Raytheon’s Command, Control, Communications and Intelligence Core Market
Delivering Operational Advantages for Our Customers
The Perimeter Intrusion Detection System ... assisting the Port Authority of New York and New Jersey

Intrusion detection, tracking and assessment
Raytheon was awarded a $100 million contract in January 2006 to develop the Perimeter Intrusion Detection System (PIDS) for the Port Authority of New York and New Jersey (PANYNJ). PANYNJ operates the world’s premier airport system serving almost 90 million passengers annually. These airports — John F. Kennedy International (JFK), Newark Liberty International, LaGuardia (LGA), and Teterboro — employ close to 70,000 people and represent a combined annual economic contribution to the region of $48 billion.

The PIDS mission is to detect, assess and track intruders attempting to gain access into exterior secure areas, and to aid PANYNJ in determining and dispatching the appropriate response forces to counter intrusions. Threats include landside intrusions at all four airports and waterside intrusions at JFK.

PIDS provides a layered, multi-sensor defense against intrusions by employing intrusion detection, tracking and assessment throughout all required secure areas in good and adverse weather. Various sensors — ground surveillance radars (GSR), video motion detection-equipped cameras and smart fencing — combined with overlapping sensor coverage provide a minimum 95 percent probability of detection ($P_D$), a low probability of false alarm ($P_{fa}$), a low nuisance alarm rate (NAR), and a 99.9 percent operational availability ($A_o$). Target locations are displayed in real-time on an airport facility map at the operator’s control and display workstation (CDW).

Upon detection of an intrusion event, PIDS provides an assessment capability based on infrared (IR), low light level, and daylight video cameras in good and adverse weather. Assessment cameras are automatically slaved to the intruder location, and surveillance sensor feedback maintains the camera(s) on the target track. Users may also manually control any assessment camera. Video is displayed to the PIDS users on the CDW and on large screen (46” diagonal) ceiling- or wall-mounted monitors at selected facility locations.

There are several components to the user interface presented on the CDW: (1) the facility map with intruder and police vehicle locations; (2) multiple video windows displaying live or recorded video; (3) an event queue, with standard operating procedures automatically displayed based on the selected event’s type; and (4) system administration tools. The PIDS operator is able to control all aspects of the system from this single user interface.

Wireless mobile communications with Port Authority Police Department officers in the field is also provided. Target locations are displayed on vehicle mounted computers. In addition, officers may view assessment video. Police vehicle locations are also tracked and displayed. These capabilities greatly improve the situational awareness of response forces.

PIDS also interfaces with two legacy systems: (1) an Access Control System (ACS); and (2) existing Closed Circuit Television (CCTV) systems.

**System Requirements**

Key requirements that drove the system design are:

**Target Characteristics:** These include the target types — person, vehicle, watercraft — and their cross-sectional area. In general, only the smallest target type needs to be specified, as the system is designed to detect and track such targets. This is typically a person, usually with a cross-sectional area of 0.5 m$^2$ to 1 m$^2$. The target speed range should also be specified; a typical range is 0.1 m/s to 30 m/s.

**Operational Availability:** This is expressed as the percentage of time the system is fully available to perform its mission. An $A_o$ of 99.9 percent corresponds to a downtime of 8.76 hours/year. The allowed downtime encompasses both total system failure and degraded mode operations, as well as periods of reduced system performance caused by extreme weather. Achieving a specified $A_o$ typically involves providing redundancy among system components, and providing overlapping sensor coverage.

**Environmental Factors:** Maximum rain rate is a key parameter impacting sensor performance and consequently $A_o$. A selected rain rate is used in modeling sensor performance. Similar considerations apply to snow, fog and wind.

**Probability of Detection:** The system is designed to detect targets with the specified characteristics under specified adverse weather conditions. Target detection zones are identified, usually around the facility perimeter. Within these zones, a minimum $P_D$ of 95 percent is maintained.

**Probability of False Alarm:** False alarms are associated with sensor noise. $P_{fa}$ is specified on a sensor basis. A typical GSR $P_{fa}$ is $10^{-6}$.

**Nuisance Alarm Rate:** Nuisance alarms are generated by the system detecting targets that do not satisfy the target characteristics. For example, a small dog or bird may be detected and tracked, even though it may not satisfy the required target characteristics. The NAR is usually expressed as an allowable number of nuisance alarms per detection zone, per specified time period. The achievable NAR is highly dependent on the facility environment.

**System Architecture and Design**

The PIDS implementation effort is dominated by the design and construction of the civil infrastructure necessary to support both the sensor network and the mobile communications. Raytheon’s approach to designing the physical system architecture begins with facility drawings augmented by site surveys. The drawings show where existing power and fixed communications nodes are located. These existing nodes are employed wherever possible to reduce implementation time and effort.

Accurate sensor models for both radars and cameras (visible and infrared), expressed as $P_D$ versus range curves, are developed. These curves incorporate weather effects and target characteristics, along with

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specific sensor characteristics. This modeling results in a maximum usable sensor range.

The power and communications locations contained in the facility drawings are used with the sensor models to develop a sensor network layout. Raytheon’s Sensor Terrain Analysis Tool (STAT), which utilizes the $P_d$ versus range curves, terrain data including buildings, height restrictions and other topographic constraints, is employed for this purpose. STAT produces a color coded $P_d$ map of the entire facility. Low $P_d$ areas are corrected by adding additional sensors.

The PIDS program was generalized to develop a system concept called the Integrated Security System for Airports (ISSA). Each subsystem is COTS-based, modular in design, with well defined interfaces. This supports future upgrades and expansions as new and improved products become available. The components and functions of each subsystem are described in the following.

**Intrusion Detection and Tracking Subsystem (IDTS):** The IDTS functions as the surveillance sensor front end. Any type of surveillance sensor can be integrated, however, three principal sensor types are usually employed. (1) GSRs are employed in unobstructed areas as the principal means of detecting and tracking targets due to their excellent all-weather capabilities and low cost/ft² surveillance and tracking capabilities; (2) Video motion detection–equipped CCTV and IR cameras are employed in areas with obstructions, typically near facility buildings and other types of structures; and (3) smart fence sensors are employed in low traffic areas as a supplementary means of intrusion detection. Surveillance sensor inputs are collected, processed and fused, and alarms are generated and transmitted to the command and control subsystem. ACS events are also processed within the IDTS and passed to the command and control subsystem.

**Intrusion Assessment Subsystem (IAS):** The IAS provides video to assess intrusion events 24/7 in good and adverse weather conditions, thereby assisting users in determining the appropriate response. A combination of visible light and IR cameras are employed to allow assessment in the full range of lighting and weather conditions. The cameras can be operated manually, automatically and in touring mode. In automatic mode, IDTS-generated position data automatically slave a camera to a moving target.

**Command and Control Subsystem (C2S):** The C2S provides the operator interface and event management functions. Both a geographical map and a tabular list representation are displayed to the operator. Alarms from different sources are processed: access control system alarms, perimeter intrusion alarms, loss of communications alarms, low power alarms, tampering alarms, etc. Alarms are prioritized based on user defined rules. The highest priority alarm is always presented to the operator for action. The operator employs video from assessment cameras and standard operating procedures to validate the alarm and react appropriately in concert with security force personnel. The C2S also logs all operator actions and incident data.

**Communications Subsystem (CS):** The CS connects all field components including sensors to computer resources located in server rooms. A high speed (1 Gbps or greater) Ethernet fiber optic network is employed, combining high bandwidth communications necessary for video transport with low communications latency. Mobile data and video communications with response forces are also provided.

**Power Subsystem (PS):** The PS provides the power distribution system and Uninterruptible Power Supplies for all system components — interior and exterior.

**Video Management Subsystem (VMS):** The VMS manages all video, including real-time display, replay, storage and archiving. The number of cameras, the video resolution and frame rate, and the video retention period are significant parameters that drive the required video storage capacity. Legacy CCTV systems are accessed through the VMS.

In conclusion, Raytheon provides a total solution to our PANYNJ customer, including technology, civil infrastructure design and construction, and maintenance. In addition, the PIDS design, as generalized by the ISSA concept, is also applicable to protecting other critical transportation infrastructure, such as seaports and rail yards.

Guy Germana
guy_t_germana@raytheon.com
Simon Hennin
simon_j_hennin@raytheon.com
Len Garcia
leonard_garcia@raytheon.com