WebPeer: A P2P-based System for Publishing and Discovering Web Services

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Outline

- □ Background of P2P Research
- □ A Glance of our Current Projects
- □ WebPeer: A Web Services Oriented Peer-to-peer System
- □ Experiments & Implementation
- □ Summary & Ongoing Work

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Society Development

First phase:

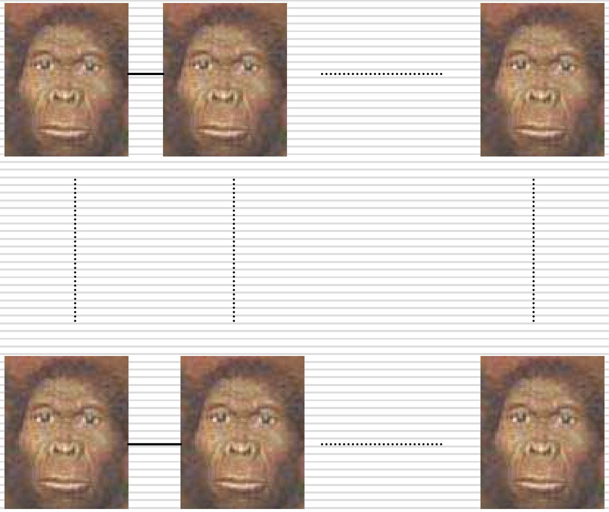
  Before B.c. 2000

Hominid society:

  cooperative

  equal

  commutative



The Day After Tomorrow

Service Architecture Development

The Arch. After Those

Peer-to-Peer Architecture!

Predictions

- From Forbes (Feb., 2005)
  - (Internet) Applications based on peer-to-peer topologies will be the mainstream.
- From Brainpower of U.S (Jan., 2005)
  - Self-Aware Peer-to-Peer Systems will develop resilient, scalable sensor/computation networks with decentralized control.

Distributed Computing Economics

(Views of Jim Gray)

- An equivalent price for following computing items:
  - one database access
  - 10 bytes of internet traffic
  - 100,000 instructions
  - 10 bytes of disk storage
  - a megabyte of disk bandwidth
- The break-even point is 10,000 instructions per byte
- This serves a basis how we do cost-effective Internet-based computing, such as peer-to-peer computing

What is Peer-to-Peer?

- □ A model of communication where every node in the network acts alike.
- □ As opposed to the Client-Server model, where one node provides services and other nodes use the services.
- □ In P2P network, every node is both client (consumer) & server (producer).

Why P2P ?

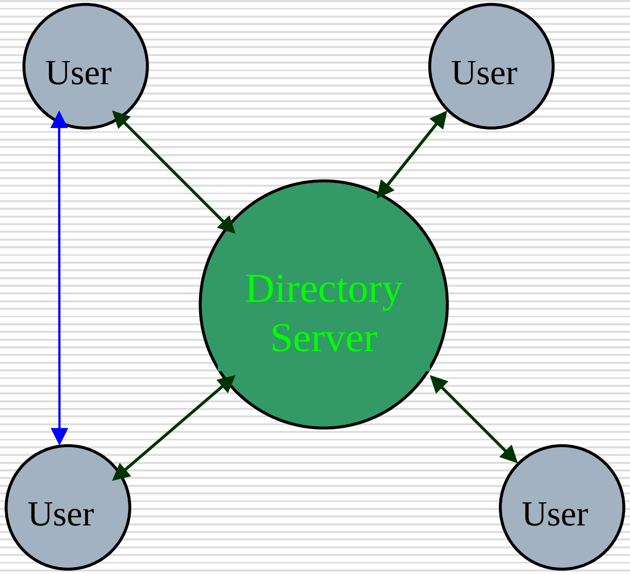
□ Inherent scalability

□ Abundant resources

□ No central point of failure

□ No guarantee about QoS

Building P2P Topology



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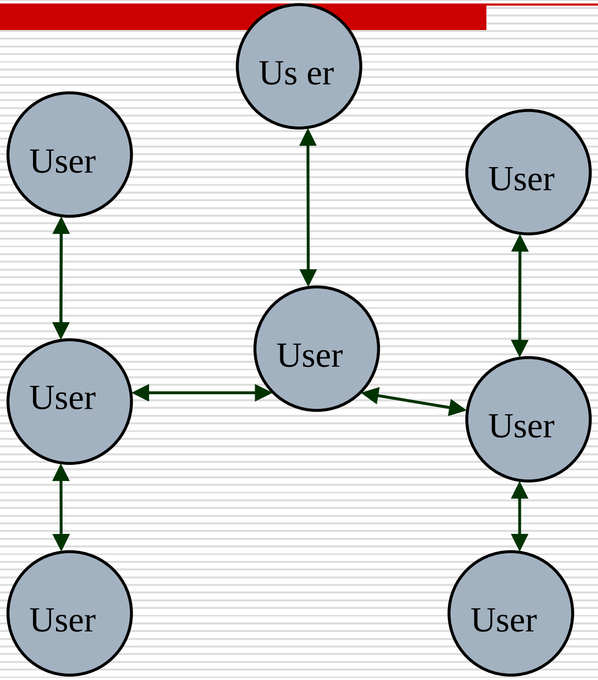

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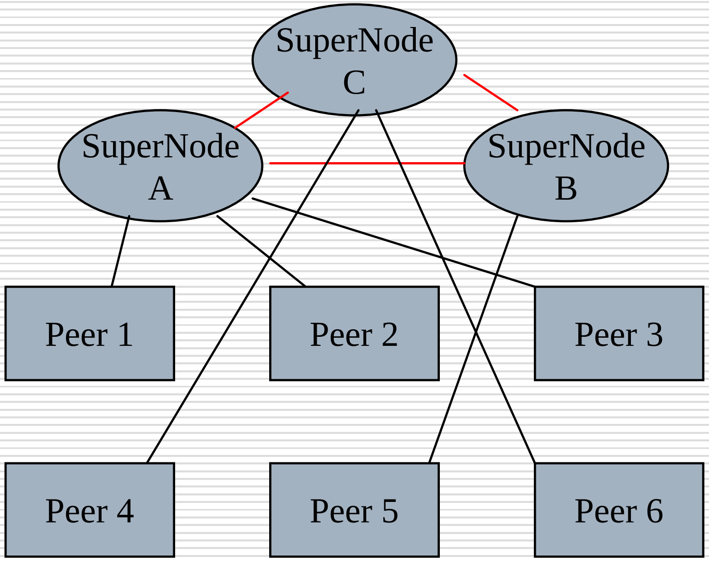
Peer 4: File 1, File 2, File 3, ...

Peer 6: File 1, File 2, File 3, …



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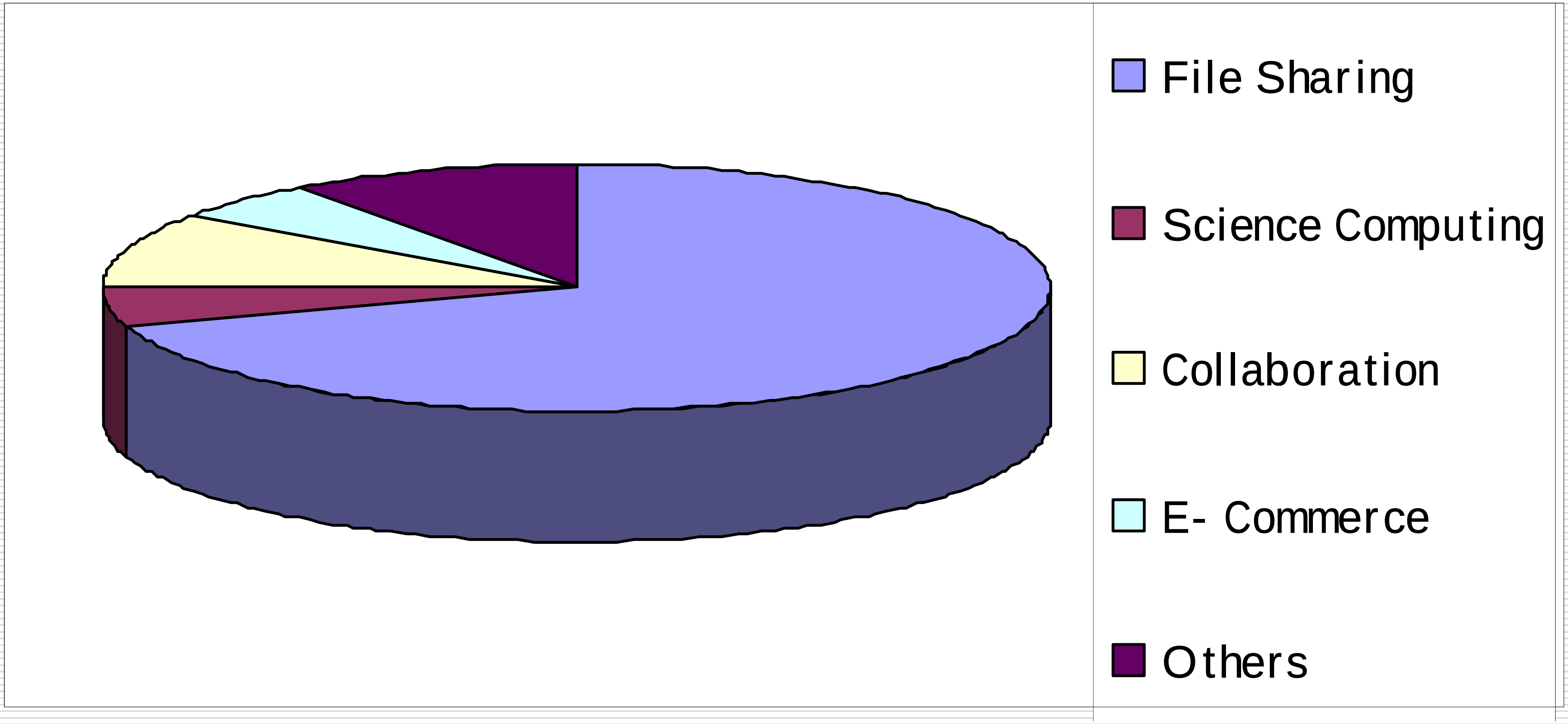
Hybrid Centralized P2Ps
- **Napster**
- **Central Metadata**
- **Single Failure Point**
- **Low Scalability**

Pure Decentralized P2Ps
- **Gnutella, Freenet**
- **No Central Point**
- **Good Scalability**
- **Flooding-based Search**
- **Hard Management**

Partially Decentralized P2Ps
- **KazaA, Morpheus**
- **Structured**
- **Good Scalability**

P2P Applications



Key Issues

- □ Topology Maintenance
- □ Searching Scheme (Routing Protocol)
- □ Data Dissemination Scheme
- □ Buffer Management
- □ Security and Reputation

Our Experiences on P2P

- WebPeer
  - A Web Services Oriented P2P System
  - http://idc.hust.edu.cn/webpeer/
- CoEdit
  - A P2P Based Collaborative Editing System
  - http://idc.hust.edu.cn/coedit/
- TrustedPeer
  - A Secure and Dynamic Trusted P2P System

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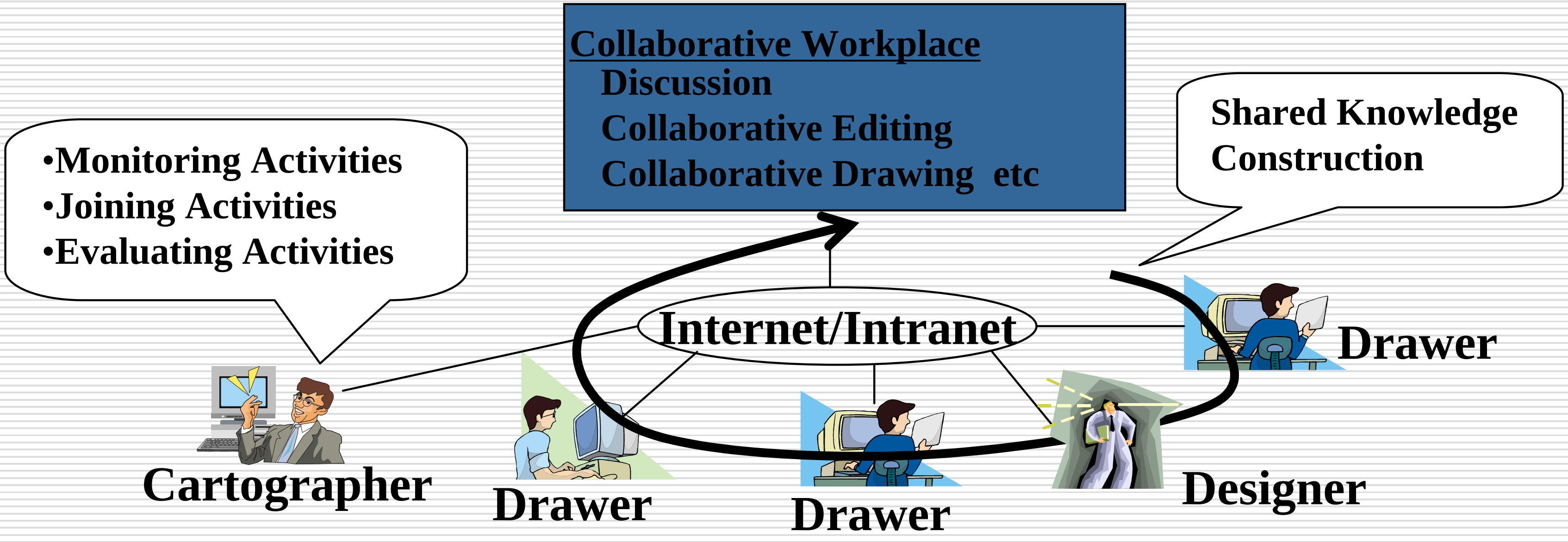
CoEdit: Overview

- □ **Collaborative Editing** is a form of Editing which involves a group editing process.
- □ **Scenario**: Cartographers, designers and drawers fulfill drawing objectives, through sharing resources, context and group interaction.



Collaborative Workplace

Discussion

Collaborative Editing

Collaborative Drawing etc

•Monitoring Activities

•Joining Activities

•Evaluating Activities

Shared Knowledge Construction

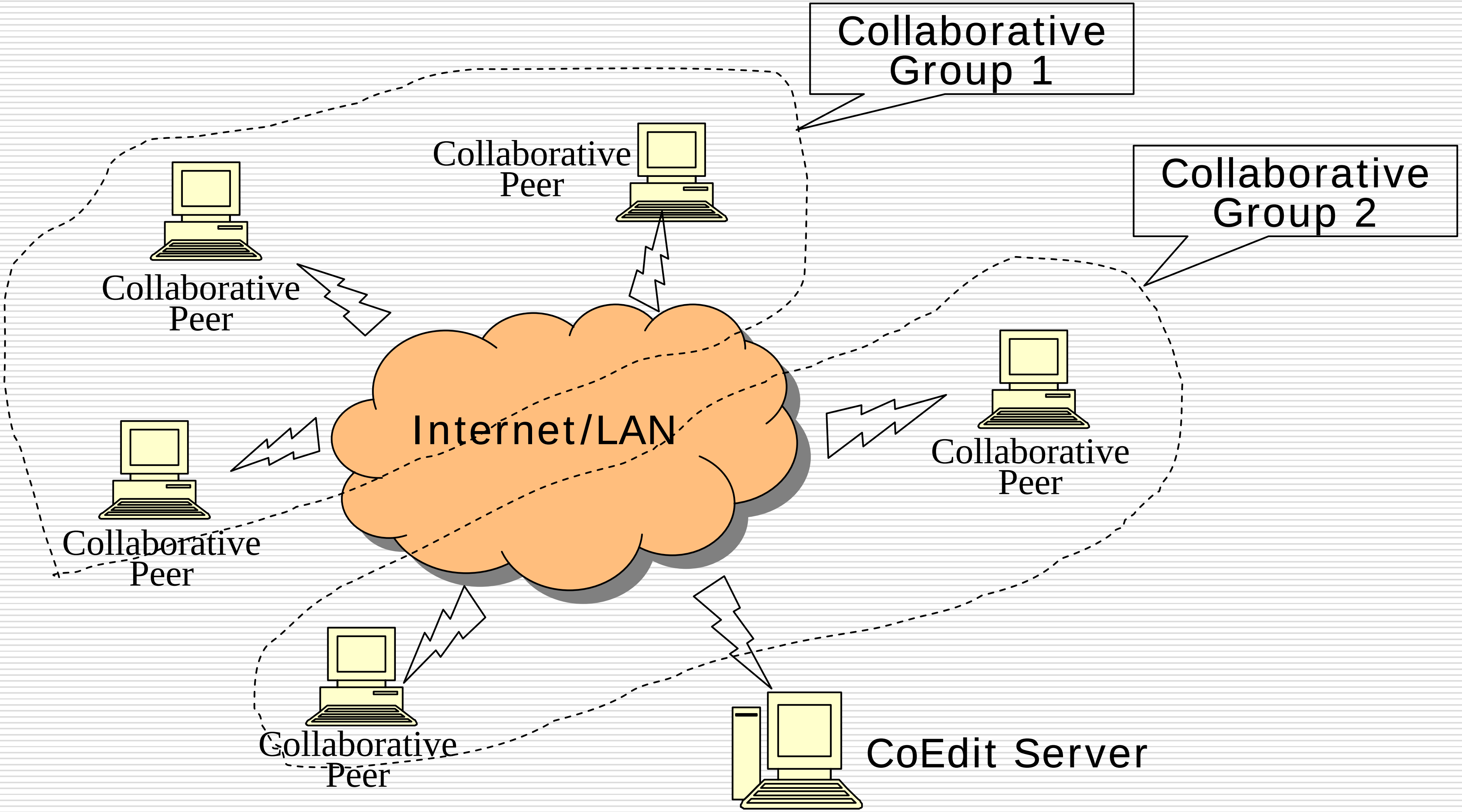
CoEdit: Issues

- □ **Session Management**: How do distributed users create, destroy, join and leave collaborative sessions?
- □ **Concurrency Control**: How do we ensure that concurrent users do not enter inconsistent commands, or merge concurrent commands entered by different users?
- □ **Undo/Redo**: What are the semantics of undo/redo in a collaborative session?
- □ **Awareness**: How are users made aware of “out of band” activities of their collaborator?
- □ **Access Control**: How do we ensure that users do not execute unauthorized commands?
- □ Other Aspects: …

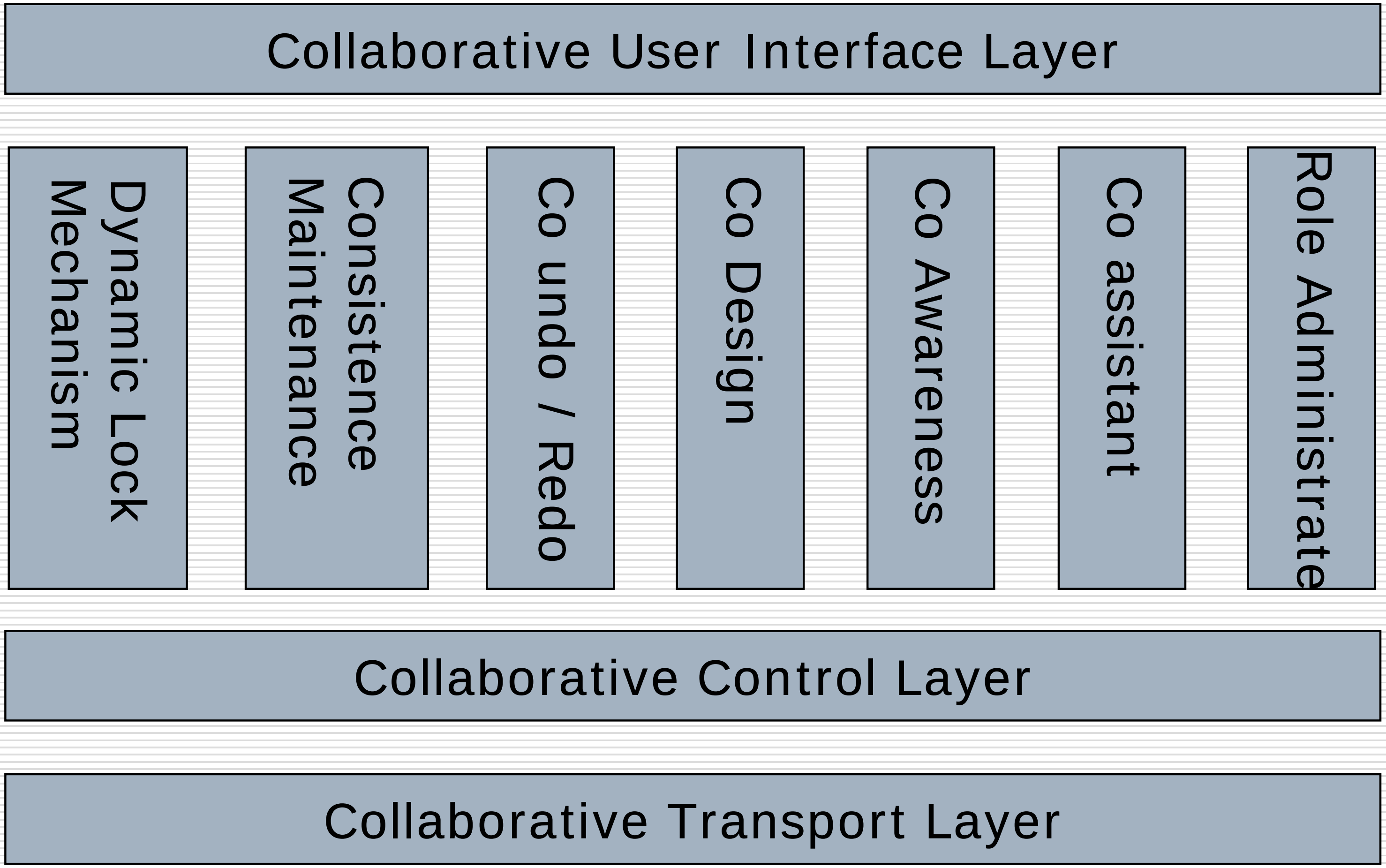
CoEdit: Our Approach

- Enhance the efficiency and performance through employing P2P technology.
  - Centralized and decentralized architecture
  - Direct communication between collaborative sites
  - Message routing in the collaborative group
  - Access control among different peers

CoEdit: Arcgitecture



CoEdit: Function Model



Collaborative User Interface Layer

Dynamic Lock Mechanism

Consistence Maintenance

Co undo / Redo

Co Design

Co Awareness

Co assistant

Role Administrate

Collaborative Control Layer

Collaborative Transport Layer

Another Project

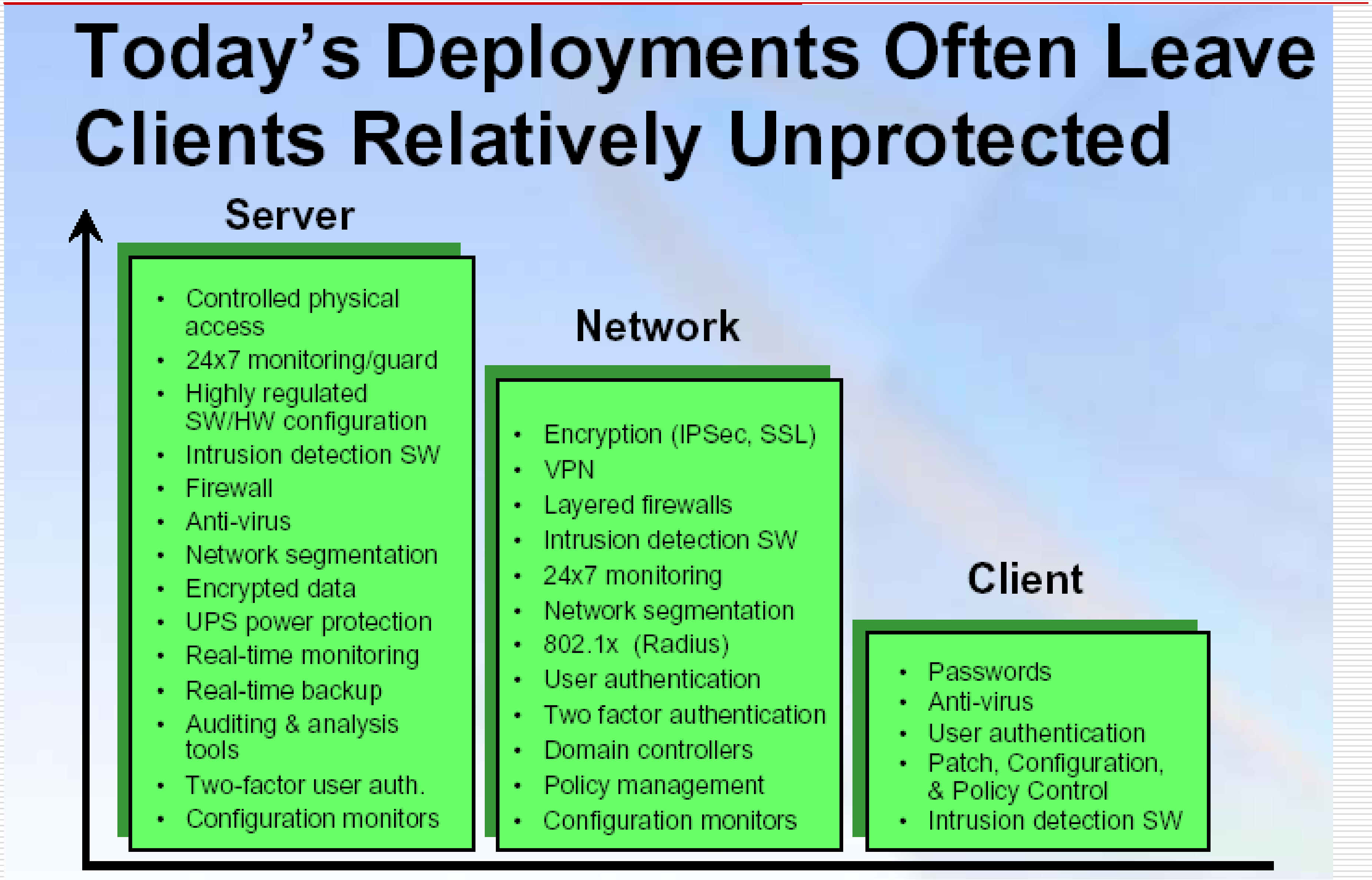
TrustedPeer —

One of the security related projects

TrustedPeer: Overview

referenced

IDC-Lab



Today’s Deployments Often Leave Clients Relatively Unprotected

Server

- Controlled physical access
- 24x7 monitoring/guard
- Highly regulated SW/HW configuration
- Intrusion detection SW
- Firewall
- Anti-virus
- Network segmentation
- Encrypted data
- UPS power protection
- Real-time monitoring
- Real-time backup
- Auditing & analysis tools
- Two-factor user auth.
- Configuration monitors

Network

- Encryption (IPSec, SSL)
- VPN
- Layered firewalls
- Intrusion detection SW
- 24x7 monitoring
- Network segmentation
- 802.1x (Radius)
- User authentication
- Two factor authentication
- Domain controllers
- Policy management
- Configuration monitors

Client

- Passwords
- Anti-virus
- User authentication
- Patch, Configuration, & Policy Control
- Intrusion detection SW

TrustedPeer: Overview

- Trust on client platform is needed in modern systems and emerging applications
  - Distributed Dissemination CONtrol (DDCON)
    - *e.g, Health records of a patient may be transmitted from a primary physician to a consultant who can access them for some limited period of time and cannot transmit them to anyone else*
  - P2P VOIP Application
    - Realtime protection of audio data in a platform
      - conversation is not eavesdropped or illegally recorded.
    - Forward control of audio object (e.g., voice mail)
      - Control the platform and user to forward
  - P2P E-Commerce
    - Electronic currency between peer platforms
    - Payment systems for p2p e-commerce

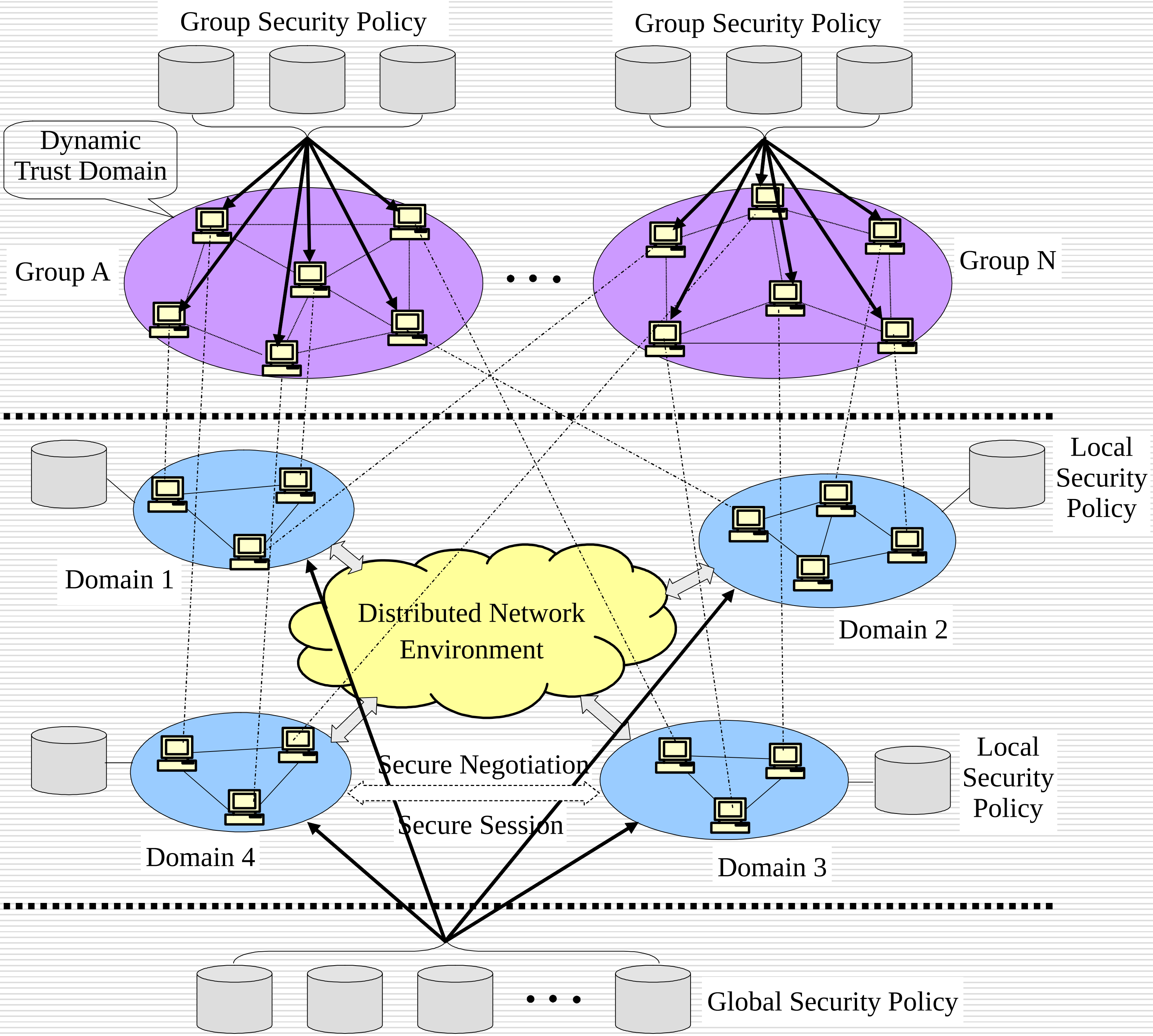
TrustedPeer: Overview

- □ Need new security model and architecture
  - Change of trust relation between client and server
    - ✓ No centralized and strongly protected server
    - ✓ Data located in peers or general client platforms
  - Location of policy enforcement changed
    - ✓ Client-side policy enforcement needs trust
  - Trust of platform and application
    - ✓ Dynamic environment
    - ✓ Software-based attacks
  - Trusted user authentication and authorization in client platform
  - Trusted path from peer to peer
    - ✓ Spoofing and “man-in-the-middle” eavesdropping or modification attacks
    - ✓ Trusted information exchange between peers

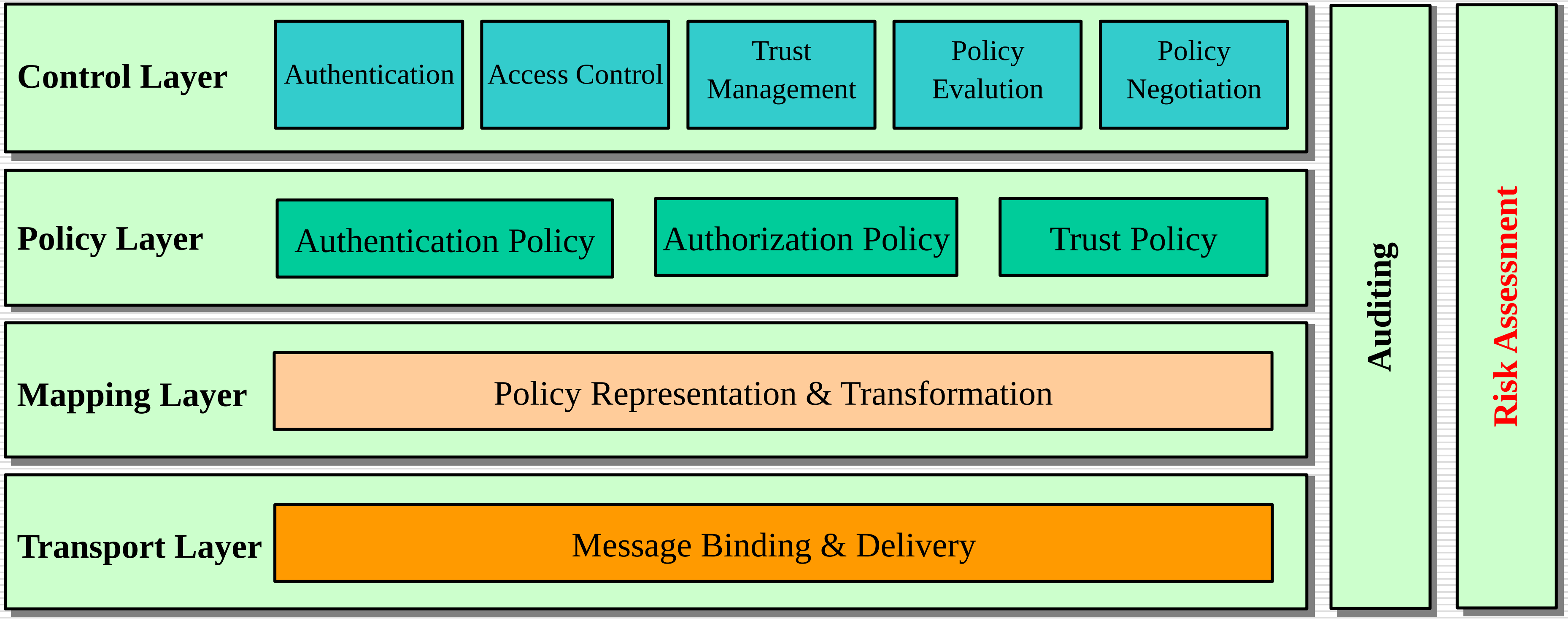
TrustedPeer: What's our Focus?

- Three types of researches for P2P security
  - Reputation systems
  - Recommendation systems
  - Trust systems
- TrustedPeer – part of the following project
  - Policy-based Secure Interoperability among Multiple Autonomous Domains
    - TrustedPeer: A Secure and Dynamic Trusted P2P System
    - OntoRBAC: Ontology-based Description and Enforcement of RBAC
    - OntoPolicy: Ontology-based Secure Interoperability among Multiple Security Policies (extended OntoRBAC)

Policy-based Secure Interoperability Architecture



Protocol Layers



Control Layer

Authentication

Access Control

Trust Management

Policy Evalution

Policy Negotiation

Policy Layer

Authentication Policy

Authorization Policy

Trust Policy

Mapping Layer

Policy Representation & Transformation

Transport Layer

Message Binding & Delivery

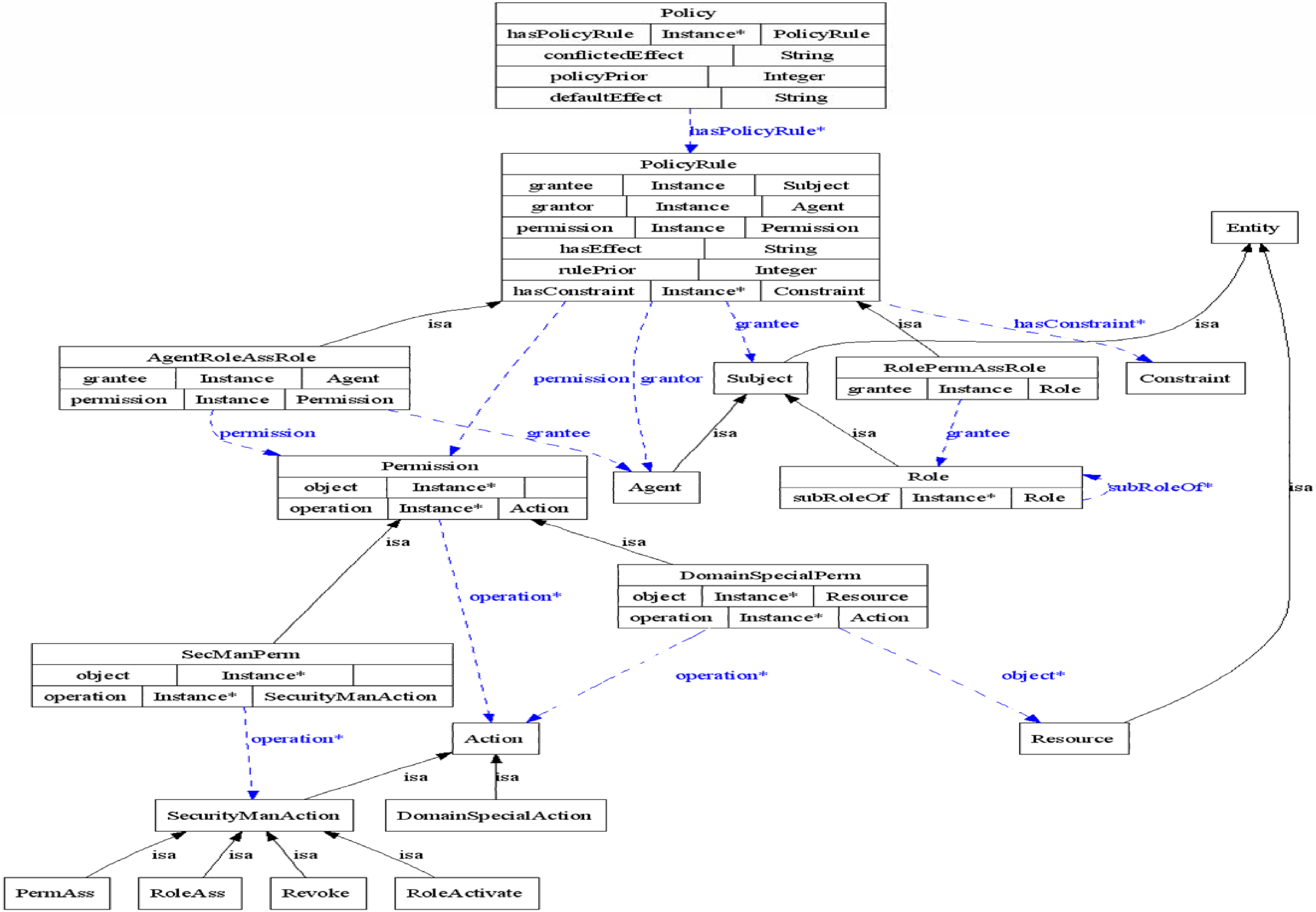
Auditing

Risk Assessment

OntoRBAC

- Kinds of methods for security policy description
  - Logic-based (FOL, Stratified Logic, Deontic Logic)
  - XML-based (XACML, XRBAC, SAML, …)
  - Ontology-based (Rei, KAoS)
- OntoRBAC
  - Ontology-based Description and Enforcement of RBAC
  - Concepts: Entity, Subject, Role, PolicyRule, Permission, Action, Policy, …

OntoRBAC: Concept-Relationship Diagram



Policy		
hasPolicyRule	Instance*	PolicyRule
conflictedEffect	String	
policyPrior	Integer	
defaultEffect	String	

PolicyRule		
grantee	Instance	Subject
grantor	Instance	Agent
permission	Instance	Permission
hasEffect	String	
rulePrior	Integer	
hasConstraint	Instance*	Constraint

AgentRoleAssRole		
grantee	Instance	Agent
permission	Instance	Permission

RolePermAssRole		
grantee	Instance	Role

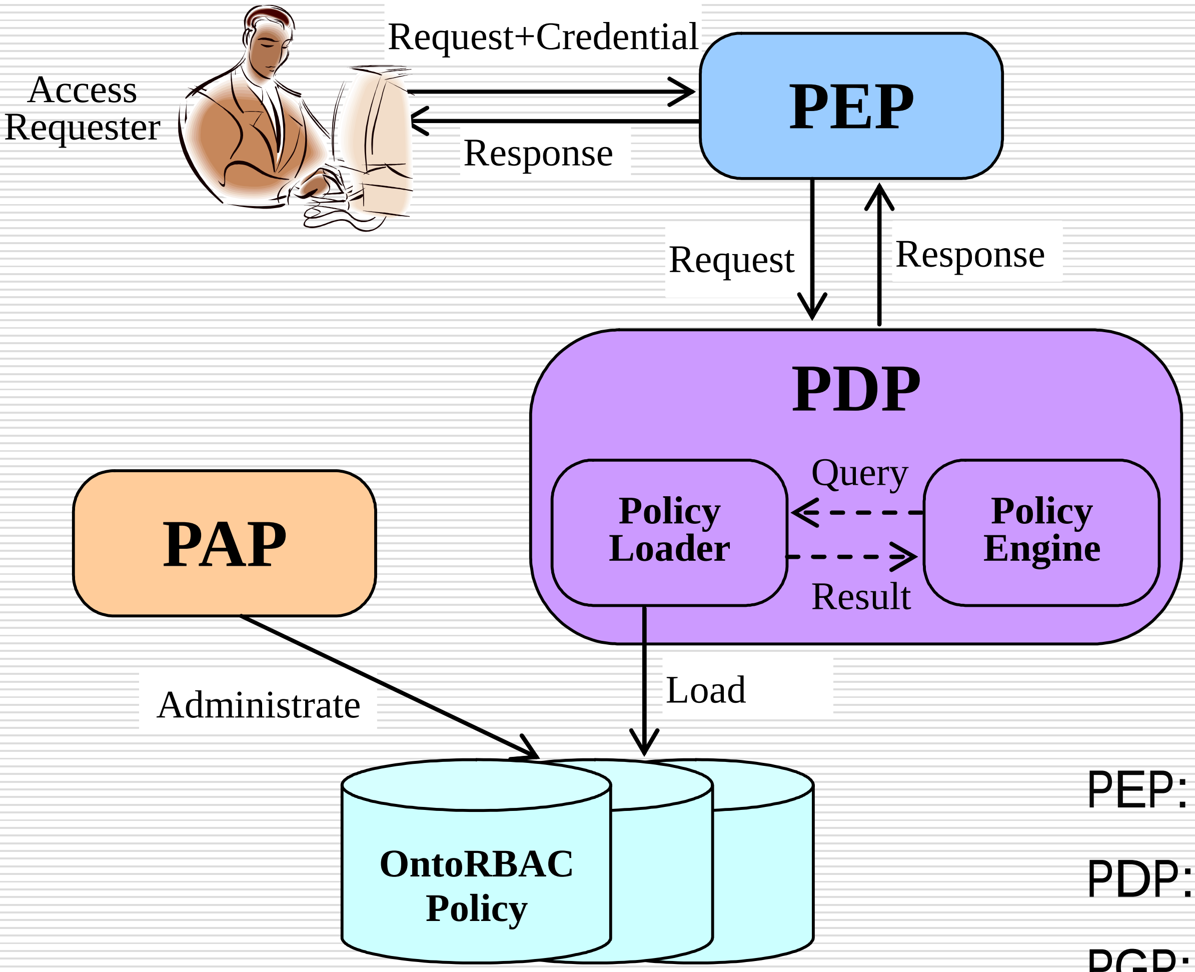
Permission		
object	Instance*	
operation	Instance*	Action

Role		
subRoleOf	Instance*	Role

DomainSpecialPerm		
object	Instance*	Resource
operation	Instance*	Action

SecManPerm		
object	Instance*	
operation	Instance*	SecurityManAction

OntoRBAC: Architecture



PEP: Policy Enforcement Point

PDP: Policy Decision Point

PGP: Policy Administration Point

OntoPolicy

- Goal: Integration of Multiple Different Security Policies
  - Heterogeneity of security model
  - Heterogeneity of security policy (description)
  - Heterogeneity of security semantics
- OntoPolicy
  - Ontology-based Secure Interoperability among Multiple Security Policies
  - Nearly ongoing

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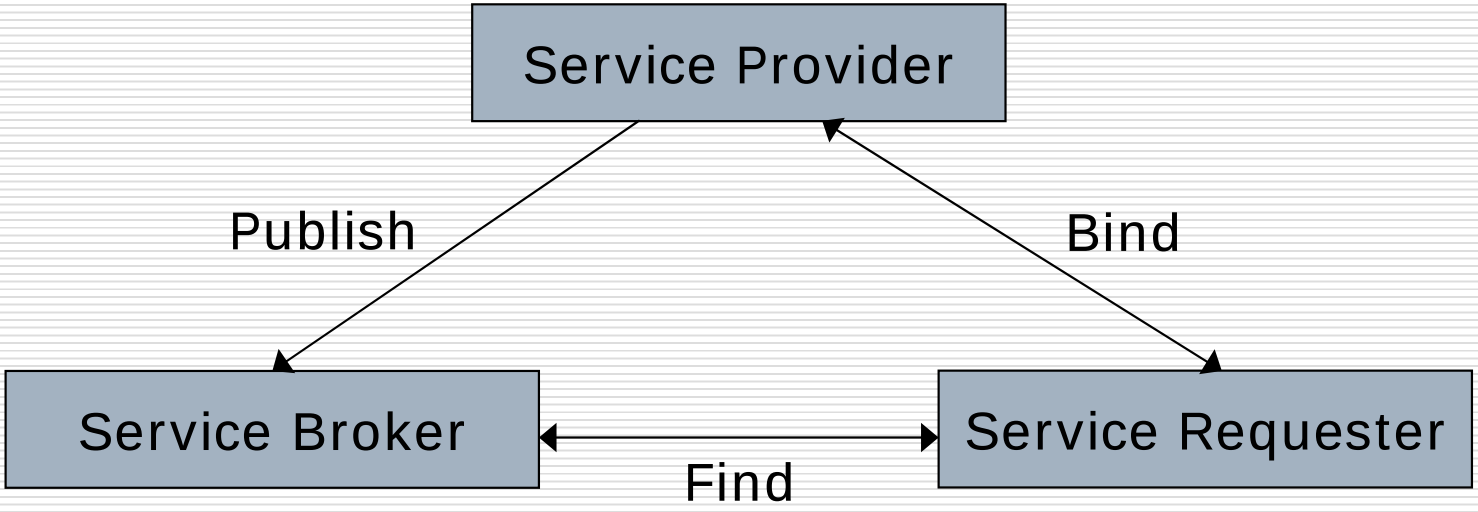
Web Services are booming …

- Classical Web Services
  - Service provider
  - Service requestor
  - Service broker (UDDI)

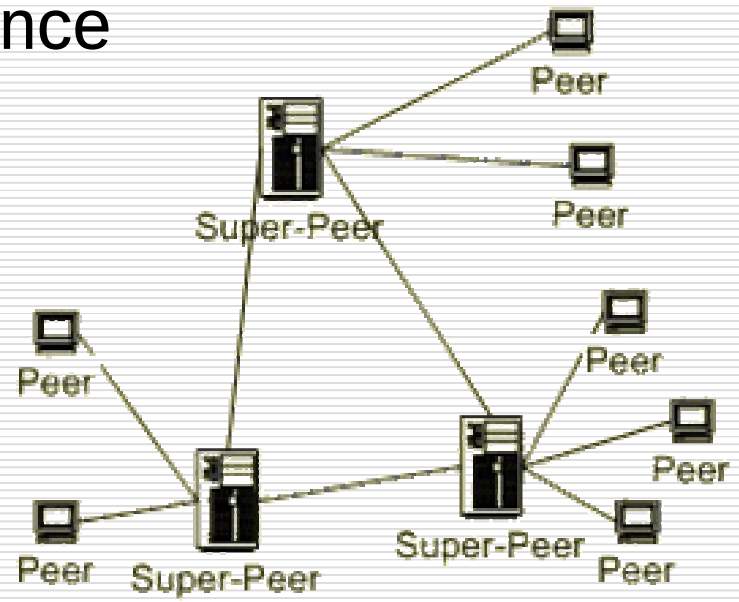


Disadvantages of Web Services

- □ Single Node Failure
- □ UDDI Bottleneck
- □ Limited Scalability
- □ Denial of Service (DoS) Attack

While Peer-to-peer Computing …

- □ Sharing plentiful resources and services among network edges
- □ Federated cooperation among companies
- □ Having Lower costs of system maintenance
- □ Fault tolerance & load balance



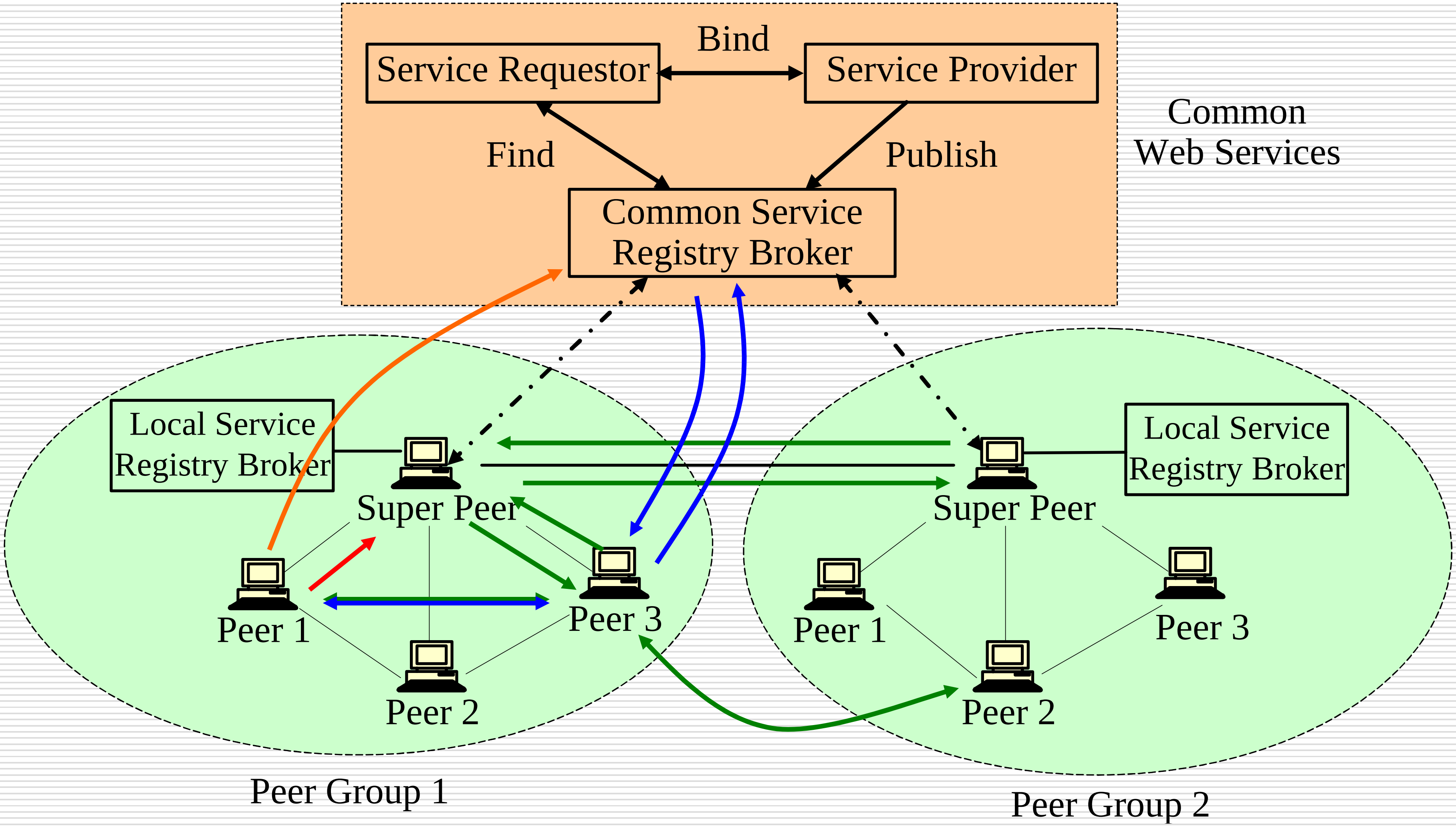
Combination of the two technologies

- Using P2P-based technologies to publish and discover Web Services
  - Combination of centralized and decentralized characteristics
  - The node providing web services act as a peer
  - Each peer can request web services from other peers
  - Extend the reliability and scalability of the current web services architecture

Related Work

- Content-based search in P2P networks
  - CAN(*AT&T*), Pastry(*Microsoft*), Chord(*MIT*)
- Combination of web services and peer-to-peer networks
  - Self-Serv (*UNSW*, *QUT*)
  - Peermetrics
- P2P platform supporting Web Services
  - JXTA (*Sun*)

WSOP: Web Services Oriented Peer-to-peer Architecture



CSRB & LSRB

- CSRB: Common Service Registry Broker
  - Common Web Services
  - Service provider, requestor, broker
  - UDDI (CSRB), SOAP, WSDL
- LSRB: Local Service Registry Broker
  - Local Web Service
  - Peers (service provider, requestor)
  - Super peers (LSRB)
  - Peer group (same interests, neighbors)

Service Publishing

- Publishing services to LSRB
  - Register services to one peer group (super peer)
  - Register services to multiple peer groups
- Publishing services to CSRB
  - As a traditional service provider
- Publishing to both LSRB and CSRB
  - Mappings between LSRB and CSRB

Service Discovery

- Step 1: search the services in its peer group
  - If matches, enjoy the service
  - Otherwise, go to Step 2
- Step 2: request will be delivered to other peer groups
  - If matches, return the result, and cache the result on the way home
  - Otherwise, go to Step 3

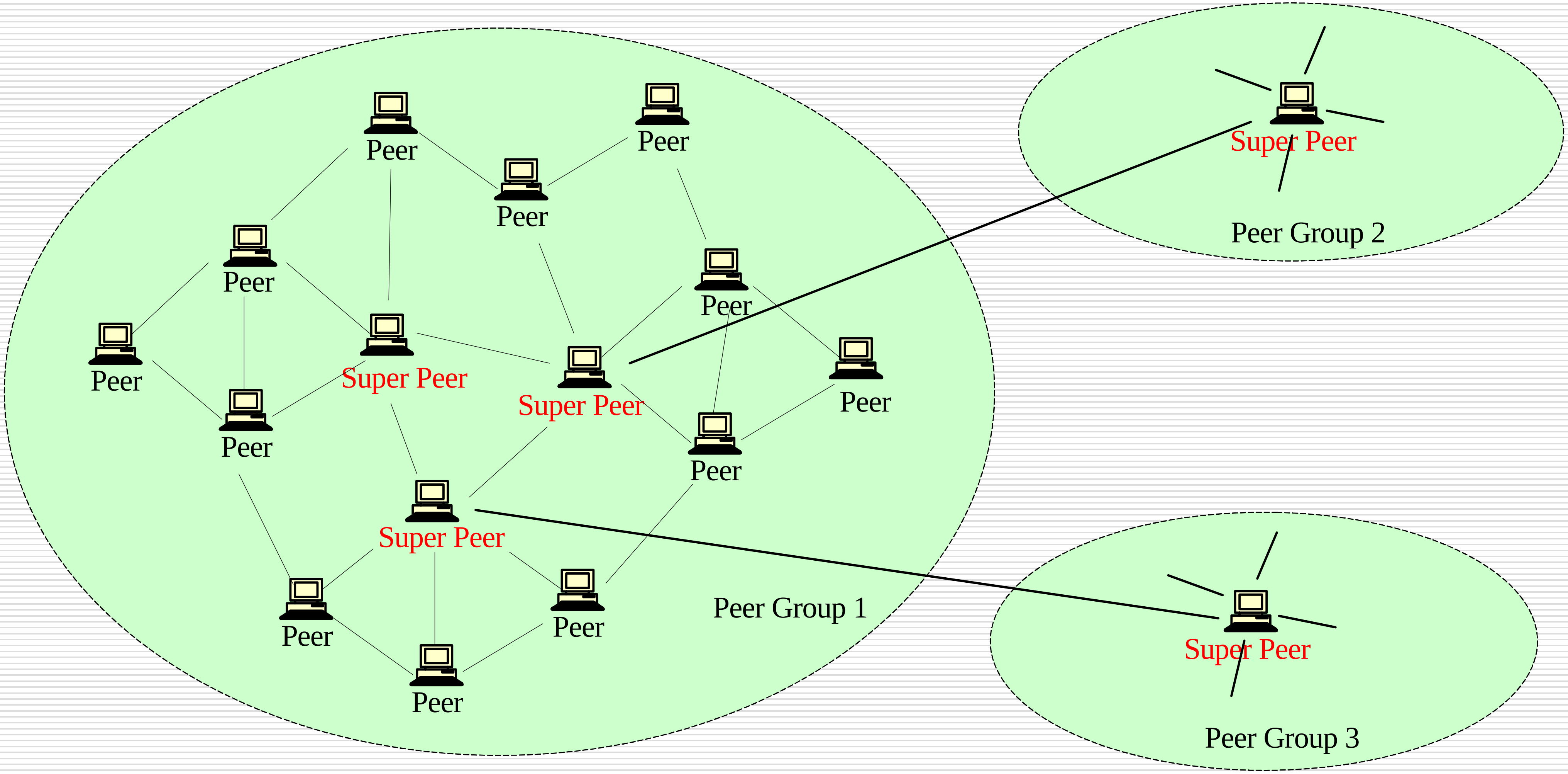
Service Discovery

- Step 3: request will be delivered to CSRB
  - If matches, return the result
    - Establish mappings on LSRB
    - Cache the result on LSRB
  - Otherwise, service not found

Existing Problems

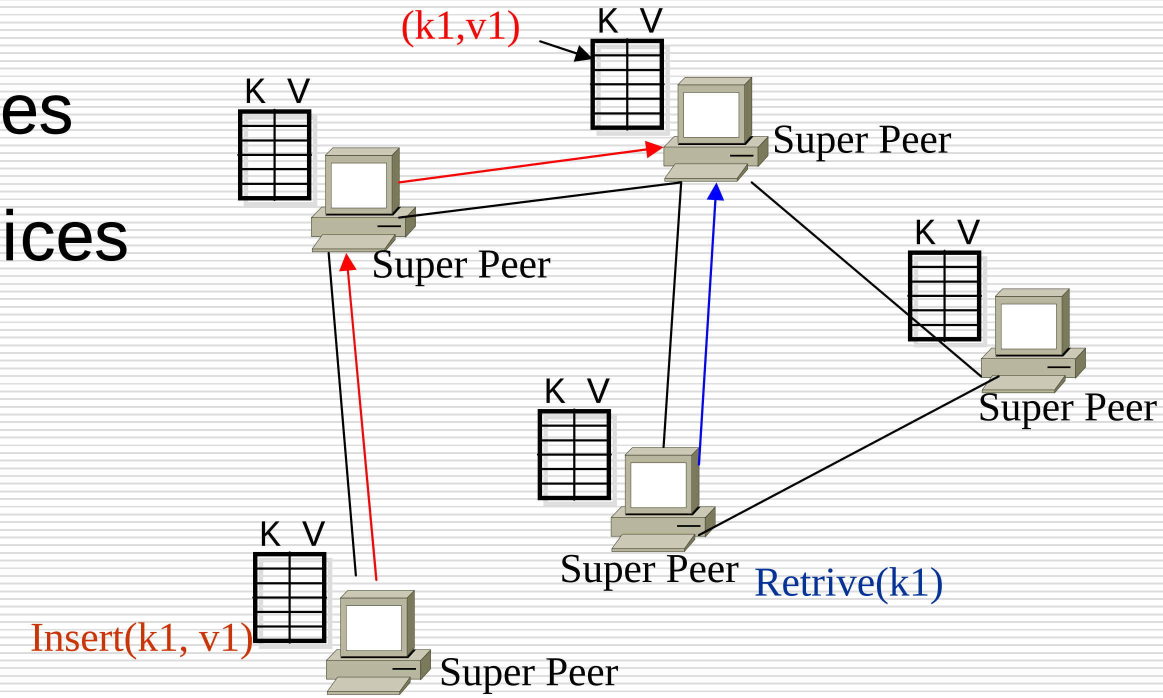
- Open problem:
  - Super peer will be the bottleneck if the peer group grows large enough
- Solutions:
  - Using more than one super peer in the group
  - Using Distributed Hash Table (DHT) to organize LSRBs on super peers

Using Multiple Super Peers



Modified DHT Approach

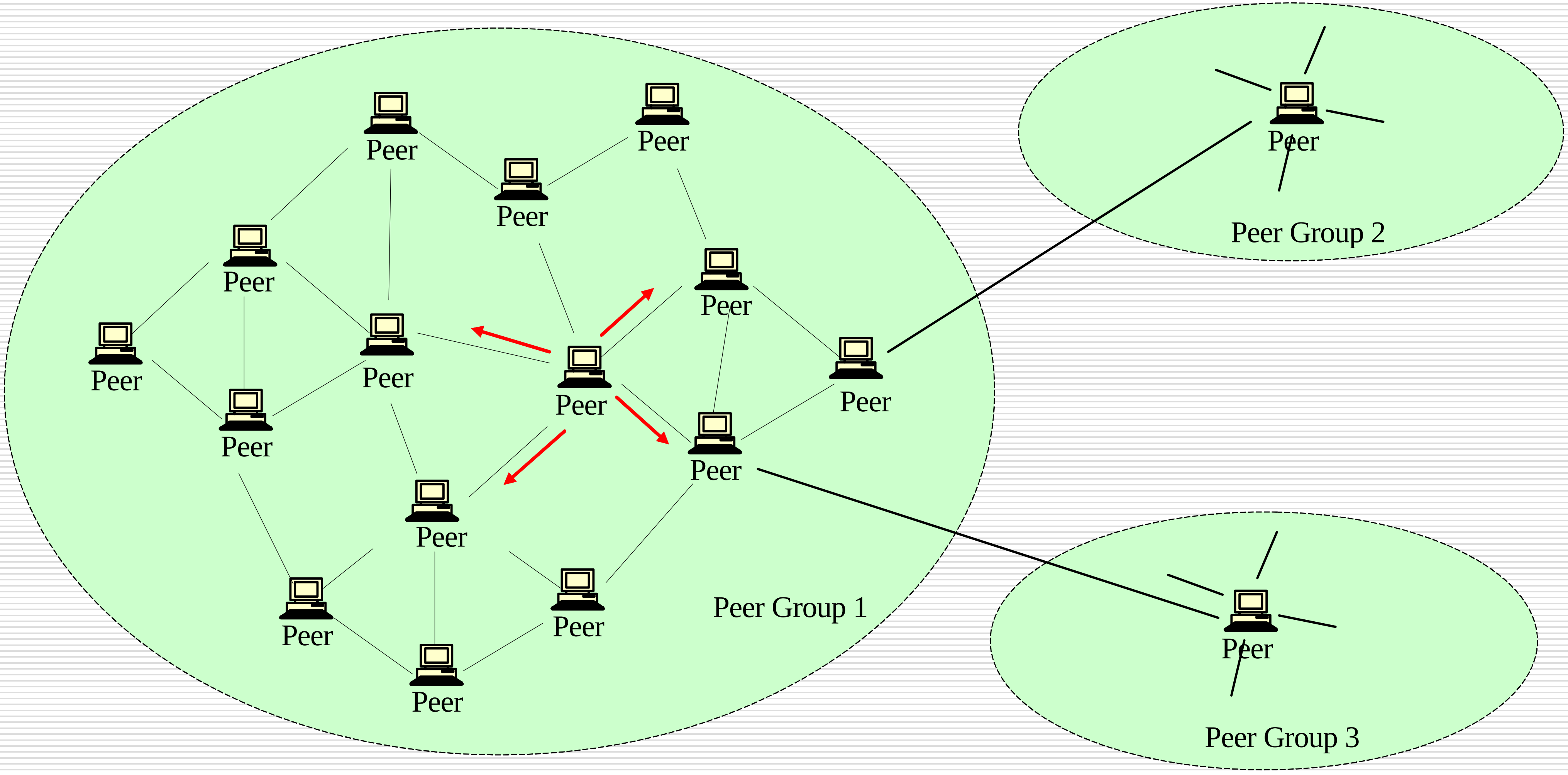
- □ Establish DHT among Super Peers
  - DHT: key-based search, need cost of maintenance
  - Super peers are less dynamic and transient than other peers
  - Publishing services
  - Discovering services



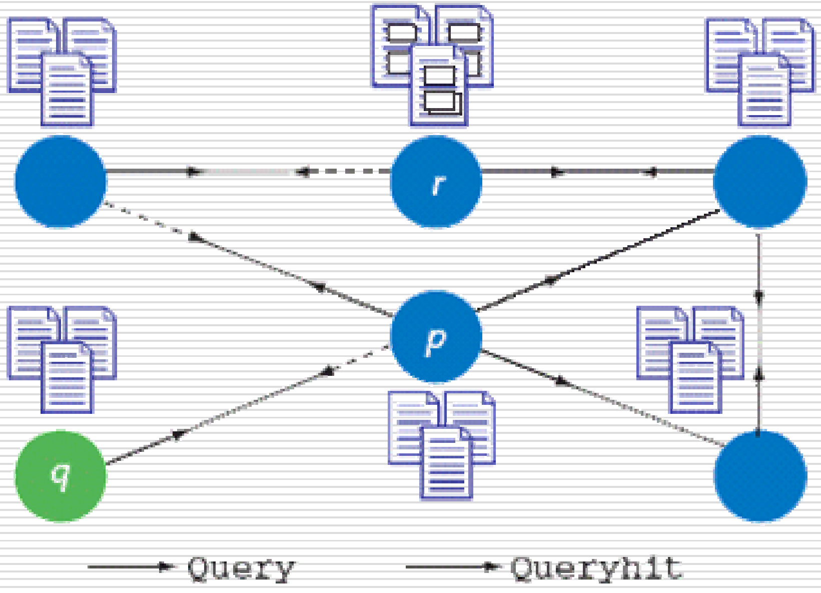
Another Solution

- Using peer groups, but no super peers
  - Publishing services to its neighbors
    - Selected peers (including itself)
  - Discovering services from its neighbors
    - Breadth-First Search (BFS)
    - Random Breadth First Search (RBFS)
    - Intelligent Search Mechanism (ISM)
    - Most results in the past (>RES)
    - Maybe other approaches …

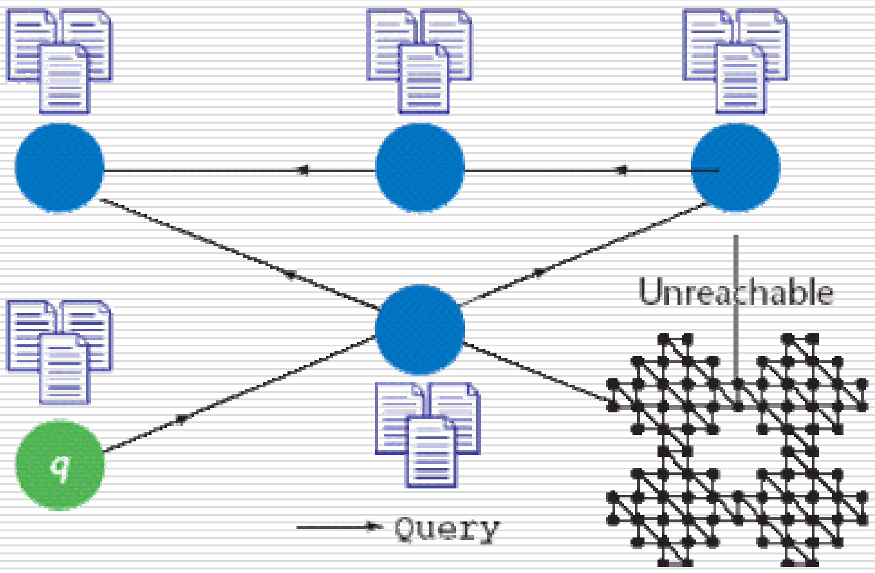
No Super Peers



Service Discovery Techniques



Breadth First Search
(BFS)

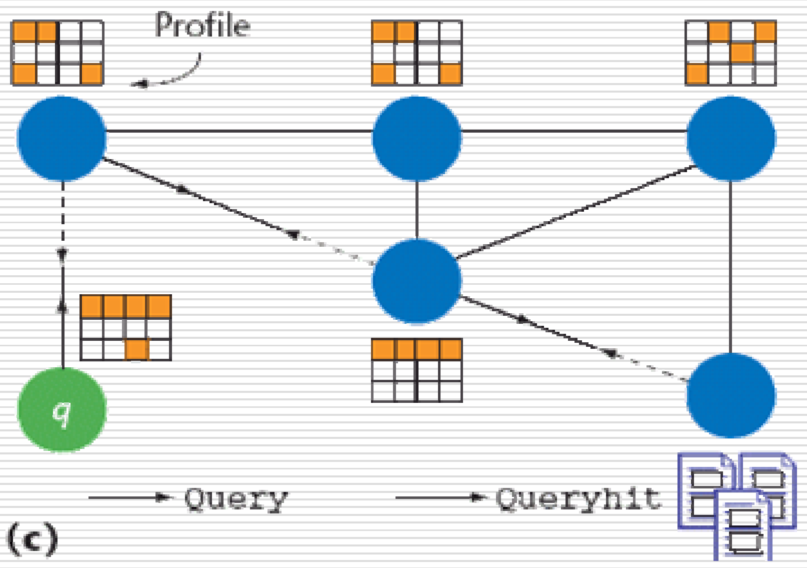


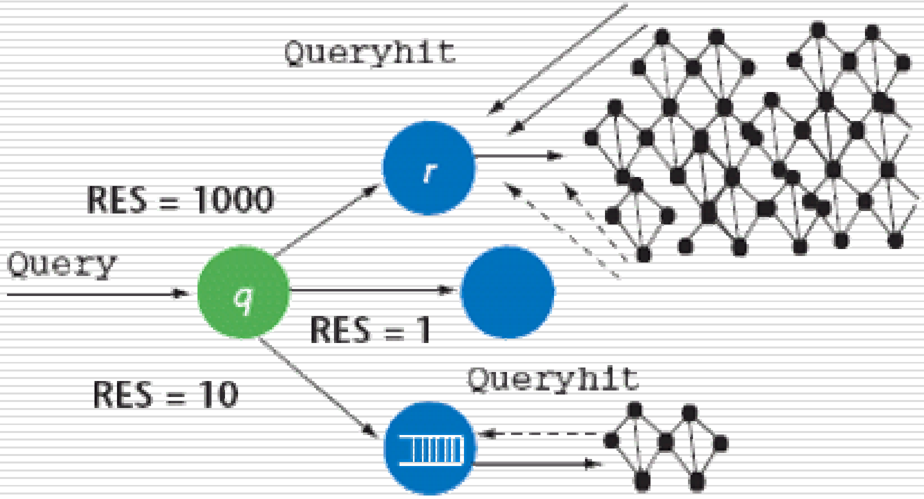
Random Breadth First Search
(RBFS)

✓query all neighbors

✓query a random subset of neighbors

Service Discovery Techniques (Cont.)





Intelligent Search Mechanism (ISM)

Directed BFS and >RES

✓intelligently query a subset of neighbors according to the relevance rank

✓query the neighbors that returned the most results in the last 10 queries

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- □ WebPeer: A Web Services Oriented Peer-to-peer System
- □ **Experiments & Implementation**
- □ Summary & Future Work

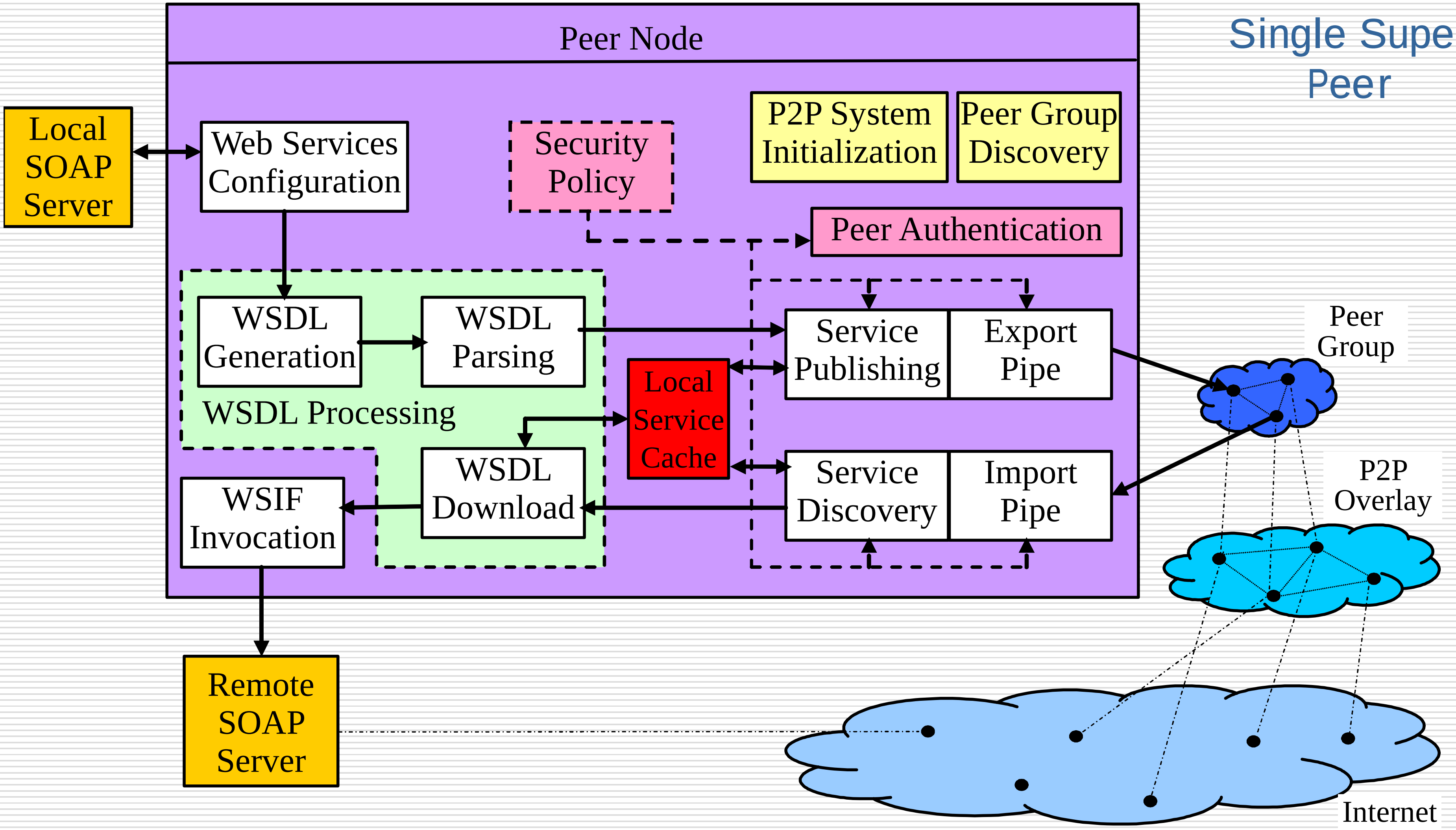
Experiments

- Experiment Parameters
  - Vary nodes between 1,000..100,000
  - Vary percentage of nodes for service publishing between 0.1..0.5
  - Vary percentage of nodes for service discovery between 0.5..0.9
  - Initial topology random graph

Experiments

- Simulations for the four types of approaches
  - CSRB: Traditional UDDI server only
  - LSRB: Using single super peer
  - MSP: Multiple super peers
  - NSP: None super peers
    - BFS, RBFS, ISM, >RES
- Results will come out soon

Implementation: Detailed Architecture



Single Super Peer

An Instance of Web Services Advertisement

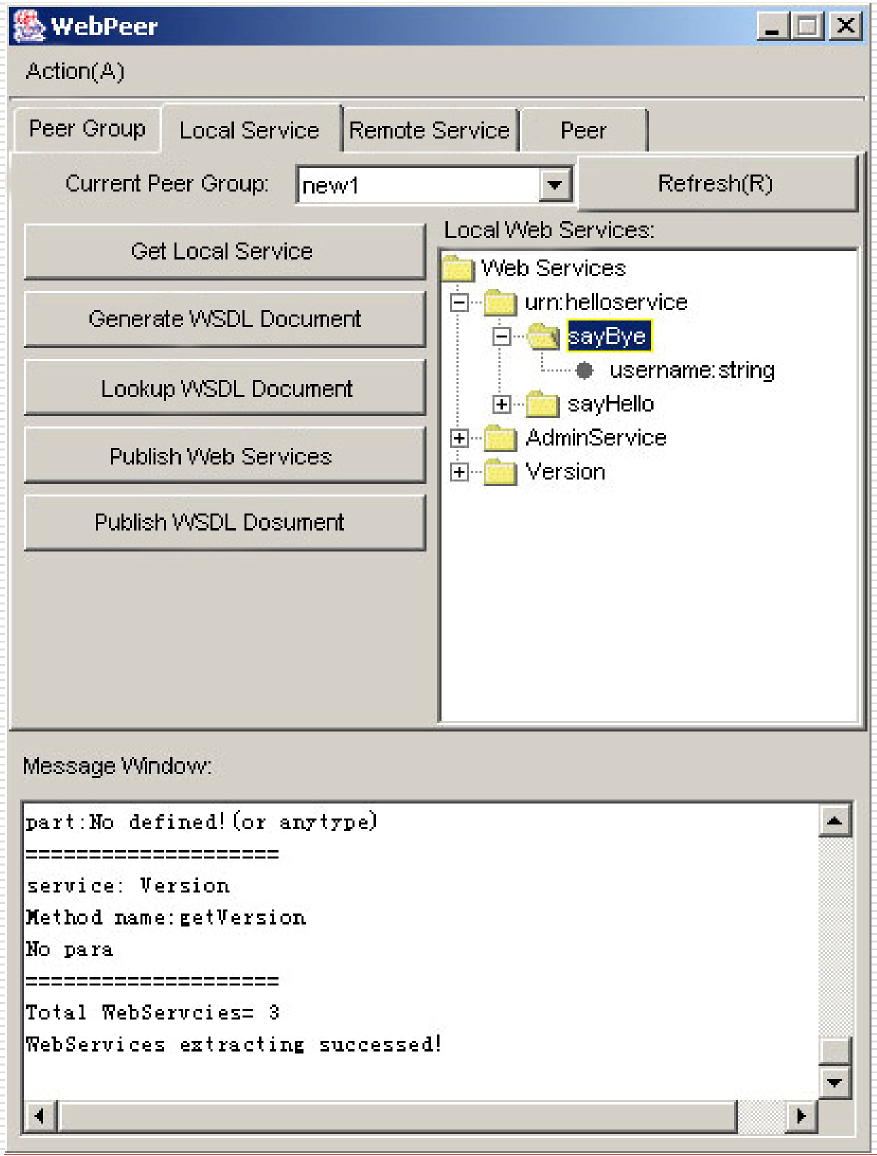
```
<?xml version="1.0"?>
<!DOCTYPE jxta:MSA>
<jxta:MSA xmlns:jxta="http://www.jxta.org">
   <MSID>urn:jxta:uuid-D110E7397F24401EA8318F383CFF29
      4035B8C3C1CF6645EABD13B9C76EBB115906</MSID>
   <Name>JXTASPEC:WebServices:urn:helloservice</Name>
   <Crtr> Example.org </Crtr>
   <SURI> http://www.example.org </SURI>
   <Vers> 1.0 </Vers>
   <Desc> A service allow you to say hello </Desc>
   <Parm>
      <wsdlURI>
         http://www.example.org/helloservice/
         helloservice.wsdl
      </wsdlURI>
   </Parm>
   <jxta:PipeAdvertisement xmlns:jxta="http://jxta.org">
      <Id>urn:jxta:uuid-2EC8CDF870744C468B7CB111E337A0
         1EE5E3818 F9BBD405B90D2B7626E1549C504</Id>
      <Type> JxtaUnicast </Type>
      <Name> WebServices:RespPipe:urn:helloservice</Name>
   </jxta:PipeAdvertisement>
</jxta:MSA>
```

Algorithms of Discovering Web Services

```
PROCEDURE discoverWebServicesAdvertisement
BEGIN
  WHILE
    Looking up Web Services Advertisements in local service cache;
    IF (search result doesn’t match the request)
    BEGIN
      Sending discovery request to peer group;
      IF (search result matches the request)
        Saving result in local service cache;
      ELSE
      BEGIN
        Sending discovery request to CSRB;
        IF (search result matches the request)
          Saving result in local service cache;
        ELSE
          Return result with no matches;
      END;
    END;
    return the discovery result;
  UNTIL (number of discovery request is 0);
END;
```

```
PROCEDURE getWsdlDocument
BEGIN
  WHILE BEGIN
    Getting a Web Services advertisement;
    IF (parameters of advertisement are not null)
    BEGIN
      Call doc(StructuredTextDocument) to create a structured text document;
      Saving parameters of advertisement into created document;
      elements := doc;
      WHILE BEGIN
        Getting names of subitems;
        IF (subitem is wsdlURI)
        BEGIN
          Getting the value of wsdlURI;
          IF (the value of wsdlURI is not null)
          BEGIN
            return the value of wsdlURI;
            break the inner LOOP;
          END
        END
      END
    END
    else
      repeat the outer loop;
  UNTIL (peers has more elements);
END;
```

WebPeer System Interfaces



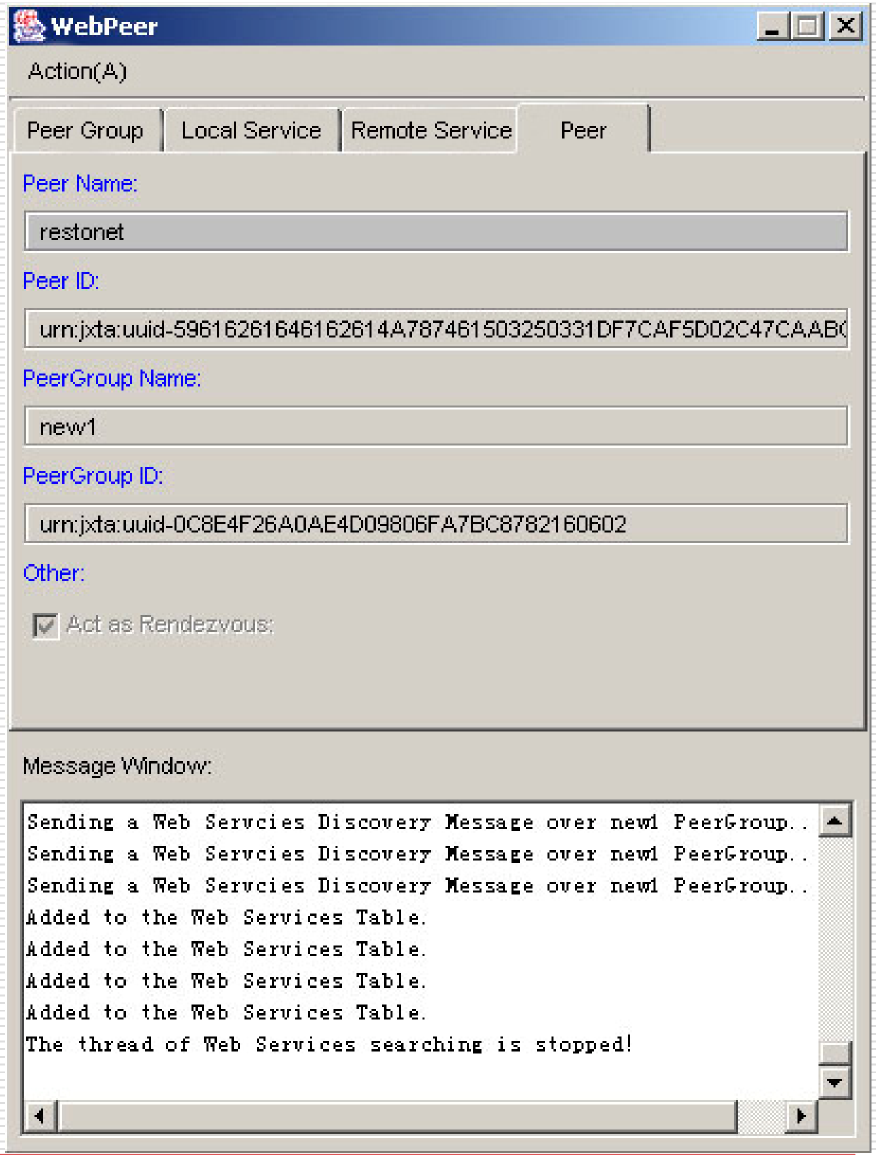
Current Peer Group: new1

Local Web Services:

- Web Services
  - urn:helloservice
    - sayBye
      - username:string
    - sayHello
  - AdminService
  - Version

Message Window:

```
part:No defined!(or anytype)
====================
service: Version
Method name:getVersion
No para
====================
Total WebServcies= 3
WebServices extracting successed!
```



Peer Name: restonet

Peer ID: urn:jxta:uuid-59616261646162614A787461503250331DF7CAF5D02C47CAAB(

PeerGroup Name: new1

PeerGroup ID: urn:jxta:uuid-0C8E4F26A0AE4D09806FA7BC8782160602

Other:

☑ Act as Rendezvous:

Message Window:

```
Sending a Web Servcies Discovery Message over new1 PeerGroup..
Sending a Web Servcies Discovery Message over new1 PeerGroup..
Sending a Web Servcies Discovery Message over new1 PeerGroup..
Added to the Web Services Table.
Added to the Web Services Table.
Added to the Web Services Table.
Added to the Web Services Table.
The thread of Web Services searching is stopped!
```

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Summary & Ongoing Work

IDC-Lab

- □ Security models for different approaches and topologies
- □ Semantic-based model for service publishing and discovery
- □ Possible mobility of Web Services in P2P Environment

Thanks!