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Integrated Nuclear Security in the 21st Century: thinking multilaterally

Garry J George

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550

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FOREWORD

The work presented in this paper has been carried out as part of Sandia's programme to understand global nuclear futures, including the Nuclear Pathways Project executed jointly by the University of California at Berkeley and Sandia National Laboratories.

EXECUTIVE SUMMARY

There is wide agreement that the early part of this Century presents the International Community with many interconnected 'security challenges': some left over from the 20th Century and some that are emergent 21st Century ones. Of particular visibility is the matter of how to: meet Nuclear non-Proliferation Treaty's Article VI commitment; deal with the threat of nuclear-related terrorism; satisfy ever-increasing energy needs by deploying greater nuclear power generating capacities; whilst assuring national security, including the threat of state-level Nuclear Weapons use.

This paper attempts to bring various intersecting national and international security matters into a coherent framework and identify ideas directed at achieving Global Integrated Nuclear Security. For instance:

- A risk-informed and risk-managed pathway from where we are now towards a world where the NPT Article VI has been realised;
- A Double-Zero Pathway Process to Article VI compliance, based on way or hold points where the international community may assure itself that progression to the next step is warranted;
- A structured approach to transforming nuclear weapon based deterrence, that helps to 'enable' the pathway to Article VI compliance;
- Moving deterrence from a calculus built upon having deployed NWs, to one based on a non-deployed, second-strike calculus, i.e. NW deterrence that is highly/fully biased/based on latency;
- A view that the international community will need to adopt a stronger systems-level approach to addressing integrated nuclear security;
- Three new (treaty) tools to help the States with Nuclear Weapons meet international expectations regarding arms control;
- A Nuclear Warhead Security Regime (NWSR) that is designed to mature and expand over time, as the international community gains confidence and additional members join the NWSR;

- A structured approach to help the States with NWs better able to communicate with each other as they progress their multilateral engagement;
- A controlled and potentially transformable linkage between any NWSR and any future IAEA Safeguards verification regime;
- The adoption of no-knowledge verification methods for use at the nuclear warhead level;
- An adoption, in time, of an inclusive approach that addresses all States With Nuclear Weapons and not 'just' the so-called P5;
- Thoughts on extended deterrence needs for the 21st Century security environment;
- Thinking directed at aligning the current disparate international security tools into a more structured framework for the 21st Century security needs, to better enable Article VI compliance.

The paper is, by design, broad in its scope. Integrated Nuclear Security thinking is not for the faint hearted. In addition, as the ideas in this paper are directed at conveying an integrated approach, they are not presented in fully actionable detail: further work will be required to ensure meaningful action.

Nevertheless, this paper's prime purpose will be met if it stimulates greater multilateral, integrated and systems thinking on the matter of dealing with 21st Century global nuclear security.

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INTRODUCTION

Many believe that, for international and substantive nuclear arms control progress in the 21st Century, the International Community[1] will need to focus its thinking towards **integrated and systems-based** solutions: addressing nuclear weapon (NW) arms control in isolation, or non-multilaterally, is unlikely to achieve the collective security result the world is looking for. There is also a need to address the material and the materiel[2].

The main focus of this paper is to present options for 21st Century 'Multilateral Nuclear Weapon[3] Arms Control'; as part of a broader Integrated Nuclear Security (INS) process or framework, covering NW-based deterrence, nuclear non-proliferation and nuclear terrorism threat reduction. The thinking is not presented against any particular dates (years or decades), but against possible **way points**, and a potential **end point**.

This way point approach is designed to provide those taking any multilateral journey together, a structured process by which to assess their individual and collective security; before moving on to a subsequent way point or, indeed, 'the' end point.

These nuclear security way points will need to be related to phase-changes in overall world stability, i.e. nuclear arms control progress requires an ever-maturing and enabling global security environment.

[1] The term International Community and N192 (the number of UN members) are used interchangeably in this paper.
[2] The term materiel is used to cover material stored in weapon-usable configurations. That is, the spectrum of manufactured components to assembled NWs. Material is restricted to cover a pre-manufactured configuration.
[3] Where there is potential ambiguity, every effort has been made in this paper to differentiate between nuclear weapons (meaning deliverable systems) and nuclear warheads (parts of a nuclear weapon system). Although both use NW as an acronym.

This paper's prime objective is to encourage more systems-level thinking. The paper is thus, by design, broad in its scope. Integrated Nuclear Security thinking is not for the faint hearted.

20th CENTURY LEGACY

Deterrence Perspective

Much has been written on 'the theory of deterrence' and in particular the special case of NW-based deterrence. As there appears to be no universally agreed view as to what deterrence means, this paper starts with the premise that most, if not all, nation-states will adopt their own position on what may be called 'integrated deterrence'[4].

Integrated deterrence implies a nation-state has arrived at a rational analysis[5] of the threats it could, and does, face, and how best to minimise them in order to reduce the potential for: armed conflict with another nation-state, and ultimately loss of territory or nation-statehood; or (survivable) damage to its sovereign territory, including the possibility of this being achieved by state or non-state sponsored terrorism.

Integrated deterrence will follow from each country's views of the threats they perceive. For instance, in the early part of the 21st Century, with the 20th Century still fresh in our minds, the following will likely inform integrated deterrent thinking.

- Great powers and their relationships remain in transition;
- Some regional peers continue to seek/obtain/develop Nuclear Weapons (NWs)[6];
- The saliency of NW-based deterrence still appeals to 'old' and 'new' players;
- Mass terrorism, including nuclear-based, may appeal to some;

[4] For an assessment of how key countries approach nuclear deterrence, see, for example, Minimum Nuclear Deterrence Research, dated May 15, 2003, by Gregory Giles, Christine Cleary and Michèle Ledgerwood of the Defense Threat Reduction Agency's Advanced Systems and Concepts Office.
[5] 'Simple' or 'strict' nuclear deterrence is usually built on the premise that nation-states are able to pass 'a reasonable person' test, i.e. are objective and rational, and thus deterreable. For one perspective of why 'regional players' are different to, say, the US or Russia, see The Challenge of Nuclear-Armed Regional Adversaries, David Ochmanek, and Lowell H. Schwartz. RAND, ISBN 978-0-8330-4232-3
[6] NW is used in this paper to cover Nuclear Weapon as well as Nuclear Warhead. That is a Nuclear Weapon is a system composed of a nuclear warhead and a delivery system. In addition, a deliver system may be conventional or non-conventional in nature, for example a terrorist group constitutes a non-conventional delivery system for a nuclear warhead.

- World energy demands and oil cost instabilities are 'stressing' global economies and relationships, and indicate the need for a global and sustainable energy enterprise;
- Globalisation is transforming national security perspectives[7] ;
- 'New' natural threats (e.g. pandemics) are emerging all the time;
- Cyber security, as it related to NW and non-NW security systems, is an emerging threat;
- Global financial systems are in a fragile state and create a blinding focus for world leaders;
- Our international security systems (e.g. treaties etc) remain fragmented, and/or decoupled from each other, with 20th Century security pedigrees.

Integrated deterrence implies a wide array of nation-state-level tools, and is not limited to offensive capability alone. For instance, a nation-state's integrated deterrence strategy is likely to encompass some or all of the following 'layered-deterrent' features:

- Defensive capabilities, including sea, air and missile defences, to protect the 'homeland'[8] from externally imposed, nation-state-level threats;
- Offensive capabilities to deter other nation-states from considering any 'incursion' into the homeland;
- Peace-keeping capabilities to support internationally agreed actions to minimise and/or stabilise international nation-state-level threats/instabilities outside of its own nation-state border;
- Civil defence capability to minimise any consequences resulting from attempted 'offensive' actions on its homeland and ensure recovery;
- Intelligence gathering capabilities to anticipate/predict threats so that the 'controlling mind' of the nation-state can decide on appropriate action;
- Covert capabilities to counter/pre-empt emergent threats;
- Control over inappropriate exports of material and materiel;

[7] For example, in 2008 the US, which represents China's top trade partner, had a $266B negative trade imbalance with China.
[8] The term homeland is left deliberately vague to capture the realism that a nation-state will likely adopt an adaptable definition to encompass its territories and other interests.

- Active engagement in the UN community to help maintain global stability;
- Commitment to international treaties, and their verification protocols, directed at minimising global risk, e.g. in the case of NWs the NPT and CTBT;
- Nuclear weapons (e.g. the so-called N8 who acquired NWs in the 20th Century).

The above simplified view of integrated deterrence implies that nuclear weapons should 'only' be seen as a possible element of a nation-state's integrated deterrent thinking. In particular, covering those nation-states that developed their nuclear security doctrines in the 20th Century. Or, put another way, NW ownership may be seen as a legacy matter to be managed by the International Community: a 'left over' from 20th Century's relationships, and should not axiomatically be considered an enduring feature of the 21st Century, and beyond, integrated deterrent thinking.

No further comments on the broader (political and technical) aspects of integrated (non-NW-based) deterrence will be made, as this paper's focus is directed at discussing the issues associated with the NW dimension of integrated deterrence, and its intersection with global efforts directed at minimising NW proliferation and realising multilateral NW arms control.

History tells us that the first and only operational[9] use of NWs was not as a result of the application of deterrence, but as a tool for use during an active conflict, e.g. a war termination and casualty minimisation tool towards the end of the Second World War[10]. Once the NW genie was out of the bottle, however, and NWs spread further than a single nation-state, the role of NWs became 'established'. For example, as a tool:

- for deterring state-level WMD aggression, especially NW-focused;
- for coercion/influence, directed at another nation-state;
- to 'offset' perceived inadequacies in conventional forces;

[9] That is physical use as opposed to 'influence-level use'.
[10] See, for example, The Atomic Bomb and the End of World War II, A Collection of Primary Sources, National Security Archive Electronic Briefing Book No. 162, Edited by William Burr - 202/994-7000. http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB162/index.htm

- to convey ‘status’.

Over the past sixty years or so, the core language associated with NW deterrence has not changed that much; although various ‘dialects’ have emerged, and been lost, in response to changes in world affairs, e.g. NATO-Warsaw Pact interactions in Europe. Nevertheless, one view of NW deterrence strategy has endured, namely, the role of NWs to symmetrically negate the potential advantage that NW ownership conveys to a nation-state, so-called “strict deterrence”. Although this balancing, or negating, role of NWs has its birth in the Cold War; it seems to be a strategy followed today by some nation-states to address more regionally focused tensions.

The above, of course, is a highly simplified view of a complex matter. It nevertheless covers most of the current (Nation-) States with Nuclear Weapons (SWNWs)[11].

In passing it is also worth recognising that some nation-states have unilaterally given up NWs. Ignoring the ephemeral SWNWs that existed following the fall of the USSR[12], through NW inheritance, one example that is often quoted is South Africa[13], which unilaterally disarmed and, (over) simplifying the analysis once again, did so for broader strategic security reasons.

Not all countries with NWs have adopted symmetrical strategies. Some NW-focused national security agendas are built on asymmetric NW deterrent strategies. That is, they appear to adopt the simple logic that ‘no one messes with’ a nation-state with (even) a few nuclear weapons (or even one NW), and/or NWs are ‘relatively cheap’ ways of offsetting conventional-based threats.

[11] In this paper, which focuses on integrated multilateral futures, there is no distinction made between the de jure nuclear weapons nation-states, as defined by the NPT, and the de facto nuclear weapon nation-states who are not yet signatories of the NPT. Following accepted terminology, this paper calls this community the N8, i.e.it excludes the (emergent) DPRK.
[12] Those nation-states inheriting NWs after the collapse of the Soviet Union are recognised as a ‘special case’, now dealt with, and not discussed any further in this paper.
[13] See: “Nuclear verification in South Africa: Verifying South Africa's declared nuclear inventory, and the termination of its weapons programme, was itself a complex task”. IAEA BULLETIN, 1/1995.

Much has also been written about extended deterrence[14]. That is the projection of one nation-state's nuclear umbrella to protect another nation-state, especially as part of a commitment not to acquire NWs. Whether the concept is a real influence on proliferation appears arguable. For example, one interpretation of history[15] implies neither the UK nor France fully believed in the concept, i.e. protection under a US umbrella during the post-WWII Cold War period.

The UK position to seek NWs was also complicated by the introduction into US law of the 1946 McMahon Act[16]: in retrospect a non-proliferation policy action that likely helped stimulate the UK into a NW programme. As 'The Future of the United Kingdom's Nuclear Deterrent Fact Sheet 5' states: "Wartime UK-US nuclear collaboration was brought to an end by the 1946 US Energy Act (the McMahon Act), following which, in 1947, the Attlee Government decided to resume an independent UK programme to develop an atomic weapon."

Also, there appears to be no unified 'calculus' that equates perceptions of the level of deterrence to holdings of NW warheads (including zero holding). Figure 1 illustrates the 'challenge' faced by a multilateral NW arms control community (e.g. the N8). That is, each country will have their own perception of what constitutes their (stockpile) Pareto point, beyond which NW holdings are of non-added-value (knob Y). In addition, some states, either those seeking NWs or those that fall under an extended deterrent

[14] For instance see: Contemporary Challenges for Extended Deterrence by Thomas Scheber, http://www.au.af.mil/au/aunews/archive/2009/0411/Articles/ContemporaryChallengesforExtendedDeterrenceMay09.pdf

[15] The History of the UK's Nuclear Weapons Programme: Start of the UK's nuclear weapons programme. The Future of the United Kingdom's Nuclear Deterrent Fact Sheet 5.

[16] The Atomic Energy Act of 1946, informally known as the McMahon Act, determined how the United States government would control and manage the nuclear technology that had been jointly developed with the British. Most significantly it ruled that nuclear weapon development and nuclear power management would be under civilian, rather than military, control, and established the U.S. Atomic Energy Commission for this purpose. It was sponsored by Senator Brien McMahon, a Democrat from Connecticut, the chair of the U.S. Senate Special Committee on Atomic Energy whose hearings led to the fine-tuning and passing of the Act. One of the provisions of the Act was a strict ban on the release of atomic technology to other powers, even to allies.

protection, will benefit from some form of NW deterrence 'value', e.g. especially 'strategic influence', without any physical holdings (knob X).

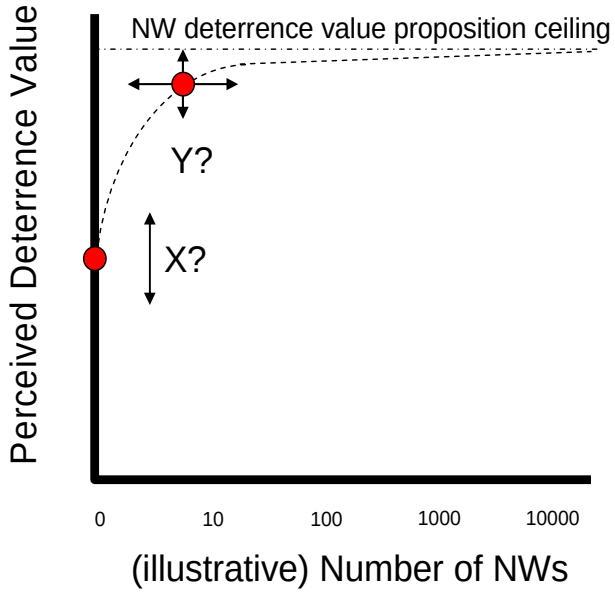

Figure 1: The Nuclear Deterrent Value-Proposition

Thus, through various processes, e.g. through intelligence gathering and Confidence Building Measures such as 'transparencies'[17], each nation-state's view of knob X and Y will need to be (at least partially) understood for multilateral arms control progress. Failures to address such understandings could lead to early 'multilateral communication problems', i.e. each SWNWs talking from their perspective, not necessarily fully appreciating/accepting the others' position.

Finally, the role of NWs as an extension of international influence, including projecting a nation-state's science and technical gravitas on the world stage, may also influence some nation-states into keeping NWs, or at least tipping the decision-making that way.

[17] The term 'transparencies' appears not to be universally used by all the SWNWs. In this paper it is used in a similar way to declarations or Confidence Building Measures, i.e.SWNWs telling each other, and potentially non-SWNWs, either freely or through a treaty commitment, something about its deterrent to increase mutual trust and stability; but without the burden of verification.

In summary, although there appears to be near universal acceptance that nuclear arms control is a complex one that requires a multilateral approach[18], not all SWNWs see NWs in the same way, for example as tools to:

- Address global threats
- Address regional threats
- 'Just' negate NW threats
- (also) Negate 'C/BWMD' threats
- (also) Negate conventional threats
- Strategically influence/coerce/negotiate
- Convey status
- Provide options for (future) war termination

As implied above, there appears to be no universal theory of deterrence that fits all. At best deterrence seems to be in the eye of the beholder and strongly driven by national security perceptions held at the nation-state level, or at least in the nation-state's 'controlling mind'. Deterrence is also likely to be more complicated and complex when it involves more than two parties. Thus, as the international community seeks multilateral engagement, the need for each nation-state to 'understand' others' controlling minds will be critical. [19]

Although NWs have potentially multiple uses, a strong theme of all nation-state-specific deterrence models is that NW deterrence is ultimately associated with the concept of

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[18] For example: The Future of the United Kingdom's Nuclear Deterrent - presented to Parliament by The Secretary of State for Defence and The Secretary of State for Foreign and Commonwealth Affairs By Command of Her Majesty. December 2006. Cm 6994. Conference on Disarmament, Speech by the UK Secretary of State for Defence, "Laying the Foundations for Multilateral Disarmament" 5 February 2008. HMG paper (Feb 09) "Lifting the nuclear shadow: Creating the conditions for abolishing nuclear weapons". Speech on nuclear energy and proliferation by British PM: "…we must drive forward the multilateral agenda…" Tuesday 17 March 2009. HMG at NPT PrepCon (30 April-11 May 2009).

[19] For example see: Strategic Personality and the Effectiveness of Nuclear Deterrence: Deterring Iraq and Iran, Caroline F. Ziemke: Institute of Defense Analyses, IDA Paper P-3658.

retaliatory action. That is, the role of NWs as tools for a second strike[20], NW threat balancing, or nation-state-directed coercion/influence, through their possible use in extremis[21].

Following from the above, one view of nuclear deterrence thinking[22] implies the calculus of deterrence (whatever that means in the eye of the beholder) does not axiomatically require a nation-state to have deployed NWs. A latent stockpile (deployable in, say, days, weeks or even a few months) is likely to be equally effective (as long as it is 'survivable'), as one that is actively deployed. In fact the threat of a NW stockpile deployable in years also appears to have (influence) value to some.

Proliferation Perspective

From 20th Century history it may be inferred that the prime NW (non-)proliferation agenda was mainly focused at stopping (or, more realistically, slowing down) those nation-states seeking to acquire NWs from actually achieving their objectives

The NPT (together with the IAEA safeguards system[23]) is the main international mechanism that addresses the (fissile) material dimension of proliferation (e.g. control and access), and represents the famous "bargain" between the original SWNWs (US, 'Russia', UK, France and China) and the other NPT signatories. That is the legitimate access an NPT signatory has to nuclear reactor technology and nuclear materials, for

[20] The second strike deterrence rationale may be seen as a manifestation of one particular cooperation strategy, i.e. the Tit-for-Tat strategy. That is cooperate first, then do what your adversary does: see The Evolution of Cooperation by Robert Axelrod.

[21] An exception to NWs being offensively focused is the possibility of a nuclear warhead tipped anti-ballistic missile shield, which is arguably a defensive use of NWs and could be deployed by a country without any offensively targeted NWs.

[22] As multilateral NW arms control progresses, one implication is that, in time, all SWNWs are in a similar NW deterrent condition and state-to-state (nuclear force structure) asymmetries are minimal. An alternative view is that certain SWNWs will 'unilaterally' remove themselves from the 'club' as multilateral arms control matures and their threat perceptions change; hypothetically leaving the 'last two (or three?)' to take the final steps together, i.e.N8 to N3 to N0 say.

[23] www.iaea.org/OurWork/SV/Safeguards/safeg_system.pdf

example for power generation and peaceful non-power generation uses, such as the production of medical, industrial and agricultural isotopes.[24]

The first non-proliferation articles in the NPT nation-state:

- Article I "Each nuclear-weapon State Party to the Treaty undertakes not to transfer to any recipient whatsoever nuclear weapons or other nuclear explosive devices or control over such weapons or explosive devices directly, or indirectly; and not in any way to assist, encourage, or induce any non-nuclear weapon state to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices, or control over such weapons or explosive devices."
- Article II "Each non-nuclear-weapon State Party to the Treaty undertakes not to receive the transfer from any transfer or whatsoever of nuclear weapons or other nuclear explosive devices or of control over such weapons or explosive devices directly, or indirectly; not to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices; and not to seek or receive any assistance in the manufacture of nuclear weapons or other nuclear explosive devices."

Articles I and II have helped shape the global proliferation agenda, and subsequent international actions, for 50 years, since the Treaty for the Non-Proliferation of Nuclear Weapons was signed on 1st July, 1968, by the United States, Soviet Union, United Kingdom, and 59 other countries.

Following its entry into force, on 1st March, 1970, the non-nuclear weapon nation-states that signed the treaty have been obligated to open their nuclear facilities to inspection by the International Atomic Energy Agency and to agree to safeguards directed at

[24] The recent US-India nuclear deal brings an additional perspective to the 'inside or outside' of the NPT, but one that will not be developed further in this paper.

minimising the risk that nuclear technology and materials are covertly diverted to military uses.

Today the non-proliferation agenda appears little different from what it was some fifty years ago, albeit augmented by 'additional protocols'[25]. Namely, those NPT signatory nation-states without NWs should not seek them, and those with NWs should not transfer NWs to others.

The NPT also states, under Article VI, language directed at the NW states:

- "Each of the Parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control."

There remains a 'rich debate' in the International Community associated with how to measure commitments[26] to the various explicit and implicit 'deals', that the NPT and, for example, the Comprehensive Test Ban Treaty have created between the (NW) haves and the (NW) have-nots.

Although not a new idea, the prospects of NW latency[27], that is nation-states being NW capable (including the possibility of a nation-state being in a latent condition having 'disarmed', i.e. as a legacy of its past) has gained greater visibility over the past few

[25] For example INFCIRC/540, MODEL PROTOCOL ADDITIONAL TO THE AGREEMENT(S) BETWEEN STATE(S) AND THE INTERNATIONAL ATOMIC ENERGY AGENCY FOR THE APPLICATION OF SAFEGUARDS

[26] See, for example, Learning from Past Success: The NPT and the Future of Non-proliferation, Jim Walsh, Paper prepared for the Weapons of Mass Destruction Commission, Stockholm, Sweden October, 2005

[27] Although the term latency has not gained universal recognition (some use the term virtual NW capability), it will be used in this paper to capture the condition of a nation-state being able to convert 'quickly' to detonating a warhead. Quickly here is used in a relative sense and is likely to mean days or weeks for the N8 community, and years for those still seeking NWs. The term also has relevance for non-nation-state actors, i.e. the latent nuclear device capability of a terrorist organisation. Time (or latency) may also be seen as a stabilising security intervention, for, as John Wheeler has stated, "Time is nature's way to keep everything from happening all at once". Others have stated that …latency should be considered to be the product of… technical capability and the **intent** to proceed toward the acquisition of nuclear weapons. Wolfgang K. H. Panofsky, 14 June 2007.

years. In this paper latency is considered a positive (as well as a negative) attribute, as it is proposed as a way of achieving multilateral arms control progressions towards zero.

Related to the above is the increasing concern that (industrial) nation-states will inevitably 'drift or grow' towards a latent/virtual NW capability because, amongst other things, there exists:

- Greater uncertainty, because of the existence of more complex threats than during the polarised Cold War, e.g. mass terrorism: which require nation-states to understand those (NW) threats and potentially have defensive mechanisms in place to address them;
- Exponential increases in commodity-level high performance computing capability, and related Commercial-Off-The-Shelf (COTS) scientific and engineering computer codes, which may allow some level of product design (assuming the codes are verified/validated) without the need for large and costly, experimental facilities; together with shorter development times than those who follow a 'test-based' approach alone;
- Readily accessible scientific and technical knowledge, especially through internet-based sources, thus reducing the time required to create validated information.

This virtual condition, of having inherent NW 'capability' because of pervasive and intrinsic knowledge available in the 21st Century's commoditized world, e.g. computing power, and science/engineering software, is an emerging proliferation threat that the N192 must face. That is not 'just' intent based threats, but (intrinsic) knowledge-based threats[28].

One 'proliferation threat', therefore, is that in the future, some (entry level) NW design knowledge will be accessible to all; that is all nation-states and terrorist groups will be in a latent state, e.g. will know how to design and build some form of NW (for conventional or non-conventional deployment), i.e. all/most will have some **knowledge-based**

[28] For example, see Virtual Nuclear Weapons, Joseph F Pliat, LA-UR 97-2380

nuclear (latent) deterrent status. The two main factors stopping any nation-state proliferators actually obtaining NWs will remain their **intent** and their (tempting) **access** to (fissile) material.

As discussed above there are a multitude of reasons why proliferators may seek NWs and SWNWs may wish to maintain their NW stockpiles. In addition to the 'usual reasons' covered above are, what may be called, target-drivers. That is those with NWs see a proliferation of 'adversarial targets' that can 'only' be addressed via NWs, e.g. hardened and deeply buried 'targets' (HDBTs). This highlights the need for the International Community to consider how to enable NW reductions by, potentially, 'controlling' such 'proliferating threats' as HDBTs[29].

The NPT, although the cornerstone of global nuclear security, does not offer an integrated process or pathway for addressing multilateral arms control, horizontal/vertical proliferation and terrorist threats. For this reason, this paper offers the idea that, for integrated (global and substantive) progress on NW arms control and broader nuclear security, the N192 should first consider adopting **'the spirit'** of the NPT Article VI intent, together with a broad array of additional (diplomatic/operational) tools[30].

That is the N8, endorsed by the International Community, use the NPT Article VI language as a 'guide star', and focus on how first, in the 21st Century, to achieve a world with near-zero/zero **deployed** warheads **and** strengthen non-proliferation: as part of a global Integrated Nuclear Security (INS) environment. The subsequent agenda then becomes realising the full intent of Article VI, i.e. **'the letter'.**

Integrated Nuclear Security also implies interactions across many 'treaty tools', both existent and emergent e.g. NPT, CTBT, FMCT, PSI, etc. and with (potentially) non-

[29] This subject is likely to be highly contentious as it implies that in a world with no NWs, there should be no need to maintain HDBT-like facilities. However, unless HDBTs are addressed, the likelihood of achieving Article VI will be 'more difficult', i.e. some may see the need to maintain NWs to address such 'threats'.

[30] The author considers it highly unlikely that some all-embracing language will be found that integrates the many separate treaty text, that currently exists or are emergent, into a single integrated framework. The 'secret' will be to ensure the various treaties and norms are mutually re-enforcing and aligned.

signatory countries. Trying to use the NPT 'tool' alone, will likely be too non-inclusive, i.e. interpreting the language, within, say, the confines of the NPT community alone. The Article VI challenge is beyond the NPT to 'solve' single-handedly, but Article VI nevertheless remains a succinct vision.

Finally, in a world dominated by complex global terrorist threats, where classical deterrence theory appears not to offer much assistance (other than addressing potential nation-state-sponsored WMD acts) and nation-states have a potential (legitimate) need to address nuclear terrorism; the N192 should ask themselves some (new) proliferation-related questions, e.g.:

- is the NPT (offensively-biased) definition of proliferation sustainable?
- is all NW knowledge proliferation bad for international security?
- how can one differentiate between the potential ambiguities of defensive-based and offensive-based NW (knowledge) proliferation?
- is it possible to stop the natural emergence of globalised NW design knowledge?

Nuclear Terrorism Perspective

Putting aside the difficult question of the DPRK (which some consider fails the reasonable person test in the International Community), and which will continue to be a near-term non-proliferation focus; in the 21st Century many believe the most likely use of NWs is not going to be by a SWNWs, but by a radical terrorist organisation (nation-state sponsored or not)[31].

The likely defining feature of such a scenario is that a 'nuclear device' or nuclear warhead[32] will be delivered by unconventional and covert means; that is, not by a

[31] See, for example, Annual Threat Assessment of the Intelligence Community for the Senate Select Committee on Intelligence, Dennis C. Blair, Director of National Intelligence, 12 February 2009

[32] In this paper the term NW will be used to describe all classes of yield generating nuclear device irrespective of pedigree, i.e. militarily weaponised or not.

recognised (nor militarily detectable) platform. The nuclear warhead that is likely to be delivered in this scenario may be classified as one of three basic types:

- Radiological Dispersal Device [RDD] (non yield generating potential, by design or not)
- Improvised Nuclear Device [IND] (yield generating potential by design or not)
- Stolen Nuclear Warhead [SNW] (yield generating potential by design)

If nation-states are to be prepared for such a scenario, the following questions seem to imply themselves: what science and technical capability should a nation-state include in its civil defence 'toolbox'? how might these capabilities be acquired?; and, would a nation-state acquiring such capabilities be in breach of their NPT commitments?

The following three defensively-biased deterrent strategies (which could form part of a nation-state's integrated deterrent posture) appear to represent a reasonable (minimal deterrent) response to the terrorist NW threat scenario:

1. ensure adequate border and internal detection mechanisms to reduce the possibility of fissile material being illicitly introduced into, or transferred within, a country;

2. ensure crisis-management[33] capabilities are in place to address an unconventionally delivered RDD, IND or SNW;

3. ensure consequence-management and continuity-management response capabilities are in place to allow a nation-state to return to 'normality' (that is deny/minimise any terrorist gain) as soon as practicable following a crisis; and execute any post-event actions in the international (UN) arena, e.g. attribution and 'prosecution'.

[33] Whilst there are many ways of looking at terrorist-initiated 'civil defence', in this paper the three-Cs model is used: Crisis management, Consequence management and Continuity management.

Some recognise a fourth defensive capability, namely an operational Anti-Ballistic Missile and/or air defence system to address conventional or 'militarily' delivered threats. However, other than addressing the ABM arms control issue, air defences are not discussed in this paper, as such nation-state-level defence capability is not primarily focused at NWs or the terrorist scenario (other than the possible case of a NW delivered by a terrorist group via an aircraft).

Capabilities #1 and #3 are likely to be realisable by most modern industrial nation-states, especially those with recognised nuclear industries. For those nation-states without such industries, e.g. no nuclear power generation or nuclear research capability, the NPT appears to offer the mechanism for such capabilities to be transferred from those nation-states with these capabilities, as no NW knowledge is required. The challenge thus appears to be how to address capability #2.

For the purposes of this paper, capability #2 is further defined as the ability to:

a) Search for and locate a potential NW threat object;
b) Identify a NW threat object as either a dispersal or a yield generating device;
c) Control, neutralise and mitigate the consequences of a NW threat object;
d) Dispose of the residue from a neutralised NW threat object;
e) Assess the source of the device (attribution) to enable subsequent actions.

For the purposes of this paper; search and location sub-capability (a), and disposition sub-capability (d), are assumed to be addressed by capabilities #1 and #3 above. That is, if a nation-state has the capability to detect fissile material at its borders, it is likely to be able to engage in more mobile and directed detection[34]. Also, if a nation-state is able to address major industrial incidents (chemical and (non-NW) nuclear for instance), it should have the wherewithal to address the consequence phase (the aftermath) of a NW terrorism incident, e.g. remediation and recovery.

[34] This paper does not discuss the technical nuances of detection of different types of fissile material; for instance highly enriched uranium or plutonium.

Sub-capabilities (b), (c) and (e) appear, however, to present a real challenge for the International Community and the NPT proliferation agenda, as they require a nation-state to be able to assess the design of a NW. For example to:

- Assess the composition of a threat object, without disassembling the object[35], e.g. isotopic, mass, shape, tamping, as well as firing circuit design and initiation etc;
- Assess the 'criticality' of the fissile material in the object;
- Assess whether a threat object is single point safe[36];
- Be able to differentiate between a dispersal and a yield generating object[37];
- Undertake potentially aggressive neutralisation of the threat object, with the risk of initiating any conventional explosive and the subsequent potential consequence of initiating fissile material dispersal or nuclear yield (especially if the object is not single point safe).
- 'Backtrack' the object's provenance and handling chain, i.e. forensics and attribution.

The above capabilities, however, if acquired by a Non-NWS, would potentially lead it to be in breach of the NPT. The NPT makes no distinction between acquiring detailed NW knowledge solely for defensive, as opposed to offensive, purposes. This also leads to questions over latent NW capabilities for defensive protection not offensive projection.

To emphasise the above, consider the following scenario for hypothetical country X:

- A highly industrialised nation-state with access to a modern scientific and technical infrastructure and a computational (terascale) capability;
- Safeguarded nuclear power generating capability;
- Safeguarded research reactors;
- A nuclear fuel-cycle capability;

[35] This addresses the need to 'respect' a potential threat object, until full control of the object is obtained.
[36] For example see: DSC-AD NAR, LOCAL AUTHORITY AND EMERGENCY SERVICES INFORMATION (LAESI) EDITION 6, DEFENCE NUCLEAR MATERIALS TRANSPORT, CONTINGENCY ARRANGEMENTS.
[37] This paper does not discuss NW design classes, but notes that these are many and understanding one class is unlikely to help much in addressing all classes.

- All radioactive sources, including fissile ones, supplied through controlled and legitimate routes under IAEA safeguards;
- Zero quantities of fissile material outside of safeguarded areas.

Country X assesses there is a real possibility of a terrorist NW threat, or even an unconventional delivery of a NW by a regional peer. Country X initiates a defensively-focused research programme, directed at understanding the design and weaponization of NWs, and putting in place crisis/consequence-focused capabilities to address the possible threat.

How should the International Community assess country X? Country X should be held accountable in the International Community as a nation-state in breach of Article II. Would any NWS NPT signatory, if they assist Country X in accruing the relevant knowledge, be in breach of their Article I commitment? If this is not difficult enough, how should the International Community respond if the NW owning nation-states outside the NPT assist Country X?

The nuclear terrorism-based threats perspective for the 21st Century will be developed further in the next section, where the defence-based proliferation is identified as a key matter for the international community.

21st CENTURY PROLIFERATION PERSPECTIVES

Figure 2 below presents a simple deterrence-proliferation model that illustrates both defensive and offensive focused NW 'needs' create a broad proliferation continuum. The scope of this paper does not allow the complexities that exist at the interfaces between the three 'zones of concern' to be explored; but potential 'leakage' between the zones is recognised as an area that will need to be closely managed.

The main sigmoid proliferation path maps NW capability growth (proliferation) against increasing international visibility/concern regarding possible nation-state-level nuclear weapon use (measured by the 'crude' assumption the more SWNWs and NWs that exist, the greater the potential for NW 'use', deliberate or not).

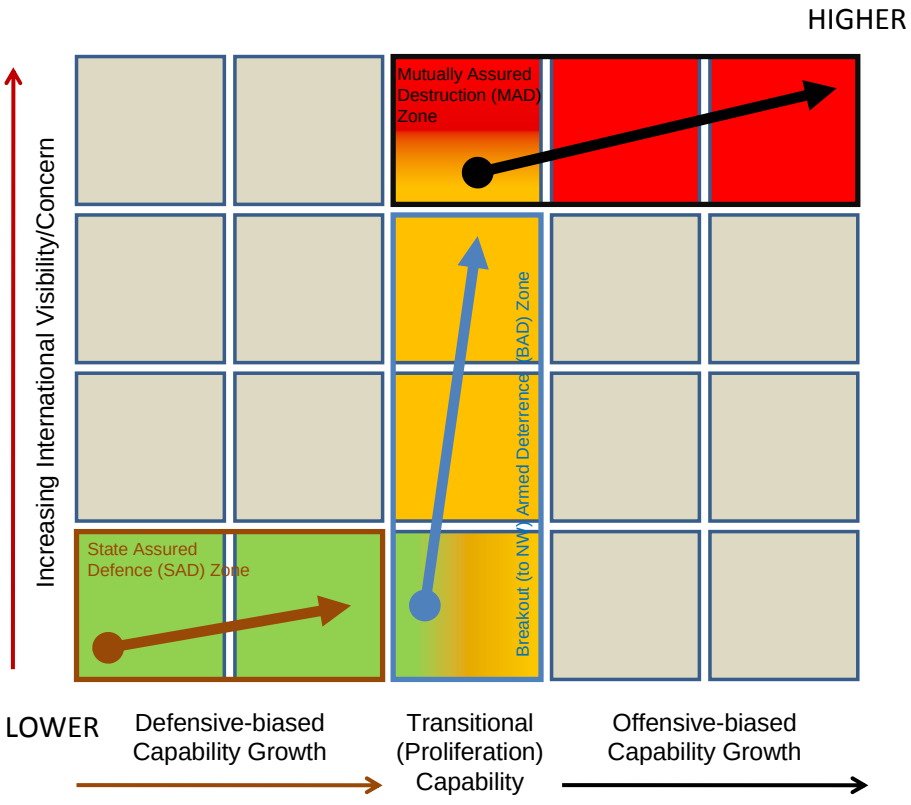

Figure 2: The SAD, the BAD and the MAD

The following may be inferred from the above proliferation model, where colour has been used to provide a feeling of increasing international concern. The boxes represent three different proliferation vectors, or 'zones of concern', with respect to national security agendas and hence potentially the need to apply different suppression and/or verification tools:

- The black box represents a zone of 'vertical proliferation' by known SWNWs. That is a SWNW acquiring greater technical capability, but not necessarily for offensive gain or capacity[38]; it is the zone that is associated with Mutually Assured Destruction (MAD) biased deterrence strategies. 'Verification' in this zone is not multilateral and is currently dominated by US-Russian bilateral arms control agreements, e.g. START-like. Verification is also underpinned by opaque, nation-state-level intelligence and National Technical Means;

- The blue box represents the focus of the current NPT proliferation agenda. Effort is applied here by the International Community to ensure nation-states do not complete the transition to a SWNW, through a process of **offensively-focused** weaponization and weapon-quality fissile material acquisition. Nation-states acting in this zone will have decided to adopt, what this paper calls a "Breakout (to NW) Armed Deterrence (BAD)" strategy. That is a breakout from the NPT and away from international norms. Verification in this zone is through many international regimes and protocols, e.g. NPT Safeguards, Proliferation Security Initiative (PSI) and various export control regimes;

- The brown box represents a 'new' **defensively-biased** proliferation category, and, potentially, a new verification regime, that covers what this paper terms a (nuclear) "State Assured Defence (SAD)" strategy. This zone captures those nation-states that assess they need NW knowledge (and potentially material for

[38] Whilst vertical proliferation may be undertaken for offensive gain, it may also be undertaken for NW reliability, safety and security reasons, i.e. reducing NW risks.

evaluation and training) purely for self-protection against terrorist-based NW threats on their sovereign territory;[39]

Ignoring the actual mechanism at this stage, the SAD-based zone is likely to present a real challenge for verification, as the prospects of differentiating between defensive- and offensive-based NW (BAD) activities, especially early in any research programme, will likely be problematic. Also the ability (intent) for a nation-state to switch from SAD to MAD focused deterrence is strongly related to whether the nation-state has access to weapon quantities of fissile material.

The possibility of a nation-state having an overt defensive-based capability programme, but a hidden, offensive-based, latent one, is thus a scenario that needs to be understood. Differentiation between SAD, BAD and MAD is likely to be intent and threat-perception biased rather than technology driven.

The brown, blue and black lines are illustrative of potential proliferation vectors. That is the (non-linear) path that a nation-state may follow, within a given zone, as part of their natural capability maturity. Hence, in each zone, nation-states will acquire additional capability, thus increasing the risk that they could transition, or be 'forced', into the next proliferation zone, until finally they become an SWNW (real or highly latent, i.e. deployed or non-deployed).

Finally, the sigmoid form of the model is an attempt to suggest that transitioning or converting from a SAD to a MAD, through a BAD, strategy could be (relatively) seamless.

The threat of a SAD-based deterrent strategy being adopted may potentially be minimised by adopting the principle of extended (SAD-based) deterrence. That is,

[39] The terms SAD, BAD and MAD are considered by the author to be evocative of the conditions created by the existence of NWs. Namely, it is potentially MAD that nation-states are still forced to address threats using an offensive NW strategy; it is BAD that nation-states seek NW ownership to address international threat perceptions; and it is SAD that nation-states are forced to adopt a defensive NW strategy to address the evils of nuclear terrorism.

'legitimate' NW nation-states projecting their knowledge and capability umbrella, to nation-states without NW knowledge through crisis/consequence support assistance. Such assistance may be regionalised, 'multilaterised' or provided through bilateral arrangements. The extended (SAD-based) deterrence role of those SWNWs currently outside of the NPT also needs to be understood.[40]

[40] There is a potential analogy here with the IAEA Response System, e.g.Response Assistance Network (RANET) and the Response Plan for incidents and Emergencies (REPLIE).

21st CENTURY NUCLEAR ARMS CONTROL

Multiple Zero Thinking

Multilateral nuclear arms control, and universally meeting the Article VI vision of a 'world with nuclear weapons', will not be easy. In fact, one of the first issues to discuss is what does zero mean? For example:

- Zero intent to acquire NWs
- Zero ownership of NWs
- Zero deployment of NWs
- Zero global physical existence of NWs
- Zero knowledge of how to design NWs

Because of the consequences that NWs potentially create, this paper suggests that in order to make progress, the N192 should initially adopt a broad view of zero, i.e. there is no such thing as a single 'absolute zero' when it comes to nuclear weapons arms control progression. It is all about managing (and reducing) risk in a controlled manner.

Also the N192 will need to accept that, at this time, not all agree that 'giving up' NWs, especially unilaterally, necessarily reduces risk. Thus the World will likely only be able to approach 'zero' asymtopitcally and by transforming current international security models.

To ensure the INS thinking has appropriate global context, this paper simplifies the world's (NW-related) security into six 'clusters' or families (of nation-states), who are coupled together directly or indirectly:

- The US/Russia couplet (cluster A)
- The UK/French/China triplet (cluster B, which with cluster A creates the P5)[41]
- The remaining nation-states with NWs, i.e. the N8-P5 (cluster C)
- The North Korean singlet (cluster D)

[41] The possibility of an intermediate cluster existing, between A and B, is recognized. That is a cluster composed of the US, Russia and China. For simplicity, this cluster is not explored further in this paper.

- The 'New Players'[42] (cluster E)
- The nation-states without NWs or any desire to have NWs (cluster F)

This paper proposes that the N8 (cluster A, B and C) need a structured process to focus the international arms control discussions and plan risk-informed, multilateral NW arms control actions. This paper therefore offers a **Double-Zero Pathway Process (DZPP)**.

By adopting such an approach, the N8 may communicate/parse/manage arms control risk/progress by initially **aiming** to meet the **spirit** of Article VI, via a series of way points that create a pragmatic corridor to the ultimate NW zero (meeting the (NW) **letter** of Article VI).

Figure 4 illustrates the essence of the Double-Zero Pathway Process. That is a 'way point' where there are no deployed NWs, but where NW (second strike) deterrence calculus (and NW norms, e.g. no first use) still operates for the SWNWs; and an 'end point', where NWs have been multilaterally eliminated.

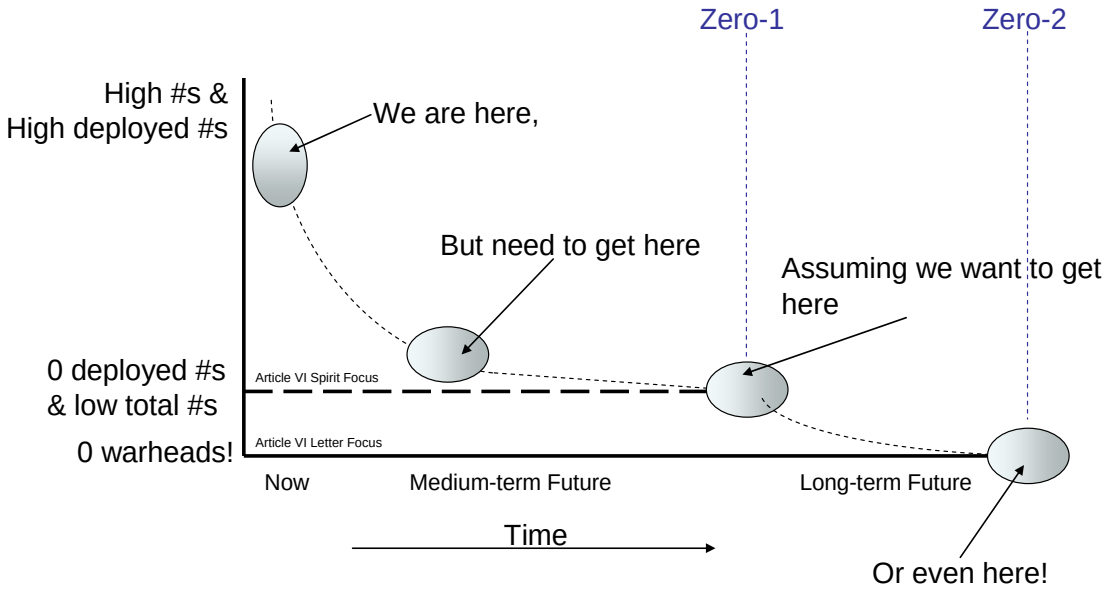

Figure 4: The Double-Zero Pathway Process (DZPP)

[42] In this paper the term 'New Players' is used as shorthand for those nation-states that are seeking or may (in time) seek NWs (actual or highly latent). New Players may move in out of cluster F and thus raise and lower their proliferation visibility in various ways and at various times.

Pragmatically, progression to Zero-1 or Zero-2 will only likely occur if there is stability in the broader global security environment. Thus collective [N192] security is required in order to create the enabling environment for N8 NW actions, i.e. reducing (threat and intent-based) NW proliferation drivers. As the N8 thinks about the NW security dimension, it will be necessary to ensure appropriate links to the broader collective security environment: as NWs are 'just' one part of global integrated security. For convenience, in this paper, these broader security needs are packaged into three groups, creating the global 'ESR security' agenda:

- **E**nergy (e.g. electricity)
- **S**ustenance (e.g. water & food)
- **R**elationships (e.g. commercial, territorial & conventional military)

Thus the Double-Zero Pathway Process is really part of a triple-zero pathway as illustrated in Figure 5 below, where Zero-3 relates to the elimination of energy, sustenance and relationship insecurities and thus full Article VI compliance (the letter), albeit with a need to address enduring non-proliferation threats.

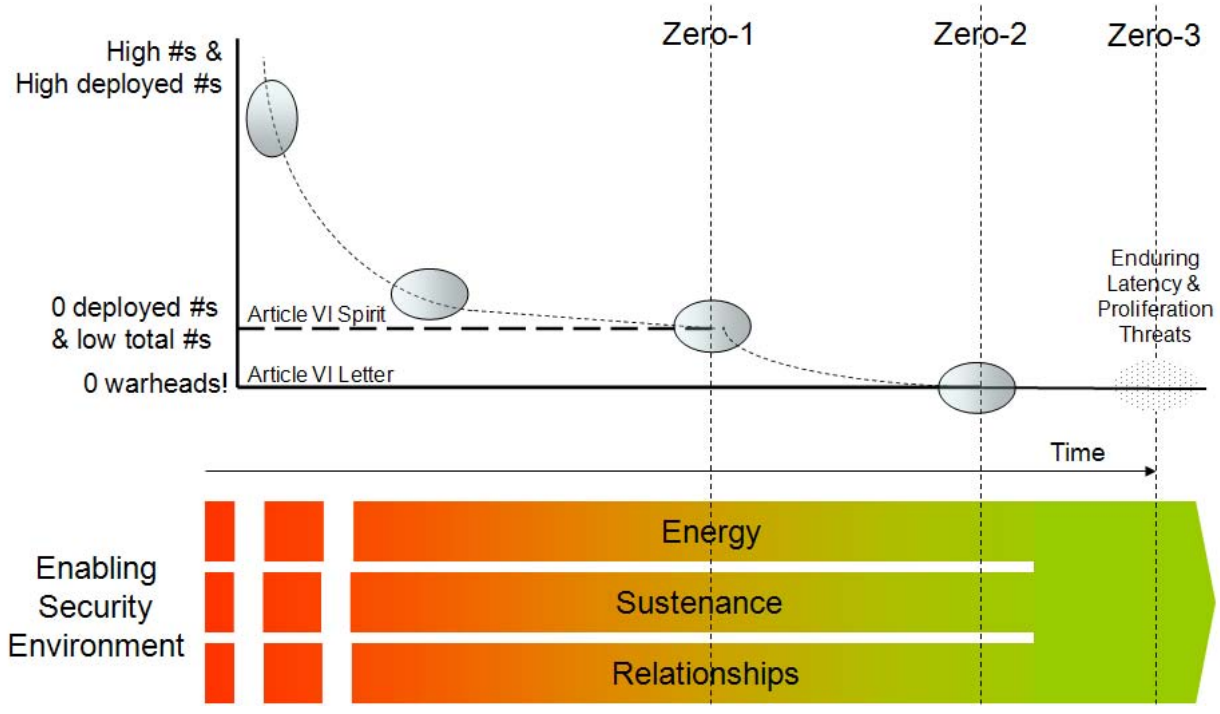

Figure 5: the triple-zero view of Integrated Nuclear Security

Using the Double-Zero Pathway Process concept as our model for multilateral NW arms control, the next step is to construct potential progression scenarios[43], or way points, which in turn identify 21st Century NW arms control actions. Progression scenarios may thus be seen as gravity points to direct/shape phase changes in global security and changes in the deterrence postures of the SWNWs.

Nuclear Warhead Security Regime

As the N8/192 cannot afford to keep re-inventing multilateral NW treaties, this paper proposes the creation of a single, but adaptable, **Nuclear Warhead Security Regime** (NWSR). One that is permissive enough to change/adapt its engagement level as the N8 progress towards Zero-1 and Zero-2. Moving from one NWSR condition to the next will thus reflect maturity in the international security environment and global NW confidences, for example, one staged engagement approach for a NWSR (with increasing 'intrusiveness') could be:

- Stage -0 NWSR: NW Complex and Stockpile declarations[44]
- Stage -1 NWSR: NWC/S infrastructure registration
- Stage -2 NWSR: NWC/S material/materiel movement monitoring
- Stage -3 NWSR: NW material/materiel counting
- Stage -4 NWSR: NW material/materiel reductions
- Stage -5 NWSR: NW material/materiel elimination

In addition, although the DZPP approach is ultimately a multilateral process, initially this will not likely be the case. Multilateral progress will need to build upon, say, US-RU bilateral progress (which will likely remain outside, albeit coupled to, any multilateral

[43] Whilst scenario thinking is a recognised tool, to help people develop the capacity to look into the future and beyond any 'limitations' in current thinking, it is also potentially a way of creating aim points for real action.

[44] Stage-0 declarations are differentiated from Stage-1 registrations, in that Stage-0 is considered to be a confidence building stage to allow each party to freely declare their respective NW Complex and Stockpile. Registration is defined as the step at which on-site 'verification' visits may be made to the NW Complex, i.e. confirm a declared part of the NWC does indeed exist.

NWSR). Figure 6 is a highly stylised and illustrative view of a ‘NWSR roadmap’, that is designed to mature over time.

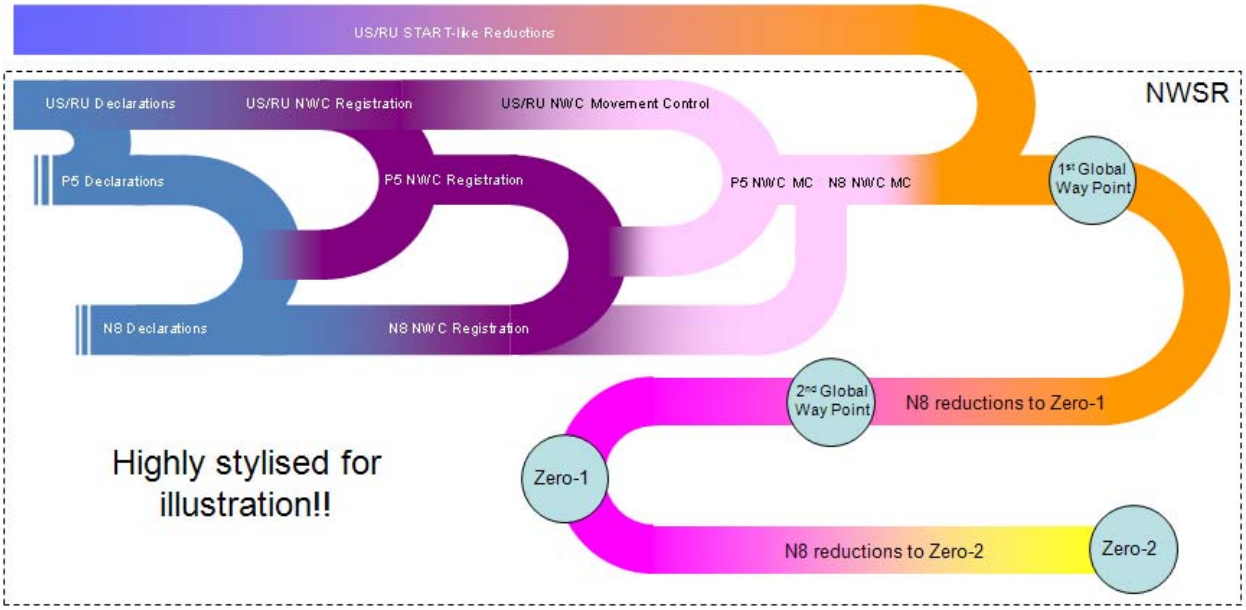

Figure 6: Illustrative NWSR Maturity Roadmap

Although progression scenarios will be interconnected, in the following section the scenarios are not shown in strict time order. For example, progression scenario #3 (The DPRK) is a current (priority) international focus. In addition, each gravity point may also be used to explore ‘points of departure’ (positive and negative), i.e. opportunities and threats associated with the gravity point or way point as reality unfolds. That is opportunities to stop, slow or speed up arms control actions. Using such scenario thinking tools will help the International Community ‘imagine’ **possible** futures and hence assist them in better preparing for such futures: to respond in a more structured fashion.

Managing Staged Progression

Figure 7 presents the full Double-Zero Pathway Process and illustrates the possible multilateral progressions by the SWNWs and the way/hold points that allow assured progression.

It may be seen as a storyboard for visualising progress against the spirit and letter of Article VI, i.e. NW stockpile and NW materiel control.

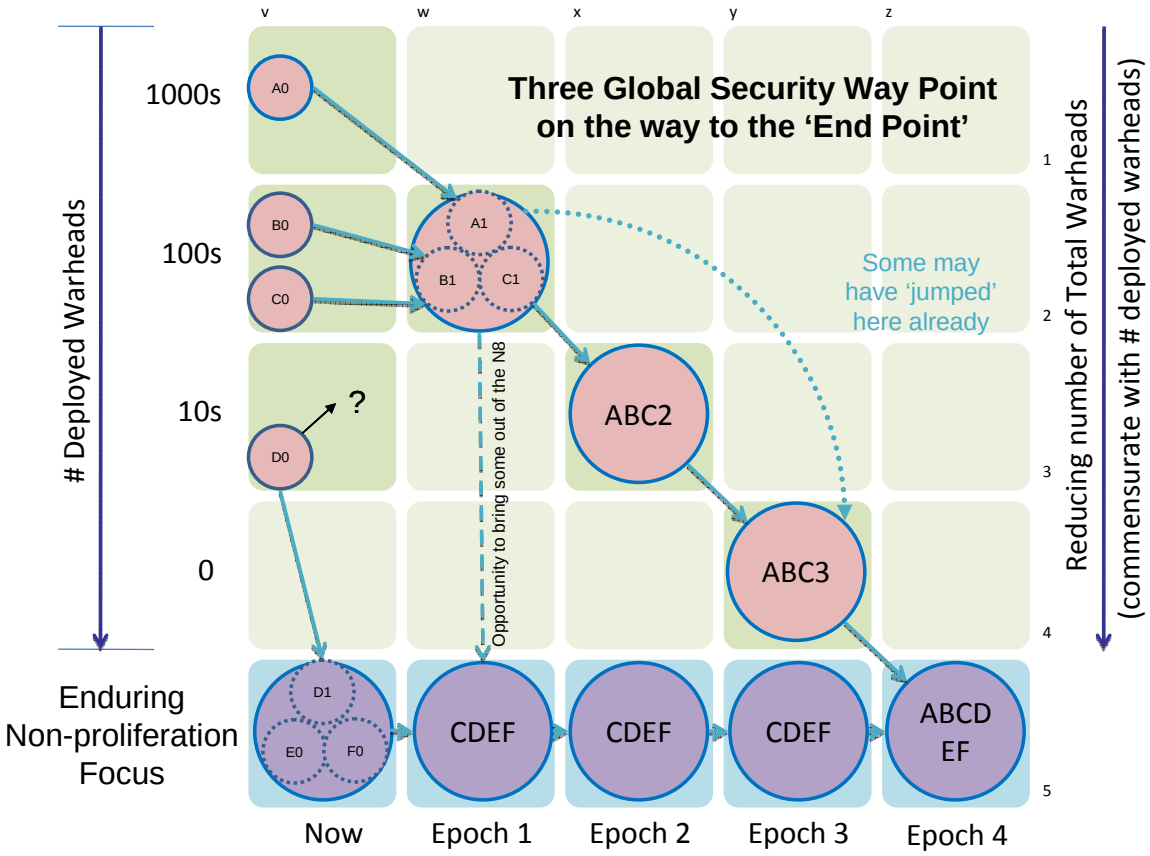

Figure 7: The Double Zero Pathway Process

The space is divided into four deterrent-focused (warhead) number zones

- A Cold War (legacy) Zone (1000s[45] deployed warheads)
- An early Transition Zone (100s deployed warheads in each SWNWs, e.g. <999)

[45] As this paper's aim is to convey a process, the 'numerology of warhead counting' has been left illustrative at this time.

- A late Transition Zone (10s deployed warheads in each SWNWs, e.g. <99)
- A full Latency Zone (no deployed warheads)

Time is represented in terms of Epochs, i.e. phase changes in world affairs/orders/relationships, i.e. ESR security maturity. It is envisioned that epochs will be related to years through expectations and negotiation in the International Community. For the purposes of this paper, however, it is sufficient to simply focus on the phase changes, although Figure 8 illustrates how to couple epochs to real dates.

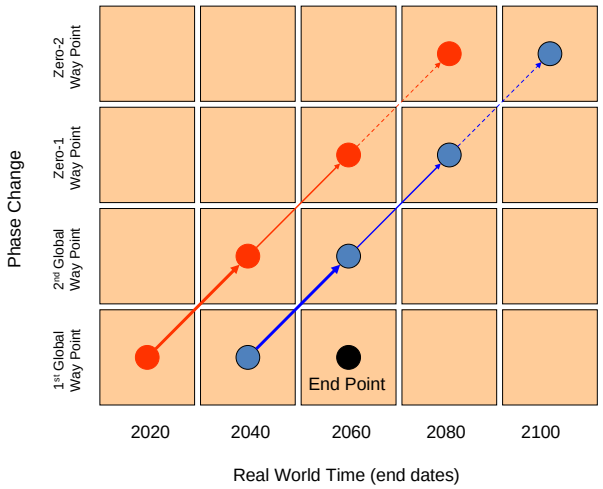

Figure 8: Linking progression to time

The red and blue routes illustrate couplings between the DZPP waypoints and real-world time, whilst the black circle represents a 'premature' stopping point, indicating a future NWSR, albeit with lower numbers of deployed NW under multilateral control. It will be up to the International Community (N8 and N192) to make their real-world expectations clear.

Progressing through the DZPP

This section presents the evolution of the DZPP, from the current world state through to the Article VI end state.

Figure 9 illustrates the relative starting position of all the main NW-focused NPT players (NW deterrent based or NW seekers), as well as the rest of the International Community. The vertical axis measures progression simply by measuring the number of deployed NW numbers.[46] The number of deployed (and the related total number of)

[46] Real progression will need to encompass metrics associated with, say, deployed NWs, non-deployed stockpile numbers, delivery systems, infrastructure, (fissile) material holdings and even capability.

warheads is considered a ‘simple’ surrogate measure of progress, i.e. to many it represents increased risk of something going ‘wrong’, either deliberately or accidentally.

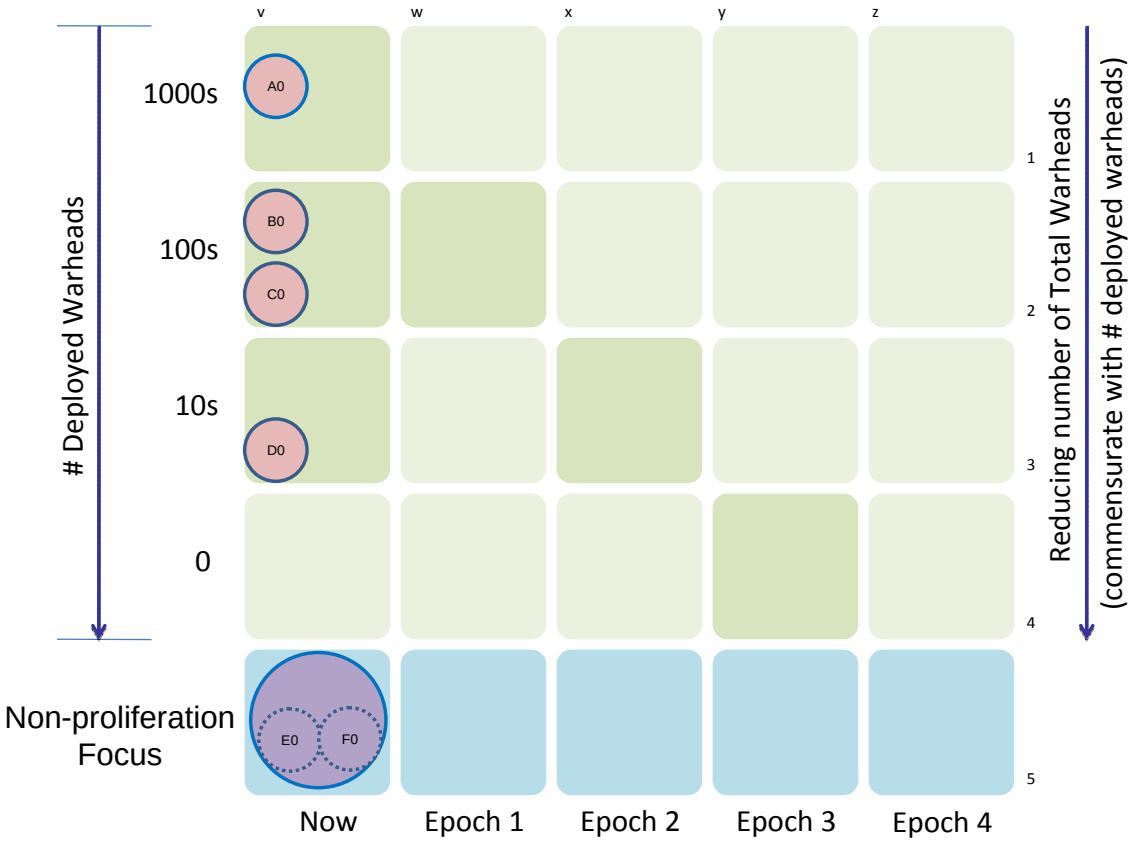

Figure 9: The DZPP Starting Position

Although not illustrated, the baseline Progression Scenario (#0) is to ensure there is an enabling global environment in place for multilateral NW arms control to start, for example:

- Reinforcing/strengthening universalities, e.g. IAEA Model Addition Protocol, NPT (especially full Article VI), C/BWC, CTBT etc
- ‘Exploiting’ other related ‘treaties’, ‘norms’ and ‘protocols’, e.g. CFE, INF, MTCR, NWFZs, OST, PSI, UNSC ‘actions’, Export Controls etc
- Aligning NW re-assurances/commitments, e.g. Negative & Positive Security Assurances, extended deterrence commitments (SAD & MAD based) etc

The first substantive NW arms control progression scenario (v1 to w2)[47] recognises three interrelated bilateral arms control actions. The first bilateral action is that the US and Russia will continue their (START-like) engagements to reduce their respective strategic (sic) stockpiles, illustratively assumed to be some 1000 to 1500[48] total NWs.

The second bilateral action, not shown in Figure 7, is coupled to v1-w2, as it focuses on a legacy bilateral relationship between Russia and the US. That is the 'denuclearisation' of Missile Defence. As it is a distinct way point, it needs to be recognised as a gravity point on its own.[49]

The third bilateral action, also not shown in Figure 7, is that the US and Russian bring all NWs into a single category and reduce their total holdings to, say, 500 to 1000. That is there is no taxonomy associated with nuclear warheads: a nuclear warhead is a nuclear warhead. Thus bringing both Russia and the US stockpiles individually into 'close' numerical alignment with the other P5 members' total/combined stockpiles (w2 way point).

The post-START, bilateral US and Russia actions should be seen as the first stages of a multilateral NWSR. The US-RU processes thus will act in a pathfinding sense for the other SWNWs. The possibility of the bilateral actions being 'visible' to all SWNWs, as a confidence building measure, should therefore be considered, as all members of the N8 will, in time, tread where the US and Russia have trodden. The US and Russia thus need to think in a multilateral norm-setting fashion, as they progress bilaterally.

[47] All progression vectors are referenced to the cells in Figure 7.
[48] It is recognised that some use stockpile 'hedges'. In addition, some have suggested that a more responsive NW infrastructure will allow a smaller (deployed) stockpile and a very low, if not non-existent' hedge, i.e.a total of, say, 1000. As the purpose of this paper is to present a process, this paper uses 'approximate' numbers for illustration, i.e. others will need to agree what the deployed and total NW numbers equate to each epoch's focus.
[49] Although not developed further in this paper, air and missile defences are considered one of the defensive components of an integrated deterrent. Denuclearising such systems is considered by the author to be a necessary part of NW arms control progression. The alternative is a 'treaty' to eliminate ABM-like systems.

The further and substantive progression scenario, and an international priority, is to bring the DPRK back into the IAEA control regime (v3 to v5). As there is much international debate and action already underway on this way point, this paper will not comment further: other than to say, the DZPP approach and the NWSR is potentially adaptable to an N8+x addition, although this should be avoided if at all possible.

Once the US and Russia, individually, have similar stockpile sizes to the total of the other states with NWs combined (assumed to be some 1000 for illustration), the next substantive progression scenarios emerge, which focuses on multilaterally, first bringing the P5, then the N8, into a similar condition of 100s (i.e. 1000 or less)[50] of total warheads, all under the control of a multilateral NW Security Regime, creating the first N8 global security way point (via v1+v2 to w2): see Figure 10.

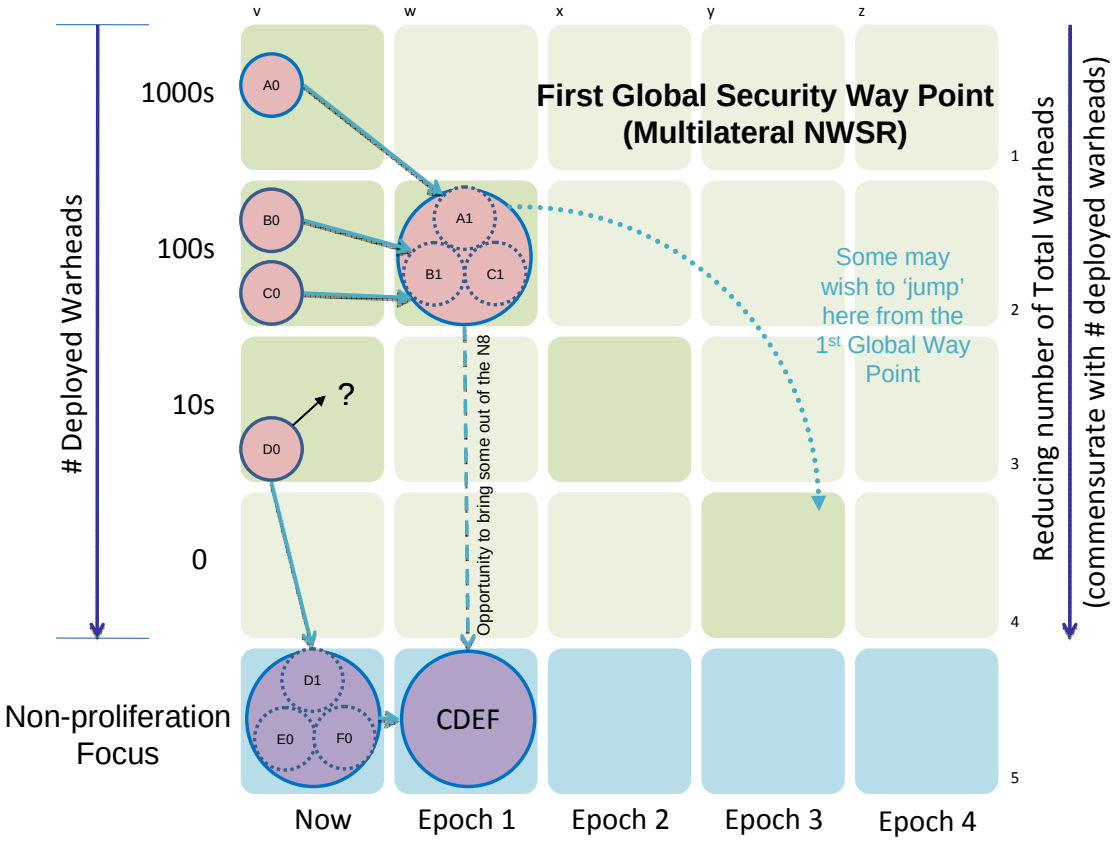

Figure 10: The first Integrated Nuclear Security way point

[50] By saying this, the author is not suggesting that the other members of the N8 increase their stockpiles to 'match' those of the US and Russia. The 1000 number represents total stockpile maximum permitted at this point and, other than the US and Russia, the other members of the N8 will be expected to maintain their declared numbers, if not reduce them, i.e. NOT increase them.

The NWSR expectation at this first global way point is that it will 'just' establish a NW registration and movement control[51] environment for the N8. After additional confidence building measures, this may then be built upon to move the NWSR into a counting and then a reduction regime, i.e. NW numbers and related material/materiel addressed in a verifiable manner.

As can be seen, the first global way/hold point (w2) is also an opportunity for some to 'unilaterally' move to Zero-1 or Zero-2. Such unilateral moves cannot be predicted, as each SWNWs will need to make its own determination as to the health of the prevailing security environment.

A parallel and substantive progression scenario to the above is to bring all members of the N8 into the NPT, including the 'hold outs', and full scope (civil) IAEA control. That is, bring civil nuclear assets under IAEA safeguards, and within the NPT (v2 to w5), and link this to a verifiable Fissile Material Cut-off Treaty (FMCT). Bringing the full N8 into the NPT will require interpreting the NPT in the spirit and not the letter, i.e. recognising the full N8 membership as the starting point for the 21st Century nuclear security agenda.

Although 'diplomatically difficult', the coupling of the NPT and NWSR regime (together, say, with a CTBT and FMCT) will create a global security framework that should allow a new 'grand bargain' for the 21st Century to be struck, i.e. global and integrated fissile material **and** materiel security.

Once the N8 NW assets have been brought under common registration and movement control (at the first global way point), the next logical progression scenario (w2 to x3) focuses on reducing the number of deployed and (commensurate) total warheads held by the ABC cluster (the N8). This ABC gravity point is the precursor to achieving a state

[51] As will be seen in a future section, achieving registration and movement control should be achievable without compromising of national security (NW) information.

of full latency (x3 to y4), i.e. no deployed NWs, but (second strike) nuclear deterrence remaining a national security tool for the N8 (or whoever is left in the N8).

Of course, some may see the x3 (or w2) global way point as representing a (realistic) 'final' end point. That is lower numbers of deployed/stored/total NWs under multilateral 'visibility'. Thus the value of recognising the x3 condition is that it potentially represents the lowest risk configuration for a world that 'tolerates' some (small number of) deployed NWs. That is an N8 (or N8+x), each with a few tens of deployed NWs coupled with small total stockpiles of non-deployed NWs, that are stored in a non-useable (safe and secure) configuration[52].

Finally, if obtainable, the x3 to y4 progression scenario (Figure 11) will allow the International Community to recognise that Article VI compliance has been achieved in spirit, i.e. a condition of global latency, with no deployed warheads and low numbers of non-deployed NWs (or a NW 'recovery' capability).

[52] Note, assuming missiles exist in this future world, low numbers of deployed NWs does not necessarily mean low numbers of deployed ICBMs or SLBMs, say. The rationale for this statement is that any offence could deploy penetration aids (decoys etc) and that there could be many more decoys than NWs deployed; thus requiring appropriate numbers of missiles (to penetrate any missile defence). Thus penetration aids represent potential complexities for ballistic missile based arms control (NW counting and ABM linkages) and will need to be addressed, especially as NW numbers fall.

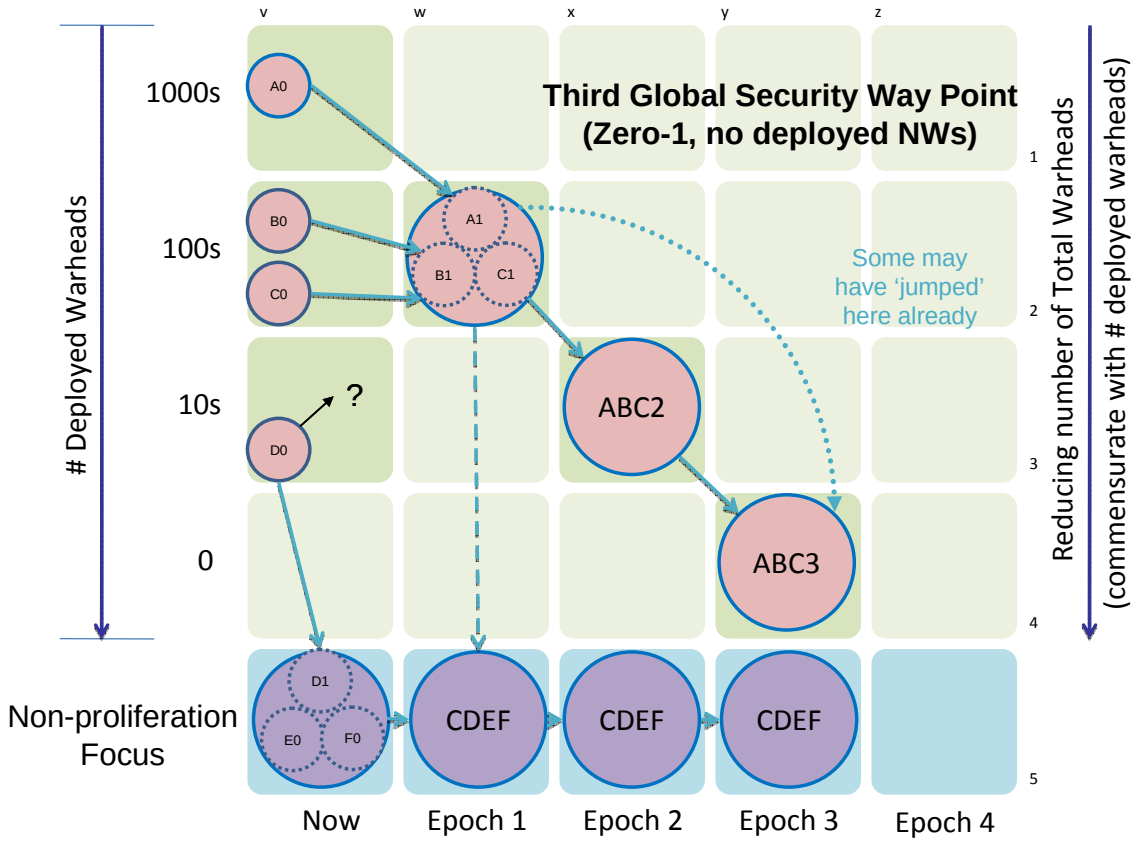

Figure 11: Third Global Security Way Point – Zero-1

Whilst the above progression scenarios have focused on the N8, there exist a set of 'parallel' scenarios (w5 to x5 to y5) that cover continuing and enduring strengthening of IAEA control and verification regime, as well as strengthening, and better integrating, other non-proliferation and counter-terrorism tools, e.g. PSI, CTBT and FMCT etc. N8 progress to Zero-1 or Zero-2 will not likely be made unless the N192 continue their focus on the 'non-proliferation and terrorism' agenda.

The ultimate 'end state', z5, i.e. a world with zero NWs, whilst referenced in the paper for completeness, is not discussed further; and its realisation is left to others to discuss as it will likely require a radically different world from the one that currently exists, e.g. full Energy, Sustenance and Relationship security.

Key Arms Control Actions for the DZPP

In conclusion, the Double-Zero Pathway Process, together with an adaptable NW Security Regime offers a structured approach for multilateral NW arms control thinking/action in the 21st Century (and beyond!). As well as way points, the Double-Zero Pathway also provides security hold points (temporary or 'indefinite').

The following summarizes the main international arms control actions necessary for the DZPP to progress towards Article VI:

- Progression Scenario #0 – Create the global enabling environment for multilateral NW arms control, e.g. CTBT, FMCT and MAP etc
- Progression Scenario #1 – Continuing US/Russian Engagement
    - #1A – reduce the total numbers of strategic warheads using a START-like process
    - #1B – denuclearise ABM/NMD (and debate ABM elimination)
    - #1C – bring strategic & non-strategic NWs into a bilateral Nuclear Warhead Security (NWSR) Regime and reduce the total numbers to a level that allows 'connection' with the P5
- Progression Scenario #2 – Close out with the DPRK 'problem'
- Progression Scenario #3 – 'Multilaterals' the engagement by building on the US/RU NWSR progress
    - #3A – first with the P5 (although the possibility of a precursor US-RU-CN engagement is recognised)
    - #3B – then with the N8
- Progression Scenario #4 (first global way/hold point) – Use the N8 NWSR to enable the non-P5 civil ABC cluster to move into the IAEA control regime + potential unilateral moves to Zero-1 or Zero-2
- Progression Scenario #5 (second global way/hold point) – Move N8 NWSR into an arms reduction mode and reduce deployed NWs (and overall NW numbers)
- Progression Scenario #6 (third global way/hold point) – Take all NWs off deployment – Zero-1

- Progression Scenario #7 (global end point) – Take all of NWs out of ‘physical existence’ by moving the NWSR into an elimination mode, i.e. condition of global illegality and hence terrorism threats ‘only’ – Zero-2

TOOLS FOR TRANSITION

The progression scenarios identified above, stimulated by their way/gravity points, will not just occur. They will take considerable leadership and effort, and the International Community will likely need new tools, or at least reinvigorated tools.

In addition to the need to think about multilateral arms control in a new way, the author suggests the following three (new) tools will likely be instrumental to meeting the Article VI challenge:

- Enterprise modelling, which will aid understanding of the respective N8 nuclear weapon complexes (NWCs) and socialising the differences in NWC approach between the N8 membership;
- An adaptable NWSR or protocol which will allow the N8 NWCs to mature their multilateral engagement in a structured and risk-managed fashion, i.e. declaration, before registration, before movement control, before counting, before reductions, before elimination;
- Infrastructure surety which will bring member and international confidence to the respective NW complexes and allow IAEA Safeguards community and the NWSR to share (most/all) technology (and potentially development and operational costs).

Enterprise Modeling

This is a tool that should have value for confidence building as well as verification (planning and operations). Each N8 country would declare an enterprise model (Nuclear Weapon Complex (NWC) configuration[53]), as part of its NWSR commitments, using a unified approach, e.g. using a pictorial as well as textual approach to aid multilingual and multicultural understanding. Such a modelling tool may be seen as a

[53] The declared enterprise model would identify process/handling/storage/deployment sites as well as process flow between them.

communication, transparency and confidence-building process between the N8 membership, and hence an essential element for having a multilateral discussion.

For transparent understanding of the respective NWCs it will be necessary to clearly define a vocabulary of basic terms needed for infrastructure and process modelling. Each NWC will have its own 'technical language' that implies the creation of an NWC thesaurus or need to create a NWC Esperanto.[54]

The enterprise modelling phase is suggested as a necessary first (confidence building) step to help the NWSR members' socialise their respective NWCs. The models will thus assist NWSR members' better understanding of a NWSR member's NWC operational flows and where NWSR 'monitoring' needs to be applied. In addition the NWC models may be used for planning verification inspections.

By definition, any facility outside of the registered model (and any IAEA registration model) will, be considered a non-compliant site. Thus a transparent NWSR enterprise model links to other risk-reduction tools such as 'societal verification'[55].

Nuclear Warhead Security Regime

The NWSR multi-staged maturation approach presented above is designed to allow the members of the NWSR to grow in their confidences and thus accept potentially greater intrusiveness. Key to any acceptance of NW-based intrusiveness will be the ability to manage the risk of 'losses of national security sensitive information.

As each member state of the NWSR will likely have their own perceptions of risk, the staged approach suggested for the NWSR is designed to allow risk-managed,

[54] As an example see the English-Chinese Chinese-English Nuclear Security Glossary, which was published by the Committee on International Security and Arms Control (CISAC) with and its Chinese counterpart, the Chinese Scientists Group for Arms Control at the Institute for Applied Physics and Computational Mathematics in Beijing.
[55] For one insight, see Societal Verification by Dieter Deiseroth. www.vertic.org/assets/VY00_Deiseroth.pdf

verification growth. Thus, Stage-0 will represent a lower national security threat than Stage-1 etc:

- Stage -0 NWSR: NW Complex and Stockpile declarations
- Stage -1 NWSR: NWC/S infrastructure registration
- Stage -2 NWSR: NWC/S material/materiel movement monitoring
- Stage -3 NWSR: NW material/materiel counting
- Stage -4 NWSR: NW material/materiel reductions
- Stage -5 NWSR: NW material/materiel elimination

Stages 1 and 2 are considered pivotal in the maturation of the NWSR and identifying an appropriate approach will be critical. The author suggests building upon existing work, for example US and Russian bilateral arms control work, e.g. START, the US-Russian-IAEA Trilateral work and the original ideas by Robert L. Rinne: An Alternative Framework for the Control of Nuclear Materials, May 1999[56].

A NWSR based on Rinne's thinking (including addressing his thoughts on the potential 'weaknesses' for such an approach) will allow the N8 NWCs to be brought under declaration/registration and (in time) movement control[57], using modern infrastructure surety technology, whilst managing national security concerns. At its simplest level, the NWSR erects a non-porous, non-intrusive 'security membrane' around an NWC.

Each registered NWSR site will only be allowed to move material/materiel through a recognised portal. In addition, there would be two routes through such a portal. The first would be associated with a NWSR move, i.e. from one declared/registered NWSR site

[56] Center for International Security and Cooperation, Stanford University, Encina Hall, Stanford, California. ISBN 0-935371-55-9

[57] Although not addressed in this paper, the creation of a NWSR will allow N8 arms control progress without the need to address the actuality of material and materiel held. In addition, once the NWSR is assessed as having 'captured' all potential sites related to the NW processing, it will have enabled the first positive step in addressing the issue of Material/Materiel Unaccounted For'. That is NW M/MUF remains 'protected' behind the NWSR membrane, until verifiable processes are in place to account for all of a NWC inventory of NW-related material and materiel. For a material view of MUF see, for example, http://www.hse.gov.uk/nuclear/safeguards/muf.htm

to another. Such a move will ‘only’ be associated with a tagging/registering and tag-inspection operation.

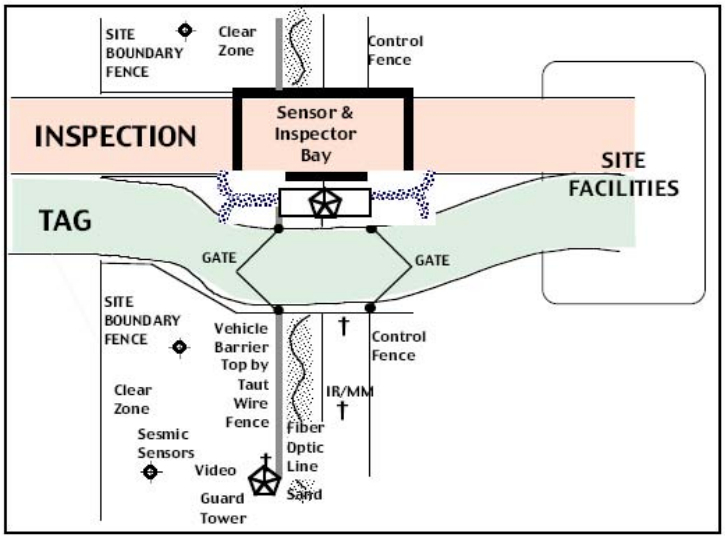

Figure 12: NWSR access control (taken from ISBN 0-935371-55-9)

The second route would be associated with a move of material to international safeguards or a ‘commercial’ transaction. In this case the move would be open to full and complete NWSR (or IAEA) inspection. The above graphic and Figure 13 below are illustrative of such a movement control regime.

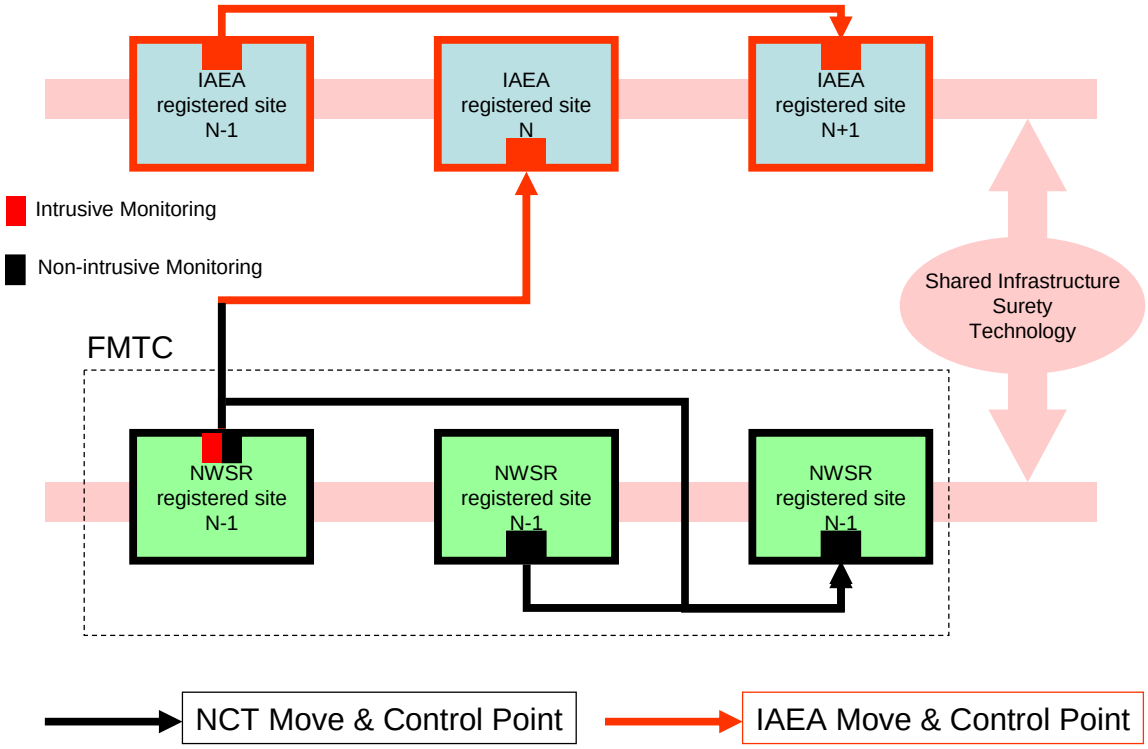

Figure 13: Illustration of the potential coupling between the IAEA and NWSR

Building an NWSR, based on Rinne's ideas, thus allows a risk-managed and structured approach to arms control. First, declarations and registration, then movement control (NW material/materiel related), and finally reductions. It will also help NWSR members protect their national security sensitivities, until concerns have been addressed, i.e. confidence gained, especially under a 'challenge inspection'.[58]

Infrastructure Surety

Infrastructure Surety[59] is enabled by appropriate use of trusted technology. In order to minimise the costs of putting a NWSR in place, it is suggested that technology (and processes) are kept in balance as much as possible across both IAEA and NWSR systems e.g.:

[58] Whilst this paper does not address challenge and planned inspections in detail, experiences from other treaties should help inform any NWSR implementation. For example, the value and risks of a 'managed access' approach to sensitive information. See, for example, http://dtirp.dtra.mil/products/CWC/119p.htm
[59] For one insight into Infrastructure Surety see: http://www.sandia.gov/Surety/SurWP.htm

- Portal Monitoring
    - IAEA (intrusive)
    - NWSR (non-intrusive)
- Movement monitoring
    - Tags and seals
- Near-field monitoring
    - OSI tools for IAEA and NWSR
- Far-field monitoring
    - INFCIRC/153 agreement
    - Additional IAEA protocols have obvious NWSR links

Finally, Infrastructure Surety will also need to ‘survive’ various post-event ‘tests’, for example related to an inter-site movement accident, and, say, the legacy from a terrorist incident.

IMPLEMENTATION PRACTICALITIES

The latency-based/biased, Integrated Nuclear Security process presented in this paper will need to be tested against many real-world realities and perceptions. Not all will see a seamless path forward. National security concerns related to nuclear weapons are not universally understood, and the (perceived) value of nuclear weapon ownership is very much in the eye of the beholder.

In the following sections several ‘practicalities’ are discussed. These practicalities, unless faced, could create insurmountable barriers to the goal of realizing any of the global way points.

Realising a Global Enabling Security Environment

As stated above, collective [N192] security will be needed to create the enabling environment for N8 actions, i.e. reduce proliferation drivers associated with ‘ERS securities’: (fissile material based) Energy, Sustenance (e.g. water & food), Relationships (e.g. commercial, territorial & conventional military).

Thus, for any NWSR to multilaterally progress towards Zero-1 and -2, the N192 will likely need to bolster its collective ESR security, which, for illustration, is assumed to mature in the following way:

- Stage I – Shared ESR global security vision
- Stage II – Collective ESR global security norms agreed
- Stage III – Operational ESR global security verifiably deployed

According to the maturity of our Stage I, II or III ESR environment, the NWSR pathway to Zero may veer, pause or even stop as illustrated below in Figure 14.

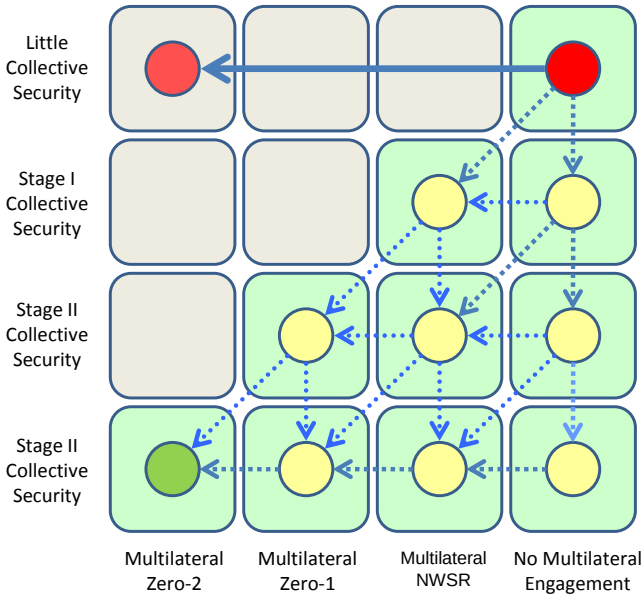

Figure 14: The ESR linkage to Zero-2

In Figure 14 the current global position is illustrated by the red circle in the top-right. One path to Zero-2 is to 'just' jump there, as illustrated by the red circle in the top left. A more risk-managed approach is illustrated by the various yellow circles, which show there are multiple paths and hold points to the bottom left, Zero-2 state.

By recognising the existence of risk-informed way points, each member of the N8 will continue to have the same goal (Zero-2), but, according to their own security needs/perceptions, they may travel to this goal via differing, but accepted pathways. The key principle would be a collective commitment to arrive at an agreed point, by a specified time, before all continue to the next way/end-point.

As was illustrated in Figure 6, in the early phases of any NWSR (Epochs 1 and 2) there will likely need to be an interacting set of engagements, for example:

- START-like US and Russian bilateral reductions to, about, 1000 warheads in total on each side; likely taking the opportunity to improve surety through spiral (Life Extension) insertion into existing design-space;
- Declarations (some may call these transparencies) within the N8 to increase confidence and strategic stability associated with their current stockpiles and NWCs;
- US and Russia initiating a phased bilateral NWSR arrangement (on top of START-like reductions);
- The rest of the P5, possibly via US-RU-CN phase, joining the US Russian NWSR arrangement in a phased manner;
- The rest of the N8 joining the NWSR regime in a phased manner.

The focus of the above, of course, is to reach a point where the N8 have entered into a multilateral NWSR (in this paper suggested to be based on the ideas of Rinne), thus creating the environment for multilateral risk-managed progress towards Zero-1 or Zero-2.

Stockpile Partitioning and Hedging Practicalities

At any time an 'active' nuclear weapon stockpile may be partitioned into two components, i.e. a deployed component and a non-deployed component[60]. That is (logistics) latency is already built into many stockpiles, i.e. not all active warheads are

[60] Note: active numbers encompass both operationally deployed and those that sit in non-deployed storage, as part of the stockpile's logistic management process. As an example, the UK has stated that each Trident SSBN will not have greater than 48 warheads on board (www.parliament.uk/documents/upload/DefCtteeNuclearDeterrentLetter.pdf). The UK, because of their SSBN fleet, is unlikely to have more than two SBBN's in operation at any one time. Hence, the UK would have either 48 or 96 warheads deployed at any one time, with the remainder of its stockpile (http://www.mod.uk/NR/rdonlyres/1297F6C1-4850-4767-84D4-F4B2430D23C1/0/Cm6994_Factsheet1.pdf), some 60 or 110 warheads in active logistic storage and processing.

deployed at their delivery sites or on delivery systems (i.e. warhead/ship storage sites, SSBNs on patrol or ICBM silos).

In addition, some, because of their threat perceptions, have a third stockpile component[61]. That is a so-called 'responsive force', which is not part of the active stockpile of deployed and non-deployed warheads, and which sits in the background, as a 'just in case' force to address breakout concerns and possibly (technical) fragilities associated with the active stockpile. As with the non-deployed, but active, warheads, these 'responsive' warheads are held in a latent state, e.g. likely requiring many weeks/months to be processed into a deliverable condition.

As NW numbers reduce, the author believes the value of adopting an integrated hedging strategy becomes critical. That is not 'just' having a 'hedge stockpile'. If a SWNW has in place an integrated hedging strategy, it will likely create a more enabling environment for reductions/eliminations, i.e. risk-informed and risk-managed. Components of an integrated hedging strategy could include the following:

- System diversity hedge (e.g. addressing common mode failure concerns)
- Logistics hedge (e.g. gaining some comfort from those non-deployed NWs being (logistically) managed 'behind the scenes')
- Science-based surveillance hedge (e.g. ensuring one has a 'look ahead' to address, say, age-related problems)
- (strategic) Conventional Prompt Global Strike hedge (e.g. time-critical strategic strike without NWs)[62]
- Technology readiness hedge (e.g. ensuring an integrated technical capability to respond to time-critical stockpile concerns and/or SAD/MAD-based threats)
- Intel hedge (e.g. reducing threat surprises)

[61] For example see US Nuclear Weapons: Changes in Policy and Force Structure, Amy F Woolf, CRS RL31623

[62] Although a potentially contentious possibility, see Conventional Warheads for Long-Range Ballistic Missiles: Background and Issues for Congress, Amy F Woolf, CRS RL33067, such 'technologies' may be the cost of a world without NWs: until Zero-3 is reached.

- Responsive infrastructure hedge (e.g. being able to respond in a timely manner, which should be easier for ‘small’ stockpile sizes, i.e. 10s vs. 1000s, i.e. adopting a like-for-like remanufacture-based strategy)
- Countermeasures hedge (e.g. assuming ABMs are not eliminated, maintaining sufficient deterrent confidence to ‘get to target’ if there is, say, an ‘ABM breakout’)
- Arms Control hedge (e.g. confidence through treaty-based awareness)
- Diplomacy hedge (e.g. managing threats through relationships and internationally endorsed actions)

This paper has presented a ‘way point’ where there are no deployed nuclear weapons (Zero-1), ‘only’ stored nuclear warheads held in a latent state (demated from delivery platforms and stored in a safe/secure condition that requires some form of pre-use processing). A path to such a latent-based deterrent, will allow the SWNWs to recognise the distinction between warheads designed for active deployment (what might be termed ‘old-world’ NWs) and ‘a new class’ of warhead architecture (albeit with the same mission/yield profile), with the addition of integrated (full scope) surety technologies, that is ‘new-world’ NWs. That is, NWs designed to enable the pathway to Zero-1 and Zero-2, designed for safe and secure, non-deployed storage, and in-extremis (timely) deployment; as well as (potentially) with embedded ‘arms control’ registration technologies, eg unambiguously, and without national security compromise, allowing NWSR states-parties to conform that a given warhead is a legitimate part of the agreed stockpile (ie unit n of m).

The practicalities of the first steps towards full latency (Zero-1) will mean that any active, deployed and non-deployed, stockpiles (say in the US for illustration), will start from a stockpile configuration composed of current generation warhead types, either as is or ‘LEPed’[63]. For this reason it will be necessary to migrate the deterrent to a latent configuration in phases, during Epoch 2 and 3.

[63] The US currently appears to have three broad strategies related to stockpile management: status quo; Life Extension Programme (LEP); or Replacement, i.e.Reliable Replacement warhead (RRW). See, for

Taking the US as an example, the following is one possible (illustrative) migration path they could take:

- Phase 1: Eliminate any reserve-hedge and reduce active, deployed and non-deployed (logistic), inventories to, say, 1000; and take the opportunity to address any 'surety' needs in these systems, e.g. LEP insertion of some surety technologies[64];
- Phase 2: Transition, over time, a proportion of the active stockpile over to a NWSR-compliant class of warhead designed for confident, latent-based deterrence, e.g.:
    - Warheads that are (more) surety-coupled into their (storage and transportation) environment.
    - Have condition monitoring biased/based stockpile surveillance;
    - Warheads that are 'NWSR enabled' and compliant, i.e. verifiable and 'countable' without loss of national security information.
- Phase 3: The active stockpile (of 'old world' designed warheads, albeit surety LEPed from the 20th Century) is withdrawn and 'only' the NWSR enabled, non-deployed, warhead class comprise the deterrent, i.e. a state of latency (Zero-1).
- Phase 4: The number of non-deployed (latent) deterrent warheads is reduced, through an N8 multilateral NWSR, to ever lower numbers, until, potentially, Zero-2 is reached.

Delivery System Practicalities

While in the NWSR the warheads will be the main focus, the other side of the NW arms control coin is the delivery system. Although some will consider it contentious, this paper suggests that delivery systems be dealt with under a separate security regime.

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example, The Reliable Replacement Warhead Program: Background and Current Developments, Jonathan Medalia, CRS RL 32929

[64] Note LEP insertion here is related to the system, i.e.surety enhancement may be gained outside of the warhead itself.

The rationale behind this thinking is three-fold. First, in the case of N8 engagement, not all members will have 'like-for-like' approaches to realise their NW delivery needs. Second, many, if not all, NW delivery platforms have conventional 'dual use' and thus should be a focus of Zero-3, i.e. 'general and complete disarmament'. Finally, other than the first global way point, as NW numbers reduce, subsequent way points are unlikely to be able to sustain a triad, although not all may transition to a biad in the same way.

Thus each country will need to decide how to best maintain its stockpile, based on its security and deterrent requirements. Whilst the transition from triad, to biad to monad cannot be predicted, the author considers one obvious pathway to be:

- Triad: Aircraft + SSBN + ICBM
- Biad
    - option 1 Aircraft + SSBN
    - option 2 Aircraft + ICBM
- Monad: Aircraft

In other words, for the N8, once low warhead numbers and/or Zero-1 is reached; it is considered highly likely that 'only' aircraft will be used for military delivery (gravity or standoff) of NWs, i.e. an air-delivered monad.

ABM/NMD Practicalities[65]

As stockpile numbers reduce, and ballistic missiles remain as delivery options, some will question the utility of deterrence in a world that also has relatively 'large numbers' of ABMs (anti-ballistic missiles)[66]. Unless ABMs are eliminated through a verifiable process, there will be a need to address the intersection between ABMs and ballistic missile delivered NWs.

[65] This paper makes no distinction between Anti-Ballistic Missile (ABM) systems and terminology such as National Missile Defence.
[66] In addition, there will likely need to be appropriate control of 'space launch' technologies and applications.

The fact is that history tells us that ABMs do not axiomatically lead to increases in the number of warheads[67]. The adoption of decoys or penetration aids (penaids) is likely to have value in overcoming a large numbers of ABMs, without increasing the number of deployed NWs. It is suggested that penaids and countermeasures will need to be addressed by the (NWSR) arms control community (unless ABMs and penaids (and their technologies) are eliminated through treaties).

Regime Practicalities

The NWSR ideas presented in this paper are directed at addressing nuclear warhead materiel and material control, currently outside of IAEA Safeguards. Although it has many technical and procedural links to the IAEA Safeguards regime, the national security sensitivities related to NWs means that many will wish to keep the NWSR regime (technically) separate from material safeguards: at least initially.

For such reasons there will need to be a discussion within the N8 (and N192) as to whether any NWSR should stand alone, or be brought close to or even within the IAEA.

Graphically, and simplifying things, e.g. no FMTC is shown, Figure 16 illustrates three possible governance models for nuclear material and materiel control, i.e.:

- A standalone model: in this arrangement the IAEA Safeguards and NWSR operate in ‘isolation’ from each other, although some verification technology sharing should be possible;
- A coupled model: in this arrangement the IAEA Safeguards and NWSR regimes share some verification arrangements, e.g. common portal monitoring, although some matters remain detached, e.g. challenge inspections under NWSR.
- An embedded model: in this arrangement NWSR becomes an extension of the IAEA Safeguards regime.

[67] The Future of the British Nuclear Deterrent: http://www.parliament.uk/commons/lib/research/rp2006/rp06-053.pdf

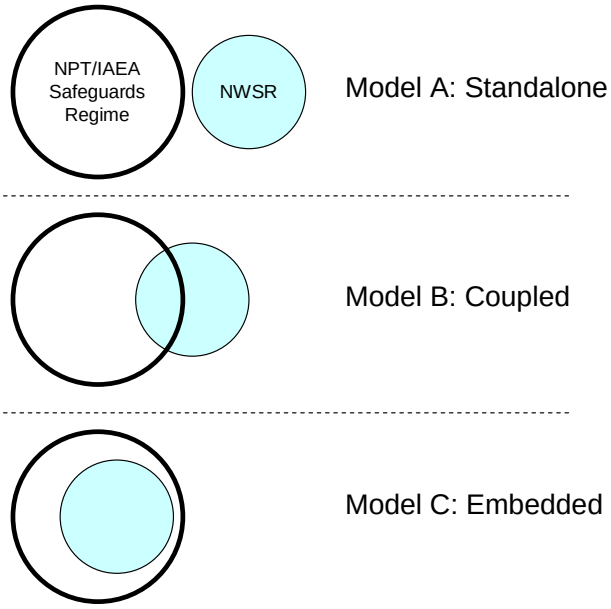

Figure 15: Three possible NWSR Governance models

The three governance models illustrated above also present a potential maturation pathway for the NWSR and the NPT. That is the NWSR and NPT remain distinct in the beginning, but, over time, as confidence grows, the NWSR verification regime becomes operationally closer to (and in the end consumed within) the NPT/IAEA verification regime.

Verification Practicalities

Once the NWSR regime is in place, the N8 community will gain from there being a registration and control 'membrane' around their respective NW infrastructures, i.e. shared transparencies and confidence-building, plus 'provenance management'. That is NW-related fissile material (and NW materiel) can only move between registered sites in a verified chain of custody. Any move outside of a NWSR move (or to an IAEA site) by definition will be cause for challenge.

Whilst NWSR is first a registration arrangement, it will, in time, need to be extended to encompass verifiable movement control, counting and reductions in warheads, and

fissile material: including the irreversible transfer of fissile material from NWSR control to IAEA Safeguards.

Some of the experiences from the US-Russian-IAEA Trilateral[68] and other US-Russian bilateral experiences[69] should be exploited, e.g. the use of trusted information barriers. Although it is thought that verification of a complex system, such as a nuclear warhead, will need more consideration than the verification of 'just' a plutonium (say) pit.

For this reason, this paper offers the following perspectives on early (stage-3) NW-level verification, as part of a maturing NWSR.

To date two broad verification techniques have been explored: based an attribute or a template approach. In the attribute approach the verification parties agree a set of physical 'attributes', e.g. mass, volume and, potentially, more complex attributes such as a radiation signature at a specific energy level. These attributes will likely be associated with some acceptance criteria, to account for the normal (manufacturing and age) variability in the item being verified.

In the template approach a broader set of 'attributes', usually held behind an information barrier, is processed by a trusted computer-based system, which will merge the attributes and 'decide' that the item under consideration is indeed that which it is claimed to be. Verification may be shown by a simple yes/no process (green/red light) to a verifying agent, who may be a third party with no knowledge of the details of the item being verified.

[68] REPORT ON THE TRILATERAL INITIATIVE, IAEA VERIFICATION OF WEAPON-ORIGIN MATERIAL IN THE RUSSIAN FEDERATION & THE UNITED STATES, BY THOMAS E. SHEA. IAEA BULLETIN, 43/4/2001

[69] Non-proliferation and Threat Reduction Assistance: US Programs in the Former Soviet Union. Amy F Wolf, February 11 2009. CRS RL31957

In the case of warhead-level verification, as opposed to pit-level verification, at least four complications arise. Namely:

- each state-party will not wish their warhead design information to be promulgated to others, e.g. discussing 'feature space';
- each state-party will likely have greatly differing designs to achieve the same stockpile objective. For example, the N8 will not be able to assume that the warheads in, say, 100kt-class re-entry bodies, on ICBMs or SLBMs, are similar in design;
- each stockpile being verified may have sub-sets within that stockpile, with grossly different internal features, e.g. for mission, age or build standard;
- Fully assembled warheads will create more complex radiation signatures than 'simple' fissile components such as pits.

For this reason, it is suggested that 'no-knowledge' approaches should be considered for NW-level verification. For the purposes of this paper, two illustrative examples are offered: a positive or direct verification method and a 'negative' or indirect one. In the direct approach one seeks to prove (verify) the object is a NW and in the indirect approach one seeks to prove the object is **not** a NW. The indirect approach having the obvious advantage that no NW-level information is involved, ie one is confirming no fissile material (of any kind) is present in an aeroshell, say.

Direct Verification, No-Knowledge Example

If it is considered necessary to positively measure a Treaty Registered Object (TRO)[70], for example a declared NW, use could be made of a Jackknife or Bootstrap[71] approach; especially one based on non-parametric techniques, where the TRO self-generates its verification statistics.

The complicating factor for the direct approach is that, even within a single stockpile, there may be several warhead 'variants' within the same carrier vehicle, e.g. Inert

[70] The term Treat Registered Object covers the possibility that a stockpile may be composed of NWs and other objects that look like NWs, e.g.decoys.
[71] An Introduction to the Bootstrap, Bradley Efron and Robert J. Tibshirani. ISBN-10: 0-412-04231-2.

Heads[72], decoys (for a ballistic system), age or an Alteration (Alt) or modification (mod)[73]. These variants will have statistically significant variability in their templated signature.

Figure 16 illustrates how a Bootstrap Verification Process could work, e.g. an 'NWSR challenge' would be addressed in the following manner:

- Stockpile action 'challenged', i.e. a treaty-party challenges the claim of another treaty-party, e.g. 'prove' you are moving the 30 TROs you say you are from location A to location B;
- A template has previously been created using a Bootstrap process behind a trusted information barrier, i.e.TROs are binned into one of n agreed bins[74];
- Change (challenge or request) is verified via the bootstrapped template.

[72] Inert Head covers the use of full mass aeroshells as ballast on a MIRVed system and aeroshells used for flight or ground trials.
[73] For example, see http://www.acq.osd.mil/ncbdp/nm/AcronymsGlossary.html for a glossary of (US) used terms.
[74] It is beyond the scope of this paper to explore bootstrapping in any detail. However, it is important to note that the number of bins itself could be protected. For example, a treaty may allow a variable number of bins up to a specified maximum. The actual number used, would thus remain hidden behind the information barrier, thus protecting stockpile partitioning.

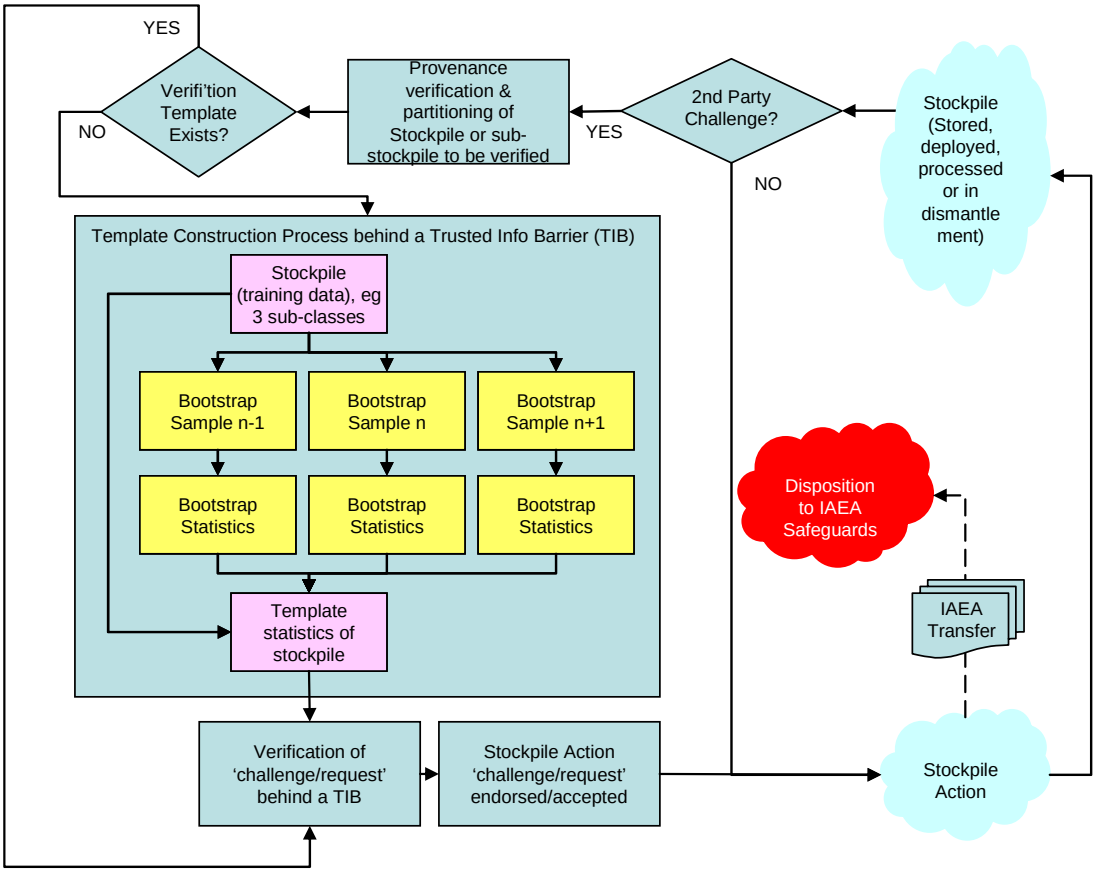

Figure 16: Outline of a possible NWSR Bootstrap Verification Process

Any stockpile partitioning is 'hidden' behind the information barrier. That is, as long as the TRO's signature, from the stockpile being verified, falls into one of the bootstrapped 'bins', hidden behind the information barrier, it is declared a TRO.

In the case of the direct method, the weakness (and strength, according to ones perspective), is that the actual size of the NW component of the stockpile is 'protected/hidden'. That is, the only information that is transferred is that the total number of NWs, decoys and IHs is equal to or less than the treaty allowed number; unless the states-party declares the number of NWs as being less than the agreed treaty maximum; or allows the bin statistics to be visible.

Indirect Verification, No-Knowledge Example

If the direct, or positive approach, is deemed too intrusive, or costly (time and money), it may be possible to consider an indirect approach. The assumption in the indirect approach is that a TRO is a NW. Thus visual counting (verified aeroshells, carrier vehicles[75] or containers[76]) establishes that the size of the stockpile is not larger than agreed/declared; and according to the size of the agreed number of TROs, further verification should not be required (until the stockpile is eliminated/dispositioned). Two scenarios present themselves in the case of indirect verification: one based on total TRO numbers and one on nuclear warhead numbers.

In the first scenario the total number of TROs (sic), i.e.NWs, decoys and IHs, are held to be less than a treaty agreed number. In this scenario, counting-based verification should be sufficient, i.e.verified counting of aeroshells, 'bomb cases' or containers, irrespective of whether they are NWs are not.

In the second scenario, a states-party has a mixture of NWs, decoys and IHs, that, in total, exceed the agreed number of NWs (sic). In this case there will be a need to confirm that the number of NWs does not exceed the agreed treaty level. For example, if a treaty specified no more than, say, 500 ballistic NWs in the operational stockpile, and the stockpile was composed of N (yield-generating) NWs (where N is less than 501) and a mixture of M inert heads and/or full mass decoys that were not NWs (where N + M > 500) only the aeroshells beyond 500 would be offered for verification. In this case the verification would simply need to confirm that no fissile material (of any kind, shape or mass) was present in objects presented for verification.

The weakness (and strength, once again according to ones perspective) of indirect approach is that, the actual size of the stockpile may be 'protected/hidden'. That is, the only information that is transferred is that the stockpile (TROs or implied NWs) is equal

[75] In this paper the term Carrier Vehicle covers those NWs outside of an ICBM/SLBM, i.e.an air-delivered stockpile.

[76] Although not developed further in this paper, the prospects of a multilateral verification regime being based on 'container counting' is considered a possible approach to a non-knowledge indirect (or even direct) verification regime. That is, each states-party is permitted a maximum of n 'stockpile' containers.

to or less than the treaty allowed number; unless the states-party decides to voluntarily declare (as a non-verifiable transparency measure) the number of NWs as being less than the agreed treaty maximum.

System-level Perspectives

Both the direct or indirect approaches will likely need to be associated with three additional verification 'processes':

- Registered sites with access/egress controlled portals
- A point of provenance verification (i.e. a deployed site such as a ICBM field)
- Chain of custody verification

The above will be achieved through the introduction of a stage-2 NWSR. That is warheads are moved from a registered point in a states-party's complex (storage or deployment point) in a verified (e.g. tagged and sealed) manner.

In addition, whether direct or indirect verification is adopted, consideration will need to be given to the verification of operational MIRVed systems (if allowed by a treaty). That is SLBM/ICBMs carrying a mixture of NWs, decoys or IHs. In this case, either the direct or indirect approach could be used; according to the level of information a states-party is prepared to release.

Finally, in a multilateral (N8) NWSR a valid question to ask is: what should we be measuring or controlling? Delivery Vehicles? Warheads? Technology? All of these?

In order for progress to be made, this paper suggests some simple guiding principles, for the 'bring under registration and control phase':

- Don't assume (warhead) design (addressed through the adoption of a direct, bootstrap approach or an indirect approach);
- Count TROs e.g. warheads, decoys, IHs and/or 'treaty-compliant containers containing TROs;
- Don't attempt to assume/measure yield;
- Don't 'count' delivery platforms within an N8 NWSR.

As indicated above, the fourth principle may appear counterintuitive and cut across the current US/RU 'treaty practices'. The rationale is that as Zero-1 is approached, it is unlikely that any SWNWs will wish to maintain a bi-ad or tri-ad of NW delivery options. In a Zero-1 world, 2nd strike delivery options will likely be addressed through air-delivery (or unconventional delivery).

Integrating Verification Regimes

As implied above, as multilateral NW verification matures, this paper suggests consideration be given to moving 'delivery systems' into the security regime that addresses 'general and complete disarmament'. The rationale here being that delivery systems are dual use, i.e. NW and non-NW.

Further, it is suggested that the current (fragmented) approach to global security regimes needs to move towards a more integrated model, with three verification regime 'channels':

- Nuclear Warhead Security Regime (the main focus of this paper)
- Non-Proliferation & Terrorism Security Regime
- Delivery System and Conventional Materiel Security Regime

Figure 17 is designed to convey the concept of moving towards a rationalised global security agenda, in a structured fashion, as the N8/192 move towards Zero-1, -2 or -3.

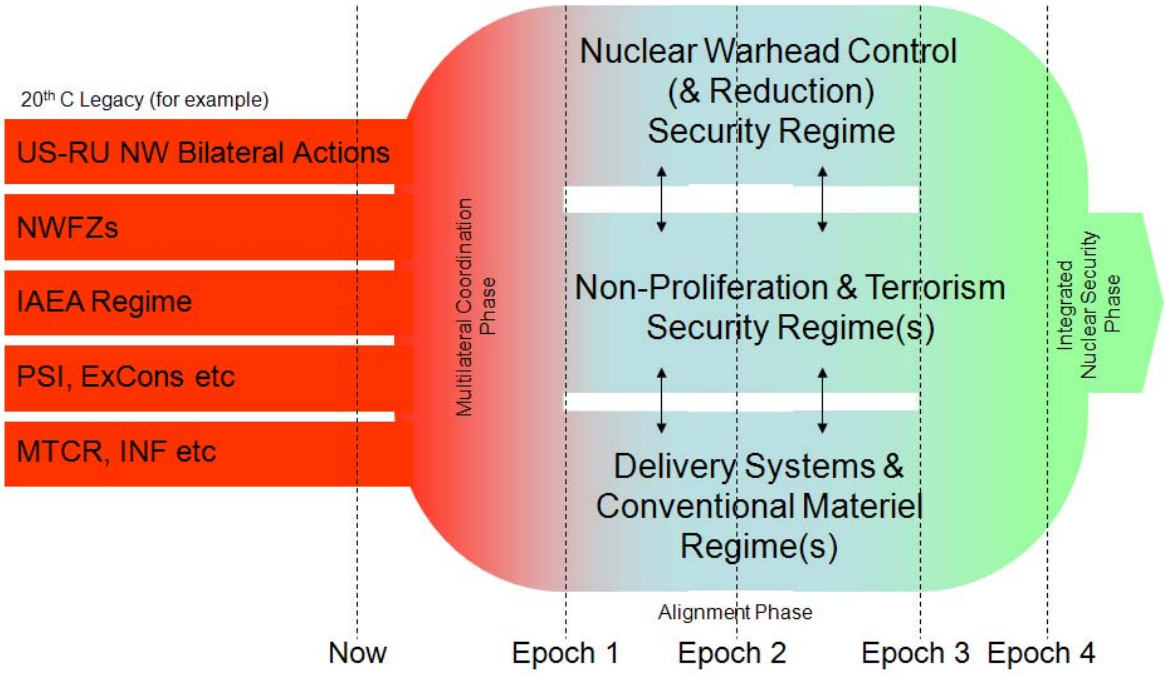

Figure 17: Aligning Security Tools into three 'channels'

In conclusion, although much (bilateral) work has been done on verification, e.g. through the Trilateral initiative, it is likely more will be required to put in place an acceptable, zero-knowledge approach, for a multilateral warhead system verification: especially one directed at 'NW accountancy' and in-service processing control, as opposed to withdrawal/disposition verification, i.e. following breakdown and demilitarisation action. In addition, if the International Community is to maintain a focus on the three Zeros, it will need to adopt a more structured approach to the various international security efforts and verification regimes, i.e. bring them into stronger, re-enforcing alignment.

Strategic Messaging

The ownership and deployment of Nuclear Weapons represents a strategic communication tool for a nation-state. Of course, as with all communications, messages are sent and received when one thinks one is communicating, as well as when one believes one is not communicating!

Deterrence messaging has evolved over the years, in step with the changing international environment. For example:

- US-Soviet/Russian Cold War messaging, although undertaken with a NATO-Warsaw Pact backdrop, represented a dialogue between two ‘balanced’ superpowers;
- Simplifying matters, India and Pakistan messaging can also be seen as part of a strategic dialogue;
- The strategic messaging by other N8 members have also evolved over the years, e.g. the UK’s withdrawal of NWs from Europe; and its policy of Continuous at Sea Deterrence (CASD), through its Polaris and Trident patrols.

The international scene, however, has become more complex over the years following the Cold War, and is now permeated by ‘new’ players/threats, e.g. proliferation nation-states and global terrorists groups.

In the future, if progress towards Zero-1 or -2 is to be realised, with the requirement for at least the N8 to communicate in a stable fashion with each other, the International Community will need to consider strategic messaging from a many-on-many perspective and not a one-on-one, linear process that transmits a message from sender to receiver.

In conclusion, as the N8 community thinks about alternative NW-based deterrence postures, i.e. non-deployed, latent ones, it will need to think about communicating its (unilateral and multilateral) actions (e.g. strategic messages) in a way that reinforces a shared (Article VI) goal.

FINAL REFLECTIONS

The paper has presented a possible means of realising Integrated Nuclear (warhead) Security, based on a global condition of latency, and progressing towards NPT Article VI through a risk-informed (Double-Zero) process. For instance:

- A Double-Zero Pathway Process to Article VI compliance based on recognised way or hold points, where the international community may assure itself that progression to the next step is warranted;
- First meeting the spirit of Article VI (no deployed NWs) before progressing to the letter (no NWs and general and complete disarmament);
- A structured approach to transforming nuclear weapon based deterrence, that helps to 'enable' the pathway to Article VI compliance;
- Moving deterrence from a calculus built upon having deployed NWs, to one based on a non-deployed, second-strike calculus, i.e. NW deterrence that is highly/fully biased/based on latency;
- A strong message that the international community will need to adopt a stronger systems-level approach to addressing international security: especially with respect to Energy, Sustenance and Relationship security;
- Three new (treaty) tools to help the States with Nuclear Weapons meet international expectations regarding arms control;
- A Nuclear Warhead Security Regime (NWSR) that is designed to mature and expand over time, as the international community gains confidence and additional members join the NWSR;
- A structured approach to ensuring the States with NWs are able to communicate with each other as they progress their multilateral engagement;
- A controlled and potentially transformable linkage between any NWSR and any future IAEA Safeguards verification regime;
- An inclusive approach that addresses all States With Nuclear Weapons and not 'just' the so-called P5;

- The potential need for a SAD-based extended deterrent model for the 21st Century;
- The adoption of no-knowledge verification methods;
- Thinking directed at aligning the enabling current, but disparate, international security tools into a more structured framework for the 21st Century security needs, to better enable Article VI compliance.

It has not been the author's intention to be evangelical regarding arms control agendas. Rather, the author offers the various ideas and models presented in this paper, e.g. the Double-Zero Pathway Process, the NWSR ideas, and the SAD, BAD and MAD 'zones of proliferation concern', as a process for discussing some 'difficult questions' in the International Community.

This paper has also identified some practicalities (potential barriers) to stimulate further debate on the DZPP and NWSR ideas. These practicalities are by no means an exhaustive set to be faced: others will emerge. However difficult some of these practicalities may appear, the test question remains: is a goal of meeting Article VI in spirit (no deployed warheads and very low (second strike) stockpile numbers) worth the effort? Assuming the answer to this is yes, the next obvious question is: what step(s) should the N8 take next?

Some would say that 'I wouldn't start from here if I were you': i.e. 1000s of cold-war legacy NWs and no multilateral 'dialogue'. But the world is where it is. Others would say we won't get there in one leap: so let's be pragmatic in our steps. Yet others would say we cannot move from where we are, as the risk is not worth the gain.

As the multilateral debate has only just started, the ideas offered in this paper will hopefully generate further work. For example:

- How the N192 will the (non-proliferation and general security) environment for realising Article VI?

- How, from a diplomatic perspective, would a (fully) latent deterrent operate and how would it be ‘used’?
- If a Zero-1 state is achieved, how will NW-based deterrence be operationally managed, e.g. through a monad?
- Is it useful to continue to partition nuclear warheads into linguistic bins, e.g. strategic vs. tactical? Or should the N8 recognise a nuclear warhead as a nuclear warhead in order to make arms control progress?
- How would NW designers exploit a latent-biased stockpile, e.g. for increased surety (e.g. safety, security and surveillance)?
- How would ‘strategic messaging’ be handled with a latent-biased stockpile?
- From an arms control perspective, should the N8 decouple nuclear warheads from any delivery system treaty?
- How would a country move from a triad, to a biad to a monad?
- How would an SSBN-based (or SSGN) platform be operated in a latent configuration, i.e. not necessarily on continuous patrol?
- How would stockpile stewardship/management operate with a latent deterrent?
- Could latent NW designs be made less attractive to terrorists and rogue nation-states?
- How would latent (MAD-based) extended deterrence operate?
- How would latent (SAD-based) extended deterrence operate?
- Etc etc etc

Finally, the author makes the following observation: if latent-biased stockpiles, with low/zero numbers of deployed NWs, are a necessary precursor to a world with no NWs, the world should focus on this challenge and work towards it multilaterally: but recognise, however, this is not ‘just’ an N8 matter; it is an N192 issue as well. All have a role in collective security.

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AUTHOR'S BIOGRAPHY

Garry George graduated from University in 1977 with a First in mechanical engineering.

Garry has worked at AWE, for over 30 years (both when it was part of MoD and since its conversion to a Government Owned, Contractor Operated entity in 1993), during which time he has been involved with, and led, a broad spectrum of deterrence and threat reduction related activities.

In 2000, Garry led the creation of, and took the position of the first Head of AWE's Engineering & Threat Reduction Division: during which he led AWE's support to the UK delegation to the NPT Prep and Rev Cons.

Garry's last UK assignment was as the Head of Engineering & Systems Division, which covers similar accountabilities to those of the Sandia warhead mission.

In Spring 2008 Garry was seconded to the US NNSA Lab complex, working out of Sandia/Ca and LLNL.

Garry is a Chartered Engineer and a Fellow of the Institution of Mechanical Engineers. He is also a member of the Institute of Directors, and was recognised as a Chartered Director in 2003.

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