Container scanners

X-rays, gamma rays, bio-imaging - which are the best technologies to see if a container has any weapons inside, and do they cause any harm to personnel? Tim Power reports

BEFORE SEPTEMBER 11TH 2001, supply chain security efforts concentrated on theft, piracy and drug smuggling. Since then, the threat from terrorism has been uppermost in peoples' minds, particularly in the USA.

This threat has been encapsulated in the idea of the 'Bomb in a Box', an idea given frightening credibility when, in October 2001, Italian authorities found a suspected Al Qaeda operative locked inside a container bound for Canada.

The challenge of finding the individual box containing the threat is daunting to say the least. 17,000 deep-sea containers enter the US every day.

An obvious answer to the problem would seem to be to increase dramatically the level of import container inspections, but the US cannot afford to put the brakes on the flow of trade; the risks are untold economic damage to itself and its trading partners.

On the other hand, the consequences of failure to detect are, of course, far worse. Not only could there be horrific loss of life but also, as Robert Bonner, Commissioner of US Customs, points out, devastating economic repercussions.

"Simply put, the shipping of sea containers would stop, claimed Mr. Bonner. "The American people would not likely permit one more sea container to enter the United States until there was a significantly greater assurance - such as 100% inspections - that no additional terrorist weapons would be smuggled into the country.

"Governments in other major industrial countries would no doubt adopt a similar policy, bringing the global economy to its knees."

The fate of the airlines post-9/11 makes chilling reading and no one engaged in maritime trade wishes to share it. Smarter approaches are required that achieve improved security while minimising the economic impact.

The problem boils down to finding out what is inside a box without slowing the flow of cargo through a port. Physical inspection on a large scale is clearly not an option; a full out-turn of a container takes, on average, two hours for a gang of four men. Physically inspecting all inbound containers to the US would require a workforce of over 25,000 and more importantly, would bring the country's ports to a standstill.

The information contained in carriers' manifests is also not a great help; lines rely on shippers to provide information on the contents of all full-load containers and routinely clause bills of lading 'Shipper's Load Stow and Count'. This means that, while in the vast majority of cases this information will be accurate, it is easy to falsify.

The problem of detection is, of course, not confined to container shipping. The airline industry has been confronting this challenge since hijacking began and has used various kinds of scanners to find weapons of all kinds in baggage. The use of scanners is now growing in container shipping too.

Scanners

The Heimann Systems Group is a large provider of scanning equipment whose product range includes the typical airport hand-luggage scanner, metal detectors and biometrics.

It also offers a range of X-Ray scanning equipment for the inspection of vehicles and containers called Cargo Vision.

Cargo Vision uses high energy X-Rays that are able to penetrate up to 380mm of steel to create an image of the contents of the container. This image is analysed with the help of additional tools such as dedicated edge enhancement, filters, zoom and pseudo-colours, all of which help to pick out suspicious zones in a consignment.

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The process of scanning and analysis starts when the vehicle driver checks in at the scanning station and presents the cargo manifest. This is fed into the Cargo Vision system and provides the basis for checking discrepancies. The vehicle is then driven onto a conveyor, which takes it through the scanning area as the image is captured.

The operator views the image from above or from either side and with the image enhancement tools mentioned above, looks for suspicious objects and deviations from the manifested contents.

When the analysis is complete and the container is declared clear, the vehicle and attached container are free to proceed on their journey. The whole process takes 10-15 minutes, most of which is taken up by analysis; the conveyor can handle up to 27 containers per hour.

Cargo Vision comes in various shapes and sizes: from the very big HCV Stationery fixed facility; to the truck mounted HCV Mobile. Naturally, the fixed facilities are higher energy (up to 9 MeV), while power and penetration are lower on the mobile installations (2.5 MeV and 200 mm).

There are HCV Stationary installations in ports such as Hamburg, Rotterdam and Yokohama and others, with more scheduled for delivery in 2002 and 2003.

Other suppliers are also active: Bio-Imaging Research Inc. (BIR) in partnership with Japan's IHI, has recently been awarded a contract by the Japanese Ministry of Finance to supply large X-Ray cargo inspection facilities to the ports of Kobe and Osaka. BIR will provide the radiology sub-systems including 9 MeV vertical and horizontal beams, linear detector systems and workstations.

SAIC

Science Applications International Corporation (SAIC) uses gamma rays as the energy source for its Vehicle and Cargo Inspection System (VACIS).

Instead of using a power source to generate high energy X-Rays, VACIS uses a radioactive isotope to generate a beam of gamma rays that is tightly focused on the detector.

These gamma rays are themselves high energy and exhibit levels of penetration comparable with high energy X-Ray equipment.

Gamma ray detectors are inherently more sensitive than X-Ray detectors and therefore capture more data, more quickly. The result of this combination is a much smaller installation that handles traffic faster.

SAIC reports that VACIS can scan a 40 inch container in less than ten seconds, giving a typical inspection cycle time of one to two minutes.

A recent demonstration of a gamma-ray system at the Port of Miami, which is using VACIS to support its campaign against car theft, resulted in the inspection of over 1300 TEU in a single shift. If this kind of productivity is sustainable, it holds out the possibility of achieving significantly higher inspection percentages without impeding the flow of trade.

Bio imaging research

Barry Smith, development manager of Illinois based bio-imaging research (BIR) also reports high productivity.

"We are inspecting 20 containers per hour in Japan," he says.

He also points out the importance of image resolution. "High Energy X-ray sources (linear accelerators) have finer focal spots that an equivalent chunk of cobalt," he says.

"The resolution is a factor of the source spot size, detector pitch and signal-to-noise ratio.

"BIR manufactures detectors with 1.4 mm, 2.3 mm and 4.6 mm detector pitch. In typical systems, these give resolutions in the cargo of 1.1 mm, 1.8 mm and 3.6 mm respectively."

US Customs

Scanning technology forms an integral part of US Customs' Container Security Initiative, which aims to screen inbound containers before they reach the US.

US Customs' Commissioner Bonner describes the logic for attacking the problem at origin.

"Even if we select a container for inspection by x-ray technology at the port of entry on the suspicion that it contains a weapon of mass destruction, by that time it could be too late.

"And that is fundamentally why we need to push our zone of security back further in the importation process." This means US Customs taking an active role at origin.

The four core elements of CSI are: establishing security criteria to identify high-risk containers; catching high-risk containers before they arrive at U.S. ports; using technology to quickly pre-screen or inspect high-risk containers; and developing and using smart and secure containers.

Technology will play an important role throughout the chain. US Customs' Automated Targeting System (ATS) sorts through the vast Automated Manifest System (AMS) looking for anomalies and flagging high-risk consignments. Bonner says, "This system has functioned as Customs' main method of picking the needles out of the haystacks, and it has served us very well."

Consignments flagged in this way would be inspected at origin ports using the latest scanning machines and radiation detectors. Bonner envisions the electronic sharing of images obtained through the use of detection equipment, allowing consultation about anomalies detected prior to the release of the cargo for its destination overseas.

This technology is not cheap. BIR says that a high energy X-Ray system of the type it and IHI are installing in Kobe costs in the range 2 to 4 million dollars. SAIC estimates that costs for a gamma ray system are typically half that of an X-Ray equivalent.

On a more encouraging note, Heimann points out that the outlay can be recouped, "Previous experience has shown that investment in a stationary HCV system repays itself within a short time. For example, the additional customs duties from discovered smuggled goods cover the purchase sum of the system many times in less than one year."

This sounds like the best news in the whole security field to date - buy the tools to thwart the terrorists and get the criminal fraternity to foot the bill! DS

Useful Websites

The Heimann Systems Group
www.heimann.com

Cargo Vision
www.heimanncargovision.com

Bio-Imaging Research Inc.
www.bio-imaging.com

SAIC
www.saic.com

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How do you seal a container?

Plastic seals on containers prove whether or not anyone opened the door, but nothing else; electronic seals can tell you when someone opened the door. How much use are seals on containers? Tim Power investigates

LIKE THE WAX AND SIGNET RING used by our ancestors to close up letters, the modern container door seal provides only a flimsy barrier to someone determined to get into a box. Its job, in fact, is to alert the recipient that the box has been tampered with.

Indeed, the early seals made no attempt at all to act as a lock; many were made strip seals made of thin bands of metal or plastic that could be cut with a sturdy pair of scissors. However, an intruder could not open the box without destroying the seal and thereby providing clear evidence of entry.

Seals also had a unique reference number, making it difficult to reseal a container without detection.

Checking a plastic seal

Supporting the use of the seal was a series of checks during the lifecycle of the container movement.

The process goes like this.

The haulier takes the box to the shipper with a collection note and a seal (whose number is already recorded in the carrier's systems). The container is packed and the seal attached to the closed door.

From this point on, the seal number is associated with the box and its consignment throughout the movement to the eventual consignee.

There are three seal checks during the journey to ensure the integrity of the box.

First, a check at the entry gate of the loading terminal; next, a check at the exit gate of the discharging terminal; and finally, a check on arrival at the consignee. If the seal is found to be broken at any of these points, the container will be opened and investigated.

This approach to container security remains in place today, although the design of the seals themselves has advanced and there is greater variety.

Alongside the old-style strip seals, lines are increasingly using bolt seals. Although these are far from invincible, they do require more than a pair of scissors to sever. The Universeal Locktainer 200, for example, has a pull load of 1.3 T and requires the attention of a large pair of bolt cutters to remove it. The seal's design ensures that this action damages it beyond repair.

RFID tags

Seal manufacturers are now looking to add RFID (radio frequency identification) tags to seals to improve the efficiency of detection. Radio tags send radio data signals, identifying the tag and stating whether or not the seal has been broken; it's a lot easier to read a seal this way than having to go right up to the door and peer at the tiny lettering.

Universeal is developing its new Trackman and Electrack seals while Brooks now offers an Electronic Container Seal in which a bolt seal is combined with an RF transmitter.

OneSeal has formed an alliance with Savi Technology that combines the former's expertise in seal manufacture with Savi's RFID tag technology, which has been deployed by the US Department of Defense (DoD) in its Total Asset Visibility programme.

These electronic tags are read as they pass RFID readers, which receive information about the container and the consignment and, when the tag is integrated into a bolt seal, can also detect whether the seal has been tampered with.

Stephen Lambright, Savi's vice president of marketing, explains how this combination works.

"The bolt of the seal closes a magnetic circuit," he says. "If the bolt is tampered with in any way, the circuit will generate a distorted signal which will immediately be detected by the reader."

In the Savi SmartChain system, the data captured by the tag readers is fed to a site manager, which acts as a data router, providing access to tracking information, through the SmartChain web application, and generating alerts to the relevant parties, for example, in the event of tampering.

The data feed to the site manager can be via Ethernet, 802.11 or via satellite. Mr Lambright points out that having the DoD as a major customer means that Savi has learnt to capture data in a wide variety of environments and a wide variety of conditions, some of them extreme.

The Savi tags use two RF bands: the first, 433.92 MHz is the draft ISO standard with a range of 100m and is used for data flowing from the tag to the reader; the second, with a range of 4m is 132 kHz and is used to input data to the tag. 433.92 MHz is almost universally available but not quite; in China and Japan, this frequency is used for other traffic, leading to an important gap in applicability.

A second problem with this frequency is data security. Karl Bohman, CEO of All Set Tracking, is concerned that this issue has not been solved in the current draft ISO standard and that this poses a significant security risk.

Anyone with a reader device (or copycat reader) as openly specified in the current draft standard, he suggests, can start communicating with an e-seal, retrieve the ID number, copy it and simply put an exact duplicate back. This means that a terrorist, for example, could breach the container without trace on the e-seal. Savi refutes this claim and says this issue has been thoroughly addressed and easily resolved with encrypted algorithms set in the seal and container IDs.

The AllSet protocol

All Set's own approach is based on a Challenge/Response protocol. This works in conjunction with dynamic and constantly changing electronic hidden ID numbers that are being exchanged.

All Set also uses security measures already implemented in standard GSM wireless networks.

All Set's radio technology is based, not on backscatter but on so-called Peer-to-Peer radio communication, where there are two identical radio transceivers that transmit signals alternately.

These technologies, which include, for example, Bluetooth, operate on a licence-free and globally available ISM frequency band at 2.4GHz and use modulation techniques that spread the signals over the entire available spectrum, achieving high bandwidth without interfering with other devices. Not everyone agrees that 2.4 GHz is the right band, citing concerns both about congestion (the frequency is used for Wireless LANs and cordless phones) and signal loss in certain environments.

Tag readers

Of course, these tags are no use without a network of readers. In this respect, Savi's work with the DoD has provided the beginnings of an infrastructure; 400 readers are now set up in 40 countries and this is being added to through Savi's participation in the Smart and Secure Trade Lanes initiative. The focus of this effort is largely on the ports, while the hinterland is yet to be dealt with.

There are widespread concerns about the cost of all this, particularly among the carrier community whose financial results remain very poor.

Savi and OneSeal are working to create a disposable unit with a cost of around US$10. As Stephen Lambright points out, "At this level, the cost of an e-seal compared with the value of a containerised consignment is very low".

However, as proportion of carriers' net margins, it is very high - price sensitivity will clearly depend both on who ends up paying and what additional benefits are delivered by this technology. Improved asset management arising from better visibility could be an important contributor.

All Set's approach to the device, as in the case of the wireless technology, is different. It is providing an e-seal that is permanently installed inside the container and is designed to last for the life of the box.

The ALLTrack e-seal is attached to the doorframe of the container and includes a door switch sensor, a radio antenna and a 10-year AA battery. It can also take input from external sensors.

All Set estimate that the effective cost per trip will be of the order of US$0.50, giving a significantly lower cost per loaded trip than the disposable seal and allowing tracking to continue when the box is empty.

What does it do?

It is important to stand back from the intricacies of all this impressive technology and ask what it will actually do. The answer is that, where a reader network is present, it will tell you two things: where a box is and whether someone has tampered with the seal. For asset management this is very useful; for security purposes, it is valuable but not sufficient.

Savi's Mr Lambright sees e-seals as just one part of the solution to container security,

"Seals by themselves are not the answer," he says. "We need a marriage of this technology with a whole set of new and secure processes, such as those put forward in US Customs' C-TPAT programme.

"These processes must cover the whole supply chain, right back to the manufacturer. These multiple layers will both reduce the size of the haystack we have to search and raise the bar for the terrorists."

This is going to be a very long haul. DS

Useful Websites

All Set Tracking	*www.allset.se*
Universeal	*www.universeal.co.uk*
OneSeal	*www.oneseal.com*
Savi Tchnology	*www.savi.com*