

The ALMA high speed optical communication link is here.

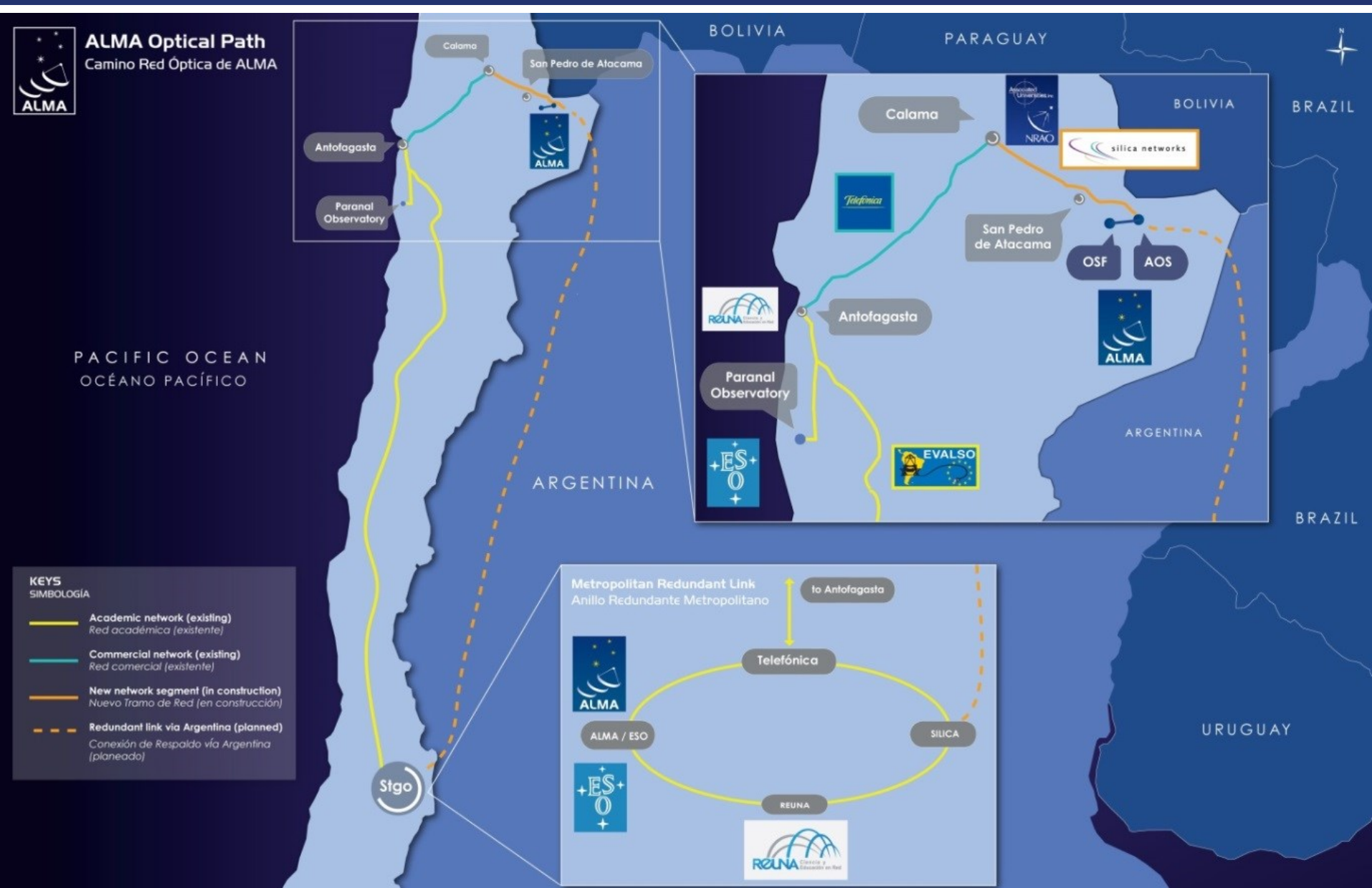
An essential component for reliable present and future operations.

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Abstract: Announced in 2012, started in 2013 and completed in 2015, the ALMA high bandwidth communication system has become a key factor to achieve the operational and scientific goals of ALMA. This paper summarizes the technical, organizational, and operational goals of the ALMA Optical Link Project, focused in the creation and operation of an effective and sustainable communication infrastructure to connect the ALMA Operations Support Facility and Array Operations Site, both located in the Atacama Desert in the Northern region of Chile, with the point of presence of REUNA in Antofagasta, about 400km away, and from there to the Santiago Central Office in the Chilean capital through the optical infrastructure created by the EC-funded EVALSO project and now an integral part of the REUNA backbone. This new infrastructure completed in 2014 and now operated on behalf of ALMA by REUNA, the Chilean National Research and Education Network, uses state of the art technologies, like dark fiber from newly built cables and DWDM transmission, allowing extending the reach of high capacity communication to the remote region where the Observatory is located. The paper also reports on the results obtained during the first year and a half testing and operation period, where different operational set ups have been experienced for data transfer, remote collaboration, etc. Finally, the authors will present a forward look of the impact of it to both the future scientific development of the Chajnantor Plateau, where many installations area are (and will be) located, as well as the potential Chilean scientific backbone long term development.

Location and Project goals



Be a long term (>15 years) solution capable to cope with projected operational needs (i.e., a Gbps-class infrastructure). Be available as soon as the array enters in full operation and have low Operational Costs (OPEX).

Construction New Optical Fiber Cable

ALMA has a dark fiber pair between AOS and CALAMA (about 150km) from a new cable installed by SILICA DATCO, completed in December 2014.



From top left: layout of the new fiber cable between Calama and ALMA AOS (“Camino a” “Road to”; “Rio” “River”; “Campo Minado” “Minefield”), specialists from the Chilean Army clearing one of the minefields; crossing of the San Pedro and Vilama rivers; opening the trench for the cable and installing the chamber for the splice box; final splicing of the ALMA fiber pair into the connection to the Observatory; final handshaking between the SILICA and ALMA Project Managers.

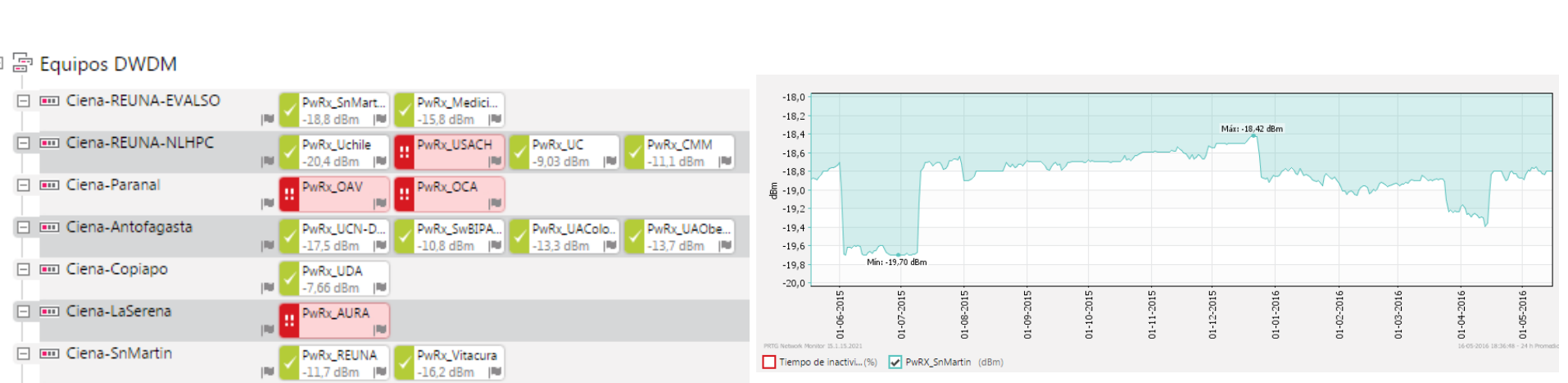
Conclusion: High-bandwidth communication is a key factor for scientific installations as Observatories and the ALMA optical link is delivering the promised value. Beyond purely increasing the bandwidth and lowering latency, boosting performances of applications directly making use of these two parameters, the new system is also an enabler for potential processes transformations that could deliver further advantages. The project, now about to enter the full exploitation, it is also part of a more general evolution of the academic and research network in Chile that in the coming years could bring even more advantages to ALMA and to the other scientific projects in the area.

Operating the link

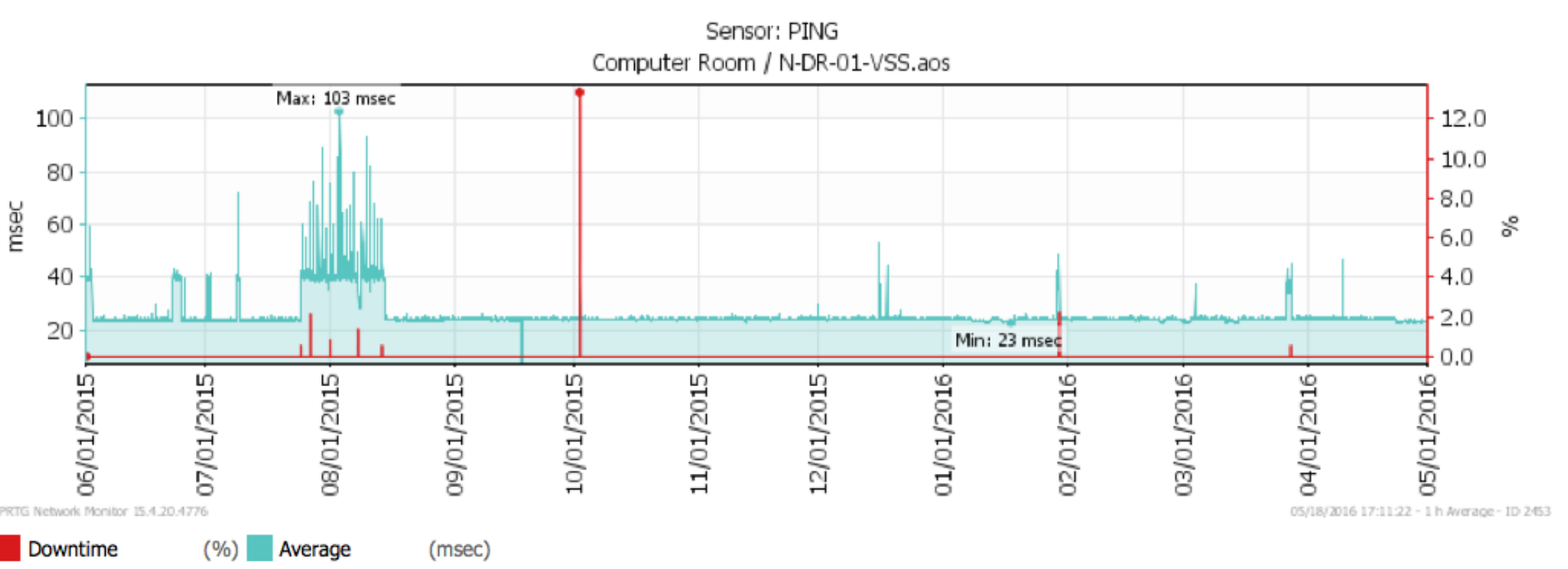
Configuration
The first end-to-end test was on December 2104. The 2.5 sub-lambda is configured as 2x1Gbps:

- **SCI Traffic:** 1Gbps for scientific data only (Archive traffic)
- **ALMA Traffic:** 1Gbps for the remaining non-scientific data

Operations & Monitoring
The operation of the link is done by REUNA, the Chilean Research and Academic Network, from the Network Operation Center (NOC) in Santiago. The activity covers both physical (like Optical Power) as well as end-to-end functionality (ping). Monthly reporting is also delivered.



Report Time Span:	06/01/2015 00:00:00 - 05/01/2016 00:00:00
Sensor Type:	Ping (30 s Interval)
Probe, Group, Device:	Cluster Probe > Computer Room > N-DR-01-VSS.aos
Cluster Node:	SCO - PRTG
Uptime Stats:	Up: 99.997 % [334d14h42m23s] Down: 0.003 % [12m5s]
Request Stats:	Good: 99.912 % [963609] Failed: 0.088 % [852]
Average (Average):	26 msec



- Periods:
- Month: April 2016, 30 days, 720 hours
 - Trimester: February to April 2016
 - Year: September 2015 to April 2016, 243 days, 5832 hours

Service	Monthly			Yearly		
	Uptime [hours]	Downtime [hours]	Availability [%]	Uptime [hours]	Downtime [hours]	Availability [%]
1	720	2,16	97,30%	5832	53,01	99,09%

Table 3: Availability

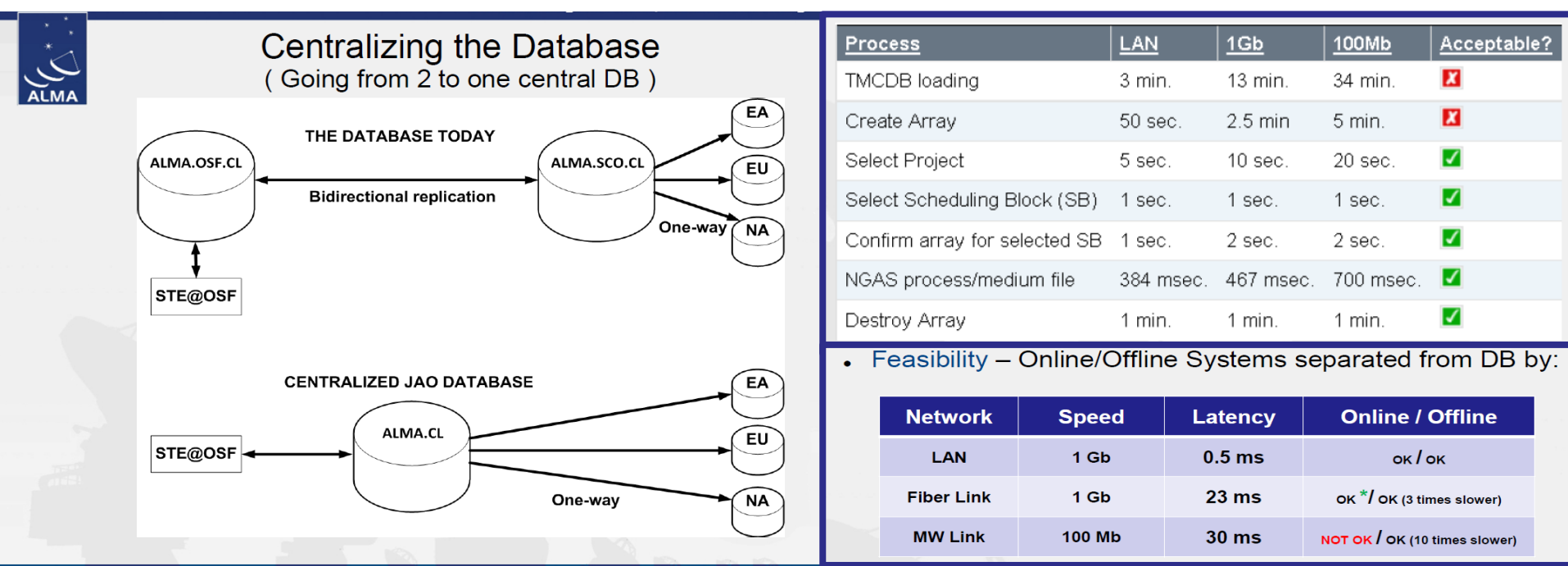
2015 accidents: March: exposed cable after heavy rain in; May: burned fiber vault in Santiago during riots; July: damaged cable in the Calama fiber vault by a maneuvering truck.



Using the link

Scientific Archive
Nodes in OSF and SCO, with bidirectional replication. The new link will allow data transfer without accumulating backlog: cycle3 (current) ~300 GB/day, cycle4 850GB/day, cycle5 ~1TB/day.

The new link allows also considering replacing the current dual node scheme with a single database in SCO, with obvious savings in HW and operational costs. Application testing showed acceptable performance levels and also latency has , that for this type of applications plays a pivotal role, is compatible with the application requirements.



Remote Operations
High bandwidth and low and constant latency are enablers for remote operations. One could consider to move the control room (now 30km away from the antennas) to SCO, 1200km away, still with comparable performances, but lower costs and better comfort for the operators.

Future

REUNA aims to have a national backbone along the Chilean territory based on dark fiber where “unlimited” bandwidth capacity can be offered together, thanks to redCLARA peering, access to the European GEANT, the North American INTERNET2, and the AmLight initiative. Key elements of this strategy are the agreement with the LSST project and AURA, (700Kms of dark fiber will be deployed and lighted with 100Gbps lambdas) and the possible participation to the BELLA initiative (a fiber based terrestrial network along Latin America connected to the new submarine cable from Europe to Latin America EULALINK).