

COMPUTER SCIENCE TRIPOS Part IB – 2022 – Paper 5

1 Computer Networking (awm22)

Consider a satellite network consisting of a constellation of S satellites placed at an altitude of 1,000km above the Earth (Earth's diameter is $\approx 12,750$ km) and G ground stations connecting both customers and Internet exchange points. Each orbit of the constellation consists of 50 satellites (20 orbits total). Each satellite is equipped with five communications laser-receivers; one to communicate with the ground and four to communicate with the nearest neighbour satellites. The satellites are not geostationary. You may assume each satellite only communicates with its nearest neighbours at any time. Each node—satellite, or ground station—has a unique identifier of 16 bytes which it knows.

Design a topology-discovery protocol that can identify the shortest path among any two ground stations using the 1,000 satellites in orbit.

Symmetric paths may be presumed.

- (a) Outline a protocol (including message formats) for a node to learn about its immediate neighbours. [3 marks]
- (b) Design a protocol (including message formats) for distributing this information across the network. [7 marks]
- (c) Give a bound on the total amount of non-redundant information which is transmitted to ensure that every node acquires complete topology information. [5 marks]
- (d) The channel bandwidth is given as B , an approximation of 3×10^8 meters per second may be used for the speed of light, and per node packet processing time may be considered zero.
 - (i) Make an estimate of the worst-case total amount of time the exchange of this information will take to propagate across the network. [2 marks]
 - (ii) Outline one method to improve the time-period. Speculate on the improved upper bound of total time for the information exchange. [3 marks]