JXTA™ Technology for XML Messaging

OASIS Symposium
New Orleans, LA
27-April-2004

Richard Manning
Senior Software Architect
Advanced Technology & Edge Computing Center
Sun Microsystems Inc.

www.jxta.org
www.java.net
www.sun.com
Agenda

- Peer-to-Peer Computing
- JXTA™ Technology
  - Virtual network
  - Architecture
  - Concepts & components
- JXTA Messaging & Security
- Interoperability & Future
- Q & A
What is Peer-to-Peer (P2P)?

* P2P is different things to different people...
  - Sharing files or swapping music
  - Instant messaging & pervasive devices communicating
  - Sharing CPU and storage resources
  - Distributed search and indexing
  - Collaborative work (and play)
  - New forms of content distribution and delivery

* P2P is not...
  - A specific architecture, technology, market, or business model
  - 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
What is JXTA Technology?

- An open set of XML-based protocols for creating peer-to-peer style network computing applications and services
  - A virtual network overlay
  - Protocol based → language, OS, network, and service agnostic technology
  - Defines mechanisms, not policies
- Open Source project: [www.jxta.org](http://www.jxta.org)
An Open Source Model

- **www.jxta.org**
  All source, projects, docs, examples are open
- **Apache-style software license**
  No barriers to getting started
  No royalties, no fees, no registration
- **Meritocracy**
  The more you’ve done, the more you’re allowed to do
JXTA License & Governance

• Source code for Project JXTA has been released to the open source community under a variant of the Apache software License.

• Functionally equivalent to the Apache Software License with minor changes to reflect the Project JXTA name and Sun Microsystems as the original contributor.

• http://www.jxta.org/project/www/license.html

• http://www.jxta.org/project/www/govern.html
What JXTA Technology Does
Creating Connected Communities

* Brings devices, services, and networks together
* Enables interactions among highly dynamic resources
* Takes the complexity out of the network and operating environments so developers can quickly build peer-to-peer applications
* Users have better access to content across multiple devices, regardless of location
  - Find it, get it, use it
JXTA Enables P2P Applications

- Content delivery and sharing
- Communication, collaboration, gaming
- Transactional Web Services
- Resource Sharing
Problems JXTA Technology Solves

• Provides a set of building blocks that provide a foundation for P2P applications
• Provides an open and interoperable set of protocols that do not have special licensing requirements
• Quick time to market for new products and services
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
JXTA Virtual Network

![Diagram of JXTA Virtual Network and Physical Network]

- **Peer** nodes are connected in a virtual network.
- **Virtual Mapping** connects peers to the physical network.
- **TCP/IP**, **HTTP**, and **NAT** are components of the physical network.
- A **Firewall** is also part of the physical 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**
- Sample Applications
  - Instant Messaging
  - File Sharing
  - Resource Sharing
  - Collaborative Apps
  - Content Viewers

**JXTA Services**
- Sample Services
  - Search
  - Indexing
  - Discover
  - Membership

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

**Any Connected Device**

© 2004 Sun Microsystems Inc. All Rights Reserved.
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)
Peer Types

✦ Micro peer

✦ Peer

✦ Super Peer
  Relay
  Rendezvous
  Proxy
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://JxtaHttpClinetuuuid-...)
- Used to establish point-to-point connections between two peers
- Direct connections not required; intermediary peers can route messages
Protocols

- JXTA technology 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

Super Peer:
- Peer Rendezvous Protocol
- Peer Discovery Protocol
- Peer Information Protocol
- Pipe Binding Protocol

Peer:
- Peer Information Protocol
- Pipe Binding Protocol

Micro Peer:
- Endpoint Routing 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.
Additional Pipe Types

- BiDiPipe
  - JXTA bi-directional Pipe
  - Request-Response

- JXTASockets
  - JXTASocket
  - JXTAServerSocket
  - JXTAMulticastSocket

- May be designated reliable and/or secure reliable!
Pipe Service Protocols

- **JXTA Pipe Binding Protocol**
  Mechanism to resolve the location of pipes to a physical peer
  Decentralized

- **Pipe Resolver Protocol**
  Uses dynamic and adaptive search mechanism
  Attempts at all times to find peers where an instance of the pipe is running
Messages

* Object sent between JXTA peers; basic unit of data exchange
* Ordered sequence of named/typed contents called Elements
* Contains its own routing information
* XML and binary representations are used
Message Routing Via Relay Peers

A

Peer

Send Message

Super Peer

Receive Message

Request Message

B

Peer

Firewall

Firewall
Message Routing Via Relay Peers

A

Peer

Send Message

Peer

Super Peer

Relay Message

Super Peer

B

Peer

Receive Message

Request Message

Firewall

Firewall
Services

- Set of functions that a provider offers
- Provider peer publishes service advertisement
- Pipes 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
Resolvers

• In JXTA technology, 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
Discovery Service

- Asynchronous mechanism for discovering advertisements (peers, peer groups, pipes, services)
- Can retrieve advertisements in local cache
- Can send Discovery Query Message
  - To a specific peer
  - Propagated to the JXTA network
Request Propagation via Rendezvous Super Peers

1. Push SRDI Index
2. Map and push index copy
3. Query
4. Route Query
5. Forward Query
6. Query Response
Security
Security Requirements

- Confidentiality
- Authentication
- Authorization
- Data integrity
- Refutability
Intrinsic Security in P2P Networks

- Decentralization
- Privacy
- Locality
- “Web of Trust”
JXTA Security Technologies

- Transport Layer Security (TLS)
- End-to-end transport independence of JXTA protocols
- Digital certificates and certificate authorities
- Encryption

By adopting a security model that relies on existing, trusted technologies, JXTA can provide strong security quickly, adopt new technologies, and retain flexibility.
Transport Layer Security (TLS)
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
Security Resources

* JXTA Security project
  http://security.jxta.org
discuss@security.jxta.org

* White papers
  http://www.jxta.org/white_papers.html

* TLS
  http://www.ietf.org/rfc/rfc2246.txt
  http://www.claymoresystems.com (Pure TLS)

* Cryptography
  http://www.bouncycastle.org/
Interoperability Examples

• JXTA SOAP
  – Designed to allow SOAP communication over the JXTA P2P network
  – Leverages JXTA virtual network for dynamic discovery
  – Community Project at: http://soap.jxta.org/

• JMS-for-JXTA
  – Designed to allow JMS over JXTA
  – Designed to allow JXTA over JMS
  – Community Project at: http://jms-for-jxta.jxta.org/
Interoperability Example

• Java Web Services
  – JXTA can be integrated at many levels within the Java Technologies for Web Services:
    • Java API for XML-Based RPC (JAX-RPC)
    • Java API for XML Messaging (JAXM)
    • Java API for XML Registries (JAXR)
    • Java API for XML Processing (JAXP)
    • Java Architecture for XML Binding (JAXB)
    • SOAP with Attachments API for Java (SAAJ)

• Please remember JXTA is hardware/OS platform, programming language and network agnostic!
JXTA Technology Status

- JXTA technology specification, code, demos, docs, and tutorials on-line
- Virtual network beginning to build
- Active community - contributing and integrating technology
JXTA Community Momentum


- 2,500,000+ downloads
- 80+ Projects
- 17,500+ members
- Active discussion groups
- Community actively contributing and integrating technology

Please join our efforts!
JXTA Implementation Platforms

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

- **JXTA-C**
  - Standard Peer functionality only
  - Runs on Linux, Solaris™ OE, and Windows

- **JXTA Technology for J2ME™**
  - Micro Peer functionality only
  - MIDP-1.0 compliant
  - iappli compliant
Community Projects

- Python
- Perl
- Objective-C
- Ruby
- Smalltalk
- Services
- Applications
- And many others...
Future Directions

• Enhanced Performance, Scalability, and Security
  – SAML
  – expanded use of credentials

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

• Specification standardization through public organization
  – http://spec.jxta.org/
Q & A