# Information-Rich Commerce at a Crossroads:
Business and Technology Adoption Requirements

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Robert G. Fichman
Boston College
Wallace E. Carroll School of Management
452B Fulton Hall, 140 Commonwealth Ave.
Chestnut Hill, MA 02467-3808
Phone: 617-552-0471
Fax: 617-552-0433
fichman@bc.edu

Mary J. Cronin
Boston College
Wallace E. Carroll School of Management
350A Fulton Hall, 140 Commonwealth Ave.
Chestnut Hill, MA 02467-3808
Phone: 617-552-3925
Fax: 617-552-0433
cronin@bc.edu



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## Introduction

The Information Age is getting personal. Detailed individual profiles are being captured in digital form, and a variety of technologies are emerging to permit ubiquitous access to these profiles. What this means is that before long—no matter where we are, no matter what we are doing—we may have the option (or perhaps sometimes even the obligation) of having commerce of almost any kind mediated by computers that know and understand quite a bit about us. Or in other words, the day is approaching when most of our everyday transactions could become information-rich. The technology for information gathering and personal profiling, however, is charging ahead of business models for delivering profits to corporate pioneers providing information-rich services. At the same time, consumer concerns about privacy and fairness are on the rise. It is important to understand how emerging technologies relate to these business and personal issues, in order to evaluate the potential for pervasive adoption of information-rich commerce.

This article presents a vision for information-rich commerce and describes example applications and supporting technologies. It also discusses how this space seems to be evolving, and identifies key factors that will affect the diffusion and acceptance of pervasive information-rich commerce.

## A Vision For Information-rich Commerce

Information-rich commerce means that detailed data about consumers—their personal characteristics, preferences, capabilities, and historical actions—are used to customize transactions in ways that add value to consumers and providers. This customization could affect what kinds of products and services are offered (and at what prices), how value is exchanged, and what information gets shared with third parties.



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Information-rich commerce holds the promise of major economic benefits to businesses and consumers [5, 9]. For consumers, such commerce enables new kinds of electronic capabilities that otherwise would not be feasible. These include support for new kinds of convenient and secure payment options, assistance in finding the best products at the best prices, customization of marketing offers, and increased control over how digital profiles are stored and used. For merchants, it creates the prospect of more efficient marketing via existing channels, increased reach via new channels, increased consumer loyalty, and more efficient pricing structures [1]. Table 1 below draws some contrasts between information-poor and information-rich transactions in three example areas.

**TABLE 1: INFORMATION-POOR VS. INFORMATION-RICH TRANSACTIONS**

| | Information-poor | Information-rich |
|---|---|---|
| **Media** | • Consumers choose from a collection of traditional media (radio and TV stations, newspapers etc.) designed for a mass audience<br>• Payment method is determined largely by type of media rather than consumer preferences | • Consumers may subscribe to custom media feeds (talk radio, music, video, text news, etc.) designed to their preferences<br>• Form of payment (subscription, pay per use, advertising, etc.) is based on user preferences |
| **Marketing offers** | • Uniform marketing messages are sent to large audiences (via TV, radio, billboards, print)<br>• Most messages reaching consumers are irrelevant and unwanted | • Messages are tailored to the individual (e.g., ads are inserted dynamically based on user profile) who can act immediately accept an offer<br>• Individuals have some control over the level of intrusion of marketing messages (e.g., can chose to pay a subscription for media feeds in place of advertising) |
| **Communication Services** | • Consumers have separate accounts for email, voice messaging, text messaging, paging, etc., each of which passively accepts and stores all incoming communications | • Consumers have a unified messaging system that, based on knowledge of their personal schedule and present location, directs all incoming messages to the most appropriate accounts, after performing any necessary translations |

Information-rich commerce—in a primitive form—is happening now. In a single day a modern consumer might encounter dynamic internet ads (whereby ad content is determined based on recent web searches), customized product suggestions (based on preferences of similar consumers), tailored grocery



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coupons (based on scan card data), and suggestions on what TV shows to record (based on what the consumer has recorded in the past). These fragmented attempts to make commerce more tailored and intelligent just scratch surface of what will be possible in the near future.

Yet, despite its potential advantages, information-rich commerce raises important issues related to privacy and perceived fairness [3, 4]. Some consumers may resist the idea of widespread use of digital profiles, as indicated by the backlash following news of DoubleClick Inc.'s plan (since abandoned) to match up personally identifying information from off-line sources with web browsing profiles. Also instructive is the negative reaction, due to perceptions of unfairness, that greeted Amazon.com's experiment with offering different prices to different consumers based on their profiles (so called "dynamic pricing").

Even so, it is quite possible for transactions to be information-rich while still meeting community standards for privacy and fairness. Higher levels of privacy can be assured, for example, through the use of trusted intermediaries, sometimes called "trust brokers" [5] or "infomediaries" [8, 9]. These organizations gather and hold personal profiles with the consent of the consumer, and share these profiles on a non-identifying basis to solicit tailored offers on behalf of consumers. Also, companies are gradually discovering what forms of tailored pricing are acceptable in terms of perceived fairness. While Amazon.com's first attempt at dynamic pricing failed, a more recent program that offers a different set of personally tailored "Gold Box" discount offers each day, has been received favorably.

Baring some chilling legislation, information-rich commerce is here to stay in one form or another. The main issue is whether information-rich commerce will remain sporadic and fragmented—based on some random accumulation of



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magnetic stripe and chip cards, internet site registrations, web browsing profiles, POS transactions, etc.—or whether some dominant, unifying platforms will emerge. While the idea of unified platforms for information-rich commerce may seem alarming to some, we believe they will be essential for the vision of pervasive, economically efficient and user-controllable information-rich commerce to become a reality. The sections that follow introduce key technologies that will underlie such platforms, and then two case examples are provided that demonstrate the advantage of unified platforms to support information-rich commerce.

## Technologies to Support Pervasive Information-rich Commerce

Due to rapid advances in the price/performance of portable computing devices and supporting network infrastructures (especially wireless), it will soon be feasible for individuals to carry around—literally, or in effect—detailed personal information and the means to selectively release this information to support commercial transactions.

Three kinds of infrastructure (see Table 2) are required to support the vision of pervasive information-rich commerce: (1) portable intelligent devices (to allow secure identification of users, and possibly to store profile data and conduct transactions), (2) wireless networking technologies (to get information-rich commerce to locations where wireline networking is not feasible), and (3) a well-developed trust infrastructure (to ensure that transactions are conducted privately, securely, and in accordance with consumer preferences). In addition, a fourth category of technologies, known as web services (such as Microsoft .net and SunOne), may play an important role by facilitating the storing and sharing of profile data.

A key question for adoption is whether a few unified architectures will emerge to deliver information-rich commerce or whether the benefits provided to



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consumers and corporations will be sufficient to support many diverse architectures.

**TABLE 2: SUPPORTING INFRASTRUCTURES**

| Infrastructure Component | Features and Limitations |
|---|---|
| **1. Devices** | |
| • **Smart Card**: A plastic card with an embedded chip that stores and transacts data between uses | • Comparatively simple, secure, portable and cheap<br>• Emerging card-readers support thumbprint biometrics for identification/authorization<br>• Requires specialized card readers<br>• Data may be permanently lost if card is misplaced or stolen |
| • **Wireless Information Device (WID):** Includes wireless PDAs, smart-phones, media players and other hand-held devices | • Supports most emerging wireless protocols (GPRS, WiFi, Bluetooth)<br>• Can operate stand-alone, with no need for specialized card-readers and other devices (kiosks, POS terminals) to view data stored on the device<br>• New devices will support biometrics (e.g., based on thumbprints or voice)<br>• More expensive and complex, and less secure than smart cards<br>• Greater theft target than smart cards |
| • **Special Purpose Devices**: Includes POS terminals, ATMs, kiosks, etc. | • Comparatively simple and inexpensive<br>• Inflexible; usually based on proprietary architectures |
| **2. Wireless Networking** | |
| • **2.5G Widearea Wireless Networking**: Includes GPRS and EDGE | • Supports instant network access and much higher data rates than 2G (up to 115 kpbs for GPRS and 384 kbps for EDGE)<br>• Suitable for streaming audio, HTML web pages and low quality video<br>• Geographic coverage for 2.5G is expanding rapidly and prices are dropping |
| • **3G Widearea Wireless Networking**: Primarily UMTS based on WCDMA | • Supports instant network access and very high data rates (up to 2 mbps)<br>• Suitable for all high bandwidth applications, including high quality video<br>• Rollout of 3G has been delayed in most countries |
| • **Wireless Local Area Networking** Dominant standard is WiFi (802.11) | • Supports instant network access and very high data rates (up to 11 mbps for 802.11b and 54 mbps for 802.11a)<br>• Suitable for all high bandwidth applications, including high quality video<br>• WiFi "Hot spots" are increasingly available at airports, hotels, cafes, etc.<br>• Must be within 300 feet of a network access point; doesn't |

| | |
|---|---|
| • **Personal Area Wireless Networking:** Dominant standard is Bluetooth | support "roaming"; must be configured to recognize each NAP<br>• Supports instant access and high data rates (up to 720 kbps)<br>• Low power consumption (about one-tenth of WiFi)<br>• Bluetooth devices automatically recognize each other<br>• Devices must be within 30 feet of each other |
| **3. Trust** | |
| • **Identification/ authorization:** Includes biometrics (via thumbprints, retinal scan, speech, facial thermograms, and hand geometry) identify tokens (e.g., key chain fobs) and PINs | • Biometrics are most secure and convenient, but require more advanced technologies and raise special privacy concerns by capturing physical identify (not just purpose-specific identity, such as "account holder")<br>• Identify tokens (e.g., key fobs) are highly convenient but can be used by anyone if lost or stolen, unless combined with other measures, such as PINs<br>• PINs are simple, but inconvenient and comparatively insecure |
| • **Authentication/ non-repudiation/ security:** Usually based on Public Key Infrastructure (PKI) and related encryption technologies | • PKI supports encrypted private communications that can only be read by intended recipient, and digital signatures that ensure the identify of the sending party<br>• PKI encryption keys can be created and exchanged over insecure channels without creating vulnerability, in a way that is entirely transparent to end-users |
| • **Privacy:** For example, P3P, the Platform for Privacy Preferences, developed by the World Wide Web Consortium (W3C) | • P3P defines a standard for defining privacy preferences and practices; allows comparison of privacy practices to the user's preferences and warns of mismatches<br>• P3P requires sophistication on the part of users to express privacy preferences; provides no enforcement procedures in the event of privacy violations |

In the sections that follow, we present two early stage examples of information-rich commerce as implemented today and discuss how the information-rich component could be deepened using current and emerging technologies. This discussion sets the stage for an analysis of the business and technology issues that must be resolved before pervasive information-rich commerce takes hold.

The first application is for metro area transit, as implemented through Hong Kong’s Octopus smart card; and the second illustrates physician use of Palm PDAs in the U.S. to process prescription information. The goals of these examples are three fold: (1) to show what kinds of information-rich transactions are already taking place in various industries and the benefits of



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such transactions, (2) to demonstrate some of the diversity of technology that is available to support and deepen the future expansion of information-rich commerce, and (3) to provide a backdrop for an ensuing discussion of key factors that will determine whether applications such as these will become a pervasive reality.

## Application 1: Hong Kong Octopus Card

**Description**: The Octopus card is a stored value, contactless smart card launched in 1997 by Creative Star Limited, a consortium of transportation companies, to provide a common method of payment across all commuter transport. The Octopus has grown to encompass a wide variety of additional pre-pay functions. Commuters can currently use their Octopus cards to pay for parking, vending machine and kiosk services and convenience purchases at participating vendors. The Octopus card also provides admission to participating residential and commercial properties. As of February 2002, more than 8.3 million Octopus cards were in circulation in Hong Kong, with almost 7 million transactions taking place each day (www.octopuscards.com).

**Use Scenario**: A Hong Kong commuter uses a combination of private car, ferry, and bus to get to work. In the morning, the commuter drives to the ferry station and parks, gaining admittance to the lot by waving his smart card past a contactless reader (thus creating a record on the card of when the lot was entered). The commuter enters the ferry dock and waves the card at a turnstile, which creates a time and location stamp on the card. He travels to the destination and waves the card at another turnstile, which completes the record of the trip (i.e., it adds destination, distance traveled, time in route) and triggers a payment transaction using value stored on the card. The cost of the trip is based on time of day (peak/off peak) and distance traveled. The commuter then hails a bus and waves the card at a reader to pay for the trip.



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He rides the bus to his destination, disembarks, and buys a coffee and paper at a convenience store, which is accomplished by waving the card at the POS terminal. He also stops by the photo-finishing kiosk across the street to pick up and pay for his finished photos. At the end of the day the sequence is reversed, with the last action being a deduction from the Octopus card to pay for parking at the commuter lot.

**Information-Rich Data:** This scenario yields an enormous amount of information about the daily activities, purchasing preferences, and marketing profile of the individual consumer. The data collected through each transaction is sent back to the Octopus central computer at the end of the day for clearing and settlement purposes. In the aggregate, such data provides valuable input for analysis and optimization of transit operations and traffic flow throughout the area while preserving the anonymity and privacy of individual commuters. More interesting for the pervasive implementation of information-rich commerce is the potential for using individual information to personalize transactions and offers, and in fact the Octopus technology supports personalized cards as well as anonymous stored data cards.

The possible incentives for consumers, merchants, and card issuers to take advantage of this next stage of information-rich commerce are summarized below:

- ***Consumers****:* In exchange for consenting to share the information collected through daily use of a transit/retail smart card, a consumer could become eligible for a variety of financial and convenience incentives. He could, for example, get priority boarding of crowded ferries and buses, or receive bonus frequent traveler points that could be redeemed for free trips or other services. Special rate structures could be introduced based on consumer status (i.e., discount rates for off-peak travel by students and seniors). In the retail context, vendors could make tailored offers based on the consumer's demographic profile, purchasing preferences, and transaction history.
- ***Merchants*** *w*ould benefit from the ability to target their offers and increase the loyalty of regular customers. Providing point of sale



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discounts based on the transaction history of a particular customer could also encourage consumers to try new products and services—for example a discount on a new brand of beverages or a high-end photo finishing service could be downloaded to the card for redemption at the kiosk opposite the consumer's regular transit stop, increasing the probability of a positive response.

- ***Card issuers*** would benefit from the additional revenue provided by increased volume of transactions and potentially from taking on the role of information and trust broker for participating merchants and vendors. As a trust broker, the card issuer would assume responsibility for authorizing and clearing all card-based transactions in return for a small commission on each transaction.

## APPLICATION 2: WIRELESS ELECTRONIC PRESCRIPTIONS (EPHYSICIAN)

**Description:** Founded in 1998, California-based ePhysician is one of a number of companies providing wireless PDA solutions and services to the health care industry. The ePhysician Practice product suite allows doctors to use Palm-OS compatible PDAs to write and transmit prescriptions and check individual medical records for drug interactions and patient prescription history, as well as to create billing and future appointment information (www.ephysician.com).

**Use Scenario**: A busy physician is making rounds at a regional orthopedic rehabilitation center. He visits an elderly female patient with a fractured pelvis. This patient presents signs of a bronchial infection. Before prescribing any new medication, the doctor checks the patient's records on his wireless PDA and notes that she is already taking medications for high blood pressure and heart problems and is also allergic to penicillin. He then uses the PDA to check an online drug database for the most effective treatment compatible with the patient's other medications. Returning to the individual patient record, he confirms that the prescription coverage provided by her insurance company extends to the recommended brand of medication. Finally, the doctor fills out a short form on the PDA screen to authorize and send the prescription via a wireless network to the patient's pharmacy. The system



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automatically updates the patient's medical record and flags the doctor's home office appointment system to remind him to follow up.

**Information-Rich Data:** The data components of this system include individual patient medical records, prescription histories (which may be supplied by participating pharmacies), appointment records from the physician's home office, and billing records from a medical facility or insurance provider. Because of the private nature of medical and prescription records, this information is protected by encryption when it is transmitted over the network. The PDA is also protected by a required log-on procedure that is known only to the physician, so that this device provides personalized and secure access to the information-rich medical record environment.

Incentives for deepening information-rich commerce among the key players in this scenario are as follows:

- ***Users**:* The physician benefits from the convenience and error reduction components of wireless access to individual patient, prescription, and insurance coverage data. As medical treatments grow more complex, the possibility of unfavorable drug interactions increases, as does the importance of dynamic updating of medical records to reflect the latest information on reactions. The complexity of specific insurance rules and billing procedures takes significant time from the doctor's clinical work and simplification of these processes can be of great value.
- ***Insurers**:* The real time nature of wireless PDA prescriptions and the link to back end insurance guidelines and billing systems gives insurers an important window into the cost of benefits for individual patients. The aggregate information also provides data that can be used to negotiate more favorable pricing for prescriptions and other services. In addition, real-time checking for drug allergies and interactions can alert physicians to problems that might otherwise cause serious complications and expensive additional treatment.
- ***Pharmacies**:* Error reduction is a major benefit, since hand written prescriptions are notoriously difficult to read and frequently require pharmacy personnel to call back physicians for verification. By linking to the system, pharmacies also become the provider of choice for participating physicians and insurers.

As more physicians, insurers, and pharmacies implement the type of integrated, real time access to patient and prescription information that



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ePhysician represents, medical records become even more information-rich, providing a map of the efficacy and cost of specific treatments at the individual and the aggregate level that will be of great interest to various segments of the health care community. While the patient does not currently have direct access to the records described in this case example, healthcare providers are starting to let individuals view their medical records online. Despite initial skepticism by doctors and hospitals, patients have been positive about such access and have reported significant benefits [11]. However, the future uses of information-rich medical data at the individual level raises a number of questions about privacy and confidentiality that may become barriers to further deepening the information-rich content that is generated in the health care process. This represents a case where the technology infrastructure may be ahead of the business and cultural readiness for integrated information-rich services. On the other hand, the recent federal affirmation of deadlines for implementation of HIPPA (Health Insurance Portability and Accountability Act) could provide an impetus for new investments in this area, as it requires that medical data be stored in a shareable digital form and also delineates privacy guidelines.

## Future Directions

The two applications presented above demonstrate the general technical feasibility of information-rich commerce and the diverse forms such commerce might take. However much more than feasibility will be required for businesses to be willing to invest in the applications and infrastructure required to support this vision, and for individual consumers to be willing to accept it. It appears that the interplay of three factors—architecture, economics and trust—will largely determine the fate of information-rich commerce.

**Architecture:** A key reason for the success of the Octopus card is a perfect alignment of the requirements of the application and the chosen technical architecture. Designers chose a decentralized architecture, with the smart card itself serving as the repository of stored value and other user data, and with supporting servers only being updated once a day. This makes sense given the relative simplicity of the applications, limited amount of personal data being stored on the card, and the current difficulty of providing real time



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network links to thousands of distributed devices (subway turnstiles, busses, ferrys, parking lots, convenience stores, etc.).

However, as the medical example illustrates, there exists an alternative, centralized architecture whereby personal data are maintained on servers and downloaded to devices in real time only as needed to complete transactions. As the internet extends its reach, this decentralized architecture could become the preferred approach to delivering information-rich commerce. It will be soon be feasible to have every device involved in commerce—POS terminals, PDAs, kiosks, even vending machines and parking meters—connected directly to the internet [2]. Furthermore, considerable resources are being committed to web-services initiatives (such Microsoft's .NET and Sun's SunOne) intended to allow multiple internet servers to cooperate when responding to user requests. Once this occurs, it raises the possibility of having each distributed device trigger access to personal profiles as stored on one or more remote network servers on an as-needed basis. Under this architecture, a smart card or a token would not act as repository of personal information, but rather would serve as the key that "unlocks" access to remote repositories.

The main advantages of centralization over decentralization are: easier standardization and distribution of applications, instant availability of real time data to all transactions, and greater ease-of-use (since users would be spared the burden of updating applications, synchronizing devices, or backing up data). Also the devices used in information-rich commerce could be simpler and cheaper. The disadvantages are greater networking infrastructure costs, exposure to network delays or outages, and greater security and privacy concerns. Regarding the latter, since all personal data would be resident on network servers it would be physically accessible at all times, not just when a consumer is conducting a transaction.



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Markedly different sorts of investments are required depending on whether the decentralized or centralized approach is chosen. As a result, a question arises as to whether one architecture will emerge as the dominant winner (leaving those that chose the loser to face an expensive conversion process) or whether both general architectures can thrive side-by-side.

**Economics**. Regardless of which architectural approach is used, developing the infrastructure to support pervasive information-rich transactions will be expensive. For example, the cost just to upgrade the POS terminal infrastructure to support smart cards in the United States has been estimated at several billion dollars. For some portions of the required infrastructure, market trends appear quite favorable, and so information-rich commerce may benefit from a free ride on infrastructure developed for other purposes. For example, it seems clear that the device infrastructure and wireless networking will continue robust diffusion regardless of what happens with information-rich commerce.

In other areas—the trust infrastructure and web services—the barriers to diffusion will be greater. Much of the value from building these infrastructures will derive from information-rich commerce itself, and this creates a chicken-and-egg situation. Until information-rich applications have been deployed, there is no economic pay back from building the supporting infrastructure, but such applications can not be deployed until the infrastructure is in place. In some instances an individual company or tight consortium controls both the infrastructure and applications (as in the examples above). This is a simple way to solve the chicken-and-egg problem, though in many situations it is not feasible and it tends to produce purpose-specific infrastructure rather than general purpose infrastructure.



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Another key issue here is whether dominant standards will emerge in these areas, as has occurred in other areas of computing. Dominant standards drive crucial scale economies for the sponsoring vendor and third party suppliers, and also reduce uncertainty and fear of stranding among adopters [7, 12]. Another positive development would be the emergence of a "killer app"—an application with a value proposition so compelling that it single handedly justifies the cost of deploying a multi-purpose supporting infrastructure [6]. If, for example, wireless access to information-rich medical data markedly reduces the cost of treatment and the occurrence of prescription errors, this could motivate healthcare providers and insurers to invest in the necessary infrastructure to make provide this capability to all physicians in the U.S. A third key issue is whether any single entity in the private sector has the necessary mix of resources and incentives to play the trust broker role and to push information-rich commerce ahead. Historically, the public sector has mandated or subsidized much of the infrastructure for adoption of technologies such as smart cards and national networks. It may be that only large companies spanning many business segments will have right mix of incentives and resources.

**Trust**. The high cost of developing information-rich commerce requires that businesses must reap significant benefits. Since much of the value-added in this area comes from the ability to make transactions personal [1], the economics of information-rich transactions are intimately tied to the issue of trust [5].

Trust takes on many dimensions in this realm. Consumers must be able to trust that their personal data will be held accurately and securely, that it will be shared only in accordance with their wishes, and that it will be protected against misuse or theft. Businesses must be able to trust that the information



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supplied by consumers is correct, that customers are who they say they are, that they only take actions they are authorized to take, and that they can not deny taking actions they actually have taken.

The continued deployment of supporting technologies will play a crucial role in establishing the necessary environment of trust. However new business practices—whether voluntarily adopted or legally imposed—will be just as important. To inspire trust, businesses that gather and hold personal data must be viewed as taking into account the interests of individuals [10], perhaps with fiduciary duties on par with personal lawyers or accountants [5]. Ideally, this would mean: providing transparency in what data are stored; providing security and consumer protection guarantees; and empowering consumers to determine how data will be shared. And it will also mean splitting with consumers the efficiency benefits brought about by personalization and data sharing.

Such a view is a radical departure from current business practices in the US, where personal data have traditionally been treated as the property of organizations gathering the data [4]. However, it appears this may be changing. Motivated either by fears of government regulation or a dawning realization of the importance of consumer trust, many business are moving towards more customer-oriented privacy practices. In addition, the United States and the European Union have reached an agreement whereby US-based firms must move towards the higher standards of information privacy that exist in Europe. And it appears that genuine infomediaries—organizations that allow transactions to take into account personal data with out revealing the identity of the people involved—are beginning to gain a foothold, albeit in niche areas. Whether these voluntary, market-based solutions will be sufficient to ensure the requisite climate of trust for information-rich



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transactions to thrive remains to be seen. Another possibility is that new government regulation will be enacted that strikes the right balance between personalization and trust.

## Conclusions

In the near future, it will be feasible for most everyday transactions to be structured around knowledge of consumers' personal characteristics, preferences and capabilities. The benefits for both consumers and business could be substantial. Consumers could benefit from lower prices, better service, more tailored offerings and more convenient payment options. Business could benefit from more efficient marketing and operations, increased customer reach, and improved customer loyalty. As the two examples developed above demonstrate, these sorts of benefits can be compelling indeed.

On the other hand, the pervasive diffusion of information-rich transactions is by no means guaranteed. To make it happen, an extensive supporting infrastructure must be developed in three areas: devices, networking, and trust. This requires that the economics of information-rich commerce be large enough to encourage business investment, which in turn means that detailed personal information be captured and shared, since such information is what drives the value added. Therefore, information-rich commerce is headed for an inevitable collision with concerns about information privacy and security. As a result, it appears new business practices and perhaps entirely new kinds of business (such as infomediaries) will have to be adopted along side the physical infrastructure to create a climate that encourages sufficient levels of consumer trust.



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