Headquarters U.S. Air Force

Integrity - Service - Excellence

21st Annual AIAA / USU Conference on Small Sats

Mr. Gary Payton
Deputy Under Secretary for Space Programs
Our Space Program is the envy of the entire world ...

- **DoD Systems** …
  - See EVERY MISSILE LAUNCH of CONSEQUENCE - 24/7/365
  - Provide the MOST CAPABLE and SOPHISTICATED worldwide communications systems in the world
  - GPS is THE WORLD’S STANDARD for precision positioning, navigation, and timing worldwide and is FREE to the users
  - Weather systems track cloud formations everywhere every day AND precisely measure atmospheric temperature - humidity
  - Track over 16000 space objects every day

- **NASA Systems** …
  - Orbited with and then landed on an asteroid
  - Continue to explore Mars after 1200 days on the surface
  - Great Observatories and International Space Station
Another Legacy of Success:
Launch

- 22 May 99  Titan IVB-12 NRO
- 20 Jun 99  Titan IIG-7 NASA QuikSCAT
- 07 Oct 99  Delta II GPS 2R-3
- 12 Dec 99  Titan IIG-8 DMSP F-15
- 21 Jan 00  Atlas IIA/MLV-8 DSCS
- 08 May 00  Titan IVB-29 IUS DSP-20
- 11 May 00  Delta II GPS 2R-4
- 16 Jul 00  Delta II GPS 2R-5
- 17 Aug 00  Titan IVB-28 NRO
- 21 Sep 00  Titan IIG-13 NOAA-L
- 20 Oct 00  Atlas IIA/MLV-9 DSCS
- 10 Nov 00  Delta II GPS 2R-6
- 06 Dec 00  Atlas IIA/MLV-11 NRO
- 30 Jan 01  Delta II GPS 2R-7
- 27 Feb 01  Titan IVB-41 MILSTAR-4
- 18 May 01  Delta II GeoLITE NRO
- 06 Aug 01  Titan IVB-31 IUS DSP-21
- 08 Sep 01  Atlas IIA/MLV-10 NRO
- 05 Oct 01  Titan IVB-34 NRO
- 11 Oct 01  Atlas IIA/MLV-12 NRO
- 16 Jan 02  Titan IVB-38 MILSTAR-5
- 24 Jun 02  Titan IIG-14 NOAA-M
- 21 Aug 02  Atlas V Eutelsat Hotbird 6
- 20 Nov 02  Delta IV Eutelsat W5
- 06 Jan 03  Titan IIG-4 Coriolis
- 29 Jan 03  Delta II GPS 2R-8

- 10 Mar 03  Delta IV DSCS A3
- 31 Mar 03  Delta II GPS 2R-9
- 08 Apr 03  Titan IVB-35 MILSTAR-6
- 29 Aug 03  Delta IV DSCS III B6
- 09 Sep 03  Titan IVB-36 NRO
- 18 Oct 03  Titan II G-9 DMSP F-16
- 02 Dec 03  Atlas IIA/MLV-14 NRO
- 21 Dec 03  Delta II GPS 2R-10
- 14 Feb 04  Titan IVB-39 DSP-22
- 20 Mar 04  Delta II GPS 2R-11
- 23 Jun 04  Delta II GPS 2R-12
- 31 Aug 04  Atlas IIA/MLV-13 NRO
- 06 Nov 04  Delta II GPS 2R-13
- 03 Feb 05  Atlas III/MLV-15 AC-206
- 29 Apr 05  Titan IVB-30 NRO
- 26 Sept 05  Delta II GPS 2R-14M
- 19 Oct 05  Titan IVB-26 NRO
- 19 Jun 06  Delta II MiTeX
- 27 Jun 06  Delta IV NRO
- 25 Sep 06  Delta II GPS 2R-15M
- 04 Nov 06  Delta IV DMSP-17
- 17 Nov 06  Delta II GPS 2R-16
- 14 Dec 06  Delta II NRO
- 08 Mar 07  Atlas V STP-1
- 15 June 07  Atlas V  NRO

51 in a Row!

Integrity - Service - Excellence
Acquisition Stages: Block Approach
GPS: A Legacy of Successful “Blocks”

Increasing System Capabilities • Increasing Defense/ Civil Benefit

Block IIA/IIR
Block IIR-M, IIF
Block III

Integrity - Service - Excellence
The final DSP is about to launch on a Delta IV Heavy… Next comes SBIRS.
DSP & SBIRS

“Back to Basics” - Back on Track

We cannot let success take the edge off our need to revolutionize how we do space

DSP to SBIRS

Legacy of Success
The TACSAT program has shown how Services can work together and use Small Sats to satisfy new strategic objectives

- Operationally Responsive Space “ORS”

TacSat-2 weighs about 814 pounds

The TacSat-2 launch was the first Minotaur vehicle launched from the Mid-Atlantic Regional Spaceport (MARS)
ORS - Emphasis

- Tier I – “Command it” – time scale on minutes to hours – on demand re-tasking of existing assets

- Tier II – “Deploy it / Launch it” – time scales of hours to days – on-call, ready to field or redeploy

- Tier III – “Build and launch it” – time scales of weeks to months, up to one year – deliver new or modified capabilities

The ORS Office is located at Kirtland AFB in New Mexico
Small Sats ≠ Small Missions

Small Sats need to provide Big Sat “Bang-for-the-Buck”

IMPOSSIBLE -- NOT NECESSARILY

Small Sats could to take on some very big missions if they carry new, sophisticated sensor technology

Small Sats could be where needed - when needed to meet Tier 1 or 2 requirements with enough Delta-V

Small Sats could fully exploit the data advantage of the new sensors if we provided them big comms

Problem -- can we combine powerful sensors, big comms, and lots of maneuvering capability and stay small?
New Sensors
Small and Powerful

AIRSS focal plane arrays and optics – great successes

• Modular Cameras built up from 2k x 2k staring arrays
  • Much smaller primary apertures - relatively simple optics sized by Ground Sample Distance (GSD), not by need to collect photons
  • Can generate in excess of 1.5 Gbps RAW at high frame rate
  • Choice is to push data processing or comms – what would you choose?

• TacSats
  • Imager and Data Link
  • Signal Intercept Package
  • Hyperspectral
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The problem – large comm pipes and Small Sats are generally mutually exclusive, especially from GEO
Big Maneuver
New Paradigm

Orbital Express built on XSS-11 and earlier missions
Proved autonomous rendezvous, docking, refueling,
and on-orbit servicing using Orbital Replacement Units
Powerful Sensors
Drive Big Comms

Communications is a key Challenge and Opportunity

Massive data rates
Near-real-time requirements

High capacity, long haul communications systems are neither small nor lightweight

GEO Missions – high power and big antennae
Non-GEO Missions – store-and-forward or relay

We need to make Wireless Broadband a Space Utility

We can create a wireless infrastructure that Small Sats could use for all their mission communications needs…
The SBG Architectural Concept

- Mutually supporting, mission defined spacecraft flying in formation
- Featuring two types of spacecraft – Utility and Mission
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• Mutually supporting, mission defined spacecraft flying in formation
• Featuring two types of spacecraft – Utility and Mission

• Utility – Comm Concentrator (CC) and Group Support (GS)
  • Provide utility services -- comm downlink, maneuver, …
  • Based on mature technologies, design life commensurate with technology – generally significantly longer than mission spacecraft
The SBG Architectural Concept

- Mutually supporting, mission defined spacecraft flying in formation
- Featuring two types of spacecraft – Utility and Mission

**Utility – Comm Concentrator (CC) and Group Support (GS)**

**Mission – Mission Spacecraft (MS) that use utility services – “out-source” wideband downlink comm, tanking/tug, SSA**
- Missile Warning, Environmental, ISR, Comm Relay…
- Highly maneuverable - redeploy/reposition as needed, when needed
- Short tech cycles – decoupled development, rapid evolution in capability
This concept can also work in LEO, MEO, and HEO
Fast Transit - the Other Utility

- Adopt an “event vs. forecast” driven maneuver strategy
- Objective – Be there when the carriers arrive
  - Based on Orbital Express -- ~110 m/sec Delta-V for 18°/day
  - Re-tank MS when maneuver is complete
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Small Sats can be peers of Big Sats if unconstrained by propulsion and comm
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Small Sats – Back to the Future

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Once upon a time, all our satellites were Small Sats. As expectations grew, technology allowed us to build big satellites for big missions. Today, we're finding new ways to fit big capabilities into small packages. SBG enables even greater performance and flexibility. Small Sats – Back to the Future. Small Sats can provide BIG performance.