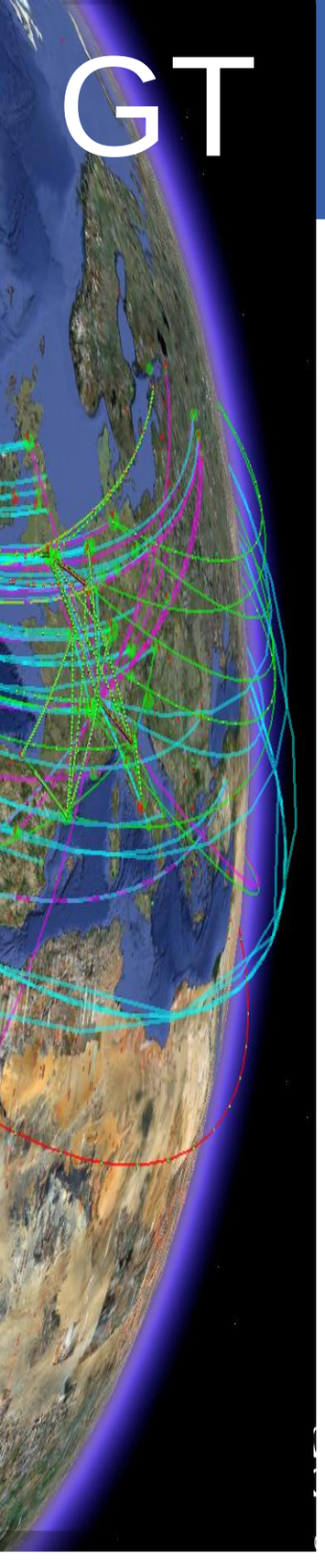

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Dynamic Federations

A demo with dCache, DPM and a cloud storage provider

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Patrick Fuhrmann (presenter)
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Daniel Becker
Adrien Devresse (did the work)
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Credits to ShuTing Liao (ASGC)

Partially funded by EUROPEAN MIDDLEWARE INITIATIVE *and* dCache

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EMI is partially funded by the European Commission under Grant Agreement INFSO-RI-261611

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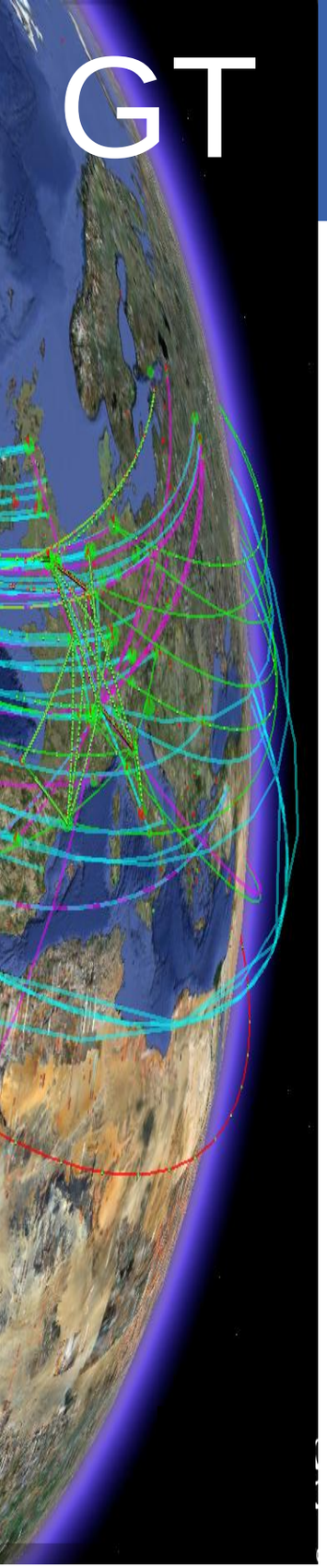

Storage Federations: Motivations

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- Currently data lives on islands of storage
  - catalogues are the maps
  - FTS/gridFTP are the delivery companies
  - Experiment frameworks populate the island
  - Jobs are directed to places where the needed data is
    - or should be .....
  - Almost all data lives on more than one island
  - Assumption:
    - perfect storage (unlikely to impossible)
    - perfect experiment workflow and catalogues (unlikely)
- Strict locality has some limitations
  - a single missing file can derail the whole job
    - or series of jobs
- Failover to data on another island could help
    - → Federation

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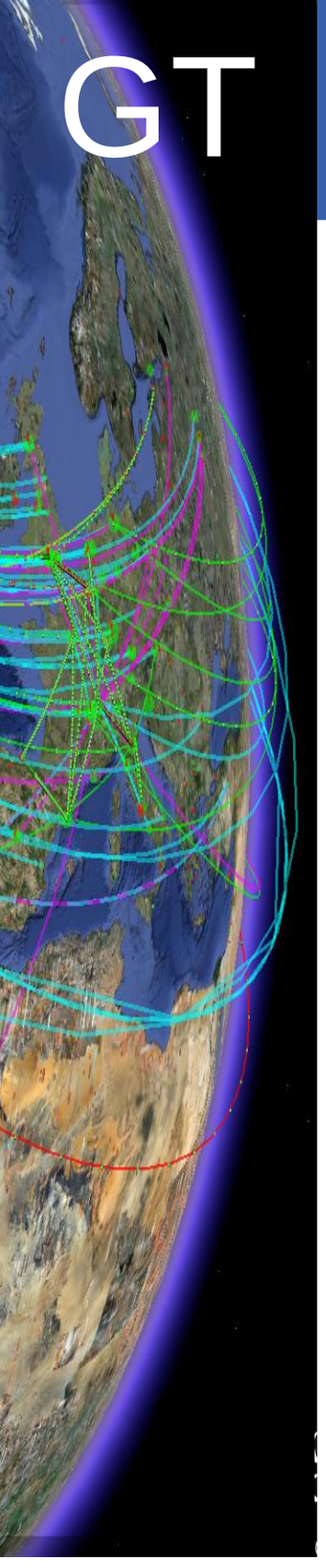

Storage federations

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- What has to be done?
  - Make different storage clusters **be seen as one**
  - Make **global file-based data access seamless**
- How should this be done?
  - No strange APIs, everything looks “banal”
  - Use dynamic systems that are **easy to setup/maintain:**
    - no complex metadata persistency
    - no DB babysitting (keep it for the experiment’s metadata)
    - no central catalogue inconsistencies, by design
  - Use systems that exhibit **high performance**
    - Goal is hundreds of Ks interactions per second (peak)
  - Try to optimize by using proximity etc.

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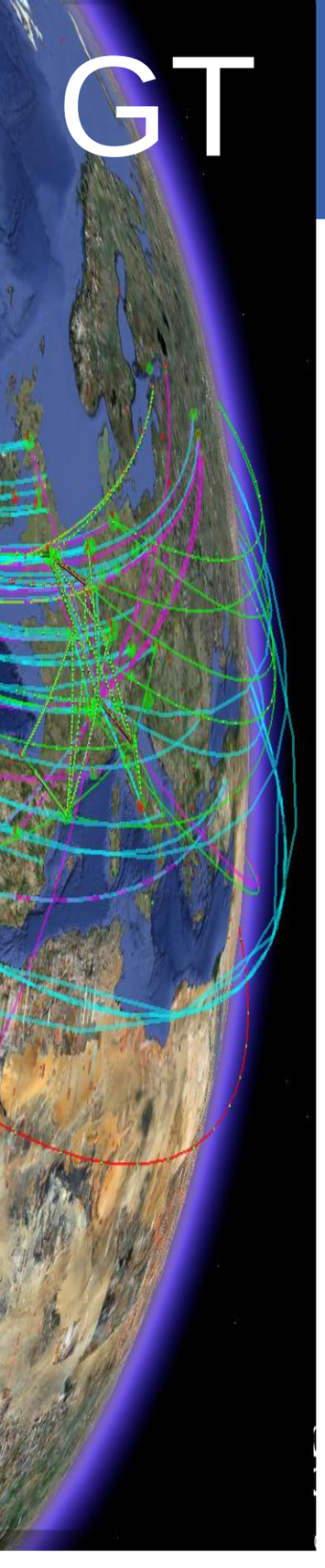

Vision: Everything Everywhere

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- Transparent access to remote data
  - should feel natural
  - This includes interactive browsing of files and directories
- Seamless storage federations of:
  - Official Storage Elements, LFCs, catalogues...
  - Cached data (i.e. SQUID-like things, not registered in any catalogue)
  - HTTP/DAV-based servers
  - Cloud storage services
  - HTTP-enabled XROOTD/EOS clusters, sharing the data.
- Base everything on open ‘just works’ technologies
- Local SE as a preference, give the freedom to point to an **efficient and reliable global federation**
  - Optimize redirections based on on-the-fly **client-data proximity**
  - Avoid inconsistencies, just looking at where the files are now.
- Limit complexity: read only
  - Usually writes happen to well-known, close islands

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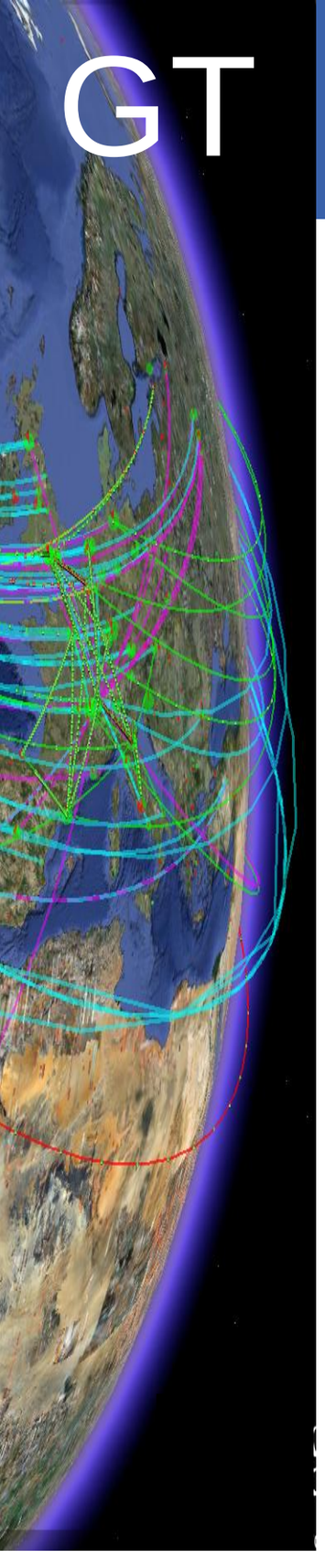

Dynamic Federations

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- We federate (meta)data repositories that are ‘compatible’
  - Name space (modulo simple prefixes)
  - Permissions (they don’t contradict across sites)
  - Content (same key or filename means same file)
- Dynamically and transparently discovering metadata
  - looks like a unique, very fast file metadata system
  - properly presenting the aggregated metadata views
  - redirecting clients to the geographically closest endpoint
- As a plus: can be used by client tools that **everybody knows**
  - **focus on HTTP/DAV**, we can use
  - it by ROOT via Browswer, OS’es to smartphones

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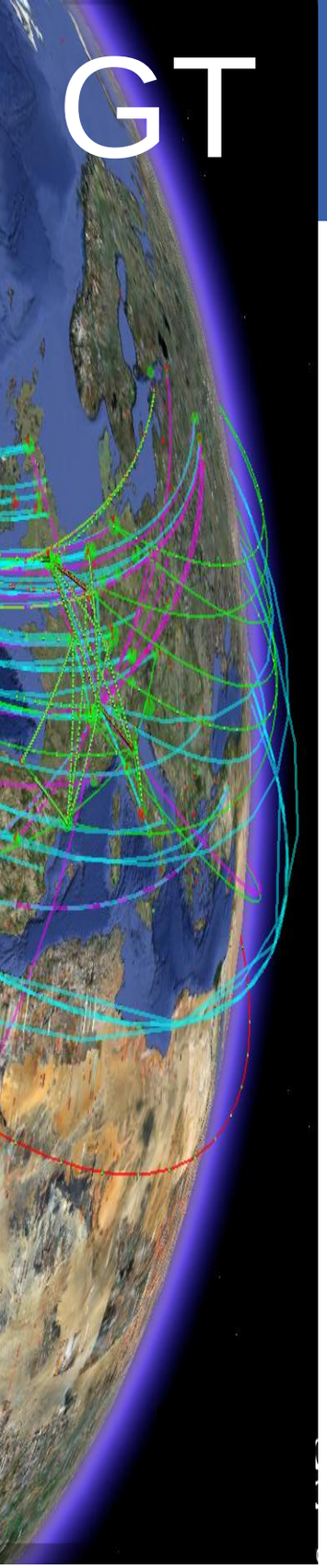

Dynamic Federations

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- Technically TODAY we can aggregate:
  - dCache DAV/HTTP instances
  - DPM DAV/HTTP instances
  - LFC DAV/HTTP instances
  - Cloud DAV/HTTP services
  - Native LFC and DPM databases (through DMLite used as a client)
  - **Can be extended to other sources**
- The system also can load a “Geo” plugin
  - Gives a geographical location to replicas and clients
  - Allows the core to choose the replica that is closer to the client
- The one that’s available uses GeoIP (free)

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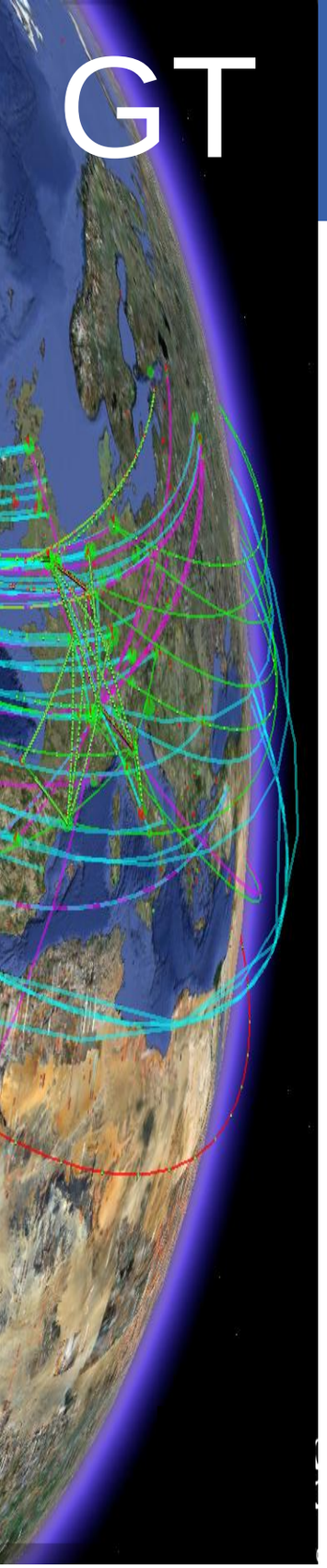

Demo

- The demo federates three storages via HTTP/DAV:
  - a DPM instance at ASGC (Taiwan)
  - a dCache instance in DESY
  - a Cloud storage account by Deutsche Telecom

- The feeling it gives is surprising
  - performance is in avg higher than contacting the endpoints

- I put one test file in 3 sites, i.e. 3 replicas.
  - /myfed/atlas/fabrizio/hand-shake.JPG
  - **Clients in EU get the one from DESY/DT**
  - **Clients in Asia get the one from ASGC**

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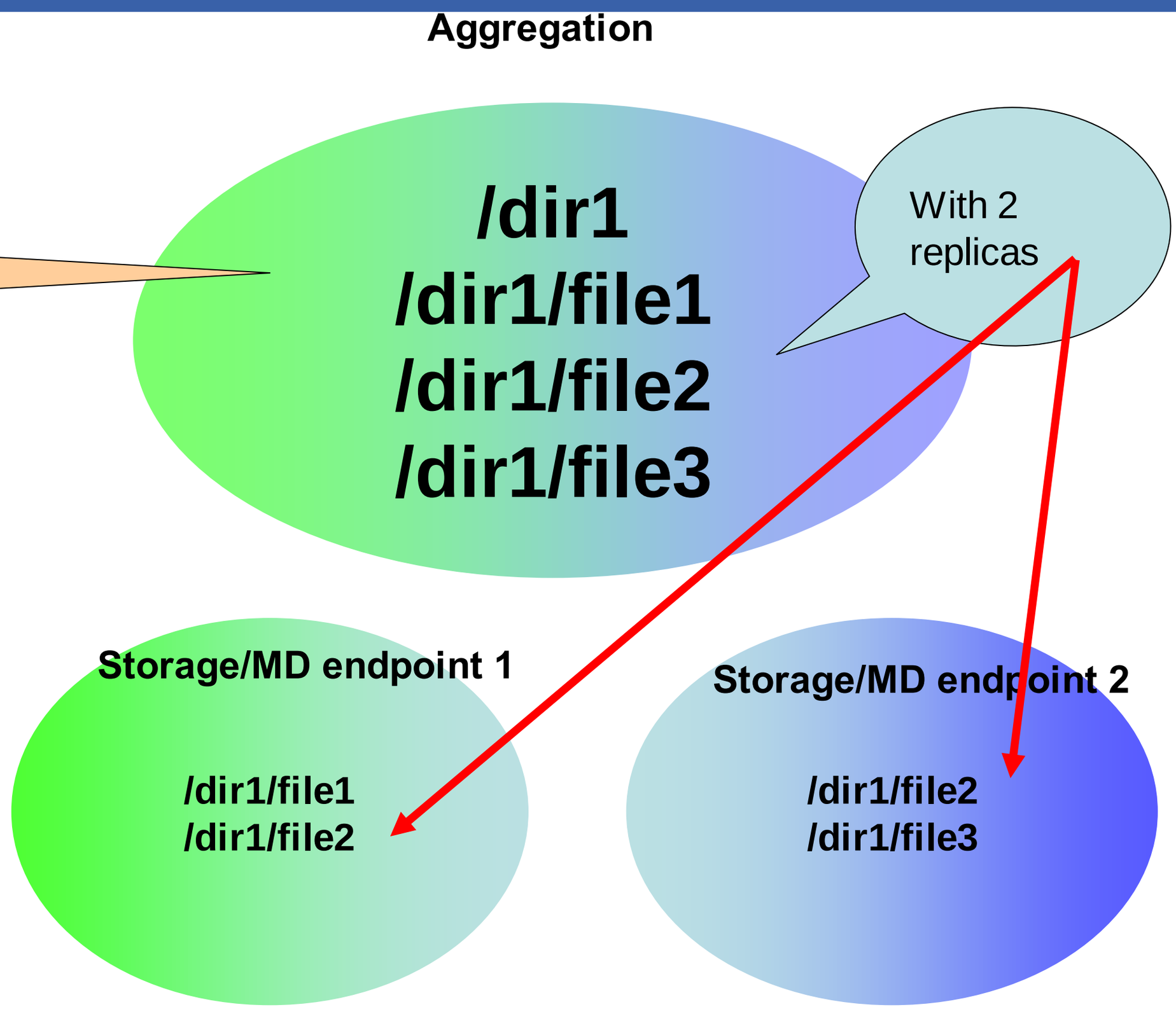
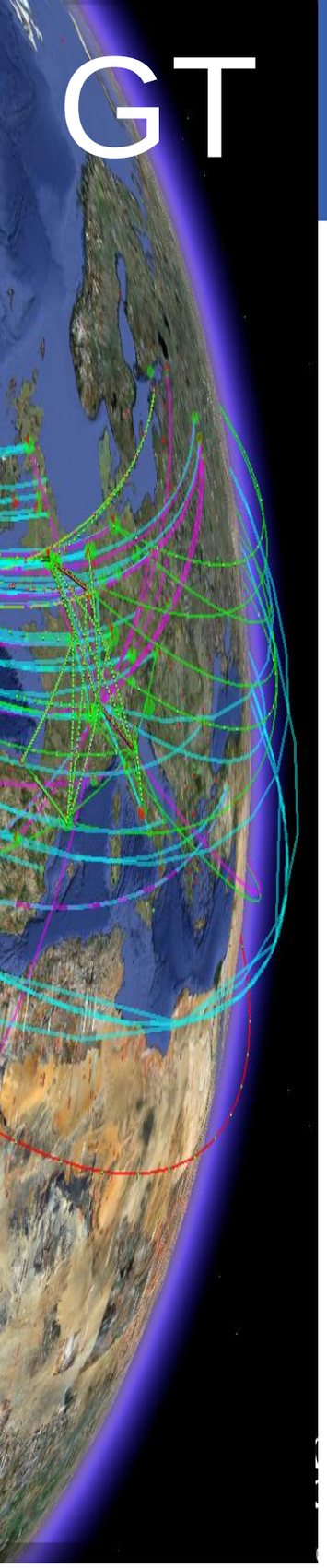
The basic idea

We see this

All the metadata interactions are hidden

NO persistency needed here, just efficiency and parallelism





Dynamic Federations

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- Technically “loosely coupled storage systems”
- Idea: a single entry point for a federation of ***endpoints***
  - “lonely” storage clusters (e.g. dCache, DPM, plain HTTP servers)
  - site/VO catalogues (e.g. LFCs) pointing to storage elements
- This entry point knows its ***endpoints***, can ***redirect*** clients to them, it can present their metadata to clients
- Many interesting possibilities
  - Federate third party outsourced HTTP/DAV servers (also clouds)
  - Federate the content of SQUID caches
  - Federate them together with the information of some experiment’s DB
  - When requesting a file we would get it from an ***endpoint*** that is good for us, it could be a cache or a non-cache one.
  - See as one experiment’s DBs (e.g. two LFCs), also considering what’s in the SQUID caches worldwide
    - Transparent, direct access to the official replicas AND the cached ones as well

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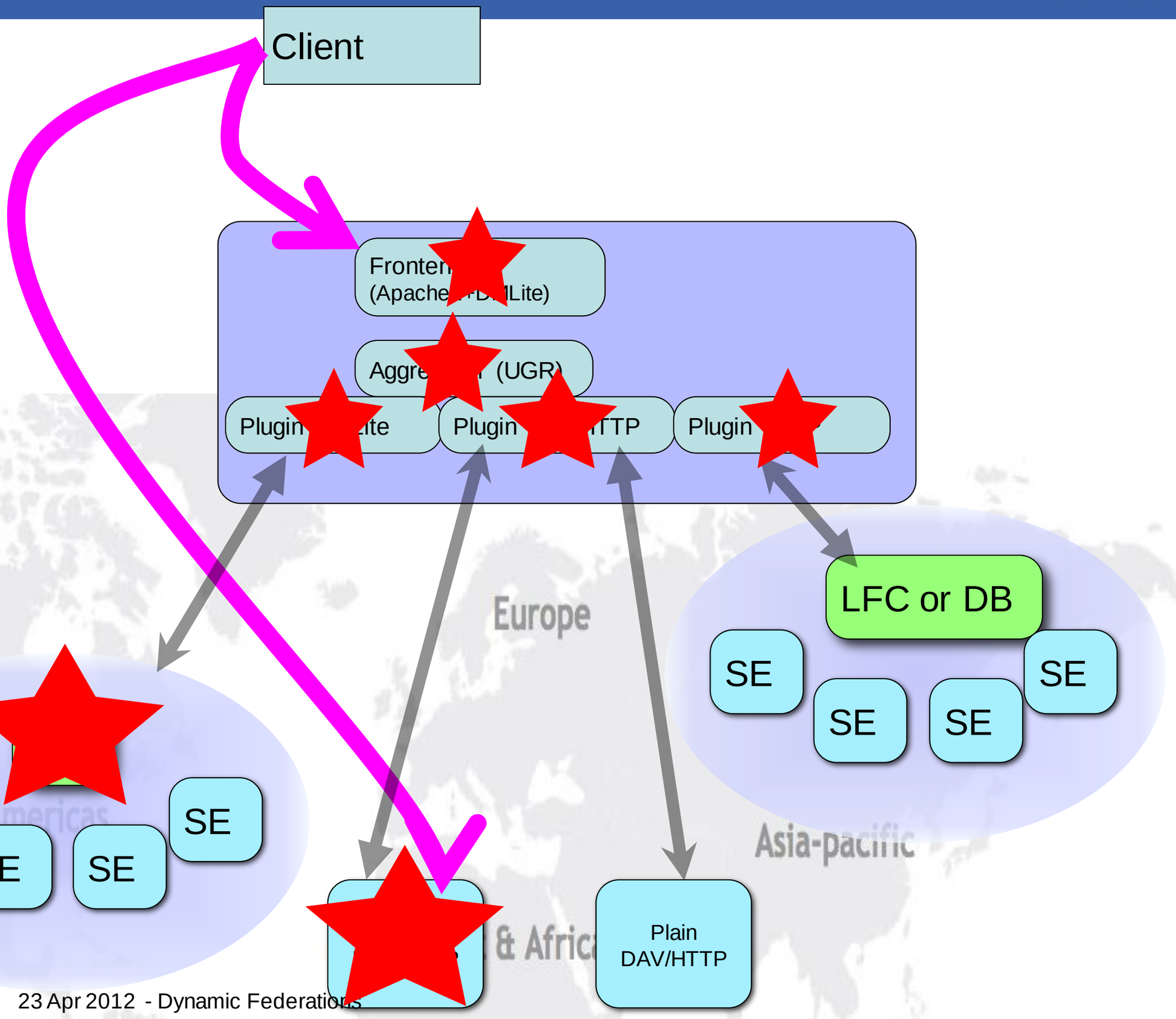
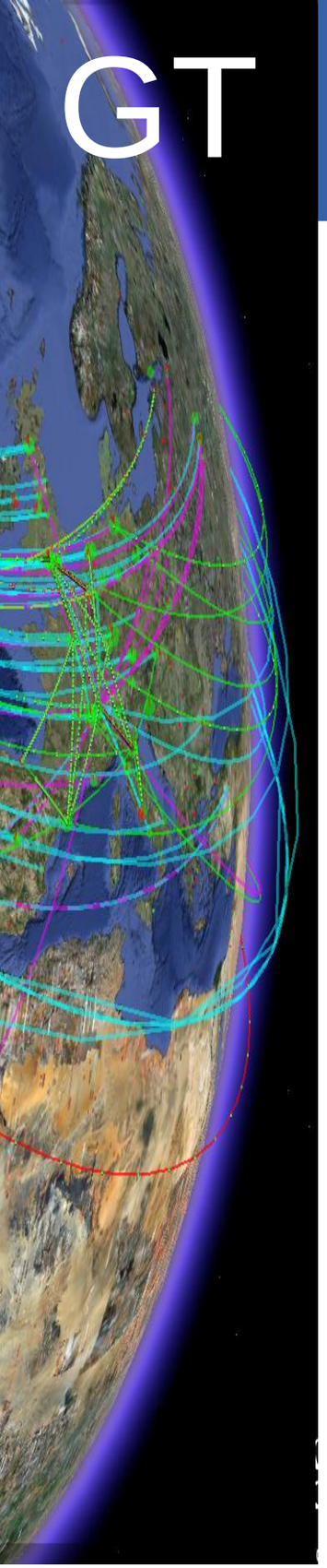
Dynamic Federations

- The ***endpoints*** are a federation, hence they are homogeneous
  - Same access protocol (e.g. HTTP/DAV)
  - Same name space (not necessarily same content!)
  - The same file/replica has the same (or compatible) path/name
  - They grant access to the same groups of users
- This entry point learns dynamically, automatically about their metadata content
  - As clients contact it to get access to files
  - It can ask the ***endpoints*** for information on the fly
- This entry point redirects each client to the proper ***endpoint***
  - Ev. applying some smart criteria, e.g. geographical proximity
- In principle it would work for any data access protocol that
  - works over WAN
  - supports redirections
- The system core is fully protocol-agnostic
- Our focus is towards HTTP/DAV
  - DPM and dCache are releasing support for it (StoRM is on it's way)
- Work in progress, priority is read access
  - As, in general, write access is done in the local site

Example


Client
Plugin
Plugin
Plugin
LFC or DB
SE
SE
SE
SE
SE
SE
SE
Plain
DAV/HTTP
Europe
Asia-pacific



Why HTTP/DAV?

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- **It's there**, whatever platform we consider
  - A very widely adopted technology
- **We (humans) like browsers**, they give an experience of **simplicity**
- Goes towards **convergence**
  - Users can use their devices to access their data easily, out of the box
  - Jobs just go straight to the data

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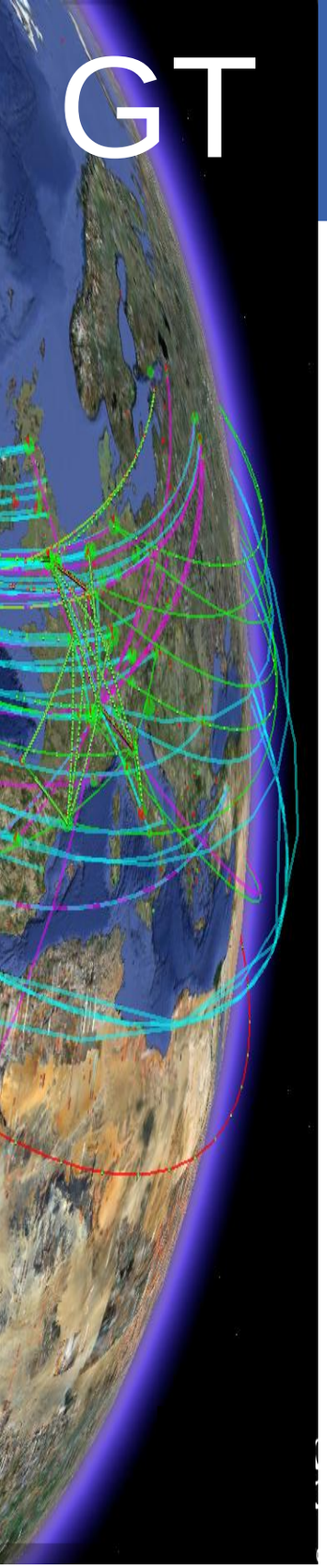

System design

- A system that only works is not sufficient
- To be usable, it must privilege speed, parallelism, scalability
- The core component is a plugin-based component called originally “Uniform Generic Redirector” (Ugr)
  - Can plug into an Apache server thanks to the DMLITE and DAV-DMLITE modules (by IT-GT)
  - Composes on the fly the aggregated metadata views by managing parallel tasks of information location
    - Never stacks up latencies!
  - Able to redirect clients to replicas
  - By construction, the responses are a data structure that models a partial, volatile namespace
  - Keep them in an LRU fashion and we have a fast 1st level namespace cache
    - Peak performance is ~500K->1M hits/second per core by now

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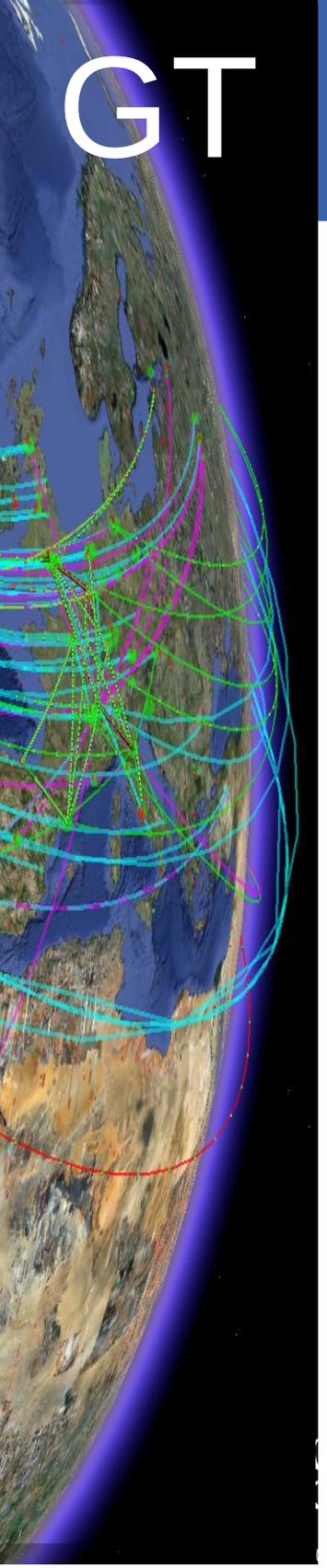

Focus: performance

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- Performance and scalability have primary importance
  - Otherwise it's useless...
- Full parallelism
  - No limit to the number of outstanding clients/tasks
  - No global locks/serializations!
  - The endpoints are treated in a completely independent way
  - Thread pools, prod/consumer queues used extensively (e.g. to stat N items in M endpoints while X clients wait for some items)
- Aggressive metadata caching
  - A relaxed, hash-based, in-memory partial name space
  - Juggles info in order to always contain what's needed
  - Stalls clients the minimum time that is necessary to juggle their information bits
  - Peak perf per CPU core: 0.5~1M stats/sec
- High performance DAV client implementation (DAVIX)
  - Loaded by the core as a "location" plugin
  - Uses libneon w/ sessions caching
  - Compound list/stat operations

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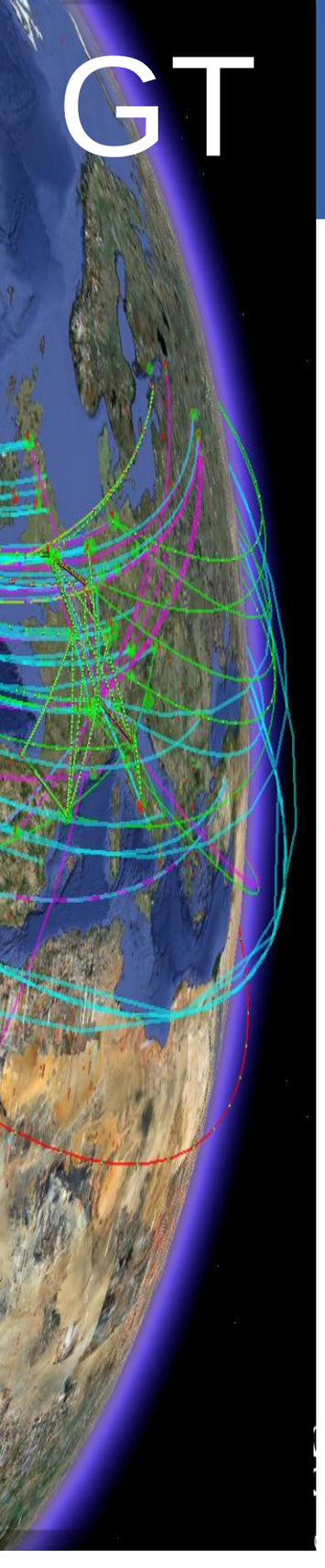

Dynamic Feds vs XROOTD feds

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- XROOTD federations are focused on the “redirection” concept
  - Very light at the meta-manager, just redirect clients away as soon as possible
    - If not possible, the penalty is 5 seconds per jump
  - Global listing is implemented in the client, slow, a bit more difficult, less robust
  - Some details do not match yet very well with geography-aware redirections

- Dynamic Federations support both the “redirection” concept and the “browsing” concept by design
  - Cache metadata for the clients, in-memory
  - Designed for scalability, performance and features
  - Extendable plugin architecture, geography-aware redirection
  - Can speak any protocol, our focus in on **http**-based things

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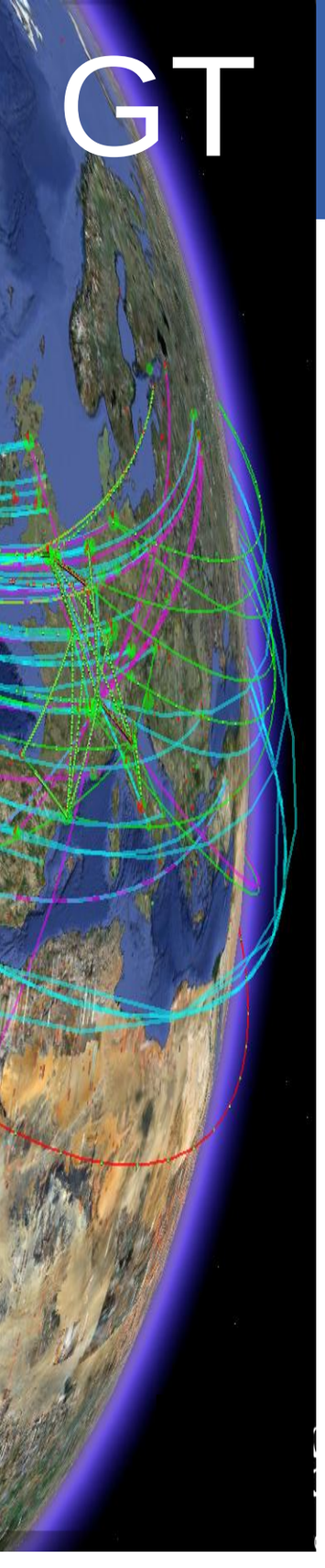

Next steps

- Implement the missing bits of security, without hurting scalability and performance.
- More massive tests, with many endpoints, possibly distant
- Precise performance measurements
- Handle gracefully the ‘death’ of the endpoints
- Understanding the impact of the production workloads
  - Does the machinery need a 2nd level of caching? Which characteristics?
- Immediate sensing of changes in the endpoints’ content, e.g. add, delete
  - SEMsg in EMI2 already has some useful notifications (default off)
- Some more practical experience (getting used to the idea, using SQUIDs, CVMFS, EOS, clouds,... <put your item here>*)
- Power users helping in getting the best out of the system

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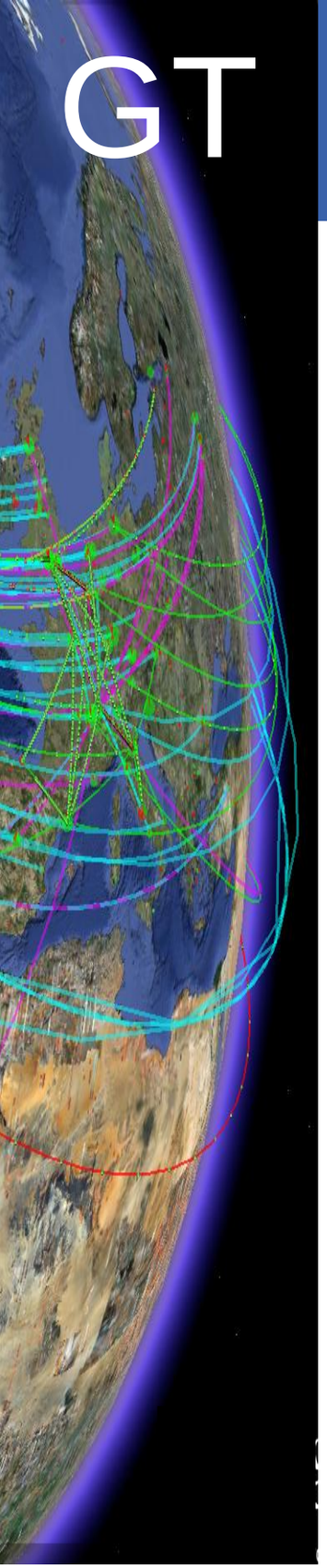

Conclusions

- Dynamic Federations: an efficient, persistency-free, easily manageable approach to federate remote storage endpoints
- Usable for fast changing caches and clouds
- Gives ways to solve some nasty Data Management problems
- Peak performance is very high: $O(10^5)$ hits/s
- Opens our Data world to a large variety of already available clients, by using standard protocols.
- Work in progress, first milestone was now.

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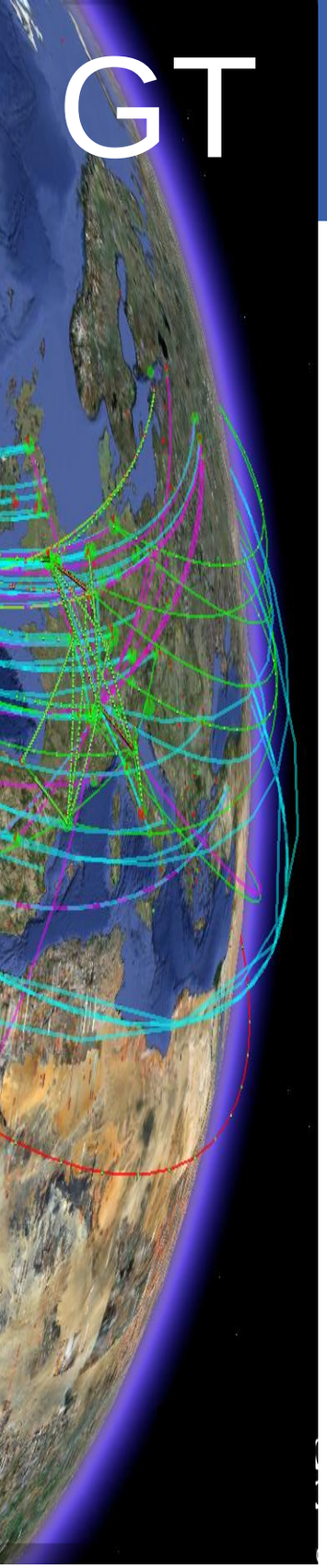

Thank you

Questions?

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