




# Floating InterNet (FIN) Module

*A SEA4G Presentation*

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# The Challenge

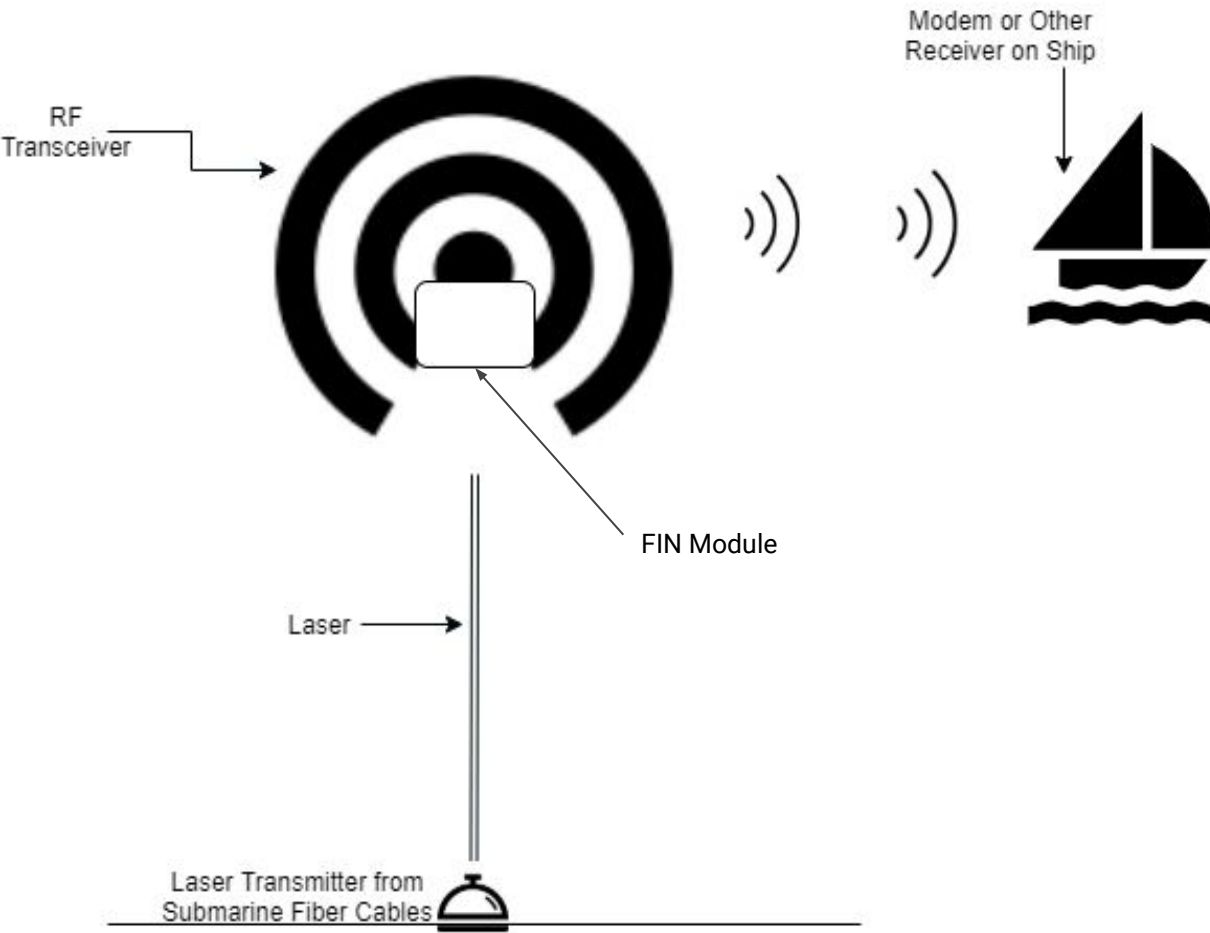
“The internet is not easily accessible in many areas of the world, like the Earth’s oceans. Fishermen, sailors, and others have limited data connection with the rest of the world. Although satellite internet is widely available, it is very expensive for a user to implement. Your challenge is to design a low-cost method of delivering internet to people located far away on the ocean.”



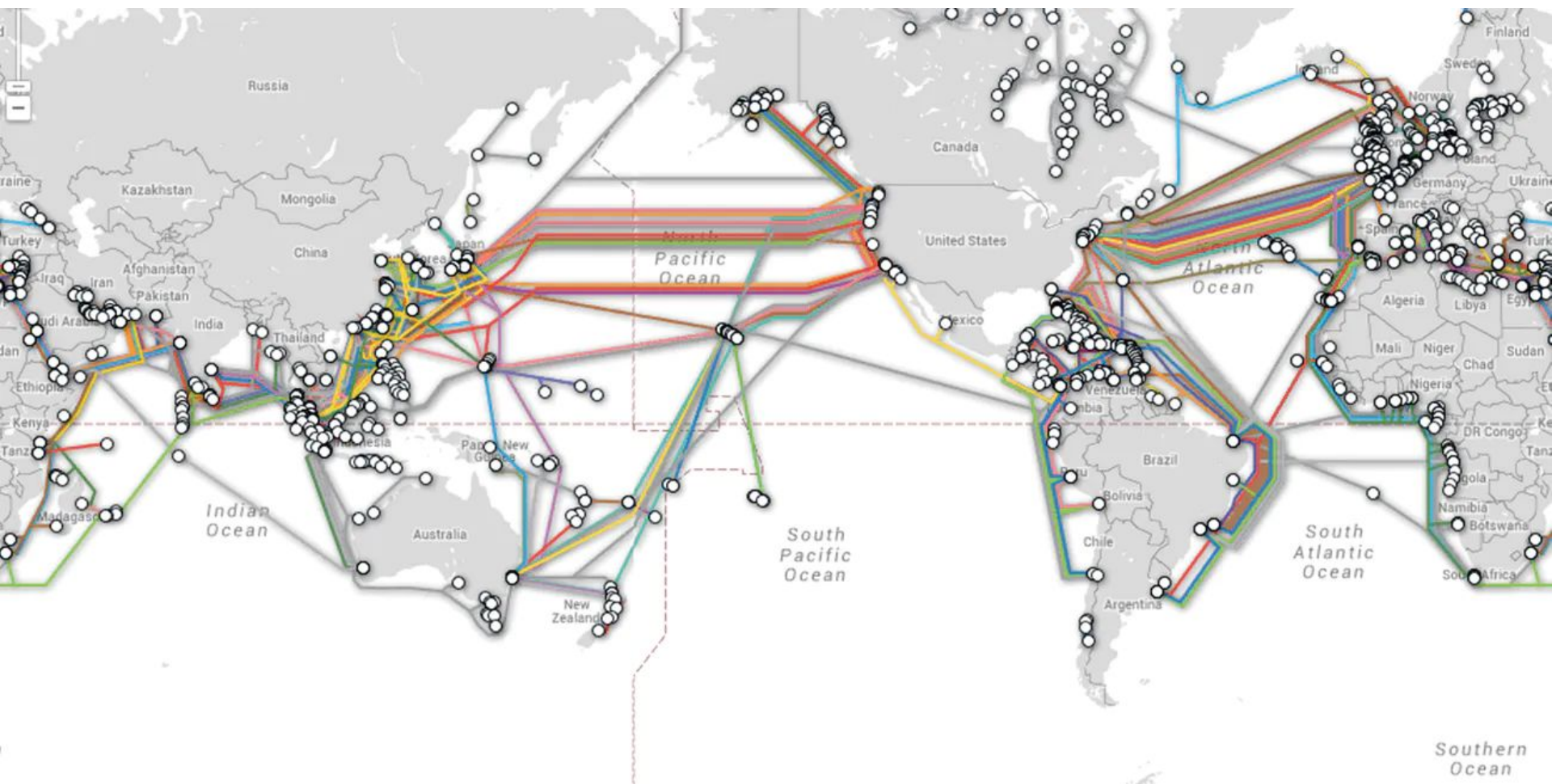
# Why FIN?

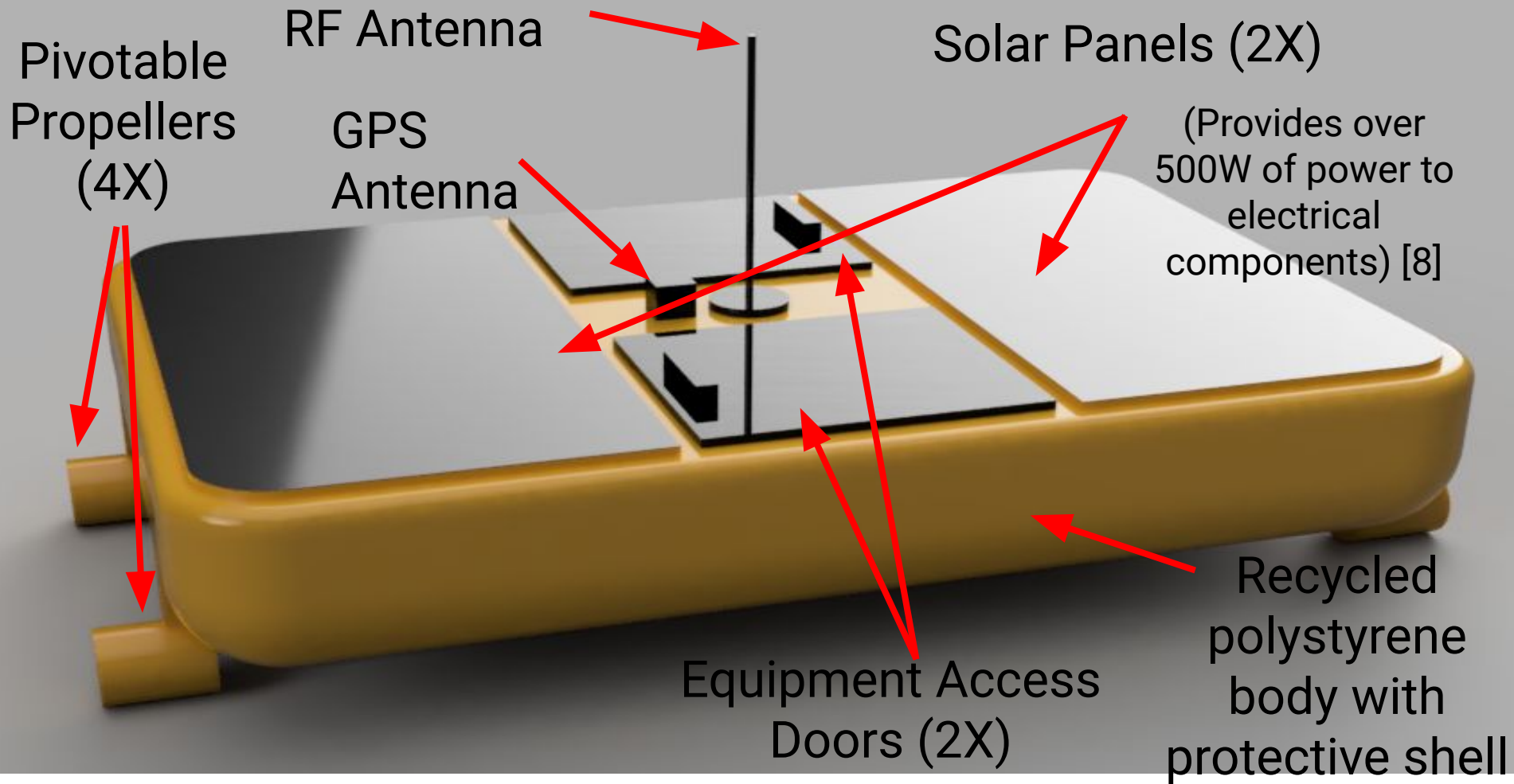
- Significantly cheaper
- More dependable connection, no cloud interference
- Reduces amount of space clutter
- Emergency distress communication available
- Sensors on the FIN monitor ocean health



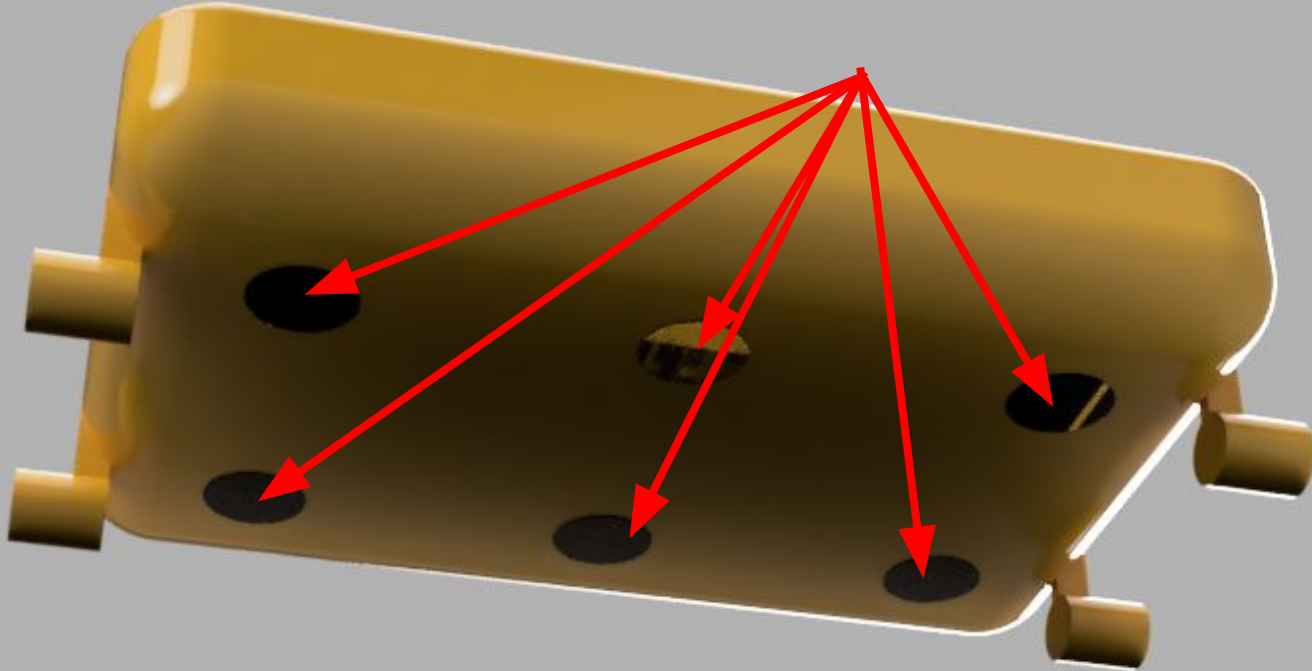


- Lay new undersea fiber cable with laser transceivers at the location of optical repeaters, every 100 km
- Build Floating InterNet (FIN) Modules which translate laser data into a radio signals for internet
- Users access internet through off the shelf radio modems



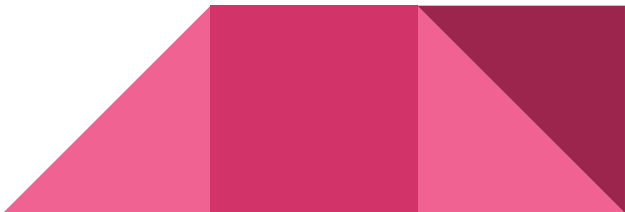


## Laser transceiver array (6X)



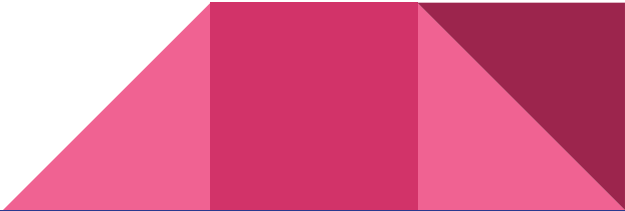
According to Archimedes principle, a volume of 3m x 2m x 3cm is buoyant enough to support 500 lb force.

# FIN Module - Electrical Components

- 12V 50Ah lithium battery (1X)
  - 1x2m 300W 24V solar panel (2X)
  - RF Antenna (1X)
  - Laser Transceivers (6X)
  - GPS module (1X)
  - Processor (1X)
  - Pivotal Propellers (4X)
  - Environmental sensors (1X)
- 



# FIN Module - Transceivers

- Above water, signal sent by Radio Waves
    - Frequency near 400 MHz, in ITU band allocated for land/mobile communication
    - Transmitting power of 500W for 55 km radius
    - Quarter-wave monopole antenna
  - Below water, signal sent by blue laser
    - Frequency near 400 nm at absorption minimum
    - Array of 6 transceivers on bottom of FIN
  - Possibly use sonar instead of blue laser
    - Technology more proven
    - Higher latency and lower capacity
- 

# Latency Calculation compared to Satellite

- Laser signal through ocean depth:  
d = 3339 km (Average depth of Atlantic Ocean) [10]  
v =  $2 \times 10^8$  m/s [9]  
**latency =  $1.5 \times 10^{-5}$  s**
- Sonar Signal through ocean depth  
d = 3339 km  
v = 1500 m/s [3]  
**latency = 2.23 s**
- Roundtrip electromagnetic signal to satellite  
d =  $1.57 \times 10^6$  m [4]  
v =  $3 \times 10^8$  m/s  
**latency = 0.0052 s**
- Roundtrip electromagnetic signal to geosynchronous satellite  
d =  $7.2 \times 10^7$  m [4]  
v =  $3 \times 10^8$  m/s  
**latency = 0.24 s**

$$\text{Latency} = \text{distance} / \text{velocity}$$



# Capacity Calculations

Use of blue lasers for undersea communication is discussed in the literature. However, the best experimental results show data rates of 11.5 Gbps over only 10m [10].

Blue light has very low absorption in sea water  $\alpha_{\text{abs}} = 0.01 \text{ 1/m}$  [12]

Scattering coeff. is small compared to absorption coeff.  $\alpha_{\text{scatter}} \lesssim \alpha_{\text{abs}} = 0.01 \text{ 1/m}$  [11]

Overall, this is a loss of 20dB/km

Shannon Hartley Theorem

$$C = B \log_2 \left( 1 + \frac{S}{N} \right)$$

Assuming a bandwidth of 10MBps and S/N=10,  
**approximate capacity is 35MBps**

# Cost Considerations

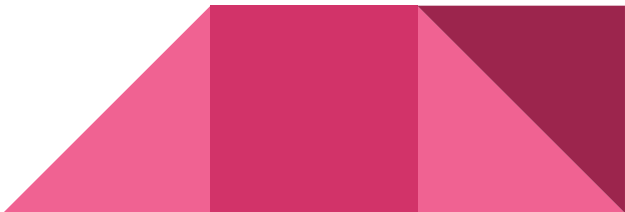
- The world needs more bandwidth and we can expand with it
- FIN coverage is only within 55 km of undersea fiber lines, but most boats and planes are also there
- 28M Cruise ship passengers per day willing to pay \$5/day to \$.75/minute [16]
- Cost to lay new undersea cable \$300M [14]
- FIN maintenance costs are \$1.1M/year (Assuming 55 units, one per 100km to cross the Atlantic ocean, we replace  $\frac{1}{5}$  of the units each year, and each FIN module costs \$100K.)

# Comparison Summary

	Satellite	FIN	Ref	Best?	Comment
Latency in seconds	0.2	$1.5 \times 10^{-5}$		FIN	Compared to geosynchronous sat.
Installation Cost	\$60B	\$300M	[1]	FIN	Compared to Starlink
Repair Cost/Yr	\$12B	\$1.1M	[1]	FIN	Compared to Starlink
Coverage	All earth	Within 50km of fiber	[18]	Satellite	Most boats and lanes are along fiber routes
Realtime water, envir., boat, and plane	😊	😊		FIN	FIN includes water monitoring sensors
Capacity in Mbits/s	506Mbps	35Mbps	[17]	Satellite	
Radio Astronomers	😞	😊	[2]	FIN	

# References

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- [2] <https://spacenews.com/little-legal-recourse-for-astronomers-concerned-about-starlink/>
- [3] Here's how we calculate sonar time... According to <https://www.worldatlas.com/aatlas/infopage/oceans/atlanticocean.htm>, the average depth of Atlantic Ocean is 3339m. According to [https://www.asu.edu/courses/art345/pike\\_b/terrainmapping/sonar.htm](https://www.asu.edu/courses/art345/pike_b/terrainmapping/sonar.htm), Sonar under water can travel at 1500m/s. Using these values, we calculated it takes 2.26 seconds for the sonar signal to travel 3339m.
- [4] Here's how we calculate electromagnetic signal time to satellite ...Geosynchronous orbit is  $3.6 \cdot 10^7$ m above earth <https://science.howstuffworks.com/satellite7.htm>. Multiply this distance by 2 for round trip and divide by the speed of light to get 0.24 seconds.
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[9] <https://www.rpi.edu/dept/phys/Dept2/APPhys1/optics/optics/node4.html>

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# Keeps the sky open

The main proposed solution

