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Design study of REC-XPOZ network for ITER Remote Experimentation Centre (REC)

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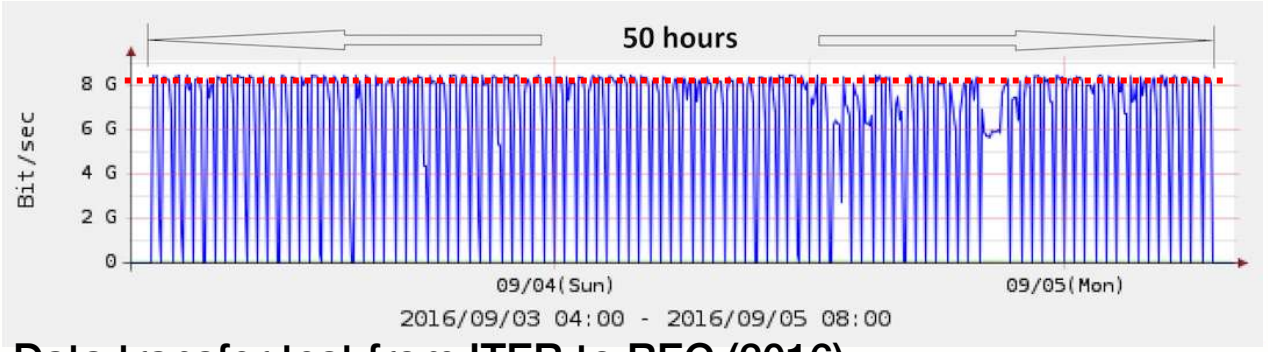
1. ITER Remote Experimentation Centre

ITER Remote Experimentation Centre (REC) has been constructed in Rokkasho, Japan. It is a sub-project of International Fusion Energy Research Centre as part of the **Broader Approach (BA) activities between JA and EU**.

The distance between REC and IO (10000km) causes **200ms latency**. **Full data replication** enables **smooth data access without delay for domestic researchers** and also reduces **onsite computation load and network congestion**.

Data transfer test using *MMCFTP*, average 7.9 Gbps data migration speed with 8 Gbps target speed via L2VPN from IO to REC had been proved. 105TB data was transferred in 50h.

Demonstrations of remote participation with tokamaks, e.g., JET, JT-60SA (mock test), TST-2 (Univ. of Tokyo) and WEST had been successfully carried out during the BA phase I.

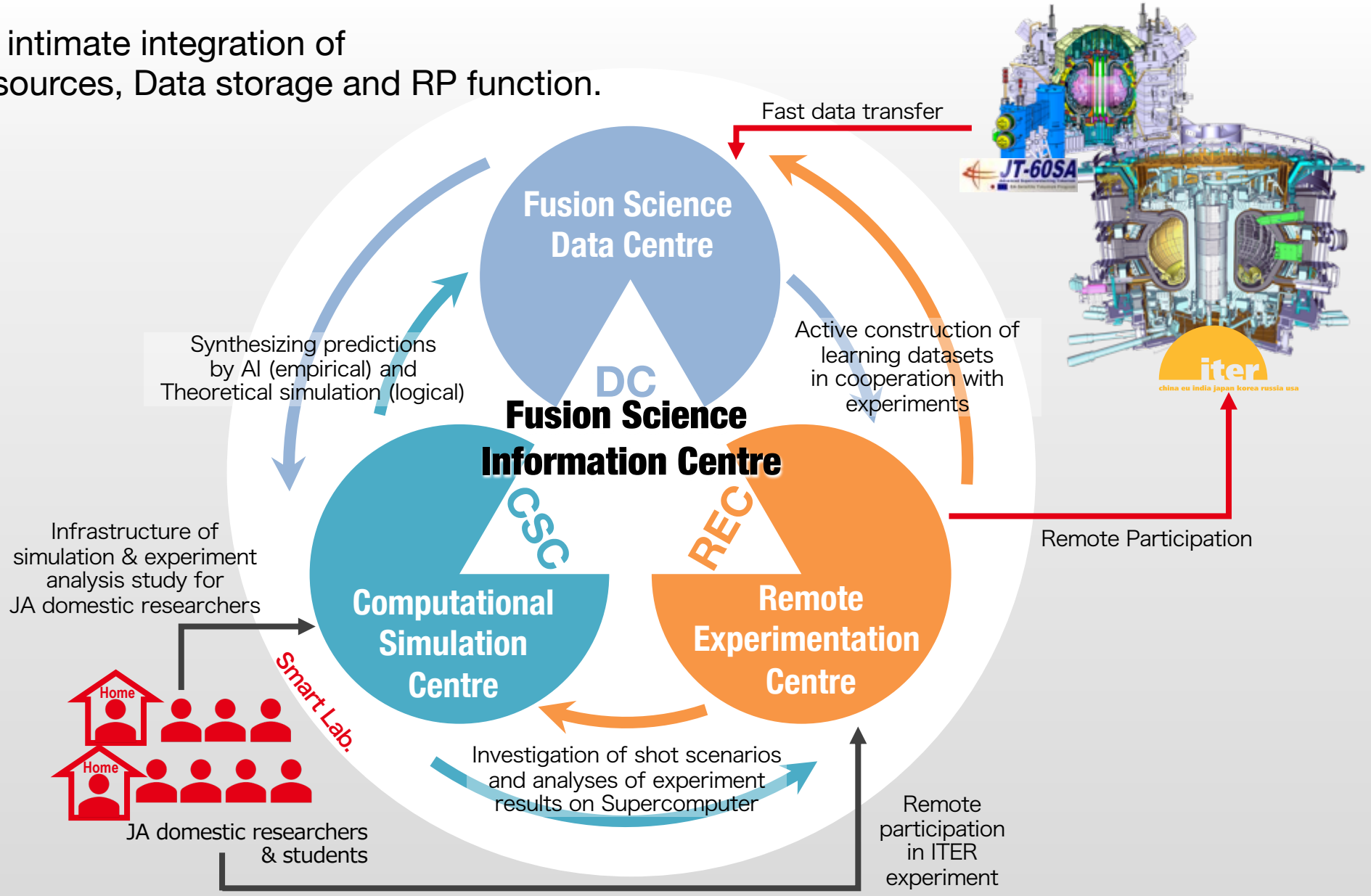


Data transfer test from ITER to REC (2016)

Remote experiment test from REC with WEST (2018)

2. Motivation

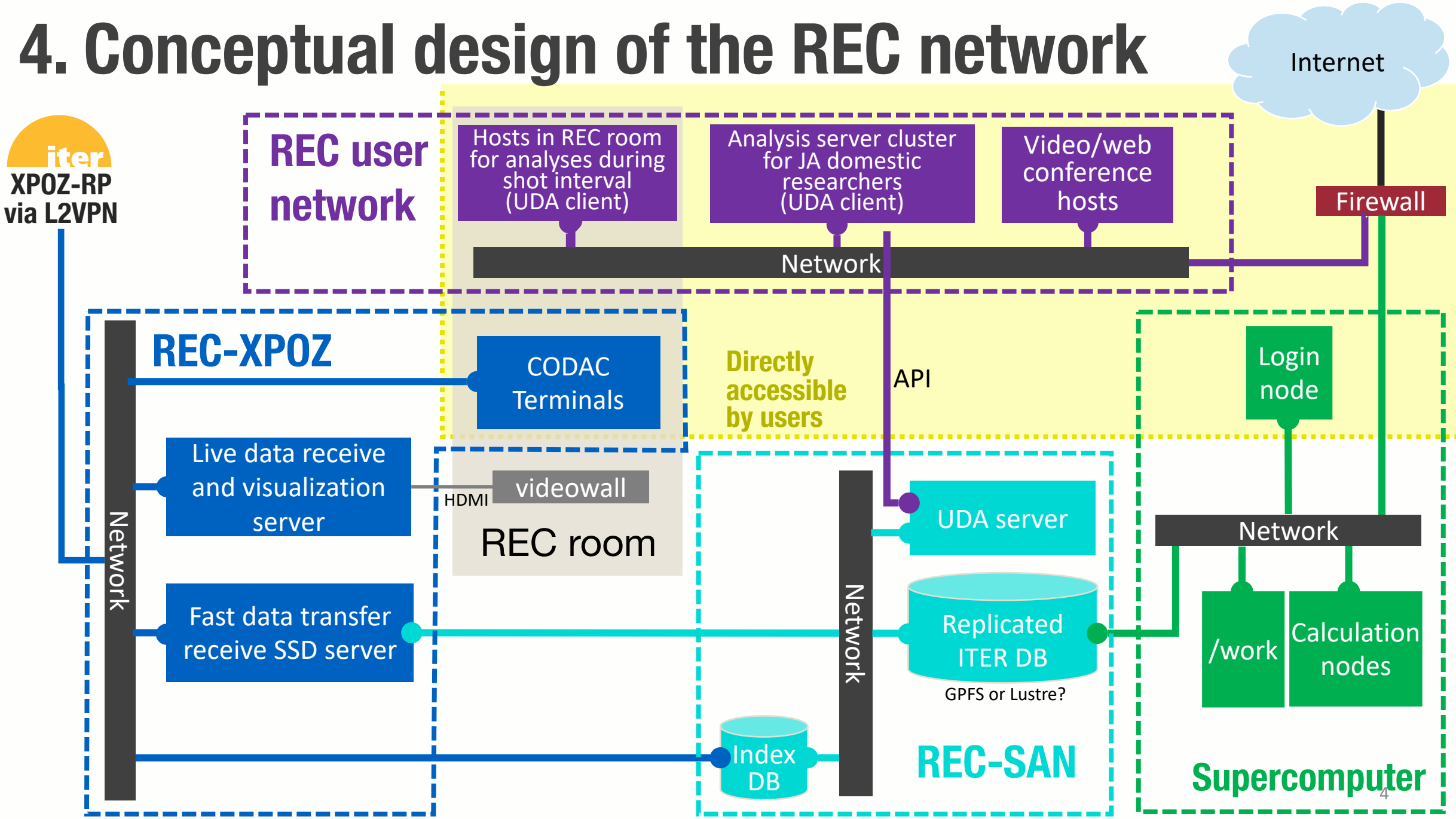
JA is planning intimate integration of
Computing resources, Data storage and RP function.



3. Requirements

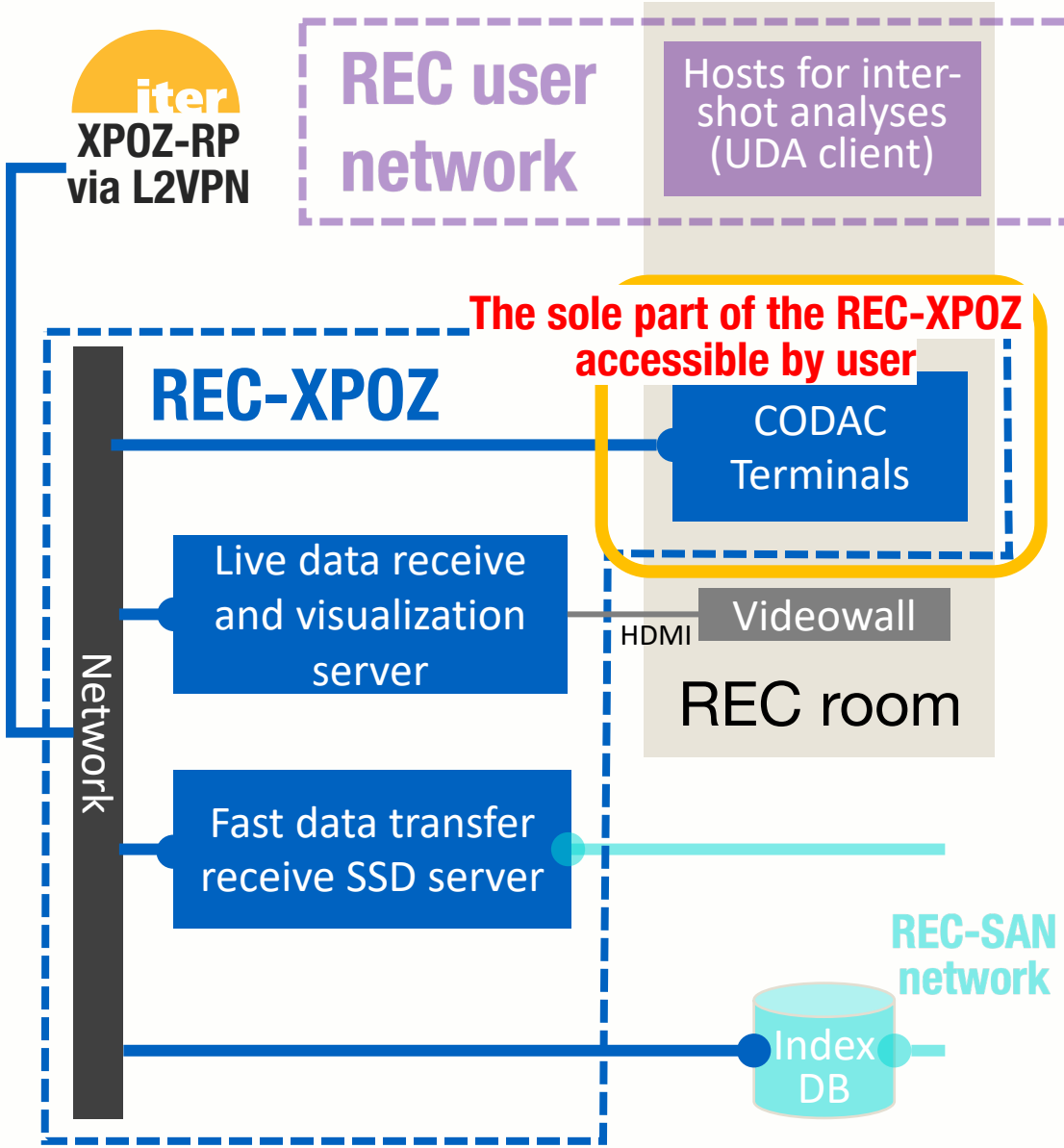
- **Functions**
  - Making proposals for experiments
  - Live monitoring of the current status (experiment and facilities)
  - Efficient scientific verval communication amongst remote sites
  - Analyses during shot interval for next shot
  - Offline post-analysis by researchers in REC or the other JA domestic institutes
- **Performance**
  - Sufficient throughput to replicate whole data generated in ITER to REC
  - Minimize latency to enable smooth operation of CODAC applications from remote site and smooth communication with participants in MCR
  - Nimble access to the replicated dataset from computation resources in Rokkasho for efficient data-driven modeling study based on the ITER data
- **Security**
  - Ensure information security of the dedicated network between IO and REC

4. Conceptual design of the REC network



5. REC-XPOZ(1)

- REC-XPOZ is regarded as an extension of “S3 zone”, which is the same security level as XPOZ in IO, to remote site.
- L2VPN connection between XPOZ-RP and REC-XPOZ via SINET-GEANT-RENATER had been established in 2020. Bandwidth between REC and the nearest SINET DC is currently 10Gbps. (It is **going to be upgraded to 100Gbps** in 2022).
- Construction of REC-XPOZ needs cooperation with IO. Following descriptions are proposal from JA-REC at this moment.
- REC-XPOZ contains CODAC terminals, visualization server to receive live streaming data and SSD gateway server for fast data transfer. There are **no linkage with the other networks except for path for storing the transferred data to REC storages**.



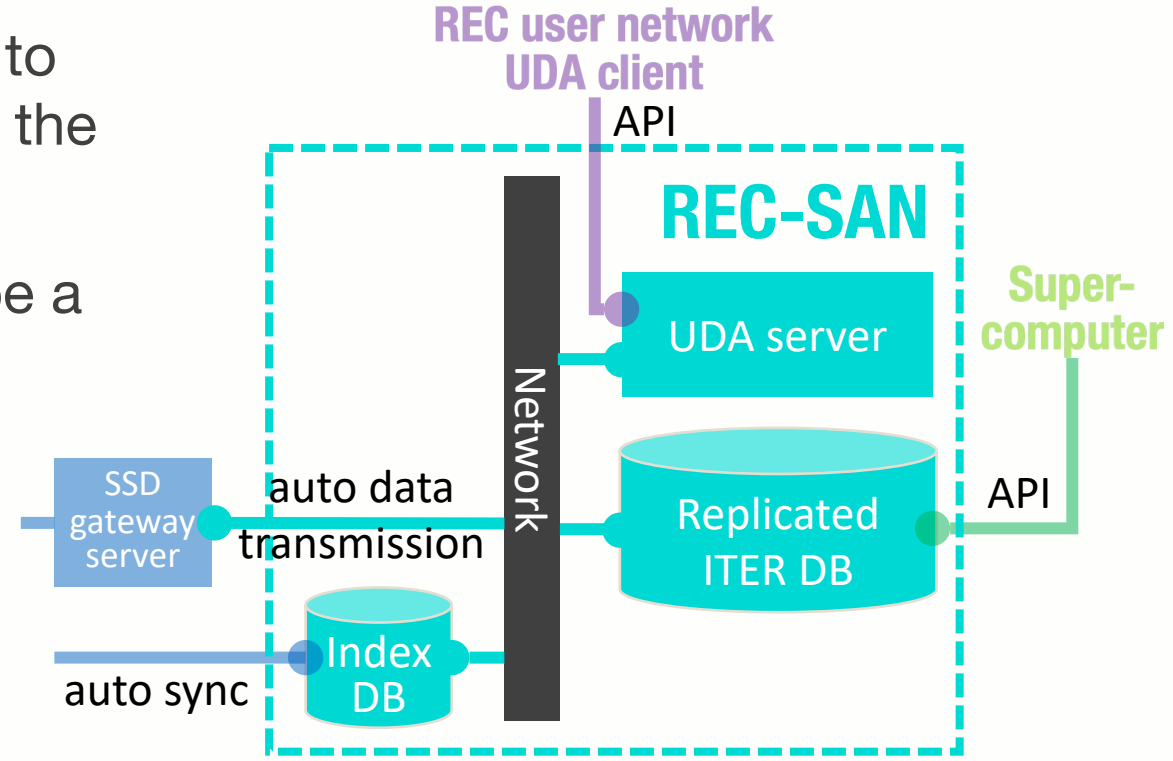
5. REC-XPOZ(2)

- CODAC terminal will be used for accessing CODAC applications hosted in ITER site, e.g., PSPS, ORG, E-log, UDA… and so on. It is based on the CCS and will basically run 24x7.
- Live data montoring server will receive streaming data without time-consuming disk I/O (memory-to-memory transfer) and visualize them on the REC Videowall.
- Ultra-fast file transfer method, e.g., MMCFTP will be empolyed for data replication. Data is expected to be sent from XPOZ-RP to the SSD gateway server in REC-XPOZ via L2VPN.
- **Security of the REC-XPOZ needs special care**
  - **Security of the CODAC terminals**
    CODAC terminals are in REC room where accesible by users. Improvement of physical security of the CODAC terminals are ongoing in addition to current physical access control of the REC room.
  - **Security of the SSD gateway server**
    REC-XPOZ is isolated from the other networks except for data re-transmission channels from the SSD gateway server to REC storage. The SSD server must not be logined by user. It automatically re-transmit the received data to REC storage and works as a **protocol translator** (e.g. from MMCFTP to Lustre over RDMA).

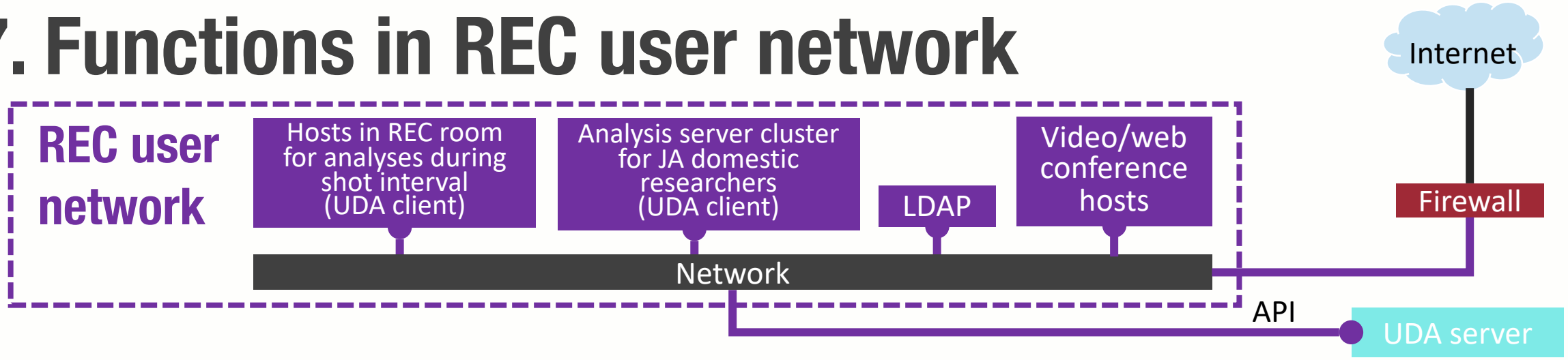
6. Design of REC-SAN (Storage Area Network)

- REC-SAN will store and serve all of the replicated data for analyses.
  It is also an isolated network and **no direct human access is expected**.
  Data I/O only via dedicated API, automatic data transmission/synchronization are permitted.

- A UDA server will be prepared in the REC-SAN to serve the data against retrieval request through the API from UDA clients in “REC user network”.
- The Index DB for ITER data repository should be a part of this segment as well.
  It would synchronize with original DB in IO via the L2VPN or another path.
- Access from supercomputer may need another fast dedicated API.



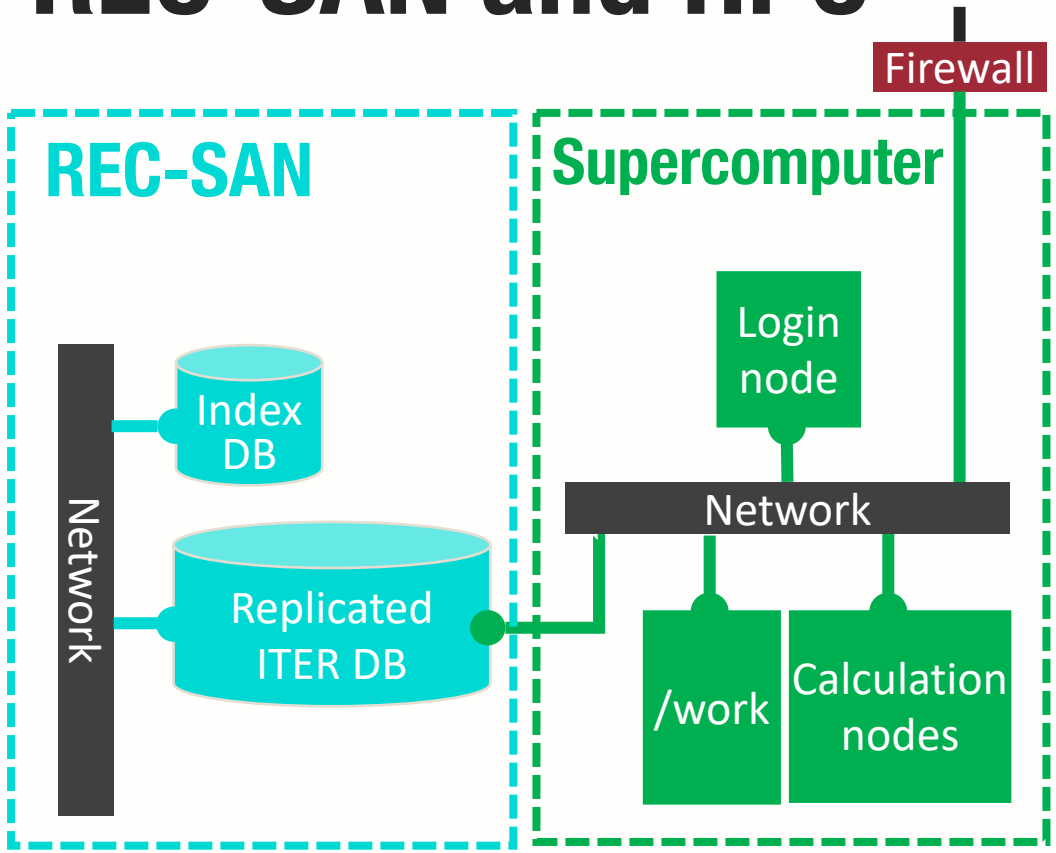
7. Functions in REC user network



- REC user network (RUN) is general user network for daily activities of researchers. It allows usual internet access. Thus, **web conference services** are available.
- Data analyses based on the replicated data are feasible on UDA clients in th RUN.
- Analysis server cluster for JA domestic researchers will be prepared. Registered user can remotely login to the server via internet with secure authentication process and carry out ITER experimental study remotely from their institutes.
- RUN is **strictly separated from REC-XPOZ** (no connection path exists).

8. Toward to linkage between REC-SAN and HPC

- Statistical analyses, data-driven modeling and so on based on ITER data will be one of the essential research theme toward to DEMO. **Fast and efficient link between ITER data storage and computing resources is a key factor of REC network** as an infrastructure for such researches.
- Machine learning method demands loading dataset consist of numerous number of shots. It would cause **different access pattern to the storage than shot-by-shot data retrieval** for conventional analyses to be covered by the UDA system. Another API could be demanded.
- Efficient linkage between growing huge experimental data storage system and “closed” HPC system is a new challenge for data acquisition and analysis system.



9. Summary

- Conceptual design study of REC-network for remote participation in ITER experiment is progressing.
- Design of REC-XPOZ has been proposed as the isolated network from the other networks. Security of CODAC terminals needs special care.
  A gateway SSD server for fast data transfer from XPOZ-RP in IO to REC-XPOZ over L2VPN exists in REC-XPOZ. It automatically re-transmits the transferred data to the REC-SAN with different protocol.
- The REC-SAN will be prepared to store and serve the replicated data as another isolated network segment where no direct human access is expected.
- Researchers in REC and from the other domestic institutes can access to replicated database kept in REC-SAN via UDA client-server system from the RUN. Communication by web conference services is capable.
- REC network has to be consturcted through close discussion with IO CODAC/IT. It will be carried out based on the cooperation arrangement between IO and BA.