Steve Dennis, Program Manger for Cell All at the Department of Homeland Security Science and Technology Department, tells *CBRNe World* about their mobile detection concept

Hanging on the telephone...

Mobile phones are becoming indispensable; for many, their phone represents them as a person – part filofax, part confidante – but what if their phone could also save their life? This is the concept envisioned by the Department of Homeland Security's Science and Technology Directorate: that inside each cell phone could be a chemical detector that would alarm, warning an emergency operations centre before SMSing you the best decon site, or how to get out of the plume. "Cell all", as it is called, is a delightfully easy concept, but behind this lurks enormous technological difficulties. Currently the smallest chemical detectors are the size of a couple of packs of cigarettes and provide a limited level of detection – the larger the detector gets the more agents it detects and the better its background discrimination. Some detectors have been known to alarm on certain brands of aftershave or perfume, and the last thing a hazmat team wants to find when they rock up is the corner gigolo getting ready for a date. The concept of Cell All is that the ubiquity of mobile phones acts in its favour; you can have small, false alarming detectors, because the sheer number of them creates a huge sensor fusion net. One alarm does not constitute an alert, while five might be an amber alert and 100 indicates something big.

Yet it is not just the technical problems of chemical detection, but also the integration into cell phones – which are not engineered with excess space. There is also the issue of the concept of operations – what does the low granularity information from this kind of detector provide that is better than an emergency services call? Steve Dennis explained the concept. "What we are trying to do is establish a functional basis for the devices," he said. "Can we get good detection in a miniaturised platform that can be integrated into a phone? We have three prototypes in development that show promise to be able to improvise functional sensing capability with low-cost integration paths into the phone. So we have not spent a lot of money completely miniaturising and setting them into phones yet, but they are miniature; two have been plugged into a phone and showed the kind of reading and signalling one could expect from a future device.

"That said, we have only proved functionality for a few select analytes, and we are looking at doing more in 2010 – we are looking to increase the number of detectors we can cram into a single chip. We have been exploring sample detection from a phone perspective, which is not easy, and we want to take a number of these devices and find one that can be used for early indication of a problem. It is not going to give you the type of reading that larger equipment would give you in terms of accuracy, but it will give you the geographic coverage that you can't get anywhere else. The nice thing is that the phones go where people are; you are sensing where people are – not spying on them, but rather seeing what the chemical map is now.

"We are working with industry and have large cell phone manufacturers and equipment providers involved, and they are all giving us the wisdom of the integration of various capabilities in the phone; they have done this many times over and know what works and what doesn't. We are looking at personal safety in the next year, as what we would like is a capability that is not networked but adds a great deal to an individual's safety and protection; it can be part of their phone and save their life, or of a loved one or relative."

Military chemical detectors work on the basis that only certain chemicals are suited to battlefield applications and have devised simplified detectors that are very good at picking them up, while civilian detectors have a far wider remit and, as such, tend to be more specialised and complicated. What then of Cell All? It will not have the power to pick up all potential agents, so there will have to be some form of specialisation – a concentration on agents of high volatility and lethality, like some organophosphates. Mr Dennis agreed. "That is exactly right, but we are not just looking at terrorist agents," he said. "We are also looking at accidental release; it is hazardous materials detection as well – not just terrorism. While we are exploring the chemical sensing capability of the phone we are also opening the door for other applications. DNDO works with us and is interested in rad and is keeping an eye on it as a future platform. We have worked with Health and Human Services and their bio dosimetry programme – and dosimetry might be another feature you want as part of the phone. So while we are looking at Cell All for chemical, we are examining other possibilities that could add value."

Cell All as a concept is teetering on the edge of the technically viable; radiological detection – or at least dosimetry – in a phone is fact, but biological detection in a phone? That is out there with manned missions to Mars; we know we'll be able to do it some day, but don't hold your breath. Mr Dennis admitted this was a huge problem. "We did have bio in Cell All and tried to go

out and find a solution, and it became clear we were not going to solve that problem in the near-term," he said. "So in FY10 we have a programme targeting the development of low-cost bio detection, but it is not something we are going to miniaturise and put in a phone. Chemical detection is a stretch; we are attempting to build something that has never been done before and we are learning a lot of lessons from reaching out this far."

Yet even if we work on the assumption that the technology can be manufactured small, cheap and effective enough to be fit for purpose, what is the need? The specification of the device will be low, aimed at the fast-acting, unpleasant agents, and its thresholds will be high to ensure it does not go off all the time, so alarms will be set above miosis. What, then, is the use of a system that sends messages to an ops centre, screaming "Organophosphate", when the centre will be inundated with calls describing the symptoms in a way that makes the system redundant. "Each of the 911 calls is an individual giving their perception of what is going on," said Mr Dennis. "But the system and sensors will give you a picture against which to compare that information. You might see movement or dissipation, or get a better feel for where that is happening, that an image-related story related to you over the telephone, so it might be usable during a response. We will look at the concept of operations and test it compared to other modes of information that might be available – which is why we have the policy folks and the first responders around the table as we go forward. They will be the first ones to tell us that it does or doesn't add value. We are trying to balance our desire for innovation against reality. We are balancing these issues, and if you are right and we find as we go forward that it is not worth it... well, that is what innovation is for. We are perfectly happy to stop the project if we get to the point where we don't think it is viable, but we have a number of reasons to suspect that this is a good idea and we are going to put effective tools in the hands of individuals that might save their, and others', lives."

The trick would seem to be to look for orthogonal detection; certainly most men keep their phones in a pocket of some variety (since the popularity of "man-bags" seems ever out of reach) this is a good opportunity to harvest biomedical information – heartbeat, temperature, muscle state (relaxed, contracted, spasming...) etc. This could then be fed into an algorithm that says "Suspected Nerve Agent" or "Suspected Choking Agent", as well as the more mundane things like "Suspected Heart Attack" or "Suspected Stroke". Mr Dennis agreed it would work, but suggested industry was well on the way to solving the technical and political problems. "Industry is already addressing that; it doesn't need government investment," he said. "If you talk to people that who are making

Operator, can you help me place this smell? It's sort of green corn-ie... ©CBRNe World

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future devices you will find they are pouring in billions of dollars; it is a huge market. If you are able to work with the doctor in a Hippocratic and more convenient way than you do today, then that market is tremendous. We see no need for government money there – but you have a huge privacy problem! People have to allow their medical data to flow to an emergency centre and there is a huge debate over whether you own your vital signs. I don't want to get involved in that debate and the investment is so high that that capability will show up; it is not going to be enhanced by us. I agree with you that it is complementary, but getting passed the privacy issues is huge and a research programme on that would not only be competing with industry but we would never get out of the privacy office!"

Yet many of the technical problems result from trying to make the detector that small. The fact that it has its own communication packaged attached to it is a bonus, but how about other ubiquitous platforms – such as traffic lights or traffic cones – that have a larger space envelope and could fit a more sophisticated sensor? Wouldn't this be the better path – to get a larger, less dispersed system out there and, as the conops and technology mature, take it down to the cell phone? "You could take that path," said Mr Dennis. "But you are not putting the sensors where people are; you don't know that people are actually in those locations where you have a fixed asset. If you have a sensor that, by virtue of having a reading and location, you know that people are there you can start planning your response and where to respond to."

One is a false alarm, five might be an amber alert, but a school bus full of alarms? That's a goer... ©CBRNe World

There is such a desire to tear into Cell All purely on the challenge basis – technical, political, operational – that sometimes it is hard to remember this is a research programme. As Steve Dennis admits, the problems might overwhelm it and it will have to be stopped – but isn't that what research programmes are about? In fairness, this is not government trying to foist another technical white elephant on first responders; there are a range of agencies assessing it to see whether the technical capability that *could* be delivered actually offers any advantage. This is exactly the sort of project that the S&T Directorate was set up to do: something that, if all the stars align, will make a major difference not only to the first responders but to the people that really matter – those at ground zero. If affected civilians can be mustered in the right place, if they can be shepherded to mass decon rather than self-presenting (and shutting down) hospitals, if they can do basic countermeasures (gaining elevation, disrobing, etc), if they can provide timely advice and information to command centres, then the chances of an event becoming a CBRN disaster are minimised exponentially. The benefits are all there, as are the challenges, and such are the nature of the challenges that it is only going to be government funding that overcomes them – they are too much for any one company. Cell All is only in its first year; it will be interesting to watch its progress.

Three companies have been producing some form of technology demonstrator for Cell All. They are: NASA Ames Centre for Nanotechnology, Rhevision Technology and Qualcomm Government Technologies.

Rhevision's Team are working on an image-based technology and porous silicon to read chemical sensor signals. Despite being very small, Rhevision are confident that the porous silicon contains hundreds of individually addressable sensing elements for the detection of a wide variety of volatile organic compounds. Chemical attachment to the silicon alters the surface reflectivity that can be read colormetrically by a commercial CMOS imager with the assistance of Rhevision's fluidic lens module. The wide tuning range of the fluidic lens supports both sensor readout with high resolution and the regular function of a video camera. Rhevision hopes this approach of integrating chemical sensors with the camera module will offer a viable path to incorporate sensors into cell phones.

NASA were unable to provide any specific information but were able to inform us that they had a postage stamp-sized sensor that would be able to detect ammonia, chorine and methane utilising the Apple iPhone. The sensor contains 64 nanosensors that utilise technology used on the space shuttle, and would run intermittently on a user-defined cycle.

Qualcomm were unable to provide any information.