

SURFnet

SURFnet8 Photonic Layer

TENDER

PUBLIC
PROCEDURE

REQUEST FOR PROPOSALS

June 2016
SURFnet BV
Utrecht, the Netherlands
2016

Important notice

This Request for Proposals contains all available information in relation to the submission of Proposals, contractual conditions, and other aspects of the Tender Procedure for SURFnet8 photonic layer. Interested parties are invited to submit their Proposal as directed by this Request for Proposals. The awarding of the Contract will be based on Exclusion Criteria specified in chapter 5 and the Minimum Requirements and Awarding Requirements specified in chapter 6 and chapter 7.

Glossary

Procedural terminology	Definition
CE(S)T	Central European (Summer) Time
Consortium	A group of organizations within the meaning of article 4 of the EU Directive 2014/24/EC.
Contract	Mutually accepted agreement between Partner and SURFnet concerning the equipment and services to be provided, laid down in a document signed by both parties.
Documentation	All documents released or exchanged between SURFnet and Tenderer under this Tender Procedure, including but not limited to this Invitation to Tender, the Proposal, any Contract resulting from this Tender Procedure.
Institution	An organization, typically an educational or research organization that is connected to SURFnet's national research and education network in the Netherlands.
Partner	The Tenderer that will be awarded the Contract.
Participant	A member of a Consortium.
Proposal	Proposal submitted by a Tenderer during the Tender Procedure.
Question and Answer process	The period during which Candidates can state questions and to which SURFnet will respond.
Request for Proposals	Request to Tenderers to submit a Proposal for the awarding of a Contract.
Tenderer	A potential Partner that wishes to be considered for the award of the Contract.
Tender Procedure	This Public Procedure for the selection and awarding of a Contract.

Table of contents

1	Introduction.....	5
1.1	About SURFnet	5
1.2	Scope of the intended Contract	5
1.3	About the Tender procedure	6
2	About the photonic layer.....	7
2.1	The current SURFnet7 network.....	7
2.2	The envisaged SURFnet8 network.....	8
3	Guidelines for participation	20
3.1	General	20
3.2	Applicable law and competent court	21
3.3	Tender-related complains	21
3.4	Clarification questions.....	22
3.5	Registration through a joint Proposal or sub-contracting	22
3.6	Proposal	24
4	Evaluation procedure of proposals.....	25
4.1	Awarding decision	26
4.2	Verification.....	26
4.3	Contracting	26
4.4	Reassessment of Proposals.....	27
5	Exclusion grounds and suitability requirements	28
5.1	Introduction	28
5.2	Exclusion grounds	28
5.3	Suitability requirements	28
6	Photonic layer requirements.....	30
6.2	Architecture	31
6.3	Optical Supervisory Channel	36
6.4	Resilience	36
6.5	Security and encryption	37
6.6	Bi-directional transmission for TFT services	38
6.7	Optical telemetry and monitoring.....	38
6.8	Network management and monitoring.....	39
6.9	Control Planes	42
6.10	Network planning.....	43
6.11	Methods and procedures	45
6.12	Equipment configuration and practice	45
6.13	Type I DWDM interfaces.....	47
6.14	RAMAN amplification	49
6.15	Maintenance and support	49
6.16	Society, environment and (worker) safety	50
6.17	Innovation	51
6.18	Software and licenses	52
6.19	Implementation and migration plan	52
6.20	Roadmap, lifecycle, exit and migration	56
7	Financial	57
8	Contractual requirements	62

1 Introduction

SURFnet is searching for a Partner that can provide a solution for the SURFnet8 photonic layer. The aim of the Tender Procedure is to award a Contract to a Partner that can provide the requested hardware, software and support.

1.1 About SURFnet

SURFnet operates and innovates the national research and education network (NREN) in the Netherlands, serving approximately 190 Institutions¹ and 1 million users in higher education and research. SURFnet is an operating company of the cooperative association SURF, which is a joint platform where Dutch research universities, universities of applied sciences and research institutions work together to develop ICT innovations. Representatives of these Institutions are active in the SURF Members Council².

SURFnet ensures that researchers, teachers, and students can work together simply and effectively with the aid of ICT. It therefore promotes, develops, and operates a trusted, connecting ICT infrastructure that facilitates optimum use of the possibilities offered by ICT. SURFnet puts in a sustained effort to continuously improve the ICT infrastructure and to develop new applications and services for its users. Hence, it is the driving force behind ICT-based innovation in education and research in the Netherlands. Furthermore, SURFnet collaborates with its international peers and operates as one of the global leaders among research and education networks worldwide.

SURFnet has executed several multiyear innovation projects in the past, funded by the connected institutions, industry partners, and the Dutch government. Each project resulted in a new generation of the SURFnet network. The SURFnet7 network is the latest SURFnet network generation. SURFnet7 is a fixed, network which consists of 11,000 km of fiber optic cables in the Netherlands. It delivers point to point and internet access bandwidth up to 100 Gbit/s.

1.2 Scope of the intended Contract

For the next generations of the SURFnet network, SURFnet requires a new photonic layer. This Tender aims to renew the bandwidth providing photonic layer, which is used for SURFnet's domestic services and potentially the Cross Border Fiber (CBF) systems.

The scope of the Contract for delivering the SURFnet8 photonic layer consists of;

1. Hardware, i.e. the physical equipment including installation related materials;
2. Software and licenses (including software interfaces (APIs)) for planning, performance monitoring, troubleshooting, fault detection, provisioning, security and accounting, automation, and programmability;
3. Layer 0 and layer 1 control plane functionality;

¹<http://www.surf.nl/en/about-surf/subsidiaries/surfnet/about-surfnet/connecting-to-surfnet/connected-institutions/index.html>

² More information about SURF and SURFnet is available on <http://www.surf.nl/en/about-surf> and <http://www.surf.nl/en/about-surf/subsidiaries/surfnet>, respectively.

4. Training and periodic training sessions for current staff and staff to be hired in the future, and external personnel;
5. A migration scenario from our existing Ciena CPL and DWDM layer to a new solution. This may include field service support and the provision of temporary hardware;
6. High level design activities for migration, introduction of new features or equipment, and complex changes;
7. M&S (Maintenance and Support). SURFnet will stock its own spares;
8. Installation and de-installation procedures for equipment and software;
9. Delivery and setup of a test bed.

The maximum duration of the Contract is 10 years with an initial term of 4 years and 6 optional extensions of 1 year each.

1.3 About the Tender procedure

This Tender Procedure is based on a **public procedure**. The purpose of this Tender Procedure is to select a Partner who will, together with SURFnet, design, deliver and support the SURFnet8 photonic layer as described in Section 1.2 of this document. The process of selecting the Partner for the SURFnet8 photonic layer will comply with the Dutch 'Aanbestedingswet 2012³' on public procurement.

Candidates are required to submit their proposal to the SURFnet offices in Utrecht, The Netherlands ultimately

September 8 2016, 13:00 hours, CEST.

1.3.1 Timetable

The following timetable provides information concerning the planning of the Tender. From e) onwards the provided dates are indicative.

a) Publication of Request for Proposals	June 3, 2016
b) Due date for questions for clarification	August 25, 2016
c) Publication of clarifications (earlier if possible)	Sept. 1, 2016
d) Due date for Proposals	Sept. 8, 2016
e) Announcement of award decision*	October 2016
f) Awarding of the Contract	November, 2016

** The decision concerning the awarding of the Contract is followed by a 20 days stand still period*

³ <http://wetten.overheid.nl/BWBR0032203/2014-08-01>

2 About the photonic layer

SURFnet intends to implement SURFnet8 as a successor to the current SURFnet7. SURFnet8 will consist of a photonic layer and a service layer, as shown in Subsection 2.2.1. This Tender procedure for the SURFnet8 photonic layer is part of this effort. A tender for the new SURFnet8 service layer will be published separately.

2.1 The current SURFnet7 network

SURFnet7 is the current SURFnet network, delivering connectivity services to SURFnet’s customers. In this network the optical transport function, switching function, and routing function are implemented in distinct technology domains. The switching function is distributed across the network and the routing function is implemented as a collapsed IP Core with two geographically redundant POPs in Amsterdam. Transport is based on a DWDM core network, where its DWDM interfaces are placed in the carrier Ethernet switches. The access network exists of CWDM rings terminating at DWDM core nodes. In the access network, CWDM interfaces are implemented in the carrier Ethernet switches.

The photonic layer of SURFnet8 continues to build upon the meshed photonic layer topology of SURFnet7. In SURFnet7 the photonic layer consists of a meshed DWDM core network and of CWDM access rings. Figure 2-1 displays an abstraction of the SURFnet7 core network.

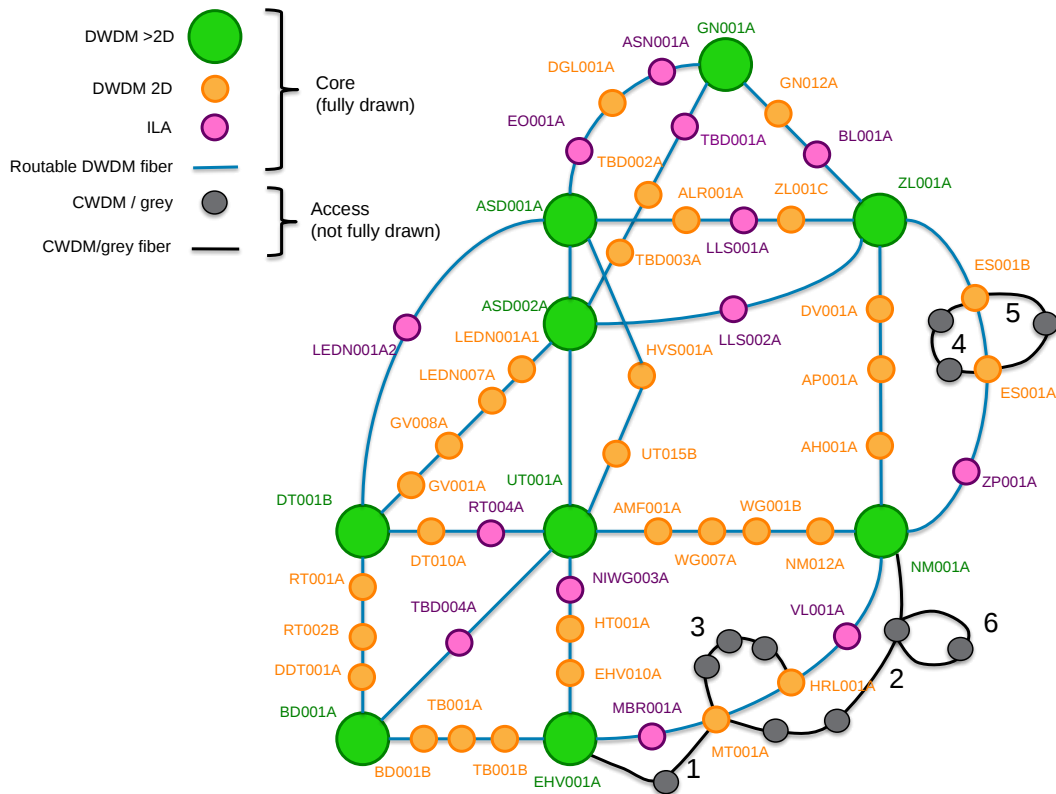


Figure 2-1 Photonic layer of SURFnet7 with a meshed DWDM core and CWDM access rings (numbered 1 to 6).

The meshed core domain is based on Ciena's CPL equipment and features fixed add/drop and ROADM functionalities on all nodes with a nodal degree of three and higher. Some nodes with a nodal degree of two also have ROADM functionality.

The core network predominantly transports 10Gb/s ASK-NRZ DWDM signals in the linear regime and uses dispersion slope compensation modules to reduce dispersion to a level the 10Gb/s receivers can tolerate. In SURFnet7 the DWDM transceivers consist of 10GbE 80km C-band tuneable XFP and SFP+ pluggable modules and 10GbE 80km C-band tuneable XFP pluggable modules with OTN wrapping on the pluggable module. The pluggable modules reside in the SURFnet7 carrier Ethernet switches.

In addition to serving the SURFnet7 carrier Ethernet switches, there are also transponder platforms in the network. A total of approximately twenty 10G transponder links with electronic dispersion compensation and four 100G coherent transponder links have been implemented.

The core network of SURFnet7 is characterized by:

- Wavelength routing by means of ROADM nodes using MEMS based broadcast and select WSS technology;
- A 50GHz fixed grid;
- No L0/L1 control plane;
- No colorless add/drop;
- No directionless add/drop;
- Dispersion Slope Compensating Fiber Module for up to 80%-90% dispersion compensation;
- EDFA amplification.

The access rings (Figure 2-1 shows six examples, numbered 1 to 6) deploy CWDM to transport a mix of 10GbE and 1GbE signals between customer locations and the DWDM core network and between customer locations situated in the same access ring. Up to eight CWDM channels are supported in access rings. Optical-Electrical-Optical (OEO) regeneration on the carrier Ethernet switches is used whenever the power budget depletes or dispersion limits are about to be exceeded. The CWDM access network uses 10GbE and 1GbE pluggable XFP and SFP modules, which are also placed in the SURFnet7 carrier Ethernet switches.

2.2 The envisaged SURFnet8 network

2.2.1 High-level vision on SURFnet8

SURFnet8 is the proposed successor of the SURFnet7 network that will excel by its high quality and reliability exceeding the expectations of our demanding connected Institutions and will allow for the introduction of new functionality, such as Virtualized Network Functions (VNF) and fine-grained traffic classification. SURFnet8 will also allow for composed services to seamlessly combine existing network services with new functionality like VNFs. All users of the network will be able to Create, Modify, and Delete (CMD) services, including composed services, on demand through a role based central GUI and API. Moreover, economic and environmental aspects are also important: the net-

work must combine high performance, at a reasonable cost, with low power consumption, and a small environmental- and physical footprint.

The different network functions will be implemented and spread over a number of technology domains as depicted in Figure 2-2. These technology domains could be the optical transport function, the routing or switching function, but also the NFV function. The distribution of the network functions over domains will depend on the characteristics of the network function and the opportunities new emerging technologies provide. Each technology domain offers abstracted interfaces for the functions implemented inside the technology domain and allows for fully automated CMD of these network functions. These abstracted interfaces should also provide for automatic resource usage optimization within the technology domain based on both internal performance metrics and external user supplied metrics.

Protection and restoration is handled inside each technology domain and should be independent from other technology domains, as much as possible. The new umbrella orchestration function will tie together all functionality provided in the different technology domains to provide higher level service abstractions. This modularity allows SURFnet to innovate each technology domain independently and at a different pace, thereby allowing for the best of breed solutions per technology domain.

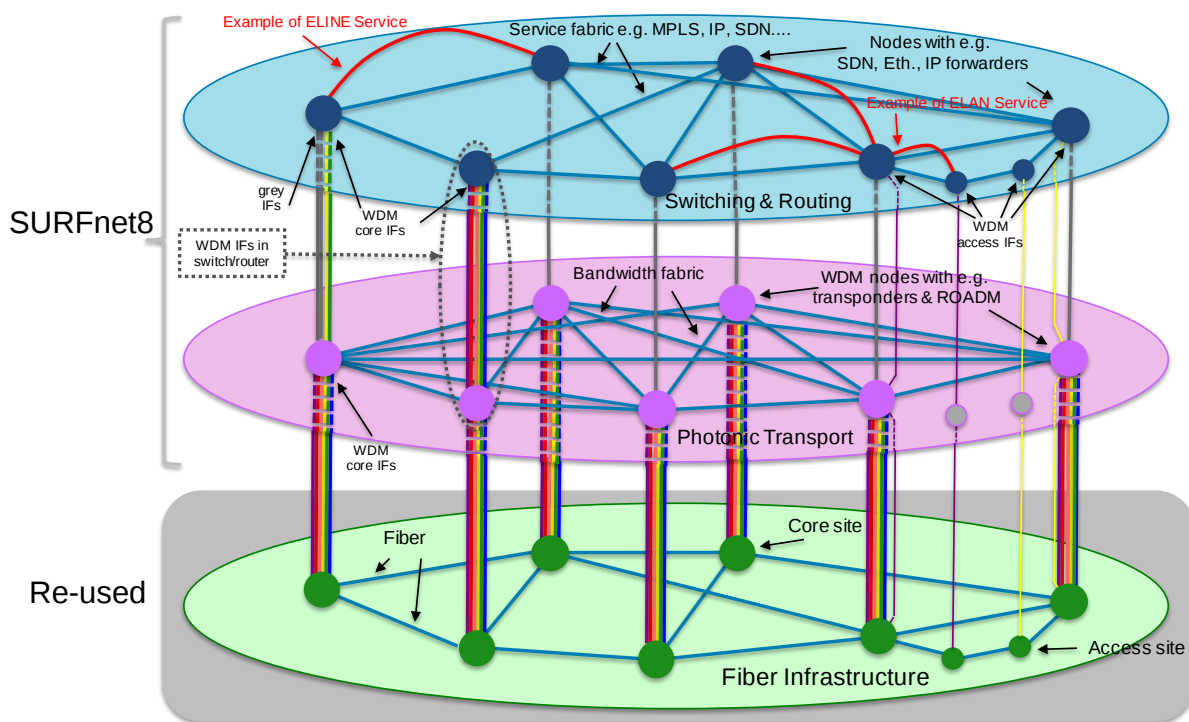


Figure 2-2 High-Level view on technology network layers as foreseen in SURFnet8.

This Tender is about the photonic layer in Figure 2-2. The service layer will be implemented on top of the photonic layer. The photonic layer must therefore provide the flexibility to support any current or future service layer platform.

2.2.2 Technology vision on photonic transport in SURFnet8

Compared to SURFnet7, SURFnet8 will rely on different technologies, which enable a lean and efficient transport of light as well as improved flexibility for restoration purposes. At the same time operational considerations such as an effective and efficient network management, stable operation and low-complexity field-service procedures must be cast into the design and technology of the equipment and software.

The SURFnet8 photonic layer is therefore characterized by:

- Absence of global dispersion compensation using dispersion slope compensation fiber or gratings. A dispersion slope compensation fiber or grating requirement may only be present for 100G coherent pluggable modules in service platforms and legacy 10G ASK-NRZ direct detection pluggable modules. The impact must remain on a single branch and must be as small as possible. In such a case these waves will be terminated not further than the first Type A or B core node (see Subsection 2.2.4.1).
- Restoration, which allows bandwidth to be restored using an alternative route. In case of fiber or node failures, SURFnet would like, as much as possible, to re-deploy all 100G (and beyond) coherent WDM interfaces, which were impacted by the failure, in order to restore services and bandwidth availability to the service layer of the network. Colorless and directionless access is considered an essential feature of the core network.
- Flexible utilization of optical spectrum (Flexgrid) is important, because: (1) it allows optimization of the total transport capacity (2) it allows the photonic layer to be future proof against an increase in symbol rate in case electro-optical and electrical components become available with improved frequency response, and (3) it postpones contentionless access as it optimizes the amount of unused optical spectrum and reduces blocking probability.
- At present, time and frequency transfer (TFT) has been implemented as an experimental service. In the next decennium SURFnet expects this service to become more important. The new photonic layer must allow bi-directional waves to propagate in the same fiber. The bi-directional waves behave like an OSC channel as they are added and dropped on each adjacent node in each direction. At a node the waves can be bi-directionally amplified, regenerated or terminated. Bi-directional amplification and termination equipment is not part of this Tender. Tenderer will be requested to provide an architecture that allows, per span, bi-directional adding and dropping of waves.
- No, or a very limited deployment of RAMAN amplification. RAMAN amplification will be avoided as much as possible. SURFnet believes innovation in optical amplification and compensation of non-linearities has not yet reached a stand-still.
- CWDM add/drop multiplexers, which have been deployed the access rings should be reused if possible. Optical amplification in access rings must be avoided if possible. If 100G is required at service platforms at customer sites in the access rings, the preferred order of implementation is: (1) re-use existing CWDM multiplexers, (2) replace CWDM multiplexers with passive DWDM multiplexers at the customer site, (3) daisy chain 100G interfaces in the services layer, and (4) deploy a photonic transport system.

2.2.3 Bandwidth providing photonic layer in SURFnet8

In SURFnet8, we expect a further increase in needed capacity in the coming years. We foresee that this growth requires customers to become connected via a 100GbE interface to service platforms in SURFnet8 and beyond. This will be a gradual process and will be triggered for each individual Institution based on the bandwidth consumption by that Institution.

Although SURFnet expects Institutions, which are connected to the SURFnet8 DWDM core nodes, to request 100GbE connectivity to service platforms first, Institutions, which are connected to nodes in the access rings must also have the option for a 100GbE connection to service platforms, whenever this is needed. In addition to providing services, the service platforms may also aggregate (multiplex) traffic from other service platforms. For these reasons, service platforms are interconnected by a bandwidth providing photonic transport service.

There are several criteria that determine how this photonic transport service is implemented in terms of photonic functionality (colorless and directionless add/drop or fixed add/drop), nodal degree (number of fibers leaving a node) and choice of DWDM interfaces (transponder-based or service platform pluggable modules). The most important criteria are:

- Volume of the aggregated ingress and egress traffic and transit traffic.
- Topological distance to adjacent (logical) service platforms.
- Importance of the node's service platforms to remain connected to different service platforms in case of e.g. fiber breaks and equipment failures.
- Compatibility with existing CWDM 10GbE and 1GbE waves.
- Cost and required investments.

The bandwidth providing photonic layer is envisaged to be adaptable to the location of users, and the location of the customer's production platforms, such as data storage facilities and virtual machines, which can be placed on campus and in data centers.

Both the increase in bandwidth and the topological changes that will occur in the branched core network and the access rings will result in the core branches and the access rings to resemble each other. It is for this reason that SURFnet's bandwidth providing layer can profit (improve resilience) from access rings becoming core branches. This allows access rings to profit from restoration capabilities and the core network to profit from an improved meshed fiber infrastructure. Such absorption of access rings into the core network implies a change in functionality for the photonic access-ring nodes to support the same features as core network nodes: routing of waves, colorless and directionless add/drop, and to become aware of the L0/L1 control plane.

2.2.4 Photonic transport nodes and waves in SURFnet8

2.2.4.1 Photonic Transport Nodes

SURFnet has identified six types of nodes of different functionality and technology, which will be used to create the photonic layer. Type A, B, C, and F are nodes, which form the Photonic Core Mesh Network. Type C, D, E and F nodes are nodes, which will be used to implement the Photonic Access Network.

Type A Node

This node is capable of colorless and directionless add/drop and supports a nodal degree of three and higher. Transponders are used to connect service platforms. These nodes are key in supporting restoration of bandwidth in the network. Waves originating from multiple transponders destined to the same number of transponders at a different location can be grouped to form a super channel. Alternatively, they may be routed individually to create diversity in the bandwidth fabric.

Nodes of Type A also contain service platforms with pluggable DWDM 100G modules. Waves from these modules terminate on adjacent nodes.

Access rings terminate on these nodes (not counted as degrees). This node is typically found in the meshed core of the transport network of SURFnet8.

Type B Node

This node is similar to node A with the difference that it is a node of degree two (terminated access rings are also not counted as degrees). This node is found on a branch of the meshed core of the transport network of SURFnet8.

Type C Node

Type C nodes feature fixed-wavelength and fixed-direction add/drop functionality for a fixed number of waves in a fixed grid. These nodes are transparent for waves added by nodes of Type A and B, and which are not intended to be dropped at a C-type node. This node is typically found on branches in the meshed DWDM core of SURFnet8 and on access rings without CWDM waves. A Type C node may also terminate access rings regardless if the Type C node is part of a core branch or access ring.

Type D Node

Node D is an un-amplified node (in contrast to nodes of Type A, B, C, and F). This node features the directional add/drop of one or more DWDM waves that fit into the 1551nm CWDM band. This node is intended to add and drop 100G waves from service platforms in a short access ring, typically found in cities. Type D nodes can be placed in an access ring with Type E nodes. At the terminating ends of an access ring all DWDM waves can be added and all DWDM waves are dropped. On a Type D node it is also possible to electrically regenerate a 100G wave (similar to what is done in SURFnet7) on a service layer platform. Migrating all nodes to Type C nodes can be considered when e.g. optical power budget depletes.

Type E Node

Node E is also an un-amplified node and is a conventional CWDM add/drop node for legacy 10GbE and 1GbE waves, typically found in access rings. It can add and drop any of the eight CWDM wavelengths except the 1511nm wavelength. Type E nodes can be placed in an access ring with Type D nodes. At the terminating ends of an access ring all CWDM waves can be added and are dropped. On a Type E node it is also possible to electrically regenerate a 10GbE or 1GbE wave (similar to what is done in SURFnet7) on a service layer platform.

Type F Node

Node F is an in-line amplification node. Adding and dropping of waves is not possible. All ingress waves are amplified to compensate for encountered signal losses.

2.2.4.2 Waves

SURFnet has identified the following three types of waves:

Type I: Non-alien waves from transponder based interfaces

These DWDM interfaces are part of the transponder platform of the same make and product line as the photonic nodes. They may be implemented fixed and as pluggable modules on transponder blades. Together with node Types A and B a very flexible core transport network is constructed allowing bandwidth to be flexibly and resiliently provided to connected service platforms.

Type II: SURFnet-internal alien waves from SURFnet-internal interfaces

These interfaces are placed in service platforms, which are under control by SURFnet's network management.

Type III: SURFnet-external alien waves from SURFnet-external interfaces

These DWDM interfaces are not placed in platforms, which are under control by SURFnet. The interfaces are controlled by external entities such as fellow NREN organizations and selected customers.

The photonic layer must transport all three types of waves.

2.2.5 SURFnet8 photonic network evolution

2.2.5.1 Expanding the photonic network

Figure 2-3 displays the first stage of the upgrade of the network in which the DWDM core nodes have become part of the new photonic SURFnet8 network (and have been assigned SURFnet8 functionality). All access-rings are still passive CWDM rings and their nodes do not support 100G coherent DWDM transmission.

SURFnet8 Photonic Layer Tender

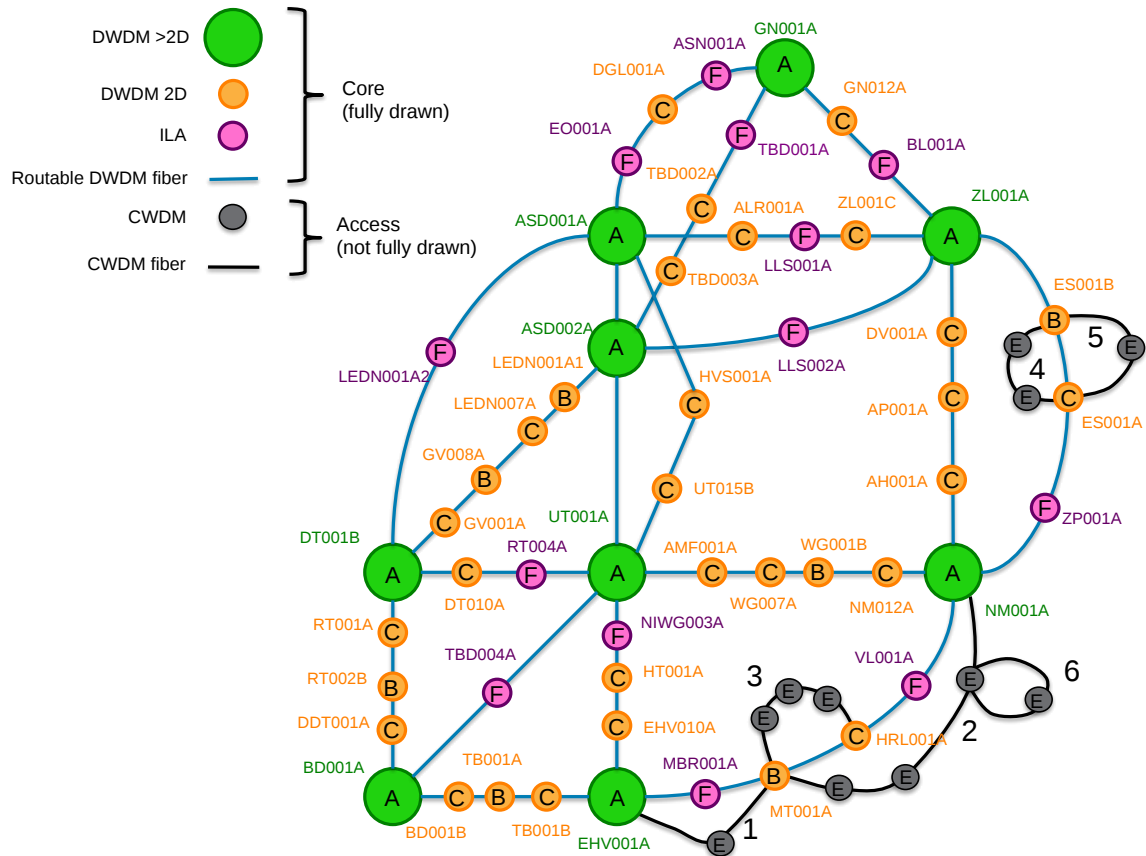


Figure 2-3 Example of an initial SURFnet8 photonic network where only the core nodes (Type A, B, C, D, and F) have become part of a new photonic network. Access rings, number 1 to 6, remain CWDM-only.

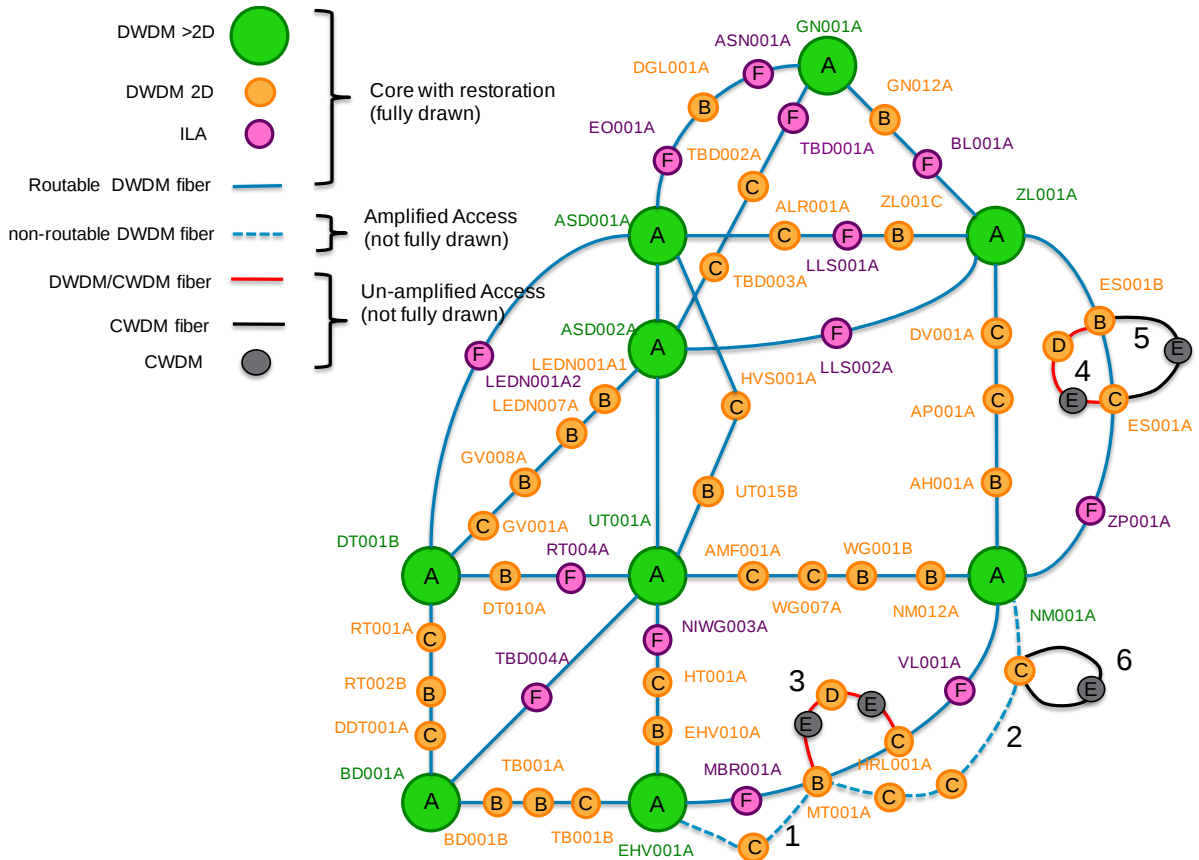


Figure 2-4 Example of a snapshot of the photonic layer of SURFnet8. Access rings are numbered 1 to 6. Rings 1 and 2 are amplified DWDM point-to-point. Access rings 3 and 4 are un-amplified with a mix of CWDM and DWDM. Only access rings 5 and 6 remain CWDM only. In addition, LEDN007A and AH001A are now Type B nodes.

Figure 2-4 shows how the photonic transport of network of SURFnet8 may look like after 100G waves and services have been introduced. In this example the same six access rings are drawn (numbered 1 to 6) as shown in Figure 2-3; however some access rings have evolved to support 100G waves. Access ring 1 contains an amplified DWDM node with fixed add/drop (Type C). This node is similar to Type C nodes found on core-branches. Access ring 2 is similar to access ring 1 accept that access ring 6, with unamplified 10GbE CWDM transport, terminates on the node adjacent to NM001A. Access rings 3 and 4 are unamplified rings with one 100G node and CWDM legacy waves. Access ring 5 is also a CWDM ring, with one node, which must still be migrated to 100G.

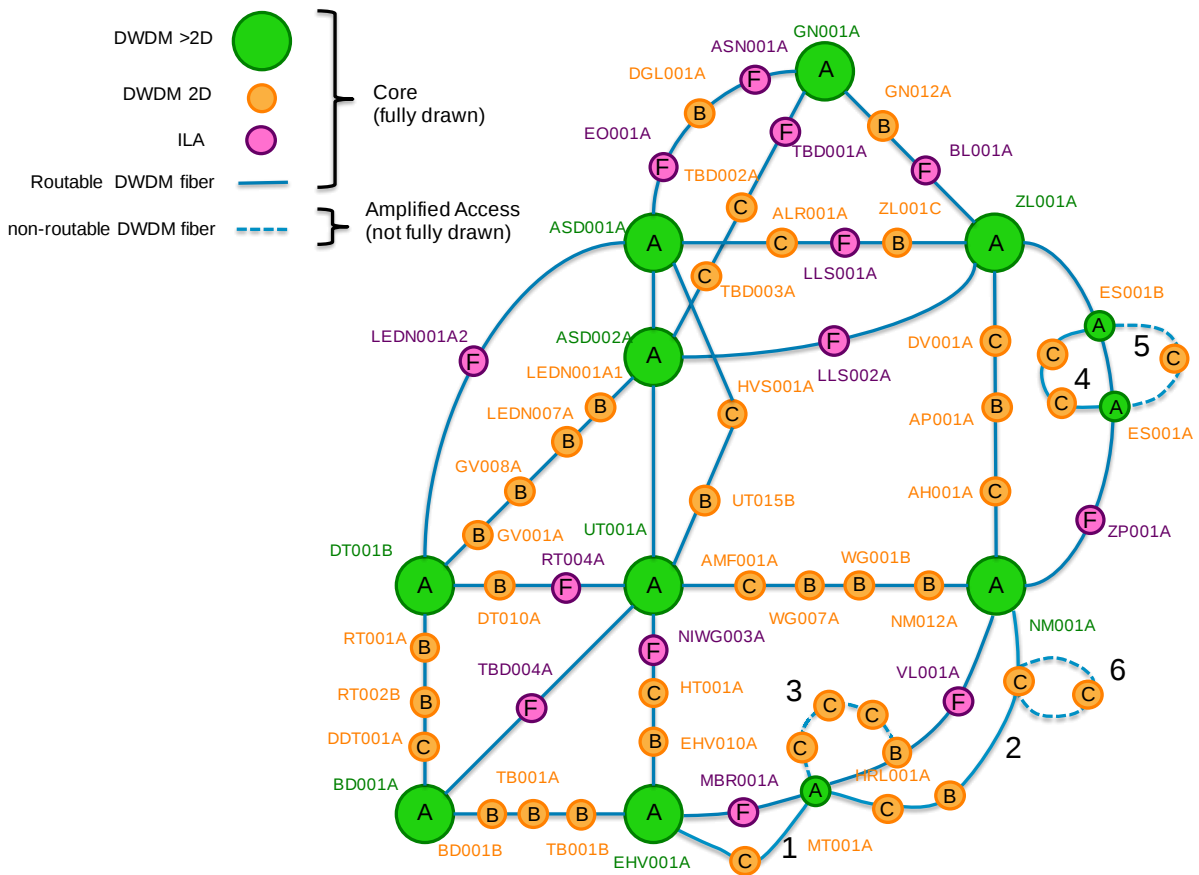


Figure 2-5 Example of a highly advanced SURFnet8 transport network. Three nodes have become nodes of nodal degree three or more and more nodes have been given colorless and directionless functionality. In the access rings, numbered 1 to 6, all CWDM waves have disappeared.

Figure 2-5 shows how the photonic layer of Figure 2-4 has further evolved and has grown to a network where all waves are now 100G DWDM waves. In additions more Type A and B nodes exist and selected access-rings have become part of the core network (numbered 1, 2, and 4). This network implies more capabilities for restoration and improves on contention because blocking probabilities are reduced due to a higher degree of connectivity.

2.2.5.2 Node type transition

Subsection 2.2.3 has described how the SURFnet8 photonic layer is envisaged to grow from a separated DWDM core and CWDM access networks to a single network where both core network and access network can overlap. The mechanism and triggers behind this nodal transition is outlined in Figure 2-6. This figure shows how nodes can transition as they become 'more important' in the network (from a Type E to a more feature-rich type). Alternatively, nodes may also revert back in the direction A to E to become less feature rich. By being able to change the node type, SURFnet aims to meet changes in demand for network connectivity and service bandwidth. Node Type F is

not part of this process because it only amplifies and is therefore agnostic to transformation triggers.

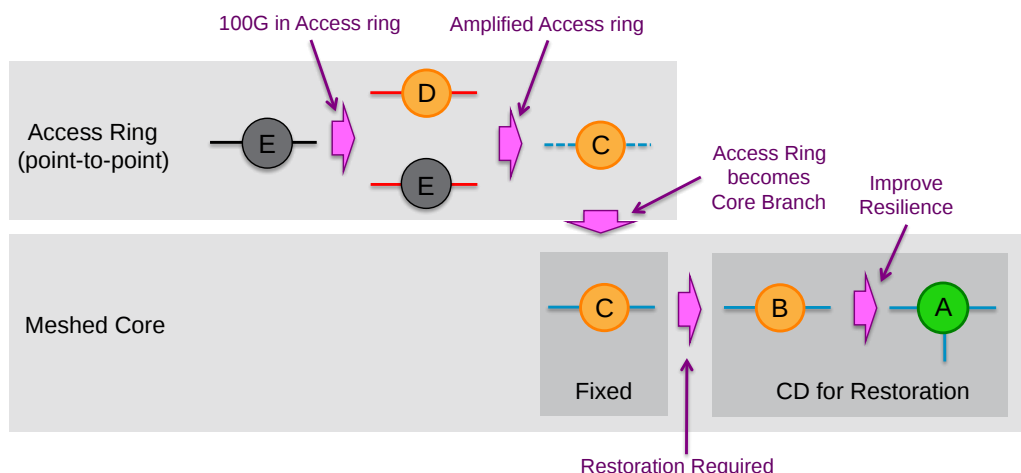


Figure 2-6 Node transformation from a passive CWDM 10GbE access node to multi-degree meshed core node with restoration.

2.2.5.3 Branch and Access Ring Composition

In order for the dynamic network evolution and node type transition to be successfully deployed, nodes must co-exist in core branches and the different types of access rings as shown in Figure 2-4. Figure 2-7, Figure 2-8, and Figure 2-9 show examples of how different node types can be combined. Node Type F has not been drawn because of its amplification-only function. This makes it a trivial node when part of an amplified link.

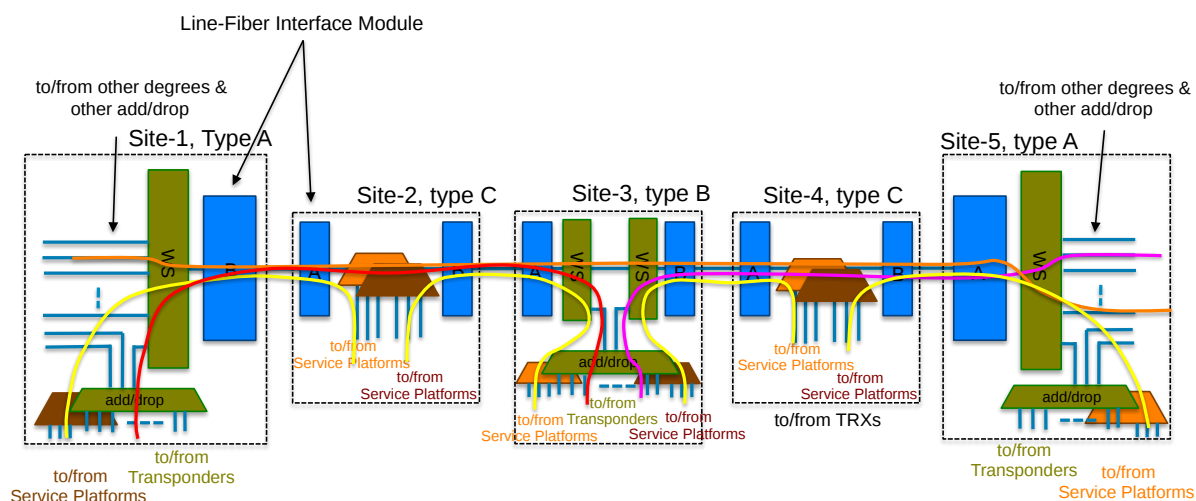


Figure 2-7 Example of a core branch between two Type A nodes and on the branch two Type C nodes and a Type B node.

Figure 2-7 shows an example of a core branch. Between all nodes on the branch and the terminating nodes fixed wavelength and fixed direction transport has been implemented between service platforms situated on each adjacent two nodes. Nodes on Site-1, -3, and -5 are capable of colorless and directionless adding and dropping of waves from and to transponder shelves placed on Site-1, -3, and -5.

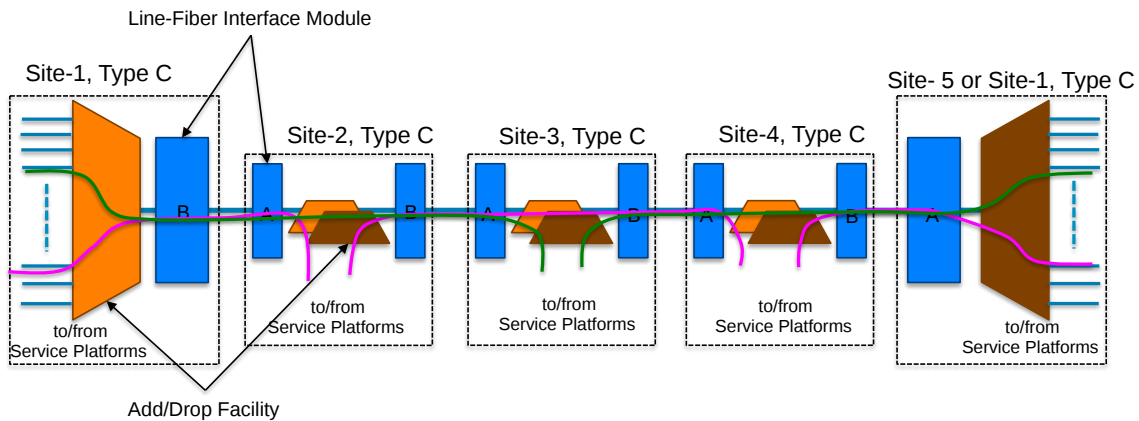


Figure 2-8 Example of a DWDM access ring with amplified nodes of Type C.

Figure 2-8 Shows an amplified access ring, which has been upgraded to support DWDM for the transport of 100G traffic. Because all traffic is terminated at the ring's ends, this ring can only become part of the core network when it connects to the wavelength routing/switching facilities, which must be in place at Site-1 and/or Site-5. In this configuration nodes at Site-2, -3, and -4 are not supposed to transition to a Type B node until the ring becomes wavelength routable by upgrading Site-1 and Site-5 from Type C to Type A.

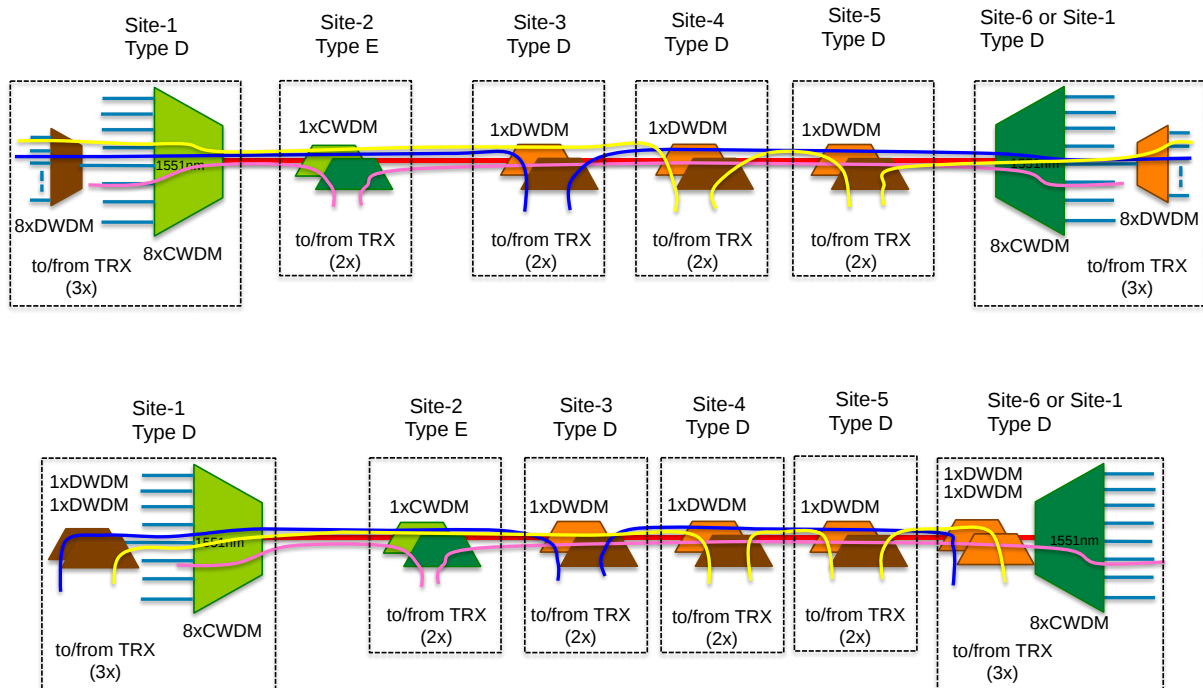


Figure 2-9 Un-amplified access ring with a mix of CWDM and DWDM optical add and drop nodes. In this example two possible options for implementation are displayed.

Figure 2-9 shows an un-amplified access ring. Similar to the case of the amplified access ring all traffic is terminated at Site-1 and/or Site-6. Because DWDM traffic is dropped at Site-1 and Site-6, these nodes are by convention of Type D.

3 Guidelines for participation

3.1 General

3.1.1 Completeness and correctness of information

The Proposal must contain all requested documentation and information and any other document that the Tenderer wishes to include or refer to. By submitting a Proposal, the Tenderer agrees that SURFnet is entitled to investigate all information provided by the Tenderer in its Proposal, immediately or later in the course of the procedure, concerning the correctness of the information. If the Tenderer refuses co-operation or provides incorrect information, SURFnet is entitled to exclude the Tenderer from the Tender Procedure without further questions.

3.1.2 Confidentiality and publicity

All Proposals will be treated confidentially. All Proposals and each item of the Proposal sent to SURFnet is considered the property of SURFnet and will not be returned to the Tenderers.

Tenderer is not allowed to share any confidential information concerning this project to third parties, except in the case of contracted associate parties, subcontractors and/or helping hands. In all cases, Tenderer will be responsible for imposing the same confidentiality obligations to such third parties while Tenderer holds responsibility for complete project confidentiality. Without written consent from SURFnet, no publicity is to be given to this project.

Information contained in Proposals shall be deemed confidential, but shall not entitle Tenderer having submitted it to any claims or property rights thereto.

3.1.3 Errors and ambiguities

This document has been drafted with great diligence. If any errors or contradictions are observed, please contact SURFnet (see Section 3.4) stating the possible contradictions or proposed corrections before the due date for questions as shown in the timetable in Section 1.3.1 on penalty of forfeiture of rights. SURFnet will respond to these inputs as part of the Question and Answer process, stating whether and in what way the document shall be amended.

The technical expressions and abbreviations used in this document are considered to be known by Tenderer. In the case of any ambiguity, please contact SURFnet (see Section 3.4) stating the possible contradictions and/or proposed corrections before the due date for questions as shown in the timeline in Section 2.5 on penalty of forfeiture of rights. SURFnet will respond to these inputs as part of the Question and Answer process.

3.1.4 Language

English will be the working language for the entire Tender procedure and the Contract. During the execution of the Contract the language to be used in communication, reports, and billing may be Dutch or English. Proposals and supporting documents in Dutch language will be accepted.

3.1.5 Compensation

SURFnet shall not compensate or be liable for any compensation with respect to the issuing of Proposals. Moreover, correspondence and Proposals will not be returned.

3.1.6 Duration of validity

Proposals must be valid and sustained for the minimum period of 180 days. If the awarding of the contract is delayed, for instance because of legal proceedings, SURFnet may request Tenderer to extend the validity of the Proposal.

3.1.7 No back channelling

It is not allowed for Tenderer in any way to parley or to make arrangements with other Tenderers that may adversely affect the price or competition.

3.1.8 No obligation to award the Contract

Completing the procedure of this Tender in no way imposes on SURFnet an obligation to award the Contract.

SURFnet disclaims any and all liability for costs or losses Tenderers may incur in relation to this procurement procedure, the premature termination thereof, your participation therein, or your exclusion thereof.

3.1.9 Acceptance of Tender conditions

By submitting a Proposal, Tenderer agrees to all conditions stated in this document.

3.2 Applicable law and competent court

The Tender Procedure and all Documentation are subject to Dutch law. The competent Court of Utrecht (in the Netherlands) shall resolve all disputes arising between SURFnet and Tenderer(s) or other third parties in connection with the Tender Procedure and all Documentation.

3.3 Tender-related complains

SURFnet is committed to public sector best practice. Competitive processes are governed by EU law and Dutch legislation. If you are of the opinion that SURFnet, in dealing with this tender, is not abiding by the applicable rules, please contact SURFnet via the contact person as stated in Section 3.4. If this does not result in a satisfactory answer, you may then issue a formal complaint with the Complaint Committee.

Please refer to the SURF Regulation On Handling Tender-Related Complaints:

<http://www.surf.nl/en/about-surf/contact/complaints/index.html>

Please note that any questions you may have relating to the scoring of your Proposal leading to an awarding decision of SURFnet, are best dealt by the contact person of SURFnet on behalf of this Tender Procedure. In this case please contact the contact person as indicated in Section 3.4 for either a personal meeting or teleconference for a clarification on the given scores and awarding

decision based on the scores. If after this clarification, you cannot abide by such clarification, we refer to the procedure as described in Section 4.1 of this Request for Proposals document.

3.4 Clarification questions

During the Tender Procedure questions for clarifications from organizations considering taking part in the Tender will be answered. Clarification to this Request for Proposals has to be requested via the TenderNed platform⁴ (www.tenderned.nl), or, in case the TenderNed platform fails, as a fall-back via e-mail to the tender email address (see below). Any comments regarding the procedures described in this document must also be submitted as soon as possible, but no later than the due date for questions as stated in the timetable in Subsection 1.3.1 in order to ensure an adequate answer and to prevent a forfeiture of rights (see Subsection 3.1.3).

A document that lists all questions and answers will be published without mentioning the names of the inquiring parties. Only the answers provided in that document represent SURFnet's response to the inquiring parties; answers provided in any other way will be deemed invalid.

Communication regarding this Tender Procedure will take place with the contact person (liaison) of SURFnet exclusively. Violation will lead to exclusion from the Tender Procedure.

Contact person on behalf of SURFnet is:

Mr. Jac Kloots

Clarifications via the TenderNed platform: www.tenderned.nl

Tender e-mail address: sn8-tender@surfnet.nl

3.5 Registration through a joint Proposal or sub-contracting

Companies wishing to participate in this Tender Procedure can join forces as a Consortium, or through subcontracting. Both joint submissions and subcontracting are allowed in response to this Request for Proposals. This must be made clear through the self-declaration form in Annex B. Proposals may also combine both approaches.

In any case, the Proposal must specify clearly whether each company involved is acting as a Participant in a Consortium or as a subcontractor (this also applies if the various companies involved belong to the same group, or even when one is the parent company of the others).

In any event, joint submissions will be treated in the same way as any other Proposal, each being assessed on their own merits in relation to the criteria and the evaluation procedure set out in this document.

⁴ Take note that (free) registration at TenderNed is required to submit questions regarding this tender. Registration is also required for digital submission.

3.5.1 Joint submission

A Proposal jointly submitted by a group of two or more companies is a joint submission. If awarded a Contract, the Participants of the Consortium shall be jointly and severally liable towards SURFnet for the entire duration of the Contract.

A Participant can only be part of one Consortium. If a company joins a Consortium it is not allowed to submit a Proposal as (solo) Tenderer, nor as subcontractor to any other Tenderer.

In its Proposal, the Consortium (Tenderer) shall issue a statement in which it is made clear:

- i. how their co-operation will be organized in order to achieve the expected results (i.e. what each Participant's role will be);
- ii. which Participant will be assigned to act on behalf of the Consortium and to carry out all the contacts with SURFnet.

This statement shall be the basis of the agreement between Participants before they are awarded the Contract.

The joint submission has to be signed by all Participants. Alternatively, Participants may issue a power of attorney to another Participant. In that case the relevant declaration must be attached to the Proposal.

The assigned Participant will be responsible for the delivery of one integral Proposal on behalf of all Participants of the Consortium.

All Participants, however, must sign the Contract if awarded.

3.5.2 Subcontracting

Certain tasks described in the Contract may be entrusted to subcontractors, but the main contractor remains fully liable towards SURFnet for the performance of the Contract as a whole.

Accordingly, SURFnet will treat all contractual matters, including payments and liability, exclusively with the main contractor, whether or not a subcontractor performs the tasks.

Under no circumstances can the main contractor avoid liability towards SURFnet on the grounds that the subcontractor is in default.

If subcontracting is proposed the roles, activities and responsibilities of subcontractor(s) must be clearly described, and a signed letter of intent by each subcontractor stating its intention to collaborate with the Tenderer if he wins the Contract shall be included.

During execution of the Contract, the main contractor will need SURFnet's explicit authorization to replace a subcontractor with another and/or to subcontract tasks for which subcontracting was not envisaged in the original Proposal.

3.6 Proposal

3.6.1 Submission of the Proposal

The Proposal may only be submitted digitally.

The address for digital submission is: www.tenderned.nl.

If, due to file size, digital submission of (parts of) Candidate's Qualification Submission is not possible through TenderNed, Candidates can apply for a SURFfilesender voucher to upload their files to a specific SURFnet drive. Applications can be sent to the email address as stated in Section 3.4.

Online help from TenderNed to submit digitally is available at their website, phone 0800-TenderNed or email servicedesk@TenderNed.nl.

3.6.2 Deadline for submission of Proposal

Proposals must be delivered no later than the due date and time for submissions as noted in the timetable in Subsection 1.3.1.

3.6.3 Legal signing

The Proposal must be legally signed and accompanied by a legally signed cover letter, signed by an *authorized signatory registered at the Chamber of Commerce*. In case the signatory is not registered a document must be provided proving that the signatory is authorized to represent the company. This document must be no older than 3 months. For verification purposes of the signature SURFnet may request a clear copy of the identity card or passport of the signer to be provided within 5 calendar days after SURFnet's first request.

3.6.4 Format of the Proposal

All Tenderers are required to provide information according to a prescribed format, which is the major guideline for the submission of information. The structure for the Proposal is given in Annex A.

4 Evaluation procedure of proposals

After receipt of Proposals, each Proposal will be examined and evaluated by an evaluation committee of SURFnet, after which the economically most advantageous Tenderer will be decided. The assessment consists of the following consecutive steps:

Step 1: Application of formal validity

The Proposal must be submitted according to the guidelines in Chapter 3. SURFnet will assess completeness, and check that the guidelines are observed. If the Proposal is incomplete or not according to the guidelines, SURFnet is entitled to exclude the submission. SURFnet may qualify the incompleteness as an omission which can be remedied by additional information; however, SURFnet has no obligation to ask for additional information.

Step 2: Application of exclusion grounds and suitability requirements

If the Proposal is complete and according to the guidelines, SURFnet will assess whether the Tenderer qualifies for tendering based on the exclusion grounds (Section 5.2) and the suitability requirements (Section 5.3). If any of the circumstances of the exclusion criteria apply to the Tenderer or its Participants, or if Tenderer does not comply with the suitability requirements, SURFnet will exclude the Tenderer.

Step 3: Application of Minimum Requirements

For all Tenderers who are not excluded in Steps 1 and 2, their Proposals will be assessed on the Minimum Requirements by an evaluation committee. The evaluation committee will determine whether the Proposal qualifies for further awarding. In addition to the confirmation statement, the provided substantiation will be used to verify the stated compliance. The Minimum Requirements are marked 'Minimum Requirement', and numbered as "MR nn".

If any of the Minimum Requirements is not met, SURFnet shall exclude the Tenderer.

Step 4: Application of Awarding Requirements

Proposals that are not excluded in Step 3 will be assessed, assigning scores for each Awarding Requirement as indicated in the Awarding Requirement. Provided specifications and descriptions by Tenderer to Minimum Requirements will be taken into account. Each Awarding Requirement has a number of points which can be awarded. The Awarding Requirements are marked 'Awarding Requirement', and numbered as "AR nn".

Scoring system per Awarding Requirement

In Chapter 6 the Awarding Requirements are described, including the criteria upon which Tenderer's response will be assessed.

For the application of the Awarding Requirements, SURFnet will assess the complete answer of each Tenderer. Thereby the complete answer of each Tenderer will be evaluated, instead of the various (individual) elements that are stated in the description of the Awarding Requirements. Preferably Tenderer should provide compact and concise answers. Detailed descriptions of process-

es or technical details should be put in separate appendices to which the Tenderer must specifically (document title, chapter, appendix, section, subsection, page number) refer to in its answer.

When applicable, an expert panel will be consulted on the interpretation in order to determine scoring.

Scoring system per Proposal towards final score

A threshold score for each Proposal is calculated by adding awarded points of the Awarding Requirements AR 1 to AR 32. This excludes TCO requirement: AR 33.

The TCO Awarding Requirement AR 33 will only be scored if a 60% minimal score for the Awarding Requirements AR 1 to AR 32 is met. In the case less than three proposals meet the 60% fraction, the 60% fraction will be lowered such that a maximum of three proposals meet this lowered fraction. Proposals of which the TCO is not judged are excluded.

The final score is determined by adding all points awarded for all Awarding Requirements. This includes TCO requirement: AR 33.

The Tenderer with the highest final score will be awarded the Contract. In case there are two or more Tenderers with the same final score, out of these Tenderers the Tenderer with the lowest TCO will be awarded the Contract.

4.1 Awarding decision

After SURFnet has taken its awarding decision, it will inform all Tenderers in writing (electronically) of its awarding decision. In case an unsuccessful Tenderer wants to take legal action by initiating interlocutory proceedings, he must do so within 20 calendar days after the date of notification at the competent court in Utrecht (The Netherlands) on penalty of forfeiture of rights. Prior to starting such interlocutory proceedings, SURFnet requests the Tenderer to contact the contact person to see if a clarification on the awarding decision (see also Section 3.4) may be sufficient to take away any objection to the awarding decision. If not, for the sake of an adequate progression, parties concerned are asked to timely inform SURFnet of such legal action by means of providing a copy of the summons to a court of law.

4.2 Verification

SURFnet has the right to verify or re-verify the documentation provided by the Tenderer before proceeding to the contracting stage. If during verification the Tenderer does not comply, or no longer complies, with the Requirements, SURFnet reserves the right to declare the Tenderer's proposal invalid and exclude it. In that case the assessment of Proposals will be carried out again with the remaining Tenderers.

4.3 Contracting

SURFnet together with this Request for Proposals has published a draft framework agreement as specified in Annex F. Tenderer has the possibility to send his remarks and text proposals with re-

gard to the aforementioned draft framework agreement before the deadline for questions as mentioned in Subsection 1.3.1 of this Request for Proposals document. SURFnet will reply to these remarks and text proposals, and define the final framework agreement. On or before the last date for answering questions as mentioned in the planning SURFnet will provide the final version of the framework agreement to Tenderers.

When submitting its Proposal Tenderer shall be deemed to have unconditionally accepted the final version of the framework agreement. After the awarding decision, SURFnet will refuse any request from Tenderer to renegotiate the final framework agreement or to change the minimum requirements of the Tender.

4.4 Reassessment of Proposals

If, for any reason, SURFnet fails to secure the Contract with the Tenderer to whom the Contract was awarded originally, within a period of two months after the notification of the awarding decision, SURFnet reserves the right to re-assess the Proposals of the remaining Tenderers and award the Contract to the new economically most advantageous Tenderer. Please note that due to the way points are awarded in this Tender, the new economically most advantageous Tenderer is not necessarily the Tenderer who was ranked second in the original assessment.

If, during the first six months after the notification of the awarding decision, the Contract entered into between SURFnet and the Tenderer to whom the Contract was awarded originally is terminated, irrespective of the underlying reason for such termination, SURFnet reserves the right to re-assess the Proposals of the remaining Tenderers and award the Contract to the new economically most advantageous Tenderer. Please note that due to the way points are awarded in this Tender, the new economically most advantageous Tenderer is not necessarily the Tenderer who was ranked second in the original assessment.

5 Exclusion grounds and suitability requirements

5.1 Introduction

To assess whether a Tenderer qualifies for the 'SURFnet8 photonic layer' Tender, SURFnet has defined the guidelines for submission of a Proposal in Chapter 3. If the Proposal is delivered according to these guidelines, criteria for qualification will be assessed according to the procedure in Chapter 4.

Note that at the time of awarding of the Contract, the Tenderer cannot be in any of the circumstances defined in Section 5.2 and must still comply with the Minimum Requirements defined in Chapter 6. If the Tenderer is a Consortium, this means that none of the Participants of the Consortium can be in any of the circumstances defined in Section 5.2 and that the Consortium (as a whole) must still comply with the minimum requirements defined in Section 5.3. SURFnet will exclude the Tenderer, should this not be the case.

5.2 Exclusion grounds

In the Proposal, Tenderer must provide a self-declaration form (see Annex B), duly signed and dated, stating that the firm is not in one of the situations as listed in Article 2.86, 2.87a and 2.87d of the Aanbestedingswet 2012. The Tenderer awarded with a Contract may be asked to provide documents of proof before signing of the Contract. If this Tenderer fails to provide the aforementioned document, he will be excluded.

The optional exclusion grounds (sub a and sub d of Article 2.87 of the Aanbestedingswet 2012) apply to ensure that the awarded Contract will actually be performed.

5.3 Suitability requirements

The suitability of Tenderer regarding their technical and professional ability will be evaluated and verified in accordance with the information requested in this section.

5.3.1 Financial and economic standing

Tenderer must have the economic and financial capacity to carry out the Contract subject of this Tender for the whole duration of the Contract, including possible extensions. Tenderer must provide a declaration (Annex B) on its honour, duly signed and dated, stating that its enterprise complies with the following financial and economic standing:

- a) a healthy financial and economic standing of its enterprise, guaranteeing continuity of its services for the duration of the contract and during any possible extended period;
- b) that Tenderer will provide, at SURFnet's first request, a bank statement (dating back three months at most) stating that the Tenderer has sufficient financial and economic standing for the execution of the project.

Tenderer may be asked to provide documents of proof to be provided within 10 calendar days after first request, such as the presentation of balance sheets or extracts from balance sheets and the profit and loss statements (copy of the audited annual accounts).

Commercial undertakings established less than three years before the date of publication of the Proposal must give evidence of their financial capacity by providing equivalent documents.

5.3.2 Technical and professional capacity

Tenderer must have three (3) core competences required to carry out the task involved of this Tender, as specified in the table below. Tenderer must provide the evidence that demonstrate its technical and professional capacity by submitting recent references (see the form of Annex C). These are minimum requirements.

Table 1: Core competences regarding technical and professional ability.

#	Core competence	What the reference must demonstrate
1	Supply and integrate a Photonic DWDM Transport Network containing at least 25 nodes or extend such a network with at least 10 nodes	The reference must show the awarding of a contract and a written statement of the operator confirming finalization of the operational network.
2	Play an active role in the research and standardization community on photonic transport and optical communication.	Provide minimal 5 references of contributions to scientific journals (min. 1), (European) research projects (min. 1), Conferences (min. 1), and Standardization Bodies (min. 1) in the field of photonic transport and optical communications.
3	Supply and integrate a photonic DWDM transport network with an active L0/L1 control plane.	The reference must show a written statement by an operator with an activated L0/L1 control plane supplied by Tenderer.

Tenderer must provide references, to demonstrate the required core competences. A single reference may address one or more core competences.

The references must have taken place within the last three (3) years and the relevant elements must have been demonstrated before publication date of this Tender.

Tenderer must explicitly describe its role in relation to the reference(s) (see Annex C) regarding core competences 1 and 3. If a reference applies to equipment and services which were delivered through a consortium of companies, only Tenderer's own role will be taken into account in establishing its technical and professional capacity. Take note that SURFnet may inquire directly at the reference customer contact person.

6 Photonic layer requirements

This chapter contains the functional specifications of the solution which the Partner must provide to SURFnet.

This chapter is divided in sections, where each section covers an important aspect of the solution for the bandwidth providing photonic service to be offered.

The Minimum Requirements to which Tenderer must comply are numbered and marked as “**MR nn**”. The Awarding Requirements are also numbered and marked as “**AR nn**”. Please refer to chapter 4 for the description on how the Proposals will be assessed.

6.1.1 Phases/schedule for migration and upgrade

Phase A: Migrate and upgrade core network – 2017/2018

Phase B: Upgrade to 100G of some locations in access rings starting beginning of 2020 and bandwidth capacity upgrades in the core network by introducing more transponders of 100G and beyond and migrating selected Type B nodes to Type A nodes. During Phase B RAMAN amplification could be introduced. A subset of these upgrades has been added to the TCO model of Annex D.

MR 1: SURFnet8 renews and upgrades SURFnet7 in a future proof fashion

Tenderer’s proposed solution must be future proof and capable of serving existing bandwidth requirements from SURFnet7 as specified in Section 2.1 and MR 73. The solution must allow for incremental bandwidth upgrades in the core and allow for access-ring locations to be upgraded to core network locations up to at least the year 2025.

6.1.2 Photonic services in SURFnet8

The photonic layer in SURFnet8 should realize the following services:

1. Provide bandwidth between service platforms placed at arbitrary locations which are connected to the photonic layer via “grey” client interfaces (Type I);
2. Provide alien wave services at 10G or 100G or higher for photonic transport between service platforms connecting to the photonic layer via DWDM coherent detection interfaces (Type II and Type III);
3. Provide bi-directional single-fiber photonic transport bandwidth for a time and frequency transfer service.

MR 2: Transport of waves

Tenderer’s proposed solution must support the generation of Type I waves and the transport of waves generated by Type I, II, and III interfaces and the transport of bi-directional waves in a single fiber. The solution must support transport of waves over a spectrum of 4.4THz in the C-band and must support a minimum of 88 waves.

6.1.3 SURFnet’s fiber infrastructure

SURFnet uses leased dark fiber for its transport services. The dark fiber infrastructure is composed of ITU-T G.652, G.655, and G.653 fiber pairs. SURFnet avoids G.653 as much as possible because

of its zero dispersion crossing in the C-band. For transport of time and frequency, SURFnet uses its fibers bi-directional on a span-to-span basis.

Termination of the fiber at SURFnet locations is done:

1. Directly onto SURFnet's ODF in SURFnet's rack (1 connection < 0.5dB loss);
2. Onto ODF of dark fiber supplier and from there directly onto SURFnet's ODF in SURFnet's rack (2 connections < 1.0dB loss);
3. Onto ODF of dark fiber supplier in a MMR and from there via patch cable to SURFnet's ODF (3 connections < 1.5dB loss).

SURFnet demands each splice to be less than 0.15dB loss. Average loss of all splices must be better than 0.1dB. SURFnet aims to reduce the number of patches made by the dark fiber supplier as much as possible and allows for two patches in order to allow suppliers to attach e.g. G.652 access fibers to G.655 core fibers.

SURFnet does not allow lumped losses and is critical on bend losses. SURFnet aims to have SC/PC or LC connector interfaces on its ODF. However SC/APC and E2000/APC and E2000/PS(4) (RAMAN) are also present at some spans. The typical ORL of SC/PC connector interfaces is 40dB.

Global ORL values, when measured at the ODF, are better than 30dB.

MR 3: Solution must be compatible with existing fiber infrastructure

Tenderer's proposed solution must support the outlined fiber infrastructure of SURFnet and must interwork with SC/PC connector interfaces as found on SURFnet's ODFs.

MR 4: Uni-Directional transmission

Tenderer's proposed solution must deploy uni-directional transmission in each fiber of the fiber pair, except in the case of bi-directional transmission intended for time and frequency transfer waves.

6.2 Architecture

In Subsection 2.2.3 SURFnet has outlined the intended photonic architecture, which is based on five different add/drop node Types (A to E) and an amplification node (Type F), of which two types are also capable of routing waves, and in-line fiber amplifier nodes. Changing customer and user demands (in terms of capacity, locations, and continuity) trigger changes in the photonic layer in the form of changes of node type. Figure 2-6 explains how node types can transition and how this impacts capacity, routing, and restoration capabilities.

The DWDM waves that are ultimately responsible for transporting traffic will be generated by transceivers implemented in both a transponder layer and implemented as pluggable modules on service platforms.

6.2.1 High-Level Photonic and Transport

MR 5: Core photonic layer solution

Tenderer must provide a solution for each of the three node types (A, B, and C) and the in-line amplifier node type (F). Solutions for nodes A, B, C and F must be fully interoperable in order to perform as one meshed photonic layer and allow for any mix of these node types on branches of the meshed core-network. The solution for node C and F must be the same as the solution for node C and F given in MR 13 and MR 19.

MR 6: Access-ring photonic layer solution

Tenderer must provide a solution for each of the four node Types (C, D, E, and F). The solution for node C and F must be the same as the solution for node C and F given in MR 5. Solutions of node type D and E must be fully compatible. At both ends of an access ring solutions of node Type C, D, and E must add and drop all waves, one wave per port.

MR 7: Transponder platform solution

Tenderer must provide a solution for a coherent-detection DWDM transponder platform, which is fully interoperable and can fully interwork with the proposed solutions for node Type A, B, C, D and F as presented by Tenderer in MR 5 and MR 6.

MR 8: Transport of DWDM coherently-detected waves (Type I, II, and III)

Tenderer's solutions proposed in MR 5 and MR 6 (excluding node Type E) must transport any Type I, II, and III DWDM wave generated by and terminated on a coherent DWDM transceiver. Type II and III waves can be assumed of same symbol rate, modulation format, FEC-engine performance, and with equal transmission impairment compensation capabilities on their transceivers as Type I waves.

MR 9: Transport of DWDM direct-detected waves (Type I and II)

Tenderer's solutions proposed in MR 5 and MR 6 (excluding node Type E) must transport any Type I, II DWDM waves generated by and terminated on direct-detection DWDM transceivers. Transceivers transmitting and receiving Type II waves can be assumed to be in line with 10GBASE-ZR 80km 10 Gb/s Tuneable (50GHz grid) DWDM transceivers.

MR 10: Transport of CWDM direct-detected waves (Type II)

Tenderer's proposed solution for Node Type E in MR 6 must transport any Type II CWDM wave generated by and terminated on direct-detection CWDM transceiver. Transceivers transmitting and receiving Type II CWDM waves can be assumed 1GbE and 10GbE waves generated by 1GBASE-ZR and 10GBASE-ZR/ZW CWDM pluggable modules.

6.2.2 Node Type A

MR 11: Node Type A basic functionality

Tenderer must provide a solution for Type A nodes, which:

- allows colorless, and directionless adding and dropping of DWDM waves, colored adding and dropping of waves per line fiber interface, and routing of waves between any ingress line fiber interface to any egress line fiber interface.*

- supports the ITU-T DWDM flex-grid standard for colorless and directionless adding, dropping, and routing of waves and the ITU-T DWDM 50GHz grid standard for colored per line fiber interface adding, dropping, and routing of waves.
- supports a nodal degree (counted over the line fiber interfaces) of at least six (6), without compromising on the number of add/drop structures required for dropping of waves as outlined in MR 21 and MR 22.

Tenderer must provide a detailed technical description of the solution with a technical diagram of the functional components.

AR 1: Node Type A with support of a nodal degree of 10 or more (excl. add/drop structures)

+2 Points are awarded if Tenderer's portfolio includes a node Type A with a nodal degree of 10 or more. This node Type A model does not have to be included in the TCO model in Annex D. The price shall not exceed twice the price of the node Type A solution in MR 11 as offered in the TCO model. Add/Drop ports to add/drop structures are not counted as a degree.

AR 2: Performance of node Type A with a nodal degree of 6 (excl. add/drop structures)

Tenderer is asked to specify the minimum loss encountered by a wave routed from an ingress line-fiber to an egress line-fiber, measured between the output port of the ingress pre-amplifier and the input port of the egress post-amplifier increased by the average of the noise figure of a pre-amplifier and the noise figure of a post-amplifier. In case more amplifiers have been implemented, all losses between two amplifiers must be increased with the averaged noise figures of both amplifiers and listed. In case equipment practice or deployment rules require padding or a Variable Optical Attenuator (VOA) to be set to a typical value, the loss of the pads or VOA must be taken into account.

The sum of all the values listed by Tenderer above should be as small as possible and within:

- value ≤ 15 dB for +3 points
- $15 < \text{value} \leq 20$ dB for +2 points
- $20 < \text{value} \leq 25$ dB for +1 point

Tenderer is asked to show the calculation and how this relates to the implementation as proposed.

6.2.3 Node Type B

MR 12: Node Type B basic functionality

Tenderer must provide a solution for Type B nodes, which:

- allows colorless, and directionless adding and dropping of DWDM waves, colored adding and dropping of waves per line fiber interface, and transparent transit of waves not dropped.
- must support the ITU DWDM flex-grid standard for colorless and directionless adding, dropping, and transit of waves and the ITU DWDM 50GHz grid standard for colored per line fiber interface adding, dropping, and transit of DWDM waves.

- *must support a nodal degree (counted over the line fiber interfaces) of two, without compromising on the number of add/drop structures required for dropping of waves as outlined in MR 21 and MR 22.*

Tenderer must provide a detailed technical description of the solution with a technical diagram of the functional components.

AR 3: Performance of node Type B

Tenderer is asked to specify the minimum loss encountered by a wave routed from the ingress line-fiber to the egress line fiber, measured between the output port of the pre-amplifier and the input port of the post-amplifier increased by the average of the noise figure of a pre-amplifier and the noise figure of a post-amplifier. In case more amplifiers have been implemented, all losses between amplifiers must be listed increased with the average noise figures of both amplifiers. In case equipment practice or deployment rules require padding or a VOA to be set to a typical value, the loss of the pads or VOA must be taken into account.

The sum of all the values listed by Tenderer above should be as small as possible and within:

- *value ≤ 13 dB for +3 points*
- *$13 < \text{value} \leq 16$ dB for +2 points*
- *$16 < \text{value} \leq 20$ dB for +1 point*

Tenderer must show the calculation and how this relates to the implementation as proposed.

6.2.4 Node Type C

MR 13: Node Type C basic functionality for in-line deployment

Tenderer must provide a solution for Type C in-line nodes, which:

- *allows colored adding and dropping of at least 8 but not more than 16 DWDM waves per line fiber interface, and transparent transit of waves, which are not dropped.*
- *must support the ITU DWDM 50GHz grid standard for colored per line fiber interface adding, dropping, and transit of DWDM waves.*
- *must support the ITU DWDM flex-grid standard for transit DWDM waves.*

Tenderer must provide a detailed technical description of the solution with a technical diagram of the functional components.

MR 14: Node Type C basic functionality for access-ring termination deployment

Tenderer must provide a solution for Type C access-ring termination nodes, which allows colored adding and dropping of at least 8 but not more than 16 DWDM waves for the line fiber interface.

AR 4: Added features node Type C

Points are awarded if Tenderer's portfolio includes a solution that allows wavelength selective adding and dropping per direction and adding and dropping of at least 40 channels in a 50GHz grid.

Tenderer can receive either of the following points if its solution includes the following features:

- +1 point for wavelength selective adding and dropping
- +2 points for wavelength selective adding and dropping and dropping at least 40 channels

This model does not have to be included in the TCO model in Annex D. The price shall not exceed the price of the node Type B solution in MR 12 as offered in the TCO model.

AR 5: Performance of the node Type C

Tenderer is asked to specify the minimum loss encountered by a wave routed from an ingress line-fiber to an egress line fiber, measured between the output port of the pre-amplifier and the input port of the post-amplifier increased by the Noise Figure of a pre-amplifier and the Noise Figure of a post-amplifier (assume dual stage amplifier). In case padding must be inserted or a VOA must be set to a typical value (e.g. to meet engineering or equipment practice rules) padding or typical VOA value must be added to the encountered loss.

The sum of all the values listed by Tenderer above should be as small as possible and within:

- value $\leq$ 12dB for +3 points
- $12 < \text{value} \leq$ 15dB for +2 points
- $15 < \text{value} \leq$ 18dB for +1 point

Tenderer is asked to show the calculation and how this relates to the implementation as proposed.

6.2.5 Node Type D

MR 15: Node Type D basic functionality for in-line deployment

Tenderer must provide a solution for Type D nodes, which allows non-amplified filtered adding and dropping of one DWDM wave on the 50GHz or 100GHz ITU-T grid in the CWDM 1551nm band (1548.11nm to 1554.13nm) for each of the two line-fiber interfaces, and transit of all CWDM waves (1471nm, 1491nm, 1511nm, 1531nm, 1571nm, 1591nm, and 1611nm), that are not dropped.

MR 16: Node Type D basic functionality for access-ring termination deployment

Tenderer must provide a solution for a Type D ring-termination node, which allows non-amplified filtered adding and dropping of all DWDM waves on the 50GHz ITU-T grid in the CWDM 1551nm band (1548.11nm to 1554.13nm) and all CWDM waves (1471nm, 1491nm, 1511nm, 1531nm, 1571nm, 1591nm, and 1611nm) for the line fiber interface

6.2.6 Node Type E

MR 17: Node Type E basic functionality for in-line deployment

Tenderer must provide a solution for Type E in-line nodes that allows non-amplified filtered adding and dropping of one CWDM wave (1471nm, 1491nm, 1511nm, 1531nm, 1551nm, 1571nm, 1591nm, and 1611nm) for each of the two line-fiber interfaces, and transit of all CWDM waves, which are not dropped.

MR 18: Node Type E basic functionality for access-ring termination deployment

Tenderer must provide a solution for a Type E ring-termination node that allows non-amplified filtered adding and dropping of all CWDM waves (1471nm, 1491nm, 1511nm, 1531nm, 1551nm, 1571nm, 1591nm, and 1611nm) for the line fiber interface.

6.2.7 Node Type F

MR 19: In-line amplification node basic functionality

Tenderer must provide a solution for an in-line amplification node that amplifies ingress DWDM waves to a predefined output power level, while maintaining relative differences in power levels between co-propagating DWDM waves. The proposed solution must support the ITU-T DWDM Flex-grid and 50GHz grid standard.

6.3 Optical Supervisory Channel

MR 20: All photonic nodes must be connected using an Optical Supervisory Channel

Tenderer's proposed solution must connect all photonic transport nodes via an Optical Supervisory Channel (OSC). The OSC must allow span based exchange of any information required by the photonic layer to function as intended. In addition, Tender's OSC solution must support a wayside channel for the delivery of external Ethernet traffic. The wayside interface must be IEEE 802.3 100BASE-T or 1000BASE-T (GbE). Wayside traffic must never disrupt the management and control plane of the photonic layer.

6.4 Resilience

MR 21: No single point of failure impacting more than one line-fiber interface.

Tenderer's proposed solution for active nodes A, B, and C must be such that failure of a single component of any implemented solution results, in a worse-case scenario, in loss of all signals on only one single line fiber interface (node degree). Catastrophic failure of the backplane of the chassis can be ignored.

Tenderer must show by means of a technical drawing how this is achieved.

MR 22: No single point of failure add/drop structure

Tenderer's proposed solution for active nodes A, B, and C must be such that failure of a single, component in the add/drop structure of any implemented solution results, in a worse-case scenario, in loss of a maximum of 50% of the total waves added/dropped to/from across all degrees of the node. Catastrophic failure of the backplane of the chassis can be ignored.

Tenderer must show by means of a technical drawing how this is achieved.

MR 23: Robustness

Failure of any one component, which is not in the optical path, must not lead to any service outage or service degradation during the first 48 hours. Catastrophic failure of the backplane of the chassis can be ignored.

Tenderer must explain which mechanisms are in place and specify realistic assumptions.

AR 6: Survivability

Tenderer is asked to explain which mechanisms and features are present in the proposed solution aimed to avoid service outage in case of (partial) failures of components, fiber, etc., which are in the optical path as well as software and human errors (such as fiber pinching). Between 0 to +2 points can be awarded, depending to what extent the proposed solution will remain functional in the case components and software (partially) fail.

MR 24: Availability of a chain of nodes

Tenderer must compute the end-to-end annual availability A , in the absence of any resilience mechanism, of a wavelength setup between two Type A nodes with four in-line-amplification nodes. Tenderer must, on a component level, provide insight into the provided figure, where Tenderer is allowed to assume DWDM transceivers, fiber, and power supply to be 100% available). Tenderer is to assume a MTTR of 8 hours. Tender must show that an availability of at least $A > 99.9\%$ is achieved. Tenderer must show calculations and FIT values for each component.

AR 7: Availability of a chain of nodes

In addition to the minimal availability as determined in MR 24, the following points are awarded for an availability A of:

- *99.995% $\leq A < 100\%$ for +2 points*
- *99.95% $\leq A < 99.995\%$ for +1 point*

Tenderer must show calculations and FIT values for each component.

6.5 Security and encryption

MR 25: Management interfaces

Tenderer's proposed solution must provide secure access on all management interfaces against unauthorized access, eavesdropping, and attacks. Tenderer must outline features of the proposed solution that make the solution secure and robust against attacks. Central user authentication using RADIUS, or equivalent, must be offered.

SURFnet believes that end-to-end encryption is the best way to provide secure end-to-end transfer of information. SURFnet also believes that additional measures, such as line-side encryption, fortify secure end-to-end data transport.

AR 8: Line encryption on transponders

SURFnet prefers to have line encryption on transponders. If Tenderer has, as an optional part of its proposed solution, implemented line encryption as a transponder feature, Tenderer must certify that the implementation is free of backdoors and that at the time of production all known day-0 vulnerabilities have been fixed and that any fixes not yet implemented are committed roadmap features. Tenderer must explain line encryption features, aimed at complicating eavesdropping the DWDM signal.

+2 points are awarded if Tenderer offers line encryption complying to FIPS140-2 Level 2 or higher certification or equivalent.

6.6 Bi-directional transmission for TFT services

In order to transfer time and frequency information, bi-directional transmission in a single fiber helps determining half of the round-trip time and uses this information to provide the right off-set with as little uncertainty as possible when correcting the replicated time for the experienced transmission delay.

MR 26: Bi-directional transmission for time and frequency transfer

Tenderer's proposed solution must allow for span-based transmission of bi-directional waves in a single fiber for the offered proposal for Type A, B, C, and F nodes. The proposed solution must include add and drop functionality and outline the dependencies to the photonic layer solution provided in this Tender. Both nodes at each end of one fiber of a span must have a single connector where one wave is added and a second wave is dropped.

AR 9: Bi-directional transmission for time and frequency transfer

A maximum of +2 points are awarded for those solutions to MR 26 which can be implemented today with as little ease as possible and with as little impact to existing services (waves). SURFnet considers solutions that do not increase the OSNR of existing channels more attractive (+1 point) as well as solutions that do not require the optical path to be interrupted such as solutions that exploit co-propagation close to the wavelength of the OSC (+1 point).

6.7 Optical telemetry and monitoring

Aging and changes to the fiber infrastructure can cause changes in optical performance. For this reason, SURFnet is keen on implementing a monitoring system which can provide SURFnet with information in the status of its leased fiber infrastructure.

MR 27: Telemetry and monitoring of the fiber infrastructure

Tenderer must provide a solution that allows the monitoring of the optical fiber infrastructure. The solution must allow the telemetry data to be exported to a central server, where trend analysis can be done in order to identify increased fiber loss due to aging or due to works on the infrastructure. The central server could be part of the NMS solution.

AR 10: Telemetry and monitoring of the fiber infrastructure

Tenderer lists parameters, which can be measured and explains the measurement methodology, accuracy, and measurement ranges of the parameters. SURFnet considers OSC optical power measurements as basic (0 points), OTDR measurements as more advanced (+2 points). Tenderer lists parameters, which can be measured and explains the measurement methodology, accuracy, and measurement ranges of the parameters. This model does not have to be included in the TCO model in Annex D. The price shall not exceed 20K Euro for the first degree of a node.

AR 11: Telemetry and monitoring of waves

Tenderer must explain an architecture, which allows the monitoring of the optical signal's fidelity, such as OSNR (+1 point) and depolarization (+1 point). The solution must be implemented on a per span basis per wavelength within the photonic nodes. Tenderer lists parameters, which can be

measured and explains the measurement methodology, accuracy, and measurement ranges of the parameters. This model does not have to be included in the TCO model in Annex D. The price shall not exceed 20K Euro for the first degree of a node. Up to +2 points can be awarded.

6.8 Network management and monitoring

This NMS of the optical layer must be operated as a standalone system, which interfaces directly with the optical and transponder nodes using local Ethernet Connections and Optical Supervisory Channels between nodes on different locations. The NMS must provide both automatic and manual wavelength provisioning. Manual provisioning means that the NOC operator selects the start and end node and selects intermediate nodes, which become part of the link. After the NOC operator selects the wavelength and possibly the DWDM interface type or bandwidth and modulation format, the NMS builds the route. Automatic provisioning means that the NOC operator only selects the start and end node. The NMS should also be able to cooperate with the restoration function part of a L0 / L1 control plane.

It is important that the optical NMS can interface with an orchestrator to allow the orchestrator to centrally perform provisioning, alarm and event management.

In summary, the Network Management System (NMS), should provide several functions:

- Cover both the photonic transport system as well as the transponder layer.
- Support for element, network and end-to-end wavelength service management.
- Retrieving and processing network telemetry data (alarms and performance).
- Providing a documented and free to use API
- Ability to be integrated in a network orchestration solution.
- Generate topology views, ranging from abstract wavelength service topologies to detailed topology with all network elements and their interconnections.

MR 28: Minimal NMS functionality

The NMS must possess the following minimal functionalities:

- *Allow NOC and field engineers to commission and decommission nodes. If this cannot be performed using a Local Craft Terminal or other means, perform all required configuration management, and provision end-to-end waves between add/drop ports and bandwidth between client ports, using a Graphical User Interface which can run on a medium sized and featured PC and by means of a command-line interface.*
- *Provide information on the status, of each node, including alarms.*
- *Perform software upgrades, downgrades (if applicable), add and remove (if applicable) updates.*
- *Configure and activate performance monitoring and display performance monitoring data.*
- *Collect alarms, correlate alarms, mask alarms, clear alarms, and display alarms.*
- *The NMS must physically connect to not more than two geographically divided Type A nodes in order to meet the required uptime and availability of MR 30. The NMS relies on an internal Data Communication Network (DCN) formed by point-to-point links using an Optical Supervisory Channel to communicate to nodes that are not directly connected to the NMS host.*

- *It must be possible to make the NMS resilient by deploying it on at least two geographically separated VM's or stand-alone servers.*
- *In case the NMS relies on third party software, Tenderer delivers this software and its licenses as part of the installation.*
- *All software and hardware licenses, including third-party software licenses, must be included in the TCO and must not depend on the hardware configuration, such as, but not limited to the number of processor cores. The entire solution must be transferable to a different VM, or stand-alone server.*
- *Provide a documented and free to use northbound API.*

MR 29: Minimal NMS functionality - ignore alarms

SURFnet performs regular tests on its optical network and transponder layer. It is important to isolate testing related alarms from production network alarms. As such we require the NMS to be able to ignore alarms on a per wave basis. This includes alarms generated by the source and terminating transponder card. This function must be available 1 year after contract signing.

AR 12: NMS solution - functionality

Please describe your NMS solution and how it handles each of the following items (Max. +6 points):

- *Support for element, network and end-to-end wavelength service management.*
+2 points are awarded in case Tenderer shows that its NMS has automation features which reduce task loading of the NOC Operator by reducing the number of interventions and the complexity of the interventions. Please consider the following tasks: Troubleshooting, Wave (photonic) and Bandwidth (transponder) creation/deletion/modification, Software Release Management, Configuration Management.
- *Retrieving and processing network telemetry data (alarms and performance) improves fault detection, isolation and the early detection of problems.*
+2 points are awarded in case Tenderer explains what telemetry data is retrieved, how it is processed, and how this eventually leads to improved fault detection, isolation and early detection of problems.
- *Topology views, ranging from abstract wavelength service topologies to detailed topology with all network elements and their interconnections.*
+2 points are awarded in case Tenderer demonstrates that its NMS can show which network elements are traversed by a wave or client-to-client transponder connection, both for the active and the restoration path of a wavelength.

AR 13: Insight into performance degradation of wavelengths and fiber infrastructure

Please provide an insight into how performance degradation of wavelengths (increase of pre FEC errors) or fiber loss increase of the fiber plant can be extracted from the optical network and transponder layer and presented to the operator. A mechanism to report on loss differences between each of the two fibers of fiber pairs in the fiber plant would be valued highly. SURFnet prefers an approach where long-term trends can be analysed. (Max. +2 points)

- *+1 point is awarded if Tenderer shows that it is possible to store performance monitoring data on a storage server external to the NMS or on the NMS.*

- +1 point is awarded if Tenderer explains how his tooling makes it easy for SURFnet to detect long term trends in this stored data, including trends in increasing fiber.

MR 30: NMS uptime and availability

Tenderer's proposed solution must allow the NMS to reach all nodes 99.9% or a higher percentage of the time. The NMS is considered "up" when all NMS functions are available via all activated interfaces. As a consequence, all nodes can be reached (assuming no fiber breaks or photonic equipment failures, which isolate a node) and all databases or information stores (incl., performance monitoring), which are part of the NMS solution, are clean and filled with correct and up to date information and that it is possible to set-up, tear-down, and modify end-to-end photonic waves and bandwidth between two client ports.

MR 31: Multi-user NMS

The NMS must support 16 or more simultaneous management and control sessions across all its activated interfaces such as (but not limited to) GUI, North-Bound Interface, local, SNMP, TL1, SSH, etc. Sessions automatically or autonomously set-up by the photonic transport and transponder equipment and the NMS itself are not counted.

AR 14: NMS hosting platform

Tenderer is to specify the requirements (both hardware and software) for the server platform(s) hosting the NMS. +1 point is awarded for support on Linux VM hosted on commonly used platforms. Tenderer must specify the required number of CPU cores, RAM memory and storage.

AR 15: NMS client

Tenderer is to specify the requirements (both hardware and software) for the clients accessing the NMS. +1 point is awarded for browser-based access on any OS.

MR 32: Virtualization of Type II DWDM interfaces on the NMS

The NMS for the photonic transport solution provided by Tenderer must support the virtualization of Alien Wave DWDM interface management (type II waves) into the DWDM network management system not later than one year after contract signing. Tenderer may assume that the service platforms hosting the type II wave DWDM interfaces support the IETF Black Link MIB or have an NMS with a documented and free to use API with equivalent functionality as the IETF Black Link MIB.

AR 16: Virtualization of Type II DWDM interfaces on the NMS

(maximum 2 points)

1. Standardized interfaces

- a. Is the management interface of the physical Type II DWDM interfaces proprietary or standardized (e.g. SNMP Black Link MIB based, accessible via a documented and free to use API, based on a Yang Model, etc.)? +1 point is awarded if the interfaces have been standardized. Tenderer provides a reference to the applicable standard.
- b. To what level are manageable features of the alien wave (Type II) DWDM interfaces at par with the management of non-alien wave (Type I) DWDM interfaces. Tenderer may assume an alien wave DWDM interface with equal configuration and per-

formance monitoring capabilities compared to the non-alien wave DWDM interface. Does the solution allow the configuration, monitoring, and retrieval of capabilities of: transmit power, wavelength, FEC rate, PRE-FEC BER, Q-factor, Post-FEC BER rate, OSNR, CD, PMD/DGD, Error Seconds (ES), Severely-ES; +1 point is awarded in case all features are at par.

Or,

2. *Non-standardized interfaces.*

- a. *If Tenderer has non-standardized interface(s) or a partly standardized interface(s), Tenderer must specify and document such interface(s), including all layers, including structure, syntax, and semantics of the information transferred). The parameters which are needed to lit a new wavelength need to be present in the interface. +1 point is awarded if Tenderer delivers the requested specification and shows how to activate and monitor a wave.*

MR 33: Automation: NMS Northbound interface to Create, Delete, and Modify connections

The NMS solution provided by Tenderer must have a documented and free to use northbound API that allows an external entity to initiate the Create, Delete, and Modify photonic connection between two client ports on two transponders, including the enabling of the client interfaces and to add a wave to the photonic layer between an optical add port and an optical drop port.

6.9 Control Planes

The photonic layer of SURFnet8 will have two control planes. One control plane is responsible for managing the optical integrity and end-to-end fidelity of the photonic signals and bandwidth. A second control plane is responsible for guaranteeing the availability of bandwidth by providing restoration functionality on the optical plane, taking into account the capabilities and features of the transponders.

MR 34: Pre-provisioning of end-to-end waves

The control plane must support the pre-provisioning of end-to-end waves. Once optical power is added it must be able to have the wave be activated manually and/or automatically.

AR 17: Fast adding and deleting of waves

+2 point shall be awarded to those proposals, which activate an end-to-end wave within 1 minute, independent of the number of already activated waves and their routing. The activation time is measured from the moment optical power is applied to an add-port until the time the system reports the service is active. Please take as a reference the core network in the TCO model of Annex D and assume a wave from GN001A via ASD001A, UT001A to NM001A.

MR 35: Controlling the integrity of optical signals

The solution of the Tenderer must incorporate a control plane, which optimizes the quality and fidelity of dropped photonic signals. The optimization must take into account: optimization of the power levels at the add/drop structures to meet transmitter and receiver power characteristics,

OSNR optimization, and minimization of encountered non-linear impairments. The control algorithm must support and include information on modulation and symbol rate dependent provisioning of fiber launch powers.

The control plane must also guarantee that when adding and deleting waves performance of existing or remaining waves is not impacted.

AR 18: Controlling the integrity of optical signals

Up to +2 points are awarded for features, which include a) a feature that improves the end-to-end OSNR without causing pre-FEC BER degradation, b) a feature that improves the non-linear distortion without causing pre-FEC BER degradation, and c) a feature that improves RX power stability of end-to-end waves.

Tenderer must explain and proof the feature's objective.

- +1 point is awarded for two proven features (out of the three mentioned in this AR)
- +2 points are awarded for three proven features (out of the three mentioned in this AR)

MR 36: L0 and L1 control plane – restoration capabilities

The control plane shall be capable of restoring bandwidth and wavelengths in case of failure(s) by routing for restoration selected waves via another fiber path. Not selected waves are left unattended. The control plane must be capable of using the colorless and directionless add and drop features of Type A and B nodes and Type I DWDM interfaces and Type II DWDM interfaces when virtualized in the NMS (MR 32). The chosen optical path must be predefined, but could also be calculated during restoration. Whenever the failure has disappeared from the network, it must be possible to restore the original path manually.

The control plane must take into account the transmission impairment compensating capabilities of the DWDM transceiver as well as the encountered transmission impairments.

AR 19: L0 and L1 control plane – restoration capabilities.

Additional points are awarded if the restoration algorithm can take into account different criteria when determining the alternative path or performing wavelength restoration (Max. +3 points):

- +1 point is awarded for Tenderers that allow path selection to take into account shared risk links in order to avoid Single Points of Failure as much as possible or low latency.
- +1 point is awarded for Tenderers that allow the restoration process to be triggered based on increased or threshold crossed pre-FEC BER, PMD, power, or other events that indicate eminent loss of a wave or bandwidth.
- +1 point is awarded for Tenderers implementing revertive restoration on specific time (e.g. reversion during night).

In order to earn these points Tenderer must explain and proof the proposed features and indicate what information is required from SURFnet. This feature does not have to be included in the TCO model in Annex D. The price of this feature shall not exceed 10% of the license fee for the L0/L1 control plane.

6.10 Network planning

MR 37: Modelling and simulation - general

Tenderer must include a Modelling and Simulation tool as part of the proposed solution. This tool must allow for the validation of type I DWDM interfaces. The tool must take into account the following transmission impairments in the validation process:

- *Chromatic Dispersion*
- *PMD / DGD*
- *ASE noise*
- *Non-linear distortion (SPM, XPM, FWM)*
- *Polarization dependent loss (PDL)*
- *Spectral filtering (if applicable)*
- *Received optical power*

The tool must allow SURFnet to model the fiber infrastructure as outlined in Subsection 6.1.3. The tool must allow SURFnet to model the entire core network as is realized at any point in time (only for the part supplied by Tenderer). Partner must, within a period of 6 months after the general availability of new equipment and software, make new models available in order for the network model to be at par with the actual network.

The tool must create a validation report indicating the remaining system margin (expressed in OSNR, Euclidian Distance of the constellation, Error-Vector-Magnitude, or any other physical quantity) and for each of the transmission impairments the report must show how much room is still available.

SURFnet must be able to make changes to the resources of the network such as changes of fiber type, amplifier type, node cut-in and cut-out, and type change of a node, or an element of a node, without having to modify, delete, and add any DWDM interface, under the condition that the changes in resources allow all interfaces to remain present (i.e. the tool must be user-friendly).

Tenderer must indicate the limitations of the validity of the tool.

AR 20: Modelling and simulation – Type II and III waves

Tenderer can earn +2 points if its simulation tool allows Type II and Type III waves to be simulated in co-existence with Type I waves. SURFnet will award solutions which show how modelling of alien wave interfaces is done from a user perspective and show which alien wave (interface) parameters are required.

AR 21: Modelling and simulation – model complexity and accuracy

(Max 3 points). Tenderer must provide a reference to any model used. For example, indicate if nonlinear distortion is modelled using the Gaussian Non-linear model or the Extended Gaussian Non-linear model, or differently.

+2 points are awarded if Tenderer can prove that the simulated system margin results are accurate within 2dB.

+3 points are awarded if Tenderer can prove that the simulated system margin results are accurate within 1dB.

Tenderer must indicate the limitations of the validity of the tool.

MR 38: Modelling and simulation - provisioning

The tool must calculate, during simulation runs, network provisioning parameters, which have not been manually specified. The provisioning parameters minimally include: amplifier gain, maximum

channel amplifier output power, variable optical attenuators, pads or fixed attenuators of simulated components, sub-systems and network elements.

AR 22: Modelling and simulation – usability

(Max 3 points)

- *+1 point is awarded if the planning and simulation tool is capable of optimizing network provisioning parameters. Please show how this optimization takes place.*
- *+1 point is awarded if the network-planning and simulation tool of Tenderer is capable of extracting a network model from a real network. Tenderer must explain which information is extracted and how this is used to create the network model. Tenderer must show which information must be added by SURFnet and how this is used to create the network model.*
- *+1 point is awarded if the tool is capable of reporting a Bill of Material (BoM) and installation diagrams.*

6.11 Methods and procedures

MR 39: Methods and procedures

All methods and procedures to commission, decommission, insert, remove, replace, and change, equipment and nodes in the network, must be made available by Partner if requested. The selected Partner must also provide any method and procedure needed to upgrade, downgrade, add updates, and remove updates of the software on any equipment and nodes in the network. The selected Partner must provide methods and procedures to reset, restore factory setting, and wipe information of equipment and nodes.

6.12 Equipment configuration and practice

MR 40: Size and volume of the photonic equipment

The equipment as proposed by the solution of the Tenderer must be 19" wide and smaller than 14HU (Height Units of 1.75 inch) per line-fiber in case the equipment has a depth equal to or less than 300mm. In case the equipment has a depth larger than 300mm the solution per direction must not consume more than 8HU. Equipment must not exceed a depth of 600mm.

MR 41: Size and volume of the transponder equipment (1)

The equipment as proposed for the solution of the Tenderer must be 19" wide and smaller than 14HU (Height Units of 1.75 inch) in case the equipment has a depth equal to or less than 300mm. In case the equipment has a depth larger than 300mm the solution per direction must not consume more than 8HU. Equipment must not exceed a depth of 600mm.

MR 42: Size and volume of the transponder equipment (2)

In addition to MR 41, Tenderer must also provide a solution for a small transponder shelf, which must be 19" wide and smaller than 8 HU (Height Units of 1.75 inch) and must be able to house a minimum of two transponders of the same type as deployed in MR 41. Equipment must not exceed a depth of 600mm.

AR 23: Combining photonic and transponder equipment

The Tenderer may combine photonic and transponder equipment into a single chassis used for either transponder or photonic equipment as long as this does not create SPoFs.

+2 points will be awarded if Tenderer shows that such a scenario improves rack and chassis utilization and saves on common equipment such as processor and control boards. Taking into account the minimum requirements on resilience outlined in Section 6.4.

MR 43: Installation related materials must be included

Tenderer must include in its offer all Installation Related Materials. SURFnet considers the following items as Installation Related Materials:

- Patch cords to the ODFs of SURFnet normal connectivity to customers and line fibers: (SC/PC, LC/PC, SC/APC, E2000/APC)
- Optical Attenuators.
- Labels and label kits (excl. fiber labels).
- Power cables (-48V DC / 230V AC)
- Patch cords for internal optical connections (including connections that must be made to allow future expansion and extension without service interruption).
- Miscellaneous cables for (but not limited to) inventory management, craft terminals.
- Fiber management components, such as trays and ODFs

MR 44: Power connections

The solution of Tenderer must be able to be powered from -48V DC (resistant to -36V DC to -60V DC) using an A and B-feed and must be able to be powered from a single phase 230V AC (resistant to 208V AC to 240V AC) source also using an A and B feed. Tenderer must use a standard IEC 60320-1 10A or 16A connectors for 230V AC. For -48V DC Tenderer must use a power connection commonly used in the telecommunication sector. In case 230V AC or -48V DC is not supported Tenderer must include a power converter per node of sufficient rating. The equipment provided by Tenderer must survive -48V polarity reversal.

MR 45: Grounding

The chassis (photonic and/or transponder) must be grounded to the rack. The rack is grounded by a grounding wire of at least 16mm² thick and at most 1m long.

MR 46: Temperature

The solution proposed by Tenderer must operate in an environment with temperatures ranging from +5°C to +40°C with an average between 20°C and 26°C.

MR 47: Humidity

The solution proposed by Tenderer must operate in an environment with a humidity between 20% and 80%, non-condensation.

MR 48: Fans and cooling

The solution of the Tenderer must support placement in cold/warm corridors. To this end venting in- and outlet directions must be configurable irrespective of the depth of the equipment.

In case this results in not being able to place equipment back-to-back (2x300mm in a 600mm shelf) Tenderer must add a 100KEuro penalty to the TCO model (Annex D).

MR 49: Fan and dust-filter replacement

It must be possible for field engineers to replace failed fans and dust filters in-service. If fans are placed in power supplies or rectifiers, the power supply or rectifier must be replaceable in-service.

6.13 Type I DWDM interfaces

The photonic layer of SURFnet8 will use a transponder layer in its core network for transporting traffic between Type A and Type B node combinations. In case service platforms are not capable of supporting a DWDM interface (e.g. a Type II SURFnet-internal Alien Wave) SURFnet will also deploy transponders between Type A, B, C, and D combinations.

The photonic layer of SURFnet8 will also use DWDM pluggable modules and DWDM blades fitted into service platforms which are part of the aggregation network found in the access layer.

MR 50: DWDM interfaces residing on transponders owned by SURFnet

Tenderer must offer a 100Gb/s coherent-detection transponder-based solutions for 100GbE transport in the core network and the access network. Tenderer takes into account that a 100GbE transponder solution in the access network (Node Types C, D, E) could be of lower complexity compared to a 100GbE transponder solution in the core network (Node Types A, B, C) to optimize TCO. Transponders must be capable of compensating PMD, CD, and ASE (OSNR), and ROADM filtering impairments. Tenderer specifies modulation format and symbol rate. The required spectrum must fit the 50GHz ITU-T grid.

MR 51: DWDM interfaces residing on transponders owned by SURFnet for long-haul cross-border transport

Tenderer must offer a 100Gb/s coherent transponder-based solution for 100GbE long-haul transport across SURFnet cross-border fibers. The transponder must be capable of being deployed on links exceeding the 2000km SMF composed of 80km EDFA amplified spans and passing a minimum of 4 ROADM nodes. Transponders must be capable of compensating PMD, CD, and ASE (OSNR), and ROADM filtering impairments. Tenderer specifies modulation format and symbol rate. The required spectrum must fit the 50GHz ITU-T grid.

MR 52: Single-blade transponders

Both the DWDM line-side transceiver and the corresponding client-side transceiver must be implemented on a single blade.

AR 24: Single-blade transponders

+2 points are awarded for Tenderers which are capable of integrating two or more DWDM and two or more client interfaces on a single blade provided that the DWDM interfaces are hot swappable as pluggable modules or as mezzanine boards. This capability must be available one year after contract signing.

MR 53: Client Interface types on 100Gb/s coherent DWDM line card

Tenderer's portfolio for the Type I 100G coherent DWDM interface solutions must contain solutions for transporting one 100GbE client signal, ten 10GbE client signals, and one or more 40GbE client signals. The 10GbE and 40GbE client ports are allowed to be implemented on a separate client interface card. 100GbE client ports shall be implemented on the same line card as the DWDM line-side transceiver as specified in MR 52. The maximum frame size of the client data is minimally 9200bytes. Tenderer specifies the maximum frame size supported.

AR 25: Beyond 100Gb/s coherent DWDM interface capacity

+2 points are awarded for Tenderers that support a Type I DWDM interface solution of 200Gb/s or 400Gb/s or higher, capable of transporting all data in multiple 100GbE client signals. Tenderer specifies the super-channel structure (if applicable) including modulation formats and symbol rates and required spectrum.

MR 54: 100Gb/s coherent DWDM interface performance

Tenderer's proposed solution for the 100G DWDM coherent interfaces must be capable of error free (Post-FEC BER less than 10^{-15}) transport between any two Type A or Type B nodes in the network via two geographically diverse paths.

MR 55: Portfolio includes 100G, 40G, and 10G client interface types.

The portfolio of 100G transponder cards must offer at least at the client side:

- 100GBASE-SR10
- 100GBASE-LR10
- 40GBASE-SR4
- 40GBASE-LR4
- 10GBASE-SR
- 10GBASE-LR

Vendor is to describe if 40GBASE-SR4 and 100GBASE-SR10 modules support 10GBASE-SR 10GbE break out per 10G lane.

AR 26: Portfolio includes 100GBASE-CWDM4 and 100GBASE-SR4 client interface types on a QSFP28 form factor

Max +2 points are awarded if Tenderer supports the 100GBASE-CWDM4 (+1 point) and/or 100GBASE-SR4 (+1 point) QSFP-28 form factor.

MR 56: Transponder remote client port status replication and loopback mode

Tenderer's transponder solution must replicate the local client port status to the remote client port to signal and must support loopback mode on client and DWDM port.

AR 27: Network analyzer support on transponder blade

(max 3 points) Tenderer can earn +2 points by showing that the solution offered by Tenderer has the capability to performing a BER test on the DWDM line using the transponder blade. Tenderer can earn +1 point if this test can be performed bi-directionally using remote loopback mode on the remote DWDM port or remote client port.

6.14 RAMAN amplification

Although SURFnet aims to avoid RAMAN amplification as much as possible, a solution must exist in case OSNR requirements force deployment of RAMAN amplification.

MR 57: RAMAN amplification medium length

Tenderer must provide a 1st order counter-propagating RAMAN amplifier solution for spans between 80km and 120km. The solution must be compatible with the SURFnet fiber infrastructure, where an E2000PS(4) connector replacement on the ODF is allowed. Tenderer must explain that its solution has appropriate safety measures.

AR 28: RAMAN amplification medium length

A maximum of +2 points is awarded for RAMAN solutions, which meet:

- High on-off gain (higher is better) SURFnet will evaluate the total pump power as on-off gain is fiber type dependent. SURFnet believes a minimum total pump power of 850mW is needed. (+1 point)*
- Ability to flatten gain on a per span basis, more pump lasers with output power control on different wavelength is better. SURFnet believes a minimum of four pump lasers is required. (+1 point)*

MR 58: RAMAN amplification sub-marine length (up to 240km)

Tenderer must provide a 3rd order RAMAN amplifier solution for spans between 120km and 240km. The solution must support two high-power E2000PS(4) connector transitions at the ODF of the dark fiber supplier and at the ODF of SURFnet. Tenderer must explain that its solution has appropriate safety measures.

AR 29: RAMAN amplification sub-marine length (up to 240km)

A maximum of +2 points is awarded for RAMAN solutions, which meet:

- Achieved on-off gain (higher is better) SURFnet will evaluate the total pump power as on-off gain is fiber type dependent. SURFnet believes a minimum total pump power of 3000mW is needed as well as a seed laser of sufficient power to exploit the pump power. (+1 point)*
- Insertion losses in Rx and Tx path between EDFA pre- and post-amplifier and the line fiber connectors of the RAMAN module must be less than 3dB for the Rx path and 1dB for the Tx path, respectively. (+1 point)*

6.15 Maintenance and support

MR 59: Spares and supplies

SURFnet will stock its own spares. Assume for the spares calculation of the TCO that SURFnet maintains one warehouse and uses an MTTR value of 8 hours.

MR 60: Return and replace

The cost associated with Return and Repair or Replace shall be included in the maintenance and support cost of the optical network.

MR 61: Delivery of hardware and software within 8 weeks after ordered

Delivery of hardware and software of production available components shall be within 8 weeks after placement of purchase order.

MR 62: Pre- and post-sales design activities

The cost associated with pre- and post-sales activities, including but not limited to high-level design activities as part of the migration, introduction of new equipment and features in the future, and complex network changes, shall be included in the maintenance and support cost of the optical network.

MR 63: Maintenance and support cost

Maintenance and support cost is calculated on the installed base hardware of the network only. Hardware on stock shall not be included. For the first year the maintenance and support cost is part of the guarantee, and shall be zero. Furthermore, a fixed percentage of the hardware cost must be used, to ensure that a predictable maintenance and support cost can be expected when the network differs from the reference model as detailed in the TCO model (Annex D).

MR 64: Maintenance and support SLA

The Tenderer must propose an SLA, which includes all items as specified in Annex E.

MR 65: Tenderer provides training sessions

Within 2 months after the contract has been signed, Tenderer must organize training sessions to start transferring knowledge to SURFnet's staff and her outsourced staff, covering all relevant topics. The training session takes place at SURFnet HQ with remote laboratory/test environment per two participants as a bare minimum, to be provided by tenderer. After one year or completion of Phase A, Tenderer will organize a second and similar training session at SURFnet HQ.

Tenderer must add two training sessions for a maximum of 12 persons in the TCO calculation in Annex D.

Upon request by SURFnet Tenderer offers training sessions for current staff and staff to be hired in the future, and outsourced personnel. Tenderer will give on-site instruction-led courses with remote laboratory/test environment within three months after a request has been made. For groups of three persons or smaller Tenderer will arrange access to a class-room as Tenderer sees fit.

6.16 Society, environment and (worker) safety

SURFnet adheres much value to solutions that are environmentally sound and do not pose danger to workers.

MR 66: Safety

The solution proposed by Tenderer must be a solution that is safe for workers to transport, store, install, operate, uninstall and remove equipment. If additional measures are needed to comply with Dutch and European laws, Tenderer will add the cost of those additional measures to the TCO-model.

MR 67: Environment

All equipment proposed by Tenderer must comply with Dutch and European environmental laws and obligatory guidelines and directions (RoHS6 is an example). In case these laws become stricter, Partner is required to offer a substitute (with the same set of requirements and performance) for the solution or any part of subsystem at the same or less cost as the discontinued solution.

AR 30: Removal of equipment

Tenderer must incorporate a solution to discard old and obsolete equipment from SURFnet's network and dispose of the equipment in a socially responsible and environmental friendly fashion. Tenderer describes this service and specifies an optional fee for this service. SURFnet prefers solutions that are durable, can be recycled and fit in frameworks, such as People-Planet-Profit and Cradle-to-Cradle. +1 point is awarded for solutions that comply with SURFnet's e-waste policy (see <https://www.surf.nl/binaries/content/assets/surf/en/2014/surfnet-ewastepolicy.pdf>).

MR 68: Social responsibility

Tenderer certifies that all equipment, software and services offered have not been realized and will not be realized using child labour, slavery, or applying any other form of repression, abuse, and exploitation to any individual or group of individuals.

6.17 Innovation

MR 69: Setup of a test bed

After contract signing, the selected Partner will provide a testbed for the purposes of training, testing of procedures and operational activities, and for testing and innovation of new features. The testbed will be under control of SURFnet and placed at a SURFnet location (or a location of SURFnet's choice, for example at a contractor of SURFnet or at a co-location site) within the Netherlands. SURFnet will determine the size and configuration using pricing and applicable discounts as per contract. The testbed must contain all functional features as present in the production network.

AR 31: Innovation program

Tenderer is to outline a collaborative innovation program on research topics Tenderer considers relevant to SURFnet and her customers and which lines up with research topics of Tenderer.

In this outline Tenderer is encouraged to include activities that may involve Dutch research institutions, such as (but not limited to) the Eindhoven University of Technology Electro-Optical Communications Research Group, The Informatics Institute of The University of Amsterdam, Delft University of Technology, and The Netherlands Institute for Radio Astronomy and may also include National Research and Education Network operators of different countries and GEANT.

Related to this Tender the following fields of innovation are of interest to SURFnet (not exhaustive):

- *Network robustness and survivability*
- *Photonic services: for example, Time and Frequency Transfer & Quantum Transport*
- *High-spectral efficient transport: Optical transport beyond the non-linear Shannon limit.*
- *Future of optical fiber: Reusing existing fiber or Deploying e.g. few mode fiber and multi-core fiber.*

- *Monitoring of Type II and III waves and fiber infrastructure.*
- *Network automation and orchestration*

Please describe in your proposal how you would implement such activities, e.g. a joint research activity, participation in a European research project, or support of a student's master thesis or Ph.D., etc.

A maximum of +3 points are awarded to those offering a program, based on:

- *The relevance, and expected impact of the proposed activities,*
- *The clarity and solidity of this part of the proposal,*
- *The degree to which the proposal demonstrates that the research topics proposed line up with both SURFnet and Tenderer's activities.*

6.18 Software and licenses

This section touches on software and license cost. Any cost related to a Right to Use (RTU) are considered a type of license and are therefore included in license fees.

MR 70: All necessary software must be included

All software (including software interfaces (APIs)) for planning, performance monitoring, troubleshooting, fault detection, provisioning, security and accounting, automation, and programmability must be included in the offer.

MR 71: All licenses must be included

All necessary licenses to operate the equipment, software, network management, etc. like described by the TCO model (Annex D) must be included in the offer.

The licenses must have a lifetime of at least 15 years. Licenses must be transferable to other equipment and services.

MR 72: Upgrade and update cost is for free

Upgrade and update cost for acquiring and deploying the latest available Software and Firmware for any purchased optical equipment, transponders, NMS, optical simulation and planning tools, and control plane or other software must be free of charge.

AR 32: Software alignment structure and dependencies

Please explain the software alignment structure and dependencies between NMS, optical components and release schedule.

+1 point is awarded if the NMS is backwards compatible to a minimum of two major releases of the software of the transponder and photonic platforms.

+1 point is awarded if the NMS can be updated with a configuration file to allow support for new hardware components in the transponder and photonic platforms. The support provided on this shall be in scope with the existing software release of the NMS.

6.19 Implementation and migration plan

This section touches on a migration scenario to phase out the old SURFnet7 photonic equipment and insert the photonic equipment proposed by Tenderer. In order to minimize complexity and

reduce the impact on the service platforms, SURFnet has decided to decouple the migration of the photonic layer from the introduction of a new service layer. This section only covers migration of the core DWDM photonic core network as this is the most difficult and complex part of the optical transport layer.

Migration solution outline:

Figure 6-1 displays how in SURFnet7 10Gb/s DWDM waves from the service platforms are transported over Branch A of the photonic layer. Site-1 and Site-4 are 3-degree and 4-degree ROADM sites and connect branches B and C and D, E, and F to Branch A, respectively. In this simplified example it can be observed that waves can not only add and drop but also transit (pass-through), enter and drop, and add and leave a branch.

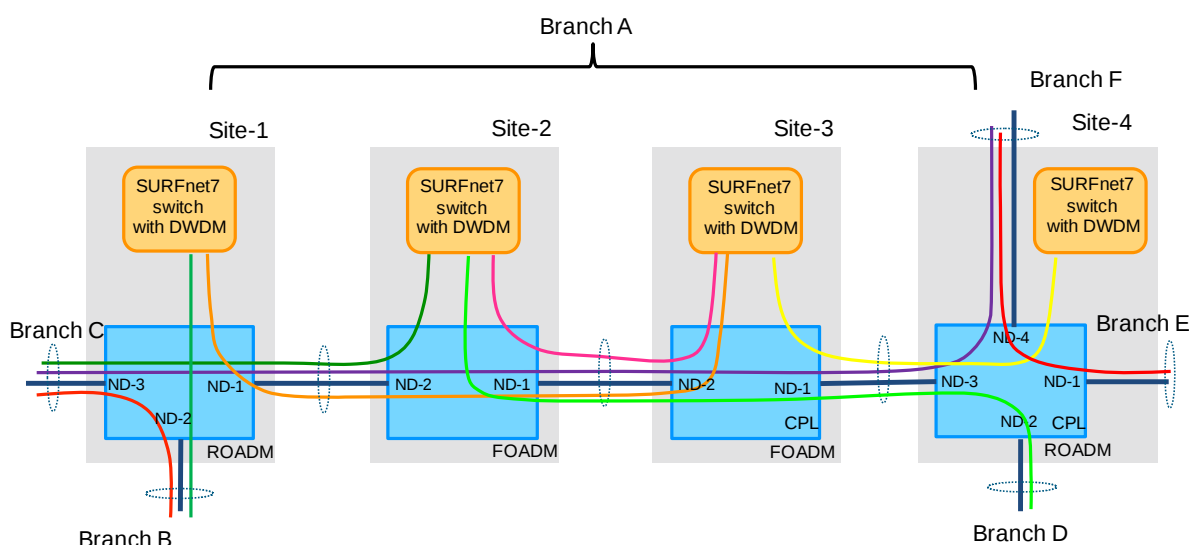


Figure 6-1 Simplified example of SURFnet7 DWDM wave routes between SURFnet7 carrier Ethernet switches on Branch A. Some waves add and drop on the same Branch A. Waves may also transit or pass-through Branch A. Other waves arrive from a different branch and drop only on Branch A or add on Branch A and drop on a different branch.

As a first step SURFnet aims to isolate Branch A by forcing all waves transported by Branch A to originate/terminate on an add/drop mux mapped to a nodal degree (line-fiber-interface) belonging to the Branch A. This isolates Branch A. This can be observed in Figure 6-2 and requires Optical-Electrical-Optical regeneration on the SURFnet7 carrier Ethernet switches.

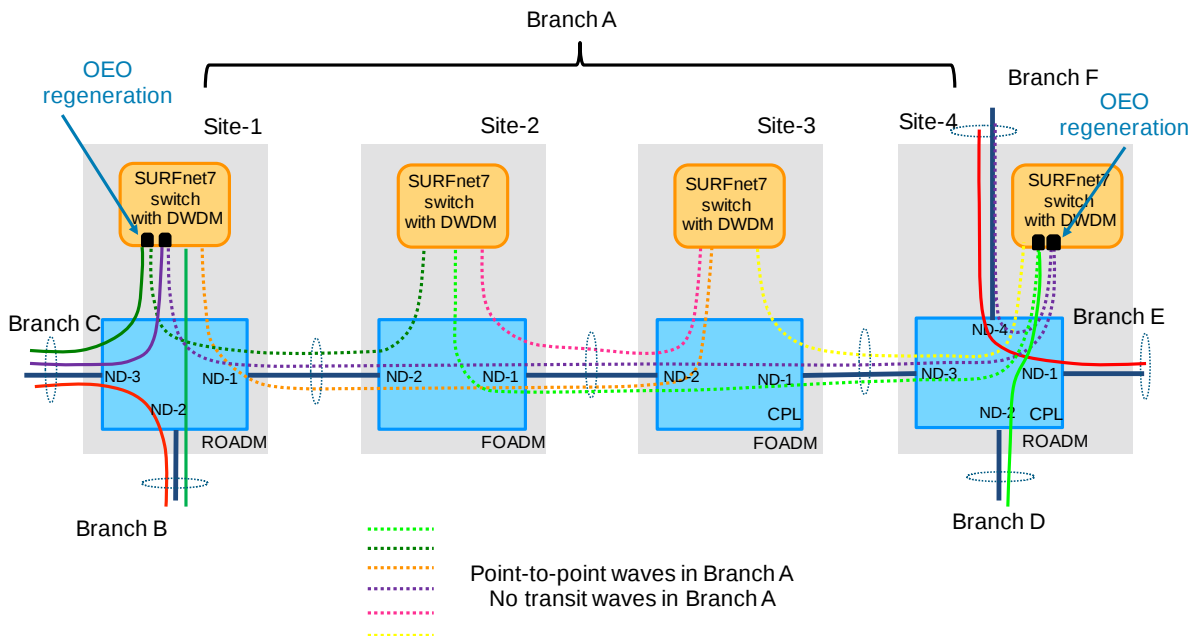


Figure 6-2 Branch A now only supports waves that are added and dropped on Branch A. This is achieved by implementing Optical-Electrical-Optical regeneration on the SURFnet7 carrier Ethernet switches. No waves enter or leave Branch A via a different branch.

A second step is to replace the photonic equipment of Branch A by the equipment proposed by Tenderer, Figure 6-3. This step may allow for the waves of Branch A to be changed in wavelength in order to fit the filtered add/drop facilities of the SURFnet8 photonic equipment. In addition, residual dispersion slope compensation might be required, but is limited to Branch A. DSCM modules of SURFnet7 can be reused. The actual migration of the equipment and transition of the waves onto the new equipment is done per span starting at site-1 or site-4.

Only until SURFnet8 service transition has been completed and SURFnet7 service platforms are free of traffic, temporarily installed equipment shall be removed. For the purpose of the TCO model Tenderer may assume that the SURFnet8 service transition will complete within 24 months after start of migration.

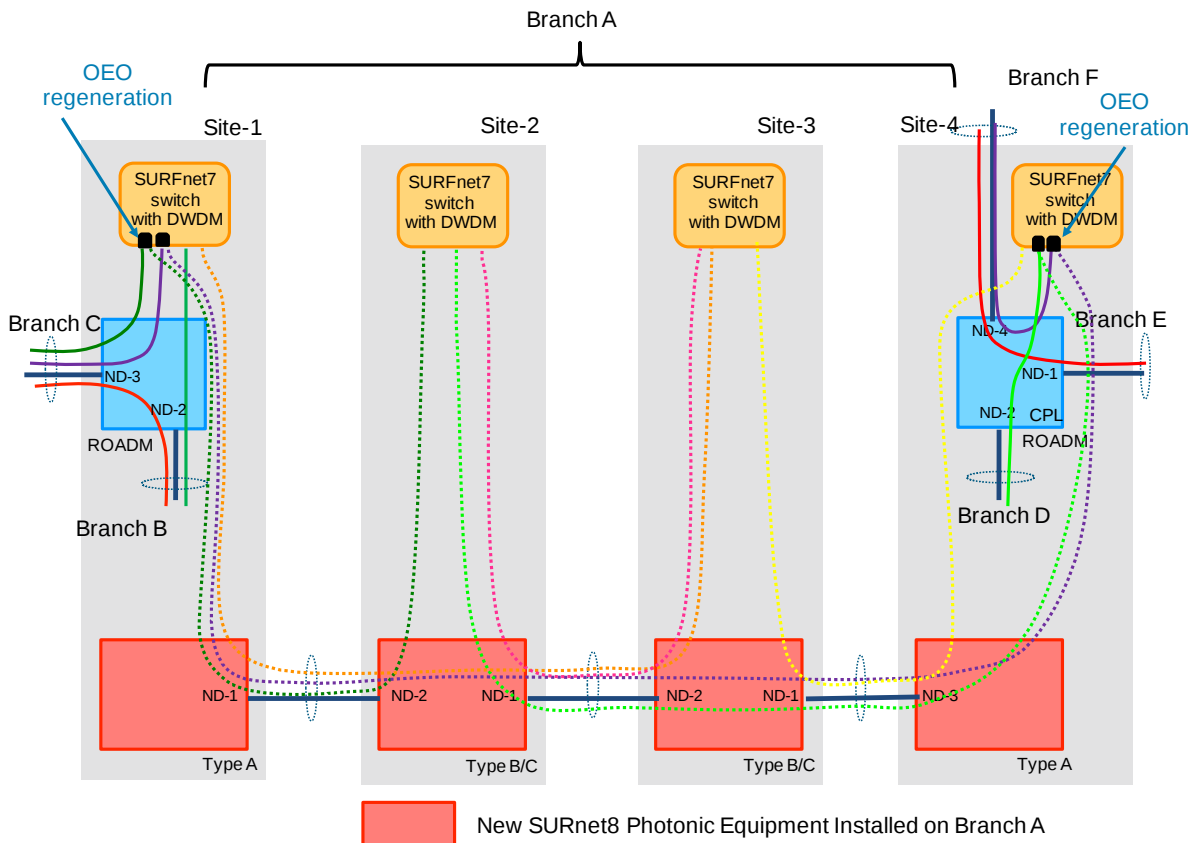


Figure 6-3 The new SURFnet8 photonic equipment replaces the existing CPL equipment one branch at a time.

MR 73: Migration scenario

Tenderer's offer must include a migration scenario from our existing Ciena CPL and DWDM layer to a new solution. Assume that no second fiber pair is available to be lit. The migration is thus a change on a live network. The migration scenario must support the full DWDM 10GbE ASK SURFnet7 migration onto the proposed solution as outlined above. If Tenderer cannot meet this requirement, then Tenderer must provide an alternative scenario, which is equivalent or superior to the scenario outlined below. SURFnet reserves the right to consider the alternative migration scenario as invalid, in case equivalence or superiority is not met on all of the following topics:

- Topology of the SURFnet7 waves must remain as is. OEO regeneration is allowed as long as this does not impact the L2 topology;
- Migration per span and per branch must be possible;
- Rate of migration must not be slower than one branch per week;
- Migration of a branch (max. 6 sites per branch) must be possible in one service window of 18 hours;
- Risks identified by Tenderer must be included, realistic and manageable;
- Cost of temporary required equipment must be specified in the TCO model in Annex D. Tenderer may assume for Type A nodes 16 10Gb/s waves per nodal degree, for Type B nodes 6 waves per nodal degree, and for Type C nodes 3 waves per nodal degree.

MR 74: Field service support for migration

Tenderer offers field service support for the successful migration of at least three branches. Tenderer offers remote support during field service activity during the entire migration. Cost of remote and field service support must be included in the TCO model of Annex D.

6.20 Roadmap, lifecycle, exit and migration

MR 75: Roadmap

Tenderer must provide a global roadmap up till 1st of July 2017 of all planned features, equipment, software, of the proposed product lines and software tools. The roadmap must indicate the planned GA date and committed GA date of any planned features, equipment, and software.

MR 76: Lifecycle

Tenderer must explain the process when a product, product line, feature, software tool, or any other item part of the SURFnet8 solution changes its general availability status. Tender must commit to continue sale of all components used in the TCO model (Annex D) during a minimum duration of 5 years. Deviation of this requirement is only allowed in agreement with SURFnet; a one for one replacement can be discussed.

Support (including, but not limited to, repair, software upgrades, and bug fixes) must continue at least four years after the End-of-Life announcement.

MR 77: Exit and migration

In a future replacement of the photonic layer, Tenderer agrees that during the transition period to a new solution the use of the existing network for the purpose of transitioning will be free of RTUs and licenses.

7 Financial

MR 78: Pricelist

Tenderer must specify the prices of all equipment. Prices should be realistic and in accordance with market prices (see also draft agreement). Also, prices offered must not be negative. Any pricing structure or method which manipulates the model or TCO calculation is not allowed.

MR 79: Total cost of ownership

The TCO must be calculated for a period of 10 years starting 1st of January 2017 and must include:

- Price in Euros, Excl. Dutch or EU VAT, but including all applicable foreign tax and transport costs.*
- Differentiation between non-recurring cost and recurring cost.*
- No one-time discount*
- All recurring cost shall be included in the maintenance and support cost.*
- Sufficient Spare Parts, for SURFnet to place on stock. See MR 59*
- Removal of equipment penalty as specified in AR 30*
- Cold-warm back to back penalty as specified in MR 48*
- Maintenance and Support cost. See Section 6.15*
- NMS and Control planes. See Sections 6.9 and 6.10*
- Training. See MR 65*
- Network Planning, Modelling, and Simulation tooling. See Section 6.10*
- All migration related costs needed for the migration of the photonic layer. Tenderer is allowed to lease or lend migration related equipment and resources which are not part of the final solution. Tenderer must clearly indicate such equipment. See MR 73*
- Installation Related Material. See MR 43*

Tenderer is aware that in the TCO model the following costs can be ignored:

- Cost of power consumption*
- Cost of rack and rack space, except for the cold-warm back to back penalty as specified in MR 48*

The TCO model will calculate the net present value of the M&S cost, using a 5% discount factor per year.

AR 33: TCO calculation

Please provide the pricing elements for the described network reference models below (Tenderer must use the format in Annex D).

Include a detailed priced kit list per location and supply a network description to highlight the main features of your solution. The cost shall include all HW cost, IRM, SW licenses, maintenance cost for the duration of 10 years as outlined in MR 79. The proposed solution shall comply to all Minimal Requirements as set out in this document, and shall contain solutions as proposed in all Awarding Requirements, but do not have to include the solutions as described in AR 1, AR 4, AR 8, AR 10, AR 19.

- 1. Core network DWDM*

- a. Phase A
- b. Phase B
2. Access ring 1 Model 1 - CWDM only
3. Access ring 1 Model 2 - CWDM & DWDM
4. Access ring 2 Model 3 - CWDM only
5. Access ring 2 Model 1 - CWDM & DWDM
6. Access ring 2 Model 2 - DWDM amplified

Awarding of points for TCO:

- Tenderer with lowest TCO will receive 80 points.
- Tenderers with a TCO above twice the lowest TCO will receive zero points
- Tenderers with a TCO between the lowest TCO and twice the lowest TCO will receive between 0 and 80 points, according to the following calculation:

$$\text{Points} = 80 - 80 * \frac{TCO - TCO_{\text{lowest}}}{TCO_{\text{lowest}}}$$

Network reference models for TCO calculation:

Core network DWDM

1. For the core network SURFnet would like to understand the cost impact of replacing its entire core network with the proposed solution by Tenderer. This is Phase A. In addition, the cost impact of a Phase B upgrade must be specified.

Tenderer is requested to provide per site the costs for implementing its proposed solution by considering for Phase A:

Photonic Transport Network including a 100G coherent transponder layer, which provides ca. 75% (114 transponders) of the bandwidth as outlined in attached Excel document as detailed in Annex D.

The remaining ca. 25% of the bandwidth will be implemented by DWDM interfaces residing on Service Platforms (42 interfaces).

For Phase B Tenderer is to add:

- 10x the total upgrade cost of a 2D CD OADM node (Type B) to a 3D CD OADM node (Type A)
- 40 times a 100G Transponder (line-side and client-side)
- 5x first-order RAMAN solution for medium distance span.
- 1x third-order RAMAN solution for long distance span.

The following boundary conditions apply:

- The reach of the line-side coherent transponder interface must be in agreement with the fiber transmission distance objective, including cases where restoration applies and including non-fiber related losses or filtering.

- *The client interfaces of the transponders must be either 100GBASE-SR10 or 100GBASE-SR4. Tender is to supply the prices for 100GBASE-LR4 and 100GBASE-CWDM4.*

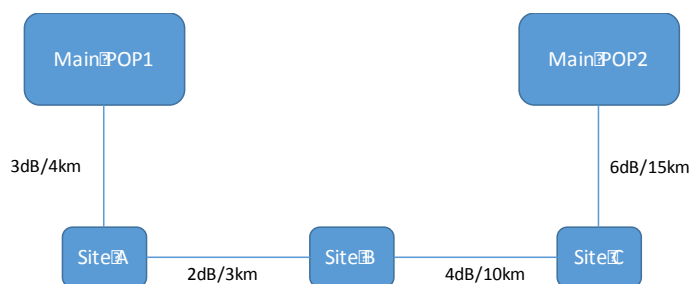
Access ring network models

The access-ring network models use two access ring reference models. One with short distances and low fiber loss (Figure 7-1); this model requires only unamplified (passive) filter techniques. The second access ring model (Figure 7-2) is representing a larger access ring for which an amplified DWDM solution may be cost effective.

For each access ring model SURFnet would like to understand the cost impact of adding 100G to CWDM rings.

The following boundary conditions apply:

- *10G and 100G demands are destined to both Main POP1 and Main POP2*
- *CWDM and DWDM filters are supplied by the Tenderer.*
- *100G DWDM channels are supplied by the Tenderer, it may be assumed that the core location has available slot capacity in the transponder chassis.*
- *Passive access-rings must be exempt from alien-wave licenses.*
- *10G CWDM/DWDM optics are supplied by SURFnet, and have an optical budget of 22dB. The cost of the 10G C/DWDM optics may be assumed nihil.*
- *Optical link engineering for both the 10G and 100G channels must be met for EOL of 10years. The link loss values include the ODF loss.*
- *Regeneration locations of 10G CWDM channels need to be specified*
- *Amplified DWDM access ring models must be compatible with the Core DWDM network, such that channels from the access ring can be optical routed to non-adjacent Core nodes.*
- *The DWDM node must be of Type C and therefore of the same product line as used in the core network*
- *One fiber pair is available per access ring*
- *Any 10G or 100G demand consumes a separate wavelength, thus no daisy chaining of the wavelengths is possible. If regeneration is needed, it requires a dedicated set of transponder cards at the regeneration site.*
- *The client interfaces of the 100G transponders must be either 100GBASE-SR10 or 100GBASE-SR4.*



Access Ring	Model 1	Model 2
	CWDM only	CWDM with DWDM at Site A & B
Site A	10G	100G
Site B	10G	100G
Site C	10G	10G

Figure 7-1 Topology of access ring 1

2. Access Ring 1 Model 1 - CWDM only

Straightforward access ring with 10G waves using a single fiber pair with CWDM filters. The node type of sites Main POP1, A, B, C, and Main POP2 shall be node Type E. Optical budget of the 10G optics is sufficient to terminate the 10G waves without regeneration at the Main POP locations. In the TCO this model is to be multiplied ten times.

3. Access Ring 1 Model 2 - CWDM & DWDM

Two sites within Access Ring 1 have been upgraded to 100G (Site A and Site B). The node type of sites Main POP1, A, B, and Main POP2 shall be node Type D. The 100G waves are terminated at Main POP1 and Main POP2, without intermediate regeneration. In the TCO this model is to be multiplied ten times.

4. Access Ring 2 Model 1 - CWDM only

Similar network model like Access ring1 CWDM only, but for longer fiber spans. The node type of sites Main POP1, A, B, C, and Main POP2 shall be node Type E. It will require 10G regeneration, as the optical budget of 22dB will not be sufficient for at least the link Site A – Main POP2. If more regeneration is required, please explain where and add the correct number of CWDM filters. In the TCO this model is to be multiplied ten times.

5. Access Ring 2 Model 2 - CWDM & DWDM

In this model two sites have been upgraded to 100G nodes. This solution should only use regeneration as a way to overcome link engineering challenges. The node type of sites Main POP1, A, B, and Main POP2 shall be node Type D. If this model is more expensive than the "Access Ring 2 Model 3 - DWDM amplified" access ring solution, the price shall be ignored and replaced with the price of "Access ring 2 Model 3 - DWDM Amplified". In the TCO this model is to be multiplied ten times.

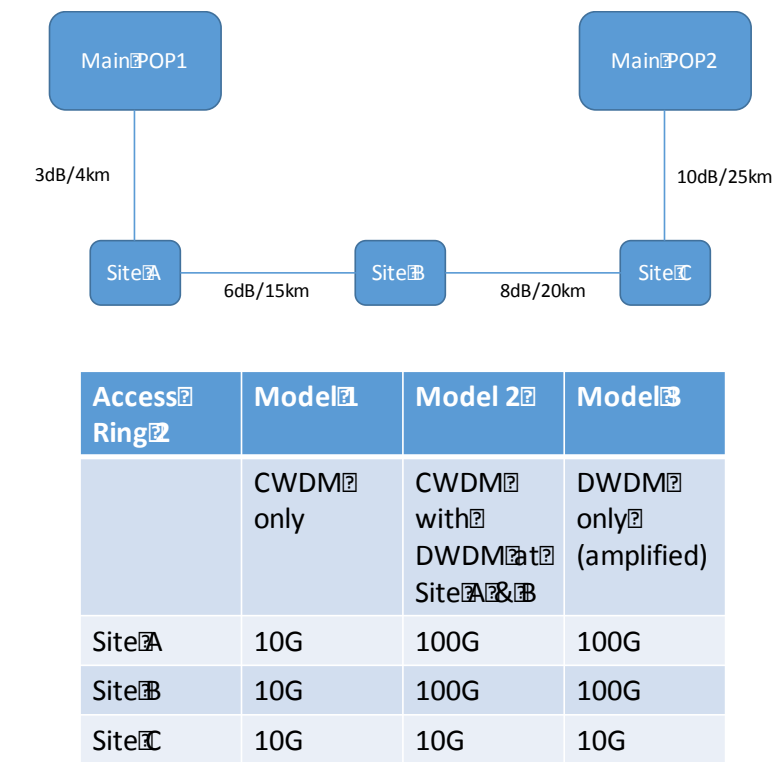


Figure 7-2 Topology of Access Ring 2

6. Access Ring 2 Model 3 - DWDM amplified

In this access ring model, all CWDM filters have been replaced by DWDM components and no re-generation is allowed. The node type of sites Main POP1, A, B, C, and Main POP2 shall be node Type C. Optical link budget challenges are to overcome by the use of amplification. In the TCO this model is to be multiplied five times.

8 Contractual requirements

MR 80: Compliance to contract

Tenderer agrees with the final version of the model contract as supplied in Annex F, including any modifications communicated during the Questions and Answers process.

MR 81: Service Level Agreement

Tenderer offers a service level agreement that is in line with or better than the minimal requirements in this document, the SLA-requirements as provided in Annex E, and the responses to the Awarding Requirements in Tenderer's Proposal.

Annex A. Checklist for the submission of Proposals

Tenderer is required to submit their Proposal according to the format below. Where requested in the Proposal, Tenderer must make use of the prescribed formats (Annexes) for delivery of requested information and re-label these accordingly. In cases where supplemental documents are requested in the Proposal and/or the Annexes, Tenderer should add these.

Document	Title	Checkbox
	Cover letter	☐
Annex A	Checklist for the submission of Proposals	☐
Annex B	Self-declaration form	☐
Annex C	Technical and professional ability	☐
Annex D	TCO core model and TCO input form	☐
Annex E	Service Level Agreement Requirements	☐
Annex F	Draft agreement	☐
Annex G	MR and AR input form	☐

Annex B. Self-declaration form

This document has been added separately to this Request for Proposals in the form of file 'Annex_B_Self_declaration_form'. The completed form forms an integral part of your Proposal.

Annex C. Technical and professional ability

Tenderer must use this format for each reference. It is added to this Request for Proposals as file 'Annex_C_Technical_professional_ability'. The completed form(s) form an integral part of your Proposal.

Reference no.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Name of organization:					
Country:					
Details of contact person	Name:				
	Function:				
	Tele-phone:				
Core competences					
Please indicate which of the core competences as stated in 5.3.2 are fulfilled through this reference					
☐ 1. Supply and integrate a Photonic DWDM Transport Network containing at least 25 nodes or extend such a network with at least 10 nodes					
☐ 2. Play an active role in the research and standardization community on photonic transport and optical communication.					
☐ 3. Supply and integrate a photonic DWDM transport network with an active L0/L1 control plane.					
Short description of the project					
Please describe below how the core competence(s) is (are) fulfilled through this reference, thereby elaborating on the specifications of a single core competence as described in the third column of Table 1 of Subsection 5.3.2 .					

Annex D. TCO core model and TCO input form

These documents in the form of Excel files 'Annex_D_TCO_core_model' and 'Annex_D-TCO_input_form' have been added separately to this Request for Proposals. Please use the input form to complete the TCO model calculation. The completed input form forms an integral part of your Proposal.

Annex E. Service Level Agreement Requirements

This document has been added separately as file 'Annex_E_SLA_requirements' to this Request for Proposals. Your proposed SLA forms an integral part of your Proposal.

Annex F. Draft agreement

This document has been added separately as file 'Annex_F_Draft_agreement' to this Request for Proposals.

Annex G. MR and AR input form

This document has been added separately as file 'Annex_G_MR_AR_input_form' to this Request for Proposals. Please use this document to answers all MRs and ARs. The completed input form forms an integral part of your Proposal.