International Journal of Advanced Computer and Mathematical Sciences
ISSN 2230-9624. Vol 3, Issue 4, 2012, pp 418-423
http://bipublication.com

PEER-TO-PEER APPROACH OF LOCATING SERVANTS

V. Sandeep Kumar Reddy, Surya Bahadhur, S.Murali Krishna

Dept of CSE, Madanapalle Institute of Technology & Science, Madanapalle, A.P, India

[Received-11/09/2012, Accepted-02/10/2012]

ABSTRACT

This paper explores the possible overlay architectures that can be adopted to provide such services, showing how an unstructured solution based on a scale-free overlay topology is an effective option to deploy in this context. Consequently, we propose EQUATOR (Equivalent servant locator), an unstructured overlay implementing the above mentioned operating principles, based on an overlay construction algorithm that well approximates an ideal scale-free construction model.

Index Terms—Distributed services, equivalent servants, peer-to- peer overlays,

INTRODUCTION

At the same time, the current wave of distributed sharing services tends to involve resources available at the edge of the network and hence bases on the peer-to-peer (P2P) paradigm to achieve performance, scalability, and robustness. Among the possible examples, the *Desktop Grid* computing exploits unused resources (storage, computational power, etc.) available on widely located (home) computers, while *NaDa* [1] uses P2P technologies to build "Nano Data Centers" that exploit the DSL gateways placed in our homes. The idea is that users owning enough resources (e.g., a DSL gateway or a home-PC, which are unused for a great portion of time) may enter the cloud and start offering services.

In this context, a new set of services is emerging, where every servant is potentially able to satisfy users' requests. In fact, many operations delegated to the cloud (especially by thin clients) often require "limited" resources in terms of bandwidth, storage or CPU cycles, and therefore can be easily handled by any of the many peers participating in the abovementioned service-oriented overlays. We can say that these services are based on multiple, equivalent servants. As a few examples, we can cite the offloading of some computations that are too expensive for mobile devices, the localization of a relay required for anonym zing a communication (e.g., Tor [2]) or establishing a successful VoIP transfer (e.g., Skype [3]), the necessity to keep the state of users in an online game [4], or a Personal Video Recorder that temporarily stores TV streams when the user is offline, not to mention new online-based computational platforms (e.g., Google Chrome OS [5]). In this scenario, applications require the localization of an available servant (i.e., a node that is currently free and hence can offer the service) in the shortest time, rather than a precise resource localization (e.g., a precise document, or a host with a given amount of CPU time available or at least N Megabytes of spare space).

Existing works lack in providing adequate support to these emerging distributed systems. In fact, most of them focus on the development of a system supporting specific requests, ranging from a unique specific file to a set of resources characterized by well-defined parameters. While these systems can also support the localization of equivalent servants, they are not optimized for this purpose because of the different requirements they comply with, more stringent in terms of resource constraints, but simpler in terms of timely response. Hence, for example, they might be unable to locate a serving node in a very short time, such as a relay to be used in an incoming VoIP call. Furthermore, they may insert an unnecessary overhead in the servant lookup, due to the features they provide to support complex queries, which are of little help in the context of services based on equivalent servants.

This paper focuses on services provided by equivalent servants and models and analyzes the performance of structured and unstructured overlays when used to provide such services. We demonstrate that the architecture chosen for the P2P network has a huge impact on the overall performance of the service. In particular, with the support of some analytical and simulation results, we show how an unstructured network based on epidemic dissemination and built over a scale-free overlay topology is an effective solution to deploy in this context. Then, we present EQUATOR (Equivalent servant locator), a P2P-based architecture deployable in real networks for the provision of services based on equivalent servants. EQUATOR aims at guaranteeing high lookup performance, as well as high robustness to failures and churn phases, when a significant number of peers joins/leaves the network.

Disadvantages

- ✓ some possible overlay architectures that can be adopted to support the location of equivalent servants and shows the benefits of scale-free networks
- ✓ Where most of the service is provided only based upon the servants

RELATED WORK

During the last few years, *structured* (e.g., Chord [6], Kademlia [7]) and *unstructured* (e.g., Gnutella [8], KaZaA [9]) P2P solutions have started to be adopted as building blocks for the definition of more complete P2P systems able to provide arbitrarily complex distributed services. For example, [10] and [11] present two similar unstructured architectures for the provision of Grid-like services. Other solutions have been proposed in the context of video distribution (e.g., [12], [13]). On the structured side, some examples of these architectures have been presented in [14]–[17].

However, all these proposals address a problem that is different from the scenario we have in mind, where users are interested in locating one of the many available servants. Even more important, they do not investigate the effects of the overlay topology on the performance of this type of resource lookup in order to determine the best overlay technology for the given service.

The equivalence of servants is considered in [18]–[20]. In [18], the authors propose a scheme for CPU cycle sharing over an unstructured P2P network. They consider the unbalanced node degree distribution, which may result in real overlay networks, as a possible obstacle to the lookup effectiveness of the system and, consequently, they propose mechanisms to overcome these limitations. In this paper, we show instead how an unbalanced node degree distribution (specifically, a scale-free topology), if properly exploited, ensures high lookup performance. Peer-to-peer SIP (P2PSIP [19]) proposes to use a DHT to support lookups of relay nodes among all the equivalent participating peers, which can be done by randomly selecting a target node and then moving over the DHT to reach this target. Our previous work [20] explores the idea of a service based on equivalent servants, but it limits its application to a distributed connectivity service in a SIP infrastructure.

This paper focuses on services based on equivalent servants and brings several contributions to the existing work on this topic. First, we compare the possible overlay architectures to support our class of services and we show, through extensive analytical and simulation studies, that an unstructured overlay based on a scale-free topology is an interesting solution in this context. Furthermore, we show the corresponding penalty in case a DHT architecture is chosen, as proposed in [19]. Second, we propose a novel overlay construction.

OVERLAY ARCHITECTURE OPTIONS

PROPOSED SYSTEM

It focuses on services based on equivalent servants and brings several contributions to the existing work on this topic. First, we compare the possible overlay architectures to support our class of services and we show, through extensive analytical and simulation studies, that an unstructured overlay based on a scale-free topology is an interesting solution in this context. Furthermore, we show the corresponding penalty in case a DHT architecture is chosen, as proposed. Second, we propose a novel overlay construction algorithm which (*i*) is suitable for implementation in real networks, (*ii*) supports a generic service, and (*iii*) approximates an ideal well-known scale-free construction model. Third, we analyze different network scenarios by varying the servant characteristics (e.g., their lifetime), which provides an insight of the possible performance of different services in our context.

Advantages

- ✓ All peers provide the same functionality (i.e., we have only one resource provided by many nodes), the number of copies predominates over the number of distinct services.
- ✓ A possible more effective approach may be to include epidemic dissemination in the structured overlay, so that nodes may increase the number of servants they can offer to querying users.

Structured overlays

We first investigate the possibility to deploy a structured overlay based on a general DHT, as it has been proposed in [19] for the P2PSIP architecture.

Since in our scenario all peers provide the same functionality (i.e., we have only one resource provided by many nodes), the number of copies predominates over the number of distinct services and therefore the ability of DHTs to locate a specific resource is of little help. Therefore, [19] proposes to use the DHT in a more clever way: queries are performed by randomly selecting a target key and then moving in the overlay to reach this target.

Since it does not cause further complexity and possibly improves the system performance, we introduce an additional feature to this querying mechanism: during the lookup process, any node encountered along the path is checked for availability and can be selected as a servant for the querying user. Notice that this operating mode makes the approach independent of the adopted DHT. In fact, only the overlay topology (which is a regular graph in existing DHTs) is of interest in our context. In other words, we adopt the topology of a generic DHT, with a fixed number of neighbors for each node, but we use a different routing mechanism. This solution will be however referred to as DHT in the rest of the paper.

The idea of using a DHT for our scenario of equivalent servants is especially interesting in case a DHT has to be implemented anyway for some other services. For example, P2PSIP already uses a structured overlay to index all possible targets of a multimedia communication, i.e., all the user agents registered in the SIP domain. Using the same DHT to locate, if necessary, a relay node to support the communication (i.e., a servant among the many peers existing in the SIP domain) may be a considerable advantage for that application, which needs to maintain only one overlay structure that can be used for both functions.

Unstructured overlays

An efficient unstructured overlay is characterized by high lookup performance and small amount of traffic required to maintain the overlay. Both parameters are influenced by the topology and the operating principles (e.g., how nodes spread information) of the overlay. This section elaborates on these aspects in the context of services based on equivalent servants, proposing to adopt a scale-free topology and motivating this choice. An interesting lookup solution that avoids the deleterious traffic overhead generated by flooding-based queries is the adoption of a service lookup based on *random walks* [21] encompassing a bounded number of nodes. The effectiveness of random walks depends on the overlay topology adopted in the system. Among other possibilities, a scale-free topology [22] may offer interesting features. In a scale free network, the node degree distribution follows a power-law

$P(n) = cn^{-\gamma}$, where P(n) is the probability that a node has n connections and c is a normalization factor. Hence, only few nodes (usually referred to as *hubs*) have a high degree, i.e., are aware of the existence of a large number of participating peers. The idea is that directing random walks toward hubs means looking for the service where there is a great knowledge of servants. This ensures high lookup performance with respect to an overlay based on a balanced degree distribution (e.g., a random graph or a regular topology) where service requests are randomly distributed among peers. This result derives from a well-known property of queuing systems, which says that a unique M/G/k/k queuing system servicing an arrival process with rate λ performs better than k separated M/G/1/1 systems each one servicing an arrival process with rate λ/k. In essence, concentrating the traffic on some nodes that have a deep knowledge of the network (i.e., the hubs, which know a lot of possible servants) provides better performance than accurately distributing the requests among all nodes, as random solutions try to do. This extends the results obtained by Adamic et al. [23] in the context of traditional file lookups in P2P systems, which demonstrated the effectiveness of random walks in scale-free networks due to the greater knowledge of resources available at the hubs.

One of the most popular mechanisms to build a scale-free network was proposed by Barabási and Albert [22] and for this reason is referred to as Barabási-Albert model. Let m denote the out-degree of a node and d denote its in-degree. The Barabási-Albert model requires a set of m_0 nodes to be already in the system at the beginning of the process. Then, each entering node connects to m existing nodes, chosen proportionally to their popularity. This process is known as *preferential attachment*. This network formation algorithm results in a scale free network characterized by a node degree distribution $P(n) = cn^{-3}$ and an average path length which behaves as ln N/ ln lnN [22].

CONCLUSION

This paper focuses on service-oriented overlays where users are interested to locate any of the many available overlay peers in the shortest time, i.e., the offered service is based on equivalent servants. Existing solutions, either structured or unstructured, can support these services but are not optimized for this purpose, which however is growing in importance due to the spread of many applications which need these specific features (e.g., a proxy node to anonymize a communication). which overcomes the issues related to the deployment of a scale-free topology for service location in a real network, mainly due to the static nature of the ideal scale-free construction algorithm and the lack of a global knowledge of the participating peers.

REFERENCES

[1] V. Valancius, N. Laoutaris, L. Massoulie, C. Diot, and P. Rodriguez, “Greening the internet with nano data centers,” in *Proc. ACM CoNEXT*, 2009.

[2] “Tor: anonymity online.” [Online]. Available: http://www.torproject.org

[3] “Skype: Free internet telephony that just works.” [Online]. Available: http://www.skype.com

[4] P. Bettner and M. Terrano, “1500 archers on a 28.8: Network programming in age of empires and beyond,” in *Proc. Game Develop. Conf.*, 2001.

[5] S. Pichai and L. Upson, “Introducing the google chrome os,” 2009. [Online]. Available: http://googleblog.blogspot.com/2009/07/introducing-google-chrome-os.html

[6] I. Stoica, R. Morris, D. Liben-Nowell, D. R. Karger, M. F. Kaashoek, F. Dabek, and H. Balakrishnan, “Chord: a scalable peer-to-peer lookup protocol for internet applications,” *IEEE/ACM Trans. Netw.*, vol. 11, no. 1, pp. 17–32, 2003.

[7] P. Maymounkov and D. Mazières, “Kademlia: A Peer-to-Peer information system based on the XOR metric,” in *Peer-to-Peer Systems*, 2002, pp. 53–65.

[8] T. Klinberg and R. Manfredi, “Gnutella 0.6,” Jun. 2002. [Online]. Available: http://groups.yahoo.com/group/the_gdf

[9] “Kazaa media desktop,” 2001. [Online]. Available: http://www.kazaa. com/

[10] *A Peer-to-Peer Approach to Resource Location in Grid Environments*, vol. 0. Los Alamitos, CA, USA: IEEE Computer Society, 2002.

[11] D. Puppin, S. Moncelli, R. Baraglia, N. Tonellotto, and F. Silvestri, “A grid information service based on peer-to-peer,” in *Euro-Par*, 2005, pp. 454–464.

[12] D. Tran, K. Hua, and T. Do, “A peer-to-peer architecture for media streaming,” *IEEE J. Sel. Areas in Comm.*, vol. 22, no. 1, pp. 121–133, Jan. 2004.

[13] T. Do, K. Hua, and M. Tantaoui, “P2vod: providing fault tolerant videoon- demand streaming in peer-to-peer environment,” in *Proc. IEEE Int.Conf. Comm.*, vol. 3, June 2004, pp. 1467–1472.

[14] *MAAN: A Multi-Attribute Addressable Network for Grid Information Services*, vol. 0, 2003.

[15] A. R. Bharambe, M. Agrawal, and S. Seshan, “Mercury: supporting scalable multi-attribute

range queries," *SIGCOMM Comput. Commun Rev.*, vol. 34, no. 4, pp. 353–366, 2004.

[16] Y. Zhu and Y. Hu, "Ferry: A p2p-based architecture for content-based publish/subscribe services," *IEEE Trans. Par. Distrib. Systems*, vol. 18, no. 5, pp. 672–685, May 2007.

[17] J. Albrecht, D. Oppenheimer, A. Vahdat, and D. A. Patterson, "Design and implementation trade-offs for wide-area resource discovery," *ACM Trans. Int. Technol*., vol. 8, no. 4, pp. 1–44, 2008.

[18] A. Awan, R. A. Ferreira, S. Jagannathan, and A. Grama, "Unstructured peer-to-peer networks for sharing processor cycles," *Parallel Comput.*, vol. 32, no. 2, pp. 115–135, 2006.

[19] C. Jennings, B. Lowekamp, E. Rescorla, S. Baset, and H. Schulzrinne, "Resource location and discovery (reload) base protocol," Internet Engineering Task Force, Internet Draft draft-ietf-p2psip-base-06, Nov. 2009, (Work in progress).

[20] L. Ciminiera, G. Marchetto, F. Risso, and L. Torrero, "Distributed connectivity service for a sip infrastructure," *IEEE Network*, vol. 22, no. 5, pp. 33–40, 2008.

[21] Q. Lv, P. Cao, E. Cohen, K. Li, and S. Shenker, "Search and replication in unstructured peer-to-peer networks," *SIGMETRICS Perform. Eval. Rev*., vol. 30, no. 1, pp. 258–259, 2002.

[22] R. Albert and A.-L. Barabási, "Statistical mechanics of complex networks," *Rev. Mod. Phys*., vol. 74, pp. 47–97, Jan. 2002.

[23] L. A. Adamic, R. M. Lukose, A. R. Puniyani, and B. A. Huberman, "Search in power-law networks," *Phys. Rev. E*, vol. 64, no. 4, pp. 046 135+, Sep 2001.

[24] K. Klemm and V. M. Eguíluz, "Growing scale-free networks with small world behavior," *Phys. Rev. E*, vol. 65, 2002, 057102.

[25] J. Liang, R. Kumar, and K.W. Ross, "The kazaa overlay: A measurement study," *Comp. Netw*., vol. 49, no. 6, 2005.

[26] R. Cohen, K. Erez, D. B. Avraham, and S. Havlin, "Resilience of the internet to random breakdowns," *Phys. Rev. Lett.*, no. 21, pp. 4626–4628, Nov.

[27] S. Voulgaris, D. Gavidia, and M. van Steen, "Cyclon: Inexpensive membership management for unstructured p2p overlays," *J. Netw. Syst. Manag*., vol. 13, no. 2, 2005.

[28] W. Yeager and J. Williams, "Secure peer-to-peer networking: The jxta example," *IEEE IT Profess.*, vol. 4, no. 2, pp. 53–57, 2002.

[29] E. Tamani and P. Evripidou, "Applying trust mechanisms in an agent based p2p network of service providers and requestors," in *Proc. IEEE Int. Symp. Cluster Comp. and the Grid*, 2006, p. 13.

[30] F. Dabek, R. Cox, F. Kaashoek, and R. Morris, "Vivaldi: a decentralized network coordinate system," *SIGCOMM Comput. Commun. Rev.*, vol. 34, no. 4, pp. 15–26, 2004.

[31] G. P. Jesi, A. Montresor, and O. Babaoglu, "Proximity-aware super peer overlay topologies," *IEEE Trans. Netw. Serv. Manag*., vol. 4, no. 2, pp. 74–83, Sep. 2007.

[32] F. Hong, Y. Feng, M. Li, and Z. Guo, "Constructing incentive oriented overlay on mobile peer-to-peer networks," in *Proc. IEEE Int. Conf. Par. Process.*, 2007, p. 52.

[33] G. Tan and S. Jarvis, "A payment-based incentive and service differentiation scheme for peer-to-peer streaming broadcast," *IEEE Trans. Par. Distr. Syst.*, vol. 19, no. 7, pp. 940–953, July 2008.

[34] A. T. S. Ip, J. C. S. Lui, and J. Liu, "A revenue-rewarding scheme of providing incentive for cooperative proxy caching for media streaming systems," *ACM Trans. Multim. Comput. Commun. Appl.*, vol. 4, no. 1, pp. 1–32, 2008.

[35] L. A. Adamic, "The small world web," in *Proc. Springer-Verlag Europ. Conf. Res. and Adv. Techn. for Dig. Libr.* London, UK: Springer-Verlag, 1999, pp. 443–452.

[36] *Node selection for a fault-tolerant streaming service on a peer-to-peer network*, vol. 2. Los Alamitos, CA, USA: IEEE Computer Society, 2003.

[37] R. de Camargo, F. Kon, and R. Cerqueira, "Strategies for checkpoint storage on opportunistic grids," *IEEE Distrib. Syst. Online*, vol. 7, no. 9, pp. 1–1, Sept. 2006.

[38] D. Bonfiglio, M. Mellia, M. Meo, and D. Rossi, "Detailed analysis of skype traffic," *IEEE Trans. Multim.*, vol. 11, no. 1, pp. 117–127, 2009.

[39] V. Aggarwal, O. Akonjang, A. Feldmann, R. Tashev, and S. Mohr, "Reflecting P2P user behaviour models in a simulation environment," in *Proc. Euromicro Conf. Par., Distr. and Netw.-Based Process.*, 2008, pp. 516–523.

[40] R. Cohen, K. Erez, D. Ben-Avraham, and S. Havlin, "Breakdown of the internet under intentional attack," *Phys. Rev. Lett.*, vol. 86, pp. 3682– 3685, Apr. 2001.

[41] J. Zhao and K. Xu, "Enhancing the robustness of scale-free networks," *J. Phys. A: Mathem. and Theor.*, vol. 42, no. 19, p. 195003, May.

[42] Locating Equivalent Servants over P2P Networks Guido Marchetto, Luigi Ciminiera, Marco Papa Manzillo, Fulvio Risso, Livio Torrero, *Members, IEEE,* IEEE TRANSACTIONS ON NETWORK AND SERVICE MANAGEMENT, VOL. 8, NO. 1, MARCH 2011