

IEEE Spectrum

FEATURE CONSUMER ELECTRONICS

The Consumer Electronics Hall of Fame: TiVo

A revolution in TV viewing was fomented in part by the need to let people answer nature's call

BY BRIAN SANTO

07 NOV 2019





Black Box: The original TiVo digital video recorder was introduced in 1999. Like all of the early TiVos, this model, designated HDR112, was manufactured by Philips. PHOTO: BRUCE BISPING/STAR TRIBUNE/GETTY IMAGES

T HE TIVO IS THE LEAST SUCCESSFUL, MOST significant consumer electronics device ever. When it came out in early 1999, it was one of the first two digital video recorders (DVRs), the other being the digital video recorder from ReplayTV, which was introduced at almost the same time. ReplayTV (founded by Anthony Wood, the same guy who later founded Roku) was sued over some of the functions it offered, and it never recovered from the legal entanglement. TiVo survives to this day. Nevertheless, the acronym “DVR” is recognized as the defining device of early 21st-century television viewing, while “TiVo” is fondly recalled in some circles as having been a verb for a few years.

In the early 1990s, TiVo cofounders Jim Barton and Mike Ramsay both worked at Silicon Graphics Inc. (SGI), where they were each hip-deep in the digitalization of video. Ramsay was selling SGI workstations to Hollywood studios for

advanced graphics effects. Barton was on the SGI team that supported Time Warner Cable's Full Service Network interactive TV experiment, which ran from November 1994 to May 1997. After they both left SGI, they met up and decided to create a company together.

Because of their backgrounds, they both knew that video digitalization was creating opportunities for startups. At the time, people were batting around the concept of a home gateway that would manage and direct data flowing into a house. Barton himself had pondered it in connection with the Full Service Network experiment. The upshot was that it was clear there were going to be multiple sources of digital content coming into the home, and it would probably be useful to have a single central device to manage all the traffic in and out, distributing signals to the appropriate places—video to the TV in the den, Internet to the computer in the home office. And someday all sorts of electronic devices might be connected—refrigerators and power meters and who knew what else. Barton and Ramsay decided to make a home gateway.

But as they talked to their contacts about the idea, the responses weren't enthusiastic. In fact, 20 years later there still isn't much of a market for that kind of a gateway. "Then someone told us—I don't even remember who—but they said,

‘What I’d really like to be able to do is pause the TV and go the bathroom.’ And I realized: I know how to do that!” Barton says in an interview.

There was already high-end digital video production equipment that stored data on hard drives. The idea was to base a consumer device on a hard drive—and also allocate buffer space on the drive. With a buffer, the device would be able to play and record simultaneously. You could do that with a video cassette recorder, too, but all sorts of so-called trick plays that were impossible with a single VCR were eminently possible with a single hard drive. Including pausing to let people go to the bathroom.

Hard drives had a characteristic that was going to be a problem for TiVo, however. Every time data is stored, the drive needs to locate physical storage space for it. But as time goes on and more data gets recorded and erased and recorded over, free spaces get smaller and smaller. The drive ends up breaking new incoming streams into smaller and smaller segments and scattering those snippets more widely all over the disk’s surface. The bottom line is that data gets fragmented, and accessing it becomes more time consuming.





Playback Was the Hitch: Ted Malone, TiVo's vice president of consumer products and services, recalls that playing back data stored on a hard disk presented a substantial technical challenge. PHOTO: TIVO

Data fragmentation wasn't a major problem for computers running spreadsheets or word processing programs, but it was going to be one hell of a problem when dealing with video.

Disk drives mount their read heads at the tip of a delicate arm that skitters above the surface of the storage disk seeking each bit of requested data, and the mechanism simply wasn't fast enough to reconstitute fragmented video data in a steady-enough stream for the video to play smoothly. TiVo needed to build a system that recorded and played back data in a controlled manner, according to Ted Malone, currently TiVo's vice president of consumer products and services. (Malone is in his second stint with the company; he was originally hired when the company was developing its first DVR.)

In an interview, Malone discloses that TiVo hired a team of engineers away from National Semiconductor to build an application-specific integrated circuit that would sit between the computing system and the hard drive to “basically unfragment in real time”—that is, manage write and read requests to minimize the scattering of data and, therefore, the seeking. This real-time defragmentation assured that the DVR would continue to operate smoothly over the life of the system, Malone says. Eventually, drives would get so fast that fragmentation was no longer a problem, but that was years away.

The system would also need an encoder, an integrated circuit that would take incoming analog video and convert it to

digital, for storage on the hard disk. To keep the cost down, it would have to be a single-chip encoder, Barton says, but no such thing existed. The only encoders available were multichip products for encoding into a compression format called MPEG-1 (MPEG stands for Moving Picture Experts Group).

“Just a few months after we set up the company, Sony announced an MPEG-2 encoder,” Barton recalls. It was a single chip at a reasonable price. At about the same time, IBM debuted its PowerPC processor, and TiVo decided to use that as the machine’s central processor. The company sourced its drives from Maxtor. “We got it all to a cost that was not where we’d like it to be, but it was close to a consumer price point,” Barton adds.

The other big technological decision was to use the Linux operating system rather than the most obvious choice, Windows from Microsoft. “That’s not talked about a lot—TiVo was the first consumer electronics product to run on Linux,” Barton declares.

It was a risky choice. Linux had its fans in the computer industry, but it was still new then and regarded with suspicion. Nevertheless, to TiVo it seemed like the safer choice. “We just didn’t want to have to wait on Microsoft to fix things,” Barton

explains.

The upside of using Linux—an open-source OS—was that TiVo could modify it if necessary. The downside was that modifying it was definitely going to be necessary. But then Linux couldn't do what TiVo wanted it to do—function as a real-time OS. “There was RT Linux [real-time Linux], but it was very thin, it didn't have a lot of capabilities, and it was too complicated to work with,” Malone says. “TiVo made the decision to take regular Linux and ‘fix’ it so it was fast enough to do what we wanted it to do.”



TiVo's Twosome: Jim Barton (left) and Mike Ramsay (right) founded TiVo after meeting at Silicon Graphics, where they both worked on video-related projects in the 1990s. PHOTOS, LEFT: J. SCIULLI/WIREIMAGE/GETTY IMAGES; RIGHT: PAUL SAKUMA/AP

Barton adds, "I remember early on, we were talking to some people at Sony, we were discussing us becoming an OEM [original equipment manufacturer] for them. We had a meeting in this big conference room. One whole wall was windows, and on the other wall there was a TV playing. They were pounding the table, yelling at us, 'You can't do this with Linux! It's not a real-time operating system!' I showed them the TV playing behind me and told them, 'That's Linux.' It all proved out in the end, but yeah, it was a big deal back then."

Malone explains that engineers elsewhere in the industry appreciated the improvements TiVo made in Linux. That may be so, but TiVo restricted access to its version of the code, and that rubbed some Linux adherents the wrong way. Some called the licensing approach that TiVo took "tivoization"; it was not meant as a compliment. Then Linus Torvalds, the godfather of Linux, allowed that there might be a legitimate rationale for tivoization, and the whole controversy blew over.

The TiVo was introduced in 1999. The first model had a maximum storage capacity of 14 hours, and it sold for US

\$499. That was followed by a dual-drive 30-hour model for \$999. Each TiVo came with a distinctively peanut-shaped remote control that was a model for ease of use. Customers also had to pay a one-time fee of \$199 for a lifetime subscription or subscribe to the TiVo service for \$9.95 per month or \$99 a year. That got subscribers access to a networked service that included a well-designed program guide and a “Wish List” that allowed viewers to set their TiVos to record things in advance, for example, every “Seinfeld” episode, or all televised St. Louis Cardinals games, or a *Star Wars* marathon.

TiVo had other advantages over competing video recording technologies, too. Let’s say a VCR owner programmed her machine to record a show. Let’s further say that she decided to watch the show while it was still being broadcast—but she missed the beginning. With a VCR, she had only two options. She could start viewing the live broadcast in progress or she could wait until the broadcast (and the simultaneous recording of that broadcast) was over and then watch the recorded version from the beginning. Okay, sure, middle-class problems. But bear in mind that many popular shows started at 9 or 10 p.m. or later. So if she wanted to watch the whole show after it was recorded, starting from the beginning, it would mean staying up into the wee hours.

With DVRs, viewers getting to their TVs however many minutes late could start watching from the beginning immediately. Viewers could also pause a live program, and then restart it right where they left off. They could perform instant replay—go back to an earlier point in a show and watch a scene over (and over) again, then resume watching the rest of the program live in progress. TiVo viewers also quickly figured out they could exploit those same capabilities to fast-forward through commercials in not-quite-live TV. That's the feature that makes a video recorder of any type popular.

Once one of these features was employed, the viewer thereafter was really watching the recorded (or buffered) version. At that point the word “live” was obviously inaccurate, but for viewers, the experience was pretty much the same as watching live TV. In aggregate those features represented a huge leap in time-shifting capabilities.

The fact that the TiVo was networked allowed the company to log viewing behavior at a level of detail never before possible. When Janet Jackson experienced a “wardrobe malfunction” that bared most of her right breast for 0.5 seconds while singing with Justin Timberlake during Super Bowl XXXVIII's halftime show, TiVo was able to state precisely how many

times TiVo users had replayed the moment. (It was a big number indeed.)

The people who used TiVos tended to get evangelical about the device. TiVo's problem, Barton and Malone agree, is that it was (and still is) incredibly difficult to get potential customers to use a TiVo long enough to appreciate that it's more than just a VCR with additional storage.

That perception also made it hard to justify the subscription fee, which could seem duplicative. Well over 60 million Americans were already paying a monthly subscription for cable TV. Why pay for two TV subscriptions? Worse still, even if you were willing to pay for two TV subscriptions, TiVo didn't work with cable. You couldn't record cable-TV programs.

The company sold 48,000 TiVo DVRs in 1999. Thereafter, TiVo's sales averaged a few hundred thousand per year at most. Subscribership from direct sales peaked at 1.7 million in 2008; it's now at about 1 million. The TiVo box never quite took off, but the concept caught on in a very big way.

When TiVo first started, the two direct-broadcast-satellite (DBS) companies, Dish Network and DirecTV, were also new,

and they needed something to differentiate themselves from their well-established cable rivals. DirecTV decided the DVR would be a good differentiator; it collaborated with TiVo on a combination satellite receiver and DVR that became popular with DirecTV subscribers. To compete with DirecTV, Dish Network was compelled to develop a similar receiver/DVR too, which it sourced from its parent company, EchoStar.

TiVo wanted to collaborate with cable companies in the same way it was working with DirecTV, but cable operators wanted nothing to do with TiVo. TiVo was shut out of the enormous cable market. The friction between TiVo and the cable industry got complicated and bitter.

With limited prospects for new markets, TiVo had few business options. Among its assets was a rich patent portfolio covering its numerous innovations; in 2004 TiVo sued EchoStar for patent infringement and won a \$500 million judgement. The company then embarked on a campaign of suing others for patent infringement, going after DVR manufacturers and service providers alike. Cable companies had eventually responded to DBS competition by getting their set-top box vendors to integrate hard drives and DVR functionality into their set-top boxes too; Internet Protocol TV providers (these were mostly traditional phone

companies) had done likewise. There were a lot of potential patent infringers for TiVo to go after. And they did.

By one estimate, TiVo made \$1.6 billion dollars enforcing its patents through 2013. Having established an apparently unassailable patent position, TiVo then began to license its technology. Today, there are roughly 60 cable and Internet Protocol TV service providers—mostly midsize companies—scattered all around the world that use set-top boxes integrated with TiVo-branded DVR functionality. Many of them bear the label “powered by TiVo.”

As of 2019, TiVo was still making and marketing its own DVRs, and they still weren’t selling all that well. It doesn’t matter. It was TiVo technology, not the TiVo box itself, that was a triumphal success. The real legacy of the TiVo box was the DVR technology that let people watch TV on their own terms.