

## AN UPDATE ON ELECTRONIC COMMERCE

Since my article "Atomicity in Electronic Commerce" appeared last year, new developments in electronic commerce have been coming thick and fast. Here are some of the more salient changes as they relate to my original paper.

As the reprinted article mentions, even in 1994 total electronic commerce (including business-to-business, financial and consumer) exceeded \$245 billion. We've all noticed the tremendous expansion of financial services available electronically, but especially dramatic has been the growth in consumer-level electronic commerce. Estimates vary on the dollar volume of consumer-based electronic commerce sales in 1997, from Forrester Research's \$2.4 billion to American Express's estimate of \$4 billion to \$6 billion. IDC predicts that consumer sales will reach \$20 billion by the end of 1998.

And indications point to widespread acceptance of electronic commerce by the public. Here are just a few examples: A study by Ernst & Young of a shopping cart of consumer goods indicated that in 90% of all cases, the best prices were found on the World Wide Web. Dell now sells \$3 million worth of computers each day from its Web site. Egghead Software has decided to abandon its retail stores and switch to a Web-only presence. And 10% of all flower orders received by 1-800-FLOWERS arrive via the Web.

Nonetheless, the vast majority of consumer-oriented elec-

tronic commerce is transacted by fairly simple means — usually, credit card numbers exchanged via SSL (or, surprisingly often, in the clear). As I discussed in my article, this has negative implications for both atomic transactions and for microtransactions. The result is that the sale of information goods over the Web has been inhibited, and electronic commerce microtransactions are rare.

When microtransactions are permitted, they usually take place in the framework of subscriptions to a service. For example, *The Economist*, a financial newsmagazine, sells archived articles to subscribers. The old articles cost \$1 each, but a user must purchase a minimum of \$10 in credits since individual microtransactions are not supported at that Web site. Many researchers, including me, believe that highly atomic purchases and microtransactions represent vast markets to be mined.

### Atomic Protocols in the Marketplace

What about the two highly atomic protocols — NetBill and cryptographic postage indicia — that I described at length in my article? Both of these systems have become commercialized. The NetBill project has been completed at Carnegie Mellon, and the technology has been licensed to CyberCash, which uses certified delivery in its CyberCoin product. (For

more details, see <http://www.cybercash.com> and <http://www.netbill.com>.) Cryptographic postage indicia are now formally approved for use in the U.S., as part of the U.S. Postal Service's Information Based Indicia Program. On March 31, the first official cryptographic indicia were applied to envelopes in a ceremony at the Smithsonian National Postal Museum. E-Stamp Corp. is the first vendor producing cryptographic postage indicia. For more information, go to <http://www.usps.gov> and <http://www.e-stamp.com>.

The SET standard discussed in my article has continued to develop slowly. SetCo (<http://www.setco.org>) has assumed responsibility for maintaining the SET standard. SET has not been widely deployed, however, and the standard has been criticized in *The New York Times* and elsewhere for its complexity and ambiguous security properties. For example, in SET a key design issue is to prevent a merchant from obtaining, and perhaps improperly using, a consumer's credit card number, but SET has a mode in which credit card numbers are explicitly sent back to a merchant. Today, SET's security model is not clear, and that will impede its acceptance. SetCo has an opportunity to address many of SET's shortcomings in the new SET-2 standard.

DigiCash vendors have dramatically lowered the cost of

providing DigiCash service. Mark Twain International Markets in St. Louis, for instance, has reduced the cost of providing a single DigiCash transaction to 1.9% of purchase price and a \$50 annual fee, making its system comparable to a credit-card transaction system. Mark Twain has not released detailed information about the costs of processing those transactions, so we can only guess at the complete cost of DigiCash transactions, but evidence indicates that they are substantially more expensive than other forms of electronic commerce. (See <http://www.digicash.com> and <http://www.marktwain.com> for more information.)

A number of new electronic commerce systems have been proposed. One of the most interesting is Digital Equipment Corp.'s MilliCent system for microtransactions (<http://www.millicent.digital.com>). While MilliCent provides only money atomicity, it is one of the most aggressive uses of microtransactions to date.

For more detailed information on developments in electronic commerce and related areas, take a look at the extensive set of links maintained by Hal Varian at UC Berkeley (<http://www.sims.berkeley.edu/resources/infoecon/>). Additional information, including technical details of the systems discussed in the article, is available at my Web site (<http://www.cs.cmu.edu/~tygar/>).