### Contention 1 --- Inherency

### Near-Earth Object detection is underfunded --- preventing NASA from beginning key projects

New Yorker 11 (“Vermin of the Sky; Who Will Keep The Planet Safe From Asteroids?”, 2-28, Lexis)

At the moment, the number of asteroids judged suitable for a human visit is fewer than nine, and perhaps as few as zero. So there is an obvious need to find more asteroids-and to learn considerably more about what it's like to operate in their neighborhoods. Paul Abell, the lead NEO scientist at NASA's Johnson Space Flight Center, said that, to find the right asteroid for a human mission, "my personal opinion is we need a space-based survey telescope, which could give us up to forty times the number of targets." Within two and a half years, the Venus-orbit telescope touted by the Task Force could find several hundred promising asteroids closer to home, which could cut billions of dollars out of the price of a mission. Yet what would be a small step for a human mission turns out to be a giant leap for planetary defense: NASA has already indicated that it doesn't have the roughly six hundred and fifty million dollars needed to fund the telescope. And a practice grapple with an asteroid may occur, as vaguely promised by the White House, only when the human mission launches, in fourteen years. (If it does launch: in January, an internal NASA study suggested that a human mission to an asteroid would be "too costly.")

### Advantage 1 --- NEO Strikes

### Huge numbers of NEOs could hit at any time without warning and cause extinction --- lack of detection technology leaves us helpless

NRC 10 (National Research Council, “Defending Planet Earth: Near-Earth Object Surveys and Hazard Mitigation Strategies”, Committee to Review Near-Earth-Object Surveys and Hazard Mitigation Strategies, http://www.nap.ed u/catalog.php?record\_id=12842)

2. In December 2004, astronomers determined that there was a non-negligible probability that near-Earth asteroid Apophis (see Chapter 4 for more details) would strike Earth in 2029. As Apophis is an almost 300-meterdiameter object, a collision anywhere on Earth would have serious regional consequences and possibly produce transient global climate effects. Subsequent observations of Apophis ruled out an impact in 2029 and also determined that it is quite unlikely that this object could strike during its next close approach to Earth in 2036. However, there likely remain many Apophis-sized NEOs that have yet to be detected. The threat from Apophis was discovered only in 2004, raising concerns about whether the threat of such an object could be mitigated should a collision with Earth be determined to have a high probability of occurrence in the relatively near future.

### Strikes are likely --- two distinctions:

### 1st --- *Long-Period Comets* --- they’re likely, evade current defenses, and risk extinction

IAA 9 (International Academy of Astronautics, “Dealing With The Threat To Earth From Asteroids And Comets”, http://iaaweb.org/iaa/Scientific%20Activity/Study%20Groups/SG%20Commission%203/sg35/sg35finalreport.pdf)

Detection of Long-Period Comets Long-period comets (LPCs) tend to be ignored in NEO studies at this time because the probability of an impact by a long-period comet is believed to be very much smaller than by an asteroid. However, virtually all NEOs larger than a few kilometers are comets rather than asteroids, and such large NEOs are the most destructive, and potentially the “civilization killers”. Additionally, the Earth regularly passes through the debris field of short-period comets giving us the annual meteoroid showers such as the Leonids and Taurids. These are very predictable but thankfully benign impact events. If the Earth were to encounter sizable objects within the debris field of a long-period comet, we would likely have very little warning time and would potentially be confronted with many impactors over a brief period of time. Although this type of event is currently speculative, this is a conceivable scenario which humanity could face. While the risk of a cometary impact is believed to be small, the destruction potential from a single large, high velocity LPC is much greater than from a NEA. Therefore, it is important to address their detection and potential methods for deflecting, disrupting, or mitigating the effects before one impacts the Earth.

### 2nd --- *Small NEOs* --- they’re extremely frequent and pass through current detection

Binzel 11 (Richard, Professor of Planetary Sciences – MIT, “Richard Binzel on Near-Earth Asteroids”, Space Daily, 7-1, http://www.spacedaily.com/reports/Richard\_Binzel\_on\_near\_Earth\_asteroids\_999.html)

Actually, asteroids of this size passing this close to Earth is relatively normal and the fact that they miss more often than hit is just good fortune - Earth is a relatively small target in the vastness of space. We expect that objects like this come by this close once every five to 10 years - very frequently by astronomical standards. Credit goes to the LINEAR program for their dedicated survey work that found this one. Even though Lincoln Lab astronomers and a very small number of other teams are working to scan the entire sky over the course of a month searching for incoming asteroids, the telescopes available for this work are rather modest in size and objects such as this might easily slip through the search network. Our Lincoln Lab colleagues have been surveying for more than a decade and it has been just a matter of time that an object like this one might be caught in their search pattern.

### It’s try-or-die --- comet or asteroid impact is inevitable

Verschuur 96 (Gerrit, Adjunct Professor of Physics – University of Memphis, Impact: The Threat of Comets and Asteroids, p. 158)

In the past few years, the comet impact scenario has taken on a life of its own and the danger of asteroids has been added to the comet count. In the context of heightened interest in the threat, reassuring predictions have been offered about the likelihood of a civilization-destroying impact in the years to come. Without exception, the scientists who have recently offered odds have been careful in making any statement. They have acted in a "responsible" manner and left us with a feeling that the threat is not worth worrying about. This is not to criticize their earnest efforts, only to point out that estimates have been attempted for centuries. The way I look at the business of offering odds is that it hardly matters whether the chance of being wiped out next century is 1 in 10,000, for example, or that the likelihood of a civilization-destroying impact is once in a million years. That's like betting on a horse race. The only thing that is certain is that a horse will win. What matters is the larger picture that begins to force itself into our imagination; comet or asteroid impacts are inevitable. The next one may not wipe us out in the coming century, or even in the century after that, but sooner or later it will happen. It could happen next year. I think that what matters is how we react to this knowledge. That, in the long run, is what will make a difference to our planet and its inhabitants. It is not the impact itself that may be immediately relevant; it is how we react to the idea of an impact that may change the course of human history. I am afraid that we will deal with this potentially mind-expanding discovery in the way we deal with most issues that relate to matters of great consequence; we will ignore it until the crisis is upon us. The problem may be that the consequences of a comet catastrophe are so horrendous that it is easiest to confront it through denial. In the end, though, it may be this limitation of human nature that will determine our fate.

### The impact is extinction --- *high magnitude* and *aperiodic strikes* shatter traditional considerations of “timeframe” and mean we should treat NEO threats as immanent

Brownfield 4 (Roger, Gaishiled Project, “A Million Miles a Day”, Presentation at the Planetary Defense Conference: Protecting Earth From Asteroids, 2-26, [http://www.aiaa.org/content.cfm?pageid=406&gTable= Paper&g](http://www.airpower.maxwell.af.mil/airchronicles/cc/france2.html?pageid=406&gTable=%20Paper&g) ID=17092)

Once upon a time there was a Big Bang... Cause/Effect - Cause/Effect -Cause/Effect and fifteen billion years later we have this chunk of cosmos weighing in at a couple trillion tons, screaming around our solar system, somewhere, hair on fire at a million miles a day, on course to the subjective center of the universe. Left to its own fate -- on impact -- this Rock would release the kinetic energy equivalent of one Hiroshima bomb for every man, woman and child on the planet. Game Over... No Joy... Restart Darwin's clock… again. No happy ever after. There is simply no empirical logic or rational argument that this could not be the next asteroid to strike Earth or that the next impact event could not happen *tomorrow*. And as things stand we can only imagine a handful of dubious undeveloped and untested possibilities to defend ourselves with. There is nothing we have actually prepared to do in response to this event. From an empirical analysis of the dynamics and geometry of our solar system we have come to understand that the prospect of an Earth/asteroid collision is a primal and ongoing process: a solar systemic status quo that is unlikely to change in the lifetime of our species. And that the distribution of these impact events is completely aperiodic and random both their occasion and magnitude. From abstracted averaged relative frequency estimates we can project that over the course of the next 500 million years in the life of Earth we will be struck by approximately 100,000 asteroids that will warrant our consideration. Most will be relatively small, 100 to 1,000 meters in diameter, millions of tons: only major city to nation killers. 1,000 or so will be over 1,000 meters, billions of tons and large enough to do catastrophic and potentially irrecoverable damage to the entire planet: call them global civilization killers. Of those, 10 will be over 10,000 meters, trillions of tons and on impact massive enough to bring our species to extinction. All these asteroids are out there, orbiting the sun... now. Nothing more needs to happen for them to go on to eventually strike Earth. As individual and discrete impact events they are all, already, events in progress. By any definition this is an existential threat. Fortunately, our current technological potential has evolved to a point that if we choose to do so we can deflect all these impact events. Given a correspondingly evolved political will, we can effectively manage this threat to the survival of our species. But since these events are aperiodic and random we can not simply trust that any enlightened political consensus will someday develop spontaneously before we are faced with responding to this reality. If we would expect to deflect the next impact event a deliberate, rational punctuated equilibrium of our sociopolitical will is required now. The averaged relative frequency analysis described above or any derived random-chance statistical probabilistic assessment, in itself, would be strategically meaningless and irrelevant (just how many extinction level events can we afford?). However, they can be indirectly constructive in illuminating the existential and perpetual nature of the threat. Given that the most critically relevant strategic increment can be narrowly defined as the next “evergreen” 100 years, it would follow that the strategic expression of the existent risk of asteroid impact in its most likely rational postulate would be for one and only one large asteroid to be on course to strike Earth in the next 100 years... If we do eventually choose to respond to this threat, clearly there is no way we can address the dynamics or geometry of the Solar System so there is no systemic objective we can respond to here. We can not address 'The Threat of Asteroid Impact' as such. We can only respond to this threat as these objects present themselves as discrete impending impactors: one Rock at a time. This leaves us the only aspect of this threat we *can* respond to - a rationally manifest first-order and evergreen tactical definition of this threat Which unfortunately, as a product of random-chance, includes the prospect for our extinction. Asteroid impact is a randomly occurring existential condition. Therefore the next large asteroid impact event is inevitable and expectable, and that inevitable expectability begins... now. The Probability is Low: As a risk assessment: “The probability for large asteroid impact in the next century is low”... is irrelevant. Say the daily random-chance probability for large asteroid impact is one in a billion. And because in any given increment of time the chance that an impact will not happen is far greater than it will, the chance that it will happen can be characterized as low. However, if we look out the window and see a large asteroid 10 seconds away from impact the daily random-chance probability for large asteroid impact will still be one in a billion... and we must therefore still characterize the chance of impact as low... When the characterization of the probability can be seen to be tested to be in contradiction with the manifest empirical fact of the assessed event it then must also then be seen to be empirically false. Worse: true only in the abstract and as such, misleading. If we are going to *respond* to these events, when it counts the most, this method of assessment will not be relevant. If information can be seen to be irrelevant ex post it must also be seen to be irrelevant ex ante. This assessment is meaningless. Consider the current threat of the asteroid Apophis. With its discovery we abandon the average relative frequency derived annual random-chance probability for a rational conditional-empiric probabilistic threat assessment derived from observing its speed, vector and position relative to Earth. The collective result is expressed in probabilistic terms due only to our inability to meter these characteristics accurately enough to be precise to the point of potential impact. As Apophis approaches this point the observations and resulting metrics become increasingly accurate and the conditional-empiric probability will process to resolve into a certainty of either zero or one. Whereas the random-chance probability is unaffected by whether Apophis strikes Earth or not. These two probabilistic perceptions are inherently incompatible and unique, discrete and nonconstructive to each other. The only thing these two methodologies have in common is a nomenclature: probability/likelihood/chance, which has unfortunately served only to obfuscate their semantic value making one seem rational and relevant when it can never be so. However, merely because they are non rational does not make averaged relative frequency derived random-chance probabilities worthless. They do have some psychological merit and enable some intuitive 'old lady' wisdom. When we consider the occasion of some unpredictable event that may cause us harm and there is nothing tangible we can do to deflect or forestall or stop it from happening, we still want to know just how much we should worry about it. We need to quantify chance not only in in case we can prepare or safeguard or insure against potentially recoverable consequences after the fact, but to also meter how much hope we should invest against the occasion of such events. Hope mitigates fear. And when there is nothing else we can do about it only then is it wise to mitigate fear... “The probability for large asteroid impact in the next century is low” does serve that purpose. It is a metric for hope. Fifty years ago, before we began to master space and tangibly responding this threat of asteroid impact became a real course of action, hope was all we could do. Today we can do much more. Today we can hold our hope for when the time comes to successfully deflect. And then, after we have done everything we can possibly do to deflect it, there will still be of room for hope... and good luck. Until then, when anyone says that the probability for large asteroid impact or Extinction by NEO is low they are offering nothing more than a metric for hope -- not rational information constructive to metering a response or making a decision to do so or not. Here, the probability is in service to illusion... slight-of-mind... and is nothing more than comfort-food-for-thought. We still need such probabilistic comfort-food-for-thought for things like Rogue Black Holes and Gamma Bursts where we are still imaginably defenseless. But if we expect to punctuate the political equilibrium and develop the capability to effectively respond to the existential threat of asteroid impact, we must allow a rational and warranted fear of extinction by asteroid impact to drive a rational and warranted response to this threat forward. Forward into the hands and minds of those who have the aptitude and training and experience in *using* fear to handle fearful things. Fear focuses the mind... Fear reminds us that there are dire negative consequences if we fail. If we are going to concern ourselves with mounting a response and deflecting these objects and no longer tolerate and suffer this threat, would it not be far more relevant to know in which century the probability for large asteroid impact was *high* and far more effective to orient our thinking from when it *will not* to when it *will* occur? But this probabilistic perspective can not even pretend to approach providing us with that kind of information. As such, it can never be strategically relevant: contribute to the conduct of implementing a response. The same can be said when such abstract reasoning is used to forward the notion that the next asteroid to strike Earth will likely be small... This leads us to little more than a hope based Planetary Defense. If we are ever to respond to this threat well then we must begin thinking about this threat better. Large Asteroid Impacts Are Random Events. Expect the next one to occur at any time. Strategically speaking, this means being at DefCon 3: lock-cocked and ready to rock, prepared to defend the planet and mankind from the worst case scenario, 24/7/52... forever. Doing anything less by design, would be like planning to bring a knife to a gunfight. If we expect our technological abilities to develop and continue to shape our nascent and still politically tacit will to respond to this threat: if we are to build an effective Planetary Defense, we must abandon the debilitating sophistry of “The probability for large asteroid impact in the next century is low” in favor of rational random inevitable expectation... and its attendant fear.

### Asteroid-induced extinction is *by far* the biggest impact

Matheny 7 (Jason G., Professor of Health Policy and Management – Bloomberg School of Public Health at Johns Hopkins University, “Reducing the Risk of Human Extinction”, Risk Analysis, 27(5), October, [http://jgmatheny.org/ matheny\_extinction\_risk.htm](http://www.airpower.maxwell.af.mil/airchronicles/cc/france2.html))

Even if extinction events are improbable, the expected values of countermeasures could be large, as they include the value of all future lives. This introduces a discontinuity between the CEA of extinction and nonextinction risks. Even though the risk to any existing individual of dying in a car crash is much greater than the risk of dying in an asteroid impact, asteroids pose a much greater risk to the existence of future generations (we are not likely to crash all our cars at once) ([Chapman, 2004](http://www.airpower.maxwell.af.mil/airchronicles/apje.html)). The "death-toll" of an extinction-level asteroid impact is the population of Earth, plus all the descendents of that population who would otherwise have existed if not for the impact. There is thus a discontinuity between risks that threaten 99% of humanity and those that threaten 100%.

[CONTINUES – OMITTING SEVERAL MATH-CENTRIC TABLES]

I believe that if we destroy [hu]mankind, as we now can, this outcome will be *much worse* than most people think. Compare three outcomes:

1. Peace

2. A nuclear war that kills 99% of the world's existing population

3. A nuclear war that kills 100%

2 would be worse than 1, and 3 would be worse than 2. Which is the greater of these two differences? Most people believe that the greater difference is between 1 and 2. I believe that the difference between 2 and 3 is very much greater … . The Earth will remain habitable for at least another billion years. Civilization began only a few thousand years ago. If we do not destroy [hu]mankind, these thousand years may be only a tiny fraction of the whole of civilized human history. The difference between 2 and 3 may thus be the difference between this tiny fraction and all of the rest of this history. If we compare this possible history to a day, what has occurred so far is only a fraction of a second.

Human extinction in the next few centuries could reduce the number of future generations by thousands or more. We take extraordinary measures to protect some endangered species from extinction. It might be reasonable to take extraordinary measures to protect humanity from the same.19 To decide whether this is so requires more discussion of the methodological problems mentioned here, as well as research on the extinction risks we face and the costs of mitigating them.20

### Even small strikes have a massive impact --- *economic* and *climatic* effects are on par with nuclear war

Nemchinov 8 (Ivan, Valery Shuvalov, and Vladimir Svetsov, Institute for Dynamics of Geospheres, Russian Academy of Sciences, Main Factors of Hazards Due to Comets and Asteroids, Catastrophic Events Caused by Cosmic Objects)

A large number of special and review papers devoted to the problems of hazards due to comets and asteroids have been published recently, e.g., Morrison et al. (1994, 2002), Toon et al. (1994, 1997), Binzel (2000), and Chapman et al. (2001). It is now generally accepted that impacts of cosmic bodies of about 1 km and larger pose a serious danger to modern civilization and even to the survival of humanity. Nevertheless, smaller bodies can be hazardous also. Asteroids and comets from 30-50 m to 0.5-1 km, “small” cosmic bodies, collide with the Earth much more frequently than large impactors. The NEO programs now search for objects 1-2 to 0.1-0.2 km in size, but it is difficult to find small bodies in space because their cross-sections are very small and they are faint at large distances from the Earth. Therefore, catalogues of these bodies will be 90% completed not earlier than 15-20 years from now, even if the necessary large telescopes are constructed. If some of the NEOs are on a collision course with Earth, they will be found only a short time before impact, and a short warning time hinders adoption of necessary mitigation measures. The consequences of the impact of small cosmic bodies have not been thoroughly studied; however, they have specific features in comparison with larger impacts. During a passage through the atmosphere small bodies become deformed and fragmented by aerodynamic forces. A resulting stream of fragments, vapor, and air has a larger cross-section and smaller density, and releases a large portion of its energy in the atmosphere before the impact on the ground or the surface of oceans and seas. Thus, amplitudes of seismic and/or tsunami waves substantially differ from those produced by impactors that hit the ground as compact bodies. To predict these and other effects investigators need to know the shape, structure, strength, composition, and other properties of impactors that influence the result of impacts much more than in the case of large bodies. Nevertheless, simple estimates and analysis of the famous Tunguska event, which occurred in the almost uninhabited Siberian taiga in 1908, show that even if energy on the order of 5-20 Mt TNT is released above the ground (e.g., at altitudes of 5-10 km in the case of the Tunguska event), the resultant shock wave and thermal radiation produce great devastation. If such an event were to happen above a major city with a size of about 20-30 km and a population of several million persons, economic losses and human casualties would be enormous. Hazardous factors such as shock waves, fires, ejection of dust and formation of soot, seismic waves, and tsunamis are now well known. Some additional bodies: the presence on the Earth’s surface of so-called dangerous, e.g., hydroelectric dams, nuclear power plants, radioactive waste depositories, chemical plants producing poisonous substances, and so on. Concentration of such objects, as well as population density, differs from one geographic region to another. Some regions, such as Europe, are much more vulnerable to impacts than others. The study of the consequences of small impacts is partially based on the results of nuclear tests. The yield of the most powerful nuclear explosion exploded in the air at a low altitude above Novaya Zemlya in 1961 was 58 Mt TNT. This is on the order of the energy released by the Tunguska meteoroid on 30 June 1908. However, cosmic bodies, which here are named small bodies, may have a much larger kinetic energy equivalent of 10^3- 10^4 Mt TNT. The characteristic sizes of high-pressure volumes and fireballs produced by impacts with such energies are comparable to the atmospheric scale height. Moreover, behind a descending body heated air expands of the atmosphere leads to substantial difference in the shock wave amplitude and thermal radiation flux at the Earth’s surface. Therefore, the usage of a simple energy scaling law is not accurate, and the authors use the results of numerical simulations. High energies, in comparison with nuclear tests, cause severe ionospheric and magnetospheric disturbances that may lead to disruption of radio communications and hinder normal functioning of radiolocation, GPS, and other technical systems, which play more and more important roles for modern humanity.

### *Undetected* small objects trigger military early-warning systems, sparking accidental nuclear war

David 2 (Leonard, Senior Space Writer – Space.com, “First Strike or Asteroid Impact?”, 6-6, http://abob.libs.uga.edu/bobk/ccc/cc060702.html)

Military strategists and space scientists that wonder and worry about a run-in between Earth and a comet or asteroid have additional worries in these trying times. With world tensions being the way they are, even a small incoming space rock, detonating over any number of political hot-spots, could trigger a country's nuclear response convinced it was attacked by an enemy. Getting to know better the celestial neighborhood, chock full of passer-by asteroids and comets is more than a good idea. Not only can these objects become troublesome visitors, they are also resource-rich and scientifically bountiful worlds. Slowly, an action plan is taking shape. Noted asteroid and comet experts met here May 23-27, taking part in the National Space Society's International Space Development Conference 2002. Sweat the small stuff Being struck by a giant asteroid or comet isn't the main concern for Air Force Brigadier General Simon Worden, deputy director of operations for the United States Space Command at Peterson Air Force Base, Colorado. He sweats the small stuff. Worden painted a picture of the next steps needed in planetary defense. His views are not from U.S. Department of Defense policy but are his own personal perspectives, drawing upon a professional background of astronomy. For example, Worden said, several tens of thousands of years ago an asteroid just 165-feet (50 meters) in diameter punched a giant hole in the ground near Winslow, Arizona. Then there was the Tunguska event. In June 1908, a massive fireball breached the sky, then exploded high above the Tunguska River valley in Siberia. Thought to be in the range of 165-feet (50 meters) to 330 feet (100 meters) in size, that object created a devastating blast equal to a 5 to 10 megaton nuclear explosion. A similar event is thought to have taken place in the late 1940s in Kazakhstan. "There's probably several hundred thousand of these 100-meter or so objects...the kind of ones that we worry about," Worden said. However, these are not the big cosmic bruisers linked with killing off dinosaurs or creating global catastrophes. On the other hand, if you happen to be within a few tens of miles from the explosion produced by one of these smaller near-Earth objects, "you might think it's a pretty serious catastrophe," Worden said. "The serious planetary defense efforts that we might mount in the next few decades will be directed at much smaller things," Worden said. Some 80 percent of the smaller objects cross the Earth's orbit, "some of which are potentially threatening, or could be in the centuries ahead," he said. Nuclear trigger One set of high-tech military satellites is on special round-the-clock vigil. They perform global lookout duty for missile launches. However, they also spot meteor fireballs blazing through Earth's atmosphere. Roughly 30 fireballs detonate each year in the upper atmosphere, creating equivalent to a one-kiloton bomb burst, or larger, Worden said. "These things hit every year and look like nuclear weapons. And a couple times a century they actually hit and cause a lot of damage," Worden said. "We now have 8 or 10 countries around the world with nuclear weapons...and not all of them have very good early warning systems. If one of these things hits, say anywhere in India or Pakistan today, we would have a very bad situation. It would be awfully hard to explain to them that it wasn't the other guy," Worden pointed out. Similarly, a fireball-caused blast over Tel Aviv or Islamabad "could be easily confused as a nuclear detonation and it may trigger a war," Worden said. Meanwhile, now moving through the U.S. Defense Department circles, Worden added, is a study delving into issues of possibly setting up an asteroid warning system. That system could find a home within the Cheyenne Mountain Complex outside Colorado Springs, Colorado. The complex is the nerve center for the North American Aerospace Defense Command (NORAD) and United States Space Command missions. Next steps Where do we go from here? An important step, Worden said, is cataloging all of the objects that are potentially threatening, down to those small objects that could hit and destroy a city. To do this type of charting, military strategists now champion a space-based network of sensors that keep an eye on Earth-circling satellites. These same space sentinels could serve double-time and detect small asteroids, he said.

### That escalates to global nuclear war

Forrow 98 (Lachlan, MD, et al, “Accidental Nuclear War – A Post-Cold War Assessment”, New England Journal of Medicine, iis-db.stanford.edu/pubs/20625/acciden\_nuke\_war.pdf)

Earlier assessments have documented in detail the problems of caring for the injured survivors of a nuclear attack: the need for care would completely overwhelm the available health care resources. Most of the major medical centers in each urban area lie within the zone of total destruction. The number of patients with severe burns and other critical injuries would far exceed the available resources of all critical care facilities nationwide, including the country's 1708 beds in burn-care units (most of which are already occupied). The danger of intense radiation exposure would make it very difficult for emergency personnel even to enter the affected areas. The nearly complete destruction of local and regional transportation, communications, and energy networks would make it almost impossible to transport the severely injured to medical facilities outside the affected area. After the 1995 earthquake in Kobe, Japan, which resulted in a much lower number of casualties (6500 people died and 34,900 were injured) and which had few of the complicating factors that would accompany a nuclear attack, there were long delays before outside medical assistance arrived. From Danger to Prevention Public health professionals now recognize that many, if not most, injuries and deaths from violence and accidents result from a predictable series of events that are, at least in principle, preventable. The direct toll that would result from an accidental nuclear attack of the type described above would dwarf all prior accidents in history. Furthermore, such an attack, even if accidental, might prompt a retaliatory response resulting in an all-out nuclear exchange. The World Health Organization has estimated that this would result in billions of direct and indirect casualties worldwide.

# 1AC: Nuclear Option Advantage

### Advantage 2 --- Nuclear Option

### U.S. *attempts* at NEO deflection are inevitable --- the only question is *what form* it’ll take

Koplow 5 (Justin, JD Candidate – Georgetown University Law Center, Georgetown International Environmental Law Review, Lexis)

C. ROCKS NOT ROCKETS The fundamental procedures of intercepting an incoming missile and diverting an asteroid are significantly different. But the fundamental legal theory is strikingly similar. What the United States has done through the Bush expansion of missile defense is to make a commitment to aid foreign nations in preventing a disaster that would not cause injury to U.S. territory. In this sense, the foreign impact of an asteroid and the foreign impact of a ballistic missile are remarkably similar and so are the U.S. agreements and legal conceptions of duty and response there under. Many States -- including England, Japan, Australia, Canada, Italy, and Poland -- have shown interest in the U.S. BMD plans. n119 The desired fruit of discussions with such States is a framework agreement whereby the one party agrees to host U.S. interceptors, radar installations, or related facilities, and the United States agrees that the shield will be extended to the protection of that state. n120 Presumably typical of such framework agreements is the 2003 Memorandum [\*299] of Understanding Between Secretary of Defense on Behalf of the Department of Defense of the United States of America and the Secretary of State for Defense of the United Kingdom of Great Britain and Northern Ireland Concerning Ballistic Missile Defense (MOU). n121 As stated in its title, the MOU was concluded between U.S. Secretary of Defense Donald Rumsfeld and U.K. Secretary of State for Defense Geoff Hoon to cover the establishment of cooperative relations in missile defense. The introductory section begins with recitation of the "recognitions" that are the foundation for the agreement, including that the United States and the United Kingdom have a "common interest in defense;" that the U.S. government has made the decision to "develop and deploy a set of missile defense capabilities;" and that the cooperation envisioned in the MOU should proceed to the understanding that "security of the Participants will be enhanced." n122 The MOU's first section, Purpose and Scope, reiterates the basis of the U.S. decision to pursue this line of technology and defense, as well as recalling the Bush line of "friends and allies," before getting to the real substance of the agreement: "the United Kingdom (U.K.) government supports these U.S. [missile defense] efforts and has welcomed assurances that the United States is prepared to extend coverage and make missile defense capabilities available to the U.K." n123 The subsequent paragraphs establish a few concrete details of the cooperation, including that the United Kingdom will upgrade the early warning radar systems at the Royal Air Force base at Fylingdales; that the United States and United Kingdom will engage in closer technical cooperation in other areas of missile defense; and that the MOU should serve to facilitate opportunities for U.K. and U.S. industries to participate in the U.S. ballistic missile defense system (BMDS) program. n124 The tangible products of such agreements are also in their effect. While several countries already have a substantial U.S. military presence (such as Fylingdales, the U.S. military bases in Japan, and the jointly-run NORAD system with Canada) that makes cooperation a commonplace occurrence, there are new indications and emplacements that can only be attributed to missile defense commitments and cooperation. In the Pacific theater, where North Korea is the [\*300] greatest threat and China a no-less-significant but less likely threat, the United States has moved an Aegis class cruiser equipped with a Standard Missile 3 system to defend against short-or medium-range missiles into permanent patrol on the Sea of Japan. n125 The Bush administration has also considered selling advanced missile defense systems to Taiwan. n126 In the European theater, interceptors and sensors have been placed in England, while Poland and Turkey, per strategic geography, would be prime locations for similar installations. n127 Israel has long been a missile defense partner and permitted use of the Patriot and jointly developed Arrow systems in both Iraq conflicts. n128 Both wars with Iraq also featured the use of interceptors to combat Iraqi Scud missiles, whether fired at U.S. troops or into Kuwait and neighboring states. n129 The simple fact is that the United States, and specifically the Bush administration, has made a commitment to missile defense and is willing to export it around the world in the interest of promoting international peace and security. The realities of shooting down a missile in its boost phase, the fundamental logic behind missile defense, and the idea that U.S. national defense is served by having missile interceptors stationed around the globe can each be analogized to the asteroid scenario. In the initial boost phase, it is not immediately apparent what the final target of a missile will be because trajectories can be adjusted and manipulated such that a missile launched from North Korea could be targeted for Seoul, Tokyo, Beijing, Sydney, Honolulu, or Los Angeles. n130 But despite all of these possibilities in the first few moments, the missile defense systems in the area would activate and attempt to destroy the missile without care for whether a MOU has been worked out with every specific possible target. The rewards, stopping a missile that might hit Japan, a missile defense cooperating State, are far greater than the "risk," a "free rider" concern that, for instance, Beijing would be protected without China having to explicitly agree to cooperate. In essence, what the United States has committed itself to is not defense of specific countries with which it makes explicit agreements, but rather to whole regions, and indeed, to the whole world. This "boost phase anonymity" situation shows how the United States will be willingly acting in the world's interests without a concern for exactly whom it is they are protecting. In any missile launch where there is the possibility that it would be in the United States' interests to prevent the impact, the missile defense system will attempt to do just that. [\*301] Under a system of foreign asteroid defense, the United States would be bound to defend countries from an attack little different, save for the presence of an instigating party, from a missile launch. The main difference is that the actual or predicted target would be known in the case of an asteroid; however, as the United States has shown a blanket willingness to protect States under the missile defense system, it would be hard-pressed not to use the tools and methods at its disposal in an asteroid context simply because the area of impact was not politically "desirable." VI. TREATY ON POINT AND CONCLUSION The ultimate question of this note is whether the United States has through its participation in various space and weapons treaties and agreements created a duty by which it would be bound to attempt to avert the catastrophic effects of a foreign asteroid impact. The above explorations demonstrate that there is a large basis for an affirmative answer. Examination of U.S. involvement in space treaties and its own pursuit of international missile defense shows that the United States has created a special relationship from actual and superior knowledge coupled with a situation in which foreign States are being denied normal means and opportunities for self-defense and protection. This would, if it were under Minnesota law, indicate a special relationship and thereby a duty of protection. This is important in an era where space travel is increasingly privatized, and it also points to a possibly emerging custom. n131 However, U.S. law neither makes international law nor binds the relationships of the United States and foreign sovereign States. The international community is loath to simply create and foist duties and obligations upon members who did not actively participate in the bargaining for such deals and understandings. n132

### Nuclear deflection will be used now --- only the combination of detection and deflection forces the U.S. away

Chapman 6 (Clark, Senior Scientist – Southwest Research Institute Dept. of Space Studies, and Member of the Board – B612 Foundation, “Critique of "2006 Near-Earth Object Survey and Deflection Study: Final Report" Published 28 Dec. 2006 by NASA Hq. Program Analysis & Evaluation Office”, http://www.b612foundation.org/papers/NASA-CritChap.doc)

Furthermore, the Report takes a totally backwards approach to characterization, saying that we first need to determine what deflection system we will use before addressing what characterization option we will try to build and implement. The "logic" is not what it should be, namely that we will select (from a tool-kit of relevant technologies) what deflection approach would be appropriate for an \*identified\* threatening NEO of a particular size; rather, it says (specifically in the last paragraph of pg. 73) that we will soon select a one-approach-fits-all deflection system (e.g. stand-off nuclear) as the preferred generic deflection scheme and only then design a characterization effort that will address the needs of that sole deflection approach. (The seriousness of this error is illustrated by the fact that the Report seems to select stand-off nuclear as the preferred approach -- because it is "most effective" -- and then ridiculously concludes that we need to know \*less\* about the physical nature of the NEO for stand-off nuclear than for all other deflection options! [This absurd argument is "developed" in the middle paragraph of pg. 61.].) The logical approach, instead (and of course!), is to have a tool-kit of deflection approaches that will address the range of feasible cases, then characterize any threatening NEO that is found, and finally fold the results of that characterization into designing the appropriate deflection mission (which may involve more than one deflection technique) from among the techniques in our tool-kit.

### Nuclear deflection *fails* and sends warheads *back to Earth* --- risks extinction

IAA 9 (International Academy of Astronautics, “Dealing With The Threat To Earth From Asteroids And Comets”, http://iaaweb.org/iaa/Scientific%20Activity/Study%20Groups/SG%20Commission%203/sg35/sg35finalreport.pdf)

There is a persistent notion in lay circles that the way to deal with a dangerous NEO is to simply hit it with an ICBM and vaporize it in space. Unfortunately, reality is far removed from this illusion. While it is likely that we may be able to rapidly reconfigure an ICBM computer guidance system to intercept a point or object in near-Earth space, ICBM propulsion system performance is insufficient to enable intercept beyond a few hundred kilometers above the Earth’s surface. Stages must be added to an ICBM to enable it to achieve the necessary escape velocity and to place the weapon on an intercept trajectory with a NEO. While these upper stage technologies are space qualified, such a system would have too low a reliability for the NEO intercept mission given the potentially horrendous consequences of an Earth impact, and might thus require many sequential launches of several such vehicles to have any reasonable chance of successfully deflecting a NEO. Such attempts would be part of a dedicated “campaign” utilizing several different launch vehicle types, designed with different upper stages, using different end game techniques, and different nuclear warhead types, in order to obtain a high probability of success. Furthermore at least one failed launch attempt is likely if many are required, and with a nuclear payload this could result in serious environmental effects in and of itself. Thus, it is clear that for the nuclear concept several dedicated designs of a inherently highly reliable launch vehicles and multi-stage interceptors would be extremely desirable to loft the nuclear warheads, and thus the use of existing ICBMs, even if outfitted with current technology upper stages, is highly undesirable if not essentially ruled out. Nevertheless, if there were no other option due to insufficient warning time we might want to do all we can with the tools at hand rather than sit passively like the dinosaurs, and attempt intercepts with current space launchers and current upper stages if no dedicated vehicles exist or could be developed in the time available. It would be perfectly rational to divert any and all launchers and spacecraft being designed for planetary exploration to becoming NEO interceptors, whatever their state of development. Finally it must be made clear that many nuclear warheads intended for ICBMs exist that could be used with few, if any, modifications as payloads for the purpose of deflection of NEOs, whatever launch vehicle and upper stage is used to get them to the NEO (see ref. 4).

### The U.S. is key --- no one else will invest in deflection and only the U.S. act act

Koplow 5 (Justin, JD Candidate – Georgetown University Law Center, Georgetown International Environmental Law Review, Lexis)

A third, but related question, goes to how to pay for the system contemplated in the above discussion. The costs involved in such a system are not minimal, and there will be those who claim that the costs of the system outweigh what would be saved from preventing an asteroid impact. This point is easy to dismiss. In the first place, just because one asteroid impact is detected and dealt with, the threat has not been permanently extinguished. Furthermore, the benefit of multiple preventions and the security and peace of mind provided by a known system would outweigh the costs. n138 Secondly, the system and whatever plans and tactics it devises would also be Earth's best strategy for planetary defense against a global killer. In that event, no cost would be too dear. Turning from justifications to actual expenses, the greatest costs will be in maintaining readiness for both the monitoring States and the acting States. n139 For the former, new observatories will [\*304] have to be constructed or current facilities will have to be re-tasked. This, however, will likely not be too great a cost as States will not be truly starting from scratch; as the Time article shows, many States already have facilities and astronomers who spend a great deal of time searching the skies. n140 This is further bolstered by the grassroots efforts of the legions of amateur astronomers, who would be an invaluable resource. In all, for the monitoring States, the greatest costs would be start-up: organizing individually to search, setting up new or re-tasking existent facilities, and organizing an international system to handle and maintain the data and monitor the search. The required costs for the acting States would be much higher in the event of an actual mission. These costs would have to be distributed among all parties, similar to U.N. dues allocations, to whatever degree they are identifiable and it is practicable. The harder part, but one that has been dealt with in the context of missile defense, is basic maintenance and readiness costs. The United States does not keep a space shuttle ready to fly at all times and could not immediately mount an emergency mission. Costs would be incurred in increasing availability. However, allocating costs between the benefit to the asteroid defense program and the benefit to the overall military of an actor State will be difficult. Each actor state would likely demand to retain close control over its weapons and systems, creating a further gap between the payments for the program and the payments for the national military. n141 These costs and problems are troublesome, but would likely have to be accepted for the greater good. One way to minimize the problems would be to have the specific actor country pay for a greater percentage of the improvements done to its systems, as it is receiving the primary benefit. n142 Asteroid defense agreements could also require a commitment that the actor States maintain an established level of readiness with minimal oversight, but with only a percentage of the costs of such readiness provided from other treaty participants.

### The plan solves the “nuclear option” --- and even if it doesn’t, radar and telescopes provide data to make it effective

Schweickart 4 (Russell, Chair of the B612 Foundation, former astronaut, Executive Vice President of CTA Commercial Systems, Inc. and Director of Low Earth Orbit (LEO) Systems and research, and scientist at the Experimental Astronomy Laboratory of the Massachusetts Institute of Technology (MIT), “Asteroid Deflection; Hopes and Fears,” Aug., Presented at the World Federation of Scientists Workshop on Planetary Emergencies, Erice, Sicily, August 2004 http://www.b612foundation.org/papers/Asteroid\_Deflection.doc)

The nuclear explosive options will all be strongly dependent on the bulk and surface structural characteristics of asteroids, a feature about which we know very little today. It is also likely that we will find substantial variation in these structural characteristics from one asteroid type to another, and perhaps even within the population of any given type. Therefore the nuclear option may require quite extensive detailed information about each asteroid to be deflected, an information set not easily acquired. Until much more is known about this subject predicting the result of a nuclear explosive deflection effort will be highly unreliable. In addition to predicting the result of a nuclear deflection, measuring the actual result of a deflection mission will be challenging due to the violent nature of the operation. A double spacecraft compound mission, with one component serving as the deflector and a second as observer is one solution to this challenge. However since the velocity change being sought is less than one part in 106 verifying success from a spacecraft flying past at 10 km/sec is daunting. If the operation also fragments the asteroid, even partially, the task of determining the result of the operation may well be impossible. Finally, any nuclear explosive option is and will remain inextricably intertwined with global geopolitics and, in fact, raise to prominence the spectre of space nuclear weapons. International treaties ban these objects in space today, but if no other deflection technique has been tested and/or validated when the world experiences either a near miss or perhaps a small but significant impact, the world public demand for action to prevent a recurrence of such an event may be sufficient to enable a state, so determined, to justify abrogating the treaties against weapons in space on the grounds of protection of the world public. It is critical therefore, that the soft options be developed, demonstrated and known to be viable as soon as possible. This task is of utmost importance in order to avoid a situation in which the public misperception that the nuclear option is the only one available to protect the Earth from asteroid impacts.

# Plan

### The United States federal government should increase its exploration of near-Earth objects and its development of near-Earth object deflection systems, including telescopes, radar, and deflection technology.

# 1AC: Solvency

### Contention 2 --- Solvency

### Plan allows new telescopes, radar, and development of deflection tech

NRC 10 (National Research Council, Defending Planet Earth: Near-Earth Object Surveys and Hazard Mitigation Strategies, Committee to Review Near-Earth-Object Surveys and Hazard Mitigation Strategies, http://www.nap.edu/catalog.php?record\_id=12842)

The committee outlined three possible levels of funding and a possible program for each level. These three, somewhat arbitrary, levels are separated by factors of five: $10 million, $50 million, and $250 million annually. • $10-million level. The committee concluded that if only $10 million were appropriated annually, an approximately optimal allocation would be as follows: $4 million for continuing ground-based optical surveys and for making follow-up observations on long-known and newly discovered NEOs, including determining their orbits and archiving these along with the observations; the archive would continue to be publicly accessible; $2.5 million to support radar observations of NEOs at the Arecibo Observatory; $1.5 million to support radar observations at the Goldstone Observatory; and $2 million to support research on a range of issues related to NEO hazards, including but not necessarily limited to (see Chapter 6) the study of sky distribution of NEOs and the development of warning-time statistics; concept studies of mitigation missions; studies of bursts in the atmosphere of incoming objects greater than a few meters in diameter; laboratory studies of impacts at speeds up to the highest feasible to obtain; and leadership and organizational planning, both nationally and internationally. The $10-million funding level would not allow on any time scale the completion of the mandated survey to discover 90 percent of near-Earth objects of 140 meters in diameter or greater. Also lost would be any possibility for mounting spacecraft missionsfor example, to test active mitigation techniques in situ. (A caveat: The funds designated above to support radar observations are for these observations alone; were the maintenance and operations of the radar-telescope sites not supported as at present, there would be a very large shortfall for both sites: about $10 million annually for the Arecibo Observatory and likely a larger figure for the Goldstone Observatory.) • $50-million level. At a $50-million annual appropriations level, in addition to the tasks listed above, the committee notes that the remaining $40 million could be used for the following: Support of a ground-based facility, as discussed in Chapter 3, to enable the completion of the congressionally mandated survey to detect 90 percent of near-Earth objects of 140 meters in diameter or greater by the delayed date of 2030. The $50-million funding level would likely not be sufficient for the United States alone to conduct space telescope missions that might be able to carry through a more complete survey faster. In addition, this funding level is insufficient for the development and testing of mitigation techniques in situ. However, such missions might be feasible to undertake if conducted internationally, either in cooperation with traditional space partners or as part of an international entity created to work on the NEO hazards issue. Accommodating both the advanced survey and a mitigation mission at this funding level is very unlikely to be feasible, except on a time scale extended by decades. • $250-million level. At a $250-million annual budget level, a robust NEO program could be undertaken unilaterally by the United States. For this program, in addition to the research program a more robust survey program could be undertaken that would include redundancy by means of some combination of ground-and space-based approaches. This level of funding would also enable a space mission similar to the European Space Agency’s (ESA’s) proposed Don Quijote spacecraft, either alone, or preferably as part of an international collaboration. This space mission would test in situ instrumentation for detailed characterization, as well as impact technique(s) for changing the orbit of a threatening object, albeit on only one NEO. The target could be chosen from among those fairly well characterized by ground observations so as to check these results with those determined by means of the in situ instruments. The committee assumed constant annual funding at each of the three levels. For the highest level the annual funding would likely need to vary substantially as is common for spacecraft programs. Desirable variations of annual funding over time would likely be fractionally lower for the second level, and even lower for the first level. How long should funding continue? The committee deems it of the highest priority to monitor the skies continually for threatening NEOs; therefore, funding stability is important, particularly for the lowest level. The second level, if implemented, would likely be needed at its full level for about 4 years in order to contribute to the completion of the mandated survey. The operations and maintenance of such instruments beyond this survey has not been investigated by the committee. However, were the Large Synoptic Survey Telescope to continue operating at its projected costs, this second-level budget could be reduced. The additional funding provided in the third and highest level would probably be needed only through the completion of the major part of a Don Quijote-type mission, under a decade in total, and could be decreased gradually but substantially thereafter. Finding: A $10-million annual level of funding would be sufficient for continuing existing surveys, maintaining the radar capability at the Arecibo and Goldstone Observatories, and supporting a modest level of research on the hazards posed by near-Earth objects. This level would not allow the achievement of the goals established in the George E. Brown, Jr. Near-Earth Object Survey Act of 2005 on any time scale. A $50-million annual level of funding for several years would likely be sufficient to achieve the goals of the George E. Brown, Jr. Near-Earth Object Survey Act of 2005. A $250-million annual level of funding, if continued for somewhat under a decade, would be sufficient to accomplish the survey and research objectives, plus provide survey redundancy and support for a space mission to test in situ characterization and mitigation.

### Research on deflection methods *now* is key to effectiveness --- detection alone means tech will be undeveloped and untested

NRC 10 (National Research Council, Defending Planet Earth: Near-Earth Object Surveys and Hazard Mitigation Strategies, Committee to Review Near-Earth-Object Surveys and Hazard Mitigation Strategies, http://www.nap.edu/catalog.php?record\_id=12842)

WARNING TIME FOR MITIGATION A key issue associated with the hazard from NEOs is that the length of time needed to execute a mitigation strategy involving orbit change is likely to require acting before the knowledge of the trajectory is sufficiently accurate to know with high confidence that an impact would occur without mitigation. It is possible, therefore, that action to mitigate could be deferred until it is too late if plans are not already in place to act when the probability of impact reaches some level that is well below unity. As addressed in Chapter 5, the time required to mitigate optimally (other than only by means of civil defense) is in the range of years to decades, but this long period may require acting before it is known with certainty that an NEO will impact Earth. Chodas and Chesley (2009) have simulated the discovery of objects that would impact within the 50 years starting at the beginning of the next generation of surveys (see Chapter 3), using estimates of the (decreasing) orbital uncertainty as observations are accumulated. Although there are many assumptions in this approach, the most important is whether or not the surveys and the follow-up programs to determine the orbits will be funded and will operate as assumed. Chodas and Chesley (2009) assume that an NEO is declared “truly hazardous” and worthy of mitigation preparations when the probability of hitting Earth reaches 0.5 (any other assumption regarding the decision point is also easily simulated). In this simulation, about 90 percent of impacting NEOs larger than about 140 meters in diameter are discovered in a 10-year survey. The temporal distribution of discoveries in this simulation showed that several percent of the 140-meter-sized objects that impact do so before discovery, but the total number of impactors per century is not large, so that a few percent represents an exceptionally unlikely event. Most of the impactors in this size range are discovered to be truly hazardous within several years of discovery, typically at the next time that the object is in a location in which it is viewable, thus providing warning times of a decade to several decades. By contrast, more than 10 percent of the objects larger than 50 meters in diameter that would impact within 50 years do impact before discovery, and there are many more of these than there are of the larger objects. Such smaller objects would generally be found to be truly hazardous within weeks to months before impact. Objects in the size range of 10 to 50 meters in diameter make up the majority of all potentially hazardous NEOs larger than 10 meters. The damage that could be caused by one of these smaller objects is less than for a larger object, but those smaller ones that are detected are likely to be found, at most, hours to months prior to their final plunge, with civil defense then being the only plausible mitigation strategy. Currently, by far the most probable scenario is that of a small impactor, likely to cause at most only local destruction. However, the assessed probability of any particular scenario is changing with time as the next- generation surveys discover most of the larger objects and the understanding of impact processes, such as airbursts and tsunami generation, improves. Thus, planning for mitigation must continue to evolve over time. Furthermore, when working with the statistics of small samples, and particularly when less likely scenarios have outcomes that are so much more catastrophic than the most likely scenario, one should not assume that the next event will be the most likely one.

### Combination of ground and space-based observations is key --- they provide complementary data necessary to accurately deflect

NRC 10 (National Research Council, Defending Planet Earth: Near-Earth Object Surveys and Hazard Mitigation Strategies, Committee to Review Near-Earth-Object Surveys and Hazard Mitigation Strategies, http://www.nap.edu/catalog.php?record\_id=12842)

Combined ground- and space-based surveys have a number of advantages. Such surveys discover more NEOs of all sizes, including a substantial number smaller than 140 meters in diameter. These combined surveys also provide more characterization data about the entire NEO population. With both infrared and visible data for most targets, it would be possible to obtain accurate diameter estimates for all objects, as well as measurements of their albedos and their surface and thermal properties. These high-value characterization data could help to guide mitigation campaign studies. Additionally, a dual survey provides much information on the population of objects smaller than 140 meters in diameter. Finding: The selected approach to completing the George E. Brown, Jr. Near-Earth Object Survey will depend on nonscientific factors: • If the completion of the survey as close as possible to the original 2020 deadline is considered more important, a space mission conducted in concert with observations using a suitable ground-based telescope and selected by peer-reviewed competition is the better approach. This combination could complete the survey well before 2030, perhaps as early as 2022 if funding were appropriated quickly. • If cost conservation is deemed more important, the use of a large ground-based telescope is the better approach. Under this option, the survey could not be completed by the original 2020 deadline, but it could be completed before 2030. To achieve the intended cost-effectiveness, the funding to construct the telescope must come largely on the basis of non-NEO programs. As noted above, neither Congress nor the administration has requested adequate funding to conduct the survey to identify ≥90 percent of the potentially hazardous NEOs by the year 2020. Multiple factors will drive the decision on how to approach this survey in the future. These include but are not limited to the perceived urgency for completing the survey of 140-meter-diameter NEOs as close to the original 2020 deadline as feasible and the availability of funds to provide for the successful completion of the survey. The combination of a spacebased detection mission with a large ground-based telescope could complete the survey in the shortest time, that is, closest to the original 2020 deadline. A space-based mission alone could complete the survey only 2 to 4 years later than a survey conducted with both a space-based telescope and a large ground-based telescope. The cost of optimizing the LSST for NEO detection observations was estimated in 2007 to be an increment of approximately $125 million to the cost of the basic telescope system (Ivezić, 2009), becoming the most cost-effective means to complete the survey. (Note that the annual operating cost of a ground-based telescope is approximately 10 percent of the development and construction costs.) The completion date would be extended. The decision to extend this date requires the acceptance of the change in risk over that time.