Building Efficient Data Planner for Peta-scale Science

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    - FAQ
    - Optimization
    - Requested features
2. *Implementation*
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    - Database schema
    - Data Mover
3. *Show case*
4. *Conclusions*

Why planning and scheduling in distributed environment?

Exploiting remote sites and centers implicitly opens the question:

How to handle, control and efficiently use the resources?

- balance between being fair to the users and optimizing utilization
- random and uncoordinated access to the resources will hardly be optimal

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Current goal

Create mechanism for efficient and controlled way of moving datasets (replicated) to the destinations in the fastest way

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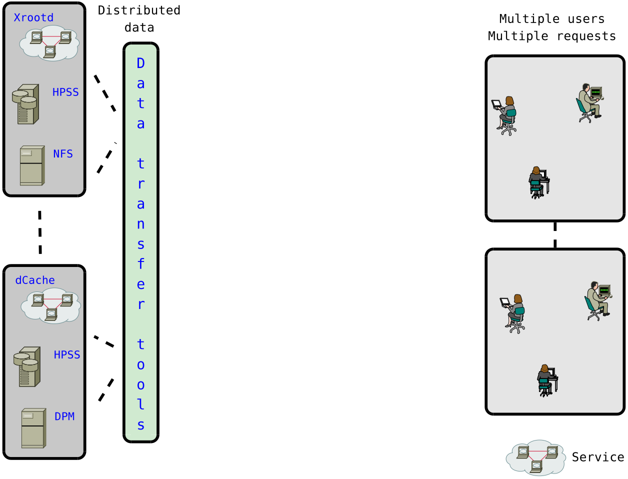
Create mechanism for efficient and controlled way of moving datasets (replicated) to the destinations in the fastest way

⇒ combination of deliberative and reactive planning ⇐

Situation



Distributed data

Xrootd

HPSS

NFS

dCache

HPSS

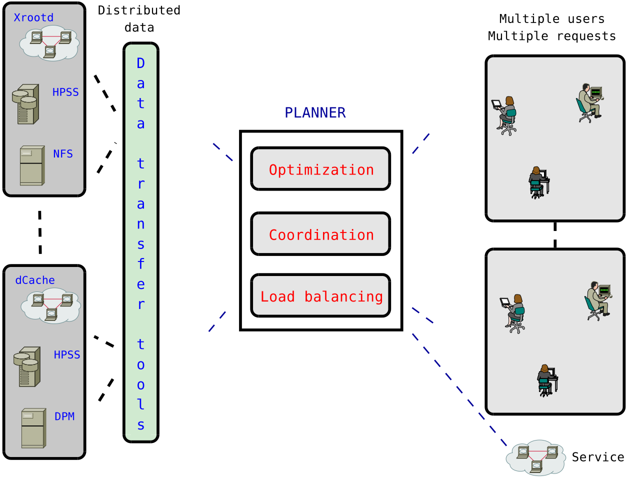
DPM

Data transfer tools

Multiple users
Multiple requests

Service

Goal


Xrootd
HPSS
NFS
dCache
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DPM
Distributed
data
Data transfer tools
PLANNER
Optimization
Coordination
Load balancing
Multiple users
Multiple requests
Service

FAQ

Are you building another N^{th} data transfer tool?

- No, we are building a mechanism sitting between users and existing efficient data transfer tools providing control, optimization and load-balancing.

Are you mirroring the topology and characteristic of the full network in your model?

- No, the model is based on approximation of the latencies/bandwidth and is from its startup point self adaptive to the environment.

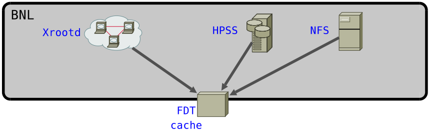
Can I use my own planner or fair-share policy?

- Yes, all decision-making modules are separate independent plugins.

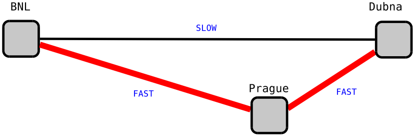
Optimization

Two levels of optimization:

1. Among **data services** (sharing the data)



2. Among sites - **data centers** (geographically spread)



Requested features

Control:

- respect different user priorities and usage history
- support any queue-based fair share policy
- provide estimates and status for the users

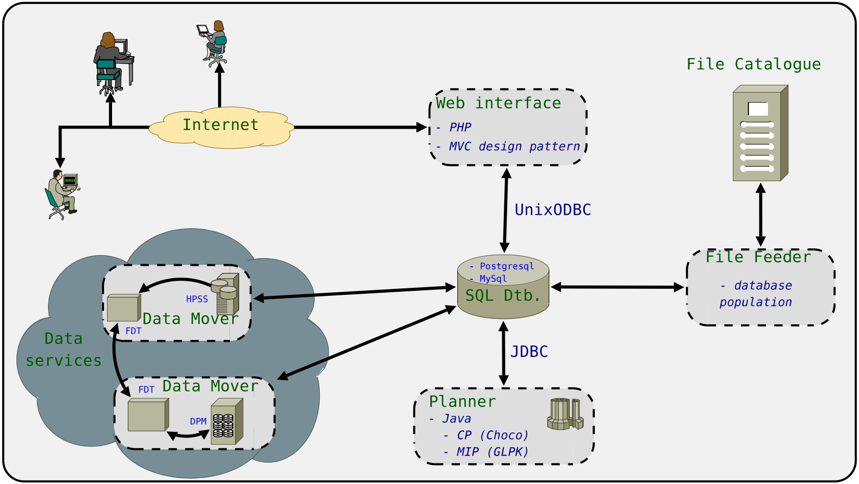
Load balancing:

- prevent uncontrolled access and overloading of resources
- load balancing of storage elements and network

Adaptability:

- proper balance between *reactive* and *deliberative* planning
- adapt to the network or service changes automatically

Architecture

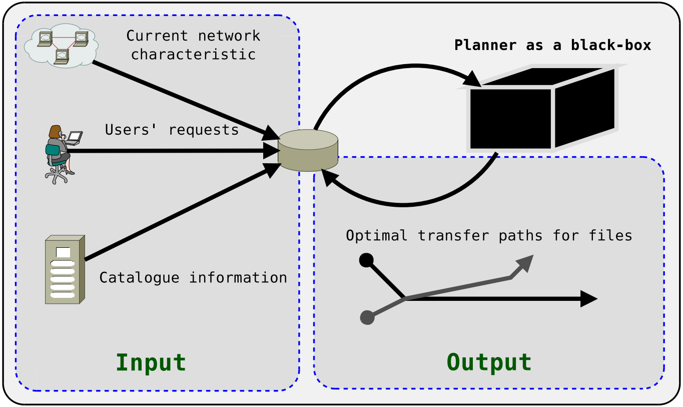


Planner

Constrained based, two approaches:

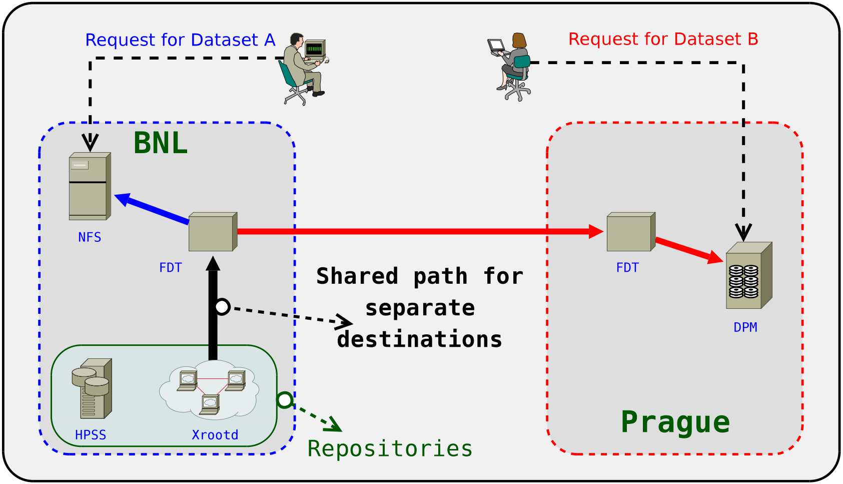
- Constraint Programming (Choco)
- Mixed Integer Programming (GLPK)

Fast, short-term deliberative planning



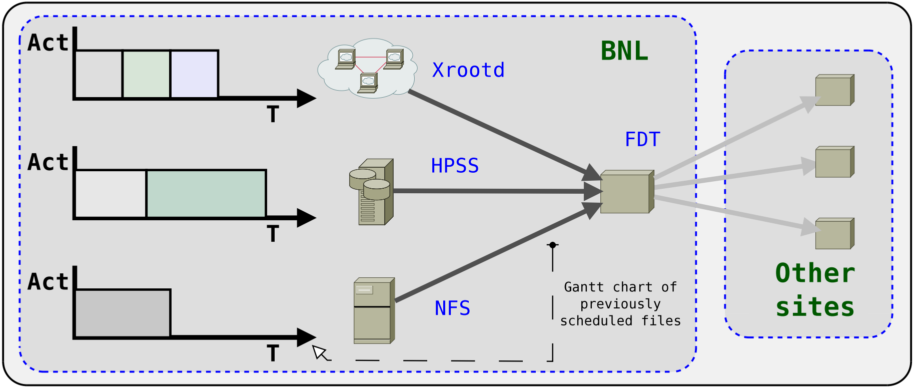
Requested features

- resources should be used effectively
- objective: **minimize time** to bring files to the users



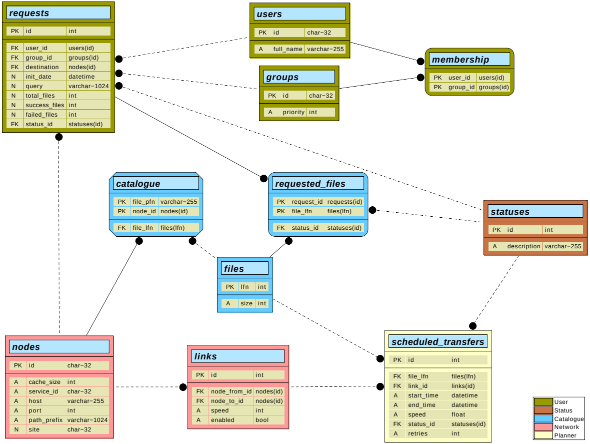
Requested features (cont.)

- use information about links usage from previously scheduled transfers
- avoid creating bottlenecks



Database schema

- most exposed parts: $10^5 - 10^6$ records in STAR
- support for *MySQL (InnoDB)* and *Postgresql*



requests

PK	id	int
FK	user_id	users(id)
FK	group_id	groups(id)
FK	destination	nodes(id)
N	init_date	datetime
N	query	varchar−1024
N	total_files	int
N	success_files	int
N	failed_files	int
FK	status_id	statuses(id)

users

PK	id	char−32
A	full_name	varchar−255

groups

PK	id	char−32
A	priority	int

membership

PK	user_id	users(id)
PK	group_id	groups(id)

catalogue

PK	file_pfn	varchar−255
PK	node_id	nodes(id)
FK	file_lfn	files(lfn)

requested_files

PK	request_id	requests(id)
PK	file_lfn	files(lfn)
FK	status_id	statuses(id)

statuses

PK	id	int
A	description	varchar−255

files

PK	lfn	int
A	size	int

nodes

PK	id	char−32
A	cache_size	int
A	service_id	char−32
A	host	varchar−255
A	port	int
A	path_prefix	varchar−1024
N	site	char−32

links

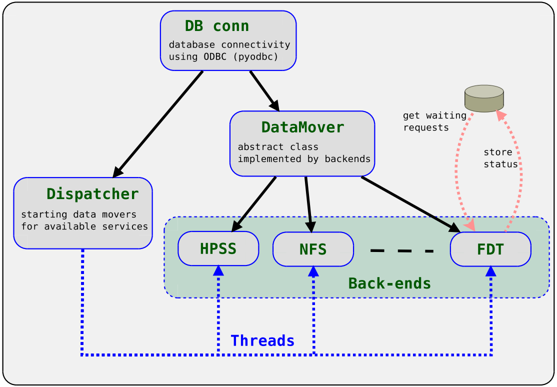
PK	id	int
FK	node_from_id	nodes(id)
FK	node_to_id	nodes(id)
A	speed	int
A	enabled	bool

scheduled_transfers

PK	id	int
FK	file_lfn	files(lfn)
FK	link_id	links(id)
A	start_time	datetime
A	end_time	datetime
A	speed	float
FK	status_id	statuses(id)
A	retries	int

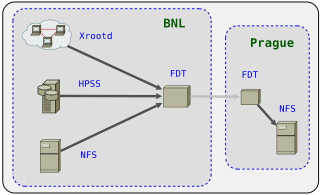
Data Mover

- **distributed** component, using efficient and existing transfer tools
- running at each computing center, implemented in Python
- back-ends for available services realize the transfers
- works in a reactive way, following the computed plan



Show case - setup

- moving data set to the single destination - **NFS** location in Prague
- every file from the dataset available at **HPSS**, **NFS** and **Xrootd** service in BNL



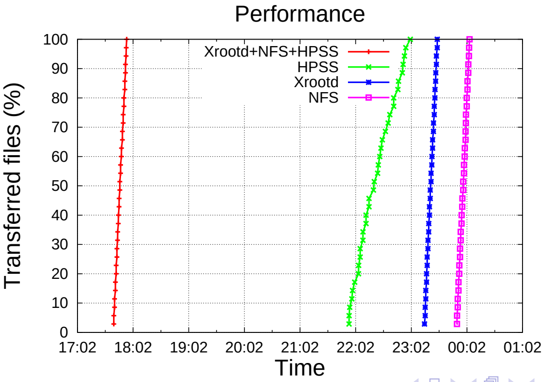
- matrix for success is to be limited by *WAN* speed alone

Show case - comparison

Planner was set up to reason about:

1. all services (HPSS, NFS, Xrootd) as possible data sources,
2. only HPSS (slow),
3. only NFS (fast),
4. only Xrootd (fast)

The use of resources was: HPSS - 19%, NFS - 38%, Xrootd - 43%



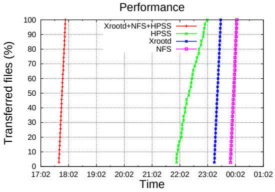
Show case - conclusion

Remarks:

- Files are usually not all on NFS (central storage reserved for ongoing data production in STAR, not past data production series)
- Users would have to grab files from Xrootd or HPSS

  Xrootd would create a load and impact analysis - our system provides **immediate** relief without sacrifice of the transfer plan time

  HPSS stress and frequent access to **HPSS** hence tape access could be damaging to tape (wear-out) + competes with other access (production sync to HPSS)
- Our system balances resources in an adaptive fashion.



Ultimately

Utilizing all resources brings the same performance as relying only on the fastest one (NFS/Xrootd) while bringing load-balancing, control and redundancy.

Conclusions

Status:

- planner, database, web interface are prepared and functional
- performance of the pure planner extensively studied and tested in simulated environment
- all components are functional and installed in STAR, currently running tests

Perspectives:

- implement multi-site transfers: we expect similar benefits in balancing
    - immediate relief to the *Tier-0* center
    - self-adaptive capabilities will determine the best transfer path
    - data integrity benefits for "free"

Summary:

- the concept of controlled and efficient data movement brings:
    - better efficiency due to **intelligent planner**
    - controlled **coordination**
    - **load-balancing**

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Thank you!