Global Leader Program for Social Design and Management

東京大学 THE UNIVERSITY OF TOKYO

4th GSDM International Symposium

Trends in Aerospace Innovation: Future Prospects and Challenges

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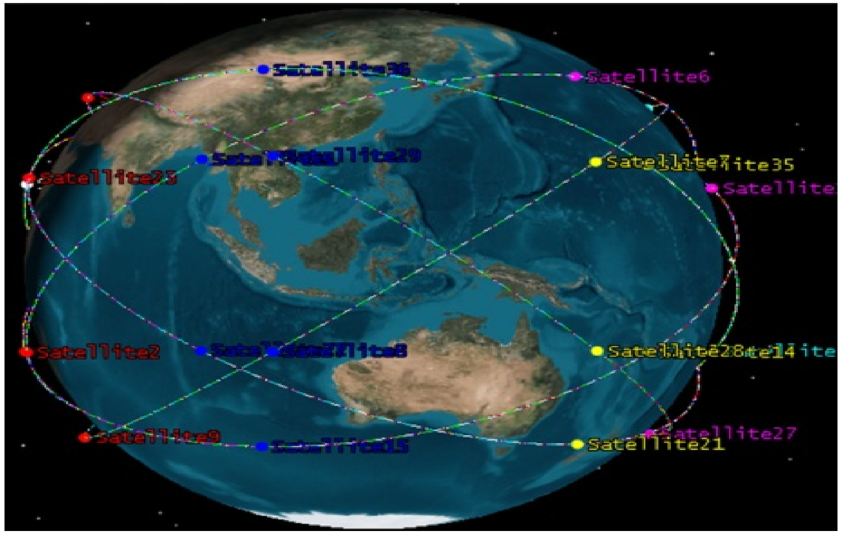
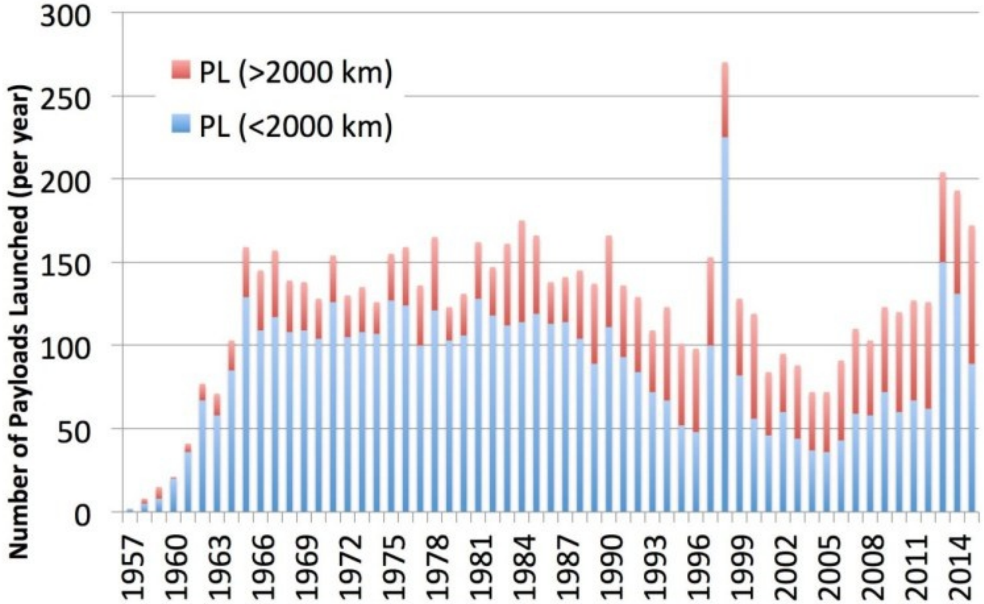
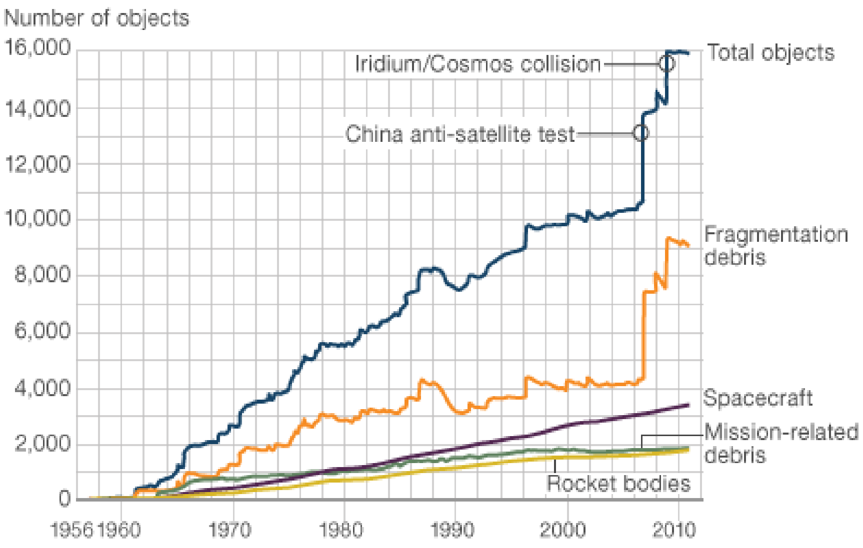
JAXA Explore to Realize

Impact of Miniaturization of Satellites

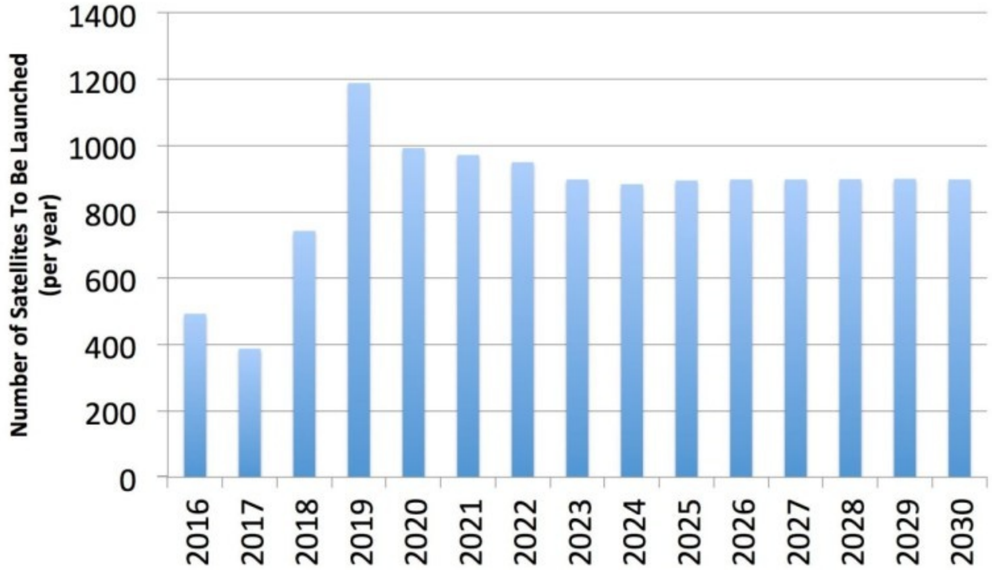




Growth of orbital space objects including debris



Source: Nasa

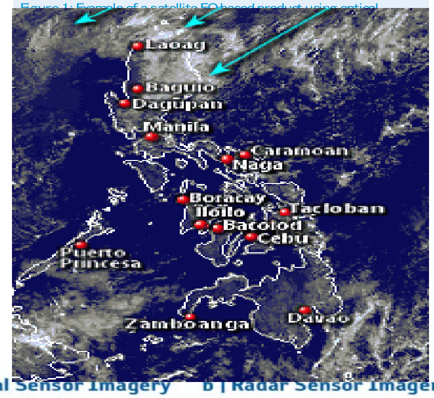


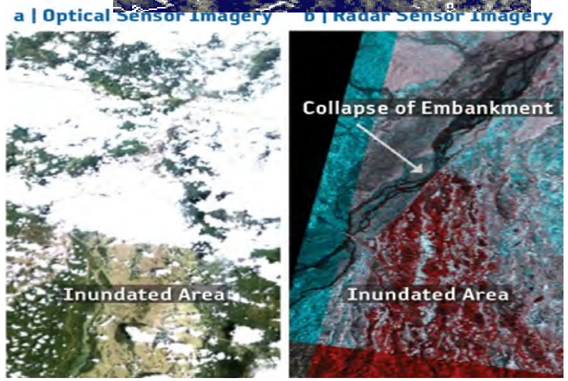
Useful Earth Observation Space Data

- <u>Earth-Observing satellite *images*</u>
  - Usually visible (or IR), 80-1m resolution
  - Revisiting period varies, order of 1-14 days
    - vulnerable to clouds
  - Monitor droughts and floods, land use etc.

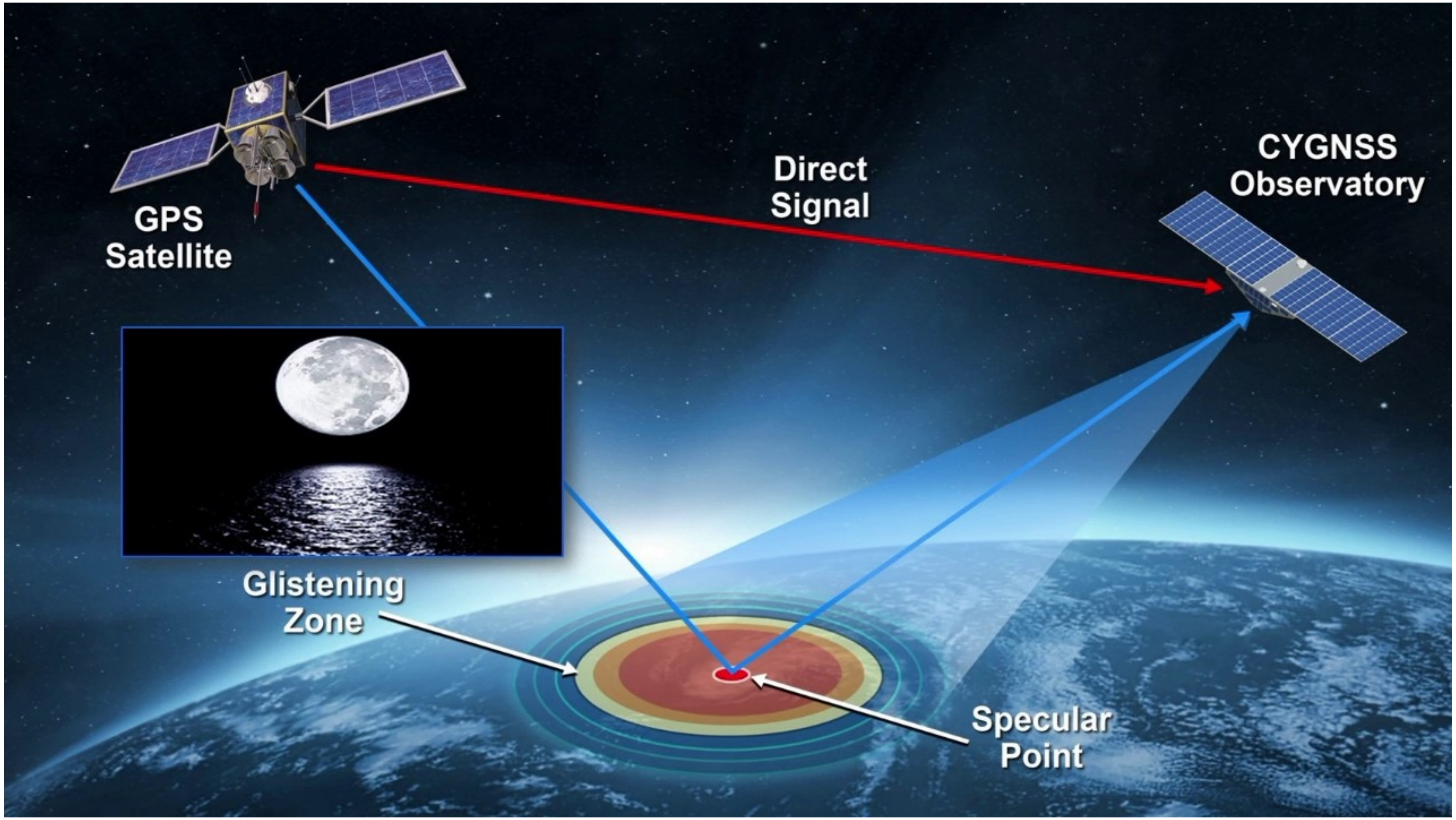
- <u>Meteo satellites</u>
  - Images & atmospheric measurement for weather
  - 1 km resolution
  - Image every ~30 minutes
  - Weather, drought, flood <u>prediction</u>; vegetation

- <u>Satellite radar</u>
  - Sea surface temperature measurements, >30m resolution
  - Revisiting period varies, order of 1-7 days
    - Through clouds or at night (energy view)
  - Weather prediction & hazard monitoring, flood & drought



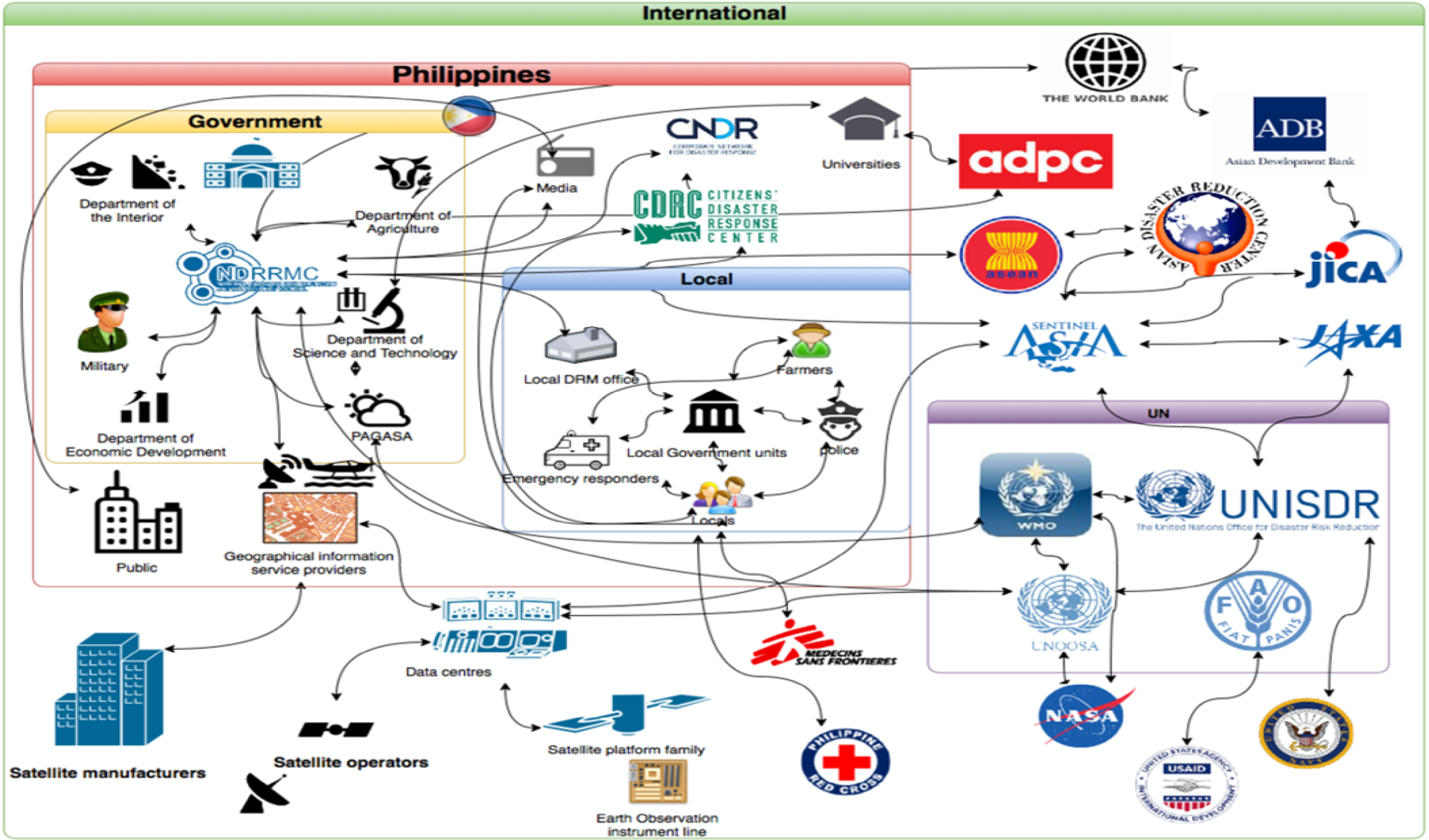


NASA CYGNSS Mission 2016

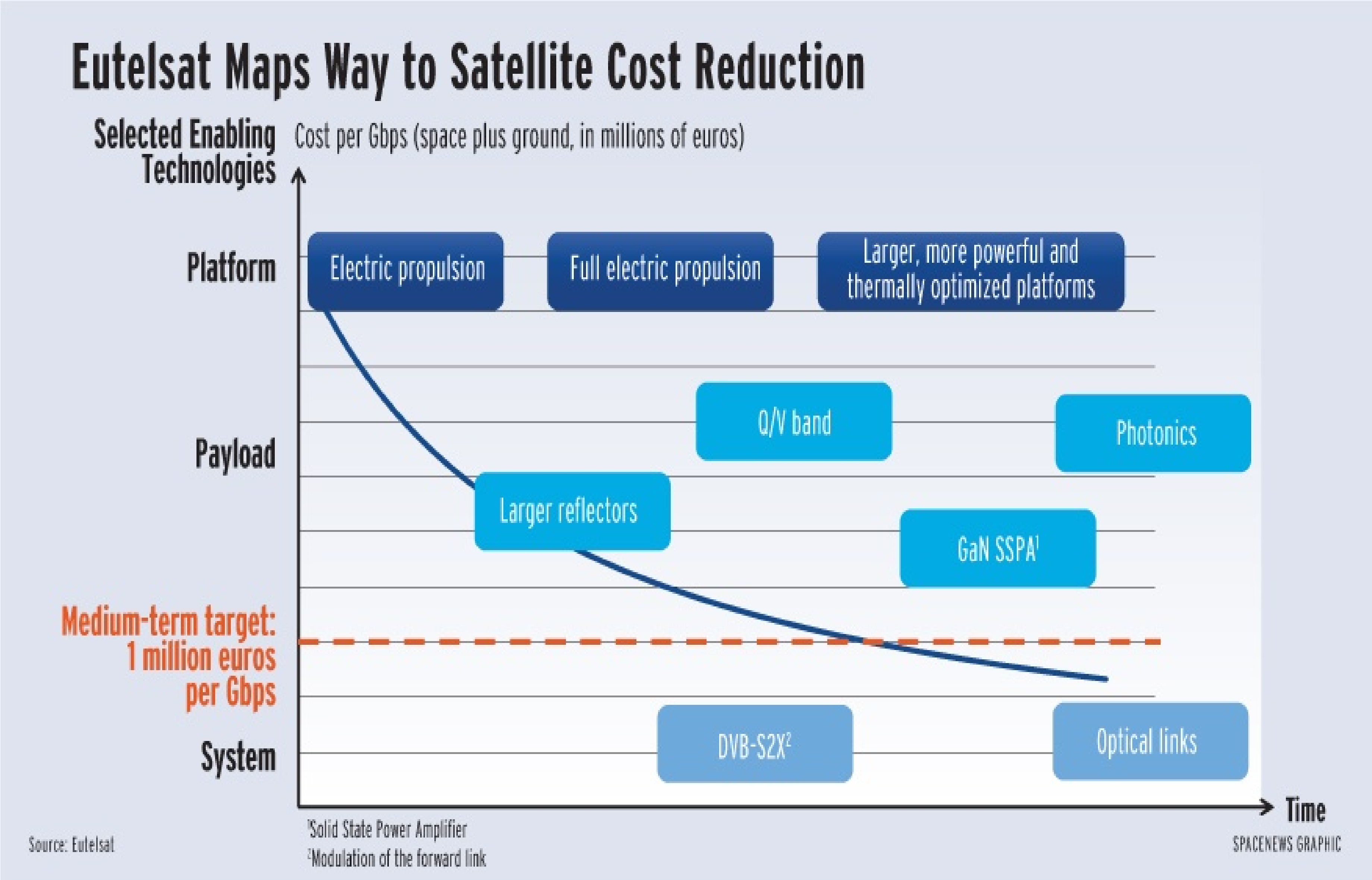


Using a constellation of 8 small satellites in bi-static mode with GPS satellites and 5 ground-stations for tropical storm monitoring, Revisit time is reduced to 7 hours (3 times faster)

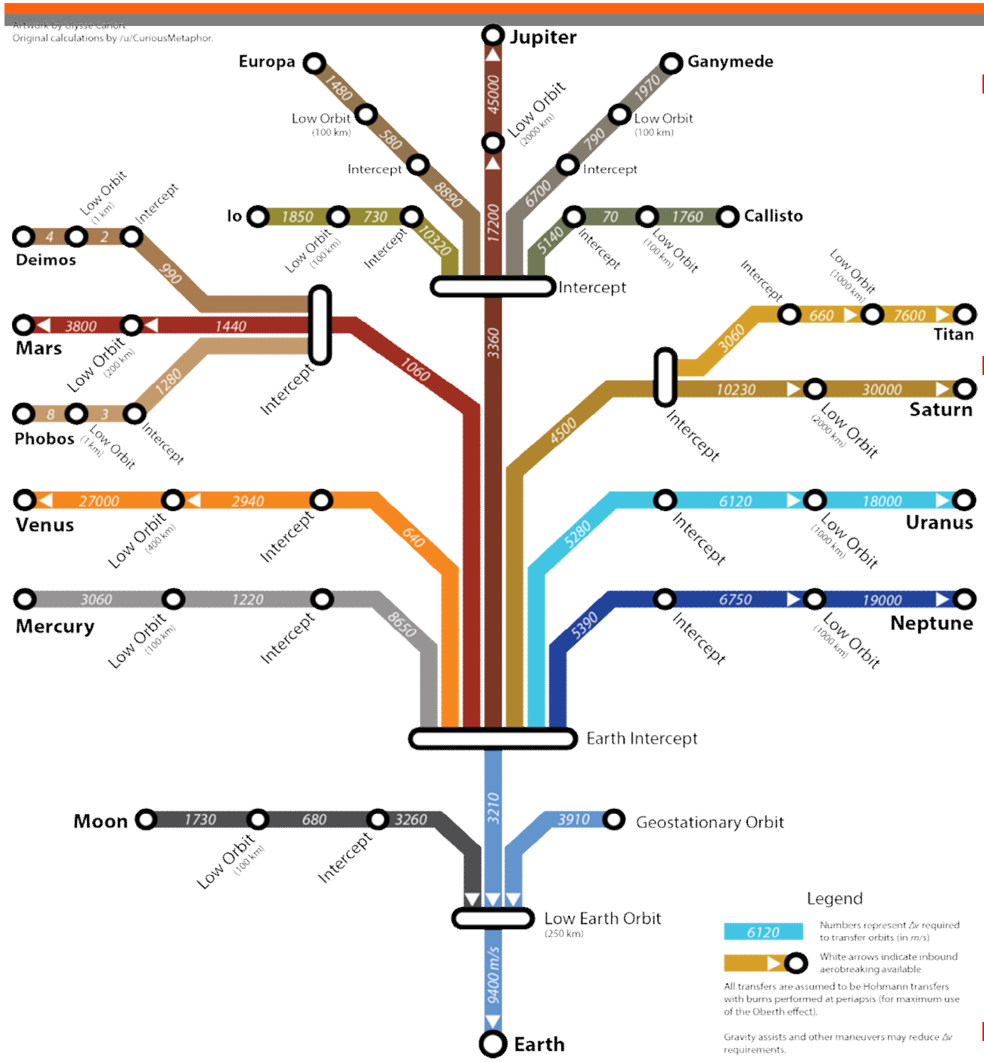
Necessity for International Cooperation among Diverse Stakeholders



Propulsion and Cost Reduction Strategies



Delta-V needs for space exploration

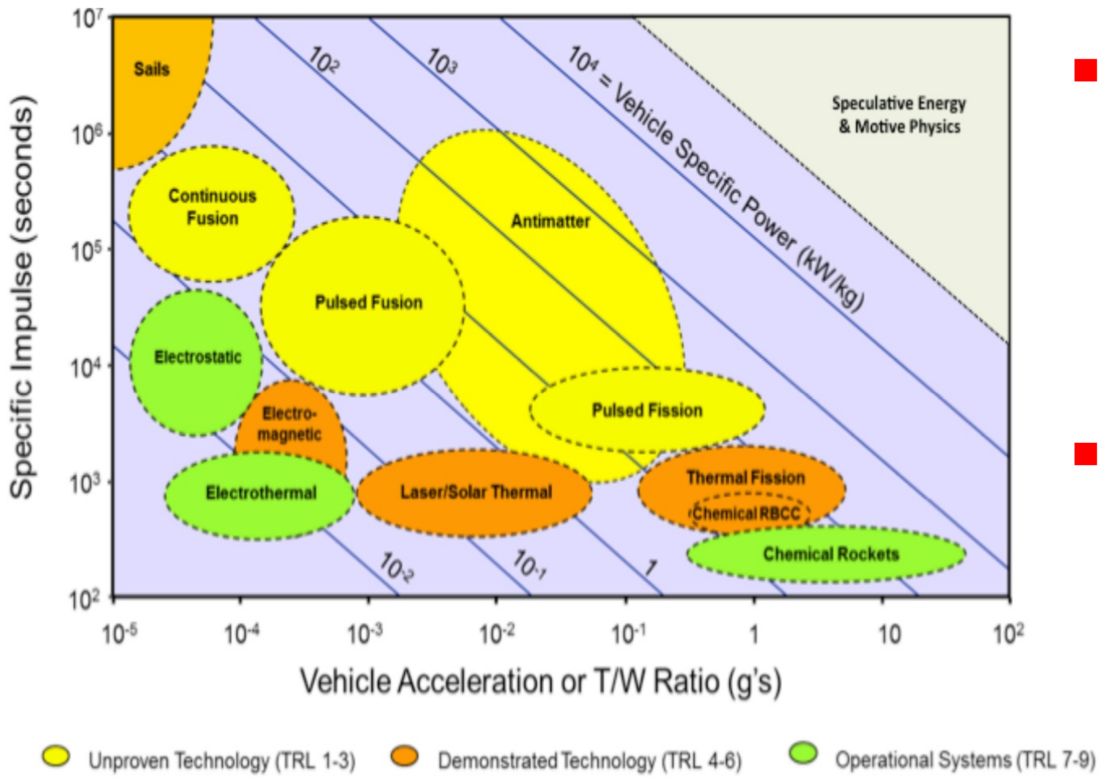


- Delta-V is one of the major limitations to large scale exploration missions

- Various methods to improve delta-v capabilities or reduce needs:
  - increase Isp (Specific Impulse)
  - more propellant
  - gravity assist
  - aerobraking (arrival only)

- Manned missions require round-trip capability, doubling the delta-v cost

Current and Future Propulsion Capabilities

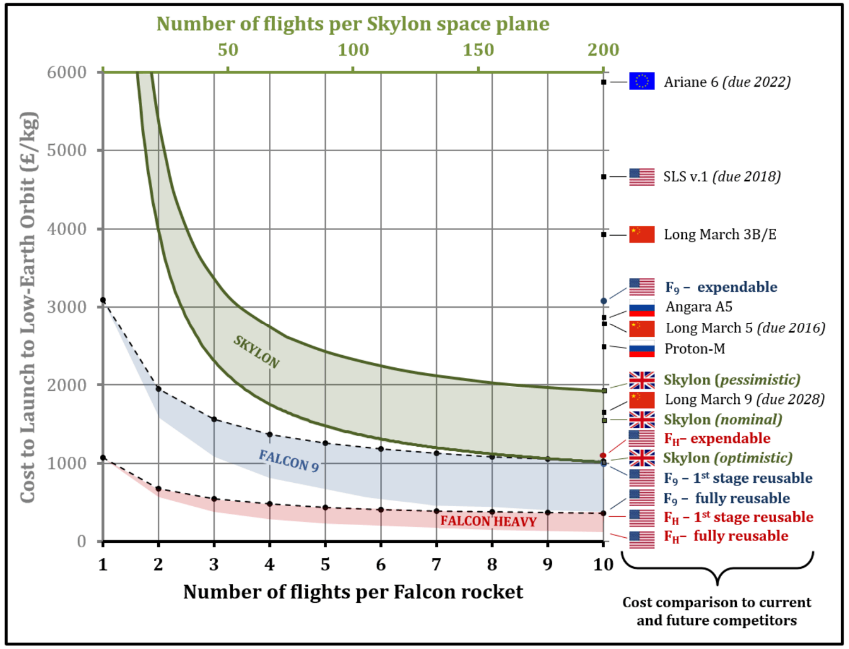


- Chemical propulsion has higher thrust (T/W R>1 for liftoff), electric propulsion higher Isp.
- High thrust reduces transfer time, which is necessary for manned missions.

No currently available propulsion method is fully satisfactory, we need a development strategy.

Rocket Reusability

- Reusability introduces a new variable in rocket propulsion
- Multiple launch capability increases the delta-V on orbit
- Cost reductions up to 2/3 of standard procedures. Non-reusable rockets risk to become out of market

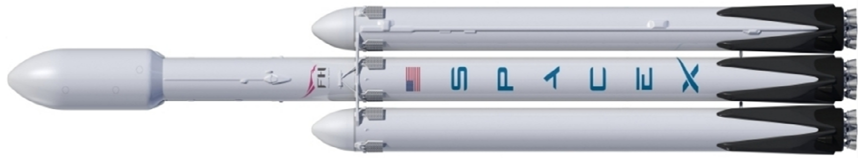


Reusability technology should be included in any development strategy

New Space: A clear shift in Aerospace Industry

- Private companies **self-fund R&D**, reducing costs
- Reusable Rockets: The Way Forward?

  e.g. Falcon 9
- Some contracts shifting technology-push to **demand-pull**
  - NASA-COTS
  - Google X-Prizes
- Innovations from **smaller entities**:
  - Micro/small satellites
  - Crowd-funding
  - private spaceflight



Focusing these trends with economic growth:

- R&D inputs becoming available
  - **HR** via micro/small satellites
  - Influx of private entrepreneurs
- With lower tech cost space R&D is becoming **accessible** to less developed countries
- Aerospace R&D causes **spillovers**, benefitting the economy

Challenges

- What are the necessary policy reforms for relaxation of existing stringent regulations and privatization of space sector in both developed and developing countries?
- How can we reduce costs for Future Space Missions in the backdrop of economic turmoil and political instability?
- What technological innovation is necessary to achieve better Time-Resolution and Faster Revisit Time for Earth Observation Satellite constellations?
- What new policies need to be implemented for better International Cooperation among diverse stakeholders?