# Title

# Authors

# Author Affiliations

# Keywords

# Abstract

Network Service Interface (NSI) was created as a result of brainstorming in the community of network and application engineers. The objective was to deliver the missing piece of solution to integrate services with network infrastructures and provide it as integrated product to the end users, often lacking a technical knowledge. The first step was to make a protocol which enable automated creation of multi-domain heterogeneous network circuits and offer it as a “*Connection Service”* at global scale.

The concept was put into a protocol specification by August 2011 under the umbrella of Open Grid Forum (OGF) NSI-WG. A month later seven partners were able to demonstrate an operating protocol which orchestrated six different independent provisioning systems (AutoBAHN, dynamicKL, G-Lambda, OpenDrac, OpenNSA, OSCARS) into united service with single point of contact. The demonstration took place in Rio de Janeiro on 13th Sept 2011 and involved GÉANT, KISTI, AIST, KDDI Labs, SURFnet, NORDUnet and ESNET organisations. The demonstration has shown the strength of the protocol and the potential to enable global automated provisioning.

Encouraged with the Rio de Janeiro success, at Future Internet Week in Poznan between 24th and 28th Oct 2011 another NSI demonstration has reached next step of interoperability by including data plane functionality. The NSI enabled provisioning systems were not only able to talk and negotiate resources but also to configure the network and deliver transatlantic circuits to the end users. Connections from a server located in GÉANT through PIONIER, NetherLight, StarLight, and JGN-X networks were made within seconds to reach AIST, KDDI or KISTI servers. The functionality was supported by visualization systems based on Google Earth® display and dynamic calendar/topology charts.

The next demonstration took place during SuperComputing 2011 event in Seattle WA between 14th and 17th Nov 2011. Twelve partners with six provisioning system implementations were constantly setting up multiple point-to-point circuits across the world without any manual configuration requirement. This demonstration shown the full potential of the NSI protocol as a layer to unite network services at global level and deliver easy to use provisioning mechanism for research communities. A big scale deployment and dynamic adaptation to network condition and user requirements introduces the ability to build new reliable global connection services based on existing network infrastructures and their interconnectivity.

The NSI protocol relies on basic assumption to hide network complexity by creation of additional Network Service Plane (NSP) and give users and applications a simple way to request the connection services. The NSP relies on Network Service Agents, which can use NSI to communicate and create entities of threefold nature – Requestor, Provider, and Requestor-Provider agents. The Requestor Agent (RA) can request network resources, while Provider Agent (PA) is responsible to deliver the service to the RA. That functions can be merged, as the same agent can behave as RA or PA for different requests depending on configuration and particular request cases. The reservation requested to the system has a defined state machine which is assuring that processing is performed correctly according to NSI rules and system policies. Current state machine has eleven states and defines permitted transition between them, which can be initiated by events or message occurrences. The state machine supports the operations of accepting a request, reserving resources, provisioning a connection, releasing a connection after pre-defined time, and cancelling a reservation at any time. Reservations can be requested to be configured immediately or scheduled for the future, according to internal resources calendars available at particular provisioning systems.

As the NSI by itself is not a provisioning system, but rather a stateful protocol for resources scheduling and provisioning, it relies on independent provisioning tools deployed over network infrastructures. The tools functionality is extensively used by NSI protocol for verification of local resources availability, global and local pathfinding, booking and provisioning of resourcs, while the NSI support offers an opportunity to deliver inter-domain services and extend service coverage to global dimension. The service range is constantly growing, by involving more and more systems including AutoBAHN (GÉANT), DRAC (CESNET, NetherLight, UvA), DynamicKL (KISTI), G-Lambda (AIST, JGN-X, KDDI), OpenNSA (NORDUnet, SURFnet), OSCARS (ESnet). Despite the fact that this environment is not operational one and was built for demonstration purposes only as a proof of concept, it shows the potential and interest in unified network services delivered at largest possible scale.

The OGF NSI-WG activity is now using the critical mass to continue the work even more intense than before. The demonstrations have shown the usability of the protocol and acts as a proof of concept for global network services development and the actions now are focused to release a new stable version of NSI protocol which will be base for operational deployment. Most of engaged NRENs and organizations expressed an interest in providing NSI peering for their infrastructures, providing approximate timescale and resource commitment. The year 2012 then, is expected to be a series of NSI coming out events and enlarging NSI cloud in order to reach more and more infrastructures and end users.

Since the NSI protocol readiness for operational activities was proved, there are still some missing puzzles required to deliver the highest quality and reliability of the service. The NSI-WG has created a list of features which are subject of investigations for further protocol releases. The list involves items learned by experience from the three past demonstrations of the NSI protocol, and also requirements issued by NSI contributors and potential users. The most crucial ones are AAI and Topology exchange functionality. Since security is one of the most important matters in opened infrastructures, the systems must be resistant to potential intruder attacks, control take over, or resources abuse. Therefore an authentication and authorization mechanism must be included in the further protocol definition as a requirement for safe service providing and guarantees of constant service delivery to the end users. Lack of AAI support in the current protocol version is a critical factor which may prevent the protocol to be widely adopted by NRENs and network providers. Another functionality needed in short time scale is topology exchange, which will provide mechanisms for dynamic network management at global scale. Currently a statically downloaded topology file is used by NSI implementations, which obstacles adoption to network changes in the sense of topology and resources available. As the NSI is designed to dynamic network management it must have access to accurate and up to date network information with possible predictive behavior for advance reservation features. Having both AAI and Topology distribution problems solved, the protocol will become a fully functional proposition for all kind of deployment in either research or commercial environments. The list of future features however is not limited to this two issues and assures that the NSI-WG will require lot of efforts to work on e.g. monitoring, accounting, service reliability and robustness, etc.

# Acknowledgements

# References

# Author Biographies