# Towards Composed Communication Services in Future Networks

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The Future Internet is expected to cope with a very high level of heterogeneity related to interconnected networks, devices, and applications. Network virtualization and service composition can thereby provide an alternative to the patchwork design of the current architecture.

We consider *network virtualization* as a key technology for the Future Internet as it provides the possibility to operate multiple virtual networks in parallel, each tailored to the needs of respective applications. During the deployment of a virtual network, virtual nodes are instantiated and virtual links between them are set up including the reservation of resources in the underlying network infrastructure. This requires appropriate signaling protocols for the set-up and management of such virtual networks. For example, resources may need to be re-distributed during run-time in order to accommodate new virtual networks without disturbing the properties of already operating ones. Flexibility, robustness and efficiency are important properties of such protocols. Moreover, security aspects are of great importance, for example with respect to proper accounting. Within G-Lab[1], enhanced signaling protocols with appropriate security solutions will be designed.

With these virtual networks in place, tailored network architectures can be provided rather easily compared to today's cumbersome introduction. This, however, also requires proper protocols operating in these network architectures. The design and development of protocols, however, is a tedious and error-prone task. Applying composition technologies known from software engineering perspectives may increase design efficiency. Therefore, protocols are decomposed in so-called building blocks (BBs). These BBs are, then, composed in order to provide tailored protocols as needed by the application. The semantics of such a BB are provided by a service description, which also includes additional meta-data. Based on the information contained in the service description, appropriate BBs are selected and composed. During the composition process, the properties of the compound BBs have to be evaluated. Furthermore, a selection is needed when multiple BBs fulfill the requirements. The selected compound BB could then, for instance, be instantiated inside a so-called Netlet which was defined within the 4WARD project along with a flexible Node Architecture [1].

The Netlet itself, however, may need to adapt parameters and mechanisms during run-time in order to cope with changing situations in the network (cf., Fig. 1). We aim at a close integration of Netlets into a distributed management and monitoring framework. The adaption part of the Netlet itself is responsible for short-term adaption and interfaces with a monitoring component, which gathers appropriate information, using the so-called tuning interface. Generally, each BB interfaces with the adaption component, which informs BBs about network events. This way, cross-layer issues will also be addressed. The exchange of information between different BBs is handled by signaling mechanisms. The design of the interfaces as well as the adaption algorithms are currently under investigation within the G-Lab project. Additionally, dependencies between BBs must be considered when adapting certain parameters. The resulting Netlet must still comply to the properties required during its composition. If this is not the case, a new Netlet may be instantiated and the communication may be switched from the old to the new Netlet. These steps are also considered in the current work of the G-Lab project.

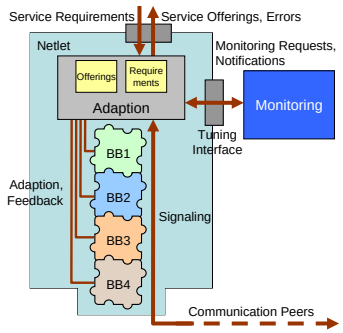


*Figure 1:* Netlet and adaption of BBs

## References

[1] L. Völker, D. Martin, I. El Khayat, C. Werle, and M. Zitterbart. A Node Architecture for 1000 Future Networks. In *Proceedings of the International Workshop on the Network of the Future 2009*, Dresden, Germany, June 2009. IEEE.

[1] http://www.german-lab.de