Project JXTA: An Open P2P Applications Platform

Introduction and Update

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www.jxta.org
Peer to Peer (P2P) is not new. However, the time is now right for the broad P2P applications deployment.

The Project JXTA technology lets developers build and deploy P2P solutions more quickly.
Topics

- Peer-to-Peer Computing
- JXTA Technology
  - Virtual network
  - Architecture
  - Concepts & components
- JXTA Today
- Future Directions
What is Peer-to-Peer (P2P)?

- P2P covers a wide range of applications...
  - Sharing files, distributed search and indexing
  - Sharing CPU and storage resources
  - Instant messaging & devices communicating together
  - Collaborative work (and games)
  - Web services
  - New forms of content distribution, sharing, and delivery

- P2P is not...
  - New or a specific architecture or technology
  - A business model or a market
  - About eliminating servers or centralized services

- P2P is about any device easily connecting “directly” to other devices to enable a more cooperative, or social, style of computing.
P2P Makes Sense Now

- More people connected, more data generated
- More nodes on the Internet and wireless Web
- More bandwidth available
- More computing power available (disk, memory, CPU)
- More interesting applications, content, and services
- Edge devices are increasingly providers of resources
JXTA Technology Objectives

- **Interoperability**
  - Across different P2P systems and communities

- **Platform independence**
  - Programming languages, system platforms, and networking platforms

- **Ubiquity**
  - Every device with a digital heartbeat

- **Security and Monitoring**
  - For commercial and enterprise deployment
What is JXTA?

An open set of XML-based protocols for creating peer-to-peer network computing applications and services.

- Language, OS, network, and service agnostic
- Virtual network overlay
- Mechanisms, not policies
- Open Source project: www.jxta.org
What JXTA Technology Does

Creating Connected Communities
- Brings devices, services, and networks together
- Takes the complexity out of the network and operating environments
- Users have better access to content across multiple devices, regardless of location
- Enables a more cooperative or social style of computing to occur (e.g. people-to-people)
- Search and share with yourself, your friends, and your community
JXTA Enables Classic P2P Applications

- Communications, collaboration, gaming
- Content delivery and sharing networks
- Transactional web services
- Resource sharing
JXTA Sample Applications – myJXTA2 and PicShare
Characteristics of Ideal P2P Applications

• Applications best suited for P2P implementation are those where:
  • Centralization is not possible or desired
  • Massive scalability is desired
  • Relationships are transient or ad-hoc
  • Resources are highly distributed

• Its value or performance increases as more nodes participate in the network
Evolution of Distributed Computing

- **TCP/IP**
- **HTTP**
- **JXTA**

**Client-Server**

**Web-based**

**Peer-to-Peer**
JXTA defines a set of Protocols

- JXTA defines XML message formats, or protocols, for communication between peers
- Protocols used to discover peers, advertise and discover resources, communicate and route messages, and provide monitoring
- Asynchronous; based on query/response model
- Can be implemented in any language and sent across different networks
JXTA Virtual Network

Physical Network

Virtual Mapping

TCP/IP

Firewall

HTTP

NAT

JXTA Virtual Network
JXTA Virtual Network Building Blocks

- Uniform peer addressing
  - Peer IDs
- Dynamically configurable peer domains
  - Peer groups
- Uniform resource representation
  - Advertisements
- Virtual communication channels
  - Pipes
- Security and Monitoring
JXTA Software Architecture

JXTA Applications
- Instant Messaging
- File Sharing
- Resource Sharing
- Collaborative Apps
- Online Games

JXTA Services
- Search
- Indexing
- Discovery
- Membership

JXTA Core
- Peer Groups
- Peer Pipes
- Peer Monitoring
- Peer Advertisements
- Peer IDs
- Security

Any Connected Device
Peers

- Any networked device that implements one or more JXTA protocols
  - PC, server, PDA, cell phone, etc.
- Operate independently, asynchronously
- Spontaneously discover each other on the network
  - Transient relationships
  - Persistent relationships (peer groups)
JXTA Peer Types

- Micro peers
- Simple peers
- Super peers:
  - Rendezvous peer
  - Relay peer
  - Proxy peer
Message Routing Via Relay Peers

A

Peer

Send Message

Super Peer

Relay Message

B

Peer

Firewall

Request Message

Receive Message

Super Peer

Firewall
Identifiers

- JXTA IDs uniquely identify resources: peers, peer group, pipes, etc.
- Uniform peer addressing scheme
  - Unique Peer IDs enable peers to be addressed independently of their physical network location
- Example Peer ID:
  Urn:jxta:uuid-59616261646162614E504720503250338E3E786229EA460DADC1A176B69B731504
Peer Endpoints

- Network interface(s) published by peer
- Example:
  - TCP/ IP (tcp:// 129.127.29.65:9700)
  - HTTP (http:// JxtaHttpClientuuid-…)
- Used to establish point-to-point connections between two peers
- Direct connections not required; intermediary peers can route messages
Protocols

- JXTA defines XML message formats, or protocols, for communication between peers
- Protocols used to discover peers, advertise and discover resources, communicate and route messages, and provide monitoring
- Asynchronous; based on query/response model
- Can be implemented in any language
JXTA Protocols

- **Core Protocols**
  - Peer Resolver Protocol
  - Endpoint Routing Protocol

- **Simple Peer**
  - Peer Information Protocol
  - Pipe Binding Protocol

- **Micro Peer**

- **Super Peer**
  - Peer Rendezvous Protocol
  - Peer Discovery Protocol
  - Peer Information Protocol
  - Pipe Binding Protocol
Peer Groups

JXTA Virtual Network

Physical Network

Virtual Mapping
JXTA Core Peer Group Services

- Discovery Service
- Membership Service
- Access Service
- Pipe Service
- Resolver Service
- Monitoring Service

Peer Groups are not required to implement all services; can use default net peer group services.
Why Use Peer Groups?

- Create secure and protected domains
- Scope peer operations
  - Discovery, search, communications
- Provide a “group” identity
  - Group peers sharing a common interest
- Enable monitoring
Pipes

- Used to send/receive messages
- Asynchronous and unidirectional
- Support the transfer of any object
  - Binary code, data strings, etc.
- Dynamically bound
- Virtual communication channels
  - May connect peers that do not have direct physical link
  - Can be bound to more than one peer endpoint
Pipe Types

- **Point-to-Point Pipe**
  - Connects exactly two peer endpoints together

- **Propagate Pipe**
  - Connects one output pipe to multiple input pipes

Additional pipe types can be created from the core types.
**Services**

- Set of functions that a provider offers
- Provider peer publishes service advertisement
- Pipes typically used to communicate with service
- Types of services:
  - Peer Services
  - Peer Group Services (discovery, membership, etc.)
Advertisements

- All JXTA resources represented by advertisements
- Language-neutral XML documents
- Peers cache, publish, and exchange advertisements
- Each advertisement published with a lifetime (time-to-live)
  - Enables deletion of obsolete resources without requiring centralized control
Example Pipe Advertisement

<?xml version="1.0"?>
<!DOCTYPE jxta:PipeAdvertisement>
<jxta:PipeAdvertisement xmlns:jxta="http://jxta.org">
  <Id>
    urn:jxta:uuid-59616261646162614E504720503250338E3E786229
    EA460DADC1A176B69B731504
  </Id>
  <Type>
    JxtaUnicast
  </Type>
  <Name>
    TestPipe.end1
  </Name>
</jxta:PipeAdvertisement>
Resolvers

- In JXTA, all “binding” operations are simple discovery of advertisement(s)
- Example resolution operations
  - DNS (search for Peer or Peer Group advertisement)
  - Directory Service (search for a Peer adv.)
  - Socket Binding (search for a Pipe adv.)
Advertisement Discovery

- Local neighbor discovery
  - TCP/IP multicast
- Rendezvous peers
  - Discovery requests forwarded between rendezvous peers
  - Any peer may be a rendezvous peer
  - Cache a large number of advertisements
  - Each peer group has a set of rendezvous peers
- Out-of-band discovery
Request Propagation via Rendezvous Super Peers

Limited Range Walker

Query (asked for two answers)

Super Peer

Found no match

Super Peer

Found no match

Super Peer

Found one match
Resend query asking one answer

Super Peer

Response: one answer

Super Peer

Found no match

Super Peer

Found no match

Super Peer

End of query

Super Peer

End of RPV
Security in JXTA

- TLS Endpoint Transport
- Simple cryptography library
- Peer security
  - Every peer has its own root certificate
  - Public key certificate part of peer advertisements
  - Credential certificate embedded in every JXTA protocol message
- Authentication framework
- Password-based login scheme
JXTA Implementation Platforms

- **J2SE™ Implementation**
  - Full implementation of JXTA protocols
  - APIs and functionality frozen

- **JXTA-C**
  - Full edge-peer functionality
  - Interoperates with J2SE relay and rendezvous peers
  - Runs on Linux, Solaris™ OE, and Windows

- **JXTA for J2ME™**
  - MIDP-1.0 compliant
  - (new) iAppli compliant
JXTA Wireless P2P on J2ME (MIDP)

P2P Messaging
Group and 1:1 Chat

P2P Entertainment
TicTacToe Game
JXTA Wireless P2P on J2ME (iAppli)

- P2P Messaging
  - Group and 1:1 Chat
- P2P Image Sharing
Any Platform, Any Network

MyJXTA (J2SE on Windows)

JXTA Chat (MIDP)

JXTA Virtual Network

JXTA-C Shell (On Solaris)
Current Platform Work – Scalability and Performance Enhancements

- Instrumentation & Benchmarks
- “Vertical” scalability
  - Optimize single platform instance (memory, thread, message queues, cpu, network, etc.)
- “Horizontal” scalability
  - Multi-peer platform optimization (discovery, resolver, propagation, Rendezvous, etc.)
Instrumentation and Benchmarking

- Adding instrumentation to the code and developing test suites
- Determining performance bottlenecks and tracking scalability improvements
- Measurements validate optimizations and changes
- Open community benchmark project (http://bench.jxta.org) serves as a repository of benchmarking tests and results
“Vertical” Scalability

- Optimize Resource Usage
  - Memory footprint usage
  - Endpoint thread and queue “fairness” management
- Enhance TCP/IP Transport
  - Bi-directional communications
- Reduce internal message copying
"Horizontal" Scalability

- Edge peers index their contents on Rendezvous peers
- Propagation limited to Rendezvous network
- Structure Rendezvous peers into a "semi-consistent" tree organization
- Add Resolver Access Point "hints" to speed resolution of resource endpoints (e.g. Pipes)
Community Projects

- Python
- Perl
- Objective-C
- Ruby
- SmallTalk
- TINI
- Services (e.g. JXTA-SOAP)
- And many others...
Looking Ahead

- New services and opportunities
  - E.g. content management, digital rights, presence, identity, integration with Web services

- Specification standardization through public organization – IETF (Internet Engineering Task Force)
  - See http://spec.jxta.org/v1.0/docbook/JXTAProtocols.txt
jxta.org Based on a Proven Open Source Model

www.jxta.org
  - All source, projects, docs, examples on-line

Apache–style software license
  - No barriers to getting started
  - No royalties, no fees, no registration

Meritocracy
  - The more you've done, the more you can do
JXTA Community Momentum


- 690,000 downloads
- 80+ projects
- 11,100+ members
- Active discussion groups
- Community actively contributing and integrating technology

Please join our efforts!
Project JXTA Resources

- Project home: http://www.jxta.org
- Downloads, tutorials, spec, documentation
  - http://platform.jxta.org
  - http://download.jxta.org
  - http://spec.jxta.org

- Mailing Lists and Active Community
  - Announce, Discuss, Dev, User @ jxta.org
  - Project-specific (e.g. http://jxme.jxta.org)

- Independent Software Vendors and Sun Microsystems Professional Services
JXTA Books

http://www.jxta.org/bookshelf.html

- Early Adopter: JXTA, Sing Li, 2001
- JXTA, Brendon J. Wilson, 2002
- Mastering JXTA Development, Joe Gradecki, August 2002
- Java P2P Unleashed, Robert Flenner, et al, 2002
Summary

- Project JXTA is an open source platform for P2P applications – it is free!
- Project JXTA technology is language, operating system, network, and service agnostic.
- Project JXTA works on any network device -- from cell phones to super servers
- Future Directions:
  - Massive Scaling, High Performance
  - Protocol Standardization with IETF
- Project JXTA resources and large, active community at http://www.jxta.org
If you only remember one thing...

Project JXTA lets you build and deploy enterprise and commercial P2P solutions more quickly.