RECURSION SOFTWARE, Inc.

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Beyond the Internet: Building Location-Based Services for Multiplatform Device Communities

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Gartner predicts a future of mobile 'ambient business', where consumers explore their environment to find relevant value propositions…Data will be selectively pushed to the user based on context, matching the users' needs, interests, mood, location and even recent behavior…Location, combined with personal presence, creates transient communities, which offers an opportunity for better use of [wireless] time or marketing.

-- Nick Jones, *Gartner Says Corporate Mobility Becomes Mainstream and Outlines the Shape of the Future with Mobile Business 2.0*, April 3, 2006

Executive Summary

Autonomous intelligent devices communicating, collaborating and discovering each other is a world vision hitherto relegated to the Sci-Fi channel. Yet, with recent breakthroughs in intelligent middleware, device communities can extend beyond the Internet by communicating peer-to-peer regardless of platform or OS. Agent-based intelligent middleware can enable collaborative device communities that communicate in real-time and push content without requiring the user to 'Google' for, or even think about it. Read this white paper to learn how to create these intelligent apps and prepare your organization for the next generation of multiplatform software beyond the upcoming FCC spectrum auction.

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LBS Insights and Opportunities

These apps represent the trifecta of today's most hyped mobile applications. At present, these and most location-based apps and services (LBS) are a mashup of existing services, such as Internet search, GPS positioning, mapping software, or text messaging, combined and repackaged. Today's LBSs are not ubiquitous because they are dependent upon the Internet and are therefore constrained by intermittent network access, reliance on often static yellow page directories and mapping databases and ultimately suffer from the inability to provide ad-hoc device discovery. This realization begs the question: how good are LBSs like mobile social networking (MoSoSo) if your device can't find new friends? The true power of MoSoSo, or any location-based app, lies in the ability for a wireless device to autonomously discover another wireless device in your immediate location in real-time.

Even Google, the undisputed leader in mobile search, has yet to incorporate true context awareness. Today's mobile search and advertising is not much different from the desktop model that is passive and historical, not proactive and immediate. It forces you to know your location and enter your query then pulls previously published content from a database. GPS- location technology alone only solves one part- the easiest part- of the equation. In most cases, search results offer too much information. After all, what good are 600,000 page hits if you're only interested in a few highly relevant search results? For some applications, like email and instant messaging, the current limitations are perfectly acceptable. However, for location-based, time-sensitive applications, like MoSoSo or mobile search/advertising, the moment of opportunity or the person or business of greatest value could quickly pass you by. Location-based filtering, personalized search and content delivery, and integration with inventory systems will filter out searches by context, preference, and availability.

Peer-to-Peer is Here!

Enter peer-to-peer distributed ad-hoc networks. While the Internet is on a different time horizon, one could argue that a reactive timeframe, distributed ad-hoc networks would bring any flavor of mobile apps into the "now". Such collaborative device communities provide real-time location-based device discovery in which a device is actively entering, leaving and seeking other devices within a community.

The next evolution of location-based services will allow "edge" devices, either business or consumer, human or machine operated, wireless or embedded, to participate in coordinated knowledge sharing, problem solving and transactions that span dynamically assembled communities of devices and multiple companies/ organizations and/or consumers.

A software platform that is device and language agnostic is necessary to unify and transform the multiple mobile devices of professionals and consumers into wireless learning machines that form intelligent device communities. A platform must also enable server-level intelligence on small footprint devices that can learn the user's behaviors and habits. Based on a user's history, their opt-in preference profile, and the user's state (location, work or play, time or day, etc.) these devices will be able to deduce the user's needs and proactively deliver content without requiring the user to 'Google' for, or even think about.

Will companies like Google cease to be relevant in the world of push content? Quite the contrary. Google or LBS pioneers might literally end up powering it, not only threaten Microsoft in the process, but also telco carrier giants such as AT&T and Verizon (see *Google: The Next Microsoft and AT&T?*)

Google: The Next Microsoft and AT&T?

Although Google's core competency is advertising, it has quickly become a leader in web and mobile app development. For the moment, these apps are just another means for attracting more views to the advertisements they host or deliver. Devices, OSs, wireless networks, web sites and even applications are simply the means to deliver their advertisements.

Why is Google taking a much-publicized open access position on the upcoming Federal Communications Commission (FCC) auction of wireless spectrum? The federal government's upcoming auction of wireless spectrum in the 700-megahertz (MHz) band is part of the transition from analog to digital TV broadcasts that must be complete by February 2009. This band is arguably the last chance for new entrants in the cell phone market to gain equal access. From their public policy blog, Google suggested that the following four open standards should apply to the license conditions:

1. **Open applications:** There should be no restrictions to consumers on what software applications, content, or services that can download and use
2. **Open devices:** Consumers should be free to use any wireless network they prefer in the 700 MHZ range on their handheld communications device;
3. **Open services:** Resellers should be able to acquire wireless services from a 700 MHz licensee at wholesale prices
4. **Open networks:** Internet service providers and other third parties should be able to tap in at any technically feasible point in a 700 MHz licensee's wireless network.

In late July, Google urged the Commission to adopt rules for the auction that ensure that, regardless of who wins the spectrum at auction, consumers' interests are served. Google also announced its intent to commit a minimum of $4.6 billion to bidding in the upcoming auction.

A Partial Victory for Google and Third Party Apps

Under the rules released by the FCC in early August, Google had two important victories. Consumers will be able to use any software application or device on networks using a portion of the spectrum to be auctioned (points #1 and #2). However, the FCC did not approve the provision that would have required the winner of the auction to sell access to its network on a wholesale basis to other companies (point #3). This means that Google, or another company or coalition dedicated to open access, must win the auction in order to fully achieve open access. In the instance that a big telco wins the auction, they still have to leave it open to devices it does not approve or control. However, telcos are free to charge consumers or other third parties for access to its network (point #4).

While telcos will likely be bidding against Google, at the same time Google is partnering with one carrier, T-Mobile, at the same time partner with them on Google's upcoming phone. In all appearances, Google has selected T-Mobile and HTC to build the Google Phone. Many believe that Google's first mobile phone will run a Linux operating system on a Texas Instruments "Edge" chipset and will likely ship to T-Mobile and Orange customers in the Spring of 2008, according to unconfirmed reports. It is also speculated that Google Phone call minutes and text messages will be funded by mobile advertising.

If all goes well for Google, it just may have an open (application/device) wireless network, a set of web-enabled software applications that run on any device, as well as a slick Smartphone of their own. It appears that Google has started the race to commoditize and abstract devices, operating systems and telco networks, which should have Microsoft and AT&T worried.

With a growing set of tools, such as Google Apps, Google has already started to abstract the operating system, which aims at the heart of Microsoft's business model. For AT&T, their core business is the network. Controlling the network has given AT&T almost unrivaled power to dictate who has access to what wireless and broadband services. If Google ends up owning the 700 MHZ band, it will be position to abstract the telco networks as well.

Can Google do it? Will AT&T, Microsoft or IBM or someone else step in? At the moment, Google seems to be the best positioned given its current business model. Of course, it is not the only company that can embark on this initiative. The obvious other players in this high-stakes game would be the telco giants and software giants. It would be a bold move for Google and, arguably, the correct move in the long-term if trends toward open access continue to gain consumer favor.

The Perfect Storm: The FCC, Google, and Intelligent Agent Platforms

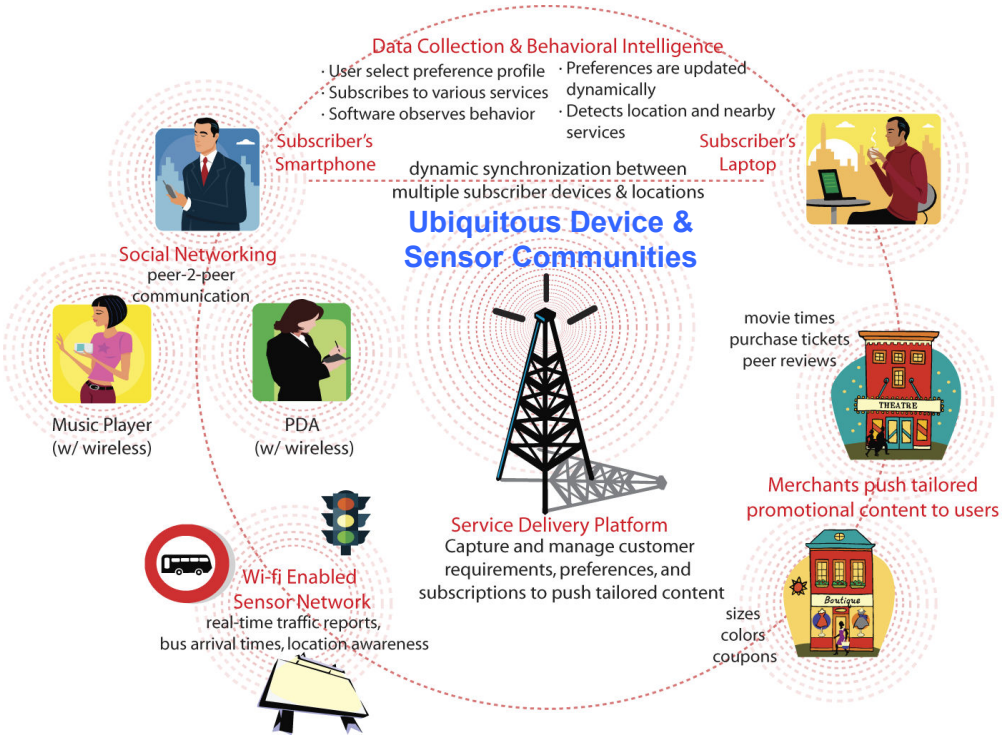
In light of the recent FCC auction and the anticipation of open access, a perfect storm is brewing that will enable the next-generation of location-based services. The missing piece is a software platform that can act as an intelligent software abstraction and communications layer for all wireless networks (not just telco), as well as wireless and embedded devices. A platform must enable any wireless device, including Smartphones, MIDs, UMPCs, laptops, set-top boxes, gaming devices, embedded devices, sensors, RFID readers, etc., to share information seamlessly peer-to-peer in real-time.

Imagine a platform that can run applications and provide and/or display relevant, timely, location sensitive content to you at any time, wherever you are, and with whatever device you are using or viewing. The device could be the laptop, wireless phone, TV, Smartcar, or a sign you pass in the mall or on the road.

This advanced technology combined with an open access network would provide a super highway for apps, knowledge sharing, and social and business transactions. It would connect people person-to-person, person-to-business, or business-to-business. It can turn everyone into an advertiser and social networker and discover other entities with compatible interests, careers, services, etc.

While revolutionary, such technology is just the tip of the iceberg when it comes to the type of intelligent content delivery that can occur on this type of platform. Think about personalized advertising pushed to individuals as they walk by stores, restaurants, coffee shops, concession stands, and souvenir shops in a mall, amusement park, resort, large stadium, or even a flea market. This would be entirely opt-in and configurable by the consumer, as they would be able to set preferences that filter out all extraneous information. The consumer can expedite their shopping process, and find the best deals on an item while stores can promote sales and inform consumers in real-time. Malls, parks, resorts or stadiums can differentiate themselves from competitors, as can the telco carriers, handset manufactures or any other company who dares to embrace this vision.

Can Google make it happen? If it isn't planning beyond the FCC auction, then someone should. A company with the right vision and the right platform will be unstoppable in delivering new applications and intelligent, content delivery and knowledge sharing to people wherever they are, with whatever device they have and whatever wired/wireless networks it supports.



Intelligent LBS Platform Requirements: A Top 10 List

While today's location-based apps are limited by their technology, a next-generation software platform, which can abstract wireless networks, operating systems and devices and provide intelligent messaging will enable the next wave of context-aware applications and advertising. The following is a checklist for choosing a next-generation platform that can handle the demands of a networked world.

1. Wireless/Embedded Device Support

A true peer-to-peer application must be able to run, in some form, on all devices. To do so, its software platform must be pervasive and supported on these same devices. Software agents comprising these applications, also need to be able to run in the popular embedded software stacks, such as Java's Micro Edition, Microsoft's Compact Framework, and OSGI Containers, on a wide range of embedded operating systems such as Windows Mobile, Symbian, and Embedded Linux and Sun's JavaFX to name just a few.

2. Decentralized and Centralized Messaging w/Ad-Hoc Communities

A next-generation platform must enable communication between groups of devices/systems without the need of a centralized messaging server. It must support the creation of ad-hoc communities of devices or nodes, as well as the ability to support filtering of messages across these communities.

To effectively accomplish this, support must exist for devices joining and leaving the network, which will result in changing "internet" addresses. Integration with a SIP Server is a requirement not only to provide dynamic IP support but voice, data, and chat support over IP. The platform must also support passing messages over standard centralized messaging servers for integration with enterprise and legacy systems. More specifically, there needs to be seamless integration with Microsoft's Message Queue (MSMQ), Java's Message Server (JMS) and Object Management Group (OMG)'s Data Description Service (DDS), etc.

3. Mobile SOA Architecture

A next-generation platform must provide a Service-Oriented Architecture (SOA). These services need to be accessible via centralized Web Service Container such as Microsoft's Internet Information Services (IIS) and those provided in the Java world, but also must be accessible in a decentralized fashion directly to agents, exposed as web services, that are running on edge and wireless devices. The location of intelligent mobile agents and the Mobile Web Services they expose must be irrelevant to the web service client. Finally, all agents need to be accessible by a Service Description in a Yellow-pages directory, ideally one that is Universal Description, Discovery, and Integration (UDDI)- compliant.

4. Increase Network Survivability and Mobility

A next-generation platform must enable data processing at the source to minimize network traffic, handle unreliable and/or limited network connections, and adjust to hardware failures or CPU load. Therefore, these devices must be able to persist data via a micro database. Additionally, the software components or agents running on edge devices need to support multiple wireless protocols (GSM, CDMA, Wi-Fi, UWB, Bluetooth, NFC, RFID, etc.) and associated networks (telco, Wide Area, Local, Personal, etc.). Ideally, they will dynamically reconfigure themselves to use a communication protocol that best matches the capabilities of their current network connection and the current node(s) they are in communication with.

5. Security

In a ubiquitously networked world, it will often be necessary to maintain data on edge devices. The security concerns facing enterprises today will need to incorporate solutions that extend into a collaborative environment. Applications must provide an extremely high level of security to ensure privacy and protection from rogue/viral clients and software agents. This will involve security agents and agent managers that provide capabilities above and beyond the current encryption, authentication, and authorization that are currently employed in today's centralized client server applications.

6. Provide a Single Unified Platform for .NET, Java and C++

These sophisticated applications cannot be limited to a single development environment and programming language. Furthermore, the same API should be provided to .NET, Java and C++

developers. This would greatly increase programmer productivity and allow developers from all camps to easily work together and share software.

7. Seamless .NET, Java and Legacy Interoperability

A next-generation platform must seamlessly integrate with .NET, JEE and legacy (MVS, CORBA, etc.) enterprise systems and services, and any combination thereof, in either a traditional Web Services architecture, or in a high performance manner. These Mobile 2.0 applications may often need to communicate with more than one enterprise or organization.

8. Transactional at the Edge

A next-generation platform must extend transactions from the enterprise to include edge devices allowing for distributed, but coordinated tasks among peers, peer groups, and the enterprise. Support must be provided to allow for intelligent agents running on the edge to participate in guaranteed message delivery with XA-compliant enterprise transaction managers such as those provided in .NET's Microsoft Transaction Service (MTS), Java's Transaction Service (JTS), and OMG's Object Transaction Service (OTS).

9. Artificial/Cognitive Intelligence

A next-generation application will need to utilize intelligent software agents that can gather data, respond quickly based on this data as it changes, produce and distribute knowledge, and possibly initiate other agent activities.

The underlying rules engine must be easy to use, provide very high performance against potentially large rule sets, and must be available in .NET and Java.

10. Embedded and Enterprise Database Integration and Synchronization

A next-generation platform must provide a simple way to access databases, regardless of the type of database whether it is a relational, object, XML or a multi-user enterprise database or single-user embedded. Developers need to be shielded from the intricacies that exist with these various flavors and have support for data synchronization between the edge and enterprise.

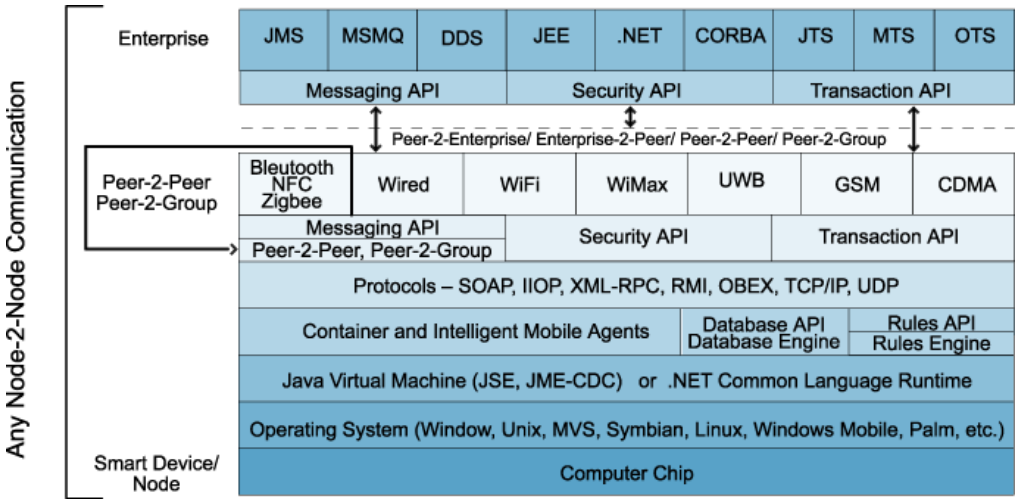
Convergence of Devices, Platforms, and Messaging

An intelligent, distributed computing platform that can provide these capabilities, will provide a superhighway for software engineers to create the next-generation of applications and deliver intelligent, location-based information to any person, anywhere, regardless of the device they are using.

Long considered a technology before its time, Voyager (formerly Voyager ORB) from Recursion Software is an agent-based software platform that has been used to build intelligent applications since late-1990s. The latest version, Voyager Edge, extends server-level intelligence to a wide range of device communities, embedded and wireless operating systems, and software languages using varied distributed protocols and messaging capabilities.

Voyager Next-Gen Communications Platform

Device/Server Intelligent Software Abstraction Layer



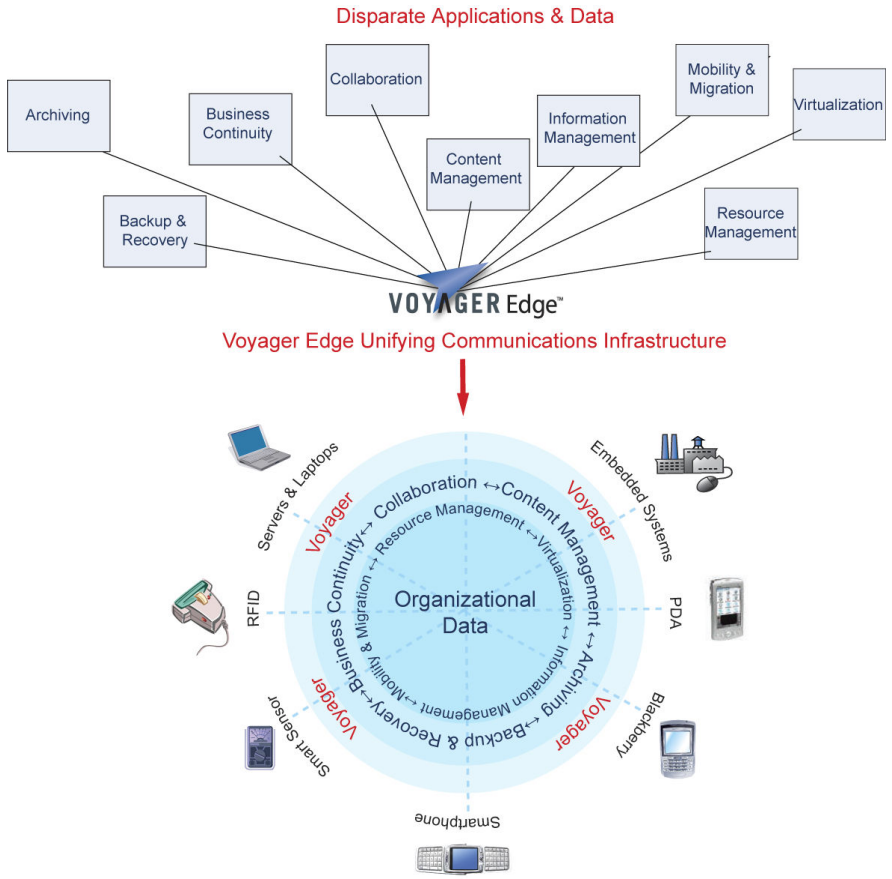
Software architects and engineers using Voyager Edge have the flexibility to freely develop dynamic, intelligent, and decentralized applications in both .NET and Java, on the devices and servers they need to target. This is possible whether the device/node is a desktop, PDA, Smartphones (CDC), set-top box, RFID reader, mall or road sign, embedded sensor or smart-tag (see *Getting Started with Voyager Edge* for code sample). Support for Voyager Edge is planned mid-2008 for .NET Compact Framework, JME-CLDC and .NET Micro Framework.

By utilizing Voyager Edge, developers will have at their disposal a choice of wireless networks, distributed protocols, and decentralized and centralized messaging capabilities to leverage in creating the ad-hoc, distributed, social, knowledge, and problem-solving networks of tomorrow. Combined with rules engines, such as a RETE-based rules engine that is integrated within the Voyager Edge platform, engineers can also weave artificial intelligence and cognitive capabilities into the location-based software they deploy to all targeted devices and servers. Engineers will be able to produce applications that provide real-time intelligence, situational awareness, and coordination at the edge not found today.

Legacy Integration and Mobilization

Enterprise software stacks, like software languages, continue to be born, but old ones never go away. JEE and .NET architectures and related languages dominate, yet CORBA and Mainframe systems and their associated languages are still prevalent within many organizations. A very similar situation exists in the device world where Windows Mobile, Symbian, Embedded Linux, Blackberry, PalmOS, and most recently Sun's JavaFX, compete with many other embedded operating systems. The same is true for wireless networks like Bluetooth, WiFi, and the emerging Near Field Communication (NFC) and WiMax networks.

Using Voyager Edge as a communications backbone will provide a single cohesive and comprehensive runtime environment that allows next- generation applications to seamlessly integrate in this diverse software and device environment, and the increasingly varied wired and wireless networks used to connect them.



Privacy, Security, and Spam in a Networked World

When discussing a ubiquitously networked world one of the first concerns consumers raise is the protection of privacy. An extension of this issue is the risk of communications technology making consumers vulnerable to receiving a barrage of unwanted messages and advertising. There are several methods already in place to prevent this, including legislation and filtering controls, but the simplest way is to ensure messaging is an optional opt-in service for the consumer

The Can Spam Act of 2005
When Congress passed the Can Spam Act in 2005, it became illegal in the US to send any message to a user without the user opting-in to receive such messages. While this law has slowed the proliferation of email spam generated in the US, it remains a huge problem. Enforcement will have similar challenges in a mobile situation. This is one argument for a single company, like Google, that will open up access to legitimate apps, while acting as a policing agent for unwanted advertising. Another argument proposes to keep LBS communications software from going open source to control access from those who may abuse the pipeline.

Opt-In Profile
In support of the Can Spam Act, user's participation can be on a strictly opt-in basis. A user would complete a detailed profile where they could specify what type of services and people they wish to contact them. Should a person's preferences change his or her profile can easily be changed in real-time.

Location Filtering
Another way to combat random spam messaging is to confine messaging to the user's immediate surroundings, therefore only messages from nearby people and businesses would be received by a user instead of a barrage of requests from non-relevant locations. The user's profile could be set to receive only the most pertinent information using a predetermined radius that could be expanded if the user desires.

Security
In addition to standard network-level and payload level encryption, authentication or authorization, security software agents on the user's device can watch for requests or data from nodes that are trusted or un-trusted. Agents also would enforce multiple levels of security that were sensitive to the type of information (e.g. payload) being passed (financial, business, social, recreational etc.), from and to whom, and even when and where. Again, users would be able to easily add and remove approved entities from their white list, just as they would any email subscriber, as well as add or remove locations and times they do not want to receive approved content.

A World of Location-Based Apps

The potential impact of ubiquitous computing reaches beyond mobile services and into several industries such as telecom management, healthcare, energy, transportation, insurance, education, finance and entertainment industries. When one really stops to think about how far reaching this technology will be, indeed there is not a vertical in the commercial, government or consumer arena that will not greatly benefit from the revolutionary capabilities an intelligent platform brings to a networked world.

Some industry insiders predict that intelligent location-based applications remain a goal to be obtained over the next few years, yet the architecture for such next-generation applications exists today for those willing to take the first step toward this world.▪

For more information and white papers on mobile agent technology, visit: recursionsw.com

See *Getting Started With Voyager Edge* to view sample code and get a free download.

Getting Started with Voyager Edge: Sample Code

Believing that Voyager Edge can enable these next-generation intelligent apps is best demonstrated by a real-world example. To get started, download a free community edition of Voyager Edge. It comes with extensive documentation and over 40 examples covering all of the features of Voyager Edge, including examples in Java, C#, VB.NET and Managed C++.

1. Creating, naming and moving a mobile object on/to any node

The following is a code snippet to:

1. create an object
2. bind it to our federated, decentralized Naming Service
3. move it

```
// create a remote component on the
local node
IStockmarket market1 =
(IStockmarket)
Factory.create("examples.stockmarke
t.Stockmarket");

// create an remote component on
node "//dallas:8000"
IStockmarket market2 =
(IStockmarket)
Factory.create("examples.stockmarke
t.Stockmarket", "//dallas:8000");

// bind to naming service
Namespace.bind("//dallas:8000/NASDA
Q", market );

// move to another node "//
tokyo:9000"
IMobility mobility = Mobility.of(
market ); // obtain mobility facet
3b.mobility.moveTo("//tokyo:9000"
); // move the object to a new
location
```

2. Turning a remote component into an autonomous agent

The following is a code snippet to:

1. create an object
2. bind it to our federated, decentralized Naming Service
3. turns it into an agent
4. makes it autonomous
5. move it to another node

```
// create a remote trader component
on the local node
ITrader trader = (ITrader)
Factory.create(
Trader.class.getName() );

// create an Agent facet
IAgent aAgent =
AgentFacet.of(trader);

// setting to autonomous, prevents
it from being garbage collected
// default is true
aAgent.setAutonomous(true);

// move to node and reset it at
arrival by calling "atMarket"
method
aAgent.moveTo("//dallas:8000",
"atMarket" );
```

3. Creating and joining an object/agent community (a.k.a space) on any node

The following is a code snippet to:

1. create an agent space on a remote node
2. create a remote component and add it that that community
3. create another agent space on a remote node
4. create another remote component and add it that the community just created

```
// creating a space on a remote
node
ISubspace subspace1 = (ISubspace)
Factory.create(
"com.recursionsw.ve.space.Subspace"
, "8000/Subspace1" );

// creating a remote component on
that node
IConsumer consumer1 = (IConsumer)
Factory.create(
"examples.space.Consumer", new
Object[]{ "jack" }, "8000/Jack" );

// adding the remote object to that
remote space
subspace1.add( consumer1 );

// creating another space on
another remote node
ISubspace subspace2 = (ISubspace)
Factory.create(
```

```
"com.recursionsw.ve.space.Subspace"
, "8000/Subspace1" );

// creating a remote component on
that node
IConsumer consumer2 = (IConsumer)
Factory.create(
"examples.space.Consumer", new
Object[]{ "jack" }, "8000/Jack" );

// adding the remote object to that
remote space
subspace2.add( consumer2 );
```

4. Joining two object/agent communities on any nodes

The following is a code snippet to:

1. connect or chain the two spaces that were previously created on different nodes

```
// connecting two agent communities
together
// regardless of what nodes they
are located on
subspace1.connect( subspace2 );
```

5. Multicasting a message within an object/agent community

The following is a code snippet to:

1. lookup an object/agent community
2. get a multicast proxy
3. call a method on any objects of type "consumer" located in that community

```
// looking up an agent community
ISubspace subspace1 = (ISubspace)
Namespace.lookup( "8000/Subspace1"
);

// get the multicast proxy
associated with Consumer agent
IConsumer consumer1 = (IConsumer)
subspace1.getMulticastProxy(

      "examples.space.IConsumer" );

// publish the message to the
community
// calls "news" method on every
Consumer object in the community
Multicast.invoke( subspace1,
"news", new Object[] { "newsflash
2!" },

      "examples.space.IConsumer" );
```

6. Exposing and accessing an object/agent via its automatically created Web Service

The following is a code snippet to:

1. enable web services support
2. call a method on a remote component using SOAP

```
// enable web services support
com.recursionsw.ve.web.services.Web
Services.enableWebServices();

// Create a service model for the
web service client
ServiceFactory serviceFactory = new
ObjectServiceFactory();
Service serviceModel =
serviceFactory.create(IStockmarket.
class);

// Create a client proxy
XFireProxyFactory proxyFactory =
new XFireProxyFactory();

String hostName =
InetAddress.getLocalHost().getHostN
ame();
IStockmarket market =
      (IStockmarket)proxyFactory.cr
eate(serviceModel,
      "http://dallas.recursionsw.co
m:8000/services/Stockmarket");

// call "getQuote" using on
IstockMarket Web Service using SOAP
market.getQuote("sun");
```

About Recursion Software, Inc.

Recursion Software is an innovative provider of intelligent middleware and distributed computing solutions based on Service Oriented Architecture (SOA) principles and interoperability standards between multiple languages and platforms. Recursion products help enterprises to extend their current application architecture while providing the tools developers need to build the next-generation of intelligent, mobile, applications. The company is a small, privately held corporation, located in the Dallas-Fort Worth area with a large customer base of government and commercial clients across the world. Since 1993, our products have enabled complex, performance-oriented software development solutions for mission-critical applications and systems. The majority of clients are in the defense, financial, energy, computer technology, and telecommunications industries.

Recursion Software is regarded for its Voyager Edge platform, a powerful agent-based interoperable platform that supports a total range of edge devices, including handheld devices, PDAs, sensors and cameras. The company remains the leading proponent and preferred platform for intelligent mobile agent and agent space technology and has been issued more than 18 patents related to distributed computing, with 30 patents in various states of pending and filing.

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