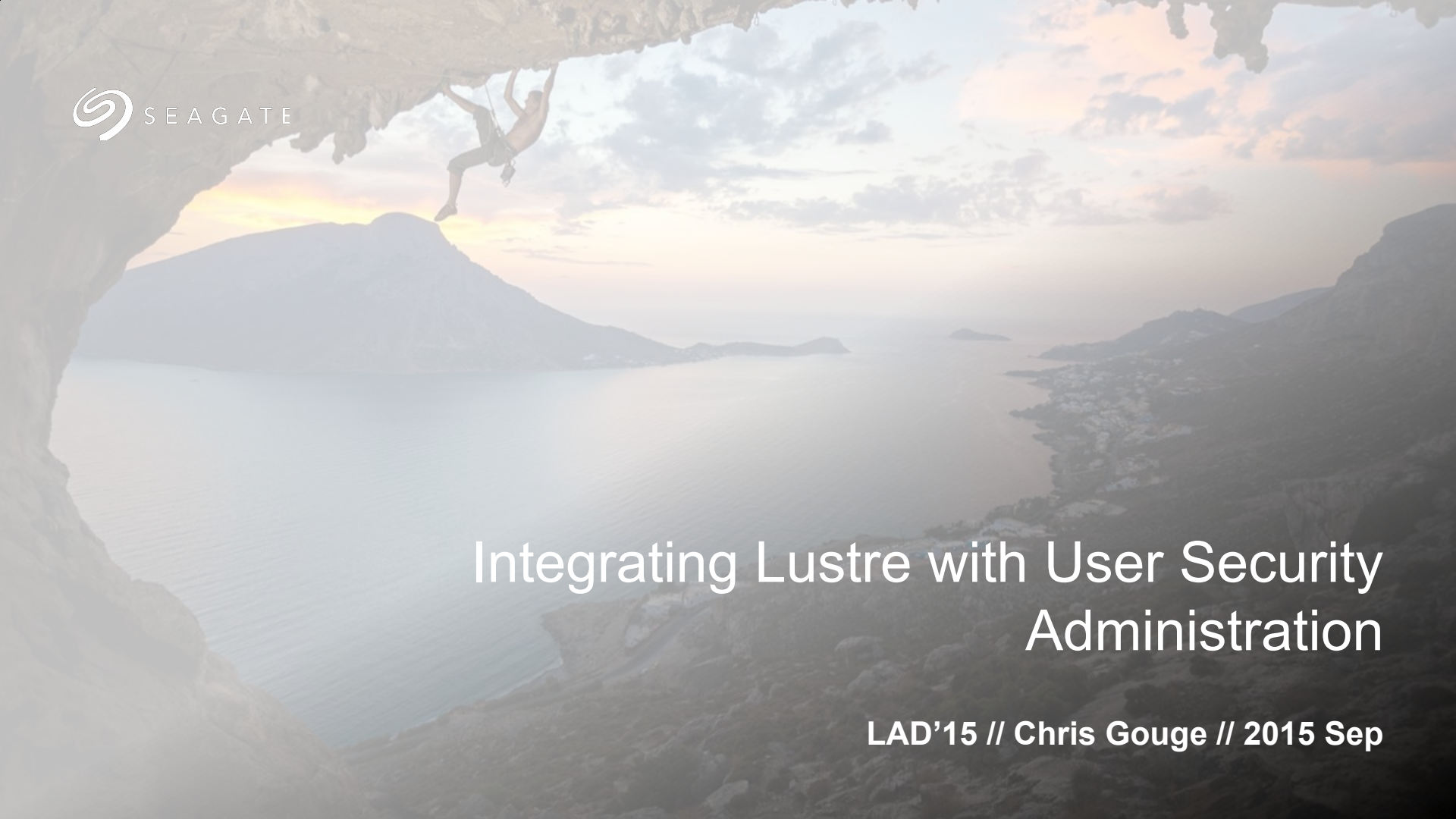


Integrating Lustre with User Security Administration

LAD'15 // Chris Gouge // 2015 Sep

Topics

- User Security in Linux
- POSIX Permissions
- The Requirement for Upcall in Lustre
- Upcall Utilities Overview
- Upcall with Samba Gateways

User Security in Linux

User Security: Authentication vs. Authorization

	Establishes:	*By means of:*
Authentication	Identity	Login
Authorization	Access	Permission check

Common Linux Frameworks for User Security

- PAM (Pluggable Authentication Module)
  - framework for logging into a Linux system, i.e. proving identity
  - result of login is a user account (username/uid/default gid)
  - multiple methods of login are supported
    - as hinted by the name
- NSS (Name Service Switch)
  - framework for queries to various “name services”, including user/group records
  - can be used to resolve group membership while checking permissions
  - multiple kinds of name services are supported
    - as hinted by the name

Common Choices for User Security in Lustre Environments

Many nodes requires synchronization of user accounts across all nodes

- LDAP (Lightweight Directory Access Protocol)
- AD (Active Directory)
  - Mostly LDAP compatible; older versions have quirks
- NIS (Network Information System)
- Local files (`/etc/passwd` and others)
  - Replicated manually, or via puppet, etc. to all nodes

User Security for Lustre

- Users login on the Lustre client nodes (compute nodes)
  - User accounts configured using PAM and NSS on these nodes
  - Upon login, users get their `uid` and `default gid` on these client nodes
    - This is all irrelevant to the Lustre filesystem.

- Upon file I/O requests, the Lustre client passes the `uid/gid` to the Lustre MDS for permissions check
  - Users do not login to the Lustre MDS directly, or otherwise directly interact with any Lustre server.

POSIX Permissions

POSIX Identity

- User account
  - `username` – systemwide unique name
  - `uid` – systemwide unique number
  - `default gid`
- Group account
  - `groupname` – systemwide unique name
  - `gid` – systemwide unique number
  - member list (a list of `usernames`)
- “Supplemental groups” – groups other than the default group, that a user belongs to

POSIX I/O Request

- Each *process* running in the system maintains:
  - `effective uid`
  - `effective gid`
- In the simplest case, these are the `uid` and `default gid` of the logged-in user.
- The process sends these 2 numbers in each I/O request to the filesystem.

POSIX File Permissions

- The finest granularity of POSIX filesystem permissions is a file.
- Each file has the following permission info recorded in its directory record:
  - `owner uid`
  - `owner gid`
  - **`r`**`ead/`**`w`**`rite/e`**`x`**`ecute` bits for the `owner uid`
  - **`r`**`ead/`**`w`**`rite/e`**`x`**`ecute` bits for the `owner gid`
  - **`r`**`ead/`**`w`**`rite/e`**`x`**`ecute` bits for everyone else
- Access Control Lists (ACLs) are optional, and stored in extended attributes.
  - Lustre supports ACLs; stored on MDS

POSIX Permission Checking: Examples

Permission Check Scenario #1

- Suppose we have a file:

- And the filesystem gets a “write” request for this file with `uid=`**`1003`** and `gid=3001`
  - The `uids` match, so the “owner uid” (or “user”) permission bit for “write” is checked. Writes are allowed to this file. In fact **`rwx`** means reads and executes are also allowed for user 1003.

Permission Check Scenario #2

- Suppose we have a file:

- And the filesystem gets a “read” request for this file with `uid=1071` and `gid=3001`
  - The `uids` don’t match; user bits are ignored.
  - The “owner gid” (or “group”) permission bit for “read” is checked. Reads are allowed, due to `r-x`, for users in group 3001.
  - (Or really, processes running with that effective `gid`.)

Permission Check Scenario #3

- Suppose we have a file:

- And the filesystem gets a “read” request for this file with `uid=`**`1071`** and `gid=`**`3449`**
  - The `uids` don’t match; user bits are ignored.
  - The `gids` don’t match… but now we have an interesting question:
  - **Is user 1071 in group 3001?**
  - The filesystem cannot answer this on its own, it must *call out* (or *call up*) to user security services.

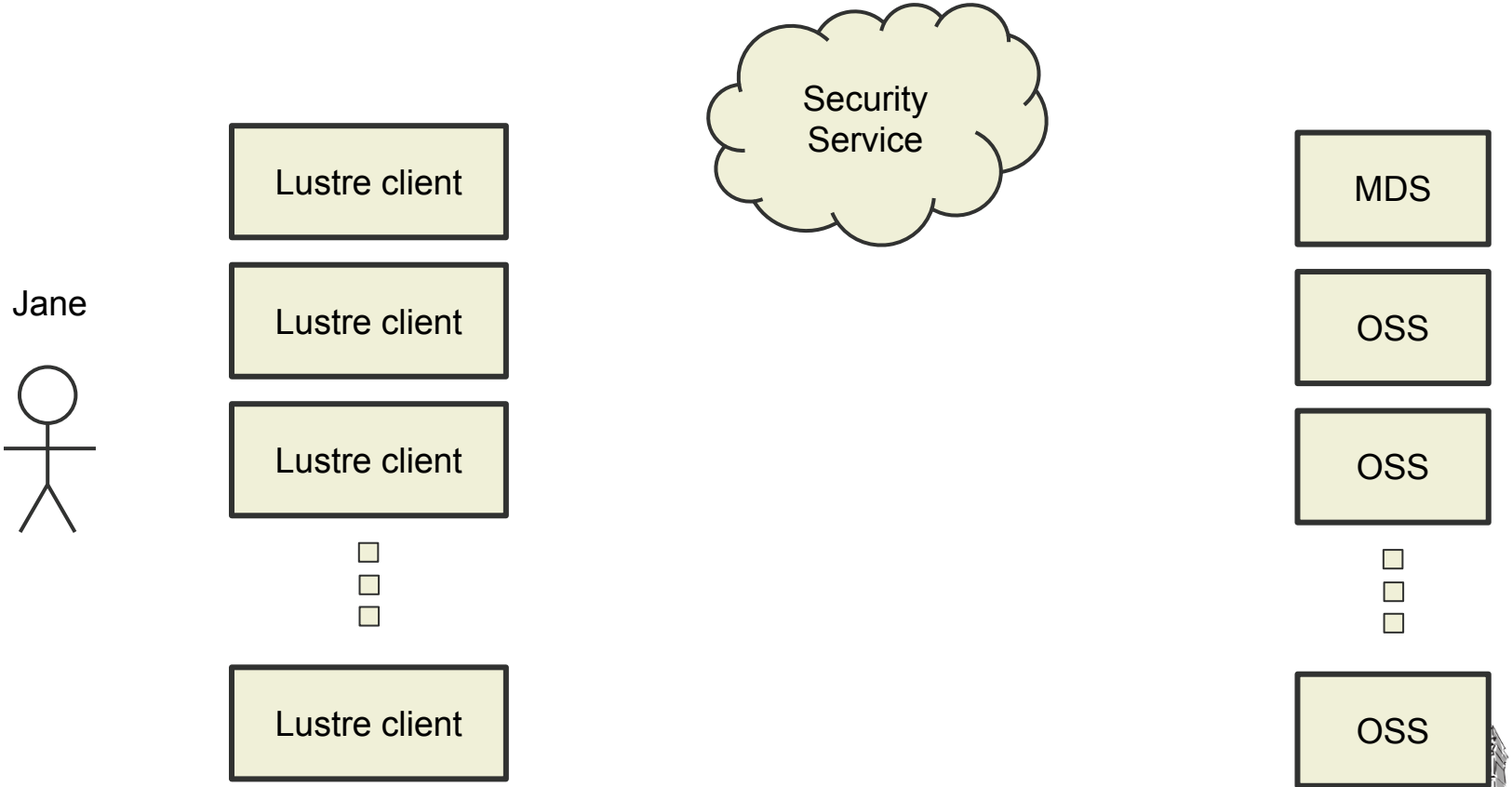
Scenarios with Lustre

User Security for Lustre (redux)

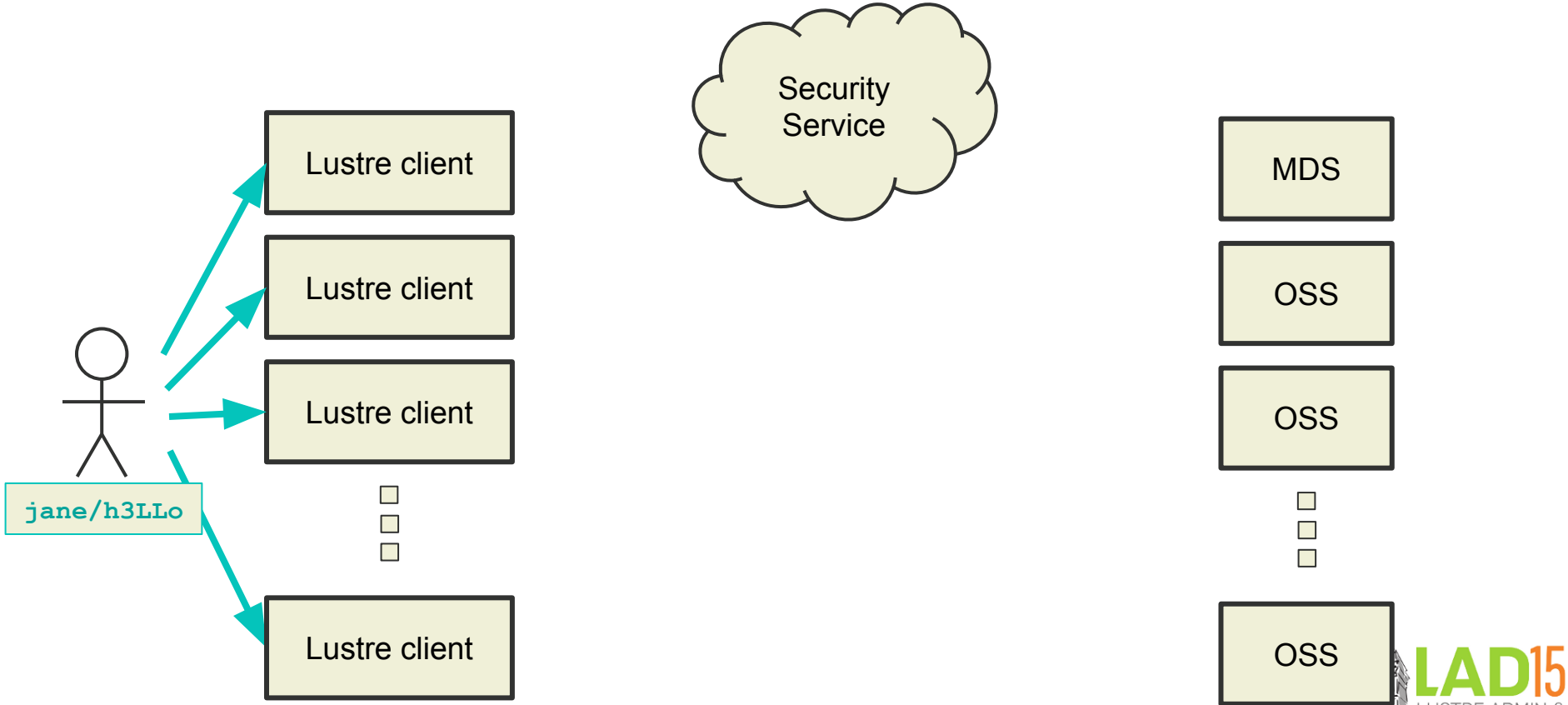
- Users login on the Lustre client nodes (compute nodes)
  - User accounts configured using PAM and NSS on these nodes
  - Upon login, users get their `uid` and `default gid` on these client nodes
    - This is all irrelevant to the Lustre filesystem.

- Upon file I/O requests, the Lustre client passes the `uid/gid` to the Lustre MDS for permissions check
  - Users do not login to the Lustre MDS directly, or otherwise directly interact with any Lustre server.

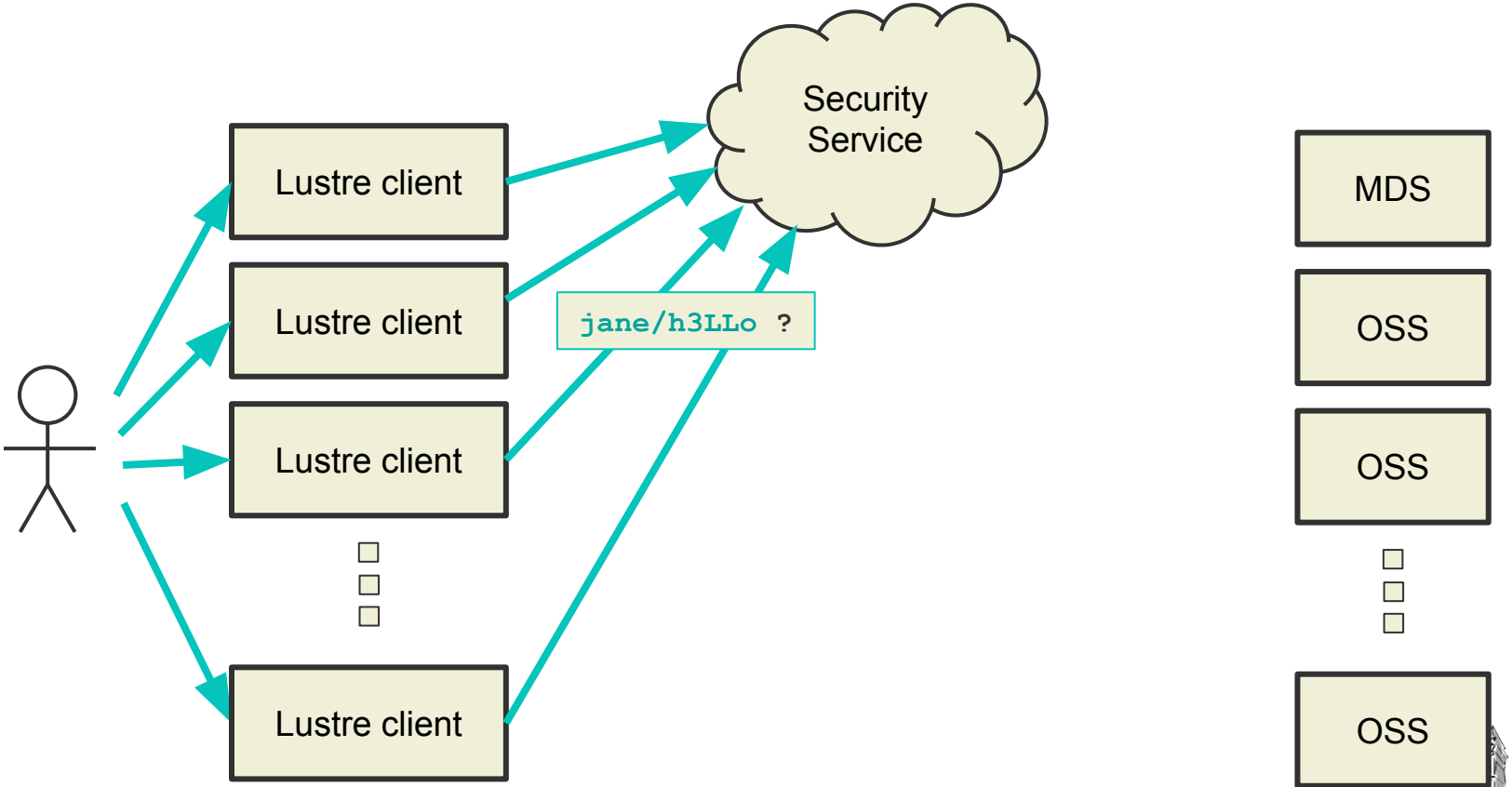
Lustre User Login - 1 of 4



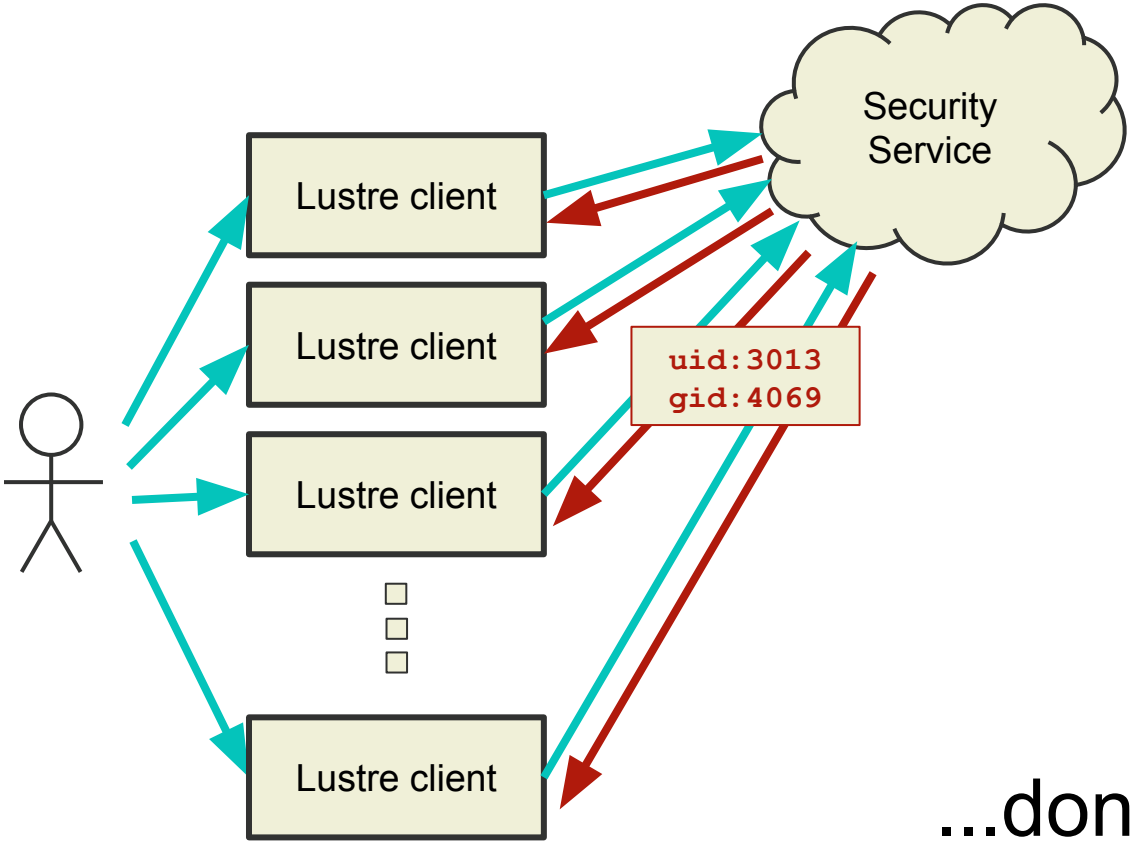
Lustre User Login - 2 of 4

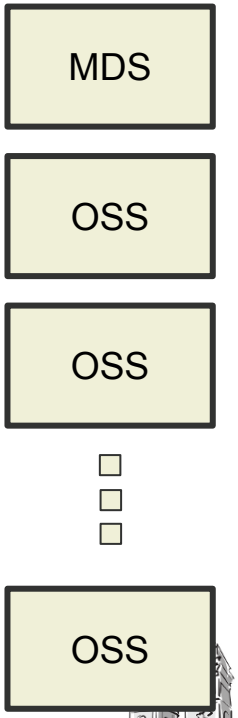


Lustre User Login - 3 of 4



Lustre User Login - 4 of 4

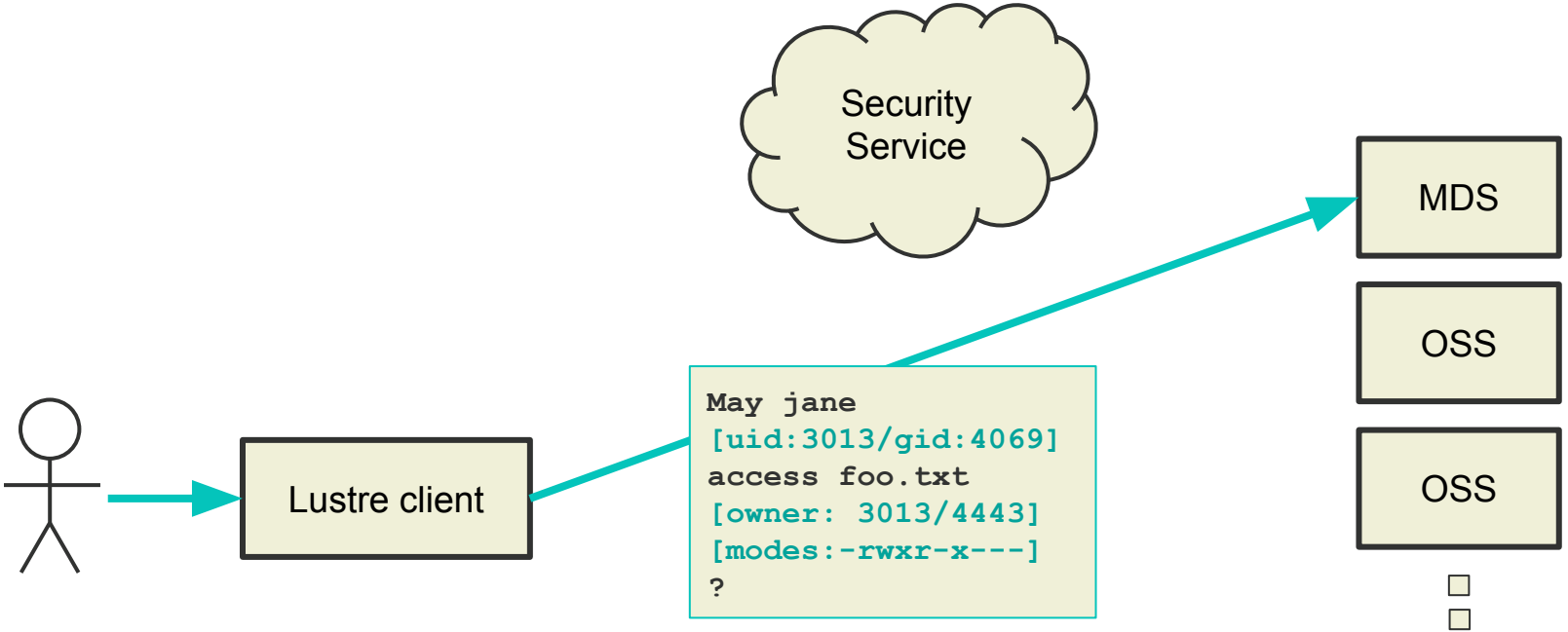




...done!

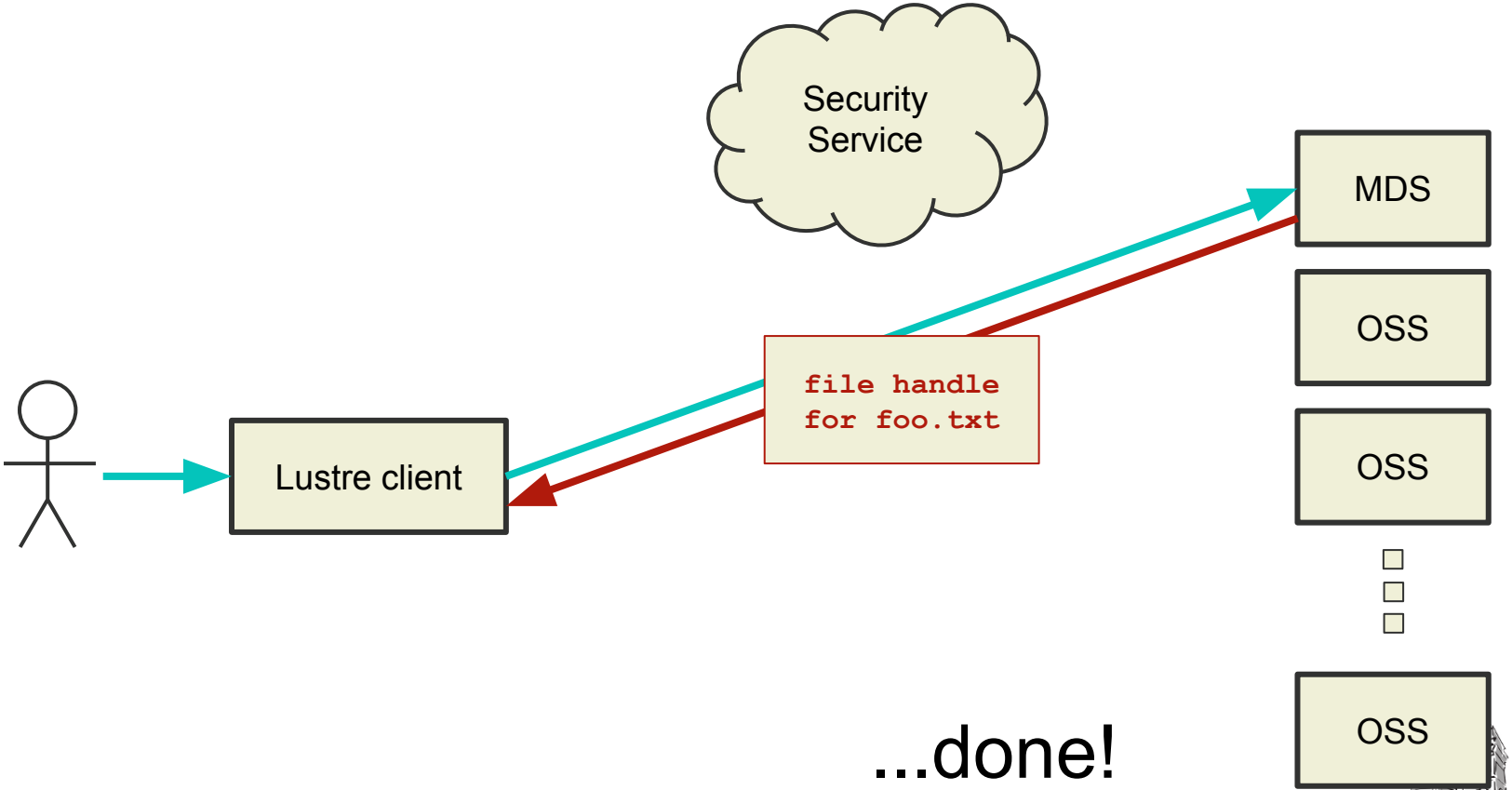
Lustre File Access

Lustre File Access (Simple) - 1 of 2



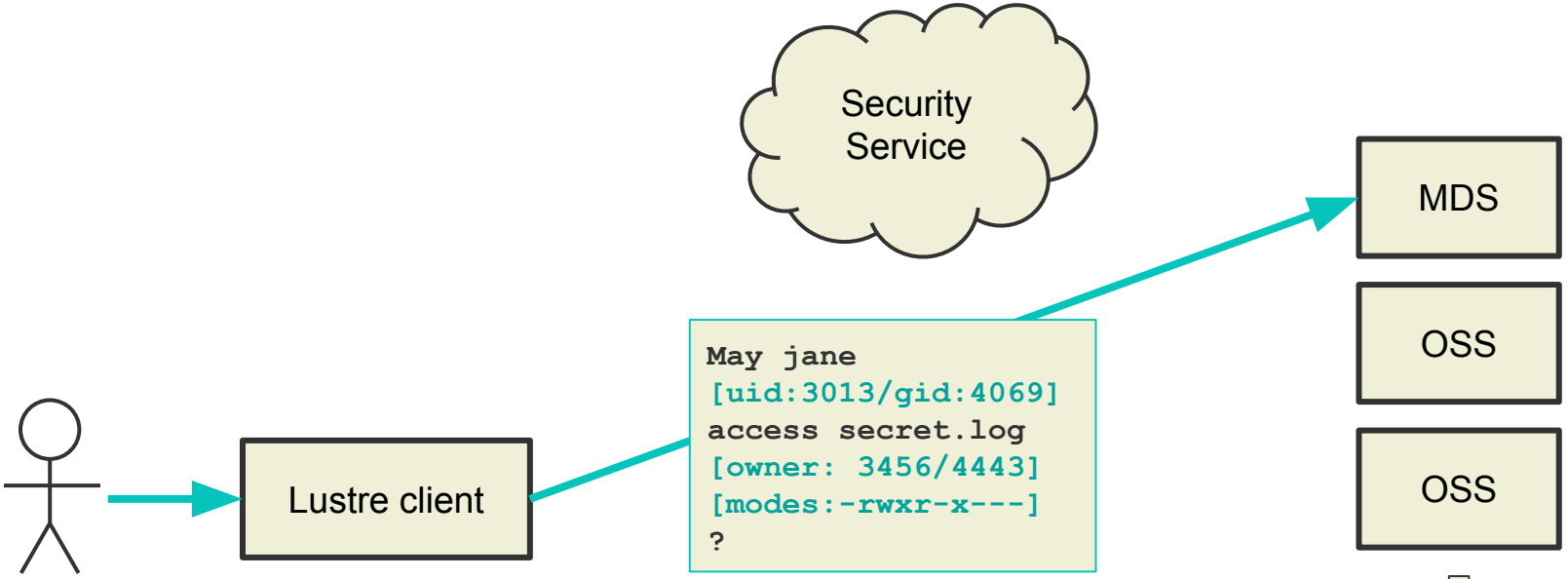
Notes:
jane is uid 3013
foo.txt owner is 3013
jane owns this file and owner has rwx permission

Lustre File Access (Simple) - 2 of 2



...done!

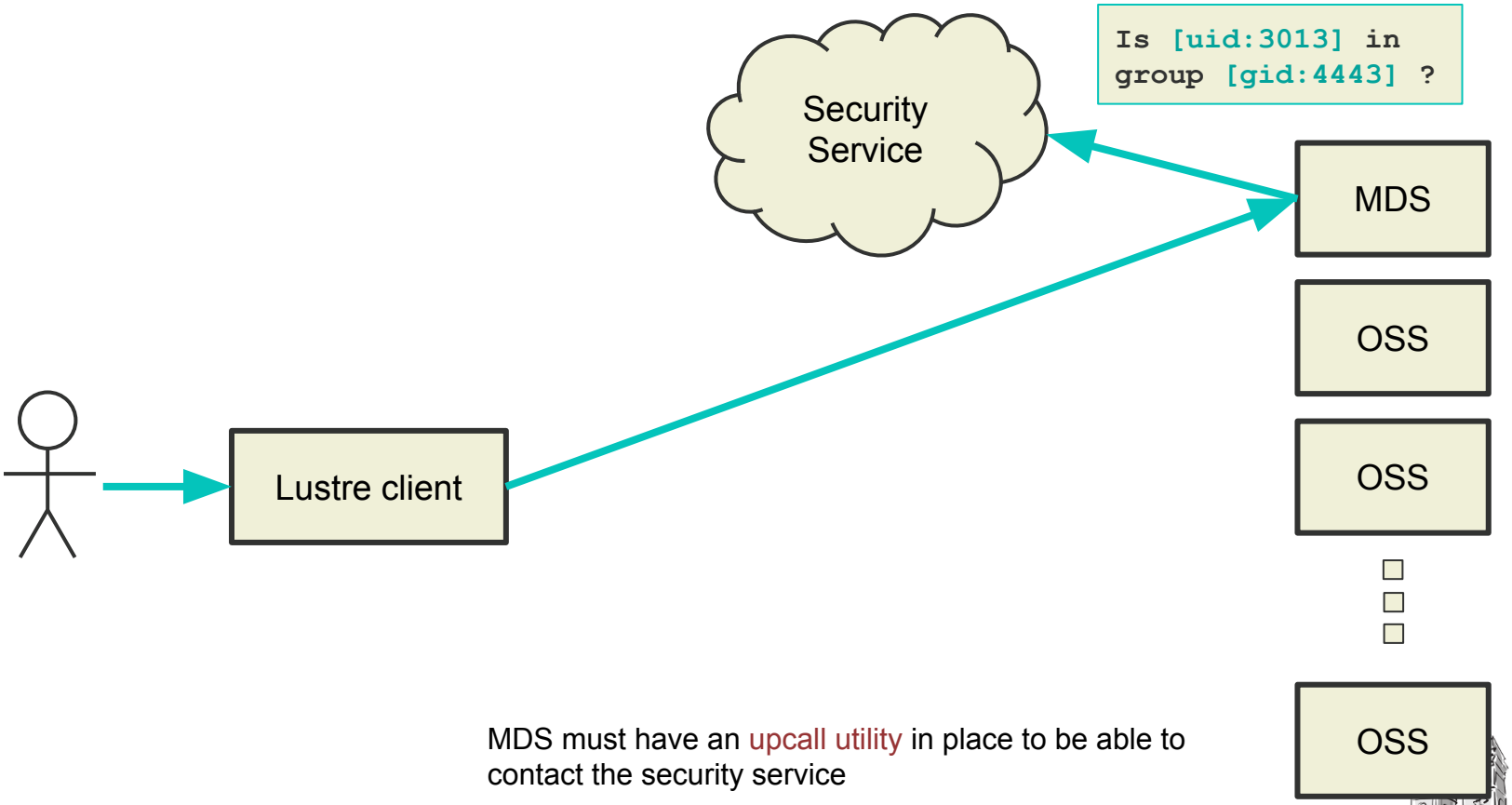
Lustre File Access (Group Upcall) - 1 of 2



Notes:
jane does not own the file
jane's *default* gid does not match
What is jane's permission?
MDS does not know.

SEAGATE
LAD15 LUSTRE ADMIN & DEV WORKSHOP PARIS - FRANCE - 2015

Lustre File Access (Group Upcall) - 2 of 2



MDS must have an upcall utility in place to be able to contact the security service

Upcall Utilities

Upcall Utilities for Lustre

- External / Separate from Lustre / Not part of Lustre
  - Although, a default is provided
  - And it works well enough for most sites
- The Magic Incantation:

```
[root@mgs]
# lctl conf_param myfs-MDT0000.mdt.identity_upcall=/usr/sbin/l_getidentity
```

- No reason there can't be other ways of doing it

Common Lustre Upcall Utilities

- `l_getidentity` (used to be `l_getgroups`)
  - Default
  - Looks for user/group membership on the MDS using NSS
    - NSS, in turn, relies on:
      - Separate configuration of external security service
      - Locally-defined user/group accounts on the node
  - This is both versatile & vulnerable
    - Any kind of user/group account configuration can be used.
    - But users should never need to login to these nodes!

- `l_adsidentity`
  - Looks for user/group membership on an Active Directory server
  - Mostly relevant to older AD server implementations
  - Supports only 1 AD server, no SSL connection

l_getidentity versus l_adsidentity

- l_getidentity can do anything that l_adsidentity can!
  - ** with correct configuration of relevant Linux services*
  - Protocol for Active Directory is LDAP
  - Schema configurable via nslcd.conf
    - RFC2307bis
    - Active Directory mappings (current schema)
    - Microsoft Services For Unix
- l_getidentity can do even more!
  - ** indirectly, by leveraging Linux services*
  - Backup servers
  - SSL connections
  - Alternate Bind methods

Limitations of `l_getidentity`

- Requires extensive configuration of the base system
  - Its greatest strength is its weakness
- If you do the minimal configuration to make Lustre work, then users will be able to login to Lustre server nodes.
  - This is a security issue at some sites
  - Multiple ways to prevent this:
    - Set user shell to `/sbin/nologin`
    - Disable PAM modules
    - etc.
  - Requires even more configuration!.

Introducing `l_getidentity_nss`

- Leverages NSS without requiring PAM configuration
  - LDAP (including Active Directory)
  - NIS
  - others
- Supports local user/group definition *without* creating any accounts
  - `passwd` and `group` files in `/etc/lustre`
- Supports multiple types of security service (user/group definitions) at once
  - Search order is set separately from `nsswitch.conf`

`l_getidentity` versus `l_getidentity_nss`

- `l_getidentity_nss` can do anything that `l_getidentity` can!

  ** relevant to Lustre*

- `l_getidentity_nss` doesn't open up user logins on Lustre servers in its simplest usage

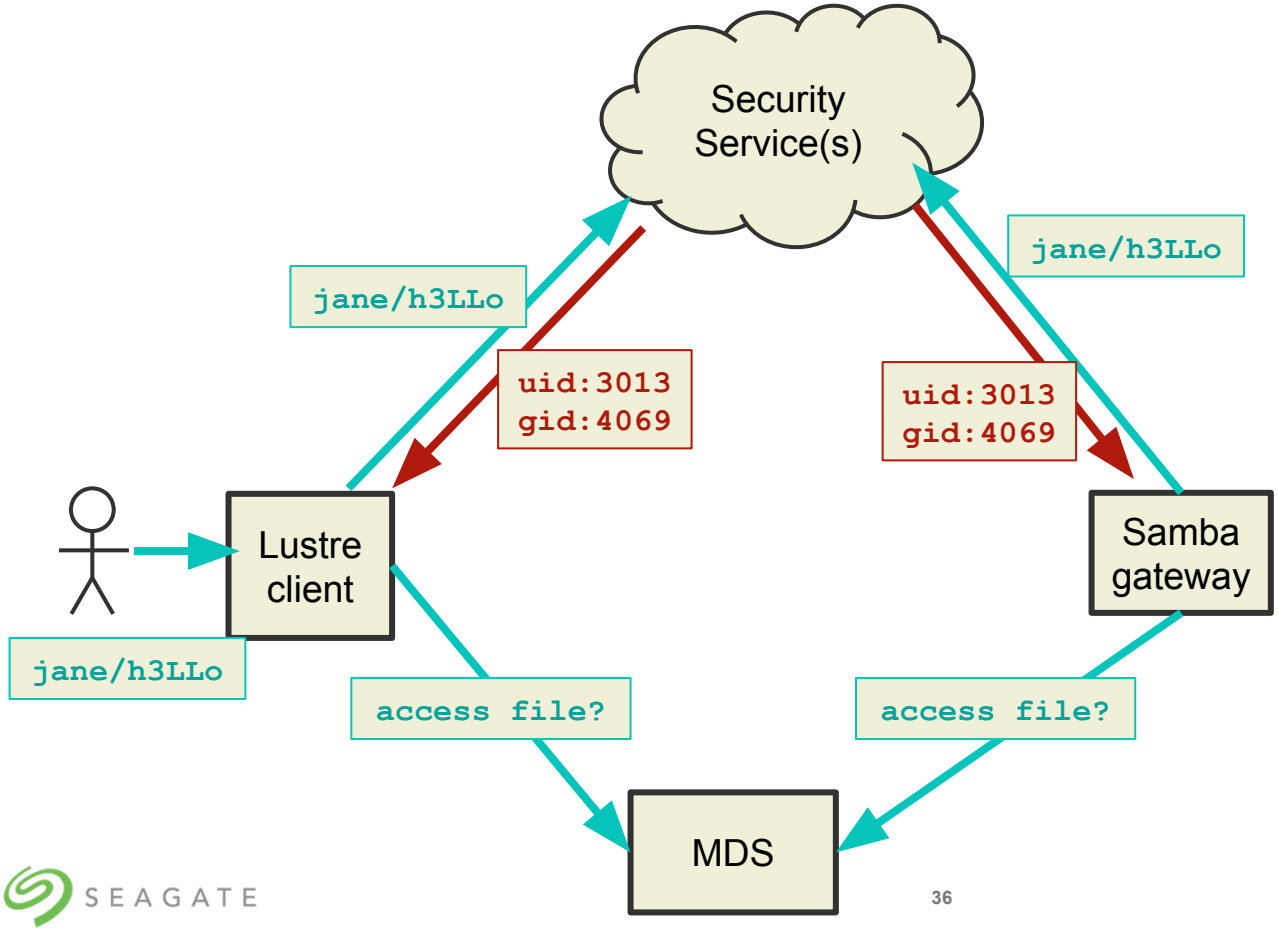
- Both still require configuration of the base system.
  - Maybe `l_getidentity_nss` requires a little bit less in some cases.

Is `l_getidentity_nss` even needed?

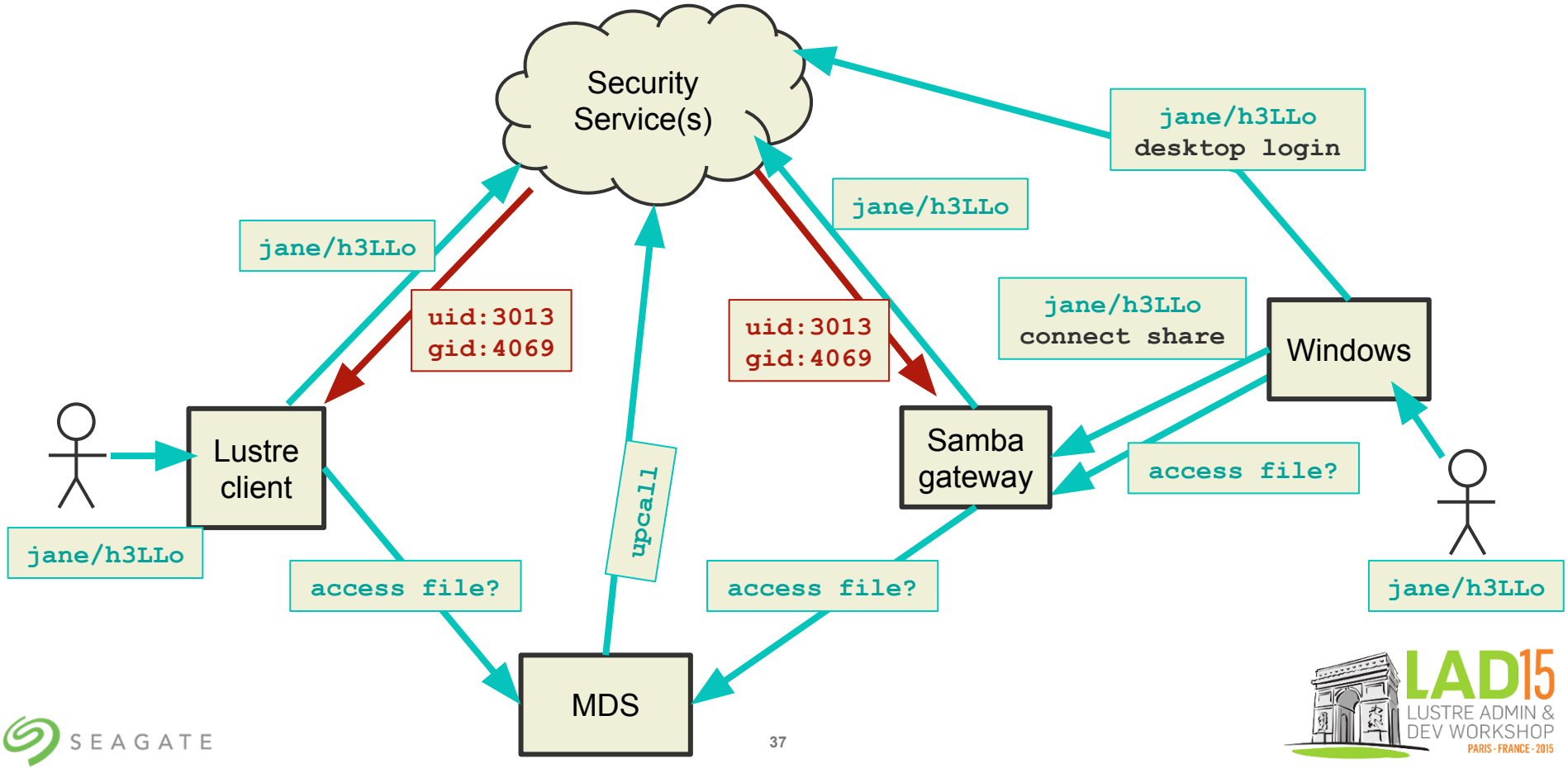
- We don't hear a lot of users clamoring for new upcall utilities
- We do hear general concerns about securing systems
  - Every site has different policies and different focus areas
  - Preventing server logins is a concern for some sites
- Some Lustre developer opinions (my paraphrasing)
  - "It's a small thing."
  - "Not worth bothering anyone to commit it upstream."
- Is there any interest?

Upcall with a Samba Gateway

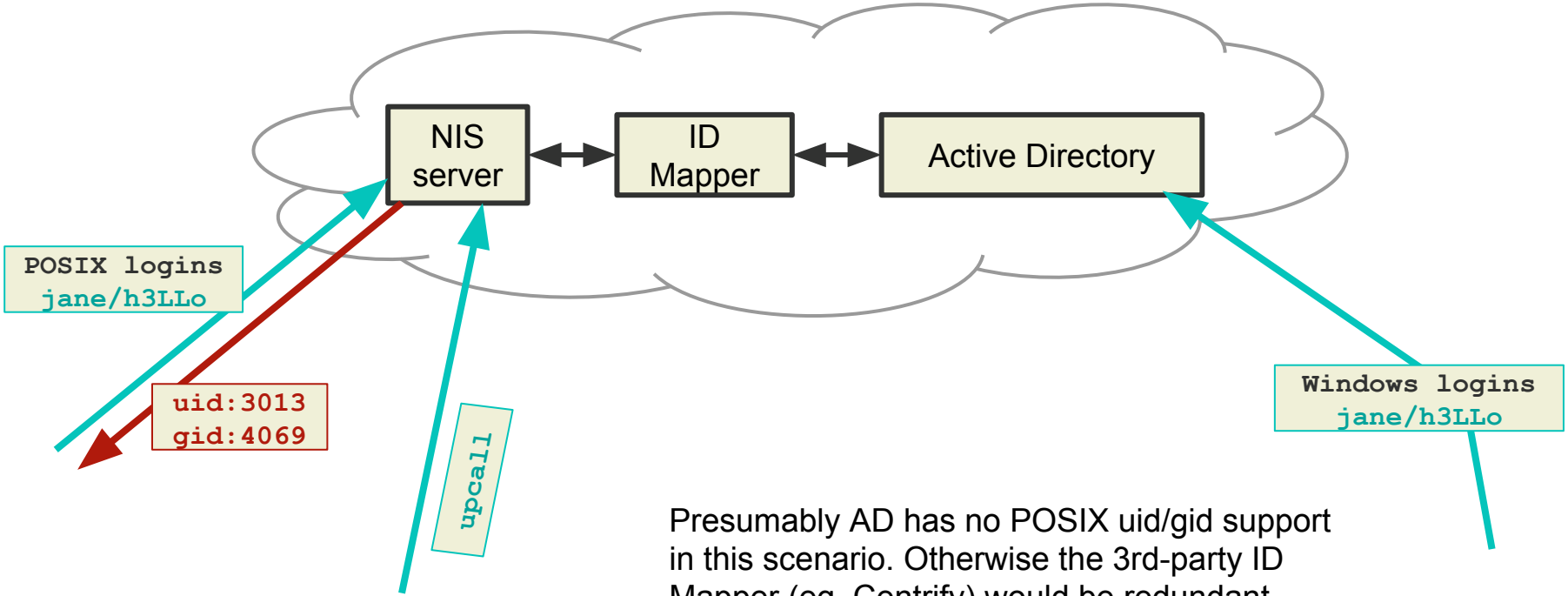
Samba Gateway as a Lustre Client



Upcall due to CIFS Client of Samba Gateway



Security Service: NIS + AD + ID Mapping Service



Presumably AD has no POSIX uid/gid support in this scenario. Otherwise the 3rd-party ID Mapper (eg. Centrify) would be redundant.

Questions?

chris.gouge+lad@seagate.com