IPNDV Working Group 3: Technical Challenges and Solutions
Chain of Custody (CoC) Technologies Mapping Table
September 18, 2017

Technical Area	Technology	Related Technology Paper	Description	Key Limitations	Equip Availability (TRL?)	IB Needed (TRL?)	Comments	Step 6: Initial storage at dismantlement facility	Step 7: Movement of NED within dismantlement facility	Step 8: Warhead dismantlement	Step 9: Movement of components within dismantlement facility	Step 10: Storage of components (SNM and HE) at dismantlement facility
Surveillance	Personnel	N/A	Inspector watching in person	Depends on the abilities of the person.	Readily in use	N/A		Applicable but possibly impractical for continuous monitoring	Applicable depending on safety and security procedures	Not applicable for inspectors	Applicable depending on safety and security procedures (likely more restrictions with HE)	Applicable but possibly impractical for continuous monitoring
	Video	N/A	Video surveillance to capture all optical images	High effort (human/technology) required for the video review. Change detection algorithms are affected by ambient light and authorised movement.	Readily in use	Possibly - dependent on the content of the image	Challenge to screen through surveillance; best when paired with a trigger system	Applicable	Applicable, but possibly not practical due to security concerns	Applicable but fields of view must be selected to avoid capturing images of sensitive activities, equipment or material; could be used to monitor door access	Applicable, but possibly not practical due to security concerns	Applicable
	3D	CoC1 - 3D Surveillance	Realtime 3D camera that provides distance measurements complementary to video system	The resolution is lower than static 3D scanner or video imagery.	Readily in use	Possibly - dependent on the content of the image	Possible to use as a trigger for surveillance system	Applicable	Applicable when used in a curtain configuration	Could be used in a curtain configuration to monitor access control (doors, vents, etc)	Applicable when used in a curtain configuration	Applicable
	Portal Monitor	CoC5 - Radiation Detection	Non-spectroscopic radiation portal monitor used to detect movement of radiation emitting device into or out of an area	Shielding will affect the measurement; susceptible to background levels	Readily in use	No (as long as no information is retained)	Could be used to confirm presence of radiation emitting device and can act as a trigger for other surveillance systems; No IB is needed for system with limited functionality; must account for authorized movements.	Could be used at storage door entrance to monitor movement of radiation emitting devices into or out of the storage area	Applicable for monitoring; could be used in pairs to determine direction of movement	Could be used at door entrance to monitor movement of radiation emitting devices into or out of the dismantlement area	Applicable for monitoring presence or absence of SNM; could be used in pairs to determine direction of movement	Could be used at SNM storage door for entrance to monitor movement of radiation emitting devices into or out of the storage area
	Accelerometers	CoC4 - Accelerometers	Sensors that can indicate whether or not an object of interest has moved; can provide continuous monitoring and triggering.	Battery lifetime (can run for years but not indefinitely)	Readily in use in other applications	No	Could be applied to the outside of the container to monitor movement of container; if it cannot be applied to a container could be applied to mechanical structures.	Applicable	Applicable; could be used to determine changes in movement	Not applicable	Applicable; could be used to determine changes in movement	Applicable
	Scale	N/A	Can be used for total material balance to detect diversion of material.	Should not be used to determine mass of NED or SNM or containers themselves.	Readily available (9)	Yes?	May also be used to identify a container type based on gross weight.	Most likely not at this step.	Not applicable	Could be used to do total mass balance of containerized NED and other containers before and after dismantlement	Not applicable	Most likely not at this step.
	Radiation Detection	CoC5 - Radiation Detection	Monitoring system (attended or unattended) that performs qualitative measurements of gamma and neutron counting to indicate movement or presence of a radiation emitting device	Shielding and room configuration will affect the measurement; susceptible to background levels; senstive to peak drifts over time/temperature	Yes	no	Primarily for storage area(s) in close proximity to item(s)	Applicable in attended or unattended mode for continuous monitoring	Applicable in unattended mode if on the container	Could be used in attended mode to check room before and after to ensure absence of radiation emitting material	Applicable in unattended mode if on the SNM container	Applicable in attended or unattended mode for continuous monitoring in SNM storage room

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Containment	Tamper Indicating Devices (TID)/Seals	CoC6 - Tamper-indicating Seals and Enclosures	Various devices that can be used to indicate if a container or room has been opened or tampered with	Containers need to be conducive to application of a seal or tamper indicating device	Yes (9)	No	Examples include adhesive and loop seals/TIDs	Applied if not already in place; possibly applied to storage door as well as containers	If already applied to container could be checked before and after movement to ensure not tampered with; could be applied to transportation vehicle if some sort of enclosed chamber is used; could be applied on doors along a specified path in the facility to ensure detours were not taken.	TID for containerized NED should be broken at this point; TID should be applied to containerized components post dismantlement; could be used on facility equipment that should not be used	If already applied to container could be checked before and after movement to ensure not tampered with; could be applied to transportation vehicle if some sort of enclosed chamber is used; could be applied on doors along a specified path in the facility to ensure detours were not taken.	Possibly applied to storage door as well as containers
	3D Laser Change Detection System	CoC1 - 3D Facility Verification and Change Detection	3D laser system used to measure a room that enables inspector to identify changes between two inspections in the 3D geometry of a facility and the installed equipment.	The detection limit is approximately 1mm	Readily available (9)	Possibly - dependent on the content of the image	Can be used to verify design information, verify the absence of undeclared changes, detect movement of containers and for containment verification; could be a fixed system that remains installed or portable system that is brought in for each inspection	Applicable	Not applicable	Could be used for facility verification before and after dismantlement	Not applicable	Applicable
	Optical Change Detection Systems	CoC8 - Optical Change Detection	Optical system used to detect changes in configuration between two inspections	Changes in lighting may trigger a configuration change determination; detection limit is variable depending on camera characteristics and lighting, typically less accurate than the 3D laser system	Readily available (9)	Possibly - dependent on the content of the image	Can be used to verify design information, verify the absence of undeclared changes, detect movement of containers and for containment verification; could be a fixed system that remains installed or portable system that is brought in for each inspection	Applicable	Not applicable	Could be used for facility verification before and after dismantlement	Not applicable	Applicable
	Accelerometers	CoC4 - Accelerometers	Sensors that can indicate whether or not an object of interest has moved; can provide continuous monitoring and triggering	Battery lifetime (can run for years but not indefinitely)	Readily in use in other applications	No	Could be applied to the outside of the container to monitor movement of a container; if it cannot be applied to a container could be applied to mechanical structures	Applicable	Not as applicable for containment during this step.	Could be used on doors	Not as applicable for containment during this step.	Applicable
	Tamper indicating enclosure (TIE)	CoC6 - Tamper-indicating Seals and Enclosures	TIE can be used if sealing a container isn't possible or is not considered to be sufficient enough. Few systems exist, but specific TIEs could be developed.	Needs to be designed to the specifc requirements.	Requires specific development for possible application (7-8)	No	Potential technologies are laser verification of enclosure, active electrical mesh, under pressure monitored enclosure, special coating, …	Possibly applicable for monitoring equipment	If a TIE is designed for moving the NED, this could be applicable.	Could be used for monitoring equipment	If a TIE is designed for moving the containers, this could be applicable.	Possibly applicable for monitoring equipment
	Container Integrity Assessment	CoC7 - Container Integrity Assessment	Technologies to establish and to maintain confidence in the integrity of containers; categories include acoustic, electromagnetic, and optical.	Considered active as they need to interact with the container as part of a measurement. May need to come into contact with the container.	In use for other applications, may require adaptations (7-9)	No	Can be used to monitor warhead and warhead component containers as well as monitoring equipment enclosures.	Applicable	Applicable if container can be interrogated before and after move.	Could be used for confirming the integrity of monitoring equipment	Applicable if container can be interrogated before and after move.	Applicable

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Identification	Radiation-hardened Radiofrequency Identification (RFID)	CoC9 - Radio Frequency Identification	Devices that can be used to assign a unique ID to a container using radiofrequncies; RFID-based devices range from very simple, passive systems to complex, active systems integrating other sensor information.	Active systems are battery powered and have a limited lifetime. Active systems would have to meet safety and security requirements. Information security / authentication is an issue for simple systems.	9	No	If combined with other sensors, it can also be used for tamper indication (e.g. ARG-US RFID)	Applicable if not already applied	Applicable to verify containerized NED before and after movement	Applicable to verify containerized NED just prior to dismantlement; could be applied to containerized components post dismantlement	Applicable to verify containerized components before and after movement	Applicable
	3D Container Identification	CoC2 - 3D Indentification and Containment	Laser system that performs a high-accuracy 3D measurement of the unique surface structure of a container to fingerprint and identify the item.	The item requires a unique surface geometry (e.g. a weld surface) with variations on the micrometer scale	(7-8)	No	Depending on the scenario, can be used for identification, authentication and tamper indication. Each use case requires specific development. TLR needs to be evaluated according to the specific application	Applicable	Applicable before and after movement to verify ID and ensure containment was not breached during movement	Applicable to verify containerized NED just prior to dismantlement; could be applied to containerized components post dismantlement	Applicable before and after movement to verify ID and ensure containment was not breached during movement	Applicable
	Tagging (unique identifier)	CoC10 - Unique Identifiers	Any visual identifier (e.g. bar code, QR code, id number, reflective particle tag) that can be read visually or by an electronic reader.	Should not be used on its own for authentication	9	No	Tags are simple and fast to apply and read. They can be complemented with another technology (e.g. weld identification, TID) for authentication.	Applicable if not already applied	Applicable to verify unique ID on containerized NED before and after movement	Applicable to verify containerized NED just prior to dismantlement; could be applied to containerized components post dismantlement	Applicable to verify unique ID on containerized components before and after movement	Applicable