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News & Highlights

Legacy Information Technology Compounds Pandemic Pain

Mitch Leslie

Senior Technology Writer

When the coronavirus disease 2019 (COVID-19) pandemic exploded in the United States in March 2020, the US Congress passed a bill to provide extra unemployment benefits to the record numbers of people who had lost their jobs. The task of disbursing the money fell to the individual states, but in more than 20 of them, aged computer systems struggled to handle the surge in claims, delaying payments to many financially strapped residents by weeks and even months [1,2].

In the state of California, USA, a team of expert investigators found that although the employment department's information technology (IT) system—the core of which is an International Business Machines Corporation (IBM) mainframe computer—performed fairly well, it was partly to blame for the delays, which were some of the longest in the nation. The system's limitations slowed payments and complicated the unemployment claims process in several ways [3]. For instance, even making claims was difficult for many, because the filing website was not compatible with mobile phones or accessible by people with disabilities [3]. And the field for home address in the database that records applicants' information was too short, so claims from people with long addresses required slower manual processing.

The difficulties many US states encountered with their unemployment payments highlight how old, clunky, and inefficient many essential IT systems are. Aged IT systems are also to blame for a large share of banking outages, airline delays, and security breaches [2]. "These problems are constant," said David Eaves, a lecturer in public policy at Harvard University in Cambridge, MA, USA. "Our track record at modernizing is very poor."

Yet there is no simple remedy for outdated IT. Replacing or renovating legacy hardware and software is expensive, time-consuming, and risky. One survey of corporate leaders found that 74% of IT upgrades at their companies had failed [4]. Some novel approaches, such as deploying artificial intelligence (AI) to revamp outmoded software [5], may make overhauls easier. But in some cases, "the systems reach a size when they cannot be modernized," said Harry Sneed, an assistant professor of software engineering at Dresden University of Technology in Germany.

Experts have long warned about the problem of aging IT. A 2016 report by the US Government Accountability Office (GAO) identified the ten systems at federal agencies that most needed upgrading [6]. The Department of the Treasury's master files that hold data on US taxpayers and businesses, which are now more than 60 years old, were the most ancient. But the most disturbing example came from the Department of Defense, which controlled the country's nuclear weapons with the help of a 1970s IBM Series/1 computer (Fig. 1) that still used 8 in (1 in = 2.54 cm) floppy disks [7].

That system has since been revamped so that it no longer requires the long-obsolete disks (Fig. 2) [8], and the Department of the Treasury is now updating its taxpayer records [9]. Still, the most recent edition of the GAO report, published in 2019, identified another six vital federal government systems that were more than 30 years old [10].

Other examples of legacy IT abound. The world's financial system depends on the programming common business oriented language (COBOL), which handles 95% of automatic teller machine transactions [11]. The language was introduced in 1959, and many of the programmers who know it are about the same vintage—their average age is now around 60, although interest in COBOL has recently surged [1,12]. And Japan's government is so reliant on out-of-date technology, including fax machines, that it recently launched a new agency to speed modernization [13].

There are numerous reasons to replace elderly technologies. For one thing, old systems are expensive to run. In 2019, the US government spent more than 80% of its IT budget of roughly 90 billion USD to maintain existing systems, many of which are legacy technology [10]. Old hardware is slow and lacks modern capabilities. Dinosaur machines like the IBM Series/1 at the Department of Defense have far less computing power than a single modern smart phone [14]. As the recent state unemployment pandemic-related

Fig. 1. The US Department of Defense uses an IBM Series/1 computer from the 1970s to help control the country's nuclear arsenal. Until 2019, the computer still needed 8 in floppy disks. Credit: US GAO (public domain).

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Fig. 2. Now legacy technology, the 8 in floppy disk (rear) was an information storage breakthrough, holding 80 kb of data, when it was commercially introduced in 1971. Its 1980s successor, the 3.5 in floppy disk (left), is now also obsolete, replaced by universal serial bus (USB) data keys (bottom right) that today can hold many gigabytes of data. Credit: Wikimedia (public domain).

problems revealed, aged systems can also be less flexible during a crisis. In 2017, the state of Massachusetts shifted its unemployment system to the cloud, allowing it to respond faster when COVID-19 put many people out of work [15]. States are required to deliver recipients' first payments within three weeks, and Massachusetts met that deadline 68% of the time, whereas Florida, which was using older technology, succeeded only 28% of the time in the first months of the pandemic [15].

Modernizing out-of-date systems seems like an obvious strategy, yet organizations often stick with legacy tech. One reason is that, in many cases, it still does the job. "There are billions of lines of code that work, day in and day out," said Jon Pyke, chief executive officer of the software upgrade company CIMtrek in Woodham Surrey, UK. "Only when unprecedented events occur do things fall apart." Moreover, users are often more productive with a mature system they are familiar with, said Sneed.

But probably the biggest reason aged IT systems remain in operation is the many obstacles that block their modernization or replacement [2]. The costs to upgrade are often prohibitive, the work can be disruptive, and the odds of success are low. In addition, corporations and governments often lack incentive to begin these projects, said Eaves. For example, politicians are reluctant to push for overhauls of government systems, he said. Given that many upgrades take more than a decade, they know that they probably will "not get the credit or benefit but will face the criticism for delays or failure." IT managers can be similarly hesitant to back upgrade projects, Sneed said. "Their jobs are on the line."

The complexity of legacy systems also makes them difficult to overhaul. Software provides a good example. Much of the world's legacy code is a mess, said Sneed, who has worked on more than 70 software modernization projects for private and public sector clients, including Volkswagen and Swiss Bank. Over the years, many software systems have grown to enormous size, and they are riddled with non-functional or redundant code. Between 1979 and 2017, one of Sneed's corporate clients saw its software system expand from 2 million lines to 11 million lines. A related problem is poor documentation. Sneed recalled that almost every organization he consulted for had "a room full of dusty notebooks" that supposedly recorded how its software operated. But these records were rarely up to date, and the original programmers had usually departed by the time an upgrade was under consideration.

One solution for problematic code, according to Sneed, is to replace it with off-the-shelf, purpose-written software. These programs can be cumbersome, however, and often "users are forced to work around them instead of with them," he noted. Organizations may also decide to retain the original software and add a new interface that provides capabilities today's users expect, such as friendly, graphics-based access. But this option does not correct any problems of the underlying system. In the end, rewriting ancient code may be the "least bad" option, Sneed concluded. But before programmers can recast old software in a modern language, they may have to analyze millions of lines of code to figure out how it works and what functions it enables. Revising old software is such an enormous task that computer giant IBM has its Watson AI system working on the problem [5].

Despite all the obstacles, there are some IT modernization success stories. For example, the northeastern European country Estonia has received praise for adopting a smart IT strategy [16]. The country had to start from scratch when it became independent in the early 1990s, allowing it to be more innovative. Taking a preventive approach to legacy IT, Estonia replaces all critical systems before they are 13 years old [16]. For some organizations, an agile approach, in which they develop and roll out modules that perform certain operations, may work better than organizing an upgrade as a massive project with a single launch, said Eaves. The latter "waterfall" projects "have a high propensity for failure," he said.

Although the unemployment crisis triggered by COVID-19 continues, some out-of-work people are seeing the benefits of IT upgrades. In January 2020, the state of Colorado launched its modernized system, which for the first time will allow the state to communicate with recipients through e-mails or texts [17,18]. But other beneficiaries will have longer to wait. Oregon, the last US state to send out supplementary unemployment payments in 2020, has only just begun to upgrade its system, with the new version not expected online until at least 2025 [19].

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