LCG 3D Project

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Service Challenge Meeting at CERN

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Distributed Deployment of Databases

- LCG provides infrastructure for storage, distribution and replication of file based data

- Physics applications (and grid m/w) require a similar services for data hosted in relational databases
  - Several applications and grid services use RDBMS - and more are coming this year
  - Several sites have already experience in providing RDBMS services

- Goals for the 3D project as part of LCG
  - provide LCG apps with a consistent, location independent access to database services
  - increase the availability and scalability of database applications via replication
  - arrange for shared deployment and administration of this infrastructure during 24 x 7 operation

- Joint project between LCG sites, experiments and s/w projects
  - Time frame for first service: deployment in autumn this year
  - Evolve together with computing models and requirements towards LHC startup

- Held Distributed Database workshop at CERN last December
  - http://agenda.cern.ch/fullAgenda.php?ida=a044341

LCG 3D Non-Goals

- Store all database data
  - Experiments are free to deploy databases and distribute data under their responsibility.
- Setup a single monolithic distributed database system
  - Given constraints like WAN connections one can not assume that a single synchronously updated database could work and provide sufficient availability.
- Setup a single vendor system
  - Technology independence and a multi-vendor implementation will be required to minimize the long term risks and to adapt to the different requirements/constraints on different tiers.
- Impose a CERN centric infrastructure to participating sites
  - CERN is one equal partner of other LCG sites on each tier
- Decide on an architecture, implementation, new services, policies
  - Produce a technical proposal for all of those to LCG PEB/GDB

http://lcg3d.cern.ch/

WP1 -Data Inventory and Distribution Requirements

- Members are s/w developers from experiments and grid services that use RDBMS data
- Gather data properties (volume, ownership) and requirements
- Integrate access to 3D services into their software

WP2 - Database Service Definition and Implementation

- Members are technology and deployment experts from LCG sites
- Propose a deployment implementation and common deployment procedures

WP3 - Evaluation Tasks

- Short, well defined technology evaluations against the requirements delivered by WP1
- Evaluation are proposed by WP2 (evaluation plan) and typically executed by the people proposing a technology for the service implementation and result in a short evaluation report

3D Data Inventory

- Collect and maintain a catalog of main RDBMS data types

- Experiments and grid s/w providers fill a table for each data type which is candidate for storage and replication via the 3D service
  - Basic storage properties
    - Data description, expected volume on T0/1/2 in 2005 (and evolution)
    - Ownership model: read-only, single user update, single site update, concurrent update
  - Replication/Caching properties
    - Replication model: site local, all t1, sliced t1, all t2, sliced t2 …
    - Consistency/Latency: how quickly do changes need to reach other sites/tiers
    - Application constraints: DB vendor and DB version constraints
  - Reliability and Availability requirements
    - Essential for whole grid operation, for site operation, for experiment production,
    - Backup and Recovery policy
      - acceptable time to recover, location of backup(s)

Requirement Gathering

- All participating experiments have signed up their representatives
  - Rather 3 than 2 names
  - Tough job, as survey inside experiment crosses many boundaries!
- Started with a simple spreadsheet capturing the various applications
  - Grouped by application
    - One line per replication and Tier (distribution step)
  - Two main patterns
    - Experiment data: data fan-out - T0->Tn
    - Grid services: data consolidation - Tn->T0
  - But some exceptions which need to be documented…
- Aim to collect complete set of requirements for database services
  - Eg also online data or data which is stored locally but never leaves a tier
  - Needed to properly size the h/w at each site

Application/Data Type	Distribution [none/fan out/gather]	Tier	Source/Producer	Volume[GB/site]	# of clients / site	acces mode[r/w/u]	owner [1-user/n-user/1-site/n-site]	write/update rate [MB/d]	Max. Latency [mins]	RAL used [y/n]	Oracle Impl [y/n/partial]	MySQL Impl [y/n/partial]	s/w responsible
Conditions	fan out	online	online RECO	300		w	1u	1		n	p		LCG-AA
		0	T0 REC	500		w	1u		30	n	p		
		1	T0 copy	500		r	0		30	n	p		
		2	T1 slice	50		r	0			n		y	
		4	T1 slice	5		r	0			n		y	
GeometryDB ATLAS	fan out	online								y			ATLAS
		0								y			
		1								y			
		2								y			
LCGMon	gather	2	T2 SE	10		w	1u	1	30	n	y		LCG-GD
		1	T2 merge	100		r	0	10	30	n		n	
		0	n/a										
File catalog	gather	2	T2 WN										EGEE
		1	T2 merge										
		0											
Local replica catalog	none	0	local										EGEE
		1	local										
		2	local										

Preliminary Summary for 2005

- Applications mentioned so far
  - FileCatalog, Conditions, Geomentry, Bookkeeping, Physics Meta Data, Collections, Grid Monitoring, TransferDB
  - Suspect that several smaller(?) applications are still missing

- Total volume per experiment: 50-500 GB
  - Error bars likely as big as the current spread
  - Significant flexibility/headroom required for service side!

- Number of applications to be supported: O(5)
  - Some still not existing or bound to MySQL at the moment
  - Distributed applications use either RAL or ODBC based implementation

- Distributed Data becomes read-only down from T0
  - Conservative approach for first service deployment
  - Current model does not require multi-master replication

- Please make sure your experiment representatives know about your application requirements!

Service Integration with Application Software

- Distributed database service to be coupled to the user application
  - Plan to use POOL RAL as 3D reference implementation
- How does an application find a suitable database?
  - DB vendor may vary depending on site where job is scheduled
- Database Service Catalog
  - Avoid embedding physical connection strings in code
    - ..or spreading them as part of configuration file copies
    - Allow a local service to be transparently relocated to another machine
- 3D prototype based on POOL file catalog
  - supports network disconnected lookup based on XML files
  - Final implementation may still change
    - Eg if a suitable grid-service has been identified

More Application Integration..

- Connection Pooling and Error Handling
  - ATLAS developments being integrated into RAL
- Authentication and Authorization
  - Mapping between grid certificate and database role
    - Need to support roles in experiments computing model
  - Plan to evaluate/integrate with package developed by G.Ganis for ROOT and xrootd
- Client Diagnostics
  - Collect timing of top queries of the current application in RAL
  - Evaluate package developed at FNAL to aggregate diagnostics across many clients
- Most of the above are useful for local or centralized database applications too

3D Site Contacts

- Established contact to several Tier 1 and Tier 2 sites
  - Tier 1: ASCC, BNL, CERN, CNAF, FNAL, GridKa, IN2P3, RAL
  - Tier 2: ANL, U Chicago
- Regular 3D meetings
  - Bi-weekly phone meeting back-to-back for
    - Requirement WG
    - Service definition WG
  - Usual difficulties of distributed
  - Organised a 3day 3D workshop at CERN
- Visited RAL, FNAL and BNL
  - Very useful discussions with experiment developers and database service teams there
  - Plan to visit CNAF beginning of March together with SC meeting there
- All above sites have expressed interest in project participation
  - BNL has started to setup Oracle setup
  - Most sites have allocated and installed h/w for participation in the 3D test bed
  - U Chicago agreed to act as Tier 2 in the testbed
- Will contact DB teams at PIC, NIKHEF and Bari

Database Services at LCG Sites Today

- Several tier 1 sites provide Oracle production services for HEP and non-HEP applications
  - Significant deployment experience and well established service exists…
  - … but can not be changed easily without affecting other site activities
- Tier 2 sites can only provide very limited manpower for database service
  - Part time administration by the same people responsible for fabric
  - Only a simple, constrained database service should be assumed
- MySQL is very popular in the developer community
  - Several applications are bound to MySQL
  - Used for experiment production, though not at very large scale
  - Expected to be deployable with limited db administration resources

- Expect both database flavors to play a role implementing different parts of the LCG infrastructure

Database Service Policies

- Several sites have deployment policies in place
  - E.g. FNAL:
    - Staged service levels
      - Development -> Integration -> Production systems
    - Well defined move of new code / DB schema during development process
      - Apps developers and DB experts review and optimize schema before production deployment
- Similar policy proposal prepared for CERN physics database services
  - To avoid recent interference between key production applications of different experiments on shared resources
    - Caused by missing indices, inefficient queries, inadequate hardware resources
  - Storage volume alone is not a sufficient metric to define a database service
- Need a complete list of applications and a reference workload for each key application to define and optimize the service
  - How many requests (queries) from how many clients on how much data are required to meet the performance goals?
- Especially for distributed DB service this will be essential to avoid surprises on either side

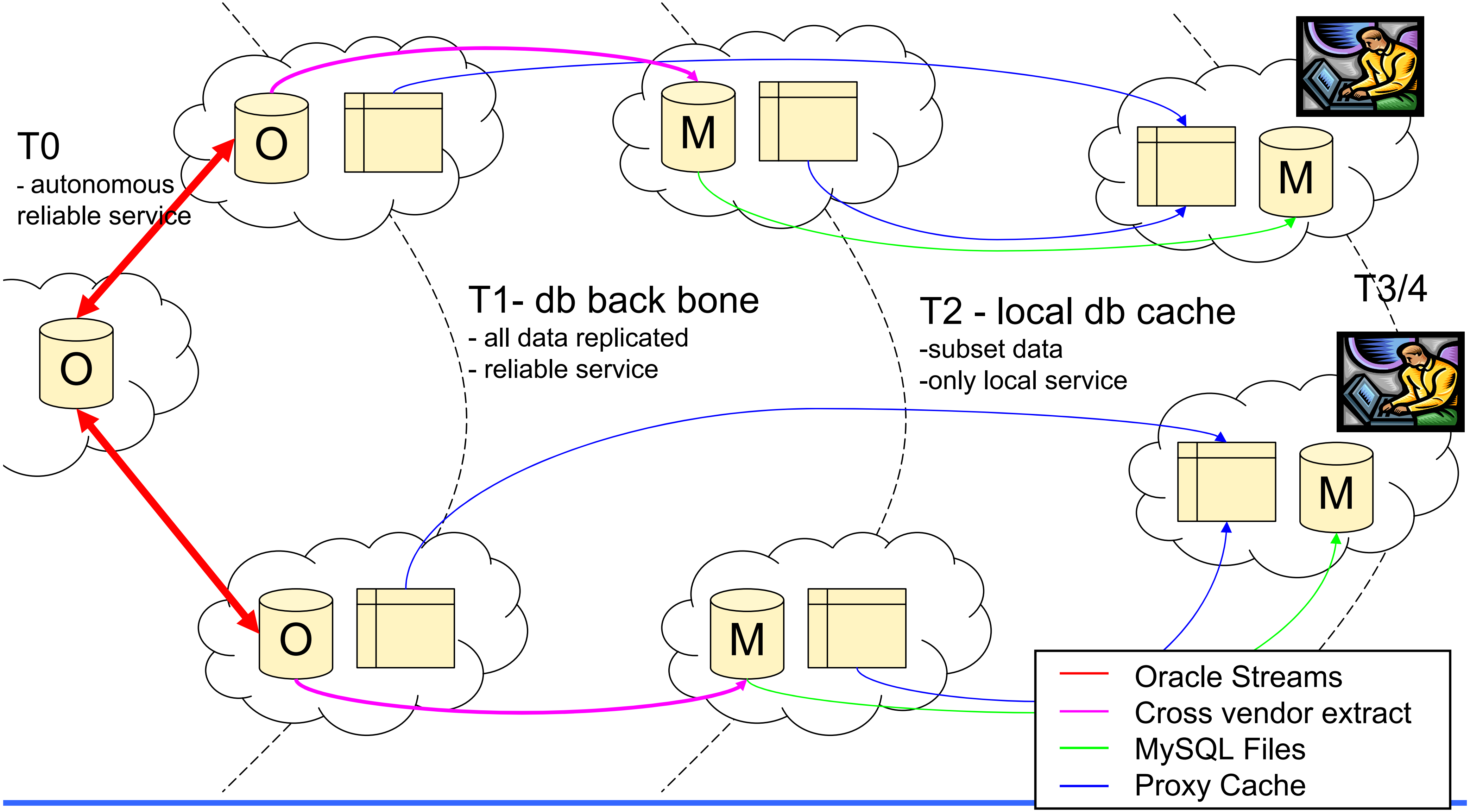
Tier 1 Service Split

- Discussion only just starting
  - Draft proposal based on input received from FNAL (Anil Kumar)
- Local Services
  - Server installation, bug & security fixes
  - OS patches/upgrades
  - Backup/recovery support
  - Data migration (between db servers)
- Shared Services
  - Db and OS accounts & privileges
  - Storage support (adding more space)
  - Monitoring
    - DB alerts, “killer queries cron job output
    - Host system load, space thresholds
  - Performance problems & optimization
- Site Communication
  - Proposal to setup a shared (web based) Log-Book, mailing lists
  - Need to establish regular DBA meeting
  - eg as part of weekly/bi-weekly 3D meetings

Local Database vs. Local Cache

- FNAL developed FroNtier system
  - a combination of http based database access with proxy caches on the way to the client
  - Performance gains
    - reduced real database access for largely read-only data
    - reduced transfer overhead compared to low level SOAP RPC based approaches
  - Deployment gains
    - Web caches (eg squid) are much simpler to deploy than databases and could remove the need for a local database deployment on some tiers
    - No vendor specific database libraries on the client side
    - “Firewall friendly” tunneling of requests through a single port
- Expect cache technology to play a significant role
  - towards the higher tiers which may not have the resources to run a reliable database service

Proposed 3D Service Architecture



T0
- autonomous reliable service

T1- db back bone
- all data replicated
- reliable service

T2 - local db cache
-subset data
-only local service

T3/4

Oracle Streams
Cross vendor extract
MySQL Files
Proxy Cache

LCG 3D Testbed

- Oracle 10g server
  - Install kits and documentation are provided for test bed sites
    - CERN can not offer offsite support though
  - At least 100GB storage
  - Application and reference load packaged by CERN / experiments
- FroNtier installation
  - FroNtier server at CERN and FNAL
    - plus squid installations at other sites
  - FNAL has prepared s/w packages and will install on the testbed
- { also expect some worker nodes to be available to run reference load }

- Oracle Enterprise Manager installation for test bed administration and server diagnostic
  - Client side monitoring being defined and integrated into POOL/RAL
    - Based on experience gained at RUN2 database deployment

Possible 3D use in SC3

- Timescale for first 3D deployment only after SC3 start
  - But will try to arrange for a preproduction service with the participating sites
  - Need a list of DB applications to be deployed in SC3
    - Eg a subset of the 3D spreadsheet with reduced volume (and lower number of sites)
  - Need to coordinate the software integration with the experiment development teams to be ready for SC3
  - Need to allocate database resources for SC3
- Once the list of candidate apps has been discussed with the experiments:
  - Either reduced database service at SC3 start
  - Or join SC3 later as 3D service / 3D database apps become available

Summary

- A distributed database infrastructure promises to provide scalability and availability for database applications at LHC
  - The LCG 3D project has been started as joint project between experiments and LCG sites to coordinate the definition of this service
  - Several distribution options are available for planning/design of new applications
- DB Service Definition
  - Very relevant deployment/development experience from RUN2 @ FNAL
  - Service task split and application validation policy proposals are firming up
  - Oracle 10g based replication test-bed expands to first T1
- Several new DB applications will be developed this year
  - Expect high support / consultancy load on database services (especially at Tier 0) for 2005
  - Early planning of concrete deployment and distribution models is key for successful production
- SC3 support from 3D is only now being discussed
  - Participation in SC3 would be a very useful first test of 3D services
  - Concrete time plan needs negotiation with experiments/sites