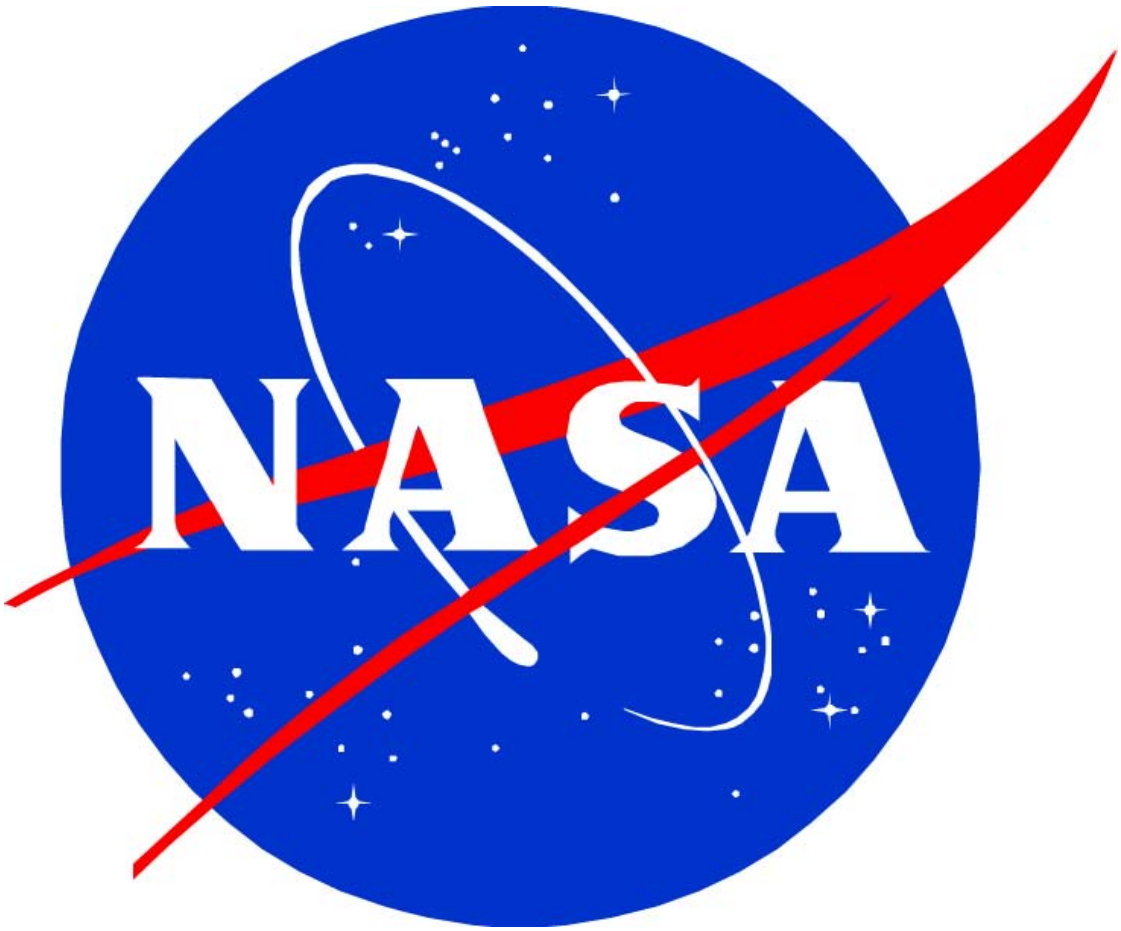
Brief history of the birth and evolution of the Madrid Deep Station Communication Complex



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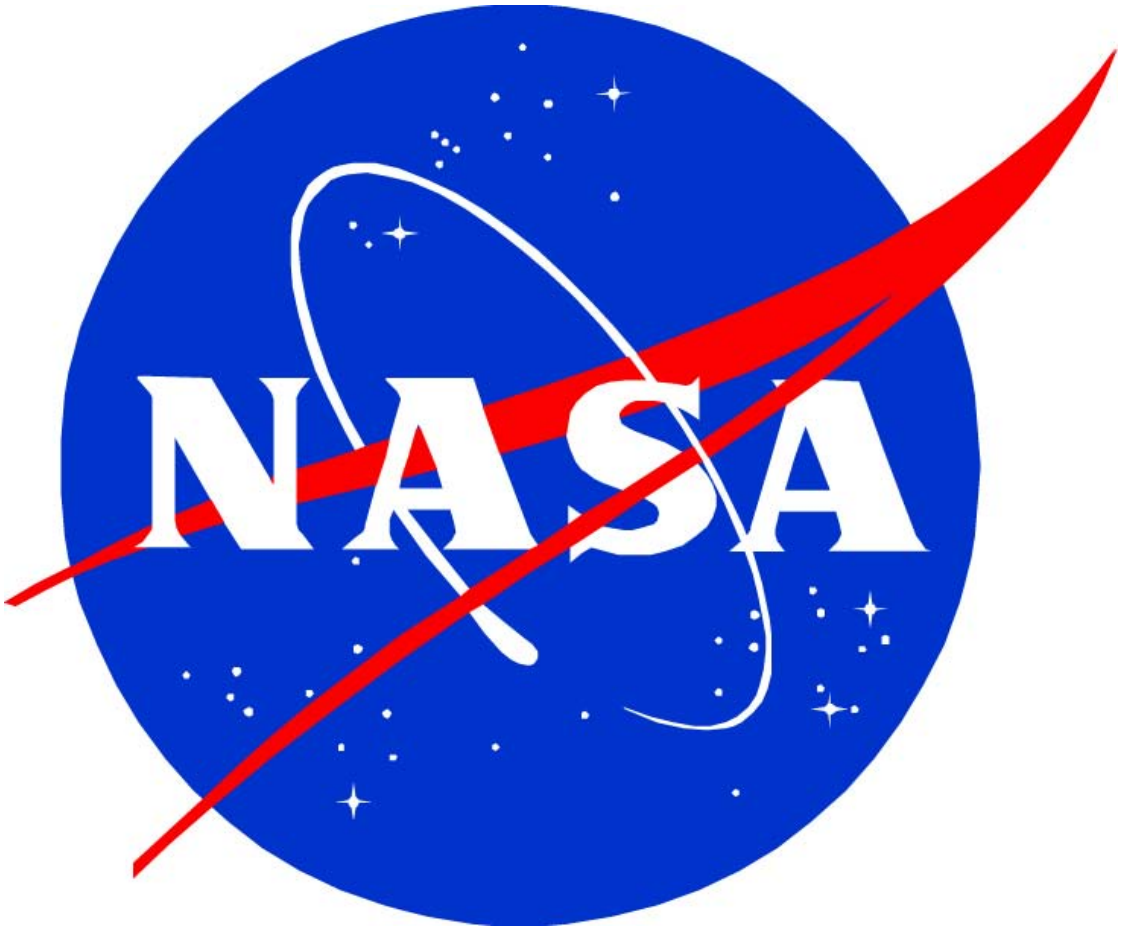

This essay, as all previous, is dedicated to my wife, Estrella, and daughters, Raquel and Sara, who have seldom seen me in the last months while I was busy with compiling the memories of people that participated in this endeavor with my own.

Carlos González

Brief history of the birth and evolution of the Madrid Deep Station Communication Complex

(Carlos Gonzalez. Former MDSCC Operations Manager)

Foreword

It is year 1959 - 1960.

USA is conscious that soviet´s advantage in the Space Race is difficult to counteract.

It is obvious that a strong and spectacular action is necessary to show the world that technology and economic power in the USA is superior to that of the USSR.

NASA seriously believes that the only remaining available opportunity is to conquest our natural satellite by an American human being.

So NASA develops a plan that includes Project *Mercury* as the first test to validate the tolerance and adaptability of human beings to microgravity, Project *Gemini* as a training platform to ensemble two spacecraft vehicles in space and as a bridge to Project *Apollo* which would take a human to the Moon and bring him back to Earth alive.

It is also necessary to map the lunar surface to find the best landing location and to do that, NASA establishes a series of unmanned vehicle launches that would take as many photographs as possible of selected sites and, thus, projects *Ranger, Lunar Orbiter* and *Lunar Surveyor* are born.

All these vehicles were to be launched from Cape Canaveral, Florida, eastward and with a low elevation so a tracking station in a geographical location to the east of Florida was vital, especially for the manned missions.

Where better than in the Canary Islands to install a tracking station for this kind of job?

And thus it begins.....

MDSCC

MADRID DEEP SPACE COMMUNICATIONS COMPLEX

1. MASPALOMAS
(The beginning)

By the end of the 50´s NASA was seriously considering that its only opportunity to balance the Space Race with the Soviet Union was to take an astronaut to the Moon and return him safely back to Earth.

To face such a challenge, they developed the manned projects: *Mercury* and *Gemini* and the unmanned: *Ranger, Lunar Orbiter* and *Lunar Surveyor* just before the final project, The *Apollo*.

It was also necessary to create a tracking network large enough to be able to ascertain view of any of these vehicles constantly.

Fig. 1.1 First Maspalomas antenna (1961)

All of these projects were launched from Cape Canaveral, Florida. Eastwardly to take advantage of Earth´s rotation and using a low elevation profile so…….

Contacts between Spanish and American governments were initiated during the years 1959 – 1960, and an agreement of friendship and cooperation was signed, a part of which included the construction of a tracking station. NASA and INTA were assigned as actors for this negotiation. [1]

Less than a year later, Maspalomas (South of Gran Canary Island) started work with a 9 m antenna and Project *Mercury* (1961 – 1963).

Fig. 1.2 Maspalomas today 1

Once this Project finished, and due to the necessities of its successor, the *Gemini,* the station was reconfigured to adapt to the new requirements and equipment.

After the conclusion of Project *Gemini* (1965 – 1966), and in an effort to get as far as possible from the interferences caused by the touristic development of the area, the whole station was geographically moved to a different location where Maspalomas continued its support of the *Apollo,* the *Skylab* and the *Apollo-Soyuz Test Project.*

When all of these projects were finished, NASA decided to deactivate Maspalomas and handed over all the infrastructures to INTA while transferring, at the same time, the 9 m antenna to Fresnedillas to supplement the already existing 26 m.

In 1979 the now INTA Station reopened offering its services to the international community and Spanish projects like HISPASAT or MINISAT.

Presently it serves:

ESA-ESOC: 15 m TT&C
ESA-ESRIN: 10 m + 1.8 m RX
EUMETSAT: 9.3 m TT&C
COSPAR-SARSAT: 2 x 4.8 + 2.4 m RX
NASDA-JAXA: 10 m TT&C
HISPASAT: 3.8 m
XTAR: 16.4 + 2 x 6.3 m
HELIOS: 10 m

Fig. 1.3 Maspalomas today 2

[1] Initial contacts with the Spanish government: Aug / 4th / 1959
Official request for a visit: Aug / 10th / 1959
Discussions and technical visit: Sep / 3rd / 1959
Agreement signed: Mar / 18th / 1960

2. ROBLEDO

With the cooperation protocol already established, NASA and INTA agreed on the construction of a Deep Space Station in the peninsula, but Why Spain?

Fig. 2.1 Front page of a newspaper back then

Spain fulfilled all of the requisites:

1. Location about 120° of longitude from Canberra and California.
2. Political stability.
3. Favorable currency exchange.

There already existed a 26 m antenna at that same longitude however.

The location was Johannesburg, South Africa, but political stability there was questionable and NASA decided to find other places that would assure proper coverage.

There were also negotiations with Italy (Palermo) but an agreement was not reached.

And…..Why Madrid?

Fig. 2.2 Madrid in the 60´s

OK, Spain, and now.... The new station needed of an international airport nearby, close to a big city with all the appropriate infrastructures, an important university and free of radio electric interferences.

Several locations were scrutinized, Sevilla, Málaga, Madrid, etc. and after an exhaustive analysis of the adequate characteristics of each one, a region 54 km west of Madrid, in the township of Robledo de Chavela was chosen.

The selected region was in a valley with no obstacles between 90° and 270° of Azimuth and was protected by small hills in the north, east and west. This situation was ideal for the tracking of the deep space vehicles which would move in the ecliptic plane.

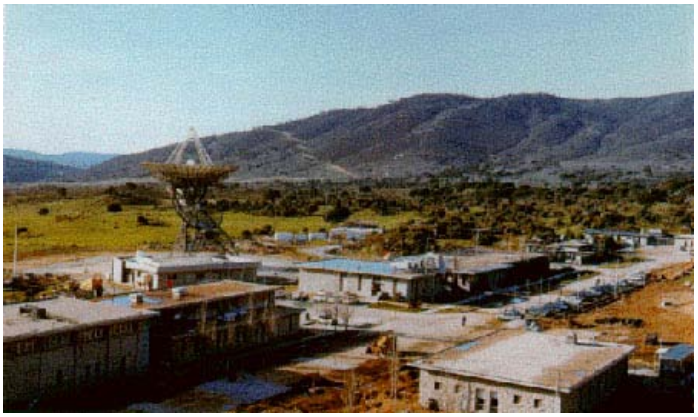

Fig. 2.3 Robledo Station, DSS-61 in the 60s

The construction of a 26 m diameter antenna with equatorial mount (DSS–61, Deep Space Station 61) and the necessary infrastructures were immediately initiated and finished in a record time, just in the right moment to receive the images transmitted from the encounter of *Mariner IV* with planet Mars, Jul, 15th 1965.

These were the first images ever transmitted from a space probe from a planet other than Earth

Robledo continued its path with other interplanetary projects but paid an especial dedication to the *Lunar Orbiter* in its mission to map the Moon to

prepare the future manned flight to our satellite and as a backup to the Fresnedillas Station.

In 1970, and in accordance with the 1964 reimbursement contract between NASA and INTA, and the especial clause of transference of responsibilities to the Spanish personnel, NASA transferred the maintenance and operation roll to INTA.

In 1999, after 35 years of intense space exploration and the participation in several historic landmarks, its closure was decided.

Per the contract stipulations, the antenna would have to be dismantled and the terrain returned to its original conditions.

Fig. 2.4 DSS-61 today

Inspired by project GAVRT, NASA offered this whole infrastructure to INTA to be used in an academic Project dedicated to High Schools, College, Universities, Astronomical Associations and any other related entities.

In February 2001 an agreement as to the educational model is reached and representatives from MDSCC, the Space Astrophysical Laboratory and Fundamental Physics (LAEFF), and Professors from different Colleges, Universities and High Schools established a protocol as to the use of these premises.

Finally, between June and July, 2001, NASA and INTA signed the pre-agreement of Collaboration to put the Project into effect.

PARTNeR was born. The responsibilities of its functions were assigned to the Astro-Biological Centre (CAB) belonging to CSIC-INTA through its Unit of Scientific Culture.

The coordination centre was then located inside the campus of LAEFF in the ESAC installations at Villafranca del Castillo, Madrid.

MDSCC

MADRID DEEP SPACE COMMUNICATIONS COMPLEX

3. CEBREROS / FRESNEDILLAS

Due to the big increase of launches in the decade of the 60s and Project Apollo, NASA promoted a new agreement with INTA in 1965 for which two new antennas would be constructed.

CEBREROS

A 26 m diameter, equatorial mount, (DSS–62), was built in Cebreros, Avila, 12 Km west of Robledo to complement the resources of the NASA / JPL network for Deep Space (DSN).

The construction was finished in a record time of 14 months and started its activity by sharing tracking time between the Deep Space *Pioneers* and Project *Surveyor* (1966 – 68) that was preparing the assault to our Moon.

Soon, in 1969, the operations and maintenance responsibilities were transferred to INTA just before the Mars encounters of *Mariner 6* and *7*.

Fig. 3.1 Cebreros DSS-62 antenna (1967)

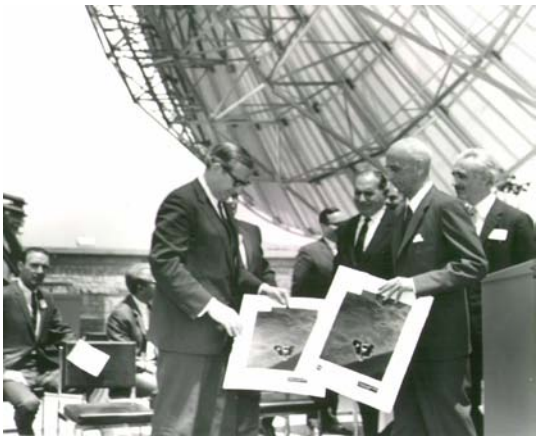

Fig. 3.2 Operation and maintenance transfer of Cebreros Station from NASA to INTA (1969)

The Station continued its participation in other interplanetary missions like *Mariner 9,* (first space vehicle to orbit other planet) while contributing to the improvement of the network by the development of multiple technological findings, the most significant of which was the demonstration of the array of antennas to improve the reception of data (1969 – 1970) using DSS-61 as its counterpart.

It also offered its free time to the Spanish astronomical community to initiate and increase the vocation of the future radio astronomers.

During the space exploration crisis at the end of the 70s and beginning of the 80s, NASA decided its deactivation (1981) and conveyed all the infrastructures to INTA who finally closed it in 1986.

FRESNEDILLAS

The second antenna, also a 26 m and with a X – Y mount, initiated construction at Frenedillas / Navalagamella, Madrid, at the same time as the Cebreros one but dedicated to manned flights as part of the MSFN network (Manned Space Flight Network) that along with its counterparts at Canberra, (Honeysuckle Creek), Australia, and California (Godstone), USA, were dedicated to Project *Apollo*.

It started its endeavor in 1967 and participated in all of the manned flights of Project Apollo, from VII to XVII. [2]

In 1972, with the end of the above mentioned Project, INTA

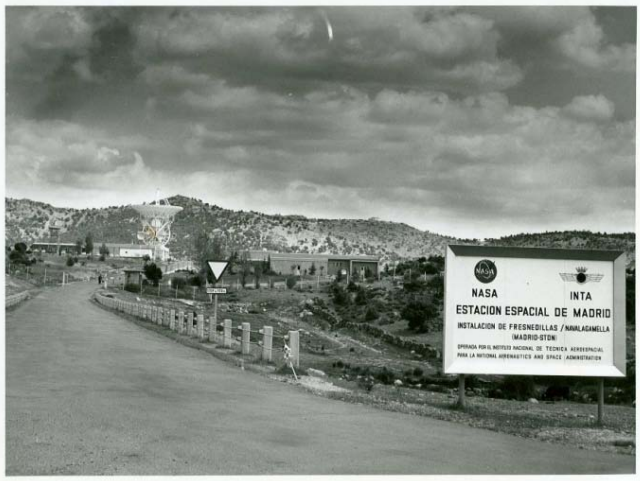

Fig. 3.3 Main entrance to the Fresnedillas / Navalagamella Station (1967)

Fig. 3.5 26 m, 9 m, VHF and UHF antennas (1978)

assumed the role of the Operation & Maintenance for the Station.

The Station was then integrated into the STDN and, as such, it participated in *Skylab, Apollo-Soyuz, Shuttle, ATS,* and a myriad of Earth orbiting and Moon orbiting satellites.

That same year, 1972, the Station received two new antennas to cope with the outburst of data that that was to come along with *Skylab.*

The pigtail, which was the UHF transmitting antenna, came from Guaymas, México, while the receiving VHF antenna was transferred from the Canary Islands.

Later on, in 1976 another two antennas were received to be able to communicate with ATS6 satellite.

These antennas had already been used to transmit educational programs to rural areas of difficult access in the Rocky Mountains and Alaska and had proven the usefulness of such transmissions.

With the endorsement of UNESCO and the government of India, the satellite was repositioned to an intermediate longitude between Madrid and New Delhi from where it could cover a vast region of endemic sub development and undergrowth.

Fig. 3.4 ATS antennas at Fresnedillas (1976)

The Fresnedillas Station was a fundamental in achieving this goal.

In 1978 the 9 m antenna at Maspalomas was transferred to Fresnedillas where it continued the satellite tracking operations until 1985 when the 26 m was integrated into the Robledo Complex. In 1987, all of the remaining Fresnedillas infrastructures were handed over to INTA.

Two years later, and due to lack of activity, the 9 m antenna that had been left in the grounds of the Station was reintegrated into the NASA assets and was sent to Bermuda.

[2] During the landing and taking off operations of the Apollo XI to/from the Moon, all the tracking was conducted from Fresnedillas .

4. EVOLUTION OF ROBLEDO

As part of NASA´s planet exploration plans, and to supplement DSS–61 assets, the construction of a gigantic 64 m antenna within the Robledo grounds was approved.

Fig 4.1 Construction of DSS-63 (1973)

It had an Az. / El. mount and reception capability in the S and X bands.

It was called Robledo II (DSS-63) and evolved from the necessity of receiving the very low signals from vehicles going to the external planets like *Pioneer 10,* first to travel beyond the asteroid belt to visit Jupiter in 1973, and *Pioneer 11* reaching Saturn in 1979.

A few new spacecraft were added to the already list of vehicles tracked at Robledo: *Mariner Venus-Mercury (Mariner 10), Helios, Pioneer 12* and *13* to Venus and the initial phase of the *Voyager* to the external planets.

But the most ambitious project, by far, was the *Viking* to Mars in 1975. This was comprised by two identical vehicles each with an orbiter and a lander and their mission: Explore the planet and look for signs of life.

After a year´s trip, both vehicles arrived to Mars and both of the landers made a soft touchdown with no problems.

Fig. 4.2 DSS-61 after enlargement (1979)

The orbiters obtained millions of scientific facts and more than 50,000 photos while, in the ground, the landers got some magnificent sights of the surrounding terrain. But the biological results were not conclusive. This deception, plus the end of Project Apollo and the start of Shuttle initiated some difficult times and there was no other launch in the next 10 years.

But we had to adapt to the future and to the main going-on Project, *Voyager,* so in 1979 DSS-61 was modified to include reception in X band and main dish was enlarged to 34 m.

This upgrade forced the construction of four concrete pedestals to raise the antenna so it would not hit the ground when pointing to the horizon.

Fig. 4.3 DSS-61, DSS-63 and DSS-66 (1985)

Project *Voyager* practically took all the activity during those years with a few exceptions like the *Venus Balloon.* This reduced workload permitted, however, the implementation of a few upgrades.

In 1985 the 26 m antenna at Fresnedillas was dismantled and transferred, along with its associated equipment, to the Robledo Complex where it was re-assembled and with its new designator, DSS-66, continued the tracking of the Space Shuttle and EOS.

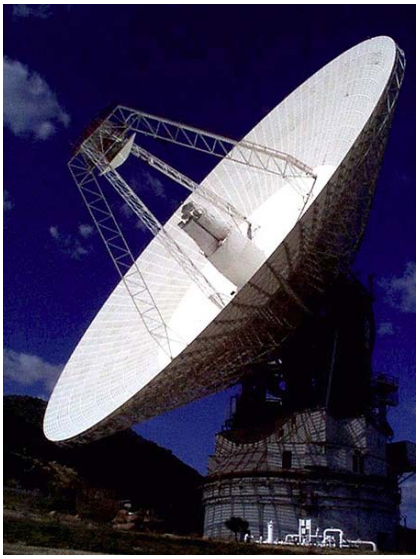

Fig. 4.4 DSS-63 after enlargement (1987)

In that year, the installation, check out and operation acceptance of a software/hardware system of supervision and remote control of Complex equipment from a centralized position were initiated. (MARK IV A).

In 1987, to optimize the reception of data from the Voyager when reaching the external planets, the 64 m antenna, DSS-63, upgraded its

dish to 70 m and reshaped its surface to increase its precision obtaining a net gain of 59%.

At the same time, the constructions of a new High Efficiency, Az. / El. mount, 34 m diameter and with transmission and reception in S and X bands (transmission in the X band up to 20 kw) called DSS-65 starts.

And, finally, between 1989 and 1990 *Magellan, Galileo* and *Ulysses* were launched and the whole network began rolling at full speed.

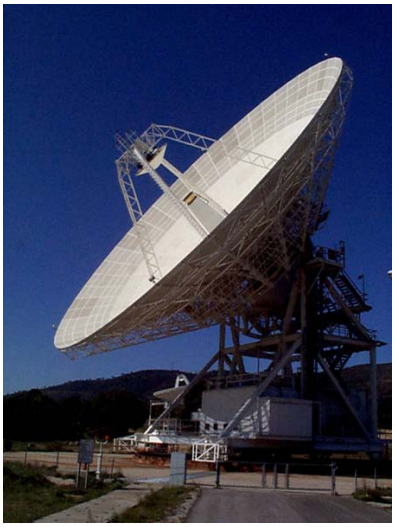

Fig. 4.5 DSS-65 (1987)

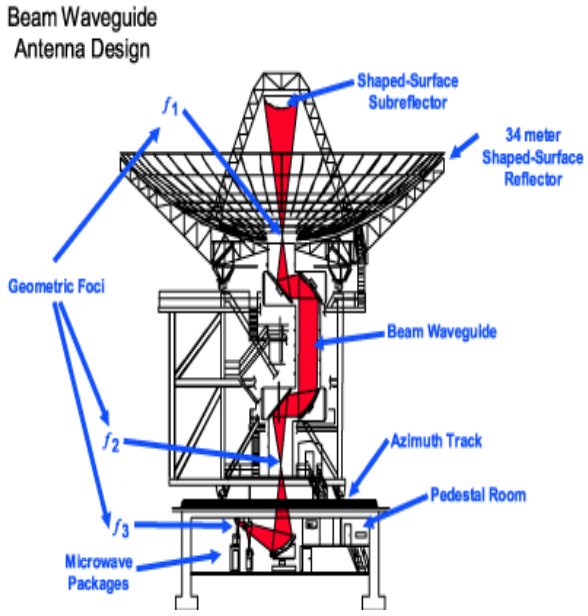

Fig. 4.6 Path of signal inside a BWG antenna

These launches, along with the future *Cassini* mission to Saturn, and the obsolescence of the first antenna (DSS-61), justified the construction of a brand new antenna. Az. / El. mount, 34 m diameter and of the type BWG (DSS-54).

This new type of antenna uses radio frequency mirrors to conduct the received signal from the main reflector all the way down to the underneath of the pedestal where the reception equipment is located. With this configuration, the weight is greatly reduced and maintenance simpler. Also, it is less affected by weather conditions.

Fig. 4.7 DSS-54 (1999)

Uses S, X and Ka bands and has the possibility of future upgrades without

Fig. 4.8 DSS-53 in the Winter of 1996

increasing weight.

Earlier, in 1996, a new antenna built by Scientific Atlanta and with a diameter of 11 m was added to the existing ones and was named DSS-53. This antenna had an estrange Az. / El. mount by which it could change the azimuth plane angle to eliminate the blackout zones of the sky. It was dedicated to a Project called Orbiting VLBI using satellites that were to be launched from Russia and Japan.

The Russian satellite was not launched due to economical problems and the Project did not achieve its full goals although it obtained an incredible amount of data.

In 2005 it was dismantled and the El. gear was sent to Norway as replacement parts while the rest was sent to Wallops Island.

In 2003 a new 34 m BWG antenna was approved and constructed, DSS-55.

There´s four operational antennas for NASA´s projects, one more dedicated to an educative Project, PARTNeR, and one more deactivated 26 m at this moment.

Fig. 4.9 DSS-55 (2003)

And that´s all.....for the time being.....

Very recently, and in coincidence with MDSCC´s 50th anniversary, the NASA – INTA contract has been re-negotiated and two new BWG antennas have been approved for construction within the next five years.

Future is, no doubt, promising.

Amen.

5. ACKNOWLEDGEMENTS

a. All photographs depicted in this essay are from public Internet publications and, in no way, they will be used to collect any income.
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k. A special mention to my Friend José Araujo. His enthusiasm for all the NASA projects and, in particular, for the Space Race, is so contagious that made me consider seriously that such a part of History couldn't just go unnoticed. We must take into consideration that this is part of the History of Humanity, not just of a specific Country.

6. GLOSSARY OF TERMS

APOLLO	**Project to send a man to the Moon.**
ATS	**Applications Technology Satellite.**
Az.	**Azimuth.**
BWG	**Beam Wave Guide.**
CAB	**Astro Biology Centre.**
CEBREROS	**City in Avila.**
COSPAR	**Committee on Space Research.**
CSIC	**Scientific Investigations Superior Committee.**
DSN	**Deep Space Network.**
DSS	**Deep Space Station.**
El.	**Elevation.**
EOS	**Earth Orbiting Satellites.**
ESA	**European Space Agency.**
ESAC	**European Space Astronomy Centre.**
ESOC	**European Space Operations Centre.**
ESRIN	**European Space Research Institute or ESA's centre for Earth observation.**
EUMETSAT	**European Organization for the Exploitation of Meteorological Satellites.**
FRESNEDILLAS	**City in Madrid.**
GAVRT	**Goldstone Apple Valley Radio Telescope.**
GEMINI	**Bridge Project between Mercury and Apollo. The capsule housed two astronauts and was mainly used for training to ensemble two spacecraft (Gemini and Agena) in space.**
HELIOS	**Military European Observation Satellite.**
HISPASAT	**Operating company for a number of Spanish communications satellites.**
INTA	**National Institute for Aerospace Techniques.**
JAXA	**Japan Aerospace Exploration Agency.**
JPL	**Jet Propulsion Lab, Pasadena, California.**
LAEFF	**Space Astrophysics and Fundamental Physics Lab.**
MASPALOMAS	**City in the Gran Canary Islands.**

MDSCC	**Madrid Deep Space Communications Complex.**
MERCURY	**First NASA manned Project.**
MSFN	**Manned Space Flight Network.**
NASA	**National Aeronautics and Space Administration.**
NASDA	**National Space Development Agency of Japan.**
NAVALAGAMELLA	**City in Madrid.**
PARTNeR	**Academic Project with NASA´s Radio Telescope in Robledo.**
ROBLEDO	**City in Madrid.**
RX	**Receive.**
SARSAT	**Search And Rescue Satellite Aided Tracking.**
STDN	**Space Tracking and Data Network.**
TT&C	**Telemetry Tracking and Command.**
VILLAFRANCA	**City in Madrid.**
VLBI	**Very Long Baseline Interferometry.**
XTAR	**Commercial satellite operator providing services in the X-band.**