Passenger Screening: any improvement?

The world recently marked the five-year anniversary of the 11 September terrorist attacks. Since that fateful day we have suffered several other serious attempts to target aviation by means of passengers carrying threat items through the airport security checkpoint. Even so, regulators have taken only tentative steps to improve checkpoint-screening technology despite their recognising that the reliance on a combination of metal detectors and X-ray needs serious re-evaluation. ***Steve Wolff*** *assesses where we are, reviews potential candidate technologies to improve checkpoint effectiveness and explores options for improving passenger screening for explosives, the terrorists' latest hand-carried weapon of choice.*

Although more sensitive than prior to 9/11, walkthrough metal detectors (WTMDs) are the only scanners used to screen all passengers. Improved secondary search procedures, such as more thorough pat-downs and the occasional use of trace detectors (e.g. for screening medical casts in the US) have been implemented. However, as WTMDs do not find explosives on the body, only passenger profiling or a random process can potentially identify terrorists carrying explosives. This makes secondary search of only marginal overall benefit against today's sophisticated terrorists, who are familiar enough with the checkpoint operations to slip themselves and their devices through.

WTMDs will still be needed, but new technologies configured in operationally practical ways to detect explosive threats must be deployed. Recently, new systems have emerged and have undergone trials at government laboratories and airports worldwide.

The options for screening passengers are limited; naturally the types of hard radiation applied to bags cannot be used for health reasons. An additional complicating factor is personal privacy.

In spite of these limitations, several promising technologies already available today can play a partial – though not complete – role in screening passengers and have undergone trials in the US, UK and Russia. Companies are developing other less mature techniques that may form part of practical, cost-effective screening solutions in the future. Regardless, adopting new technologies will reshape the checkpoint significantly and extensive effort will be needed to avoid creating bottlenecks, especially at secondary search. So, what technologies are out there and how might they be used?

Short-term Options

As with baggage, technologies largely fall into three categories: trace detectors (ETDs), bulk detectors and imaging systems. Let's start with ETDs as they have been around the longest and are currently the most mature systems.

ETDs can be configured as desktop devices that use a manual, contact technique for sampling or walk-in/through portals, relying on puffs of air to dislodge minute particles, which are then sucked into a sensor. ETDs suffer from one fundamental disadvantage: they only detect explosives, so other techniques must be added to detect weapons. The most mature trace portals are the GE EntryScan 4 and the Smiths Sentinel II, though a new entry by Syagen, which uses Mass Spectrometry, a more sensitive technique, is also available. L3 Cyterra's EMD system combines various sampling techniques with a novel laser-based technique. In the US, the TSA has conducted extensive lab and field trials of the EntryScan, culminating in the limited operational trial of 47 systems in airports around the US. Recently though, the TSA has halted deployment due to reliability and efficacy issues.

Next are bulk detection systems. These automatically identify the presence of a threat without an image. Examples of such systems are shoe scanners, which use radio frequency techniques such as Quadrupole Resonance (QR) or radar, to rapidly inspect shoes for explosives and metallic objects, without requiring passengers to remove them. GE Security and QR Sciences have developed or demonstrated prototypes where passengers stand on a short platform and are scanned within 5 seconds. A red/green light indicates either threat or no threat and a turnstile lets cleared passengers through.

While QR is limited in the breadth of explosives that it can find, its strengths and capabilities match the type of materials likely to be configured as shoe bombs: compact, high power explosives. A trial of the GE shoe scanner is currently underway at San Francisco airport as part of an integrated technology kiosk that also scans fingerprints, boarding cards and verifies passengers' identity. One company, EMIT Technologies, is working on a full body screening system that uses low energy, low dose microwaves along with inspection algorithms to pinpoint concealed objects. It uses a red dot superimposed on a wire-frame image or digital photo of the passenger to show where concealed objects reside.

Possibly the most interesting and potentially controversial are the Whole Body Imaging systems. The term is a bit of a misnomer as they currently have blind spots, including "internal conceal-ment". There are two approaches: non-ionising radiation using radio frequencies of millimetre wave or terahertz energies and ionising radiation, which uses micro-dose, low energy X-rays.

Non-ionising: Several companies, including Smiths, L3 – SafeView, Trex/SAGO, Brijot and TeraView are working on such systems. Many countries, especially in Europe, prefer – or are required – to use non-ionising radiation on members of the public. A passenger stands inside a "phone box"

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where a scanning antenna array generates a rough holographic image of the person in anywhere from 2 sec (L3-SafeView's ProScan) to roughly 20 sec/ passenger (Smiths Tadar). Clothes are transparent to RF in the 25 – 150 GHz range typically used, but threat items reflect these waves differently from skin so they show up with different contrast on screen. The image quality, while currently not great, is sufficient to allow operators to identify some threats, while others appear as anomalies on the body and require additional inspection. Liabilities include poorer image quality, blind spots and the potential absorbent characteristics of water. These techniques have the interesting – but so far not practically demonstrated – ability to perform standoff detection, i.e. to inspect a passenger from a distance before they reach the checkpoint. SAGO and Brijot have focused on standoff detection based on millimetre wave technology, but so far, image quality is low.

Ionising: In the West, so far only micro-dose, low energy backscatter X-ray in the 30 – 60 kV is considered safe for routine passenger screening. These X-rays are either absorbed in the first few millimetres of skin, or reflected back. A passenger stands in front of a panel and is scanned by the system. The reflected X-rays are detected and reconstructed into an image for operator inspection. Backscatter X-ray systems are produced by both OSI Rapiscan and AS&E. The technique has better image resolution, though contrast for certain threat objects is poorer than millimetre wave. At this time, inspection is slower, requiring roughly 10 seconds per scan and 3 or 4 scans at different passenger positions to minimise blind spots. In their current configuration, backscatter X-ray systems may be too slow for primary screening, although the image quality makes it ideal for a rôle in resolving threats. However, this same image quality gives the technique an undeserved reputation (especially in the US) of being an electronic strip search. Oddly enough, the two concerns with the technique – privacy and X-ray safety – play differently around the world. The US is concerned about privacy, whereas overseas, especially in Europe, X-ray exposure, even at the miniscule levels used in the machines, is an obstacle.

One non-controversial application soon to be trialed in the US and the UK as well as elsewhere in 2007, uses backscatter X-ray to screen passengers with medical casts, prosthetic limbs or in wheelchairs, all conditions that other systems are ill-suited to scanning. Recognising the potential security loophole, the US TSA proactively funded Spectrum San Diego, Inc. to develop and conduct initial lab and field trials of this system, known as CastScope.

An option that is being occasionally used in Russia is transmission X-ray. Unlike X-ray backscatter, these devices allow X-rays to pass through the body and produce an image that can be used to detect items concealed ▶

GE's SRT Kiosk

both outside the body and in body cavities. Naturally, the radiation concerns are higher, both in terms of X-ray energy and dose (at least 10 times), than for backscatter, making this technique currently unacceptable for Western regulators, even if privacy concerns are avoided. That said, transmission X-ray may find applications by prison services and customs agencies where greater licence for more extensive search is often afforded by the regulators.

Whole body transmission X-ray systems, such as OD Security's Soter and Adani's DRS SecureScan are physically wide to minimise image distortion, which poses installation challenges in the tight spaces available at most checkpoints. Adani sells a more compact transmission X-ray system for scanning casts and prosthetic limbs. Such an application would result in a lower full body X-ray exposure than a whole body transmission X-ray scan.

Possibly the last uninvestigated part of the electromagnetic spectrum is

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Longer-term Options

Terahertz (THZ), which lie between millimetre wave (>1000GHz) and infrared on the electromagnetic spectrum. THZ has both radio and optical qualities, giving it two possible advantages: better image quality due to the smaller wavelength and the potential for discriminating different materials via their THZ spectra. If successful, this would allow automatic material identification rather than merely providing an operator with an image. However, cost effective THZ emitters (typically specialty lasers) are still expensive and much remains unknown about material properties at these energies. Picometrix (US) and TeraView (UK) are both working on terahertz systems.

QR whole body scanning. Quadrupole Resonance, an RF technique that uses energies in the AM radio band can be used to screen passengers if the dose rate is sufficiently low. Challenges remain, not least due to radio frequency interference, to create a compact, safe and cost-effective system. An advantage is the ability to inspect body cavities, but the breadth of materials detected remains limited. GE has been working on this technology for some time under a U.S. government grant.

Fusing Technologies

While developing new devices is important, fusing a suitable combination of technologies to find the broader range of threats without further inconveniencing passengers is critical and is a major challenge. Several private companies and governments have started the integration process. The UK government recently established an off-airport facility aimed at investigating radical revisions to the UK's "search cone". It is expected to yield a new passenger checkpoint for deployment at UK airports over the next few years. A western company called Security Technology Group is working with Domodedovo Airport, Moscow to trial both advanced passenger and baggage screening systems in an advanced screening concept.

Despite the progress made and the operational trials, significant challenges remain to be overcome:

Cooperation:
Individual companies are combining their technologies into integrated systems – such as GE's SRT Kiosk, which combines biometric identity verification with trace and QR shoe scanning. Recent initiatives by Smiths, GE and L3 to combine technologies into their own "Checkpoint of the Future" concepts are a good start, but they currently include only the companies' own equipment. No single company has a complete solution at this time; it is important for different companies to cooperate or consolidate with each other or implement common communications protocols to allow the right technology mix to be achieved. The only recent example of such cooperation occurred the year following 9/11, when several companies (including GE, OSI Rapiscan and Quantum Magnetics) joined forces to create and have the National Safe Skies Alliance test their vision of a suicide bomber checkpoint incorporating different companies' technologies.

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Improve Secondary Search:
Adding new technologies to screen all passen-gers for a wider variety of threats will invariably result in a greater burden on secondary search. If this inefficient process is not improved, either massive delays or more secondary search stations (and hence more space) will be needed to cope with these extra rejects. Improved communications – including transfer of images and scan results – from primary search should allow secondary search personnel to avoid starting largely from scratch. A selection of different systems likely will be needed depending on why the passenger (or bag) was rejected.

Space:
Currently, new technologies are self-contained, which places a huge burden on space, throughput, passenger coordination and cost. Once effective technologies are identified, they need to be integrated into single, compact enclosures to minimise space and ▶

The 'Guardian' portal from Syagen.

SmartCheck from AS&E

passenger confusion. As well as simplifying the process for passengers it would reduce manpower, which otherwise would increase.

Privacy:
This is a bigger concern for some countries than for others. AS&E and OSI Rapiscan are testing so-called "modesty" algorithms on their back-scatter X-ray systems. However, the challenge is to avoid masking legitimate threats. Over time, both companies expect some level of automatic detection and even threat identification.

Radiation Exposure:
So far, this has been a larger concern in Europe than in the US and currently only affects X-ray systems. This concern alone may limit the wide-spread use of backscatter X-ray and almost certainly will eliminate trans-mission X-ray as an option in the West.

Cost:
WTMDs cost roughly US$3000 – US$8000. Any advanced solution for screening passengers will be at least 10x as expensive. Hence, there is a need to reduce the number of passengers screened by advanced technology. Passenger segregation techniques, such as by studying passenger patterns as soon as they reach the airport, using watch lists and registered traveller programmes will allow regulators to use the new technologies on subsets of travellers. This would require fewer checkpoint lanes to be upgraded. Once cost reduction, better integration and operational enhancements have been made to these "high security lanes", the remaining lanes can then be upgraded.

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Sustainable Opportunities:
For manufacturers – and their investors – to be encouraged to commit resources, forge strategic alliances and develop cost effective, multi-sensor devices, regulators will need to develop, communicate and implement a long-range vision and deployment plan for the checkpoint that makes economic sense to the industry.

Summary

Despite a dramatic broadening of the range of threats we are still using metal detectors to screen all passengers. Technology options for screening people are limited due to safety and privacy constraints, and the broad, complex range of threats and concealment methods means that multiple technologies are needed, making check-point upgrades much more complicated.

Further, the relative importance of safety and privacy varies around the world, making a coherent solution more challenging. However, technologies are available today that can improve passenger screening; the problem is, they're not cheap; they're slower, they will impact secondary search, and will need more space and manpower.

In the short-term, only segregating passengers and limiting the number that are scanned by new technology is likely to allow a practical approach for deploying these new systems. Risk assessment approaches such as Registered Traveller, computer-assisted passenger monitoring and profiling while not ideal, can help with this transition by avoiding the burden of simultaneously upgrading all checkpoint lanes. An added advantage to limited deployment is the ability to fine-tune on a smaller operational scale prior to a widespread rollout. ▶

Summary Table:
Technology Benefits & Liabilities

Technology	Benefits	Liabilities
Deep Trace	Able to find explosives Red/green light detection	Time consuming, procedure intensive Labour intensive May be defeated by good cleanliness Not able to find metallic weapons
Trace Portals	Able to find explosives Red/green light detection	Reliability issues have been noted Slow – about 15 sec/passengers May be defeated by good cleanliness Not able to find metallic weapons
!QR Shoe Scanner	Rapid method for screening shoes Detects small quantities of high power explosivesRed/green light detection	Limited breadth of materials – Complimentary technology needed Cost/benefit ratio needs to be improved.
QR Portal	Able to find small quantities regardless of location and distribution	Limited breadth of materials Background noise elimination may yield a large system Some safety issues to be resolved
Millimetre Wave	Rapid inspection possible Minimal passenger impact Able to locate concealed items No use of ionising radiation	Poor image quality – need a method to resolve anomalies Large systems Blind spots on/in the body No automatic detection
Backscatter X-ray	High quality image	No automatic detection Slow inspection – passenger intrusive Blind spots on/in the body Ionising radiation Privacy vs. detection concerns
Transmission X-ray	High quality image No/minimal blind spots Rapid inspection	Larger dose of ionising radiation No automatic detection Insensitive to some explosive geometries Physically wide system
Terahertz	Potential for material discrimination Potential stand-off detection	Costly Immature Signal affected by water/vapour Operationally unproven

Regulators need to formulate, communicate and fund a long-range vision and rollout plan. This will encourage private industry and investors by giving a consistent long-term return for their technology developments, deployment and improvements and reduce the cyclic nature of the business. Companies will need to cooperate with each other, consolidate or purchase complimentary technologies to truly address the overall problem rather than just promote their own inventory.

The recent attempted terrorist acts in the UK should provide governments with the impetus to set aside funds, rapidly trial and start deploying the more mature solutions while encouraging development of newer approaches that may play a future role. Security improvements won't be cheap, but with the appropriate will among the stakeholders and refined processes for testing and deploying new technologies, it should be possible to achieve real security improvements for passenger (and cabin baggage) screening in the short term. Let's hope we have the luxury of time to do so before terrorists once again test our defences.

The author is President of Wolff Consulting Services