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The price is right

An intriguing startup called InvisibleHand Networks wants to bring Adam Smith's famous metaphor to life all over the Net.

Several years ago, the business-to-business bug bit big and everyone, it seemed, was talking digital marketplace. Rivers of venture money flowed, hundreds of startups popped up, and B2B conferences spilled over as eager entrepreneurs' eyes danced with visions of building a whole new parallel universe. It felt almost as if mankind had finally discovered the Internet's true raison d'etre: to serve as the freest of free markets where every buyer and seller, from every spot on the globe, could come together and do business as never before.

Maybe B2B fever was a millenial phenomenon, a momentary but inevitable plunge into irrationality that occurs every time the calendar shows an excess of zeros. Or, it may have been the logical extension of so much free-market policy-making during the '80s and '90s. As it turned out, of course, the "frictionless commerce" trumpeted so loudly by Bill Gates and others was but a daydream—unless you count the near-total lack of traction achieved by most would-be marketplace operators.

More reasonable an explanation is the fact that while the Internet truly does have the potential to create entirely new kinds of markets, the technology required just wasn't ready. Markets, like the village and towns that traditionally have grown up around them, are exceedingly complex entities, perhaps describable only through metaphor and perhaps only one aspect, or layer, at a time. Is Chicago a set of streets, the buildings on those

Continued on Page Two

Private Profile: Digital Harbor

Linking legacy software to create rich, new, composite apps

We've been hearing for years about this and that technology designed to "integrate" enterprise applications and enable them to exchange information at one level or another. It's a powerful idea and one that has attracted a great deal of talent and investment. Every season, it seems, brings forth a new genre of enterprise application integration (EAI) technology, based on data translation, middleware, XML tags, Web services, you name it.

We're not sure if Digital Harbor's product marks the launch of yet another new class of EAI schemes. As we'll see, there is a small group of companies with which it has sometimes been lumped. But certainly, its product strikes us as unique, in the true sense of that word, and one that is different enough from the pack to warrant investors' attention. The technology builds on a range of activity and thinking that has gone on in university and intelligence labs in recent years but delivers something we've not seen before. And if that's not enough, Digital Harbor has customers and significant revenues, which further distinguish it

Continued on Page Six

This Week

InvisibleHand

Continued from Page One

streets, the people in those buildings, or the activities in which all those people engage? All of that and more, we'd say. And the Chicago Mercantile Exchange? Is that just the famous "pit" where traders jostle each other to make deals? Or is it the prices and other numbers that their shouts, nods, and raised fingers signify? Again, that and more, including all the bodies, minds, strategies, prices, 1s and 0s flying through computers, and even obtuse abstractions like 90-day pork-belly futures.

Is the Chicago Merc just the famous "pit" where traders jostle each other to make deals?

Under the hammer

Getting a computer to faithfully simulate such an incredibly rich but quite unchoreographed dance turns out to be about as tricky a programming challenge as has ever been considered. So, it's no wonder that virtually all grand B2B schemes fell flat on their face, unrealized beyond an overheated press release or two. And it's no wonder, either, that the few successful B2B startups there are have each been devoting themselves to building essentially one aspect or function of the electronic marketplace: catalog management, strategic sourcing, product information, and so forth.

One of the more compelling concepts to emerge from all this activity was that of dynamic pricing. With buyers and sellers interacting electronically and near-instantaneously, the theory goes, prices can be permitted to rise and fall according to the laws of supply and demand, profits may be maximized, and commodities allocated in the most efficient way possible. Thus, a growing number of companies were seen setting up private auctions to obtain better prices from their roster of suppliers while others, including even IBM, began selling finished goods through their own auctions and those run by eBay and others.

Agent agenda

Of all the outfits we've encountered working with dynamic pricing model, one of the most intriguing is InvisibleHand Net-

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works. It's focused on one of the more vital but intangible commodities being sold online these days, namely IP bandwidth and IP-based services. The firm has designed its software to help Internet service providers create what amounts to a spot market where they can sell their excess bandwidth in ways—and at prices—that until now have been impossible. The software, called Merkato, relies on a set of distributed agents and proprietary algorithms—based on game theory and economic theory—that create something larger, in a sense, than the sum of their parts.

Once a customer has bought a chunk of bandwidth, the Merkato system is able to automatically communicate with the appropriate networking gear.

The wasteland

As it is, ISPs have generally employed circuit-based business models, which tend to leave a fair amount of potential revenue son the table. ISPs sell their available bandwidth to customers as fixed-price packages, or circuits, under fixed-period contracts. They price these packages according to what they figure the market will bear—say, $500 a month for a T1-capacity line. Based on the fact that most Net traffic is bursty in nature—downloading a Web page consumes only a momentary spike of packets and e-mail takes up little capacity at all—the ISP typically reckons that on average, each customer will actually use only 40% of the rated capacity of his "circuit." (In effect, the customer pays for the ability to have immediate access to the circuit's maximum capacity during those times when he needs it.)

This way of building slack into the pricing has mixed results. On the one hand, it enables the ISP to oversell its "circuits," with their aggregate maximum capacity exceeding what the ISP would actually be able to provide. On the other hand, if too many customers consume their full share of capacity at the same moment, each may experience degraded service. Worse for the service provider, most of the time a good deal of capacity goes unused and essentially wasted. Were the right mechanisms in place, this slack could be sold at a profitable price.

Big squeeze

Company officials explain that the Merkato software eliminates what amounts to a supply-based guessing game with real-time, dynamic, demand-based pricing. This approach, they claim, can bring ISPs extra, high-margin revenue by squeezing a major inefficiency out of their business model.

Risky bid-ness

Merkato recognizes IP bandwidth as the unique commodity it is. It is shareable, as unused capacity can be made available to others. Indeed, consumption of bandwidth can take place at the moment it is purchased; as with gas and electricity, there is no waiting for delivery. But it is perishable, too. It cannot be stored for later use but must be consumed now. Demand for IP bandwidth may fluctuate rapidly over time—imagine the momentary stress of a video conference, for instance. And finally, it shows strong price elasticity: it's relatively easy for customers to switch between suppliers and, given the right incentive, they will.

Given all this, the trick for ISPs is to come up with the right price at which to sell the excess capacity they have available at any given moment. Merkato helps by creating a spot marketplace that discovers and negotiates that price based on inputs from the seller and all potential buyers. Once a customer has bought a chunk of bandwidth, the Merkato system is able to automatically communicate with the appropriate networking gear—usually an edge router attached to the seller's net—and get the bandwidth provisioned to that customer. In a typical setup, the system undertakes this bidding and price-discovery process every 5 minutes.

Emergent behavior

The company emphasizes the radically distributed nature of its software. Each of sellers and buyers in a Merkato marketplace are represented within the system by their own autonomous agent, programmed to pursue their specific goals regarding price, quality of service (QoS), and other parameters. From the complex interaction of these independent and "intelligent" agents emerges, in theory, the most efficient and mutually beneficial allocation of resources possible—in effect, the invisible hand classical economist Adam Smith wrote about some 200 years ago.

We're impressed by the far-reaching

vision behind Merkato. The system is designed so that real-time data about traffic levels can continuously be fed back into each buyer agent, thereby enhancing its ability to make correct decisions about what to buy and for how much.

Get the message

The Merkato exchange can be set up to serve in several different locations on the Net. The simplest would be at a so-called peering, or co-location, point, where numerous networks link together to exchange traffic. Buyers would be enterprises with traffic to send over these networks, content providers with servers located at the peering point, or ISPs buying bandwidth from peer networks. In addition to creating spot markets, the system makes possible reservation markets. There, buyers could reserve a certain amount of capacity for a pre-arranged price—in effect, a hedging strategy.

InvisibleHand tells us that one of its main achievements has been to make its software scale well to a very large number of diverse and self-interested participants, each represented by its own agent. Done the wrong way, so many agents would require too much computational horsepower and internal message processing to be practical. But the Merkato system is built around a core of shared market rules and other resources and a lightweight signaling scheme. Depending on the size of a Merkato marketplace and its volume of activity, it can be run on a single machine or distributed across multiple platforms each run independently of the others.

Now, IP transit, available in massive quantity, easily provisionable, and deliverable at any level of QoS, looks like a perfect trading opportunity.

Balancing act

The decentralized architecture, with a virtual "micromarket" designated for each type or level of service being offered, enables sellers to offer just the right mix of those services. History has shown, InvisibleHand tells us, that most new types of Internet traffic—streaming media, voice-over-IP, and so on—have emerged from out of the blue, catching ISPs pretty much by surprise. They've often over- or underestimated demand for each type. And except for over-provisioning, they've not had a way of making sure demand for one traffic type doesn't interfere with the others.

The company's value proposition is simply stated and quite compelling, we believe: With billions of dollars invested in IP infrastructure and budgets as tight as a drum, telecommunications providers need ways of squeezing more profits from that investment. Over time, value-added services will have their day, but without a way to bill more efficiently for existing capacity, even those services will not deliver the returns carriers and ISPs need to show their investors. InvisibleHand says its setup can increase revenues by 45%, boost gross margins by as much as five times, and still help buyers enjoy 30% savings on bandwidth.

Liquidity

Already, we've seen numerous attempts at creating bandwidth exchanges, run by firms such as **Arbinet**, **Band-X**, and **Ligh-Trade** (recently defunct.) They've focused mainly on long-distance telephone calls, enabling telcos to buy and sell minutes in short- and long-term contracts. (If it isn't going on already, the time is near when such exchanges begin to influence the routing of individual telephone calls.) Now, IP transit, available in massive quantity, easily provisionable, and deliverable at any level of QoS, looks like a perfect trading opportunity, too—if only pricing issues could be worked out. IP bandwidth trading is just starting to show up as a business and InvisibleHand tells us that it views all players in that sector as potential customers for its software.

Clearly, right now, any discussion of trading IP bandwidth takes place with the Enron house-of-cards debacle still reverberating in everyone's ears. Indeed, InvisibleHand tells us that Enron was a Merkato beta customer, trying out the software in support of its own (now highly suspect) bandwidth-trading activities. But the startup points out that Merkato is a product available for all carriers and providers to use, while Enron's game was to offer trading services and, as monkey in the middle, collect a percentage for itself.

InvisibleHand's flagship customer is **Telehouse America**, partly owned by Japan's **KDD**, which operates a handful of colocation and neutral peering facilities around the country. Telehouse is using the technology to make its peering more liq-

uid: customers with services or content to deliver can buy bandwidth as they need it, on a Merkato-based spot market. Meanwhile, InvisibleHand has set up StreamingHand, a service that supplies bandwidth, priced by Merkato, to some 65 streaming content providers. For these companies, bandwidth accounts for as much as 90% of their cost-of-goods-sold. StreamingHand is expected to reach cash-flow break-even this quarter.

Hoppity, hop, hop

InvisibleHand's business model is licensing-based but suitably flexible. It offers to collect transaction-based fees or charge for each participant in a Merkato-based market. In short, as customers gain value from the software, so does the startup.

The company's technology stems from research originally undertaken at Bell Labs and Columbia University. Much of the thinking has gone into basic market mechanisms, including something called the progressive second price auction algorithm. It is described as allocating "variable-size shares of a resource among multiple users" in a way that maximizes total user value. Equally important is that Merkato is designed to handle any network topology or business model a customer wishes to pursue. For instance, the company has described in one of its whitepapers a hop-by-hop model, in which buyers would "construct their own paths or virtual networks by buying from a large number of [Merkato-based] micromarkets, one for each link in a network."

For streaming media companies, bandwidth accounts for as much as 90% of their cost-of-goods-sold.

Alas, poor network

As might be expected, this work is part of a larger research trend into online markets, auctions, and even methods for getting competing agents to cooperate to mutual benefit. Evidently, markets are widely envisioned as a good way of allocating and pricing all sorts of electronic services that show much the same fluidity as IP bandwidth: content delivery, server-grid-based computation, and network storage, for example. We can imagine a future, too, where wireless networks might sell radio bandwidth to mobile virtual network operators (MVNOs) and others on spot markets, especially as wireless data services come online.

A quick delve into Google reveals that research into market-based bandwidth allocation is underway at numerous companies, **IBM**, **Sun Microsystems**, **Fujitsu**, and **British Telecom** (BT) among them. Because of its shared, decentralized nature, IP bandwidth and services present some fascinating technical challenges related to pricing and allocation. Always lurking is the so-called tragedy-of-the-commons: If one too many self-interested users hogs a shared resource, he can bring it down to the point where it's no longer available to himself or anyone else.

Traffic jam

Hewlett-Packard, BT and Norwegian PTT **Telenor**, along with several European universities, have been working on something called the market-managed multiservice (M3I) Internet project. Its premise, to quote the group's website, is "that a simple packet network may be able to support an arbitrarily differentiated set of services by conveying information on congestion from the network to intelligent end-nodes, which themselves determine what should be their demands on the packet network. There would then be no need for large buffers or priority queues within the network, or connection acceptance control at the border of the network." A key technology to make such a scheme work is a proposed addition to TCP called explicit congestion notification (ECN), which helps feed information about congestion back to the origination point of a transmission. There, decisions can be made about alternate routing.

If there's anything that worries us about InvisibleHand's business it's that we're not entirely sure the marketplace is ready for such a sophisticated product. It may turn out that many ISPs and other service provider customers are happy to go along with today's way of doing business, paying a little extra, perhaps, but having a fairly straightforward set of purchasing decisions to make. InvisibleHand will therefore have to do its best to educate its market. No doubt, showing them hard-dollar savings will be the best way to convince service providers that, as Karl Marx stated after pondering Adam Smith's handiwork, there's nothing to lose but a few chains.

Creating Composite Apps on the Client Side

Continued from Page One

Data entered into one app would automatically flow into the others—and perhaps cause them to alter the view of information they present.

from most of the startups with it is compared.

Unlike most other EAI approaches, Digital Harbor's is end-user-centric. It's designed, that is, to enable analysts, managers, and other more or less normal, non-technical people to weave together the apps that matter to them and—virtually as needed, drag-'n'-drop-style—create essentially new composite apps. That's in stark contrast to all but a few of the other EAI setups we've seen, which are geared to helping programmers, working behind the scenes, to build bridges between apps. Those bridges may ultimately help the end-user by synthesizing something brand new on their computer screens, but the bridges are usually quite rigid and not directly manipulable by the end-user.

The meaning of meaning

With Digital Harbor's setup, however, end-users can embed their favorite programs inside each other, no matter if they're actually executing on the local desktop PC or on a remote server. Indeed, apps can be embedded within embedded apps, and linked together to share information in very fluid and dynamic ways. Most important, the apps maintain context, so that the information one of them presents in response to a new query may be perceived and acted on automatically by the others. In short, these composite apps maintain a high, perhaps unprecedented level of semantic richness.

For example: A telecommunications company's call center fields requests from customers for new services to be brought online—a T1 here, a DSL line there, and so forth. To process the orders, telephone reps must consult a variety of apps, each with its own set of information: A provisioning app, for instance, indicates if the requested service is available in the caller's location and what kind of network changes will be required. Another app handles the scheduling of field technicians who may be needed to make those changes. Other apps contain zoomable maps of the company's network, in both logical and physical form, and still another maintains billing and other financial information.

Clickaway

Normally, the telephone rep would keep a window for each of these apps open on his screen—perhaps even multiple screens— and switch his attention between them. He would repeatedly have to enter the same bits of data into one app after another. If a problem showed up—a scheduling conflict, say, or the customer changes her mind well into the order process—the rep would probably be forced to go back retype data into each of the apps again.

With Digital Harbor's setup in place, all of these information systems could be presented together, in their own windows but invisibly linked so as to maintain context with each other. Data entered into one app would, selectively, automatically flow into the others—and perhaps cause them to alter the view of information they present. Clicking on the customer's house on the geographical map, for instance, might immediately summon the logical network map to show the appropriate links and devices bringing service to that house. Then, clicking on one of those devices' icons might reveal details of its settings and capacity, all stored in a separate database somewhere else. Selecting a date on a calendar app would signal the workforce app to show only those work teams that are both available on that day and also familiar with the equipment involved in provisioning the new service.

Abracadabra

Granted, it's one of those things one probably has to see to fully grasp. And even in person, we have to say, demos of rich systems like this remind us of something we learned during a youth misspent learning card magic: Things are rarely as they appear. Conjuring impresses as it does largely because the audience is actively encouraged to freely extrapolate from rigged demonstrations. Likewise, com-

At a Glance

Digital Harbor

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CEO Rohit Agarwal

Founded February 1997 **Employees** 65

Financing $2 million, currently seeking $8 million in venture money

Investors individuals, including Ray Noorda (ex-Novell CEO)

Business Provides software that integrates Web-based applications at the client, creating rich, new, composite apps.

puter demos are best understood as demonstrating only that the computer is capable of doing exactly what was shown, nothing more.

Which isn't to say that we don't believe that Digital Harbor is on to something quite important and useful. We do. It has come up with a way to get stovepipe apps to collaborate at a substantially higher conceptual level than usual. It maintains awareness of dynamic relationships between the items, or entities, that matter in business: people, processes, rules, events, dates, and so forth.

Key to the client's operation is a set of tags, called the Hyper Application Markup Language, that help associate different types of data with each other

The point of it all

Much of the development work behind Digital Harbor's product, called PiiE,was originally funded by and done for intelligence agencies. With floods of data collected from satellites, spies' field reports, analyst desks, debriefing sessions, and electronic intercepts, outfits like the CIA and Defense Intelligence Agency have long sought bettter ways of quickly correlating items plucked from disjointed databases. Ideally, as an analyst clicks through one database, the information he retrieves should be available to instantly act as an input into other databases. Again, context and semantics are the keywords--or data fusion, as the spooks and military developers like to call it. Or, to steal a page from *Zen in the Art of Archery*, ideally, the apps themselves should disappear, becoming one with the analyst and his intentions and thereby enabling him to concentrate on the information he's evaluating, not on the means of retrieving it.

How does it work? The trick is a hidden layer of intelligence, operating outside the legacy apps, that "understands" the relationships between the various entities that all those apps describe. Digital Harbor calls this layer a business ontology. It is essentially a map of the fundamental objects a particular business deals with—the people, rules, events, and so forth—and how they relate to each other. Thus, one type of Person might be an Employee, and Employees have EmployeeNumbers. But Persons might be governed by certain Business Rules, too, which in turn are affected by Places and Events.

Tagging along

The firm tells us that this web-like ontology describes richer relationships than can be captured in the multi-dimensional data arrays at the heart of online analytic processing (OLAP) databases. Actually traversing this map is an inference engine, as the company calls it, that's programmed to keep tabs on what kind of object an end-user is working with in one app so that other apps can be made to display related information.

The complete architecture is not worth describing here, except to say that the ontology is kept in a back-end server while a substantial piece of front-end software is required at the client. This is not a terribly fat client, we're assured—on the order of a few megabytes—and it is designed to stream into place piece by piece as required. It's job is to present data from the remote apps, delivered in the form of Web services, and help with their interaction. Key to the client's operation is a set of tags, called the Hyper Application Markup Language, that help associate different types of data with each other and call into action any of some 30 different run-time services—for creating and displaying graphics, for instance.

Through thick and thin

This reliance on a not-so-thin client, as opposed to a vanilla Web browser, is hardly unique to Digital Harbor. Perceived competitors such as **Droplets**, **Altio**, **Curl Technologies**, and **Fourbit** all have software running on the client device whose job is to format and present data delivered via Web service-like links—in some cases with only XML, no HTML, involved. The great

advantage of not using a bare HTML browser is that the information display can be refreshed piecemeal and in real-time, without entire Web pages having to be constructed back at a server for each update. Living with thick(er) clients will come to be widely accepted, we believe, as their advantages prove to be indispensable. In the meantime, no doubt, simple transaction-based apps will continue to migrate from client-server to browser-only delivery.

Opportunity knocks

Digital Harbor says it can get an enterprise started with its software, in a limited way, for as little as $50,000 and in about 6 weeks' time. Installation time will be key, we believe, because after grasping the worth of the software, the first question most prospective customers will raise is how long does it take to bring this scheme online. As always in software, there's no free lunch. The upside is that full enterprise licenses can run well more than $1 million. Digital Harbor, operating until now as Eidea Labs and selling mainly to the government, says it will be profitable this year on revenues of $7 million. The firm plans to bring out a new version of its code in August and, with help from some new financing it is seeking, to beef up its marketing and sales effort in the financial services, CRM, telecommunications, and manufacturing industries. Digital Harbor sees opportunity in working with systems integrators, too, which might develop libraries of business ontologies for use in specific industries. It is already working with several application server firms, and it wants to interest enterprise app suppliers and ASPs in the technology, too.

Clearly, EAI is a crowded field these days, and Digital Harbor will have to work hard to rise above the noise. No EAI scheme worth the name is simple to describe or easy to install—that's the nature of the technology. It means, though, that customers will likely take their time in choosing one or the other, for first they will have to educate themselves about the different approaches and products available to them.

Watch this

What will speak loudest, we imagine, will be strong demos—no smoke and mirrors, thank you—and enthusiastic customer testimonials. Digital Harbor's current customers, working mainly with hush-hush intelligence agencies, may not be too helpful in that regard, given what's going on in the world. But we think the company still has a good shot at making a go of its technology in the much broader and, for now, more lucrative commercial marketplace.

Technologic Briefings

Notes from recent meetings with emerging companies

Quiver

Provides software that helps corporate librarians categorize masses of documents so that they can be searched and distributed with improved accuracy.

• **What's new** Quiver tells us it has just signed its fourth customer, an insurance company, and it's planning to raise $3 million to $5 million in venture financing, which would be enough to help it reach cash-flow positive.

• **Profile** The problem of how to extract the meaning, or subject, of a text document and then tag it with a Dewey Decimal number or XML tag has challenged computer researchers for decades. Quiver has taken a powerful approach, admitting that no computer can do as well as a person, so why try?. The computer can achieve an accuracy of as high as 90% in some cases, but that still leaves many documents that people must read and categorize themselves--documents concerning product or workplace safety, for instance, that it's crucial to identify as such and route to the appropropriate person.

So, Quiver has built software that combines an automatic categorization engine with workflow management facilities that can automatically route troublesome documents to experts for their learned judgement.

• **Upside** Quiver appeals to librarians, doesn't try to replace them.

• **Downside** The firm faces some well-funded competitors.

• **CEO** Scott Potter, earlier an executive vice-president at WorldRes

www.quiver.com • 650-653-3577
HQ San Mateo, CA **Founded** 1999 **Employees** 30
Financing $23 million in three rounds **Investors** Baron Capital Management, El Dorado Ventures, Hummer Winblad Venture Partners, London Merchant Securities, Partech International, Staenberg Private Capital, Weber Capital Management, Weiss, Peck & Greer