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Satellite Payload Reconfiguration Optimization

Apostolos Stathakis

UNIVERSITÉ DU LUXEMBOURG

Outline

1. General context
2. Objectives of our research
3. Past and current work
4. Experimental results and future work

A few things about me

- Electrical and Computer Engineering

➢ MEng degree, Faculty of Engineering, Aristotle University of Thessaloniki

- Information and Computer Science

➢ MSc degree, Faculty of Science, Technology and Communication, University of Luxembourg

- Professional Experience

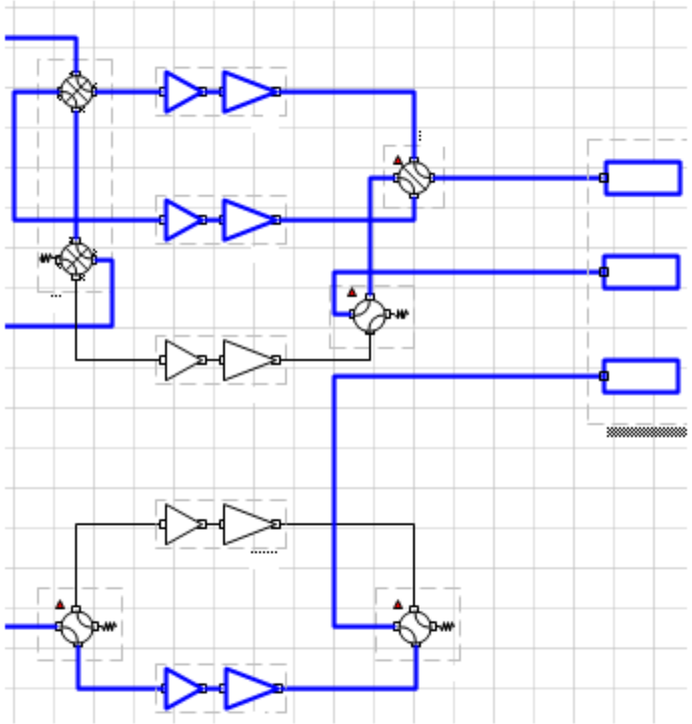
➢ SES Astra, 06/2009 – 09/2009

➢ SES Astra, 02/2010 – 09/2010

Context

- Communication payload is the subsystem on satellite responsible for reception, conversion and retransmission of signals to earth
- Currently flexibility is required on payloads that comes to the expense of higher payload size and complexity.
- Currently, the payload is manually managed by payload engineers but this is getting difficult and time consuming
- Need for finding optimized solutions

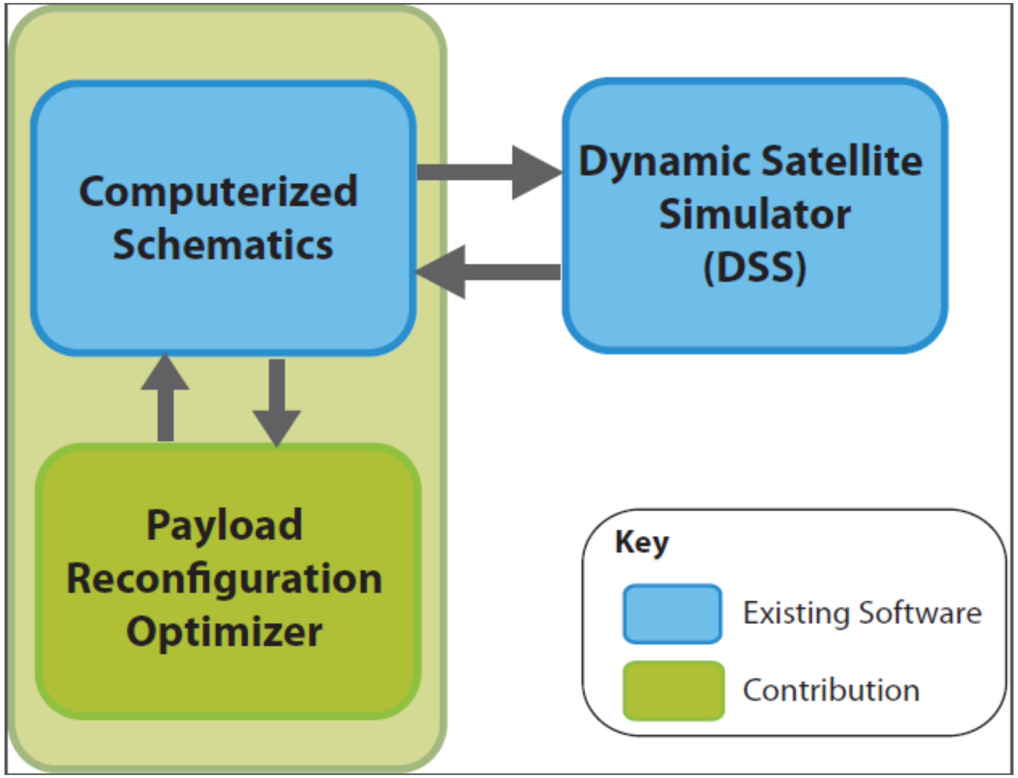
Problem example



Objectives

- Develop a modular mathematical model of communication satellites payload components and connectivity.
- Optimize payload (re)configurations for the whole set of objectives and respecting all the satellite technical constraints.
- Implement a “payload reconfiguration optimizer” library implementing those algorithms and interfacing with SES computational schematics tool.

Objectives



Computerized Schematics

Dynamic Satellite Simulator (DSS)

Payload Reconfiguration Optimizer

Key

🟦 Existing Software

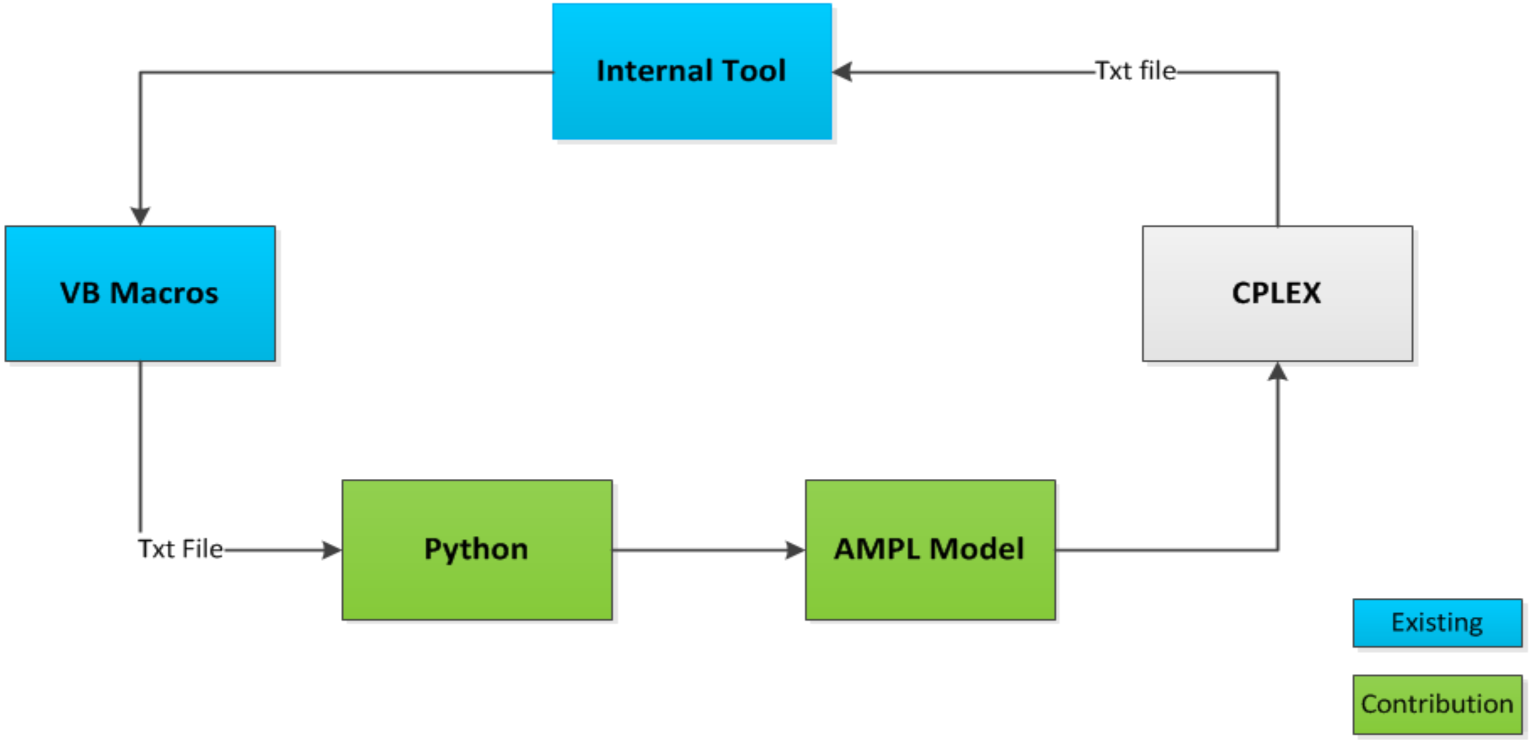
🟩 Contribution

Past and Current Work

Payload problem modeling

- First mathematical linear model (ILP)
- Implementation of the mathematical model in AMPL (A Mathematical Programming Language)
- Testing of the model on CPLEX optimizer software on real and full payload structures
- Validation from SES computerized schematics

Interaction with internal tool



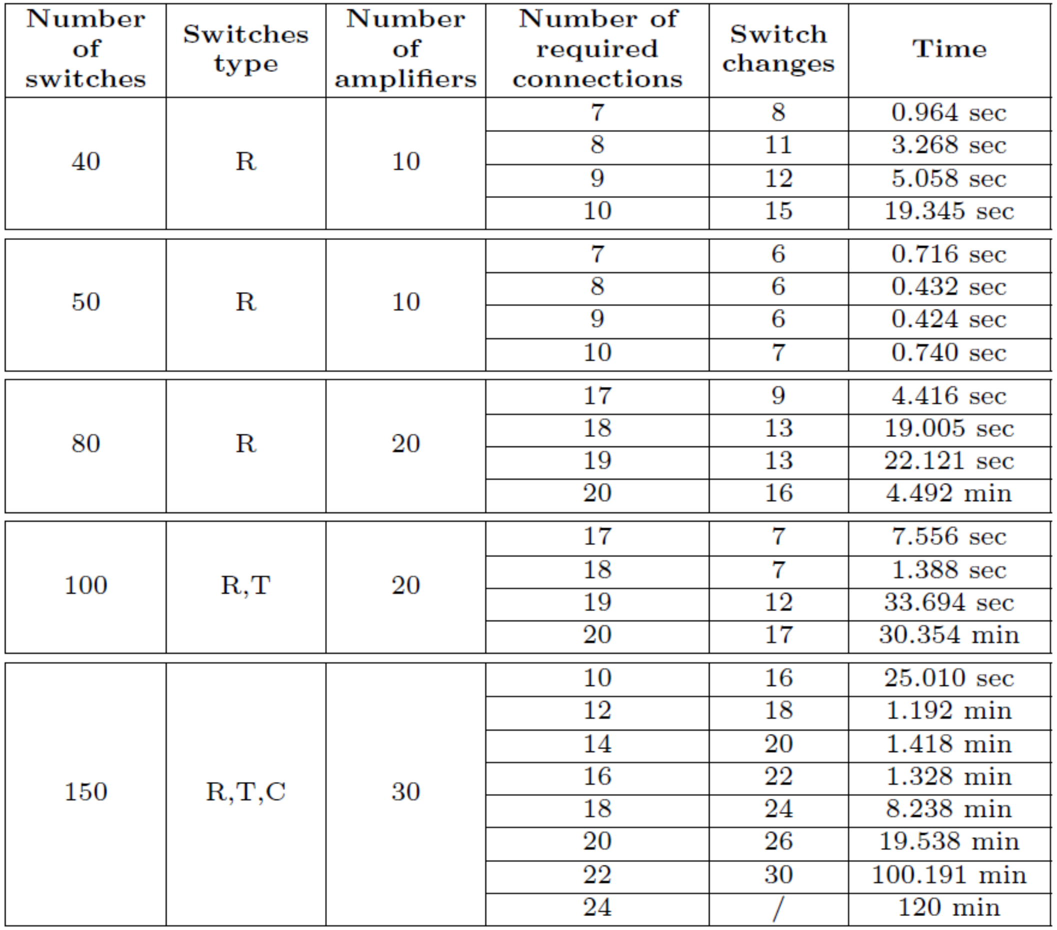
Model Functionalities

- ➢ Flexibility
- ✓ We can handle any switch type
- ✓ We can define tubes appropriate for a subset of channels
- ✓ We can handle any payload component (not only amplifiers and switches)

- ➢ Failures
- ✓ We can deal any type of possible failure

- ➢ Attenuation and Interruptions are considered

Results



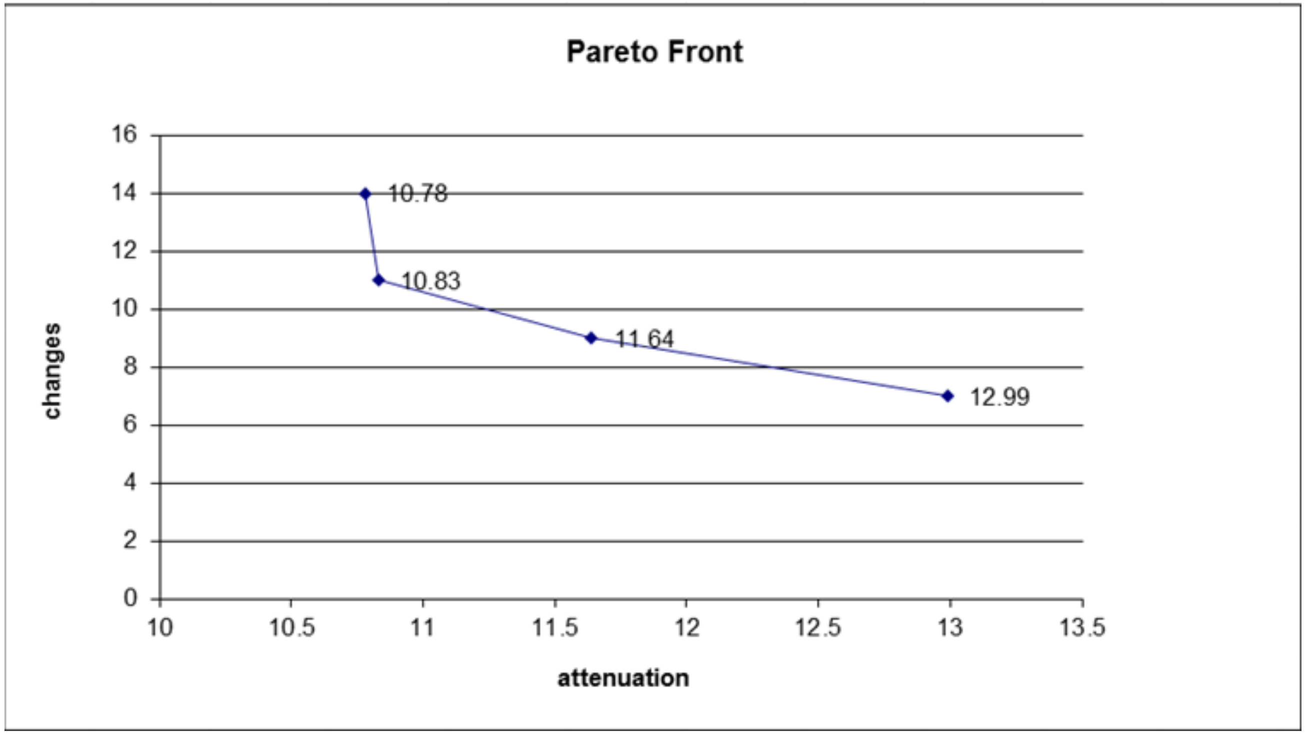
Number of switches	Switches type	Number of amplifiers	Number of required connections	Switch changes	Time
40	R	10	7	8	0.964 sec
			8	11	3.268 sec
			9	12	5.058 sec
			10	15	19.345 sec
50	R	10	7	6	0.716 sec
			8	6	0.432 sec
			9	6	0.424 sec
			10	7	0.740 sec
80	R	20	17	9	4.416 sec
			18	13	19.005 sec
			19	13	22.121 sec
			20	16	4.492 min
100	R,T	20	17	7	7.556 sec
			18	7	1.388 sec
			19	12	33.694 sec
			20	17	30.354 min
150	R,T,C	30	10	16	25.010 sec
			12	18	1.192 min
			14	20	1.418 min
			16	22	1.328 min
			18	24	8.238 min
			20	26	19.538 min
			22	30	100.191 min
			24	/	120 min

Table 1. Experimental results on different payloads configurations

Results

First results using multi-objective exact approaches

- ε-constraint approach



Future work

- ➢ Model Robustness
- ✓ Ensure functionality in case of possible future failures

- ➢ Testing, comparison and investigation of multi-objective exact algorithms

Thank you