



To the Moon and beyond

Advanced Technologies from Medium Enterprises for Space Exploration

a contribution of:



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To the Moon and beyond

January 2004 Presidential Directive defined the new frontiers for the mankind:

- First: to the Moon**
- Then, beyond: to Mars, to the moons of Jupiter, to the other Planets of the Solar System**



A Global Challenge

□ The Presidential Directive also states:

“The fundamental goal of this vision is to advance U.S. scientific, security and economic interests”

“implementing international and commercial participation”

□ A world wide endeavour is required, in order to materialise such a vast vision in the desired time-span:

- Governments must provide the necessary funds
- Space Agencies must work together in a co-ordinated effort
- All best scientific and industrial resources must be made available to the project



The Competences

- ❑ **A few examples of required abilities**
 - ❑ **Power plants, energy transmission**
 - ❑ **Environmental impact on human beings: medicine, psychology, biology, pharmacology**
 - ❑ **Food production**
 - ❑ **Transportation, Communication**
- ❑ **Such competences may not be all available within the European Space Industry, as presently structured**
- ❑ **On the other hand, Europe has deeply rooted scientific and technological traditions**
- ❑ **Space exploration is a unique opportunity to have them applied and further developed**



Summoning the Competences

Many of the required disciplines and technologies may be better studied and developed by institutions and enterprises different and often smaller than the traditional “Big” ones

The Opportunity

Involving more and new contributors means a higher, better distributed number of stake-holders, possibly providing more convincing arguments for governments to finance the mission

The Risk

Cooperation between “Big” and Smaller Players has proven so far not always fruitful and effective.

Industry to industry agreements, often preferred in international Space projects, leave little room for smaller contributors

A Focused Approach

Specific policies and dedicated procedures should be studied and applied in order to overcome present hurdles and to ensure the involvement and the participation of technologically advanced alternative contributors



W Band Applications in Space Missions

- ❑ **W Band (75-110 GHz) technology represents a typical example of a niche expertise best developed and available in medium size institutions and enterprises**
 - ❑ **Oerlikon Contraves and the University of Tor Vergata, Rome, have more than 20 years unique experience and competence in the development and in the application of W Band technologies (e.g. 95 GHz)**
 - ❑ **W Band can offer a determinant contribution to:**
 - ❑ **Communications**
 - ❑ **Surface Radar Survey**
 - ❑ **Safety**
 - ❑ **Energy transmission**
- in Space exploration missions**



Why the W Band

- ❑ In terrestrial applications, the potential benefits of W Band technology are severely limited by atmospheric attenuation
- ❑ In Space applications, all benefits of W Band can be fully exploited:
 - ❑ Reduced mass and size of components
 - ❑ Broad bandwidth
 - ❑ High data rate
 - ❑ High resolution and high discrimination surface Radar imaging
 - ❑ Small debris detection
 - ❑ Rendezvous and docking (complementary to optic systems)



W Band full Space Communications Network

- ❑ Any long range space mission (Moon, Mars, Solar System) will be based on the use of GEV, orbiters, landers, rovers, UAV (Mars)
- ❑ Reliable, accurate, high rate, safe, secure data transmission is provided by W Band communication links
- ❑ Additional advantages:
 - ❑ Reduced mass and volume of components
 - ❑ Small size of antennas
 - ❑ Small antenna beamwidth
 - ❑ Low power consumption

$$P_R = \frac{K}{R^2} \cdot \frac{P_T \cdot A_T \cdot A_R}{\lambda^2}$$



Surface Radar Survey

- ❑ High resolution radar imaging from orbiters and satellites of potential landing and settlement areas (polar regions, crater bottoms) represents a fundamental preliminary step in the colonisation process of the Moon and Mars
- ❑ UAV can be used in the thin atmosphere of Mars for aerial radar survey and mapping of much broader surfaces than with wheeled rovers



W Band Radar high Resolution Surface Imaging

- Lunar orbiters and satellites offer particularly favourable support for W Band radar applications:
 - Lack of atmosphere
 - Much lower orbital speed compared to Earth (1: 5)
 - Very low distance from surface
 - Static environment (no time constraints)
- Under those circumstances, W Band radar imaging can offer the needed resolution, at much more favourable conditions compared to medium frequency SAR solutions:
 - Reduced mass, size and complication of the system
 - Lower cost of the equipment
 - Much reduced overall cost of the mission



Further potential Applications of W Band Technologies

❑ Safety on trip

High resolution radar for

- ❑ Detection and mapping of small debris
- ❑ Rendezvous and docking operations

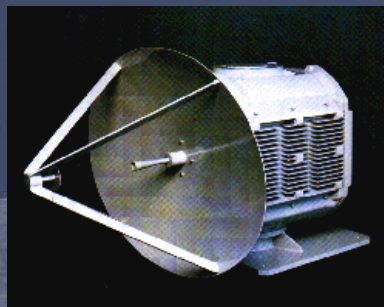
❑ Power transmission

Energy beam from power plant (nuclear or solar) to users (ground based, orbiting or flying)

- ❑ Reduced mass and size of transmitter
- ❑ High focusing, pencil beam capability with smaller antennas



OCI W Band Expertise



1983

Monopulse tracking Radar



1992-1993

Comparative RCS measurements



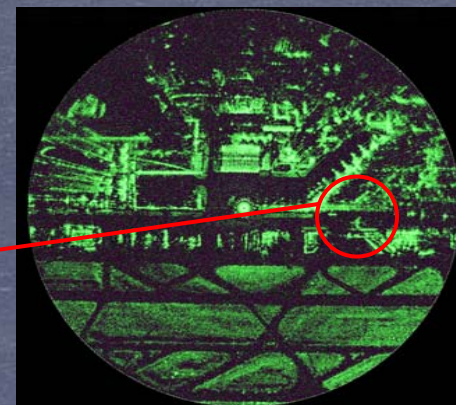
2000

Quasi optical diplexer for cloud radar



2000

Anticollision radar experiment



1996 SMART radar for airport surface surveillance



W Band Expertise Joint Programs



2000 JANUS: Joint (W and X Bands) Access to the Net
for the Uers of the Space Station

2000 WARDEN: W Band Advanced Radar for Debris Early
Notification from ISS

2004 WLINK: W Band Communication Link

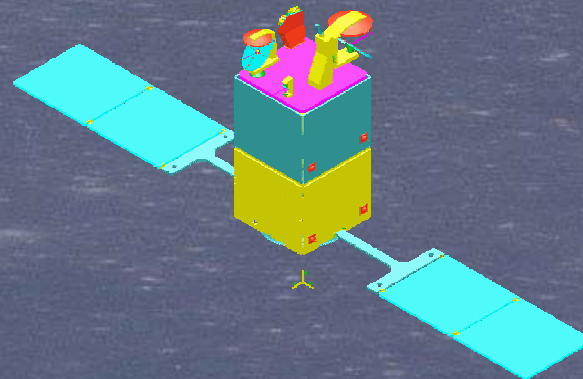


Current Joint W Band Projects

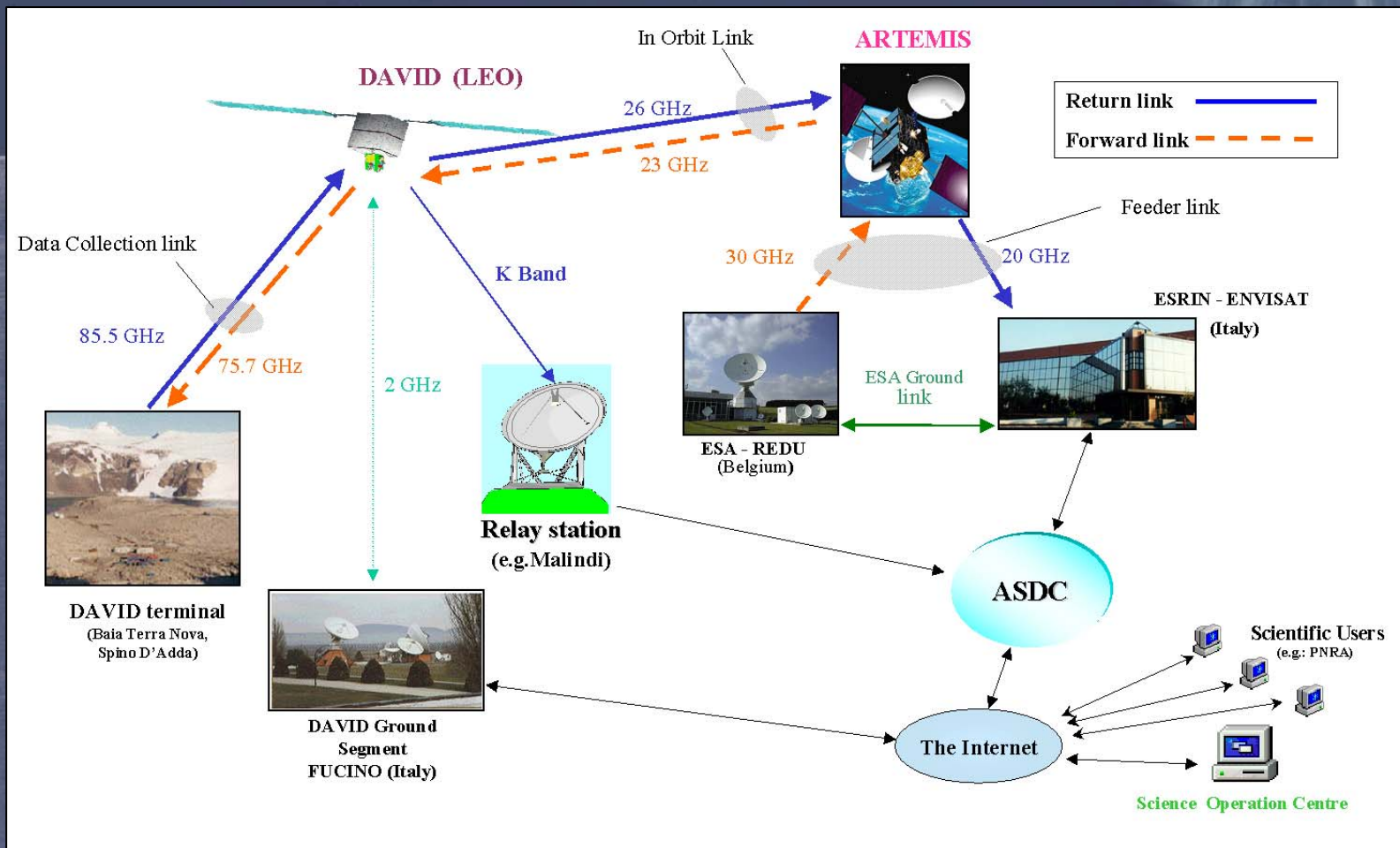


DAVID: DAta and Video Interactive Distribution

Advanced telecommunication payload in LEO orbit



W Band Expertise DAVID

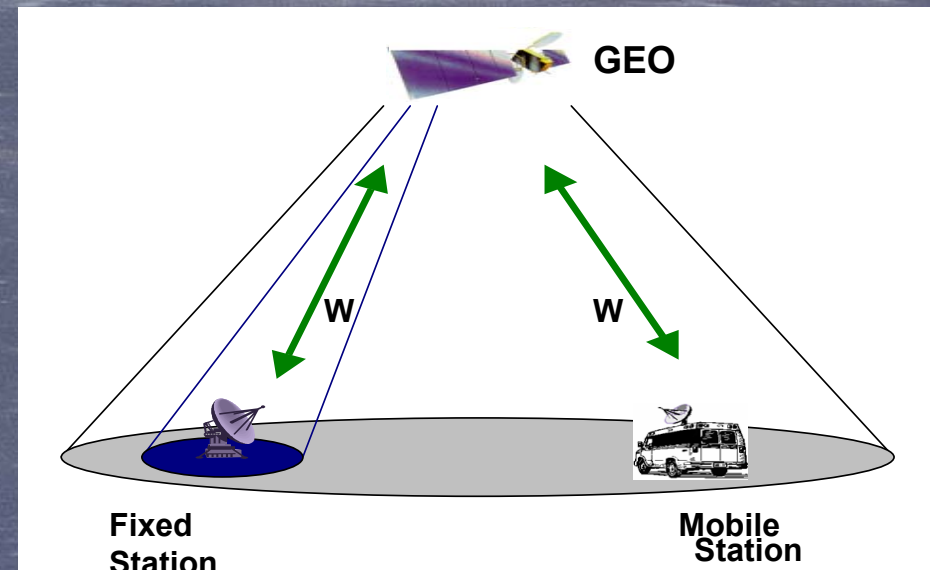


Current Joint W Band Projects



WAVE: W Band Analysis and Verification

LEO/GEO satellite or stratospheric carrier payload for experimental analysis of W Band communications

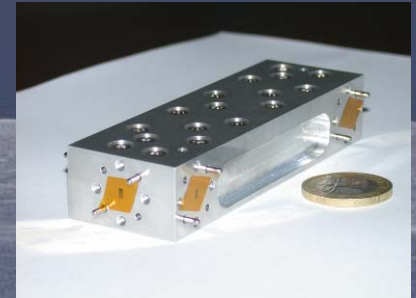
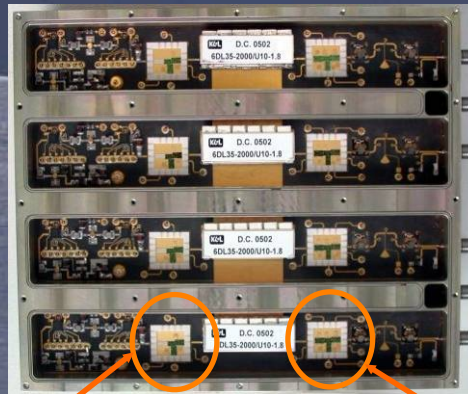




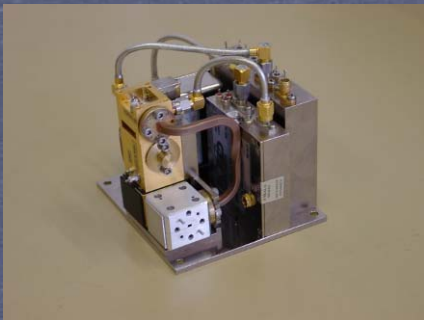
W Band Expertise - WAVE



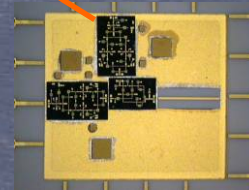
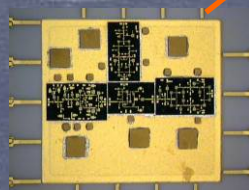
Feeder



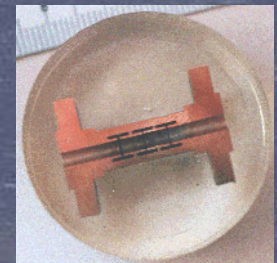
Triplexer



Oscillator



Multi channel Receiver



Filter



Conclusions

- ❑ **Smaller enterprises and institutions have developed a portfolio of expertise and competences, key for space missions, not always available in traditional space industries.**
- ❑ **We must ensure, through an appropriate approach to the issue, that those competences are exploited and implemented in future missions to the Moon and beyond.**
- ❑ **W Band technology, developed over more than twenty years by Oerlikon Contraves, Rome, represents a typical example.**
- ❑ **The laws of physics clearly speak in favour of W Band frequencies for**
 - ❑ **Communication**
 - ❑ **Surface radar survey**
 - ❑ **Energy transmission**
 - ❑ **Safety on trip**
- ❑ **Oerlikon Contraves, Rome can offer their contribution for the development and the implementation of specific space applications, in order to exploit all the potential benefits in terms of**
 - ❑ **Speed and reliability of data exchange**
 - ❑ **Radar imaging quality**
 - ❑ **Mass and volume saving**
 - ❑ **Energy consumption**
 - ❑ **Equipment and overall mission cost efficiency**