

Trend Analysis of Science and Technology R&D Networks

Sung-Uk Park*, Shinji Shimojo**

*Department of Policy Research, KISTI, 335 Gwahagno, Yuseong, Daejeon, 305-806, Korea

**JGN2plus Otemachi Research Center, NICT, 1-8-1 Otemachi, Chiyoda-ku, Tokyo 100-0004, Japan

supark@kisti.re.kr, sshinji@nict.go.jp

Abstract— One of the highest priorities of the 21st century is to promote education and scientific research with a global and interdisciplinary spirit. Global spirit is needed in order to spread scientific knowledge and activities in all the countries over the world for fighting against the inequalities based on ignorance and to reach a better worldwide equilibrium. GLORIAD is an unprecedented shared commitment of the U.S., Russia, China, Korea, Canada, the Netherlands, and the Nordic countries to promote scientific and education cooperation between scientists and educators. In this paper, I summarize a trend about abroad science and technology R&D network and propose the implication through comparison between cases (including a scale and service, an economic ripple effect) of other country and KREONET and GLORIAD..

Keywords— KREONET, GLORIAD, Backbone Infrastructure, Service of R&D Network,

I. INTRODUCTION

KREONET(Korea Research Environment Open Network) is a national R&D network supported by MOST(Ministry of Science and Technology), and managed and operated by KISTI(Korea Institute of Science and Technology Information) since 1988. KREONET has a high performance network infrastructure to provide R&D resources, including a wide range of information on science and technology, supercomputing, GRID, e-science, for about 200 key R&D centers in the industrial, the academic, and the corporate sector [1].

GLORIAD(GLObal Ring Network for Advanced Application Development) is the world first 10Gbps Global R&D Network, which connects entire world with a circular-shaped optical network involving 11 countries, including Korea, the U.S.A, China, Russia, Canada, the Netherlands, and 5 countries in Northern Europe. It is a cooperative global science and technology R&D network to promote joint international R&D projects in the fields of state-of-the-art science and technology, where the transmission of massive amounts of data is required [1].

KREONET and GLORIAD are representative services of KISTI. So KREONET is comprised of 14 areas and 15 regional network centers, including Kyungpook National Univ., GIST, Jeju National Univ., and etc. A network

infrastructure which supports a range of location-independent R&D activity is established based on the regional network centers. KREONET is providing an important national R&D infrastructure for cooperative state-of-the-art R&D activity.

In addition, KREONET is providing a specialized 10Gbps backbone, in the form of the SuperSiReN(Daeduck advanced science and technology research network) to link 7 organizations including KISTI, KAIST, KARI, KRIBB, KIGAM, and CNU, boosting their advanced applied R&D and tests with high performance network. KREONET also about 50 members connected with more than 1 Gbps high bandwidth links as advanced R&D network for state-of-art application R&D. Also, GLORIAD connects 11 countries through a maximum 10Gbps optical network, Daejeon(Korea), Seattle(USA), Calgary(Canada), Chicago(USA), Amsterdam(Netherlands), Stockholm(Sweden), Moscow, Khabarovsk(Russia), Beijing, HongKong(China) are connected.

Especially, The GLORIAD initiative is being developed by excellent global partnership, which includes representative of the world's most innovative creators of next generation high performance communication high performance communication services and networking technologies. The applications and services that are supported by GLORIAD today enable its participants to experience extremely advanced communications and collaboration capabilities [2].

In this paper, I summarize a trend about abroad science and technology R&D network in order to emphasizing the representative services of KISTI. And I compare scales and services, an economic ripple effect and the success cases of abroad network with KREONET and GLORIAD of KISTI. So I deduce the implication through comparison between abroad network with KREONET and GLORIAD of KISTI.

II. INTERNATIONAL R&D NETWORK

A. SURFnet

SURFnet is both the name for the organisation that develops, implements and maintains the national research and education network of the Netherlands as well as the network it operates. As one of the first networks linked to the internet outside the U.S.A the organisation has taken the lead in the evolution of the internet in the Netherlands and Europe. SURFnet's executives have been founders of or occupied board positions

in organisations like Ebone, CENTr, SIDN, Ams-IX, Terena, DANTE, RIPE NCC, ISOC, IEFT, IESG and IAB [3].

SURFnet is a national R&D network supported by ministry of the Netherlands. SURFnet has a high performance. SURnet is comprised of about 200 nonprofit organizations. A network infrastructure which supports 75million persons. It is called SURFnet6 from 2006. So SURFnet6 is providing a specialized Education and Science and Technology fields with a high performance network. SURFnet6 also connected with more than 14,000Terabytes to the external network and 8,000Terabytes to the internal network in 2005.

SURFnet6 is over 4000km fiber pairs available today. This average price paid for 15 year IRUs, 7 EUR/meter per pair. Also Managed dark fiber infrastructure will be extended with new routes, approx. 1000km more to be ready for SURFnet6 [4].



Figure 1. IP networking of SURFnet [1]

The Universities, University hospitals, specialized institutions, research institutes, scientific libraries except Government agencies are joined in SURFnet6. So SURFnet6 make a money from subscribers more than 90% of revenue.

SURFnet looks for new technical possibilities and translates these into innovative services for our target groups. To SURFnet, innovation has not succeeded until it leads to large-scale use. SURFnet's role is only over, when market provides for this use. So they focus on developing and managing. Firstly, There are A network infrastructure as a foundation for all collaboration. Secondly, There are Authentication and authorisation services to provide reliable access. Finally, There are Online multimedia collaboration services to make collaboration across institutions and interaction with high quality visuals and audio possible [5].



Figure 2. SURFnet domestic connectivity [1]

B. CA*net4

CANARIE, the Canadian Advanced Network and Research for Industry and Education, is a Canadian government supported non-profit corporation, founded in 1993 which maintains a set of leased wide area network links and also develops and deploys advanced network applications and technologies for education and high-speed data transfer purposes. So their computer network is called CA*net [6].

CANARIE is led by universities and partners with several companies in areas from networking and technology industries. As of 2007, the organization has 84 members mostly universities, institutes and other places of higher education, together with several companies and government agencies. Headquartered in Ottawa, the company maintains and modifies a set of leased wide area network links for educational and research organizations of Canada.

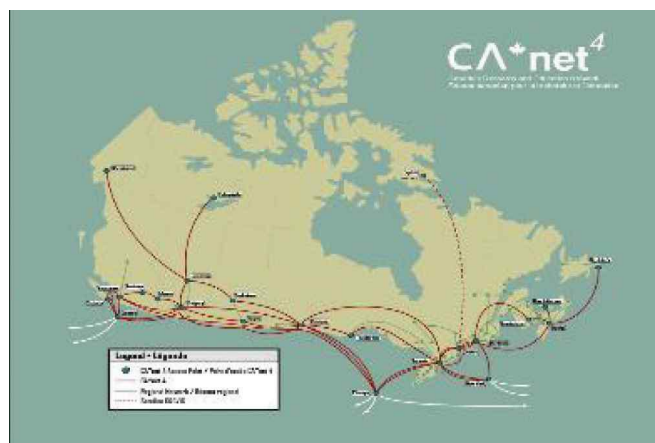


Figure 3. Linking Canada to Europe [1]

As mandated by industry Canada, CANARIE's simplified objectives for 2007 to 2012 are to operate, expand and upgrade the high-speed network, increasing use and enhancing international networking and networking-focused collaborations. Also they are to develop, demonstrate and implement next-generation technologies, advancing the network as a recognized leader and facilitating the flexible use of network resources and of distributed equipment and resources [7].

CA*net4 create a facility where the user controlled interfaces and frameworks for the CA*net4 Lightpath cross-connect devices can be tested and demonstrated safely in a real world environment, following thorough "in-vitro" testing. It develops and adapts grid applications which are designed to interact with a Lightpath Grid service which treats networks and network elements as grid resources which can be reserved, concatenated, consumed and released [8].

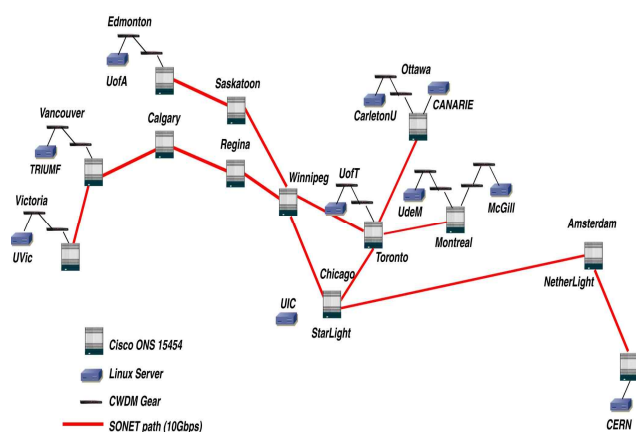


Figure 4. CA*net4 International Grid Testbed [8]

C. ESnet

ESnet(Energy Sciences Network) is a high-speed network serving thousands of Department of Energy scientists and collaborators worldwide. A pioneer in providing high-bandwidth, reliable connections, Esnet enables researchers at national laboratories, universities and other institutions to communicate with each other using the collaborative capabilities needed to address some of the world's most important scientific challenges [9].

Managed and operated by the ESnet staff at Lawrence Berkeley National laboratory, ESnet provides direct connections to all major DOE sites with high performance speeds, as well as fast interconnections to more than 100 other networks, Funded principally by DOE's Offices of Science, Esnet services allow scientists to make effective use of unique DOE research facilities and computing resources, independent of time and geographic location [10].

Large-scale collaborative science is now a key element of DOE's office of science. The science community that participates in DOE's large collaborations and facilities is almost equally split between SC labs and universities, and

has a significant international component. Very large international facilities and international collaborators participating in US based experiment are now also a key elements of SC science, requiring the movement of massive amounts of data between the SC lab and these international facilities and collaborators.

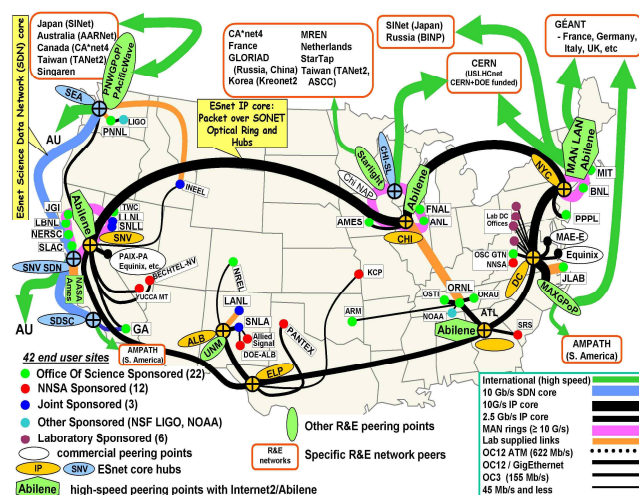


Figure 5. ESnet Connectivity [10]

ESnet FY06 budget is approximately \$26.6M. Mostly SC funding is \$20.1M in the total funds. But Mostly Circuits & hubs is \$12.7M in the total expenses [11].

ESnet is currently satisfying its mission by enabling SC science that is dependant on networking and distributed, large-scale collaboration. ESnet has put considerable effort into gathering requirements from the DOE science community and has a forward-looking plan and expertise to meet the five-year SC requirements.

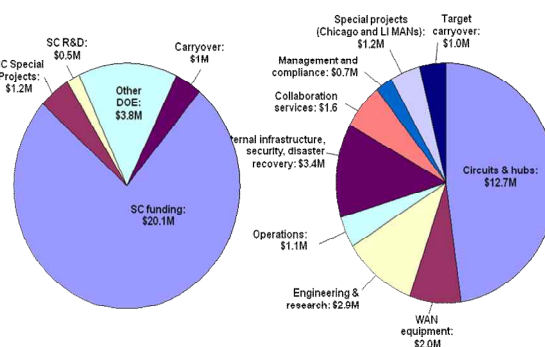


Figure 6. ESnet Connectivity [11]

D. SINET3

The Science Information NETWORK3 (SINET3) is an information communication network connecting universities and research institution throughout Japan via nationwide nodes, it is designed to promote research and education as well as the circulation of scientific information among universities, research institutions, and similar entities. The Science

Information Network is also connected to research networks such as Abilene in the U.S and GEANT in Europe to facilitate the international dissemination of research information and to promote collaboration with research networks overseas. SINET3 began operation in April 2007, and it replaces the previous SINET and Super SINET. SINET3 plays an important role as the core component of the Cyber Science Infrastructure [12].

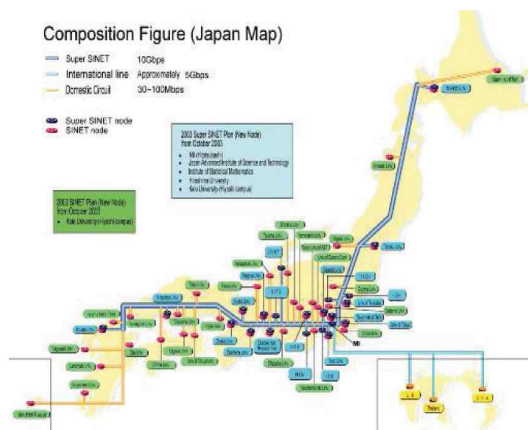


Figure 7. Network Connectivity of SINET3 [1]

The network topology of SINET3 has edge nodes and 12 core nodes, i.e., 75 layer. The line speed between the edge and core nodes is 1 to 20 Gbps and the backbone line speed between the core nodes is a maximum of 40 Gbps. The network deploys Japan's first STM256(40Gbps) lines between Tokyo, Nagoya, and Osaka. The backbone links form three loops to enhance network resiliency nationwide and to enable quick service recovery after network failures. The topology also enables efficient use of network bandwidth by sharing backbone links among users for all services.

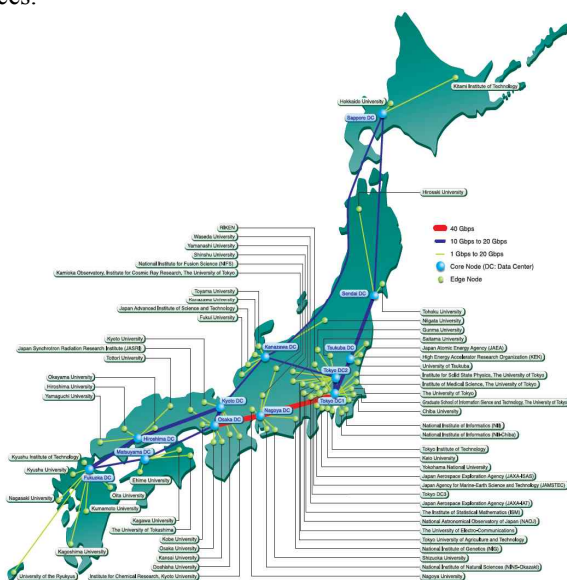


Figure 8. Topology of SINET3 [12]

E. JGN2plus

NICT(National Institute of Information and Communications Technology) has launched the JGN2plus (Japan Gigabit Network2 plus) with an open testbed network which aims to realize the research and development for Information Communication Technology during April 2008 ~ March 2011. In the JGN2plus, various activities have been conducted for the purpose of contributing to the future IT society, implementing extensive R&D of ICT(Information Communication Technology), collaborating with the industry, the academia, the government and regional organizations, activating regional activities, fostering human resource and promoting the international collaboration and cooperation.

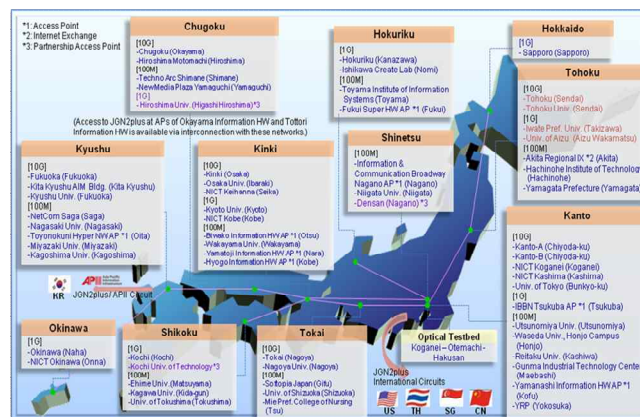


Figure 9. JGN2plus Network Outline [13]

To efficiently promote of R&D activities using JGN2plus, NICT Otemachi has been established. So main research theme is “Research on Operations and Management Technologies for New Generation Network”, and they will further promote R&D activities inside NICT Otemachi by setting 6 research topics .

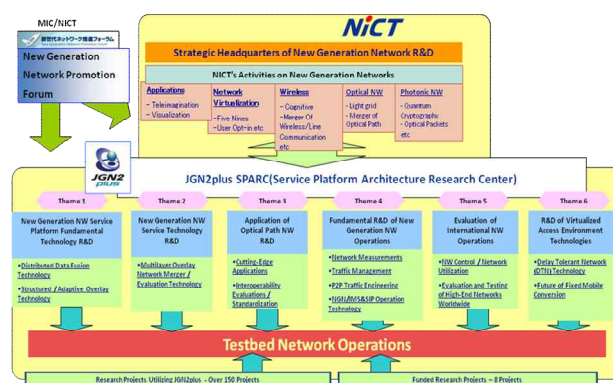


Figure 10. JGN2plus Research Center [13]

2 Types of JGN2plus services are Network Service and Platform Service. Network Service is comprised of Layer 3 Service, Layer 2 Service and Optical Network Testbed Service. The Layer 3 Service allows users to connect more than 2 access points on the IP level. Bandwidth can be chosen from 100Mbps

to 10Gbps. The Layer 2 Service allows users to connected more than 2 access points on the Ethernet level by VLANs. The last Optical Tested Service allows Dark fiber optical transmission between Koganei, Tokyo - Otemachi, Tokyo - Hakusan, Tokyo with total length 592km.

Platform Service will further collaborate operation and R&D activities for realizing New Generation Network[13].

III. DOMESTIC R&D NETWORK

A. KREONET

The National Science and Technology R&D Network(KREONET) backbone is a national R&D network infrastructure that is comprised of a domestic backbone, including 14 areas and 15 regional network centers with Seoul and Daejeon as the main sites and an international backbone. The KREONET domestic backbone is based on optical equipment specifically an MSPP-based state-of-the-art optical transmission system to provide max. 20Gbps, min 2.5Gbps network infrastructure. This is a world class high performance hybrid network infrastructure comparable to the best networks found in the most advanced countries. In addition, it supports diverse connection points by interlinking with domestic and international key R&D networks and IX/ISP to provide a high performance and highly available network infrastructure. This provides appropriate network environment for location independent state-of-the-art R&D [2].

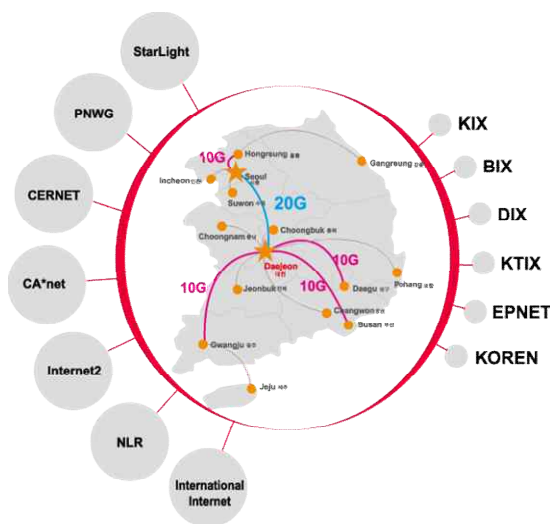


Figure 11. KREONET Connectivity [2]

The IPv6, which has recently been recognized as a next-generation network protocol, is also being used in advanced R&D networks. The science and technology R&D network procured sTLA in 2001, and started IPv6 backbone network installation. Now, there are 9 IPv6 local network centers and they are interlocked with diverse international R&D networks. In addition, KREONET is cooperating with domestic and international organizations to prepare the basis

for next-generation IPv6 application by installing 6GN for IPv6 Gbit users in cooperation with ANF IPv6 TFT [2].

The Grid is based on 4A future technology. 4A means Advanced network, Advanced computers and equipment, Advanced applications and Advanced scientific technology. It reconfigures each virtual resource, virtual gigantic computing resource, and virtual research organization. The Grid is basically a total network and the Grid network is a key element that reconfigures resources and elements [2].

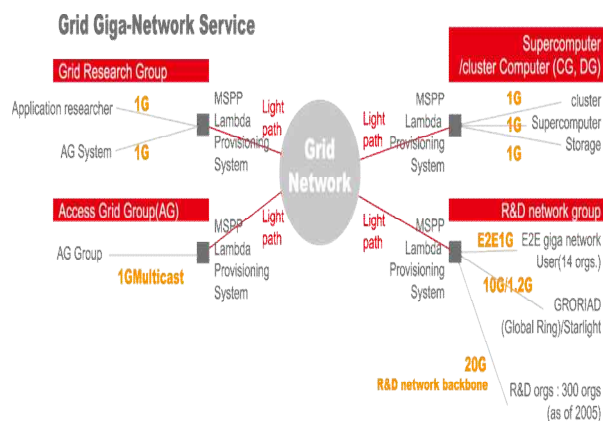


Figure 12. Grid Network Service [2]

B. GLORIAD

Global Ring Network for Advanced Applications Development (GLORIAD) is built on a fiber-optic ring of networks around the northern hemisphere of the earth providing scientists, educators and students with advanced networking tools that improve communications and data exchange enabling active daily collaboration on common problems. With GLORIAD, the scientific community can move unprecedented volumes of valuable data effortlessly, stream video and communicate through quality audio and video conferencing [14].



Figure 13. Grid International Connectivity [2]

GLORIAD is a cooperative global and technology R&D network that was built with the aim of promoting joint

international R&D projects in the fields of advanced science and technology where the transmission of massive amounts of data is required [15].

C. Economic ripple effects

Economic ripple effects of KREONET including GLORIAD from 2005 to 2007 are summarized as follows. The total benefits are from 145 billion Won in 2005, to 316 billion Won in 2007 [1]. We can understand through this results. The cost opportunity reduction effect of international line is increasing, so we will prepare need of national advanced research network in future.

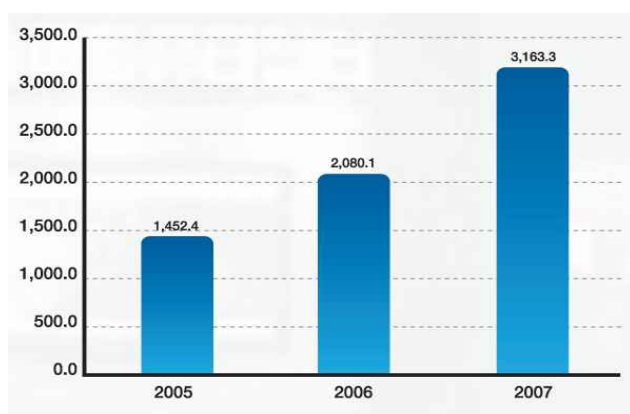


Figure 14. Total benefits [1]

Total benefits means cost opportunity reduction effect of domestic/international line and annual subscription revenue of subscriber. And Total costs are from 10 billion Won in 2005 to 11 billion Won in 2007 [1].

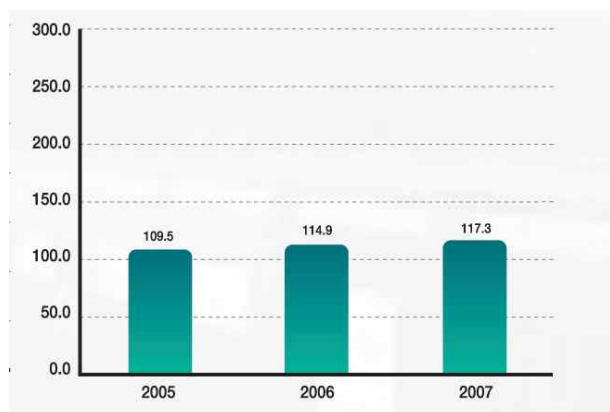


Figure 15. Total costs [1]

Total costs means KREONET construction cost and operation cost.

IV. CONCLUSIONS

KREONET including GLORIAD has been a key enabler of global scientific collaborations both across the Atlantic and Pacific, benefiting not only the LHC physics program that is expected to break new ground in our understanding of matter and the universe but many other fields of data intensive science.

Also, KISTI through KREONET including GLORIAD is serving KREONET infrastructure provision service, KREONET operation and technical support service, Next generation network engineering service, Advanced Science and Technology R&D Support service and Science and Technology key infrastructure connecting service.

Through GLORIAD project, we can induce expected effects. Firstly we activate international collaboration in state-of-the-art science and technology requiring real-time large capacity data transmission. Secondly we make Korea one of the strong countries in the fields of science and technology, through collaborative R&D in nuclear fusion, high energy physics, medical science. Finally, we play the role of the R&D hub of Northeast Asia.

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