LILY HAY NEWMAN

A Bad S
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The undersea
especially hard

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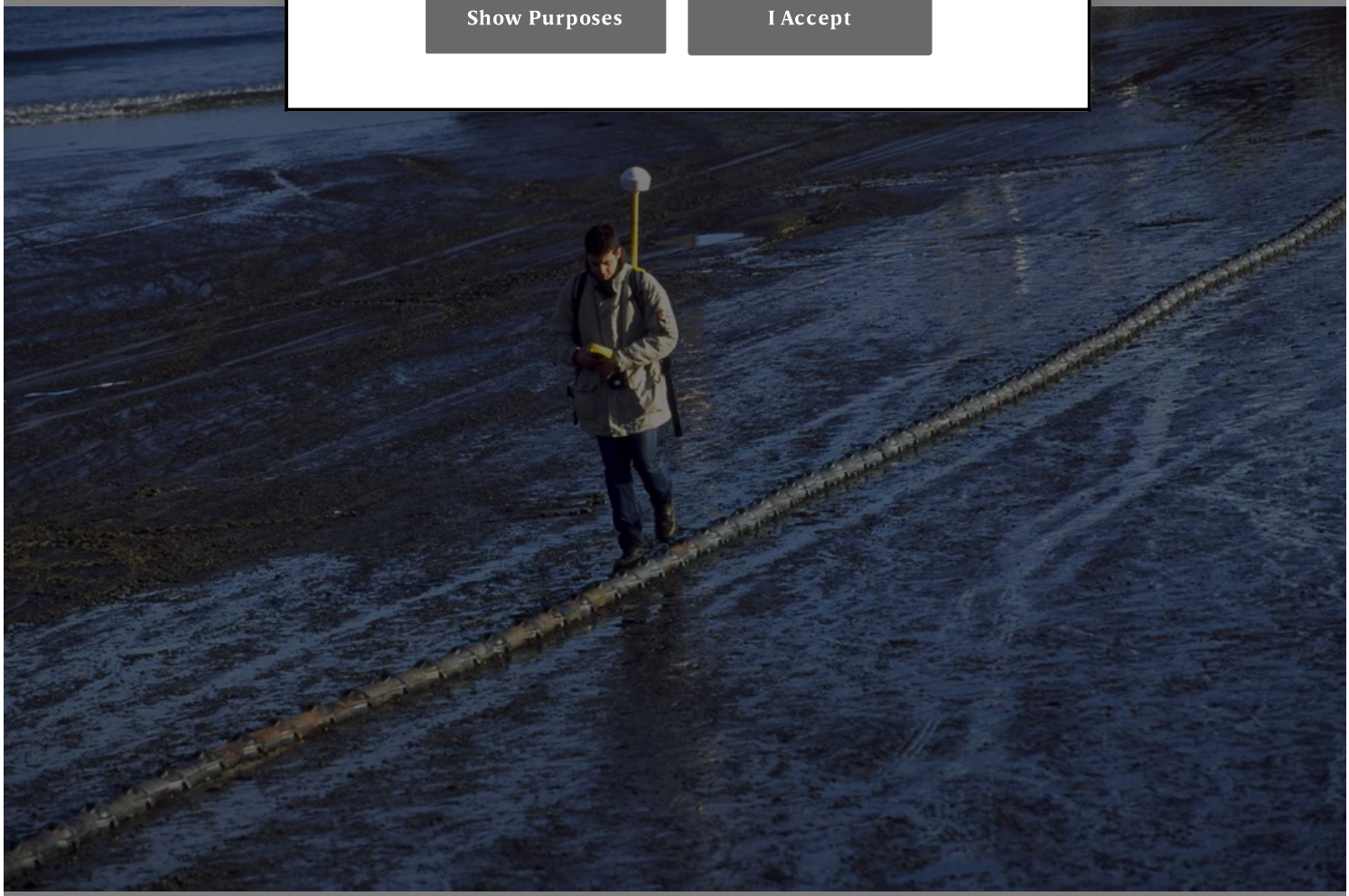

Even if the power comes back after the next big solar storm, the internet may not. PHOTOGRAPH: JEAN CLAUDE MOSCHETTI/REA/REDUX

SCIENTISTS HAVE KNOWN for decades that an extreme solar storm, or coronal mass

ejection, could damage electrical grids and potentially cause prolonged blackouts. The repercussions would be felt everywhere from global supply chains and transportation to internet and GPS access. Less examined until now, though, is the impact such a solar

emission could ha vs that the failures could be c n the global internet.

At the SIGCOMM 2 ha Abdu Jyothi of the University for an Internet Apocalypse," an e d solar particles could cat dditional nuance to a black eturns in hours or days, mass inte

There's some goo ernet infrastructure wou ecause optical fiber itself isn't affected by geomagnetically induced currents. Short cable spans are also grounded very regularly. But for long undersea cables that connect continents, the risks are much greater. A solar storm that disrupted a number of these cables around the world could cause a massive loss of connectivity by cutting countries off at the source, even while leaving local infrastructure intact. It would be like cutting flow to an apartment building because of a water main break.

"What really got me thinking about this is that with the pandemic we saw how unprepared the world was. There was no protocol to deal with it effectively, and it's the same with internet resilience," Abdu Jyothi told WIRED ahead of her talk. "Our infrastructure is not prepared for a large-scale solar event. We have very limited understanding of what the extent of the damage would be."

That information gap mostly comes from lack of data. Severe solar storms are so rare that there are only three main examples to go off of in recent history. Large events in 1859 and 1921 demonstrated that geomagnetic disturbances can disrupt electrical infrastructure and communication lines like telegraph wires. During the massive 1859 "Carrington Event," compass needles swung wildly and unpredictably, and the aurora borealis was visible at the equator in Colombia. But those geomagnetic disturbances occurred before modern electric grids were established. A moderate-severity solar storm in 1989 knocked out Hydro-Québec's grid and caused a nine-hour blackout in northeast Canada, but that too occurred before the

rise of modern internet infrastructure.

Though they don't happen often, coronal mass ejections are a real threat to internet resilience, says Abdu Jyothi. And after three decades of low solar storm activity, she and other researchers point

Undersea interne a few reasons. To shepherd data vals of roughly 50 to 150 kilomet l signal, making sure that ile fiber optic cable isn't directly ts, the electronic interna an entire undersea cable in extended intervals hundred components like repeaters mo sition of the sea floor also varies, p others.

On top of all of this, a major solar storm could also knock out any equipment that orbits the Earth that enables services like satellite internet and global positioning.

“There are no models currently available of how this could play out,” Abdu Jyothi says. “We have more understanding of how these storms would impact power systems, but that's all on land. In the ocean it's even more difficult to predict.”

Coronal mass ejections tend to have more impact at higher latitudes, closer to the Earth's magnetic poles. That's why Abdu Jyothi worries more about cables in some regions than others. She found, for example, that Asia faces less risk, because Singapore acts as a hub for many undersea cables in the region and is at the equator. Many cables in that region are also shorter, because they branch in many directions from that hub rather than being set up as one continuous span. Cables that cross the Atlantic and Pacific oceans at high latitude would be at greater risk from even moderate storms.

The global internet is built for resilience. If one pathway isn't available, traffic reroutes across other paths, a property that could potentially keep connectivity up, even at reduced speeds, in the event of a solar storm. But enough damage to these vital arteries would start to destabilize the network. And depending on where the cable outages occur, Abdu Jyothi says that foundational data routing systems like the Border Gateway Protocol and Domain Name System could start to malfunction, creating knock-on outages. It's the internet version of the

traffic jams that would happen if road signs disappeared and traffic lights went out at busy intersections across a major city.

North America an…res for grid operators related …of the Smart Grid Center at Tex… progress mitigating the risk… …gnetic disturbances are s… …e extreme weather events or…

“Part of the proble… Overbye says. “There are some p… …strophic scenario and ther… …kind of in the middle. I think it’s… …ared for and I’ve been working… …her things going on in the industry that are important, too.”

The internet infrastructure side contains even more unknowns. Abdu Jyothi emphasizes that her study is just the beginning of much more extensive interdisciplinary research and modeling that needs to be done to fully understand the scale of the threat. While severe solar storms are extremely rare, the stakes are perilously high. A prolonged global connectivity outage of that scale would impact nearly every industry and person on Earth.

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