

Third-party-copy Transfer Service Status of JUNO Experiment

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Introduction



Jiangmen Underground Neutrino Observatory (JUNO) is a multi-purpose neutrino experiment located in southern China.

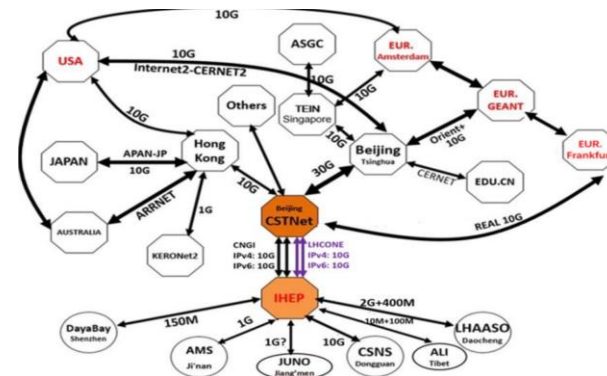
JUNO Computing resources status (at the end of 2021):

- ~94 KHepSpeco6 (~4600 cores).
- ~4.6 PB Disk and ~2 PB Tape.

| Site | Computing (KHepSpeco6) | Storage (Disk + Tape, TB) |
|----------|------------------------|---------------------------|
| CNAF | 3.83 | 620 + 100 |
| IHEP | 40 | 4300 + 2000 |
| CC-IN2P3 | 2.3 | 200 + 51.5 |
| JINR | 48 | 600 + 0 |
| Total | 94.3 | 4560 + 2151.5 |

JUNO joined LHCONE in April, 2021:

- IHEP <-> JINR, IN2P3, CNAF, 10 Gbps.
- CNAF <-> IN2P3, 100 Gbps.
- GEANT <-> JINR, 10 Gbps.



JUNO Experiments Transfer Task

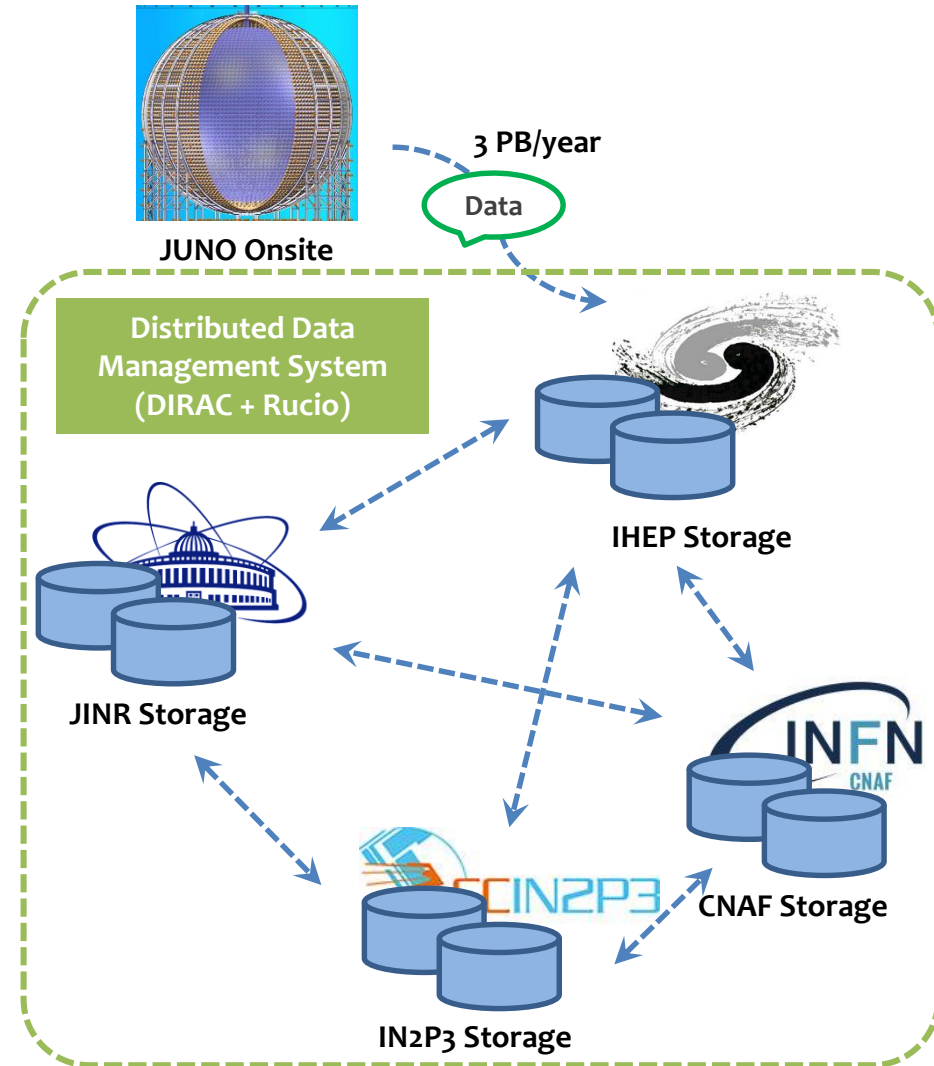


Task and Challenge:

1. ~3 PB/year data transfer. IHEP, China
-> CNAF / CC-IN2P3 / JINR, Europe.
2. Users / Production data transfer tasks managements, generated by DIRAC.

TPC Goals for JUNO:

1. HTTP / Xrootd protocol replaces Gridftp.
2. Support TPC transfer in present distributed data management system.
3. Support TPC protocols in all data centers storage.
4. Monitoring system with regular TPC function and performance test.
5. Mass TPC transfer test before experiment production.



JUNO Experiment Transfer Model

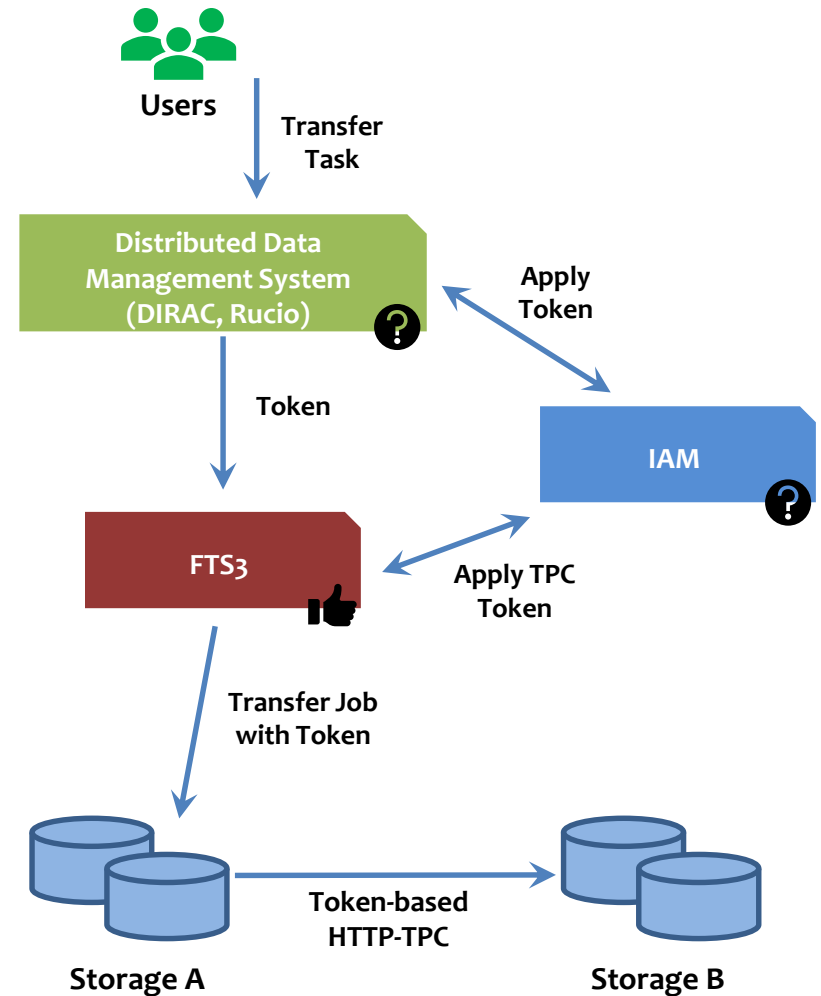


Model Design:

- IHEP-DIRAC, integrated with Rucio, works as distributed system, managing data transfer tasks.
- IAM, with X509 and tokens support, manages TPC transfer token exchange.
- FTS3 manage TPC transfer jobs between storages, with generated token.

Status:

- An independent Rucio system is in production, DIRAC integration based on BelleII experience is in developing.
- IAM test beds in CNAF and IHEP are deployed.
- FTS3 services is ready for token-based TPC.
- At present, Macaroon token is already supported in test and data pre-production.



TPC Protocols Supports in Storages



| Data Center | Storage System | Access Protocols | Token-based HTTP-TPC Support | Xrootd TPC Support | Available Tokens | Working Status |
|-------------|----------------|-------------------|------------------------------|--------------------|------------------|----------------|
| CNAF | StoRM | HTTP, Xrootd, SRM | Yes | No | Tokens, Macaroon | In production |
| IHEP | EOS | HTTP, Xrootd | Yes | Yes | Macaroon | In production |
| CC-IN2P3 | dCache | HTTP, Xrootd | Yes | No | Macaroon | In Production |
| JINR | EOS | HTTP, Xrootd | Not yet, Streamed Only | Yes | Not yet | In Production |

JUNO TPC Protocols Design:

- [HTTP protocol works as main protocol](#), providing both data access service and token-based TPC transfer. Supporting Tokens and Macaroon.
- [Xrootd protocol works as back-up protocol](#).

Status:

- All JUNO storages have already supported data access by HTTP / Xrootd protocol.
- CNAF / IHEP / CC-IN2P3 have already supported HTTP-TPC. JINR will soon support HTTP-TPC in first half of this year.
- Macaroon is the basic available token, sci-token support with IAM system is in progress.

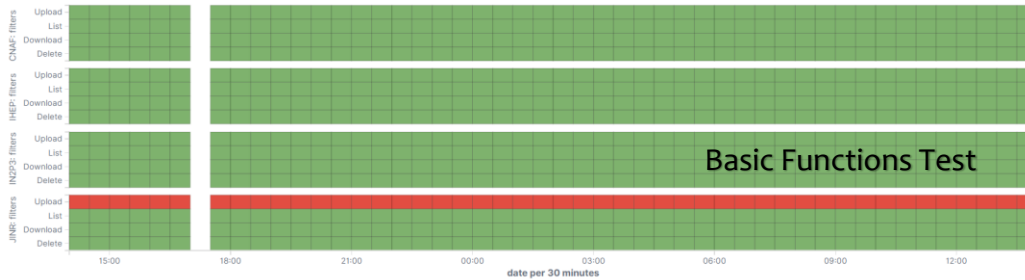


TPC Active Probing System

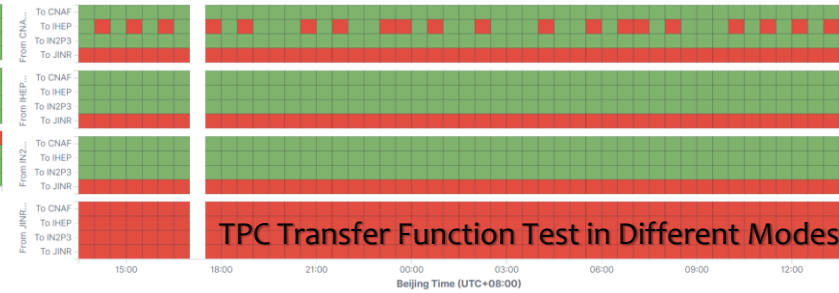
Active Probing system for JUNO TPC function and speed is developed.

- Tests executed by Gfal2 tools, results collected and shown in Elasticsearch-Kibana.
- Function tests: Upload/download, list, remove test in every 30 minutes.
- TPC mode tests: pull/push/streamed mode test in ever 30 minutes.
- Transfer performance tests in ever 2 hours.

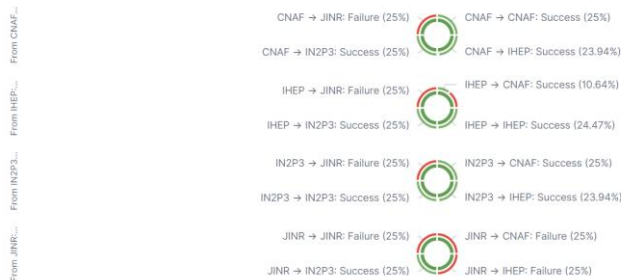
Basic Functions Results: History



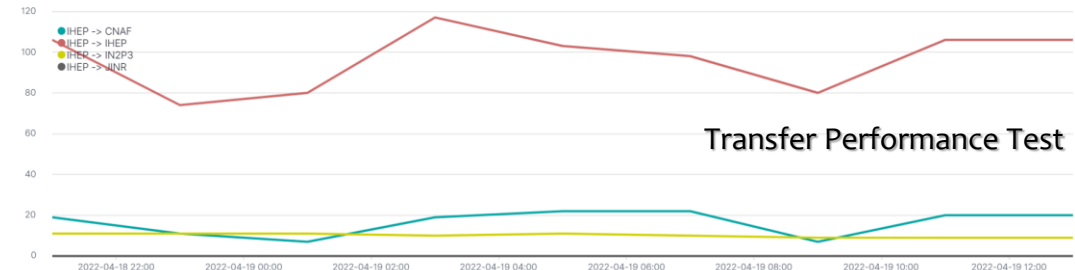
TPC Push Results: History



TPC Pull Success Rate: History



Speed from IHEP



Transfer Performance Test

TPC Monitoring System (Cont.)



Email notification,

- Daily test results will be sent by email to each storage administrators.
- Error logs is included for debugging.

Hello,

This mail is the auto-sent weekly TPC speed test results. Only HTTP/WebDav protocol is tested.

Note:

1. Test file size is 4.88 GB.
2. Because TPC is handled by each SE itself, not local test server, each direction transfer test is executed asynchronously under different threads.
3. To successfully test TPC speed, no TPC mode is specified. Gfal-copy will automatically choose the TPC mode to do the transfer.

| From \ to | CNAF-HITPD | IHEP-JUNOE0S | IN2P3-DCACHE | JINR-E0S |
|--------------|------------|--------------|--------------|-----------|
| CNAF-HITPD | 35.23 MB/s | 2.50 MB/s | 142.19 MB/s | Failed[1] |
| IHEP-JUNOE0S | 19.04 MB/s | 106.97 MB/s | 11.26 MB/s | Failed[2] |
| IN2P3-DCACHE | 46.25 MB/s | Failed[3] | 254.60 MB/s | Failed[4] |
| JINR-E0S | Failed[5] | Failed[6] | 42.11 MB/s | Failed[7] |

```
[1]TRANSFER ERROR: Copy failed with mode streamed, with error: HTTP 502 : Unexpected server error: 502
[2]TRANSFER ERROR: Copy failed with mode streamed, with error: HTTP 502 : Unexpected server error: 502
[3]TRANSFER ERROR: Copy failed with mode streamed, with error: (Neon): 201 Created
[4]TRANSFER ERROR: Copy failed with mode streamed, with error: timeout of 3600s
[5]TRANSFER ERROR: Copy failed with mode streamed, with error: timeout of 3600s
[6]TRANSFER ERROR: Copy failed with mode streamed, with error: timeout of 3600s
[7]TRANSFER ERROR: Copy failed with mode streamed, with error: timeout of 3600s
```

Hello,

This mail is the auto-sent daily TPC test results. XrootD/HTTP/Davs protocols are tested and results are summarized here.

Note:

1. For IN2P3 site, XrootD server will not be used, so only dCache HTTP test are list here.
2. For CNAF site, StoRM server does not support XrootD TPC.

| HTTPS Function Test (0 = Success, X = Failure) | | | | |
|--|--------|------|----------|--------|
| Sites | upload | list | download | delete |
| CNAF-HITPD | 0 | 0 | 0 | 0 |
| IHEP-JUNOE0S | 0 | 0 | 0 | 0 |
| IN2P3-DCACHE | 0 | 0 | 0 | 0 |
| JINR-E0S | X[1] | 0 | 0 | 0 |

[1]TRANSFER ERROR: Copy failed with mode streamed, with error: HTTP 502 : Unexpected server error: 502

| HTTPS TPC Test (0 = Success, X = Failure) | | | | |
|---|---------------|---------------|--------------|-------------------|
| From / to | CNAF-HITPD | IHEP-JUNOE0S | IN2P3-DCACHE | JINR-E0S |
| CNAF-HITPD | 0/0/0 | 0/0/0 | 0/0/0 | X[1]/X[2]/X[3] |
| IHEP-JUNOE0S | 0/0/0 | 0/0/0 | 0/0/0 | X[4]/X[5]/X[6] |
| IN2P3-DCACHE | 0/0/0 | 0/0/0 | 0/0/0 | X[7]/X[8]/X[9] |
| JINR-E0S | X[10]/X[11]/0 | X[12]/X[13]/0 | 0/X[14]/0 | X[15]/X[16]/X[17] |

```
[1]TRANSFER ERROR: Copy failed with mode 3rd pull, with error: copy HTTP 400 : Server Error
[2]TRANSFER ERROR: Copy failed with mode 3rd push, with error: copy HTTP 400 : Server Error
[3]TRANSFER ERROR: Copy failed with mode streamed, with error: HTTP 502 : Unexpected server error: 502
[4]TRANSFER ERROR: Copy failed with mode 3rd pull, with error: copy HTTP 400 : Server Error
[5]TRANSFER ERROR: Copy failed with mode 3rd push, with error: copy HTTP 400 : Server Error
[6]TRANSFER ERROR: Copy failed with mode streamed, with error: HTTP 502 : Unexpected server error: 502
[7]TRANSFER ERROR: Copy failed with mode 3rd pull, with error: copy HTTP 400 : Server Error
[8]TRANSFER ERROR: Copy failed with mode 3rd push, with error: transfer failed: failure: rejected PUT: 502 Bad Gateway'n
[9]TRANSFER ERROR: Copy failed with mode streamed, with error: HTTP 502 : Unexpected server error: 502
[10]TRANSFER ERROR: Copy failed with mode 3rd pull, with error: copy HTTP 400 : Server Error
[11]TRANSFER ERROR: Copy failed with mode 3rd push, with error: copy HTTP 409 : Conflict, File Exist
[12]TRANSFER ERROR: Copy failed with mode 3rd pull, with error: copy HTTP 400 : Server Error
[13]TRANSFER ERROR: Copy failed with mode 3rd push, with error: copy HTTP 409 : Conflict, File Exist
[14]TRANSFER ERROR: Copy failed with mode 3rd push, with error: copy HTTP 409 : Conflict, File Exist
[15]TRANSFER ERROR: Copy failed with mode 3rd pull, with error: copy HTTP 400 : Server Error
[16]TRANSFER ERROR: Copy failed with mode 3rd push, with error: Connection terminated abruptly: Status of TPC request unknown
[17]TRANSFER ERROR: Copy failed with mode streamed, with error: HTTP 502 : Unexpected server error: 502
```


Transfer Data Challenge



Challenge Purpose for TPC:

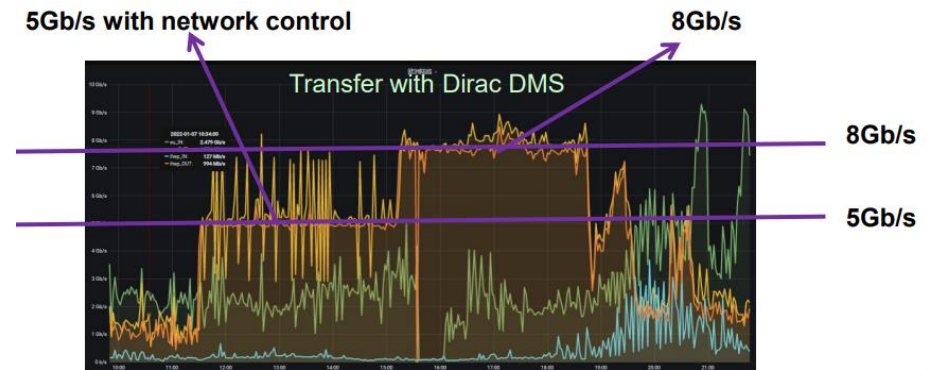
- Check HTTP TPC supports and performances in each SEs.
- Check each transfer services in transfer models, including DIRAC, Rucio, FTS3. IAM is not ready so not included.
- Check network availability for TPC.

Tested Transfer Route:

- IHEP(China) -> Europe, HTTP-TPC.
- CNAF -> IHEP, HTTP-TPC.
- JINR -> IHEP, Xrootd.

Results:

- Transfer success rate with FTS3: 100%.
- Managed by FTS3, TPC transfers reach to ~80% of bandwidth limit of IHEP(China) -> Europe.
- Enough for JUNO Experiment transfer requirements.



Problems & Experiences



We did some experiments and tests on HTTP-TPC, and try to realize it...

HTTP-TPC suffers from random failure:

- StoRM, dCache, EOS -> EOS, with HTTP-TPC pull mode.
- Same problem exist at CMS Beijing site webdav sam test.

StoRM <-> EOS transfer failure:

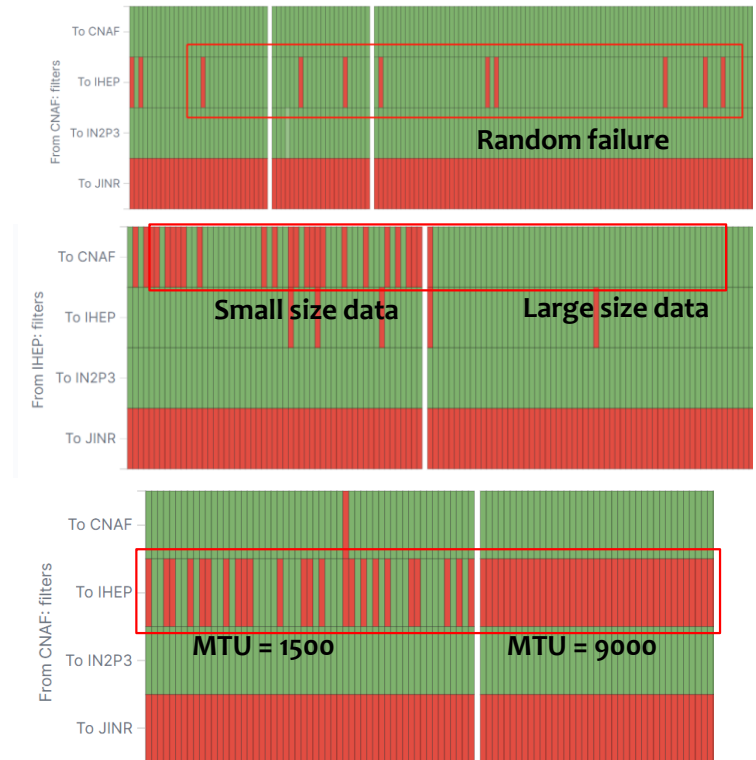
- Random failure with small size data in EOS -> StoRM pull mode, but OK in large size data.

MTU modification impact on HTTP-TPC:

- We tried to increase MTU to increase transfer speed for single large file.
- StoRM -> EOS push mode have random failure when MTU was 1500, but fully failed when MTU changed to 9000.

Connection issues?

HTTP header issues?



Summary



Milestones:

1. HTTP was determined as the main TPC protocol.
2. CNAF/IHEP/IN2P3 supported token-based HTTP-TPC, IHEP/JINR supported XrootD TPC.
3. A mass data transfer test by DIRAC / Rucio was finished and turned to be well performed.
4. Monitoring and notification system for TPC function and performance was developed and in working.

Plans:

1. Complete all SEs token-based HTTP-TPC support.
2. Solve the problems we met.
3. IAM system support for JUNO experiment token.
4. Following future WLCG TPC developments and applying on JUNO Experiment.

Thanks for your attention!