



# File management at 140 million miles

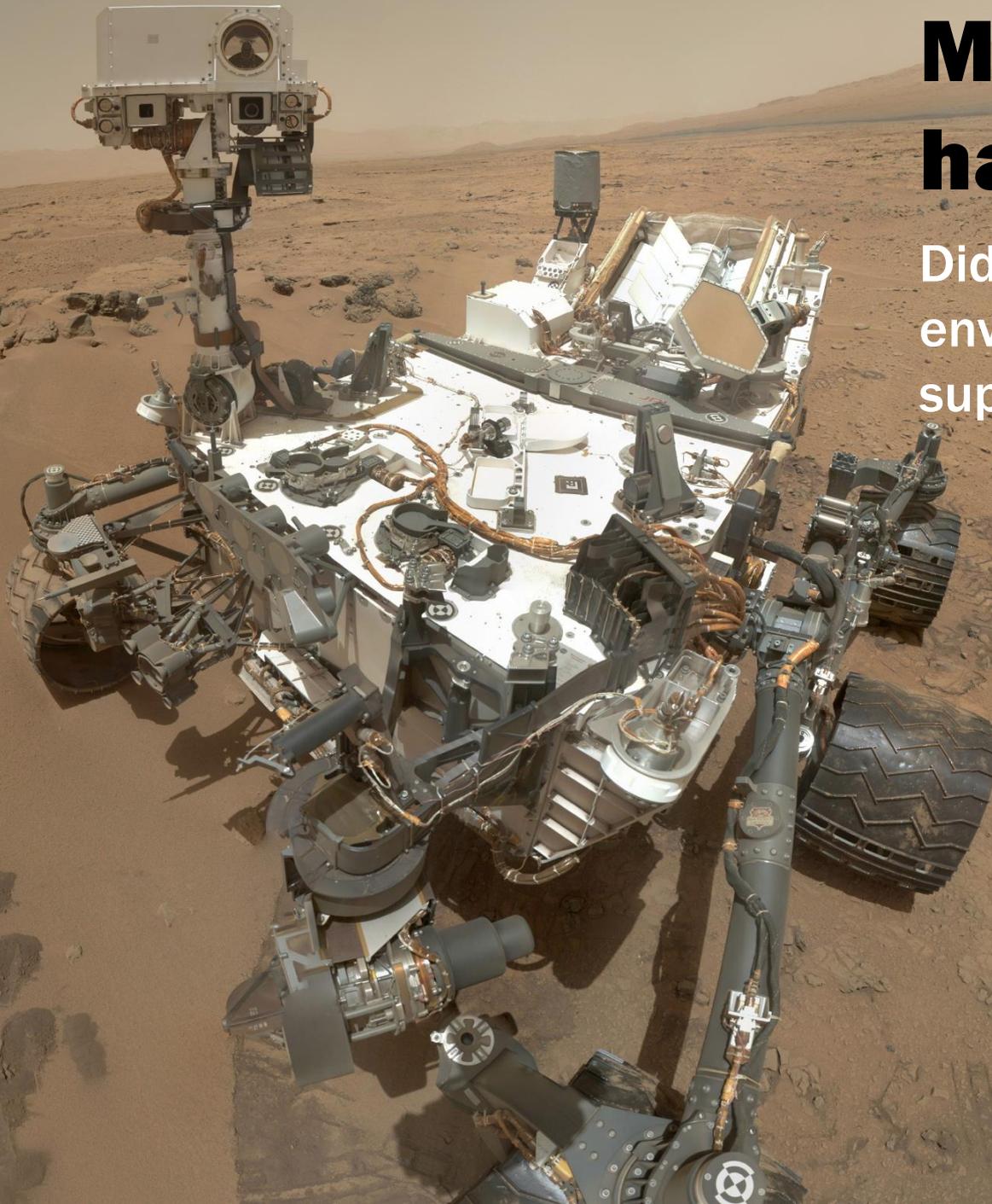
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# MSL studies habitability

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?**

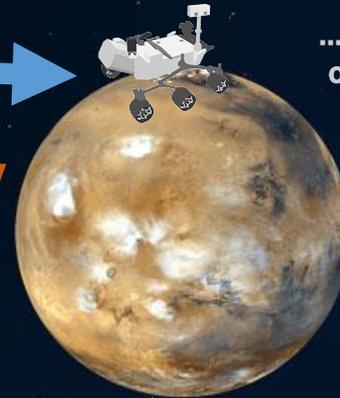
**Earth**

**Mars**

(It takes 30  
of these...



**every day**



...to command  
one of these)

(Planet sizes to scale; distances not to scale)

**“Uplink”**

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



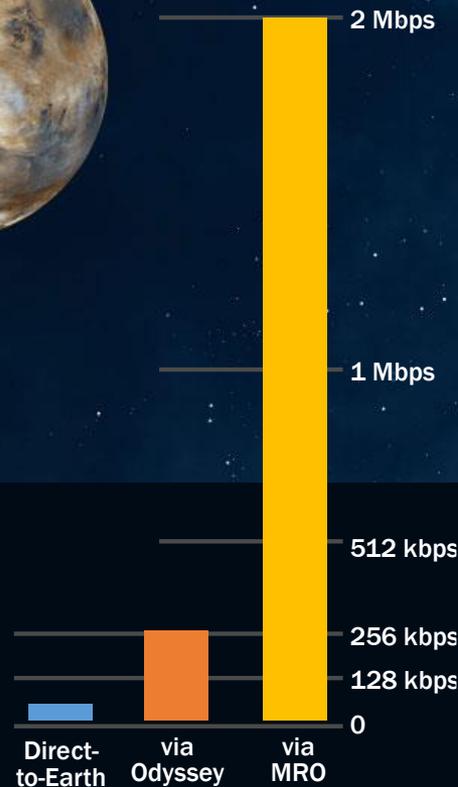
# Earth

# Mars



(Planet sizes to scale; distances not to scale)

## “Downlink”



# Earth



# Mars



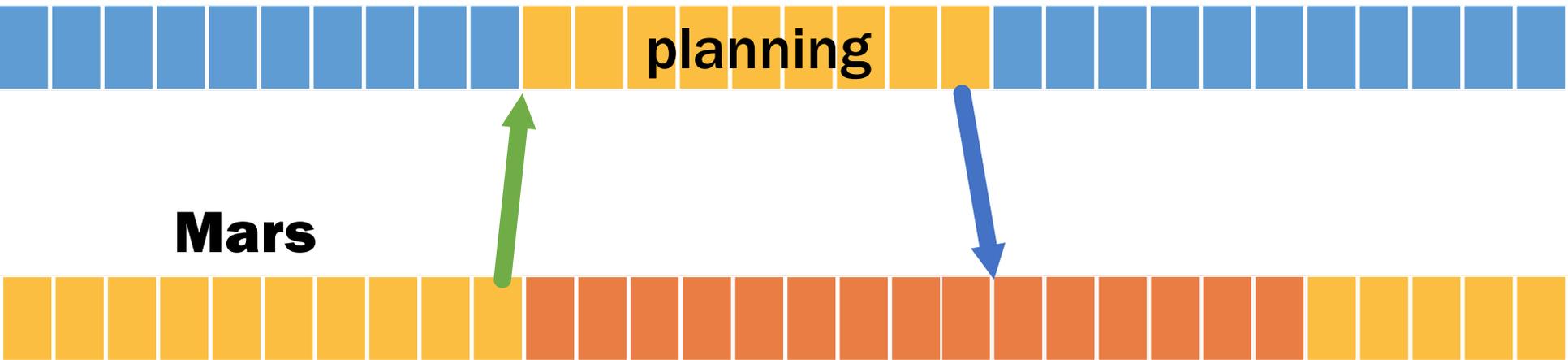
**Earth**

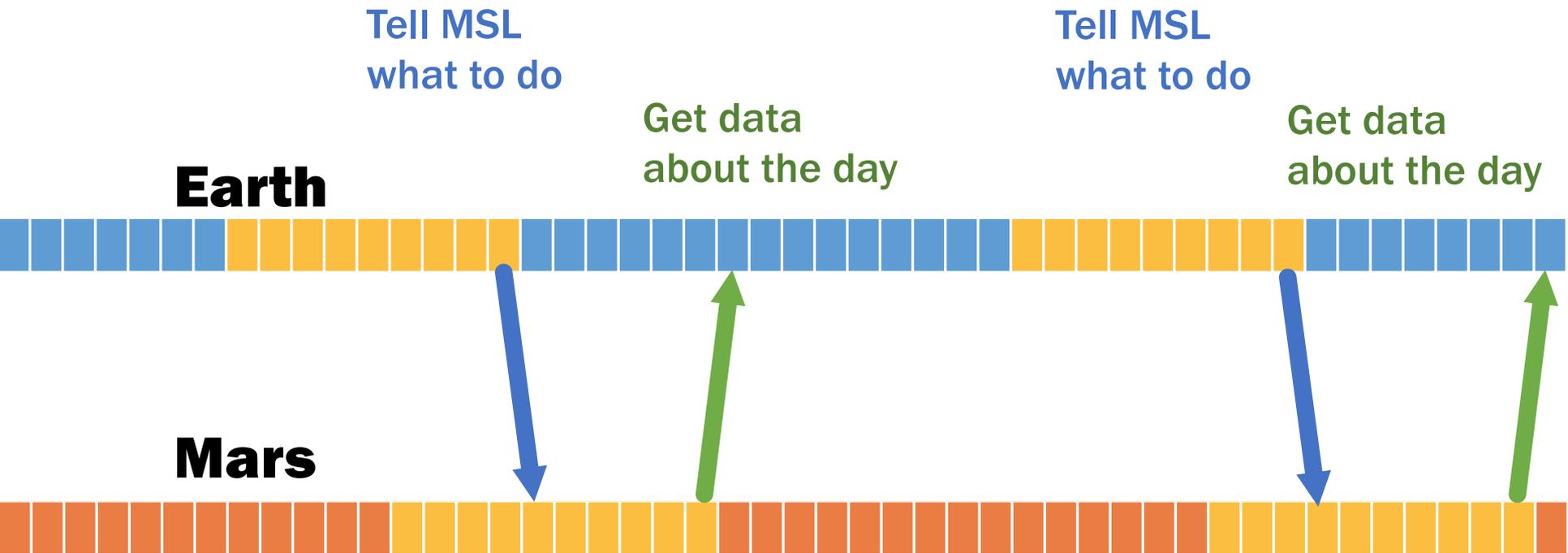
Get data from  
MSL just as  
the Martian  
sol ends

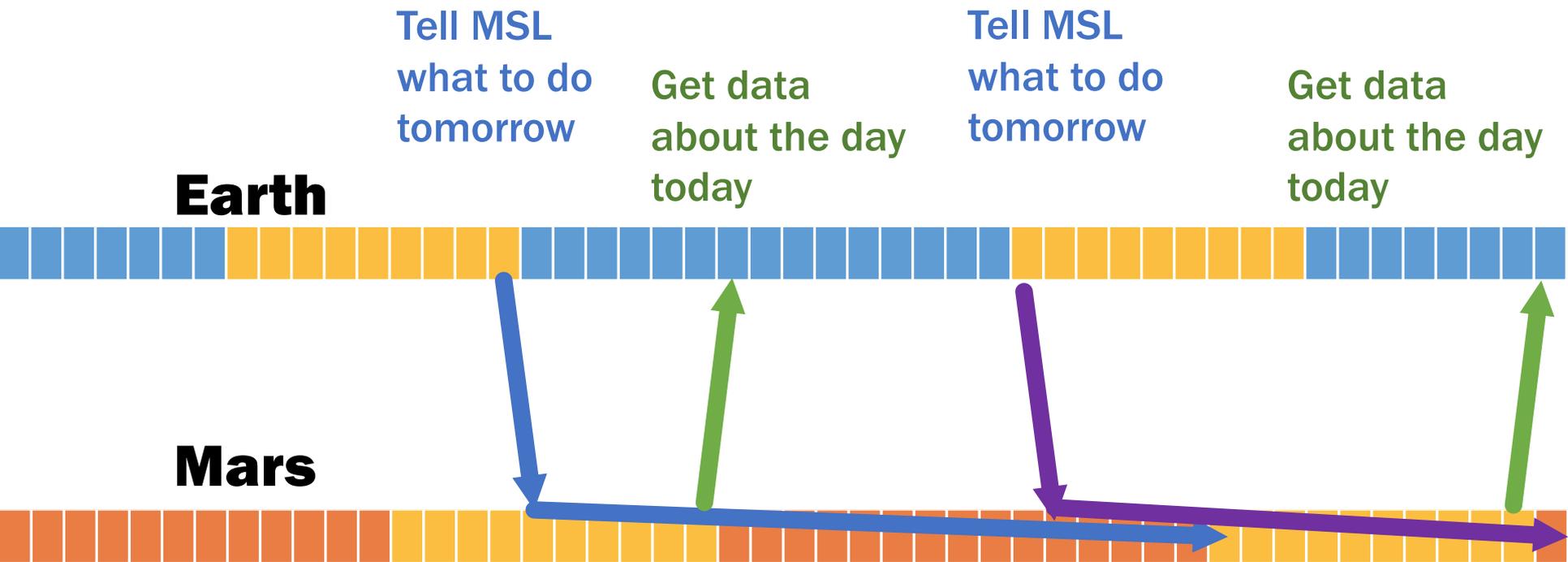
Tell MSL what  
to do next day  
at the end of  
Earth day

planning

**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 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

RAD 750

RAM

Flash  
memory

X-Band  
radios

direct-to-Earth  
low bandwidth  
100s of bps

## Backup Computer

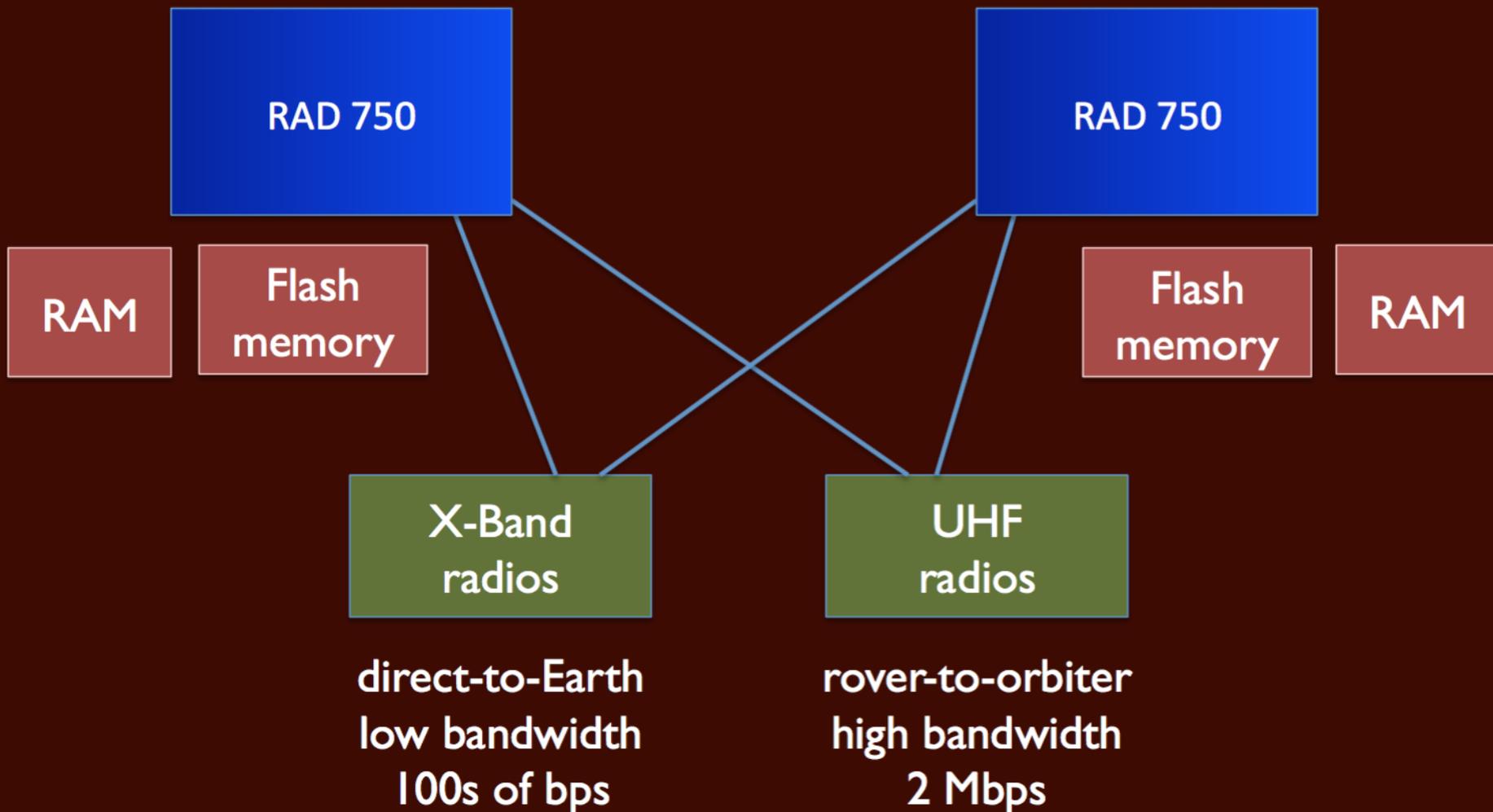
RAD 750

Flash  
memory

RAM

UHF  
radios

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**

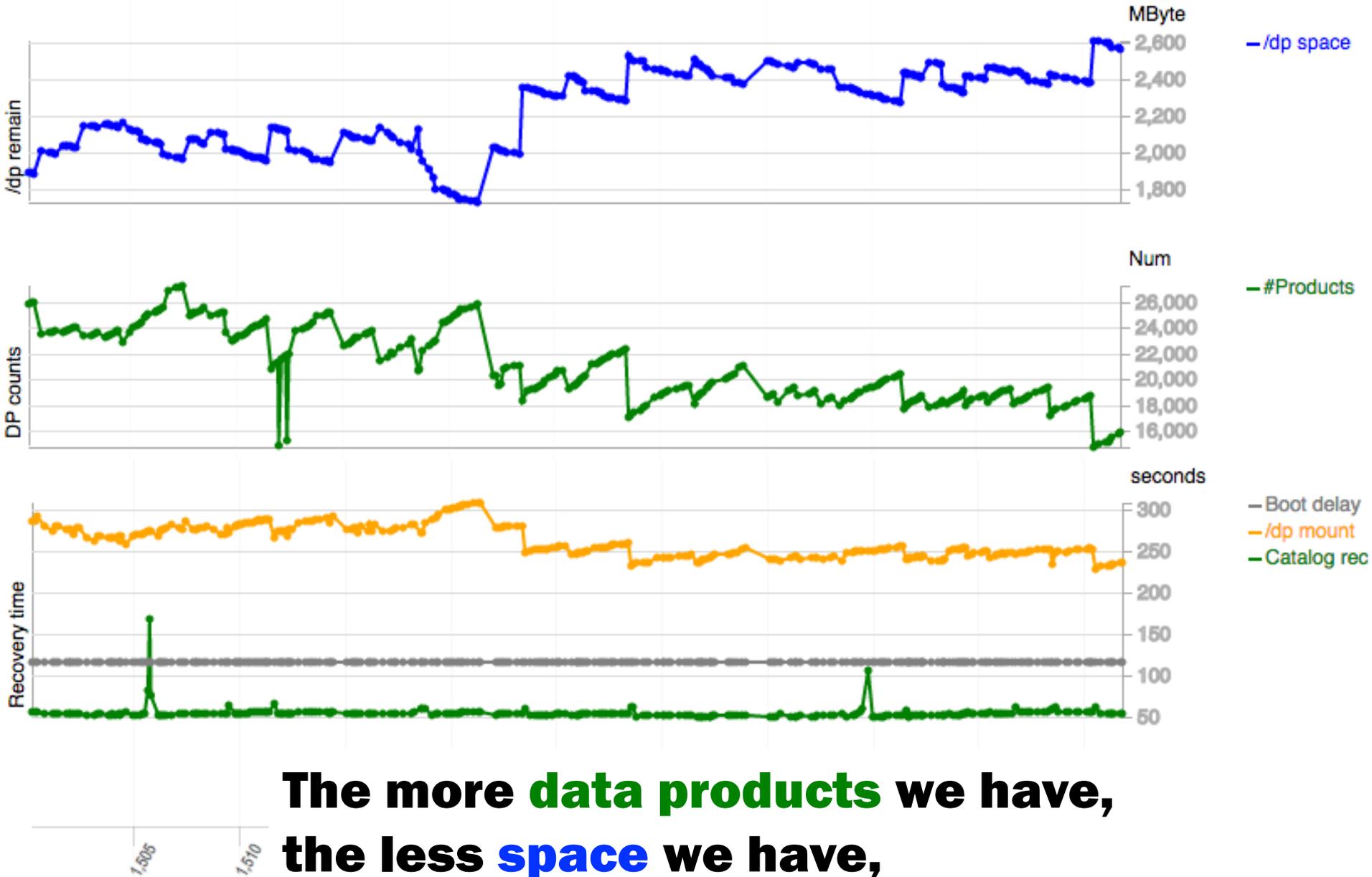


Constraints on **disk space** and **mount times**

Space remaining: **~2,550 MB**

Mount time: **~250 s**

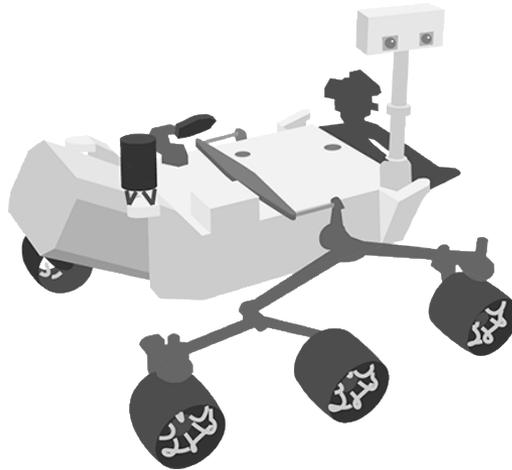
**Why?**



**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

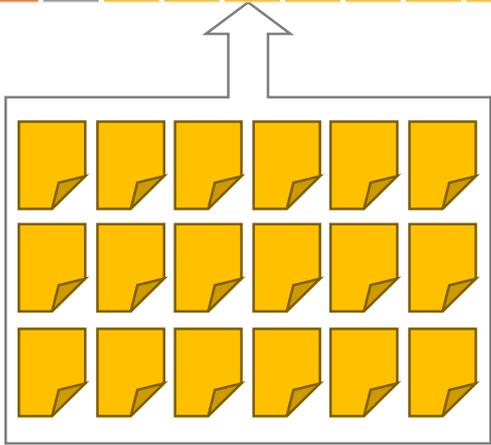


**1–43 Critical priority:** Needed for rover health and safety

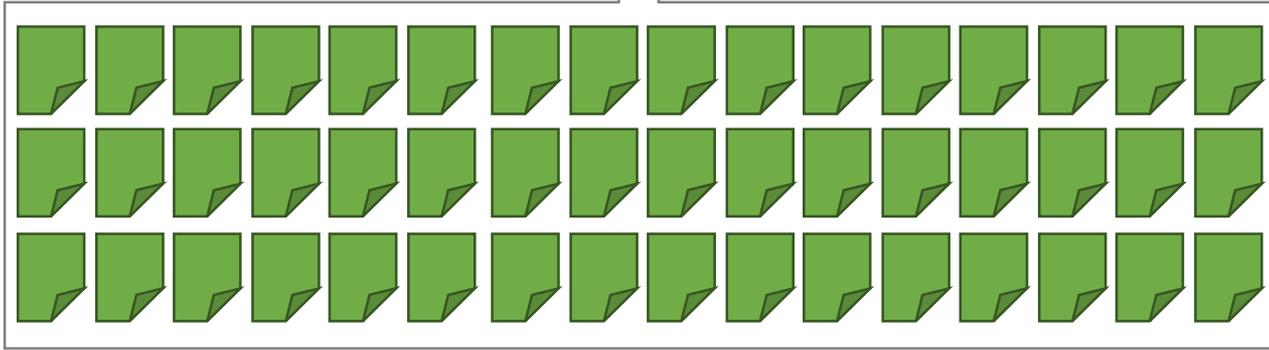
**44–66 High priority:** Needed for science planning

**67–86 Medium priority:** Nice to have for science planning and results

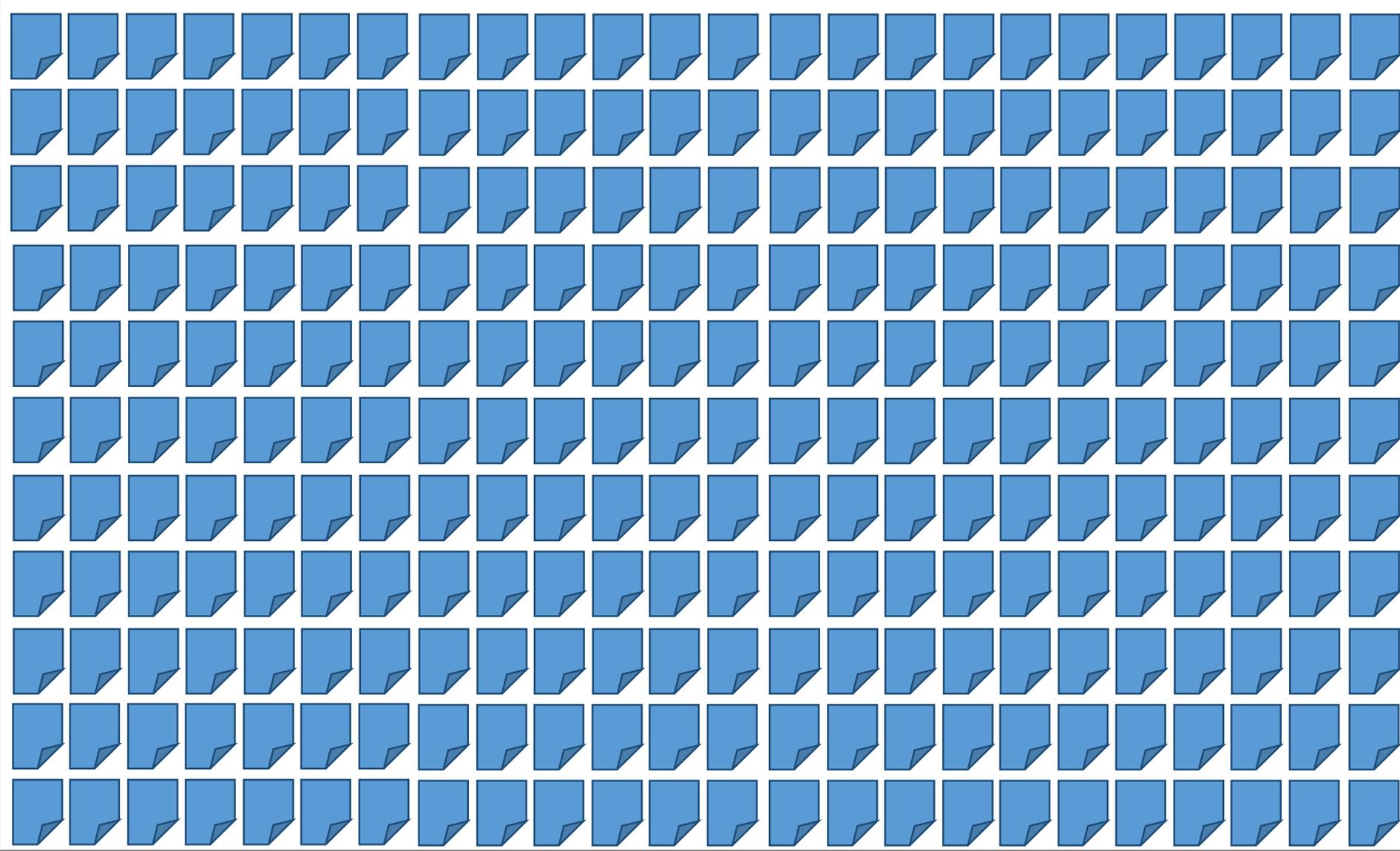
**87–99 Low priority:** Nice to have eventually for science results



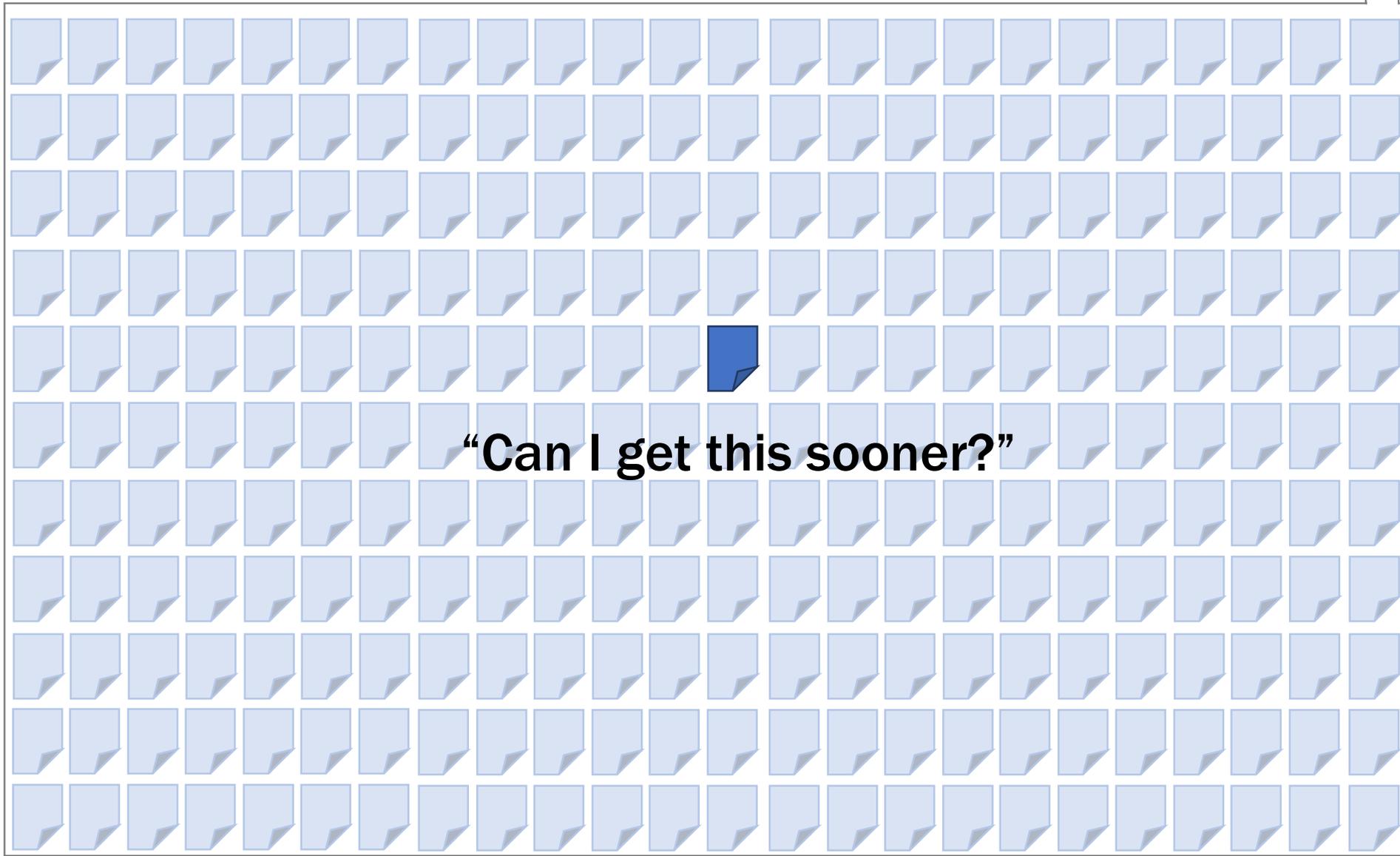
1	2	3	4	5	6	7	...	44	45	46	47	48	49	50	51	...	67	68	69	70	71	72	73	...	93	94	95	96	97	98	99
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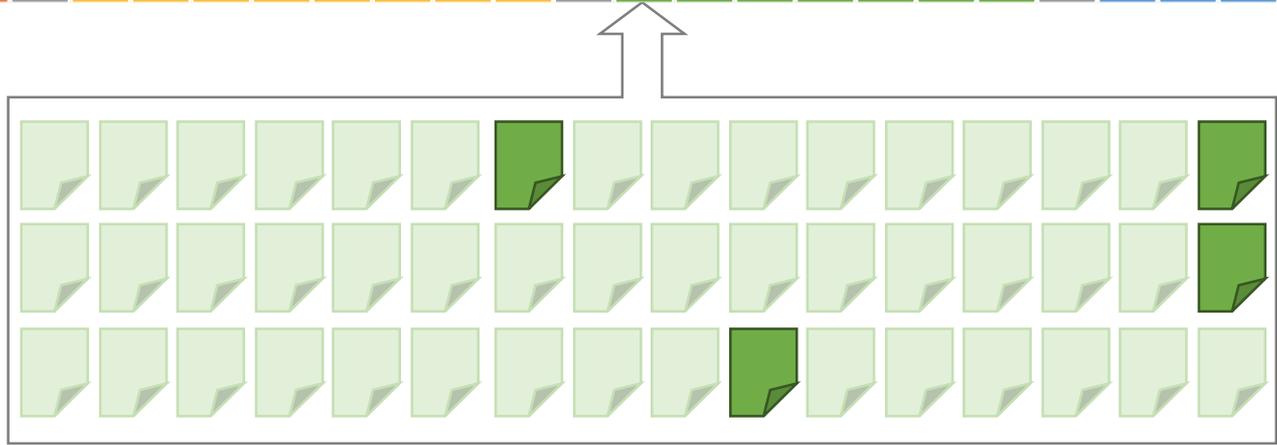
1 2 3 4 5 6 7 ... 44 45 46 47 48 49 50 51 ... 67 68 69 70 71 72 73 ... 93 94 95 96 97 98 99



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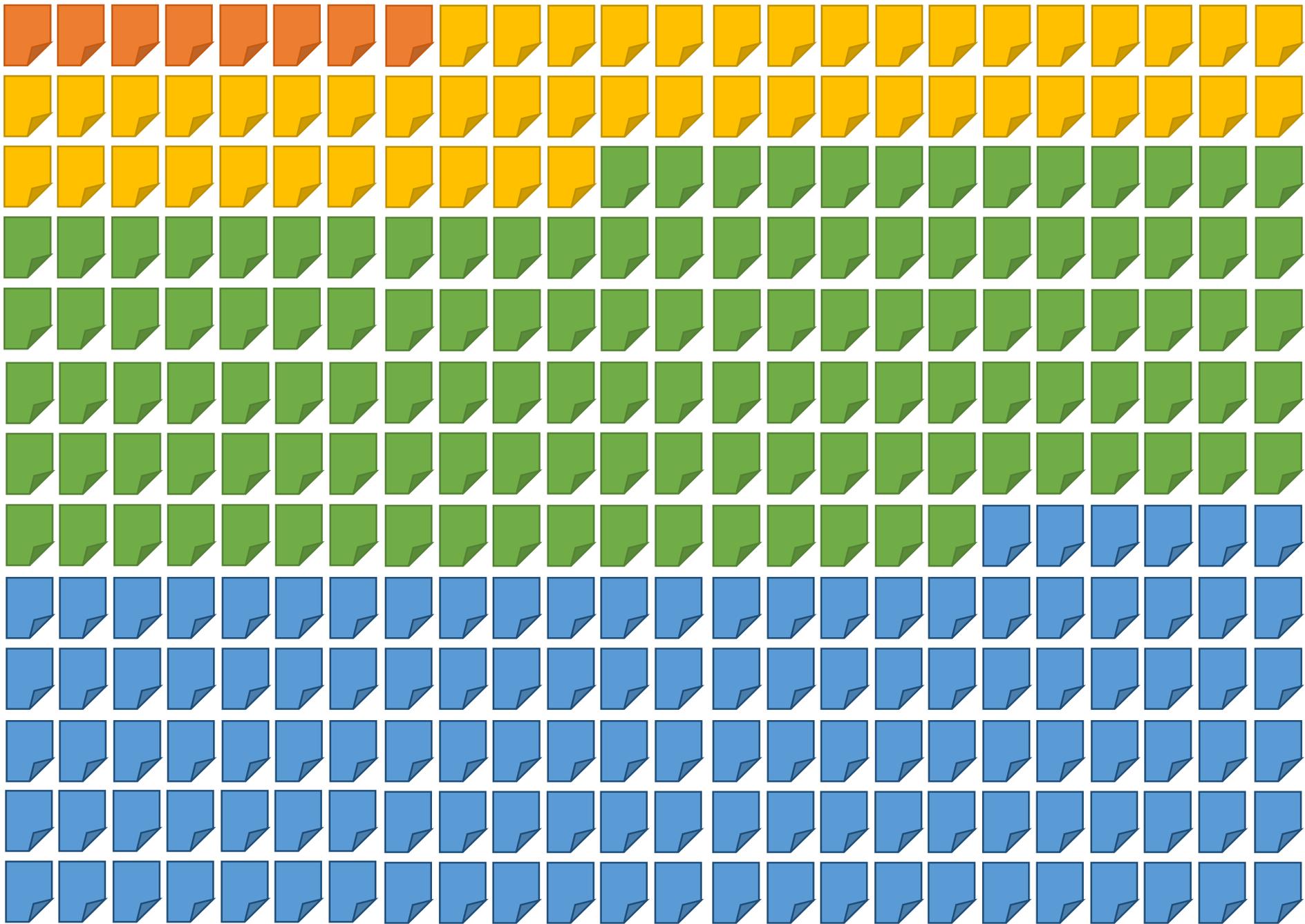
**“Can I get this sooner?”**

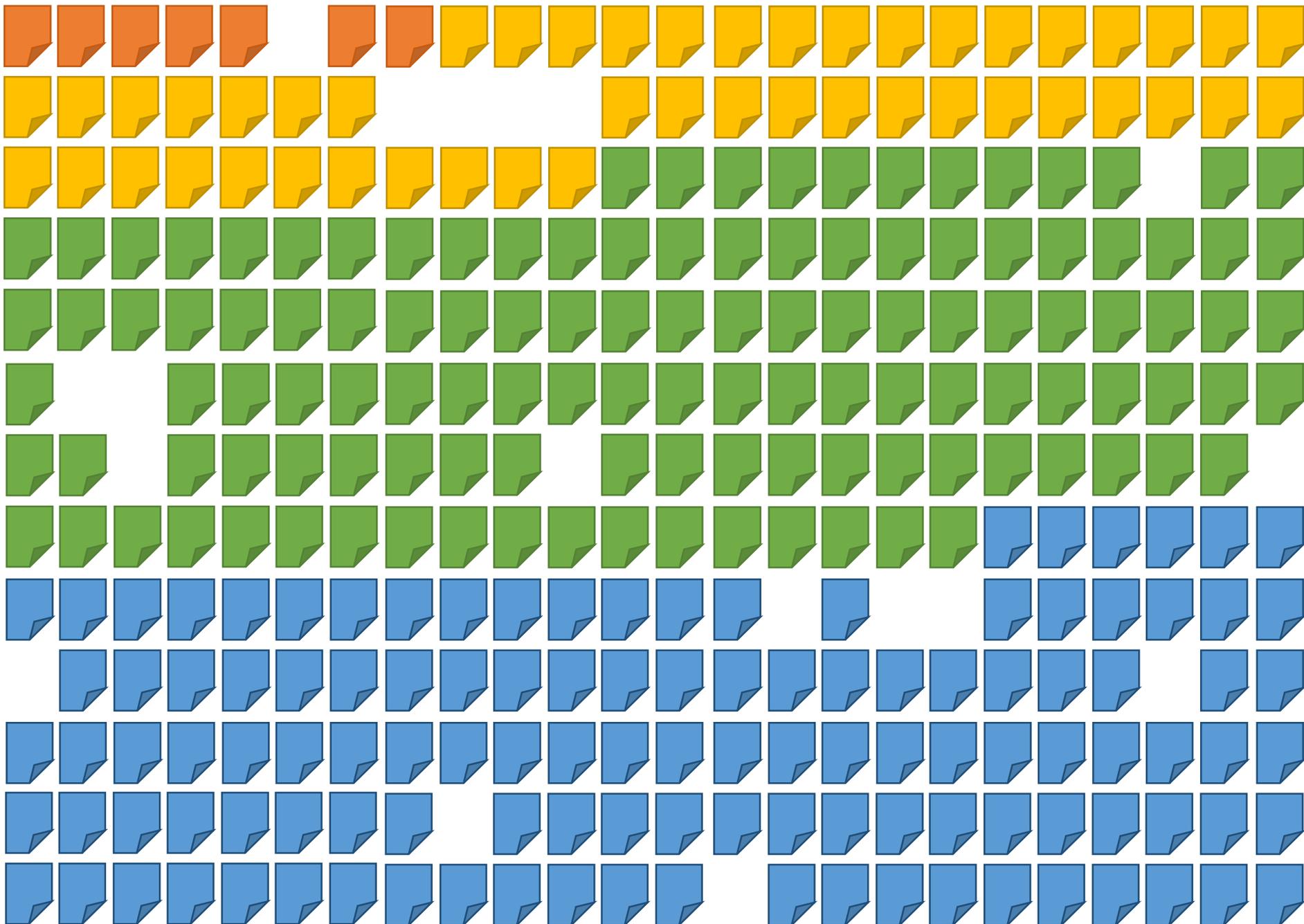


“I don’t need these right away.”

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

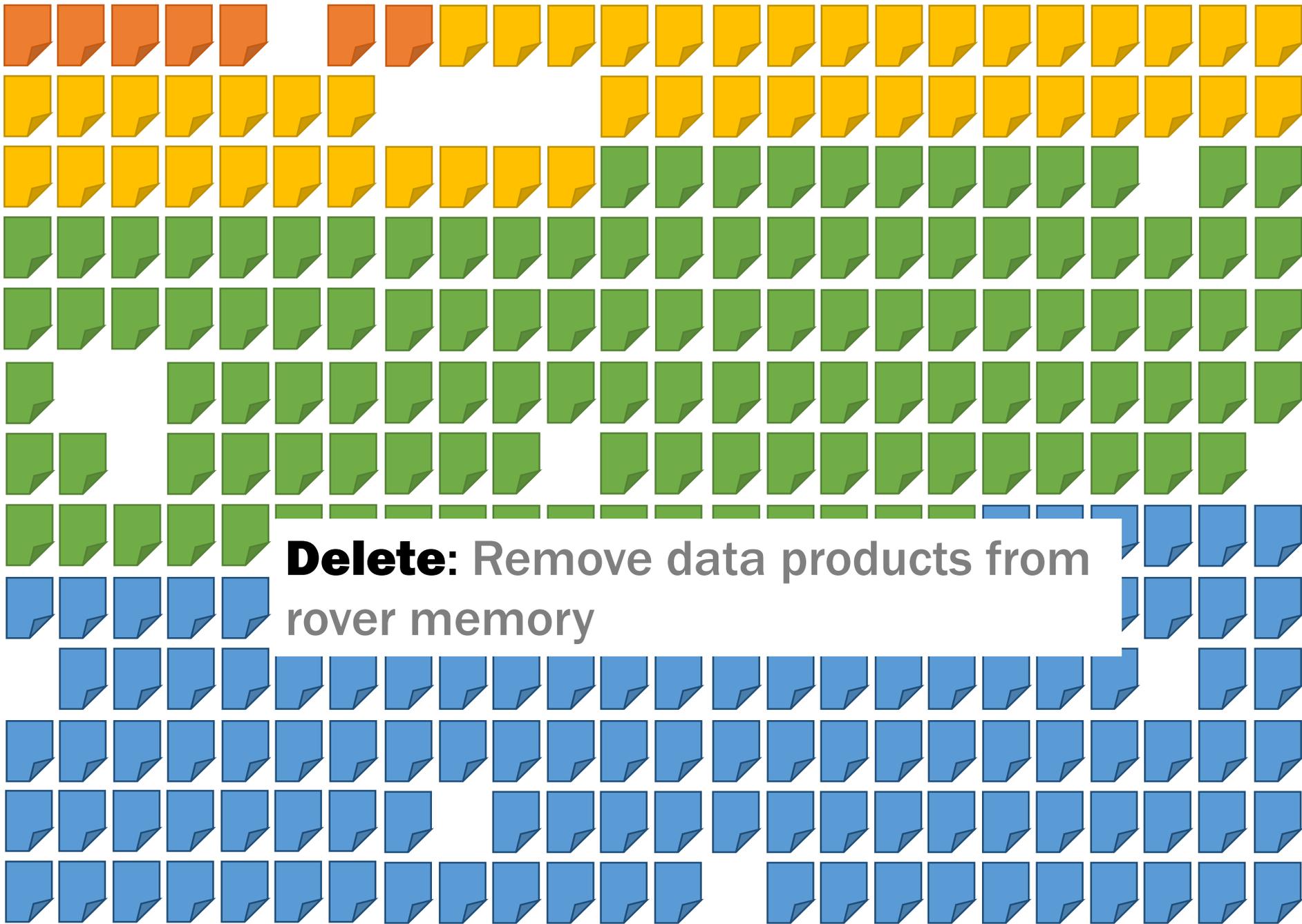








**Retransmit:** Request data products to be sent again



## **Commanded Deletes**

Dear Rover:

Please remove the following data products (list attached).

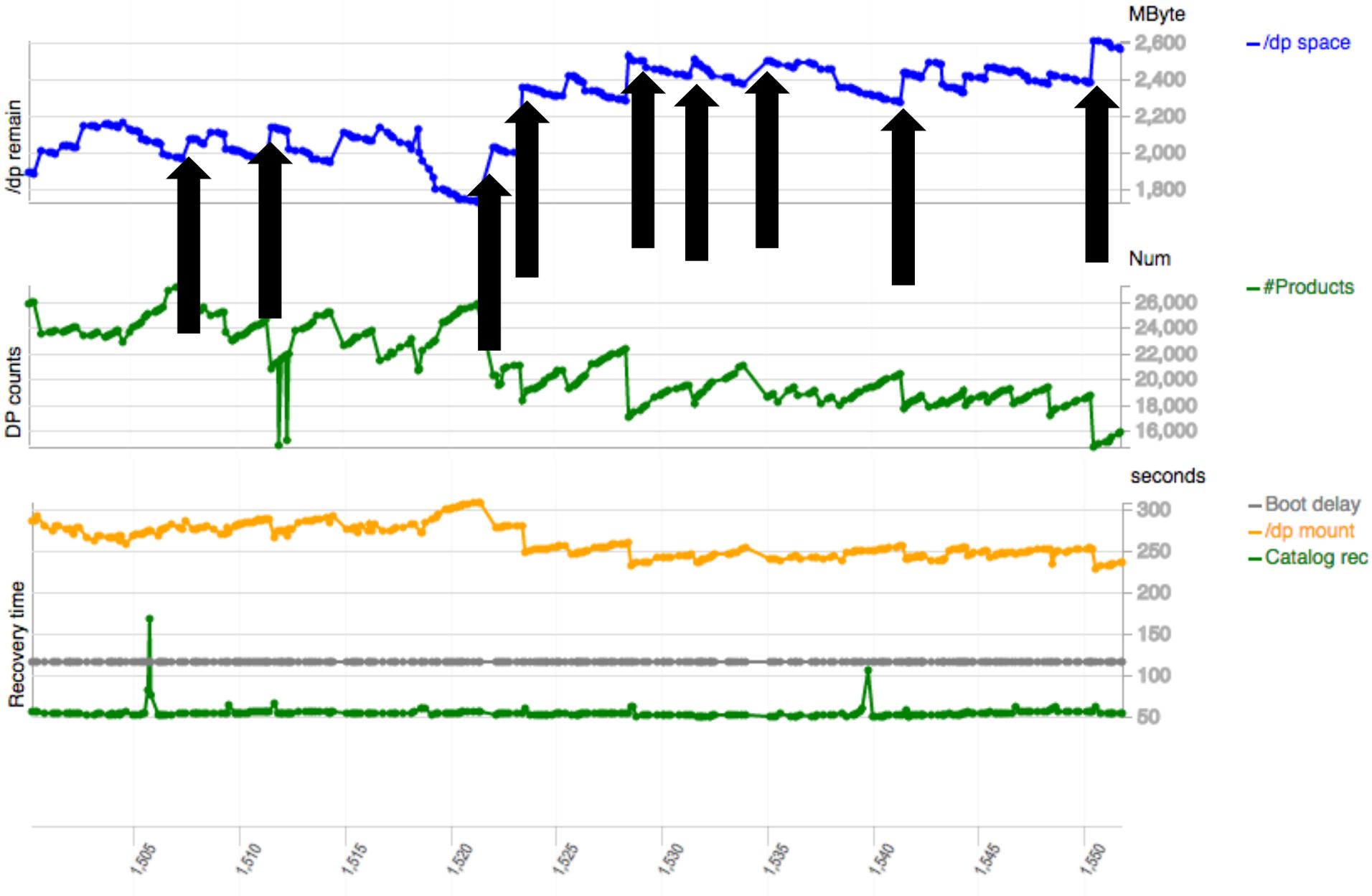
Yours,  
Ground Team

## **Automatic Deletes**

Dear Ground Team:

I deleted a bunch of your old data products.

Yours,  
MSL



**Deletes:** We do these every day or two

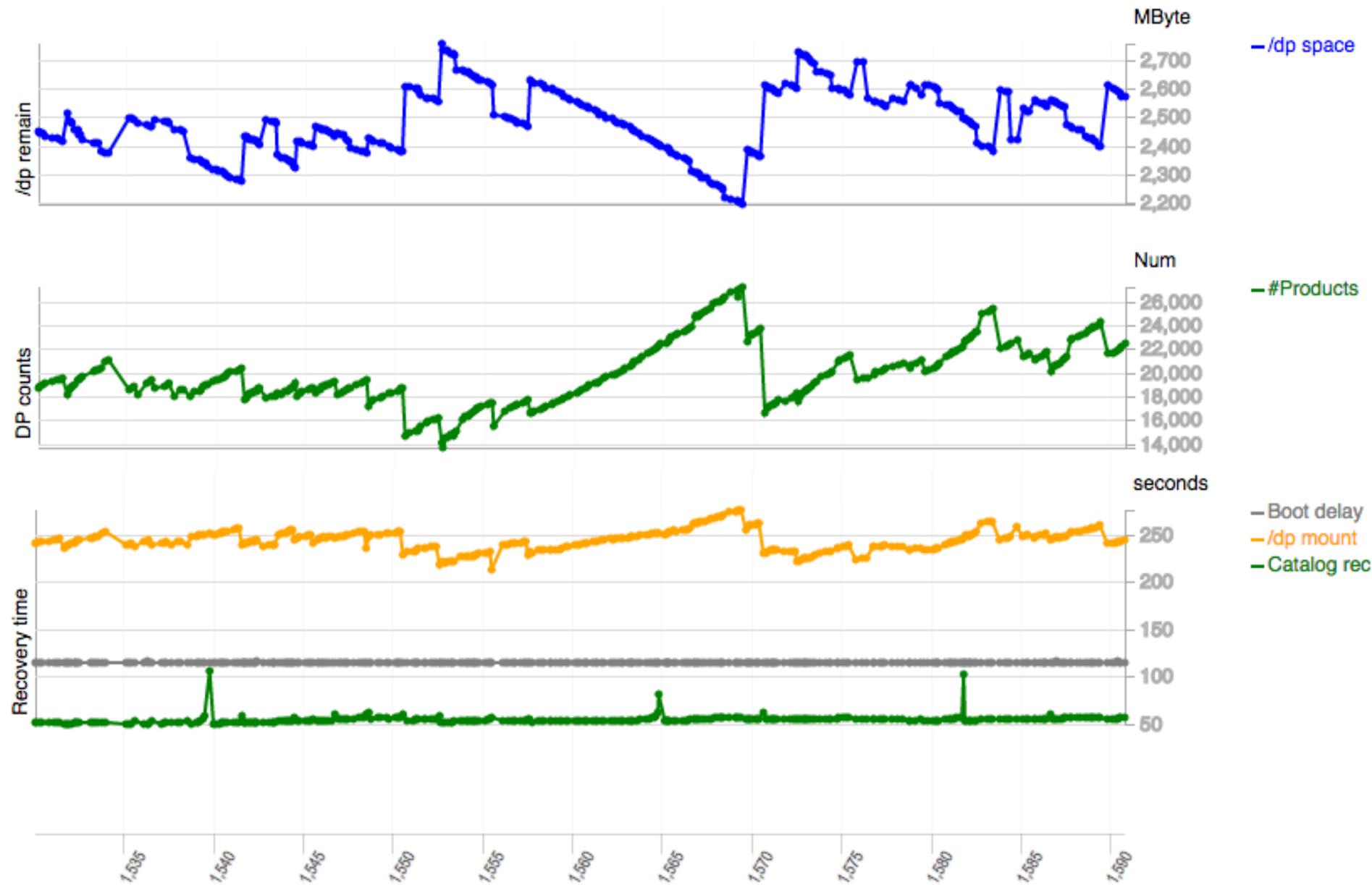
# Data Management Products

**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.**

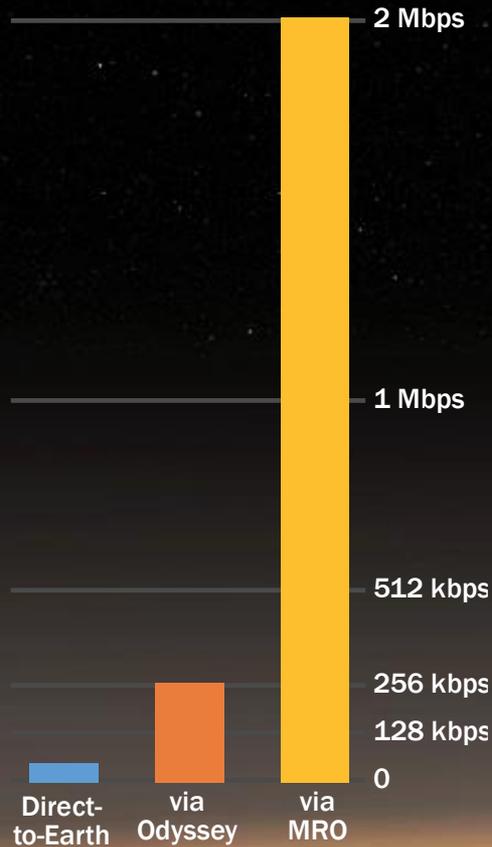
It helps to understand the way files are created, stored, migrated, and catalogued.

**Dare Mighty Things**



**Jet Propulsion Laboratory**  
California Institute of Technology

# 48GB of data downlinked in prime mission



Direct to Earth  
500–32k bps

via Odyssey  
128k | 256k bps

via MRO  
Up to 2M bps

