System Analysis of Lunar Computations-Communication Architectures

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SpaSys

Introduction

Permanent settlement on the Moon is the next frontier. However, due to the advance in the technology, autonomous rovers integrated in a larger infrastructure will be employed first requiring significant computational resources. The limited electrical power suggests to distribute computational tasks. Yet, the transmission equally requires electrical power. A model is needed.

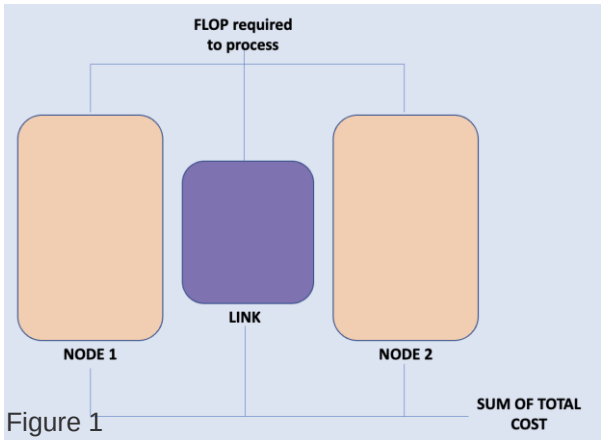

Figure 1

Simulation Model

A comprehensive simulation model was developed for a computational-communication infrastructure. Transmission of data from different nodes for processing enables the model to determine the most cost-efficient solution. This simulation can be used for more complex systems as it is created in Simulink for intuitive use and integrability with further models. The concept is shown in Fig 1. and our SIMULINK implementation in Fig. 2

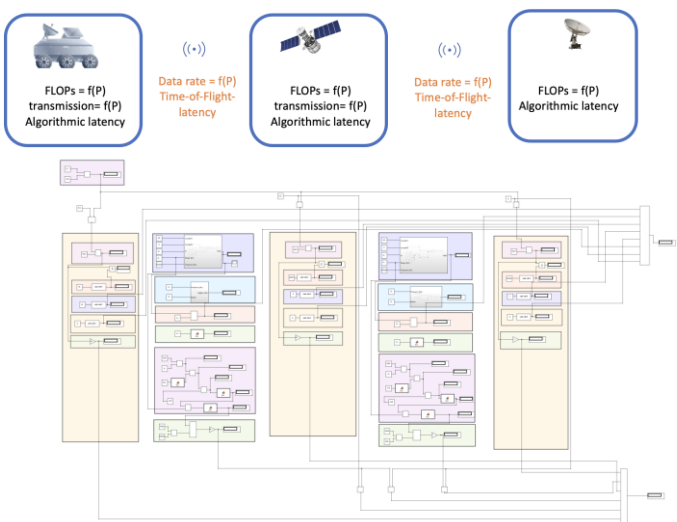

Figure 2

Node Description

Each node is composed of:

- Power needed to process data
- Max power the node can generate
- All latencies in the node

Link Description

Each link is composed of:

- Free Space Path
- Doppler Shift
- Energy required for transmitting data

Results: Practical Use-case

Objective: determine cost-optimal location (rover, lunar satellite or Earth) for a computational task of 0.1 GFLOPs.

Assumptions: cost power production, Eb/No, data rate, frequency.

share in computational task			total cost
rover	satellite	groundstation	
100%	0%	0%	256%
0%	100%	0%	100%
0%	0%	100%	3256%
50%	50%	0%	179%
33%	33%	33%	1181%

Conclusion:

- processing in lunar satellite is the cost-optimal
- distributed processing is promising alternative