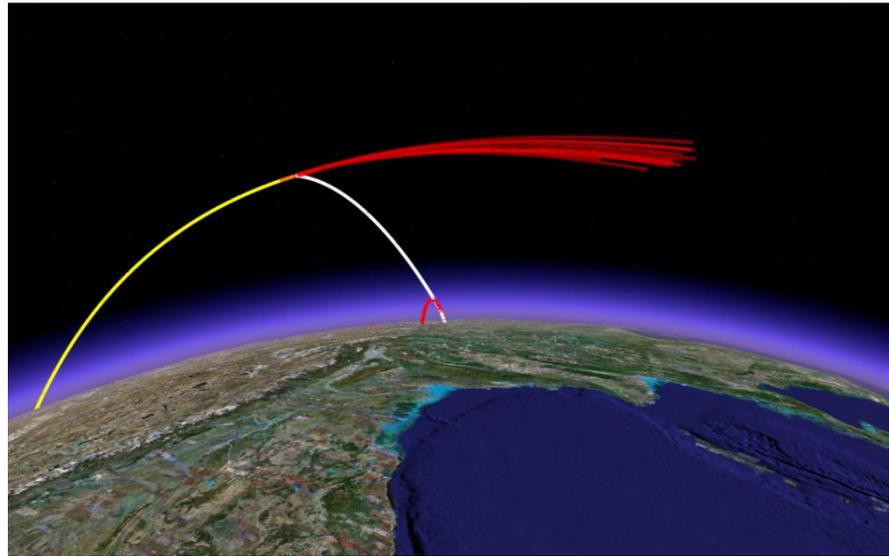


Protecting Space Assets Through Denial Deterrence

Brian Weeden
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- The challenge of protecting space assets
- Deterrence concepts
- Denial deterrence for space
- Examples from the IT world
- Towards a space protection strategy
- Key enabling technologies

THE CHALLENGE OF PROTECTING SPACE ASSETS



Chinese SC-19



Soviet Co-Orbital



US ASM-135



US Aegis SM-3

*“The last Titan rocket, 4B-26, was launched on Oct 19. It deployed USA 186, a classified NRO satellite, into polar orbit. **Hobbyists have observed the satellite and determined its orbit to be 264 x 1050 km x 97.9 deg. This confirms that the satellite is one of the imaging reconnaissance satellites, replacing a satellite launched in 1996.**”*

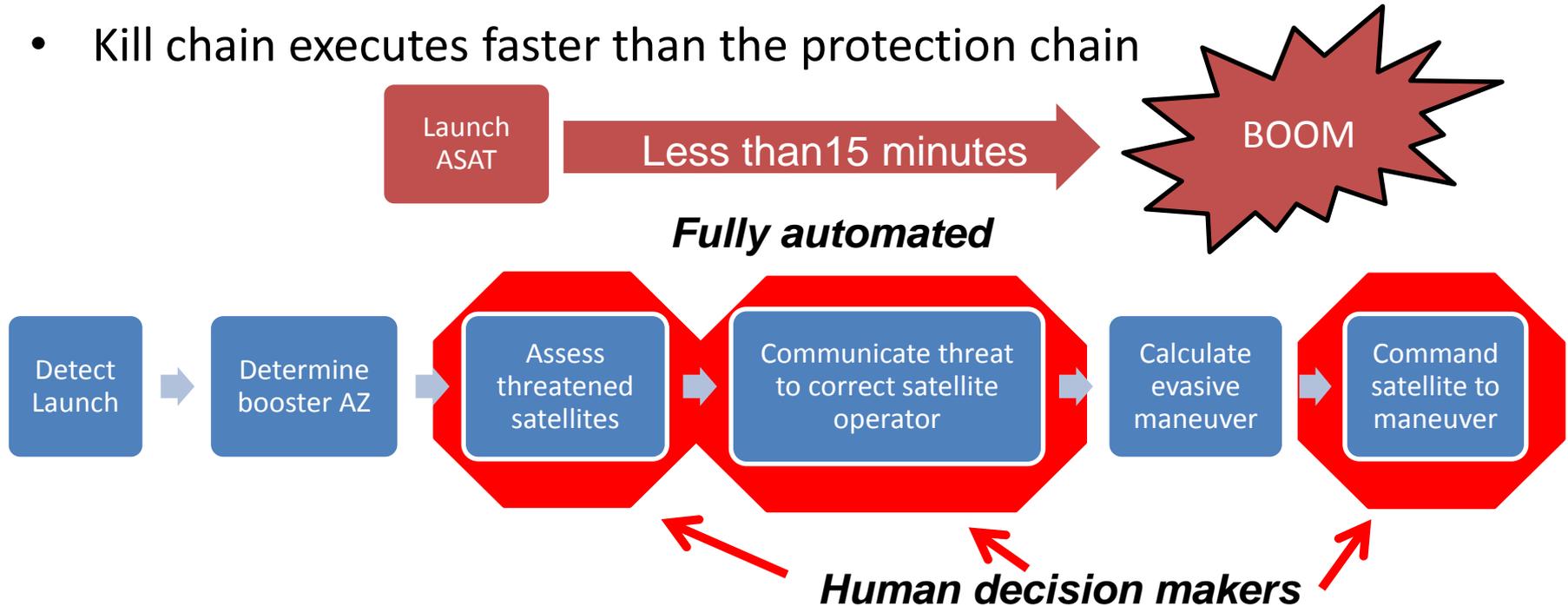
– Jonathan's Space Report, Nov 2005



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28888 05 042A 2701 G 20080816020752690 17 25 0218065+573443 18 S
28888 05 042A 2701 G 20080816020811950 17 25 0329816+593344 28 S
28888 05 042A 2701 G 20080816020940570 17 25 0611645+523739 18 S
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1 28888U 05042A 08229.08029740 .00005163 00000-0 48953-4 0 07
2 28888 97.9296 290.4131 0543547 73.9612 292.0741 14.75806181 00
```

- Kill chain executes faster than the protection chain



- Could **possibly** solve the answer with on-board auto-detection systems
- Physics of last minute maneuvers almost impossible (delta-v)
- False alarms (Sun glints? Passing debris?) and spoofing prevention
- What's the risk of accidental airbag deployment?

- Maneuvering high-value satellites before crossing into hostile territory would put them out of range of direct ascent ASATs....**but**:
 - What's the quality of your intelligence on the ASAT locations?
 - Are the ASATs mobile?
 - How do these avoidance maneuvers affect the ability of these satellites to conduct their missions?
 - Sun-sync: change in altitude requires change in inclination, both affect ground-track repeat
 - How many times can you do this before fuel is an issue?
 - 10 ASATs at < \$100M each force a \$1B satellite to maneuver 10 times for 100% of its fuel = Attacker Win

If a maneuvered satellite cannot fulfill its mission, the attacker wins!!

DETECTING ATTACKS ON SPACE ASSETS

deterrence (noun):

- 1) *the act or process of discouraging actions or preventing occurrences by instilling fear or doubt or anxiety*
- 2) *a communication that makes you afraid to try something*
- 3) *a negative motivational influence*

See also: discouragement, intimidation, disincentive

This is known as reprisal deterrence

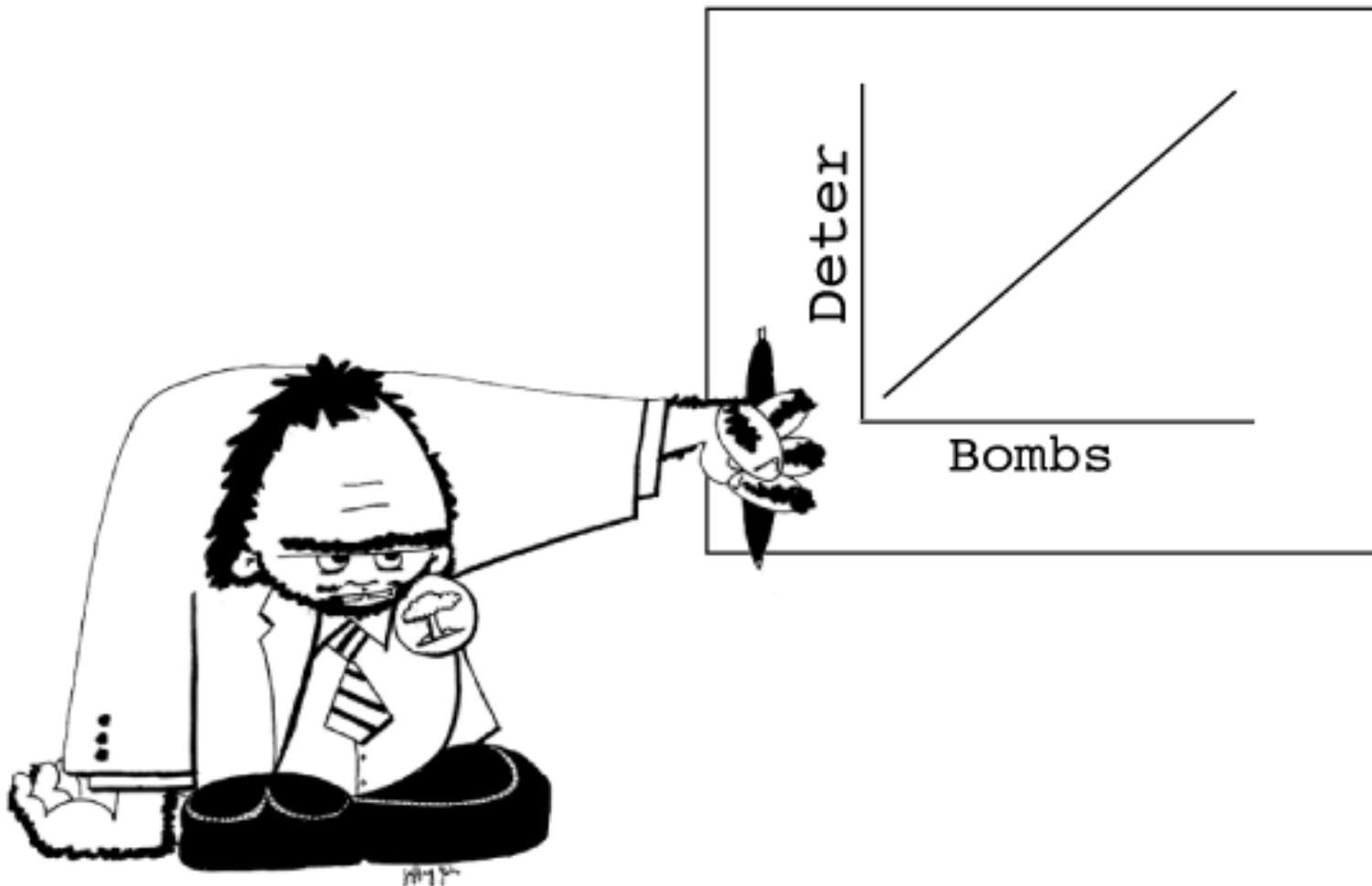
Common forms of reprisal deterrence

Promoting ~~Cooperative~~ Solutions for Space Security



The usual military approach to deterrence

Promoting ~~Cooperative~~ Solutions for Space Security



More Bombs Deter More. Next Slide Please.



- Feb 2000 – March 2004
- 275 alerts
- 12th Missile Squadron, Malmstrom AFB



denial deterrence:

*detering attacks by removing any
advantage an attacker would gain*

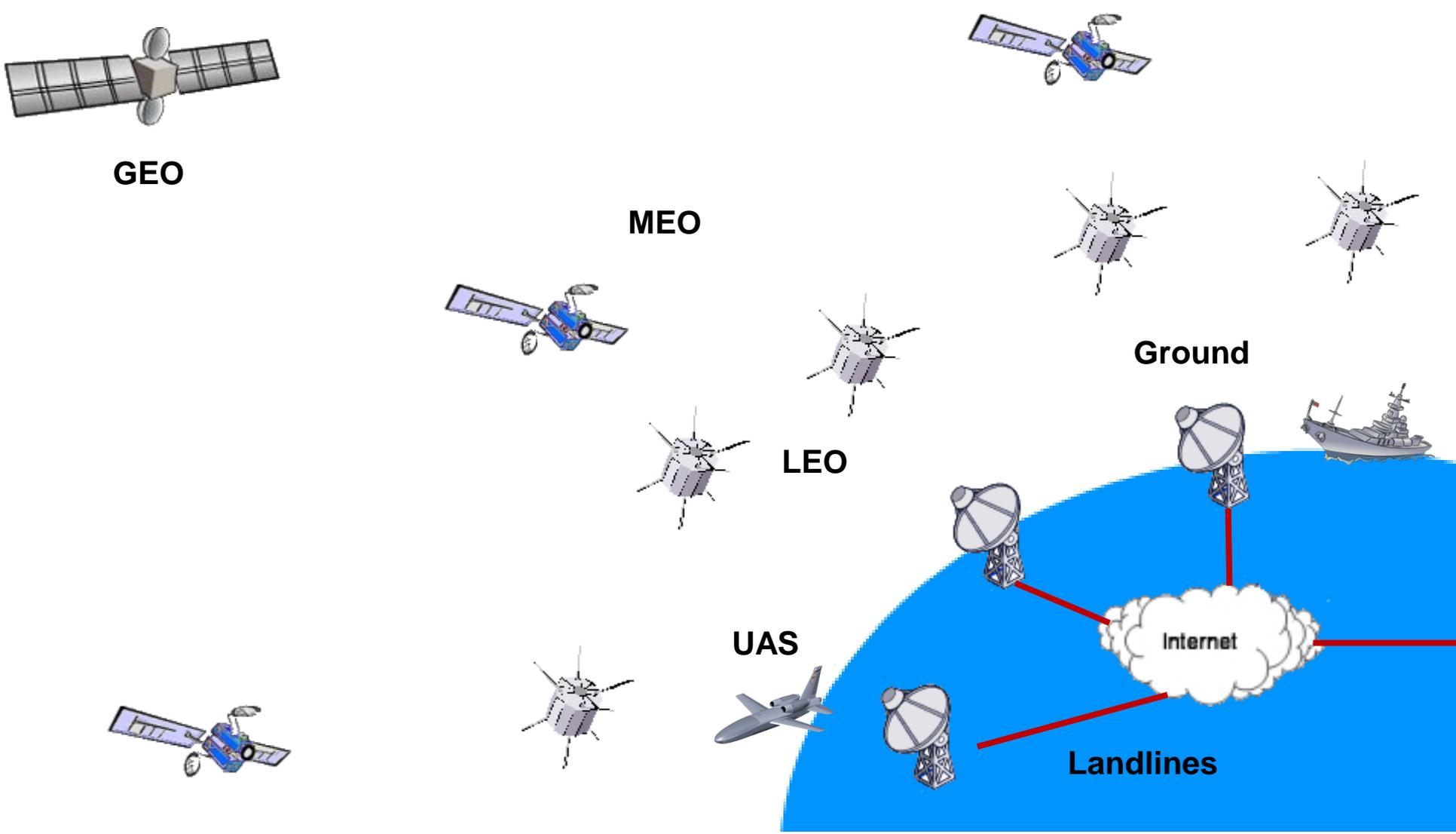
- **Shift from one/few critical nodes to many nodes**
 - “A Multi-tiered Microsatellite Constellation Architecture” Astropolitics, Volume 6 Issue 2 (2008)
 - Presented here by Dr. William Marshall of NASA AMES last year
- **Redundancy on multiple levels**
 - Multiple satellites in same orbit regime and across different orbit regimes providing same function
 - Robust links between space, air, sea and ground systems
- **Easy node replacement**
 - Smaller, lighter, cheaper satellites
 - Faster, more agile acquisition cycle
 - Operationally Responsive Space

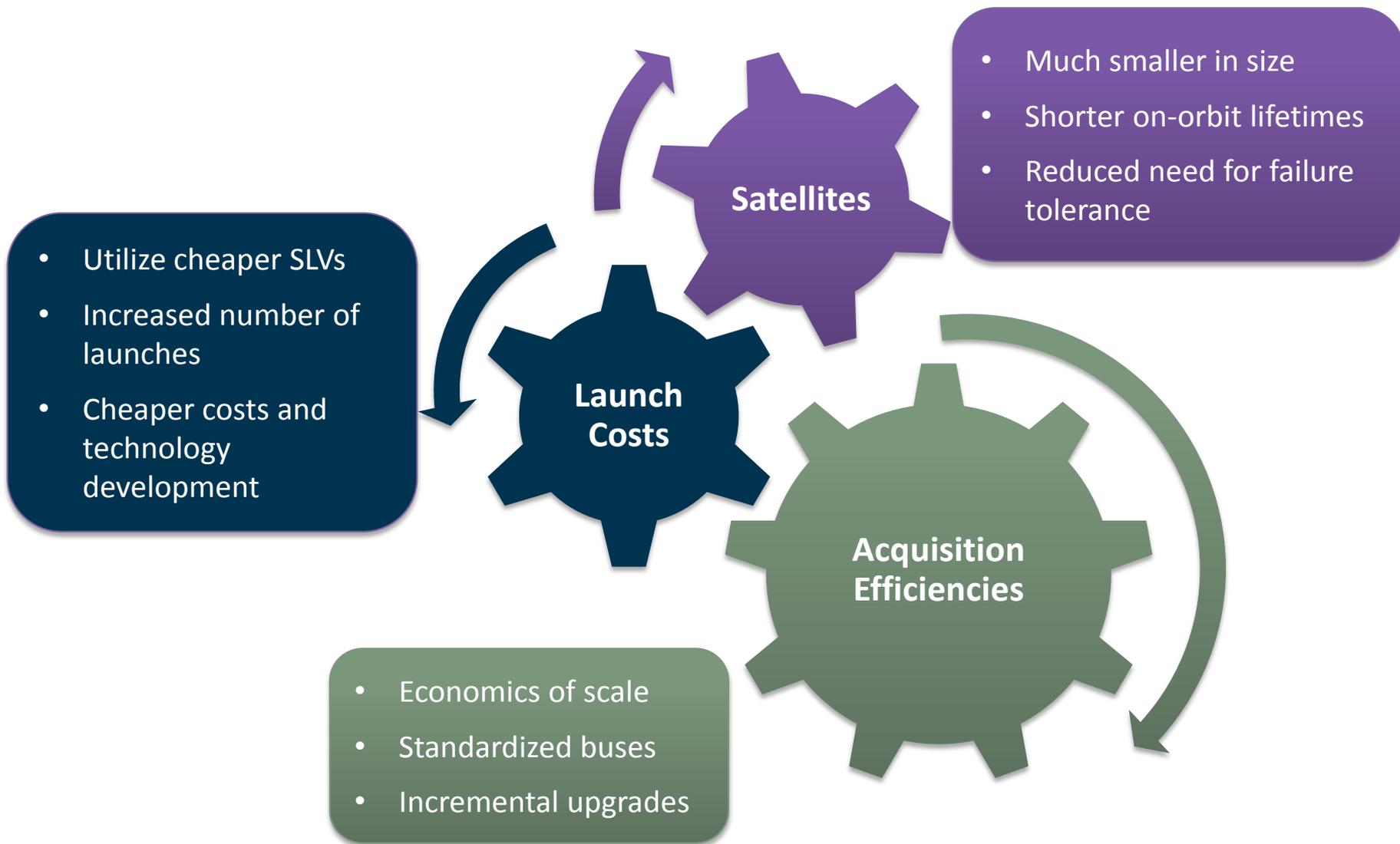
System	Notional Current		Proposed MMCA	
	# of Nodes	Size Each	# of Nodes	Size Each
Early Warning	10 GEO	2,500 kg	12 MEO	150 kg
			12 GEO	150 kg
Remote Sensing	10-12 LEO	15,000 kg	50 LEO	400 kg
			10 MEO	150 kg
Comm	6 HEO	2,000 kg	21 LEO	100 kg
	25 GEO	2,000 kg	80 GEO	100 kg

*numbers taken from Astropolitics paper by William Marshall

Redundancy on multiple levels

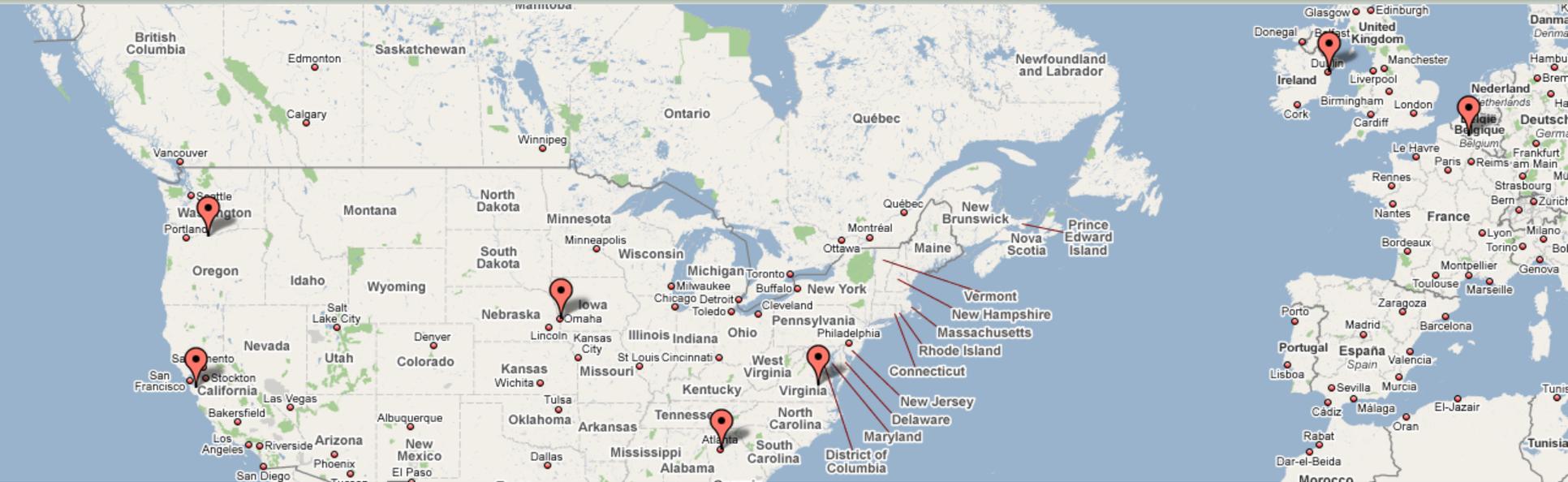
Promoting ~~Cooperative~~ Solutions for Space Security





EXAMPLES FROM THE IT WORLD





- 400,000+ nodes made of small, cheap PCs (maybe more...no one knows for sure)
- Data and applications distributed across all nodes
- Separate power grids, separate data backbones

A POSSIBLE WAY FORWARD

- Shift development of future space systems towards redundant constellations of microsatellites
 - Exploit acquisition and manufacturing advantages
 - Design systems that are interchangeable, interleaving, and flexible for the end user
- Funnel adversaries towards non-kinetic means
 - Jamming, hacking, spoofing
 - Dangerous, yes, but probably non-destructive attacks which will leave asset intact and not impact long-term sustainability of space
- Focus on increasing defenses within this reduced attack surface

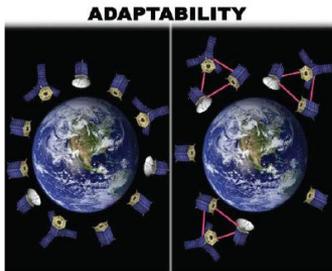
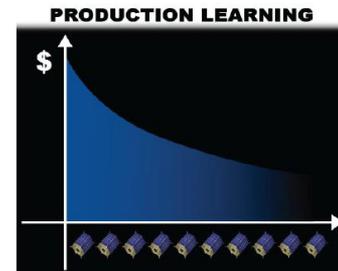
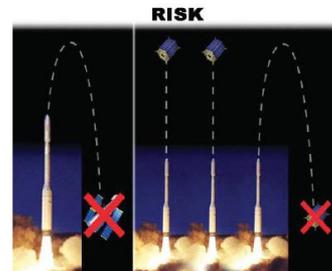
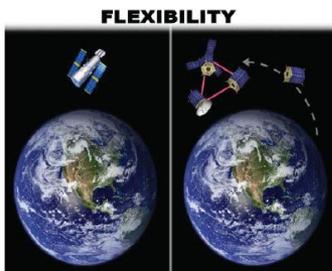
- Doesn't need to be specifically crafted for a certain adversary in a certain situation
- Don't need to know who the adversary is (only method of attack)
- Don't actually need the adversary to be deterred
 - if system is truly distributed and redundant then any kinetic attacks will have little to no effect on overall system performance

- Microsatellites
 - SurreySat
- Optical interferometry
 - ESA LISA Pathfinder
- Packetized, routable, delay-tolerant data traffic (i.e. “Routers in space”)
 - IRIS (Internet Router Protocol in Space), UK-DMC Satellite
- Laser communication links
 - NFIRE, TSAT

I'm not the first one to think of this concept

Promoting ~~Cooperative~~ Solutions for Space Security

- DARPA F6 program
- Future, Flexible, Fast, Fractionated, Free-flying



- Deterrence does have applications for protecting space assets, but not necessarily in the classical sense
- Denial deterrence and the shift towards distributed, redundant, microsatellite infrastructure is the primary means of defeating kinetic ASAT weapons
- Denial deterrence should be part of an overall Space Protection Strategy
- US **must** put as much intellectual analysis into space security concepts as it did Cold War strategies
 - See recent Council on Foreign Relations report on China

Many Thanks Any Questions?

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