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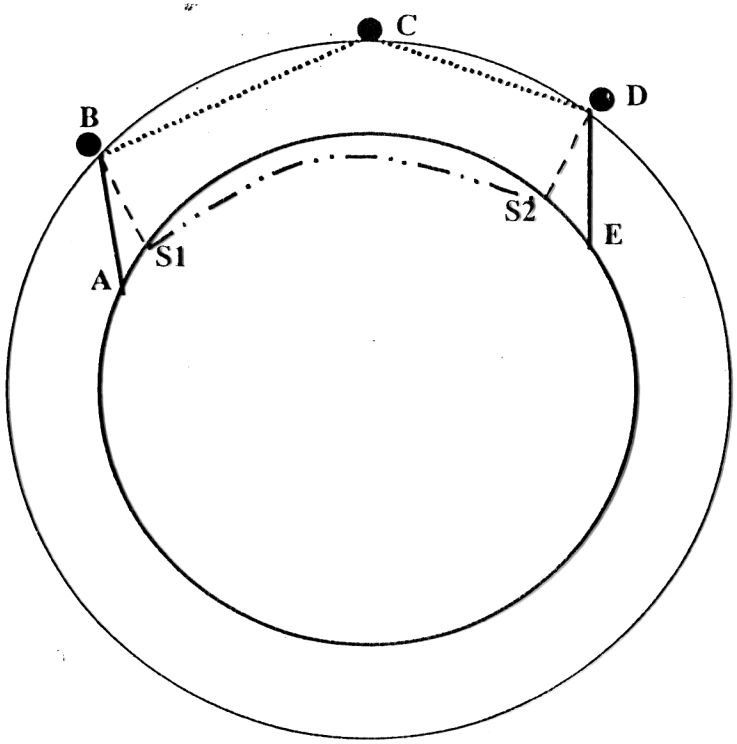


Teledesic System:
A = End user number 1
B, C, D are Teledesic satellites
E = End user number 2
..... = Teledesic ISL paths
(Control links not shown)

Skybridge System:
A = End user number 1
B, C, D are Skybridge satellites
E = End user number 2
S1 = Skybridge Gateway 1
S2 = Skybridge Gateway 2

___ = Skybridge gateway links to Skybridge satellite

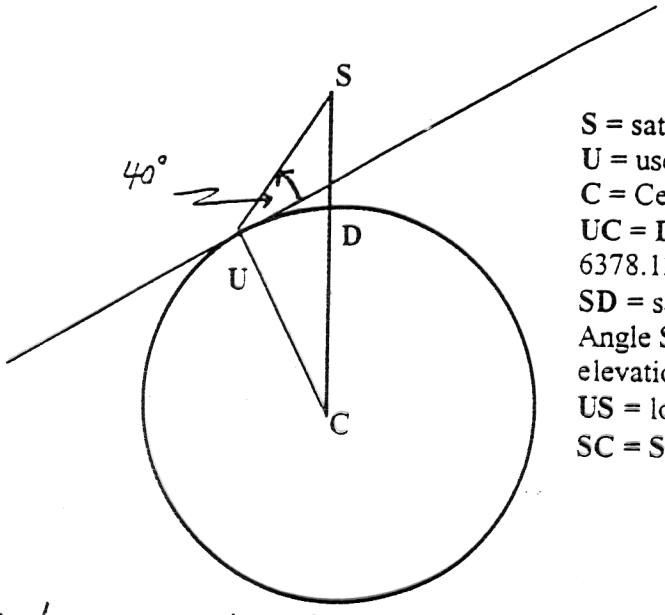
—··—·· = fiber optic long haul link between Skybridge gateways

Problem statement

- Skybridge users transmit to the nearest satellite, which transponds these signals down to the nearest gateway earth station, and thence to the far end over a standard PSTN fiber optic long haul link

  A to B to S1 to S2

- Teledesic users send their signals to the nearest satellite, whis then sends the signals via ISL links to the appropriate satellite at the far end.
- The longest path to either satellite system occurs with the minimum elevation angle, 40°



S = satellite
U = user
C = Center of earth
UC = DC = radius of earth = 6378.137 km
SD = satellite height = 1,400 km
Angle SUC = 130° (minimum elevation angle of 40° + 90°)
US = longest path
SC = SD + DC = 7,778.137 km

(d) By the Law of sines

$$\frac{\sin(USC)}{UC} = \frac{\sin(CUS)}{SC} = \frac{\sin(CUS)}{SD+DC}$$

$$\frac{\sin(USC)}{6378.137\text{ km}} = \frac{\sin(130^\circ)}{1{,}400\text{km} + 6378.137\text{km}}$$

$\therefore$ angle(USC) = 38.9147°
angle(UCD) = 180° − 130° − 38.9147 = 11.0853°

Again, by the law of sines

$$\frac{SU}{\sin(UCD)} = \frac{SC}{\sin(SUC)}$$

$$SU = \frac{(7{,}778.137\text{ km})\sin(11.0853)}{\sin 130^\circ} = \frac{(7{,}778.137)(0.1923)}{0.7660} = 1{,}952.2417\text{ km}$$

Now, for a path length of 1,952.2417 km, the ~~path delay~~

$$\text{Path delay} = \frac{\text{distance}}{\text{Velocity}} = \frac{1{,}952.2447\text{ km}}{2.997(10^8)\text{ m/sec}} = \boxed{6{,}514\text{ m seconds}}$$

e) The Teledesic user-to-user path = uplink + Cross-link + Cross-link + downlink
= 1952.2417 km + 6,000 km + 1952.2417 km = 9,904.4834 km

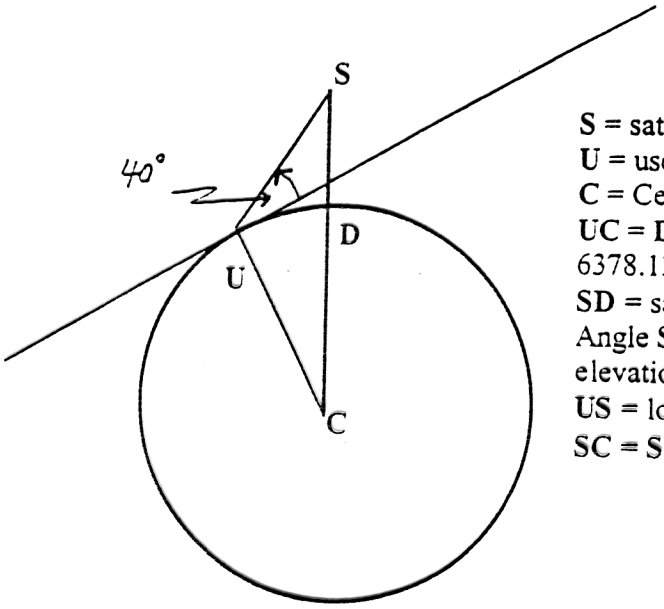
$\therefore$ The one-way path delay is $\frac{9{,}904.4834\text{km}}{2.997(10^8)\text{ m/sec}} = \boxed{33\text{ m seconds}}$

f) The skybridge user-to-user path = uplink (from user) + down link (to gateway)
+ 8000 km + uplink (from gateway) + down link to user

Assume that the gateway and user links are both at the minimum elevation angle of 40°

= 1952.2417 km + 1952.2417 km + 8000 km + 1952.2417 km + 1952.2417 km
= 15,808,966.8 meters

$\therefore$ one way path delay = $\frac{15{,}808{,}966.8\text{ meters}}{2.997(10^8)\text{ m/sec}} = \boxed{52.7\text{ m seconds}}$



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9) A window has to be long enough to permit an ACK signal to be returned to the sender terminal so that no time-out interrupts the message. The minimum window time is therefore double the one way delay time

∴ Teledesic

33 m seconds + 33 m seconds

= **66 m seconds**

Skybridge

52.7 m seconds + 52.7 m seconds

= **105.2 m seconds**