Service Composition System Optimizing Network and Service Resources in E3-DCN

Naohiko Shibuta†, Kenta Nakahara†, Kou Kikuta†, Daisuke Ishii†, Satoru Okamoto†, Eiji Oki‡, and Naoki Yamanaka†

†School of Fundamental Science and Technology, Graduate School of Science and Technology, Keio University, 3-14-1 Hiyoshi, Kouhoku, Yokohama, 223-8522, Japan
E-mail: naohiko.shibuta@yamanaka.ics.keio.ac.jp

‡Department of Information and Communication Engineering, Faculty of Informatics and Engineering, The University of Electro-Communications, 1-5-1 Chofugaoka, Chofu, Tokyo, 182-8585, Japan

Abstract—While being the nearness of realization of ubiquitous society, it is expected that everything will be connected to the network. We previously presented “Ubiquitous Grid Networking Environment (uGrid)”. In uGrid, everything on the network such as devices, contents, and software is defined as “Service-Part”, and users are provided with composition of the several Service-Parts on the network. In uGrid, there are “Service-Routing” and “Service-Signaling” as the method of determining the path from source to destination and establishing the optical path by using of IP protocol. However, in uGrid, in order to provide the services for users via the specified Service-Parts, these cost of services is high. Also, since users must designate the combination of Service-Parts, it is inflexible. Then, we propose “Energy Efficient, and Enhanced-type Data Centric Network (E3-DCN)” which is based on uGrid. In the E3-DCN, users request content names to the network and receive them from the network. If the requested contents are not found in the network, the network constructs the requested contents with Service-Parts. In addition to that, E3-DCN aims at energy efficiency. In this paper, we propose a cost reduction method by Service-Parts copy as part of E3-DCN. Cost is reduced by copying the Service-Parts which have a software function to the optimal position. This method is defined as “Service-Copy”. By the evaluation using ILP (Integer Linear Programming), it is shown that the case with Service-Copy can reduce the total cost of service by about 12 ~ 17%.

I. uGRID

In uGrid [1] [2], it is expected that Service-Parts are hardware like video camera, contents like movie pictures, and software like automated translation processing. By assigning IP addresses to Service-Parts, it becomes possible to compose Service-Parts on the network layer. Figure 1 shows a service model in uGrid. For example, high-definition processing is performed for the movie filmed in the stadium by Service-Part, and it provides for the user who has HD monitor. By placing Service-Parts on the network and sharing with users, each user can receive various services only have to have minimum equipment.

Figure 2 shows the procedures from step 1 to step 4 to service in uGrid. The network is divided into C-Plane (Control-Plane) which controls the network logically by using GMPLS (Generalized Multi-Protocol Label Switching) technology, and D-Plane (Data-Plane) which actually transmits contents. The uGrid server manages Service-Parts and users, and mediates between both sides.

step 1: In addition to Link-Cost, performance and power consumption of Service-Parts are defined as “Service-Cost”. Topology information, Link-Cost, and Service-Cost are advertised by OSPF-TE (Open Shortest Path First-Traffic Engineering), and a link state database is built.

step 2: The user requests for service by designating the combination of Service-Parts to the “uGrid-Server”.

step 3: Based on the request from the user, the uGrid server performs routing so that the total of Link-Cost and Service-Cost becomes the minimum. This routing process is defined as “Service-Routing” [3] and this cost is defined as “Total-Cost”.

step 4: The uGrid-Server directs the source node (Service-Part A in Fig. 2) to establish the optical path by using a signaling protocol such as RSVP-TE (Resource reSerVation Protocol-Traffic Engineering). This signaling process is defined as “Service-Signaling” [5]. Service is provided after Service-Signaling.

There are problems in uGrid. One of them is high Total-Cost. In order to provide the contents for users via the specified Service-Parts, it is necessary to detour optical paths. Another is inflexible. Because users must designate the combination of Service-Parts to receive the requested contents, it is difficult of users to request services.
II. E3-DCN

The DCN (Contents Centric Network) [6] [7] is widely studied. In the DCN, users request content names to the network and receive requested contents from the network. We propose E3-DCN which is a new DCN environment based on uGrid. E3-DCN adopts the mechanism of DCN to uGrid. Figure 3 shows comparison of uGrid and E3-DCN. One of purposes of E3-DCN is giving the mobility of Service-Parts and making cost reduction. By allocating middle Service-Parts between source and destination dynamically, the length of path becomes shorter and it can contribute to cost reduction. The other is that E3-DCN adopts the mechanism of DCN to uGrid. If the exactly matched users’ requested contents are not found in the network, the network constructs the requested contents with “Service-Parts” and provide the contents to the users. So, in E3-DCN, users can receive requested contents without designating the composition of Service-Parts.

III. PROPOSED TOTAL-COST REDUCTION METHOD: SERVICE COPY

We propose a cost reduction method by copying Service-Parts in E3-DCN. It is expected that there is more Service-Parts consisted of CPUs and memories which perform only calculation than Service-Parts which have a specific software function. The Service-Parts which only calculate are defined as “Copy-Part”. By copying Service-Parts to Copy-Parts temporarily if needed, E3-DCN-Server can establish the lower cost optical path than uGrid which does not copy. When all the paths established via the Copy-Part are released, the software function on the Copy-Part is also released and it becomes possible to be used for Service-Copy.

Figure 4 shows the Service Routing model which reaches the user via Service-Part A, B and C with Service Copy. The network topology is defined as “3D-Topology”. It is considered in three dimensions for every stage. Each service stage expresses the path states of service offers, and advances the stage for every passage about Service-Parts. Each copy stage expresses the path of Service-Copies and stages differ for every oriented Service-Parts function. As mentioned above, if three dimensions network topology regard a link as a separate link for every stage, it is possible to calculate the minimum cost paths by ILP. On the copy stage 2, if a Service-Part B is copied to a Copy-Part, the Copy-Part B can be used as the service B between the service stages 1 and 2. In order to the Service-Part A always continue to perform as a video camera function while providing service, there is no effect of the cost reduction by Service-Copy. So, there is copy stage 1.

IV. EVALUATION BY ILP

By using ILP simulation, Total-Cost with Service-Copy was compared with Total-Cost without Service-Copy. Figure 5 shows the simulation model. The arrow of a solid line expresses the path of contents and the arrow of a dotted line shows the path of the Service-Copy. Numerical values concerning Service-Parts and Copy-Parts show Service-Cost for every user unit time. Numerical values concerning links show Link-Cost for every user unit time. In addition to both costs, the cost of Service-Copy is defined as “Copy-Cost”. In
this evaluation, Copy-Cost is taken as 100 unit time of the total of the Link-Cost via Service-Copy and the Service-Cost of the original Service-Part and the Copy-Part. In E3-DCN, Total-Cost is the total of Link-Cost, Service-Cost and Copy-Cost. One Service-Part and one Copy-Part can be used by several users. At an example in Fig. 5, The Total-Cost of providing the service through service parts A, B, and C to one user for 1000 unit time, the case of without Service-Copy is 97000, the case of with Service-Copy is 86000. Therefore, the Total-Cost reduced by about 11% with Service-Copy.

![Fig. 5. The simulation model.](image)

Figure 6 shows the comparison of the Total-Cost by service time for the number of users. In the Total-Cost of the service which provides user through Service-Parts A, B and C, Total-Cost with Service-Copy is normalized by Total-Cost without Service-Copy. From this figure, when service time is 1000, Total-Cost is reduced by about 12% the case with one user, by about 17% the case with four users by with Service-Copy compared to the case without Service-Copy. If a Service-Part is copied to a Copy-Part one time, several users can use the Copy-Part as the Service-Part. So, more users reduce the ratio of Copy-Cost, and it becomes larger effect of Total-Cost reduction. Copy-Cost is not concerned with time, but fixed. So, for the same reason as previously, longer service time becomes larger effect of the Total-Cost reduction. Moreover, for the same reason as previously, in the case of one user, the effect of Service-Copy appeared from service time 300, in the case of four users, appeared from 100.

**V. CONCLUSION**

We previously presented uGrid which provides services which combined Service-Parts on the network. Service-Parts are assigned IP address for executing the uGrid service composition in the network layer. The uGrid server manages users and Service-Parts, performs Service-Routing and Service-Signaling according to users’ requests. It results in services. However, in uGrid, there is no DCN element and services are high cost. Then, we propose E3-DCN as a new generation cloud computing. E3-DCN aims at flexibility of users’ requests by taking DCN elements into uGrid, and cost reduction by giving mobility to Service-Parts. In this paper, we proposed the cost reduction method by Service-Copy inf E3-DCN. The Total-Cost of services without Service-Copy and with Service-Copy was evaluated using ILP. It turned out that with Service-Copy, the more there are many users and long service time, the more efficient Total-Cost reduces than without Service-Copy.

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**REFERENCES**


Introduction

uGrid (Ubiquitous Grid Networking Environment)
- Users are provided contents generated combining data and software (Service-Parts) connected to the network.
  - Faithful to users’ demands
  - Simplification of the apparatus of the sources and users

DCN (Data Centric Network)
- Users require network by contents name.
- Contents in caches return as responses of demands from network.

Energy Efficient
- Cost reduction by avoiding the detour of paths

E³-DCN Architecture

From users’ demands to offers of contents

Step 1) Users require of DCN by contents name.
Step 2) Contents are searched on DCN.
  - When found in cache → Contents are transmitted to users on DCN. (End)
  - When found in Service-Parts specification → Step 3)
Step 3) Contents are generated combining Service-Parts on DGN, and transmitted to Users.
  - Service-Routing: Paths from sources to users via Service-Parts are determined.
  - Service-Signaling: The paths determined by Service-Routing are established

Service Copy

Present Way
- Paths via fixed Service-Parts are redundant.
  - High cost, Generating of congestion

Proposed Way
- Service-Parts are copied to platforms (Service-Copy).
  - Lower cost, Avoiding congestion

Evaluation

Comparison of the Total-Cost by with Service-Copy and without

- Cost reduction by Service-Copy is so large that there are many users.
  - It is possible for many users to use Copy-Parts after Service-Copy.
- Cost reduction by Service-Copy is so large that service time is long.
  - Execution of Service-Copy requires cost.

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