Cyber Threats and Nuclear Weapons

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Two types of cyber risk

- Deliberate cyberattack against US may lead to inability to use nuclear weapons when appropriate (e.g., in retaliation)
  - An adversary conducts offensive cyber operations to compromise or degrade a proper and authorized U.S. nuclear use.
- Risk of inadvertent/accidental escalation by the US as result of cyber operation
  - An adversary conducts offensive cyber operations against the US for a non-nuclear purpose and the US misinterprets this act as being for nuclear purposes.
  - An adversary conducts offensive cyber operations to provoke or catalyze an inappropriate use of nuclear weapons (e.g., false flag operation by terrorists)

Possible cyber risks (deliberate) across the enterprise

- Nuclear weapons design and production (and stewardship)
  - corrupted nuclear simulation codes, databases ➔ degraded or unwarranted confidence in judgements of stockpile reliability
- Nuclear delivery systems
  - Cyber vulnerabilities to compromise nuclear delivery systems
- Nuclear command, control, and communications
  - Glitches in early warning/attack assessment (EW/AA) cause false warning of attack; cyberattack causes EW/AA to fail to warn of actual attack
  - Nuclear planning: data corruption leads to suboptimal outcomes
  - Nuclear decision-making
    - Conflations between nuclear/conventional, intelligence/attack preparation ➔ overreaction
    - Corruption of decision-making processes through cyber-enabled information operations
  - Cyber attack or glitches cause disconnect of NCA with nuclear forces
  - Crisis communications with adversaries
- Nuclear operations
  - Execution of operational plans—turning plans into effects

Deliberate risk: What DOD penetration testers could do

- Testers took one hour to gain initial access to a system, one day to gain full control.
- Security measures prevented access by remote users, but not insiders and near-siders.
- Testers took control of the operators' terminals, and …
  - Saw, in real-time, what the operators were seeing on their screens
  - Manipulated the system.
  - Able to disrupt the system and observe how the operators responded
- Testers caused a pop-up message to appear on users' terminals instructing them to insert two quarters to continue operating.
- Testers were able to copy, change, or delete system data, including one team that downloaded 100 gigabytes of data.
- Testers successfully used default passwords for open-source software to achieve access.
- Testers found one system using access controls but also unencrypted communications that allowed them to capture credentials in transit.
- Testers were sometimes detected but no action was taken.
- Testers rebooted a system in operation.

Known vulnerabilities represent a fraction of total vulnerabilities

- Not all programs have been tested
- Tests do not reflect the full range of threats.
- Review sometimes prohibited for proprietary software(!)
- Cybersecurity testing would interfere with operations.

Program officials said systems were secure and discounted some test results as unrealistic(!)

Inadvertent/accidental risk: hypothetical scenarios

Scenario 1: Cyberattack vs espionage/intelligence gathering

- During crisis (or during limited conventional conflict), U.S. detects Russian or Chinese cyber intrusion in nuclear NC3.
  - US is concerned that R/C is attempting to degrade US nuclear capabilities
  - R/C wants to know that US is not preparing to escalate to nuclear.

Scenario 2: Cyberattacks on dual-purpose targets

- Some US systems serve both conventional and nuclear missions.
  - During the initial phases of a conflict, R/C conduct offensive operations to degrade U.S. conventional capabilities.
  - US sees cyberattacks on systems with a nuclear mission, raising concerns that R/C seeks to degrade US nuclear capabilities
  - Examples: US early warning satellites, AEHF communications satellites

In both scenarios, US and R/C perceptions of intent underlying cyber intrusion are entirely different!

Policy implications

- Entanglement of conventional/nuclear systems raises the risk of inadvertent nuclear escalation.
  - Operational advantages in warfighting must be weighed against an increased escalatory risk.
  - Minimize possibility that cyber attacks on conventional assets will be seen as attacks on nuclear.
    - Require impact statements as part of war plans to ensure consideration of possible adversary conflation between attack on conventional vs nuclear capabilities
    - Require impact statements for U.S. systems regarding nuclear decision making by both adversaries and U.S. decision makers.
  - US STRATCOM should have acquisition authority for nuclear C3.
  - Decision makers should develop an independent backup system to provide the minimum essential core functionality for NC3.
  - Assured communications channels between nuclear adversaries should be maintained.

- Legacy NC3 system has not failed catastrophically, and corrective procedures and technology have been deployed. Can't say the same for any modernized system.
  - System architects should ensure that a modernized system does what a legacy system would do in the same situation and should run both systems until the track record is proven.
  - Downside of keeping two systems running simultaneously for multiple years is high—more people; more cost—but it's worth it.

- The tension between keeping up with a rapidly changing threat environment and maintaining adequate cybersecurity posture cannot be resolved.
  - Designers of modernized computer-driven systems, whether NC3 or weapons platforms, should moderate their appetites for increased functionality.
  - Users and designers must be prepared to make trade-offs between measures to reduce cyber risk and performance requirements.
  - Reduce conventional-nuclear integration (often done to reduce cost)
- Do best practices for cybersecurity
  - All of the cybersecurity problems already identified across the nuclear enterprise should be fixed!
  - Do periodic red-teaming against nuclear-capable systems.
  - All operators should take precautions that would be necessary if they were using systems and networks known to be compromised by an adversary.
    - Inconvenient, but the only way to limit the effects of an actual security compromise.
    - Systems should a possibility of manual control for humans to take over a minimal set of functions when necessary.
- Strategic choices can compensate for additional cyber risk to some extent.
  - Elimination of LOW has some negative effect on credibility of deterrence threat but also allows time for decision making and technical examination of systems to address risk of cyber failure.
  - As Prob [attack on ICBMs] decreases, risk of cyber failure becomes relatively higher.
  - Reconfiguration of U.S. nuclear forces to eliminate such missiles could reduce cyber risks associated with short warning times.

For more information…

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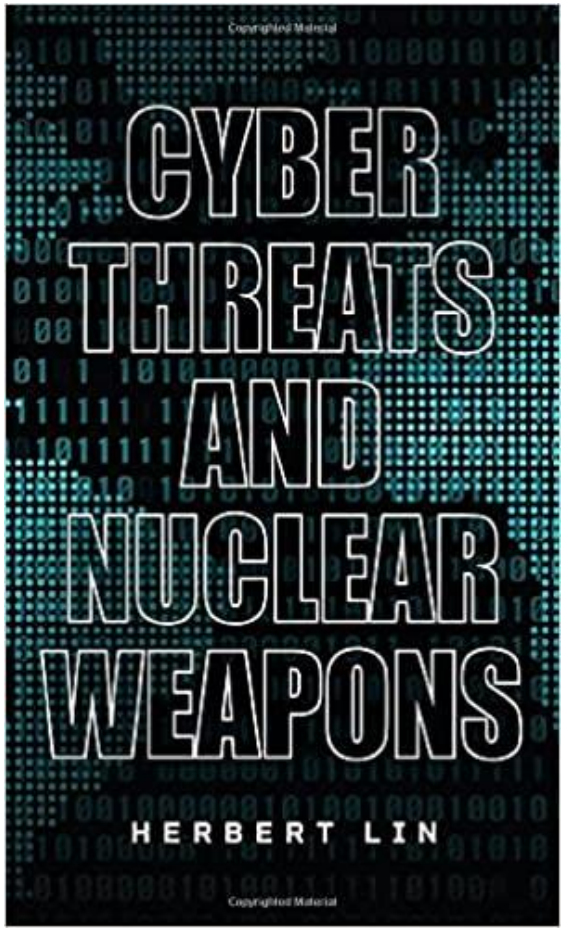

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