Cost & Benefit Analysis of Space Debris Mitigation Measures

Manuel Metz (DLR – German Aerospace Centre)

Acknowledgements: **S. Flegel, C. Wiedemann (Technische Universität Braunschweig),** Detlef Alwes (DLR)

Cost & Benefit Analysis

Cost-Model

- Simplified Satellite Model
- Mitigation measures (Passivation)

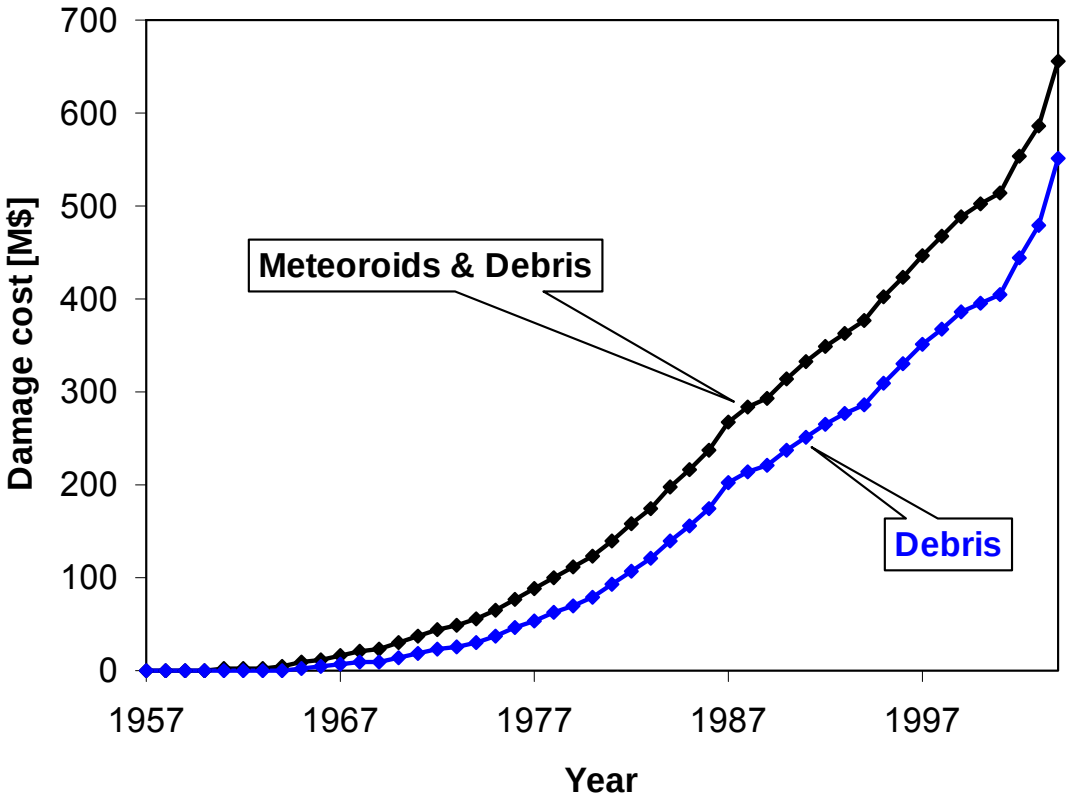
- Conservative damage cost model

Modelling of Future SD Population

- Long-term Orbit Propagation
- Launch Scenario
- End-of-life Manoeuvre
- Explosions & Collisions

Damage-Cost-Model

applied to years 1957-2004



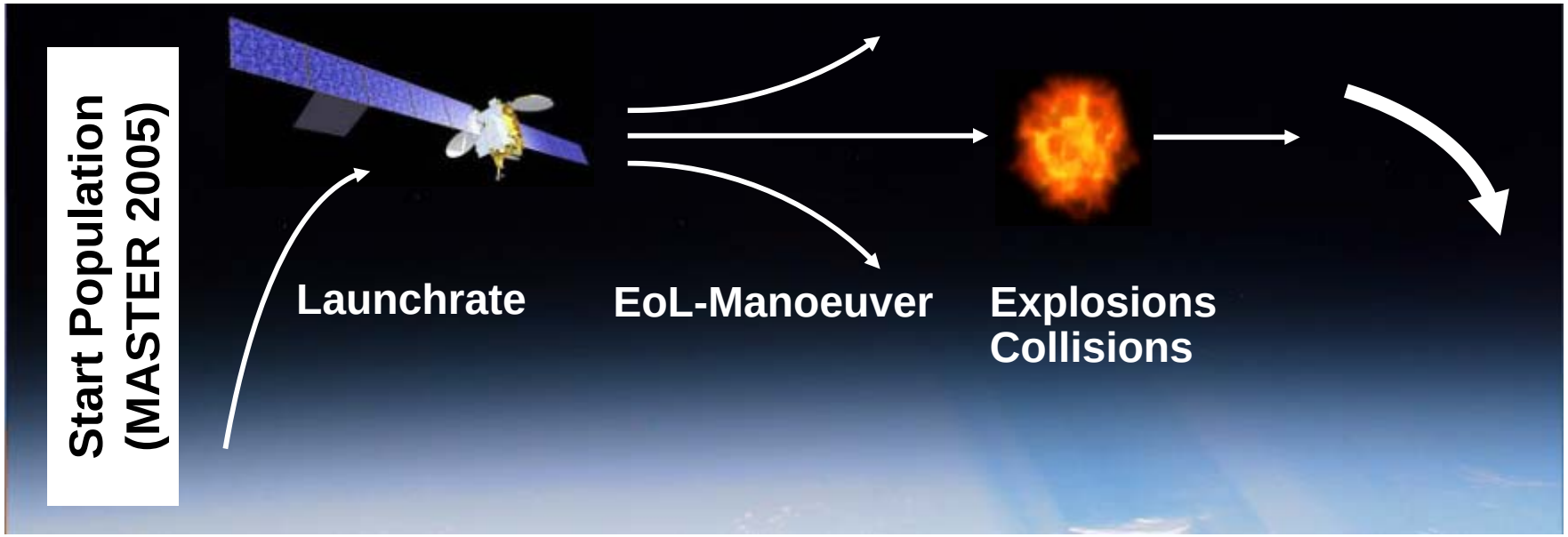
Damage cost 1957-2004

Total: 650 M$
↔ cost of 5 satellites

SD : **550 M$**

Damage costs are based on *conservative* model.

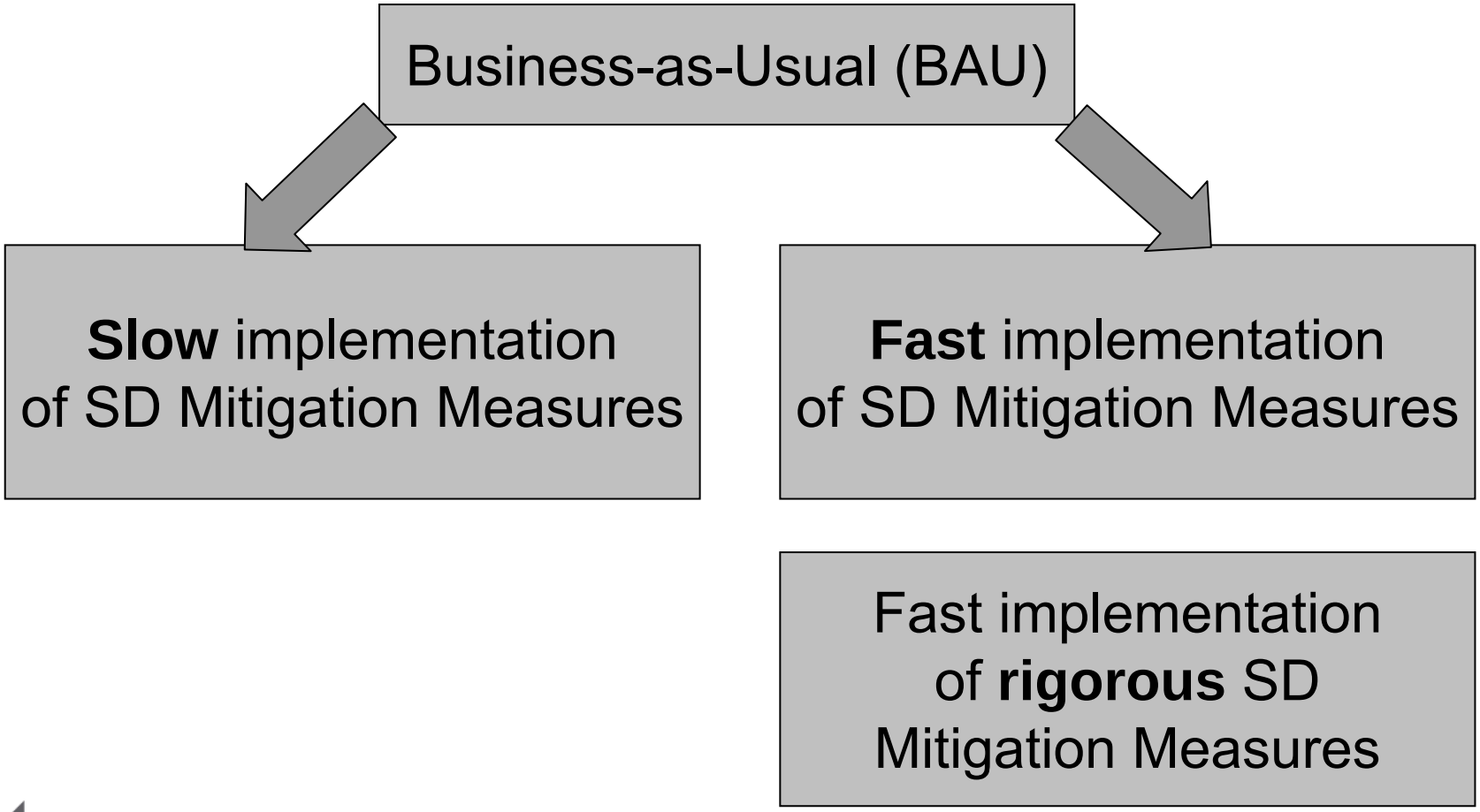
LUCA – Long Term Utility for Collision Analysis



For the C&B analysis: trend analysis of parameters applied to future scenario.

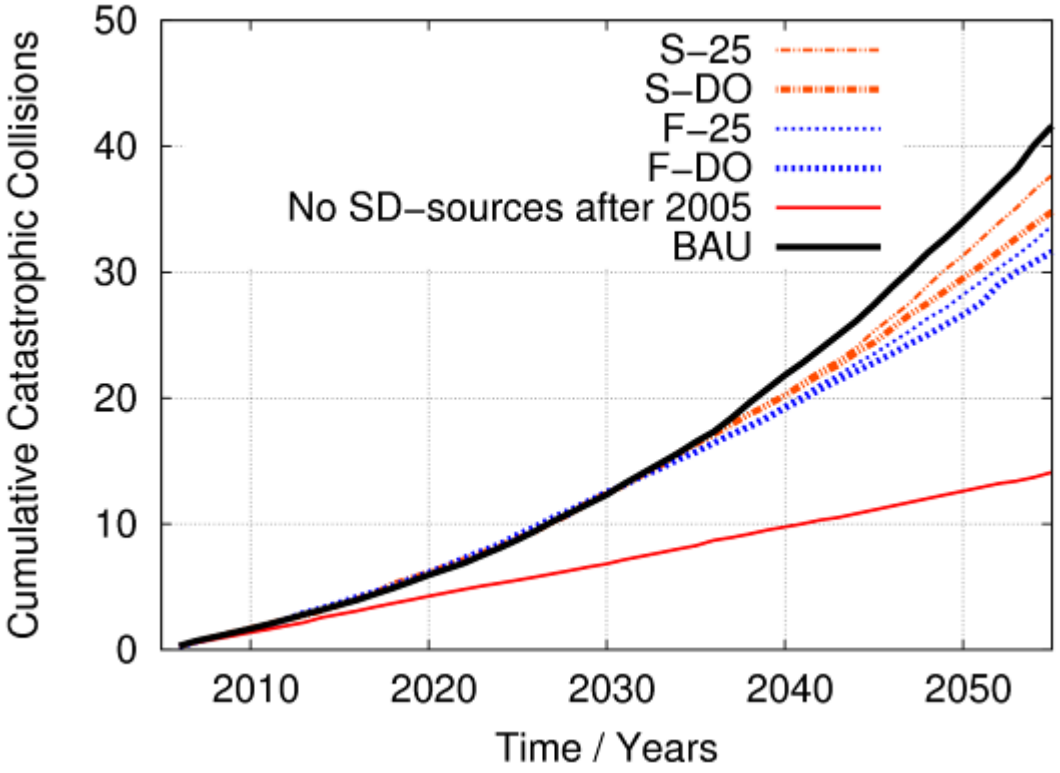
Cost & Benefit Analysis

Definition of future Scenarios



Catastrophic Collisions

- Greatest influence on collision rate:
  - Explosions rate
  - EOL-Manoever
- 90 % of explosions occur **after** EOL
- EOL de-orbiting reduces number of on-orbit objects ***AND*** explosion rate



Legend:

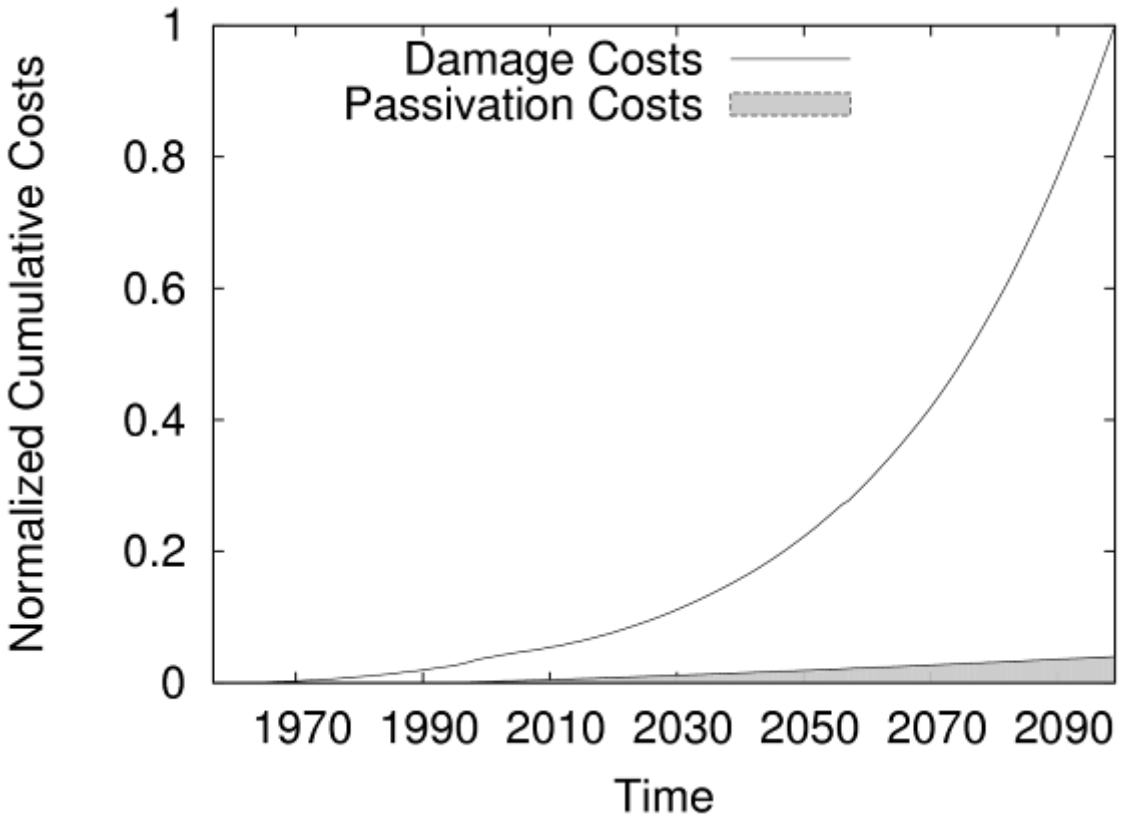
S-25: slow implementation of 25years rule;
S-DO: slow implementation of direct de-orbiting;
F-25 : fast implementation of 25-years rule
F-DO: fast implementation of direct de-orbiting
BAU: business-as-usual

Costs of Business-as-Usual Scenario

- Damage Costs based on loss of amortisation through satellite failure
- Passivation Costs

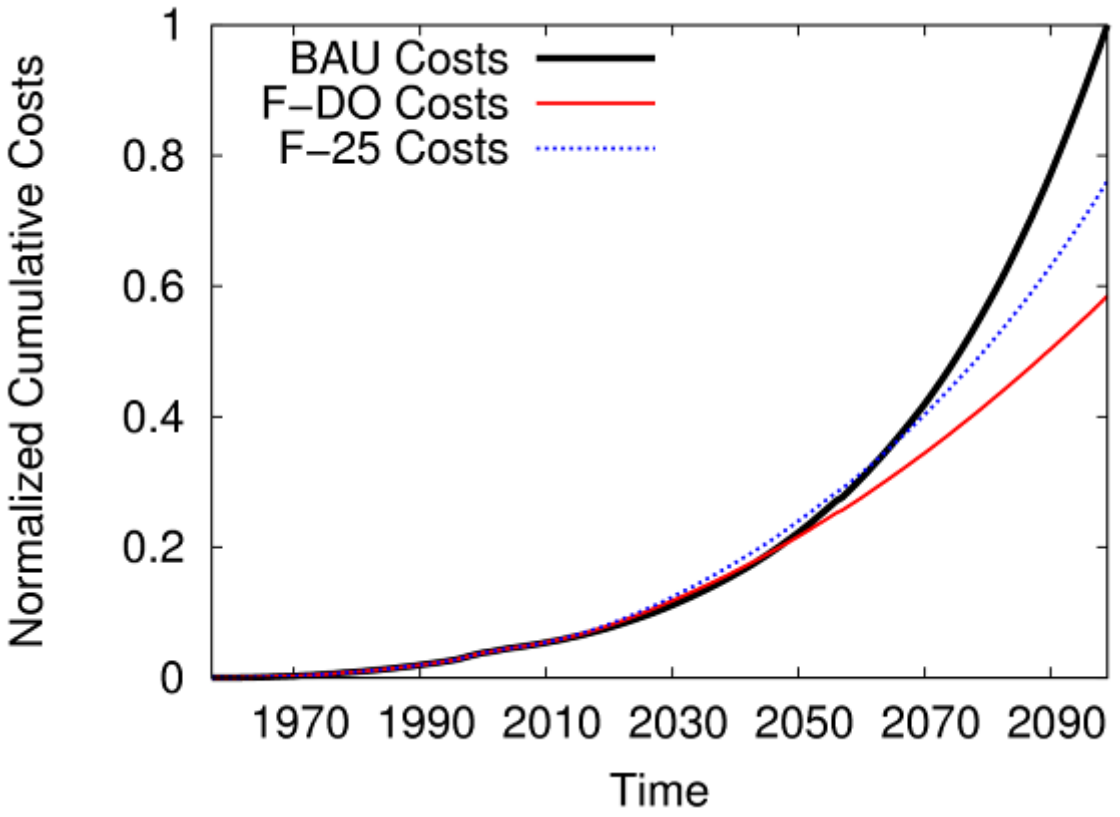
  1991 – 2005:
  Linear increase from 0 to 30 %

  After 2005:
  constant passivation of 30 %



Cost & Benefit Analysis

- Fast introduction of 25-year orbit after EOL: break-even point **after 2060**
- Fast introduction of immediate de-orbit after EOL: break-even point **before 2050**



Summary

- Simplified cost models were developed for: Satellite Costs, Mitigation Measures and Damage Costs

- Catastrophic collision risk after 2005
  - BAU-Scenario shows ca. 40 catastrophic collisions up to 2055
  - Largest influence:
    rate of explosions and
    number of on-orbit satellites and rocket bodies
  - EOL-Manoeuvres have positive effect on *both* influences

- Slow introduction of mitigation measures leads to break-even point beyond 2060 with little long-term cost benefit
- Fast, rigorous introduction of mitigation measures can lead to break-even point before 2050 with significant long-term cost benefit

Thank you for your attention !