guessing the encryption keys until the right ones are found. The intended use for the software was to enable **Linux**-based computers to play DVDs, not to enable illegal copying. However the fact remains that the DeCSS software is, indeed, an encryption breaker.

Unlike the Napster case, where the guardians of intellectual property had a clear target, once the DeCSS source code was released onto the **Internet**, a suit against Johansen would be too late—although he was, nevertheless, subject to arrest and interrogation. The Motion Picture Association of America (MPAA) focused on those who provide access to the source code, filing suit against the hacker Webzine *2600: The Hacker Quarterly*, to force them to remove the DeCSS source code from their site *and* to remove links that send users to other sites that provide the code. In August 2000, Judge Lewis Kaplan (1944–) agreed that *2600* was in violation of the DMCA and ruled in favor of the film industry.

Many aspects of Judge Kaplan's ruling were of great concern to activists such as the EFF. For example, will future programmers be held responsible for unforeseen illegal uses of their software? What are the ramifications of making an **HTML** link illegal? Further, what is the point of doing so when *2600* was able to get around the injunction simply by listing the links as text files, so that users could copy the addresses into their browsers by hand. Finally, perhaps the most pressing question, is source code protected by the First Amendment of the U.S. Constitution? In the case of ***Bernstein v. U.S. Department of Justice***, the court ruled that source code is a form of speech and is therefore protected. Judge Kaplan's ruling veers sharply in the opposite direction, and unfortunately, the DMCA offers no clear-cut guidance on this point.

Free-speech activists have parodied the ruling, presenting the offending source code in a variety of apparently nonoffending forms: DeCSS can be found in the form of a greeting card, a T-shirt, a song, and a dramatic reading, among many other interpretations. Meanwhile, the MPAA has continued to pursue other DeCSS providers, and in a separate case, the company that licenses the CSS software recently identified more than 500 infringing Web sites. It is a certainty that this multifaceted, complex case will not be entirely resolved for some time, and the DMCA will continue to be a hotly contested piece of legislation.

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—*Hilary W. Poole*

Digital Subscriber Line

Digital subscriber line (DSL) is an upgrade of the existing telephone system that allows high-**bandwidth** transmission of data over ordinary telephone lines. In asymmetric DSL (ADSL) there is less bandwidth allocated for the flow of information in one direction than the other. The advantage of DSL over other competing high-bandwidth services is the current availability of billions of phone lines.

DSL works by allowing the telephone central office to send digital data directly to the home user. In the traditional telephone system, digital data arriving at the central office through the **backbone** are converted into an analog wave (one that can be "heard"), which is sent to homes. This analog signal is then transformed again into digital data by the user's **modem**. DSL removes this digital–analog–digital bottleneck by allowing full digital communication through the phone line. Different technologies are used to transmit the digital signals, one of them being *discrete multitone technology* (DMT).

The existing telephone system has been optimized for the transmission of voice, but higher rates of data transmission are possible. In the 1980s **Joseph W. Licklider** (1915–90) proposed the use of high transmission velocities over the comparatively short distance from each home to the telephone central office. These offices are interconnected using optical fiber, so they can provide a high-speed backbone of several gigabits per second for the network.

By the early 1990s, several companies had developed the first DSL prototypes, which could transmit nearly 1 megabyte per second (Mbps) over a distance of 4 kilometers. However, the switches at the central offices must be modified to deal with the new transmission form. Since the home user usually consumes more information than he or she provides, the ADSL technique allocates up to 6 Mbps for the downstream data (flowing to the consumer) and only 0.6 Mbps for the upstream signals. ADSL can also combine voice and data transmissions over the same line. The home user needs a filter (signal splitter) to separate the data from the voice signal coming from the line. A variation of ADSL that allocates less bandwidth to the users (1.5 Mbps in the downstream channel) is known as G.Lite. It is cheaper to install than DSL and should make subscriber lines more popular.

The advantage of DSL and ADSL over alternative technologies—such as **cable modems**, which transmit data using cable television lines—is that the user has one channel all for him or herself. Cable modem users, by contrast, are typically connected to a common carrier, and they compete for the use of the bandwidth. Projections show that the number of DSL users will soon surpass the number of cable modem users, but there is plenty of room for both technologies to coexist for several years, together with high-bandwidth wireless services, until the economics of the new transmission media are fully worked out and one technology is adopted by a majority of users.

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— *Raúl Rojas*

Dijkstra, Edsger W.

1930–

Dutch Computer Scientist

Edsger Dijkstra has been one of the most important contributors to the science and art of programming. In the late 1950s he was a major participant in the development of **ALGOL**, an important and elegant high-level programming language. He has contributed greatly to the understanding of the structure, representation, and implementation of programming languages and they way they are used. With Ole-Johan Dahl (1931–) and **C. Antony R. Hoare** (1934–), he was a leading proponent of **structured programming** (a term he coined) in the late 1960s and 1970s, having published a short but influential paper entitled **"GO TO Statement Considered Harmful"** in 1968.

In his youth, Dijkstra originally considered studying law, but because he had scored well in scientific subjects, he decided to opt for theoretical physics instead. At the University of Leiden he undertook the Candidaats Examen in Mathematics and Physics in 1951. In the summer of that year, he attended a summer school on programming at the University of Cambridge in England, and in March 1952 he started working part-time under A. van Wijngaarden at the Mathematical Center in Amsterdam, where his interest in programming grew. Here he was to meet another programmer, M. C. Debets, who later became his wife. He obtained his Doctoraal Examen in theoretical physics in 1956 and his Ph.D. in 1959 at the University of Amsterdam. In 1962, Dijkstra became a professor of mathematics at Eindhoven.

In 1956, Dijkstra devised the *shortest-path algorithm,* sometimes also know as *Dijkstra's algorithm,* to demonstrate the power of the ARMAC computer then at the Mathematical Center in Amsterdam. This algorithm finds the best route to travel from a specified vertex to other vertices of a connected weighted graph. He also used this to solve the problem experienced by the ARMAC design engineers of how to minimize the amount of wiring needed. This was dubbed the *shortest subspanning tree algorithm.*

In the early 1960s, Dijkstra applied the idea of mutual exclusion to communication between a computer and its **keyboard**. He developed the concept of *semaphores* and used the letters P and V (standing for Dutch words) to represent the two operations needed in the mutual exclusion problem. This technique has become important in computer processors and memory systems since 1964, when **IBM** first used it in its widely adopted 360 architecture.

Dijkstra recognized a problem with which many computer engineers are faced that he formulated as the *din-*