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Prioritization Of Emerging Technologies As Impacting The Field Of International Nuclear Safeguards

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Introduction & Motivation

- Rapid advancement in technological development has a profound effect on all nuclear applications

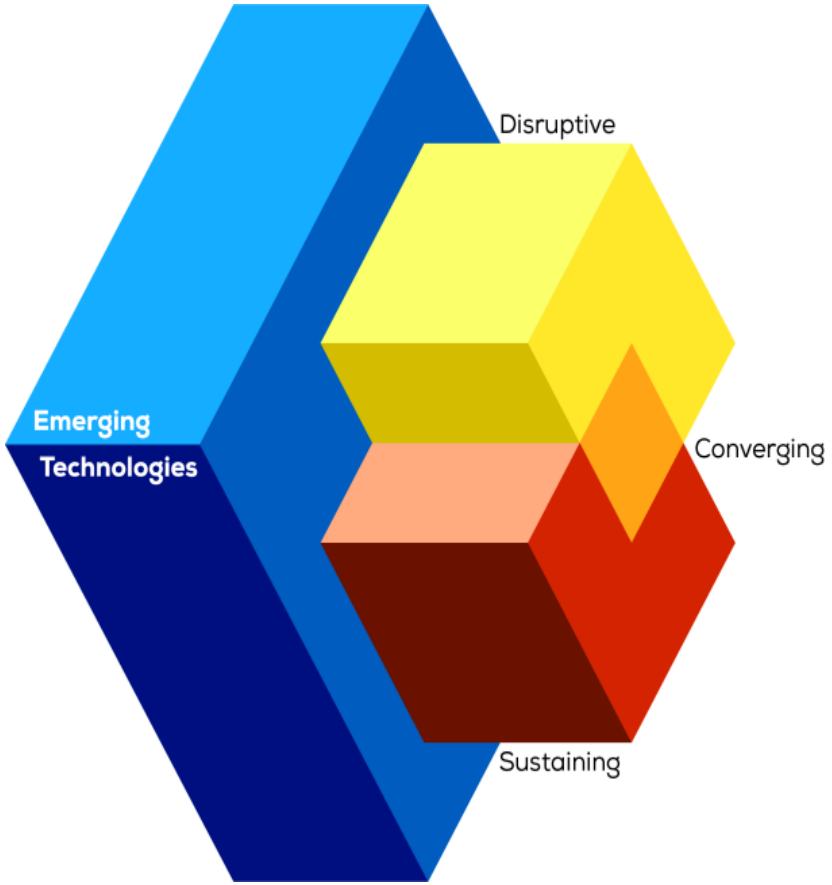
- The research objective of this work was to develop a systematic understanding of:
  - **Which technologies have the potential to impact the field of international safeguards?**
  - **How do these technologies rank relative to each other in terms of their ability to support the safeguards regime and their ability to pose a threat to international safeguards?**

- Enable decision makers to evaluate the potential impact of emerging technologies and prioritize investments

What is an Emerging Technology?

Emerging technologies - *are technical innovations that breach new territory in a particular field*

- over centuries, innovative technologies were developed and opened up new avenues for lifestyle and market transformation
- some of the emerging technologies are developed via theoretical research, while others are based on commercial research and development



Technology inclusion criteria:

- has been recently developed or proven feasible, or
- has not been broadly implemented into safeguards applications, or
- has a path for development over the next 5 - 10 years

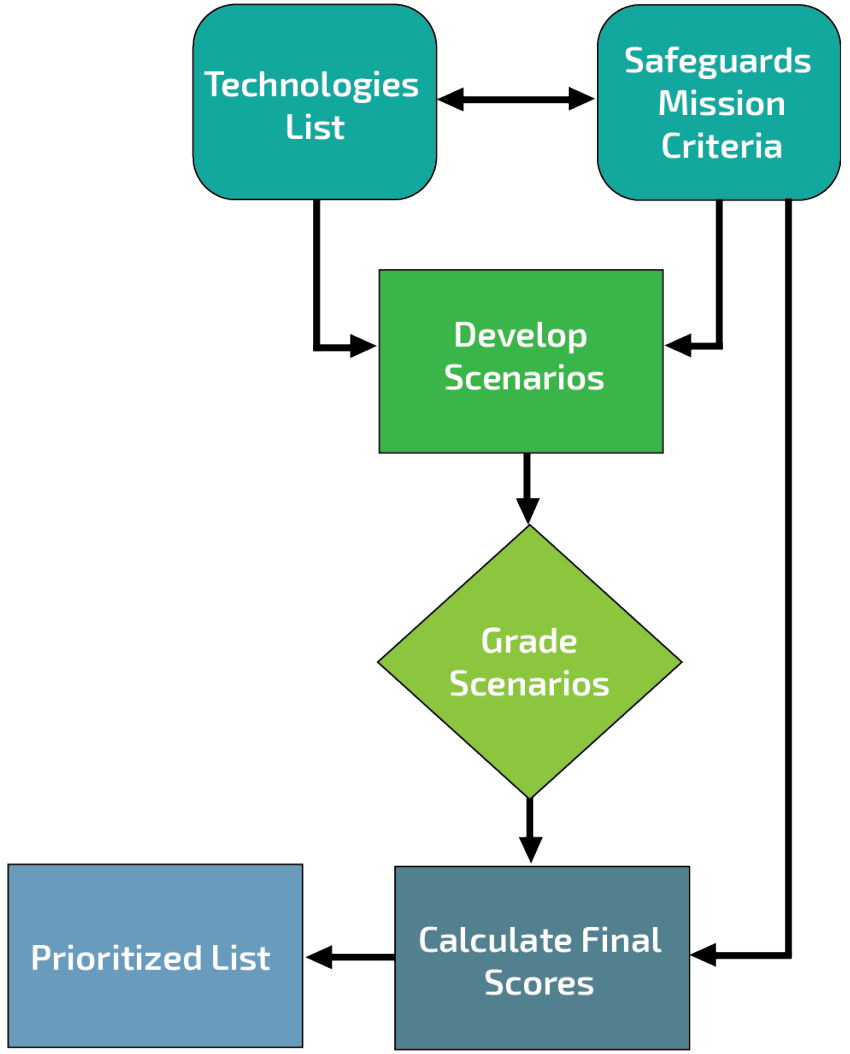
Distinction was made between a technological category and an application of a technology

Framework Overview

Analysis framework requirements

- Effectively address specific safeguards mission areas
- Flexible (capable of adding and removing technologies to the analysis)
- Scalable (capable of handling a large number of technologies and applications)

Technological Categories/Applications	Safeguards Mission Criteria			
	None	Scenario	Scenario	Scenario
	Scenario	None	Scenario	Scenario
	Scenario	Scenario	Scenario	Scenario
	Scenario	None	Scenario	None
	None	Scenario	Scenario	Scenario



Safeguards Mission Criteria

Two sets of criteria were developed to provided a comprehensive description of the main elements of the safeguards regime.

Strengthen Criteria	*Challenge Criteria*
A category addresses potential new opportunities that emerging technologies may present to enhance the performance of the international safeguards regime. For example, detection of undeclared material or the diversion of declared material	A category addresses the ways in which new technologies can be used to challenge or create threats to the safeguards system, such as the misuse of facilities or the interference with the International Atomic Energy Agency's (IAEA) activities.

Scenario Development and Grading

- Scenarios were developed by Subject Matter Experts (SMEs) for the application of each technology within the specific safeguards mission space
- Introduced subjectivity was mitigated by:
  - Scenarios were developed and graded by multiple SMEs
  - Averaging the score of all scenarios, for a given application, across each criteria category
  - Close collaborations with SNLs Innovative Safeguards Working Group (ISWG)
- The final scores for each technology were taken to be the score of its highest application

Strengthen

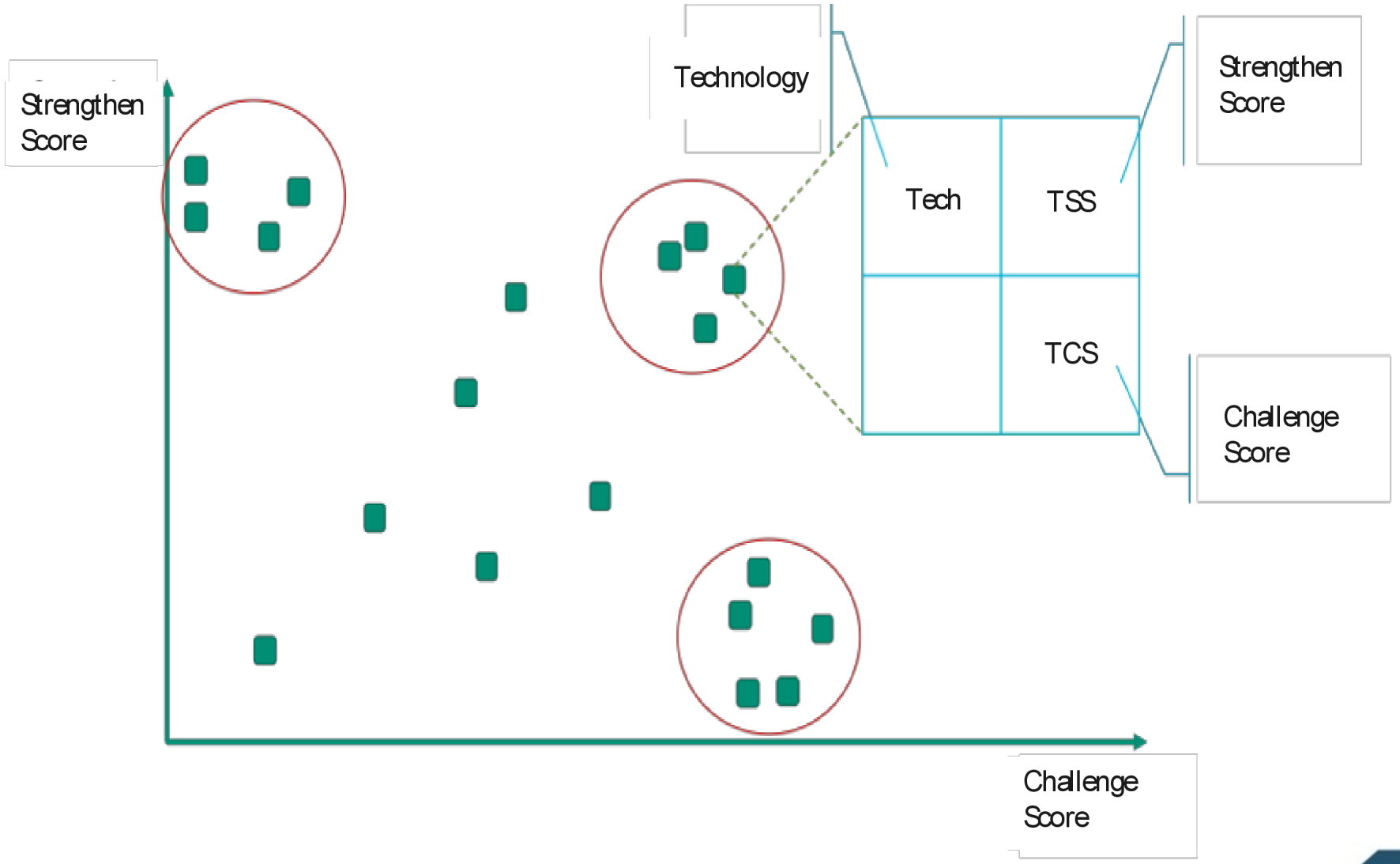
	IMPACT			
	TRIVIAL LITTLE TO NO EFFECT	MINOR EFFECTS ARE FELT, BUT NOT CRITICAL TO THE MISSION	MAJOR SERIOUS IMPACT ON THE MISSION	CRITICAL COULD RESULT IN A COMPLETE CHANGE OF APPROACH
LIKELIHOOD				
IMPROBABLE UNLIKELY TO OCCUR	VERY LOW – 1 –	LOW – 2 –	MEDIUM – 6 –	HIGH – 9 –
POSSIBLE MAY OCCUR	LOW – 2 –	MEDIUM – 5 –	HIGH – 8 –	VERY HIGH – 10 –
PROBABLE WILL MOST LIKELY OCCUR	MEDIUM – 6 –	HIGH – 8 –	VERY HIGH – 9 –	EXTREME – 11 –
HIGHLY PROBABLE WILL DEFINITELY OCCUR	HIGH – 8 –	VERY HIGH – 10 –	EXTREME – 11 –	EXTREME – 12 –

Challenge

	IMPACT			
	ACCEPTABLE LITTLE TO NO EFFECT ON THE SYSTEM	TOLERABLE EFFECTS ARE FELT, BUT NOT CRITICAL	UNDESIRABLE SERIOUS IMPACT TO THE SYSTEM MISSION	INTOLERABLE COULD RESULT IN DISASTER
LIKELIHOOD				
IMPROBABLE UNLIKELY TO OCCUR	VERY LOW – 1 –	LOW – 2 –	MEDIUM – 6 –	HIGH – 9 –
POSSIBLE MAY OCCUR	LOW – 2 –	MEDIUM – 5 –	HIGH – 8 –	VERY HIGH – 10 –
PROBABLE WILL MOST LIKELY OCCUR	MEDIUM – 6 –	HIGH – 8 –	VERY HIGH – 9 –	EXTREME – 11 –
HIGHLY PROBABLE WILL DEFINITELY OCCUR	HIGH – 8 –	VERY HIGH – 10 –	EXTREME – 11 –	EXTREME – 12 –

Technology Prioritization

	Strengthen Score	Challenge Score
Technology	8	1
	2	6
	5	7
	1	1
	4	0



Sample Analysis (Technologies & Criteria)

- Disclaimer -
This "sample analysis" is intended for illustration purposes only

Technology Application
Additive Manufacturing
Low-volume production
Counterfeit goods production
Autonomy
Autonomous Vehicles
Information and Data Analysis
Crowdsourcing
Video/Photo Analytics

Strengthen	Detection of Diversion of Declared Material
	Detection of Undeclared Material
Challenge	Facility Misuse
	IAEA Activities Interference

Sample Analysis (Scenarios)

Low-Volume Production:

- The production of spare parts at facilities or regional offices for faster repairs and maintenance of critical equipment

Counterfeit Goods Production:

- Creation of a material container or facility modification with hidden compartments to conceal material or equipment

Autonomous Vehicles:

- The use of fully autonomous vehicles in inspection activities to aid inspectors, access hazardous areas and perform long mundane tasks

Crowdsourcing:

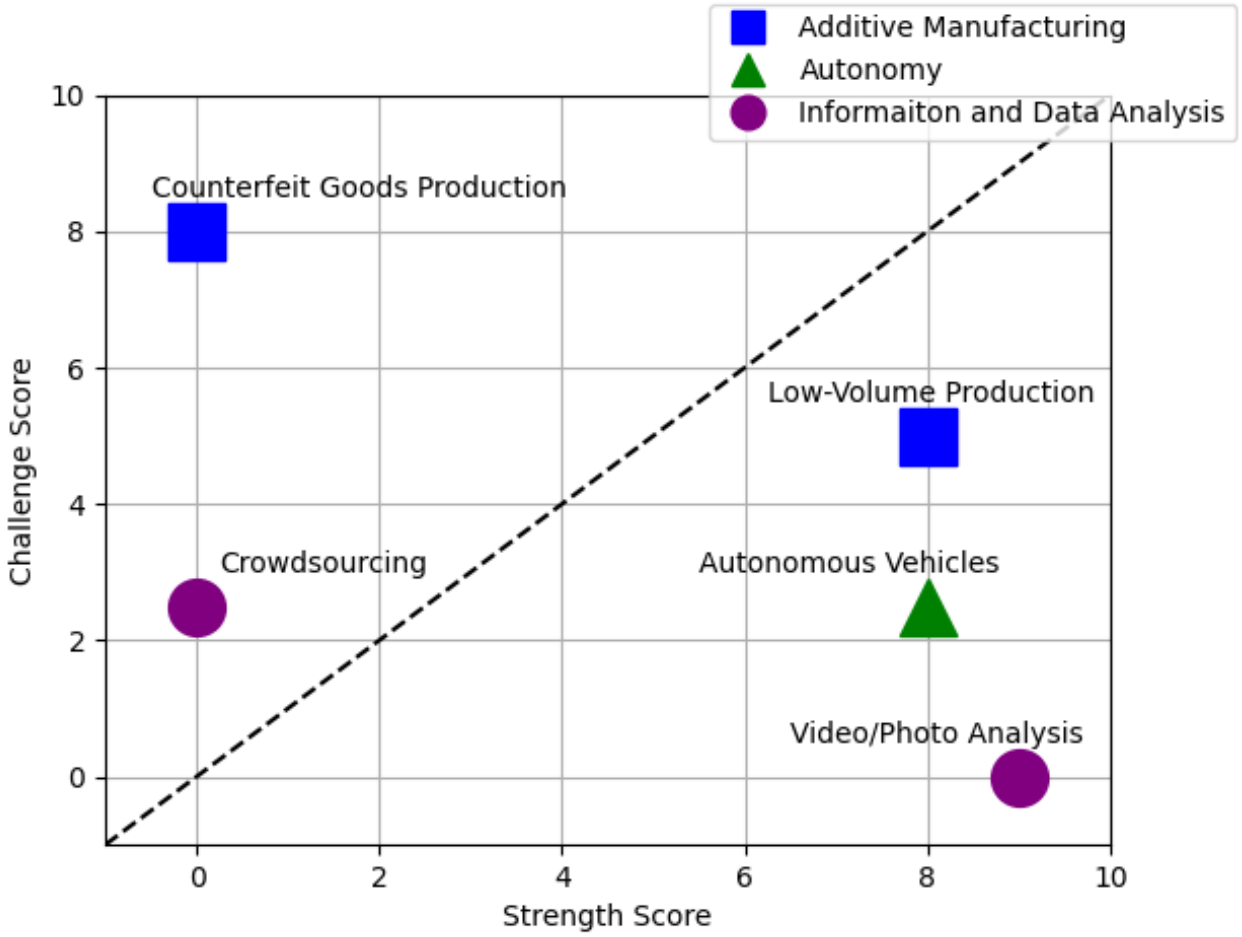
- Infiltration of these activities by states/operators to distract IAEA attention from the right areas

Video/Photo Analytics:

- Analysis of imagery data from a nuclear facility to identify anomalous activities which may indicate diversion

Sample Analysis (Final Results)

Technology Application	Strengthen Score	Challenge Score
Additive Manufacturing		
Low-volume production	8	5
Counterfeit goods production	0	8
Autonomy		
Autonomous Vehicles	8	2.5
Information and Data Analysis		
Crowd sourcing	0	2.5
Video/Photo Analytics	9	0



Summary

- In the coming years, emerging technologies have the potential to significantly impact the field of international safeguards through:
  - Providing opportunities for enhanced operations and performance
  - Creating new threats that challenge the safeguards regime
- Despite their potential to advance the nuclear safeguards space, it is important to acknowledge the risks such technologies may introduce.
- An analysis methodology was developed for the comparison of multiple technologies, their potential impacts, and prioritization through quantitative analysis
- A periodic update is recommend to ensure that the roster of relevant emerging technologies aligns with safeguards focus and priorities over time.