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**Peaceful Use of Lasers in Space: Context-Based Legitimacy in Global Governance of Large Technical Systems**

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**Abstract**

*Technology offers unique sets of opportunities, from human flourishing to civilization survival, but also challenges, from partial misuse to global apocalypse. Yet technology is shaped by the social environment in which it is developed and used, prompting questions about its desirable governance format. In this context, we look at governance challenges of large technical systems, specifically the peaceful use of high-power lasers in space, in order to propose a conceptual framework for legitimate global governance. Specifically, we adopt a context-based approach to legitimacy to address the trade-offs between effectiveness (output legitimacy) and inclusivity (input legitimacy) in the governance of large technical systems. We show that distinguishing two basic phases of space laser policy which call for different legitimacy criteria helps balance out the trade-offs without sacrificing either effectiveness or inclusivity. Finally, we construe LTSs’ governance as a tool for creating globally networked spaces which may enable coordinated global democratic governance.*

**Keywords**

*global governance, large technical systems, space policy, democratic dilemma, security studies*

# Introduction

Human ingenuity has brought about game-changing scientific discoveries that revolutionized society. However, not always is technological progress matched by social progress. The use of originally benign technology depends on the environment in which it is developed and deployed: the social dimensions can turn discoveries into a threat (artificial intelligence), limit their potential (gene editing), or even prevent their use (nuclear devices). As humanity expands its activities beyond the Earth, the absence of functioning social and governance frameworks also affects the realm of space technology, which includes laser use in space.

This paper explores the issue of global governance of large technical systems (LTSs), specifically a high-power laser system, and offers a context-based conceptual framework for assessing its legitimacy. LTSs have become influential socio-technical structures which co-form the international order and as such present a host of foundational challenges to political decision-making. As there is no global governing authority or global democratic process analogous to those within nation-states, domestic-inspired approaches to their governance have only limited applicability. Insofar as we consider *legitimate* governance a desirable state of affairs, however, this implies that LTSs call for of a novel and adequate understanding of legitimacy which would provide both normative and policy guidance. It is safe to assume that no single actor possesses the necessary knowledge or capacities to address the complex issues as they arise in international politics (Kooiman, 2003, p. 4); at the same time, solutions to these problems are obviously needed. However, it is an open question what kind of governance regime will be adopted.[[1]](#footnote-1) Our working assumption is that nature of regime legitimacy speaks a lot to the desirability of any regime. This is precisely where LTSs’ importance comes to the fore: as pointed out by Maxmilian Meyer and Michele Acuto (2015), they may have a momentous impact in the power politics of international relations and global governance, including either strengthening or disrupting of structures and mechanisms of political decision-making.[[2]](#footnote-2) From a normative point of view, LTSs may also help overcome the powerful principles of sovereignty and national interests which, as a priori defining standards of practices and processes, still structure major areas of international politics.

With this general background in mind, we look in the paper into the conditions of peaceful use of high-power lasers in space, arguing that it offers valuable insights about legitimate governance beyond territoriality. Precisely because high-power laser systems induce us to think and act in larger spatial and temporal domains, they constitute a useful entry point into theorizing the legitimacy of global governance structures inhabited by multiple (types of) actors. Given that the complexity of global governance spreads vertically across local, regional, national, continental, and global levels, as well as horizontally across many issues and actors, such an inquiry promises to provide more general lessons.

Building upon the conceptual apparatus of *context-based legitimacy* recently put forward by Pietro Maffettone and Luke Ulaş (2019), we outline the contours of legitimate global governance of high-power laser systems that could a) enable the development and use of high-power lasers to address space-related challenges all of humanity shares and b) maintain a reasonable degree of global inclusivity. Specifically, we show how the inevitable trade-offs between effectiveness and democratic quality (inclusivity) can be conceptualized within a complex picture of legitimate decision-making. We do this by distinguishing two phases of space laser policy, namely *development* and *deployment*. Each phase possesses distinct characteristics and thus calls for different criteria of evaluation as regards choice (in)sensitivity, the social environment that accompanies it, the type of constituency to which decision-making should be accountable, and the trade-off priorities pertaining to input and output legitimacy. This is where Maffettone and Ulaş’s context-sensitive framework proves especially useful. Among other things, our contribution lies in showing how the general framework may combine with a specific policy/governance challenge (use of high-power lasers in space) which, even if complex, is rather clearly delineated and rests on a high degree of scientific consensus.

The paper is organized as follows. The next section overviews the prospects of laser use in space and related space governance issues. The lack of robust structures of governance in this area leads us to unpack in the subsequent section the concept of legitimacy as applied to the transnational level, emphasizing the interplay between effective problem solving and inclusive decision-making which gives rise to the democratic dilemma. Against this background, we then discuss the promises and perils of high-power laser technology qua an LTS, as triggered by its technical complexity and security sensitivity. In the next section, we show that the concept of context-based legitimacy provides a useful toolbox for grappling with the inevitable trade-offs between inclusivity at the input and effectiveness at the output of LTS’s governance, because it enables flexible yet consistent adjustment of the criteria of legitimacy. In the last section, we argue that the development and deployment phases of *space laser policy* provide precisely such a general contextual distinction. The former accommodates effectiveness-based criteria together with choice-insensitivity and a constituency consisting primarily of a narrower class of directly involved stakeholders, while the latter takes on board inclusivity-based criteria, choice-sensitivity, and a constituency composed of all-affected, or at least all-subjected, actors. We thus reconceptualize the classic dilemma between effectivity and inclusivity and instead of understanding it as a mutually exclusive trade-off between the two, we see it as a trade-in, in which both inclusivity and effectivity reinforce each other. As we shall see, an important piece of the puzzle is provided by private actors.

# Use of Lasers within Space Governance

Of the numerous issues related to the use of lasers in space, we focus in this paper on three distinct areas of space policy: (1) space debris removal, (2) planetary defense from asteroids and comets, and (3) space exploration, including space resource utilization and space travel at relativistic speeds. We highlight these three because they are most promising – most scientifically explored – as regards the real-world applicability of laser technology. We show that all of them currently lack effective problem-solving mechanisms as well as sources of democratic legitimacy; however, if retheorized properly, the use of high-power lasers may suggest both a technological and political blueprint for global governance of LTSs. As argued by Meyer and Acuto, by their very existence LTSs may, in turn, contribute to the emergence of common interests, shared decision-making structures, and perhaps ultimately a common identity on a global scale.

(1) The European Space Agency estimates that there are more than 34 000 objects larger than 10 cm, 900 000 objects between 1 cm a 10 cm, and 128 million objects bellow 1 cm in size on Earth’s orbit.[[3]](#footnote-3) With the average speed of 28 000 kph, each of them represents a potentially lethal threat to orbiting satellites which are not only part of a 400-billion-dollar economy but also indispensable for the functioning of modern societies. While advances in space surveillance and tracking (SST) have been exponential, the most important capabilities and authoritative datasets remain almost exclusively in the hands of public entities and militaries.[[4]](#footnote-4) Despite numerous efforts, no binding, concentrated international measures, or a coordinated plan for space debris removal, have been enacted. Furthermore, the planned release of thousands of nanosatellites by private companies as well as the growing prevalence of anti-satellite weapons suggests that safety on the orbit will deteriorate rather than improve. In principle, the solution for small hard-to-remove debris is at hand: the use of lasers for maneuvering and removing orbital debris has been theoretically and practically explored for ground-based photon pressure systems (Esmiller et al., 2014; Grosse et al., 2018; Phipps et al., 2012; Scharring et al., 2016; Soulard et al., 2014) as well as space-based ablation methods (Schmitz et al., 2015; Vetrisano et al., 2015). However, the involved actors remain reluctant to use the existing laser technology to remove dangerous debris, the main reason being the absence of widely accepted governing mechanisms. Any activity in this direction would be potentially subject to liability and security issues. Firstly, the origins of millions of small debris cannot be easily determined, leaving culprits unaccountable for their emission. Secondly, however, if such “authorship” *could* be determined in at least some cases, then laser operators, even if the ultimate goal of moving the debris was its removal, would become accountable for those pieces which caused an unexpected collision. Thirdly, both ground- and space-based high-power lasers constitute highly effective weaponry capable of attacking space assets, which has to do with the well-known problem of dual-use technology, a technology which can be used for both civil and military purposes (Dobos & Prazak, 2019).

It would be surely dubious to expect state actors to suddenly switch their cautious stance. However, there seems to be a way of mitigating this problem, if not around it, in that states are far from the only actors capable of policing the outer space. Specifically, safety on the orbits can be provided by the private sector which possesses growing financial and technological power. Despite governments representing 80% of the SST market value, the privatization of the domain, just like the entire space sector, is expecting to shrink it to 60% by 2035 (Euroconsult, 2020). Companies like LeoLabs, Astroscale, D-Orbit ClearSpace-1 are contracted by both military and civilian state entities (such entities include the United States Department of Defense, National Aeronautics and Space Administration as well as the European Space Agency) to provide monitor as well as remove space debris. We will see that this is far from the only issue which invites greater activity of private (commercial, industrial etc.) actors.

(2) Laser technology, however, carries even more ambitious potential. One such area concerns the defense of planet Earth against dangerous asteroids and comets which has attracted a growing scientific and policy community. As of 2020, over 23,000 near-earth asteroids and 110 near-earth comets are on record and being monitored, with planet defenders tirelessly looking for other potentially hazardous objects that could impact Earth.[[5]](#footnote-5) From a technical point of view, lasers have the potential to become critical elements of planetary defense, for they may be used to deflect asteroids by the photon pressure method (Lubin et al., 2016; Zhang, Lubin, & Hughes 2019; Zhang et al., 2016). Related, they can be used to explore asteroids’ internal composition through laser-induced ablation, thus facilitating other possible methods of deflection.[[6]](#footnote-6) Rudiments of a governance mechanism are traceable: besides the bi-annual *Planetary Defense Conference* which allows scientists and public officials to practice responses to an incoming asteroid, the UN-mandated Space Mission Planning Advisory Group (SMPAG) meets twice a year to prepare an international response and engage in “exchange of information, development of options for collaborative research and mission opportunities, and to conduct NEO threat mitigation planning activities.”[[7]](#footnote-7) However, as merely an advisory body to the UN with only 19 members, it lacks legitimacy in terms of either effective problem-solving capabilities or democratic input and control.

Other than that, any international decision-making mechanisms or governance frameworks for dealing with a threat of such global proportions are lacking, leaving the area without legitimate authority that would be able to both effectively address the issue and reflect the interests and preferences of all those threatened. Accordingly, scholars point out the risk of global political instability which would undermine even the rudimentary normative and institutional framework of global cooperation.[[8]](#footnote-8) First, there is the worry over unilateral planetary defense actions by great powers; second, the extant mechanism of international political decision-making would leave the survival of threatened countries either in the hands of the highly exclusive United Nations Security Council, or at the mercy of the notoriously slow United Nations General Assembly which, moreover, suffers from democratic deficits stemming from the one state, one vote system.[[9]](#footnote-9)

(3) Closely related to planetary defense considerations are visions of space exploration and space resource utilization. While space exploration used to be the domain of astronomers or robotic probes, nowadays it includes private actors with the resources, capabilities, effectiveness, and will greater than those of nation-states to venture into the realm of space colonization, interstellar travel and search for extra-terrestrial life. For example, the non-profit philanthropic organization *Breakthrough Initiatives* funds comprehensive research and development of such technology (Parkin, 2018). The most futuristic uses, including large-scale laser arrays or interstellar travel (Kulkarni, Lubin, & Zhang 2018; Phipps et al., 2018), have robust scientific background, to the effect that the main obstacles to their implementation are practical (financial, political etc.). However, apart from specialized scientific fora, there is no legitimate platform for discussing such topics with great civilization impact. There is also no measure to hold powerful private actors accountable in such civilizational endeavors.

Space resource utilization is another rapidly expanding area in both technical and policy-related terms. Importantly, the utilization of various chemical elements and mineral resources available in space, especially on the Moon, Mars, and near-earth asteroids, is a critical step for sustainable human expansion into space. Close-distance laser-induced breakdown spectroscopy (LIBS) has been already deployed for chemical analysis on Mars (Wang et al., 2014) while parameters for its long-distance use to analyze the physical and chemical properties of Celestial bodies have been further explored by many (Choi & Yoh 2012; Knight et al., 2000; Ferus et al., 2019). Yet, despite many developments in the area, the lack of international legal framework and the resulting gridlocks once again block greater progress. The ambiguous language of the Outer Space Treaty does not provide legal clarity regarding provisions that prohibit the appropriation of Celestial bodies or require the use and exploration of space “for the benefit and in the interest of all countries”, describing such activities as “the province of all mankind”.[[10]](#footnote-10) International competition over who will get to control and exploit areas rich in key resources – which are legally considered as a province of all mankind with significant geopolitical or commercial value – is one of the causes of the gridlock over establishing a legal framework.[[11]](#footnote-11) The UN Committee on the Peaceful Uses of Outer Space (COPUOS) as the dedicated body dealing with space activities has in three years of discussions only managed to uncover numerous irreconcilable positions of different states.[[12]](#footnote-12) In the meantime, the United States, the UAE and Luxembourg have tried to unilaterally break the international gridlock by enacting domestic legislation that defies the OST principles.[[13]](#footnote-13)

# Comprehensive Legitimacy for Sustainable Governance

From this short overview, we can already discern the set of challenges that confronts sustainable governance of LTSs on the transnational and/or global levels. The long-term development, as well as the use of lasers in space, crucially require a stable form of legally sanctioned political rule which is based on acceptance of the overarching authority. Of the two sources of acceptance widely recognized in the literature – *compliance* and *legitimacy* (Kratochwil, 1984; Hurd, 1999; Wendt, 1999) –, we are mostly interested in this paper in the latter, even though we do not deny that abidance arising from actors’ self-interest or fear of punishment (as the two main modalities of compliance) may also play a temporarily stabilizing role. We nonetheless proceed on the fairly uncontroversial assumption that legitimacy, understood as an authority’s claim to rule which is either accepted as justified by its subjects or can claim acceptance on other grounds, constitutes a necessary condition of a long-term sustainable system of governance.

The “either…or” part of the previous sentence reveals that legitimacy can be approached from either the *empirical* (sociological) or *normative* perspectives. Empirical legitimacy judgments look into the facts of social reality: what matters is whether the authority’s claim has been accepted as such by its subjects.[[14]](#footnote-14) The normative view, on the other hand, employs moral principles, values, or certain procedural criteria that need to be satisfied in order for the claim to authority to qualify as legitimate. In liberal democracies, normative legitimacy is linked both to *constitutionalist principles* (rule of law, basic rights and liberties) and to *democratic values* such as self-determination and inclusive participation. If respected to a sufficient degree, these confer legitimacy on the authority’s decisions, which in turn allows the authority to *demand* rule acceptance by its subjects.[[15]](#footnote-15) We should not, however, overlook the *performance* aspect of legitimacy, usually tied to goals such as economic prosperity or maintaining peace and security, which may be again approached either empirically or normatively.

We can see that cutting across the empirical–normative distinction are the dimensions of *input* and *output* legitimacy. The former concerns the participation of the subjects of authority (usually citizens) in political decision-making, including the degree of their oversight and control of the authority; the latter captures its effectiveness at dealing with issues.[[16]](#footnote-16) From the output perspective, authority becomes legitimate if it exhibits competence (which is in turn dependent on concentrating knowledge and expertise and effectively executing an enlightened decision). The input side has to do with the authority’s capacity and willingness to reflect preferences, interests, beliefs etc. of citizens, via some aggregative (usually majoritarian) or deliberative process, or preferably both. The input v. output distinction can be variously rephrased as a tension between effective problem-solving and democratic quality, between expertise and popular voices, or between the elites and the people. Although a perfect solution to this puzzle will perhaps never be discovered, on the domestic level we can at minimum speak of a dynamic equilibrium under which both elements promise to compensate for each other’s deficiencies.

The process of globalization greatly complicates matters. The inability of states to individually address global issues, due to their territorially limited mandate as well as bounded capabilities and knowledge, undermines effective rule not only within the states themselves but also with respect to the entire international order. Some have argued that traditional international organizations (IOs) such as the United Nations, the International Monetary Fund or the World Trade Organization are uniquely placed to secure precisely this kind of goods (Lisa Maria Dellmuth & Tallberg, 2011; Ecker-Ehrhardt, 2012). Let us assume for the moment that IOs are indeed capable of effective action in the given domains. It is nonetheless obvious that the supranational input side is seriously lacking, for reasons of weak legitimacy chains (Marchetti, 2008), decreasing public support for IOs (mainly as a result of the negative effects of economic globalization which is turning those who were left behind against IOs) (Bearce & Scott, 2019), manifold gaps in the representativeness of IOs’ decision-making bodies,[[17]](#footnote-17) or the continuing autonomation of IOs (Barnett & Finnemore, 2004; Peters, 2017). Discussing the dilemma between effective governance and inclusive governance on the transnational and global levels, Robert Dahl voiced already years ago a general skepticism about legitimate *democratic* transnational/global decision-making and concluded that the deficiencies on the input side were impossible to fix.[[18]](#footnote-18) On the face of it, this would leave us with output legitimacy/effectiveness, and Fritz Scharpf’s pioneering work on legitimacy in the EU is a great example of the hope that effective output side of a political system may create space for multiple overlapping identities of its subjects (Scharpf, 1999). A complementary strategy has been recently suggested by the legal scholar Wojciech Sadurski who argues for uncoupling legitimacy from democratic mechanisms altogether on the transnational level and shifting the legitimization burden to the practice of “supranational public reason“. Democratically legitimized nation-states are construed as actors who grant (or deny) approvalto norms produced by the supranational authority, depending on the quality of *reasons* put forward on their behalf. The public justifiability of norms includes criteria such as openness to diverse points of view, offering good reasons for decisions, or “deliberate screening off of prejudice, hostility and self-interest” (Sadurski, 2015). This approach places technical output-oriented institutions under the requirement to provide additional justificatory arguments, in order to compensate for their lack of input legitimacy.

We believe that abandoning transnational democratic inputs in such a straightforward way is a mistake, a premature step that cannot be upheld. An oft-cited and a supposedly unnegotiable obstacle to transnational democracy is the absence of globally shared social pre-requisites (national identity, history or language) that enabled the emergence of democratic institutions on the national level. However, as many have pointed out, democratic decision-making institutions, *once in place*, can become themselves a generative source of them (Zürn, 2000, p. 212). Accordingly, we will emphasize below LTS’s sociability attribute under which networked space may lead to unexpected beneficial social outcomes: the procedures facilitating technological cooperation among diverse actors create social conditions out of which common political positions and ultimately common identities may emerge, opening the door for democratic input legitimacy. More speculatively, the seeming irreconcilability of input and output legitimacy could be challenged from a cosmopolitan perspective of *planet politics* which refuses to take national communities as the exclusive sources of legitimacy (Burke et al., 2016). In the context of globalized issues, especially those regarding national security or civilizational survival, we surmise that a global decision-making process possessing both input and output legitimacy is not only possible but also desirable.

In the absence of a unified global government, the idea of a system of *governance* has been put forward as a promising way of facing the challenges (Dryzek, 2002; Weiss & Wilkinson, 2013). Most generally, the concept describes collective action of various types of actors, both public and private, in different realms (national or international), irrespective of any clear boundaries (territorial or otherwise) (Stoker, 2018). Combining governance with the neighboring concept of *multi-stakeholderism*, we receive the idea of multi-stakeholder governance which splits authority and responsibility among multiple (types of) actors, opening up the possibility of productive synergy among their different perspectives, knowledge, and capabilities. It thus allows us to avoid the hasty conclusion that democracy can be rescued only through a transposition of the domestic democratic model to the global level (Bäckstrand, 2006, p. 293). As such, multi-stakeholder governance has been construed as a fix to existing legitimacy gaps (Haas, 2004; Macdonald, 2008), not least because it is assumed to provide more accountability and transparency (Arts, 2006).

In general, we welcome the idea as straightforwardly applicable to space laser policy. Multi-stakeholderism expands the scope of participants with relevant knowledge beyond political entities led by territorially limited security concerns, thus potentially addressing the difficulties arising from technical complexity and security sensitivity (see the next section). It is extremely relevant in the space sector, which has been highlighted by the rise of new private actors (commercial, like SpaceX and philanthropic, like Breakthrough Initiatives) that come with different perspectives and interests than traditional national space actors. And while the public contracts for space activities still represent the vast majority of financing and thus power in the space sector, private contracts for space security services are rapidly growing, which will inevitably come with greater influence and power of private actors. Multistakeholderism also helps avoid unworkable domestic analogies (Rolf, 2014). At the same time, however, the context-dependent approach to legitimacy we adopt from Maffettone and Ulaş leads us to restrict its applicability primarily to the development phase of space laser policy. To anticipate our later discussion, balancing the trade-offs between effective problem-solving and democratic inclusion depends on the particularities of each case and topic, tying the legitimizing criteria and mechanisms to the relevant circumstances. Precisely because the nature of LTSs facilitates the building of common identities (as prerequisites for democratic inclusion at the input), it also invites more ambitious considerations pointing towards more centralized global decision-making mechanisms in the deployment phase. From now on, we thus understand space laser governance as situated in the space whose outer bounds are defined jointly by the ideas of decentralized multi-stakeholderism and a centralized global political authority.

# Fixing Legitimacy? Legitimacy Dilemmas in the Use of Lasers

All three areas of the use of high energy laser discussed earlier involve either of two laser-based methods – photon pressure or laser ablation, achievable, respectively, by continuous wave lasers and pulsed lasers. The fact of the matter is that no single actor possesses all the necessary tools for the development of such technology, because it requires huge resources and pooled knowledge. But, and this motivates much of our subsequent argument, no single actor is capable of uncontroversial subsequent deployment either – here the predicament concerns the legitimacy of decisions with global-level ramifications.

We can say with some certainty that the first steps toward cooperative solutions have been already made. On September 25–27, 2019, a group of state and non-state institutions organized the *Prague Laser SpaceApps Workshop 2019* in Prague, Czech Republic, which brought together an international cohort of top laser and optics scientists from Russia, United States, Europe or Australia to discuss the main technical and policy challenges to the development and deployment of lasers in space.[[19]](#footnote-19) The momentum led to the establishment of the Peaceful Use of Lasers in Space initiative (PULS), as a multi-stakeholder global effort aimed at establishing global cooperation and governance regime for the peaceful use of lasers in space.[[20]](#footnote-20) We take this initiative as a useful starting point for reflecting on global legitimizing mechanisms in the governance of LTSs. In this respect, we can identify two aspects of space lasers qua a quintessential LTS in which the lack of an accepted framework of legitimacy is felt most. The present section, therefore, elaborates on the challenges pertaining to their *technical complexity* and to the *security sensitivity* that accompanies them – challenges which reveal the obstacles to effective and legitimate governance in a system dominated by states.[[21]](#footnote-21) Both exemplify the dilemma between input and output aspects of legitimacy, that is, between inclusivity and effectiveness.

## a) Technical Complexity

As mentioned above, the creation and deployment of such a large technical system are unlikely to be achieved by a single actor. With respect to the obvious technical complexity of LTSs, the inherent issue affecting the input perspective is that while no one knows your own preferences better than you do, citizens are not guaranteed to have the information, knowledge, and capability to make the best, or at least a good, decision. The growing amount of available knowledge in our society has not resulted in an improved and better-informed decision-making ability of the general public. As we can no longer acquire relevant knowledge through our own efforts, we become increasingly reliant on the intermediaries of knowledge – the experts. The result is what David Innerarity calls *well-informed ignorance* (Innerarity, 2013). At the same time, however, it is hard to dispute that the growingly complex societal issues demand *more expertise and knowledge*, in some cases making mass democratic participation at the input rather problematic. Put bluntly, some areas of social life are for good reasons shielded from direct democratic control.[[22]](#footnote-22) The complexity of the world has led some to claim that there are few policy areas left that are *choice-sensitive*, that is, areas for which the distribution of preferences among citizens actually matters or should matter. For highly technical questions that are choice-insensitive, citizens’ preferences clearly matter less, making input legitimacy appear less relevant. Another set of reasons for lowered expectations on the input arises from the increasing unpredictability of future policy agendas and issues.

At the same time, however, the empirically observable growing distrust towards elites, official authorities, and experts suggests that on its own, output legitimacy is insufficient. Moreover, too much emphasis on the performance itself contributes to real-world demands for greater input legitimacy – essentially a more direct say of the citizens themselves – especially if the performance is worse than expected. Technocratization and expertization of decision-making may prove equally dangerous to liberal democratic politics as populism, and one could even argue that the former has contributed to the emergence of the latter.[[23]](#footnote-23) So there seems to be real tension between the undeniable choice-insensitiveness of certain technically complex issues and the ubiquitous democratic desideratum of inclusion. A positive way of approaching the desideratum could be linked to recent research on epistemic benefits of diversity: There is a strong if qualified case to be made for the view that more diverse and inclusive pool of actors and ideas may significantly increase effective problem solving, especially in areas where no single actor can reasonably amass all the relevant knowledge (which is, for all we know, precisely the case with LTSs). The competition of ideas, different viewpoints, and aggregation of otherwise dispersed knowledge about complex topics *via inclusive deliberative mechanisms* seem to be capable of producing highly desirable results.[[24]](#footnote-24) But of course, harnessing and/or channeling diversity in such a way requires treating the given issue as choice-sensitive, so that various actors may contribute their pieces of knowledge. Which topics are choice-sensitive, and thus when to prefer democracy over efficiency (and vice versa), is the central dilemma of legitimacy that any theorizing about the governance of laser use in space must address.

## b) Security Sensitivity

The security sensitivity of laser use in space is abundant. Space-based lasers were heavily weaponized already by the 1980s Strategic Defense Initiative,[[25]](#footnote-25) and laser-related capabilities of major geopolitical adversaries to blind, disrupt or damage space-based assets are frequently discussed to this day (Defense Intelligence Agency, 2019; Dobos & Prazak, 2019). A ground-based infrastructure that can move space debris, deflect asteroids, or propel probes to relativistic speeds thus logically carries dramatic national security concerns due to its dual-use nature. Moreover, control over space areas rich in essential resources will determine the actors’ relative power in outer space. An additional security concern is raised by the use of lasers in emergencies, such as a substantial threat of an asteroid impact. Emergency situations are often used to justify exceptional politics and processes that would be off-limits in normal situations. In such scenarios, input legitimacy and democratic principles are side-tracked to give the political authority sufficient space to deal with the threat. Its elimination becomes the main goal while how this is achieved matters much less. Safety checks and balances are disabled and so is accountability. In short, framing an issue in terms of emergency necessarily reduces the scope and quality of democratic inputs.

An enlightening perspective on how to assess and possibly avoid such developments has been provided by Critical Security Studies (CSS). Authors working in this tradition point out that security should be construed as *securitization*, that is, a social act of constructing a security threat to a specific referent object by a securitizing actor (Buzan et al., 1998). We may thus understand the resulting beliefs as a product of the politics which precedes them – that is, the acts of the securitizing actors. Because nation-states remain the dominant political structures in both domestic and international security politics, their actions in the domain, based as they are on a political mandate acquired from the citizens of the state, rather understandably addresses primarily threats to national security. Other possible referent objects such as individual human beings, humanity as such, or the planet are predominantly pushed to the margins (Buzan et al., 1998). Even if there is a threat shared by different referent objects (countries), it will be most likely ascribed different meanings and represent different risks depending on by whom it is securitized. Hence, security constructed against the background of national interests and national political contexts creates inherent incongruence or even rivalry among actors.

However, the social nature of threat construction and securitization also opens up a path towards a refocusing of the securitization discourse. On the one hand, the dominant Copenhagen School of CSS tends to construe security as *essentially* contested, which, building on the concept of a security dilemma increases the security of one actor entails insecurity for another whose perception of the threat is different (Booth & Wheeler, 2007). A contrary perspective is advocated by the Welsh School of CSS which sees security as *contingently* contested (Booth, 2008). This means that security perceptions can be compatible if the process through which they emerge is inclusive and involves all threatened actors. However, in the current international security regime, these perceptions are overwhelmingly based upon the domestic/national perspective, which constitutes a barrier to finding shared threat perceptions and a consensus on how to tackle them. Importantly, this problem befalls securitization not only in the political but also in the scientific domain. In other words, science and politics both fall victim to securitization. Context-dependent science, especially in the field of security-sensitive technology, tends to be shaped by extant national security concerns.[[26]](#footnote-26) A globally inclusive process would, therefore, both increase input legitimacy and significantly contribute to output legitimacy, by overcoming incompatible national security interests through shared threat perception.

Hence the security sensitivity variant of the input v. output dilemma: while nation-states remain the key actors for incentivizing technological research and development as well as for immediate deployment in cases of emergency, unilateral use of space lasers is at odds with a desirable cosmopolitan perception of security that would transcend incompatible national security interests. Again, our intuition is that generating such shared priorities would be facilitated by a globally inclusive decision-making process, providing, in turn, comprehensive legitimacy for LTS governance.

# Context-Based Legitimacy Criteria

Developing a comprehensive account of legitimacy in the transnational realm is however a formidable task: the democratic dilemma is real, technical complexity of space lasers undeniable, and their security sensitivity understandable. In this paper we can, therefore, offer only the contours of a fruitful normative-theoretical approach, taking inspiration from Maffettone and Ulaş’s concept of *context-based legitimacy*. This is a meta-normative view exploring the conditions under which “a social process of seeking agreement on legitimacy criteria should proceed” (Maffettone & Ulaş, 2019, p. 82). It deliberately avoids the formulation of transcendental (context-independent) normative criteria of legitimacy (as political philosophers are wont to do), to carve out more expansive space for its empirical-sociological aspect. In doing so, it aspires to provide practical guidance for the involved actors “here and now”, emphasizing the need for enabling the effective functioning of the institution or body in question. It inquires into questions such as “Which agents are supposed to participate?” and “What are the normative constraints to their legitimizing activity?” As we shall see, theorizing legitimacy as primarily a social practice proves congenial to the issue of the use of high-power lasers in space, because it allows us to work, without obvious incoherence, with different criteria of legitimacy for different phases of the entire enterprise – while allowing context-specific trade-offs. Specifically, we will argue that each phase requires prioritizing a different set of actors, that the output and input desiderata of legitimacy can be usefully distributed between the phases (thus dissolving the dilemma), and finally that the choice-(in)sensitivity of issues can also be dealt with in a similar way. First of all, however, we will reconstruct the conceptual core of Maffettone and Ulaş’s proposal.

## a) Constituencies and their Motivation

We start with the element which comes last for Maffettone and Ulaş. In democratic theory, the foundational question of the constituency is typically dealt with along two principles of inclusion: a) the *all-subjected principle*, whereby all those who will have to abide by a norm ought to be given a say in its making, and b) the *all-affected principle*, which has it that all those who will be affected by a norm should be given the opportunity to shape it (Goodin, 2007; Näsström, 2011; Owen, 2016). The resulting group on either version is called *institutional constituency* by Maffettone and Ulaş, that is, a “fully inclusive population” picked by the respective principles. In its stead, the authors propose the idea of a *practical constituency* which is not institutionally pre-defined but changes its shape depending on the degree of interest and motivation the involved actors have with respect to the topic. After all, it is a well-known fact that regular people are in general uninterested in most political topics. Let us coin this approach the *all-involved* *principle*.

Maffettone and Ulaş think that in order for a decision to be made at all, practical constituency under the all-involved principle needs to be “far less inclusive” than the other two principles suggest and to possess “significant discretion”, a kind of “epistemic guardianship” (Maffettone & Ulaş 2019, p. 104).[[27]](#footnote-27) But we do not think this is “inevitable”, as they claim. The motivation to be involved in a technically complex or security-sensitive issue will be indeed primarily triggered by various actors’ professional interests as researchers, state officials, or profit-seekers; this is why we suggest linking practical constituency to the development phase of space laser policy. However, we cannot rule out that a wider class of actors will find the requisite motivation, for example in response to a credible threat of space debris or asteroid impact. Although such enlarging of the practical constituency may negatively affect the effectiveness of decision-making, there is also the upside in increased knowledge and epistemic quality. Moreover, the principle improves the participation strength of those whose security is disproportionately more affected.

Nonetheless, we assume that highly technical decision-making such as that related to the research & development phase of space laser policy will attract a narrower, epistemically qualified “technocratic” constituency that can provide meaningful informed consent and thus boost the effectiveness of the whole process. To employ our earlier terminology, because scientific questions surrounding laser technology are less choice sensitive or outright choice-insensitive, an institutional constituency would be unable to provide the desired solutions. This approach thus clearly shifts the balance towards effectiveness while still allowing some degree of openness. But there is a “normative floor”, too, furnished by the institutional constituency’s basic human rights which cannot be (normally) violated.[[28]](#footnote-28)

## b) Issue Criticality

The severity of the issue at hand is another element that can push legitimacy trade-offs towards effectiveness and away from inclusivity. In case of a critical need to address an emergency issue, output legitimacy or efficiency gains priority at the expense of input legitimacy and inclusivity. Such criticality can rest on scientific objectivity, argue Maffettone and Ulaş, and give the example of the scientifically justified extension of competences of the World Health Organization (WHO) in dealing with the 2003 SARS-CoV-1 epidemic. States themselves retrospectively accepted and therefore legally validated the broadening (Maffettone & Ulaş, 2019, pp. 94–95). What certainly helped the case was the empirically widely shared recognition of the seriousness of the threat, the common interest in containing the virus, and the prevalent trust that the WHO was well-equipped to deal with it.[[29]](#footnote-29) Imagine a contrary scenario in which states generally resorted to unilateral actions on the back of particularistic scientific recommendations and security perceptions dictated by national interests: effective coordinated solution would seem to be out of reach. We suggest that the behavior of many states, including China and the USA, in defiance of the WHO guidelines or in an attempt to influence WHO communication during ongoing SARS-CoV-2 pandemic, was a clear example of such a scenario. It seems justified to link their actions to the underlying national dynamics that affect the direction of science or industry by the power of the purse and national legislation. Now it might be objected that precisely the fact that many states fell back on self-regarding motives and interests in the 2020– pandemic supports the (neo)realist geopolitical image of world politics, which is of course very inhospitable to cosmopolitan-inspired political goals.[[30]](#footnote-30) However, the 2003 events and their aftermath seem to reveal a more optimistic story. At a minimum, therefore, the jury is still out; we also want to stress that in this paper we are not after a proposal for institutional design, as opposed to the conceptual exploration of legitimacy inspired by developments in an important policy sector.

At any rate, such exception-driven policies carried out by whichever actor bring about risks of a “securitization creep”, whereby the extraordinary measures become the new normal, thus gradually increasing the powers of securitizing actors. To some degree, Maffettone and Ulaş acknowledge risks inherent in relaxing the legitimacy criteria in critical situations, both as regards false negatives (think of climate change) and false positives. On the international level, the latter was felt in the debates about the *Responsibility to Protect* doctrine after its invocation in the Libyan case. The unprecedented emergency legitimization invoked to breach state sovereignty for reasons of protection of human lives (UN Security Council Resolution No. 1973) arguably led to Western countries’ overstepping their mandate: instead of protecting lives, they set their sights on regime change (de Waal, 2013). In response, the Brazilian diplomacy put forward a new concept of *Responsibility while Protecting* that included additional legitimizing mechanisms during the operations as well as afterwards, in order to balance out the shift in legitimization in critical situations (Tourinho et al., 2016).

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## c) Institutional Time Point

Finally, Maffettone and Ulaş claim that legitimacy should be judged differently for new institutional authorities than for those that already exist. Bringing subjects under a new authority calls for greater attention to the decision-making processes and overall governance design. In contrast, already existing institutions are evaluated rather on the quality of their outcomes, not least because digging too deep into well-established processes of decision-making may subvert the very grounds of the legitimacy of the institution and thus lead to its disintegration – which will be oftentimes more calamitous than its deficits in democratic inclusion. To link this aspect to the global governance dilemma, there are arguably no globally inclusive decision-making mechanisms with appropriate social and political requisites in place at this moment, and neither are international governance institutions for the use of high-power lasers in space. In contrast, the domestic infrastructures for research and development are well-evolved in many countries, often supported by scientific and administrative collaborative networks.

This is where LTSs come into play again. As complex networks, they have the potential to reinforce and sometimes create from scratch the socio-technical structures of international order and global governance. Take as an example the internet or the International Space Station: one component of their impact is that they generate important by-products without an explicit consent, intention, or even direct awareness of the involved actors. The networked reality of the given LTS disregards state sovereignty and national interests as the otherwise dominant guiding principles of political processes and practices. Instead, the sociability of LTSs creates a new networked social environment as well as normative principles for its workings. LTSs, therefore, combine both time points: first, the desirable creation of a new global institution (body) to govern an LTS such as a space laser system is likely to focus on the input-related procedures and processes. Once established, the focus shifts to its outcomes. Importantly, however, this second step happens in an already networked environment, held together by normatively regulated procedures.

# Two Phases of Space Laser Policy

We can now finally synthesize our conceptual fix on the trade-offs between inclusivity and effectiveness, read against the contextual background of technical complexity and security sensitivity. We have already hinted that space laser policy, as well as the related governance framework, can be divided into the development and deployment phases. The development phase is concerned with the governance of the research and development of high-power lasers for space; the goal here is to reach the highest possible level of technology readiness and deployability. The deployment phase concerns the governance of legitimate use of this powerful technology for the global benefit of humankind by various actors. In the two following subsections, we explain how these phases differ, linking them to what has been said in the paper so far. There are two reasons for this distinction. First, because each provides different outputs, they also require different inputs and thus different legitimacy requirements. Secondly, the two phases mutually complement each other and compensate for each other’s deficiencies. In this regard, the trade-off between inclusivity and effectivity only exists within each phase based on its characteristics. However, rather than basing the legitimacy mechanisms of the entire governance model (in other words of the two phases together) on a trade-off, which favors inclusivity for effectivity or vice-versa, we base it on a trade-in, in which an emphasis on inclusivity in one phase is compensated by an emphasis on effectivity in the other. We thus leave the idea of an irreconcilable dilemma.

## a) The Development Phase

The main goal of the development phase is effective and perhaps ground-breaking advancement of new technologies, on the back of global collaboration of multiple stakeholders across research institutes, universities, national agencies, and private companies. The legitimacy trade-offs we propose closely follow the characteristics of the development phase guide – that is, the context of legitimacy. Firstly, the development is technically very complex and, in many aspects, choice-insensitive. Secondly, it carries lower risks of security misuse compared to the deployment phase, because the research itself is benign in comparison to the subsequent use of powerful technology. Decisions pertaining to the process and conditions of scientific discovery are more easily shielded off against misuse or hijacking under the pretense of criticality. This means that in the development phase of space laser policy, greater generosity as regards the room for technocratic decision-making can be afforded. Of course, there might be some rogue regime employing top scientists with the purpose of developing space laser technology for its own purposes, while happily disregarding any internationally negotiated norms which are meant to regulate research in the given scientific area. But such evil plans would go on even if we subjected all other actors to democratic mechanisms. The more general point is that there are more efficient instruments of control of/over critical issues in research and development itself than broad democratic inclusion.[[31]](#footnote-31) On the other hand, deployment of powerful laser technology brings about much larger risks which would put in question not only regular security interests (as regards space debris removal) but, in the case of planetary defense against asteroids, ultimately also the overall survival of some actors, simply due to the hugely powerful technology involved. Here, a much more elaborate mechanism of global democratic oversight and control seems necessary. And thirdly, the outcomes of development are of greater importance than wide-ranging inclusion in the process itself. Accordingly, the technically complex and choice-insensitive area of development clicks with the less inclusive practical constituency, calling for the application of the *all-involved principle*. While open in principle, the practical constituency normally includes those actors who provide some investment in terms of capital, human resources, knowledge or infrastructure.

One could object that the development phase ultimately concerns also the all-affected or all-subjected constituencies, as long as the good or bad consequences of this new powerful technology befall them, intended or not. Such a constituency, in fact, would have to include also future generations since once the technology is born, it cannot be undeveloped. However, nipping the research of highly promising technology in the bud just because there is some danger of its future misuse seems absurd (after all, there is always also the possibility of highly beneficial use for those excluded). It is the social environment, circumstances and normative frameworks which imprint technologies with certain ethical qualities (Rees, 2004). This is why we suggest that ethical questions be predominantly publicly addressed and dealt with in the deployment phase, where inclusive democratic participation is easier to achieve thanks to lower technical complexity of the subject matter. To cite two historical examples, we should not blame millions of deaths on the discoverers of nuclear reaction or ammonia but on the deployers of the technology, especially given the fact the discoverers unlocked a highly efficient source of energy as well as fertilizers that helped feed and save billions of people. Of course, one cannot *in principle* prohibit democratic publics from addressing matters of scientific research and development. However, experience suggests that while the public can easily become interested in the results of scientific discoveries, it largely leaves the administration of LTSs to the presumed experts. For example, while the fundamental scientific knowledge delivered by the LHC project routinely attracts the attention of wide lay audiences, we do not hear calls for greater democratic control of what is going on in the labs and tunnels at the outskirts of Geneva.

The practical constituency of all-involved actors nonetheless carries a substantial coordination cost. National agencies can be motivated by the threat of debris or acquisition of powerful technology, commercial entities by the marketability of new technologies or utilization of untapped space resources, philanthropes by funding noble pet-projects of interstellar travel, and scientific institutions by unique research opportunities. Such motivations come with different purposes. This obviously applies, on the one hand, to commercial entities and national security-focused actors who are both concerned with competition in some sense, and public good-oriented entities who prioritize collaboration on the other. Geopolitical as well as commercial competition can be at odds with collaboration, information sharing, and open access to knowledge and data that make such collaborative initiative possible in the first place. While competition drives innovation, collaboration enables it. To deal with the collaboration-competition dilemma, the European Organization for Nuclear Research (CERN), arguably the biggest existing scientific collaboration, uses healthy competition over certain parts of research between different research teams as a tool to increase effectivity of the scientific collaboration (Robinson, 2019, p. 44). Best practices of existing international scientific projects like the International Thermonuclear Experimental Reactor (ITER), International Space Station (ISS) or Internet Corporation for Assigned Names and Numbers (ICANN) offer a plethora of such valuable mechanisms that go beyond this paper.

Furthermore, the involved actors are understandably keen to participate in the development of high-tech elements and sensitive parts of the infrastructure, either in order to have greater access to the created valuable knowledge or because such added-value tasks have higher returns. Still, one outstanding issue is that a mechanism that divides labor according to members’ existing capabilities would favor stronger players. Should all produced knowledge be made fully free, then some actors could free-ride by securing mundane and cheap tasks, while leaving the difficult and risky to others, generating an environment where everyone gets everything no matter their contribution. Such an environment would prove self-undermining, in the sense of preventing effective collective action. This is why there needs to be a threshold that separates freely available techno-knowledge from that which all actors can benefit from but also can compete in its innovative applications. In this model, careful distribution of knowledge, tasks, and capabilities would prevent a single actor from gaining the knowledge of the complete system. In sensitive areas, this division would have to be carefully designed in order not to threaten the national security or competitiveness of involved developers. An example of such an approach is the EU’s Copernicus and Galileo satellite programs that make their data freely available for commercialization. Meanwhile, more security-sensitive data are reserved only for the security authorities of the EU member states. All in all, practices which coordinate different motivations towards a functioning LTS are to stand at the forefront of the legitimacy discussion in the development phase.

The processes and practices that will be adopted to address the coordination issues over space lasers will define the social structure of this LTS. They will constitute the networked reality shared by all stakeholders, embedding the particularistic (national, commercial, philanthropic) interests of the respective actors in a collaborative enterprise. This is the shift of the underlying social dynamics brought about by LTSs, one which leads away from power constellations of international politics which are locked in by national interests and state sovereignty (Mayer & Acuto, 2015, p. 672–73). In *security-sensitivity* terms, the multi-stakeholder networked environment of shared practices, processes, and procedures is in itself socially constitutive, bringing closer together the perceptions of involved stakeholders. This does not mean that conflicting national perspectives will suddenly align under shared interests (as we have witnessed with the recent CoV-SARS-2 pandemic which initially created more geopolitical rivalry rather than cooperation). Rather, the multi-stakeholderism will give a bigger voice and power to commercial and philanthropic actors, who are becoming more resourceful and influential (for example in the areas of Space Safety). This is a trend we can see especially with the rise of new private (commercial and philanthropic) actors in space, who, thanks to their hard-to-match financial power and technological breakthroughs, become highly influential in shaping the international rules, practices, and dynamics in the outer space domain. The networked reality of the multi-stakeholder environment would thus shift with their direct involvement. Equipped with a modicum of constructivist optimism regarding the malleability of actors’ identities and interests, we may plausibly expect national security preferences and priorities to change as well, even though possibly not to an identical degree or direction.

In terms of *technical complexity*, multi-stakeholder environment enables exploiting the epistemic diversity that comes with varied sources of dispersed knowledge, thus increasing the effectiveness of research. The development phase is likely to produce technology with spin-off uses on the commercial market, which will entice the involvement of private actors and therefore incorporate profit-driven innovation and effective utilization of the technology (also, private stakeholders often seek external legitimization for their commercial activities). Such spin-off use, whether in the medical, heavy industry or communication sectors, represents an important reason for both private and public, commercial and non-commercial actors to invest in basic research and development.

The three types of application of lasers in space – orbital debris removal, defense of Earth against comets and asteroids, and space exploration and space resource utilization – each come with a different level of technology readiness. While some require dramatic progress in their technology readiness level (TRL) beyond critical first steps, others face a different set of challenges.[[32]](#footnote-32) TRL progress as the core measurable output in this phase is to be evaluated against a list of critical checkpoints set by the epistemic community; this will be facilitated by regular independent reports on scientific progress. For all these reasons, the trade-off between effectiveness and inclusivity in the development phase is tilted towards the former. The lack of democratic input and accountability can be compensated for in the deployment phase, thanks to its lower technical complexity but also the already globally networked social space of high-power space lasers development. While the nuts and bolts of development cannot be fully understood by the wider public, they can be translated into choice-sensitive decisions about the deployment of the LTS, for which a sufficiently informed consent of the public seems more likely.

## b) The Deployment Phase

The deployment phase concerns the use of the laser system for the three types of task. Our core idea is that the related legitimacy trade-offs can balance out the output tilt of the development phase, because deployment encompasses more choice-sensitive issues which are already embedded in a globally networked environment of the given LTS (as it has emerged during research and development). The combination of broader technical accessibility, higher security risks, and networked environment transcending borders both enable and require a more inclusive constituency. This is why institutional constituency, whether in its all-affected or all-subjected forms, becomes both possible and desirable in this phase.

First, decisions about the use of the high-power laser system present lower technical complexity and thus require less expert knowledge from the constituency, broadening its potential scope. In the development phase, it seems justifiable to tilt the trade-off towards effectiveness secured by a less inclusive scientific development authority, because it does not directly affect the basic rights and security of all affected or subjected individuals. In contrast, the deployment of laser technology for orbital safety, planetary defense, or space exploration quite obviously *does* concern all of humankind, whether viewed through a legal, political, economic, or ethical lens.

Second, the deployment phase during which extremely powerful technology will be put in use presents a much higher risk of premature unilateral securitization, which is why such decisions require a much higher degree of accountability to the subjects. As explained earlier, security perceptions are determined by the context, processes, and actors involved in the social construction of security. Making the process as inclusive as possible helps avoid irreconcilable – that is, *essentially* contested – perceptions of (in)security, opening the door to *contingently* contested (= reconcilable) perceptions. Higher democratic control increases the probability that the technical system is not hijacked by a particular stakeholder for his or her particular security interests but is utilized within a normative framework of shared (preferably global) security perceptions. But this still leaves sufficient room for emergency (“critical”) cases which justify exceptional legitimacy trade-offs in favor effectiveness. Of course, there cannot be a blank emergency cheque for the deploying authority, which is why each decision to use the laser system needs to be scrutinized, at minimum, retrospectively once the situation eases up (as also suggested by Maffettone and Ulaş).

Third, the institutional timepoint criterion allows combining input and output legitimacy in yet another manner. On the one hand, multi-stakeholder governance of the LTS during the development phase creates the socially shared perceptions, practices and processes – networked environment – that generate, as their by-product, the social conditions necessary for global democratic institutions. We have argued that these are necessary for the legitimate deployment of a high-power laser system in space. On the other hand, desirable outcomes in terms of global public goods, be it orbital safety, defense against asteroids or space exploration are an indirect consequence of the very existence of these networks. Moreover, these objectives are also well-specified which makes achieving them more easily measurable and publicly verifiable. For example, remote laser-ablation would facilitate physical and chemical analysis of regolith found on Celestial bodies, which is necessary for subsequent resource utilization, scientific understanding of the Solar System’s past, or selection of an appropriate asteroid deflection method in case such need arises.

All these objectives would need to be quantifiable, verifiable, and subject to independent auditing. The commodification of space debris removal or prospecting of threatening asteroids, for example by assigning to these otherwise non-profitable public goods s either a financial value (as exemplified by the carbon emission market), or use of tradable certificates enabling space resources utilization, can provide a source of funding for the high-power laser system, while also provide a new legal framework for these three laser-related areas. Avoiding the specifics, the main contribution of our framework is the establishment of a shared global mechanisms of input legitimacy and accountability which would move us closer to breaking through the current gridlock, by pushing the mechanisms we have been analyzing. These include facilitation of closer and perhaps even shared threat perceptions, moderation of the security dilemma, or reframing of national interests as contingently contested. Table 1 summarizes the elements of our discussion.

Table 1: Legitimacy Trade-Offs Between Development and Deployment Phases

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | *Choice-sensitivity* | *Social environment* | *Constituency* | *Trade-off priority* |
| **Development phase** | Lower due to higher technical complexity, lower risk of securitization and criticality | Multiple stakeholders with different interests and motivations | Practical constituency (all-involved) | Effectiveness (output-oriented legitimacy) |
| **Deployment phase** | Higher due to lower technical complexity, higher risk of securitization and criticality | Globally networked large technical system | Institutional constituency (all-affected or all-subjected) | Inclusivity (input-oriented legitimacy) |

# Conclusion: LTSs as a Way Towards Networked Social Reality

The ongoing changes of the world, as a result of the technological advances, dominance of profit economy, and variety of globalization, have been described by Ulrich Beck as a value-free metamorphosis of the world (Beck, 2016). Social sciences and especially international relations theory need to help us understand this metamorphosis, including its causal role in the increasing incongruence between the borderless reality of the globalized world in terms of technology and the persisting territorial social and political structures. In this context, we have looked at high-power space lasers as a quintessential example of a large technical system which can shift the bounds of sociability beyond territorially defined polities. Our overarching aim has been to put forward a novel conceptualization of context-based legitimacy trade-offs between effectiveness and inclusivity.

Firstly, we have argued that the trade-off ought to be designed according to the context of the governance area. Thus, for the case of a large technical system, we employ a context-based legitimacy framework focused on criticality, institutional timepoint, and motivational landscape. This has allowed us to explore the trade-offs between effectivity and inclusivity in the highly technical, security-sensitive and global governance-heavy area of a large laser system. Building upon this, the main contribution of the paper is in construing the dilemma not as a trade-off, in which effectivity and inclusivity are mutually exclusive, but as a *trade-in*, in which they both are mutually essential and need to be accorded equal importance so that they jointly provide the required legitimacy. Our argument is that by abandoning inclusivity for effectivity or the other way around, we end up diminishing both. We thus abandon the logic of a dilemma and move towards mutually constitutive trade-in between effectivity and inclusivity, in which both are possible. Also, while it might be desirable to increase the weight of one at the expense of the other in some parts of the governance process, it should be compensated for in others. Accordingly, by analyzing choice-sensitivity, social environment, and constituency of each phase, we have explained how and why the development stage allows prioritizing effectiveness over inclusivity while the deployment phase requires the opposite approach.

The underlying hope is that peaceful use of lasers in space offers some more general lessons about political decision-making vis-à-vis great challenges brought about by the globalized world. Initiatives as the Peaceful Use of Lasers in Space, which aim to create multi-stakeholder scientific cooperation on the development and deployment of a large laser system, have the potential to nurture a networked social reality complementing, influencing, and potentially perhaps surpassing the dominant national perspectives. With the rise of new private actors especially in space technology and exploration, the emergence of private-funded LTSs having global impacts is not only likely but in fact already happening, as the case of the SpaceX company attests. We are not claiming that states will be suddenly willing to cooperate on scientific projects that will bring them automatically closer together. Rather, we have highlighted the shift of power in terms of finance and technology from the public towards the private and considered the motivation for states to participate in such a large technical system: contributing to the collective effort is a way to secure their continuing relevance and power even in the context of growing empowerment of New Space players as the shapers of the social environment in which technology emerges.

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1. For example, at least four models of a global political regime (authoritarian-collective, globalist, radical democratic, and anarchic) are put forward by Mann & Wainwright, 2018 as possible results of the existential need to deal with climate change. [↑](#footnote-ref-1)
2. Examples include multi-stakeholder governance models of the internet (ICANN), telecommunication (ITU), or space (ISS). [↑](#footnote-ref-2)
3. Data according to European Space Agency Space Debris Office. Available at <https://www.esa.int/Safety_Security/Space_Debris/Space_debris_by_the_numbers>. [↑](#footnote-ref-3)
4. While private companies are contracted to provide capabilities and data on SST by public entities, the complete catalogs of objects, related services, and overall space situational awareness remain in the hands of governments. [↑](#footnote-ref-4)
5. Data according to European Space Agency Planetary Defense Office NEO Coordination Centre. Available at <http://neo.ssa.esa.int/> [↑](#footnote-ref-5)
6. The SMPAG recommended development of technologies for compositional analysis as well as push deflection methods of asteroids in September 2019 and January 2020, respectively. [↑](#footnote-ref-6)
7. As quoted in the *Terms of Reference* of the Space Mission Planning Advisory Group, available at <https://www.cosmos.esa.int/web/smpag/terms-of-reference-v0> [↑](#footnote-ref-7)
8. The *SMPAG Legal Report* points out further legal issues for the planetary defence such as illegality of the use of nuclear explosive devices for deflection. [↑](#footnote-ref-8)
9. For example, within the United Nations General Assembly 5% of the global population possesses the majority of votes. See Archibugi 2004, 448–49. [↑](#footnote-ref-9)
10. Art. 1 of the OST. For succinct review of the issue see Švec, Bohacek, & Schmidt 2020. [↑](#footnote-ref-10)
11. Among all resources water is seen as the most realistic and valuable for its use, as are oxygen and hydrogen, key fuel elements which can unlock development of cis-lunar economy. Its concentration in scarce permanently shadowed areas of the Moon’s poles invite many analogies with terrestrial conflicts over resources. [↑](#footnote-ref-11)
12. UN COPUOS Legal Subcommittee, Report of the Legal Subcommittee on its Fifty-Fifth Session, held in

Vienna from 4 to 15 April 2016, UN Doc A/AC.105/1113. [↑](#footnote-ref-12)
13. Other examples of the gridlock include failures of the UN COPUOS to launch non-formal discussions about forming working groups on space mining, or the non-binding and inconclusive findings of the Hague Working Group. [↑](#footnote-ref-13)
14. Research on factors contributing to the decisions being perceived as legitimate suggests that there are both individual and structural factors at play. The former have to do with socio-economic well-being, identity and personal values, or familiarity with politics (See Norris, 2000; Hooghe, 2017; Lisa M. Dellmuth et al., 2018), the latter include such issues as the level of economic development or specific historical and cultural patterns (See Inglehart & Welzel, 2005; Scholte & Tallberg, 2018). [↑](#footnote-ref-14)
15. For a comprehensive overview with a wealth of references see Peters, 2010. [↑](#footnote-ref-15)
16. The distinction between input and output legitimacy has been developed by Fritz Scharpf since 1970s; see Scharpf, 1999. [↑](#footnote-ref-16)
17. Among the most apparent examples is the exclusive United Nations Security Council or the United Nations General Assembly in which many small populations are awarded significantly bigger voice and voting power “per capita” in IOs. See also Archibugi, 2004. [↑](#footnote-ref-17)
18. The main issues identified by Dahl include diversity as an obstacle for consensus, lack of global political culture enabling prevention of conflicts, and the inability to secure informed consent on global topics. See Dahl, 1999, 1994. [↑](#footnote-ref-18)
19. See Institute of Physics of the Czech Academy of Sciences, 2019 or McEnchroe, 2019. [↑](#footnote-ref-19)
20. UNCOPUOS STSC statement by the Czech Republic from February 6th 2020 available at <https://www.unoosa.org/documents/pdf/copuos/stsc/2020/statements/2020-02-06-PM-Item04-05-CzechiaE.pdf> [↑](#footnote-ref-20)
21. While this is certainly not an exhaustive list, it reflects the main governance challenges identified in the final report of the *Prague Laser SpaceApps Workshop*. [↑](#footnote-ref-21)
22. The judicial branch is another such example. The importance of democratic deficits in certain areas is well argued in Moravcsik, 2002. [↑](#footnote-ref-22)
23. For an inquiry into this dynamic in the Central and Eastern Europe see Kosař, Baroš, & Dufek, 2019; also Caramani 2017. [↑](#footnote-ref-23)
24. See Hong & Page, 2004; Landemore & Page, 2015. [↑](#footnote-ref-24)
25. Two authoritative sources are the Bloomberg-Patel’s “Report to the American Physical Society of the Study Group on Science and Technology of Directed Energy Weapons” and the Strategic Defense Initiative Organization’s “Space-Based Chemical Laser in Strategic Defense”. [↑](#footnote-ref-25)
26. This is a huge topic to which we cannot do justice here. The claim that even scientific truths are subject to social realities they emerge in as well as to interests that shape the way these scientific observations are interpreted has been developed along many paths in Science and Technology Studies, and more generally in the sociology of science. Nonetheless, all converge on the observation that a full evaluation of security cannot be done without a throughout analysis of the process, context and consequences of reaching the state of security. See Rychnovská, Pasgaard, & Berling, 2017; Li, 2007; Jasanoff, 1990. Although Meyer and Acuto do expand on this topic in their paper on LTS governance, we have different aims here. [↑](#footnote-ref-26)
27. This is likely a reference to Dahl’s discussion of guardianship-type of rule in Dahl 1989, chap. 4. [↑](#footnote-ref-27)
28. Perhaps unless a “catastrophic moral horror” is imminent, to use Nozick’s memorable phrase. See Nozick, 1974, p. 30. [↑](#footnote-ref-28)
29. We are not claiming the stance was unanimous, as the actions of China, the USA, and several other states attest. [↑](#footnote-ref-29)
30. We thank the reviewer of the journal for pressing us on this point. [↑](#footnote-ref-30)
31. We add some specifics below when discussing the development phase itself. [↑](#footnote-ref-31)
32. Technology Readiness Level is a measurement for the maturity of technologies developed by NASA. [↑](#footnote-ref-32)