MANTICORE II: IP Network as a Service Pilots at HEAnet, NORDUnet and RedIRIS

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Extended abstract

MANTICORE II follows the Infrastructure as a Service (IaaS) paradigm to enable National Research and Education Networks (NRENs) and other e-infrastructure providers to enhance their service portfolio by building and piloting the deployment of tools to provide infrastructure resources and IP networks as a service to virtual research communities.

IaaS consists on offering remote access and control of infrastructure elements to third party organizations through software services. By using IaaS services these organizations can control the remote infrastructures as if they owned it and be billed either per use or based on a monthly fee. The flexibility provided by IaaS comes at the cost of increased management complexity; therefore IaaS management solutions that keep track of permissions, infrastructure resource allocation, usage and monitoring are of key importance to fully exploit the IaaS advantages. Even though a few IaaS commercial solutions exist (Amazon EC2 and S3 [1], BlueLock [2]), they mostly focus on providing virtual machines (computing) and storage on demand; thus MANTICORE II tools and services innovation is as important as complementary within the IaaS landscape.

Typically, three user roles can be identified in the IaaS scenario:

- **Infrastructure Provider:** The infrastructure owner. Assigns permissions to the infrastructure resources so that external users can control them. In MANTICORE II, infrastructure providers are NRENs (HEAnet, NORDUnet, RedIRIS) providing control over physical or virtual routers.
- **Virtual Operator:** The infrastructure aggregator. This user gains access to several infrastructure instances and aggregates them under his management domain. In MANTICORE II, an organization managing the resources of a virtual research community would take this role. For example, it could be the network administrator of an international research project that created a dedicate IP network using NREN infrastructure.
- **End user:** Uses the services provided by the virtual operator. In MANTICORE II this user will be empowered to change some of the attributes of the IP Network Service through the use of a simple graphical interface.

IP Network as a Service can be a key enabler of the flexible and stable e-Infrastructures of the future. Today some tool prototypes to provide point-to-point links to researchers have been developed (AutoBAHN [3], Harmony [4], G2MPLS [5], G-Lambda [6] and others). These tools, while providing high bandwidth pipes to researchers, only address one site of the problem. Researchers that want to create a virtual community to address scientific problems are still connected to each institution's networks, and it is a major problem to directly connect them with high bandwidth pipes because it causes a number of issues such as security or routing integrity [7]. One of the ways of efficiently solving this problem is to create a logically separated IP network (on top of the high bandwidth pipes), or by using separate instances of virtualized routers, or a combination of both, and dedicating it to one virtual research community. In order to maximize the flexibility and convenience of the IP Network Service, the users of the virtual community should be able to modify the characteristics of their IP Network by themselves (such as addressing, dynamic routing protocols, routing policies, quality of service and so on).

The MANTICORE II project is built upon the successful results achieved by its predecessor: the MANTICORE project [8]. MANTICORE delivered a proof of concept of a system to manage logical routers, physical routers and IP Networks based on Globus Toolkit 4 [9]. MANTICORE produced a successful working prototype suitable to proof the concepts and ideas behind MANTICORE, to make demonstrations to educate people and be used in research projects [10]. Being a prototype, however, it is not robust enough and does not implement enough features to be deployed in a full production environment. Therefore, the main goal of MANTICORE II is to provide an implementation that can be deployed in a production network and can be used in real life by real users. MANTICORE II is carrying out the following activities:

- **Robust and modular implementation of IaaS management** tools to provide routers and IP networks as a service. This implementation is based on the IaaS Framework [11] technology.
- **Pilot software deployment and evaluation at HEAnet, NORDUnet and RedIRIS**. MANTICORE II software tools will be deployed on a subset of the NRENs e-infrastructure. A series of pilot activities evaluating the operation and the use of the IP Network Service will be carried out, identifying: i) operational procedures, ii) improvements in the software iii) added value of the service (in terms of improving the operational efficiency and enhancing the flexibility and satisfaction of customers).

- **Design and implement a simple yet powerful graphical interface** for the IP Network Service that allows end users to change some of the service attributes: addressing, internal routing, peering, firewalls, and quality of service.
- **Integration with eduGAIN**: Study and prototype the integration of MANTICORE II's Authentication and Authorisation Infrastructure (AAI) with eduGAIN.
- **Study and simulate mechanisms to implement an infrastructure marketplace**, where infrastructure providers can publish their infrastructure offerings with the usage conditions (Service Level Agreement, price) and virtual operators can use powerful query capabilities to automatically select the best resources to assemble their dedicated networks.
- **Study business models and use cases for commercial services based on MANTICORE II principles**. Some of these use cases are: i) "open garden" networks that treat partner traffic with the same level of service as "walled garden" traffic, ii) Network as a Service (NaaS): private IP backbones for other service providers, and iii) network sharing: share infrastructure, maintenance, engineering and technology costs for networks.

Moreover, the MANTICORE II project has recently expanded its activities by starting collaboration with the Canadian GreenStar Network (GSN) project [12]. GSN is a CANARIE funded initiative that will deploy a testbed and carry out studies on the feasibility of powering e-Infrastructures with unstable renewable energy sources, such as solar or wind. GSN will exploit IaaS and virtualisation to migrate virtual infrastructure resources from one site to another based on power availability, trying to minimise the impact on the services that these virtual infrastructures are supporting. MANTICORE II will collaborate with GSN providing the IaaS management tools that the project is developing, and extending the Canadian GSN testbed with European NREN resources.

Currently, MANTICORE II is focusing its effort on the implementation of the improved IaaS tools: a first version of them will be available by the end of March 2010. Pilot tests are expected to start by the end of April 2010, and last for 2 months. The next stage will be to carry out pre-operational service deployments at each NREN, deeply involving selected research communities. On top of this, MANTICORE II tools would also be integrated with the IaaS Framework tools for layer 1 (Argia [13]) and layer 2 (Ether); thus providing a complete L1-L3 IP Network Service.

Acknowledgements

References

[1] Amazon web services website [Online]. Available at http://aws.amazon.com
[2] BlueLock website [Online]. Available at http://www.bluelock.com
[3] AutoBAHN: GEANT2 Bandwidth on Demand (BoD). GEANT2 Deliverable DJ3.4.2 "Technical Documentation and Pilot Deployment Report for Bandwidth on Demand Service Manager" [Online]. Available at http://www.geant2.net/upload/pdf/GN2-08-151v3_DJ3-4-2-Technical_Documentation_and_Pilot_Deployment_Report_for_BoD_Service_Manager.pdf

[4] A. Willner, C. Barz, J. A. Garcia, J. Ferrer, S. Figuerola, P. Martini; "Work in progres: Harmony – Advance Reservations in Heterogeneous Multi-Domain Environments". IFIP TC6, Networking Congress 2009.

[5] PHOSPHORUS Deliverable D2.10: "Final Grid-GMPLS control plane prototype" [Online]. Available at http://www.ist-phosphorus.eu/files/deliverables/Phosphorus-deliverable-D2.10.pdf

[6] G-Lambda website [Online]. Available at http://www.g-lambda.net

[7] Dave Wilson, "Routing Integrity in a world of Bandwidth on Demand". TERENA Networking Conference 2006 [Online]. Available at
http://www.terena.org/events/tnc2006/programme/presentations/show.php?pres_id=242

[8] E. Grasa, X. Hesselbach, S. Figuerola, V. Reijs, D. Wilson, J. Uzé, L. Fischer, T. de Miguel; "The MANTICORE Project: Providing users wih a Logical IP Network". TERENA Networking Conference 2008 [Online]. Available at
http://tnc2008.terena.org/schedule/presentations/show.php?pres_id=98

[9] Globus Toolkit webpage [Online]. Available at http://www.globus.org/toolkit/

[10] A. Berna, E. Grasa, S. Figuerola; "Extending MANTICORE to Manage IP and Virtual Machine Slices in the FEDERICA project". TERENA Networking Conference 2009 [Online]. Available at http://tnc2009.terena.org/schedule/presentations/show.php?pres_id=104

[11] IaaS Framework website [Online]. Available at http://www.iaasframework.com

[12] GreenStar Network project website [Online]. Available at
http://www.greenstarnetwork.com/

[13] E. Grasa, S. Figuerola, A. Forns, 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.

Biographies

Dr. Eduard Grasa is a Graduate in Telecommunication Engineering of the Technical University of Catalonia (UPC, July 2004) and Ph.D. (UPC, February 2009). In 2003 he joined the Optical Communications Group (GCO), where he did his thesis on software architectures for the management and control of sliceable networks. During his thesis elaboration he collaborated with the Network Technologies Cluster of the i2CAT Foundation, which he joined in September 2008. He has participated in several national and international research projects, including UCLPv1, UCLPv2, HULP, FP6 PHOSPHORUS, FP7 FEDERICA, DREAMS, HPDMnet, IaaS Framework, Argia, MANTICORE and MANTICORE II.

Sergi Figuerola: Coordinator of the Network Technologies Cluster of the i2CAT Foundation since 2004. A graduate in Telecommunication Engineering of the Technical University of Catalonia (UPC, January 2002), he holds a Masters in Project Management from La Salle (Universitat Ramón Llull- 2004). He is a PhD candidate of the Signal Theory and Communications Department of the UPC, awarded with a PhDs fellowship by the Spanish Science and Education Ministry in 2003. He is served as Work Package leader of the PHOSPHORUS project (EC FP6) and is currently co-leading a Joint Research Activity of the FEDERICA project (EC FP7). Since January 2010 he will be the Technical Leader of the EC FP7 GEYSERS project.

Xavier Barrera: Graduated in Telecommunication Engineering of the Technical University of Catalonia (UPC, May 2007). In December 2007 he joined the i2CAT Foundation to collaborate with the Dreams and Argia projects.

Carlos Báez received the Bachelor's degree in Computing Engineering specialized in Management of the University of Rovira i Virgili (URV, February 2006). In June 2006 he

presented his final project about Koorde networks (P2P). He is finalizing his studies in Computing Engineering (UPC, February 2010). Since October 2007 he is working for the Telematics department of UPC and i2CAT foundation and he has participated in the research projects like PHOSPHORUS and MANTICORE, related with network virtualisation, web services and IP networks.

Laia Ferrao: Graduated in Computer Science Engineering of the Technical University of Catalonia (UPC, December 2007). In February 2007 she joined the i2CAT Foundation, where she did her master thesis on Chronos. At the moment she is still a member of the i2CAT Foundation and collaborates with the Argia, Chronos and HPDMnet projects.

Pau Minoves: He studied telecommunications at the Polytechnic University of Catalonia (UPC, 2005). In September 2007, he enrolled in the Erasmus Mundus on Software Engineering master which was given at Polytechnic University of Madrid (UPM, 2007) and Blekinge Technical High School (BTH, 2008). In the context of the EMSE master thesis, he joined Karlskrona's Ericssson R&D department to perform and study, compare and assess on Open Source development methodologies. He joined I2CAT foundation as team lead for the MANTICORE II development effort.

Dr. Xavier Hesselbach is an Associate Professor at the ETSETB, in Barcelona, Spain. He received the M.S. degree in Telecommunications Engineering in 1994 and the PhD. degree in 1999, from the Technical University of Catalonia (UPC). He has been involved in several national and international projects. His research interests address MPLS traffic control and GMPLS networks, QoS and traffic grooming in IP/MPLS over optical networks. He is author of more than 40 national and international publications in conferences and journals. He is co-author of 4 books. Since 1992, he is member of the IEEE. In 1994 he received the award from the COIT/AEIT of Spain for the best Master Thesis on Networks and Telecommunication Services.

Juan Felipe Botero is a Ph. D. Student of the Technical University of Catalunya (UPC) department of Telematics Engineering. He received the M. Sc. degree in Telematics engineering in 2008 from UPC, and he joined Ph. D. Studies in 2008. In 2008, he joined he Design, modeling and evaluation of broadband networks group in the Telematics Engineering Department of the UPC. His research interests include network virtualization, next generation Internet architecture, next generation networks. He has participated in the MANTICORE I proof of concept project from 2007 to 2008.

Victor Reijs has studied at the University of Twente in the Netherlands, worked for KPN Telecom Research and SURFnet, since 1999 working for HEAnet. He was involved in CLNS/TUBA (one of the earlier alternatives for IPv6). Experience was gained with X.25 and ATM in a national and international environment. His last activity at SURFnet was the tender for SURFnet5 (a step towards optical networking). Emigrating to Ireland, he is managing the Network Development department of HEAnet and is actively involved in international activites such as GN2, TF-NGN and Grids as well as on (optical) networking, point-to-point links and monitoring.

Dave Wilson studied in University College Dublin, and has worked on HEAnet since 1996, joining HEAnet Ltd on its establishment in 1997. Dave is a Senior Network Engineer working for the Network Development team. His role of Network Planning involves him in subjects such as IPv6, RIPE and GEANT. Last year Dave was elected by RIPE members to the ICANN Address Supporting Organisation Address Council, which has a role in global number policy. Dave spoke at TNC 2006 on the subject of routing integrity with Bandwidth on Demand, and is currently working on the rollout of HEAnet's new IP networking platform.

Lars Fischer has been the CTO of NORDUnet since 2004 and is active in international collaborations such as GN2, GLIF, TERENA and works among other things with optical and IP networking and grid computing. He has worked with research infrastructure for more than 20

years, starting at Aalborg Universirty where he helped introduce IP networking and support an NREN in the mid 80's. Lars holds a M.Sc.E.E. from Aalborg University, Denmark. Before joining NORDUnet he worked Tele-2 and COLT Telecom.

Tomás P. de Miguel is Director of the Spanish National Research Network (RedIRIS) and doctor in telecommunication engineering by the Technical University of Madrid (UPM). He has been associate professor at UPM, where he imparted informatics and communications courses and developed his research activity and technical management in the Engineering and Telematic Systems Department (DIT), working on formal specification of protocols and technologies for the new generation of Internet, especially with IPv6 protocol, advanced collaborations technologies and services federation. Prior to RedIRIS, Tomás was responsible of informatics and communication services at E.T.S.I Telecomunicación UPM, providing new high speed networking capabilities to facilitate new Internet services introduction.

Jean Marc Uzé has been a consultant at Juniper Networks since 2001, focusing on Research, Education and Government Networks and Institutions. He spent 4 years at GIP Renater (the French Academic Research Network). He directed the Renater 2 Project, the new generation National Research Network of France and managed several projects such as TEN-34, TEN-155 and US connectivity. He also coordinated the MPLS activities of the European technical Task Force TF-TEN and TF-TANT. Jean-Marc has a Master of Science in Network Engineering, and started his career as head of the Data-processing centre of INRA, the French Agronomic Research Institute in Versailles.

Chris Lonvick is director of Consulting Engineering at Cisco and Chair of the IETF Security Issues in Network Event Logging (Syslog) working group.

Dimitra Simeonidou is the Head of the HPN group at the University of Essex, UK. She joined Essex in 1998 (previously with Alcatel Submarine Networks). She is an active member of the optical networking and Grid research communities and participates in several national and European projects and initiatives. Main areas of research are: photonic switching, ultra high-speed network technologies and architectures, control and service plane technologies for photonic networks and architectural considerations for photonic Grid networks. She is the author and co-author of over 250 papers, 11 patents and several standardisation documents.

Isidro Cabello joined Telefónica I+D in 1989 and he participated in the design and development of a packet switching prototype in the TESYS project. He was involved in the deployment of "Infovia", the first national IP network in Spain, where he contributed in the IP network interconnections systems. Then, he became the chief responsible of the "Networks Interconnection" department. For ten years, was responsible of "IP Access Technologies" department, which includes projects regarding broadband access technologies (XDSL and Metro Ethernet), performance characterization of equipments in IP networks, and some research activities on new edge technologies such as Voice over IP systems, metropolitan networks and IPv6. Responsible of network initiatives in the metro Ethernet technology for Telefónica eBA project. Now since two years he is responsible of the patents generation and innovation on FP7 and National projects in the area of New Network Technologies for Telefónica I+D.