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--enable-gss

Strong authentication in Lustre&friends

Daniel Kobras

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IT-Dienstleistungen und Software für anspruchsvolle Rechnernetze

Tübingen | München | Berlin | Düsseldorf

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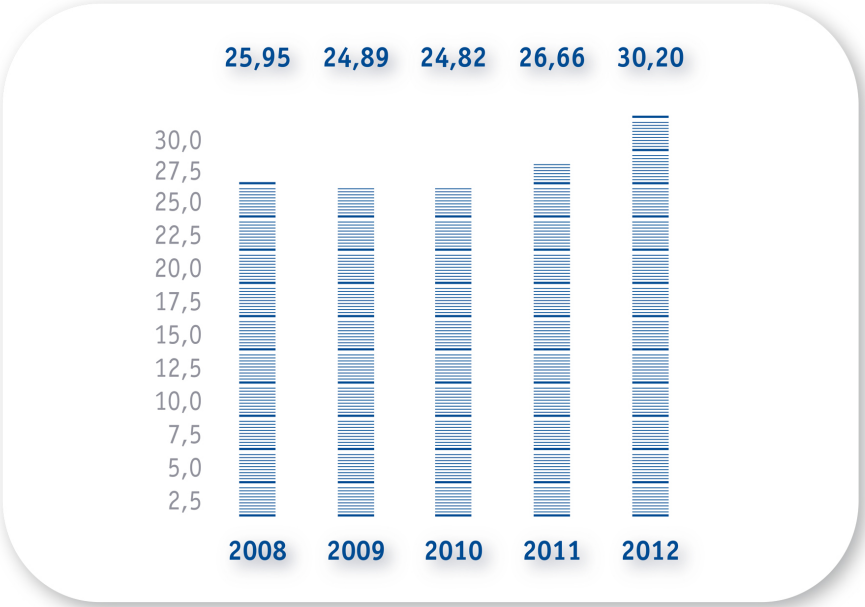
Founded in	**1989**
Offices	**Tuebingen**
	Munich
	Duesseldorf
	Berlin
Employees	**275**
Shareholder	**Bull S.A. (100%)**
Turnover 2012	**30.2 Mio. EUR**



Portfolio

IT Service for complex computing environments
Complete solutions for Linux- and Windows-based **HPC**

scVENUS System management software for efficient administration of homogeneous and heterogeneous environments

Outline

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Practical look at current status of Lustre with GSS feature from an admin perspective:

- Why bother?
- What is it good for?
- Is it any good?

Authentication in Lustre

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- User authentication
  - **`Null`** authentication by default
  - MDS **trusts** uid sent by **client**
  - Root access on any Lustre client means full access to all data in filesystem
- Client authentication
  - Anything that can reach port 988 is allowed as a client
  - Firewalls can impose access restrictions
  - Still, full access is only an IP address away
- Security on par with NFSv3 and earlier
- Since Lustre 2.0: compile time option **`--enable-gss`** for increased filesystem security with **Generic Security Service** (GSS)

Why secure your (Lustre) filesystems?

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- Because there's always someone to hide your data from (students, competitors, „Chinese hackers“, NSA, ...)
- Because stolen data makes you lose money, reputation, or a court case
- Because secure infrastructure keeps admins happy

… and also allows more options in hardware/network configuration

Configuration example without GSS

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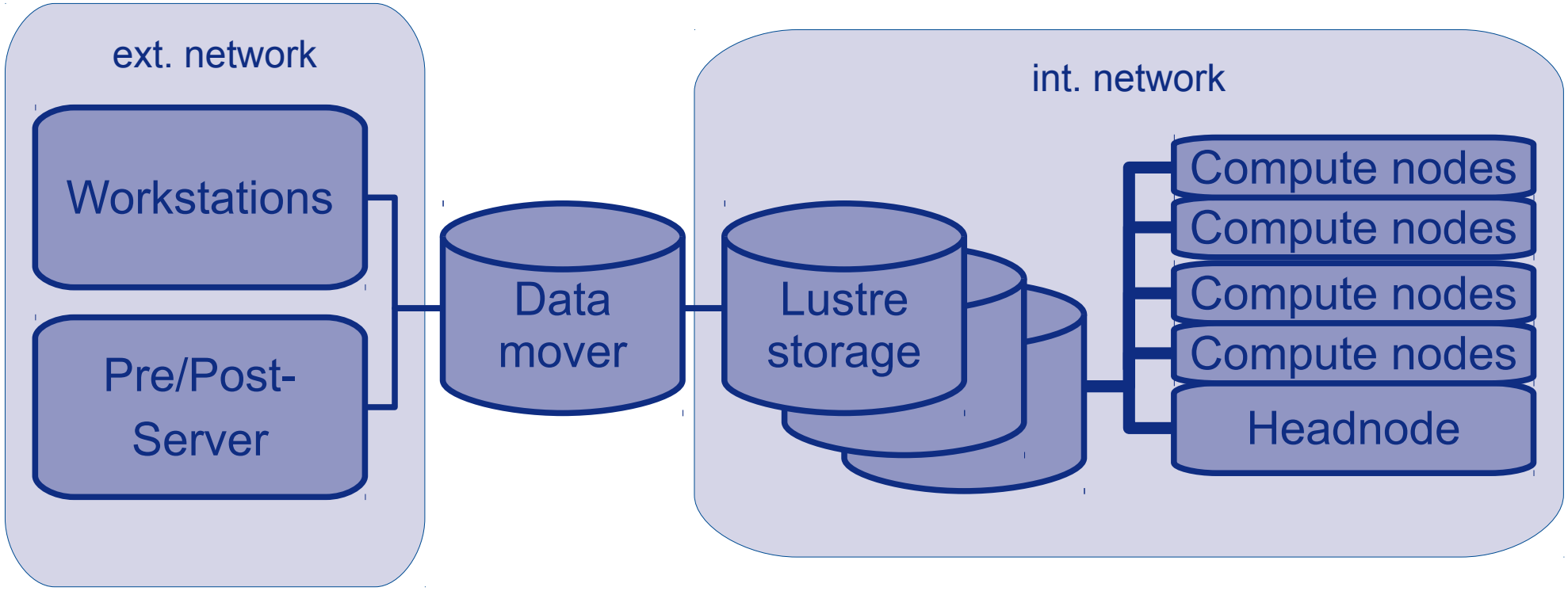

Insecure filesystems limited to secure(TM) environments (eg. Cluster-internal network)

Configuration example without GSS

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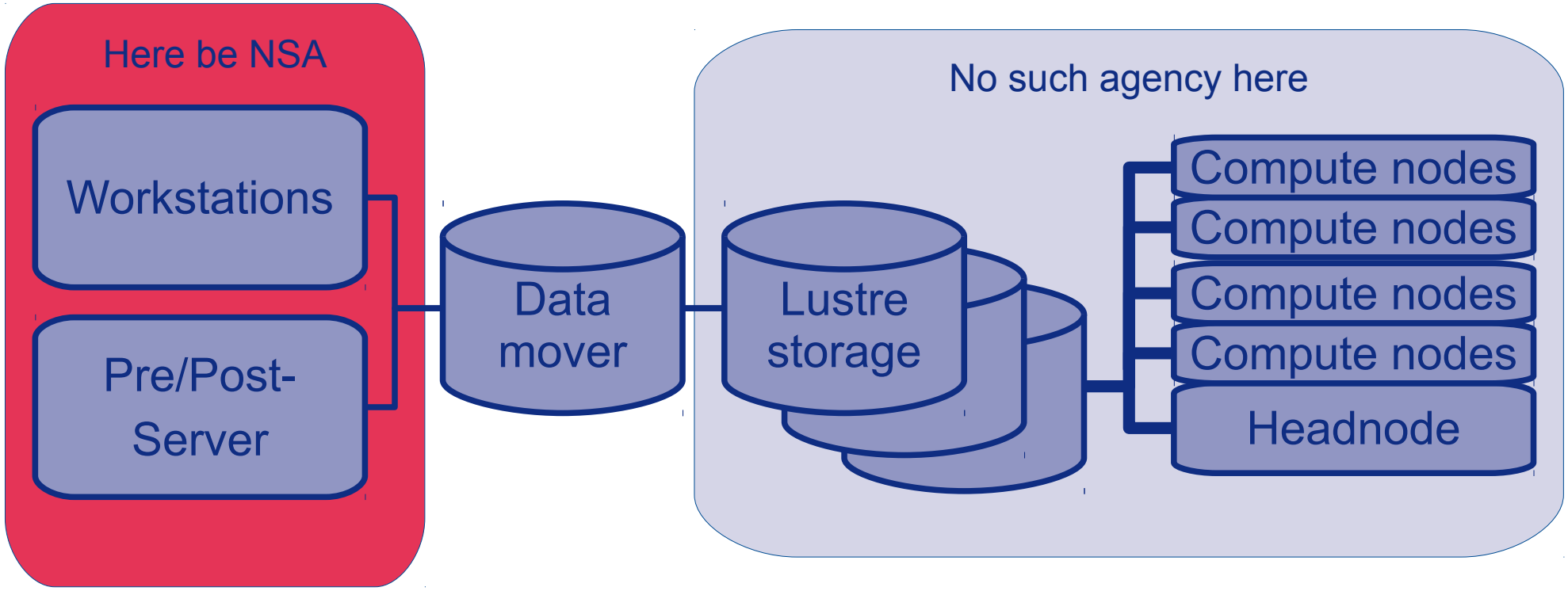

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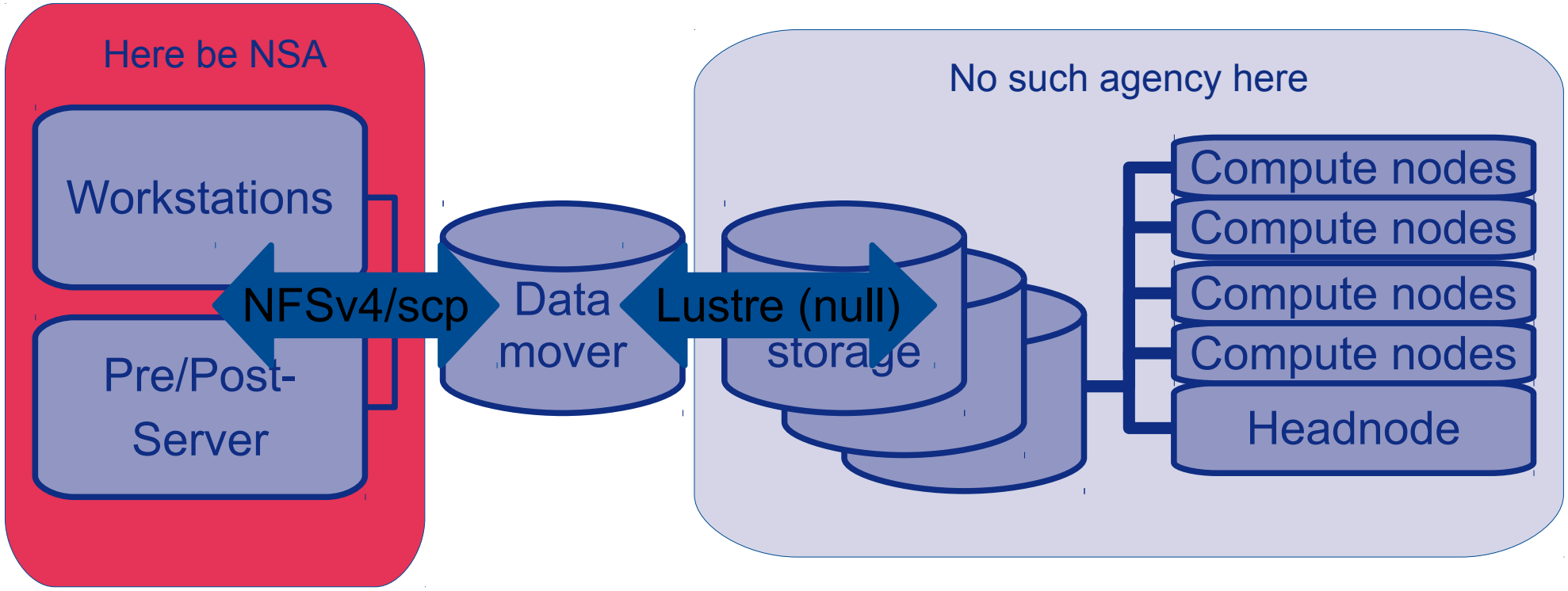

Outside access requires data copies or transition to different access protocol (NFS, CIFS)

Configuration example with GSS

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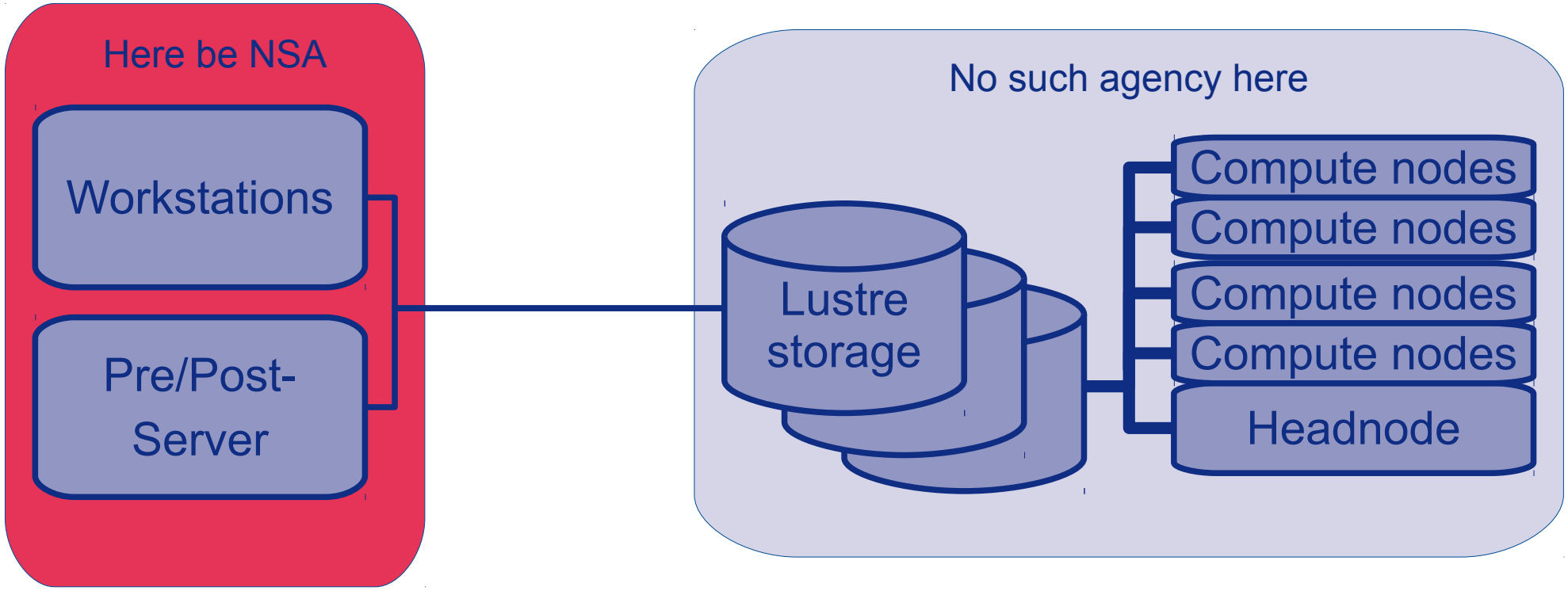
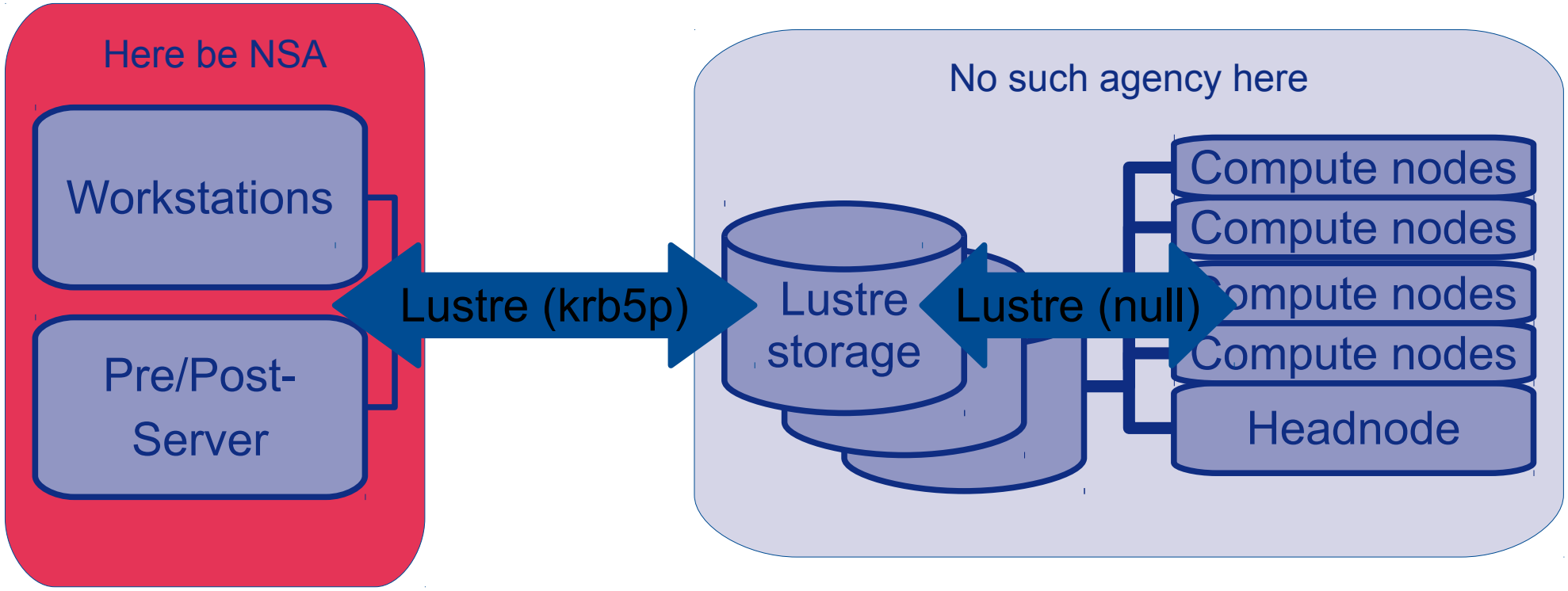


Configuration example with GSS



If desired, overhead can be avoided if filesystem allows secure access via untusted networks (WAN, campus, outside datacenter)

Why GSS/Kerberos in filesystems?

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- Secure communication needs to provide **privacy**, **integrity**, strong **authentication**
- Two major options
    - SSL/TLS – based on certificates/passphrases
    - Kerberos – (usually) based on shared secrets (passwords/keys)
- Passwords don't require persistent storage
  → common network filesystems (NFS, CIFS, AFS, Lustre) use Kerberos authentication
- Kerberos protocol standard, but different implementations use different APIs
- Standard GSSAPI providing Kerberos (and other) authentication systems (initial RFC 1508 published Sept. 1993)

Kerberos in a nutshell

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- Kerberos authentication service issues **tickets** as **short-lived** identification credentials for specific services
- Kerberization: Services outsource authentication to KDC as **trusted third party**
- KDC itself can be kerberized to provide **Single Sign-On** (identify with TGT instead of password)

- Kerberos authenticates users and services (**principals**)
- Kerberos can provide **mutual authentication** between communication endpoints
- Kerberos protocol **never sends passwords** across the wire (not even encrypted)
- Kerberos needs sane DNS and synchronized clocks

Headaches with kerberized filesystems

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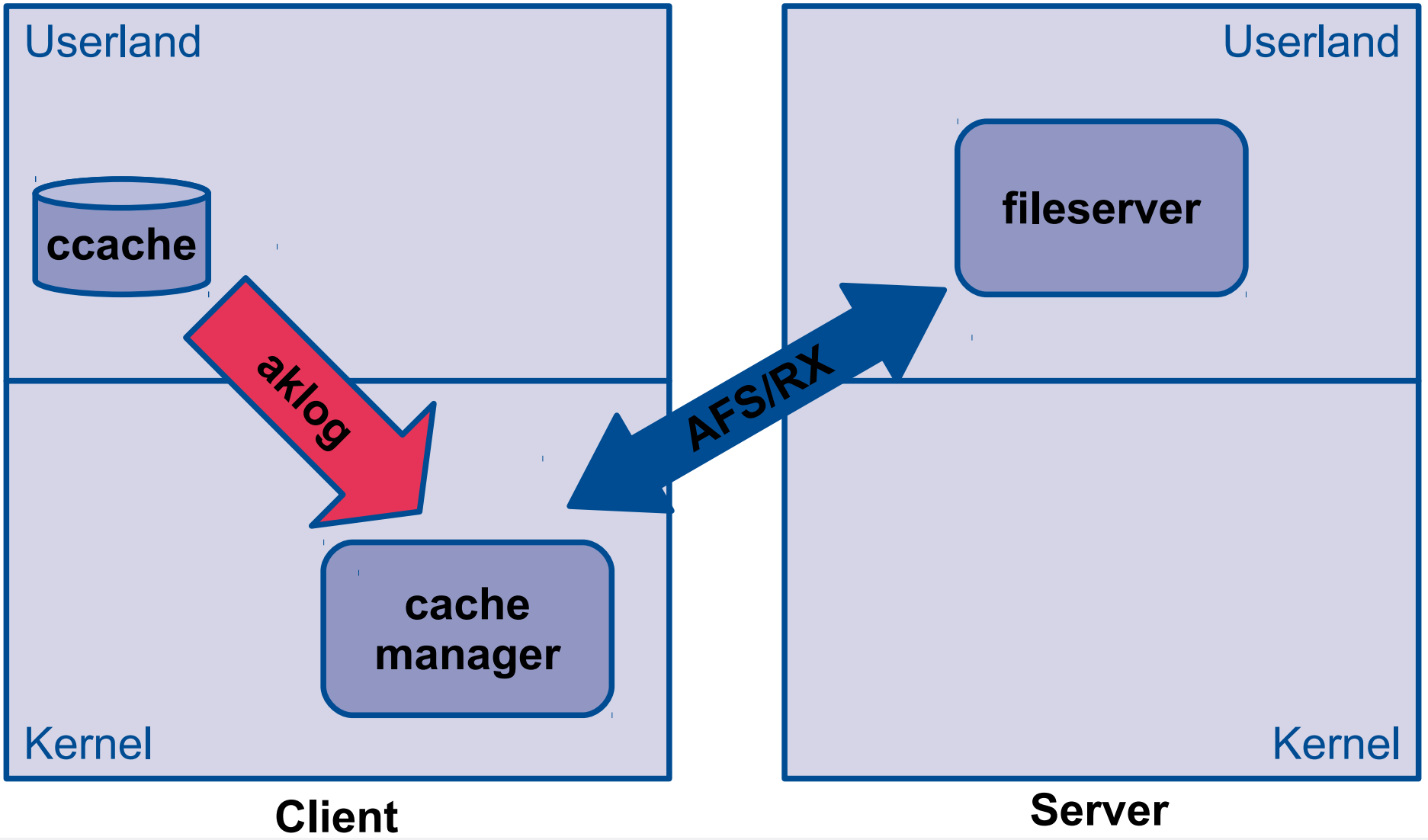
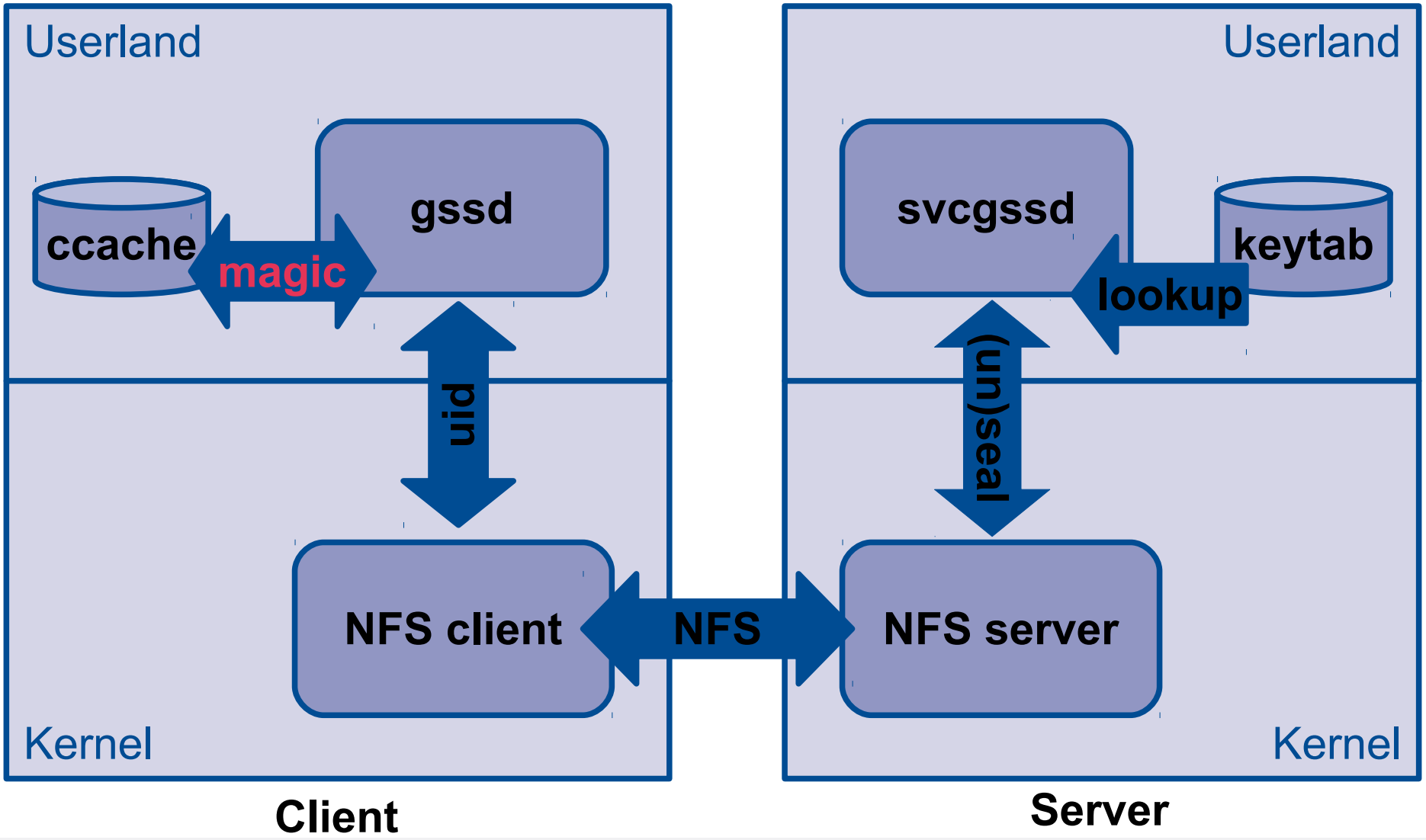
- Initial setup well documented (required principals, keytab creation, configuration options, etc.)
- Flow of credentials usually isn't – but that's where admins have to look when debugging:
    - Filesystem clients live in kernel space
    - Kerberos lives in user space
    - Kerberized filesystem client needs access to Kerberos credentials of calling user
    - Solutions:
        - Require user to push credentials into filesystem
        - Implement dedicated upcalls and lookup heuristic to automagically match uid with credentials cache
        - Use kernel keyring infrastructure with generic upcall dispatcher

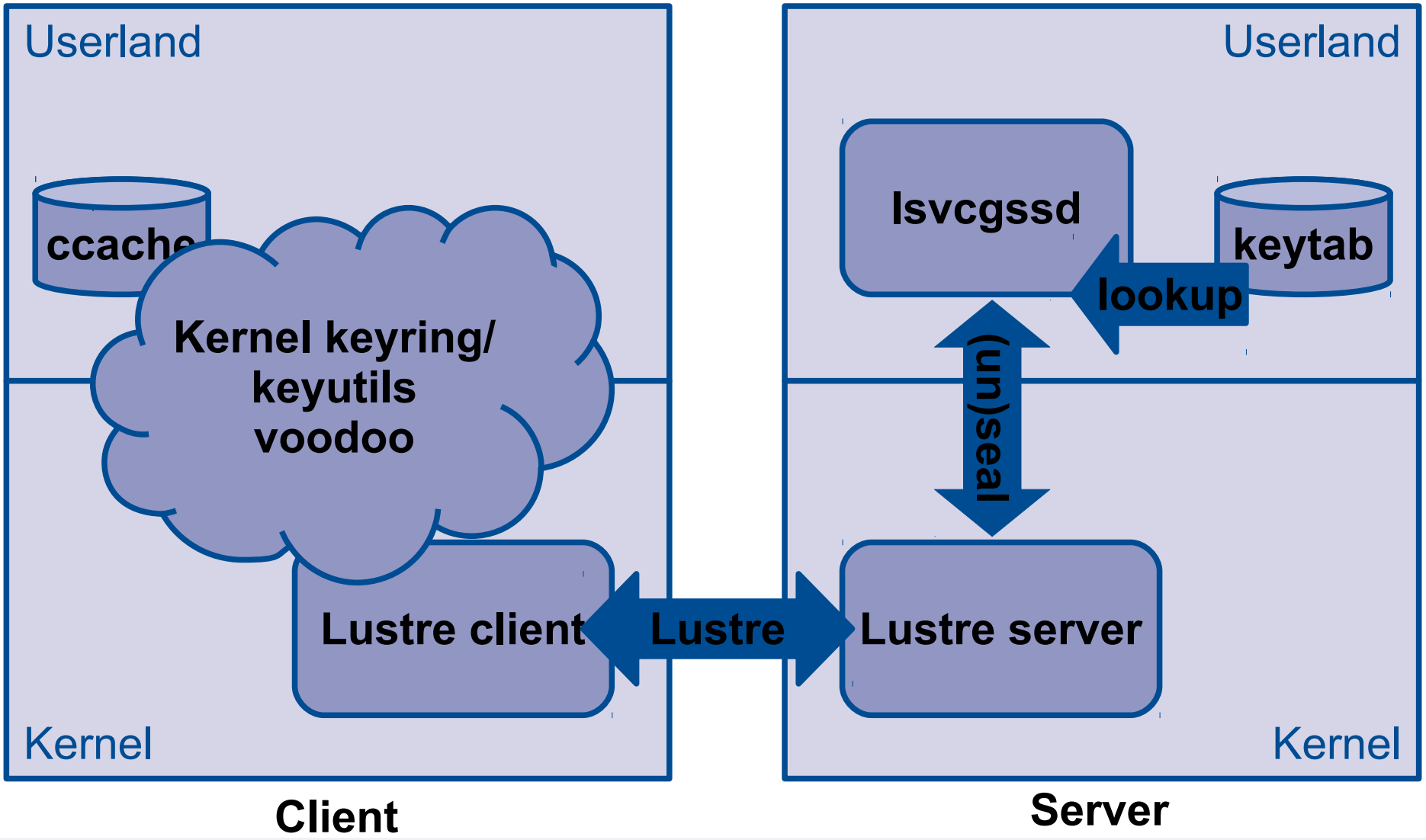
Credential passing: AFS



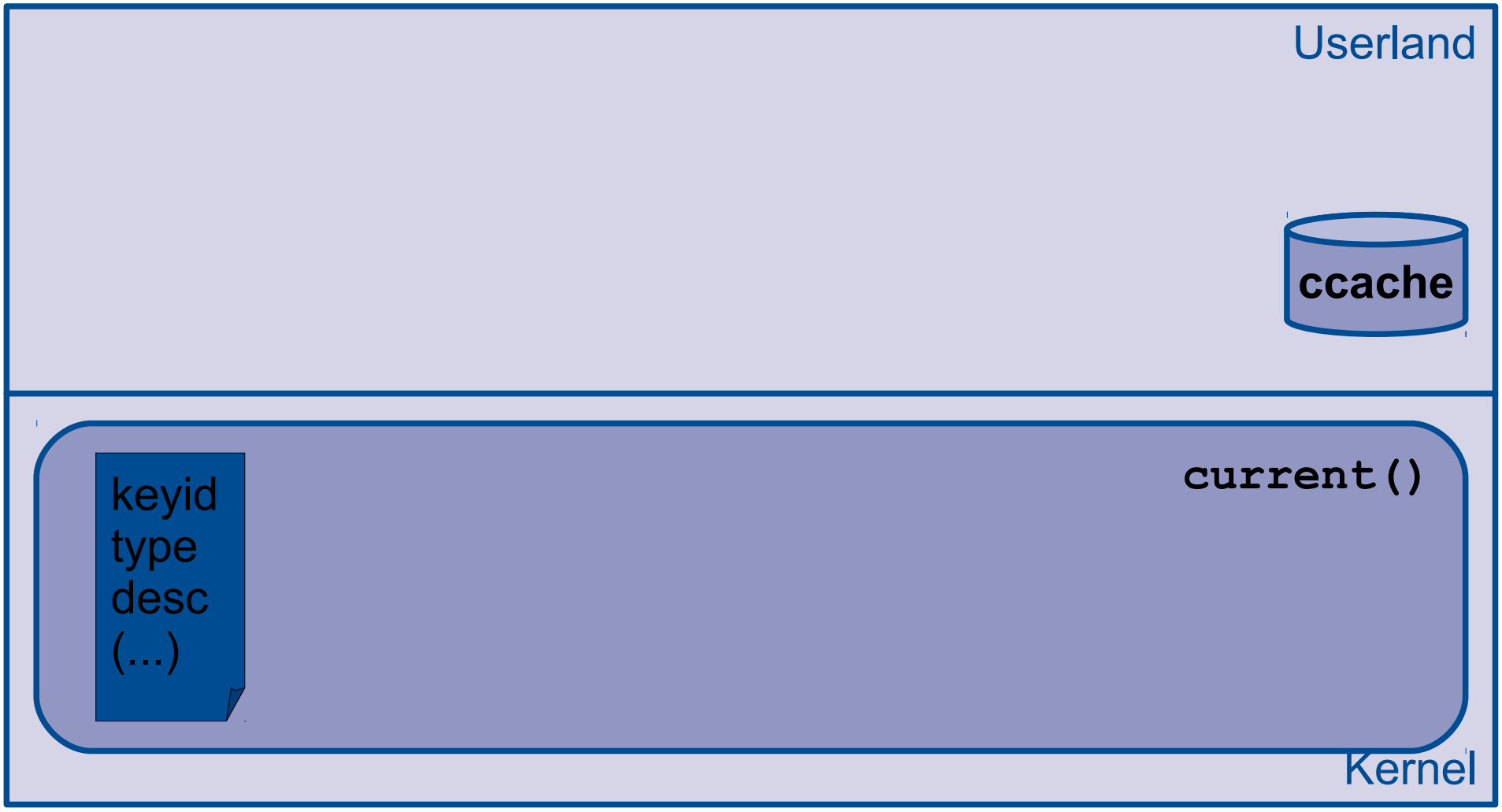
Credential passing: NFSv4



Credential passing: Lustre

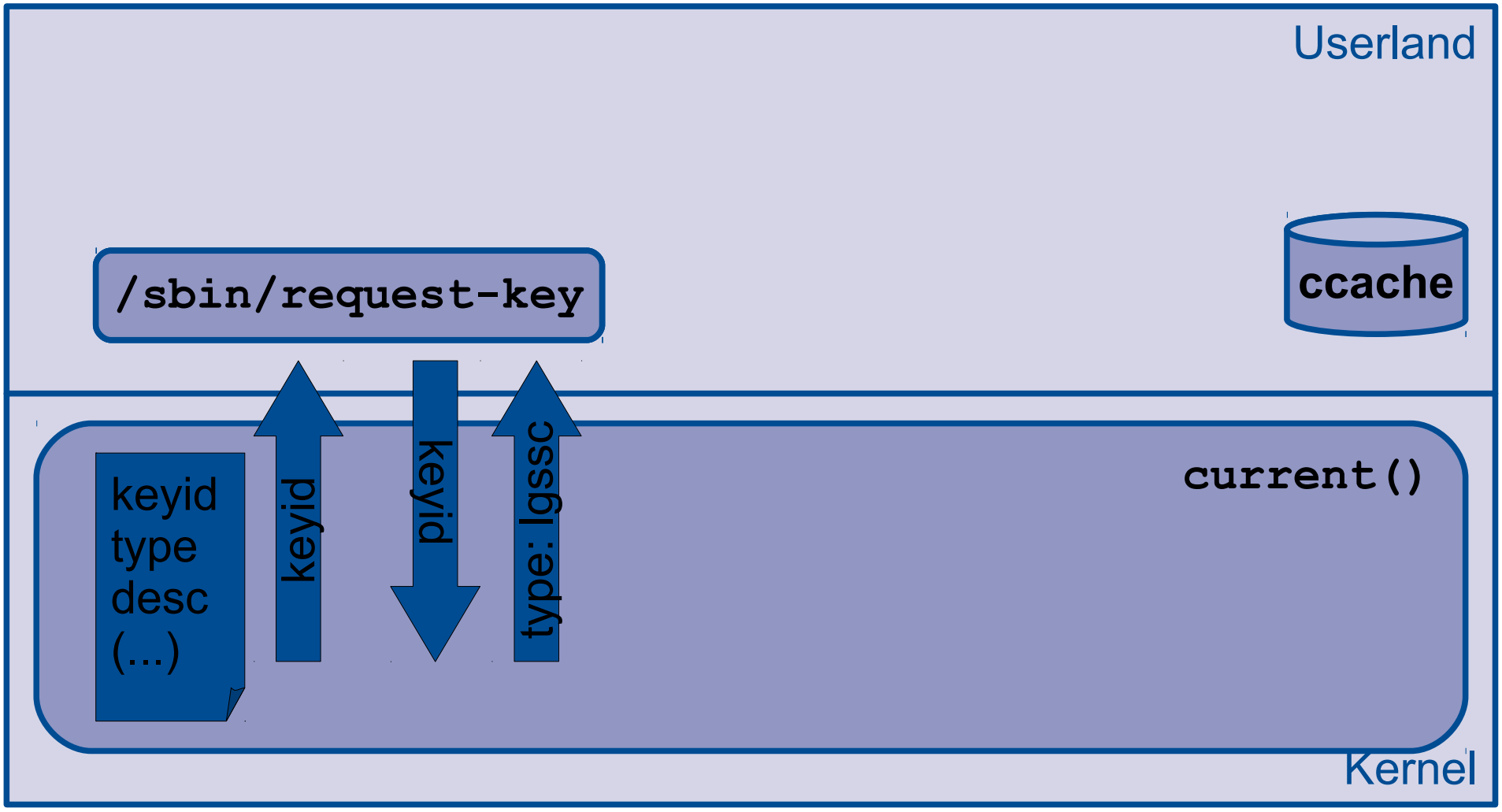


Credential passing: Lustre



Client

Credential passing: Lustre



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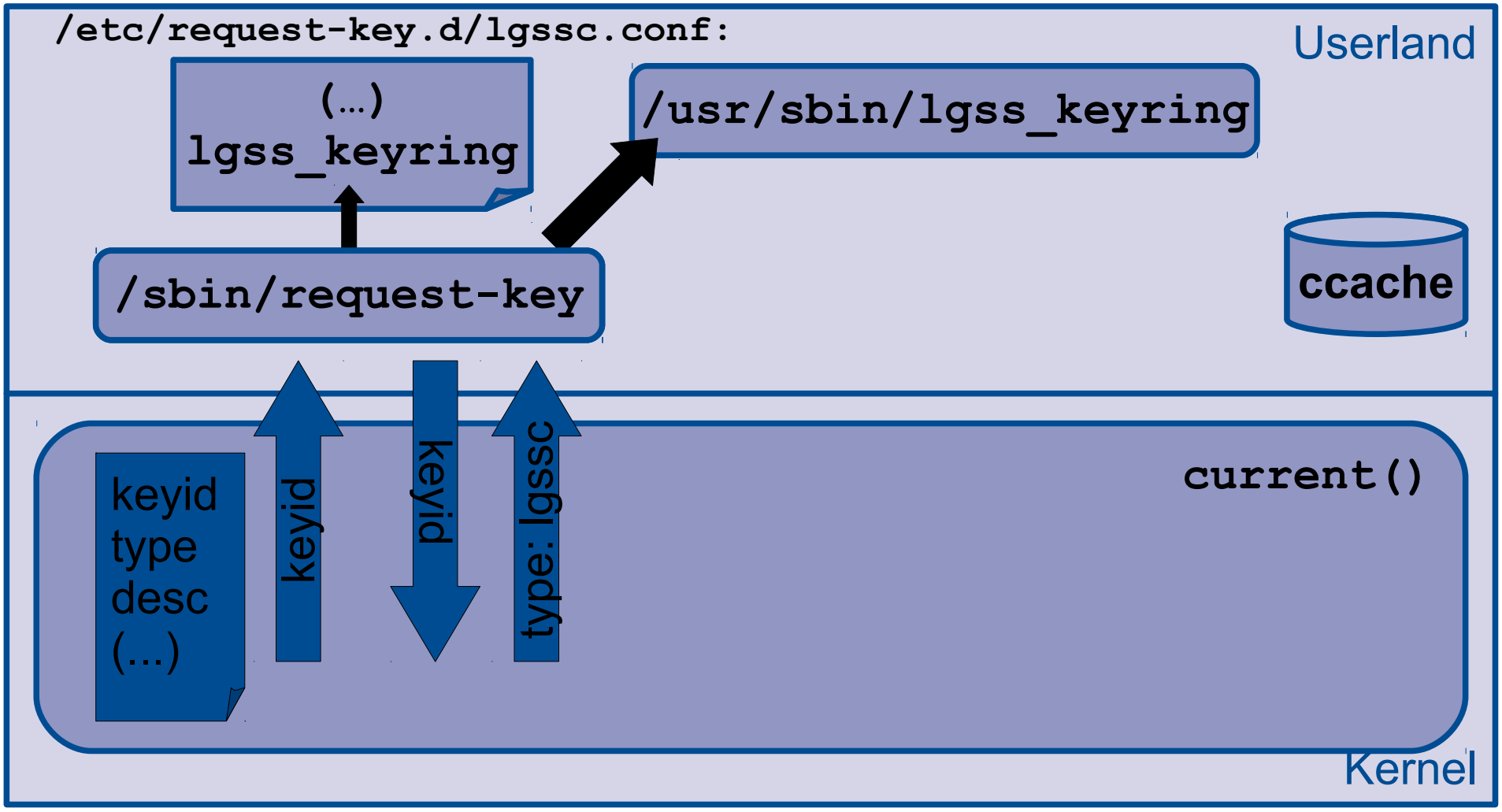
Credential passing: Lustre



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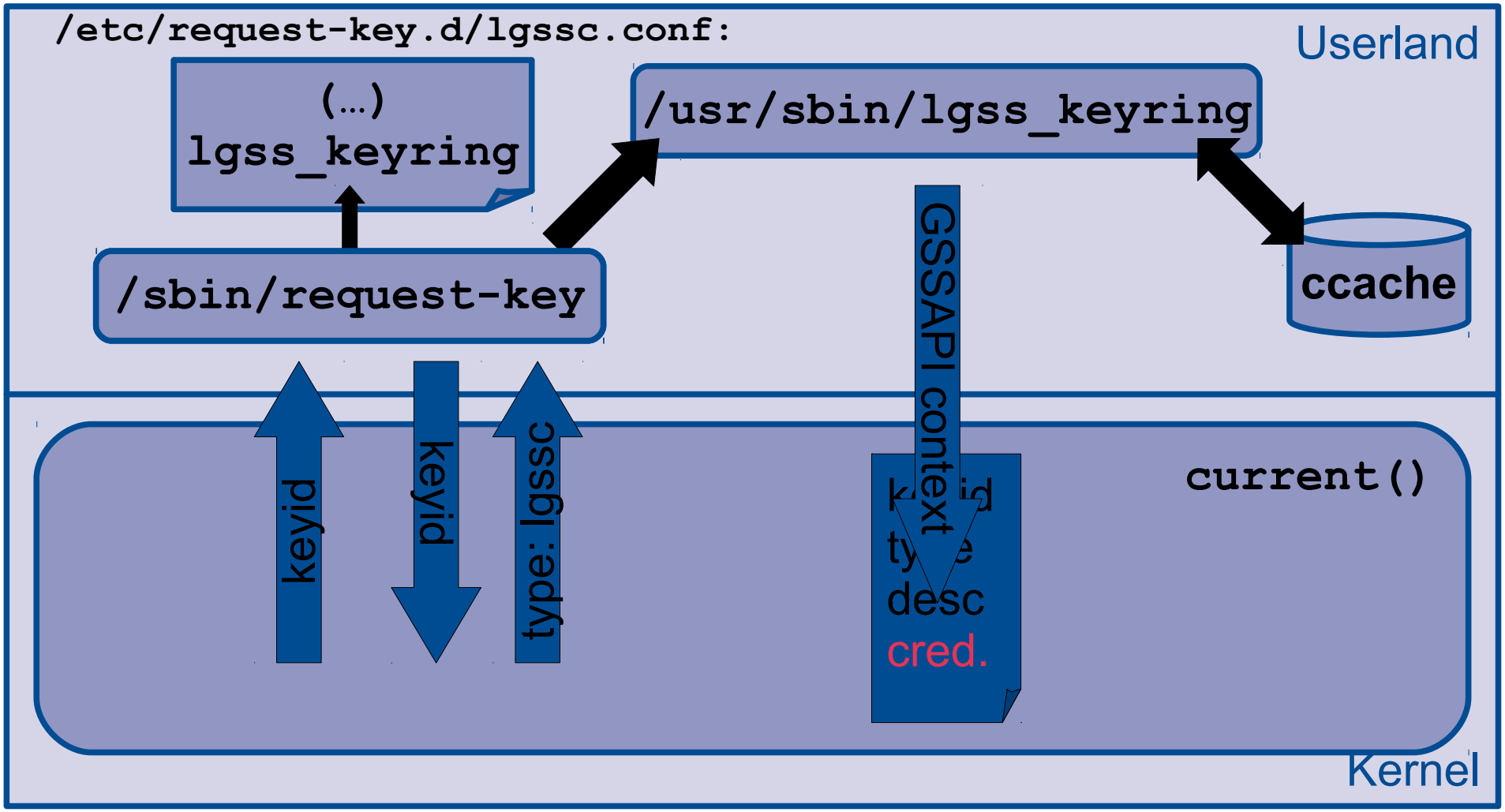
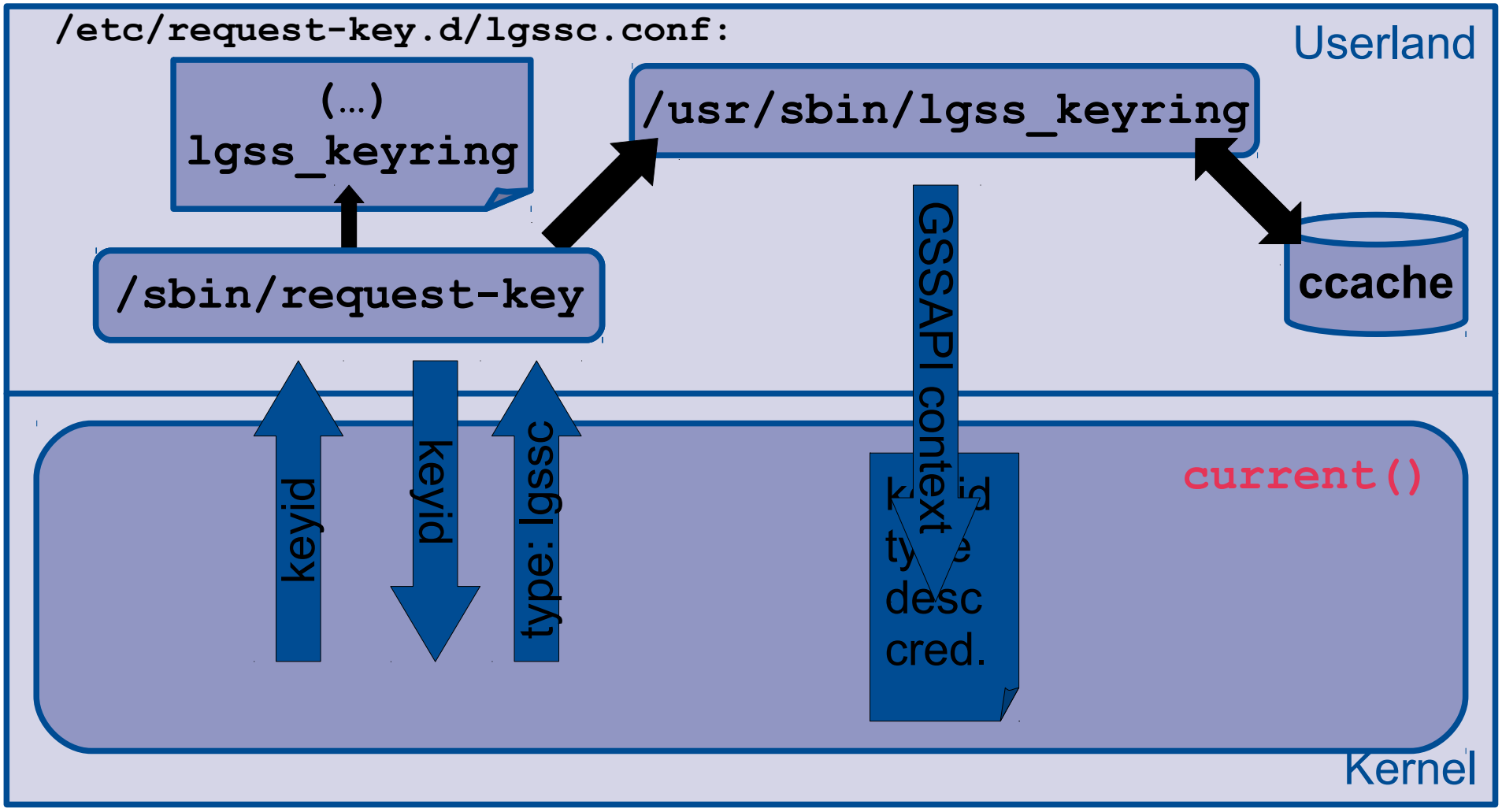
Credential passing: Lustre



Client

Credential passing: Lustre



Client

Lustre service principals

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- Each filesystem access needs to be authenticated with Kerberos credentials
- Lustre service principals
  - MGS: **`lustre_mgs/<hostname>`**, eg. **`lustre_mgs/mds01.example.org`**
  - MDS: **`lustre_mds/<hostname>`**, eg. **`lustre_mds/mds01.example.org`**
  - OSS: **`lustre_oss/<hostname>`**, eg. **`lustre_oss/oss01.example.org`**
  - Client: **`lustre_root/<hostname>`**, eg. **`lustre_root/client001.example.org`**
- Client principal used for mount and access by root user, normal users need their own principals

Lustre/GSS configuration

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- Configuration of request-key infrastructure for lgssc key type (**`/etc/request-key.d/lgssc.conf`**):

```
create lgssc * * /usr/sbin/lgss_keyring \
                          %o %k %t %d %c %u %g %T %P %S
```

- Start **`lsvcgssd`** on Lustre servers
- Configure security flavor with **`lctl conf_param <fs>.srpc.flavor.default`**:
  - **`null`**: no authentication (default)
  - **`krb5n/krb5a`**: authentication only
  - **`krb5i`**: additional integrity check of bulk data
  - **`krb5p`**: additional encryption of bulk data (DES, 3DES, RC4, AES128, AES256)
- Security flavor can be refined for different LNETs and directions

Lustre/GSS test setup

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- Requirements:
  - Kerberos infrastructure provided by ActiveDirectory (Win2k8r2)
  - Evaluate GSS feature for different Lustre branches
  - GSS feature should not require obsolete versions of Linux kernel or other software, ie. work with latest available Lustre-patched server kernels for each branch, and latest available CentOS6 kernel for Lustre clients (currently CentOS 6.4)
  - Should work with strongest available security flavor (krb5p)
  - Should be able to work securely for all communication directions, especially all client-server communication

Lustre/GSS availability

Lustre branch	feature present
b1_8	no
b2_1	yes
b2_3	yes
b2_4	yes

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Lustre branch	feature present	feature documented (*)
b1_8	no	yes
b2_1	yes	no
b2_3	yes	no
b2_4	yes	no

(*) in the Lustre manual

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Lustre branch	feature present	feature documented (*)	feature builds (#)
b1_8	no	yes	N/A
b2_1	yes	no	no
b2_3	yes	no	no
b2_4	yes	no	yes

(*) in the Lustre manual

(#) with latest Lustre-patched kernel (server) in branch and latest RHEL6.4 kernel (client)

Lustre/GSS availability

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Lustre branch	feature present	feature documented (*)	feature builds (#)	feature works (+)
b1_8	no	yes	N/A	N/A
b2_1	yes	no	no	N/A
b2_3	yes	no	no	N/A
b2_4	yes	no	yes	no

(*) in the Lustre manual

(#) with latest Lustre-patched kernel (server) in branch and latest RHEL6.4 kernel (client)

(+) Client-server communication with krb5p authentication

Practical experiences with Lustre/GSS

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- Code quality
  - Error checking through LBUG/LASSERT

    → **`lctl set_param panic_on_lbug=0`** is a must for sane debugging
  - Changes to in-kernel API break GSS build in b2_1 and b2_3 (both fixed in b2_4)
  - b2_4 introduces new proxy subsystems (lwp, osp) that GSS code doesn't know about (→ instant LBUG on service startup, LU-3778)

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- Verbose logs
  - **`lsvcgssd`**: groks option **`-v`**
  - **`request-key`**: groks option **`-d`**, but cannot change kernel upcall → add shell wrapper (logs go to authpriv, ie. **`/var/log/secure`**!)
  - **`lgss_keyring`**: debug level configured in **`/proc/fs/lustre/sptlrpc/gss/lgss_keyring/debug_level`** (no kidding)

Practical experiences with Lustre/GSS

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- Handy debugging aids
  - Traces from GSS code: **`lctl set_param debug=+sec`**
  - Query security flavor in use for each subsystem
    `lctl get_param *.*.srpc_info`
  - Query state of kernel keyring
    `cat /proc/keys` and **`keyctl show`**
  - Change hard coded ccache **`MEMORY:/self`** of **`lgss_keyring`** to accessible location like **`FILE:/tmp/krb5cc_...`**

Practical experiences with Lustre/GSS

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- ActiveDirectory (AD) specific problems
  - AD issues tickets with authorization data (PAC) by default
  - Leads to larger ticket sizes that Lustre/GSS cannot handle (→ LBUG, LU-3855)
  - Workaround: Set flag **`NO_AUTH_DATA_REQUIRED`** (0x2000000) in **`userAccountControl`** attribute of Lustre service accounts

Conclusion

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- GSS support present in Lustre code base for several years already
- Adoption hasn't gained momentum (abstract for this presentation ranks on Google page 1 when searching for „Lustre GSS“ ;-)
- Issues with GSS feature on any Lustre branch with current kernels
- Lack of comprehensive support
- GSS still a core requirement to enable use of Lustre outside of secure islands

References

- http://wiki.lustre.org/index.php/GSS_/_Kerberos – Wiki for Lustre/GSS
- http://www.opensfs.org/wp-content/uploads/2011/11/lug2012-v20.pdf
  – LUG2012 presentation from PSC
- https://jira.hpdd.intel.com/browse/LU-3490 – enable GSS builds by default
- http://wiki.lustre.org/images/6/6d/20080725161602!Gss-keyring-client.pdf
  – High-level design for Lustre Client GSS with Linux Keyrings

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Thank you!

Daniel Kobras
science + computing ag
www.science-computing.de
www.hpc-wissen.de
Telefon 07071 9457-0
info@science-computing.de