as the Bering Sea, one of the world's most biologically productive marine ecosystems. Geologists will be able to map the sea floor between Alaska and Siberia to reveal details about when the land bridge between the two was exposed, letting humans cross from Asia to North America. And chemical oceanographers will be able to track the spread of pollutants through once-pristine environments.

The *Sikuliaq* carries the latest oceanographic bells and whistles, including a high-tech boom that can be lowered over the side to deploy instruments such as sonar and oceanographic sensors. Unlike its predecessor, the now-retired *Alpha Helix*, the *Sikuliaq* has the ability to yank sediment cores up from the sea floor. A huge expanse of open deck space towards the stern will allow researchers to bring on board custom equipment, including autonomous underwater vehicles. "It's pretty amazing," says Michael Castellini, dean of the school of fisheries and ocean sciences at the University of Alaska.

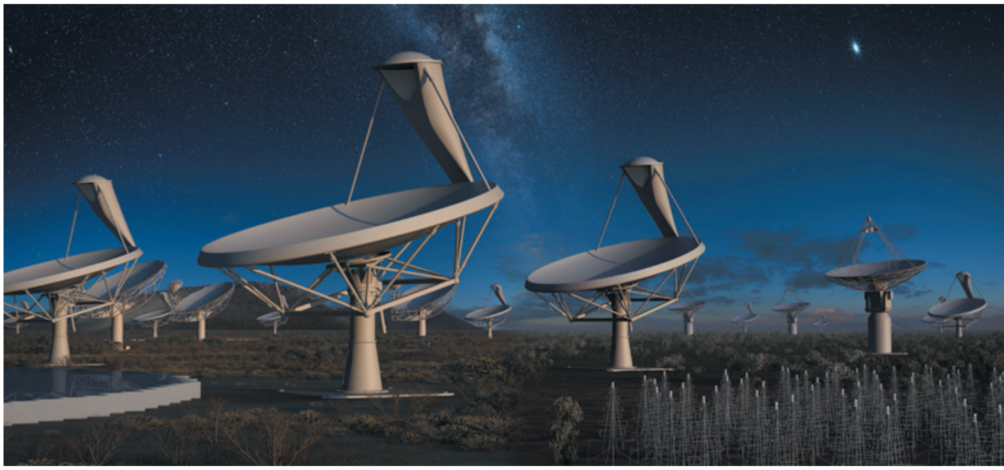
The ship also has advanced navigation technology to improve manoeuvres through sea ice. That is important, because although its reinforced double hull allows it to plough through floating ice up to a metre thick and a year old, it cannot handle thicker, multi-year ice. (In line with the vessel's capabilities, *sikuliaq* is an Inupiaq word that means 'first-year sea ice that is safe enough to walk on'.)

Although construction delays have put it roughly a year behind schedule, "they didn't significantly alter when we wanted the first science to start", says Castellini. Plans call for the *Sikuliaq* to be at sea for some 270 days a year. One advantage to having a dedicated science vessel is that it will not be diverted for other purposes; research ships such as the US Coast Guard icebreaker *Healy* are occasionally called away to attend to emergencies such as delivering fuel to the icebound city of Nome, Alaska.

"People ask, 'Why should the Arctic have a special ship?' It's a special place."

Before it can do any science, the ship must pass final tests and be transferred from its builder, Marinette Marine of Wisconsin. After the University of Alaska team takes charge, the *Sikuliaq* will head out of the Great Lakes through the Saint Lawrence Seaway and then proceed southward along the US east coast. The ship will be based in Woods Hole, Massachusetts, for about a month while it undergoes shakedown tests at sea, and will then continue on, through the Panama Canal. It will do its first research in the deep waters of the tropical Pacific Ocean before heading north to reach its home port of Seward, Alaska, by February 2015. ■

SKA ORGANISATION



Data from the planned Square Kilometre Array of radio telescopes will require vast computing resources.

TECHNOLOGY

Cloud computing beckons scientists

Price and flexibility appeal as data sets grow.

BY NADIA DRAKE

Sometime in the next decade, the Square Kilometre Array (SKA) will open its compound eyes — roughly 2,000 radio dishes divided between sites in South Africa and Australia. The radio telescope will then begin staring into supermassive black holes, searching for the origin of cosmic magnetic fields and seeking clues about the young Universe.

Meanwhile, the telescope's engineers are struggling to plan for the imminent data deluge. The photons that will stream into the array's receivers are expected to produce up to 1 exabyte (10^{18} bytes) of data per day, roughly the amount handled by the entire Internet in 2000. Electricity costs for an on-site computing cluster big enough to process those data could total millions of dollars each year. So the engineers are investigating an increasingly common choice for researchers wrestling with big data: to outsource their computing to the cloud.

"No one's ever built anything this big before, and we really don't understand the ins and outs of operating it," explains SKA architect Tim Cornwell of the Jodrell Bank Observatory near Manchester, UK. He says that cloud systems — which provide on-demand, 'elastic' access to shared, remote computing resources — would provide an amount of flexibility for the project that buying dedicated hardware might not.

Such elasticity can also benefit projects that involve massively parallel data analyses, such as processing and aligning billions of DNA base pairs, or combing through hundreds of photos to identify specific zebras from their stripe patterns. It is also a boon to scientists who require bursts of computing power rather than sustained usage, as do researchers looking at seismic data in the aftermath of an earthquake.

"The rest of the year, when there are no earthquakes happening, they're just paying for storage," says David Lifka, director of the Cornell University Center for Advanced Computing in Ithaca, New York, which runs a computing-platform service called Red Cloud.

But the economics of cloud computing can be complex. An ongoing price war between major providers such as Google, Microsoft and Amazon Web Services has cut costs overall, but in many cases, sending data to the cloud, or retrieving them, remains much more expensive than storing them. Amazon's Elastic Cloud Compute S3 service charges US customers as much as US$0.12 per gigabyte for transfer from its servers, but no more than $0.03 per month to store the same amount of data.

This comes as a surprise to many researchers, according to a 2013 US National Science Foundation survey of 80 science projects that rely on the cloud (see 'Room to grow'). "Some cloud billing mechanisms are really opaque," says Daniel Perry, director of product and marketing for Janet, a private, UK-government-funded group near Oxford that is working to link British educational facilities to a shared data centre. "Unless you know what you're doing, you may find that you've run ▶

out of your grant in three months."

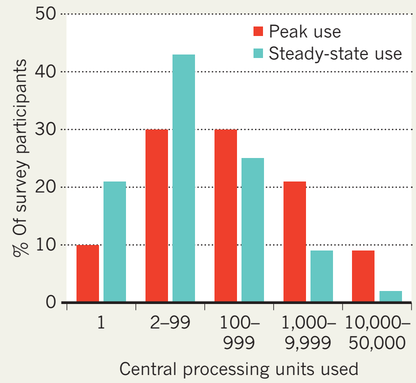
And costs aside, the cloud will probably never suit some computer projects, such as 'deep learning' networks that seek to mimic how the human brain learns. Adam Coates, a computer scientist at Stanford University in California who is involved in such work, says that these systems can require rapid information transfer between billions of connections — something not possible with the cloud. Instead, Coates relies on a dedicated on-site computing cluster. "Having that very high-speed communication is key," he says. "We want vast amounts of computation, but we don't really care about elasticity."

The cloud's dependability is also a concern, says Ken Birman, a computer scientist at Cornell. "It isn't known for being secure, and it isn't known for being extremely reliable." But not all researchers require foolproof data encryption or super-fast, reproducible computations.

For example, CERN, Europe's particle-physics laboratory near Geneva in Switzerland, assembled an in-house cloud to handle the data generated by the Large Hadron Collider. "The CERN data are public data, so we don't have any security concerns," says Tim Bell, who directs the centre's infrastructure and operating services. Instead, CERN focused on providing physicists with an efficient computing platform. "In the past, when they asked for physical hardware, they were waiting for weeks," Bell says. "Now they can ask for a virtual machine and get something in the time it takes to have a cup of coffee."

ROOM TO GROW

A 2013 survey of participants in 80 research projects powered by cloud computing reveals the flexibility it affords for handling data ebb and flow.



SOURCE: XSEDE CLOUD SURVEY

Universities are also getting into the cloud business. At Cornell, a subscription to Red Cloud costs $400 for 8,585 processing hours; for off-campus scientists, the same subscription is $640. Such on-campus services often appeal to researchers who are not ready for the do-it-yourself nature of commercial providers, which often requires expertise in programming, testing and debugging code. By contrast, Cornell cloud specialists are on site to help researchers using Red Cloud. "The thing you can't get with commercial clouds is hand-holding," Lifka says.

Meanwhile, companies such as Microsoft have set up cloud training specifically for academics, addressing issues such as data sharing and security, scientific reproducibility and how funding agencies may view the cloud. "A lot of the training and education content was tuned to a business audience. That meant the on-ramp for researchers was a bit more tricky," says Daron Green, senior director of Microsoft Research Connections. "We realized there was pretty much a latent demand within the research community." ■

MEDICAL RESEARCH

Biomedical institute opens its doors to physicists

The development is part of a growing trend to tap physics expertise.

BY ELIZABETH GIBNEY

From using soap bubbles when modelling cell division, to applying synchronized clocks to understand embryonic development, physics is becoming an increasingly effective tool for biologists. Now the field is to be a focus of a major new biomedical research hub in London, the Francis Crick Institute.

The £650-million (US$1.1-billion) centre — named after the co-discoverer of the structure of DNA, and a physicist-turned-biologist himself — will harness theoretical and experimental approaches from the physical sciences for medical research. When the institute opens in 2015, as much as one-fifth of its 1,250 staff will be physicists, chemists, mathematicians and engineers. They will be tasked with helping biomedical staff to understand why diseases develop and to find new ways to treat them.

The institute is a collaboration between the UK Medical Research Council (MRC), two charities — the Wellcome Trust and Cancer Research UK — and three London universities: Imperial College London, King's College London and University College London (UCL). The partners are already exploring the potential of bringing diverse fields together, with a workshop next week on astronomy and biomedical imaging. "When you see stars in the sky and you have to analyse their pattern and distribution and understand how they work, it's the same as looking down a microscope — the algorithms you use might well be very similar," says Jim Smith, a Crick board member and a director of the MRC's National

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