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ACCESSING

A reporter for *TechCrunch* recently observed, “Uber, the world’s largest taxi company, owns no vehicles. Facebook, the world’s most popular media owner, creates no content. Alibaba, the most valuable retailer, has no inventory. And Airbnb, the world’s largest accommodation provider, owns no real estate. Something interesting is happening.”

Indeed, digital media exhibits a similar absence. Netflix, the world’s largest video hub, allows me to watch a movie without owning it. Spotify, the largest music streaming company, lets me listen to whatever music I want without owning any of it. Amazon’s Kindle Unlimited enables me to read any book in its 800,000-volume library without owning books, and PlayStation Now lets me play games without purchasing them. Every year I own less of what I use.

Possession is not as important as it once was. Accessing is more important than ever.

Pretend you live inside the world’s largest rental store. Why would you own anything? You can borrow whatever you need within arm’s reach. Instant borrowing gives you most of the benefits of owning and few of its disadvantages. You have no responsibility to clean, to repair, to store, to sort, to insure, to upgrade, to maintain. What if this rental store were a magical cupboard, a kind of Mary Poppins carpetbag, where an endless selection of gear was crammed into a bottomless container? All you have to do is knock on the outside and summon an item, and abracadabra—there it is.

Advanced technology has enabled this magical rental store. It’s the internet/web/phone world. Its virtual cupboards are infinite. In this maximal rental store the most ordinary citizen can get hold of a good or service as fast as if they possessed it. In some cases, getting hold of it may be faster than finding it in your own “basement.” The quality of goods is equal to what you can own. Access is so superior to ownership in many ways that it is driving the frontiers of the economy.

Five deep technological trends accelerate this long-term move toward accessing and away from ownership.

Dematerialization

The trend in the past 30 years has been to make better stuff using fewer materials. A classic example is the beer can, whose basic shape, size, and function have been unchanged for 80 years. In 1950 a beer can was made of tin-coated steel and it weighed 73 grams. In 1972 lighter, thinner, cleverly shaped aluminum reduced the weight to 21 grams. Further ingenious folds and curves introduced yet more reductions in the raw materials such that today the can weighs only 13 grams, or one fifth of its original weight. And the new cans don’t need a beer can opener. More benefits for just 20 percent of the material. That’s called dematerialization.

On average most modern products have undergone dematerialization. Since the 1970s, the weight of the average automobile has fallen by 25 percent. Appliances tend to weigh less per function. Of course, communication technology shows the clearest dematerialization. Huge PC monitors shrunk to thin flat screens (but the width of our TVs expanded!), while clunky phones on the table become pocketable. Sometimes our products gain many new benefits without losing mass, but the general trend is toward products that use fewer atoms. We might not notice this because, while individual items use less material, we use more items as the economy expands and we thus accumulate more stuff in total. However, the total amount of material we use per GDP dollar is going down, which means we use less material for greater value. The ratio of mass needed to generate a unit of GDP has been falling for 150 years, declining even faster in the last two decades. In 1870 it took 4 kilograms of stuff to generate one unit of the U.S.’s GDP. In 1930 it took only one kilogram. Recently the value of GDP per kilogram of inputs rose from $1.64 in 1977 to $3.58 in 2000—a doubling of dematerialization in 23 years.

Digital technology accelerates dematerialization by hastening the migration from products to services. The liquid nature of services means they don't have to be bound to materials. But dematerialization is not just about digital goods. The reason even solid physical goods—like a soda can—can deliver more benefits while inhabiting less material is because their heavy atoms are substituted by weightless bits. The tangible is replaced by intangibles—intangibles like better design, innovative processes, smart chips, and eventually online connectivity—that do the work that more aluminum atoms used to do. Soft things, like intelligence, are thus embedded into hard things, like aluminum, that make hard things behave more like software. Material goods infused with bits increasingly act as if they were intangible services. Nouns morph to verbs. Hardware behaves like software. In Silicon Valley they say it like this: "Software eats everything."

The decreasing mass of steel in an automobile has already given way to lightweight silicon. An automobile today is really a computer on wheels. Smart silicon enhances a car's engine performance, braking, safety—and all the more true for electric cars. This rolling computer is about to be connected and become an internet car. It will sport wireless connection for driverless navigation, for maintenance and safety, and for the latest, greatest HD 3-D video entertainment. The connected car will also become the new office. If you are not driving in your private space, you will either work or play in it. I predict that by 2025 the bandwidth to a high-end driverless car will exceed the bandwidth into your home.

As cars become more digital, they will tend to be swapped and shared and used in the same social way we swap digital media. The more we embed intelligence and smarts into the objects in our households and offices, the more we'll treat these articles as social property. We'll share aspects of them (perhaps what they are made of, where they are, what they see), which means that we'll think of ourselves as sharing them.

When Amazon founder Jeff Bezos first introduced the Kindle ebook reader in 2007, he claimed it was not a product. He said it was a service selling access to reading material. That shift became more visible seven years later when Amazon introduced an all-you-can-read subscription library of almost a million ebooks. Book fans no longer had to purchase individual books, but could buy access to most books currently published with the purchase of one Kindle. (The price of the basic entry Kindle has been dropping steadily and is headed to be almost free soon.) Products encourage ownership, but services discourage ownership because the kind of exclusivity, control, and responsibility that comes with ownership privileges are missing from services.

The switch from "ownership that you purchase" to "access that you subscribe to" overturns many conventions. Ownership is casual, fickle. If something better comes along, grab it. A subscription, on the other hand, gushes a never-ending stream of updates, issues, and versions that force a constant interaction between the producer and the consumer. It is not a onetime event; it's an ongoing relationship. To access a service, a customer is often committing to it in a far stronger way than when he or she purchases an item. You often get locked into a subscription (think of your mobile phone carrier or cable provider) that is difficult to switch out of. The longer you are with the service, the better it gets to know you; and the better it knows you, the harder it is to leave and start over again. It's almost like being married. Naturally, the producer cherishes this kind of loyalty, but the customer gets (or should get) many advantages for continuing as well: uninterrupted quality, continuous improvements, attentive personalization—assuming it's a good service.

Access mode brings consumers closer to the producer, and in fact the consumer often acts as the producer, or what futurist Alvin Toffler called in 1980 the "prosumer." If instead of owning software, you access software, then you can share in its improvement. But it also means you have been recruited. You, the new prosumer, are encouraged to identify bugs and report them (replacing a company's expensive QA department), to seek technical help from other customers in forums (reducing a company's expensive help desk), and to develop your own add-ons and improvements (replacing a company's expensive development team). Access amplifies the interactions we have with all parts of a service.

The first stand-alone product to be "servicized" was software. Today, selling software as service (SaS) instead of product has become the default mode for almost all software. As an example of SaS, Adobe no longer sells its venerable Photoshop and design tools as discrete products with dated versions, 7.0 or whatever. Instead you subscribe to Photoshop, InDesign, Premiere, etc., or the entire suite of services, and its stream of updates. You sign up and your computer will operate the latest best versions as long as you

pay the monthly subscription. This new model entails reorientation by customers comfortable owning something forever.

TV, phones, and software as service are just the beginning. In the last few years we've gotten hotels as service (Airbnb), tools as service (TechShop), clothes as service (Stitch Fix, Bombfell), and toys as service (Nerd Block, Sparkbox). Just ahead are several hundred new startups trying to figure how to do food as service (FaS). Each has its own approach to giving you a subscription to food, instead of purchases. For example, in one scheme you might not buy specific food products; instead, you get access to the benefits of food you need or want—say, certain levels and qualities of protein, nutrition, cuisine, flavors.

Other possible new service realms: Furniture as service; Health as service; Shelter as service; Vacation as service; School as service.

Of course, in all these you still pay; the difference is the deeper relationship that services encourage and require between the customer and the provider.

Real-Time On Demand

Access is also a way to deliver new things in close to real time. Unless something runs in real time, it does not count. As convenient as taxis are, they are often not real time enough. You usually wait too long for one, including the ones you call. And the cumbersome payment procedure at the end is a hassle. Oh, and they should be cheaper.

Uber, the on-demand taxi service, has disrupted the transportation business because it shifts the time equation. When you order a ride, you don't need to tell Uber where you are; your phone does that. You don't have to settle payment at the end; your phone does that. Uber uses the phones of the drivers to locate precisely where they are within inches, so Uber can match a driver closest to you. You can track their arrival to the minute. Anyone who wants to earn some money can drive, so there are often more Uber drivers than taxis, especially during peak demand times. And to make it vastly cheaper (in normal use), if you are willing to share a ride, Uber will match two or three riders going to approximately the same place at the same time to split the fare. These UberPool shared-ride fares might be one quarter the cost of a taxi. Relying on Uber (or its competitors, like Lyft) is a no-brainer.

While Uber is well known, the same on-demand "access" model is disrupting dozens of other industries, one after another. In the past few years thousands of entrepreneurs seeking funding have pitched venture capitalists for an "Uber for X," where X is any business where customers still have to wait. Examples of X include: three different Uber for flowers (Florist Now, ProFlowers, BloomThat), three Uber for laundry, two Uber for lawn mowing (Mowdo, Lawnly), an Uber for tech support (Geekatoo), an Uber for doctor house calls, and three Uber for legal marijuana delivery (Eaze, Canary, Meadow), plus a hundred more. The promise to customers is that you don't need a lawn mower or washing machine or to pick up flowers, because someone else will do that for you—on your command, at your convenience, in real time—at a price you can't refuse. The Uber-like companies can promise this because, instead of owning a building full of employees, they own some software. All the work is outsourced and performed by freelancers (prosumers) ready to work. The job for Uber for X is to coordinate this decentralized work and make it happen in real time. Even Amazon has gotten into the business of matching pros with joes who need home services (Amazon Home Services), from cleaning or setting up equipment to access to goat grazing for lawns.

One reason so much money is flowing into the service frontier is that there are so many more ways to be a service than to be a product. The number of different ways to recast transportation as a service is almost unlimited. Uber is merely one variation. There are dozens more already established, and many more possible. The general approach for entrepreneurs is to unbundle the benefits of transportation (or any X) into separate constituent goods and then recombine them in new ways.

Take transportation as an example. How do you get from point A to point B? Today you can do it in one of eight ways with a vehicle:

1. Buy a car, drive yourself (the default today).
2. Hire a company to drive you to your destination (taxi).
3. Rent a company-owned car, drive yourself (Hertz rental).
4. Hire a peer to drive you to your destination (Uber).

5. Rent a car from a peer, drive yourself (RelayRides).
6. Hire a company to drive you with shared passengers along a fixed route (bus).
7. Hire a peer to drive you with shared passengers to your destination (Lyft Line).
8. Hire a peer to drive you with shared passengers going to a fixed destination (BlaBlaCar).

There are variations upon the variations. Hire the service Shuddle to pick up someone else, like a child at school; some call it an Uber for kids. Sidecar is like Uber, except it runs a reverse auction. You set the price you are willing to pay and let drivers bid to pick you up. There are dozens of emerging companies (like SherpaShare) aimed at serving the drivers instead of riders, helping them manage more than one system and optimizing their routes.

These startups try to exploit inefficiencies in novel ways. They take assets that are unused part-time (such as an empty bedroom, a parked car, unused office space) and match them to people eagerly waiting for them right this second. Employing a distributed network of freelance providers, they can approximate near real-time delivery. Now repeat these same experimental business models in other sectors. Delivery: Let a network of freelancers deliver packages to homes (Uber for FedEx). Design: Let a crowd of designers submit designs, just pay the winner (CrowdSpring). Health care: Coordinate sharing insulin pumps. Real estate: Rent your garage as storage space, or an unused cubicle as office space for a startup (WeWork).

Most of these companies won't make it, even though the idea will thrive. Decentralized businesses are very easy to start, with low cost of entry. If these innovative business models are proven to work, established companies are ready to adapt. There is no reason a rental car company like Hertz can't rent freelancers cars, and no reason why taxi companies can't implement aspects of Uber. But the remixing of benefits will continue to flourish and expand.

Our appetite for the instant is insatiable. The cost of real-time engagement requires massive coordination and degrees of collaboration that were unthinkable a few years ago. Now that most people are equipped with a supercomputer in their pocket, entirely new economic forces are being unleashed. If smartly connected, a crowd of amateurs can be as good as the average solo professional. If smartly connected, the benefits of existing products can be unbundled and remixed in unexpected and delightful ways. If smartly connected, products melt into services that can be accessed continuously. If smartly connected, accessing is the default.

Accessing is not very different from renting. In a rent relationship the renter enjoys many of the benefits of ownership, but without the need for an expensive capital purchase or upkeep. Of course, renters are disadvantaged as well because they may not gain all the benefits of traditional ownership, such as rights of modification, long-term access, or gains in value. The invention of renting was not far behind the invention of property, and today you can rent almost anything. How about women's handbags? Top-of-the-line brand-name handbags sell for $500 or more. Since bags are often matched to outfits or seasonal fashions, a selection of fancy bags can get expensive real quick, so a sizable bag rental business has emerged. Rentals start around $50 per week, depending on the bag's demand. As expected, apps and coordination make renting smoother, more effortless. Renting thrives because, for many uses, it is better than owning. Bags can be swapped to match outfits, returned so one does not need to store them. For short-term uses, sharing ownership makes sense. And for many of the things we will use in the upcoming world, short-term use will be the norm. As more items are invented and manufactured—while the total number of hours in a day to enjoy them remains fixed—we spend less and less time per item. In other words, the long-term trend in our modern lives is that *most* goods and services will be short-term use. Therefore most goods and services are candidates for rental and sharing.

The downside to the traditional rental business is the "rival" nature of physical goods. Rival means that there is a zero-sum game; only one rival prevails. If I am renting your boat, no one else can. If I rent a bag to you, I cannot rent the same bag to another. In order to grow a rental business of physical things, the owner has to keep buying more boats or bags. But, of course, intangible goods and services don't work this way. They are "nonrival," which means you can rent the same movie to as many people who want to rent it this hour. Sharing intangibles scales magnificently. This ability to share on a large scale without diminishing the satisfaction of the individual renter is transformative. The total cost of use drops precipitously (shared by

millions instead of one). Suddenly, consumer ownership is not so important. Why own when you get the same real-time utility from renting, leasing, licensing, sharing?

For better or worse, our lives are accelerating, and the only speed fast enough is instant. The speed of electrons will be the speed of the future. Deliberate vacations from this speed will remain a choice, but on average communication technology is biased toward moving everything to on demand. And on demand is biased toward access over ownership.

Decentralization

We are at the midpoint in a hundred-year scramble toward greater decentralization. The glue that holds together institutions and processes as they undergo massive decentering is cheap, ubiquitous communication. Without the ability to remain connected as things spread wide into networks, firms would collapse. That's true, but also slightly backward. It's truer to say that the technological means of instant long-distance communications *enabled* this era of decentralization. That is, once we wrapped the globe in endless circles of wires crossing the deserts and beneath the oceans, decentralization was not only possible, but inevitable.

The consequence of moving away from centralized organization to the flatter worlds of networks is that everything—both tangible and intangible—must flow faster to keep the whole going together. Flows are hard to own; possession seems to just slip through your fingers. Access is a more appropriate stance for the fluid relations that govern a decentralized apparatus.

Nearly every aspect of modern civilization has been flattening down except one: money. Minting money is one of the last jobs left for a central government that most political parties agree is legitimate. It takes a central bank to battle the perennial scourges of counterfeit and fraud. Someone has to regulate the amount of money issued, keep track of the serial numbers, ensure that the money is trusted. A robust currency requires accuracy, coordination, security, enforcement—and an institution that takes responsibility for all those. Thus behind every currency stands a watchful central bank.

But what if you could decentralize money as well? What if you created a distributed currency that was secure, accurate, and trustworthy without centralization? Because if money could be decentralized, then *anything* can be decentralized. But even if you could, why would you?

Turns out you can decentralize money, and the technology to do this may be instrumental in decentralizing many other centralized institutions. The story of how the most centralized aspect of modern life is being decentralized holds lessons for many other unrelated industries.

To begin: I can pay you in cash, and that decentralized transaction is anonymous to a central bank. But moving physical cash around is not practical as our economy goes global. PayPal and other peer-to-peer electronic systems are able to bridge the vast geographical spans on a global economy, but each of its peer-to-peer payments must go through a central database to be sure a dollar is not spent twice or is not fraudulent. Mobile phone and internet companies devised very useful payment schemes for impoverished areas based on a phone app, such as M-Pesa. But until recently even the most advanced e-money system needed a central bank to keep the money honest. Six years ago some shady characters who wanted to sell drugs online with the anonymity of cash were looking for a currency without a government hand. And some admirable characters championing human rights were looking for a money system that would work outside of corrupt or repressive governments, or in places of no governance at all. What they together came up with is Bitcoin.

Bitcoin is a fully decentralized, distributed currency that does not need a central bank for its accuracy, enforcement, or regulation. Since it was launched in 2009, the currency has $3 billion in circulation and 100,000 vendors accepting the coins as payment. Bitcoin may be most famous for its anonymity and the black markets it fueled. But forget the anonymity; it's a distraction. The most important innovation in Bitcoin is its "blockchain," the mathematical technology that powers it. The blockchain is a radical invention that can decentralize many other systems beyond money.

When I send you one U.S. dollar via a credit card or PayPal account, a central bank has to verify that transaction; at the very least it must confirm I had a dollar to send you. When I send you one bitcoin, no central intermediary is involved. Our transaction is posted in a public ledger—called a blockchain—that is distributed to all other bitcoin owners in the world. This

shared database contains a long "chain" of the transaction history of all existing bitcoins and who owns them. Every transaction is open to inspection by anyone. That completeness is pretty crazy; it's like every person with a dollar having the complete history of all dollar bills as they move around the world. Six times an hour this open distributed database of coins is updated with all the new transactions of bitcoins; a new transaction like ours must be mathematically confirmed by multiple other owners before it is accepted as legitimate. In this way a blockchain creates trust by relying on mutual peer-to-peer accounting. The system itself—which is running on tens of thousands of citizen computers—secures the coin. Proponents like to say that with bitcoin you trust math instead of governments.

A number of startups and venture capitalists are dreaming up ways to use blockchain technology as a general purpose trust mechanism beyond money. For transactions that require a high degree of trust between strangers, such as real estate escrows and mortgage contracts, this validation was previously provided by a professional broker. But instead of paying a traditional title company a lot of money to verify a complex transaction such as a house sale, an online peer-to-peer blockchain system can execute the exchange for much less cost, or maybe for free. Some blockchain enthusiasts propose creating tools that perform a complicated cascade of transactions that depend on verification (like an import/export deal) using only decentralized automated blockchain technology, thereby disrupting many industries that rely on brokers. Whether Bitcoin itself succeeds, its blockchain innovation, which can generate extremely high levels of trust among strangers, will further decentralize institutions and industries.

An important aspect of the blockchain is that it is a public commons. No one really owns it because, well, everyone owns it. As a creation becomes digital, it tends to become shared; as it becomes shared, it also becomes ownerless. When everyone "owns" it, nobody owns it. That is often what we mean by public property or the commons. I use roads that I don't own. I have immediate access to 99 percent of the roads and highways of the world (with a few exceptions) because they are a public commons. We are all granted this street access via our payment of local taxes. For almost any purpose I can think of, the roads of the world serve me as if I owned them. Even better than if I owned them, since I am not in charge of maintaining them. The bulk of public infrastructure offers the same "better than owning" benefits.

The decentralized web/internet is now the central public commons. The good of the web serves me as if I owned it, yet I need to do very little to maintain it. I can summon it anytime, with the snap of a finger. I enjoy the full benefits of its amazing work—answering questions like a genius, navigating like a wizard, entertaining like a pro—without the burdens of ownership, simply by accessing it. (I pay its taxes with my subscriptions for internet access.) The more our society decentralizes, the more important accessing becomes.

Platform Synergy

For a long time there were two basic ways to organize human work: a firm and a marketplace. A firm, such as a company, had definite boundaries, was permission based, and enabled people to increase their efficiency via collaboration more than if they worked outside the firm. A marketplace had more permeable borders, required no permission to participate, and used the "invisible hand" to allot resources most efficiently. Recently a third way to organize work has emerged: the platform.

A platform is a foundation created by a firm that lets other firms build products and services upon it. It is neither market nor firm, but something new. A platform, like a department store, offers stuff it did not create. One of the first widely successful platforms was Microsoft's operating system (OS). Anyone with ambition could build and sell a software program that ran on the OS that Microsoft owned. Many did. Some, like the first spreadsheet, Lotus 1–2–3, prospered tremendously and became mini platforms themselves, birthing plug-ins and other third-party derivatives for their product. Levels of highly interdependent products and services form an "ecosystem" that rests upon the platform. "Ecosystem" is a good description because, just as in a forest, the success of one species (product) depends on the success of others. It is the deep ecological interdependence of a platform that discourages ownership and promotes access instead.

Later, a second generation of platforms acquired more of the attributes of markets, so they were a bit of a market and a firm. One of the first of these was iTunes for the iPhone. Apple, the firm, owned the platform, which also became a marketplace for phone apps. Vendors pitched a virtual stall and

sold their apps on iTunes. Apple regulated the market, weeding out junky, exploitative, or nonworking applications. It set rules and protocols. It oversaw the financial exchanges. You could say Apple's new product was the marketplace itself. ITunes was an entire ecosystem of apps constructed on the capabilities built into the phone, and it boomed. Since Apple kept adding ingenious new ways to interact with the phone, including new sensors such as a camera, GPS, and an accelerometer, thousands of novel species of innovations deepened the iPhone ecology.

A third generation of platforms further expanded the power of the marketplaces. Unlike traditional two-sided markets—say, a farmers' market that enables buyers and sellers—a platform ecosystem became a multisided market. A good example of this is Facebook. The firm created some rules and protocols that formed a marketplace where independent sellers (college students) produced their own profiles, which were matched up in a marketplace with their friends. The attention of the students was sold to advertisers. Game companies sold to students. Third-party apps sold to advertisers. Third-party apps sold to other third-party apps. And so on in multiple-way matches. This ecosystem of interdependent species keeps expanding, and will keep expanding as long as Facebook can manage its rules and its own growth as a firm.

The wealthiest and most disruptive organizations today are almost all multisided platforms—Apple, Microsoft, Google, and Facebook. All these giants employ third-party vendors to increase the value of their platform. All employ APIs extensively that facilitate and encourage others to play with it. Uber, Alibaba, Airbnb, PayPal, Square, WeChat, Android are the newer wildly successful multiside markets, run by a firm, that enable robust ecosystems of derivative yet interdependent products and services.

Ecosystems are governed by coevolution, which is a type of biological codependence, a mixture of competition and cooperation. In true ecological fashion, supporting vendors who cooperate in one dimension may also compete in others. For instance, Amazon sells both brand-new books from publishers and, via its ecosystem of used-book stores, cheaper used versions. Used-book vendors compete with one another and with the publishers. The platform's job is to make sure it makes money (and adds value!) whether the parts cooperate or compete. Which Amazon does well.

At almost every level of a platform, sharing is the default—even if it is just the rules of competition. Your success hinges on the success of others. Maintaining the idea of ownership within a platform becomes problematic, because it rests on notions of "private property"; but neither "private" nor "property" has great meaning in an ecosystem. As more is shared, less will act like property. It is not a coincidence that less privacy (constant sharing of intimate lives) and more piracy (disregard of intellectual property) are both breeding on platforms.

However, the move from ownership to access has a price. Part of what you own with ownership is the right—and ability—to modify or control the use of your property. That right of modification is sorely missing in many of today's popular digital platforms. Their standard terms of service forbid it. You are legally restricted as to what you can do with the stuff you access versus what you buy. (To be honest, the ability to modify is also squeezed from classic retail purchases as well—think of those silly shrink-wrap warranties.) But the right and ability to modify and control are present in open source platforms and tools such as the Linux OS or the popular Arduino hardware platform, which is part of their great attraction. The ability and right to improve, personalize, or appropriate what is shared will be a key question in the next iteration of platforms.

Dematerialization and decentralization and massive communication all lead to more platforms. Platforms are factories for services; services favor access over ownership.

Clouds

The movies, music, books, and games that you access all live on clouds. A cloud is a colony of millions of computers that are braided together seamlessly to act as a single large computer. The bulk of what you do on the web and phone today is done on cloud computing. Though invisible, clouds run our digital lives.

A cloud is more powerful than a traditional supercomputer because its core is dynamically distributed. That means that its memory and work is spread across many chips in a massively redundant way. Let's say you were streaming a long movie and suddenly an asteroid smashed one tenth of the machines that made up the cloud. You might not notice any interruption in

the movie because the movie file did not reside in any particular machine but was distributed in a redundant pattern across many processors in such a way that the cloud can reconfigure itself if any of those units fail. It's almost like organic healing.

The web is hyperlinked documents; the cloud is hyperlinked data. Ultimately the chief reason to put things onto the cloud is to share their data deeply. Woven together, the bits are made much smarter and more powerful than they could possibly be alone. There is no single architecture for clouds, so their traits are still rapidly evolving. But in general they are huge. They are so large that the substrate of one cloud can encompass multiple football field–size warehouses full of computers located in scores of cities thousands of miles apart. Clouds are also elastic, meaning they can be enlarged or shrunk almost in real time by adding or dropping computers to their network. And because of their inherent redundant and distributed nature, clouds are among the most reliable machines in existence. They can provide the famous five nines (99.999 percent) of near perfect service performance.

A central advantage of a cloud is that the bigger it gets, the smaller and thinner our devices can be. The cloud does all the work, while the device we hold is just the window into the cloud's work. When I look into my phone screen and see a live video stream, I am looking into the cloud. When I flick through book pages on my tablet, I am surfing the cloud. When the face of my smartwatch lights up with a message, it is coming from the cloud. When I flip open my cloudbook laptop, everything that I work on is actually somewhere else, in a cloud.

The ambiguity of where my stuff is and whether it is in fact "mine" can be illustrated by the example of a doc on Google. I usually use the Google Drive app to write a marketing letter. "My" letter appears on my laptop or my phone, but its essence lives in Google's cloud, dispersed across many far-flung machines. A key reason I use Google Drive is its ease of collaboration. A dozen or more collaborators can see that letter on their tablet and work on it—edit, add, delete, modify—as if it were "their" letter. Changes made on any of those copies will appear simultaneously—in real time—on all other copies anywhere in the world. It's kind of miraculous, this distributed cloud existence. Each instance of the letter is much more than a mere copy, a term that suggests an inert reproduction. Rather, each person experiences the distributed copy as the original on their device! Each of the dozen copies is as authentic as the one on my laptop. Authenticity is distributed. This collective interaction and distributed being makes the letter feel less mine and more "ours."

Because it lives on the cloud, Google could easily apply cloud-based AI to our letter in the future. Besides automatically correcting the spelling and critical grammar, Google might also fact-check the statements in the letter with its new truth-checker called Knowledge-Based Trust. It could add hyperlinks to appropriate terms, and add (with my assent) smart additions that improve it significantly so that it further erodes my sense of possession. More and more of our work and play will leave the isolated realm of individual ownership and migrate to the shared world of the cloud in order to take full advantage of AI and other cloud-based powers.

I already google the cloud for answers instead of trying to remember a URL, or even the spelling of a difficult word. If I re-google my own email (stored in a cloud) to find out what I said (which I do) or rely on the cloud for my memory, where does my "I" end and the cloud start? If all the images of my life, and all the snippets of my interests, and all my notes, and all my chitchat with friends, and all my choices, and all my recommendations, and all my thoughts, and all my wishes—if all this is sitting somewhere, but nowhere in particular, it changes how I think of myself. I am larger than before, but thinner too. I am faster, but at times shallower. I think more like a cloud with fewer boundaries, open to change and full of contradiction. I contain multitudes! This whole mix will be further enhanced with the intelligence of machines and AIs. I will be not just Me Plus, but We Plus.

But what happens if it were to go away? A very diffused me would go away. Friends of mine had to ground their teenager for a serious infraction. They confiscated her cell phone. They were horrified when she became physically ill, vomiting. It was almost as if she'd had an amputation. And in one sense she had. If a cloud company restricts or censors our actions, we'll feel pain. Separation from the comfort and new identity afforded by the cloud will be horrendous and unbearable. If McLuhan is right that tools are extensions of our selves—a wheel an extended leg, a camera an extended eye—then the cloud is our extended soul. Or, if you prefer, our extended self. In one sense, it is not an extended self we own, but one we have access to.

Clouds are mostly commercial so far. There is the Oracle Cloud, IBM's SmartCloud, and Amazon's Elastic Compute Cloud. Google and Facebook

run huge clouds internally. We keep coming back to clouds because they are more reliable than we are. They are certainly more reliable than other kinds of machines. My very stable Mac freezes or needs to be rebooted once a month. But Google's cloud platform was down only 14 minutes in 2014, a near insignificant outage for the immense amount of traffic served. The cloud is the Backup. Our life's backup.

All business and much of society today run on computers. Clouds offer computation with astounding reliability, fast speed, expandable depth, and no burdens of maintenance for users. Anyone who owns a computer recognizes those burdens: They take up space, need constant expert attention, and go obsolete instantly. Who would want to own their computer? The answer increasingly is no one. No more than you want to own an electric station, rather than buy electricity from the grid. Clouds enable organizations to access the benefits of computers without the hassle of possession. Expandable cloud computing at discount prices has made it a hundred times easier for a young technology company to start up. Instead of building their own complex computing infrastructure, they subscribe to a cloud's infrastructure. In industry terms, this is infrastructure as service. Computers as service instead of computers as product: access instead of ownership. Gaining cheap access to the best infrastructure by operating on the cloud is a chief reason so many young companies have exploded out of Silicon Valley in the last decade. As they grow fast, they access more of what they don't own. Scaling up with success is easy. The cloud companies welcome this growth and dependence, because the more that people use the cloud and share in accessing their services, the smarter and more powerful their service becomes.

There are practical limits to how gigantic one company's cloud can get, so the next step in the rise of clouds over the coming decades will be toward merging the clouds into one intercloud. Just as the internet is the network of networks, the intercloud is the cloud of clouds. Slowly but surely Amazon's cloud and Google's cloud and Facebook's cloud and all the other enterprise clouds are intertwining into one massive cloud that acts as a single cloud—The Cloud—to the average user or company. A counterforce resisting this merger is that an intercloud requires commercial clouds to share their data (a cloud is a network of linked data), and right now data tends to be hoarded like gold. Data hoards are seen as a competitive advantage, and sharing data freely is hampered by laws, so it will be many years (decades?) before companies learn how to share their data creatively, productively, and responsibly.

There is one final step in the inexorable march toward decentralized access. At the same time we are moving to an intercloud we will also move toward one that is fully decentralized and peer to peer. While the enormous clouds of Amazon, Facebook, and Google are distributed, they are not decentralized. The machines are run by enormous companies, not by a funky network of computers run by your funky peers. But there are ways to make clouds that run on decentralized hardware. We know a decentralized cloud can work, because one did during the student protests in Hong Kong in 2014. To escape the obsessive surveillance the Chinese government pours on its citizens' communications, the Hong Kong students devised a way to communicate without sending their messages to a central cell phone tower or through the company servers of Weibo (the Chinese Twitter) or WeChat (their Facebook) or email. Instead they loaded a tiny app onto their phones called FireChat. Two FireChat-enabled phones could speak to each other directly, via wifi radio, without jumping up to a cell tower. More important, either of the two phones could forward a message to a third FireChat-enabled phone. Keep adding FireChat'd phones and you soon have a full network of phones without towers. Messages that are not meant for one phone are relayed to another phone until they reach their intended recipient. This intensely peer-to-peer variety of network (called a mesh) is not efficient, but it works. That cumbersome forwarding is exactly how the internet operates at one level, and why it is so robust. The result of the FireChat mesh was that the students created a radio cloud that no one owned (and was therefore hard to squelch). Relying entirely on a mesh of their own personal devices, they ran a communications system that held back the Chinese government for months. The same architecture could be scaled up to run any kind of cloud.

There are very good nonrevolutionary reasons to have a decentralized communication system like this. In a large-scale emergency when electrical power is out, a peer-to-peer phone mesh might be the only system working. Each individual phone could be recharged by solar, so a communication system could work without the electrical grid. A phone's range is limited, but you could place small cell phone "repeaters" on building rooftops, also potentially recharged by solar. The repeaters just repeat and forward a

message for a longer distance than a phone; they are like nanotowers, but they are not owned by a company. A network of rooftop repeaters and millions of phones would create an ownerless network. More than one startup has been founded to offer this type of mesh service.

An ownerless network upsets many of the regulatory and legal frameworks now in place for our communication infrastructure. Clouds don't have a lot of geography. Whose laws will prevail? The laws of your domicile, the laws of your server's domicile, or the laws of international exchange? Who gets your taxes if all the work is being done in the cloud? Who owns the data, you or the cloud? If all your email and voice calls go through the cloud, who is responsible for what it says? In the new intimacy of the cloud, when you have half-baked thoughts, weird daydreams, should they not be treated differently than what you really believe? Do you own your own thoughts, or are you merely accessing them? All these questions apply not only to clouds and meshes but to all decentralized systems.

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In the coming 30 years the tendency toward the dematerialized, the decentralized, the simultaneous, the platform enabled, and the cloud will continue unabated. As long as the costs of communications and computation drop due to advances in technology, these trends are inevitable. They are the result of networks of communication expanding till they are global and ubiquitous, and as the networks deepen they gradually displace matter with intelligence. This grand shift will be true no matter where in the world (whether the United States, China, or Timbuktu) they take place. The underlying mathematics and physics remain. As we increase dematerialization, decentralization, simultaneity, platforms, and the cloud—as we increase all those at once, access will continue to displace ownership. For most things in daily life, accessing will trump owning.

Yet only in a science fiction world would a person own nothing at all. Most people will own some things while accessing others; the mix will differ by person. Yet the extreme scenario of a person who accesses all without any ownership is worth exploring because it reveals the stark direction technology is headed. Here is how it will work soon.

I live in a complex. Like a lot of my friends, I choose to live in the complex because of the round-the-clock services I can get. The box in my apartment is refreshed four times a day. That means I can leave my refreshables (like clothes) there and have them replenished in a few hours. The complex also has its own Node where hourly packages come in via drones, robo vans, and robo bikes from the local processing center. I tell my device what I need and then it's in my box (at home or at work) within two hours, often sooner. The Node in the lobby also has an awesome 3-D printing fab that can print just about anything in metal, composite, and tissue. There's also a pretty good storage room full of appliances and tools. The other day I wanted a turkey fryer; there was one in my box from the Node's library in a hour. Of course, I don't need to clean it after I'm done; it just goes back into the box. When my friend was visiting, he decided he wanted to cut his own hair. There were hair clippers in the box in 30 minutes. I also subscribe to a camping gear outfit. Camping gear improves so fast each year, and I use it for only a few weeks or weekends, that I much prefer to get the latest, best, pristine gear in my box. Cameras and computers are the same way. They go obsolete so fast, I prefer to subscribe to the latest, greatest ones. Like a lot of my friends, I subscribe to most of my clothes too. It's a good deal. I can wear something different each day of the year if I want, and I just toss the clothes into the box at the end of the day. They are cleaned and redistributed, and often altered a bit to keep people guessing. They even have a great selection of vintage T-shirts that most other companies don't have. The few special smartshirts I own are chipped-tagged so they come back to me the next day cleaned and pressed.

I subscribe to several food lines. I get fresh produce directly from a farmer nearby, and a line of hot ready-to-eat meals at the door. The Node knows my schedule, my location on my commute, my preferences, so it's really accurate in timing the delivery. When I want to cook myself, I can get any ingredient or special dish I need. My complex has an arrangement so all the ongoing food and cleaning replenishables appear a day before they are needed in the refrig or cupboard. If I was flush with cash, I'd rent a premium flat, but I got a great deal on my place in the complex because they rent it out anytime I am not there. It's fine with me since when I return it's cleaner than I leave it.

I have never owned any music, movies, games, books, art, or realie

worlds. I just subscribe to Universal Stuff. The arty pictures on my wall keep changing so I don't take them for granted. I use a special online service that prepares my walls from my collection on Pinterest. My parents subscribe to a museum service that lends them actual historical works of art in rotation, but that is out of my range. These days I am trying out 3-D sculptures that reconfigure themselves each month so you keep noticing them. Even the toys I had as a kid growing up were from Universal. My mom used to say, "You only play with them for a few months—why own them?" So every couple of months they would go into the box and new toys would show up.

Universal is so smart I usually don't have to wait more than 30 seconds for my ride, even during surges. The car just appears because it knows my schedule and can deduce my plans from my texts, calendar, and calls. I'm trying to save money, so sometimes I'll double or triple up with others on the way to work. There is plenty of bandwidth so we can all screen. For exercise, I subscribe to several gyms and a bicycle service. I get an up-to-date bike, tuned and cleaned and ready at my departure point. For long-haul travel I like these new personal hover drones. They are hard to get when you need them right now since they are so new, but so much more convenient than commercial jets. As long as I travel to complexes in other cities that have reciprocal services, I don't need to pack very much since I can get everything —the same things I normally use—from the local Nodes.

My father sometimes asks me if I feel untethered and irresponsible not owning anything. I tell him I feel the opposite: I feel a deep connection to the primeval. I feel like an ancient hunter-gatherer who owns nothing as he wends his way through the complexities of nature, conjuring up a tool just in time for its use and then leaving it behind as he moves on. It is the farmer who needs a barn for his accumulation. The digital native is free to race ahead and explore the unknown. Accessing rather than owning keeps me agile and fresh, ready for whatever is next.