Complex Applications over Peer-to-Peer Networks

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1. ARCHITECTURE

Existing Peer-to-Peer (P2P) applications are designed to provide file sharing. We envision more complex applications on P2P systems, e.g., P2P virtual-worlds, P2P auction networks, etc. We have developed a layered software architecture called Open Peer-to-Peer Network (OPeN) Architecture to enable such applications. In particular, the objective of our OPeN Architecture is to allow application developers to focus on their tasks, rather than the details of the underlying P2P protocol, for a complex application, and to allow P2P applications to be developed independently from a specific P2P protocol.

The OPeN Architecture consists of three layers: Connectivity Layer, Services Layer, and Application Layer. The Connectivity Layer is responsible for P2P object management and routing where different protocols can be used. We enable P2P protocols to be developed transparently to the higher levels of the architecture. Services Layer uses objects that are extended from the Connectivity Layer. The use of objects allows the delegation of data processing to be seamlessly distributed over the peers in the P2P network. Applications make use of the standard interfaces provided by Services. Services consist of a variety of generic services, these currently include (but are not limited to): Peer Management, Database, and Virtual Machine. For example, a Service can query, insert, delete, and modify objects in/into/from/in a P2P network.

The Connectivity and Services Layers can be loosely aligned to the Session and Presentation Layers of the OSI Model. The existing TCP/IP Model is very close to the OSI Model without these layers. Building applications on top of the TCP/IP worked seamlessly till this day with mostly client/server based complex applications or P2P based simple applications. We believe that with the emergence of vastly distributed dynamic systems, such as P2P systems, over the Internet, we will see a growing need for complex applications to be developed in a way that decouples information routing from application semantics.

Using the OPeN Architecture, we have developed a P2P 3D virtual-world application [1]. P2P systems scale well in comparison to centralized systems, so a massive amount of participants in this world is easily achievable, e.g., for networked-games. We partition the space into regions and assign the responsibilities of regions to peers. We developed this serverless virtual-world on top of our Database Service without much difficulty or considering the details about dividing the space to peers. The underlying P2P protocol can also easily be replaced with other upcoming more efficient protocols too. The application developer can develop the 3D virtual-world as if it is being developed as a standalone application without paying much attention to the details of the network.

A neural network grid is also under development, making use of the Virtual Machine Service; that allows applications to allocate resources such as processors under a single distributed structure. Artificial neural network scientists can run and share learning algorithms via this application. Scientists can choose an algorithm and execute multiple copies of it with parameters generated from a range. The results can be monitored by all involved. In this case, the software design defines a farming application and a monitoring application for interactive use by the scientists.

One of the main advantages of our architecture is the ability to allow application, Service, and P2P protocol developers to test and experiment with their work independently of other layers. We are currently developing wrappers for our Services and will test them on a large scale simulated network.

We are planning to develop other Services as our future work, e.g., Naming Service. Our initial experience with the OPeN Architecture is very positive and we believe it can be extended and used for other highly distributed dynamic environments for enabling easy development of complex applications.

2. REFERENCES

[1] E. Tanin, A. Harwood, and H. Samet. A serverless 3D world. In *Proceedings of the ACM GIS Symposium*, Washington, DC, November 2004.