



Education

pNFS, parallel storage for grid and enterprise computing

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- pNFS, parallel storage for grid and enterprise computing
 - ◆ This session will appeal to Data Center Managers, Cluster/Grid/Compute Server administrators, and those that are seeking a fundamental understanding pNFS. This session will cover the four key reasons to start working with NFSv4 today. Explain why pNFS is a great parallel storage option for grids and enterprise computing, unlocking hidden potential in clustered storage. We'll conclude the session with an overview of the storage layouts for parallel NFS; NFSv4.1 Files, Blocks and T10 OSD Objects.

- Introduction to NFS
- NFS v4 – Security, High Availability, Internationalization and Performance (SHIP)
- NFSv4.1 – Status and Overview (pNFS)
- pNFS – Layout Overview
 - ◆ Files based access
 - ◆ Block based access
 - ◆ Object based access
- pNFS – OpenSource Client Status

➤ Network File System

- ◆ Protocol to make data stored on file servers available to any computer on a network
- ◆ NFS clients are included in all common Operating Systems, e.g. Linux, Solaris, AIX, Windows etc.....
- ◆ Application and OSI layers (remote procedure calls)

➤ NFS Server; Inspiration to NAS and appliances

- ◆ Commodity Operating Systems have NFS servers
- ◆ NAS Appliance – Control, Consistency and Cadence
- ◆ Vendors offer commodity hardware, w/ management software

NFSv4 SHIP is sailing

	Functional	Business Benefit
Security	<ul style="list-style-type: none"> ACLs for authorization Kerberos for authentication 	<ul style="list-style-type: none"> Compliance, improved access, storage efficiency
High availability	<ul style="list-style-type: none"> Client and server lease management with fail over 	<ul style="list-style-type: none"> High Availability, Operations simplicity, cost containment
International characters	<ul style="list-style-type: none"> Unicode support for utf8 characters 	<ul style="list-style-type: none"> Global file system for multi-national organizations
Performance	<ul style="list-style-type: none"> Multiple read, write, delete operations per RPC call Delegate locks, read and write procedures to clients 	<ul style="list-style-type: none"> Better network utilization for all NFS clients Leverage NFS client hardware for better I/O

Lower costs and increase productivity with NFSv4

NFSv4 - HA and Performance

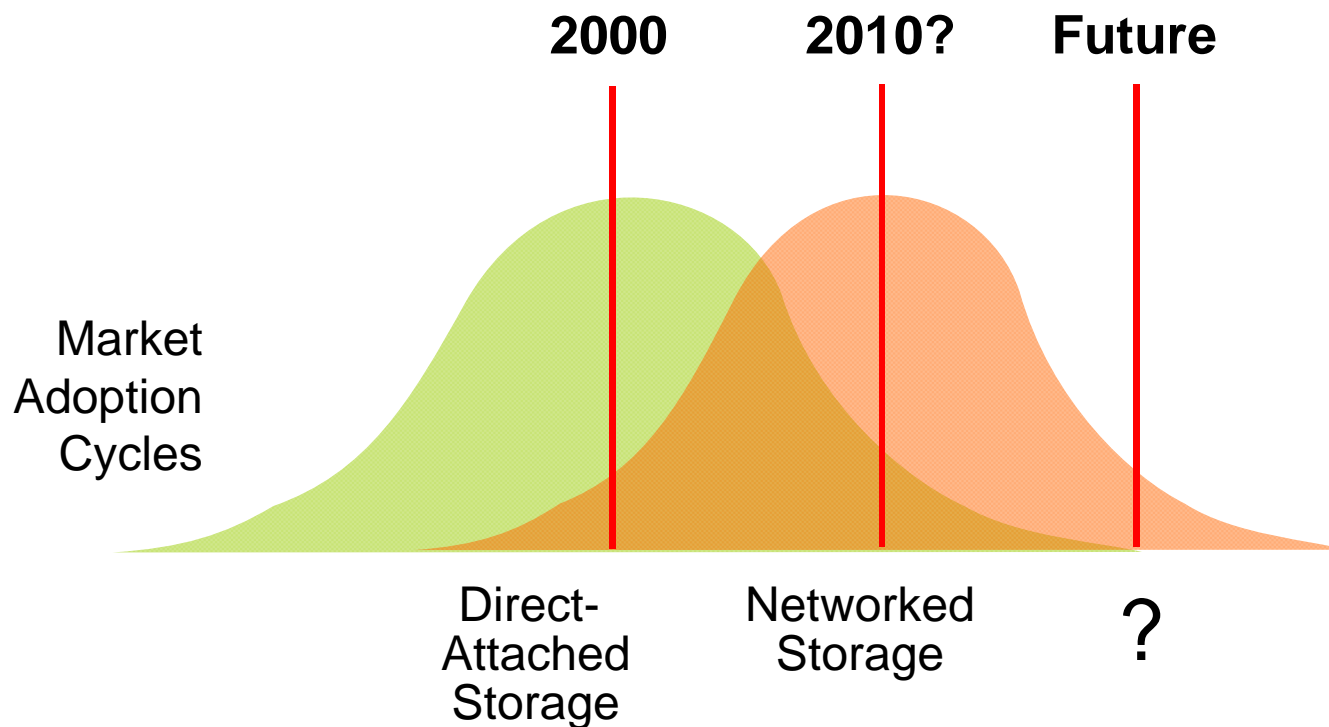
➤ High Availability via Leased Lock

- ◆ Client renews lease on server file lock @ n Seconds
- ◆ Client fails, lock is not renewed, server releases lock
- ◆ Server fails, on reboot all files locked for n Seconds
 - Gives clients an n Second grace period to reclaim locks

➤ Performance via Delegations

- ◆ File Delegations allow client workloads for single writer and multiple reader
- ◆ Clients can perform all reads/writes in local client cache
- ◆ Delegations are leased and must be renewed
- ◆ Delegations reduce lease lock renewal traffic

The Evolution of Storage



Evolving Requirements

- Economic Trends
 - ◆ Cheap and fast computing clusters
 - ◆ Cheap and fast network (GigE to 10GigE)
- Performance
 - ◆ Exposes single threaded bottlenecks in applications
 - ◆ Evolution of computing models
 - ◆ Reduced time to market, Response Time
 - ◆ Competitive edge or IOPS
- Powerful compute systems
 - ◆ more data at exponential rates

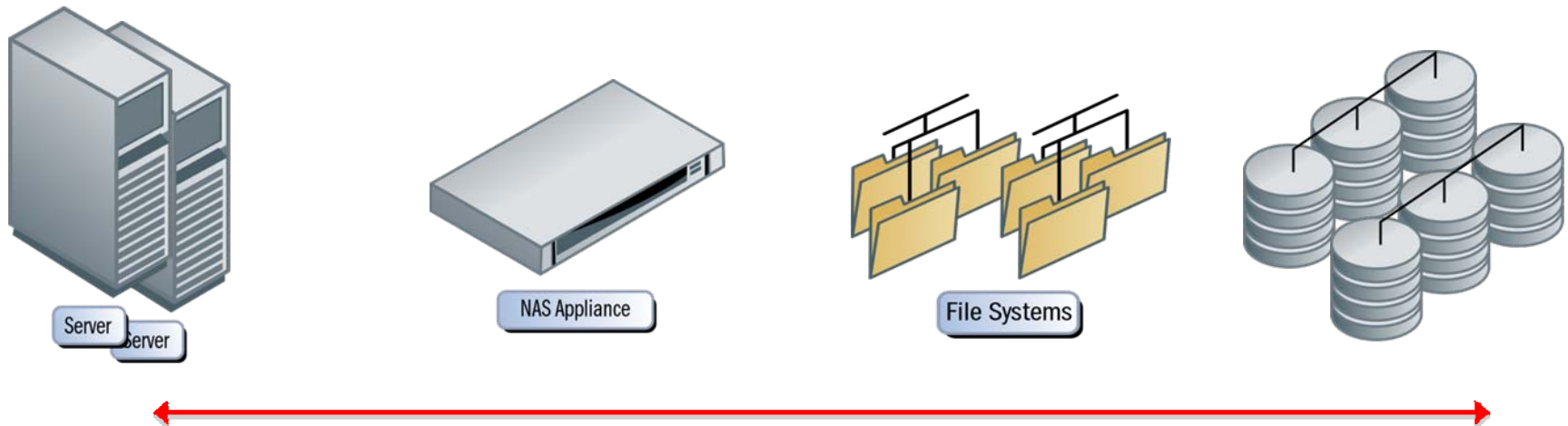
NFS – What’s the problem?

➤ In-band data access model

- ◆ Easy to build, Limited in scale
- ◆ Well-defined failure modes
- ◆ Limited load balancing options

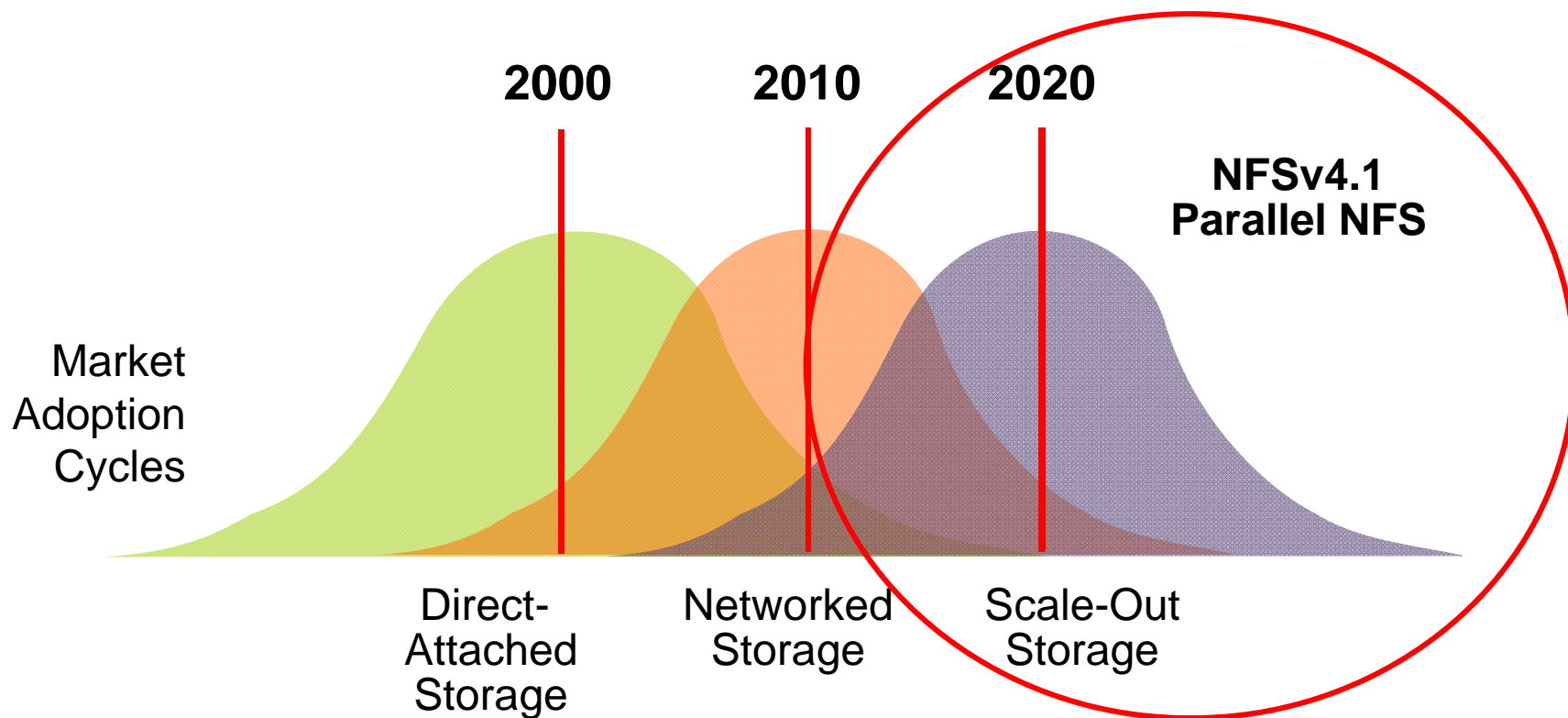
➤ Results in Limitations

- ◆ Islands of storage
- ◆ Server and Appliance HW
- ◆ Networking and I/O



- Random I/O and Metadata intensive workloads
 - ◆ Memory and CPU are hot spots
 - ◆ Load balancing limited to pair of NFS heads
 - ◆ Limited to dual-head configuration
- Compute farms are growing larger in size
 - ◆ NFS head can handle a 1000+ NFS clients
 - ◆ NFS head hardware comparable to client CPU, I/O, Memory
 - ◆ NFS head requires more spindles to distribute the I/O
- Reliability and availability are challenging
 - ◆ Data striping limited to single head and disks
 - ◆ Non-disruptive upgrades affect dual-head configurations
 - ◆ Access and load balancing are typically limited to a pair of NFS server heads

What is the Solution?



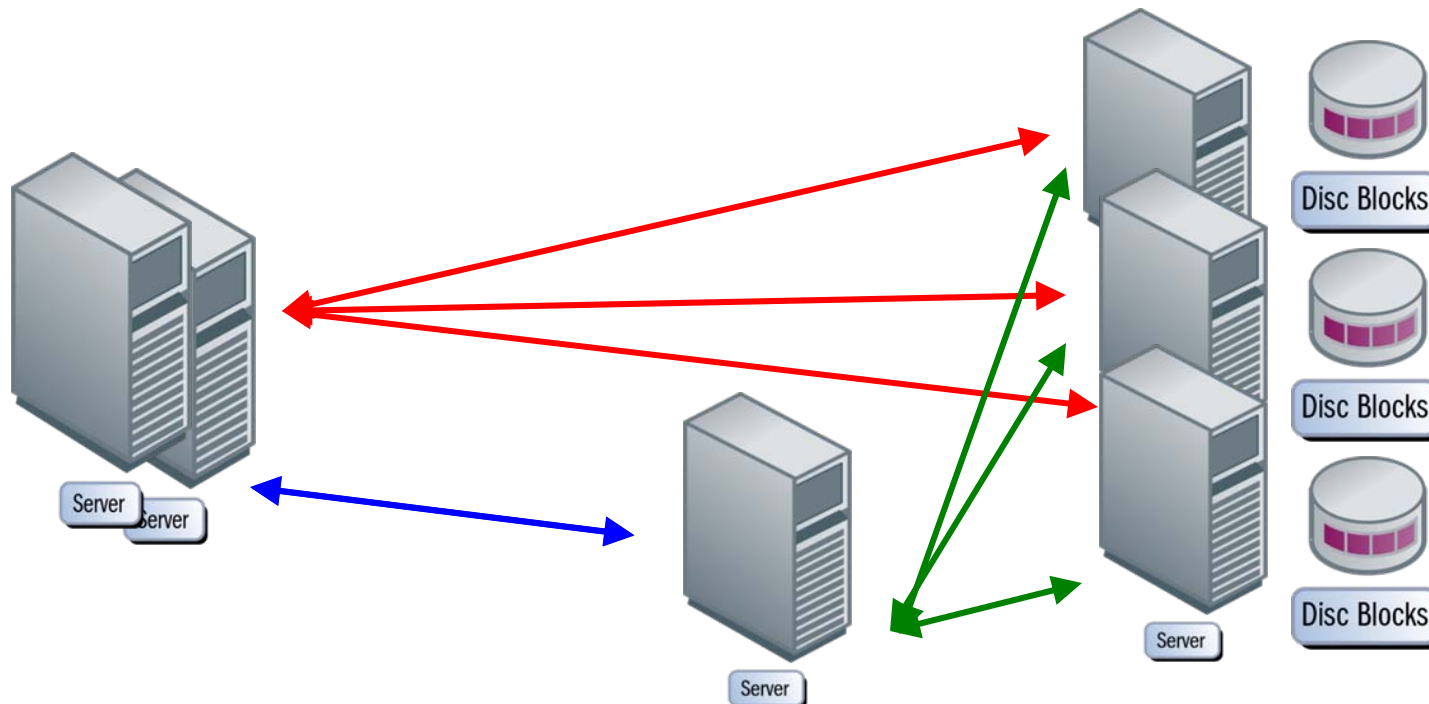
NFSv4.1 – Parallel Data Storage

➤ NFSv4.1 – Three Storage Types

- ◆ Files – NFSv4.1
- ◆ Blocks – SCSI
- ◆ Objects – OSD T10

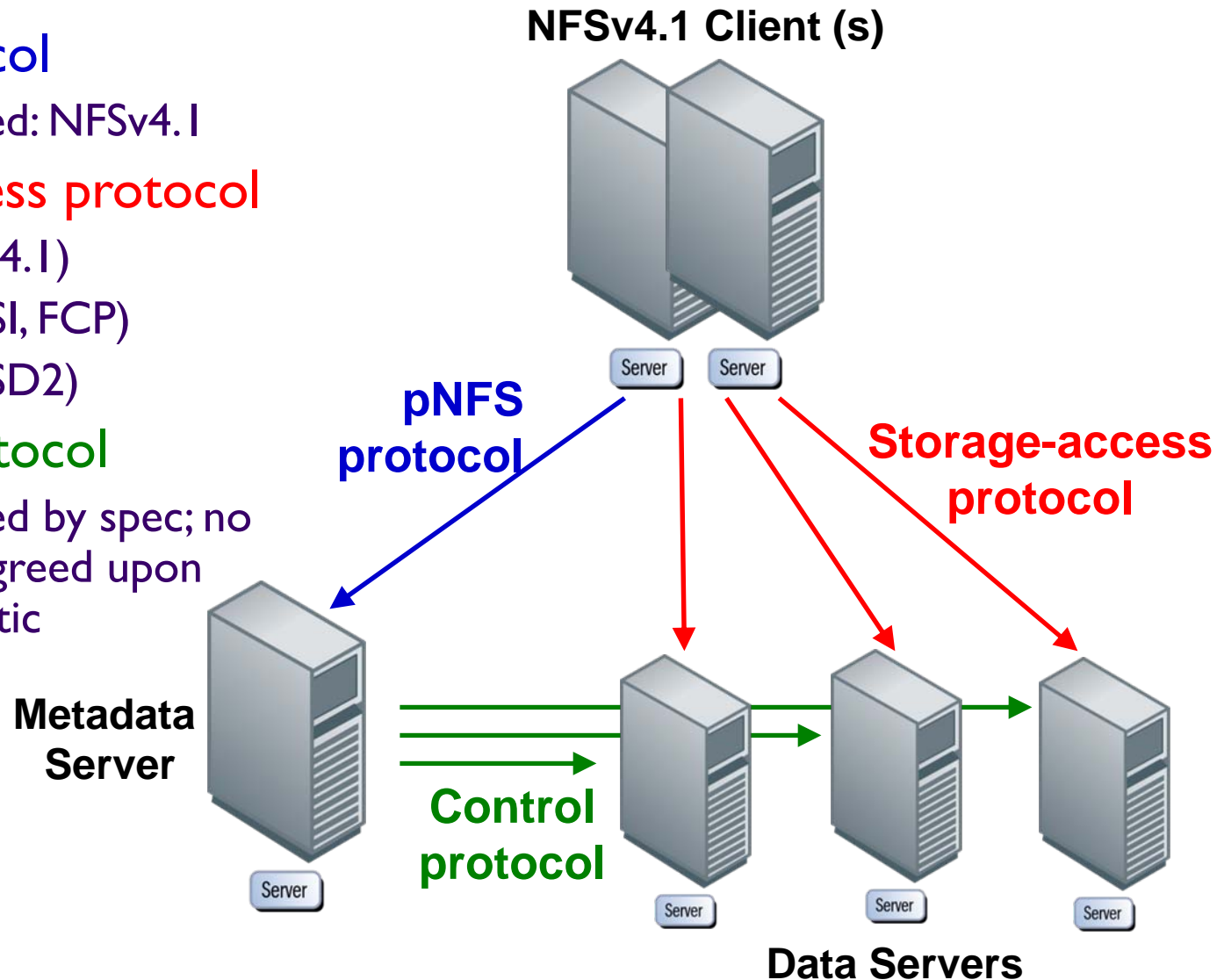
➤ Results in Improvements

- ◆ Global Name Space
- ◆ Head and Storage scaling
- ◆ Non disruptive upgrades while maintaining performance



NFSv4.1 - Parallel NFS 101

- **pNFS protocol**
 - ◆ Standardized: NFSv4.1
- **Storage-access protocol**
 - ◆ Files (NFSv4.1)
 - ◆ Block (iSCSI, FCP)
 - ◆ Object (OSD2)
- **Control protocol**
 - ◆ Not covered by spec; no generally agreed upon characteristic



NFSv4.1 – Status and Overview

- 2004 – CMU, NetApp and Panasas draft pNFS problem and requirement statements
- 2005 – CITI, EMC, NetApp and Panasas draft pNFS extensions to NFS
- 2005 – NetApp and Sun demonstrate pNFS at Connectathon
- 2005 – pNFS added to NFSv4.1 draft
- 2006 - 2008 – specification baked
 - ◆ Bake/Connect a thons; 29 iterations of NFSv4.1/pNFS spec
- 2008 – NFSv4.1/pNFS reaches IETF Approval (December)

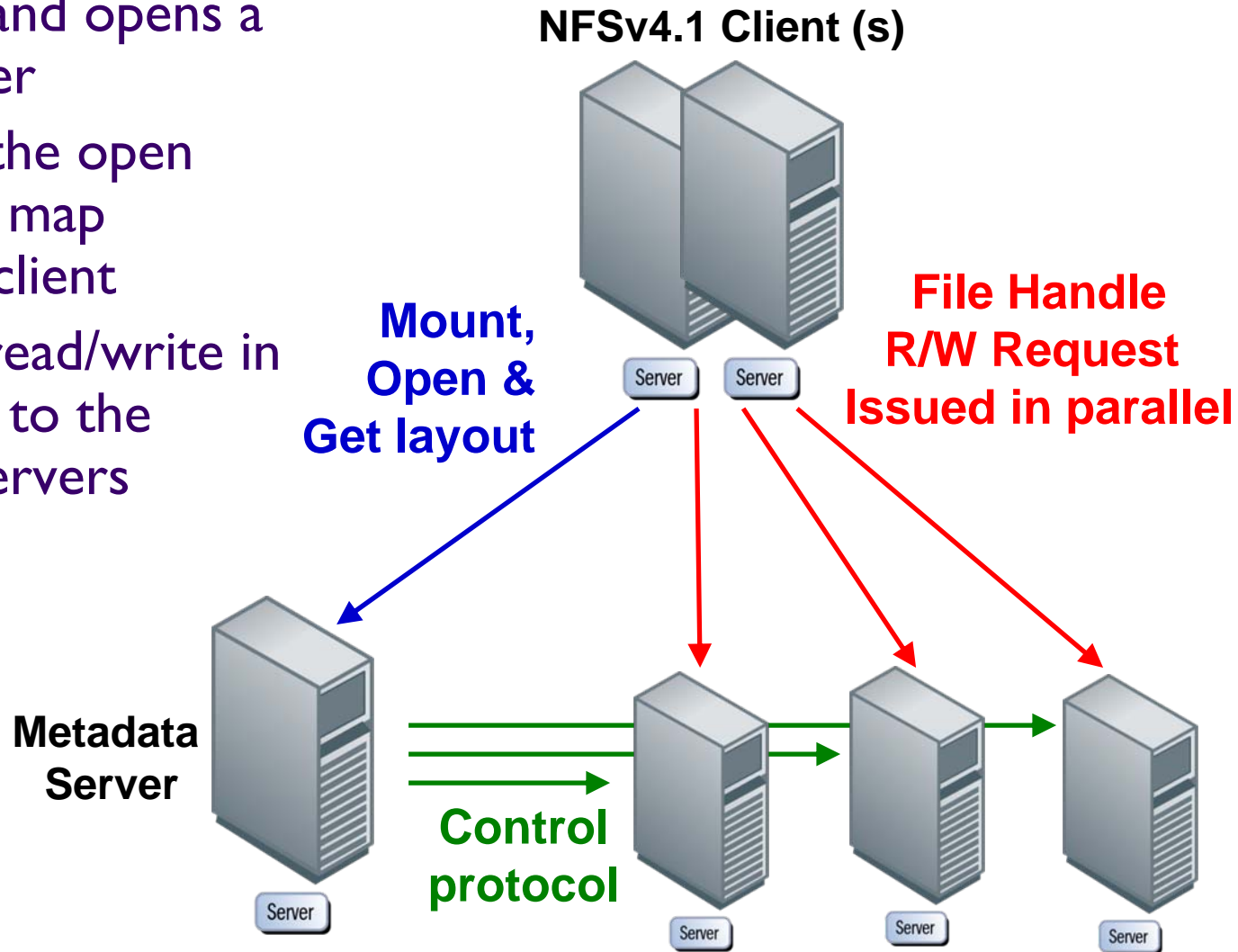
pNFS Standards Status

- NFSv4.1/pNFS were standardized at IETF
 - ◆ NFSv4 working group (WG)
- All done except for RFCs:
 - ◆ WG last call (DONE)
 - ◆ Area Director review (DONE)
 - ◆ IETF last call (DONE)
 - ◆ IESG approval for publication (DONE)
 - ◆ IANA review (TBD)
 - ◆ RFC publication (Expected 2009)
- Will consist of several documents:
 - ◆ NFSv4.1/pNFS/file layout
 - ◆ NFSv4.1 protocol description for IDL (rpcgen) compiler
 - ◆ blocks layout
 - ◆ objects layout
 - ◆ netid specification for transport protocol independence (IPv4, IPv6, RDMA)

- LAYOUTGET
 - ◆ Obtains the data server map from the meta-data server
- LAYOUTCOMMIT
 - ◆ Servers commit the layout and update the meta-data maps
- LAYOUTRETURN
 - ◆ Returns the layout; Or the new layout, if the data is modified
- GETDEVICEINFO
 - ◆ Client gets updated information on a data server in the storage cluster
- GETDEVICELIST
 - ◆ Clients requests the list of all data servers participating in the storage cluster
- CB_LAYOUT
 - ◆ Server recalls the data layout from a client; if conflicts are detected

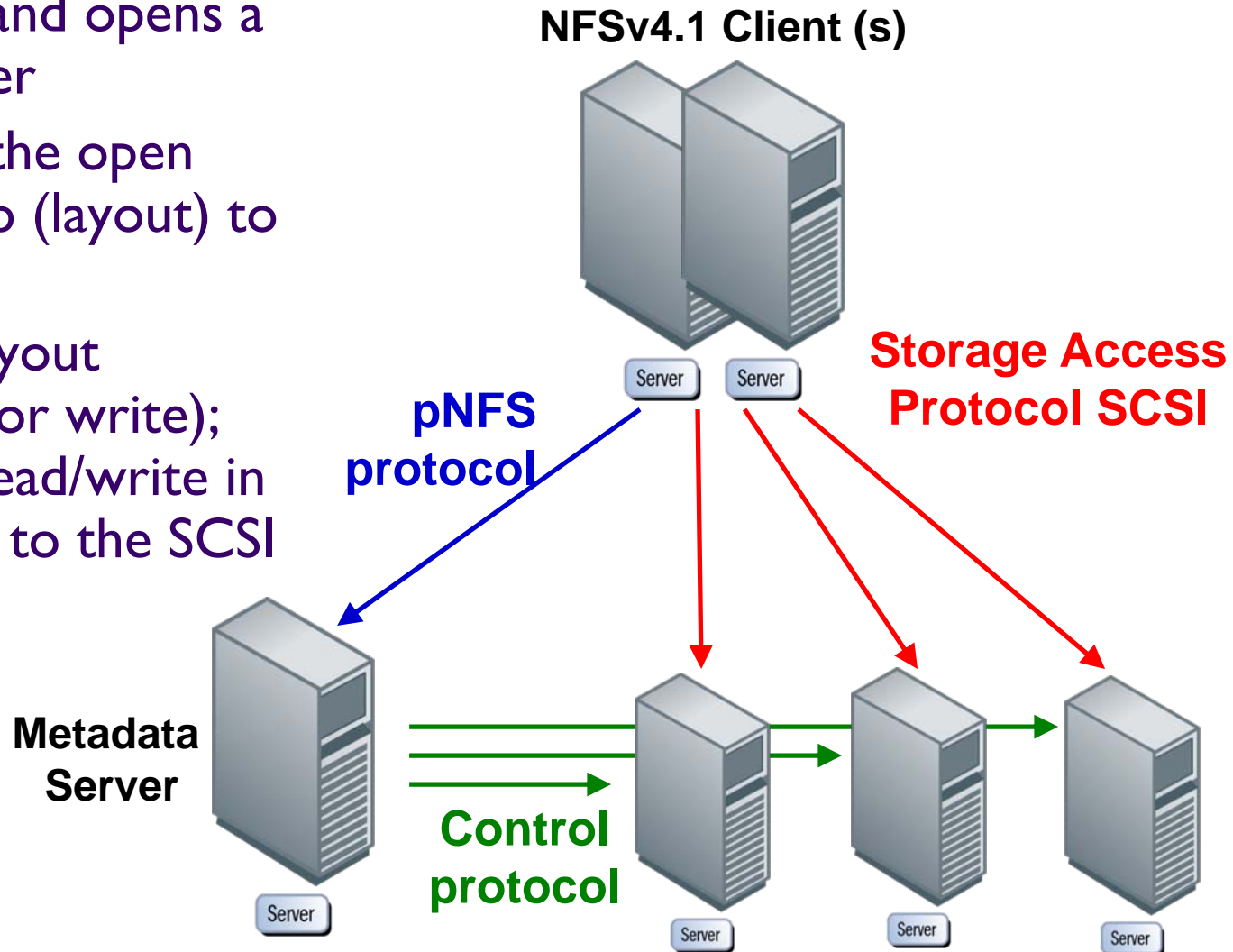
pNFS – NFSv4.1 files access

- Client mounts and opens a file on the server
- Servers grants the open and a file stripe map (layout) to the client
- The client can read/write in parallel directly to the NFSv4.1 data servers



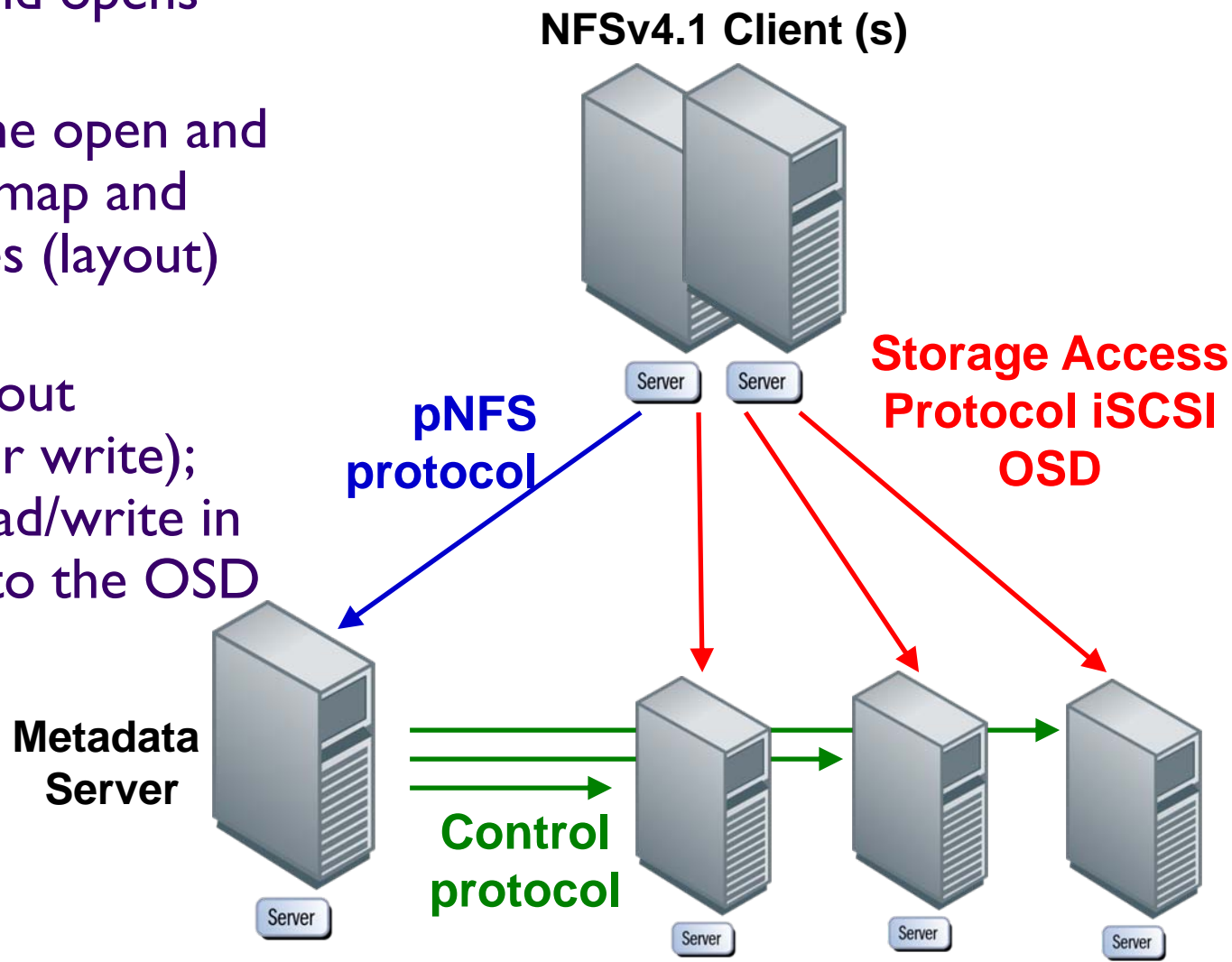
pNFS Blocks Access Model

- Client mounts and opens a file on the server
- Servers grants the open and a block map (layout) to the client
- Based on the layout obtained (read or write); the client can read/write in parallel directly to the SCSI target's



pNFS Objects Access Model

- Client mounts and opens Object
- Servers grants the open and an object stripe map and object capabilities (layout) to the client
- Based on the layout obtained (read or write); the client can read/write in parallel directly to the OSD targets



NFSv4.1 – OpenSource Client Status

➤ Client and Server

- ◆ Support files (NFSv4.1)
- ◆ Support in progress blocks (SCSI), objects (OSD T10)
- ◆ Client consists of generic pNFS client and “plug ins” for “layout drivers”

➤ Predicted timeline:

- ◆ Basic NFSv4.1 features 1H2009
- ◆ NFSv4.1 pNFS and layout drivers by 2H2009
- ◆ Linux distributions shipping supported pNFS in 2010

- Please send any questions or comments on this presentation to SNIA: tracknetworking@snia.org

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- SNIA Education Committee

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