File management at 140 million miles

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MSL studies habitability

Did Mars ever have an environment able to support life?

Prime Mission:

Was Mars wet?
Does Mars breathe?
Can people survive on Mars?

MSL found evidence of liquid water, organic carbon in rock, and active methane in the atmosphere

But radiation makes it a bad place for humans

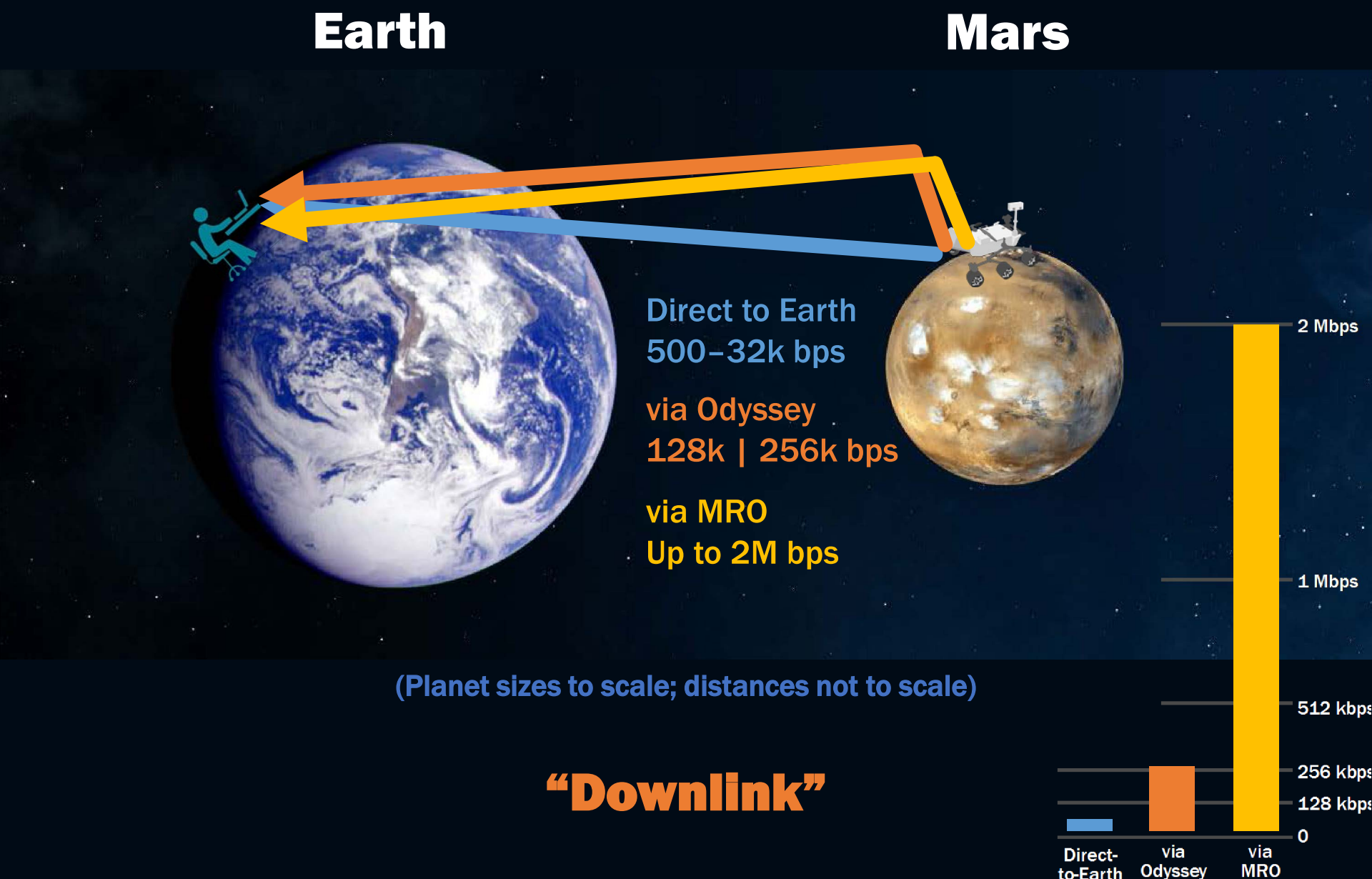
:(

How do we tell the rover what to do?

(Planet sizes to scale; distances not to scale)

“Uplink”

70-meter antenna "Mars"
at Goldstone Deep Space
Communications Complex


Earth
Mars
Direct to Earth
500–32k bps
via Odyssey
128k | 256k bps
via MRO
Up to 2M bps
(Planet sizes to scale; distances not to scale)
2 Mbps
1 Mbps
512 kbps
256 kbps
128 kbps
0
Direct-to-Earth
via Odyssey
via MRO

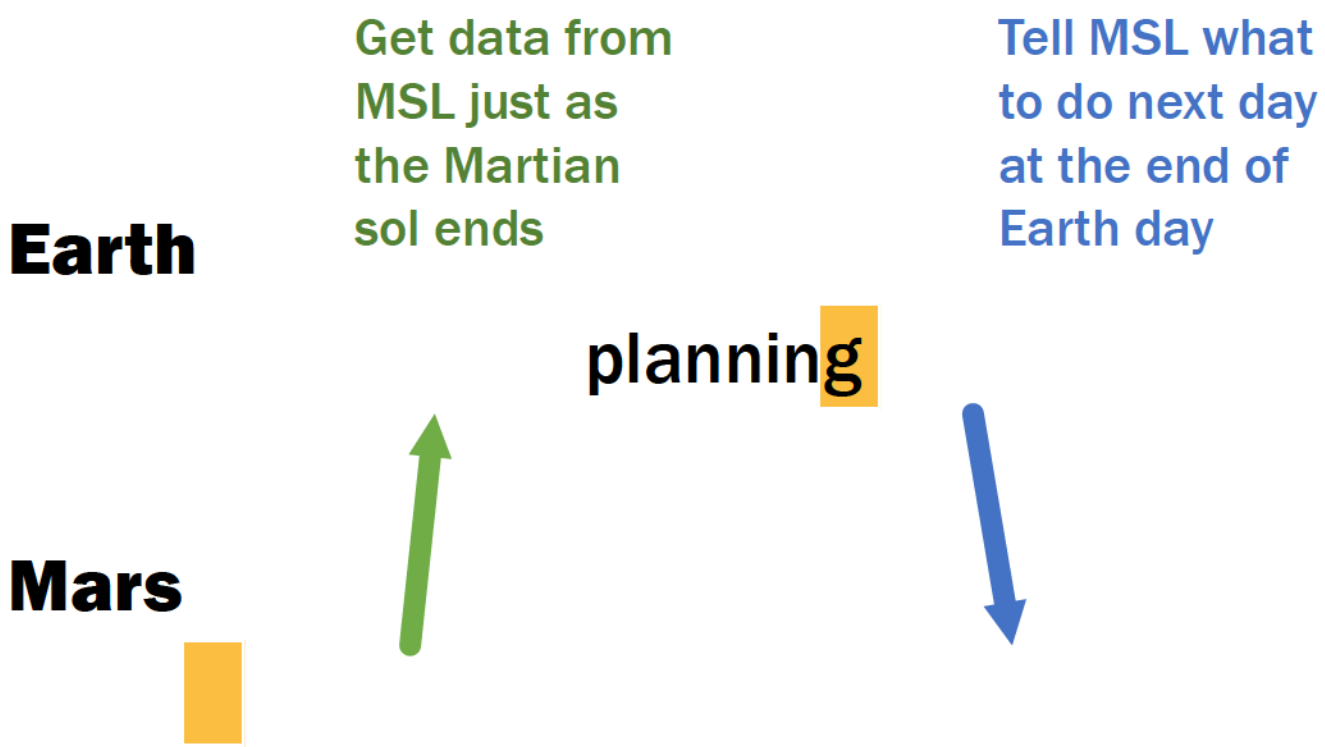
"Downlink"

Earth

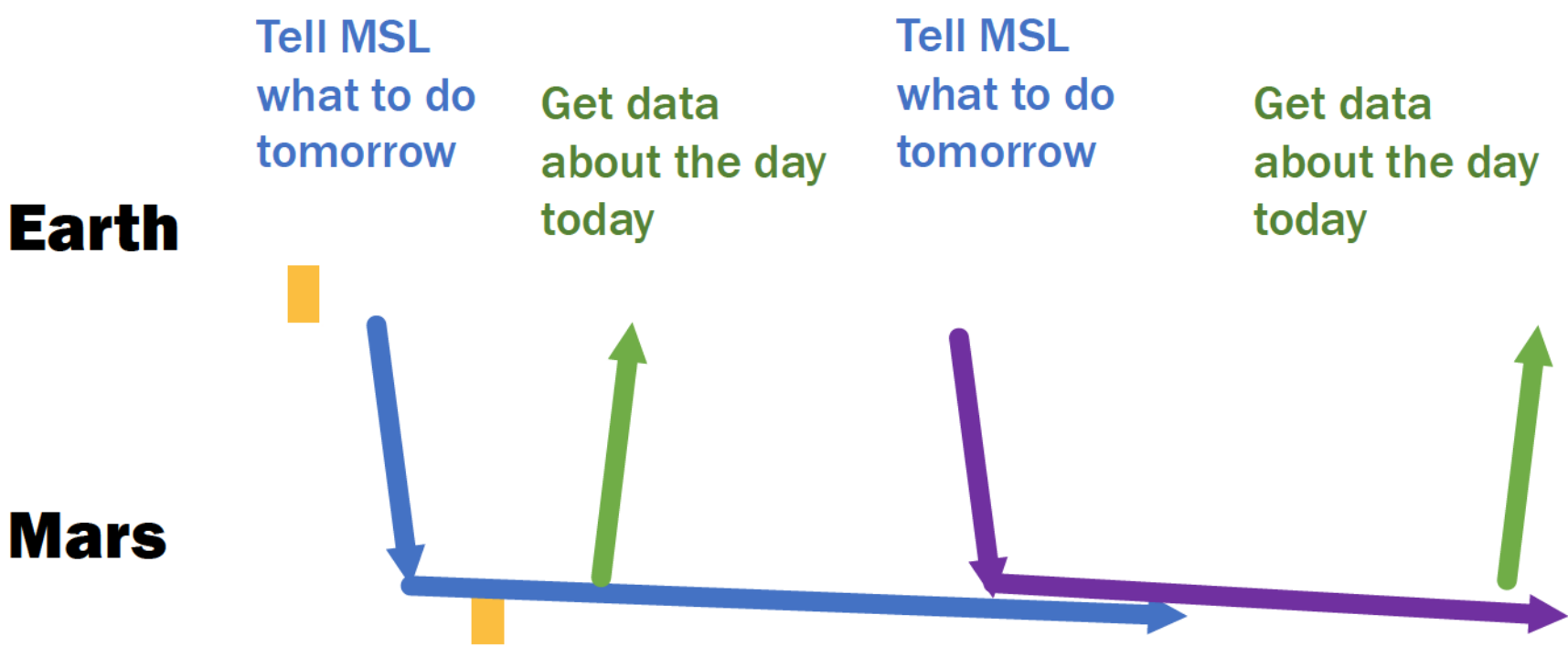
night day night

Mars

night sol night


Get data from MSL just as the Martian sol ends
Tell MSL what to do next day at the end of Earth day
Earth
planning
Mars

Tell MSL
what to do
Get data
about the day
Tell MSL
what to do
Get data
about the day
Earth
Mars


Tell MSL what to do tomorrow
Get data about the day today
Tell MSL what to do tomorrow
Get data about the day today
Earth
Mars

Every morning, members of the Engineering Operations team assess the rover's health and safety.

A sampling of subsystems

Mobility and mechanisms

Payload coordination

Sample processing

Telecom

Thermal

Power

Data management

Data Management
Engineering Cameras
NASA

Data Management Tasks

1. Assess rover health and safety: Do we have complete data products on the ground?
2. Create command products: Reprioritizations, retransmits, deletes

Files

Identified uniquely by

1. File name
2. Directory name in file hierarchy
3. Navigated via directory structure

E.g.,
/home/fire/rot-13.asm

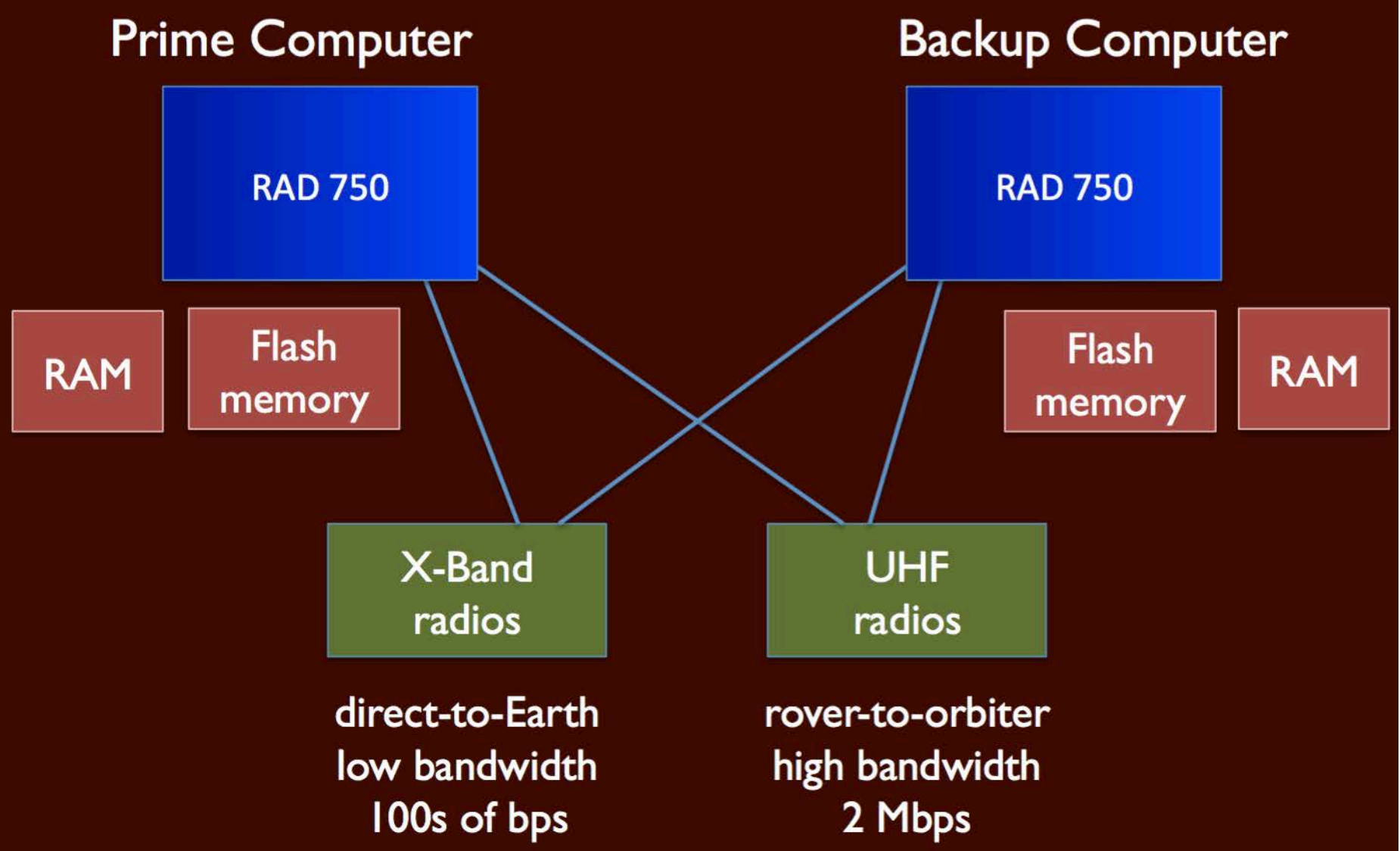
MSL Data Products

Identified uniquely by

1. Spacecraft timestamp
2. Application ID unique to the subsystem or instrument
3. Metadata navigated via database query

E.g.,
APID=123 Time=73904984_11421

Avionics


Prime Computer
Backup Computer
RAD 750
RAD 750
RAM
Flash memory
Flash memory
RAM
X-Band radios
UHF radios
direct-to-Earth
low bandwidth
100s of bps
rover-to-orbiter
high bandwidth
2 Mbps

How do we know what's on board?
Once a month we ask for a DP listing
Once a wake-up we ask for a delta
Once a day we correlate our database

How many data products are there?

Right now (sol 1584): 22,778

(And another 7000 in instrument memory)

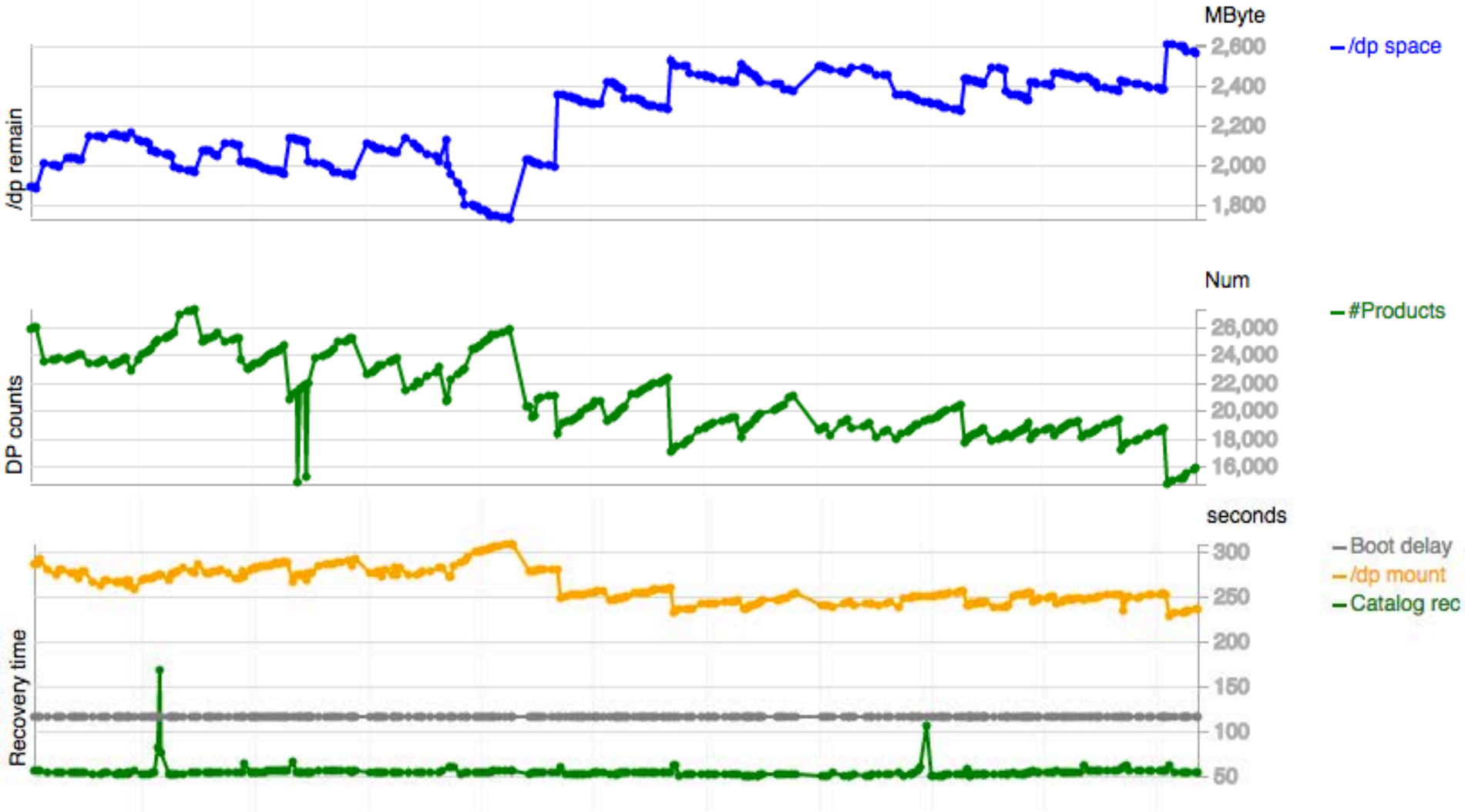
We can support 300,000

Constraints on disk space and mount times

Space remaining: ~2,550 MB

Mount time: ~250 s

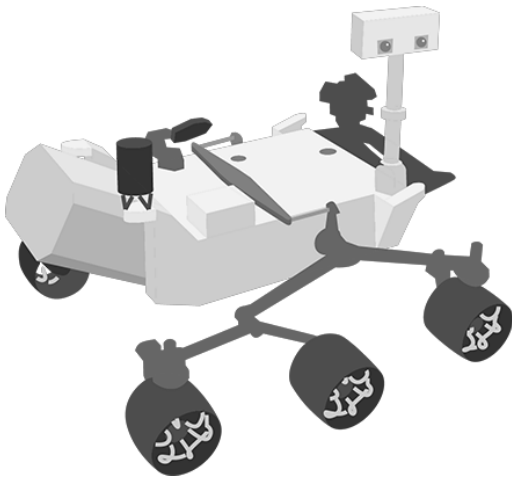
Why?



The more data products we have,
the less space we have,
and the longer it takes to mount

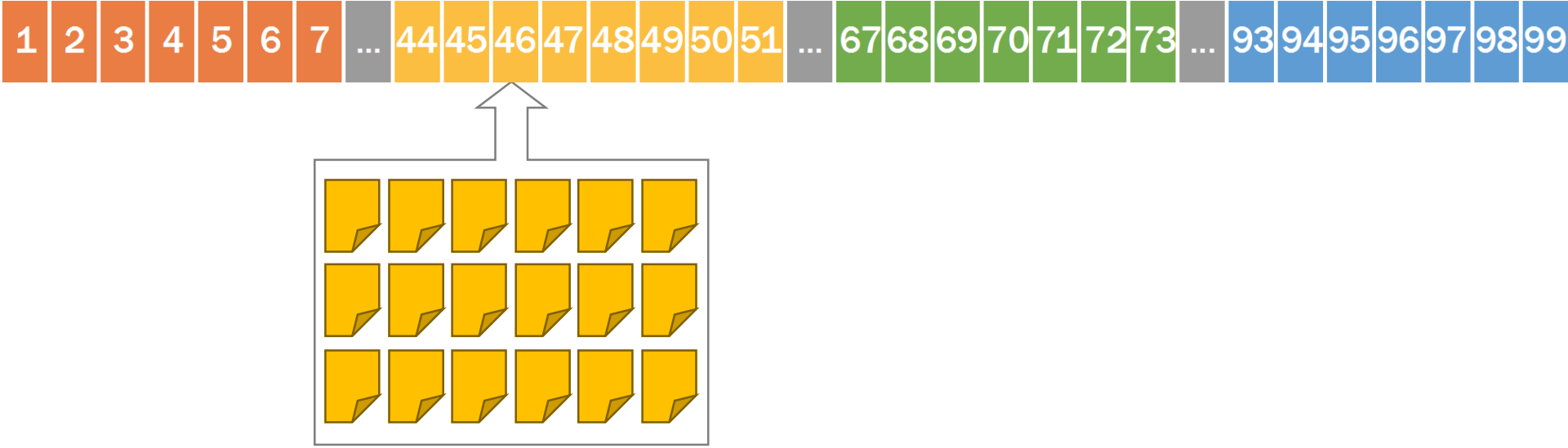
Plus, SCIENCE!

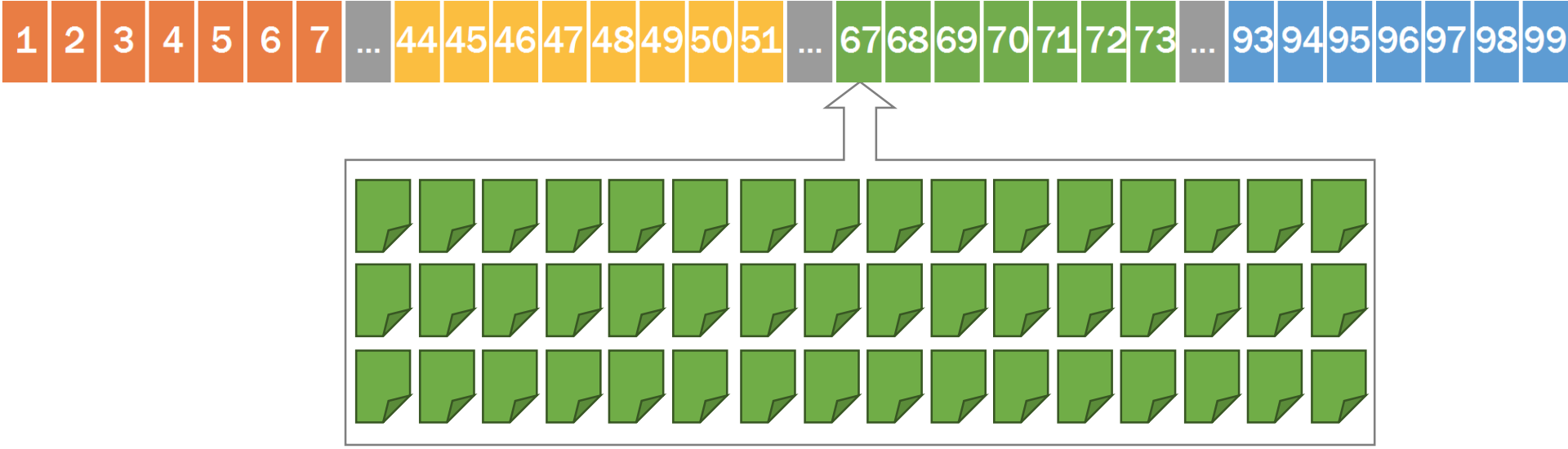
We gotta get these data products off the rover and onto Earth.



MSL> Here comes the orbiter
MSL> Time to packetize these data products and send them
Earth> hurry up

1–43	**Critical priority:** Needed for rover health and safety
44–66	**High priority:** Needed for science planning
67–86	**Medium priority:** Nice to have for science planning and results
87–99	**Low priority:** Nice to have eventually for science results


1 2 3 4 5 6 7 ... 44 45 46 47 48 49 50 51 ... 67 68 69 70 71 72 73 ... 93 94 95 96 97 98 99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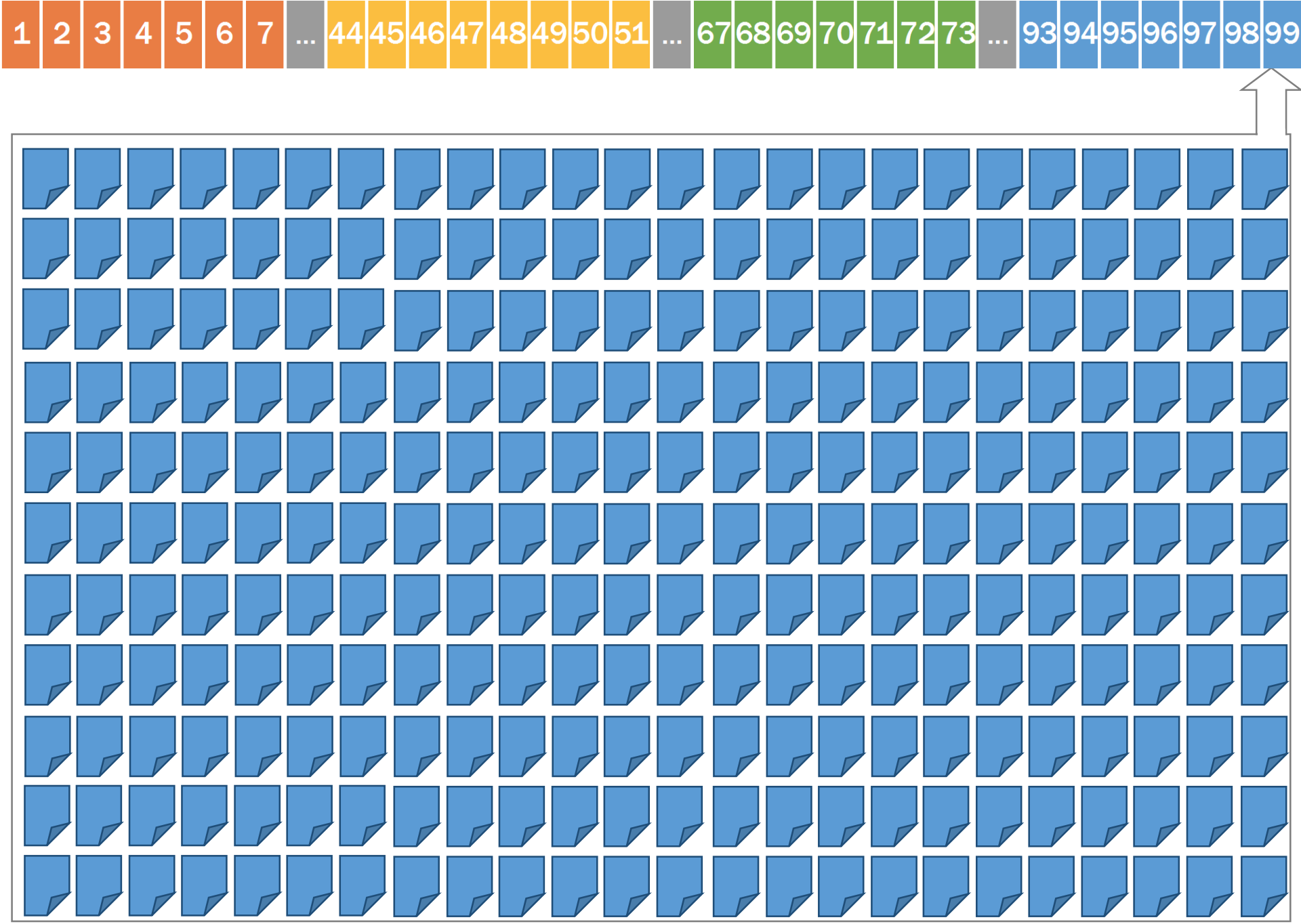
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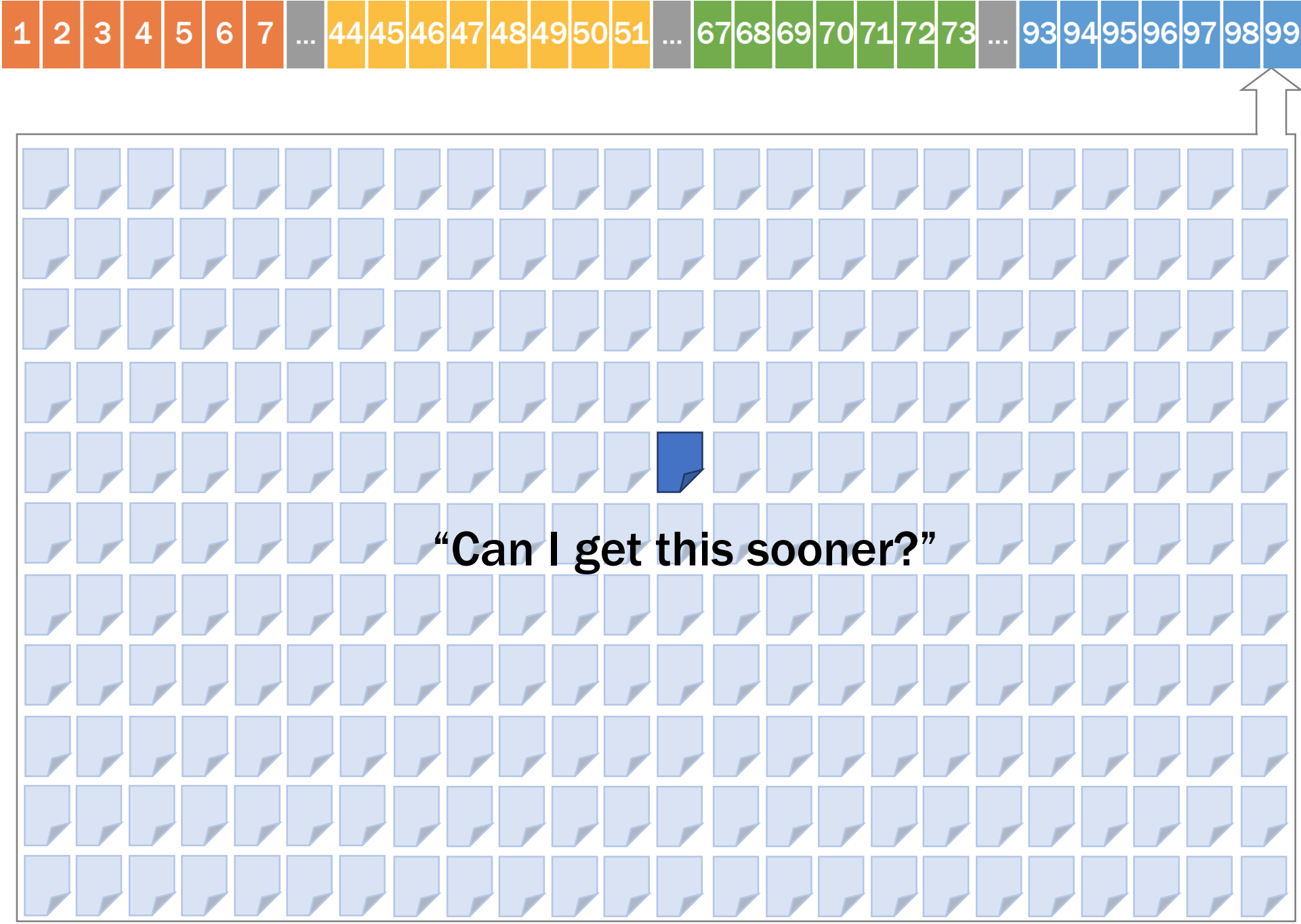
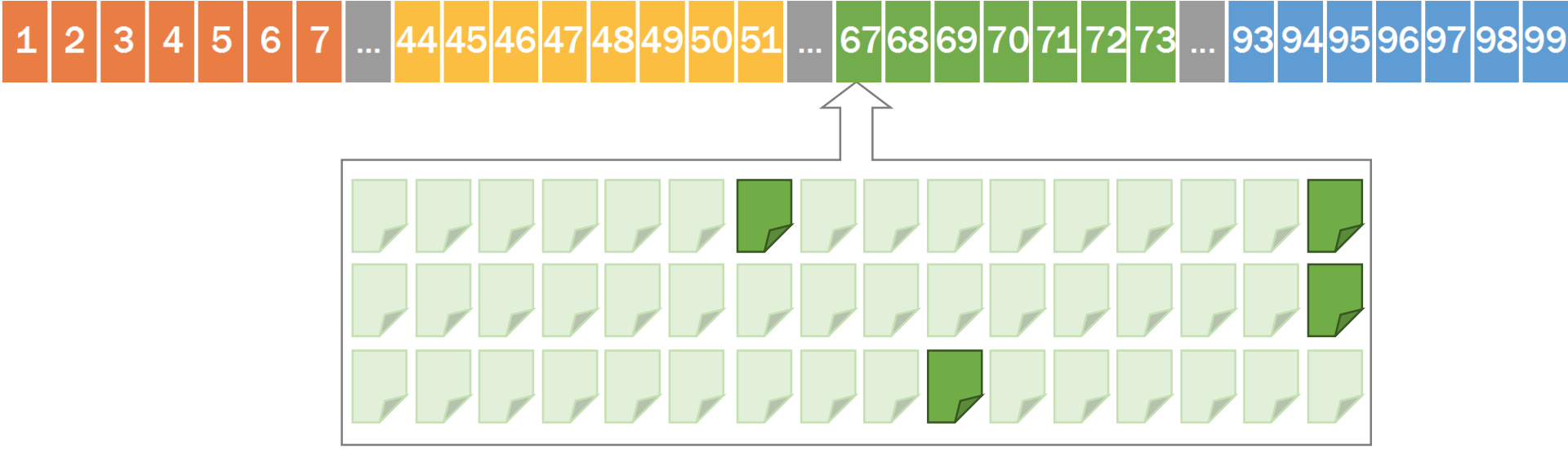
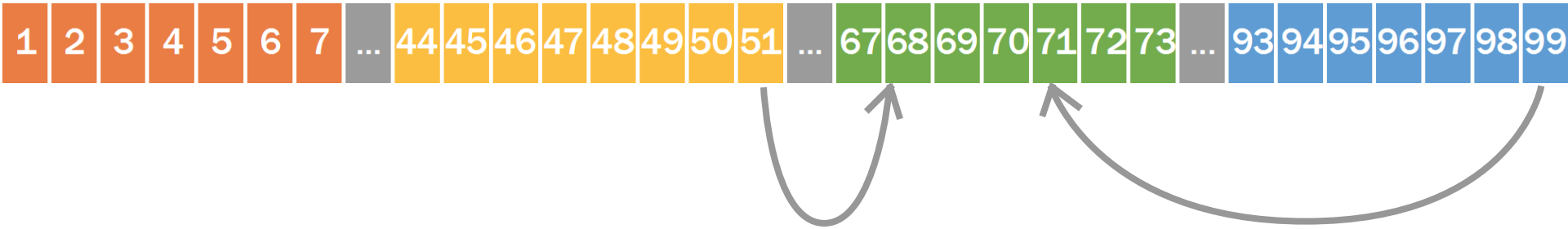
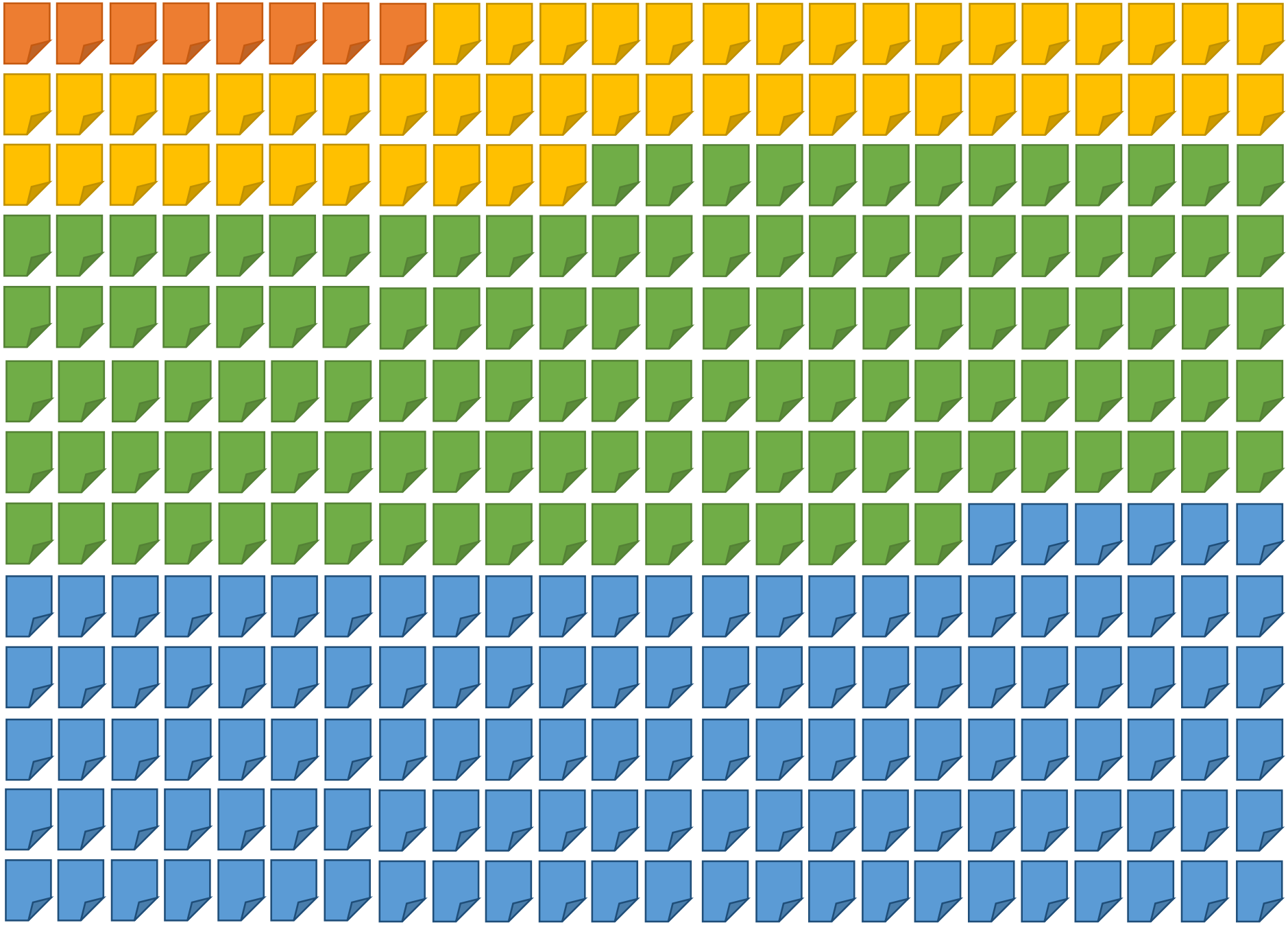

1 2 3 4 5 6 7 ... 44 45 46 47 48 49 50 51 ... 67 68 69 70 71 72 73 ... 93 94 95 96 97 98 99
“Can I get this sooner?”

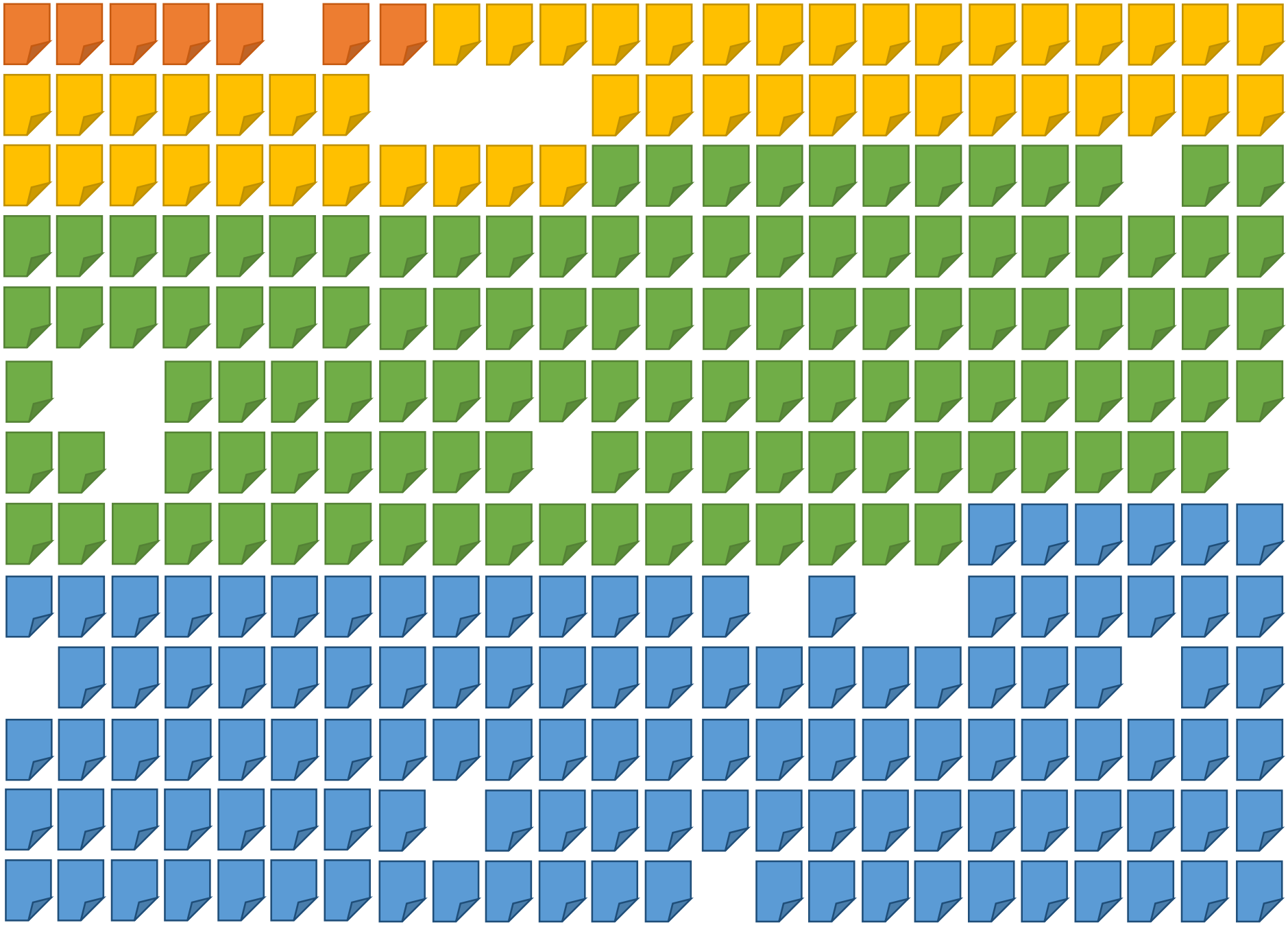


"I don't need these right away."

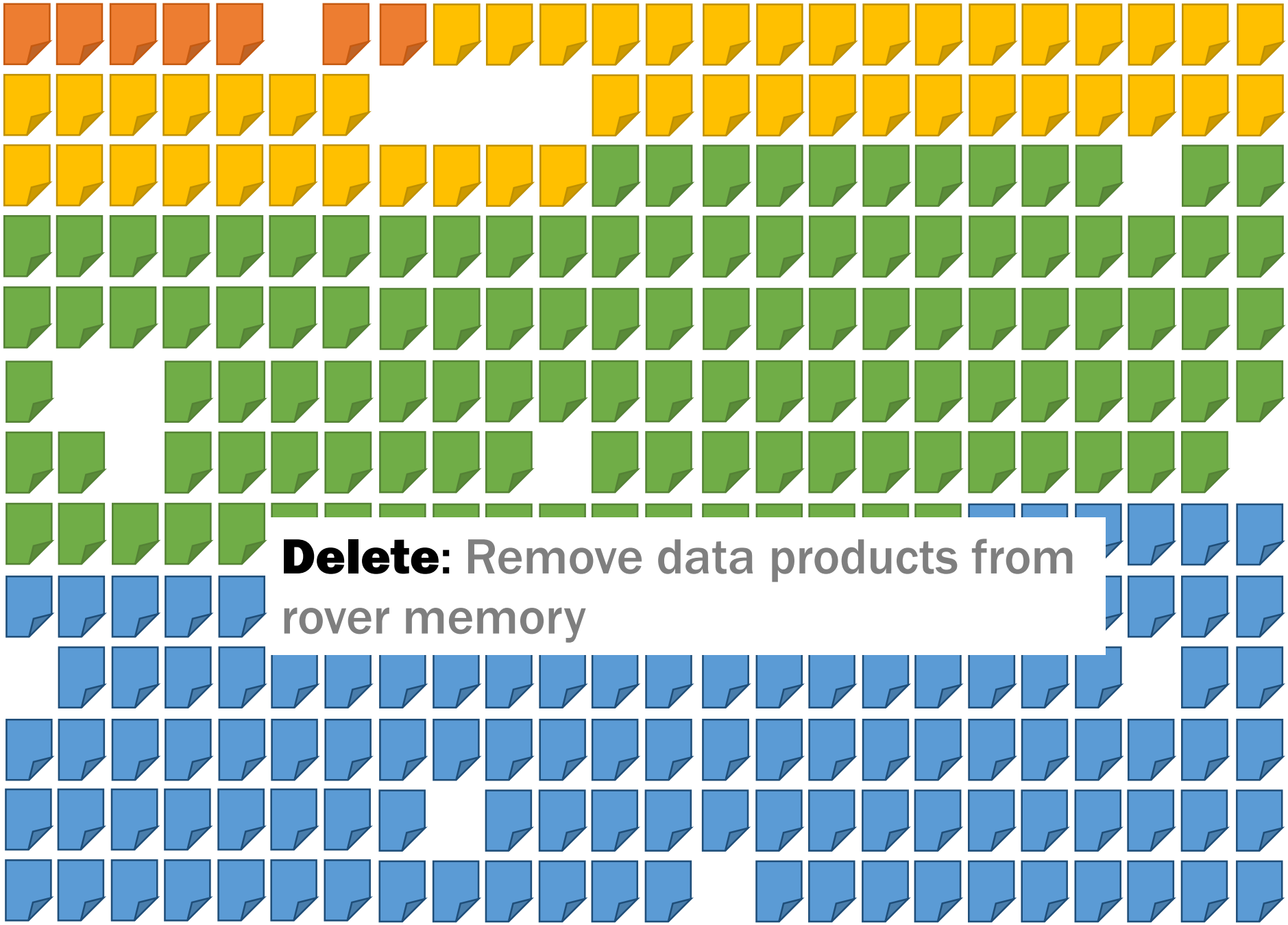
Reprioritize: Change the priority bin for a file or set of files







Retransmit: Request data products to be sent again



Delete: Remove data products from rover memory

Commanded Deletes

Dear Rover:

Please remove the following data products (list attached).

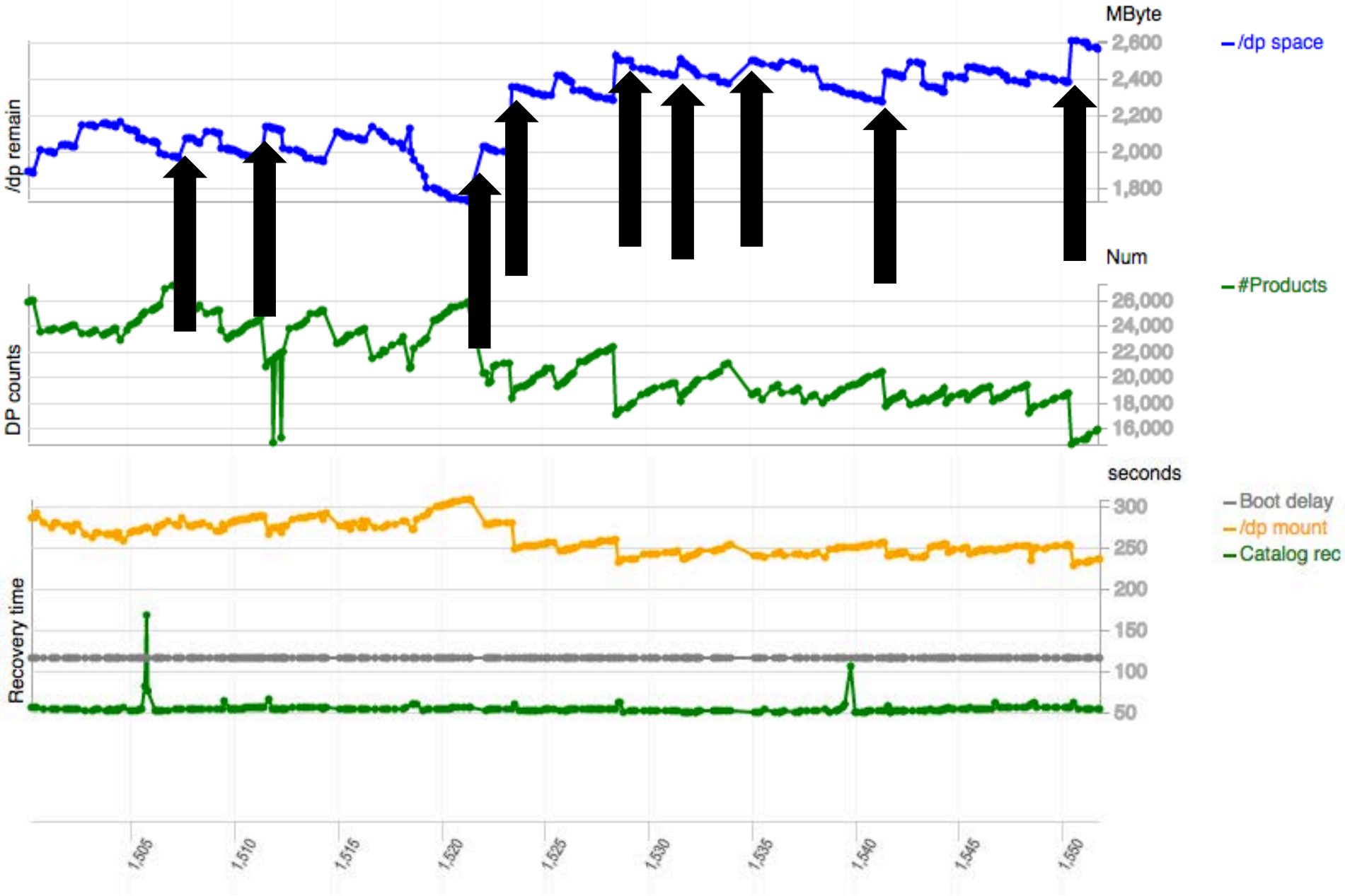
Yours,
Ground Team

Automatic Deletes

Dear Ground Team:

I deleted a bunch of your old data products.

Yours,
MSL



Deletes: We do these every day or two

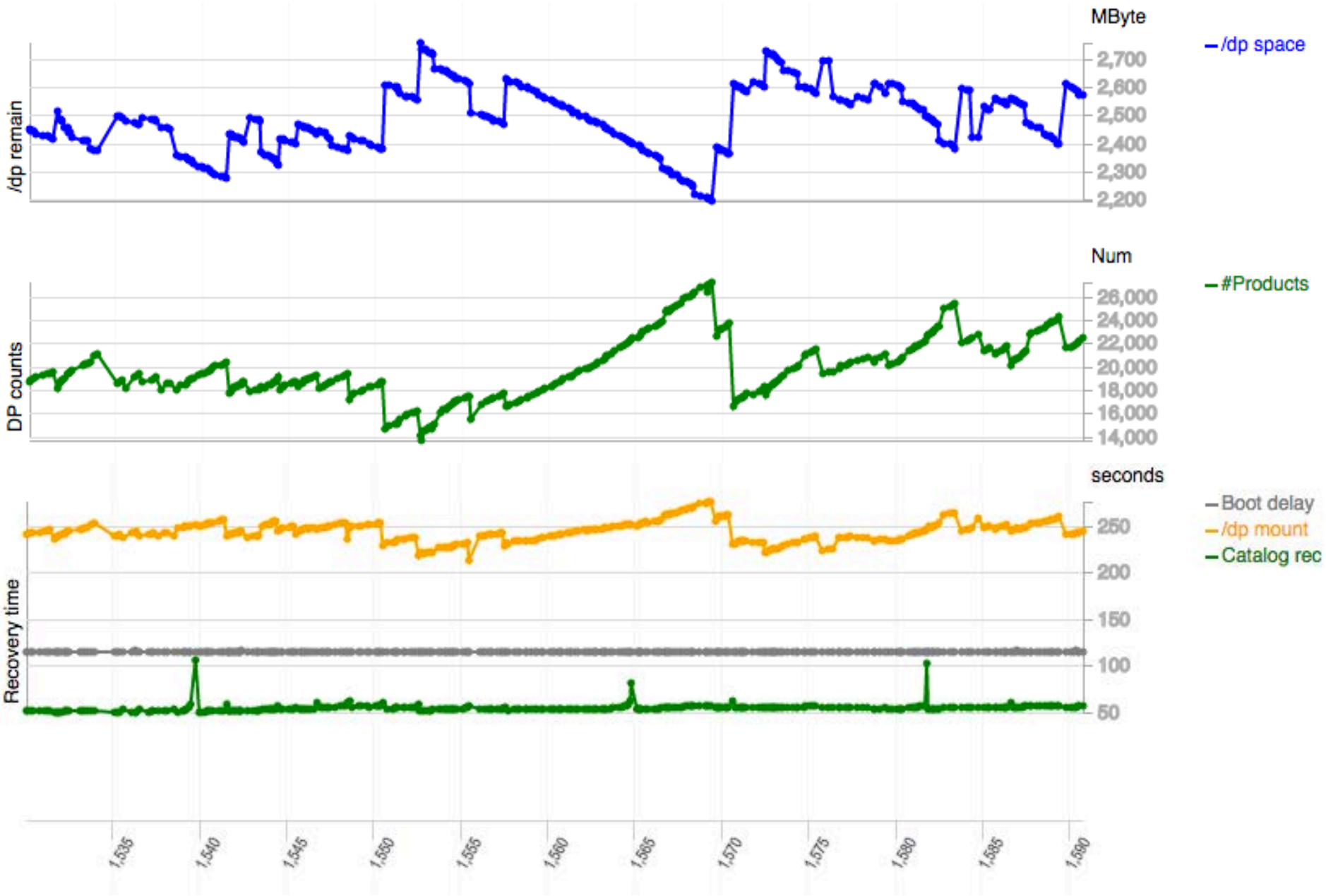
Data Management Products

Reprioritize: Change the priority bin for a file or set of files

Retransmit: Request data products to be sent again

Delete: Remove data products from rover memory

Holiday planning



Deleting files is serious business when there's no undo. In many cases, you can't redo science.

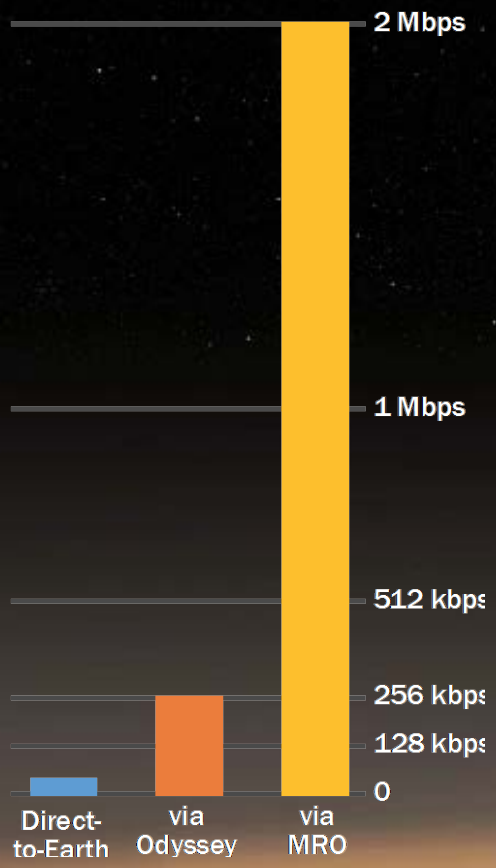
Everything you learn(ed) in Operating Systems is important.

It helps to understand the way files are created, stored, migrated, and catalogued.

Dare Mighty Things

Jet Propulsion Laboratory
California Institute of Technology

48GB of data downlinked in prime mission



Direct to Earth
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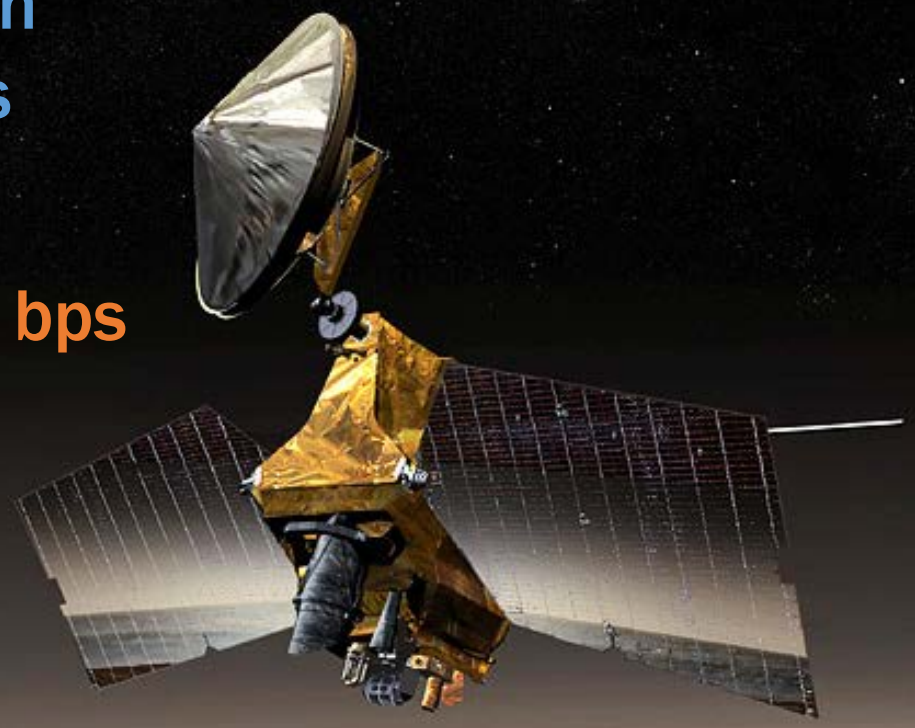
via MRO
Up to 2M bps