would process it and provide forecasts, for example, of what the weather will be in New York in the next 2 hours, 4 hours, 6 hours, 8 hours, 24 hours, and so forth.

The question of how we could make such a system pay—it must obviously be done on an international basis—could be solved quite easily by offering people who participate in the program the benefit of this weather service. Take a smaller country, like Portugal, that cannot afford its own major space program. The Portugese could either subscribe to the service or they could get this service in exchange for making a few trawlers available to service some buoys in a certain stretch of the Atlantic Ocean.

Now the next item listed for improving life on earth is navigation and traffic control. We are conducting a study here at the Marshall Center on what else one can do in the area of navigation and traffic control from orbit. You may be aware that there are transit satellites in orbit today that are used by the Navy to track ship positions. Such satellites are relatively simple. When such a satellite comes over the horizon of a ship anywhere on earth, the satellite furnishes its own orbital data, in coded form. Now these orbital data were originally established when the thing went into orbit, but due to normal orbital decay, it is necessary to update these data and this is done with ground tracking stations. Every now and then they send the satellite a new set of updated orbital data on its own position in orbit that's good for the next few weeks. Now there's a receiver on the ship that gets this signal from the spacecraft as it passes. It makes use of the doppler effect.

For an example of the doppler effect, when a locomotive is approaching you with its whistle blowing, the tone suddenly drops as the locomotive is passing you. It is just as if you are in a boat running against the waves; you see waves of higher frequency than you would if you were running with the waves. So as the sound waves are coming from the train approaching you, you hear a higher frequency than when the train is going away from you. The same doppler effect, the electronic equivalent of it, is used in these navigation satellites. The satellite produces a tone, and you measure the doppler effect. If you have a slanting pass, the doppler effect is not as great and not as abrupt as if it passes directly overhead. Now for the ship to calculate its position, it follows a procedure similar to that used by a surveyor who wants to know where he is. He looks at mountain A and mountain B, and makes a triangulation. He knows the distance between the two mountains, so he knows the baseline of the triangle. He measures the angle between the two mountains and thus determines where he is. Well, when the satellite goes through an orbit, it knows its orbit and it knows: At this moment I am here, a little later I am there, and still a little later I am over yonder. So what the ground- or ship-based computer really does is make a triangulation with a single but "moving mountain." The ship itself need not send out any signals at all. It carries a handbook showing when a particular satellite will be visible from a certain part of the world just like you get a sunrise and sunset chart. So all the skipper does is take the satellite's signal, and after the satellite has passed, the little combination receiver-computer in the ship gives him a print-out of the longitude and latitude of his