

## Ground Station Engineering Services

### Space Communication Systems Studies

#### Overview of our experience

Callisto has a long history of undertaking Satellite Communications and Systems Design Studies for its clients over many years. The following provides a brief overview of our experience in this area.

#### Future Architectures of ESA Deep Space Stations

The objective is to study and investigate solutions for building ground stations for future Deep Space missions for exploration of the outer reaches of the solar system. In the coming decades ESA is planning to send spacecraft to explore the planetary systems of Jupiter and Saturn. In order to communicate with spacecraft at distances of up to 1 billion kms from the Earth a new generation of Ground Stations will be required with much greater sensitivity in reception and power for transmission.

The solutions which will be investigated will include the option of building a very large antenna greater than 70m diameter, or building an array of smaller antennas which can be combined together. The study undertaken for ESOC addressed not only the engineering challenges associated with the various options, but also the cost, with a clear goal of identifying the most cost effective approach.



#### Study on the use of 25.5-27GHz Band in ESA ground stations

In 2006/7 Callisto conducted a GSP study for ESOC into the feasibility of upgrading ESAs Deep Station ground stations to support reception of high rate telemetry in the 26 GHz band. This study was completed in September 2007 and the main results were presented at the ESA TTC 2007 Workshop.

As prime contract Callisto was responsible for the management and coordination of a team of European companies and Universities. In addition Callisto was directly responsible for the following technical aspects of the study:

- Mission requirements analysis
- System analysis including propagation and link analysis.
- Development of Ground Station System Specifications
- Ground Station K Band LNA and Downconverter feasibility analysis.
- End-to-end system performance analysis.

#### Independent Advice

Callisto is a small consultancy company which is totally independent of any equipment manufacturing company or Systems company.

This ensures that the client can depend on totally objective advice and analysis. The small size means that the client enjoys a fully dedicated service with flexibility to meet the client's requirements.

#### Square Kilometre Array Study

Callisto carried out a study on the cryogenics options for the Square Kilometre Array (SKA) Organization, which aims to develop the largest radio telescope in the World (see [www.skatelescope.org](http://www.skatelescope.org)) in order to study a wide range of scientific phenomena, including many related to the origins and early development of the Universe. Located in a remote desert, either in Southern Africa or Australasia, the SKA is expected to use thousands of 15 metre diameter dishes, each equipped with multiple antenna feeds to give continuous frequency coverage from a few hundred MHz up to 10 GHz.

High performance cryogenic receiver front ends will be vital to the success of the SKA; Callisto's study, which drew on experience with high reliability satellite ground station systems as well as radio astronomy, examined a range of potential technical solutions, aiming to maximize receiver sensitivity whilst keeping the overall cost of system ownership within budget.

### Study on Fade Mitigation Techniques in K-Band SATCOMs

In 2008 Callisto undertook an internal study into techniques of Fade Mitigation due to weather for K-Band SATCOM services. The objective of this study was to assess and quantify the benefits of using a dual mode LNA to improve communication link availability.

The concept LNA was a miniature cryogenic LNA which could be operated in cooled mode with improved noise figure, when propagation conditions required improved ground station G/T. The study involved the analysis of atmospheric propagation models combined with communications link budgets in order to calculate service availabilities. The results of the study were used to support a bid for funding of the development of a prototype dual mode LNA under the ARTES program.



### Study on G/T Measurement Techniques for Ka Band Active Array Antennas

Active phased array antennas are often considered for many applications in radar and communications, particularly in millimeter wavelengths. The antenna noise temperature of an active array is an important performance parameter, which is difficult to measure compared to a classical passive antenna. In 2007-2008 Callisto has undertaken a study for the French Space Agency (CNES) to devise a new method for the measurement of the noise temperature of a Ka band active phased array antenna when mounted in a Compact Antenna Test Chamber (CATR).

An important objective of the study was to find a method which did not rely on the substitution of the antenna under test with a reference antenna, which is the method often used in practice. The method of measurement of noise was based on digital processing of signal to noise ratio rather than analogue detection of noise level, which improves the measurement

### Ka-Band Market Survey – MTG Ground Stations

Callisto has undertaken an analysis of ground station RF equipment in the 26-27 GHz band which will be used by the third generation of METEOSAT to download payload data.

The equipment survey was used to establish preliminary specifications for the MTG ground stations, taking into account the availability of COTs products and identifying areas where new developments might be required. Link budgets and G/T budgets have been used to dimension antenna size requirements.



### CDMA – Communications studies

In 2005/6, Callisto undertook a communications study into the use of mixed CDMA & FDMA communications system over an Earth – satellite - Earth link. The objective was to assess the feasibility of overlaying a CDMA link on an existing FDMA communications service and to evaluate the traffic capacities and limits on each service.

As part of this study various techniques of interference suppression using advanced DSP were investigated and simulated. End to end communication link simulation models have been developed in order to evaluate the overlay CDMA links with different communications parameters and types of FEC.