A Distributed Middleware Framework for Peer-to-Peer Services using the IRTL

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s y r a c u s e u n i v e r s i t y

The eternal p2p “Free-Riding”

- Socio-economically unstable system
- Tragedy of Commons
- The need of incentive and disincentive mechanisms
- Binding ownership with transactions and accounting

Background and Related Works

- Various p2p platforms for applications development.
  Sun's JXTA. / Open source Gnutella.
- OGSA Grid Service Model for resource allocation among well-defined network of computers.
- Context aware services for nomadic computing through a middleware platform.
- Do any of these models mentioned above contain functionality for charging control or reputation management or transaction accounting for information usage and retrieval?

Key Terminology

- **Peer-to-Peer:** A class of systems and applications that employ distributed resources to perform Critical functions and services in a de-centralized manner.
- **Resources:** The hardware and software resources that are needed to provide a service and to perform the functions and tasks defined by the peer operating them.
- **Services Interaction:** The fusion of different services during sale/barter of content to create implied services.
- **Content:** Content in its most simplistic way can be defined as data in bits and bytes. Content can be either structured or unstructured. Content can also be distributed or shared across various services.
- **Middleware Framework:** A generic framework that allows p2p applications to interact independent on software, or other external resources. Middleware can also mean functionalities which peers can utilize to create economically viable p2p environments. Additionally Middleware can also include definitions for p2p services which branch out to peers.
- **Application:** An “application” defines the actual software which is deployed in peers in a p2p environment. The most common examples being Napster and Kazaa among an ever-growing number of others. An application necessarily contains “services” which are distributed. An application can also be looked as “software” built on top of the Middleware framework.

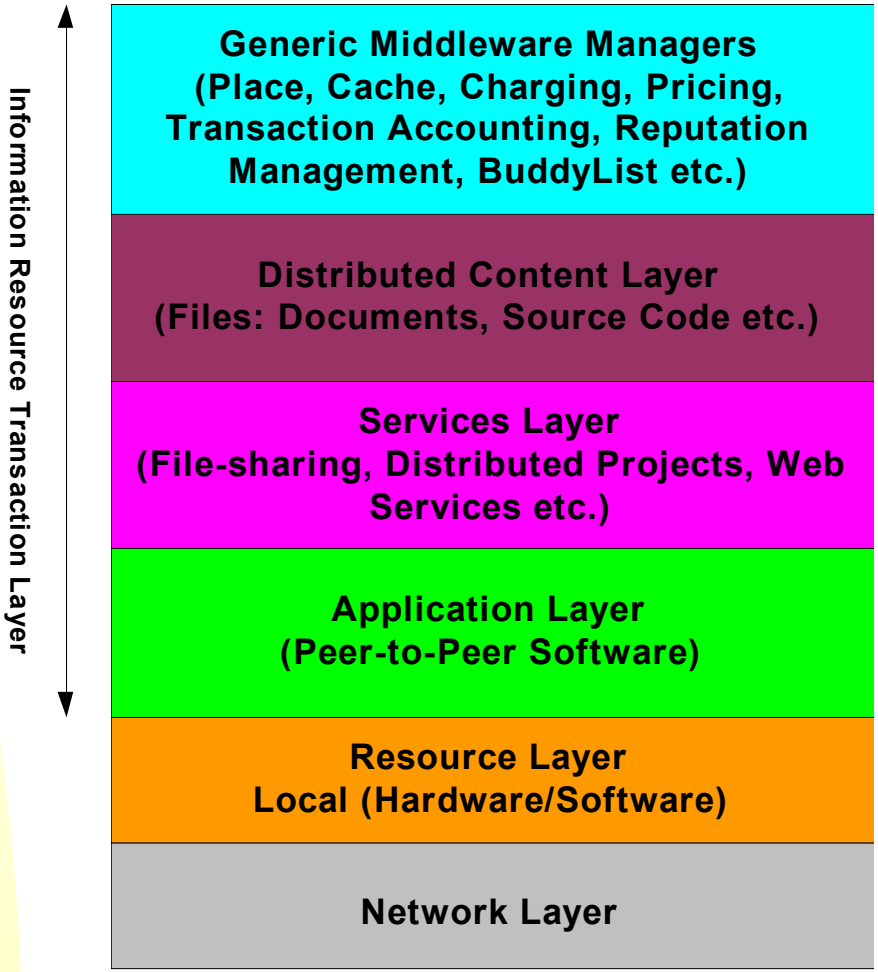
Introduction

- Need for accounting and transaction control for p2p applications.
- Differentiation between “free” and “charged” p2p application services.
- Integrating heterogeneous p2p applications served in different platforms like JXTA, Gnutella, .NET etc.
- Separation of monitored p2p services as opposed to non-secure p2p interactions.
- Substantial reward for service providers in p2p environments?
- Is it possible to emulate popular business-to-business models involving economic principles to p2p environments? If so, what would be the technical challenges associated in achieving this goal?

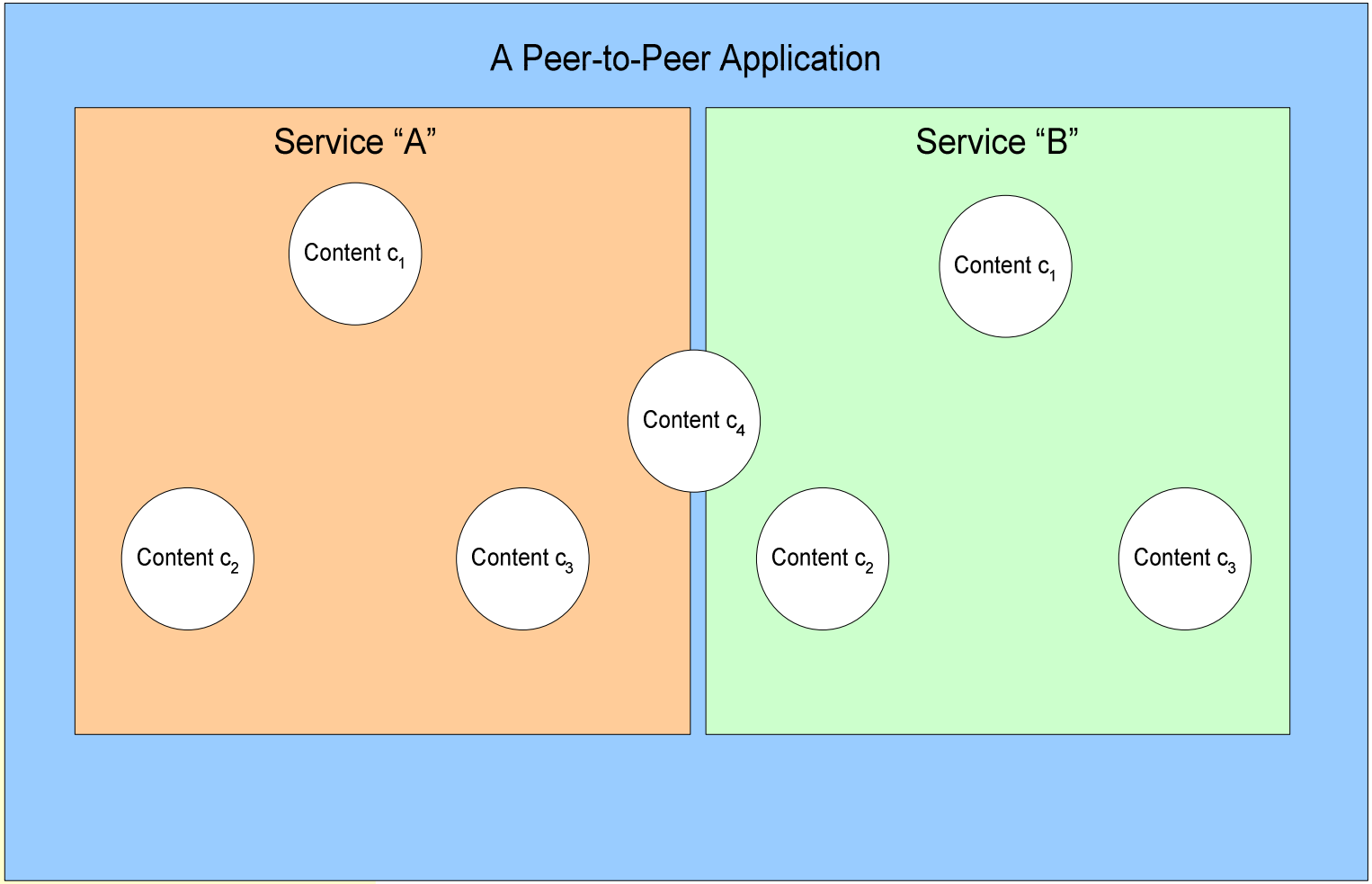
What Is IRTL?

- The Information Resource Transaction Layer offers a **"glue"** layer of various service **"managers"** that integrates heterogeneous resource transactions in p2p environments.
- Some of the functionalities of IRTL include:
  - Tools to transform heterogeneous resource information to metadata abstractions.
  - Discovery facilitation for finding resources information among peers.
  - Communication functions among peers and peer users.
  - Reputation Management functionality among peers and peer users.
  - Charging and accounting functionality for peer-to-peer services.
  - Integrated abstracted API's for peer-to-peer transactions.
  - Research instrumentation for following transaction histories and assessing user reactions.
  - Benefit P2P application developers and researchers to enhance various transaction functionalities for heterogeneous environment.

IRTL Middleware Architecture



IRTL Application Environment



IRTL Layers - Application

- The Application Layer comprises of a number of p2p applications that make a connection to the Middleware framework. Typically, these applications embed “services” and “content” (managed through managers).

IRTL Layers - Service

- The Services layer contains relevant “units” or entities to which users or peers belong to. Ideally, services are made up of structured distributed content attributed by several managers defined. Also, services by themselves can contain certain rules as defined by their manager.

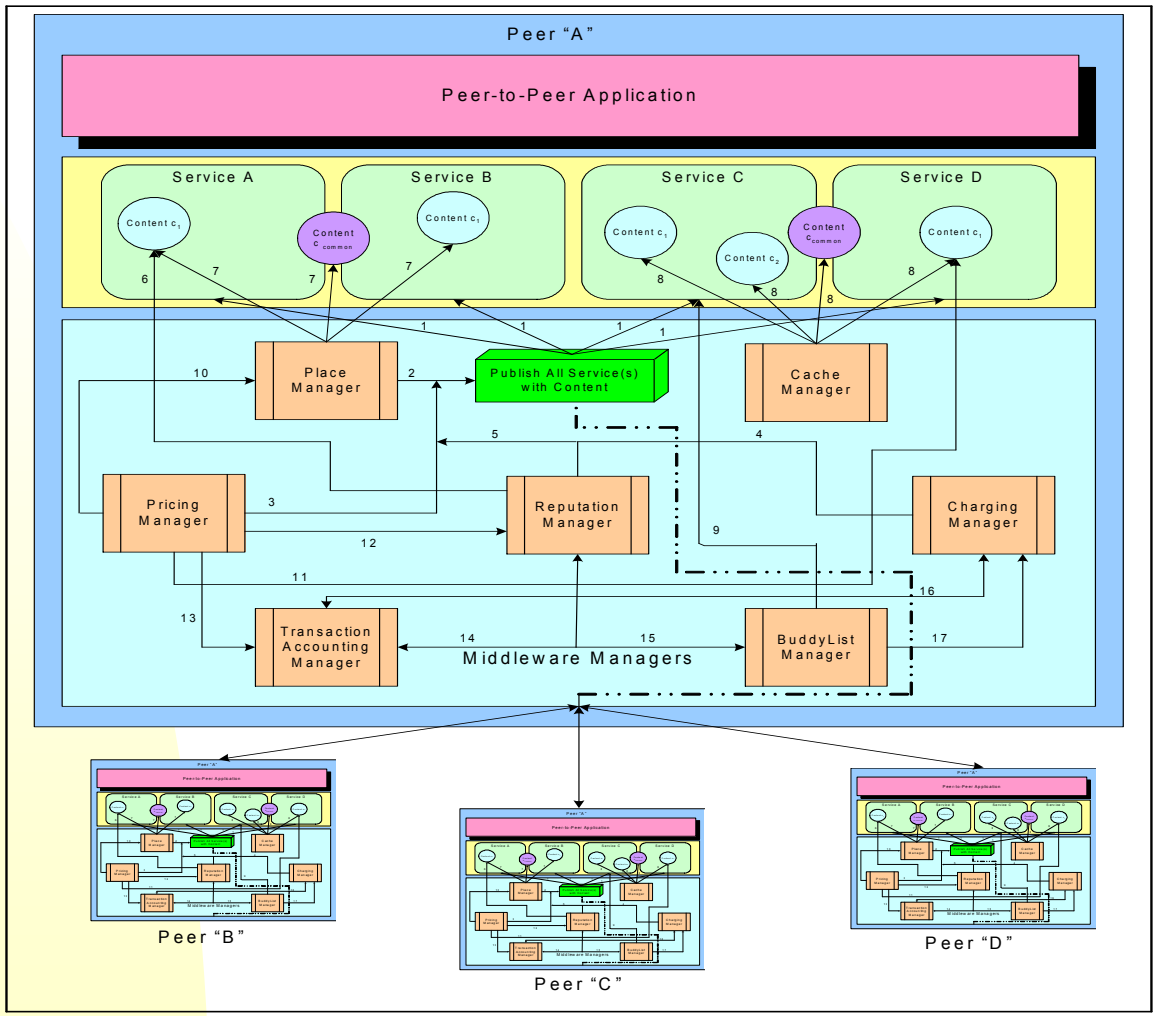
IRTL Layers - DCL

- The Distributed Content layer contains the actual file(s) operating in a p2p environment. The nature of such content can range from documents to source code to address-book entries. Content can be made available in any number of services available to the peer.

IRTL Layers – Manager Layer

- The Generic Middleware Managers Layer forms the core of the architecture. They define additional attributes to content ranging from Price to Reputation to longevity. They also define rules in which services reside on the peer.

Manager Interaction



IRTL "Managers"

- Role-specific invocation (E.g. p2p manager for peer management, resource manager for resource information, place manager for location based access)
- Distributed component architecture
- Inter-communication and intra-communication through XML/WSDL methods
- Object oriented design principles in development
  - Re-use of functionalities for p2p application specific development
  - Integration between several p2p platforms (JXTA, Gnutella etc.)
- Charging control principles (buddy list information), transaction accounting principles (micro/macro payment) implementation

Common "Manager" Types

- Cache manager
  - Management of **recurrent requests** by peers for similar information
- Place manager
  - Peer/resource location management
- Pricing manager
  - Define and allocates different pricing schemes / Interacts with RM and CM

Common "Manager" Types

- Reputation manager
  - Reputation indices ranging from Peer to Services to Content
- Charging manager
  - Service-level charging integrated with transaction accounting
- Transaction Accounting manager
  - Control all types of transactions or inter-intra manager invocation
- Peer manager (Buddy List manager)
  - Define "Peer Buddies" and manage associated contents, services and applications

Market Management for Peer-to-Peer Services (MMAPPS)

- EU Funded Project involving several universities like ETH-Zurich, Athens School of Business, Darmstadt University and industry partners comprising of British Telecom, Telekom Austria, HP Labs.
- Focuses on economic paradigms as core functionalities for a p2p system
- Implemented the classic file-sharing model on top of JXTA

"Monopoly" File-Sharing Demonstration

- Rendezvous peers – Peers that act as banks, primarily in validating transactions between peers
- Normal Peers – A set of peers that belong to a rendezvous peer
- Token-based Accounting – A kind of micro-payment model similar to the popular "Monopoly" game

Conclusion

- Establishing a “middleware” layer for integration of various p2p platforms to perform enhanced p2p transaction functionalities
- “Manager(s)” implementation on a distributed computing architecture schema providing capability for specific p2p services plug-ins.
- Providing standardized solutions to problems of transaction security, directory services, QoS, discovery of services, accounting etc.
- Creating a basis for study of resource provisioning among heterogeneous peers integrated through several p2p platforms.
- Creating several research specific platform independent p2p communities with charging control/transaction accounting principles.
- Creating handy service and application development environment for market-based p2p applications.

Thank you !

More information on the project?

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http://web.syr.edu/~jshwang/IRTL