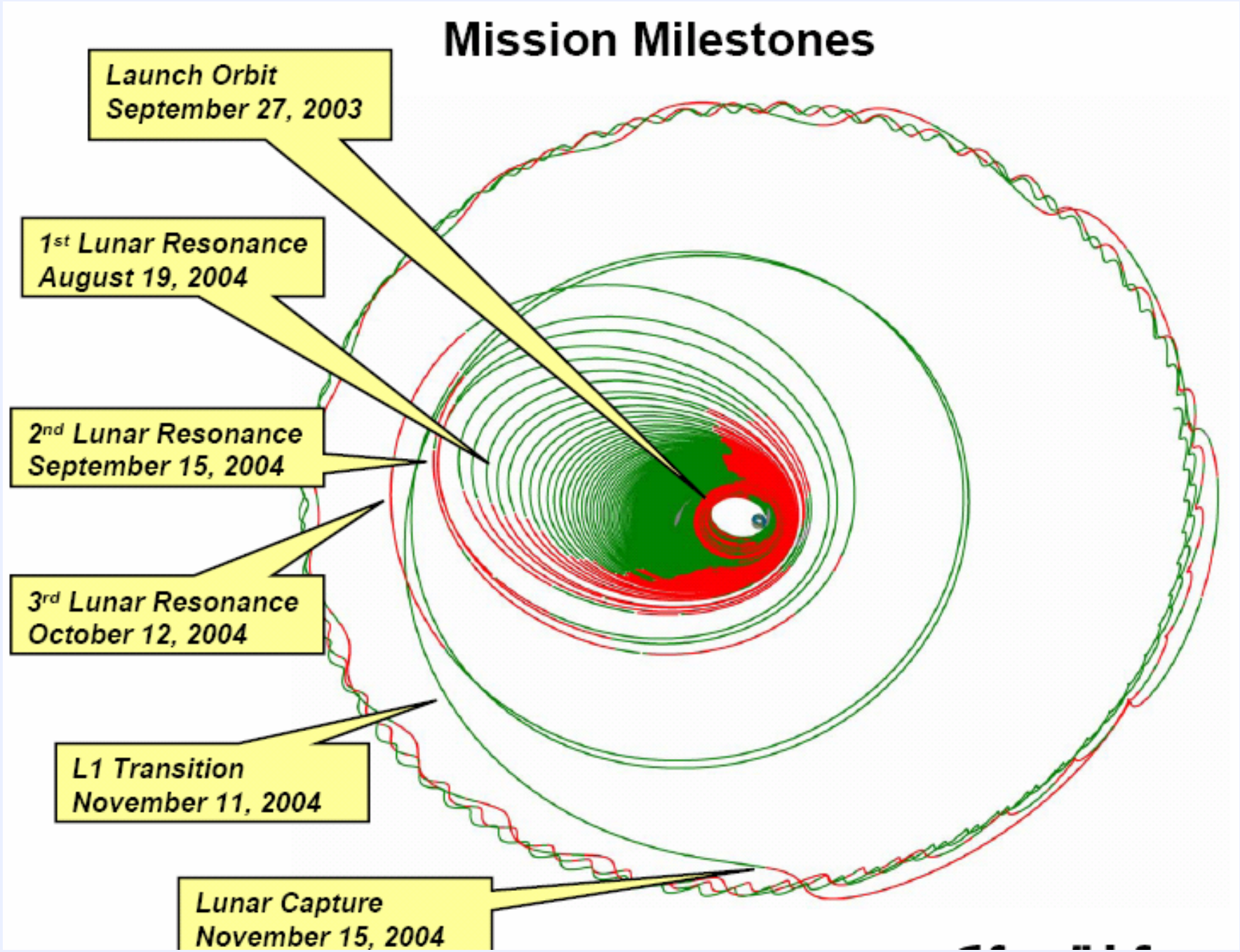
Summary

- Introduction
  - Motivating examples
- Models
  - Hybrid automata
  - Solutions
- Control
  - Stability
  - Stabilization
- Verification
  - Transition systems
  - Reachability
- **Summary**
  - **Outlook, references**

Another Motivating Example

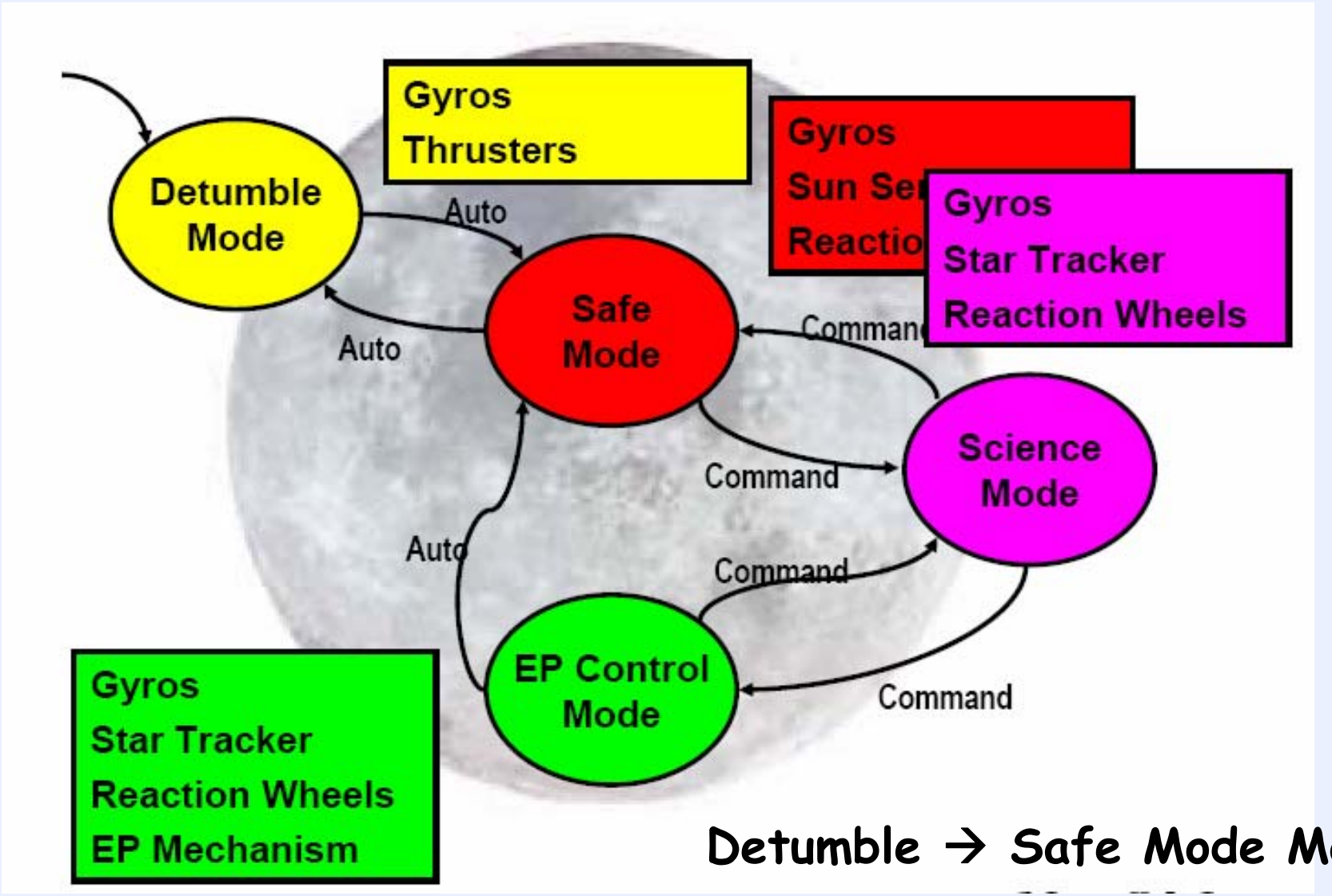
- **Orbit movie**
- **Moon capture movie**

Bodin, Swedish Space Agency, 2005



Bodin, Swedish Space Agency, 2005

Hybrid Controller



Detumble → Safe Mode Movie

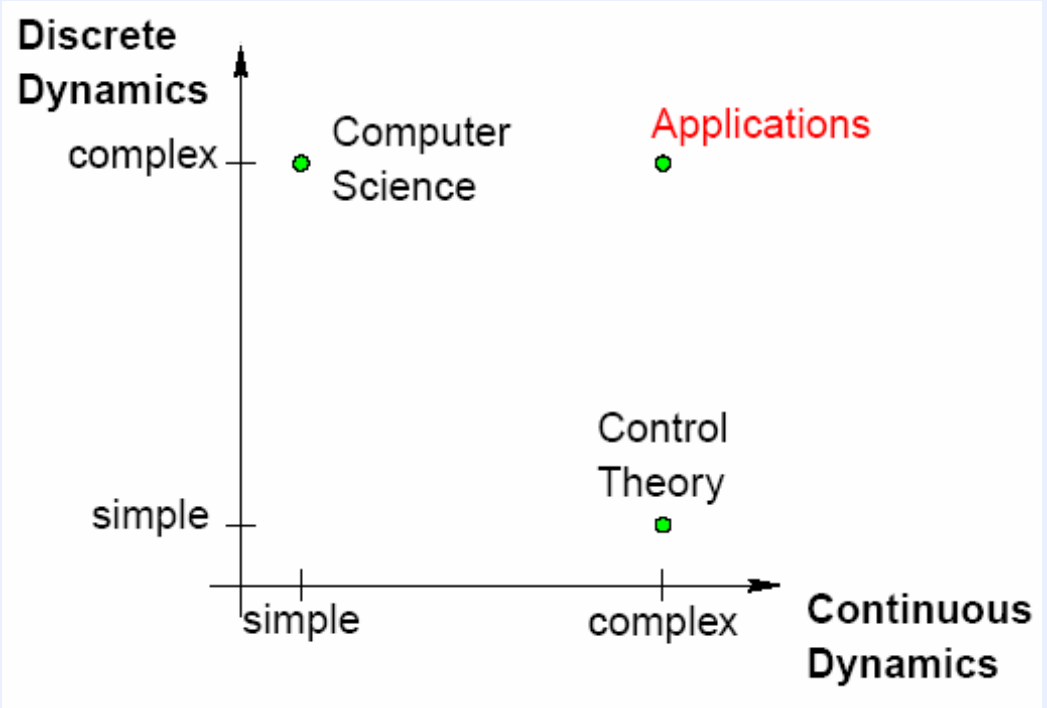
Why are Hybrid Systems Useful?

- Embedded computer systems are hybrid
  - Real-time software interacting with physical environment
- Abstractions in design lead to hybrid dynamics
  - Time-scale separation, hierarchical modeling
- Control strategies are hybrid
  - On-off, optimal control, control constraints, operation modes
- Improved performance
  - Brockett integrator, supervisory control, variable structure systems
- Nature is hybrid
  - Relays, impact mechanics, state constraints

A New Systems Science

- Driving need to guarantee safety in the design phase of complex distributed computer-controlled system
- Hybrid systems enable implementation-aware analysis and design of embedded control systems

- Hybrid systems integrate mathematical tools from computer science and control theory



What was not covered (so far)

- Related models classes, e.g., Petri net, stochastic hybrid systems
- System identification and computer-aided modeling
- Estimation and observers
- Optimal control
- Computational tools for simulation and verification
- Implementation

- Automotive (and many other) applications

- And much more…

Some References

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