



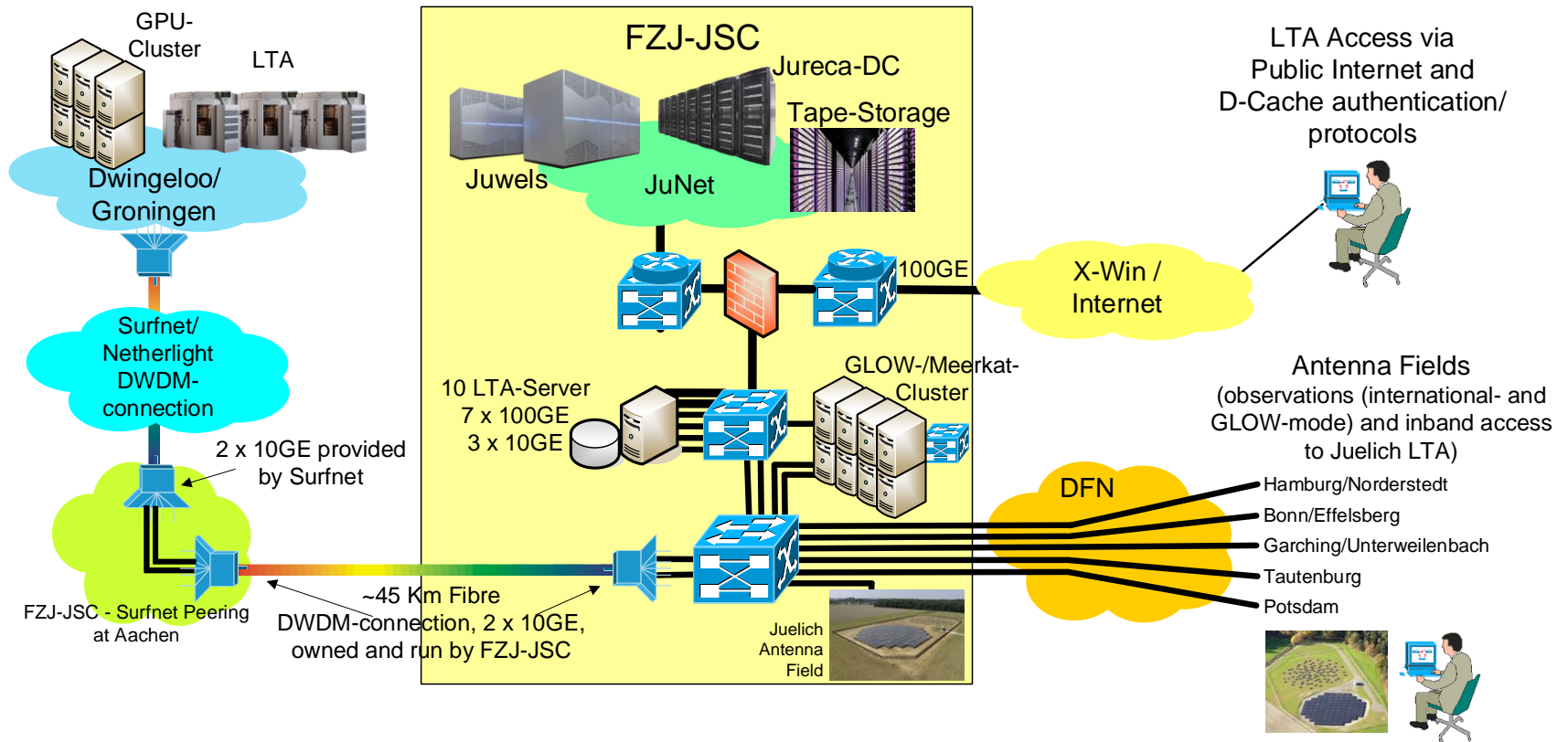
NETWORKDESIGN FOR LOFAR 2.0

13.11.2024, ERLANGEN, RADIO2024, OLAF MEXTORF (FZJ/JSC)

THE LOFAR-/GLOW-NETWORK

- Is designed to cover the following demands
 - Transport real-time observation data from the German antenna-fields via Jülich to the correlator at Dwingeloo (ILT-mode) at about 6 x 3 Gbit/s
 - Transport LTA-data from Dwingeloo into the Jülich LTA at about 10 Gbit/s
 - Transport real-time observation data from the German antenna-fields to the correlator at Juelich (GLOW-mode) at about 6 x 3 Gbit/s
 - Transport real-time observation data from the German antenna-fields to the correlator at Bonn (GLOW-mode) at about 3 x 3 Gbit/s (10 Gbit/s maximum)
 - Transport LTA-data from Juelich LTA to Bonn at 10 Gbit/s

ACTUAL SETUP OF THE GERMAN LOFAR NETWORK

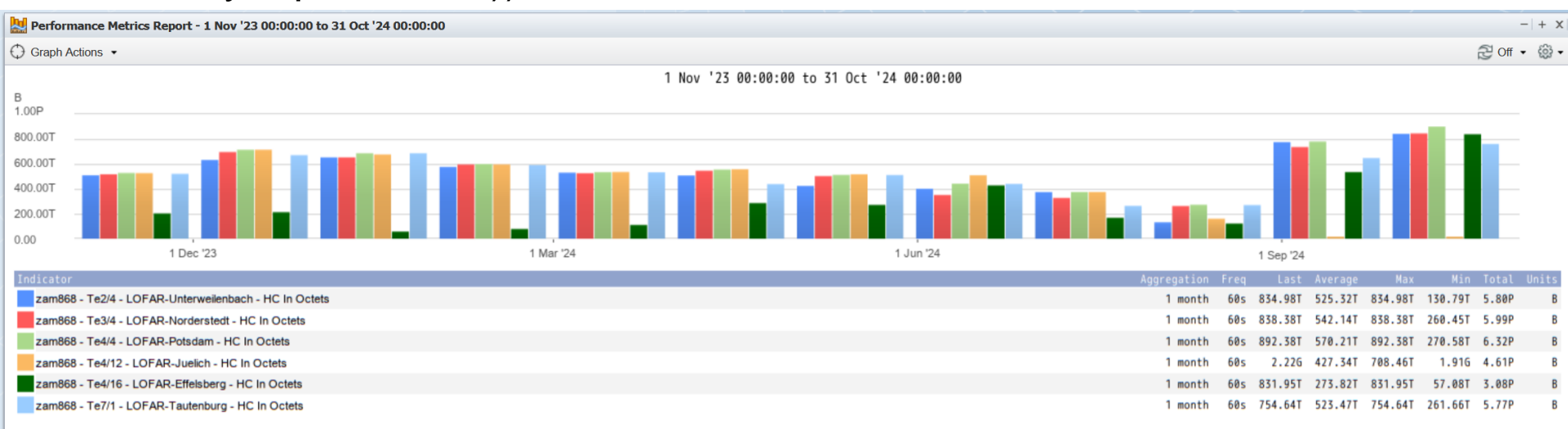


OPERATIONAL EVENTS

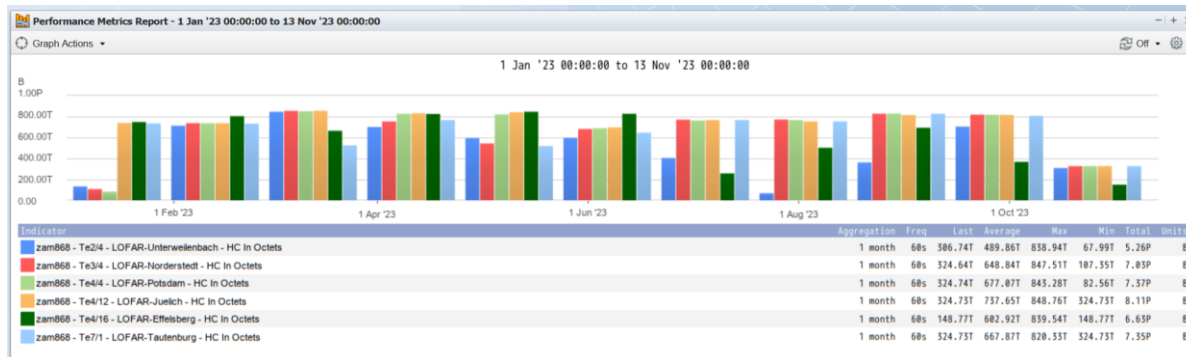
- Multiple maintenances of the links from the German stations to Jülich by DFN and subcontractors during the last 12 months
 - Roughly on the same level as throughout the last years (about 6 maintenances per antennafield and year)
 - A few link-outages due to station issues (e.g. temperature problems)
 - One link-outage of the Juelich antennafield because of maintenance-work (change of fibre-path) due to the erection of a new meteorological tower at the FZJ-campus
- Unterweilenbach
 - 20.02.2024
 - 10.06.2024
 - 29.07.2024
 - 30.07.2024
 - 30.10.2024
 - 13.08.2024Link-Flaps, temperature in antenna-container
 - Tautenburg/Jena
 - 08.02.2024
 - 18.04.2024
 - 05.06.2024
 - 06.06.2024
 - 12.06.2024
 - 09.10.2024
 - 28.11.2024 (canceled)
 - Bonn/Effelsberg
 - 20.02.2024
 - FZJ/JSC
 - 16.08.2024building of new met. tower

DATA VOLUMES TRANSPORTED

- Data from German stations to Jülich at a volume of about 600 TByte per month and station (slightly lower than 2023 (~700 TByte per month))

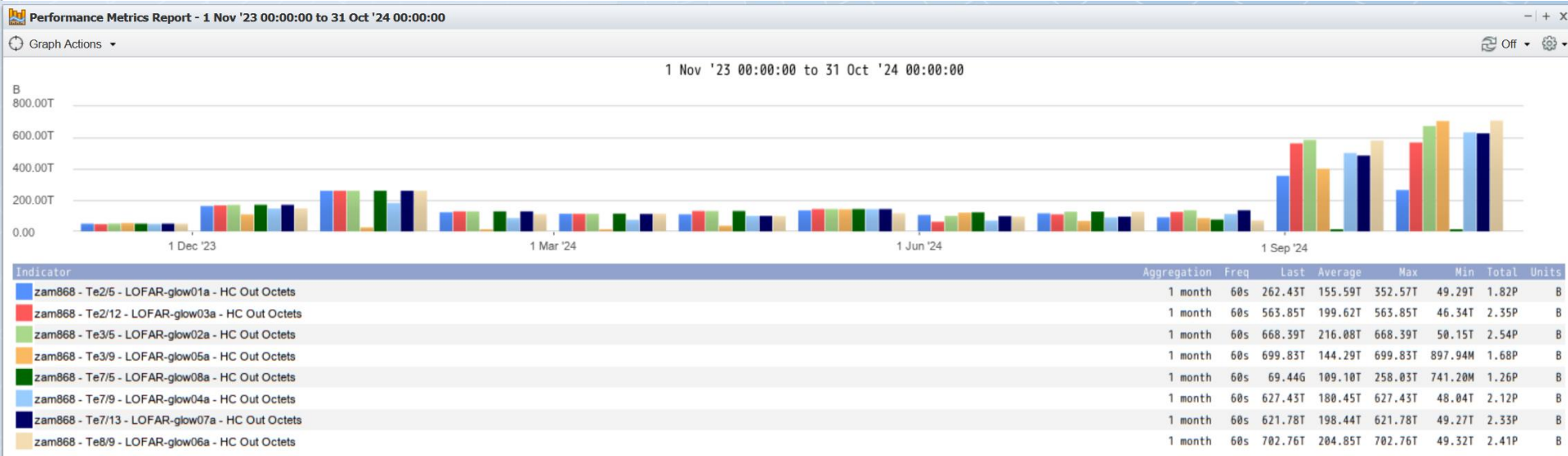
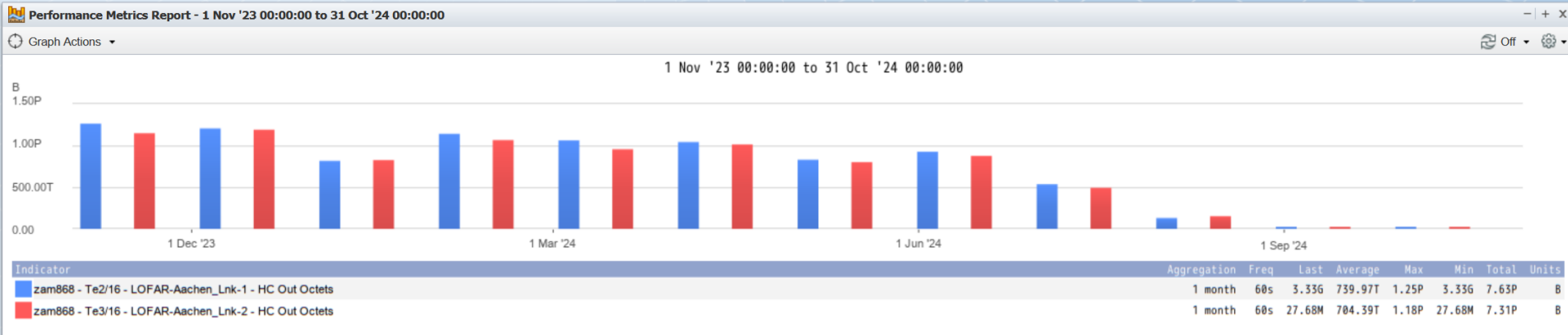


2023->



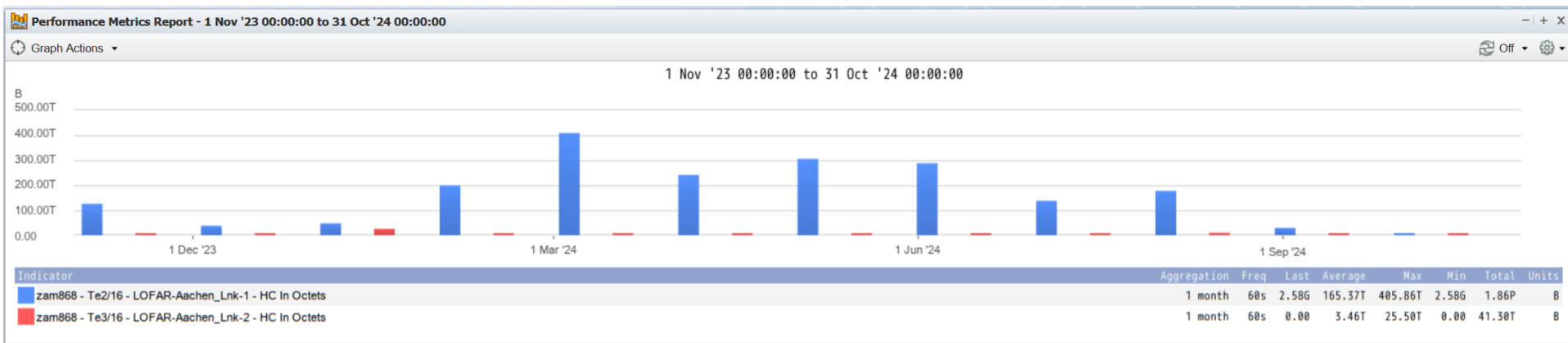
DATA VOLUMES TRANSPORTED

- Destination of incoming data from the stations (changed from correlator at Dwingeloo to correlator at Juelich as ILT-mode terminated)

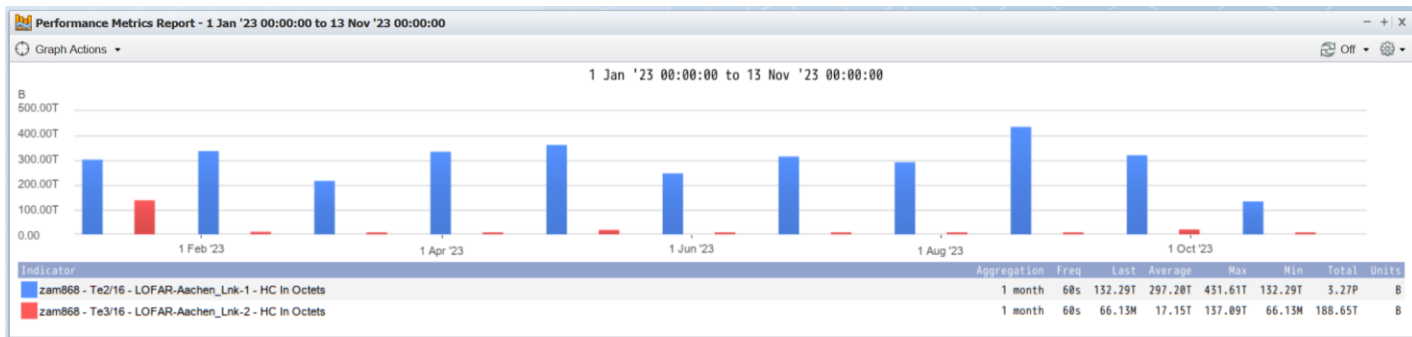


DATA VOLUMES TRANSPORTED

- Data from Dwingeloo to the Jülich-LTA at a volume of about 200 TByte per month (2023: ~300 TByte per month)

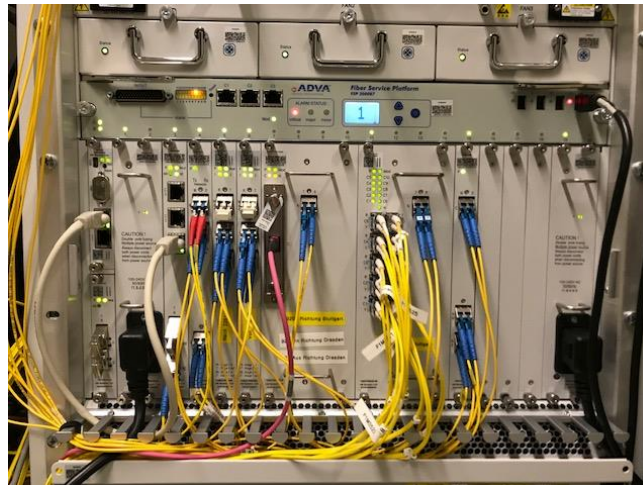


2023->



LOFAR 2.0

- With LOFAR 2.0 we expect more bandwidth to be needed (about a factor of 2 to 3 at the beginning)
 - From stations to Jülich
 - Technically those links are 10GE-based at the customer-edge
 - We checked with DFN that 10Gbit/s meanwhile is guaranteed all over the DFN-core for all LOFAR-links
 - From Jülich to Dwingeloo/Groningen via Surf-peering at Aachen
 - The actual number of two 10GE links just fit the needs for the parallel operation of LOFAR-ILT and eVLBI
 - The links are deployed as lambdas on Jülich's ADVA-DWDM platform



LOFAR 2.0 (CONT.)

- The DFN is planning in parallel to get rid of 10GE-lambdas (like the LOFAR station-to-Jülich-links) in their core to prepare for an upgrade of their optical platform towards 400GE-payloads
- Lambdas will then still be available but on a 100GE-basis
- Options for the LOFAR-links offered by the DFN are
 - To migrate to an MPLS-based forwarding instead of dedicated lambdas in the DFN-core
 - No changes at the customer-edge necessary
 - Technically no guaranteed bandwidth anymore
 - Technically less separation from other traffic than with lambdas
 - To migrate to 100GE-lambdas (per station)
 - No bandwidth limitations anymore
 - One-time invest of 35 T € (for transceiver) per link
 - Slightly lower monthly/annual costs than today

LOFAR 2.0 (CONT.)

- What happened so far
 - GLOW (Dominik Schwarz / Matthias Hoefft), FZJ/JSC (Sabine Werner and me) and DFN (Stefan Piger) had multiple VCs to agree on the 100GE-per-station-path and already exchanged some details
 - we (FZJ/JSC) had multiple VCs with André Gunst from Astron and his team to synchronize all necessary upgrade-steps and the general network-design
 - we (FZJ/JSC) agreed with the DFN on 100G-LR-S as the type of 100GE-optic (IEEE-standard) to be used for the hand-over of the 100GE-lambdas from the stations at Juelich; these optics have already been ordered



QSFP-100G-LR4-S



QSFP-100G-SR4-S



QSFP-100G-CWDM4-S

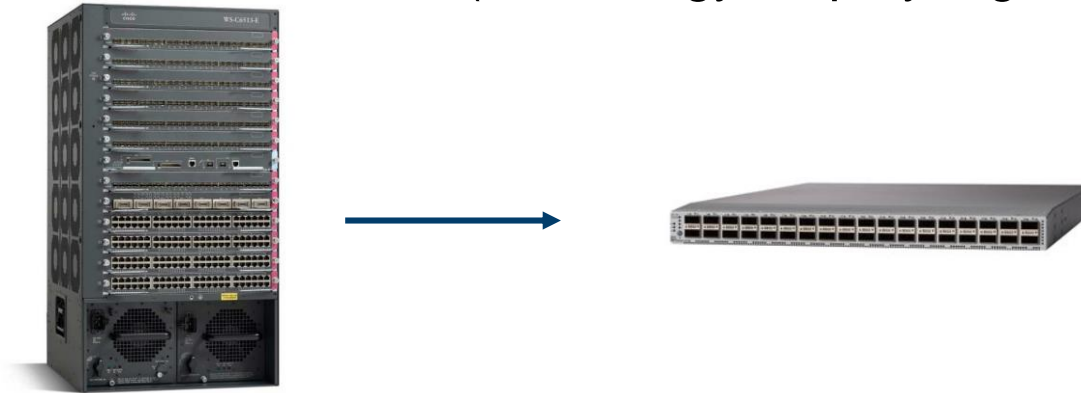


QSFP-100G-PSM4-S



LOFAR 2.0 (CONT.)

- What happened so far
 - we (FZJ/JSC) prepared a new switch to interconnect the upcoming 100GE-links from the station, the 100GE-link to Dwingeloo, the GLOW-cluster and the LTA (technology-step by 2 generations)



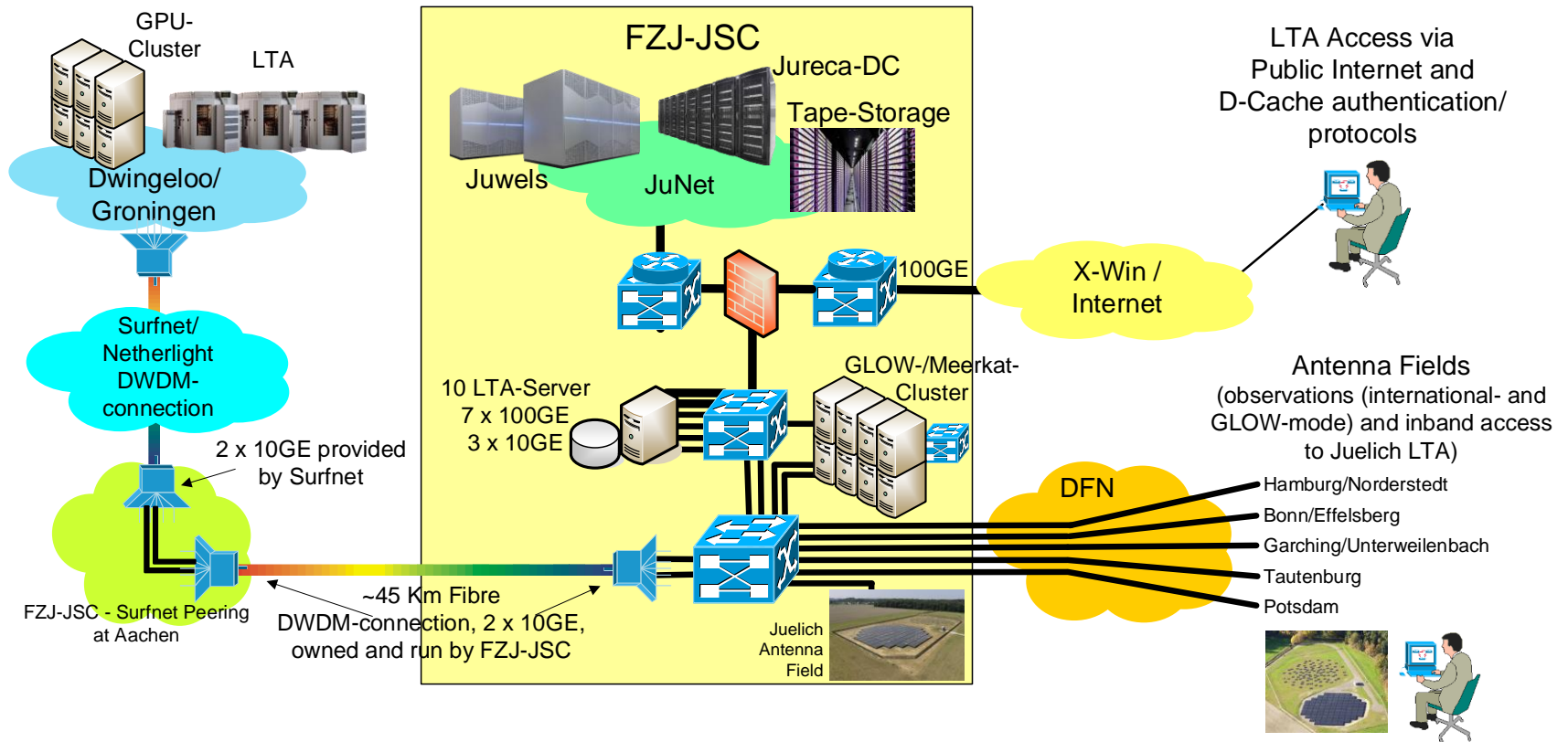
Cisco Catalyst 6509 (720 Gbit/s) Cisco Nexus 9336C-FX2 (7.2 Tbit/s)

- we are in regular contact with Migiel de Vos and his team from Surf as well as Astron and even Poznan on networking-topics
- we are currently negotiating the optical 100GE-standard to be used for the link between Juelich and Surf (we proposed 100GBase-ZR) with Surf

LOFAR 2.0 (CONT.)

- Challenges ahead
 - The DFN is planning to finish their migration of the optical core to the new DWDM-platform until the end of 2025
 - The station-upgrade needs to get aligned
 - The contracts between the station-owners and the DFN need to get signed/renewed
- Opportunities ahead
 - On our request the DFN is interested in testing WhiteRabbit as a service-offering for time-synchronisation
 - Plenty of bandwidth will be available per station that not only covers even future upgrades in the antenna-technology but also opens room for additional applications, e.g. higher eVLBI-datarates, GLOW-correlator at a station/institute (e.g. MPI-Bonn), LTA-data retrieval “inline” (already tested with MPI-Bonn), high-bandwidth access of data from the GLOW-correlator at Juelich, ...
 - The available bandwidth for LTA-data from Dwingeloo to Juelich will be raised by a factor of 10

GOING ALL 100GE



Thank you !

Any questions ?