# Title

# Authors

# Author Affiliations

# Keywords

# Abstract

The Network Service Interface (NSI) was created as a result of collaborative brainstorming by the network and application engineers primarily within the Research and Education (R&E) community. The objective was to deliver network infrastructures as a service to both novice and expert end users. The first step was to design a protocol which could enable the automated creation of multi-domain heterogeneous network circuits and offer it as a “*Connection Service”* at global scale.

The concept was formalized into a protocol specification in August 2011 under the umbrella of the Open Grid Forum (OGF) NSI-WG. Within three months, six distinct implementations of the NSI protocol demonstrated interoperability at a global scale by negotiating resources and provisioning circuits across twelve domains. The demonstrations tool place at the GLIF Technical meeting in September 2011 in Rio de Janerio (Brazil), at the Future Internet Week in October 2011 in Poznan (Poland), and at the SuperComputing’11 event in November 2011 in Seattle (WA, USA). The current list of tools for network provisioning which are capable of using the NSI protocol includes AutoBAHN (GÉANT), Open(?)DRAC (CESNET, NetherLight, UvA), DynamicKL (KISTI), G-Lambda (AIST, JGN-X, KDDI), OpenNSA (NORDUnet, SURFnet), OSCARS (ESnet, Internet2, RNP). The protocol is currently a prototype, however there are plans for future operational deployment.

The goal of the NSI is to hide network complexity from the end user. This is accomplished by the creation of the Network Service Plane (NSP) which provides a simple way for a user or application to request for network resources. The NSP is composed of Network Service Agents (NSA) which can assume one of three roles; a Requestor, a Provider, or a Requestor-Provider.. The Requestor Agent (RA) can request network resources, while the Provider Agent (PA) is responsible for delivering the service to the RA. A Requestor-Provider agent can behave both as an RA or PA depending on its configuration and the specific request.

The NSI is not just a protocol, but rather a framework for service protocol development, a defined set of principles and relations that form the basis of the protocols, which can be used to build a variety of architectures and services. The first prototype service was the Connection Service that delivers end-to-end provisioning features and was the scope of recent demonstrations. Other services are being explored, including topology exchange, performance verification, fault localization and remediation, and provisioning of general IT resources. The NSI-WG is comprised of a well-rounded group of contributors with various expertises. This ensures that the NSI framework is developed within a multi-dimension environment.

The currently defined NSI CS is stable and functional, which makes it easy to migrate into a production service deployed over production infrastructures around the globe. It has a defined reservation state machine which assures that processing is performed consistently and correctly according to the NSI rules and system policies. The current state machine has eleven states and defines the necessary events or messages needed to transition between them. The state machine supports the following operations; i) accepting a request, ii) reserving resources, iii) provisioning a connection, iv) releasing a connection after a pre-defined time, and v) cancelling a reservation at any time. Reservations can be requested to be begin immediately or scheduled for a future time, according to resources available from the requested provisioning systems.

As the NSI CS by itself is not a provisioning system, but rather a stateful protocol for resource scheduling and provisioning, it relies on independent provisioning tools that are deployed over network infrastructures. Where the tools functionality is extensively used by the NSI protocol for verification of local resource availability, global and local path-finding, and reserving and provisioning of resources, the NSI support offers the ability to deliver inter-domain services and extend service coverage to a global dimension. By involving more and more deployments in addition to recent demonstration partners, the reach of the NSI is continually growing. Despite the fact that the current environment is not an operational one but was built for demonstration purposes only as a proof of concept, it shows the potential and interest in unified network services delivered at the largest possible scale.

The OGF NSI-WG activity is leveraging the critical mass to push the work forward more intensely than before. The demonstrations have shown the usability of the protocol as a proof of concept for global network services development. Moving forward, the NSI-WG is now focused on releasing a new stable version of the NSI CS protocol that will be the base for operational deployment. Most of the engaged NRENs and organizations have expressed interests in providing a NSI CS capable peering for their infrastructures that support approximate timescale and resource commitments. In 2012, it is expected that there will be a series of NSI coming out events to expand the NSI cloud in order to reach more infrastructures and end users.

The NSI CS protocol’s readiness for operational activities has been proven. However, there are still some missing functionality required to deliver the highest reliability and level of the service. The NSI-WG has created a list of features which are subject to investigations for further protocol releases. The list involves issues learned from the past three demonstrations of the NSI protocol, as well as experience and requirements of the NSI contributors and potential users. The two most crucial issues are the Authentication Authorization Infrastructure (AAI) and Topology exchange functionality. Since security is one of the most important matters in open infrastructures, the service must be resistant to potential intruder attacks, unauthorized control, and resource abuse. Therefore an authentication and authorization mechanism must be integral to the future protocol definition as a requirement for production service deployment. The lack of AAI support in the current protocol version is a critical factor that may prevent wide adoption by NRENs and other network providers. Another urgently needed functionality is topology exchange, which will provide mechanisms to support dynamic network management at global scale. Currently, the statically downloaded topology files used by NSI implementations cannot reflect dynamic network changes such as topology and resources availability. As the NSI is designed for dynamic network management, it must have access to accurate and up to date network information with possible predictive behavior for advance reservation features. Once both the AAI and Topology distribution problems have been solved, the protocol will become a fully functional proposition for all kinds of deployment in either research or production environments. The list of future features are not limited to these two issues, but include monitoring, accounting, service reliability and robustness to name a few. Developing all these functionalities will not be trivial but it provides a systematic roadmap for the NSI-WG .

# Acknowledgements

# References

# Author Biographies