

OpenLDAP

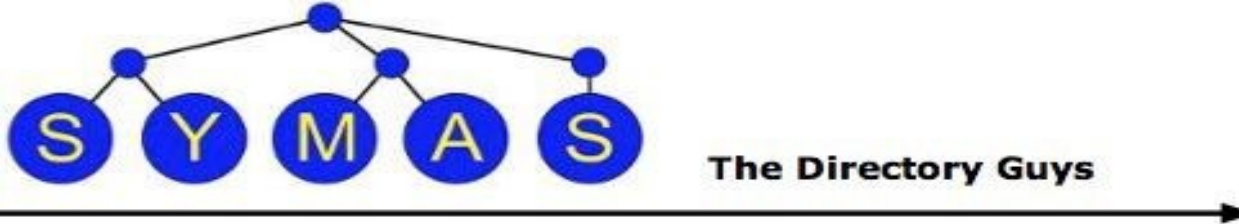
Setting a Course for the Enterprise

Howard Chu, hyc@symas.com

Chief Architect, Symas Corp

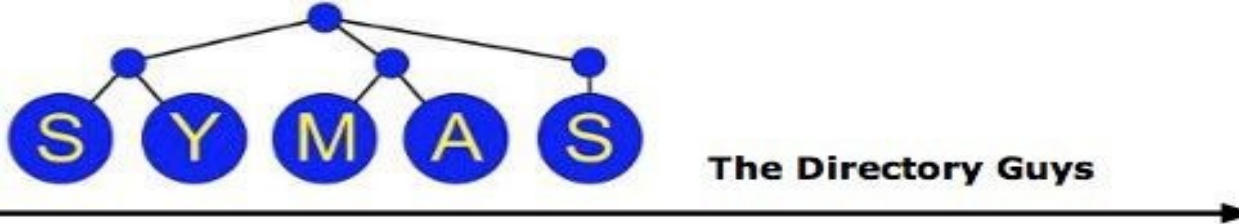
Chief Architect, OpenLDAP Project

SCALE5x 2007-02-10



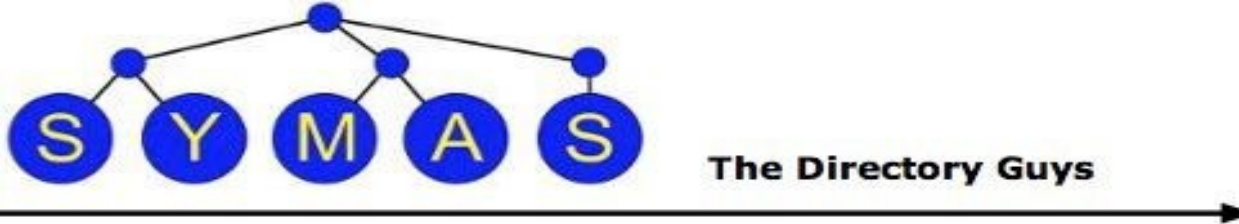
OpenLDAP Project

- Open source code project
- Founded 1998
- Three core team members
- A dozen or so contributors
- Feature releases every 12-18 months
- Maintenance releases roughly monthly



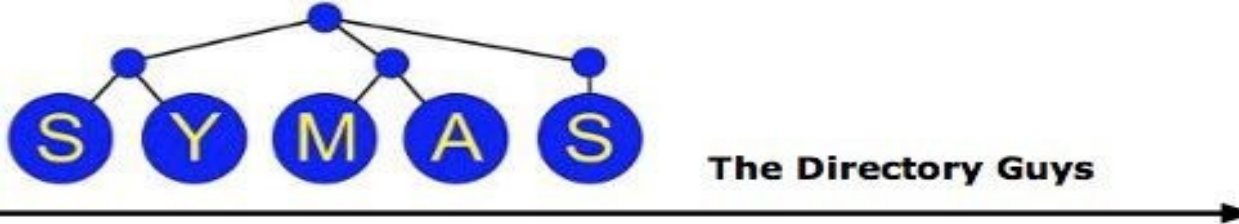
OpenLDAP Releases

- Release 1.x 1998/08/08 – 2001/09/11
 - Basically the UMich 3.3 code
 - Supported LDAP version 2
- Release 2.0 2000/08/31 – 2002/09/22
 - Introduced LDAP version 3 support
 - Added security with SASL and SSL/TLS
- Release 2.1 2002/06/09 – 2004/04/15
 - Significantly faster than 2.0
 - Added Unicode support
 - Added back-bdb backend



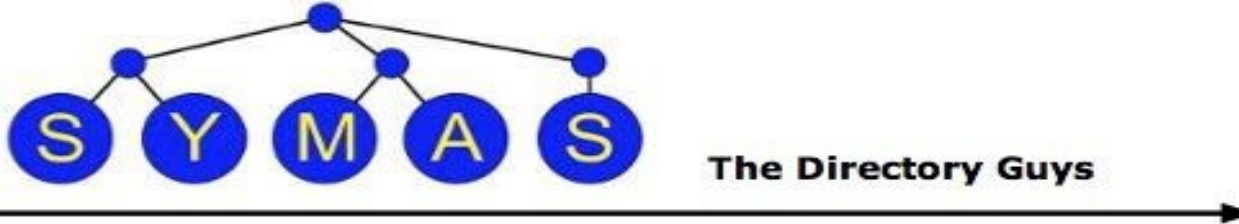
OpenLDAP Releases, cont'd

- Release 2.2 2003/12/31 – 2005/11/21
 - Further optimization
 - Added back-hdb
 - More extensibility using slapd overlays and/or SLAPI plugins
- Release 2.3 2004/12/30 – now
 - Component-based matching
 - More overlays
 - Dynamic reconfiguration



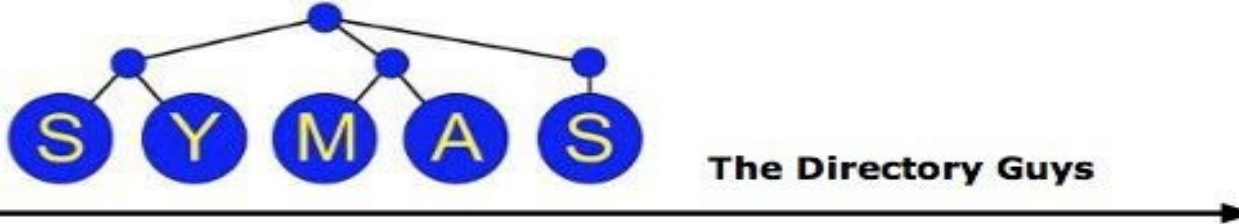
OpenLDAP Today

- The fastest Directory Server
- The most reliable
- The most scalable
- The most active Open Source DS project
- The most aggressive, looking forward



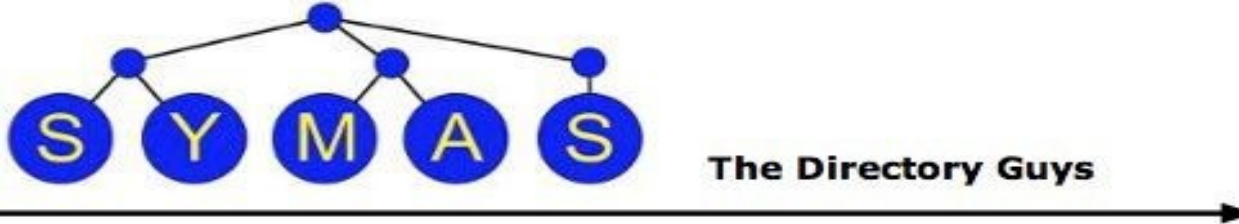
A Word About Symas

- Founded 1999
- Founders from Enterprise Software world
 - *platinum* Technology (Locus Computing)
 - IBM
- Howard joined OpenLDAP in 1999
 - One of the Core Team members
 - Appointed Chief Architect January 2007



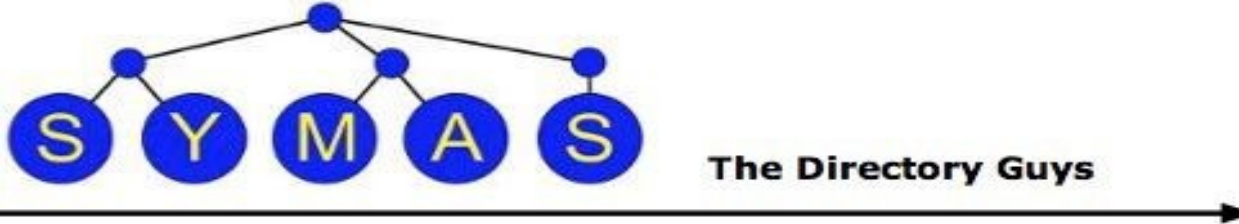
Notable Features

- Introduced in 2.1:
 - Transactional Backend (back-bdb)
- Introduced in 2.2:
 - Hierarchical Backend (back-hdb)
 - Content-Sync Replication (syncrepl)
 - Overlays
- Introduced in 2.3:
 - Dynamic Configuration (back-config)



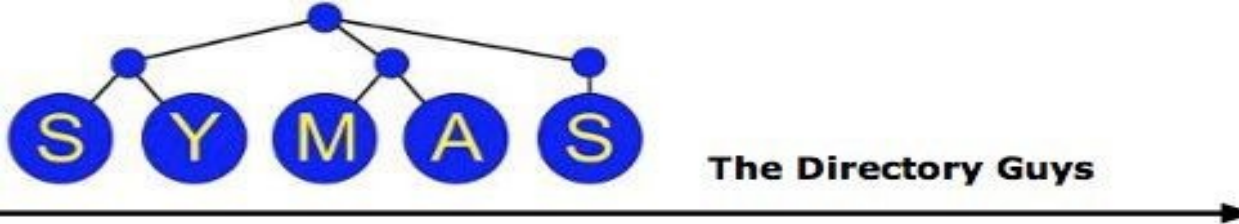
back-bdb

- Fully transactional backend with full ACID semantics
 - Atomicity: changes are all-or-nothing
 - Consistency: no structural corruption
 - Isolation: no in-between views of data
 - Durability: once a write returns success, it cannot be undone
- Extremely reliable



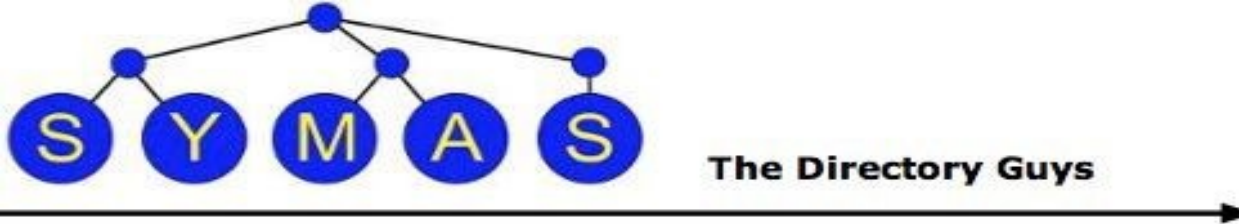
back-hdb

- Fully hierarchical backend
 - Higher write throughput than other directory backends
 - Supports subtree renames in $O(1)$ time
 - Based on back-bdb code – offers same transactional reliability



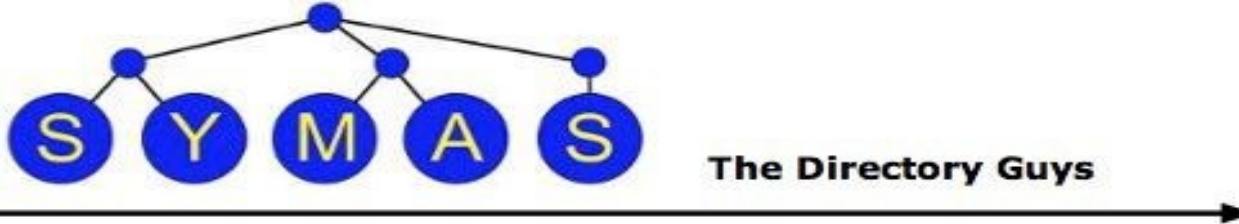
syncrepl

- Replaces the old slurpd-based replication mechanism
- Documented in RFC4533
- Very flexible operation with minimal administration overhead



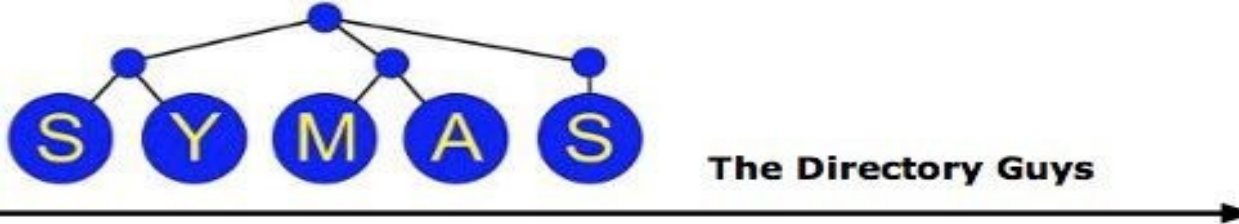
Slapd overlays

- Modular plugin framework using slapd's native API
- Allows for rapid development and deployment of enhancements and new features



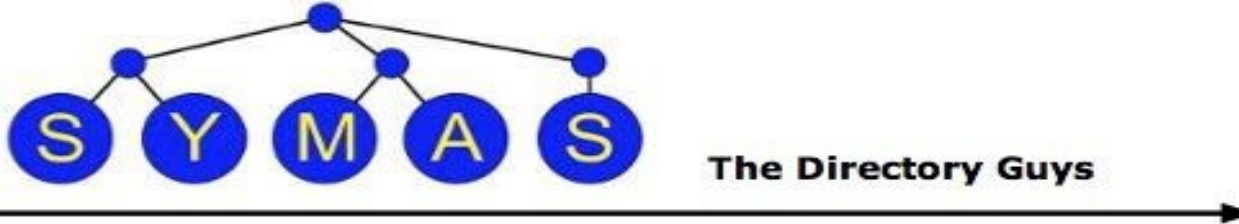
Overlay Examples

- Enterprise-oriented features
 - In-directory password policy
 - Referential integrity
 - Translucency
 - Attribute uniqueness
 - Value sorting
 - In-directory logging



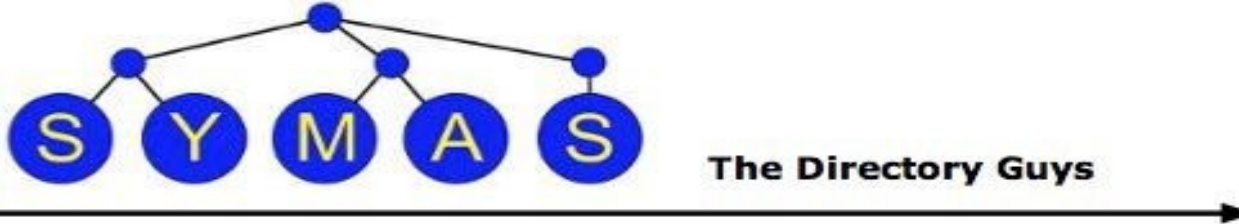
Dynamic Configuration

- cn=config database
 - Config engine is backward compatible with slapd.conf
 - Allows runtime changes of almost all settings
 - ACLs
 - Schema
 - Databases
 - DB indexing
 - Dynamic modules
 - Changes take effect immediately, no downtime required



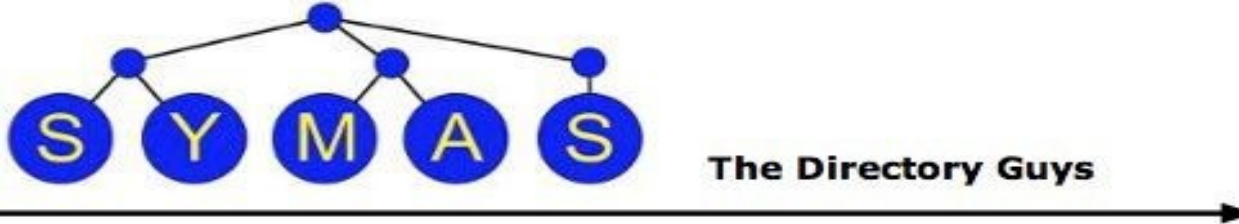
CN=config Future

- Zero administrative downtime
 - dynamically replace/re-exec binaries
- Fine-grained syncrepl for shared configuration components
 - Available in OpenLDAP 2.4
- config_entry API
 - allow backends/overlays to access their own config entries and persist private state
- Your suggestions welcome...



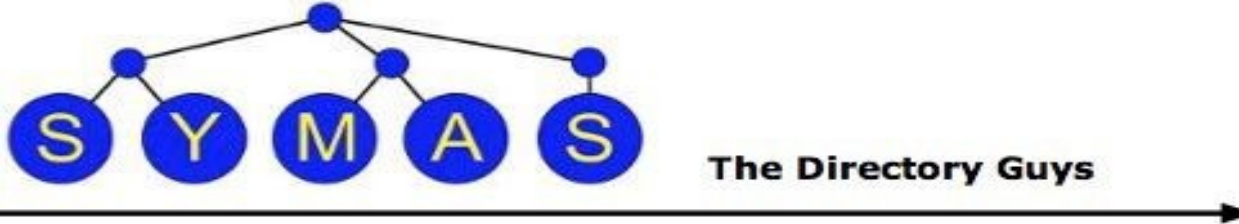
New Developments

- Syncrepl enhancements
 - Delta-syncrepl
 - Push-mode syncrepl
 - Mirrormode
- Upcoming work
 - lessons learned from deployment, ITS's



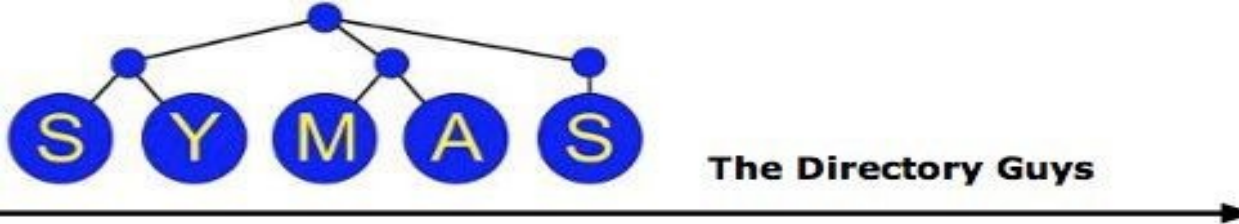
Syncrepl

- Delta-syncrepl
 - Addresses bandwidth concerns from plain syncrepl
 - Relies on a persistent log of changes
 - Ordering of log entries is fully serialized; no out of order updates
 - Automatic fallback to plain syncrepl if consumer loses sync with log



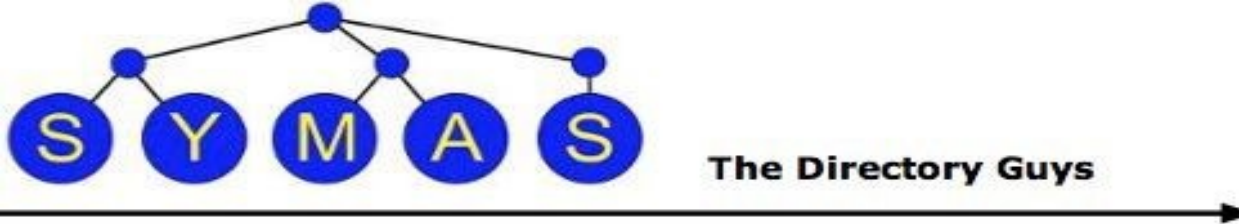
Syncrepl...

- Push-mode syncrepl
 - Just a syncrepl consumer sitting on back-ldap
 - Can add a customization overlay for mapping the contextCSN to a suitable remote attribute, or to store the contextCSN locally
 - Provides a simple, robust, dynamically configurable replacement for slurpd



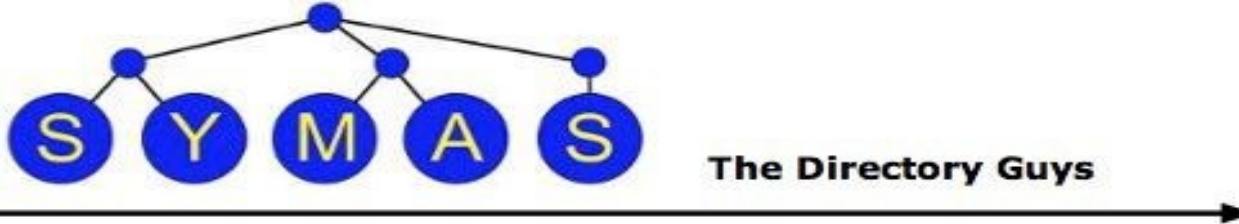
Syncrepl...

- Mirrormode
 - Allows a single active master and many standby masters
 - Preserves single master consistency while allowing automatic promotion of alternate masters
 - Requires use of an external frontend to guarantee that writes are only sent to a single master at a time
 - Addresses the high availability/SPOF concerns with minimal fuss
 - Already in use at some Symas customer sites



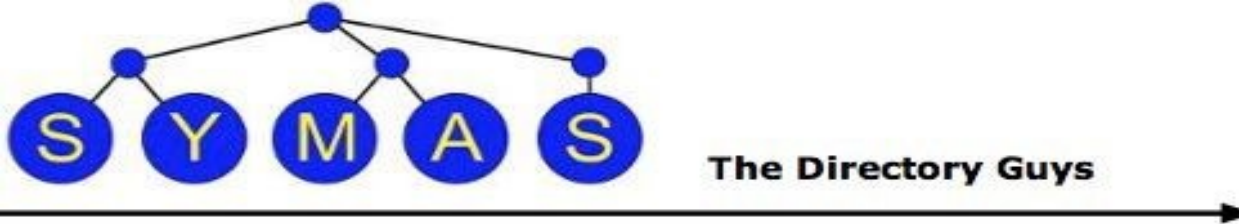
Syncrpl...

- Full N-Way Multimaster Support
 - requires synchronized clocks for all contexts
 - requires use of hostID field of CSN
 - requires per-consumer contextCSNs in addition to (*not instead of*) provider contextCSN
 - Available in OpenLDAP 2.4



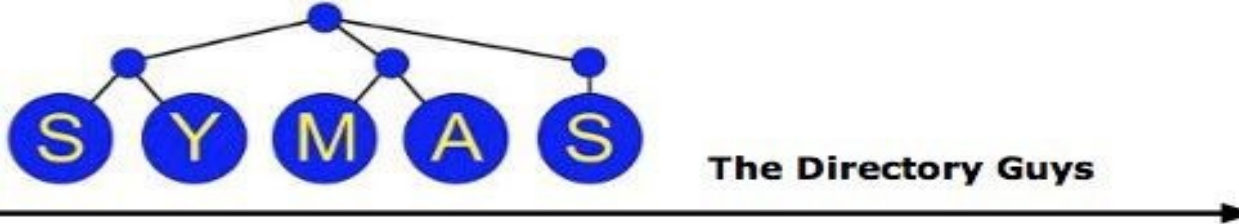
Performance

- Fixed Lightweight Dispatcher
 - eliminated unnecessary locking in connection manager
 - slapd-auth test against back-null yielded over 32000 binds per second on 100Mbps ethernet
 - over 128000 frames per second - ~90% of available bandwidth – essentially saturated
 - No other LDAP server we tested delivers this speed on identical hardware



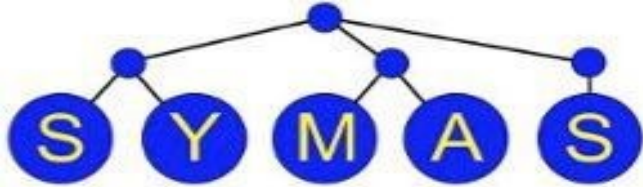
Performance...

- Fixes to pcache (proxy cache) overlay
 - Fixed $O(n^2)$ query containment behaviors
 - Optimized case where a single entry is expected
 - Added negative caching support
 - Results:
 - pcache used to be slower than a direct proxy lookup above about 500 queries
 - pcache is now always faster than passing through



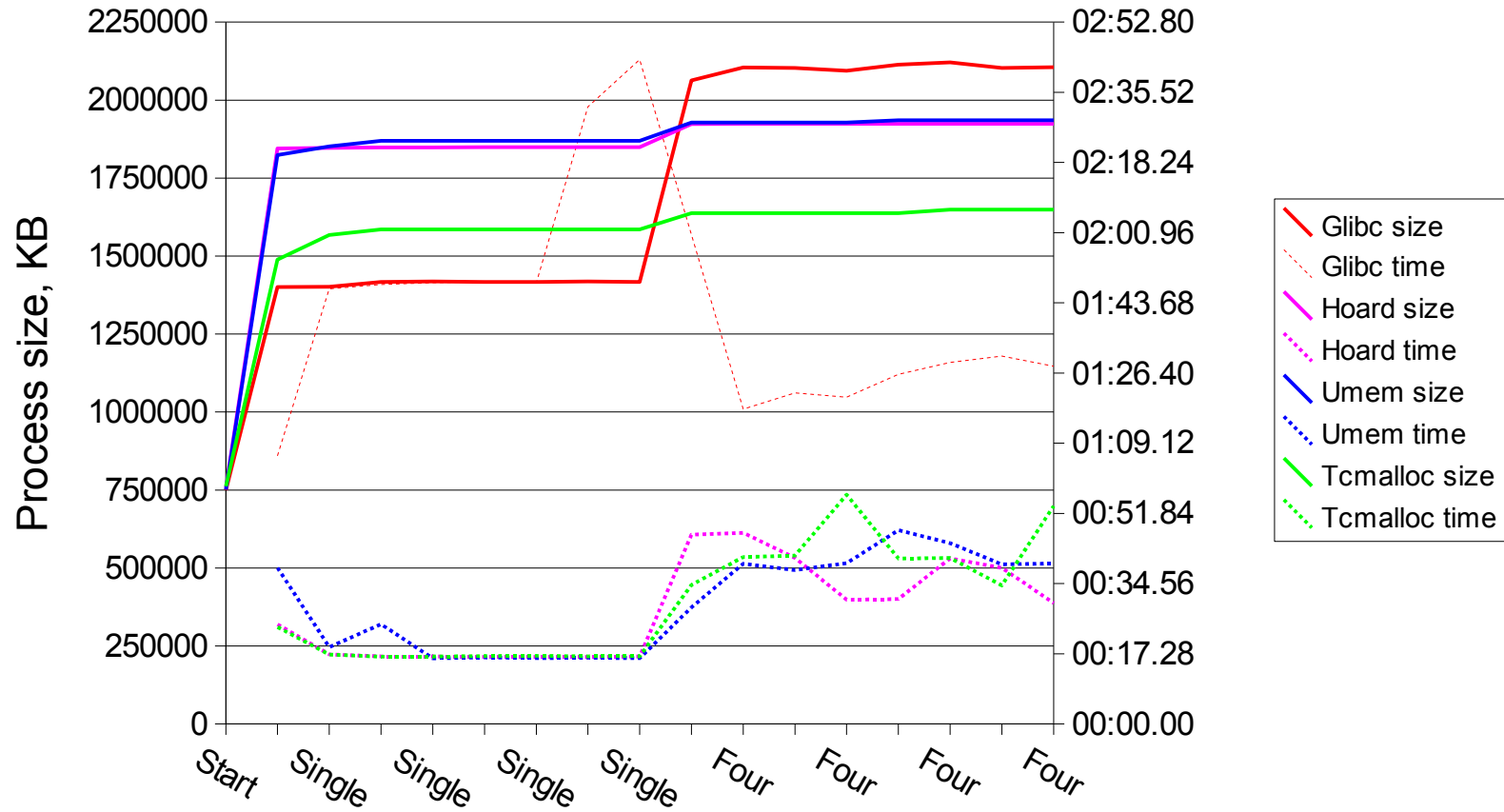
Performance...

- libc malloc() still has a major impact
 - refactored Entry and Attribute management to further reduce number of calls to malloc
 - using a thread-oriented allocator like hoard provides further advantages

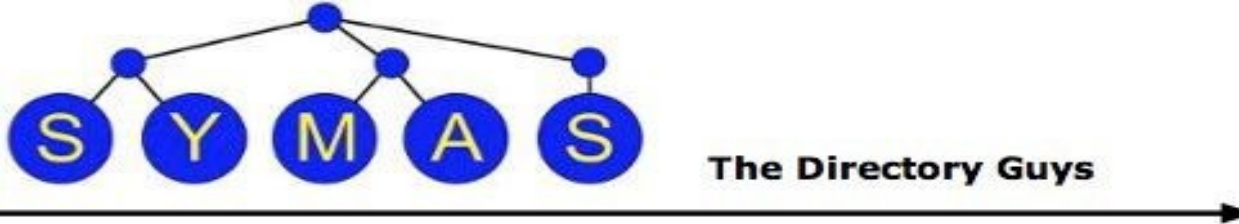


The Directory Guys

Malloc performance

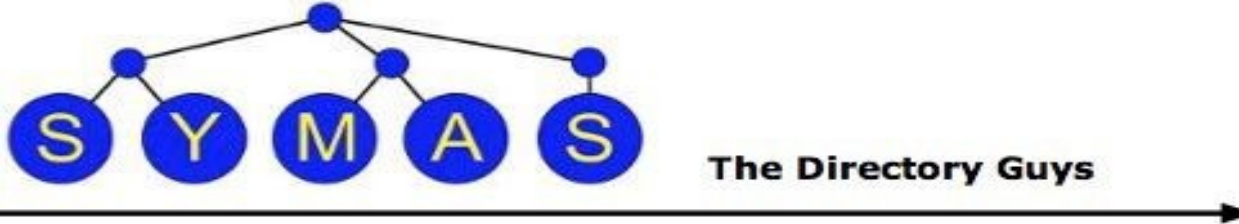


see [openldap-devel](#) August 30 2006...



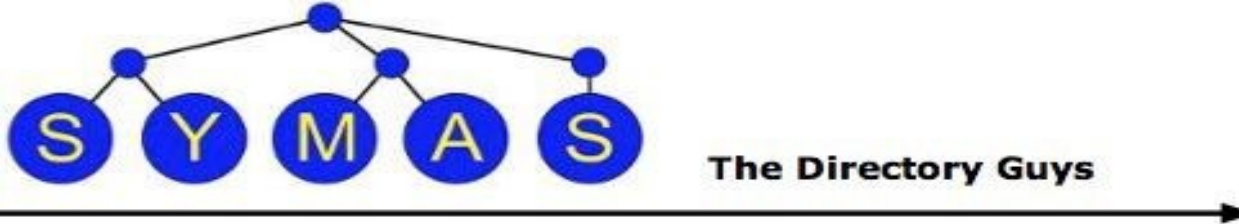
malloc Performance

- Tested on 2.6 Linux kernel with glibc 2.3.3
- Results will obviously vary by platform
- glibc malloc does not handle tight memory conditions gracefully
- libhoard is marginally fastest
- Google tcmalloc is most space-efficient
- umem on non-Solaris appears unmaintained



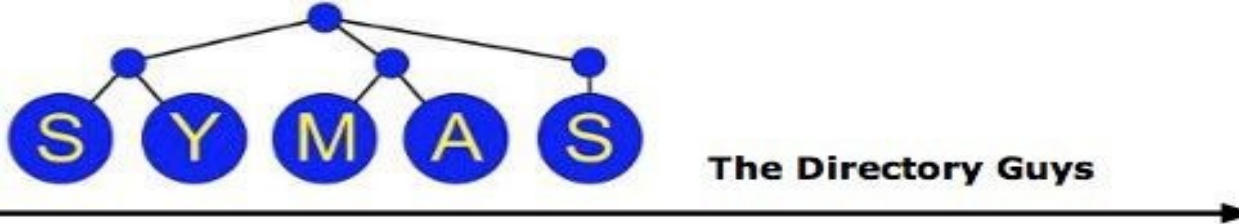
Performance...

- Scaling to large deployments
 - Demonstrated performance at over 150 million entries
 - November 2005: 16600 queries/second, 3400 updates/second
 - April 2006: 22000 queries/second, 4800 updates/second
 - Over 1 terabyte of real data
 - Other popular directories' claims of scaling are provably false
 - Several other products were tested with the same data, all of them failed
 - Only OpenLDAP passed



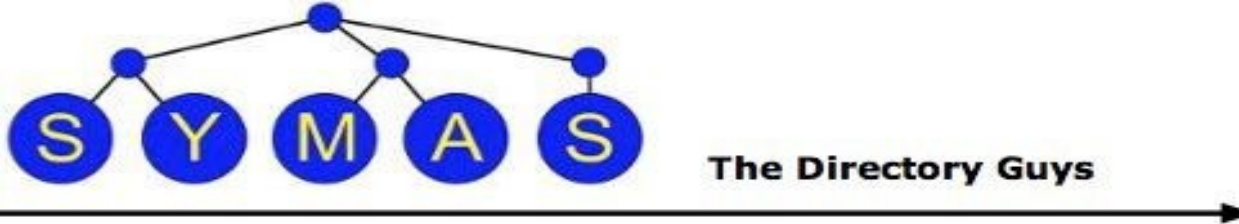
Performance...

- benchmark details available on www.symas.com
- we may want to consider investing effort in a C-based benchmarking framework
 - existing frameworks are not credible
 - DirectoryMark in perl, fast enough to measure slow directories, not fast enough for OpenLDAP
 - SLAMD in java, same story again



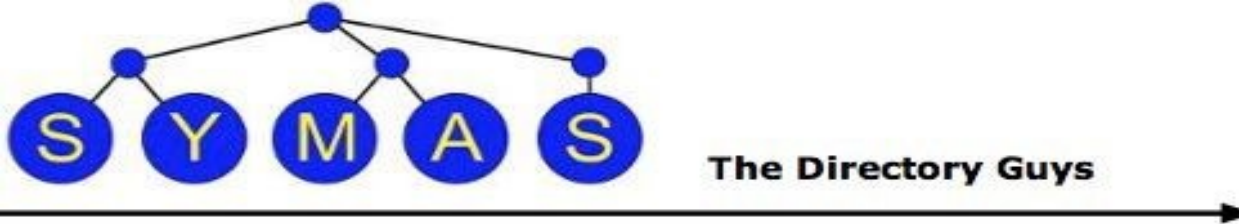
A Word from Our Sponsors

- OpenLDAP is no longer only of interest to a handful of developers
 - Significant investment from Symas, HP, Sys-Net, Sendmail (pcache), others.
 - Is now running all of HP's corporate IT, displacing previous proprietary server
 - Feature wise, performance wise, there is no credible competition



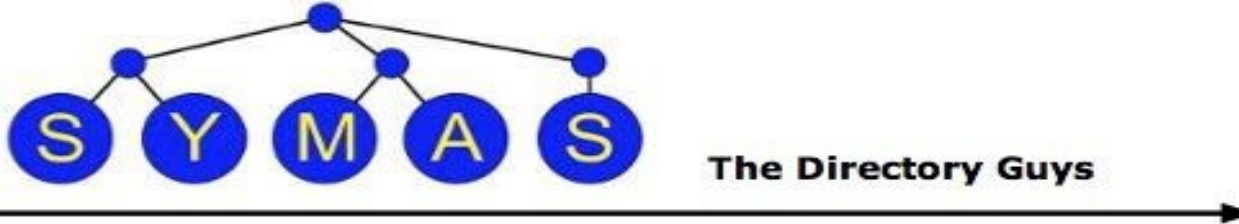
The Road Ahead

- The unmatched code quality is not matched by documentation quality
 - Working on OpenLDAP Admin book, to be published by Addison-Wesley in Spring 2007
 - The manpages need to be fleshed out, missing pages need to be written



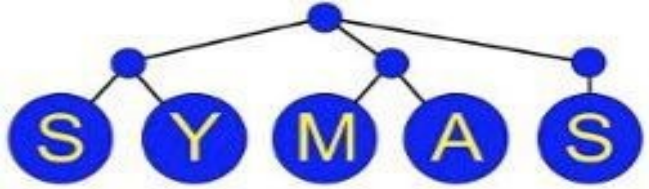
The Road Ahead...

- Work on scale-out, vs scale-up
 - allow multi-terabyte DBs to be served without requiring a single giant server
 - page-oriented, lock-free DB to allow multiple backends to serve portions of a single shared DB
 - distributed indexing
 - cluster-friendly optimizations



Final Thoughts

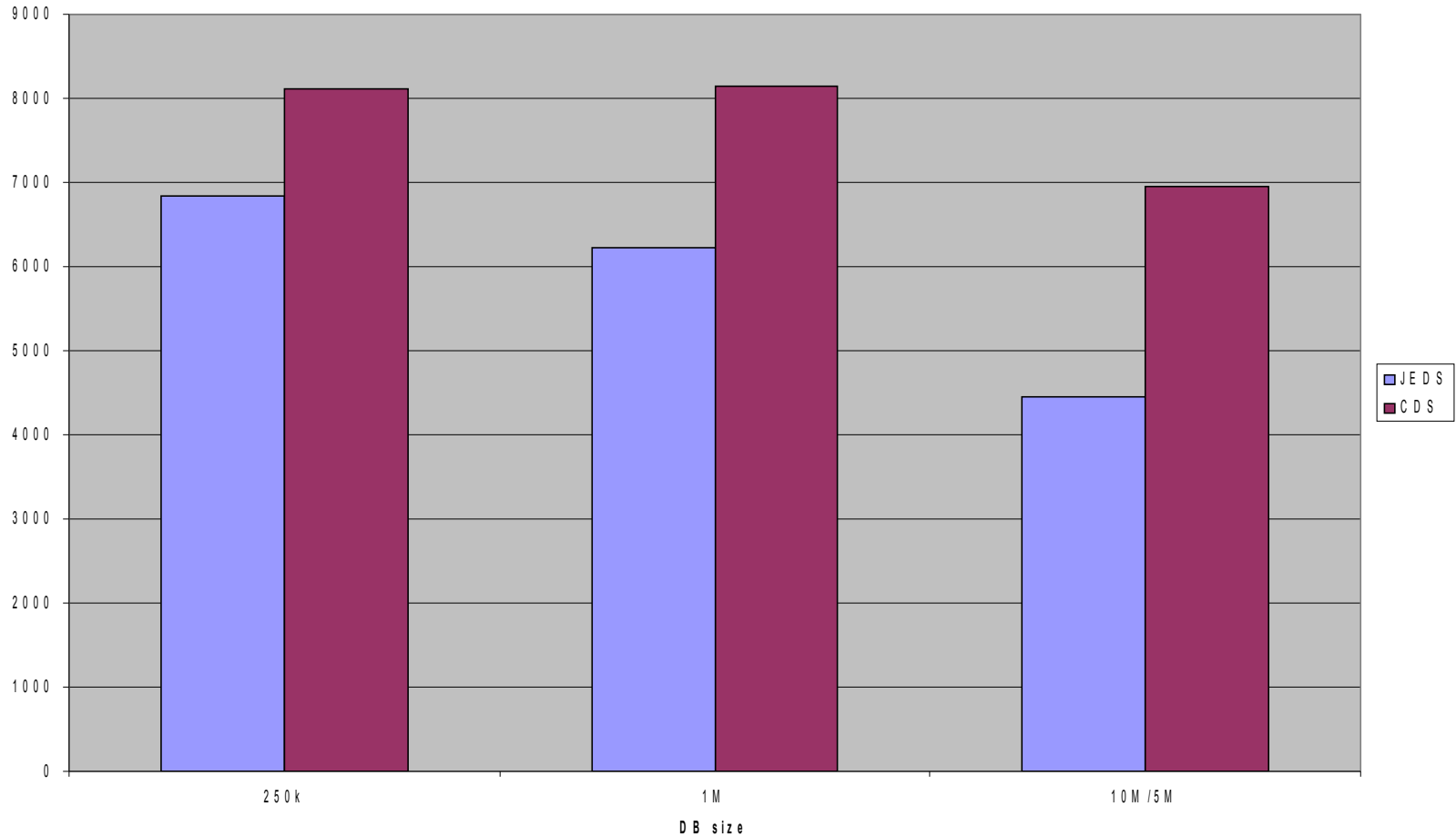
- OpenLDAP is taking over the enterprise
 - reliability, flexibility, scalability beyond all users' or competitors' comprehension
- The OpenLDAP community continues to thrive
 - with special thanks to the corporate members of the community
- Code quality is self-evident, but needs to be balanced with documentation quality

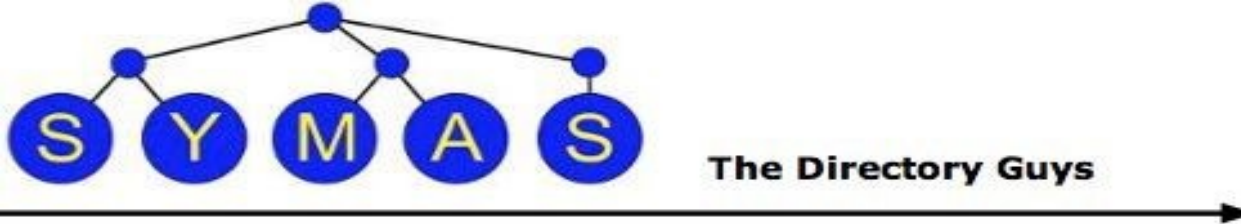


The Directory Guys

Authentication Performance

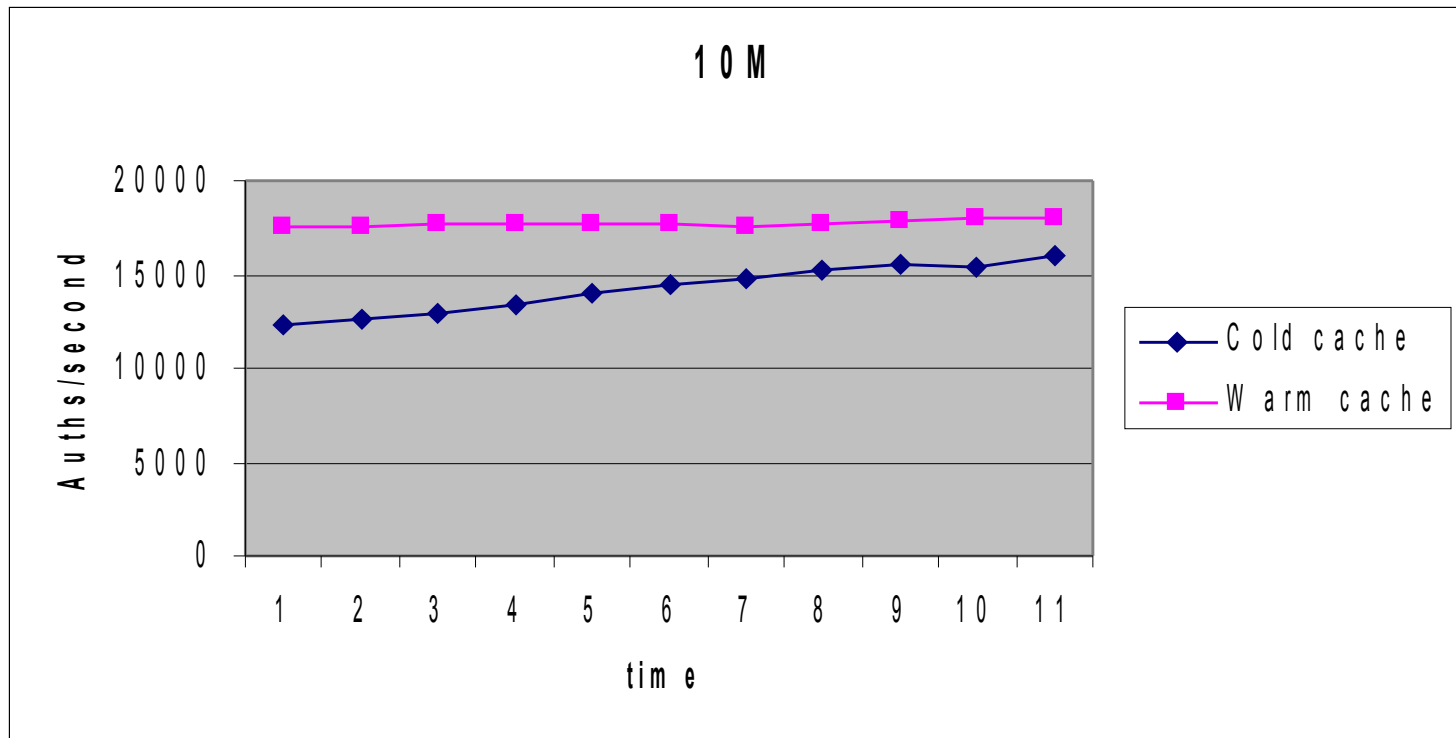
Authentication Rates

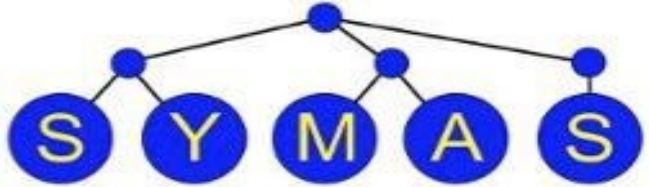




Authentication Performance

- AMD 4-processor dual-core
- 10 million entry DB

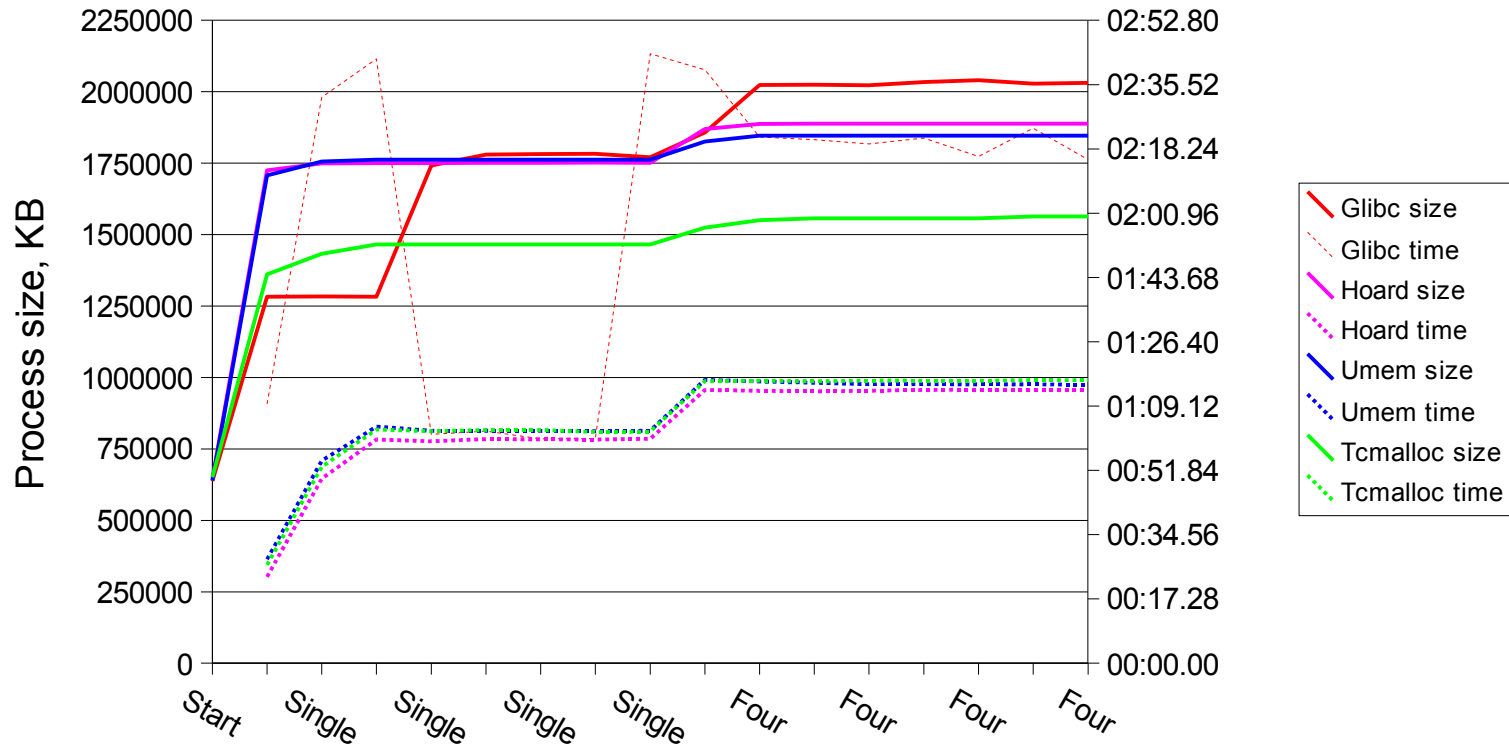


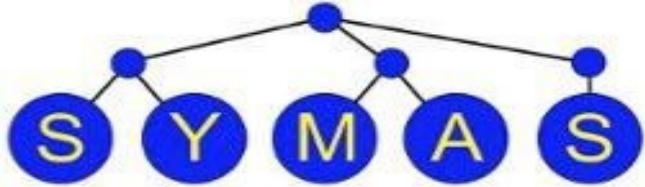


The Directory Guys

BDB 4.2 performance

Malloc performance

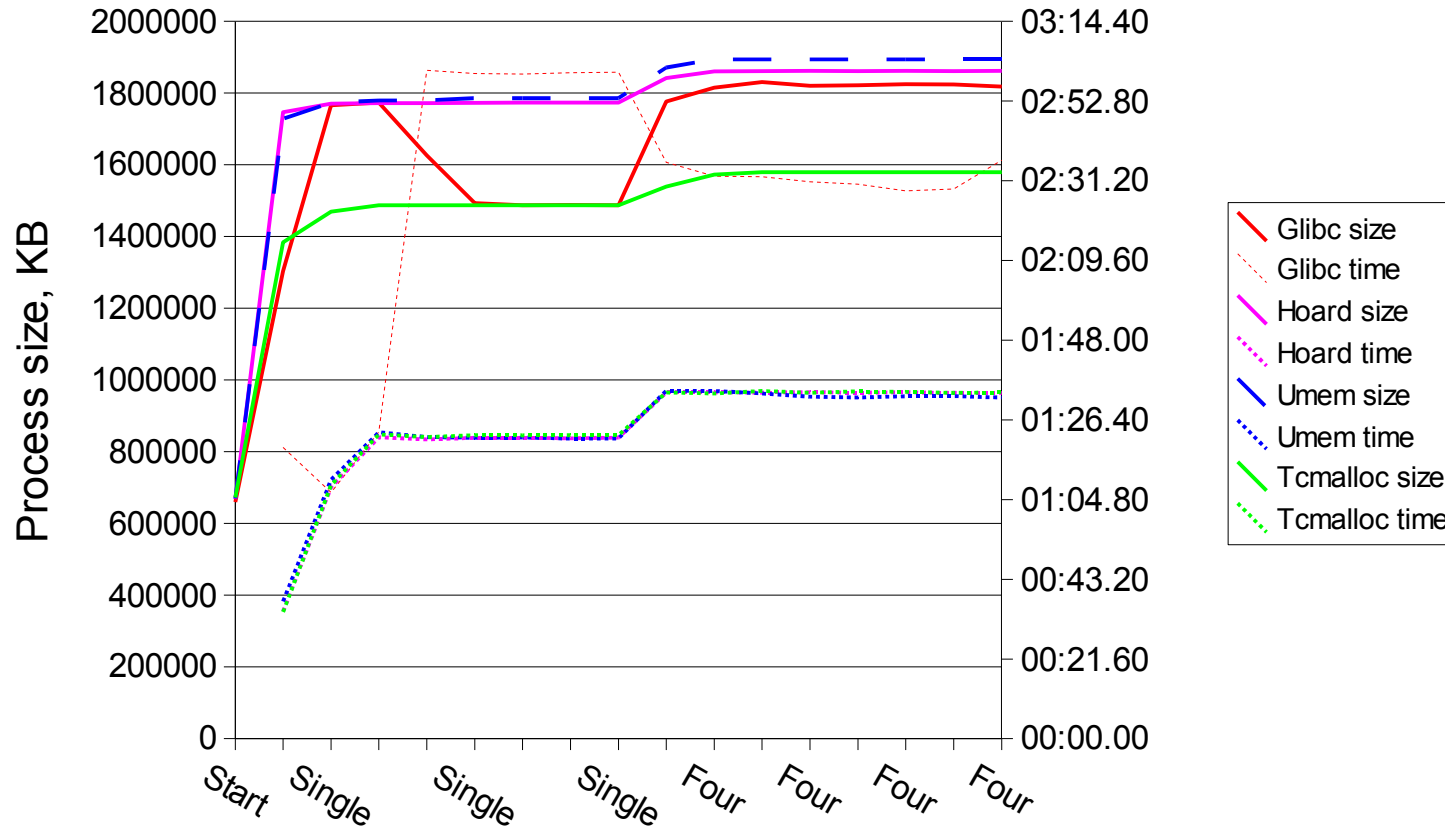


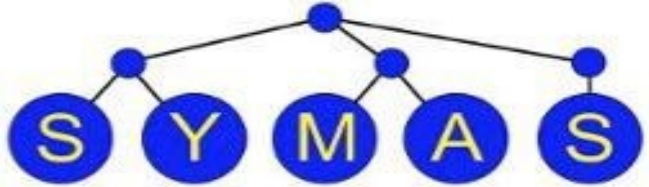


The Directory Guys

BDB 4.5 Performance

Malloc performance

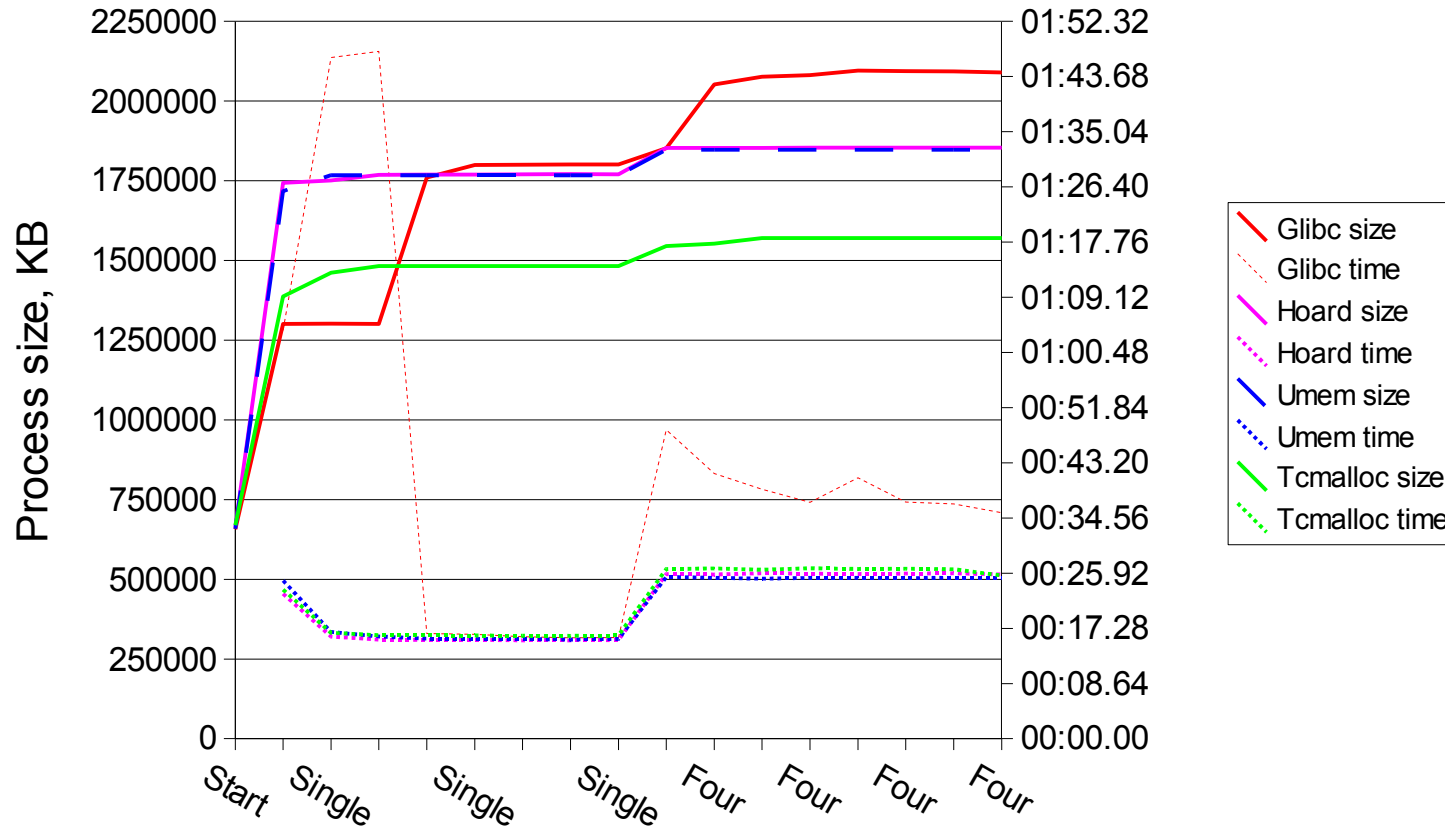


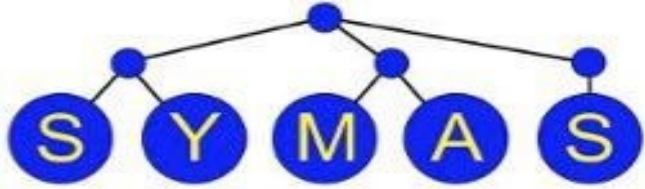


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BDB 4.6 Performance

Malloc performance

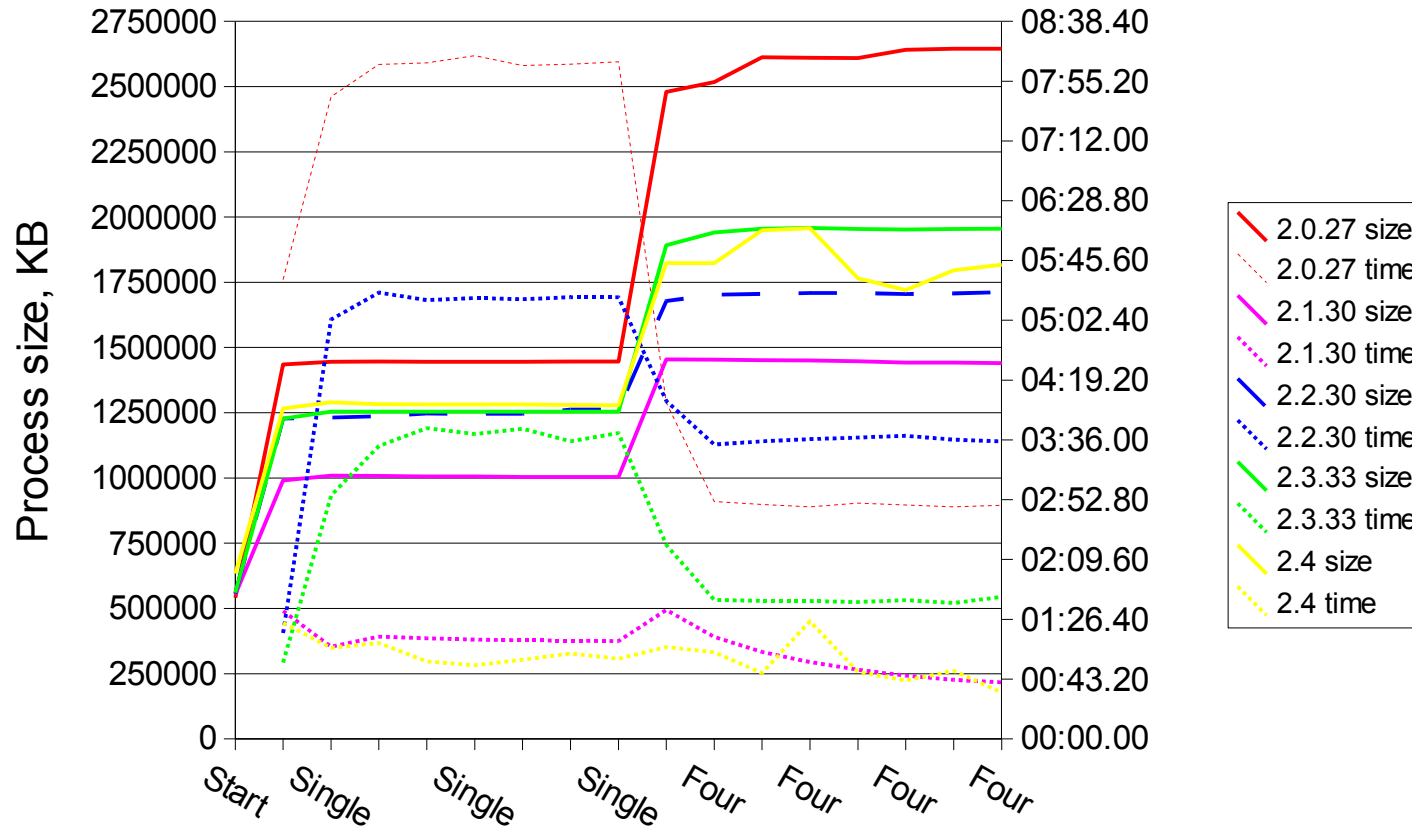


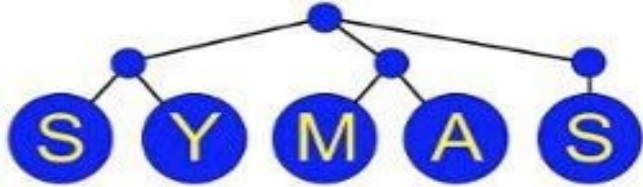


The Directory Guys

Worst Case Search Performance

Search performance

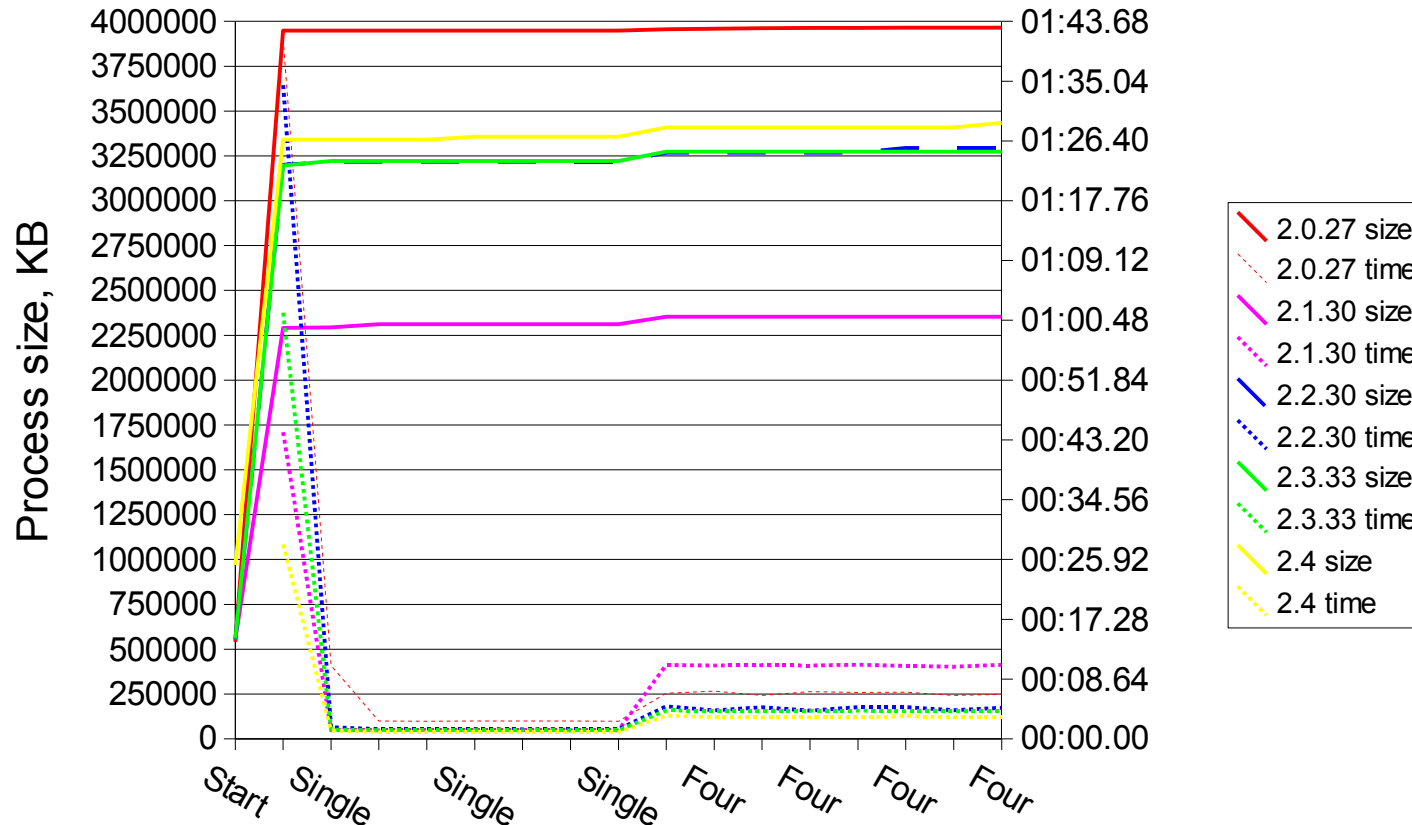


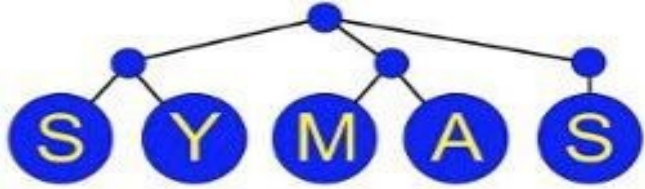


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Cached Search Performance

Cached Search performance

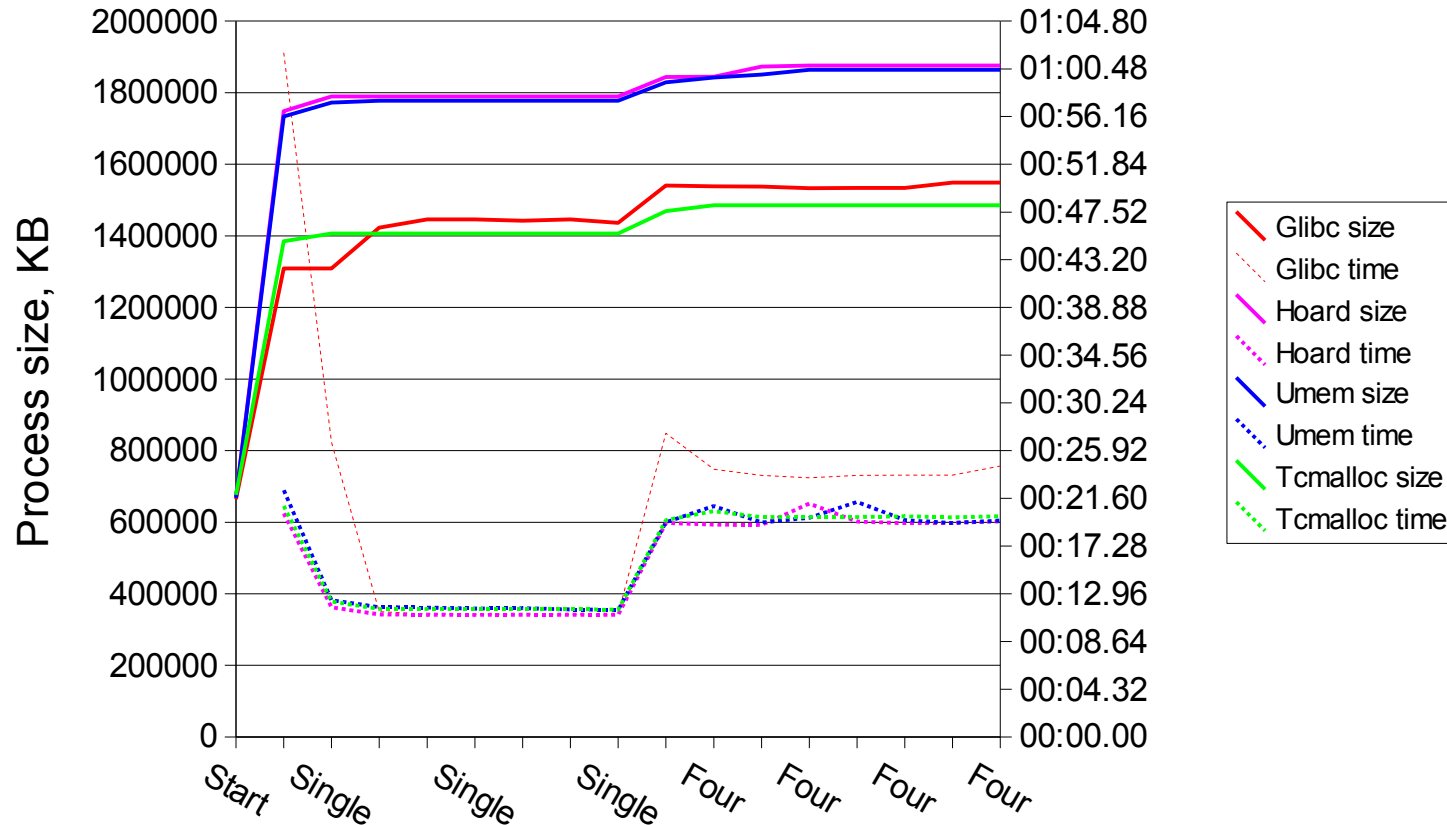


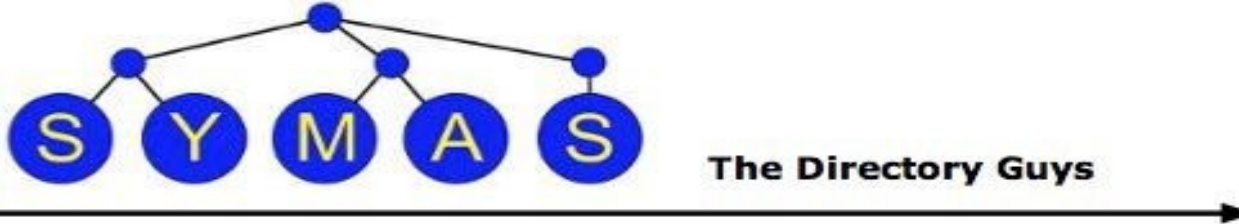


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Current Performance

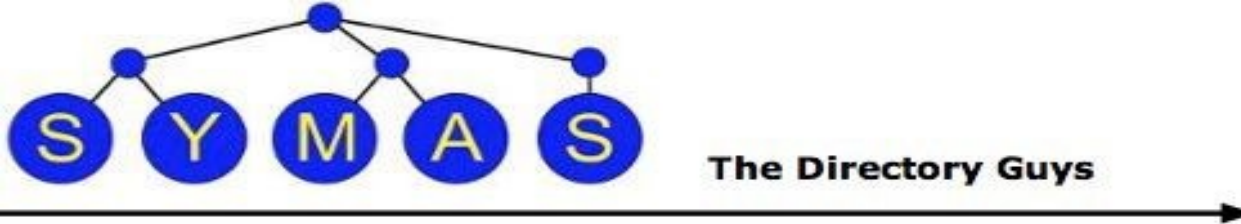
Malloc performance





Database Parameters

- 380836 entries
 - Range in size from 3K to 10MB
- Total size on disk ~1.3GB
- Running on Socket939 2.4GHz AMD64 X2 w/512KB L2 cache per core, 4GB DDR400 ECC/REG RAM
- No disk I/O during searches
- Using 2.3 as of November 2006 unless otherwise noted



2.0.27 DB Parameters

```
Ldbm BDB 4.2.52 dbnosync, dbcachesize 512MB
```

```
slapadd 113.455u 8.004s 2:16.96 88.6% 0+0k 0+0io 0pf+0w
```

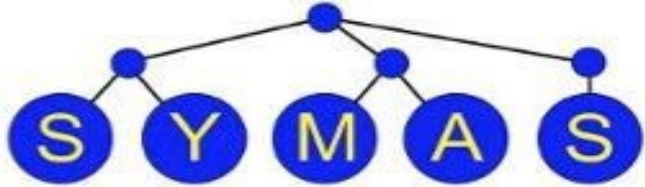
```
total 1281133
```

```
-rw----- 1 hyc users 88879104 2007-02-09 23:46 dn2id.dbb
```

```
-rw----- 1 hyc users 1220915200 2007-02-09 23:46 id2entry.dbb
```

```
-rw----- 1 hyc users 8192 2007-02-09 23:46 nextid.dbb
```

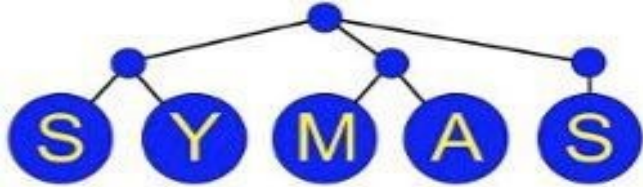
```
-rw----- 1 hyc users 798720 2007-02-09 23:46 objectClass.dbb
```

The Directory Guys

2.1.30 DB Parameters

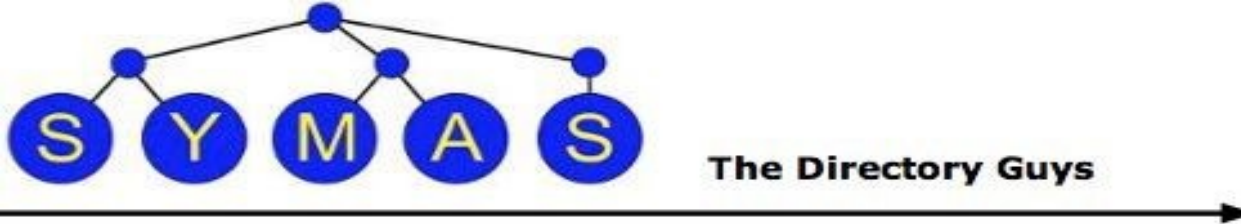
```
bdb BDB 4.2.52 TXN_NOSYNC, TXN_NOT_DURABLE
slapadd 162.582u 8.300s 3:04.30 92.7% 0+0k 0+0io 7189pf+0w
total 850295
-rw----- 1 hyc users      16384 2007-02-10 04:35 __db.001
-rw----- 1 hyc users 536870912 2007-02-10 04:35 __db.002
-rw----- 1 hyc users   2359296 2007-02-10 04:35 __db.003
-rw----- 1 hyc users   663552 2007-02-10 04:35 __db.004
-rw----- 1 hyc users      16384 2007-02-10 04:35 __db.005
-rw-r--r-- 1 hyc users        177 2007-02-10 01:30 DB_CONFIG
-rw----- 1 hyc users 79978496 2007-02-10 04:38 dn2id.bdb
-rw----- 1 hyc users 782745600 2007-02-10 04:38 id2entry.bdb
-rw----- 1 hyc users         28 2007-02-10 04:35 log.0000000001
-rw----- 1 hyc users   6553600 2007-02-10 04:38 objectClass.bdb
```



The Directory Guys

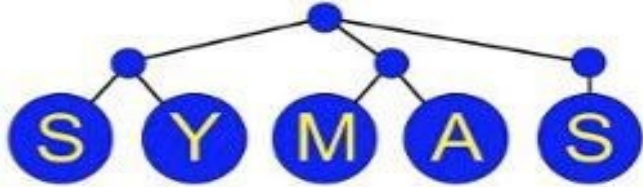
2.2.30 DB Parameters

```
bdb BDB 4.2.52 TXN_NOSYNC, TXN_NOT_DURABLE
slapadd 284.789u 10.836s 5:04.65 97.0% 0+0k 0+0io 7136pf+0w
total 1869554
-rw----- 1 hyc users      16384 2007-02-10 02:42 __db.001
-rw----- 1 hyc users 536870912 2007-02-10 02:42 __db.002
-rw----- 1 hyc users   2359296 2007-02-10 02:42 __db.003
-rw----- 1 hyc users   663552 2007-02-10 02:42 __db.004
-rw----- 1 hyc users   32768 2007-02-10 02:42 __db.005
-rw-r--r-- 1 hyc users      177 2007-02-10 01:30 DB_CONFIG
-rw----- 1 hyc users 79978496 2007-02-10 02:47 dn2id.bdb
-rw----- 1 hyc users 1288781824 2007-02-10 02:47 id2entry.bdb
-rw----- 1 hyc users      28 2007-02-10 02:47 log.0000000001
-rw----- 1 hyc users 6549504 2007-02-10 02:47 objectClass.bdb
```



2.3.33 DB Parameters

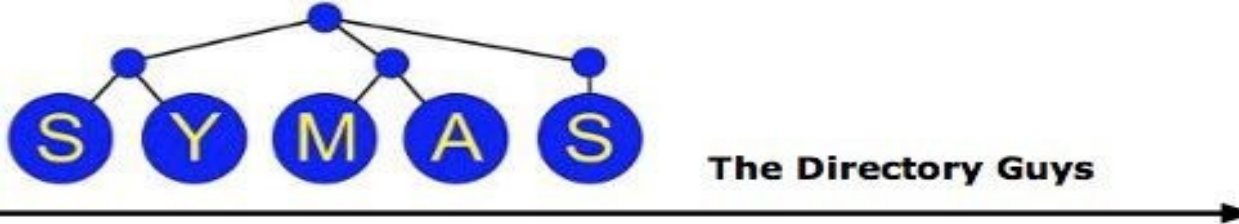
```
bdb BDB 4.2.52 TXN_NOSYNC, TXN_NOT_DURABLE
slapadd 118.447u 9.256s 2:17.26 93.0% 0+0k 0+0io 7126pf+0w
total 1344299
-rw-r--r-- 1 hyc users          2048 2007-02-10 04:42 alock
-rw----- 1 hyc users         16384 2007-02-10 04:40 __db.001
-rw----- 1 hyc users    536870912 2007-02-10 04:40 __db.002
-rw-r--r-- 1 hyc users          177 2007-02-10 01:30 DB_CONFIG
-rw----- 1 hyc users    79978496 2007-02-10 04:42 dn2id.bdb
-rw----- 1 hyc users 1288142848 2007-02-10 04:42 id2entry.bdb
-rw----- 1 hyc users    6549504 2007-02-10 04:42 objectClass.bdb
```



The Directory Guys

2.4 DB Parameters

```
bdb BDB 4.2.52 TXN_NOSYNC, TXN_NOT_DURABLE
slapadd 138.416u 10.060s 2:39.27 93.2% 0+0k 0+0io 7127pf+0w
total 1348137
-rw-r--r-- 1 hyc users          2048 2007-02-10 05:39 alock
-rw----- 1 hyc users         16384 2007-02-10 05:39 __db.001
-rw----- 1 hyc users    536870912 2007-02-10 05:39 __db.002
-rw----- 1 hyc users     2359296 2007-02-10 05:39 __db.003
-rw----- 1 hyc users     663552 2007-02-10 05:39 __db.004
-rw----- 1 hyc users     32768 2007-02-10 05:39 __db.005
-rw-r--r-- 1 hyc users          177 2007-02-10 01:30 DB_CONFIG
-rw----- 1 hyc users    79978496 2007-02-10 05:38 dn2id.bdb
-rw----- 1 hyc users 1292042240 2007-02-10 05:38 id2entry.bdb
-rw----- 1 hyc users     6549504 2007-02-10 05:38 objectClass.bdb
```



ldapadd performance

- DB taking 2:42.64 for slapadd -q took 1:33:08.74 using ldapadd
- Optimized server and client in HEAD bring the time down to 5:20.00
- Remaining network and encode/decode overhead unlikely to go away