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### The Longest Tubes

The underwater telecommunications cable known as SAT-3 sweeps down the Atlantic coast of Africa from the western edge of Europe, linking Lisbon, Portugal, to Cape Town, South Africa, with stops along the way in Dakar, Accra, Lagos, and other West African cities. When it was completed in 2001, it became the most important link for South Africa's five million Internet users, but a horribly insufficient one. SAT-3 was a relatively low-capacity cable with only four strands of fiber, while the biggest long-distance undersea cables might have up to sixteen. Worse, its meager capabilities were further reduced by the needs of the eight countries SAT-3 connected before arriving in Cape Town. South Africa was the bandwidth equivalent of an attic shower. The country faced a widely discussed "bandwidth crisis," with low usage caps and exorbitantly high prices.

house twist: for all the expanse these cables spanned, they were skinny little buggers. There wasn't all that much to them. The cables spanned oceans and then landed at incredibly specific points, tying up to a concrete foundation inside a manhole near the beach—a far more human-scaled construction. I imagined them like elevators to the moon, diaphanous threads disappearing to infinity. In their continental scale, they invoked *The Great Gatsby's* image of an expanse “commensurate to [man's] capacity for wonder.” Our encounters with this kind of geography typically come with more familiar images, like a ribbon of interstate, a length of train track, or a 747 parked expectantly at the airport gate. But undersea cables are invisible. They feel more like rivers than paths, containing a continuous flow of energy rather than the occasional passing conveyance. If the first step in visiting the Internet was to imagine it, then undersea cables always struck me as its most magical places. And only more so when I realized their paths were often ancient. With few exceptions, undersea cables land in or near classic port cities, places like Lisbon, Marseille, Hong Kong, Singapore, New York, Alexandria, Mumbai, Cyprus, or Mombasa. On a daily basis it may feel as if the Internet has changed our sense of the world; but undersea cables showed how that new geography was traced entirely upon the outlines of the old.

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For all that magic, my journey to see the cables began in an office park in southern New Jersey. The building was true Internetland—unmarked, shiny, near the edge of the highway, with apparently no one around except the FedEx guy. It be-

longed to Tata Communications, the telecom wing of the Indian industrial conglomerate, which in recent years had made a strong push to be a major competitor among the Internet's global backbones. In 2004, Tata paid \$130 million for the Tyco Global Network, which included almost forty thousand miles of fiber-optic cable spanning three continents, including major undersea links across both the Atlantic and Pacific Oceans. The system was a beast. Tyco was best known for manufacturing cables, not owning them, but as part of the corporate largesse-turned-malfeasance under CEO Dennis Kozlowski—who was convicted of grand larceny and securities fraud and sent to prison in 2005—Tyco spent more than \$2 billion building a global network of its own, at an unprecedented scale. The piece of the network known as TGN-Pacific, for example, consisted of a fourteen-thousand-mile loop from Los Angeles to Japan and back to Oregon—two full crossings of the mighty Pacific. Finished in 2002, it had eight fiber pairs, double the number of its competitors. From an engineering standpoint, the Tyco Global Network—rechristened the Tata Global Network—was grand and beautiful. But financially the project was an unmitigated disaster, perfectly timed for the 2003 low point of the technology industry. As the Englishmen who dominate the undersea cable industry liked to say, the capacity they're selling is too often “cheap as chips.”

Simon Cooper was Tata's Englishman, with the job of making the company's investment pay off. Internet traffic has grown continually in the last decade, but prices have fallen just as fast. Tata planned to buck the trend by finding the places in the world with latent potential. Its strategy was to be the telecommunications network that finally linked the “global south,” the poorer—

and less connected—regions of the world, especially Africa and South Asia. Cooper spent his time trying to decide what countries to plug in next. Recently, he'd begun an ambitious building program to supplement the original Tyco network with even more cables—stringing them around the earth like lights around a Christmas tree.

In New Jersey, I waited a few minutes in the office kitchen, watching a group of Indian engineers make tea. Then, just before ten o'clock, I was invited into a conference room dominated by three giant flat-screen televisions, lined end to end facing a long table. Cooper was sitting inside the middle screen. He was in his early forties, with a shiny pate and a cheerful grin, looking a little worn out, alone in a room in Singapore late at night, coming to me via Tata's high-end video-conferencing link. We'd spoken once before. That time, Cooper was in an airport lounge in Dubai at midnight. He seemed to be constantly roaming, physically and mentally, as if he were the human incarnation of the network itself. I suppose the fact that I was talking to a TV had something to do with it, but I couldn't shake the notion of Cooper as a man inside the Internet. In a business filled with obfuscation, he was good humored and direct. I knew why: Tata was eager to compete with the AT&Ts and Verizons of the world, which meant improving their name recognition in the United States—and inviting over any journalists who asked.

"We've done the belt around the world and now we're reaching up and down a little bit," Cooper said nonchalantly, talking about the planet as if it were his lawn. Tata had extended its cable between the United States and Japan with a new link to Singapore and then onward to Chennai. Then from Mumbai another

Tata cable passed through the Suez to Marseille. From there, the routes went overland to London, and finally connected to the original transatlantic cable that connected Bristol, England, to New Jersey. Cooper made it sound like no big deal, but he'd built a beam of light around the world.

To go "up and down," Tata bought a stake in SEACOM, the new cable to South Africa, as well as another new cable down Africa's western coast, intended to break SAT-3's grip. And they were making a move into the Persian Gulf, planning a new cable that would connect Mumbai to Fujairah on the Emirates' eastern shore, and then around the Strait of Hormuz to Qatar, Bahrain, Oman, and Saudi Arabia. The cable would go from port to port around the gulf like a packet ship.

"You get a number of benefits from being global," Cooper said from inside the screen, chopping at the desk on the other side of the world. "We're connected to thirty-five of the biggest Internet exchanges around the world, so you can get to DE-CIX or AMS-IX or London, whether it's the last mile, or the last three thousand kilometers. And we get to talk about our global restoration, our round-the-world capability." In other words, Tata could promise that if its path from Tokyo to California were somehow obstructed—by an earthquake, say—they'd happily send your bits around the other way. It reminded me of Singapore Airlines' two daily flights from New York to Singapore: one goes east and one goes west. But only with the Internet do we treat the scale of the planet so casually—and only then because we have physical links like these.

For Tata, it was all an effort toward connecting the unconnected places—and thereby getting away from the falling prices



ously shallow, putting any cable at risk of being struck by fishermen. What's left is the Bashi Channel in the Luzon Strait, which with depths of up to four thousand meters seemed the perfect cable highway.

Perfect, that is, until Boxing Day 2006, when just after eight in the evening local time a 7.1 magnitude earthquake struck south of Taiwan, causing major underwater landslides that severed seven of the nine cables passing through the strait, some in multiple places. More than six hundred gigabits of capacity were knocked offline, and Taiwan, Hong Kong, China, and most of South Asia were temporarily disconnected from the global Internet. Taiwan's Chunghwa Telecom reported that 98 percent of its capacity with Malaysia, Singapore, Thailand, and Hong Kong was offline. The big networks scrambled to reroute their traffic on the working cables, or send it around the world the other way. But trading of the Korean won was temporarily halted, an Internet service provider in the United States noticed a sharp decrease in Asian-born spam, and a provider in Hong Kong publicly apologized for YouTube's slow speed—a full week later. It was two months before things were back to normal. And the name “Luzon” still brings shudders to network engineers.

At the logical level, the Internet is self-healing. Routers automatically seek out the best routes among themselves. But that works only if there are routes to be found. At the level of physical cables, rerouting traffic means creating a new physical path, stringing a fresh yellow patch cable from the cage of one network to the cage of another—maybe in Equinix's facility in Tokyo, or at the Palo Alto Internet Exchange, or inside One Wilshire in Los Angeles, all of which are places where the ma-

jor transpacific networks have meeting points. But otherwise network owners are faced with the excruciatingly analog task of snatching up cables from the ocean floor with steel hooks. After Luzon, Tata had three ships in the area for nearly three months, picking up cables, splicing them together, lowering them back down, and then moving on to the next break. So when Tata planned a new cable in the region—the first postearthquake—Cooper thought twice about the route. “We went as far south as we could, which maybe isn't the optimal route from Singapore to Japan, but if there's an earthquake in the old place, we won't be affected, and if there's an earthquake near us, the other networks will generally stay up,” he told me, sitting up in his chair in Singapore, which matched mine in New Jersey. “You make these tactical decisions.” And then you turn the decisions back to the economics. Vietnam has eighty million people and poor connectivity. “Maybe they'd be interested in a new cable?” Cooper ventured. I tried to imagine what that would be like, a new cable hauled up on a white sand beach in Vietnam. Of all the moments of the Internet's construction, it struck me as the most dramatic—the literal plugging in of a continent. I asked Cooper if Tata might have a new cable landing anytime soon. With enough warning, and if they didn't mind, I'd try to be there to see it.

“Actually we do have a landing coming up,” he said from inside the TV.

“Where!?” I shouted. Then I got worried. What if it was on the other side of the world, maybe in Guam (a big cable hub) or Vietnam? Or what if it was somewhere not entirely conducive to visiting journalists watching critical infrastructure, like Bahrain,

or Somalia? This might not be so easy. But Cooper was cool. "It depends on the weather," he said. "We'll let you know."

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In the meantime, I set out for the spiritual home of undersea cables. If the Internet's newest links tended to settle in the corners of the map, the old ones concentrated in more familiar places, and in one place above all others: a small cove called Porthcurno, in Cornwall, near the western tip of England, just a few miles from Land's End. Throughout the entire 150-year history of underwater communications cables, Porthcurno has been an important landing spot, but also a training ground—the cable world's Oxford and Cambridge. Looking at a map, I could easily see why. The geography hadn't changed. Land's End was still the westernmost point of England; England was still a hub for the world. According to TeleGeography, the busiest intercontinental route is between New York and London—primarily from 60 Hudson to Telehouse North. Several of the most important physical paths passed through Porthcurno.

But visiting a cable landing station wasn't as easy as getting inside the big urban hubs. The Docklands, Ashburn, and others had a constant stream of visitors. Security was tight, but there was a sense of them as inherently shared places, nearly public ones. But the cable landing stations were quietly hidden away, and they rarely received visitors. But Global Crossing, then the operator of a major transatlantic cable known as Atlantic Crossing-1, finally responded to my entreaties—perhaps officials were pleased I was paying attention to something other than the company's spectacular 2002 bankruptcy. My press contact only asked that I have a

chat with her director of security, who would in turn "notify his government contacts" of my plans. Ah yes, *those* plans: to visit the Internet.

A little while later I was boarding a Penzance-bound train at London's Paddington Station. The iron arches of its rail shed were the perfect send-off. Paddington was designed by Isambard Kingdom Brunel, the greatest of Victorian engineers, who also laid the route and surveyed the tracks of the Great Western Railway, toward Bristol and beyond. But Kingdom Brunel also designed the SS *Great Eastern*, the largest ship in the world at the time of her completion in 1858, specifically designed to carry enough coal to steam to Trincomalee, Ceylon (today's Sri Lanka), and back, a distance of twenty-two thousand miles. He and Simon Cooper would have had something to talk about, even more so given the *Great Eastern's* most famous use: the laying of the first transatlantic telegraph cable, whose 2,700-mile length could be coiled in the massive ship's hull. Cooper would have especially liked the early transmission rates: \$10 per word, with a ten-word minimum. Practically speaking, I was on my way to Porthcurno. But I was aware that really I was on the trail of a broader idea about the triumph of technology over space—and for that there was no better patron saint than Kingdom Brunel.

Within a few hours the tracks looked out over the stormy seas where the English Channel met the Atlantic. Britain was beginning to feel like the island it is. With each mile the view out the window became more nautical. I was headed to the end of the gangplank, a spit of land known as the Penwith Peninsula—the westernmost of the pincers that look as if they're about to snip at the ships entering the Channel. To my American eyes the



out boxes of documents from early cable landings on the beach and surveyors' maps of the bay. The engineer's report of the "Porthcurnow—Gibraltar No. 4 Cable," laid in 1919, was a testament to competence if ever there was one. The cable ship *Stephan* left Greenwich with 1416.064 "nauts"—nautical miles—of cable, made by Siemens Brothers, late in November. A few days later, in a gentle northeasterly breeze, she anchored in the cove at "PK" and sent the end of the cable ashore, supported in the water by ninety wooden casks. By 5:20 that evening, the anchor was hoveled in, the cable was paying out over the stern, and the *Stephan* was steaming toward Gibraltar, "all proceeding satisfactorily." Within two weeks she was in Gibraltar Bay, preparing to land the other end of the cable on a "fine, bright and clear" day. "Completed final tests and advised the managing Director," the report concluded. Cable laying was already routine (notwithstanding the engineer's complaints about "the obvious risks of laying cables in deep water in Winter time on crowded seas and the fact that the *Stephan* is difficult to handle"). It was a reminder that Porthcurno had already been the communications center of a humming empire for two generations then—and would be for a long time to come, if more quietly so.

Late that afternoon I walked down to the beach where the old telegraph hut was maintained by the museum and opened up for visitors on good beach days. The sun was setting against the cliffs, and there were only a few couples staring out at the water. High up on the beach was a worn-out sign that said TELEPHONE CABLE, as a warning for passing boats. I hiked up a steep staircase built into the rocks to a path along the cliffs. A fishing boat passed far below, a speck smaller than my fingernail.

Way out at sea, a big tanker steamed toward the Channel. The ocean was a flat steel-blue carpet stretching to the horizon, an image of infinity. I tried to picture the cables on the ocean floor, in their last few feet before landfall. In the museum's gift shop I'd bought a small sample of actual cable, mounted in a vitrine the size of my thumb. The cable's plastic casing was cut away to reveal the power-conducting copper tube and the fibers within. It was smaller in diameter than a quarter—but went on forever. The whole thing was simultaneously accessible and inaccessible, easy to grasp in one dimension but hardly imaginable in the other. It was like the ocean itself: the biggest thing on earth, yet traversable by plane in a day or electronically in an instant. How strange to be reminded while looking for the Internet, so often rhapsodized as making the world smaller, just how big the world is. The network hadn't erased distance, but left its streaks visible, as if on a just-cleaned blackboard.

Walking back toward the village, I saw a manhole with the word *ductile* forged into it. As I approached the beach parking lot, there were more manholes and then a little compound of equipment surrounded by a wood fence, nestled in the reeds. It hummed. Sprouting out of a drainage ditch were huge prehistoric stalks of *Gunnera*, or giant rhubarb, each one bigger than a man—as if their growth were nurtured from below by the light passing beneath them.

That night at the B&B, I Skyped with my wife in New York, about the drawings our daughter made at day care, the mess the dog made, the man who was coming to fix the leak. Unlike a phone call, our conversation went over the Internet; it was free and crystal clear, composed of something like 128,000 bits each

second. Afterward, out of curiosity, I ran a traceroute to see if I could discern which way they had all gone. The path went back to London—before doubling back through here to New York. The B&B was perched nearly on top of the road, and beneath the road was an umbilical connecting the United States and Europe. But it flew right by without stopping, like the jetliners high above. When I turned out the light, the valley was so quiet that my ears rang.

The next morning, the Global Crossing station manager, Jol Paling, met me at the B&B and I followed him in my car toward the landing stations. Immediately out of the valley we came upon what amounted to a High Street of the undersea cable world—a half-dozen stations lined up along the road. The first was disguised as a stone house and would have been unrecognizable as a landing station at all if it weren't for the heavy automatic gate in front. Next came a huge gymnasium of a building with a broadly curving roof and playful porthole-like blue vents in the walls. It belonged to the system known as FLAG and served as the hinge of two cables that—like Tata's—stretched west to New York and east all the way to Japan. The locals called the place "Skewjack," after the surfers' camping ground that used to be on the site. Paling then led me into a narrow lane towered over by tall hedgerows. We had to squeeze to the left to let a tractor, loaded with hay, pass by. At a bend in the lane was a tan building with corrugated concrete walls, a hideous brutalist bunker. A NO TRESPASSING sign indicated that this station belonged to BT. Later I learned that it was designed according to off-the-shelf Cold War-era plans that presumed it would be underground. But when the Cornish granite proved too tough, BT

put it aboveground instead. It looked ready for a war—the most menacing of the group.

At the crest of a hill I finally caught a glimpse over the hedgerows and saw pasture in all directions, dotted with an unlikely skyline of satellite dishes, mostly backup communication for the landing stations. We passed through a small suburban hamlet, and then the lane widened into a yard. A farmer in tall rubber boots had just pulled a red Land Rover out of a garage filled with tractors. His border collie raised his tail at me. On a wooden fence was a washed-out white sign with black letters that said WHITESANDS CABLE STATION. I followed Paling up the long driveway, with a potato field on one side and more pasture on the other. Dairy cows stuck their heads over the hedges, as if in the stocks. The farmer next door had a fire roaring in a steel drum, mixing the smell of peat smoke in with the manure. We thumped over a cattle grate and into the landing station's small parking lot. It had the shape of a house but was overscaled, like in a Texas suburb. Its exterior walls were faced in rough-hewn blocks of granite—at the request of the county planning commission—and there were green steel shutters. Beneath the eaves was a glass plaque that said ATLANTIC CROSSING. 1998. A GLOBAL CROSSING PROJECT.

Inside, rain slickers hung beside the doorway. The place smelled not unpleasantly of wet dog. Tia, a hefty spaniel, reclined in the corner. With its mismatched furniture, lime-green walls, maroon carpets, and a dropped ceiling, it had the feel of a technical shop rather than a slick high-tech command center. Give-away maps from cable manufacturers were tacked to the wall. An old Global Crossing poster said "One Planet. One Network."



There was a cramped lobby, and a few private offices overlooking an idyllic Cornish scene of cows and emerald earth. The sound of a football game emanated from a television in the kitchen.

Paling had grown up in the area and had been with Global Crossing since 2000. Pushing forty, he was a big guy, more than six feet, with small blue eyes and a quiet face. He wore jeans, a stylish cardigan, and black skater shoes. If the Internet exchange guys tended toward the nerdy, most at home behind their screens, the undersea cable people were more likely to be the type who wouldn't hesitate walking into a sailors' bar in a foreign port. And indeed, Paling started out with BT in London, then spent time at sea laying and repairing cables, before returning to Cornwall to raise a family. His father had been "F1" with Cable & Wireless—the highest designation for a foreign officer—and had trained in Porthcurno. As a boy, Paling moved with his family among foreign stations, from Bermuda to Bahrain, the Gambia to Nigeria.

At Global Crossing, Paling wasn't only in charge of this station but of the field engineering for the entire undersea network, which included the link across the Atlantic, as well as major cables that connected the United States with South America, looping down both the Atlantic and Pacific coasts. Paling's eyes were bloodshot from a late night supervising, via conference call, equipment repairs on the link between Tijuana, Mexico, and Esterillos, Costa Rica. He knew the guys on the other end of the line well. His closest colleagues were on the other side of the world—which was also often the other end of the cable. This was typical. A cable across the ocean works like a single machine, with the equipment on one coast intricately linked with

the equipment on the other. In the old days each cable would have an "order wire," a telephone headset labeled with the name of the city on the other end, providing a direct communications link. Today, the order wire has mostly been subsumed into the usual corporation communication system, although on an earlier visit I'd made to a cable station near Halifax, in Canada, I saw its progenitor in action. When I arrived in the morning a few minutes before the station manager, his colleagues on the other end of the cable—in Ireland—answered the doorbell and opened the gate remotely. Their systems were linked.

Ushering me into his office, Paling tossed his keys on the desk, beside a remote control yellow submarine, the size of a football. "For repairs," he said, nodding at it. Not really—it was his son's toy. We walked down the hall and into a room with wires strung overhead, racks of equipment arranged in narrow aisles, and the familiar roar of hot computer exhaust and blowing air conditioners. Paling led me straight to the far corner. A black cable came out of the floor and was attached with steel clamps to a heavy-duty frame set a few inches from the wall. It had been manufactured in New Hampshire. Over the course of a long passage through a series of machines worthy of Rube Goldberg, eight individual strands of fiber were woven with layers of rubber, plastic, copper, and steel. The cable was then spooled into steel trays the size of merry-go-rounds, like something stolen from Richard Serra's storehouse. A ship tied up to the factory's pier on the Piscataqua River, and the entire multithousand-mile length of cable was fed through a quarter-mile-long catwalk down to the water, into three cylindrical tanks in the hull. Out at sea, the ship paid the cable out its stern along a precisely planned path from a beach in



Long Island across the ocean to the sweeping arc of Whitesand Bay, a mile or so from here. Then it ran beneath the cows to the side of this large house, crossed the foundation, and popped up here. In its last foot, it had a label: AC-1 CABLE TO USA. For Paling, this was the plaque near his desk. For me, it was among the most amazing directional signs I'd ever seen. It pointed the way home, along a path that was physically utterly inaccessible—but that I'd in a way followed thousands of times before. "That's the cable going to the US," Paling said. The physical Internet couldn't get much more literal.

Having followed it across the ocean, I followed it a little farther, across the station. Paling showed me the PFE, or "Power Feed Equipment," a white box the size of a refrigerator that sent four thousand volts through the cable's copper shielding, to power the undersea repeaters that amplified the light signals. The companion machine on the other end of the cable, in Long Island, was adjusted to the same voltage, so that the flows of electrons met in the middle of the ocean and used the earth itself as a ground. "We're negative current, they're positive current," Paling said. It was a one-way flow of power, a simultaneous pushing and pulling.

The light through the cable was emitted (and received) from another bank of refrigerator-like machines, lined up in a row nearby. Paling found a spare length of yellow optical cable and plugged it into the "monitor" port of one of the machines, harmlessly tapping into the inbound light signal of one of the fibers. Then he plugged the other end of the cable into an optical spectrum analyzer—a desktop machine that looked like a Betamax, with a screen showing the waveforms of light, like on an EKG

machine. "I like to think of it like a big jelly," he said about what was on the screen. "If you push that bit down"—he pointed to one of the waves—"then these all will go up. It's very much a case of playing around and trying to get that piece of jelly so each of the waves is at their best power." The technology was known as "dense wavelength division multiplexing." It allowed many wavelengths, or colors, of light to pass simultaneously through a single fiber. Each strand of fiber can be "filled up" with dozens of waves—each of which carries ten, twenty, or even forty gigabits per second of data. One of Paling's jobs was to tune the lasers to fit in more wavelengths, like a harmonizing chord, getting each one right so they all work well together.

Theoretically this can be done from anywhere, but Paling liked to be beside the machine, seeing the light with the analyzer. Making the process occasionally more difficult, any movement of the cable at the bottom of the ocean can change the way the waves move through the fiber, potentially knocking the whole arrangement out of whack, like static on an old TV. Once Paling had everything adjusted, he'd put the cable on a "confidence trial," generating artificial traffic to send through the fiber, and then looping that traffic, "backwards and forwards from here to America thirty times, or whatever." Things moved fast. The day I was there, one of the fiber pairs was "decommissioned" in preparation for an upgrade. New equipment was going to squeeze more twenty-gigabit waves into it, increasing the capacity of the whole cable.

"So the fiber's actually dark?" I asked.

"It's not dark, no," Paling said. "We call it 'dim.' There is power on those amplifiers. They are putting out ASE"—amplified spon-

taneous emission. "Noise. If you put a meter on there, you'd see light. But there's no band noise. It's only just background noise." A flickering.

As Paling explained all this, he absentmindedly flipped open a protective plastic shield and tapped his finger against one of the "lit" fibers. All across Europe—if not the whole Eastern Hemisphere—there were millions and millions of strands of fiber. They merged and merged, again and again, emerging out of Telehouse in a thick bundle, then heading here. The final merge could be read in the yellow cables plugged into the front of this machine: many fibers went in, but ultimately only four came out. It was these four that would cross the ocean. They were the thickest veins at the end of a continent of capillaries—in terms of what they contained, but certainly not their physical size. It was just before noon. The European markets were open, but New York was still waking up. Paling's lips were moving, but all I could concentrate on was his finger tapping on the cable. Short of renting a submarine, this was as close as I was going to get to a physical transatlantic link.

Our final stop was back across the hall. We'd followed the cable from where it came out of the dirt to the major subsea equipment. Now we were looking at the "backhaul," the links from the station to the rest of England. One rack was labeled SLOUGH, a bland London suburb, not far from Heathrow, where Equinix had its biggest UK data center (and the original version of *The Office* is set). The one next to it was labeled DOCKLANDS. Whatever the size of the world, not for the first time, I thought to myself how small the Internet itself could seem.

Later that afternoon, after Paling had gotten back to work and

we'd said our good-byes, I drove out to Land's End. There's a theme park there with a fake medieval street, but it was past the season and almost everything was closed up, except for a famous photo concession near the edge of the cliff, looking out over the ocean. For fifteen quid, you chose letters to spell out the name of your hometown and slid them into one of those signs that point to far-off places and list their distances. The photographer in a thick wool sweater snapped your picture, and a few weeks later the print arrived in the mail. Two of the destinations on the sign were permanent: John O'Groats, the most northerly place on mainland Britain (874 miles), and New York (3,147 miles). I figured since New York was already there I could ask for a different place and thought, what the hell: Would he mind if I put "The Internet" up there, and call it two miles away? For fifteen quid he said he didn't mind at all, and he knew exactly why I'd asked. He knew the cables well. He'd watched the ships come by the water below. After my official shot, he offered to take an extra one with my phone.

Back in the warmth of the car, I emailed the picture to a few people in New York. I couldn't help but think what that meant: the connection with the nearby cell tower, the backhaul to the Docklands, the U-turn to Cornwall, the quick pass through the cable landing station, the long journey to Long Island, into 60 Hudson, and then to my own email server in Lower Manhattan, before splattering out to its recipients. I knew these physical paths existed. But I also knew the Internet was still wily, diverse, multitudinous. I couldn't say which path that photo went; it could just as easily have gone through the big Tata cable, which lands farther up the coast. The movement of a single clump of data was

difficult to nail down, but that didn't make the particularities along its path any less real. I was struck again by this challenge of catching lighting in a bottle—of nailing the Internet down, if only for a minute. There was still this gap between the physical and the virtual, the abstract of information and the damp breeze off the sea.

It took me a few months, but back in New York I eventually found a free afternoon to drive out to the beach and look for the other end of Atlantic Crossing-1. I decided not to call ahead. Paling had been a great host in Cornwall, and it felt like overkill to request to see yet another landing station—much less the matched pair. The town of Shirley on Long Island was AC-1's officially listed landing point, but that left a fairly wide swath of beach where it could actually be. My wife and daughter came along, and they humored me as I nosed around at the edge of the parking lot of a public beach, kicking sand around like a scavenger. I eventually found a weather-beaten plastic post with a warning about a buried fiber-optic cable—but I couldn't be sure if it was my cable. As we headed back toward the city, me a little disappointed that the landscape hadn't been so easy to read, a building a mile or so from the beach caught my attention out of the corner of my eye. It sat on the edge of a suburban subdivision and looked basically like a house except for being too big, and it had telltale steel vents beneath its eaves. I swung around at the next light and pulled up in front. It had a sturdy gate, big surveillance cameras, and a few cars in a small parking lot—including a white pickup truck with a tool case in the back and an AT&T logo on the door. That's when I noticed the mailbox: hardware store stickers spelled "TT," with the faint outline of the ripped-

off "A" still visible. This wasn't my cable, but it was my kind of place—clear enough to particularize the single pathway, to layer the fluid geography of the Internet on the sandy ground of Long Island, and across the ocean in between.

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In the interval, I had been holding out for word from Simon Cooper at Tata, about a new cable landing on a beach, somewhere. The email from the press person in Mumbai came on a Thursday morning and said that, depending on the weather, the landing was planned for that coming Monday. Somewhere near Lisbon. Where exactly she wasn't sure. I didn't reply right away. Instead, I started looking for a plane ticket.

That Sunday morning I arrived in Portugal, crossed the Tagus River from Lisbon and turned west, again toward the Atlantic. I followed the sandy Costa da Caparica south for a few miles before heading back inland, into a neighborhood of modest weekend villas. Tata's cable landing station sat slightly back from the road behind a high security fence. Unmarked and slightly sinister looking, it had thick concrete walls and windows with heavy steel frames. It could be mistaken for the home of an arms dealer, or perhaps the listening post of a top-secret intelligence service. It was far bigger than Paling's station in Cornwall—a textbook example of Tyco's excess. I pressed the intercom button and waited as the gate swept open, then mustered the extent of my jet-lagged concentration to ease the clutch on the manual transmission and slide into the small parking lot, crowded on a Sunday morning.

Rui Carrilho, the station manager, was a compact guy in his



early forties. He wore a bright blue polo shirt, jeans, and leather oxfords, as if dressed for a Sunday stroll with his wife. He was not happy to see me. I was there on the invitation of his boss, Simon Cooper, but this was not a good week for visitors. Despite the calm winds and clear sky, he was in the middle of a shit storm. There was the reason I had come: the arrival on the beach of the West Africa Cable System, or WACS, which would soon reach from this hillside down the coast of Africa. But the station was also hosting a pair of technicians from Tyco headquarters in the United States, who had been working around the clock on the final commissioning of WACS's direct competitor, the Main One cable, which followed nearly the identical route. They had been on call around the clock, waiting for direction from Tyco's cable-laying ship, the *Resolute*, bobbing somewhere off the coast of Nigeria, the cable hauled up into its workshop, as its own technicians struggled to get out the kinks. And on top of all that, Tata brass had been pushing Carrilho to complete upgrades on the station's third cable, which ran beneath the Bay of Biscay to England, crossed AC-1 somewhere in the deep, and landed at another large former Tyco station near Bristol. The cable station staff had been sleeping on the office floor all week and eating their evening meals at a restaurant nearby—sometimes joined by the exhausted Tyco engineers from New Jersey. Carrilho sat at the head, leading his men like the air force officer he once was. But the bags under Carrilho's eyes—and the nervous intensity with which he gripped his BlackBerry and his Camels—made it clear: there was a lot going on. And I, a tourist, had walked into the middle of it.

I'd hardly stepped into the place when he turned me back out

the door and into the station minivan. "I am going to show you where the beach landing is, so you can get there on your own," he said, eager to get rid of me as soon as possible. We headed toward the ocean, following a leafy boulevard, beneath which ran the cable from the beach (and far beyond). At the bottom of a steep hill was a tiny beach hamlet, a dusty turnaround where mangy dogs slept in the sun. Carrilho put on a hard hat and orange safety vest and mounted an orange flashing light to the top of the van. A pair of old men in plaid shirts shifted their gaze from the sea to us. A square of sand the size of a beach blanket had been scraped away to reveal a manhole, opening into a concrete vault. The manhole cover was stamped "Tyco Communications." The vault had been dug a decade earlier in preparation for a cable that never arrived and had sat empty since. A red tent had been erected beside it, to house a temporary workshop.

The next day, the cable-laying ship *Peter Faber*—specially designed for "near-shore operations"—would steam over from Lisbon with two miles of cable in its hold. It would be dragged up on the beach by a diver and affixed to a heavy steel plate inside the manhole. The *Peter Faber* would then head out to sea a couple of miles, turn slightly to the south, and drop the loose end over the side. A couple months later a much larger ship would come back to pick it up with a grappling hook, fuse it to the end of the remaining nine thousand miles of cable it carried in its hull tanks, and turn southward, following a precisely prescribed route above underwater canyons and along the edges of invisible cliffs. For the people of South Africa, Namibia, Angola, the Democratic Republic of Congo, the Republic of Congo, Cameroon, Nigeria, Togo, Ghana, Côte d'Ivoire, Cape Verde, and the

Canary Islands—the cable’s successive landing points—this singular spot on the earth would soon affix this continent to the other. That, at least, was the plan for the next days and months. The plan for the next hour was lunch.

Almost on top of the manhole was a beachside restaurant with Coca-Cola umbrellas on the patio. At a long table inside, the underwater construction team had assembled. With their red jumpsuits, sea-weathered faces, and windblown hair, they looked like a band of pirates. I helped myself to a seat beside one wearing a bandanna over his unruly black hair and a gold loop in his ear. Carrilho sat at the other end of the table, between the wizened construction manager, Luis, with a yellow mustache, and his foreman, Antonio, who looked a bit like Tom Cruise and had the determination and emotional intensity of a preschooler. They sketched the next day’s landing plans on the white paper tablecloth until an enormous pot of fish stew arrived, along with glasses of Super Bock, the Portuguese lager. The conversation had been a mix of Portuguese and Spanish and had stopped for the soccer game on the TV. But when it came time to toast the success of the operation, they used the English term: to the “beach landing!”

Landing day dawned cold and bright, the blues of the ocean and sky in apparent competition to be the deepest. Carrilho had his hard hat and vest on, and he’d brought along one of the young guys from the station, who wore a big camera around his neck. He paced in and out of the café, ordering espressos and checking the horizon. The construction team arrived by boat from a port a few miles down the coast, bouncing in on their inflatable skiff like a platoon of marines. A group of Angolan day laborers

had assembled, and Luis handed out red polo shirts from a big cardboard box. A pair of British engineers, in fleece and cargo pants, kept to themselves, perched on the edge of a small sand cliff. They worked for Alcatel-Lucent, the telecommunications conglomerate that manufactured the cable and owned the ships that would lay it on the ocean floor.

A large Hyundai excavator was parked down by the water, its articulated arm raised in a curled salute, a sign reading CARLOS propped against its windshield. Carlos himself sat inside the cab, leaning forward against the dashboard. Normally he demolished historic buildings in Lisbon—delicate work. Luis had worked with him before. “He can scratch your nose with his bucket, and you wouldn’t mind,” Luis said, wiggling a finger at me. The previous day, Carlos had dug a deep trench in the beach, leaving a sandcastle as big as his machine. In its depths was the mouth of a steel conduit that ran back up to the manhole; the fiber-optic cable would be pulled through it like a string through a straw.

Just before nine one of the divers hopped out of the skiff and into the surf. Under his arm, he carried a length of lightweight green nylon line. He high-stepped through the waves up onto the beach and handed the line to one of the laborers. There was no handshake or ceremony to mark this first moment of physical connection, the initial link between land and sea that would be leveraged into a nine-thousand-mile path of light—and, its backers hoped, a stream of information that would transform a continent. Carrilho stopped his pacing on the café patio to watch. Soon after, the blue hull of the cable ship *Peter Faber* steamed into view from the north, its large white antennae dome perched like a Ping-Pong ball at the peak of its superstructure. Longer



than a tugboat and sleeker than a trawler, its GPS-controlled propulsion system allowed it to hover in place, even in rough conditions. It parked almost a kilometer offshore, precisely lined up with the beach manhole, and wouldn't move from that spot for a day and a half.

The skiff headed out to meet it, paying out the lightweight green messenger line as it went. Two dogs frisked on the beach, jumping back and forth across the thick rope. A bulldozer chugged down to the water, and the rope was knotted to its hitch. It began a series of slow processions down the beach, parallel to the water, dragging the line around a pulley, a hundred meters at a time in from the ship. The dozer would chug out at a walking pace, drop the knot, and then reverse along the same tracks, to pick up the next length. The fiber-optic cable itself soon began coming off the ship, suspended just below the surface of the water by a necklace of orange buoys—the modern-day version of the “casks” used in Porthcurno, in 1919. As each buoy reached the shore, a laborer skipped into the surf and untied it from the cable.

Carrilho and I watched the action from the restaurant patio, sitting at separate tables. He had a tab open, and I joined him in a steady alternating rhythm of espresso and beer. A soft onshore breeze brought the pleasantly nautical smell of the skiff's two-stroke engines. It had been working hard keeping fishing boats from crossing the cable, patrolling back and forth like a border collie. By lunchtime, the bulldozer had completed its slow laps, and the cable arced in from the ship beneath its necklace of orange buoys. Wearing thick gloves, the laborers manhandled it

into the mouth of the conduit, straining under its weight. They laid it out in an S-pattern down to the surf, in case the ocean wanted a little more for itself. I emailed Simon Cooper a picture of the action and captioned it “taken forty-five seconds ago.” I got a message back a few minutes later: “And viewed on my BlackBerry whilst roaming in Tokyo.”

With the cable in position, the diver walked back into the surf holding a knife. Bobbing his head under the waves, he began to cut the orange buoys free, so that the cable could drop to the seafloor. With each slice, a buoy popped a few feet into the air, and then shot south with the breeze. By the time he was a hundred or so meters out, I could no longer see him, only his handiwork: orange buoys popping up out of the surf like beach balls, the skiff chasing each one down. When he arrived at the cable ship, the Dutch crew gave him a few cookies and a glass of juice, and then he jumped back into the ocean and swam the kilometer back to shore. Back on the beach, chest heaving and eyes wide, he lit a cigarette.

I walked around to the side door of the restaurant, where the two English engineers were hard at work on the cable. They'd driven from Alcatel-Lucent's offices in London, in a station wagon full of tools. Matt was tall, with a square head, a big potbelly, and a jolly voice. He lived in Greenwich—“home of time,” he sang—and was eager to get back there for his son's birthday that weekend. Mark was rougher, with a gold tooth and a big tattoo on an arm Popeye would envy. He'd spent his working life all over the world on Alcatel's behalf, in places like Bermuda (“perfect”), California (“lovely”), Singapore (“a great city, if you like



sitting down in the evening with a beer"). In blue Alcatel polo shirts and cargo work pants, the two of them went at the cable with hacksaws. It was armored with two layers of woven steel mesh that had to be stripped off before they made the "joint" in the manhole. They put their full weight into peeling back the casing, as if butchering a shark. While they worked, a fisherman in a flannel shirt and rubber boots knocked on the kitchen door. He had a stiff tote bag filled with two glistening dourada, or sea bream, the same as in yesterday's fish stew. The chef took them. Matt yelled into his telephone: "We've got twenty-five in the manhole and another twenty on the beach," meaning meters of cable—enough slack underground to finish the joint, and enough on the beach to allow the cable some give in a storm.

Once the cable was stripped back to its pinkish intestines, Matt and Mark fed it into the red tent to begin the work of fusing the fibers together. Matt set a cup of tea beside him on the workbench and began using a tool that looked like a corkscrew to shear off the cable's plastic inner core, which surrounded a perfect tube of shiny copper. Inside of that was another layer of black threads; inside of each, colored rubber; inside of the rubber, the fiber itself. With the removal of each successive layer, the work became increasingly delicate: he worked first like a butcher, then a fisherman, then a sous-chef, now finally a jeweler, as he held each fiber between his pursed lips. When the fiber itself was finally visible, the eight strands glinted in the sunlight, each a hundred and twenty-five microns wide. He put baby powder in his palm and ran the end of each fiber through it, like a violin's bow, to clean off any residue.

Then he began to fuse each to its shoreside mate. There were eight strands, each a different color, looped around the worktable. One at a time, Matt placed a strand inside a machine that looked like a hole puncher. A small screen magnified the fibers' alignment, and he adjusted it so the two ends lined up, like the hand of God in Michelangelo's fresco. Then he pressed a button that baked the two ends together, sipping tea with his pinky up while the machine did its work. Then he slid a little protective plastic sheath over the now-continuous strand and mounted it in a dainty rack, like a fishing tackle. With today's technology, each fiber could transmit more than a terabit of data per second, on an undersea journey of two-tenths of a second.

I had been watching from just outside the red tent that sheltered the makeshift workshop, and Carrilho came up beside me, intently watching Matt's delicate work. "That's the fiber," Carrilho said. "That's what makes the money."

With all eight strands finally spliced together, Matt mounted them inside a finely machined black steel case, with two large red laser warning stickers, and an elegant Alcatel-Lucent plaque, with *Origin France* written in energetic italic script—the hood ornament of Tata's \$600 million wire. Mark had been working in the manhole, doing the heavy labor of tightening the steel mesh cable around a heavy steel plate built into its wall. Matt passed the case down to him, to be mounted inside.

A car pulled up behind me and Carrilho, and a man in a pressed white shirt and tie, on his way home from work, stepped out. He looked into the manhole, at the equipment arrayed inside the tent, and the ship steady offshore.

"A cable? To Brazil?" he asked.

"Africa," Carrilho replied.

The commuter raised his eyebrows, shook his head, and went home to dinner. For the people of this seaside village, this was a temporary disruption, a few days of bulldozers on the beach and some extra trucks in the municipal lot. By the end of the week, the manhole would be covered, and the cable to Africa would be forgotten under the sand.

## 7

## Where Data Sleeps

The Dalles, Oregon, has always been a special kind of cross-roads, a place where geography has repeatedly forced the hand of infrastructure. Its odd name—it rhymes with neither "balls" nor "bells"—comes from the French word for "flagstone" and refers to the rocks in the mighty Columbia River, which narrows here before plunging through the great gap in the Cascade Range known as the Columbia River Gorge. Everything here has followed from that.

When Lewis and Clark arrived in 1805 on their exploration of the west, they found the largest Native American gathering place in the region. During the annual salmon runs, the population swelled to nearly ten thousand, about the same size as the town today. For a while the Oregon Trail ended in The Dalles, where western settlers faced the uncomfortable choice of mule-packing