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# Padoc: A framework for Software and Operational Data deployment in an isolated Ground Center

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## Abstract

The French Space Agency, CNES, has been operating an S+X-band Ground Stations Network for more than 30 years. This network is a multi-mission asset that provides Tracking, Telemetry and Command (TT&C) services to French and Multinational governmental satellites (currently around 10 in flight) in Launch and Early Orbit Phase (LEOP), in mission phase and in the End Of Life operations (EOL). On occasions, the spare capacity of the network provides equivalent services to other satellite or network operators in the frame of cross supports or commercial agreements.

The COR (the Operational Network Center) Facility, set in Toulouse France, implements all the services between Satellites Control Center or Mission Centers and WorldWide Antennas. The center is composed of several systems, affected to several goals. The center is 24/7 manned.

Software and data processing in an operational facility with 7/7 in-orbit satellites activity need to be done very carefully, in a high level of availability. The time lapse between updates are not very frequent (twice-major updates a year per system) and could be seen trivial at first glance. But, lifetime of the whole center is several decades, so it has to be able to implement new services for new satellites while maintaining the services for current missions, taking into account huge technology gaps in some cases.

Tailoring between integrity versus scalability for updating software on an internal network isolated from internet is not easy and need to be done very carefully. CNES Network Operational Center chose to deploy and customize an autonomous system based on AnsibleTower, Git, Nginx, to manage several softwares and platforms from multiples providers (COTS, internal handmade tools, or specific ordered products).

After a brief recall of the COR architecture, this paper will highlight maintenance and update needs on the long term taking into account the lessons learnt of decades of usage of the center for satellites campaigns. Then the paper will explain the approach taken to find, after several rounds of specifications, the right balance between on one hand integrity and security aspects and, on the other hand, availability and scalability of the whole center.

The Agile approach, used for the implementation of this new system named PADOC (French acronym for Automated Platform for Operational Data Deployement in COR), will be described.

Finally, the paper will show the benefits of the chosen architecture based on well known COTS and how it allows us to reach the target after several years of workaround. The deployment of this system has also an impact on operational procedures and the support provided to the operational teams will be explained.

PADOC has been designed for easily implementing new services by configuration only: at the end, the roadmap for next planned improvements will be presented.

**Keywords:** Sofware deployment, Long term lifecycle software

## Acronyms/Abbreviations

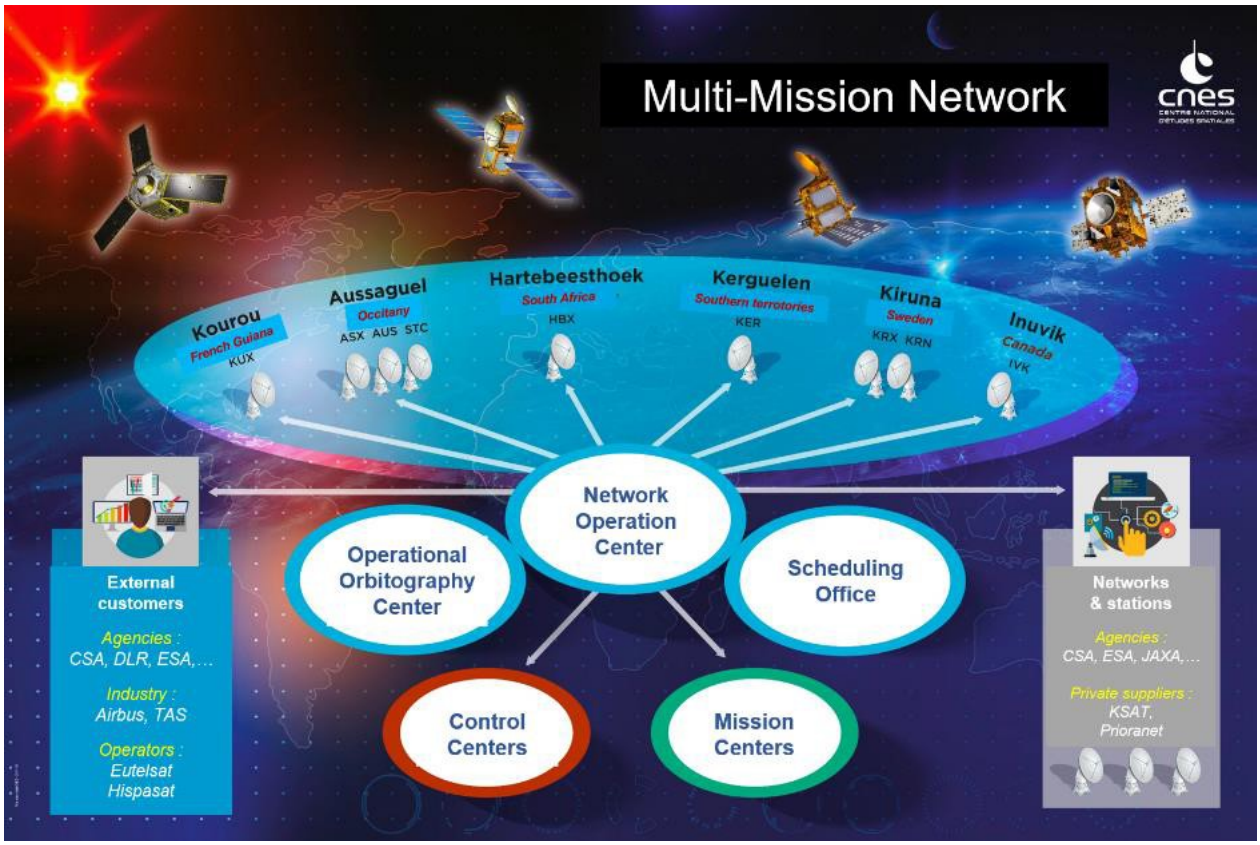
Centre d'Opération Réseau (COR)
Plateforme Administration Données Opérationnelles Configuration (PADOC)
Centre National d'Etudes Spatiales (CNES)
Ingestion et de Diffusion Externe des Fichiers reçus en bande X (IDEFIX)
Commercial-off-the-shelf (COTS)

## 1. Overview

Since 1984 the CNES Ground Stations Network has been providing ground stations supports to satellites from the Low Earth Orbit (LEO) to Geostationary Earth Orbit (GEO) altitudes range and in all mission phases from Launch and Early Orbit Phase to End of Life. This Network is currently composed of:

- 5 dual-band (S and X) and 2 S-band multimission antennas compatible with LEO, MEO and GEO satellites requirements (link budgets, antenna speeds and accelerations…)
- A Network Operations Center (NOC) managing the operations of the ground stations and the interfaces with the user's control and mission centers
- A Scheduling Office in charge of the elaboration of the ground stations schedule and of statistics on the performance of the services
- An Orbit Computation Center (OCC) in charge of the processing of the localization measurements performed by the ground stations, the restitution of the orbits of the satellites and the provision of predicted pointing data to the ground stations.

The perimeter of the CNES Ground Stations Network and its interfaces with internal and external customers as well as with external suppliers is shown on the following picture.




**Perimeter of the CNES Ground Stations Network**

The Network Operations Center is the central point of the global Network in terms of architecture but also for the provision of the services required by the control and mission centers of the supported missions. On a 24/7 basis, the main role of the NOC operator is to:

- Monitor the status of the ground stations and operate them.

- Monitor and operates all systems and interfaces involved in the data exchanges between the stations and the customer's centers for the provision of the services:
- Platform and/or payload telemetry provision in real time and/or post-pass
- Real-time sending of commands
- Collection and provision post-pass of localization data (ranging, 1-way or 2-way Doppler and antenna angles measurements)

All those systems have their own software lifecycle and for the long term stability needed, maintaining, integrating new versions, just keeping everything running is a real challenge

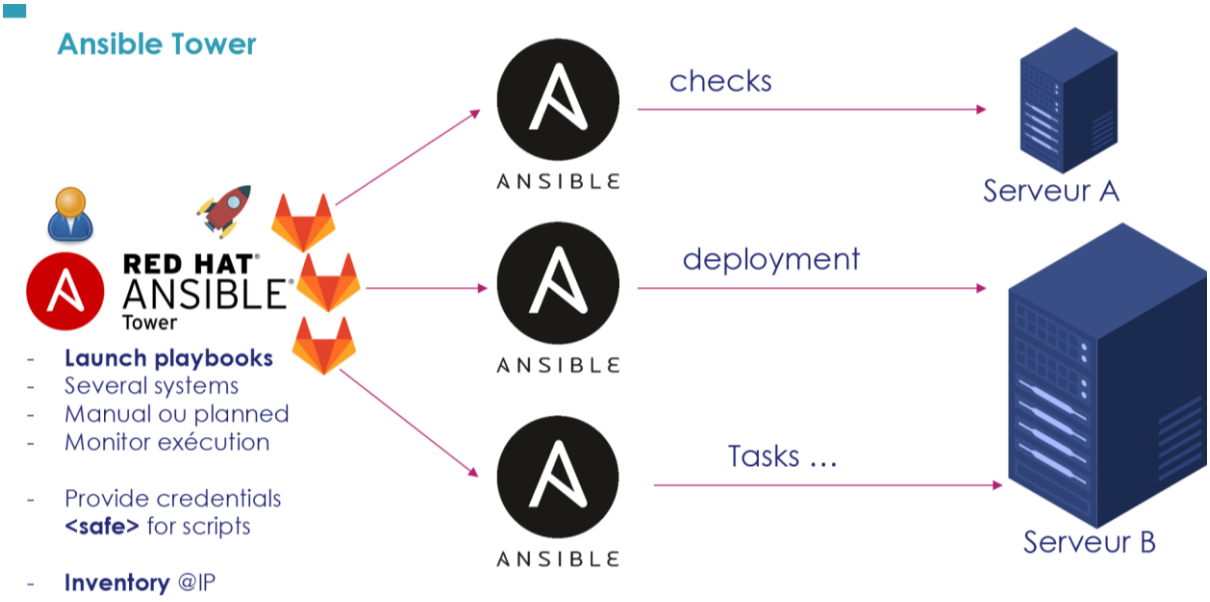
PADOC project started in 2015 on this purpose

## *2.* Architecture and Methodolgy

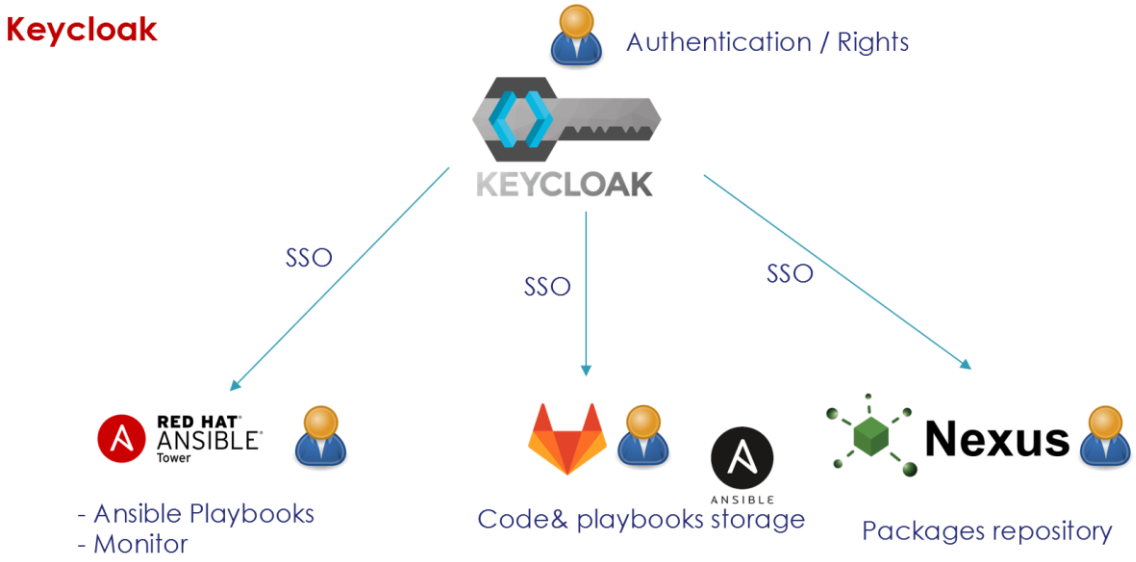
From 2015, several rounds of specifications occurs but it was very difficult to find the right balance between on one hand integrity and security aspects and, on the other hand, availability and scalability of the whole center.

Finally, at the end of 2021, we chose to architecture the system with well-known cots mainly used in CNES. This choice gave us access to local support during the development and the integration.

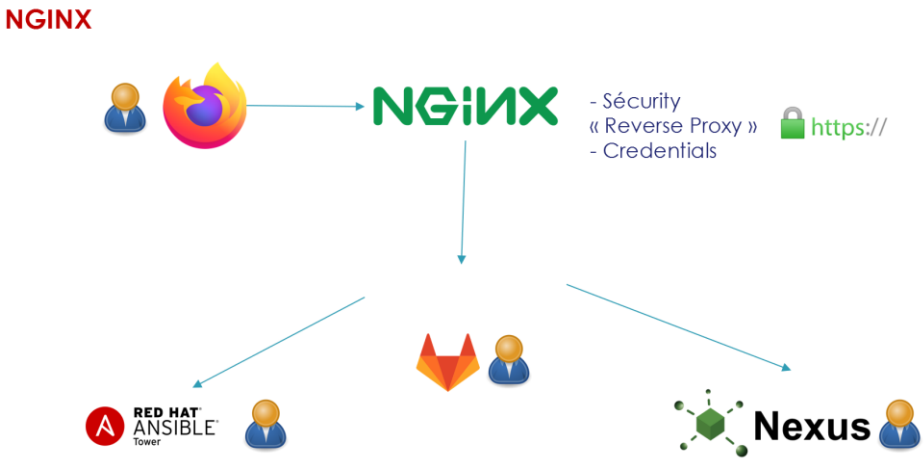
The choice of Ansible was guided by his "clientless" design and the python scripting language already on use on some platforms, we only have credentials to manage.

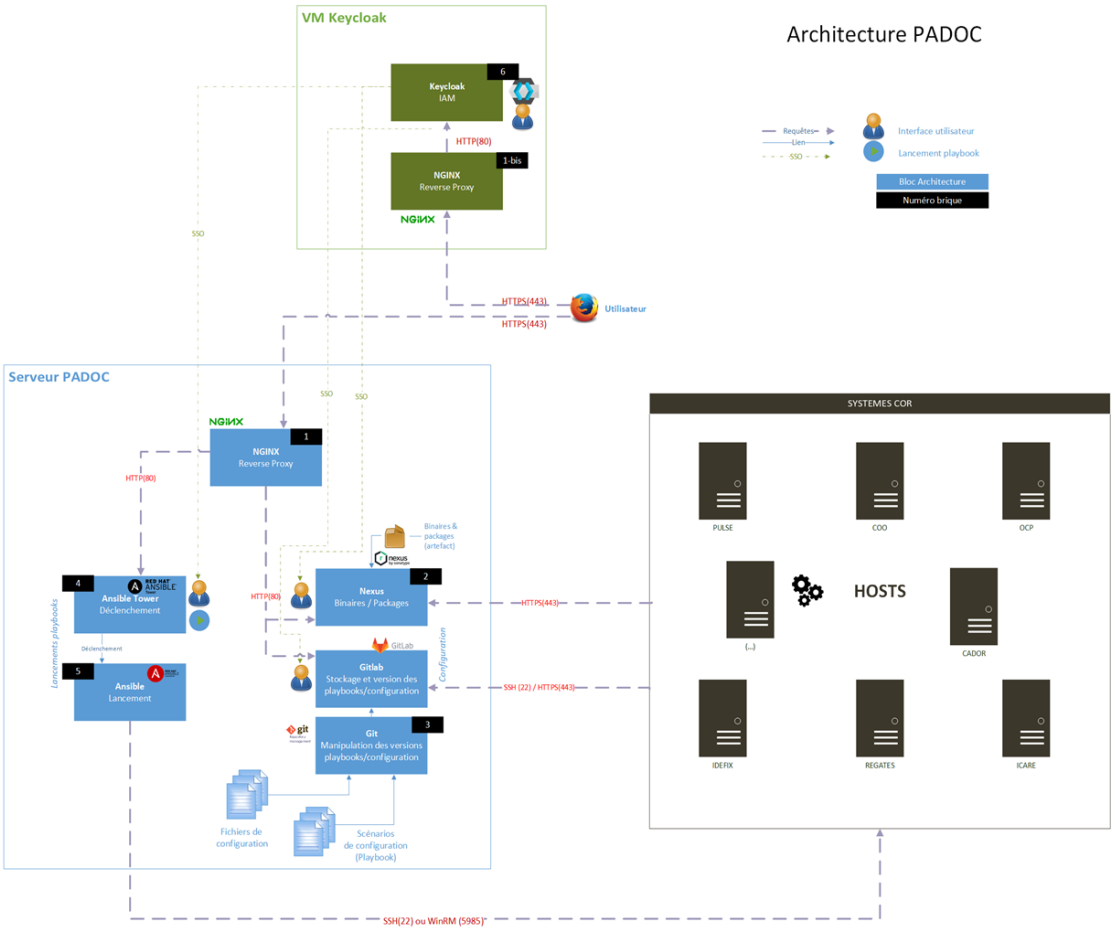


For the security aspects, we implement a reverse proxy Nginx and resort to Keycloak for credentials management.




Repository and version management issue is managed by GITlab and Nexus for bigger packages

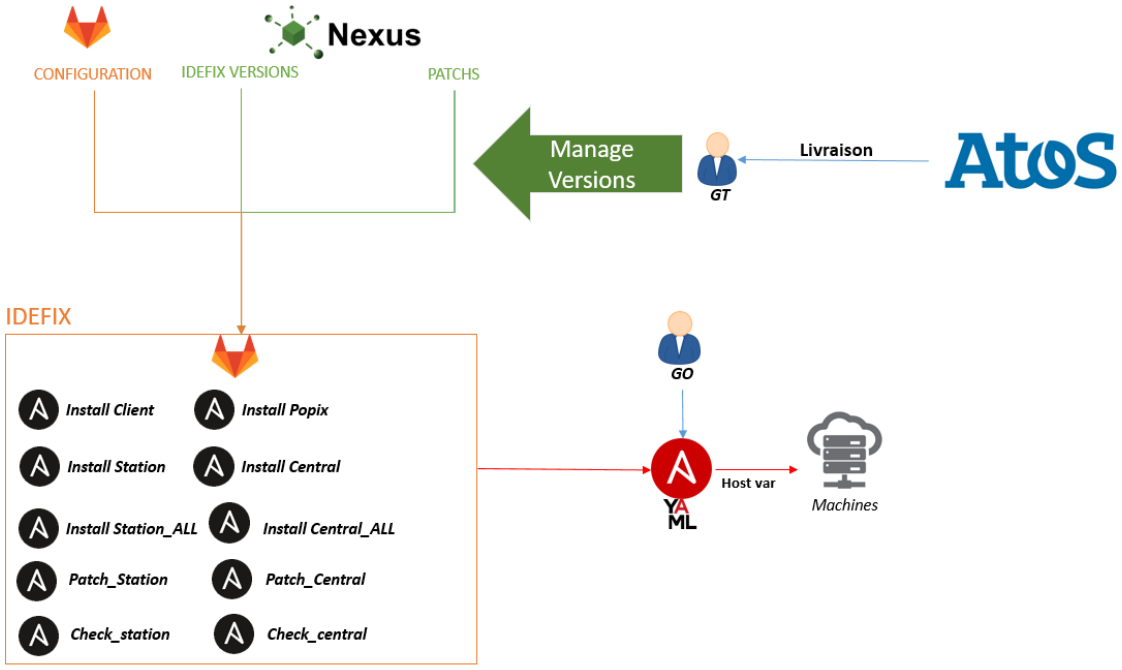





**PADOC Architecture**

After the design was agreed, we take an Agile "light" approach, namely we had several workshop "run" with all Software leaders for both showing the PADOC design and them the benefits of ansible and to refine the way they actually managed their operational data.

After each workshop an evaluation of complexity and priority for coding the ansible scripts. A schematic proposal for each selected software. The following picture is an example of a workshop result for IDEFIX component




**PADOC Workshop result for IDEFIX component**

A few week after each workshop, we agreed with the Software Leader and start the ansible scripts

## 6. Conclusions

The development of the PADOC with this method was very useful to understand how the heterogeneous components of the COR was managed.

Scripting with ansible all the deployment / patch methods will help Software Leaders to be more efficient for long term stability of their system. It could induce some minor changes for operate but the workshops were very constructive and we finally be able to match their needs.

Today the PADOC system is deployed on the pre-production platform (mirror and backup of whole COR components) and succeed to deploy each initial component candidate, but PADOC had been designed for easily implementing new services by configuration only for the future.

The deployment on the operational platform is planned on the first quarter 2023.

Keep everything working on a so complex operational system as is the COR, with so much interfaces and technologies needs us mastering our software components, even with very long lifecycle software.

PADOC gives us this ability and we succeed to ingest knowledge that will remain in PADOC even if the initial developers are retired !

## References

COTS used for the PADOC system:

GITlab : GitLab — Wikipédia (wikipedia.org)
Ansible & Ansible Tower : Ansible is Simple IT Automation
Nginx : Advanced Load Balancer, Web Server, & Reverse Proxy - NGINX
Nexus: Welcome - Nexus Repository Manager (onap.org)
Keycloak: Keycloak