PLANETARY DEFENSE
INTERAGENCY
TABLETOP EXERCISE 5

Quick-Look Briefing

13 May 2024

NASA

FEMA

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cneos

Ames Research Center

Lawrence Livermore
National Laboratory

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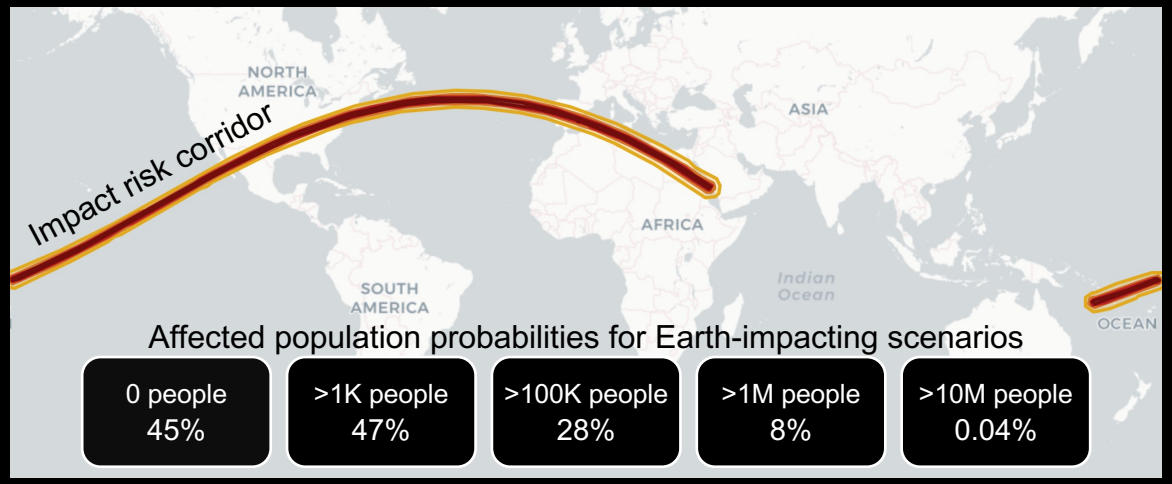
Executive Summary

PLANETARY DEFENSE INTERAGENCY TABLETOP EXERCISE 5

2–3 April 2024
Johns Hopkins APL with remote participation

U.S. interagency exercise sponsored jointly by NASA and FEMA to improve preparedness and planning for an asteroid impact; emphasis on international coordination and collaboration.



Scenario

- 72% chance that an asteroid may hit Earth in 14 years.
- Requirements for preventing its impact are unknown.
- Models indicate the asteroid could devastate a regional- to country-scale area, if it should impact.

Objectives

- Awareness raising; space mission options; disaster preparedness; information sharing and public messaging.

Participants: Several U.S. agencies and organizations, as well as the UN Office of Outer Space Affairs and international partners.

TTX Takeaways

- 14-year timeline complicates decision making when large uncertainties still exist, which underscores the need for capabilities to obtain better information about the asteroid.
- Clear support for international collaboration at all stages.

Key Gaps

- Decision-making processes and risk tolerance not understood.
- Limited readiness to quickly implement needed space missions.
- Timely global coordination of messaging needs attention.
- Asteroid impact disaster management plans are not defined.

A typo on this slide was corrected 27 July 2024.

A Series of Interagency Exercises

New scenarios with different participants and new lessons learned

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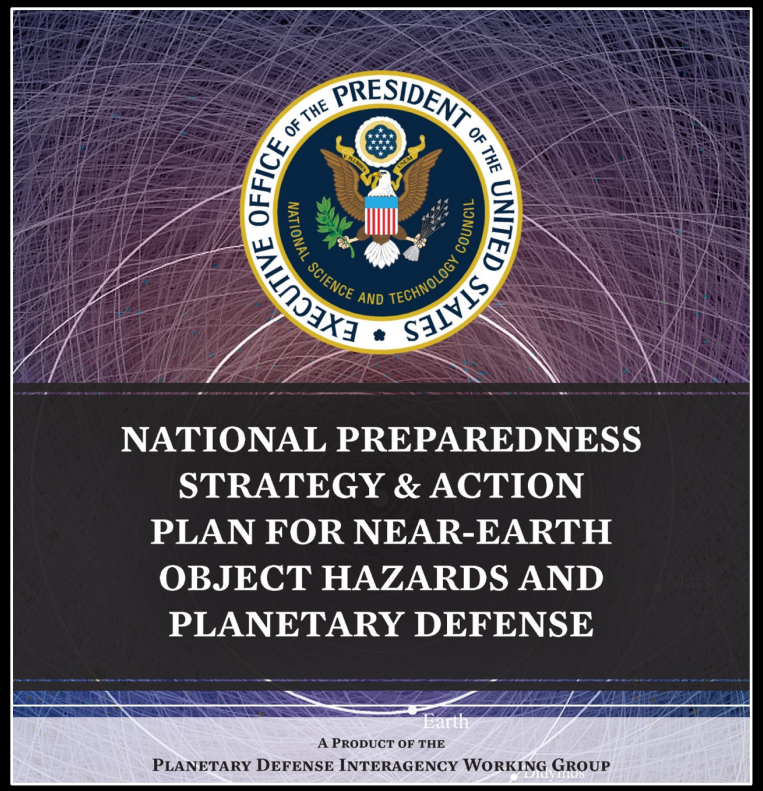

Goal 5: Strengthen and Routinely Exercise NEO Impact Emergency Procedures and Action Protocols

TTX 1 (2013)

TTX 2 (2014)

TTX 3 (2016)

TTX 4 (2022)

TTX 5 (2024)

6+

Future

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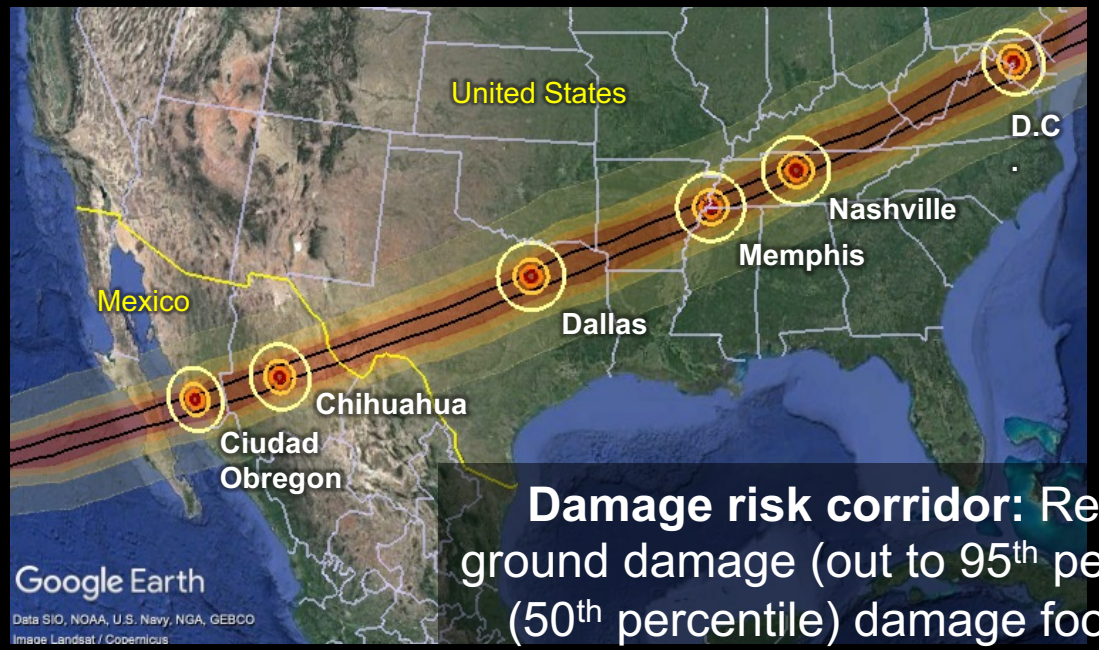
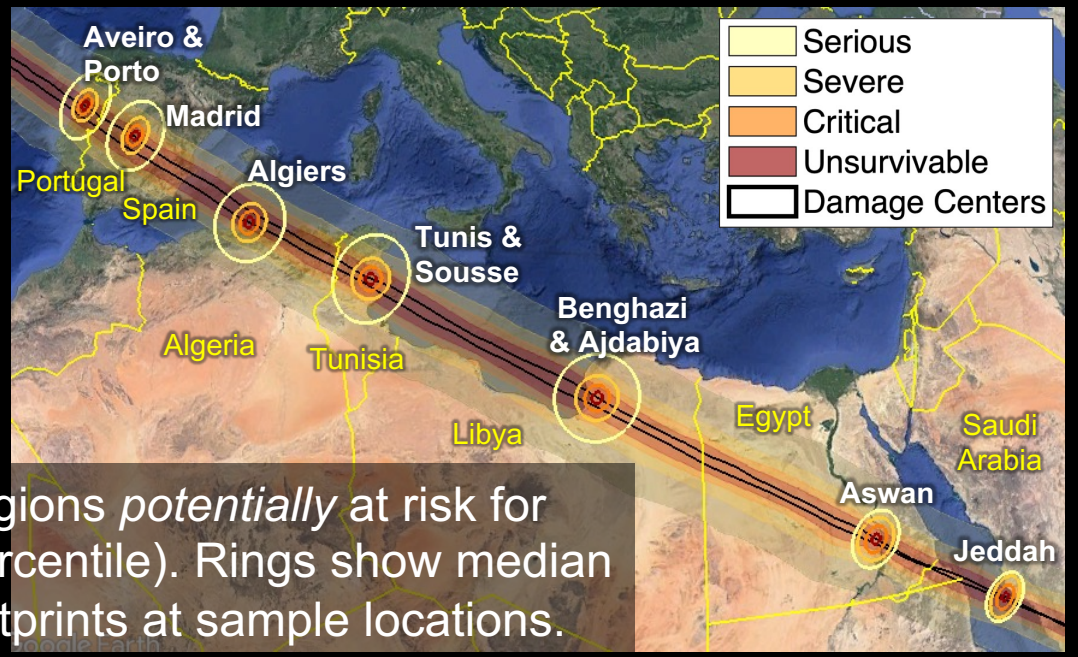
Scenario Overview: One Moment in Time

72% chance of Earth impact on 12 July 2038 (14.25 years warning time); many large uncertainties at this time; no new ground observations possible for seven months





Damage risk corridor: Regions *potentially* at risk for ground damage (out to 95th percentile). Rings show median (50th percentile) damage footprints at sample locations.

0	>1K	>100K	>1M	>10M
45%	47%	28%	8%	0.04%

Affected population probabilities
for Earth-impacting scenarios

60 m — 800 m

Range of possible asteroid sizes
Most likely: 100–320 m

TTX5 in Context

TTX5 builds on TTX4, which was held in 2022

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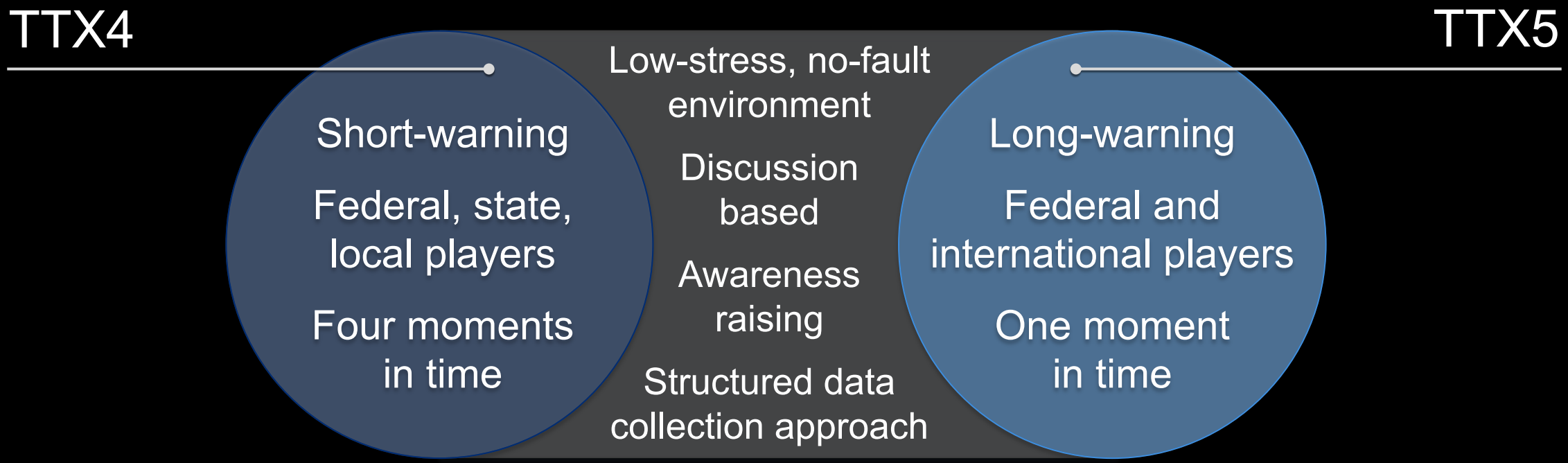

Used an adapted exercise approach from the Department of Homeland Security Exercise & Evaluation Program (HSEEP)

TTX4 After-Action Report led to investments and actions to address some of the identified gaps

Exercise Planning Team

Many organizations helped design and execute this event

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- NASA Planetary Defense Coordination Office (PDCO), including **FEMA** detailee: TTX direction and management.
- Department of State Office of Space Affairs: International collaboration and coordination.
- Johns Hopkins Applied Physics Laboratory (APL): TTX planning, execution, assessment; space mission options.
- Jet Propulsion Laboratory's Center for Near Earth Object Studies (JPL CNEOS): Asteroid impact threat scenario.
- NASA Ames's Asteroid Threat Assessment Project (ATAP): Asteroid properties; asteroid impact risks and damage effects.
- NASA Goddard Space Flight Center (GSFC): Space mission options.
- Lawrence Livermore National Laboratory (LLNL): Asteroid deflection modeling.
- Los Alamos National Laboratory (LANL): Asteroid deflection modeling.
- United Nations Office of Outer Space Affairs (UNOOSA): International collaboration and public messaging.
- Space Missions Planning Advisory Group (SMPAG): Recommendation of space mission options.

Objectives

Each with measurable subobjectives to ensure meaningful outcomes

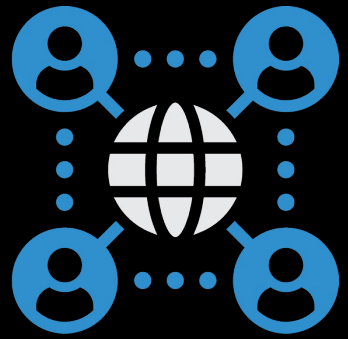
Awareness raising

Raise awareness of the nature of asteroid threats and challenges related to preparing an effective international response

Space response

Explore potential in-space responses to an asteroid threat with >10 years of warning time, including international collaboration and contributions

Disaster preparedness



Assess the challenges of, and readiness for, international emergency preparedness and response to an asteroid impact that would be large enough to devastate entire regions

Information sharing & public messaging

Identify current mechanisms for, and barriers to, international asteroid threat-related information sharing and communications, including public messaging strategies

Structure of TTX5

A single moment in time through the lens of three themes

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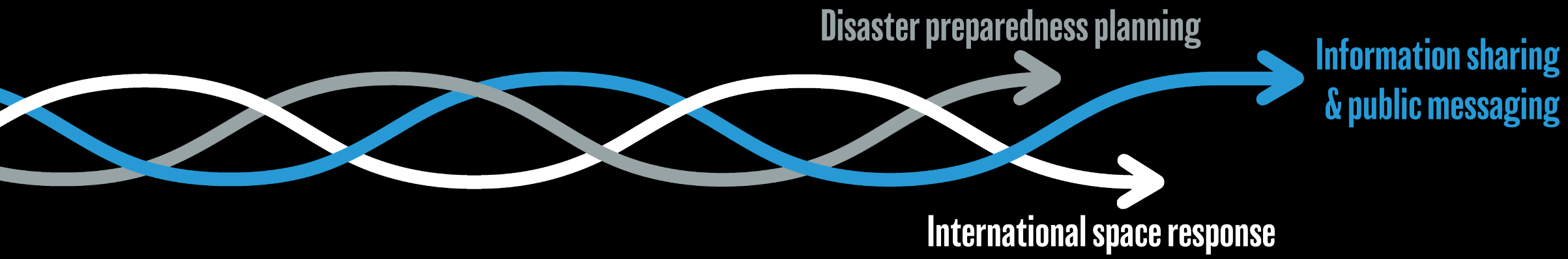

Module	Description	Day 1
1	Scene setting and initial international coordination	
2	Space mission options	
3a	Recommended courses of action	

Module	Description	Day 2
3b	Senior leader briefing	
4	Public information messaging	
5	Disaster preparedness	

Courses of Action Discussed on Day 2

Senior leaders favored 2 & 3, but noted political realties would limit immediate action

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1

Wait until November

for new observations

2

U.S.-Led Flyby

~$200 – $400M ROM LCC

2a: Encourage international partners to develop missions

3

Purpose-Built Rendezvous

~$800M – $1B ROM LCC

3a: Make hybrid mission @ additional ~$200 – 300M

Discussion themes

- Importance of information gathering via reconnaissance missions
- Repurposing of other missions and instruments for reconnaissance
- Congress unlikely to act unless impact became certain
- Pursuit of mission(s) by various countries to achieve redundancy
- Go/no-go points and funding profile(s) for courses of action
- Earth impact prevention feasibility

*rough, order of magnitude life cycle cost

High-Level Takeaways

Slide 1 of 2

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- The exercise **increased overall awareness** of the nature of asteroid threats and challenges related to preparing an effective international response; the large majority of participants reported that they left the exercise feeling **prepared with better understanding** to deal with an asteroid impact threat.
- The large and varied **uncertainties** about the potential impact and its consequences **posed challenges** as participants discussed the scenario and possible responses.
- The **14-year timeline** prompted discussion about preparedness over a longer timeframe than many other hazards and raised **varied concerns for different stakeholders**.
- **Better information** about the asteroid would reduce uncertainties in the potential consequences of an impact, thereby enabling **better decision making** about how to respond.

High-Level Takeaways

Slide 2 of 2

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- Many stakeholders expressed that they would want **as much information** about the asteroid **as soon as possible** but expressed **skepticism that funding** would be forthcoming to obtain such information without more definitive knowledge of the risk.
- Bilateral, multilateral, and UN-led agreements could facilitate **international collaboration and coordination** of space missions, disaster management, and communication.
- The **timelines** of space mission planning, disaster management, information sharing, and communications are **intertwined** in ways that were not fully appreciated at first.
- **Misinformation and disinformation** would have to be dealt with.
- Although specific **disaster management plans** for an NEO impact threat do not currently exist, plans for response to other catastrophes may be a **suitable starting point**.

High-Level Gaps and Recommendations

Gap: The role of the UN-endorsed **Space Mission Planning and Advisory Group** (SMPAG) in an asteroid impact threat scenario is not fully understood by all participants.

Recommendation: Inform more organizations about SMPAG's role as a coordination and advisory group. Emphasize that it is the purview of Member States to decide whether to pursue space mission(s) recommended by SMPAG.

Gap: The **process for making decisions** about space missions in an asteroid threat scenario remains unclear. The process has not been adequately defined in the U.S. or internationally.

Recommendation: Establish a process for deciding which space mission options to pursue in different planetary defense scenarios. Exercise the process.

High-Level Gaps and Recommendations

Gap: The **risk tolerance and decision criteria** for undertaking a space-based response in a planetary defense scenario are not sufficiently codified.

Recommendation: Establish a framework for decision criteria for a space-based response in an impact threat scenario by considering the cost, benefits, and risks to guide choices about response options and funding needs.

Gap: Information about **go/no go points** for space missions is not adequately infused into discussions about courses of action in response to an asteroid impact threat.

Recommendation: Identify relevant decision points for pursuit of planetary defense mission options, the timing of decisions needed to preserve future response options, and compile approximate costs associated with identified decision points. Codify criteria used to determine when a mission option is no longer considered viable.

High-Level Gaps and Recommendations

Gap: The ability to use a spacecraft to **quickly gather information** about the asteroid via flyby or rendezvous is limited (see related TTX4 capability gap).

Recommendation: Develop the capability to rapidly launch an NEO reconnaissance mission. Determine information required and processes for repurposing existing spacecraft and/or instruments to rapidly gather information about an asteroid threat.

Gap: Only one technology for **Earth impact prevention**—kinetic impact—has been demonstrated in flight, and it has only been demonstrated once.

Recommendation: Do additional Earth impact prevention flight demonstration(s) to increase their maturity and reliability (e.g., ion beam, additional kinetic impactors).

Note: The potential use of nuclear explosive devices for planetary defense purposes poses legal, international, and proliferation concerns that have not been fully resolved (see related TTX4 capability gap).

High-Level Gaps and Recommendations

Gap: Mechanisms for **timely international coordination** of public messaging about asteroid impact threats have yet to be fully developed.

> **Recommendation:** Expand existing efforts that take advantage of asteroid close approaches, planetary defense exercises, and other opportunities to coordinate national and international public information messaging strategies.

Gap: The rare nature of the potential impact threat and the need to develop new public messaging content may delay the **timely release of accurate information** to the public.

> **Recommendation:** Develop templates for preapproved holding statements for several different planetary defense scenarios (e.g., long warning, short warning, impact without warning).

High-Level Gaps and Recommendations

Gap: Sustaining the space mission, disaster preparedness, and communications efforts across a fourteen-year timeline would be challenging due to budget cycles, changes in political leadership, personnel, and ever-changing world events.

Recommendation: Use periodic briefings and exercises to continue to raise awareness of planetary defense and increase readiness for preparation and response to an asteroid impact threat.

Gap: The **interconnectedness** of timelines for space mission planning, disaster preparedness, and communications is **not fully understood**; an increased understanding of these needs would enhance planning and preparedness.

Recommendation: Engage in cross-agency dialogue to identify dependencies and the means to share needed information with the relevant agencies at the right times.

High-Level Gaps and Recommendations

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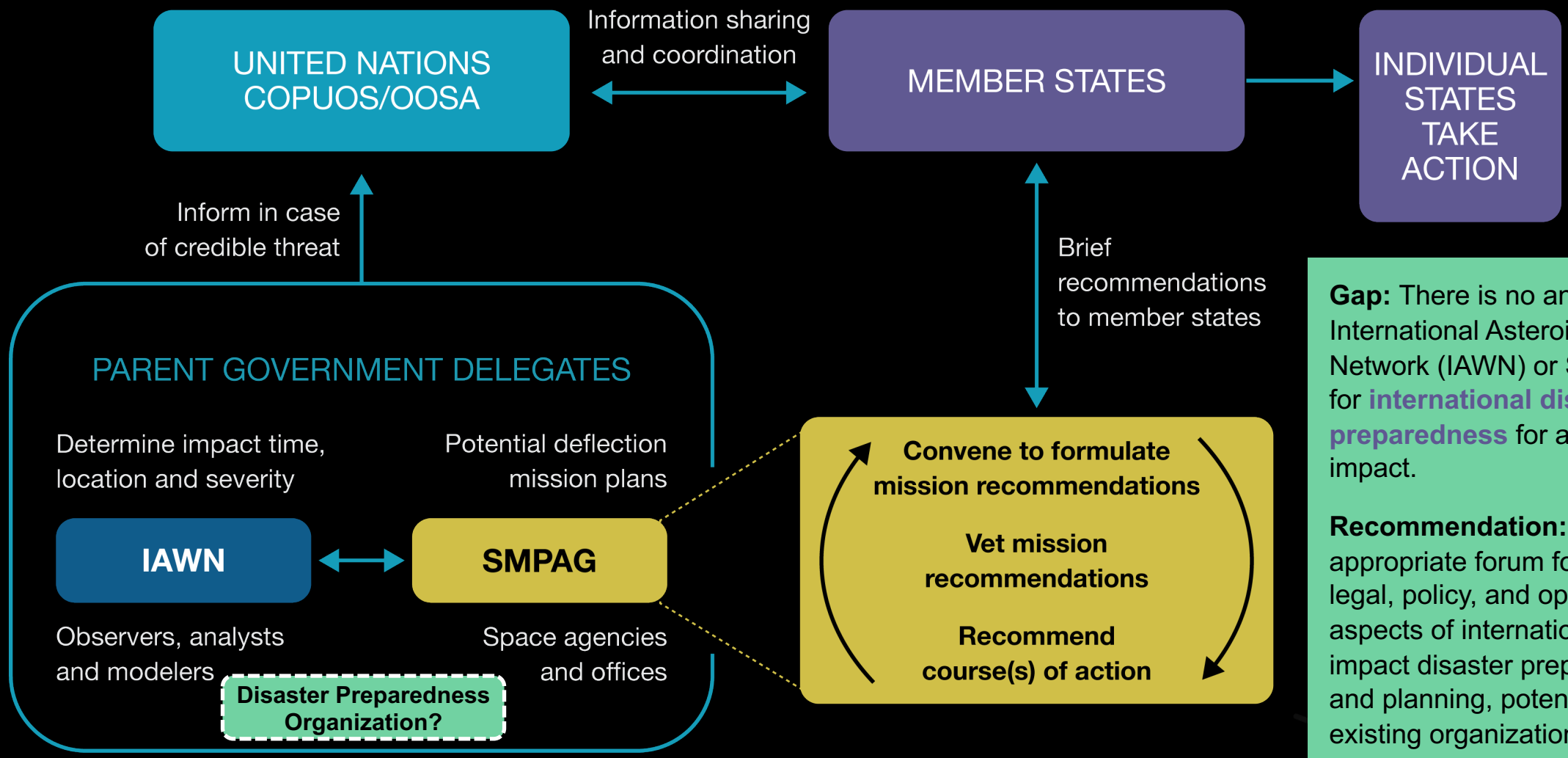

Gap: There is no analogy to the International Asteroid Warning Network (IAWN) or SMPAG for **international disaster preparedness** for an NEO impact.

Recommendation: Identify an appropriate forum for discussing legal, policy, and operational aspects of international NEO impact disaster preparedness and planning, potentially through existing organizations at the UN or elsewhere.

~100 exercise participants between two days

Key participants from many federal agencies and international partners

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United States

OSTP
NASA
FEMA
State Department
National Space Council
OSD
USSPACECOM
USGS
NNSA
NSF
DHS
NRO
USAID
LLNL
AFRL
Smithsonian
UMD
Aerospace Corp.
USSF (v)*
NGA (v)
LANL (v)
Rand Corp. (v)

International

UNOOSA
ESA
UKSA
SMPAG (v)
DLR (v)
JAXA (v)
CSA (v)
U. Cambridge (v)

*(v) = participated virtually

Selected Highlights from Likert-scale Questions

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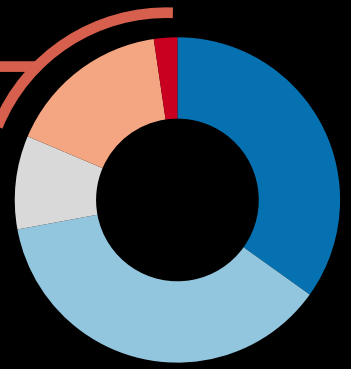
Adequate readiness for planning and implementation of space missions?

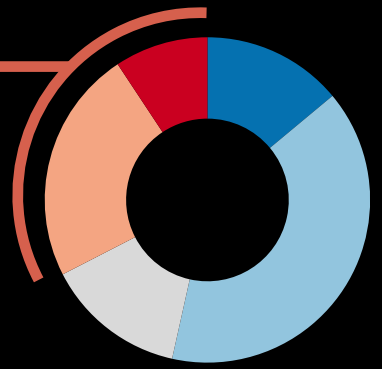
19%

Reconnaissance missions



33%

Earth impact prevention missions

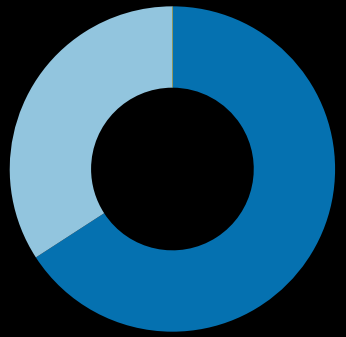


Legend

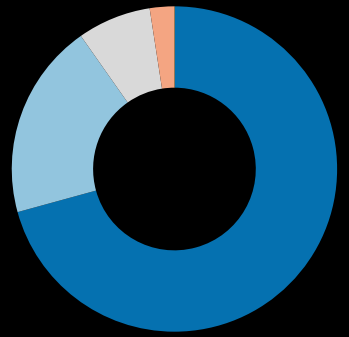
- Strongly agree
- Somewhat agree
- Neither agree nor disagree
- Somewhat disagree
- Strongly disagree

Participant assessment of TTX

Provided opportunities to address **significant decisions** to support international response to an asteroid threat.



Left **better prepared** to deal with capabilities and challenges addressed.



Selected questions from eight participant feedback forms (41 responses, on average)

Selected Participant Comments

Anonymized per evaluation plan and expectations set during exercise

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"International involvement early will be critical. That credibility is essential and must be established *now*."

"I know what I would prefer [to do], but Congress will tell us to wait."

"Maintaining trust at the start of this event is critical and that means talking early—probably earlier than the scientists and lawyers are comfortable with."

"This is a complex decision to be made, and I'm not sure we fully understand how that will happen. I think it will be an informed trial-and-error process, and exercising it more than a couple of times will be useful to at least document what doesn't work."

"The most important item of the morning was the discussion involving the political nature of the decision making."

"Overall a great discussion about the challenges. I think people will go back to their organizations [with] a lot of questions to improve the next TTX."

Next Steps for TTX5

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- After-Action Report (AAR) and Improvement Plan (IP) to be released summer 2024.
  - AAR will include strengths and gaps identified from analysis of TTX data, as well as recommendations for improvement.
  - The Improvement Plan (IP) is a key component of the AAR – it assigns responsibilities for actions to ensure follow-through on appropriate recommendations.
- Outcomes will influence future TTXs and workshops to ensure ongoing improvements to planetary defense preparedness.

Example after-action report

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