

J³

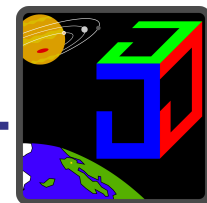
CubeSats as a Platform for In-Orbit Verification of Scientific Instruments for Interplanetary Missions

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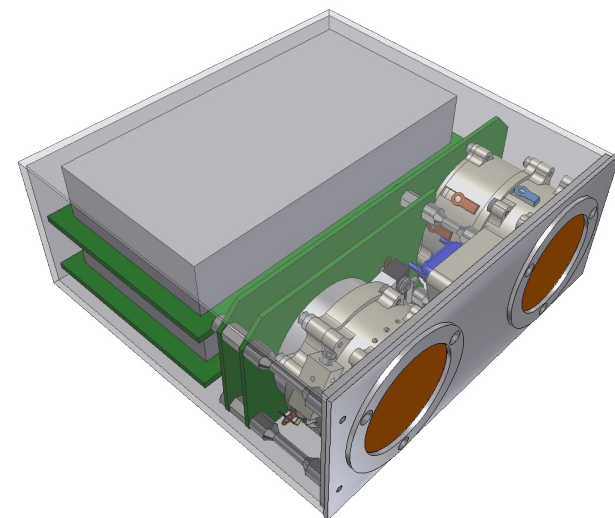


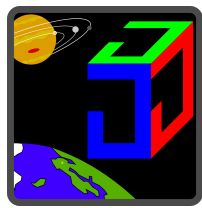
CubeSats as a Test Platform

- Development in the recent years:
 - Availability of COTS CubeSat components
 - Experience with CubeSat development & operations increases
- Result:
 - Entry barrier continues to being lowered
 - Rapid development of CubeSat missions become feasible

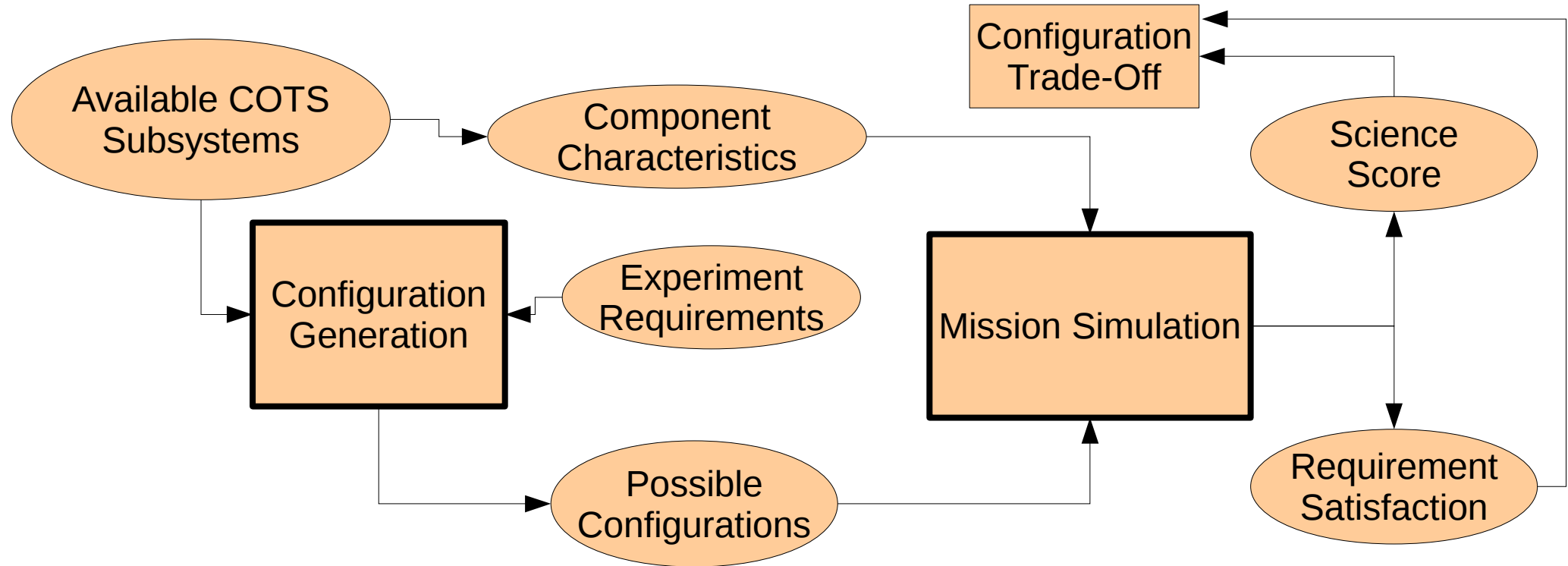
J³ Mission

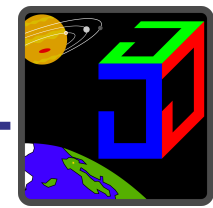
- Goal:
 - Test of components for instruments for the JUICE mission to Jupiter
- Design requirements:
 - Formfactor: 1U CubeSat, ½U Payload
 - Limit launch costs
 - COTS Components
 - 3x-10x cost reduction compared to RAD-hard components
 - Reduce development time
 - Reduce design inherent risk





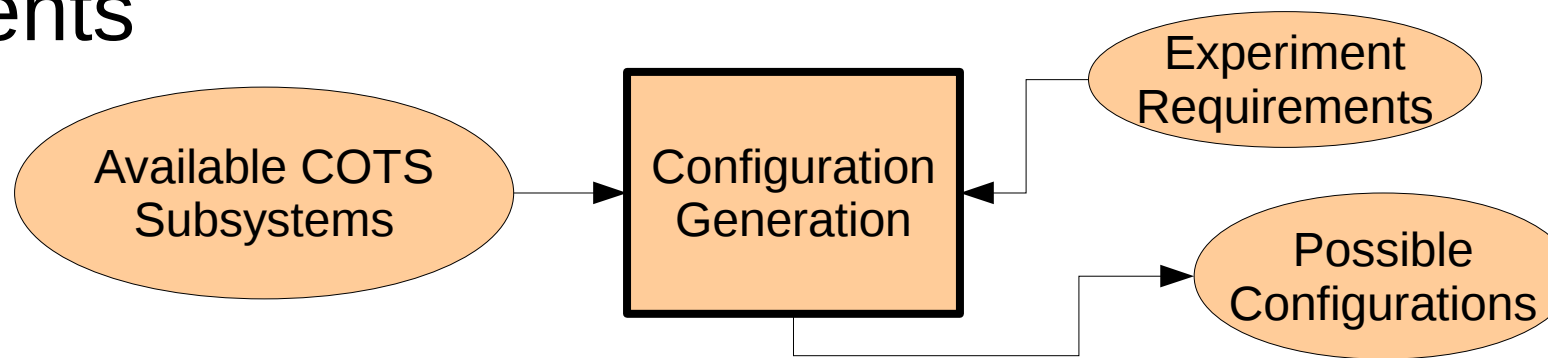
Development Workflow

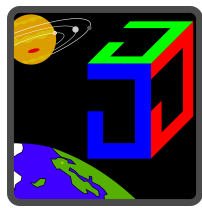




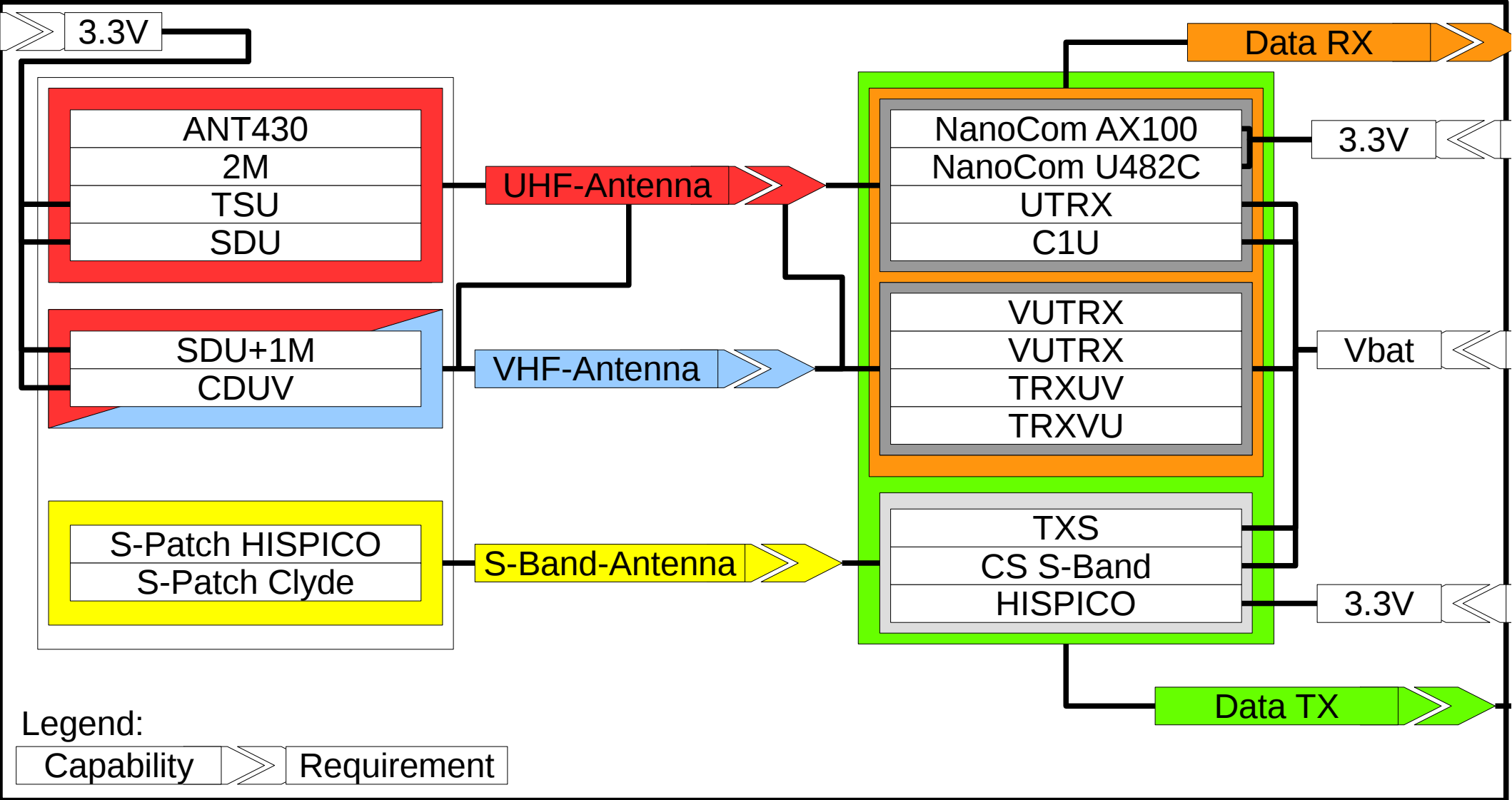
Configuration Generation

- Search sets of components which fulfill payload requirements
- Match requirements and capabilities of selected components
- Output configurations which have no open requirements



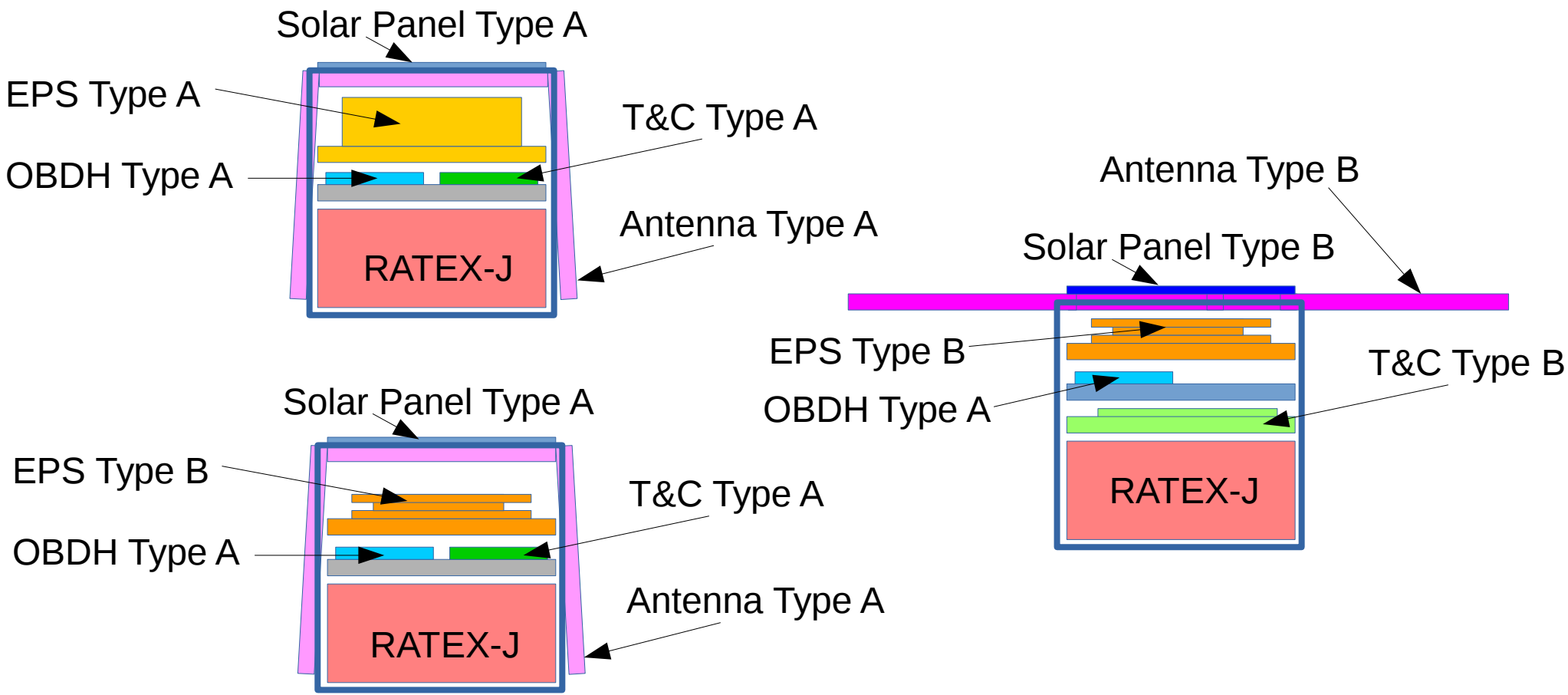


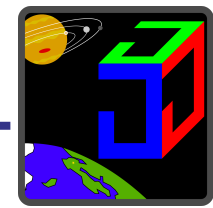
Requirements/Capabilities Visual Example





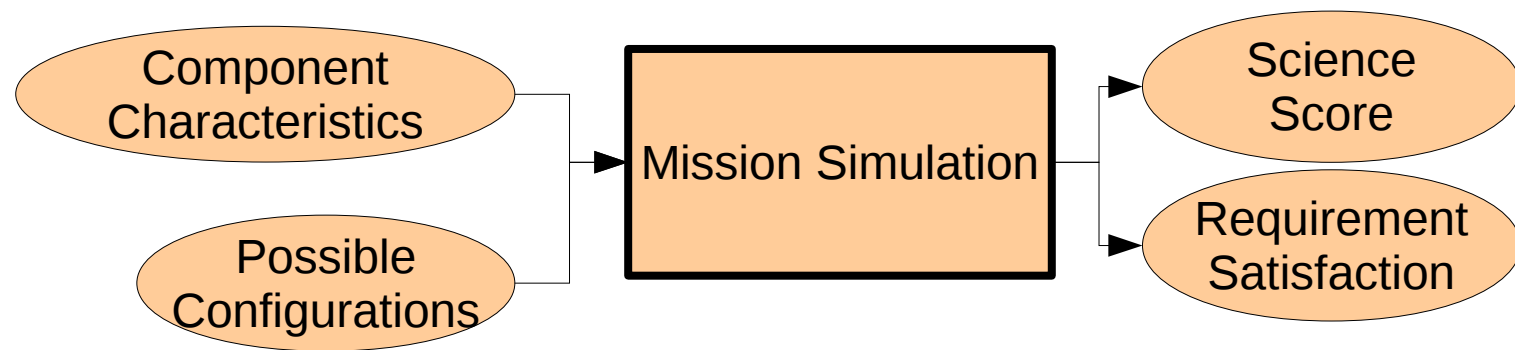
Examples for Different J³ Configurations





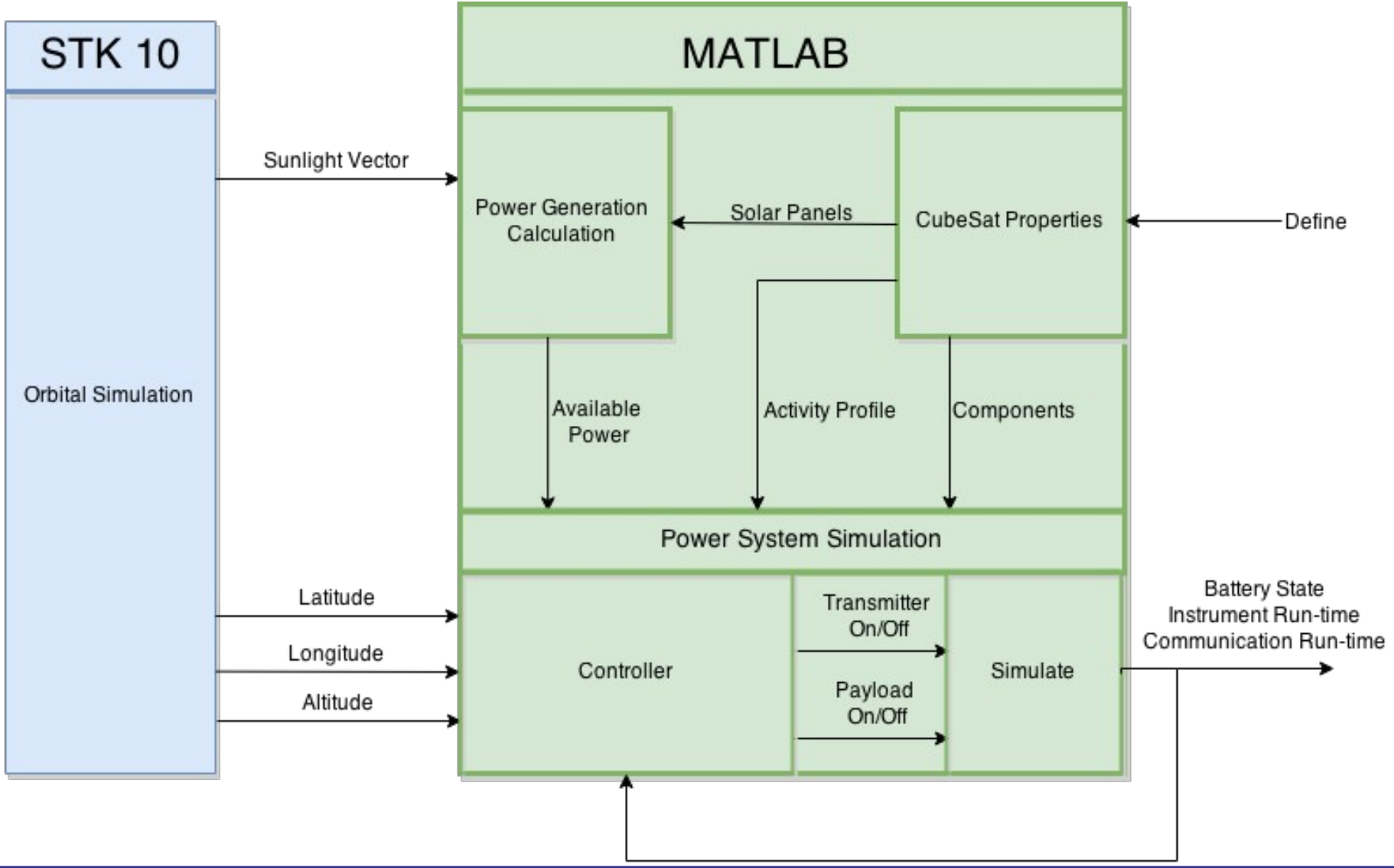
Mission Simulation

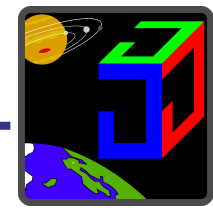
- Simulate complete mission for generated solutions
- Reduce complex trade-off criteria into scientific output score
- First verification of some design requirements





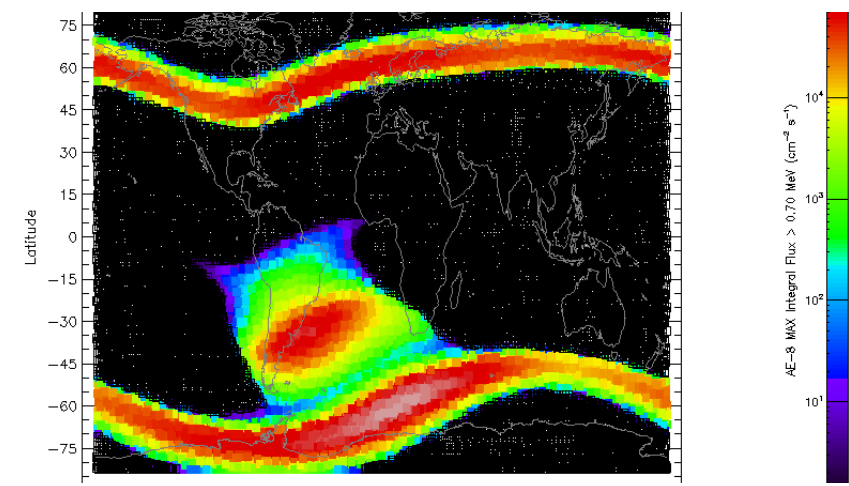
Mission Simulation

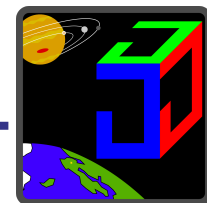




Mission Simulation Science Score

- Score the spacecraft based on the science output generated
- Score based on the mission description
 - e.g. J³: Simulated amounts of electron counts

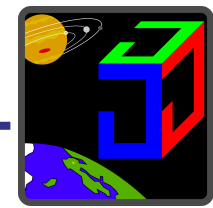




Mission Simulation

Energy Budget

- Simulate the performance of the electrical power system
 - Energy collection by solar panels
 - Battery charge controller efficiency
 - Power rail converter efficiency
 - Based on simulated load of the subsystems
- Verify depth-of-discharge limits can be obeyed

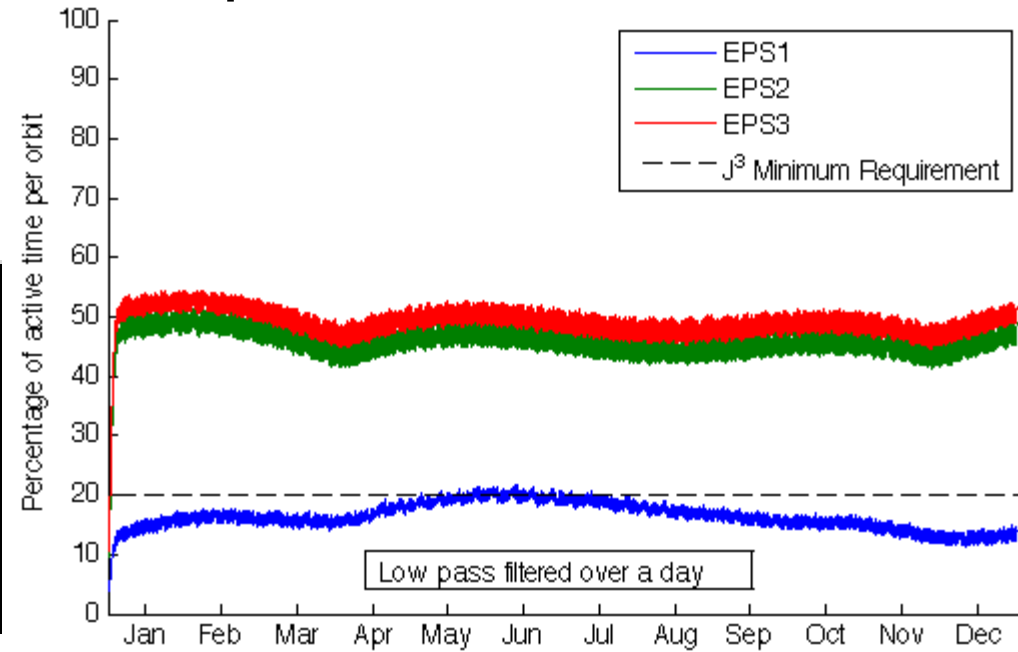


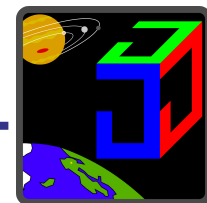
Mission Simulation

Energy Budget

- J³:
 - Different converter load/efficiency curve have significant impact on available power

	Instrument Off			Instrument On		
	3.3	5	12	3.3	5	12
EPS1	56	-	-	75	41	76
EPS2	93	-	-	93	94	80
EPS3	91	-	-	93	62	87





Mission Simulation

Communication & Data Handling

- Simulate storage of generated data
 - Test if satellite does not run out of memory
- Simulate ground contact windows and link budget
 - Estimate bit error rates

Mission Simulation

Communication & Data Handling

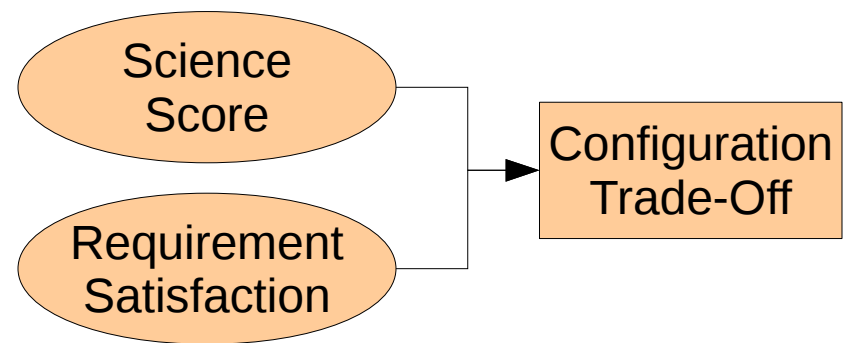
- J³:
 - No need for a high speed data link (>9.6kbps) has been identified
 - Ground contact almost every orbit (>75%), at most after 5 orbits
 - Ground station based at high latitudes
 - Relatively low data generation
 - ~32 kByte/orbit

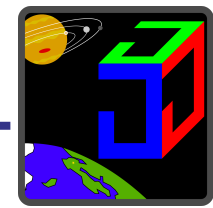




Trade-Off

- Trade-Off criteria have been reduced by determining the influence on the science output
- Few manual trade-off classifications remain:
 - e.g. development effort
(software, customization of hardware)





Conclusion

- 1U CubeSat mission feasible for complex test article
- Tools for future missions have been developed to speed up the process further
- Future work:
 - More extensive component requirement/capability description to reduce manual filtering

