Evaluation of Future Network Architectures and Services in the G-Lab Testbed

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Abstract. Our current Future Internet research in the G-Lab project [1] comprises clean slate network architectures and services. In this vast topic, we focus on two different aspects: (1) Composition as well as adaptation of application and network tailored protocols and (2) novel addressing and routing schemes based on locator/identifier-split. In the following, we describe these aspects including their benefit and usage of the G-Lab testbed. Then we detail our ongoing cooperation and the development of a joint prototype.

1 Composition and Adaptation

In our composition approach, we envision the following development cycle for application and network optimized communication protocols in future networks: First, new protocols are composed by (re-) using units called *Building Blocks* in a design tool. Second, the newly created protocols—called *Netlets*—are evaluated in the G-Lab testbed. Finally after successful evaluation, the newly implemented Netlets can be deployed easily in real networks. The testbed with its real hardware and operating system APIs enables us to use the same Netlet execution framework for the evaluation and the deployment in real networks.

As Netlet framework we use the *Node Architecture* [2] outlined in Figure 1 (left): A requirements-based application interface allows exchanging Netlets without modifying applications since protocol selection and name to address resolution is completely handled by the Netlet framework. A selection algorithm within the *Netlet Selection* component chooses a suitable Netlet based on the requirements given by the application. A generic *Naming and Addressing* component delegates name to address resolution to a component responsible for the current network. This could be, for instance, the mapping service described in the following section. The streams of the respective Netlets are (de-) multiplexed by the *Netlet Multiplexer*. The *Management and Adaptation Component* constantly monitors the conditions of the Netlets, the network, and the applications. If changes are detected, it tunes configuration parameters to adapt Netlets as good as possible to the new conditions. As an abstraction for network connectivity the *Network Access* (NA) is used. Although it can be compared to today's

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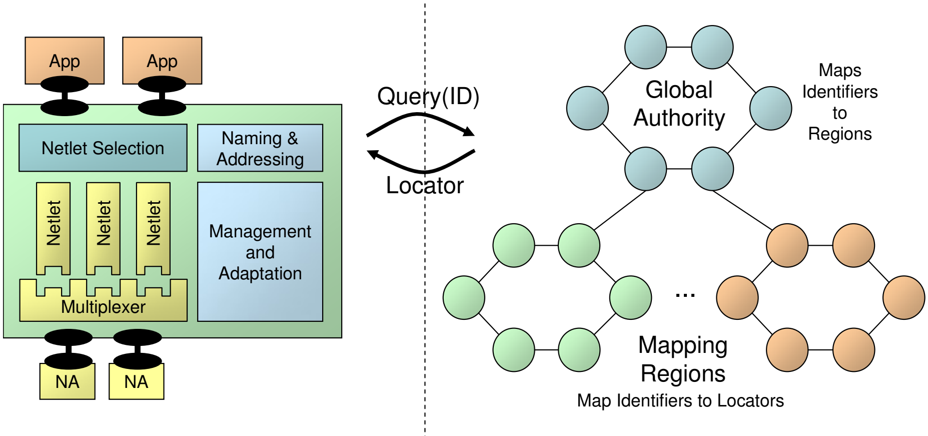

Fig. 1. Separated experiments and their interaction (left: Netlet framework, right: Locator/Identifier-Split Mapping Service)

network interface, it is a more flexible abstraction of any type of network (e. g., physical as well as virtual networks). Especially in virtual networks, we expect more detailed information about the current network condition due to a more sophisticated virtual network management infrastructure.

The combination of the G-Lab testbed and our Netlet framework provides us with an appropriate test environment for our experiments. In a first stage, we want to experiment with various Netlets including transport, routing, and management/monitoring protocols. Thus, we expect to gain better insights on the interaction of Netlets, their possible deployment strategies, signaling mechanisms, and monitoring concepts. In a second stage, we plan to emulate different dynamic network properties (e.g., packet loss, reordering, latency, and data rates) in the G-Lab testbed. Then we will evaluate Netlet adaptation concepts which aim to compensate such network properties and optimize communication.

2 Locator/Identifier-Split

By using the idea of the locator/identifier-split (loc/id-split) for a next generation Internet addressing scheme, we can overcome several problems of today's IP based architecture. The two semantic meanings of today's IP address—who do we want to contact and where can we find him?—are split into two different addresses, the identifier and the locator. The loc/id-split, however, requires a system which is able to map these two addresses before any connection can be established. The so called *mapping service* [3] depicted in Figure 1 (right) can be queried to retrieve the current valid locator for an identifier in order to contact the corresponding node. The mapping service needs to store the identifier/locator tuple for any assigned identifier and has to cope with the burden of frequent locator updates as mobile nodes roam and change their point of attachment towards the network. Because of the expected high load a centralized approach for the mapping system is not feasible. We therefore suggest the usage of a decentralized system like DHTs. Instead of one large decentralized database, the mapping system is split up in different regions. Each region stores the loc/id-mapping of nodes registered in this region. A region for example is a country or a continent. If the mapping region for a specific identifier is not known, the so called global authority is queried, which maps identifiers to the corresponding regions. The global authority also serves as a single point of trust for a PKI-based security infrastructure. In order to avoid long lookup times in the DHT we use a protocol which resolves a query in only one hop.

To validate our approach, we implemented a prototype of the mapping service and deployed it to the G-Lab experimental facility. As the mapping is based on structured peer-to-peer principles, many nodes are required to instantiate a solid mapping infrastructure. Additionally, measurements only become significant if performed on a large scale.

3 Conclusion and Future Work

The G-Lab experimental platform enables us to connect our prototypes of the two independent research aspects mentioned above. Unlike with two experiments running within separate simulation frameworks, the two prototypes are able to communicate with each other. Therefore, they can utilize the functionality provided by the respective counterpart. In our current setup, the Netlet framework is accessing the information provided by the mapping service to address end-nodes and services by identifiers (cf. Figure 1). In that way, it doesn't have to deal with mobility issues—addressing wise—and end-nodes are able to roam freely. On the other hand, we have the possibility to construct a hybrid mapping service that utilizes peers implemented as Netlets. This is a next step towards a migration of the mapping service to a Netlet based solution. All this wouldn't be possible with separated simulations. The G-Lab experimental platform, therefore, plays a major role in validating theoretical results of the proposals, enables us to gain real-world measurements from our prototypes, and supports our ongoing cooperation.

References

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