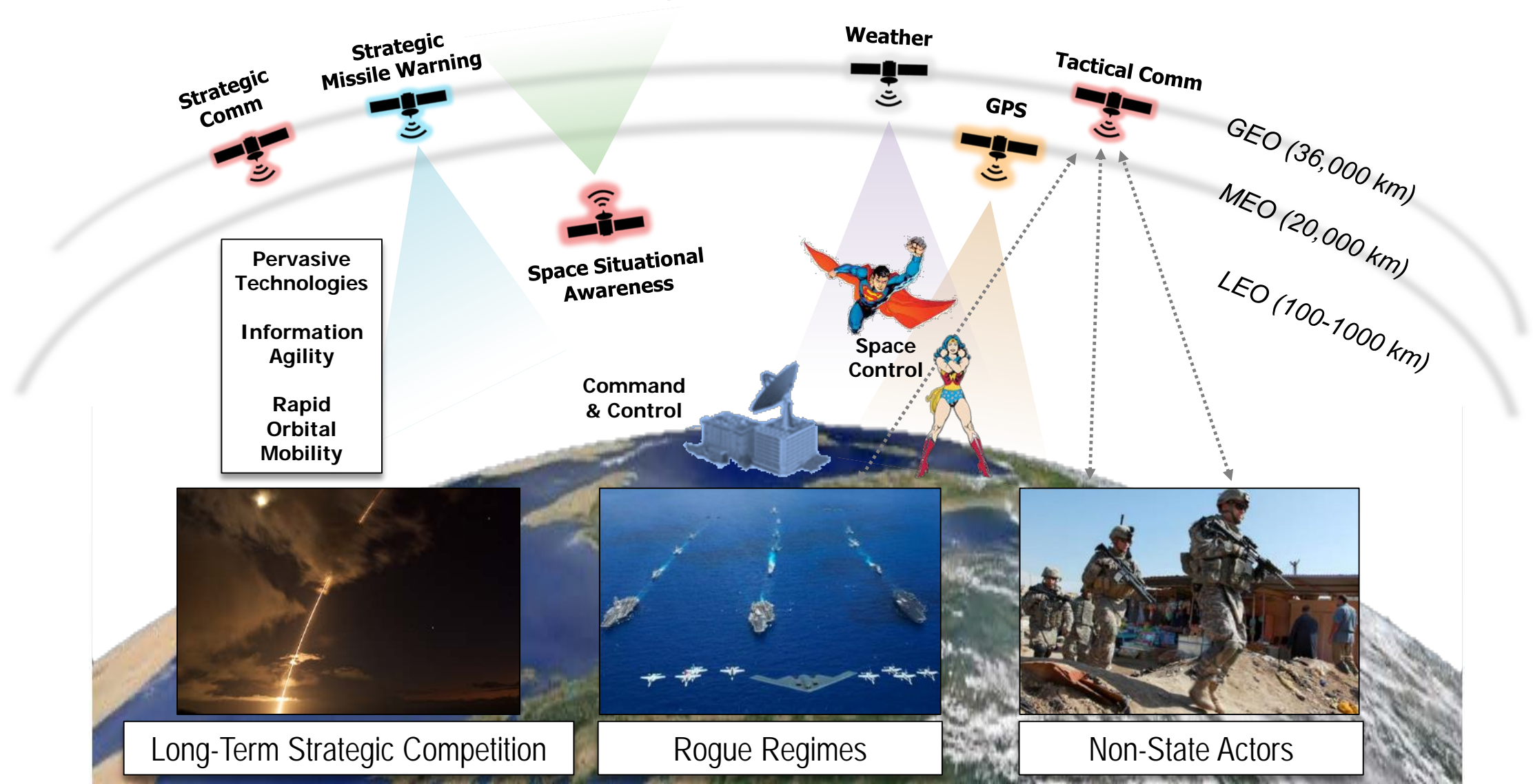




# Space Power for Space Power

COLONEL ERIC J. FELT, DIRECTOR  
SPACE VEHICLES DIRECTORATE, 02 APRIL 2019

# Space is Vital to the Warfighter



# ... and Vulnerable

China confirms anti-satellite missile test

-The Guardian, 2007



Russia has figured out how to jam U.S. drones in Syria, officials say

-NBCNews.com, 2018

Attack Gave Chinese Hackers Privileged Access to U.S. Systems

-New York Times, 2015

North Korea could test hydrogen bomb over Pacific Ocean, says foreign minister

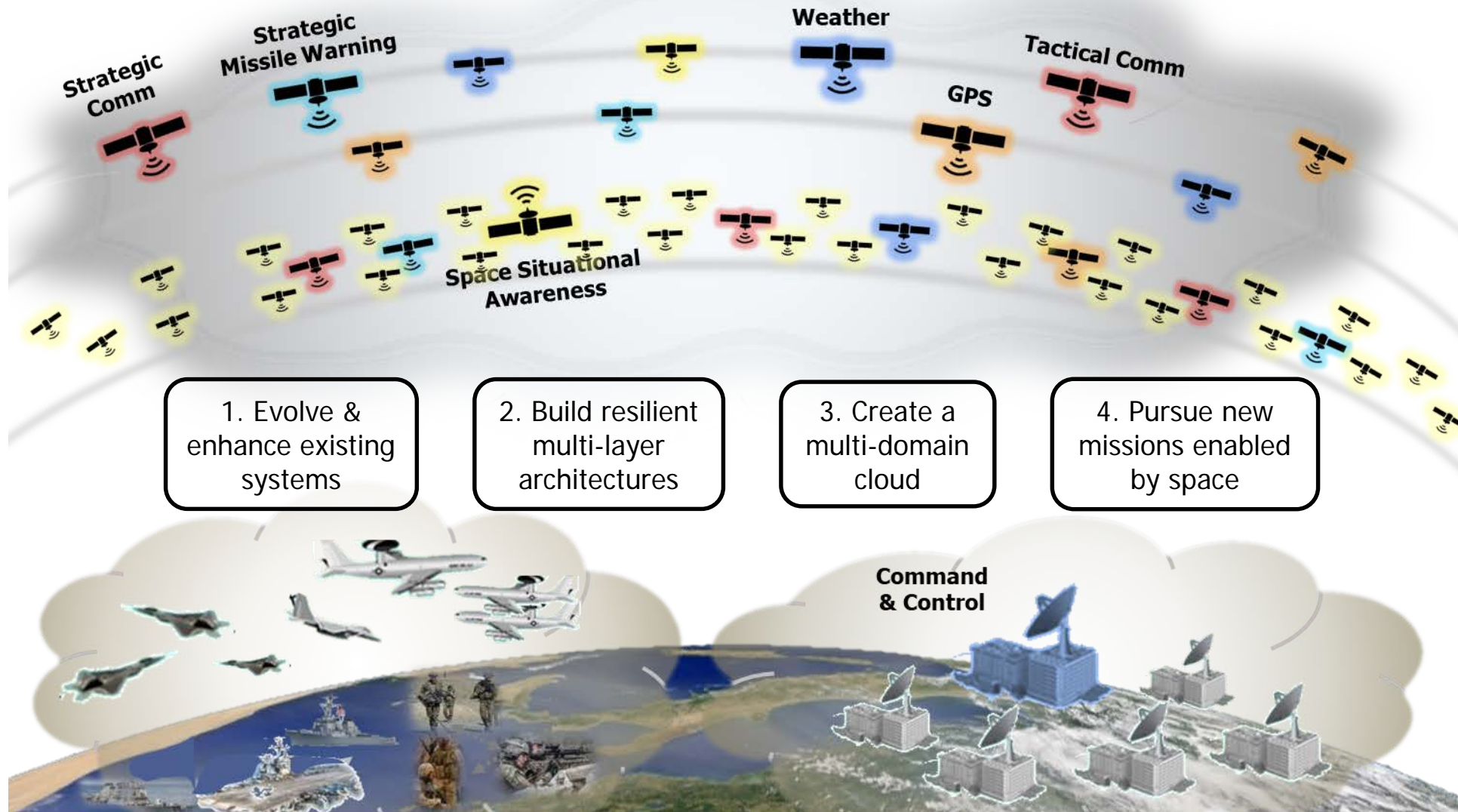
-CNN.com, 2017

**“Potential adversaries can threaten our use of space in many orbital regimes and will soon be able to threaten all US space capabilities in all orbital regimes.”**

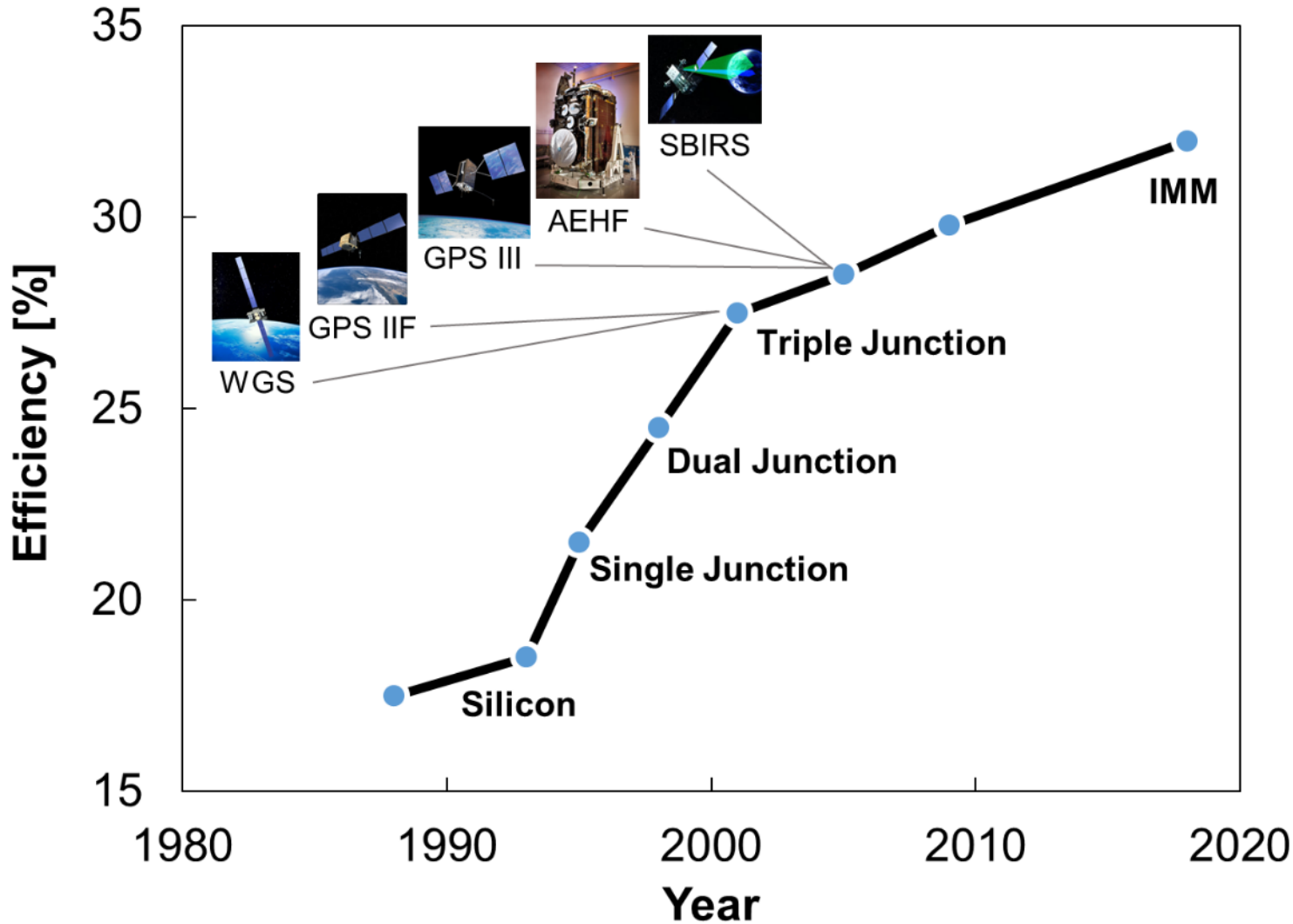
General Jay Raymond (AFSPC/CC), 2018 Commander’s Strategic Intent



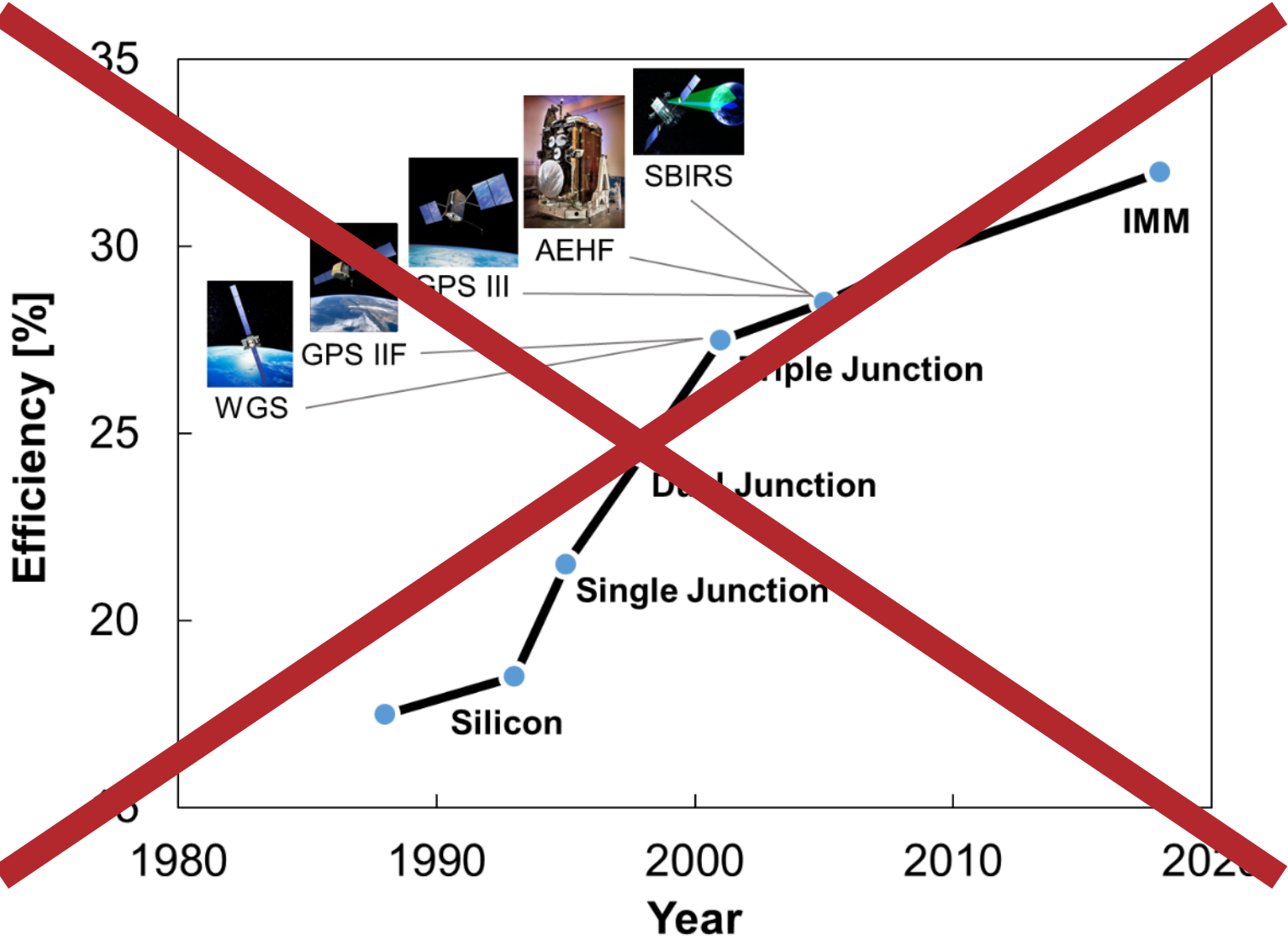
# AFRL Space S&T Strategy



# Historic look at AFRL-led Space Solar Cell Development



# Solar Cell Efficiency is No Longer the Name of the Game



Resilience: Hardening

Proliferation: Production

New Mission: High Power

# DARPA – AFRL Blackjack: Proliferated LEO





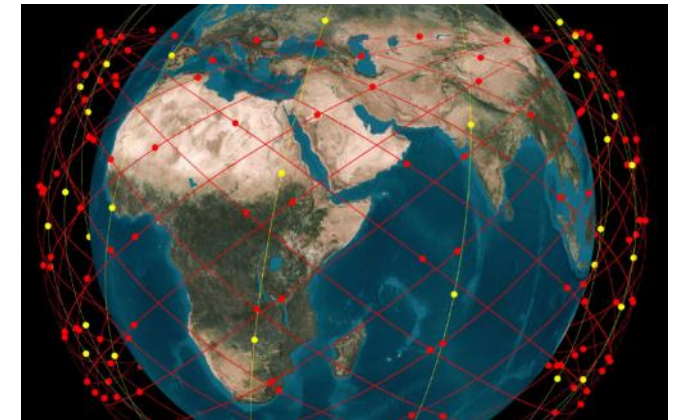
# Space 2.0: Rise of Commercial LEO



**OneWeb**



**SpaceX**



**Telesat**



# Space 2.0: Assembly Lines for Space Systems?



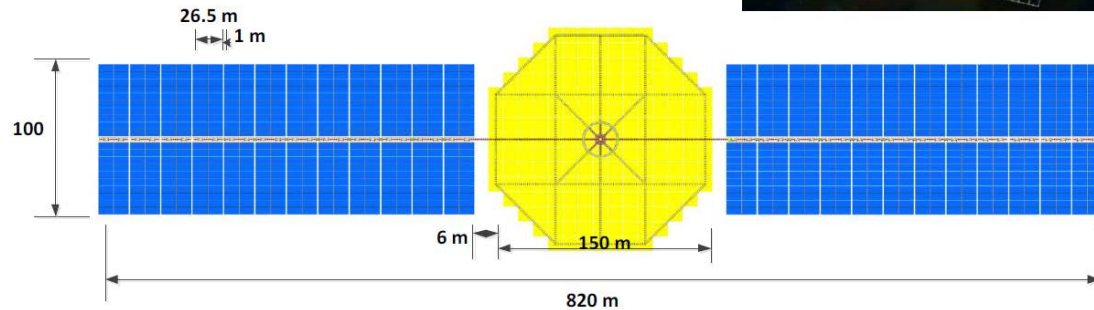
<https://www.teslarati.com/tesla-tsla-shares-50-percent-rally-negative-media-coverage-baird/tesla-body-assembly-line/>



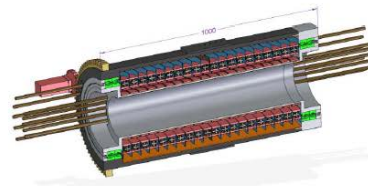
# New Missions: Space Solar Power Plans from China

## 3. A Pilot MW SPS system

### □ Configuration



The configuration is based on Multi-Rotary joints SPS (MR-SPS) concept. The hollow rotary joints are used to simplify the structure by removing perpendicular trusses. But it's difficult to assembly the cable.

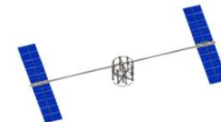


## 3. A Pilot MW SPS system

### 3.4 Transportation and system construction

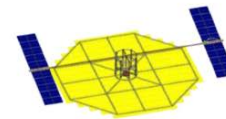
#### • Construction

##### First stage



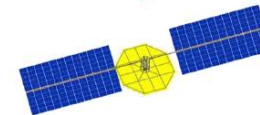
- 2 solar sub-arrays and the center structure will be launched and assembled in space.
- It is the basic structure during the construction of the whole system.
- Supply power for the service devices.

##### Second stage



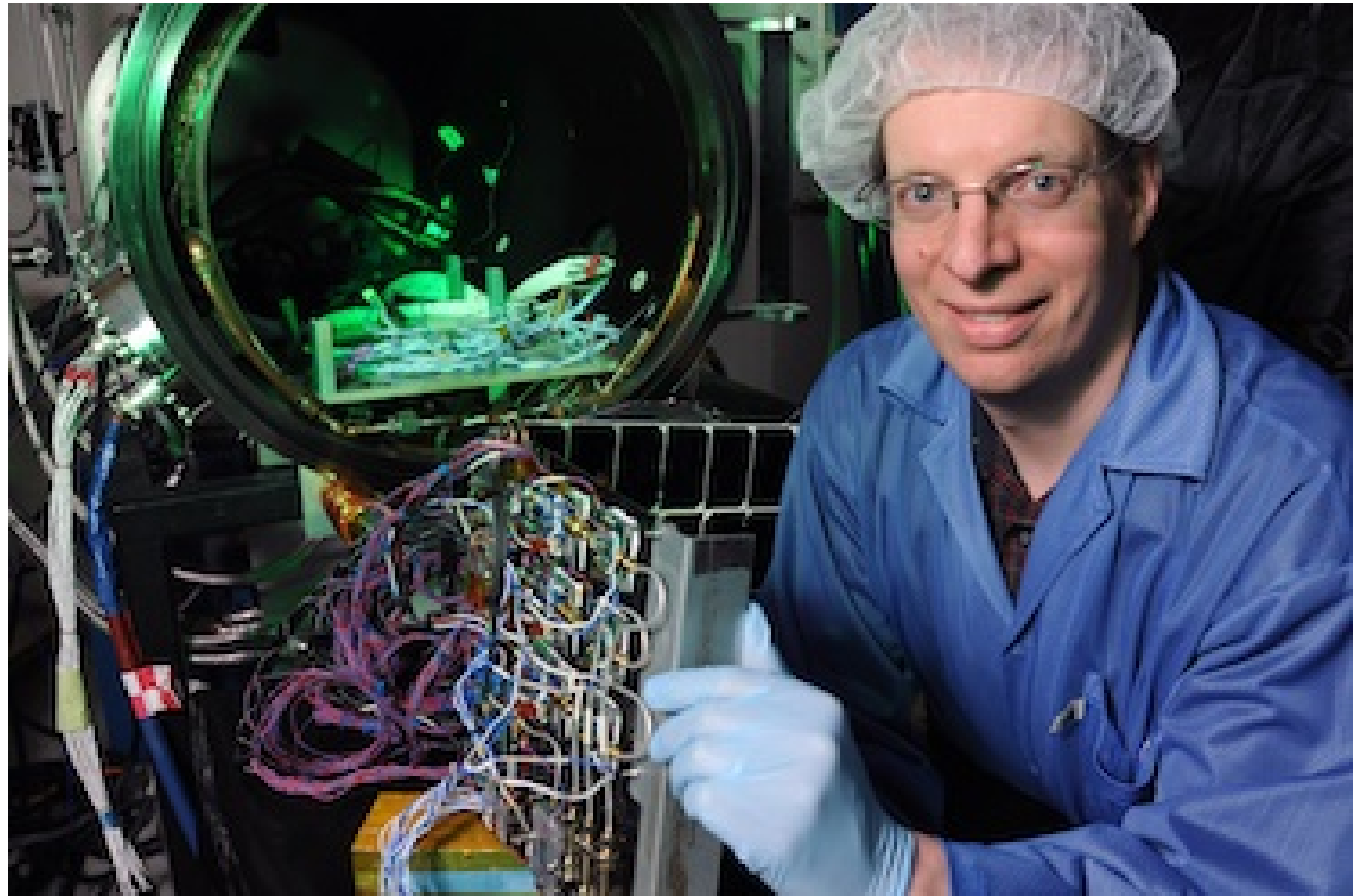
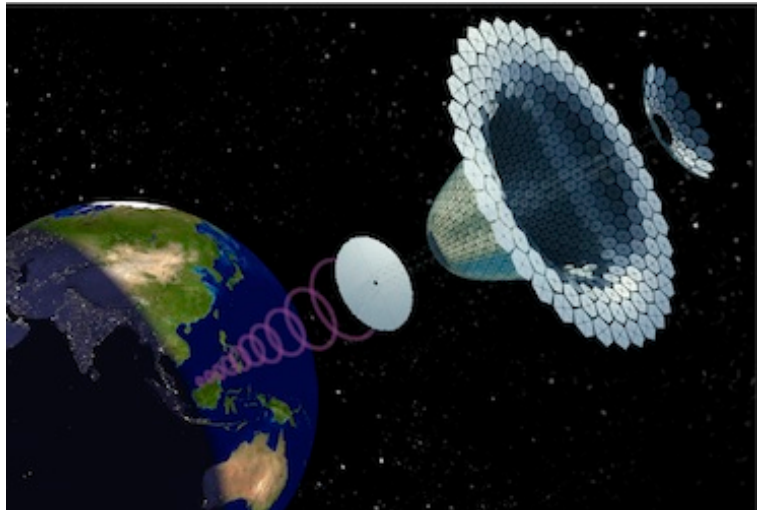
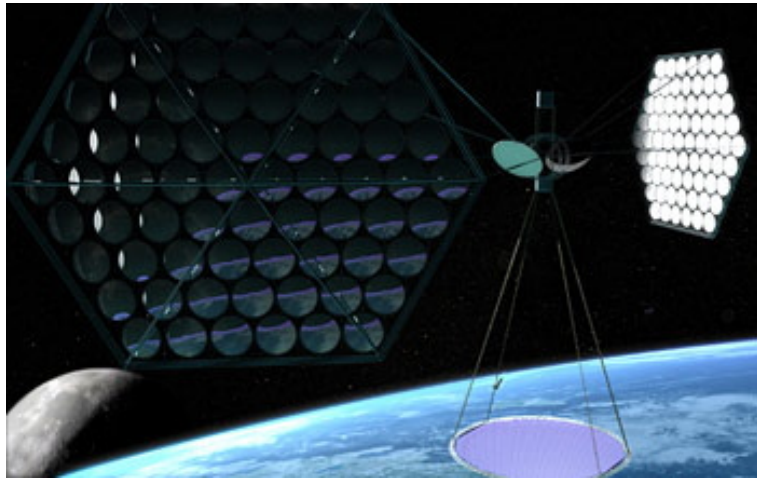
- The antenna structure modules will be launched and assembled in space.
- A part of antenna will be used to transmit power from space to ground.

##### Third stage



- All solar sub arrays will be launched and assembled in space.
- The whole antenna will be used to transmit power from space to ground.

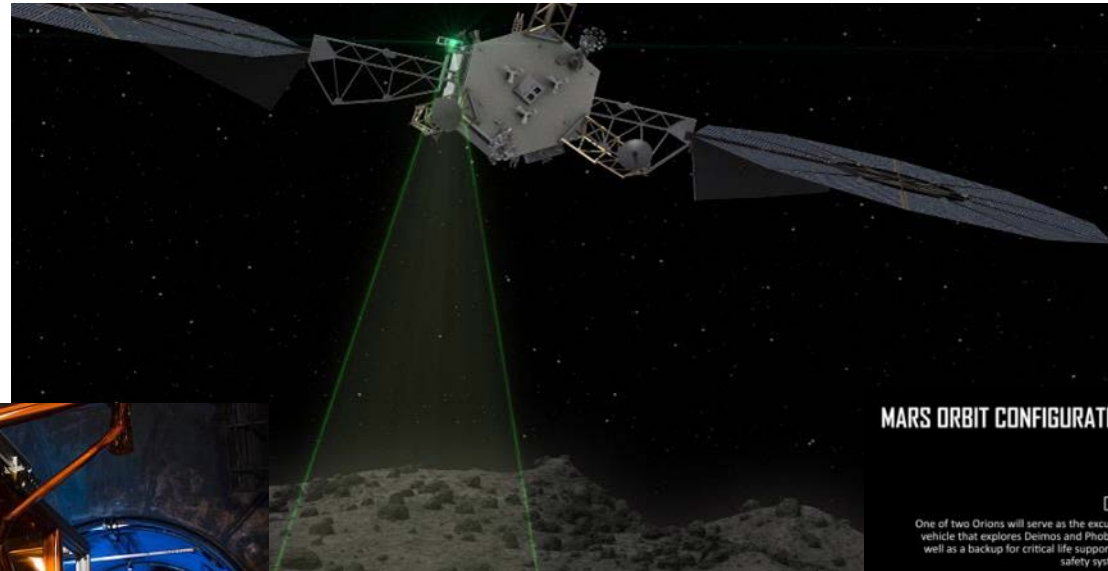
# New Missions: Space Solar Power Plans from United States





# New Missions: High Power Applications

## NASA JPL Asteroid Redirect Mission



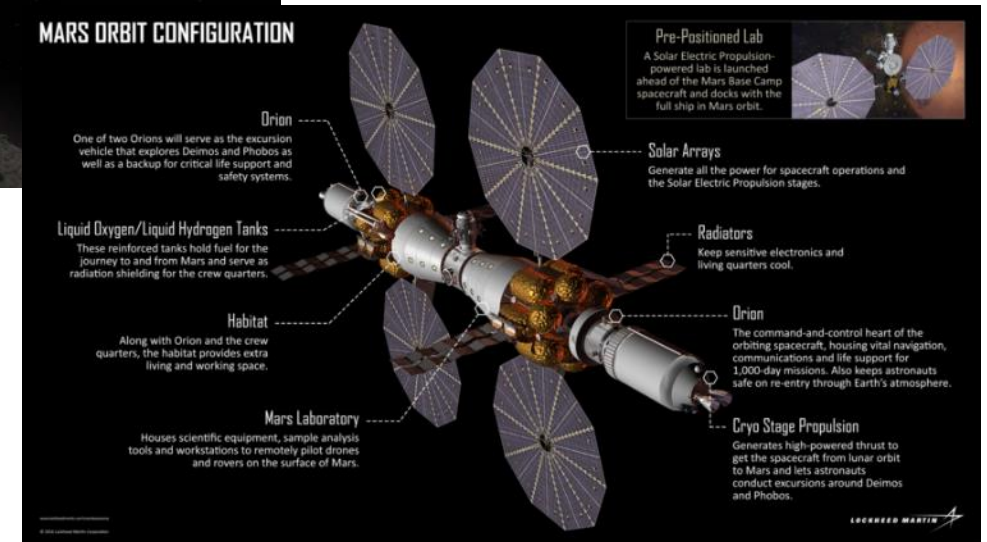
### Electric Propulsion



<https://www.jpl.nasa.gov/spaceimages/details.php?id=PIA21062>

<https://www.nasa.gov/image-feature/electric-propulsion-will-thrust-exploration-into-deep-space>

### Human Exploration



[https://planetary.s3.amazonaws.com/assets/images/human-space/20160519\\_MarsBaseCampLockheedMartinConcept.jpg](https://planetary.s3.amazonaws.com/assets/images/human-space/20160519_MarsBaseCampLockheedMartinConcept.jpg)

## Beyond Solar Power...

### Kilowatt Reactor



*NASA and NNSA engineers lower the wall of the vacuum chamber around the Kilowatt Reactor Using Stirling TechnologY (KRUSTY system). Credits: Los Alamos National Laboratory*

???

**How do we get  
to Megawatt  
Power?**

# Need to Move Faster, Accept Risk



<https://marketoonist.com/2014/07/safe-is-risky.html>

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Questions?