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NATIONAL RECONNAISSANCE OFFICE

# NRO's Historical, Current, and Potential Future Use of Small Satellites

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50 YEARS OF VIGILANCE FROM ABOVE

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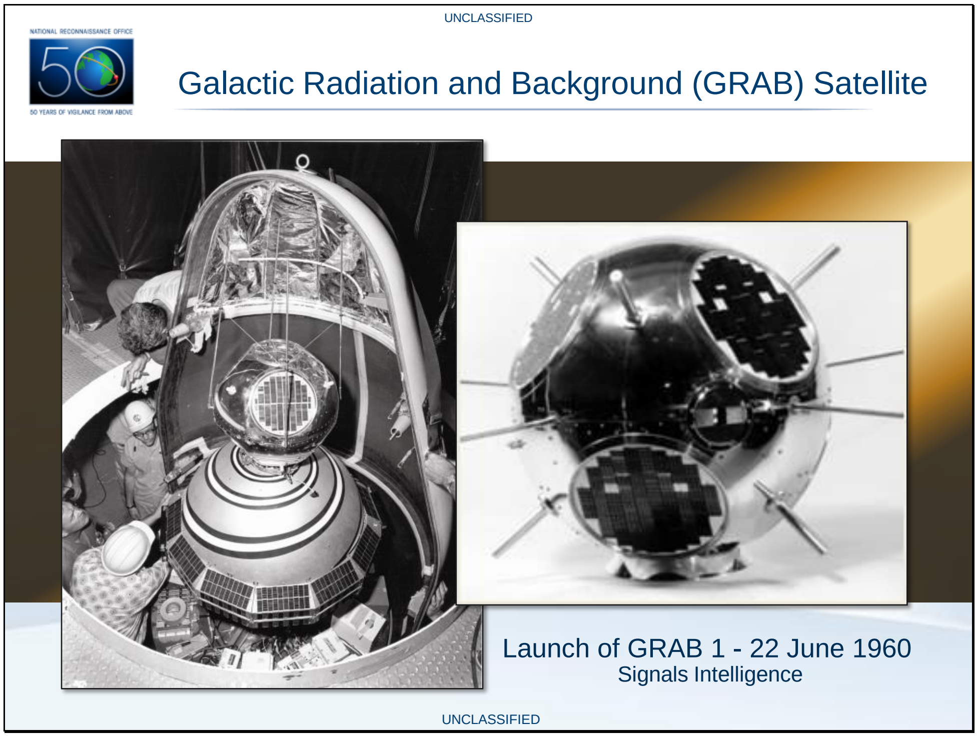


- In August1959, President Eisenhower authorized the Naval Research Lab to develop the GRAB Satellite – world's first electronic signals intelligence satellite designed to intercept and analyze radar signals from Soviet Air Defenses.
- The theory behind GRAB had been developed more than a year earlier by NRL research engineer Reid Mayo, while he was stranded in a Pennsylvania restaurant during a blizzard
  - Waiting for the snow to clear, Mayo considered the application of crystal video technologies he developed for submarine periscope systems  during World War II
  - He penciled range calculations on a paper placemat and determined that such a system could intercept Soviet radar signals up to an altitude of 600 miles
- A solid-state version of the intercept system was mounted in a 20-inch solar-powered Vanguard satellite
- On May 1st, 1960 Gary Powers U-2 was shot down and four days later President Eisenhower approved the launch of GRAB-1 .  It was launched from Cape Canaveral, Florida, on 22 June and operated for 3 months
- When the NRO was created in September 1961, it assimilated NRL's electronic intelligence satellite activities and the GRAB Satellite program which operated until August 1962

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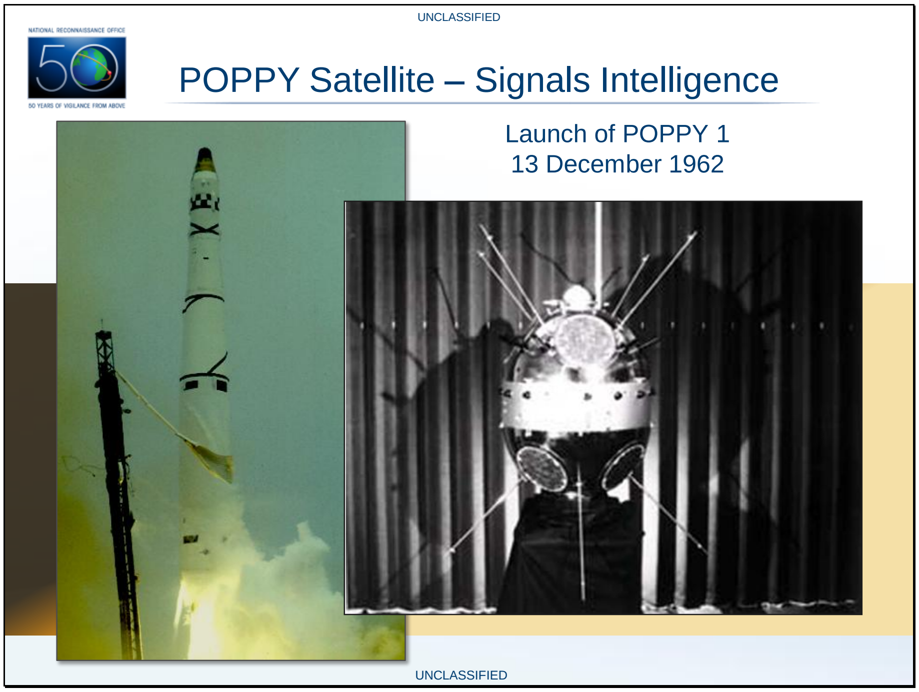


- The NRO's POPPY program, GRAB's successor, launched in December 1962, consisted of a total of 7 satellites, and operated for nearly 15 years – all 7 satellites were launched from Vandenberg Air Force Base, California
- POPPY had two designs – the stretched sphere pictured here and a 12-sided multi-face design. The largest of the POPPY satellites measured 27 by 34 inches and weighed 282 pounds
- GRAB and POPPY dramatically increased the capability of U.S. intelligence to acquire Electronic Intelligence data deep within the Soviet Union
  - They provided cues to the location and capabilities of radar sites within the Soviet Union; provided Strategic Air Command characteristics and locations of air defense equipment to support building the U.S. Single Integrated Operations Plan (SIOP); and provided ocean surveillance information to Navy operational commanders

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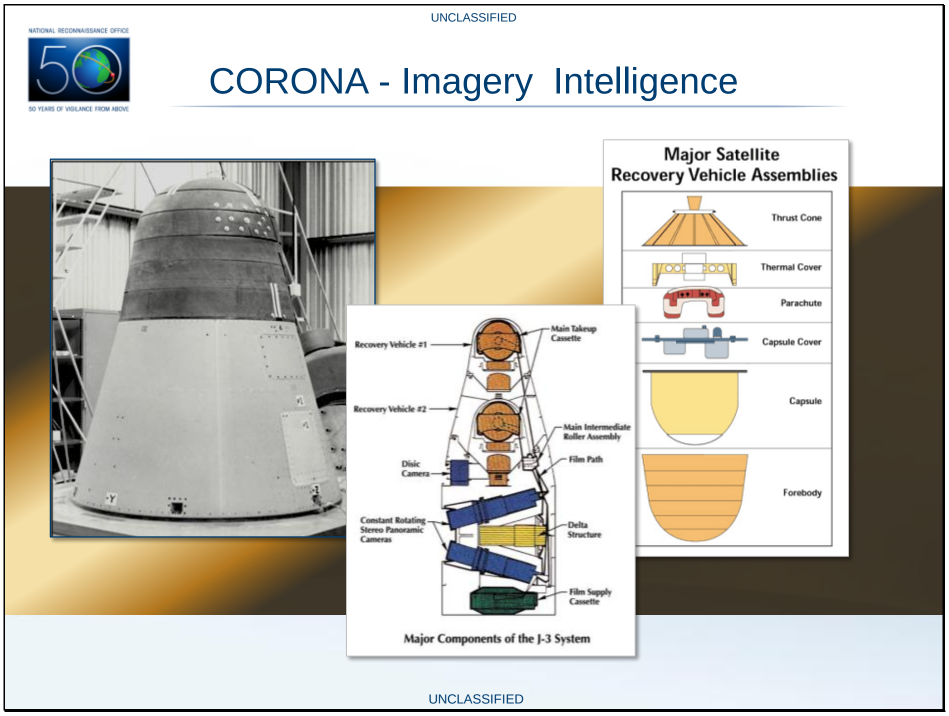


- As I mentioned earlier, Gary Powers fateful U-2 flight was the last flown over the Soviet Union . While GRAB and Poppy could identify air defense radars, they could not identify nuclear threats or other vital Soviet strategic information.  Scientists had been working on a satellite that could transmit near real-time images from space for a few years, but had been unable to overcome the challenges.
- While it isn’t a Small Satellite in the truest sense it was in concept, as the CORONA program was developed as a work-around to the image transmission problem and provided a vital capability
- After 13 failures, which included a test version exploding on the launch pad, a reentry capsule landing on Spitzbergen Island Norway, and debris being spread over Vandenberg Air Force Base from the range safety officer exploding a vehicle shortly after launch, Discoverer 13’s film-return capsule was successfully recovered after its 10 August 1960 launch – the Air Force created Discoverer as an unclassified medical project to explain the CIA’s CORONA program and initially used the C-119 Boxcar to catch the returning capsules
- The first successful return of an object from space concluded with the delivery of a US Flag to President Eisenhower and paved the way for photoreconnaissance from space

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- On 18 August 1960, Discoverer 14 was launched – the first full-fledged CORONA mission
- On its first mission, CORONA and it’s KH-1 camera provided more photographic coverage of the Soviet Union than all of the previous U2 missions combined
- More importantly though, CORONA’s 40-foot resolution provided hard evidence of the pace and scope of Soviet ballistic missile deployments and allowed analysts to count Soviet heavy bombers
- The data from this first mission also disproved the existence of a “missile gap” in favor of the Soviet Union and contributed to the overall stability of the nuclear balance

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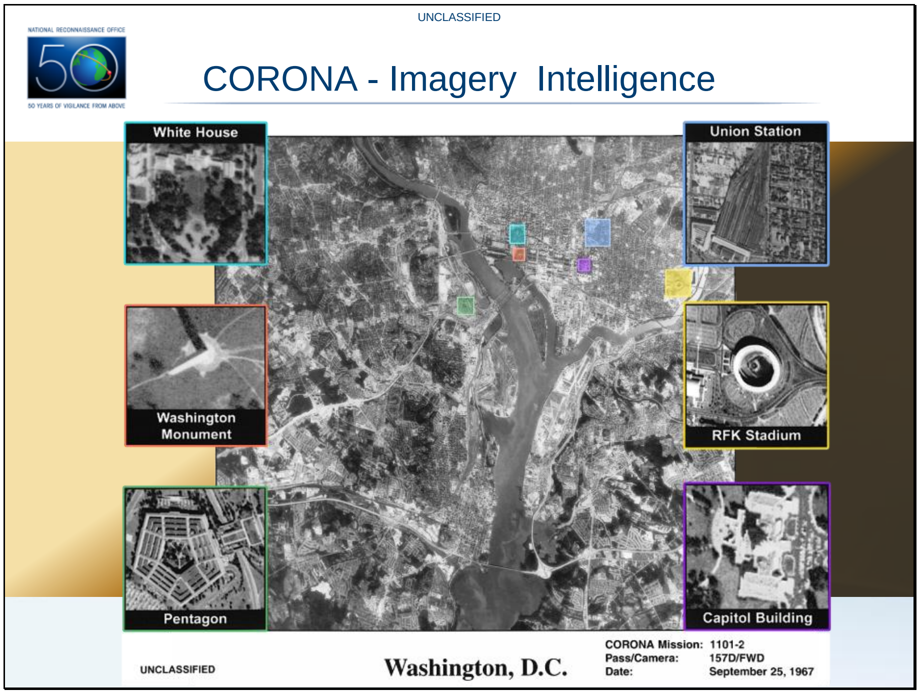


- The CORONA program continued until 1972 and achieved a number of notable "firsts"
  - First to recover objects from orbit
  - First to deliver intelligence information from a satellite
  - First to produce stereoscopic satellite photography
  - First to employ multiple re-entry vehicles, and
  - First satellite reconnaissance program to pass the 100-mission mark – 145 satellites were launched under the CORONA program
- CORONA, combined with the GRAB and POPPY programs, provided unprecedented insight into the activities of the Soviet Union and truly helped the U.S. win the Cold War. These Small Sat systems also provided the foundation for the reconnaissance capabilities the NRO has today.

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- This year marks the 50th Anniversary of the NRO. During that time our mission has transitioned from a mission focused on the USSR to a diverse and widely dispersed mission which includes international terrorists, drug traffickers, peacekeeping, and humanitarian relief operations to name a few.
- This year we also completed our most recent launch campaign – huge success of six satellites in seven months, the most aggressive in 25 years. During the days of film return satellites, launches were almost a regular occurrence. In fact, Dr. Flax one of my predecessors at the NRO oversaw 74 launches during his almost 3 ½ year term – most under any one director of the NRO. In our more recent history, we have averaged only 1 or 2 launches per year
- Of these six launches, one was dedicated to the NRO's Small Satellite efforts

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- The NRO used Orbital Science's Minotaur I to launch the Rapid Pathfinder vehicle – our existence proof for the fielding of Small Satellites
  - Rapid Pathfinder went from program design review to launch ready in less than two years at a cost of less than $20M
  - Small, low-cost bus carrying advanced technology component payloads
  - 95% heritage parts; 20x20x20 inches and 519 pounds with payload
  - Launched advance dosimeters to characterize the space environment from a 1,200 kilometer orbit

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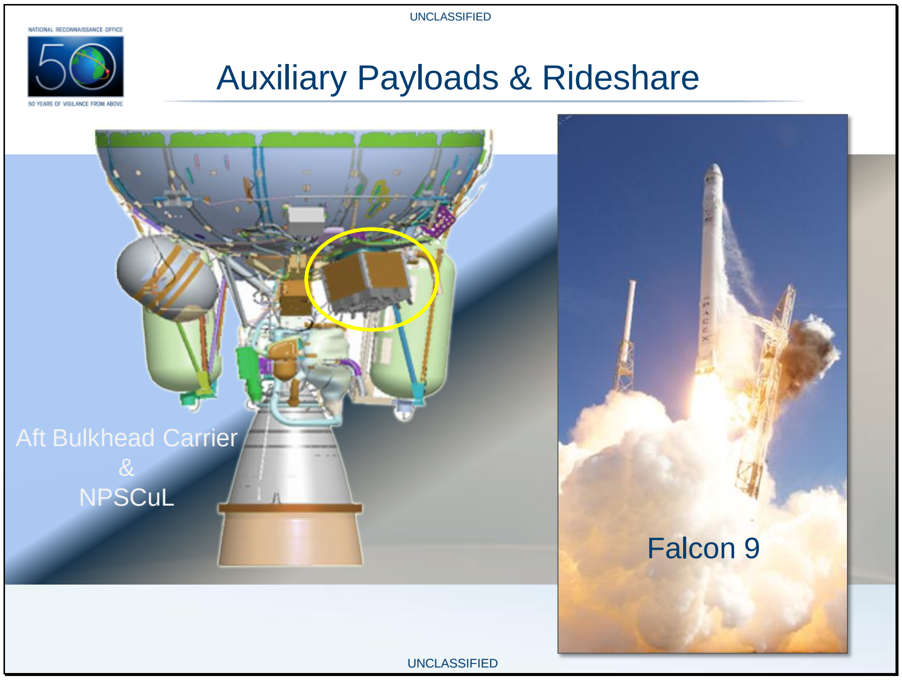


- Because of their size, small satellites are able to be utilized as auxiliary payloads on other missions and rideshare as space is available
- To assist with the effort to capitalize on auxiliary payloads, the NRO helped develop the Aft Bulkhead Carrier, which is capable of carrying 175 pounds to orbit using the Centaur upper stage of the Atlas – we plan to use the Aft Bulkhead Carrier on NROL-36, one of our four launches in 2012, to deploy multiple CubeSats from Government and government-sponsored agencies, to include universities. It will also be our first use of the Naval Postgraduate School CubeSat Launcher
- In addition to the Aft Bulkhead Carrier, we are developing a larger carrier, the A-Deck carrier, which will be capable of delivering a variety of small satellite configurations up to 2,000 pounds on all EELV-class vehicles – we plan to have it ready by the end of the year.
- Last December, the NRO was able to rideshare on SpaceX's Falcon 9 and launch two Colony One buses with various CubeSats

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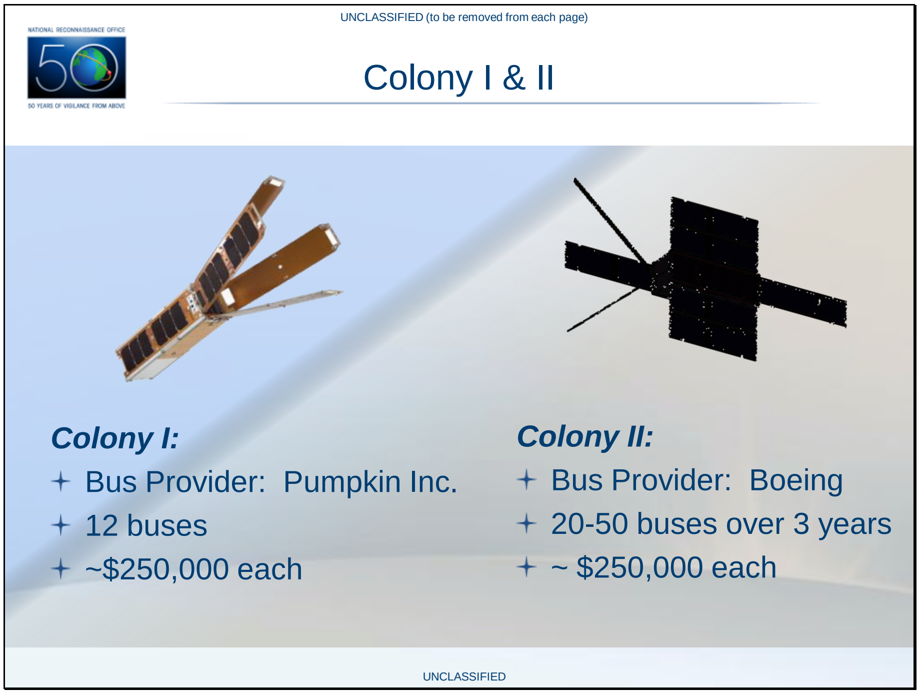


- A significant part of our near-term CubeSat investment has focused on maturing the bus components needed to provide the foundation for future experiments under an effort we call Colony – to date, we have more than 25 government, industry and university partners, to include our host Utah State University, on the Colony program
- Through this common CubeSat bus, Colony allows designers to focus on developing experiments and demonstrating concepts of operations rather than re-inventing the supporting subsystems (power, attitude determination and control system, processing, communications, etc) for each launch
- We have been using the Colony I bus, but will launch our first Colony II bus next year on NROL-36. The Colony II bus has more power and better pointing accuracy than Colony I

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- The NRO will continue to use small satellites to develop and demonstrate innovative technologies that solve our users' most challenging problems and to support University and Industry outreach
- With the greatly reduced design to launch timeline, Small Satellites will continue to play an important role in helping to maintain the space industrial base and develop our future workforce
- Perhaps though, we'll fly many small satellites in formation in order to produce large synthetic apertures for higher resolution
- Or maybe we'll be able to rapidly change on-orbit configurations and formation geometry in response to evolving mission sensing requirements
- But whatever the use in the future, small satellites have already proved invaluable since the earliest days of space reconnaissance and the NRO

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