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MarFS

A Near-POSIX Namespace Leveraging Scalable Object Storage

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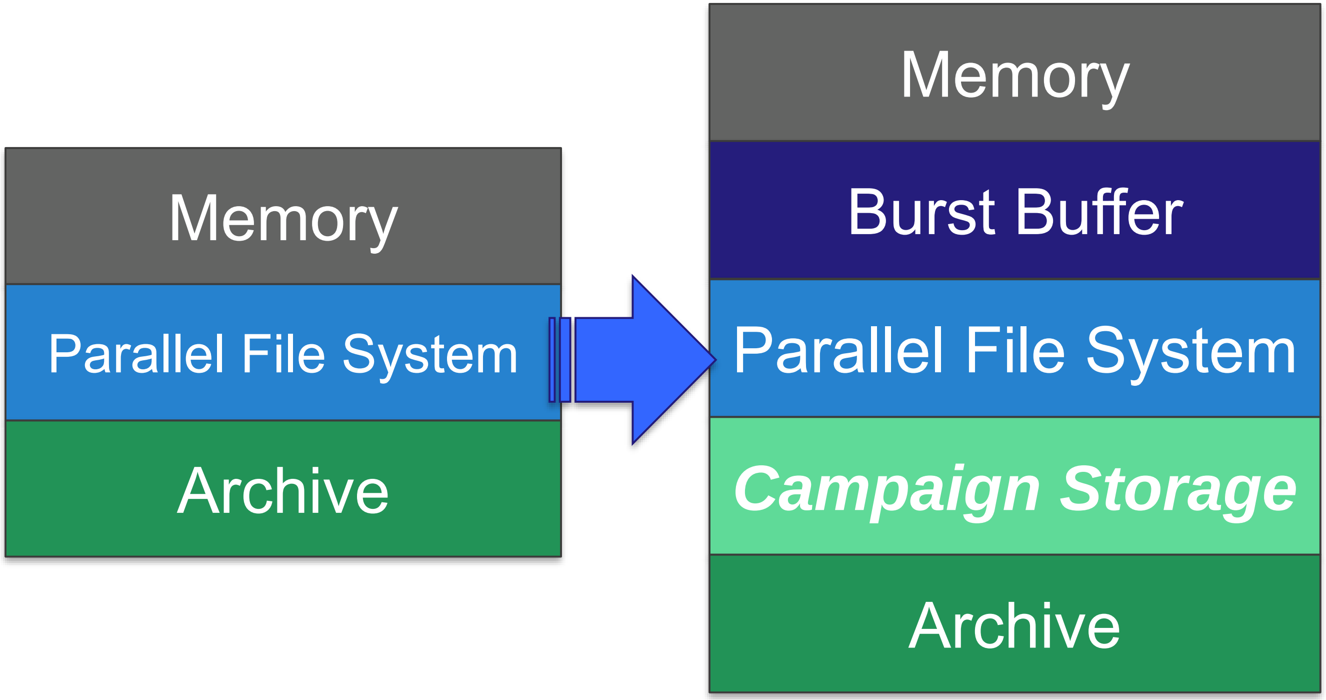
Overview

- **What's the problem?**
- **What do we really need?**
- **Why existing solutions don't work**
- **Intro to MarFS**
  - What is it?
  - How does it work?
- **Status**
  - Current
  - Future

What's the problem?

- Campaign Storage (Trinity+ Version)



1-2 PB/sec
Residence – hours
Overwritten – continuous

4-6 TB/sec
Residence – hours
Overwritten – hours

1-2 TB/sec
Residence – days/weeks
Flushed – weeks

100-300 GB/sec
Residence – months-years
Flushed – months-years

10s GB/sec (parallel tape)
Residence – forever

What do we really need?

- Large capacity storage, long residency
- No real IOPs requirement for data access
- “Reasonable” bandwidth for streaming
- Metadata / tree / permissions management that’s easy for people and existing applications
- Do we need POSIX?

Why existing solutions don't work

- So we need a high capacity, reasonable bandwidth storage tier…
  - Parallel tape is hard and expensive
  - Object solutions?
  - Big POSIX expensive, $$$ hardware
- Existing solutions don't make the right compromises (for us)
  - Petabyte scale files, and bigger
  - Billions of "tiny" files
  - Try to maintain too much of POSIX, this leads to complicated schemes, too many compromises

So what is MarFS?

- MarFS is a melding of the parts of POSIX we (people) like with scale-out object storage technology
  - Object style storage is scalable, economical, safe (via erasure), with simple access methods
  - POSIX namespaces provide people usable storage
- Challenges:
  - Objects disallow update-in-place (efficiently)
  - Access semantics totally different (permissions, structure)
  - Namespace scaling to billions/trillions of files
  - Single files in the many petabyte+ range

So what is MarFS?

- What are we restricting?
  - No update in place, period
  - Writes only through data movement tools, not a full VFS interface
    - 100% serial writes possible through FUSE, pipes?
- What are we gaining (through the above)?
  - Nice workloads for the object storage layer
  - Full POSIX metadata read/write access, full data read access

So what is MarFS?

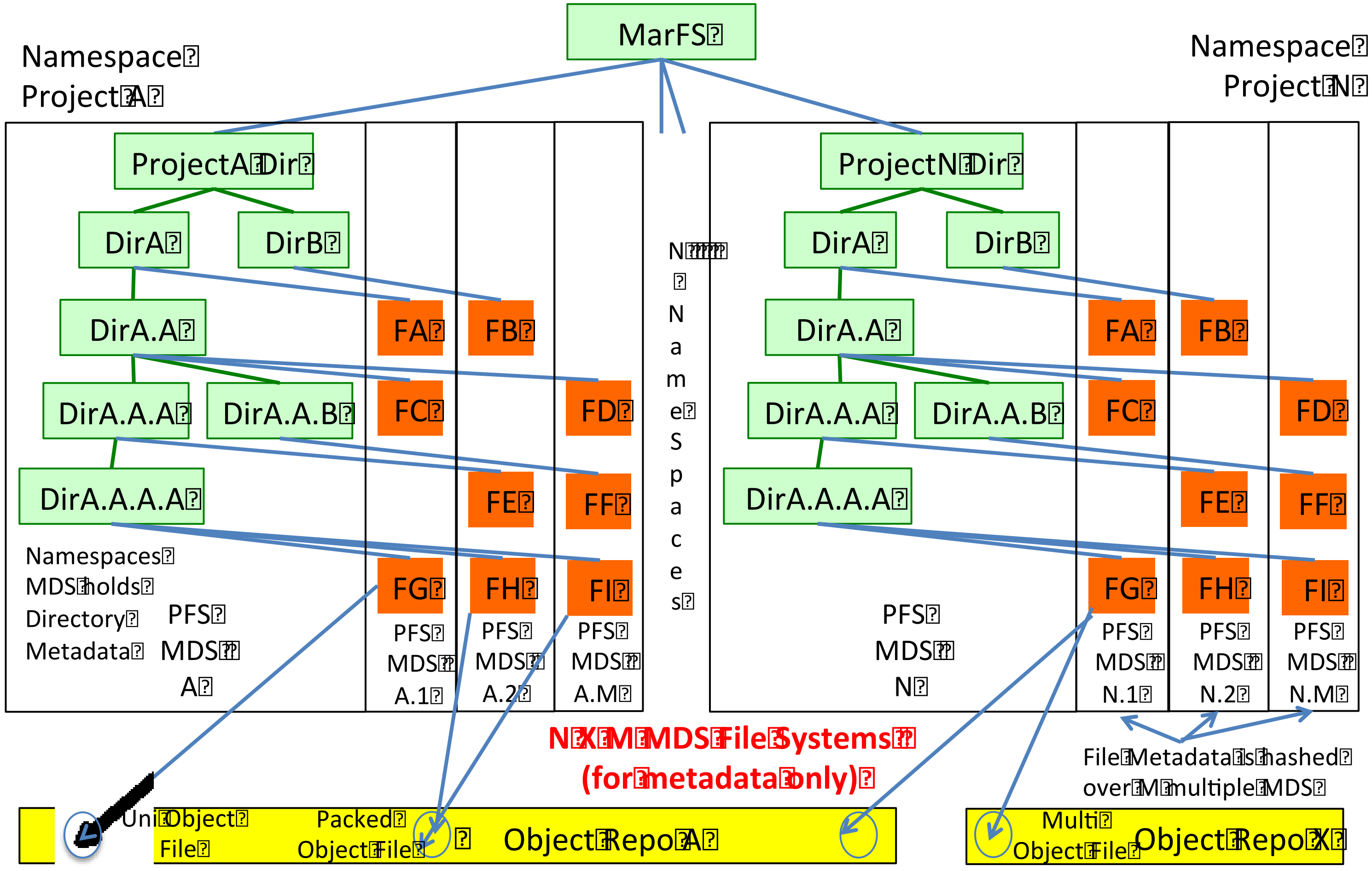
- Stack overview:
  - Smallish FUSE daemon for interactive metadata manipulation, viewing, etc
  - Parallel file movement tool (copy/sync/compare/list)
  - A handful of tools for data management (quotas, trash, packing)
  - Library that the above utilizes as a common access path
- Metadata stored in at *least* one global POSIX namespace
  - Utilizes standard permissions for security, xattr/sparse file support
- Data stored in at *least* one object/file storage system
  - Very small files packed, very large files split into "nice" size objects

Scaling basics

- So how does the namespace scale?
  - Up to N-way scaling for individual directories/trees
  - Up to M-way scaling *within* directories for file metadata
  - Directory MD is abstracted to allow for alternate storage (kvs)
  - We're using GPFS, lists are easy, so it's manageable!

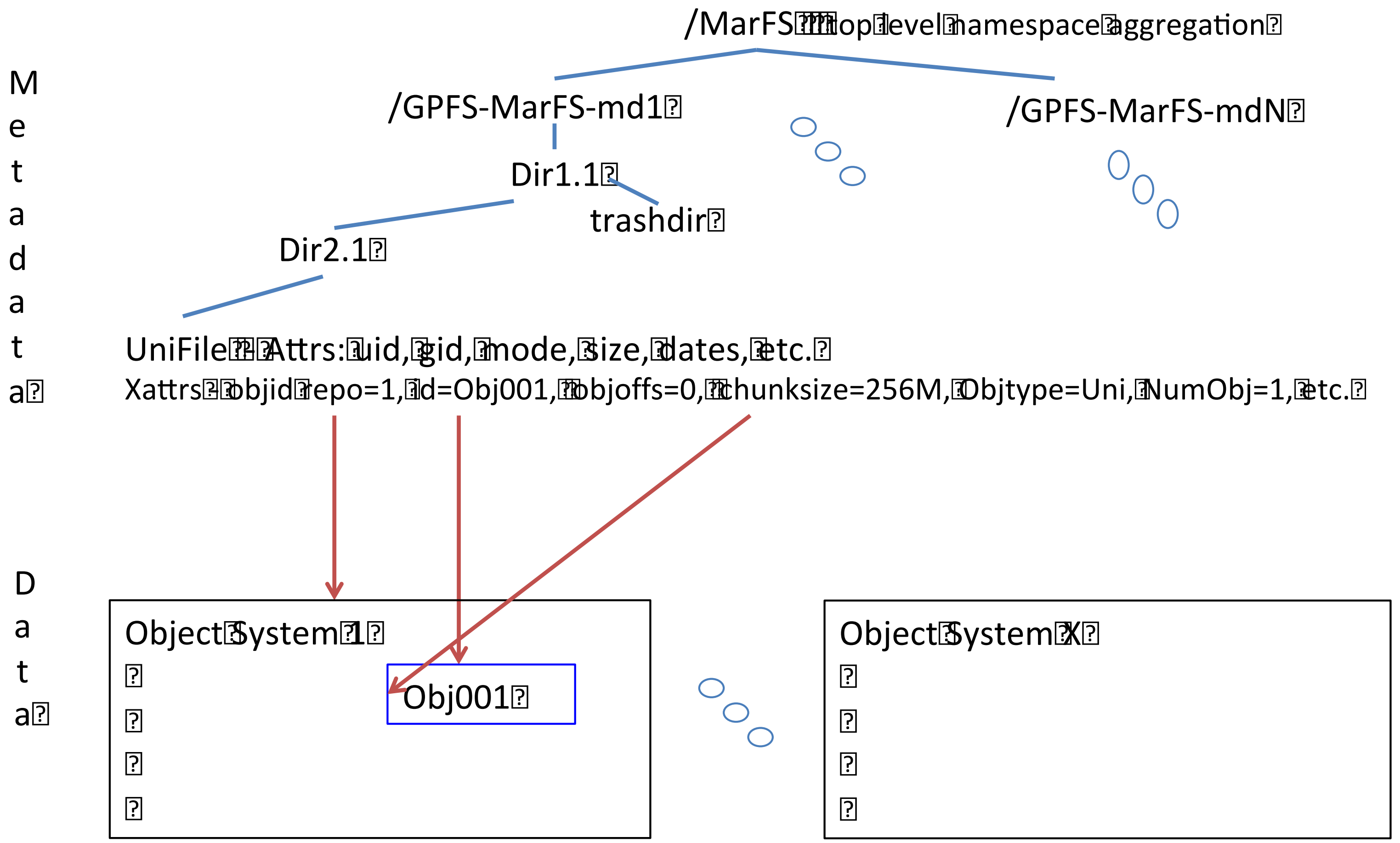
- How does the data movement scale?
  - No real limit on number of data storage repositories
  - New data can be striped within a repo and across repos
    - Repos can be scaled up and scaled out
    - New repos can be added at any time

MarFS Scaling

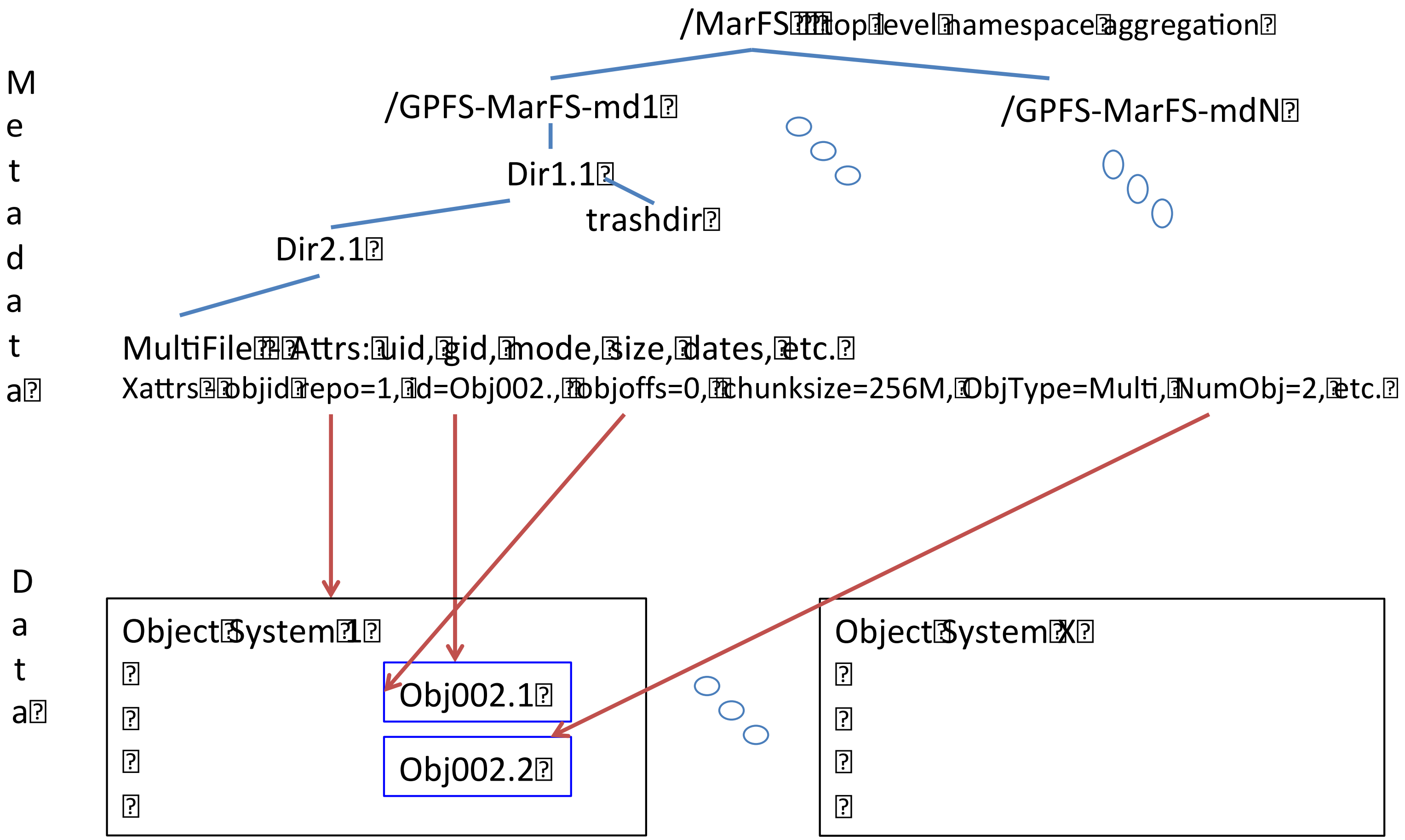


Striping across 1 to X Object Repos

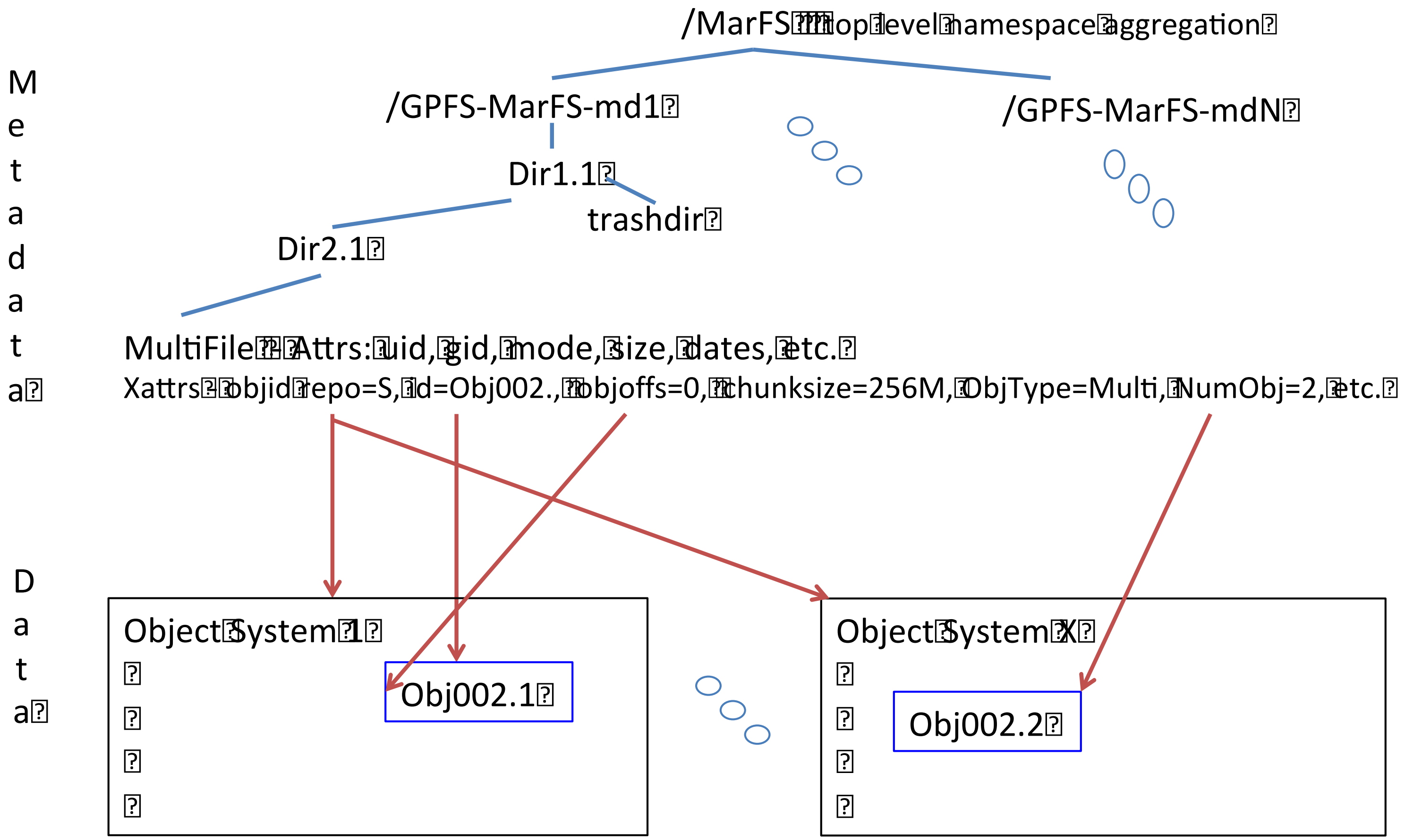
MarFS Internals Overview Uni-File


/MarFS top level namespace aggregation
/GPFS-MarFS-md1
/GPFS-MarFS-mdN
Dir1.1
trashdir
Dir2.1
Metadata
UniFile - Attrs: uid, gid, mode, size, dates, etc.
Xattrs - objid repo=1, id=Obj001, objoffs=0, chunksize=256M, Objtype=Uni, NumObj=1, etc.
Data
Object System 1
Obj001
Object System X

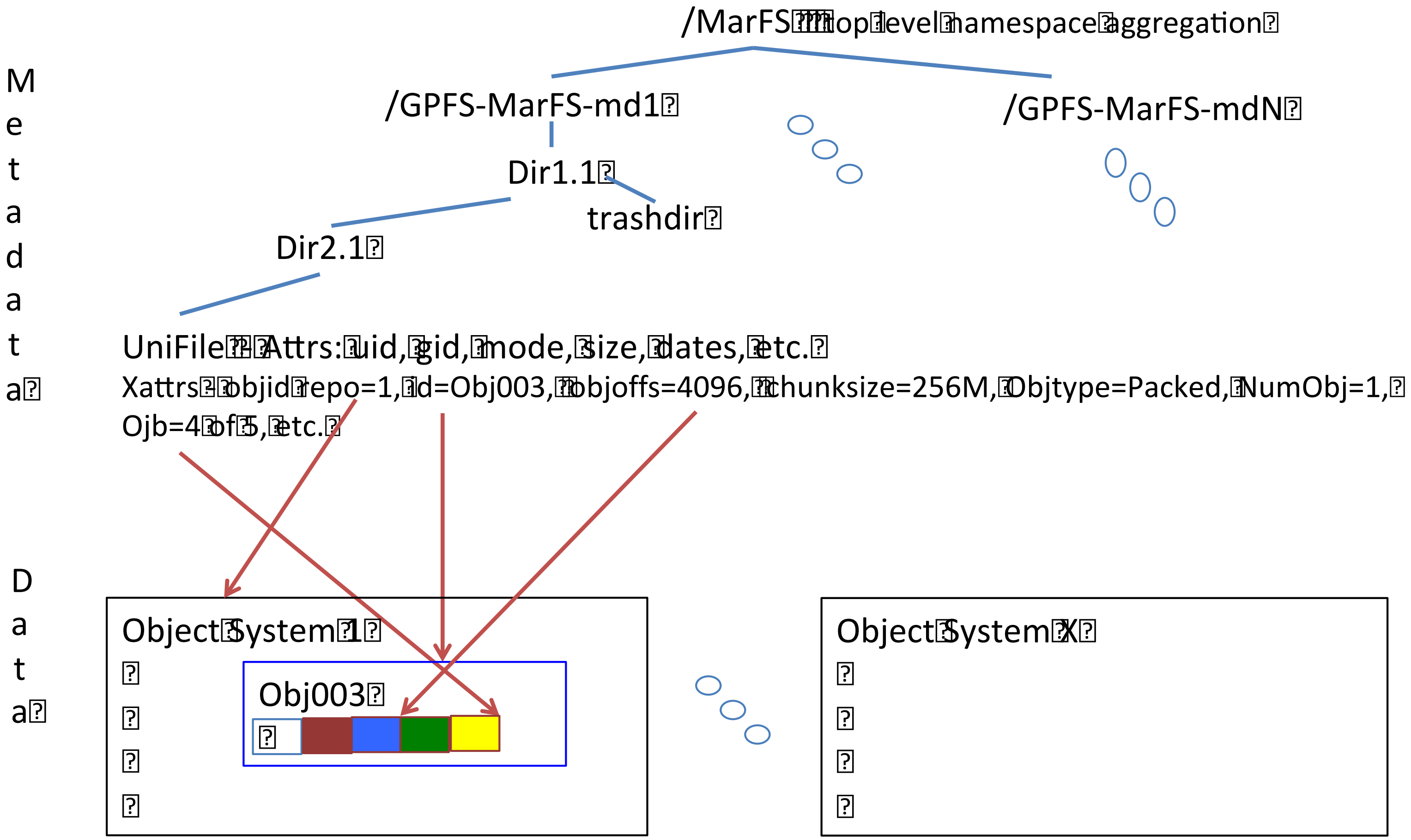
MarFS Internals Overview Multi-File


/MarFS top level namespace aggregation
M e t a d a t a
/GPFS-MarFS-md1
/GPFS-MarFS-mdN
Dir1.1
trashdir
Dir2.1
MultiFile - Attrs: uid, gid, mode, size, dates, etc.
Xattrs - objid repo=1, id=Obj002., objoffs=0, chunksize=256M, ObjType=Multi, NumObj=2, etc.
D a t a
Object System 1
Obj002.1
Obj002.2
Object System X

MarFS Internals Overview Multi-File (striped Object Systems)


/MarFS top level namespace aggregation
/GPFS-MarFS-md1
/GPFS-MarFS-mdN
Dir1.1
trashdir
Dir2.1
MultiFile - Attrs: uid, gid, mode, size, dates, etc.
Xattrs - objid repo=S, id=Obj002., objoffs=0, chunksize=256M, ObjType=Multi, NumObj=2, etc.
Metadata
Data
Object System 1
Obj002.1
Object System X
Obj002.2

MarFS Internals Overview Packed-File


/MarFS top level namespace aggregation
/GPFS-MarFS-md1
/GPFS-MarFS-mdN
Dir1.1
trashdir
Dir2.1
Metadata
UniFile - Attrs: uid, gid, mode, size, dates, etc.
Xattrs - objid repo=1, id=Obj003, objoffs=4096, chunksize=256M, Objtype=Packed, NumObj=1,
Ojb=4 of 5, etc.
Data
Object System 1
Obj003
Object System X

Current Status

- Where are we now?

- Open Science runs completed without real issue, ~4 PB scale system
  - ~2-3 GB/s bandwidth, utilized Scality RING storage
  - Discovered edge-case bugs with varied workloads
- Next system is currently being deployed, ~30 PB scale
  - ~28 GB/s bandwidth, also utilizing Scality RING storage

- Packing in parallel movement utility in progress

Future work

- Metadata in-directory scaling
  - Billion files in a directory…
- Compression / encryption within MarFS
- Data protection *in* MarFS – erasure on erasure, dual copy, etc
- Other access methods
  - HPSS, Globus, etc
- Migration tools (background movement)
- Dual copy would allow for DR opportunities on tape/offline media, tools to support this
- Alternate views of metadata (files within date, related project files, etc)

Learn more!

- https://github.com/mar-file-system/marfs
- https://github.com/pftool/pftool

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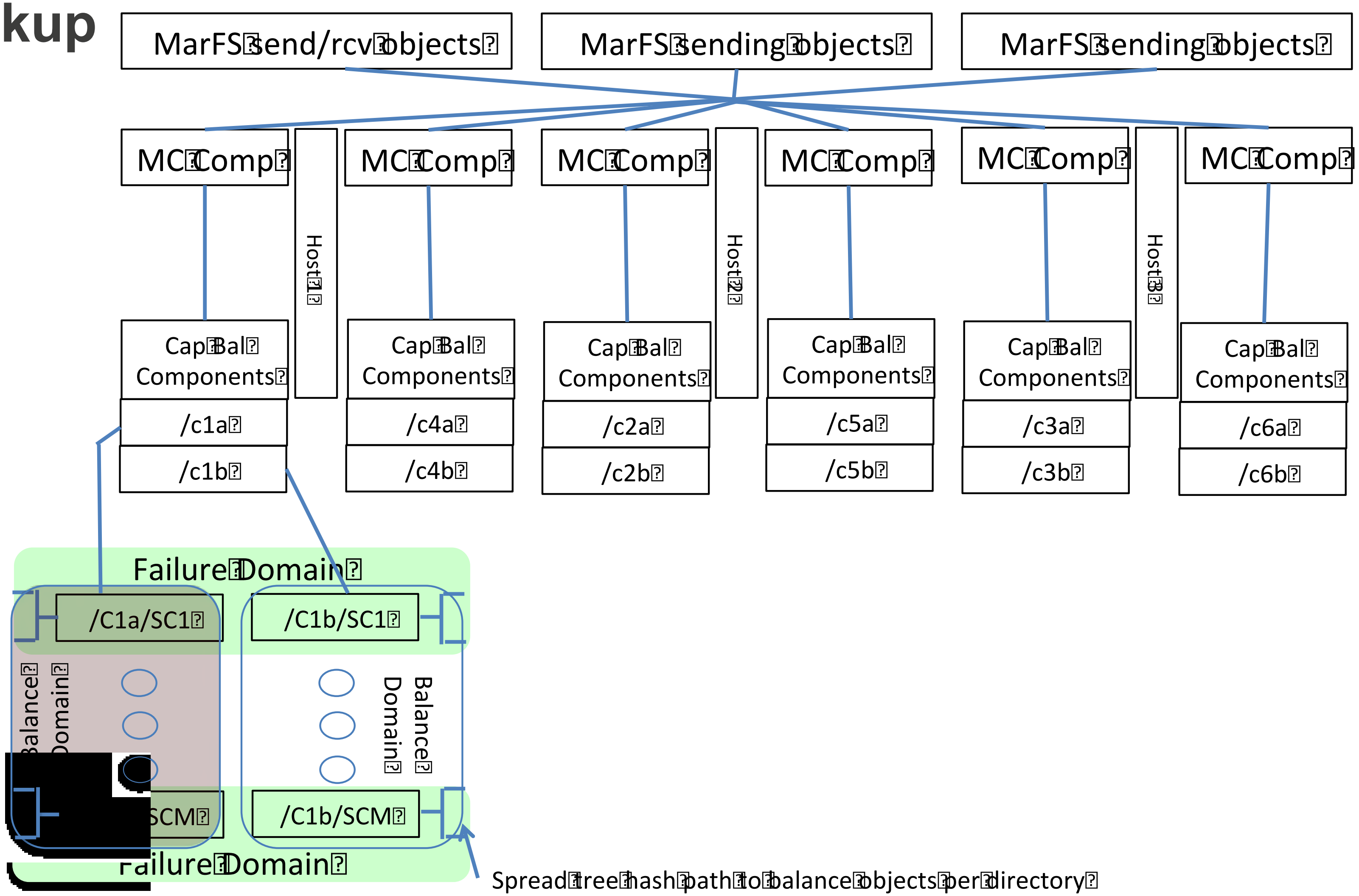
MAY THE FOURTH

Thanks for your attention!

BE WITH YOU

Backup



Spread tree hash path to balance objects per directory