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CONSORTIUM FOR VERIFICATION TECHNOLOGY

OVERVIEW OF THE POLICY RESEARCH THRUST

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CVT Kickoff Meeting
University of Michigan, Ann Arbor, October 16, 2014

Revision 3d

CVT POLICY RESEARCH THRUST

BACKGROUND

TWO WAYS OF APPROACHING THE VERIFICATION PROBLEM

Technology-focused and mission-focused approach;

CVT seeks to combine both; unique opportunities for synergisms

given diversity of 13 + 9 CVT partner institutions and groups

POLICY THRUST: A TREATY-ENABLING APPROACH

Emphasizes mission-focused dimension (as defined by existing and

expected future treaties); support and guide CVT technology developments

toward specific treaty applications; track emerging technologies

Source: www.engin.umich.edu (top) and news.kremlin.ru (bottom)

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RELEVANT NUCLEAR ARMS CONTROL TREATIES

NUCLEAR NON-PROLIFERATION TREATY

Bans the acquisition of nuclear weapons by non-weapon states and commits the five weapon states to nuclear disarmament; verified by IAEA safeguards

COMPREHENSIVE TEST BAN TREATY

Bans all nuclear explosions in all environments and would be verified by extensive verification mechanisms (International Monitoring System, CTBTO)

FISSILE MATERIAL (CUTOFF) TREATY

At a minimum, treaty would ban fissile material production for weapons purposes; Issue about treaty scope: Would it also cover existing stocks?

NEXT-GENERATION NUCLEAR DISARMAMENT TREATIES

Agreements that place limits on total number of nuclear warheads in arsenals would pose qualitatively new verification challenges

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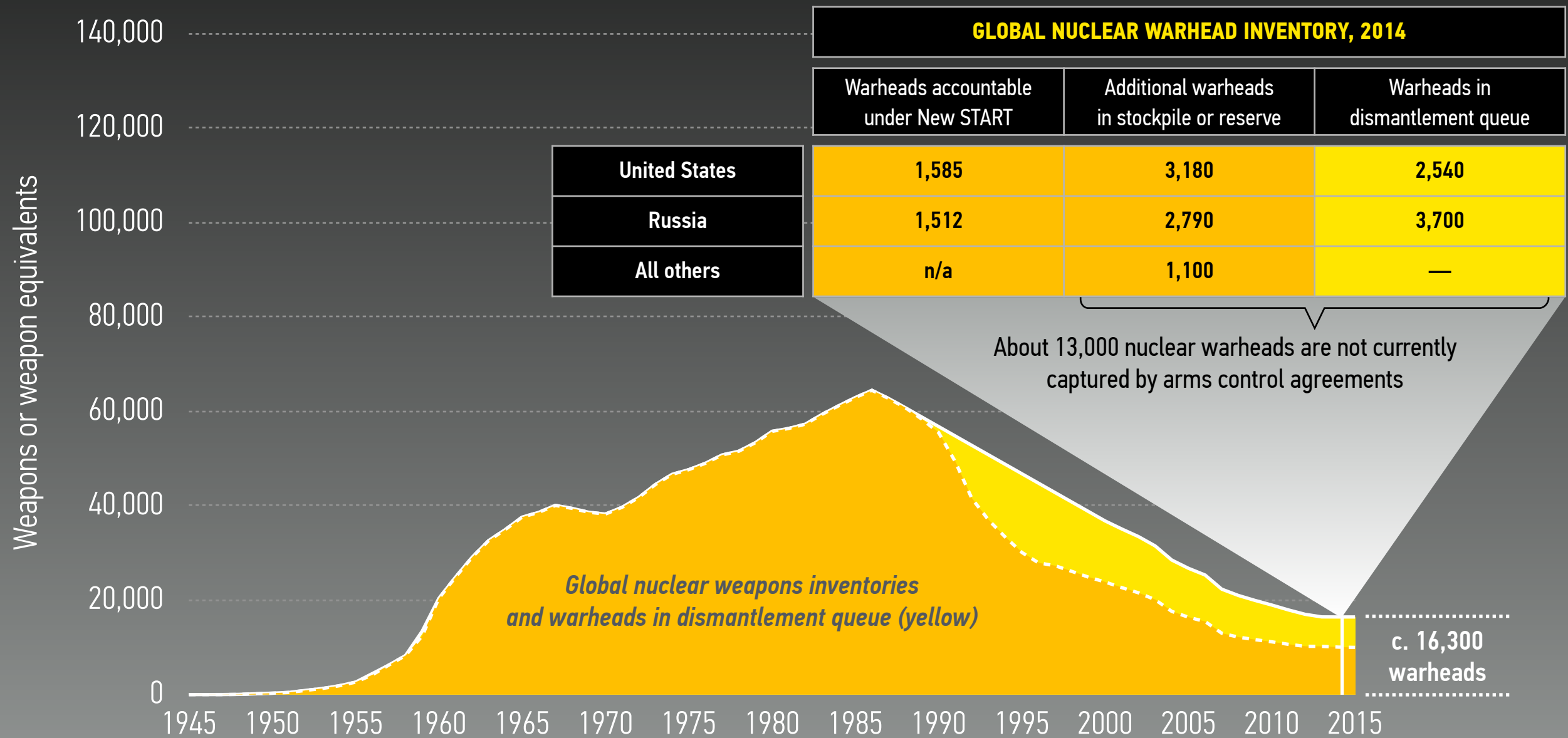## NEXT-GENERATION NUCLEAR DISARMAMENT

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GLOBAL NUCLEAR WEAPON INVENTORY

1945–2014

GLOBAL NUCLEAR WARHEAD INVENTORY, 2014		
Warheads accountable under New START	Additional warheads in stockpile or reserve	Warheads in dismantlement queue
United States — 1,585	3,180	2,540
Russia — 1,512	2,790	3,700
All others — n/a	1,100	—

About 13,000 nuclear warheads are not currently captured by arms control agreements

Global nuclear weapons inventories and warheads in dismantlement queue (yellow)

c. 16,300 warheads

Weapons or weapon equivalents

140,000 · 120,000 · 100,000 · 80,000 · 60,000 · 40,000 · 20,000 · 0

1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015

Hans M. Kristensen and Robert S. Norris, "Global Nuclear Weapons Inventories, 1945–2013," *Bulletin of the Atomic Scientists, 69* (5), 2013, 75–81
U.S. Department of State; and H. M. Kristensen and R. S. Norris, "Worldwide Deployments of Nuclear Weapons, 2014," *Bulletin of the Atomic Scientists, 70* (5), 2014

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THOUSANDS OF NUCLEAR WEAPONS
ARE CURRENTLY NON-DEPLOYED (i.e., IN RESERVE OR AWAITING DISMANTLEMENT)

W87/Mk–21 Reentry Vehicles in storage, Warren Air Force Base, Cheyenne, Wyoming
Photo courtesy of Paul Shambroom, www.paulshambroom.com

KEY VERIFICATION CHALLENGES

OF NUCLEAR DISARMAMENT AT LOW NUMBERS

WARHEAD COUNTING AND WARHEAD AUTHENTICATION

Need to gain confidence in the correctness of baseline declarations using warhead counting techniques (combined with CoK/CoC) and, prior to dismantlement, high confidence in the authenticity of the warhead

ART OF DEVISING FLEXIBLE VERIFICATION APPROACHES

Best concepts can be initially non-intrusive, but are designed to accommodate "upgrades" to technologies and procedures; concepts ought to be acceptable/adequate for other weapon states

Source: U.S. Department of Energy (top) and U.S. Department of Defense, www.defenseimagery.mil (bottom)

WARHEAD COUNTING
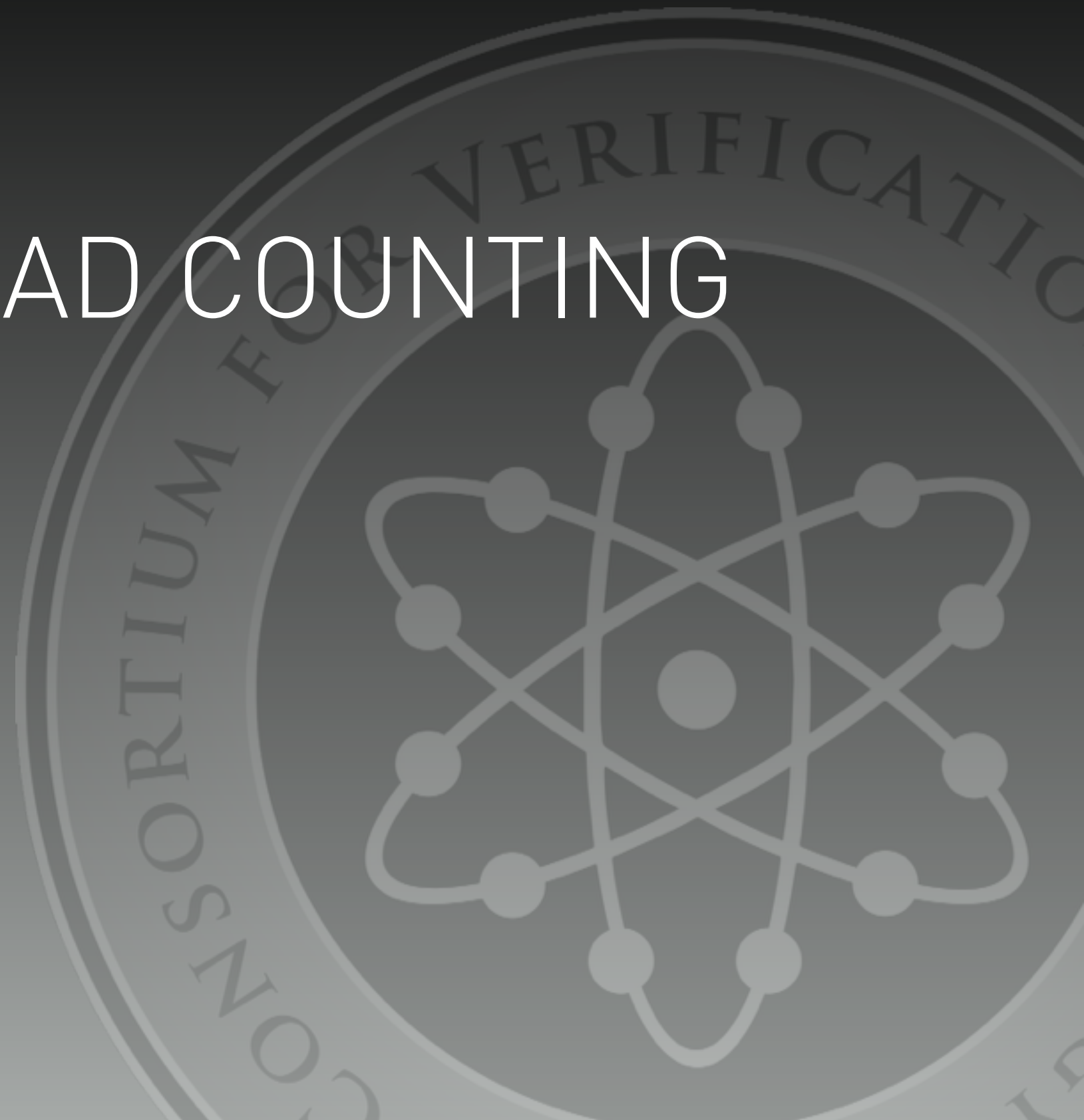
TAGGING

TRANSFORMING A "NUMERICAL LIMIT" INTO A "BAN ON UNTAGGED ITEMS"

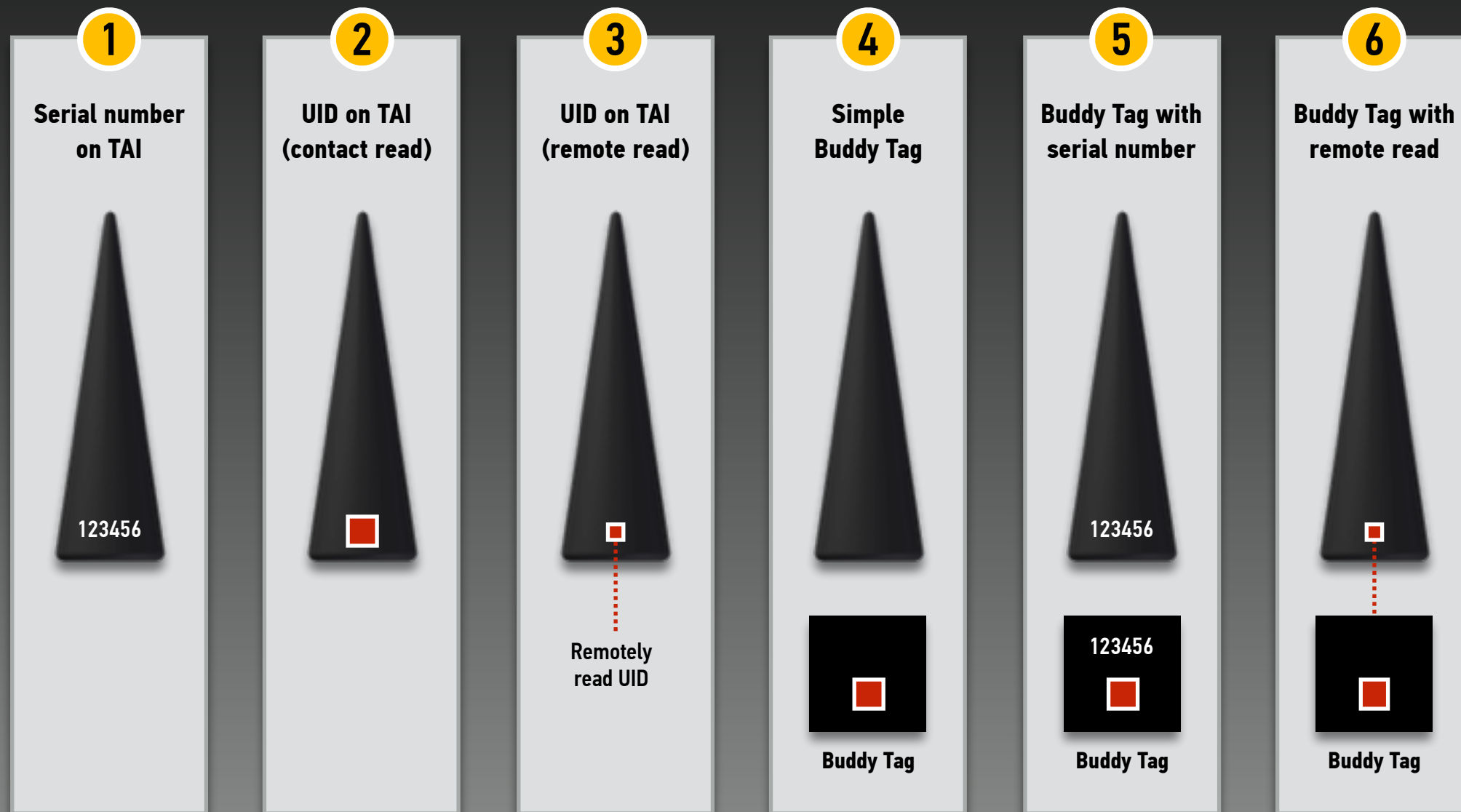*Source: www.automoblog.net*

Steve Fetter and Thomas Garwin, "Using Tags to Monitor Numerical Limits in Arms Control Agreements"
in Barry M. Blechman, ed., Technology and the Limitation of International Conflict, Washington, DC, 1989, pp. 33–54

COUNTING OPTIONS

WITH VARIOUS LEVELS OF INTRUSIVENESS AND ROBUSTNESS

1 Serial number on TAI

123456

2 UID on TAI (contact read)

3 UID on TAI (remote read)

Remotely read UID

4 Simple Buddy Tag

Buddy Tag

5 Buddy Tag with serial number

123456

123456

Buddy Tag

6 Buddy Tag with remote read

Buddy Tag

Several CVT participants are working on technologies that will help ensure Continuity of Knowledge (CoK)

(including Chain-of-Custody (CoC) detectors for treaty accountable items or materials)

WILL YOU KNOW A NUCLEAR WEAPON WHEN YOU SEE ONE ?

Nuclear weapons have unique signatures but most of them are sensitive and cannot be revealed to inspectors
Black Sea Experiment, July 1989

Liquid scintillator passive well counter to determine the plutonium mass in samples of unknown size
Source: U-Michigan, DNNG

Information barriers (e.g. using electronic components) can sanitize measured data; Certification and authentication is challenging
Source: UK-Norway Initiative

Several CVT participants are working on technologies that will help enable inspection systems for treaty verification

(e.g. advanced detector technologies; software and hardware for new types of information barriers)

VERIFIED WARHEAD DISMANTLEMENT

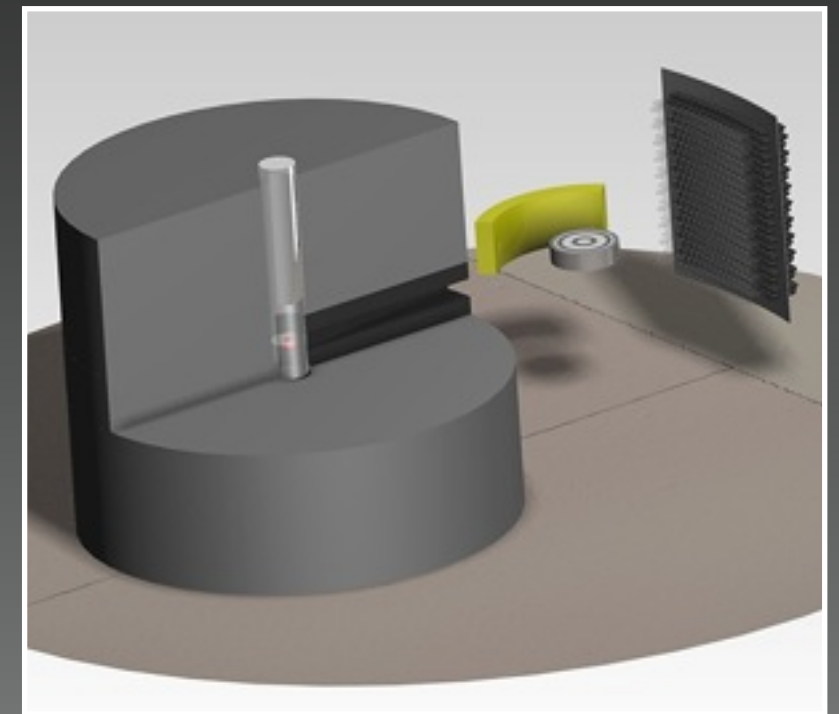## IMPORTANT PRECEDENTS EXIST AND FUTURE WORK CAN BUILD ON THEM

Inspection System developed as part of the
1996–2002 Trilateral Initiative during a
demonstration at Sarov
Source: Tom Shea

Visual contact with a mockup nuclear weapon
during a dismantlement exercise carried out
as part of the UK-Norway Initiative
Source: UK Norway Initiative, David Keir

Rendering of the Princeton setup using a
zero-knowledge protocol with 14 MeV
neutrons and non-electronic detectors
Source: Sébastien Philippe

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EMERGING TECHNOLOGIES

REAL-TIME SATELLITE IMAGERY, BIG DATA, AND CROWDSOURCING

QUASI REAL-TIME IMAGERY
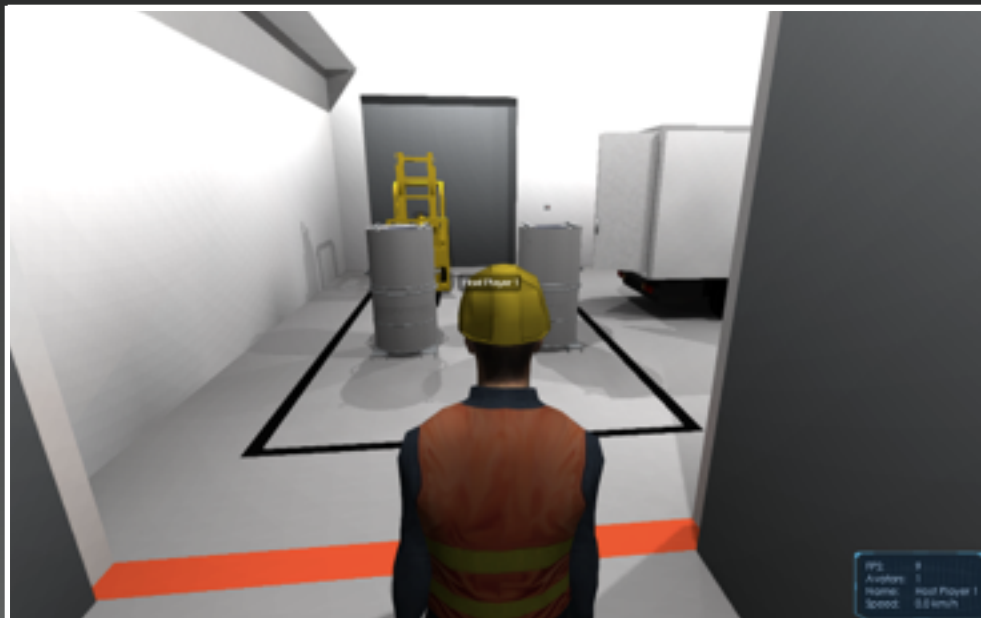## COULD SUPPORT VERIFICATION OF SEVERAL NUCLEAR ARMS CONTROL TREATIES

Posted in February 2014, www.youtube.com/watch?v=BsW6IGc4tt0 see also www.skyboximaging.com

Several CVT participants are focusing on data analytics

(including data fusion, event correlation, and anomaly detection)

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VIRTUAL ENVIRONMENTS
WARHEAD DISMANTLEMENT FACILITY AND MANAGED-ACCESS SIMULATOR

WHY USE VIRTUAL ENVIRONMENTS?

Explore different architectures and inspection protocols

Encourage "trial and error" and "learning by doing"

No classified information at risk

PROPOSED NEW FEATURES

Integration of virtual (real-time) radiation fields

Enable host-vs-inspector game play

Facilitate collaborations between CVT partners

*Source:Tamara Patton Schell, VCDNP*

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"VERIFICATION CHALLENGES"
LEVERAGING THE WISDOM OF THE (CVT) CROWD

2009 DARPA RED BALLOON CHALLENGE

Ten numbered eight-foot weather balloons deployed at public locations across the continental United States; find and submit the coordinates of all ten balloons as quickly as possible
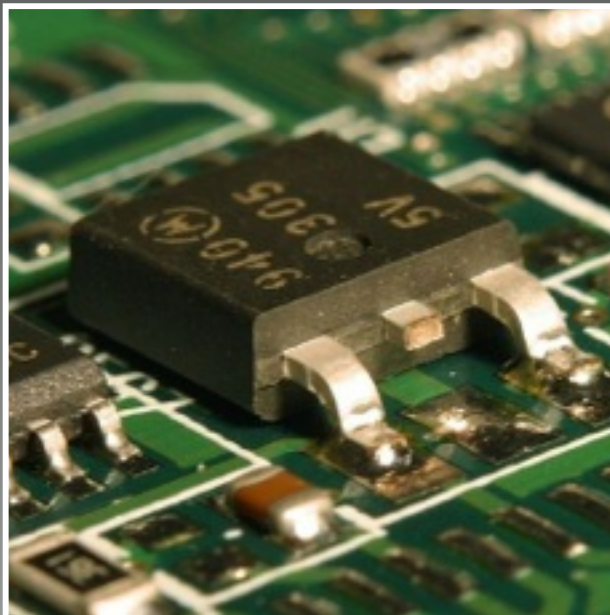
POSSIBLE VERIFICATION CHALLENGES (RELEVANT) FOR THE CVT

"Stack-Monitoring" Challenge (proposed by Ted Bowyer, PNNL)

"Lifting-the-Tag" Challenge

"Defeating-the-Inspection-System" Challenge

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