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## Renewable Power Associated InfraStructure as a Service

The objective of the Greenstar Network <sup>[1]</sup> GSN/Mantychore liaison is to create a pilot test bed environment from which to derive best practices and guidelines when building data networks which would use Infrastructure as a Service (IaaS) paradigm while minimising the carbon footprint of such a network.

GSN will use the flexible platform provided by the Mantychore FP7<sup>[2]</sup> project to move virtualised data-centres towards network nodes powered by green energy sources distributed in a multi-domain network, particularly between European and North America domains. This research shows how these resource provisioning solutions can be integrated and studies the feasibility of powering e-Infrastructures in multiple domains worldwide with renewable energy sources. Management and technical policies are being developed to leverage new virtualisation approaches, which will help to migrate resources from one site to another based on power availability without suffering connectivity interruptions. Another set of influences being considered is the physical location factors for such relocation e.g. weather predictions, estimation of solar power generation, etc. As energy produced from renewable sources has the potential to become one of the industries in each of these countries, it is vital to see how new network provisioning technologies can be developed to maximise network connectivity to where these energy production facilities are located.

Converging server and network virtualisations allows migration of virtual data centres over network nodes to happen as part of virtual infrastructure management. GSN offers an IT middleware solution built around the IaaS Framework and provides extensions to manage servers, virtual machines as well as power meters and PDUs (all plug-ins for the platform and can be deployed in any IaaS container).

The software consists of the following components:

- GSN Controller is the intelligence module for GSN infrastructure and is responsible for planning and executing the migration of virtual machines across GSN facilities according to the availability of renewable green energy.
- Network Manager is responsible for controlling and managing network resources and exposing these as network services via its NSI Interface.
- Cloud Manager controls and manages computing resources such as clouds, hosts, virtual machines, and storage.
- Facility Manager is responsible for control and management of any Facility Resources. A Facility Resource is an abstraction of a GSN facility or a node which performs computations to predict availability of power based on current and long term weather forecast and historical data.

Using Infrastructure as a Service (IaaS) as a management tool facilitates the use of such renewable energy within the GSN. Integrating this with Mantychore allows the NRENs to provide a complete, flexible network service that offers research communities the ability to create an IP network under their control, where they can configure:

- a. Layer 1, Optical links. Users will be able to get access control over optical devices like optical switches, to configure interface cards and ports using an integrated Argia<sup>[3]</sup> framework.
- b. Layer 2, Ethernet and MPLS. Users will be able to get control over Ethernet and MPLS (Layer 2.5) switches to configure different services as Mantychore will integrate the Ether project and its capabilities for the management of Ethernet and MPLS resources.
- c. At Layer 3, the Mantychore FP7 suite includes features for:
  - Configuration and creation of virtual networks,
  - Configuration of physical interfaces,
  - Support of routing protocols, both internal (RIP, OSPF, ISIS, iBGP) and external (BGP),
  - Support of QoS and firewall services,
  - Creation, modification and deletion of resources (interfaces, routers) both physical and logical,
  - Support of IPv6. It allows the configuration of IPv6 in interfaces, routing protocols, networks.

GSN using a virtualised approach provides this type of network architecture built with multiple layers, for a large number of resources. As part of the service, the user can monitor and control resources, which allow them to run their application in a virtual infrastructure powered by green energy sources. Virtualised management has been proposed for service delivery regardless of the physical location of the infrastructure which is determined by resource providers. Resources are only allocated according to user requirements, which allow high utilisation and optimization levels to be achieved.

Each domain in the GSN has a hub and a number of spoke nodes. The hub is powered by sustainable energy sources (e.g., hydroelectricity), and run continuously to keep service alive in the domain. Spokes nodes are powered by intermittent green energy sources. Service is provided by spoke nodes whenever energy is available. Otherwise, the hub hosts the service. The current GSN includes a hub at Montreal connected to spoke nodes across Canada, USA and Europe.

In autumn 2011 GSN will interconnect hubs in Europe and Canada connected to nodes in each region powered by renewable energy sources, using IaaS Virtualisation techniques to manage such a network, allowing migration of data centres following green energy source availability, such as solar and wind.

## REFERENCES

- ❖ Greenstar Network project website [Online]. Available at <http://www.greenstarnetwork.com/> .
- ❖ Mantychore FP7 project website [Online]. Available at <http://www.mantychore.eu/>
- ❖ E. Grasa, S. Figuerola, A. Forn, G. Junyent, J. Mambretti; “Extending the Argia software with a dynamic optical multicast service to support high performance digital media”. Optical Switching and Networking, Vol 6, Issue 2, pp. 120-128. April 2009.