Nuclear Command, Control and Communications (NC3)
Is there a ghost in the machine?

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www.nautilus.org

NPTG 8651 - Seminar: The President & the Bomb

Middlebury College West!

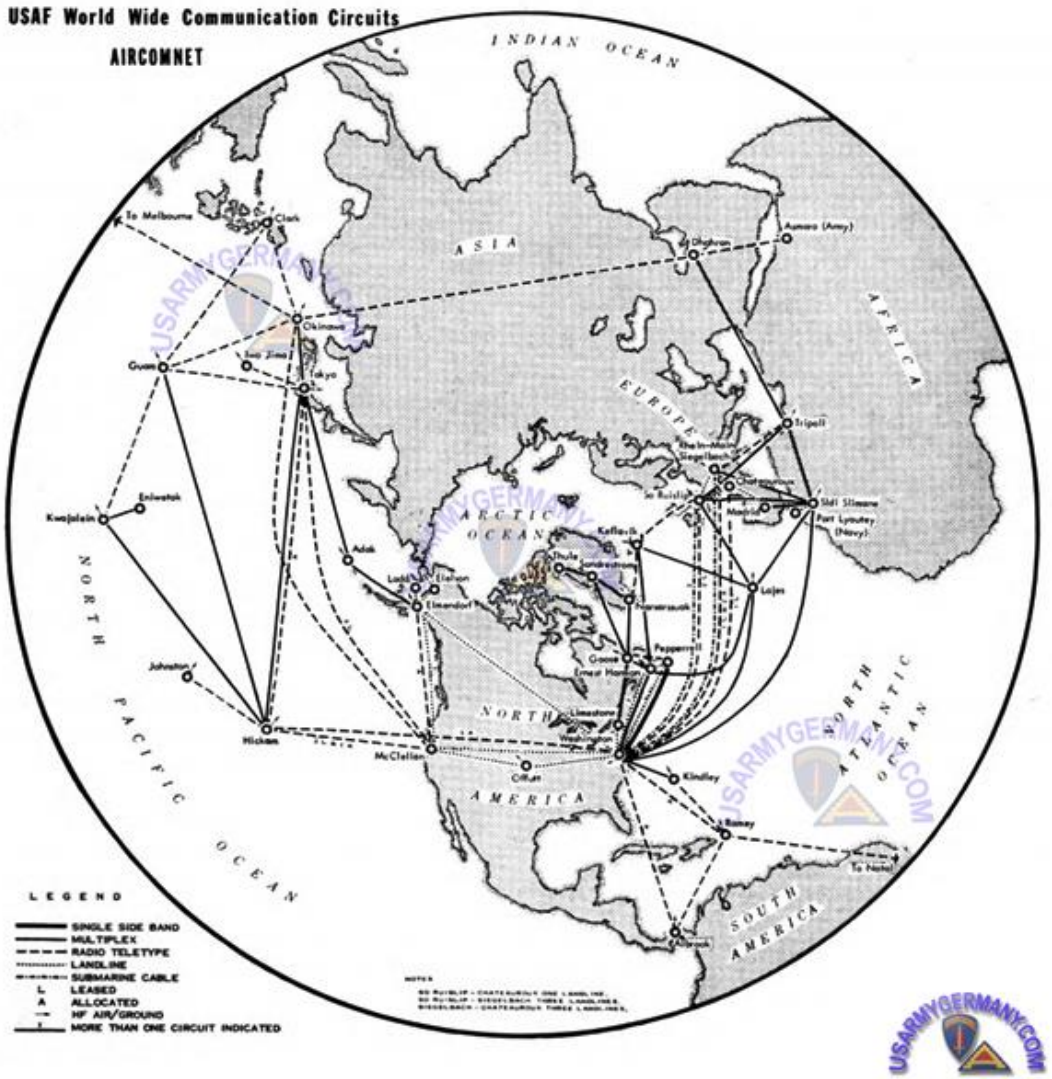
April 9, 2018

Roadmap of Talk: DO NOT TAKE NOTES!

1. Cold War NC3I
2. Vulnerability and Failure Assessment end Cold War
   Ash Carter 87 Scott Sagan 93 Redux
3. Post Cold War Force and NC3I Restructuring
4. NC3 Shocks & Modernization
5. Global NC3I Meta-System
6. NC3 Stresses
   - Russia
   - China
   - SSBNs
   - North Korea
   - False alarms-social media triggering of EW systems
   - Non-State Catalytic attack
   - Disruptive AI, Q-Tech
7. Possible Antidotes
   - Multilateral Data Exchange & Independent Early Warning Networks
   - Global NC3 Code of Conduct
   - Nuclear Refuseniks
   - Command Discipline, military tradition and honor
   - “Duty to disobey” humanitarian international law
   - Trade warheads for NC3 upgrade

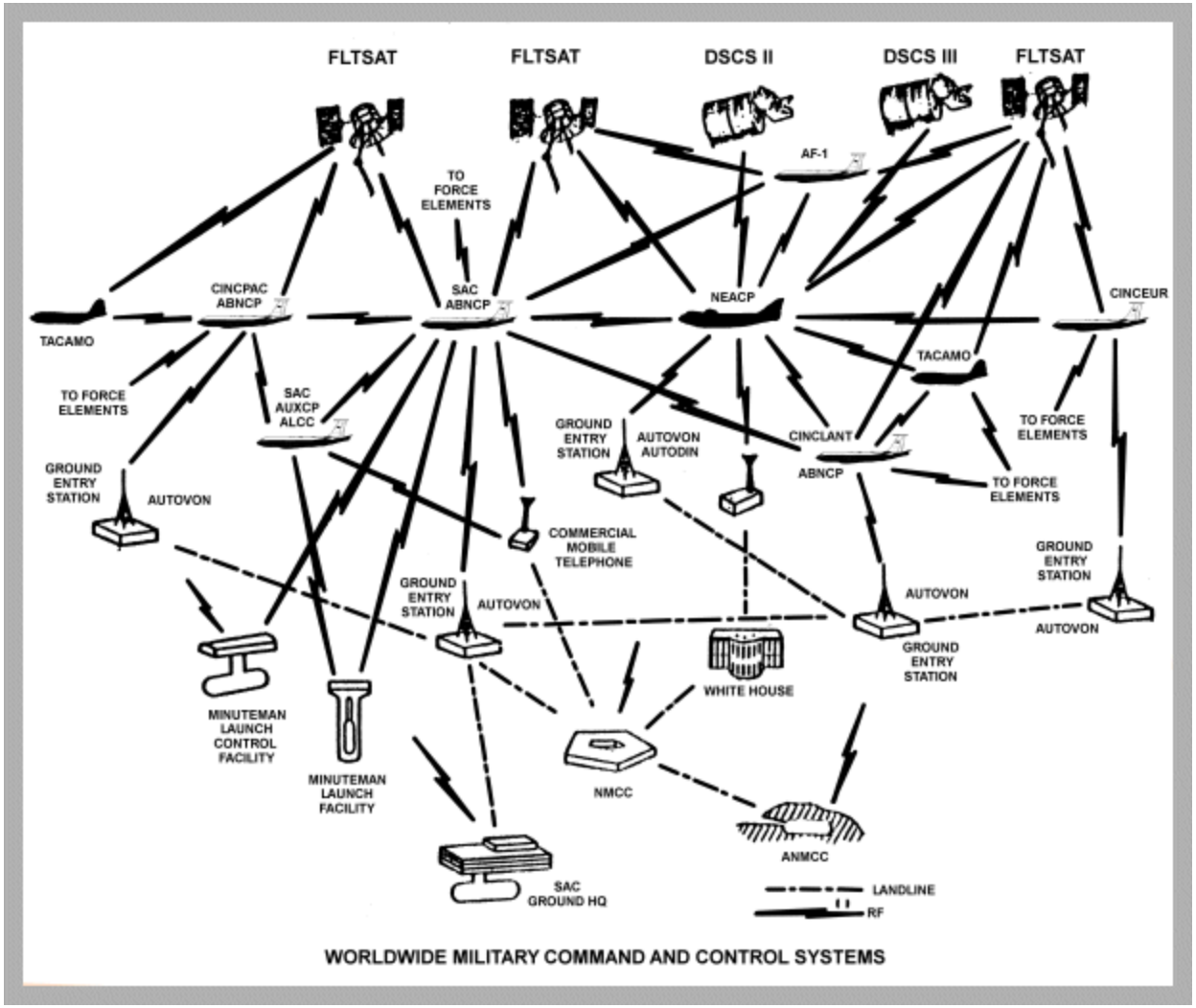
1. Cold War NC3I

Cold War Nuclear C3I to support bombers + EW radars



Air Force World Wide Communications System , 1955 (SIGNAL)

Early Triad, Sixties : Worldwide Military Command and Control System WWMCCS



Cold War Centralization N-C3I

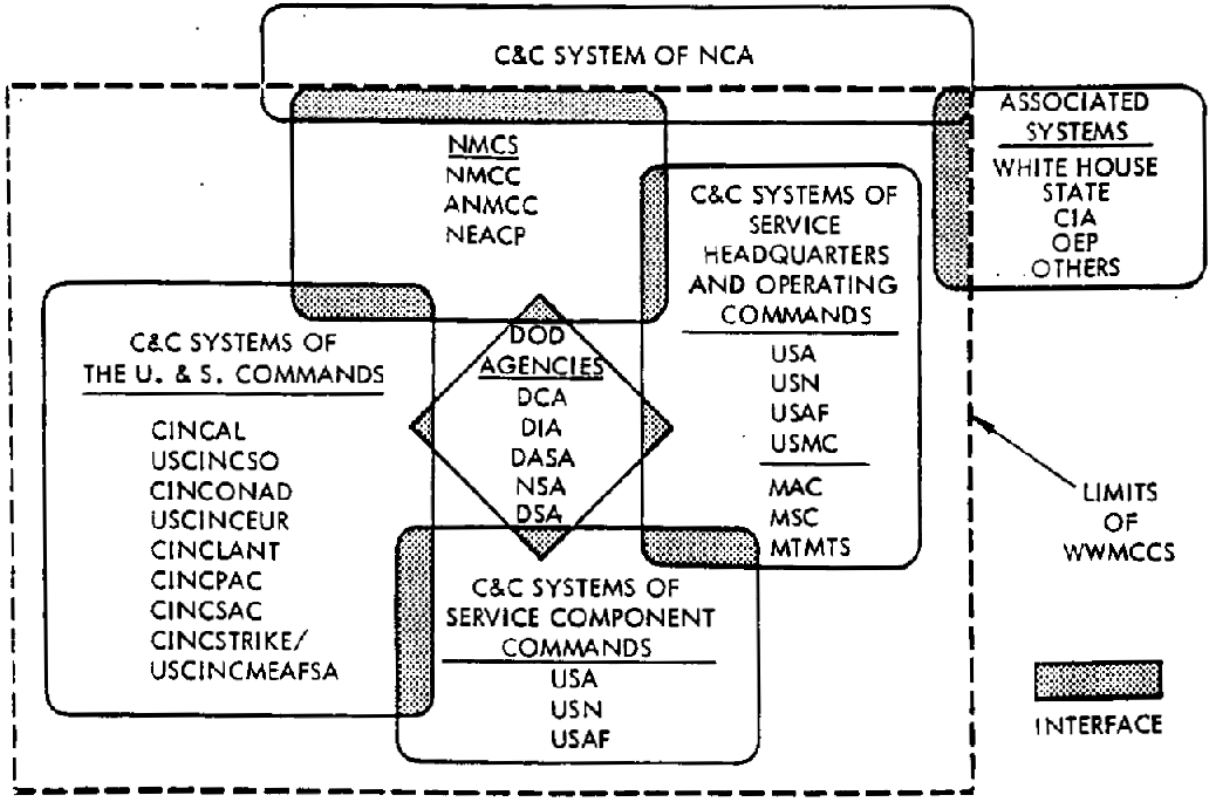


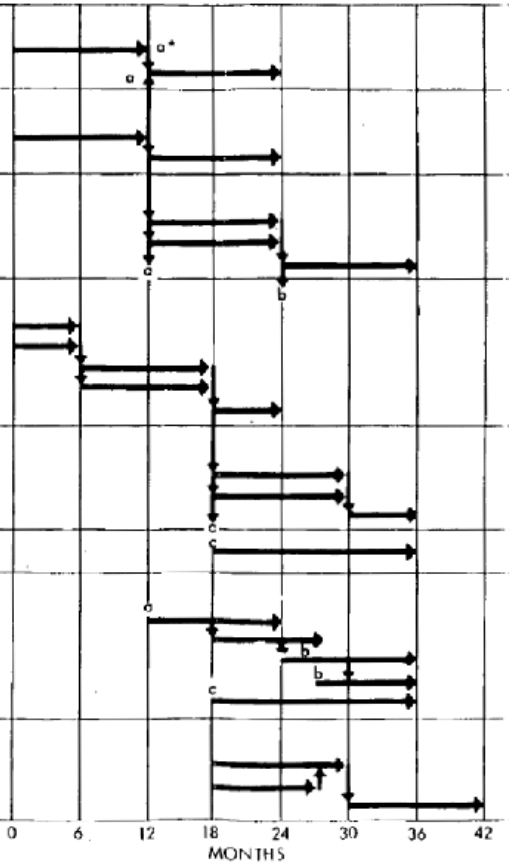
FIGURE 1 (U). WWMCCS Interfaces

Source: R. Finkler, *Command, Control, and Communication Problems,* Weapons Systems Evaluation Group WSEG 159, IDA, 1971.

Key NC3 Issues, 1971, IDA Report

STUDIES AND TASKS	RESPONSIBLE AGENCY	EFFORT IN MAN-YEARS	STUDY NO. AND PAGE REFERENCE
STUDY 1: FRAMEWORK FOR MANAGING, PLANNING, PROGRAMMING, AND BUDGETING			1
1.1 INPUTS TO OBJECTIVES PLAN	JCS	8	1.1 Pg. 96
1.2 MANAGEMENT RELATIONSHIPS AMONG DOD INFORMATION SYSTEMS	JCS/OSD	5	1.2 98
STUDY 2: COMMAND & CONTROL IN THE NATIONAL SECURITY COMMUNITY			2
2.1 REQUIREMENTS FOR WWMCCS SUPPORT OF CONTINGENCIES	JCS	5	2.1 Pg. 32
2.2 REQUIREMENTS FOR WWMCCS NON-DOD OPERATIONS/WATCH CENTERS SUPPORT **	OSD/NSC	5	2.2 34
STUDY 3: INFORMATION FLOW AND CONVERGENCE			3
3.1 OPERATIONS/INTELLIGENCE INFORMATION REQUIREMENTS AND USE	JCS	10	3.1 Pg. 57
3.2 INFORMATION FLOW THROUGH STRUCTURED REPORTS	JCS/OSD	10	3.2 59
3.3 SELECTION & REPORTING OF INTELLIGENCE AT SELECTED ECHELONS	JCS/OSD	5	3.3 60
STUDY 4: COMMAND & CONTROL FOR RETALIATION IN STRATEGIC WAR			4
4.1 SURVIVAL OF THE PRESIDENTIAL AUTHORITY AND CONTINUITY PROCEDURES **	JCS/OSD/NSC	1	4.1 Pg. 70
4.2 SURVIVAL OF COMMAND POSTS	JCS/OSD	2	4.2 72
4.3 SURVIVAL OF ESSENTIAL SIOP COMMUNICATIONS	JCS/OSD	4	4.3 75
4.4 SURVIVAL AND RESTORATION OF LANDLINES	JCS/OSD	4	4.4 77
4.5 C&C CONSTRAINTS ON SIOP DECISION PROCESS **	JCS/OSD/NSC	2	4.5 78
STUDY 5: COMMAND & CONTROL FOR CONDUCT AND TERMINATION OF STRATEGIC WAR			5
5.1 DAMAGE ASSESSMENT FOR COUNTERFORCE AND WAR TERMINATION	JCS/OSD	4	5.1 Pg. 80
5.2 SAFEGUARD-MINUTEMAN COORDINATION	JCS/OSD	1	5.2 81
5.3 SIOP & RISOP PLANNING FACTORS AND DOCTRINE	JCS/OSD	3	5.3 82
STUDY 6: INFORMATION SYSTEMS FOR DECISION SUPPORT IN STRATEGIC WAR	JCS/OSD	6	6 Pg. 85
STUDY 7: CONCEPTS, MEASURES & COST METHODOLOGY			7
7.1 COMMAND & CONTROL CONCEPTS FOR FUTURE WWMCCS	JCS	3	7.1 Pg. 100
7.2 PERFORMANCE MEASURES (PERSONNEL, EQUIPMENT & OPERATIONS)	JCS	3	7.2 101
7.3 UTILITY MEASURES FOR INFORMATION (REPORTS)	JCS	4	7.3 102
7.4 COST METHODOLOGY FOR REPORTING SYSTEMS	JCS/OSD	3	7.4 103
7.5 RELATION OF C&C TO THE EFFECTIVENESS OF STRATEGIC FORCES	JCS/OSD	10	7.5 104
STUDY 8: FLEXIBILITY OF COMMAND & CONTROL WITHIN EUCOM & PACOM			8
8.1 UNILATERAL OPERATIONS	JCS/EUCOM/PACOM	6	8.1 Pg. 47
8.2 LATERAL AND SURGE INFORMATION EXCHANGE	JCS/OSD	3	8.2 49
8.3 OPERATIONS WITH ALLIES	OSD	4	8.3 49
TOTAL MAN YEARS		111	

SCHEDULE IN MONTHS FROM INITIATION



NOTES: *A LETTER AT THE BEGINNING OF A TASK INDICATES THAT IT DEPENDS ON ANOTHER TASK DESIGNATED BY THE SAME LETTER. ARROWS CONNECTING TASKS INDICATE SIMILAR DEPENDENCE.

Source: R. Finkler, *Command, Control, and Communication Problems,* Weapons Systems Evaluation Group WSEG 159, IDA, 1971.

Mature US NC3 System, Early 1980s

Figure 1

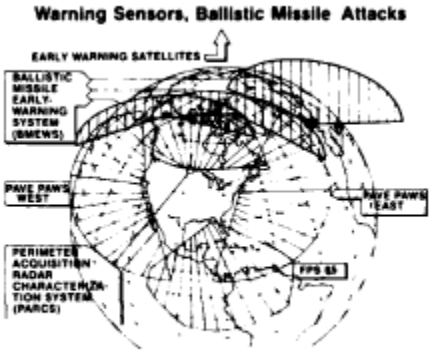


Figure 2

Figure 3

Figure 4

Figure 5

Figure 6

Source: C. Zraket, presentation in C3 Systems for President and Military Commanders, session 3 National Security Issues Symposium 1981, Strategic Nuclear Policies, Weapons and the C3 Connection, Electronic Systems Division USAF, MITRE Corporation, MITRE Document M82-30, pp, 87-92.

2. Vulnerability and Failure Assessment end Cold War

Ash Carter 87 Scott Sagan 93 Redux

Carter, 1987: NC3 Vulnerability 3

Identifies 3 categories of US command centers, communication nodes, warning/assessment sensors (mid-80s, notional numbers) as potential Soviet targets (560-566)

Cat 1: highest priority US national nuclear command sites	**143**
Cat 2: second priority US national nuclear command sites, eg regional	**587**
Cat 3: communications , small command sites, alternate airfields	**1577**
Total Cat 1, 2, 3 NC3I targets	**2307**
Primary and secondary US strategic nuclear force targets	**1580**

With 2 WH per site, Soviets can hit all targets. But not before US missiles fired on warning or under attack, bombers are airborne, and submarines are alerted.

Concludes that US strategic N forces cannot be decapitated, some NC3I will survive such that massive retaliation assured by surviving, self-directed elements of 3 legs of triad, even if delayed. (607)

Un-targetable airborne control posts + relays critical, to all legs of triad, all regions
Attack to "stun" NC3I system would not be limited but massive, unlike eg regional nuclear war.
New vulnerabilities on horizon due to innovation…eg lasers
Reviews technological fixes to specific vulnerabilities…eg better warning and attack assessment so can retarget surviving US forces

Carter, 1987: NC3 Error and Uncertainty 3

Type II error, ie, **launch with false data**, sensors can discriminate between attack and otherwise anomalous signals; and very unlikely that redundant sensors inform falsely on same time/day. But if sensors share common failure mode**,** system may defeat itself. Such error more likely in midst of mischaracterized limited nuclear attack leading to launch under warning.

Redundancy not simple solution: problem is not error across all sensors/displays at once, but some failures, an inconsistent picture based on true and false data…and error of inference.

"*This prospect comes alive when one realizes that* ***conflicting sensor data are not an aberration, but the norm in the warning system****. Current sensor systems are not precise enough or cross-calibrated closely enough to make it likely that they would all agree on the assessment*."

CINCNORAD expects different sensors to present differently, even very different assessments. + may be real N detonation creating confusion, making ltd vs all-out attack difficult to determine because inconsistent sensor readings even less surprising.

Lesson: better attack characterization, fewer outages in sensor system, can help avoid both types error. Adding too much sensor redundancy may make both types errors more likely. May increase odds of conflicting information, increase complexity of data processing and comms system behind data processing and transfer and common failure mode.

Sagan 2: High Reliability vs Normal Accidents Test of Nuclear Safety

October 1962 Cuban Missile Crisis
Safety-Loss of Control

Vandenberg October 26 1962

Fired unarmed Titan test missile while rest converted to active duty, nuclear armed missiles w/o orders knowledge of senior leaders.

Malmstrom Minutemen Missiles rushed into ready status w/o proper certification, procedures, launch control

October 26, U2 took new route more north for sampling Soviet tests, had to use sextant, but aurora prevented star sighting, strayed into Soviet airspace. Soviet MIGs scrambled; U2 ran out of fuel, glided back to Alaska, US F102A interceptors armed only with nuclear weapons sent to escort U2, block MIGs. Possible precursor reconnaissance for pre-emptive attack from Soviet perspective.

October 26-27, UK nuclear forces on full alert w/o US seniors knowing, and QRA nuclear-armed aircraft on alert in Turkey w/o senior oversight although such given to missiles

Scott Sagan, *The Limits of Safety, Organizations, Accidents, and Nuclear Weapons*, Princeton, New Jersey 1993

Sagan 3: High Reliability vs Normal Accidents Test of Nuclear Safety

October 1962 Cuban Missile Crisis
Intelligence and Early Warning:

October 25, bear climbing fence set off perimeter security, leading to false klaxon alarm at another base and alert of nuclear-armed F106A interceptors readying for takeoff

October 31, Ontario radar reported 2 unidentified planes, base went to Defcon 3.

October 28, Falling Leaves SW US emergency warning radar net created; Moorestown NJ radar, 2nd false alarm, software test simulating missile launch from Cuba, combined with coincidental Soviet satellite on screen, appeared and reported as precursor of missile attack. Warned SAC in Omaha. No detonation detected few minutes after predicted impact in Florida. Redundancy failed (other radars not working, no advice that satellite pending)

November 2, US spy Penkovsky, already arrested in Moscow by KGB, sent false warning of pending Soviet attack

+ **1968 Thule Bomber Accident (co-location nuclear weapons with early warning system)**

+ Oct 73 Defcon 3 alert SAC changes in alert, dispersion, but again rushed to arm test ICBMs and Cobra Ball flew edge of Soviet airspace

Sagan 4: High Reliability vs Normal Accidents Test of Nuclear Safety

NORAD 1979 False Warning-- NORAD NORAD, SAC, Pentagon, Fort Richie displays show full-scale Soviet SLBMs ICBMs attack. NORAD alerted entire air defense, 10 interceptors took off; presidential NEACP launched (but after attack declared false alarm). Terminated after 6 minutes, after direct contact with warning sensors, radars, satellites.

Occurred during testing of software of new computer also supporting actual displays. ***NORAD was never able to replicate source of error***. Moreover, alert of fighter interceptors was due to message and communication formatting errors.

Parallel to today: new software and spirits lurking in circuits result of grafting new redundant sensors and comms onto nuclear warning system, increasing interactive complexity. Soviet force levels demanded rapid response to warning and tighter coupling of warning to forces.

Conclusion: "Nuclear weapons may have made *deliberate* war less likely, but, the complex and tightly coupled nuclear arsenal we have constructed has simultaneously made *accidental* war more likely."

Sagan 5: High Reliability vs Normal Accidents Test of Nuclear Safety

LESSONS LEARNED

- More trial and error learning, safety culture, training, exercises, redundancy
- More independent review
- Vicarious US-RF learning
- Detailed NC3 studies
- Shift from warrior to guardian culture
- More NUWEX, accident prevention
- Fewer weapons to coordinate improves safety.
- Nuclear weapons should never be located or transported near national warning systems
- Nuclear weapons should not be stored at missile testing facilities.
- Separate pits from warheads
- Separate Pu from high explosives
- De-alert ICBMs from L on warning posture
- SSBNs not be able to launch nuclear weapons w/o PALs
- Install timers to prolong launch time on missiles
- Re-institute civilian custody of nuclear weapons
- Install radio-controlled devices to destroy missiles in flight
- Cooperative missile defenses?
- Reduce complexity, avoid complexifying, needless redundancy
- Reduce coupling

Cold War N-C3I Role in Near-Use Incidents

Incidents of near nuclear use

Date	Incident	States involved	Cause
October 1962	Operation Anadyr	Soviet Union	Miscommunication
27 October 1962	British nuclear forces during the Cuban missile crisis	United Kingdom	Conflict escalation
27 October 1962	Black Saturday	United States	Conflict escalation and miscommunication
22 November 1962	Penkovsky false warning	Soviet Union	Espionage
October 1973	1973 Arab–Israeli war	Israel	Conflict escalation
9 November 1979	NORAD: Exercise tape mistaken for reality	United States	Exercise scenario tape causes nuclear alert
3 June 1980	NORAD: Faulty computer chip	United States	Faulty computer chip
25 September 1983	Serpukhov-15	Soviet Union	Technical error
7–11 November 1983	Able Archer-83	Soviet Union, United States	Misperception of military training exercise
18–21 August 1991	Failed coup	Soviet Union	Loss of command and control structure
25 January 1995	Black Brant scare	Russia	Mistaken identity of research rocket launch
May–June 1999	Kargil crisis	India, Pakistan	Conflict escalation
December 2001–October 2002	Kashmir standoff	India, Pakistan	Conflict escalation

Three other cases:

- **1958 Quemoy-Matsu Crisis**
- **1962 Okinawan missiles in Cuban Missile Crisis**
- **August 76 DMZ Crisis**

P. Lewis et al, "*Too Close for Comfort: Cases of Near Nuclear Use and Options for Policy*" Royal Institute of International Affairs, April 2014

Credibility, risk taking, flexible response, limited nuclear war

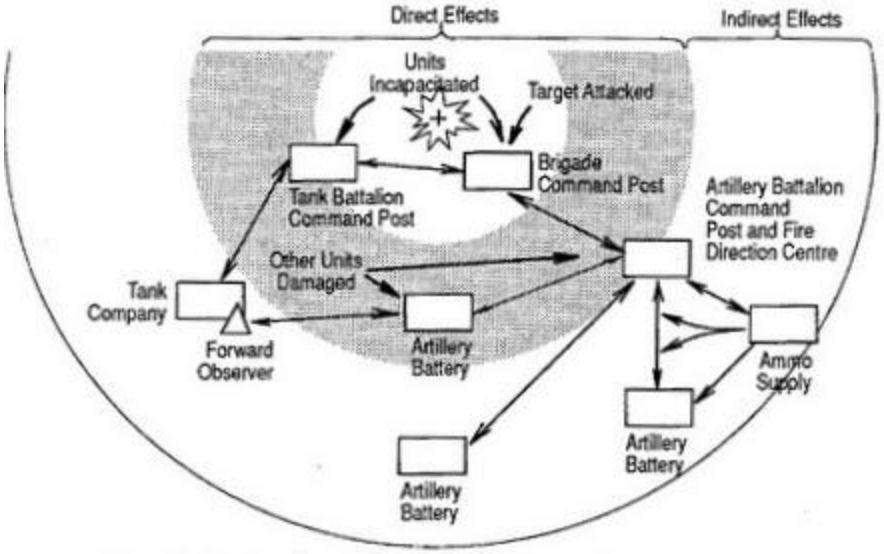
Risk inherent in Massive Retaliation led to new declaratory doctrine of "Flexible Response"

In Korea, this combination of forces disposed for massive retaliation with new doctrine = Inflexible Response

Theater nuclear operations required **LNO-Limited Nuclear Options** to defeat superior (or inferior, eg North Korea) conventional forces

In Korea, the "flexible response" doctrine (lower threshold) was combined with forward-deployment (from the former massive retaliation" era) of nuclear forces to create a hybrid best called **Inflexible Response**. **Here is a typical example of such thinking (1976) that was in play in August 1976 Panmunjon Crisis**

66 • *Pacific Powderkeg*



Source: Science Applications, Inc., *Vulnerability of North Korean Forces, Evaluation of Vulnerability of North Korean Divisions to Tactical Nuclear Weapons*, vol. 1, report to U.S. Defense Nuclear Agency, DNA 4570F-1, McLean, Va., March 1978, p. 1–9; released under a U.S. Freedom of Information Act Request.

Figure 4–2. Nuclear Effects on North Korean Combat Units

Peter Hayes, "THE AUGUST 1976 INCIDENT REVISITED—THE LAST NEARLY NUCLEAR WAR IN KOREA", NAPSNet Special Reports, March 03, 2018
https://nautilus.org/napsnet/napsnet-special-reports/the-august-1976-incident-revisited-the-last-nearly-nuclear-war-in-korea/

3. Post Cold War Force and NC3I Restructuring

NC3, End Cold War

Nuclear Safety Glass 1% empty 99% full

We survived the Cold War

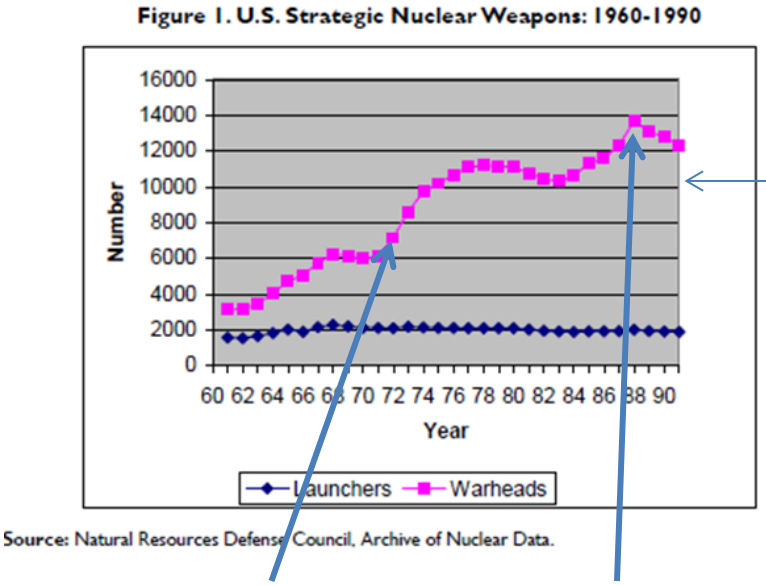
Reliability Culture Perspective on NC3

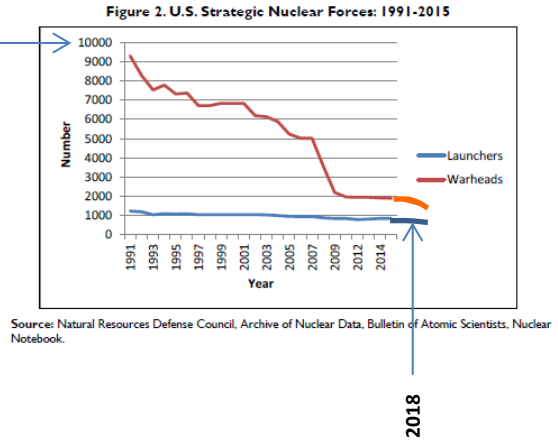
- **US NC3 best in world**
- **USNC3 had leadership committed to nuclear safety, redundancy in controls, early warning sensors, decision making systems; strong reliability culture; continuous alert, high level training, PRP, ethos**
- **Not so tightly coupled so still time to react, recover to near-misses**
- **Nett result: safe routinely, even safer in crisis**

Normal Accident Perspective on NC3

- **High levels interactive complexity , eg weapons, NC3 in close proximity**
- **Dependence on sensors with long, interruptible communications**
- **Opacity and secrecy high, oversight low**
- **High level of coupling, rapid warning, decision, launch times with global coordination**
- **Poor readiness for unanticipated crises and events**
- **Bugs in systems, procedures, software, concepts**
- **Accident waiting to happen**

Massive Reduction, Re-Structuring Strategic Nuclear Force Structure: 1990-2018





MIRVs on ICBM/SLBMs

MX ICBM

1990	Delivery	Warheads	Fraction
SSBN-SLBM	600	5216	42%
ICBM	1000	2450	20%
Bombers	260	4648	38%
Total Warheads	**1860**	**12314**	**100%**

2018 "New Start"	Delivery	Warheads	Fraction
SSBN-SLBM	280	1090	70%
ICBM	454	400	26%
Bombers	60	60	4%
Total Warheads	**794**	**1550**	**100%**

Source: A. Woolf, U.S. Nuclear Strategic Forces: Background, Developments, and Issues, CRS RL33640, November 3, 2015, pp. 2-8, at: http://www.fas.org/sgp/crs/nuke/RL33640.pdf

Carter, 1987: NC3 Vulnerability 4

Deep Cuts since Cold War Greatly Reduced NC3 Vulnerability

Carter notes (596): Only deep cuts would reduce Soviet ability to target US category 1/2 NC3I targets (730).

If still 730 such NC3 targets in 2015, and US strategic delivery targets now 1860 targets, heading to 794 in 2018, then US total targets for Russia (730+1860) = 2590 targets in 2018.

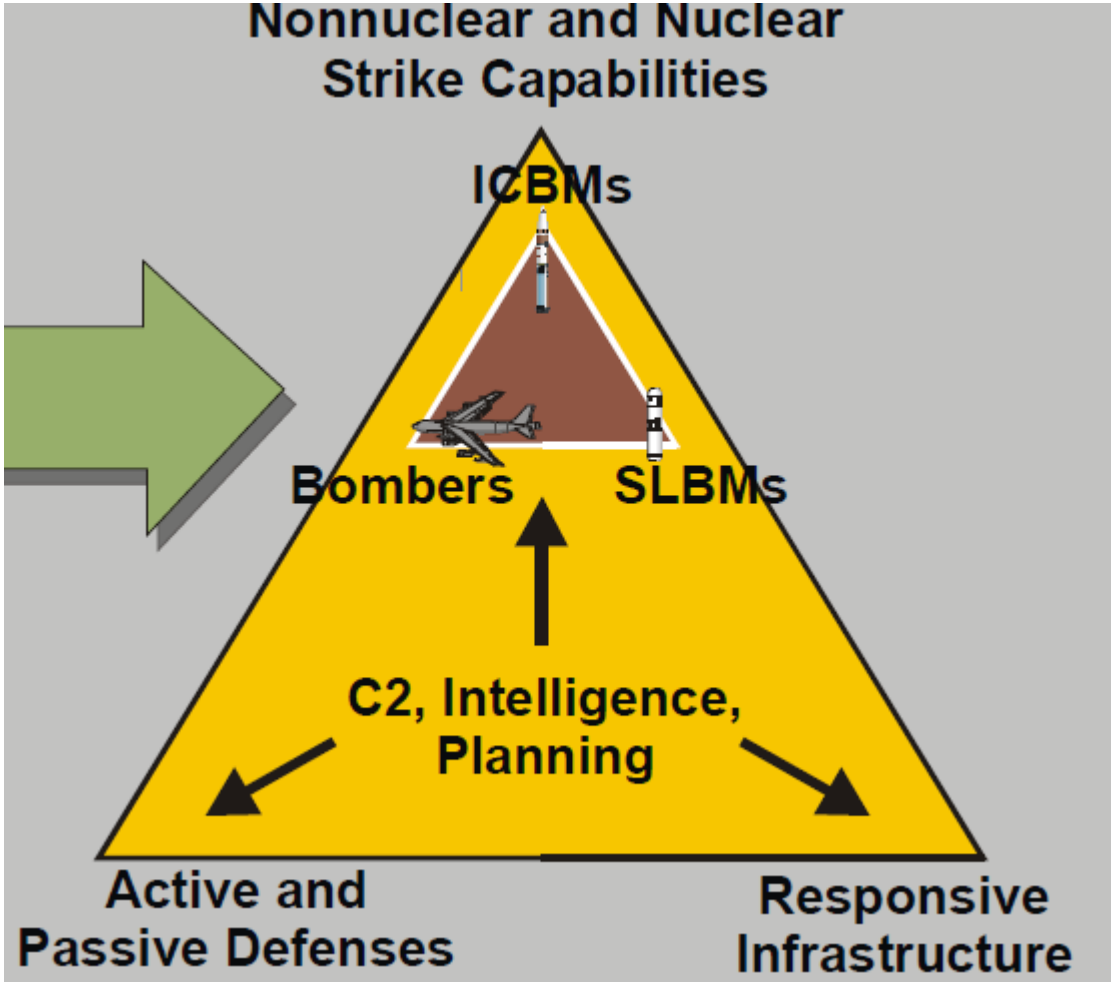
Assuming double targeting (>5000 warheads), the US target set now vastly exceeds Soviet deployed strategic warheads under START II (1862) and will do so even when US strategic delivery targets falls to 794 in 2018 (total targets then fall to 1524, with double targeting = 3048 warheads).

Prima facie case that proliferating survivable NC3 nodes & links is powerful way to overcome vulnerability when numbers fall—as they now have.

NEW TRIAD

2001, DOD outlined how conventional forces bolster nuclear strategic deterrence, rendering the latter less important and in some cases, unnecessary.

This posture was conceptually enshrined in the 2010 Nuclear Posture Review and resulting presidential guidance as to how the US should reform its nuclear forces in the "new triad"



C2: Command and Control
ICBM: Intercontinental Ballistic Missile
SLBM: Submarine-Launched Ballistic Missile

1992-2006: Organizational Centralization and Consolidation

1991 tactical and theater nuclear weapons removed from unified and regional commands except for small number of gravity bombs in NATO

1992 US Strategic Command created, Air Force flattened structure, halved in size, shifted out of Cold War culture

2002 Space Command merged into STRATCOM

Then added global strike, computer network operations, information operations, global intelligence, surveillance and reconnaissance, strategic warning and assessments, combating WMD

Fought major conventional wars in Middle East, counter-insurgency war in Afghanistan, global counter-terrorism operations

2002, a 4 star general responsible for nuclear weapons at STRATCOM

By 2008, senior military official was a Lt-Col.

Source: U.S. Strategic Command, "History," at:
https://www.stratcom.mil/history/

4. NC3 Shocks & Modernization

2005-2014, 5 NC3 Perfect Storm of System Shocks Revenge of Near-Normal Accidents?

2005-7: mistaken shipment MK-12 RV assemblies to Taiwan

2007: Unauthorized transfer of six nuclear warheads left insecure 24 hours, loss of control

2010: Launch Control Center Launch Facility Down status and lost command-connectivity with 50 missiles

2014-15: USAF missileer certification cheating, cultural failure

2014: Maj. Gen Davey fired/retired after partying drunkenly in Moscow (former Deputy Director, Command, Control and Nuclear Operations; at time, in charge AF missiles)

"Doom 99" Unauthorized Transfer of six nuclear warheads August 2007 Most dangerous loss of control in history apart from 1966 Palomares loss of H-Bomb in ocean?

***29–30 August 2007*. Six AGM-129 cruise missiles, each loaded with a W80-1 nuclear warhead, were mistakenly loaded onto a B-52H, call sign "Doom 99," at Minot Air Force Base and transported to Barksdale Air Force Base. The nuclear warheads in the missiles were supposed to have been removed before taking the missiles from their storage bunker. The missiles with the nuclear warheads were not reported missing and remained mounted to the aircraft at both Minot and Barksdale for a period of 36 hours. During this period, the warheads were not protected by the various mandatory security precautions for nuclear weapons.**

USAF and Department of Defense at first decided to conceal the incident.

***Investigation found* that "the intricate system of nuclear checks and balances was either ignored or disregarded," and a "chain reaction" of leadership and supervision failures led to turning off of two separate warning systems designed to prevent unauthorized transfer of nuclear weapons.**

***Six mistakes:* 1. Oversight to label trailer due to loose procedures on storage nuclear-conventional weapons. 2. Scheduling error and coordination failure munitions and maintenance personnel re what weapons to transfer at last minute. 3, 4, munitions and handling crew did not monitor move and follow checklist to ensure weapons were non-nuclear. Not checked as drove past security. 5. Aircraft crew chief signed off w/o checking weapons. 6. Radar navigator checked only one of non-nuclear missiles.**

***Six major investigations* by US AF and other panels led to establishment in October 2008 of *Air Force Global Strike Command* to control all USAF nuclear bombers, missiles, and personnel, operational on 7 August 2009**

***Procedural change:* The USAF issued a new policy directive regarding the handling of nuclear weapons and delivery systems, which prohibits the storing of nuclear armed and nonnuclear armed weapons in the same storage facility. The directive further instructs that all nonnuclear munitions and missiles must be labeled with placards clearly stating that they are not armed with nuclear warheads. Wing commanders are now charged with approving any movement of nuclear weapons from weapons storage areas and must appoint a single individual as a munitions accountability system officer and weapons custodian. All units that handle nuclear weapons must develop a coordinated visual inspection checklist. The policy further directs that airmen charged with handling or maintaining nuclear weapons cannot be on duty for longer than 12 hours, unless during an emergency, when their duty period can be extended to a maximum of 16 hours**

Sources: Sources: Commander Directed Report of Investigation Prepared by Major General Douglas L. Raaberg, Investigating Officer Concerning an Unauthorized Transfer of Nuclear Warheads between Minot AFB, North Dakota and Barksdale AFB, Lousiana, 30 August 2007, released under FOIA and redacted, at: http://cryptome.org/dodi/af-megadeath-fumble.pdf and Michelle Spencer *et al, The Unauthorized Movement of Nuclear Weapons and Mistaken Shipment of Classified Missile Components: An Assessment*, The Counterproliferation Papers Future Warfare Series No. 56 January 2012 USAF Counterproliferation Center, Air University, Maxwell Air Force Base, Alabama, at: www.dtic.mil/get-tr-doc/pdf?AD=ADA557097

DISA 2010: NC3 “patchwork”

“There is no one NC3 system. The NC3 system as it exists today is a patchwork of disparate systems, each with its own characteristics. There is no one operating system or coding language”

The contractor shall be responsible to design, develop, and conduct recurring operational assessments to assist in the determining, in a quantitative manner, the operational capabilities of the Nuclear Command, Control and Communications (C3) System.
This system supports the President and the Secretary of Defense, Joint Staff, and Combatant Commanders' decision making across the spectrum of conflict and threat environments. Included in the Nuclear C3 System are the Survivable Mobile Command and Control Centers consisting of airborne resources, selected fixed and mobile ground command centers, the strategic and non-strategic (theater) nuclear forces, and surviving command elements (including shipboard) of the nuclear and non-nuclear Combatant Commanders, the military services, and the DoD agencies as defined in the Emergency Action Procedures of the Chairman, Joint Chiefs of Staff (EAP-CJCS Volumes VI and VII) and the National Military Command System/Department of Defense Emergency Communications Plan (NMCS/DoD Emergency Communication Plan). T
he objectives of the assessments are to identify deficiencies in equipment, both hardware and software, and procedures and to recommend corrective action to improve the operational capability.

Source: Answer to Question 1 at: Nuclear Command, Control, and Communications System Operational Assessment Program Solicitation Number: HC104710R4009, Agency: Defense Information Systems Agency, Office: Procurement Directorate Location: DITCO-NCR, August 4, 2010, at:
https://www.fbo.gov/index?s=opportunity&mode=form&id=ca9ed977f427844fb095c1e170a579ee&tab=core&_cview=1

2014: Council on Oversight of the National Leadership Command, Control and Communications System (CONLC3S).

Council on Oversight of the National Leadership Command, Control, and Communications System, established by section 1052 of the National Defense Authorization Act for Fiscal Year 2014 (Public Law 113-66)
(b) MEMBERSHIP.—The members of the Council shall be as follows:
(1) The Under Secretary of Defense for Policy.
(2) The Under Secretary of Defense for Acquisition, Technology, and Logistics.
(3) The Vice Chairman of the Joint Chiefs of Staff.
(4) The Commander of the United States Strategic Command.
(5) The Director of the National Security Agency.
(6) The Chief Information Officer of the Department of Defense.
(7) Such other officers of the Department of Defense as the Secretary may designate.
(c) CO-CHAIR.—
The Council shall be co-chaired by the Under Secretary of Defense for Acquisition, Technology, and Logistics and the Vice Chairman of the Joint Chiefs of Staff.
the Council shall be responsible for the following:
(A) Oversight of performance assessments (including interoperability).
(B) Vulnerability identification and mitigation.
(C) Architecture development.
(D) Resource prioritization.

Council prompted by the recent departure of former Deputy Defense Secretary Ash Carter and the impending exit of Defense Undersecretary for Policy James Miller.
Sources:
10 U.S. Code § 171a - Council on Oversight of the National Leadership Command, Control, and Communications System
https://www.law.cornell.edu/uscode/text/10/171a
R. Oswald, "Congress Wants Pentagon to Upgrade Nuclear Command and Control," Global Security Newswire, December 18, 2013, at: http://www.defenseone.com/management/2013/12/congress-wants-pentagon-upgrade-nuclear-command-and-control/75645/

Council on Oversight of the National Leadership Command, Control and Communications System (CONLC3S).

The CONLC3S purpose: bring NC3 stakeholders together to synchronize and prioritize NC3 modernization efforts, and then articulate those priorities to Congress.

Established 2013-14, annual report to Congress

Specific NC3 upgrade-modernization programs include:

1. Family of Beyond-line-of-sight Terminals
2. Presidential National Voice Conferencing
3. Multi-Role Tactical Common Data Link
4. Phoenix Air-to-Ground Communications Network
5. E-4B Low Frequency Transmit System
6. B-2 Common Very Low Frequency Receiver
7. E-6B service life extension and Airborne Launch Control System replacement programs
8. Global Aircrew Strategic Network Terminal
9. Minuteman Minimum Essential Emergency Communications Network Program Upgrade

Admiral Cecil D. Haney, "House Armed Services Committee Testimony," February 26, 2015, Washington DC, at: https://www.stratcom.mil/speeches/2015/132/House_Armed_Services_Committee_Testimony/
GAO, NUCLEAR COMMAND, CONTROL, AND COMMUNICATIONS: Update on DOD's Modernization, GAO-15-584R, June 2015 at: http://www.gao.gov/products/GAO-15-584R

Minutemen Communications Upgrades

We are also equipping ICBM launch control centers (LCC) with **modernized communications systems t**hat will upgrade or replace other aging and obsolete systems. The LCC Block Upgrade is an overall modification effort that *replaces multiple LCC components to include a modern data storage replacement for floppy disks and new Voice Control Panels to provide high quality voice communications*. We expect a contract to be awarded this year with production in 2018 and deployment in 2019.

The Minuteman Minimum Essential Emergency Communications Network Program Upgrade will modernize and better secure the Emergency Action Message network; this upgrade will begin fielding early next year.

However, command and control (C2) and infrastructure recapitalization is necessary to continue safe, secure, and effective operations. It is no small task to upgrade the command and control systems along with the underlying infrastructure that supports the weapon system. For example, *at our largest missile field operated by the 341st Missile Wing, we must connect and support hardened systems across almost 14,000 square miles.* As a comparison, this is larger than the entire state of Maryland; *our nuclear command and control is currently serviced by copper wire and equipment installed in the 1960s*.

AFGSC is *defining approaches to upgrade C2 and modernize necessary facilities*.

Lieutenant General Stephen Wilson, Commander Air Force Global Strike Command, "Status of Air Force Nuclear and Strategic Systems," Testimony to US Senate Armed Services Committee Strategic Forces Subcommittee, April 22, 2015, at: http://www.armed-services.senate.gov/imo/media/doc/Wilson_04-22-15.pdf

Advanced Extremely High Frequency (AEHF) Satellite System

July 2015: "initial operational capability" (IOC) status on constellation of three AEHF satellites

- **AEHF-1: launched August 2010 but took more than a year to reach its geostationary operating orbit due to a propulsion glitch.**
- **AEHF-2 launched May 2012**
- **18-month delay on an AEHF Mission Control Segment software Increment 5, support Low Data Rate and Medium Data Rate communications over a combined constellation of Milstar and AEHF satellites. MCS Increment 5 can support Extended Data Rate (XDR) for command and control and limited XDR tactical communications support, into service on August 1, 2013**
- **AEHF-3 launched September 2013.**
- **AEHF-4 maybe December 2016.**
- **AEHF-5, 6, to launch in June 2018 and February 2019**

General Characteristics	
Primary Function:	Near-worldwide, secure, survivable satellite communications
Primary Contractor:	Lockheed Martin Space Systems Company
Satellite Bus:	A2100 line
Weight:	Approximately 14,500 lbs at launch, 9,000 lbs on-orbit
Orbit Altitude:	22,300 miles (Geosynchronus)
Payload:	Onboard signal processing, crossbanded EHF/SHF communications
Antennas:	2 SHF Downlink Phased Arrays, 2 Crosslinks, 2 Uplink/Downlink Nulling Antennas, 1 Uplink EHF Phased Array, 6 Uplink/Downlink Gimballed Dish Antenna, 1 Each Uplink/downlink earth coverage horns
Capability:	Data rates from 75 bps to approximately 8 Mbps
Number of Terminals Supported:	6000
Reconfiguration Time:	Minutes
Launch vehicle:	Delta IV and Atlas V EELVs
Inventory:	3 satellites ordered
Unit Cost:	Approximately $580 million per satellite

Mike Gruss, "U.S. Air Force Declares Three-satellite AEHF Constellation Operational," August 10, 2015, at: http://spacenews.com/u-s-air-force-declares-three-satellite-aehf-constellation-operational/#sthash.QXonYAHQ.dpuf

"Advanced Extremely High Frequency (AEHF) Satellite Communications System," at: http://www.dote.osd.mil/pub/reports/FY2013/pdf/af/2013aehf.pdf

STRATCOM Control Center 2016: leaks, fires, outages, 2010, 2011

"A new Strategic Command and Control Complex and Nuclear C3 node at Offutt Air Force Base, NE, is at the center of our nuclear C3 plans... Today's building, command center, and computer systems took shape long before the IT revolution and now lack the capacity to support current mission demands. The buildings' systems strain to support numerous computer and communication systems, and the spaces occasionally experience serious heating and cooling problems, electrical failures, and other outages.

For example, in December 2010 and January 2011, two water pipe ruptures caused significant system outages and dislocated staff for several days, although the Command remained capable of performing its missions due to extraordinary workarounds and the remarkable efforts of the dedicated staff and a small army of outside emergency help…"

Current site (built 1989) not only leaks: when aging fans quit, they caught fire, about once/month until 2010. Under floor is a "riot of multicolored wires, all added over the decades to accommodate new technologies as they were introduced."

Cooling: 3 chillers, all of which must function perfectly in order to keep up. There are no backup systems. "If any of the three chillers goes off, we have to start shutting down computers."

New site: now, 10,000 computer work stations, 3,500 military & civilian employees.

New facility, to be completed 2016, will be blast and EMP-protected.

Site also has high groundwater, so new center is a "five-story building, surrounded by this bathtub."

Many delays, cost overruns—now for completion end 2019…

Sources: Prepared Statement by Gen. C. Robert Kehler, HEARINGS Before The COMMITTEE ON ARMED SERVICES, U.S. Senate, 112th Congress, 1st Session on S.1253,DEPARTMENT OF DEFENSE AUTHORIZATION FOR APPROPRIATIONS FOR FISCAL YEAR 2012 AND THE FUTURE YEARS DEFENSE PROGRAM, Part 7, Strategic Forces, MARCH 30; APRIL 6, 13; MAY 11; JUNE 3, 2011, at: http://www.gpo.gov/fdsys/pkg/CHRG-112shrg68090/html/CHRG-112shrg68090.htm

Steve Liewer, "At worksite at Offutt, $1.2 billion StratCom HQ taking shape," Omaha-World, March 16, 2015, at: http://www.omaha.com/news/military/at-worksite-at-offutt-billion-stratcom-hq-taking-shape/article_5687667c-2ee2-5492-87f1-0b466d262c03.html

D. Miles, "New Complex to Support Stratcom's 21st-century Missions," American Forces Press Service, April 1, 2013, at: http://archive.defense.gov/news/newsarticle.aspx?id=119660

B-2: Common Very Low Frequency Receiver (CVR)

CVR Increment 1 will provide the B-2 aircrew another, more reliable means to receive presidential force direction via emergency action messages. Currently, the B-2 uses an ultra-high frequency communications system to fill that role. However, the Military Strategic Tactical and Relay, MILSTAR, satellites that facilitate that form of communication are approaching the end of their operational life. The Advanced Extremely High Frequency (AEHF) satellite family of systems will, when fielded, provide the capability in the future.

The upgraded communication system would allow the B-2 to receive Very Low Frequency signals bounced off of lower levels of the atmosphere, bypassing the satellite relay. This would ensure the B-2 remains a viable nuclear platform until such time as a replacement for current satellite communications can be deployed.

First phase includes the modification, qualification, and testing of a U.S. Military VLF Communications System which consists primarily of a terminal/receiver, antenna, Human Machine Interface (HMI) display, and ancillary cabling, rack, and equipment to enable receipt and display of emergency action messages.

Although CVR Increment 1 is designed purely for use on the B-2 Spirit, a proposed second increment would expand the system into other platforms such as the B-52 Stratofortress and the E-4B Advanced Airborne Command Post.

--J. Raatz, Air Force Global Strike Command, "B-2 undergoes comm upgrade, September 5, 2013, at: http://www.af.mil/News/ArticleDisplay/tabid/223/Article/467040/b-2-undergoes-comm-upgrade.aspx

--Federal Business Opportunities, Common Very Low Frequency Receiver Increment 1 (CVR INC 1)

Solicitation Number: FA8616-13-C-6061, July 2, 2012, at:
https://www.fbo.gov/index?s=opportunity&mode=form&id=f45b1da3e41de7cd62692c6708537e49&tab=documents&tabmode=list&subtab=list&subtabmode=list&=

Tobyhanna Army Depot has been named the Depot Source of Repair for the Air Force's B-2A Spirit Bomber's Common Very Low Frequency Receiver (CVR). Repairs are scheduled to begin in fiscal year 2019. Built by Rockwell Collins, the B-2A CVR is a receive-only End Cryptographic Unit for off-line encoded Emergency Action Messages. It consists of the KGR-72 cryptographic terminal, antenna, human machine interface and power supply. This work directly aligns with Tobyhanna's designation by the Secretary of the Air Force as the Air Force's Technology Repair Center for command, control, communications, computers, intelligence and tactical missile systems

http://cecom.army.mil/DOTS-N-DASHES/2014/SEPTEMBER/files/assets/basic-html/page13.html

E-4B Airborne Command Posts: Low Frequency Transmit System and Advanced EHF terminals and Presidential National Voice Conferencing

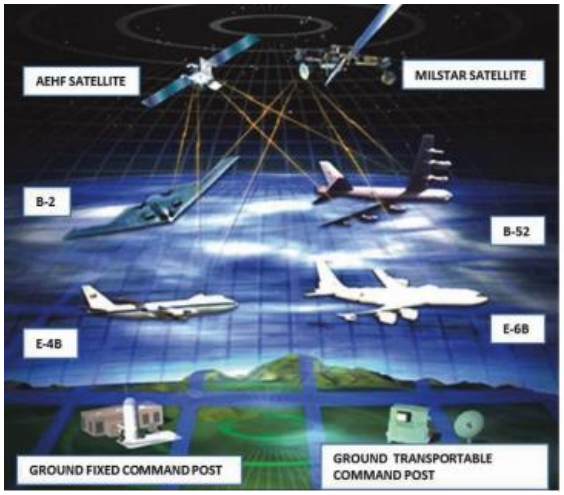
Sept 30/14: Boeing Aerospace Operations in OK City, OK receives a $9.8 million contract modification to design and develop a modern "E-4B low frequency transmit system," through to the stage of system requirements review and finalized system requirements. $4.7 million is committed immediately, and this is just the 1st stage of a FY14$ 92 million effort to replace onboard LF/VLF systems that are considered obsolete. Initial Operational Capability for the new system is planned for FY 2019.

Low frequency is also known as the kilometer band, and is useful for long-range transmission because it can be bounced off of the ionosphere and diffract over obstacles. A small subset in the 30-50 kHz range can even communicate with submarines that aren't too far underwater. Surer sub-surface communication can be had below this range through ELF and VLF sites, but those methods require structures whose size is measured in square miles. The USA decommissioned its fixed ELF sites in 2004, but continues to maintain several VLF locations.

The Low Frequency Transmit System (LFTS) program will replace the current Very Low Frequency/Low Frequency (VLF/LF) Transmit system that is on the E-4B. The current system has been on the E-4B for over 35 years and is past its useful life. This system must be replaced in order to meet existing National Security Presidential Directive (NSPD)-28 requirements and ensure there is constant and consistent connectivity to National Leaders and Forces in real world situations. The transmit system consists of three primary equipment groups: a Receiver/Transmitter group, a Power Amplifier-Coupler (PA-C) group, and a Trailing Wire Antenna (TWA) group.

> **"Blog: Boeing to Deliver Prototype E-4B Low-Frequency Transmit System," Signal, February 23, 2015, at: http://www.afcea.org/content/?q=boeing-deliver-prototype-e-4b-low-frequency-transmit-system and "Rockwell Collins selected to provide communications for E-4B program," July 23, 2105, at: https://www.rockwellcollins.com/Data/News/2015_Cal_Yr/GS/FY15GSNR45-E4B.aspx**

The Advanced Extremely High Frequency (AEHF) Compatible Terminal/ Presidential National Voice Conferencing (PNVC) Program integrates externally provided AEHF Compatible Command Post Terminals and PNVC capability onto the E-4B NAOC platform. This integration is necessary to replace the legacy Military Strategic, Tactical and Relay (MILSTAR) terminal, and provide access to protected wideband AEHF satellite networks. PNVC replaces Survivable Emergency Conferencing Network (SECN), which will not be supported once the AEHF satellite network is in place.



Family of Advanced Beyond Line-of-Sight Terminals (FAB-T)

FAB-T consists of ground and aircraft communication terminals with two terminal types – Command Post Terminals CPTs and Force Element Terminals (FETs). FAB-T is part of the terminal and control segments of the Advanced Extremely High Frequency (AEHF) satellite system and is designed to operate with AEHF Low Data Rate (75 – 2,400 bits per second (bps)) and Extended Data Rate (up to 8.192 Megabits per second (Mbps)) waveforms. • The CPT is intended to replace existing airborne (E-4B and E-6B), ground-fixed, and ground-transportable Milstar command post terminals. The CPT will include satellite and network control functions, end-user telecommunication device interfaces, and the ability to operate the terminal from a distant location using a remote node. • The FET is intended to be installed in airborne force elements (B-2, B-52, and RC-135). The FET is a requirement but is currently neither funded nor on contract for development and production.

Mission • The President, the Secretary of Defense, Combatant Commanders, and support Air Force component forces will use FAB-T to provide strategic nuclear and non-nuclear command and control with EHF, wideband, protected, and survivable communications terminals for beyond line-of-sight communications. • U.S. Strategic Command will use the FAB-T to perform the satellite Telemetry, Tracking, and Commanding functions of the AEHF/Milstar constellation, including management of the satellites, communication networks and cryptologic keys.

Lead contractor switched from Boeing to Raytheon in mid-2014. FOBT strategic terminal system expected to go into production by the end of 2015.

Sources: Mike Gruss, "U.S. Air Force Declares Three-satellite AEHF Constellation Operational," August 10, 2015, at: http://spacenews.com/u-s-air-force-declares-three-satellite-aehf-constellation-operational/#sthash.QXonYAHQ.dpuf

Family of Advanced Beyond Line-of-Sight Terminals (FAB-T), FY14 Air Force P RO G R AMS, at: http://www.globalsecurity.org/military/library/budget/fy2014/dot-e/af/2014fab-t.pdf

FAB-T: Example of Disabling Code in Critical NC3 Link Upgrade

MISSION OF THE FAB-T IS TO ALLOW AMERICAN COMMANDERS TO CONDUCT STRATEGIC NUCLEAR AND NON-NUCLEAR COMMAND-AND-CONTROL WITH EHF, WIDEBAND, PROTECTED, AND SURVIVABLE COMMUNICATION TERMS FOR BEYOND LINE-OF-SIGHT COMMUNICATIONS….

THE FAB-T SOFTWARE INCLUDED ABOUT 1.3 MILLION LINES OF CODE WRITTEN OVER EIGHT YEARS AND MORE THAN A 100 SOFTWARE ANOMALY REPORTS REMAINED OPEN AS OF SEPTEMBER 2011, WITH CLOSURES APPROXIMATELY EQUAL TO DISCOVERIES…

MISSED OR INACCURATE REPRODUCTION OF THE ORIGINAL MESSAGE CAN CAUSE SIGNIFICANT PROBLEMS IN THE COMMAND AND CONTROL OF NUCLEAR ASSETS DURING OPERATIONS…

THE FAB-T PROGRAM MANAGER DETERMINED THAT THESE PROBLEMS WERE DUE TO FAULTY SOFTWARE WHICH WAS FIXED BY THE CONTRACTOR, AND TESTED AGAIN ON JUNE 24, 2015, TO VERIFY THE FIXES. "THE 46TH TEST SQUADRON DETERMINED MOST OF THE PROBLEMS WERE FIXED, BUT NEW ONES WERE FOUND." AS OF 2016, THIS CRUCIAL COMMUNICATIONS LINK IN THE FAB-T SYSTEM WAS FOUND TO STILL FALL BELOW "RELIABILITY GROWTH" THAT REACHES USER REQUIREMENT OF 80 PERCENT CONFIDENCE.

U.S. Department of Defense, Director, Operational Test and Evaluation, "FY 2015 Annual Report," January 2016, p. 335-6, at: http://www.dote.osd.mil/pub/reports/FY2015/pdf/other/2015DOTEAnnualReport.pdf
U.S. Department of Defense, Developmental Test and Evaluation and Systems Engineering, FY 2011 Annual Report, March 2012, p. 192, at: www.acq.osd.mil/dte-trmc/docs/FY2011_DTE_SE_AnnualReport.pdf

E-6B service life extension and Airborne Launch Control System replacement programs for SSBN connectivity

The E-6B, which is part of the Take Charge and Move Out (TACAMO) strategic communications relay mission, is an airborne command post and communications relay based on the Boeing 707-320. E-6B Mercury is uniquely configured to perform Take Charge and Move Out (TACAMO), Airborne Command Post, and Airborne Launch Control System (ALCS) missions.

The aircraft conveys instructions from the National Command Authority to the Navy's fleet ballistic missile submarines in its TACAMO role, and helps control land-based missiles and nuclear-armed bombers in its Looking Glass role. The E-6B would provide command and control of U.S. nuclear forces should ground-based control become inoperable. To communicate with SSBNs, the E-6 uses Very Low Frequency (VLF) radios and a Long Trailing Wire Antenna to assign targets and issue EAMs.

The E-6B is currently undergoing significant upgrades and modifications, including a Service Life Extension Program (SLEP) designed to extend the life of the E-6B to 2040. E-6B aircraft are expected to reach the end of their service life of 45,000 hours around 2040.

E-6B modifications and upgrade contractors include The Boeing Company (Airframe and ADWS/Avionics); Rockwell Collins and L-3 Communications (Block I);Lockheed Martin (Mission Computer Set); and L-3 Communications/VERTEX (contractor logistics support).

E-6B ABCP Multi-Role Tactical Common Data Link

Northrop Grumman Systems Corp., Herndon, Virginia, is being awarded a $10,298,096 modification to previously awarded firm-fixed-price contract N00019-12-C-0096 to exercise an option to build, install, and test modifications to the E-6B aircraft, incorporating the Multi-Role Tactical Common Data Link B-Kit #3, B-Kit #4, and B-Kit Spares #2. Work will be performed in Salt Lake City, Utah (75 percent); and San Diego, California (25 percent), and is expected to be completed in September 2017. Fiscal 2016 aircraft procurement (Navy) funds in the amount of $10,298,096 will be obligated at time of award, none of which will expire at the end of the current fiscal year. The Naval Air Systems Command, Patuxent River, Maryland, is the contracting activity.

J. Keller, "Northrop Grumman to build SATCOM capability for E-6B strategic airborne command post," November 7, 2013, at: http://www.militaryaerospace.com/articles/2013/11/northrop-e6b-satcom.html

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US Department of Defense, Contracts, Press Operations, Release No: CR-210-15, November 2, 2015, at:

http://www.defense.gov/News/Contracts/Contract-View/Article/627052

National Nuclear Command, Control, and Communications (NNC3) Modernization Demonstration

Senior defense, government and U.S. Strategic Command (USSTRATCOM) leaders prepare to board the National Airborne Operations Center (NAOC) E-4B aircraft at Offutt Air Force Base, Neb., Aug. 28, 2015, to participate in a National Nuclear Command, Control, and Communications (NNC3) modernization demonstration, which highlighted future global situation monitoring and decision-making capabilities for national senior leaders on the nation's NNC3 platforms

- Connectivity failures in September 11 2001 dry run
- Trump objections
- New: can launch silo missiles from Looking Glass

Need for Uniform NC3 Training in Nuclear Safety Culture?

Table 2 Positions across Nuclear Command and Control Platforms

	Senior Adviser	*Team Lead and/or Conference Manager*	*Assistant and/or Conference Manager*	*Strike Adviser (SA)*	*Emergency Action Controller (messaging)*	*SOC (communications)*	*SURVO (warning)*	*NPES (N Plng / Exec Sys)*	*Staff Support / Surge*
Platform 1	*DDO (0-6/0-7)*	*DDO (0-6/0-7)*	*(O-5) (assistant)*	*SA (O-5/O-4)*	*EA ×2*	*2× Comm NCO: Generalist*	*SURVO (NORAD as backup)*	none	*"Ops Officer"*
Platform 2	*DDO (0-6/0-7)*	*DDO (0-6/0-7)*	*(O-5) (assistant)*	*SA (O-5/O-4)*	*EA ×2*	*2× Comm NCO: Generalist*	*SURVO (NORAD as backup)*	**Contract Support**	*"Ops Officer"*
Platform 3	*Team Chief (O-6)*	*Team Chief (O-6)*	none	*SA (O-5/O-4)*	*EA ×4*	*2× Comm NCO: Generalist*	none	*NPES×2*	**Staff Support**
Platform 4	**Commander**	*Team Chief (O-6)*	none	*SA (O-5/O-4)*	*EA ×2*	*6× Comm NCO: Specialist*	*SURVO (NORAD as backup)*	*NPES (×2-5 w/ surge)*	**Staff Support**
Platform 5	**DDO (0-6/0-7)**	*DDO (0-6/0-7)*	none	*SA (O-5/O-4)*	*EA ×1*	*5× Comm NCO: Specialist*	*NPES operator*	*NPES operator*	**Staff Support**
Platform 6–9	**Commander**	*Battle Watch Captain (O-6)*	none	*SA (O-5/O-4)*	*EA ×2*	*6× Comm NCO: Specialist*	*SURVO (NORAD as backup)*	*NPES (×2 w/ surge)*	**Staff Support**
Platform 10	**Commander**	**Branch Chief (O-5)**	**Branch Chief (O-5)**	**SA (O-5/O-4)**	*EA ×2 (×3/4 in surge)*	**EA**	none (NORAD as backup)	**NPES**	**Staff Support**
Platform 11	**Commander**	*Conference Manager (O-4/O-5)*	none	*SA (O-5/O-4)*	*EA ×3/4*	*2/3× Comm NCO: Specialist*	*NPES operator*	*NPES operator*	**Staff Support**
Platform 12	**Commander**	**SA/Branch Chief (O-5)**	**Conference Manager (O-4)**	**SA (O-5/O-4)**	*EA ×2*	*2× Comm NCO: Generalist*	*SURVO (NORAD as backup)*	**NPES**	**Staff Support**

Notes: Italic denotes day-to-day operations; bold denotes surge operations. There is *no* standard requirement for positions, nor are there descriptions for each position. Most platforms have both day-to-day *and* surge numbers that are different. These are the most recent configurations; they can change as the platform deems appropriate. Where titles match in different columns of same line, the position is filled by the same person. Staff support functions vary by platform. For example, there is a weather officer on three platforms and some add extra EA or strike expertise. Comms, communications; DDO, deputy director for operations; EA, emergency action; NCO, noncommissioned officer; NORAD, North American Aerospace Defense Command; NPES, Nuclear Planning and Execution System; SOC, secure operations console; SURVO, surveillance.

Source: This table was provided to the author by the U.S. Nuclear Command and Control System support staff.

2014: System Shift: Hard-wired point-point to networked IP-based C3 architecture

Nuclear Command, Control and Communications. Assured and reliable NC3 is critical to the credibility of our nuclear deterrent. The aging NC3 system continues to meet its intended purpose, but risk to mission success is increasing. Our challenges include operating aging legacy systems and addressing risks associated with today's digital security environment. Many NC3 systems require modernization, but it is not enough to simply build a new version of the old system—rather; we must optimize the current architecture while leveraging new technologies so that our NC3 systems interoperate as the core of a broader, national command and control system.

We are working to shift from point-to-point hardwired systems to a networked IP-based national C3 architecture that will balance survivability and endurability against a diverse range of threats, deliver relevant capabilities across the range of interdependent national missions, and ultimately enhance Presidential decision time and space.

Specific programs now in work include the Family of Beyond-line-of-sight Terminals (FAB-T), Presidential National Voice Conferencing (PNVC), the Multi-Role Tactical Common Data Link (MR-TCDL), Phoenix Air-to-Ground Communications Network (PAGCN), the E-4B Low Frequency communications upgrade, the B-2 Common Very Low Frequency Receiver communications upgrade, and the E-6B service life extension program.

Admiral Cecil D. Haney, Commander, U.S. Strategic Command, APRIL 2, 2014 FISCAL YEAR 2015 NATIONAL DEFENSE AUTHORIZATION BUDGET REQUESTS FROM U.S. FORCES KOREA AND U.S. STRATEGIC COMMAND U.S. HOUSE OF REPRESENTATIVES, COMMITTEE ON ARMED SERVICES ONE HUNDRED THIRTEENTH CONGRESS, SECOND SESSION, at: https://www.hsdl.org/?view&did=754624

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Specific NC3 Modernization Design and Implementation Questions

1. NC3 architecture still largely shaped by its Cold War origins
2. Increasing capacity of existing and new links to nuclear forces, introduced new levels of complexity to these sensing, communications, and decision-support systems.
3. Same delivery platform may support conventional and nuclear weapons in all legs of triad. If President authorizing conventional strikes, then how does NC3 ensure that EAM system never confuses nuclear and conventional strike orders? Same question arises for release and authorization of cyber-strikes with cyber-munitions.
4. How does NC3 sequence missile defense decisions and operations with retaliatory or pre-emptive strikes, and what decision support systems integrate missile defense forces and assessment with nuclear decisions and C3I systems, sequencing, and logic? Is bandwidth and inter-operability available that integrates NORTHCOM, CENTCOM etc?
5. The US nuclear command-and-control system increasingly supports many conventional mission requirements, adding complexity to the network of nodes, links, and sensors, plus the computational support and defenses against external attack and hacking.
6. **Will NC3 systems be used for FEMA emergency response to terrorist attacks, natural disasters, and are these uses compatible with dedicated requirements for safe, responsive control of nuclear forces?**
7. Do these missions compete with each other organizationally and in priority for bandwidth and sequencing?
8. Should nuclear operations be conducted only on dedicated platforms, staffing, acquisition, and NC3 to achieve simplicity, decoupling, safety, reduce errors and normal accidents?
9. Many modernization actions are delayed or still in future (GAO found key satellite communication terminals for strategic bomber aircraft has been deferred by several years plus other classified shortfalls)
10. Shift to internet protocol or IP-network based communications by STRATCOM to support its many distributed functional sites and organizations may not provide assurance of rapid message transmission needed for nuclear command and control (2005). Will IP-routing ensure priority of nuclear force direction messages? Is NC3 system integrated or dedicated and separate in an IP-networked based architecture?
11. **Who will ensure compatibility in this integration and ensure that procedures and protocols are reconciled in a distributed architecture, at different levels in the command chain?**

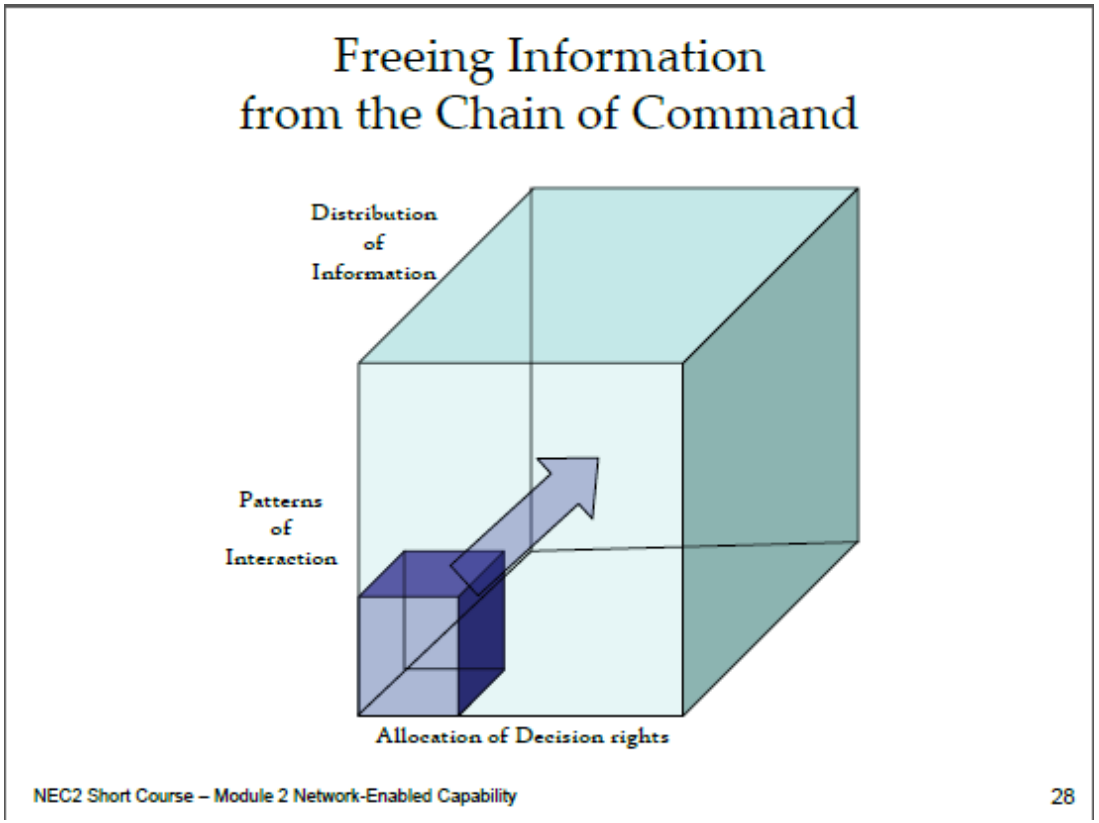
Sources:

Robert Critchlow, *Nuclear Command and Control: Current Programs and Issues*, Congressional Research Service, RL33408, May 3, 2006, pp. 24-25.

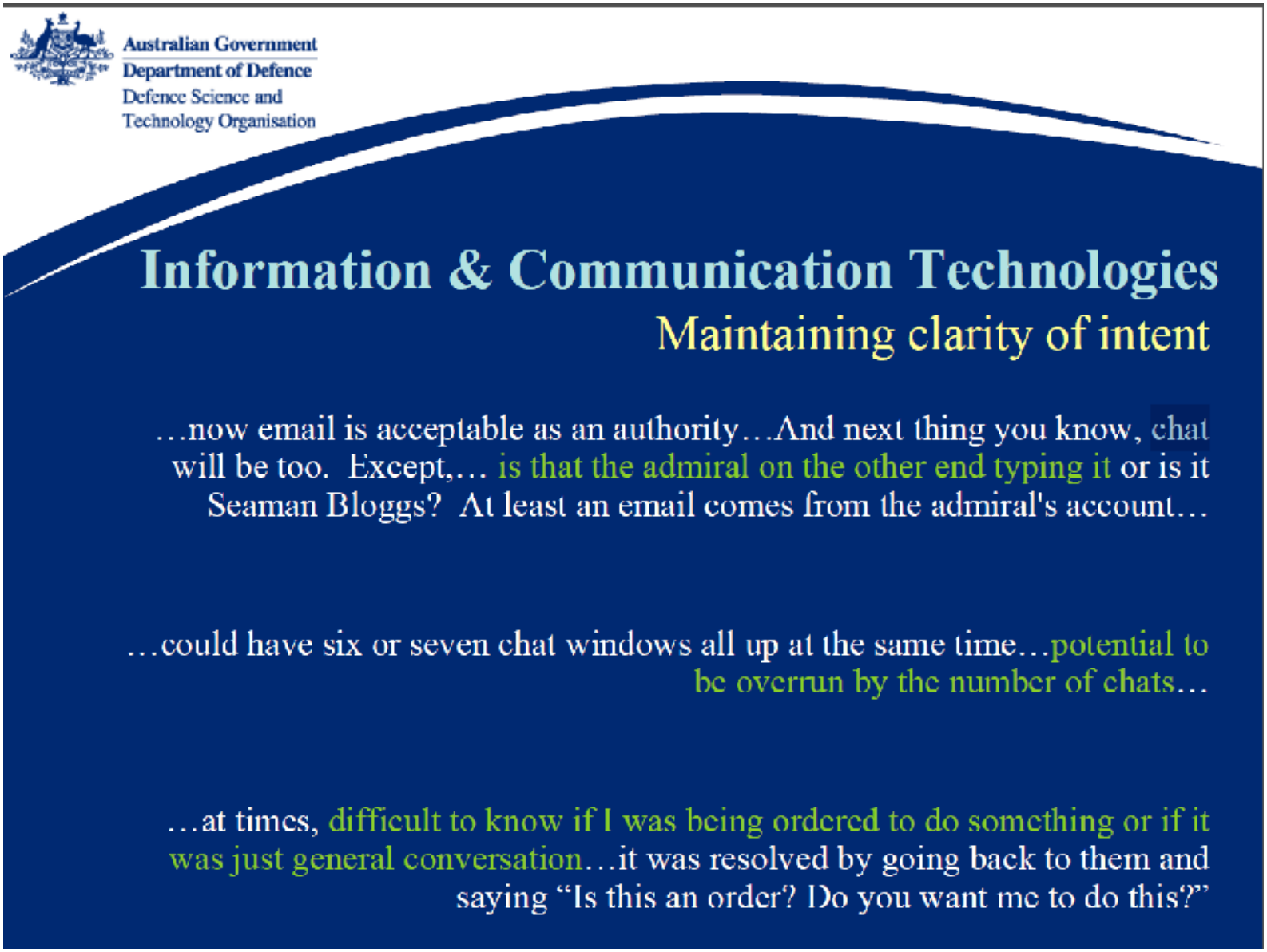
General Accounting Office, *Nuclear Command, Control, And Communications: Review of DOD's Current Modernization Efforts*, GAO-14-414R, March 18, 2014.

SOURCE: GAO, NUCLEAR COMMAND, CONTROL, AND COMMUNICATIONS: Update on DOD's Modernization, GAO-15-584R, June 2015 at: http://www.gao.gov/products/GAO-15-584R

Complex Conventional C2



"Power to the Edge"
Agility
Devolution
Coevolution
Individual Initiative

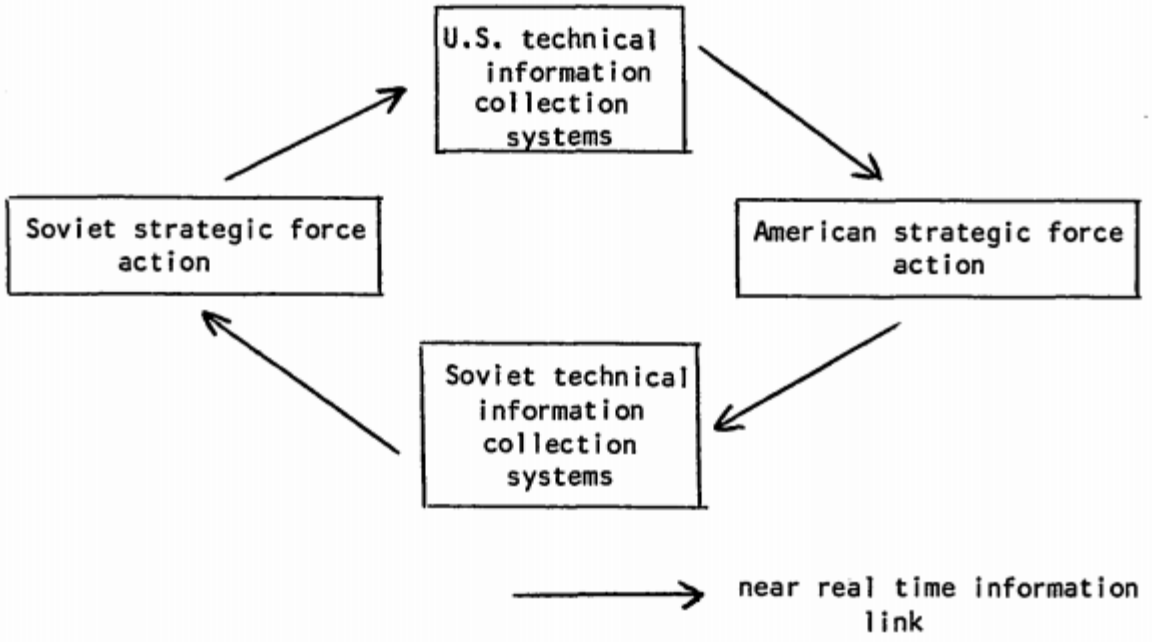


C. Pascoe et al, Network Centric Warfare and the New Command & Control: An Australian Perspective, Defense Science and Technology Organization, Australian Department of Defense, presented to 13th International Command and Control Research and Technology Symposium, 2008, at: http://dodccrp.org/events/13th_iccrts_2008/CD/html/plenary_presentations/pascoe.pdf

5. Global NC3I Meta-System

FIGURE 2-1

THE COUPLING OF STRATEGIC FORCES



nuclear C3I was both cause and effect of the risk of nuclear war

P. Bracken, *The Command of Strategic Forces*, Dissertation, Yale University, 1982, p. 39

NC3-Meta-System

Carter asks how lessons of complex systems and normal accidents should be applied "to the combined forces of the United States and the Soviet Union treated as one gigantic interacting system"(635)…and then moves on.

Sagan also addresses the combined (coupled) system.

- **Notes that in Cuban Missile Crisis, "political authorities in Moscow may have been more aware of the Bomber Command's actions than were the U.S. civilian officials in Washington"**
- **Soviets may have perceived a provocation where none was intended**
- **Soviets may mirror image own centralized C2 and saw US and UK actions in NATO as more coordinated than in fact they were**
- **Admits can't study meta-system due to lack of access, but suggests if US NC3I problems were/are bad, how much worse in FSU/Russia? And by implication…their interactions may not even be known today (Able Archer example).**

In footnote, raises a critical issue: how to measure coupling between 2 or more nuclear armed states (and possibly with non-state nuclear armed actors) which may be less complex but very tightly coupled with short decision times.

See Perrow: interaction-coupling graphs…splintered vs complicated effects

In Normal Accidents Frame, Shift from Complicated to Splintered Worlds
And back? Or both

End Cold War

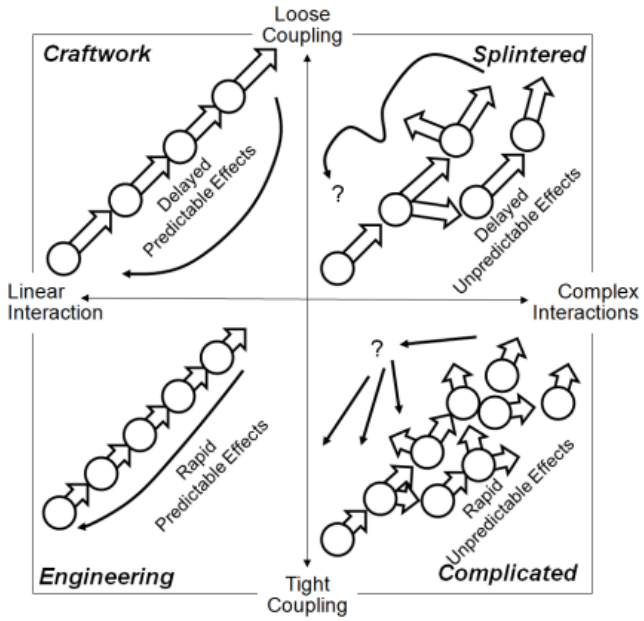


Figure 5. Coupling and Effects Predictability

2015

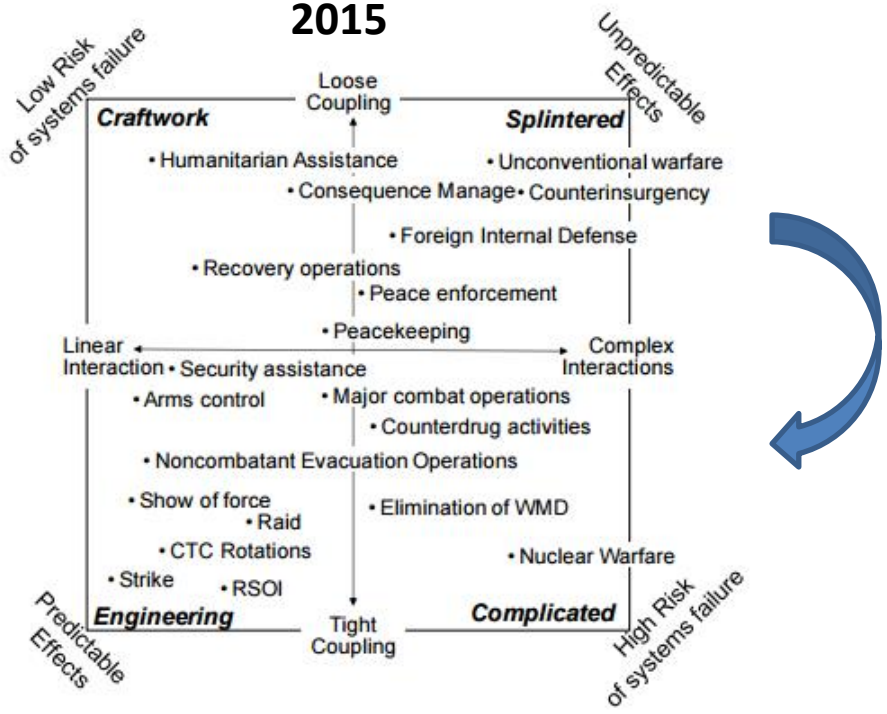


Figure 6. Variation of a Perrow Interaction Coupling Chart with possible Military Operations, Effect Predictability, and Risk[37]

Perrow Interaction/Coupling Graphs
Splintered generates delayed unpredictable effects
Complicated generates rapid unpredictable effects

Back to the Future: The Global Meta-System of NC3

Problem is not one national nuclear weapons system with associated NC3I, considered in isolation, but the set of NC3I systems:

- **How, when, and where their different dynamics intersect—needs to be simulated in detail using various complexity measures and coupling theories**
- **Where they overlap—needs to be mapped**
- **How they stimulate the other's systems**
- **What logic and sequencing mismatches may occur**
- **What failures of understanding, different concepts, words, meanings are employed**

Even alliances have this problem.

In Korean, the answer to a negative question "You didn't hit the target?" is conventionally the opposite to English.
In American English, you'd say "No, I didn't."
In Korean, you'd say "Yes, I didn't."

Even for—especially for—fluently bilingual Koreans and Americans, it's impossible to know with certainty what is meant by the answer to a negative question without a discussion!

Global NC3 Interaction

Primary interaction of nuclear weapons states is via standing strategic forces, which appear stable; and conventional forces where overlap, and therefore, NC3 systems also intersect.

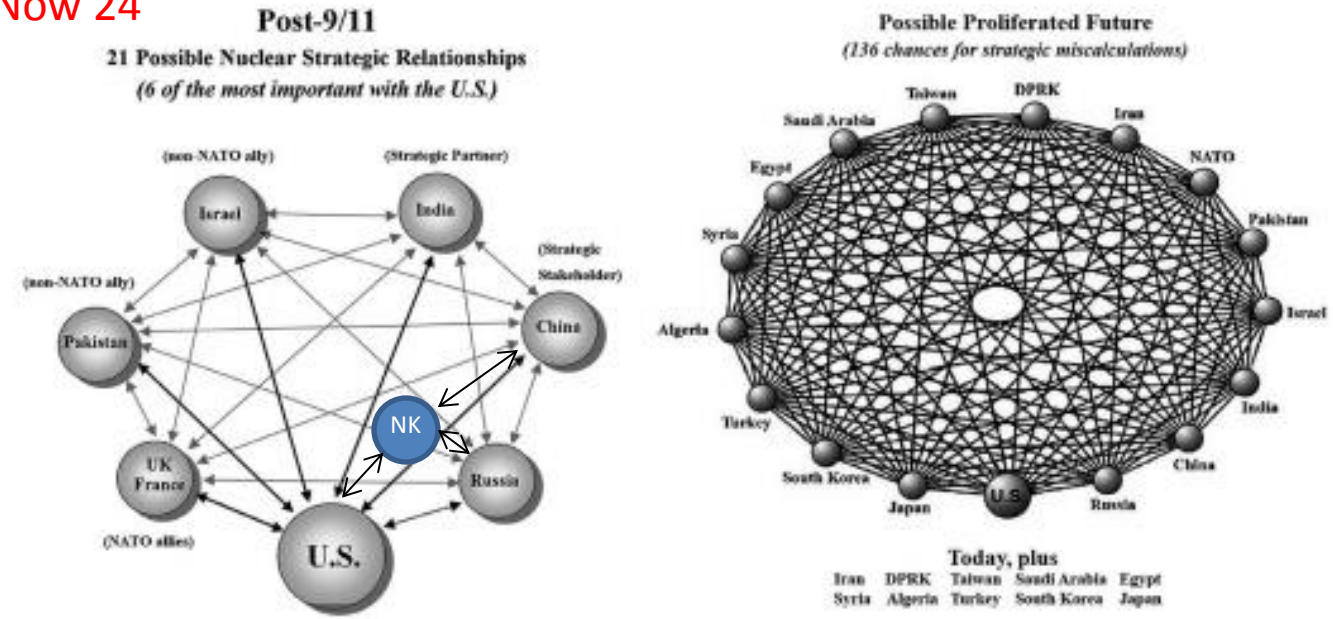
1. **US-NATO interaction with Russian nuclear forces**
2. **US-allied interaction with Chinese nuclear forces**
3. **Russian interaction with Chinese nuclear forces**
4. **US allied intersection with DPRK nuclear forces.**

But in a complex global system, and multi-tiered set of nuclear armed states, how other parts play in the system is poorly understood, even in the great power nuclear "truel."

Does "stability" even have a meaning in such a complex system?

Figure 5.1: Phase Transition from Complicated to Complex Nuclear Weapons Problems

Now 24

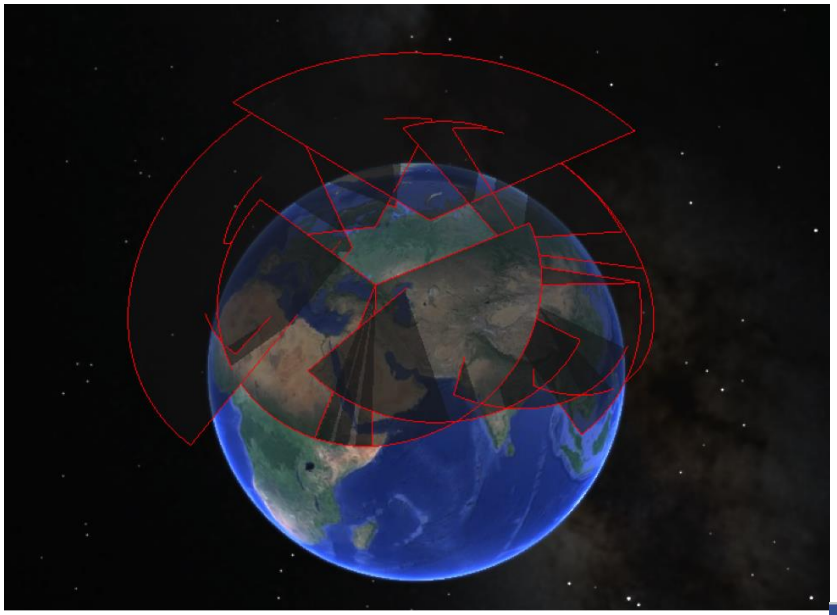


Source: Henry Sokolski, "Nuclear Abolition and the Next Arms Race," in *In the Eyes of the Experts: Analysis and Comments on America's Strategic Posture, Selected Contributions by the Experts of the Congressional Commission on the Strategic Posture of the United States*, ed. by Taylor Bolz (United States Institute of Peace Press, Washington DC), pp. 207-08, http://www.usip.org/files/In%20the%20Eyes%20of%20the%20Experts%20full.pdf

6. Current NC3 Stresses:

- **Russia**
- **China**
- **SSBNs**
- **North Korea**
- **False alarms-social media triggering of EW systems**
- **Non-State Catalytic attack**
- **Disruptive AI, Q-Tech**

Russian NC3 EW Deficit and Modernization



DETERRENCE: Revealed: Russia's ambitious new ICBM early warning system, Sputnik News (19 August 2015)
The main contractor for Russia's strategic early warning system is under severe financial pressure. Its designer admits that the new system of satellites, ground radars and drones is error prone.

"The system's ground echelon…is a uniquely complicated technical system and malfunctions cannot be excluded. Here a lot depends on how the system's various components interact with one another: the false alarms that can occur in one station must be quickly analyzed and verified by the command post."

Weird readings on NK missile 2017 tests…

Russia's satellite nuclear warning system down until november, The Moscow Times (30 June 2015)

Early warning, Russian Strategic Forces

China Evolving NC3I

Historical Drivers

- C2 failures Korean War
- US nuclear threats, 1958 Q/M crisis
- 1969 Soviet nuclear threat

Early NC3 Disposition

- Dispersal leadership
- Underground siting CPs, missiles
- Little early warning radar capacity in 70s

Current NC3

- Central Military Commission and General Staff Director separate comm links to 2nd Artillery
- 2nd Artillery laying fiber optic, installing microwave, satellite and cellular links, informatization and networked communications
- Same personnel operate conventional and nuclear forces
- DF21 missiles conventional and nuclear armed
- Mating of warheads and missiles key indicator but hard
- Ambiguity for US and allied sigint and interpretation of missile launches
- Likely HF and VHF radio relayed by aircraft and satellite links to submarines

Key questions

- Who controls SSBN forces, over what lines, with what pre-delegation?
- What ASW forces emerging?
- If China wants to shift to launch on warning, especially as part of area denial strategy aimed at US and its allies, must construct a new early warning radar and satellite system.

Emerging Interaction 1:
SSBNs-ASW Interaction and NC3I Error, Uncertainty

- US Ohio SSBNs deployed mid-eastern Pacific or beyond
- Russian Borei SSBN now deployed in Russian Far East, may operate in Sea of Okhotsk or beyond
- Chinese Jilin SSBN now deployed off SE coast of China or beyond
- US, Russian, Chinese ASW forces deployed—SSNs, ASW aircraft, sonar, hydrophones
- Submarine drones in rapid R&D
- SSBN-ASW truel in the making?

Time to consider ASW-free zones to separate forces?

What cooperative measures can be used to ensure these forces are separated, do not overlap, and that ASW forces do not clash with each other or SSBNs?

What are the implications for each states NC3 systems arising from this redeployment, potentially tight coupling at SSBN-ASW interface?

Peter Hayes, "Off the Beach: Underwater Warfare in the 21st Century," *Global Asia*, 13: 1, March Spring 2018 at: https://nautilus.org/wp-content/uploads/2018/03/Global-Asia-Off-the-Beach-Submarine-Warfare-March-2018.pdf

Emerging Interaction 2: North Korea NC3I

- In April 2012, North Korea reportedly upgraded its Missile Guidance Bureau to become a Strategic Rocket Force, apparently separate from the KPA's Army, Navy and Air Force. Its Commander, Lt. Gen. Kim Rak Gyom was elected to the Korean Worker's Party Central Military Committee, underscoring the commitment to developing a deliverable strategic nuclear weapon
- For such a centralized and personalized command structure as North Korea, this question of control is critically important. KJU is in command.
- Moreover, the peculiarly North Korean pyramid of power presents the possibility of instant propagation of error and possible inadvertent escalation for a military command structure prone to constant probing by and interaction with devolved US and ROK military forces at the "hard edges" of the DMZ and the Northern Limit Line.
- Cybernetic errors may creep into the DPRK nuclear command and control system
- Kim's nuclear command-and-control system may be susceptible to the Byzantine (traitorous) General subversion problem should war come at a time of disorder and near collapse in the DPRK itself.
- DPRK NC3I simple but very tightly coupled with DPRK conventional and nuclear forces
- Preplanned STRATCOM target sets likely obsolete by time war breaks out. Improvised targeting combined with delayed delivery time by strategic bombers generates real risk of useless nuclear attack.
- DPRK communications are fiber optic underground, and opaque to SIGINT, making EW difficult
- US-ROK inclination is to strike early and possibly first in revised OPLAN 2015, but attacking CPs and leadership, not just weapons and missiles, may lead to DPRK nuclear first-use.
- North Korean strategic retreat may lead to KJU-KPA taking Pyongyang hostage with nuclear weapons.
- What then?
- Coincident risks? Taiwan Sts crisis? Terrorist attack? ROK irrational move?

Emerging Interaction 3: Nuclear Terrorism as Trigger Event: Key Questions Non-State Actor NC3I

- Would nuclear-armed non-state actor eg terrorist group, have centralized single commander or adopt decentralized and delegative contingent authority? How do non-statea NC3I systems differ from state-based NC3I systems?
- Would decapitation attack on network leader prompt non-state actor nuclear use?
- What precedents exist eg Aum Shinrikyo, Al Qaeda, what formal, informal, or tacit rules and behaviors of non-state actor C3I
- Mumbai attack is archetype for self-organizing attack with centralized C2 with prior reconn, real-time situational awareness via social media, trans-border
- Does time compression of decision-making drive delegation for non-state actors as with states?
- Would non-state actors mimic launch-under-attack or launch-under-warning of attack state policies?
- What geographic depth, ability to preposition nuclear weapons, and other factors affect non-state actors propensity and ability to use nuclear weapons, and related NC3I systems?
- How does organizational structure (eg star, daisy-chain, all-channel network) affect possible nuclear threat-attack strategies?
- How do motivational goals, eg political-ideological orientation and aspiration to proto-statehood versus religious-apocalyptic orientation, affect resources, partnerships, stamina, operational procedures and strategies, targeting for nuclear threat or attack?
- How would non-state actor implement transnational C3I demands; use of non-state NCI leads to sigint, targeting, strikes, even if use encrypted communications? (including non-state cyber-attacks eg Anonymous against Islamic State
- How would non-state acquisition, threat, or use of nuclear weapons interact with n-state NC3I systems in various combinations and scenarios?

Sources:

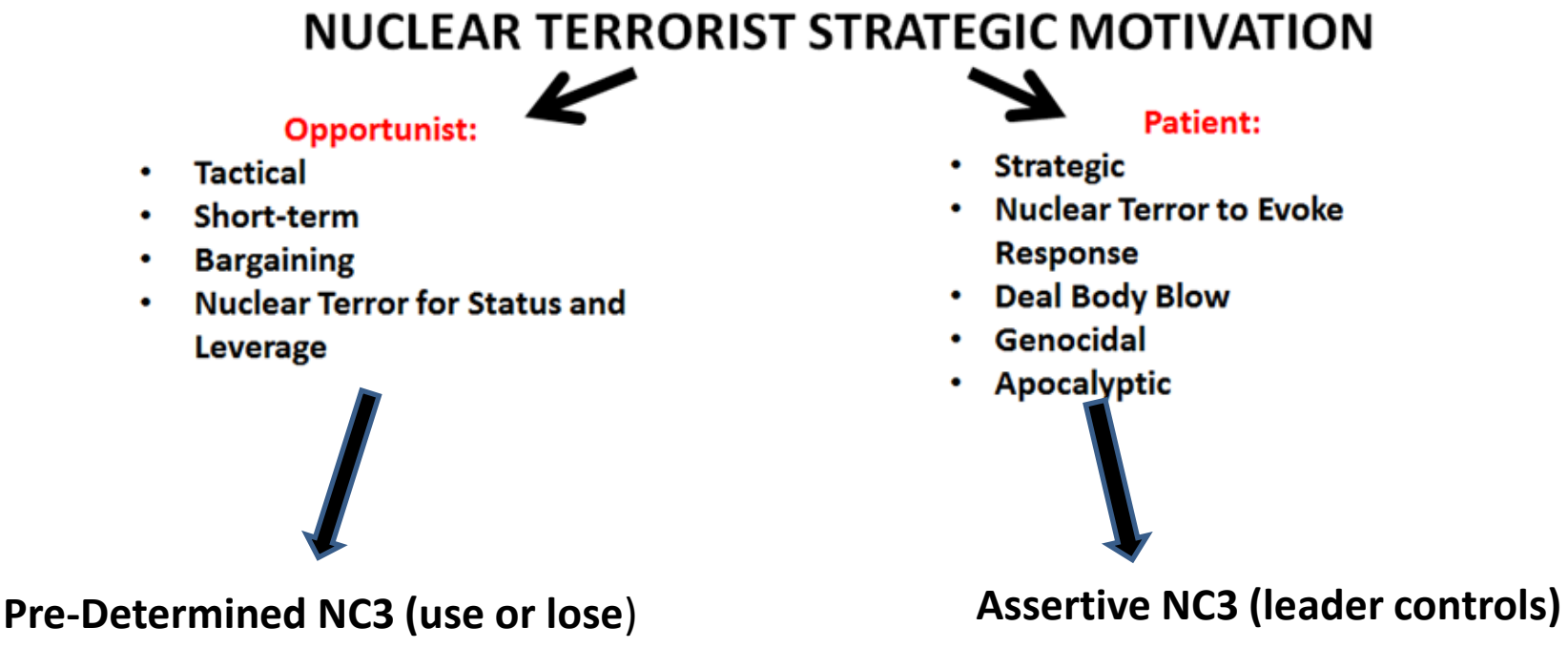
Daniel Byman, "Why ISIS might regret the decision to go global," Brookings blog, November 16, 2015

David Killcullen *Out of the Mountains: The Coming Age of the Urban Guerrilla*. New York: Oxford University Press. 2013

C. Blair, Non-State Actor Nuclear Command and Control, FAS Public Interest Report, Fall 2010 at: http://fas.org/programs/tap/_docs/Non-State%20Actor%20Nuclear%20Command%20and%20Control.pdf

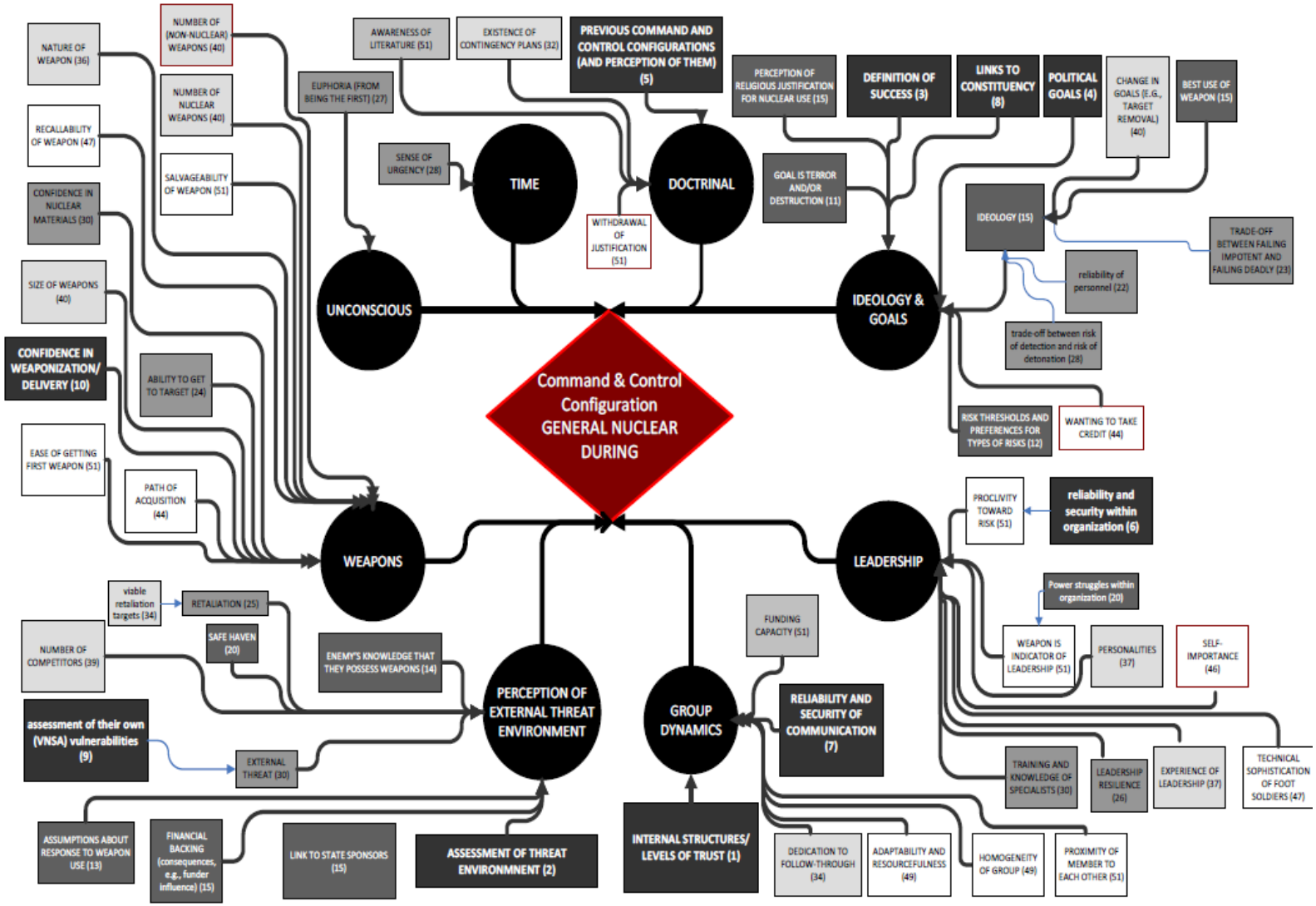
Robert Ayson, "After a Terrorist Nuclear Attack: Envisaging Catalytic Effects," *Studies in Conflict and Terrorism*, 33, 2010, pp. 571-593.

Figure 2: Opportunist versus strategic nuclear terrorist motivation



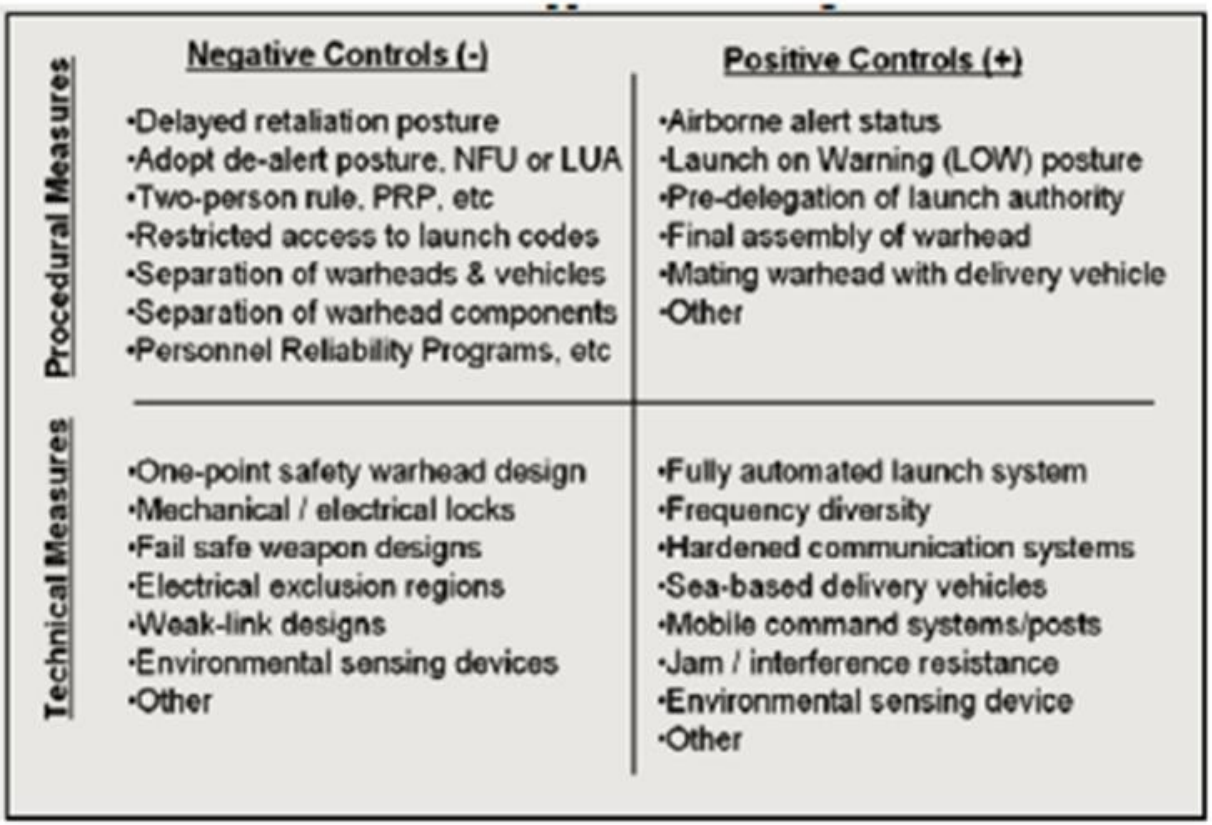
Peter Hayes, "NON-STATE TERRORISM AND INADVERTENT NUCLEAR WAR", NAPSNet Special Reports, January 18, 2018, https://nautilus.org/napsnet/napsnet-special-reports/non-state-terrorism-and-inadvertent-nuclear-war/

Factors Affecting Terrorist Nuclear Command-and-Control



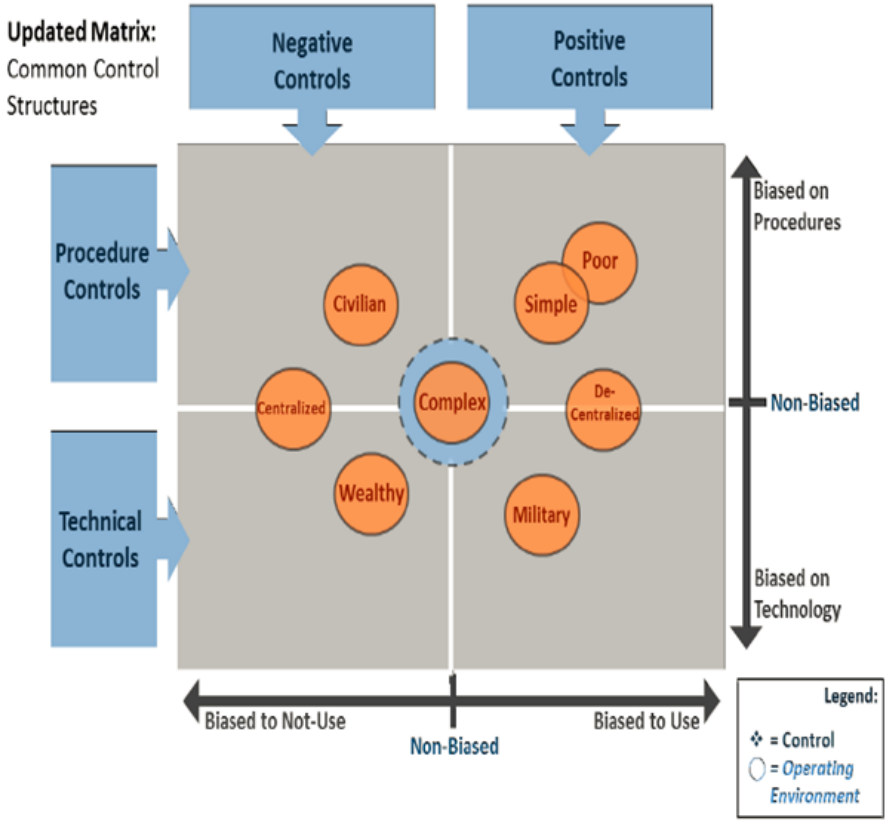
C. Blair, Two Open Source Nuclear Terrorism Projects," IGCC Nuclear Security D.C. Policy Series, December 15, 2011, at: http://fas.org/wp-content/uploads/2011/12/Blair_FAS_IGCC_Presentation_Dec_2012.pdf

Figure Six: Controls and Measures on Nuclear Weapons Use



Source: Virginia Tech Applied Research Corporation, Nuclear Command, Control, and Stability Framework, December 29, 2016, at: https://calhoun.nps.edu/bitstream/handle/10945/48707/Nuclear%20Command%20Control%20and%20Stability%20Assessment_Final%20report_29Dec15%20rev2.pdf?sequence=1&isAllowed=y

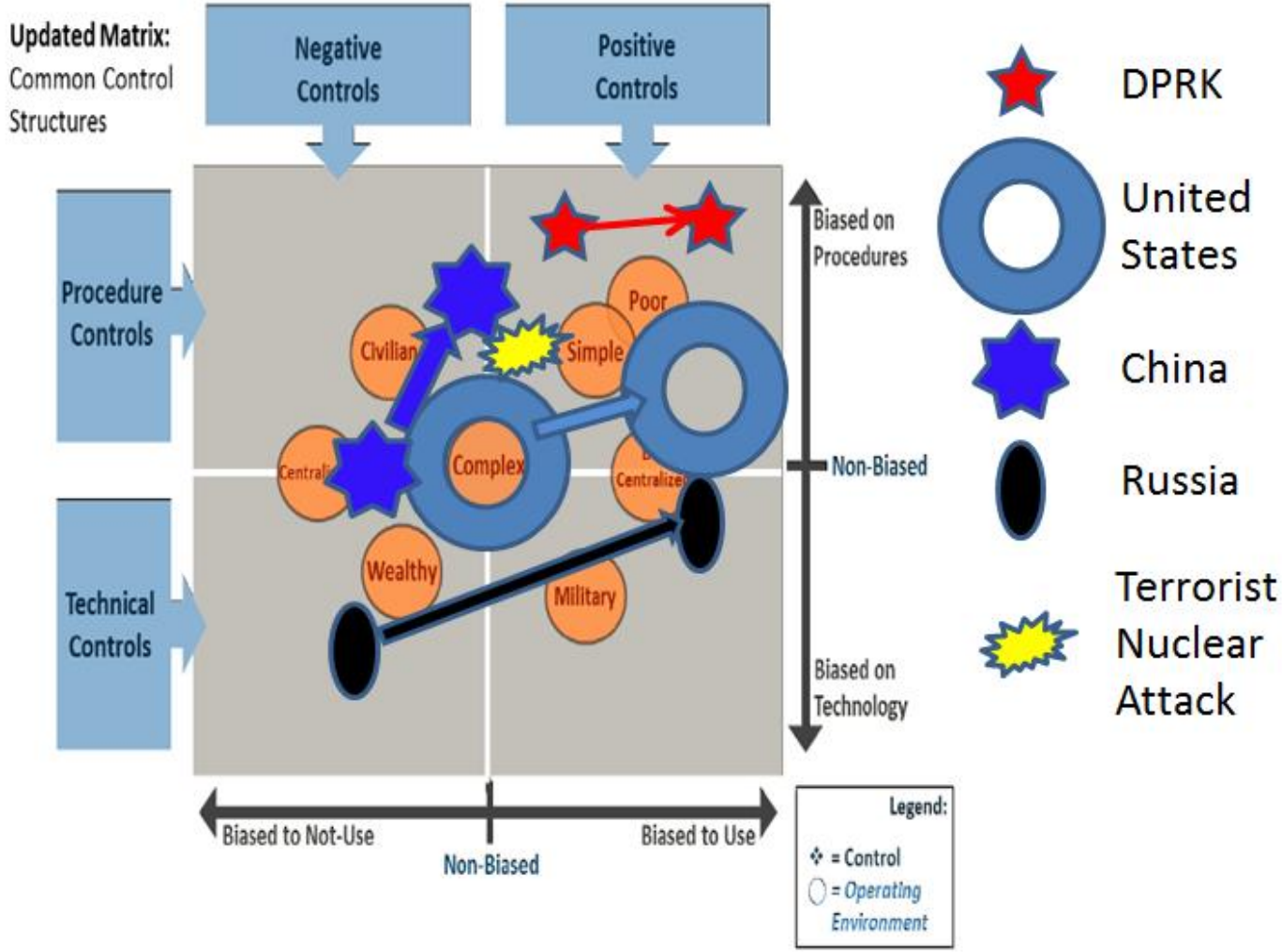
Figure Seven: **State nuclear weapons control biases by NC3 type**



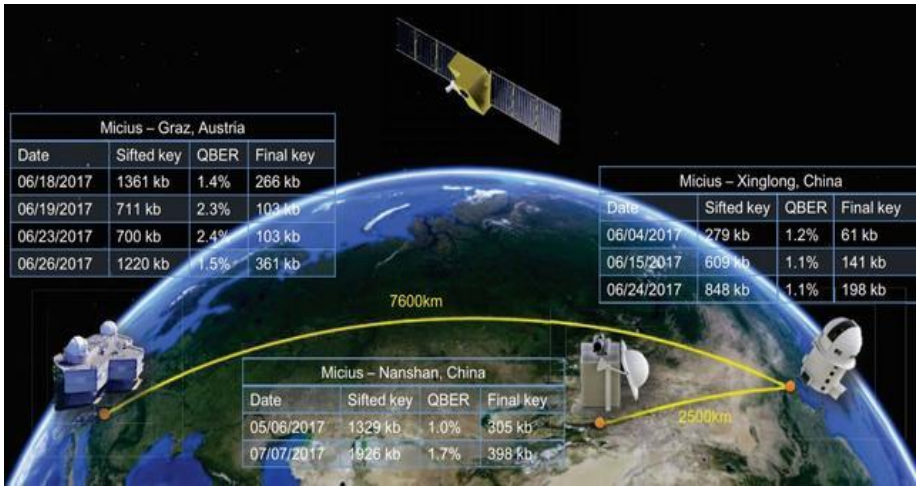
Note: according to dominant characteristic shown in orange circle; also, real states may exhibit more than one characteristic

Source: Virginia Tech Applied Research Corporation, Nuclear Command, Control, and Stability Framework, December 29, 2016, at: https://calhoun.nps.edu/bitstream/handle/10945/48707/Nuclear%20Command%20Control%20and%20Stability%20Assessment_Final%20report_29Dec15%20rev2.pdf?sequence=1&isAllowed=y

Figure 8: **Impact of a Terrorist Nuclear Threat or Attack on Interstate Nuclear Use Control**



NUCLEAR COMMAND-AND-CONTROL IN THE QUANTUM ERA



China's Micius satellite long distance Q communication test from here

Q-NC3 communications
Q-NC3 encryption: secrecy and past data files, eg PRP, procedures
Q-NCE Solving Computationally Massive Problems
Q- Rendering Visible Nuclear Weapons and Delivery Systems—and Command Centers
Q- Quantum Monitoring and Verification

Peter Hayes, "NUCLEAR COMMAND-AND-CONTROL IN THE QUANTUM ERA",
Blue Peter NAPSNet, March 29, 2018,
https://nautilus.org/napsnet/nuclear-command-and-control-in-the-quantum-era/

7. Possible Antidotes

- **Multilateral Data Exchange & Independent Early Warning Networks**
- **Global NC3 Code of Conduct**
- **Nuclear Refuseniks**
- **Command Discipline, military tradition and honor**
- **Laws of War, humanitarian international law**
- **Trade warheads for NC3 upgrade**

Antidotes for Relative EW Deficit-Remedies 1

Joint Data Exchange Center (JDEC)

Provisions
The Memorandum Of Agreement Between The Government Of The United States and Government Of The Russian Federation On The Establishment Of A Joint Center For The Exchange Of Data From Early Warning Systems And Notifications Of Missile Launches established a Joint Data Exchange Center (JDEC) in Moscow for the exchange of information derived from each side's missile launch warning systems on the launches of ballistic missiles and space launch vehicles. The JDEC is also intended to serve as the repository for the notifications to be provided as part of an agreed system for exchanging pre-launch notifications on the launches of ballistic missiles and space launch vehicles.

Background: President Clinton and President Yeltsin issued a joint statement 02 September 1998 announcing that they had reached agreement on a cooperative initiative between the United States and Russia regarding the exchange of information on missile launches and early warning, and the potential establishment of a multilateral notification system for the launch of ballistic missiles. President Clinton and President Putin signed the Memorandum Of Agreement in Moscow on 04 June 2000. The JDEC will builds upon the successful establishment and operation during the millennium rollover of the temporary joint center for Y2K Strategic Stability in Colorado Springs. The system is to be set up in phases, and by the end of the third phase, it will include information on ballistic missile and space launches of third parties.

2015…DOA…moribund?

New Concept: Replace JDEC with Mulilateral Data Exchange Network

- **Revive as multilateral mechanism based on multiple levels of reciprocal, bilateral data exchange between nuclear weapons states, and including data from non-nuclear states?**
- **Devolved, self-implementing networked data exchange on bilateral basis (NOTAMs-ICAO system)**
- **Include nuclear and non-nuclear weapons states**
- **Parallel civil society based early warning-surveillance system, especially cities**

GLOBAL NC3 CODE OF CONDUCT

// to 2002 *Hague Code of Conduct against Ballistic Missile Proliferation*

CODIFICATION OF NORMS AND STATES PRACTICES, EG

"DO NOT TARGET THE NATIONAL HIGH COMMAND OF A NUCLEAR WEAPONS OR NUCLEAR ARMED STATE;"

"DO NOT CO-LOCATE NUCLEAR WEAPONS WITH ONE'S OWN HIGH COMMAND POST OR EARLY WARNING INTERPRETATION SITES OR SENSORS;"

"DO NOT MIX/FUSE/SHARE NUCLEAR AND CONVENTIONAL COMMUNICATIONS SYSTEMS;"

"WHEREVER POSSIBLE, USE DEDICATED NUCLEAR COMMUNICATIONS SYSTEMS;"

"DO NOT ATTACK OR INTERFERE WITH A NUCLEAR WEAPONS STATE'S NATIONAL TECHNICAL MEANS," INCLUDING BY IMPLICATION,

"DO NOT ATTACK THE UNDERLYING COMMUNICATIONS AND COMPUTER SYSTEMS ON WHICH NTM RELY FOR NC3 OPERATION;"

"DO NOT TAKE NC3 COUNTER-MEASURES THAT REDUCE DECISION TIME AND INCREASE IMMEDIACY OF NUCLEAR DECISIONS UNDER INTERNATIONAL LAW."

"DESIGNATE A LEGITIMATE AND ACCOUNTABLE NATIONAL COMMAND AUTHORITY FOR ALL NUCLEAR FORCES."

"INSTITUTE A TWO-PERSON RULE FOR ALL LAUNCH DECISIONS AND IMPLEMENTATION STEPS IN NC3 OPERATIONS."

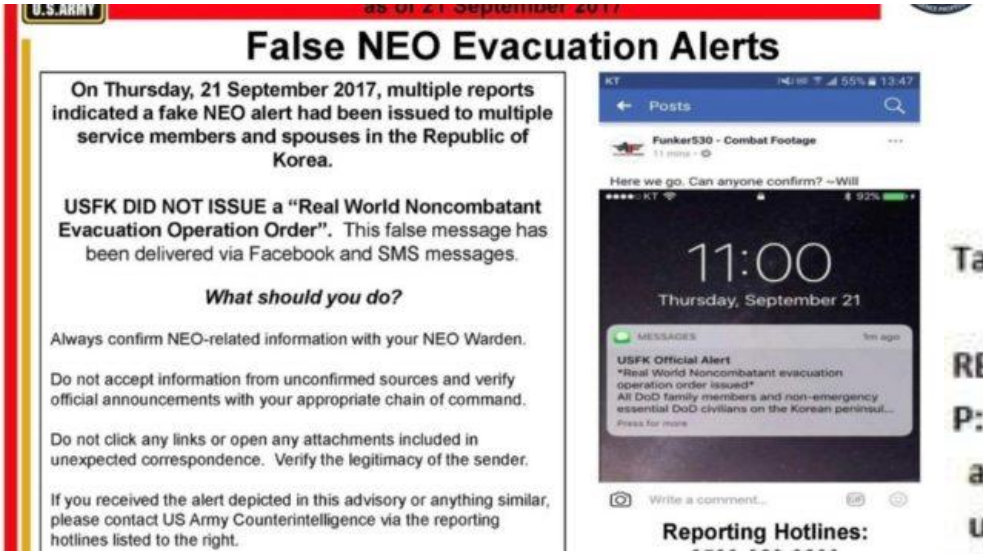
Trident submarine-launched ballistic missile fired on November 7 from offshore Los Angeles
Social Media Storm
Aliens?
Armageddon?
Nuclear attack?
Early warning for CH, RF, DPRK?
Already in play

SF image above from:
https://vimeo.com/145029572?utm_source=AM+Nukes+Roundup&utm_campaign=2dab571683-AM_Nukes_Roundup&utm_medium=email&utm_term=0_547ee518ec-2dab571683-391728633&mc_cid=2dab571683&mc_eid=1d0f44d114

Briefing image in submarine from:
https://www.flickr.com/photos/usstratcom/sets/72157658690516614

False alarms

- Seoul Facebook non combatant evacuation Feb 2017
- Guam false alarm July 2017
- Hawaii false alarm September 2017
- Tokyo false alarm September 2017
- Minuteman/Trident missile launch, Dec 6 2017



False NEO Evacuation Alerts

On Thursday, 21 September 2017, multiple reports indicated a fake NEO alert had been issued to multiple service members and spouses in the Republic of Korea.

USFK DID NOT ISSUE a "Real World Noncombatant Evacuation Operation Order". This false message has been delivered via Facebook and SMS messages.

What should you do?

Always confirm NEO-related information with your NEO Warden.

Do not accept information from unconfirmed sources and verify official announcements with your appropriate chain of command.

Do not click any links or open any attachments included in unexpected correspondence. Verify the legitimacy of the sender.

If you received the alert depicted in this advisory or anything similar, please contact US Army Counterintelligence via the reporting hotlines listed to the right.

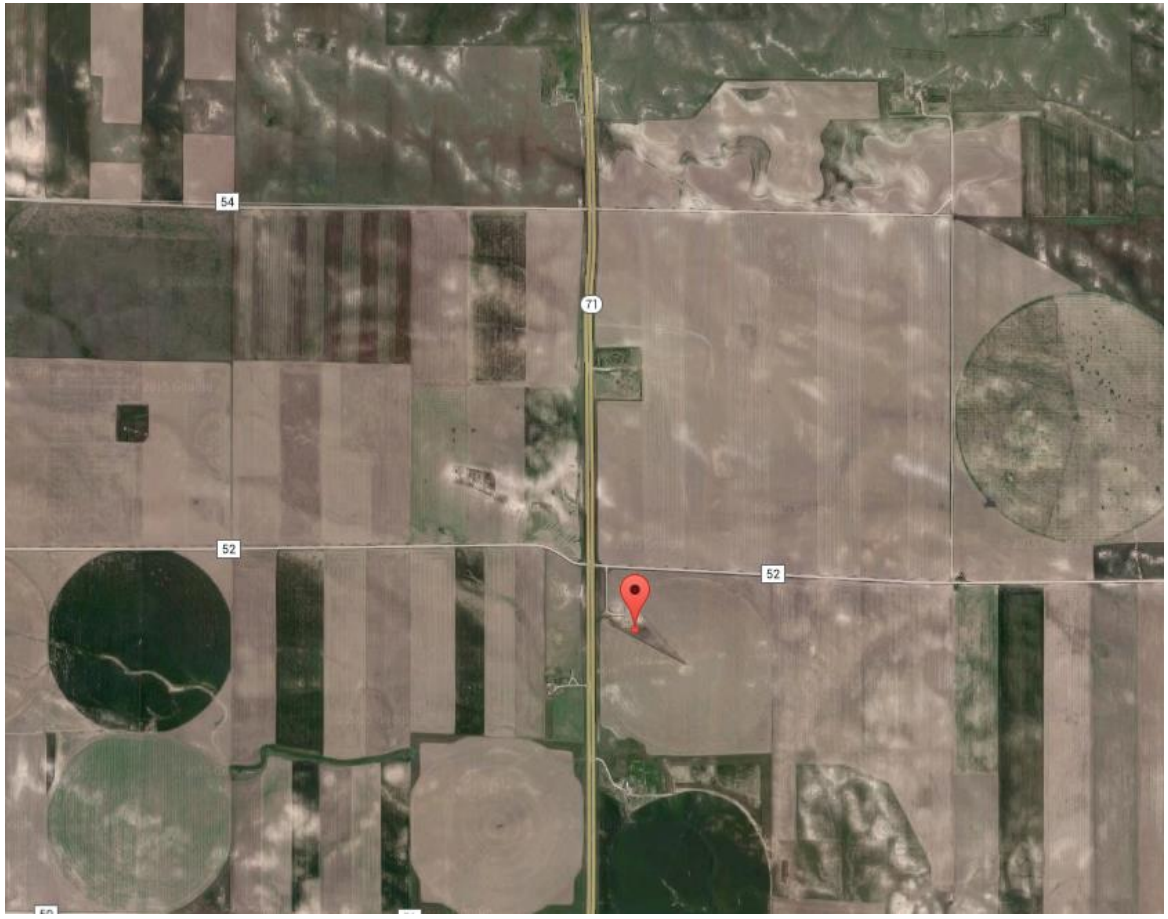
Reporting Hotlines:

Table 2: Combinations of Truth Content and Report

REPORT	TRUTH CONTENT F: FALSE	M: MIXED	T: True
P: POSITIVE attack is under way	FP	MP	TP
C: CONTESTED attack is, is not underay	FC	MC	TC
N: NEGATIVE no attack	FN	MN	TN

Peter Hayes, "REDUCING THE RISK THAT SOCIAL MEDIA STORMS TRIGGER NUCLEAR WAR: ISSUES AND ANTIDOTES", Blue Peter NAPSNet, February 01, 2018, https://nautilus.org/napsnet/reducing-the-risk-that-social-media-storms-trigger-nuclear-war-issues-and-antidotes/

Antidotes-Remedies 2



Kimball Nebraska missile silo at: 41°21’46.0”N 103°39’38.0”W

Antidotes-Remedies 2

Kimball Nebraska missile silo at: 41°21’46.0”N 103°39’38.0”W

Antidotes-Remedies 2

Kimball Nebraska missile silo at: 41°21’46.0”N 103°39’38.0”W

Antidotes for NC3 system failure 3: Duty to Disobey and NC3 Refuseniks?

October 28, 1962: ~ 12.30 am Air Force Capt. William Bassett unit in Okinawa received authenticated launch order to fire Mace missiles *at China* and Russia in spite of Defcon2 not 1 status. He challenged the order, even after it was resent, and took measures to ensure no missiles would be fired, until stand-down order received.
~ 6 hours later in real time
October 27, 1962, ~ 5pm Vasili Arkhipov, political officer on Russian sub B-59 and in command of Russian sub flotilla, voted against firing nuclear torpedo at US aircraft carrier, 1 of 3 votes, after an argument.

September 26, 1983: Stanislav Petrov, lieutenant colonel in the Soviet Air Defense Forces, was the officer on duty at the Serpukhov-15 bunker near Moscow which housed the command center of the Soviet early warning system. Dismissed multiple warnings of incoming US missile attack as errors. Later alarm determined due to rare alignment of sunlight on high-altitude clouds and satellite orbits.

1968 Michael Roach, ADM officer, Korea
1975, Major Harold Hering

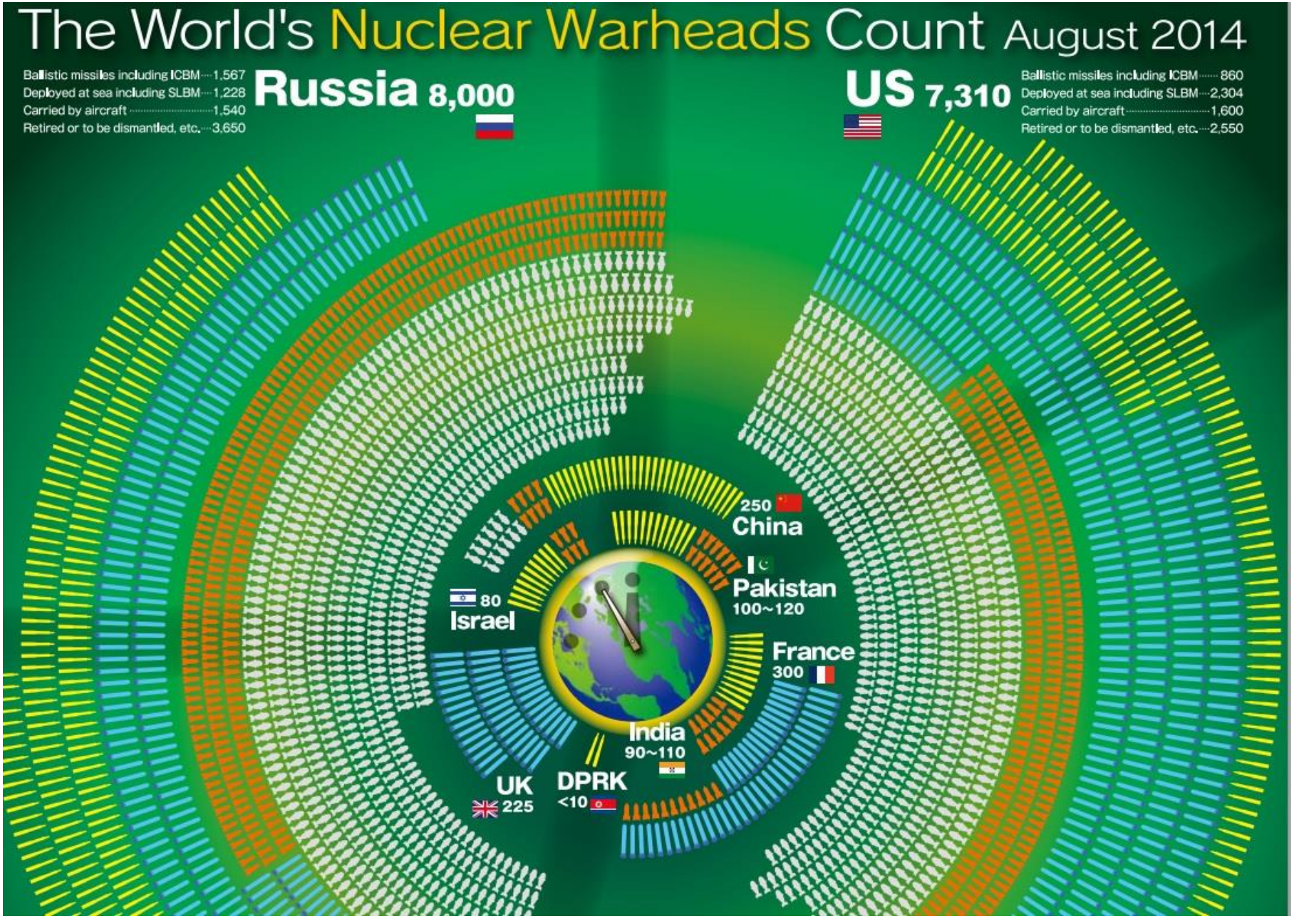
What norms, standards, principles, if any, justify refusal by military personnel at receiving end of NC3 system to refuse to fire nuclear weapons?
Humanitarian law: "manifestly illegal"

- **Necessary**
- **Proportional**
- **Civilian-military principle**

Anthony J. Colangelo, "THE DUTY TO DISOBEY ILLEGAL NUCLEAR STRIKE ORDERS", NAPSNet Policy Forum, October 09, 2017, https://nautilus.org/napsnet/napsnet-policy-forum/the-duty-to-disobey-illegal-nuclear-strike-orders/

Antidote 4

Trade smaller arsenals for upgraded NC3 force multiplier (reducer)



Concluding Thoughts on the Ghost in the NC3 Machine

The Ghost in the Machine refers to long-standing philosophical objection to the mind-body dualism that treats mind [the Ghost] as inhabiting but separate from the body.

NC3 is an extreme example where one can't separate the material from the mental. Behavior matters, especially organization.

NC3 *is* the ghost in the machine, neither independent nor purely material, joining annihilative intention with warheads.

The nuclear commander's psyche, including his or her secret fears, neuroses, psychosis, paranoia as well as rationality, infuse NC3.

But these psychological impulses collide with organizational cybernetics, procedural failure, accidents, degraded decision-making, stereotypical thinking, misinterpretation.

Which leads to the ultimate question: what do we do with the ghosts if we get rid of the machines but keep the people?

蘋果日報

韓星趙敏基自殺亡

C4
《娛樂》版

繪圖 游本源

狂人高峰會 核危機大轉折

川普將見金正恩

Key Research Questions

What are the performance requirements in virtual nuclear command-and-control (and related CISR) systems in organizations that must meet near perfect standards to avoid catastrophic failure (such as nuclear accidents or war) in the Milleniels era?

How well is the social enactment of such exacting systems understood in militaries heavily reliant on automated and computerized control systems?

Do these systems give rise to the illusion of central control over conventional and nuclear operations?

What are the distinct organizational cultures of the US, Russian, Chinese and DPRK militaries and their related CISR systems?

What **tacit knowledge and cultural factors** that contribute to or avoid catastrophic failure in complex technological systems?

What are the implications for strategy stability that arise from their interaction?

What should be done to rectify organizational and cultural differentials—especially their possibly matching rather than offsetting deficits that could generate trigger events or amplify the effects of such events in a crisis?

How do we measure complexity and coupling within and between NC3 systems

Sources:

Karen Marais, Nicolas Dulac, and Nancy Leveson, "Beyond Normal Accidents and High Reliability Organizations: The Need for an Alternative Approach to Safety in Complex Systems," Engineering Systems Division Symposium, MIT, Cambridge, MA, March 29-31, 2004

N. Leveson, *Engineering a Safer World, Systems Thinking Applied to Safety*, The MIT Press, Cambridge, Massachusetts, 2011.

For analysis of control systems analogous to linked national nuclear command-and-control systems, see T. Ishimatsu, N. Leveson, C.Fleming, M. Katahira, Y. Miyamoto, and H. Nakao, "Multiple Controller Contributions To Hazards," paper to *Conference of the International Association for the Advancement of Space Safety* , Versailles, France, October 2011.

T. La Porte, "High Reliability Organizations: Unlikely, Demanding and At Risk," *Journal of Contingencies and Crisis Management*, 4:2, June 1996, p. 64.

Need for Cross-Disciplinary and Cross-Sectoral Research

Command-and-control said to be as much craft as a science, just as deterrence theory is said to be a practice informed by an amalgam of parts of theories, not a theory in its own right.

Beyond organization theory, complexity theory, IR theory, the global NC3 research agenda needs to draw on:

- **Systems engineering**
- **Software theory (coupling)**
- **Discourse theory**
- **Futurist theory**
- **Anthropology**
- **Ethnography**
- **Sociology**
- **History**
- **Ergonomics**
- **Network theory**
- **Complexity theory**
- **Simulation theory and modelling of digital command-control**
- **Thermodynamics**
- **Theories of military command and control**
- **Game theory**
- **Theories of state and decision making**
- **Laws of war, international law, universal law**
- **Translation and multi-linguality**
- **Communication theory**
- **Art theory (of the image, icon, symbol)**
- **Perception theories…**
- **Literary theory**
- **Agent-based modelling**
- **Ornithology (vocalized wave-like transmission of threat warnings)**