An Architecture for Peer-to-Peer Economies

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Abstract

The MMAPPS project is researching the use of techniques from economics and social science to tackle some of the fundamental difficulties in creating well-founded, sustainable, P2P applications. The project's central approach is to extend market management techniques to improve cooperation between peers while enhancing the community-oriented structure of P2P architectures.

1. Introduction

The MMAPPS project [1] is researching, designing, and building middleware to enable developers to innovate in the creation of economies inside groups of peers (or communities) running P2P applications. It has developed a novel architecture for P2P economies that defines how the consumption and contribution of each peer is monitored and constrained by the other peers in the community. This aims to overcome the classic "free-riding" problem [5] as well as encourage cooperation. The architecture is based upon the use of community rules that constrain peers to behave co-operatively.

Pricing schemes have been suggested as a means to improve contribution by peers, eg in [4, 6]. However, pricing schemes can often act against the collaborative, community-forming nature of P2P. It permits peers to charge each other where the rules of the community allow this. So MMAPPS is looking to enhance such schemes with innovative, non price-based accounting schemes such as ratings.

The resultant middleware will provide developers with the tools to produce new incentive schemes for their applications. The basic building blocks are the use of groups (communities), community rules and distributed accounting mechanisms to ensure rules are adhered to.

2. The MMAPPS architecture

Figure 1 illustrates the MMAPPS architecture. The architecture decomposes the behaviour of the peers into three decoupled functional layers. The figure shows these layers instantiated on three representative peers, a consumer of a service, the provider of that service and other third-party peers. The figure shows what happens within the system when one peer provides a service to another peer. Here a third peer (or a group of other peers) may get involved in monitoring the provider and consumer.

The boxes in the figure represent the behaviour of the peers. The arrows represent the flow of information between layers and between peers.

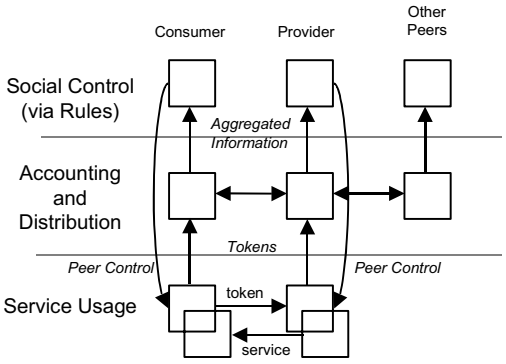

Figure 1. Abstract architecture structure

In this architecture, the consumer peer uses the services of a provider peer within the Service Usage layer. This use of the service is accompanied by the flow of tokens (eg receipts, coins) from consumer to provider to account for their consumption. Information about the service usage and any token transfers then flows into the next layer up.

In the Accounting and Distribution layer, distributed mechanisms keep track of the service provision information by, for example, passing it to other peers to hold. These mechanisms may provide aggregated information to the top level.

The Social Control layer holds the community rules. In this layer peers check the data provided by the layer below and perform actions, such as reward and punishment, based on local policy and community rules.

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2.1. The Service Usage layer

In the Service Usage layer the act of service provision is combined with flows of service usage related information

In the simplest protocol the provider sends the desired item to the consumer and the consumer sends a signed receipt. However, each can fail to play their part and blame the other. This is the fair exchange problem to which there are technical solutions available (e.g. [2]) under certain assumptions, principally the trading of digital goods and the existence of somewhat trusted third parties.

Because of the overhead of fair exchange mechanisms and the difficulty of finding an appropriate trusted third party, the architecture will primarily base exchange on a simple core reputation mechanism dedicated to detecting and expelling peers deliberately failing to comply with the exchange protocol. In environments without fair exchange mechanisms, such as eBay, simple reputation mechanisms based on votes by the buyers have been proved to be surprisingly effective [3]. However, the architecture will permit the use of fair exchange protocols where their complexity is justified.

The service usage layer is extensively configurable including, eg price-based or non-price-based, pre-pay or post-pay, the nature of the tokens exchanged and the protocol used, and how small the granularity of provision should be (ie how often to exchange tokens).

2.2. The Accounting and Distribution layer

The Accounting and Distribution layer provides mechanisms for recording and aggregating information about the service usage by peers, and for distributing this information appropriately. This allows peer oversight of individual peer behaviour. The flows of accounting information from peer to peer prevent individual peers from falsifying that information (eg to obtain unearned credit) and provide aggregated information to those peers who need it for social control purposes (ie to check that the community rules are being adhered to).

It is expected that the accounting system will obtain tokens for each exchange of value. Its job now is to maintain these records so that it can provide information to peers so that they can deduce how to act. It is here that the project plans to offer a ``toolbox" of mechanisms that achieve trustworthy accounting and distribution of these records. The mechanism used in this layer needs to match the nature of the token exchange, to support it and to provide appropriate information to the layer above.

2.3. The Social Control layer

Community rules are the key mechanism operating in the Social Control layer. Developers will be provided with the tools to design rules that are appropriate to the particular application and peer-group that will use it. These community rules take the information obtained from the accounting layer and make decisions on acts of reward or punishment toward other peers.

Developers of a new group create community rules that embody their idea of how the group will work. Different sorts of rules will need different sorts of enforcement. Some rules can be enforced mechanically on a per transaction basis, while others might need third-party checks perhaps on a random policing basis. Others still (involving a somewhat subjective perception of quality, say) might never be explicitly represented within the service, and just arise from a human understanding between the people involved.

The methods of reward include preferential service and real money while punishment can be financial, against entitlements held by the group or, ultimately, expulsion from the group, based on consensus-forming mechanisms such as voting.

3. Conclusion and further work

The project has produced a novel architecture that structures the P2P economy to make the control of peers explicit. It is defining practical generic mechanisms (both price-based and non-price-based) within that architecture. These will allow application developers to improve cooperation within the P2P economy by providing appropriate incentives while preserving the P2P nature of the application.

The architecture is currently being implemented in middleware and applications developed on top will be the subject of user trials later in the project.

4. References

[1] Market Management of Peer-to-Peer Services (MMAPPS). http://www.mmapps.org/

[2] N. Asokan, “Fairness in electronic commerce”, Tech. Rep. RZ 3027 (#93073), 1998

[3] C. Dellarocas, “Analyzing the economic efficiency of eBay-like online reputation reporting mechanisms", in *Proceedings of the 3rd ACM Conference on Electronic Commerce*, 2001

[4] P. Golle, K. Leyton-Brown, I. Mironov, and M. Lillibridge, “Incentives for Sharing in Peer-to-Peer Networks", in *Proceedings of WELCOM'01*, 2001

[5] G. Marwell and R. Ames, “Experiments in the provision of public goods: I. resources, interest, group size, and the free-rider problem”, *American Journal of Sociology*, no. 84, 1979

[6] J McCoy, “Mojo Nation Responds”, http://www.openp2p.com/pub/a/p2p/2001/01/11/mojo.html

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