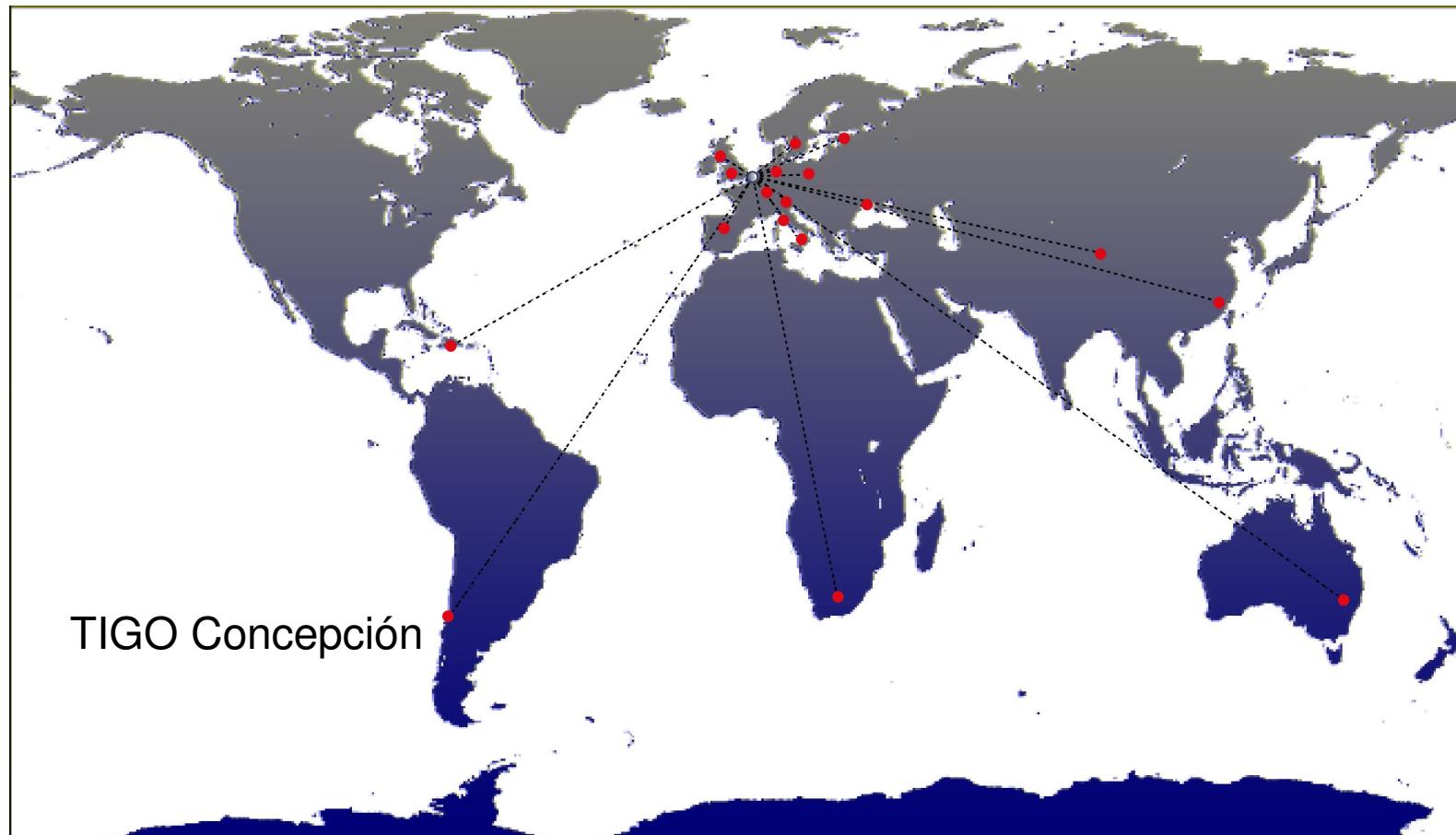


High-Speed Networking for Astronomy and Geodetic Applications

Connecting VLBI Radiotelescopes to one Global Instrument
The Chilean Part

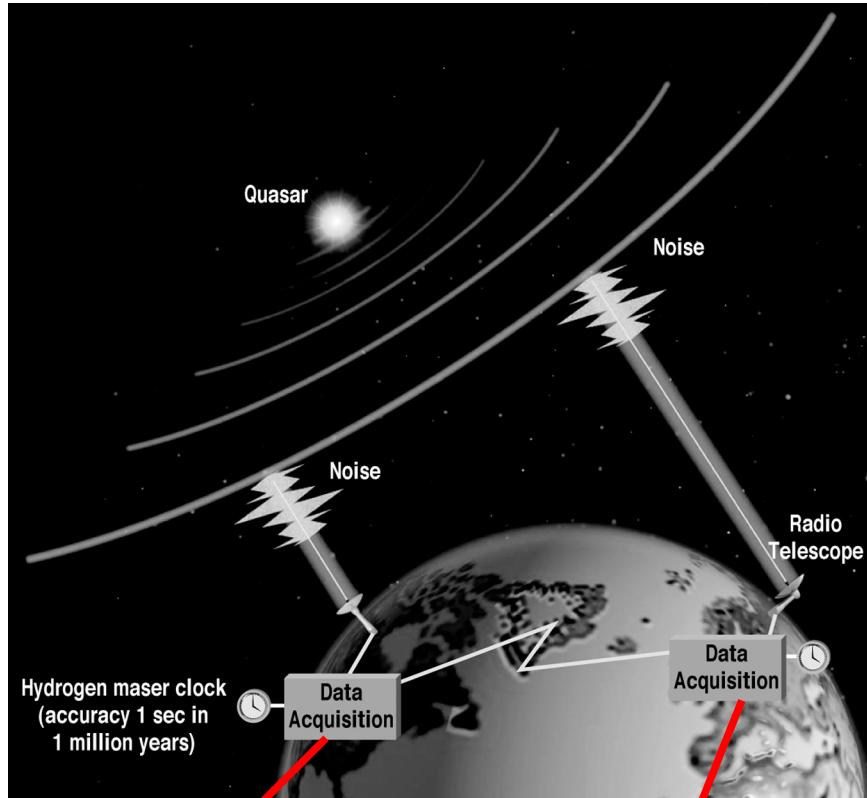


Charles Yun, JIVE
Hayo Hase, BKG, on behalf of UdeC-TIGO



Very Long Baseline Interferometry (VLBI)

One method – two user groups



JIVE Correlator Center, NL

Radioastronomy:

- monitoring the universe
(astrophysical phenomena)

Geodesy:

- monitoring the Earth
(geophysical phenomena)

Problems:

- huge amount of data
(2TB/24h/station)
- long distances to correlation center

The VLBI Network Station TIGO at Universidad de Concepción



TIGO is a Chilean-German cooperation project between
Universidad de Concepción, Universidad del Bío Bío,
Instituto Geográfico Militar and
Bundesamt für Kartographie und Geodäsie.



Current Method of VLBI Data Transfer from TIGO



2TB data leaving TIGO

- 2006: 111 times 2TB sent via parcel service to Europe or North America.
- 2TB over 10.000km = ~100 USD.
- Minimum delay observation-results = 1 week

Activities within EXPReS



“Last mile” of optical fibre to TIGO
is realized since 2002

- TIGO is part of the EXPReS Service Activity 2 (SA2): *Network Provision for a Global eVLBI Array*
- Focus: “Miles in between” Concepción and Europe
- Aiming for maximum bandwidth possible on the *long distance*

The EXPRoS Test Case: SMART-1 crash at Moon observed by TIGO

2006-09-03 01:42:22 UT

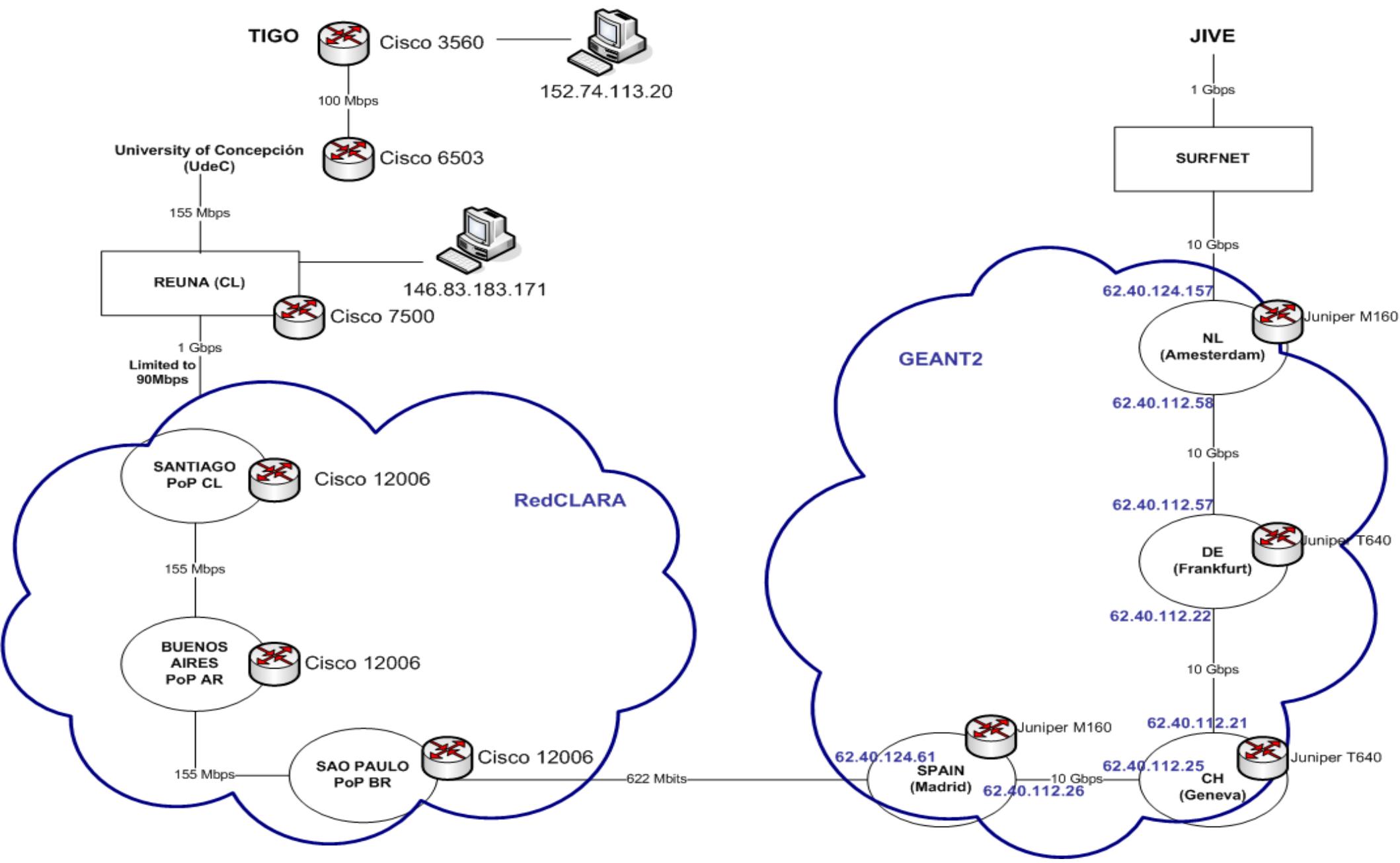
Small
Missions for
Advanced
Research in
Technology



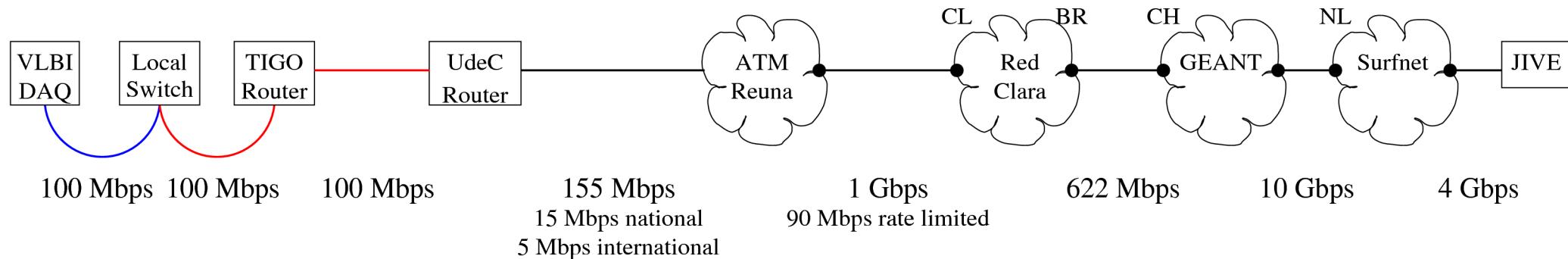
WWW.ESA.INT

first European lunar mission by ESA

Connecting TIGO to JIVE

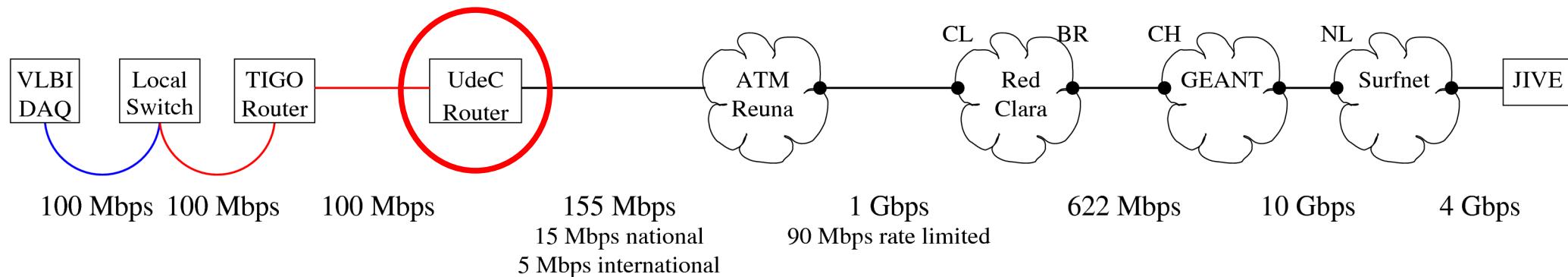


Status June 2006

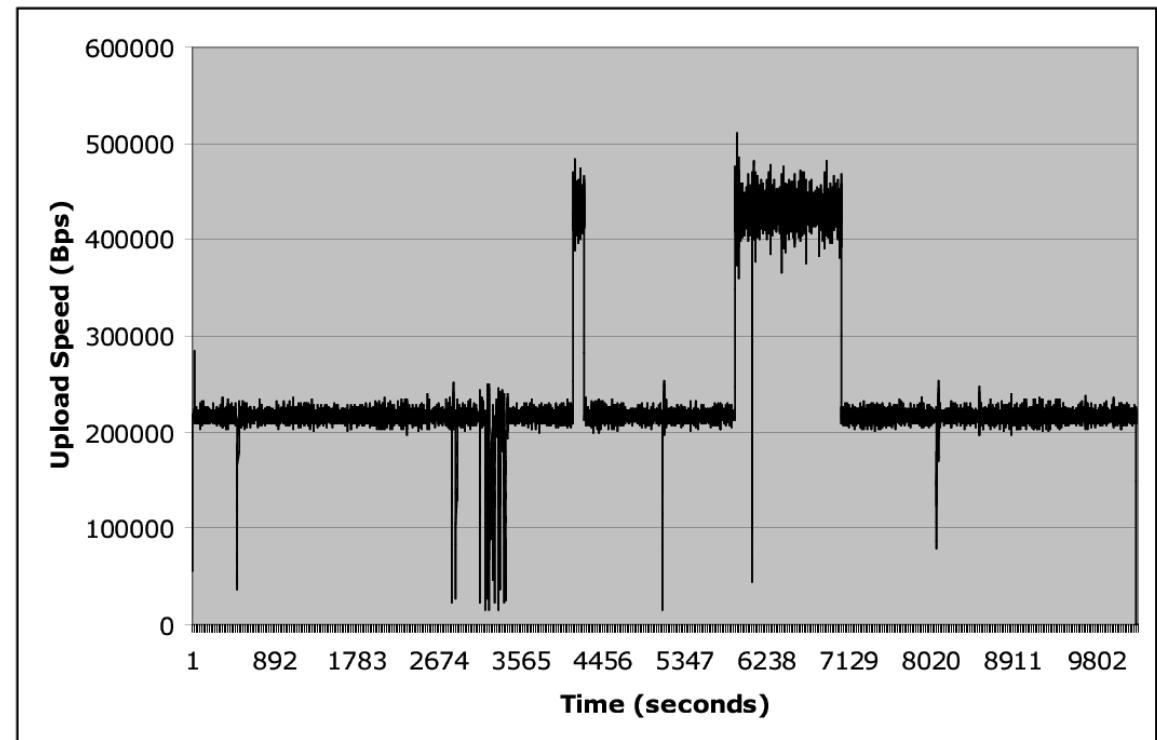


- international link from UdeC limited to 5 Mbps
- international link from REUNA to RedClara limited to 30 Mbps

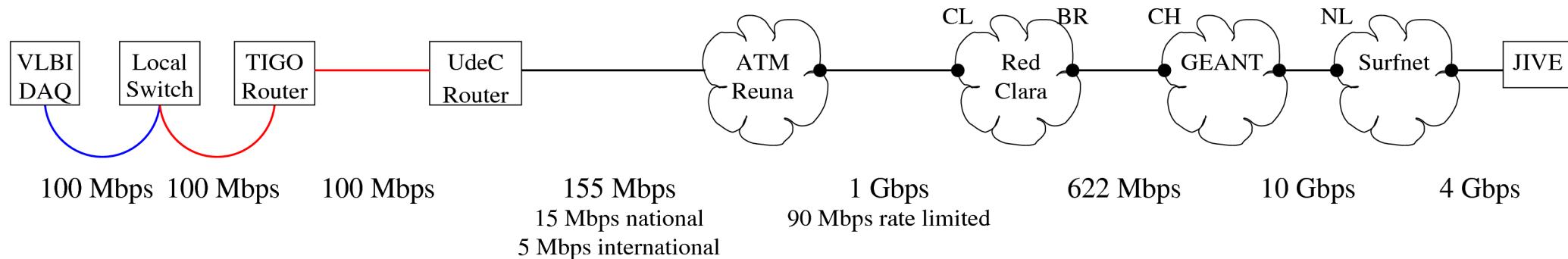
Test July 2, 2006 TIGO-Geant (CH)



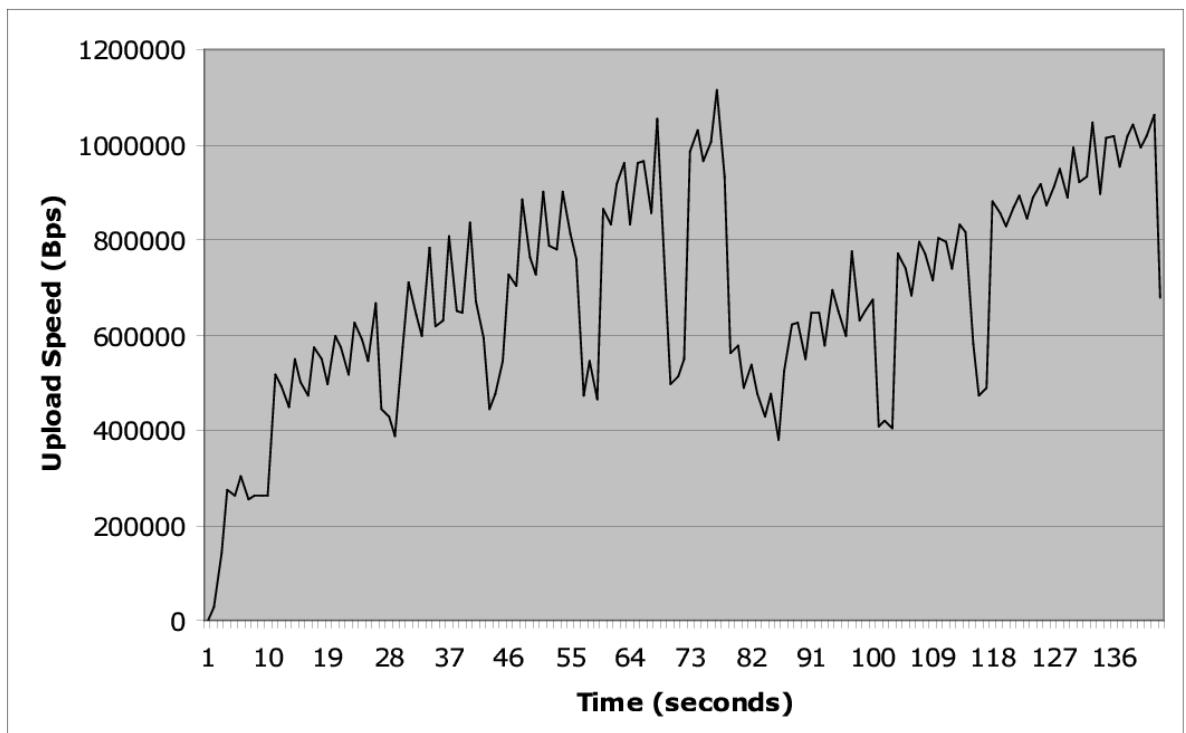
- Reuna lifted limits
- result:
 - 1.6 or 3.2 Mbps
- limiting factor:
router configuration
UdeC



Test July 9, 2006 TIGO-Geant (CH)

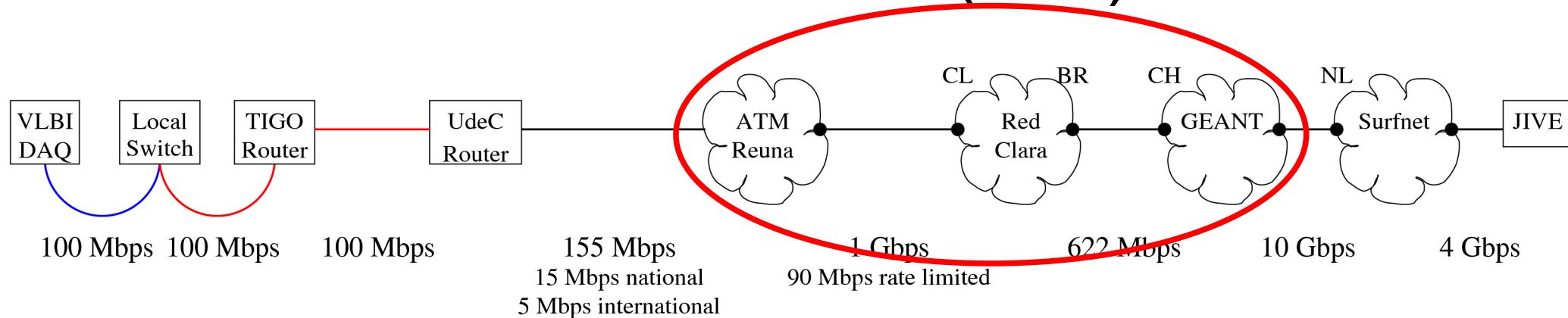


- Reuna lifted limits
- result:
 - 5.3 ... 8.7 Mbps
- limiting factor: ???

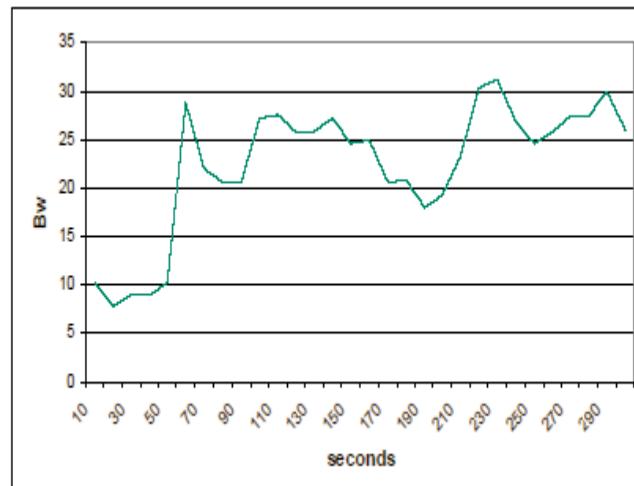


Tests August 17/22, 2006

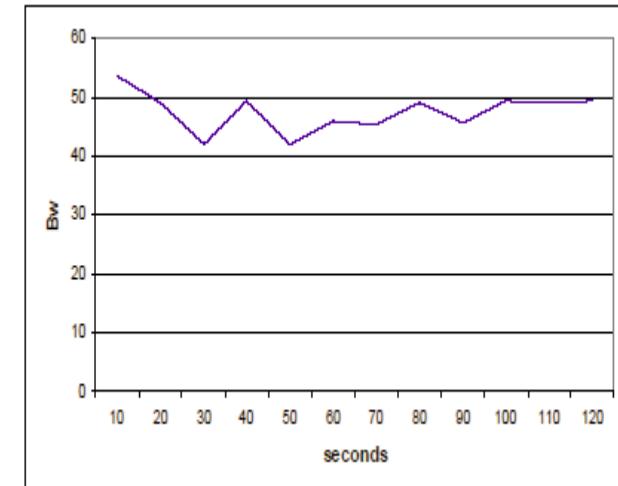
TIGO-Geant (CH)



- Reuna lifted limits
- result:
 - 22.4 Mbps
- limiting factor: ?
- TIGO-UdeC: 68 Mbps
- UdeC-Reuna: 75 Mbps



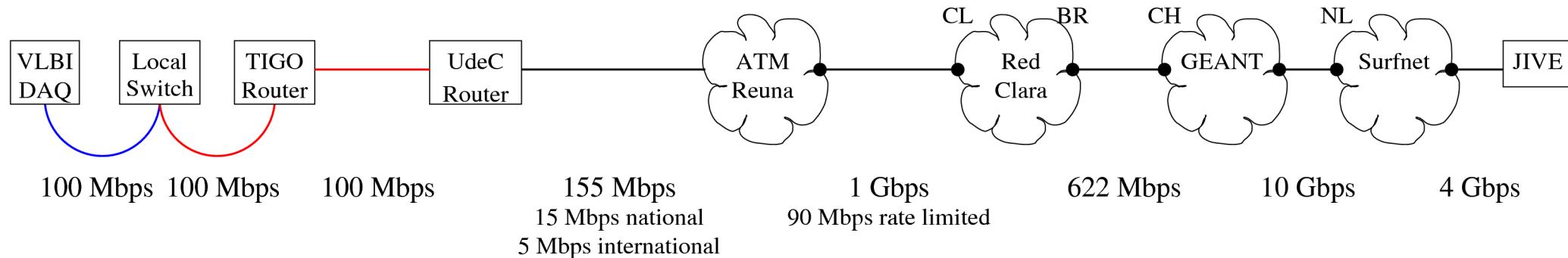
TIGO-Geant
22.4 Mbps



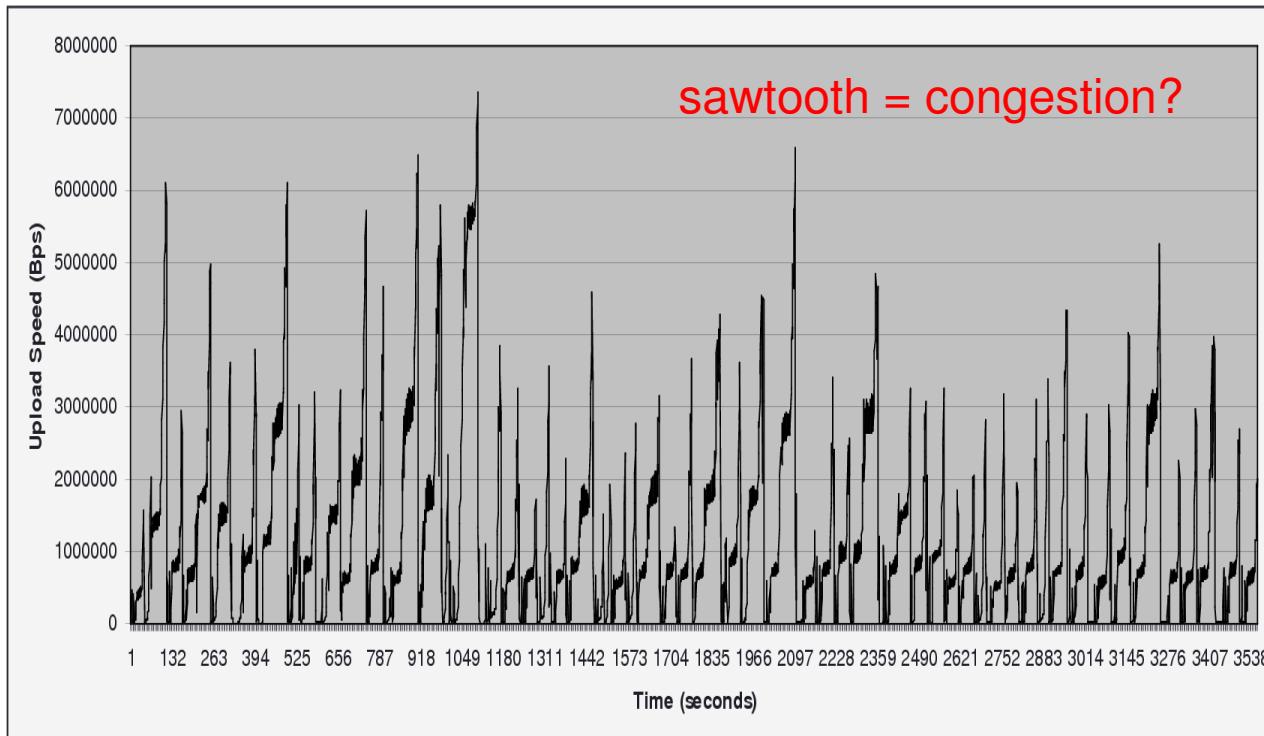
TIGO-Reuna
46.9 Mbps

Test August 27, 2006

TIGO-JIVE

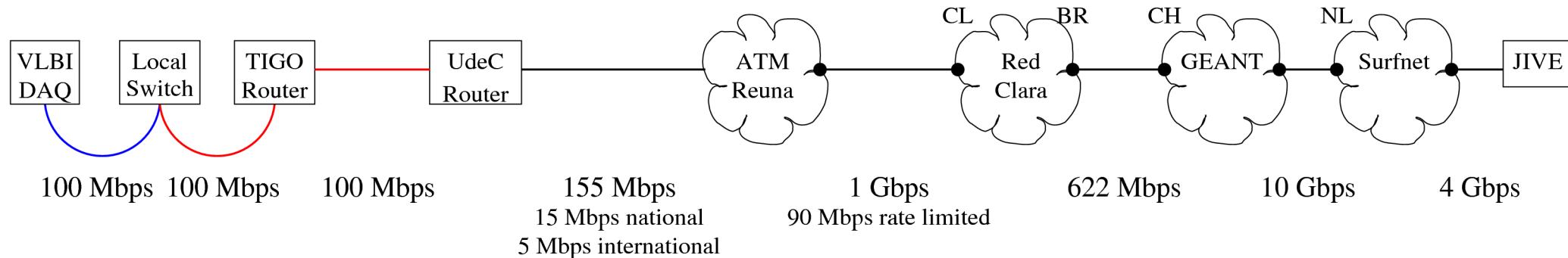


- Reuna lifted limits
- result:
 - max. 57 Mbps
 - average 8.8 Mbps
 - 3.6 GB/h
- limiting factor: ???

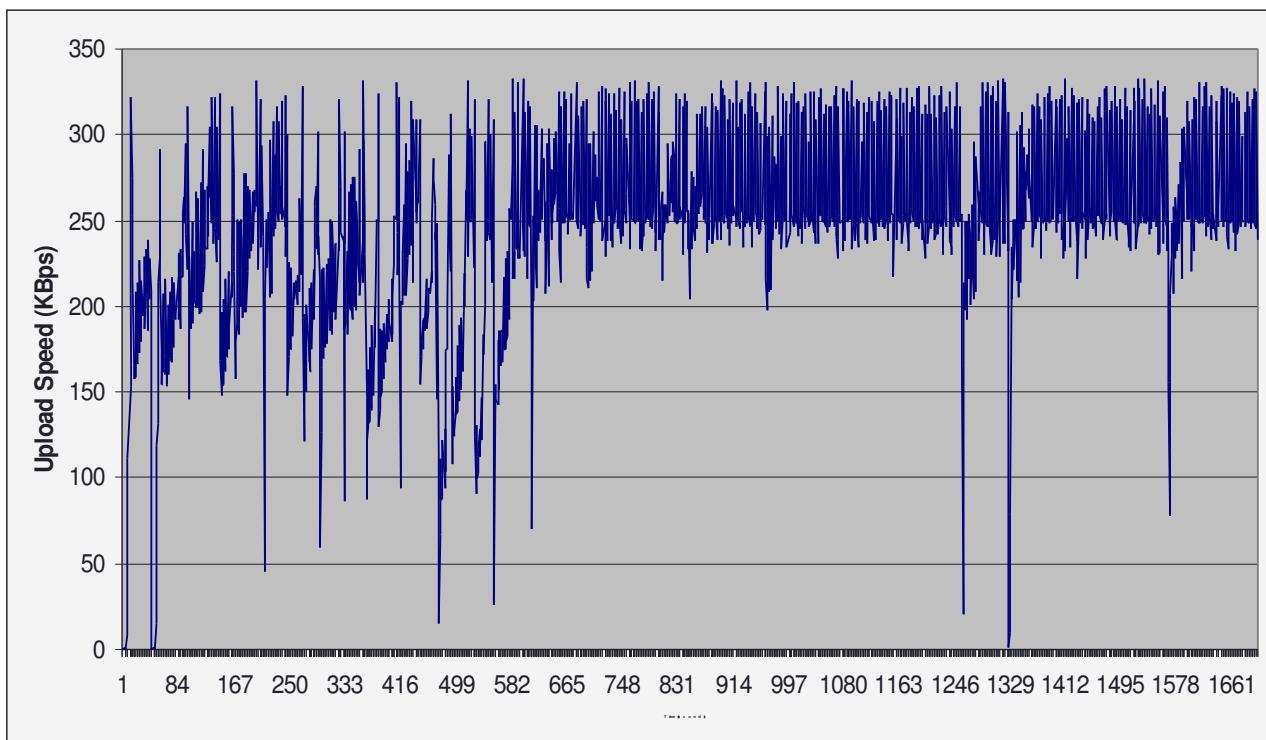


No Test September 3, 2006

TIGO-JIVE

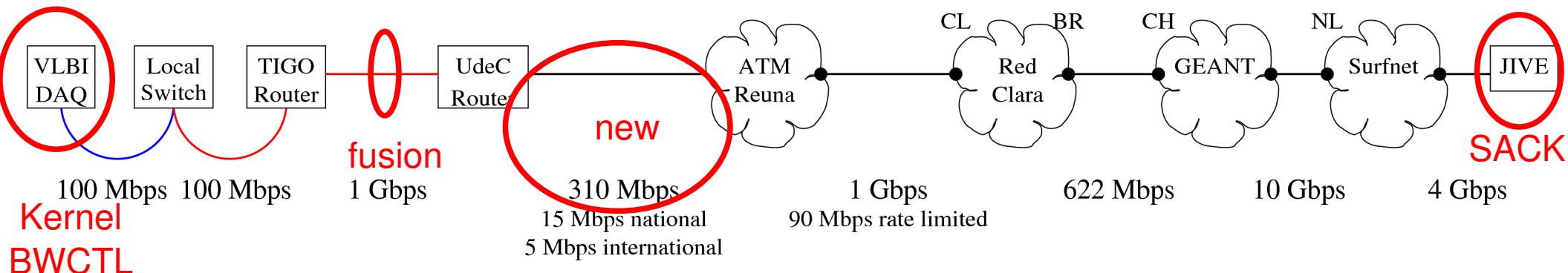


- Reuna lifted limits?
- result:
 - only 1.6 Mbps on the average
- limiting factor: unknown



Maintenance Nov./Dec., 2006

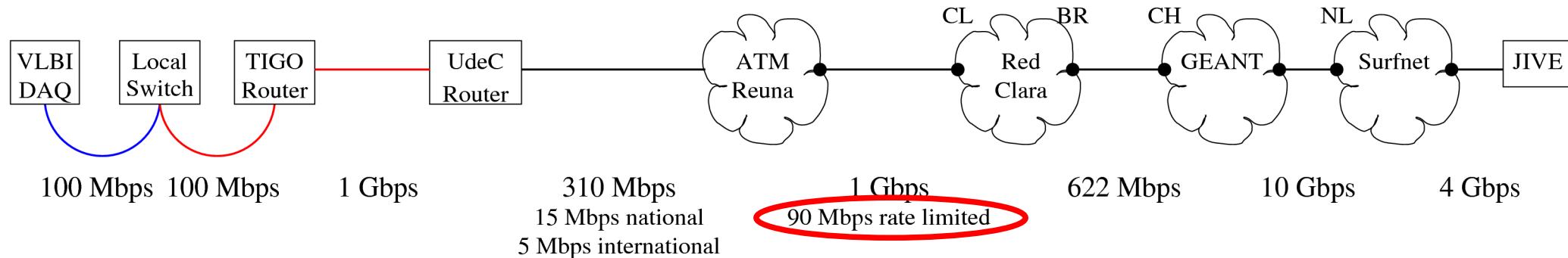
Backbone Reuna doubled



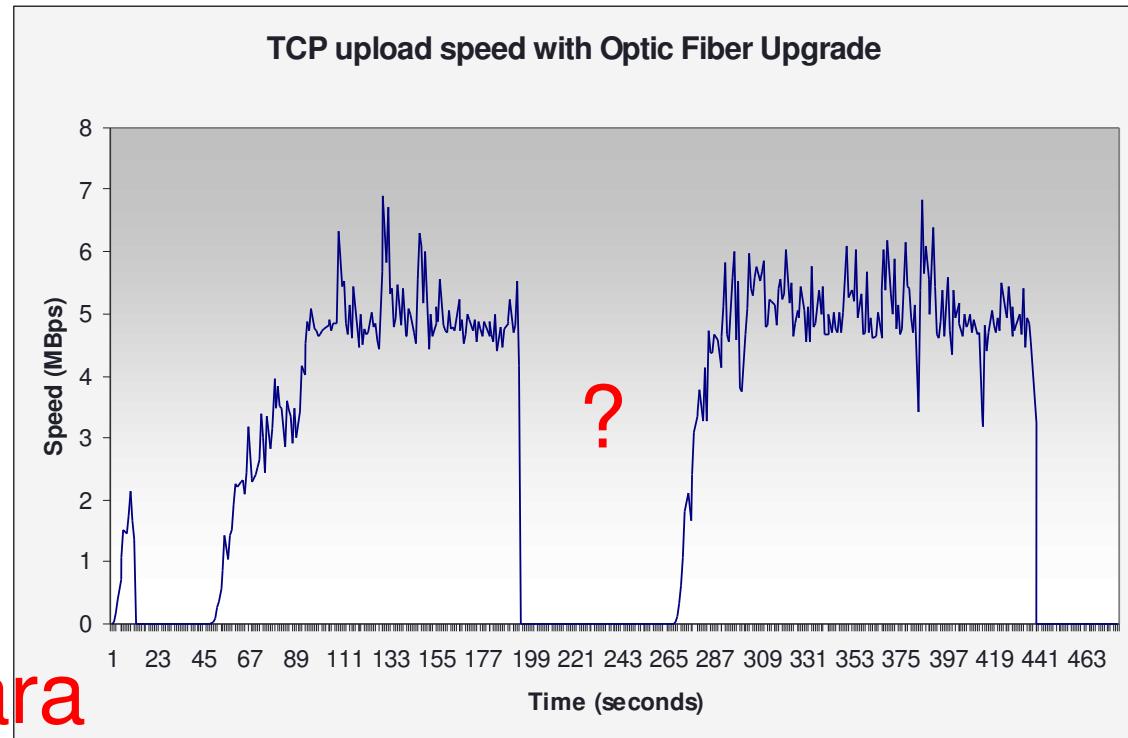
- Reuna upgraded the backbone to the south of Chile by doubling the bandwidth to 310 Mbps
- UdeC replaced a mechanical optical fibre connector by fusion enabling 1 Gbps
- Linux kernel update and BWCTL server installed at TIGO
- JIVE enables Selective Acknowledgement (SACK)

Test January 5, 2007

TIGO-JIVE



- Reuna lifted limits
- results:
 - 55 Mbps max. (TCP)
 - 24 Mbps average
 - 85 Mbps max. (UDP)
- limit: **90 Mbps RedClara**



Conclusion and Wishes

- EXPReS in Chile is a successful demonstration of pushing intercontinental communication networks for scientific applications to the limits.
- Further improvements address bandwidth upgrade of RedClara (CL-AR-BR backbone only 155 Mbps).
- Global research projects need equal infrastructure.
- Chile needs the same connectivity to Europe as it exists within Europe. Santiago is not Chile.
- Non-profit users of science infrastructure need free and full access to it.

Thanks and Acknowledgements

- Sergio Sobarzo, Cristian Herrera, TIGO
- Eduardo Rivera, César González, UdeC-DTI
- Sandra Jaque, Paola Arellano + Team, REUNA
- Florencio Utreras + Team, RedClara
- Pekka Savola, Andras Sako, Simon Leinen, PERT-Team, GEANT
- John Chevers, DANTE
- Team SurfNET
- Arpad Szomoru, Max Avruch, Charles Yun, Leonid Gurvits, Sergei Pogrebko, Paul Boven, EXPReS-Team, JIVE