

商用クラウドを活用した日本ーチリ間の アルマデータアーカイブの ネットワーク接続およびデータ転送

Network Connection and Data Transfer of
ALMA Data Archive Between Japan and Chile
using Commercial Cloud



Abstracts

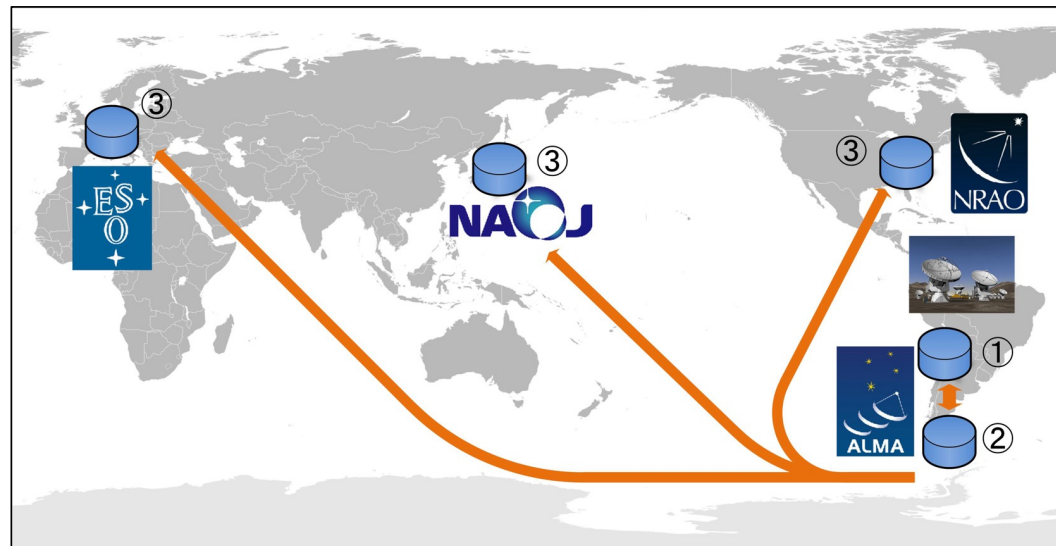
- アルマ望遠鏡のデータアーカイブにはチリの観測所で生成される毎年200TB以上のデータが保存されており、日米欧のデータアーカイブへリアルタイム転送されている。日本ではチリー北米間の専用回線を使用していたが、検証の結果、日本およびチリの国内回線と商用クラウドを組み合わせることで帯域を確保しつつより安価にデータ転送を行えることがわかった。本公演では商用クラウドを活用したネットワーク構成について説明する。
- The ALMA data archive stores more than 200 TB of data generated by ALMA observatory in Chile each year. The data is transferred in real time to the data archives in Japan, the United States and Europe. In Japan, previously, a dedicated private academic line between Chile and North America was used. After some verifications, we found that combining domestic lines in Japan and in Chile with commercial cloud service can ensure bandwidth and data transfer at a lower cost. In this presentation, we will explain the network configuration that utilizes the commercial cloud.





ALMA Archive Network

- ALMA Archive consists of 5 Archive locations.
 - ① OSF (Operations Support Facility) ALMA Frontend Archive - Store observed data temporary.
 - ② SCO (Santiago Central Offices) ALMA Science Archive - Main ALMA Archive
 - ③ ARC (ALMA Regional Center) Archive - EU:ESO, EA:NAOJ, NA:NRAO
- Archive data is stored to Main ALMA Archive and copied to 3 ARCs.
- Science users use the closest archive.



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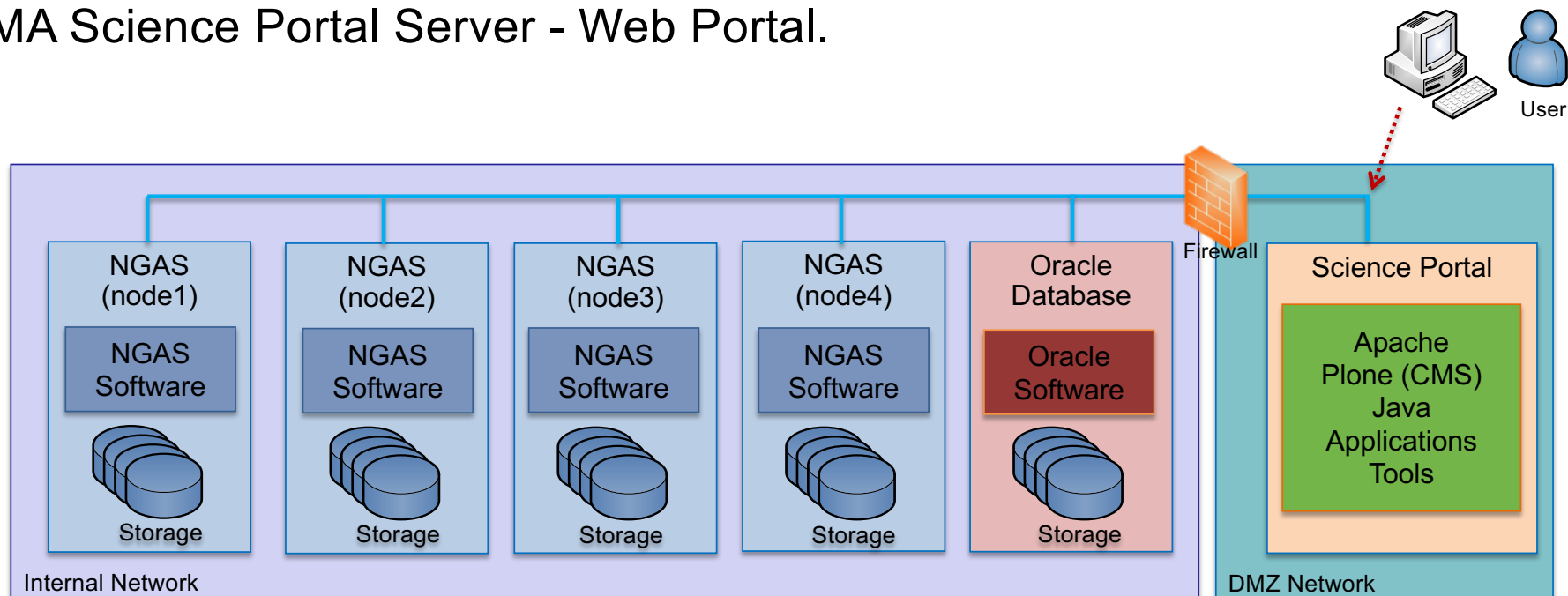
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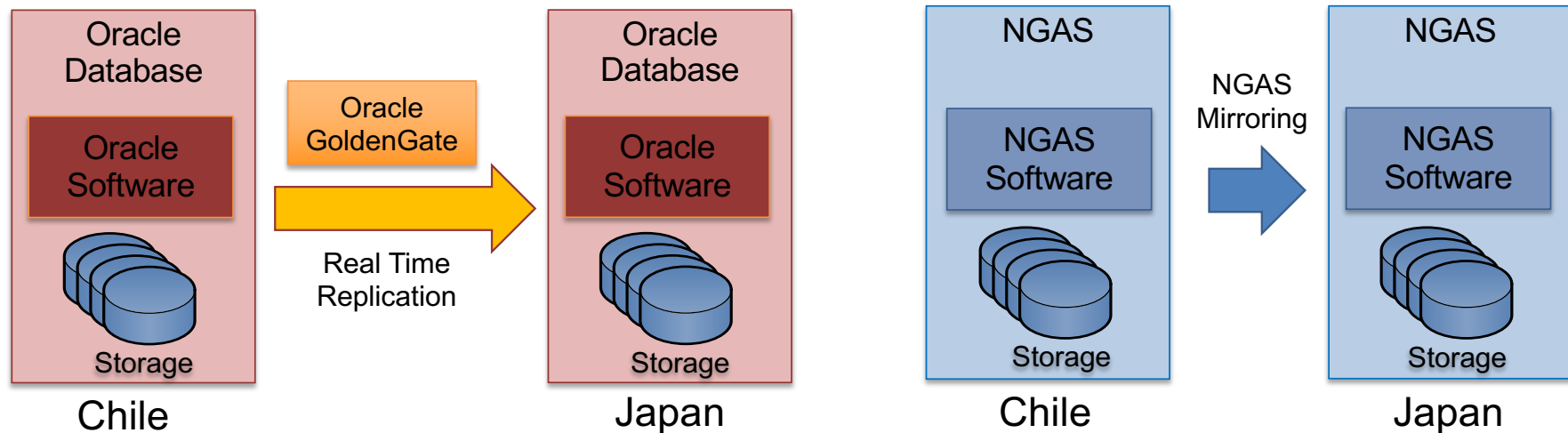
EA ALMA Archive System Key Components

- Oracle Database Server - Store meta-data.
- NGAS Server (Object Storage Server) - Store Binary Data.
- ALMA Science Portal Server - Web Portal.



Real Time Data Transfer from Chile

- Oracle GoldenGate
 - Oracle Software for Real time Oracle Database replication
- NGAS Mirroring
 - NGAS Software has own data copy mechanism.





Previous Network Diagram

- EA - SCO is connected with 2 international lines and IPsec-VPN.
 - NTT OCN (Tokyo - North America)
 - REUNA (North America - South America)
 - Red Universitaria Nacional (National University Network - Chile)
- REUNA network line contract.
 - 400Mbps guaranteed (no best effort).
- Performance
 - Latency: around 300ms
 - Throughput: around maximum 80Mbps per session and maximum 300 - 400Mbps in parallel.





Reduce Costs by Using Commercial Cloud

- Requirements

- Ensure bandwidth and latency are same or better than current levels.
- Stable connection.
- Security must be maintained.
- Ability to use the application without modification.
- Reduce the cost to transfer 200TB of data per year.

- Preliminary validation and cost simulation showed that Oracle Cloud Infrastructure (OCI) met the requirements.

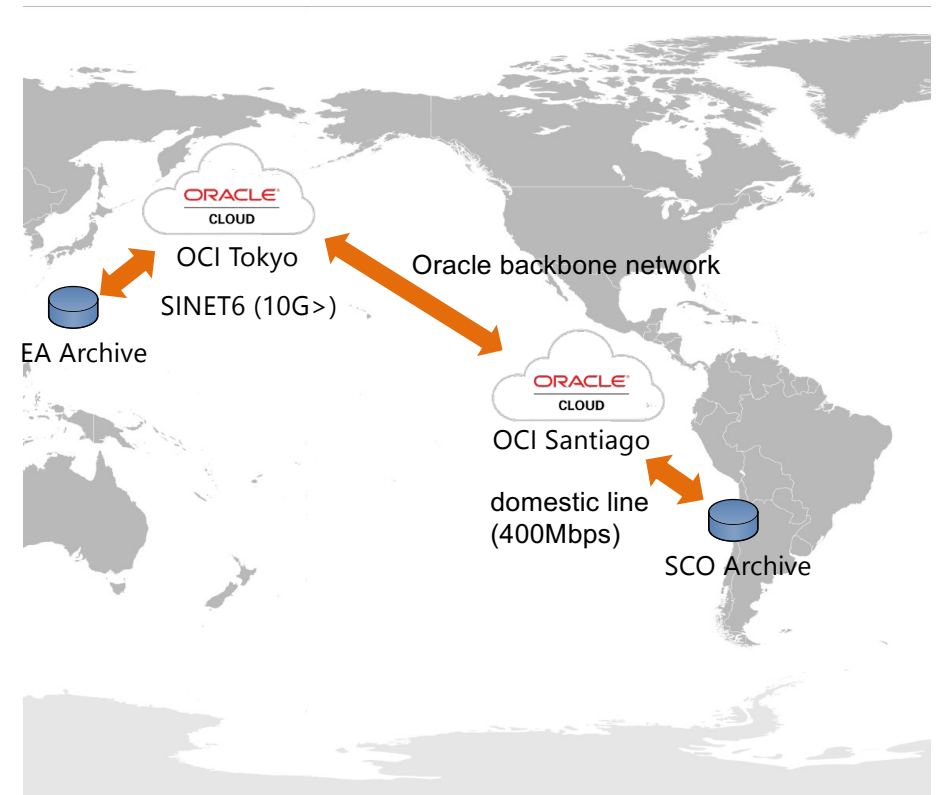
- OCI data center opened at Santiago on December 2020, we can use cheaper network line from ALMA Chile office to OCI Santiago.
- OCI outbound traffic charge is fixed price if connection is private line,
- OCI provides enough throughput and latency between Tokyo and Santiago.
- Confirmed we can get the required data transfer ability, security and bandwidth without making any changes to the application.
- Confirmed the total cost is to be smaller.





New Network Diagram

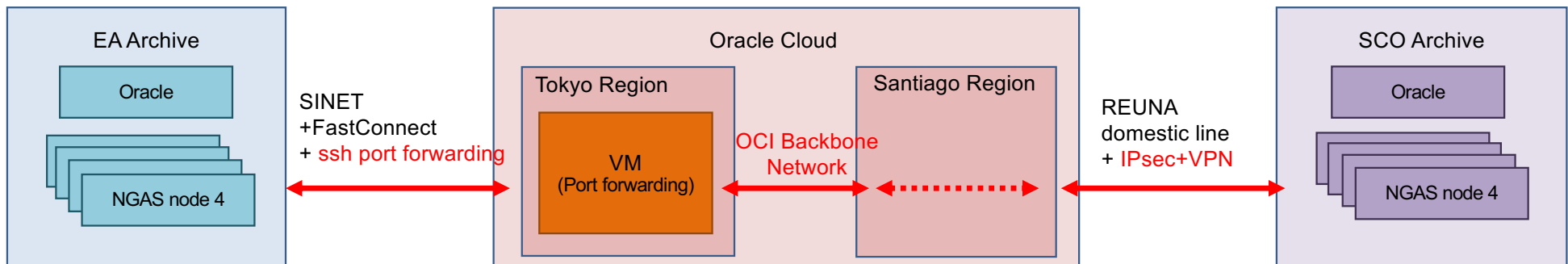
- EA - SCO is connected with 2 domestic lines both in Japan and in Chile and Oracle Cloud commercial service.
- Configured network connection between EA and SCO via Oracle Cloud.
 - EA - OCI Tokyo: SINET6 academic private line (>10Gbps) + OCI FastConnect (1Gbps)
 - OCI Tokyo - OCI Santiago: OCI backbone network (Not disclosed, actual 6-7Gbps, latency: around 200ms)
 - OCI Santiago - SCO: IPsec-VPN with REUNA domestic line (400Mbps guaranteed).





Security Configuration

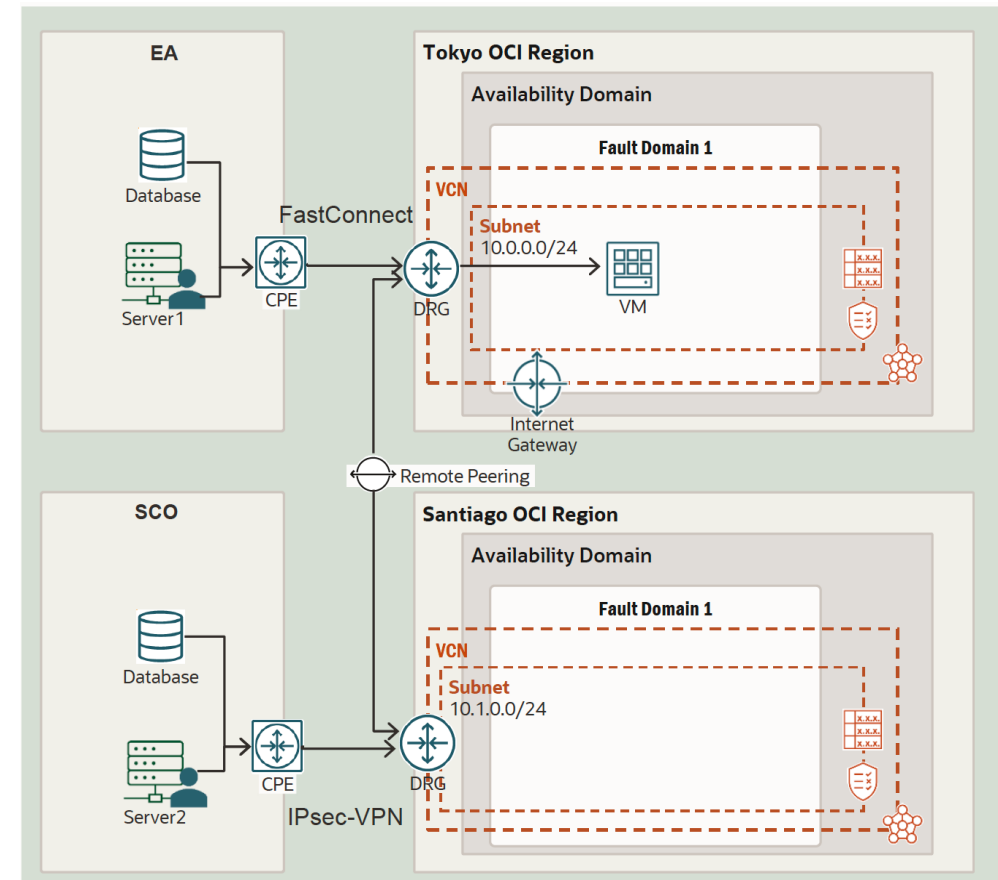
- EA - OCI Tokyo:
 - SINET6 + FastConnect does not encrypt transfer data.
 - Data encryption is implemented by ssh port forwarding.
- OCI Tokyo - OCI Santiago:
 - Data transfer is encrypted by Oracle policy (Not disclosed).
- OCI Santiago - SCO: Data transfer is encrypted by IPsec-VPN.
- Access control is managed by OCI security, NAOJ firewall and SCO firewall.
- Enable Oracle Cloud Guard to detect problems in OCI environment.





Setting for Routing on OCI

- SINET + FastConnect (EA - OCI Tokyo)
 - Create FastConnect via SINET6 with BGP routings.
 - Attach FastConnect on Dynamic Routing Gateway(DRG)
 - Make Route Table for FC import the routings from only VCN. (for not making directory routes between SCO and EA)
- OCI Backbone Network (OCI Tokyo - OCI Santiago)
 - Create the Remote Peering Connection(RPC) on each DRGs(Santiago, Tokyo).
 - Connect each RPCs using OCID.
 - In Tokyo side, Make the route table import the route from only VCN
- IPsec + VPN (OCI Santiago - SCO)
 - Create CPE object.
 - Set up Site-to-Site VPN configuration.





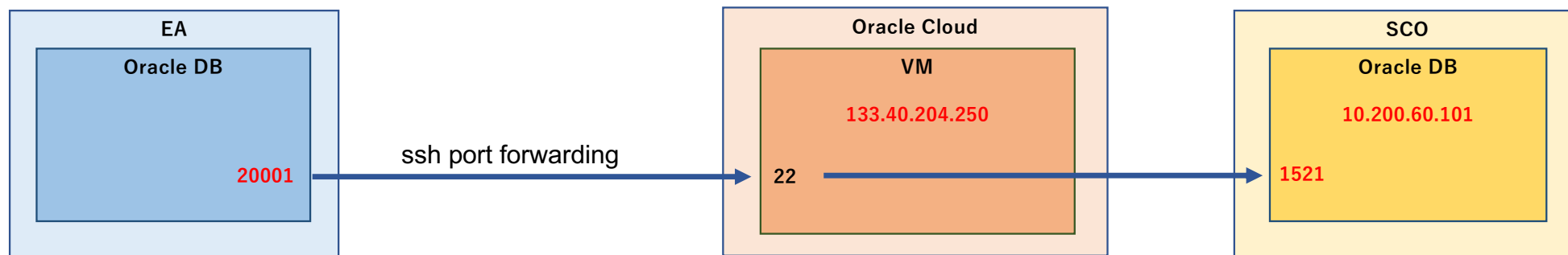
Application's Connection via OCI

- Configure ssh port forwarding and DNAT to enable to make network session with IP address and port numbers at SCO.

```
# ssh -N -f -g -L 20001:10.200.60.101:1521 alma@133.40.204.250
# firewall-cmd --permanent --direct --add-rule ipv4 nat OUTPUT 0 -d 10.200.60.101 -p tcp --dport 1521
  -j DNAT --to-destination 127.0.0.1:20001
# sqlplus user/pass@localhost:20001/ALMA.SCO.CL
```

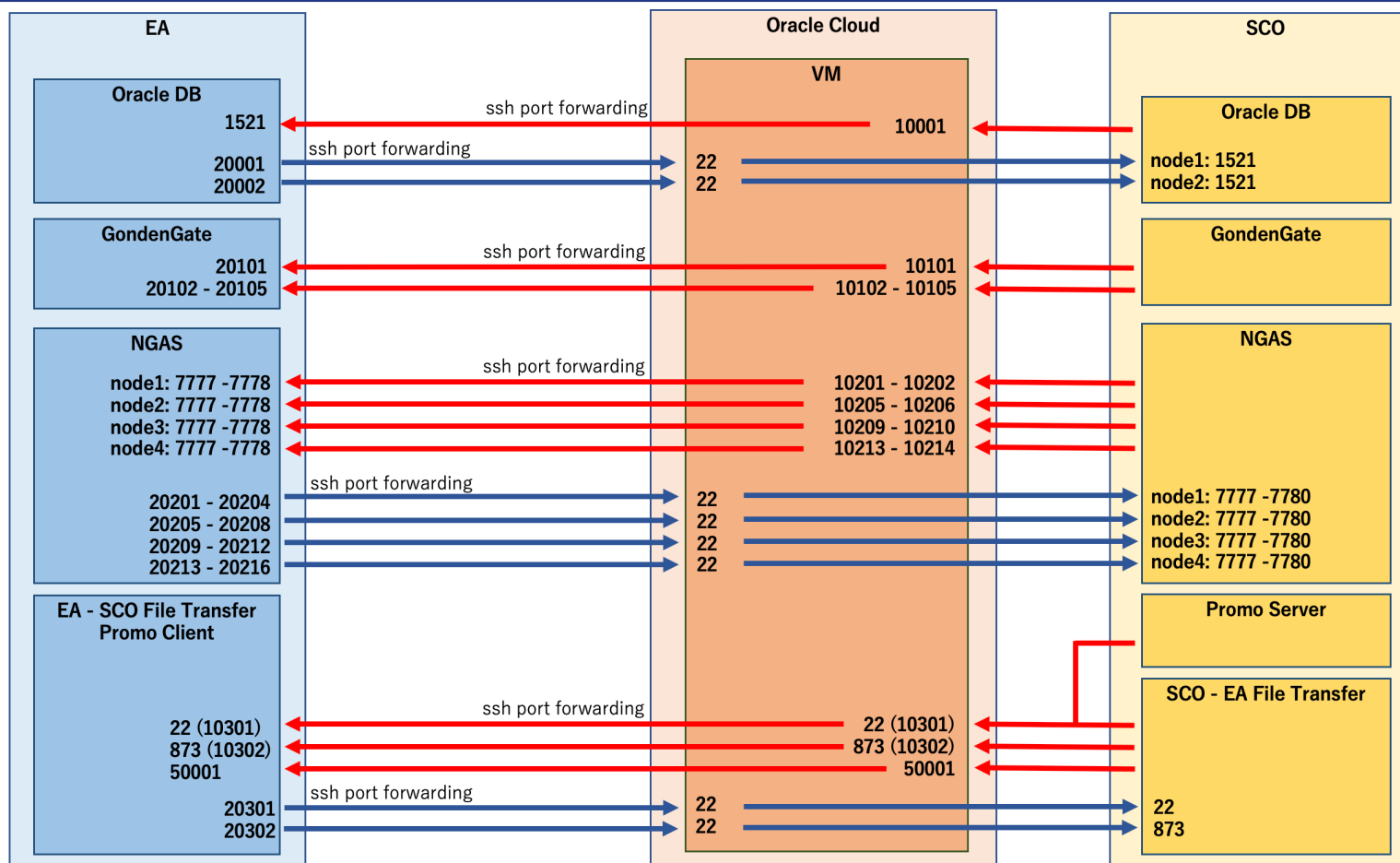
- Make network session from EA Oracle DB to SCO Oracle DB without application configuration change.

```
# sqlplus user/pass@10.200.60.101:1521/ALMA.SCO.CL
```





SSH Port Forwarding for Each Service Connection



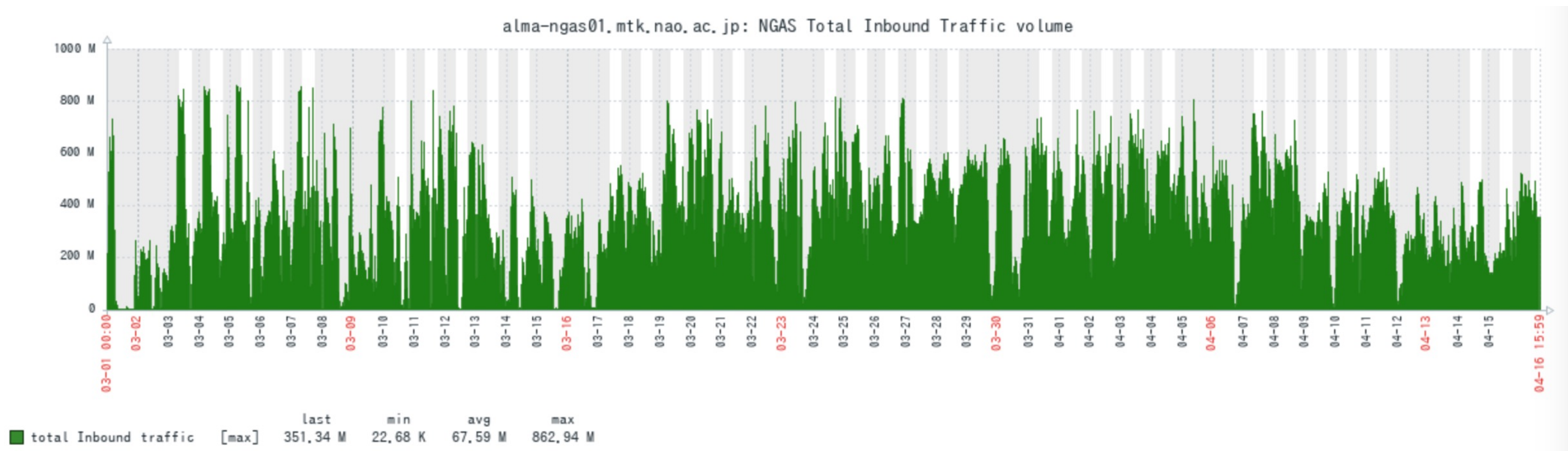
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Actual ALMA Data Transfer Rate

- Measured the throughput of total inbound traffic on all the EA NGAS nodes.
 - From 1st March 2025 (production network migration date)
- Data transfer rates was measured over 400 Mbps constantly.

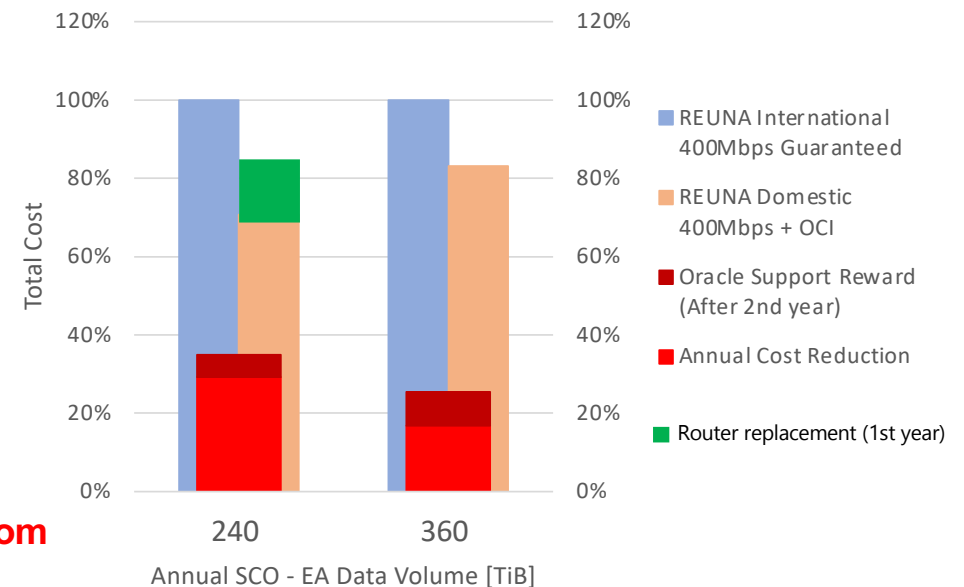




Annual Cost Prediction

- REUNA 400Mbps international line: define this cost as 100%
- REUNA domestic internet line + OCI: 70.7%
 - REUNA 400 Mbps domestic Internet line: 46.8
 - SINET: no cost (NAOJ is paying)
 - OCI Virtual Machine (1 node): 1.6%
 - FastConnect (1Gb) + OCI outbound data transfer: 22.3%
 - EA <-> OCI Tokyo: no charge (FastConnect).
 - OCI Tokyo <-> OCI Santiago: 3.875 JPY/GB (Inter-Region Traffic).
 - OCI Santiago -> SCO: 3.875 JPY/GiB (Outbound traffic).
 - First 10TB is not charged every month.
- Router replacement is required on first year. (18.7%)
- **Annual cost reduction: 29.3%**
- **Oracle Support Reward (25% of OCI usage is discounted from next year's software support fee) : 5.6%**

EA - SCO Network Cost Comparison



SCO -> EA Data Volume [TiB]	REUNA International 400Mbps Guaranteed	REUNA Domestic 400Mbps Guaranteed (30UF)	REUNA Domestic 400Mbps + OCI	Annual Cost Reduction (1st year)	Oracle Support Reward (After 2nd year)	Annual Cost Reduction (after 2nd year, includes Oracle Support Reward)
240	100%	46.8%	70.7%	29.3%	5.6%	34.9%
360	100%	46.8%	83.2%	16.8%	8.7%	25.5%





Considerations

- Possibility the cost is increased by software bug, unexpected big data transfer.
- Possibility the service and prices are changed.
- Possibility the cost-effectiveness may not be achieved on huge volume of ALMA data in the future (PB per year on WSU).
- Keep gathering the information on commercial cloud services and prices, and research if there is a better configuration.



Q&A

