FROM RESEARCH TO INDUSTRY

Lustre performance on DDN SFA18KE

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TOPICS

- T1KF project
- Hardware Storage
- Performance clarification
- Page cache revival
- Performance in real life
- Overstriping

T1KF Project – Key numbers

T1KF: Flash Parallel Filesystem (Q4 2019) for the next exascale supercomputers

Target:

- First store storage level (same Lustre FS as STORE) with Lustre Pool
- 1 TB/s in write sequential (5% of times)
- Mounted by all supercomputers
- Data migration with RobinHood (via lfs migrate)
- Hide complexity to end users

Usage:

- Checkpoint restart files (mostly sequential writes)
- Final files (mostly sequential writes)
- Data post-processing (sequential writes + random read)

T1KF Project – Flash required?

- **Reasons:**
  - Low footprint (limit to 5 racks)
  - Random read
  - High write throughput

- **External things to monitor:**
  - Weight (density is not light)
  - Power (SSDs consume energy)

- **Collaboration with DDN engineering**

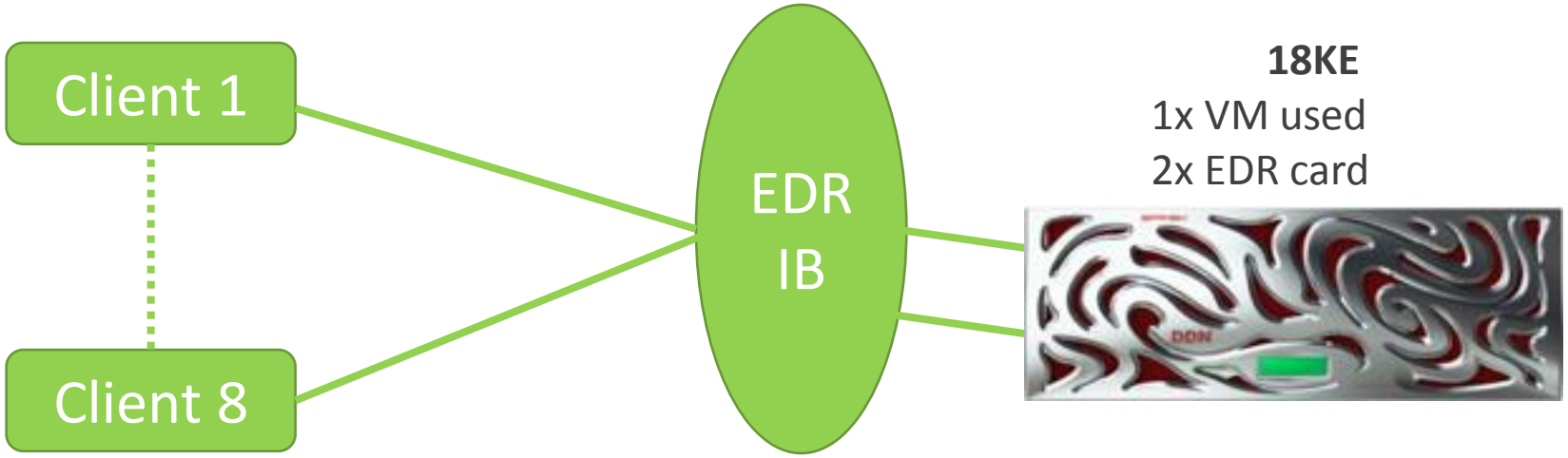
- **Goal: Evaluate Lustre performance with SSD drives**

Hardware storage

- **DDN SFA18KE with SFAOS 11.5 GA**
  - Dual controllers
  - Skylake processors
  - 784 GB of RAM
  - 8x Infiniband Mellanox EDR ConnectX5 dual-port
  - QEMU inside for Embedded
  - 8x VMs per couplet
- **2x Declustered RAID pool (56x SSD HGST SS530)**
  - 2x hotspares
  - 27x usable disks (RAID5 inside means 24 for write)
- **Tested configuration: 1x VM (OSS inside)**
  - 75 GB of RAM
  - 4x CPU cores (8x virtual with hyperthreading)
  - 1x EDR Infiniband card

Common parameters

- Devices formated with no lazy initialization
- CentOS 7.6 (ioscheduler: none)
- MOFED 4.5.1
- Lustre 2.12.2 (ldiskfs backend)
- Lustre clients tuning (no checksums, max_pages_per_rpc=512)
- FIO 3.11 (direct=1, ioengine=libaio)
- IOR 3.2.1 (8 EDR clients)
- EDR Infiniband network



Performance clarification

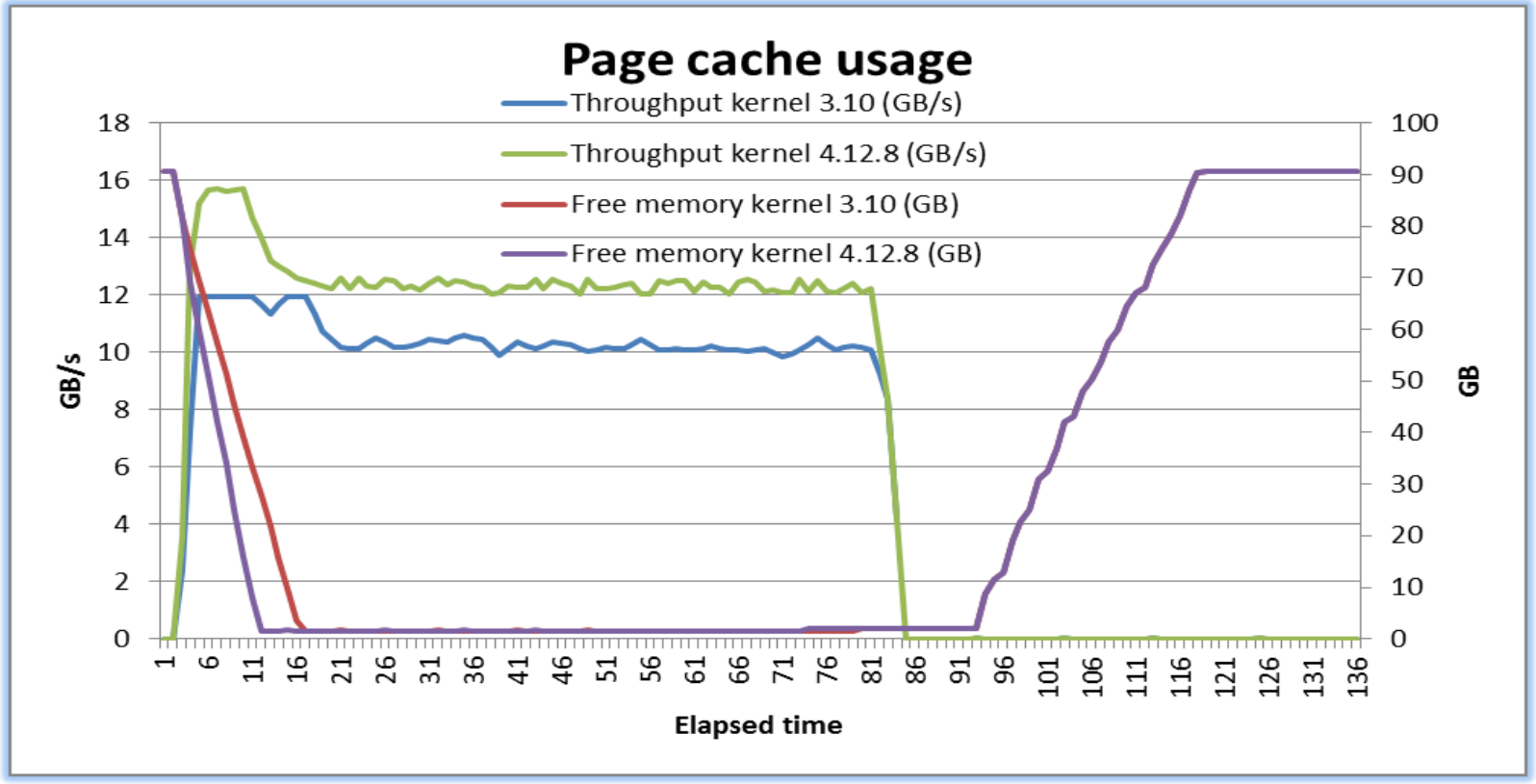
- **Lustre performance is often bad?**
  - Sure?
  - Investigations needed before affirmation ☺

- **Lustre can perform if under layers are, like:**
  - Network
  - Internal PCIe architecture
  - I/O devices
  - CPU resources
  - Kernel I/O layers

  …
  - Lustre layers (focused today)

Page cache revival

- **LUG 2018 talk: Lustre server on kernel 4.12.8**
  - http://cdn.opensfs.org/wp-content/uploads/2018/04/Delbary-Lustre_Server_On_Kernel_4_12_8.pdf
  - LU-10942 and LU-11071 based



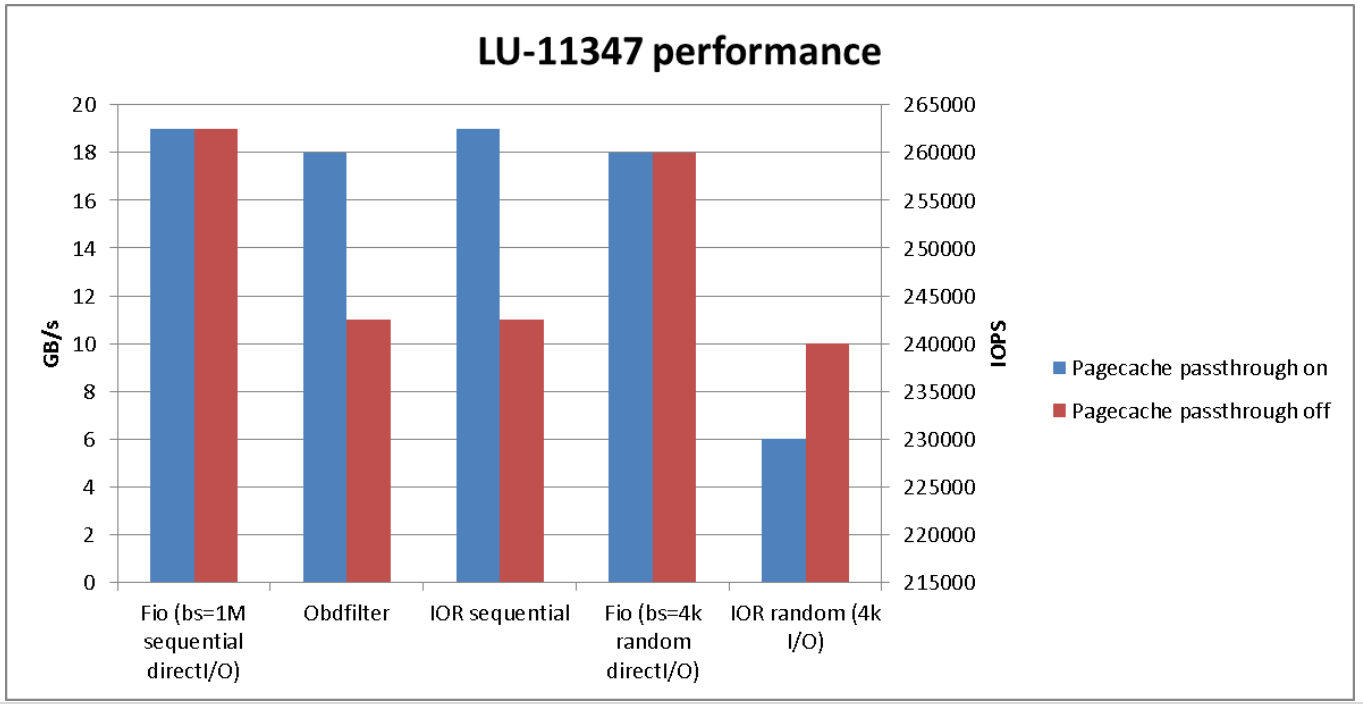
Summary:
Reducing latency = better throughput

Not perfect solution:
- throughput fluctuation
- cpu usage for memory reclaim and not for I/O

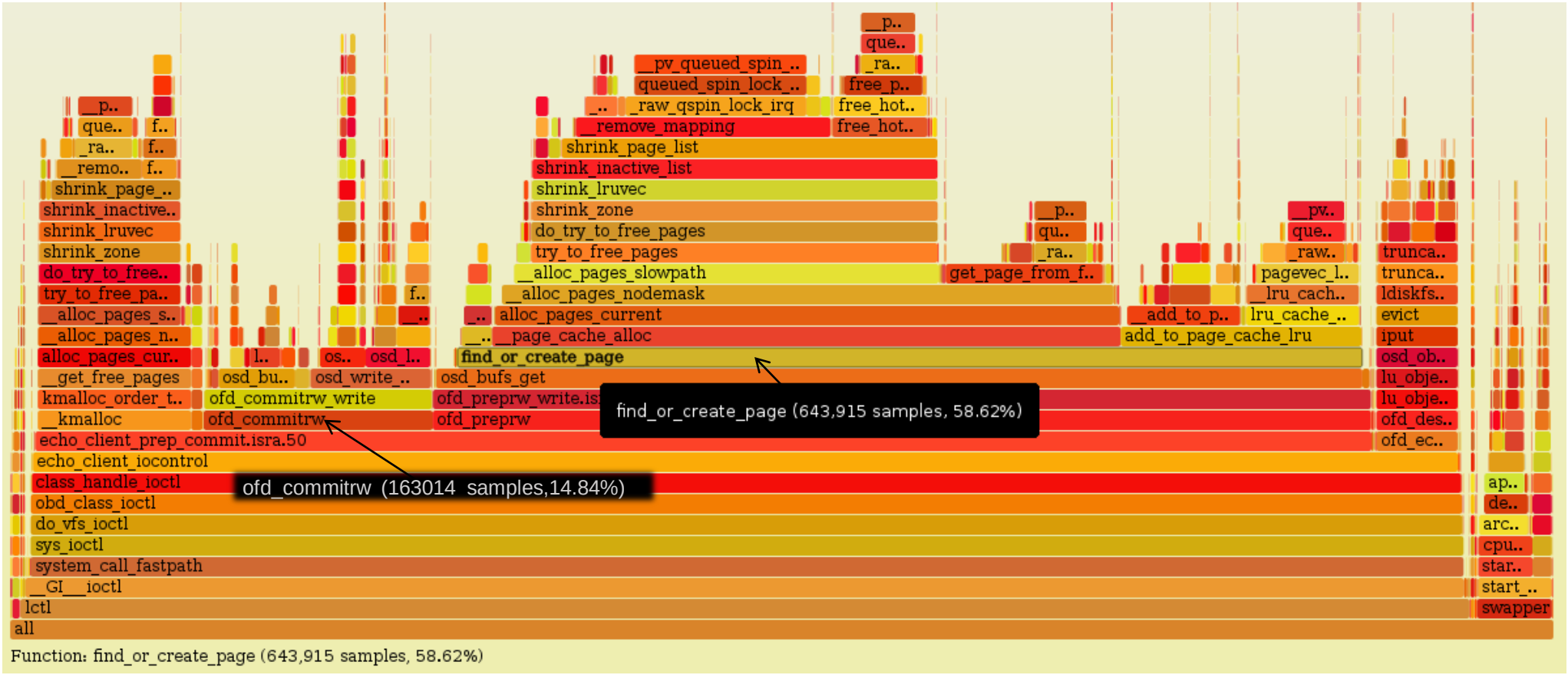
LU-11347 rescue

Page cache revival: LU-11347

- **LU-11347: Do not use pagecache for SSD I/O when read/write cache are disabled**
- **Requirements (for 2.12.2):**
  - lctl set_param osd-ldiskfs.*.read_cache_enable=0
  - lctl set_param osd-ldiskfs.*.writethrough_cache_enable=0
  - echo 0 > /sys/block/"device"/queue/rotational



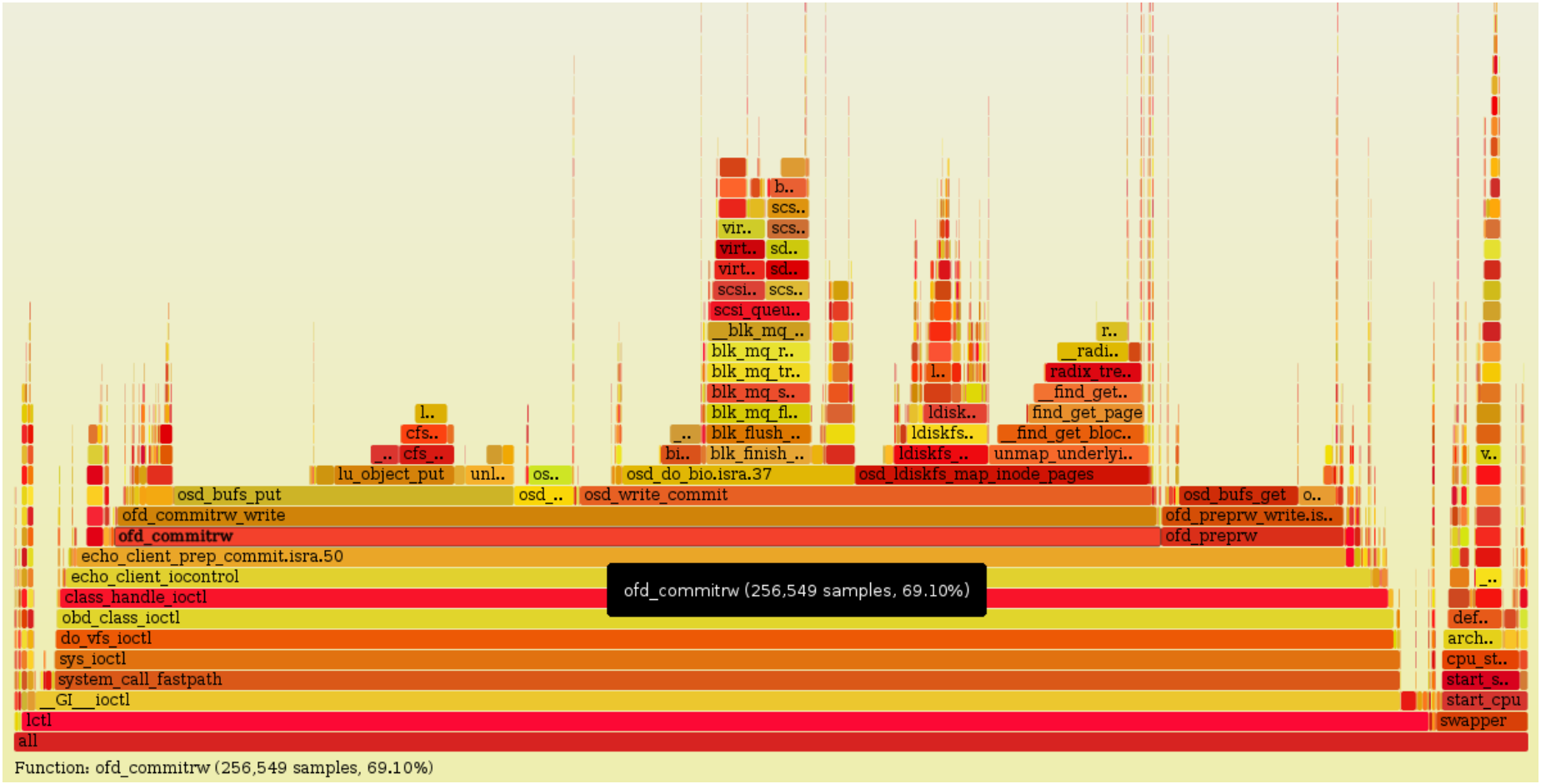
Page cache revival: LU-11347 light deep dive



- **LU-11347: pagecache passthrough off**
  - I/O done by ofd_commitrw (15%)
  - Find_or_create_page (59%)
  - I/O is running? Bottleneck idea?

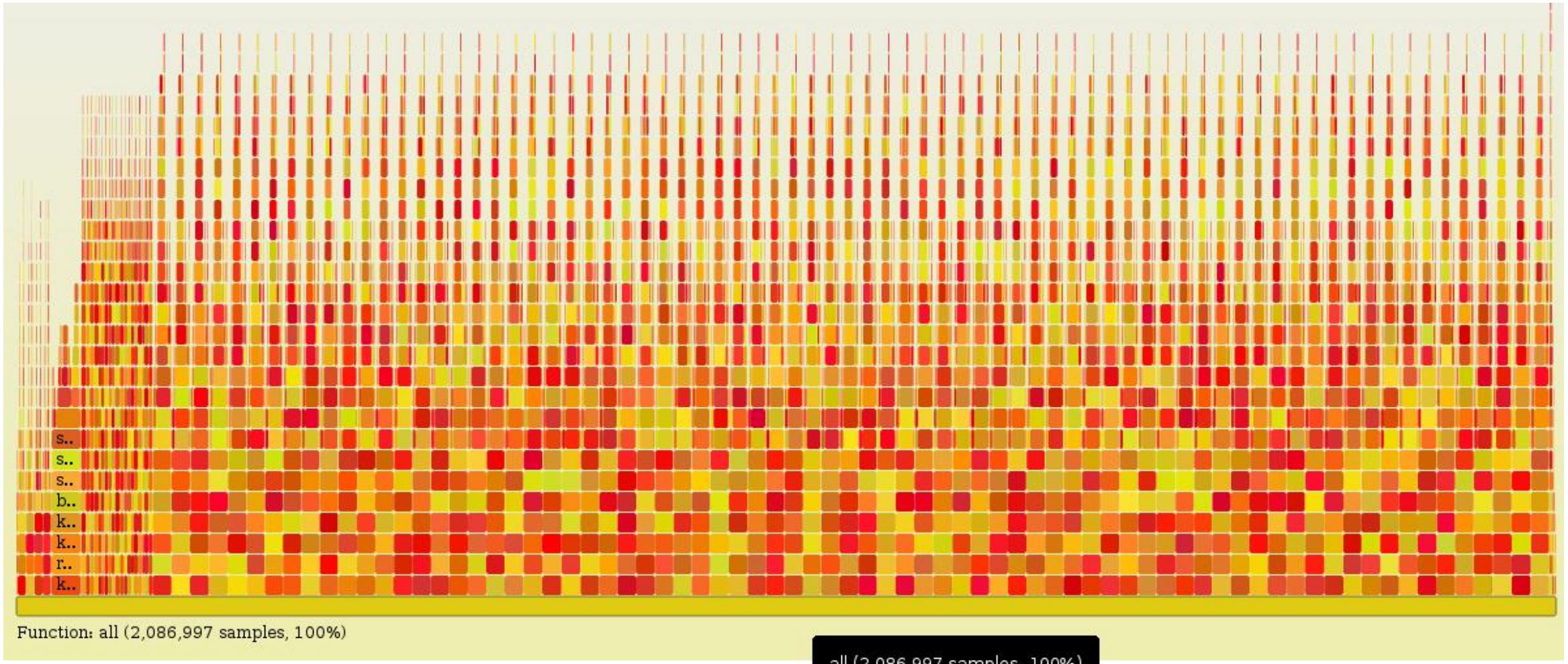
```
Warning:
Processed 2472283 events and lost 81 chunks!

Check IO/CPU overload!
```

Page cache revival: LU-11347 light deep dive



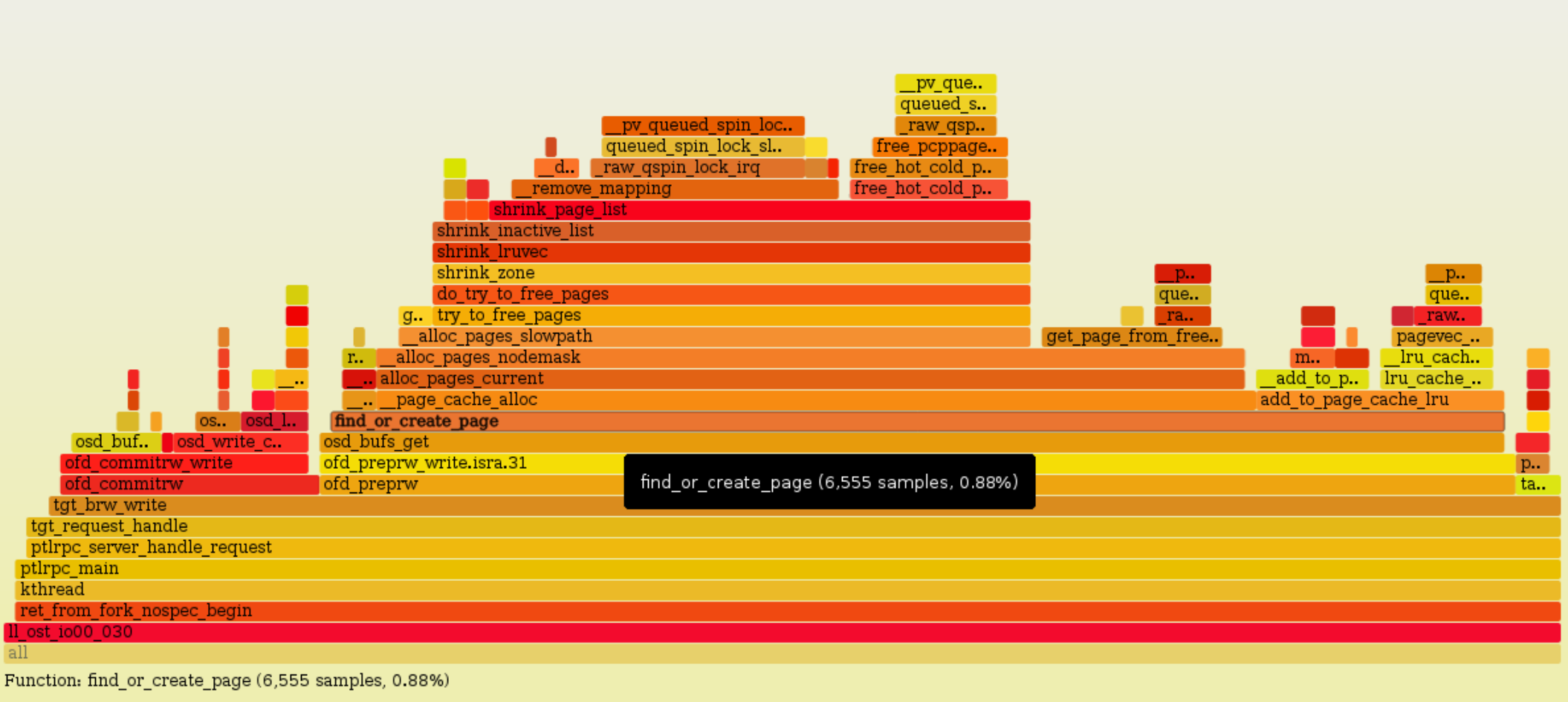
- **LU-11347: pagecache passthrough on**
  - I/O done by ofd_commitrw (69%)
  - Time past in block layers
  - Block device is the bottleneck

Page cache revival: LU-11347 light deep dive in real life



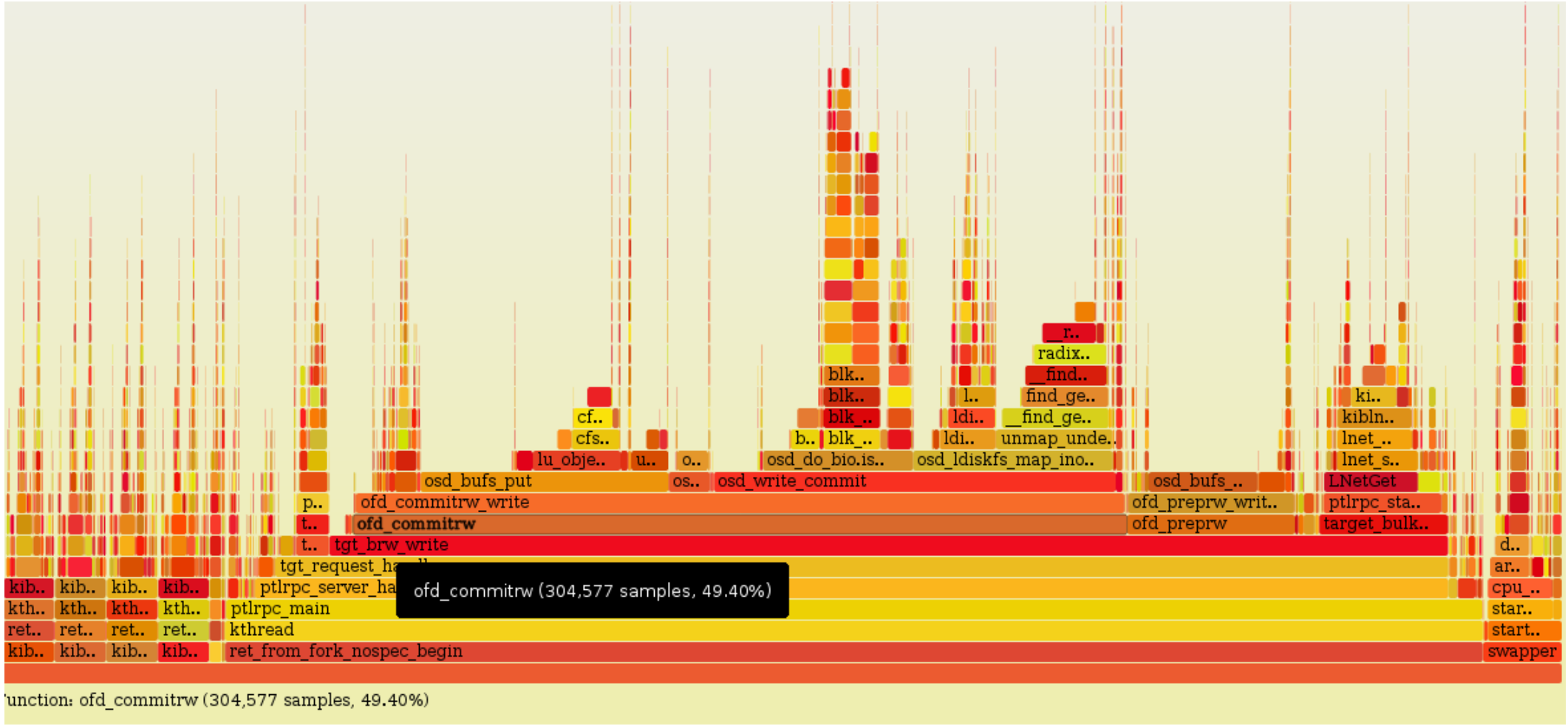
- **LU-11347: pagecache passthrough off: ior write sequential (files per process)**
  - Do you see something?

Page cache revival: LU-11347 light deep dive in real life



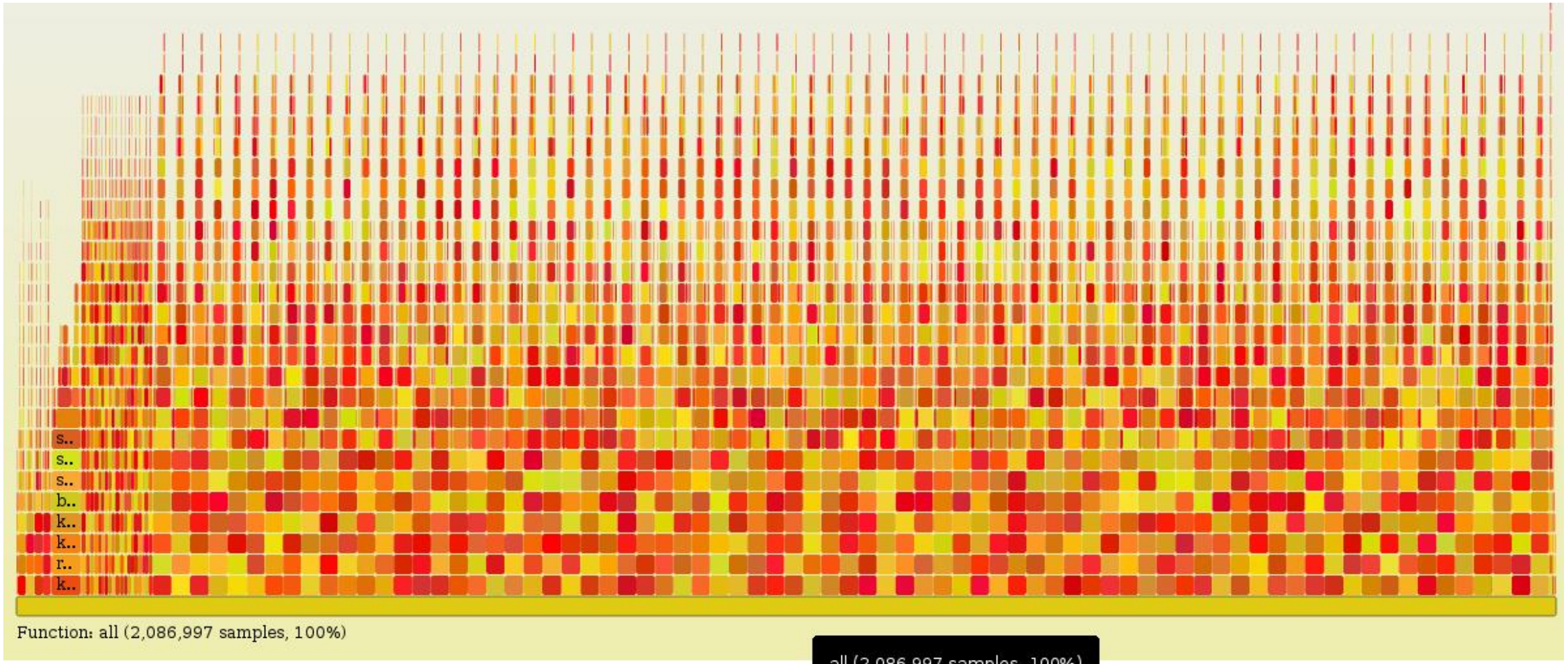
- ll_ost_io*: Lustre processes to “run” I/O on LUN
  - Too much find_or_create_page (0.88% , too low)
  - Direct reclaims occurs

Page cache revival: LU-11347 light deep dive in real life



- Same graph as the first one
- All ll_ost_io* have been aggregated

Page cache revival: LU-11347 light deep dive in real life



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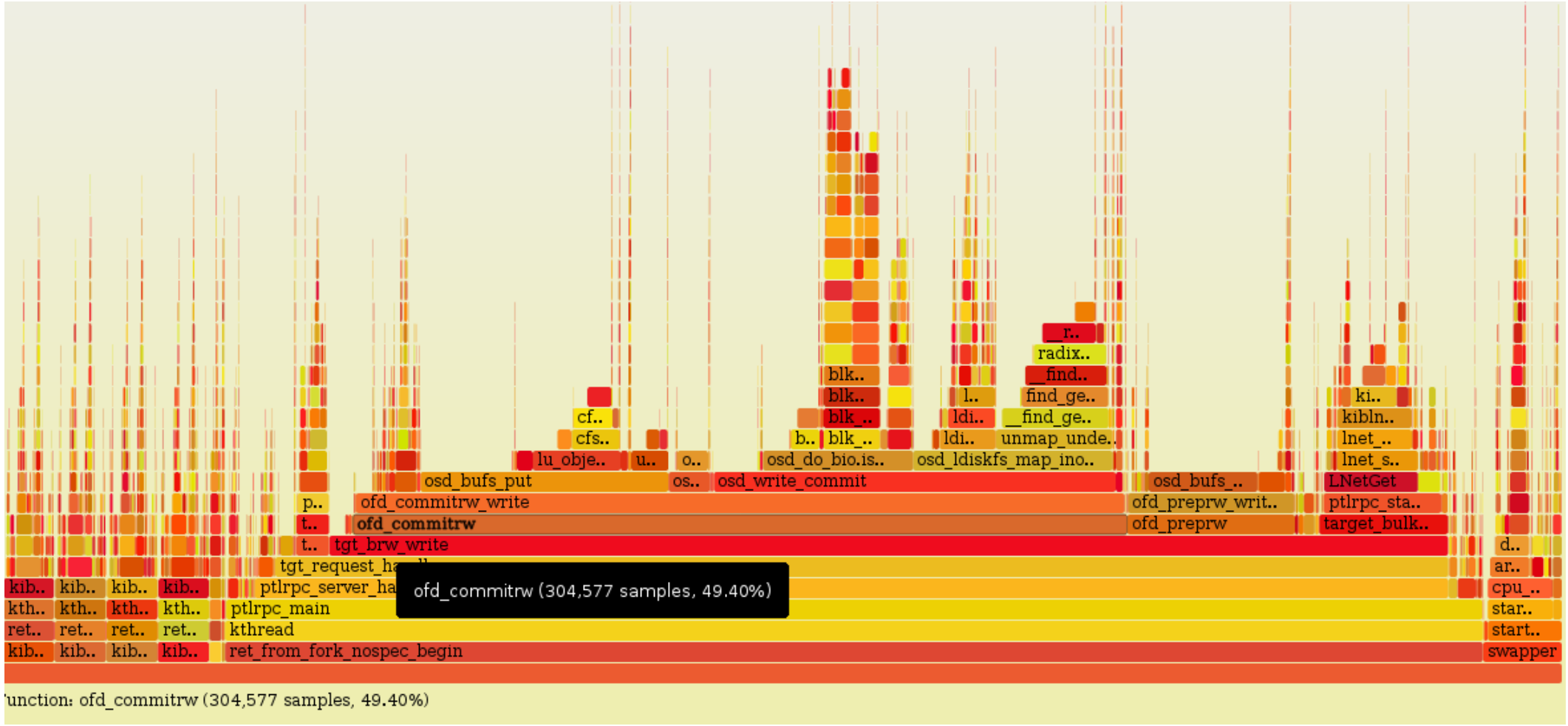
Page cache revival: LU-11347 light deep dive in real life

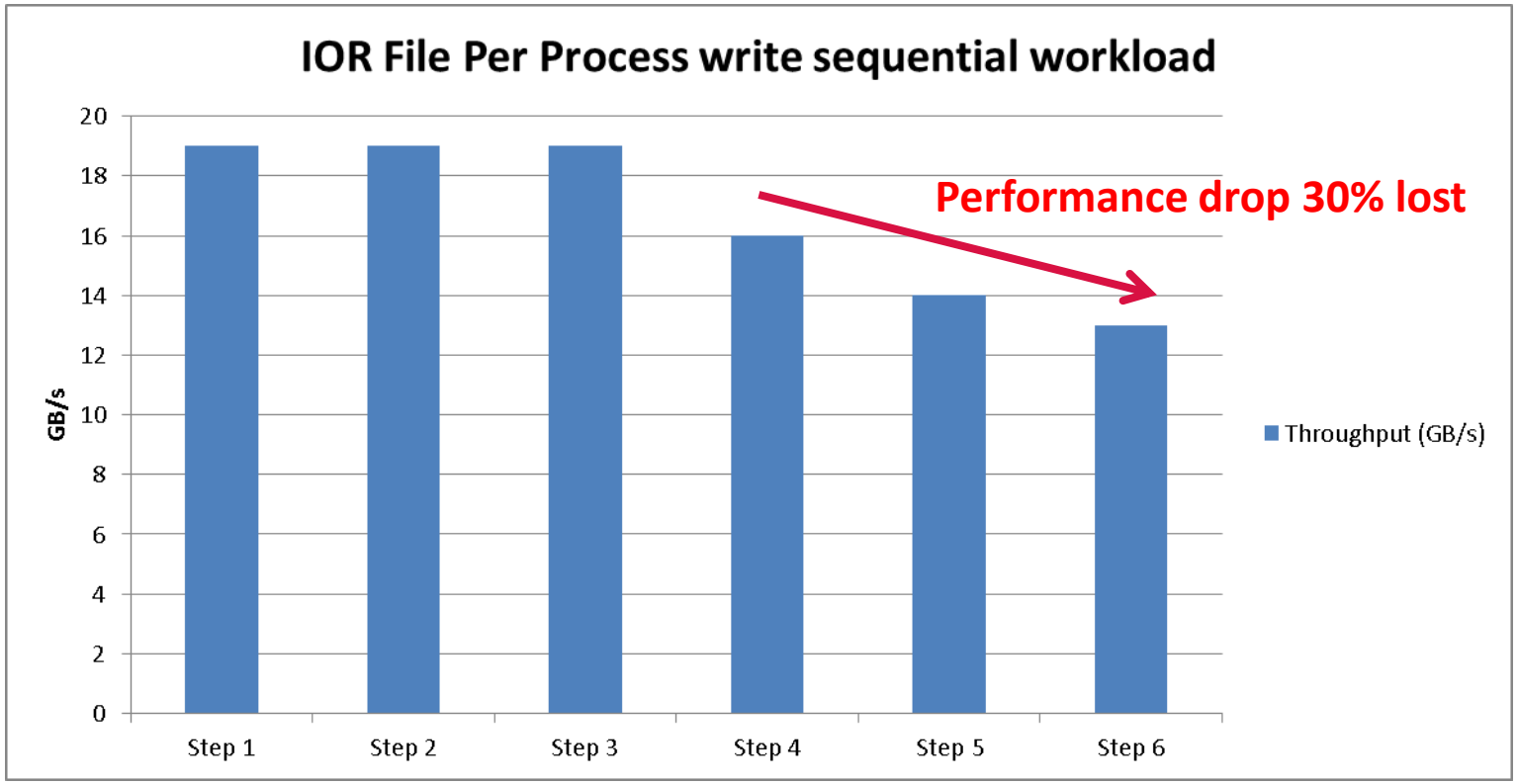


- 4x lustre network processes are running
- Ofd_commitrw are signficant
- I/O bottleneck

Performance in real life: reproductibility

▶Focus: IOR File per Process write sequential workload

ior -F -D 60 -k -E -w -v -t 2m -b 64g



Performance in real life: Analysis

- **Switch to block device (FIO on raw device, don't do this in production)**
- Same performance drop (follow IOR graph)
- Backend disks seems slower
  - Storage array is fine
  - SSD drives state?

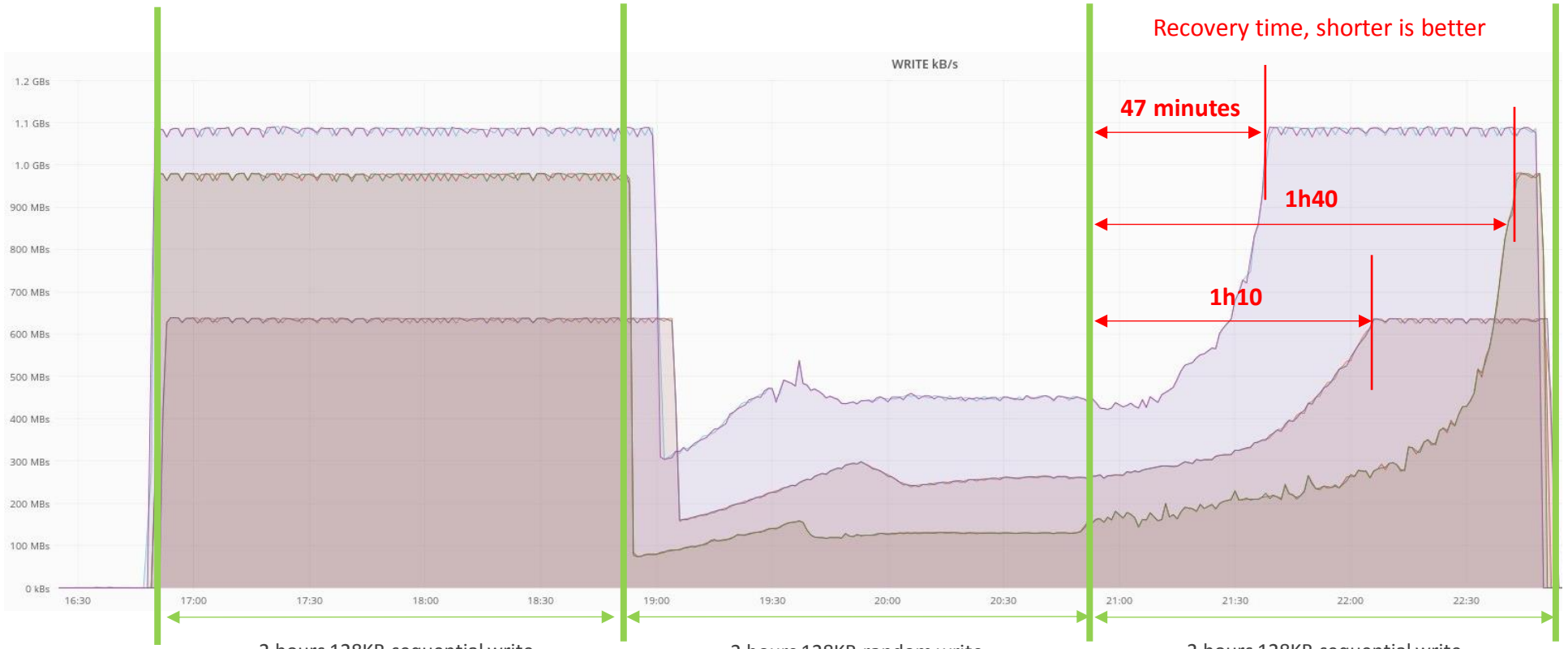
- Garbage collector is running
  - Write amplification mechanism

- Solution: planned or synchronous fstrim (-o discard)
  - Erase nand cells which are not anymore used by FS
  - **LU-11355** to run manually trim operation on OST target

Performance in real life: SSD choice criteria

▶XSR methodology

- Goal: monitor SSD capability to regain « nominal » performance



Overstriping: LU-9846

- **Patrick Farrel LUG'19 slides:**
  http://wiki.lustre.org/images/b/b3/LUG2019-Lustre_Overstriping_Shared_Write_Performance-Farrell.pdf
- **Requirements:**
  - LU-11796: Remove unnecessary assert
  - LU-9846: Add overstriping support
  - Landed for Lustre 2.13

- **Main idea: more than one stripe per ost**
- **Main target: single shared file (Lustre killer)**

- **Patrick F. modesty:** "Basic change is trivial: Remove explicit checks preventing this"
- **Result:** +866, -125 code lines (huge work)

Summary

- LU-11347 helps for write sequential workload
- LU-9846 add performance for single shared files
- Flamegraph: good tool to troubleshoot and understand what is going on low layers

http://www.brendangregg.com/flamegraphs.html

- Community efforts are efficient and bring Lustre features/performance

- Todo for T1KF:
  - Benchmarks at scale (Infiniband topology to improve)
  - Kernel CentOS 8
  - IO500

Questions?