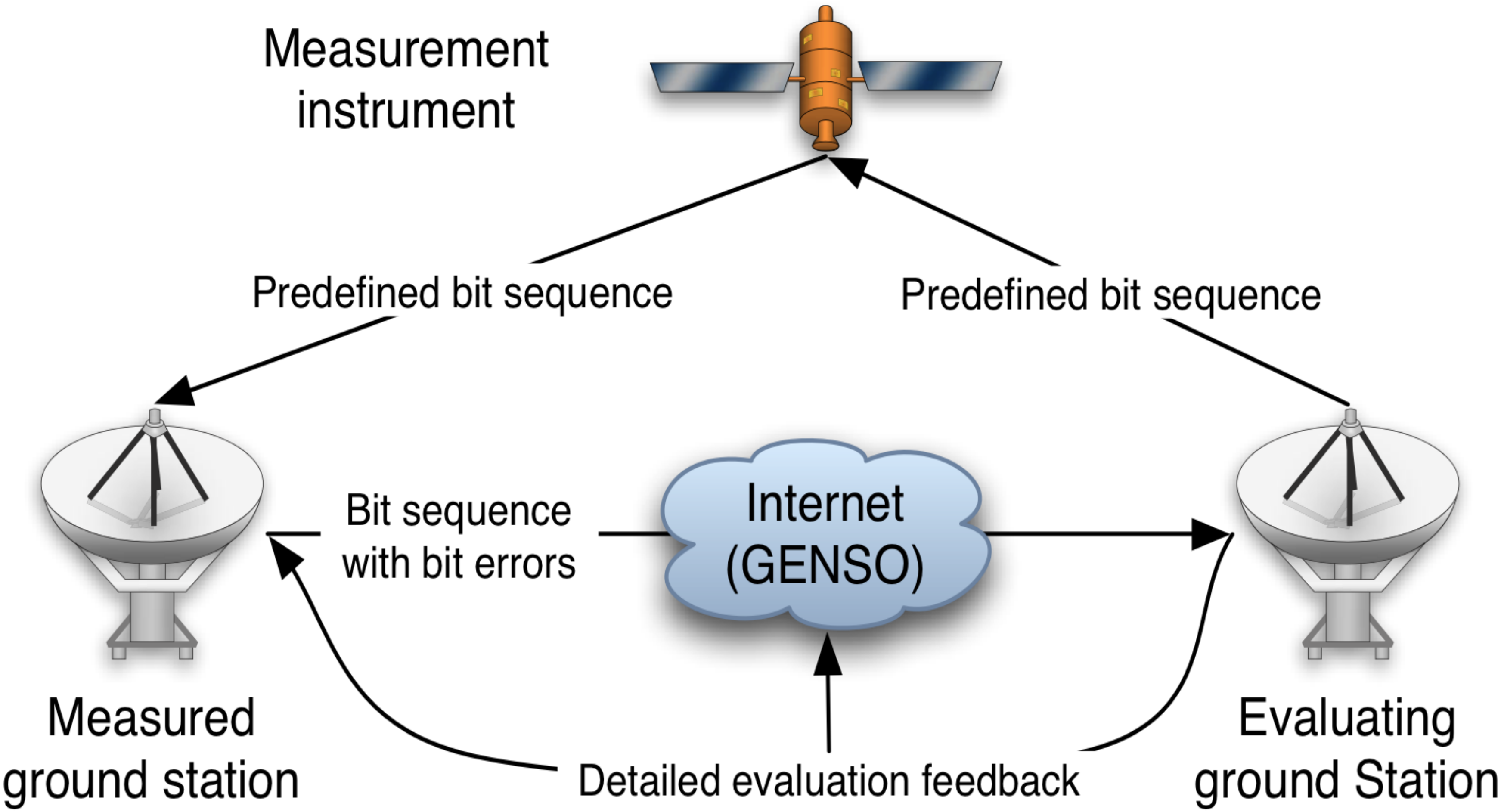
GT-Sat
a double CubeSat for testing the link quality between the satellite and the GENSO ground stations

QB50 using GENSO

- A lot of cubesat-radios produced by **students**
- A lot of ground-stations produced by **students** and **radio amateurs** (HAMs)

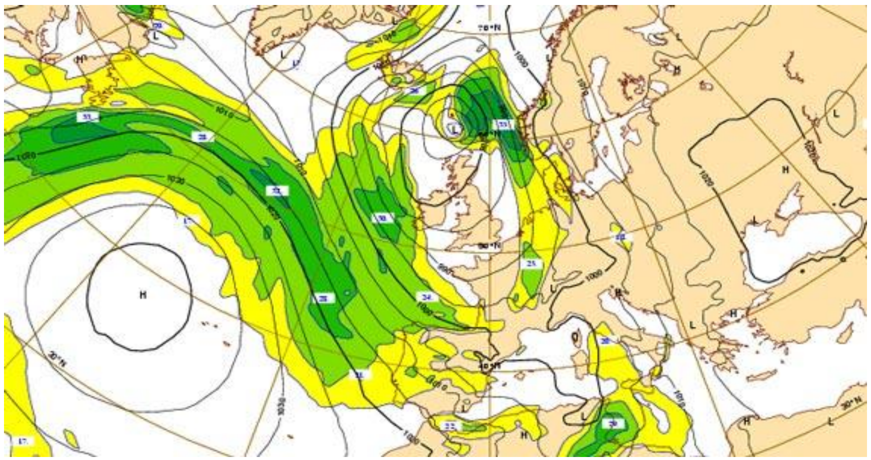
- More or less unpredictable link quality
- Link-scheduling policy should be optimal due to short lifetime of the satellites / project

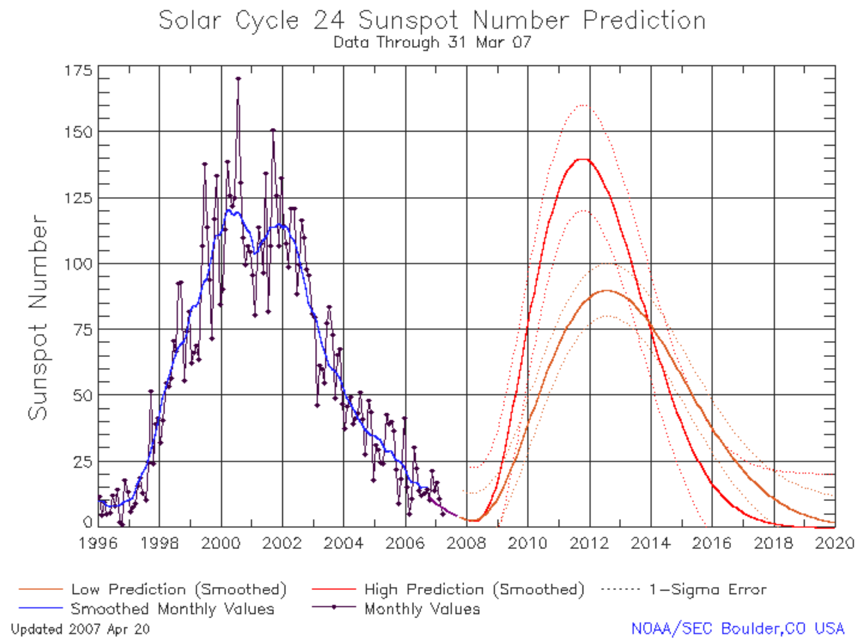
How GT-Sat works

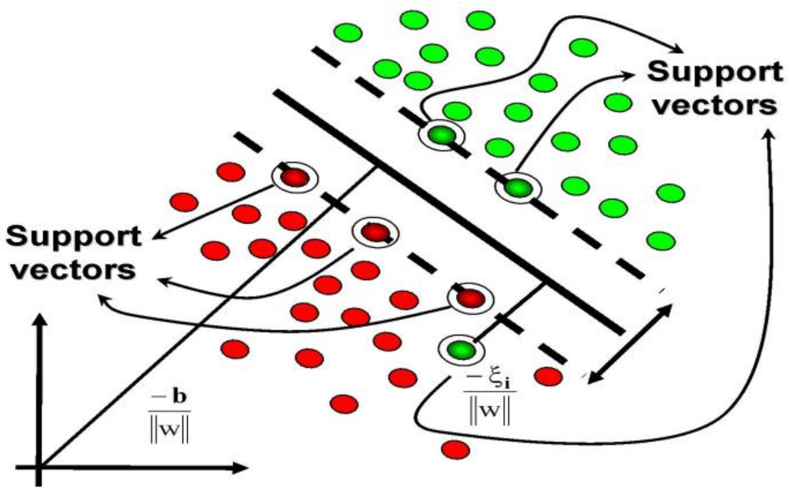


Establishment of a Link Quality Reference

Precise Link Quality Prediction Model



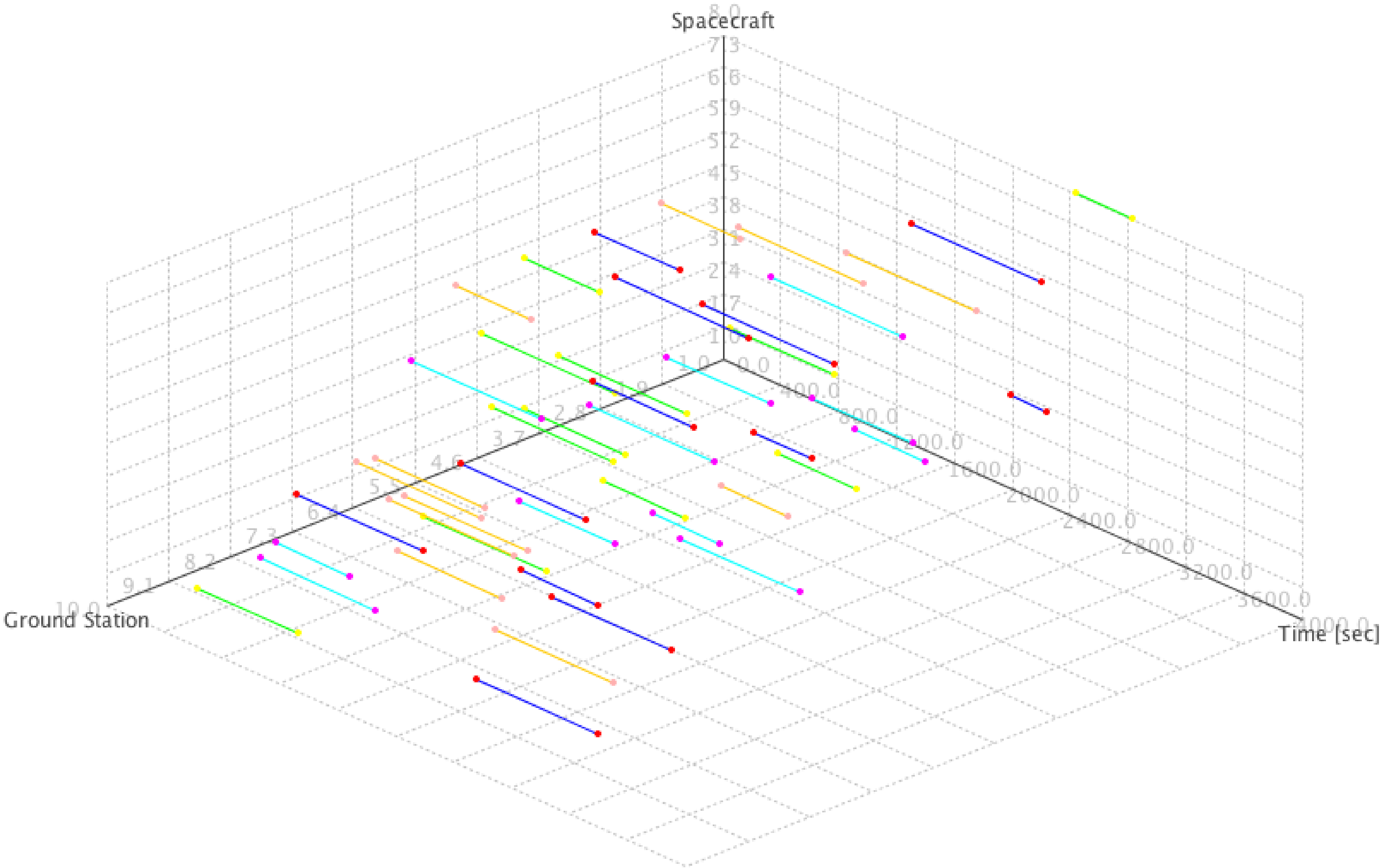




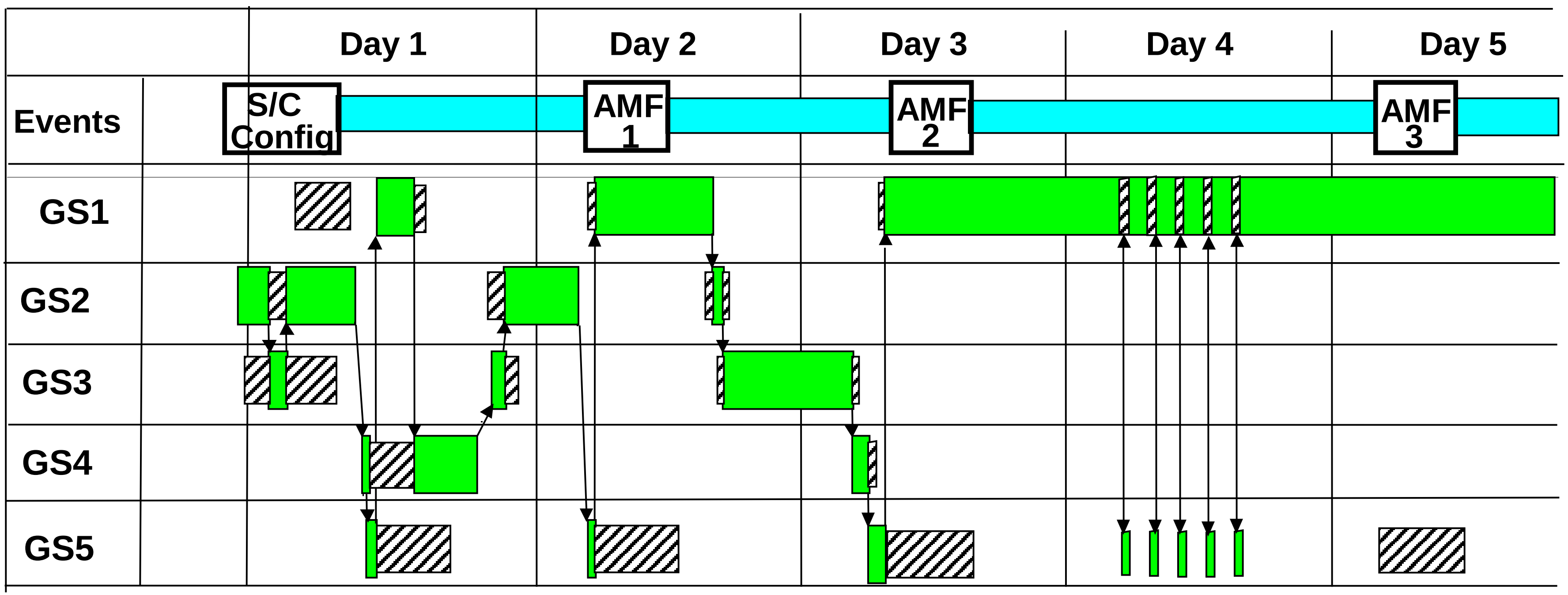
Issues

- Ground station network characteristics were widely unknown
- Network load predictions and calculations were never performed
- The network‘s behavior when growing in size and the amount of supported missions has never really been investigated
- No solutions for <u>centralized</u> orchestration of satellite links („satellite range scheduling“) within large-scale ground station networks were available (essential for constellations like QB50)
- No other parameters than pass lengths have been taken into account for local scheduling
- Consequence: A <u>framework</u> addressing this issues has been developed

3-Dimensional Scheduling Problem: SC, GS, Time



Optimization of Network Utilization and Link Scheduling



Implemented and Evaluated Algorithms

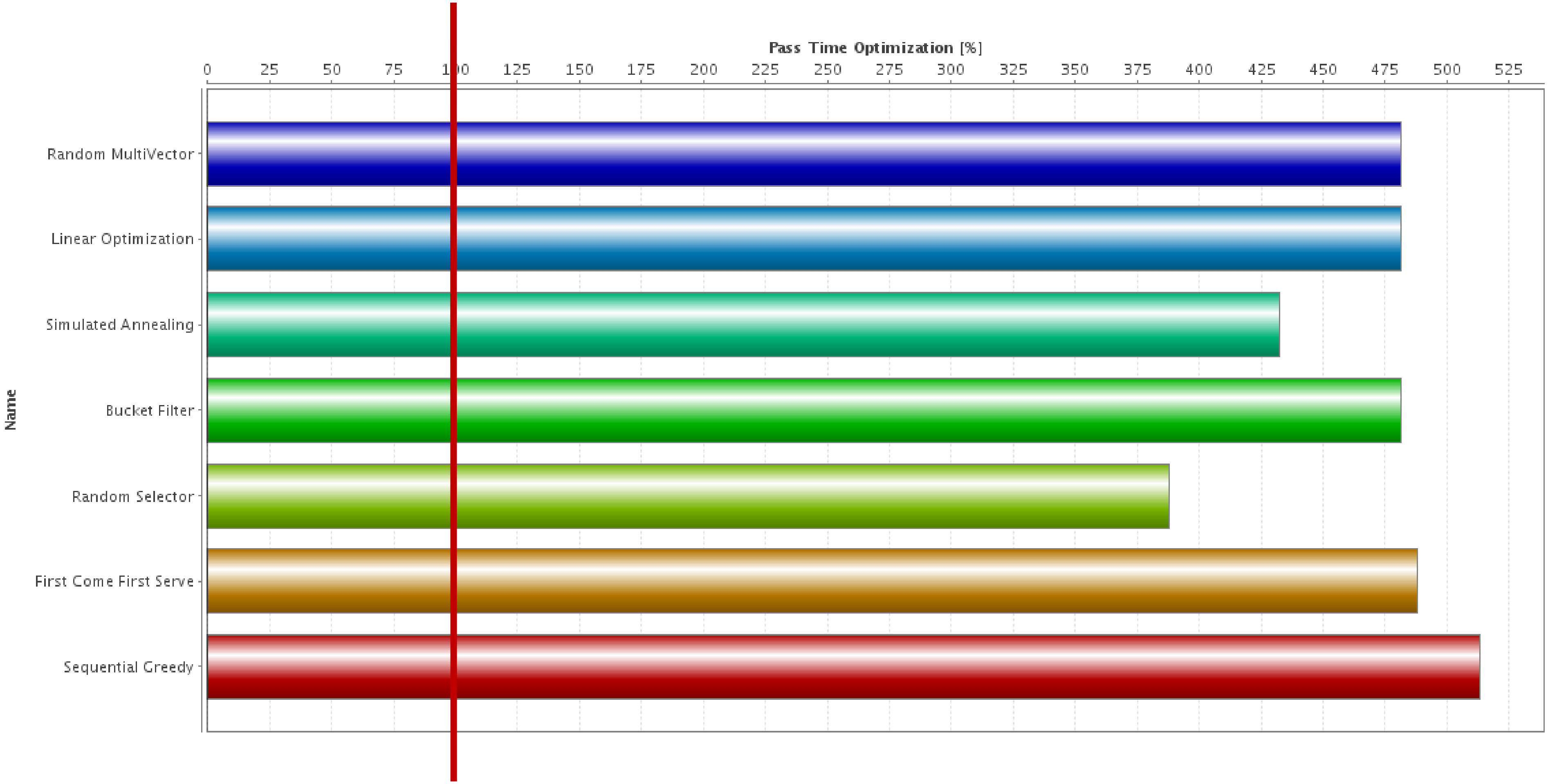
- Common First-Come-First-Serve (easy, DK- Aalborg)
- Random Selector (worst case)
- Bucket Filter (simple and effective)
- Sequential Greedy (take the next best and fill in the rest)
- Random Multi-Vector (distributed approach)
- Linear Optimization (theoretical approach)
- Simulated Annealing (optimize from both sides SC / GS)

QB50 Simulation Outcomes

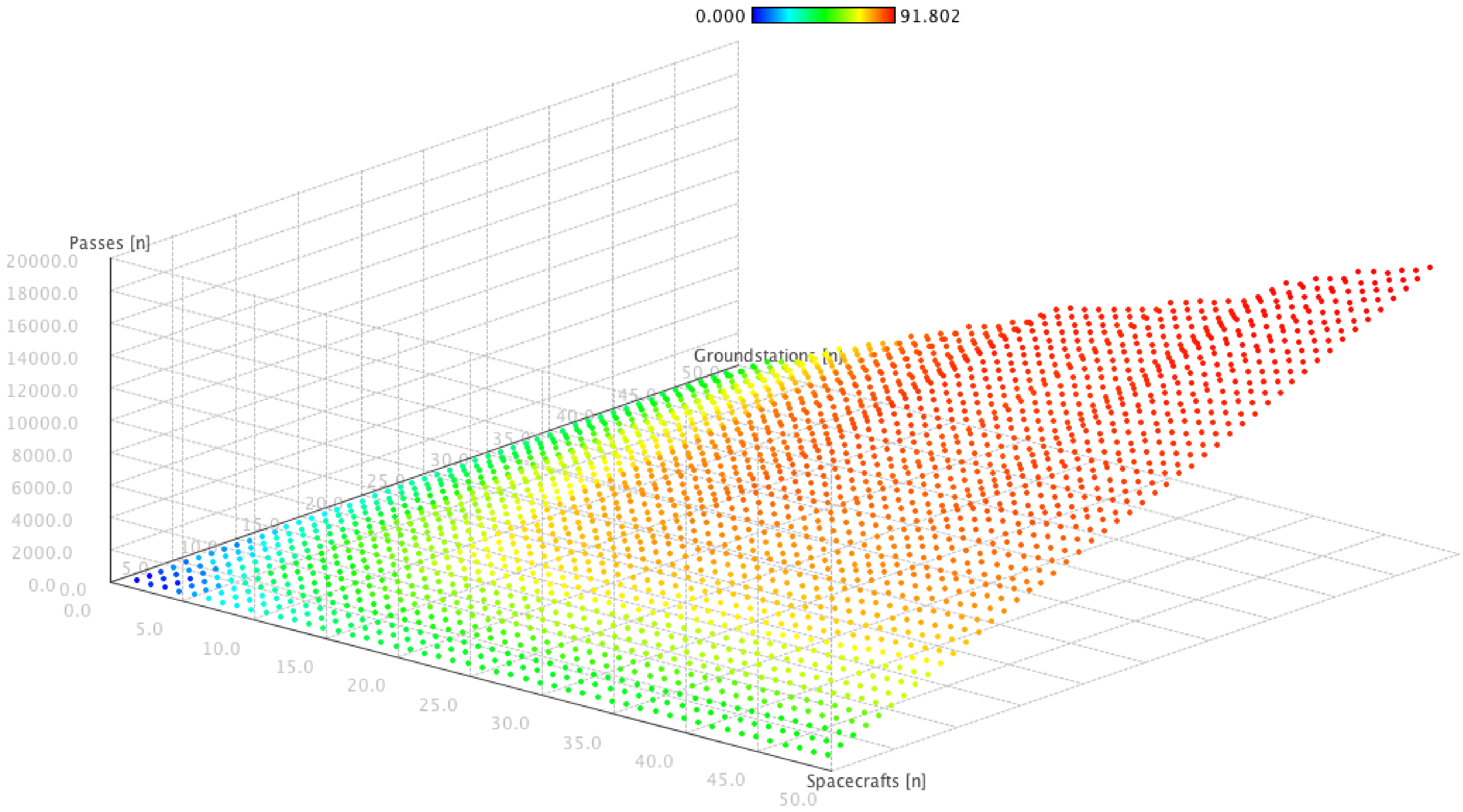
- Scenario: 50 spacecrafts, 300 ground stations
- Average of 6 passes per ground station per spacecraft per day
- Average communication time frame: 30 minutes/day (half the amount of time as for common LEO satellites!)
- Maximum of 65 passes per day per ground station (compare to 80 passes for common LEO satellites)

  Reason: Small communication horizon due to low orbit
- Consequence: Lower mission return on standalone operations compared to higher LEO missions

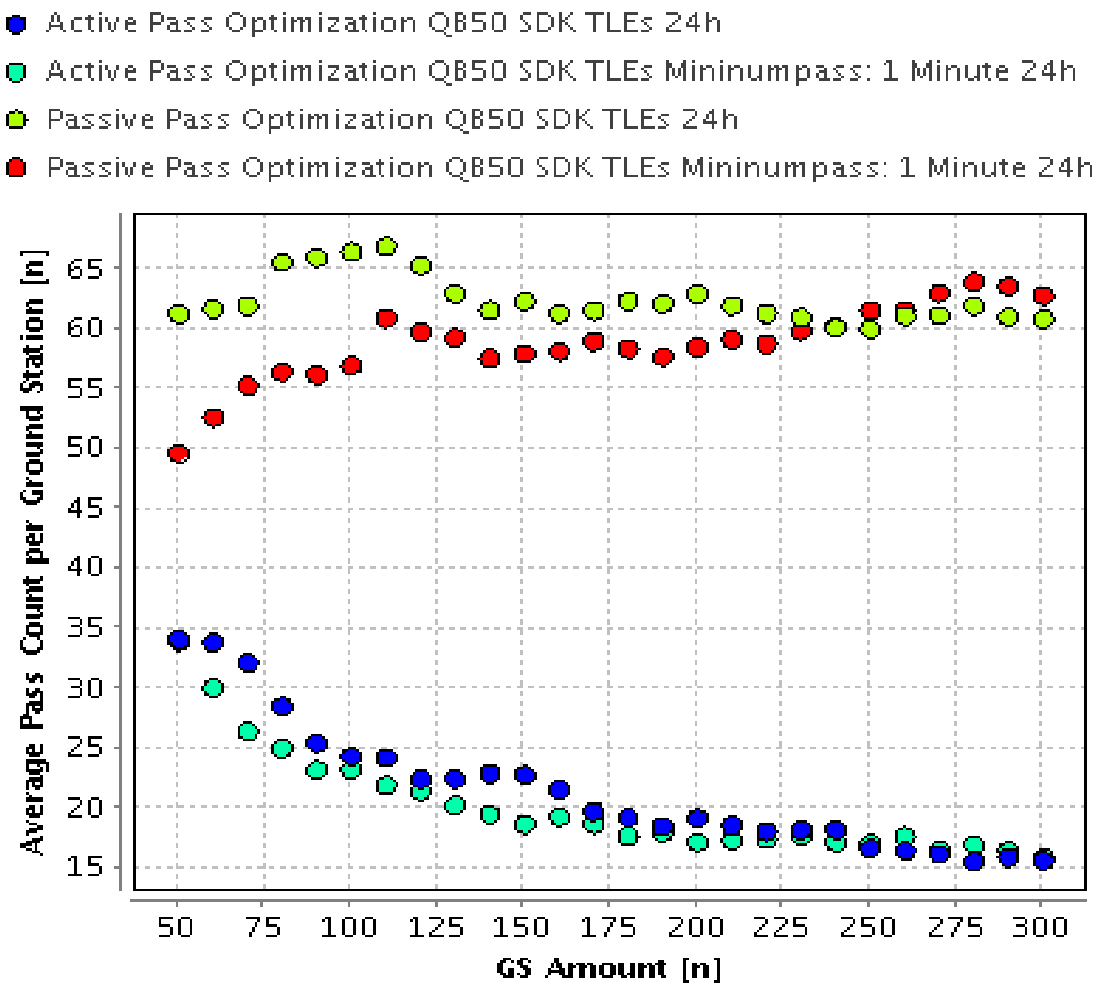
Plot: Scheduler Performance Comparison



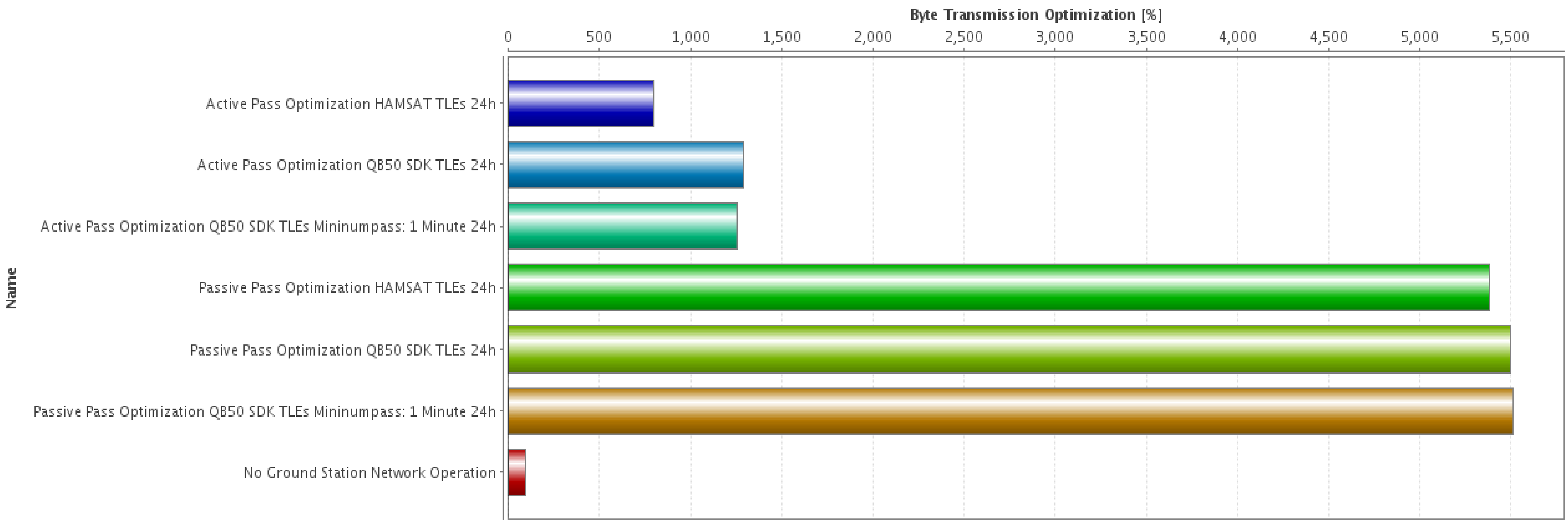
Plot: Pass Conflicts on Network Growth (Active)



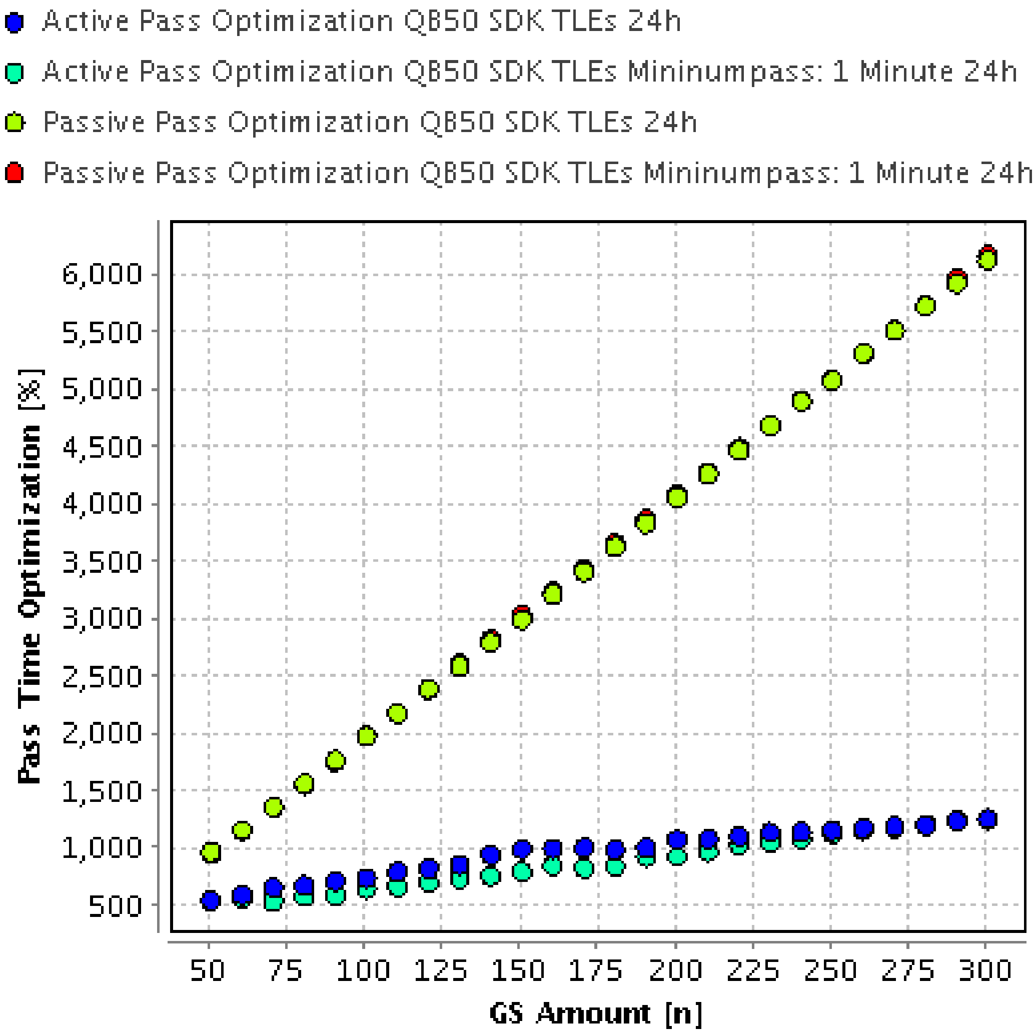
Pass Particularities

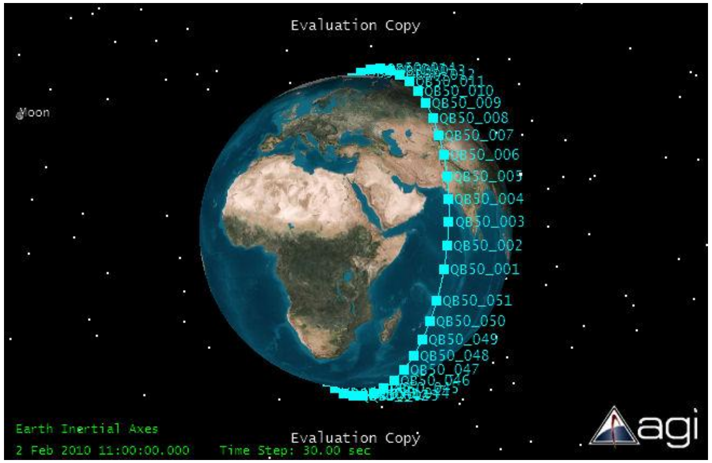


Opimization Potental: Mission Data Return



Plot: QB50 GENSO Simulation





Best / worst case scenario