Resource Management Method Considering Characteristics of Virtual Nodes in Massive Experiments

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Larger scale verifications of various network functions and services are demanded, as real world networks including the Internet continue to expand everyday. There are testbeds that provides experimental resources to experimenters who perform such verifications. Experimenters emulate nodes in the real using experimental resouces provided by the testbeds. To perform a massive scale verification, it is nessesary to increase number of nodes which are emulated in the testbeds. However, it is difficult to increase experimental resources in the same way as real networks. To enable massive scale verification that supports expanding real world networks, it is nessesary to emulate the massive network using smaller number of nodes. A focus of this research is to maximize the utilization of experimental resources in the testbeds to facilitate massive verification.

Creating virtual node using various virtualization technology and multiplexing multiple virtual nodes into a single physical node is a common technique to increase the size of the verifications. The virtualization technology include process abstraction, virtual machines and so on. Different verifications require different virtualization technology, or combination of the virtualization technology. Each virtual node occupies a certain range

of resources. A virtual node occupies certain amount of resources, that depends on the specific virtualization technology used to create the node. Experimenters can limit the range to smaller range in order to increase the multiplicity of virtual nodes. A degree of multiplexing increases as amount of resources occupied by the virtual node, but performance and functionality of the node decreases. In this research, the amount of resources occupied by the the virtual node, or a size of the virtual node in short, is called a granularity of the virtual node. A virtual node requires a granularity that is large enough for objectives of the verification. On the other hand, the cost of the virtual node becomes smaller to applying smaller grain size.

Adapting appropriate grain size to each virtual node would increase the degree of multiplexing. However, there are problems to realize this strategy. To select appropriate grain size, experimenters need to comprehend the virtual node's characteristics such as function, performance and so on. Additionally, control interfaces of each multiplexing method are different. Therefore, experimenters need to learn controll interfaces for all multiplexing methods used in a verification. But it is difficult for experimenters to learn those interfaces at each verification. Moreover, SpringOS, a management system to support experiments, is developed and operated. SpringOS controls each physical machines appropriately with detail configurations. To run a massive verification, the load on management system becomes larger. As stated above, there are some problems to run a massive verification.

To run a massive verification, it is necessary to control each virtual node considering it's characteristics. Therefore, I designed BlackSmith, Virtual Node Pack Control System. BlackSmith make control of virtual nodes more efficient. I abstracted characteristics from multiple virtual nodes and defined the Virtual Node Pack. Virtual Node Pack consists of 2 things. One is multiplexing method applied to each node. With the existing environment, experimenters have to control each virtual node apporopriately for each multiplexing method applied to the nodes. I defined common interface of virtual node independently of multiplexing methods. BlackSmith converts abstract controls with this interface to controls of each multiplexing methods. This makes it possible to use various multiplexing methods

easily. The other is the number of nodes constructing Virtual Node Pack. Experimenters do not control each virtual node in the environment adapted Virtual Node Pack. Experimenters can control the Pack as if they control each virtual node which belongs to the Pack. In a Virtual Node Pack, management nodes are deployed for each physical machine in order to split and distribute control. This reduces the load of each management node.

I implemented BlackSmith to control Virtual Node Pack actually. BlackSmith is constructed by Agents which provide Virtual Node Control Interface and Controllers which provide control of Pack. These components are placed in each physical machine. With BlackSmith, introduction of multiplexing methods is easier than previous verification. In Addition, the load of each management node relating to control of many nodes is reduced.