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An Electronic Database Delivery System

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While much public discussion has focused on how businesses can profitably use the Web and Internet, electronic commerce has not yet become a true element of the business model. The question of how to make money on the Web has no clear answer. Industry and academics should really be asking, "How can we use the Web and Internet to control costs and save money?" This question lends itself to many more solutions if we consider the cost benefits of improving customer service, reducing time to market, and improving the final product—all of which require initial investment but yield significant payoffs in the long run. These solutions lend themselves very well to Web-based implementation.

Businesses have begun testing several models on the Web. In general, these are based on advertising, fees, or transactions. An advertising Web site, for example, offers an advertisement as part of the screen. Many search engines, such as Infoseek (www.infoseek.com), include advertisements with the information they deliver. Fee-based sites, which charge users to retrieve information, have not done well. Slate.com is one of several fee-based sites that have indefinitely deferred fee implementation. *The Wall Street Journal* has been able to offer a fee-based site, while *The New York Times* has site visitors register but does not charge them to use the site. Transaction-based sites have begun to succeed, however. Apparently, commerce on the Web succeeds when the offerings include timely information and services not easily available elsewhere. People seem willing to pay for convenience or privileged information—as with any business, exclusive rights and services promote success.

By using the Web to deliver goods and services, businesses hope not just to make money but also to enhance their relationships with customers and improve sales, customer satisfaction, and brand identification. However, while new products can easily be tailored to new delivery environments such as the Web, tried-and-true products, with their substantial customer base, remain largely untouched by new technology.

Creating a new delivery system

A strong relationship exists between AlliedSignal's Center for Process Improvement (CPI) in Teterboro, New Jersey, and the Advanced Telecommunications Institute (ATI) at Stevens Institute of Technology, Hoboken, New Jersey. ATI, which comprises electrical engineering and computer science faculty and graduate students, applies emerging technologies to business problems, focusing on the interaction of telecommunications, database design, and multimedia systems. AlliedSignal's CPI had been working closely with the Commercial Avionics group of AlliedSignal Aerospace and developed a project for ATI to tackle.

The problem: Inefficient product delivery

The problem presented to ATI involved providing monthly updates of a Global Positioning System (GPS) database. AlliedSignal's Commercial Avionics group sells a variety of GPS products that help commercial and private pilots navigate their aircraft (Figure 1, next page, shows an example).

EDD on the Web

To see AlliedSignal's EDD site as delivered, go to www.ati.stevens-tech.edu/allied/cas.

The site in production resides at www.alliedsignal.com/aerospace/flightdeck/gpsdatabase.

CyberCash is at www.cybercash.com.

Figure 1. The Bendix-King KLX-100 handheld GPS unit.

Central to the GPS product line is the navigational database that contains information on airports, navigation waypoints, special-use airspace, and other aviation information, including GPS nonprecision approaches. Every 28 days, these database changes must be shared with all GPS customers.

When this project began, AlliedSignal provided customers monthly updates by one of two means, following the industry standard: Customers signed up either for a cartridge exchange program or to receive a set of diskettes each month. This process required labor to take telephone orders, mass-produce cartridges and diskettes, process billing, and distribute updates via conventional delivery systems. Copy protection, a key concern for AlliedSignal, often caused compatibility problems once the materials were distributed. This project thus sought to improve the GPS update delivery system within a highly secure environment, improve customer service, and reduce delivery time.

Customers were unhappy with existing delivery means; many felt the standard five business days was too long. They also perceived the cost of receiving the updates as too high. As with any replicate medium, quality problems occasionally occurred. The task presented a volume challenge as well, with 55,000 updates sent out in 1996 and consistent, steep growth expected in this market. The project also had to reduce "lost time," measured from the product's creation to its delivery to the customer, which resulted from internal "shelf time" (time the prepared product spent waiting to move off AlliedSignal premises onto the customer site), traditional overland mail delivery delays, and billing-related delays.

ATI researchers thus faced a clear challenge: Could we develop a real-time delivery environment that would permit AlliedSignal's customers to visit a Web site and order, pay for, and receive the product in one seamless, highly secure transaction? What would such a system look like? How would it run? AlliedSignal was not interested in a speculative prototype; they wanted a functioning system within six months.

A solution: Web-based delivery

Most merchant Web sites permit visitors to register and sign up for mailings and other special promotional offerings. These small, inexpensive items can be easily replaced if lost. Mainstream firms are not actively selling and delivering goods and services over the Internet, however, for several reasons. First, many goods and services do not lend themselves to electronic delivery. Second, corporations remain acutely concerned about security.

Today's Web systems, however, are robust and distributed, and can be designed and deployed in ways not even thought of just a year ago. Sites such as www.amazon.com, a bookseller, let their customers order books, pay for them, and sit back and wait for delivery. The Amazon environment is comparable to the Electronic Database Delivery (EDD) system ATI developed for AlliedSignal, with a few notable exceptions:

1. The EDD system instantly delivers the latest navigational data online. There is no delay in receiving the product once ordered and authorized.

2. The EDD system "remembers" a user who returns within 28 days, recalling the date and type of the previous GPS database purchase.

3. The EDD environment integrates CyberCash, a commercial transaction provider, to approve all online credit card transactions.

4. The EDD product design includes many levels of security, including Netscape Secure Commerce Server, CyberCash transaction security, and AlliedSignal's own application-level security.

A distributed development process

Tom Henderson from AlliedSignal's CPI managed this project. The GPS application specification came from Olathe, Kansas, home of AlliedSignal's Commercial Avionics Systems Group, which contributed team members Kelly Dillard and David Goddard. The final application and associated servers would reside in AlliedSignal's Computing Technology Center (CTC) in Tempe, Arizona; Chuck Necker and Dan Tulledge represented CTC's interests. The Stevens Institute of Technology team consisted of a faculty member and two research assistants, Ranjit Deshpande and Ameet Kamath.

This group's size was common for a project of this duration and magnitude. Atypically, the team members never met face-to-face despite the implementation's complexity, involving more than 100 pages of specifications and adjunct team members from such AlliedSignal groups as Order Entry, Finance, Legal, and Marketing.

We coordinated project management through virtual group meetings including regular teleconferences and e-mail exchanges to support verbal discussions. We used the Web itself as a product proving ground. ATI always iteratively develops project deliverables whenever possible. In this case, we made a protected Web space available to team members for viewing the work in progress. This provided a beta test site for a selected group of users, and the feedback it generated helped all team members better understand the ongoing efforts and the projected result.

EDD system components

Major components to be developed included

1. the customer interface,
2. a maintenance interface,
3. database access,
4. product security,
5. transaction security, and
6. payment tracking and recall.

We used common Web development languages to implement EDD. We provided redundant security in several ways, specifically though the use of a database key and Netscape's Secure Commerce Server, and the CyberCash interaction.

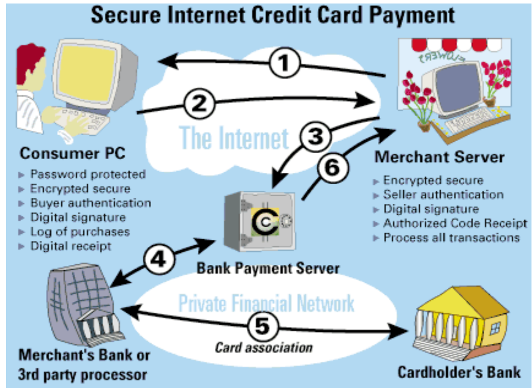


Figure 2. Secure Internet credit card payment process.

CyberCash (Reston, Virginia) and First Virtual (San Diego, California) were the two major players in electronic commerce when we began developing the EDD system. Early in development, ATI recommended incorporating CyberCash into the AlliedSignal site as the transaction processing vendor. First Virtual's software lets merchants accept transactions over the Internet and forward the transactions to financial institutions through a separate secure network. Because the "merchant," AlliedSignal in this case, did not want to become a banker, ATI favored the CyberCash solution. CyberCash supplies each customer with an electronic "wallet" that presents several payment options. A customer's payment information is passed to the merchant in encrypted form and then forwarded to the CyberCash computers. A separate network connects CyberCash to financial institutions to complete the transaction. Figure 2 illustrates this process.

Developing payment and customer interfaces

While not technically overwhelming, developing the interface from the EDD product to the CyberCash wallet and crediting the correct AlliedSignal accounts presented some logistical challenges. Once the EDD application had been properly associated with the CyberCash environment, and user interaction transferred from EDD to CyberCash and back to EDD after authorization, the development team had to wait for the debited moneys to be credited to AlliedSignal's accounts, signifying the financial loop's successful construction. It took a while, but the funds did eventually arrive, and kept arriving once the first moneys had flowed in.

We faced several challenges developing the financial transaction path for the first deposits, however. The most significant design challenges came from the database environment. We origi-

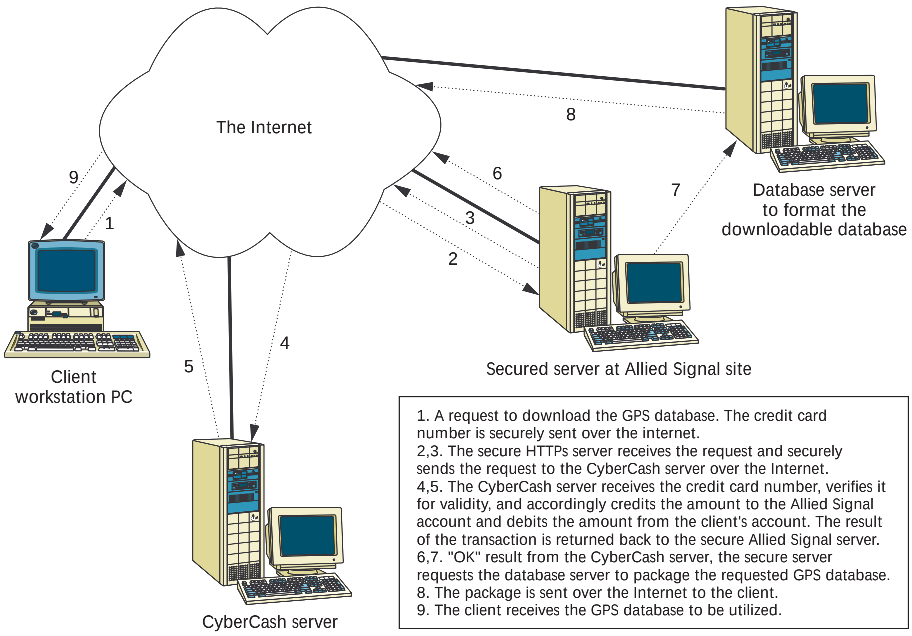


Figure 3. EDD process diagram. (Artwork by Huzaifah Basrai.)

nally intended the system to deliver a self-extracting executable file to the customer; however, AlliedSignal's Solaris server requirement made this impossible. Creating a self-extracting archive for an Intel-based machine on another architecture (such as Sparc) is possible, but at the time we had no tools readily available to accomplish this. We could have written or licensed one, but either would have been too time consuming and costly; hence, we chose not to deliver self-extracting files. Additionally, database delivery requires delivering a sequence of files; we identified and prepared that sequence for delivery programmatically using a script.

The EDD system supports a variety of products, each with different delivery requirements. To further enhance customer service, ATI implemented the ability to recall whether a customer has purchased an update within the last 28 days; if so, the update is provided at no additional fee. (The system makes allowances for erroneous downloads.)

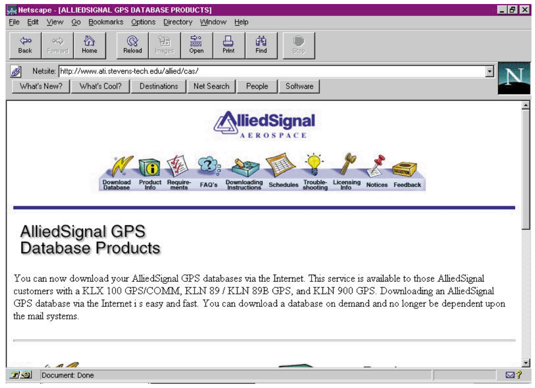


Figure 4. Initial EDD screen, showing instructions and available services.

Site operation

The resulting site works as follows, illustrated in Figure 3:

1. A customer visits the Web site (shown in Figure 4) and selects the desired product from the Database Selection screen (Figure 5). Pull-down menus help identify the products available (Figure 6). A database key, download method, and payment method also appear.

2. The request is sent to the AlliedSignal Web Server, which processes the order and the payment method. If the user requests CyberCash, he completes the CyberCash Wallet, which is forwarded to the CyberCash system. The approval is returned to the AlliedSignal Web Server. If the customer is using an existing AlliedSignal account or has already paid, the information is forwarded to the AlliedSignal Web Server.

3. The AlliedSignal Web Server forwards the request to the EDD Application, which prepares the database request response. The correct version of the database is selected, assembled, packaged, and forwarded to the Web Server for delivery to the end user.

Results and customer feedback

AlliedSignal's customers have responded very positively to the site. Pilots need 24-hour, seven-day global access and especially appreciate the "on-demand" availability of this information. What once took five days—ordering and receiving database updates—now takes less than 30 minutes. The site has also eliminated all labor costs for generating the monthly media mailing. The aviation industry received the product enthusiastically, citing it in *Flying* magazine in February 1997.

The site has been in operation since January 1997. AlliedSignal Commercial Avionics maintains the production site. Site volume continues to grow, and customer response is very encouraging; pilots in remote areas with unreliable postal

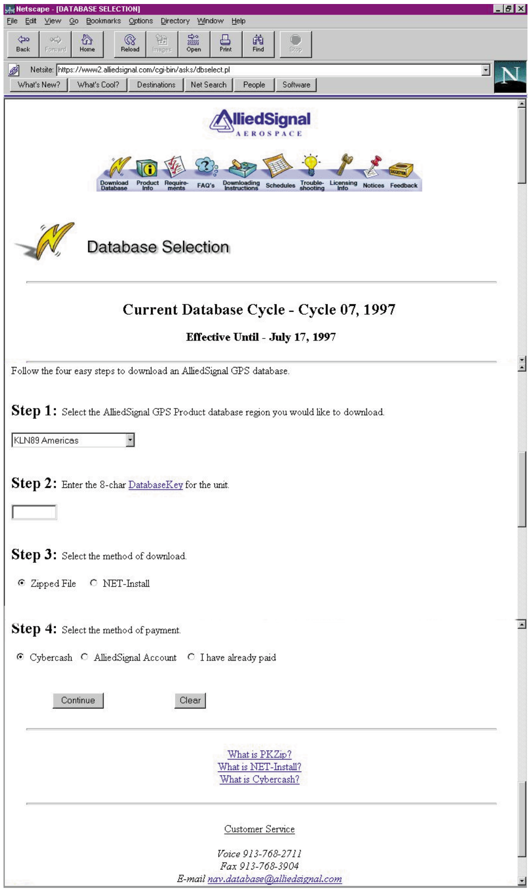
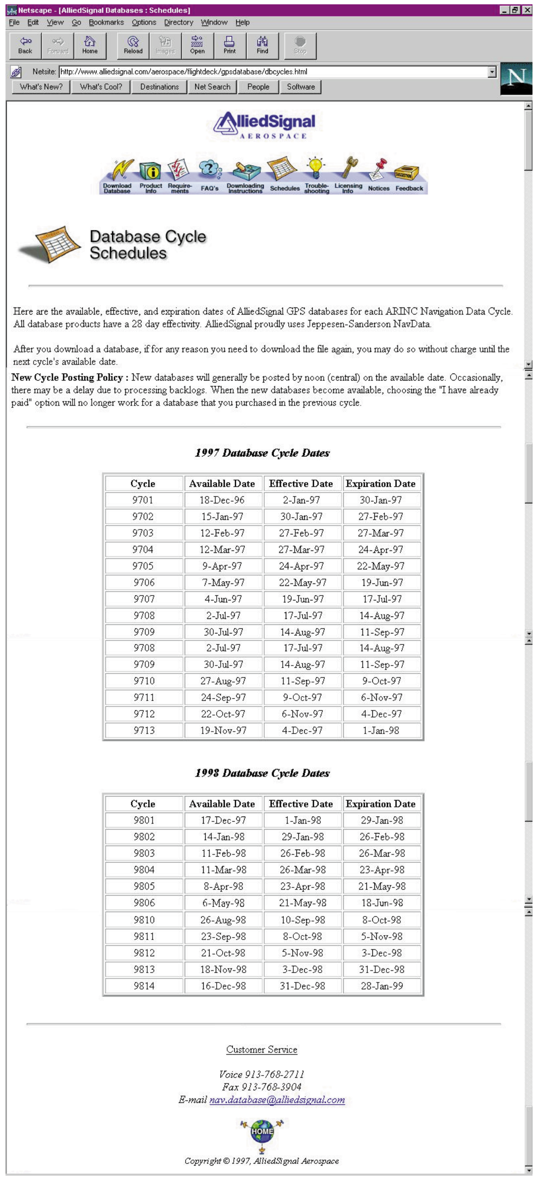


Figure 5. Selecting a product from the database selection screen.



1997 Database Cycle Dates

Cycle	Available Date	Effective Date	Expiration Date
9701	18-Dec-96	2-Jan-97	30-Jan-97
9702	15-Jan-97	30-Jan-97	27-Feb-97
9703	12-Feb-97	27-Feb-97	27-Mar-97
9704	12-Mar-97	27-Mar-97	24-Apr-97
9705	9-Apr-97	24-Apr-97	22-May-97
9706	7-May-97	22-May-97	19-Jun-97
9707	4-Jun-97	19-Jun-97	17-Jul-97
9708	2-Jul-97	17-Jul-97	14-Aug-97
9709	30-Jul-97	14-Aug-97	11-Sep-97
9708	2-Jul-97	17-Jul-97	14-Aug-97
9709	30-Jul-97	14-Aug-97	11-Sep-97
9710	27-Aug-97	11-Sep-97	9-Oct-97
9711	24-Sep-97	9-Oct-97	6-Nov-97
9712	22-Oct-97	6-Nov-97	4-Dec-97
9713	19-Nov-97	4-Dec-97	1-Jan-98

1998 Database Cycle Dates

Cycle	Available Date	Effective Date	Expiration Date
9801	17-Dec-97	1-Jan-98	29-Jan-98
9802	14-Jan-98	29-Jan-98	26-Feb-98
9803	11-Feb-98	26-Feb-98	26-Mar-98
9804	11-Mar-98	26-Mar-98	23-Apr-98
9805	8-Apr-98	23-Apr-98	21-May-98
9806	6-May-98	21-May-98	18-Jun-98
9810	26-Aug-98	10-Sep-98	8-Oct-98
9811	23-Sep-98	8-Oct-98	5-Nov-98
9812	21-Oct-98	5-Nov-98	3-Dec-98
9813	18-Nov-98	3-Dec-98	31-Dec-98
9814	16-Dec-98	31-Dec-98	28-Jan-99

Figure 6. EDD download cycle schedules, with effective and expiration dates.

service, such as sub-Saharan Africa and the Australian outback, particularly appreciate it. Due to customer demand, AlliedSignal has added GPS products not originally considered for support via this Web site.

The EDD solution permits a pilot anywhere in the world to instantaneously update a database. This newly defined delivery system will reduce the cost of the product to the customer by 20 to 35 percent. Concerns about the quality of the deliverables have also been removed, and overall customer service has improved.

We expect future delivery systems to follow the design approach outlined here. "Virtual" development teams, recognized only by their voices and ability to work together, will become more common as the Web enhances collaborative, but not co-located, work efforts. The Web's usefulness as a distribution mechanism has become apparent with ATI's other successful efforts in digital libraries, mobile agents, and distance learning, now joined by this electronic commerce example.

We cannot overstate the importance of emphasizing customer service, borne out in the production site by the inclusion of a feedback area and FAQs. In short, this project succeeded by keeping the customer in mind from initial development to final implementation. MM

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