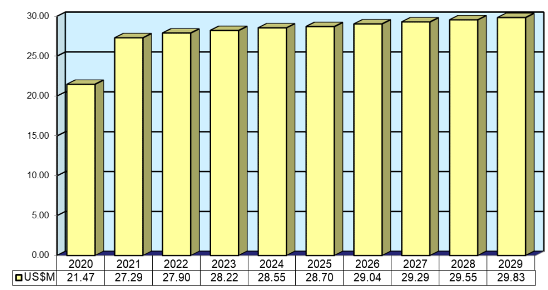
S3I Technology

Outlook

- Approximately $280 million will be invested in the subprojects that were derived from the S3I Technology program from 2020 through 2029
- In its FY20 budget, the Army reprogrammed all S3I Technology activities into new start programs, where they were combined with related subprojects
- Subprojects derived from the S3I Technology program will remain well-funded by the U.S. Army long into the future, with broad approval from legislators

Funding Forecast 2020-2029



Orientation

Description. The U.S. Army's S3I Technology project funded research, design, test, and evaluation of advanced sensor components, signal processing systems, and information algorithms that provided new capabilities to locate, identify, and engage battlefield targets in tactical environments.

The S3I Technology project's focus included electro-optics, radar, and robotics. The project was designed to complement other Army RDT&E programs.

For its FY20 budget, the U.S. Army reprogrammed S3I Technology project efforts into new start RDT&E projects. The new projects are more tightly focused on individualized research, combining subprojects from throughout the budget that align with a common goal.

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Status. Research, development, test, and evaluation.

Application. The S3I Technology project was purely an RDT&E effort to increase the lethality, range, and speed of soldier engagements. Real-world applications included the development of novel materials, electro-optic and radar emitters, sensors, signal processors, vehicle technologies, and robotics.

Contractors

Contractor(s) not selected or not disclosed.

Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; rich.pettibone@forecast1.com

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Technical Data

The S3I Technology project is part of Program Element #0602120A – Sensors and Electronic Survivability. For the FY20 budget, the U.S. Army reprogrammed all S3I Technology project activities into a wide assortment of new start projects, combining disparate subprojects from other RDT&E projects therein.

As of 2019, S3I Technology subprojects included the following:

Laser Protection Technologies (previously known as Networked Compact Radar, Wide Bandgap Optoelectronics, and Laser Protection Technologies). The Laser Protection Technologies subproject develops new materials and devices to protect sensing and vision through optical sights from laser threats, such as high-power continuous wave and ultrashort (femtosecond) pulsed lasers. Passive organic and inorganic optical limiting materials are researched for visible and short-wave infrared (SWIR) spectrum operations, as are active man-made materials for uncooled sensor and long-wave infrared (LWIR) operations. Additionally, the vulnerability of optical and other sensor systems to high-power and ultrashort pulsed laser threats is studied.

Multi-Mode Air Defense Radar. The Multi-Mode Air Defense Radar subproject researches technical challenges associated with air defense radar, including current and emerging RF spoofing, RF jamming, and RF signature management. Electromagnetic modeling, RF measurement, and experimental methods are used.

Networked Sensing and Data Fusion. The Networked Sensing and Data Fusion subproject assesses the linking of physical sensors and other information sources to soldiers and small units. Specifically, the research focuses on:

- Information distribution
- Interoperability and networking of previously unincorporated sensors and information sources
- Multimodal sensor fusion for the detection and classification of activity and of infrastructure such as chemicals, computers, machinery, personnel, RF emissions, and vehicles in confined or hidden locations
- Various approaches to integrate the results of processed sensor outputs, including acoustic, electric, and magnetic sensors and hyperspectral, infrared, and visible light imagers

Non-Imaging Intelligence, Surveillance, and Reconnaissance (ISR) Sensing. The Non-Imaging ISR Sensing subproject funds the design, development, and evaluation of technologies for multimodal, low-cost networked sensors. These sensors allow enhanced, persistent sensing capabilities to increase the probability and accuracy of target detection.

Multimodal sensor technologies include acoustic, electric and magnetic field, infrasound, passive RF, and seismic detectors. Combined, these sensors allow the detection of hostile electrical equipment, explosions, gunfire, underground facilities, vehicles, and weapons launch.

RF Sensing for Concealed / Low-Signature Threat Detection (previously known as Ultra Wideband [UWB] Radar). This subproject concerns the development of UWB radar and other active and passive radio frequency (RF) sensing technologies. These technologies support concealed and low-signature target detection of threats such as IEDs and landmines, UAVs, and other electronics. They also support detection in environments that require foliage penetration and through-wall sensing.

Specific areas of research include computational electromagnetic algorithms and models, radar measurement, signal processing, and, as mentioned above, active and passive RF sensing.

Program Review

For its FY20 budget, the U.S. Army dispersed all subprojects in the S3I Technology project to a wide assortment of new start projects, combining subprojects with those of other RDT&E projects.

For historical record, below are details on the progress made under the identified S3I Technology subprojects as of 2019.

Laser Protection Technologies (previously known as Networked Compact Radar, Wide Bandgap Optoelectronics, and Laser Protection Technologies). In FY11, this subproject applied RF biometric algorithms to an unattended compact radar for perimeter watching as part of a larger unmanned ground system network.

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From FY12 through FY13, new methods for moving target classification based on micro-Doppler analysis were developed. Also explored was the phenomenology and image processing technologies associated with sub-millimeter-wave imaging of human-borne improvised explosive devices (IEDs).

Software and hardware architectures were created in FY14 to enable compact radars to network with unattended ground sensors, and in FY15, ways to protect sensors – and eyes – from ultrashort pulses and near-IR high-power threats were studied.

In FY16, Laser Protection Technologies funded the investigation of active long-wavelength protection filters for use in uncooled infrared cameras and focal plane arrays to reduce their vulnerability to damage and "dazzle." Efforts in FY17 largely centered on research into advanced active protection techniques and new nonlinear optical materials based on the results of bipyridine and iridium dye experiments.

During FY18, the Laser Protection Technologies subproject investigated the use of short-pulsed or femtosecond optical limiting materials to prevent sensor damage and determine if some of the destructive effects of these types of pulses could be mitigated. Additionally, solid material limiters for microsecond and nanosecond threats were developed and tested, and then compared to the performance of liquid material limiters.

Plans for FY19 called for the improvement of a multi-chromophore, solid-state optical limiter based on previous experiments and the investigation of femtosecond limiter solutions in the mid-wavelength infrared (MWIR). Additional experiments to validate high-power continuous wave laser protection methods were to be conducted, with the combined result of these efforts to be designed to enable transmission of low light intensities while blocking laser radiation with high irradiance.

Multi-Mode Air Defense Radar. Beginning in FY15, the Multi-Mode Air Defense Radar subproject investigated current and emerging technologies across a broad RF spectrum, including those that may limit the performance of air defense radar systems.

Novel algorithms for integration on next-generation air defense radars, allowing the tracking of rockets, artillery, and mortar targets, were researched in FY16. The design and characterization of multiband elements with integrated front-end radar components, including amplifiers and mixers, were a key focus of FY17 efforts.

In FY18, electromagnetic modeling results were finalized and documented, and advanced circuit designs and cognitive algorithms were developed.

FY19's efforts focused on the adaptation of front-end RF technologies for the next generation of fire control radars.

Networked Sensing and Data Fusion. In FY11, the Networked Sensing and Data Fusion subproject exploited multimodal sensing and fusion concepts to characterize underground facilities, materiel, and tunnels. Employment of acoustic and seismic techniques to augment E-field subsurface imaging was added in FY12.

In FY13, the development and assessment of novel multimodal sensing and processing algorithms continued. In FY14, the subproject developed "pattern of life" algorithms and statistics to discriminate between potential threat activities and normal behavior.

In FY15, research was conducted into the implementation of anomaly detection algorithms by fusing the output of social networks with disparate multimodal sensors to determine patterns of behavior.

FY16 efforts looked into improving the capability to fuse relevant social media data with sensor data. The research into personnel and ground vehicle classification and anomaly determination algorithms using multimodal sensors to produce "robust," high-confidence reports was furthered in FY17, alongside research into how to classify "automatic" human and vehicle activity in full motion video (FMV) and wide area motion imagery (WAMI).

Subproject activities in 2018 included the development of distributed processing and fusion algorithms for shared decision-making and sensor interoperability and integration standards. Additionally, tools for creating and visualizing a multisensor 3D common operating procedure were developed, including multiple aerial and ground-based active and passive imaging sensors. Tools were also created for biometric and human activity recognition from video feed sources.

FY19 activities included the development of infrasonic classification methods and their integration with long-range sound propagation models. Algorithms to provide automated tipping and cuing of sensor arrays for the common operating picture were being developed, as were tools for creating and visualizing multisensor 3D COPs for real-time data geo-registration and fusion of heterogeneous data from multiple aerial and ground-based active and passive imaging sensors.

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Biometric and human activity recognition research and the investigation of social media evaluation techniques continued, incorporating methods of subjective logic Bayesian networks.

Non-Imaging Intelligence, Surveillance, and Reconnaissance (ISR) Sensing. Activities in FY11 included the continued enhancement of acoustic localization accuracy through meteorological correction of solution vectors. In FY12, new fusion techniques were investigated for enhanced discrimination between vehicles, humans, and animals.

The subproject continued to investigate, design, and code new algorithms and assess sensor performance in FY13, and in FY14, it evaluated the combined colocation of passive IR sensors in order to discriminate humans from animals with a high level of confidence.

Work on the exploitation of multimodal sensing, fusion, and sensor processing systems using static and mobile sensors and networked systems was conducted in FY15. In FY16, the subproject focused on developing acoustic, magnetic and electric field sensors and arrays for detection and location of threats in complex environments. This effort continued into FY17.

FY18 activities included the improvement of acoustic and infrasound sensors; an investigation of E/H fields from Earth, electrical equipment, and power lines; the development of E/H field sensors and algorithms; and optimization of the cost, power, size, and weight of monitoring nodes. Additionally, methods for providing lower Army echelons with persistent ISR and decision-making support capabilities were investigated, as were landing zone assessment techniques for SOCOM mobility.

Plans for FY19 called for the development of low-cost yet robust acoustic sensors in the 1-Hz to 10-kHz frequency band, sensor miniaturization and small arrays, novel wind noise reduction techniques, and new tools to calibrate and characterize quasi-static E/H field sensors for long-wavelength applications.

RF Sensing for Concealed / Low-Signature Threat Detection (previously known as Ultra Wideband [UWB] Radar). In FY11, the Ultra Wideband Radar subproject continued to investigate advanced IED-discrimination algorithms that exploit physics-based features to reduce false alarms in low-artifact radar imagery. Methods to utilize information embedded in low-frequency radar data for effective combination of interior building maps, moving target indication algorithms, and RF measurement and signature intelligence technology were investigated in FY12.

FY13 efforts were centered on building interior structure maps using radar data, and developing stationary target detection techniques using 3D computer-generated radar images In FY14, the subproject developed techniques to combine UWB radar with complementary sensors in order to improve the probability of detecting and confirming targets. FY15 saw the development of computational electromagnetic models to address new target deployments.

In FY16, the utility of combining forward-looking radar with EO/IR sensors was investigated to improve the standoff detection of explosive hazards and to reduce false alarm rates. In FY17, new UWB stepped frequency, radar standoff explosive hazard detection data set collection, and assessment methods were studied to address RF interference and self-interference in relevant environments, as well as for use in clutter mitigation.

Work in 2018 included the incorporation of passive RF sensing with UWB radar to improve the detection of electronic targets (such as radio-controlled triggers) combined with an assessment of combined forward-looking sensors. A lightweight, UAV-compatible RF sensor with the equivalent sensitivity of a vehicle-mounted stepped frequency radar was to be developed, and adaptive and learning electronic front-ends to incorporate UWB radar were to be investigated. Low-cost software-defined radio technology and 2D antenna arrays were to be utilized for detection, geo-location, and tracking of aerial and ground-based electronics threats.

For FY19, the RF Sensing for Concealed / Low-Signature Threat Detection subproject worked on reducing sensor size, including onboard signal processing for automatic detection and tracking, and investigated the benefits of cooperative RF sensing in complex environments. Also, processing constraints created in distributed sensing were assessed.

EO ISR Sensor Technology can be incorporated in U.S. Army systems like the RQ-7 Shadow TUAV.

Source: U.S. Army

Contracts/Orders & Options

Contracts for work conducted under the S3I Technology project were not publicly disclosed.

Timetable

Year	Major Development
FY08	The Sensor and Data Fusion subproject validates and integrates a hypermodal sensor testbed tailored for urban operations
FY09	Unattended Ground Sensors subproject introduced; it evaluates a combination of advanced imaging sensors for aided/automatic target recognition
FY10	Ultra Wideband Radar subproject introduced; devises "realistic" CAD models of rooms of high complexity
FY11	RF biometric algorithms introduced, applied to an unattended compact radar for perimeter watching
FY12	Networked Sensing and Data Fusion subproject introduced; employs acoustic and seismic techniques to augment E-field subsurface imaging
FY13	Adaptive Information Collection and Fusion subproject introduced; assesses cloud-based cellular architectures
FY14	Non-Imaging ISR Sensing subproject introduced; evaluates a combination of colocated passive IR sensors in order to discriminate humans from animals
FY15	Ultra Wideband Radar subproject introduced; investigates computational electromagnetic models to address newly deployed targets

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Year	**Major Development**
FY16	Networked Compact Radar, Wide Bandgap Optoelectronics, and Laser Protection Technologies subproject introduced; investigates active long-wavelength protection filters for uncooled infrared cameras and focal plane arrays to reduce their vulnerability to damage and dazzle
FY17	Multi-Mode Air Defense Radar subproject introduced; designs and characterizes multiband elements with integrated front-end radar components, including amplifiers and mixers
FY18	Networked Sensing and Data Fusion subproject introduced; works to develop tools for biometric and human activity recognition from video feeds
FY19	Multi-Mode Air Defense Radar subproject introduced; adapts front-end RF technologies for next-generation fire radars
FY20	All S3I Technology activities reprogrammed to various new start projects

Worldwide Distribution/Inventories

S3I Technology was a **U.S. Army** research, development, test, and evaluation project. Its activities have been reprogrammed to a number of other RDT&E projects.

Forecast Rationale

From 2020 through 2029, just over $279.8 million will be invested in the subprojects derived from the U.S. Army S3I Technology RDT&E program. The various subprojects will be fully funded throughout this period and well into the future.

In its FY20 budget, the Army spun off the S3I Technology's subprojects into a number of new start projects, where they were combined with other, subject-related subprojects. The budget reorganization was designed to bring subprojects that may have overlapping or synergistic purposes under a "common roof" where funds could be spent with a better focus on economy.

Technologies that were researched under the auspices of the S3I Technology program will remain relevant and necessary to enhance the Army's mission into the foreseeable future. This will result in legislative approval of the Army's funding requests well into the 2030s and beyond. While the S3I Technology program's specific technologies and research topics have been reorganized into new, more tightly focused R&D projects, the real-world gains derived from the program's activities will be perennial and retain a permanent place in the Army's planning.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR RDT&E FUNDING (in millions US$)

Designation or Program		High Confidence				Good Confidence			Speculative			
	Thru 2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	Total
MFR Varies												
S3I Technology <> United States <> Army												
	300.23	21.47	27.29	27.90	28.22	28.55	28.70	29.04	29.29	29.55	29.83	279.83
Total	300.23	21.47	27.29	27.90	28.22	28.55	28.70	29.04	29.29	29.55	29.83	279.83