Satellite Communication Project

Starlink introduction

Although Starlink is still considered a new and fancy technology , a Beta version of Starlink satellite internet is available for testing in limited parts of the US, Canada, Mexico, New Zealand, Australia, the UK, and several other countries. Therefore the satellite constellation isn't fully built out yet, there is limited availability. Also, beta testers may experience slower speeds than Starlink will eventually deliver. Periodic outages are common. Remember—Elon Musk himself calls it the "better than nothing beta program."

Starlink is a satellite internet company developed by SpaceX as a revenue-generating business to fund SpaceX's plans to colonize Mars. Starlink satellites are in low-Earth orbit, which is much closer than satellite providers generally use. This could enable Starlink to deliver lower latency than you can usually get with satellite service.

As of October 4, 2021, Starlink has 1,791 satellites in low-Earth orbit. That sounds like a big number. And it is—Starlink has long been the world's largest satellite constellation. But that doesn't mean that Starlink is ready to offer full-fledged satellite internet service yet. Starlink will need to have up to 42,000 satellites in its constellation—which means it's still a long road ahead for Starlink. Thus far, only 12,000 Starlink satellites have been approved by both the FCC (Federal Communications Commission) and the ITU (International Telecommunication Union).

This project will focus on performance evaluation of the coverage and data rate at the receiver stations on the ground (Downlink Receiver). The position of the current starlink satellites along with ground stations can be found using online tracking tool that will be introduced next section.

Starlink tracking tool

Use starlink tracking tool to pick any 10 Starlink communication satellites, it is preferred to pick satellite in the same orbital plane. The tarcking tool can be found via this link:

https://satellitemap.space/

- You need first to set the home location to any location in Jordan.
- Pick any 10 communication satellites within the same orbital plane and write down its numbers.
- Check when will be the next pass for each satellite above Jordan.
- Knowing the satellite altitude, calculate the semimajor access (radius), the orbiting period and the orbiting velocity for the satellites knowing that the mass of the satellite is 500Kg. (tabulate the values)

Check the Starlink downlink and uplink transmitter specifications:

Starlink Beam Formation, G/T, and EIRP Schedule S Values

Characteristic	Gateway Beam (Operation Functions)	User Beam (Service to End Users)
Beams	4	16
G/T (dB/K)	13.7 - 8.7	9.8 - 8.7
Peak Downlink EIRP (dBW)	39.44 - 0	39.44 - 0

StarLink Frequency Allocation and Modulation Type

Characteristic	Uplink	Downlink
Frequency (GHz)	14.0 -14.5	10.7 - 12.7
	27.5 - 29.1	17.8 - 18.6
	29.5 - 30.0	18.8 - 19.3
	47.2 - 52.4	37.5 - 42.5
Modulation Type	BPSK, QAM	OQPSK, QAM

STK Simulation:

Refer to Tutorial 1 and 2 to start a new simulation and do the following:

- Insert the ten satellites that you picked using the tracking tool.
- Define a facility in Jordan to be the receiver.
- For each satellite add a sensor with 5 degrees field of view.
- For each satellite add downlink transmitter and downlink receiver based on the values displayed in the previous section tables.
- For each satellite define uplink transmitter and uplink receiver.
- Define transmitting antenna and a receiving antenna and link it to the previously defined transmitters and receivers.
- Run the simulation and generate the access report for each satellite out of the 10 satellites.
- Which one out of the 10 satellites has the largest access period
- Generate a graph showing the variation of Eb/N0 with time
- Generate a graph showing the variation of BER with time.

Now refer to tutorial 3 to do the following:

- Knowing that there is another nearby starlink sat that transmit to the same ground station using the same frequency, evaluate the interference that may be caused and discuss how to eliminate it.