



Taking Funet light paths into use
- for end-users

Report

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Table of Contents

1	Introduction	4
2	Normal Funet connection, Light path or VPN	5
3	Why a light path?	7
4	What does Funet's light path service include?	8
5	Issues related to the acquisition of a light path from the perspective of a member organisation	9
6	Processes	10
	6.1 Specification	10
	6.2 Delivery	10
	6.3 Operations	11
7	Afterword	12
	References	13
	Abbreviations	13

1 Introduction

Funet Light path (hereinafter 'light path') is its own, separate, congestion-free data transfer channel that may be internal to Finland or, if necessary, reach Europe or the United States in an inter-organisation cooperation project. The connection in question is a separate connection enabling high connection speeds, its purposes including connecting different sites of a member organisation and constructing a geographically decentralised IT infrastructure. Examples can be found from among both scientific organisations (e.g. grid infrastructure, virtual work environment) and member organisations managing special national tasks, for example universities, vocational high schools and research organisations.

The light path acquisition guide for the member organisations describes the acquisition of the light path service, related questions and needs from the perspective of end users and the IT staff of the member organisation. The document also touches on commissioning and operative activities. The document does not go into the technical details of light paths; instead, it describes the process from the moment a need for a light path arises to its maintenance and invoicing.

2 Normal Funet connection, Light path or VPN

This section contains a brief description of the differences between a normal Funet connection, a light path and a VPN solution. It also explains the suitability of the different implementations for the demands of the member organisation.

What kind of a private network can Funet implement between IT equipment located in different organisations? A normal Funet connection (Funet trunk network and the Internet) at the main office is enough, if the member organisation does not operate at more sites and the special questions related to the demand, such as the capacity requirement and the necessity of a dedicated connection, have been determined. Solutions implemented separately from other data traffic can be roughly divided into virtual solutions built on the public Internet, for example VPN (Virtual Private Network) that can be implemented with hardware or software, and separate connections reserved for certain use, such as the light path, on which this document concentrates.

With regard to performance, two things need to be considered at the same time in both the light path and VPN solutions: bandwidth and latency (delay). In 2012, Funet, light paths have had a typical bandwidth of 1 Gbps (or around 125 MB/s) or 10 Gbps (1,250 MB/s, which is more than regular hard drives can write!). A normal Funet connection currently has a capacity of 1 Gbps or 10 Gbps, which means that it is also well suited to most purposes of use.

The transfer delay or latency must be taken into consideration in the service architecture. If the service produced by a member organisation transfers large amounts of data over the network at a time, or the transfer is primarily unidirectional, latency does not have much effect. However, the situation changes if the usage is interactive or comprises several small transactions. The lower limit of latency is determined by the speed of light. In practice, every 100 kilometres of physical distance causes a one-millisecond latency to the round-trip time (RTT), with additional latencies caused by network equipment, (over)load, encoding methods, buffering, etc. See Table 1 for a general comparison of Light path and VPN solutions, and the Funet connection.

Technology	Light path	VPN**	Normal Funet connection
Bandwidth/Capacity	dedicated	shared	shared
Issues affecting latency	network topology (distance)	network topology (distance); VPN hardware performance; performance of the trunk and local area network	performance of the trunk and local area network; performance of the firewall
Information security	physically separate from other traffic	separated from other traffic through VPN technology	amongst other traffic (firewall/access control lists)
Issues affecting reliability	optical network (route redundancy)	VPN hardware; trunk and local area network	trunk and local area network
Typical usage	static and symmetric topology, few terminal points, continuous use	limited number of users, asymmetric usage	asymmetric usage, potentially a lot of users, random usage
Costs*	fixed annual fee	VPN system (hardware, service and maintenance fees)	included in Funet membership fee

* Actual costs always depend on the details of the implementation.

** Funet does not currently deliver VPN solutions

Table 1 (a general comparison of Light path and VPN solutions, and the Funet connection)

When planning the alternatives, the goal is to find the best possible solution for the connection's purpose of use. The connection must be cost-effective network solution which also meets the technical requirements. Funet will help member organisations in finding the best solution.

3 **Why a light path?**

A light path enables different network connection purposes. One of the most common and popular applications is connecting the remote units of Funet members to the main campus network. As the light path is a secure end-to-end connection, the remote unit can be connected to be part of the LAN network. Other typical applications include connecting a research device producing a lot of data to a data centre or a computer room and its services located elsewhere, where the data is stored and refined further, for example through computation. Various computational science GRID projects and research projects using them are heavy users of light paths. Other similar applications include the connections between computer rooms or data centres at different offices, where a lot of data is transferred.

Funet has good connections to international networks through the Nordic NORDUnet. NORDUnet and other international cooperation enables international light path connections between research teams in different countries (e.g. the European DEISA PRACE and the Nordic NDGF).

4 What does Funet's light path service include?

Light paths are separate, ultra-fast end-to-end data communications connections, implemented at the optical level. The user of a light path has the use of the full data transfer capacity of the data communications connection in question. Data transfer speeds currently in use are 1 Gbps and 10 Gbps, depending on the required data transfer capacity.

A light path provides information security. Unlike on the Internet, other network users are unable to intentionally or unintentionally disrupt the light path connections of others. There is also no need to use firewalls, if the parties at the ends of the light path connection trust each other. The direct operational model saves time, effort and money from both the users and maintainers of the connection.

The Funet light path includes the fibre between the sites, end users, etc., regardless of the distance, and CWDM (Coarse Wavelength-Division Multiplexing)/DWDM (Dense Wavelength Division Multiplexing) MUX (Multiplexer) hardware. Light paths can also be constructed via international research networks. Funet will be responsible for the end-to-end operation of the connection, its monitoring and maintenance.

Funet as an organisation does not seek profits (price at cost), which means that pricing is very competitive and the member organisations can easily anticipate the costs thanks to a fixed annual fee (depending on the capacity), charged from the member organisation in connection with the Funet membership fee. The prices are confirmed annually. In addition to this, some extra costs may be incurred by the construction of the connection. Contact your local IT unit or Funet for more information. The costs of international light paths are determined on a case-by-case basis. Funet charges the member organisation (usually an IT unit) which will, if necessary, handle the service-related internal invoicing of, for example, another organisation, projects, research teams, or between them.

The light path technology is constantly developing, and you can find out news concerning interesting updates via your local IT organisation (for example, the future speeds of 40 Gbps and 100 Gbps) and developments in Funet's light path service (for example, dynamic light paths). All changes to the service affecting a member organisation will be carried out in a controlled manner in cooperation with the local organisation's IT unit.

You can find technical information on Funet light paths on the info.funet.fi site (requires access codes). In the public Internet, you can find an English document 'Use of light path in Campus Networks [1]' on Terena's website, for example, approaching the subject from a more technical perspective.

5 Issues related to the acquisition of a light path from the perspective of a member organisation

The end user of a light path may be a member organisation, a research team or a national or international project. The member organisation's IT unit places the order.

The end user must determine the need and requirements for the light path. Such issues include capacity now and in the near future, and whether redundant connections are required for the purpose of guaranteeing even higher reliability for an extremely critical service. At an early stage, it is important to also note any required updates and constructions in one's own network environment (fibre laying, cabling, hardware, configurations, etc.) in order to be prepared for the light path implementation.

The delivery time of a light path may range from weeks to several months, so time needs to be reserved for the commissioning of the service. Planning must be started well in advance of the desired commissioning. The readiness of the fibre infrastructure has a significant impact on the length of the delivery time. Delivery times are longer in international connections, and need to be investigated on a case-by-case basis. Competitive tendering of new acquisitions might also have an effect on the schedule.

Light paths are not covered by Funet's membership fee, so the member organisation needs to take the annual cost into consideration in its budgeting. Funet experts will support the IT unit in the different phases of the process, in both administrative and technical issues.

6 Processes

This section describes the processes and roles related to the acquisition of a light path at different stages of the process. The member organisation's IT unit acts as the end user's interface throughout the entire process (acquisition, delivery and operations), which in turn is in connection with Funet. See Figure 1 for a rough depiction of the process.

6.1 Specification

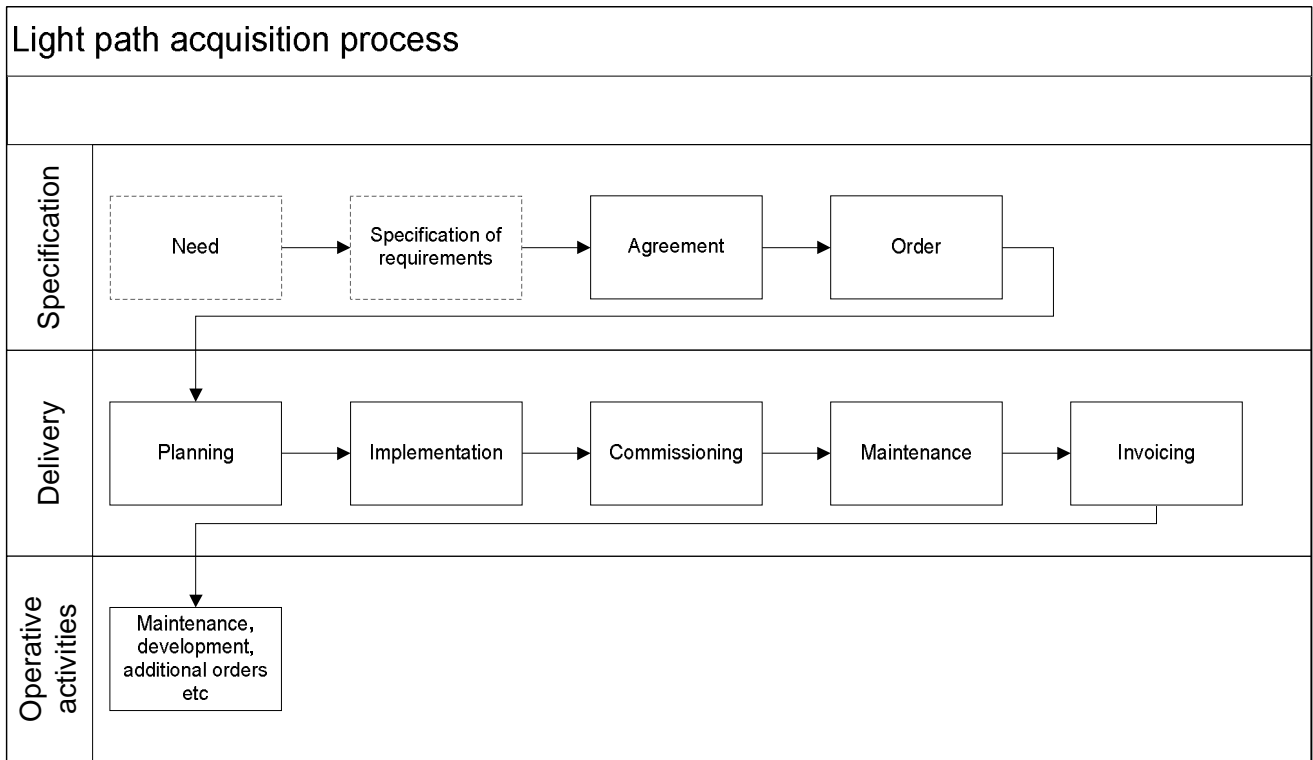
At the first stage of the process, the member organisation determined the demand for the light path, any related route redundancies, etc., in cooperation with the end users. Next, the agreement concerning the light path is concluded between the member organisation and Funet, and the order is placed. The IT unit of the member organisation and Funet will agree in more detail on the activities (technical and administrative) required in the implementation of the light path. Here, the end user and the member organisation should take into consideration the possible changes in their own internal network, their effects on the delivery process, and notify Funet of them as required.

6.2 Delivery

The second stage of the process comprises the delivery of the light path, where communications occur primarily between the member organisation's IT unit and Funet. If necessary, the planning started already during the specification phase between the IT unit and Funet will be continued during the delivery stage. In Finland, the delivery process takes from one week to several months. The duration of the delivery is affected by Funet's trunk network and the availability of fibre. International connections and their delivery schedule must be determined on a case-by-case basis. Any changes in the intranet of the end user and member organisation will be implemented during the delivery if they affect the commissioning. Testing the light path constitutes a part of the delivery stage. In order to switch to maintenance, the member organisation and possibly also the end users must prepare for the switchover from the old connection to the delivered light path. Invoicing begins once the delivery has been completed, beginning from the start of the next month. If necessary, the IT unit will inform the end users on matters related to the commissioning (for example, the switch-over).

6.3 Operations

Maintenance and other operative activities, such as invoicing, service development and further orders, are handled in a centralised manner between the member organisation's IT unit and Funet. This means that the end users need to contact the member organisation's IT unit for new orders or changes. Funet's network monitoring operates 24/7, through which any light path fault situations are handled. End users may enquire service downtimes affecting services provided by the light path from the member organisation's IT unit, which is notified by Funet of any future service downtime.



----- Member organisation's internal function

———— Function between member organisation and Funet

Figure 1 (Figure 1 a depiction of the process)

7 **Afterword**

A light path is very suitable for connecting remote sites as part of the main campus network, for a connection to a computer room or data centre and its services, and for connecting research teams nationally and internationally. Contact Funet's experts for further information on questions regarding light paths.

References

[1] http://www.terena.org/activities/campus-bp/pdf/gn3-na3-t4-light_path-in-campus-net.pdf

Abbreviations

CWDM	Coarse wavelength-division multiplexing
DWDM	Dense wavelength-division multiplexing
LAN	Local area network
MUX	Multiplexer
RTT	Round-trip time
VPN	Virtual private network

