SUPRANATIONAL OR STATELESS INCORPORATION FOR SPACE TRAFFIC MANAGEMENT AND CONTROL?

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ABSTRACT

The growing success of space transportation, measured in many ways, will be accompanied with people killed, properties destroyed and services denied due to traffic-related events. At some unknown date a critical value will be achieved and surpassed at such a rate to establish space traffic controllers, who will share the space traffic managers and operators' (of the world) responsibilities for orbit safety and mission success. Neither the value proposition model for traffic control nor the critical events (i.e., traffic incidents and accidents types) weighted by the stakeholders' preferences of space operations have been formally defined and introduced for comment and resolution. This paper proffers a set of three legal regimes, frameworks, and/or systems for the space traffic controllers of the future. At one end, the fabrication of a supranational corporation is reviewed. Next, a legal institution composed of a stateless corporate model with that of a supranational one is examined. Finally, a regulatory paradigm of stateless authority for space traffic control is described. All three are compared against a chosen value proposition model for the key duties, tasks and responsibilities of space traffic control.

INTRODUCTION

When the outer space regime, with its lofty principles and reactionary procedures becomes crowded space with increasing incidents and eminent accidents, its tenuous framework needs a trusted system. Nation-states need to incorporate a public authority for space transportation before the first space disaster.

The corporation will systematically militate against rising probabilities of death, destruction and denial of services (DoS) in geospace. Geospace is a vacuous shell with a spherical inner surface 100 kilometers above mean sea level. A polygonal surface with telescoping vertices defined by the greatest apogee of a closed orbit in each vertex direction for a 10,000-kilogram iron sphere defines the outer surface. The sun and moon changing positions affect the maximum closed orbit's apogee, which cause the vertices to telescope, changing the surface. As a result, outer space is the universe beyond the rippling outer boundary of geospace.

The consequence of not planning sooner than later might be a commercial tragedy or a military disaster, which will instantly turn political systems to enact a swift remedy. A benefit of a near-term political consensus to establish a supranational or stateless corporation might be prosperous space tourism. Undoubtedly, a holistic view of the environment, actors, and vehicular systems' relationships must be modeled, visualized, animated, and simulated to aid this strategic decision.

Physical traffic is neither restricted in geospace (i.e., freedom of navigation) nor politically, commercially, or functionally divided like incomparable but related 6-degrees-of-freedom (6-DOF) air and submerged traffic. The electromagnetic (EM) transmissions up to 3,000 GHz, which are allotted, allocated, and/or assigned (i.e., highly regulated) by the

International Telecommunications Union's Radiocommunication Bureau (ITU-R) between transmitters and receivers, form the other type of traffic considered but extended to all EM frequencies transmittable by machinery in geospace.[1] Geospace traffic envisioned below 100 Mm are uniquely suited for corporate management and control.[2] Such a corporation would be endowed by nations with trusted human resources and guaranteed materiel supplies to operate an independent surveillance, navigation and telecommunication network. Every air traffic management and control center and orbiting proximity control center would be networked with this centerpiece. It would be entrusted with traffic plans and proximity surveillance. Volunteered vehicular vulnerability, survivability, and operability data would be fused with surveillance of non-cooperative and uncooperative vehicles to holistically compose an operating picture. Lastly, this corporation would be empowered as a supranational authority to command traffic vehicles and operations via their vehicle pilots after non-commanding protocols have been exhausted. This mode would be entered knowing the commands minimized the privacy, secrecy, security, and superiority concerns of the vehicles and actors commanded or affected.

This organizational proposition was formed around the symbolism of central force motion (i.e., centralized management and control), which governs geospace orbits and trajectories of primary concern.

BACKGROUND

There are billions of cubic kilometers of water and air spaces that are the province of all mankind but millions of each is under sovereign control. These two volumes have irregular and dynamic surface boundaries defined by scores of territorial boundaries. A supranational or stateless corporation neither manages nor controls traffic through non-sovereign waters (i.e., high seas).[3] No such corporation exists to independently gather global surveillance in near real-time and cognitively militate against the risks of vehicular death, destruction, and/or denial of service via command and control. The same is not quite true for global air traffic because a cooperative and loosely connected air traffic control system operated by several nations creates civil air capacity and manages civil air safety along air routes over the non-sovereign surfaces.[4] Military aviation equips their vehicles and trains their pilots to operate with selected civil air traffic systems when it is in their best interest.

Traffic

The evolution of 6-DOF transports began with the air vehicles in the early 19th century and the submerged vehicle in the mid 19th century. Because no central registration exists for air and submerged vehicles global statistics are not readily available. However, the author estimates there are $<10^7$ air vehicles but $<10^6$ are airborne at any moment.[5] Probably $<10^3$ submarines and submersibles are functional yet $<10^2$ are submerged at any moment.[6] The first geospace flight likely occurred in 1940s but the first orbital flight was not until 1957. Today, $<10^3$ spacecraft are functional at any moment but estimates as high as 10 million orbiting objects greater than 1 mm accompany this traffic.[7] These coarse statistics are but a sample of dozens of interrelated parameters integral to understanding the origins of principles to practices for water, air and geospace transportation.

Environments

Environmentally, 1.4×10^{18} km^3 of water hosts 3×10^{12} kg of biomass and exerts up to 1100 atmospheres at its deepest point. The 5×10^{10} km^3 of global airspace is composed of 5×10^{18} kg of solid, liquid, and gaseous matter that limit aircraft performance especially at the upper boundary where barely a dyne/cm^2 of pressure exists.[8,9] The near emptiness of matter in geospace is offset with a broader spectrum of high-energy particles, EM waves and fields too

numerous to discussed here. The bottom line is transports' energy capacity, the medium's energy density, and the energy transfer, conversion, and consumption dynamics are significantly different between submerged, air, and geospace vehicles. Therefore, adapting water and air traffic's regulatory regimes for geospace will be just as discontinuous as the physical media.

SYSTEM DYNAMICS

Navigation

The traffic management and control systems for water and air spaces have no universality because submerged and air vehicles do not have global trajectories. Those dynamics can be characterized as a collection of slow paced arcs, most within the surface area of an Earth octant. A few vehicles have the energy capacity to circumnavigate the globe by air or submerged. It has been done more as technological demonstrations of superiority or personal/national prowess. Conversely, space vehicles with suborbital trajectories are rare compared to near-circular-to-highly elliptical orbits of the space traffic population.

Communications

Space radio transmitters and transmissions are governed by the ITU-R Radio Regulations.[10] Managing 3,000 GHz of spectrum transmitted by thousands but received by millions using space, frequency, time, and code division techniques is difficult and complex. The ITU-R regime survives in the face of much criticism because of its members' heroic abilities more than the bureau's processes and filing systems automation.[11] The emergence of high power microwaves sources and lasers of various types for military or peaceful purposes in outer space are beyond ITU-R's purview. Yet this traffic will be just as important to clear passage for as large surface area and linear dimension vehicles like solar sails and space tethers.[12] The EM transmitter population multiplied by its discrete waveform assignments increases the total space traffic by an order of magnitude if not more. If space receivers' interference vulnerabilities are factored into traffic management, the population would double (e.g., 1000 s/c x 10 tx per s/c x 2 rx per tx = 20,000 traffic objects).

Air and Water Surveillance

Global traffic control centers do not exist for the contiguous water or air spaces because those vehicles are not circumnavigating the globe. Moreover, no supranational radio frequency management center exists. Instead, national frequency authorities monitor the radio waves and deal with meaconing, interference and jamming incident reports from licensed radio operators. Those who experiment with high-energy lasers, microwaves, and particle beams in free space are mindful of an incident/accident consequence, so their activity is ephemeral and isolated. Nets of surveillance capacity define traffic control volumes of public authorities; together they form a global surveillance system.

National and regional boundaries, and economic interests define water and air jurisdictions. Actors and "smart" vehicles maneuver within and across these virtual boundaries either clandestinely or with freedoms agreed to in bi-lateral to international treaties, accords, and conventions. Neither a supranational nor stateless operations center conducts real-time global surveillance to manage transports in the non-territorial waters or airspace carrying traffic. There have been a few submerged and air traffic accidents in these regions but no call to supranationalize a control authority followed.[13] The water and air traffic centers operate with a "my space" paradigm.

Antarctic airspace had air safety issues after a few incidents and accidents. Air traffic control centers were installed as a result.[14][15] Those centers are not the property of the International Civil Aviation Organization (ICAO) though.

The integration of proximity surveillance technologies on high-value transports increasing their independence has mitigated some of their navigation risks.

Geospace Surveillance[16]

Operations centers at the North American Aerospace Defense (NORAD) command, which independently gathers geospace surveillance with its radar and optical space surveillance network, has a "one space" mindset. They have to because the dynamics of the traffic requires it. Many space faring nations have a space surveillance capability to support space launch and satellite missions.[17] Therefore, they are duplicating at least some of the others work for the same reason, orbital safety. The results are fewer space objects reconnoitered per unit time, older and duplicative space surveillance databases. The Office of Outer Space Affairs (OOSA) maintains a space object registry on behalf of the United Nations but it is of little operational use since it does not contain orbital debris ephemeredes, and is not refreshed in at the rate of change of the traffic dynamics.[18] Similarly, you will not find worldwide submerged vehicle tracks in the high seas on an IMO web server or international airspace vehicle tracks web-cast from the ICAO web site, yet both organizations are duly focused on mitigating risks to this traffic and improving their safety.

Actors

The body of law and safety regulations for water and air traffic grows roughly in proportion to its markets valuation or passenger population. The intersection of economics and politics usually engenders regulation. Traffic diversification breeds the same. The more lives, properties and services are at risk, the more legislation, policing, and/or litigation might occur. Actors' privacy, secrecy, security, and superiority concerns are weighty factors in regulatory regimes. Each factor adds a layer of system complexity, enforcement difficulty and operational risk to a relatively simple task of pilots transporting passengers and cargo between destinations. Geospace has yet to experience any large-scale passenger and frequent cargo processing.

The education and training of water and air vehicles' pilots are national responsibilities. Geospace vehicle pilots, those who pilot inside the vehicle, are aircraft pilots before spacecraft pilots. But they are not licensed and rightfully so because there is no authority of outer space or geospace. Similarly, submariners are not licensed for the submerged navigation and safety portion of their journeys. Because submarines surface and navigate amongst maritime traffic in controlled waterways, they usually are licensed for that. A special certificate may be issued for submerged navigation skills or operations for a class of vehicle by local maritime authorities.[19] Aircraft pilots who travel to certain heights are recognized with altered insignia for their astronaut status.[20] It will be interesting to see the licensing requirements for remotely piloted air vehicles that may carry cargo only but use commercial airports. Simultaneously, keep watch for ideas of licensing space vehicle operators, often referred to as satellite controllers, mission controllers, and/or satellite constellation managers who never venture into geospace.

Regimes

The insufficiency of a regime is partly determined by the will of its people to change it with their buying power, bloodshed, and/or ballot. In the air regime, the revolution came with the Convention of International Civil Aviation on December 7, 1944. Tens of thousands of lives have been lost to air accidents and aerial warfare not to mention thousands of air vehicles destroyed.[21] The revenues from denied services as a result of the losses are incalculable. The water regime recently produced the United Nations Convention on the Law of the Sea (UNCLOS), although it is a surface sea convention not an

undersea one. Nonetheless, thousands have perished at sea as passengers and sailors from inclement weather, collision, and attack. Submarine accidents, accidents while submerged, are isolated to the military.[22] The services of submarines have little commercial value compared to military utility in defending a nation. And loss of life is an acceptable price for national defense. No fatalities have occurred while submerged in commercial submarine operations.[23] Regardless of sector (i.e., military, civil, commercial or private), geospace shares the same flat line record in geospace deaths. The author estimates because submerged persons statistics are not readily available, fewer than 10^3 people have travel in geospace compared to fewer than 10^6 have traveled underwater to date. The author could not find any signs in the international community of a move afoot to regulate submarine activity.

The precedence to change regimes from no control to positive control appears to shift with the death toll and/or dollars at risk. A new statecraft, supranational entrepreneurship, appeared to lead nations to agree on superficial universalities beyond common principles.[24] The entrepreneurial momentum that resulted in the body of space law today during by the Apollo era faded by the inaugural launch of the US Space Shuttle. The international space station program, while unprecedented, did not engender the kind of change being proffered in this paper. The recent space initiative announcement of the US President Bush might be the impetus to bend the space transportation line into a upward curve. Until then, this supranational or stateless incorporation discussion may appear premature and unfounded without a devastatingly death toll or devaluation of the market. These ideas are iconoclastic but not quixotic for geospace transportation.

VALUE PROPOSITION MODEL

A hierarchical model of a corporation's values for itself, customers and the market expounded in its business plans that are funded, supplied with materiel, and assigned human resources is an executable value proposition.

Value Proposition

The author proposes the idea of geospace traffic controllers who manage information that mitigates risks to human activities, which arise from vehicular and transmission traffic in geospace.

Geospace Traffic Controller

The geospace traffic controller will have duties, tasks and responsibilities commensurate to the knowledge, skills and abilities for the position. These are too numerous to list all inclusively here but the primary groupings are discussed. First the controller's primary duties are 1) conserve the geospace environment for navigation and telecommunication, 2) serve geospace traffic with safety mindfulness, and 3) improve the relationships with nations to increase their cooperation in the traffic network. Secondly, the controller's primary tasks are 1) gather geospace surveillance independently and interdependently with trusted surveillance sensors, 2) selectively communicate situational awareness to geospace traffic vehicles mindful of its non-safety value, and 3) handover traffic and environmental data with air traffic controllers in accordance with coordinated plans and established protocols. Lastly, the controller's primary responsibilities are 1) reduce the complexity of gathering surveillance, 2) simplify the difficulty of command and control, and 3) increase the value of safety services without an overall decrease in actors' security, secrecy, privacy and prosperity.

Value model

Regardless of the incorporation type, the value proposition model's upper hierarchy should be fairly static. The model's lower hierarchy will vary with the incorporation type to align with

actors' interests and investments. Broadly speaking, superiority, prosperity, secrecy, security, and privacy are their interests whether in absolute or relative terms. The measures (e.g., operator license type, transport certification type, or environmental consequence type) of alternatives the corporation considers to deliver its safety services partially define the model's utility functions. Utility is a unitless definition of value calculated using subjective and objective scoring based on measures' scales that atomize the model's goals. The corporate leadership weighted preference of measures and objectives defines the remaining elements of the utility function. The organizational decision of how to deliver safety services should be aided with the ranking of alternatives against the overall objective and those lower in the hierarchy.

The author proposes the model's overall objective is to effectuate safe space operations with selectively communicated data, which prevents death, destruction, and DoS primarily by informing humans and "intelligent" vehicles of hazards and risky situations. The proposed second tier objectives are to 1) develop actors' safety mindfulness, 2) imbue transport space worthiness, and 3) preserve the geospace environment. Third tier objectives consider the delicate issues of security, secrecy, privacy, prosperity, and superiority amongst cooperative, uncooperative, and non-cooperative actors consuming safety services. Undoubtedly, these services have value beyond safety of spaceflight, and guaranteeing EM transmission and reception.

The proposed objectives under safety mindfulness are 1) ensure security of intent before cooperating, 2) ensure secrecy and privacy of cooperation, and 3) avoid direct assistance of prosperity. Under space worthiness, 1) ensure secrecy of systems' capabilities, 2) avoid assisting superiority missions or maneuvers, and 3) ensure information assurance are proposed. Lastly, preserve geospace sub-objectives should be 1) discourage lethal EM energy persistence, 2) reduce probability of debris consequence, and 3) assist life saving geospace climate operations.

The possible measures for each objective are not addressed, however, defining the scales with subjective labels or engineering units are tantamount to a comprehensive set of objectives.

Alternatives

Alternatives are the organizational designs made to deliver the proposed value. The strategic decision to be made by nations will be chosen from a ranking of alternatives. Assuming a logical decision is sought, a calculation using value-based ranking will provide a unitless value on a linear scale of each alternative. The author's first alternative is a supranational corporation.

SUPRANATIONAL INCORPORATION

The concept of incorporating a not-for-profit business that provides highly reliable, safety-, mission-, and life-critical information services from non-sovereign territory interdependently with traffic vehicles, which are only in a different non-sovereign volume, is unprecedented. This business is considered narrowly defined and functionally specific to geospace transportation foreseen this century. The development of missions, vehicular systems, pilots, passengers, and cargo in geospace transportation is not the business of such a supranational corporation. Instead, its business is the development of risk control systems, processes and practices for state, military, commercial, and individual defined geospace missions.

The author believes a "sweet spot" exists for the supranational entrepreneur to aim for when forming the consensus to incorporate. The supranational society of geospace will define this "sweet spot". The narrowness of the definition in geospace traffic management and

the functional specificity of traffic control will be success factors in establishing supranational governance from which to incorporate a business.

Corporations to model?

The author found no supranational governance with supranational authority to incorporate and centrally operate a business in a unified sector that is global. Geospace, as delimited, might have the only traffic dynamics that will engender pan-national (i.e., supranational) governance. And incorporate an operational unit for its traffic safety.

The International Maritime Organization (IMO), International Civil Aviation Organization (ICAO), ITU-R, and World Meteorological Organization often are recommended for examination. Research revealed these intergovernmental institutions, composed of contracting and member states, are not public authorities who command traffic. These mature organizations facilitate cooperation mindful of competition and conflict between states. The younger outer space regime has a weaker framework and no operational systems when compared to the water and air regimes.

The United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) and the Committee on Space Research (COSPAR) as committees have no employees that operate mission-critical services to ensure geospace safety, let alone have operational authority over traffic vehicles in geospace. The Office of Outer Space Affairs handles symposia, meetings, and conferences for the UNCOPUOS and its subcommittees but it is not designed for real-time matters of geospace operations. The COSPAR web site does not provide real-time space weather services for geospace operations, which are provided by national web sites.[25].

Overall, these institutions do not individually enforce the treaties, accords, agreements, regulations, standards, practices, and other instruments they facilitate authoring. Nations enact versions of the signed instruments into law so a basis for enforcement and judicial procedure can exist. Nations police themselves and others in the provinces of all mankind. Violators and criminals of the states' and international law are brought to the International Court of Justice ICJ or a tribunal.[26]

These safety-concerned intergovernmental organizations have significant shortcomings for deriving the design supranational governance over geospace or a niche business to serve its safety needs.

The following alternative designs assume the authority to swiftly dispatch enforcers from capable and willing nation-states. The ICJ or a tribunal would be used to adjudicate qualifying cases brought to it.

Supranationalism

The author could not find any works discussing supranationalism and incorporation in the context of outer space activity, specifically a public safety authority.

Supranationalism comprises governance that makes decisions beyond states' rational reasonability. The concept may be transferable to any two adjacent levels in the hierarchy of governance. For example, a national government making decisions its states cannot seem to rationalize as reasonable but they may realize later the decision was reasonable. If not national and state governments then consider state and county governments.

Decision-making power in the hierarchy of governance and control over limited resources like clean air and water, require persistence, coverage and resolution of surveillance broader than the area swept out by traffic. The author believes a supranational corporation is a business that controls humans and vehicles' effects by dissemination control of environmental and traffic surveillance. This does not mean misinforming traffic and further

limiting their rational reasonability to navigate. To achieve a supranational level of performance and functionality might require unprecedented human development in perception, cognition, and reaction. Moreover, to evince these abilities to states could require their admittance of limited mindfulness for safety and/or devaluation of a supranational society's life, property, and prosperity.

States would be surrendering a "slice" of their sovereign right to freely navigate and transmit in geospace, if they conceded to space law's insufficiency and a supranational incorporation. The author believes only nonlinear space object growth from space debris growth, frequent space launch, space tourism and warfare will accelerate our linear progress. Each state has to be compelled to yield their rights for supranational requirements mindful of increasing order and decreasing geospace risks without disordering governance elsewhere.

The new statecraft of supranational entrepreneurship to establish a regime, in or outside the UN system, is among us.[27] The geospace entrepreneur will have to address an operational need to reduce the risks to space traffic and operations. The most recent literature about supranational entrepreneurship is the development of the European Community (EC) or Union (EU). The formation of the EU and its fiscal policies (e.g., euro conversion and usage) is more regionalism than supranationalism but the conditions and tactics may scale up to geospace. The EU formation bought significant economic and political powers to its region and the world scene in terms of cooperation (e.g., Eurocontrol), competition (e.g., Galileo vs. GPS), and conflict. Supranational governance should not be in competition with its empowering states' governance; its peers will be the functionally equivalent lunar and interplanetary authorities with abutting boundaries.

Incorporation

To incorporate a space business for traffic safety at the supranational level should imply supranational governance exists with the mandate, responsibility and authority to certify and authorize a corporation to transact business or conduct its affairs within the supranational province, which is geospace. Supranational governance will be executed by the corporation.

The practicality of system design and operating efficiency for any global surveillance infrastructure includes a surface or ground segment wirelessly connected to strategically placed or based sensors and detectors. Arguably, air traffic control should be aloft with its traffic. Submarine traffic control, if it existed, would be submerged throughout the oceans. Following this logic, geospace traffic control centers would be orbiting with every other high-energy space object. With the exception of the air traffic control centers in Antarctica, a non-sovereign territory, all fixed traffic management and control centers are in sovereign territories.

The author's system design has four geospace traffic control centers and its headquarters in non-sovereign territories including Antarctica. This expensive yet symbolic basing keeps the corporation's facilities and personnel out of states' territories. More importantly, the operations concept has all supranational business originating from and terminating on geospace vehicles in non-sovereign territories or provinces. This means only inter-satellite communications serve geospace traffic needs. Links between remotely piloted geospace vehicles and space mission elements in sovereign spaces would be the responsibility of the vehicle owners and operators. Conversely, inter-satellite links between traffic control and every other traffic management and control system will be the responsibility of the corporation. By responsibility, the author

means frequency assignments directly from the ITU-R to itself.

Regime

A regime is a form of government (e.g., democratic), the particular government in power (e.g., Bush administration) and the period of its rule (e.g., 8 years). The alternative regime descriptions proffered are all autocratic and exercise positive control. A democratic regime for rule making may complement the unfavorable perception by states of unlimited supranational power in real-time control. But if states want high traffic flows and near zero losses, indicative of safety-oriented operations and highly reliable employees, they probably have few affordable options to accept besides autocracy. Issues of equipage and space insurance mandates, and technology export and non-proliferation controls loom in the details of universal interoperability and deployment.

Positive control does adopt risk mitigation practices of license and certification programs from the air regime. It does not mean the corporation will have the force to deny and remove actors without licenses and certifications. A license and certification will not be duplicative to license and certification programs in states. States' programs cover to their airspace, not geospace. A single authority for a single sector, geospace, is consistent and common sense for licensing and certifying the geospace worthiness of vehicles and transmitters for holistic management. Nation-states would empower the corporation with such authority and be co-executors in country, considering the current difficulties of on-orbit inspection, repair and assembly.

Once established, the corporation would be nearly impossible to disestablish, assuming traffic levels grow. However, changes in employees, properties, and services will fluctuate with the environmental and traffic dynamics. The proliferation and export of dual-use technologies between states, groups and individuals will be inhibiting as much as information sharing will be enabling cooperation for achievement of safety level objectives.

Framework

The author considers a supranational framework the basic structure of ideas for delivering the value proposed to geospace traffic. Mindful of the theory of opposites, the entrepreneur will have to simultaneously address important missed deliveries of value or destructive actions to traffic safety from system failures and employees' negligence. The antithetical structure of the value proposition might be the blueprint of a well-designed space force that has a global dominance vision for its nation's defense. If such a blueprint exists, it is likely to be highly classified and thus not worth conjecturing about here. The valuable discussion focuses on structural considerations to minimize the corporate and employee's liabilities. These structures should persuade actors to cooperative to the fullest extent.

Recalling the overall objective proposed, the information assurance structure between traffic vehicles and actors is the foundation to this framework. Every element attributed to the synthesis of data into knowledge of a communicable situation relevant for traffic safety defines the scope for information assurance. The ideas to effectuate this include the use of a universal coordinate system for geospace positioning, adopting Universal Time Coordinate system for time tagging, integrating the metric units system for all engineering data, public key encryption, secret key encryption, regular sensor/detector calibration, and multi-spectral emitters for enhanced visibility and detection.

A geospace university, transportation institute, and safety school will be supranational structures for imbuing safety mindfulness into actors. One geospace, one education authority is the author's current belief. The International Space University does not exist to educate or train geospace navigators and pilots in their

traffic roles; space faring nations, companies and militaries produce unlicensed and uncertified yet mission specific competencies in individuals. Using tele-education technologies with expected and renowned academic institutions, the corporation will construct a curriculum for actors-in-training to sit for a geospace license. The International Academy of Astronautics studies germane topics like this but it is not a teaching institution.[28]

To achieve high levels of geospace worthiness, a vehicle design center will be virtually operated from within the control centers. The endowment of a constellation of geospace vehicles that aid navigation, switch telecommunications, and independently gathers surveillance to deliver the proposed value might be on the scale of International Space Station (ISS) program. The favorable view is the ISS happened so this framework is conceivable. The design center primary responsibility will be for its own geospace blueprints. But it will host vehicle designers and operators to exchange design and operations concepts and those proven to enhance vehicular operability, survivability and reduce vulnerability. Thorny issues of non-proliferation and technology export controls between nations should be dealt with in this structural environment.

Lastly, the geospace preservation from an environmental perspective will be addressed with the restructuring of the WMO and COSPAR to reflect the continuum of climate and weather patterns from the Earth's subsurface to outer space despite the discontinuities of traffic patterns between air and geospace. If gigawatt class transmitters are mid-century realities and space launch/re-entry rates simultaneously skyrocket, depositing megatons of rocket exhaust in the geospace and below, a geospace weather service like the Space Environment Center operated by the US National Oceanographic and Atmospheric Administration will essentially get relabeled.

System

A supranational system is the real-time machinery, software and information flowing under the watch and control of its operators (i.e., employees) and within the governance framework. System design descriptions were alluded to but cannot be offered without societal consensus of the framework and regime objectives. The laws and penal code surrounding specific system implementation and misuse will be changed in proportion to the magnitude of the probable damage, which should be assessed annually. Governance over operators, vehicles and operations balance the maximum probabilities of framework and system damages.

Employee Citizenship

In order to emphasize the quality of an employee's response to their membership in a supranational corporation, the author saw no other option but change their citizenship status. This framework element might be the most counter-intuitive proposition to accept considering there is no territory associated with the corporation.

Simply put, supranational employees will be citizens of all nations concurrently while in non-sovereign territory by possessing a new citizenship, geospace citizenship. They will have all the rights and privileges to these states whenever in those states. This carte blanche access comes with a development and selection process tantamount to its privileges. The author foresees a formalized pipeline of candidates having to begin in high school and the initial cadre of instructors, coaches, mentors, teachers, counselors, commanders, controllers, operators, managers, designers, and leaders coming from only the space faring nations.

HYBRID INCORPORATION

The hybrid corporation would be a specialized agency of the United Nations staffed with international civil servants employed to deliver the value proposition.

Regime

The UN mode of governance is democratic, evinced with it many assemblies, councils, and committees' resolutions, agreements and treaties. This corporation would have fewer than all states contracting to the necessary convention establishing it. Moreover, the convention might have exclusionary provisions for non-civil geospace traffic similar to that in the Chicago Convention.

The UNCOPUOS and COSPAR members would play a significant role establishing the models of leaders appropriate for international control over geospace operations. The limits of liability for this corporation should be limited to the value of its endowment by member states. The control centers would be in sovereign territories of the most vested members but staffed by minor and upcoming members in favor with the host country's political system.

Framework

The structural elements described for a supranational corporation are identical for a hybrid corporation. The one exception is the effect of basing functions in neutral or polarized countries. The author thinks diluting the resources by basing its framework elements in sovereign territories might have negative effects on this unique endeavor.

System

An international system operating in an international framework for the safety of life, property, and the environment beyond all national boundaries will have its failure effects and modes analyzed just like the supranational designs. These analyses will contribute to the liabilities and penalties of employee and operator misuse. Simultaneously, the system design requirements will be influenced with initial functional and performance goals. The deployed system will have accident investigation provisions that aid insurers, lawyers, and justices' opinions and arguments, and limit the extent of the law over its operation.

Employee Citizenship

The author believes the duty, loyalty and allegiance of international civil servants will be less than those hoped for in the supranational paradigm. If this were to be true, it may be preceded with system implementations that have shorter and less rigorous pipelines for geospace traffic controllers, higher employee turnover, lower retention, and greater mishaps, incidents and accidents from workplace factors derived from not being isolated in non-sovereign territories. Or worst yet, citizenship loyalties, duties and allegiances not suppressed while performing geospace functions.

STATELESS INCORPORATION

The author found statelessness as a condition only applied to humans who are essentially aliens. They are usually victims of a country or state that was overcome by armed events.[29] The UN established rights for these people's unwanted condition. Their rights as stateless persons allow them to bring violators of those rights to the International Court of Justice.[30] Readers must expand their thinking to accept a desired incorporation of a stateless business from no state or non-territorial government over a traffic flows and operations in a province of all mankind.

Statelessness

If a state is identified by its territorial possessions then geospace fits well in the statelessness paradigm because it is composed of no territory. There are a few megatons of matter in geospace but no land, water, ice or air as most humans are accustomed to on Earth. It cannot sustain life of any form and therefore, it

has no traditional natural resources for governance or valuation. Its relative position to the Earth's surface, broader and higher EM energy spectrum, microgravity, and magnetic fields are its natural resources.

The argument is statelessness can extend to legal entities, namely corporations, since statelessness describes a legal state of human being. The difference is the intent to be stateless and the context of the corporation's business. Humans do not desire statelessness even though they can renounce their citizenship or state of origin. Citizenship provides many humans with rights, securities, and privileges that are commonly valued and unattainable as aliens. But what legal entity can certify and authorize a stateless corporation to conduct business and affairs in a stateless territory or in this context, geospace? The struggle with the wording comes from the associated mental imagery and constructs of this business, which is gathering critical information and exchanging it with state and non-state actors in a non-state place termed geospace.

Regime

The mode of stateless governance over traffic management will be positive control similar to the other alternatives. It might seem statelessness does not fit in the classification of states (i.e., that is supra-nation-state, nation-state, and sub-nation-state) but it does. This stateless corporation is the equivalent of a state public authority for transportation. With the specificity of the value proposition, it governs less than any state.

The author believes the holistic risk control responsibility within traffic management engenders state-like powers. States do not have to explicitly yield their sovereignty for this corporation to claim it, instead the corporation's by-laws and articles of incorporation must acknowledge all states rights to freely navigate and transact information with it guaranteeing their rights remain undisturbed as traffic increases. This declaration of mission empowers the corporation to dutifully govern the spatial, temporal and spectral awareness of geospace hazardous situations entrusted to it before perturbing actors' power balances by controlling risks with it.

Framework

The stateless corporation framework differs from the supranational corporation only in the citizenship of its employees. The authority, operations, capacity and capability shadow the supranational descriptions.

Employee Citizenship

The framework of a stateless corporation uses stateless employees to conduct its business. The employees will have to renounce their citizenship, becoming aliens to all states before employment and conducting the business of the corporation. This is the opposite design of the supranational alternative. However, this structure should not foster an uninterested mindset. Employees may feel disinterested before returning to being wholly interested in his/her prized position of traffic controller. In each alternative, the employees' entitlements are left for negotiation because the entrepreneurs' ability to staff any organizational alternative, especially one based in Antarctica, will pose significant opportunities and challenges.

System

The factors expressed in the hybrid corporation apply to the stateless corporation.

CONCLUDING REMARKS

The system dynamics of geospace, airspace, and underwater traffic regimes are significantly different in regulation, valuation, and population. The opportunity for supranational governance to incorporate a business springs from no nation-state having sovereignty over a piece of geospace unlike their stewardship of air and water. The risks and consequences to geospace traffic should be holistically managed

and that will require a highly reliable corporation with employees' mindfulness never wavering from safety first. The supranational citizenship each employee has is a key element of this design.

Hybrid and stateless incorporation alternatives offer some practical but inconsistent solutions. The statecraft of supranational entrepreneurship has to catalyze the states to consider these alternatives before a catastrophe captures the their attention and demands a quick fix. States will have to endow, empower, and entrust some form of authority for space safety services if not the supranational corporation proffered by the author. Their decision-making must start with a written consensus of measurable values for life, property and prosperity in geospace.

The Earth Outer Space Organization will continue its research and development of designs for geospace traffic management and control. A database of geospace traffic events, environments and actors will shape its portfolio of programs and projects to verify and validate system dynamics models of actual geospace traffic management and control.

REFERENCES

[1] International Telecommunication Union, Radio Communication web site, www.itu.int, 2004.

[2] Bekey, Ivan, Advanced System Space Concepts and Technologies: 2010-2030+, The Aerospace Press, Reston, 2004, pp. 131-133.

[3] International Maritime Organization, web site, www.imo.org, August 2004.

[4] International Civil Aviation Organization, web site, www.icao.int, August 2004.

[5] US Bureau of Transportation Statistics web site, www.bts.gov, August 2004.

[6] US Submarines Inc. web site, www.ussubmarines.com, August 2004.

[7] 1998 Summer Session Program, Hazards to Spaceflight, International Space University, Ch. 4. 1998.

[8] Sherman, K., and L.M. Alexander, eds. 1989. Biomass yields and geography of large marine ecosystems. AAAS [Amer. Assoc. Adv. Sci.] Sel. Symp. 111.

[9] World Meteorological Organization, web site, www.wmo.ch, August 2004.

[10] International Telecommunication Union, Radio Communication web site, www.itu.int, 2004.

[11] Sung, Liching, "ITU Cost Recovery: A Means to What End?", Vol. 15 No. 30, Space News, 2004.

[12] Bekey, Ivan, Advanced System Space Concepts and Technologies: 2010-2030+, The Aerospace Press, Reston, 2004.

[13] Drew, Annette L, Christopher Drew, and Sherry Sontag, Blind Man's Bluff: The Untold Story of American Submarine Espionage, PublicAffairs™, New York, 1998.

[14] Monaghan, Andy,"Trip Report: McMurdo and Terra Nova Bay Antarctica 7-27 December 2001", The Ohio State University, February 2002.

[15] Antarctica Photographs, http://www.johnj.com/pole00/image_html/image_roll209_res10_Img0095.html, John Jacobsen. August 2004.

[16] National Research Council, ORITBAL DEBRIS: A Technical Assessment, National Academy Press, Washington, DC, 1995.

[17] Inter-Agency Space Debris Coordination Committee (IADC), "Activities and Views on Reducing Space Debris From Launch Vehicles", Paper presented to the 38th Session of the Scientific and Technical Subcommittee of UNCOPUOS, Feb. 2001.

[18] Office of Outer Space Affairs web site, www.oosa.int, 2004.

[19] Interview with owner and CEO of US Submarines, 20 August 2004.
[20] Interview with Frederick Gregory, Deputy Administrator, NASA, 29 August 2004.
[21] International Civil Aviation Organization, "Memorandum on ICAO: the story of the Aviation Organization", 14ed., Public Information Office, 1990.
[22] Drew, Annette L, Christopher Drew, and Sherry Sontag, Blind Man's Bluff: The Untold Story of American Submarine Espionage, PublicAffairs™, New York, 1998.
[23] Telephone interview with CEO and owner, US Submarines Inc., www.ussubmarines.com, 20 August 2004.
[24] Keller, Berndt, Platzer, Hans-Wolfgang, eds., Industrial relations and European integration: trans- and supranational developments and prospects, Burlington, VT : Ashgate, c2003.
[25] US National Oceanic and Atmospheric Administration web site, www.noaa.gov, August 2004.
[26] International Court of Justice www.icj-cij.org, web site, 2004.
[27] Moravcsik, Andrew, "A New Statecraft? Supranational Entrepreneurs and International Cooperation", Working Paper Series 98-10, Weatherhead Center for International Affairs, Harvard University. August 1998.
[28] International Academy of Astronautics, "IAA Cosmic Study: Traffic Management Rules for Space Operations", 29 March 2004, DRAFT.
[29] Haveman, Roelof, Olga Kavran, Julian Nicholls, eds., Supranational criminal law: a system sui generis, Ardsley, NY, Transnational Publishers, 2003.
[30] Gormley, W. Paul, The procedural status of the individual before international and supranational tribunals, The Hague, M. Nijhoff, 1966.