A simple introduction to the Grid

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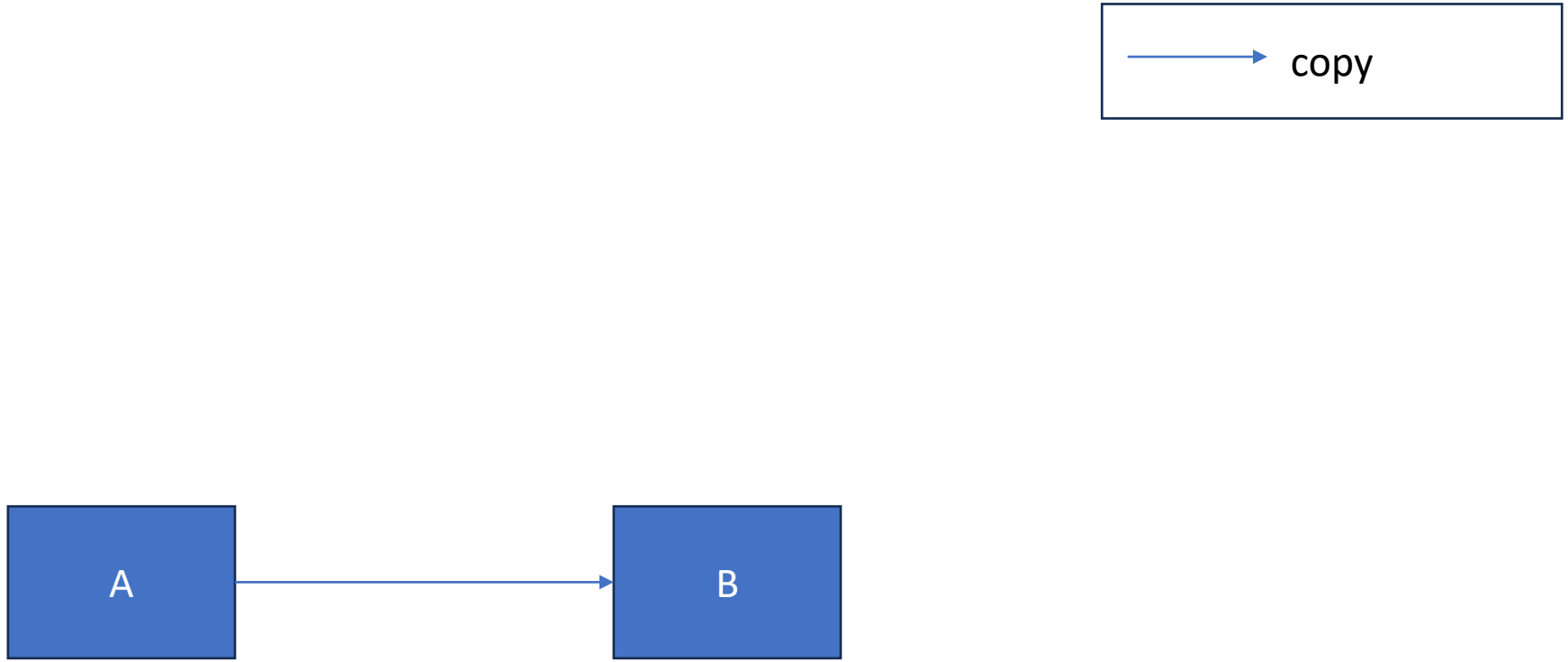
Disclaimer

- This is an oversimplified explanation.
- The order that components are discussed in this presentation may not match the order in which they were created or architected.
- The research generated by the wider grid collaboration[1] is very important, but it will not be covered by this presentation and will be generalised as ‘Science’.
- This presentation is meant to give a broad idea on what different groups/software do and why they’re used in the Grid
- The list of software discussed is not exhaustive. There are other software and groups that are part of the grid but won’t be covered here.

[1] https://lpcc.web.cern.ch/lhc-data-publications

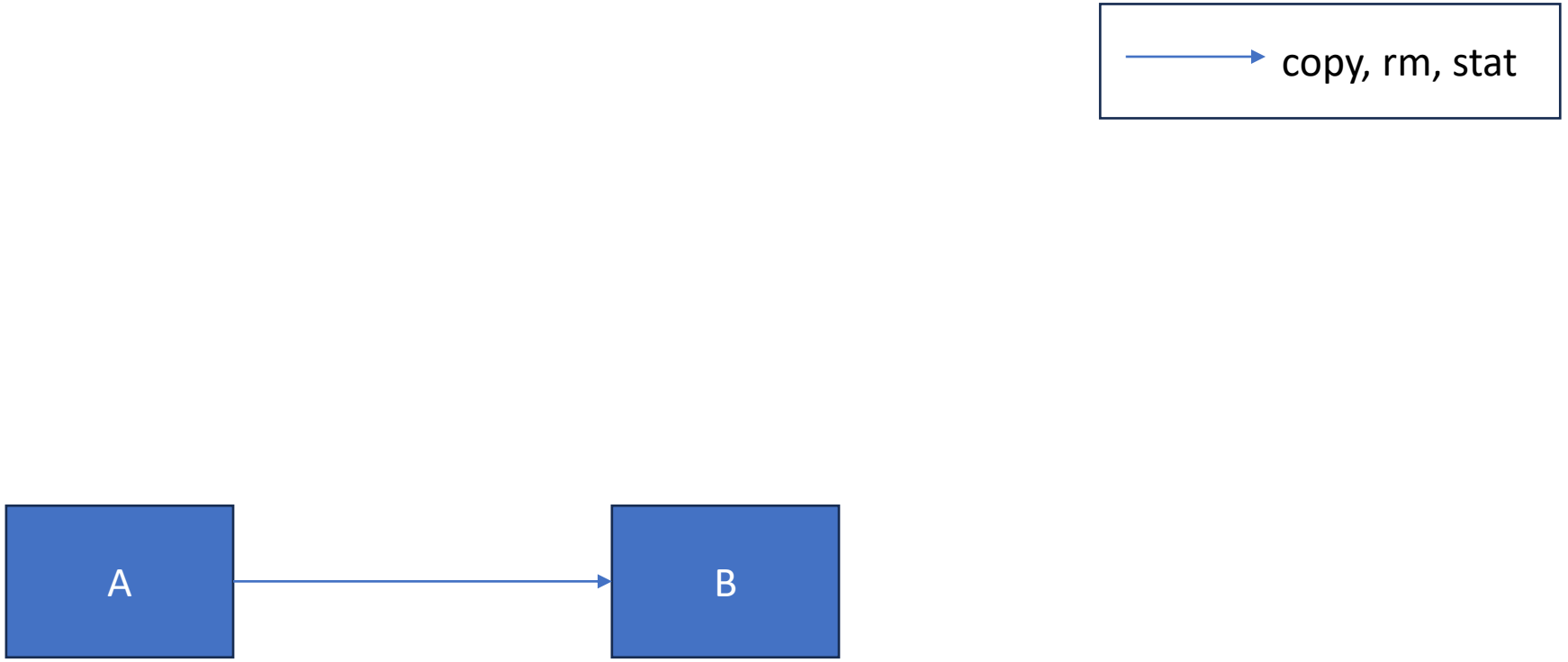
I want to copy a file


copy
A
B

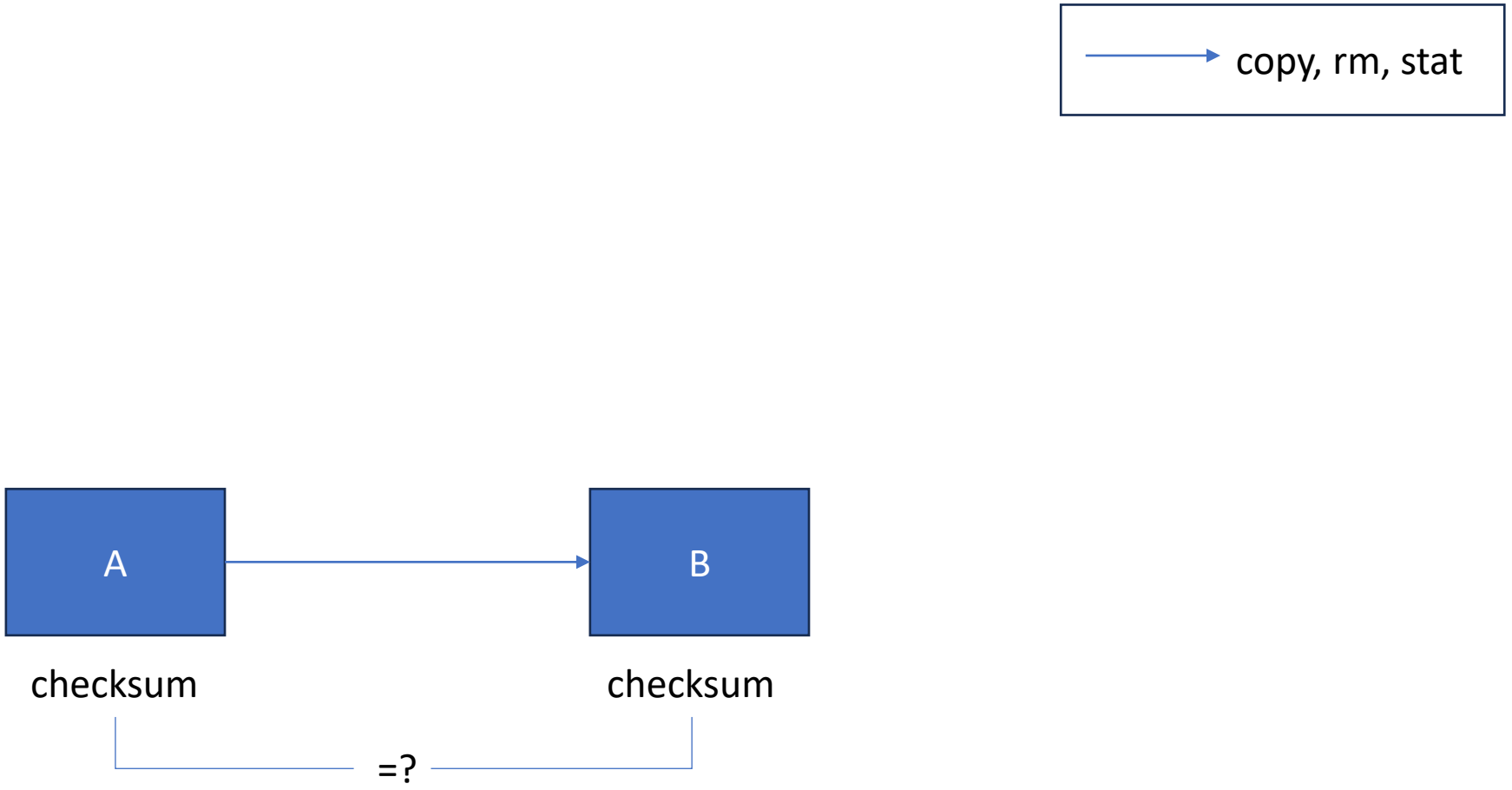
I need to delete it now


copy, rm
A
B

Does it exist? How big is it?

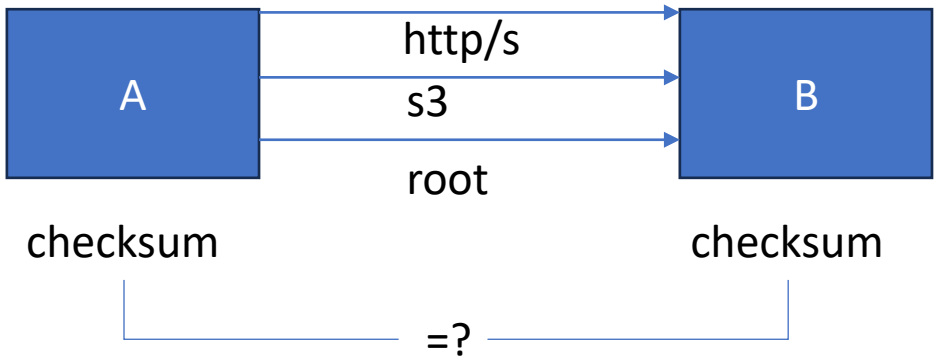

copy, rm, stat
A
B

Is the file I got the right one?


copy, rm, stat
A
B
checksum
checksum
=?

How do you want to copy it?

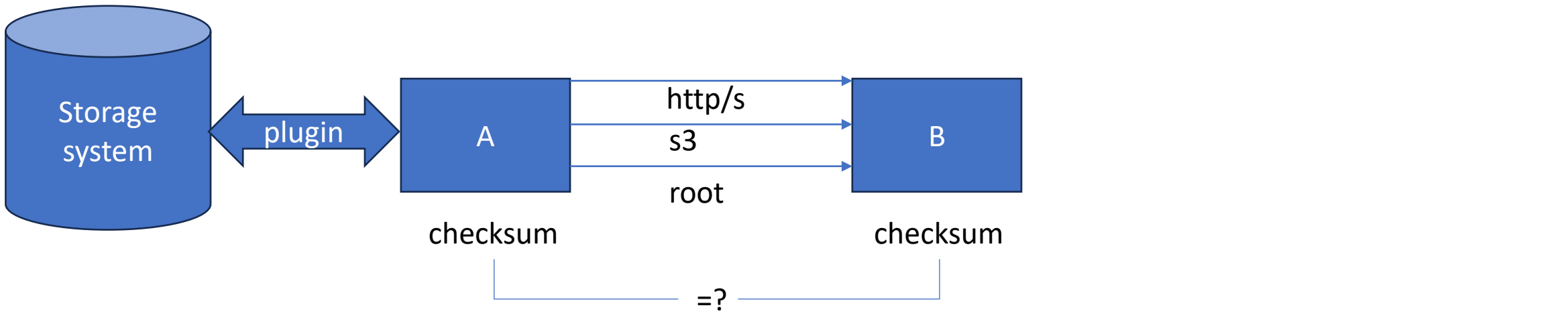
Or, the proliferation of protocols



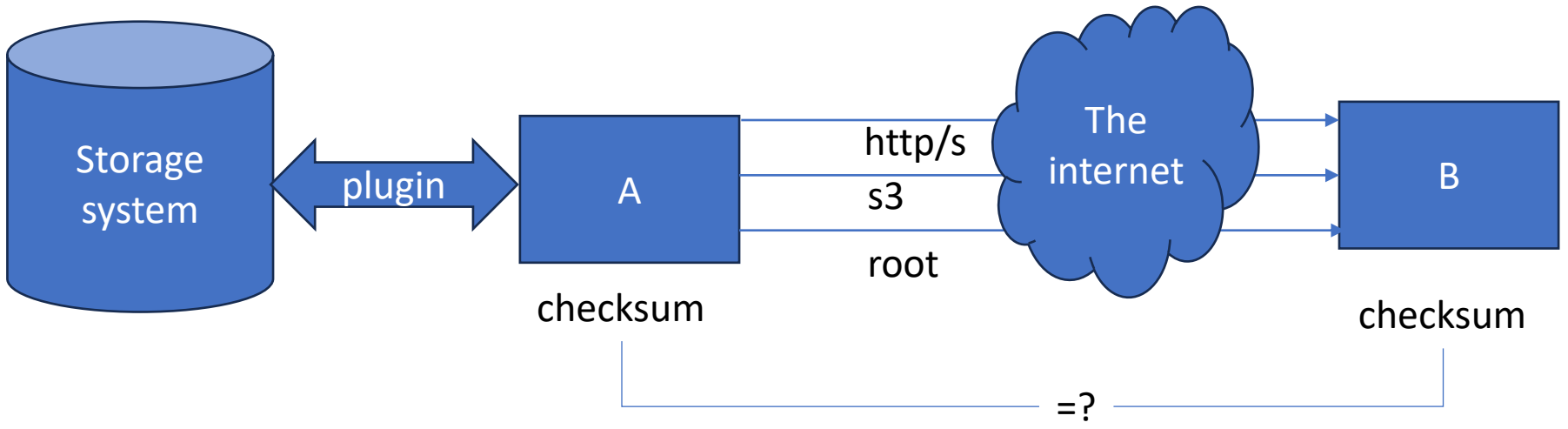
copy, rm, stat

The file is part of a large dataset

Too big for 1 computer

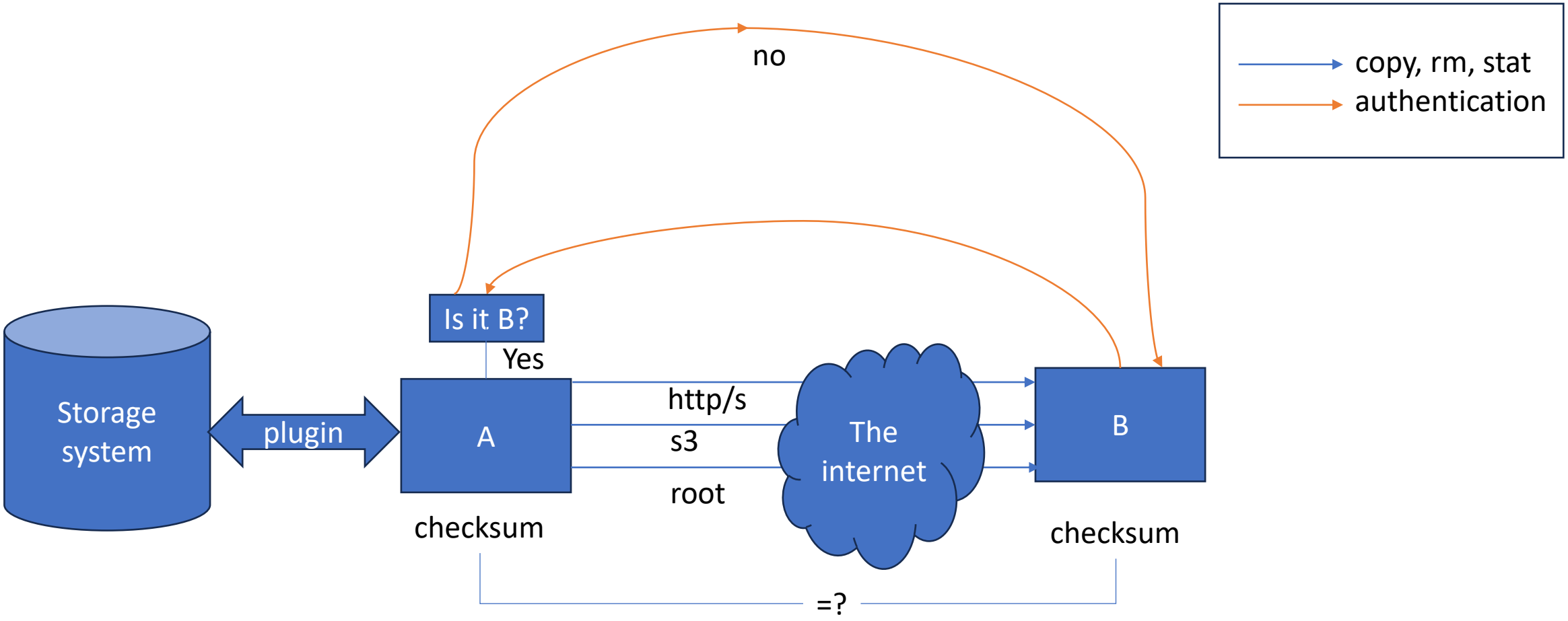

copy, rm, stat
Storage system
plugin
A
http/s
s3
root
B
checksum
checksum
=?

I want to copy it far away

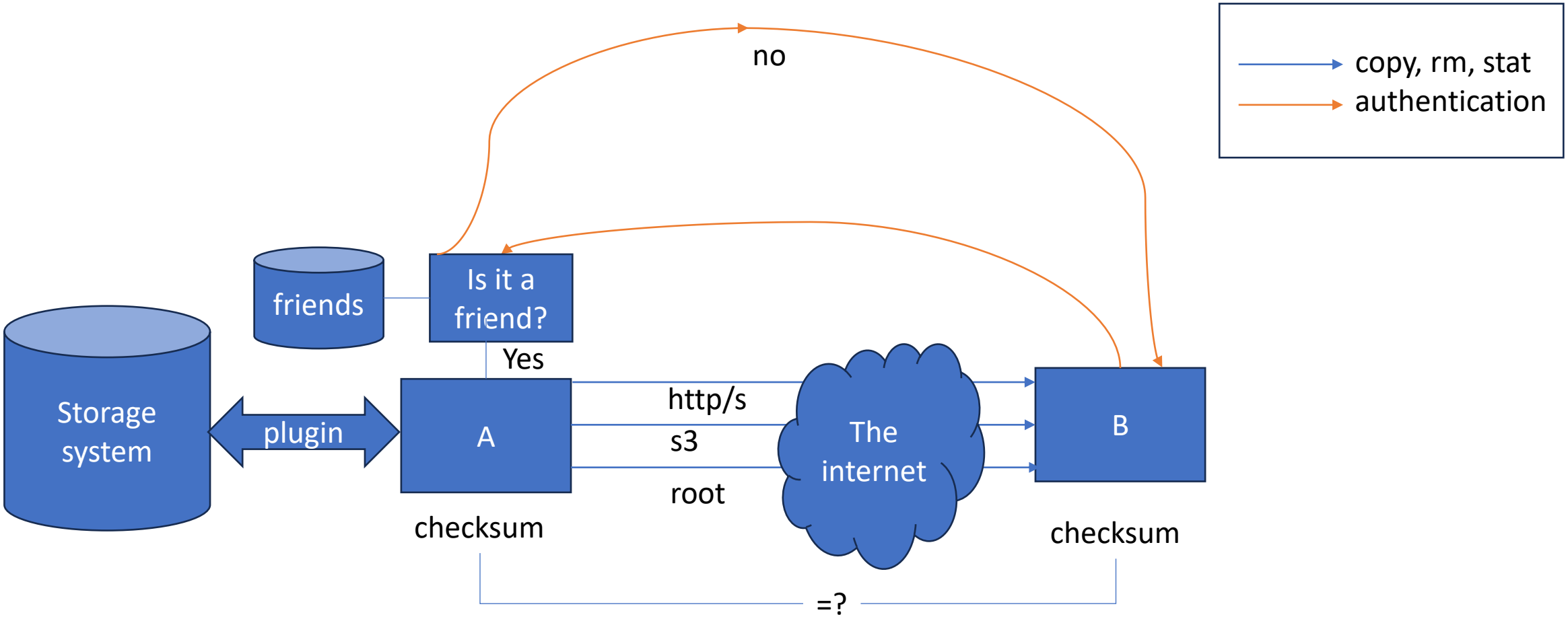

copy, rm, stat
Storage system
plugin
A
http/s
s3
root
The internet
B
checksum
checksum
=?

This is a basic xrootd setup.

I don’t want anyone else to have that file

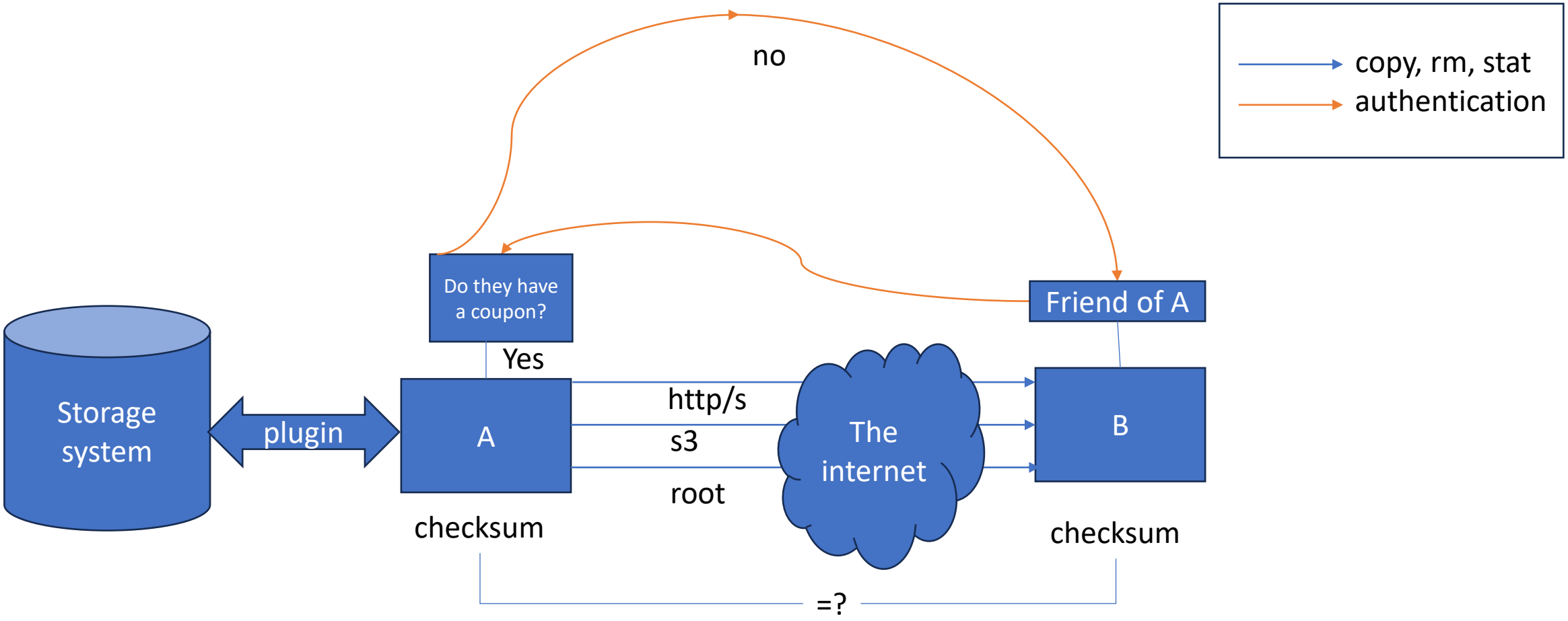

copy, rm, stat
authentication
no
Is it B?
Yes
Storage system
plugin
A
http/s
s3
root
The internet
B
checksum
checksum
=?

Maybe my friends could have that file?


copy, rm, stat
authentication
no
friends
Is it a friend?
Yes
Storage system
plugin
A
http/s
s3
root
The internet
B
checksum
checksum
=?

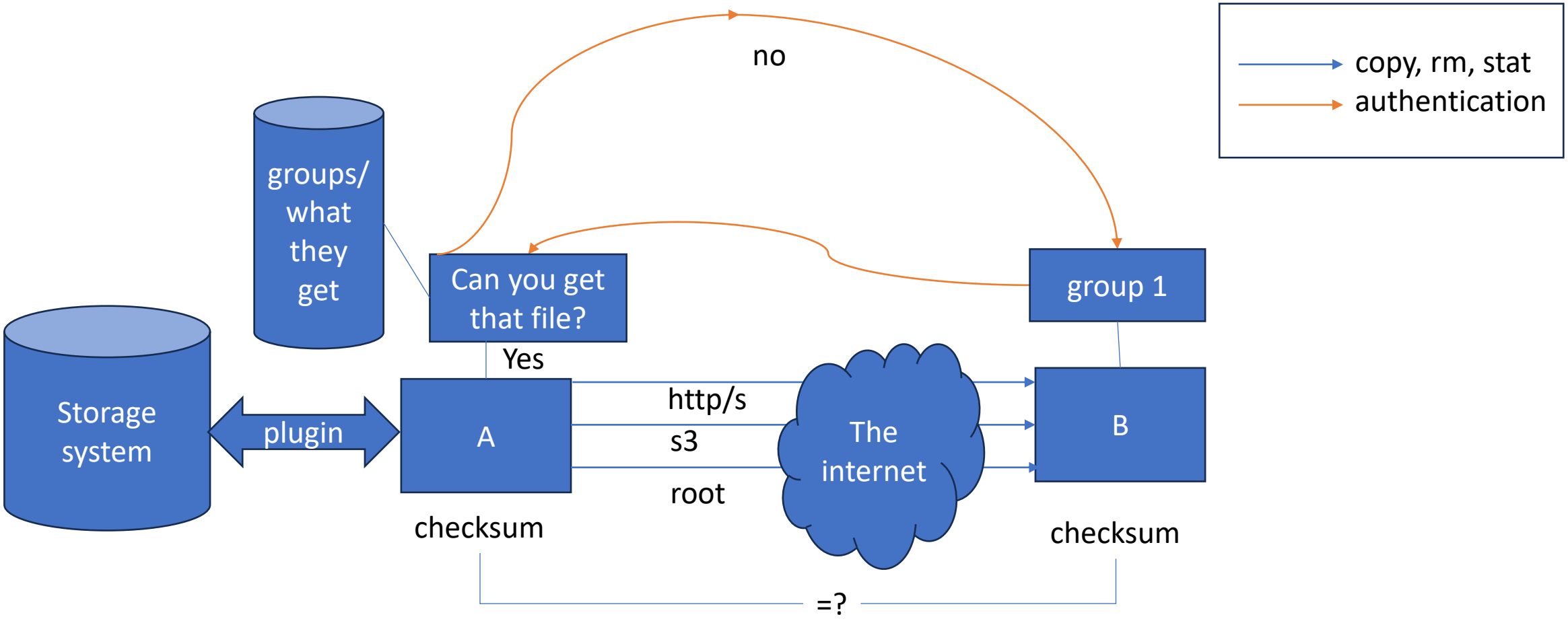
New friends keep joining and leaving and I can’t be bothered to keep track anymore

So I give them a coupon (x509 certificate)


copy, rm, stat
authentication
no
Do they have a coupon?
Yes
Friend of A
Storage system
plugin
A
http/s
s3
root
The internet
B
checksum
checksum
=?

Groups form and they start to want different files from A

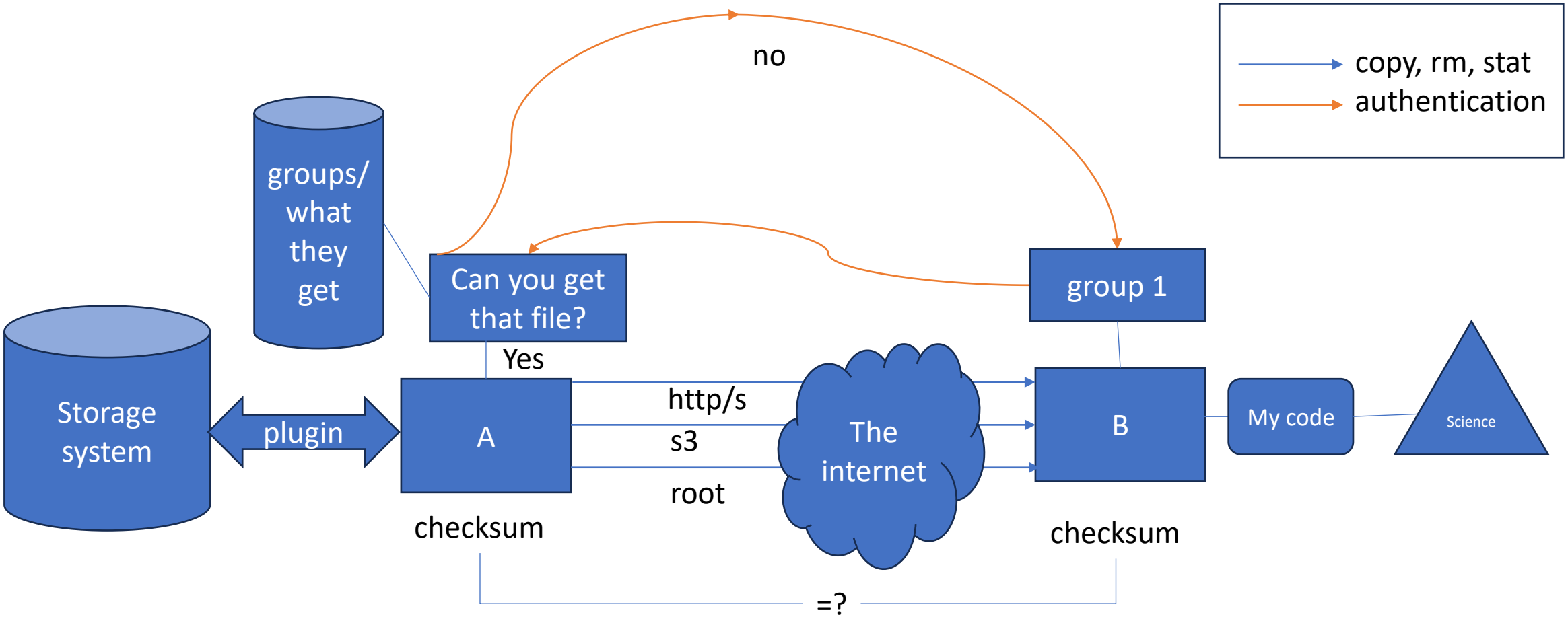
And to not share stuff with each other


copy, rm, stat
authentication
no
groups/
what
they
get
Can you get
that file?
group 1
Yes
Storage
system
plugin
A
http/s
s3
root
The
internet
B
checksum
checksum
=?

You now have an authentication system

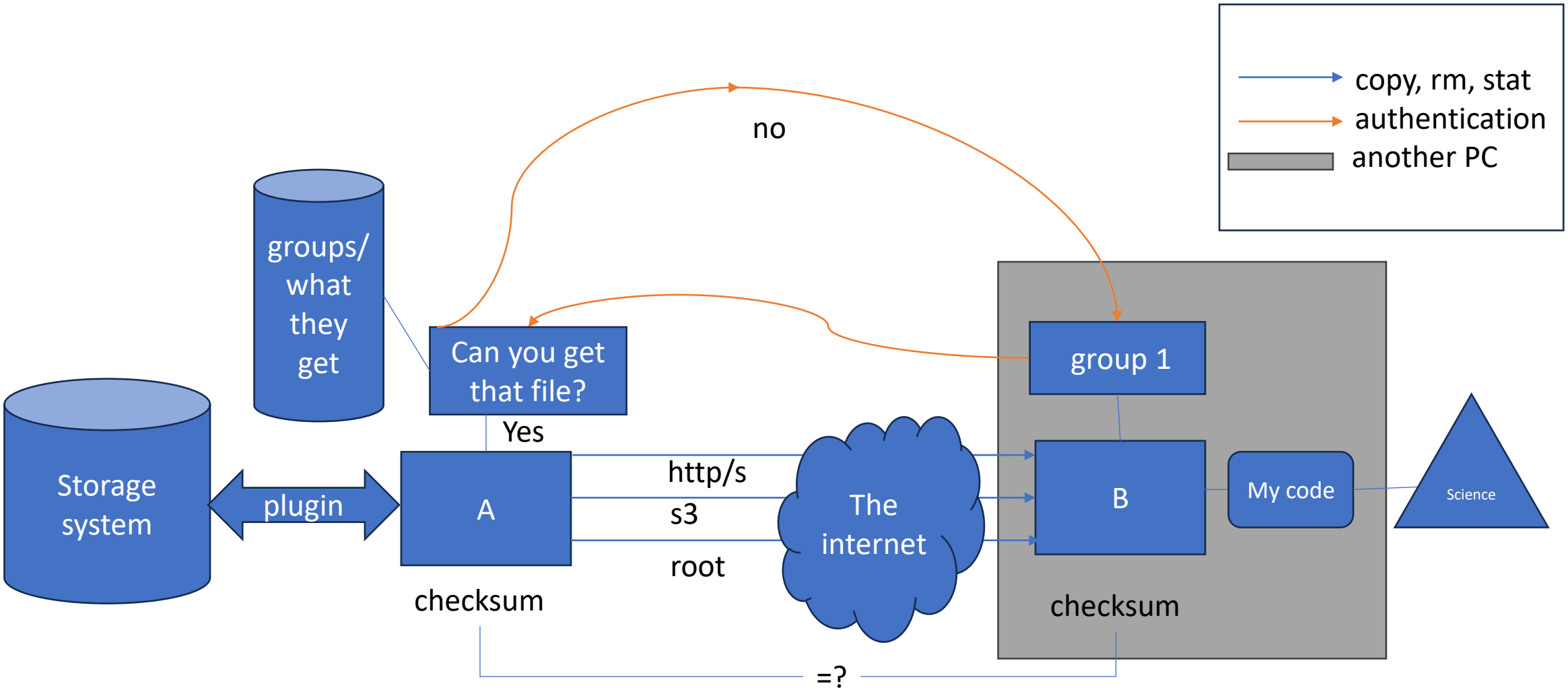
VOMS/tokens

I want to run some code on this file

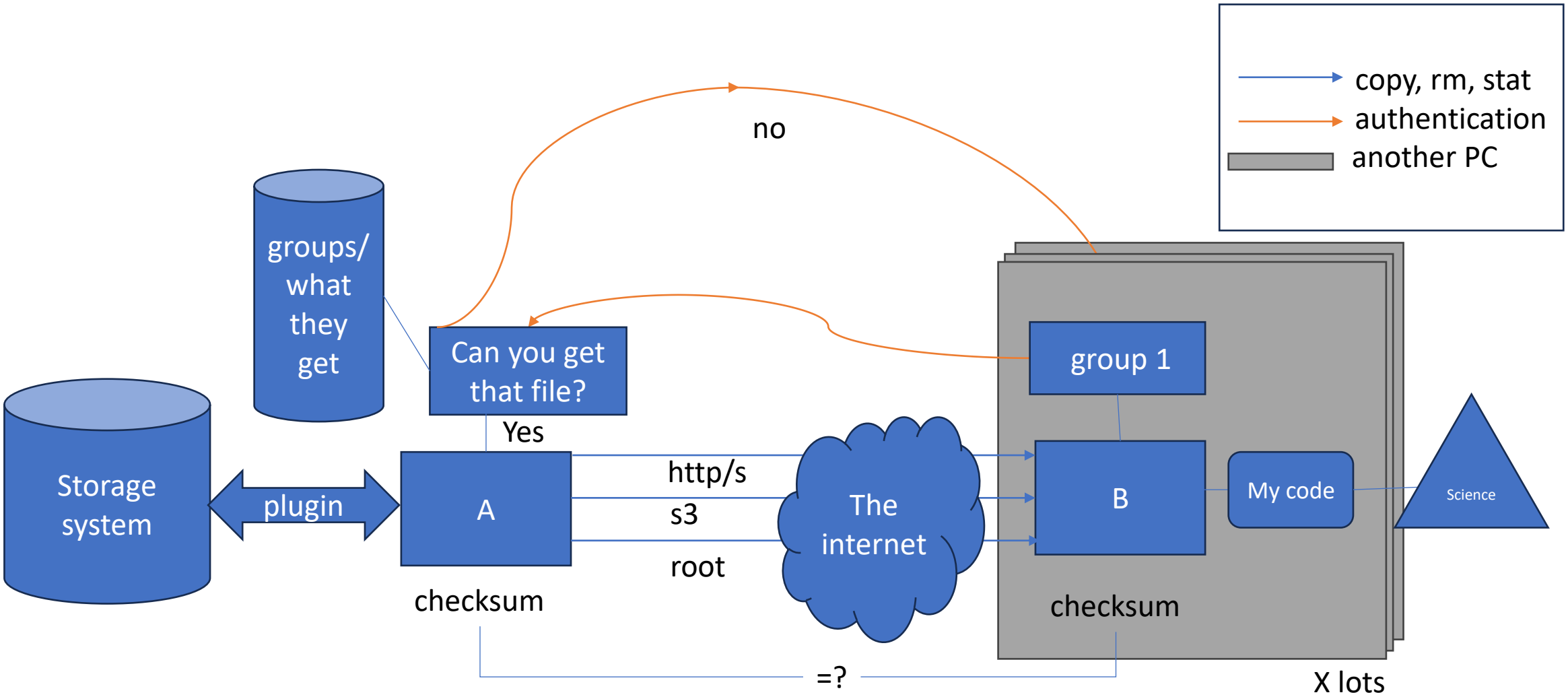

copy, rm, stat
authentication
no
groups/ what they get
Can you get that file?
group 1
Yes
Storage system
plugin
A
http/s
s3
root
The internet
B
My code
Science
checksum
checksum
=?

The code is too powerful

My PC can’t run it

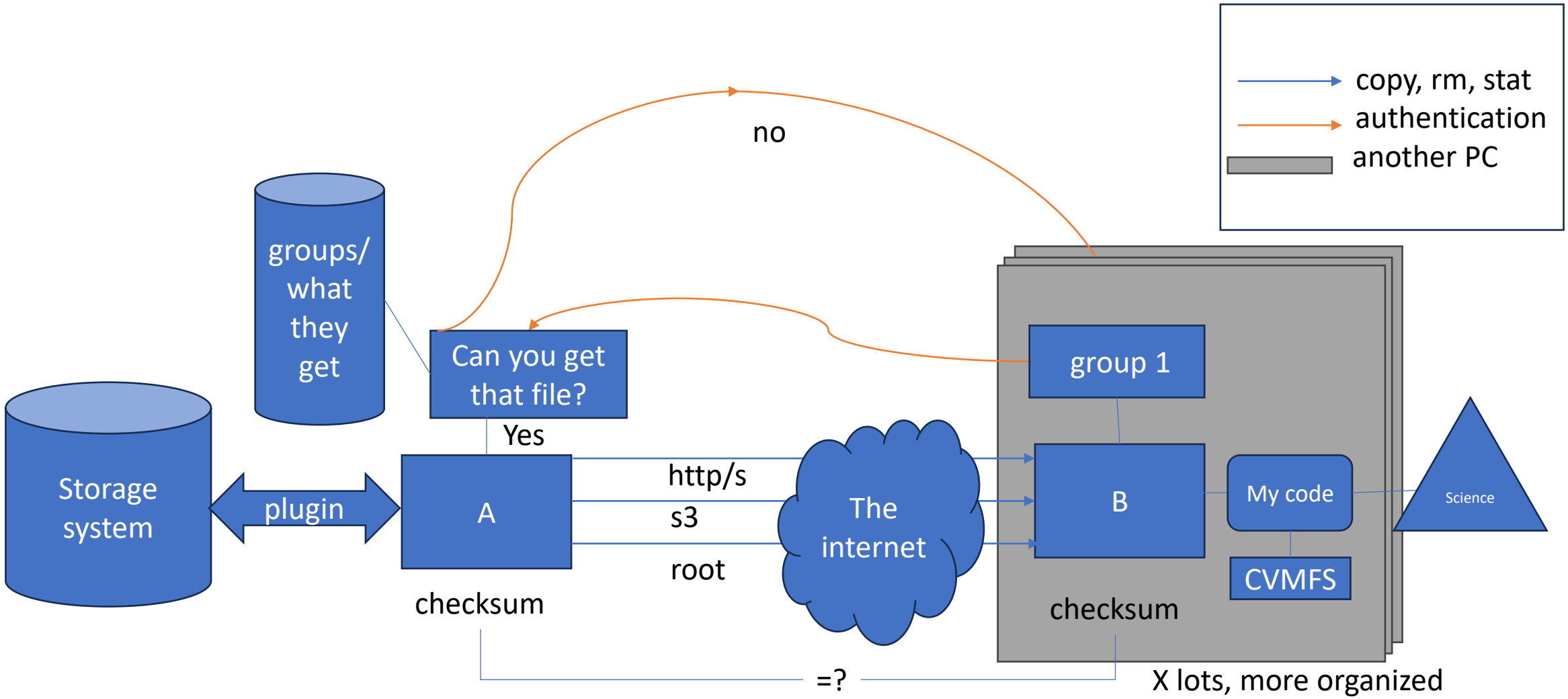

copy, rm, stat
authentication
another PC
no
groups/
what
they
get
Can you get
that file?
Yes
Storage
system
plugin
A
http/s
s3
root
The
internet
group 1
B
My code
Science
checksum
checksum
=?

Lots of people have the same idea


copy, rm, stat
authentication
another PC
no
groups/ what they get
Can you get that file?
Yes
Storage system
plugin
A
checksum
http/s
s3
root
The internet
group 1
B
My code
Science
checksum
=?
X lots

The guy loaning you all his PCs needs to manage this mess

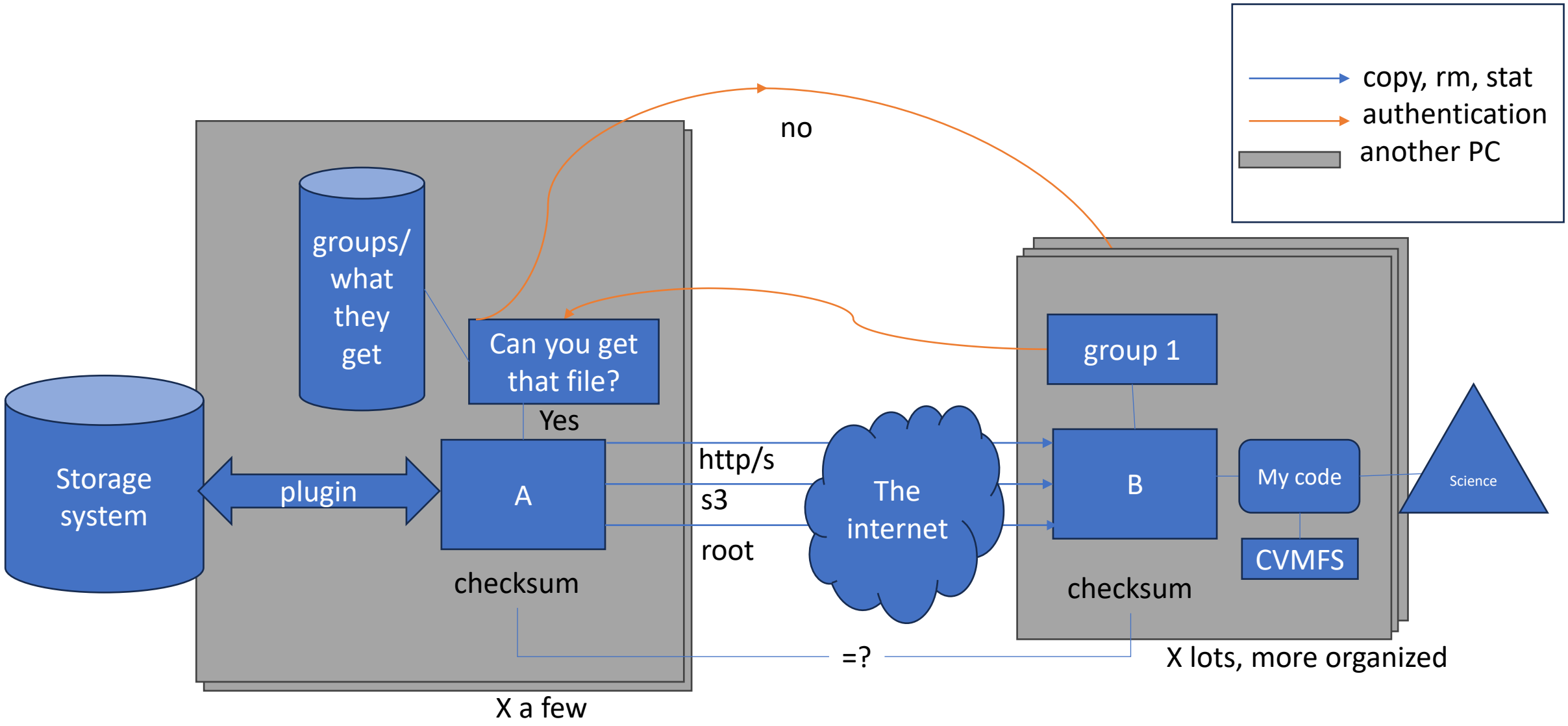
And make sure everyone has all the dependencies they need for the code


copy, rm, stat
authentication
another PC
no
groups/ what they get
Can you get that file?
Yes
Storage system
plugin
A
http/s
s3
root
checksum
The internet
group 1
B
My code
CVMFS
Science
checksum
=?
X lots, more organized

You now have a batch farm

A is getting too many requests

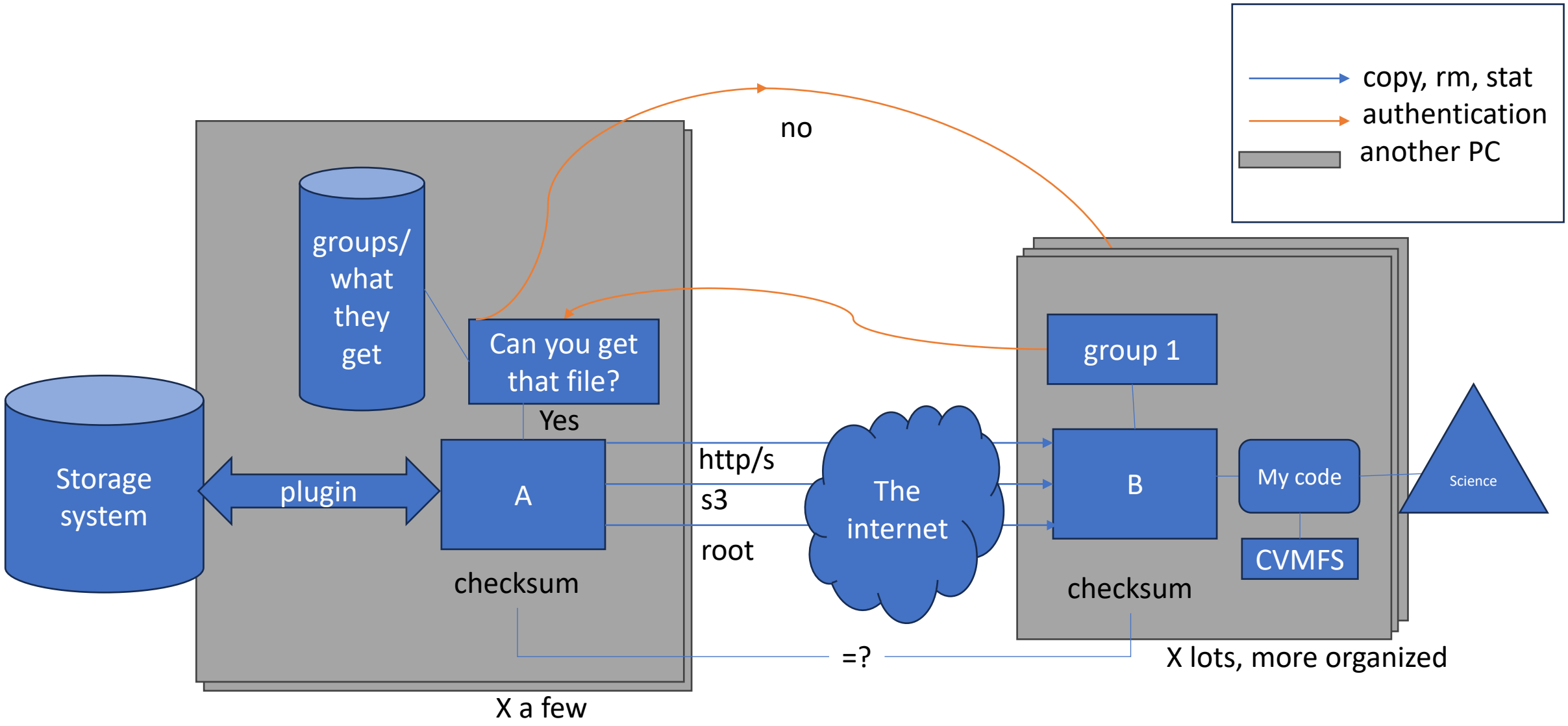
And they also scale up


copy, rm, stat
authentication
another PC
no
groups/ what they get
Can you get that file?
Yes
Storage system
plugin
A
http/s
s3
root
checksum
=?
X a few
The internet
group 1
B
My code
CVMFS
Science
checksum
X lots, more organized

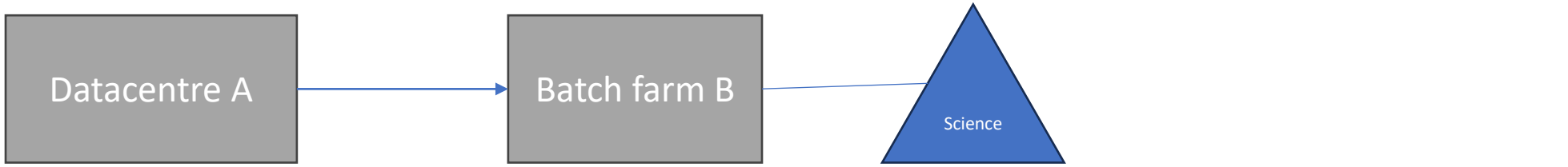
You now have a data centre

Let’s compress things a bit

This


copy, rm, stat
authentication
another PC
no
groups/ what they get
Can you get that file?
Yes
Storage system
plugin
A
http/s
s3
root
checksum
=?
X a few
The internet
group 1
B
My code
CVMFS
Science
checksum
X lots, more organized

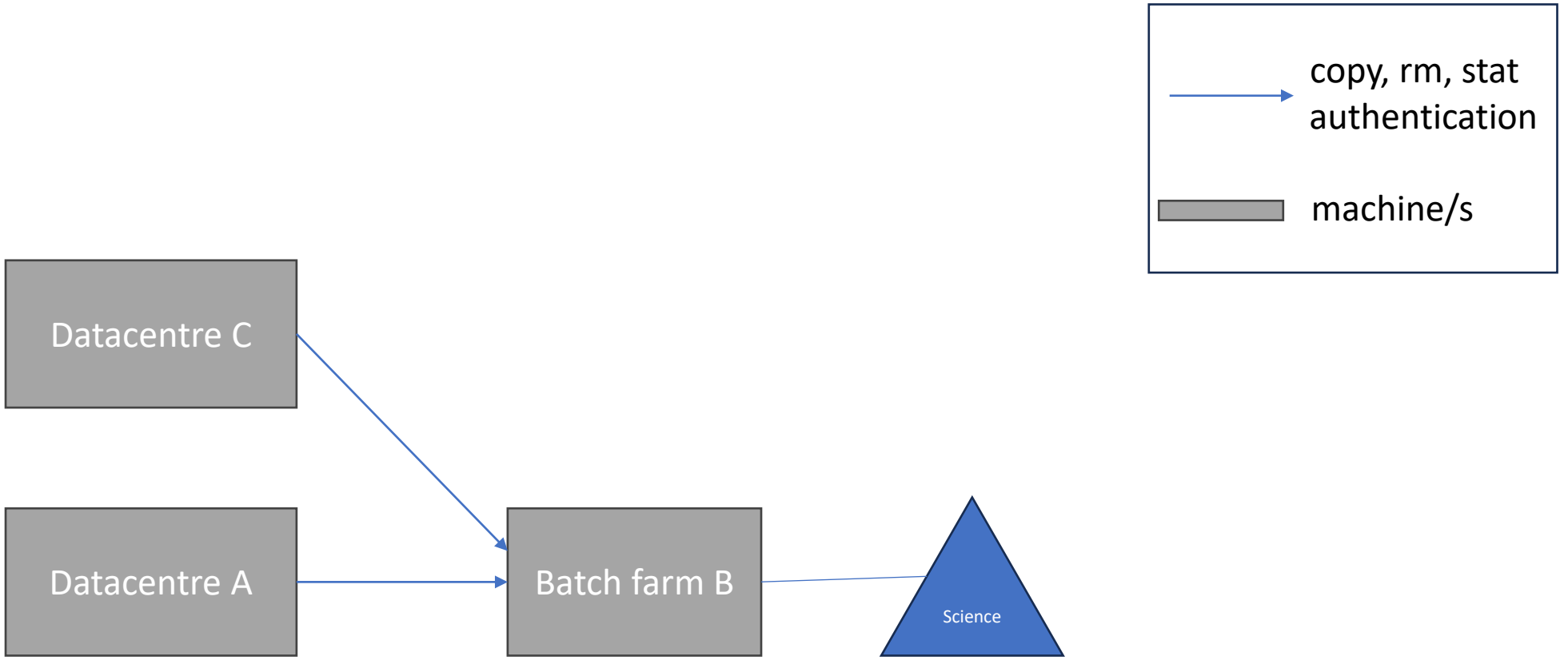
Is now this


copy, rm, stat
authentication
machine/s
Datacentre A
Batch farm B
Science

Ok?

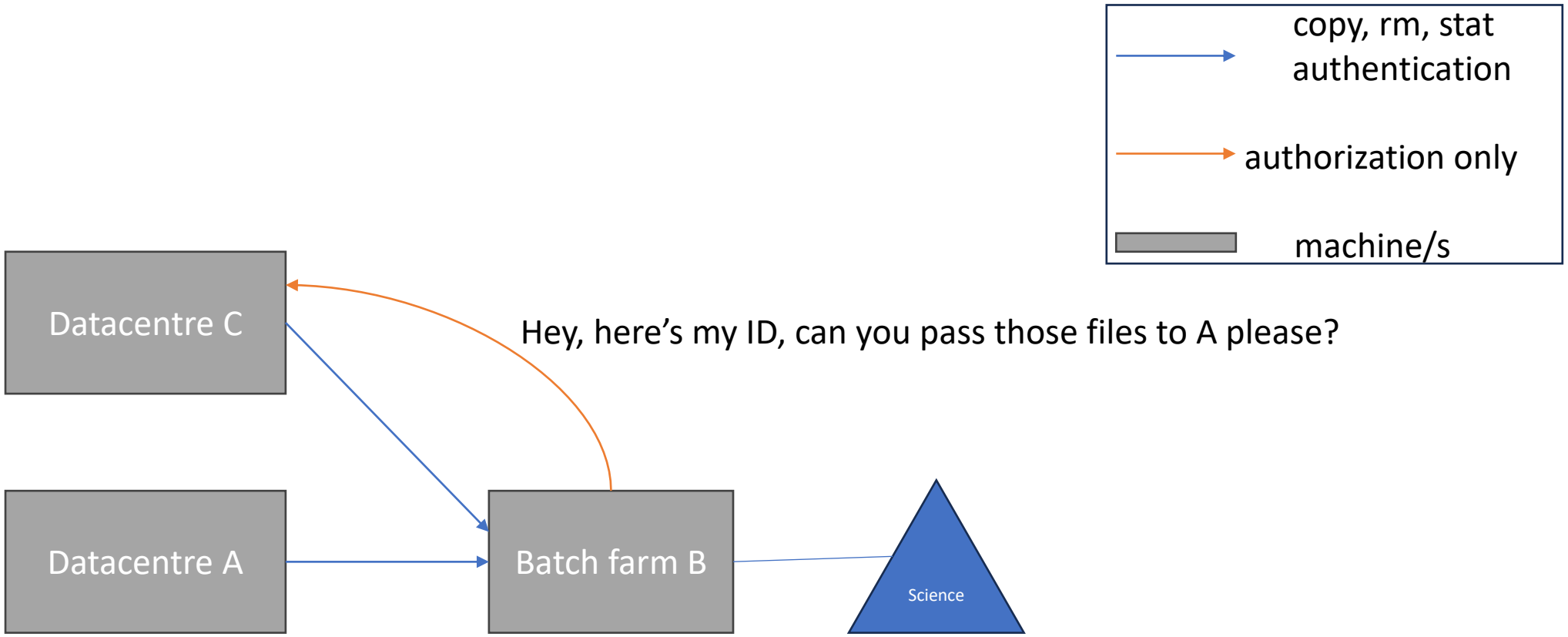
Ok.

C wants to join in and has some new data

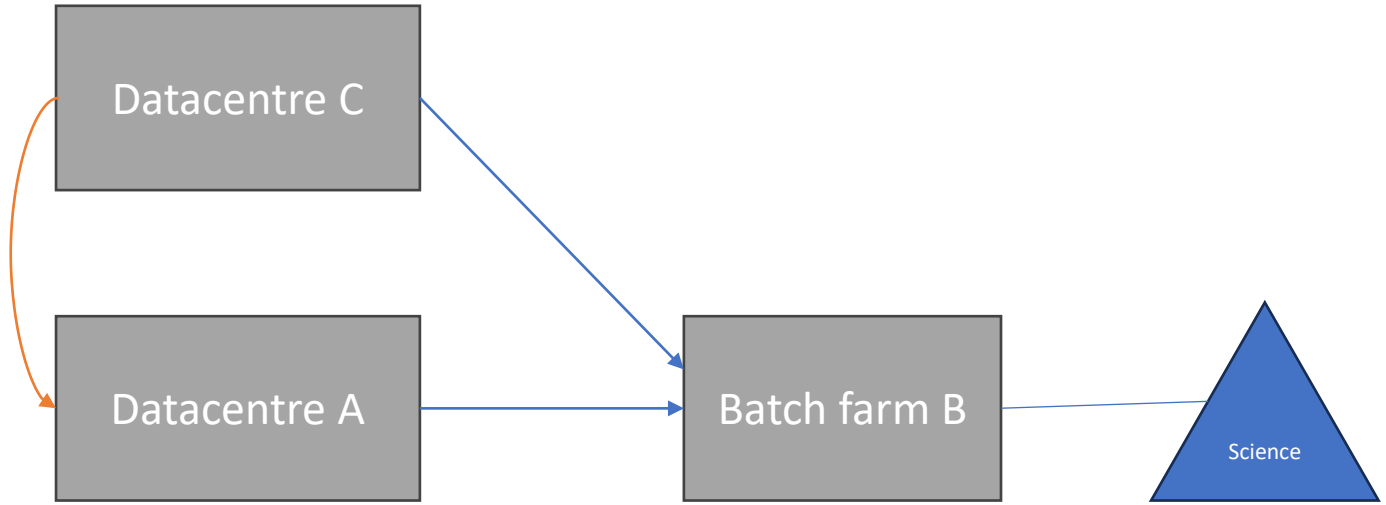

copy, rm, stat
authentication
machine/s
Datacentre C
Datacentre A
Batch farm B
Science

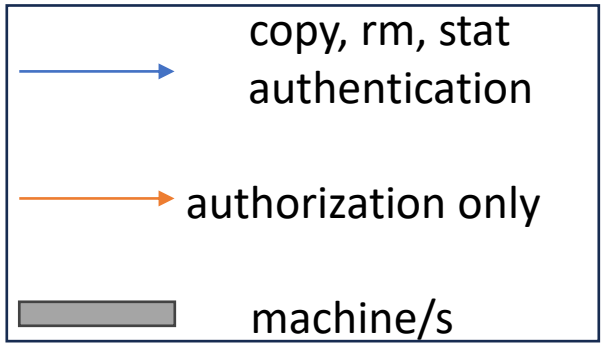
I want to get the new files to A

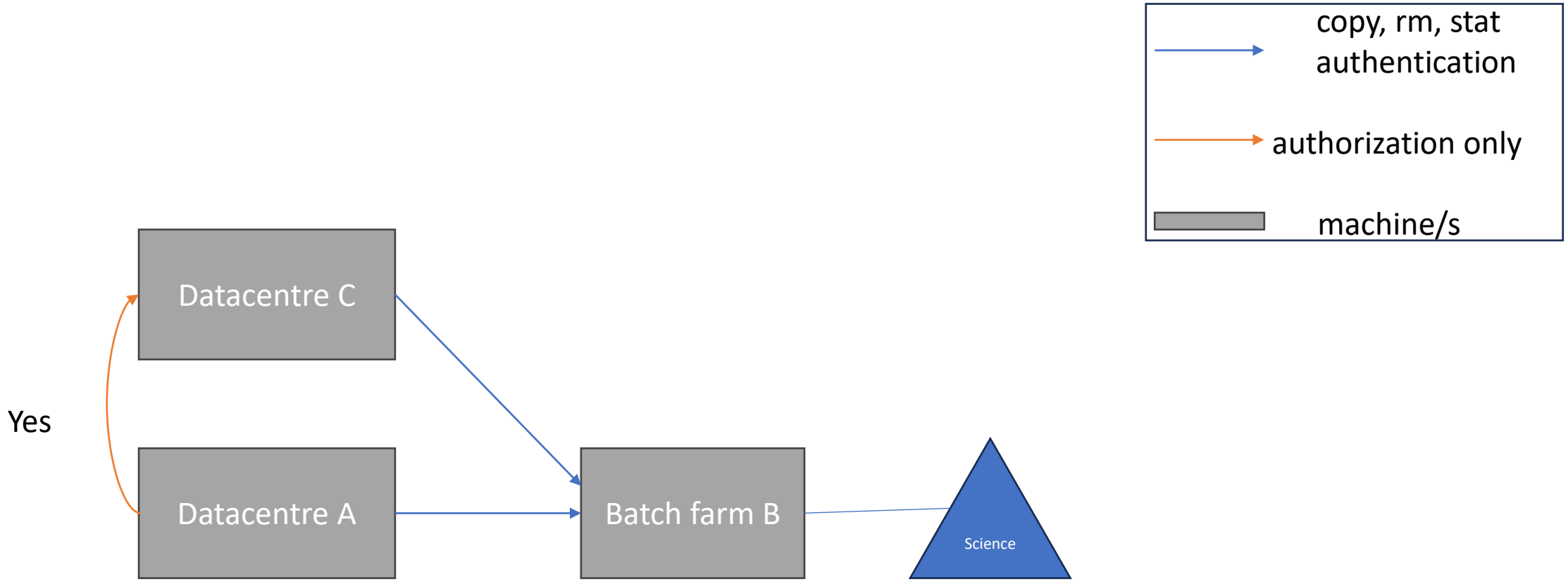
But I don’t have enough space on B

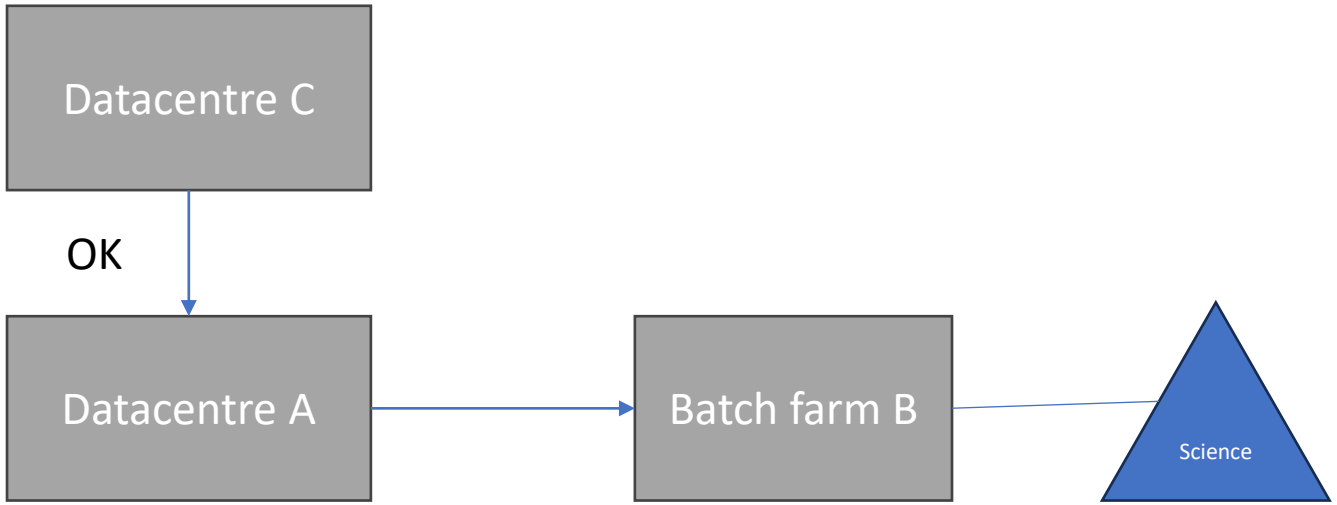

copy, rm, stat
authentication
authorization only
machine/s
Datacentre C
Hey, here's my ID, can you pass those files to A please?
Datacentre A
Batch farm B
Science

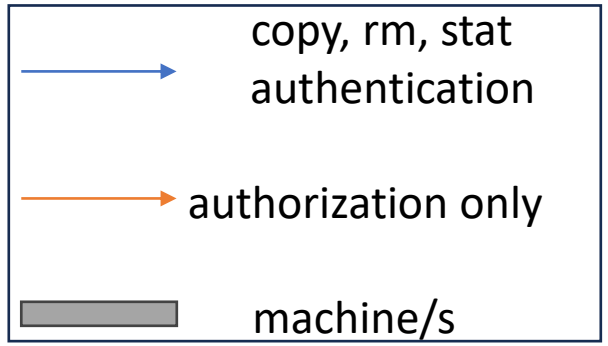
Can B do that?

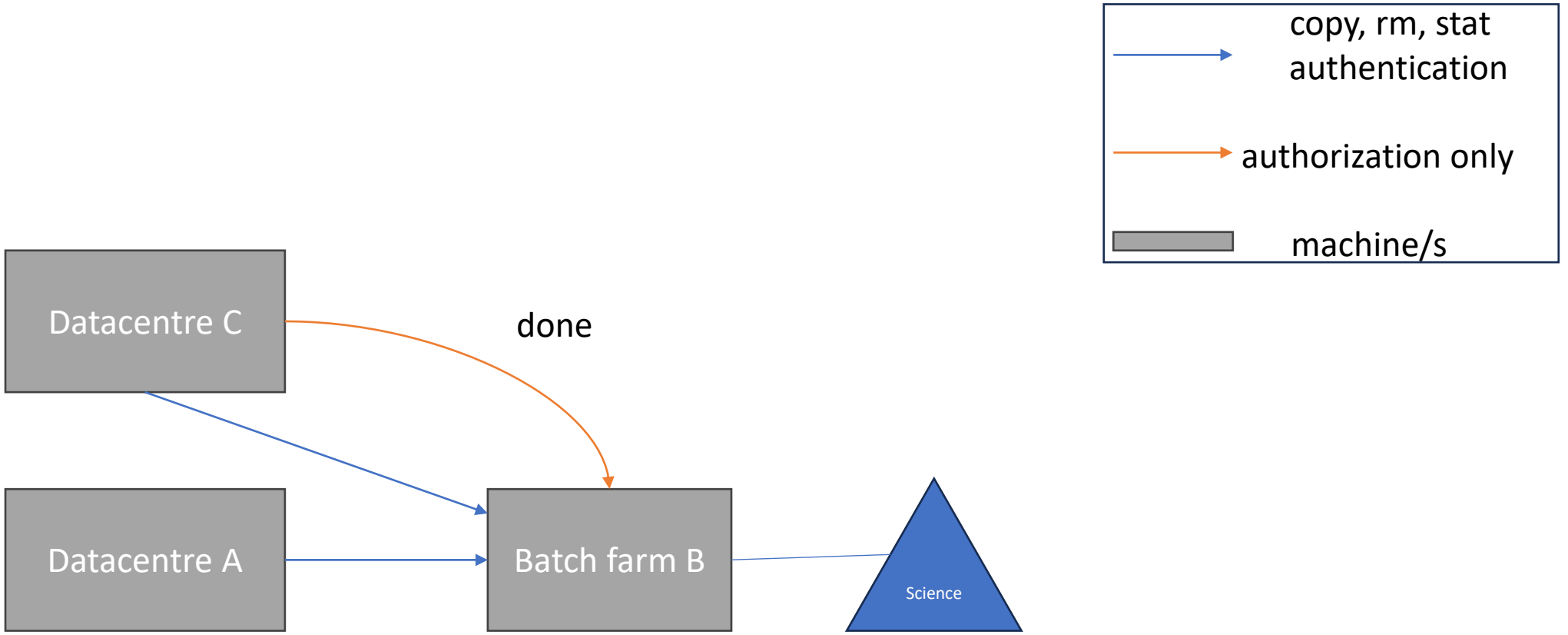

Datacentre C
Datacentre A
Batch farm B
Science


copy, rm, stat
authentication
authorization only
machine/s


copy, rm, stat
authentication
authorization only
machine/s
Datacentre C
Yes
Datacentre A
Batch farm B
Science

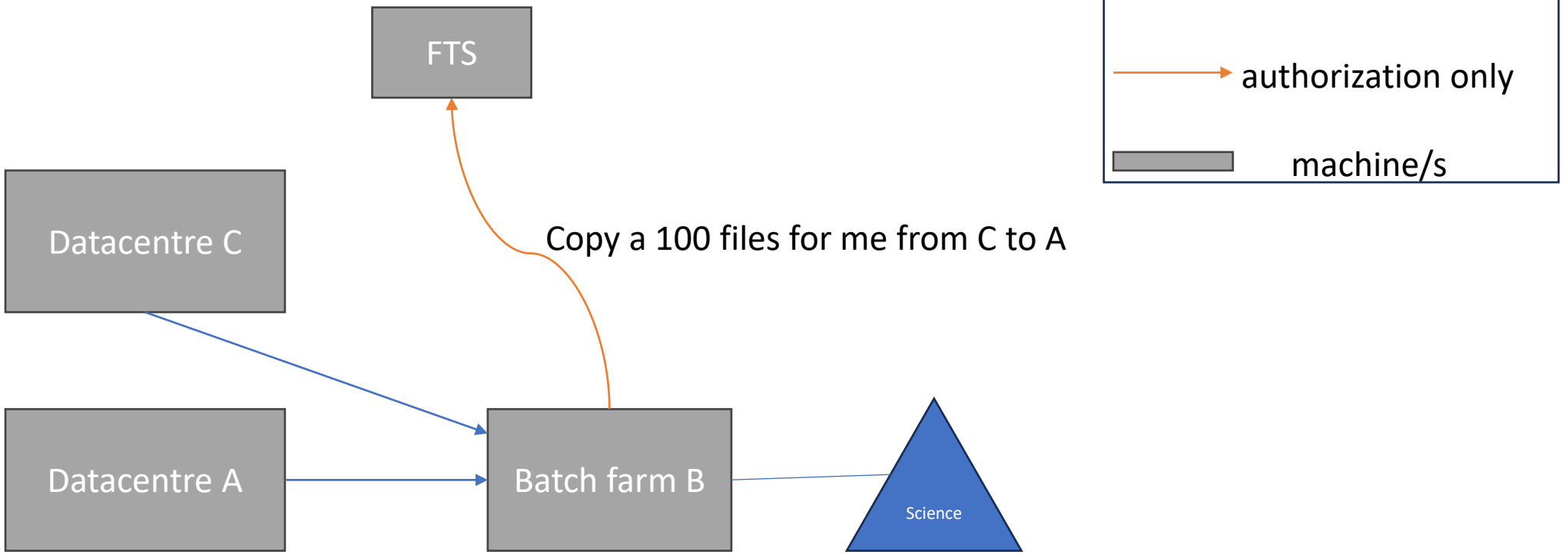

Datacentre C
OK
Datacentre A
Batch farm B
Science

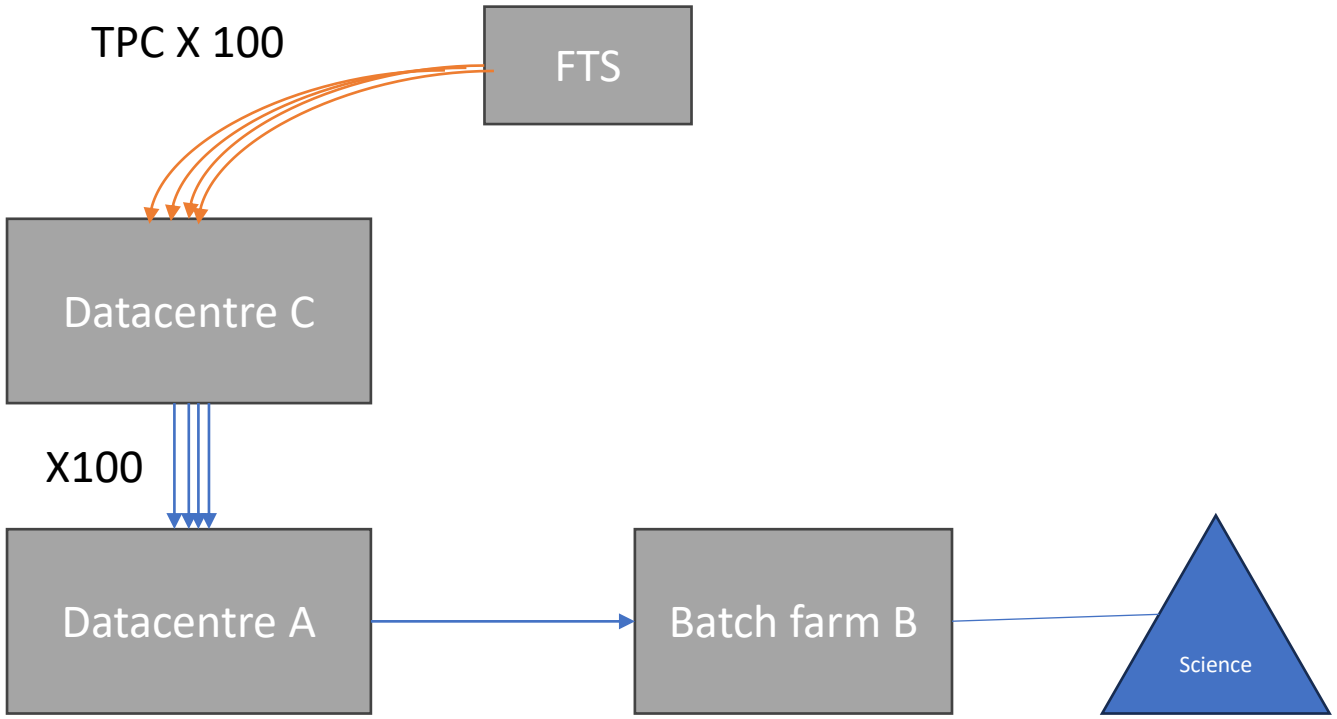

copy, rm, stat
authentication
authorization only
machine/s

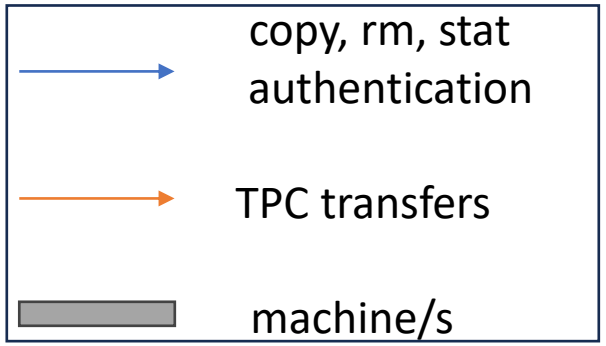

copy, rm, stat
authentication
authorization only
machine/s
Datacentre C
done
Datacentre A
Batch farm B
Science

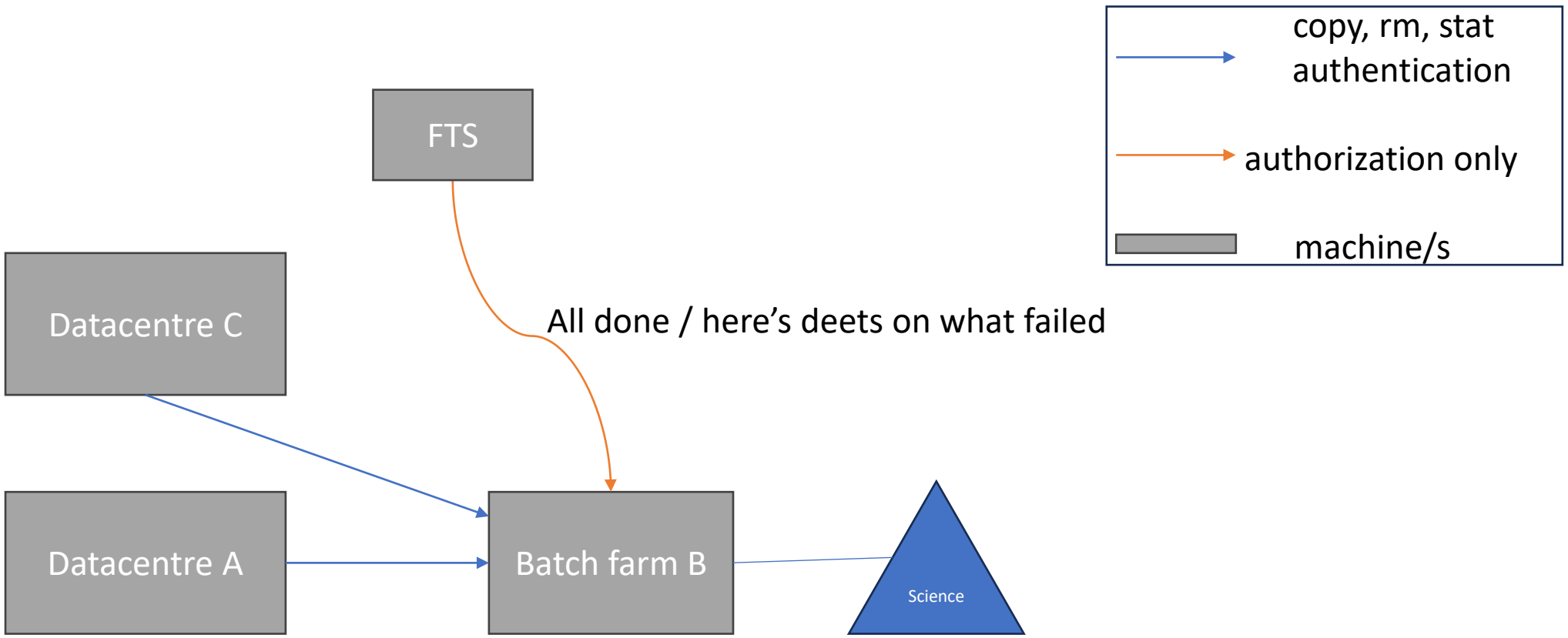
This is how Third Party Copy (TPC) works

I want to send lots of files


copy, rm, stat
authentication
authorization only
machine/s
FTS
Datacentre C
Copy a 100 files for me from C to A
Datacentre A
Batch farm B
Science


TPC X 100
FTS
Datacentre C
X100
Datacentre A
Batch farm B
Science

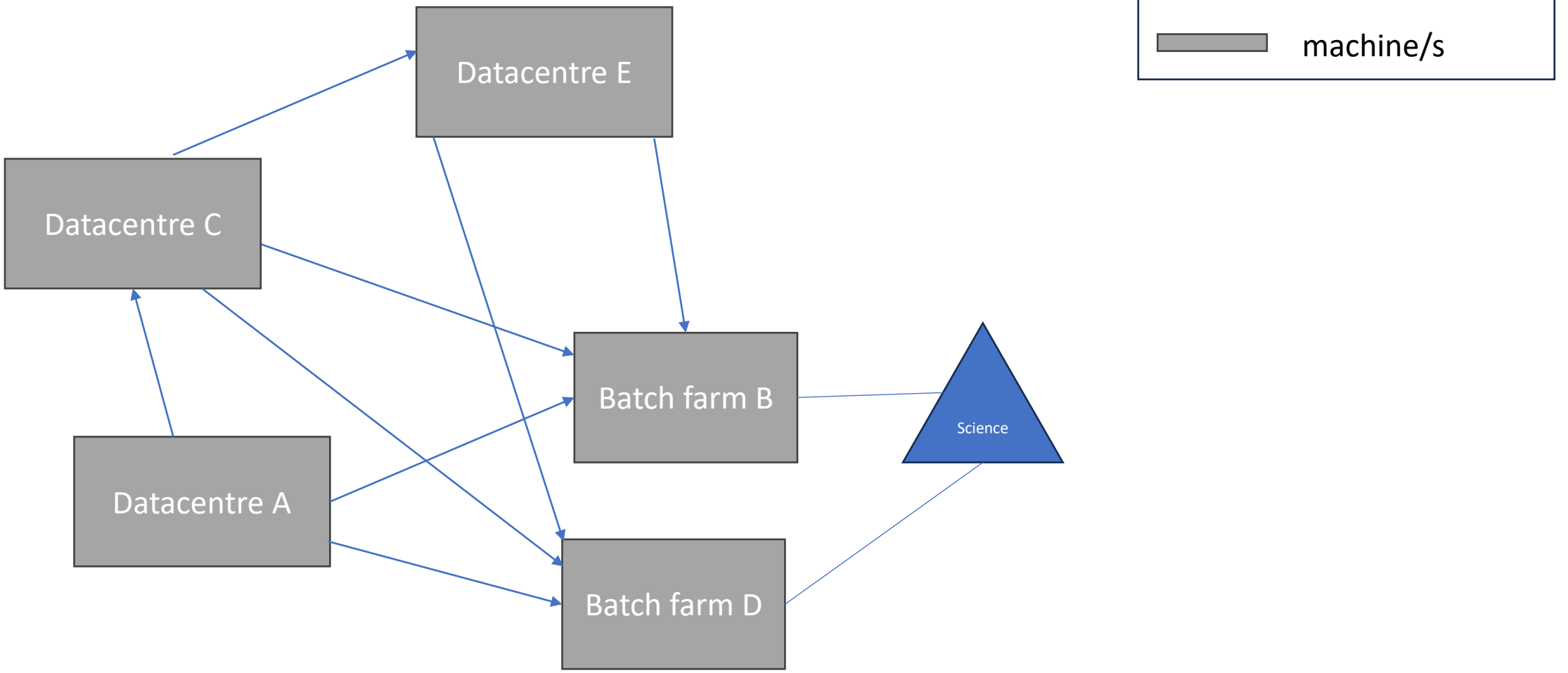

copy, rm, stat
authentication
TPC transfers
machine/s


copy, rm, stat
authentication
authorization only
machine/s
FTS
All done / here's deets on what failed
Datacentre C
Datacentre A
Batch farm B
Science

This is how FTS works

A lot more people get in the action

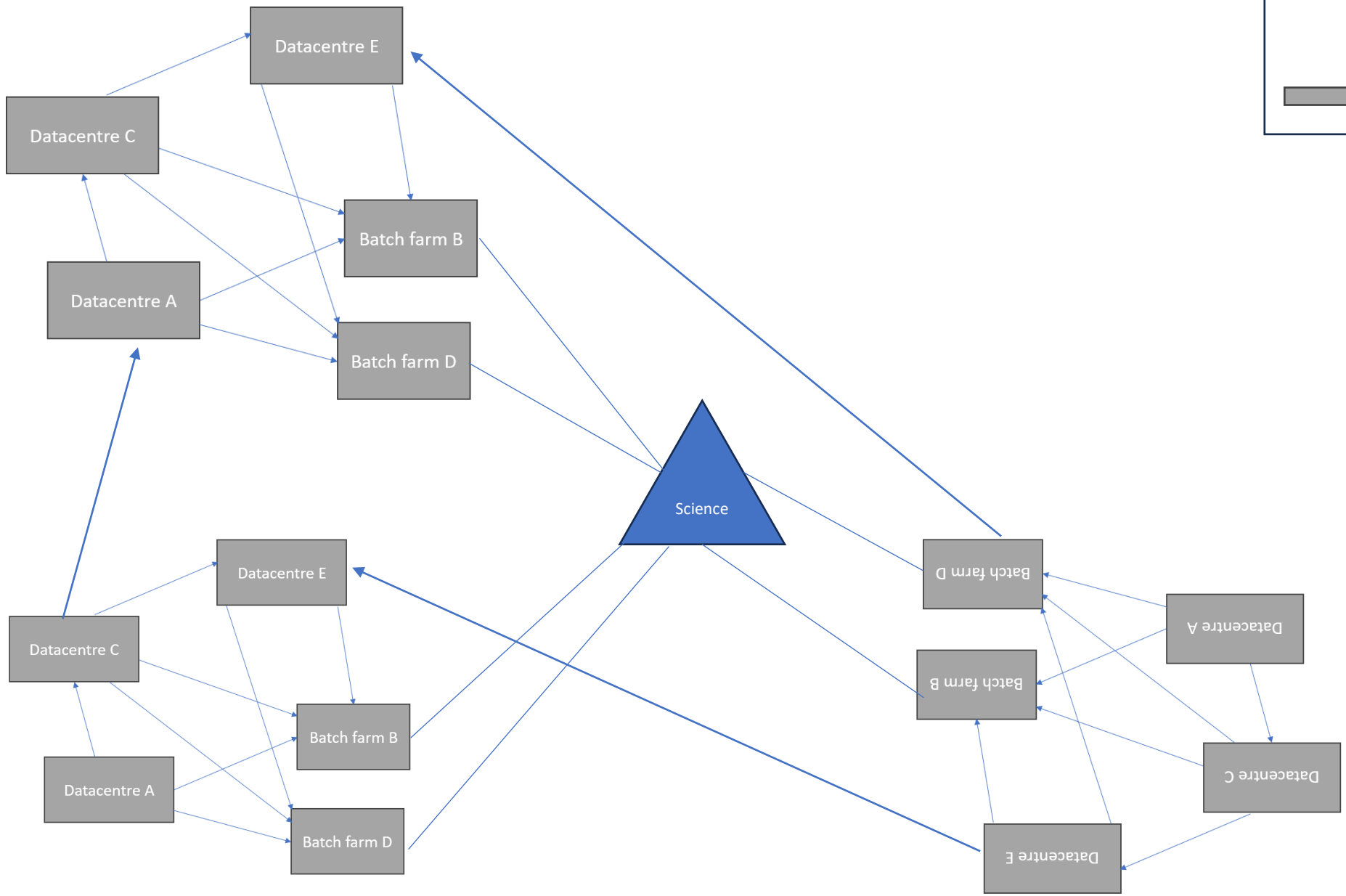
a national collaboration you might say


copy, rm, stat
authentication
machine/s
Datacentre E
Datacentre C
Batch farm B
Science
Datacentre A
Batch farm D

This is a model of the grid (GRIDPP)

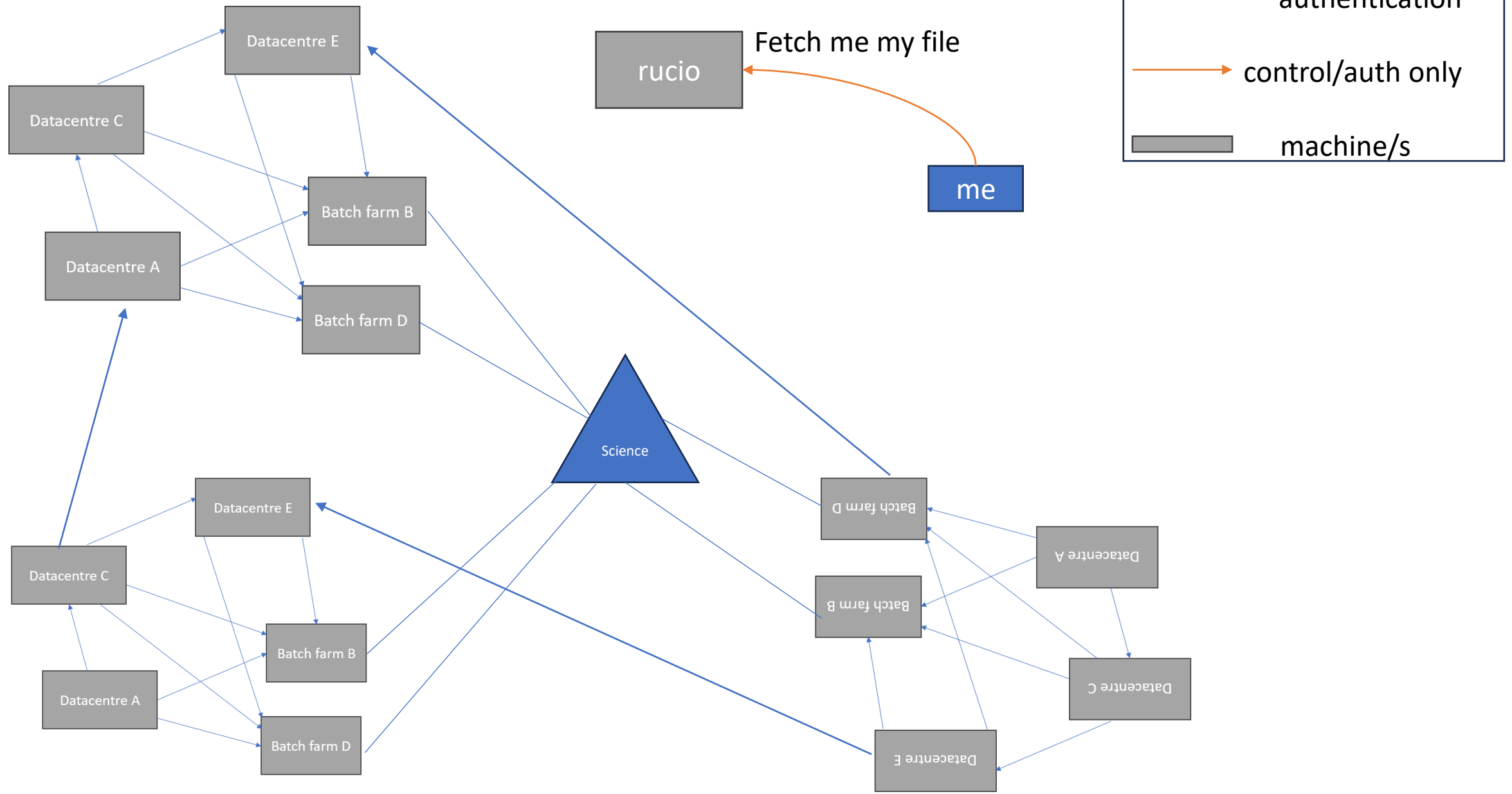
A LOT more people get in the action

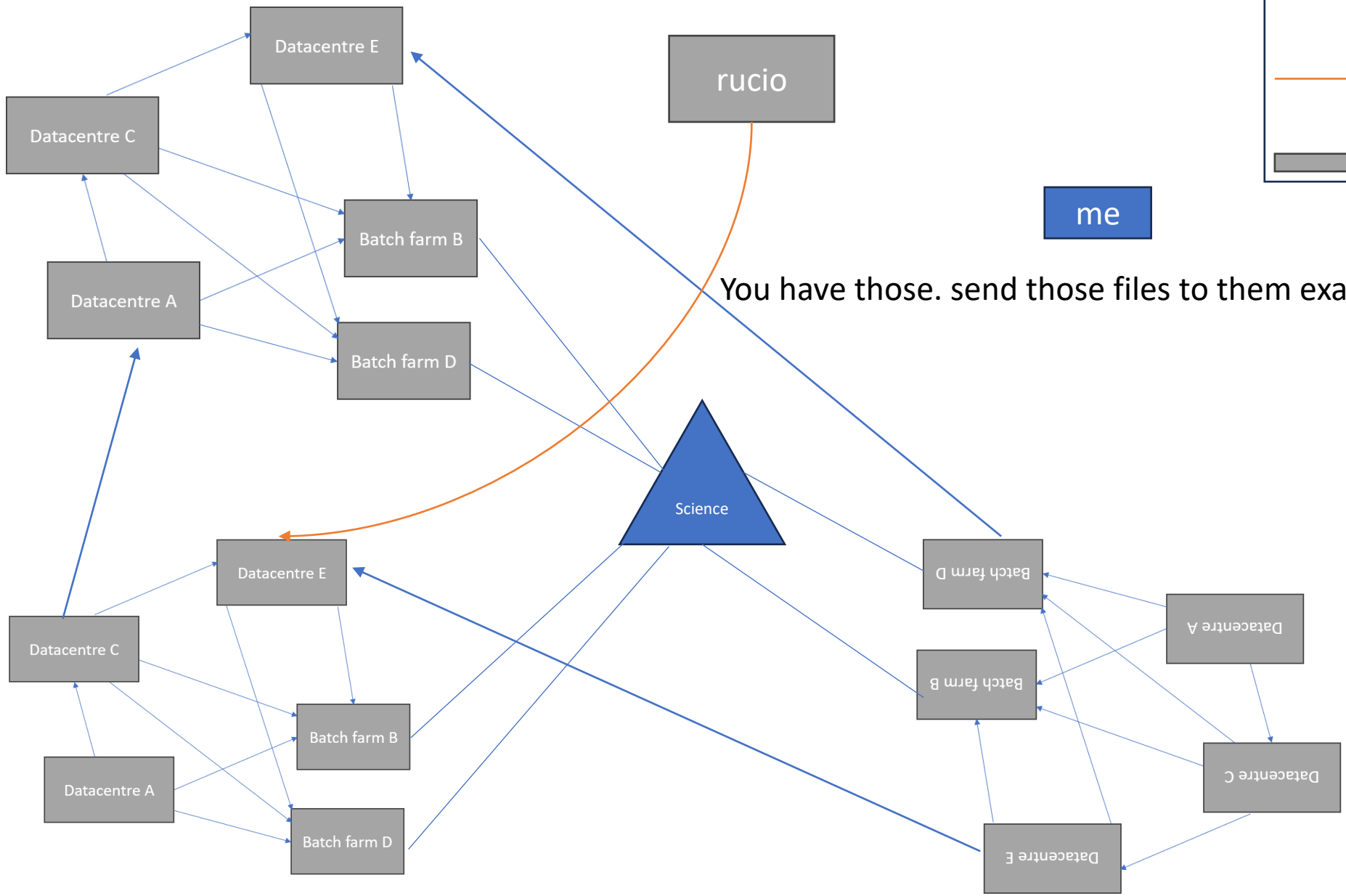
The whole world in fact

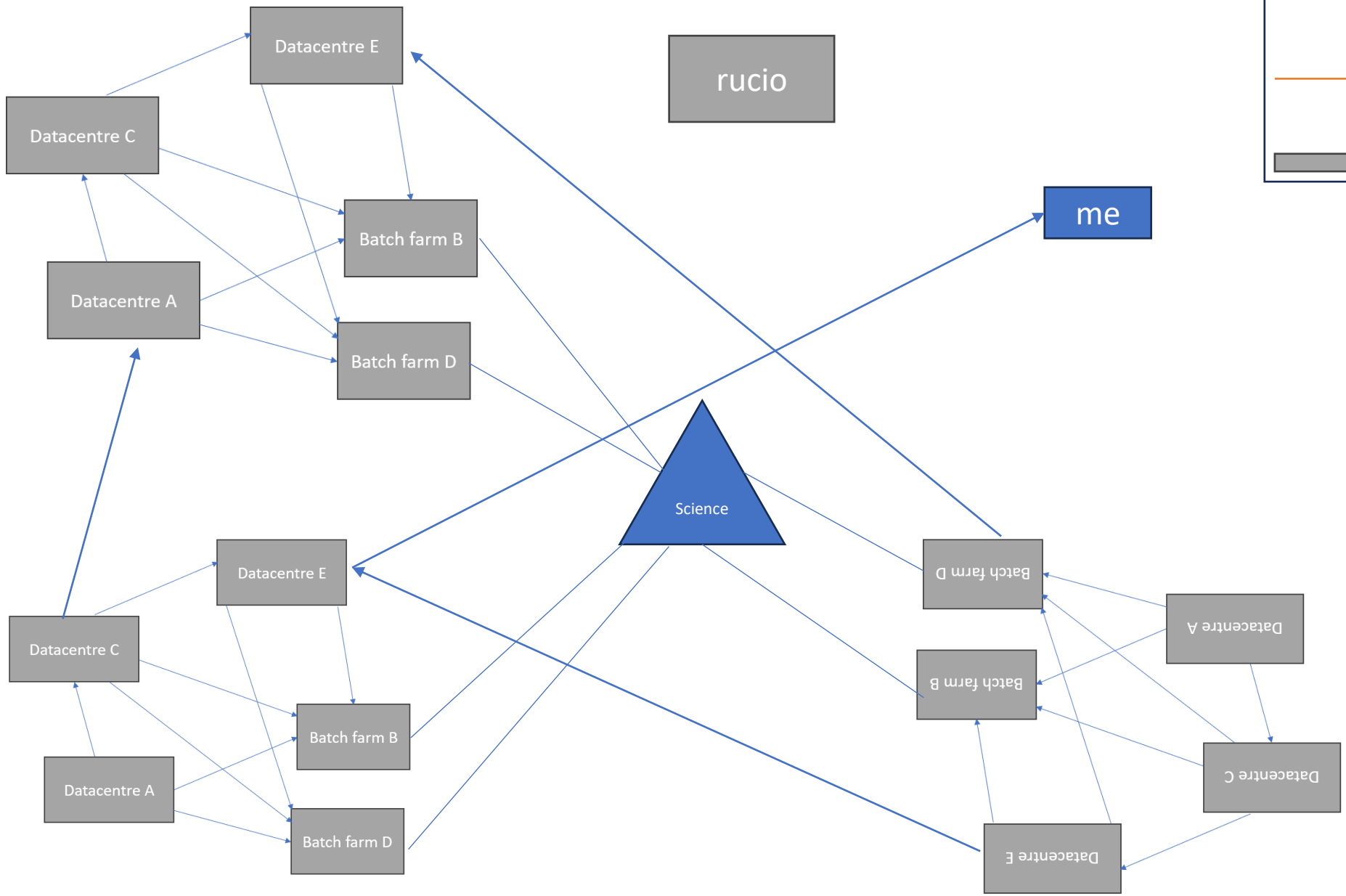

copy, rm, stat
authentication
machine/s
Datacentre E
Datacentre C
Batch farm B
Datacentre A
Batch farm D
Science
Datacentre E
Datacentre C
Batch farm B
Datacentre A
Batch farm D
Batch farm D
Datacentre A
Batch farm B
Datacentre C
Datacentre E

This is a model of the WLCG

This is getting very complex. I just want my file


copy, rm, stat
authentication
control/auth only
machine/s
rucio
Fetch me my file
me
Datacentre E
Datacentre C
Batch farm B
Datacentre A
Batch farm D
Science
Datacentre E
Datacentre C
Batch farm B
Datacentre A
Batch farm D
Batch farm D
Datacentre A
Batch farm B
Datacentre C
Datacentre E


copy, rm, stat
authentication
control/auth only
machine/s
rucio
me
You have those. send those files to them exactly how I tell you to
Datacentre E
Datacentre C
Batch farm B
Datacentre A
Batch farm D
Science
Datacentre E
Datacentre C
Batch farm B
Datacentre A
Batch farm D
Batch farm D
Datacentre A
Batch farm B
Datacentre C
Datacentre E


copy, rm, stat
authentication
control/auth only
machine/s
rucio
me
Science
Datacentre E
Datacentre C
Batch farm B
Datacentre A
Batch farm D
Datacentre E
Datacentre C
Batch farm B
Datacentre A
Batch farm D
Batch farm D
Datacentre A
Batch farm B
Datacentre C
Datacentre E

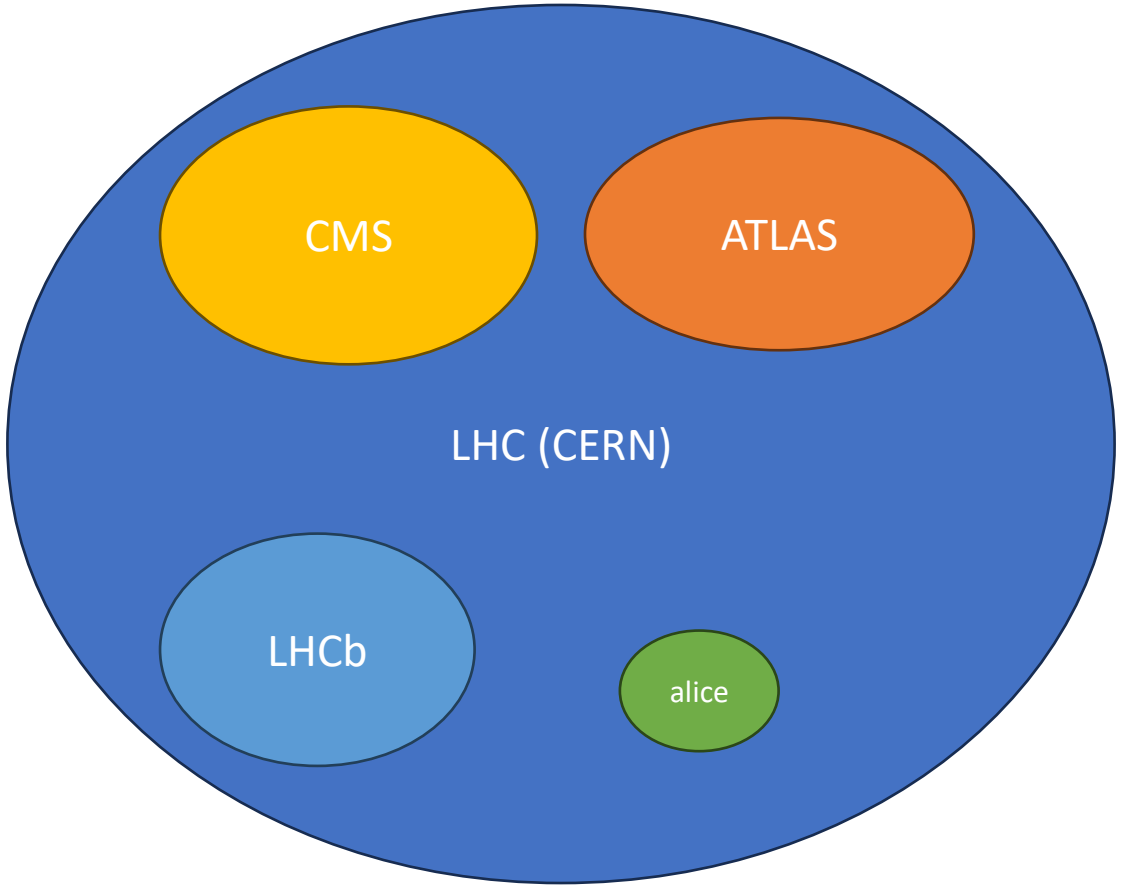
That's how rucio works

So who does what?

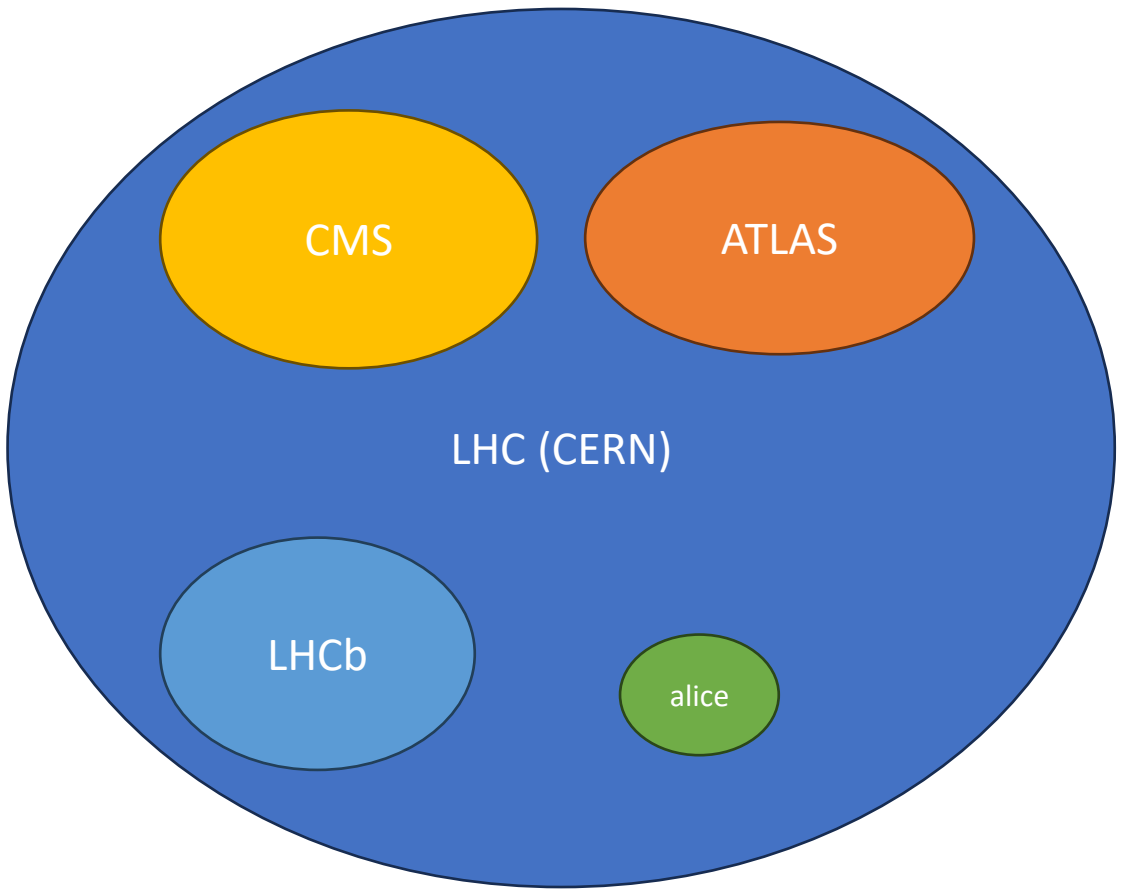

WLCG
GRIDPP/SWIFT-HEP

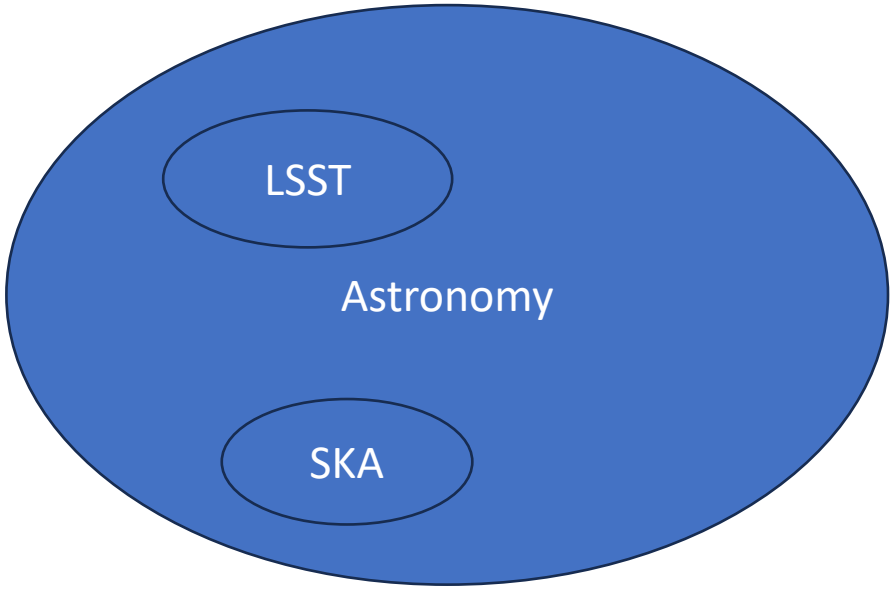
GRIDPP gets you the data, SWIFT-HEP turns it into science

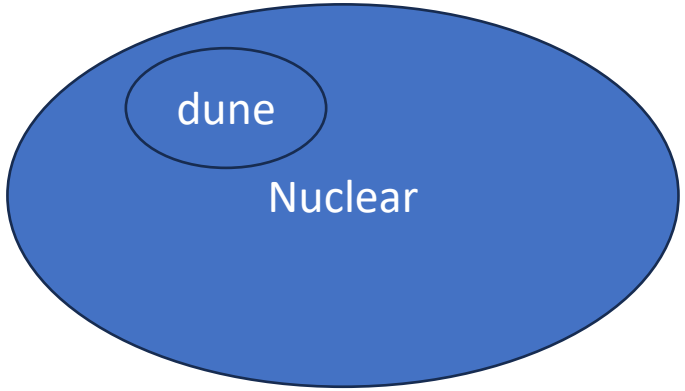
There are 4 main CERN experiments


CMS
ATLAS
LHC (CERN)
LHCb
alice

But we do other stuff too


CMS
ATLAS
LHC (CERN)
LHCb
alice


LSST
Astronomy
SKA


dune
Nuclear

What’s this about tiers?

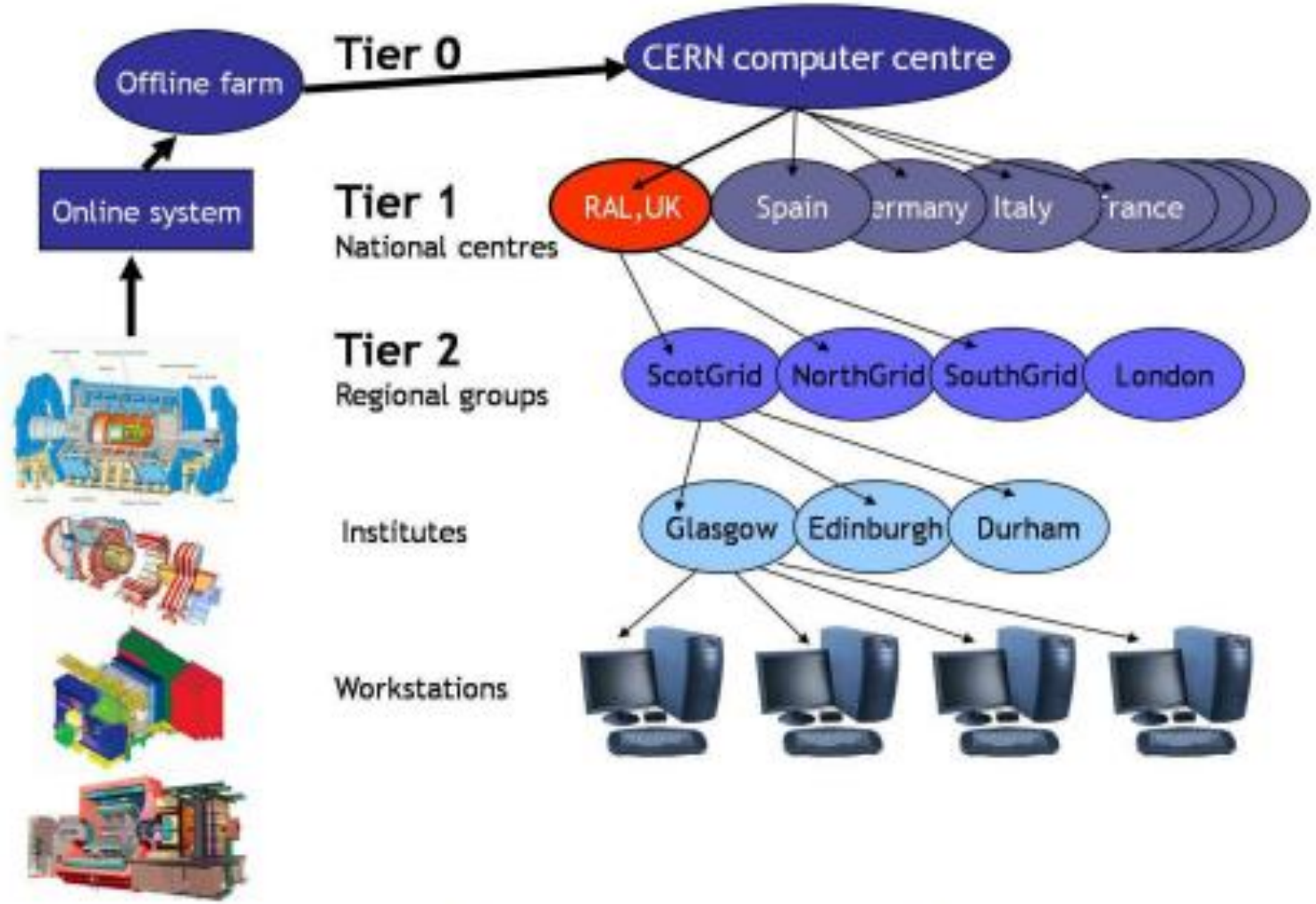


Figure 1. Hierarchical tier structure of the Worldwide LHC Grid

David Britton et al. (2009). "GridPP: The UK grid for particle physics".

Why so many tiers?

Imagine they’re hot pizzas

You make it near where you eat it

- Data redundancy in case of site failures
- Cost distribution
- High availability
- Time zone based support

Quick explanations

- GocDB – database of sites part of the WLCG (endpoints, protocols, VOs)
- APEL – accounting for storage and compute. Keeps track of how much resources are used by each VO.