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SANDIA LABS LUSTRE FILESYSTEM CUSTOMER IO DOS MITIGATION USING NRS TOKEN BUCKET FILTERS

Using Built-In Token Bucket Filter and Scheduling features of Lustre FS

Michael Aguilar, Jason Peters

File Storage Team, HPC Systems

Sandia National Labs, Albuquerque, NM 87114

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PROBLEM---CURRENT SHARED FILESYSTEM ISSUE

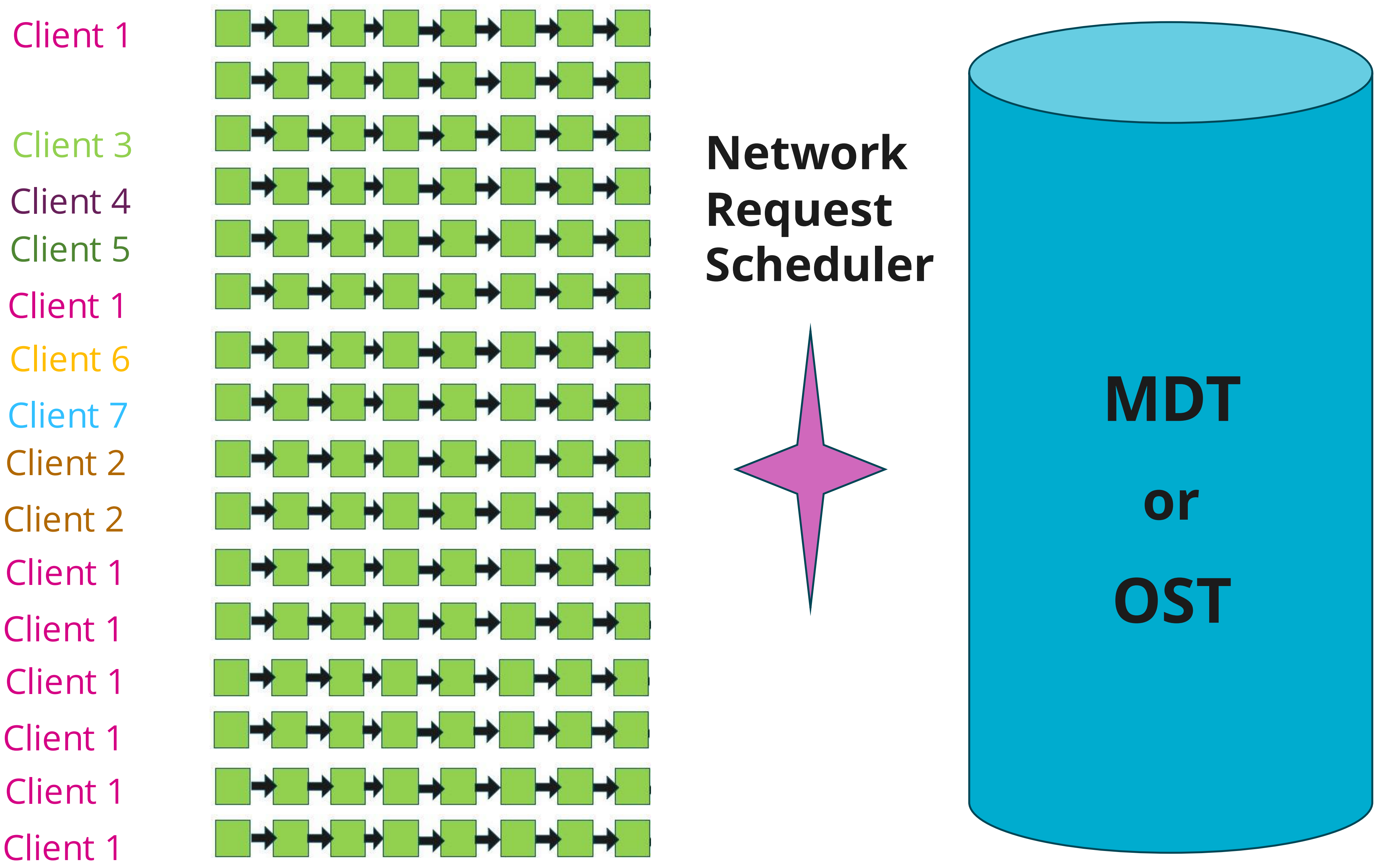
- Scratch filesystems are shared between several users and HPC machines, on Sandia's internal HPC networks
- One 'bad' batch run can create an IO load issue on the Lustre Filesystems and load down the MDTs and OSTs.
- A method for throttling communications to the filesystems, for bad applications, could be advantageous to us, as it could help to reduce the scratch filesystem outages.
  - Our goal is to reduce the impact that any single batch job can have on a shared filesystem
  - We want to be able to make it so the filesystem can respond to all of the users
  - We want to protect the filesystem from 'falling over'.

CURRENT LUSTRE FILESYSTEM INFRASTRUCTURE

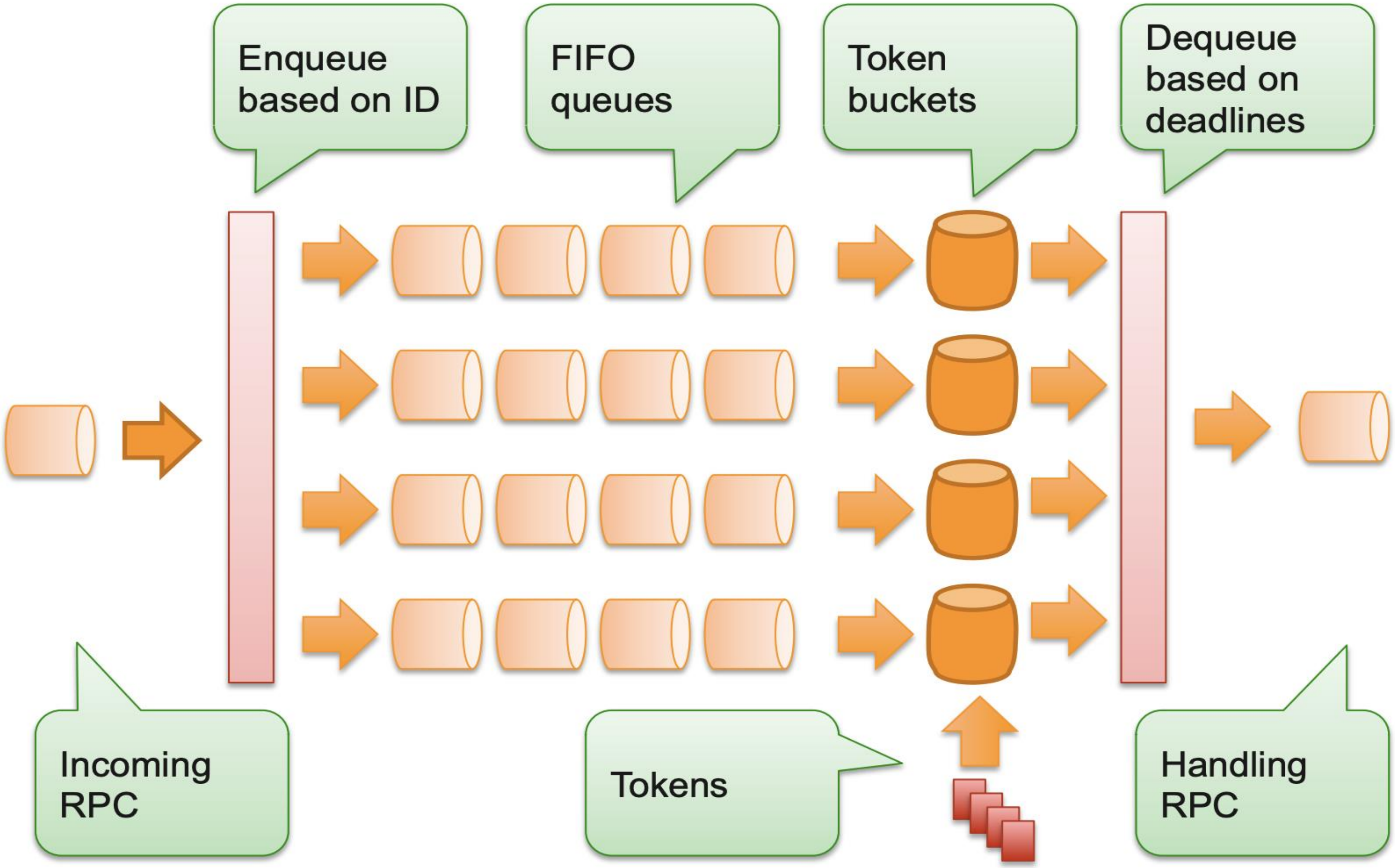
- We can leverage a couple of tools within Lustre to maintain some user control of Lustre Server access.
  - Lustre operates the transactions, with client applications, with Remote Procedure Calls (RPC)
  - In order to maintain filesystem transactional control of the RPCs, Lustre has a ‘Network Request Scheduler’ (NRS) that gets the RPC requests, in parallel, from all of the running batch jobs, on all of the HPC systems
  - The NRS is able to throttle the RPC rates before handing them over to the appropriate Lustre filesystem Metadata and Object Storage Server threads
  - A **Token Bucket Filter (TBF) policy** is the method that Lustre has implemented for throttling control
  - Lustre provides internal information, that **with new modifications**, will be able to provide us with easy UID/GID information on ’bad users’

CURRENT LUSTRE FILESYSTEM INFRASTRUCTURE

RPC IO transaction calls



CURRENT LUSTRE FILESYSTEM INFRASTRUCTURE

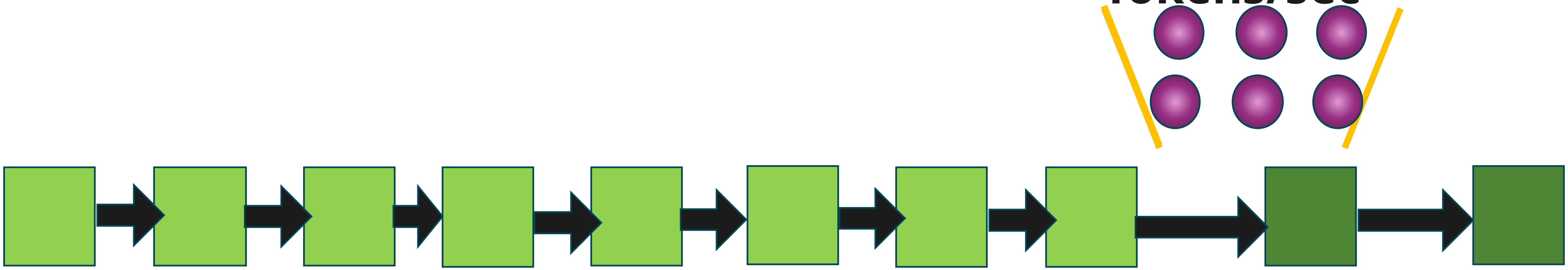


LEVERAGING TOKEN BUCKET FILTER TYPES

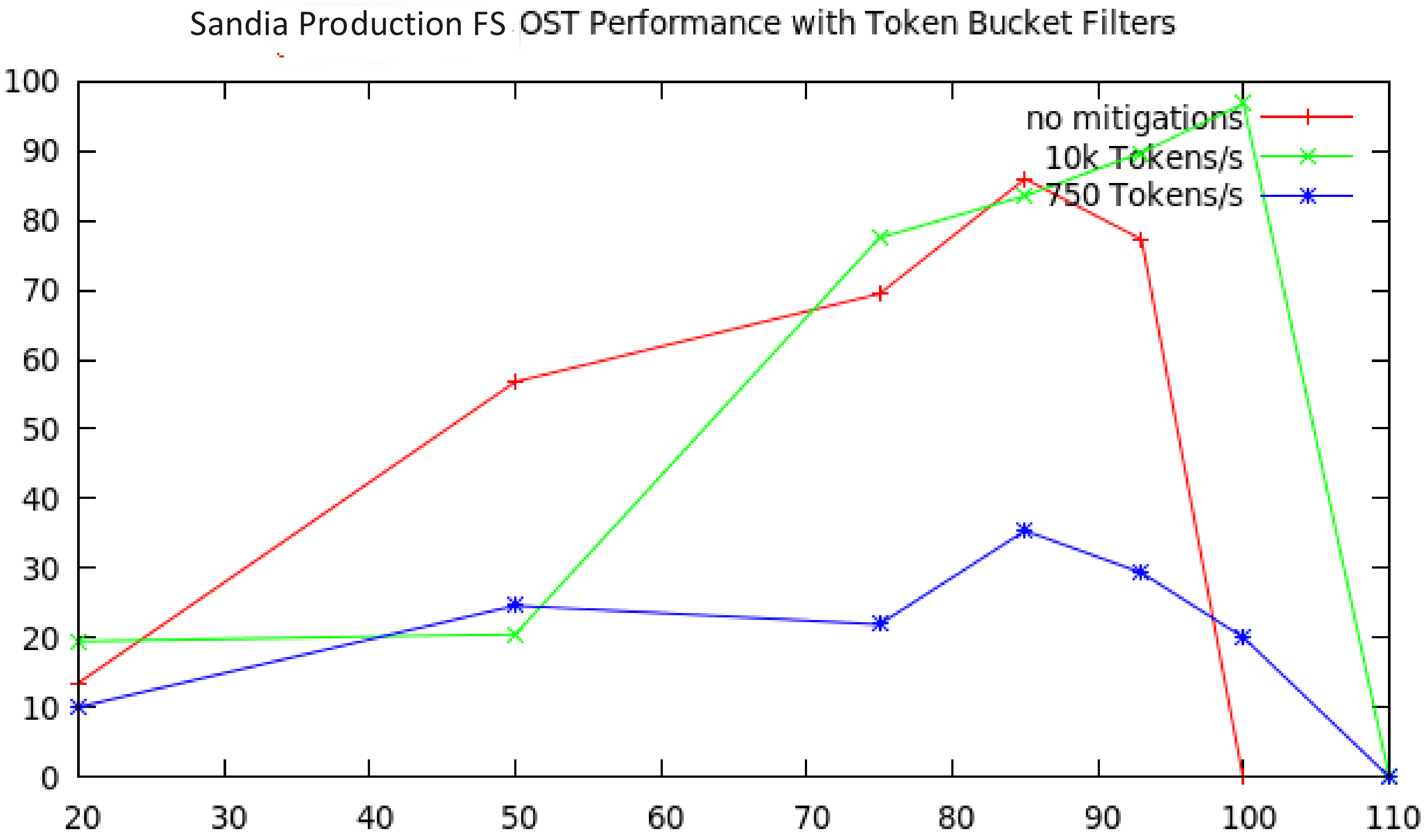
- **NID**
  - We can **throttle** user transactions by **limiting the RPC communication transaction rates available** to all Lustre network connected users, by IP Range. This sets up a **‘base rate’,** an **expectation of a normal TBF** rate for the filesystems.

base_rate=< Preset experimentally gathered value >

Tokens/sec

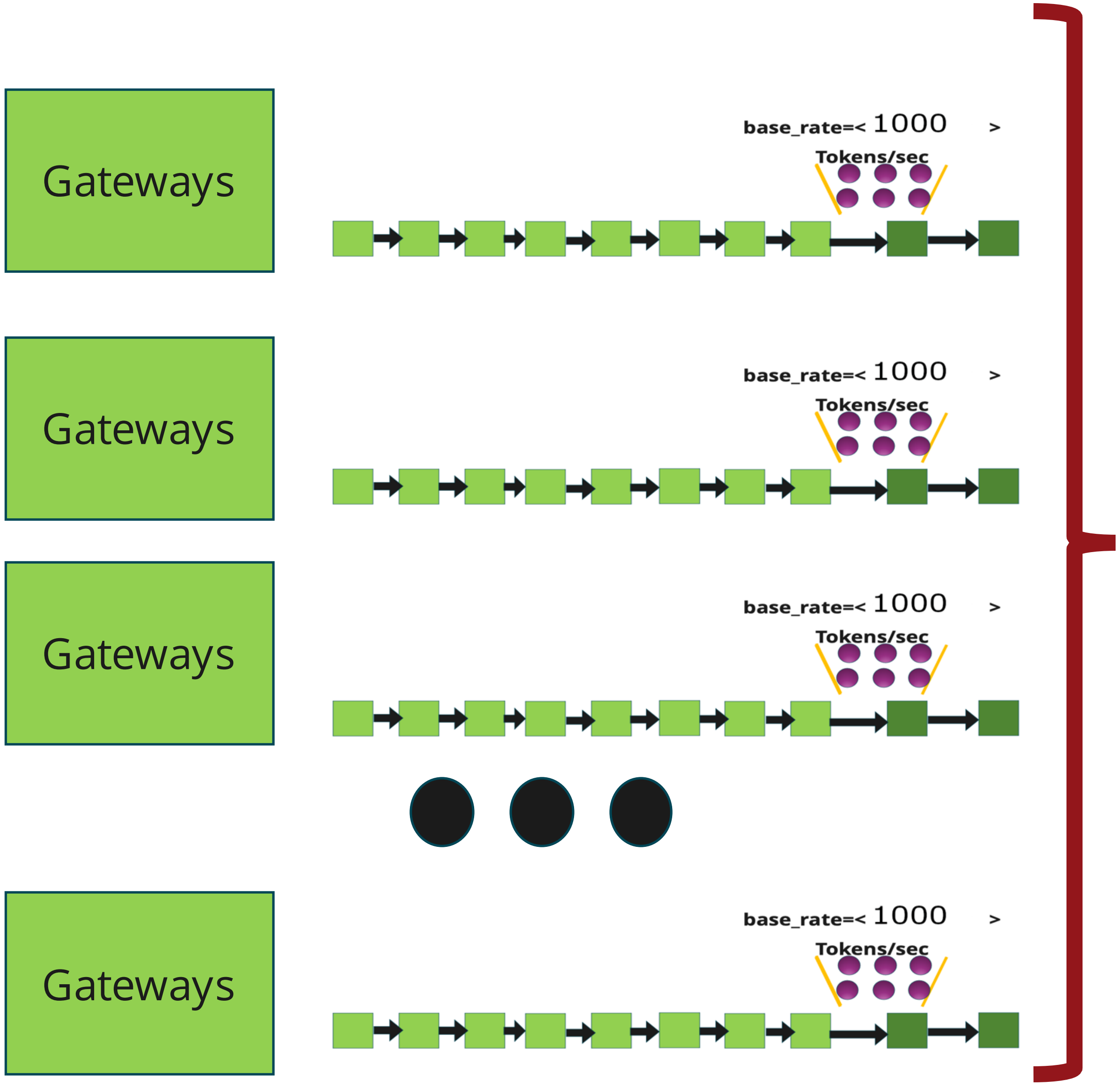


EXPERIMENTAL TOKEN BUCKET FILTER IMPLEMENTATION RESULTS

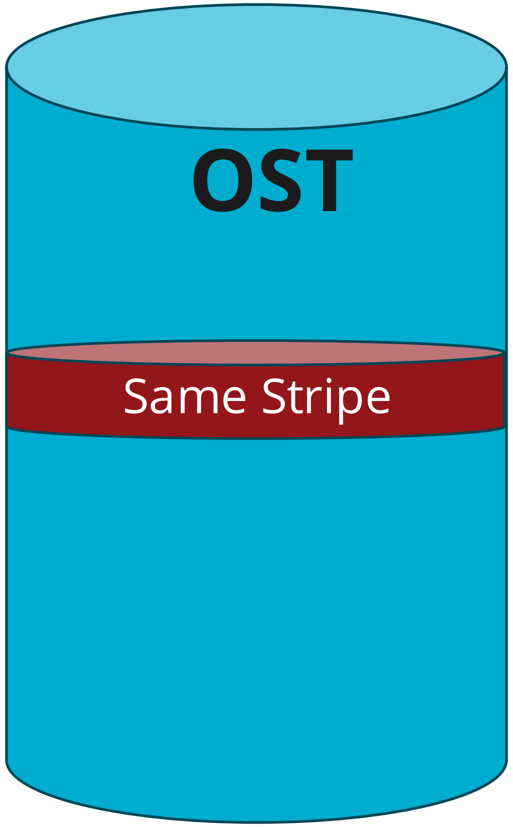


LEVERAGING TOKEN BUCKET FILTER TYPES

Limits to the Base Rate

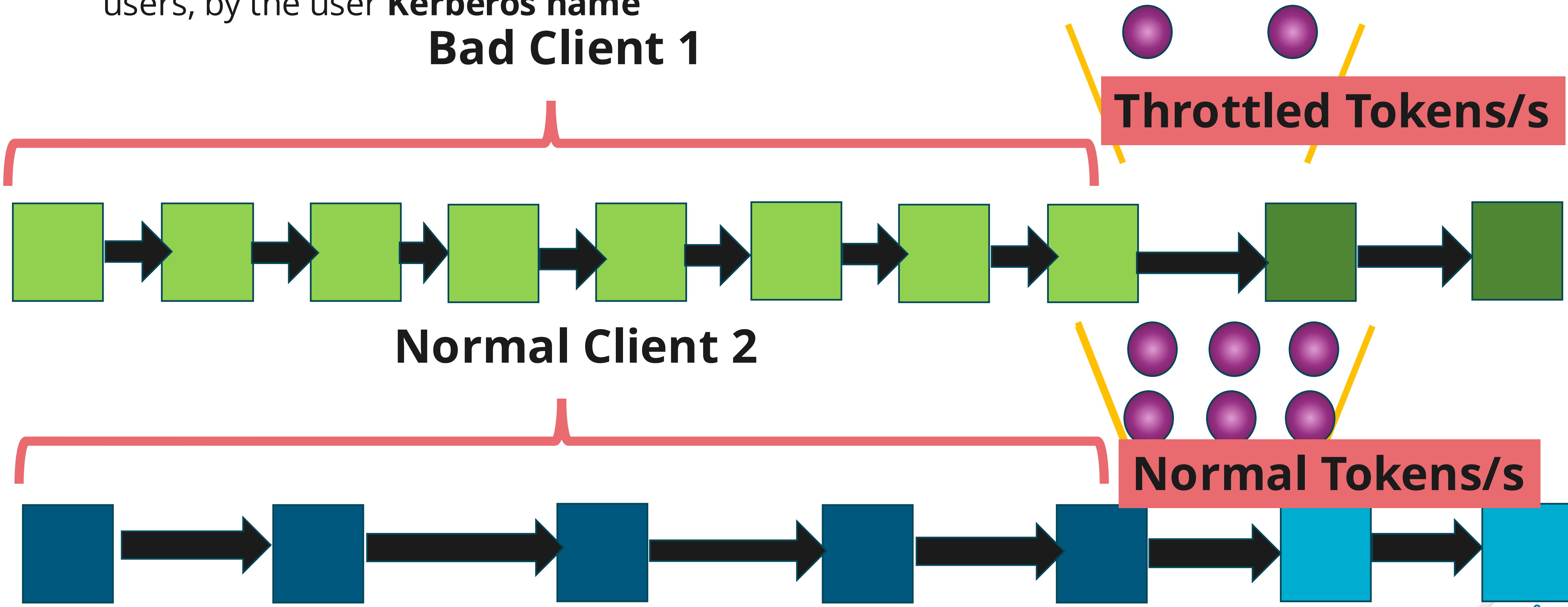


Large number of requests, from a large number of compute nodes, on a single HPC cluster, or a set of HPC Clusters **can still overload** a **single stripe with IO**



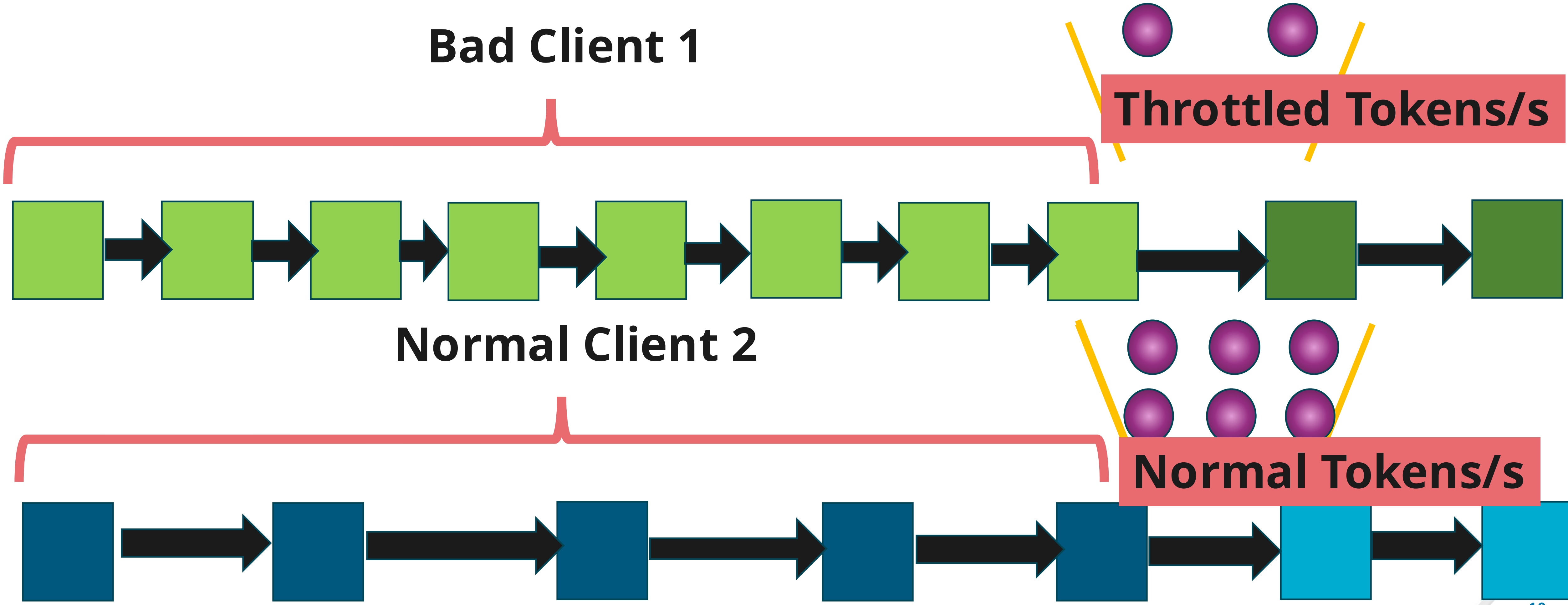
LEVERAGING TOKEN BUCKET FILTER TYPES

- **JOBID/UID**
  - We can **additionally throttle** user transactions by limiting the RPCs available to ‘bad’ users, by the user **Kerberos name**



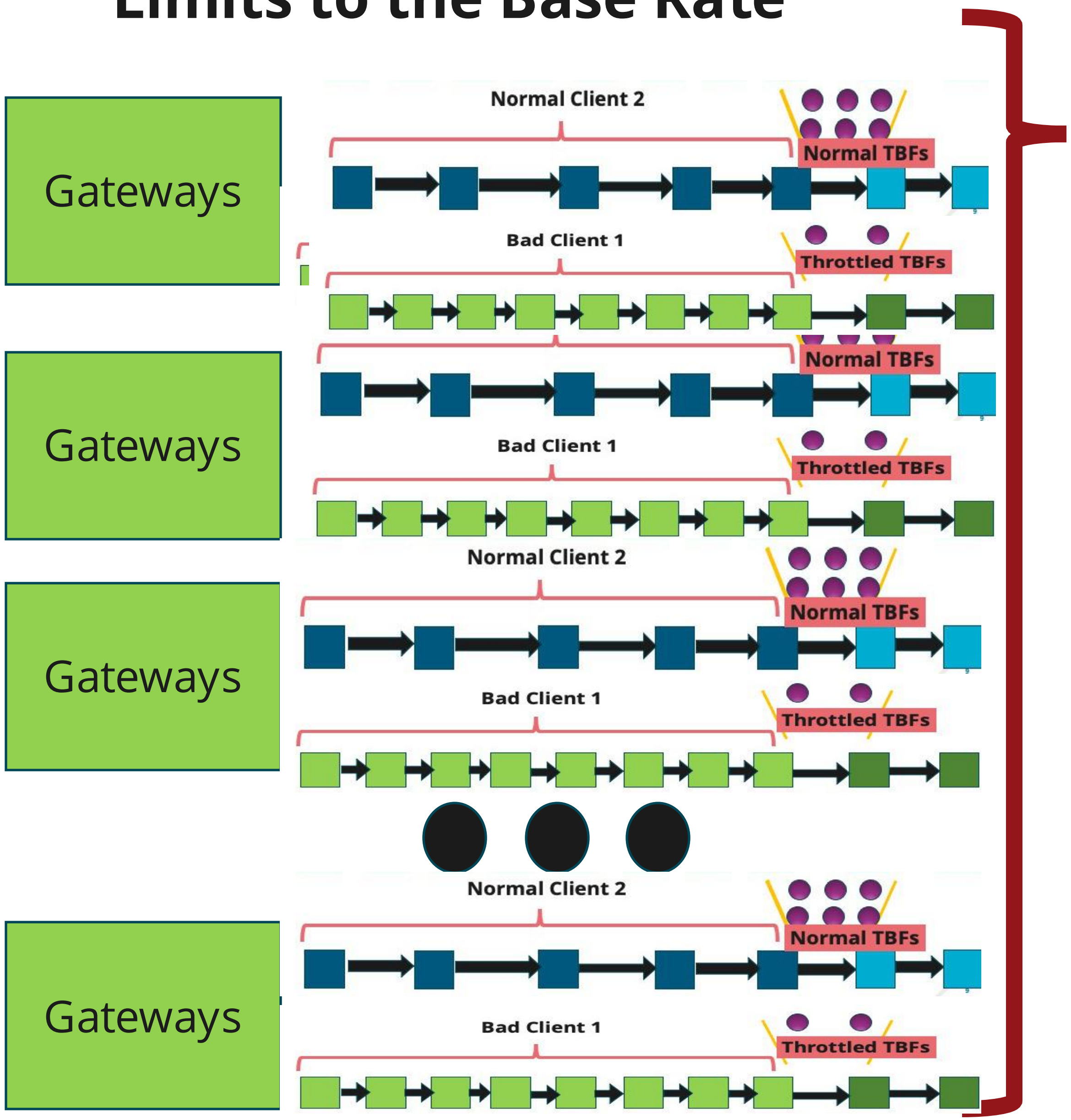
LEVERAGING TOKEN BUCKET FILTER TYPES

- **NID**
  - We can **throttle** user transactions by limiting the RPCs available to ‘bad’ users, by the user **Client Server Address**



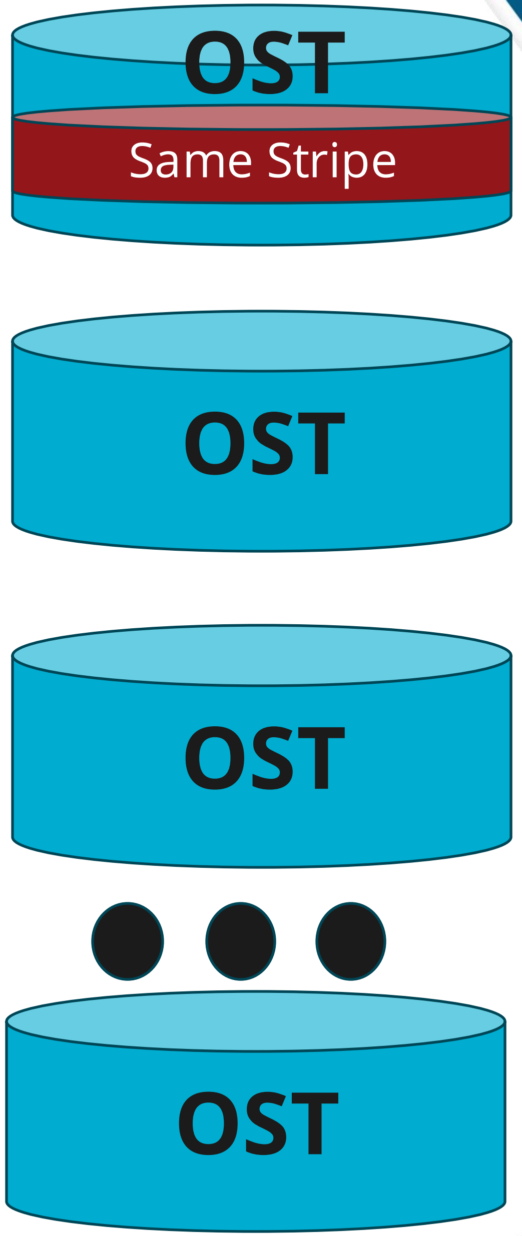
LEVERAGING TOKEN BUCKET FILTER TYPES

Limits to the Base Rate



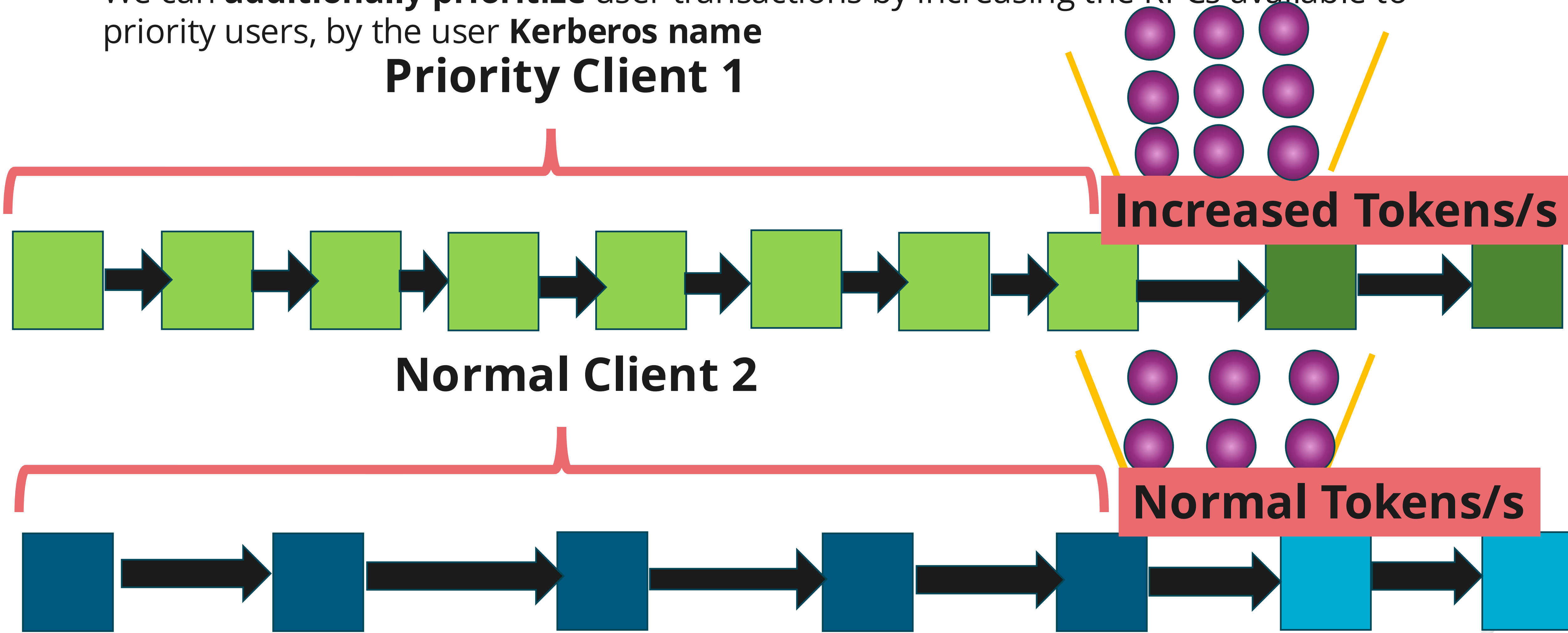
The **Bad Client has a large number of requests**, from a **large number of individual compute nodes**, on a single HPC cluster, or a set of HPC Clusters are now throttled per User. This means that if the **client has jobs running on all connected compute nodes on all of the HPC clusters,** he is still **limited** to the same **quantity of Tokens** and will still be throttled.

Normal Clients still use the **same Base Rate** of Tokens/Sec. Other users still have the usual access to the filesystem



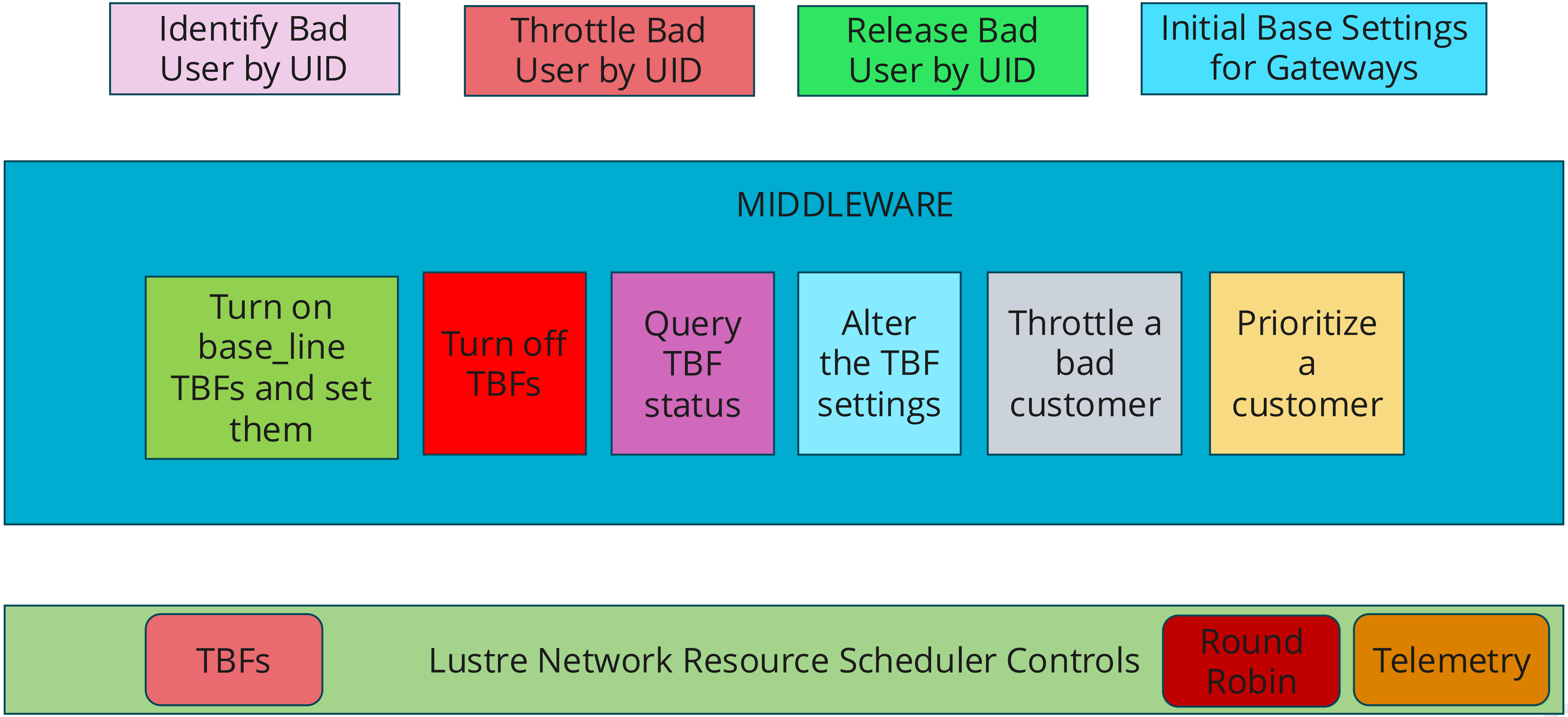
LEVERAGING TOKEN BUCKET FILTER TYPES

- **JOBID/UID**
  - We can **additionally prioritize** user transactions by increasing the RPCs available to priority users, by the user **Kerberos name**



LEVERAGING TOKEN BUCKET FILTER TYPES

Operations Front-End Controls



Identify Bad User by UID

Throttle Bad User by UID

Release Bad User by UID

Initial Base Settings for Gateways

MIDDLEWARE

Turn on base_line TBFs and set them

Turn off TBFs

Query TBF status

Alter the TBF settings

Throttle a bad customer

Prioritize a customer

TBFs

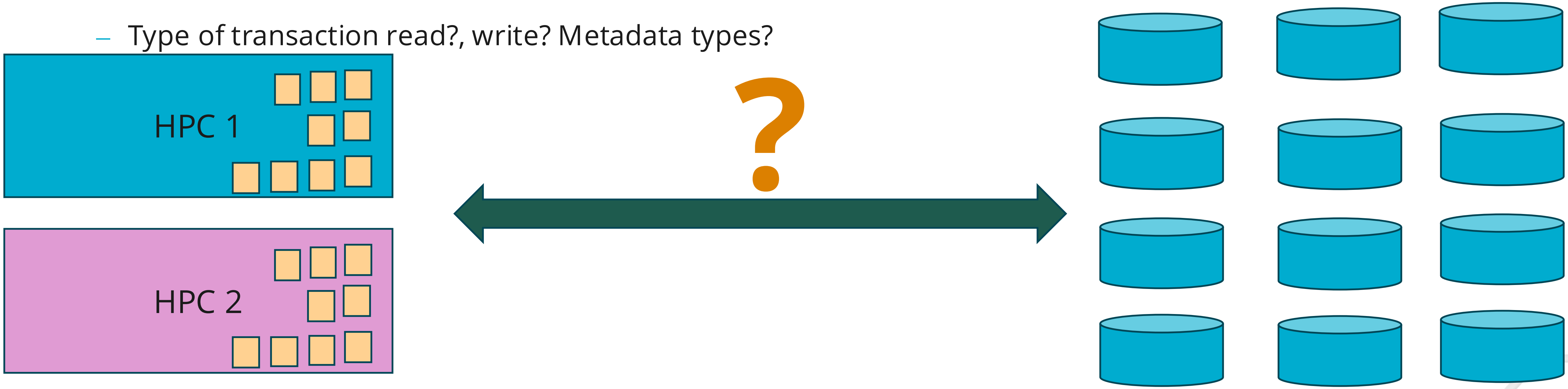
Lustre Network Resource Scheduler Controls

Round Robin

Telemetry

BAD USER IDENTIFICATION TELEMETRY FROM LUSTRE

- The Lustre filesystem is falling over.
  - How do we find the bad user that we want to throttle?
  - Lustre provides us with run-time telemetry that we can use
  - Next: **We are working on identification scripts that allow us to quickly gather the IP address(es) of the bad user(s) and the bad job IDs**
    - **IP address**
    - Running RPC transaction count so that we can sort out the bad batch job(s)
    - Type of transaction read?, write? Metadata types?

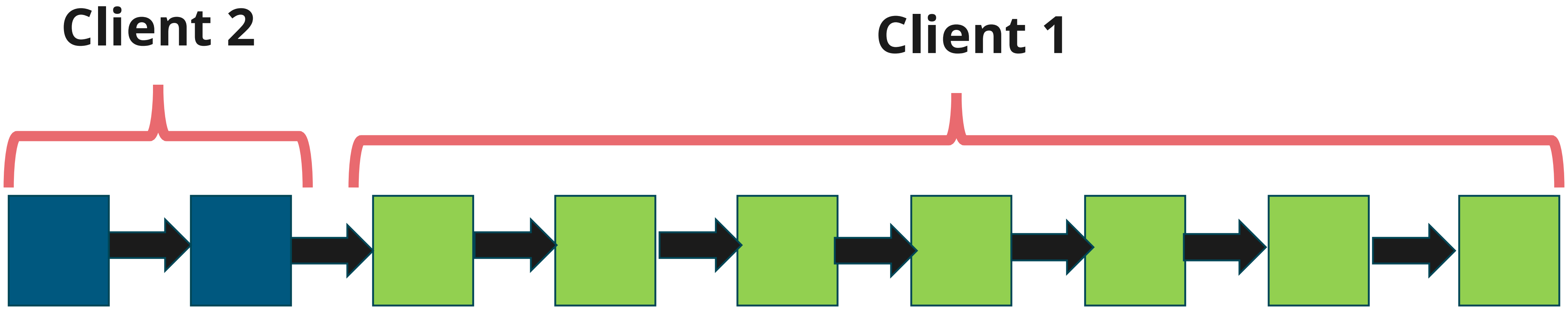


BAD USER IDENTIFICATION TELEMETRY FROM LUSTRE

- **What is missing is the UID/GID of the bad IO customer that we can quickly recover at the MDS and OSS server NRS.**
- New code is being developed for Lustre, to be placed into the Lustre code tree
  - Will provide am streamlined UID/GID association for Bad IO Customers
  - **<UID> <RPC Quantity> <NID address> <Read/Write>**
    - This information is not currently provided in Lustre
  - This information will allow us to work towards **automatically throttling and unthrottling Bad Users**

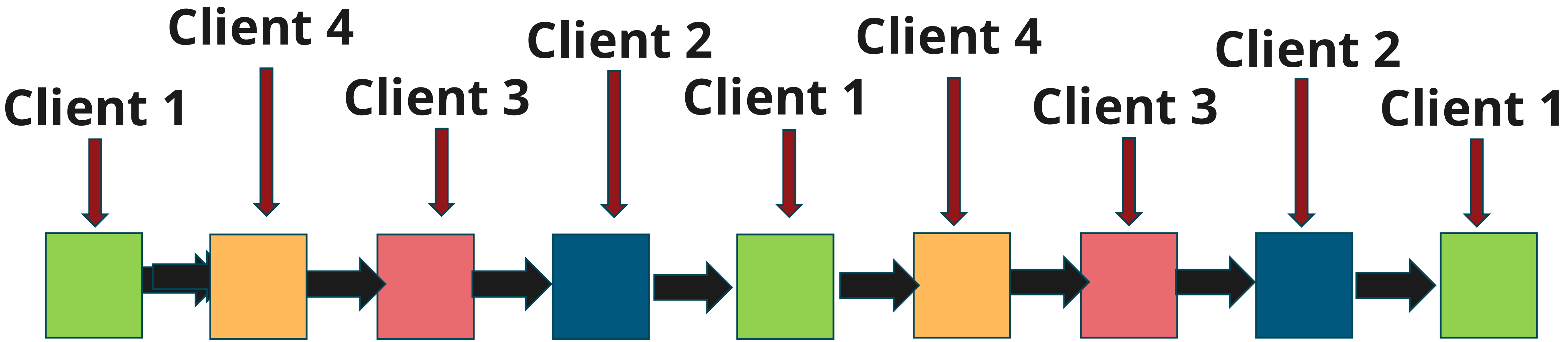
SCHEDULING RPC TRANSACTIONS

- Lustre is set up with a **FIFO RPC scheduling algorithm**. There is Round Robin capabilities that can be implemented to provide better fair-share and provide some initial mitigation to user-based DoS.
  - **Simple**, because you satisfy the Lustre transactions, one-at-a-time
  - **Not optimal** for our **shared filesystems** situation because a single user can more easily ‘bog’ down each server



SCHEDULING RPC TRANSACTIONS

- **Client Round Robin by NID (CRRN)** ★
  - Other clients will be able to get something done with their file IO when a specific user is flooding the Lustre server with IO
  - Each Lustre set of RPC transactions is executed by the servers by NID, as a RPC transaction **'Quantum'** determined by a set quantity of RPC transactions
  - After each Quantum, the next client gets access to the server.
  - **Round-Robin Client IO scheduling and Token Bucket Filters**, at the same time



SPECIAL THANKS AND QUESTIONS

- Chuck Ritter (DDN), Andreas Dilger (Whamcloud), James Simmons (ORNL)
- Questions?