

Description of the international LOFAR station datatransport system

	Organisatie / Organization	Datum / Date
Auteur(s) / Author(s): D.H.P. Maat	ASTRON	
Controle / Checked:	ASTRON	
Goedkeuring / Approval: A. Gunst	ASTRON	
Autorisatie / Authorisation: Handtekening / Signature J. Reitsma	ASTRON	

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1 Introduction

1.1 Document scope and purpose

In this document the design of the E-LOFAR station datatransport system is given. In addition the operational and technical requirements for this system are described. E-LOFAR station is used throughout the rest of the document as synonym for an international LOFAR station.

1.2 Applicable documents (AD)

Ref.nr.	Document number	Title
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1.3 Reference documents (RD)

Ref.nr.	Document number	Title
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1.4 Abbreviations

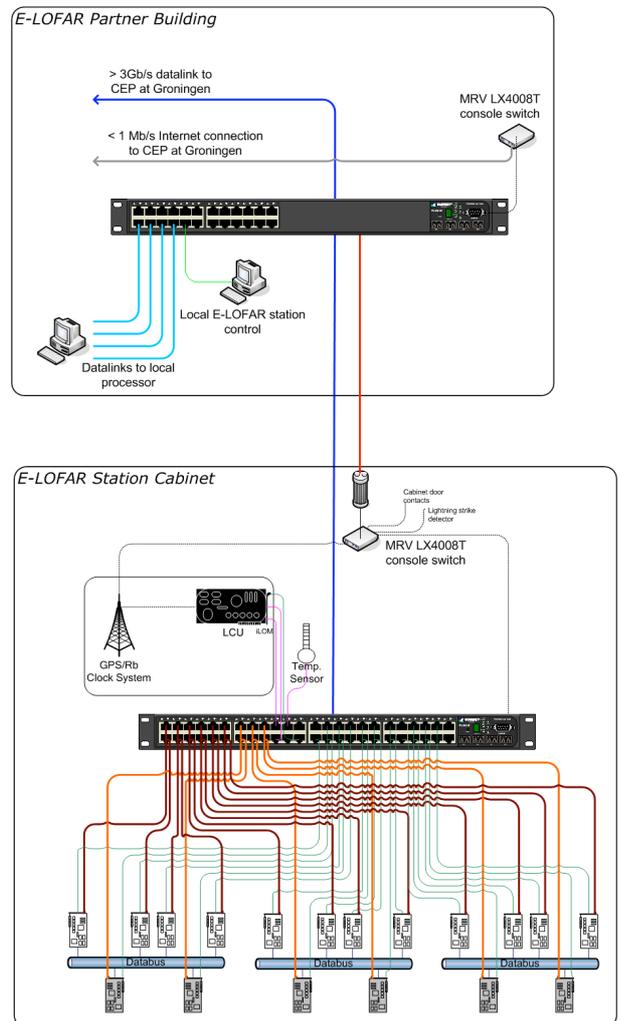
2 Station network design

The data network of an E-LOFAR station contains two switches. Switch1, a Foundry FastIron LS 648, is located inside the E-LOFAR cabinet. Switch2 is located at the E-LOFAR Partner institute. Switch1 is used as the communication node of the E-LOFAR station. It handles all internal traffic and aggregates all in and outgoing traffic of the station into a single 10GbE link. Via this link a connection is realized to Switch2, a Foundry FastIron LS 624. With the use of Switch2 the two operation modes of the E-LOFAR station are realised: in operational mode 1 all the RSP-board observation data that is produced by the E-LOFAR station is sent to the central processor at Groningen. In operational mode 2 this observation data is made available to the E-LOFAR partner by connecting the RSP-board VLAN to the E-LOFAR partner ports of Switch2. In this latter mode the E-LOFAR station acts as a stand alone station, whose data is available for the local E-LOFAR partner, via four GbE links., These four 1GbE links are accessible via four 1000BASE-T ports. In addition to the data connection, the E-LOFAR partner can also connect to the Local Control Unit (LCU) at the E-LOFAR station via its E-LOFAR partner ports. For this LCU link a local LCU VLAN is available.

To be capable of sending the data to the central processor, a 10GbE port of Switch2 must be connected to a 10GbE port of a dedicated link which connects a Switch2 10GbE port directly to CEP at Groningen. The dedicated link, which must have a bandwidth of at least 3 Gb/s, needs to be installed and maintained by the E-LOFAR partner. The optical 10GbE port of Switch2, with which the connection to the link to Groningen is realized, will be equipped with a 10GBASE-LX XFP. Since the entire LOFAR data transport network is based on 10Gb/s technology, the use of 10Gb/s lightpath technology for the link to Groningen is preferred.

In addition to the 10GbE data link between the two switches, a second link is present. This link connects a console switch at the E-LOFAR station to Switch2 via a media converter and a 100BASE-FX link. This network management link will be aggregated into the 10GbE link by Switch2, such that a connection to the network management system at Groningen is realized. Switch2 will be managed via a console switch at the partner building. For realizing a connection between this switch and CEP at Groningen a <1Mb/s Internet connection needs to be available. At the console switch a RJ-45 10/100Base-T port is available for realising this connection.

The communication equipment that will be delivered as part of the E-LOFAR station is summarized in Section 2.2. These items will be configured, controlled and maintained by ASTRON-LOFAR, with support of the E-LOFAR partner. The fiber-optic cable (and its terminations) between the E-LOFAR cabinet and the E-LOFAR partner building, that is used for connecting both E-LOFAR switches, must be designed, deployed and maintained by the E-LOFAR partner. This will be done in such a way that the mentioned 10GBASE-LX and 100BASE-FX based links will function according to their specifications.



2.1 Requirements for the fiber link between station and partner building

In this subsection the requirements for the two fiber pairs between the E-LOFAR cabinet and the patch panel at the Switch 2 location is given. The detail level in this specification is such that it can be used in the negotiations with the company that will deploy the cable. The given specification holds for a distance of less than 10km. In case a larger distance needs to be bridged, an adjusted specification and component list is needed, which also will be provided by ASTRON-LOFAR.

Requirements for the fiber cable

- The fibers in the cable must be of type G652-C or G652-D (IEC60793-2-50 B 1.3).
- The optical properties of the fibers must be according to the current common quality levels, both per kilometer as over its entire length.
- The optical loss of every fiber between the E-LOFAR station and the patchpanel at Switch2 must be below 4 dB in the wavelength window between 1310 nm and 1625 nm. This loss is measured between the adapters on the patchpanel at the E-LOFAR station and the patchpanel at the Switch2 location.
- The absolute chromatic dispersion in the O-band (1260 nm – 1360 nm) is less than 3,5 ps/nm.km.
- The chromatic dispersion in the C-band (1530 nm – 1565 nm) is less than 18 ps/nm.km.
- Low PMD levels (less than 0,5 ps/√km) are preferred.

Requirements for the patchpanel adapters and connectors

- The fibers between the E-LFOAR cabinet and the Switch2 location will be terminated on patchpanels with SC/PC adapters.
- The adapters and connectors in the link between the E-LOFAR cabinet and the Switch2 location must have a reflection level below -30 dB and must be specified for a optical loss of less than 0.5 dB.

Requirements for the splices

- Only fusion splices must be used. Glued or mechanical splices are not allowed.
- The maximum allowed optical loss over a single splice is 0.5 dB
- The average loss per splice must be less than 0.10 dB.

2.2 E-LOFAR station network components

The following items are part of the E-LOFAR station hardware:

- 1 x Foundry FastIron LS 648
- 1 x Foundry FastIron LS 624
- 3 x 10GBASE-LX XFPs
- 1 x 100BASE-FX SFP
- 2 x MRV Console Server
- 1 x MRV 10/100BaseTX to 100BASE-FX converter (SM, 1310nm, 0-35km, DSC)

2.3 Requirements for the link between the partner site and the central processor

For connecting the E-LOFAR station to the Central Processor (CEP) at Groningen, the E-LOFAR partner needs to provide a communication link with a 10GbE interface at both sides. This link has to transfer the data traffic to and from Switch2 with a bandwidth (per direction) of at least 3 Gb/s. This communication link will hold a number of data streams which are virtually separated with the use of VLANs. The E-LOFAR connection link must be a layer 2 link that supports:

- At least 3 Gb/s of bandwidth
- 10GbE interfaces at both sides
- VLAN tagging and QinQ in case of a VLAN conflict
- The transfer of VLANs whose numbering will be determined by ASTRON / LOFAR
- IPv4 and IPv6
- 9kB Jumboframes
- Packet routing based on MAC addresses
- TCP/IP

The E-LOFAR connection to CEP must be a dedicated link which transfers its data separated from the Internet. The most suitable technology for this is 10Gb/s lightpath technology that is a.o. supplied by many ISPs. The link has to comply with a number of availability, maintenance and security requirements which are described in Chapter 3.

3 Requirements for the partner systems

In addition to the E-LOFAR communication hardware mentioned in Section 2.2, the following items are needed for the E-LOFAR communication link:

- a fiber-optic cable between the E-LOFAR cabinet and the Switch2 location
- a communication link with a minimum bandwidth of 3 Gb/s, which connects a 10GBASE- LX port on the E-LOFAR routing switch to a 10GBASE- LX port on the lightpath switch at the central processor site at Groningen.
- a <1Mb/s Internet connection

All three items need to be provided by the E-LOFAR partner. Below, a number of requirements for the construction, availability, maintenance and security of this cable / link are given which have to be followed up by the E-LOFAR partner for a flawless operation.

1.	The fiber-optic cable between Switch1 and Switch2 must be terminated at both sides on a patch panel with SC/PC patch positions.
2.	This fiber-optic cable and its terminations are configured, constructed and maintained in such a way that the Switch1 and Switch2 can realize a 10GbE connection via that cable.
3.	The data connection between Switch2 and the lightpath/CEP switch should be transparent regarding transport of data to the CEP. In addition, the sequence of the data as produced by the station shall not be altered, first data bit produced by the station arrives first at CEP.
4.	The data connection between Switch2 and the lightpath/CEP switch may not alter the data packets as they are sent out by the E-LOFAR routing switch
5.	Small amounts of packet loss (<10 packets/s per station) in the data connection between Switch1 and the lightpath/CEP switch is only acceptable after consultation with ASTRON / LOFAR
6.	A high level of packet loss (>10 packets/s per station) in the data connection between Switch2 and the lightpath/CEP switch is not acceptable
7.	The data link between Switch2 and the lightpath/CEP switch may not have a delay larger than 100 ms.
8.	<p>The 10GbE stream from a E-LOFAR station contains the following sub-streams:</p> <ul style="list-style-type: none"> a. Observation with required bandwidth: 2.2 Gb/s b. Monitoring and Control with required bandwidth of 100 Mb/s c. Network control with required bandwidth of 10 Mb/s d. Transient Mode with a varying required bandwidth which is in the order of several Gb/s <p>Each stream will require its own VLAN. All mentioned streams will be needed in the final situation. Before upgrading at least item a, b and c need to be supported. An upgrade plan for the required bandwidth needs to be negotiated with each E-LOFAR partner.</p>
9.	Any maintenance to the fiber-optic cable between the Switch1 and Switch2 must be reported at least 1 week in advance. In case the announced maintenance does not concur with LOFAR scheduling the partner and LOFAR/ASTRON should agree a more suitable timeframe.
10.	Any maintenance to the data link between Switch2 and the lightpath/CEP switch at Groningen must be reported at least 1 week in advance. In case the announced maintenance does not concur with LOFAR scheduling the partner and LOFAR/ASTRON should agree a more suitable timeframe.
11.	In case of failure in the fibre-optic infrastructure between Switch1 and Switch2, a report must be created by the E-LOFAR partner. This report contains an incident and

	a repair plan which will be provided to ASTRON/LOFAR preferably within 3 hours after the failure has been detected. The repair plan informs ASTRON / LOFAR about the nature of the failure and the schedule for the repair. In case the problem exists for several days, ASTRON/LOFAR will be informed daily on the status of the repair.
12.	The hard- and software of Switch1 and Switch2 will be configured and maintained by ASTRON / LOFAR. The local E-LOFAR partner organization supplies assistance in this configuration and maintenance task.
13.	In case of failure of the active equipment and / or failure in the fiber-optic infrastructure in the link between Switch2 and the lightpath/CEP switch, an incident and repair plan must be made. This incident and a repair plan should be provided to ASTRON/LOFAR preferably within 3 hours after the failure has been detected. The repair plan informs ASTRON / LOFAR about the nature of the failure and the schedule for the repair. In case the problem exists for several days, ASTRON/LOFAR will be informed daily on the status of the repair.

Security and availability related items

The E-LOFAR partner has the responsibility to connect his equipment to the data transfer system in such a way that the LOFAR data link and connection to Central Processor at Groningen will not be endangered in any way. In case LOFAR/ASTRON notices any problems that originate from the partner's data link, it will be disconnected from the LOFAR systems. In order to prevent such a situation the following preventive measures are strongly recommended to be taken by the partner:

1.	In case an intrusion is detected in the active equipment that is placed in the link between Switch2 and the lightpath/CEP interface switch, this should be directly (within 1 hour) reported to ASTRON / LOFAR (LOFAR control room)
2.	In case a connection between an E-LOFAR station and the lightpath/CEP switch at Groningen is suspected to be intruded/corrupted and/or is causing problems in the LOFAR Central Processor system at Groningen, ASTRON / LOFAR will disconnect this connection immediately. After the E-LOFAR partner has shown that the mentioned issues are removed / not present the link will be restored.
3.	An E-LOFAR partner has the responsibility to provide a secure link. N.B.: The security of the link will be assessed based on information provided by the E-LOFAR partner regarding the link between the E-LOFAR station and the lightpath/CEP switch at Groningen.
4.	An E-LOFAR partner has the responsibility to provide a qualitative good link with proper availability.
5.	Before the link between an E-LOFAR station and the lightpath/CEP switch at Groningen is connected to the LOFAR systems at Groningen, the involved E-LOFAR partner has to supply a report in which the construction and configuration of the link between Switch2 and Groningen is described. ASTRON / LOFAR will assess with the E-LOFAR partner the quality of the link.
6.	In case an E-LOFAR partner wants to connect his local data processor systems to the Internet and /or other, non-LOFAR networks, the partner has to install a proper firewall and intrusion detection system between the local data processor system and the Internet /non-LOFAR networks.