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POINTING MECHANISMS FOR OPTICAL SPACE COMMUNICATION

NEW SPACE & FSO CONTEXT

The MEPCOS Project is at the heart of two revolutions.

> THE FIRST REVOLUTION IS NEW SPACE:

Telecommunication satellite constellations are forming a new space segment that is revolutionising the space telecoms market. Instead of a single, large and highly-expensive geostationary satellite at an altitude of 36,000 km, operating mainly in broadcast mode, the market is turning towards sets of small, inexpensive satellites orbiting at low altitudes of 200 to 1000 km, linked to each other and to the ground. The size of current or future constellations in the short term is tending to grow considerably: 882 satellites for ONEWEB, 298 for LIGHTSPEED from TELESAT, 12 000 for STARLINK from SPACE X, etc.

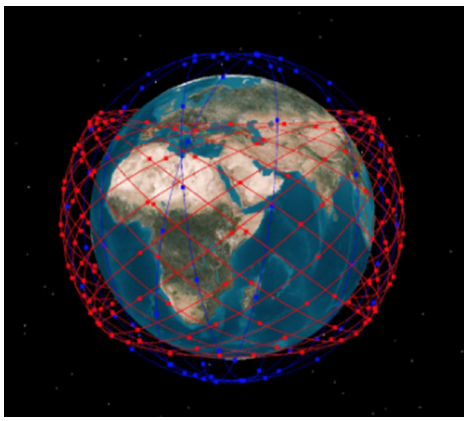


Fig. 1: LIGHT SPEED constellation
Credits: Telesat

This New Space context is shaking up the current space players for, unlike in the past, large numbers of low cost, but highly reliable, satellites now have to be manufactured. New Space is the brainchild of private American players. The independence of Europe in space is therefore seriously challenged. The current French system manufacturers AIRBUS DS (ADS) and THALES ALENIA SPACE (TAS) are challenged but still in the race: ADS supplies the ONEWEB satellites and TAS would be the supplier of the LIGHT SPEED constellation planned with TELESAT.

> THE SECOND REVOLUTION INVOLVES OPTICAL LASER TELECOMS:

Until recently, all satellite telecoms used radio frequency. This is still true for ONEWEB. But demonstrations show the possibility of communicating via Free Space Optics (FSO). This offers the considerable advantage of 1000 times faster throughputs and is the solution adopted in LIGHT SPEED for TELESAT. The challenge for Europe in coming to grips with this technology is also huge, for the ability to communicate at very high speed opens up the markets of the future, of 5G, of the Internet of Things (IoT), autonomous vehicles and so on.

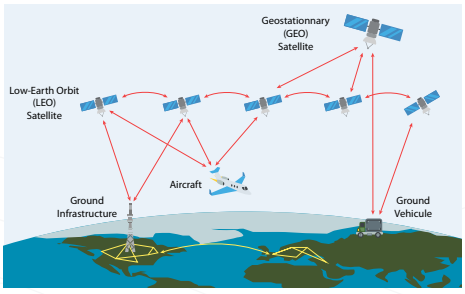


Fig. 2: FSO optical communication

The difficulty with optical communication is its high directivity, meaning that the laser transmitter has to be pointed precisely towards the receiver. This difficulty is increased by the relatively rapid movement of the satellites. The architecture of an optical satellite terminal now comprises a first, wide-angle rough pointing system combined with at least a second, highly-accurate fine pointing system designed to correct the static and dynamic errors of the first system.

MEPCOS PROJECT

The target for the MEPCOS Project, financed by BPI France under FRANCE RELANCE, is the industrialisation of these optical pointing mechanisms.

MEPCOS will benefit from CTEC's three-way experience in space, optronics and innovation in industrialising efficient space mechanisms for the constellation markets.

The purpose of the activities planned in the MEPCOS Project is:

> FINALISE AND QUALIFY THE SPACE DEFINITION OF P-FSM AND M-FSM MODELS

- Qualify the two specially designed "design-to-cost" products,
- Qualify the mirror integration, mechanism assembly and acceptance processes,
- Validate assembly times and purchase costs to set a frequently recurring selling price.

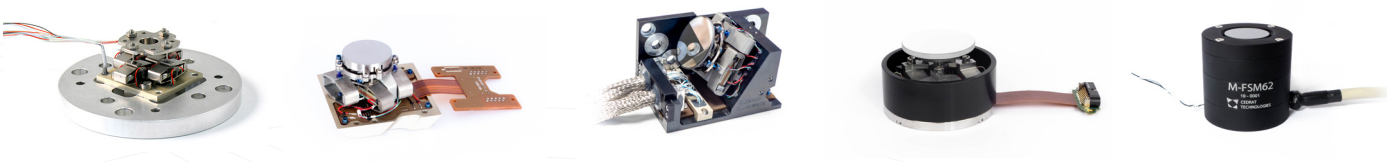
> SET UP AND QUALIFY THE NECESSARY MANUFACTURING ORGANISATION

- Infrastructures and facilities: extension of premises (+350 m²), testing means (Interferometry),
- Specific CAPM tools (Computer-Aided Production Management),
- Pilot production line to manufacture and test P-FSM and M-FSM batches.

The target is to be P-FSM production-ready from end 2021 and M-FSM from 2022.

CTEC EXPERIENCE BEHIND THE MEPCOS PROJECT

CTEC has been developing innovative fine pointing solutions for space and optronic applications for twenty years. Historically these solutions, called FSM (Fast Steering Mirrors), are created by mechanisms with four Amplified Piezoelectric Actuators APA® and can orientate a mirror through two rotation axes accurately and rapidly, in harsh environments.



DTT35XS PHARAO Mission CNES/SODERN	DTT60S ATLID EARTHCARE Mission ESA/ADS/SODERN	PAM30 PSYCHE Mission NASA/JPL/L3 HARRIS	DTT60SM P-FSM base **MEPCOS**	M-FSM62 M-FSM base **MEPCOS**
2003	2016	2020		

These pointing functions are created in the space sector for scientific missions, with the goal of delivering small quantities of flight models, typically a few units. The closest function to the MEPCOS goal is the CTEC PAM30 in the NASA PSYCHE mission, designed for deep space optical communication (DSOC). The major challenge with constellation requirements is therefore to supply such FSM in quantities one hundred times larger at unit prices that are ten to twenty times lower.

For optronics, especially in defence, CTEC delivers two-axis optical mechanisms based on APA® in batches of

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one to five hundred units. The requirement is almost as high as for the space sector but applying an industrial approach can reduce the unit costs.

In terms of innovation, CTEC is advancing its FSM technologies through several channels to achieve the expected specifications in the different fine pointing functions for the FSO optical terminals:

- Continuous progress in P-FSM piezoelectric mechanisms has increased performances to achieve optical strokes of more than 10 mrad, validated on the DTT60SM, the initial MEPCOS base. High resolution and very low static consumption are the advantages of these mechanisms.

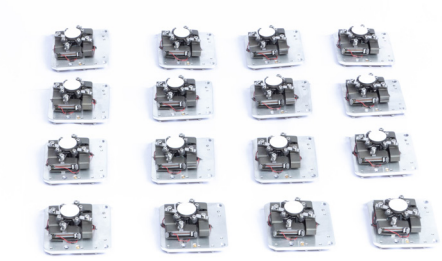

Fig. 3: P-FSM150S batch: Typical optronics series

- New magnetic mechanisms M-FSM, mainly the M-FSM62, the second MEPCOS base, cover optical stroke needs potentially reaching 60 mrad. These mechanisms have higher static consumption than their P-FSM counterparts but have the advantage of a long stroke and huge dynamics.

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The MEPCOS Project is financed by BPI France under FRANCE RELANCE