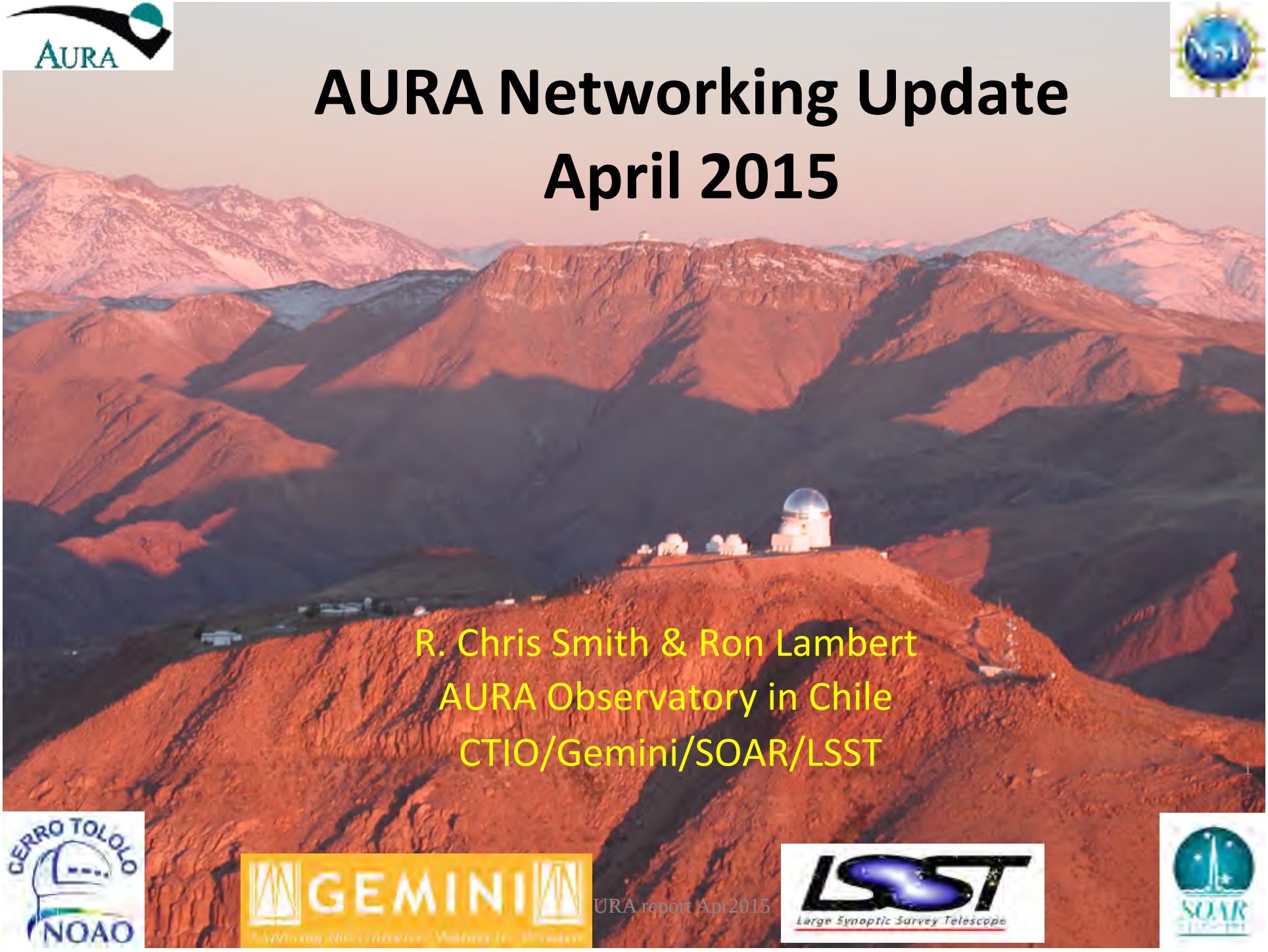
AURA Networking Update
April 2015



R. Chris Smith & Ron Lambert
AURA Observatory in Chile
CTIO/Gemini/SOAR/LSST

AURA Network Backbone

- Three segments
  - Summits (Tololo+Pachón) to Base (La Serena)
    - Currently: Microwave link @ 2 x 155 Mbps
    - Testing additional radio technologies
  - La Serena to Santiago
    - Currently: REUNA @ 1Gbps
  - Santiago to U.S. RENs
    - Currently: AmLight+LAUREN @ 1Gbps (up to 10Gbps)

AURA Backbone Users

- Large users
  - NOAO/CTIO
  - Gemini
  - SOAR
  - KMTnet/KASI (Korean)
  - **LSST**
  - Carnegie (La Serena)
  - NRAO/ALMA (Santiago)
  - GMT (La Serena/Stgo)
- Smaller Users
  - SMARTS
  - PROMPT (x8 now)
  - GONG
  - ALO
  - WHAM
  - LCOGTN
  - mEarth (Harvard)
  - T80S (Brazil)

New Links for AURA/LSST:

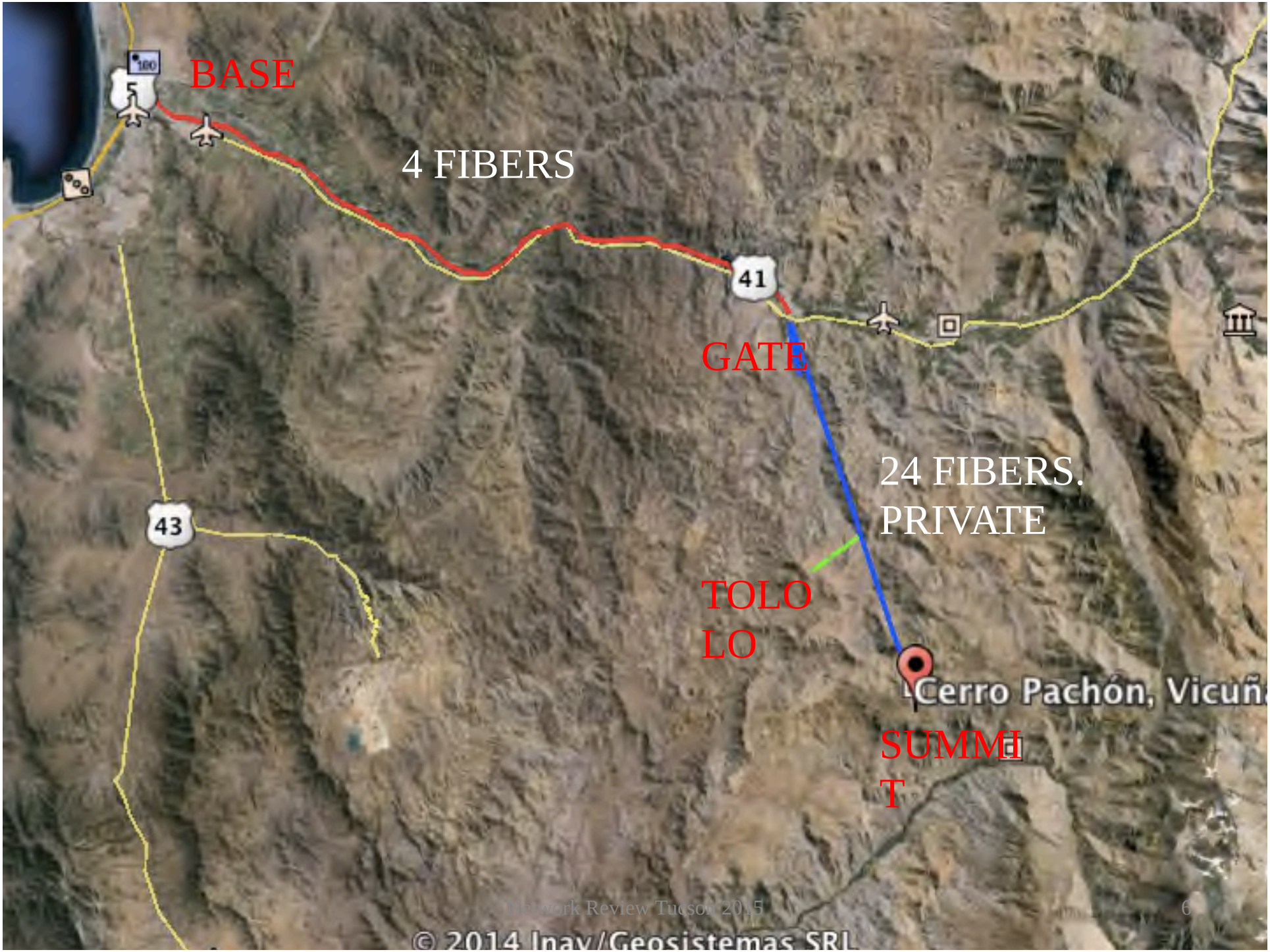
To be Provided by REUNA/Telefonica

- Outline of solutions
  - "Segment 1" = Mountain-La Serena
    - At least 300Gbps
  - "Segment 2" = La Serena-Santiago
    - At least 140Gbps
  - Equipment
    - Evaluation of options
  - Operations
    - Shared operations model

Segment 1:
Mountain-La Serena

- Good news: Commercial interests driving fiber installation up Elqui valley and then down to Santiago
  - Project T3 = 96 fibers from La Serena to Santiago

- Two sub-segments
  - AURA Gate to Summit (aerial)
    - 12 pairs of fibers, privately owned on AURA property
    - To be installed by Telefonica
  - La Serena to AURA Gate (aerial + some buried)
    - 2 pairs of fibers provided by Telefonica to REUNA on shared T3 bundle, 20 year IRU
  - Links to be maintained by Telefonica/REUNA (SLA), managed by AURA


BASE
4 FIBERS
41
GATE
24 FIBERS.
PRIVATE
43
TOLO
LO
Cerro Pachón, Vicuñ
SUMMI
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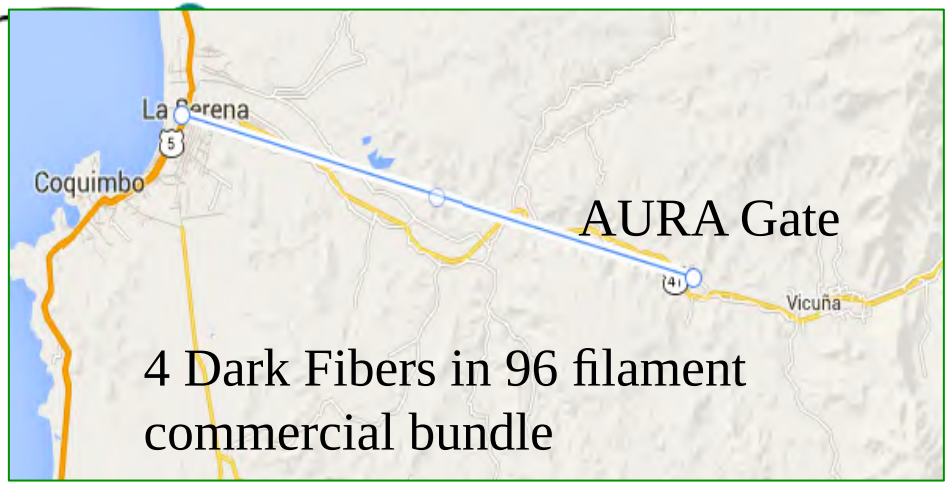
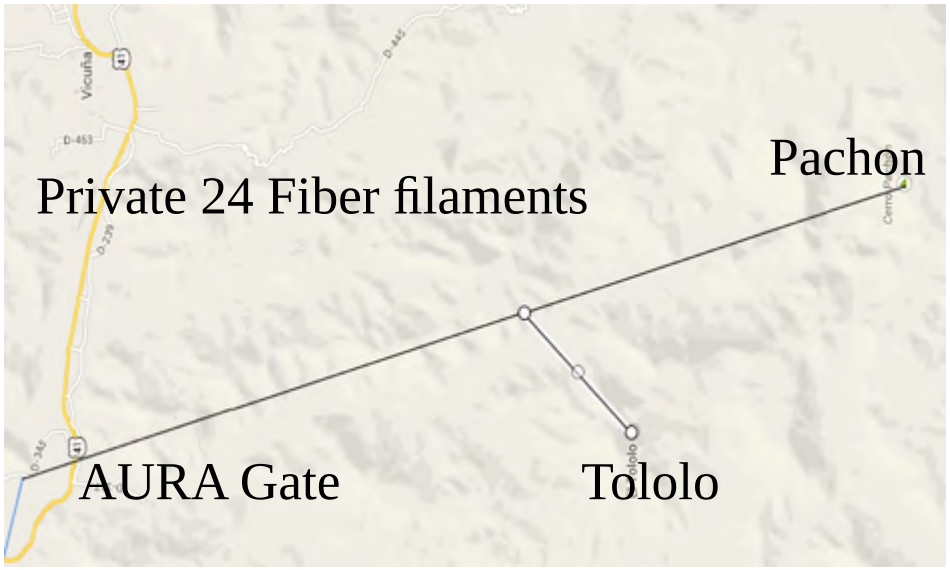
© 2014 Inav/Geosistemas SRL



Three main Telecoms investing in a fiber bundle for an alternate route from La Serena to Vicuna and Santiago. AURA will have an 18 year IRU (2016-2034) with REUNA for 4 dark fiber filaments in this bundle. Completion dated 2015.



REUNA/Telefonica will install in 2015 a private 12 fiber pair bundle for the sole use of LSST and AURA.

Typical public highway posts to La Serena. SLA with MTTR=4-6hrs

"ADSS cable is so tough it resists up to two pole failures" - Telefonica

Typical posts on AURA land. SLA w/ MTTR=8hrs during daylight

SEGMENT 2: LA SERENA – SANTIAGO (Fully REUNA Operated)

- *Blue line indicates the path in which REUNA will have a 20 year IRU for a dark fiber pair on the T3 bundle*
- *AURA/LSST and REUNA will each utilize a 100G circuit.*
  - *LSST will occupy one 100Gbs circuit.*
  - *Other AURA traffic will flow over the REUNA 100G circuit.*
- *AURA/LSST will have an optional additional 9 x λs within this pair, each of which can be 10,40,100Gbs, and possibly 400Gbps soon*

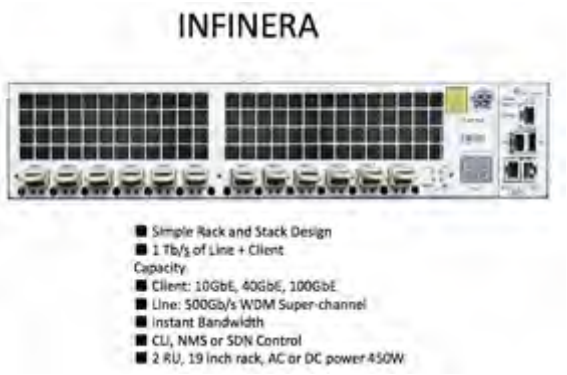
- *Red line indicates the legacy Pan American route where AURA/LSST will have 4Gb between 2016 and 2019 which will increase to at least 40Gb as a diverse path*

WDM Equipment

Currently considering PADTEC, INFINERA and CIENA Wave Division Multiplexing equipment, with 100G and/or 40G λ.

Further detailed investigation required to understand technical differences and options such as support, firmware upgrades, MTBF rates, latency throughput, Post FEC limits, etc.

Competitive tender planned before October 2015, in coordination with REUNA's additional network purchases



Network Operations Planning

- Segment 1: Mountain-La Serena
  - Standard maintenance of fiber links by Telefonica through REUNA contract
  - Light paths and traffic managed by AURA, in coordination with REUNA
- Segment 2: La Serena-Santiago
  - Standard maintenance of fiber links by Telefonica through REUNA contract
  - Light paths managed by REUNA, with 1 lambda dedicated to LSST traffic (up to 9 more reserved)
- **END-TO-END** Operations actively managed by Network Management group (AURA/LSST, FIU, REUNA, NCSA, +)

Key Features of Solutions

- Meets demanding requirements for LSST Operations
- Meets AURA facilities current needs, with significant room for expansion (including those of affiliates like Carnegie, GMT, etc.)
- Meets AURA's commitment to Chileans to make best effort to invest in bandwidth through Chilean research and educational network infrastructure

and

- Provides REUNA an important segment in its national high-speed network strategy, including possible links to northern international observatories