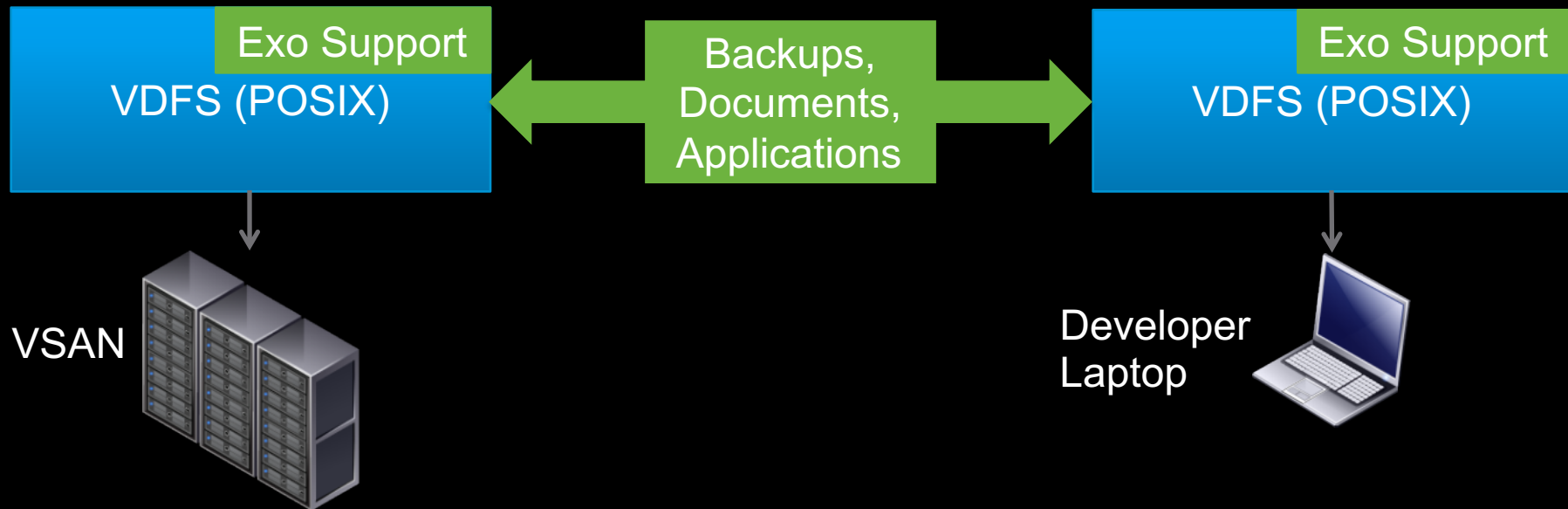


# Exo-clones

## Instantaneous Change Tracking for the Whole File System

**Richard P. Spillane**, Wenguang Wang, Luke Lu, Maxime Austruy, Christos Karmanolis, Rawlinson Rivera

May 10<sup>th</sup>, 2016



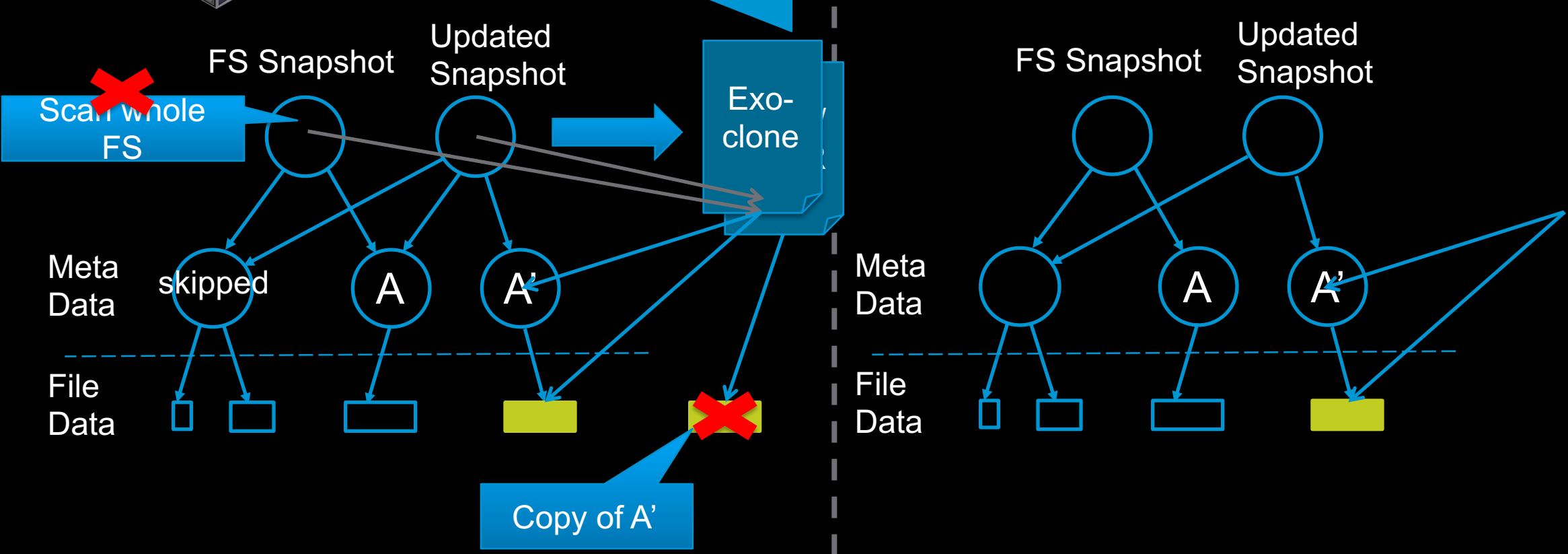
# What is an Exo-clone?



VDFS on VSAN

- “free” to store
- “free” to create
- “free” to import

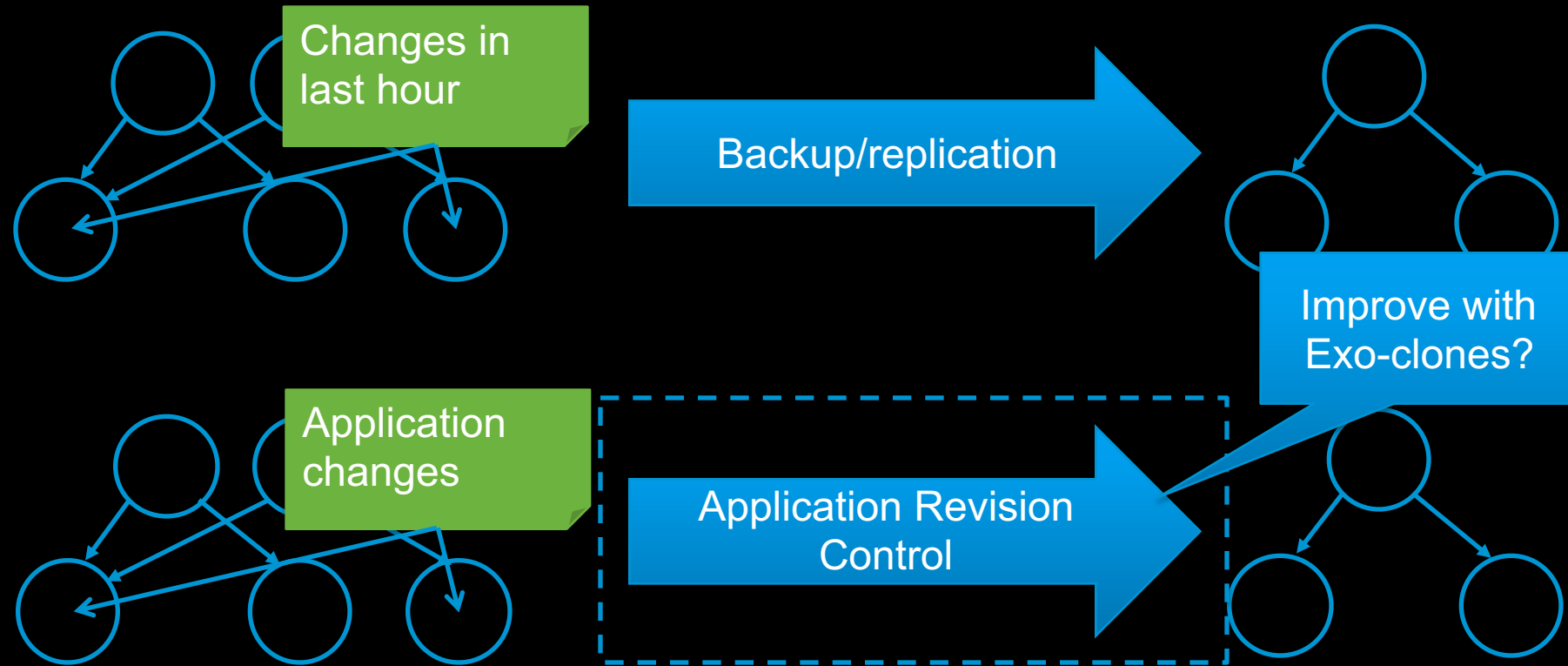
VDFS on Developer Laptop



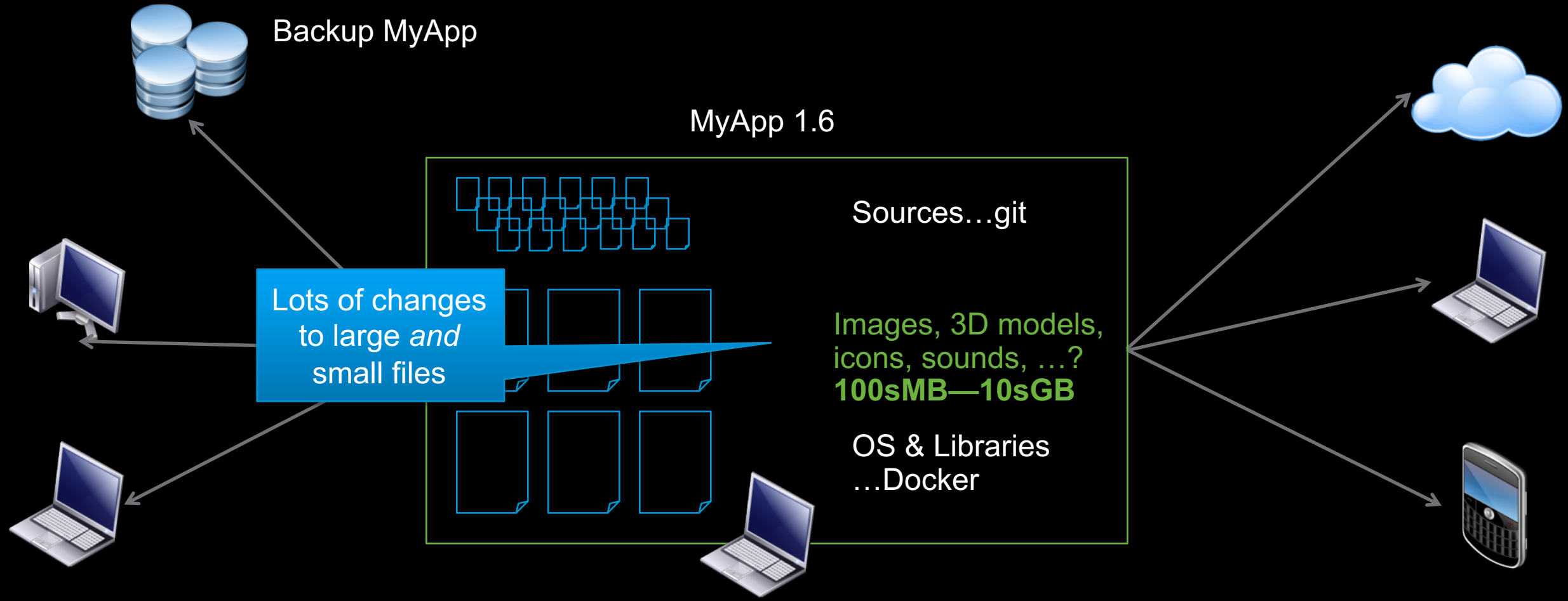
# Benefits of Exo-clone

|                        | No duplication | No FS Scanning |
|------------------------|----------------|----------------|
| diff -R                | ✗              | ✗              |
| git pack-objects       | ✓              | ✗              |
| Docker FS layers       | ✗              | ✓              |
| ZFS/BtrFS send/receive | ✗              | ✓              |
| <b>Exo-clones</b>      | ✓              | ✓              |

# Exo-clone Use Cases

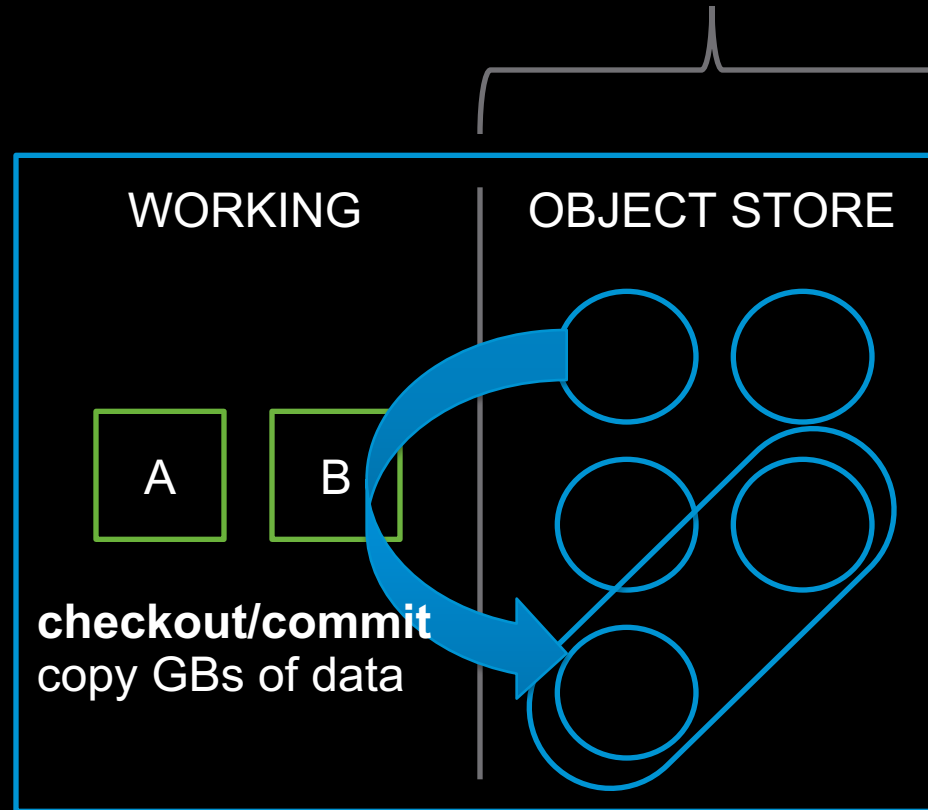


# A Common Problem...

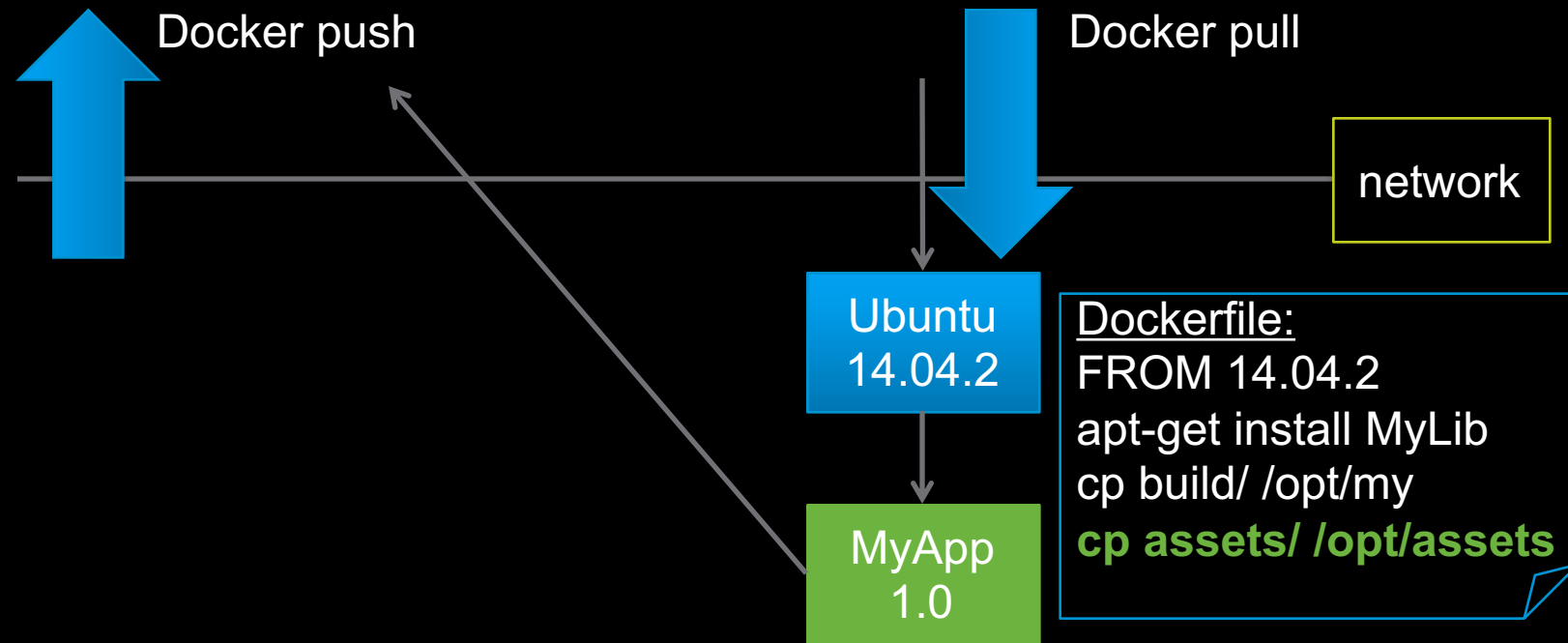


# git? Sadly, no...

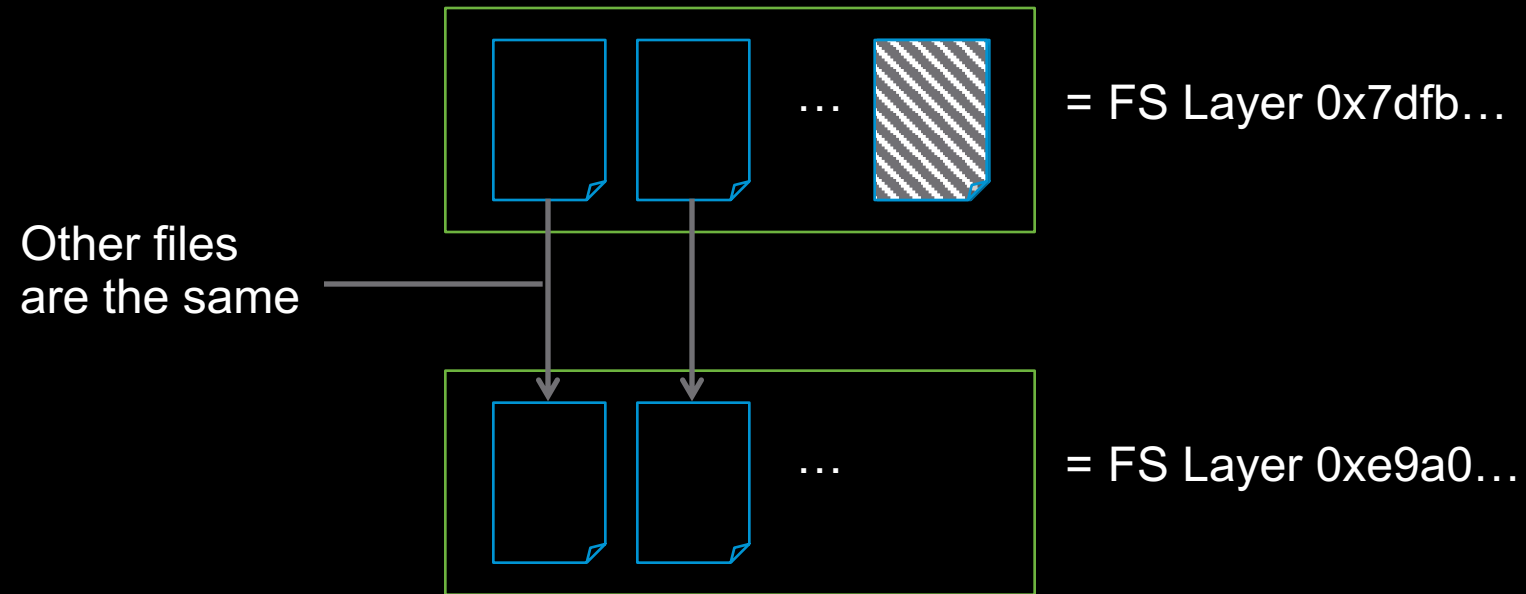
Redundant copy, 5-10x bigger than  
current working state



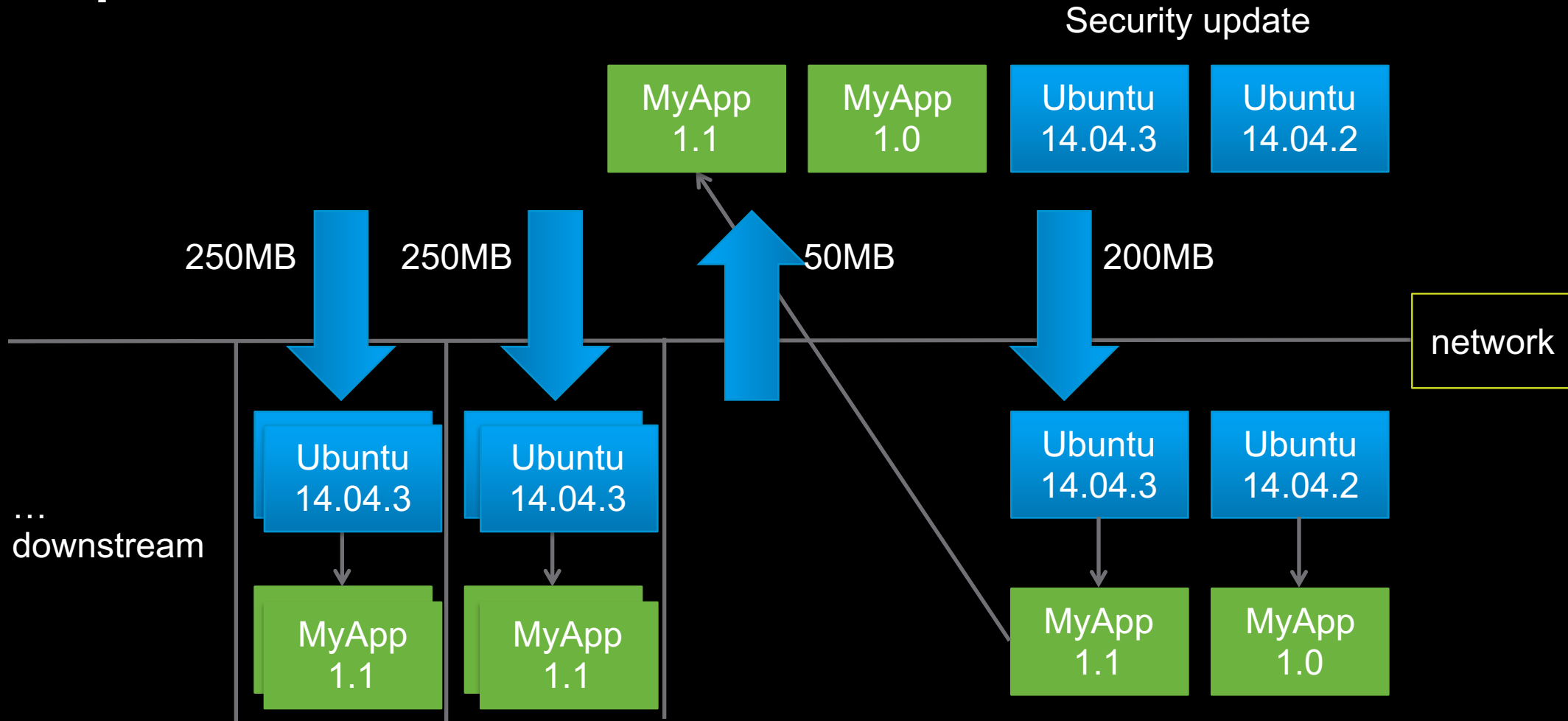
# Docker?



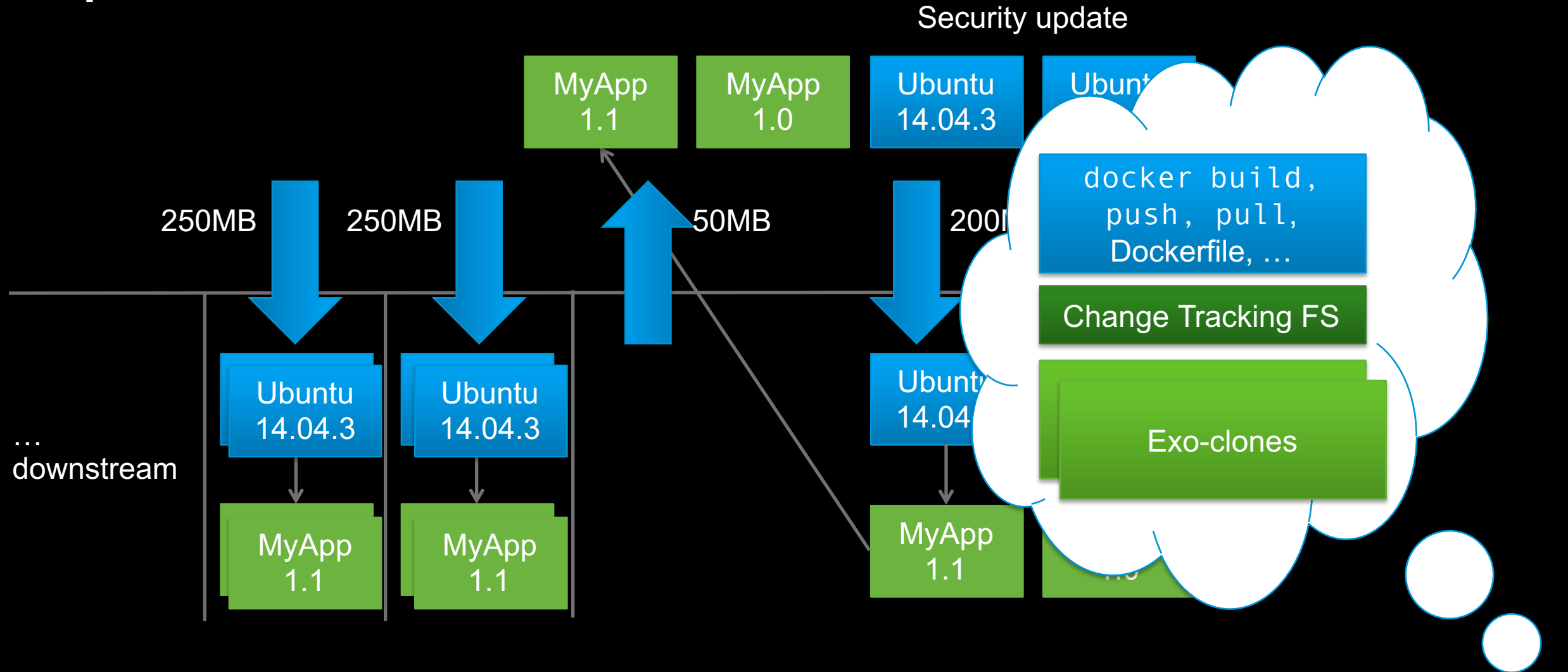
# Docker FS Layer



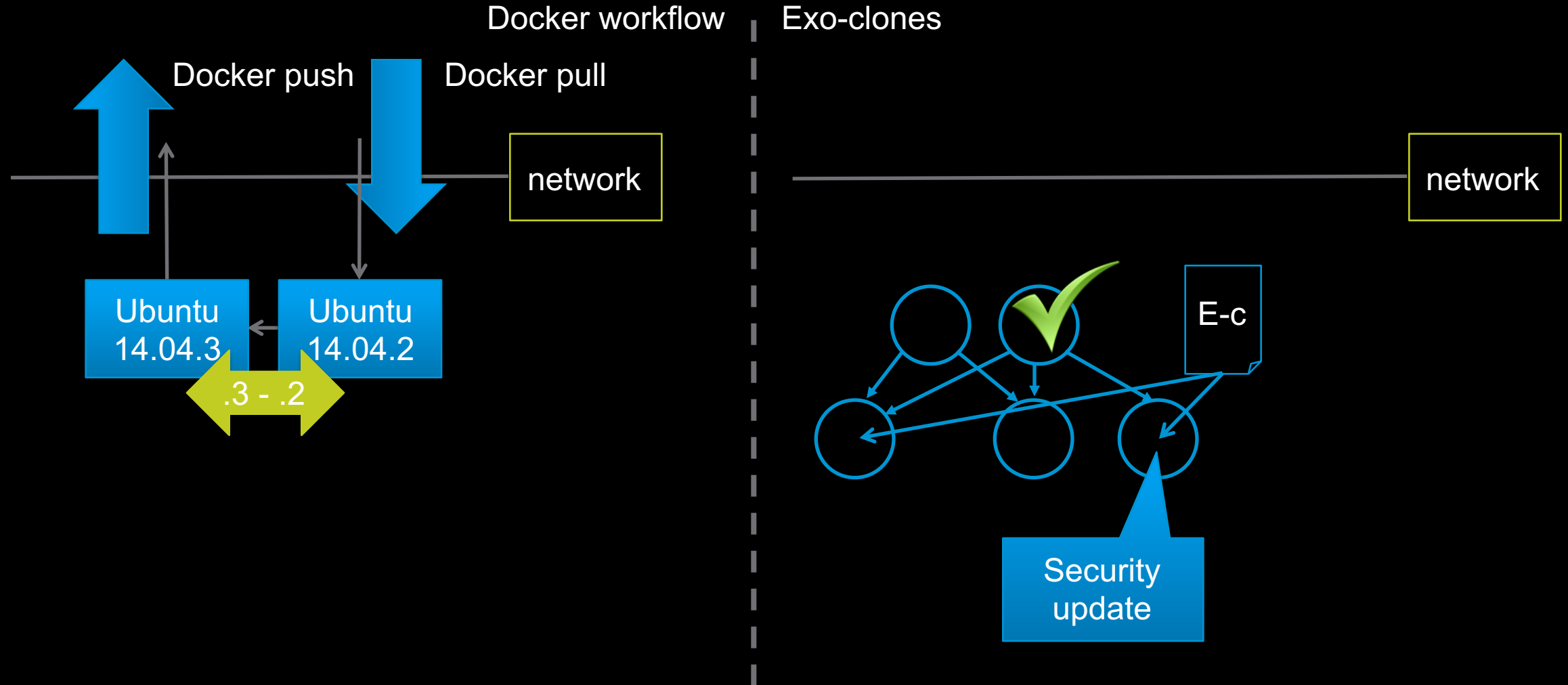
# Update With Docker Pull



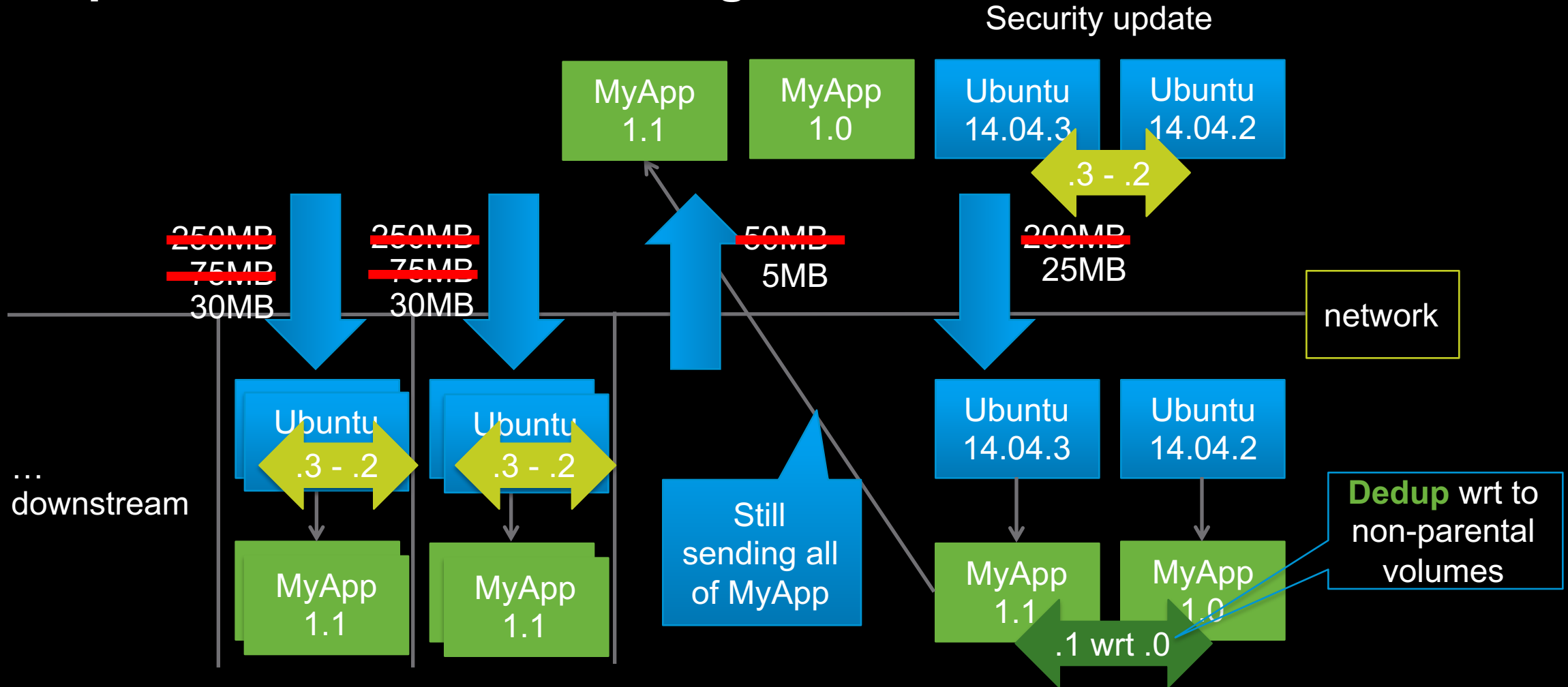
# Update With Docker Pull



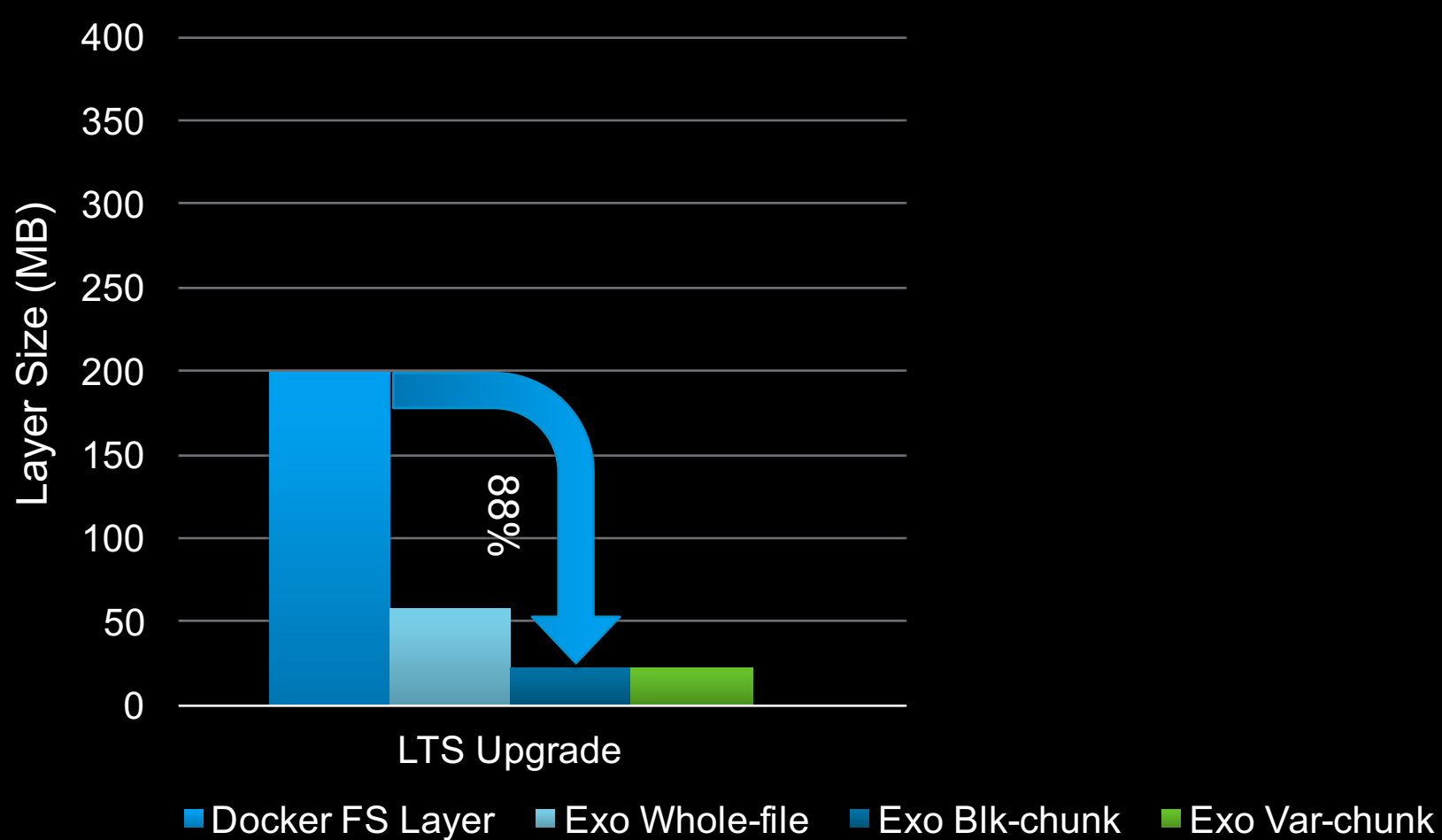
# Updating Base Layers With Exo-clones



# Update With Docker Utilizing Exo-clones



# Network Overhead of Docker FS Layers vs. Exo-clones



Transfer size of Docker FS layers compared to Exo-clones using whole-file dedup and Exo-clones using either block or 6-9KB variable length chunking

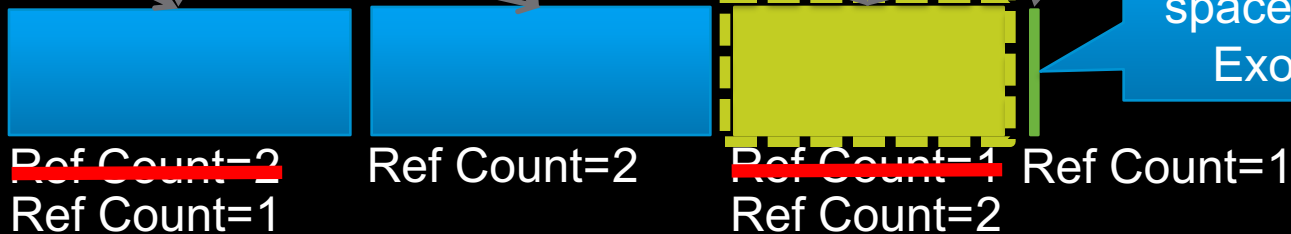
# Exo-clone Format

1. `rm /a/1`
2. `curl http://img.com/huge > /new/foo`
3. `commit /.exo/clone1`

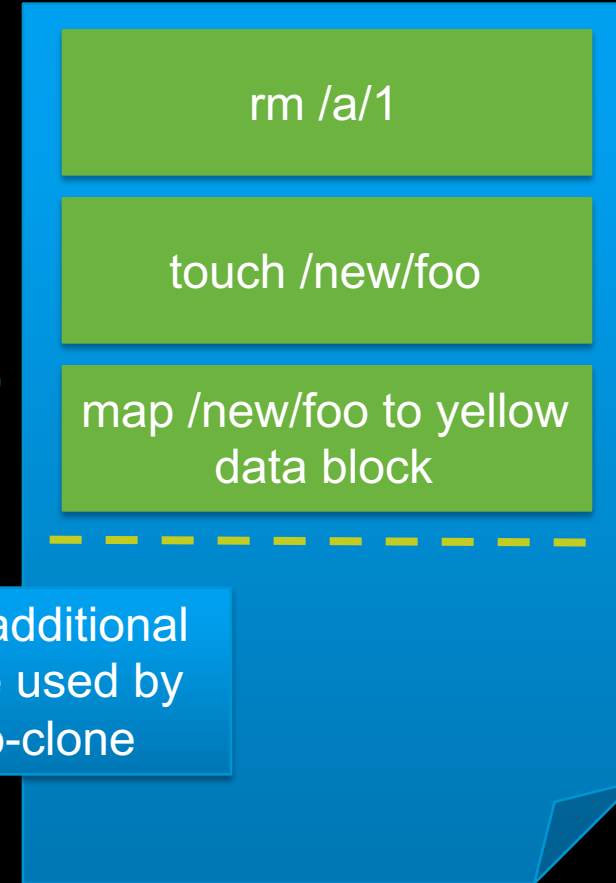
Child SS:



Parent SS...



clone1:



Meta-data Section

Data Section

# Summary

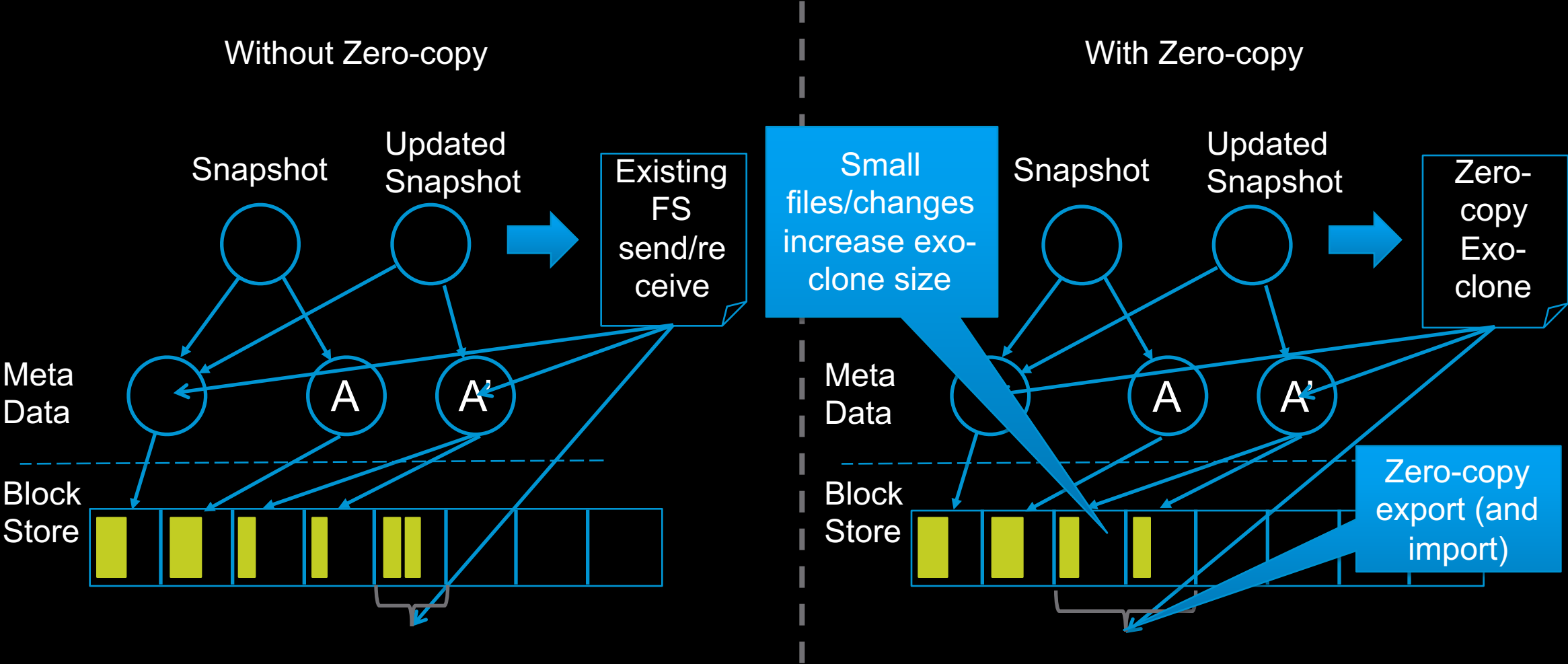
- Instantly create and share diffs between any two FSes with
  - No space overhead
  - No sending the same block twice over the wire
- Better backend for Docker, rsync, git
- Easy but efficient backup/replication between any storage environment
- What becomes simpler when we make revision control on the whole FS *cheap and standard*?
  - **What if every FS (e.g., ZFS, BtrFS, LVM, NASes) supported exo-clones?**

# Thank You

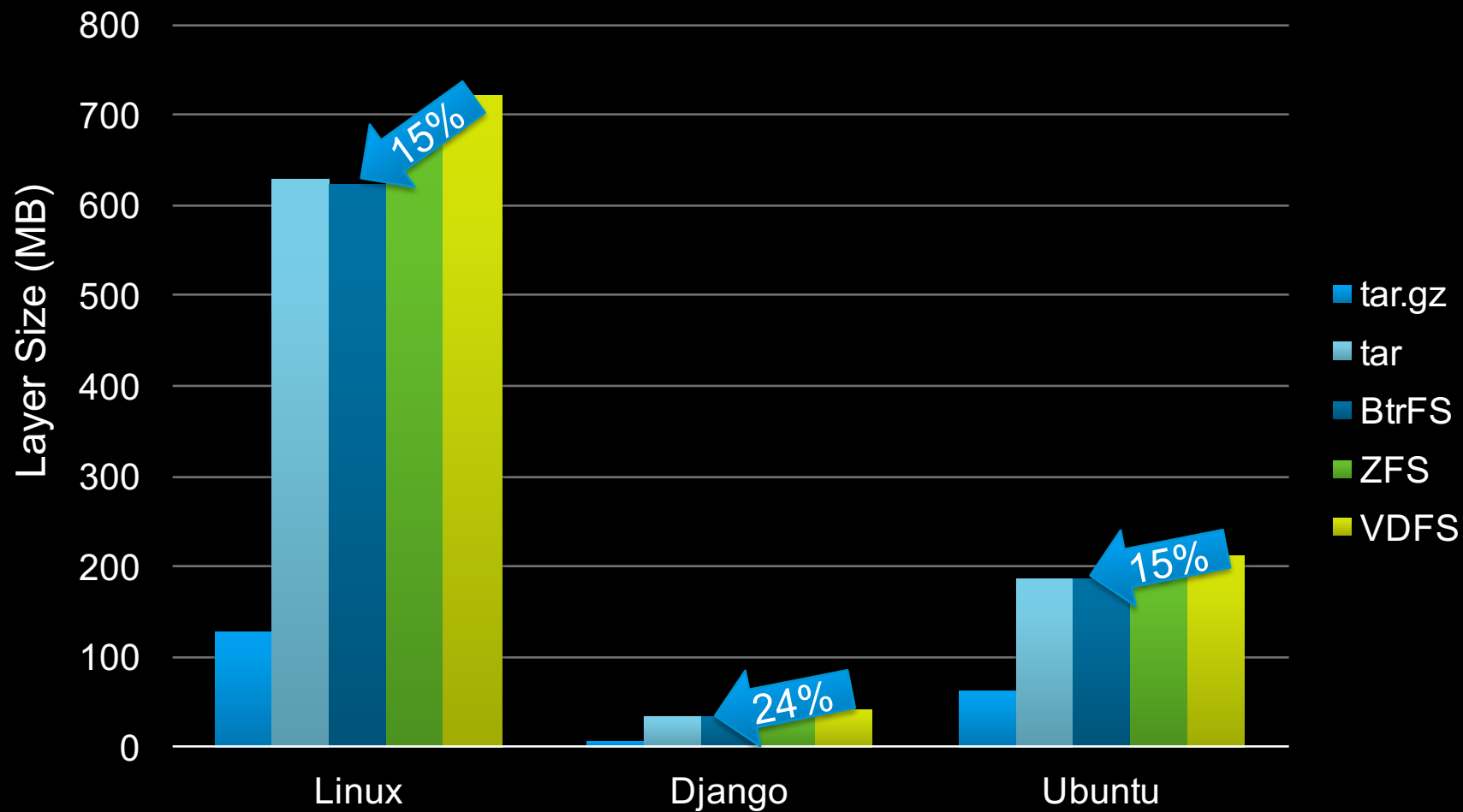
[rspillane@vmware.com](mailto:rspillane@vmware.com)

<http://telegram.me/necro351>

# Zero-copy Requires Block Alignment



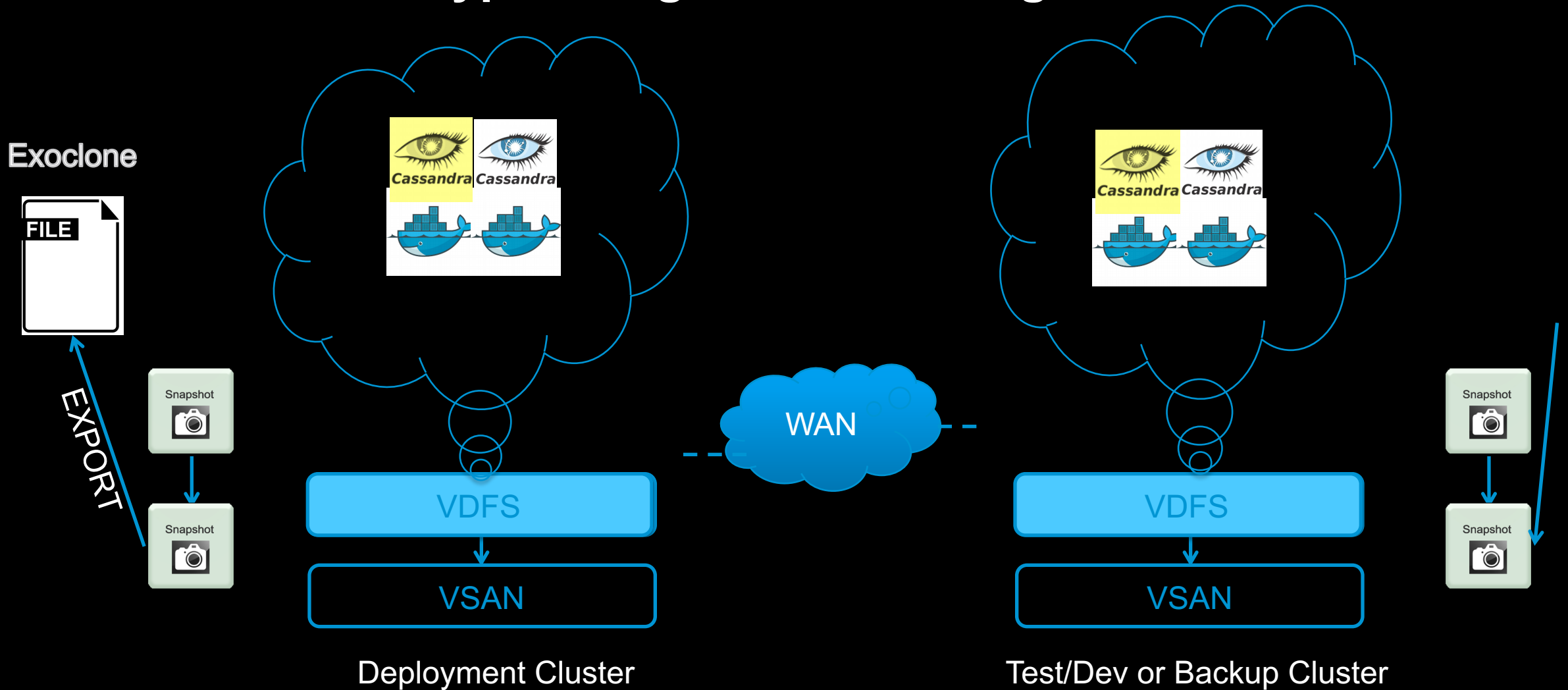
# How do exo-clones compare to ZFS and BtrFS send/receive?



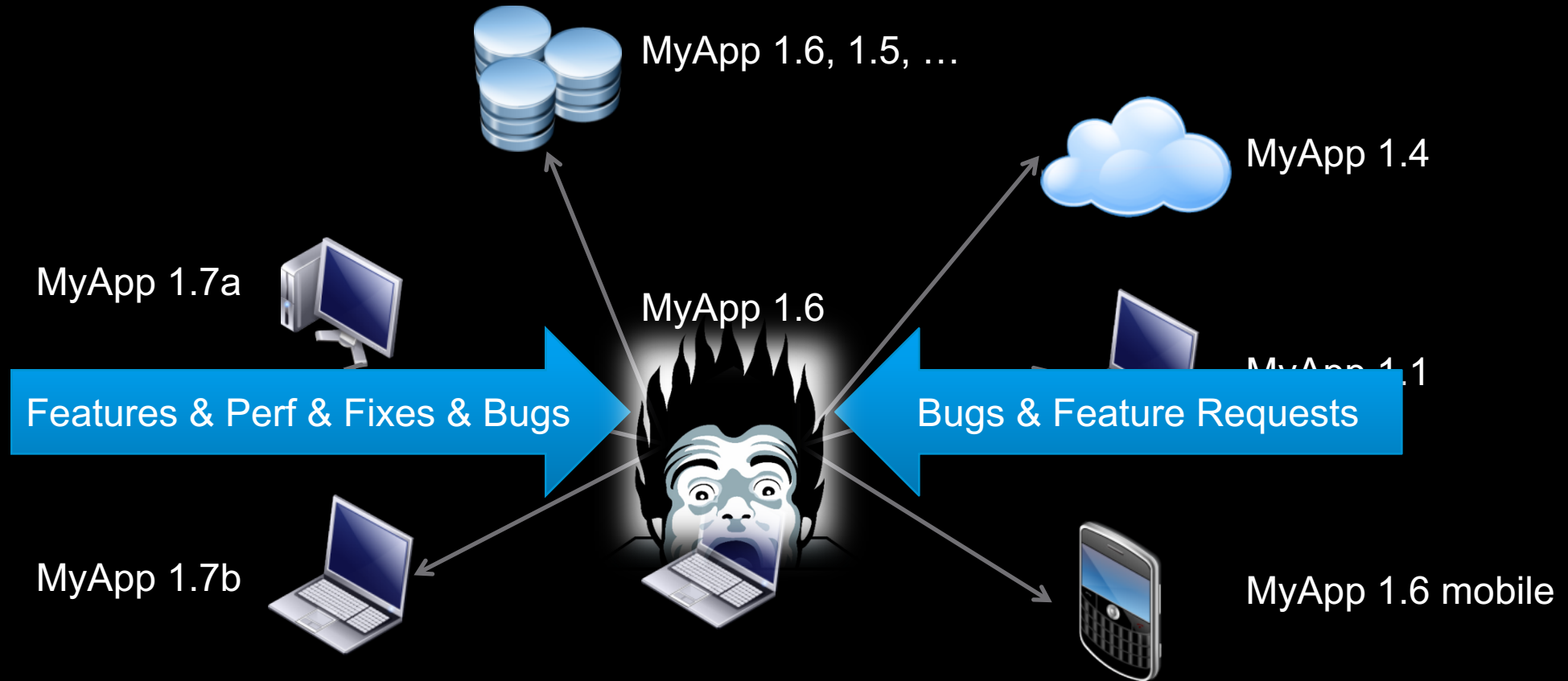
Volumes full of small files are encoded less efficiently in exchange for zero-copy

We rely on an additional gzip pass when transferring over network

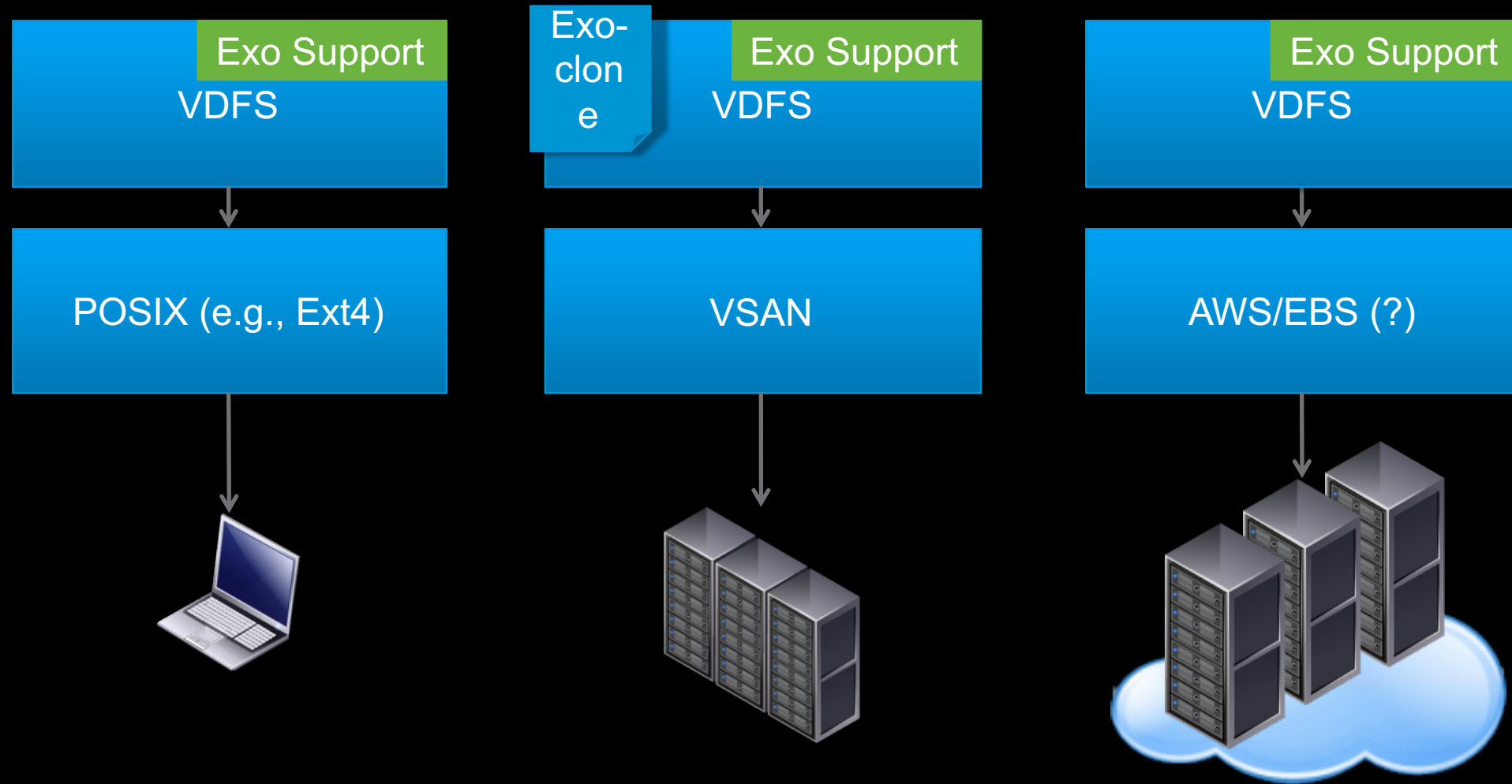
# Exo-Clone Prototype doing Cassandra Migration



# Application Revision Control



# Implementation of Exo-clones on VDFS



# git? Sadly, no...

