FUJITSU

shaping tomorrow with you

Btrfs
Current Status and Future Prospects

Oct 13 2014

Satoru Takeuchi <takeuchi_satoru@jp.fujitsu.com>
Fujitsu LTD.

Agenda

FUJITSU

- Background
- Core Features
- Developments Statistics
- Future Prospects

Agenda

FUJITSU

- **Background**
- Core Features
- Developments Statistics
- Future Prospects

Background

FUJITSU

- Fujitsu has developed Btrfs for Mission Critical (MC) systems since 2010
- Requirements of MC systems
  - High robustness
    - Don’t crash: data duplication
    - Error detection: checksum
    - Repair, recovery: snapshot, backup/restore, repairing tools
  - High availability: Should work 365days/24h
    - Limited maintenance time: enlarge storage size and backup online
- Btrfs is designed for such the requirements

Agenda

FUJITSU

- Background
- **Core Features**
- Developments Statistics
- Future Prospects

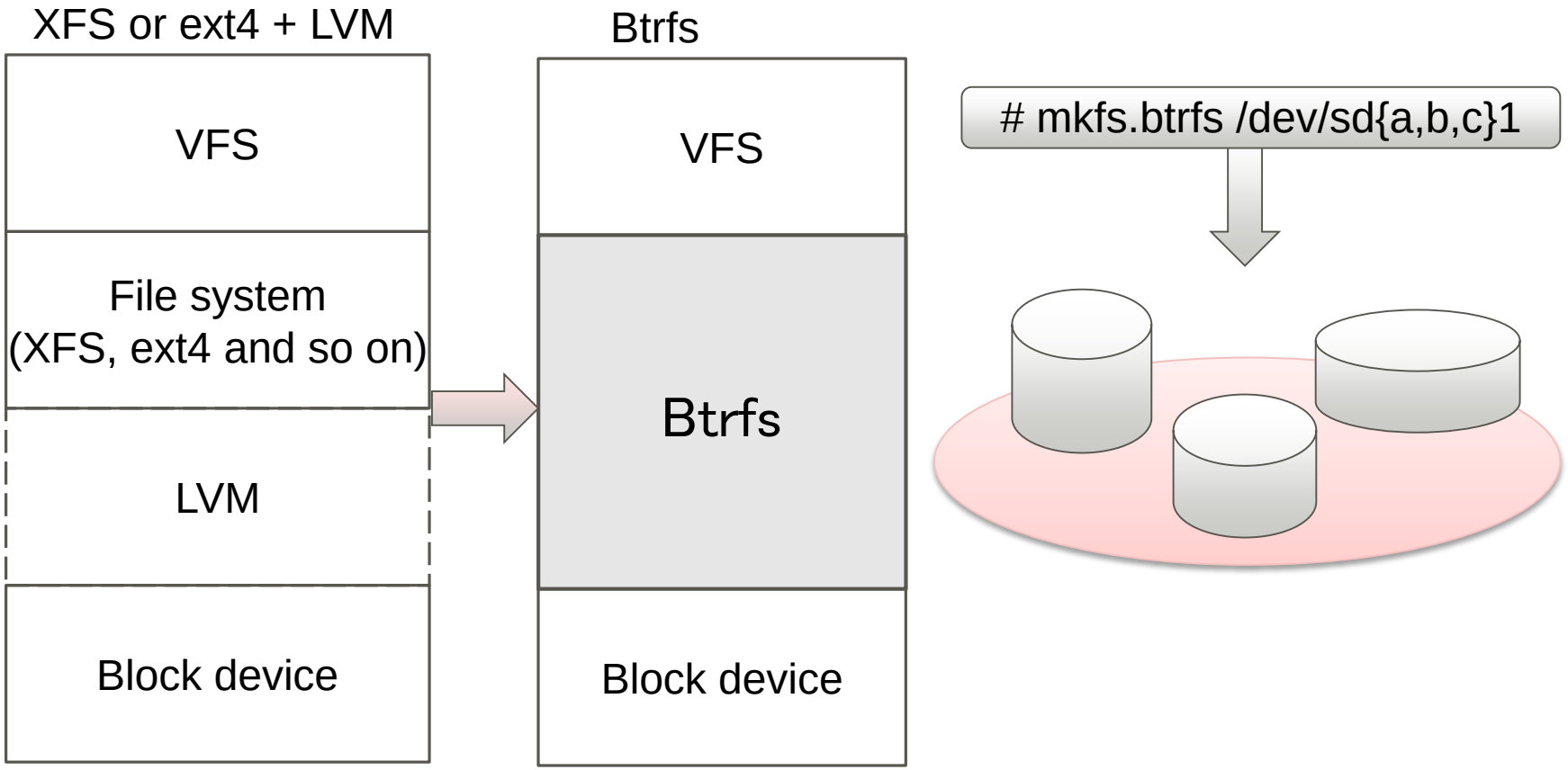
Core Features

- Multi-volumes
- Copy-on-Write Style Update
- Data/Metadata Checksum
- Subvolume
- Snapshot
- Transparent Compression

Multi-volumes

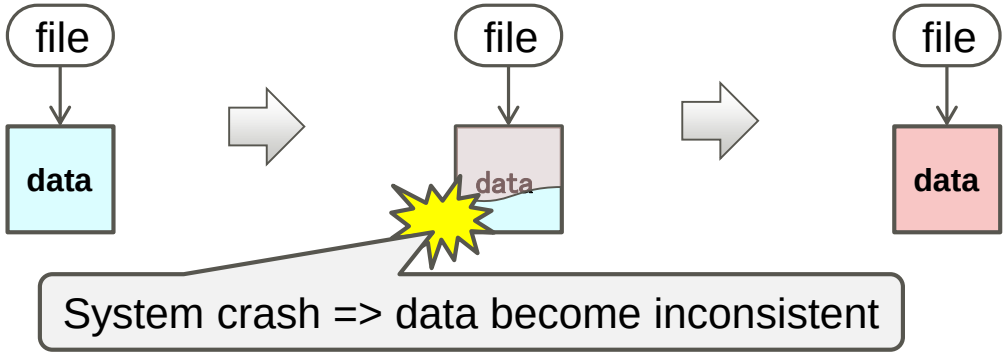
FUJITSU

- Btrfs file system can consists of multiple volumes
  - Low layered and low overhead than LVM
  - Many features: RAID, online {add/remove/replace} devices

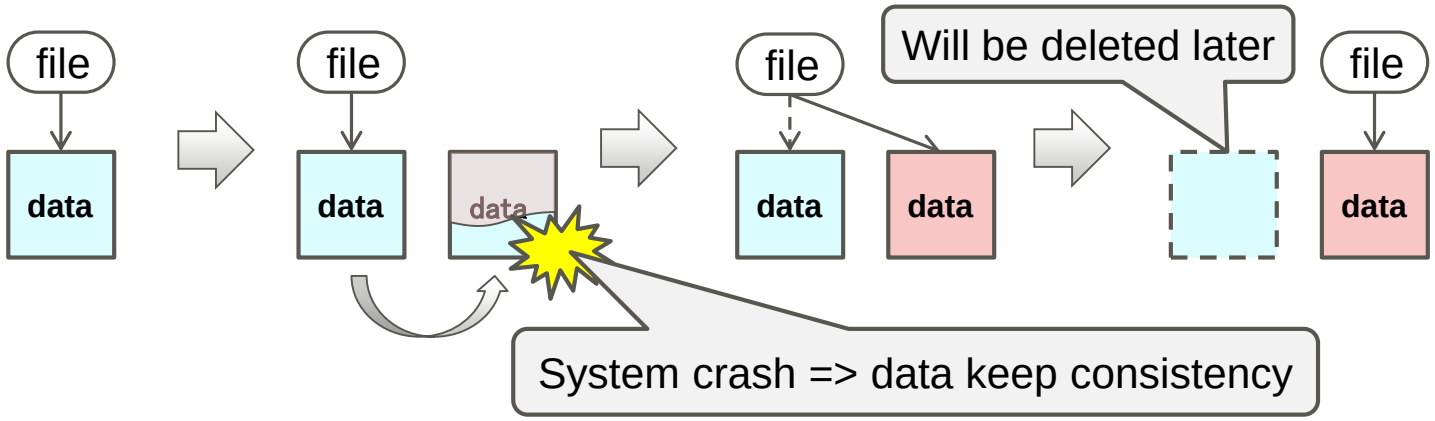


Copy-on-Write(CoW) style update

- Btrfs uses CoW style data/metadata update
  - Safer than overwrite style update by design
- Overwrite style: Update the data in place



- CoW style: Copy, update, and replace pointer



CoW versus Overwrite

FUJITSU

- 1,000 surprising power failure test
  - Linux File System Analysis for IVI system, Mitsuharu Ito, Fujitsu

    http://events.linuxfoundation.jp/sites/events/files/slides/linux_file_system_analysis_for_IVI_systems.pdf
- Result
  - Ext4: Metadata was corrupted
  - Btrfs: Worked fine without any problem
- In my internal similar testing, XFS corrupted too.

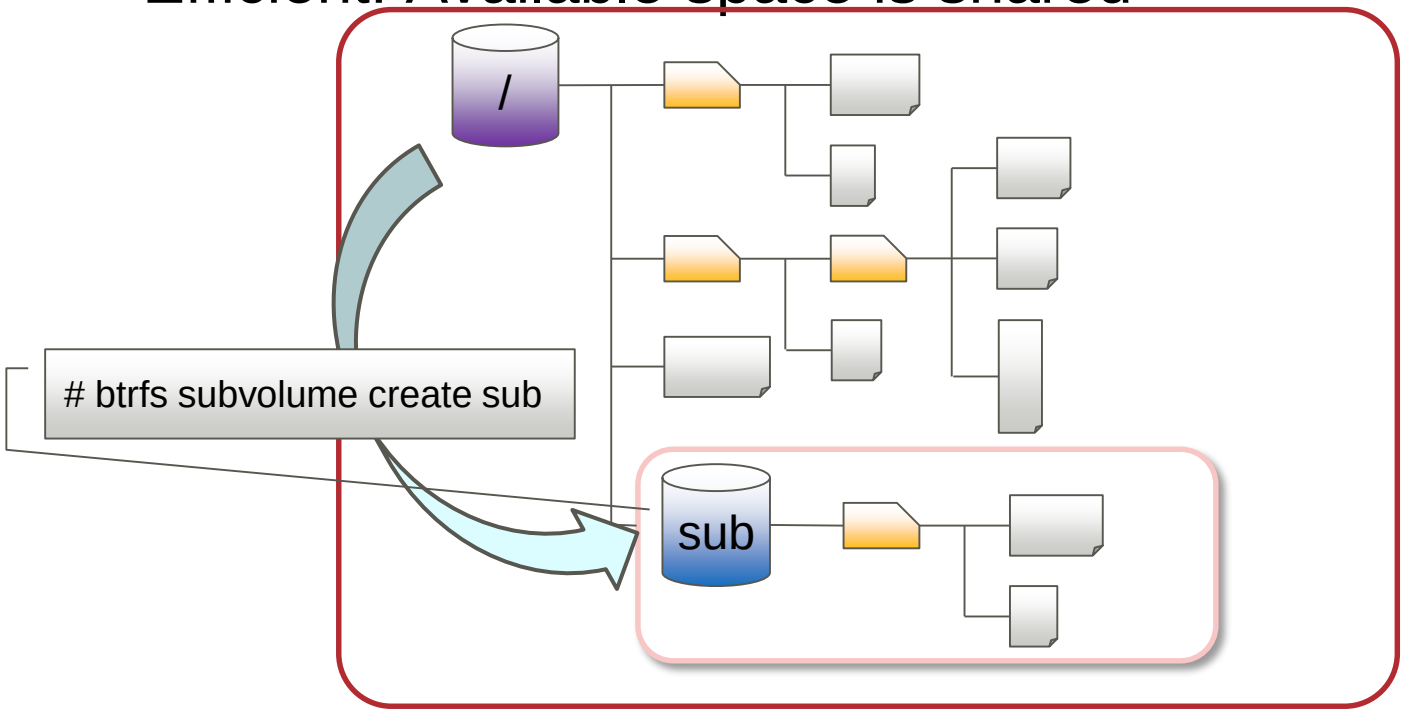
Data/Metadata Checksum

FUJITSU

- Btrfs has checksum for each data/metadata extent to detect and repair the broken data
- When Btrfs reads a broken extent, it detects checksum inconsistency
  - With mirroring: RAID1/RAID10
    - Read a correct copy
    - Repair a broken extent with a correct copy
  - Without mirroring
    - Dispose a broken extent and return EIO
- With “btrfs scrub”, Btrfs traverses all extents and fix incorrect ones
  - Online background job

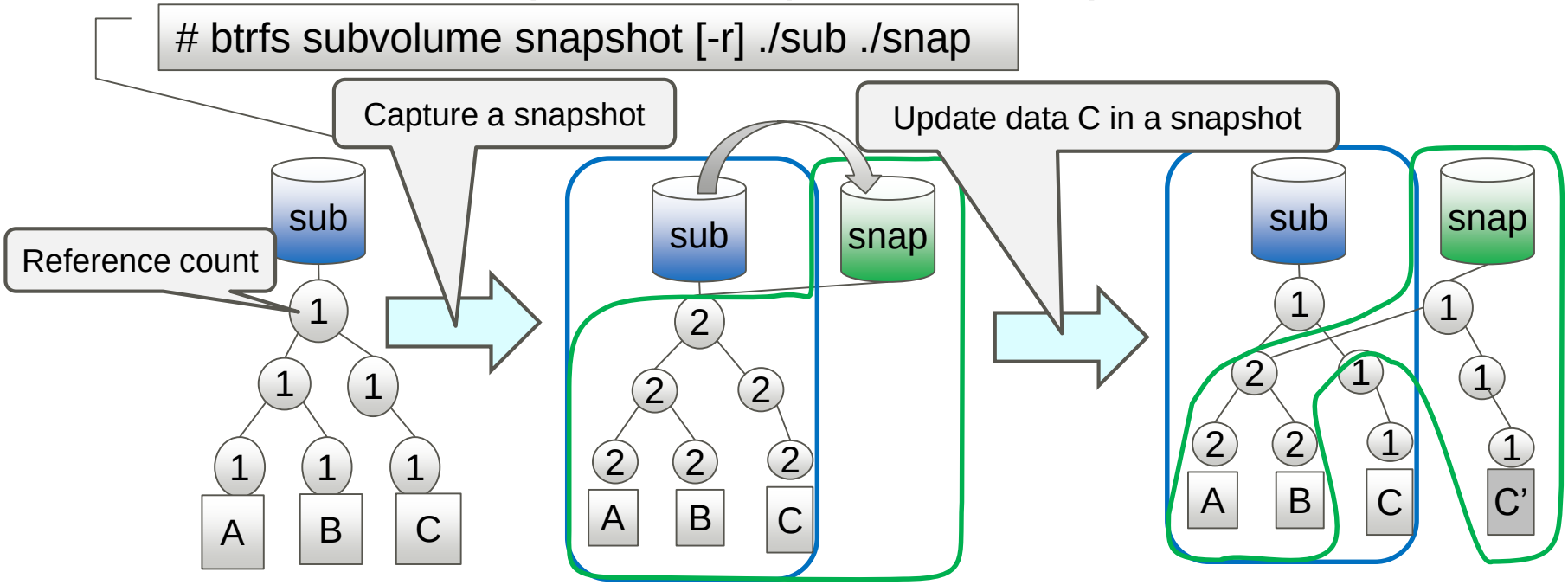
Subvolume

- A subvolume is a file system inside file system
  - Can be treated as a file system root
    - Mountable: most mount options are shared
    - Own inode namespace and quota limit
  - Efficient: Available space is shared



Snapshot

- Copy of a subvolume
  - Far faster than LVM
    - Not a full copy, but only update metadata in CoW style
  - Readonly snapshot: with –r option
  - Incremental snapshot: snapshot of snapshot



Performance of Snapshot: Btrfs versus LVM

FUJITSU

1. Copy the following data to a volume
   - Consists of 100 directories and 100 files for each directory
     - File size: 1MB
2. Capture a snapshot of the volume

Hardware Environment	Software Environment

• PRIMERGY RX300 S6
  • CPU: Intel Xeon X5690 3.47GHz x12 core
  • Memory: 16GiB
  • Storages: 100GB HDD x 2
	• Red Hat Enterprise Linux 7.0
	• File systems
	  • Btrfs
	  • Data/metadata: RAID1
	  • Other options: default
	  • XFS: default options
	• Volume manager for XFS
	  • dm-thinp: chunksize is 256KiB
	  • LVM: RAID1

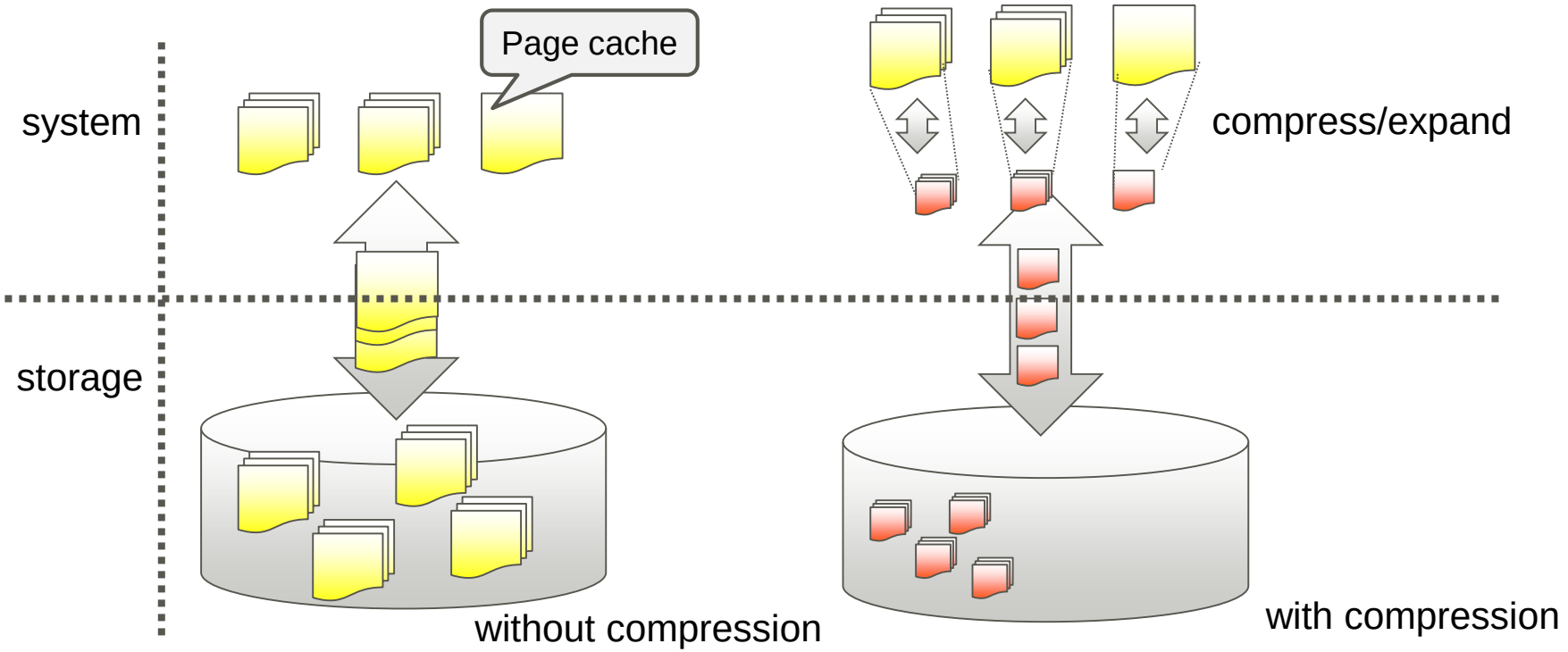
Result

- Copy: Btrfs > LVM >>> dm-thinp
- Snapshot: Btrfs > dm-thinp >>> LVM

Volume type	Copy	Snapshot	
		Without page cache	With page cache
Btrfs	106s	0.126s	11.7s
XFS on dm-thinp	209s	0.260s	15.5s
XFS on LVM	133s	1.03s	45.2s

Transparent compression

- Automatically compress/expand file data on I/O
  - Low space consumption and high I/O performance
    - Need some extra CPU time
  - Usage: mount -o compress={lzo,zlib} <device> <mnt point>
    - Can also be enabled/disabled for each file



Agenda

FUJITSU

- Background
- Core Features
- **Developments statistics**
- Future Prospects

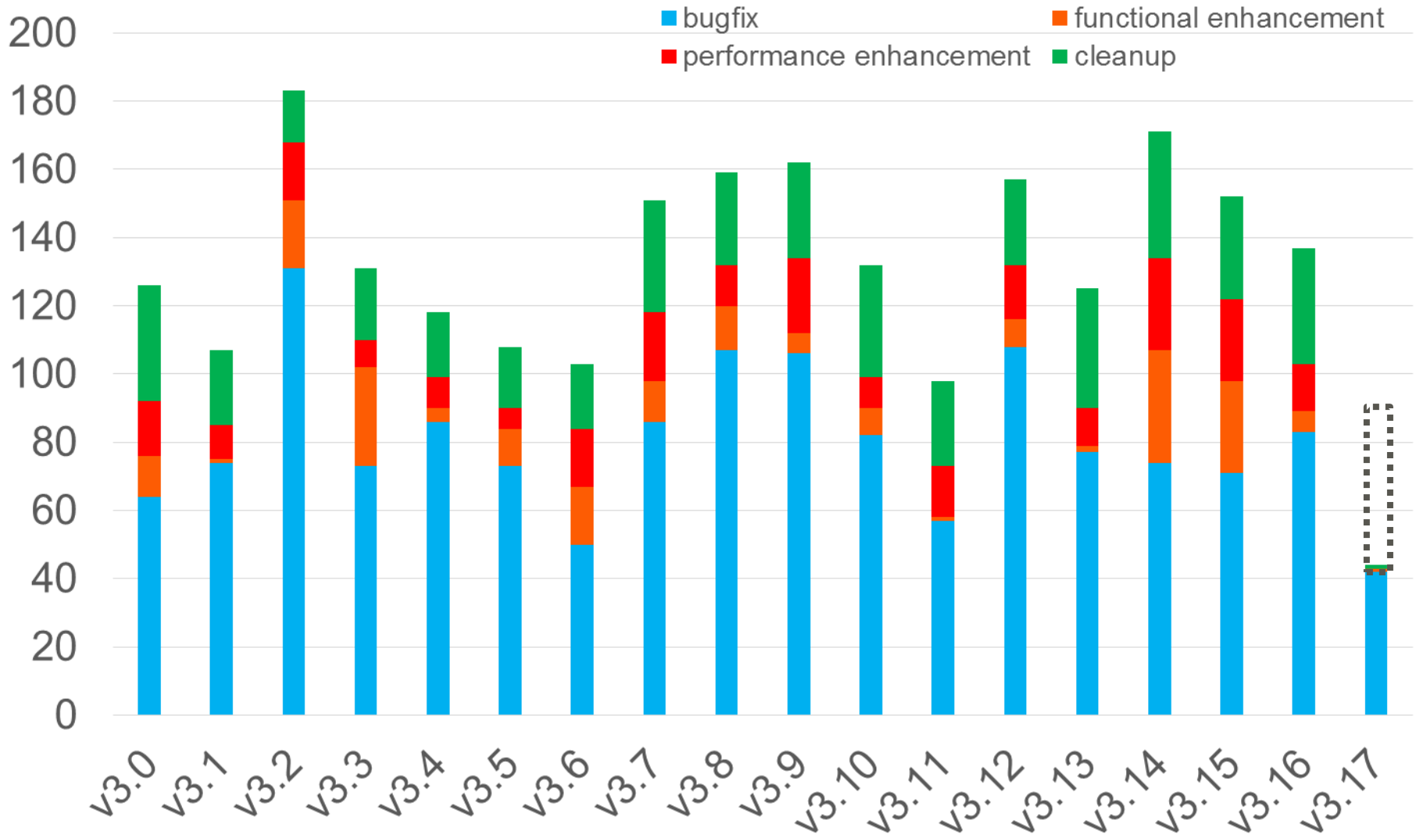
Developments statistics

FUJITSU

- Patch statistics
- Performance
- Summary

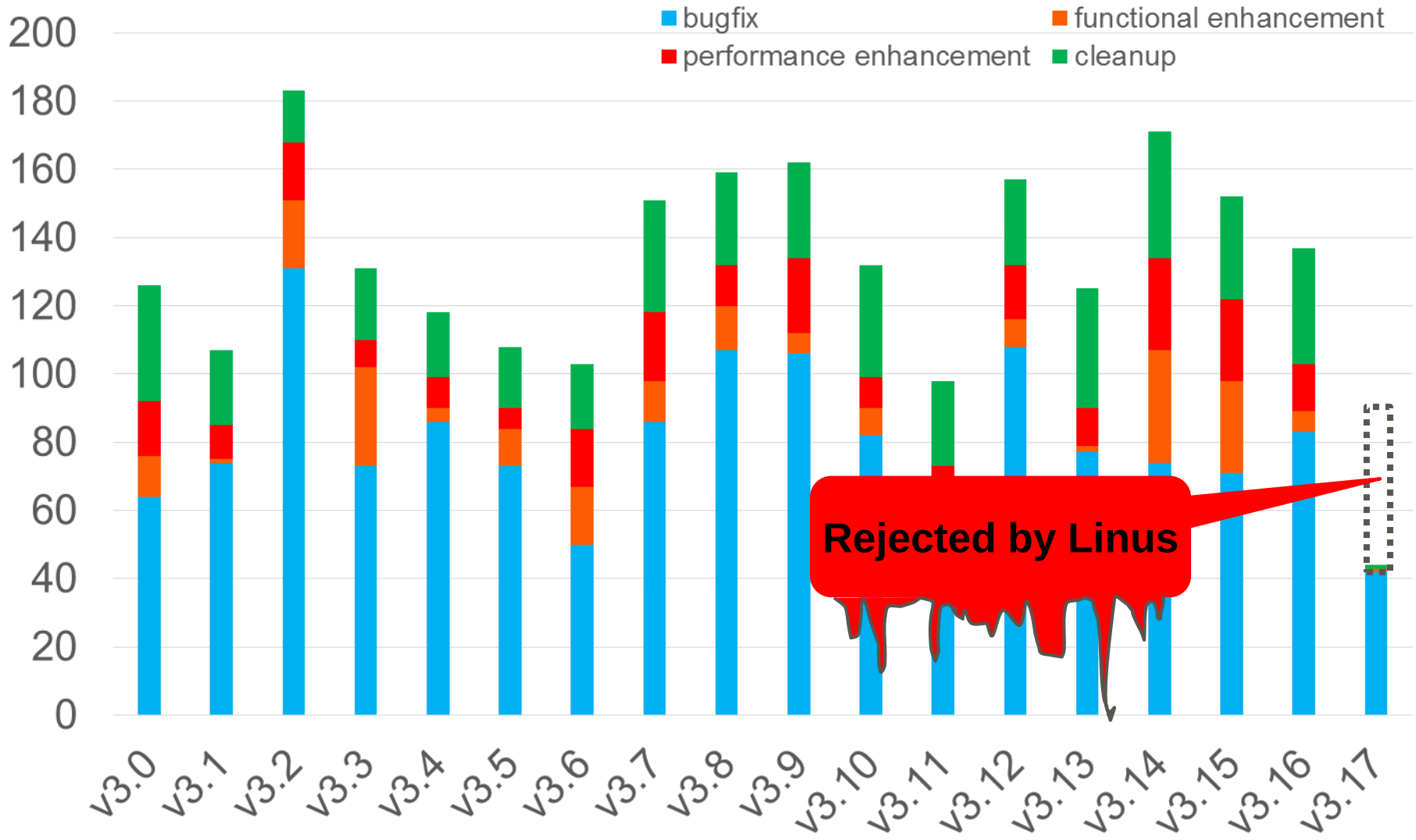
Patch Statistics

FUJITSU



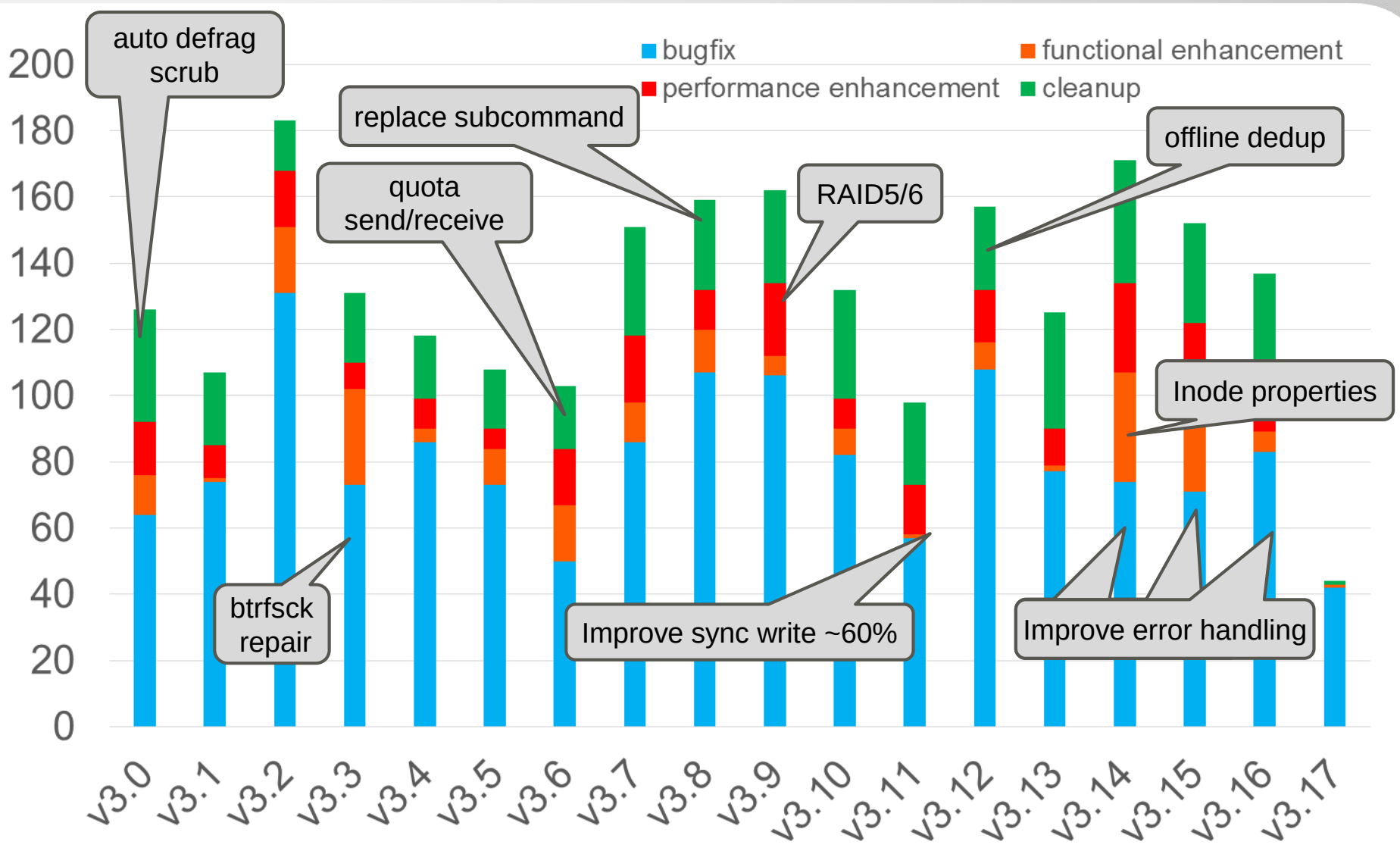
Patch Statistics: Tips of v3.17

FUJITSU



Patch statistics: Main changes

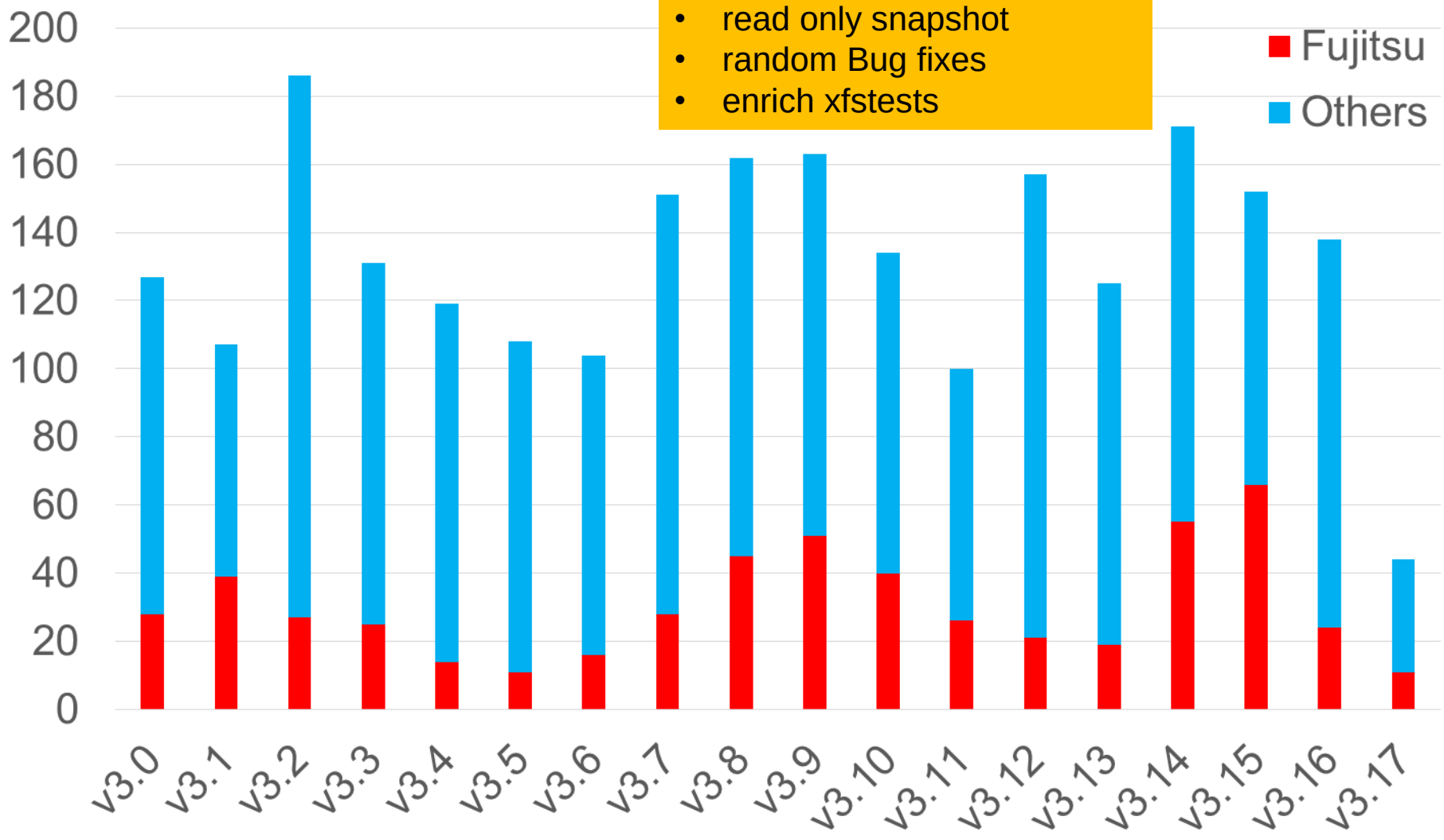
FUJITSU



Fujitsu's contribution

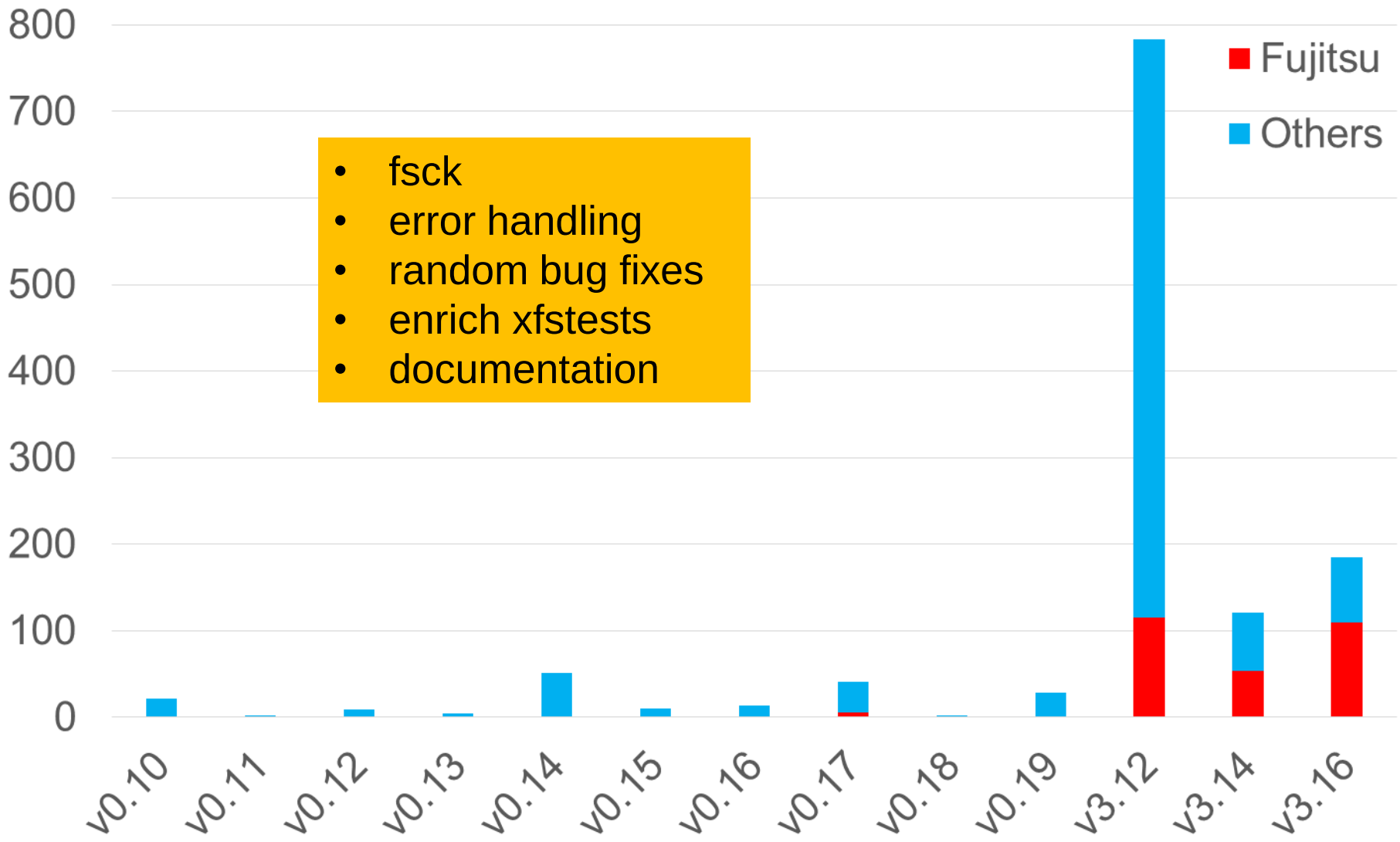
- btrfsck, error handling
- fast {random/async} write
- LZO compression
- read only snapshot
- random Bug fixes
- enrich xfstests

FUJITSU



Fujitsu's contribution: btrfs-progs

FUJITSU



Performance measurement

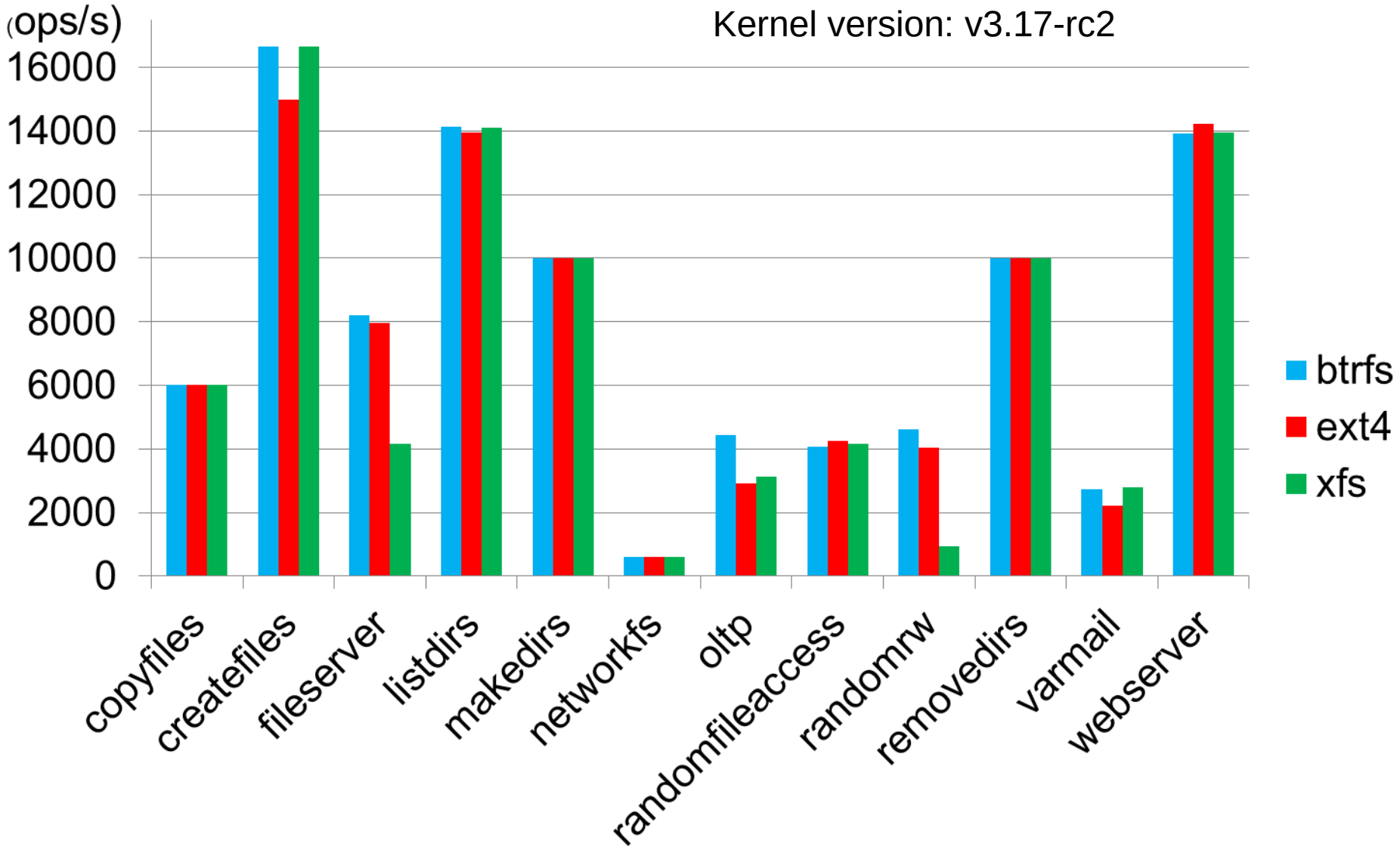
FUJITSU

Hardware Environment	Software Environment

• PRIMERGY TX300 S6
  • CPU: Xeon x5670 x 2
  • 12 core
  • HT is disabled
  • Memory: 4GB
  • HDD: 300GB x 1
  • MegaRAID SAS, HITACHI HUS156030VLS600
	• Benchmark software: filebench
	• Kernel: 3.14.11, 3.15.4, 3.16.3, and 3.17-rc2
	  • I/O scheduler: deadline
	  • File systems: Btrfs(single volume), XFS, and ext4
	  • default mkfs options and mount options

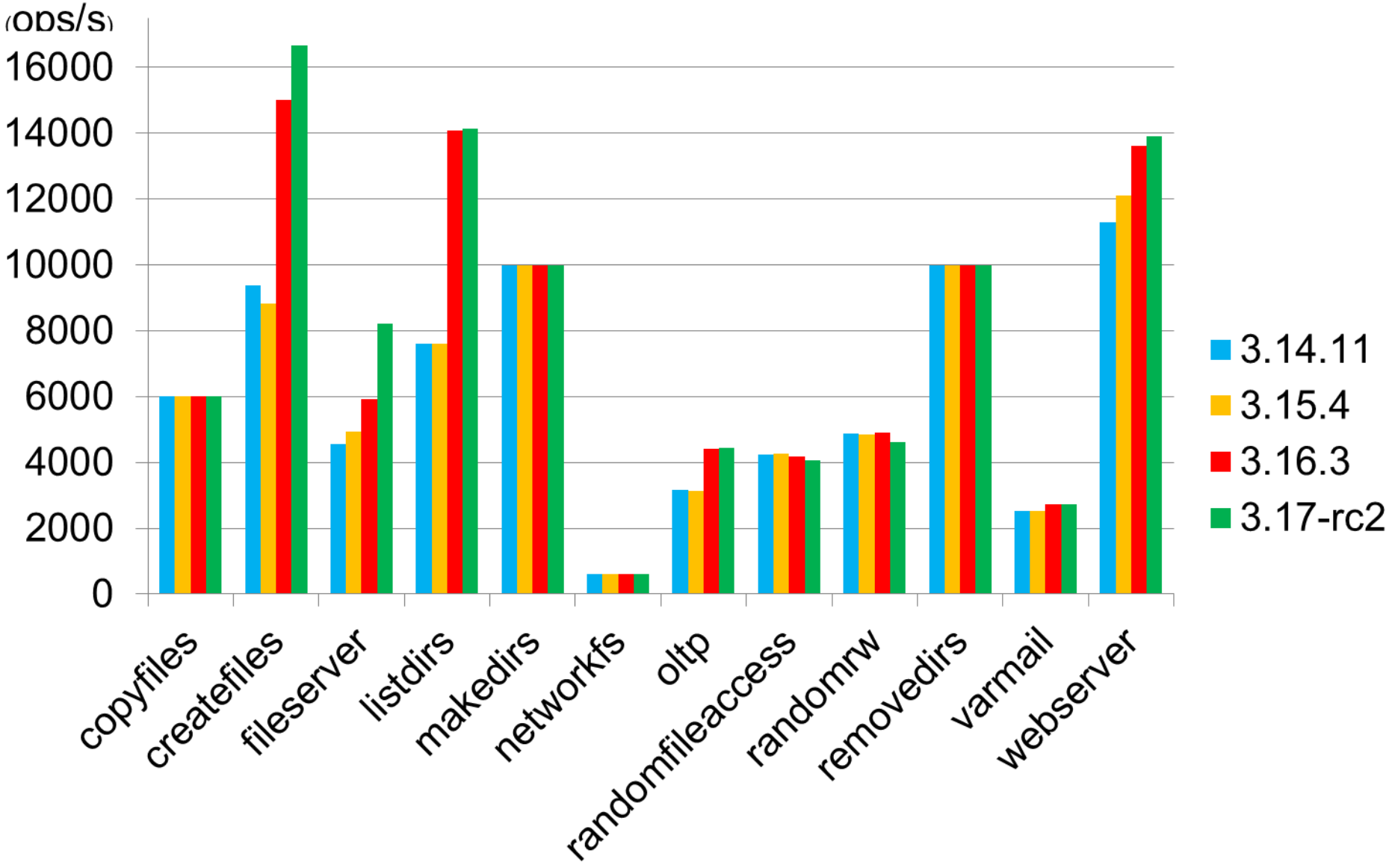
The result: Compare with other file systems

FUJITSU



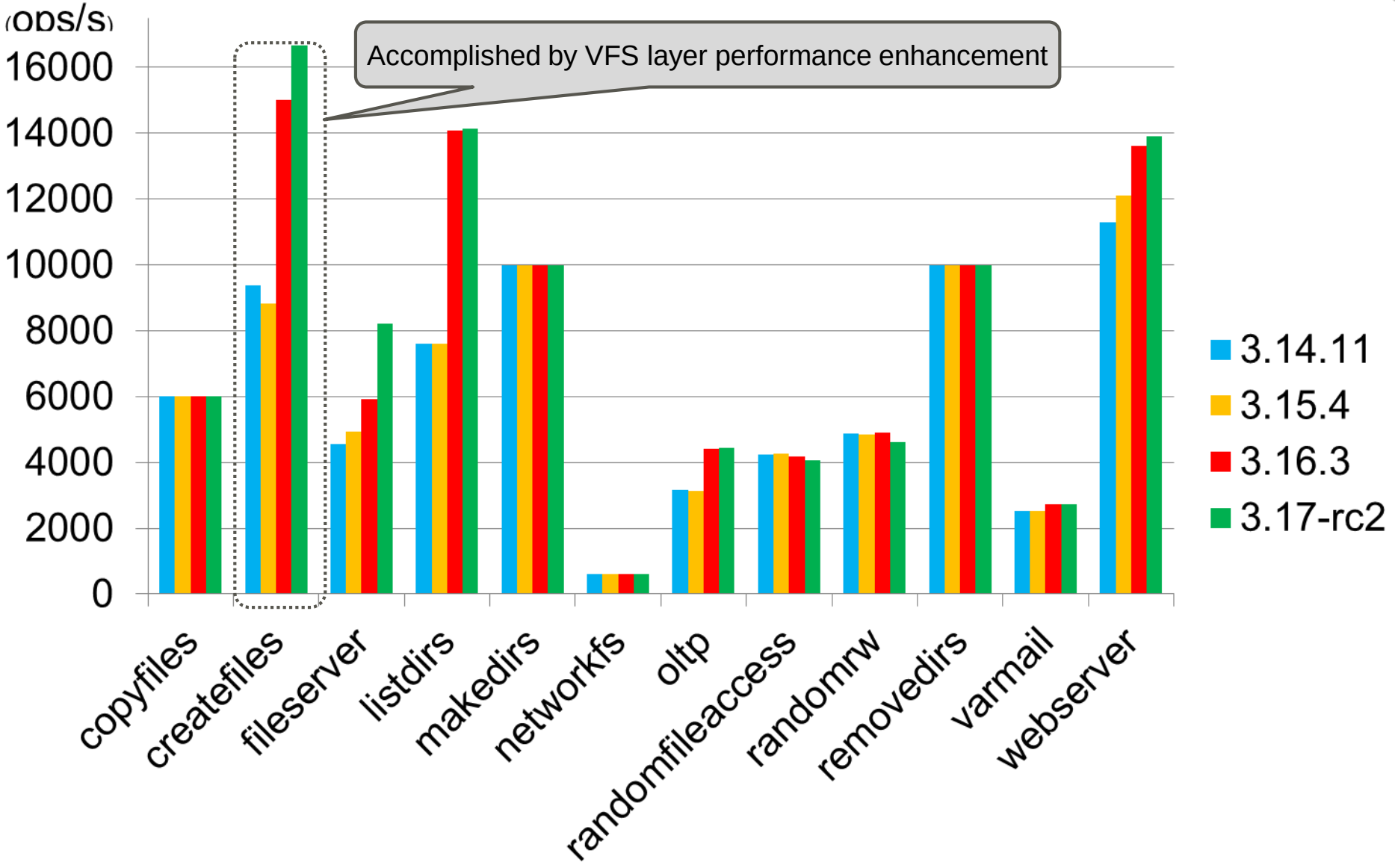
The result: Compare with old Btrfses

FUJITSU



VFS has also improved performance

FUJITSU



Summary

FUJITSU

- Ready to use without RAID5/6
  - Performance: OK
  - Stability: OK
    - # of new features has decreased
    - Test coverage has increased
  - Features: almost OK
    - RAID5/6: Lack of scrub and replace subcommands
- RAID1 and RAID10 are the best choice
  - Especially safe and stable

Agenda

FUJITSU

- Background
- Core Features
- Developments statistics
- **Future Prospects**

Future Prospects: Fujitsu's plan

FUJITSU

- RAID 5/6 enhancement
  - Add scrub and replace subcommands
    - We're testing patches now and will post it to linux-btrfs ML soon
  - Add five tests for these features to xfstests
- Further enhancement of robustness and performance
  - Repairing tools and so on
- Education and documents for this purpose
  - Operation know-how
    - Btrfs operations are different from other file systems
      - e.g. Btrfsの基礎 part1 機能編(It's in Japanese. Now translating to English…)

    http://www.slideshare.net/fj_staoru_takeuchi/btrfs-part1
  - File system structure
  - Code logic

Future Prospects: Btrfs users are increasing

FUJITSU

- Will be used by OpenSuSE13.2 as its default
- Supported by Ubuntu
- Available with RHEL7 as tech-preview
- Will be used for In Vehicle Infortaiment(IVI) system
  - Linux File System Analysis for IVI system, Mitsuharu Ito, Fujitsu

    http://events.linuxfoundation.jp/sites/events/files/slides/linux_file_system_analysis_for_IVI_systems.pdf

Conclusion

FUJITSU

- **Please try Btrfs**
- **It’s ready to use**
  - **RAID1/10 are the best choice**
  - **RAID5/6 need some more work**
  - **Recommend the newest stable kernel**

References

FUJITSU

- Linux File System Analysis for IVI system, Mitsuharu Ito, Fujitsu

  http://events.linuxfoundation.jp/sites/events/files/slides/linux_file_system_analysis_for_IVI_systems.pdf

- Btrfsの基礎 part1 機能編

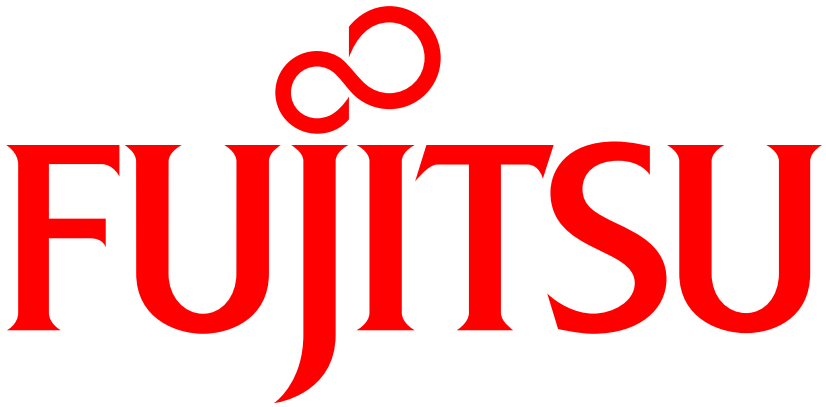
  http://www.slideshare.net/fj_staoru_takeuchi/btrfs-part1

- Linux-btrfs ML

  linux-btrfs@vger.kernel.org

- Btrfs wiki

  https://btrfs.wiki.kernel.org/index.php/Main_Page



shaping tomorrow with you