

Space Roadmap for Luxembourg

Marie-Jose Deutsch*

Space research is in many people's mind, associated with the "Man on the Moon" program and the "Grand Tour" of the planets by the Voyager Missions, in other words multi-billion dollar programs of the 60s and 70s that only large nations could undertake. However, in today's space research environment this misconception leads to missed opportunities for Luxembourg's industry, education and research institutions. Micro and nano-technology advances allow students to build a space mission for as little as 2 mil. EUR a nominal expenditure compared to space missions of a couple decades ago or to the expense of a "new building on Kirchberg", to cite familiar examples. Space Research is very much like conventional research, with the added benefit of being in the forefront of discoveries and having the largest proven return on investment.

Space research is a very vast domain, cutting across most research areas. It allows the traditional research domains to expand their purview into an exciting and rapidly growing field.

Space research is multidisciplinary by nature, and enables the crossover of ideas among the different research fields, which contribute to its extraordinary growth and return.

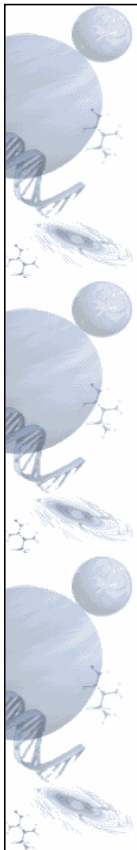
Since the dawn of civilization, space has captivated the imagination of humankind and it is a perfect tool in the educational arena, stimulating student interest in science and engineering. High technology industry is locating in areas around universities that graduate young multi-

disciplinary talent that it can draw upon for effective cooperation and knowledge transfer.

Space research is only possible through international cooperation with other space agencies like ESA, CNES, ...etc. International cross-fertilization will give Luxembourg research much needed credibility and is a source of added research money. Through ESA/EU programs, industry is given the opportunity to participate in high technology applications it can use to build up its capacity for future commercial ventures.

A proposal has been submitted to the FNR, to consider laying the groundwork that will prepare Luxembourg to participate in space research. It will provide direction for disparate space studies and thus foster international collaboration, and focus Luxembourg's efforts in obtaining R&D funds from EU/ESA. Hence the proposal to the FNR for a Space Roadmap. The proposal is broken into three phases, strategic plan, space workshop, and proposal development, each building upon the results of the previous stage.

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Space RoadMap for Luxembourg*

**Original proposal submitted in March 2000
in response to the FNR announcement of opportunity**

Marie-Jose Deutsch

for the
**Ministre de la Culture, de l'Education Supérieure et de
la Recherche**

Presentation to the Fonds National de la Recherche
June 26, 2000
Luxembourg

Space Roadmap Proposal Presentation

Why a Space Research Program in Luxembourg?

- On-going EU/ESA coordination effort in space technology research and development toward the development of a European Space Strategy is being pursued in the following four areas:
 - Space based information and communication services
 - Science, Research and Space Exploration
 - Security
 - Access to Space
- Luxembourg has a need for a plan in order to actively contribute to the EU/ESA master plan
 - *Carve out Luxembourg's particular niches*
 - *Bring research funds to Luxembourg*
- Challenge:
 - Elimination of overlap in space research between ESA and the individual nations
 - Concept for complementary centers for technology interests eliminating duplication

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Why a Space Research Program in Luxembourg? (continued)

- Space Research has surpassed all other research programs in terms of innovation and return on investment
- Space research covers an extremely wide array of scientific and technical fields
- Research in private sector limited to applied research. **High Technology Industries locate where there is a pool of young talent that provides for effective cooperation among universities, government and industry.**
- Public support for space exploration:
 - environment
 - education
 - scientific, technologic and economic fall-out
 - national prestige
- It is important for countries with emerging space research potential to develop their **own independent programs** in cooperative effort with international projects and missions

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Why a Space Research Program? Specific Arguments for Luxembourg

- Environment
 - Air and water pollution, deforestation, hazardous waste, ozone depletion
- Education and training
 - Information technology, small satellites, multidisciplinary education and training
- Security
 - High resolution digital maps, data processing, data analysis
 - Communications, large bandwidth, mobile satellite communications,
 - Simple & intuitive military field operations centers
 - Global Positioning System (GPS)
- Public and industrial research
 - Communications
 - Medicine and biotechnology
 - Micro- and nano-technology, materials research
 - Earth and space science, disaster management,

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Remote Sensing and its Applications

(multispectral remote sensing and multifrequency imaging radar)

- Earth Observation Satellites
 - environmental monitoring
 - meteorological applications
 - military security
 - disaster management
- Possibilities for countries with emerging space potential
 - automated pipeline digital data processing,
 - development of data (de)compression algorithms,
 - rapid turn around data analysis technologies useful for disaster management and military field use where instant impact assessment is required
 - 3D viewing of digital maps
 - precision farming - sustainable agriculture w/o environmental impacts
 - climate changes, geologic knowledge (seismic faults), hydrological cycle study, biomass study, historic site identification
- Can be developed and operated with the help of students with computer science and science backgrounds
- Furthers international collaborative science research
- Become partner in a constellation of microsattellites,
- Transfer of technology for application to local industry

IKONOS, a private satellite, and SoyuzKarta have a resolution of < 1 meter pictures that sell for \$500 each.

Interpreting the photos takes some expertise

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Satellite Communications

High rate data delivery

- Digital Communications
 - **space based internet** functionality allowing satellites to function as nodes on internet
 - **radiation hardening** of chips for high data rate modems
 - **creation of wideband composite signal**; overlap of different channels/frequencies without interference
- Satellite networks
 - provide **seamless interoperability between space networks and terrestrial communications networks**
 - enable **high data rate communications** over space networks
- Devices
 - Development of micro-electromechanical systems (**MEMS**) devices for efficient communications systems applications
- Autonomous operations and protocols & standards
- Applications:
 - Provide global connectivity for advanced communications for Air/Ship Traffic Management
 - Weather information communication; dissemination in timely manner for aviation
 - Tele-education; global teaching and learning
 - Tele-medicine; across countries and continents
 - global television, telephony, internet,

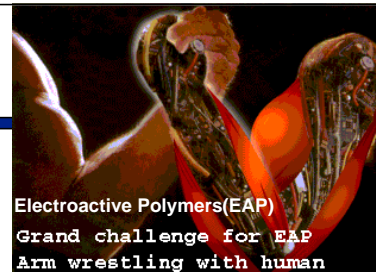
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Micro- and Nanotechnology Advanced Materials Technology

- Development of **new and improved materials**
 - advancement of micro- and nano-technology
 - for ultralight-weight very large and deployable structures in space
- Breakthroughs in new materials with improved properties at the atomic and molecular level is going to be the next great frontier enabling nanotechnology and large light-weight structure development
 - quantum size effects at the nanoscale level become important and present a whole new range of opportunities for designer materials
 - nanotechnology is emerging as a new field that has potential to transform health care and medicine, biotechnology, manufacturing, energy, and information processing
- Applications include:
 - electronic devices, sensors, lab-on-a-chip analytical materials, chemical processing and catalysis, nanoscale molecular wires, switches, devices and even computers.
- **Mechatronics and space robotics** (Japan)
 - Space and terrestrial robot applications
 - motion control technologies: position and force control, digital signal processors to increase response and stability of control systems, miniaturized actuators and components



Electroactive Polymers(EAP)
Grand challenge for EAP
Arm wrestling with human
* Courtesy of NASA/JPL and Israel

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Basic Space Science

- The primary interest is the **pure scientific knowledge** in the understanding of the beginnings, evolution and future of the Universe and Life itself.
- The **educational value** starts in “secondary” and even “elementary” school levels through graduate education. It is an essential part of a multidisciplinary formation.
- Applications are
 - astronomy
 - electro-magnetic field study
 - (micro-)gravity field
 - gas and fluid dynamics
 - atmospheric study
 - geologic studies
 - chemical evolution of the Universe
 - lifescience studies

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Space Mission Development and Operations

- Management and system engineering of space missions
- Mission Operations center
- Mission Design center
- Data Analysis center
- Science and Technology applications to space missions
- Public Outreach
- Commercialization

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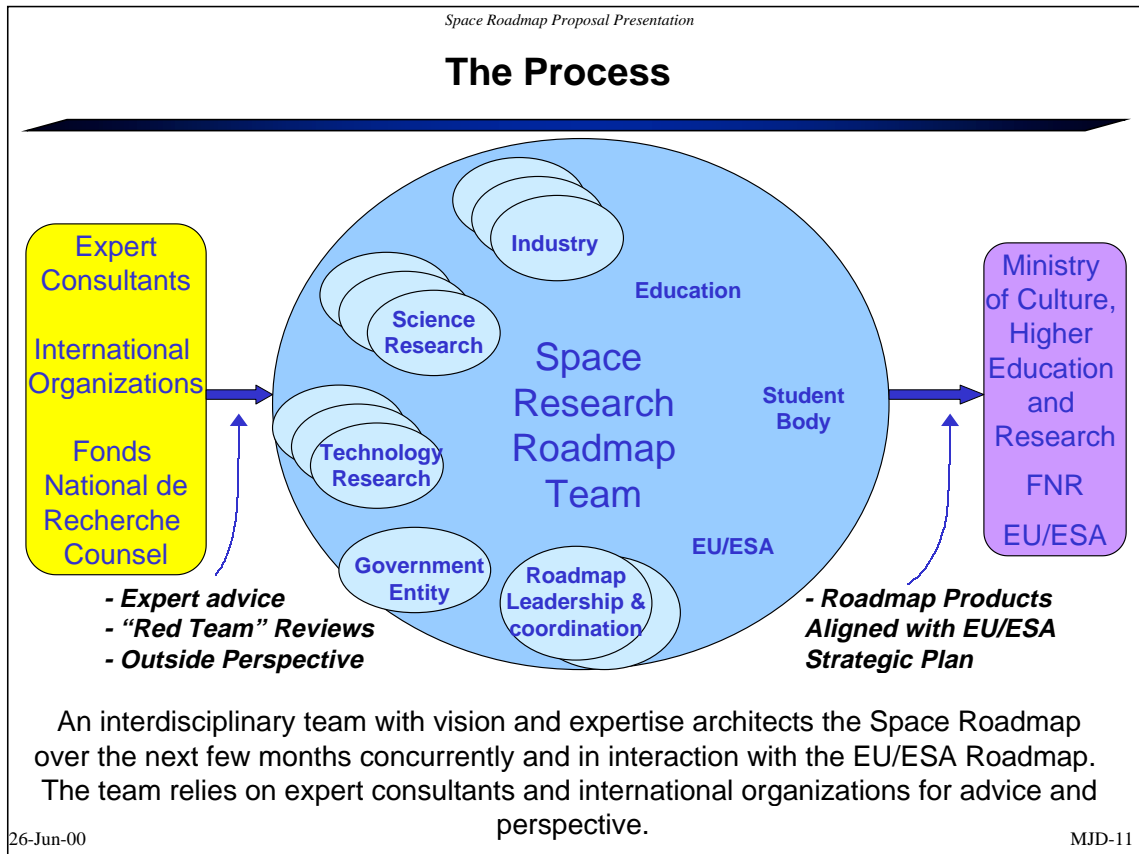
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Three Phased Development 1) Strategic Plan

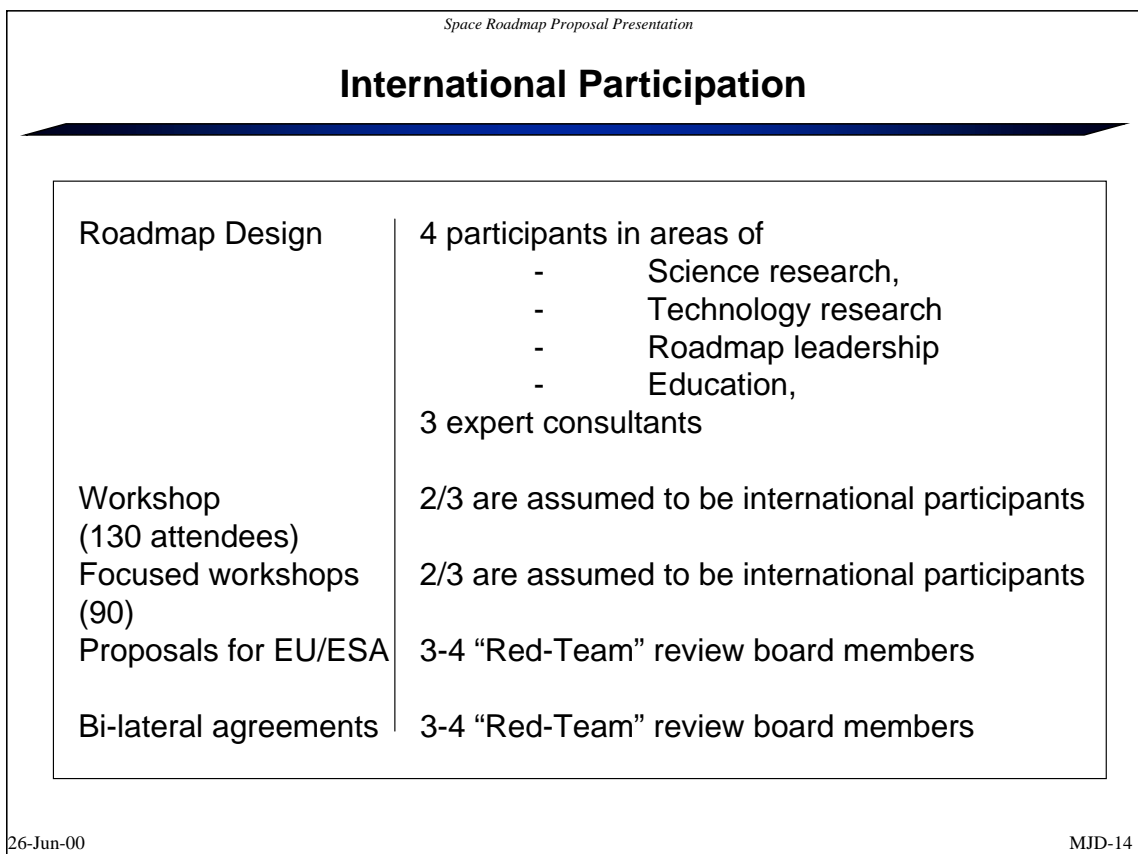
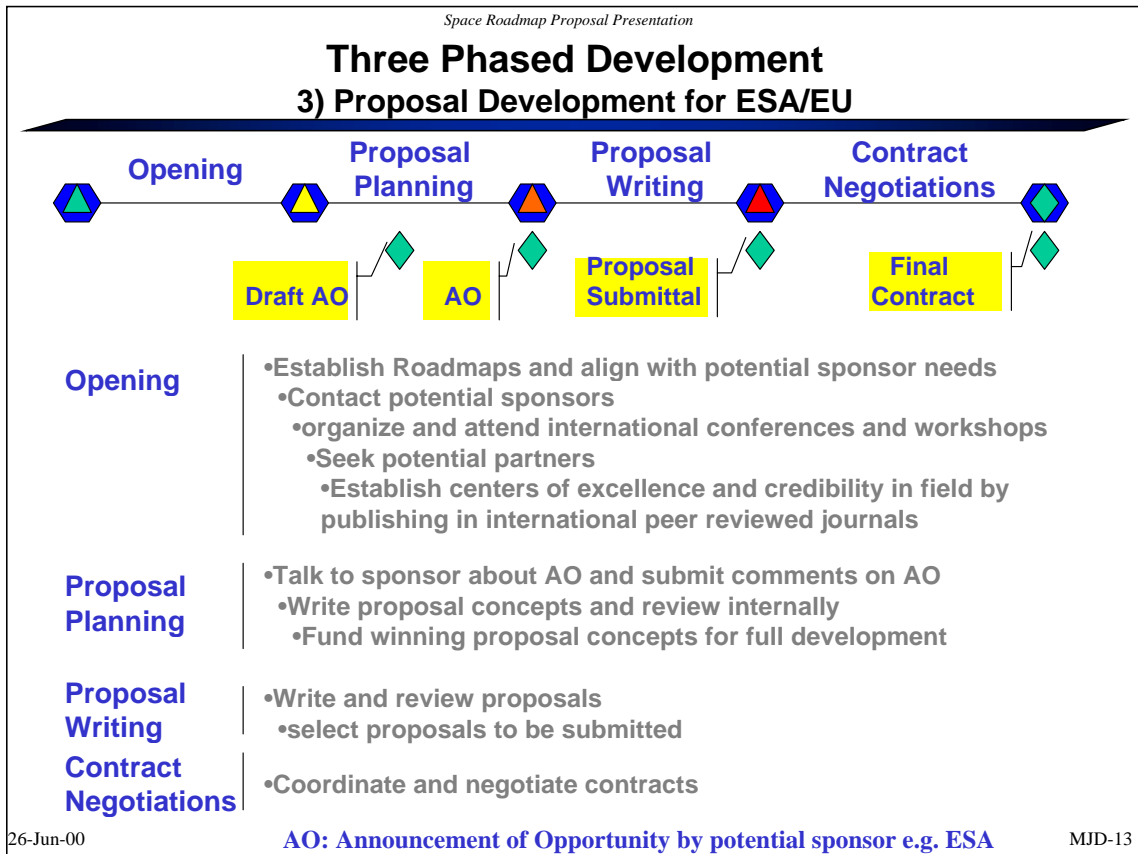
- Develop a **strategic plan and a vision** of Luxembourg's research capabilities
 - 15 year stretch goals.
- Lay out detailed achievements to be reached in 5 years and program for 10 year goals.
- **Identify special niches** within the vast array of possibilities in the space domain, where Luxembourg can make a difference now or in the future.
- The Team is broken into focus groups that work on individual goals
 - remote sensing and its applications
 - meteorology
 - satellite communications
 - basic science
 - possible: micro-technology or other goals
- First steps are to
 - evaluate existing capabilities in the country
 - determine existing cooperative agreements
 - determine sources of funding for current funding and potential new ones
 - determine which ESA/EU programs are open for collaboration
 - determine possibilities and benefits of above research domains

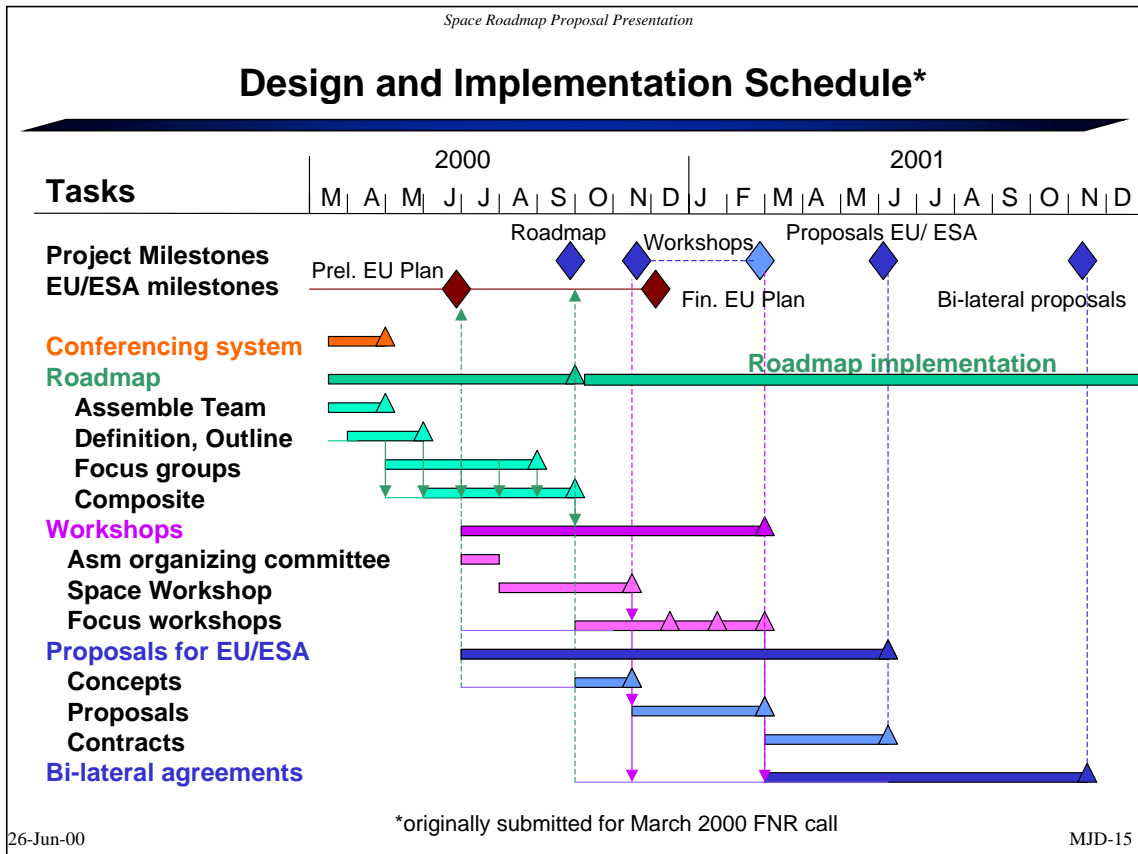
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- Space Roadmap Proposal Presentation*
- ## Three Phased Development
- ### 2) International Space Workshop
- The second phase in the emergence of space science and technology research in Luxembourg, involves the hosting of a space workshop, with international participation of experts in the science and technology domains identified in the Roadmap.
 - Alternative is to have a series of smaller more focused workshops
 - Participation of Luxembourg researchers at international space research conferences and workshops
 - Goals:
 - Educational
 - Furthers cooperative contacts
 - Determines the state of the art of research in a given area
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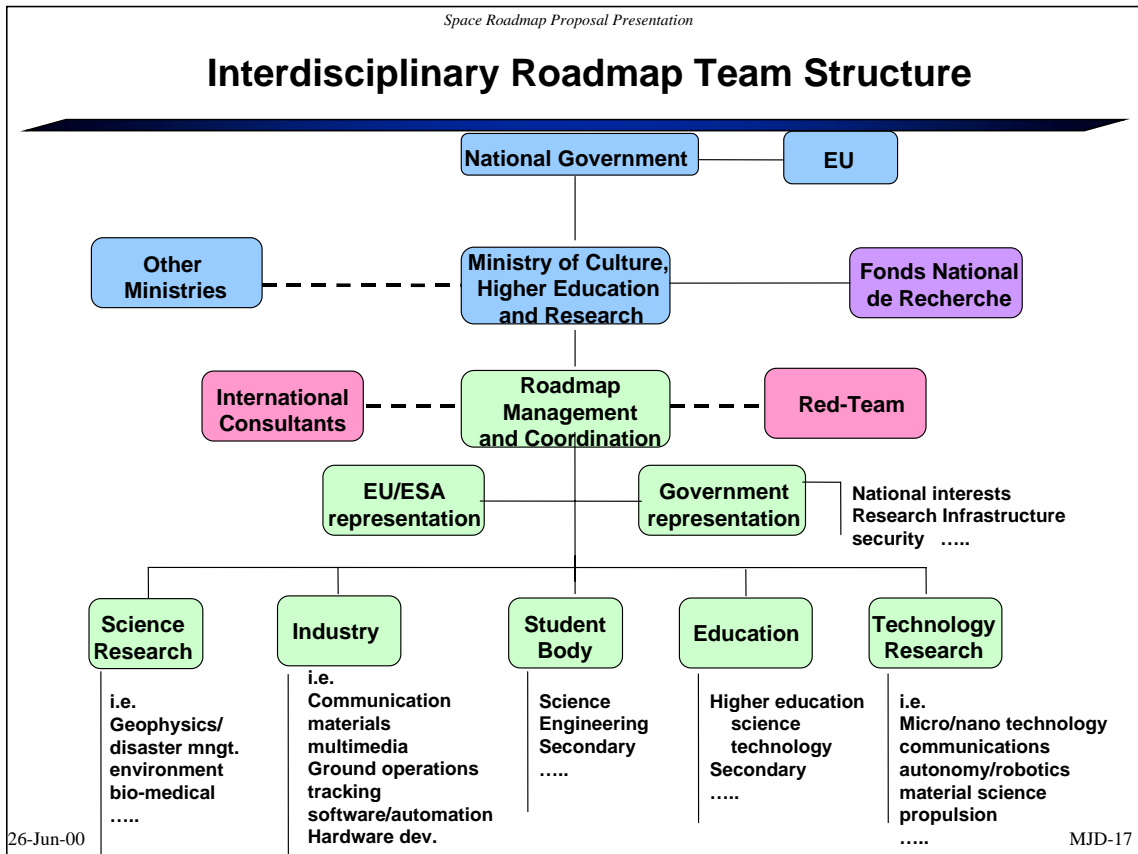


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Establishment of Space Counsel and Space Coordination Entity

- Secure the emergence of space research and development in Luxembourg and its continued growth
 - establish a space science counsel and an advisory board for space research and development
 - establish a space leadership and coordination entity under the auspices of the MCESR. The mission of this agency is to
 - coordinate and integrate the space research and applications programs
 - promote development and efforts in the space research and applications domain
 - be the government representative in the international space cooperation
 - be the implementer of the space roadmap

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Cost for the Design and Implementation of Initial Roadmap

The proposal is broken into three phases which can be funded in stages.

- Strategic Plan
- Workshop
- Proposals

The expenses required to realize the proposal are driven by the international involvement, which is crucial in providing consulting and in initiating international collaboration in the space domain. However, such investment is in the nominal range if taking into account the return on the endeavor.

- This fact has been born out by other countries like Denmark, which only within the last 5 years seriously pursued space research with ESA. After a short couple of years their space industry and research soared.

Laying the ground work is essential for the successful entry and growth of space research in Luxembourg. The proposal will accomplish this feat for a nominal expense of 240,000 EUR for the 1st phase, an investment risk worthwhile taking.

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Why Fund this Proposal?

Buy Expertise to Develop a Space Roadmap

- **Proactive contribution to EU/ESA master plan** for space development, by determining a **national roadmap**, ensuring an **optimal return** on investment.
- **Space research outpaces all others for innovation and technological return**
- Luxembourg space program is to be one totally **integrated with local research, application and education.**
- The Roadmap team is a **multidisciplinary and international team with strong national commitment, vision, knowledge and experience.**
- The proposal lays the necessary **ground work** to enter successfully into space research domain at a **nominal cost.**

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Experience/ Expertise Summary

Marie-Jose Deutsch

Marie-Jose has a multidisciplinary background with over 20 years experience at the JPL/CalTech in space mission design, development and critical flight operations during launch, initial spacecraft check-out, orbit correction maneuvers and planetary encounters.

- ◇ Management and support of mission proposals, advanced technologies studies and NASA “**Solar System Exploration**” roadmap.
- ◇ **Extensive Management and System engineering** experience negotiating operable and low cost space missions through the design of common flight-ground systems. Responsible for yearly budgets of \$4 mil, committed to multiyear budgets of \$75 mil covering the life of the mission.
- ◇ **Expert system architect** for the development of innovative, efficient, and low cost Data and Mission Operations Systems for astronomy, interplanetary, and interstellar missions.
- ◇ **Geophysicist and Plasma Scientist** performing environmental studies for the US Nuclear Regulatory Commission and research on high radiation impacts on spacecrafts.

Project Experience

Mission types supported range from micro-missions (i.e. mars micro-mission US \$ ~75 mil) to legacy missions, (Voyager, Galileo, Cassini-Huygens, Iras, SIRTf US \$ ~1bil) These missions are US and Internationally funded, and supported by ESA, CNES, Universities and Industrial partners.

Education

Graduate from Lycee Robert Schuman, Luxembourg, DUES in Math-Physics, Maitrise in Physics, University of Grenoble, France M.S. in Geophysics and Space Science, Major Seismology, UCLA, USA Continuing Education in Project, Contract and Proposal management, Leadership and Creativity Management, and Information Systems.

Awards

1990, NASA Exceptional Service Medal, for the management of the Voyager team at Neptune encounter. 1990 and 1998, Group Achievement Award, Management Team, Galileo launch and Cassini/Huygens probe development and Launch.

Educational Outreach

US delegate to the UN/ESA Basic Space Science workshops (1999 and 2000), UNISPACE III as science counsel to the Luxembourg delegation, member Science Counsel at the IST (1998–p) and advisor/counsel to Minister of Culture, Higher Education and Research in Luxembourg. (1998–p)

Publications

Many publications, seminars and invited talks on space mission development and operations, space technology development, geophysics and plasma research. Some recent papers most relevant to this proposal are:

- M.J. Deutsch, “A Case for Space Science and Technology Education and Research in Luxembourg”, white paper to MEN, Luxembourg, May 10, 1999.
- M.J. Deutsch, “Report on UNISPACE III”, Vienna, July 19–30, 1999, to the MCESR, September 21, 1999