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It's Not your Father's NFS

Steve Dickson
Consulting Software Engineer, Red Hat
steved@redhat.com

presented by

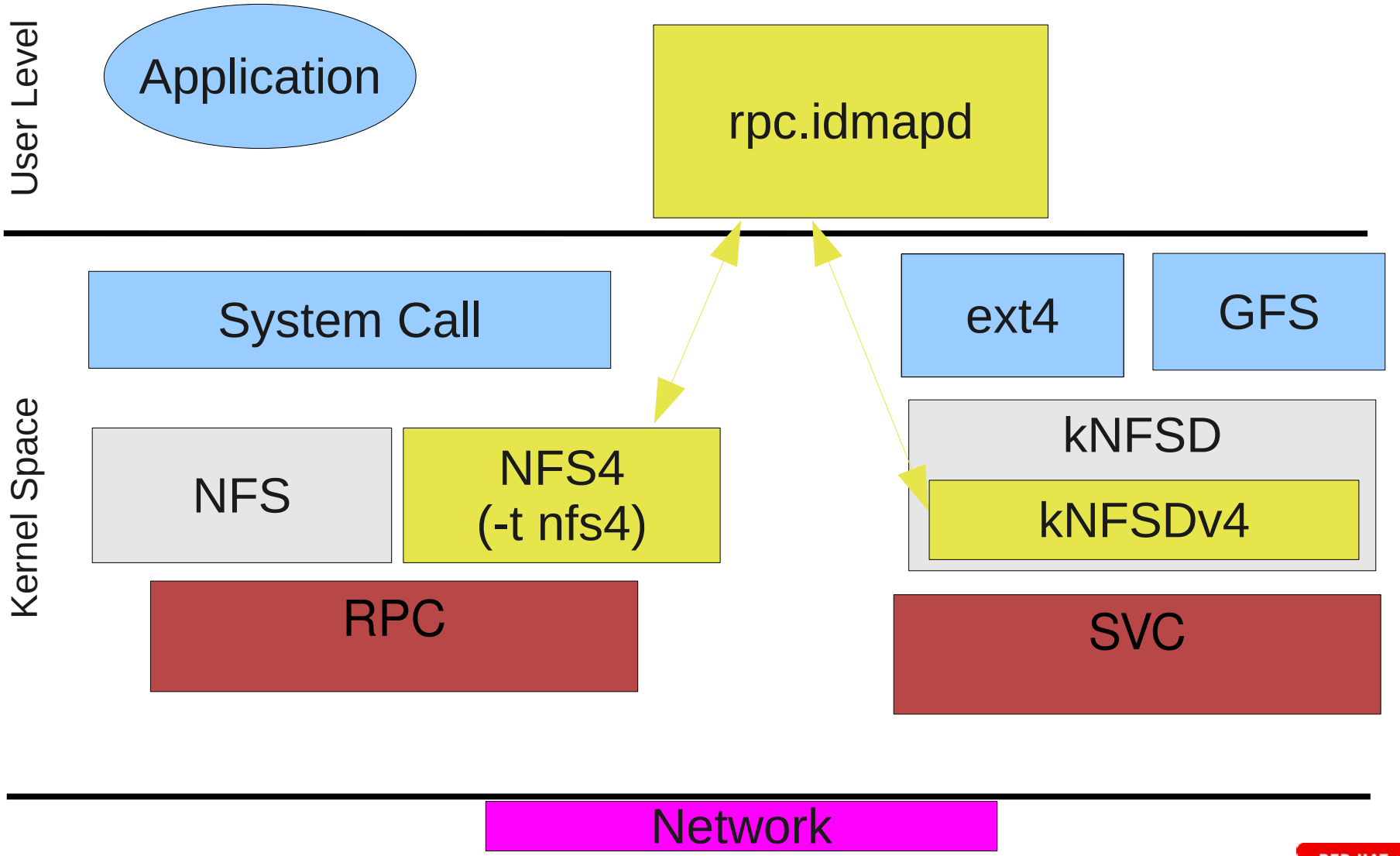
Outline

- Moving to NFS version 4
- NFS version 4.1 and pNFS
- NFS and FS-Cache
- NFS Tracepoints
- NFS and SystemTap scripts
- NFS Metrics
- NFS and IPv6 Support

NFSv4 Advantages

- Performance
  - Read/Write Delegations
- Server maintains client state
  - Callbacks to Clients
- Multi-Component Messages
  - Less Network traffic
- Mandates strong security architecture
  - Available on **ALL** versions
- Elimination of 'side-car' protocols
  - No rpc.statd or In-kernel lockd
  - Only port 2049

NFSV4 Architecture



NFSv4 improvements

- Emphasis on stabilizing the code for enterprise use.
  - NFSv4 state management improvements have resulted in a much improved state recovery code
  - Fixes a number of corner cases when server reboots and/or network partitions occur.
  - Locking simplifications reduce SMP contentionissues.
  - Delegation management improvements ensure clients do not hold onto delegations when files are not in use.
  - Improves server and cluster scalability

(Slide Courtesy of: Network Appliance)

NFSv4 Default Protocol

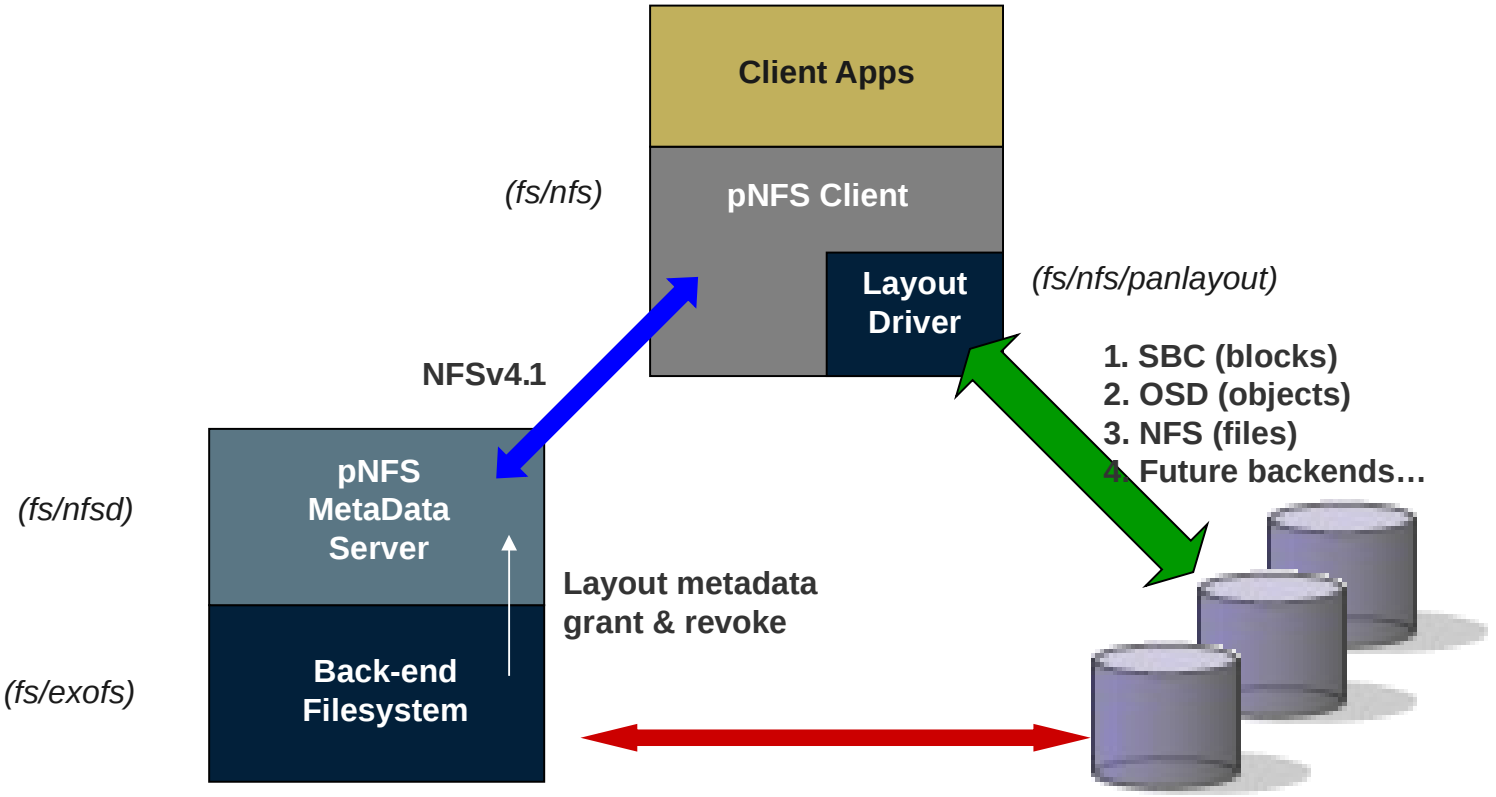
- Current exports will work seamlessly
  - No need for fsid=0 export
- A mount configuration file
  - Options per mount point
  - Options per server
  - Global options
- Mount to negotiate From V4
  - -t nfs4 option no longer needed.

NFS minor version 1 (NFS41)

- Sessions
  - Exactly-Once semantics
    - Duplicate Request Cache
  - Callbacks –
    - More Firewall friendly
      - Made on same connection as requests
      - Client initiated
  - Directory Delegations
  - Enabling pNFS

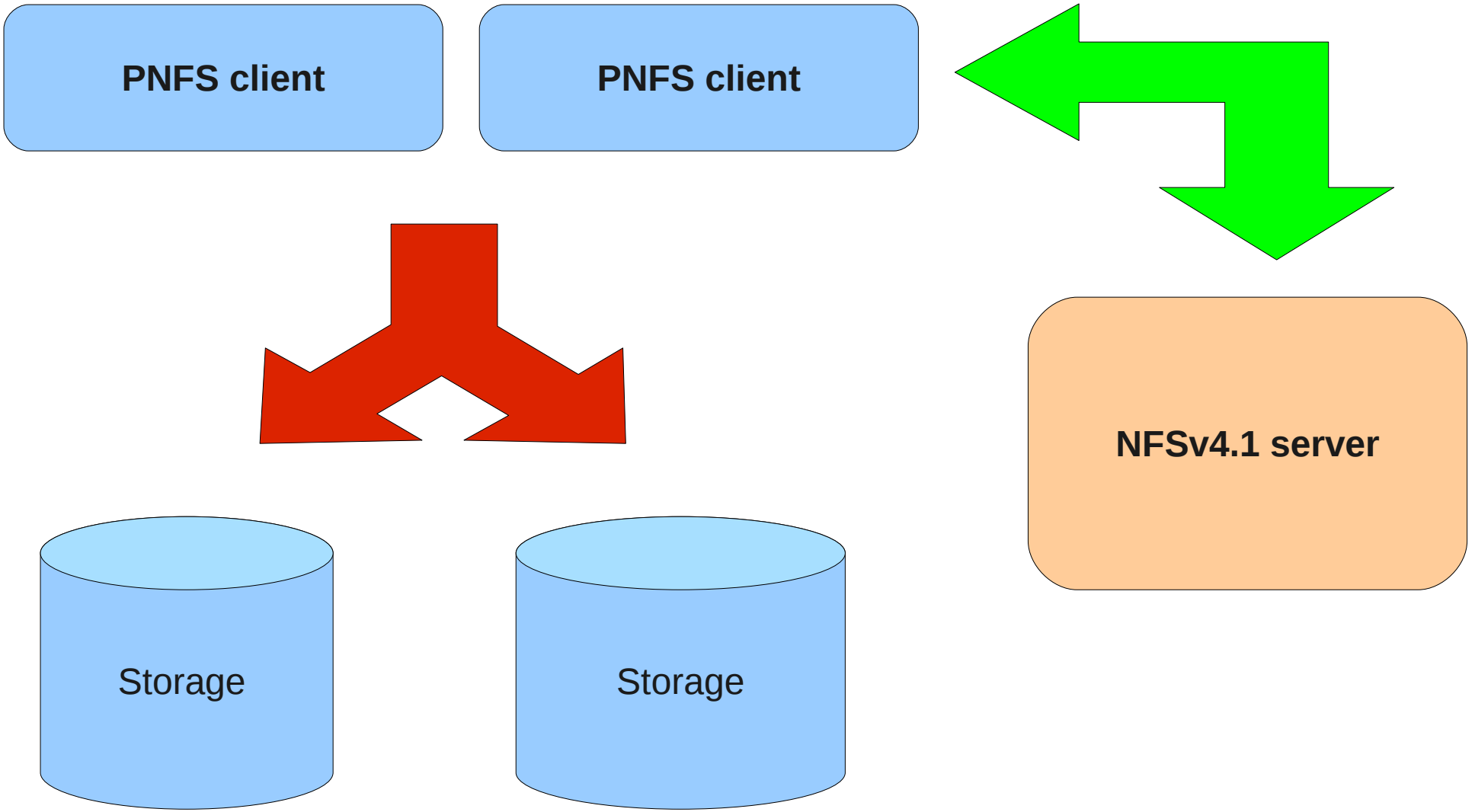
Linux pNFS Overview

- Common client and server code for different back ends
- Integrated with existing NFSv4 codebase



(Slide Courtesy of: Benny Halevy, Panasas)

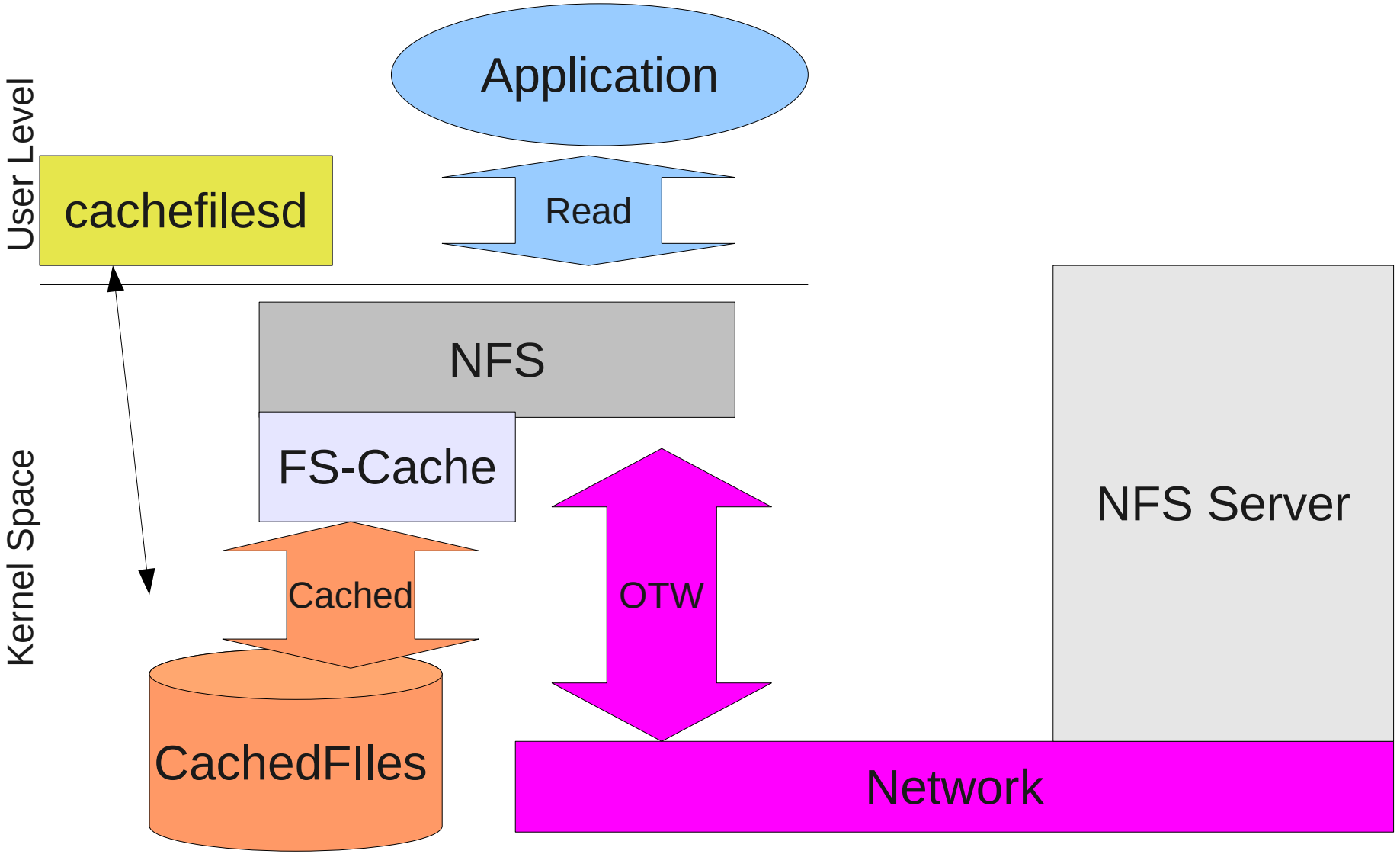
PNFS
Allows Clients to access storage directly



NFS and FS-Cache

- Main Goal: Improve Server Scalability
  - Some short term performance degradation on client
- Only Reads are Cached.
  - Opening the file for writes flushes and disables cache.
- Cache is maintained through umounts and reboots
- User level daemon used to maintain cache
  - Cachefilesd
- Possible Tech Preview in RHEL6

FS-Cache Architecture



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NFS TracePoints

- Trace Points are availability in RHEL5.3 and beyond.
  - 3 tracepoints used for diagnostics
- rpc_call_status
  - Shows all errors that occur during NFS operations
- rpc_connect_status
  - Shows errors that occur during network connections
- rpc_bind_status
  - Show errors that occur during the binding of network connections

NFS and TracePoints (con't)

- Need to install kernel-devel rpm
  - yum install kernel-devel
- stap -L 'kernel.trace("*")'
  - Show all the available tracepoint
- The tracepoints can be access by systemtap script:

```
probe kernel.trace(“rpc_call_status”)
{
    terror =  task_status($task);
    If (terror) {
        printf(“%s[%d]:call_status::%s:%s: error %d(%s)\n”,
            execname(), pid(), cl_server($task), cl_prog($task),
            terror, errno_str(terror));
    }
}
```


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NFS and Systemtap

- Systemtap home page: **http://sourceware.org/systemtap/wiki/HomePage**
- Need to install **both** kernel-devel and kernel-debuginfo rpms
- man -k stap – shows all the 'built in' tap scripts which live in **/usr/share/systemtap/tapset** directory
  - man stapprobes.nfs – shows NFS scripts
- “Home grown” NFS tap scripts
  - git://fedorapeople.org/~steved/systemtap.git

NFS Metrics

- iostat -n
  - New '-n' flag to iostat command
    - yum install sysstat
    - Operations per sec
    - Reads and Writes per sec

```
Filesystem:  rBlk_nor/s   wBlk_nor/s   rBlk_dir/s   wBlk_dir/s   rBlk_svr/s   wBlk_svr/s   ops/s
rops/s    wops/s

tophat:/home   0.50        0.01        0.00        0.00        0.00        0.01     0.00     0.00      0.00
tophat:/home   15.71       0.01        0.00        0.00        0.00        0.01     0.00     0.00      0.00
```

NFS Metrics

- nfs-iostat
  - NFS client per-mount I/0 statistics
    - Statistic per memory page
    - Statistics per directory operations
    - Statistics per file access
    - Uses /proc/self/mountstats

rawhide:/home mounted on /mnt/home:

op/s	rpc bklog
233.00	2.10

read:	ops/s	kB/s	kB/op	retrans	avg RTT (ms)	avg exe (ms)
	232.000	14908.719	64.262	0 (0.0%)	61.875	83.925

NFS Metrics

- mountstats
  - Overall NFS client per-mount statistics

```
GETATTR:
        3 ops (0%)    0 retrans (0%)      0 major timeouts
        avg bytes sent per op: 138 avg bytes received per op: 112
        backlog wait: 0.000000      RTT: 0.333333     total execute time: 0.333333 (milliseconds)
LOOKUP:
        4 ops (0%)    0 retrans (0%)      0 major timeouts
        avg bytes sent per op: 144 avg bytes received per op: 176
        backlog wait: 0.000000      RTT: 0.750000     total execute time: 0.750000 (milliseconds)
READ:
        8001 ops (20%)    0 retrans (0%)      0 major timeouts
        avg bytes sent per op: 140 avg bytes received per op: 65655
        backlog wait: 22.235471     RTT: 58.915511    total execute time: 81.165479 (milliseconds)
WRITE:
        14997 ops (37%) 0 retrans (0%)      0 major timeouts
        avg bytes sent per op: 35107    avg bytes received per op: 136
        backlog wait: 1892.769887       RTT: 51.310862    total execute time: 1944.124225 (millisecon
```

NFS and IPv6 Support

- **Client side (almost done):**
  - Goal is to have it “just work” when a hostname resolves to IPv6 address.
  - NFSv4 support is complete. NFSv2/3 is done except for rpc.statd, which is being rewritten.
  - Current release target is Fedora 13.
- **Server side (still experimental):**
  - Kernel pieces are mostly in-place, rpc.nfsd is finished
  - IPv6-capable mountd/exportfs is still work-in-progress

Acknowledgments

NFSv4.1: An update
Mike Eisler, Network Appliance February 23, 2009
http://www.connectathon.org/talks09/eisler_cthon_2009.pdf

Progress on NFSv4.1: Definition and a review of changes from NFSv4.
Dave Noveck, Network Appliance, February 5, 2007
http://www.connectathon.org/talks07/NFSv41update.pdf

NFSv4 Sessions Linux Implementation Experience
Jon Bauman & Mike Stolarchuk, CITI, U of Michigan
Center for Information Technology Integration
University of Michigan, Ann Arbor
http://www.connectathon.org/talks05/bauman.pdf

Parallel NFS (pNFS)
Garth Goodson, Network Appliance, February 28, 2006
http://www.connectathon.org/talks06/goodson.pdf

Acknowledgments

NFS Version 4 Minor Version 1
draft-ietf-nfsv4-minorversion1-25.txt
http://www.nfsv4-editor.org/draft-25/draft-ietf-nfsv4-minorversion1-25.html

Object-based pNFS in linux
Benny Halevy, Panasas, May 4, 2009

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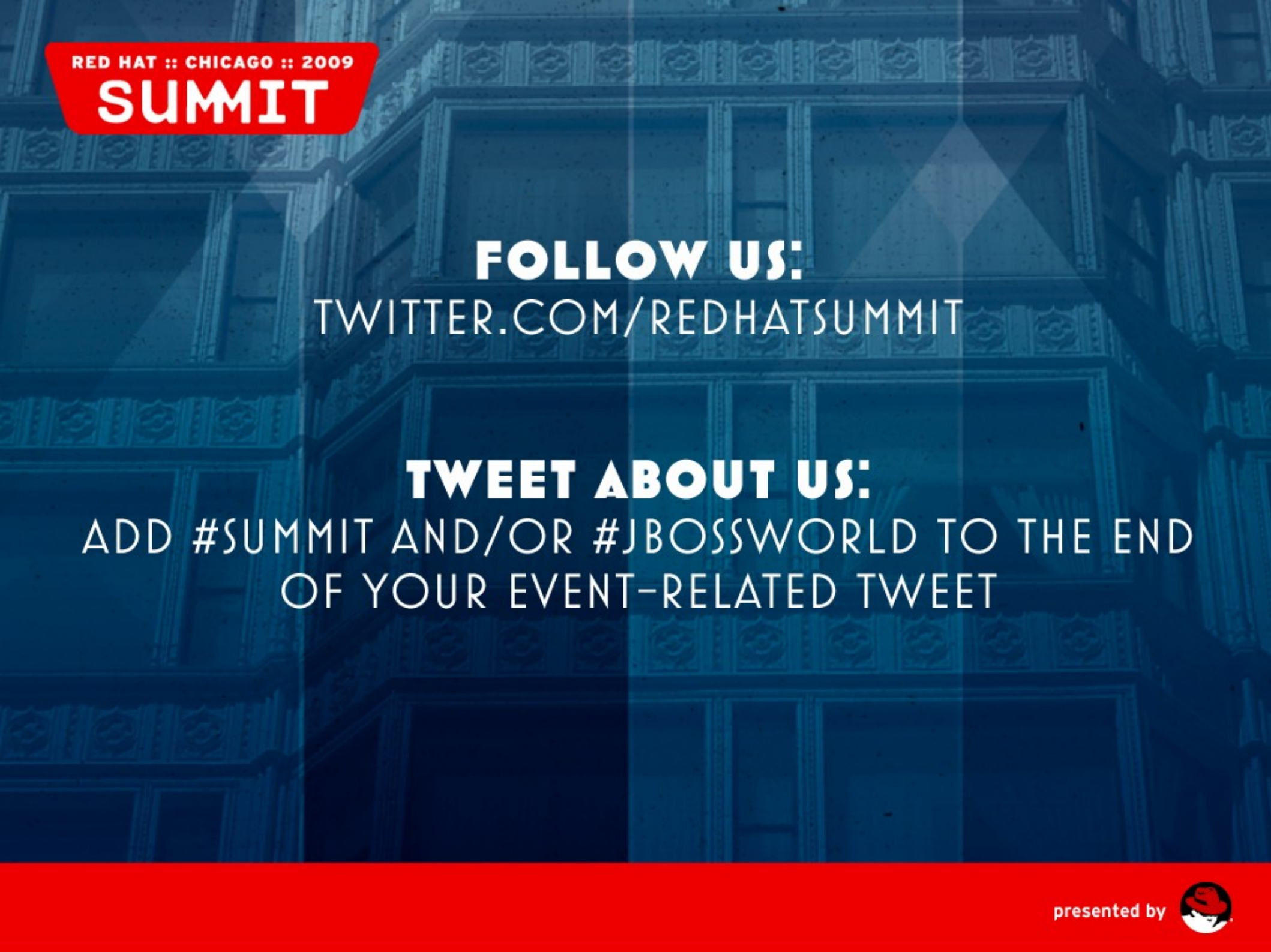
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