



Emerging Technologies and Strategic Stability

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An abstract graphic featuring a network of glowing nodes connected by thin lines. The nodes are primarily yellow and green, with some blue nodes at the top. The background is a gradient from dark blue at the top to orange at the bottom. The network structure is dense at the bottom and more sparse at the top.

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Sept 6 2007.

On 14 October
[The New York Times](#) cited
U.S. and Israeli military
intelligence sources saying the
target had been a nuclear
reactor under construction by
North Korean technicians.

How did non-stealthy Israeli
aircraft penetrate without
interference against
competent Syrian air defense?

How did Israel do it?

- Not just “brute-force jamming
- Network penetration:
 - remote air-to-ground electronic attack
 - penetration through computer-to-computer links
 - “Higher-level, non-tactical penetrations”
- Sophisticated network attack and electronic hacking (part of the Israel Defense Forces arsenal of digital weapons--and of other militaries)

<https://www.military.com/defensetech/2007/11/26/israels-cyber-shot-at-syria>

Essentially this was a cyber attack from the air.

- Modified aircraft allowed specialists to hack into Syria’s networked air defense system
- Network raiders can conduct their invasion from an aircraft into a network and then jump from network to network until they are into the targets communications loop.
- Whether the network is wireless or wired doesn’t matter anymore (according to U.S. industry specialist.)

Illustrative of a suite of capabilities that every advanced military has, or will soon have.

- Secretive capabilities
- Developing quickly, and often proliferating
- We often learn of a capability when it is first used (e.g. Stuxnet)

We divide capabilities into cyber or conventional or nuclear.

What happens at the confluence of these elements?

Roadmap:

- **Defining terms:**
 - What is “**strategic stability**”?
 - What are “**emerging technologies**”?
- **Three types of capabilities** that emerging tech offers: striking, sensing, disrupting
- What are people worried about?
 - **Nuclear use**—will emerging tech lower bar to accidental, inadvertent, or intentional use?
 - **New arms race** (among existing nuclear possessors)
 - **Proliferation to new states**
 - **Challenges** (and opportunities) to disarmament
- **Possible stabilizing benefits** of emerging tech
- **What can be done?** (By governments and by non-governmental groups)

What do we mean by strategic stability?

“First-strike stability”

- *Delicate Balance of Terror* (Albert Wohlstetter)
- A stable equilibrium in which countries are confident that their adversaries would not be able to undermine their nuclear deterrent capability.
 - “stability of mutual deterrence”

Related concepts: “crisis stability,”

“arms race stability”

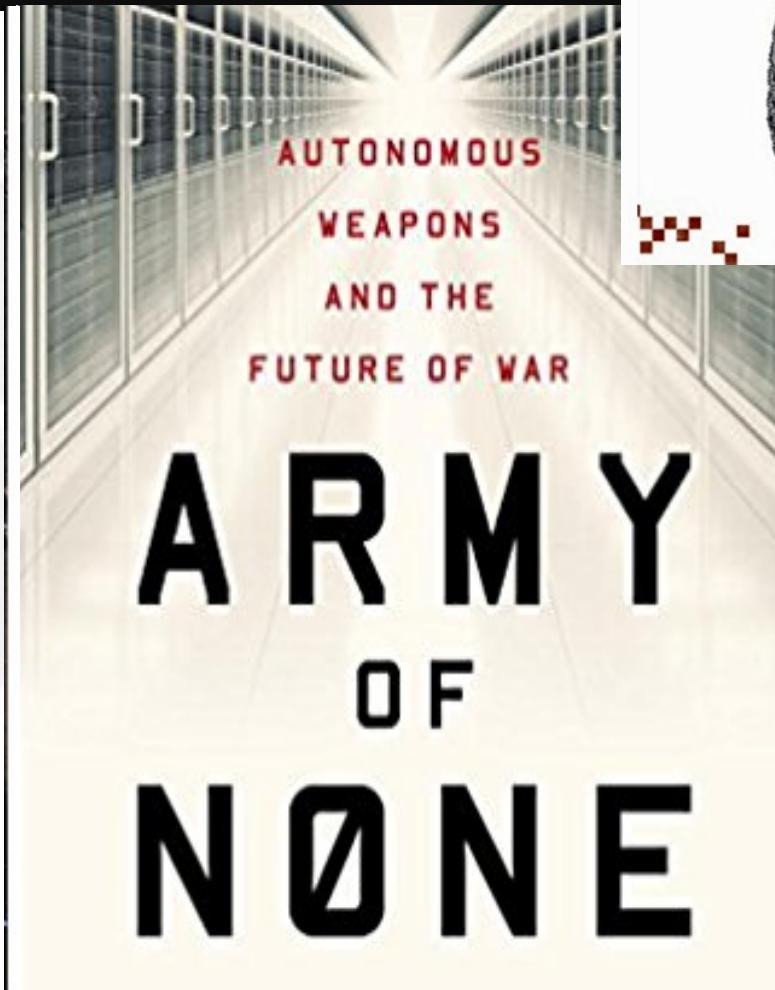
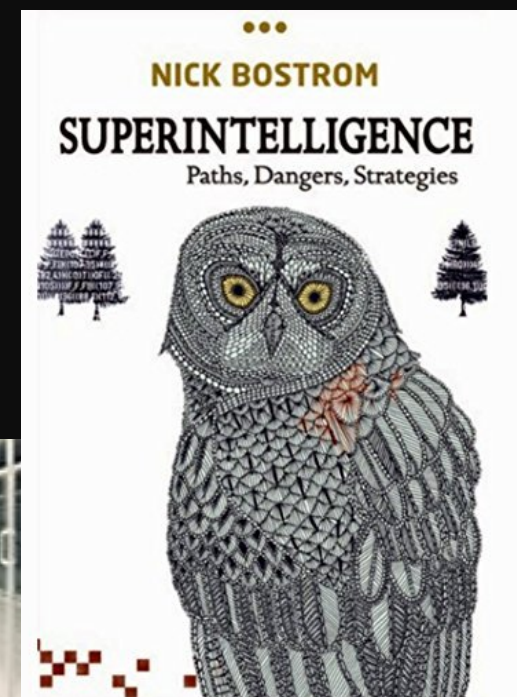
“Conflict stability”

- Bridge Colby: (*Strategic Stability: Contending Interpretations*)
- “must incorporate...ways in which nuclear weapons deter...other forms of aggression against a nation’s core interests”
- “strategic stability should be understood to mean a situation in which no party has an incentive to use nuclear weapons save for vindication of its vital interests in extreme circumstances.”

What do we mean by “emerging technology”?

- **Cyber weapons**
- **Artificial intelligence/Machine Learning**
 - Autonomous weapons
 - Enabling autonomous systems
- **Space:**
 - Proliferation of military assets in space—and reliance upon them
 - Potential space weapons
 - Counter-space weapons (some terrestrial, some space-based)
- **Hypersonic weapons** (boost glide and cruise missiles)
- **Next gen ballistic missile defense:** right now, missile defense doesn't work except in narrow circumstances. What if tech advances (e.g directed energy) allowed it to work?
- **Other**

Science Fiction to Science Reality?



Cyber warfare / Digital warfare

1. **Direct threat to control of nuclear weapons**
 - Cyber “Achilles’ heel”? U.S. Minuteman missiles were vulnerable to a disabling cyberattack, and no one realized it for many years.
2. **Attack on civilian nuclear power plant or fuel cycle facility.**
3. **Alternative vector of attack** (asymmetric) that could lead to conventional conflict and escalate to nuclear conflict.
4. **Challenge to situational awareness**
5. **Challenge to concealment (and thus survivability) of nuclear delivery systems**
 - Paul Bracken: cyber = “collection of digital technologies and links”; key to tracking mobile targets....If you can track an adversaries weapons, you can disable them.

Machine Learning and Artificial Intelligence (AI)

- **AI as the enabling technology** for a fourth industrial revolution
 - How does this affect strategic stability?
1. **Robotics, continued evolution of unmanned vehicles, etc.**
 2. **Fully autonomous weapons (LAWS)**
 3. **AI-enabled cyber attack**
 4. **AI-enabled network of sensors**
(terrestrial, aerial, space, undersea) could allow countries to pinpoint, with high confidence, the location of an adversaries assets.

Penetrating

Group 5

- > 1320 lbs
- > FL180



USN
UCLASS



FAA-XX

Persistent

Group 4

- > 1320 lbs
- < FL180



Tactical

Group 3

- < 1320 lbs
- < FL180
- < 250 knots



Small Tactical

Group 2

- 21-55 lbs
- < 3500 AGL
- < 250 knots



Micro/Mini Tactical

Group 1

- 0-20 lbs
- < 1200 AGL
- < 100 knots

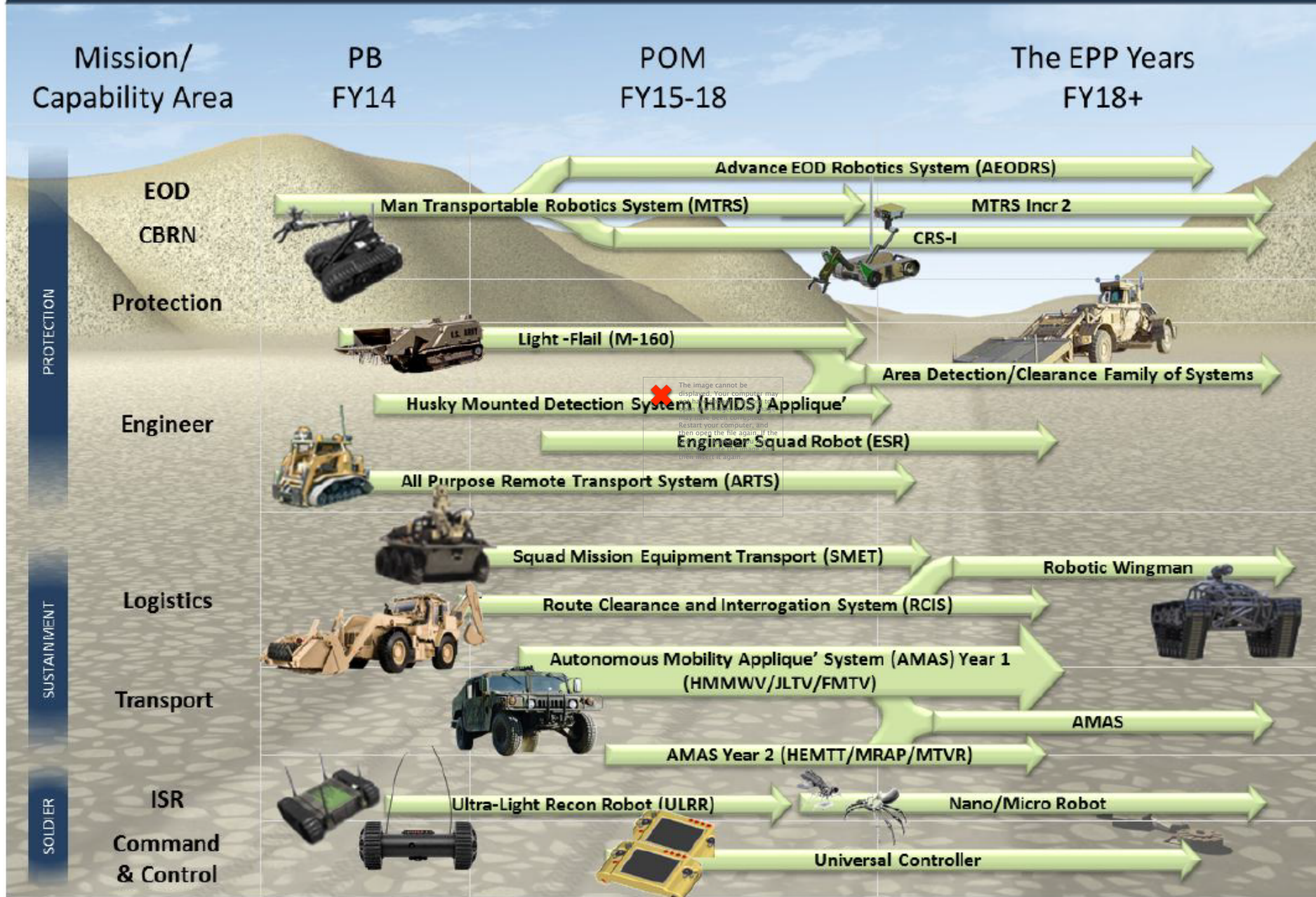


Small Family of Systems



USA Nano UAS

Unmanned Ground Systems



Unmanned Maritime Systems (PB13 and beyond)

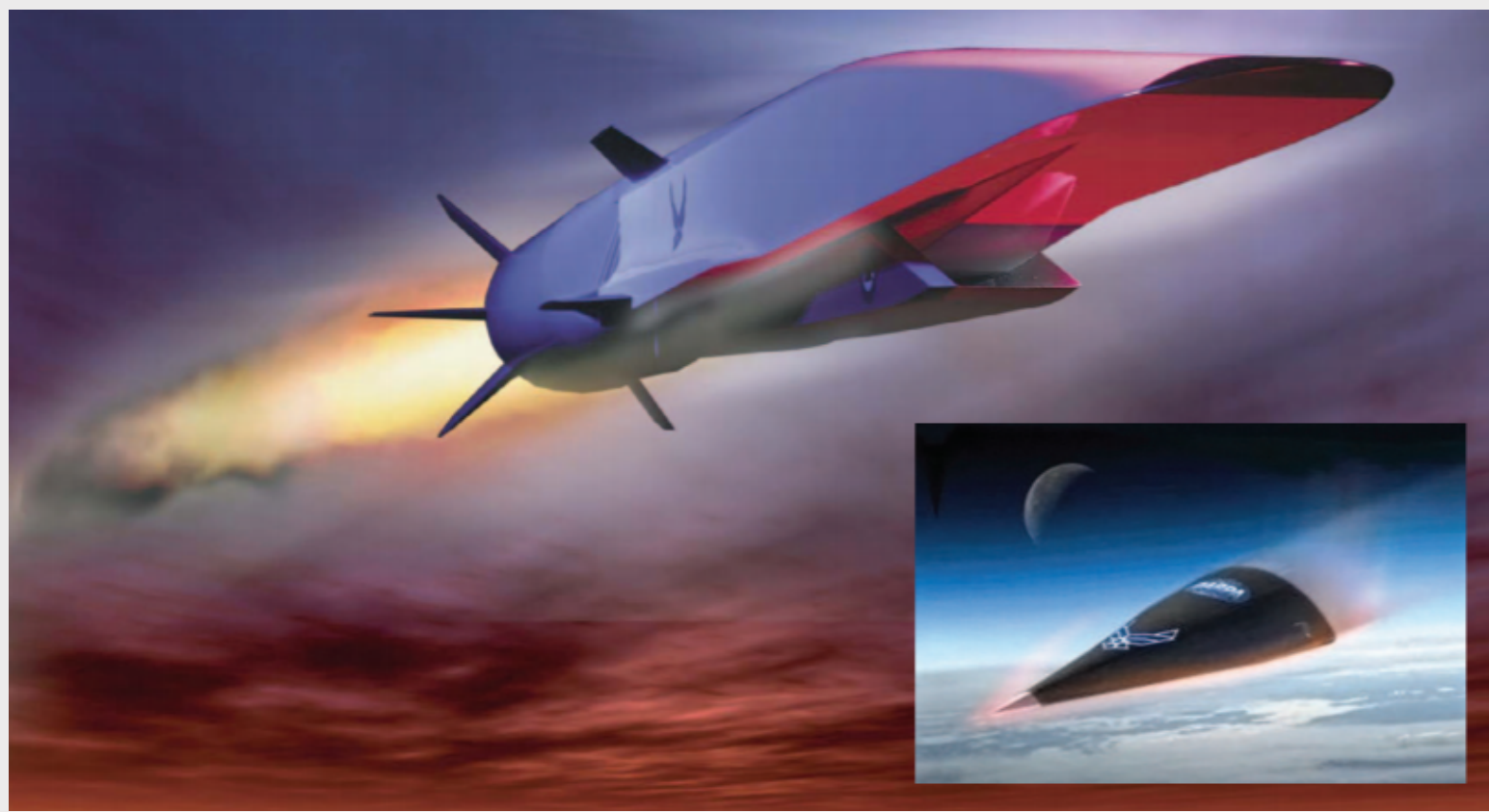


Space and counterspace

- Modern military operations rely heavily on space for navigation, surveillance, and communications
- Will space become the next frontier for warfare?
- Denying an adversary situational awareness is now routine at the start of military operations.
- What happens when countries rely on the same assets for tactical warfighting and for their strategic deterrent?
- Morning's conversation on "entanglement"

Hypersonic weapons

- Testing by US, Russia, & China.
- Two distinct weapons:
 - Hypersonic cruise missiles – uses “scramjet”
 - Hypersonic glide vehicles (HGVs)—initially propelled by rocket but then glide using aerodynamic forces in flight. Maneuverability means gliders can conceal their target until seconds before they hit.

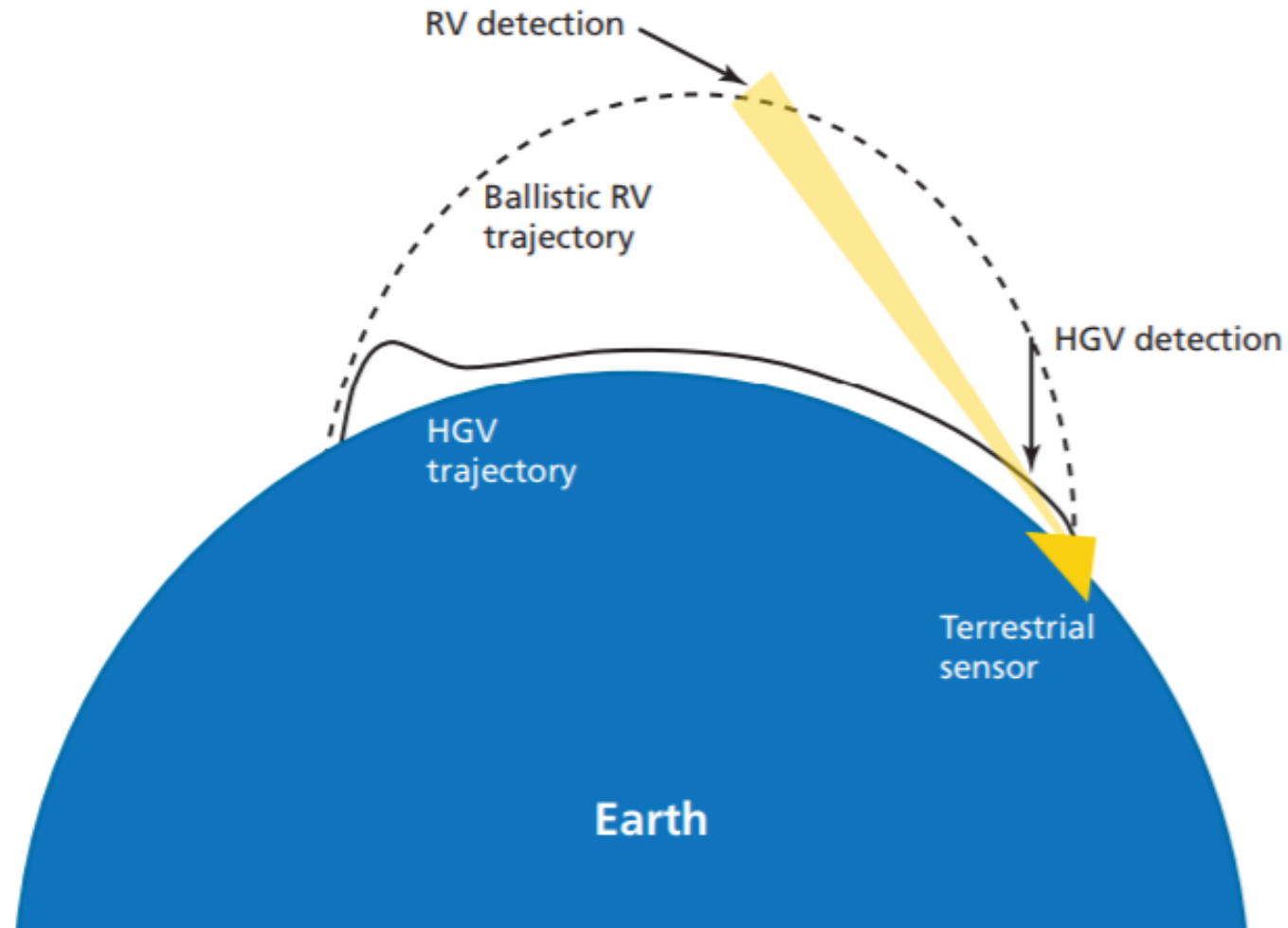


Both systems:

- Compress decisionmaking time
- Create target ambiguity
- Create problems for missile defenses

Detected 12 minutes from impact → 6 minutes

Figure 2.2
HGV Versus RV Terrestrial-Based Detection



Next generation ballistic missile defense

- Today's missile defenses only work in narrow circumstances
- There are relatively simple countermeasures to defeat them
- But a suite of technologies are advancing that may make the Reagan's dream of a real missile shield a possibility.
- Space-based? Boost phase? Lasers?

Social media?



Donald J. Trump 

@realDonaldTrump

Just heard Foreign Minister of North Korea speak at U.N. If he echoes thoughts of Little Rocket Man, they won't be around much longer!

11:08 PM - 23 Sep 2017

Nothing new in concern over “new technologies”

- Throughout nuclear era, each new capability led to concern about strategic stability:
 - ICBMs
 - MIRVs (Multiple Independently Targeted Re-entry Vehicles)
 - Cruise Missiles
 - Missile Defense
 - Stealth
 - Accuracy revolution
 - ...and others

Nothing new in concern over “new technologies” (2)

- **1970 Pugwash Symposium: “The Impact of New Technologies on the Arms Race”** drew attention to how advancements in intelligence, surveillance, and precision guidance might alter the dynamics of the U.S.-Soviet nuclear balance.
- The monograph that resulted predicted many of the important technological security challenges that emerged during the next twenty years.

But is this time different?

- **Faster technological rate of change**
 - AlphaGo to Alpha Zero
- **Covert, unobservable capabilities** (cyber and AI) create greater risk of strategic surprise
 - Austin Long and Brandan Rittenhouse Green
- **Private sector driving key innovations** (cyber, AI, sensors, data integration, biotech)
 - Proliferation and arms control harder

What are people worried about?

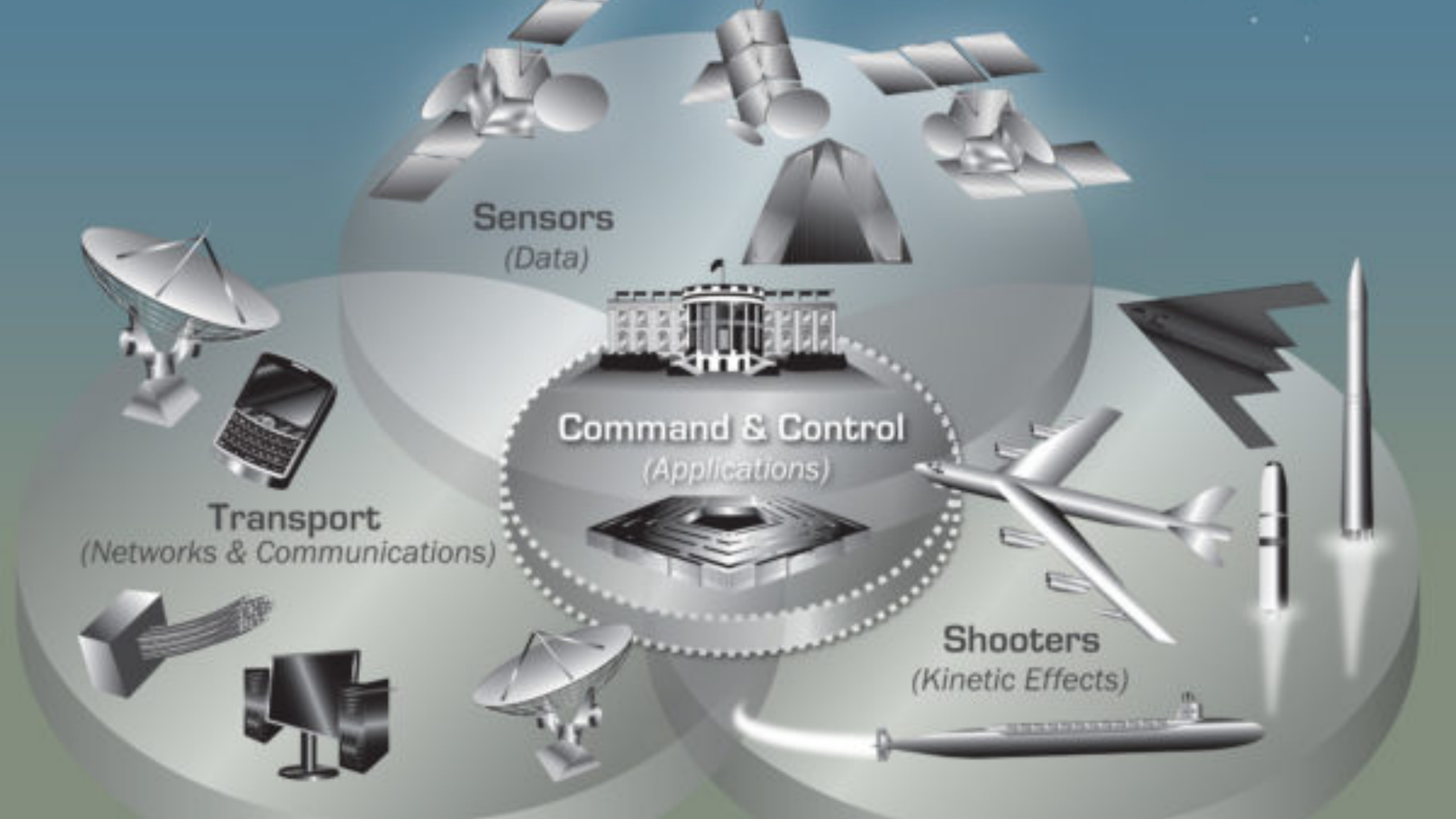
Hypothesis:

- Emerging technologies will change the dynamics of conflict and war;
- This includes the way countries think about nuclear weapons and how they employ them.
- Combine this with increasingly complex geopolitical relationships (more deterrence dyads)
- Are we entering a “second nuclear age” driven by dynamics different than the first? (Paul Bracken)

Three types of capabilities that emerging tech offers:

- **Striking** -- hypersonics, continued accuracy advances
- **Sensing** – drones, autonomous sensors, small sat revolution, SAR, AI
- **Disrupting** – cyber, missile defenses

Emerging tech allows advances in all three areas.



Sensors
(Data)

Command & Control
(Applications)

Transport
(Networks & Communications)

Shooters
(Kinetic Effects)

The Nuclear Counterrevolution?

- Rapid tech change and tech diffusion are already **calling into question inherited truths about nuclear weapons and strategic stability**
- **The nuclear revolution:** Nuclear weapons create slaughter and stalemate, and change nature of war.
- **Countries have never been comfortable with this** (see Frank Gavin's research) and have sought ways to escape.
- **Will new technologies provide an avenue to escape from mutual vulnerability?**
 - Press and Lieber articles

Broader implications of emerging tech

- Rapid tech change may have broader implications for international security and balance of power that have nothing to do with nuclear weapons.
 - However, this too could affect decisions to acquire and retain nuclear weapons
- For example:
 - Will new forms of weaponry make nuclear weapons obsolete?
 - Will nuclear weapons become the “poor man’s weapon,” a way to offset the advantages of the most advanced militaries?

New technologies will spread—and interact with a growing web of deterrence relationships

- US – Russia (Nato-Russia)
- US – China
- Russia – China
- China — India
- India—Pakistan
- Israel—regional competitors
- DPRK—US (DPRK-ROK, Japan)
- Others...

What about the benefits?

- In what ways could emerging tech improve strategic stability?
 - Improve situational awareness
 - Lowers barriers to “Dual phenomenology”
 - Levels the playing field—democratization allows states to verify on their own without having to take others words for it
 - AI advisors could reduce false alarms and reduce chance of being caught off guard
 - AI is being integrated into cybersecurity defense
 - Uncertainty about what new technologies and adversary might have could deter states from seeking short term advantage

What can be done to reduce the negative and accentuate the positive?

- How can governments adapt?
- What about Universities?
- What about the NGO sector?

RFP: New Technologies and Nuclear Risk

- Launched December 2016
- Received 53 LOIs qualified proposals (11 international):
 - Cyber (16)
 - AI (6)
 - Space (4)
 - SSBN (4)
 - Social media (4)
 - Missile defense (3)
 - New Nukes (2)
 - Advanced conventional (2)
 - Other or multiple techs (12)
- Two rounds of external review, 14 reviewers overall. Each finalist proposal reviewed 5 times.

Eight proposals selected

- **University of California, Berkeley:** Impact of nuclear weapons with low yields or alternate effects on nuclear stability
- **Center for Strategic and International Studies:** How emerging technologies may undermine strategic situational awareness and lead to nuclear crises
- **Carnegie Endowment for International Peace:** Dialogues between US, Russia, and China on cyber threats to nuclear command and control
- **Royal United Services Institute/ Middlebury College:** Understanding the impact of advanced conventional weapons in non-nuclear-weapon states
- **Atlantic Council of the United States:** On cyber, space, and missile defense and the shifting power balance affect nuclear stability
- **Australia Nation University,** On new technologies and sea-launched nuclear weapons.
- **Stockholm International Peace Research Institute:** On artificial intelligence and strategic stability
- **Center for Strategic and Budgetary Assessments:** Applying historical cases in which technological developments affected strategic stability

The image features a complex network of glowing nodes and connecting lines, resembling a molecular structure or a data network. The nodes are small circles, some of which are brightly lit with a yellow or orange glow, while others are dimmer. The lines are thin and connect the nodes in a web-like pattern. The background is a smooth gradient, transitioning from a dark blue at the top to a warm orange at the bottom. The overall effect is one of dynamic energy and interconnectedness.

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