

A close-up photograph of an astronaut in a white space suit, looking out from the helmet. The helmet's visor reflects the interior of the space station and the Earth. A bright sun is visible in the upper left corner, creating a starburst effect. The text "Protecting Access to Space" is overlaid in large white font across the center of the image.

Protecting Access to Space

Presentation to Senior Leaders

Report Documentation Page

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Protecting Access to Space

- The problem
- A framework for protecting access
- Findings
- Way ahead



The Space Problem

- We are all dependent on space in ways that are not obvious
- Space is vulnerable in ways that require us to be proactive in order to protect it

Space Dependencies

Mineral & Oil detection
Agricultural compliance
Consequence management
Security in remote districts
Ship status during search & rescue
Facilities emplacement
Ice flow monitoring
Tele-medicine

Weather forecasting
Agricultural efficiency
Timing & synchronization
Air traffic control
Disaster relief planning
Asset/fleet tracking
Missile launch detection
Power grid coordination

Mapping
Border monitoring
Unmanned aerial vehicle operations
Satellite radio
Arms control verification
Rural telephony
Missile defence command & control
TV signal distribution
Broadband internet
Reachback

Precision guided munitions

Obscure

Obvious

Space Environment is Vulnerable

A background image showing a dense field of space debris, including various pieces of metal, plastic, and other fragments, floating in space. A bright blue and white streak, likely representing the Earth's atmosphere or a satellite's path, runs diagonally across the scene.

- Persistence
- Congested
 - Finite useful orbits contain important spacecraft
- Fragile
 - “Collisional Cascade”
- Limited ability to ‘self-heal’

Threats to Space Capabilities



- Anti-Satellite Missile
- Conventional attack (Against enabling infrastructure)
- Cyber
- Electro-Magnetic Pulse (High Altitude Nuclear Explosion)
- Electronic Warfare (including Jamming / Spoofing)
- Laser (High or low-powered)
- Physical Interference

The Space Problem: Summary



Dependencies greater than military-usage

- Significant economic & societal consequences

Access to space at risk

- Current approach unsustainable
- Broad range of threats & actors

Vulnerability Gap

Need to act proactively

- Managing consequences not always an option



Solving the Problem: MNE7 Scope

In

- Space Situational Awareness
 - Assume sufficient
- Debris
 - Deliberate events
- Capability Elements

Out

- Space Situational Awareness
 - Improvements
- Debris
 - Management
- Capability Elements

Space Element



Communications Element



Ground Elements



Solving the Problem: MNE7 Scope

In

- Space Situational Awareness
 - Assume sufficient
- Debris
 - Deliberate events
- Capability Elements
 - Space
- Actors
 - States
- Situations
 - Not at war

Out

- Space Situational Awareness
 - Improvements
- Debris
 - Management
- Capability Elements
 - Communication, Ground
- Actors
 - Non-State, Individuals
- Situations
 - War

Identify **dependencies** on, **threats** to, and **vulnerabilities** of space capabilities

“Space Handbook”



Identify mechanisms to **deter, coerce,** or **influence** actors in space

Detering & Influencing in Space Process



Develop proposals for **mitigation** if deterrence fails

Collaborative Mitigation Concept



Framework to **Protect Access** to Space

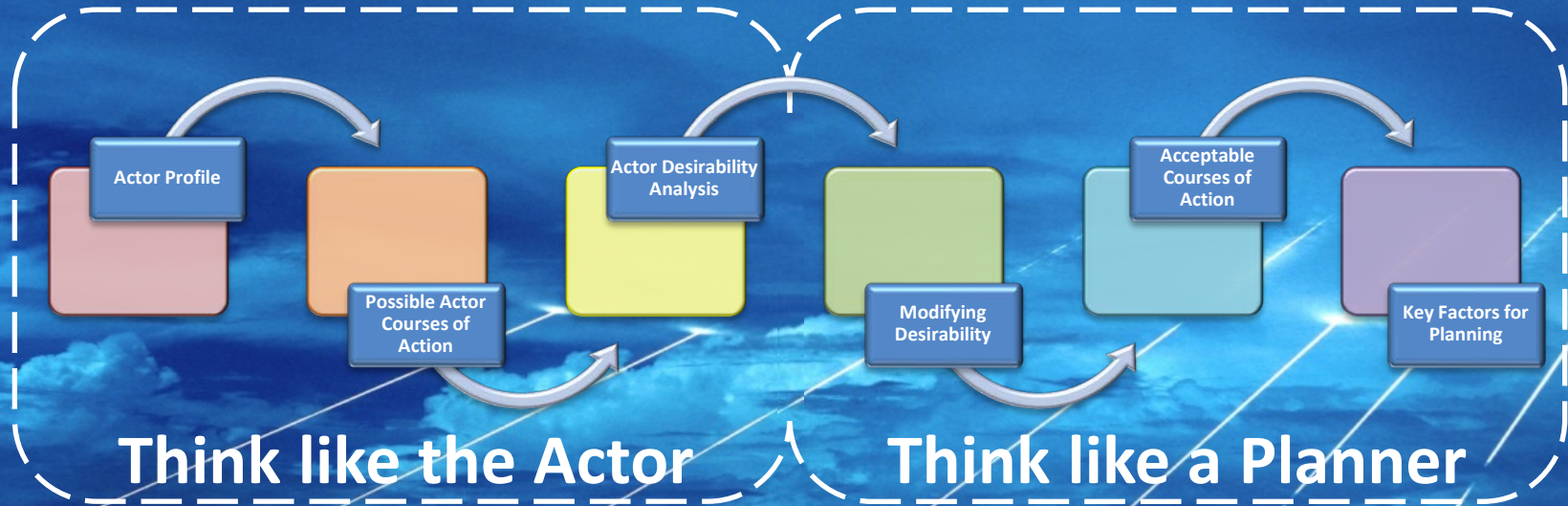
Protecting Access to Space



National Dependencies

- Critical national infrastructure sectors used
 - identifies essential national services
- Considers:
 - Time-to-failure
 - Effectiveness of backup services
 - Importance of space to activity
- An assessment is conducted to determine specific vulnerabilities
 - Relative importance
 - Targets finite resources
 - National business continuity

Deterring & Influencing in Space



Deterring & Influencing in Space

DETERRENCE IS
MORE THAN
JUST FIREPOWER



Space Defensive Measures

Provide a certain level of protection.

Defensive measures depend on the design phase.


Each kilogram dedicated to protect a satellite cannot be dedicated to the payload.


Protection increases costs



Irreversible compromise between performance and protection early in the capability development process.

Space Defensive Measures

- 
- Frequency Deconfliction
 - Manoeuvre
 - Suspend Operations
 - Autonomous Operations
 - Encryption
 - Physical Shielding
 - Radiation Hardening
 - Shutter / Filters



Reduced performance
and/or lifetime
(+ requires appropriate SSA)

Collaborative Space Mitigation

*Managing the risk
of disruption or denial effects on space capabilities.*

Assumptions:

- Latent space capacity exists
- Partnership opportunities exist to leverage latent capacity
 - Affordable & sustainable

Collaborative Space Mitigation

Concept: 5 step process

Operational requirements



Impacted functionalities



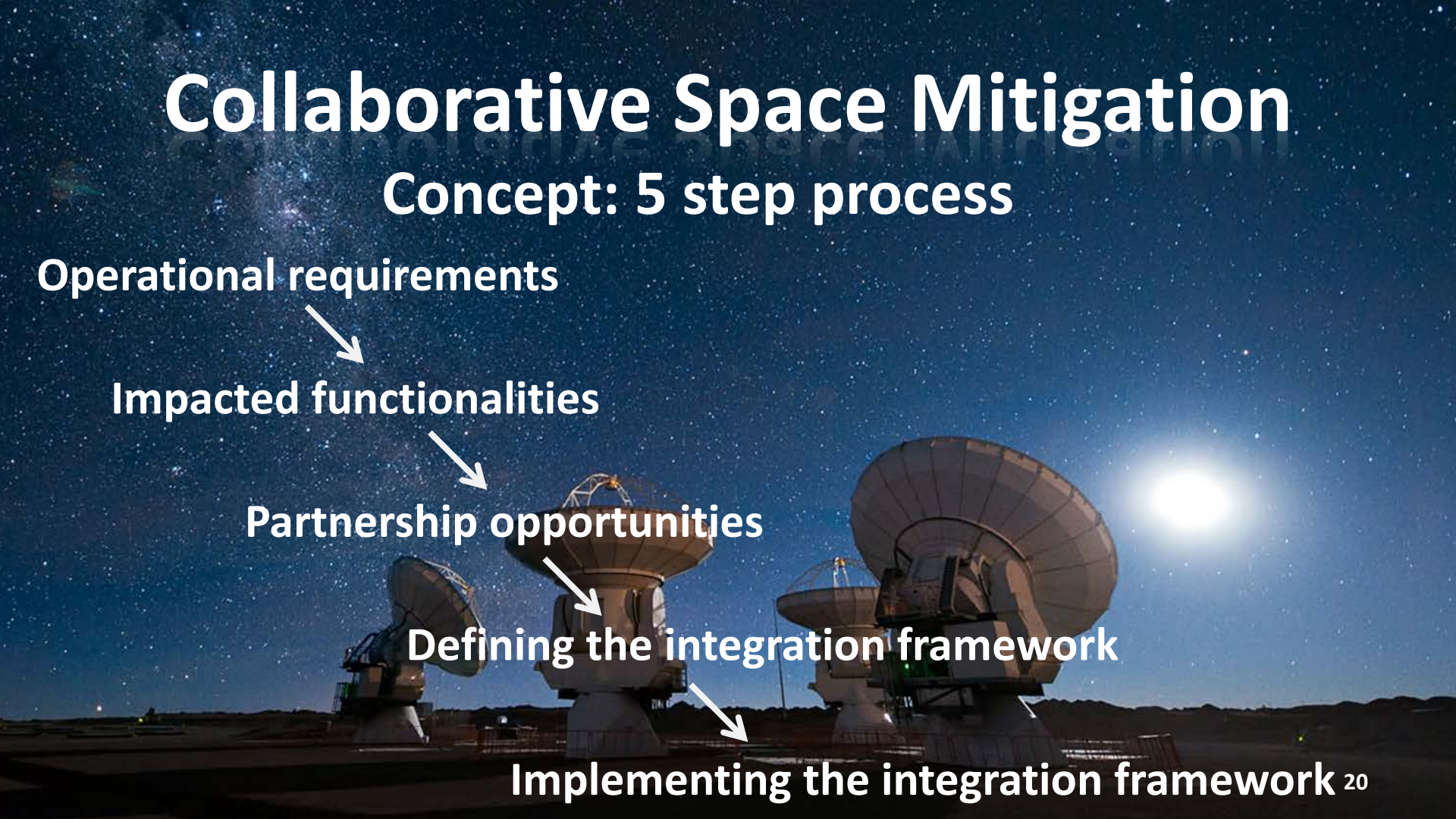
Partnership opportunities



Defining the integration framework



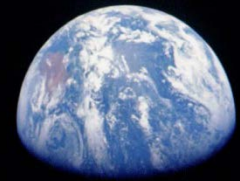
Implementing the integration framework ²⁰



Collaborative Space Mitigation

- Performance and affordability as expected;
- Interoperability comes at a cost;
- Political acceptability is critical.

Conclusions



Summary of Findings

Vulnerability gap requires a **proactive & collaborative** approach

Space is **everybody**'s business

- Anticipate & manage risks before they arise
- Prepare for the consequences

- Almost all nations, space faring or not, depend on space
- Responsibilities beyond narrow cadre of space professionals

Summary of Findings (Ctd)

Assuming latent space capacity exists

Space Defence is presently a national matter with a very high level of sensitivity

- Leveraging it through partnerships depends on willingness to collaborate, political acceptability, cost of interoperability
- Opportunities to share best practises in the framework of specific partnerships

Way ahead

Current approach unsustainable, thus the need to:

- Change perceptions

- We are all dependent
- Responsibilities for protection beyond space professionals

- Anticipate & manage risks before they arise

- Identify dependencies
- Manage behaviour

- Prevent escalation

- Avoid reciprocal strategies in space

- Prepare for the consequences

- ...in the event other efforts fail
- ‘Preparedness’

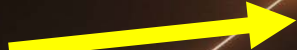
*Space Handbook &
Protecting Space Guide*



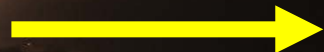
Critical Dependencies Concept



*Process on Managing
Behaviour in Space*



Concept on Mitigation



Way ahead (Ctd)

Handbook

NATO: Space course

CAN: Education of senior leaders

Process

National and multinational
crisis management process

Guide & Supporting documents

NATO: work on space dependencies and
mitigation options (NBi-SCSWG)

CAN: national capability development

CHE: domestic security and debris management (UN)





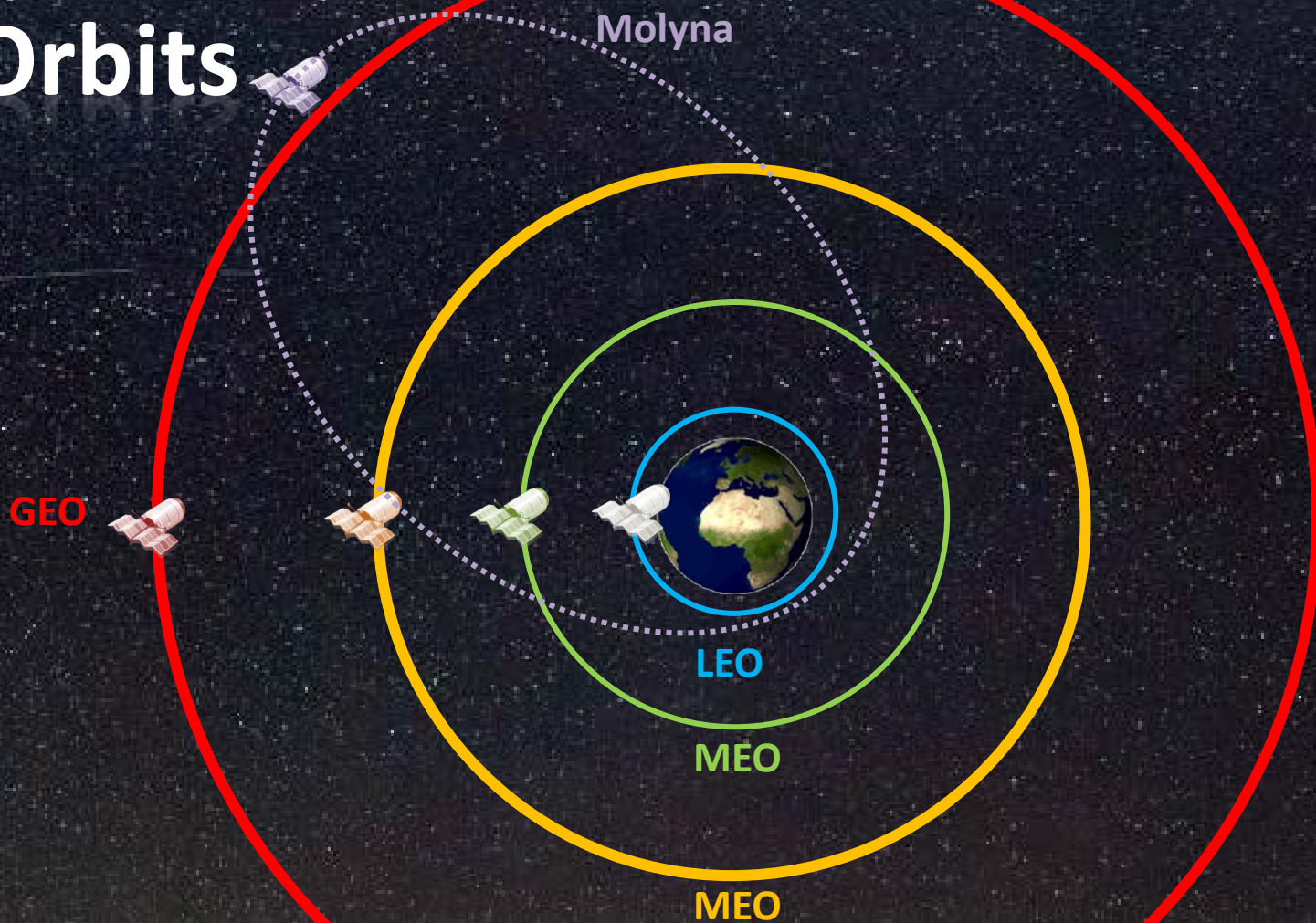
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Back Up Slides

The Space Pillars

- **Position, Navigation, & Timing [MEO]**
 - Allows user to determine position, time, or velocity
- **Satellite Communications [GEO, LEO]**
 - Beyond line-of-sight communications
 - Higher quality & capacity than alternatives
- **Intelligence, Surveillance, & Reconnaissance [LEO, GEO]**
 - Unrestricted global access to overhead observation
 - Broad applications, civil & military
- **Space Situation Awareness**
 - Comprehensive understanding of environment, including object tracking and space weather
 - Important for successful delivery of other pillars

Orbits



Dependency Case Studies

- Agriculture
 - Guides farm machinery
 - Weather forecasting
- Resource Prospecting
 - Mapping & detection of resources
 - Environmental monitoring
- Air Delivered Weapons
 - Requirements to avoid collateral damage oblige the use of precision munitions
- Missile Defence
 - Missile launch detection
 - Command & control

Space Law

- Outer Space Treaty ('67) & supporting regulations
 - Weapons of mass destruction: No WMD in orbit
 - Military bases, testing weapons, or conducting military manoeuvres on the Moon or other celestial bodies not allowed
 - Sovereignty. Launching nation maintains jurisdiction over manned spacecraft, satellites property of owner
 - Peaceful use
- But no agreed definition for where space 'starts'
 - Therefore no consensus whether spacecraft orbit in national airspace
 - E.g. Bogota declaration

Space Deterrence LOE

- Tested practicability & utility of the process
- One-sided open wargame
 - CDAG method
- 17 Participants + Experiment Team
 - 9 Nations, + EU EAS, UNIDIR
- Six vignettes examined
 - 87 Actor Courses of Action developed
- Experiment reporting via CDEMS

Space Mitigation LOE

- Examined political acceptability
 - Partner: types & capability level; Sharing: provisions & caveats; Compensation
- Two methods
 - Tabletop + Decision-support software (Swiss "CREDO")
- 7 Participants + Experiment Team
 - Canada, Germany, NATO, USA
- Examined 3 vignettes
 - ISR, SATCOM, SSA
- DRDC Technical Memorandum forthcoming