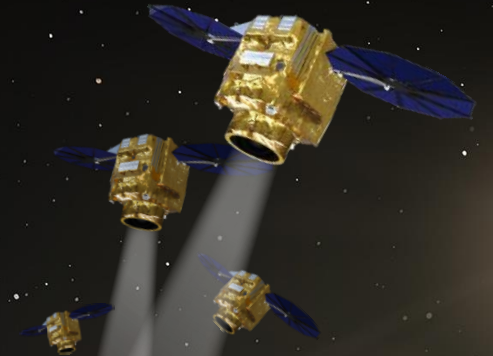




DOMINO-X: A new CONOPS for EO constellation

30/03/2023 – CNES, Toulouse, FR



Baptiste Schandeler

EO Future Programmes – System Engineer

baptiste.schandeler@airbus.com

AIRBUS

1. AIRBUS: EO SATELLITES PORTFOLIO

OPTICAL CONSTELLATION

Pléiades Neo

Pléiades

SPOT

DMC

Vision 1

RADAR CONSTELLATION

TerraSAR-X

Tandem-X

PAZ

NovaSAR

NEXT

CO3D

Zephyr

TerraSAR-X Neo

1. AIRBUS: EXPERTISE IN EO



EO Spacecraft

+



Communications



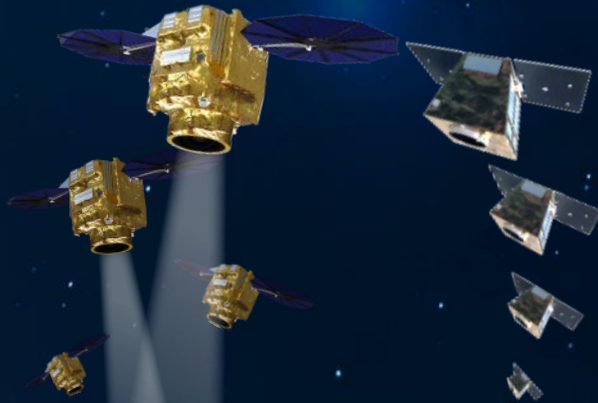
S/C Control



Tasking & ordering



Image products



S950

S250



End-to-End EO System

Airbus' E2E EO system addresses demanding missions

1. AIRBUS: EXPERTISE IN EO



More spacecrafts in EO constellations



More complexity



Timely requirements for data



Growing capacity and performances



All these features rely on the
Ground Segment





<http://domino-x.space/>

DOMINO-X

Future Earth Observation Ground Segments



Domino-X is supported by CNES and France Relance

2. DOMINO-X: Reference E2E System

Reference space system:

- Combination of optical and radar very high resolution satellites
- Access to external space data providers

Main system use cases:

- Single product acquisition
- Site monitoring & automatic reprogramming
- Coverage of Large Areas

Representative system for:

- Export
- Commercial
- Institutional
- Defence needs



2. DOMINO-X: Future EO Ground Segment



Reactivity:

- Multi-mission Federation and Ground Station as a Service (GSaaS)



Virtualisation:

- FINOPS, Cloud-deployed Control center, SDR



Automation:

- New CONOPS, Automated IQ, AI Enhanced data



Integrity and traceability:

- IA tattooed image data, authentication

2. DOMINO-X: Key Drivers



Reduce overall system costs and planning



Develop capabilities



Ease system evolutions



Increase system reactivity



Automate the monitoring and control



Provide novel User Experience concepts



10 heterogeneous spacecrafts



10 operators



Modular and scalable approach



Cloud-based environments

2. DOMINO-X: CONOPS / Architecture & path



Scalability & modularity



Standardization



Automation

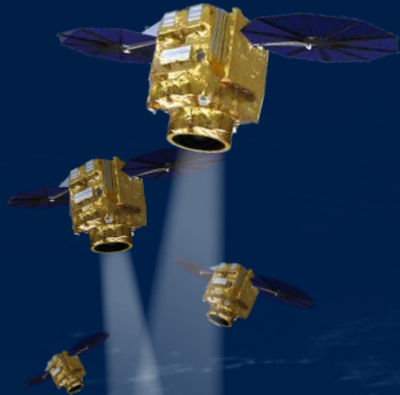
hdg
Human Design Group

Capgemini

AIRBUS

2. DOMINO-X: Overview

Heritage & expertise



*Domino-X:
modular & scalable*



Key Drivers

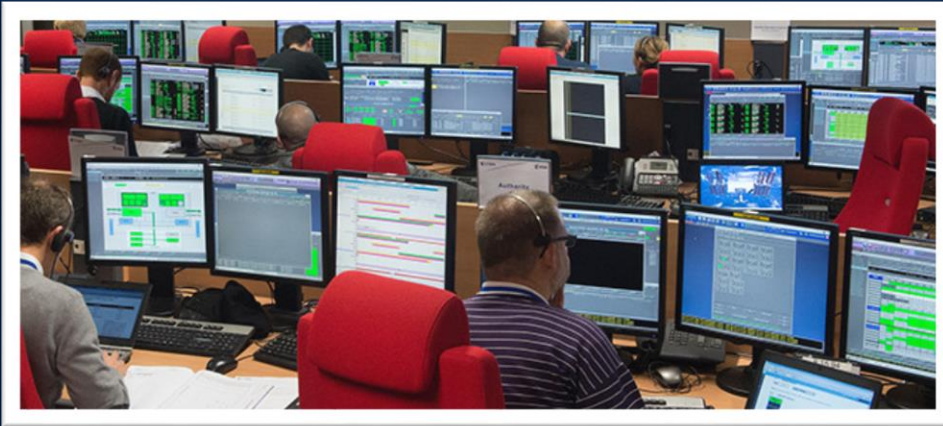


Partners



3. SYSTEM MONITORING: Currently

Most of current control rooms worldwide:



*What about if we scale up
to 10 spacecrafts?*

- Large number of operators needed
- Less customisation and scalability

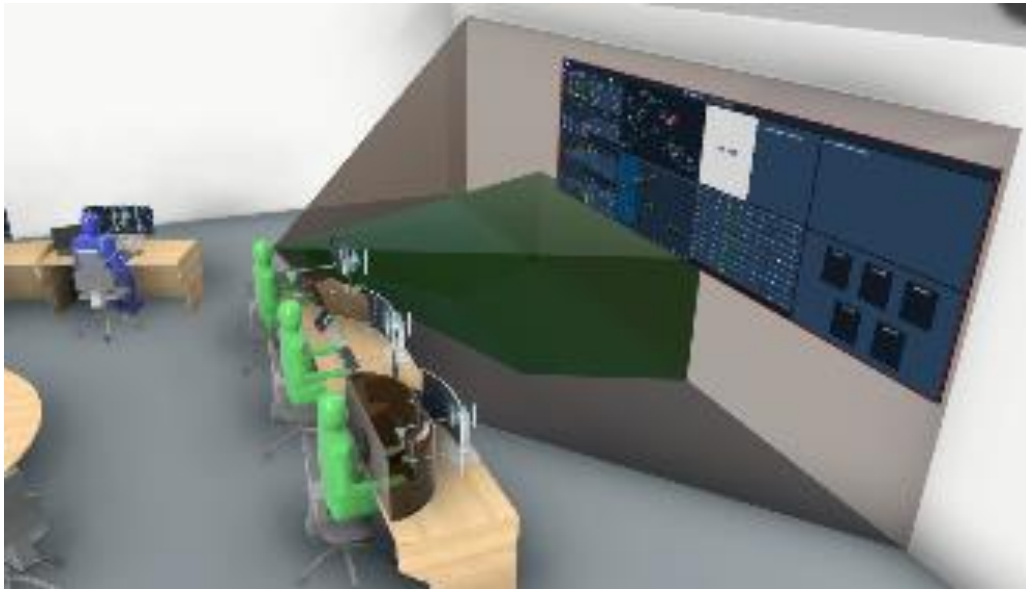
3. SYSTEM MONITORING: DOMINO-X



3. SYSTEM MONITORING: Room Layout



3. SYSTEM MONITORING: Human Factor



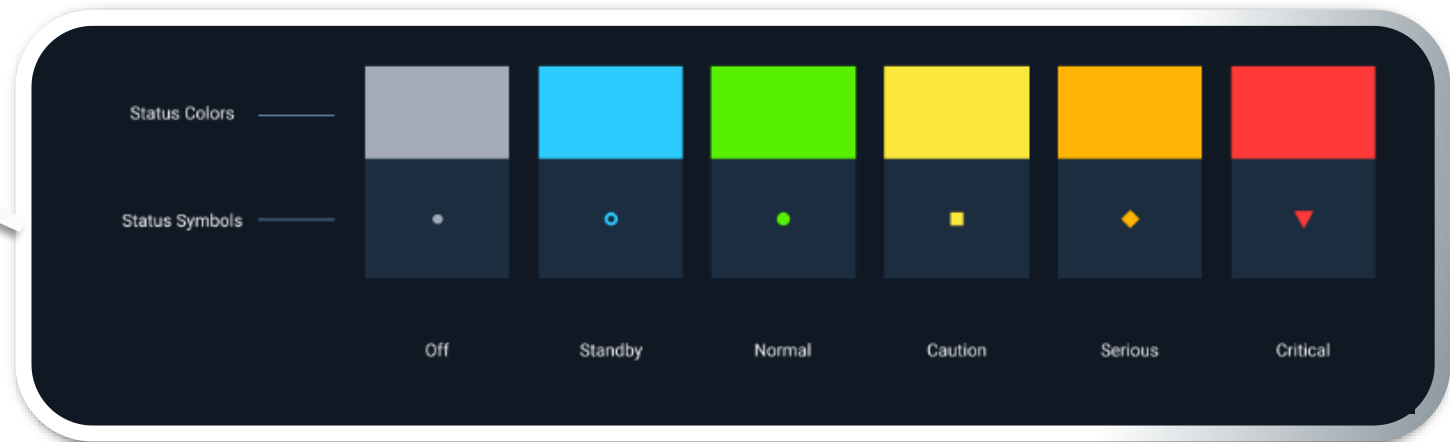
3. SYSTEM MONITORING: DOMINO-X Monitoring System



3. SYSTEM MONITORING: DOMINO-X Monitoring System

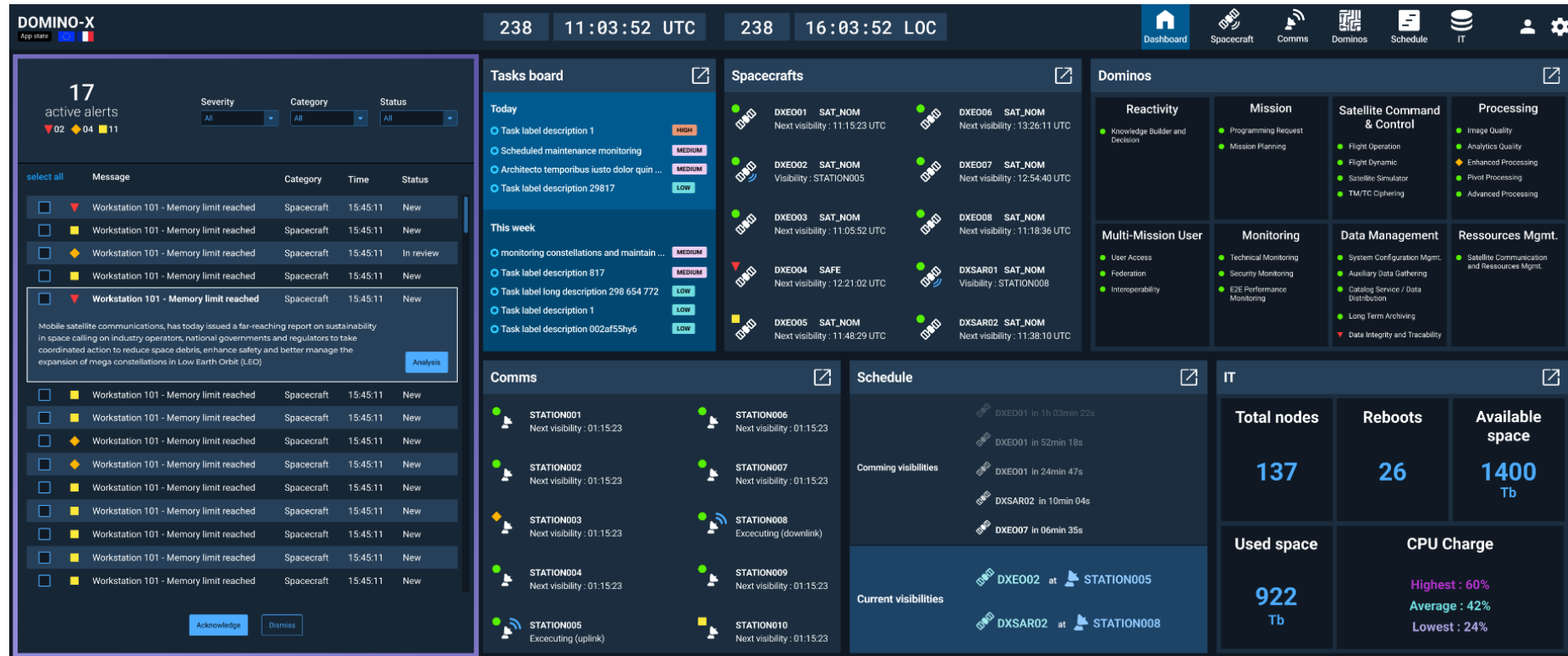


3. SYSTEM MONITORING: UI details

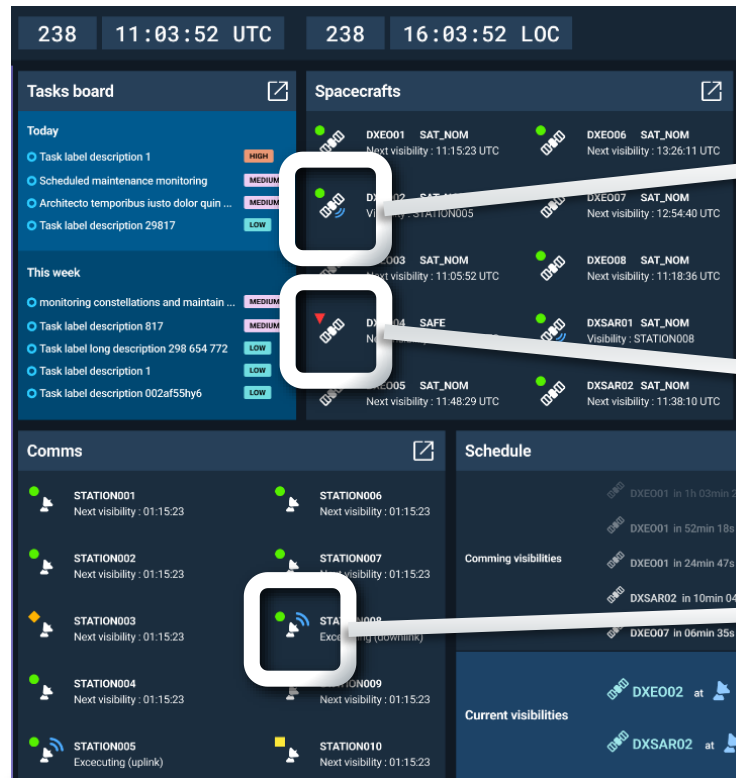


Color-coded events are associated to pictograms. On every GUI, the same components and patterns are used to ease the readability and be more inclusive

3. SYSTEM MONITORING: DOMINO-X Monitoring System



3. SYSTEM MONITORING: UI details



This spacecraft is in communication with a ground station



This spacecraft has a major issue



This ground station is in communication

4. AUTOMATION: System Monitoring



DOMINO-X: Modular and scalable architecture

- Each Domino has its own KPI, alerts, outputs... available to the Central Monitoring System



Automation algorithms and **AI**

- process data from various subsystems
- monitor real time events, contingencies, evolutions



Supervision and monitoring are **centralized** and **automated**:

- IT (workstations, network, cloud...),
- Mission (targets, mission follow-up, visibilities timeslot...)
- Spacecraft control (satellites constellation status and availability),
- high level system KPI...

This new CONOPS completely changes operator tasks.

4. AUTOMATION: Reporting and ticketing



System KPI follow-up

- necessary to enhance KPI monitoring.
- managers and decision-makers also need reports on their systems



One of the most **time-consuming** tasks during spacecraft operations is **reporting**.



Enhancing and easing reporting is one of the priorities if we want to make operations more time-efficient

Central monitoring deliver reports automatically

4. AUTOMATION: AI for Alert solving

DOMINO-X
App state: [Flags]

238 11:03:52 UTC 238 16:03:52 LOC

Dashboard | Spacecraft | Comms | Dominos | Schedule | IT | User | Settings

17 active alerts
▼ 02 ▼ 04 ▼ 11

Severity: All Category: All Status: All

select all	Message	Category	Time	Status
<input type="checkbox"/>	Workstation 101 - Memory limit reached	Spacecraft	15:45:11	New
<input type="checkbox"/>	Workstation 101 - Memory limit reached	Spacecraft	15:45:11	New
<input type="checkbox"/>	Workstation 101 - Memory limit reached	Spacecraft	15:45:11	In review
<input type="checkbox"/>	Workstation 101 - Memory limit reached	Spacecraft	15:45:11	New
<input type="checkbox"/>	Workstation 101 - Memory limit reached	Spacecraft	15:45:11	New
<input type="checkbox"/>	Workstation 101 - Memory limit reached	Spacecraft	15:45:11	New
<input type="checkbox"/>	Workstation 101 - Memory limit reached	Spacecraft	15:45:11	New
<input type="checkbox"/>	Workstation 101 - Memory limit reached	Spacecraft	15:45:11	New
<input type="checkbox"/>	Workstation 101 - Memory limit reached	Spacecraft	15:45:11	New
<input type="checkbox"/>	Workstation 101 - Memory limit reached	Spacecraft	15:45:11	New
<input type="checkbox"/>	Workstation 101 - Memory limit reached	Spacecraft	15:45:11	New
<input type="checkbox"/>	Workstation 101 - Memory limit reached	Spacecraft	15:45:11	New
<input type="checkbox"/>	Workstation 101 - Memory limit reached	Spacecraft	15:45:11	New
<input type="checkbox"/>	Workstation 101 - Memory limit reached	Spacecraft	15:45:11	New
<input type="checkbox"/>	Workstation 101 - Memory limit reached	Spacecraft	15:45:11	New
<input type="checkbox"/>	Workstation 101 - Memory limit reached	Spacecraft	15:45:11	New

Mobile satellite communications, has today issued a far-reaching report on sustainability in space calling on industry operators, national governments and regulators to take coordinated action to reduce space debris, enhance safety and better manage the expansion of mega constellations in Low Earth Orbit (LEO)

Alert Analysis

Workstation 101 - Memory limit reached
Spacecraft 15:45:11

Eos qui ratione voluptatem sequi nesciunt. Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia non numquam eius modi tempora.

Eos qui ratione voluptatem sequi nesciunt. Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia non numquam eius modi tempora.

Eos qui ratione voluptatem sequi nesciunt. Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia non numquam eius modi tempora.

id mac_address ip_address json_array memory time

1 7D-11-2F-59-98-7C 230.230.225.236 [0,0] 54.24 3:40:21 PM

2 C4-C8-08-D5-1E-D2 31.180.249.225 [0,0,0,0] -38.5 3:42:52 PM

3 0C-19-4B-51-80-EC 4.6.1.224 [0,0,0,0] 43.22 3:42:16 PM

4 1A-11-A3-20-25-13 105.21.213.53 [0,0,0,0] 18.41 3:43:44 PM

5 37-18-1C-57-C4-61 94.203.146.82 [0,0,0,0] -15.23 3:42:45 PM

6 81-E1-89-35-BE-17 60.45.151.215 [0,0] 38.05 3:41:10 PM

7 11-39-8F-9A-9A-91 144.220.121.0 [0,0,0,0] 98.69 3:40:54 PM

8 F7-31-88-5A-FE-D8 199.149.184.174 [0,0,0,0] 69.13 3:44:04 PM

9 C7-AB-4A-11-81-4D 22.122.126.126 [0,0,0,0] 55.32 3:42:19 PM

10 AC-D8-F8-5A-96-0E 29.249.246.63 [0,0,0,0] 40.59 3:44:27 PM

11 B9-20-1D-E6-66-22 155.116.76.125 [0,0,0,0] 111.63 3:44:01 PM

12 5D-36-03-5B-F6-0D 72.165.176.230 [0,0] 63.25 3:41:59 PM

13 C2-85-55-AF-8D-CE 199.42.129.155 [0,0,0,0] 64.74 3:44:58 PM

14 A9-EA-D9-C7-DD-45 61.68.244.32 [0,0] 76.43 3:43:50 PM

15 35-EC-F9-8E-C2-5F 197.224.185.188 [0,0,0,0] 76.97 3:40:14 PM

16 EA-0E-D3-C2-4F-2F 164.143.102.163 [0,0] 85.48 3:40:27 PM

17 CA-6E-64-E5-EC-DC 136.112.125.141 [0,0,0,0] 58.65 3:42:19 PM

18 6A-20-56-E5-45-90 183.254.127.35 [0,0,0,0] 34.57 3:42:36 PM

19 D7-B2-6C-FB-E8-98 120.231.5 [0,0,0,0] 74.79 3:42:25 PM

20 0F-1B-C6-4E-B8-F1 109.95.124.136 [0,0,0,0] 81.86 3:43:12 PM

21 D7-B2-6C-FB-E8-98 120.231.5 [0,0,0,0] 74.79 3:42:25 PM

IA solution n°1
Reliability : 95% Estimate time to solve : 2h to 3h

Solution description :
Eos qui ratione voluptatem sequi nesciunt. Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia non numquam eius modi tempora. Eos qui ratione voluptatem sequi nesciunt. Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia non numquam eius modi tempora.

IA solution n°2
Reliability : 80% Estimate time to solve : 30min to 1h

Solution description :
Eos qui ratione voluptatem sequi nesciunt. Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia non numquam eius modi tempora. Eos qui ratione voluptatem sequi nesciunt. Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia non numquam eius modi tempora.

Charts

Buttons: Approve, Transfer to OP2, Acknowledge, Dismiss, No reliable solution?, Transfer to technical manager

CONCLUSION



Automation: 1st step to gather and analyze large amount of data.



Artificial intelligence:

- analyze deeper
- propose solutions to fix contingencies
- anticipate future trends



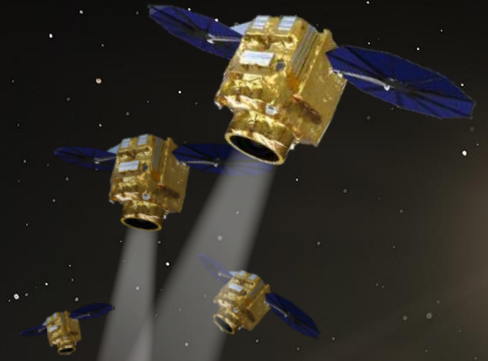
The CONOPS is completely modified ➡ redesign human/machine interaction.

New way to operate an EO constellation
In the medium-term future, the ambition is to achieve a “lights-off” center



DOMINO-X: A new CONOPS for EO constellation

30/03/2023 – CNES, Toulouse, FR



Thank you

Baptiste Schandeler

EO Future Programmes – System Engineer

baptiste.schandeler@airbus.com





<http://domino-x.space/>

DOMINO-X

Future Earth Observation Ground Segments



Domino-X is supported by CNES and France Relance