Chapter 3

Peer-to-Peer Search Techniques for Service-Oriented Computing

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ABSTRACT

Peer-to-peer (P2P) networks attract attentions worldwide with their great success in file sharing networks (e.g., Napster, Gnutella, BitTorrent, and Kazaa). In the last decade, numerous studies have been devoted to the problem of resource discovery in P2P networks. Recent research on structured and unstructured P2P systems provides a series of useful solutions to improve the scalability and performance of service discovery in large-scale service-based systems. In this chapter, the authors systematically review recent research studies on P2P search techniques and explore the potential roles and influence of P2P networking in dependable service-based military systems.

INTRODUCTION

The use of service-oriented architecture (SOA) has been motivated by many industries changing focus from product delivery to service-based delivery. The focus on service delivery has also been apparent in software, where networking has become faster, more reliable and more available by reduced cost. The approach to SOA in software enables business process integration that characterises business functions as services, and integrates dynamically across departments and organisations (D. J. Russell, Dew, & Djemame, 2007; Smith & Fingar, 2003; Turner, Budgen, & Brereton, 2003).

The conceptual SOA can be used to integrate businesses, systems and computing by using different levels of abstraction. The architecture is made of service suppliers and consumers, with suppliers advertising through registries or brokers for consumers to discover (Alonso, Casati, Kuno, & Machiraju, 2004; D. Russell & Xu, 2007). Systems based on SOA are called service-based systems. Most service-based systems utilise centralised registries to provide the functionalities to advertise
and discover services. Using a centralised registry, a service can be quickly found and consumed. However, the centralisation of the registry raises the issues of scalability caused by the limitation of resources at the registry, such as network bandwidth, CPU capability and storage space. Moreover, the centralisation of the registry also introduces a single-point-of-failure (Vinod, Exarchakos, & Antonopoulos, 2009) to the system. If the centralised registry is removed or is not available for use, no alternative can take its place and all the information about registered services on the registry will be unavailable.

In contrast to centralised service-based systems, peer-to-peer (P2P) systems do not rely on a centralised server to provide services. P2P offers an appealing alternative to the existing centralised models especially for large-scale distributed applications. In this chapter, we will systematically review recent research studies on P2P search techniques and explore the potential roles and influence of P2P networking in future service-based military systems.

This chapter is organised as follows: Current search methods in P2P networks are outlined in the Section: Peer-to-Peer Search Techniques. The relevant studies on the provision of Network Enable Capability based on SOA and P2P are discussed in the Section: Provision of NEC through SOA and P2P. In the Section: Dependable Dynamic Service Discovery for NEC, dependable dynamic service discovery is analysed in a battlefield scenario. Conclusion is given in the last section of the chapter.

**BACKGROUND**

Numerous studies on P2P search techniques have been performed to develop efficient and dependable P2P systems (DePaoli & Mariani, 2004). In this section, existing P2P search systems are analysed by classifying them into two categories: structured and unstructured P2P systems.

**Structured P2P Systems**

Structured P2P systems have a dedicated network structure on the overlay network which establishes a link between stored content and the IP address of a node. Distributed Hash Tables (DHTs) are widely used for resource discovery in the structured P2P systems like Chord (Stoica, Morris, Karger, Kaashoek, & Balakrishnan, 2001), ROME (Salter & Antonopoulos, 2005), Pastry (Rowstron & Druschel, 2001), CAN (Ratnasamy, Francis, Handley, Karp, & Shenker, 2001), and Kademia (Maymounkov & Mazieres, 2002).

In DHT-based P2P systems, each file is associated with a key generated by hashing the file name or content. Each network node in these systems is responsible for storing a certain range of keys. The network structure is sorted by routing tables (or finger tables) stored on individual network nodes. Each network node only needs a small amount of “routing” information about other nodes (e.g. nodes’ addresses and the range of keys the node is responsible for). With routing tables and uniform hash functions, network nodes can conveniently put and get files to and from other network nodes according to the keys of files.

**Chord**

Chord (Stoica et al., 2001) is a well-known DHT-based distributed protocol aimed to efficiently locate the network node that stores a particular data item. Network nodes are arranged in a ring that keeps the keys ranging from zero to \(2^m-1\). A consistent hashing is used to assign items to nodes, which provides load balancing and only requires a small number of keys to move when nodes join or leave the network (Stoica et al., 2001). The consistent hash function assigns each node and each key an ID using SHA-1.

In Chord, each network node maintains a finger table pointing to \(O(\log N)\) other nodes on the ring. Given a ring with \(2^m\) network nodes, a finger table has a maximum of \(m\) entries. The