Connecting research worldwide with lightpaths

Global Lambda Integrated Facility

What does GLIF do?

GLIF (Global Lambda Integrated Facility) promotes the paradigm of lambda networking to support demanding scientific applications.

GLIF makes lambdas available as an integrated global facility for use by scientists and projects involved in data-intensive scientific research.

GLIF brings together leading networking engineers from across the world, who learn from each other's experiences. They seek to establish best practices, work together to enable the development, testing and implementation of new lambda networking technologies, middleware and applications, and generally collaborate to take the technology forward.

"Lambda networking was still in its infancy when we agreed to the name 'GLIF' (Global Lambda Integrated Facility) in Iceland in 2003. In hindsight, this name seems quite forward-looking. The cooperative spirit of GLIF's users and providers combined with GLIF's lightweight, flexible governance structure fit perfectly into what is now recognised as the living e-infrastructure ecosystem essential for today's modern research."

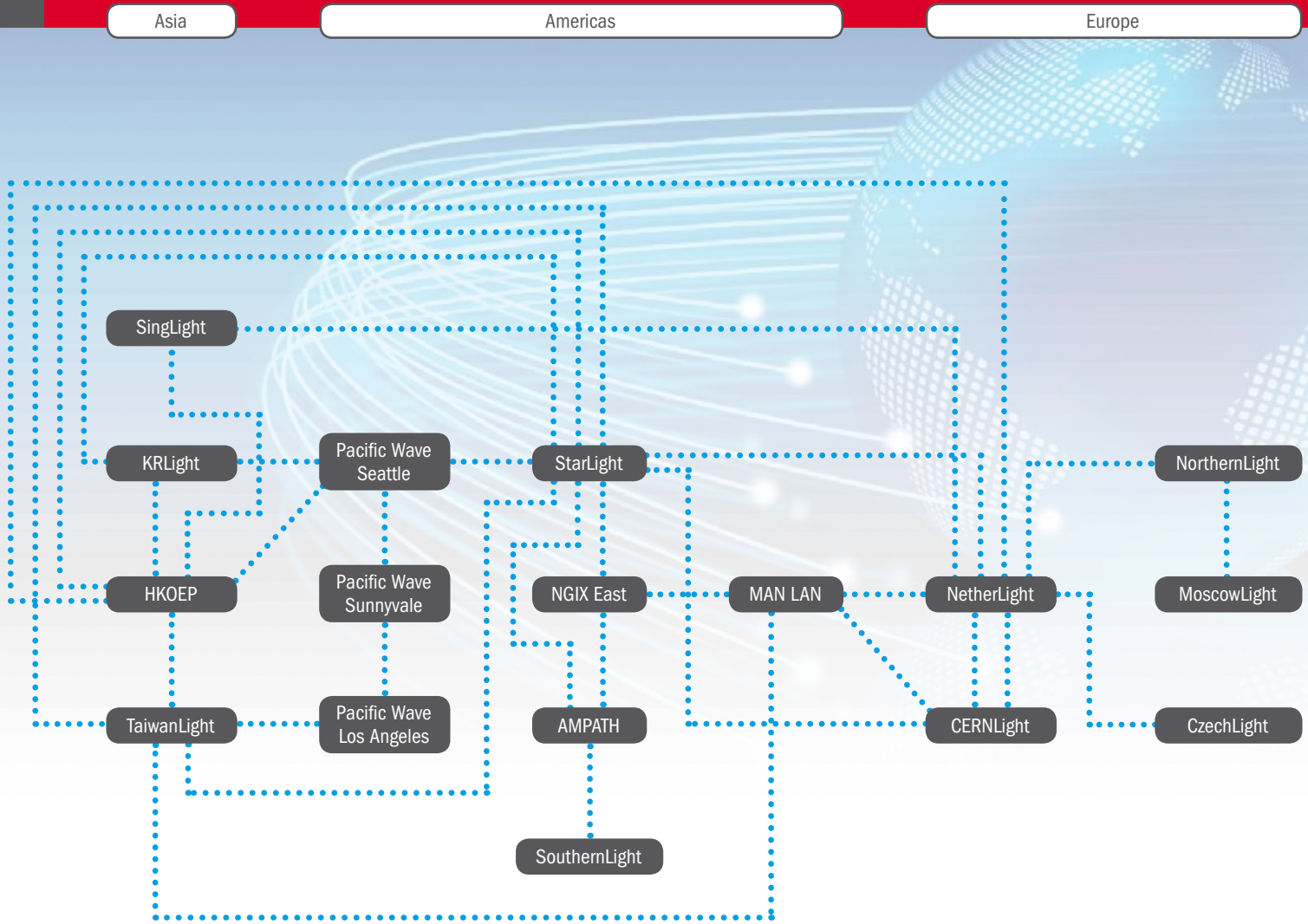
Kees Neggers, GLIF Governance Working Group Chair

Established in 2001, GLIF provides a worldwide laboratory that facilitates the development of advanced middleware and applications, and makes the use of distributed systems extremely practicable. It is also a forum for making contacts, exchanging information and experiences, and resolving technical problems. Those taking part in GLIF are working towards the harmonisation of policies and services to allow institutions to easily communicate with others over high-bandwidth links.

Optical networks are an increasingly important element in supporting today's most data-intensive scientific applications. Their ability to support regular Internet services, as well as dedicated high-speed point-to-point links for demanding applications, represents the next generation of research networking.

GLIF makes use of the cost and capacity advantages offered by optical multiplexing, in order to build an infrastructure that can take advantage of various processing, storage and instrumentation facilities around the world. The aim is to encourage the shared use of resources by eliminating the traditional performance bottlenecks caused by a lack of network capacity.

In fibre optic telecommunications, wavelength division multiplexing is a technology that enables a single optical fibre to carry multiple signals using different wavelengths (or lambdas) of light. This allows for a significant increase in transmission capacity, as well as physical separation of channels.



GOLEs – GLIF Open Lightpath Exchanges

This diagram is for illustration purposes only and is subject to change without notice

GOLEs, lambdas and lightpaths

The GLIF resources include lambdas contributed by the GLIF participants who own or lease them. These are interconnected through a series of exchange points known as GOLEs (GLIF Open Lightpath Exchanges) that are located around the world.

GOLEs are operated by GLIF participants, and are comprised of equipment that is capable of managing lambdas and performing lightpath switching. This allows different lambdas to be connected together to create end-to-end lightpaths.

The resources that make up GLIF are provided by National Research & Education Networks, consortia, institutions and individual research initiatives who collaborate to provide end-to-end lightpaths to, from and across their respective domains. GLIF does not provide any network services itself, so users must contact their nearest GLIF network resource provider if they wish to obtain lightpath services.

A lightpath is a communications channel (virtual circuit) established over designated lambdas that connects two end-points in the network. It can take up some or all of the capacity of these lambdas, or indeed can be interconnected across several lambdas. Lightpaths can be established using different protocols (e.g. Ethernet or SONET/SDH), depending on the application.

WLCG: Transferring large-scale scientific datasets globally for distributed data analysis

The Large Hadron Collider (LHC) is the world's largest and highest-energy particle accelerator and lies beneath the Franco-Swiss border near Geneva, Switzerland. It was built by the European Organization for Nuclear Research (CERN), in collaboration with over 10,000 scientists and engineers from over 100 countries as well as hundreds of universities and laboratories, with the intention of testing various predictions of high-energy physics.

Physicists and small groups located at sites around the world repeatedly access, extract and transport multi-terabyte data sets on demand from petabyte data stores in order to optimally select the rare "signals" of new physics from the potentially overwhelming "backgrounds" from already-understood particle interactions. To fully exploit the potential for scientific discoveries, more than 100 petabytes (10^{15} bytes) of data will be processed, distributed, and analysed using a global grid of 130 computing and storage facilities located at laboratories and universities around the world, rising to the exabyte range (10^{18} bytes) during the following years. These computing facilities form the Worldwide LHC Computing Grid (WLCG).

The WLCG takes advantage of a global network infrastructure, in which many of the lightpaths are also GLIF network resources, to transport the data to where it is needed. There are 11 major centres (Tier 1s) worldwide connected to CERN (Tier 0) with multiple 10 Gbps lightpaths. Second and third level centres (Tier 2s and Tier 3s) are connected to all the Tier 1s with a high capacity transoceanic backbone dedicated to the LHC traffic (LHCONE) or with guaranteed bandwidth lightpaths.

GLIF activities

GLIF's collaborative activities include workshops and working groups. The network managers, network engineers and scientific researchers participating in these working groups mostly work together using electronic means of communication, complemented by a small number of face-to-face meetings each year.

Technical Issues Working Group

The Technical Issues Working Group identifies GOLE connection and equipment requirements, and defines which functions and services should be provided. It maintains a database of GLIF resources and documents best practices, and is actively investigating automation mechanisms for lightpath setup. It undertakes some of this work through small task forces that focus on specific technical issues.

Research & Applications Working Group

The Research & Applications Working Group identifies applications that can benefit from optical networks, and helps define the services that the user communities need. The group also aims to promote the use of lightpaths in e-science, and to teach the next-generation workforce how to use them.

Governance Working Group

The Governance Working Group sets objectives, formulates policies and defines the conditions for participation in GLIF. It also supervises the work of the GLIF Secretariat and sets its budget.

Global LambdaGrid Workshops

The Global LambdaGrid Workshops have been held annually since 2001. These provide an opportunity for those working in optical networking to come together to share new developments and to discuss operational advancements. They continue to grow in popularity, and typically attract more than 100 participants from government, research and education and companies around the globe.

Administrative support is provided by the GLIF Secretariat, which is operated by TERENA, the European Association of Research and Education Networks.

The OptIPlanet Collaboratory: Enabling global virtual organisations to share and interact with ultra-high-resolution imagery

Advanced networks are giving rise to a new kind of collaborative laboratory, or "collaboratory." International teams of researchers work together and share information, as if they are in the same room, to tackle issues of global priority, such as the environment, climate change, biosciences, disaster response, or the physical nature of the universe. Their collaboration is made possible by being able to interact with one another, via high-definition video conferencing, while accessing, sharing and interacting with ultra-high-resolution imagery over dedicated multi-gigabit optical networks provided by the GLIF community.

The OptIPlanet Collaboratory started in 2002 with the "OptIPuter," a US National Science Foundation funded grant to dynamically configure a global-scale "metacomputer," which relied upon optical networks as the "backplane" to connect distributed computing, storage and visualisation resources. The goal of the OptIPuter project was to enable users to interactively access, display and share a variety of data-intensive information, in a variety of resolutions and formats, from multiple sources, with the same ease that the Web affords for accessing lower-resolution objects today.

This required the development of "OptIPortals," tiled display walls driven by computer clusters and connected to 1 - 10 Gbps lightpaths, interconnected by global optical networks provided by the GLIF community. OptIPortals can be used to display one or more uncompressed high-definition video teleconferencing streams at 1.5 Gbps, one or more uncompressed super-high-definition visualisations at or exceeding 6 Gbps per stream. Over one hundred OptIPortals have been built worldwide, thereby creating the burgeoning "OptIPlanet Collaboratory," the model for the collaborative research laboratory of the future.

GLIF Participation

GLIF is open to any organisation that shares the GLIF vision and is willing and able to make resources (e.g. lambdas and equipment) available on an agreed-upon basis when they are not required for its own needs. GLIF is also open to organisations whose experts contribute actively to the technical work in the GLIF working groups.

AARNet	ESnet	MIT	TeraGrid
AMPATH	Extreme Networks	MCNC	TERENA
ANSP	FAST	MAX	TransLight
Argonne National Laboratory MCS	Fermilab	NLR	TWAREN
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Cisco	JGN-II	RNP	WIDE
CPqD	JANET(UK)	SARA	
CSTNET	Juniper Networks	StarLight	
DFN	KAUST	SURA	
e-Arena	KRLight	SURFnet	

CineGrid: Supporting new distributed applications of ultra-high performance digital media

CineGrid is a non-profit international membership organisation, established to promote research, development, and demonstration of networked collaborative tools to enable the production, use, preservation, and exchange of very-high-quality digital media over photonic networks. CineGrid members explore the feasibility and trade-offs of different networking approaches suitable for emerging applications of media-rich art, entertainment, distance learning, scientific visualisation, remote collaboration and international cultural exchange.

To support members' research, CineGrid organises network test beds, supported by multi-gigabit networks provided by the GLIF community. The testbeds are prepared to host a variety of experimental digital media projects and to provide appropriate security safeguards between a limited numbers of "trusted" users around the globe. Two such projects are described below.

Tri-continental premiere of 4K movie

The Electronic Language International Festival (FILE), one of the world's leading venues for new media arts, featured the first 4K digital movie to premiere simultaneously on three continents (Brazil, US, Japan) in 2009. The 4K movie by Brazilian director Beto Souza called "Enquanto a Noite nao Chega" (While the Night Doesn't Come) consisted of 750MB/sec of uncompressed video (30MB/frame x 24 fps) and 5.1 audio, broadcast over optical networks provided by the GLIF community.

Live images of total solar eclipse broadcast globally

Keio University (Tokyo, Japan) used resources from the GLIF community to transmit live images of the July 2009 total solar eclipse which was otherwise visible only from a narrow corridor beginning in northern India, going through central China and Japan's Satsunan Islands and ending in the Pacific Ocean. Keio organised a networked live distribution centre in Tokyo that received live images from three solar eclipse observation sites in China and Japan. Two types of images were captured and transmitted: 1920x1080 HD videos of the sun and 3000x3000 fish-eye motion pictures of surroundings. A combination of these images was distributed from Tokyo to the world including Japan, Australia, South Korea, China, Malaysia, United States, and the Netherlands.

GLIF resources were used not only to carry the digital images around the world, but also to support research into the networking technologies needed for this type of digital media distribution for new applications such as real-time scientific observation and remote viewing.

GLIF sponsors

The GLIF Secretariat is provided by TERENA and funded by the voluntary sponsorship of GLIF participants. The following organisations contribute to its funding:

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www.glif.is

GLIF (Global Lambda Integrated Facility) is an international virtual organisation that promotes and supports optical networking. It is a collaborative initiative of National Research and Education Networks, consortia, institutions and individual research initiatives worldwide that work with lambdas.

GLIF helps facilitate the development of many advanced networking applications, as well as supports real-time events and demonstrations. It also enables international e-science collaborations, and allows specialised user communities to work together despite being located in different parts of the globe.

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