.000 000 x E -6	meter (m)
mil	2.540 000 x E -5	meter (m)
mile (international)	1.609 344 x E +3	meter (m)
ounce	2.834 952 x E -2	kilogram (kg)
pound-force (lbs avoirdupois)	4.448 222	newton (N)
pound-force inch	1.129 848 x E -1	newton-meter (N-m)
pound-force/inch	1.751 268 x E +2	newton/meter (N/m)
pound-force/foot^2	4.788 026 x E -2	kilo pascal (kPa)
pound-force/inch^2 (psi)	6.894 757	kilo pascal (kPa)
pound-mass (lbm avoirdupois)	4.535 924 x E -1	kilogram (kg)
pound-mass-foot^2 (moment of inertia)	4.214 011 x E -2	kilogram-meter^2 ($kg\text{-}m^2$)
pound-mass/foot^3	1.601 846 x E +1	kilogram-meter^3 (kg/m^3)
rad (radiation dose absorbed)	1.000 000 x E -2	**Gray (Gy)
roentgen	2.579 760 x E -4	coulomb/kilogram (C/kg)
shake	1.000 000 x E -8	second (s)
slug	1.459 390 x E +1	kilogram (kg)
torr (mm Hg, 0^0 C)	1.333 22 x E -1	kilo pascal (kPa)

*The bacquerel (Bq) is the SI unit of radioactivity; 1 Bq = 1 event/s.
**The Gray (GY) is the SI unit of absorbed radiation.

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Introduction

The Defense Threat Reduction Agency (DTRA) initiated a one-of-a-kind technology development and demonstration program in 1999 known as the Smart Building Program. The Smart Building Program Final Report has been developed in multiple volumes as identified below:

- Volume 1- Executive Summary
- Volume 2 - Smart Building Construction
- Volume 3 - Situation Awareness and Response Software
- Volume 4 - Operations, Integration and Training
- Volume 5 - Scheduling and Financial Report
- Volume 6 - Guidelines for Program Replication

The intent of this program was to design, fabricate and demonstrate a comprehensive chemical, biological and radiological (CBR) protection system. The Smart Building system was successfully demonstrated at the 2002 Winter Olympics in Salt Lake City, Utah. The facility selected, Social Hall Plaza, housed the Utah Olympic Public Safety Command (UOPSC) Olympic Coordination Center and an extensive list of supporting Government organizations. These organizations included the Federal Bureau of Investigation (FBI), Federal Aviation Administration (FAA), Federal Emergency Management Agency (FEMA), United States Secret Service (USSS), Bureau of Alcohol, Tobacco, and Firearms (ATF), local Fire and Police Departments, EMS and HAZMAT teams. Social Hall Plaza is pictured below.

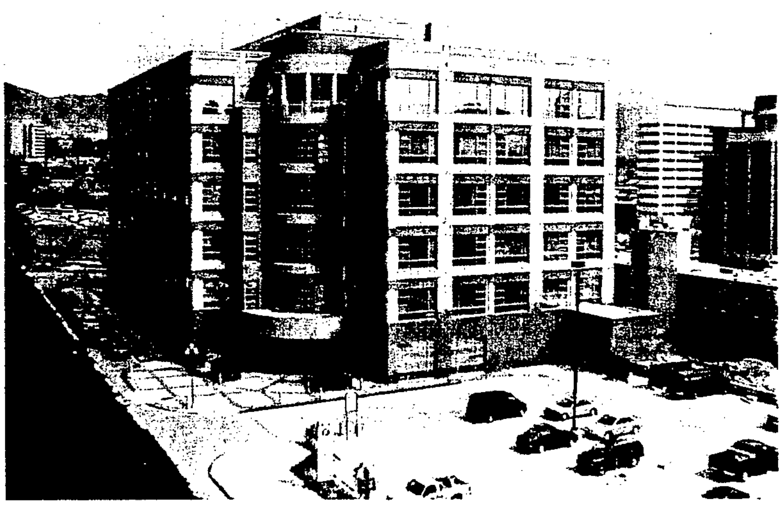

Figure 1. The "Smart Building" - Social Hall Plaza

The two key elements of the Smart Building system were infrastructure protection (IP) and consequence management (CM). These elements were managed and executed by two distinct teams.

1.0 Infrastructure Protection

1.1 Objective

The goal of the Smart Building IP team was to develop a comprehensive CBR building protection system that included collective protection, detection, decontamination, integrated control system, and physical security. The IP team focused on the utilization of commercial-off-the-shelf equipment since the aggressive program schedule did not allow for the inclusion of extensive research and development efforts or unproven technology. The specific objectives for the team were as follows:

- Design and develop a comprehensive CBR protection system that was automated, modular and transportable.
- Integrate the system into a facility housing the Utah Olympic Public Safety Command and various Federal agencies supporting the 2002 Winter Olympics in Salt Lake City, Utah.
- Document the design, fabrication, installation, operations and lessons learned.

1.2 Approach

The IP team used a systematic process to design and develop the building protection system. The initial steps in the process included conducting a threat and vulnerability assessment and a protection assessment. The intent of the threat and vulnerability assessment was to help define the problem. These assessments included the investigation of potential threat agents and release mechanisms and the identification of building strengths and weaknesses. Interviews were conducted with the FBI and the USSS to define the threat, and various modeling tools were used to help quantify the threat. Multiple teams conducted vulnerability assessments of the building to examine the effects of various threats. The protection assessment was next conducted to examine a wide array of potential building protection solutions. The protection assessment involved numerous site surveys, drawing reviews, user interviews, cost/benefit analyses, and computer modeling. An air flow model through the building was developed and utilized to quantitatively predict the effectiveness of various protective strategies against contamination events. Based upon the results of the protection assessment, DTRA and the building "stakeholders" selected an optimal protective scheme.

The optimal scheme was translated into a workable design, and the IP team fabricated the necessary equipment. The system was primarily fabricated at off-site locations and transported to the building for installation. Although the majority of the system was designed to be transportable, significant building modifications were required. These modifications required close interaction with the building owner and other local organizations. An extensive team of specialty contractors with mechanical, architectural, structural, and electrical expertise conducted the system installation. The installed protection system was operated and maintained by the IP team for a period of two months surrounding the Winter Olympics. Response procedures and plans were developed for the system in addition to training programs. The system was removed from the building in September of 2002.

1.3 System Description

The threat, vulnerability and protection assessment processes were used to help define the protective envelope and the appropriate protection strategies and system. The primary protective envelope was defined as the 5^{th} and 6^{th} floors of Social Hall Plaza, which housed the UOPSC and supporting Federal agencies. The secondary protective envelope was defined as the 1^{st} through the 4^{th} floors, which housed an array of commercial and Government tenants unaffiliated with Olympic safety issues. Differing protective schemes were used to meet the operational and technical requirements of the primary and secondary protective envelopes.

The protective system for the primary protective envelope was designed to provide continuous protection via an integrated positive pressure collective protection system and a variety of other components. The protective system for the secondary protective envelope was designed to provide stand-by protection via deliberate manipulation of the building mechanical systems and internal and external detection systems. Other system elements that helped provide protection to both envelopes included supporting building modifications, decontamination, physical security, emergency power, control and early warning system, training, and procedures. The following sections overview these key system components.

1.3.1 Building Modifications

The design, procurement and integration of the protection system into the facility was a complex process that involved multiple government agencies, building contractors, local fire department personnel and state regulators. The modifications involved an array of architectural, structural, mechanical and electrical modifications. The 5^{th} and 6^{th} floors required air conditioned and filtered air to protect against potential biological/chemical insults. This required a roof supported filtration and conditioning system. The system was supported by a steel platform mounted with enhanced structural support to distribute the load on the roof. Additional modifications included constructing mechanical rooms on the 5^{th} and 6^{th} floors to allow the outside filtered and return air to be mixed, conditioned, and then distributed throughout the protective envelope. Two additional air-handling units were installed in each mechanical room and were connected into the existing duct loop. Sealing measures were also performed for reducing the air leakage rates from the protective envelope. The two main sealing efforts that were implemented included: 1) sealing insulation on the 6^{th} floor that led to a leakage path up the side of the pre-fabricated panels and 2) sealing the roof membrane at the top edge of the outer parapet wall and at the base of the penthouse to reduce the overall leakage from the building.

A series of three rooms were also constructed at the entrance into the 5^{th} and 6^{th} floors of the facility. These rooms consisted of a mantrap, airlock and decontamination room. Mantraps were constructed in order to physically prevent personnel from entering into the facility without the proper credentials. Airlocks were constructed at the entries to the 5^{th} and 6^{th} floors to prevent contaminated air from entering into the protective envelope while processing personnel into or out of the protective envelope during a challenge on the facility. Decontamination rooms were also constructed for processing personnel into or out of the protective envelope during a challenge on the facility.

1.3.2 Collective Protection

The modular collective protection filtration system (MCPFS) was designed to provide filtered air for pressurizing the protective envelope (i.e., 5^{th} and 6^{th} floors) and preventing the infiltration of contaminants from areas either within the building or outside. The MCPFS was constructed using two standard military shipping containers (mil-vans) providing a combined 20,000 cubic feet per minute (566 m^3/min) airflow. The protective envelope consisted of approximately 60,000 square feet (5574 m^2) of floor space that was slightly over pressurized to maintain an outward flow of air in the protective envelope in up to a 15 MPH (6.7 m/s) wind incident on the building. The system was designed to be transportable using military air sizing requirements for the C-130 Hercules, C-141 and C-5 aircraft.

Each MCPFS consisted of a pre-filter, an axial fan with a variable frequency drive and ten filter housings. Each filter housing contained five military grade carbon-HEPA filter units. The HEPA element was used for removal of aerosols and the carbon element for removal of toxic vapors. A pre-filter containing standard air filters was utilized to protect the fan and to prevent premature loading of the HEPA filters.

A boiler system was also designed and installed on the roof top support platform for heating the makeup air. The final configuration of the MCPFS is shown below in Figure 2.

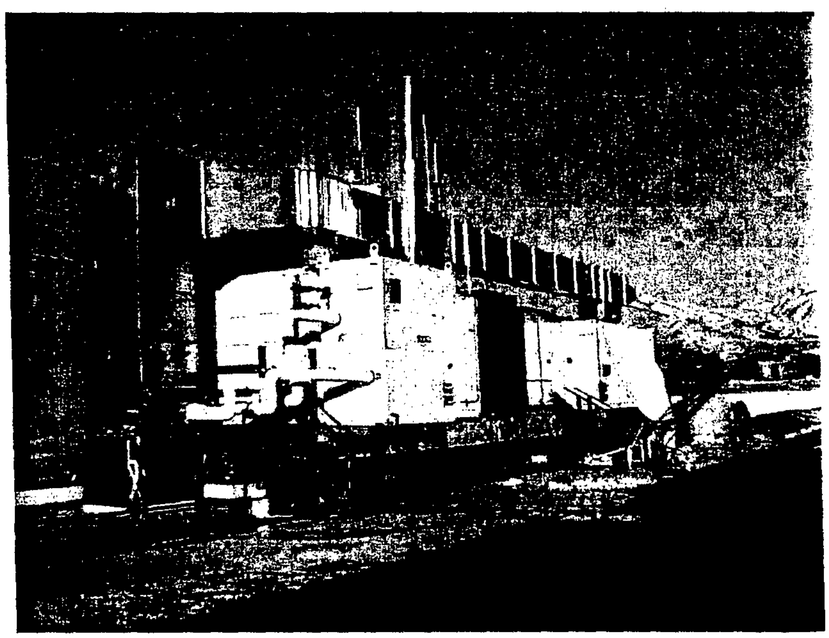

Figure 2. Modular Collective Protection Filtration System

1.3.3 CBR Detection

Chemical, biological, and radiological detectors were placed at five key locations within the Smart Building. Each location was selected based on a detailed analysis of how people and air move throughout the facility. Extensive modeling of the facility was performed using an airflow model of the building that was developed using CONTAM™, a contamination assessing computer code. This modeling was utilized in support of a detailed engineering assessment to identify the ideal locations within the facility for placing the detectors. The two chemical detector types selected for use in the Smart Building program were the CW Sentry Plus®, from Microsensors, Inc., and the RAID-1® from Bruker Daltonics. The CW Sentry Plus detector is based on Surface Acoustic Wave technology, while the RAID-1 detector utilizes Ion Mobility Spectroscopy. These detectors are designed to detect the majority of chemical warfare agents and specific toxic industrial chemicals. The toxic industrial chemicals detected are specific to both the technology and the library selected based on the specific application. The radiological detector was a customized gamma detector designed for IP applications.

The biological detection system installed in the building was the Joint Biological Point Detection System (JBPDS) from the U.S. Army Joint Program Office. This system was the only non-commercial hardware used. This was necessary since the commercial biological detectors at the time were judged unable to meet requirements. This system was located in the penthouse mixing room, where it sampled both the return air and the outside air entering into the building for biological agents of interest. Fiber optic communications from the JBPDS to the satellite control room was established by running dedicated fiber optic cables from the Smart Building control room, located on the 6th floor of the Social Hall Plaza Building, to the satellite control room located on the 8th floor of the Key Bank Building.

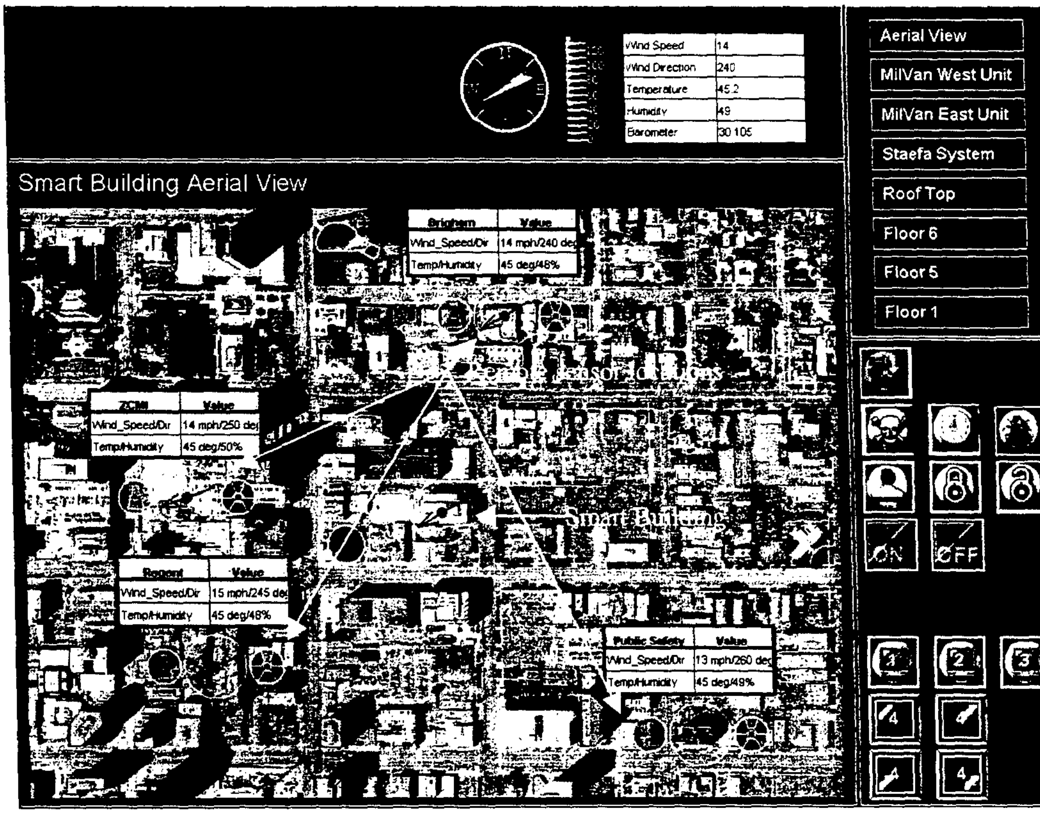

Figure 3. Control System Screen Showing External Detector Location and Status

1.3.4 Decontamination

Decontamination rooms were integrated into the facility on the 5th and 6th floors. These rooms were developed to provide a soap and water decontamination capability just prior to entering into the protective envelope should it be necessary for emergency support to enter the closed protected facility during a potential insult. An additional dry decontamination powder capability was also integrated into the overall decontamination plan that was developed for use during the Olympics. The decontamination rooms were designed to process approximately 3 to 5 people per hour either into or out of the protective envelope in the event of a medical emergency during or immediately after a challenge on the facility.

The DTRA provided trained military personnel to staff the decontamination rooms in the event of an actual incident involving this facility. These individuals provided coverage on a 24x7 basis throughout the Olympics. The decontamination teams were equipped with dry decontamination powder kits called Special Personnel Event Expedient Decontamination System, which were procured to allow for additional decontamination capability that could be utilized either inside the building or for cold weather decontamination. The decontamination teams were also provided with handheld chemical and radiation detectors.

1.3.5 Emergency Power

The existing emergency power system in the Social Hall Plaza Building was sized to meet life safety requirements in the event of a power outage. Thus it was not able to handle continuous operations requirements of UOPSC and the FBI. In support of the Smart Building Program, a temporary emergency power system was installed in the building. This system was sized to ensure that all operations conducted on the 5th and 6th floors, and the collective protection system, would remain fully operational in the event of a power outage. A 1000-kilowatt emergency generator and a 2000-gallon (7.57 m^3) cement-lined, vaulted fuel tank were installed in the third level of the parking garage. The fuel tank was sized to provide enough fuel to sustain operations for 24 hours without refueling. As a diagnostic and confidence check, the emergency generator was programmed to automatically start and run for 20 minutes once each week. A remote instrument panel was installed in the Smart Building control room on the 6th floor to allow the generator status to be monitored from within the protective envelope.

1.3.6 Physical Security

Several physical security measures were implemented in and around the Social Hall Plaza building during the Olympics. These measures consisted of limiting public access to the west lobby, closing the east lobby entrance into the Internal Revenue Service offices and restricting access into the parking garage. Security personnel were stationed at the entrance to the parking garage during the Olympics to ensure that only vehicles and personnel with proper credentials were allowed to enter the parking garage. The three story-parking garage was located directly under the building and presented a significant threat if access to the garage was not controlled. Air Force certified water-filled urban terrorism barriers were installed to establish a limited standoff distance and to protect the main column of the building (see Figure 4). These were used in lieu of standard concrete barriers due to local building code restrictions and that they caused less collateral damage were they impacted with a detonation. These barricades were also used to limit the flow of traffic to one direction on the north side of the building, from west to east, and to prevent vehicles from stopping and/or parking on the north and east side of the building.

Figure 4. Water-Filled Barriers Temporarily Positioned Along The Streets

Security personnel also established a checkpoint in the west lobby that included a magnetometer, x-ray machine and physical inspection of personal items, as necessary.

Chemical and radiation detectors were mounted in the west lobby but were not visible to personnel entering and exiting the building. Access to the fifth and sixth floors required passage through the West Lobby security checkpoint, an electronic card key to bypass the elevator interlock, and another electronic identification card to open the mantrap doors on the 5th and 6th floors. Authorized individuals without identification cards were escorted to the elevators by security personnel and subsequently processed through the mantraps by receptionists on the respective floors.

1.3.7 Control System

The Smart Building protection system was integrated through the use of a main server to monitor most of the sensors and detectors located throughout the building and at external detection sites. This server monitored the internal and external chemical and radiological detectors, differential pressure readings relative to the mantrap, airlock and decontamination rooms, differential pressure readings relative to the fourth, fifth and sixth floors, differential pressure readings across the CBR filters, outside air temperatures, wind speed, wind direction and relative humidity. The sensors and detectors were interconnected through the use of a network operating with the LonWorks communications protocol.

In addition to the main server, several other computers were also located in the control room and used to monitor various systems. A station was developed for monitoring, adjusting and confirming settings associated with specific components of the STAEFA Building Management System. The E-Team ® Incident management system software was also accessible from the control room and allowed control room operators to monitor events occurring throughout the Salt Lake valley. A station was also developed for monitoring the status of the JBPDS biological detectors located both internal and external to Social Hall Plaza.

The display for the Smart Building control system consisted of touch screens with either building floor or a filtration system schematic depending on the particular screen in use at that time. On the right hand side of the display screen was a sidebar that presented a menu of available screens at the top, a set of detector control icons in the center, and a set of CCTV monitor selection icons at the bottom. Windows on each screen were used to display critical parameters related to the particular system being displayed at that time. Touching an icon on either of the display screens would activate the device selected on the screen. Control room operators could monitor two completely different areas of the protection system using the independent display screens. For example, touching a particular CCTV camera on the floor plans and then touching the first CCTV icon would result in the video camera being displayed on the first CCTV monitor. Additionally, touching a detector icon would result in the status of that detector being displayed on the top of the screen. Touching any locations on the floor plans other than an icon would result in the display screen automatically zooming in on that particular area of the floor plan.

The control system was also designed to initiate an automated building response based on an alarm from a chemical or radiological detector. The ventilation system response was based on extensive building modeling and a detailed understanding of how the air flowed throughout the building. This understanding of how the air moved throughout the building was gained through a detailed investigation of the ventilation system, extensive analysis performed during the program and smoke testing conducted in specific areas of the building to gain a better understanding of exactly how the air moved through a particular area. The testing performed during the development of the optimal building response was based on alarm location and was intended to provide the best overall solution given the number of variables involved in a potential challenge on the facility.

The building's response following the positive identification of a biological agent was manually controlled. The JBPDS personnel monitoring their systems in a satellite control room initiated the notification. The satellite control room was hardwired to the Smart Building control room to allow CCTV video, AIPhone and fiber optic communications to be maintained between the two control rooms. A station for monitoring the status of the two biological detection systems was also located in the control room. This software package was tied directly to the satellite control room and was used by the control room operators in both locations to continuously monitor the status of each JBPDS.

Additional AIPhone installations were made throughout the building in order to ensure that communications could be maintained at all times in the event of a challenge on the facility. The additional AIPhone installations included the West Lobby security personnel, the 5th and 6th floor receptionists, the FBI camera operators, parking garage entrance security personnel and the JBPDS operators.

The building fire alarm system was also modified, with the cooperation of the State of Utah Fire Marshall, to allow the building and auxiliary air-handling units to continue functioning following a fire alarm on a lower floor. A remote fire alarm control panel was installed in the Smart Building control room to allow control room operators to monitor all fire alarms occurring within the building. Control room operators were instructed to make contact with fire department personnel arriving to address a fire alarm anywhere within the building in order to establish communications and determine if, and when, the fire department wanted the collective protection system shutdown and personnel from the 5th and 6th floors evacuated. Fire alarms occurring on the 5th and 6th floors were programmed to automatically shutdown the building ventilation system, auxiliary air-handling units through the fire alarm system.

2.0 Consequence Management

2.1 Objective

The goals of the Smart Building consequence management (CM) team were three-fold:

- Support the FBI and the UOPSC OCC with the capability to assess the potential or actual impact of a WMD event through the use of DTRA-provided hazard modeling software tools.
- Build a technology infrastructure – workstations, data networks, servers and software – for the fifth and sixth floors of the Smart Building.

- Provide the capability for multi-agency situational awareness and decision making through the selection and implementation of COTS-based command and control software.

2.2 Approach

To meet the goals stated above, the CM team used a five-stage approach:

- Assess. Prior to recommending technical solutions, the CM team conducted an extensive requirements analysis. All stake-holders – DTRA, UOPSC, FBI – were involved in this process.
- Validate. Upon the completion of the assessment stage, stake-holders were presented with the assessment results; all areas were validated and agreement and "buy-in" was obtained.
- Design. The overall systems design was developed during this stage of the process. Specific emphasis was placed on leveraging existing assets, such as the current State LAN/WAN infrastructure, and selecting proven COTS software products to minimize cost and maximize capability.
- Build. At this final stage, system hardware and software was purchased, installed and tested.
- Evaluate. Upon completion of the initial system capability, all systems were field tested and proven through the use of table top and command post exercises. Lessons learned were used as the basis for modification of software components and user training.

2.3 System Description

An extensive computer network was installed on the 5th and 6th floors and throughout the Salt Lake City valley to allow incidents occurring at various venue sites to be reported into a common incident management system. This allowed personnel with access to E-Team incident management system (IMS) software could monitor and evaluate events occurring in other locations to determine if those events would have any relevance to events occurring in adjacent locations or venue sites.

Additionally, an extensive reach back capability was developed at a site near the Smart Building and at DTRA Headquarters in Alexandria, Virginia. The consequence assessment team utilized tools such as Joint Assessment of Catastrophic Events (JACE), Consequence Assessment Toolset (CATS), and the Hazard Prediction and Assessment Capability (HPAC) models to develop "what if" modeling scenarios based on events being reported on the E-Team software.

2.3.1 Consequence Assessment Center

The Consequence Assessment Center (CAC) was an integrated suite of technology tools supporting the pre-planning, consequence assessment, emergency response, and management needs of the joint operations center and associated users. The CAC design met the following objectives:

- Ensured operational integrity of Olympic Coordination Center
- Provided an integrated system for response planning and coordination
- Used proven and existing software and hardware to support the various field exercises that were conducted in preparation for the Olympics

The CAC supported the operational needs, security, and communication requirements of a variety of end users beginning with formal pre-event exercises and continuing through the special events. End user requirements were documented and desires from potential CAC users and beneficiaries were also identified during the E-Team ® incident management system training.

The CAC tool suite contained a number of functional modules:

- Hazard analysis and consequence assessment
- Command and Control (incident management)
- Detector and meteorological data
- Resource scheduling and tracking
- Situational Awareness

Each of these modules is described below, along with the tools used.

2.3.2 Hazard Analysis and Consequence Assessment Module

Hazard and consequence assessment functionality was provided by CATS and JACE, two programs developed by DTRA in association with other Federal agencies. The CATS is a national award winning program jointly developed by DTRA and the Federal Emergency Management Agency to support emergency manager's training, exercise, contingency planning, logistical planning and calculating requirements for humanitarian aid and force protection from natural and man-made disasters.

For the CAC, CATS' basic capabilities were enhanced through the addition of analytical tools for vehicle routing and tracking, detector and met tower data display, three-dimensional data, and embedded photo and video display.

Detailed local data on the venue sites and surrounding areas were gathered and incorporated into CATS to provide expanded query and analysis capabilities.

The system for JACE was developed by DTRA in collaboration with National Ground Intelligence Center (NGIC). JACE is based on CATS, and provides for web-based access to CATS functionality as well as extended capabilities for modeling explosions and building collapse.

The Hazard Prediction Assessment Capability (HPAC) is a forward deployable, counter proliferation /counterforce collateral assessment tool. It provides the capability to accurately predict the effects of hazardous material releases, including chemical, biological, radiological, and nuclear collateral effects and their impact on civilian and military populations.

2.3.3 Command and Control Module

Users of the OCC cited response planning and coordination, including command and control, as their most critical requirement. E-Team® is a Lotus Notes/Domino based system designed to support multi-agency planning and coordination of major emergencies and special events. E-Team® is typically used as an "overlay" to existing single-agency command and control and dispatch systems, and supports multiple levels of security and access authorization.

2.3.4 Resource Scheduling and Tracking Module

The functions of resource scheduling and asset management were met by using the Asset/Resource module of E-Team®. The primary users of this module were the emergency medical personnel in the OCC, who identified air ambulance and emergency medical teams that could be dispatched by the OCC in the event of a catastrophic event.

2.3.5 Concept of Operations For CAC

The UOPSC and FBI directed that they would use a single WMD Modeling & Simulation (M&S) center for their OCC and JOC. This center was located on 5th floor across the hall from the OCC and was established and staffed by DTRA government and contract personnel. Combat strike team (CST) personnel from DOE jointly staffed the M&S center. In addition there was a full-time reach back to Camp Williams, Draper & DTRA Field/Alexandria Operations Centers. DTRA supplied a person to lead all of the connectivity and technical support for training, certification, and coordination.

The CAC was responsible for integrating the available incident reporting, hazard estimation, and situational awareness & consequence assessment tools. The CAC also integrated the software within the OCC and FBI Command Center and trained end-users on the use of the various tools.

3.0 Event Summary

The Olympics were by every measure a success including public safety. The overall public safety protected athletes, trainers, coaches, support staff and spectators. The Smart Building was an integral part of this success. John Ashcroft, Attorney General, said that the Olympic security, which includes the Smart Building activity, was a "...basis for other events to use as a model." Tom Ridge, the Homeland Security Director, said that this effort was a "...model for the nation."

The CAC monitored all events of which there were over 600 incidents and completed over one hundred "what if" scenarios in response to suspicious packages and other E-Team related events that were reported from throughout the Salt Lake valley in support of the OCC. Of these, three analyses caused a change in procedures: 1) a suspicious package was moved from its location before being rendered safe because of the potential for an unacceptable risk had the package included CBR materials; 2) the impact of a theft of an industrial chemical plant jacket with logo and keys to that facility prompted enhanced security and re-keying access locks; and 3) multiple bomb threats to a hotel near one of the venues had its security enhanced not only in the hotel itself but also in the adjacent public parking garage.

After the Olympics and Paralympics additional tracer gas testing was performed by Lawrence Berkeley Laboratories, obtaining extensive measurements that confirmed the effectiveness of the protective envelope and characterized the dispersal of aerosols throughout the building. The protection system was then removed and the building returned to its original configuration. Various pieces of equipment were transferred to local, state and federal agencies to enhanced their capabilities and limit shipping costs.

The Smart Building Program incorporated an enhanced CBR protection system into an existing office building with minimal disruption of day-to-day operations. The program was able to show that a tiered response is an effective means of protecting a wide array of assets in a cost effective manner.

4.0 Lessons Learned

The lessons learned from the Smart Building Program are extensive and have been documented for review by personnel in the process of initiating a similar program. These lessons learned range from integration of contractor efforts to minor technical details. In all cases, the lessons learned are meant to help other government agencies undertake a similar program and streamline their efforts. The lessons learned provided here focus on the higher level programmatic issues with more detailed lessons learned presented in subsequent volumes of this report.

4.1 Infrastructure Protection Team

The IP team identified many lessons learned from the program, including the following:

1. Issues will arise throughout the course of the program that require the protection system integration engineer to adjust the planned approach for integrating the system. These modifications are difficult to identify ahead of time and are usually the result of many different factors. A management reserve fund should be established to account for unexpected costs that arise during the program. During the Smart Building Program, the IP team had planned to tie into the building boiler system, but was informed later in the program by the building management company that the building's heating system could not be used for heating the filtered air. This resulted in an additional funding requirement to design, procure and install an external boiler system on the rooftop support rack.

2. The selection of hardware for use in IP programs should take into account the availability of technical support personnel. Hardware from companies located outside the United States should be scrutinized to ensure that adequate technical support is available. During the Smart Building Program, the IP team experienced problems obtained technical support for one the chemical detectors.

3. Placement of external detector systems on rooftops will require 24 hour access to the systems and arrangements need to be made to ensure that the detection systems can be accessed at all times. During the Smart Building Program, the IP team had difficulty reaching two external detection sites at night to reset one of the pumps on a chemical detector.

4. Integration of the control system into the building management system can

be improved to reduce the system response time. During the Smart Building Program, the IP team developed the interface between the building management system and the control system in a manner that limited the potential for damaging the building's ventilation system. During the development of the control system it became apparent that the response time was significantly longer based on the continuous polling process utilized by the building management system. Allowing the control system to talk directly to the specific components of the ventilation system can significantly reduce the response time. However, implementation of this approach will require programming interlocks to prevent inadvertently damaging the building's ventilation system.

5. Future programs should recognize the need to coordinate with local and state agencies to comply with local, state, and federal regulatory requirements (e.g. Americans with Disabilities Act) and to obtain all necessary permits for the building modifications that will be implemented.

4.2 Consequence Management Team

The CM team identified many lessons learned from the program, including the following:

1. It is good business practice to be prepared to train many personnel on new tools being used by field offices to report and store data. Prior planning should include the option for training hundreds of personnel from many agencies in small groups since the personnel trained for this event nearly swamped the training capability of the staff. In was nearly impossible to coordinate for large numbers in the classes and turnover.
2. A Conops should be written to require unambiguous leadership and single point final decision-making on any shift to coordinate complex tasks using multiple contractors and government agencies.
3. When dealing with a national security event, state and local agencies, many times, are not linked for joint operations. There are multiple communication systems that do not interface; different assessment tools may give conflicting results due to different input data and complexity of models in the tools. When the federal government is inserted into the situation, with its cadre of software tools such as the CATS and HPAC, it is imperative that the state and local authorities at all levels are well educated as to the value added by the software tools before they see the tools as part of the solution.
4. When the state and local agencies are in charge, they have a healthy mistrust for new ways of operation from the federal perspective. It is imperative that the federal government establishes a rapport with the local and state agencies before the new users will accept federal government's supports tools.
5. It is well understood that state and local agencies do not have a centralized command and control nor do they have clear-cut organizational authority and accountability. The same holds true for various federal governmental

agencies. The CM team that found that a successful business practice included continuing education, marketing and encouragement of participants at all levels of the organizations. This was due to most public safety agency representatives having little experience with Federal leading edge technology, analysis and modeling.

6. Given the non-centralized nature of the management structure procedural processes are very slow and inefficient. It is imperative for successful mission completion to remain flexible and maintain a success-oriented disposition.

7. It is important to have a good conops with any operation. "Free stuff is not free." It takes manpower, space and time and may impact the conops. If the capability is already being provided, it may not be helpful to accept the free items because integrating them into the conops after the fact is costly in time and manpower.

5.0 Guidelines for Program Replication

This program identified several important issues for any group wanting to replicate this effort. Volume 6 will detail these issues, but some of the most important ones are summarized here.

A Threat and Vulnerability Assessment (TVA) must be performed before beginning any building protection design activity. It must consider all of the threats that might be employed by an adversary against the building, including chemical, biological, radiological, explosive and physical assault. Once the threat has been identified, the vulnerability of the specific target must be assessed, which includes the building and the surrounding area.

The most cost effective means of integrating a positive pressure collective protection system is to design the system into the construction of new building. When that is not an option (as in this case), then choosing a building with a modern HVAC system and building management system, fast moving dampers, and a solid roof (other than a membrane type) would likely minimize cost. An HVAC system that is isolatable to specific floors or areas is also very useful in limiting the dosages from airborne threats.

The Smart Building focused on implementing off-the-shelf components to the greatest extent possible. Two components of the Smart Building Program that were new development items (regenerable filtration media and an integrated CBR detection system) were not completed in time to be thoroughly tested and implemented to support the Olympics.

During the TVA, protective measures for blast and shrapnel control were identified for implementation. However, only street level water filled barriers and controlled parking were implemented. Costs for incorporating extensive blast protection at this location would have been prohibitive due to the limited stand off distance associated with this particular building. In the future one may wish to use a facility that would allow a standoff distance that would minimize costs for added protection.

Planning efforts should include tracer gas tests in existing buildings, and modeling to predict the best way to protect the personnel in each type of threat scenario.

A future building protection project could benefit from a number of new technologies:

1. Filters that could be continuously regenerated and protect against a large number of TICs would be beneficial for long-term protection, and for protection from threats that might involve extremely large quantities of contaminants for long periods of time. Regenerable filters could be made smaller and lighter, and they could reduce unnecessary hazardous waste disposal costs.

2. No commercial biological detectors were available to support the Smart Building program. Thus it would be prudent early in any future effort to assess the state of bio-detection technology available for use in the new application.

3. Implementation of a second-generation state-of-the-art control system for integrating all of the sensors associated with establishing a Smart Building. The control system development effort is one of the areas where improvements in technologies and lessons learned from previous programs can significantly improve follow on efforts.

6.0 Funding

The total cost for the Smart Building Program, including all of the work performed by the IP team and the CM team, was $22,300,000. This includes the Smart Building Program funding and the leveraged funding from other projects and agencies. An overview of the DTRA funding breakdown (not including leveraged funding from other projects and agencies) is provided in Table 1. Further details and analyses are presented in Volume 5. Financial Report.

Table 1. Smart Building Program Funding Allocation

Task Area	Project Funding $1000	Proportion of Total
Assessing the Requirement	1,182	6.61%
Building Retrofit	5,458	30.51%
Sensor Procurement & Installation	762	4.26%
Command Post SW/HW Procurement & Installation	4,549	25.43%
Database Development	1,330	7.43%
Event Operations/Exercises	835	4.67%
Management Support	43	0.24%
Advice & Assistance Support	961	5.37%
Parking	390	2.18%
Decon Station Equipment & Supplies	500	2.79%
Decommissioning	1,880	10.51%
Final Smart Building	**17,890**	100.00%

7.0 Concluding Remarks

The "Smart Building" Program was a major success for DTRA in support of the 2002 Winter Olympics. The objectives of the Smart Building Program were accomplished and substantial improvements in IP of public buildings and special event incident management system reporting were realized as part of this program. The Smart Building Program was the first-ever integrated IP and CM system applied to support a special event. This system integrated collective protection, CBR detectors, control system and building ventilation controls in a non-intrusive manner.

The Smart Building IP team is currently addressing the development of a regenerable filtration media. Efforts to develop and test a regenerable filtration media prior to the Olympics could not be completed in time for the Olympics. The development of this filtration media is currently being addressed as a post Olympic Smart Building initiative.

Future efforts on facility protection should address shock, blast, fragmentation and thermal insults on a facility to apply cost effective building hardening and standoff measures.