The BitTorrent Effect

Movie studios hate it. File-swappers love it. Bram Cohen's blazing-fast P2P software has turned the Internet into a universal TiVo. For free video-on-demand, just click here.
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"That was a bad move," Bram Cohen tells me. We're huddled over a table in his Bellevue, Washington, house playing a board game called Amazons. Cohen picked it up two weeks ago and has already mastered it. The 29-year-old programmer consumes logic puzzles at the same rate most of us buy magazines. Behind his desk he keeps an enormous plastic bin filled with dozens of Rubik's Cube-style twisting gewgaws that he periodically scrambles and solves throughout the day. Cohen says he loves Amazons, a cross between chess and the Japanese game Go, because it is pure strategy. Players take turns dropping more and more tokens on a grid, trying to box in their opponent. As I ponder my next move, Cohen studies the board, his jet-black hair hanging in front of his face, and tells me his philosophy of the perfect game."The best strategy games are the ones where you put a piece down and it stays there for the whole game," he explains. "You say, OK, I'm staking out this area. But you can't always figure out if that's going to work *for* you or *against* you. You just have to wait and see. You might be right, might be wrong." It's only later, when I look over these words in my notes, that I realize he could just as easily be talking about his life.

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Bram Cohen is the creator of BitTorrent, one of the most successful peer-to-peer programs ever. BitTorrent lets users quickly upload and download enormous amounts of data, files that are hundreds or thousands of times bigger than a single MP3. Analysts at CacheLogic, an Internet-traffic analysis firm in Cambridge, England, report that BitTorrent traffic accounts for more than one-third of all data sent across the Internet. Cohen showed his code to the world at a hacker conference in 2002, as a free, open source project aimed at geeks who need a cheap way to swap Linux software online. But the real audience turns out to be TV and movie fanatics. It takes hours to download a ripped episode of *Alias* or *Monk* off Kazaa, but BitTorrent can do it in minutes. As a result, more than 20 million people have downloaded the BitTorrent application. If any one of them misses their favorite TV show, no worries. Surely someone has posted it as a "torrent." As for movies, if you can find it at Blockbuster, you can probably find it online somewhere - and use BitTorrent to suck it down.

With so much illegal traffic, it's no surprise that a clampdown has started: In November, the Motion Picture Association of America began suing downloaders of movies, in order to, as the MPAA's antipiracy chief John Malcolm put it, "avoid the fate of the music industry."

For Cohen, it's all a little surreal. He gets up in the morning, helps his wife feed their children, and then sits down at his cord-and-computer-choked desk to watch his PayPal account fill up with donations from grateful BitTorrent users - enough to support his family. Then he goes online to see how many more people have downloaded the program: At this rate, it'll be 40 million by 2006.

"I can't even imagine a crowd that big. I try not to think about it," he admits.

So he does what he always does. He narrows his focus to zoom in on the next thorny problem, the next interesting technical challenge. Like our game of Amazons.

He lays down another piece: "I think I've won now."

Like many geeks in the '90s, Cohen coded for a parade of dotcoms that went bust without a product ever seeing daylight. He decided his next project would be something he wrote for himself in his own way, and gave away free. "You get so tired of having your work die," he says. "I just wanted to make something that people would actually use."

Cohen was always interested in file-sharing. His last job was with MojoNation, a project based in Mountain View, California, that tried to create a "distributed data haven." A MojoNation user who wanted to keep a file safe from prying eyes could break it into chunks, encrypt the pieces, and store them on the millions of computers belonging to people who, theoretically, would be running the software worldwide. Too complicated for easy use, it expired like the other startups Cohen was part of. But it gave him an idea: Breaking a big file into tiny pieces might be a terrific way to swap it online.

The problem with P2P file-sharing networks like Kazaa, he reasoned, is that uploading and downloading do not happen at equal speeds. Broadband providers allow their users to download at superfast rates, but let them upload only very slowly, creating a bottleneck: If two peers try to swap a compressed copy of *Meet the Fokkers* - say, 700 megs - the recipient will receive at a speedy 1.5 megs a second, but the sender will be uploading at maybe one-tenth of that rate. Thus, one-to-one swapping online is inherently inefficient. It's fine for MP3s but doesn't work for huge files.

Cohen realized that chopping up a file and handing out the pieces to several uploaders would really speed things up. He sketched out a protocol: To download that copy of *Meet the Fokkers*, a user's computer sniffs around for others online who have pieces of the movie. Then it downloads a chunk from several of them simultaneously. Many hands make light work, so the file arrives dozens of times faster than normal.

Paradoxically, BitTorrent's architecture means that the more popular the file is the faster it downloads - because more people are pitching in. Better yet, it's a virtuous cycle. Users download and share at the same time; as soon as someone receives even a single piece of *Fokkers*, his computer immediately begins offering it to others. The more files you're willing to share, the faster any individual torrent downloads to your computer. This prevents people from leeching, a classic P2P problem in which too many people download files and refuse to upload, creating a drain on the system. "Give and ye shall receive" became Cohen's motto, which he printed on T-shirts and sold to supporters.

In April 2001, Cohen quit his job at MojoNation and entered what he calls his "starving artist" period. He lived off his meager savings and stayed home to work on the software all day. His pals were skeptical. "No one knew if BitTorrent would work. Everyone knew that Bram was smart, but let's face it, a lot of stuff like this fails," says Danny O'Brien, a consultant and the editor of the tech newsletter *Need To Know*.

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What kept Cohen going, say friends and family, was a cartoonishly inflated ego. "I can come off as pretty arrogant, but it's because I know I'm right," he laughs. "I'm very, very good at writing protocols. I've accomplished more working on my own than I ever did as part of a team." While we're having lunch, his wife, Jenna, tells me about the time they were watching *Amadeus*, where Mozart writes his music so rapidly and perfectly it appears to have been dictated by God. Cohen decided he was kind of like that. Like Mozart? Bram and Jenna nod.

"Bram will just pace around the house all day long, back and forth, in and out of the kitchen. Then he'll suddenly go to his computer and the code just comes pouring out. And you can see by the lines on the screen that it's clean," Jenna says. "It's clean code." She pats her husband affectionately on the head: "My sweet little autistic nerd boy." (Cohen in fact has Asperger's syndrome, a condition on the mild end of the autism spectrum that gives him almost superhuman powers of concentration but can make it difficult for him to relate to other people.)

For the program's first successful public trial, Cohen collected a batch of free porn and used it to lure beta testers. (The gambit worked, as did the code.) He started releasing beta versions of BitTorrent in summer 2001. Linux geeks took to it immediately and began swapping their enormous programs. In 2004, TV-show and movie pirates began showing up on BitTorrent blogs that, like samizdat TV Guides, pointed to long lists of pirated content.

The one person who hasn't joined the plundering is Cohen himself. He says he has never downloaded a single pirated file using BitTorrent. Why? He suspects the MPAA would love to make a legal example of him, and he doesn't want to give them an opening. He's the perfect candidate for downloading, though, since he doesn't care if he sees TV live, doesn't subscribe to basic cable, and already sits at a computer all day long. The only shows he watches are those he buys on DVD. He particularly loved the first season of Paris Hilton's *The Simple Life*. "You can watch that show for six hours," Cohen says, "and your brain is still empty."

We wander into his garage, where he hops onto a skateboard and begins zipping back and forth. I ask him if he would download television shows if he weren't BitTorrent's creator.

He pauses for a second. "I don't know," he says. "There's upholding the principle. And there's being the only knucklehead left who's upholding the principle."

You could think of BitTorrent as Napster redux - another rumble in the endless copyright wars. But BitTorrent is something deeper and more subtle. It's a technology that is changing the landscape of broadcast media.

"All hell's about to break loose," says Brad Burnham, a venture capitalist with Union Square Ventures in Manhattan, which studies the impact of new technology on traditional media. BitTorrent does not require the wires or airwaves that the cable and network giants have spent billions constructing and buying. And it pounds the final nail into the coffin of must-see, appointment television. BitTorrent transforms the Internet into the world's largest TiVo.

One example of how the world has already changed: Gary Lerhaupt, a graduate student in computer science at Stanford, became fascinated with *Outfoxed*, the documentary critical of Fox News, and thought more people should see it. So he convinced the film's producer to let him put a chunk of it on his Web site for free, as a 500-Mbyte torrent. Within two months, nearly 1,500 people downloaded it. That's almost 750 gigs of traffic, a heck of a wallop. But to get the ball rolling, Lerhaupt's site needed to serve up only 5 gigs. After that, the peers took over and hosted it themselves. His bill for that bandwidth? $4. There are drinks at Starbucks that cost more. "It's amazing - I'm a movie distributor," he says. "If I had my own content, I'd be a TV station."

During the last century, movie and TV companies had to be massive to afford distribution. Those economies of scale aren't needed anymore. Will the future of broadcasting need networks, or even channels?

"Blogs reduced the newspaper to the post. In TV, it'll go from the network to the show," says Jeff Jarvis, president of the Internet strategy company Advance.net and founder of *Entertainment Weekly*. (Advance.net is owned by Advance Magazine Group, which also owns *Wired*'s parent company, Condé Nast.) Burnham goes one step further. He thinks TV-viewing habits are becoming even more atomized. People won't watch entire shows; they'll just watch the parts they care about.

Evidence that Burnham's prediction is coming true came a few weeks before the US presidential election in November, when Jon Stewart - host of Comedy Central's irreverent *The Daily Show* - made a now-famous appearance on CNN's *Crossfire*. Stewart attacked the hosts, Paul Begala and Tucker Carlson, calling them political puppets. "What you do is partisan hackery," he said, just before he called Carlson "a dick." Amusing enough, but what happened next was more remarkable. Delighted fans immediately ripped the segment and posted it online as a torrent. Word of Stewart's smackdown spread rapidly through the blogs, and within a day at least 4,000 servers were hosting the clip. One host reported having, at any given time, more than a hundred peers swapping and downloading the file. No one knows exactly how many people got the clip through BitTorrent, but this kind of traffic on the very first day suggests a number in the hundreds of thousands - and probably much higher. Another 2.3 million people streamed it from iFilm.com over the next few weeks. By contrast, CNN's audience for *Crossfire* was only 867,000. Three times as many people saw Stewart's appearance online as on CNN itself.

If enough people start getting their TV online, it will drastically change the nature of the medium. Normally, the buzz for a show builds gradually; it takes a

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few weeks or even a whole season for a loyal viewership to lock in. But in a BitTorrented broadcast world, things are more volatile. Once a show becomes slightly popular - or once it has a handful of well-connected proselytizers - multiplier effects will take over, and it could become insanely popular overnight. The pass-around effect of blogs, email, and RSS creates a roving, instant audience for a hot show or segment. The whole concept of must-see TV changes from being something you stop and watch every Thursday to something you gotta check out right now, dude. Just click here.

What exactly would a next-generation broadcaster look like? The VCs at Union Square Ventures don't know, though they'd love to invest in one. They suspect the network of the future will resemble Yahoo! or Amazon.com - an aggregator that finds shows, distributes them in P2P video torrents, and sells ads or subscriptions to its portal. The real value of the so-called BitTorrent broadcaster would be in highlighting the good stuff, much as the collaborative filtering of Amazon and TiVo helps people pick good material. Eric Garland, CEO of the P2P analysis firm BigChampagne, says, "the real work isn't acquisition. It's good, reliable filtering. We'll have more video than we'll know what to do with. A next-gen broadcaster will say, 'Look, there are 2,500 shows out there, but here are the few that you're really going to like.' We'll be willing to pay someone to hold back the tide."

Of course, peercasting doesn't change everything. Producing a good show like *The Sopranos* or *E.R.* still costs millions. Actors aren't cheap. That's why Jarvis thinks the first creators to thrive in a BitTorrent world will be a fresh crop of how-to and reality shows, where talent is inexpensive and scriptwriters unnecessary. "*Trading Spaces* is probably $100,000 a half hour. But with a Mac and a digital video camera you can produce a much cheaper version," Jarvis says.

The major networks are watching the situation cautiously. They don't want to ignore the potential of the peercasting model, but they can't endorse it without knowing where their revenue will come from. "We're going to have to be very creative about it," says Channing Dawson, a senior vice president with Scripps Networks, which produces several food and lifestyle shows for on-demand TV. "But eventually the consumer will become the programmer. Content will be accessible anywhere, anytime." The executive vice president for research and planning at CBS, David Poltrack, elaborates: "In our research with consumers, content-on-demand is the killer app. They like the idea of paying only for what they watch." The trick, he figures, is to work out a solution before the audience for illegal downloading becomes truly huge. He figures the networks have 10 years.

The task for broadcasters is clear: Take this new platform and mine it for gold, the way Hollywood, which squawked about VHS, figured out how to make billions off video rentals. BitTorrent isn't the only way to do this. There are more corporate-friendly routes. The P2P technology company Kontiki produces software that, like BitTorrent, creates hyperefficient downloads; its applications also work with Microsoft's digital rights management software to keep content out of pirate hands. The BBC used Kontiki's systems last summer to send TV shows to 1,000 households. And America Online now uses Kontiki's apps to circulate Moviefone trailers. In fact, when users download a trailer, they also download a plug-in that begins swapping the file with others. It's so successful that when you watch a trailer on Moviefone, 80 percent of the time it's being delivered to you by other users in the network. Millions of AOL users have already participated in peercasting - without knowing it.

The Pirate Bay is a BitTorrent tracking site in Sweden with 150,000 users a day. In the fall, it posted a torrent for *Shrek 2*. Dreamworks sent a cease-and-desist letter demanding the site remove it. One of the site's pseudonymous owners, Anakata, replied: "As you may or may not be aware, Sweden is not a state in the United States of America. Sweden is a country in northern Europe [and] US law does not apply here. … It is the opinion of us and our lawyers that you are fucking morons." Shrek 2 stayed up.

For movie industry insiders, file-sharing seems like all downside. Unlike TV networks, movie studios get no revenue from advertising - getting massive online circulation won't put a penny in their box offices. For them, it seems like an open-and-shut case. They ran advertisements urging users not to download movies illegally; when that didn't work, they started suing.

"We consider it a regrettable but necessary step," says John Malcolm of the MPAA. "We saw the devastating effect that peer-to-peer piracy had on the record industry."

The music industry watched songs get stolen for years, yet as soon as it gave people what they wanted - a reasonably cheap and easy way to pay for individual tracks - customers swarmed to the legal option: the iTunes Music Store. What if the movie industry pursued a similar model? Use peercasting to distribute movies cheaply, and make it so easy and inexpensive that most of people will go the legal route. As BigChampagne's Garland points out, the film industry might even find that it will be easier for them to bring customers to its side than it is for the music industry, because Hollywood doesn't suffer from the problems that plagued the record business. Music buyers had long felt bitter about album prices. Moviegoers generally do not feel that way about films. While music consumers want to own their MP3s forever, movies are usually a one-hit blast - fewer viewers will want to permanently own the movies. That means creating a digital rights management system for downloadable movies is likely to be a lot easier than it is for music. Music lovers hate DRM limits on their MP3s because they expect their music to behave like a piece of property - something they can own forever and transfer from device to device. In contrast, Blockbuster has long proven that people are happy to just rent movies.

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Either way, the lawsuits place Cohen in the crosshairs. The record industry sued Napster into oblivion. Could the MPAA do the same thing to him? Legal experts doubt it. The courts have argued in recent years that a file-sharing technology cannot be banned if it has "substantial noninfringing uses" - in other words, if it can be used for legal purposes. BitTorrent passes that test, says Fred von Lohmann, a lawyer at the Electronic Frontier Foundation, because Linux groups and videogame companies regularly use it to shuttle software around the Net. "That puts Bram in the same situation as Xerox and its photocopiers," he says.

Cohen knows the havoc he has wrought. In November, he spoke at a Los Angeles awards show and conference organized by *Billboard*, the weekly paper of the music business. After hobnobbing with "content people" from the record and movie industries, he realized that "the content people have no clue. I mean, no clue. The cost of bandwidth is going down to nothing. And the size of hard drives is getting so big, and they're so cheap, that pretty soon you'll have every song you own on one hard drive. The content distribution industry is going to evaporate." Cohen said as much at the conference's panel discussion on file-sharing. The audience sat in a stunned silence, their mouths agape at Cohen's audacity.

Cohen seems curiously unmoved by the storm raging around him. "With BitTorrent, the cat's out of the bag," he shrugs. He doesn't want to talk about piracy and the future of media, and at first I think he's avoiding the subject because it's so legally sensitive. But after a while, I realize it simply doesn't interest him much.

He'd rather just work on his code. He'd rather buckle down and figure out new ways to make BitTorrent more efficient. He'd rather focus on something that demands crazy, hair-pulling logic. In his office, he roots through his bin of twisting puzzles and pulls out CrossTeaser, an interlocking series of colored x's that you have to orient until their colors line up. "This is one of the hardest I've ever tried, " he says. "It took me, like, a couple of days to solve it."

Cohen has even started sketching out ideas for his own puzzles. He dreams of making enough money to buy a 3-D prototyping machine and retire. Now *that*, he figures, would be a fun life: Sitting at home and designing stuff so fiendishly hard almost no one can figure it out. We know his philosophy of what makes a good game; he's got a theory of the perfect puzzle, too.

"The ideal," he says, "is that you appear to be near the end - you've got almost all the colors lined up, and you think it's nearly solved. But it isn't. And you realize that to get that last color in place, you're going to have to do something that jumbles it up all over again."

Sounds like the puzzle he's created for the television and film industries.

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How BitTorrent Works

Bram Cohen's approach is faster and more efficient than traditional P2P networking.

1. A single source file within a group of BitTorrent users, called a swarm, spreads around pieces of a film or videogame or TV show so that everyone has a chunk to share.

2. After the initial downloading, those pieces are then uploaded to other needy users in the swarm. The rules require every downloader to also do some uploading. Thus the more people trying to download, the faster everything is uploaded.

3. Before long, the swarm has shared all the pieces, and everyone has their own complete source.

How Traditional Peer-to-Peer works

Sites like Kazaa and Morpheus are slow because they suffer from supply bottlenecks. Even if many users on the network have the same file, swapping is restricted to one uploader and downloader at a time. And since uploading goes much slower than downloading, even highly compressed media can take many hours to transfer.

Clive Thompson (clive@clivethompson.net) *wrote about rebooting the political system in issue 12.09.*