SCIENCE & SECURITY November 2017

CASRA NEWSLETTER – ISSUE 17

2017 has been a busy year for CASRA with many interesting projects. By providing you more insight with this Newsletter issue, we hope you stay with us on an exciting journey into 2018.

In the section "Research Put Across", we present various implementation possibilities of remote cabin baggage screening (RCBS) based on centralized image processing (CIP). As for the "Security in Practice" section, we conducted an interview with Karen Urwin from New Zealand's Aviation Security Service (Avsec), in which she sheds some light on their processes and innovations concerning X-ray screening.

As always, we wish you a pleasant reading experience!

Dr. Diana Hardmeier
Director

Prof. Dr. Adrian Schwaninger
Chairman

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RESEARCH PUT ACROSS

CENTRALIZED IMAGE PROCESSING AT CHECKPOINT SECURITY - IMPACTS OF VARIOUS IMPLEMENTATION POSSIBILITIES

Remote screening of hold baggage based on centralized image processing (CIP) has been in use since the beginning of this century and is the common practice at larger airports. Remote screening of cabin baggage, however, is relatively new, with first projects having started around eight years ago. Introducing CIP at security checkpoints has the potential to dramatically increase an airport's capacity and the efficiency of passenger screening and is therefore a valuable option to tackle the increasing air passenger traffic numbers, which according to IATA, are forecasted to double by 2035. An analysis conducted by CASRA of previous experiences by pioneers and early adopters of CIP for checkpoint security has shown that a well-planned and thoroughly evaluated CIP implementation is critical for success. This article will give an introduction and overview of CIP, discuss the potential benefits and pitfalls to look out for and compare different CIP implementation possibilities regarding effectiveness, efficiency and human factors.

SECURITY IN PRACTICE

SCREENING PROCESSES AND FUTURE VISION - AN INTERVIEW WITH AVSEC NEW ZEALAND

The Aviation Security Service (Avsec) is a government agency (crown entity) and acts as the official provider of aviation security in New Zealand (NZ). Avsec NZ has a station at each of the five international airports located at Auckland, Wellington, Christchurch, Queenstown and Dunedin. In an interview, Karen Urwin - Group Manager of Operations at Avsec - answers questions regarding their training and certification processes as well as testing new and innovative solutions in terms of X-ray screening. She also talks about the "hot topics" concerning new and emerging threats and how Avsec NZ reacts to them.

CENTRALIZED IMAGE PROCESSING AT CHECKPOINT SECURITY - IMPACTS OF VARIOUS IMPLEMENTATION POSSIBILITIES

Text: Milena Kuhn

Over the last eight years, the concept of remote cabin baggage screening (RCBS) via the use of centralized image processing (CIP) has been implemented at a number of European airports and has been shown to potentially increase detection performance, throughput, capacity and employee satisfaction. Implementing CIP at security checkpoints hence holds many potential advantages; however, there is no 'one-size-fits-all' approach. Therefore, it is critical to plan and evaluate the most appropriate CIP approach for each airport. In a research project co-funded by the Federal Office of Civil Aviation (FOCA) Switzerland, CASRA systematically evaluated (via a multi-method approach) [see infobox 'Multi-method approach'] the advantages and disadvantages of CIP for checkpoint security based on the gathered experiences of pioneers and early adopters.

WHAT IS CIP? WHAT IS RCBS?

CIP refers to the networking of baggage images generated by X-ray machines. It allows a loosening of the conventional 1:1 relation between X-ray machine and X-ray screener, introducing a more flexible and efficient relation of the type n:n. While the concept of CIP is widely associated with the screening of hold baggage, the name 'CIP' is mainly used in connection with the screening of cabin baggage at security checkpoints. One of the main advantages of CIP is, that security screeners do not necessarily need to sit next to an X-ray machine to evaluate images, which allows an airport to be more spatially flexible when organizing the task of image analysis: remote screening, i.e. remote cabin baggage screening (RCBS) becomes possible.

CIP IMPLEMENTATIONS

The main initial motivation of airports and authorities to implement or to support the implementation of CIP at security checkpoints is the need to increase efficiency and capacity. However, implementing CIP most likely leads to many changes compared to the conventional cabin baggage screening (Figure 1), which mainly concern the spatial and structural organization of the checkpoint, but also the degree of necessary networking and automation processes.

After analyzing several real-life implementations of CIP at European airports, three main implementation types could be identified by CASRA (Figure 2):

a. Matrix-screening/remote local screening
b. Remote screening in remote room close to the checkpoint
c. Remote screening in remote room further away from the checkpoint

In all these implementation scenarios, screeners can receive images for analysis from any number of machines at the checkpoint, because the images are centrally saved and redistributed to the active image analysis stations. The main difference between the different CIP implementations lies in the location where the security screeners are located, i.e. (a) within the checkpoint, (b) in a remote room close to the checkpoint, or (c) in a remote room further away from the checkpoint (Figure 2). Before we dive into further details on the differences (see Table 1), let us first have a

INFOBOX: MULTI-METHOD APPROACH

The systematic evaluation of the current state of CIP of cabin baggage screening was conducted with a multi-method approach. Information from **experts** (e.g. airport security managers, civil aviation authority representatives, research teams), from **manufacturers** and from **end-users** (security personnel with the focus on the screeners) was gathered with document analyses, observations, expert interviews, and questionnaires.

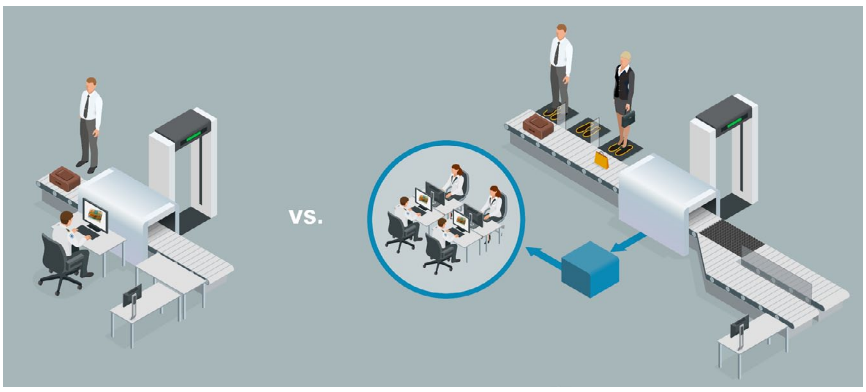


Figure 1: Conventional vs. CIP checkpoint lane

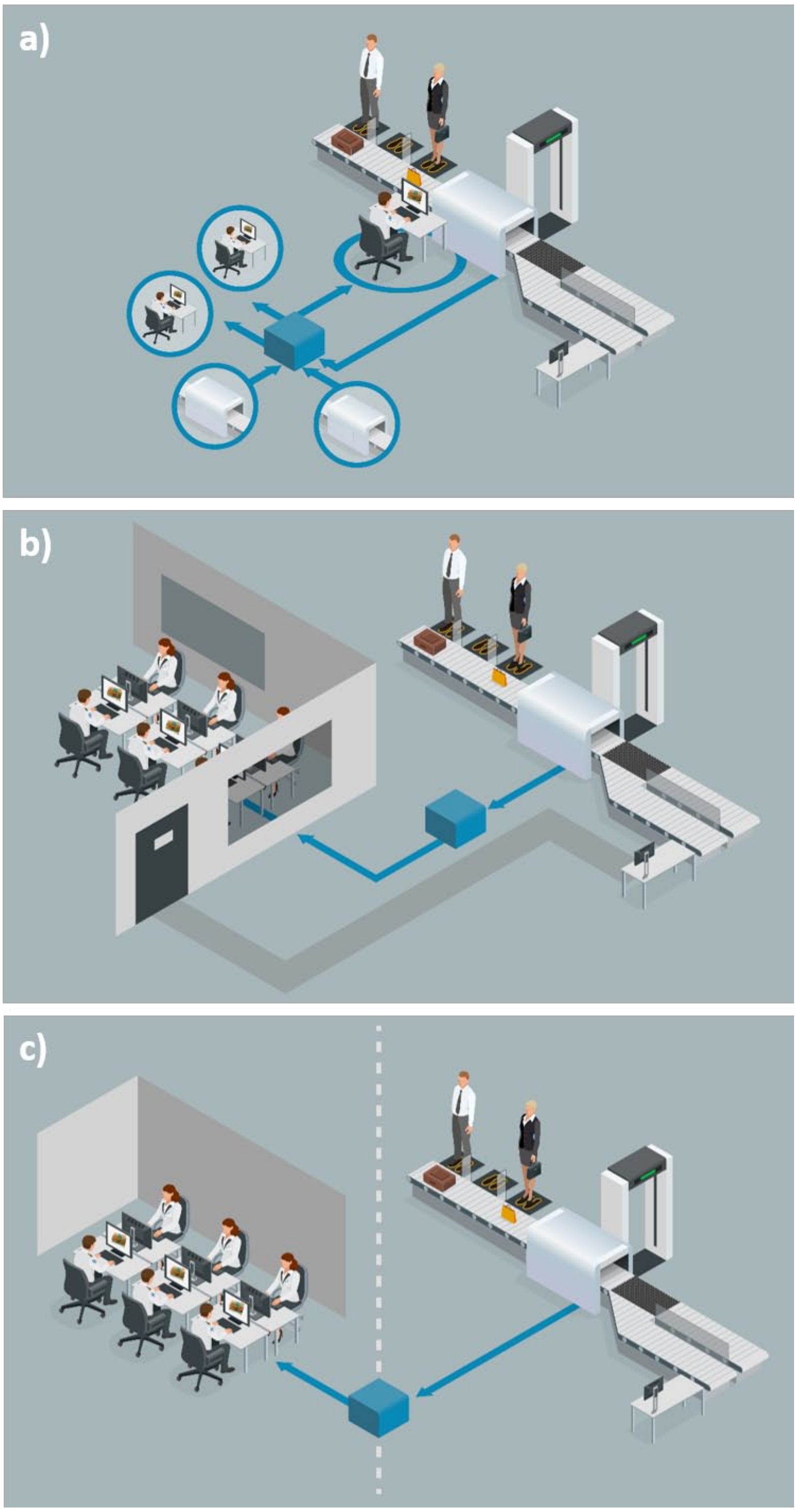


Figure 2: Three main CIP implementations

look at what it means to change a conventional checkpoint into a checkpoint operating with CIP.

CHECKPOINT COMPONENTS AND POTENTIAL CHECKPOINT MODIFICATIONS

Implementing CIP at a checkpoint does not simply mean that screeners are placed somewhere else, but it may be accompanied by several modifications and further developments of the checkpoint setup that are necessary to reach the respective objectives of CIP implementation. In general, the modifications aim to allow for a flexible location of the security screener in relation to the X-ray machine and to support maximum throughput numbers per checkpoint lane.

To enable X-ray machines to run at full capacity, passengers and the DIVESTING of their belongings need to be organized in a manner that allows the conveyor belt to be continuously loaded without unnecessary gaps in between trays or having to stop the conveyor belt. This is achieved by increasing the number of divesting stations to allow passengers to load their baggage and personal belongings in parallel ('parallel loading', see Figure 3). Parallel loading also allows faster passengers to "pass" slower passengers, making the process of divesting more efficient. The REDRESSING area needs to be enlarged accordingly to prevent a bottleneck created by the expected increase of passengers redressing at any given time.

Any type of X-RAY MACHINE can be integrated into a CIP implementation, i.e. single-view, dual-view and 3D. Often, machines are additionally equipped with a camera, which takes a picture of the tray before it progresses into the tunnel. This image is a useful source of information for the screeners conducting **IMAGE ANALYSIS**; for example, to determine whether LAGs[1] are placed inside or outside a bag. Independently of where a screener is situated, the image analysis is conducted with a CIP software, which allows the identification of a suspicious object by marking and categorizing areas of the image [see infobox 'CIP software', p.6]. If the bag is not cleared (either because an item has been identified as suspicious or because the analysis was not finished in time resulting in a timeout), it is forwarded to the **RECHECK STATION**. At the recheck station, a security agent can access the X-ray image, the photo, as well as the markings and categorizations of the screener by scanning the tagged tray (most often RFID[2] tags are used).

MATCHING OBJECTIVES TO IMPLEMENTATION SCENARIOS

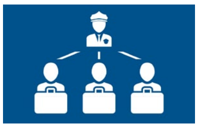
Objectives and requirements vary between different airports based on size, passenger numbers, passenger distribution, available space, etc., resulting in varying maximization and optimization goals [see infobox 'What are the main drivers for implementing CIP?'].

› *Capacity maximization with remote screening in a remote room*

In this first scenario, the aim is to maximize throughput of passengers per time, and thus maximize the capacity of the security checkpoint. There are generally more screeners than X-ray machines in use at the same time, e.g. up to five screeners are at work to analyze all the images generated by three X-ray machines.

Airport case studies showed that this objective is best achieved by conducting image analysis in a separate screening room, where the number of screeners can be adapted flexibly and increased without being limited by the available checkpoint lanes (as is the case with matrix-screening). If the remote rooms are located within a reasonable walking distance from the checkpoint, rotations of team members (similar to a screening team at conventional checkpoints) between the remote room and the checkpoint are possible. However, rotating within teams somewhat restricts the flexibility of setting the ratio between screeners and X-ray machines.

› *Efficiency maximization with matrix-screening*



In this second scenario, the aim is to maximize throughput of passengers per screener. Hence, the airport wants to use only as many screeners as necessary to screen all bags at any given time, which means that there are generally fewer screeners than X-ray machines in use simultaneously.

Airport case studies showed that this objective is best achieved by introducing a local matrix-screening solution, which, for example, allows five lanes and thus five X-ray machines to be operational, but only three screeners are needed to analyze all images. Contrary to a separate screening room, no additional supervisors are necessary when screening within the checkpoint, which makes this scenario more efficient than screening in remote rooms.

Figure 3: Parallel loading at Manchester Airport

INFOBOX: WHAT ARE THE MAIN DRIVERS FOR IMPLEMENTING CIP?

Airports that have adopted CIP for their security checkpoint screening named an increase in **efficiency** or an increase in **capacity** as their main driver that pushed them towards implementing CIP. This is mainly due to the ever-growing air passenger traffic and the increasing security and personnel costs. However, increasing security effectiveness, employee satisfaction and passenger experience are other potential areas of interest, which could be improved by a CIP implementation.

[1] According to EU regulations, liquids, aerosols and gels (LAGs) need to be placed in a separate container and visibly placed in a tray.

[2] Radio-frequency identification (RFID) is a technology for automatic and touch-free identification and localization of objects by the use of electromagnetic waves.

› *Optimization of the two approaches*

In this last scenario, the aim is to combine the advantages of the first and second scenarios. Hence, the airport wants to use screeners and X-ray machines flexibly. This is especially practical for airports with a fluctuating passenger distribution.

Airport case studies showed that this objective is best achieved by introducing a remote screening room, which is used for image analysis during busy, high-peak times and screening stations within the checkpoint for matrix-screening, which can be used during less busy, low-peak times.

COMPARISON OF CIP IMPLEMENTATIONS

Optimizing efficiency and capacity are not the only objectives that airports and authorities strive for when implementing CIP. Some first pilot studies and evaluations showed that CIP is expected to increase checkpoint security effectiveness and improve efficiency measures (see Table 1). For example, one pilot study (conducted by Southampton University) showed that in general, security screeners rejected slightly more bags when in a CIP setting compared to conventional screening, and they took slightly longer for visual inspection. However, their effectiveness (more correct responses on TIP images containing prohibited items) increased, and the reduced speed for a single image interpretation was by far outweighed by the gain in efficiency due to proficient image distribution to screeners and the optimization of the number of lanes in operation.

Table 1: CIP implementation comparison (results from first pilot studies)

	Conventional screening	Matrix-screening	Remote room close to checkpoint	Remote room further away from checkpoint
Effectiveness				
Screener effectiveness	Baseline	More correct responses on TIP images containing prohibited items than conventional screening	More correct responses on TIP images containing prohibited items than matrix-screening	
Efficiency				
Screener efficiency	Baseline	More non-TIP alarms than conventional screening	More non-TIP alarms than matrix-screening	
Extra supervisors necessary	No	No	Yes	Yes
Flexible deployment of screening personnel	Not possible	Possible	Possible	Possible
Visual inspection time	Baseline	Longer compared to conventional screening	Longer compared to matrix-screening	
Employee				
Rotation of screener position within team	Possible	Possible	Possible	Not possible
Interaction with team and passengers	Possible	Partially possible	Partially possible	Partially possible
Communication (screener to rest of team)	Verbal communication possible	No verbal communication possible	No verbal communication possible	No verbal communication possible
Group pressure	Possible	Reduced	Highly reduced	Highly reduced

Furthermore, working conditions for screeners and other security personnel will change with the implementation of CIP and should be well planned and communicated to the staff. The limited verbal communication possibilities between the screener and the rest of the team has been named as the most worrisome change for screeners when they were told that the airport plans to switch to a CIP setting. However, after some trial time the new way of communicating has been accepted by the staff and the quieter and less distracting working conditions of a remote screening room were appreciated. If possible, rotations between the screening position and other positions in the team should be maintained, as it gives the staff the opportunity to sit down occasionally and reduces the problem of having screeners conducting image analysis for too long at a time as to remain effective and efficient. Therefore, placing remote rooms close to checkpoints permits rotation within teams, but requires additional space next to a growing checkpoint area, which represents a key challenge of implementing CIP at security checkpoints.

CONCLUDING COMMENTS

CIP is very interesting for any airport that is looking for an effective solution to handle an expected increase in passenger volumes, or wants to reduce personnel and fixed costs in the long term. While it requires quite some checkpoint reorganization, the one-time investment will pay out during the first few years (as has been seen with other CIP implementations at European airports). This is especially relevant if new X-ray equipment is acquired, in order to have a reduced number of lanes running at full capacity, as opposed to having many lanes that run below capacity.

Therefore, analyze your starting point well and work out the current and future requirements of your checkpoint to find the best-suited CIP implementation, together with a compatible CIP software that can be easily integrated.

CASRA will continue with research on the socio-technical system of CIP and the role of human factors. The goal of the research project co-funded by the Federal Office of Civil Aviation (FOCA) in Switzerland is to better understand the different CIP implementations and how they compare in terms of effectiveness, efficiency, and employee and passenger satisfaction (experience). Results will be reported in future issues of this newsletter.

INFOBOX: CIP SOFTWARE

There are several CIP softwares available to choose from: eVelocity and eVolution (Vanderlande/Optosecurity1[3]), IntelliCore (L-3 SDS), Mach-SmartView/-Matrix (L-3 Communications/MacDonald Humfrey Ltd.2[4]), and Smiths Detection (Checkpoint.Evoplus). The comparison of the different systems showed that the characteristics between systems do not vary substantially. While all manufacturers offer classic image editing and enhancement functions as well as a photo-image of the bag, markings are done by setting frames in some systems, whereas others use single points to indicate suspicious objects. Choosing the CIP software was often based on how well it can be integrated with the existing checkpoint, i.e. roller beds, X-ray machine, etc. The figure below shows an example of a generic CIP software interface.

[3] Optosecurity has been acquired by Vanderlande on June 29, 2017.

[4] MacDonald Humfrey Ltd. has been acquired by L-3 Communications on November 22, 2016.

SCREENING PROCESSES AND FUTURE VISION - AN INTERVIEW WITH AVSEC NEW ZEALAND

Text: Sarina Baumgartner

The Aviation Security Service (Avsec) is a government agency (crown entity) and acts as the official provider of aviation security in New Zealand (NZ) (Figure 1). Avsec NZ is part of the Civil Aviation Authority (CAA) that is governed by a board of community and aviation industry representatives whose focus is strategic direction, accountability, and performance. In the following, CASRA presents an interview with Karen Urwin (Group Manager Operations).

Figure 1: Aviation Security Service (Avsec) in New Zealand (NZ)

In order to fulfill their role in aviation security and their regulatory mandate, Avsec NZ's aviation security activities consist of the four following principal programmes:

1. Screening of passengers and their carry-on baggage

Avsec NZ is responsible for the pre-board screening at security-designated airports of all departing international passengers and their carry-on baggage, as well as all departing domestic passengers and their carry-on baggage who are travelling on aircrafts with seats for 90 or more regular air passengers. The pre-board screening ensures that prohibited items (such as knives, firearms, incendiary devices, weapons, dangerous goods, explosives, or any other threat items) are not carried onto the aircraft. The screening process in the international environment also ensures that passengers do not bring more than the allowed quantity of liquids, aerosols, and gels (LAGs) into the cabin of the aircraft.

2. Screening of checked baggage and airport access controls

Avsec NZ screens all checked-in passenger baggage at international airports for threat items using sophisticated explosive detection system (EDS) equipment. Additionally, Avsec NZ undertakes perimeter patrols at all security-designated aerodromes (i.e. area used for the arrival, departure, and surface movement of the aircraft), together with guarding of aircraft and aircraft searches, to ensure a possible interception of persons that are located unlawfully in security areas, which in turn further increases safety for the flying public.

3. Screening of airport workers

Avsec NZ is responsible for the screening of airport workers with access to, and within security-enhanced areas (since March 31, 2008).

4. Managing of the "Airport Identity Card" system for restricted areas

Avsec NZ manages and issues "Airport Identity Cards", including the government security check process (by delegation from the director of civil aviation).

Karen Urwin, what is your role within Avsec NZ?

My function within Avsec NZ is group manager of operations. I am one of four group managers who report to the general manager of Avsec NZ. Together we make up the executive leadership team.

What is Avsec NZ's organizational structure regarding the amount of airports/screeners/etc.?

Avsec NZ has a station at each of the five international airports located at Auckland, Wellington, Christchurch, Queenstown, and Dunedin (Figure 1). A station manager, together with operation managers, and shift/team leaders heads each section. Currently, Avsec NZ consists of approximately 1000 staff members, most of whom are operational and located at the airports. The staff includes 32 explosive detection dog (EDD) teams that comprise a handler and a dog each (Figure 2). Aviation security officers are frequently rotated between duties every 150 days to ensure that they maintain certification for all key security functions (including screening duties).

What is your link to CASRA?

Avsec NZ considers their link and relationship with CASRA to be of a collaborative nature. We use CASRA's training and testing platform [see infobox 'CASRA Solution], and are willing to share information as well as contribute to research projects.

How is Avsec NZ organized regarding training and certification processes?

All frontline aviation security officers employed by Avsec in New Zealand are required to successfully complete the Avsec NZ Induction and Basic Training Course (BTC) programme. The programme is online and practical skills focused, and is comprised of modulised learning with assessments. The assessments require a pass mark of minimally 80% for each module whereas the assessment method is variable (i.e. written, online, practical, verbal, etc.).

After the graduation from the BTC, aviation security officers still require another 10 hours of supervised X-ray

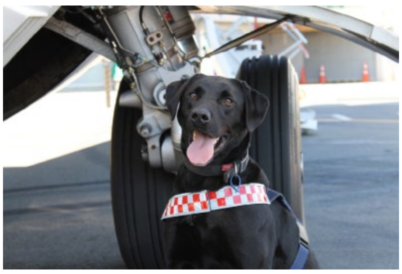


Figure 2: Explosive detection dog Shilo

INFOBOX: CASRA SOLUTION

X-RAY ORT Object Recognition Test
XRT3 X-RAY TUTOR 3
X-RAY CAT Competency Assessment Test

The CASRA Solution offers X-ray security screeners support in all phases of employment, such as staff **selection (X-Ray ORT)**, **training (XRT3)**, and **certification (X-Ray CAT)**. The modular structure of the software allows a customer-specific assembly of required solutions. The CASRA Solution is available online (Hosted Solution) or as local installation (Local Solution).

screening in the live environment and a consecutive test before being allowed to work as X-ray screener. Upon completion of the induction, BTC, and 12 months of work experience, all aviation security officers are awarded the New Zealand Qualifications Authority (NZQA) level 4 Certificate in Airport Operations – Strand – Aviation Security. This formal qualification is registered on the NZQA (Tertiary Education Commission) framework. The Avsec NZ training programme has been assessed and is audited annually by Qual Link NZ to ensure compliance with NZQA qualification standards.

We have used the X-Ray Tutor 3 [XRT3, see infobox 'XRT3'] for several years and have recognized it as useful computer-based training to enhance screeners' X-ray image identification skills when combined with practical skills training. With the recent redesigning of the Avsec NZ BTC, XRT3 has therefore been incorporated into the curriculum of the Avsec BTC.

What is your vision in certifying screeners?

Avsec NZ training has identified the value of introducing a screener certification programme that formally requires a certain XRT3 level attainment for screeners and regular login sessions to maintain the required level.

Certification of screeners would require compliance in the following four key areas:

1. Aviation security knowledge assessment (completed via e-learning modules)
2. Maintenance of a certain XRT3 minimum level
3. Meeting Threat Image Projection (TIP) percentage measurements (to be determined)
4. Covert test pass

We also consider a standardized certification test, but have not yet fully implemented all four of the screener certification elements. We have paused any further work in this area as we have determined that we would get a better security outcome if we made screening a specialized skill (involving a smaller pool of staff) rather than trying to maintain a high level of screening across our entire work force. We are hoping to roll this out when we progressively move to centralized screening.

Speaking of vision – have you been testing new and innovative solutions in terms of X-ray screening recently? Can you share with us the experiences you made?

While not testing specific X-ray technology systems recently, Avsec NZ has been looking to develop our system for the utilization of X-ray systems in New Zealand as well as its greater integration and incorporation into our systems and processes. Examples of the areas we have been seeking to develop include:

- Introduction of Smart Lane Technology at our airports and the associated Centralized Image Processing (CIP) that we would look to utilize as a result (for more information on CIP see previous article in this issue)
- The development of a certified screener process to support Smart Lane introduction and CIP (Figure 3)
- The ability for us to undertake not only Local Area Network (LAN) CIP but also potentially Wide Area Network (WAN) CIP

In your opinion, how will future security checkpoints at airports look like?

The future airport checkpoint is likely to be very much more integrated into the overall passenger end-to-end process. It will most likely be a lot more dynamic in its capabilities in that it will be able to switch between different threat levels within a singular process. To be able to make such determinations, it is also going to be reliant on the greater use of information and data.

With greater integration, it is also likely to be less intrusive and at the same time more targeted for bigger threats, as well as likely to provide greater levels of facilitation for threats of a lesser magnitude. With the continuing development of new technologies, greater fusion might also be something that will be seen to a greater extent. Where previously separate pieces of equipment were required, singular pieces of equipment will likely

INFOBOX: XRT3

The X-Ray Tutor 3 (XRT3) is the only training system designed based on scientific studies, taking into account the complex brain processes underlying the perception of visual information. Due to the **individually adaptive algorithm**, every user is presented with images tailored to his or her individual knowledge and skills. Threat objects that were not recognized are presented more often to the individual user to support them and provide optimal training. The level system used in XRT3 maximizes the motivation to achieve higher levels (maximally 18 levels can be reached). Thanks to the built-in merging algorithm, XRT3 is able to automatically generate unique bag-to-threat item combinations on the fly, which reduces the possibility that a particular bag/threat item combination will be repeated during the training. Thus, millions of individual images can be produced that are adapted to the level progress of the user and prioritized by threat items that were not recognized. Moreover, the threat objects included in the system are regularly updated based on a systematic threat assessment aimed at identifying not only current but also new and emerging threats.

be able to carry out multiple functions.

What do you think are new and emerging threats and how is Avsec NZ reacting to them?

While the Government has determined New Zealand's security threat level to be low, aviation operates within a much higher threat level and continues to be an attractive target for acts of terrorism globally. For example, some flights from New Zealand are the last point of departure (LPD) for countries that have high security threat levels – in particular the USA. These flights have been identified to be risky by new LPD requirements from the US Department of Homeland Security. International intelligence capability has also established that terrorists have achieved some success in their ongoing efforts to create viable improvised explosive devices (IEDs) using personal electronic devices (PEDs).

To prevent acts of unlawful interference against civil aviation, knowledge about new threats is of fundamental importance when it comes to the adaption of security measures in an efficient and effective way [see infobox 'Systematic Threat Assessment'].

While aviation security in New Zealand is a shared responsibility of the government, the Avsec NZ operation must continue to be effective within this dynamic global threat environment. Mechanisms to ensure operational effectiveness include owning the latest state-of-the-art X-ray and scanning technology and equipment, highly trained and skilled staff, expanding security-screening services to more airports for more flights, and increasing the explosive detection dog capability.

Figure 3: New 'smart lanes' under construction in Auckland International Airport – scheduled for use in November

INFOBOX: SYSTEMATIC THREAT ASSESSMENT

CASRA has developed and implemented a Systematic Threat Assessment (STA) to detect and prioritize latest threat scenarios and to develop appropriate defence strategies. The STA is an essential part of a long-term CASRA research project which is funded by the Swiss Federal Office of Civil Aviation (FOCA). The main project goal is to increase the threat detection performance at airports by combining up-to-date intelligence with competence of security officers based on very regular changes to current training programmes which are implemented at airports and unpredictable adaptations of the screening level. The definition or adaptation of training measures for security officers should ideally be based on information on recent incidents as well as new and emerging threats to stay in tune with current and future threat scenarios. Therefore, an intelligence-based approach for the definition of different training measures, and potentially also other countermeasures, was established. In a two-step procedure, information is first collected from different sources and then analyzed and assessed with regard to a number of factors to determine the threat potential of a scenario (for more information on the STA see previous Newsletter issue 9, March 2015).

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