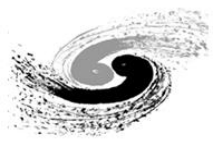

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An XRootD Agent as A Unified Storage Interface for INK Platform

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On behalf of Ink Group, IHEP Computing Center

XRootD & FTS Workshop · CNRS Rhône-Auvergne, Lyon

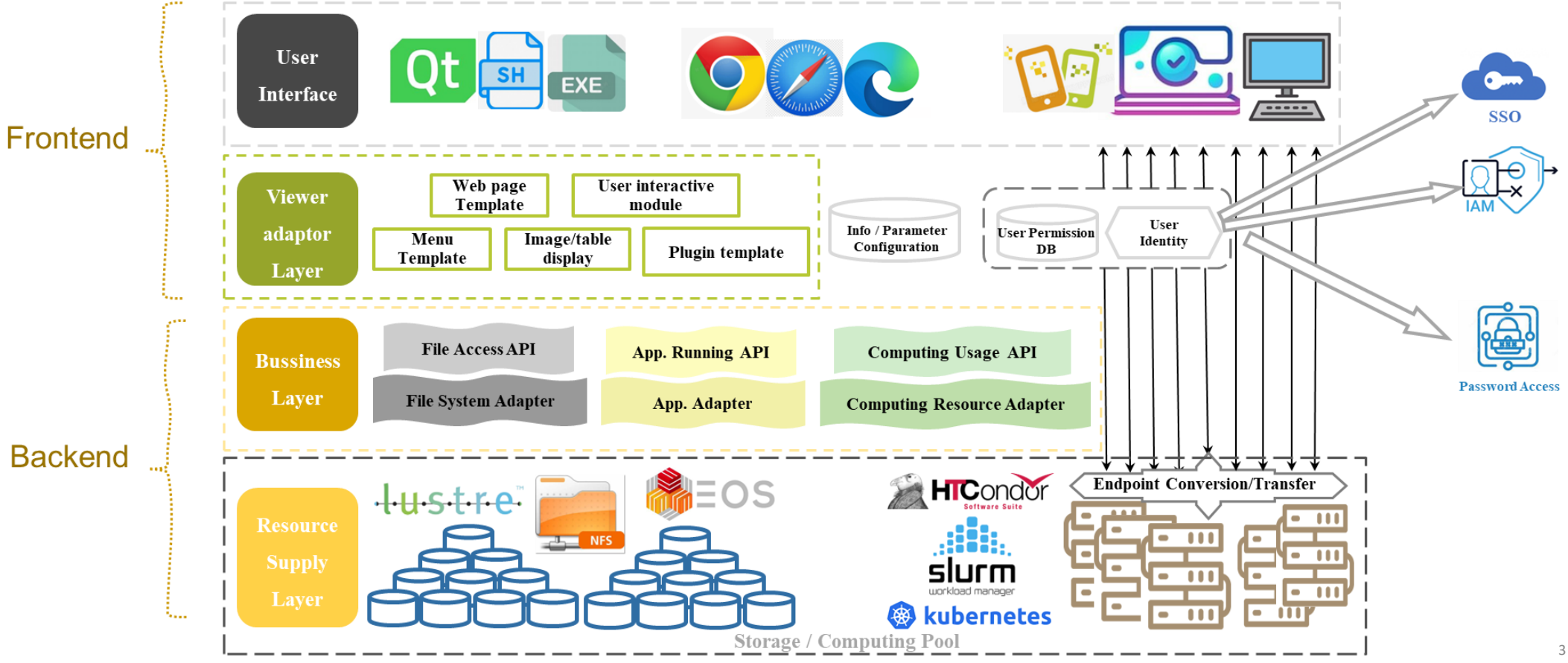
Ink - Interactive aNalysis worKbench

- A friendly web-based interactive development and research platform
  - Providing various interactive services/apps to speed up research
    - VS Code (Coder), JupyterLab, ROOT Browse, VNC, SSH tunnel, WebSSH, AI Agent
- Loose and flexible modular designing architecture
  - Easy to integrate various resources
    - Computing : HTCondor, Slurm, Kubernetes …
    - Storage : EOS, Lustre, NFS…
  - Authentication & authorization
    - Diverse methods (SSO, token, passwd, krb5)
- Flexible application integration and customization
  - Easy to deploy and develop customed service

INK Architecture

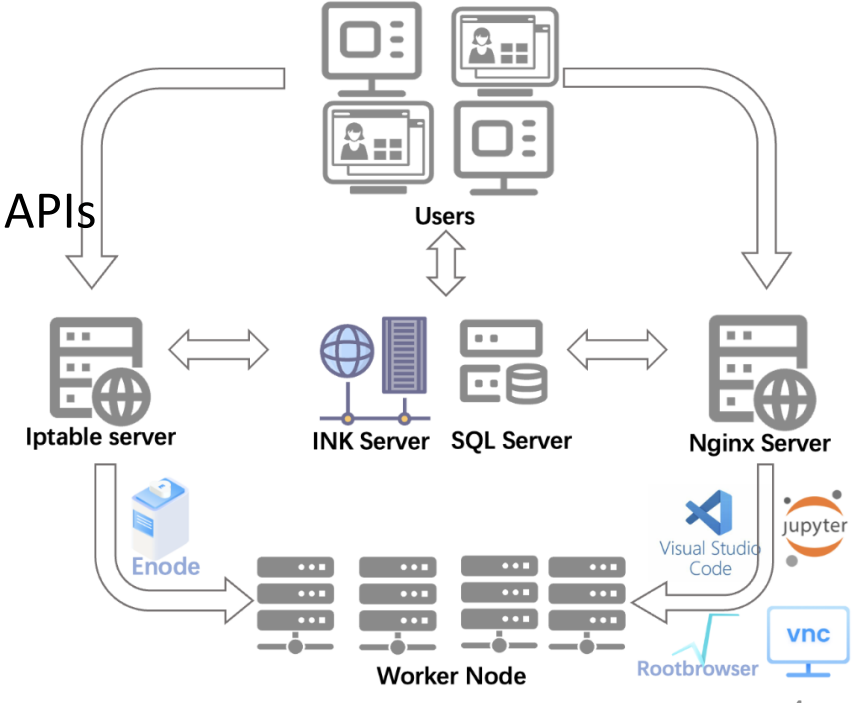
Hierarchical layers structure

Separation of frontend and backend



The Way of Ink

- Core concept - **Computing as Web Services**
  - Running modern developing and interactive analysis tools as cluster jobs
  - Cluster jobs exposed as web service proxied by web servers
  - Users can access clusters resources within modern web browsers
- Key features
  - JUST web browser, no SSH, no VM, no VPN …
  - Build & integrate custom apps with unified cluster APIs
  - All services run inside containers, easily to deploy
- Key services
  - Program developing: VS Code, Jupyter, GUI…
  - Terminal: SSH tunnel, Web-based Shell…
  - Files: Upload / Download / Delete / View / Share
  - AI Agent: OpenClaw, OpenCode, OpenChamber…



INK

Home

Navigation

Home | Dashboard | Eshell | Files | Ink Jobs | Help | biyj

Service

Services

Files | Eshell | Dashboard | INK Jobs | JobLens

Ink Jobs Statistics

Ink Jobs Statistics

Current Interactive Jobs

166 jobs

Vscode 95 | Openchamber 26 | Enode 15 | Oper 1/3

Statistics of Interactive Jobs

150 120 90 60 30 0

20:00-20:30 | 01:30-02:00 | 07:00-07:30 | 12:30-13:00 | 18:00-18:30

vscode | enode | jupyter | vnc | rootb 1/4

Applications

Application CentOS7 AlmaLinux9

OpenChamber | VScode | Jupyter | Root Browse | Vnc

User Job's Pane

My Ink Jobs

Operation	Job Type	Job Status	Job ID	OS For Job
Connect	openchamber	RUNNING	14765	AlmaLinux9
–	–	–	–	–
–	–	–	–	–

IHEP Computing Overview

Platform Overview

HTC CLUSTER | HPC CLUSTER

Running Jobs

60,000 50,000 40,000 30,000 20,000 10,000 0

19:00:00 | 21:00:00 | 23:00:00 | 01:00:00 | 03:00:00 | 05:00:00 | 07:00:00 | 09:00:00 | 11:00:00 | 13:00:00 | 15:00:00 | 17:00:00

atlas | cms | dqmjuno | dyw | gecam | herd | herdrun | higgs | hxmt | juno | junodc | ju 1/2

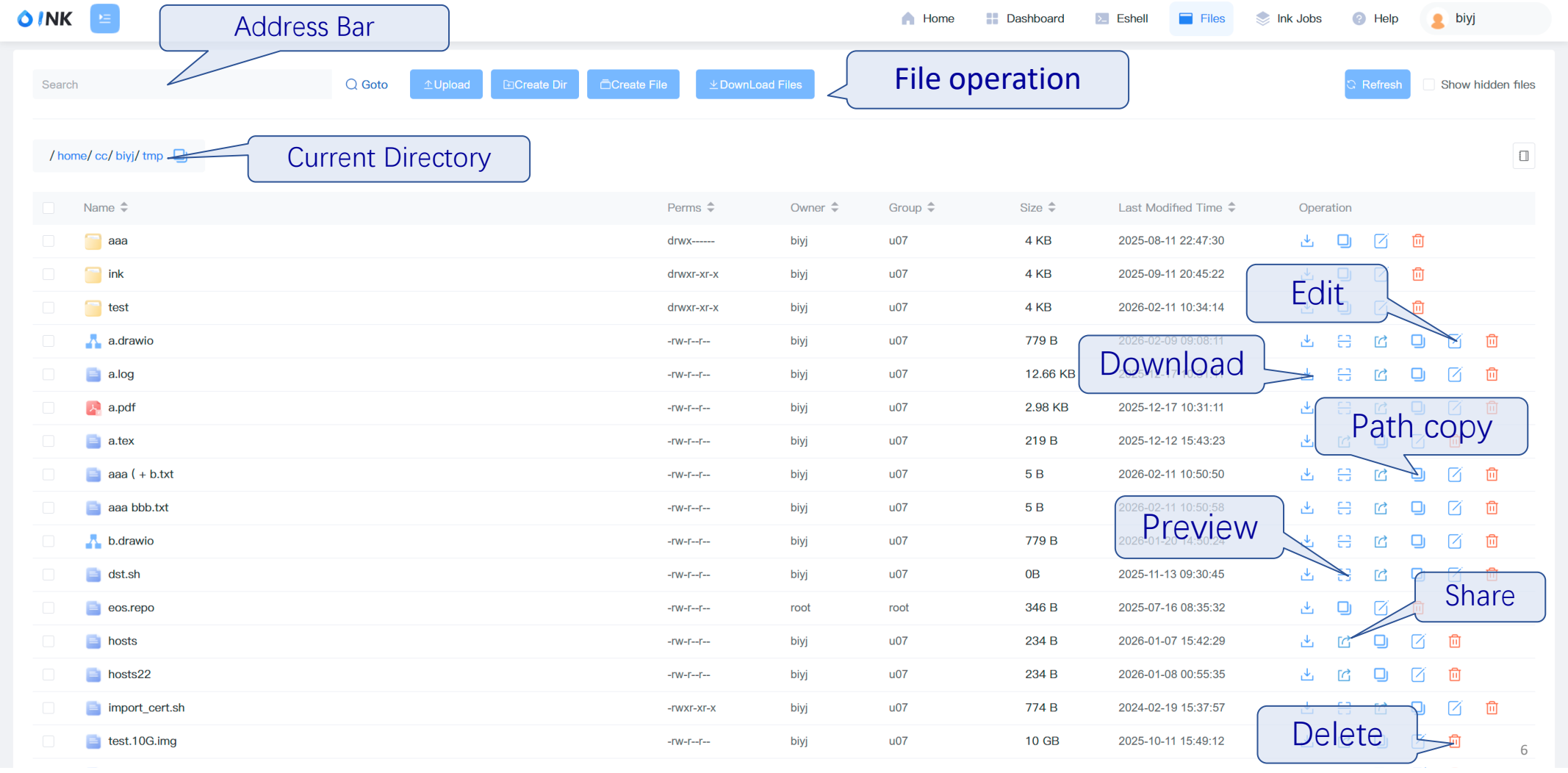
Queueing Jobs

300,000 250,000 200,000 150,000 100,000 50,000 0

19:00:00 | 21:00:00 | 23:00:00 | 01:00:00 | 03:00:00 | 05:00:00 | 07:00:00 | 09:00:00 | 11:00:00 | 13:00:00 | 15:00:00 | 17:00:00

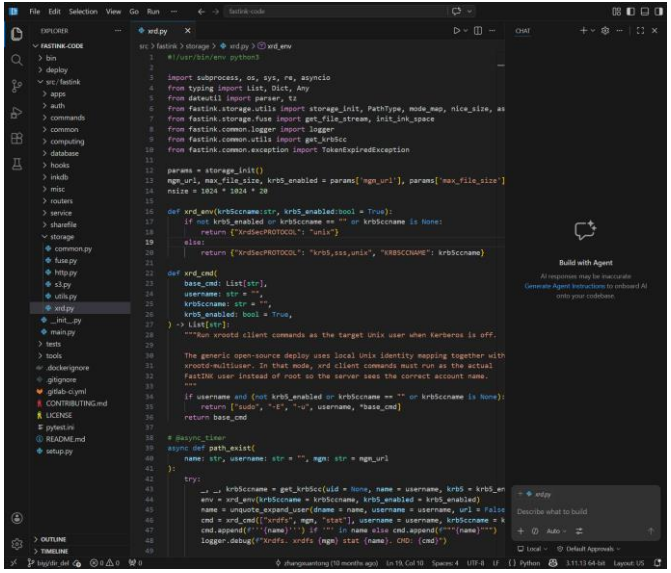
atlas | cms | dqmjuno | dyw | gecam | herd | higgs | hxmt | juno | junodc | junogns | ju 1/2

Cluster File Manager



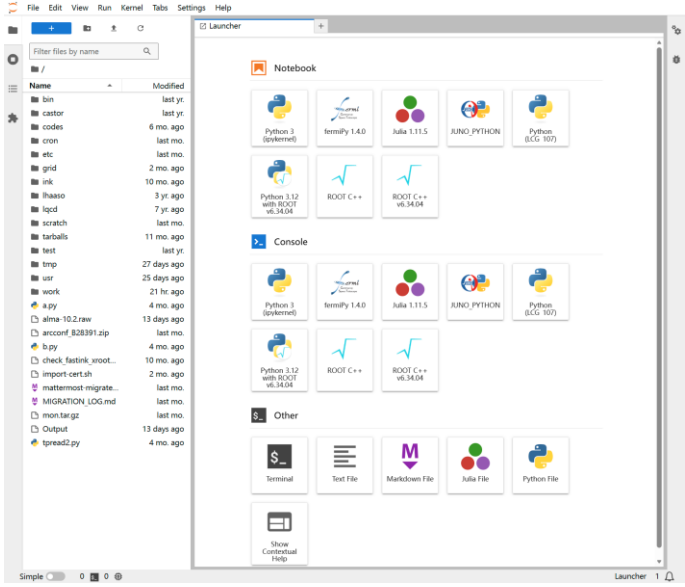
Coding and Analysis Tools

VS Code



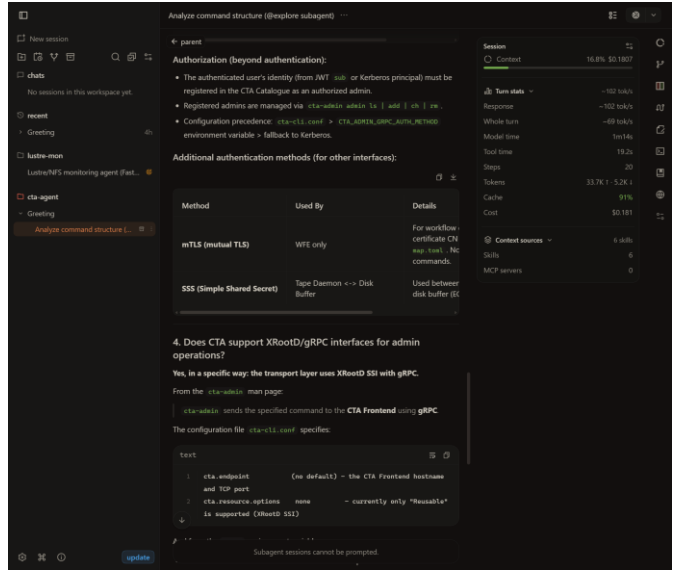
Code, terminal and extensions in a managed session

JupyterLab



Interactive notebooks with scientific and experiment kernels

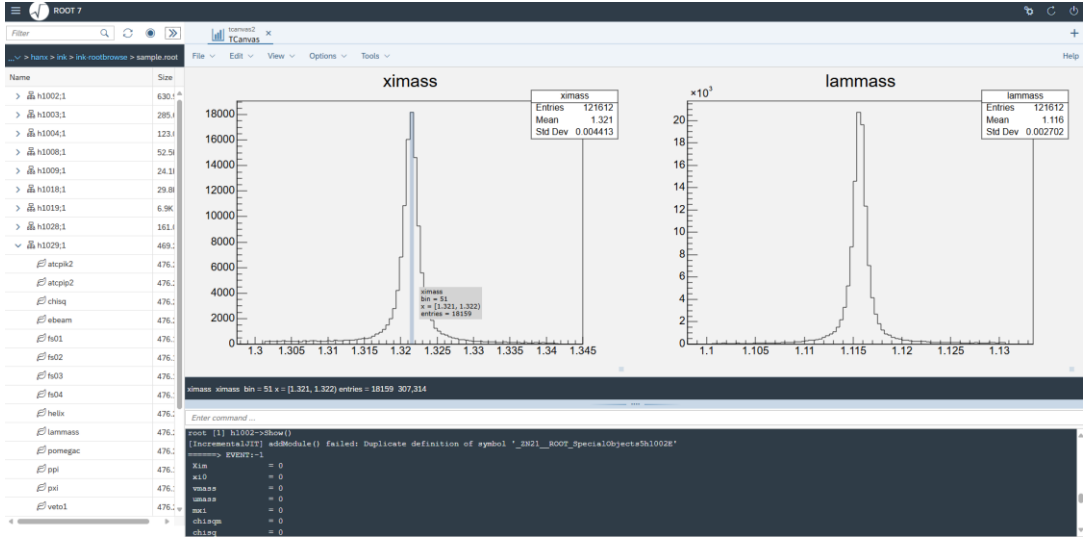
OpenChamber



Powerful AI coding agent with configurable LLM models

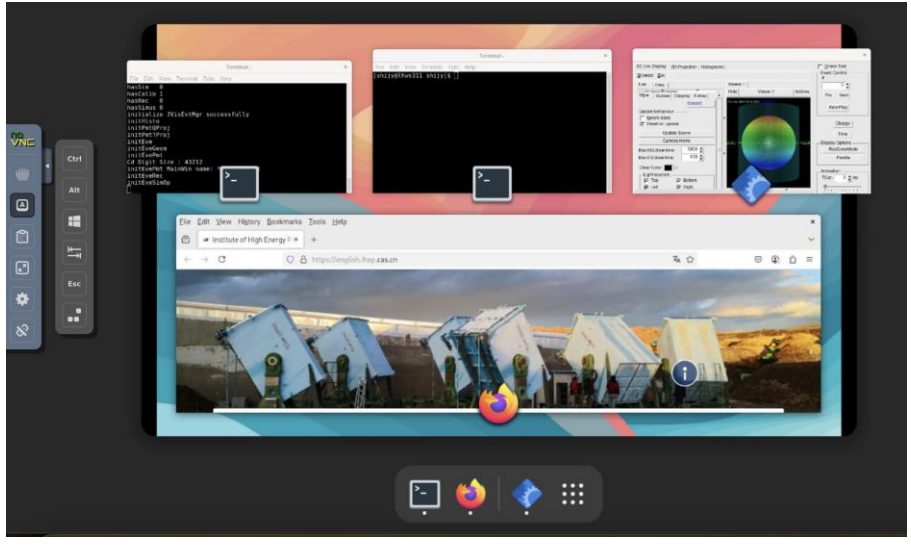
Interactive Graphical Applications

ROOT Browse



Inspect ROOT files
and interact with plots

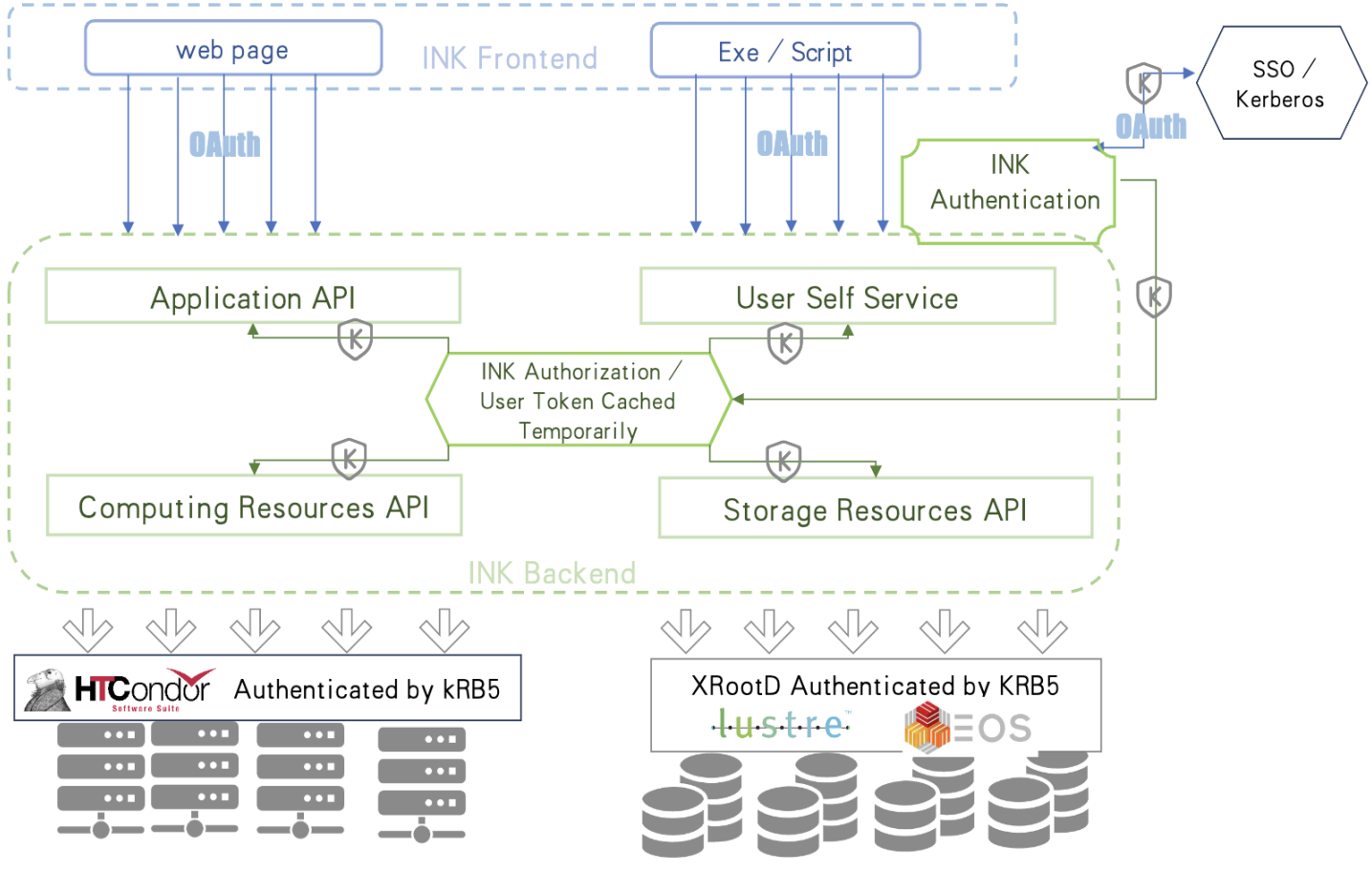
VNC desktop



Use graphical applications
close to the analysis data

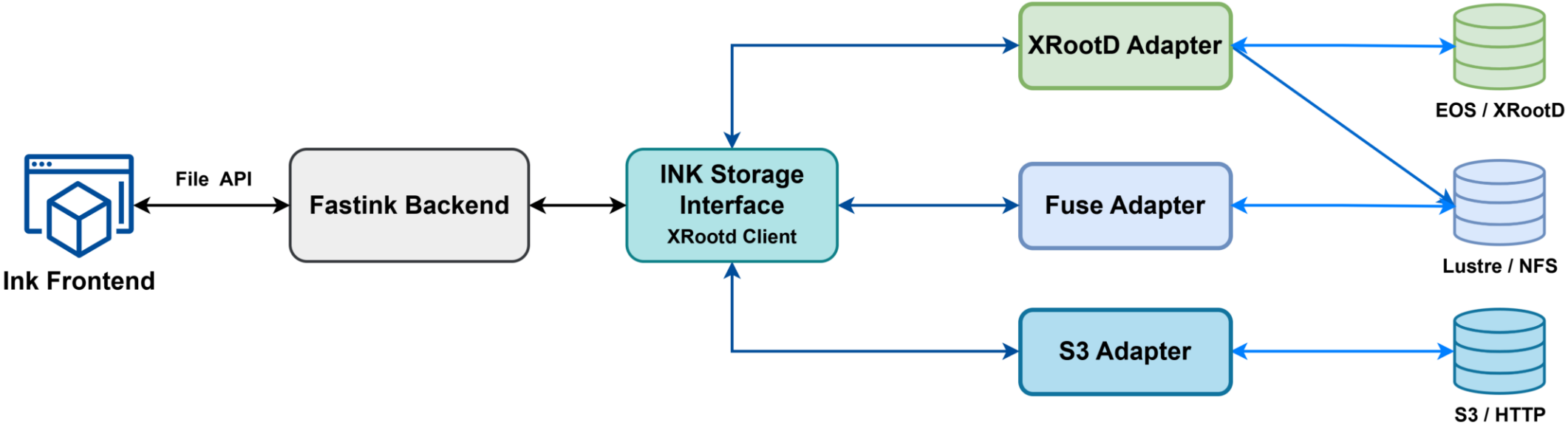
Authentication and Authorization

- **SSO/Unix authentication**
  - Kerberos 5
    - user authentication
    - Computing & storage usage
- **OAuth authentication for INK frontend/backend**
- **Krb5 authorization mechanism**
  - Kerberos 5 service provides short-term user ticket
  - INK caches and refreshes user tokens during the job execution



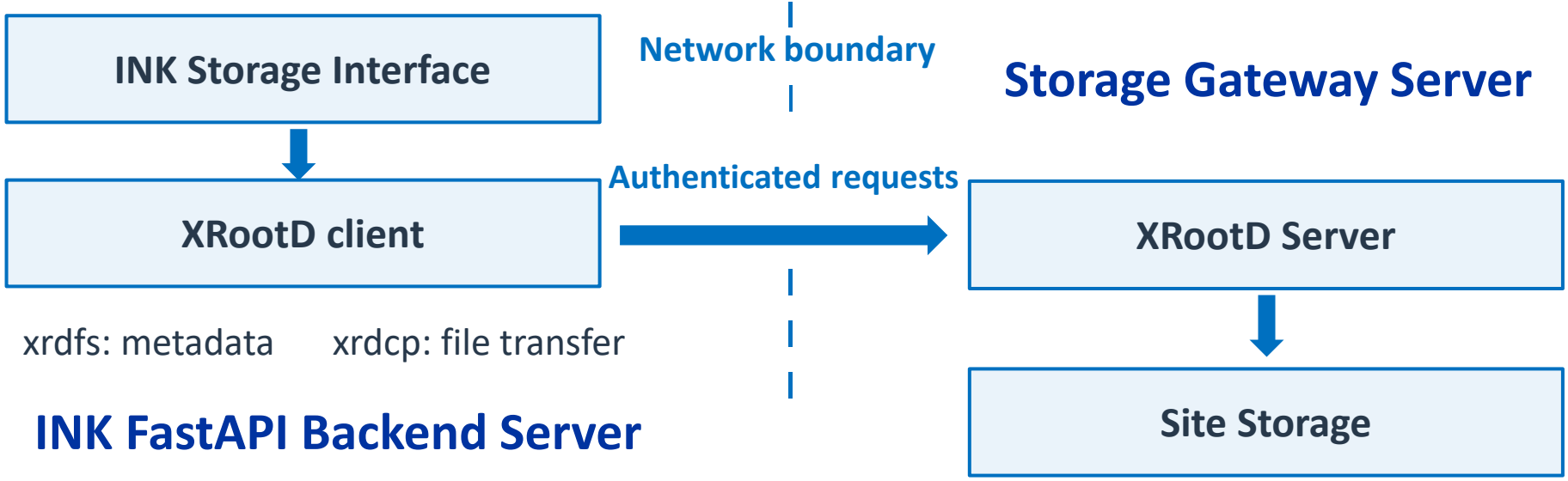
A Unified Storage Interface Using XRootD

- **Providing web users access to cluster storages using one set of unified APIs**
  - Browsing, download, upload, sharing, and manangemnt
- **XRootD toolset as an agent to talk with backend storage endpoints**
  - With user Kerberos token from database to switch to normal user



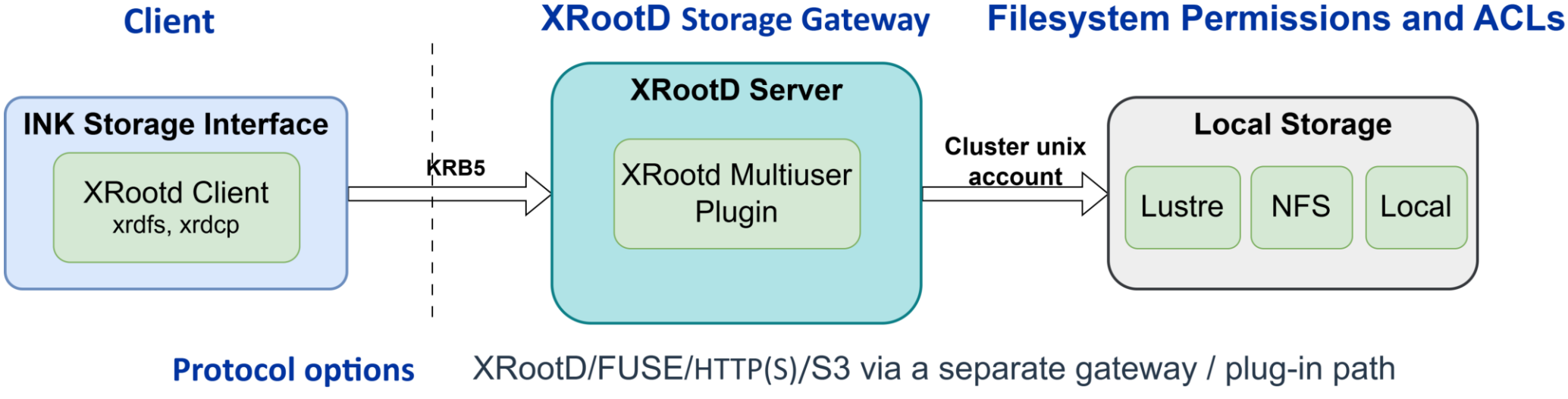
Why Using XRootD in INK?

- Various storages used in IHEP for different experiments
  - most are Lustre or NFS, some are EOSs , and Ceph/JWanFS for AI
- Supports various authentication like krb5, sss, token and protocols like xrootd, http, s3
- Client & server are separated, cluster storage will not affect Ink backend
  - If a Lustre/NFS mountpoint is dead, Ink backend can still response requests normally.

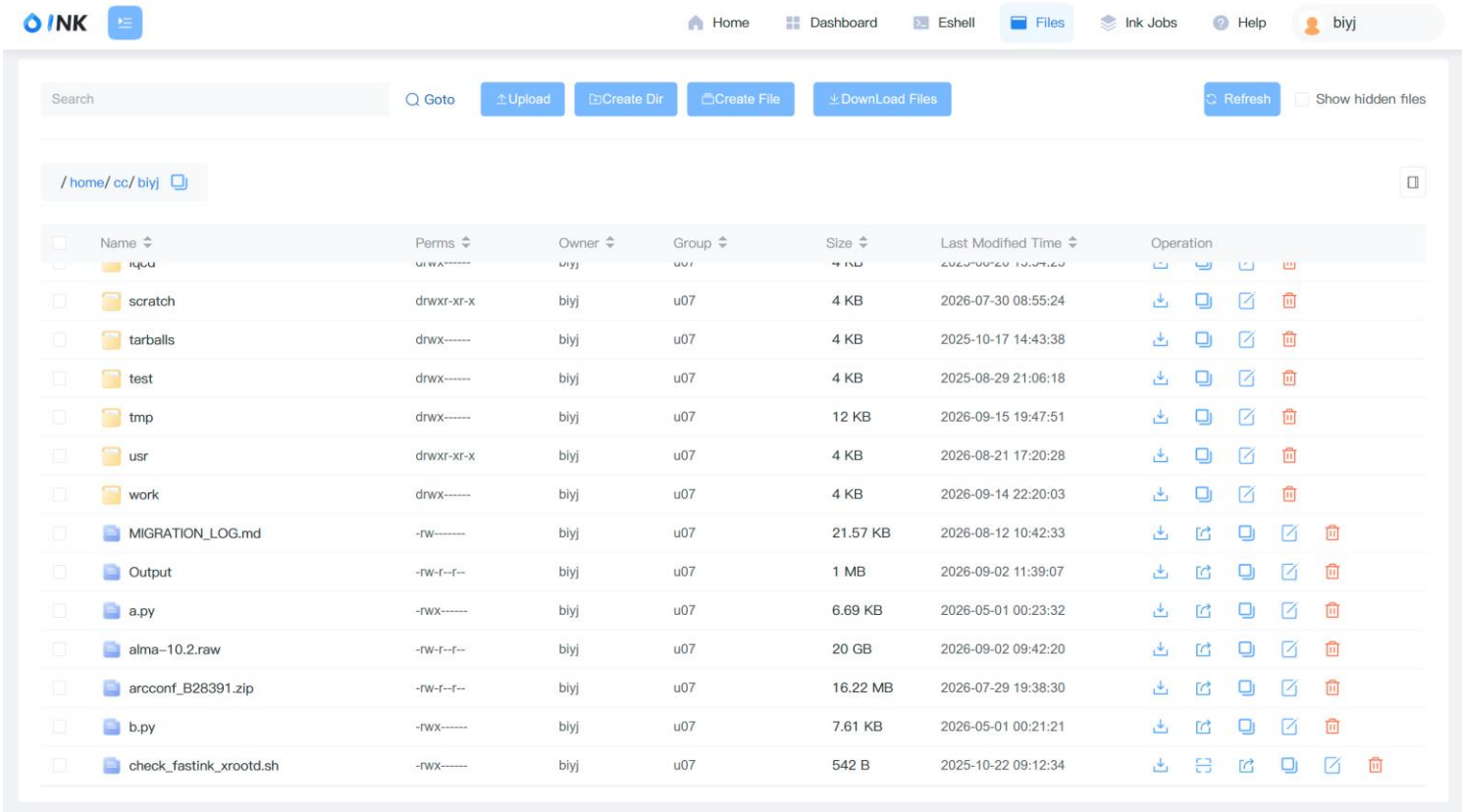


XRootD Gateway for Lustre and NFS

- Standalone Server or Cluster with KRB5 authentication enabled
- XRootD-multiuser plugin handle with cluster unix account mapping
- KRB5 is preferred than Unix or token in IHEP for security and usage scenarios
  - Lustre and NFS storages at IHEP don't support krb5 by default



File Manager APIs



Browse and inspect

List paths, find home, preview

Move data

Upload, file download, ZIP

Manage workspaces

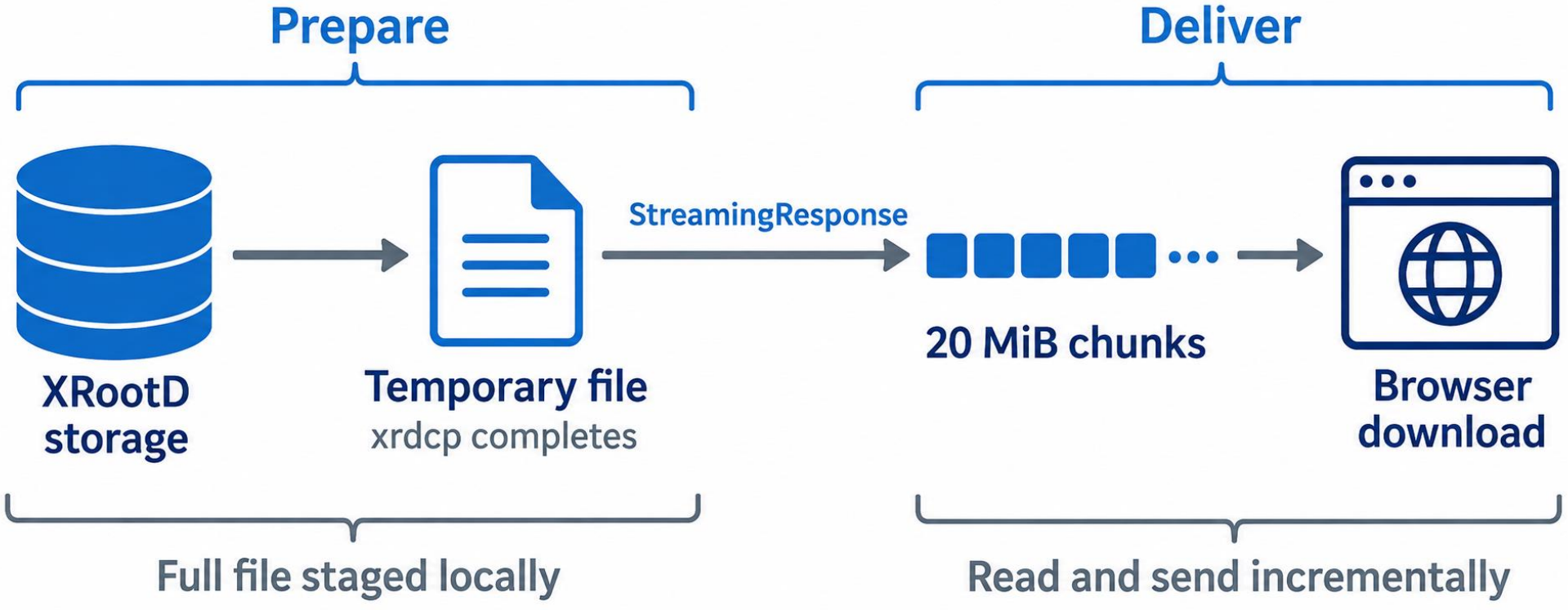
Create, rename and delete

Control access

Permissions and sharing

Browser actions use the same cluster-side files as analysis applications

Streaming Single File download



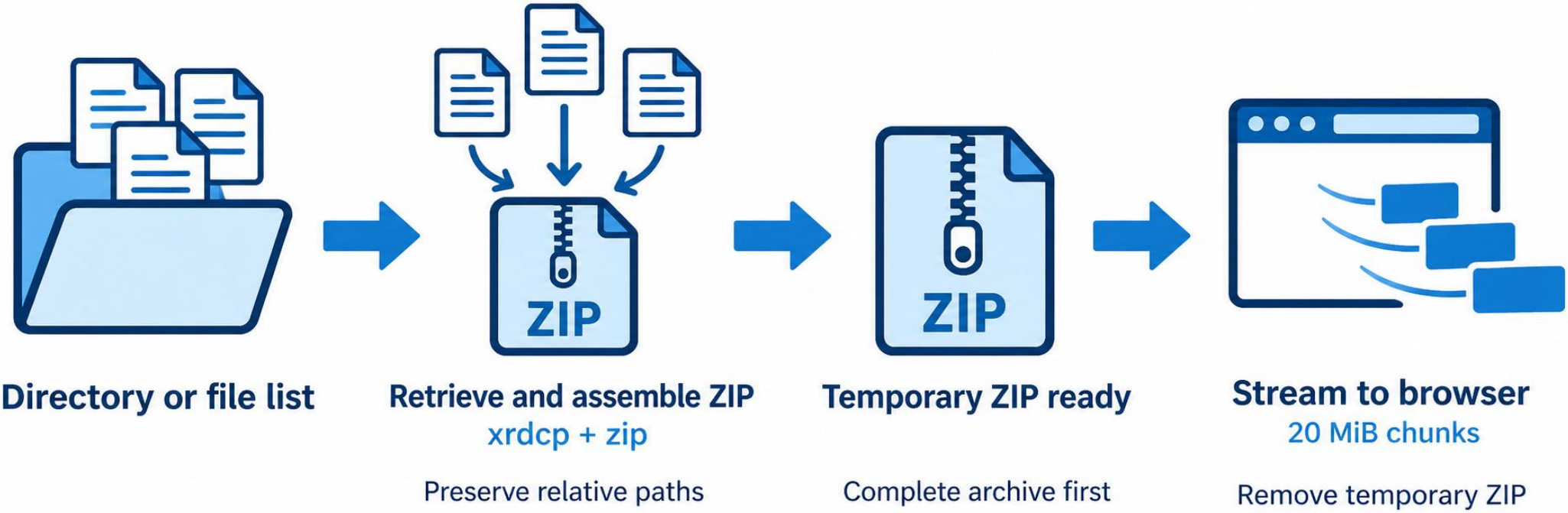
Current implementation: staging locally, then HTTP streaming to client

Archive download: directories and lists

- Create an empty zip file locally, and then append files/dirs recursively

```
xrdcp --retry 3 root://remote//path/to/file - | zip -u temp.zip
```

- Temporary ZIP file preserves the selected directory/files structure
- Stream temporary zip file using xrdcp to client browser, and remove it



Summary

- Ink is an friendly web-based interactive devops and research platform
  - Various interactive services/apps: VS Code, Jupyterlab, Web VNC, AI agent …
- Ink storage interface bridges web users and cluster storage securely
  - Using XRootD as a client, and XRootD server exports Lustre/NFS with krb5 enabled
  - xrootd-multiuser plugin handles cluster unix account mapping
  - Providing unified restful APIs XRootD gateway or other backend

https://ink.ihep.ac.cn

Thanks!