Phase 0 (a.k.a. Quick & Dirty ROM) Space Mission Estimates

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Outline

- Need – Call for Proposals
- Estimating Effort & Scope
- Spacecraft:
  - Benchmarking
  - High-level Cost Estimation Relationships
- Operations cost
- Agency Internal cost
- Cost Risk Margins
- Conclusions

Phase 0: Call for Proposals

esa

NOLOGY COSMIC VISION

CALL FOR A FAST (F) MISSION OPPORTUNITY IN ESA'S SCIENCE PROGRAMME

16 July 2018

The ESA Director of Science solicits proposals from the scientific community in ESA Member States for a Fast (F) mission to be launched in the 2026-2028 timeframe.

This Call for a Fast mission aims at defining a mission of modest size (wet mass less than 1000 kg) to be launched towards the Earth-Sun L2 Lagrange point as a co-passenger to the ARIEL M mission, or possibly the PLATO M mission. From L2 the mission should reach its target orbit or destination with its own propulsion system.

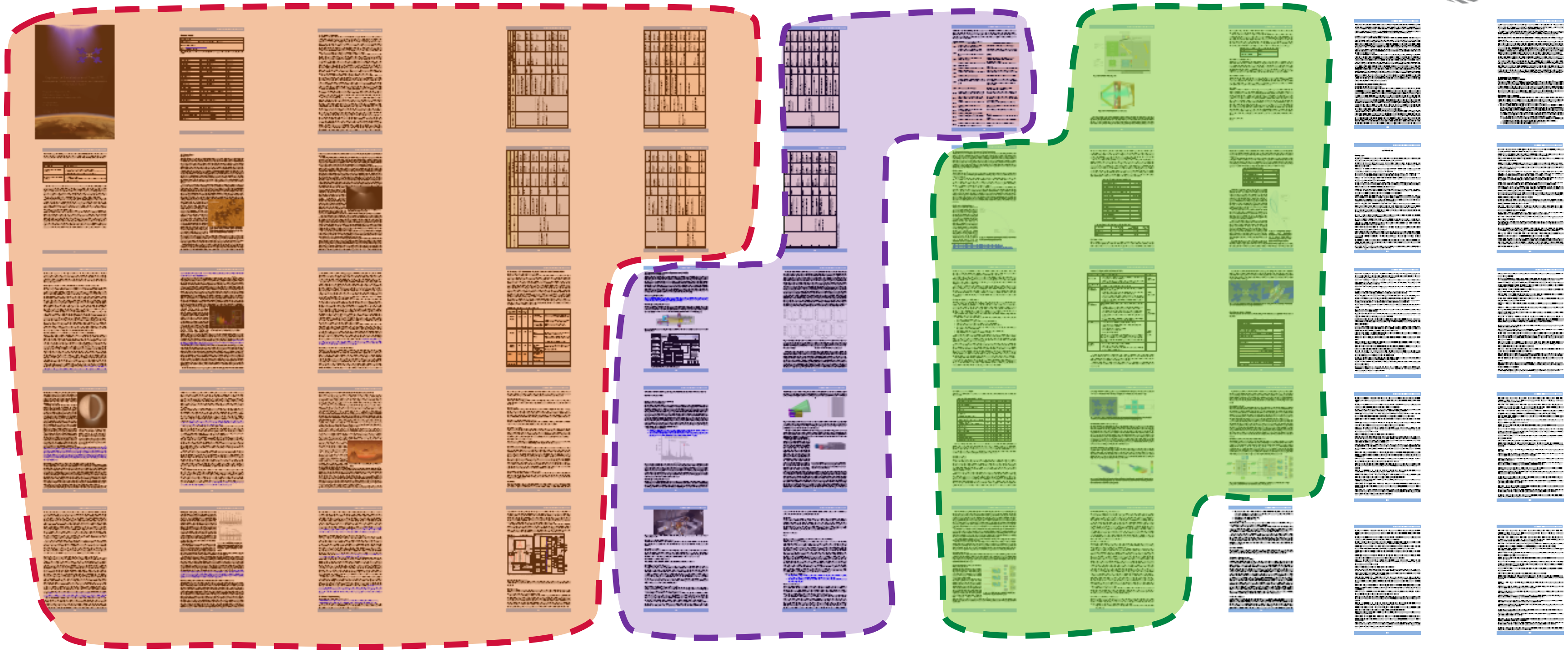
The Call is open to all areas of space science. Any scientific goal and spacecraft technical configuration will be considered, including missions aiming at multi-point scientific measurements, for example, Near-Earth Objects or Main Belt comets, considered in the studies performed by ESA following the Call for New Science Ideas issued in 2016.

Phase 0: Call for Proposals

SCHEDULE FOR THIS CALL AND IMPORTANT DATES

Release of Call for a Fast (F) mission	16 July 2018
Phase-1 proposal submission deadline	**25 October 2018 – 12:00 (noon) CEST**
Phase-1 proposal assessment	November 2018
Workshop for Phase-2 proposers	**11 December 2018**
Phase-2 proposal submission deadline	**20 March 2019 – 12:00 (noon) CET**
Letters of Endorsement deadline	**10 April 2019 – 12:00 (noon) CEST**
Proposal evaluation and scientific ranking	April – July 2019
Phase 0 study	July – December 2019
Selection of candidate mission	February 2020
Phase A/B industrial kick-off	September 2020
Mission adoption	November 2022
Mission CDR	June 2024
Spacecraft launch readiness	December 2027

Typical "Call" Proposal



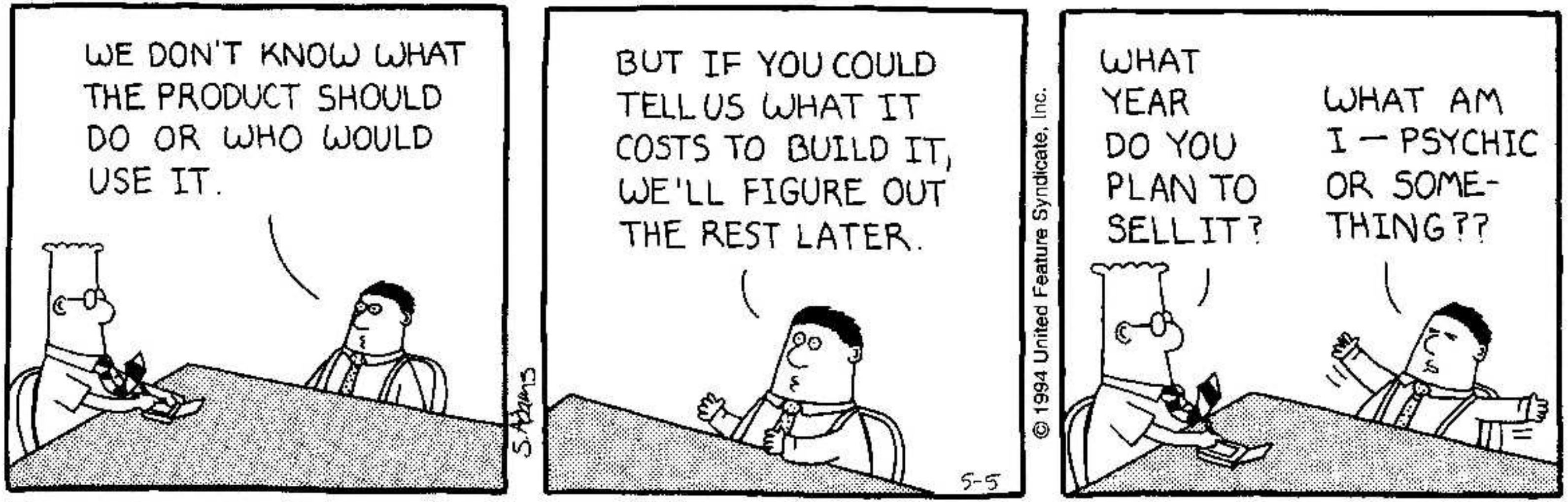
Science

Payload

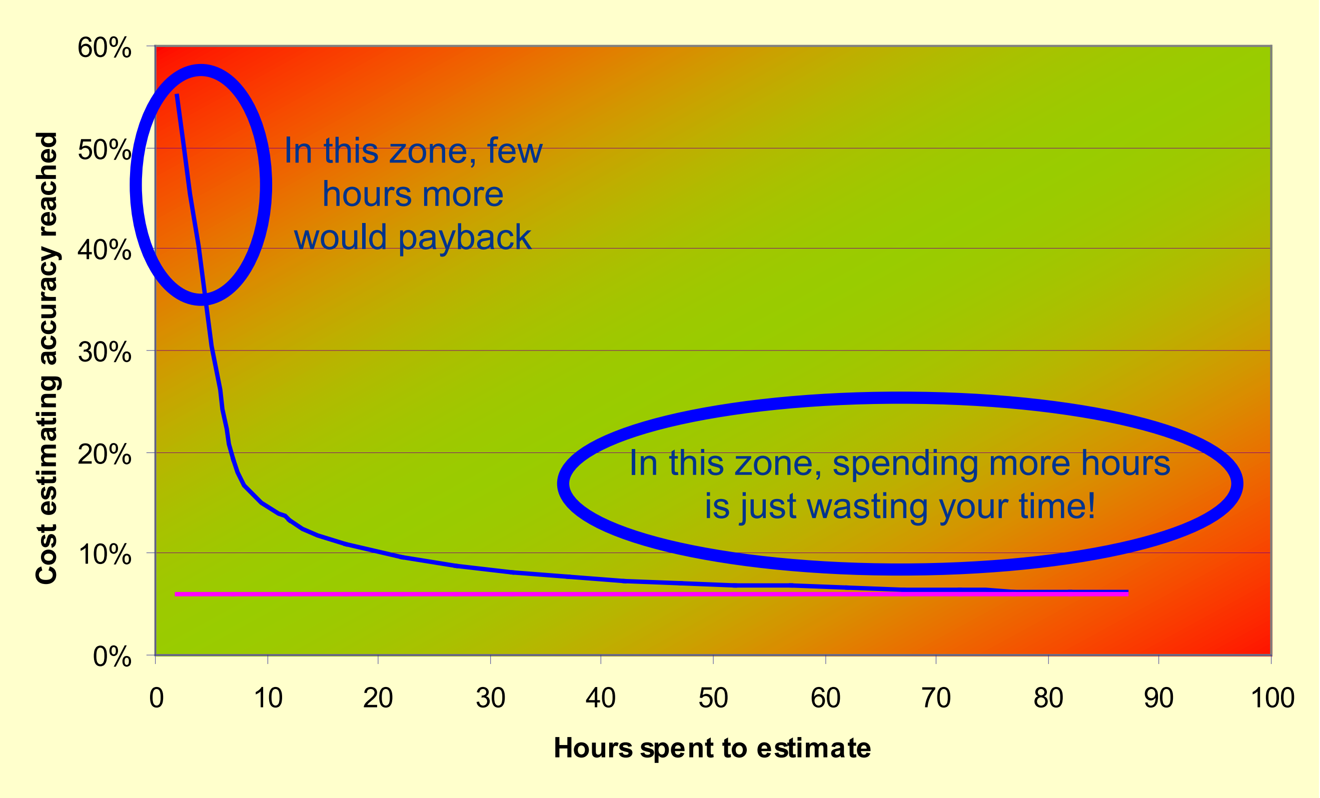
Mission, Spacecraft, Programmatics

References etc.

Little input, but a cost estimate is required…



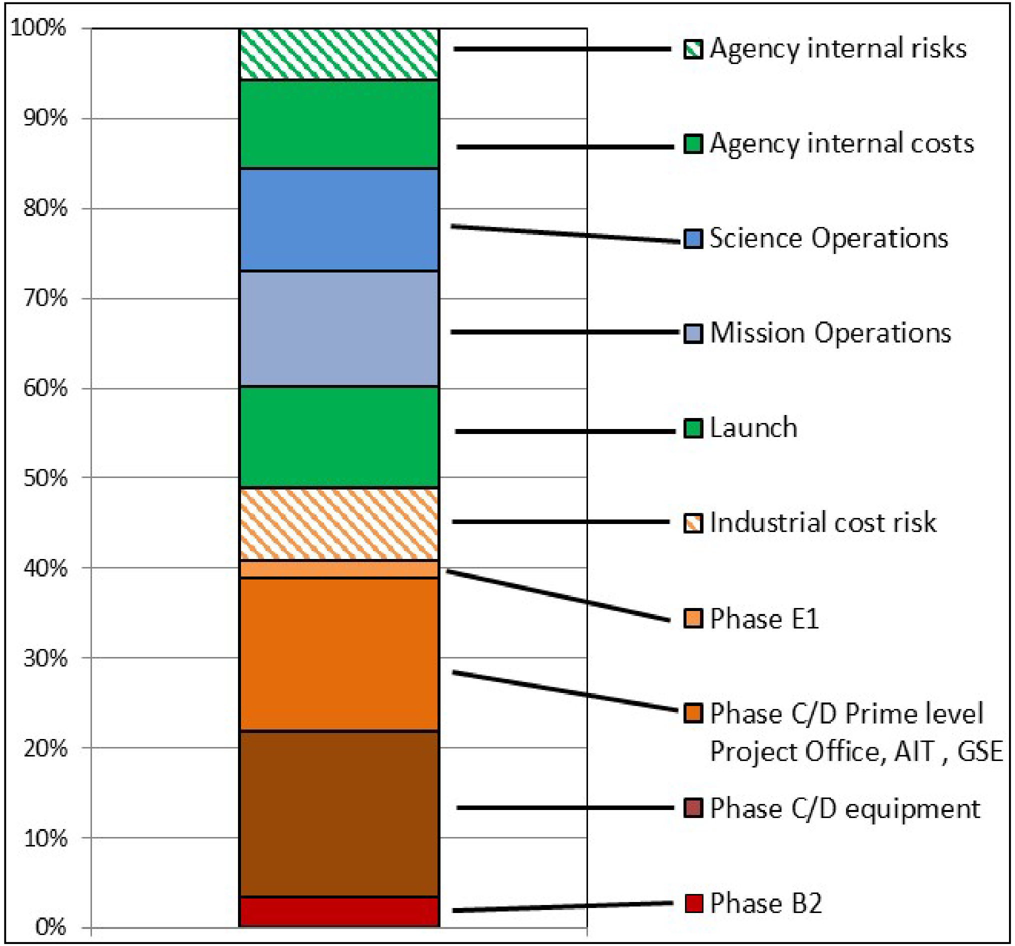
The right size of cost estimating effort



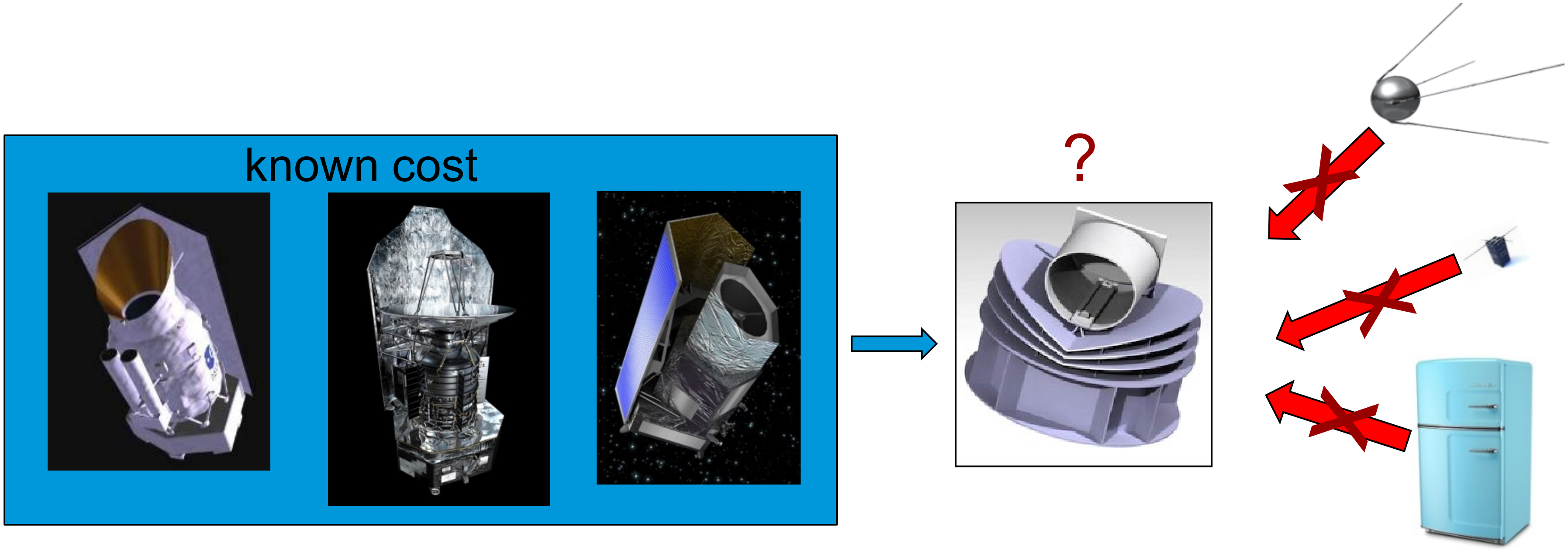
Scope

Typical ESA Science Mission example

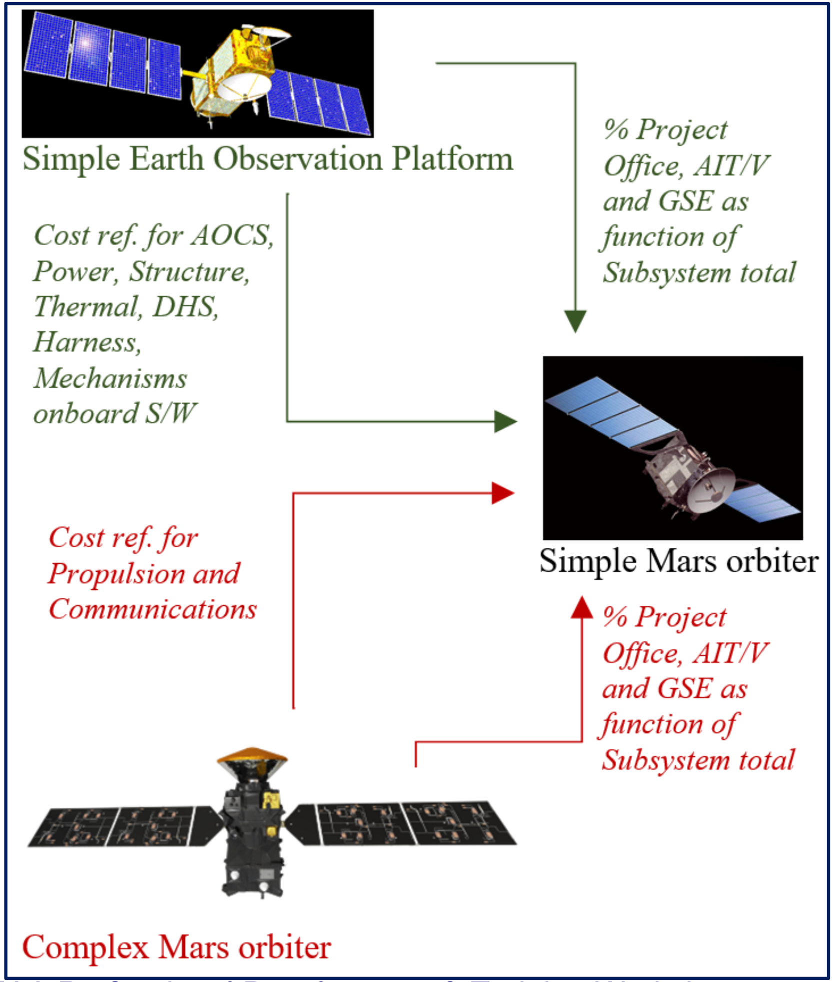
Note this does not cover Payload Instruments



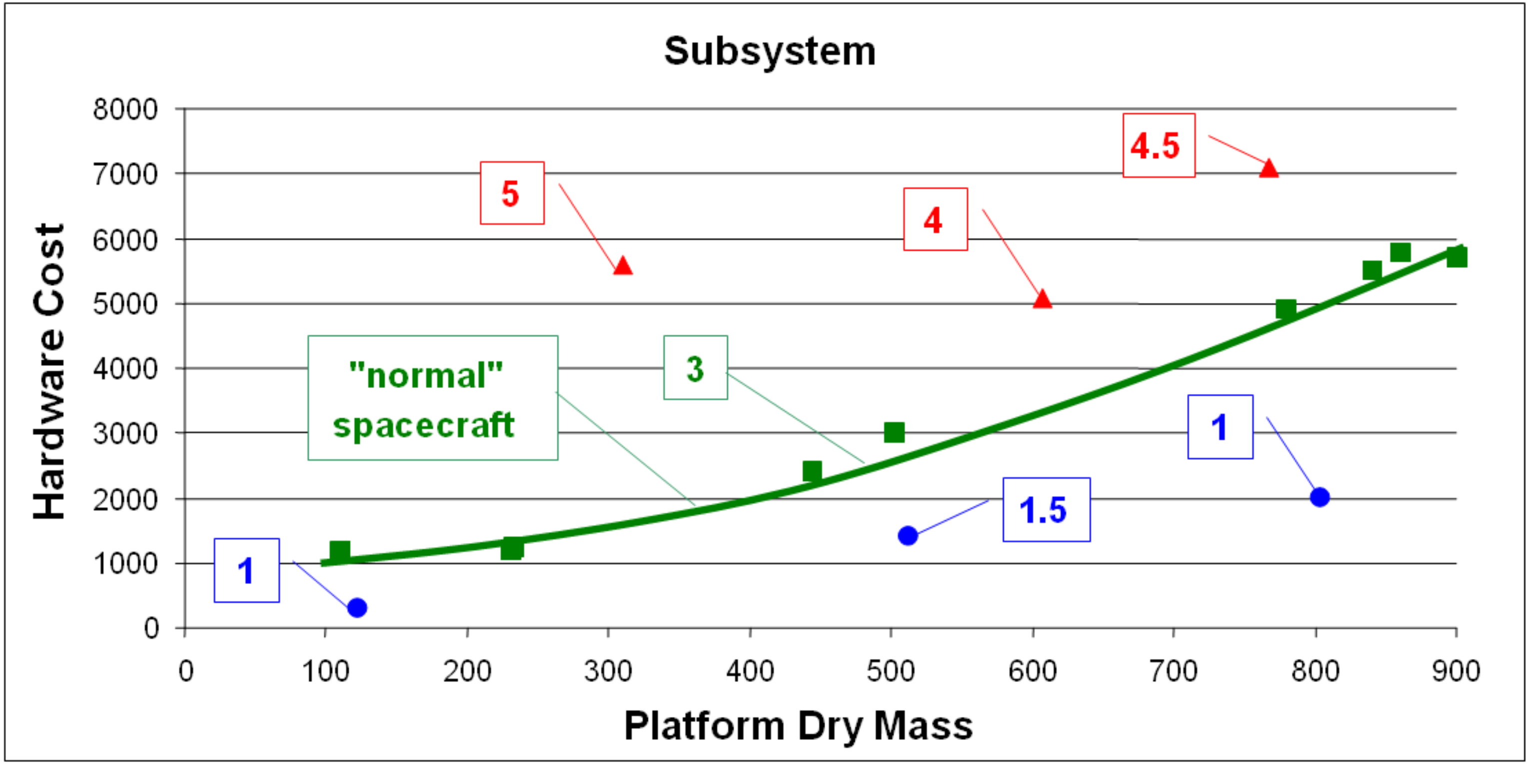
Benchmarking



Benchmark-based Phase C/D estimate



Subsystem cost as function of Platform dry mass and relative complexity



Example of complexity driving parameters

Reaction Control Subsystem Complexity	3.2

No RCS S/S ☐

Subsystem status

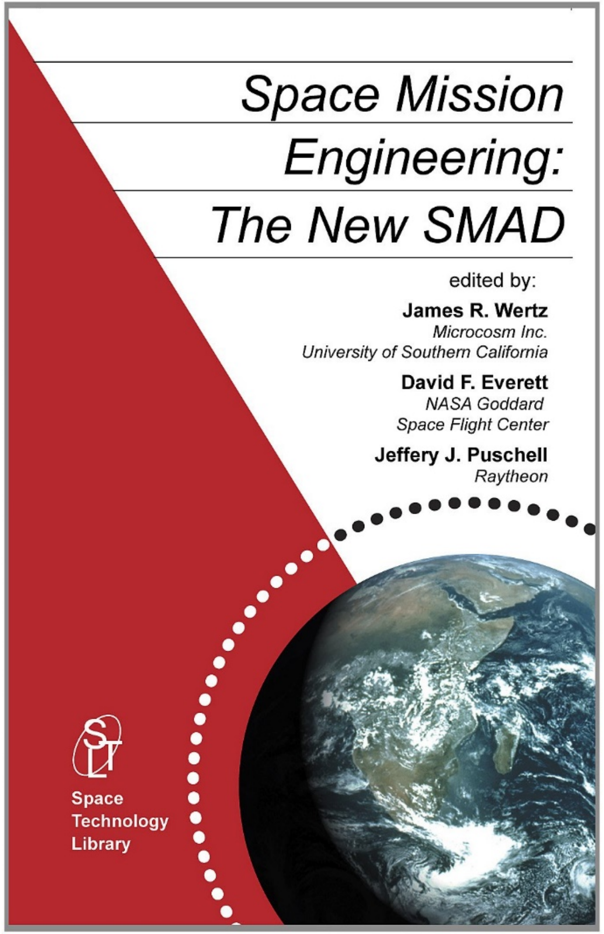
- ○ Off the Shelf
- ○ Minorly Modified (new feed system)
- ◉ Majorly Modified (new feed system + new tanks)
- ○ Newly Developed

Propulsion type

- ○ Cold Gas
- ○ Hydrazine Mono
- ○ MMH/NTO Bipropellant
- ○ Elec. Propulsion
- ◉ Hydrazine Monopropellant with Cold Gas Micropropulsion
- ○ MMH/NTO Bipropellant with Cold Gas Micropropulsion
- ○ Elec. Propulsion incorporating additional Cold Gas thrusters

SMAD

Great source of CERs, rules-of-thumb and methodology in chapter 'Cost Estimating' (by Hank Apgar)



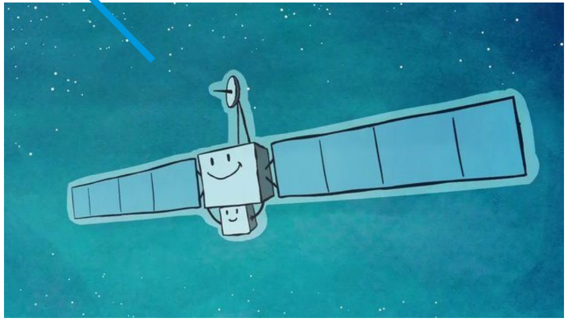
Mission Operations & Science Operations

Ops_Cost =

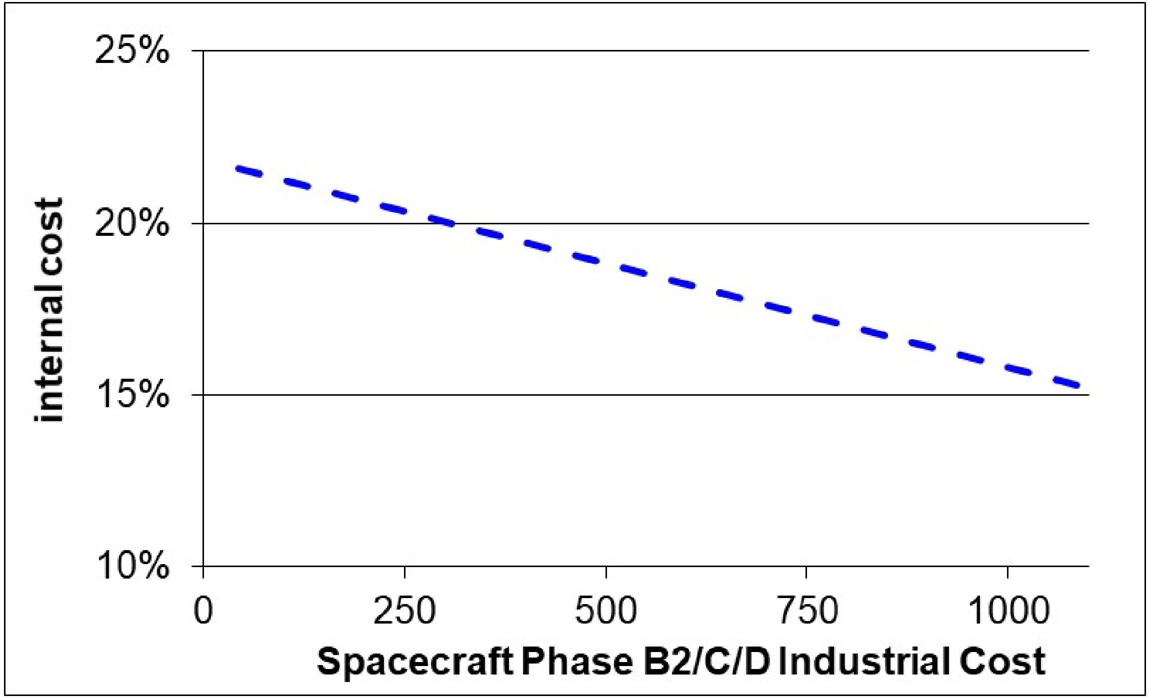
[Control Centre development & training cost]

+ [Ops cost during orbit transfer] * transfer_duration

+ [Ops cost in full operational phase] * operational_phase_duration



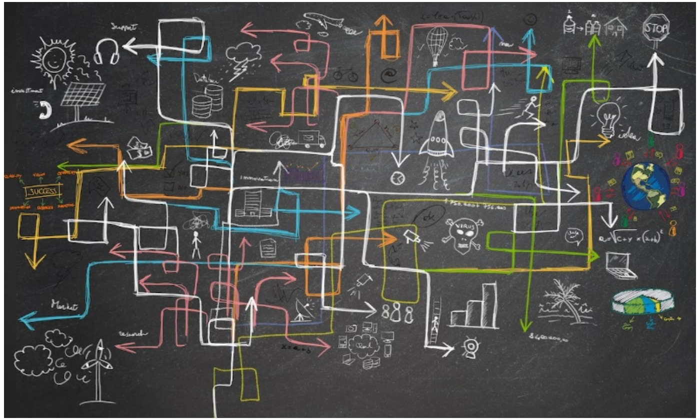
Agency Internal Cost factor as function of Industrial Cost in M€ in today's Economic Conditions



Industrial Cost Risk

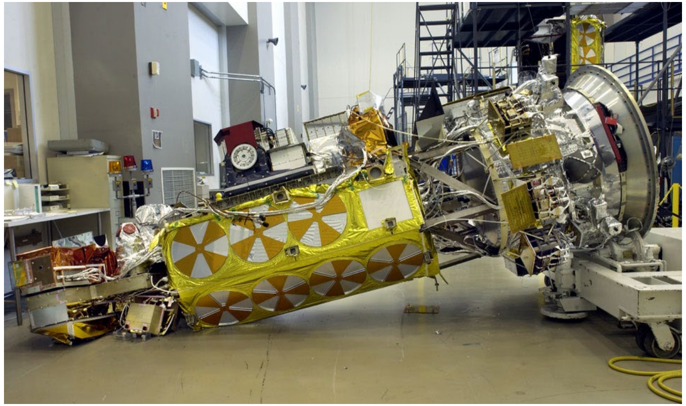
- **Technical Risk**
  - Development Status Risk (related to TRL -> use a table with cost risk% vs TRL)
  - Programmatic Risk
  - Industrial Procurement Risk (e.g. price increases)

- **Maturity Risk**
  - Design Maturity Risk (unknown risks)
  - Costing Model Accuracy Risk



Overall ~ 30% on Industry Phase B2/C/D/E1 proven reasonable for most cases

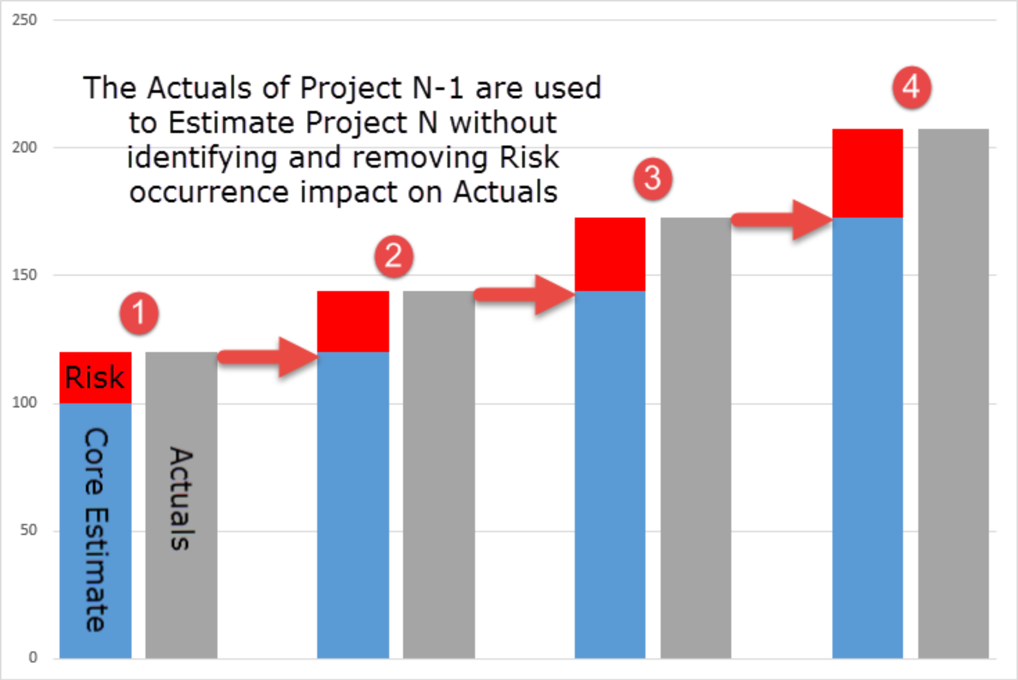
Agency Cost Risk



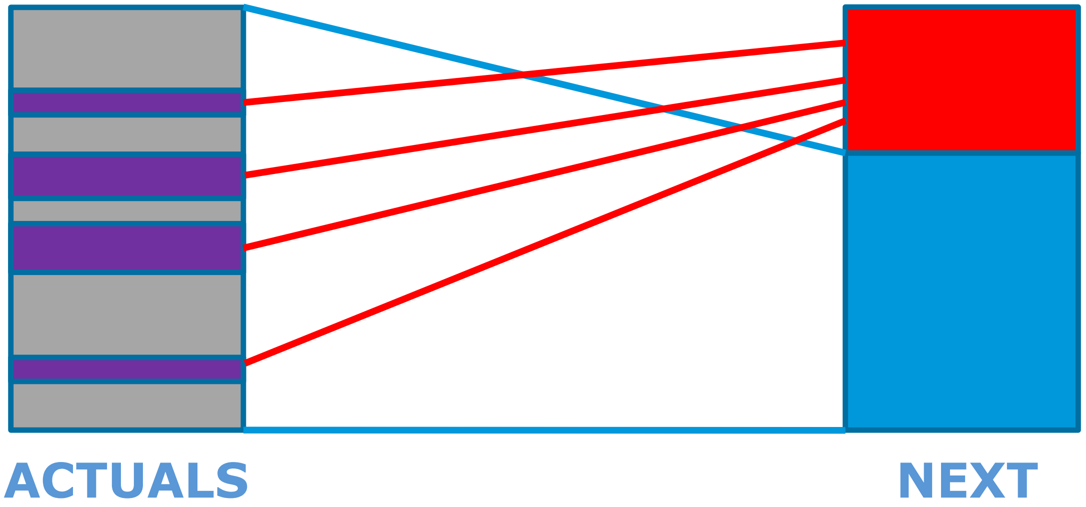
- Launch price increases
- Mission and Science Operations cost increases
- Agency project team cost increases (due to schedule stretch and/or the need for a larger project team)
- Unknown Industrial risks (Class-A Contract Change Notices, funding issues complicating the project organisation and schedule, etc.).

For this part recommend ≥ 15% on total Industrial Phase B2/C/D/E1 cost including Industrial risk margin + ESA internal project cost

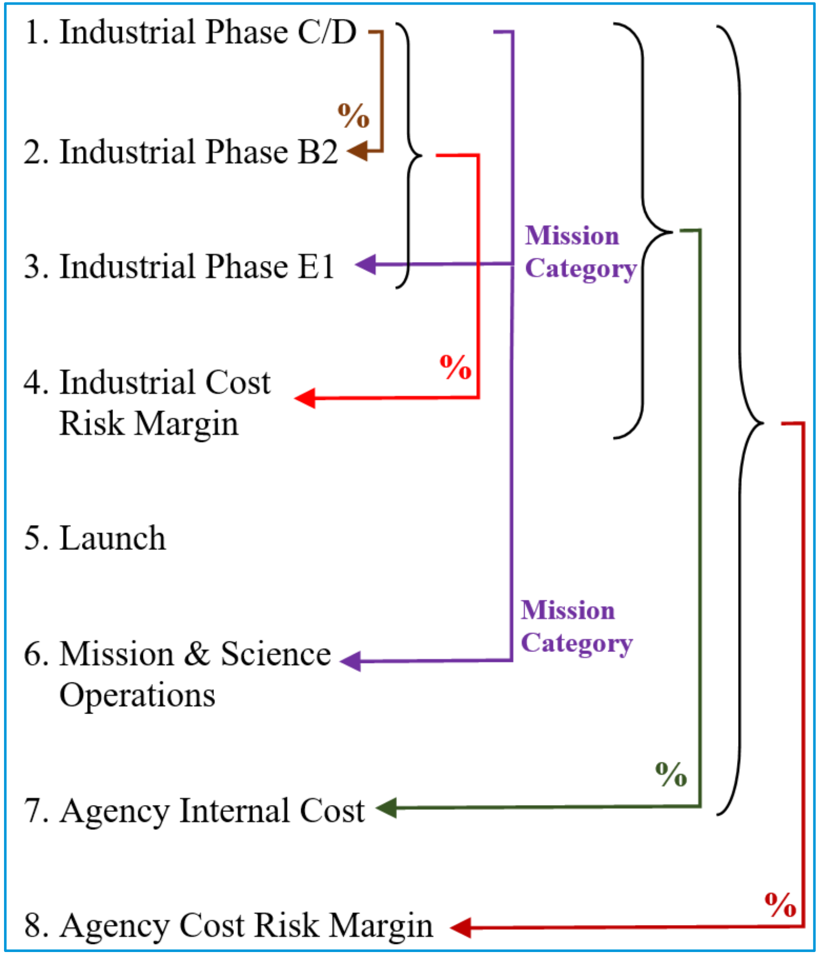
Incremental Cost / Schedule drift due to blind calibrations



Calibration requires risk occurrence analysis



Estimate logic schematic



Conclusions

- **Principles presented here allow early cost estimates in relatively little time based on little input.**
- **The estimates can be improved and further detailed as the conceptual definition progresses.**
- **The method has been implemented in various ESA Science and Earth Observation “calls for ideas”, with satisfactory results.**