DRACO7RT · GROUND SYSTEM · 23 OCTOBER 2026

The DRACO7RT ground system

Two ground stations on one telemetry stream, a live display tool, and mission planning: a plan built in NASA’s planning tool, flown on the vehicle, and compared with what actually happened

COSMOS primary station | **Yamcs** second station | **Open MCT** displays | **PlanDev** planning | **Grafana** history wall

Everything starts at the front door, https://draco.efsi.com. This deck and the others are at https://draco.efsi.com/slides/ with no sign-in.

PLAIN WORDS FIRST

Seven terms used on every slide

Term	What it means here
Ground station	Software on the ground that shows the vehicle’s telemetry and sends it commands. COSMOS and Yamcs are two of them
Telemetry	Data the vehicle sends down: packets of values such as momentum, fuel or GPS fix count, once a second or faster
Command	An instruction sent up to the vehicle, for example “dump momentum”. The vehicle counts each command it accepts
Downlink tee	A small relay that receives the vehicle’s one telemetry stream and copies every packet to both stations
Packet database	The list of every packet and field a station understands. COSMOS holds the master copy; Yamcs’s is generated from it
Plan, simulation	A timeline of activities (launch, burns, dumps) and a prediction of what they do to momentum, fuel and modes
Actuals	What really happened when the plan was flown, read back from the recorded telemetry and laid beside the prediction

The vehicle is the QEMU-emulated flight computer running real NASA cFS flight software; NASA 42 supplies the physics. Nothing here is a real spacecraft.

HOW IT FITS TOGETHER

One vehicle, one telemetry stream, two stations, one planner

Vehicle
cFS flight software on QEMU, 42 physics

→

Downlink tee
copies every packet to both

→

COSMOS primary: screens, wall, mission test, Script Runner. Feeds the Grafana history wall

Yamcs second station: archive, events, commanding (off by default). **Open MCT** draws its displays from it

PlanDev plans and simulates. Never commands; a plan reaches the vehicle only as a COSMOS script

Commands go up from COSMOS, or from Yamcs when someone switches it on: one station at a time

One vocabulary: the same packet and field names in every tool, because Yamcs's list is generated from COSMOS's

One door: every page sits behind the draco.efsi.com sign-in

Pattern from NASA's RA231 reference architecture for an open ground system: Yamcs and Open MCT for telemetry and commanding, Aerie (now PlanDev) for planning.

WHERE TO CLICK

The front door’s Ground stations panel

Sign in once

1. Open the front door, https://draco.efsi.com: **Sign in with Microsoft**, or the shared COSMOS password in the box under it, **Sign in with password**
2. Find the **Ground stations** panel under the status strip: four cards
3. Each card has a dot; three have a button, each opening a new tab: **Open COSMOS**, **Open Yamcs** (straight into the draco instance), **Open Plan**
4. Open MCT: tile **Mission Control** (the viewer) › top-bar group **Yamcs** › page **Open MCT**

The one sign-in covers COSMOS, Yamcs, Open MCT, Grafana and plan.draco.efsi.com.

Reading the dots

Dot	Means
Green	Up, and telemetry is arriving
Amber	Up, but no telemetry arriving; for Yamcs also: Yamcs is the commanding station
Red	Down
Grey	Still checking

Cards: COSMOS, Yamcs, PlanDev and the downlink tee. Strip cell **COMMANDING**: COSMOS in green, or YAMCS in amber; Demo control › COMMANDING STATION says it in words (COSMOS commanding).

Direct addresses, once signed in: /viewer/ · /yamcs/ · /openmct/ · /grafana/d/draco-wall · https://plan.draco.efsi.com

SECOND GROUND STATION

Yamcs: the same telemetry, archived, with flight events

Look at telemetry

- Front door › Ground stations › Yamcs card › **Open Yamcs**: it opens on the **draco** instance's Home page. Then use the left sidebar
- **Telemetry › Packets**: every packet as it arrives
- **Telemetry › Parameters**: one field, e.g. ACS H_MAG, with its history
- **Archive browser**: what was received, by time
- **Telemetry › Displays** › DRACO: the COSMOS pages, generated for Yamcs (Yamcs Operator Guide, slide 18)

Read flight events

- Sidebar › **Events** lists the messages the flight software reports, the same ones COSMOS shows on Viewer › Mission › **Events**
- Source = the app that sent it (ACS, LC, SCH_APP, CFE_TIME ...)
- Flight errors show in red; routine messages in black
- Example: an LC no-op gives "No-op command: Version 2.2.99.0"

Know the differences

- Yamcs stamps each packet with the time it **arrived**; the vehicle clock is not UTC
- It keeps **30 days**; a nightly job deletes older data
- No Yamcs password: the front-door sign-in is its only lock

Check it matches: ACS HK_TLM_PKT CMD_COUNT reads the same in COSMOS (Viewer › Mission › App health) and in Yamcs (Telemetry › Parameters).

COMMANDING FROM YAMCS

Off by default, one station at a time

Send one command, start to finish

1. Agree with anyone on COSMOS that you are commanding now
2. Front door › Demo control › COMMANDING STATION › **Switch to Yamcs**, **Run**. The badge reads **YAMCS commanding**
3. Yamcs left sidebar › **Commanding › Send a command**: folder **ACS/** › **NOOP**, then on step **2. Configure command** press the green **Send**
4. Watch ACS CMD_COUNT go up by one, in Yamcs **and** in COSMOS (Viewer › Mission › App health)
5. Back on the front door: **Switch to COSMOS**, **Run**

Why the rule

- Both stations reach the same command input and move the same counters
- Two people commanding at once cannot tell whose command did what
- The rule is **procedural**: anyone signed in can switch the link on in Yamcs › Links (tc-out, **Enable**)
- A Yamcs restart switches it back off

COSMOS stays the primary commanding station: the demo and the Mission buttons use it. Demo control › YAMCS › Mission test (Yamcs) flies the same mission test from Yamcs.

DISPLAYS

Open MCT: NASA’s display tool, reading Yamcs

Open it

- Viewer (tile **Mission Control**) › top-bar group **Yamcs** › **Open MCT**, or https://draco.efsi.com/openmct/
- The first visit makes a folder **DRACO starter** under My Items and opens its layout; later visits start at My Items
- Starter layout **DRACO ACS / NAV**: momentum and rate, fuel, GPS fix count plots and the now-table ACS / NAV now

Build your own

- The BROWSE tree on the left lists every Yamcs parameter under **DRACO**
- Blue **CREATE** button, top left › Display Layout, Plot or Table; drag parameters in
- The time bar along the bottom (REAL-TIME, last 15 min) switches to a past window

Know this

- **Read-only:** no commands from Open MCT
- What you build is saved in **your browser** only; another browser or a cleared cache starts fresh
- Lost the starter? Open /openmct/#reset-starter

COSMOS screens and the Grafana wall stay the displays used in the demo; Open MCT shows what an Open MCT-based mission control looks like on the same data.

PLANNING

PlanDev: a mission model built from the flight code

What PlanDev is

- NASA-AMMOS’s planning and scheduling tool, formerly called **Aerie**
- You place activities on a timeline; it **simulates** what they do to the spacecraft
- A **scheduler** can add activities to meet a goal you write
- It only plans. It never sends a command

The DRACO model

Activity	Is on the vehicle
Launch	SC START_RTS 5
Deploy, Detumble	ACS ARM / FIRE_DEPLOY, SET_MODE
MomentumDump	ACS DUMP_MOMENTUM
AutonomousMomentumDump	LC watchpoint at 4.0 starts RTS-004
StationKeep	ACS STATIONKEEP
GpsGateCheck, ImuFault…	the spoof and fault demos

Ten activity types. Graphs for ACS mode, momentum, fuel and the NAV gate step at the flight software’s own 10 Hz.

Every rate and limit in the model cites the flight source line it came from, so a flight change shows up as a model change to make.

THE DEMO PLAN

Plan 11, “DRACO launch day”: one hour, simulated

Open it

1. Front door › Ground stations › PlanDev card › **Open Plan** (a new tab)
2. Card **Log in to PlanDev**: any Username and Password, press **Login**
3. Plans list: double-click ID **11**
4. Top: activities on the timeline. Middle: the graphs. Bottom: the activity list

Everyone is an administrator in PlanDev. Change only what you made.

What it shows

- First 10 minutes: the mission test in order. Launch, burn, IMU fault, GPS spoof
- **7 automatic dumps** by minute 14: the vehicle’s own autonomy at 4.0 N m s
- From minute 15 the scheduler added **34 dumps** to keep momentum at or below 3.5
- Fuel: 12.000 → 9.445 kg in the hour

3.5 N m s is a planning margin below the vehicle’s 4.0 trigger, not a flight value. Plan dates read 2026-296 = 23 October 2026, 14:00 UTC.

PLAN TO FLIGHT AND BACK

The plan was flown on the vehicle and checked against itself

1 · Plan
PlanDev plan 11, simulated

→

2 · Script
turned into a COSMOS script: each command at its planned second, plus checks

→

3 · Fly
run for 60 minutes on a freshly booted vehicle

→

4 · Actuals
recorded telemetry loaded back into PlanDev beside the prediction

→

5 · Wall
each activity marked on the Grafana graphs

155 / 155
checks passed in the hour, the same checks the mission test makes

0.1 s
every command was sent within this of its planned time

41 / 41
momentum dumps, planned and flown: 7 automatic, 34 scheduled

Run of 22 October 2026, 21:28 to 22:28 UTC. Record: claude-notes/PLAN-VS-ACTUAL-2026-10-22.md.

PLAN AGAINST ACTUAL

The prediction held, and the gaps have reasons

Quantity	Planned	Flown	Diff
Detumble	20.2 s	19.9 s	−0.3 s
First automatic dump at	00:04:01	00:04:03.5	+2.5 s
Momentum at that dump	4.084	4.119	+0.035
Burn: fuel used	0.1000 kg	0.1004 kg	+0.0004
Max momentum after 00:15:30	3.500	3.499	−0.001
Fuel left at one hour	9.445 kg	9.442 kg	−0.003

Why they differ

- Automatic dumps fire 1–2 s late each cycle: the vehicle checks once a second, twice in a row. The lag adds up to +12.5 s by the seventh
- So the first scheduled dump found 2.96, not 3.5; the next ones were back on 3.5
- Model gap: after the IMU fault the vehicle pins its backup rate 2.8 s later, the model says 1 s

Momentum in N m s. Planned = simulation dataset 150; flown = dataset 151 from telemetry. Full table and seven explanations: PLAN-VS-ACTUAL-2026-10-22.md.

RUNNING IT

It checks itself, cleans up after itself and survives a reboot

Health

- Front door › Demo control › HEALTH › **Verify**, then **Run**: the whole-stack check, read-only; its log streams in the job pane
- It proves telemetry is **moving**: counters at the tee and in Yamcs must rise
- A station that is up but silent fails; one that is stopped warns

Retention

- COSMOS (and the Grafana wall that reads it) and Yamcs keep **30 days** of telemetry
- PlanDev keeps 30 days of simulations, plus the newest per plan
- A nightly job at 04:30 UTC does it and warns at 80% disk

Reboot

- Every ground container restarts by itself
- The vehicle boots, is aimed at the ground, and 42 comes back
- **Tested 23 October:** the server restarted at 11:03 and all was up by 11:08 with no one touching it

If the tee ever fails, the vehicle can be aimed straight at COSMOS; Yamcs then gets nothing until the tee is back.

HONEST LIMITS

What it does not do yet, and what rests on people

Rules people must keep

- **One commanding station.** Nothing stops two people commanding at once
- Yamcs and PlanDev have **no login of their own** here: anyone past the front door is an administrator in both
- So the front-door sign-in is the only lock. Share it only with people you would let command the vehicle
- The sign-in is recorded: each Microsoft name, and every button pressed and page opened under it

Not built yet

- The plan flies as a ground script; the vehicle does not yet store and fly a plan by itself
- No export of a plan to Yamcs commanding
- Open MCT does not show the plan; its displays are per browser, not shared
- The model has no sensor stream, so it misses one-second IMU dropouts seen live

The predictions are for this emulated vehicle and its simulation-grade attitude control, not for a real spacecraft.

TRY IT

A ten-minute tour, browser only

1. Sign in at the front door, https://draco.efsi.com. Ground stations panel: the four dots green
2. Yamcs card › Open Yamcs (opens on draco’s Home). Sidebar › Telemetry › Parameters, search H_MAG: the value COSMOS shows
3. Yamcs sidebar › Events: the flight software’s messages, newest first, errors in red
4. Tile Mission Control › group Yamcs › Open MCT: the DRACO starter folder, live
5. PlanDev card › Open Plan, log in with any name, open plan 11: the hour, the dumps, fuel falling
6. Optional, agreed with COSMOS users: Demo control › Switch to Yamcs, send ACS NOOP, Switch to COSMOS

More: the Yamcs Operator Guide flies the whole mission from Yamcs; the COSMOS Operator Guide covers the primary station.