Interdiction Summary Report

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The problems of interdiction were discussed during the special plenary, panel and discussion sessions. The interdiction subsystem (ISS) is a part of the Planetary Defense System (PDS) against threats from space objects. The problems discussed during the interdiction sessions of the PDW include tasks and demands of the ISS, its demands on other subsystems of the PDS, an outline of the ISS, such as requirements of the choice of interception trajectories and various means of action. The set of interdiction options depends on warning time, size of the object, and object properties: constituent matter properties (rock, stony-iron, iron, comet ices), internal composition, configuration and shape (integrity, multi-body constitution, stone and ice mixture for comet nuclei).

Interdiction objective

The objective of interdiction is to prevent or effectively weaken an imminent impact on the Earth of the NEO which has an intercept course. This can be achieved by deflection, fracturing or pulverization, or evaporation. The choice of one of these possible regimes of impact prevention or mitigation will be defined by optimization of economical and technical opportunities, efficiency and reliability of the application, and the best correspondence to various environmental demands for the Earth and in Space.

ISS structure

The interdiction subsystem will consist of a Means of Action (MoA) to act upon the threatening object and a Means of Delivery (MoD) of the MoA. MoD's include rocket launching systems, space transportation (including space navigational and ground-based control systems), autonomous preparation or manufacturing(?) of the MoA, precise targeting, guidance, and detonation of the MoA. It is possible to create an operational ISS as a part of the global PDS on the basis of existing technologies. Existing technical means, facilities and equipment should be incorporated into the ISS. Additionally, it will demand scientific and technological developments. To validate the ISS and estimate the efficiency of various options, it will be necessary provide a relevant experimentation program, including space experiments with near missing objects. The ISS implementation and subsequent development will demand a specific R&D strategy.

Key parameters for the ISS outline

The lead on the warning times defines the different approaches for research and development, choice of technologies for experimentation, and procedures for implementation of the ISS in the global PDS. Size of the object, duration of warning time, and current technology defines the choice of MoA. Possible choices include kinetic energy, nuclear explosions, nuclear jet propulsion, mass drivers, solar collectors, lasers and others which were discussed at the Workshop. Of significance is the Workshop conclusion that for the sufficiently large warning times, kinetic energy interceptions can be applied for the interdiction of small (less than 100 m) and even intermediate size objects.

The Interdiction Panel proposed the following time scale for the development and application of various interdiction technologies

MoA Technologies

Today	Near Future	Future	Far future
Kinetic projectiles Nuclear explosions	Nuclear jet propulsion	Mass drivers Solar collectors	Laser drivers & other
(1995	(2000	(2005	(2020

Existing technologies are the principal technologies for the near-term needs of PDS. However, a special R&D program must be performed to adjust these technologies to the ISS environment. It includes additional studies of efficiency for specific types of MoA (kinetic or nuclear), technologies for delivery specific MoA and fielding it in space before the hitting the target, and careful study of the results of the MoA. The program needs to include experimentation in the space and the development of basic research and technologies for prospective MoA.

A parallel R&D program needs to be conducted for the MoD. It will include improvement of existed chemical propulsion methods, and development and implementation of chemical cryogenic and electro-nuclear propulsion systems.

The material properties of threating objects, their composition, integrity, shape, and others properties define specific choice of MoA and regimes application. The NEO's trajectory, its velocity of approach, and technical capabilities of the MoD will define the technology for application of MoA.

Reliability demands, space environmental demands, decreasing of negative consequences of MoA application for the Earth and space environment will determine the final choice of MoA.

Interaction with other subsystems

Various kinds of activities must be performed to provided reliable interdiction:
ground-based observation for large (greater than 1 km) asteroids and comets, space- and ground-based observations for intermediate size (100 m - 1 km), a deeper understanding NEO impact, integration of subsystems in the consequences of PDS, adjustment of existing technologies to the PDS needs, experimental research in the laboratories in space.

The ISS needs

For the subsequent development of the ISS, it is necessary to provide validated standard models for various threats to the Earth from NEOs that account for their properties, warning times, trajectories, velocities of approach, and standard MoDs and MoAs.

The ISS R&D results

The results of R&D on interdiction will describe action phenomena for specified MoAs and different regimes of their application, accounting for energy transfer, impulse, fragmentation, spallation etc. Th e results for MoDs shall account for external parameters MoAs, requirements for the delivery, targeting, fielding in space, etc. The R&D shall also produce validated scenarios of the results of application of interdiction, including impact on the space and Earth environments; standard scenarios of interdiction missions for standard threat models, delivery, and recommendations for various threat scenarios.

Conclusion

The interdiction subsystem consists of two co-equal parts: a means of action and means of delivery. There exists today the technology and basic equipment to meet the most probable demands of the Planetary Defense System. However, a modest R&D program needs to be performed to adjust existing technologies and techniques to specific scenarios. It is important to provide experimental validation of various aspects of the ISS including interdiction mission construction and performance of different components of MoD and MoA. All the activity on the Planetary Defense issues should be planned and carried out in an international forum.