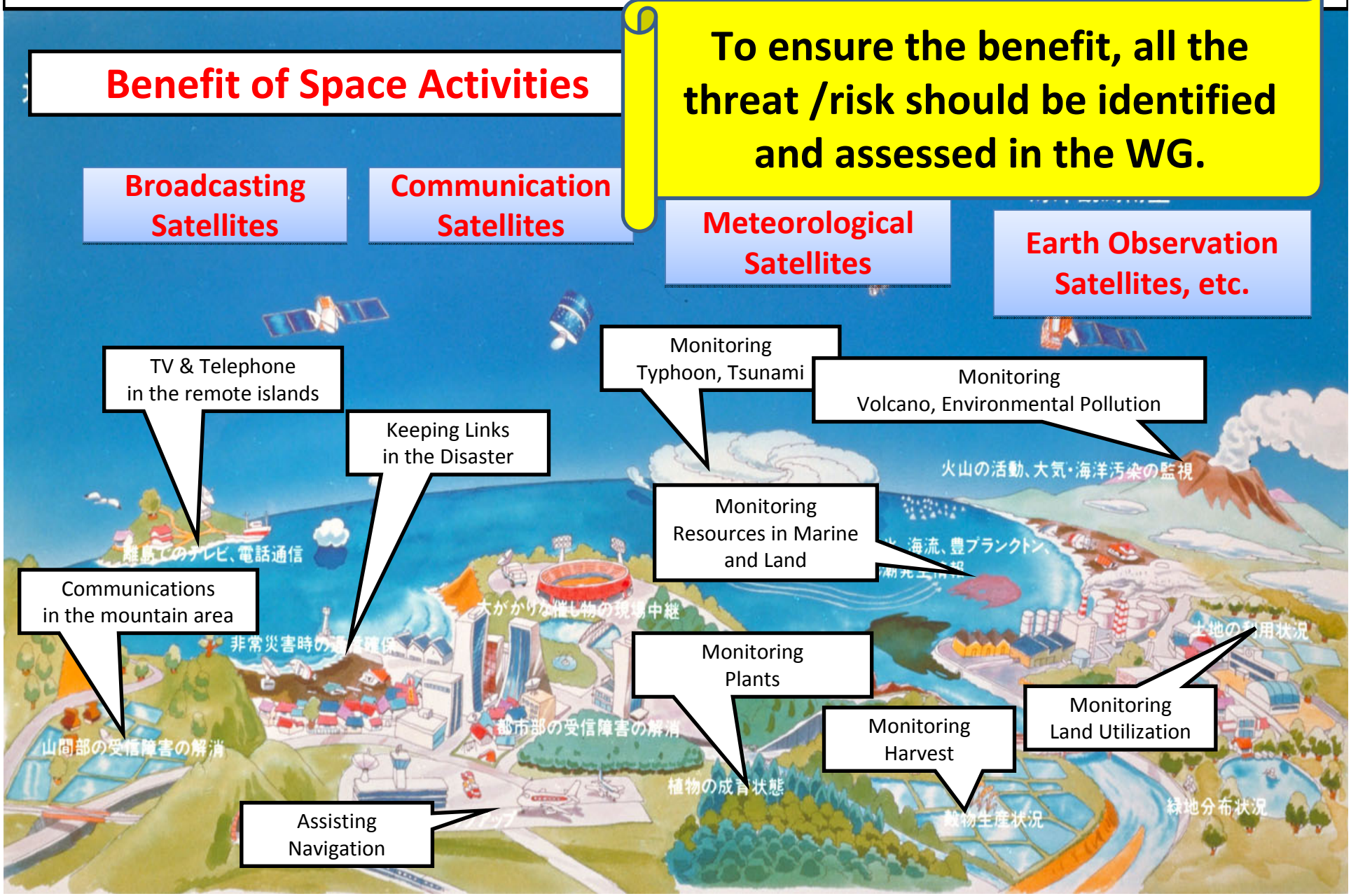
Concerning to the "ToR on the Long-Term Sustainability of Outer Space Activities of the STSC" (A/AC.105/C.1/L.307)

Procedure for Risk Assessment & Identification of Best Practices to Support the WG for Sustainability

14 February 2011

Japan

Sustainability of Space Activities means that of Human Society



SCOPE

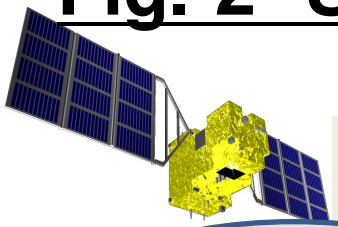
- In the ToR of WG provides clear idea, and defines the following seven areas to be studied.

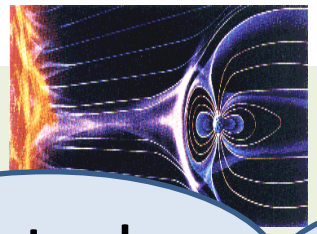
WBS defined in the ToR
(a) Sustainable space utilization supporting sustainable development on Earth
(b) Space debris
(c) Space weather
(d) Space operations
(e) Tools to support collaborative space situational awareness
(f) Regulatory regimes
(g) Guidance for new entrants in the space arena

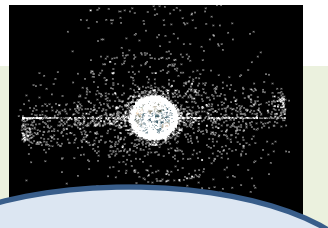
- Based on the idea in ToR, Japan would like to introduce here the approach on more detailed subjects to be discussed.
- This paper introduces the concept of the approach and the study result.

Fig.-1 Proposed Procedure

Fig.-2 STEP-1: Comprehensive Survey of Threats







Quality & Reliability Assurance

Induced Environment

Natural Environment

Man-made Environment

Cost Limitation, Lack of technology, Quality Assurance, Workmanship Error

Launch Environ. Orbital Environ. Electro-Magnetic Interference

Solar Flare Radiation Magnetic Envi. Meteoroid

Fargments Disposed - Spacecraft

Spacecraft Launch - Vehicles

Malfunction, Fragmentation, Collision

Deterioration of Orbital Environ.

Threat to other S/C

Casualties caused by Re-entry

Negative Social Impact

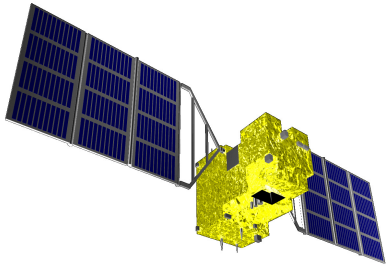
Reduce Sustainability

Table-1: Threats, their Results, Current Status

Threat		Results	Current Status
Quality & Reliability Assurance		Failure, Explosion	Usually, quality and reliability control program are applied to the spacecraft design and operation. All the space operators are expected to pay attention on these aspects.
Induced Environment		Malfunction	
Natural Environment (Solar flux, Electromagnetic, Plasma, neutral gas, etc.)		Radiation effects, etc.	Natural environment is informed by the regional warning centers of ISES. It is expected that the Space Weather Forecasting Service will be improved reflecting the discussion in the related agenda items in COPUOS.
Man-made Environment	**Fragments of break-ups**	Collision and Malfunction	Warning of conjunction with fragments are being sent frequently. Notification of break-up event should be sent. And distribution data of fragments is expected to be sent immediately.
	Collision with large objects	Collision and Break-up	Collision avoidance maneuver needs information of operation status and points of contact of approaching spacecraft.
	Collision with tiny objects	Collision and Malfunction	There are no reliable environment models for small debris Tiny debris has high collision probability, and poses un-ignorable risk to the ordinal satellites. Cost effective (mass effective) measures are expected.
	Impact on the ground	Ground casualty	To ensure the ground safety from re-entering spacecraft, design measures to reduce casualty is encouraged. To know the risk of high risk re-entering objects, its physical property should be informed.

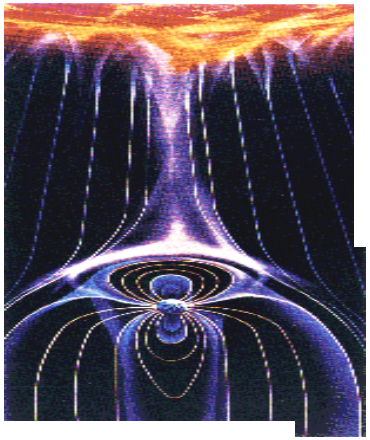
Fig.-3 STEP-2: Identification of Risk Factors

(1) Quality & Reliability Assurance



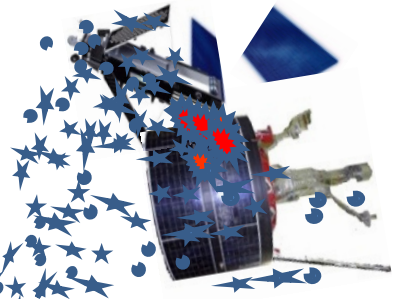
(2) Natural Environment

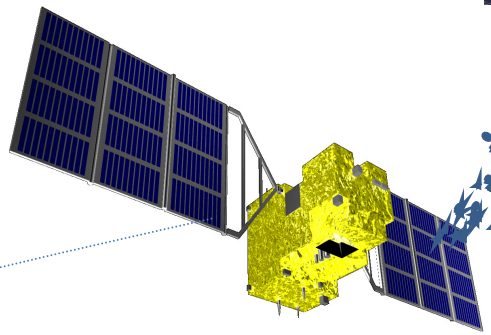
Solar flux, Electromagnetic, Plasma, Radiation, Neutral gas, etc



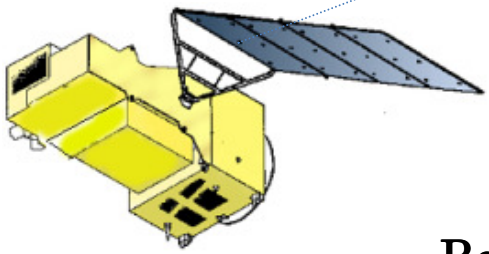
(3) Collision with Fragments

Awareness of collision accidents, and distribution of fragment data





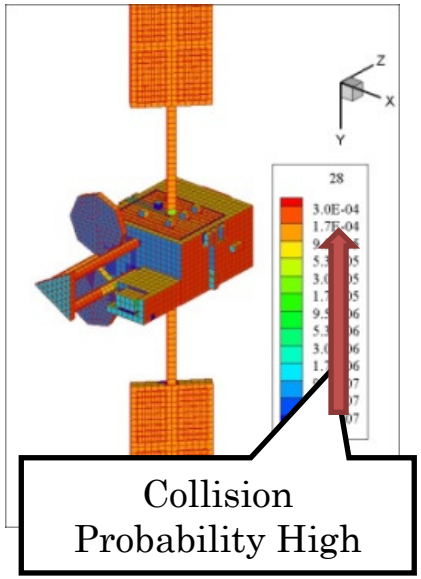
(4) Collision with Large Objects (with other spacecraft and other large debris)



form LEO

(6) Risk of Re-entering Objects

(5) Collision with tiny debris

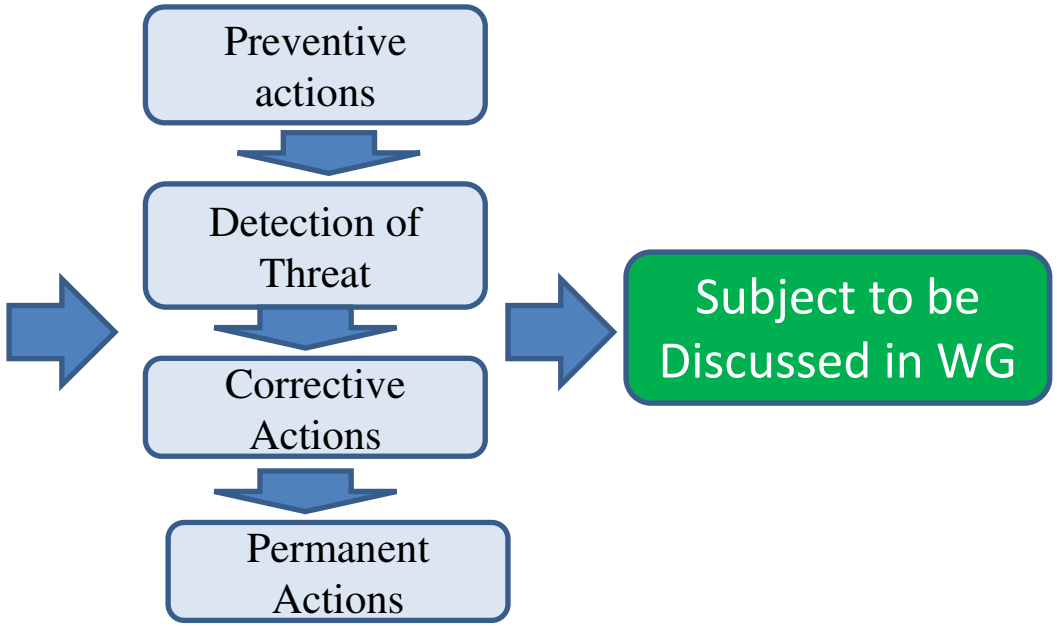


Concept of STEP-3, 4 & 5
Risk Analysis, Contingency Planning, Identification of Best Practices

1. STEP-3: Assess the risk by the probability and the influence, and identify the items for which risk magnitude is not small.
2. STEP-4: For each major risk, review the contingency plan, and identify the subjects to be improved.
3. STEP-5: Assess the subjects to be identified as the best practices

	軽微 軽微な不具合誘発	軽度 衛星一部機能の阻害 or 軽微な人的被害	重度 衛星基本機能阻害 or 人的被害	壊滅的 多量の破片による大きな環境汚染
0. 1				
0. 01				
0. 001				
0. 0001				
0. 00001 以下				

Risk Assessment matrix



contingency planning

Table-2 STEP-3: Risk Assessment

	Factors	Influence	Probability	Risk Magnitude
1	Quality & Reliability Assurance	Loss of function	Quality & Reliability differ depending on manufacture	**Risk : Various** -Probability: Large -Influence: Various -Control level is varied
2	Natural Environment	Loss of mission	Several spacecraft per ten years have terminated mission	**Risk: Medium** -Probability: Large -Influence: Medium -Monitoring & notification
3	On-orbital Break-up	Collision, and Deterioration of environment	About 200 break-up events have been observed	**Risk: Large** -Probability: Large -Influence: Large Action: Being promoted
4	Collision with large objects	Break-up, and Deterioration of environment	Satellite to satellite collision occurred once; the probability could increase	**Risk: Medium** -Probability: Small -Influence: Large - Action: Insufficient
5	Collision with micro-debris	Loss of function	Failure rate is controlled to be less than 0.01 in some countries	**Risk: Medium** -Probability: Large -Influence: Medium -Action: Insufficient
6	Impact of re-entering objects	Casualty on the ground	Number of casualties are controlled to be less than 0.0001 in some agencies	**Risk: Un-ignorable** -Probability: Small -Influence: Medium - Action: Insufficient

STEP-4: Contingency Planning

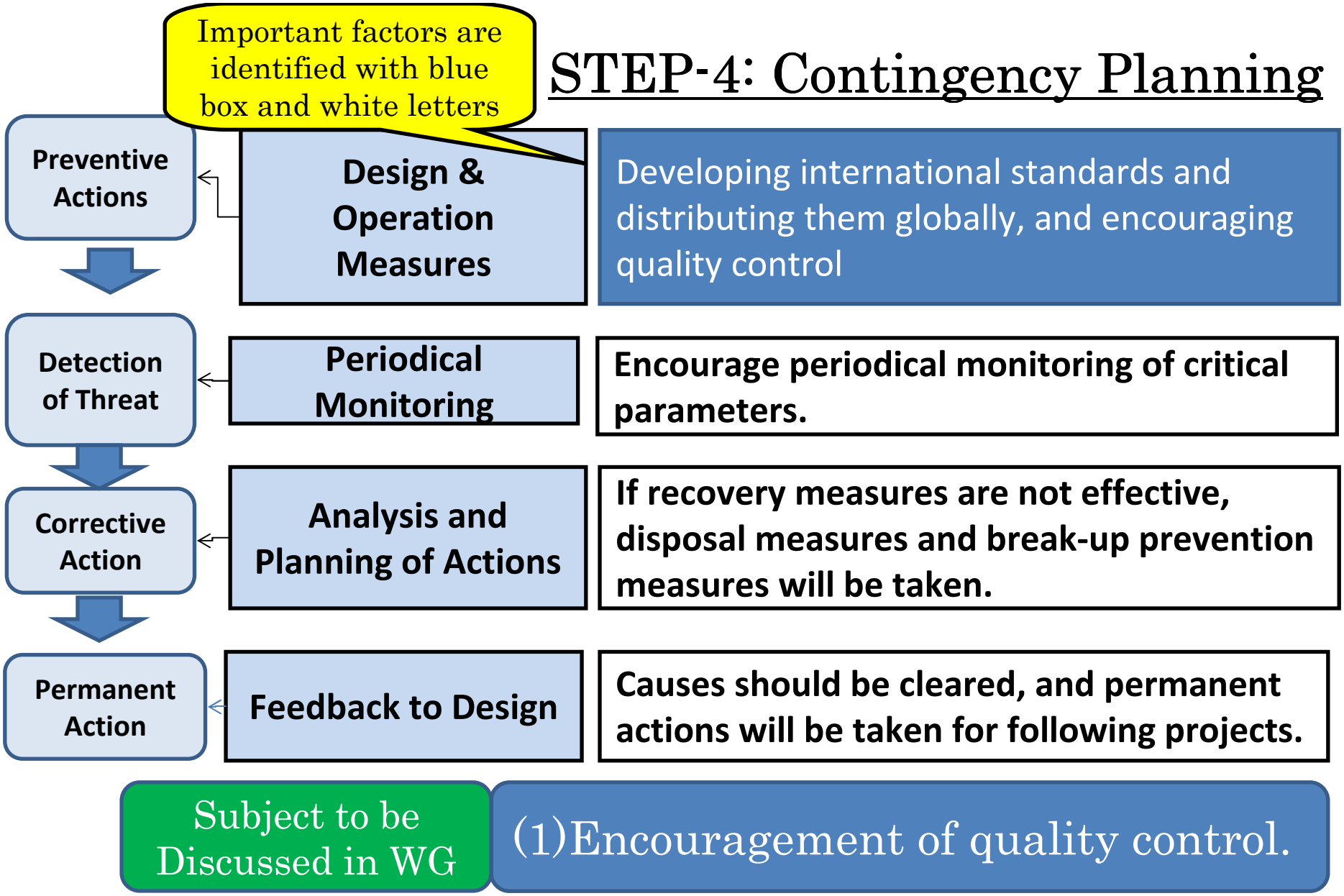


Fig.-4-1 Contingency Plan for Quality and Reliability Assurance

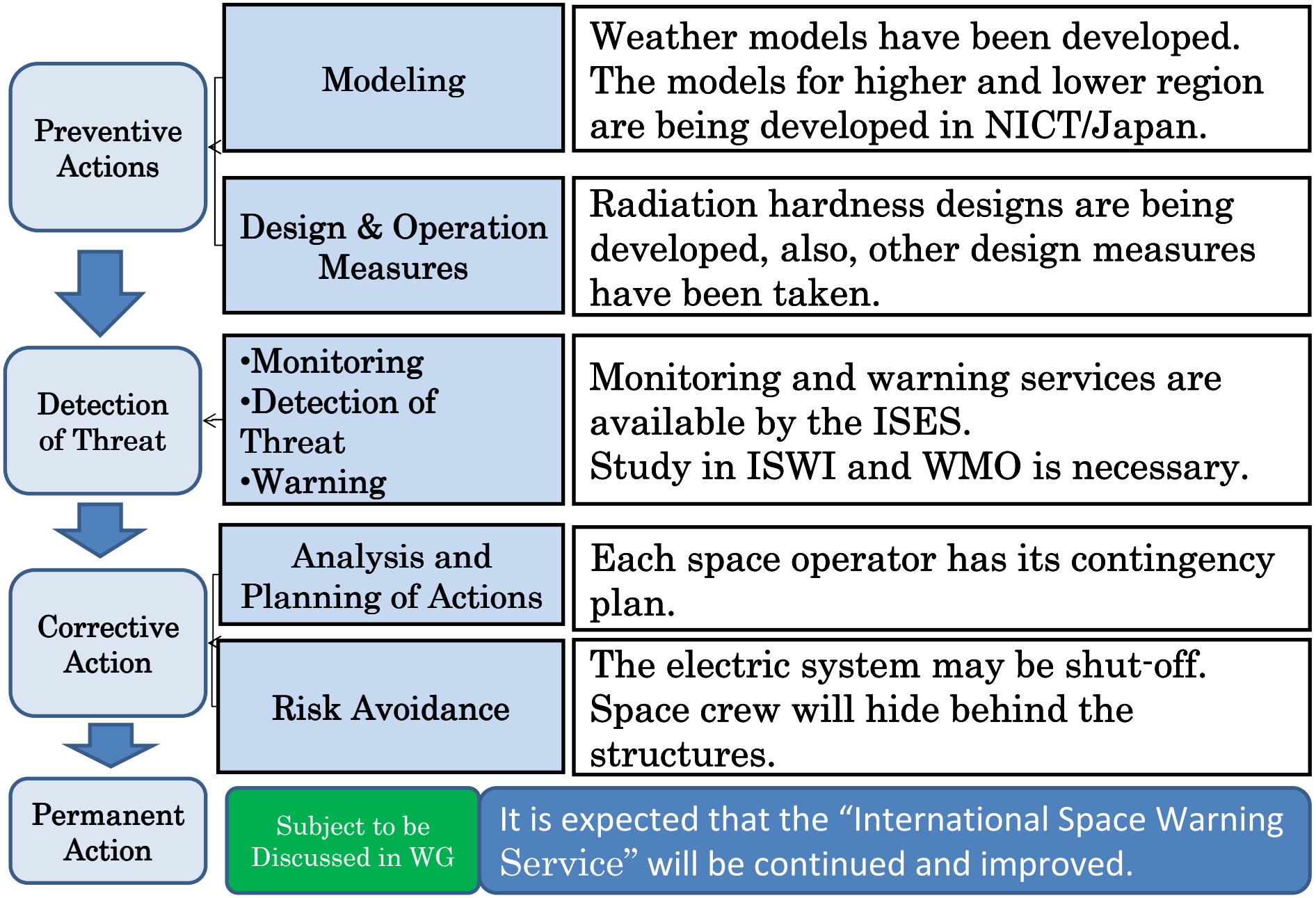


Fig.-4-2 Contingency Plan for Natural Environment

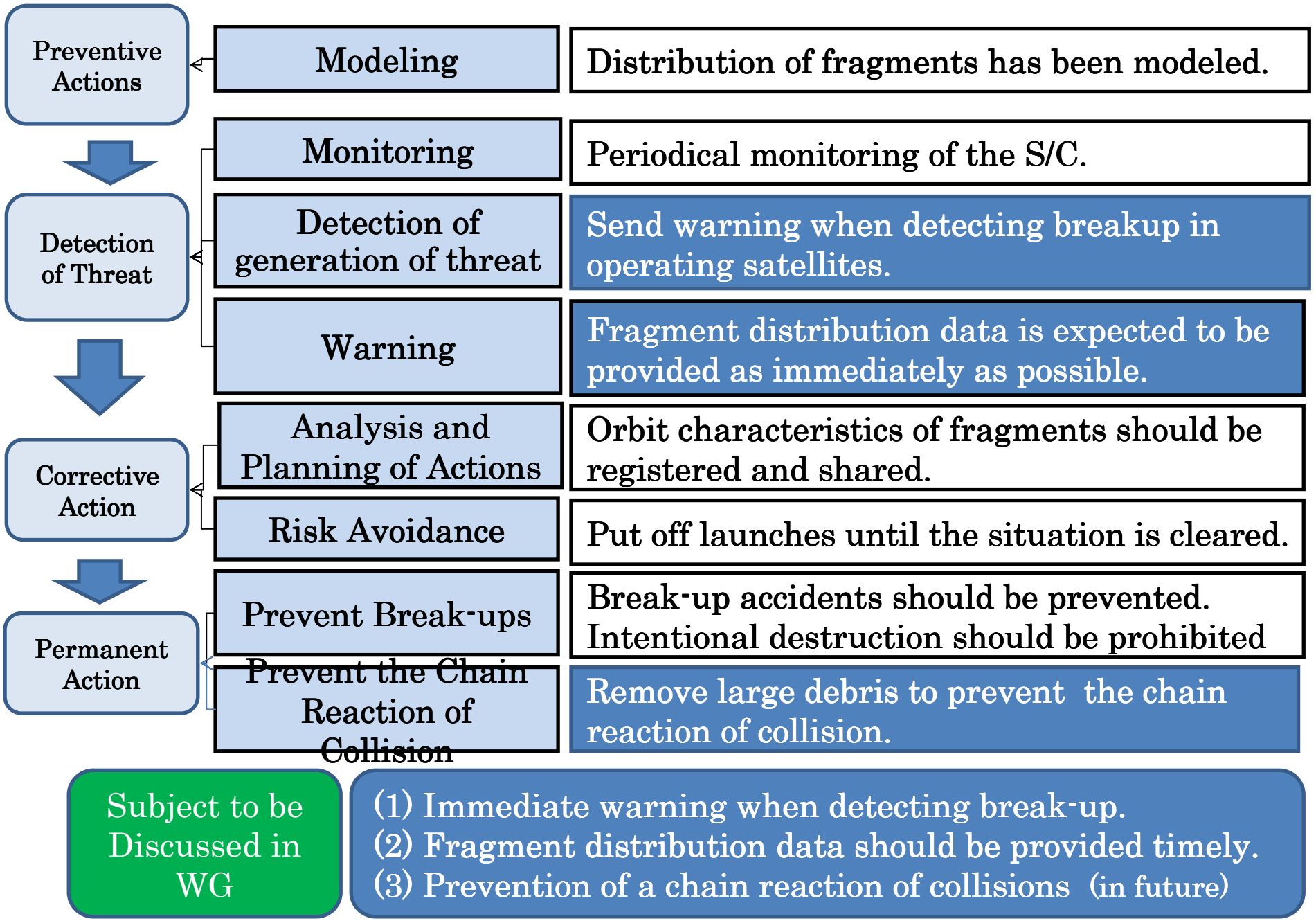


Fig.-4-3 Contingency Plan for On-orbit Break-up

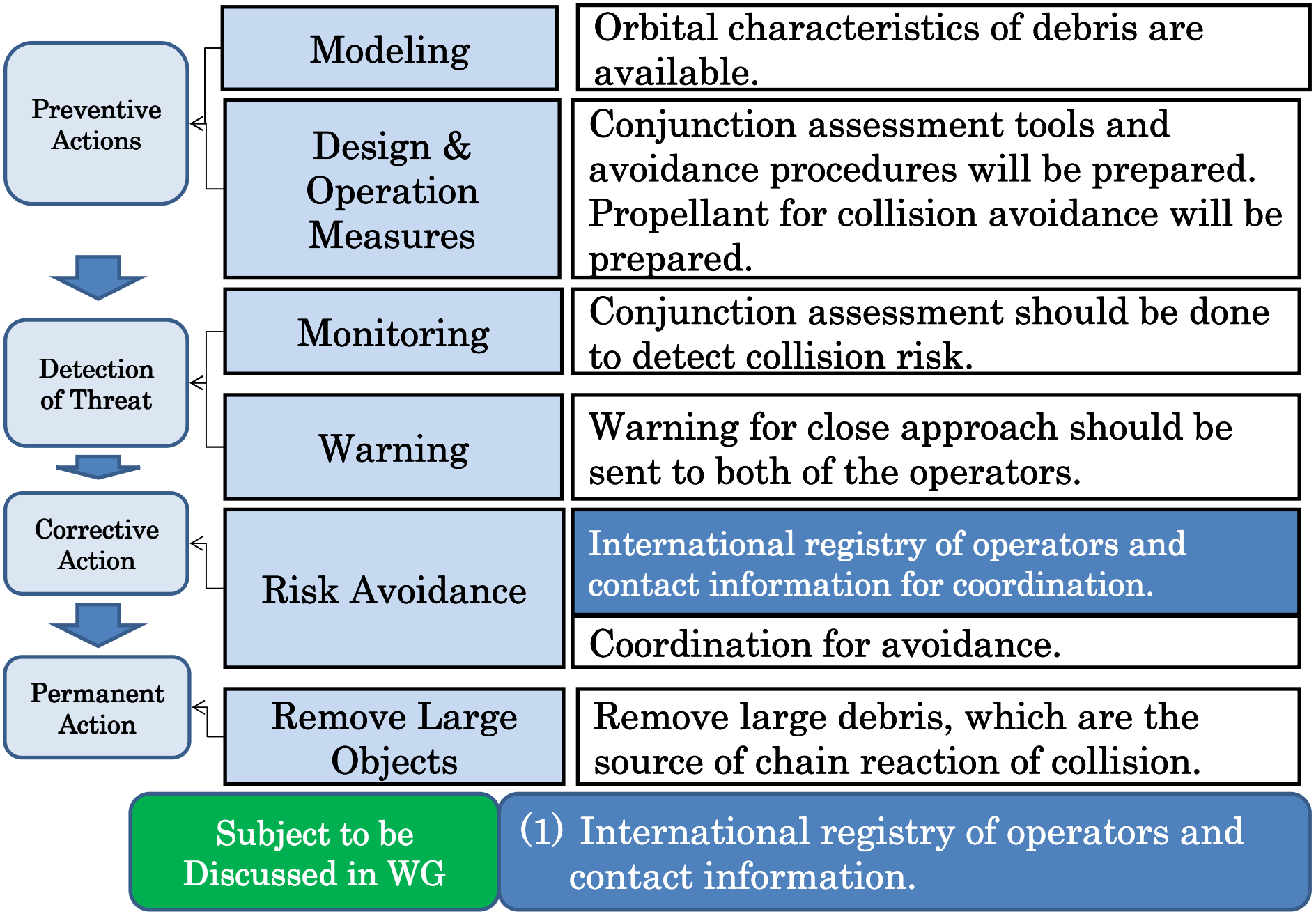


Fig.-4-4 Contingency Plan for Collision with Large Objects

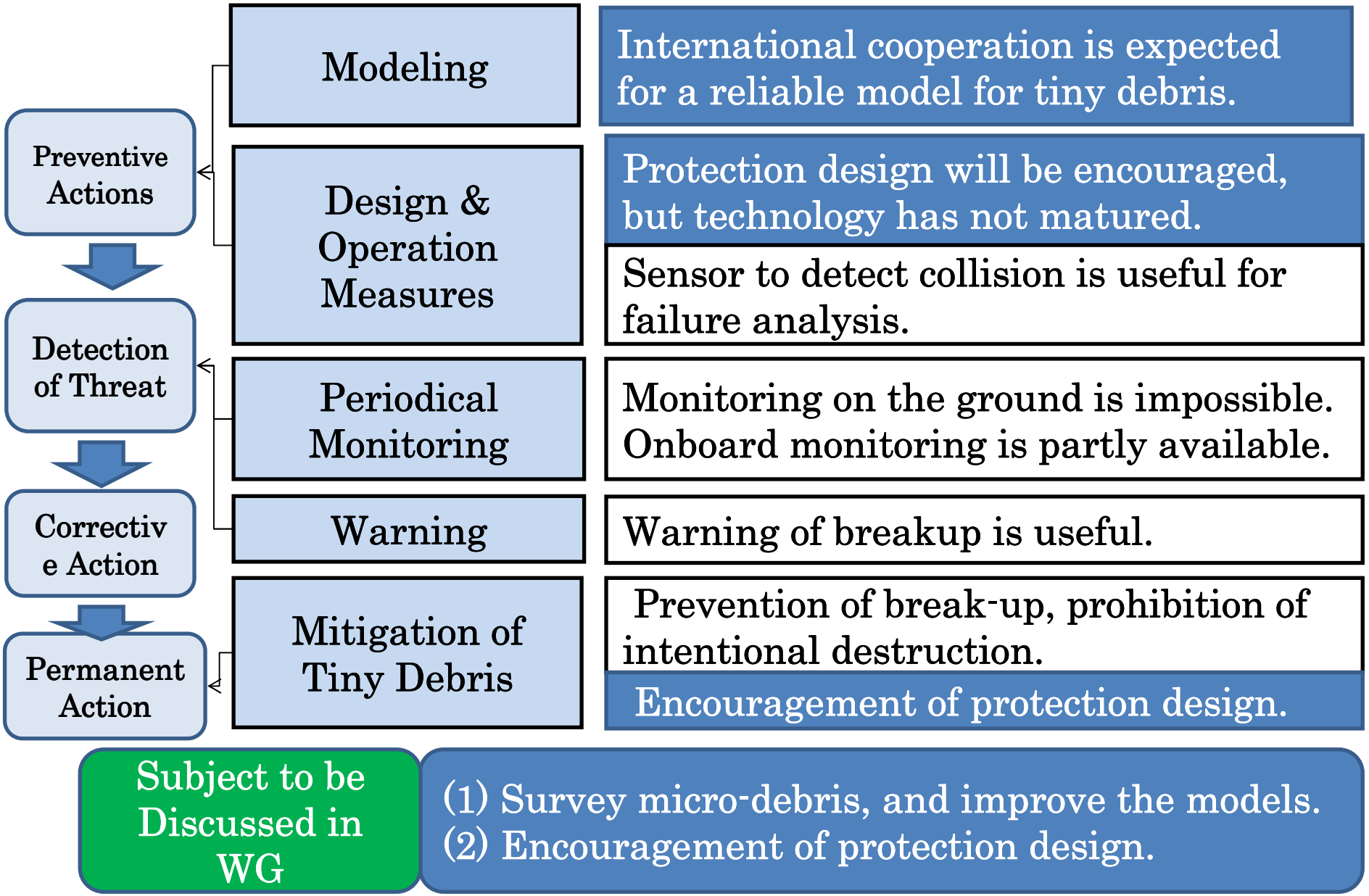


Fig.-4-5 Contingency Plan for Collision with Micro-debris

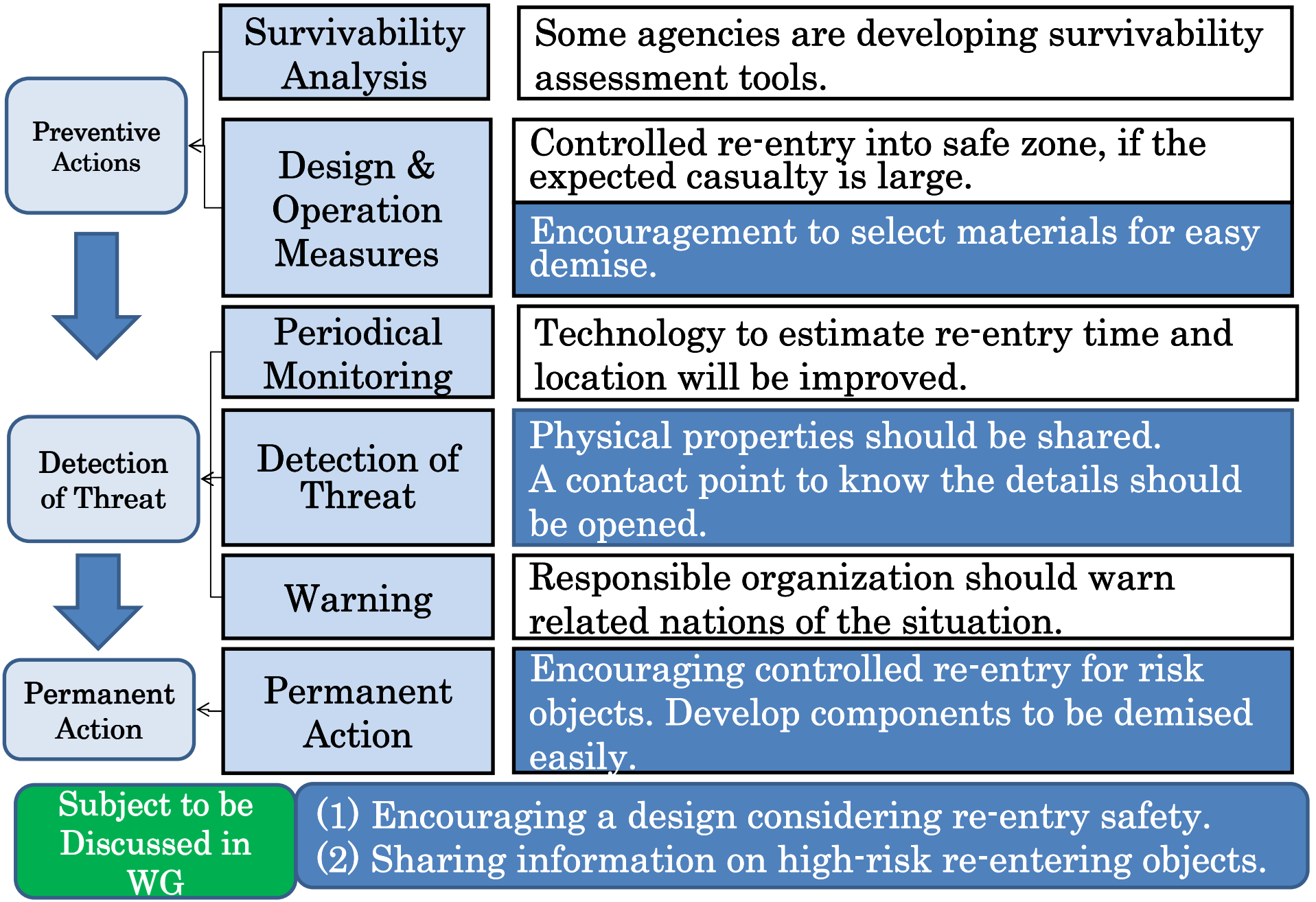
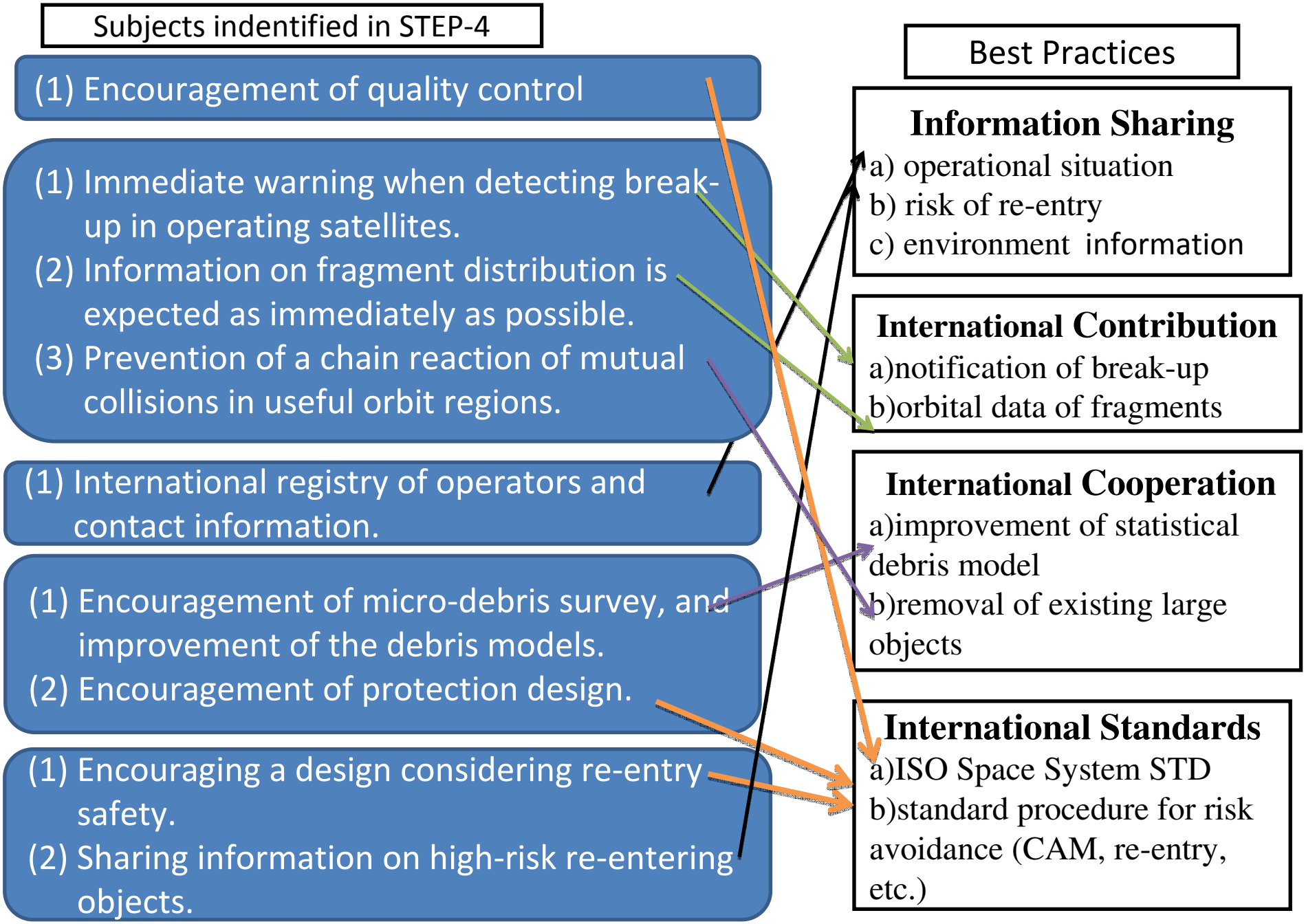


Fig.-4-6 Contingency Plan for Reentering Objects

Fig.-5 STEP-5: Subjects and Candidates for Best Practices



Conclusion

A) To ensure the benefit from space activities, all threats /risks should be identified and assessed in the WG.

B) A risk analysis and contingency planning will effectively induce the items to be discussed in the WG.

C) All the work will not be done in the WG.

For some subjects, it will be efficient for the WG to define what should be done, and allocate the work to the other agenda items in COPUOS, or other appropriate organizations.

[Reference Table] Work Allocation & Sharing Among World Authorities to Develop & Encourage the Best Practices

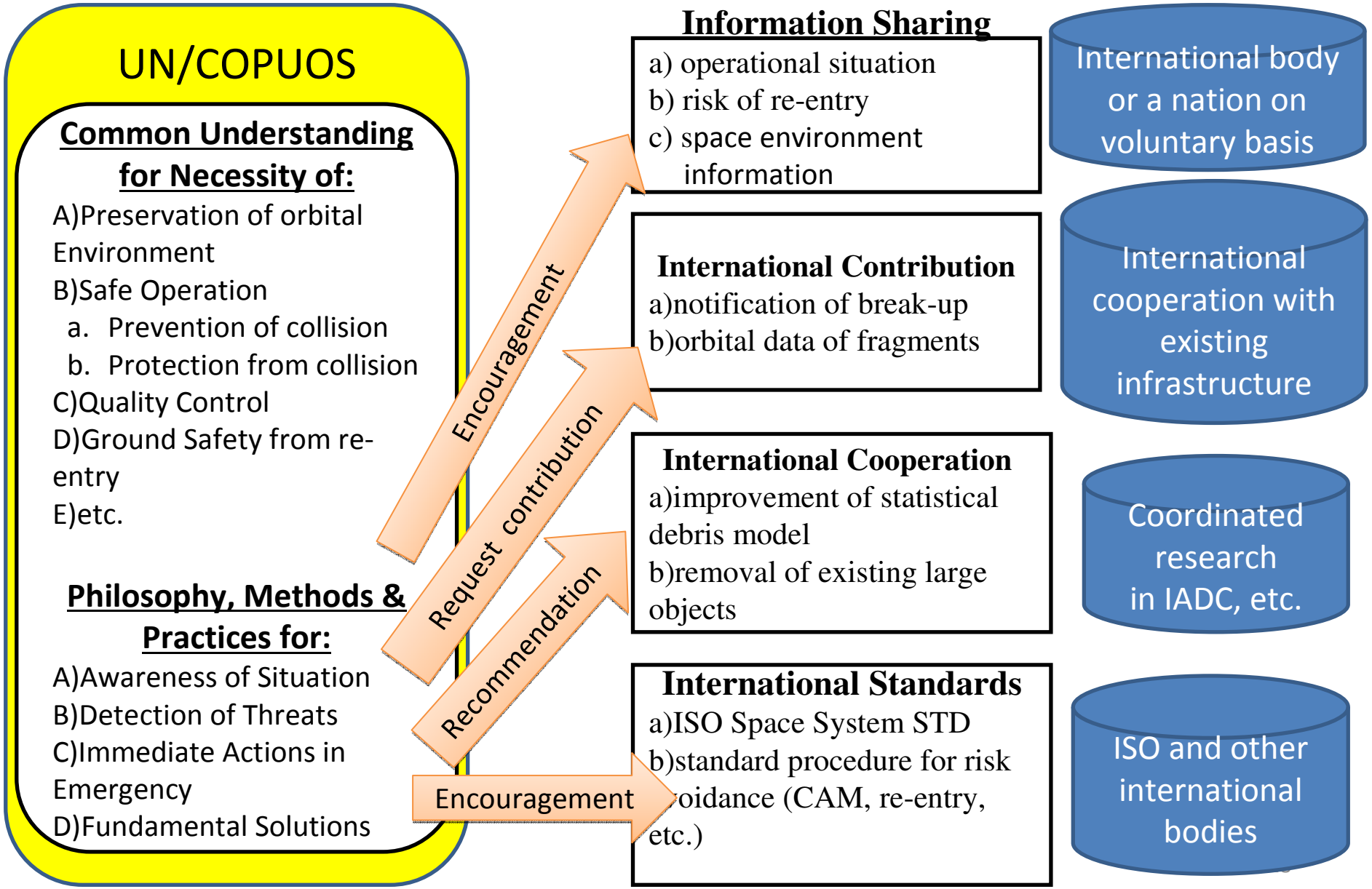


Table-3 Allocation of the subjects into the ToR (1/2)

Title	Contents of work	
(a) Sustainable space utilization supporting sustainable development on Earth	(i) The contribution of space science and technology to sustainable development on Earth	
	(ii) The concept of sustainable development extended to the domain of outer space	
	(iii) Technical capacity-building for developing countries	
	(iv) Equitable access to the limited resources of outer space	
(b) Space debris	(i) Measures to reduce the creation and proliferation of space debris ***1. Prevention of a chain reaction of mutual collisions among large debris from useful orbit regions (altitude: 800 km)**	Add-3
	(ii) Collection, sharing, and dissemination of data on space objects *1. Objects detectable from ground observation facilities ***2. Encouragement of surveying micro-debris in international cooperation, and improvement of debris models, especially those for micro-debris**	Add-4
	(iii) Re-entry *1. Re-entry notifications regarding substantial space objects ***2. Encouragement of a design considering re-entry safety (easy to demise by selecting adequate materials, controlled re-entry, etc.)** ***3. Sharing information on high-risk objects for re-entry**	Add-6 Add-7

Table-3 Allocation of the subjects into the ToR (2/2)

(c) Space weather	(i) Collection, sharing, and dissemination of data	
	(ii) Sustaining global observation capability	
	(iii) Measures to mitigate the impact of space weather phenomena on operational space systems	
(d) Space operations	(i) Collision avoidance processes and procedures	
	(ii) Pre-launch and pre-maneuver notifications	
	(iii) Common standards, best practices, and guidelines	
(e) Tools to support collaborative space situational awareness	(i) International, multinational, or national registry of operators and contact information	
	(ii) International, multinational, or national data centers for the storage and exchange of information on space objects and operational information	
	(iii) Information-sharing procedures. ***1. Immediate warning on a voluntary basis when detecting break-up by malfunction in operating satellites.** ***2. Information on fragment distribution is expected to be provided as immediately as possible.**	Add-1 Add-2
(f) Regulatory regimes	(i) Adherence to existing treaties and principles on the peaceful uses of outer space	
	(ii) Regulating space activities of the Member State nations	
(g) Guidance for new entrants in the space arena	(i) Technical standards, best practices, and lessons learned for the successful development and operation of space systems, from the pre-launch phase to the end-of-life phase ***1. Encouragement of protection design.**	Add-5
	(ii) Microsatellites and smaller satellites	