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Lustre Nodemap Update

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Lustre Nodemap Update

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- What is Nodemap? How to use Nodemap?
- How to implement isolation/multi-tenancy with Nodemap?
  - rbac
  - idmap ranges
- Upcoming Nodemap features
  - dynamic nodemaps
  - mapping offsets
  - …

What is Nodemap?

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- Nodemap is an old feature…
  - Supported from Lustre 2.9 (2016).
  - But introduced in Lustre 2.7 as a technology preview!
- … initially developed for ID mapping.
  - Multiple sites with conflicting user and group ids can operate on a single Lustre file system without collisions in UID or GID space.

How does Nodemap work?

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- Lustre discriminates clients based on their Network IDentifier (NID).
- Then file system access is filtered through the Nodemap identity mapping policy engine.

- When a connection is made from a NID:
  - Lustre decides if that NID is part of a *nodemap*: a policy group made of NID ranges.
    - NID mapping is done only once at filesystem connection time
    - Strong authentication (Kerberos or SSK) can verify client NIDs to prevent address spoofing
  - A collection of identity maps or idmaps is kept for each policy group.
    - idmaps translate client UIDs, GIDs, and PROJIDs into canonical filesystem IDs.
  - Each policy group also has properties, governing access conditions.

Basic Nodemap commands

```
(1) mgs# lctl nodemap_add Tenant1
(2) mgs# lctl nodemap_add_range --name Tenant1 --range 192.168.1.[100-200]@tcp
(3) mgs# lctl nodemap_add_range --name Tenant1 --range 192.168.2.[0-50]@tcp
```

Nodemap does not allow overlapping ranges, **globally** for all nodemaps.

```
(4) mgs# lctl nodemap_add_idmap --name Tenant1 --idtype uid --idmap 530:11000
(5) mgs# lctl nodemap_add_idmap --name Tenant1 --idtype gid --idmap 530:11000
(6) mgs# lctl nodemap_add_idmap --name Tenant1 --idtype projid --idmap 101:1001
```

projid mapping added in Lustre 2.15.

How does Nodemap work?

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- Nodemap properties govern access conditions
  - Privileged access:
    - admin: root remains root
    - trusted: no id mappings, client ids are kept as-is
    - ⇒ admin+trusted: for servers, administrative clients
  - Unmapped ids:
    - squash_uid, squash_gid, squash_projid:
      - ids will be squashed to **if unmapped**
    - deny_unknown: denies all access to unmapped ids
  - map_mode: which kind of ids are mapped: UID, GID, PROJID

Modify nodemap properties

```
(1) mgs# lctl nodemap_add TrustedSystems
(2) mgs# lctl nodemap_add_range --name TrustedSystems --range 192.168.0.[0-255]@tcp
(3) mgs# lctl nodemap_modify --name TrustedSystems --property admin --value 1
(4) mgs# lctl nodemap_modify --name TrustedSystems --property trusted --value 1
```

TrustedSystems nodemap required for proper Lustre operations.

Must include all Lustre server nodes.

```
(5) mgs# lctl nodemap_modify --name Tenant1 --property squash_uid --value 65534
```

OR

```
(6) mgs# lctl nodemap_modify --name Tenant1 --property deny_unknown --value 1
```

The `default` nodemap

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- A default nodemap is needed
  - Fallback nodemap, setting the behavior for Lustre clients that do not match any other nodemap.
    - Cannot be removed.
  - No id mapping can be defined on the default nodemap!

Enabling Nodemap

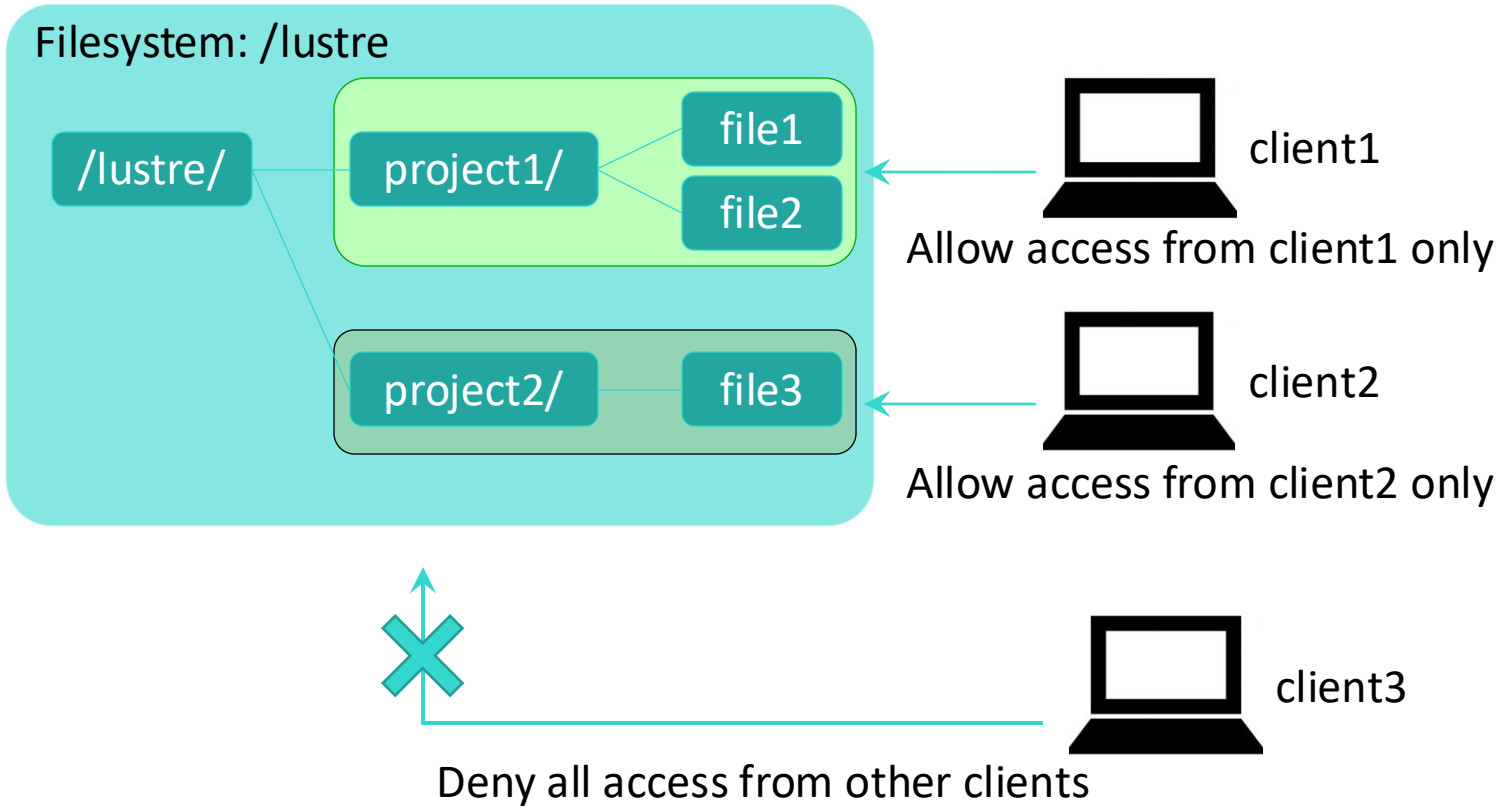
- Activate nodemap

```
mgs# lctl nodemap_activate 1
```

- Allow time for nodemap definitions to propagate
  - change events are queued and distributed across the cluster
    - this can take tens of seconds
  - prefer to save changes for a maintenance window

What to use Nodemap for?

- Nodemap is the Lustre feature of choice to implement isolation and multi-tenancy



Nodemap for Isolation

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- As long as clients NIDs can be trusted, *fileset* property guarantees isolation

```
mgs# lctl set_param nodemap.<nodemap_name>.fileset=/<directory>
mgs# lctl set_param -P nodemap.<nodemap_name>.fileset=/<directory>
```

- Groups of clients assigned to each tenant can change over time
  - Needs to update tenant definitions in nodemaps
- Can also force read-only mount
  - Property *readonly_mount*

Nodemap for Multi-Tenancy

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- New property to refine admin capabilities: LU-16524
  - Role-Based Admin Control, *rbac*
  - Available roles are (multiple choices are possible):
    - *byfid_ops*, to allow operations by FID (e.g. 'lfs rmfid').
    - *chlg_ops*, to allow access to Lustre Changelogs.
    - *dne_ops*, to allow operations related to DNE (e.g. 'lfs mkdir').
    - *file_perms*, to allow modifications of file permissions and owners.
    - *quota_ops*, to allow quota modifications.
    - *fscrypt_admin*, to allow fscrypt admin actions
      - lock/unlock encrypted dir. always possible

Recently added Nodemap feature

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- New possibility to ease mapping definitions:
  - Ability to a declare an idmap range: LU-17922
  - Syntax is:
    - `<clientid_start>-<clientid_end>:<fsid_start>[-<fsid_end>]`
    - `fsid_end` optional

```
mgs# lctl nodemap_add_idmap --name nm --idtype uid --idmap 500-510:10000
```

  - Works also to delete idmap ranges:

```
mgs# lctl nodemap_del_idmap --name nm --idtype uid --idmap 500-510:10000
```

Upcoming Nodemap features

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- Make multi-tenancy configuration easier
  - dynamic nodemaps
  - mapping offsets
  - …

Upcoming Nodemap features

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- Dynamic nodemaps: LU-17431
  - For workflows that impose frequent change of nodemap definitions
    - Nodemaps created and removed on a per-job basis
    - To contain only the nodes in the job for a specific runtime environment.
  - Current mechanism is not adapted
    - Nodemaps in the config llog would quickly consume all space in the config log
    - And would be slow to process.
  - Proposal:
    - Have **in-memory** nodemaps, created directly on servers
      - Requires some external orchestration to set nodemaps consistently across servers
        - » e.g. "clush -a lctl set_param ..."

Dynamic nodemaps: LU-17431 (cont.)

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- See dynamic nodemaps as a refinement of a generic behavior enforced by a regular nodemap.
- Dynamic nodemaps are hierarchical.
  - They have a parent (possibly `default`).
  - NID ranges of the child nodemap **must** be included in parent's NID ranges.
  - Child nodemap inherits all the parent nodemap's properties…
  - …and the id mappings.
  - Then properties/mappings can be refined.
    - Sub-nodemaps could only lower privileges, unless parent grants permission to raise.

Dynamic Nodemap commands

```
(1) mds# lctl nodemap_add -d -p Tenant1 subTen1
```

-d for dynamic, -p for parent

```
(2) mds# lctl nodemap_add_range --name subTen1 --range 192.168.1.[100-150]@tcp
```

Range for subTen1 must be **included** in parent Tenant1 ranges.

```
nodemap.subTen1.admin_nodemap=0
nodemap.subTen1.deny_unknown=0
nodemap.subTen1.fileset=/Tenant1_dir
nodemap.subTen1.idmap=
[
 { idtype: uid, client_id: 530, fs_id: 11000 },
 { idtype: gid, client_id: 530, fs_id: 11000 },
 { idtype: projid, client_id: 101, fs_id: 1001 }
]
nodemap.subTen1.rbac=file_perms,dne_ops,quota_ops,byfid_ops,chlg_ops,fscrypt_admin
nodemap.subTen1.readonly_mount=0
nodemap.subTen1.squash_gid=65534
nodemap.subTen1.squash_projid=65534
nodemap.subTen1.squash_uid=65534
nodemap.subTen1.trusted_nodemap=0
```

Properties inherited from parent Tenant1.

Dynamic Nodemap commands

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```
(1) mds# lctl nodemap_modify --name subTen1 --property rbac --value
dne_ops,byfid_ops,chlg_ops,fscrypt_admin
```

Remove file_perms and quota_ops.

```
(2) mds# lctl nodemap_modify --name subTen1 --property deny_unknown --value 1
```

Deny any unmapped access.

Upcoming Nodemap features

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- Mapping offsets: LU-18109
  - Defining and maintaining individual mappings for each ID used by a tenant can be super heavy for admins.
    - Having millions of mappings in memory can consume a lot of resources.
  - Storage admins might not have access or knowledge of tenant IDs (Cloud Service Provider).
  - But still need to isolate IDs from different tenants.
  - Proposal:
    - New option to specify an ID mapping offset:
      - Every tenant local ID automatically mapped to "ID+OFFSET" on storage.
      - No need to add mapping rules for new users in the tenant.

Mapping offsets commands

```
(1) mgs# lctl nodemap_add_offset --name Tenant1 --offset 100000 --limit 70000
```

Map client IDs from range 0-69999 to filesystem IDs in range 100000-169999

--limit specifies the number of IDs mapped by the range.

An offset range cannot overlap into another's offset range.

⇒ guarantees tenants have disjoint ID spaces.

Lustre Nodemap Update – wrap-up

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- Nodemap is a mature feature
- But evolving constantly
  - rbac
  - idmap ranges

- Nodemap is the feature of choice to implement Isolation and Multi-tenancy
- And we will keep on adding new capabilities:
  - Dynamic nodemaps
  - Mapping offsets

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Thank you!

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