Unseen load that electricity hauls

The export of electricity is also a transfer of resources

SOURCES OF ELECTRICITY IN INDIA (2017-18)		
SOURCE	**G W**	**PERCENTAGE**
Coal	986,591	75.9
Large Hydro	126,123	9.7
Small Hydro	5,056	0.4
Wind Power	52,666	4.0
Solar Power	25,871	2.0
Biomass	15,252	1.2
Nuclear	38,346	2.9
Gas	50,208	3.9

Credit Nature Energy

Total electricity production — Grey water transfers
Total electricity transfers — Blue water transfers

Blue water transfers in the US in 2010
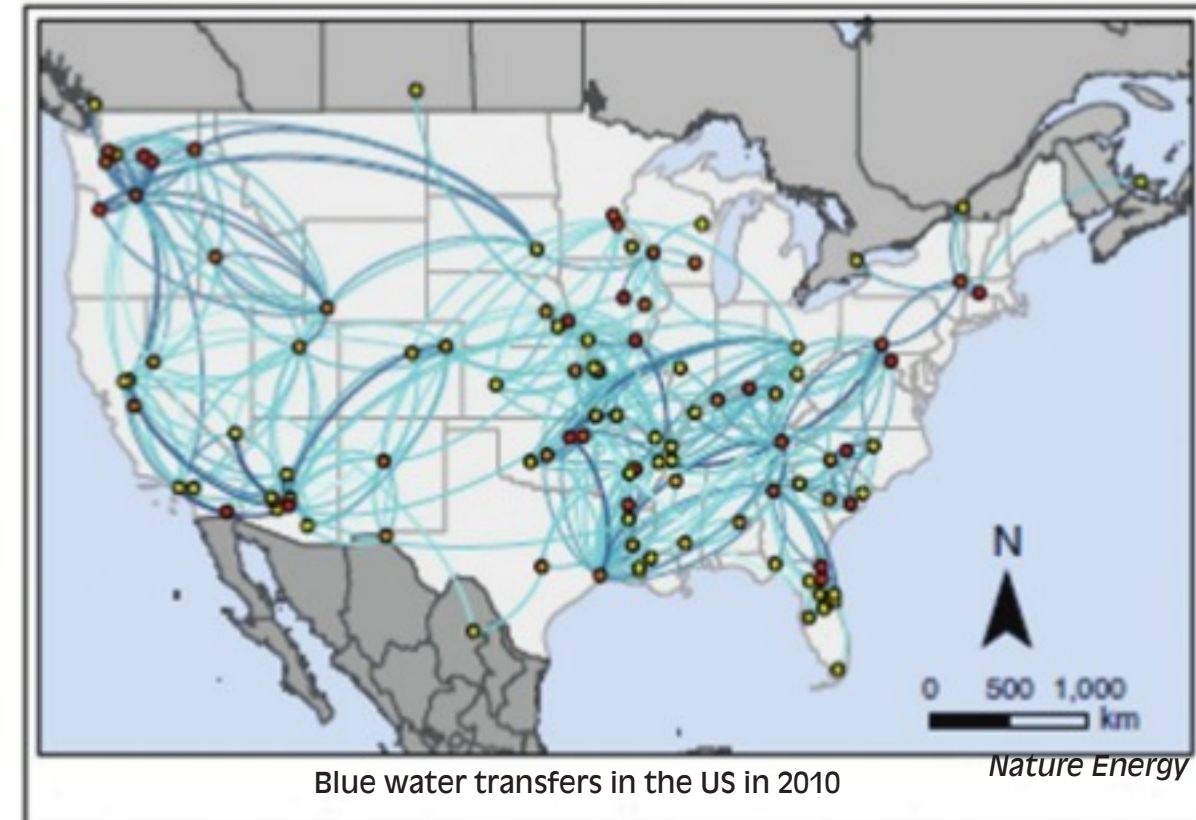
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Nature Energy

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The raw material that goes into a finished product is sometimes not apparent. Direct material, labour, energy and overheads are regularly accounted for. The value of a resource, like water, which has been consumed in generating electricity, however, does not get measured when electricity is metered.

Christopher M Chini, Lucas A Djehdian, William N Lubega and Ashlynn S Stillwell, from the College of Engineering, University of Illinois, in the journal, *Nature Energy*, consider the distribution of electricity over the grid as a case of virtual export of the water that goes into production of electricity. They divide the water used according to its quality and the extent of its degradation and analyse its movement, not physically, but virtually, along with the electricity that flows from the point of generation to centres of distribution and consumption.

"Thermoelectric power plants account for 90 per cent of electricity generation in the United States and are the largest withdrawers of water in the country. In addition, water is consumed via evaporation in hydropower", the paper says. The sources of electricity in India are similar, 84 per cent in total from coal, biomass, gas and nuclear, and 10 per cent from hydroelectric plants. The study based on the US would hence be equally relevant to India. The paper describes the water footprint of electricity generation, as an analogy of the water footprint of food, as either blue or grey. In agriculture, the blue water footprint is the consumption of water from rivers or lakes that is consumed for irrigation, and the green water footprint is the water from rainfall. Grey water is the water that is used to dilute and assimilate pollutants. In power generation, the blue water footprint is in the case of cooling towers of thermal plants and the evaporative loss in hydro plants. Grey water in thermal plants is the run-off, which carries heat, thermal waste, into the environment. This run-off water can be dangerous to fish and plant life and most states have regulations of how far this water needs to be cooled. The network that the water footprint of food forms with the food trade has been studied to create regional maps of how virtual water gets transferred, underlining the dependence of consuming centres on the aquifers in producing regions, the paper says. "However, the coupling the water footprints of electricity with electricity transfers, to map and determine the changing properties of the electricity-virtual water network is a relatively understudied, but important, area of the energy-water nexus", the paper says. The paper points out that unlike food produce, which is physically transported, with identified points of supply and consumption, in the case of electricity, all production centres are simply connected to the grid. Electricity produced at a centre then loses its identity and consumers can be connected anywhere over the national or even international grid. As electricity carries with it a component of embedded resources, such as water, it is important to understand the dynamics of consumption of resources that are transferred.

Traditionally, the policies have sought to minimise the resources consumed at the supply side, the paper says. Details of the end-use water footprints, however, are necessary for planning, policy and for conserving resources. Studies conducted over a limited geographical area and not over an extended period have not been able to make this available. The University of Illinois group hence combined the existing regional studies to create a network of electricity transfer data covering the whole of the US, over a seven year period, from 2010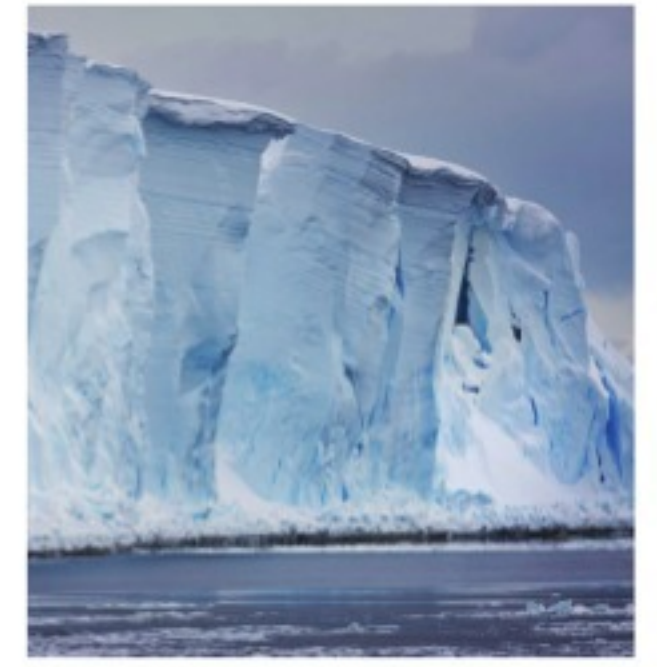 to 2016. A noteworthy trend in the transfer of virtual water is displayed by the graph. While the total electricity production went down, from 2010 to 2016, and the transfers remained unchanged, there was substantial increase in the transfer of virtual water. While the peak in 2012 can be explained by the nation-wide drought in the US, there is rise in other years too. The study was designed as a network where the nodes were the Power Control Areas (PCAs, where the output of a number of nearby plants is managed) and the value of the links between nodes, which is called the "weight", was the embedded water resources in the transfer. An example is the network of blue water transfers, shown in the picture. Analysis of the networks threw up a number of conclusions. For instance, it was seen that the nodes, which had the most number of connections to other nodes were the ones that managed a greater share of virtual water. The relationships between the virtual water handled and properties of the network then provides direction for PCAs to minimise their water footprint by selecting the electricity they import, as well as the potential for policies to intervene. The study provides a mechanism to identify the points of consumption that intensify water water-use pressure on points of production. "A potential burden shift" and regional and seasonal interdependence, the paper says. There could then be levies and subsidies, to incentivise, as well as selection of the mode of development of industry in different regions, to minimise and rationalise water consumption.

Scientific rationalising of costs and benefits would go a long way to stabilise markets, equalise opportunity and optimise resource use, in all parts of the world. There are groups that have been protesting against the virtual nuclear waste that is carried by electricity produced in nuclear plants in one country, but exported to another country. The production of electricity all over the world, which carries virtual water resources, is still 94 per cent from conventional thermal (include nuclear) and hydroelectric sources. This is likely to be the dominant source for many decades, during which the world would get progressively more water-stressed.

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An enduring cautionary tale

DANIEL N ROCKMORE

Watching a 50th anniversary screening of *2001: A Space Odyssey*, I found myself, a mathematician and computer scientist whose research includes work related to artificial intelligence, comparing the story's vision of the future with the world today.

The movie was made through a collaboration with science fiction writer Arthur C Clarke and film director Stanley Kubrick, inspired by Clarke's novel *Childhood's End* and his lesser-known short story *The Sentinel*. A striking work of speculative fiction, it depicts — in terms sometimes hopeful and other times cautionary — a future of alien contact, interplanetary travel, conscious machines and even the next great evolutionary leap of humankind.

The most obvious way in which 2018 has fallen short of the vision of *2001* is in space travel. People are not yet routinely visiting space stations, making unremarkable visits to one of several moon bases, nor travelling to other planets.

But Kubrick and Clarke hit the bull's eye when imagining the possibilities, problems and challenges of the future of artificial intelligence.

Even at 50, *2001: A Space Odyssey* offers insights about our future

What can computers do?

A chief drama of the movie can in many ways be viewed as a battle between human and computer. The artificial intelligence of *2001* is embodied in HAL, the omniscient computational presence, the brain of the Discovery One spaceship — and perhaps the film's most famous character. HAL marks the pinnacle of computational achievement — a self-aware, seemingly infallible device and a ubiquitous presence in the ship, always listening, always watching.

HAL is not just a technological assistant to the crew, but rather — in the words of the mission commander Dave Bowman — the sixth crew member. The humans interact with HAL by speaking to him, and he replies in a measured male voice, somewhere between stern-yet-indulging parent and well-meaning nurse. HAL is Alexa and Siri — but much better. HAL has complete control of the ship and also, as it turns out, is the only crew member who knows the true goal of the mission.

Ethics in the machine

The tension of the film's third act revolves around Bowman and his crewmate Frank Poole becoming increasingly aware that HAL is malfunctioning, and HAL's discovery of these suspicions. Dave and Frank want to pull the plug on a failing computer, while self-aware HAL wants to live. All want to complete the mission.

The life-or-death chess match between the humans and HAL offers precursors of some of today's questions about the prevalence and deployment of artificial intelligence in people's daily lives.

First and foremost is the question of how much control people should cede to artificially intelligent machines, regardless of how "smart" the systems might be. HAL's control of Discovery is like a deep-space version of the networked home of the future or the driverless car. Citizens, policymakers, experts and researchers are all still exploring the degree to which automation could — or should — take humans out of the loop. Some of the considerations involve relatively simple questions about the reliability of machines but other issues are more subtle. The actions of a computational machine are dictated by decisions encoded by humans in algorithms that control the devices. Algorithms generally have some quantifiable goal, toward which each of its actions should make progress — like winning a game of checkers, chess or Go. Just as an AI system would analyse positions of game pieces on a board, it can also measure efficiency of a warehouse or energy use of a data centre.

But what happens when a moral or ethical dilemma arises en route to the goal? For the self-aware HAL, completing the mission — and staying alive — wins out when measured against the lives of the crew. What about a driverless car? Is the mission of a self-driving car, for instance, to get a passenger from one place to another as quickly as possible — or to avoid killing pedestrians? When someone steps in front of an autonomous vehicle, those goals conflict. That might feel like an obvious "choice" to program away, but what if the car needs to "choose" between two different scenarios, each of which would cause a human death?

Under surveillance

In one classic scene, Dave and Frank go into a part of the space station where they think HAL can't hear them to discuss their doubts about HAL's functioning and his ability to control the ship and guide the mission. They broach the idea of shutting him down. Little do they know that HAL's cameras can see them — the computer is reading their lips through the pod window and learns of their plans.

In the modern world, a version of that scene happens all day every day. Most of us are effectively continuously monitored, through our almost-always-on phones or corporate and government surveillance of real-world and online activities. The boundary between private and public has become, and continues to be, increasingly fuzzy. The characters' relationships in the movie made me think a lot about how people and machines might coexist, or even evolve together.

Through much of the movie, even the humans talk to each other blandly, without much tone or emotion — as they might talk to a machine or as a machine might talk to them. HAL's famous death scene — in which Dave methodically disconnects its logic links — made me wonder whether intelligent machines will ever be afforded something equivalent to human rights. Clarke believed it quite possible that humans' time on Earth was but a "brief resting place" and that the maturation and evolution of the species would necessarily take people well beyond this planet.

2001 ends optimistically, vaulting a human through the "Stargate" to mark the rebirth of the race. To do this in reality will require people to figure out how to make the best use of the machines and devices that they are building, and to make sure we don't let those machines control us.

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When ice 'sings'

Scientists have heard strange "singing" noises coming out of an Antarctic ice shelf. The low-frequency noises — which sound a little like moaning when sped up — could help researchers track the ice shelves as they collapse.

The singing tones come out of the surface of the massive Ross Ice Shelf when the winds blowing across the snow dunes cause it to vibrate. That means they produce the "tones" almost constantly, and now scientists have found they can listen to them.

Doing so could help them spot how the ice shelf is forming from afar, and track the damage that is being done by climate change by tuning into the tones. Ice shelf collapses can be drastic and sudden. When they do, they can change the flow of water and raise sea levels, making it important to watch for any signs as they occur.

To try and understand how the Ross Ice Shelf is arranged, scientists put 34 very sensitive seismic detectors under its surface. They then monitored its vibrations from late 2014 to early 2017. When they checked in on that data, they found that the snowy coat that sits on top of the ice shelf appeared to be almost constantly vibrating. It was then they found that the shaking was caused by the winds travelling across the huge snow dunes and making the snow rumble, like a huge drum.

And they found the pitch changed when weather conditions altered the makeup of the snow. If a storm rearranged the dunes or the air temperature changed, the pitch would be altered at the same time. "It's kind of like you're blowing a flute, constantly, on the ice shelf," said Julien Chaput, a geophysicist and mathematician at Colorado State University in Fort Collins and lead author of the new study.

That should allow scientists to be able to use the hum to check in on the conditions on the ice.

The independent

Potential life-saver
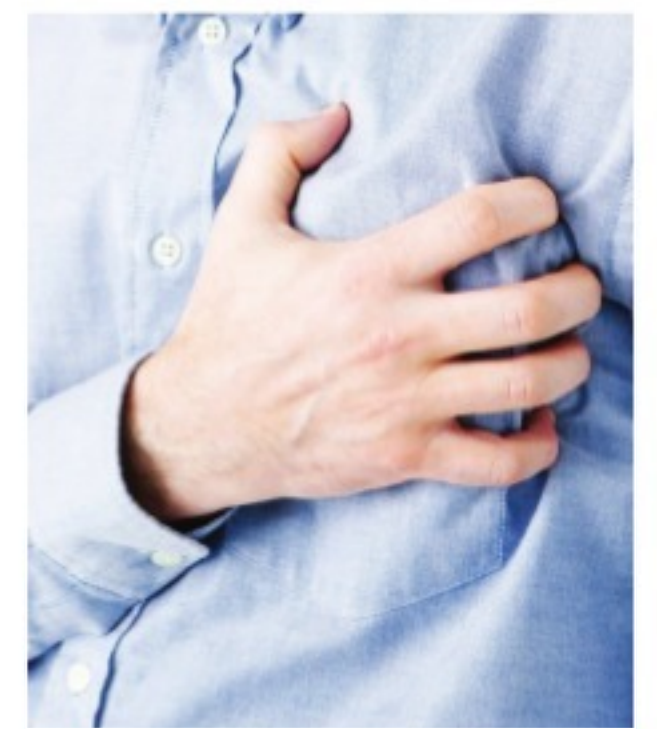
A preliminary study of a new, quick and accurate, bedside blood test performed in Emergency Departments could help reduce the time it takes to rule out heart attacks. The study findings were published last week in the *Journal of the American Medical Association* (*Jama Cardiology*).

The study is a collaborative effort between the Canterbury District Health Board and the Christchurch Heart Institute, which is run out of the University of Otago, Christchurch, New Zealand.
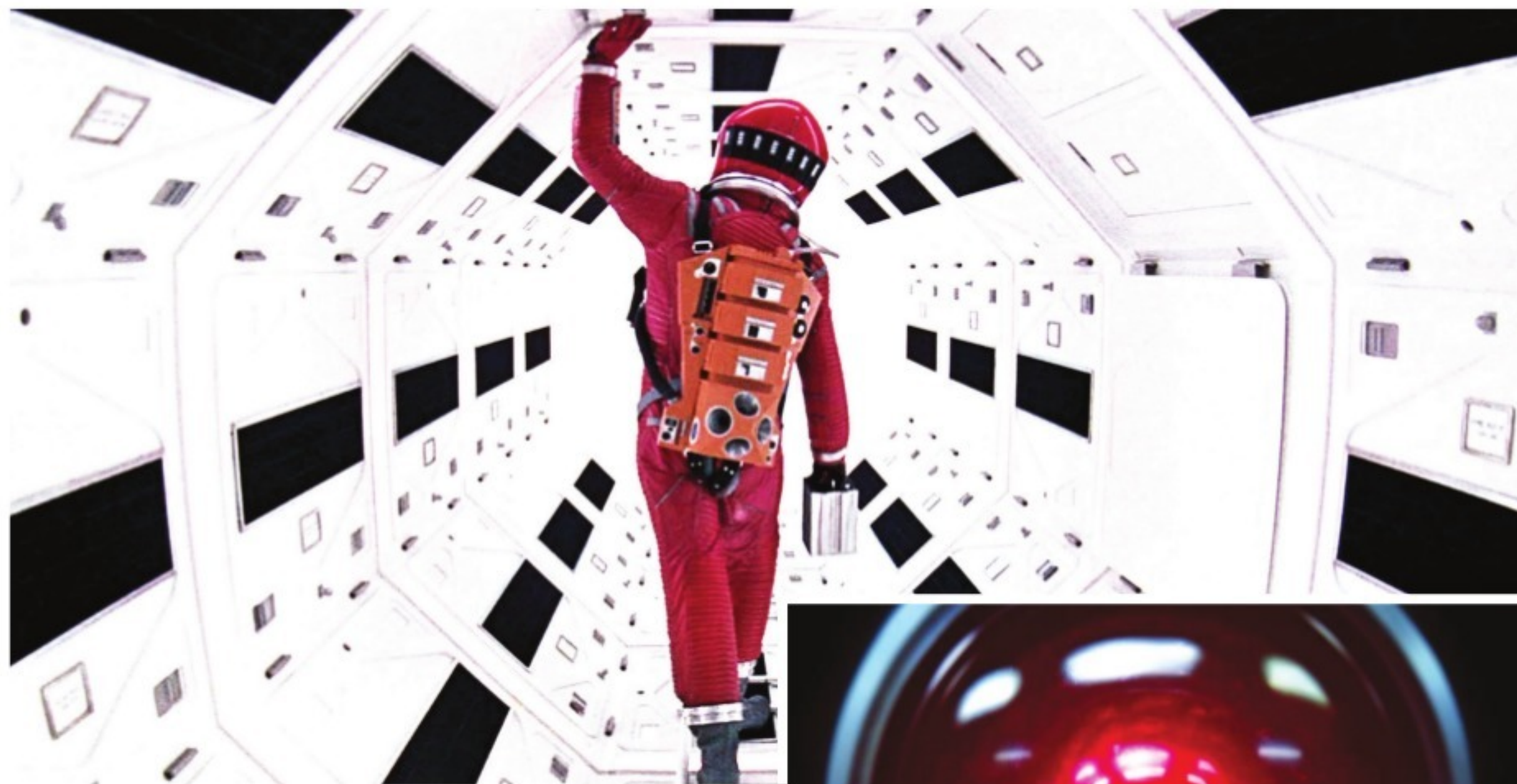
Co-Lead author and associate professor John Pickering of the University of Otago, said, "When a patient comes to ED with symptoms that suggest a potential heart attack, current laboratory blood-testing procedures can take one or two hours to reveal the risk level, whereas with this new test we can get a result in just 15 minutes, from the bedside or 'point-of-care'.

The patient can then either be cleared to leave, or quickly progressed to specialist cardiac care. The benefits are therefore a speedier diagnosis and treatment, and a reduction in the time and effort current testing procedures require of ED staff, beds, and equipment."

The analysis in this observational study (conducted from 2016-2017) at Christchurch Hospital's emergency department included about 350 patients with symptoms of a heart attack. So far, our testing has shown that close to 50 per cent of patients could have heart attacks safely excluded soon after arrival at the ED.

A wider study is in progress and an implementation study across ten District Health Boards in New Zealand is planned for next year," Dr Martin Than, senior author and emergency medicine specialist of the CDHB said.