A Study on Designing Overlay for Ubiquitous Services

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ABSTRACT

In future, every person, object or vehicle will be equiped with sensors. To realize the highly convenient, secure and safe society, various ubiquitous services using a flood of sensing data such as tracking of children, realtime traffic flow estimation in broad urban areas and climate analysis using environmental sensing data have been considered and developed. These kinds of services are the distributed systems in nature because they use location-dependent data that are usually managed and stored in different locations. Moreover, they are initiated simultaneously by a number of users. Consequently, in order to process a number of requests, services should be executed properly considering computing and network resources. In previous work, we have proposed an effective design method to design service overlay, and developed an integrated tool to test and deploy overlay component on real networks. In this study, we consider a typical example of ubiquitous services, identification and tracking a person from camera images/videos. We model this based on our method given in Ref.[1] and conducted experiments on real network to see its applicability.

Keywords: Service Design, Ubiquitous Service, Distributed System, Overlay Networking

1 Service Overlay Design Methodology

We briefly introduce our method given in Ref.[1]. In the method, we assume that an *overlay network* consists of *overlay nodes* (or simply nodes) with network connections between every pair of the nodes. Thus, an overlay network can be modeled as a complete graph. A *service* is a computation flow consisting of a set of "*service components*" and can be written as Coloured Petri Net (CPN) [2] by service developers. As an example of a distributed execution of a service on an overlay network, we consider a network of four fully-connected overlay nodes as shown in Fig. 1 and a "Video for Mobile" service (VfM service in short) that provides a video repository service for mobile users as shown in Fig. 2. Given a service model, a network model and an optimization policy, our design method can derive the distributed service description automatically. The details of these models and the design method can be found in [1]. An experimental study using a realistic multimedia application example showed that our design method was helpful to shorten the response time of the service.

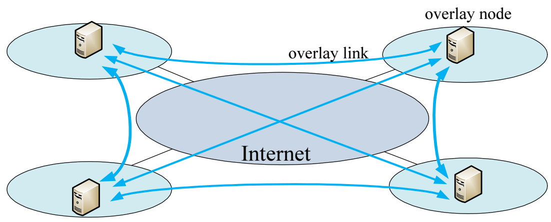

Figure 1: Overlay network architecture.

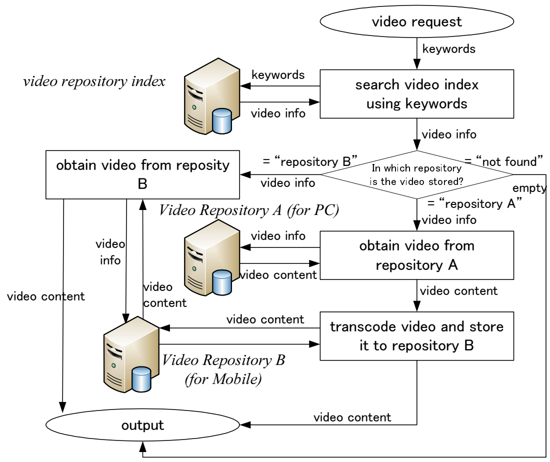

Figure 2: Overlay service example ("Video for Mobile" (VfM) service); several services like video content server, video transcoding and indexing are organized to provide highly-structured services.

2 Ubiquitous Service Description and Experiments

Network Environment In this paper, we have arranged the network that consists of 10 servers which have different computing powers. We have located 6 of 10 servers in "Area A", 2 in "Area B", 1 in "Area C" and 1 in "Area D". One of the servers which belong to an area has video cameras in the area and stores movie data. The server storing movie data in "Area X" has "Area A data repository". Servers in the same area are connected with each other via LAN and servers between dfferent areas are connected via the Internet. We assume that any server can accept any request.

Service Description In this study, we have written a following service by CPN. Fig. 3 shows a description of the broad area monitoring service. This is a monitoring service which

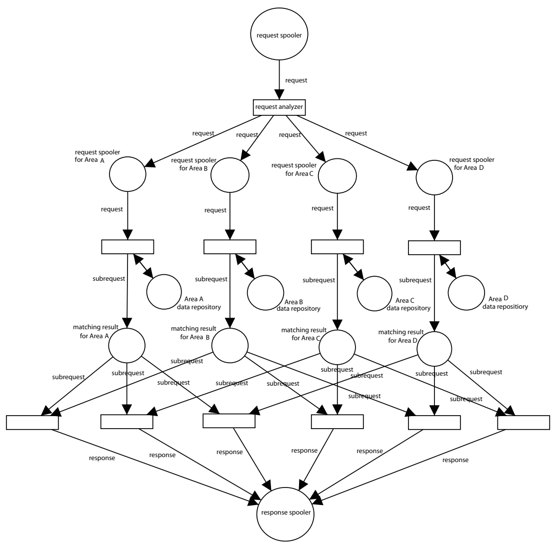

Figure 3: Broad area monitoring service for various kinds of requests processing

consists of 4 areas, A, B, C and D. As we stated before, each area has video cameras monitoring people and movie data is stored in data repositories. Image data about one person will be given a request from a service user. At first, the service tries to find the given person in video data at each of the four areas. Based on the data found, the service tries to identify the trajectories of the person and so on. This service can be used by different users simultaneously with different images.

Service Overlay Design Based on the methodology of [1], we can distribute this service on the given overlay network to minimize estimated execution time of the service. This optimization is based on the estimated processing power of servers and avaialable bandwith among them. For details, see [1].

Experimental Methodology In order to confirm applicability of our method to the service introduced in this paper, we conducted experiment to see how efficiently (in terms of delay) the derived optimized overlay can execute the given service on the given network. For this purpose, we have also derived another distributed version of the same service. This derivation is done in a heuristic manner, without our optimization method. This is called the "manual" method for convenience. For this experiment, we use a request set for experiments which is created at random. But we assume that the set that are generated randomly.

Experimental Results Table. 1 shows the average response time of 10 requests. We can see that the proposed method could process the requests about 10% faster than the "manual" method. Fig. 4 shows the number of requests that were processed in 10 sec. time slot. It indicates that Proposed has about 160% higher performance than the "manual" method. We anticipated it is not much important to optimize execution

Table 1: Average of response time.

Design method	Ave. of response time [sec.]
Proposed method	3.07
Manual method	3.27

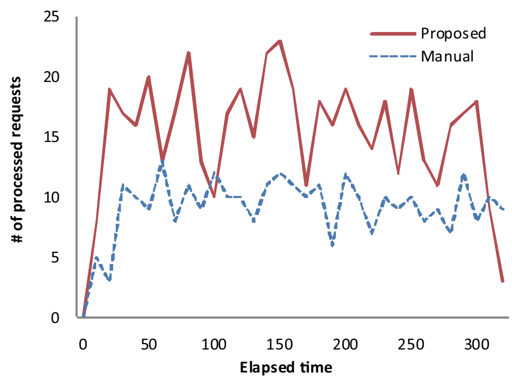

Figure 4: Number of processed requests.

time of a request in ubiquitous services, because they have the following feature, though consumption of resources to process a request may be less, the number of requests will be much more, compared to overlay services. But the effectiveness of our method could be confirmed. We can understand that our method is suitable to this kind of ubiquitous services.

3 Conclusion and Future Work

In this paper, we have applied our design method which we have proposed in [1] to an ubiquitous service, and evaluated the effectiveness of our design method through real environmental experiments. As a result, it can be said that our method is suitable for ubiquitous services as well as overlay services.

In future work, we will make on our design method more suitable for ubiquitous services. Using our integrated tool [1], we will conduct experiments using more service nodes on large-scale netwroks such as PlanetLab.

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