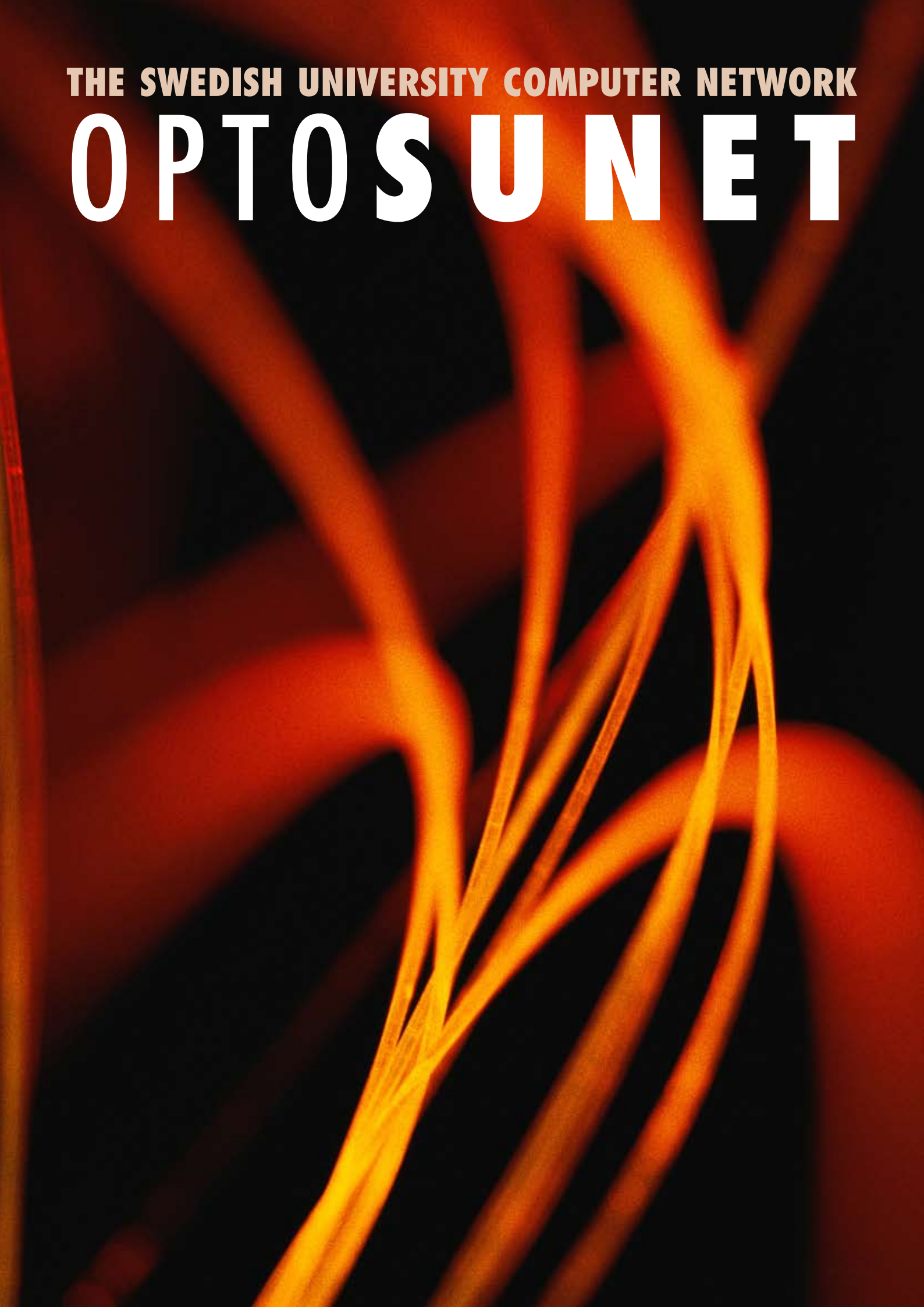
THE SWEDISH UNIVERSITY COMPUTER NETWORK

OPTOSUNET



THE UNIVERSITY COMPUTER NETWORK

OPTOSUNET

Sweden's universities are connected to the university computer network, OptoSunet.

With OptoSunet, university employees and students have access to one of the world's most modern academic computer networks.

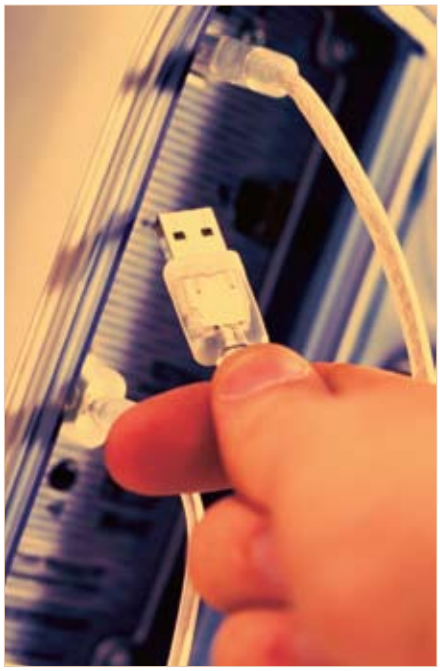
OptoSunet has redundant connections and redundant equipment.

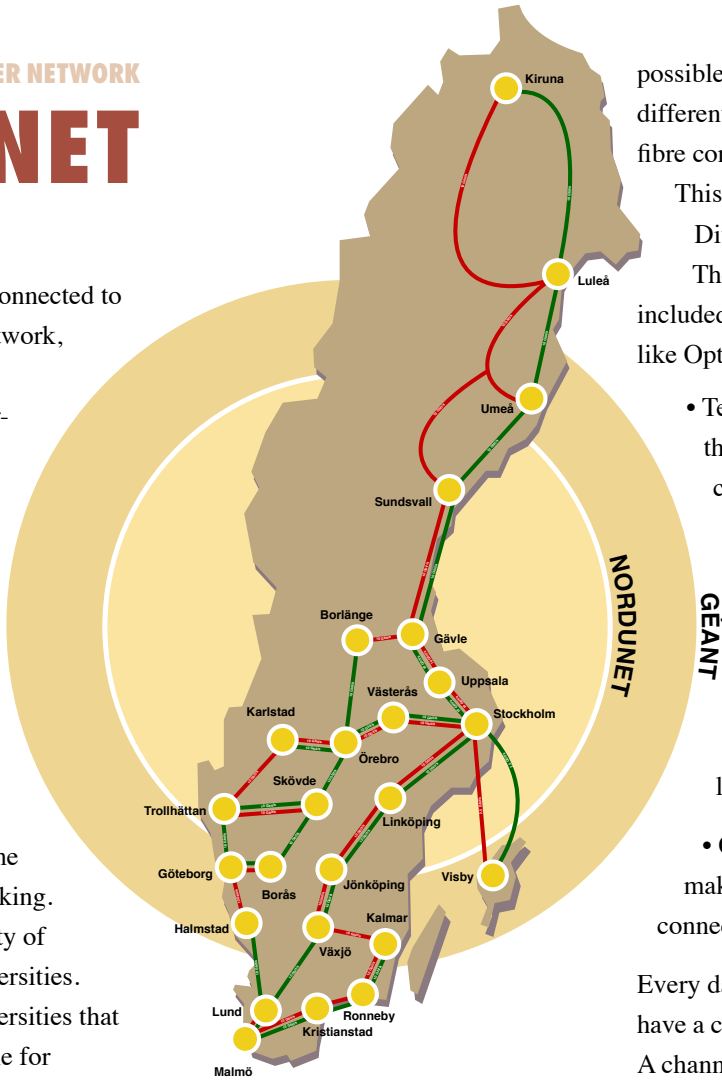
OptoSunet should in other words always work even if a cable is cut or some of the equipment stops working.

OptoSunet has a capacity of 10 Gbit/s to Sweden's universities. However, some of the universities that require less bandwidth settle for 1 Gbit/s in the initial phase.

With OptoSunet, there is also the possibility of obtaining powerful point-to-point connections for users with very large bandwidth needs.

The point-to-point connections in OptoSunet can reach speeds of 40 Gbit/s.





OptoSunet consists of a green network and a red network. The universities are connected to 10 Gbit/s (some universities have chosen to begin with 1 Gbit/s).

GREEN AND RED

OptoSunet is a fibre optic network. Data packets in the university networks are transmitted as pulses of light in the fibre optic network.

The connections between universities are leased by SUNET, which itself owns the equipment needed to use the fibre optic network.

OptoSunet comprises a green network and a red network, which together provide the quality and operational reliability that the activities at universities require.

OptoSunet must always be operational, never suffer from an outage.

The composition of OptoSunet makes it possible to send parallel data streams on different wavelengths through the same fibre connection.

This is called Dense Wavelength Division Multiplexing (DWDM).

The following components are included in a DWDM-based network like OptoSunet:

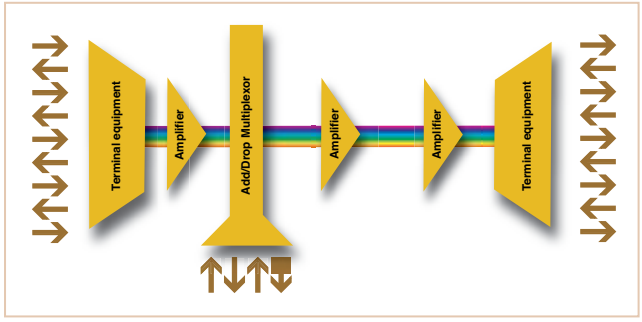
- Terminal equipment into which the data streams are input and converted to light pulses of the right wavelength and power. At the other end, the light pulses are converted back into data streams.
- Optical amplifiers at 80 to 100 km intervals that ensure the light pulses do not lose strength.
- Optical connection points that make it possible to connect or disconnect data streams.

Every data stream – or channel – can have a capacity of 1, 2.5, 10 or 40 Gbit/s. A channel with a 10 Gbit/s capacity can also be divided into 1 or 2.5 Gbit/s.

OptoSunet uses one channel to connect the routers in the central node with the respective university's local network. In this respect, OptoSunet is a traditional computer network – but OptoSunet is much more…

Other channels can namely be "tapped off" based on needs to build up direct optic connections, point-to-point between researchers and research groups that have large bandwidth needs.

In OptoSunet there is space for 80 parallel connections with capacities of up to 40 Gbit/s and probably also 100 Gbit/s.



A simplified sketch of the OptoSunet components.

THE ORGANISATION

SUNET

SUNET stands for the Swedish University Computer Network. SUNET works to provide universities access to high capacity computer networks. In other words, it is the SUNET organisation that built the OptoSunet computer network.

The Swedish Research Council has the administrative responsibility for SUNET. The Swedish Research Council also appoints the Board of SUNET. Representatives for the students also sit on the Board of SUNET.

The Board of SUNET has also co-opted a technical reference group to get advice in technical matters.

Daily work in SUNET is conducted at several locations.

For example, operation of the university network, OptoSunet, is taken care of by NORDUnet's operational organisation, NUNOC.

The Luleå University of Technology is responsible for the technology behind OptoSunet, while Umeå University is responsible for development.

Uppsala University is in charge of operating SUNET's ftp archive and the Computer Emergency Response Team, SUNET CERT.

FINANCING

Fees from universities finance three fourths of OptoSunet and other SUNET activities. SUNET receives the remaining fourth from the state through the national budget.

The universities' revenues are the starting point for the size of the SUNET fee, which usually amounts to approximately 0.25 per cent of the affiliated universities' revenues. Despite the low percentage, the Swedish universities have considerable financing responsibility – in 2007 it was SEK 100 million!

The universities' SUNET fee entitles them to the basic level of service and options – a general network with very high capacity and security.

So that the universities that consume less bandwidth will not need to finance the large consumers' needs, SUNET has introduced a finance model where those with special needs have to finance their own additional costs.

Point-to-point connections are not included in the SUNET fee.Connecting student housing is another example of special needs.

In other words, connecting student housing to OptoSunet is not free-of-charge. In spite of this fact, some ten seats of learning chose to connect their student housing to OptoSunet in June 2008.

The national museums and the National Library of Sweden are also connected to SUNET. The museums and the library connect to OptoSunet free-of-charge in accordance with a governmental decision.

OPTOSUNET FACTS

OptoSunet provides affiliated universities access to redundant connections of 10 Gbit/s. Universities that require less bandwidth can choose to be connected at 1 Gbit/s.

OptoSunet can also offer point-to-point connections with a capacity of up to 40 Gbit/s.

Three fourths of OptoSunet's financing comes from Swedish universities. The state contributes one fourth.

OptoSunet is a star shaped network with central routing in Stockholm.

Operation of OptoSunet is taken care of by NUNOC, the Nordic university computer network NORDUnet's operations centre with facilities in Stockholm.

The connections in OptoSunet are supplied by TDC Song.

The equipment is supplied by Imtech with Ciena (optical equipment), Juniper (routers) and Eltel (installation) as subcontractors.

The fibre optic connections in OptoSunet's backbone network cover a total of 7663 km spread over 46 sections.

Every university city has access networks between the backbone network and their own university. There are a total of 94 fibre connections in OptoSunet that function as access networks.

Gotland University and the Swedish Institute of Space Physics in Kiruna have been connected with lower capacity for cost reasons. Kiruna has a connection of 10 Gbit/s and an auxiliary route of 2.5 Gbit/s. Both connections to Visby have a capacity of 2.5 Gbit/s.

The current equipment is estimated to be usable for five to eight years.

OptoSunet is estimated to be in operation for more than ten years.

S U N E T & O P T O S U N E T

TODAY&TOMORROW

OptoSunet is a so-called hybrid network that combines traditional Internet technology with the possibility of arranging dedicated wavelengths for particularly capacity-intensive activities.

OptoSunet is in turn connected to the Nordic university computer network NORDUnet and the European computer net GEANT. SUNET affiliated organisations also have direct connections to US research networks.

SUNET's service offering is largely similar to the service offerings in other national research and educational computer networks. In contrast to many European computer networks, SUNET does not however connect any compulsory schools to its network.

SUNET's services include access to distribution lists, a net-meeting service and a large ftp archive, The SUNET Archive. SUNET also has a fax service that makes it possible to send fax messages to computer-sparse environments, primarily developing countries.

Wireless connections via Eduroam have also begun to be increasingly used among SUNET affiliated organisations. Swedish universities have access to the new Internet protocol IPv6 via SUNET.

In a near future, SUNET will intensify the cooperation with grid research and the university groupings that work with high-performance computers.

The universities that have use for their own point-to-point connections will briefly be informed of the possibilities of OptoSunet.

To-date, astronomers and high energy physicists have taken in the possibility. As an example, The Large Hadron Collider, LHC, located at CERN will affect traffic in OptoSunet. Gigantic amounts of information from the particle accelerator will be stored in Linköping, Stockholm and Umeå.

However, SUNET expects many new point-to-point connections to be set up in the future. Among "data-heavy-users" there are disciplines like supercomputing, genetic modelling, climate change and healthcare.

Last but not least SUNET also hopes to be able to increase its support to interest groups with special needs of network capacity.

SUNET

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