Proposal for an International Air, Sea, and Space Traffic Control Using Radio Beacons on the Vehicles

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The recent Soviet complaints about SAC polar flights lead me to believe that there may be a possibility to institute a system of great advantage to us all: the international control of air, sea, and space traffic.

The proposal is briefly this: that the United Nations create an agency which from a dozen sites around the world (none of them need be in Russia or even in the United States) would continuously and automatically interrogate all vehicles outside their own national boundaries, by means of simple radio beacons given or sold by the agency to all vehicles desiring to enter international waters or air space. By the use of large computing machines tracks would be maintained on all such individually identified vehicles and they would be automatically informed of their positions. The tracks would be available to anyone interested, although it would be legitimate to turn off the beacon over the home nation. It would be the privilege and indeed the duty of every state to use any means at its disposal (so long as its own vehicles had properly operating beacons and were thus under the protection of the UN) to detect vehicles proceeding in international areas without beacons or with false identification, and such vehicles are to be destroyed or impounded for the UN. It will be necessary to provide fail-safe operation so that the beacon sounds an emergency alarm signal if acknowledgment of its reply is not received. Adequate protection against unauthorized destruction is afforded by the international record of the destroyer's track.

A roll call of ships would be taken automatically perhaps each hour (including submarines) and one of airplanes at 5 minute intervals. The maintained track would be available also to the vehicles for navigational purposes. To eliminate the possibility of fake responses, it is desirable to interrogate in a random order.

Let us consider the advantages of such a plan to a nation which will not strike first! At present we might observe a flight of Soviet planes leaving Russia but we have no way to identify a hostile intent until they are over Canada or the U.S. Add to this the real uncertainty in their detection at long range and the fact that we must not attack these planes until they reach Canada or Alaska, and we see that our only response must be a general SAC and fighter alert (and vice-versa with the Russians). Under the proposed plan, however, we might still see a flight of Russian planes with beacons, but we would be sure of their number, existence and positions. Should our early warning not show planes whose tracks were set in the international registry we could take immediate action to destroy them without having to identify their origin or intent. In the event of a hostile incident, the tracks would be on record for the world to see the exact chronology of the outbreak. Since it would be not optional but mandatory to carry and use the beacons, it should be possible to have the powerful nations cede to the UN sites on their boundaries, on which outward-looking radars could be placed by any interested party (under UN supervision so that no view would be available of the air space over a protesting nation). The purpose of these radars is to have a test of the system performance, since an untested system deteriorates rapidly.

Such a plan should have considerable propaganda advantage in that it would certainly allay any real fears the Soviets have regarding SAC flights. The beacons would be so constructed that they could not be interrogated so often as to constitute a hazard to the vehicle (from a homing missile) and there would be a real advantage in

safety in the use of this low data-rate system for navigation and traffic control if desired. Similarly, the beacons are small and light, battery powered so that they may be used in an emergency mode to locate airplane crashes and ships in difficulty. It would be forbidden to jam or interfere, with the communications system.

Perhaps a maximum of 30,000 airplanes are involved and 500,000 ships. The airplane reporting rate is thus ~100 per second and must be done upon interrogation. Assuming some frequency multiplex, each plane may have 0.1 seconds to report and to receive its acknowledgment and position. The position would be computed from the times of receipt of the radio beacon signal at two or more of the ground stations. Thus the ground station must call the particular plane (15 bits plus a few for checking) and must acknowledge receipt (5 bits in time association with the above). If it has also to broadcast the position (to 1 mile^2) this adds about 30 bits more. So the total ground station transmission broadcast burden is a maximum of 50 bits per plane x 100 planes per second or about 5 kilocycles. An airplane need radiate but a few bits in a tenth of a second although the features of the signal must be such as to allow determination of the time of reception to ~2 microseconds out of a total a priori uncertainty ~50,000 microseconds, which corresponds to the transmission of 15 bits more (perhaps most conveniently accomplished by an optimum modulation to contain information to allow accurate determination of the beginning of the signal). To define the time to 2 microseconds requires the same radiated energy if a pulse 2 microseconds is used or if a longer coded pulse is employed. There may, however, be a limitation on <u>peak</u> power making it necessary to use the coded pulse. On the other hand, the single sharp pulse is much simpler.

At a meter wavelength the “ground station” transmission could be relayed by a few communication satellites of 10 watts average radiated power (omnidirectional) at 10,000 miles distance, and the airplanes or ships could have a fraction of a watt peak power each. Transistors and batteries should be satisfactory for the beacons, although it may be desirable to use a higher frequency like 10,000 mc for transmission, in which case semiconductor diodes can be used for the oscillator.

Should active communications relay satellites be unavailable even for 10 watts at 300 mc, one would have to use land-based transmitters. We would then be concerned with the broadcasting and receipt of information over several thousands of miles which would take many kilowatts of power on the ground stations, several watts peak power on the airplanes and would have to operate at long wavelengths to obtain propagation beyond the horizon.

This is a peacetime program and is recognized as such by all participants. To jam the satellite is forbidden by international agreement, and the sudden jamming of the transmission costs us no information that we have at present and is a sure sign of bad intentions on the part of someone, since it is a serious interference with the work of an important international agency.

In a system like this the organizational aspects are of the utmost importance - the scheme is of less than no value if proposed or accepted without the continued enforcement provided by the possibility of destruction by protected vehicles,

must include sufficient satellites and computers to provide margin against failure, must have very reliable and absolutely fail-safe beacons with no adjustments or controls.

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