
SDA
SPACE DEVELOPMENT AGENCY
Speed. Delivery. Agility.
DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

SDA
SPACE DEVELOPMENT AGENCY

Delivering Capabilities

Introduction

The Department of Defense established the Space Development Agency on March 12, 2019 to define and monitor the Department's future threat-driven space architecture and accelerate the development and fielding of new military space capabilities necessary to ensure U.S. technological and military advantage in space for national defense. To achieve this mission, SDA will unify and integrate next-generation space capabilities to deliver the National Defense Space Architecture (NDSA), a resilient military sensing and data transport capability via a proliferated space architecture primarily in low Earth orbit (LEO). The NDSA addresses the critical priorities for space and the necessary underpinning elements identified within the DoD Space Vision. Our charge is to define and deliver the Department's future resilient, threat-driven, and affordable military space architecture for the joint warfighter at or ahead of the speed of need.

SDA aims to provide responsive and resilient space capabilities in support of the joint force and as part of Joint All Domain Command and Control (JADC2)—increasing warfighters' lethality, maneuverability, and survivability. Additionally, the network will deliver:

- Low latency/high volume data transfer anywhere in the world
- Sensor to shooter connectivity
- Direct to weapons connectivity

SDA is more than just our name, it's everything we believe in, it's how we work, and most importantly it's how we will deliver capability into the hands of the warfighter. Like our agency, the mission is very streamlined and straightforward.

Speed. Delivery. Agility.

Recognized as DoD's constructive disruptor for space acquisition, SDA will quickly deliver needed space-based capabilities to the joint warfighter to support terrestrial missions through development, fielding, and operation of the NDSA. SDA capitalizes on a unique business model that values speed and lowers costs by harnessing commercial development to achieve a proliferated architecture and enhance resilience. SDA will deliver a minimum viable product—on time, every two years—by employing spiral development methods, adding capabilities to future generations as the threat evolves.

On the Cover: SpaceX's Falcon 9 launching Transporter-2 from Space Launch Complex 40 at Cape Canaveral Space Force Station, Florida.

SDA's mission is not to defend existing "product lines" but to disrupt them.

The Innovator's Dilemma

In *"The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail,"* Clayton Christensen provides context for SDA's mission. The same phenomenon that affects industry impacts government. In an ecosystem where a large entity is encumbered by an established customer, the organization focuses primarily on delivering specific capabilities in a low-risk, incremental approach. An organization cannot focus on innovation at the same time it strives to deliver a product to an existing customer. The resources, values, and processes developed in a large organization with an established customer will differ completely from those of a disruptor. The ability to go out and look at products that impact a lot of new customers enables innovation. Small wins can be a big deal.

As they should, legacy space acquisition organizations continue delivering incremental updates to existing capabilities for their main customer, in this case United States Space Command. As a clean-slate organization, **SDA's mission is not to defend existing "product lines" but to disrupt them.** SDA's "customer" is the warfighter, represented by the combatant commanders.

Seen as a "constructive disruptor", SDA has taken a completely different approach from legacy space acquisition organizations. SDA will deliver capabilities via proliferated affordable satellites, instead of very few high-value satellites. SDA's delivery complements those capabilities provided by other space organizations. Constructively disrupting the ecosystem, pushing innovation forward, and looking at completely new architectures depends upon maintaining SDA's role as a separate and distinct organization.

> "I won't support the development any further of large, big, fat, juicy targets. I won't support that. We are going to go down a different path. And we have to go down that path quickly."
>
> - Gen. John Hyten, November 2017
> Vice Chairman of the Joint Chiefs of Staff (then Commander, U.S. Strategic Command)

The Warfighter Council

The Warfighter Council (WFC) provides critical insight for SDA to identify the warfighters' most immediate needs and align the capabilities planned for each tranche of the NDSA. Meeting twice a year, WFC membership includes SDA's customer—the combatant commands—as well as the Joint Chiefs of Staff, military services, defense agencies, and intelligence community organizations. The WFC provides expertise and recommendations on current and emerging operational challenges and the military threat environment to inform SDA's architectural development, prototyping, experimentation plans, and concept of operations.

SDA's Warfighter Integration Cell coordinates the WFC and manages SDA's participation in military exercises, providing opportunities for SDA to demonstrate capabilities included in the minimum viable product for each tranche. The spiral development model allows warfighter input to rapidly fine tune and refresh capabilities available on two-year cycles.

Warfighter Council Membership

Joint Chiefs of Staff
U.S. Africa Command
U.S. Central Command
U.S. Cyber Command
U.S. European Command
U.S. Indo-Pacific Command
U.S. Northern Command
U.S. Southern Command
U.S. Space Command
U.S. Special Operations Command
U.S. Strategic Command
U.S. Transportation Command
U.S. Army
U.S. Navy
U.S. Air Force
U.S. Marine Corps
U.S. Space Force
National Reconnaissance Office
National Geospatial Intelligence Agency
National Security Agency
Missile Defense Agency
Defense Advanced Research Projects Agency
Defense Intelligence Agency
Office of Under Secretary Defense for Intelligence

Engaged with the Warfighter

SDA is working with the Army on architectures to better integrate the sensor to the shooter. The Army's current doctrine increases artillery ranges to 400km and 1000km. To that end, SDA is working with both the Navy's Maritime Targeting Cell Afloat (MTC/A) and the Army's Tactical Intelligence Targeting Access Node (TITAN) programs to ensure these troops can receive sensor-to-shooter information for rapid/precise targeting with accelerated battle damage assessment.

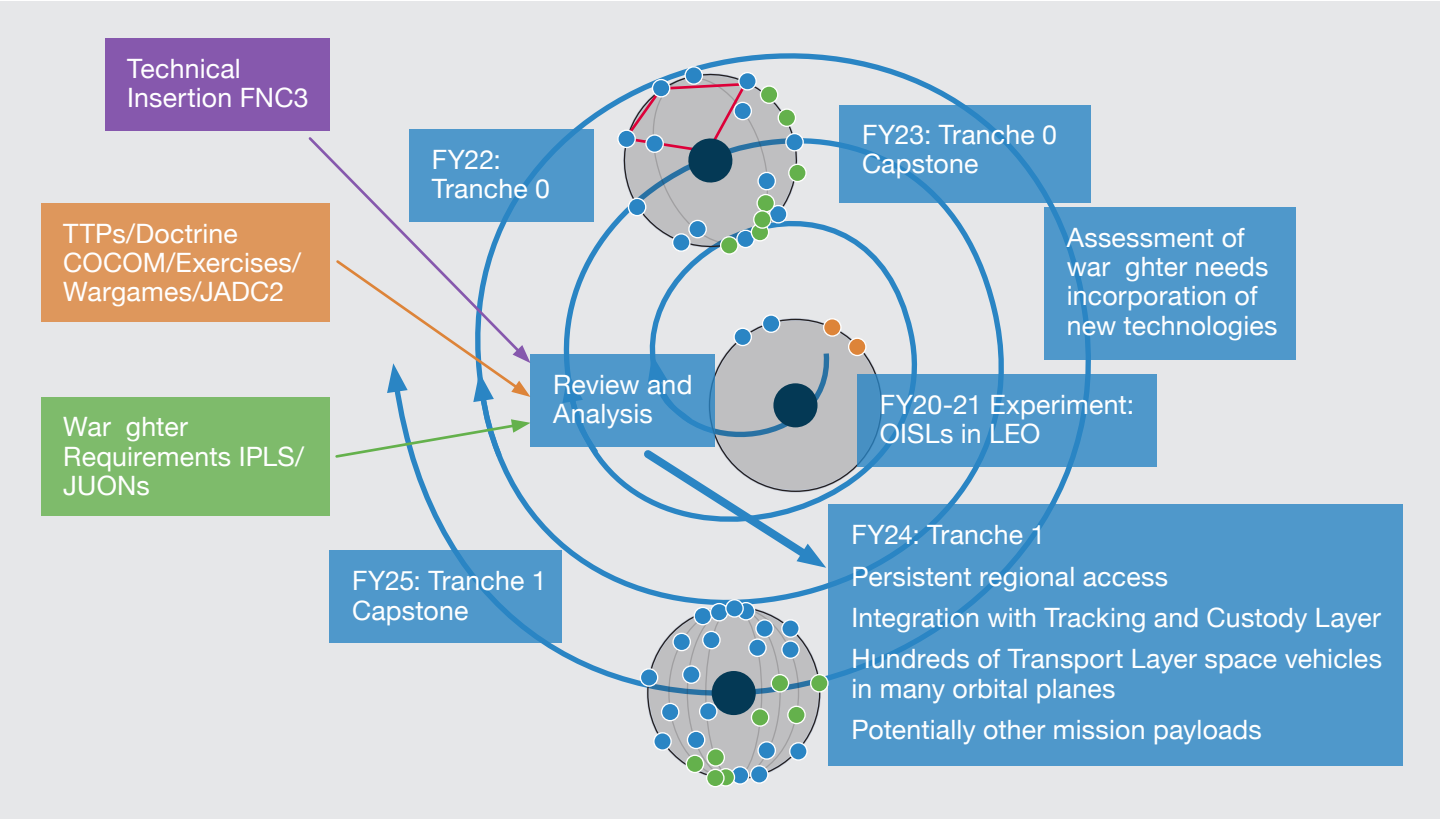
Two Pillars Approach

Proliferation

A proliferated constellation consists of many (hundreds or thousands, potentially) satellites affording resilience by providing capabilities that cannot be compromised by disruption or defeat of a small number of assets. By employing such design principles as mesh networks, the NDSA is built to continue functioning in the event that individual nodes become unavailable. The satellites that comprise the NDSA are also smaller, cheaper, and quicker to deliver and replace than some of our exquisite defense space assets deployed in limited quantities.

Spiral Development

Every two years, SDA will deliver a minimum viable product on orbit—a new tranche or spiral—getting that capability into the hands of the warfighter beginning with Tranche 0. Spiral development is the process of incrementally delivering new capabilities. SDA is committed to delivering new defense space capabilities in two-year tranches—with each tranche improving upon the last—and informing the development of those capabilities with the latest available technology advancements and intelligence assessments. Spiraling also enables SDA plans and architecture designs to quickly pivot in response or even preemptively to advances in the threat.



Focus Areas

SDA's initial focus is on two critical capabilities. First, provide beyond-line-of-sight (BLOS) targeting for time-sensitive targets, or mobile targets on land or sea, and second, provide the same for advanced missiles in flight such as hypersonic glide vehicles. SDA wants to detect, track, calculate a fire control solution, and then provide those data directly to a weapons system. SDA can achieve all of that from space.

Beyond Line of Site Targeting

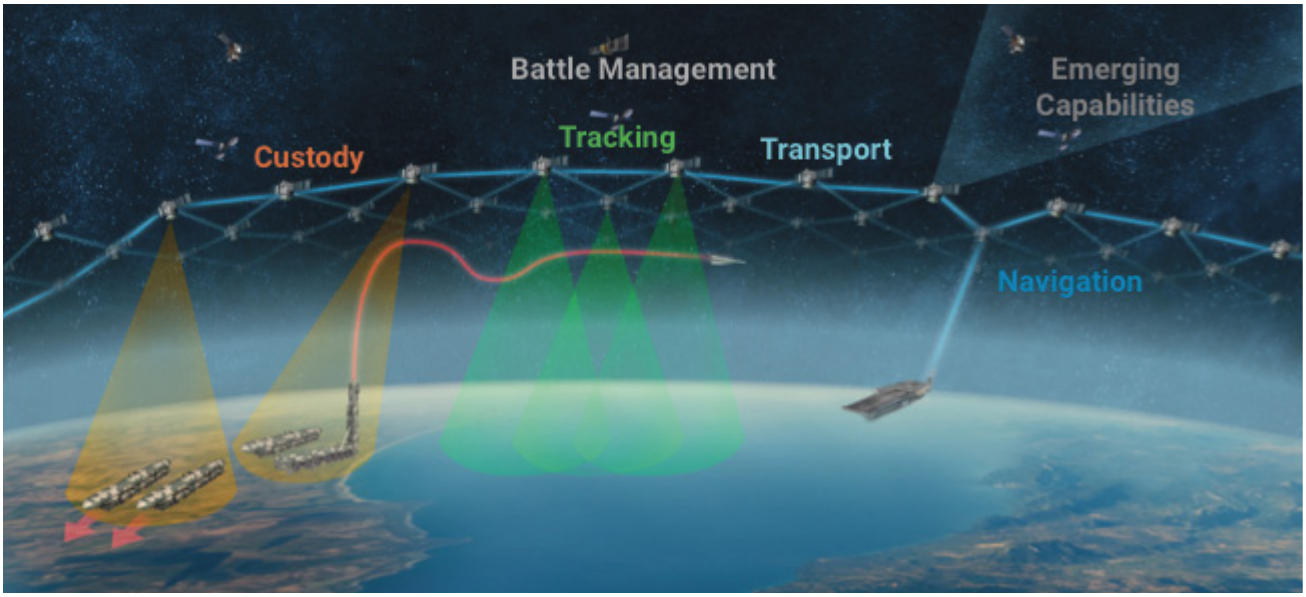
Hypersonic and Advanced Missile Threat Targeting

How Does SDA Fit In?

SDA's focus is on delivering the National Defense Space Architecture (NDSA) on a two-year spiral development model beginning with our inaugural tranche in fiscal year 2022. DARPA and the Space Rapid Capabilities Office develop leap-ahead technologies that might enable the capabilities brought to the warfighter through the NDSA. SDA in partnership with these organizations to potentially transition their technologies into further development and fielding. The Space Systems Center (SSC) works to deliver many of the space-based systems on which the joint warfighter relies today. SDA is working closely with SSC to ensure the NDSA complements those systems and shares common resources, such as ground architecture and launch services, where feasible.

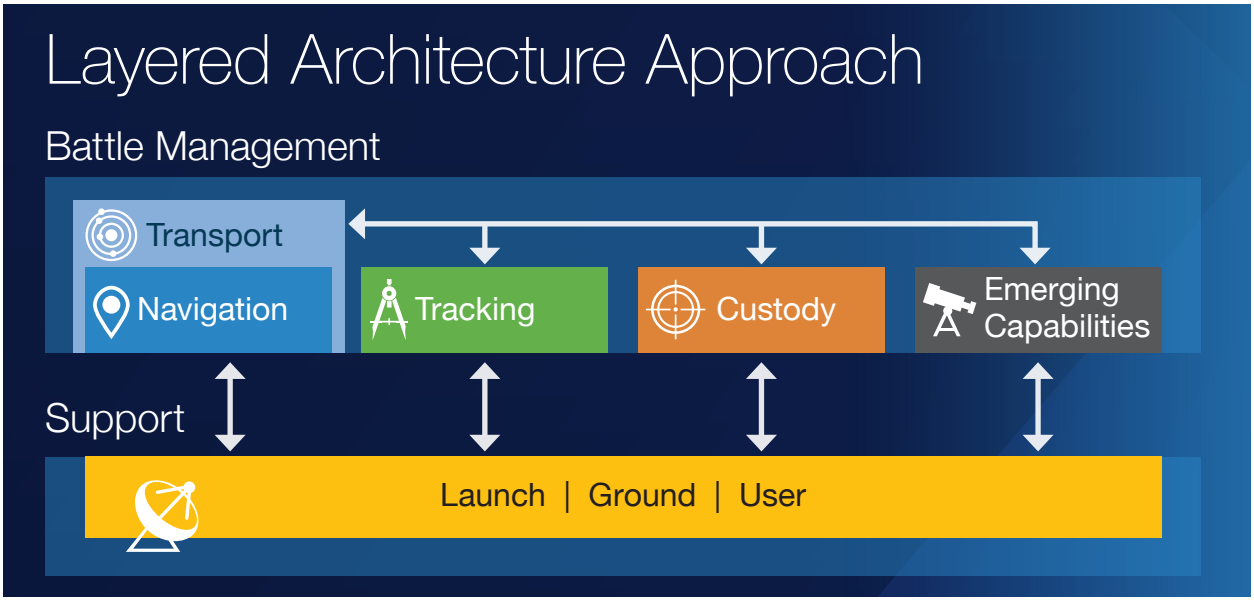
Layered Architecture Approach

A "layer" in SDA's NDSA is a particular function of the architecture that delivers or enables a warfighting capability. Not every layer will have a dedicated constellation of satellites. Some layers will deliver capabilities with sensors, processors, or other technologies hosted on another layer's satellites.



SDA envisions this architecture in order to assure, resilient, low-latency military data and connectivity worldwide to the full range of warfighter platforms. Providing architecture tasking, mission command and control, and data dissemination to support time-sensitive kill chain closure at campaign scales.

The functional block diagram on the following page illustrates how layered capabilities will interact. Each block represents an independent constellation of sensors or functions that fit together in the NDSA.



Transport Layer

The Transport Layer provides the backbone tying everything together. It comprises a mesh network of hundreds of satellites, all optically interconnected, that provide a low-latency data communication system. It also provides connectivity directly down to existing, tactical data links such as Link 16.

Navigation Layer

SDA's Navigation Layer will produce alternate positioning, navigation, and timing (PNT) for potential Global Positioning System (GPS)-denied environments. As the Navigation Layer resides inside the Transport Layer, users can calculate precise time and location of the mesh network of satellites. The network then sends that data down as a navigation message over existing tactical data links. In essence, warfighters can access an alternative PNT signal for those users on our network.

The real power for the warfighter will come when we put sensor data on top of the mesh network. The sensing layers (Tracking, Custody, and Emerging Capabilities) will feed data into the Transport Layer.

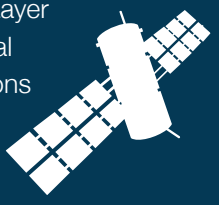
Tracking Layer

SDA's Tracking Layer will provide global indications, warning, tracking, and targeting of advanced missile threats, including hypersonic missile systems, from LEO. This capability encompasses space-based sensing, as well as algorithms, novel processing schemes, data fusion across sensors and orbital regimes, and tactical data products able to be delivered to the appropriate user.

Custody Layer

The Custody Layer refers to “target custody” and constitutes our intelligence, surveillance, and reconnaissance (ISR) function focused on deriving weapons-quality geolocations and tracks. The layer provides the ability to detect and track time-sensitive mobile targets on the Earth’s surface and at sea from LEO. The Custody cell is working with the military services on decreasing the timeline needed to address TST/TCT. All of this data feeds into the Custody function where the Naval Integrated Fires Element (NIFE) partner provides the central operational component.

Working with Industry

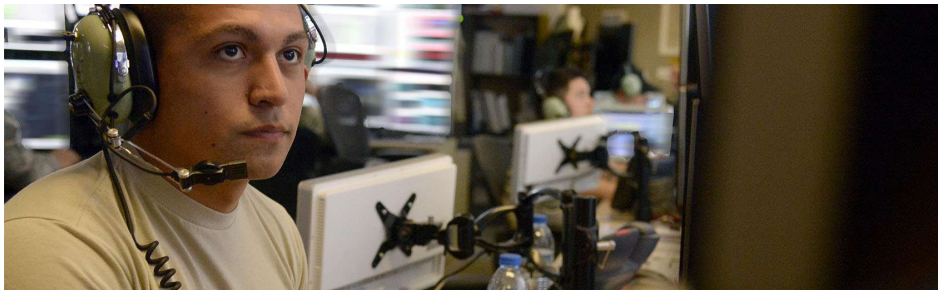


The vision for the Custody Layer includes a mix of commercial applications and constellations in addition to government-owned and operated ISR constellations. Fusing data from commercial imagery satellites into the Custody Layer would enable geolocations and tracks to engage targets beyond the range of direct line of sight of sensors used by a military unit’s organic ISR.

Emerging Capabilities

SDA’s Emerging Capabilities cell will provide a foundation for new mission concepts. In Tranche 1, this cell will establish the Partner Payload Program to host sensors and other payloads from partner organizations to explore their capabilities and interactions aboard the Transport Layer. This layer includes any spiraling capabilities that may be leveraged in future tranches such as space situational awareness and environmental monitoring developments.

Battle Management Layer



SDA's Battle Management Layer will ultimately provide automated space-based battle management through command and control, tasking, mission processing, and dissemination to support time-sensitive kill chain closure to the warfighter, wherever they are in the world. Most importantly, data must get to the Transport Layer, so it can be fused and further disseminated out to the warfighter at the tactical edge. All onboard processing, real-time algorithms that enable data fusion, automatic target recognition, and network management, occurs in the Battle Management Layer. The federated layer can run on all of the NDSA satellites, but primarily will reside within the Transport satellites, using cloud processing to enable real-time computation.

Support Layer

SDA's Support Layer will enable ground systems and launch capabilities to support a responsive and resilient space architecture. This layer provides a common, resilient ground support infrastructure necessary to underpin the space-based capabilities of the other layers to transmit, receive, process, exploit, and disseminate data.

Delivering Capability Through Tranches

Tranche 0

Tranche 0 serves as our WARFIGHTER IMMERSION tranche, affording the Combatant Commands the ability to see the data, understand what proliferated LEO can provide for their situation, and allow them to start to develop their plans around access to those data. Tranche 0 is scheduled for delivery in fiscal year 2022—the minimum viable product will demonstrate the feasibility of the proliferated architecture toward necessary performance for BLOS targeting and advanced missile detection and tracking.

Developing Technology

SDA has placed a vendor under contract to integrate an optical link into an unmanned aerial vehicle. This will deliver rapid sensor-to-shooter capabilities and provide significant improvement in the ability to prosecute time-sensitive or time-critical targets (TST/TCT).

Tranche 1

Tranche 1 delivers our INITIAL WARFIGHTING CAPABILITY from the NDSA and is scheduled for FY 2024. This tranche will provide regional persistence for tactical data links, advanced missile detection, and BLOS targeting. Tranche 1 will have enough satellites to provide persistence over a given region of interest and can support a fight in different regions. Tranche 1 also supports the Partner Payload Program to facilitate demonstration of emerging capabilities.

Tranche 2

Tranche 2, scheduled for FY 2026, will provide GLOBAL PERSISTENCE for all capabilities in Tranche 1 with hundreds more satellites on orbit. The tranche will incorporate lessons learned from operating Tranche 0 for at least two years. Additional weapons links will also be added to Tranche 2.

Tranche 3

Tranche 3 is scheduled for FY 2028, Tranche 3 will yield ADVANACED IMPROVEMENTS over Tranche 2. Those planned improvements include better sensitivity for missile tracking, better targeting capabilities for BLOS, additional PNT capabilities, advanced blue/green lasercom, and protected RF communications. Based on the spiral model, Tranche 3 includes new technology developed since Tranche 1, and addresses risks in the 2028 timeframe.

Tranche 4

Tranche 4 is scheduled for FY 2030 and beyond. Every two years, new technology is fielded, more satellites are fielded, or replenished and adjusted based on threat and need.

Tranche Timeline

The real power for the warfighter will come when we put sensor data on top of the mesh network. The sensing layers (Tracking, Custody, and Emerging Capabilities) will feed data into the Transport Layer.

DATA AND COMM TRANSPORT	ADVANCED MISSILE TRACKING	CUSTODY	NAVIGATION
RISK REDUCTION DEMO (FY 2020-2021)			
Demonstrate very low latency data transport, to include optical satellite crosslink and direct downlink.	Flight experiment to collect data in wavebands of interest at LEO.	Identify and assess candidate multi-phenomenology fusion algorithms. Use commercial data and algorithms to test T0 on-orbit processors.	Demonstrate dissemination of PNT information over Tactical Data Link (TDL).
TRANCHE 0 CAPABILITY (FY 2022)			
Periodic Regional Access • Low-latency data connectivity • Data directly to weapons • Data disseminated to theater targeting cells	**Periodic Regional Access** • For detection and tracking of HGVs • HBTSS flight for targeting quality data in FY 2023	Demonstrate multi-phenomenology, ground-based sensor fusion and as a goat demonstrate on-orbit fusion capability assisted by ground processing.	Periodic regional access of alternate PNT.
TRANCHE 1 CAPABILITY (FY 2024)			
Persistent Regional Access • Low-latency data connectivity • Data directly to weapons • Data disseminated to theater targeting cells	**Limited Global Access Capability** • For detection and tracking of HGVs & other advanced missile threats • Targeting quality data CURRENTLY UNFUNDED	Periodic regional access with multiple sensing types using mission partner contributions and demonstrate multi-phenomenology, on-orbit sensor fusion.	Persistent regional access of alternate PNT.

Acquiring Capabilities at Speed

- Awarded over $931 million in contracts in FY 2021 for future space capability, despite COVID 19 restrictions for much of 2020.
- SDA released nine solicitations including Requests for Proposals (RFP) and Broad Agency Announcements (BAA).
- The average time from draft RFP to final award was approximately 120 days.
- The agency's first set of satellites were delivered ready-for-launch nine months after appropriated funds became available.

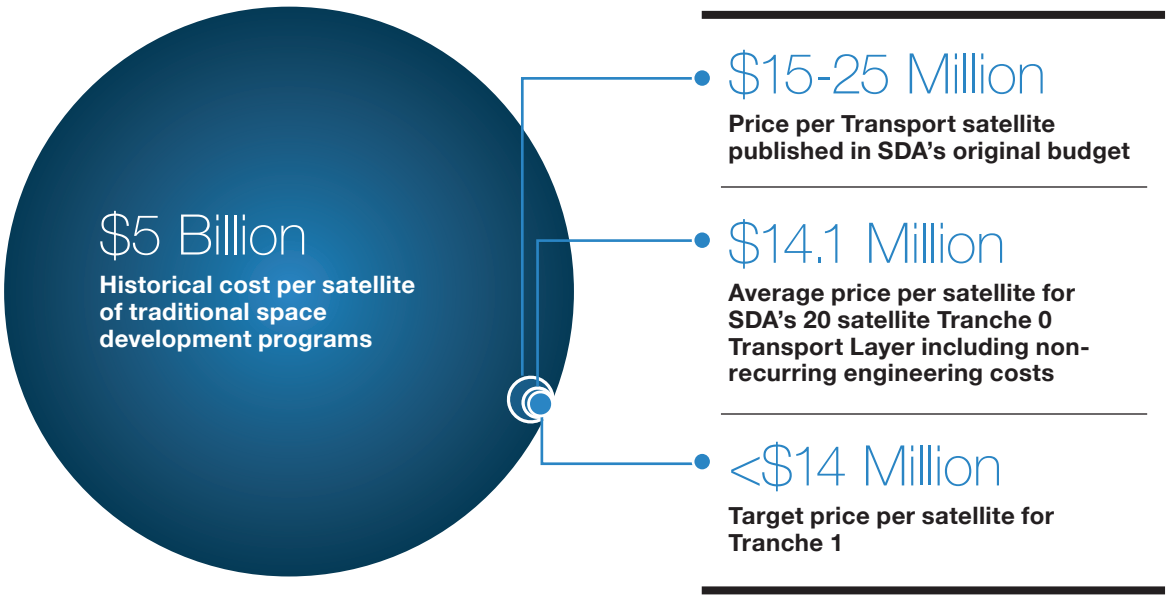
Delivering Capabilities at an Affordable Cost

To date, SDA has awarded all of the contracts required to build out Tranche 0 resulting in recognition around DoD as a real "change agent". The Tranche 0 satellites' price points demonstrate SDA can deliver the NDSA at an affordable cost, positioning SDA on target to reduce the cost per satellite as SDA moves toward acquiring approximately 150 more satellites in Tranche 1. Feedback from industry affirms that by buying more satellites in future tranches, SDA can push the price down significantly lower than the cost in the current contracts.


SPACENEWS

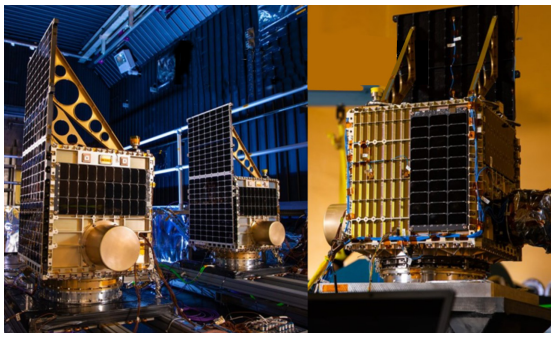
SPACE DEVELOPMENT AGENCY PRAISED AS CHANGE AGENT IN PENTAGON PROCUREMENT

Commercial innovation and industry are pushing not only pushing down the cost of these satellites, but also reducing the cost of launch. SDA will continue to partner with industry; finding ways to drive down price and drive up manufacturability so we can continue to push proliferation and spiral development.



Risk Reduction Experiments

Transport Layer



Mandrake II

- A collaborative risk reduction experiment by SDA, DARPA, and AFRL to demonstrate and characterize optical intersatellite links (OISL) in LEO.
- Demonstrations will also include connectivity to a ground station and an airborne asset.
- Satellite bus developed by Astro Digital and OISL terminals by SA Photonics.
- Launched June 30, 2021.

The Laser Interconnect and Networking Communication System (LINCS)

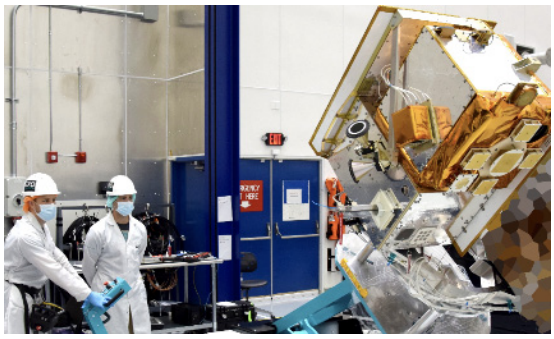
- A series of in-flight OISL demonstrations by SDA and General Atomics Electromagnetic Systems.
- Launched June 30, 2021.

Tracking Layer

Prototype Infrared Payload (PIRPL)

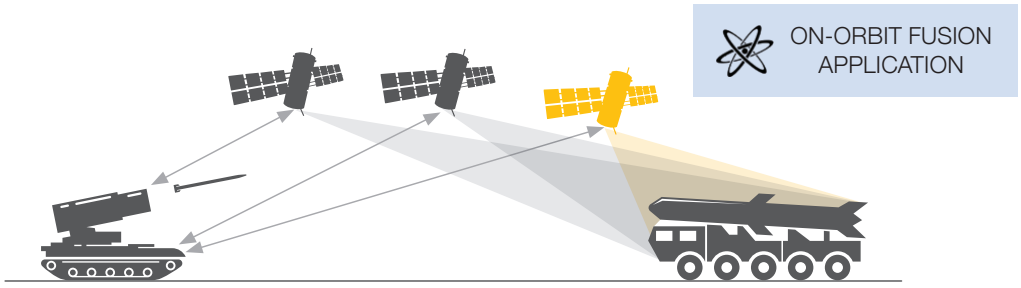
- SDA and MDA funded experiment to perform IR spectral exploration of the atmosphere in bands of interest.
- Payload flew on Cygnus International Space Station resupply mission to collect LEO scene data and is currently docked at the International Space Station.
- Launched in August 2021.

Custody Layer



Prototype On-Orbit Experimental Testbed (POET)

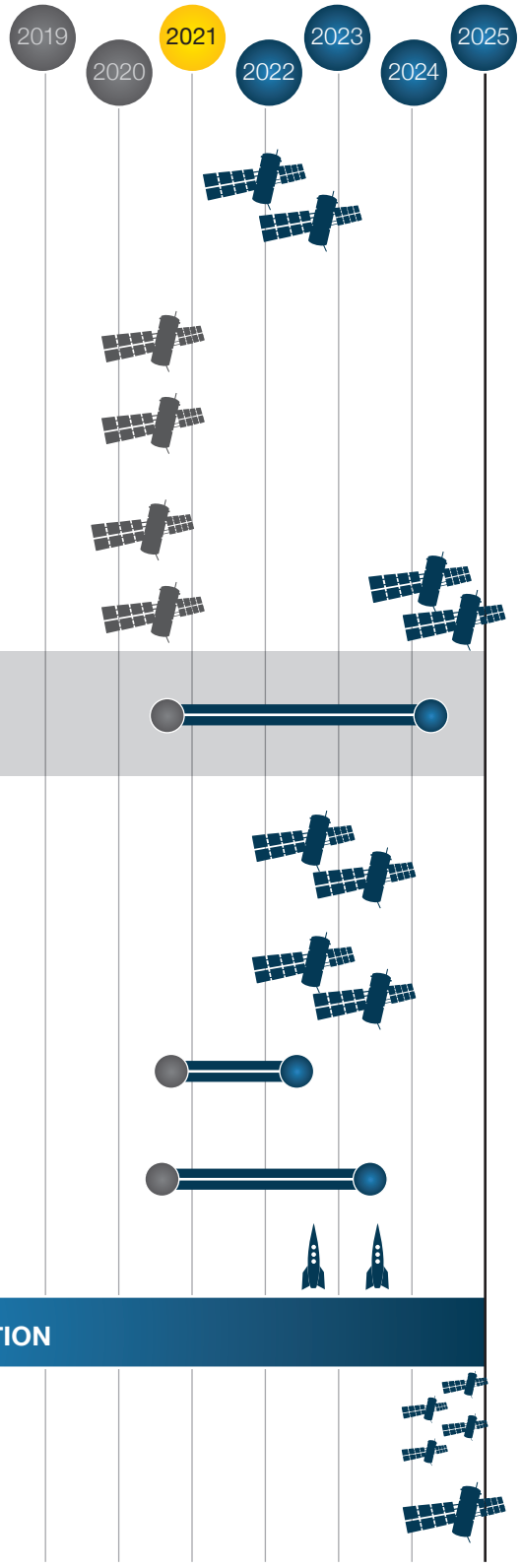
- On-orbit data fusion demonstration by Scientific Systems Company, Inc.
- Multi-INT fusion application in a modular and upgradable mission software suite integrated on Loft Orbital's YAM-3 satellite.
- Launched in June 2021.



SpaceX Transporter-2 rocket prepares for launch at Cape Canaveral Space Force Station, Florida. Photo credit: SpaceX.

High-Level Schedule

	Program/ Demo Name	Principal USG Organization	Principal Vendor(s)
EXPERIMENTS AND PROTOTYPES	Blackjack Demos	DARPA	SEAKR, SA Photonics, RTX, BCT, LM
	PIRPL	SDA/MDA	Northrop Grumman
	Mandrake II	SDA/DARPA/ AFRL	Astro Digital, SA Photonics
	LINCS	SDA	General Atomics
	XVI	SDA/AFRL	Viasat
GROUND SUPPORT CAPABILITIES	CASINO/ MDP	SSC	MSFT, Ball Aerospace
TRANCHE 0 *Limited Operational Capability/ Architecture Demonstration*	Tranport Layer	SDA	Lockheed Martin, York Space Systems
	Tracking Layer	SDA	SpaceX, L3 Harris
	MSE&I	SDA	Perspecta/ Peraton
	Ground Segment	SDA	NRL
	Launch	SDA	SpaceX
ARCHITECTURE ADOPTION			
TRANCHE 1 *Initial Capabilities/ Regional Persistence*	Transport Layer	SDA	TBD
	Tracking Layer	SDA	TBD



CASINO = Commercially Augmented Space Inter Network Operations
LINCS = Laser Interconnect and Networking Communication System
MDP = Mission Data Processor
MSE&I = Mission Systems Engineering & Integration
PIRPL = Prototype Infrared Payload
WFOV = Wide Field of View

Small Business Opportunities

- Space-based environmental and weather monitoring
- Target recognition algorithms for OPIR sensors
- Free-space optical communication technology for optical inter-satellite link (OISLs)
- L-Band multiband/Interleaved electronically scanned array antenna
- Mesh network NSA-certifiable cryptographic solution
- Advanced space mesh networking

Follow SDA on BetaSam.gov, visit sda.mil/opportunities/ and check us out on LinkedIn for updates.

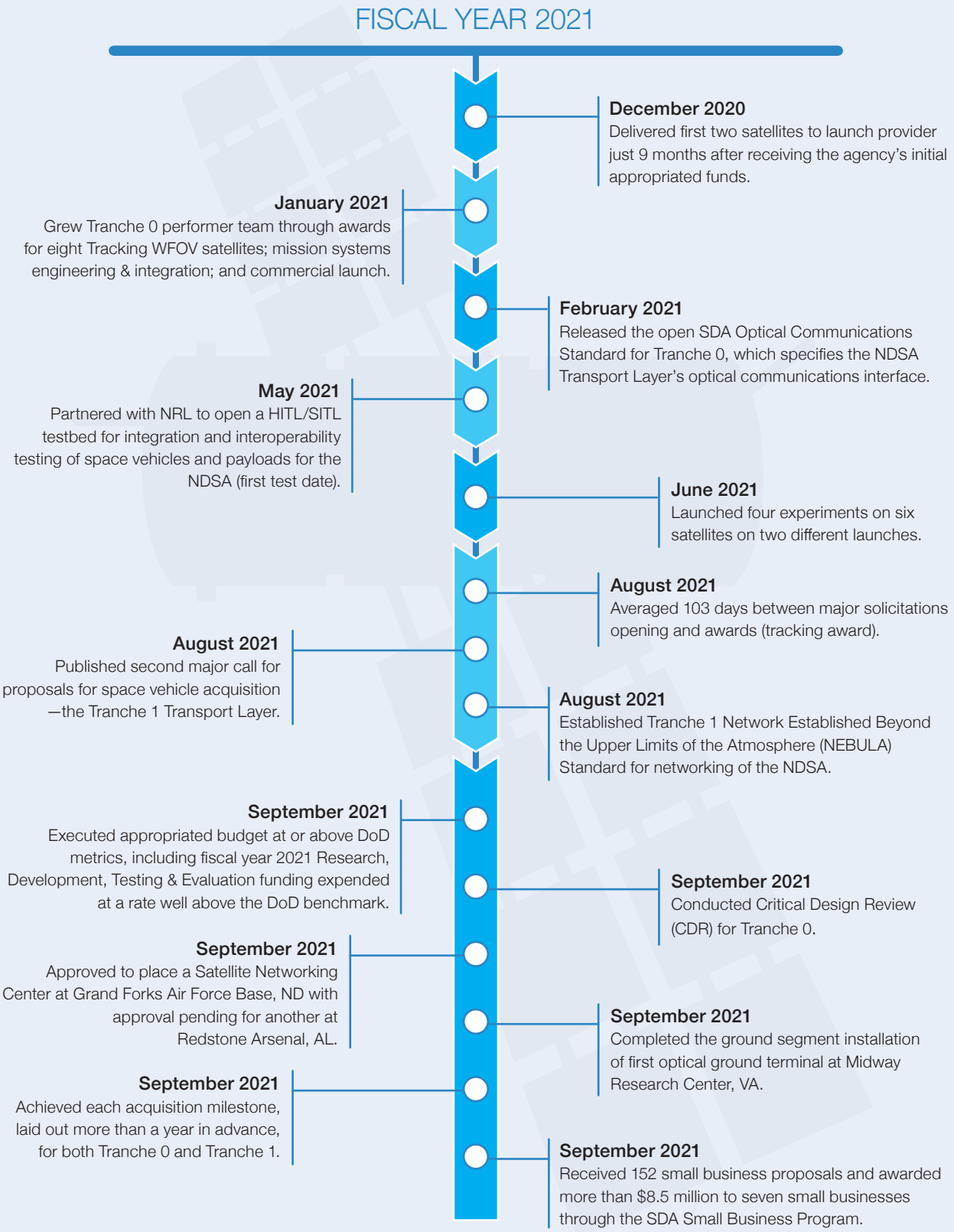
Addressing National Security Challenges

SDA is focused on:

- ☑ **Increasing warfighting effectiveness:** SDA Transport layer reduces latency and is the key space element of the JADC2.
- ☑ **Enhancing resilience:** The NDSA proliferated mega-constellation affords resiliency through numbers and cost imposition on the adversary.
- ☑ **Leveraging commercial technology and innovation:** SDA is investing in new space:
  - TRANSPORT: York Space Systems and Tyvak
  - TRACKING & LAUNCH: SpaceX
- ☑ **Rapidly responding to future threats:** SDA's spiral development model provides faster capability deployment, ongoing refresh, and the ability to pivot should there be a change in the threat.

Cygnus NG-16 spacecraft, on an Antares launch vehicle, lifts off from the Mid-Atlantic Regional Spaceport's pad 0A at NASA's Wallops Flight Facility, Wallops Island, Virginia carrying the Prototype Infrared Payload (PIRPL) experiment among other payloads. Photo credit: NASA

SDA's FY 2021 Accomplishments



Semper Citius – Always Faster

We understand the great depth of knowledge and thought needed to realize the proliferated space architecture in LEO concept. We understand the deep impact this architecture will have on our national security. We understand how advances in commercial developments have now made this technically accessible. We understand how important this mission is for the warfighter. Finally, we understand that we have a lot of brilliant people working at SDA to make this a reality and we are fortunate to be able to tap into top talent in the military services and elsewhere in the government.

If you are interested in joining our fast-moving team, please visit our website at sda.mil and follow us on LinkedIn.

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